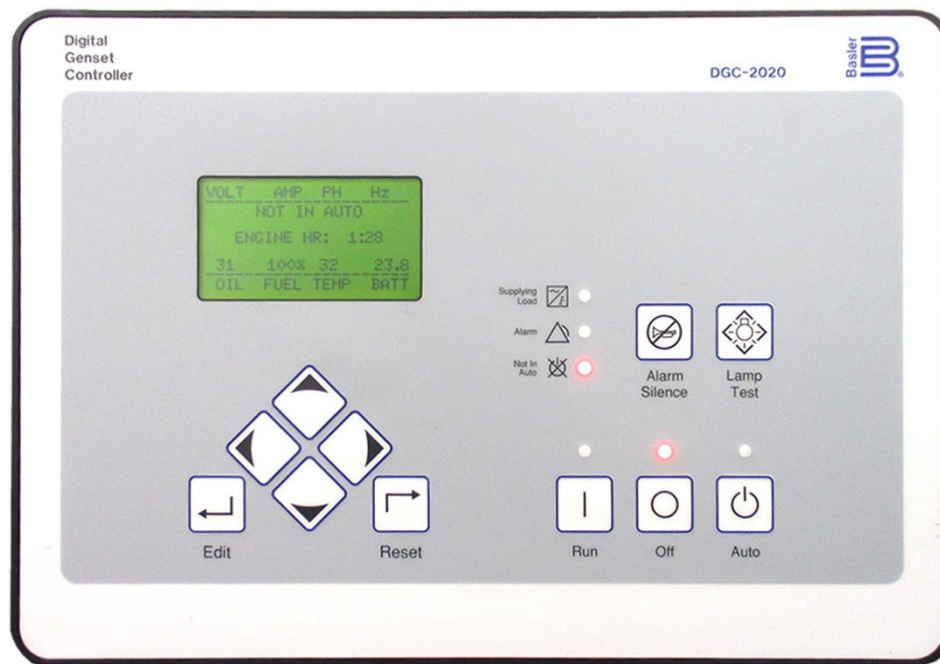




# DGC-2020

## Digital Genset Controller

*Instruction Manual*  
(Firmware Version 3.XX.XX)



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# Preface

This instruction manual provides information about the installation and operation of the DGC-2020. To accomplish this, the following information is provided:

- General information and specifications
- Functional description
- Software and programming
- Setup and installation

## ***Conventions Used in this Manual***

---

Important safety and procedural information is emphasized and presented in this manual through warning, caution, and note boxes. Each type is illustrated and defined as follows.

### **Warning!**

Warning boxes call attention to conditions or actions that may cause personal injury or death.

### **Caution**

Caution boxes call attention to operating conditions that may lead to equipment or property damage.

### **Note**

Note boxes emphasize important information pertaining to installation or operation.



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### Warning!

READ THIS MANUAL. Read this manual before installing, operating, or maintaining this equipment. Note all warnings, cautions, and notes in this manual as well as on the product. Keep this manual with the product for reference. Only qualified personnel should install, operate, or service this system. Failure to follow warning and cautionary labels may result in personal injury or property damage. Exercise caution at all times.

### Caution

Installing previous versions of firmware may result in compatibility issues causing the inability to operate properly and may not have the enhancements and resolutions to issues that more recent versions provide. Basler Electric highly recommends using the latest version of firmware at all times. Using previous versions of firmware is at the user's risk and may void the warranty of the unit.

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It is not the intention of this manual to cover all details and variations in equipment, nor does this manual provide data for every possible contingency regarding installation or operation. The availability and design of all features and options are subject to modification without notice. Over time, improvements and revisions may be made to this publication. Before performing any of the following procedures, contact Basler Electric for the latest revision of this manual.

The English-language version of this manual serves as the only approved manual version.



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### Notes

DGC-2020 controllers are mounted using the four permanently-attached 10-24 studs and the provided self-locking nuts. Failure to use the proper 10-24 locking nuts may damage the stud threads and/or improperly secure the DGC-2020.

Be sure that the controller is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the chassis ground terminal on the rear of the unit. When the controller is configured in a system with other devices, it is recommended to use a separate lead to the ground bus from each unit.

The DGC-2020 utilizes password protection that guards against unauthorized changing of DGC-2020 settings. Instructions for changing passwords are provided in Section 4, *BESTCOMSPPlus® Software, General Settings, Device Security Setup*. The default passwords are listed below.

- OEM access level: **OEM**
- Settings access level: **SET**
- Operator access level: **OP**



# Revision History

A historical summary of the changes made to this instruction manual is provided below. Revisions are listed in reverse chronological order.

Visit [www.basler.com](http://www.basler.com) to download the latest hardware, firmware, and BESTCOMSPlus® revision histories.

## Instruction Manual Revision History

| Manual Revision and Date | Change                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| H, Mar 2026              | <ul style="list-style-type: none"> <li>Added settings for Woodward PG Plus Gas engines.</li> <li>Replaced Table 3-3, <i>J1939 Data Transmitted from the DGC-2020</i>.</li> <li>Added secondary Engine ECU settings.</li> <li>Added Accelerator Pedal Counter and Accelerator Pedal Checksum settings.</li> <li>Added ECU Pre-Alarms section.</li> <li>Added Engine RPM description.</li> <li>Added Meter settings description.</li> <li>Added list of selectable parameters for Remote Analog Outputs and Configurable Protection.</li> <li>Added Trip Reset Active, Generator Alternate Rated kW Selection, and Mains Fail Transfer Timer Bypass logic elements.</li> <li>Added all J1939 diagnostic trouble codes in Appendix F.</li> <li>Moved J1939 parameters received to new Appendix G.</li> <li>Added Modbus Coils Appendix H.</li> <li>Updated Modbus register tables.</li> <li>Minor text edits throughout manual.</li> </ul> |
| G, Jan 2025              | <ul style="list-style-type: none"> <li>Updated China RoHS table in General Information, CEM-2020, and AEM-2020 sections.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| F, Sep 2024              | <ul style="list-style-type: none"> <li>Added FCC requirements.</li> <li>Updated LCD heater description.</li> <li>Removed EAC mark.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| E, Aug 2023              | <ul style="list-style-type: none"> <li>Added China RoHS for the DGC-2020, CEM-2020, and AEM-2020.</li> <li>Removed BESTCOMSPlus activation requirements.</li> <li>Added information on generator and bus status conditions.</li> <li>Updated Control Panel Metering description.</li> <li>Minor text edits throughout manual.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| D, Nov 2022              | <ul style="list-style-type: none"> <li>Added settings and metering for Deutz ECU type.</li> <li>Other text edits throughout manual.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| C, Dec 2021              | <ul style="list-style-type: none"> <li>Updated to support DGC-2020 firmware version 3.21.00 and BESTCOMSPlus version 5.02.00:             <ul style="list-style-type: none"> <li>Added Fuel Level % setting description</li> <li>Added Engine Run Time Source setting description</li> <li>Added CAN Start/Stop Configuration setting description</li> <li>Added Minimum Crank Time setting description</li> <li>Updated Exercise Timer description</li> <li>Updated ATS description</li> <li>Updated Battle Override description</li> <li>Updated settings and metering screenshots</li> <li>Added new Modbus registers</li> </ul> </li> <li>Removed Hazardous Location specs from the LSM-2020 and AEM-2020.</li> <li>Added UKCA Compliance for AEM-2020 and CEM-2020.</li> <li>Added Maritime Recognition for AEM-2020 and CEM-2020.</li> <li>Updated SPN 3701 and 3703 descriptions in Exhaust Treatment section.</li> </ul>        |

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|              | <ul style="list-style-type: none"><li>• Updated Typical Applications drawings.</li><li>• Other minor text edits throughout manual.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                   |
| B2, Sep 2021 | <ul style="list-style-type: none"><li>• Removed CSA compliance from DGC-2020.</li><li>• Added UKCA compliance for DGC-2020.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                          |
| B1, Jul 2021 | <ul style="list-style-type: none"><li>• Removed Hazardous Location specs from the DGC-2020 and CEM-2020.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| B, Oct 2019  | <ul style="list-style-type: none"><li>• Removed Rev Letter from all pages.</li><li>• Removed firmware and hardware revision histories from Introduction.</li><li>• In Section 1, updated Note 1 in Style Chart.</li><li>• In Section 4, updated operating system requirements, added Setting Entry section, modified description of Engine Control Parameter Transmit, updated description of Battle Override, and added notes about BESTCOMSP<i>Plus</i> version 4.xx.xx.</li><li>• In Appendix B, added notes about registers 45106 through 45168.</li></ul> |
| A1, Apr 2019 | <ul style="list-style-type: none"><li>• Added Proposition 65 statement.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| A, Oct 2018  | <ul style="list-style-type: none"><li>• Minor text edits.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| —, Jul 2018  | <ul style="list-style-type: none"><li>• Initial release.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

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# 1 • General Information

The DGC-2020 Digital Genset Controller provides integrated engine-genset control, protection, and metering in a single package. Microprocessor based technology allows for exact measurement, setpoint adjustment, and timing functions. Front panel controls and indicators enable quick and simple DGC-2020 operation. Basler Electric communication software (BESTCOMS*Plus*®) allows units to be easily customized for each application. Because of the low sensing burden in the DGC-2020, dedicated potential transformers (PTs) are not required. A wide temperature-range liquid crystal display (LCD) with backlighting can be viewed under a wide range of ambient light and temperature conditions.

## Hardware Versions

This instruction manual covers hardware version 3 of the DGC-2020. For hardware versions 1 and 2, refer to Basler Instruction Manual 9400200990. Differences between hardware versions are listed in Table 1-1 below.

**Table 1-1. DGC-2020 Hardware Version Differences**

| Feature                                                    | Versions 1 and 2*                                         | Version 3 |
|------------------------------------------------------------|-----------------------------------------------------------|-----------|
| Three-phase bus sensing                                    | Single-phase bus sensing only                             | Available |
| Optional RS-232 port for communication with external modem | Optional RJ-11 jack for internal modem communication only | Available |

\*Versions 1 and 2 are no longer available for ordering.

## Identifying DGC-2020 Version

DGC-2020 version information can be found through the front-panel interface and via connection to a PC running BESTCOMS*Plus* software.

Version information is displayed on the front panel LCD immediately after applying operating power and on the *Version Info* screen. To view the *Version Info* screen, navigate to Settings > General Settings > Version Info > DGC-2020 > Firmware version. The firmware version number consists of five digits. The first digit is the hardware version number. Refer to *Section 2, Controls and Indicators* for information on using the front panel.

In BESTCOMS*Plus*, the DGC-2020 hardware version is found on the *Device Info* screen. Connect to the DGC-2020 and download settings and logic. Using the *Settings Explorer*, open *General Settings, Device Info*. The hardware version of the DGC-2020 is shown in the *Application Version* field. The application version number consists of five digits. The first digit is the hardware version number. Refer to *Section 4, BESTCOMSPlus Software* for details on installing and using BESTCOMS*Plus*.

## Features

DGC-2020 Digital Genset Controllers have the following features:

- Local and Remote Generator Control
- Engine, Generator, and Loss of Mains Protection
- Automatic Transfer Switch Control (Mains Failure)
- Automatic Generator Configuration Detection
- Generator Sequencing
- Generator Soft Loading/Unloading
- Auto Synchronizing
- Programmable Analog Engine Senders
- 16 Programmable Contact Inputs
- Programmable Logic
- Exercise Timer
- ECU Communications via SAE J1939

- Marathon DVR2000E+ Voltage Regulator Control via SAE J1939
- Integrated RS485 communication (optional)
- Dial-Out Modem communication (optional)
- Additional modules available to expand the capabilities of the DGC-2020

## Functions

---

DGC-2020 Digital Genset Controllers perform the following functions:

### Generator Protection and Metering

Multifunction generator protection guards against generator overvoltage, undervoltage, reverse power, loss of excitation, underfrequency, and overfrequency. Overcurrent, phase imbalance, and loss of mains protection are available as an option. Each generator protection function has an adjustable pickup and time delay setting. Sixteen inverse time curves enable the DGC-2020 to offer overcurrent protection in a variety of applications.

Metered generator parameters include voltage, current, real power (watts), apparent power (VA), and power factor (PF).

### Engine Protection and Metering

Engine protection features include oil pressure and coolant temperature monitoring, overcrank protection, ECU specific protection elements, and diagnostic reporting.

Metered engine parameters include oil pressure, coolant temperature, battery voltage, speed, fuel level, engine load, coolant level (from ECU), ECU specific parameters, and run-time statistics.

### Event Recording

An event log retains a history of system events in nonvolatile memory. Up to 30 event types are retained and each record contains a time stamp of the first and last occurrence, and the number of occurrences for each event. For more information, see Section 3, *Functional Description, Event Recording*.

### Auto-Synchronizer

An optional automatic synchronizer monitors the bus and generator voltages and supplies discrete raise/lower correction signals to synchronize the generator voltage, frequency, and slip angle with that of the bus.

### Contact Inputs and Output Contacts

DGC-2020 controllers have one, dedicated emergency stop contact input and 16 programmable contact inputs. All contact inputs recognize dry contacts. The programmable inputs can be configured to initiate a pre-alarm or alarm. A programmable input can be programmed to receive an input from an automatic transfer switch or override DGC-2020 alarms and protection functions. Each programmable input can be assigned a user-defined name for easy identification at the front panel display and in fault records.

Output contacts include three dedicated relays for energizing an engine's glow plugs, fuel solenoid, and starter solenoid. An additional four user-programmable output contacts are provided if the style number is xxAxxxxxx. If the style number is xxBxxxxxx, an additional twelve output contacts are provided.

Additional contact inputs and output contacts can be accommodated with an optional CEM-2020 (Contact Expansion Module). Contact Basler Electric for ordering information.

### Automatic Transfer Switch Control (Mains Failure)

The DGC-2020 has the ability to detect a mains failure via a single- or three-phase Bus input. A mains failure is established when any one of the following conditions are met:



- Any phase of bus voltage falls below dead bus threshold
- Any phase of bus voltage unstable due to overvoltage or undervoltage
- Any phase of bus voltage unstable due to overfrequency or underfrequency

At this time, the DGC-2020 will start the genset and when ready, apply power to the load via the genset. The DGC-2020 implements open or closed transitions to and from the mains. When the mains returns and is considered stable, the DGC-2020 will transfer the load back to the mains. When closed transitions are required, the Auto Synchronizer option of the DGC-2020 is required in order to synchronize the generator to the mains when transferring a load from generator power to utility power.

## Communication

Standard DGC-2020 communication features include a standard USB port and SAE J1939 interface. Optional communication features include an RS-232 port for connection with an external dial-out modem and RS-485 communication port. BESTCOMS*Plus*® can communicate with the DGC-2020 through Ethernet via an optional LSM-2020 (Load Share Module). Contact Basler Electric for ordering information.

### USB Port

A USB communication port can be used with BESTCOMS*Plus*® software to quickly configure a DGC-2020 with the desired settings or retrieve metering values and event log records.

### CAN Bus Interface

A CAN Bus interface provides high-speed communication between the DGC-2020 and the engine control unit (ECU) on an electronically controlled engine. This interface provides access to oil pressure, coolant temperature, and engine speed data by reading these parameters directly from the ECU. When available, engine diagnostic data can also be accessed.

The CAN Bus interface also provides communication between the DGC-2020 and the Marathon DVR2000E+ voltage regulator. Voltage setpoint and underfrequency knee-point settings can be sent directly to the DVR2000E+ from the DGC-2020.

The CAN Bus interface supports the following protocols:

- SAE J1939 Protocol - Oil pressure, coolant temperature, and engine speed data are received from the ECU. In addition, DTCs (Diagnostic Trouble Codes) help diagnose any engine or related failures. The engine DTCs are displayed on the front panel of the DGC-2020 and may be obtained using BESTCOMS*Plus*® software.
- *mtu* Protocol - A DGC-2020 connected to a genset equipped with an *mtu* engine ECU receives Oil pressure, coolant temperature, and engine speed data from the engine controller, along with various alarms and pre-alarms that are *mtu* specific. In addition, the DGC-2020 tracks and displays the active fault codes issued by the *mtu* engine ECU.

### External Dial-Out Modem Port

An optional RS-232 communication port uses the ASCII protocol to communicate with a user-supplied external modem. The optional external dial-out modem enables remote control, monitoring, and setting of the DGC-2020. When an alarm or pre-alarm condition occurs, the DGC-2020 can dial up to four telephone numbers, in sequence, until an answer is received and the condition is annunciated.

### RS-485 Port

An optional RS-485 communication port uses the Modbus® communication protocol and enables remote control and monitoring of the DGC-2020 over a polled network.

## ***AEM-2020 (Analog Expansion Module)***

The optional AEM-2020 provides eight remote analog inputs, eight remote RTD inputs, two remote thermocouple inputs, and four remote analog outputs to the DGC-2020. The AEM-2020 communicates with the DGC-2020 through a CAN Bus interface. Refer to Section 11, *AEM-2020 (Analog Expansion Module)*, for more information.

## CEM-2020 (Contact Expansion Module)

The optional CEM-2020 provides 10 additional contact inputs and 18 or 24 additional output contacts (depending on module type) to the DGC-2020. The CEM-2020 communicates with the DGC-2020 through a CAN Bus interface. Refer to Section 10, *CEM-2020 (Contact Expansion Module)*, for more information.

## LSM-2020 (Load Share Module)

The optional LSM-2020 in conjunction with the DGC-2020 provides load sharing between governors through an analog load share line. The LSM-2020 communicates through an Ethernet port and provides access to the DGC-2020 via Ethernet. Refer to Section 9, *LSM-2020 (Load Share Module)*, for more information.

## Style Number

Standard-order DGC-2020 controllers are identified by a style number which consists of a combination of letters and numbers that define the controller's electrical characteristics and operational features. The model number, together with the style number, describes the options included in a specific controller. Figure 1-1 illustrates the DGC-2020 style number identification chart.

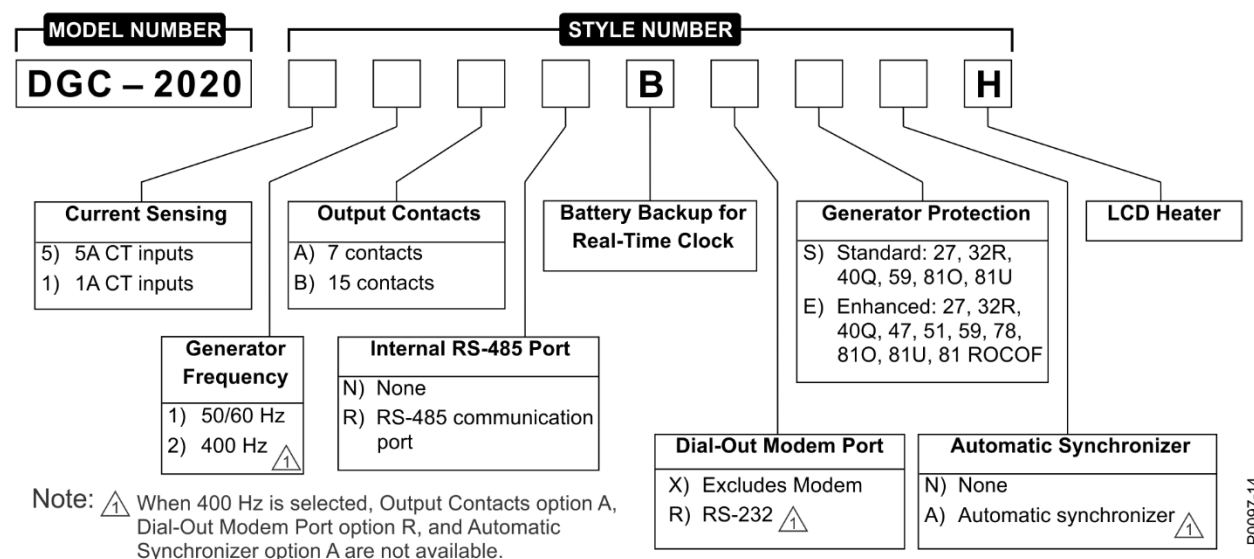


Figure 1-1. DGC-2020 Style Chart

For example, if a DGC-2020 style number were **51BNBREA H**, the controller would have the following characteristics and operating features.

- 5** 5 Aac current sensing inputs
- 1** 50/60 hertz nominal generator frequency
- B** Three fixed-function output contacts and 12 programmable output contacts
- N** No RS-485 communication port
- B** Battery backup for real-time clock during losses of control power
- R** External dial-out modem port
- E** Enhanced generator protection (27 undervoltage, 32R reverse power, 40Q loss of excitation, 47 phase imbalance, 51 overcurrent, 59 overvoltage, 78 vector shift, 81O overfrequency, 81U underfrequency, and 81 ROCOF)
- A** Auto-synchronizer
- H** LCD heater

## Specifications

---

### Operating Power

|                |                                  |
|----------------|----------------------------------|
| Nominal .....  | 12 or 24 Vdc                     |
| Range .....    | 6 to 32 Vdc                      |
| Terminals..... | 3 (+), 2 (-), 1 (chassis ground) |

### Power Consumption

|                                |                                                     |
|--------------------------------|-----------------------------------------------------|
| Sleep Mode .....               | 5W with all relays non-energized                    |
| Normal Operational Mode .....  | 7.9W - Run mode, LCD heater off, 3 relays energized |
| Maximum Operational Mode ..... | 14.2W - Run mode, LCD heater on, 6 relays energized |

### Battery Ride Through

Withstands cranking ride-through down to 0 V for 50 ms, starting at 10 Vdc.

### Current Sensing

|                |                  |
|----------------|------------------|
| Burden.....    | 1 VA             |
| Terminals..... | 68, 69 (A-phase) |
|                | 71, 72 (B-phase) |
|                | 74, 75 (C-phase) |

#### 1 Aac Current Sensing

|                        |                 |
|------------------------|-----------------|
| Continuous Rating..... | 0.02 to 1.0 Aac |
| 1 Second Rating.....   | 2 Aac           |

#### 5 Aac Current Sensing

|                        |                |
|------------------------|----------------|
| Continuous Rating..... | 0.1 to 5.0 Aac |
| 1 Second Rating.....   | 10 Aac         |

### Voltage Sensing

|                                   |                                                               |
|-----------------------------------|---------------------------------------------------------------|
| Generator Configuration.....      | Line-to-line or line-to-neutral                               |
| Bus Configuration.....            | Line-to-line                                                  |
| Range.....                        | 12 to 576 V rms, line-to-line                                 |
| Frequency .....                   | Style selectable, 50/60 Hz or 400 Hz                          |
| Frequency Range.....              | 10 to 72 Hz for 50/60 style and 10 to 480 Hz for 400 Hz style |
| Burden .....                      | 1 VA                                                          |
| 1 Second Rating.....              | 720 V rms                                                     |
| Generator Sensing Terminals ..... | 41 (A-phase)                                                  |
|                                   | 39 (B-phase)                                                  |
|                                   | 37 (C-phase)                                                  |
|                                   | 35 (Neutral)                                                  |

#### Bus Sensing Terminals

|                   |
|-------------------|
| 76, 45 (A-phase)* |
| 78, 43 (B-phase)* |
| 80 (C-phase)      |

\* Terminal 45 is internally tied to 76 and terminal 43 is internally tied to 78. This accommodates the use of connectors wired for legacy DGC-2020 versions.

### Contact Sensing

Contact sensing inputs include 1 emergency stop input and 16 programmable inputs. All inputs accept dry contacts.

Time from a DGC-2020 input application to:

Shutdown the generator via an alarm = 490 ms max

Close a relay on board the DGC-2020 = 215 ms max

Close a relay on board the CEM-2020 = 400 ms max

### Notes

A contact input is true (on) if the input is connected to battery ground with a resistance of less than 240 ohms.

The maximum length of wire that can be accommodated depends on the resistance of the wire, and the resistance of the contacts of the device driving the input at the far end of the wire.

The maximum wire length can be calculated as follows:

$$L_{\max} = (240 - R_{\text{device}}) / (\text{Resistance per Foot of Desired Wire})$$

### Terminals

Emergency Stop..... 46, 47

### Programmable

Input 1 ..... 30, 2  
 Input 2 ..... 29, 2  
 Input 3 ..... 28, 2  
 Input 4 ..... 27, 2  
 Input 5 ..... 26, 2  
 Input 6 ..... 25, 2  
 Input 7 ..... 24, 2  
 Input 8 ..... 23, 2  
 Input 9 ..... 22, 2  
 Input 10 ..... 21, 2  
 Input 11 ..... 20, 2  
 Input 12 ..... 19, 2  
 Input 13 ..... 18, 2  
 Input 14 ..... 17, 2  
 Input 15 ..... 16, 2  
 Input 16 ..... 15, 2

## Engine System Inputs

Stated accuracies are subject to the accuracy of the senders used. Values within these ranges are deemed “good” and the DGC-2020 will use them for the appropriate calculation and protection. Values outside these ranges are deemed “bad” and the DGC-2020 will begin timing towards a sender failure condition.

### Fuel Level Sensing

Resistance Range..... 0 to 250  $\Omega$  nominal

Terminals..... 9, 11 (sender common)

Accuracy.....  $\pm 1.6 \Omega$  or  $\pm 2\%$  (whichever is greater) of actual resistance

### Coolant Temperature Sensing

Resistance Range..... 10 to 2,750  $\Omega$  nominal

Terminals..... 10, 11 (sender common)

Accuracy.....  $\pm 4.5 \Omega$  or  $\pm 1.9\%$  (whichever is greater) of actual resistance

### Oil Pressure Sensing

Resistance Range..... 0 to 250  $\Omega$  nominal

Terminals..... 8, 11 (sender common)

Accuracy.....  $\pm 1.4 \Omega$  or  $\pm 2.3\%$  (whichever is greater) of actual resistance

### Engine Speed Sensing

#### Magnetic Pickup

|                      |                                      |
|----------------------|--------------------------------------|
| Voltage Range .....  | 3 to 35 V peak (6 to 70 V peak-peak) |
| Frequency Range..... | 32 to 10,000 Hz                      |
| Terminals.....       | 31 (+), 32 (–)                       |

#### Generator Voltage

|                |                 |
|----------------|-----------------|
| Range .....    | 12 to 576 V rms |
| Terminals..... | 41 (A-phase)    |
|                | 39 (B-phase)    |
|                | 37 (C-phase)    |

## **Output Contacts**

### PRESTART, START, and RUN Relays

Rating ..... 30 Adc at 28 Vdc - General purpose, 3 A pilot duty\*

### Programmable Relays (12)

Rating ..... 2 Adc at 28 Vdc - General purpose, 1.2 A pilot duty\*

\* The load must be in parallel with a diode rated at least 3 times the coil current and 3 times the coil voltage.

#### Terminals†

|                |                 |
|----------------|-----------------|
| Output 1.....  | 52, 51 (common) |
| Output 2.....  | 53, 51 (common) |
| Output 3.....  | 54, 51 (common) |
| Output 4.....  | 56, 55 (common) |
| Output 5.....  | 57, 55 (common) |
| Output 6.....  | 58, 55 (common) |
| Output 7.....  | 60, 59 (common) |
| Output 8.....  | 61, 59 (common) |
| Output 9.....  | 62, 59 (common) |
| Output 10..... | 64, 63 (common) |
| Output 11..... | 65, 63 (common) |
| Output 12..... | 66, 63 (common) |

† The number of programmable output contacts provided is determined by the output contacts character of the DGC-2020 style number. Controllers with output contacts option A have 4 programmable outputs (Outputs 1, 2, 3, and 4). Controllers with output contacts option B have 12 programmable outputs.

The programmable relays share common terminals: terminal 51 is used for outputs 1, 2, and 3, terminal 55 is used for outputs 4, 5, and 6, terminal 59 is used for outputs 7, 8, and 9, 63 is used for outputs 10, 11, and 12.

## **Metering**

### Generator and Bus Voltage (rms)

|                          |                                                        |
|--------------------------|--------------------------------------------------------|
| Metering Range.....      | 0 to 576 Vac (direct measurement)                      |
|                          | 577 to 999,999 Vac (through VT using VT ratio setting) |
| VT Ratio Range.....      | 1:1 to 125:1 in primary increments of 1                |
| Accuracy* .....          | ±1.0% of programmed rated voltage or ±2 Vac            |
| Display Resolution ..... | 1 Vac                                                  |

\* Voltage metering indicates 0 V when generator voltage is below 2% of the full-scale rating.

### Generator Current (rms)

Generator current is measured at the secondary windings of user-supplied 1 A or 5 A CTs.

|                     |                |
|---------------------|----------------|
| Metering Range..... | 0 to 5,000 Aac |
|---------------------|----------------|

|                          |                                                        |
|--------------------------|--------------------------------------------------------|
| CT Primary Range .....   | 1 to 5,000 Aac in primary increments of 1 Aac          |
| Accuracy* .....          | $\pm 1.0\%$ of programmed rated current or $\pm 2$ Aac |
| Display Resolution ..... | 1 Aac                                                  |

\* kW metering indicates 0 kW when the generator kW is below 2% of the full-scale rating.

† Applies when temperature is between  $-40^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$ .

#### Oil Pressure

Metering Range..... 0 to 150 psi, 0 to 10.3 bar, or 0 to 1,034 kPa  
 Sensing Resistance Range..... 0 to 250  $\Omega$  nominal  
 Sensing Accuracy .....  $\pm 1.4 \Omega$  or  $\pm 2.3\%$  (whichever is greater) of actual resistance  
 Display Resolution ..... 1 psi, 0.1 bar, or 1 kPa

#### Coolant Temperature

Metering Range..... 32 to 410°F or 0 to 204°C  
 Sensing Resistance Range..... 10 to 2,750  $\Omega$  nominal  
 Sensing Accuracy .....  $\pm 4.5 \Omega$  or  $\pm 1.9\%$  (whichever is greater) of actual resistance

#### Battery Voltage

Metering Range..... 6 to 32 Vdc  
 Accuracy.....  $\pm 3\%$  of actual indication or  $\pm 0.2 \text{ Vdc}$   
 Display Resolution ..... 0.1 Vdc

#### Engine RPM

Metering Range..... 0 to 4,500 rpm  
 Accuracy\* .....  $\pm 2\%$  of actual indication or  $\pm 2 \text{ rpm}$   
 Display Resolution ..... 2 rpm

\* When engine speed is below 2% of full-scale, reported rpm is 0.

#### Engine Run Time

Engine run time is retained in nonvolatile memory.

Metering Range..... 0 to 999,999 hours  
 Update Interval..... 6 min  
 Accuracy.....  $\pm 1\%$  of actual indication or  $\pm 12 \text{ min}$   
 Display Resolution ..... 1 minute

#### Maintenance Timer

Maintenance timer indicates the time remaining until genset service is due. Value is retained in nonvolatile memory.

Metering Range..... 0 to 5,000 hours  
 Update Interval..... 6 min  
 Accuracy.....  $\pm 1\%$  or actual indication or  $\pm 12 \text{ min}$   
 Display Resolution ..... 1 minute

#### Fuel Level

Metering Range..... 0 to 100%  
 Sensing Resistance Range..... 0 to 250  $\Omega$  nominal  
 Sensing Accuracy .....  $\pm 1.6 \Omega$  or  $\pm 2\%$  (whichever is greater) of actual resistance  
 Display Resolution ..... 1.0%

### **Generator Protection Functions**

#### Overvoltage (59) and Undervoltage (27)

Pickup Range..... 70 to 1,000 Vac  
 Pickup Increment ..... 1 Vac  
 Arming Delay..... 0 to 300 s  
 Arming Delay Increment..... 1 s  
 Hysteresis..... 1 to 60 Vac  
 Hysteresis Increment ..... 1 Vac  
 Activation Delay Range..... 0 to 30 s

Activation Delay Increment ..... 0.1 s  
Inhibit Frequency Range ..... 20 to 400 Hz (27 function only)

## Note

The maximum voltage that can be safely applied to the DGC-2020 is 576 volts. The pickup range is higher so that when the low-line override is used, and the scale factor is 0.5 or less, effective protection levels of 500 volts can be reached with a scale factor of 0.5.

### Underfrequency (81U) and Overfrequency (81O)

|                            |                                   |
|----------------------------|-----------------------------------|
| Pickup Range               | 45 to 66 Hz (50/60 Hz nominal)    |
|                            | 360 to 440 Hz (400 Hz nominal)    |
| Pickup Increment           | 0.1 Hz (50/60 Hz nominal)         |
|                            | 0.1 Hz (400 Hz nominal)           |
| Arming Delay               | 0 to 300 s                        |
| Arming Delay Increment     | 1 s                               |
| Hysteresis                 | 0.1 to 40 Hz                      |
| Hysteresis Increment       | 0.1 Hz                            |
| Activation Delay Range     | 0 to 30 s                         |
| Activation Delay Increment | 0.1 s                             |
| Inhibit Voltage Range      | 70 to 576 Vac (81U function only) |

### Reverse Power (32)

|                                  |                               |
|----------------------------------|-------------------------------|
| Pickup Range .....               | -50 to 5% of Genset kW Rating |
| Pickup Increment .....           | 0.1%                          |
| Arming Delay.....                | 0 to 300 s                    |
| Arming Delay Increment.....      | 1 s                           |
| Hysteresis Range.....            | 1 to 10% of Genset kW Rating  |
| Hysteresis Increment .....       | 0.1%                          |
| Activation Delay Range.....      | 0 to 30 s                     |
| Activation Delay Increment ..... | 0.1 s                         |

### Loss of Excitation (40Q)

|                                  |                           |
|----------------------------------|---------------------------|
| Pickup Range .....               | –150 to 0% of Rated kvar* |
| Pickup Increment .....           | 0.1%                      |
| Arming Delay .....               | 0 to 300 s                |
| Arming Delay Increment .....     | 1 s                       |
| Hysteresis Range .....           | 1 to 10% of Rated kvar*   |
| Hysteresis Increment .....       | 0.1%                      |
| Activation Delay Range .....     | 0 to 30 s                 |
| Activation Delay Increment ..... | 0.1 s                     |

\* Rated kvar is calculated on the *System Settings, Rated Data* screen in BESTCOMS*Plus*®.

### Overcurrent (51) (Optional)

|                           |                                                               |
|---------------------------|---------------------------------------------------------------|
| Pickup Range .....        | 0.18 to 1.18 Aac (1 A current sensing)                        |
|                           | 0.9 to 7.75 Aac (5 A current sensing)                         |
| Time Dial Range .....     | 0 to 7,200 s (fixed time curve)                               |
|                           | 0 to 9.9 (inverse curve time multiplier)                      |
| Time Dial Increment ..... | 0.1                                                           |
| Inverse Time Curves ..... | See Appendix A, <i>Time Overcurrent Characteristic Curves</i> |

### Phase Imbalance (47) (Optional)

|                        |              |
|------------------------|--------------|
| Pickup Range .....     | 5 to 100 Vac |
| Pickup Increment ..... | 1 Vac        |
| Hysteresis.....        | 1 to 5 Vac   |



Hysteresis Increment ..... 1 Vac  
Activation Delay Range ..... 0 to 30 s  
Activation Delay Increment ..... 0.1 s  
Arming Delay ..... 0 to 300 s  
Arming Delay Increment ..... 1 s

ROCOF (Rate of Change of Frequency) (81) (Optional)

Pickup Range ..... 0.2 to 10 Hz/s  
Pickup Increment ..... 0.1 Hz/s  
Activation Delay Range ..... 0 to 100 s  
Activation Delay Increment ..... 0.01 s

Vector Shift (78) (Optional)

Pickup Range ..... 2 to 90°  
Pickup Increment ..... 1°

**Logic Timers**

Hours Setting Range ..... 0 to 250  
Hours Setting Increment ..... 1  
Minutes Setting Range ..... 0 to 250  
Minutes Setting Increment ..... 1  
Seconds Setting Range ..... 0 to 1,800  
Seconds Setting Increment ..... 0.1  
Accuracy ..... ±15 ms

**Communication Interface**

USB

Specification Compatibility ..... USB 2.0  
Data Transfer Speed ..... 115200 baud  
Connector Type ..... Mini-B jack

External Dial-Out Modem (Optional)

Protocol ..... ASCII  
Data Transmission ..... Full Duplex  
Baud ..... 9600  
Data Bits ..... 8  
Parity ..... None  
Stop Bits ..... 1  
Connector Type ..... DB-9 Connector (Male)

RS-485 (Optional)

Baud ..... 9600  
Data Bits ..... 8  
Parity ..... None  
Stop Bits ..... 1  
Terminals ..... 14 (A), 13 (B), and 12 (shield)

RDP-110

Minimum Wire Size ..... 20 AWG  
Maximum Wire Length ..... 4,000 feet (1,219 meters)  
Terminals ..... 6 (RDP TXD-), 7 (RDP TXD+)

CAN**Notes**

1. If the DGC-2020 is providing one end of the J1939 bus, a 120-ohm, ½ watt terminating resistor should be installed across terminals 48 (CANL) and 49 (CANH).
2. If the DGC-2020 is not part of the J1939 bus, the stub connecting the DGC-2020 to the bus should not exceed 914 mm (3 ft) in length.
3. The maximum bus length, not including stubs, is 40 m (131 ft).
4. The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the DGC-2020.

Differential Bus Voltage..... 1.5 to 3 Vdc

Maximum Voltage ..... –32 to +32 Vdc with respect to negative battery terminal

Communication Rate..... 250 kb/s

Terminals..... 48 (low), 49 (high), and 50 (shield)

**Real-Time Clock**

Clock has leap year and selectable daylight saving time correction. Backup capacitor and backup battery sustain timekeeping during losses of DGC-2020 operating power.

Resolution ..... 1 s

Accuracy..... ±1.73 s/d at 25°C

*Clock Holdup*

Battery Holdup Time ..... Approximately 10 years

Battery Type..... Rayovac BR2032, lithium, coin-type, 3 Vdc, 195 mAh  
Basler Electric P/N 38526

**Caution**

Replacement of the backup battery for the real-time clock should be performed only by qualified personnel.

Do not short-circuit the battery, reverse battery polarity, or attempt to recharge the battery. Observe polarity markings on the battery socket while inserting a new battery. The battery polarity must be correct in order to provide backup for the real-time clock.

It is recommended that the battery be removed if the DGC-2020 is to be operated in a salt-fog environment. Salt-fog is known to be conductive and may short-circuit the battery.

**Note**

Failure to replace the battery with Basler Electric P/N 38526 may void the warranty.

**LCD Heater**

The ambient temperature is monitored by a temperature sensor located near the LCD inside the DGC-2020. The LCD heater turns on when necessary to maintain operation of the LCD.

The heater turns on below 14°F (–10°C) and turns off above 32°F (0°C).

## Type Tests

|                          |             |
|--------------------------|-------------|
| Vibration .....          | EN60068-2-6 |
| Dielectric Strength..... | EN60664-1   |
| Impulse .....            | EN60664-1   |
| Transients.....          | EN61000-4-4 |
| Static Discharge .....   | EN61000-4-2 |

### Shock

Withstands 15 G in 3 perpendicular planes.

### Vibration

Swept over the following ranges for 12 sweeps in each of three mutually perpendicular planes with each 15-minute sweep consisting of the following:

|                          |                                                          |
|--------------------------|----------------------------------------------------------|
| 5 to 29 to 5 Hz .....    | 1.5 G peak for 5 minutes                                 |
| 29 to 52 to 29 Hz .....  | 0.036 inches (0.914 mm) double amplitude for 2.5 minutes |
| 52 to 500 to 52 Hz ..... | 5 G peak for 7.5 minutes                                 |

### Radio Interference

Type tested using a 5 W, hand-held transceiver operating at random frequencies centered around 144 and 440 MHz with the antenna located within 150 mm (6") of the device in both vertical and horizontal planes.

### HALT (Highly Accelerated Life Testing)

HALT is used by Basler Electric to prove that our products will provide the user with many years of reliable service. HALT subjects the device to extremes in temperature, shock, and vibration to simulate years of operation, but in a much shorter period span. HALT allows Basler Electric to evaluate all possible design elements that will add to the life of this device. As an example of some of the extreme testing conditions, the DGC-2020 was subjected to temperature tests (tested over a temperature range of  $-100^{\circ}\text{C}$  to  $+115^{\circ}\text{C}$ ), vibration tests (of 5 to 50 G at  $+20^{\circ}\text{C}$ ), and temperature/vibration tests (tested at 40 G over a temperature range of  $-80^{\circ}\text{C}$  to  $+90^{\circ}\text{C}$ ). Combined temperature and vibration testing at these extremes proves that the DGC-2020 is expected to provide long-term operation in a rugged environment. Note that the vibration and temperature extremes listed in this paragraph are specific to HALT and do not reflect recommended operation levels. These operational ratings are included in Section 1 of this manual.

### Ignition System

Tested in close proximity to an unshielded, unsuppressed Altronic DISN 800 Ignition System.

## Environment

|                            |                                                                    |
|----------------------------|--------------------------------------------------------------------|
| Operating Temperature..... | $-40$ to $+70^{\circ}\text{C}$ ( $-40$ to $+158^{\circ}\text{F}$ ) |
| Storage Temperature .....  | $-40$ to $+85^{\circ}\text{C}$ ( $-40$ to $+185^{\circ}\text{F}$ ) |
| Humidity .....             | IEC 60068-2-38                                                     |
| Salt Fog .....             | ASTM B 17-73, EN 68-2-11                                           |
| Ingress Protection .....   | IEC IP54 for front panel                                           |

## Agency Information

### UL Certification

The DGC-2020 is a Recognized Component covered under File E97035 (CCN# FTPM2/FTPM8) and applicable to Canadian and US safety standards and requirements by UL.

Standards used for evaluation:

- UL 6200
- CSA C22.2 No. 14

**Caution**

To follow UL guidelines, replacement of the backup battery for the real-time clock should be performed only by qualified personnel.

**CE and UKCA Compliance**

This product has been evaluated and complies with the requirements set forth by the EU legislation and UK Parliament.

EC Directives:

- Low Voltage Directive (LVD) – 2014/35/EU
- Electromagnetic Compatibility (EMC) – 2014/30/EU
- Hazardous Substances (RoHS2) – 2011/65/EU

Harmonized Standards used for evaluation:

- EN 50178: *Electronic Equipment for use in Power Installations*
- EN 61000-6-4: *Electromagnetic Compatibility (EMC), Generic Standards, Emission Standard for Industrial Environments*
- EN 61000-6-2: *Electromagnetic Compatibility (EMC), Generic Standards, Immunity for Industrial Environments*
- EN 50581: *Technical documentation for the Assessment of Electrical and Electronic Products with respect to the restriction of Hazardous Substances.*

**FCC Requirements**

This product complies with FCC 47 CFR Part 15.

**NFPA Compliance**

This product complies with NFPA Standard 110, *Standard for Emergency and Standby Power*.

China RoHS

The following table serves as the declaration of hazardous substances for China in accordance with PRC standard SJ/T 11364-2014. The EFUP (Environment Friendly Use Period) for this product is 40 years.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                              |                   |                   |                                                |                                        |                                                |                                     |                                          |                                                       |                                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-------------------|-------------------|------------------------------------------------|----------------------------------------|------------------------------------------------|-------------------------------------|------------------------------------------|-------------------------------------------------------|------------------------------------------|
| <b>PRODUCT:</b> DGC-2020                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                              |                   |                   |                                                |                                        |                                                |                                     |                                          |                                                       |                                          |
| 零件名称<br>Part Name                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 有害物质<br>Hazardous Substances |                   |                   |                                                |                                        |                                                |                                     |                                          |                                                       |                                          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 铅<br>Lead (Pb)               | 汞<br>Mercury (Hg) | 镉<br>Cadmium (Cd) | 六价铬<br>Hexavalent Chromium (Cr <sup>6+</sup> ) | 多溴联苯<br>Polybrominated Biphenyls (PBB) | 多溴二苯醚<br>Polybrominated Diphenyl Ethers (PBDE) | 邻苯二甲酸二丁酯<br>Dibutyl Phthalate (DBP) | 邻苯二甲酸丁苄酯<br>Benzyl butyl phthalate (BBP) | 邻苯二甲酸二(2-乙基己基)酯<br>Bis(2-ethylhexyl) phthalate (BEHP) | 邻苯二甲酸二异丁酯<br>Diisobutyl phthalate (DIBP) |
| 金属零件<br>Metal parts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | O                            | O                 | O                 | O                                              | O                                      | O                                              | O                                   | O                                        | O                                                     | O                                        |
| 聚合物<br>Polymers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | O                            | O                 | O                 | O                                              | O                                      | O                                              | O                                   | O                                        | O                                                     | O                                        |
| 电子产品<br>Electronics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | X                            | O                 | O                 | O                                              | O                                      | O                                              | O                                   | O                                        | O                                                     | O                                        |
| 电缆和互连配件<br>Cables & interconnect accessories                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | X                            | O                 | O                 | O                                              | O                                      | O                                              | O                                   | O                                        | O                                                     | O                                        |
| 绝缘材料<br>Insulation material                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | O                            | O                 | O                 | O                                              | O                                      | O                                              | O                                   | O                                        | O                                                     | O                                        |
| <p>本表格依据 SJ/T11364 的规定编制。</p> <p>O: 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。</p> <p>X: 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求。</p> <p>This form was prepared according to the provisions of standard SJ/T11364.</p> <p>O: Indicates that the hazardous substance content in all homogenous materials of this part is below the limit specified in standard GB/T 26572.</p> <p>X: Indicates that the hazardous substance content in at least one of the homogenous materials of this part exceeds the limit specified in standard GB/T 26572.</p> |                              |                   |                   |                                                |                                        |                                                |                                     |                                          |                                                       |                                          |

**Physical**

Weight ..... 4.40 lb (1.99 kg)

Dimensions..... See Section 6, *Installation*.



## 2 • Human-Machine Interface

This section describes the components of the DGC-2020 human-machine interface (HMI). DGC-2020 HMI components are located on the front panel (controls and indicators) and the rear panel (terminals and connectors).

### Front Panel

Figure 2-1 illustrates the front panel HMI of the DGC-2020. Table 2-1 lists the call-outs of Figure 2-1 along with a description of each HMI component.

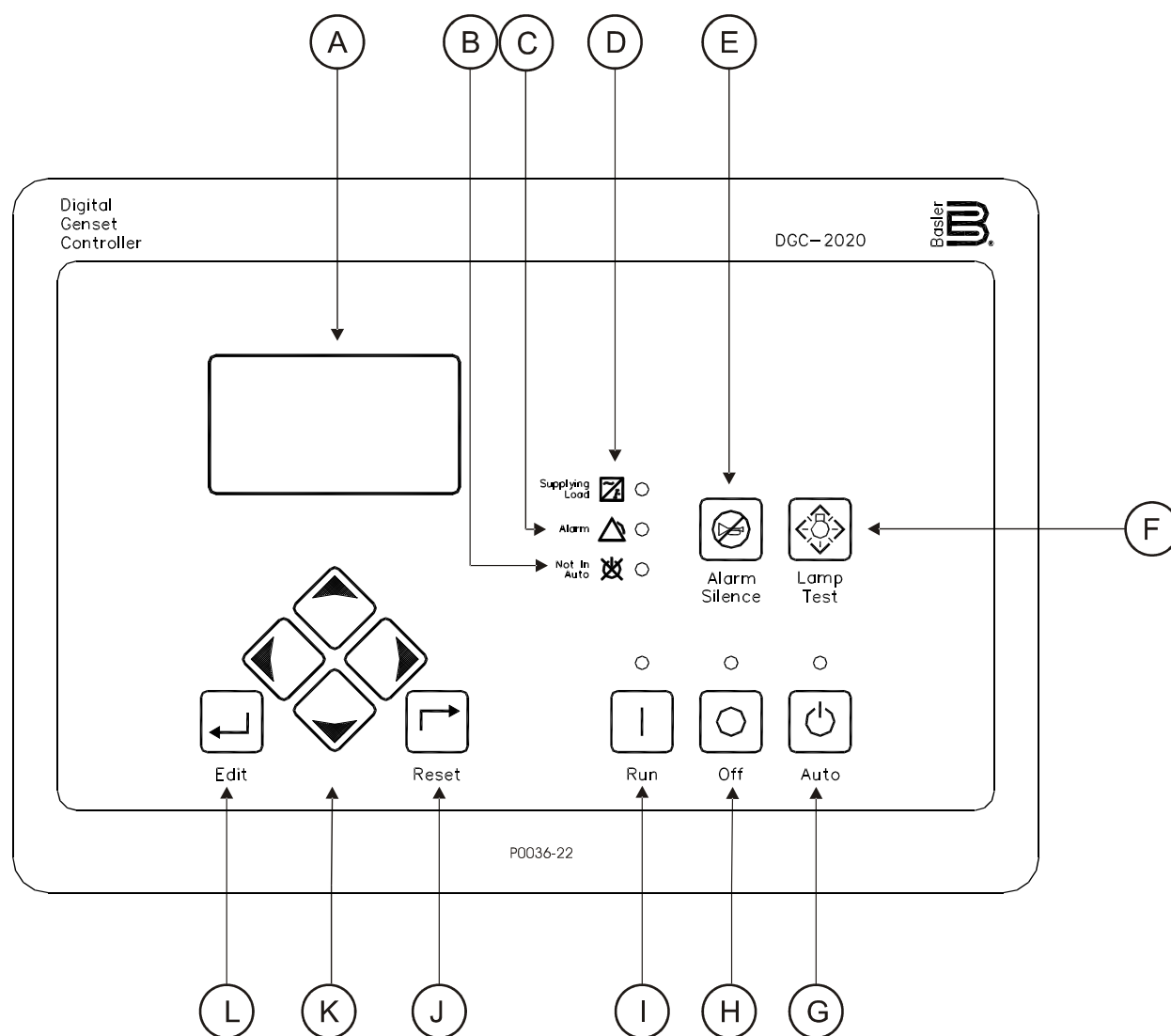


Figure 2-1. Front Panel HMI

Table 2-1. Front Panel HMI Descriptions

| Locator | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A       | <i>Liquid Crystal Display.</i> The backlit, 64 by 128 pixel LCD serves as the local information source for metering, alarms, pre-alarms, and protective functions. Display operation is maintained at –40°C.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| B       | <i>Not in Auto Indicator.</i> This red LED lights when the DGC-2020 is not operating in Auto mode.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| C       | <i>Alarm Indicator.</i> This red LED lights continuously during alarm conditions and flashes during pre-alarm conditions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| D       | <i>Supplying Load Indicator.</i> This green LED lights when the generator current is greater than EPS threshold current.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| E       | <i>Alarm Silence Pushbutton.</i> Pressing this button opens the relay output programmed as the horn output.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| F       | <i>Lamp Test Pushbutton.</i> Pressing this button tests the DGC-2020 indicators by exercising all LCD pixels and lighting all LEDs.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| G       | <i>Auto Pushbutton and Mode Indicator.</i> Pressing the Auto button places the DGC-2020 in Auto mode. The green Auto mode LED lights when Auto mode is active.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| H       | <i>Off Pushbutton and Mode Indicator.</i> Pressing this button places the DGC-2020 in Off mode. The red Off mode LED lights when the DGC-2020 is in Off mode. This button also resets the Breaker Management Pre-Alarms and all <i>mtu</i> ECU Alarms.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| I       | <i>Run Pushbutton and Mode Indicator.</i> Pressing this button places the DGC-2020 in Run mode. The green Run mode LED lights when Run mode is active.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| J       | <i>Reset Pushbutton.</i> This button is pressed to cancel a settings editing session and discard any settings changes. When pressed momentarily, this button also resets the Breaker Management Pre-Alarms and all <i>mtu</i> ECU Alarms. This button is also used to reset the Maintenance Interval when pressed for 10 seconds while viewing Hours Until Maintenance or Maintenance Due Pre-Alarm.                                                                                                                                                                                                                                                                                                                                               |
| K       | <p><i>Arrow Pushbuttons.</i> These four buttons are used to navigate through the front panel display menus and modify settings.</p> <p>The left- and right-arrow buttons are used to navigate through the menu levels. The right-arrow button is pressed to move downward through the menu levels and the left-arrow button is pressed to move upward.</p> <p>Within a level, the up-arrow and down-arrow buttons are used to move among items within the menu level. Pressing the down-arrow button moves to items lower in the list. Pressing the up-arrow button moves to items higher in the list.</p> <p>During a settings editing session, the up- and down-arrow buttons are used to raise and lower the value of the selected setting.</p> |
| L       | <i>Edit Pushbutton.</i> Pressing this button starts an editing session and enables changes to DGC-2020 settings. At the conclusion of an editing session, the Edit pushbutton is pressed again to save the setting changes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

## Display Operation

The front panel display is used to make settings changes and display metering values. Refer to call-outs J, K, and L in Table 2-1 for information on changing settings through the front panel and navigating through the Metering screens.



## Login and Permissions

### Login

To login, navigate to the SETTINGS, ENTER PASSWORD screen and press the *Edit* key. Use the *Up/Down* arrow keys to scroll through the characters. Use the *Left/Right* arrow keys to enter more characters. Once the password has been entered, press the *Edit* key to login. A LOGOUT selection now appears in the list of SETTINGS. To logout, navigate to SETTINGS > LOGOUT and press the *Edit* key. The LOGOUT selection is removed from the SETTINGS list.

If a front-panel key is not pressed for more than 15 minutes, the user is automatically logged out.

### Permissions

If communications access is active through the modem or USB, the front panel will display REMOTE COMMS, FRONT PANEL IS READ ONLY and the summary screen. This informs the user that the front panel can only be used for viewing metering data and settings information. Remote access must be ended before modifying settings through the front panel.

## Summary Screen and Configurable Metering

The summary screen can be set to standard or scrolling. When set to standard, only the following are displayed:

- |         |             |
|---------|-------------|
| • VOLT* | • OIL       |
| • AMP*  | • FUEL/DEF† |
| • PH*   | • TEMP      |
| • Hz    | • BATT      |

\* When set to standard, individual phase information can be automatically toggled at a rate set by the Phase Toggle Delay setting. Navigate to the SETTINGS > GENERAL SETTINGS > FRONT PANEL HMI screen and edit PH TOG DELAY. When the Phase Toggle Delay is set to zero, information for each phase is obtained by pressing the *Up* or *Down* arrow keys on the front panel HMI. When it is set to a number other than zero, the display will toggle through the phases automatically at the rate specified by the Phase Toggle Delay Setting.

† When a Selective Catalytic Reduction (SCR) with Diesel Exhaust Fluid (DEF) exhaust after-treatment system is implemented, the Summary screen automatically alternates the display of FUEL level and DEF level.

When the summary screen is set to scrolling, you can select/configure the metering values that are displayed. Up to 20 values can be displayed and these values will scroll at a delay time specified by the user. To select a standard or scrolling summary, navigate to the SETTINGS > GENERAL SETTINGS > FRONT PANEL HMI screen and edit the SUMMARY VIEW. The SCROLL DELAY setting is also found on this screen.

To select the scrolling values, navigate to the SETTINGS > GENERAL SETTINGS > FRONT PANEL HMI screen and edit the CONFIGURABLE METERING. The following items may be selected by the user to be placed in the scrolling summary:

- |                                                 |                                           |
|-------------------------------------------------|-------------------------------------------|
| • NONE (Removes a line from the scrolling list) | • RTD IN X (X = 1 to 8) (with AEM-2020)   |
| • BLANK (Shows nothing on this line)            | • THRM CPL X (X = 1 to 2) (with AEM-2020) |
| • OIL P                                         | • FUEL DELV P                             |
| • TEMP                                          | • kvar A                                  |
| • BATT V                                        | • kvar B                                  |
| • RPM                                           | • kvar C                                  |
| • RPM SRC                                       | • kvar TOTAL                              |
| • FUEL                                          | • INJ RAIL PRS                            |
| • RUN HRS                                       | • TOTAL FUEL USED                         |
| • GEN VAB                                       | • FUEL TEMP                               |
| • GEN VBC                                       | • ENG OIL TEMP                            |
| • GEN VCA                                       | • ENG INTCLR TEMP                         |
| • GEN VAN                                       | • COOLANT PRESS                           |

- GEN VBN
- GEN VCN
- BUS Hz
- BUS V
- GEN Hz
- GEN PF
- kWH
- GEN IA
- GEN IB
- GEN IC
- kW A
- kW B
- kW C
- kW TOT
- kVA A
- kVA B
- kVA C
- kVA TOT
- ALG IN X (X = 1 to 8) (with AEM-2020)
- FUEL RATE
- BOOST PRESS
- INTAK MNFLD TMP
- CHRG AIR TMP
- ENGINE % LOAD
- BUS VAB
- BUS VBC
- BUS VCA
- DEF 1 %
- DEF 2 %
- KW LD%
- ON LINE
- # UNITS
- SYS CAP
- SYS KW
- SY KVAR
- SYS TOTAL KW
- SYS GEN KW %

## Sleep Mode

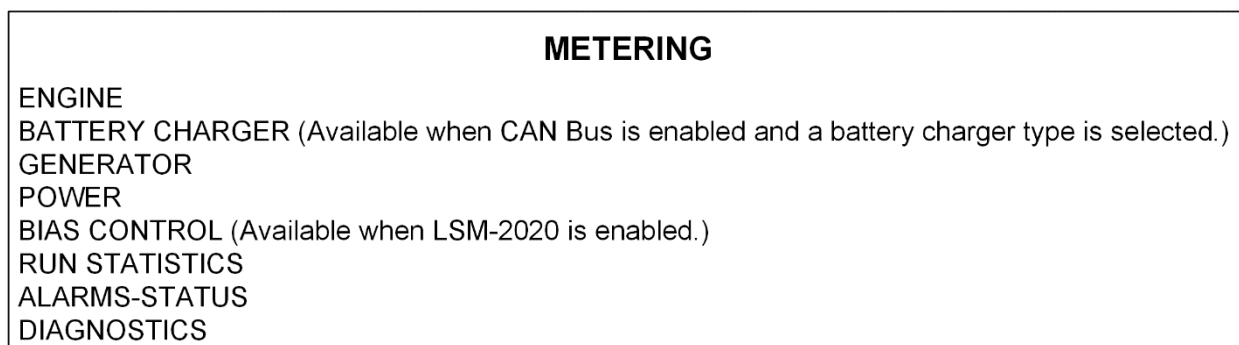
The DGC-2020 enters Sleep mode 15 minutes after the last front-panel pushbutton is pressed with the generator not running. When in Sleep mode, power is removed from the LCD screen backlight and the front-panel LEDs. The unit immediately exits Sleep mode when any front-panel pushbutton is pressed, if the genset is started, or if a pre-alarm occurs. The Sleep mode function is enabled by default and can be disabled through the front panel or in BESTCOMSP<sup>lus</sup>.

## Changing a Setting

To change a setting, navigate to the setting you want to change and press the *Edit* key. If you are not already logged in, you will be asked to enter your password at this time. Use the *Up/Down* arrows to raise or lower the value. Press the *Edit* key again when finished.

## Front Panel Display Structure

The front panel display begins with the SUMMARY SCREEN. Pressing the *Right* arrow key will open the MAIN MENU screen. The MAIN MENU screen consists of METERING, SETTINGS, and, when enabled, the ONE-LINE DIAGRAM, indicated by this symbol:  The METERING screen branches are shown in Figure 2-2. Details of the METERING screen branches follow Figure 2-2. The SETTINGS screen branches are shown in Figure 2-3. Details of the SETTINGS screen branches follow Figure 2-3. The ONE-LINE DIAGRAM screen options are shown in Figure 2-4.



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Figure 2-2. Metering Screen Branches

## ENGINE

- OIL PRESSURE
- COOLANT TMP
- BATTERY VOLT
- RPM
- SPEED SRC
- FUEL LEVEL
- ENGINE LOAD
- COOLANT LEVL (Visible when CAN Bus is enabled.)
- RUN HOURS
- ENGINE RUN TM SRC
- HRS TO MAINT
- DEF TANK 1 LVL %
- DEF TANK 2 LVL %
- REQUESTED RPM (Visible when CAN Bus is enabled.)
- REQ ACCL PEDAL (Visible when ECU CONFIG is set for Volvo Penta.)
- REQ SPEED BIAS (Visible when ECU CONFIG is set for Cummins.)

## BATTERY CHARGER (Visible when CAN Bus is enabled and a battery charger type is selected.)

- **BATTERY CHARGER 1 and BATTERY CHARGER 2**
  - VOLTS
  - AMPS
  - STATUS
  - AC
  - COMMS FAIL
  - BATTERY FAIL
  - CHARGER FAIL
  - AC OFF
  - THERMAL LIMIT (Visible when Sens battery charger type is selected.)
  - HI DC VOLTS (Visible when Sens battery charger type is selected.)
  - LOW DC VOLTS (Visible when Sens battery charger type is selected.)
  - LO CRANK V (Visible when Sens battery charger type is selected.)
  - INVLD SETNGS (Visible when Sens battery charger type is selected.)
  - SNGL UNIT FL (Visible when Sens battery charger type is selected.)
- **BATTERY TEMPERATURES**
  - BATT 1 TEMP AND BATT 2 TEMP

## GENERATOR

- GEN CONNECT
- GEN VAB
- GEN VBC
- GEN VCA
- GEN VAN
- GEN VBN
- GEN VCN
- GEN FREQ
- GEN AMPS A
- GEN AMPS B
- GEN AMPS C
- BUS CONNECT
- BUS VAB
- BUS VBC (Visible when three-phase bus connection is selected.)
- BUS VCA (Visible when three-phase bus connection is selected.)
- BUS FREQ
- **SYNCHRONIZER**
  - SLIP ANGLE
  - DELTA HERTZ
  - DELTA VOLTS
  - STATUS
- **MAX VECT SHIFT (Optional)**
- **MAX ROCOF (Optional)**
- **ROCOF (Optional)**

## POWER

- kW A
- kW B
- kW C
- kW TOTAL
- kVA A
- kVA B
- kVA C
- kVA TOTAL
- kvar A
- kvar B
- kvar C
- kvar TOTAL
- PF

## BIAS CONTROL (Visible when LSM-2020 is enabled.)

- var MODE
- PF MODE
- BL LV SRC
- BASELOAD LVL
- kvar SRC
- kvar SETPT
- PF SRC
- PF SETPT

## RUN STATISTICS

- **CUMULATIVE**
  - CUMULATIVE
    - START
    - # STARTS
    - HRS TO MAINT
    - kW-HRS
  - TOTAL RUN TIME
    - HOURS
    - MINUTES
    - ENGINE RUN TM SRC
  - LOADED RUN TIME
    - HOURS
    - MINUTES
  - UNLOADED RUN TIME
    - HOURS
    - MINUTES
- **SESSION**
  - SESSION
    - START
    - kW-HRS
  - TOTAL RUN TIME
    - HOURS
    - MINUTES
  - LOADED RUN TIME
    - HOURS
    - MINUTES
  - UNLOADED RUN TIME
    - HOURS
    - MINUTES

## ALARMS-STATUS

- **ACTIVE ALARMS**
- **ACTIVE PRE-ALARMS**
- **mtu FAULT CODES** (Visible when ECU is configured for *mtu* MDEC, *mtu* ADEC, or *mtu* ECU7/ECU8.)

- **mtu STATUS** (Visible when ECU is configured for *mtu* MDEC, *mtu* ADEC, *mtu* ECU7/ECU8, or *mtu* Smart Connect.)
  - NMT-ALIVE STATUS (Visible when ECU is configured for *mtu* MDEC or *mtu* ECU7/ECU8.)
    - SPS NODE
    - SW TYP
    - SW VAR
    - SW ED1
    - SW ED2
    - REV
    - SW MOD
  - TRIP FUEL (Visible when ECU is configured for *mtu* ECU7/ECU8.)
    - TRIP HRS
    - TRIP IDLE HRS
    - FUEL RATE
    - TRIP FL RATE
    - TOTAL RUN TM
    - DAILY FUEL
    - TOTAL FUEL
  - FUEL (Visible when ECU is configured for *mtu* ADEC.)
    - DAY TANK LVL
    - STORE TANK LVL
  - ENGINE STATUS (Visible when ECU is configured for *mtu* ADEC, *mtu* ECU7/ECU8, or *mtu* Smart Connect.)
    - *mtu* FAULT CODES
    - ENG RUNNING
    - CYL CUTOUT
    - ENG OPTIMIZED (Visible when ECU is configured for *mtu* ADEC or *mtu* ECU7/ECU8.)
    - PREHT NT RCHD (Visible when ECU is configured for *mtu* ADEC or *mtu* ECU7/ECU8.)
    - SPEC TORQUE (Visible when ECU is configured for *mtu* ADEC or *mtu* ECU7/ECU8.)
    - SPD DMD FL MD (Visible when ECU is configured for *mtu* ADEC.)
    - CURR P DEGREE (Visible when ECU is configured for *mtu* ADEC.)
    - LOAD GEN ON (Visible when ECU is configured for *mtu* ADEC, *mtu* ECU7/ECU8, or *mtu* Smart Connect.)
    - PRIME PUMP ON (Visible when ECU is configured for *mtu* ADEC.)
    - RUNUP SPD LO (Visible when ECU is configured for *mtu* ADEC.)
    - IDLE SPD LO (Visible when ECU is configured for *mtu* ADEC.)
    - CYL CUTOUT CD (Visible when ECU is configured for *mtu* ECU7/ECU8.)
    - RPM (Visible when ECU is configured for *mtu* ECU7/ECU8.)
    - DROOP % (Visible when ECU is configured for *mtu* ECU7/ECU8 or *mtu* Smart Connect.)
    - ENG COOL TEMP (Visible when ECU is configured for *mtu* ECU7/ECU8.)
    - CHRGR AIR TMP (Visible when ECU is configured for *mtu* ECU7/ECU8.)
    - INTRCOOLR TEMP (Visible when ECU is configured for *mtu* ECU7/ECU8.)
    - ENG OIL TEMP (Visible when ECU is configured for *mtu* ECU7/ECU8.)
    - FUEL TEMP (Visible when ECU is configured for *mtu* ECU7/ECU8.)
    - ECU TEMP (Visible when ECU is configured for *mtu* ECU7/ECU8.)
    - OIL PRESSURE (Visible when ECU is configured for *mtu* ECU7/ECU8.)
    - CHG AIR P (Visible when ECU is configured for *mtu* ECU7/ECU8.)
    - FUEL DELV P (Visible when ECU is configured for *mtu* ECU7/ECU8.)
    - FL RAIL P (Visible when ECU is configured for *mtu* ECU7/ECU8.)
    - CAMSHAFT RPM (Visible when ECU is configured for *mtu* ECU7/ECU8.)
    - IDLE RPM (Visible when ECU is configured for *mtu* ECU7/ECU8.)
    - ECU SHUTDOWN (Visible when ECU is configured for *mtu* ECU7/ECU8.)
    - TOTAL RUN TM (Visible when ECU is configured for *mtu* ECU7/ECU8.)
    - ECU SUPP VOLTS (Visible when ECU is configured for *mtu* ECU7/ECU8.)
    - INJCT DBR % (Visible when ECU is configured for *mtu* ECU7/ECU8.)
    - RATED RPM (Visible when ECU is configured for *mtu* ECU7/ECU8.)
    - INJCT QTY (Visible when ECU is configured for *mtu* ECU7/ECU8.)
    - RATED KW (Visible when ECU is configured for *mtu* ECU7/ECU8.)
    - RESRV PWR % (Visible when ECU is configured for *mtu* ECU7/ECU8.)
    - START SEQ (Visible when ECU is configured for *mtu* ECU7/ECU8 or *mtu* Smart Connect.)
    - ECU OVRD FDBK (Visible when ECU is configured for *mtu* Smart Connect.)
    - COOLNT PRHT DONE (Visible when ECU is configured for *mtu* Smart Connect.)
    - REQ TORQUE (Visible when ECU is configured for *mtu* Smart Connect.)
    - EXT STOP (Visible when ECU is configured for *mtu* Smart Connect.)
    - OPERATING MODE (Visible when ECU is configured for *mtu* Smart Connect.)

- SPEED (Visible when ECU is configured for *mtu* ADEC, *mtu* ECU7/ECU8, or *mtu* Smart Connect.)
  - SEL SPD DMD
  - EFF SET SPEED
  - CAN SPD DMD
  - ANLG SPD DMD
  - SPD DMD SRC (Visible when ECU is configured for *mtu* ADEC or ECU7/ECU8.)
  - RATED RPM (Visible when ECU is configured for *mtu* ECU7/ECU8.)
  - RPM (Visible when ECU is configured for *mtu* ECU7/ECU8.)
  - CAMSHAFT RPM (Visible when ECU is configured for *mtu* ECU7/ECU8.)
  - IDLE RPM (Visible when ECU is configured for *mtu* ECU7/ECU8.)
  - FREQ RPM DMD (Visible when ECU is configured for *mtu* ECU7/ECU8.)
  - SPD DMD FL MD (Visible when ECU is configured for *mtu* ECU7/ECU8.)
- SIGNL FEEDBK (Visible when ECU is configured for *mtu* ADEC, *mtu* ECU7/ECU8, or *mtu* Smart Connect.)
  - ECU\_OVRD\_FDBK
  - EXT STOP
  - SPD UP IN
  - SPD DN IN
  - CAN MODE FDBK
  - CYL CUTOUT (Visible when ECU is configured for *mtu* ECU7/ECU8.)
- DIAGNOSTICS (Visible when ECU is configured for *mtu* ECU7/ECU8.)
  - AL PWR AMP 1
  - AL PWR AMP 2
  - XSTR OUT AL
  - XSTR OUT STS
  - ECU SHUTDOWN
- CAN Bus (Visible when ECU is configured for *mtu* ECU7/ECU8.)
  - CAN MODE FDBK
  - CAN NODES
  - LOST NODES
- LIMITS (Visible when ECU is configured for *mtu* ECU7/ECU8.)
  - OIL PRESSURE
  - LO LIM OILP
  - LOLOLIM OILP
  - ENG COOL TEMP
  - CLNT LMT HI
  - CLNT LMT HIHI
  - CHRG AIR TMP
  - CHG AIR LMT HI
  - ECU SUPP VOLTS
  - L1L ECU VOLTS
  - L2L ECU VOLTS
  - U1L ECU VOLTS
  - U2I ECU VOLTS
  - INTRCOOLR TMP
  - INTCLR LMT HI
- **STATUS**
  - AUTO XFER SWITCH (Visible when the Auto Transfer Switch programmable function is configured to be driven by an input.)
    - AUTO XFER SWITCH
    - COMPLEMENTRY MODE
    - ATS N.O. INPUT
    - ATS N.C. INPUT
    - ATS CIRCUIT ERROR
    - ATS PROGFN STATUS
  - EPS SUPP. LOAD
  - GEN BREAKER
  - MAINS BREAKER
  - BATTLE OVERRIDE (Visible when the Battle Override programmable function is configured to be driven by an input.)
  - LOW LINE OVERRIDE (Visible when the Low Line Override programmable function is configured to be driven by an input.)
  - LOW COOL LEVEL (Visible when the Low Coolant Level programmable function is configured to be driven by an input.)

- BATT CHRГ FAIL (Visible when the Battery Charger Fail programmable function is configured to be driven by an input.)
- FUEL LEAK DETECT (Visible when the Fuel Leak Detect programmable function is configured to be driven by an input.)
- GRND DELTA O-RIDE (Visible when Generator Connection is configured for Delta and the Grounded Delta Override programmable function is configured to be driven by an input.)
- 1 PHASE O-RIDE (Visible when the 1-Phase Override programmable function is configured to be driven by an input.)
- 1 PHASE AC O-RIDE (Visible when the 1-Phase AC Override programmable function is configured to be driven by an input.)
- BUS DEAD
- BUS STABLE
- BUS FAILED
- BUS FWD ROT
- BUS REV ROT
- GEN DEAD
- GEN STABLE
- GEN FAILED
- GEN FWD ROT
- GEN REV ROT
- ENG RUNNING
- CLDN TMR ACTIVE
- OFF MODE COOLDN
- COOLDN REQ
- COOL & STOP REQ
- var MODE
- PF MODE
- EXT START DEL
- START DEL BYPASS
- ALT FRQ O-RIDE
- RESET
- ALARM SILENCE
- LAMP TEST
- IDLE REQUEST
- LOAD TAKEOVER
- MAINS FAIL TEST
- SYNCHRONIZING
- SYNC VOLT OK
- SYNC SLIP FRQ OK
- SYNC ANGLE OK
- SYNC BRK CL OK
- PARALLEL TO MAINS
- MF TRANSFR INHBT (Mains Fail Transfer Inhibit)
- AUTO BRKR OP INH (Automatic Breaker Operation Inhibit)
- LSM CONNECTED
- CEM CONNECTED
- AEM CONNECTED
- **INPUTS**
  - INPUT X (X = 1 to 16 (17 to 26 optional))
    - ACTIVATN DLY
- **OUTPUTS**
  - START
  - RUN
  - PRESTART
  - OUTPUT X (X = 1 to 12 (13 to 36 optional))
- **LOGIC CTL RELAYS**
  - LCR X (X = 1 to 16)
- **LSM INPUTS** (Visible when LSM-2020 is enabled.)
  - SCALED
  - RAW
    - LSM IN
- **ANALOG INPUTS** (Visible when AEM-2020 is enabled.)
  - SCALED
    - ALG IN X (X = 1 to 8)
  - RAW

- ALG IN X (X = 1 to 8)
- **THERMAL INPUTS** (Visible when AEM-2020 is enabled.)
  - SCALED
    - RTD IN X (X = 1 to 8)
    - THRM CPL X (X = 1 to 2)
  - RAW
    - RTD IN X (X = 1 to 8)
    - THRM CPL X (X = 1 to 2)
- **ANALOG OUTPUTS** (Visible when AEM-2020 is enabled.)
  - SCALED
    - ALG OUT X (X = 1 to 4)
  - RAW
    - ALG OUT X (X = 1 to 4)
- **ANALOG STATUS** (Visible when AEM-2020 is enabled.)
  - ANALOG STATUS
  - ALG IN X (X = 1 to 8)
    - ARMING DELAY
    - OVER 1 TIMER
    - ALG IN 1 O1
    - UNDER 1 TIMER
    - ALG IN 1 U1
    - OVER 2 TIMER
    - ALG IN 1 O2
    - UNDER 2 TIMER
    - ALG IN 1 U2
    - ALG IN 1 OOR
  - RTD IN X (X = 1 to 8)
    - ARMING DELAY
    - OVER 1 TIMER
    - RTD IN 1 O1
    - UNDER 1 TIMER
    - RTD IN 1 U1
    - OVER 2 TIMER
    - RTD IN 1 O2
    - UNDER 2 TIMER
    - RTD IN 1 U2
    - RTD IN 1 OOR
  - THRM CPL X (X = 1 or 2)
    - ARMING DELAY
    - OVER 1 TIMER
    - THRM CPL 1 O1
    - UNDER 1 TIMER
    - THRM CPL 1 U1
    - OVER 2 TIMER
    - THRM CPL 1 O2
    - UNDER 2 TIMER
    - THRM CPL 1 U2
    - THRM CPL 1 OOR
  - ALG OUT X (X = 1 TO 4)
    - ACTIVATN DLY
    - AEM OUT1 OUT RNG
- **CONF ELEMENTS**
  - SUMMARY VIEW
  - CONFIG ELEMENT X (X = 1 to 8)
    - CONFIG ELELENT X (X = 1 to 8)
    - ARMING DELAY
    - ACTIVATN DLY
- **CONFIG PROTECTION**
  - CONF PROT STATUS
  - CONF PROT X (X = 1 to 8)
    - ARMING DELAY
    - OVER 1 TIMER
    - CONF PROT 1 O1
    - UNDER 1 TIMER
    - CONF PROT 1 U1



- OVER 2 TIMER
  - CONF PROT 1 O2
  - UNDER 2 TIMER
  - CONF PROT 1 U2
- **TIMERS**
  - LOGIC TIMERS
    - TIMER X (X = 1 to 10)
      - HOURS
      - MINUTES
      - SECONDS
  - GENERATOR PROTECTION
    - 27 UNDERVOLTAGE
      - 27-X (X = 1 or 2)
        - ◆ ARMING DELAY
        - ◆ ACTIVATN DLY
    - 59 OVERVOLTAGE
      - 59-X (X = 1 or 2)
        - ◆ ARMING DELAY
        - ◆ ACTIVATN DLY
    - 47 PHASE IMBALANCE
      - ARMING DELAY
      - ACTIVATN DLY
    - 81 O/U FREQUENCY
      - UNDERFREQUENCY
        - ◆ ARMING DELAY
        - ◆ ACTIVATN DLY
      - OVERFREQUENCY
        - ◆ ARMING DELAY
        - ◆ ACTIVATN DLY
    - 32 REVERSE POWER
      - ARMING DELAY
      - ACTIVATN DLY
    - 40 LOSS OF EXCITATION
      - ARMING DELAY
      - ACTIVATN DLY
    - 81 ROCOF
      - ACTIVATN DLY
  - PRE-ALARMS
    - WEAK BATTERY
    - LOW BATT VOLT
    - HIGH FUEL LEVEL
    - LSM AVR OUT LMT
    - LSM GOV OUT LMT
  - ALARMS
    - HI COOL TMP ARM
    - HI COOL TMP ACTV
    - LO OIL PRESS ARM
    - LO OIL PRESS ATV
    - LOW FUEL LEVEL
  - SENDER FAIL
    - COOL SNDR FAIL
    - OIL SNDR FAIL
    - FUEL LVL SNDR
    - VOLTAGE SENSE
    - SPD SNDR FAIL
  - CRANKING
    - PRESTART
    - CRANKING
    - RESTING
    - RESTART DELAY
    - COOLING
  - AUTOMATIC RESTART
    - AUTO RESTART
  - PROG FUNCTIONS
    - BATT CHRG FAIL

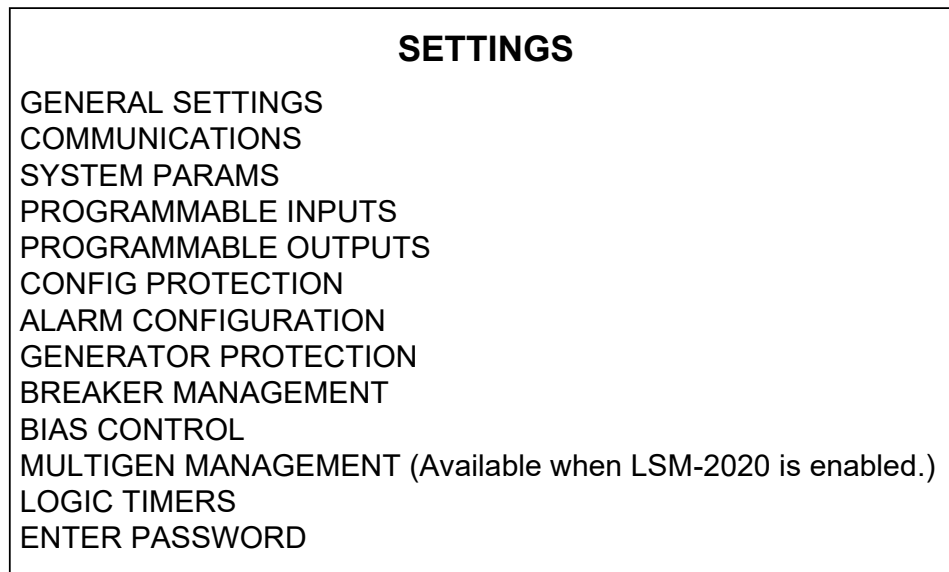
- LOW COOL LEVEL
    - FUEL LEAK DETECT
  - SYNCHRONIZER
    - FAIL DELAY
  - EXERCISER TIMER
    - SESSION LENGTH
    - SESSION ELAPSED TIME
    - TIME TO NEXT START
- **EVENT LOG**
  - [EVENT NAME]
    - ACTIVE
    - OCCURRENCE COUNT
    - FIRST DATE
    - FIRST TIME
    - LAST DATE
    - LAST TIME
    - FIRST ENG HRS
    - LAST ENG HRS
    - DETAILS
      - OCCURRENCE (Use the *Edit/Up/Down* keys to change the occurrence.)
      - DATE
      - TIME
      - ENG HRS
    - CLEAR EVENT (Visible when logged in through the front panel.)
- **J1939 DATA** (Visible when CAN Bus is enabled and ECU is configured for Standard, Volvo Penta, *mtu* ADEC, GM/Doosan, Cummins, Scania, John Deere, Isuzu, Daimler CPC4, or Yanmar.)
  - ENGINE ECU ADDR
  - THROTTLE POSITN
  - LOAD @ CRNT RPM
  - ACTUAL ENG TORQ
  - ENGINE SPEED
  - INJ CNTRL PRESS
  - INJ RAIL PRS
  - ENGINE HOURS
  - TRIP FUEL
  - TOTAL FUEL USED
  - ENG COOLANT TEMP
  - FUEL TEMP
  - ENG OIL TEMP
  - ENG INTCLR TEMP
  - FUEL DELV P
  - ENG OIL LEVEL
  - ENG OIL PRESS
  - COOLANT PRESS
  - COOLANT LEVEL
  - FUEL RATE
  - BAROMETRIC PRESS
  - AMB AIR TEMP
  - AIR INLET TEMP
  - BOOST PRESS
  - INTAK MNFLD TEMP
  - AIR FLTR DIF PRS
  - EXHAUST GAS TEMP
  - BATTERY VOLTAGE
  - ECU INPUT VOLTS
  - TRANS OIL PRESS
  - TRANS OIL TEMP
  - WINDG 1 TEMP
  - WINDG 2 TEMP
  - WINDG 3 TEMP
  - ECU TEMP
  - AUX PRESSURE1
  - AUX PRESSURE2
  - RATED KW
  - RATED RPM

- EXHAUST TMP A
- EXHAUST TMP B
- CHRG AIR TMP
- FUEL 1 LEAK
- FUEL 2 LEAK
- ALARM RST FDBK
- ECU SHUTDOWN
- DEF TANK 1 LVL %
- DEF TANK 2 LVL %
- DPF SOOT LEVEL %
- DPF ASH LEVEL %
- CRANKCASE PRESSURE
- FUEL FLT DF PRS
- OIL FLTR DIFF PRS
- **J1939 ENGINE CONFIG** (Visible when ECU is configured for Standard, Volvo Penta, *mtu* ADEC, GM/Doosan, Cummins, Isuzu, Daimler CPC4, or Yanmar.)
  - SPD @ IDLE PNT 1
  - TRQ @ IDLE PNT 1
  - SPD @ PNT 2
  - TRQ @ PNT 2
  - SPD @ PNT 3
  - TRQ @ PNT 3
  - SPD @ PNT 4
  - TRQ @ PNT 4
  - SPD @ PNT 5
  - TRQ @ PNT 5
  - SPD @ PNT 6
  - ENDSPEED GOV KP
  - REF ENG TORQUE
  - O-RIDE SPD PNT 7
  - O-RIDE TIME LMT
  - SPEED LOWER LMT
  - SPEED UPPER LMT
  - TORQUE LOWER LMT
  - TORQUE UPPER LMT
- **J1939 ECU LAMP STATUS**
  - WARNING LAMP
  - RED LAMP
  - PROTECT LAMP
  - MALFUNC LAMP
- **J1939 ACTIVE DTC** (Visible when DTC support is enabled and any ECU type is selected.)
- **J1939 PREV DTC** (Visible when DTC support is enabled and any ECU type is selected.)
- **J1939 DTC CLEAR** (Visible when DTC support is enabled and any ECU type is selected.)
  - CLEAR ACTIVE DTCS
  - CLEAR PREV DTCS
- **YANMAR STATUS** (Visible when ECU is configured for Yanmar.)
  - REGEN STATUS
    - REGENERATION STATE
    - MAN RGN REQ STATE
    - MAN REGEN STATUS
    - RGN INH PULSE STATE
    - REGEN PROGRESS
  - EGR STATUS
    - EGR INDUCEMENT
    - TIME AT INDUC LEVEL
    - PENDING EGR INDUCMT
  - AMB AIR TEMP
  - INTK MANIFLD PRESSURE
  - EXH MANIFOLD PRESSURE
  - DOC INLET TEMP
  - DOC OUTLET TEMP
  - DPF SOOT LEVEL %
  - DPF ASH LEVEL %
  - REGEN INTRLK STATUS
  - REGEN MODE

- REGEN REQ FLG
  - ASH CLEAN REQ
- **DEUTZ STATUS**
  - EPA PGN1
    - RESTRICTN DEF LEVEL
    - DEF LEVEL
  - EPA PGN2
    - RESTRICTN DEF QUALITY
  - EPA PGN3
    - INDUCEMENT REASON
- **NETWORK STATUS** (Visible when Multiple Generator is selected as System Type.)
  - SYSTEM MANAGER (Displays "0" when LSM-2020 is not connected.)
  - NUMBER OF UNITS (Displays "0" when LSM-2020 is not connected.)
  - ID (Visible when LSM-2020 is connected.)
  - NUM ON LINE (Displays "0" when LSM-2020 is not connected.)
  - ID X (X = 1 to 16) (The ID of each online unit is displayed)
  - SYS KW CAP
  - SYS GEN KW
  - SYS GEN KVAR
- **SEQUENCING STATUS** (Visible when Demand Start/Stop is enabled.)
  - NEXT TO START (Displays "0" when LSM-2020 is not connected.)
  - NEXT TO STOP (Displays "0" when LSM-2020 is not connected.)
  - START TMR 1
  - START TMR 2
  - STOP TIMER
  - WATT DEMAND
  - MODE
  - SEQUENCE ID (Displays "0" when LSM-2020 is not connected.)
  - SYSTEM MANAGER (Displays "0" when LSM-2020 is not connected.)
  - START LVL 1
  - START LVL 2
  - STOP LVL
  - START TD 1
  - START TD 2
  - STOP TD
- **MAINS FAIL TRANSFER** (Visible when Mains Fail Transfer is enabled.)
  - MAINSFAL XFER STATE
    - DISABLED ( The possible mains fail transfer states are as follows: Power From Mains, Transfer Timer Active, Transferring to Gens, Power From Gens, Return Timer Active, Transferring to Mains, Disabled (when DGC is in Off or Run modes, or in the alarm state))
  - TRANSFER DELAY (Visible when actively counting and relevant to mains fail transfer.)
  - RETURN DELAY (Visible when actively counting and relevant to mains fail transfer.)
  - MAX TRANSFER TIME (Visible when actively counting and relevant to mains fail transfer.)
  - MAX PARALLEL TIME (Visible when actively counting and relevant to mains fail transfer.)
  - OPEN TRANS DELAY (Visible when actively counting and relevant to mains fail transfer.)

## DIAGNOSTICS

- **MODBUS RD**
- **MODBUS WR**
- **FLASH WR**
- **CANBus**
- **EX ADDR**
- **EX VEC**
- **EVENT LOG**
- **SENDER INPUTS**



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Figure 2-3. Settings Screen Branches

## GENERAL SETTINGS

- **FRONT PANEL HMI**
  - SUMMARY VIEW
  - SCROLL DELAY
  - PH TOG DELAY
  - LCD CONTRAST
  - SLEEP MODE
  - LANGUAGE
  - CONFIGURABLE METERING
    - ITEM X (X = 1 to 20)
  - ONE-LINE DIAGRAM
  - ENG HRS DISPLAY
  - OVERVIEW
  - EXH DISPLAY
  - EXH DISPL SCRΝ
  - BATT CHG DISPLAY
  - DISPLAY FL LEVEL BELOW
  - DEF DISPLAY
  - BATTERY/RPM DISPLAY
- **CONFIGURE DATE/TIME**
  - YEAR
  - MONTH
  - DAY
  - HOURS
  - MINUTES
  - SECONDS
  - UTC OFFSET
  - DST ENABLED
  - CLK NOT SET WRN
- **VIEW DATE/TIME**
- **VERSION INFO**
  - DGC-2020
    - FIRMWARE VERSION
    - BOOT CODE VERSION
    - SERIAL NUMBER
    - PART NUMBER
    - MODEL NUMBER
    - LANGUAGE VERSION
    - LANGUAGE PART NUM

- FONT VERSION
- FONT PART NUM
- STYLE CODE
- LSM-2020 (Visible when LSM-2020 is enabled.)
  - VERSION INFO
    - FIRMWARE VERSION
    - BOOT CODE VERSION
  - TCP/IP SETTINGS
    - IP ADDRESS
    - SUBNET MASK
    - GATEWAY ADDRESS
    - DHCP ENABLE
- CEM-2020 (Visible when CEM-2020 is enabled.)
  - FIRMWARE VERSION
  - BOOT CODE VERSION
  - SERIAL NUMBER
  - PART NUMBER
  - MODEL NUMBER
  - BUILD DATE
- AEM-2020 (Visible when AEM-2020 is enabled.)
  - FIRMWARE VERSION
  - BOOT CODE VERSION
  - SERIAL NUMBER
  - PART NUMBER
  - MODEL NUMBER
  - BUILD DATE

## COMMUNICATIONS

### • CAN Bus SETUP

- CAN Bus SETUP
  - CAN Bus ENABLE
  - DTC ENABLE (Visible when CAN Bus is enabled.)
  - SPN CONV METHOD (Visible when CAN Bus is enabled.)
  - CAN Bus ADDR (Visible when CAN Bus is enabled.)
  - ECU OPT SLCT (Visible when CAN Bus is enabled.)
  - ECU PULSING (Visible when CAN Bus is enabled.)
  - ENG SHTDN TM (Visible when CAN Bus is enabled.)
  - PLS CYCL TM (Visible when CAN Bus is enabled.)
  - ECU SET TM (Visible when CAN Bus is enabled.)
  - RESP TIMEOUT (Visible when CAN Bus is enabled.)
  - COOL TEMP SRC (Visible when CAN Bus is enabled.)
  - OIL PRESS SRC (Visible when CAN Bus is enabled.)
  - ENGINE RUN TM SRC (Visible when CAN Bus is enabled.)
- ECU SETUP (Visible when CAN Bus is enabled.)
  - ECU CONF
  - ISUZU ECU SETUP
    - CLEAR ECU MEMORY
    - ESCAPE MODE
  - CUMMINS ECU SETUP
    - CUMMINS GEN CONTROL
  - YANMAR ECU SETUP (Visible when ECU is configured for Yanmar.)
    - NUMBER OF CYLINDERS
  - GEN DATA TRANSMIT (Visible when ECU is configured for Standard, Volvo Penta, *mtu* ADEC, GM/Doosan, Cummins, *mtu* Smart Connect, Isuzu, Daimler CPC4, Yanmar, or Deutz.)
  - ENGINE PARAM XMT
  - TRIP RESET (Visible when ECU is configured for Standard, Volvo Penta, *mtu* ADEC, GM/Doosan, Cummins, *mtu* Smart Connect, Isuzu, Daimler CPC4, Yanmar, or Deutz.)
  - DPF REGENRATE SETUP (Visible when ECU is configured for Standard, Volvo Penta, *mtu* ADEC, GM/Doosan, Cummins, *mtu* Smart Connect, Daimler CPC4, Yanmar, or Deutz.)
    - DPF MANUAL REGEN
    - DPF REGEN DISABLE
  - SPEED SELECT (Visible when ECU is configured for Volvo Penta.)
  - ACCEL POSITION (Visible when ECU is configured for Volvo Penta.)
  - MODULE TYPE (Visible when ECU is configured for *mtu* MDEC or *mtu* ECU7/ECU8.)

- ALIVE MSG (Visible when ECU is configured for *mtu* MDEC or *mtu* ECU7/ECU8.)
- START MODE
- SPEED SETUP (Visible when ECU is configured for Standard, Volvo Penta, *mtu* ADEC, *mtu* MDEC 304, *mtu* ECU7/ECU8, *mtu* Smart Connect, Isuzu, Daimler CPC4, Yanmar, or Deutz.)
  - J1939 RPM ENABLE (Visible when ECU is configured for Standard, Volvo Penta, *mtu* ADEC, GM/Doosan, Cummins, *mtu* Smart Connect, Isuzu, Daimler CPC4, Yanmar, or Deutz.)
  - ENGINE RPM
  - SAVE RPM ADJUSTS
  - RPM BAND WIDTH
  - IDLE RPM
  - RPM CHECKSUM (Visible when ECU is configured for Standard, Volvo, *mtu* ADEC, GM/Doosan, Cummins, *mtu* Smart Connect, Scania, John Deere, Isuzu, Daimler CPC4, Yanmar, or Deutz.)
  - SPEED UP (Visible when ECU is configured for *mtu* ADEC, *mtu* MDEC 304, *mtu* ECU7/ECU8, or *mtu* Smart Connect.)
  - SPEED DN (Visible when ECU is configured for *mtu* ADEC, *mtu* MDEC 304, *mtu* ECU7/ECU8, or *mtu* Smart Connect.)
  - TEST OVRSPEED (Visible when ECU is configured for *mtu* ADEC, *mtu* MDEC 304, *mtu* ECU7/ECU8, or *mtu* Smart Connect.)
  - SPD DMAND SRC (Visible when ECU is configured for *mtu* MDEC 304, *mtu* ECU7/ECU8, or *mtu* Smart Connect.)
  - IDLE REQUEST (Visible when ECU is configured for *mtu* MDEC 304, *mtu* ECU7/ECU8, or *mtu* Smart Connect.)
  - INCREASE IDLE (Visible when ECU is configured for *mtu* MDEC 304, or *mtu* ECU7/ECU8.)
- ECU SETUP (Visible when ECU is configured for *mtu* ADEC, *mtu* ECU7/ECU8, or *mtu* Smart Connect.)
  - TRIP RESET (Visible when ECU is configured for *mtu* ECU7/ECU8.)
  - INT OIL PRIME
  - GOV PRM SW (Visible when ECU is configured for *mtu* ADEC or *mtu* Smart Connect.)
  - ENG STRT PRIME (Visible when ECU is configured for *mtu* ECU7/ECU8.)
  - FAN OVERRIDE (Visible when ECU is configured for *mtu* ECU7/ECU8.)
  - MODE SWITCH (Visible when ECU is configured for *mtu* ECU7/ECU8.)
  - GOV PARAM SET (Visible when ECU is configured for *mtu* ECU7/ECU8.)
  - CAN RATING SW 1 (Visible when ECU is configured for *mtu* ECU7/ECU8.)
  - CAN RATING SW 2 (Visible when ECU is configured for *mtu* ECU7/ECU8.)
  - DIS CYL CUT 1 (Visible when ECU is configured for *mtu* ECU7/ECU8.)
  - DIS CYL CUT 2 (Visible when ECU is configured for *mtu* ECU7/ECU8 or *mtu* Smart Connect.)
  - OPERATING MODE (Visible when ECU is configured for *mtu* Smart Connect.)
  - CAN START/STOP (Visible when ECU is configured for *mtu* ECU7/ECU8 or *mtu* ADEC or *mtu* Smart Connect.)
- VOLT REG SETUP (Visible when ECU is configured for Standard, Volvo Penta, *mtu* ADEC, GM/Doosan, Cummins, *mtu* Smart Connect, Scania, John Deere, Isuzu, Daimler CPC4, Yanmar, or Deutz.)
  - AVR TYPE
  - PRIMARY VOLT
  - ALTERNATE VOLT
  - VOLT BAND WIDTH
  - FIELD CURRENT
  - PRIMARY UF HZ
  - ALTERNATE UF HZ
  - UNDERFREQ SLOPE
- BATT CHARGER SETUP (Visible when ECU is configured for Standard, Volvo Penta, *mtu* ADEC, GM/Doosan, Cummins, *mtu* Smart Connect, Scania, John Deere, Isuzu, Daimler CPC4, Yanmar, or Deutz.)
  - CHARGER 1 TYPE
  - CHARGER 2 TYPE
- BATTERY CHARGR PREALARMS (Visible when battery charger type is Standard.)
  - COMMS FAIL
  - BATTERY FAIL
  - CHARGER FAIL
  - AC OFF

- SENS CHARGR PREALARMS (Visible when battery charger type is Sens.)
    - THERMAL LIMIT
    - HI DC VOLTS
    - LOW DC VOLTS
    - LO CRANK V
    - INVLD SETTNGS
    - SNGL UNIT FL
- **MODEM SETUP** (Visible when Dial-Out Modem style option is R.)
  - DIALOUT X (X = 1 TO 4)
  - PAGER ID X (X = 1 TO 4)
  - RINGS FOR ANSWER
  - OFFLN DELAY
  - DIALOUT DLY
  - PGR BUFF LMT
  - PGR COM
- **RS485 SETUP**
  - COMM BAUD
  - COMM PARITY
  - MODBUS ADDR
  - AUTO SAVE
  - LEGACY MODBUS

## SYSTEM PARAMS

- **SYSTEM SETTINGS**
  - GEN CONNECT
  - BUS CONNECT
  - RATED kW
  - RATED VOLTS
  - RATED FREQ
  - ALTRNATE FRQ
  - RATED RPM
  - RATED PF
  - ROTATION
  - SYSTEM TYPE
  - EPS
    - EPS THRESHLD
    - LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
  - FUEL LEVEL SETUP
    - FUEL LVL TYP
    - FUEL LVL SRC (Visible when AEM-2020 is enabled)
    - FL MAX ALG % (Visible when AEM-2020 is enabled)
    - FL MIN ALG % (Visible when AEM-2020 is enabled)
  - SYSTEM UNITS
  - PRESSURE UNITS (Visible when Metric is selected for System Units.)
  - BATTERY VOLT
  - FLYWHL TEETH
  - SPEED SOURCE
  - MAINT RESET
  - NFPA LEVEL
  - POWER UP DELAY
- **REMOTE MODULE SETUP**
  - LSM SETUP
    - ENABLE
    - CAN Bus ADDRESS (Visible when LSM-2020 is enabled.)
    - AUX IN SRC
    - VERSION INFO (Visible when LSM-2020 is enabled.)
      - FIRMWARE VERSION
      - BOOT CODE VERSION
    - TCP/IP SETTINGS (Visible when LSM-2020 is enabled.)
      - IP ADDRESS
      - SUBNET MASK
      - GATEWAY ADDRESS
      - DHCP ENABLE



- LOAD SHARE DEBUG (Visible when LSM-2020 is enabled.)
    - FDBK VOLT
    - AUX VOLT
    - AUX CURR
    - SPEED BIAS
    - VOLT BIAS
    - WATT DEMAND
    - kW TOTAL
    - RATED kW
    - var DEMAND
    - kvar TOTAL
    - RATED kvar
    - LSM RT BIN
    - DGC RT BIN
  - CEM SETUP
    - ENABLE
    - OUTPUTS (Visible when CEM-2020 is enabled.)
    - CAN Bus ADDR (Visible when CEM-2020 is enabled.)
    - VERSION INFO (Visible when CEM-2020 is enabled.)
      - FIRMWARE VERSION
      - BOOT CODE VERSION
      - SERIAL NUMBER
      - PART NUMBER
      - MODEL NUMBER
      - BUILD DATE
    - CEM DEBUG MENU (Visible when CEM-2020 is enabled.)
      - DGC TO CEM BP
      - CEM TO DGC BP
  - AEM SETUP
    - ENABLE
    - CAN Bus ADDR (Visible when AEM-2020 is enabled.)
    - VERSION INFO (Visible when AEM-2020 is enabled.)
      - FIRMWARE VERSION
      - BOOT CODE VERSION
      - SERIAL NUMBER
      - PART NUMBER
      - MODEL NUMBER
      - BUILD DATE
    - AEM DEBUG MENU (Visible when AEM-2020 is enabled.)
      - DGC TO AEM BP
      - AEM TO DGC BP
      - ANALOG INPUTS
        - ◆ SCALED
          - ◇ ALG IN X (X = 1 TO 8)
        - ◆ RAW
          - ◇ ALG IN X (X = 1 TO 8)
      - THERMAL INPUTS
        - ◆ SCALED
          - ◇ RTD IN X (X = 1 TO 8)
          - ◇ THRM CPL X (X = 1 TO 2)
          - ◇ AMBIENT
        - ◆ RAW
          - ◇ RTD IN X (X = 1 TO 8)
          - ◇ THRM CPL X (X = 1 TO 2)
      - ANALOG OUTPUTS
        - ◆ SCALED
          - ◇ ALG OUT X (X = 1 TO 4)
        - ◆ RAW
          - ◇ ALG OUT X (X = 1 TO 4)
- CRANK SETTINGS
  - DISCNCT LMIT
  - PRECRNK DELY
  - PRESTRT CNTCT
  - STYLE
  - # CYCLES (Visible when Cycle is selected for Cranking Style.)

- CONT TIME (Visible when Continuous is selected for Cranking Style.)
- CYCLE TIME
- REST TIME
- MIN CRANK TIME
- COOLDWN TIME
- COOLDOWN CONFIG
- RESTART DELAY
- OFF MODE COOLDN
- PRESTART REST CONFIG
  - CONF
- OIL PRS CRANK DISC
  - ENABLE
  - CRANK DISC PRS
- **AUTOMATIC RESTART**
  - ENABLE
  - ATTEMPTS
  - INTERVAL
- **EXERCISE TIMER**
  - MODE
  - WEEK INTERVAL (Visible when Mode is set to N Week Intervals.)
  - START DAY OF MONTH (Visible when Mode is set to Monthly.)
  - WEEK OF MONTH (Visible when Mode is set to Weekday of Month.)
  - DAY OF WEEK (Visible when Mode is set to Weekly or Weekday of Month.)
  - START HOUR
  - START MINUTE
  - RUN HOURS
  - RUN MINUTES
  - BEGIN DATE MONTH (Visible when Mode is set to N Week Intervals.)
  - BEGIN DATE DAY (Visible when Mode is set to N Week Intervals.)
  - BEGIN DATE YR (Visible when Mode is set to N Week Intervals.)
  - RUN WITH LOAD
- **SENSING TRANS**
  - GEN PT PRI V
  - GEN PT SEC V
  - GEN CT PRI A
  - CT LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
  - BUS PT PRI V
  - BUS PT SEC V
- **RELAY CONTROL**
  - START
  - RUN
  - PRESTART
- **AUTO CONFIG DETECT**
  - ENABLE
  - LOW LINE THRESH
  - 1-PH THRESH
  - 1-PH GEN CONN
- **ENGINE STATISTICS**
  - START YEAR
  - START MONTH
  - START DAY
  - # STARTS
  - HRS TO MAINT
  - kW-HRS
  - TOTAL HRS
  - LOADED HRS
  - UNLOADED HRS

## PROGRAMMABLE INPUTS

- **CONFIGURABLE INPUTS**
  - INPUT X (X = 1 to 26)
    - ALARM CONFIG
    - ACTIVATN DLY
    - RECOGNITION

- NAME
- **PROG FUNCTIONS**
  - AUTO XFER SWITCH
    - INPUT MODE
    - N.O. INPUT
    - N.C. INPUT (Visible when INPUT MODE is complementary.)
    - CIRCUIT ERROR DELAY (Visible when INPUT MODE is complementary.)
    - CIRCUIT ERROR ACTION (Visible when INPUT MODE is complementary.)
  - GRND DELTA O-RIDE
    - INPUT
    - RECOGNITION (Visible when an INPUT is selected.)
  - BATTLE OVERRIDE
    - INPUT
    - RECOGNITION (Visible when an INPUT is selected.)
  - LOW LINE OVERRIDE
    - INPUT
    - RECOGNITION (Visible when an INPUT is selected.)
  - 1 PHASE O-RIDE
    - INPUT
    - RECOGNITION (Visible when an INPUT is selected.)
    - 1 PH O-RIDE CFG (Visible when an INPUT is selected.)
  - 1 PHASE AC O-RIDE
    - INPUT
    - RECOGNITION (Visible when an INPUT is selected.)
  - BATT CHRG FAIL
    - INPUT
    - ALARM CONFIG (Visible when an INPUT is selected.)
    - ACTIVATN DLY (Visible when an INPUT is selected.)
  - LOW COOL LEVEL
    - INPUT
    - ALARM CONFIG (Visible when an INPUT is selected.)
    - ACTIVATN DLY (Visible when an INPUT is selected.)
  - FUEL LEAK DETECT
    - INPUT
    - ALARM CONFIG (Visible when an INPUT is selected.)
    - ACTIVATN DLY (Visible when an INPUT is selected.)
- **LSM INPUTS** (Visible when LSM-2020 is enabled.)
  - ALG IN 1
    - INPUT TYPE
    - MIN VOLTAGE
    - MAX VOLTAGE
    - MIN CURRENT
    - MAX CURRENT
- **ANALOG INPUTS** (Visible when AEM-2020 is enabled.)
  - ALG IN X (X = 1 to 8)
    - INPUT TYPE
    - MIN VOLTAGE
    - MAX VOLTAGE
    - MIN CURRENT
    - MAX CURRENT
    - PARAM MIN
    - PARAM MAX
    - OVER 1
      - THRESHOLD
      - ALARM CONFIG
    - OVER 2
      - THRESHOLD
      - ALARM CONFIG
    - UNDER 1
      - THRESHOLD
      - ALARM CONFIG
    - UNDER 2
      - THRESHOLD
      - ALARM CONFIG
    - ARMING DELAY

- THR1 ACT DLY
  - THR2 ACT DLY
  - HYSTERESIS
  - OOR ALM CFG
  - NAME
- **THERMAL INPUTS** (Visible when AEM-2020 is enabled.)
  - RTD IN X (X = 1 to 8)
    - TYPE
    - OVER 1
      - THRESHOLD
      - ALARM CONFIG
    - OVER 2
      - THRESHOLD
      - ALARM CONFIG
    - UNDER 1
      - THRESHOLD
      - ALARM CONFIG
    - UNDER 2
      - THRESHOLD
      - ALARM CONFIG
    - ARMING DELAY
    - THR1 ACT DLY
    - THR2 ACT DLY
    - HYSTERESIS
    - OOR ALM CFG
    - NAME
  - THRM CPL X (X = 1 to 2)
    - OVER 1
      - THRESHOLD
      - ALARM CONFIG
    - OVER 2
      - THRESHOLD
      - ALARM CONFIG
    - UNDER 1
      - THRESHOLD
      - ALARM CONFIG
    - UNDER 2
      - THRESHOLD
      - ALARM CONFIG
    - ARMING DELAY
    - THR1 ACT DLY
    - THR2 ACT DLY
    - HYSTERESIS
    - OOR ALM CFG
    - NAME

## PROGRAMMABLE OUTPUTS

- **OUTPUTS**
  - OUTPUT X (X = 1 to 12) (X = 1 to 36 when CEM-2020 is enabled.)
    - NAME
- **CONFIG ELEMENTS**
  - CONFIG ELEMENT X (X = 1 to 8)
    - ALARM CONFIG
    - ACTIVATN DLY
    - RECOGNITION
    - NAME
- **ANALOG OUTPUTS** (Visible when AEM-2020 is enabled.)
  - ANALOG OUTPUT X (X = 1 to 4)
    - OUTPUT TYPE
    - MIN VOLTAGE
    - MAX VOLTAGE
    - MIN CURRENT
    - MAX CURRENT
    - PARAM MIN

- PARAM MAX
- OOR ALM CFG
- OOR ACT DLY
- PARAM

## CONFIG PROTECTION

- **SCALE FACTORS**
  - ALT FREQ SF
  - VOLT LO LINE SF
  - AMPS LO LINE SF
- **CONFIG PROT X (X = 1 to 9)**
  - PARAM
  - OVER 1
    - THRESHOLD
    - ALARM CONFIG
  - OVER 2
    - THRESHOLD
    - ALARM CONFIG
  - UNDER 1
    - THRESHOLD
    - ALARM CONFIG
  - UNDER 2
    - THRESHOLD
    - ALARM CONFIG
  - ARMING DELAY
  - THR1 ACT DLY
  - THR2 ACT DLY
  - HYSTERESIS
  - NAME

## ALARM CONFIGURATION

- **HORN CONFIGURATION**
  - HORN
  - NOT IN AUTO HORN
- **PRE-ALARMS**
  - HIGH COOLANT TEMP
    - ENABLE
    - THRESHOLD
  - LOW COOLANT TEMP
    - ENABLE
    - THRESHOLD
  - LOW OIL PRESSURE
    - ENABLE
    - THRESHOLD
  - LOW FUEL LEVEL
    - ENABLE
    - THRESHOLD
  - ENGINE OVERLOAD
    - ENG kW OVRLD-X (X = 1 to 3)
      - ENABLE
      - LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
      - 3 PHASE SETTINGS
        - ◆ THRESHOLD
        - ◆ HYSTERESIS
      - 1 PHASE SETTINGS
        - ◆ THRESHOLD
        - ◆ HYSTERESIS
  - MAINTENANCE INTERVAL
    - ENABLE
    - THRESHOLD
  - BATTERY OVERVOLTAGE
    - ENABLE

- THRESHOLD
- LOW BATTERY VOLTAGE
  - ENABLE
  - THRESHOLD
  - ACTIVATN DLY
- WEAK BATTERY VOLTAGE
  - ENABLE
  - THRESHOLD
  - ACTIVATN DLY
- HIGH FUEL LEVEL
  - ENABLE
  - THRESHOLD
  - ACTIVATN DLY
- ACTIVE DTC (Visible when DTC is enabled.)
  - ENABLE
- ECU COMMS FAIL (Visible when CAN Bus is enabled.)
  - ENABLE
- COOLANT LEVEL (Visible when CAN Bus is enabled.)
  - ENABLE
  - THRESHOLD
- AVR OUTPUT LIMIT (Visible when LSM-2020 is enabled.)
  - ENABLE
  - ACTIVATN DLY
- GOV OUTPUT LIMIT (Visible when LSM-2020 is enabled.)
  - ENABLE
  - ACTIVATN DLY
- INTERGENSET COMM FAIL (Visible when LSM-2020 is enabled.)
  - ENABLE
- LSM COMM FAIL (Visible when LSM-2020 is enabled.)
  - ENABLE
- CEM COMM FAIL (Visible when CEM-2020 is enabled.)
  - ENABLE
- AEM COMM FAIL (Visible when AEM-2020 is enabled.)
  - ENABLE
- ID MISSING (Visible when LSM-2020 is enabled.)
  - ENABLE
- ID REPEAT (Visible when LSM-2020 is enabled.)
  - ENABLE
- CHECKSUM FAIL
  - ENABLE
- SYNC FAIL PALM
  - ENABLE
- BRK CLOSE FAIL PALM
  - ENABLE
  - MONITOR
- BRK OPEN FAIL PALM
  - ENABLE
  - MONITOR
- REVERSE ROTATION
  - ENABLE
- DEF PREALARMS
  - ENABLE
- **ALARMS**
  - HIGH COOLANT TEMP
    - ENABLE
    - THRESHOLD
    - ARMING DELAY
  - LOW OIL PRESSURE
    - ENABLE
    - THRESHOLD
    - ARMING DELAY
  - LOW FUEL LEVEL
    - ENABLE
    - THRESHOLD
    - ACTIVATN DLY

- OVERSPEED
  - ENABLE
  - THRESHOLD
  - ACTIVATN DLY
- COOLANT LEVEL (Visible when CAN Bus is enabled.)
  - ENABLE
  - THRESHOLD
- CAN LOW COOL LEVEL (Visible when CAN Bus is enabled.)
  - ENABLE

### Note

The HIGH COOLANT TEMP and LOW OIL PRESSURE alarms have an ARMING DELAY setting that disables the alarm for the specified time after engine startup.

## • SENDER FAIL

- COOL TEMP SENDR FAIL
  - CONFIG TYPE
  - RECOGNITION
  - ACTIVATN DLY
  - MIN OHMS
  - MAX OHMS
  - SF DISPLAY
- OIL PRESS SENDR FAIL
  - CONFIG TYPE
  - RECOGNITION
  - ACTIVATN DLY
  - MIN OHMS
  - MAX OHMS
  - SF DISPLAY
- FUEL LEVL SENDR FAIL
  - CONFIG TYPE
  - RECOGNITION
  - ACTIVATN DLY
  - MIN OHMS
  - MAX OHMS
  - SF DISPLAY
- VOLTAGE SENSE FAIL
  - CONFIG TYPE
  - ACTIVATN DLY
- SPEED SENDR FAIL
  - TIME DELAY

## GENERATOR PROTECTION

## • 27 UNDERVOLTAGE

- 27-1 / 27-2
  - LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
  - 3 / 1 PHASE SETTINGS
    - PICKUP
    - HYSTERESIS
    - TIME DELAY
    - FREQ INHIBIT
    - ALARM CONFIG
  - ARMING DELAY

## • 59 OVERVOLTAGE

- 59-1 / 59-2
  - LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
  - 3 / 1 PHASE SETTINGS
    - PICKUP
    - HYSTERESIS

- TIME DELAY
    - ALARM CONFIG
  - ARMING DELAY
- **47 PHASE IMBALANCE (Optional)**
  - PICKUP
  - HYSTERESIS
  - TIME DELAY
  - ALARM CONFIG
  - LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
  - ARMING DELAY
- **81 O/U FREQUENCY**
  - UNDERFREQUENCY
    - INHIBIT VOLTS
    - PICKUP
    - HYSTERESIS
    - TIME DELAY
    - ALARM CONFIG
  - OVERFREQUENCY
    - PICKUP
    - HYSTERESIS
    - TIME DELAY
    - ALARM CONFIG
  - ALTRNT FRQ SCALE FCTR
    - ALT FREQ SF
  - ARMING DELAY
- **51 OVERCURRENT (Optional)**
  - 51-1 / 51-2 / 51-3
    - LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
    - 3 / 1 PHASE SETTINGS
      - PICKUP
      - TIME DIAL
      - CURVE
      - ALARM CONFIG
      - RESET TYPE
    - PROG CURVE CONSTANTS
      - A
      - B
      - C
      - N
      - R
- **32 REVERSE POWER**
  - 3 / 1 PHASE SETTINGS
    - PICKUP
    - HYSTERESIS
    - TIME DELAY
    - ALARM CONFIG
  - ARMING DELAY
- **40 LOSS OF EXCITATION**
  - 3 / 1 PHASE SETTINGS
    - PICKUP
    - HYSTERESIS
    - TIME DELAY
    - ALARM CONFIG
  - ARMING DELAY
- **LOSS OF MAINS PROTECT (Optional)**
  - 78 VECTOR SHIFT
    - PICKUP
    - ALARM CONFIG
    - OPEN MAINS ON TRP
    - OPEN GEN ON TRP
  - 81 ROCOF
    - PICKUP
    - TIME DELAY
    - ALARM CONFIG



- OPEN MAINS ON TRP
- OPEN GEN ON TRP

## BREAKER MANAGEMENT

- **BREAKER HARDWARE**
  - MAINS FAIL TRANSFER
    - ENABLE
    - RETURN DELAY
    - TRANSFER DELAY
    - MAX TRANSFER TIME
    - TRANSFER TYPE
    - IN PHASE MON EN
    - MAX PARALLEL TIME
  - CLOSE WAIT TIME
    - TIME
  - GEN BREAKER
    - CONTINUOUS
    - CLOSING TIME
    - DEAD BUS CL ENBL
    - DEAD GEN CL ENBL
    - OPEN CMD
    - CLOSE CMD
  - MAINS BREAKER
    - CONFIGURED
    - CONTINUOUS (Visible when configured.)
    - CLOSING TIME (Visible when configured.)
    - OPEN CMD (Visible when configured.)
    - CLOSE CMD (Visible when configured.)
  - BRK CLOSE FAIL PALM
  - BRK OPEN FAIL PALM
- **BUS CONDITION DETECT**
  - GEN DEAD
    - THRESHOLD
    - TIME DELAY
  - GEN STABLE
    - OV PICKUP
    - OV DROPOUT
    - UV PICKUP
    - UV DROPOUT
    - OF PICKUP
    - OF DROPOUT
    - UF PICKUP
    - UF DROPOUT
    - TIME DELAY
    - LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
    - ALT FREQ SF
  - GEN FAILED
    - TIME DELAY
  - BUS DEAD
    - THRESHOLD
    - TIME DELAY
  - BUS STABLE
    - OV PICKUP
    - OV DROPOUT
    - UV PICKUP
    - UV DROPOUT
    - OF PICKUP
    - OF DROPOUT
    - UF PICKUP
    - UF DROPOUT
    - TIME DELAY
    - LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)

- ALT FREQ SF
  - BUS FAILED
    - TIME DELAY
- **SYNCHRONIZER (Optional)**
  - TYPE
  - SLIP FREQ
  - MIN SLIP CTL LMT
  - MAX SLIP CTL LMT
  - VOLT WINDOW
  - CLOSING ANGLE
  - VG>VB
  - TIME DELAY
  - FAIL DELAY
  - VOLT GAIN
  - SPEED GAIN
  - SYNC FAIL PALM

## BIAS CONTROL

- **AVR BIAS CONTROL**
  - OUTPUT (Visible when LSM-2020 is enabled.)
    - TYPE
  - CONTACT (Visible when LSM-2020 is disabled or when LSM-2020 is enabled and OUTPUT TYPE = CONTACT.)
    - TYPE
    - CORRECTION PULSE (Visible when OUTPUT TYPE = CONTACT and CONTACT TYPE = PROPORTIONAL.)
      - WIDTH
      - INTERVAL
  - VOLT CONTROL (Visible when LSM-2020 is enabled.)
    - VOLT CTRL GAINS
      - KP
      - KI (Visible when OUTPUT TYPE = ANALOG.)
      - KD (Visible when OUTPUT TYPE = ANALOG.)
      - TD (Visible when OUTPUT TYPE = ANALOG.)
      - LOOP GAIN (Visible when OUTPUT TYPE = ANALOG.)
    - VOLTAGE TRIM
      - ENABLE
      - DEADBAND
      - VOLT TRIM SETPT RATED VOLTS (Rev 3 hardware only.)
      - RMT VLT BIAS (Rev 3 hardware only.)
      - VOLT TRM BIAS (Rev 3 hardware only.)
  - VAR CTRL
    - DROOP
    - DROOP GAIN
    - var CTRL ENABLE (Visible when LSM-2020 is enabled.)
    - var CTRL MODE (Visible when LSM-2020 is enabled.)
    - KP (Visible when LSM-2020 is enabled.)
    - RAMP RATE (Visible when LSM-2020 is enabled.)
    - kvar SETPT (Visible when LSM-2020 is enabled.)
    - kvar SRC (Visible when LSM-2020 is enabled.)
    - kvar ALG MAX (Visible when LSM-2020 is enabled.)
    - kvar ALG MIN (Visible when LSM-2020 is enabled.)
    - PF SETPT (Visible when LSM-2020 is enabled.)
    - PF SRC (Visible when LSM-2020 is enabled.)
    - PF ALG MAX (Visible when LSM-2020 is enabled.)
    - PF ALG MIN (Visible when LSM-2020 is enabled.)
    - KI (Visible when LSM-2020 is enabled and OUTPUT TYPE = ANALOG.)
    - KD (Visible when LSM-2020 is enabled and OUTPUT TYPE = ANALOG.)
    - TD (Visible when LSM-2020 is enabled and OUTPUT TYPE = ANALOG.)
    - LOOP GAIN (Visible when LSM-2020 is enabled and OUTPUT TYPE = ANALOG.)
- **GOV BIAS CONTROL**
  - OUTPUT (Visible when LSM-2020 is enabled.)
    - TYPE

- CONTACT (Visible when LSM-2020 is disabled or when LSM-2020 is enabled and OUTPUT TYPE = CONTACT.)
  - TYPE
- SPEED CONTROL
  - SPEED CTRL GAINS
    - KP
    - KI (Visible when LSM-2020 is enabled and OUTPUT TYPE = ANALOG.)
    - KD (Visible when LSM-2020 is enabled and OUTPUT TYPE = ANALOG.)
    - TD (Visible when LSM-2020 is enabled and OUTPUT TYPE = ANALOG.)
    - LOOP GAIN (Visible when LSM-2020 is enabled and OUTPUT TYPE = ANALOG.)
  - SPEED TRIM
    - ENABLE
    - SETPOINT
    - DEADBAND
    - RMT SPD BIAS
    - SPEED BIAS
- kW CTRL
  - LOAD CTRL ENABLE (Visible when LSM-2020 is enabled.)
  - LOAD SHARE (Visible when LSM-2020 is enabled.)
  - KP (Visible when LSM-2020 is enabled.)
  - KI (Visible when LSM-2020 is enabled and OUTPUT TYPE = ANALOG.)
  - KD (Visible when LSM-2020 is enabled and OUTPUT TYPE = ANALOG.)
  - TD (Visible when LSM-2020 is enabled and OUTPUT TYPE = ANALOG.)
  - LOOP GAIN (Visible when LSM-2020 is enabled and OUTPUT TYPE = ANALOG.)
  - DROOP
  - DROOP GAIN
  - RAMP RATE (Visible when LSM-2020 is enabled.)
  - BASELOAD LVL (Visible when LSM-2020 is enabled.)
  - BL LV SRC (Visible when LSM-2020 is enabled.)
  - PF SRC (Visible when LSM-2020 is enabled.)
  - BL ALG MAX (Visible when LSM-2020 is enabled.)
  - BL ALG MIN (Visible when LSM-2020 is enabled.)
  - BRKR OPEN PT (Visible when LSM-2020 is enabled.)
- **CONTROL DEBUG** (Visible when LSM-2020 is enabled.)
  - kW RAMP
  - kW RAMP DMD
  - WATT DEMAND
  - SPEED PID
  - kW PID
  - SPEED ERR
  - kW ERR
  - SPEED BIAS
  - PF SETPT
  - kvar RAMP
  - var RAMP DMD
  - var DEMAND
  - VOLT PID
  - kvar PID
  - VOLT ERR
  - kvar ERR
  - VOLT BIAS

### MULTIGEN MANAGEMENT (Visible when LSM-2020 is enabled.)

- **AVR ANALOG OUTPUT**
  - OUTPUT TYPE
  - MIN OUTPUT
  - MAX OUTPUT
  - VOLT RESPONSE
- **GOV ANALOG OUTPUT**
  - OUTPUT TYPE
  - MIN OUTPUT
  - MAX OUTPUT
  - SPD RESPONSE
- **LOAD SHARE LINE**

- MIN VOLTAGE
  - MAX VOLTAGE
- **DEMAND START STOP**
  - ENABLE
  - START TD 1
  - START TD 2
  - STOP TD
  - START LVL 1
  - START LVL 2
  - STOP LVL
- **SEQUENCING**
  - SEQUENCE ID
  - MODE
  - MAX GEN START
  - MAX GEN STOP
  - LAST UNIT SHUTDN
- **NETWORK CONFIG**
  - EXP SEQ ID X (X = 1 TO 16)

#### LOGIC TIMERS

- **TIMER X (X = 1 to 10)**
  - HOURS
  - MINUTES
  - SECONDS

#### ENTER PASSWORD

**LOGOUT** (Visible when logged in through the front panel.)

#### Breaker Hardware One-Line Diagram

A one-line diagram of the breaker hardware configuration can be displayed on the front panel. This diagram changes in real time to reflect the current state of the configured breakers. The breaker hardware one-line diagram is disabled by default. To display the breaker hardware one-line diagram using front panel controls, navigate to Settings > General Settings > Front Panel HMI > One-Line Diagram and enable the setting. If using BESTCOMSP<sub>Plus</sub>, navigate to Settings Explorer, General Settings, Front Panel HMI and select Enable on the One-Line Diagram setting.

Once enabled, the one-line diagram appears on both the front panel Summary and Main Menu screens. The One-Line Diagram Menu screen provides metering for mains fail transfer, generator and bus parameters as well as breaker controls. To reach the One-Line Diagram Menu screen, go to the Main Menu and select the one-line diagram as you would a normal menu option and press the right arrow pushbutton. The one-line diagram, mains fail transfer state (if enabled), generator and bus parameters, and breaker controls are displayed respectively from the top of the menu.

Further mains fail transfer state metering is available by selecting the “MAINSFAIL XFER STATE” and pressing the right arrow pushbutton. Mains fail transfer state, transfer delay, return delay, max transfer time, max parallel time, and open transition delay are displayed.

To issue a breaker open or breaker close command, select the appropriate menu option, press Edit and select ON.

The ONE-LINE DIAGRAM screen options are shown in Figure 2-4. Figure 2-5, below, illustrates and describes the different configurations of the one-line diagram.

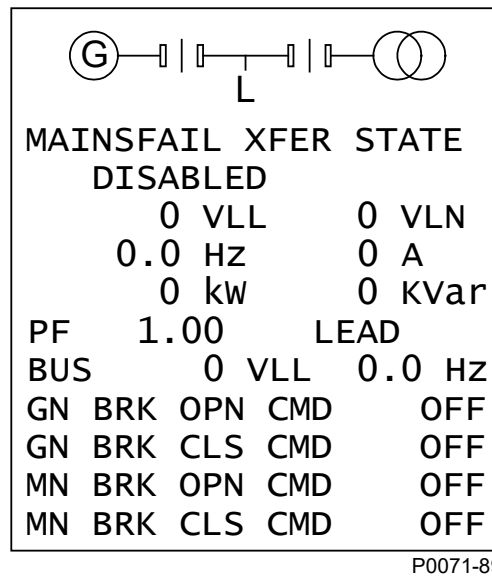


Figure 2-4. One-Line Diagram Menu Options (Available when One-Line Diagram is Enabled)

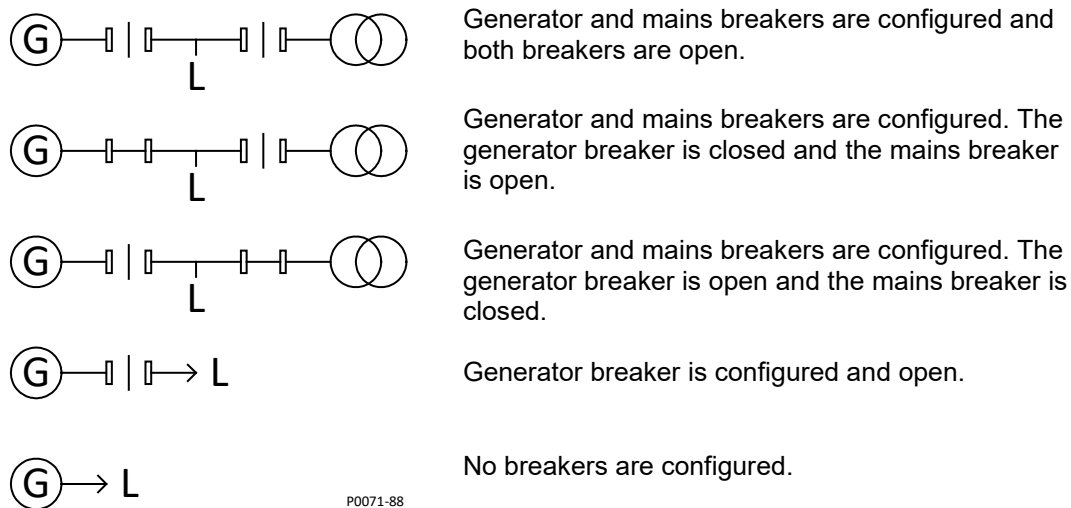


Figure 2-5. Breaker Hardware One-Line Diagram

## Generator Network Status Display

The status of the generator network is available on the front panel of each DGC-2020 when the generator is part of a multi-machine network. The *System Type* setting (found under Settings > System Parameters > System Settings) configures the machine to be part of a multi-machine network. When *System Type* is set to Multiple Generator, the machine is configured for participation in a multiple machine system.

Generator network status is found on the front panel under Metering > Alarms-Status > Network Status.

- System Manager - the sequencing ID of the machine that controls all dead bus arbitration and generator sequencing. This ID is always assigned to the machine on the network that has the lowest nonzero value of sequencing ID.
- Number of Units - the number of units on the generator network. The sequencing IDs of all machines on the network are listed as ID1:, ID2:, etc.

All machines on the network display the same value for System Manager and Number of Units. Each unit to be used as part of generator sequencing or dead bus breaker arbitration must have a unique nonzero sequencing ID. The ID Missing and ID Repeat pre-alarms annunciate when a machine is not configured for proper system operation.

The System Manager and Number of Units parameters display zero when the DGC-2020 is not communicating with an LSM-2020. The System Manager parameter displays –1 when a system manager is not present on the network (all unit IDs are zero).

### Mains Fail Transfer Status Display

Mains Fail Transfer Status can be viewed in three locations, however, Mains Fail Transfer must first be enabled.

To enable Mains Fail Transfer, navigate to Settings > Breaker Management > Breaker Hardware > Mains Fail Transfer using the front panel controls or Settings Explorer, Breaker Management, Mains Fail using BESTCOMSP<sup>Plus</sup>.

Mains Fail Transfer Status is displayed on the front panel in Metering > Alarms-Status > Mains Fail Transfer and also on the Breaker Hardware One-Line Diagram screen. It is displayed in BESTCOMSP<sup>Plus</sup> on the Metering Explorer, Mains Fail Transfer Status screen.

These screens display the Mains Fail Transfer State and any timers relevant to the mains fail transfer process. These parameters are listed below.

**Mains Fail Transfer State:** The different mains fail transfer states are described below.

*Power From Mains:* Power is being supplied to the load from the mains bus.

*Transfer Timer Active:* Transfer Delay timer is actively counting.

*Transferring to Gens:* Load is being transferred to the generator bus.

*Power From Gens:* Power is being supplied to the load from the generator bus.

*Return Timer Active:* Return Delay timer is actively counting.

*Transferring to Mains:* Load is being transferred to the mains bus.

*Disabled:* DGC-2020 is in the Off or Run operating mode or in the alarm state.

**Transfer Delay:** Displays the current timer value in seconds.

**Return Delay:** Displays the current timer value in seconds.

**Max Transfer Time:** Displays the current timer value in seconds.

**Max Parallel Time:** Displays the current timer value in seconds.

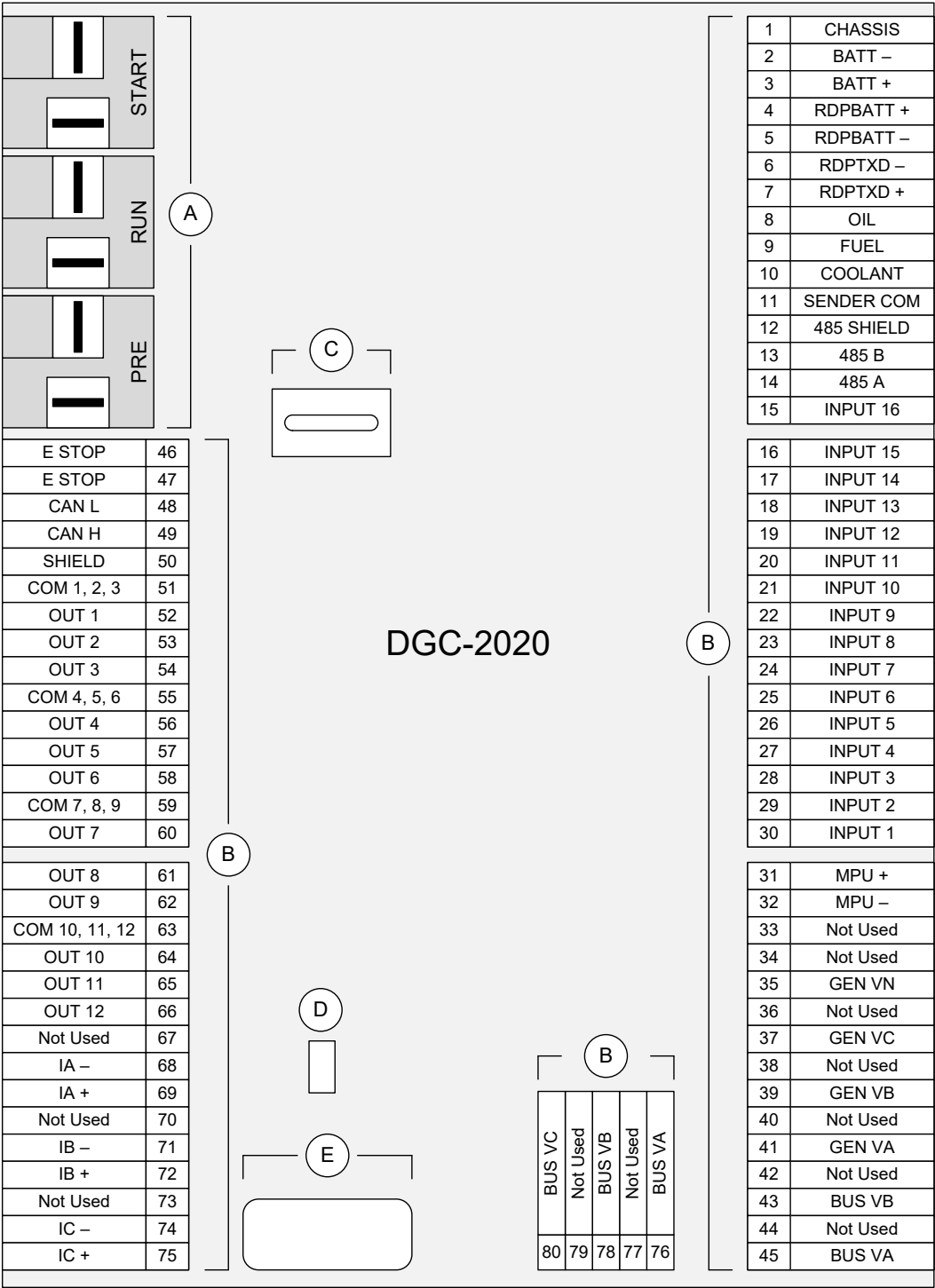
**Open Transition Delay:** Displays the current timer value in seconds.

#### Note

The Mains Fail Transfer screen found at Metering > Alarms-Status > Mains Fail Transfer only shows timers that are actively counting and are relevant to mains fail transfer. They are not otherwise visible.

### Rear Panel

All DGC-2020 terminals and connectors are located on the rear panel. Rear panel terminals and connectors are illustrated in Figure 2-6. Table 2-2 lists the call-outs of Figure 2-6 along with a description of each connector type. The DGC-2020 rear panel is shown in Figure 2-6 with the rear cover removed.



P0067-67

Figure 2-6. Rear Panel for DGC-2020

Table 2-2. Descriptions for Figure 2-6

| Locator | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A       | Connections to the DGC-2020 Start (starter), Run (fuel solenoid), and Pre (glow plug) output contacts are made directly to each relay through quarter-inch, male, quick-connect terminals.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| B       | <p>The majority of external, DGC-2020 wiring is terminated at 15-position connectors with compression terminals. These connectors plug into headers on the DGC-2020. The connectors and headers have a dovetailed edge that ensures proper connector orientation. Each connector and header is uniquely keyed to ensure that a connector mates only with the correct header. Connector screw terminals accept a maximum wire size of 12 AWG.</p> <p>Bus sensing terminal 76 (BUS VA) is internally tied to terminal 45 (BUS VA) and terminal 78 (BUS VB) is internally tied to terminal 43 (BUS VB). This maintains backward compatibility with hardware versions 1 and 2 of the DGC-2020.</p> |
| C       | The DGC-2020 provides a battery backup for the real-time clock. See Section 8, <i>Maintenance and Troubleshooting</i> , for instructions on replacing the battery. Failure to replace the battery with Basler Electric P/N 38526 may void the warranty.                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| D       | The mini-B USB socket mates with a standard USB cable and is used with a PC running BESTCOMSP <sup>Plus</sup> ® software for local communication with the DGC-2020.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| E       | DGC-2020 controllers equipped with the optional external modem port, connect to the user-supplied modem using a standard RS-232 cable.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |



## 3 • Functional Description

This section describes how the DGC-2020 functions. A detailed description of each function block is provided in the paragraphs under the heading of DGC-2020 Function Blocks.

DGC-2020 operating and metering features are described in Section 4, *BESTCOMSPlus® Software*.

### ***DGC-2020 Function Blocks***

To ease understanding, DGC-2020 functions are illustrated in the block diagram of Figure 3-1. The following paragraphs describe each function in detail.

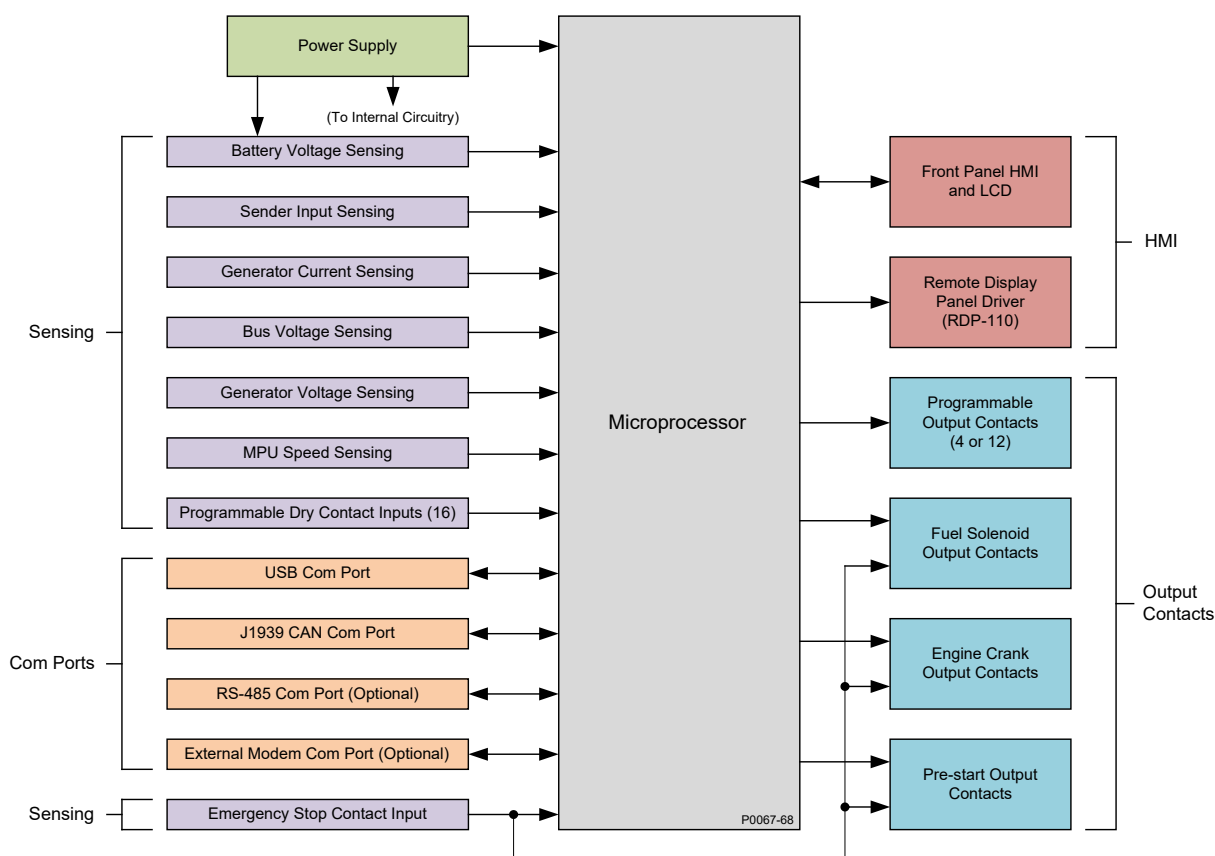


**Figure 3-1. Function Block Diagram**

#### **Power Supply**

The internal, switch-mode power supply uses the applied battery voltage to generate operating power for the internal circuitry of the DGC-2020. The power supply accepts a nominal battery voltage of 12 or 24 Vdc and has an operating range of 6 to 32 Vdc. Battery voltage is applied to terminals 2 (–) and 3 (+). Operating power must be of the correct polarity. Although reverse polarity will not cause damage, the DGC-2020 will not operate.

#### **Battery Voltage Sensing**

Voltage applied to the power supply is filtered and reduced to a suitable level for sensing by the microprocessor.

## Microprocessor

The microprocessor controls the overall functionality of the DGC-2020 and makes decisions based on programming and system inputs.

Circuits relating to the microprocessor inputs are described in the following paragraphs.

### Zero Crossing Detection

The zero crossing of A-phase to B-phase or A-phase to C-phase (user-selectable) line voltage is detected and used to calculate the generator frequency. The zero crossing of A-phase to B-phase bus voltage is used to calculate the bus frequency.

### Analog-to-Digital Converter

Scaled and conditioned signals representing the sensing voltage, sensing current, coolant temperature, fuel level, oil pressure, and battery voltage are digitized by the microprocessor's analog-to-digital converter. The digitized information is stored in random access memory (RAM) and used by the microprocessor for all metering and protection functions.

### Watchdog Timer

The watchdog timer monitors the firmware executed by the microprocessor. If the firmware ceases normal operation, the watchdog timer will reset the microprocessor. After reset, the microprocessor will resume normal operation if the condition that caused the watchdog reset is no longer present. If the condition is still present, the unit will reset repeatedly until it can resume normal operation.

## Generator Voltage Sensing Inputs

Voltages applied to the generator voltage sensing inputs are scaled to levels suitable for use by the internal circuitry. Generator voltage sensing configuration is menu-selectable.

The generator voltage sensing inputs accept a maximum voltage of 576 Vrms, line-to-line. Sensing voltage is applied to terminals 41 (A-phase), 39 (B-phase), 37 (C-phase), and 35 (neutral).

## Bus Voltage Sensing Inputs

Voltage applied to the bus voltage sensing input is scaled to a level suitable for use by the internal circuitry.

The bus voltage sensing input accepts a maximum voltage of 576 Vrms. Sensing voltage is applied to terminals 76 (A-phase), 78 (B-phase), and 80 (C-phase).

Terminal 45 is internally tied to 76 and terminal 43 is internally tied to 78. This accommodates the use of connectors wired for legacy DGC-2020 versions.

## Current Sensing Inputs

Generator currents are sensed and scaled to values suitable for use by the internal circuitry.

DGC-2020 controllers with 1 ampere current sensing (style number 1xxxxxxx) accept a maximum current value of 1 Aac. DGC-2020 controllers with 5 ampere current sensing (style number 5xxxxxxx) accept a maximum current value of 5 Aac. Sensing current is applied to terminals 68 (IA–) and 69 (IA+), 71 (IB–) and 72 (IB+), and 74 (IC–) and 75 (IC+).

## Analog Engine Sender Inputs

Programmable analog engine sender inputs give the DGC-2020 user the flexibility to select the engine sender to be used in an application. Information about programming the sender inputs is provided in Section 4, BESTCOMSP<sup>Plus</sup>® Software.

### Oil Pressure

A current is provided to the oil pressure sender. The developed voltage is measured and scaled for use by the internal circuitry. An open circuit or short circuit across the oil pressure sender terminals will cause

the DGC-2020 to indicate a failed sender. Oil pressure senders that are compatible with the DGC-2020 include Datcon model 02505-00, Isspro model R8919, and Stewart-Warner models 411K and 411M. Other senders may also be used. BESTCOMSP<sup>Plus</sup>® software allows for the programming of sender characteristics. See Section 4, BESTCOMSP<sup>Plus</sup>® *Software*, for more information.

Oil pressure sender connections are made at terminals 8 and 11 (sender common).

#### Coolant Temperature

A current is provided to the coolant temperature sender. The developed voltage is measured and scaled for use by the internal circuitry. An open circuit or short circuit across the coolant temperature sender terminals will cause the DGC-2020 to indicate a failed sender. Coolant temperature senders that are compatible with the DGC-2020 include Datcon model 02019-00, Faria model TS4042, Isspro model R8959, and Stewart-Warner model 334P. Other senders may be used. BESTCOMSP<sup>Plus</sup>® software allows for the programming of sender characteristics. See Section 4, BESTCOMSP<sup>Plus</sup>® *Software*, for more information.

Coolant temperature sender connections are made at terminals 10 and 11 (sender common).

#### Fuel Level

A current is provided to the fuel level sender. The developed voltage is measured and scaled for use by the internal circuitry. An open circuit or short circuit across the fuel level sender terminals will cause the DGC-2020 to indicate a failed sender. Fuel level senders that are compatible with the DGC-2020 include Isspro model R8925. Other senders may be used. BESTCOMSP<sup>Plus</sup>® software allows for the programming of sender characteristics. See Section 4, BESTCOMSP<sup>Plus</sup>® *Software*, for more information.

Fuel level sender connections are made at terminals 9 and 11 (sender common).

### **Speed Signal Inputs**

The DGC-2020 uses signals from the generator voltage sensing inputs and magnetic pickup input to detect machine speed.

#### Generator Voltage Sensing Input

The generator voltage sensed by the DGC-2020 is used to measure frequency and can be used to measure machine speed.

Sensing voltage is applied to terminals 41 (A-phase), 39 (B-phase), 37 (C-phase), and 35 (Neutral).

#### Magnetic Pickup Input (MPU)

Voltage supplied by a magnetic pickup is scaled and conditioned for use by the internal circuitry as a speed signal source. The MPU input accepts a signal over the range of 3 to 35 volts peak and 32 to 10,000 hertz.

Magnetic pickup connections are provided at terminals 31 (+) and 32 (–).

### **Contact Inputs**

The DGC-2020 has seventeen contact sensing inputs: an emergency stop input and 16 programmable inputs. Additional contact inputs can be accommodated with a CEM-2020 (Contact Expansion Module). Contact Basler Electric for availability and ordering information.

#### Emergency Stop Input

This input accepts Form B, dry contacts. An open circuit at this continuously monitored input initiates an emergency stop. An emergency stop removes operating power from the DGC-2020 Pre-Start, Run, and Fuel output relays.

Emergency stop contact connections are made at terminals 46 and 47.

### Programmable Inputs

Each programmable input (Input 1 through Input 16) can be independently configured to perform the following functions. By default, each programmable input is disabled.

- Auto Transfer Switch
- Battery Charger Fail
- Battle Override
- Fuel Leak Detect
- Grounded Delta Override
- Low Coolant Level
- Low Line Override
- Single-Phase A-C Override
- Single-Phase Override

The programmable inputs accept dry contacts. A contact is connected between a programmable input and the negative side of the battery. Through BESTCOMS*Plus*®, each programmable contact input can be assigned a name (16 alphanumeric characters, maximum) and configured as an alarm input, a pre-alarm input, or neither. The default names for the inputs are INPUT\_x (where x = 1 to 16). When a programmable contact input is closed, the front panel display shows the name of the closed input if it was programmed as an alarm or pre-alarm input. Alarm inputs are annunciated through the Normal display mode screens of the front panel. Pre-alarm inputs are annunciated through the pre-alarm metering screen of the front panel. If neither is programmed, no indication is given. Programming an input as neither is useful when a programmable input is used as an input to programmable logic.

Connections for the programmable inputs are provided at terminals 15 (Input 16) through 30 (Input 1). The negative side of the battery voltage (terminal 2) serves as the return connection for the programmable inputs.

### **Front Panel HMI**

The front panel HMI provides a convenient interface for viewing system parameters and for controlling the DGC-2020/generator set. Front panel HMI components include an LCD (liquid crystal display), LED (light emitting diodes) indicators, and pushbuttons.

#### LCD

The backlit LCD provides metering, pre-alarm, and alarm information. Detailed information about the LCD is provided in the *Software Operation* sub-section.

#### LED Indicators

The LEDs indicate pre-alarm and alarm conditions along with DGC-2020 status and generator status.

#### Pushbuttons

The pushbuttons are used to scroll through and select parameters displayed on the LCD, change setpoints, start and stop the generator, and reset alarms.

### **Remote Display Panel (Optional)**

Applications that require remote annunciation can use Basler Electric's Remote Display Panel, RDP-110. Using the RDP-110 with the DGC-2020 meets the requirements of NFPA Standard 110. The RDP-110 uses a dedicated, four-terminal interface with the DGC-2020. It communicates with the DGC-2020 via terminals 6 (RDP TXD-) and 7 (RDP TXD+) and receives power from terminals 4 (RDP BATT+) and 5 (RDP BATT-). Remote indication of many pre-alarm and alarm conditions is provided by the RDP-110.

The following pre-alarm conditions are indicated by LEDs on the RDP-110 front panel:

- Battery charger failure \*†
- Battery overvoltage †
- High coolant temperature
- Low coolant temperature
- Low fuel level

- Low oil pressure
- Weak battery or low battery voltage

The following alarm conditions are indicated by LEDs and an audible alarm on the RDP-110 front panel:

- Low coolant level \*
- High coolant temperature
- Low oil pressure
- Overcrank
- Overspeed
- Emergency stop
- Fuel leak/fuel sender failure \*†
- Engine sender unit failure †

\* Can be configured in the DGC-2020 as *None*, *Alarm*, or *Pre-Alarm*. See Section 4, *BESTCOMSPlus® Software, Programmable Inputs, Programmable Functions*, for more information. The light on the RDP-110 turns on when the input that is assigned to the programmable function is closed, whether the function is configured as *None*, *Alarm*, or *Pre-Alarm*.

† For DGC-2020 units loaded with firmware version X.14.00 and higher this LED is fully programmable via BESTlogic™ *Plus*.

Additionally, the RDP-110 indicates when the DGC-2020 is not operating in Auto mode and when the generator is supplying load. When the DGC-2020 is in an alarm state not listed above, the *Switch Not In Auto* LED lights and the horn sounds. For more information about the RDP-110, request product bulletin SNE.

RDP-110 communication connections are made at DGC-2020 terminals 6 (RDP TXD–) and 7 (RDP TXD+). RDP-110 operating power is supplied at DGC-2020 terminals 4 (RDP BATT+) and 5 (RDP BATT–).

## Communication Ports

DGC-2020 communication ports include a USB jack, CAN terminals, optional RS-485 terminals, and an optional modem jack.

### USB

The rear-panel, mini-B USB socket enables local communication with a PC running BESTCOMSPlus® software. The DGC-2020 is connected to a PC using a standard USB cable. BESTCOMSPlus® is a Windows® based communication software package that is supplied with the DGC-2020. A detailed description of BESTCOMSPlus® is provided in Section 4, *BESTCOMSPlus® Software*.

### CAN

A Controller Area Network (CAN) is a standard interface that enables communication between multiple controllers on a common network using a standard message protocol. DGC-2020 controllers have a CAN Bus interface that supports the SAE J1939 protocol and the *mtu* protocol.

Applications using an engine-driven generator set controlled by a DGC-2020 may also have an Engine Control Unit (ECU). The CAN Bus interface allows the ECU and DGC-2020 to communicate. The ECU reports operating information to the DGC-2020 through the CAN Bus interface. Operating parameters and diagnostic information, if supported by the ECU, are decoded and displayed for monitoring.

The primary use of the CAN Bus interface is to obtain engine operating parameters for monitoring speed, coolant temperature, oil pressure, coolant level, and engine hours without the need for direct connection to individual senders. A list of all J1939 parameters received by the DGC-2020 is found in Appendix G. Table G-1 lists the ECU parameters and Table 3-1 lists the engine configuration parameters supported by the DGC-2020 CAN Bus interface. These parameters are transmitted via the CAN Bus interface at preset intervals. See the column labeled Update Rate in Table G-1 for transmission rates. This information can also be transmitted upon user request.

CAN Bus interface connections are made at 48 (CAN L), 49 (CAN H), and 50 (SHIELD).

**Table 3-1. Engine Configuration Parameters Obtained from CAN Bus Interface**

| ECU Parameter                                   | Metric Units | English Units | Update Rate | * SPN |
|-------------------------------------------------|--------------|---------------|-------------|-------|
| Engine Speed at High Idle Point 6               | rpm          | rpm           | 5 s         | 532   |
| Engine Speed at Idle Point 1                    | rpm          | rpm           | 5 s         | 188   |
| Engine Speed at Point 2                         | rpm          | rpm           | 5 s         | 528   |
| Engine Speed at Point 3                         | rpm          | rpm           | 5 s         | 529   |
| Engine Speed at Point 4                         | rpm          | rpm           | 5 s         | 530   |
| Engine Speed at Point 5                         | rpm          | rpm           | 5 s         | 531   |
| Gain (Kp) of End Speed Governor                 | %/rpm        | %/rpm         | 5 s         | 545   |
| Maximum Momentary Engine Override Speed Point 7 | rpm          | rpm           | 5 s         | 533   |
| Maximum Momentary Engine Override Time Limit    | seconds      | seconds       | 5 s         | 534   |
| Percent Torque at Idle Point 1                  | %            | %             | 5 s         | 539   |
| Percent Torque at Point 2                       | %            | %             | 5 s         | 540   |
| Percent Torque at Point 3                       | %            | %             | 5 s         | 541   |
| Percent Torque at Point 4                       | %            | %             | 5 s         | 542   |
| Percent Torque at Point 5                       | %            | %             | 5 s         | 543   |
| Reference Engine Torque                         | N•m          | ft-lb         | 5 s         | 544   |
| Requested Speed Control Range Lower Limit       | rpm          | rpm           | 5 s         | 535   |
| Requested Speed Control Range Upper Limit       | rpm          | rpm           | 5 s         | 536   |
| Requested Torque Control Range Lower Limit      | %            | %             | 5 s         | 537   |
| Requested Torque Control Range Upper Limit      | %            | %             | 5 s         | 538   |

\* SPN is suspect parameter number.

### Caution

When the CAN Bus is enabled, the DGC-2020 will ignore the following sender inputs: oil pressure, coolant temperature, and magnetic pickup.

Under certain circumstances, the following strings may be displayed on the front panel HMI and in the Metering Explorer of BESTCOMSP<sup>®</sup>Plus:

- **NC (Not Connected)** - String displayed for a J1939 parameter when the engine ECU is not connected to the DGC-2020.
- **SF (Sender Fail)** - String displayed for a J1939 parameter when the engine ECU sends a special code indicating a measurement failure for the parameter. For example, if oil sender is determined to be bad by the ECU, it sends a special code in place of the J1939 oil pressure data indicating a sender fail condition.
- **NS (Not Sent)** - String displayed for a J1939 parameter when the J1939 parameter has not been sent to the DGC-2020 by the engine ECU.
- **NA (Not Applicable)** - String displayed for a J1939 parameter when the engine ECU sends a special code for the parameter indicating that the parameter is not implemented or not applicable in the ECU.
- **UF (Unknown Failure)** - String displayed when the J1939 parameter data received by the ECU is not within the valid J1939 data range for the parameter but is not one of the special codes above.

Table 3-2 lists the J1939 data transmitted from the DGC-2020.

**Table 3-2. J1939 Data Transmitted from the DGC-2020**

| J1939 Standard Communications of Engine Related Parameters |                  |          |     |                                |       |        |            |
|------------------------------------------------------------|------------------|----------|-----|--------------------------------|-------|--------|------------|
| Request                                                    | PGN 0xEA00 59904 | Standard |     | Transmission Rate: As Required |       |        |            |
| J1939 Parameter Name                                       | SPN              | Byte     | Bit | Length                         | Scale | Offset | Data Range |

Functional Description

DGC-2020

|                                                          |                                                                   |                 |              |                                     |                   |         |                                        |                                                       |
|----------------------------------------------------------|-------------------------------------------------------------------|-----------------|--------------|-------------------------------------|-------------------|---------|----------------------------------------|-------------------------------------------------------|
|                                                          |                                                                   | Position        | Position     |                                     | Factor            |         |                                        |                                                       |
| Parameter Group Number (PGN) Requested                   | 2450                                                              | 1               | 1            | 3 bytes                             | 1                 | 0       | Any valid PGN number can be requested. |                                                       |
| PGNs requested by DGC-2020:                              | PGN 0xFECA 65226 Currently Active Diagnostic Trouble Codes        |                 |              |                                     |                   |         |                                        |                                                       |
|                                                          | PGN 0xFECB 65227 Previously Active Diagnostic Trouble Codes       |                 |              |                                     |                   |         |                                        |                                                       |
|                                                          | PGN 0xFED3 65235 Clear Currently Active Diagnostic Trouble Codes  |                 |              |                                     |                   |         |                                        |                                                       |
|                                                          | PGN 0xFECC 65126 Clear Previously Active Diagnostic Trouble Codes |                 |              |                                     |                   |         |                                        |                                                       |
|                                                          | PGN 0xFEE5 65253 Engine Hours, Revolutions                        |                 |              |                                     |                   |         |                                        |                                                       |
|                                                          | PGN 0xFE8C 65164 Auxiliary Analog Information                     |                 |              |                                     |                   |         |                                        |                                                       |
|                                                          | PGN 0xFEB1 65201 ECU History                                      |                 |              |                                     |                   |         |                                        |                                                       |
|                                                          | PGN 0xFEE5 65253 Engine Hours, Revolutions                        |                 |              |                                     |                   |         |                                        |                                                       |
|                                                          | PGN 0xFEBC 65214 Electronic Engine Controller 4                   |                 |              |                                     |                   |         |                                        |                                                       |
|                                                          | PGN 0xFEB3 65203 Fuel Information 1 (Liquid)                      |                 |              |                                     |                   |         |                                        |                                                       |
|                                                          | PGN 0xFEE9 65257 Fuel Consumption                                 |                 |              |                                     |                   |         |                                        |                                                       |
|                                                          | PGN 0xFD7B 64891 Aftertreatment 1 Service 1                       |                 |              |                                     |                   |         |                                        |                                                       |
|                                                          | PGN 0xEE00 60928 Address Claim                                    |                 |              |                                     |                   |         |                                        |                                                       |
|                                                          |                                                                   |                 |              |                                     |                   |         |                                        |                                                       |
| <b>Torque/Speed Control 1</b>                            | <b>PGN 0x0000 0</b>                                               | <b>Standard</b> |              | <b>Transmission Rate: 10 msec.</b>  |                   |         |                                        |                                                       |
| J1939 Parameter Name                                     | SPN                                                               | Byte Position   | Bit Position | Length                              | Scale Factor      | Offset  | Data Range                             |                                                       |
| Engine Requested Speed/Speed Limit                       | 898                                                               | 2-3             | 2.1          | 2 bytes                             | 0.125 rpm per bit | 0 rpm   | 0 to 8 031.875 rpm                     |                                                       |
| Message Counter                                          | 4206                                                              | 8.1             | 8.1          | 4 bits                              | 1 count per bit   | 0 count | 0 to 15 count                          |                                                       |
| Message Checksum                                         | 4207                                                              | 8.5             | 8.5          | 4 bits                              | 1 count per bit   | 0 count | 0 to 15 count                          |                                                       |
|                                                          |                                                                   |                 |              |                                     |                   |         |                                        |                                                       |
| <b>Cruise Control/Vehicle Speed 1</b>                    | <b>PGN 0xFEf1 65265</b>                                           | <b>Standard</b> |              | <b>Transmission Rate: 100 msec.</b> |                   |         |                                        |                                                       |
| J1939 Parameter Name                                     | SPN                                                               | Byte Position   | Bit Position | Length                              | Scale Factor      | Offset  | Data Range                             |                                                       |
| Engine Shutdown Override Switch                          | 1237                                                              | 8.7             | 8.7          | 2 bits                              | 1 count per bit   | 0       | 0 to 3                                 | 00b=Off 01b=On 10b=Error 11b=Not available            |
|                                                          |                                                                   |                 |              |                                     |                   |         |                                        |                                                       |
| <b>Engine Electrical System/Module Information (EES)</b> | <b>PGN 0xFE93 65171</b>                                           | <b>Standard</b> |              | <b>Transmission Rate: 200 msec.</b> |                   |         |                                        |                                                       |
| J1939 Parameter Name                                     | SPN                                                               | Byte Position   | Bit Position | Length                              | Scale Factor      | Offset  | Data Range                             |                                                       |
| Electrical Load                                          | 1204                                                              | 1               | 1            | 2 bytes                             | 0.5 kW/bit        | 0       | 0 to 32127.5 kW                        |                                                       |
|                                                          |                                                                   |                 |              |                                     |                   |         |                                        |                                                       |
| <b>Dash Display 1</b>                                    | <b>PGN 0xFEFC 65276</b>                                           | <b>Standard</b> |              | <b>Transmission Rate: 1 second</b>  |                   |         |                                        |                                                       |
| J1939 Parameter Name                                     | SPN                                                               | Byte Position   | Bit Position | Length                              | Scale Factor      | Offset  | Data Range                             |                                                       |
| Fuel Level 1                                             | 96                                                                | 2-3             | 1            | 1 byte                              | 0.4% per bit      | 0%      | 0 to 100%                              |                                                       |
|                                                          |                                                                   |                 |              |                                     |                   |         |                                        |                                                       |
| <b>Engine Fluid Level/Pressure 1</b>                     | <b>PGN 0xFEfF 65263</b>                                           | <b>Standard</b> |              | <b>Transmission Rate: 500 msec.</b> |                   |         |                                        |                                                       |
| J1939 Parameter Name                                     | SPN                                                               | Byte Position   | Bit Position | Length                              | Scale Factor      | Offset  | Data Range                             |                                                       |
| Engine Oil Pressure 1                                    | 100                                                               | 4               | 1            | 1 byte                              | 4 kPa per bit     | 0 kPa   | 0 to 1 000 kPa                         |                                                       |
|                                                          |                                                                   |                 |              |                                     |                   |         |                                        |                                                       |
| <b>Cab Message 1</b>                                     | <b>PGN 0xE000 57344</b>                                           | <b>Standard</b> |              | <b>Transmission Rate: 1 second</b>  |                   |         |                                        |                                                       |
| J1939 Parameter Name                                     | SPN                                                               | Byte Position   | Bit Position | Length                              | Scale Factor      | Offset  | Data Range                             |                                                       |
| Aftertreatment Regeneration Inhibit Switch               | 3695                                                              | 6               | 6.1          | 2 bits                              | 4 states          | 0       | 0 to 3                                 | 00b=Not active 01b=Active 10b=Error 11b=Not available |
| Aftertreatment Regeneration Force Switch                 | 3696                                                              | 6               | 6.3          | 2 bits                              | 4 states          | 0       | 0 to 3                                 | 00b=Not active 01b=Active 10b=Error 11b=Not available |



|                                                                      |                         |                 |              |                                      |                       |                    |                                     |                                                                                                                                                                                                                                                   |
|----------------------------------------------------------------------|-------------------------|-----------------|--------------|--------------------------------------|-----------------------|--------------------|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Engine Configuration Commands</b>                                 | <b>PGN 0x8F00 36608</b> | <b>Standard</b> |              | <b>Transmission Rate: 10 seconds</b> |                       |                    |                                     |                                                                                                                                                                                                                                                   |
| J1939 Parameter Name                                                 | SPN                     | Byte Position   | Bit Position | Length                               | Scale Factor          | Offset             | Data Range                          |                                                                                                                                                                                                                                                   |
| Coolant Level Engine Protection Shutdown Override Command            | 5565                    | 1               | 1.1          | 2 bits                               | 4 states              | 0                  | 0 to 3                              | 00b=Disable engine protection shutdown override due to low coolant level<br>01b=Enable engine protection shutdown override due to low coolant level<br>10b=Reserved 11b=Don't care/take no action                                                 |
|                                                                      |                         |                 |              |                                      |                       |                    |                                     |                                                                                                                                                                                                                                                   |
| <b>Generator Control 1</b>                                           | <b>PGN 0xFD93 64915</b> | <b>Standard</b> |              | <b>Transmission Rate: 100 msec</b>   |                       |                    |                                     |                                                                                                                                                                                                                                                   |
| J1939 Parameter Name                                                 | SPN                     | Byte Position   | Bit Position | Length                               | Scale Factor          | Offset             | Data Range                          |                                                                                                                                                                                                                                                   |
| Requested Engine Control Mode                                        | 3542                    | 1               | 1            | 4 bits                               | 16 states             | 0                  | 0 to 15                             | 0000b=Normal Engine Shutdown 0001b=Rapid Engine Shutdown<br>0010b=Emergency Engine Shutdown 0011b=Normal Engine Start 0100b=Rapid Engine Start 0101b to 1101b=available for SAE assignment<br>1110b=<reserved><br>1111b=Don't care/Take no action |
| Generator Alternator Efficiency                                      | 4078                    | 2               | 1            | 2 bytes                              | 0.002 5% per bit      | 0%                 | 0 to 160.637 5%                     | Always has a value of 100%                                                                                                                                                                                                                        |
| Generator Governing Speed Command                                    | 4079                    | 4               | 1            | 2 bits                               | 4 states              | 0                  | 0 to 3                              | 00b=Rated Speed 01b=Low Idle Speed 10b=Reserved<br>11b=Don't care/take no action                                                                                                                                                                  |
| Generator Frequency Selection                                        | 4080                    | 4               | 3            | 4 bits                               | 16 states             | 0                  | 0 to 15                             | 0000b=50 Hz 0001b=60 Hz<br>0010b=400 Hz 0011b to 1101b=SAE Reserved<br>1110b=Unknown<br>1111b=Don't care/take no action                                                                                                                           |
|                                                                      |                         |                 |              |                                      |                       |                    |                                     |                                                                                                                                                                                                                                                   |
| <b>Electronic Brake Controller 1</b>                                 | <b>PGN 0xF001 61441</b> | <b>Standard</b> |              | <b>Transmission Rate: 100 msec</b>   |                       |                    |                                     |                                                                                                                                                                                                                                                   |
| J1939 Parameter Name                                                 | SPN                     | Byte Position   | Bit Position | Length                               | Scale Factor          | Offset             | Data Range                          |                                                                                                                                                                                                                                                   |
| Engine Auxiliary Shutdown Switch                                     | 970                     | 4               | 5            | 2 bits                               | 4 states              | 0                  | 0 to 3                              | 00b=Off 01b=On 10b=Error<br>11b=Not available                                                                                                                                                                                                     |
|                                                                      |                         |                 |              |                                      |                       |                    |                                     |                                                                                                                                                                                                                                                   |
| <b>Generator Control 2</b>                                           | <b>PGN 0xF01E 61470</b> | <b>Standard</b> |              | <b>Transmission Rate: 100 msec</b>   |                       |                    |                                     |                                                                                                                                                                                                                                                   |
| J1939 Parameter Name                                                 | SPN                     | Byte Position   | Bit Position | Length                               | Scale Factor          | Offset             | Data Range                          |                                                                                                                                                                                                                                                   |
| Generator Governing Bias                                             | 3938                    | 1               | 1            | 2 bytes                              | 0.004% per bit        | -125%              | -125 to 132.02%                     |                                                                                                                                                                                                                                                   |
|                                                                      |                         |                 |              |                                      |                       |                    |                                     |                                                                                                                                                                                                                                                   |
| <b>Electronic Engine Controller 14</b>                               | <b>PGN 0xFDC2 64962</b> | <b>Standard</b> |              | <b>Transmission Rate: 20 msec</b>    |                       |                    |                                     |                                                                                                                                                                                                                                                   |
| J1939 Parameter Name                                                 | SPN                     | Byte Position   | Bit Position | Length                               | Scale Factor          | Offset             | Data Range                          |                                                                                                                                                                                                                                                   |
| Fuel Type                                                            | 5837                    | 7               | 1            | 8 bits                               | 256 states            | 0                  | 0-255                               | 0x17=Natural Gas<br>0x07=Propane 0x18=Bi-fuel vehicle using NG – BI_NG                                                                                                                                                                            |
|                                                                      |                         |                 |              |                                      |                       |                    |                                     |                                                                                                                                                                                                                                                   |
| <b>J1939 Standard Communications of Generator Related Parameters</b> |                         |                 |              |                                      |                       |                    |                                     |                                                                                                                                                                                                                                                   |
| <b>Requested Generator Average Basic AC Quantities</b>               | <b>PGN 0xF01C 61468</b> | <b>Standard</b> |              | <b>Transmission Rate: 100 msec</b>   |                       |                    |                                     |                                                                                                                                                                                                                                                   |
| J1939 Parameter Name                                                 | SPN                     | Byte Position   | Bit Position | Length                               | Scale Factor          | Offset             | Data Range                          |                                                                                                                                                                                                                                                   |
| Requested Generator Average Line-Line AC RMS Voltage                 | 3386                    | 1               | 1            | 4 bytes                              | 0.007 812 5 V per bit | 0                  | 0 to 32 899 071.992 187 5 V         |                                                                                                                                                                                                                                                   |
|                                                                      |                         |                 |              |                                      |                       |                    |                                     |                                                                                                                                                                                                                                                   |
| <b>Generator Total AC Reactive Power</b>                             | <b>PGN 0xFE04 65028</b> | <b>Standard</b> |              | <b>Transmission Rate: 100 msec.</b>  |                       |                    |                                     |                                                                                                                                                                                                                                                   |
| J1939 Parameter Name                                                 | SPN                     | Byte Position   | Bit Position | Length                               | Scale Factor          | Offset             | Data Range                          |                                                                                                                                                                                                                                                   |
| Generator Total Reactive Power                                       | 2456                    | 1               | 1            | 4 bytes                              | 1 VAR per bit         | -2 000 000 000 VAR | -2 000 000 000 to 2 211 081 215 VAR |                                                                                                                                                                                                                                                   |



|                                                      |                         |                            |              |                                     |                              |                   |                                    |                                                                                                                                                                             |
|------------------------------------------------------|-------------------------|----------------------------|--------------|-------------------------------------|------------------------------|-------------------|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Generator Overall Power Factor                       | 2464                    | 5                          | 1            | 2 bytes                             | 0.000 061 035 156 25 per bit | -1                | -1 to 2.921 813 964 843 75         | -1 to +1 Operational Range                                                                                                                                                  |
| Generator Overall Power Factor Lagging               | 2518                    | 7                          | 7.1          | 2 bits                              | 4 states                     | 0                 | 0 to 3                             | 00b=Leading 01b=Lagging 10b=Error 11b=Not available or not installed                                                                                                        |
|                                                      |                         |                            |              |                                     |                              |                   |                                    |                                                                                                                                                                             |
| <b>Generator Total AC Power</b>                      | <b>PGN 0xFE05 65029</b> | <b>Standard</b>            |              | <b>Transmission Rate: 100 msec.</b> |                              |                   |                                    |                                                                                                                                                                             |
| J1939 Parameter Name                                 | SPN                     | Byte Position              | Bit Position | Length                              | Scale Factor                 | Offset            | Data Range                         |                                                                                                                                                                             |
| Generator Total Real Power                           | 2452                    | 1                          | 1            | 4 bytes                             | 1 W per bit                  | -2 000 000 000 W  | -2 000 000 000 to 2 211 081 215 W  |                                                                                                                                                                             |
| Generator Total Apparent Power                       | 2460                    | 5                          | 1            | 4 bytes                             | 1 VA per bit                 | -2 000 000 000 VA | -2 000 000 000 to 2 211 081 215 VA |                                                                                                                                                                             |
|                                                      |                         |                            |              |                                     |                              |                   |                                    |                                                                                                                                                                             |
| <b>Generator Average Basic AC Quantities</b>         | <b>PGN 0xFE06 65030</b> | <b>Standard</b>            |              | <b>Transmission Rate: 100 msec.</b> |                              |                   |                                    |                                                                                                                                                                             |
| J1939 Parameter Name                                 | SPN                     | Byte Position              | Bit Position | Length                              | Scale Factor                 | Offset            | Data Range                         |                                                                                                                                                                             |
| Generator Average Line-Line AC RMS Voltage           | 2440                    | 1                          | 1            | 2 bytes                             | 1 V per bit                  | 0 V               | 0 to 64 255 V                      |                                                                                                                                                                             |
| Generator Average Line-Neutral AC RMS Voltage        | 2444                    | 3                          | 1            | 2 bytes                             | 1 V per bit                  | 0 V               | 0 to 64 255 V                      |                                                                                                                                                                             |
| Generator Average AC Frequency                       | 2436                    | 5                          | 1            | 2 bytes                             | 0.007 812 5 Hz per bit       | 0 Hz              | 0 to 501.992 187 5 Hz              |                                                                                                                                                                             |
| Generator Average AC RMS Current                     | 2448                    | 7                          | 1            | 2 bytes                             | 1 A per bit                  | 0 A               | 0 to 64 255 A                      |                                                                                                                                                                             |
|                                                      |                         |                            |              |                                     |                              |                   |                                    |                                                                                                                                                                             |
| <b>Generator Total AC Energy</b>                     | <b>PGN 0xFDFA 65018</b> | <b>Standard</b>            |              | <b>Transmission Rate: 100 msec.</b> |                              |                   |                                    |                                                                                                                                                                             |
| J1939 Parameter Name                                 | SPN                     | Byte Position              | Bit Position | Length                              | Scale Factor                 | Offset            | Data Range                         |                                                                                                                                                                             |
| Generator Total kW Hours Export                      | 2468                    | 1                          | 1            | 4 bytes                             | 1 kWh per bit                | 0 kWh             | 0 to 4 211 081 215 kWh             |                                                                                                                                                                             |
|                                                      |                         |                            |              |                                     |                              |                   |                                    |                                                                                                                                                                             |
| <b>Proprietary Cummins Engine ECU Communications</b> |                         |                            |              |                                     |                              |                   |                                    |                                                                                                                                                                             |
|                                                      |                         |                            |              |                                     |                              |                   |                                    |                                                                                                                                                                             |
| <b>GenSet Control Parameters (GCP)</b>               | <b>PGN 0xFF73 65395</b> | <b>Proprietary Cummins</b> |              | <b>Transmission Rate: 20 msec.</b>  |                              |                   |                                    |                                                                                                                                                                             |
| J1939 Parameter Name                                 | SPN                     | Byte Position              | Bit Position | Length                              | Scale Factor                 | Offset            | Data Range                         |                                                                                                                                                                             |
| Emergency Stop Indication                            | N/A                     | 1.1                        | 1.1          | 2 bits                              | 4 States                     | 0                 | 0 to 3                             | 00b=No emergency stop indication 01b=Emergency stop indication 10b=Error 11b=Don't care/take no action                                                                      |
| Utility/Isochronous Gain Select                      | N/A                     | 1.3                        | 1.3          | 2 bits                              | 4 States                     | 0                 | 0 to 3                             | 00b=Isochronous 01b=Utility 10b=Error 11b=Don't care/take no action                                                                                                         |
| Run/Stop                                             | N/A                     | 1.5                        | 1.5          | 2 bits                              | 4 States                     | 0                 | 0 to 3                             | 00b=Stop 01b=Run/start 10b=Error 11b=Not available                                                                                                                          |
| Idle/Rated                                           | N/A                     | 1.7                        | 1.7          | 2 bits                              | 4 States                     | 0                 | 0 to 3                             | 00b=Rated 01b=Idle 10b=Error 11b=Not available                                                                                                                              |
| Shutdown Override                                    | N/A                     | 2.3                        | 2.3          | 3 bits                              | 8 States                     | 0                 | 0 to 7                             | 000b=No shutdown override 001b=Start block override 010b=General shutdown override 011b=All-out shutdown override 100b=Reserved 101b=Reserved 110b=Error 111b=Not available |
| Frequency Selection                                  | N/A                     | 2.6                        | 2.6          | 3 bits                              | 8 States                     | 0                 | 0 to 7                             | 000b=50 Hz 001b=60 Hz 010b=400 Hz or other 011b=Reserved 100b=Reserved 101b=Reserved 110b=Error 111b = Don't care/take no action                                            |
|                                                      |                         |                            |              |                                     |                              |                   |                                    |                                                                                                                                                                             |
| <b>Engine Governing (EG)</b>                         | <b>PGN 0xFF69 65385</b> | <b>Proprietary Cummins</b> |              | <b>Transmission Rate: 10 msec.</b>  |                              |                   |                                    |                                                                                                                                                                             |
| J1939 Parameter Name                                 | SPN                     | Byte Position              | Bit Position | Length                              | Scale Factor                 | Offset            | Data Range                         |                                                                                                                                                                             |
| Speed Bias Reference                                 | N/A                     | 1                          | 1            | 2 bytes                             | 1/256 per bit                | -128              | -128 to 127.996                    |                                                                                                                                                                             |

|                                                                          |                         |                            |              |                                     |                  |        |            |                                                                                                                     |
|--------------------------------------------------------------------------|-------------------------|----------------------------|--------------|-------------------------------------|------------------|--------|------------|---------------------------------------------------------------------------------------------------------------------|
|                                                                          |                         |                            |              |                                     |                  |        |            |                                                                                                                     |
| <b>Data Link Keep Alive (DKA)</b>                                        | <b>PGN 0xFF0F 65295</b> | <b>Proprietary Cummins</b> |              | <b>Transmission Rate: 200 msec.</b> |                  |        |            |                                                                                                                     |
| J1939 Parameter Name                                                     | SPN                     | Byte Position              | Bit Position | Length                              | Scale Factor     | Offset | Data Range |                                                                                                                     |
| Datalink Keep-Alive                                                      | N/A                     | 2.1                        | 2.1          | 2 bits                              | 4 States         | 0      | 0 to 3     | 00b=Datalink keepalive off<br>01b=Datalink keepalive on<br>10b=Error 11b=Not available                              |
|                                                                          |                         |                            |              |                                     |                  |        |            |                                                                                                                     |
| <b>Proprietary Volvo Engine ECU Communications</b>                       |                         |                            |              |                                     |                  |        |            |                                                                                                                     |
| <b>VP70 – VP Status – Engine Control Status</b>                          | <b>PGN 0xFF46 65350</b> | <b>Proprietary Volvo</b>   |              | <b>Transmission Rate: 20 msec.</b>  |                  |        |            |                                                                                                                     |
| J1939 Parameter Name                                                     | SPN                     | Byte Position              | Bit Position | Length                              | Scale Factor     | Offset | Data Range |                                                                                                                     |
| Start Request                                                            | N/A                     | 1                          | 1.1          | 2 bits                              | 4 counts         | 0      | 0 to 3     | 00b=Inactive 01b=Active<br>10b=Error indication<br>11b=Not available                                                |
| Stop Request                                                             | N/A                     | 1                          | 1.3          | 2 bits                              | 4 counts         | 0      | 0 to 3     | 00b=Inactive 01b=Active<br>10b=Error Indication<br>11b=Not available                                                |
| Idle Speed Select                                                        | N/A                     | 1                          | 1.7          | 2 bits                              | 4 counts         | 0      | 0 to 3     | 00b=Normal Running Speed<br>01b=Idle Speed Request<br>10b=Error Indication<br>11b=Not available                     |
| Frequency Select                                                         | N/A                     | 2                          | 2.1          | 2 bits                              | 4 counts         | 0      | 0 to 3     | 00b=Primary Engine Speed Request<br>01b=Secondary Engine Speed Request<br>10b=Error Indication<br>11b=Not available |
| Preheat Request                                                          | N/A                     | 2                          | 2.5          | 2 bits                              | 4 counts         | 0      | 0 to 3     | 00b=Inactive 01b=Active<br>10b=Error Indication<br>11b=Not available                                                |
| Engine Protection Override                                               | N/A                     | 2                          | 2.7          | 2 bits                              | 4 counts         | 0      | 0 to 3     | 00b=Inactive 01b=Active<br>10b=Error Indication<br>11b=Not available                                                |
| Accelerator Pedal Position                                               | N/A                     | 3                          | 1            | 2 bytes                             | (100/1023) %/bit | 0      | 0 to 100%  | 0x000-0x3FF=0–100 %<br>0x400 – 0xFFE=Error Indication<br>0xFFFF=Not available                                       |
| Accelerator Pedal Counter                                                | N/A                     | 6                          | 6.1          | 4 bits                              | 15 counts        | 0      | 0 to 15    | 0000b to 0111b=Numeric Counter<br>1000–1110=Error Indication<br>1111=Not available                                  |
| Accelerator Pedal Checksum                                               | N/A                     | 6                          | 6.5          | 4 bits                              | 15 counts        | 0      | 0 to 15    | 0000b to 0111b=Numeric crc-3 checksum<br>1000–1110=Error Indication<br>1111=Not available                           |
|                                                                          |                         |                            |              |                                     |                  |        |            |                                                                                                                     |
| <b>Proprietary MTU ECU8/ECU9 Smart Connect Engine ECU Communications</b> |                         |                            |              |                                     |                  |        |            |                                                                                                                     |
| <b>MTU System Cruise Control/Engine Speed (MSCCES)</b>                   | <b>PGN 0xFF56 65366</b> | <b>Proprietary MTU</b>     |              | <b>Transmission Rate: 100 msec.</b> |                  |        |            |                                                                                                                     |
| J1939 Parameter Name                                                     | SPN                     | Byte Position              | Bit Position | Length                              | Scale Factor     | Offset | Data Range |                                                                                                                     |
| Operating Speed Up Switch                                                | 520207                  | 3                          | 1            | 2 bits                              | 4 states         | 0      | 0 to 3     | 00b=Speed up not active<br>01b=Speed up switch active<br>10b=Error 11b=Not available                                |
| Operating Speed Down Switch                                              | 520208                  | 3                          | 3            | 2 bits                              | 4 states         | 0      | 0 to 3     | 00b=Speed down not active<br>01b=Speed down switch active<br>10b=Error 11b=Not available                            |
| MTU Requested Speed Limit Switch                                         | 520842                  | 3                          | 7            | 2 bits                              | 4 states         | 0      | 0 to 3     | 00b=No limitation<br>01b=Limitation active<br>10b=Error 11b=Not available                                           |
|                                                                          |                         |                            |              |                                     |                  |        |            |                                                                                                                     |
| <b>MTU System Operating Station Command (MSOSC1)</b>                     | <b>PGN 0xFF55 65365</b> | <b>Proprietary MTU</b>     |              | <b>Transmission Rate: 100 msec.</b> |                  |        |            |                                                                                                                     |
| J1939 Parameter Name                                                     | SPN                     | Byte Position              | Bit Position | Length                              | Scale Factor     | Offset | Data Range |                                                                                                                     |
| Engine Start Command                                                     | 520192                  | 1                          | 1            | 2 bits                              | 4 states         | 0      | 0 to 3     | 00b=Take no action<br>01b=Reset 10b=Reserved<br>11b=Not applicable                                                  |
| Engine Stop Command                                                      | 520193                  | 1                          | 3            | 2 bits                              | 4 states         | 0      | 0 to 3     | 00b=No stop 01b=Stop engine<br>10b=Error 11b=Not available                                                          |
| Engine Safety and Protection Override Command                            | 520194                  | 1                          | 5            | 2 bits                              | 4 states         | 0      | 0 to 3     | 00b=No override commanded<br>01b=Override commanded<br>10b=Error 11b=Not available                                  |
| Engine Overspeed Test Command                                            | 520197                  | 2                          | 3            | 2 bits                              | 4 states         | 0      | 0 to 3     | 00b=Test Not Commanded<br>01b=Overspeed Test                                                                        |

|                                             |        |   |   |         |          |   |            |                                                                                                               |
|---------------------------------------------|--------|---|---|---------|----------|---|------------|---------------------------------------------------------------------------------------------------------------|
|                                             |        |   |   |         |          |   |            | Commanded 10b=Error<br>11b=Not available                                                                      |
| Disable Engine Cylinder Cutoff<br>2 Command | 520834 | 5 | 1 | 2 bits  | 4 states | 0 | 0 to 3     | 00b=Cylinder cutoff active<br>(not disabled) 01b=Cylinder<br>cutoff not active 10b=Error<br>11b=Not available |
| Intermittent Oil Priming<br>Command         | 520835 | 5 | 3 | 2 bits  | 4 states | 0 | 0 to 3     | 00b=Not active 01b=Active<br>10b=Error 11b=Not available                                                      |
| Engine Operating Mode<br>Command            | 520839 | 5 | 5 | 2 bits  | 4 states | 0 | 0 to 3     | 00b=Operating Mode 1<br>01b=Operating Mode 2<br>10b=Error 11b=Not available                                   |
| Engine Speed Governor<br>Parameter Switch   | 520841 | 5 | 7 | 2 bits  | 4 states | 0 | 0 to 3     | 00b=Default parameter<br>setting 01b=Variant 1<br>parameter setting 10b=Error<br>11b=Not available            |
| Speed Demand Switches                       | 520269 | 6 | 1 | 2 bytes | 1        | 0 | 0 to 65535 | MTU Speed Demand<br>Switches:                                                                                 |
|                                             |        |   |   |         |          |   |            | CAN Demand Switches<br>contains at:                                                                           |
|                                             |        |   |   |         |          |   |            | Bit 0–3 the source for Local<br>normal switch position                                                        |
|                                             |        |   |   |         |          |   |            | Bit 4–7 the source for Local<br>Emergency switch position                                                     |
|                                             |        |   |   |         |          |   |            | Bit 8–11 the source for<br>Remote normal switch<br>position                                                   |
|                                             |        |   |   |         |          |   |            | Bit 12–15 the source for<br>Remote Emergency switch<br>position                                               |
|                                             |        |   |   |         |          |   |            |                                                                                                               |
|                                             |        |   |   |         |          |   |            | With the following<br>assignment per bit group:                                                               |
|                                             |        |   |   |         |          |   |            | 0: Analog CAN                                                                                                 |
|                                             |        |   |   |         |          |   |            | 1: Up/Down ECU                                                                                                |
|                                             |        |   |   |         |          |   |            | 2: Up/Down CAN                                                                                                |
|                                             |        |   |   |         |          |   |            | 3: Analog ECU                                                                                                 |
|                                             |        |   |   |         |          |   |            | 4: Analog ECU relative                                                                                        |
|                                             |        |   |   |         |          |   |            | 5: Frequency                                                                                                  |
|                                             |        |   |   |         |          |   |            | 6: Notch Position (not used)                                                                                  |
|                                             |        |   |   |         |          |   |            |                                                                                                               |

#### Proprietary MTU ADEC Engine ECU Communications

| ADEC Speed Demand<br>Switches       | PGN 0xFF2F 65327 | Proprietary MTU  |                 | Transmission Rate: 500 msec |                    |        |               |                                               |
|-------------------------------------|------------------|------------------|-----------------|-----------------------------|--------------------|--------|---------------|-----------------------------------------------|
| J1939 Parameter Name                | SPN              | Byte<br>Position | Bit<br>Position | Length                      | Scale<br>Factor    | Offset | Data<br>Range |                                               |
| Specified Speed Selection<br>Switch | N/A              | 3                | 1               | 2 bytes                     | 1 digit per<br>bit | 0      | 0 to 7        |                                               |
|                                     |                  |                  |                 |                             |                    |        |               |                                               |
| ADEC Binary Inputs                  | PGN 0xFF2D 65325 | Proprietary MTU  |                 | Transmission Rate: 500 msec |                    |        |               |                                               |
| J1939 Parameter Name                | SPN              | Byte<br>Position | Bit<br>Position | Length                      | Scale<br>Factor    | Offset | Data<br>Range |                                               |
| Speed Increase                      | N/A              | 1                | 3               | 2 bits                      | 4 states           | 0      | 0 to 3        | 00b=Off 01b=On 10b=Error<br>11b=Not available |
| Speed Decrease                      | N/A              | 1                | 5               | 2 bits                      | 4 states           | 0      | 0 to 3        | 00b=Off 01b=On 10b=Error<br>11b=Not available |
| Request Test Overspeed              | N/A              | 1                | 7               | 2 bits                      | 4 states           | 0      | 0 to 3        | 00b=Off 01b=On 10b=Error<br>11b=Not available |
| Alarm Reset                         | N/A              | 2                | 3               | 2 bits                      | 4 states           | 0      | 0 to 3        | 00b=Off 01b=On 10b=Error<br>11b=Not available |
| Switchover Governor<br>Parameters   | N/A              | 6                | 5               | 2 bits                      | 4 states           | 0      | 0 to 3        | 00b=Off 01b=On 10b=Error<br>11b=Not available |
| Interval Priming                    | N/A              | 4                | 1               | 2 bits                      | 4 states           | 0      | 0 to 3        | 00b=Off 01b=On 10b=Error<br>11b=Not available |
|                                     |                  |                  |                 |                             |                    |        |               |                                               |

#### Proprietary Scania Engine ECU Communications

| DLN1 – Proprietary   | PGN 0xFF80 65408 | Proprietary Scania |                 | Transmission Rate: 200 msec. |                 |        |               |                                               |
|----------------------|------------------|--------------------|-----------------|------------------------------|-----------------|--------|---------------|-----------------------------------------------|
| J1939 Parameter Name | SPN              | Byte<br>Position   | Bit<br>Position | Length                       | Scale<br>Factor | Offset | Data<br>Range |                                               |
| Version              | N/A              | 1                  | 1               | 1 byte                       | 1               | 0      | 0 to 250      | Hard Coded to 0xA1 per<br>Scania instructions |
| Nominal Speed Offset | N/A              | 2                  | 1               | 1 byte                       | 0.4% per<br>bit | 0      | 0 to 100%     | Hard Coded to 0x00 per<br>Scania Instructions |

|                          |     |   |   |        |          |   |        |                                                                                                                      |
|--------------------------|-----|---|---|--------|----------|---|--------|----------------------------------------------------------------------------------------------------------------------|
| Low Idle Switch Released | N/A | 3 | 1 | 2 bits | 4 states | 0 | 0 to 3 | Hard Coded to 01b for Released                                                                                       |
| Kickdown Switch          | N/A | 3 | 3 | 2 bits | 4 states | 0 | 0 to 3 | Hard Coded to 00b for Kick Down Not Active                                                                           |
| Engine Start             | N/A | 3 | 5 | 2 bits | 4 states | 0 | 0 to 3 | 00b=Off 01b=On 10b=Error Indication 11b=Not available                                                                |
| Engine Stop              | N/A | 3 | 7 | 2 bits | 4 states | 0 | 0 to 3 | 00b=Off Engine Stop Not Demanded 01b=Engine Stop Demanded 10b=Error Indication 11b=Not available                     |
| Emergency Stop Demanded  | N/A | 4 | 2 | 2 bits | 4 states | 0 | 0 to 3 | 00b=Off Engine Emergency Stop Not Demanded 01b=Engine Emergency Stop Demanded 10b=Error Indication 11b=Not available |
|                          |     |   |   |        |          |   |        |                                                                                                                      |

#### Proprietary John Deere Engine ECU communications

|                                                             |                         |                               |              |                                    |              |        |            |                                                        |
|-------------------------------------------------------------|-------------------------|-------------------------------|--------------|------------------------------------|--------------|--------|------------|--------------------------------------------------------|
| <b>Stationary Regeneration/Cleaning CAN Lockout Message</b> | <b>PGN 0xEF00 61184</b> | <b>Proprietary John Deere</b> |              | <b>Transmission Rate: 1 second</b> |              |        |            |                                                        |
| J1939 Parameter Name                                        | SPN                     | Byte Position                 | Bit Position | Length                             | Scale Factor | Offset | Data Range |                                                        |
| Message Byte 1                                              | N/A                     | 1                             | 1            | 1 byte                             | 1            | 0      | 0xF2       | Hard Coded to 0xF2 per John Deere Instructions         |
| Message Byte 2                                              | N/A                     | 2                             | 1            | 1 byte                             | 1            | 0      | 0x31       | Hard Coded to 0x31 per John Deere Instructions         |
| Engine DPF Active Regeneration Allow (Interlock Status)     | JD778720                | 5                             | 6            | 2 bits                             | 4 states     | 0      | 0 to 3     | 01b=Not Allowed 01b=Allowed 10b=Reserved 11b=No Action |
|                                                             |                         |                               |              |                                    |              |        |            |                                                        |
| <b>Start Control</b>                                        | <b>PGN 0xEF00 61184</b> | <b>Proprietary John Deere</b> |              | <b>Transmission Rate: 1 second</b> |              |        |            |                                                        |
| J1939 Parameter Name                                        | SPN                     | Byte Position                 | Bit Position | Length                             | Scale Factor | Offset | Data Range |                                                        |
| Message Byte 1                                              | N/A                     | 1                             | 1            | 1 byte                             | 1            | 0      | 0xF2       | Hard Coded to 0xF2 per John Deere Instructions         |
| Message Byte 2                                              | N/A                     | 2                             | 1            | 1 byte                             | 1            | 0      | 0x24       | Hard Coded to 0x24 per John Deere Instructions         |
| Engine Start Control                                        | JD523307                | 3                             | 1            | 2 bits                             | 4 states     | 0      | 0 to 3     | 00b=Off 01b=On 10b=Error 11b=Not available             |
|                                                             |                         |                               |              |                                    |              |        |            |                                                        |

#### Proprietary Yanmar Engine ECU Communications

|                                                          |                         |                           |              |                                     |              |        |            |                                                                                                                |
|----------------------------------------------------------|-------------------------|---------------------------|--------------|-------------------------------------|--------------|--------|------------|----------------------------------------------------------------------------------------------------------------|
| <b>Engine DPF Regeneration Control Request (Y_DPFIF)</b> | <b>PGN 0xFF18 65304</b> | <b>Proprietary Yanmar</b> |              | <b>Transmission Rate: 1 second</b>  |              |        |            |                                                                                                                |
| J1939 Parameter Name                                     | SPN                     | Byte Position             | Bit Position | Length                              | Scale Factor | Offset | Data Range |                                                                                                                |
| Accelerator Interlock Switch                             | 972                     | 1                         | 1            | 2 bits                              | 4 states     | 0      | 0 to 3     | 00b=OFF (Regeneration Not Possible) 01b=ON (Regeneration Possible) 10b=Error 11b=Not available                 |
| Diesel Particulate Filter Regeneration Inhibit Switch    | 3695                    | 1                         | 3            | 2 bits                              | 4 states     | 0      | 0 to 3     | 00b=OFF (Regeneration Prohibited) 01b=ON (Regeneration Permitted) 10b=Error 11b=Not available                  |
| Diesel Particulate Filter Regeneration Force Switch      | 3696                    | 1                         | 5            | 2 bits                              | 4 states     | 0      | 0 to 3     | 00b=OFF (Forced Regeneration Not Requested) 01b=ON (Forced Regeneration Requested) 10b=Error 11b=Not available |
|                                                          |                         |                           |              |                                     |              |        |            |                                                                                                                |
| <b>Engine stop command (T_STP)</b>                       | <b>PGN 0xFF1D 65309</b> | <b>Proprietary Yanmar</b> |              | <b>Transmission Rate: As Needed</b> |              |        |            |                                                                                                                |
| J1939 Parameter Name                                     | SPN                     | Byte Position             | Bit Position | Length                              | Scale Factor | Offset | Data Range |                                                                                                                |
| Engine Stop                                              | N/A                     | 1                         | 1            | 2 bits                              | 4 states     | 0      | 0 to 3     | 00b=Engine Stop Not Requested 01b=Engine Stop 10b=Error Indicator 11b=Not available                            |
|                                                          |                         |                           |              |                                     |              |        |            |                                                                                                                |

#### Proprietary Isuzu Engine ECU Communications

|                                                      |                         |                 |              |                                                     |              |        |            |  |
|------------------------------------------------------|-------------------------|-----------------|--------------|-----------------------------------------------------|--------------|--------|------------|--|
| <b>Command Non-Continuously Monitored Test (DM7)</b> | <b>PGN 0x0300 58112</b> | <b>Standard</b> |              | <b>Transmission Rate: Sent when test is desired</b> |              |        |            |  |
| J1939 Parameter Name                                 | SPN                     | Byte Position   | Bit Position | Length                                              | Scale Factor | Offset | Data Range |  |

|                                                                     |                         |                             |              |                                    |              |        |                                 |                                                   |
|---------------------------------------------------------------------|-------------------------|-----------------------------|--------------|------------------------------------|--------------|--------|---------------------------------|---------------------------------------------------|
| Test Identifier (Manufacturer Defined) – Isuzu Memory Clear Request | 1224                    | 1                           | 1            | 1 byte                             | 1            | 0      | 1 to 64                         | Hard Coded to 0x34 for Isuzu Memory Clear Request |
| <b>Basler Voltage Regulator Proprietary Communications</b>          |                         |                             |              |                                    |              |        |                                 |                                                   |
|                                                                     |                         |                             |              |                                    |              |        |                                 |                                                   |
| <b>Basler Proprietary Field Current Setpoint</b>                    | <b>PGN 0xFF01 65281</b> | <b>Proprietary Basler</b>   |              | <b>Transmission Rate: 100 msec</b> |              |        |                                 |                                                   |
| J1939 Parameter Name                                                | SPN                     | Byte Position               | Bit Position | Length                             | Scale Factor | Offset | Data Range                      |                                                   |
| Field Current Setpoint                                              | N/A                     | 3                           | 1            | 2 bytes                            | 0.05 A/bit   | 0      | 32693.95 Amps                   |                                                   |
|                                                                     |                         |                             |              |                                    |              |        |                                 |                                                   |
| <b>Proprietary Marathon Voltage Regulator Communications</b>        |                         |                             |              |                                    |              |        |                                 |                                                   |
|                                                                     |                         |                             |              |                                    |              |        |                                 |                                                   |
| <b>VR Heartbeat Command</b>                                         | <b>PGN 0xFF01 65281</b> | <b>Proprietary Marathon</b> |              | <b>Transmission Rate: 1 sec.</b>   |              |        |                                 |                                                   |
| J1939 Parameter Name                                                | SPN                     | Byte Position               | Bit Position | Length                             | Scale Factor | Offset | Data Range                      |                                                   |
| Data bytes: All data bytes are specified to be 0xFF for this PGN    | N/A                     | 1                           | 1            | 8 bytes                            | 1            | 0      | 0xFFFFFFFF FFFFFFFF fixed value |                                                   |
|                                                                     |                         |                             |              |                                    |              |        |                                 |                                                   |
| <b>Set Point Adjust</b>                                             | <b>PGN 0xFFA1 65441</b> | <b>Proprietary Marathon</b> |              | <b>Transmission Rate: 1 sec.</b>   |              |        |                                 |                                                   |
| J1939 Parameter Name                                                | SPN                     | Byte Position               | Bit Position | Length                             | Scale Factor | Offset | Data Range                      |                                                   |
| Field Current Set Point                                             | N/A                     | 3                           | 1            | 2 bytes                            | 1 ma/bit     | 0      | 0.000–3.000 Amps                |                                                   |
| Voltage Set Point                                                   | N/A                     | 5                           | 1            | 2 bytes                            | 0.1 volt/bit | 0      | 100.0–400.0 Volts               |                                                   |
| Voltage Adjust                                                      | N/A                     | 7                           | 1            | 2 bytes                            | 0.1 volt/bit | 0      | +/- 30% of voltage setpoint     |                                                   |
|                                                                     |                         |                             |              |                                    |              |        |                                 |                                                   |
| <b>Underfrequency Knee and Slope Adjust</b>                         | <b>PGN 0xFFA6 65446</b> | <b>Proprietary Marathon</b> |              | <b>Transmission Rate: 1 sec.</b>   |              |        |                                 |                                                   |
| J1939 Parameter Name                                                | SPN                     | Byte Position               | Bit Position | Length                             | Scale Factor | Offset | Data Range                      |                                                   |
| Under Frequency (UF) Slope Coefficient                              | N/A                     | 1                           | 1            | 2 bytes                            | 1            | 0      | 0–32767                         |                                                   |
| Under Frequency (UF) Slope Exponent                                 | N/A                     | 3                           | 1            | 1 byte                             | 1            | 0      | 0–31                            |                                                   |
| Under Frequency (UF) Slope Knee                                     | N/A                     | 4                           | 1            | 2 bytes                            | 0.1 Hz/bit   | 0      | 04.0 Hz–70.0 Hz                 |                                                   |

### Diagnostic Trouble Codes (DTCs)

The DGC-2020 obtains diagnostic engine information from a compatible engine control unit (ECU). The DGC-2020 will receive an unsolicited message of a currently active diagnostic trouble code (DTC). Previously active DTCs are available upon request. Active and previously active DTCs can be cleared on request. When a DTC Clear is requested, the DGC-2020 initiates a pulse cycle (if pulsing is enabled) so the ECU will be powered up to receive the clear request. If there are two ECUs on the engine, any clear requests are sent to both ECUs.

Table 3-3 lists the diagnostic information that the DGC-2020 obtains over the CAN Bus interface.

**Table 3-3. Diagnostic Information Obtained Over the CAN Bus Interface**

| Parameter                                 | Transmission Repetition Rate |
|-------------------------------------------|------------------------------|
| Active diagnostic trouble code            | 1 s                          |
| Lamp status                               | 1 s                          |
| Previously active diagnostic trouble code | On request                   |
| Request to clear active DTCs              | On request                   |
| Request to clear previously active DTCs   | On request                   |

DTCs are reported in coded diagnostic information that includes the Suspect Parameter Number (SPN), Failure Mode Identifier (FMI), and Occurrence Count (OC). All parameters have an SPN and are used to display or identify the items for which diagnostics are being reported. The FMI defines the type of failure detected in the subsystem identified by an SPN. The reported problem may not be an electrical failure but a subsystem condition needing to be reported to an operator or technician. The OC contains the number of times that a fault has gone from active to previously active.

A complete list of all diagnostic information that the DGC-2020 obtains over the CAN Bus interface is available in Appendix F.

For certain DTCs, if the DGC-2020 recognizes a pair of SPN and FMI numbers, it displays a single string as listed in Table F-3. If the DGC-2020 recognizes an SPN in Table F-3, but the FMI does not match the FMI in Table F-3, then it displays the string from Table F-3, corresponding to the table entry where the FMI is # and a second string corresponding to the FMI number listed in Table F-2. For example, if the DGC-2020 receives SPN 29 and FMI 13, it displays ACCEL PEDAL 2 POSITN and OUT OF CALIBRATION. If the DGC-2020 does not have descriptive information about an SPN and FMI that was received, the description will display as "NO TEXT AVAILABLE".

#### *mtu Fault Codes*

A DGC-2020 connected to a genset equipped with an *mtu* engine ECU tracks and displays the active fault codes issued by the *mtu* engine ECU. Active *mtu* fault codes can be viewed through BESTCOMSP<sup>Plus</sup>® by using the Metering Explorer to expand the *mtu* tree or through the front panel display by navigating to METERING, ALARMS-STATUS, *mtu* FAULT CODES.

Each fault code is displayed with a fault description and the fault number. If the DGC-2020 does not have descriptive information about a fault number that was received, the fault description will display as "NO TEXT AVAILABLE". Fault codes displayed by the DGC-2020 are described in Appendix D, *mtu Fault Codes*.

#### *RS-485 (Optional)*

DGC-2020 controllers with the optional RS-485 communication port (style number xxxRxxxxx) can be monitored and controlled via a polled network using the Modbus® protocol. The RS-485 port supports a user-selectable baud rate of 1200, 2400, 4800, or 9600. Odd, even, or no parity is supported. Fixed communication settings include the number of data bits (8) and stop bits (1). Modbus register values for the DGC-2020 are listed and defined in Appendix B, *Modbus® Communication*. RS-485 port connections are made at DGC-2020 terminals 14 (485A), 13 (485B), and 12 (485 SHIELD).

#### *Modem (Optional)*

When a DGC-2020 is equipped with the optional external modem port (style number xxxxxExxx), it can be connected to an external, user-supplied dial-out modem. The modem enables the DGC-2020 to dial up to four pager telephone numbers and annunciate conditions selected by the user. These conditions include any DGC-2020 alarm or pre-alarm, closure of any programmable contact input, and an active cooldown timer. The modem accommodates pagers that use seven data bits with even parity or modems using eight data bits with no parity.

### **Output Contacts**

Output contact operation is controlled by the operating mode of the DGC-2020. The state of the Emergency Stop contact input also affects output contact operation. When the Emergency Stop contact input is open (emergency stop condition), the PRESTART, START, and RUN outputs open. When the Emergency Stop input is closed, all output contacts operate normally.

DGC-2020 output contacts include PRESTART, START, RUN, and up to 12 standard programmable outputs. Additional output contacts can be accommodated with a CEM-2020 (Contact Expansion Module).

### PRESTART

This output closes to energize the engine glow plugs. The PRESTART output can be programmed to close up to 30 seconds prior to engine cranking. The PRESTART output can also be programmed to open upon engine startup or remain closed as long as the engine is operating.

During the resting state, the PRESTART can be set to Off, On, or Preheat Before Crank. If Preheat Before Crank is selected, the PRESTART output will be closed for a time equal to the Pre-crank delay time prior to re-entering the cranking state. If the Pre-crank delay setting is longer than the rest interval, the PRESTART output will be closed for the entire rest time.

PRESTART output connections are made through terminals located on the PRESTART relay.

### START

This output closes when engine cranking is initiated by the DGC-2020 and opens when the magnetic pickup (MPU) or generator frequency indicates that the engine has started. Prior to engine starting, the duration of cranking is determined by the cranking style (cycle or continuous) selected. Cycle cranking permits up to 7 crank cycles with crank cycle duration of 5 to 15 seconds. The continuous crank time is adjustable from 5 to 60 seconds.

START output connections are made through terminals located on the START relay.

### RUN

This output closes when engine cranking is initiated by the DGC-2020. The RUN output remains closed until an off command or emergency stop command is received.

RUN output connections are made through terminals located on the RUN relay.

### Programmable

DGC-2020 controllers with a style number of xxAxxxxxx have four programmable output contacts (OUT 1 through 4). Twelve programmable outputs (OUT 1 through 12) are provided on controllers with a style number of xxBxxxxxx.

## ***Modes of Operation***

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### **Off**

When in the Off mode, the DGC-2020 will not start under any circumstance. It cannot be started automatically. Programmable logic functions normally in this mode.

### **Run**

When in the Run (manual) mode, the DGC-2020 runs and cannot be shut off automatically. The breaker can be open or closed through programmable logic inputs. Programmable logic functions normally in this mode.

### **Auto**

When in the Auto mode, the DGC-2020 may be started automatically or “self-start” from an automatic starting feature listed in the following paragraphs. If the DGC-2020 is not in Auto mode, the self-starting modes will have no effect. The self-starting modes are independent, with one exception, meaning that if any self-starting mode indicates that the unit should run, it will run. It will not shut down unless all self-starting modes indicate that the unit should not be running.

### ATS Contact Input

The ATS programmable function has an input mapped to it from BESTCOMSP<sup>Plus</sup>®. The unit will start and run when this contact is closed, and will stop when the contact is open. This mode is independent of the other self-starting modes.

### Generator Exerciser

The unit will start at the designated time and will run for the specified duration. The breaker will be closed if “Run with Load” is checked in the generator exerciser settings. This mode is independent of the other self-starting modes.

### Mains Fail Transfer Functionality

If mains fail transfer is enabled, the unit will run when the utility is determined to be bad, and will not stop until the utility has been determined to be good and the load has been transitioned to the utility. This mode is independent of the other self-starting modes.

### Run with Load Logic Element

When the run with load logic element start input is energized, the unit will start, close its breaker, and take on load at the programmed load rate. If the unit is the only one on the load, it will provide the full load. When the run with load logic element stop input is energized, the unit will unload at the programmed load rate, open its breaker, and stop. This mode works in conjunction with demand start/stop, otherwise it is completely independent of the other self-starting modes.

### Engine Run Logic Element

When the engine run logic element start input is energized, the unit will start. When the engine run logic element stop input is energized, the unit will unload if loaded, open its breaker if needed, cool down, and then stop.

### Demand Start/Stop Function

If the system demand is above the configured level setting for the specified time, and sequencing is enabled, the unit will start, close its breaker, and take on load at the programmed load rate. Note the unit will not start if sequencing is not enabled. If the unit is the only one on the load, it will provide the full load. If the load drops below the stop level for the specified time, the unit will unload at the programmed load rate, open its breaker, and stop. This mode works in conjunction with the run with load logic element, otherwise it is completely independent of the other self-starting modes.

### Interoperability of the Run with Load Logic Element and the Demand Start/Stop Function

These two functions can be used together; they are not independent of each other. Either one can start or stop the system, but they can share functionality in that one can stop the system even if the other one started it. Thus, if a machine was started by pulsing the run with load start, it could be stopped by demand start/stop. This can be useful in a scenario where it may be desired to start a number of generators all at the same time but sequence some off if the load does not require them. Run with load start could be pulsed on all the units causing them to start and close their breakers, then demand start/stop and sequencing could cycle them on and off as the load requirements change.

In order for Run With Load and Sequencing to operate reliably, it is recommended that the inputs to the Run with Load logic element be pulsed rather than held constant. For example, if a unit was started by sequencing, a pulse on the Run with Load Stop will shut down the unit. However, if the Run with Load Stop is held constant, sequencing could never start a unit because the sequencing starts would be immediately negated by Run with Load Stops. Similarly, if a Run with Load Start is applied and held constant, sequencing cannot shut down the unit. Any stops generated by sequencing would immediately be negated by the Run with Load Start.

## **Operating States**

The DGC-2020 goes through the operating states listed in Table 3-4 when starting and stopping the generator.

**Table 3-4. Operating States**

| State | Description                                                                                                         |
|-------|---------------------------------------------------------------------------------------------------------------------|
| Reset | The first state after a DGC-2020 power up. Not running and not able to run until system initialization is complete. |



| State      | Description                                                                                                                                                                                                                                                                       |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ready      | The engine is not running. The DGC-2020 is ready to run. This is the normal state of the DGC-2020 in Off mode, and in Auto mode when the engine is not running, or in the process of starting or stopping.                                                                        |
| Cranking   | The DGC-2020 is cranking the engine as part of the start sequence.                                                                                                                                                                                                                |
| Resting    | The DGC-2020 is resting (not cranking) the starter between crank cycles as part of the start sequence.                                                                                                                                                                            |
| Running    | The engine is running.                                                                                                                                                                                                                                                            |
| Alarm      | The engine is not running and is in the Alarm state. The engine cannot be run until the alarm is cleared by pressing the Off button on the front panel. If the engine was running when the alarm state was entered, the unit will shut down.                                      |
| Prestart   | The DGC-2020 is in a pre-start state for engine pre-heat or pre-lube purposes in anticipation of an engine start.                                                                                                                                                                 |
| Cooling    | The engine is running to allow cooldown in anticipation of an engine shutdown.                                                                                                                                                                                                    |
| Connecting | The engine is not running. The DGC-2020 is attempting to connect to the engine ECU to read data or establish communications for control. This state precedes an engine startup as part of the start sequence.                                                                     |
| Disconnect | The engine is not running and possibly spinning down after completion of a run session. The DGC-2020 removes KEY ON from the ECU after a run session is complete. This allows the engine to spin down prior to reconnecting to the ECU to read data after the engine has stopped. |
| Pulsing    | The engine is not running. The DGC-2020 is attempting to connect to the ECU to read data from it or send data requests to it.                                                                                                                                                     |
| Unloading  | When the DGC-2020 is part of a multiple-unit, load-sharing system, the engine is running, but kW output is being reduced in anticipation of cooldown and subsequent shutdown.                                                                                                     |

## Breaker Management

### Introduction

The DGC-2020 is capable of controlling the generator breaker and the mains breaker. Once it is determined that a valid breaker request is available, the DGC-2020 will attempt to operate the breaker if possible. The user can choose to control only the generator breaker, the generator and mains breakers, or none. *BESTCOMSPPlus®* is used to configure breaker management. Refer to Section 4, *BESTCOMSPPlus® Software, Breaker Management*, for setting information.

### Determining Breaker Status

The status of the breakers is determined by using *BESTlogicPlus* Programmable Logic to setup the GENBRK and MAINSBRK logic blocks. These logic blocks have outputs that can be configured to energize an output contact and control a breaker as well as inputs for breaker control and status.

### Processing Breaker Requests

Types of breaker operate requests include:

- Local Request - generated by internal functions and based on operating modes.
- Com Request - generated through a communication port using *BESTCOMSPPlus®* or the front panel HMI.
- Logic Request - generated from *BESTlogicPlus*.

The type of response given for a local request depends on the operating mode of the DGC-2020.

### Run Mode

When in RUN mode, the generator and mains breakers can be closed manually using contact inputs or the breaker buttons on the BESTCOMSPlus® *Control* screen.

### Off or Auto Mode (Not Running)

If operating in the Off mode or Auto and not running, the generator breaker cannot be closed because the generator will not be stable.

### Auto Mode (Running)

When in Auto mode and running, the mains fail transfer feature will automatically control the mains breaker and the generator breaker or the external ATS (automatic transfer switch) will start the generator and control the breakers itself. In addition, the generator breaker can be automatically controlled by the demand start/stop function, the exercise timer function, or a RUNWLOAD (run with load) start from BESTlogicPlus. The generator breaker can be manually controlled using contact inputs and outputs or the breaker buttons on the BESTCOMSPlus® *Control* screen.

## **Breaker Operation**

The DGC-2020 will attempt to close a breaker only after verifying that it can be closed. If the breaker cannot be closed, the close request will be ignored. Only one breaker can be closed at a time. Synchronization is required before closing the breaker to a live bus. Closure to a dead bus can be performed after meeting dead bus threshold and timing requirements set by the user.

### Determining if it is Acceptable to Close a Breaker

Before the generator breaker can be closed, it must be configured in BESTCOMSPlus®. If only the generator breaker is configured (mains breaker not configured) the DGC-2020 looks at user settings to determine if the generator side of the breaker is stable and the bus side is stable or dead. If both the generator and the mains breakers are configured and open, the DGC-2020 will close the generator breaker if the generator side of the breaker is stable. If both breakers are configured and the mains breaker is closed, the DGC-2020 will close the generator breaker after verifying that both sides of the generator breaker are stable and the DGC-2020 is synchronizing.

Before the mains breaker can be closed, it must be configured in BESTCOMSPlus®. If both the mains and the generator breakers are configured and open, the DGC-2020 will close the mains breaker if the mains side of the breaker is stable. If both breakers are configured and the generator breaker is closed, the DGC-2020 will close the mains breaker after verifying that both sides of the mains breaker are stable.

### Changing the Breaker State

Synchronization is required when closing a breaker to a live bus. Bus conditions act as a supervisory control over the synchronizing function. If synchronization is in process and either bus goes unstable, synchronization is suspended. To close the breaker on a dead bus, the DGC-2020 generates a breaker close request. The closing function is then run without synchronization.

The GENBRK and MAINSBRK logic blocks contain both Open and Close logic outputs that can be configured to energize an output contact, which would in turn operate the breaker. The Synchronizer screen in BESTCOMSPlus® is used to set the output contact type to pulses or continuous.

If the breaker does not seem to operate properly, refer to Section 8, *Maintenance and Troubleshooting*.

## **Synchronizer Operation**

The synchronizer acts to align the generator voltage and frequency with that of the bus inputs when the DGC-2020 desires to close the generator to a live, stable bus. Several situations must exist before the synchronizer function will begin to execute:

- The DGC-2020 must include the synchronizer option
- The generator voltage must be stable
- The bus voltage must be stable
- The DGC-2020 must be in the process of initiating a breaker close

Breaker close sources are:

- The DGC-2020 itself when the automatic transfer (ATS) feature is enabled.
- The DGC-2020 itself when the Run with Load logic element receives a Start pulse in the programmable logic.
- The DGC-2020 itself when started from a Demand Start as part of demand start/stop and sequencing.
- The DGC-2020 itself when started from the Exercise Timer and the *Run with Load* box is checked in the Generator Exerciser Settings.
- Manual Breaker Close Input Contacts applied to the Open and Close inputs on the left side of the Generator Breaker logic element in the programmable logic.

Any of the above close sources will work when the DGC-2020 is in Auto mode. Only the Manual Breaker Close Input Contacts can initiate a breaker closure when the DGC-2020 is in Run mode.

In wye, delta, grounded delta, or single-phase AB configurations, the synchronizer aligns the voltage on the GEN VA terminal with that on the BUS VA terminal, and the voltage on the GEN VB terminal with that on the BUS VB terminal. In other words, the DGC-2020 aligns the generator phase AB L-L voltage with the bus phase AB L-L voltage. In order for the synchronizer to provide correct phase alignment across a breaker, the phase AB L-L voltages on the generator side of the breaker must be wired to the GEN VA and GEN VB terminals on the DGC-2020. The phase AB L-L voltages on the bus side of the breaker (the bus to which the generator will be connected when the breaker is closed) must be wired to the BUS VA and BUS VB terminals on the DGC-2020. See Section 6, *Installation*, for a three-phase wye connection for typical applications diagram.

In single-phase AC configuration, the synchronizer aligns the voltage on the GEN VA terminal with that on the BUS VA terminal, and the voltage on the GEN VC terminal with that on the BUS VB terminal. In other words, the DGC-2020 aligns the generator phase CA L-L voltage with the bus phase CA L-L voltage. In order for the synchronizer to provide correct phase alignment across a breaker, the phase CA L-L voltages on the generator side of the breaker must be wired to the GEN VA and GEN VC terminals on the DGC-2020. The phase CA L-L voltage on the bus side of the breaker (the bus to which the generator will be connected when the breaker is closed) must be wired to the BUS VA and BUS VB terminals on the DGC-2020. See Section 6, *Installation*, for a single-phase AC connection for typical applications diagram.

Generator speed can be influenced by either the speed trim function, which is active at all times if enabled, and the synchronizer. Since the speed trim function can cause some activity on the speed bias outputs, when performing synchronizer troubleshooting it is recommended that the speed trim function be disabled.

One way to tell if the synchronizer is active is to observe the DGC-2020 front panel. When the synchronizer is active the DGC-2020 displays a synchronizer scope and angle and voltage error values on the front panel.

Another method is to check for governor and AVR *raise* and *lower* output signals. First, disable the speed trim function. If the governor or AVR bias control output type is contact, check for raise and/or lower pulses coming from the DGC-2020 during synchronization. If the governor or AVR bias control output type is analog, check the governor and/or AVR bias analog outputs on the load share module with a voltmeter during synchronization. The voltages or raise/lower pulses should be changing when the synchronizer is active. If there are no raise/lower pulses, or if the analog bias voltages do not change, the synchronizer is not active.

A readily available method of verifying synchronizer operation during initial set up and commissioning is to connect a light bulb from phase B of the machine being synchronized to phase B of the bus. Three bulbs, one on each phase can be employed if so desired. The bulb(s) should be off or very dim when it is OK for the breaker to close.

If it is not practical to use light bulbs, a voltmeter can be connected across the GEN VA and BUS VA terminals. When the DGC-2020 reports that the slip angle is near zero, the voltage read by the meter should be near zero. For single-phase ac systems, connect the voltmeter across the GEN VA and BUS VA or GEN VC and BUS VB terminals.

If the DGC-2020 is indicating that the slip angle is at or near zero, but the slip angle measured across the breaker is not near zero, it is likely that the signals measured by the DGC-2020 are not the signals that

are present at the breaker. In this case, all wiring should be checked to verify that the voltage at the GEN VA terminal of the DGC-2020 matches the voltage present at the Phase A connection on the generator side of the breaker, that the voltage at the GEN VB terminal of the DGC-2020 matches the voltage present at the Phase B connection on the generator side of the breaker, and that the voltage at the GEN VC terminal of the DGC-2020 matches the Phase C connection on the generator side of the breaker. Similar verification should be performed from the BUS VA and BUS VB terminals on the DGC-2020 to the Phase A and Phase B connections on the bus side of the breaker.

It is also required that phase rotation is the same on both sides of the breaker for synchronization to be possible.

### Notes

When using the DGC-2020 synchronizer, it is recommended that local DGC-2020 relay outputs be used for breaker closing commands to minimize the possibility of closures outside of desired breaker closing angles.

If remote (CEM-2020) outputs are to be used for breaker close commands, it is recommended that the anticipatory synchronizer type be used, and the breaker close wait time be adjusted to account for possible CEM-2020 output delays (typically 50 ms) to achieve desired breaker closing angles.

If the synchronizer does not seem to operate properly, refer to Section 8, *Maintenance and Troubleshooting*.

## Dead Bus Breaker Close Arbitration

Dead bus breaker close arbitration ensures that only one machine (assigned by the system manager) closes its breaker to a dead bus. The system manager controls generator sequencing. The system manager is the unit with the lowest numbered nonzero sequencing ID. After a machine issues a dead bus close request and the system manager grants it, the machine that received the grant closes its breaker to the dead bus. Now that the bus is no longer dead, all remaining units must synchronize to the live bus.

Individual units issue dead bus close requests to the system manager when they want to close their generator breaker and a dead bus is detected. An individual unit issues a dead bus close request when all of the following are true:

1. The generator is stable
2. A dead bus is detected
3. A generator breaker close request is received

An individual unit with its System Type parameter set to Multiple Generator will not close its breaker onto the dead bus unless it receives a dead bus close grant from the system manager via Ethernet. The LSM-2020 provides Ethernet communication between the DGC-2020 and the network. The System Type parameter is found on the *System Settings* screen in BESTCOMSPlus®. After an individual unit issues a dead bus close request and receives a dead bus close grant from the system manager, the unit maintains its dead bus close request unless one of the following occurs:

- The dead bus close grant is removed by the system manager
- The generator breaker encounters a breaker close fail
- A generator breaker open request is received
- The generator becomes unstable

An individual unit can close to a dead bus at any time when the System Type parameter is set to Single Generator or an LSM-2020 is not providing Ethernet communication between the DGC-2020 and the network.

The Unit ID of the system manager can be found on the front panel of each unit and in BESTCOMSPlus®. Refer to Section 2, *Human-Machine Interface, Display Operation, Generator Network Status Display*.

All units in the system reporting a dead bus must be visible to the system manager via Ethernet before any dead bus close grant is issued. The system manager removes any dead bus close grant if any machine reports the bus is not dead. A dead bus close grant is not removed by the system manager unless the unit that received the grant removes its request or another machine reports that the bus is not dead.

For consistent operation, all units should be set up with the same demand start/stop and sequencing criteria. This ensures that system manager functionality is transferred accordingly as the lowest numbered nonzero sequence ID changes in the system.

## Event Recording

An event log retains history of system events in nonvolatile memory. Fifty event records are retained and each record contains a time stamp of the first and last event occurrence, and the number of occurrences for each event. In addition, each record contains details of the time, date, and engine hours for the most recent 30 occurrences of the event. The number of occurrences stops incrementing at 99. If an event occurs which is of a type that differs from those in the 50 records in memory, the record that has the oldest “last” event occurrence is removed from the log, and the new category takes its place. Since 50 event records with up to 99 occurrences each are retained in memory, a history of nearly 5,000 specific events are retained in the DGC-2020. Detailed occurrence information is retained for the most recent 30 occurrences of each event record, and there are 50 event records; thus the time, date, and engine hours details for up to 1,500 specific event occurrences are retained in the event log.

BESTCOMS<sup>Plus</sup>® can be used to view and download the event log. The event log may also be viewed through the front panel HMI by navigating to *Metering > Alarms-Status > Event Log*. Use the Up/Down keys to highlight an event and press the *Right* key to view the summary of that event record. The summary contains the description of the event, date, time, and engine hours of the first occurrence of the event, along with date, time, and engine hours of the most recent occurrence of the event. To view details of specific event occurrences, press the *Down* key until DETAILS is highlighted, and then, press the *Right* key. The occurrence number can be changed by pressing the *Edit* key, *Up/Down* keys to select #, and pressing the *Edit* key again to exit. Table 3-5 lists all possible event strings (as shown in the event log), causes, and corrective actions.

**Table 3-5. Event List**

| Event String       | Event Description/Cause/Corrective Action                                                                                                                                               |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 27-1 UNDVOLT TRP A | 27-1 Undervoltage Trip (Alarm)                                                                                                                                                          |
|                    | <i>Cause:</i> The generator voltage is below the 27-1 undervoltage threshold in at least one phase and the 27-1 Undervoltage element is configured as an alarm.                         |
|                    | <i>Corrective Action:</i> Check the generator wiring, machine configuration, the generator voltage regulator, and the load for faults that could cause low voltage conditions.          |
| 27-1 UNDVOLT TRP P | 27-1 Undervoltage Trip (Pre-Alarm)                                                                                                                                                      |
|                    | <i>Cause:</i> The generator voltage is below the 27-1 undervoltage threshold in at least one phase and the 27-1 Undervoltage element is configured as a pre-alarm.                      |
|                    | <i>Corrective Action:</i> Check the generator wiring, machine configuration, the generator voltage regulator, and the load for faults that could cause low voltage conditions.          |
| 27-2 UNDVOLT TRP A | 27-2 Undervoltage Trip (Alarm)                                                                                                                                                          |
|                    | <i>Cause:</i> The generator voltage is below the 27-2 undervoltage threshold in at least one phase and the 27-2 Undervoltage element is configured as an alarm.                         |
|                    | <i>Corrective Action:</i> Check the generator wiring, machine configuration, the generator voltage regulator, and the load for faults that could cause low voltage conditions.          |
| 27-2 UNDVOLT TRP P | 27-2 Undervoltage Trip (Pre-Alarm)                                                                                                                                                      |
|                    | <i>Cause:</i> The generator voltage is below the 27-2 undervoltage threshold in at least one phase and the 27-2 Undervoltage element is configured as a pre-alarm.                      |
|                    | <i>Corrective Action:</i> Check the generator wiring, machine configuration, the generator voltage regulator, and the load for faults that could cause low voltage conditions.          |
| 32 RVS PWR TRP A   | 32 Reverse Power Trip (Alarm)                                                                                                                                                           |
|                    | <i>Cause:</i> The generator is absorbing power at a level greater than the 32 reverse power protection Threshold and the 32 Reverse Power protection element is configured as an alarm. |



| Event String       | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                    | <i>Corrective Action:</i> Check the polarity of all potential transformers and current transformers used on the machine. Check load-sharing circuitry and components, and verify all machines in a load share system correctly receive generator breaker status. If the machine is paralleled to the utility, verify that the Parallel to Mains logic element is driven correctly.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 32 RVS PWR TRP P   | 32 Reverse Power Trip (Pre-Alarm)<br><i>Cause:</i> The generator is absorbing power at a level greater than the 32 reverse power protection threshold and the 32 Reverse Power protection element is configured as a pre-alarm.<br><i>Corrective Action:</i> Check the polarity of all potential transformers and current transformers used on the machine. Check load-sharing circuitry and components, and verify all machines in a load share system correctly receive generator breaker status. If the machine is paralleled to the utility, verify that the Parallel to Mains logic element is driven correctly.                                                                                                                                                                                                                                                                        |
| 40 EXC LOSS TRP A  | 40 Loss of Excitation Trip (Alarm)<br><i>Cause:</i> The generator is absorbing kvar at a level above the 40 Loss of Excitation Protection Threshold and the 40 Loss of Excitation element is configured as an alarm.<br><i>Corrective Action:</i> Check the system wiring and the system voltage regulator. In an islanded system, verify that the DGC-2020 is set up for kvar sharing and verify that intergenset communications are working correctly. If the DGC-2020 is not providing kvar sharing in an island system, verify that the voltage regulator is in droop or cross-current mode. Verify that all contact inputs to the voltage regulator are correctly received. If this occurs while paralleled to the utility, verify that the Parallel to Mains logic element is driven correctly. Check the voltage regulator settings and programming.                                  |
| 40 EXC LOSS TRP P  | 40 Loss of Excitation Trip (Pre-Alarm)<br><i>Cause:</i> The generator is absorbing kvar at a level above the 40 loss of excitation protection threshold and the 40 Loss of Excitation element is configured as a pre-alarm.<br><i>Corrective Action:</i> Check the system wiring and the system voltage regulator. In an islanded system, verify that the DGC-2020 is set up for kvar sharing and verify that intergenset communications are working correctly. If the DGC-2020 is not providing kvar sharing in an island system, verify that the voltage regulator is in droop or cross-current mode for island system sharing. Verify that all contact inputs to the voltage regulator are correctly received. If this occurs while paralleled to the utility, verify that the Parallel to Mains logic element is driven correctly. Check the voltage regulator settings and programming. |
| 47 PHS IMBAL TRP A | 47 Phase Imbalance Trip (Alarm)<br><i>Cause:</i> The difference in generator line-to-line voltages between phases is greater than the 47 phase imbalance threshold and the 47 Phase Imbalance element is configured as an alarm.<br><i>Corrective Action:</i> Check the generator wiring and the load for the cause of phase imbalance. This could be caused from losing one leg of the wiring to the machine.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 47 PHS IMBAL TRP P | 47 Phase Imbalance Trip (Pre-Alarm)<br><i>Cause:</i> The difference in generator line-to-line voltages between phases is greater than the 47 phase imbalance threshold and the 47 Phase Imbalance element is configured as a pre-alarm.<br><i>Corrective Action:</i> Check the generator wiring and the load for the cause of phase imbalance. This could be caused from losing one leg of the wiring to the machine.                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 51-1 OVRCURR TRP A | 51-1 Overcurrent Trip (Alarm)<br><i>Cause:</i> The generator current is above the 51-1 overcurrent threshold on at least one phase and the 51-1 Overcurrent element is configured as an alarm.<br><i>Corrective Action:</i> Check the generator wiring, machine configuration, and load-sharing devices in multiple generator applications, and the load for source of overcurrent condition. Verify integrity of intergenset communications.                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 51-1 OVRCURR TRP P | 51-1 Overcurrent Trip (Pre-Alarm)<br><i>Cause:</i> The generator current is above the 51-1 overcurrent threshold on at least one phase and the 51-1 Overcurrent element is configured as a pre-alarm.<br><i>Corrective Action:</i> Check the generator wiring, machine configuration, and load-sharing devices in multiple generator applications, and the load for source of overcurrent condition. Verify integrity of intergenset communications.                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 51-2 OVRCURR TRP A | 51-2 Overcurrent Trip (Alarm)<br><i>Cause:</i> The generator current is above the 51-2 overcurrent threshold on at least one phase and the 51-2 Overcurrent element is configured as an alarm.<br><i>Corrective Action:</i> Check the generator wiring, machine configuration, and load-sharing devices in multiple generator applications, and the load for source of overcurrent condition. Verify integrity of intergenset communications.                                                                                                                                                                                                                                                                                                                                                                                                                                                |

| Event String           | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 51-2 OVRCURR TRP P     | 51-2 Overcurrent Trip (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|                        | <i>Cause:</i> The generator current is above the 51-2 overcurrent threshold on at least one phase and the 51-2 Overcurrent element is configured as a pre-alarm.                                                                                                                                                                                                                                                                                                                                                               |
|                        | <i>Corrective Action:</i> Check the generator wiring, machine configuration, and load-sharing devices in multiple generator applications, and the load for source of overcurrent condition. Verify integrity of intergenset communications.                                                                                                                                                                                                                                                                                    |
| 51-3 OVRCURR TRP A     | 51-3 Overcurrent Trip (Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|                        | <i>Cause:</i> The generator current is above the 51-3 overcurrent threshold on at least one phase and the 51-3 Overcurrent element is configured as an alarm.                                                                                                                                                                                                                                                                                                                                                                  |
|                        | <i>Corrective Action:</i> Check the generator wiring, machine configuration, and load-sharing devices in multiple generator applications, and the load for source of overcurrent condition. Verify integrity of intergenset communications.                                                                                                                                                                                                                                                                                    |
| 51-3 OVRCURR TRP P     | 51-3 Overcurrent Trip (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|                        | <i>Cause:</i> The generator current is above the 51-3 overcurrent threshold on at least one phase and the 51-3 Overcurrent element is configured as a pre-alarm.                                                                                                                                                                                                                                                                                                                                                               |
|                        | <i>Corrective Action:</i> Check the generator wiring, machine configuration, and load-sharing devices in multiple generator applications, and the load for source of overcurrent condition. Verify integrity of intergenset communications.                                                                                                                                                                                                                                                                                    |
| 59-1 OVRVOLT TRP A     | 59-1 Overvoltage Trip (Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|                        | <i>Cause:</i> The generator voltage is above the 59-1 overvoltage threshold on at least one phase and the 59-1 Overvoltage element is configured as an alarm.                                                                                                                                                                                                                                                                                                                                                                  |
|                        | <i>Corrective Action:</i> Check the generator wiring, machine configuration, the generator voltage regulator, and the load for faults that could cause high voltage conditions.                                                                                                                                                                                                                                                                                                                                                |
| 59-1 OVRVOLT TRP P     | 59-1 Overvoltage Trip (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|                        | <i>Cause:</i> The generator voltage is above the 59-1 overvoltage threshold on at least one phase and the 59-1 Overvoltage element is configured as a pre-alarm.                                                                                                                                                                                                                                                                                                                                                               |
|                        | <i>Corrective Action:</i> Check the generator wiring, machine configuration, the generator voltage regulator, and the load for faults that could cause high voltage conditions.                                                                                                                                                                                                                                                                                                                                                |
| 59-2 OVRVOLT TRP A     | 59-2 Overvoltage Trip (Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|                        | <i>Cause:</i> The generator voltage is above the 59-2 overvoltage threshold on at least one phase and the 59-2 Overvoltage element is configured as an alarm.                                                                                                                                                                                                                                                                                                                                                                  |
|                        | <i>Corrective Action:</i> Check the generator wiring, machine configuration, the generator voltage regulator, and the load for faults that could cause high voltage conditions.                                                                                                                                                                                                                                                                                                                                                |
| 59-2 OVRVOLT TRP P     | 59-2 Overvoltage Trip (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|                        | <i>Cause:</i> The generator voltage is above the 59-2 overvoltage threshold on at least one phase and the 59-2 Overvoltage element is configured as a pre-alarm.                                                                                                                                                                                                                                                                                                                                                               |
|                        | <i>Corrective Action:</i> Check the generator wiring, machine configuration, the generator voltage regulator, and the load for faults that could cause high voltage conditions.                                                                                                                                                                                                                                                                                                                                                |
| 78 VECTOR SHIFT TRIP A | 78 Vector Shift Trip (Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                        | <i>Cause:</i> The unit is operating in Parallel to Mains and the number of degrees between successive phase voltage zero crossings has shifted by an amount greater than the 78 vector shift threshold. This is usually indicative of loss of the utility to which the generator is paralleled. This is considered Loss of Mains Protection and it is intended as a means of taking the generator off line before damage occurs in the event of utility loss. When configured as an alarm, this will cause a machine shutdown. |
|                        | <i>Corrective Action:</i> Check for loss of utility while operating in parallel with utility. If utility is lost, protection operated as desired. Verify that the Parallel to Mains logic element is driven correctly. Verify that the settings are at a level that will not cause nuisance trips by adding and removing large block loads while parallel to the utility.                                                                                                                                                      |
| 78 VECTOR SHIFT TRIP P | 78 Vector Shift Trip (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                        | <i>Cause:</i> The unit is operating in Parallel to Mains and the number of degrees between successive phase voltage zero crossings has shifted by an amount greater than the 78 vector shift threshold. This is usually indicative of loss of the utility to which the generator is paralleled. This is considered Loss of Mains Protection and it is intended as a means of taking the generator off line before damage occurs in the event of utility loss. When configured as an alarm, this will cause a machine shutdown. |
|                        | <i>Corrective Action:</i> Check for loss of utility while operating in parallel with utility. If utility is lost, protection operated as desired. Verify that the Parallel to Mains logic element is driven correctly. Verify that the settings are at a level that will not cause nuisance trips by adding and removing large block loads while parallel to the utility.                                                                                                                                                      |
| 81 ROC DF/DT TRIP A    | 81 Rate of Change of Frequency DF/DT Trip (Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

| Event String                    | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                 | <p><b>Cause:</b> The unit is operation in Parallel to Mains and the frequency is changing at a rate above the 81 rate of change of frequency threshold. This usually indicates loss of the utility to which the generator is paralleled. This is considered Loss of Mains Protection and it is intended as a means of taking the generator off line before damage occurs in the event of utility loss. When configured as an alarm, this will cause a machine shutdown.</p> <p><b>Corrective Action:</b> Check for loss of utility while operating in parallel with utility. If utility is lost, protection operated as desired. Verify that the Parallel to Mains logic element is driven correctly. Verify that the settings are at a level that will not cause nuisance trips by adding and removing large block loads while parallel to the utility.</p>                                                                                              |
| 81 ROC DF/DT TRIP P             | <p>81 Rate of Change of Frequency DF/DT Trip (Pre-Alarm)</p> <p><b>Cause:</b> The unit is operation in Parallel to Mains and the frequency is changing at a rate above the 81 rate of change of frequency threshold. This usually indicates loss of the utility to which the generator is paralleled. This is considered Loss of Mains Protection and it is intended as a means of taking the generator off line before damage occurs in the event of utility loss. When configured as a pre-alarm, the machine will continue running, but annunciate the pre-alarm.</p> <p><b>Corrective Action:</b> Check for loss of utility while operating in parallel with utility. If utility is lost, protection operated as desired. Verify that the Parallel to Mains logic element is driven correctly. Verify that the settings are at a level that will not cause nuisance trips by adding and removing large block loads while parallel to the utility.</p> |
| 81O OVRFREQ TRP A               | <p>81 Overfrequency Trip (Alarm)</p> <p><b>Cause:</b> The generator frequency is above the 81 overfrequency threshold and the 81 Overfrequency element is configured as an alarm.</p> <p><b>Corrective Action:</b> Check the Rated Frequency setting, the speed bias into the engine governor, the engine governor, and any load-sharing devices in multiple generator applications.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 81O OVRFREQ TRP P               | <p>81 Overfrequency Trip (Pre-Alarm)</p> <p><b>Cause:</b> The generator frequency is above the 81 overfrequency threshold and the 81 Overfrequency element is configured as a pre-alarm.</p> <p><b>Corrective Action:</b> Check the Rated Frequency setting, the speed bias into the engine governor, the engine governor, and any load-sharing devices in multiple generator applications.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 81U UNDFREQ TRP A               | <p>81 Underfrequency Trip (Alarm)</p> <p><b>Cause:</b> The generator frequency is below the 81 underfrequency threshold and the 81 Underfrequency element is configured as an alarm.</p> <p><b>Corrective Action:</b> Check the Rated Frequency setting, the speed bias into the engine governor, the engine governor, and any load-sharing devices in multiple generator applications.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 81U UNDFREQ TRP P               | <p>81 Underfrequency Trip (Pre-Alarm)</p> <p><b>Cause:</b> The generator frequency is below the 81 underfrequency threshold and the 81 Underfrequency element is configured as a pre-alarm.</p> <p><b>Corrective Action:</b> Check the Rated Frequency setting, the speed bias into the engine governor, the engine governor, and any load-sharing devices in multiple generator applications.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| AEM COMM FAIL P                 | <p>AEM-200 Communications Failure (Pre-Alarm)</p> <p><b>Cause:</b> Communications with the AEM-200 have failed. The machine will continue running, but annunciate the pre-alarm.</p> <p><b>Corrective Action:</b> Check CAN Bus wiring to all devices on the CAN Bus. Verify that a 120-ohm termination resistor is installed on each end of the main wire. Verify that the AEM-200 is powered up and the LED is blinking to indicate it is functioning properly. If there are intermittent communication failures, unplug and reseal the connectors on the AEM-200.</p>                                                                                                                                                                                                                                                                                                                                                                                  |
| AEM OUTX OUT RNG (X = 1 to 4)   | <p>User Configurable Analog Output X Out of Range (X = 1 to 4) (Status)</p> <p><b>Cause:</b> The programmable output is trying to drive to a level outside the configured range. The event string text is user programmable. Status is available to logic and will appear in the event log, but will not be annunciated. The status is true if the alarm configuration is set for Status Only, Alarm, or Pre-Alarm.</p> <p><b>Corrective Action:</b> Check the parameter that drives the analog output and verify that it's within the valid range. Verify that the range used to map the parameter to the analog output range is correct.</p>                                                                                                                                                                                                                                                                                                            |
| AEM OUTX OUT RNG A (X = 1 to 4) | <p>User Configurable Analog Output X Out of Range (X = 1 to 4) (Alarm)</p> <p><b>Cause:</b> The programmable output is trying to drive to a level outside the configured range and the alarm configuration is set to Alarm. The event string text is user programmable.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |



| Event String                    | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
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|                                 | <i>Corrective Action:</i> Check the parameter that drives the analog output and verify that it's within the valid range. Verify that the range used to map the parameter to the analog output range is correct.                                                                                                                                                                                                                                                                                                                                                |
| AEM OUTX OUT RNG P (X = 1 to 4) | User Configurable Analog Output X Out of Range (X = 1 to 4) (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                 | <i>Cause:</i> The programmable output is trying to drive to a level outside the configured range and the alarm configuration is set to Pre-Alarm. The event string text is user programmable.                                                                                                                                                                                                                                                                                                                                                                  |
|                                 | <i>Corrective Action:</i> Check the parameter that drives the analog output and verify that it's within the valid range. Verify that the range used to map the parameter to the analog output range is correct.                                                                                                                                                                                                                                                                                                                                                |
| AL ECU FAULTY P                 | ECU Faulty (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                                 | <i>Cause:</i> Bit Data (0 or 1) has been received from an <i>mtu</i> ECU indicating that the ECU is faulty.                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                                 | <i>Corrective Action:</i> Consult engine manufacturer to determine the corrective action for this condition.                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| ALG IN X O1 (X = 1 to 8)        | User Configurable Analog Input X Over 1 (X = 1 to 8) (Status)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|                                 | <i>Cause:</i> Analog Expansion Module Input X is above the programmed input threshold setting. This indicates that the programmable analog input is metering at a level above the threshold setting. The event string text is user programmable. Status is available to logic and will appear in the event log, but will not be annunciated. The status is true if the alarm configuration is set for Status Only, Alarm, or Pre-Alarm.                                                                                                                        |
|                                 | <i>Corrective Action:</i> Check the parameter measured by the input and verify that it does not indicate that the measured parameter is above the desired threshold setting. If it does not, check the integrity of the wiring between the analog transducer driving the input and the analog input itself. Verify that there are no open or shorted wires. Verify that the range used in mapping the parameter range to the analog input range is correct. Verify that the value measured by the transducer is within normal operating limits.                |
| ALG IN X O1 A (X = 1 to 8)      | User Configurable Analog Input X Over 1 (X = 1 to 8) (Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                                 | <i>Cause:</i> Analog Expansion Module Input X is above the programmed input threshold setting and the alarm configuration is set for Alarm. This indicates that the programmable analog input is metering at a level above the threshold setting. The event string text is user programmable.                                                                                                                                                                                                                                                                  |
|                                 | <i>Corrective Action:</i> Check the parameter measured by the input and verify that it does not indicate that the measured parameter is above the desired threshold setting. If it does not, check the integrity of the wiring between the analog transducer driving the input and the analog input itself. Verify that there are no open or shorted wires. Verify that the range used in mapping the parameter range to the analog input range is correct. Verify that the value that the transducer is measuring is within normal operating limits.          |
| ALG IN X O1 P (X = 1 to 8)      | User Configurable Analog Input X Over 1 (X = 1 to 8) (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                                 | <i>Cause:</i> Analog Expansion Module Input X is above the programmed input threshold setting and the alarm configuration is set for pre-alarm. This indicates that the programmable analog input is metering at a level above the threshold setting. The event string text is user programmable.                                                                                                                                                                                                                                                              |
|                                 | <i>Corrective Action:</i> Check the parameter measured by the input and verify that it does not indicate that the measured parameter is above the desired threshold setting. If it does not, check the integrity of the wiring between the analog transducer driving the input and the analog input itself. Verify that there are no open or shorted wires. Verify that the range used in mapping the parameter range to the analog input range is correct. Verify that the value measured by the transducer is within normal operating limits.                |
| ALG IN X O2 (X = 1 to 8)        | User Configurable Analog Input X Over 2 (X = 1 to 8) (Status)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|                                 | <i>Cause:</i> Analog Expansion Module Input X is above the programmed input threshold setting. This indicates that the programmable analog input is metering at a level above the threshold setting. The event string text is user programmable. Status is available to logic and will appear in the event log, but will not be annunciated. The status is true if the alarm configuration is set for Status Only, Alarm, or Pre-Alarm.                                                                                                                        |
|                                 | <i>Corrective Action:</i> Check the parameter measured by the input and verify that it does not indicate that the measured parameter is above the desired threshold setting. If this appears to be correct, check the integrity of the wiring between the analog transducer driving the input and the analog input itself. Verify that there are no open or shorted wires. Verify that the range used in mapping the parameter range to the analog input range is correct. Verify that the value measured by the transducer is within normal operating limits. |
| ALG IN X O2 A (X = 1 to 8)      | User Configurable Analog Input X Over 2 (X = 1 to 8) (Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

| Event String                | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
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|                             | <p><i>Cause:</i> Analog Expansion Module Input X is above the programmed input threshold setting and the alarm configuration is set for Alarm. This indicates that the programmable analog input is metering at a level above the threshold setting. The event string text is user programmable.</p> <p><i>Corrective Action:</i> Check the parameter measured by the input and verify that it does not indicate that the measured parameter is above the desired threshold setting. If it does not, check the integrity of the wiring between the analog transducer driving the input and the analog input itself. Verify that there are no open or shorted wires. Verify that the range used in mapping the parameter range to the analog input range is correct. Verify that the value measured by the transducer is within normal operating limits.</p>                                                                                                                                                                                                                 |
| ALG IN X O2 P (X = 1 to 8)  | <p>User Configurable Analog Input X Over 2 (X = 1 to 8) (Pre-Alarm)</p> <p><i>Cause:</i> Analog Expansion Module Input X is above the programmed input threshold setting and the alarm configuration is set for pre-alarm. This indicates that the programmable analog input is metering at a level above the threshold setting. The event string text is user programmable.</p> <p><i>Corrective Action:</i> Check the parameter measured by the input and verify that it does not indicate that the measured parameter is above the desired threshold setting. If it does not, check the integrity of the wiring between the analog transducer driving the input and the analog input itself. Verify that there are no open or shorted wires. Verify that the range used in mapping the parameter range to the analog input range is correct. Verify that the value measured by the transducer is within normal operating limits.</p>                                                                                                                                     |
| ALG IN X OOR (X = 1 to 8)   | <p>User Configurable Analog Input X Out of Range (X = 1 to 8) (Status)</p> <p><i>Cause:</i> The programmable input is receiving a value outside the configured range. The event string text is user programmable. Status is available to logic and will appear in the event log, but will not be annunciated. The status is true if the alarm configuration is set for Status Only, Alarm, or Pre-Alarm.</p> <p><i>Corrective Action:</i> Check the parameter measured by the input and verify that it does not indicate that the parameter is outside of the configured range. If it does not, check the integrity of the wiring between the analog transducer driving the input and the analog input itself. Verify that there are no open or shorted wires. Verify that the range used in mapping the parameter range to the analog input range is correct. Verify that the value measured by the transducer is within normal operating limits.</p>                                                                                                                      |
| ALG IN X OOR A (X = 1 to 8) | <p>User Configurable Analog Input X Out of Range (X = 1 to 8) (Alarm)</p> <p><i>Cause:</i> The programmable input is receiving a value outside the configured range and the alarm configuration is set to Alarm. The event string text is user programmable.</p> <p><i>Corrective Action:</i> Check the parameter measured by the input and verify that it does not indicate that the parameter is outside of the configured range. If it does not, check the integrity of the wiring between the analog transducer driving the input and the analog input itself. Verify that there are no open or shorted wires. Verify that the range used in mapping the parameter range to the analog input range is correct. Verify that the value measured by the transducer is within normal operating limits.</p>                                                                                                                                                                                                                                                                  |
| ALG IN X OOR P (X = 1 to 8) | <p>User Configurable Analog Input X Out of Range (X = 1 to 8) (Pre-Alarm)</p> <p><i>Cause:</i> The programmable input is receiving a value outside the configured range and the alarm configuration is set to Pre-Alarm. The event string text is user programmable.</p> <p><i>Corrective Action:</i> Check the parameter measured by the input and verify that it does not indicate that the parameter is outside of the configured range. If it does not, check the integrity of the wiring between the analog transducer driving the input and the analog input itself. Verify that there are no open or shorted wires. Verify that the range used in mapping the parameter range to the analog input range is correct. Verify that the value measured by the transducer is within normal operating limits.</p>                                                                                                                                                                                                                                                          |
| ALG IN X U1 (X = 1 to 8)    | <p>User Configurable Analog Input X Under 1 (X = 1 to 8) (Status)</p> <p><i>Cause:</i> Analog Expansion Module Input X is below the programmed input threshold setting. This indicates that the programmable analog input is metering at a level below the threshold setting. The event string text is user programmable. Status is available to logic and will appear in the event log, but will not be annunciated. The status is true if the alarm configuration is set for Status Only, Alarm, or Pre-Alarm.</p> <p><i>Corrective Action:</i> Check the parameter measured by the input and verify that it does not indicate that the measured parameter is below the desired threshold setting. If it does not, check the integrity of the wiring between the analog transducer driving the input and the analog input itself. Verify that there are no open or shorted wires. Verify that the range used in mapping the parameter range to the analog input range is correct. Verify that the value measured by the transducer is within normal operating limits.</p> |
| ALG IN X U1 A (X = 1 to 8)  | <p>User Configurable Analog Input X Under 1 (X = 1 to 8) (Alarm)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

| Event String               | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
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|                            | <p><i>Cause:</i> Analog Expansion Module Input X is below the programmed input threshold setting and the alarm configuration is set for Alarm. This indicates that the programmable analog input is metering at a level below the threshold setting. The event string text is user programmable.</p> <p><i>Corrective Action:</i> Check the parameter measured by the input and verify that it does not indicate that the measured parameter is below the desired threshold setting. If it does not, check the integrity of the wiring between the analog transducer driving the input and the analog input itself. Verify that there are no open or shorted wires. Verify that the range used in mapping the parameter range to the analog input range is correct. Verify that the value measured by the transducer is within normal operating limits.</p>                                                                                                                                                                                                                 |
| ALG IN X U1 P (X = 1 to 8) | <p>User Configurable Analog Input X Under 1 (X = 1 to 8) (Pre-Alarm)</p> <p><i>Cause:</i> Analog Expansion Module Input X is below the programmed input threshold setting and the alarm configuration is set for Pre-Alarm. This indicates that the programmable analog input is metering at a level below the threshold setting. The event string text is user programmable.</p> <p><i>Corrective Action:</i> Check the parameter measured by the input and verify that it does not indicate that the measured parameter is below the desired threshold setting. If it does not, check the integrity of the wiring between the analog transducer driving the input and the analog input itself. Verify that there are no open or shorted wires. Verify that the range used in mapping the parameter range to the analog input range is correct. Verify that the value measured by the transducer is within normal operating limits.</p>                                                                                                                                    |
| ALG IN X U2 (X = 1 to 8)   | <p>User Configurable Analog Input X Under 2 (X = 1 to 8) (Status)</p> <p><i>Cause:</i> Analog Expansion Module Input X is below the programmed input threshold setting. This indicates that the programmable analog input is metering at a level below the threshold setting. The event string text is user programmable. Status is available to logic and will appear in the event log, but will not be annunciated. The status is true if the alarm configuration is set for Status Only, Alarm, or Pre-Alarm.</p> <p><i>Corrective Action:</i> Check the parameter measured by the input and verify that it does not indicate that the measured parameter is below the desired threshold setting. If it does not, check the integrity of the wiring between the analog transducer driving the input and the analog input itself. Verify that there are no open or shorted wires. Verify that the range used in mapping the parameter range to the analog input range is correct. Verify that the value measured by the transducer is within normal operating limits.</p> |
| ALG IN X U2 A (X = 1 to 8) | <p>User Configurable Analog Input X Under 2 (X = 1 to 8) (Alarm)</p> <p><i>Cause:</i> Analog Expansion Module Input X is below the programmed input threshold setting and the alarm configuration is set for Alarm. This indicates that the programmable analog input is metering at a level below the threshold setting. The event string text is user programmable.</p> <p><i>Corrective Action:</i> Check the parameter measured by the input and verify that it does not indicate that the measured parameter is below the desired threshold setting. If it does not, check the integrity of the wiring between the analog transducer driving the input and the analog input itself. Verify that there are no open or shorted wires. Verify that the range used in mapping the parameter range to the analog input range is correct. Verify that the value measured by the transducer is within normal operating limits.</p>                                                                                                                                            |
| ALG IN X U2 P (X = 1 to 8) | <p>User Configurable Analog Input X Under 2 (X = 1 to 8) (Pre-Alarm)</p> <p><i>Cause:</i> Analog Expansion Module Input X is below the programmed input threshold setting and the alarm configuration is set for Pre-Alarm. This indicates that the programmable analog input is metering at a level below the threshold setting. The event string text is user programmable.</p> <p><i>Corrective Action:</i> Check the parameter measured by the input and verify that it does not indicate that the measured parameter is below the desired threshold setting. If it does not, check the integrity of the wiring between the analog transducer driving the input and the analog input itself. Verify that there are no open or shorted wires. Verify that the range used in mapping the parameter range to the analog input range is correct. Verify that the value measured by the transducer is within normal operating limits.</p>                                                                                                                                    |
| ATS CIRCUIT ERROR          | <p>ATS Circuit Error (Pre-Alarm)</p> <p><i>Cause:</i> The ATS programmable function Input Mode is set for Complementary, and the Normally-Open Input and Normally-Closed Input are not in the opposite states for a time greater than the Circuit Error Delay.</p> <p><i>Corrective Action:</i> Check all wiring and contacts or switches that are part of the ATS circuit and correct any issues found.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| ATS INPUT CLOSED           | ATS Input (Status)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

| Event String        | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
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|                     | <p><i>Cause:</i> This indicates that the ATS input has transitioned from open to closed.</p> <p><i>Corrective Action:</i> Correct operation. No corrective action necessary.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| AUTO MODE           | <p>DGC-2020 has entered Auto mode (Status)</p> <p><i>Cause:</i> This indicates that the DGC-2020 was put in Auto mode. This can be done through the front-panel buttons, Modbus communication, BESTCOMSP<sup>lus</sup> communication, or logic.</p> <p><i>Corrective Action:</i> Correct operation. No corrective action necessary.</p>                                                                                                                                                                                                                                                                                                                                                                                  |
| AUTO RESTART        | <p>Automatic Restart in Progress (Status)</p> <p><i>Cause:</i> The Automatic Restart function of the DGC-2020 is in the process of resetting alarms and restarting the unit. This occurs only when the Automatic Restart function is enabled.</p> <p><i>Corrective Action:</i> Correct operation. No corrective action necessary.</p>                                                                                                                                                                                                                                                                                                                                                                                    |
| AUTO RESTART FAIL A | <p>Automatic Restart Fail (Alarm)</p> <p><i>Cause:</i> The Automatic Restart function of the DGC-2020 has attempted and failed to restart the engine the number of times programmed in the Number of Start Attempts setting. This occurs only when the Automatic Restart function is enabled.</p> <p><i>Corrective Action:</i> Check which alarms are in effect or appear in the event log and address the issues indicated. Then, clear alarms and restart or put the unit in Auto mode and verify that the unit starts and runs.</p>                                                                                                                                                                                   |
| BATT CHRG FAIL A    | <p>Battery Charger Fail (Alarm)</p> <p><i>Cause:</i> The contact input associated with the Battery Charger Fail programmable function has been true for the duration of the Battery Charger Fail Activation Delay and the Battery Charger Fail programmable function is configured as an alarm.</p> <p><i>Corrective Action:</i> Correct battery charger issues.</p>                                                                                                                                                                                                                                                                                                                                                     |
| BATT CHRG FAIL P    | <p>Battery Charger Fail (Pre-Alarm)</p> <p><i>Cause:</i> The contact input associated with the Battery Charger Fail programmable function has been true for the duration of the Battery Charger Fail Activation Delay and the Battery Charger Fail programmable function is configured as a pre-alarm.</p> <p><i>Corrective Action:</i> Correct battery charger issues.</p>                                                                                                                                                                                                                                                                                                                                              |
| BATT OVERVOLT P     | <p>Battery Overvoltage (Pre-Alarm)</p> <p><i>Cause:</i> Battery voltage is above the Battery Overvoltage pre-alarm threshold setting.</p> <p><i>Corrective Action:</i> Correct issues with the system battery charger or charging alternator that cause battery voltage to increase above normal limits.</p>                                                                                                                                                                                                                                                                                                                                                                                                             |
| BATTLE OVERRIDE     | <p>Battle Override (Status)</p> <p><i>Cause:</i> The contact input associated with the Battle Override programmable function is true.</p> <p><i>Corrective Action:</i> Correct operation. No corrective action necessary.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| BUS REV ROT         | <p>Bus Reverse Rotation (Pre-Alarm)</p> <p><i>Cause:</i> The detected rotation of the bus does not match the Phase Rotation setting (A-B-C or A-C-B). This can be caused by crossing phases between sensing transformers and DGC-2020 terminals. For example, phase B PT connected to phase C input terminals and phase C PT connected to phase B input terminals.</p> <p><i>Corrective Action:</i> Verify that the Phase Rotation setting is configured correctly for the desired rotation. Check wiring of the sensing PTs to ensure they are wired correctly for the desired rotation.</p>                                                                                                                            |
| CAN BUS OFF         | <p>CAN Bus entered Bus Off state (Status)</p> <p><i>Cause:</i> CAN Bus communication between the DGC-2020 and the engine ECU, CEM-2020, or AEM-2020 has entered a BUS OFF state and stopped communicating. Status is available to logic and will appear in the event log, but will not be annunciated. During installation and commissioning, some occurrences can be expected.</p> <p><i>Corrective Action:</i> Verify that the engine ECU and/or CEM-2020/AEM-2020 is powered up when communication is expected. Check CAN Bus wiring from the ECU to the DGC-2020. Verify that a 120-ohm resistor is installed on each end of the main wire.</p>                                                                      |
| CAN ERR PASSIVE     | <p>CAN Bus entered Error Passive state (Status)</p> <p><i>Cause:</i> CAN Bus communication between the DGC-2020 and the engine ECU, CEM-2020, or AEM-2020 has entered an ERROR PASSIVE state. In this state, communications will be received, but not broadcast on the CAN Bus. Status is available to logic and will appear in the event log, but will not be annunciated. During installation and commissioning, some occurrences can be expected.</p> <p><i>Corrective Action:</i> Verify that the engine ECU and/or CEM-2020/AEM-2020 is powered up when communication is expected. Check CAN Bus wiring from the ECU to the DGC-2020. Verify that a 120-ohm resistor is installed on each end of the main wire.</p> |
| CEM COMM FAIL P     | CEM-2020 Communications Failure (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

| Event String                | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
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|                             | <p><i>Cause:</i> Communication with the CEM-2020 has failed. A pre-alarm is annunciated, but the machine continues running.</p> <p><i>Corrective Action:</i> Check CAN Bus wiring to all devices on the CAN Bus. Verify that a 120-ohm resistor is installed on each end of the main wire. Verify that the CEM-2020 is powered up and the LED is blinking to indicate it is functioning properly. If there are intermittent communication failures, unplug and reseal the connectors on the CEM-2020.</p>                                                                             |
| CEM HW MISMATCH P           | <p>Connected CEM-2020 is wrong type (Pre-Alarm)</p> <p><i>Cause:</i> The setting for number of CEM-2020 outputs does not match the number of outputs on the connected CEM-2020.</p> <p><i>Corrective Action:</i> Change the setting to match the number of CEM-2020 outputs.</p>                                                                                                                                                                                                                                                                                                      |
| CHARGER1 AC OFF P           | <p>Battery Charger 1 AC Off (Pre-Alarm)</p> <p><i>Cause:</i> The ac power to the battery charger is off or disconnected.</p> <p><i>Corrective Action:</i> Restore ac power to the battery charger.</p>                                                                                                                                                                                                                                                                                                                                                                                |
| CHARGER1 BATT FAIL P        | <p>Battery Charger 1 Battery Failure (Pre-Alarm)</p> <p><i>Cause:</i> Battery Charger 1 has detected that the battery has failed.</p> <p><i>Corrective Action:</i> Check existing battery and associated wiring. Replace battery if necessary. Correct any issues with the battery harness wiring.</p>                                                                                                                                                                                                                                                                                |
| CHARGER1 COMMS FAIL P       | <p>Battery Charger 1 Communications Failure (Pre-Alarm)</p> <p><i>Cause:</i> J1939 communications from the battery charger is expected, but not being received.</p> <p><i>Corrective Action:</i> Check CAN Bus wiring and terminations. Verify that battery charger is set up for J1939 communications. Service or replace charger if necessary.</p>                                                                                                                                                                                                                                  |
| CHARGER1 FAILURE P          | <p>Battery Charger 1 Charger Failure (Pre-Alarm)</p> <p><i>Cause:</i> The battery charger has detected that it has failed.</p> <p><i>Corrective Action:</i> Service or replace charger and/or charging system wiring as necessary.</p>                                                                                                                                                                                                                                                                                                                                                |
| CHARGER1 HI DC VOLTS P      | <p>Battery Charger 1 High Output Voltage (Pre-Alarm)</p> <p><i>Cause:</i> Battery charger has detected high output voltage.</p> <p><i>Corrective Action:</i> Disconnect charger and check if charger voltage is high when disconnected from the charging system. If so, service or replace charger. Check and service charging circuit wiring. If this is a multiple battery system, isolate batteries one at a time and check voltage to determine which is causing the high voltage condition.</p>                                                                                  |
| CHARGER1 INVALID SETTINGS P | <p>Battery Charger 1 Invalid Settings (Pre-Alarm)</p> <p><i>Cause:</i> The battery charger has detected that some of its settings are invalid.</p> <p><i>Corrective Action:</i> Correct battery charger settings.</p>                                                                                                                                                                                                                                                                                                                                                                 |
| CHARGER1 LO CRANKING V P    | <p>Battery Charger 1 Low Cranking Voltage (Pre-Alarm)</p> <p><i>Cause:</i> Battery voltage during cranking has been detected to be low.</p> <p><i>Corrective Action:</i> Check charger wiring and battery terminals and service where necessary. Service or replace charger if there are no wiring issues.</p>                                                                                                                                                                                                                                                                        |
| CHARGER1 LOW DC VOLTS P     | <p>Battery Charger 1 Low Output Voltage (Pre-Alarm)</p> <p><i>Cause:</i> Battery charger has detected low output voltage.</p> <p><i>Corrective Action:</i> Disconnect charger and check if charger voltage is low when disconnected from the charging system. If so, service or replace charger. Check and service charging circuit wiring. Check the battery circuit for something that is causing excessive battery discharge. If this is a multiple battery system, isolate batteries one at a time and check voltage to determine which is causing the low voltage condition.</p> |
| CHARGER1 SINGLE UNIT FAIL P | <p>Battery Charger 1 Single Unit Failure (Pre-Alarm)</p> <p><i>Cause:</i> In chargers with multiple charging stages, one or more of the charging stages has failed.</p> <p><i>Corrective Action:</i> Check charger wiring and battery terminals and service where necessary. Service or replace charger if there are no wiring issues.</p>                                                                                                                                                                                                                                            |
| CHARGER1 THERMAL LIMIT P    | <p>Battery Charger 1 Thermal Limit (Pre-Alarm)</p> <p><i>Cause:</i> The charger has exceeded a thermal limit.</p> <p><i>Corrective Action:</i> Check the battery and charger circuit connections to ensure all connections are clean and tight. Check devices on the charging circuit to see if something is causing excessive current draw from the battery charger. Check and service battery or replace if necessary.</p>                                                                                                                                                          |
| CHARGER2 AC OFF P           | <p>Battery Charger 2 AC Off (Pre-Alarm)</p> <p><i>Cause:</i> The ac power to the battery charger is off or disconnected.</p> <p><i>Corrective Action:</i> Restore ac power to the battery charger.</p>                                                                                                                                                                                                                                                                                                                                                                                |



| Event String                | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                        |
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| CHARGER2 BATT FAIL P        | Battery Charger 2 Battery Failure (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                                    |
|                             | <i>Cause:</i> Battery Charger 2 has detected that the battery has failed.                                                                                                                                                                                                                                                                                                                                                                        |
|                             | <i>Corrective Action:</i> Check existing battery and associated wiring. Replace battery if necessary. Correct any issues with the battery harness wiring.                                                                                                                                                                                                                                                                                        |
| CHARGER2 COMMS FAIL P       | Battery Charger 2 Communications Failure (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                             |
|                             | <i>Cause:</i> J1939 communications from the battery charger is expected, but not being received.                                                                                                                                                                                                                                                                                                                                                 |
|                             | <i>Corrective Action:</i> Check CAN Bus wiring and terminations. Verify that battery charger is set up for J1939 communications. Service or replace charger if necessary.                                                                                                                                                                                                                                                                        |
| CHARGER2 FAILURE P          | Battery Charger 2 Charger Failure (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                                    |
|                             | <i>Cause:</i> The battery charger has detected that it has failed.                                                                                                                                                                                                                                                                                                                                                                               |
|                             | <i>Corrective Action:</i> Service or replace charger and/or charging system wiring as necessary.                                                                                                                                                                                                                                                                                                                                                 |
| CHARGER2 HI DC VOLTS P      | Battery Charger 2 High Output Voltage (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                                |
|                             | <i>Cause:</i> Battery charger has detected high output voltage.                                                                                                                                                                                                                                                                                                                                                                                  |
|                             | <i>Corrective Action:</i> Disconnect charger and check if charger voltage is high when disconnected from the charging system. If so, service or replace charger. Check and service charging circuit wiring. If this is a multiple battery system, isolate batteries one at a time and check voltage to determine which is causing the high voltage condition.                                                                                    |
| CHARGER2 INVALID SETTINGS P | Battery Charger 2 Invalid Settings (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                                   |
|                             | <i>Cause:</i> The battery charger has detected that some of its settings are invalid.                                                                                                                                                                                                                                                                                                                                                            |
|                             | <i>Corrective Action:</i> Correct battery charger settings.                                                                                                                                                                                                                                                                                                                                                                                      |
| CHARGER2 LO CRANKING V P    | Battery Charger 2 Low Cranking Voltage (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                               |
|                             | <i>Cause:</i> Battery voltage during cranking has been detected to be low.                                                                                                                                                                                                                                                                                                                                                                       |
|                             | <i>Corrective Action:</i> Check charger wiring and battery terminals and service where necessary. Service or replace charger if there are no wiring issues.                                                                                                                                                                                                                                                                                      |
| CHARGER2 LOW DC VOLTS P     | Battery Charger 2 Low Output Voltage (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                                 |
|                             | <i>Cause:</i> Battery charger has detected low output voltage.                                                                                                                                                                                                                                                                                                                                                                                   |
|                             | <i>Corrective Action:</i> Disconnect charger and check if charger voltage is low when disconnected from the charging system. If so, service or replace charger. Check and service charging circuit wiring. Check the battery circuit for something that is causing excessive battery discharge. If this is a multiple battery system, isolate batteries one at a time and check voltage to determine which is causing the low voltage condition. |
| CHARGER2 SINGLE UNIT FAIL P | Battery Charger 2 Single Unit Failure (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                                |
|                             | <i>Cause:</i> In chargers with multiple charging stages, one or more of the charging stages has failed.                                                                                                                                                                                                                                                                                                                                          |
|                             | <i>Corrective Action:</i> Check charger wiring and battery terminals and service where necessary. Service or replace charger if there are no wiring issues.                                                                                                                                                                                                                                                                                      |
| CHARGER2 THERMAL LIMIT P    | Battery Charger 2 Thermal Limit (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                                      |
|                             | <i>Cause:</i> The charger has exceeded a thermal limit.                                                                                                                                                                                                                                                                                                                                                                                          |
|                             | <i>Corrective Action:</i> Check the battery and charger circuit connections to ensure all connections are clean and tight. Check devices on the charging circuit to see if something is causing excessive current draw from the battery charger. Check and service battery or replace if necessary.                                                                                                                                              |
| CHECKSUM FAIL P             | Corrupt user settings or firmware code (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                               |
|                             | <i>Cause:</i> This could indicate settings corruption or firmware file corruption. It will occur one time after a firmware upgrade if the upgrade contains new settings, but should never be seen in normal operation.                                                                                                                                                                                                                           |
|                             | <i>Corrective Action:</i> Reload settings into the DGC-2020. If the pre-alarm still occurs, reload firmware and then settings again. If the pre-alarm persists, there may be a problem with DGC-2020 hardware.                                                                                                                                                                                                                                   |
| COMBINED RED A              | Combined Red (Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                             |
|                             | <i>Cause:</i> This indicates that a combined red alarm has been received over the CAN Bus from an <i>mtu</i> engine ECU. This alarm will shut down the engine.                                                                                                                                                                                                                                                                                   |
|                             | <i>Corrective Action:</i> Consult the <i>mtu</i> fault code list to determine the cause of the combined red alarm. Perform the corrective actions recommended by <i>mtu</i> to address the issue indicated by the fault code.                                                                                                                                                                                                                    |
| COMBINED YELLOW P           | Combined Yellow (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                             | <i>Cause:</i> This indicates that a combined yellow alarm has been received over the CAN Bus from an <i>mtu</i> engine ECU. A pre-alarm is annunciated, but the machine continues running.                                                                                                                                                                                                                                                       |

| Event String                  | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
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|                               | <p><b>Corrective Action:</b> Consult the <i>mtu</i> fault code list to determine the cause of the combined yellow alarm. Perform the corrective actions recommended by <i>mtu</i> to address the issue indicated by the fault code.</p>                                                                                                                                                                                                                                                                                                                                                            |
| CONF PROT X O1 (X = 1 to 8)   | <p>Configurable Protection X (X = 1 to 8) Over Threshold 1 (Status)</p> <p><b>Cause:</b> The parameter measured by Configurable Protection Element X is above the programmed input threshold setting. The event string text is user programmable. Status is available to logic and will appear in the event log, but will not be annunciated. The status is true if the alarm configuration is set for Status Only, Alarm, or Pre-Alarm.</p> <p><b>Corrective Action:</b> Examine causes for the parameter metered by Configurable Protection Element X to be above the programmed threshold.</p>  |
| CONF PROT X O1 A (X = 1 to 8) | <p>Configurable Protection X (X = 1 to 8) Over Threshold 1 (Alarm)</p> <p><b>Cause:</b> The parameter measured by Configurable Protection Element X is above the programmed input threshold setting and the alarm configuration is set to Alarm. The event string text is user programmable.</p> <p><b>Corrective Action:</b> Examine causes for the parameter metered by Configurable Protection Element X to be above the programmed threshold.</p>                                                                                                                                              |
| CONF PROT X O1 P (X = 1 to 8) | <p>Configurable Protection X (X = 1 to 8) Over Threshold 1 (Pre-Alarm)</p> <p><b>Cause:</b> The parameter measured by Configurable Protection Element X is above the programmed input threshold setting and the alarm configuration is set to Pre-Alarm. The event string text is user programmable.</p> <p><b>Corrective Action:</b> Examine causes for the parameter metered by Configurable Protection Element X to be above the programmed threshold.</p>                                                                                                                                      |
| CONF PROT X O2 (X = 1 to 8)   | <p>Configurable Protection X (X = 1 to 8) Over Threshold 2 (Status)</p> <p><b>Cause:</b> The parameter measured by Configurable Protection Element X is above the programmed input threshold setting. The event string text is user programmable. Status is available to logic and will appear in the event log, but will not be annunciated. The status is true if the alarm configuration is set for Status Only, Alarm, or Pre-Alarm.</p> <p><b>Corrective Action:</b> Examine causes for the parameter metered by Configurable Protection Element X to be above the programmed threshold.</p>  |
| CONF PROT X O2 A (X = 1 to 8) | <p>Configurable Protection X (X = 1 to 8) Over Threshold 2 (Alarm)</p> <p><b>Cause:</b> The parameter measured by Configurable Protection Element X is above the programmed input threshold setting and the alarm configuration is set to Alarm. The event string text is user programmable.</p> <p><b>Corrective Action:</b> Examine causes for the parameter metered by Configurable Protection Element X to be above the programmed threshold.</p>                                                                                                                                              |
| CONF PROT X O2 P (X = 1 to 8) | <p>Configurable Protection X (X = 1 to 8) Over Threshold 2 (Pre-Alarm)</p> <p><b>Cause:</b> The parameter measured by Configurable Protection Element X is above the programmed input threshold setting and the alarm configuration is set to Pre-Alarm. The event string text is user programmable.</p> <p><b>Corrective Action:</b> Examine causes for the parameter metered by Configurable Protection Element X to be above the programmed threshold.</p>                                                                                                                                      |
| CONF PROT X U1 (X = 1 to 8)   | <p>Configurable Protection X (X = 1 to 8) Under Threshold 1 (Status)</p> <p><b>Cause:</b> The parameter measured by Configurable Protection Element X is below the programmed input threshold setting. The event string text is user programmable. Status is available to logic and will appear in the event log, but will not be annunciated. The status is true if the alarm configuration is set for Status Only, Alarm, or Pre-Alarm.</p> <p><b>Corrective Action:</b> Examine causes for the parameter metered by Configurable Protection Element X to be below the programmed threshold.</p> |
| CONF PROT X U1 A (X = 1 to 8) | <p>Configurable Protection X (X = 1 to 8) Under Threshold 1 (Alarm)</p> <p><b>Cause:</b> The parameter measured by Configurable Protection Element X is below the programmed input threshold setting and the alarm configuration is set to Alarm. The event string text is user programmable.</p> <p><b>Corrective Action:</b> Examine causes for the parameter metered by Configurable Protection Element X to be below the programmed threshold.</p>                                                                                                                                             |
| CONF PROT X U1 P (X = 1 to 8) | <p>Configurable Protection X (X = 1 to 8) Under Threshold 1 (Pre-Alarm)</p> <p><b>Cause:</b> The parameter measured by Configurable Protection Element X is below the programmed input threshold setting and the alarm configuration is set to Pre-Alarm. The event string text is user programmable.</p> <p><b>Corrective Action:</b> Examine causes for the parameter metered by Configurable Protection Element X to be below the programmed threshold.</p>                                                                                                                                     |
| CONF PROT X U2 (X = 1 to 8)   | <p>Configurable Protection X (X = 1 to 8) Under Threshold 2 (Status)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

| Event String                    | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                 | <p><b>Cause:</b> The parameter measured by Configurable Protection Element X is below the programmed input threshold setting. The event string text is user programmable. Status is available to logic and will appear in the event log, but will not be annunciated. The status is true if the alarm configuration is set for Status Only, Alarm, or Pre-Alarm.</p> <p><b>Corrective Action:</b> Examine causes for the parameter metered by Configurable Protection Element X to be below the programmed threshold.</p>                                                                |
| CONF PROT X U2 A (X = 1 to 8)   | <p>Configurable Protection X (X = 1 to 8) Under Threshold 2 (Alarm)</p> <p><b>Cause:</b> The parameter measured by Configurable Protection Element X is below the programmed input threshold setting and the alarm configuration is set to Alarm. The event string text is user programmable.</p> <p><b>Corrective Action:</b> Examine causes for the parameter metered by Configurable Protection Element X to be below the programmed threshold.</p>                                                                                                                                   |
| CONF PROT X U2 P (X = 1 to 8)   | <p>Configurable Protection X (X = 1 to 8) Under Threshold 2 (Pre-Alarm)</p> <p><b>Cause:</b> The parameter measured by Configurable Protection Element X is below the programmed input threshold setting and the alarm configuration is set to Pre-Alarm. The event string text is user programmable.</p> <p><b>Corrective Action:</b> Examine causes for the parameter metered by Configurable Protection Element X to be below the programmed threshold.</p>                                                                                                                           |
| CONFIG ELEMENT X A (X = 1 to 8) | <p>Configurable Element X (X = 1 to 8) (Alarm)</p> <p><b>Cause:</b> Logic has driven the state of Configurable Element X true and the configurable element alarm configuration is set for Alarm. The event string text is user programmable.</p> <p><b>Corrective Action:</b> Refer to the programmable logic and perform corrective action for the conditions that have driven the configurable element true.</p>                                                                                                                                                                       |
| CONFIG ELEMENT X P (X = 1 to 8) | <p>Configurable Element X (X = 1 to 8) (Pre-Alarm)</p> <p><b>Cause:</b> Logic has driven the state of Configurable Element X true and the configurable element alarm configuration is set for Pre-Alarm. The event string text is user programmable.</p> <p><b>Corrective Action:</b> Refer to the programmable logic and perform corrective action for the conditions that have driven the configurable element true.</p>                                                                                                                                                               |
| COOL LVL SNDR FL A              | <p>Coolant Level Sender Fail (Alarm)</p> <p><b>Cause:</b> The coolant level sender has transmitted data values beyond the normal operating range to the engine ECU. This alarm is annunciated by only an engine ECU. The DGC-2020 does not have a coolant level sender input.</p> <p><b>Corrective Action:</b> Consult the engine manufacturer's documentation regarding the coolant level sender. Check the wiring and grounding of the coolant level sender. Check coolant level sender and replace if necessary.</p>                                                                  |
| COOL SNDR FAIL                  | <p>Coolant Temperature Sender Fail (Status)</p> <p><b>Cause:</b> If the DGC-2020 is receiving data from a coolant temp sender, the input from the sender is beyond the valid range for the device. If the DGC-2020 is receiving coolant temperature data over CAN Bus from an engine ECU, but the ECU sends a special code indicating that the sender has failed, Coolant Temperature Sender Fail will also be true.</p> <p><b>Corrective Action:</b> Check the sender, the sender wiring, and the sender common wiring from the engine block to the DGC-2020 and/or the engine ECU.</p> |
| COOL SNDR FAIL A                | <p>Coolant Temperature Sender Fail (Alarm)</p> <p><b>Cause:</b> Coolant Temperature Sender Fail status is true and the Coolant Temperature Sender Fail alarm configuration is set for Alarm.</p> <p><b>Corrective Action:</b> Check the sender, the sender wiring, and the sender common wiring from the engine block to the DGC-2020 and/or the engine ECU.</p>                                                                                                                                                                                                                         |
| COOL SNDR FAIL P                | <p>Coolant Temperature Sender Fail (Pre-Alarm)</p> <p><b>Cause:</b> Coolant Temperature Sender Fail status is true and the Coolant Temperature Sender Fail alarm configuration is set for Pre-Alarm.</p> <p><b>Corrective Action:</b> Check the sender, the sender wiring, and the sender common wiring from the engine block to the DGC-2020 and/or the engine ECU.</p>                                                                                                                                                                                                                 |
| DEFAULTS LOADED                 | <p>Default settings were uploaded into the DGC (Status)</p> <p><b>Cause:</b> Default settings were uploaded into the DGC, indicating either a successful firmware upload or a manual reset (UP and DOWN pushbuttons being held).</p> <p><b>Corrective Action:</b> Correct operation. No corrective action necessary.</p>                                                                                                                                                                                                                                                                 |
| DEF FLUID EMPTY P               | <p>Diesel Exhaust Fluid Empty (Pre-Alarm)</p> <p><b>Cause:</b> Diesel exhaust fluid level is critically low.</p> <p><b>Corrective Action:</b> Add diesel exhaust fluid to the SCR system.</p>                                                                                                                                                                                                                                                                                                                                                                                            |
| DEF FLUID LOW P                 | <p>Diesel Exhaust Fluid Low (Pre-Alarm)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |



| Event String         | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                              |
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| DEF CONSUMPTN ERR P  | <i>Cause:</i> Diesel exhaust fluid level is low.                                                                                                                                                                                                                                                       |
|                      | <i>Corrective Action:</i> Add diesel exhaust fluid to the SCR system.                                                                                                                                                                                                                                  |
|                      | Diesel Exhaust Fluid Consumption Incorrect (Pre-Alarm)                                                                                                                                                                                                                                                 |
| DEF INDUCEMENT P     | <i>Cause:</i> The exhaust system controller has determined the rate of DEF consumption is not within normal ranges. The DGC-2020 receives this information over J1939 CAN Bus.                                                                                                                         |
|                      | <i>Corrective Action:</i> Consult exhaust system documentation for recommended corrective actions or contact engine manufacturer or exhaust system manufacturer.                                                                                                                                       |
|                      | Diesel Exhaust Fluid Inducement (Pre-Alarm)                                                                                                                                                                                                                                                            |
| DEF INDUCMT O-RIDE P | <i>Cause:</i> The ECU has notified the DGC-2020 that the exhaust system has entered a state of inducement to add DEF Fluid or correct an issue with the Selective Catalytic Reduction (SCR) system. Inducement may result in a reduction of engine performance or a torque or speed limited operation. |
|                      | <i>Corrective Action:</i> Check the diesel exhaust fluid level and quality. Correct any issues. Troubleshoot any other indicated SCR system issues.                                                                                                                                                    |
|                      | Diesel Exhaust Fluid Inducement Override (Pre-Alarm)                                                                                                                                                                                                                                                   |
| DEF LOW SEVERE P     | <i>Cause:</i> The Selective Catalytic Reduction (SCR) system is in an inducement state, but the inducement state has been overridden by an override request from the DGC-2020. Operation will continue in the Inducement Override state for a limited time only.                                       |
|                      | <i>Corrective Action:</i> Check the diesel exhaust fluid level and quality and correct any issue. Troubleshoot any other indicated SCR system issues.                                                                                                                                                  |
|                      | Diesel Exhaust Fluid Low Severe (Pre-Alarm)                                                                                                                                                                                                                                                            |
| DEF PRESVR INDUCMT P | <i>Cause:</i> Diesel exhaust fluid level is critically low.                                                                                                                                                                                                                                            |
|                      | <i>Corrective Action:</i> Add diesel exhaust fluid to the SCR system.                                                                                                                                                                                                                                  |
|                      | Diesel Exhaust Fluid Pre-Severe Inducement (Pre-Alarm)                                                                                                                                                                                                                                                 |
| DEF QUALITY POOR P   | <i>Cause:</i> The Selective Catalytic Reduction (SCR) system is approaching a state of severe inducement not to run the engine. This is usually caused by low diesel exhaust fluid level, poor diesel exhaust fluid quality, or tampering with the SCR system.                                         |
|                      | <i>Corrective Action:</i> Check the diesel exhaust fluid level and quality and correct any issue. Troubleshoot any other indicated SCR system issues.                                                                                                                                                  |
|                      | Diesel Exhaust Fluid Quality Poor (Pre-Alarm)                                                                                                                                                                                                                                                          |
| DEF SEVERE INDUCMT P | <i>Cause:</i> The exhaust system controller has determined the DEF quality is not acceptable. This could be due to age, or it could be an indication that some fluid other than DEF was added to the DEF tank. The DGC-2020 receives this information over J1939 CAN Bus.                              |
|                      | <i>Corrective Action:</i> Drain out existing DEF if possible and replace with new DEF.                                                                                                                                                                                                                 |
|                      | Diesel Exhaust Fluid Severe inducement (Pre-Alarm)                                                                                                                                                                                                                                                     |
| DEF TAMPERING P      | <i>Cause:</i> The Selective Catalytic Reduction (SCR) system is in a state of severe inducement not to run the engine. This is usually caused by low diesel exhaust fluid level, poor diesel exhaust fluid quality, or tampering with the SCR system.                                                  |
|                      | <i>Corrective Action:</i> Check the diesel exhaust fluid level and quality and correct any issue. Troubleshoot any other indicated SCR system issues.                                                                                                                                                  |
|                      | Diesel Exhaust Fluid Tampering (Pre-Alarm)                                                                                                                                                                                                                                                             |
| DEF WARNING          | <i>Cause:</i> The exhaust system controller has determined the DEF system has been tampered with. The DGC-2020 receives this information over J1939 CAN Bus.                                                                                                                                           |
|                      | <i>Corrective Action:</i> Correct any modifications that have been made to the DEF system. Consult engine or exhaust system manufacturer.                                                                                                                                                              |
|                      | Diesel Exhaust Fluid Pre-Inducement Warning Level 1 (Pre-Alarm)                                                                                                                                                                                                                                        |
| DEF WARNING LEVEL 2  | <i>Cause:</i> The Selective Catalytic Reduction (SCR) system is approaching a state of inducement not to run the engine. This is a second-level warning. This is usually caused by low diesel exhaust fluid level, poor diesel exhaust fluid quality, or tampering with the SCR system.                |
|                      | <i>Corrective Action:</i> Check the diesel exhaust fluid level and quality and correct any issue. Troubleshoot any other indicated SCR system issues.                                                                                                                                                  |
|                      | Diesel Exhaust Fluid Pre-Inducement Warning Level 2 (Pre-Alarm)                                                                                                                                                                                                                                        |
| DEMAND START         | <i>Cause:</i> The Selective Catalytic Reduction (SCR) system is approaching a state of inducement not to run the engine. This is a third-level warning. This is usually caused by low diesel exhaust fluid level, poor diesel exhaust fluid quality, or tampering with the SCR system.                 |
|                      | <i>Corrective Action:</i> Check the diesel exhaust fluid level and quality and correct any issue. Troubleshoot any other indicated SCR system issues.                                                                                                                                                  |
|                      | Demand Start Request (Status)                                                                                                                                                                                                                                                                          |
|                      | <i>Cause:</i> The DGC-2020 performed a demand-based start of the generator.                                                                                                                                                                                                                            |

| Event String           | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
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|                        | <i>Corrective Action:</i> Correct operation. No corrective action necessary.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| DEMAND STOP            | Demand Stop Request (Status)<br><i>Cause:</i> The DGC-2020 performed a demand-based stop of the generator.<br><i>Corrective Action:</i> Correct operation. No corrective action necessary.                                                                                                                                                                                                                                                                                                                                                                                                                   |
| DGC HEARTBEAT FAIL P   | DGC-2020 Heartbeat Fail (Pre-Alarm)<br><i>Cause:</i> An AEM-2020 or CEM-2020 is not receiving the periodic heartbeat message over CAN Bus from the DGC-2020.<br><i>Corrective Action:</i> In general, this will never be seen because it is a message from an I/O module to the DGC-2020 indicating that the I/O module is not receiving communications from the DGC-2020. Usually if there are communication issues that result in the I/O module not seeing the DGC-2020, then the DGC-2020 cannot see the I/O module either, so it will not receive the heartbeat fail communication from the I/O module. |
| DIAG TRBL CODE P       | Diagnostic Trouble Code (Pre-Alarm)<br><i>Cause:</i> Diagnostic trouble codes have been received from the engine ECU and are active.<br><i>Corrective Action:</i> Consult the engine manufacturer's documentation to address any issues indicated by the diagnostic trouble codes.                                                                                                                                                                                                                                                                                                                           |
| DIAL OUT FAILED        | Modem Dialout Failed (Status)<br><i>Cause:</i> The modem dial out feature is enabled and circumstances occurred for which the DGC-2020 initiated a modem dial out, but the dial out was not successful.<br><i>Corrective Action:</i> Check the integrity of the phone lines and verify that the phone number which the modem dials is active and functioning correctly.                                                                                                                                                                                                                                      |
| DIAL OUT SUCCESS       | Modem Dialout Success (Status)<br><i>Cause:</i> The modem dial out feature is enabled and circumstances occurred for which the DGC-2020 initiated a modem dial out, but the dial out was successful.<br><i>Corrective Action:</i> Correct operation. No corrective action necessary.                                                                                                                                                                                                                                                                                                                         |
| DPF REGNRATE DISABLD P | Regeneration Disabled (Pre-Alarm)<br><i>Cause:</i> Pre-alarm from the Diesel Particulate Filter (DPF) system that regeneration of the filter has been disabled by request of the DGC-2020.<br><i>Corrective Action:</i> Enable DPF regeneration.                                                                                                                                                                                                                                                                                                                                                             |
| DPF REGEN REQD P       | Regeneration Required (Pre-Alarm)<br><i>Cause:</i> Pre-alarm from the Diesel Particulate Filter (DPF) system that regeneration of the filter is necessary.<br><i>Corrective Action:</i> Start a DPF regeneration cycle or remove the Regeneration Disable so that an automatic regeneration cycle can occur. If regeneration is not occurring when expected, consult the engine manufacturer or DPF system manufacturer and troubleshoot DPF system issues.                                                                                                                                                  |
| DPF SOOT LVL EXT HI P  | Diesel Particulate Filter Soot Level Extremely High (Pre-Alarm)<br><i>Cause:</i> Pre-alarm from the Diesel Particulate Filter (DPF) system indicating that the accumulated soot level is extremely high.<br><i>Corrective Action:</i> Start a DPF regeneration cycle or remove the Regeneration Disable so that an automatic regeneration cycle can occur. If regeneration is not occurring when expected, consult the engine manufacturer or DPF system manufacturer and troubleshoot DPF system issues.                                                                                                    |
| DPF SOOT LVL MOD HI P  | Diesel Particulate Filter Soot Level Moderately High (Pre-Alarm)<br><i>Cause:</i> Pre-alarm from the Diesel Particulate Filter (DPF) system indicating that the accumulated soot level is moderately high.<br><i>Corrective Action:</i> Start a DPF regeneration cycle or remove the Regeneration Disable so that an automatic regeneration cycle can occur. If regeneration is not occurring when expected, consult the engine manufacturer or DPF system manufacturer and troubleshoot DPF system issues.                                                                                                  |
| ECU SHUTDOWN A         | ECU Shutdown (Alarm)<br><i>Cause:</i> The ECU has sent a shutdown indication to the DGC-2020 over CAN Bus indicating that the ECU has shut down the engine.<br><i>Corrective Action:</i> Check for diagnostic trouble codes and/or fault codes to diagnose and troubleshoot issues with the engine and/or engine ECU.                                                                                                                                                                                                                                                                                        |
| EMERGENCY STOP A       | Emergency Stop (Alarm)<br><i>Cause:</i> A contact input has initiated the Emergency Stop programmable function or logic is driving the Emergency Stop logic element.<br><i>Corrective Action:</i> Correct operation. No corrective action necessary.                                                                                                                                                                                                                                                                                                                                                         |
| ENGINE RUN START       | Engine Run logic element received a <i>start</i> request (Status)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

| Event String       | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                 |
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|                    | <p><i>Cause:</i> The engine was started due to a start request applied to the Engine Run logic element.</p> <p><i>Corrective Action:</i> Correct operation. No corrective action necessary.</p>                                                                                                                                                                                                                           |
| ENG kW OVRLD-1 P   | <p>Engine kW Overload 1 (Pre-Alarm)</p> <p><i>Cause:</i> The kW output of the generator is above the threshold set for the kW Overload 1 protection element.</p> <p><i>Corrective Action:</i> Check generator wiring, machine configuration, and load-sharing devices in multiple generator applications and the load. Shed some load if necessary.</p>                                                                   |
| ENG kW OVRLD-2 P   | <p>Engine kW Overload 2 (Pre-Alarm)</p> <p><i>Cause:</i> The kW output of the generator is above the threshold set for the kW Overload 2 protection element.</p> <p><i>Corrective Action:</i> Check generator wiring, machine configuration, and load-sharing devices in multiple generator applications and the load. Shed some load if necessary.</p>                                                                   |
| ENG kW OVRLD-3 P   | <p>Engine kW Overload 3 (Pre-Alarm)</p> <p><i>Cause:</i> The kW output of the generator is above the threshold set for the kW Overload 3 protection element.</p> <p><i>Corrective Action:</i> Check generator wiring, machine configuration, and load-sharing devices in multiple generator applications and the load. Shed some load if necessary.</p>                                                                   |
| ENGINE RUNNING     | <p>Engine Running (Status)</p> <p><i>Cause:</i> Status indication that the engine is running.</p> <p><i>Corrective Action:</i> Correct operation. No corrective action necessary.</p>                                                                                                                                                                                                                                     |
| ENTERED PROG MODE  | <p>DGC-2020 has entered programming mode (Status)</p> <p><i>Cause:</i> The DGC-2020 has entered programming mode to upload firmware.</p> <p><i>Corrective Action:</i> Correct operation. No corrective action necessary.</p>                                                                                                                                                                                              |
| EPS SUPPLYING LOAD | <p>Emergency Power System is Supplying Load (Status)</p> <p><i>Cause:</i> The output current of the machine is greater than the percentage of CT Primary Current indicated by the EPS Threshold setting on the System Settings screen.</p> <p><i>Corrective Action:</i> Correct operation. No corrective action necessary.</p>                                                                                            |
| FUEL FLT PRS HI P  | <p>Fuel Filter Differential Pressure High (Pre-Alarm)</p> <p><i>Cause:</i> The ECU has detected high fuel filter differential pressure and sent a notification to the DGC-2020.</p> <p><i>Corrective Action:</i> Check fuel filter for clogging. Check fuel pressure on both sides of the filter. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.</p> |
| FUEL LEAK 1 P      | <p>Fuel Filter 1 Leak (Pre-Alarm)</p> <p><i>Cause:</i> The ECU has detected a leak in Fuel Filter 1 and sent a notification to the DGC-2020.</p> <p><i>Corrective Action:</i> Check fuel filter for leakage and clogging. Check fuel lines and hoses on both sides of the filter. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.</p>                 |
| FUEL LEAK 2 P      | <p>Fuel Filter 2 Leak (Pre-Alarm)</p> <p><i>Cause:</i> The ECU has detected a leak in Fuel Filter 2 and sent a notification to the DGC-2020.</p> <p><i>Corrective Action:</i> Check fuel filter for leakage and clogging. Check fuel lines and hoses on both sides of the filter. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.</p>                 |
| FUEL LEAK DETECT A | <p>Fuel Leak Detect (Alarm)</p> <p><i>Cause:</i> The contact input to which the Fuel Leak Detect programmable function is assigned has been turned on and Fuel Leak Detect is configured as an Alarm.</p> <p><i>Corrective Action:</i> Check the fuel tanks and fuel lines for leakage. Check the fuel leak detect sensor and verify if fuel is actually present on the sensor.</p>                                       |
| FUEL LEAK DETECT P | <p>Fuel Leak Detect (Pre-Alarm)</p> <p><i>Cause:</i> The contact input to which the Fuel Leak Detect programmable function is assigned has been turned on and Fuel Leak Detect is configured as a Pre-Alarm.</p> <p><i>Corrective Action:</i> Check the fuel tanks and fuel lines for leakage. Check the fuel leak detect sensor and verify if fuel is actually present on the sensor.</p>                                |
| FUEL LEVL SENDR A  | <p>Fuel Level Sender Fail (Alarm)</p> <p><i>Cause:</i> The input from the sender is beyond the valid range for the device and the Fuel Level Sender Fail Alarm Configuration is set for Alarm.</p> <p><i>Corrective Action:</i> Check the sender, the sender wiring, and the sender common wiring from the engine block to the DGC-2020.</p>                                                                              |

| Event String         | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
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| FUEL LEVL SENDR FAIL | <p>Fuel Level Sender Fail (Status)</p> <p><i>Cause:</i> The input from the sender is beyond the valid range for the device and the Fuel Level Sender Fail is enabled.</p> <p><i>Corrective Action:</i> Check the sender, the sender wiring, and the sender common wiring from the engine block to the DGC-2020.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| FUEL LEVL SENDR P    | <p>Fuel Level Sender Fail (Pre-Alarm)</p> <p><i>Cause:</i> The input from the sender is beyond the valid range for the device and the Fuel Level Sender Fail Alarm Configuration is set for Pre-Alarm.</p> <p><i>Corrective Action:</i> Check the sender, the sender wiring, and the sender common wiring from the engine block to the DGC-2020.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| GEN REV ROT          | <p>Generator Reverse Rotation (Pre-Alarm)</p> <p><i>Cause:</i> The Generator Phase Rotation is set for ABC, but the detected rotation is ACB or the Generator Phase Rotation is set for ACB, but the detected rotation is ABC. The DGC-2020 will not issue a gen breaker close request if a rotation pre-alarm is active.</p> <p><i>Corrective Action:</i> Check machine wiring and configuration and implement correct rotation and sensing.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| GEN TEST LOADED      | <p>Generator Exerciser Test with Load (Status)</p> <p><i>Cause:</i> A test run has been started by the Generator Exercise Timer and the Run with Load setting is enabled on the Exercise Timer screen in BESTCOMSPlus.</p> <p><i>Corrective Action:</i> Correct operation. No corrective action necessary.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| GEN TEST UNLOADED    | <p>Generator Exerciser Test without Load (Status)</p> <p><i>Cause:</i> A test run has been started by the Generator Exercise Timer and the Run with Load setting is disabled on the Exercise Timer screen in BESTCOMSPlus.</p> <p><i>Corrective Action:</i> Correct operation. No corrective action necessary.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| GLBL SNDR FAIL A     | <p>Global Sender Fail (Alarm)</p> <p><i>Cause:</i> A Sender Fail alarm is active. This can be triggered by a Fuel Level Sender Fail, Oil Pressure Sender Fail, Coolant Temperature Sender, or Voltage Sensing Fail if any are configured as an alarm and the alarm is active. The individual Sender Fail alarm and the Global Sender Fail alarm will be annunciated.</p> <p><i>Corrective Action:</i> Perform corrective action for the underlying Sender Fail alarm that is active while the Global Sender Fail alarm is active.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| GN BKR CL FL P       | <p>Generator Breaker Fail to Close (Pre-Alarm)</p> <p><i>Cause:</i> The DGC-2020 issued a breaker close output, but the breaker status did not report the breaker as closed before the Breaker Fail Wait Time expired. The breaker will not operate until this pre-alarm is cleared. This latched pre-alarm can be cleared only by pressing the Reset button on the front panel of the DGC-2020, placing the machine into Off mode, or placing the breaker in the correct state.</p> <p><i>Corrective Action:</i> Check the wiring from the DGC-2020 to the breaker. Verify that the DGC-2020 is receiving correct open/closed status from the breaker. Verify that the breaker is receiving open/close commands from the DGC-2020. If pulse breaker commands are employed, verify that the pulse is long enough for the breaker to change states. Consider increasing the Breaker Close Wait Time.</p>                                                                                                                                                                 |
| GN BKR OP FL P       | <p>Generator Breaker Fail to Open (Pre-Alarm)</p> <p><i>Cause:</i> The DGC-2020 issued a breaker open output, but the breaker status did not report the breaker as open before the Breaker Fail Wait Time expired. The breaker will not operate until this pre-alarm is cleared. This latched pre-alarm can be cleared only by pressing the Reset button on the front panel of the DGC-2020, placing the machine into Off mode, or placing the breaker in the correct state.</p> <p><i>Corrective Action:</i> Check the wiring from the DGC-2020 to the breaker. Verify that the DGC-2020 is receiving correct open/closed status from the breaker. Verify that the breaker is receiving open/close commands from the DGC-2020. If pulse breaker commands are employed, verify that the pulse is long enough for the breaker to change states. Consider increasing the Breaker Close Wait Time.</p>                                                                                                                                                                     |
| GN BKR SYN FL P      | <p>Generator Breaker Synchronization Fail (Pre-Alarm)</p> <p><i>Cause:</i> The Sync Fail Activation Delay expired before the generator was synchronized and the breaker closed. If the machine values move within the voltage and phase or slip criteria for synchronization, it will not annunciate a synchronizer fail even if the generator does not close since synchronization was received. Once this pre-alarm is annunciated, synchronization has failed and the synchronizer will no longer attempt to synchronize.</p> <p><i>Corrective Action:</i> This latched pre-alarm can be cleared by pressing the Reset button on the front panel of the DGC-2020, placing the machine into Off mode, or issuing a breaker open request. Check the wiring from the DGC-2020 to the breaker. Verify that the DGC-2020 is receiving correct open/closed status from the breaker. Consider increasing the Sync Fail Activation Delay. Check speed controller tuning, re-tune to make it more aggressive if possible. Check the speed and voltage bias output wiring.</p> |

| Event String                   | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                               |
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| HI COOLANT TMP A               | High Coolant Temp (Alarm)                                                                                                                                                                                                                                                                                                                               |
|                                | <i>Cause:</i> The engine coolant temperature is above the threshold set for the High Coolant Temperature alarm.                                                                                                                                                                                                                                         |
|                                | <i>Corrective Action:</i> Check the engine thermostat and coolant level. Verify that the coolant pump is operating properly. Check the coolant radiator and passages for obstructions.                                                                                                                                                                  |
| HI COOLANT TMP P               | High Coolant Temp (Pre-Alarm)                                                                                                                                                                                                                                                                                                                           |
|                                | <i>Cause:</i> The engine coolant temperature is above the threshold set for the High Coolant Temperature pre-alarm.                                                                                                                                                                                                                                     |
|                                | <i>Corrective Action:</i> Check the engine thermostat and coolant level. Verify that the coolant pump is operating properly. Check the coolant radiator and passages for obstructions.                                                                                                                                                                  |
| HI DAY TANK LEVEL <i>mtu</i> P | High Day Tank Level (Pre-Alarm)                                                                                                                                                                                                                                                                                                                         |
|                                | <i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the fuel level in the day tank is too high.                                                                                                                                                                                                      |
|                                | <i>Corrective Action:</i> Check the level in the day tank. Check the wiring to the level sender in the day tank and check the sender itself. Verify that tank filling devices turn off when the tank is filled to the proper level. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary. |
| HI ECU VOLTS <i>mtu</i> A      | High ECU Supply Voltage (Pre-Alarm)                                                                                                                                                                                                                                                                                                                     |
|                                | <i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the ECU supply voltage is too high.                                                                                                                                                                                                              |
|                                | <i>Corrective Action:</i> Troubleshoot the ECU power supply. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.                                                                                                                                                                        |
| HI EXHAUST B T <i>mtu</i> P    | High Exhaust Temp B (Pre-Alarm)                                                                                                                                                                                                                                                                                                                         |
|                                | <i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the Exhaust System B temperature is high.                                                                                                                                                                                                        |
|                                | <i>Corrective Action:</i> Check for obstructions in the exhaust system. Check the fuel management and delivery system. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.                                                                                                              |
| HI EXHAUST A T <i>mtu</i> P    | High Exhaust Temp A (Pre-Alarm)                                                                                                                                                                                                                                                                                                                         |
|                                | <i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the Exhaust System A temperature is high.                                                                                                                                                                                                        |
|                                | <i>Corrective Action:</i> Check for obstructions in the exhaust system. Check the fuel management and delivery system. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.                                                                                                              |
| HI PRESSURE IN 1 <i>mtu</i> P  | High Pressure Input 1 (Pre-Alarm)                                                                                                                                                                                                                                                                                                                       |
|                                | <i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the Input 1 pressure is too high.                                                                                                                                                                                                                |
|                                | <i>Corrective Action:</i> Check the pressure at the input. Check the pump. Check the passage for leaks or restrictions. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.                                                                                                             |
| HI PRESSURE IN 2 <i>mtu</i> P  | High Pressure Input 2 (Pre-Alarm)                                                                                                                                                                                                                                                                                                                       |
|                                | <i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the Input 2 pressure is too high.                                                                                                                                                                                                                |
|                                | <i>Corrective Action:</i> Check the pressure at the input. Check the pump. Check the passage for leaks or restrictions. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.                                                                                                             |
| HI SUPPLY VOLTS <i>mtu</i> P   | High Voltage Supply (Pre-Alarm)                                                                                                                                                                                                                                                                                                                         |
|                                | <i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the supply voltage is high.                                                                                                                                                                                                                      |
|                                | <i>Corrective Action:</i> Check batteries and cabling, battery charging system, and charging alternator. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.                                                                                                                            |
| HI T FUEL <i>mtu</i> P         | High Fuel Temp (Pre-Alarm)                                                                                                                                                                                                                                                                                                                              |
|                                | <i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the fuel temperature is too high.                                                                                                                                                                                                                |
|                                | <i>Corrective Action:</i> Check the tank temperature. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.                                                                                                                                                                               |
| HIGH AMB TEMP <i>mtu</i> P     | High Ambient Temp (Pre-Alarm)                                                                                                                                                                                                                                                                                                                           |
|                                | <i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the ambient temperature is too high.                                                                                                                                                                                                             |
|                                | <i>Corrective Action:</i> Check the ambient temperature and verify that all devices maintaining temperature are operating correctly. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.                                                                                                |



| Event String                      | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                              |
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| HIGH CHARGE AIR TEMP <i>mtu</i> A | High Charge Air Temp (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                       |
|                                   | <i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the charge air temperature is too high. This alarm will not cause a machine shutdown, however the ECU may shut down the engine.                                                                                                                                 |
|                                   | <i>Corrective Action:</i> Check the Charge Air Cooler and the Charge Air Passages for obstructions. Check for sufficient cooling air for air-cooled-charge air coolers and sufficient engine coolant for water-cooled-charge air coolers. Consult <i>mtu</i> documentation for additional procedures to diagnose the cause of engine related issues.                   |
| HIGH CHARGE AIR TEMP <i>mtu</i> P | High Charge Air Temp (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                       |
|                                   | <i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the ambient temperature is too high. This pre-alarm will not cause a machine shutdown, however the ECU may shut down the engine.                                                                                                                                |
|                                   | <i>Corrective Action:</i> Check the Charge Air Cooler and the Charge Air Passages for obstructions. Check for sufficient cooling air for air-cooled-charge air coolers and sufficient engine coolant for water-cooled-charge air coolers. Consult <i>mtu</i> documentation for additional procedures to diagnose the cause of engine related issues.                   |
| HIGH COIL TEMP 1 <i>mtu</i> P     | High Temp Coil 1 (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                           |
|                                   | <i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the temperature of Coil 1 is too high.                                                                                                                                                                                                                          |
|                                   | <i>Corrective Action:</i> Check the coil temperature. Check cooling devices for correct operation. Check coolant media for correct coolant flow. Check coolant passages for leaks or restrictions. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.                                                 |
| HIGH COIL TEMP 2 <i>mtu</i> P     | High Temp Coil 2 (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                           |
|                                   | <i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the temperature of Coil 2 is too high.                                                                                                                                                                                                                          |
|                                   | <i>Corrective Action:</i> Check the coil temperature. Check cooling devices for correct operation. Check coolant media for correct coolant flow. Check coolant passages for leaks or restrictions. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.                                                 |
| HIGH COIL TEMP 3 <i>mtu</i> P     | High Temp Coil 3 (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                           |
|                                   | <i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the temperature of Coil 3 is too high.                                                                                                                                                                                                                          |
|                                   | <i>Corrective Action:</i> Check the coil temperature. Check cooling devices for correct operation. Check coolant media for correct coolant flow. Check coolant passages for leaks or restrictions. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.                                                 |
| HIGH COOLANT TEMP A               | High Coolant Temp (Alarm)                                                                                                                                                                                                                                                                                                                                              |
|                                   | <i>Cause:</i> The engine coolant temperature is above the threshold set for the High Coolant Temperature alarm.                                                                                                                                                                                                                                                        |
|                                   | <i>Corrective Action:</i> Check the engine thermostat. Check the coolant level and verify that the coolant pump is operating correctly. Check the coolant radiator and passages for obstructions.                                                                                                                                                                      |
| HIGH COOLANT TEMP P               | High Coolant Temp (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                          |
|                                   | <i>Cause:</i> The engine coolant temperature is above the threshold set for the High Coolant Temperature pre-alarm.                                                                                                                                                                                                                                                    |
|                                   | <i>Corrective Action:</i> Check the engine thermostat. Check the coolant level and verify that the coolant pump is operating correctly. Check the coolant radiator and passages for obstructions.                                                                                                                                                                      |
| HIGH ECU TEMPERATURE <i>mtu</i> P | High ECU Temp (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                              |
|                                   | <i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the ECU temperature is too high.                                                                                                                                                                                                                                |
|                                   | <i>Corrective Action:</i> Check for adequate air flow or coolant circulation around the engine ECU. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Consult <i>mtu</i> documentation for additional procedures to diagnose the causes of engine related issues. Contact the engine manufacturer if necessary.                                    |
| HIGH EXHAUST TEMP P               | High Exhaust Temp (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                          |
|                                   | <i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the exhaust temperature is too high. Note that this may be normal at times on some engines with Diesel Particulate Filters in their Exhaust After Treatment systems. Diesel Particulate Filter Regeneration is accomplished by raising the exhaust temperature. |

| Event String                       | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
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|                                    | <p><b>Corrective Action:</b> Check to see if Diesel Particulate Filter Regeneration is in process. If so, no action is required. If exhaust temperature is high and the system is not regenerating, check for obstructions in the exhaust system. Check fuel management and delivery system. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.</p>                                                                                                                                                                                                      |
| HIGH FUEL LEVEL P                  | <p>High Fuel Level (Pre-Alarm)</p> <p><b>Cause:</b> The fuel level reading is above the level specified in the High Fuel Level pre-alarm element.</p> <p><b>Corrective Action:</b> Avoid overfilling the tank. If an automatic fuel pump is used to fill the tank, check the fuel pump and associated wiring and verify that the pump shuts off when it should.</p>                                                                                                                                                                                                                                                       |
| HIGH FUEL RAIL PRESS <i>mtu</i> P  | <p>High Fuel Rail Pressure (Pre-Alarm)</p> <p><b>Cause:</b> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the fuel rail pressure is too high.</p> <p><b>Corrective Action:</b> Check fuel filters, fuel lines, fuel rail, and fuel injectors for obstructions. Check the fuel pump for correct pump pressure. Consult <i>mtu</i> documentation for additional procedures to diagnose the causes of engine related issues.</p>                                                                                                                                                  |
| HIGH INTRCOOLER TEMP <i>mtu</i> P  | <p>High Intercooler Temp (Pre-Alarm)</p> <p><b>Cause:</b> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the intercooler temperature is too high.</p> <p><b>Corrective Action:</b> Check for proper intercooler cooler radiator air flow. Check coolant passageways for obstructions. Check coolant level to verify that the correct amount of coolant is in the system. Consult <i>mtu</i> documentation for additional procedures to diagnose the causes of engine related issues.</p>                                                                                        |
| HIGH OIL TEMPERATURE <i>mtu</i> P  | <p>High Oil Temp (Pre-Alarm)</p> <p><b>Cause:</b> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the oil temperature is too high. This is a warning and the DGC-2020 will not cause a machine shutdown, however the ECU may shut down the engine.</p> <p><b>Corrective Action:</b> Check the oil cooler and passages for obstructions. Check for sufficient cooling air for air-cooled oil coolers and sufficient engine coolant for liquid-cooled oil coolers. Consult <i>mtu</i> documentation for additional procedures to diagnose the causes of engine related issues.</p> |
| HIGH OIL TERMPERATURE <i>mtu</i> A | <p>High Oil Temp (Pre-Alarm)</p> <p><b>Cause:</b> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the oil temperature is too high. This is a warning and the DGC-2020 will not cause a machine shutdown, however the ECU may shut down the engine.</p> <p><b>Corrective Action:</b> Check the oil cooler and passages for obstructions. Check for sufficient cooling air for air-cooled oil coolers and sufficient engine coolant for liquid-cooled oil coolers. Consult <i>mtu</i> documentation for additional procedures to diagnose the causes of engine related issues.</p> |
| HIGH STRG TANK LEVEL <i>mtu</i> P  | <p>High Storage Tank Level (Pre-Alarm)</p> <p><b>Cause:</b> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the fuel level in the storage tank is too high.</p> <p><b>Corrective Action:</b> Check the level in the storage tank. Check the wiring to the level sender in the tank and check the sender itself. Verify that tank filling devices turn off after the tank is filled to the proper level. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.</p>                                                  |
| ID MISSING P                       | <p>LSM-2020 ID Missing (Pre-Alarm)</p> <p><b>Cause:</b> A DGC-2020 with an expected sequencing ID is not present on the intergenset communications network.</p> <p><b>Corrective Action:</b> Verify that the expected sequencing ID's are set up correctly. Verify that the DGC-2020 with expected ID is powered up and connected to the Ethernet intergenset communications network. Check all Ethernet cables and hubs/switches on the network and verify that they are powered up and functioning properly.</p>                                                                                                        |
| ID REPEAT P                        | <p>LSM-2020 ID Repeated (Pre-Alarm)</p> <p><b>Cause:</b> Two DGC-2020 units with the same nonzero sequencing ID's are present on the intergenset communications network at the same time.</p> <p><b>Corrective Action:</b> Check the sequencing ID on as many units as necessary until all DGC-2020's on the network have unique nonzero sequencing IDs.</p>                                                                                                                                                                                                                                                              |
| IDLE SPD LO <i>mtu</i> P           | <p>Idle Speed Low (Pre-Alarm)</p> <p><b>Cause:</b> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the idle speed is low.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

| Event String                      | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
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|                                   | <i>Corrective Action:</i> Check the idle speed. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.                                                                                                                                                                                                                                                                                                                                                                                                |
| INPUT X A (X = 1 to 40)           | User Configurable Input X (X = 1 to 40) (Alarm)<br><i>Cause:</i> Contact Input X is driven on and the alarm configuration for the contact input is set to Alarm. The event string text is user programmable.<br><i>Corrective Action:</i> Check the system logic and/or manufacturer's documentation to determine the nature of the contact closure. Address the issues indicated by the contact closure.                                                                                                                                                          |
| INPUT X P (X = 1 to 40)           | User Configurable Input X (X = 1 to 40) (Pre-Alarm)<br><i>Cause:</i> Contact Input X is driven on and the alarm configuration for the contact input is set to Pre-Alarm. The event string text is user programmable.<br><i>Corrective Action:</i> Check the system logic and/or manufacturer's documentation to determine the nature of the contact closure. Address the issues indicated by the contact closure.                                                                                                                                                  |
| LO AFTERCLR COOL LVL <i>mtu</i> A | Low After Cooler Cool Level (Alarm)<br><i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the After Cooler coolant level is low.<br><i>Corrective Action:</i> Check the After Cooler coolant level. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.                                                                                                                                                                                        |
| LO CHG AIR CLNT LVL <i>mtu</i> P  | Low Charge Air Coolant Level (Pre-Alarm)<br><i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the Charge Air Cooler coolant level is low.<br><i>Corrective Action:</i> Check the Charge Air coolant level. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.                                                                                                                                                                                |
| LO DAY TANK LEVEL <i>mtu</i> P    | Low Day Tank Level (Pre-Alarm)<br><i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the fuel level in the day tank is low.<br><i>Corrective Action:</i> Check the fuel level in the day tank. Check the wiring to the level sender in the day tank and check the sender itself. Verify that tank filling devices activate when the level is below that for which pump start should occur. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary. |
| LO ECU VOLTS <i>mtu</i> P         | Low ECU Supply Voltage (Pre-Alarm)<br><i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the ECU supply voltage is too low.<br><i>Corrective Action:</i> Troubleshoot the ECU power supply. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.                                                                                                                                                                                                |
| LO FUEL DLV PRESSURE <i>mtu</i> A | Low Fuel Delivery Pressure (Alarm)<br><i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the fuel delivery pressure is too low. This is a warning and the DGC-2020 will not cause a machine shutdown, however the ECU may shut down the engine.<br><i>Corrective Action:</i> Check the fuel filters and fuel lines for obstructions. Check the fuel pump for proper pressure. Consult <i>mtu</i> documentation for additional procedures to diagnose the cause of engine related issues.                       |
| LO SUPPLY VOLTS <i>mtu</i> P      | Low Voltage Supply (Pre-Alarm)<br><i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the supply voltage is low.<br><i>Corrective Action:</i> Check batteries and cabling, battery charging system, and charging alternator. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.                                                                                                                                                                |
| LOAD TAKEOVER                     | Load Takeover (Status)<br><i>Cause:</i> A load takeover request has been initiated through logic. The DGC-2020 will parallel the generator to the utility, and then open the utility breaker to take the load off utility power and support it with generator power.<br><i>Corrective Action:</i> Correct operation. No corrective action necessary.                                                                                                                                                                                                               |
| LOGIC OUTPUT A                    | Logic Output (Alarm)<br><i>Cause:</i> The LOGICALM (Logic Alarm) logic element is true in the DGC-2020 programmable logic.<br><i>Corrective Action:</i> Refer to the programmable logic and perform corrective action for the conditions that have driven the logic element true.                                                                                                                                                                                                                                                                                  |
| LOGIC OUTPUT P                    | Logic Output (Pre-Alarm)<br><i>Cause:</i> The LOGICPALM (Logic Pre-Alarm) logic element is true in the DGC-2020 programmable logic.                                                                                                                                                                                                                                                                                                                                                                                                                                |



| Event String                      | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
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|                                   | <i>Corrective Action:</i> Refer to the programmable logic and perform corrective action for the conditions that have driven the logic element true.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| LOSS OF VOLT                      | <p>Voltage Sensing Fail (Status)</p> <p><i>Cause:</i> The DGC-2020 is not sensing voltage on at least one phase of the generator where voltage should be present and the Voltage Sensing Failure element is enabled.</p> <p><i>Corrective Action:</i> Check the wiring from the generator to the DGC-2020. Use a meter to verify that all generator phases are producing the correct voltage and compare the values with the DGC-2020 metering values. If there is voltage at the terminals of the DGC-2020, but the DGC-2020 does not sense it, the DGC-2020 could be faulty.</p>                                                                                                                                                                                                                 |
| LOSS OF VOLT A                    | <p>Voltage Sensing Fail (Alarm)</p> <p><i>Cause:</i> The DGC-2020 is not sensing voltage on at least one phase of the generator where voltage should be present, the Voltage Sensing Failure element is enabled, and the alarm configuration for Voltage Sensing Fail is set for Alarm.</p> <p><i>Corrective Action:</i> Check the wiring from the generator to the DGC-2020. Use a meter to verify that all generator phases are producing the correct voltage and compare the values with the DGC-2020 metering values. If there is voltage at the terminals of the DGC-2020, but the DGC-2020 does not sense it, the DGC-2020 could be faulty.</p>                                                                                                                                              |
| LOSS OF VOLT P                    | <p>Voltage Sensing Fail (Pre-Alarm)</p> <p><i>Cause:</i> The DGC-2020 is not sensing voltage on at least one phase of the generator where voltage should be present, the Voltage Sensing Failure element is enabled, and the alarm configuration for Voltage Sensing Fail is set for Pre-Alarm.</p> <p><i>Corrective Action:</i> Check the wiring from the generator to the DGC-2020. Use a meter to verify that all generator phases are producing the correct voltage and compare the values with the DGC-2020 metering values. If there is voltage at the terminals of the DGC-2020, but the DGC-2020 does not sense it, the DGC-2020 could be faulty.</p>                                                                                                                                      |
| LOSS REM COMS P                   | <p>Loss of Remote Module Communication (Pre-Alarm)</p> <p><i>Cause:</i> CAN Bus communication with a remote module has been lost. If any I/O module communications are lost, regardless of whether it is an LSM-2020, CEM-2020, or AEM-2020, this will be logged in the event log along with the specific loss of communications for the particular remote module.</p> <p><i>Corrective Action:</i> Check the CAN Bus wiring to all devices on the network. Verify that 120-ohm termination resistors are located on each end of the main wire. Verify that all remote modules are powered up, and that their Status LEDs are flashing to indicate that they are functioning properly.</p>                                                                                                         |
| LOST ECU COMM A                   | <p>Loss of ECU Communication (Alarm)</p> <p><i>Cause:</i> CAN Bus communications with the engine ECU have been lost while the engine was running. The DGC-2020 receives engine rpm data from the ECU on a periodic basis. If 10 seconds elapse without an rpm update, a Loss of ECU Communications is annunciated. If it occurs while the engine is running, it is an Alarm.</p> <p><i>Corrective Action:</i> Check the CAN Bus wiring to all devices on the network. Verify that 120-ohm termination resistors are located on each end of the main wire. Verify that the ECU is powered up and receiving a Key On signal from the DGC-2020. Verify that all remote modules are powered up, and that their Status LEDs are flashing to indicate that they are functioning properly.</p>            |
| LOST ECU COMM P                   | <p>Loss of ECU Communication (Pre-Alarm)</p> <p><i>Cause:</i> CAN Bus communications with the engine ECU have been lost while the engine was running. The DGC-2020 receives engine rpm data from the ECU on a periodic basis. If 10 seconds elapse without an rpm update, a Loss of ECU Communications is annunciated. If it occurs while the engine is not running, it is a Pre-Alarm.</p> <p><i>Corrective Action:</i> Check the CAN Bus wiring to all devices on the network. Verify that 120-ohm termination resistors are located on each end of the main wire. Verify that the ECU is powered up and receiving a Key On signal from the DGC-2020. Verify that all remote modules are powered up, and that their Status LEDs are flashing to indicate that they are functioning properly.</p> |
| LOW BATT VOLT P                   | <p>Low Battery Voltage (Pre-Alarm)</p> <p><i>Cause:</i> The battery voltage is below the level set for the Low Battery Voltage Pre-Alarm threshold.</p> <p><i>Corrective Action:</i> Check batteries and cabling, battery charging system, and charging alternator. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.</p>                                                                                                                                                                                                                                                                                                                                                                                                        |
| LOW CHARGE AIR PRESS <i>mtu</i> P | <p>Low Charge Air Pressure (Pre-Alarm)</p> <p><i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the charge air pressure is too low.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

| Event String                      | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
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|                                   | <i>Corrective Action:</i> Check the turbo charger. Check the charge air passages for obstructions. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Consult <i>mtu</i> documentation for additional procedures to diagnose the causes of engine related issues. Contact the engine manufacturer if necessary.                                                                                                                                                                                                                                                                                                                                                          |
| LOW COOL LEVEL A                  | <p>Low Coolant Level (Alarm)</p> <p><i>Cause:</i> Low coolant level indication was received from the engine ECU or a contact input in one of the following ways: 1) The coolant level information received from the ECU is below the threshold for the Low Coolant Level Alarm. 2) The ECU sent a diagnostic trouble code indicating that the coolant level is low. 3) The contact input associated with the Low Coolant Level Programmable Function is true and the alarm configuration is set for Alarm.</p> <p><i>Corrective Action:</i> Check the engine coolant level and add coolant if necessary. If the level is very low, check for and correct any coolant leaks.</p>             |
| LOW COOL LEVEL P                  | <p>Low Coolant Level (Pre-Alarm)</p> <p><i>Cause:</i> Low coolant level indication was received from the engine ECU or a contact input in one of the following ways: 1) The coolant level information received from the ECU is below the threshold for the Low Coolant Level Pre-Alarm. 2) The ECU sent a diagnostic trouble code indicating that the coolant level is low. 3) The contact input associated with the Low Coolant Level Programmable Function is true and the alarm configuration is set for Pre-Alarm.</p> <p><i>Corrective Action:</i> Check the engine coolant level and add coolant if necessary. If the level is very low, check for and correct any coolant leaks.</p> |
| LOW COOL TMP A                    | <p>Low Coolant Temperature (Alarm)</p> <p><i>Cause:</i> The coolant temperature measured by the Coolant Temperature Sender or received from the engine ECU is below the level set for the Low Coolant Temperature Alarm threshold.</p> <p><i>Corrective Action:</i> Check the engine block heater or any other devices which maintain minimum coolant temperatures when the engine is not running.</p>                                                                                                                                                                                                                                                                                      |
| LOW COOL TMP P                    | <p>Low Coolant Temperature (Pre-Alarm)</p> <p><i>Cause:</i> The coolant temperature measured by the Coolant Temperature Sender or received from the engine ECU is below the level set for the Low Coolant Temperature Pre-Alarm threshold.</p> <p><i>Corrective Action:</i> Check the engine block heater or any other devices which maintain minimum coolant temperatures when the engine is not running.</p>                                                                                                                                                                                                                                                                              |
| LOW COOLANT LEVEL <i>mtu</i> P    | <p>Low Coolant Level (Pre-Alarm)</p> <p><i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the coolant level is too low. This is a warning and the DGC-2020 will not cause a machine shutdown, however the ECU may shut down the engine.</p> <p><i>Corrective Action:</i> Check for proper coolant level and check for coolant leakage. Check the wiring of the coolant level sensor. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Consult <i>mtu</i> documentation for additional procedures to diagnose the causes of engine related issues. Contact the engine manufacturer if necessary.</p>               |
| LOW FUEL DELIV PRESS <i>mtu</i> P | <p>Low Fuel Delivery Pressure (Pre-Alarm)</p> <p><i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the fuel delivery pressure is too low. This is a warning and the DGC-2020 will not cause a machine shutdown, however the ECU may shut down the engine.</p> <p><i>Corrective Action:</i> Check the fuel filters and fuel lines for obstructions. Check the fuel pump for proper pressure. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Consult <i>mtu</i> documentation for additional procedures to diagnose the causes of engine related issues. Contact the engine manufacturer if necessary.</p>        |
| LOW FUEL LEVEL A                  | <p>Low Fuel Level (Alarm)</p> <p><i>Cause:</i> The fuel level measured by the fuel level sender is below the Low Fuel Level Alarm threshold.</p> <p><i>Corrective Action:</i> Check the fuel level and add fuel if necessary. If the alarm occurs, but the fuel level is not low, check the wiring from the sender to the DGC-2020, and verify proper ground path between the sender and the fuel tank. Check for continuity between the fuel tank and the DGC-2020 sender common terminal.</p>                                                                                                                                                                                             |
| LOW FUEL LEVEL P                  | <p>Low Fuel Level (Pre-Alarm)</p> <p><i>Cause:</i> The fuel level measured by the fuel level sender is below the Low Fuel Level Pre-Alarm threshold.</p> <p><i>Corrective Action:</i> Check the fuel level and add fuel if necessary. If the pre-alarm occurs, but the fuel level is not low, check the wiring from the sender to the DGC-2020, and verify proper ground path between the sender and the fuel tank. Check for continuity between the fuel tank and the DGC-2020 sender common terminal.</p>                                                                                                                                                                                 |
| LOW FUEL RAIL PRESS <i>mtu</i> P  | Low Fuel Rail Pressure (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

| Event String                  | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
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|                               | <p><i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the fuel rail pressure is too low.</p> <p><i>Corrective Action:</i> Check the fuel filters, fuel lines, fuel rail, and fuel injectors for obstructions. Check the fuel pump for proper pressure. Consult <i>mtu</i> documentation for additional procedures to diagnose the causes of engine related issues.</p>                                                                                                                                                                                                                                                                                                                                                                                                               |
| LOW OIL PRES A                | <p>Low Oil Pressure (Alarm)</p> <p><i>Cause:</i> The oil pressure sent to the DGC-2020 from the oil pressure sender or received from the engine ECU is below the Low Oil Pressure Alarm threshold.</p> <p><i>Corrective Action:</i> Check the engine oil level and add oil if necessary. Check the oil pump and check for obstructions in the oil lubrication passages. Check the integrity of the wiring from the oil pressure sender to the ECU or DGC-2020. Verify that sender resistance is valid. Check for a proper ground path between the sender and the engine block. Check for continuity from the sender body to the Sender Common terminal on the DGC-2020.</p>                                                                                                                                                              |
| LOW OIL PRES P                | <p>Low Oil Pressure (Pre-Alarm)</p> <p><i>Cause:</i> The oil pressure sent to the DGC-2020 from the oil pressure sender or received from the engine ECU is below the Low Oil Pressure Pre-Alarm threshold.</p> <p><i>Corrective Action:</i> Check the engine oil level and add oil if necessary. Check the oil pump and check for obstructions in the oil lubrication passages. Check the integrity of the wiring from the oil pressure sender to the ECU or DGC-2020. Verify that sender resistance is valid. Check for a proper ground path between the sender and the engine block. Check for continuity from the sender body to the Sender Common terminal on the DGC-2020.</p>                                                                                                                                                      |
| LOW OIL PRESSURE <i>mtu</i> A | <p>Low Oil Pressure (Alarm)</p> <p><i>Cause:</i> This alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the oil pressure is too low.</p> <p><i>Corrective Action:</i> Check the engine oil level and add oil if necessary. Check the oil pump and check for obstructions in the oil lubrication passages. Check the integrity of the wiring from the oil pressure sender to the ECU or DGC-2020. Verify that sender resistance is valid.</p>                                                                                                                                                                                                                                                                                                                                                               |
| LOW OIL PRESSURE <i>mtu</i> P | <p>Low Oil Pressure (Pre-Alarm)</p> <p><i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the oil pressure is too low.</p> <p><i>Corrective Action:</i> Check the engine oil level and add oil if necessary. Check the oil pump and check for obstructions in the oil lubrication passages. Check the integrity of the wiring from the oil pressure sender to the ECU or DGC-2020. Verify that sender resistance is valid.</p>                                                                                                                                                                                                                                                                                                                                                       |
| LOW STRG TANK LEVEL P         | <p>Low Storage Tank Level (Pre-Alarm)</p> <p><i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the fuel level in the storage tank is too low.</p> <p><i>Corrective Action:</i> Check the fuel level in the tank. Check the wiring to the level sender in the tank and check the sender itself. Verify that tank filling devices activate when the level is below that for which pump start should occur. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.</p>                                                                                                                                                                                                                                                    |
| LSM AVR OUT LMT P             | <p>LSM-2020 AVR Output Limit (Pre-Alarm)</p> <p><i>Cause:</i> The Automatic Voltage Regulator (AVR) bias output on the LSM-2020 is at either its maximum or minimum configured output value and cannot go beyond.</p> <p><i>Corrective Action:</i> Usually this indicates a wiring error or settings error that causes the bias output to be incompatible with the bias range on the AVR. Check the wiring and external devices to verify that the bias output and load share lines are not driven by an external device. Verify that the selected range for the bias output is compatible with the AVR bias input range. Perform testing found in the Maintenance &amp; Troubleshooting section of this manual to verify that changing bias output voltage or current values will change the generator's output voltage as desired.</p> |
| LSM COMMS FAIL P              | <p>LSM-2020 Communications Failure (Pre-Alarm)</p> <p><i>Cause:</i> Communications with the LSM-2020 have failed. When configured as a pre-alarm, the machine will continue running and annunciate the pre-alarm.</p> <p><i>Corrective Action:</i> Check CAN Bus wiring to all devices on the CAN Bus. Verify that a 120-ohm termination resistor is installed on each end of the main wire. Verify that the LSM-2020 is powered up and the LED is blinking to indicate it is functioning properly. If there are intermittent communication failures, unplug and reseat the connectors on the LSM-2020.</p>                                                                                                                                                                                                                              |
| LSM GOV OUT LMT P             | <p>LSM-2020 GOV Output Limit (Pre-Alarm)</p> <p><i>Cause:</i> The governor bias output on the LSM-2020 is at either its maximum or minimum configured output value and cannot go beyond.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

| Event String            | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
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|                         | <p><b>Corrective Action:</b> Usually this indicates a wiring error or settings error that causes the bias output to be incompatible with the bias range on the governor or engine ECU. Check the wiring and external devices to verify that the bias output and load share lines are not driven by an external device. Verify that the selected range for the bias output is compatible with the governor's or engine ECU's bias input range. Perform testing found in the <i>Maintenance and Troubleshooting</i> section of this manual to verify that changing bias output voltage or current values will change the generator's rpm as desired.</p>                                                                                                                                                                                                                                              |
| LSM HEARTBEAT FAIL P    | <p>LSM-2020 Heartbeat Failed (Pre-Alarm)</p> <p><b>Cause:</b> The DGC-2020 is not receiving a heartbeat communication signal from the LSM-2020 through CAN Bus.</p> <p><b>Corrective Action:</b> Verify that all CAN Bus communication cables are properly wired and terminated. Verify that the I/O modules in the system are enabled in the DGC-2020 settings. Verify that the I/O modules are powered up and functioning (the Status LED on the modules is flashing). If there are intermittent LSM-2020 communication failures, unplug and reseat the connectors on the LSM-2020.</p>                                                                                                                                                                                                                                                                                                           |
| LSM INTERGEN COM FAIL P | <p>LSM-2020 Intergenset Communications Failure (Pre-Alarm)</p> <p><b>Cause:</b> The DGC-2020 lost communications with the other generators on the intergenset communications network.</p> <p><b>Corrective Action:</b> Usually this indicates that a network issue is blocking communications between the generators. Verify that other generators are on line. Check network cabling and components for network issues. Verify that all devices on the network are industrially rated and designed to comply with IEC 61000-4 series of specifications. If the failure still exists, cycle power to the LSM-2020 and the network devices in an attempt to restore communications.</p>                                                                                                                                                                                                              |
| MAINS FAIL TEST         | <p>Mains Fail Test (Status)</p> <p><b>Cause:</b> A Mains Fail Test request has been initiated through logic. The DGC-2020 will initiate a mains fail transfer sequence identical to the sequence when utility power has failed. The mains breaker will open, the generator will start, and the gen breaker will close allowing the generator to power the load.</p> <p><b>Corrective Action:</b> Correct operation. No corrective action necessary.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| MAINT INTERVAL P        | <p>Maintenance Interval (Pre-Alarm)</p> <p><b>Cause:</b> The maintenance interval has expired. Service the unit.</p> <p><b>Corrective Action:</b> Service the machine and then reset the pre-alarm on the front panel of the DGC-2020 under Settings &gt; System Settings &gt; Maint Reset by setting Maint Reset to Yes. The pre-alarm will be reset and the value changed back to No. The pre-alarm can also be reset through BESTCOMSP<sub>Plus</sub> under Metering Explorer &gt; Run Statistics by clicking the Reset Maintenance Interval button.</p>                                                                                                                                                                                                                                                                                                                                         |
| MF TRANSFER             | <p>Mains Fail Transfer Complete (Status)</p> <p><b>Cause:</b> This status indicates successful completion of a mains fail transfer sequence.</p> <p><b>Corrective Action:</b> Correct operation. No corrective action necessary.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| MF TRANSFER FAIL        | <p>Mains Fail Transfer Fail (Status)</p> <p><b>Cause:</b> This status indicates unsuccessful mains fail transfer sequence. This will usually coincide with a Transfer Fail alarm.</p> <p><b>Corrective Action:</b> Check the Mains Fail Max Transfer Time setting. Verify that it is set long enough for an actual transfer to occur; consider increasing the setting. Check Mains Breaker and Generator operation, and verify that they open and close properly. When the generator is running, verify that the status is "Stable" on the Status Inputs screen in BESTCOMSP<sub>Plus</sub> or on the DGC-2020 front panel.</p>                                                                                                                                                                                                                                                                     |
| MN BKR CL FL P          | <p>Mains Breaker Fail to Close (Pre-Alarm)</p> <p><b>Cause:</b> The DGC-2020 issued a breaker close output, but the breaker status did not report the breaker as closed before the Breaker Fail Wait Time expired. The breaker will not operate until this pre-alarm is cleared. This latched pre-alarm can be cleared only by pressing the Reset button on the front panel of the DGC-2020, placing the machine into Off mode, or placing the breaker in the correct state.</p> <p><b>Corrective Action:</b> Check the wiring from the DGC-2020 to the breaker. Verify that the DGC-2020 is receiving correct open/closed status from the breaker. Verify that the breaker is receiving open/close commands from the DGC-2020. If pulse breaker commands are employed, verify that the pulse is long enough for the breaker to change states. Consider increasing the Breaker Close Wait Time.</p> |
| MN BKR OP FL P          | <p>Mains Breaker Fail to Open (Pre-Alarm)</p> <p><b>Cause:</b> The DGC-2020 issued a breaker open output, but the breaker status did not report the breaker as open before the Breaker Fail Wait Time expired. The breaker will not operate until this pre-alarm is cleared. This latched pre-alarm can be cleared only by pressing the Reset button on the front panel of the DGC-2020, placing the machine into Off mode, or placing the breaker in the correct state.</p>                                                                                                                                                                                                                                                                                                                                                                                                                        |

| Event String    | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
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|                 | <p><b>Corrective Action:</b> Check the wiring from the DGC-2020 to the breaker. Verify that the DGC-2020 is receiving correct open/closed status from the breaker. Verify that the breaker is receiving open/close commands from the DGC-2020. If pulse breaker commands are employed, verify that the pulse is long enough for the breaker to change states. Consider increasing the Breaker Close Wait Time.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| MN BKR SYN FL P | <p>Mains Breaker Synchronization Fail (Pre-Alarm)</p> <p><b>Cause:</b> The Synchronizer Fail Activation Delay expired while the generator was trying to synchronize and close the breaker. If the machine moves within the voltage and phase or slip criteria for synchronization, it will not annunciate a synchronizer fail even if the generator does not close since synchronization was achieved. Once this pre-alarm is annunciated, synchronization has failed and the synchronizer will no longer attempt to synchronize. This latched pre-alarm can be cleared by pressing the Reset button on the DGC-2020 front panel, placing the machine into Off mode, or issuing a breaker open request.</p> <p><b>Corrective Action:</b> Check the wiring from the DGC-2020 to the breaker. Verify that the DGC-2020 is receiving correct open/closed status from the breaker. Consider increasing the Synchronizer Fail Activation Delay. Check speed controller tuning. If possible, re-tune to make it more aggressive. Check the speed and voltage bias output wiring.</p> |
| MPU FAIL P      | <p>Magnetic Pickup Fail (Pre-Alarm)</p> <p><b>Cause:</b> The DGC-2020 is not receiving pulses from the magnetic pickup that senses flywheel teeth for speed sensing. This applies to only non-ECU units that use a magnetic pickup sensor to sense flywheel teeth to determine engine rpm. This will occur only if the Speed Source is set to MPU-FREQ. When set to MPU-FREQ, MPU will be the speed source. If MPU is not detected, the DGC-2020 will use Generator Frequency as the speed source and annunciate an MPU Fail Pre-Alarm.</p> <p><b>Corrective Action:</b> Remove the magnetic pickup sensor and wipe off any dirt or metal filings. Verify that the MPU sensor is positioned to maintain the correct distance between the sensor and the flywheel teeth. Check the voltage level of the MPU output and verify that it is within the range specified for the DGC-2020 MPU input. Check the wiring from the MPU sensor to the DGC-2020 and correct any issues.</p>                                                                                                |
| mtu FAULT CODES | <p>mtu Fault Codes (Pre-Alarm)</p> <p><b>Cause:</b> An mtu engine control unit has sent fault codes to the DGC-2020.</p> <p><b>Corrective Action:</b> Check the fault codes and correct the issues that are reported. If necessary, contact the engine manufacturer for assistance.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| MULTIPLE AEM P  | <p>Multiple AEM-2020's (Pre-Alarm)</p> <p><b>Cause:</b> More than one AEM-2020 is detected on the CAN Bus network.</p> <p><b>Corrective Action:</b> Ensure that only one AEM-2020 is on the CAN Bus network.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| MULTIPLE CEM P  | <p>Multiple CEM-2020's (Pre-Alarm)</p> <p><b>Cause:</b> More than one CEM-2020 is detected on the CAN Bus network.</p> <p><b>Corrective Action:</b> Ensure that only one CEM-2020 is on the CAN Bus network.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| MULTIPLE LSM P  | <p>Multiple LSM-2020's (Pre-Alarm)</p> <p><b>Cause:</b> More than one LSM-2020 is detected on the CAN Bus network.</p> <p><b>Corrective Action:</b> Ensure that only one LSM-2020 is on the CAN Bus network.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| NORM SHUTDOWN   | <p>Normal Shutdown (Status)</p> <p><b>Cause:</b> The unit has transitioned from running to not running due to a normal shutdown sequence.</p> <p><b>Corrective Action:</b> Correct operation. No corrective action necessary.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| OFF MODE        | <p>DGC-2020 has entered Off mode (Status)</p> <p><b>Cause:</b> This status indicates that the DGC-2020 entered Off mode.</p> <p><b>Corrective Action:</b> Correct operation. No corrective action necessary.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| OIL SNDR FAIL   | <p>Oil Pressure Sender Fail (Status)</p> <p><b>Cause:</b> If the DGC-2020 is reading an oil pressure sender, the input from the sender is outside of the valid range for the device. If the DGC-2020 is receiving oil pressure over CAN Bus from an engine ECU, but the ECU sends a special code indicating that the sender has failed, Oil Pressure Sender Fail will also be true.</p> <p><b>Corrective Action:</b> Check the sender, the sender wiring, and the sender common wiring from the engine block to the DGC-2020 and/or the engine ECU.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| OIL SNDR FAIL A | <p>Oil Pressure Sender Fail (Alarm)</p> <p><b>Cause:</b> Oil Pressure Sender Fail status is true and the Oil Pressure Sender Fail alarm configuration is set for Alarm.</p> <p><b>Corrective Action:</b> Check the sender, the sender wiring, and the sender common wiring from the engine block to the DGC-2020 and/or the engine ECU.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| OIL SNDR FAIL P | <p>Oil Pressure Sender Fail (Pre-Alarm)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |



| Event String                 | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
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|                              | <p><i>Cause:</i> Oil Pressure Sender Fail status is true and the Oil Pressure Sender Fail alarm configuration is set for Pre-Alarm.</p> <p><i>Corrective Action:</i> Check the sender, the sender wiring, and the sender common wiring from the engine block to the DGC-2020 and/or the engine ECU.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| OVERCRANK A                  | <p>Overcrank (Alarm)</p> <p><i>Cause:</i> The engine exceeded the Cycle Crank Time or Number of Crank Cycles threshold and did not start.</p> <p><i>Corrective Action:</i> Verify that the engine is receiving fuel and the starter is rotating the engine adequately for engine cranking. Verify that the battery voltage is sufficient to provide engine cranking. Check the cabling from the battery to the starter for loose, dirty, or corroded connections. Troubleshoot and correct any issues that could prevent the engine from starting.</p>                                                                                                                                                                                                     |
| OVERSPD TEST ON <i>mtu</i> P | <p>Overspeed Test On (Pre-Alarm)</p> <p><i>Cause:</i> This pre-alarm is sent to the DGC-2020 over CAN Bus when an <i>mtu</i> ECU is performing an overspeed test.</p> <p><i>Corrective Action:</i> Correct operation. No corrective action necessary.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| OVERSPEED <i>mtu</i> A       | <p>Overspeed (Alarm)</p> <p><i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that an overspeed condition has occurred. This is a warning and the DGC-2020 will not cause a machine shutdown, however the ECU may shut down the engine.</p> <p><i>Corrective Action:</i> Check the speed sensor and wiring. Ensure that electrical noise is not coupling into speed sender wiring. Check the engine governor and settings. Consult <i>mtu</i> documentation for additional procedures to diagnose the causes of engine and speed related issues.</p>                                                                                                                                                       |
| PRIMING FAULT <i>mtu</i> P   | <p>Priming Fault (Pre-Alarm)</p> <p><i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that a priming fault condition has occurred. This is a warning and the DGC-2020 will not cause a machine shutdown, however the ECU may shut down the engine.</p> <p><i>Corrective Action:</i> Check the priming fluid level and priming pump. Check the priming passages for restrictions or leaks. Check for ECU related pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.</p>                                                                                                                                                                                          |
| PROT SHUTDOWN                | <p>Protective Shutdown (Status)</p> <p><i>Cause:</i> This status indicates that the DGC-2020 has undergone a protective shutdown.</p> <p><i>Corrective Action:</i> Determine the associated alarm that caused the protective shutdown and perform the corrective actions for that alarm.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| REMOTE START                 | <p>Remote Start was requested via BESTCOMSP<sup>Plus</sup> or Modbus (Status)</p> <p><i>Cause:</i> This status indicates that a remote start request was received.</p> <p><i>Corrective Action:</i> Correct operation. No corrective action necessary.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| RESET                        | <p>DGC-2020 has been reset (Status)</p> <p><i>Cause:</i> This status indicates that the DGC-2020 transitioned out of reset. This occurs if the power is cycled to the DGC-2020 or a firmware upgrade was performed. It also occurs after any watchdog resets.</p> <p><i>Corrective Action:</i> If unexpected reset occurrences are logged, look for reasons that power may have been unexpectedly cycled to the DGC-2020. For example, a low battery or failed battery charger.</p>                                                                                                                                                                                                                                                                        |
| RTD IN X O1 (X = 1 to 8)     | <p>User Configurable Analog Input X Over 1 (X = 1 to 8) (Status)</p> <p><i>Cause:</i> This status indicates that the programmable RTD input is receiving a resistance value indicating a temperature above Over Threshold 1. The event string text is user programmable. Status is available to logic and will appear in the event log, but will not be annunciated.</p> <p><i>Corrective Action:</i> Verify that the resistance value that the transducer is measuring is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Allow the device to cool if appropriate or perform corrective action to lower the temperature of the device.</p> |
| RTD IN X O1 A (X = 1 to 8)   | <p>User Configurable Analog Input X Over 1 (X = 1 to 8) (Alarm)</p> <p><i>Cause:</i> This indicates that the programmable RTD input is receiving a resistance value indicating a temperature above Over Threshold 1. The alarm configuration is set for Alarm.</p> <p><i>Corrective Action:</i> Verify that the resistance value that the transducer is measuring is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Allow the device to cool if appropriate or perform corrective action to lower the temperature of the device.</p>                                                                                                       |

| Event String                | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                     |
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| RTD IN X O1 P (X = 1 to 8)  | User Configurable Analog Input X Over 1 (X = 1 to 8) (Pre-Alarm)                                                                                                                                                                                                                                                                                                              |
|                             | <i>Cause:</i> This indicates that the programmable RTD input is receiving a resistance value indicating a temperature above Over Threshold 1. The alarm configuration is set for Pre-Alarm.                                                                                                                                                                                   |
|                             | <i>Corrective Action:</i> Verify that the resistance value that the transducer is measuring is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Allow the device to cool if appropriate or perform corrective action to lower the temperature of the device.    |
| RTD IN X O2 (X = 1 to 8)    | User Configurable Analog Input X Over 2 (X = 1 to 8) (Status)                                                                                                                                                                                                                                                                                                                 |
|                             | <i>Cause:</i> This status indicates that the programmable RTD input is receiving a resistance value indicating a temperature above Over Threshold 2. The event string text is user programmable. Status is available to logic and will appear in the event log, but will not be annunciated.                                                                                  |
|                             | <i>Corrective Action:</i> Verify that the resistance value that the transducer is measuring is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Allow the device to cool if appropriate or perform corrective action to lower the temperature of the device.    |
| RTD IN X O2 A (X = 1 to 8)  | User Configurable Analog Input X Over 2 (X = 1 to 8) (Alarm)                                                                                                                                                                                                                                                                                                                  |
|                             | <i>Cause:</i> This indicates that the programmable RTD input is receiving a resistance value indicating a temperature above Over Threshold 2. The alarm configuration is set for Alarm.                                                                                                                                                                                       |
|                             | <i>Corrective Action:</i> Verify that the resistance value that the transducer is measuring is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Allow the device to cool if appropriate or perform corrective action to lower the temperature of the device.    |
| RTD IN X O2 P (X = 1 to 8)  | User Configurable Analog Input X Over 2 (X = 1 to 8) (Pre-Alarm)                                                                                                                                                                                                                                                                                                              |
|                             | <i>Cause:</i> This indicates that the programmable RTD input is receiving a resistance value indicating a temperature above Over Threshold 2. The alarm configuration is set for Pre-Alarm.                                                                                                                                                                                   |
|                             | <i>Corrective Action:</i> Verify that the resistance value that the transducer is measuring is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Allow the device to cool if appropriate or perform corrective action to lower the temperature of the device.    |
| RTD IN X OOR (X = 1 to 8)   | User Configurable RTD Input X Out of Range (X = 1 to 8) (Status)                                                                                                                                                                                                                                                                                                              |
|                             | <i>Cause:</i> This indicates that the programmable RTD input is receiving a resistance value beyond the configured range. The event string text is user programmable. Status is available to logic and will appear in the event log, but will not be annunciated. The status may be true if the Out of Range Alarm configuration is set for Status Only, Alarm, or Pre-Alarm. |
|                             | <i>Corrective Action:</i> Verify that the resistance value that the transducer is measuring is within normal operating limits. If this appears correct, check the integrity of the wiring between the RTD and the AEM-2020. Verify that there are no open or shorted wires. Replace the RTD if necessary.                                                                     |
| RTD IN X OOR A (X = 1 to 8) | User Configurable Analog Input X Out of Range (X = 1 to 8) (Alarm)                                                                                                                                                                                                                                                                                                            |
|                             | <i>Cause:</i> This indicates that the programmable RTD input is receiving a resistance value beyond the configured range. The alarm configuration is set for Alarm.                                                                                                                                                                                                           |
|                             | <i>Corrective Action:</i> Verify that the resistance value that the transducer is measuring is within normal operating limits. If this appears correct, check the integrity of the wiring between the RTD and the AEM-2020. Verify that there are no open or shorted wires. Replace the RTD if necessary.                                                                     |
| RTD IN X OOR P (X = 1 to 8) | User Configurable Analog Input X Out of Range (X = 1 to 8) (Pre-Alarm)                                                                                                                                                                                                                                                                                                        |
|                             | <i>Cause:</i> This indicates that the programmable RTD input is receiving a resistance value beyond the configured range. The alarm configuration is set for Pre-Alarm.                                                                                                                                                                                                       |
|                             | <i>Corrective Action:</i> Verify that the resistance value that the transducer is measuring is within normal operating limits. If this appears correct, check the integrity of the wiring between the RTD and the AEM-2020. Verify that there are no open or shorted wires. Replace the RTD if necessary.                                                                     |
| RTD IN X U1 (X = 1 to 8)    | User Configurable Analog Input X Under 1 (X = 1 to 8) (Status)                                                                                                                                                                                                                                                                                                                |
|                             | <i>Cause:</i> This status indicates that the programmable RTD input is receiving a resistance value indicating a temperature below Under Threshold 1. The event string text is user programmable. Status is available to logic and appears in the event log, but is not annunciated.                                                                                          |

| Event String               | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
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|                            | <p><b>Corrective Action:</b> Verify that the resistance value that the transducer is measuring is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Perform corrective action to raise the temperature of the device.</p>                                                                                                                                                                                                                                                                                                                                                                   |
| RTD IN X U1 A (X = 1 to 8) | <p>User Configurable Analog Input X Under 1 (X = 1 to 8) (Alarm)</p> <p><b>Cause:</b> This indicates that the programmable RTD input is receiving a resistance value indicating a temperature below Under Threshold 1. The alarm configuration is set for Alarm.</p> <p><b>Corrective Action:</b> Verify that the resistance value that the transducer is measuring is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Perform corrective action to raise the temperature of the device.</p>                                                                                              |
| RTD IN X U1 P (X = 1 to 8) | <p>User Configurable Analog Input X Under 1 (X = 1 to 8) (Pre-Alarm)</p> <p><b>Cause:</b> This indicates that the programmable RTD input is receiving a resistance value indicating a temperature below Under Threshold 1. The alarm configuration is set for Pre-Alarm.</p> <p><b>Corrective Action:</b> Verify that the resistance value that the transducer is measuring is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Perform corrective action to raise the temperature of the device.</p>                                                                                      |
| RTD IN X U2 (X = 1 to 8)   | <p>User Configurable Analog Input X Under 2 (X = 1 to 8) (Status)</p> <p><b>Cause:</b> This status indicates that the programmable RTD input is receiving a resistance value indicating a temperature below Under Threshold 2. The event string text is user programmable. Status is available to logic and appears in the event log, but is not annunciated.</p> <p><b>Corrective Action:</b> Verify that the resistance value that the transducer is measuring is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Perform corrective action to raise the temperature of the device.</p> |
| RTD IN X U2 A (X = 1 to 8) | <p>User Configurable Analog Input X Under 2 (X = 1 to 8) (Alarm)</p> <p><b>Cause:</b> This indicates that the programmable RTD input is receiving a resistance value indicating a temperature below Under Threshold 2. The alarm configuration is set for Alarm.</p> <p><b>Corrective Action:</b> Verify that the resistance value that the transducer is measuring is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Perform corrective action to raise the temperature of the device.</p>                                                                                              |
| RTD IN X U2 P (X = 1 to 8) | <p>User Configurable Analog Input X Under 2 (X = 1 to 8) (Pre-Alarm)</p> <p><b>Cause:</b> This indicates that the programmable RTD input is receiving a resistance value indicating a temperature below Under Threshold 2. The alarm configuration is set for Pre-Alarm.</p> <p><b>Corrective Action:</b> Verify that the resistance value that the transducer is measuring is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Perform corrective action to raise the temperature of the device.</p>                                                                                      |
| RUN MODE                   | <p>DGC-2020 has entered Run mode (Status)</p> <p><b>Cause:</b> This status indicates that the DGC-2020 has entered Run mode.</p> <p><b>Corrective Action:</b> Correct operation. No corrective action necessary.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| RUNUP SPD LO <i>mtu</i> P  | <p>Run Up Speed Low (Pre-Alarm)</p> <p><b>Cause:</b> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the runup speed is low.</p> <p><b>Corrective Action:</b> Check the startup speed. Check the runup speed and the governor. Check for ECU related Diagnostic Trouble Codes, pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.</p>                                                                                                                                                                                                                                                                                |
| RUN WITH LOAD START        | <p>Run with Load logic element received a start request (Status)</p> <p><b>Cause:</b> This status indicates that the RUNWLOAD logic element has initiated a Run with Load Start request.</p> <p><b>Corrective Action:</b> Correct operation. No corrective action necessary.</p>                                                                                                                                                                                                                                                                                                                                                                                                                         |
| RUN WITH LOAD STOP         | <p>Run with Load logic element received a stop request (Status)</p> <p><b>Cause:</b> This status indicates that the RUNWLOAD logic element has initiated a Run with Load Stop request.</p> <p><b>Corrective Action:</b> Correct operation. No corrective action necessary.</p>                                                                                                                                                                                                                                                                                                                                                                                                                           |
| SCREEN ERROR               | <p>Screen Error (Status)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |



| Event String               | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
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|                            | <p><i>Cause:</i> This status indicates that the processor attempted to display something on the front-panel LCD, but failed due to missing or corrupt data.</p> <p><i>Corrective Action:</i> Cycle power to the DGC-2020. If the error still occurs, reload the DGC-2020 firmware. If the problem persists, the DGC-2020 may need replaced.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| SERFLASH RD FAIL           | <p>Serial Flash Read Fail (Pre-Alarm)</p> <p><i>Cause:</i> A serial flash read failure has occurred.</p> <p><i>Corrective Action:</i> This failure is not expected during normal operation. If occurrences are logged, reload the DGC-2020 firmware and settings. If the problem persists, the DGC-2020 may need replaced.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| SETTINGS CHANGED           | <p>A setting was changed via BESTCOMSPi.us, Modbus, or front-panel interface (Status)</p> <p><i>Cause:</i> This status indicates that DGC-2020 settings were changed.</p> <p><i>Corrective Action:</i> Correct operation. No corrective action necessary.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| SPD SNDR FAIL              | <p>Speed Sender Fail (Status)</p> <p><i>Cause:</i> The DGC-2020 is not receiving rpm data from any speed source. Since there is no valid rpm measurement, the speed sender fail alarm will shut down the unit.</p> <p><i>Corrective Action:</i> If the speed source is a magnetic pickup, refer to MPU Fail Pre-Alarm for corrective actions. If the speed source is generator frequency, verify that valid ac voltage and frequency are received on generator phase AB of the DGC-2020. Verify that the DGC-2020 is measuring generator frequency. If it is not, check the wiring, PT configuration, and generator output to determine why the DGC-2020 is not metering generator frequency. If the engine is ECU controlled, the speed source is the ECU unless the Generator Speed Source is set for GEN-FREQ, in which case only generator frequency is used as the speed source. If the ECU is the speed source, view the generator rpm metering and verify that the value is valid. If it shows NS, the ECU is not sending engine rpm to the DGC-2020. Consult the engine manufacturer for corrective actions when the ECU is not sending rpm data to the DGC-2020.</p>                                                                                                                                                                                                                                                                                                                                                                                    |
| SPD SNDR FAIL A            | <p>Speed Sender Fail (Alarm)</p> <p><i>Cause:</i> The DGC-2020 is not receiving rpm data from any speed source. Since there is no valid rpm measurement, the speed sender fail alarm will shut down the unit.</p> <p><i>Corrective Action:</i> If the speed source is a magnetic pickup, refer to MPU Fail Pre-Alarm for corrective actions. If the speed source is generator frequency, verify that valid ac voltage and frequency are received on generator phase AB of the DGC-2020. Verify that the DGC-2020 is measuring generator frequency. If it is not, check the wiring, PT configuration, and generator output to determine why the DGC-2020 is not metering generator frequency. If the engine is ECU controlled, the speed source is the ECU unless the Generator Speed Source is set for GEN-FREQ, in which case only generator frequency is used as the speed source. If the ECU is the speed source, view the generator rpm metering and verify that the value is valid. If the value is valid, everything should be okay. If it shows NS, the ECU is not sending engine rpm to the DGC-2020. Consult the engine manufacturer for corrective actions when the ECU is not sending rpm data to the DGC-2020.</p>                                                                                                                                                                                                                                                                                                                                   |
| SPEED DMD FL P             | <p>Speed Demand Fail (Pre-Alarm)</p> <p><i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the speed demand source or rpm data is invalid.</p> <p><i>Corrective Action:</i> Remove the magnetic pickup sensor and wipe off any dirt or metal filings. Verify that the MPU sensor is positioned to maintain the correct distance between the sensor and the flywheel teeth. Check the voltage level of the MPU output and verify that it is within the range specified for the DGC-2020 MPU input. Check the wiring from the MPU sensor to the DGC-2020 and correct any issues. If the speed source is a magnetic pickup, refer to MPU Fail Pre-Alarm for corrective actions. If the speed source is generator frequency, verify that valid ac voltage and frequency are received on generator phase AB of the DGC-2020. Verify that the DGC-2020 is measuring generator frequency. If it is not, check the wiring, PT configuration, and generator output to determine why the DGC-2020 is not metering generator frequency. If the engine is ECU controlled, the speed source is the ECU unless the Generator Speed Source is set for GEN-FREQ, in which case only generator frequency is used as the speed source. If the ECU is the speed source, view the generator rpm metering and verify that the value is valid. If it shows NS, the ECU is not sending engine rpm to the DGC-2020. Consult the engine manufacturer for corrective actions when the ECU is not sending rpm data to the DGC-2020.</p> |
| SPEED TOO LOW <i>mtu</i> P | <p>Engine Speed Too Low (Pre-Alarm)</p> <p><i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the engine running speed is low.</p> <p><i>Corrective Action:</i> Check the running speed and the governor. Check the ECU and verify that it is configured so that normal running speed does not trigger this pre-alarm. Check for ECU related Diagnostic Trouble Codes, pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

| Event String                 | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
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| SS OVERRIDE ON <i>mtu</i> P  | Shutdown Override (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|                              | <i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that a Safety System Shutdown Override is in effect.                                                                                                                                                                                                                                                                                                                                                            |
|                              | <i>Corrective Action:</i> Remove the Safety System Shutdown Override to clear the pre-alarm. Typically, the Safety System Shutdown Override is sent from the ECU to the DGC-2020 when the DGC-2020 Battle Override is in effect. Removing Battle Override in the DGC-2020 will most likely remove the Safety System Shutdown Override as well. If not, the Safety System Shutdown Override is being set in the ECU by some other means (for example, a contact input) and must be removed to clear the pre-alarm. |
| START SPEED LOW <i>mtu</i> P | Start Speed Low (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                              | <i>Cause:</i> This pre-alarm was sent to the DGC-2020 because an <i>mtu</i> engine ECU determined that the Start Speed is low.                                                                                                                                                                                                                                                                                                                                                                                    |
|                              | <i>Corrective Action:</i> Check the startup speed and the governor. Check for ECU related Diagnostic Trouble Codes, pre-alarms, status, and <i>mtu</i> fault codes. Contact the engine manufacturer if necessary.                                                                                                                                                                                                                                                                                                 |
| THRM CPL X O1 (X = 1 to 2)   | User Configurable Thermocouple Input X Over 1 (X = 1 to 2) (Status)                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                              | <i>Cause:</i> This status indicates that the programmable Thermocouple input is measuring a temperature above Over Threshold 1. The event string text is user programmable. Status is available to logic and appears in the event log, but is not annunciated.                                                                                                                                                                                                                                                    |
|                              | <i>Corrective Action:</i> Verify that the temperature value that the thermocouple is measuring is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Allow the device to cool if appropriate or perform corrective action to lower the temperature of the device.                                                                                                                                     |
| THRM CPL X O1 A (X = 1 to 2) | User Configurable Thermocouple Input X Over 1 (X = 1 to 2) (Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                              | <i>Cause:</i> This indicates that the programmable Thermocouple input is measuring a temperature above Over Threshold 1. The alarm configuration is set for Alarm.                                                                                                                                                                                                                                                                                                                                                |
|                              | <i>Corrective Action:</i> Verify that the temperature value that the thermocouple is measuring is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Allow the device to cool, if appropriate, or perform corrective action to lower the temperature of the device.                                                                                                                                   |
| THRM CPL X O1 P (X = 1 to 2) | User Configurable Thermocouple Input X Over 1 (X = 1 to 2) (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                              | <i>Cause:</i> This indicates that the programmable Thermocouple input is measuring a temperature above Over Threshold 1. The alarm configuration is set for Pre-Alarm.                                                                                                                                                                                                                                                                                                                                            |
|                              | <i>Corrective Action:</i> Verify that the temperature value measured by the thermocouple is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Allow the device to cool, if appropriate, or perform corrective action to lower the temperature of the device.                                                                                                                                         |
| THRM CPL X O2 (X = 1 to 2)   | User Configurable Thermocouple Input X Over 2 (X = 1 to 2) (Status)                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                              | <i>Cause:</i> This status indicates that the programmable Thermocouple input is measuring a temperature above Over Threshold 2. The event string text is user programmable. Status is available to logic and appears in the event log, but is not annunciated.                                                                                                                                                                                                                                                    |
|                              | <i>Corrective Action:</i> Verify that the temperature value measured by the thermocouple is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Allow the device to cool, if appropriate, or perform corrective action to lower the temperature of the device.                                                                                                                                         |
| THRM CPL X O2 A (X = 1 to 2) | User Configurable Thermocouple Input X Over 2 (X = 1 to 2) (Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                              | <i>Cause:</i> This indicates that the programmable Thermocouple input is measuring a temperature above Over Threshold 2. The alarm configuration is set for Alarm.                                                                                                                                                                                                                                                                                                                                                |
|                              | <i>Corrective Action:</i> Verify that the temperature value measured by the thermocouple is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Allow the device to cool if appropriate or perform corrective action to lower the temperature of the device.                                                                                                                                           |
| THRM CPL X O2 P (X = 1 to 2) | User Configurable Thermocouple Input X Over 2 (X = 1 to 2) (Pre-Alarm)                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                              | <i>Cause:</i> This indicates that the programmable Thermocouple input is measuring a temperature above Over Threshold 2. The alarm configuration is set for Pre-Alarm.                                                                                                                                                                                                                                                                                                                                            |
|                              | <i>Corrective Action:</i> Verify that the temperature value measured by the thermocouple is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Allow the device to cool if appropriate or perform corrective action to lower the temperature of the device.                                                                                                                                           |

| Event String                  | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| THRM CPL X OOR (X = 1 to 2)   | <p>User Configurable Thermocouple Input X Out of Range (X = 1 to 2) (Status)</p> <p><i>Cause:</i> This indicates that the programmable Thermocouple input is measuring a temperature value beyond the thermocouple input operating range. The event string text is user programmable. Status is available to logic and appears in the event log, but is not annunciated. The status may be true if the Out of Range Alarm configuration is set for Status Only, Alarm, or Pre-Alarm.</p> <p><i>Corrective Action:</i> Verify that the temperature value measured by the input is within normal operating limits. If this appears correct, check the integrity of the wiring between the thermocouple and the AEM-2020. Verify that there are no open or shorted wires. Replace the thermocouple if necessary.</p> |
| THRM CPL X OOR A (X = 1 to 2) | <p>User Configurable Thermocouple Input X Out of Range (X = 1 to 2) (Alarm)</p> <p><i>Cause:</i> This indicates that the programmable Thermocouple input is measuring a temperature value beyond the configured range. The alarm configuration is set for Alarm.</p> <p><i>Corrective Action:</i> Verify that the temperature value measured by the transducer is within normal operating limits. If this appears correct, check the integrity of the wiring between the thermocouple and the AEM-2020. Verify that there are no open or shorted wires. Replace the thermocouple if necessary.</p>                                                                                                                                                                                                                |
| THRM CPL X OOR P (X = 1 to 2) | <p>User Configurable Thermocouple Input X Out of Range (X = 1 to 2) (Pre-Alarm)</p> <p><i>Cause:</i> This indicates that the programmable Thermocouple input is measuring a temperature value beyond the configured range. The alarm configuration is set for Pre-Alarm.</p> <p><i>Corrective Action:</i> Verify that the temperature value measured by the transducer is within normal operating limits. If this appears correct, check the integrity of the wiring between the thermocouple and the AEM-2020. Verify that there are no open or shorted wires. Replace the thermocouple if necessary.</p>                                                                                                                                                                                                        |
| THRM CPL X U1 (X = 1 to 2)    | <p>User Configurable Thermocouple Input X Under 1 (X = 1 to 2) (Status)</p> <p><i>Cause:</i> This status indicates that the programmable Thermocouple input is measuring a temperature below Under Threshold 1. The event string text is user programmable. Status is available to logic and appears in the event log, but is not annunciated.</p> <p><i>Corrective Action:</i> Verify that the temperature value measured by the thermocouple is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Perform corrective action to raise the temperature of the device.</p>                                                                                                                            |
| THRM CPL X U1 A (X = 1 to 2)  | <p>User Configurable Thermocouple Input X Under 1 (X = 1 to 2) (Alarm)</p> <p><i>Cause:</i> This indicates that the programmable Thermocouple input is measuring a temperature below Under Threshold 1. The alarm configuration is set for Alarm.</p> <p><i>Corrective Action:</i> Verify that the temperature value measured by the thermocouple is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Perform corrective action to raise the temperature of the device.</p>                                                                                                                                                                                                                         |
| THRM CPL X U1 P (X = 1 to 2)  | <p>User Configurable Thermocouple Input X Under 1 (X = 1 to 2) (Pre-Alarm)</p> <p><i>Cause:</i> This indicates that the programmable Thermocouple input is measuring a temperature below Under Threshold 1. The alarm configuration is set for Pre-Alarm.</p> <p><i>Corrective Action:</i> Verify that the temperature value measured by the thermocouple is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Perform corrective action to raise the temperature of the device.</p>                                                                                                                                                                                                                 |
| THRM CPL X U2 (X = 1 to 2)    | <p>User Configurable Thermocouple Input X Under 2 (X = 1 to 2) (Status)</p> <p><i>Cause:</i> This status indicates that the programmable Thermocouple input is measuring a temperature below Under Threshold 2. The event string text is user programmable. Status is available to logic and appears in the event log, but is not annunciated.</p> <p><i>Corrective Action:</i> Verify that the temperature value measured by the thermocouple is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Perform corrective action to raise the temperature of the device.</p>                                                                                                                            |
| THRM CPL X U2 A (X = 1 to 2)  | <p>User Configurable Thermocouple Input X Under 2 (X = 1 to 2) (Alarm)</p> <p><i>Cause:</i> This indicates that the programmable Thermocouple input is measuring a temperature below Under Threshold 2. The alarm configuration is set for Alarm.</p> <p><i>Corrective Action:</i> Verify that the temperature value measured by the thermocouple is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Perform corrective action to raise the temperature of the device.</p>                                                                                                                                                                                                                         |
| THRM CPL X U2 P (X = 1 to 2)  | <p>User Configurable Thermocouple Input X Under 2 (X = 1 to 2) (Pre-Alarm)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

| Event String       | Event Description/Cause/Corrective Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                    | <p><i>Cause:</i> This indicates that the programmable Thermocouple input is measuring a temperature below Under Threshold 2. The alarm configuration is set for Pre-Alarm.</p> <p><i>Corrective Action:</i> Verify that the temperature value measured by the thermocouple is within normal operating limits. If this appears correct, check the device for which temperature is being measured to determine why the threshold was exceeded. Perform corrective action to raise the temperature of the device.</p>              |
| UNKNOWN SHUTDOWN A | <p>Unknown Shutdown (Alarm)</p> <p><i>Cause:</i> The DGC-2020 detects that the engine has shut down because the rpm dropped to zero, but the DGC-2020 did not initiate a shutdown.</p> <p><i>Corrective Action:</i> Check Diagnostic Trouble Codes and/or connect Service Tool if the engine is an ECU equipped engine. Consult engine manufacturer for further information.</p>                                                                                                                                                |
| WEAK BATTERY P     | <p>Weak Battery (Pre-Alarm)</p> <p><i>Cause:</i> The battery voltage measured while the engine is cranking is below the Weak Battery Voltage Pre-Alarm threshold.</p> <p><i>Corrective Action:</i> Check the battery voltage level, the battery charging circuits, and connections from the battery to the engine. Charge the battery if necessary. The pre-alarm will not clear until a crank cycle occurs where battery voltage is above the Weak Battery Voltage Pre-Alarm threshold or power is cycled to the DGC-2020.</p> |

## 4 • BESTCOMSP<sup>Plus</sup>® Software

BESTCOMSP<sup>Plus</sup>® is a Windows®-based, PC application that provides a user-friendly, graphical user interface (GUI) for use with Basler Electric communicating products. The name BESTCOMSP<sup>Plus</sup> is an acronym that stands for Basler Electric Software Tool for Communications, Operations, Maintenance, and Settings.

BESTCOMSP<sup>Plus</sup> provides the user with a point-and-click means to set and monitor the DGC-2020. The capabilities of BESTCOMSP<sup>Plus</sup> make the configuration of one or several DGC-2020 controllers fast and efficient. A primary advantage of BESTCOMSP<sup>Plus</sup> is that a settings scheme can be created, saved as a file, and then uploaded to the DGC-2020 at the user's convenience.

BESTCOMSP<sup>Plus</sup> uses plugins allowing the user to manage several different Basler Electric products.

The DGC-2020 plugin opens inside the BESTCOMSP<sup>Plus</sup> main shell with the same default logic scheme that is shipped with the DGC-2020. This gives the user the option of developing a custom setting file by modifying the default logic scheme or by building a unique scheme from scratch.

BESTlogic™ <sup>Plus</sup> Programmable Logic is used to program DGC-2020 inputs and outputs, alarms, and generator protection functions. This is accomplished by the drag-and-drop method. The user can drag elements, components, inputs, and outputs onto the program grid and make connections between them to create the desired logic scheme.

Figure 4-1 illustrates the typical user interface components of the DGC-2020 plugin with BESTCOMSP<sup>Plus</sup>.

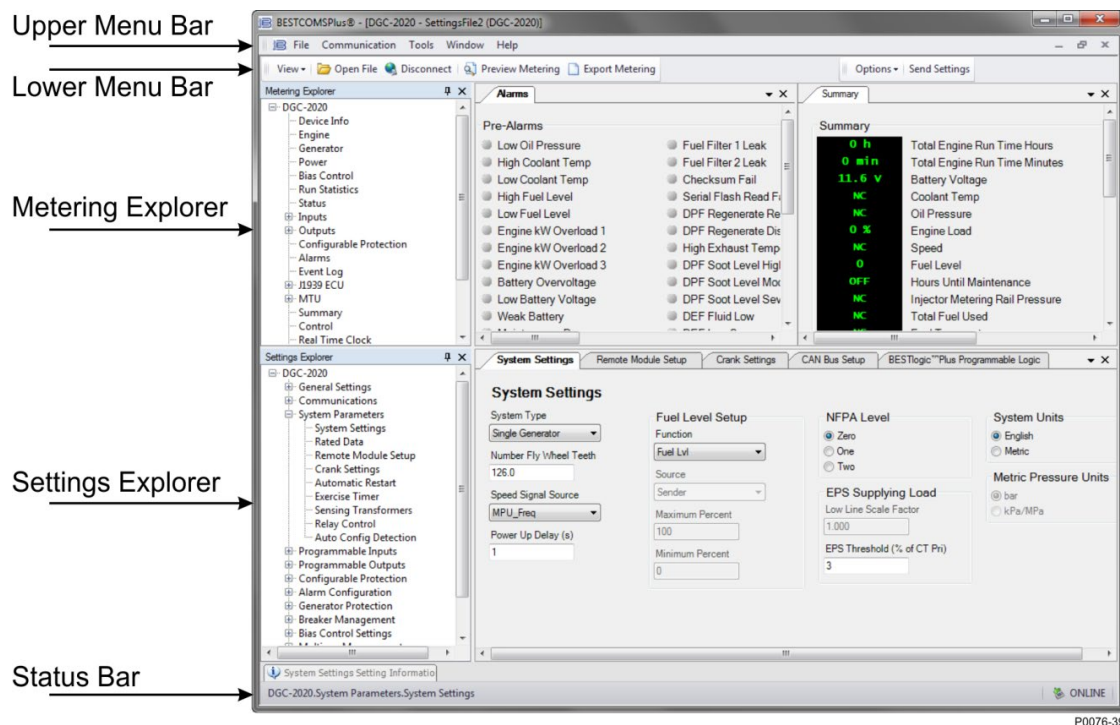


Figure 4-1. Typical User Interface Components

### Installation

BESTCOMSP<sup>Plus</sup> software is built on the Microsoft® .NET Framework. The setup utility that installs BESTCOMSP<sup>Plus</sup> on your PC also installs the DGC-2020 plugin and the required version of .NET Framework (if not already installed). BESTCOMSP<sup>Plus</sup> operates with systems using Windows® 7 SP1, Windows 8.1, Windows 10 version 1607 (Anniversary Update) or later, and Windows 11. System recommendations for the .NET Framework and BESTCOMSP<sup>Plus</sup> are listed in Table 4-1.

**Table 4-1. System Recommendations for BESTCOMSPPlus and the .NET Framework**

| System Type | Component  | Recommendation                                             |
|-------------|------------|------------------------------------------------------------|
| 32/64 bit   | Processor  | 2.0 GHz                                                    |
| 32/64 bit   | RAM        | 1 GB (minimum), 2 GB (recommended)                         |
| 32 bit      | Hard Drive | 200 MB (if .NET Framework is already installed on PC.)     |
|             |            | 4.5 GB (if .NET Framework is not already installed on PC.) |
| 64 bit      | Hard Drive | 200 MB (if .NET Framework is already installed on PC.)     |
|             |            | 4.5 GB (if .NET Framework is not already installed on PC.) |

To install and run BESTCOMSPPlus, a Windows user must have Administrator rights. A Windows user with limited rights might not be permitted to save files in certain folders.

### Installing BESTCOMSPPlus®

#### Note

Do not connect a USB cable until setup completes successfully. Connecting a USB cable before setup is complete might result in unwanted or unexpected errors.

### Download BESTCOMSPPlus

Use the following procedure to download BESTCOMSPPlus from the Basler Electric website.

1. Navigate to <https://www.basler.com/Downloads>.
2. Select DGC-2020 from the model drop down menu.
3. Under the Software heading, click the download link for BESTCOMSPPlus.
4. Sign in or create an account to continue with the download.

### Install BESTCOMSPPlus

Run the setup file for the BESTCOMSPPlus application. The setup utility installs BESTCOMSPPlus, the .NET Framework (if not already installed), the USB driver, and the DGC-2020 plugin for BESTCOMSPPlus on your PC.

When BESTCOMSPPlus installation is complete, a Basler Electric folder is added to the Windows programs menu. This folder is accessed by clicking the Windows *Start* button and then accessing the Basler Electric folder in the *Programs* menu. The Basler Electric folder contains an icon that starts BESTCOMSPPlus when clicked.

### Connect the DGC-2020 and Start BESTCOMSPPlus®

The DGC-2020 plugin is a module that runs inside the BESTCOMSPPlus shell. The DGC-2020 plugin contains specific operational and logic settings for only the DGC-2020.

#### Connect a USB Cable

The USB driver was copied to your PC during BESTCOMSPPlus installation and is installed automatically after powering the DGC-2020. USB driver installation progress is shown in the Windows taskbar area. Windows will notify you when installation is complete.

Connect a USB cable between the PC and your DGC-2020. Apply operating power to the DGC-2020. Wait until the boot sequence is complete.



## Start BESTCOMSPPlus®

To start BESTCOMSPPlus, click the Windows *Start* button, point to *Programs, Basler Electric*, and then click the *BESTCOMSPPlus* icon. During initial startup, the *BESTCOMSPPlus Select Language* screen is displayed (Figure 4-2). You can choose to have this screen displayed each time BESTCOMSPPlus is started, or you can select a preferred language and this screen will be bypassed in the future. Click *OK* to continue. This screen can be accessed later by selecting *Tools* and *Select Language* from the menu bar.

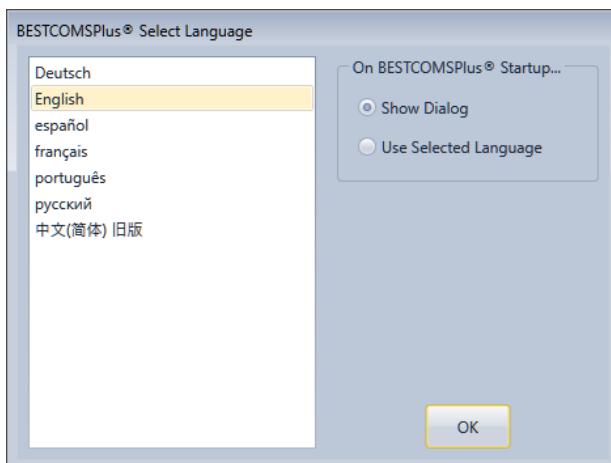


Figure 4-2. BESTCOMSPPlus Select Language

The BESTCOMSPPlus platform window opens. Select *New Connection* from the *Communication* pull-down menu and select *DGC-2020*. See Figure 4-3.

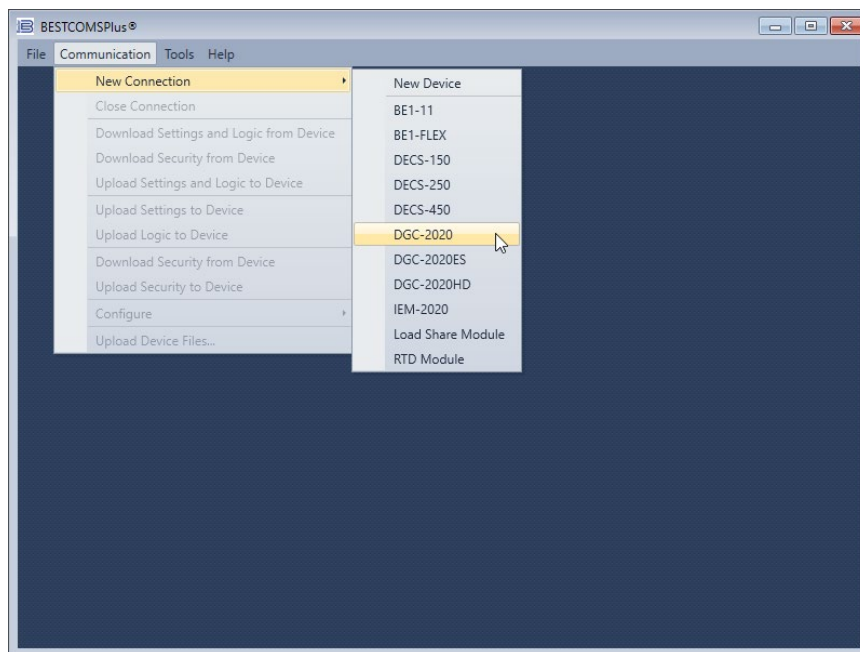


Figure 4-3. Communication Pull-Down Menu

The *DGC-2020 Connection* screen shown in Figure 4-4 will appear.

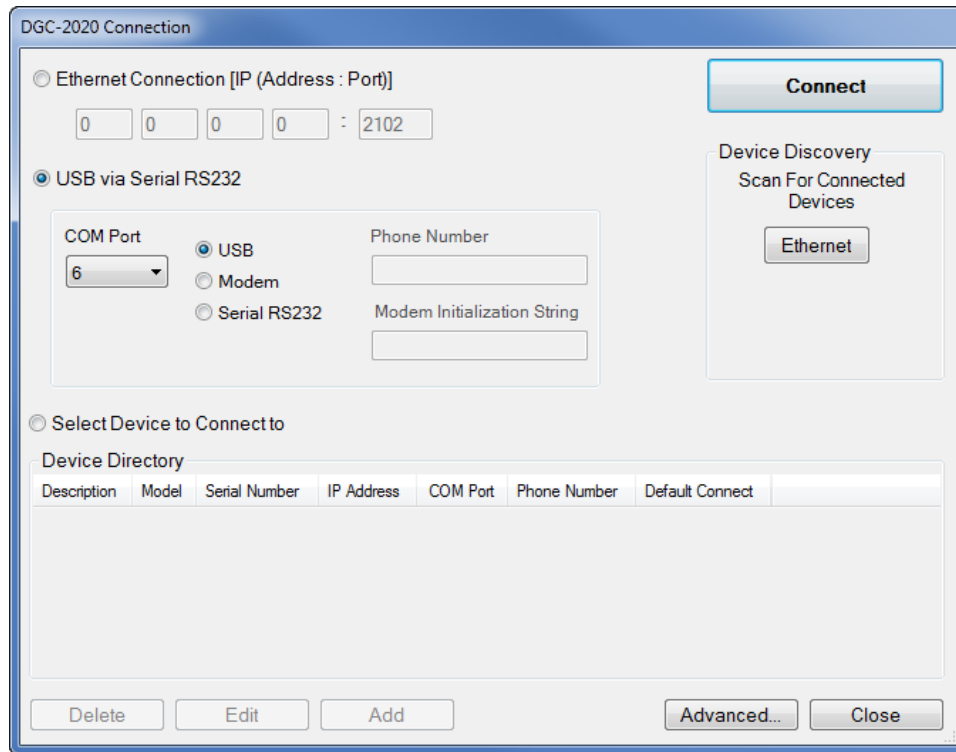


**Figure 4-4. DGC-2020 Connection**

Select *USB via Serial RS232*, *USB*, and enter *COM Port*. The USB drivers are installed automatically during the BESTCOMSPi.us installation process. To select the correct *COM Port*, open the Windows Device Manager and expand the *Ports (COM & LPT)* branch. Locate the device named *CP2101 USB to UART Bridge Controller (COMx)*. The *COM Port* number will be displayed in parenthesis (*COMx*). Be sure operating power is applied to the DGC-2020 and the USB cable is connected before opening the Device Manager. See Figure 4-5.

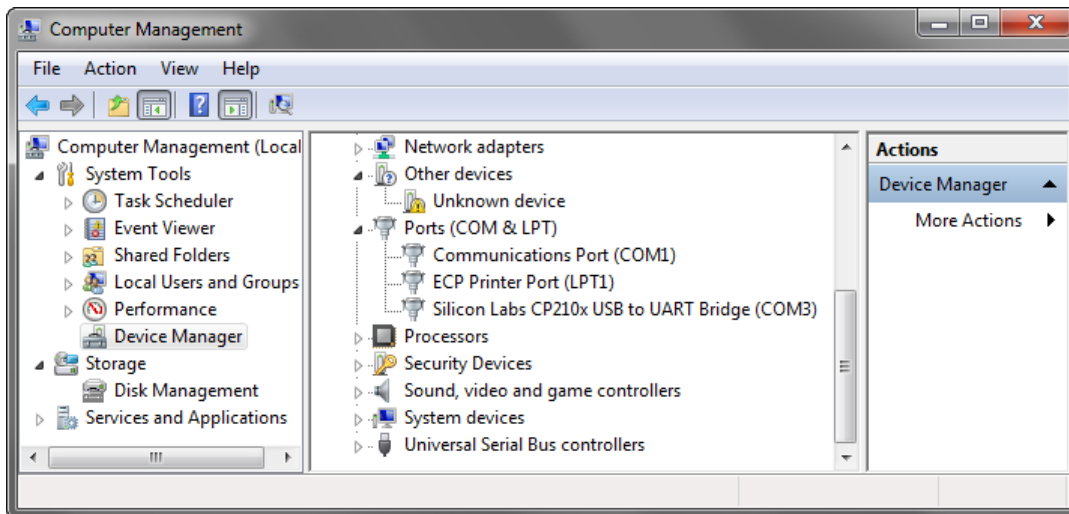


**Figure 4-5. Device Manager**

#### Installing the USB Driver if Automatic Installation Fails

To install the USB driver for the DGC-2020:

1. Apply operating power to the DGC-2020 and wait for the boot sequence to complete.
2. Connect a USB cable between the PC and DGC-2020.
3. The *Found New Hardware Wizard* dialog box appears.



4. Select **"No, not this time"** and select *Next* to continue.
5. Choose to **"Install from a list or specific location (Advanced)"** and select *Next* to continue.
6. Navigate to C:\Program Files\Basler Electric\BESTCOMSPlus\USBDeviceDrivers\ and select *Next* to continue.

When installation of the driver is complete, you might be asked to restart your computer.

---

## Communication

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### Modem (Optional)

If connecting to the DGC-2020 through a telephone line, select *USB via Serial RS232, Modem*, and enter *Phone Number*. To select the correct *COM Port*, open Windows Device Manager and expand the *Modems* branch. Right-click on the modem name and choose *Properties*. Open the *Advanced* tab to view the *COM port*. Refer to *Communications, Modem Setup*, for more information.

### Serial RS232

If connecting to the DGC-2020 through a serial port, select *USB via Serial RS232, Serial RS232*. To select the correct *COM Port*, open Windows Device Manager and expand the *Ports (COM & LPT)* branch. Select the appropriate *Communications Port* or *Serial Port*. Refer to *Communications, RS232 Setup*, for more information.

### Ethernet Communication

Communication with the DGC-2020 can be made through an optional LSM-2020 (Load Share Module). In order to use the Ethernet capabilities of the LSM-2020, the network settings in the LSM-2020 must first be configured. LSM-2020 network settings can be configured through Device Discovery in BESTCOMSPlus, through the front panel of the DGC-2020, or through the DGC-2020 and sent to the LSM-2020 over the CAN Bus interface. The following procedures can be used to configure LSM-2020 network settings and connect to the DGC-2020 through Ethernet via an LSM-2020.

#### Configure LSM-2020 Network Settings through Device Discovery in BESTCOMSPlus

1. Navigate to the *Settings, System Params, Remote Module Setup, LSM Setup* screen on the front panel HMI and verify that the LSM-2020 is enabled with the correct CAN Bus address so that the DGC-2020 and LSM-2020 are properly linked together. If a USB connection to the DGC-2020 is active, the LSM-2020 enable setting and CAN Bus address can be found by using the Settings Explorer in BESTCOMSPlus to open the *System Parameters, Remote Module Setup* tree branch. The DGC-2020 will annunciate a pre-alarm if the LSM-2020 is not connected properly when it is enabled. If the connection is valid, the network settings of the LSM-2020 can be configured through the front panel of the DGC-2020.
2. In BESTCOMSPlus, click the *Communication* drop-down menu and select *New Connection, Load Share Module*. The *Load Share Module Connection* screen appears. See Figure 4-6.

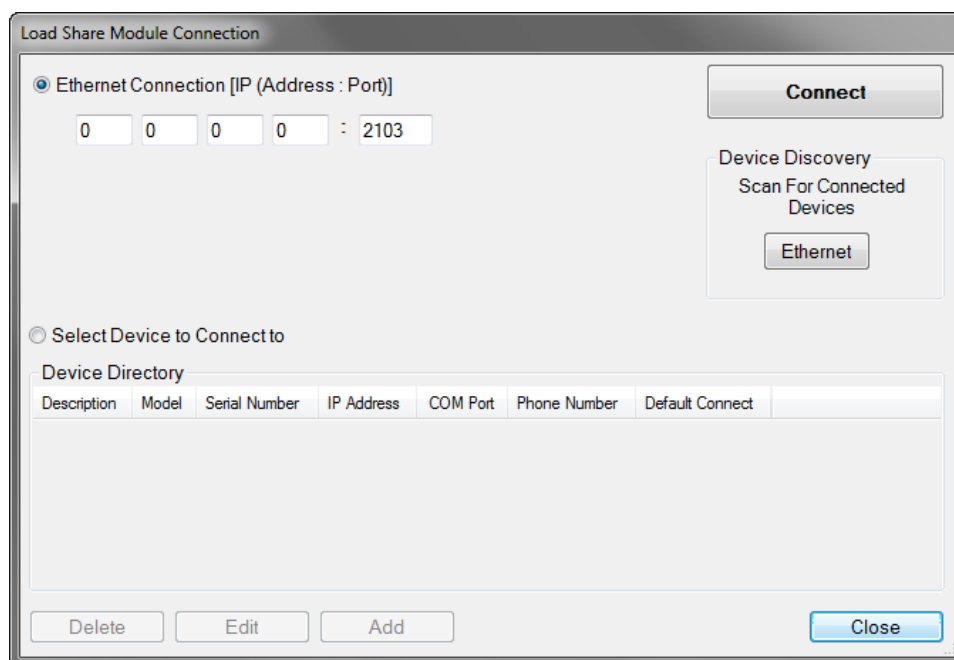


**Figure 4-6. Load Share Module Connection**

3. Click the *Ethernet* button under *Device Discovery* (*Scan For Connected Devices*).
4. After scanning for connected devices, the *Device Discovery* screen appears. See Figure 4-7.

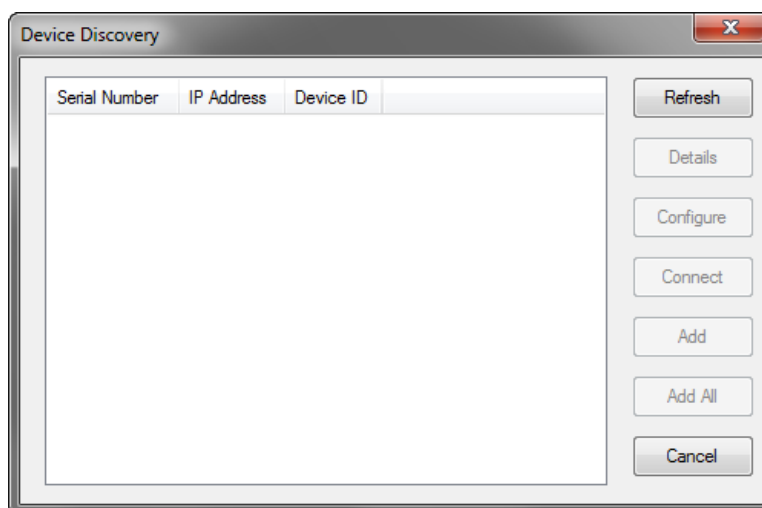


**Figure 4-7. Device Discovery**

5. Use the mouse to highlight the desired Load Share Module and click the *Configure* button.
6. The *Configure Ethernet Port* screen appears. See Figure 4-8.

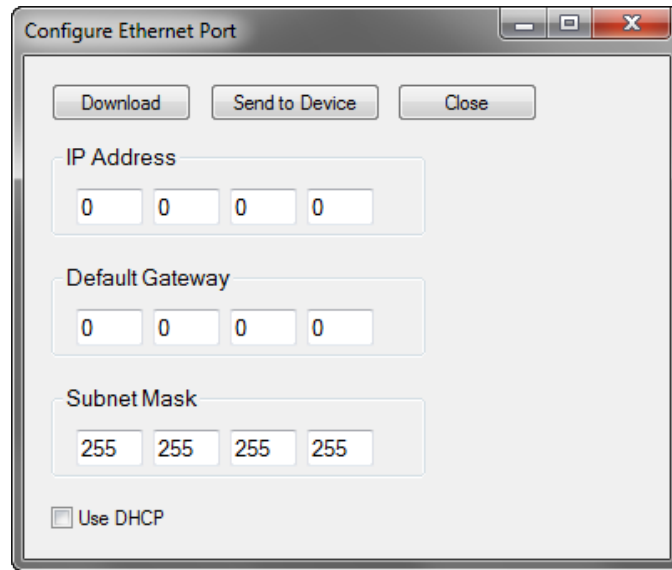


**Figure 4-8. Configure Ethernet Port**

7. Assign an IP Address, Default Gateway, and Subnet Mask to the Load Share Module by entering values in the same range as your network or PC. If DHCP will be used, check the *Use DHCP* box.
8. Click *Send to Device*. A password is required. The default password is “OEM”. The LSM-2020 will reboot and use the new settings.

*Configure LSM-2020 Network Settings through the Front Panel of the DGC-2020*

1. Navigate to the *Settings, System Params, Remote Module Setup, LSM Setup* screen on the front panel HMI and verify that the LSM-2020 is enabled with the correct CAN Bus address so that the DGC-2020 and LSM-2020 are properly linked together. If a USB connection to the DGC-2020 is active, the LSM-2020 enable setting and CAN Bus address can be found by using the Settings Explorer in BESTCOMSPlus to open the *System Parameters, Remote Module Setup* tree branch. The DGC-2020 will annunciate a pre-alarm if the LSM-2020 is not connected properly when it is enabled. If the connection is valid, the network settings of the LSM-2020 can be configured through the front panel of the DGC-2020.
2. Navigate to the *Settings, System Params, Remote Module Setup, LSM Setup, TCP/IP Settings* screen on the front panel HMI.

Configurable options include:

|                         |                                                                                                                                                                                                                          |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>IP Address:</i>      | Internet Protocol Address to be used by the LSM-2020.                                                                                                                                                                    |
| <i>Subnet Mask:</i>     | Mask used to determine the range of the current network subnet.                                                                                                                                                          |
| <i>Gateway Address:</i> | Default host to send data destined for a host not on the network subnet.                                                                                                                                                 |
| <i>Use DHCP:</i>        | Automatically configures IP Address, Default Gateway, and Subnet Mask via DHCP. This can be used only if the Ethernet network has a properly configured DHCP server running. The LSM-2020 does not act as a DHCP server. |

The values for these options should be obtained from the site administrator if the LSM-2020 is intended to share the network with other devices. If the LSM-2020 is operating on an isolated network, the IP address might be chosen from one of the following ranges as listed in IETF publication RFC 1918, *Address Allocation for Private Networks*.

10.0.0.0 - 10.255.255.255  
 172.16.0.0 - 172.31.255.255  
 192.168.0.0 - 192.168.255.255

If the LSM-2020 is operating on an isolated network, the *Subnet Mask* can be left at 0.0.0.0 and the *Default Gateway* can be chosen as any valid IP address from the same range as the LSM-2020 IP address.

3. Click the *Edit* button to change settings. After settings are configured, click the *Edit* button again to exit.
4. Use the *Left* arrow key to navigate back to the *LSM Setup* screen on the front panel HMI. After leaving the *TCP/IP Settings* screen, the LSM-2020 will reboot and use the new settings.

#### Alternate Method to Configure LSM-2020 Network Settings through the DGC-2020

1. Navigate to the *Settings, System Params, Remote Module Setup, LSM Setup* screen on the front panel HMI and verify that the LSM-2020 is enabled with the correct CAN Bus address so that the DGC-2020 and LSM-2020 are properly linked together. If a USB connection to the DGC-2020 is active, the LSM-2020 enable setting and CAN Bus address can be found by using the Settings Explorer in BESTCOMSPPlus to open the *System Parameters, Remote Module Setup* tree branch. The DGC-2020 will annunciate a pre-alarm if the LSM-2020 is not connected properly when it is enabled. If the connection is valid, the network settings of the LSM-2020 can be configured through the USB interface of the DGC-2020.
2. Connect to the DGC-2020 through the USB port as described under *USB Communication*. Select *Configure, Ethernet* from the *File* pull-down menu. If the LSM-2020 is connected properly, the *Configure Ethernet Port* screen shown in Figure 4-9 will appear.

**Figure 4-9. Configure Ethernet Port**

Configurable options include:

|                         |                                                                                                                                                                                                                          |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>IP Address:</i>      | Internet Protocol Address to be used by the LSM-2020.                                                                                                                                                                    |
| <i>Default Gateway:</i> | Default host to send data destined for a host not on the network subnet.                                                                                                                                                 |
| <i>Subnet Mask:</i>     | Mask used to determine the range of the current network subnet.                                                                                                                                                          |
| <i>Use DHCP:</i>        | Automatically configures IP Address, Default Gateway, and Subnet Mask via DHCP. This can be used only if the Ethernet network has a properly configured DHCP server running. The LSM-2020 does not act as a DHCP server. |

The values for these options should be obtained from the site administrator if the LSM-2020 is intended to share the network with other devices. If the LSM-2020 is operating on an isolated network, the IP address might be chosen from one of the following ranges as listed in IETF publication RFC 1918, *Address Allocation for Private Networks*.

10.0.0.0 - 10.255.255.255

172.16.0.0 - 172.31.255.255  
192.168.0.0 - 192.168.255.255

If the LSM-2020 is operating on an isolated network, the *Subnet Mask* can be left at 0.0.0.0 and the *Default Gateway* can be chosen as any valid IP address from the same range as the LSM-2020 IP address.

3. Click the *Send to Device* button located on the *Configure Ethernet Port* screen. A confirmation popup will be displayed notifying the user that the LSM-2020 will reboot after settings are sent. Click the *Yes* button to allow settings to be sent. After the unit has rebooted and the power-up sequence is complete, the LSM-2020 is ready to be used on a network.
4. If desired, LSM-2020 settings can be verified by selecting *Download Settings and Logic* from the *Communication* pull-down menu. Active settings will be downloaded from the LSM-2020 and DGC-2020. Verify that the downloaded settings match the previously sent settings.
5. Connection to the DGC-2020 can be made through Ethernet via an LSM-2020 with properly configured network settings. When making a new connection to the DGC-2020, the *Ethernet Connection* option shown in Figure 4-6 will allow the user to enter the IP address of the LSM-2020 with which to connect. The *Ethernet* button under *Device Discovery*, *Scan for Connected Devices*, allows automatic detection of any LSM-2020 devices connected to the local network.

### Notes

The PC running BESTCOMS*Plus* software must be configured correctly to communicate with the LSM-2020. The PC must have an IP address in the same subnet range as the LSM-2020 if the LSM-2020 is operating on a private local network. Otherwise, the PC must have a valid IP address with access to the internet and the LSM-2020 must be connected to a properly configured router. The network settings of the PC depend on the operating system installed. Refer to the operating system manual for instructions. On most Microsoft Windows based PCs, the network settings can be accessed through the *Network Connections* icon located inside the Control Panel.

Microsoft Windows 2000 and XP SP1 contain a potential bug that might prevent device discovery from functioning properly. This issue might present itself if the PC running BESTCOMS*Plus* has more than one network interface card. See Microsoft KB article 827536 for more information.

Firmware updates to the LSM-2020 are made through the Ethernet port. Firmware updates to the DGC-2020 are only available through the USB port of the DGC-2020.

## Establishing Communication

Communication between BESTCOMS*Plus* and the DGC-2020 is established by clicking on the *Connect* button on the *DGC-2020 Connection* screen (see Figure 4-4) or by clicking on the *Connect* button on the lower menu bar of the main BESTCOMS*Plus* screen (Figure 4-1). If you receive an "Unable to Connect to Device" error message, verify that communications are configured properly. If communication is established, BESTCOMS*Plus* will read all settings and logic from the DGC-2020 and load them into BESTCOMS*Plus* memory. See Figure 4-10.

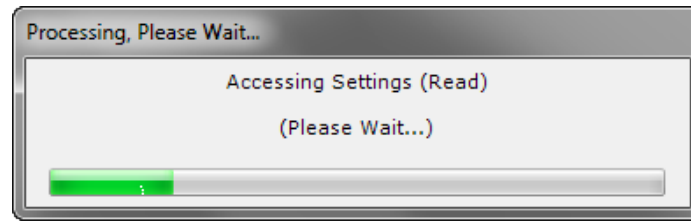


Figure 4-10. Accessing Settings, Please Wait...

## Advanced Properties

Click the *Advanced* button on the *Connection* screen to display the *Advanced Properties* dialog. Default settings are shown in Figure 4-11.

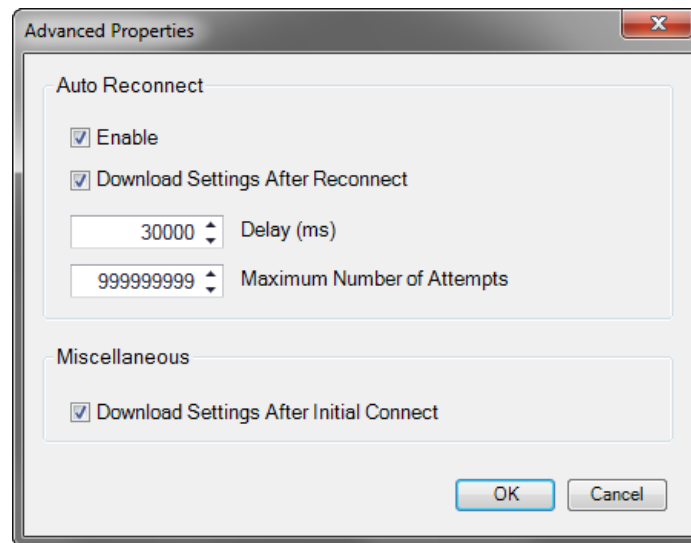


Figure 4-11. Advanced Properties

## Menu Bars

The menu bars are located near the top of the BESTCOMSP<sup>Plus</sup> screen (see Figure 4-1). The upper menu bar has five pull-down menus. With the upper menu bar, it is possible to manage settings files, configure communication settings, upload and download settings/security files, and compare settings files. The lower menu bar consists of clickable icons. The lower menu bar is used to change BESTCOMSP<sup>Plus</sup> views, open a settings file, connect/disconnect, preview metering printout, export metering, switch to live mode, and send a settings file to the DGC-2020.

### Upper Menu Bar (BESTCOMSP<sup>Plus</sup>® Shell)

Upper menu bar functions are listed and described in Table 4-2.

Table 4-2. Upper Menu Bar (BESTCOMSP<sup>Plus</sup> Shell)

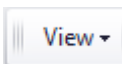
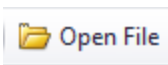
| Menu Item      | Description                              |
|----------------|------------------------------------------|
| <i>File</i>    |                                          |
| New            | Create a new settings file               |
| Open           | Open an existing settings file           |
| Close          | Close settings file                      |
| Save           | Save settings file                       |
| Save As        | Save settings file with a different name |
| Export To File | Save settings as a *.csv file            |
| Print          | Print, export, or send a settings file   |

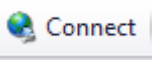
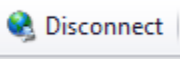
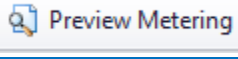
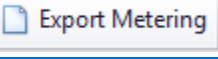
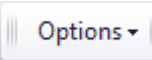
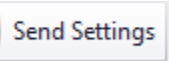
| Menu Item                                                              | Description                                                                                                           |
|------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| Properties                                                             | View properties of a settings file                                                                                    |
| History                                                                | View history of a settings file                                                                                       |
| Recent Files                                                           | Open a previously opened file                                                                                         |
| Exit                                                                   | Close BESTCOMSPlus program                                                                                            |
| <b><u>Communication</u></b>                                            |                                                                                                                       |
| New Connection                                                         | Choose new device or DGC-2020                                                                                         |
| Close Connection                                                       | Close communication between BESTCOMSPlus and DGC-2020                                                                 |
| Download Settings and Logic from Device                                | Download operational and logic settings from the device                                                               |
| Upload Settings and Logic to Device                                    | Upload operational and logic settings to the device                                                                   |
| Upload Settings to Device                                              | Upload operational settings to the device                                                                             |
| Upload Logic to Device                                                 | Upload logic settings to the device                                                                                   |
| Download Security from Device                                          | Download security settings from the device                                                                            |
| Upload Security to Device                                              | Upload security settings to the device                                                                                |
| Configure                                                              | Ethernet settings                                                                                                     |
| Upload Device Files                                                    | Upload firmware to the device                                                                                         |
| <b><u>Tools</u></b>                                                    |                                                                                                                       |
| Select Language                                                        | Select BESTCOMSPlus language                                                                                          |
| Set File Password                                                      | Password protect a settings file                                                                                      |
| Compare Settings Files                                                 | Compare two settings files                                                                                            |
| Auto Export Metering                                                   | Exports metering data on a user-defined interval                                                                      |
| Event Log - View                                                       | View the BESTCOMSPlus event log                                                                                       |
| Event Log - Verbose Logging                                            | Enable/disable verbose logging                                                                                        |
| Event Log - Verbose Communications Logging                             | Enable/disable verbose communications logging                                                                         |
| Set Default Shell                                                      | Select the default product shell view for BESTCOMSPlus. Options include Classic view, Updated view, or Combined view. |
| Generate Certificate (this function is not applicable to the DGC-2020) | Generate a certificate                                                                                                |
| Accepted Devices (this function is not applicable to the DGC-2020)     | View and delete accepted certificates                                                                                 |
| <b><u>Help</u></b>                                                     |                                                                                                                       |
| Check for Updates                                                      | Check for BESTCOMSPlus updates via the internet                                                                       |
| Check for Update Settings                                              | Enable or changed automatic checking for updates                                                                      |
| About                                                                  | View general, detailed build, and system information                                                                  |

### Lower Menu Bar (DGC-2020 Plugin)

The lower menu bar functions are listed and described in Table 4-3.

**Table 4-3. Lower Menu Bar (DGC-2020 Plugin)**

| Menu Button                                                                         | Description                                                                                                                                                                           |
|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | Show or hide the Metering Panel, Settings Panel, or Settings Info Panel.<br>Opens and saves workspaces. Customized workspaces make switching between tasks easier and more efficient. |
|  | Opens a saved settings file.                                                                                                                                                          |

| Menu Button                                                                       | Description                                                                                                                                                                      |
|-----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | Connect: Opens the <i>DGC-2020 Connection</i> screen which enables you to connect to the DGC-2020 via USB or a modem. This button only appears when a DGC-2020 is not connected. |
|  | Disconnect: Used to disconnect a connected DGC-2020. This button only appears when a DGC-2020 is connected.                                                                      |
|  | Displays the <i>Print Preview</i> screen where a preview of the Metering printout is shown. Click on the printer button to send to a printer.                                    |
|  | Enables all metering values to be exported into a *.csv file.                                                                                                                    |
|  | Displays an option entitled <i>Live Mode Settings</i> which enables <i>Live</i> mode where settings are automatically sent to the device in real time as they are changed.       |
|  | Sends settings to the DGC-2020 when BESTCOMSPlus® is not operating in Live Mode. Click this button after making a setting change to send the modified setting to the DGC-2020.   |

## Settings Explorer

The Settings Explorer is a convenient tool within BESTCOMSPlus used to navigate through the various settings screens of the DGC-2020 plugin.

Logic setup will be necessary after making certain setting changes. For more information, refer to Section 5, *BESTlogic™ Plus Programmable Logic*.

## Settings Entry

When entering settings in BESTCOMSPlus, each setting is validated against prescribed limits. Entered settings that do not conform with the prescribed limits are accepted but flagged as noncompliant. Figure 4-12 illustrates an example of flagged, noncompliant settings (locator A) and the Setting Validation window (locator B) used to diagnose faulty settings.



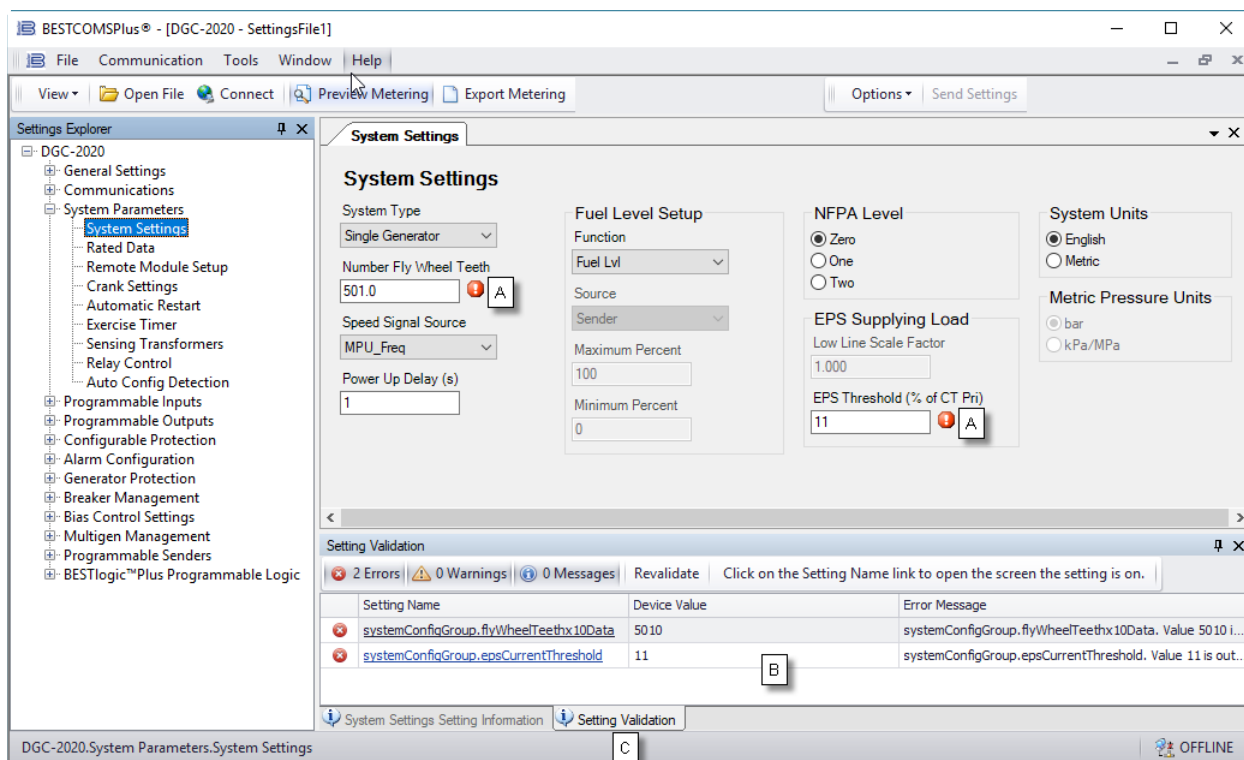


**Figure 4-12. Flagged, Noncompliant Settings and the Setting Validation Window**

The Setting Validation window, viewed by selecting the Setting Validation tab (locator C), displays three types of annunciations: errors, warnings, and messages. An error describes a problem such as a setting that is out of range. A warning describes a condition where supporting settings are invalid, causing other settings to be noncompliant with the prescribed limits. A message describes a minor setting issue that was automatically resolved by BESTCOMSPPlus. An example of a condition triggering a message is entry of a settings value with a resolution that exceeds the limit imposed by BESTCOMSPPlus. In this situation, the value is automatically rounded and a message is triggered. Each annunciation lists a hyperlinked name for the noncompliant setting and an error message describing the issue. Clicking the hyperlinked setting name takes you to the setting screen with the offending setting. Right-clicking the hyperlinked setting name will restore the setting to its default value.

### Note

It is possible to save a DGC-2020 settings file in BESTCOMSPPlus with noncompliant settings. However, it is not possible to upload noncompliant settings to the DGC-2020.

## DGC-2020 and System Parameters

Prior to use, the DGC-2020 must be configured for operation in the intended application. Descriptions of these configuration settings are organized as follows:

- General Settings
- Communications
- System Parameters
- Programmable Inputs
- Programmable Outputs
- Configurable Protection
- Alarm Configuration
- Generator Protection
- Breaker Management

- Bias Control Settings
- Multigen Management
- Programmable Senders
- BESTlogic™ *Plus* Programmable Logic

## ***General Settings***

---

General DGC-2020 settings consist of settings controlling the HMI display and indicators. Additional general settings include style number configuration, DGC-2020 identification, DGC-2020 version information, and device security setup.

### **Front Panel HMI**

The BESTCOMS*Plus* Front Panel HMI screen is illustrated in Figure 4-14 and described in the following paragraphs.

#### LCD Contrast Value

The contrast of the front panel LCD (liquid crystal display) can be adjusted to suit the viewing angle used or compensate for environmental conditions.

#### Front Panel Sleep Mode

A power saving feature, referred to as Sleep mode, will turn the front panel LCD backlight and LCD heater off when the DGC-2020 is in Off mode or Auto mode (not in Run mode) and a key is not pressed for more than 15 minutes. Normal display operation is resumed when any front panel button is pressed or the genset is started remotely via the ATS. Sleep mode is enabled and disabled in BESTCOMS*Plus*.

#### One Line Diagram

A one-line diagram of the breaker hardware configuration can be displayed on the front panel. This diagram changes in real time to reflect the current state of the configured breakers. The one-line diagram is disabled by default. See Section 2 for more information.

#### Engine Hours Display

When Engine Hours Display is enabled, engine run-time hours are displayed on the front-panel Overview screen.

#### Overview Screen Type

The Overview Screen Type can be set for Text or Symbolic. When set to Symbolic, the parameters names are displayed as symbols.

#### Exhaust Display

When Exhaust Display is set to Inverted, the LCD background, where exhaust status is displayed, is dark with light text. When set to Normal, the LCD background is light with dark text.

#### Exhaust Status Display Screen

The Exhaust Status Display Screen setting defines where DEF (Diesel Exhaust Fluid) level and exhaust status display are shown. Select Overview Screen to show the DEF level and exhaust status display on the Overview screen or select All Operating Screens to show the DEF level and exhaust status display on all screens that automatically appear during normal operation.

#### Battery Charger Display

When Battery Charger Display is enabled, battery charger output voltage and current are displayed on the front-panel Overview screen.

### Display Fuel Level Below

RPM is displayed on the front-panel Overview screen if the Fuel Level Function setting is set to disabled, or the fuel level is above the level set in the Display Fuel Level Below (%) setting.

Fuel level is displayed on the front-panel Overview screen when it drops below the level set in the Display Fuel Level Below (%) setting if the Fuel Level Function is not set to disabled.

### DEF Display Enable

This setting enables or disables the display of DEF levels on the front panel overview screen. Some engines that do not employ DEF-based exhaust treatment still broadcast a DEF level. In these cases, since the level is meaningless, the user can disable display of the DEF level on the front panel.

### Battery and RPM Display

This setting selects whether battery voltage and/or rpm is displayed on the front panel overview screen. If the Alternate option is selected, the display will alternate between battery voltage and rpm.

### Language Selection

Specific language modules can be uploaded into the DGC-2020. When the language module upload is complete, use the Language selector to select the correct language.

### Scrolling Screen

When Scrolling Screen is enabled, the front panel summary screen will scroll through the list of Scrolling Screen Items. The Scrolling Screen Delay determines the scrolling speed. When this feature is disabled only VOLT, AMP, PH, Hz, OIL, FUEL, TEMP, and BATT are shown on the front panel summary screen. The phase values are toggled at a rate defined by the Phase Toggle Delay setting. When the phase toggle delay is set to zero, information for each phase is obtained by pressing the *Up* or *Down* arrow keys on the front panel HMI.

### Initializing Message

Two custom initializing messages are displayed on the initial boot screen of the DGC-2020.

### Front Panel HMI

LCD Contrast Value  
80

Front Panel Sleep Mode  
☐ Disable  
☒ Enable

One Line Diagram  
☒ Disable  
☐ Enable

Engine Hours Display  
Enable

Overview Screen Type  
Text

Exhaust Display  
Normal

Exhaust Status Display Screen  
All Screens

Battery Charger Display  
Enable

Display Fuel Level Below (%)  
100

DEF Display Enable  
Enable

Battery and RPM Display  
Battery

Language Selection  
English

Scrolling Screen Enable  
Disable

Scrolling Screen Delay (s)  
5

Phase Toggle Delay (s)  
0

Initializing Message 1  
DGC-2020

Initializing Message 2  
0

### Configurable HMI Summary Settings

|                                          |                                       |                                     |
|------------------------------------------|---------------------------------------|-------------------------------------|
| Scrolling Screen Item 1<br>Oil Pressure  | Scrolling Screen Item 9<br>Gen VBC    | Scrolling Screen Item 17<br>Gen KwH |
| Scrolling Screen Item 2<br>Coolant Temp  | Scrolling Screen Item 10<br>Gen VCA   | Scrolling Screen Item 18<br>Gen IA  |
| Scrolling Screen Item 3<br>Battery Volts | Scrolling Screen Item 11<br>Gen VAN   | Scrolling Screen Item 19<br>Gen IB  |
| Scrolling Screen Item 4<br>RPM           | Scrolling Screen Item 12<br>Gen VBN   | Scrolling Screen Item 20<br>Gen IC  |
| Scrolling Screen Item 5<br>RPM Source    | Scrolling Screen Item 13<br>Gen VCN   |                                     |
| Scrolling Screen Item 6<br>Fuel Level    | Scrolling Screen Item 14<br>Bus Freq  |                                     |
| Scrolling Screen Item 7<br>Run Time      | Scrolling Screen Item 15<br>Bus Volts |                                     |
| Scrolling Screen Item 8<br>Gen VAB       | Scrolling Screen Item 16<br>Gen Freq  |                                     |

Figure 4-13. Front Panel HMI Settings

## Style Number

When a PC operating BESTCOMSPi+ is communicating with a DGC-2020, the style number of the DGC-2020 is automatically displayed on the BESTCOMSPi+ Style Number screen.

When configuring DGC-2020 settings off-line, the style number for the unit to be configured can be entered into BESTCOMSPi+ to enable configuration of the required settings.

The BESTCOMSPi+ Style Number screen is illustrated in Figure 4-15.

**Style Number**  
DGC-2020 Style Number  
**DGC-2020-**
5 1 B R B X E A H

DGC-2020 Style Number Options

|   |                            |    |                         |
|---|----------------------------|----|-------------------------|
| 5 | Current Sensing Input Type | 5) | 5A CTs                  |
|   |                            | 1) | 1A CTs                  |
| 1 | Generator Frequency        | 1) | 50/60 Hz                |
|   |                            | 2) | 400 Hz                  |
| B | Output Contacts            | A) | 7 Output Contacts       |
|   |                            | B) | 15 Output Contacts      |
| R | Internal RS-485 Port       | N) | No Internal RS-485 Port |
|   |                            | R) | w/ Internal RS-485 Port |
| B | Battery Backup for RTC     | N) | No Battery              |
|   |                            | B) | w/ Battery              |
| X | Dial-out Modem             | X) | Excludes Modem          |
|   |                            | R) | RS-232                  |
| E | Generator Protection       | S) | Standard Gen Protection |
|   |                            | E) | Enhanced Gen Protection |
| A | Automatic Synchronizer     | N) | No Auto Sync            |
|   |                            | A) | w/ Auto Sync            |
| H | LCD Heater                 | H) | w/ LCD Heater           |

Figure 4-14. Style Number

## Device Info

Information about a DGC-2020, LSM-2020 (Load Share Module), and CEM-2020 (Contact Expansion Module) can be obtained when communicating with BESTCOMS*Plus*.

### DGC-2020

Information about a DGC-2020 communicating with BESTCOMS*Plus* can be obtained on the Device Info tab of BESTCOMS*Plus*.

Select application version and hardware version when configuring DGC-2020 settings off-line. When on-line, read-only information includes the application version, boot code version, application build date, serial number, application part number, model number, Language Module Version, Language Module Part Number, Font Module Version, and Font Module Part Number. A site-specific unit name can be assigned to the DGC-2020.

### Load Share Module

Information about an LSM-2020 communicating with BESTCOMS*Plus* can also be obtained on the Device Info tab of BESTCOMS*Plus*.

When on-line, read-only information includes the application version, boot code version, application build date, serial number, application part number, and model number.

### Contact Expansion Module

Information about a CEM-2020 communicating with BESTCOMS*Plus* can also be obtained on the Device Info tab of BESTCOMS*Plus*.

When on-line, read-only information includes the application version, boot code version, application build date, serial number, application part number, and model number.

BESTCOMS*Plus* device information values and settings are illustrated in Figure 4-16.

### Analog Expansion Module

Information about an AEM-2020 communicating with BESTCOMS*Plus* can also be obtained on the Device Info tab of BESTCOMS*Plus*.

When on-line, read-only information includes the application version, boot code version, application build date, serial number, application part number, and model number.

The BESTCOMS*Plus* Device Info screen is illustrated in Figure 4-16.

### Device Info

Application Version Number  

>= x.20.02

Hardware Version Number  

3

Application Version  

.....

Boot Code Version  

.....

Language Module Version  

.....

Font Module Version  

.....

Model Number  

.....

Serial Number  

.....

Application Build Date  

YYYY-MM-DD

Application Part Number  

.....

Language Module Part Number  

.....

Font Module Part Number  

.....

### Identification

Unit Name String  

DGC-2020

### Load Share Module

Application Version  

.....

Boot Code Version  

.....

Application Build Date  

YYYY-MM-DD

Serial Number  

.....

Application Part Number  

.....

Model Number  

.....

### Contact Expansion Module

Application Version  

.....

Boot Code Version  

.....

Application Build Date  

YYYY-MM-DD

Serial Number  

.....

Application Part Number  

.....

Model Number  

.....

### Analog Expansion Module

Application Version  

.....

Boot Code Version  

.....

Application Build Date  

YYYY-MM-DD

Serial Number  

.....

Application Part Number  

.....

Model Number  

.....

Figure 4-15. Device Info

## Device Security Setup

Password protection guards against unauthorized changing of DGC-2020 settings. DGC-2020 passwords are case sensitive. Three levels of password protection are available. Each level is described in the following paragraphs.

- **OEM Access.** This password level allows access to all settings. The default, OEM-access password is **OEM**.
- **Settings Access.** This password level allows all except uploading of firmware and clearing of device event log. The default, settings-access password is **SET**.
- **Operator Access.** The default, operator-access password is **OP**. This password level allows all settings to be read and allows changes to be made to the following:
  - LCD Contrast
  - Sleep Mode
  - Date/Time
  - All Sender Fail Time Delays
  - Metric Conversion
  - Low Fuel Pre-Alarm Level
  - Low Fuel Alarm Level
  - Pre-Start Contact after Cranking
  - Cool Down Time
  - Pre-Crank Time Delay
  - Reset of Maintenance Interval
  - All controls on the Control screen available via the Metering Explorer in BESTCOMSPlus

### Changing Passwords

Passwords can be changed only after communication between the PC and DGC-2020 is established. Changes to passwords are made through the *Device Security Setup* screen. Use the Settings Explorer in BESTCOMSPlus to open the *General Settings, Device Security Setup* screen.

The content of the *Device Security Setup* screen depends on the password level used when accessing the screen. For example, someone logged in with a settings-access password will be able to change only the settings-access and operator-access passwords - not the OEM-access password.

The BESTCOMSPlus Device Security Setup screen is illustrated in Figure 4-17. All three access levels are shown.

A password is changed by clicking on the access level, entering the new password, and then clicking on the *Save Password* button.

| Access Level | Password |
|--------------|----------|
| OEM          | OEM      |
| Operator     | OP       |
| Settings     | SET      |

**Selected User Information**

Access Level  
Settings

Password  
SET

[Save Password](#)

Figure 4-16. Device Security Setup

### Saving Passwords in a DGC-2020 Settings File

The passwords can be modified while BESTCOMSPlus is connected to a DGC-2020, then the settings from the BESTCOMSPlus session can be saved into a settings file. The settings file will contain the new passwords. In addition, the passwords in a settings file can be modified off line, saved with the file, and then later loaded into a DGC-2020.

Saving passwords to a settings file when BESTCOMSPlus is connected to a DGC-2020 (on line):

1. When connected to a DGC-2020 with BESTCOMSPlus, click on SETTINGS EXPLORER > GENERAL SETTINGS > DEVICE SECURITY.
2. You will be prompted to enter a password.
3. Enter a password that is of a level as high as or higher than the password you wish to modify. BESTCOMSPlus will display all passwords of a level equal to and below the level of the password that was entered.
4. Click on the password you wish to modify. Type in the new password under the "Password" setting that became active when the password to modify was clicked.
5. Click the "Save" button to save the new password into BESTCOMSPlus memory (it's not in the DGC-2020 yet).
6. Repeat steps 4 and 5 for all password levels you wish to modify.
7. Once all password modifications are complete, in the main menu of BESTCOMSPlus, select *Upload Security* from the *Communications* pull-down menu. This is the step where passwords are sent to the DGC-2020. Failure to perform this step might cause all password modifications to be lost.
8. Close the *Device Security* tab in BESTCOMSPlus.
9. Re-open the *Device Security* tab in BESTCOMSPlus. This will read the passwords back out of the DGC-2020.
10. Verify the passwords obtained from the DGC-2020 are correct.
11. Once all desired settings have been loaded into the DGC-2020, save the settings file. The resulting settings file has the passwords saved as part of the saved settings.
12. At this point, the password information has been successfully saved in the settings file. The process of saving the passwords into the settings file is complete.

### Saving passwords to a settings file when working off line

1. When the settings file is open in BESTCOMSPlus, click on SETTINGS EXPLORER > GENERAL SETTINGS > DEVICE SECURITY.
2. You will be prompted to enter a password.
3. Enter a password that is of a level as high as or higher than the password you wish to modify. BESTCOMSPlus will display all passwords of a level equal to and below the level of the password that was entered.
4. Click on the password you wish to modify. Type in the new password under the "Password" setting that became active when the password to modify was clicked.
5. Click the "Save" button to save the new password into BESTCOMSPlus memory.
6. Repeat steps 4 and 5 for all password levels you wish to modify.
7. Close the *Device Security* tab in BESTCOMSPlus.
8. Save the settings file.
9. Close the settings file by clicking on the X in the upper right-hand corner of the settings file, or close BESTCOMSPlus.
10. Restart BESTCOMSPlus if you have shut it down.



11. Re-open the settings file that you have saved with the password information.
12. When the settings file is open in BESTCOMS*Plus*, click on SETTINGS EXPLORER > GENERAL SETTINGS > DEVICE SECURITY.
13. You will be prompted to enter a password.
14. Enter the password for the highest level of password modified; it should be the new modified password.
15. When passwords are shown, verify they are correct.
16. At this point, the password information has been successfully saved in the settings file. The process of saving the passwords into the settings file is complete.

#### Loading Passwords from a Settings File into the DGC-2020

1. Connect to the DGC-2020 with BESTCOMS*Plus*.
2. Once connected, click the "Open File" button that is used to load a settings file into the DGC-2020.
3. You will be prompted asking if you wish to load settings and logic into the DGC-2020. Select *Yes* if you need to upload settings and logic. Select *No* if all you need to do is update security. If you select *No*, the settings file opens into BESTCOMS*Plus* memory.
4. Whether you have loaded settings and logic to the DGC-2020 or not, the next step is to select *Upload Security* from the *Communications* pull-down menu.
5. DO NOT try to view the passwords before performing step 4. This would download the existing passwords from the DGC-2020 and they will overwrite the new passwords that were loaded into BESTCOMS*Plus* memory from opening the settings file.
6. If you are prompted for a password, enter a password of a level equal to that of the highest-level password you wish to modify.
7. The passwords are uploaded to the DGC-2020.
8. After you have uploaded the new passwords, select GENERAL SETTINGS > DEVICE SECURITY SETUP in the settings explorer of BESTCOMS*Plus*. Verify the passwords are correct.
9. This concludes loading passwords from a settings file into the DGC-2020.

### **Clock Setup**

Configuration of daylight saving time and coordination of the local time with universal time (if desired) is performed on this screen. If required, enter the *UTC (Universal Time Coordinates) Offset*. Choose the type of *DST Configuration* and then set the *Start Day*, *End Day*, and *Bias*.

The BESTCOMS*Plus* Clock Setup screen is illustrated in Figure 4-17.

#### Clock Not Set Warning

When the clock not set warning is enabled, the DGC-2020 notifies the user when the clock is not set. The Clock Not Set warning appears as a flashing indication on the summary screen on the front panel.

The warning appears when the real-time clock battery is replaced and the real-time clock loses time. The warning clears automatically once the time is set. If the real-time clock battery is dead or removed, the warning appears every time DGC-2020 power is cycled if the setting is enabled.

**Clock Setup**

**Time Zone Offset Setup**  
UTC Offset (min)  
0

**Daylight Saving Time Setup**  
DST Configuration  
Disabled

**Start/End Time Reference**  
☒ Respective to Local Time  
☐ Respective to UTC Time

**Start Day**  
Month: March  
Occurrence of Day: Second  
Weekday: Sunday  
Hour (h): 2  
Minute (min): 0

**End Day**  
Month: November  
Occurrence of Day: First  
Weekday: Sunday  
Hour (h): 2  
Minute (min): 0

**Bias Setup**  
Hour (h): 1  
Minute (min): 0

**Clock Not Set Warning**  
☐ Disable  
☒ Enable

Figure 4-17. Clock Setup

## Communications

DGC-2020 communication settings include setup parameters for CAN Bus, ECU, modem, and RS-485 communication.

### CAN Bus Setup

The DGC-2020 CAN Bus interface provides high-speed communication between the DGC-2020 and the engine control unit (ECU) on an electronically controlled engine. When ECU support is enabled, the DGC-2020 will ignore the analog coolant temperature, oil pressure, and engine speed inputs and rely upon the ECU for these parameters. The DGC-2020 will also stop calculating engine run time and begin using the run time recorded by the ECU.

When enabled, the DGC-2020 will receive and retain unsolicited diagnostic trouble codes (DTCs) from an ECU with DTC capabilities.

Early versions of the J1939 specifications were unclear about how the 19 bits of the SPN were arranged within their allocated places in the data. While it was clear which bytes and bits contained the 19 bits of SPN data, it was not clear whether the data within the bytes was arranged with the most significant bit first or least significant bit first. It was also unclear which byte was most significant and which was least significant. The ambiguity led to various engine manufacturers adopting three different methods of converting the data into SPN numbers.

This was remedied in the J1939 specs, and the SPN Conversion Method bit was added. When this bit is a zero, the conversion method is indicated as version 4. The DGC-2020 will automatically set the conversion method to 4 when the CM bit is zero; this occurs for most engine types. However, if the CM bit is 1, indicating the SPN conversion method is NOT 4, the user will have to consult the engine manufacturer to learn the correct method of SPN conversion, and set the SPN Conversion Method setting in the DGC-2020 accordingly.

A DGC-2020 operating on a CAN Bus network is identified by a unique address number. The CAN Bus Address is set internally by the DGC-2020 when certain types of ECUs are selected on the ECU Setup screen, and in this case, the user-entered value does not apply. See Table 4-4.

**Table 4-4. CAN Bus Address per ECU Type**

| <b>ECU Type</b>   | <b>CAN Bus Address</b> |
|-------------------|------------------------|
| Cummins           | 220                    |
| Daimler CPC4      | User-selectable        |
| Deutz             | User-selectable        |
| GM/Doosan         | User-selectable        |
| Isuzu             | User-selectable        |
| John Deere        | User-selectable        |
| mtu ADEC          | 1                      |
| mtu ECU7/ECU8     | 6                      |
| mtu MDEC          | 6                      |
| mtu Smart Connect | 234                    |
| Scania            | 39                     |
| Standard          | User-selectable        |
| Volvo Penta       | 17                     |
| Woodward PG Plus  | 230                    |
| Yanmar            | User-selectable        |

Set the Engine ECU Address to the address claimed by the Engine ECU operating on the J1939 communications network. In certain cases, there is more than one ECU transmitting data on the J1939 network. If so, set the Engine ECU Secondary Address claimed by the Secondary Engine ECU. For more information on J1939 address handling, see *CAN Bus Setup*. When GM/Doosan is selected as the ECU type, the value of this setting is ignored and the Engine ECU Address value is always zero (0).

In applications where the ECU is not continuously powered, the DGC-2020 has provisions for applying power to the ECU and pulsing the ECU to update its engine monitoring data. Either the DGC-2020 RUN or PRESTART relay output can be used to apply power to the ECU. If the PRESTART contact is selected, the RUN output will still close during cranking and genset operation to provide a separate indication that the genset is running. For applications where pulsing of the ECU is not desired, this pulsing feature can be disabled.

#### Bit Rate Source

This parameter specifies whether the CAN bit rate is determined by the ECU Configuration setting or the Bit Rate user setting.

If it is set for the ECU Configuration setting, ECU configurations of mtu MDEC and mtu ECU7/8 result in a bit rate of 125 kbps. Other selections result in a bit rate of 250 kbps.

If it is set for the Bit Rate user setting, possible bit rate selections include 125 kbps, 250 kbps, 500 kbps, and 1000 kbps.

#### Coolant Temperature Source

With From ECU selected, the DGC-2020 accepts coolant temperature data from the ECU on CAN Bus. With From DGC Input selected, the DGC-2020 accepts coolant temperature data from the coolant temperature engine sender input.

### Oil Pressure Source

With From ECU selected, the DGC-2020 accepts oil pressure data from the ECU on CAN Bus. With From DGC Input selected, the DGC-2020 accepts oil pressure data from the oil pressure engine sender input.

The BESTCOMSPPlus CAN Bus Setup screen is illustrated in Figure 4-18.

### Engine Run Time Source

With ECU selected, the DGC-2020 accepts engine hours data from the ECU on CAN 2 (ECU). With DGC selected, the DGC-2020 uses internally tracked engine hours.

### ECU Limitations

For some ECUs, an external source cannot stop the engine without removing power from the ECU. Turning off power to the ECU is the only way to remove fuel from the engine and shut it down. Different ECU manufacturers have their own rpm setpoints for reapplying fuel to an engine. If the ECU is powered up and the engine is still spinning above 60 rpm, then the ECU will automatically turn the fuel on. Detroit Diesel J1939 ECUs, for example, have a setpoint of 60 rpm.

Not being able to stop the engine without removing ECU power causes two problems. The first problem is that the only way to stop the engine is to turn the ECU off and wait for the engine speed to decrease below 60 rpm before powering the ECU back on. Otherwise, the engine will take off running. The second problem is that while the ECU is off, you can no longer meter and update coolant level, coolant temperature alarm/pre-alarm, and crank control.

### The DGC-2020 Solution

The DGC-2020 resolves ECU limitations by using four timers:

- **Engine Shutdown.** The time in seconds to stay disconnected from the ECU when going from running to shutdown before starting the first pulse. This timer should allow enough time for the engine to slow down so that when the DGC-2020 pulses, the ECU will not start the engine.
- **Pulse Cycle Time.** The time in minutes that the controller waits before pulsing. The range is 1 to 1,440 minutes.
- **Settling Time.** The time in tenths of seconds to gather data after connecting to the ECU during the pulsing state. This allows all the metered values to be sent and ramp as designated by the J1939 protocol. ECU values initially sent are sometimes low, and the ECU takes time to average out its own data values. The range is 55,000 to 150,000 milliseconds
- **Response Timeout.** The time in seconds to attempt communication with the ECU when the DGC-2020 is in the pulsing state or connecting state.

### CAN Bus Setup

**CAN Bus Interface**  
 ECU Support  

  
 DTC Support  

  
 SPN Conversion Method  

  
 CAN Bus Address  

  
 Engine ECU Address  

  
 Secondary Engine ECU Address  

  
 Bit Rate Source  

  
 Bit Rate Selection

**ECU Contact Control**  
 Output Select  
☒ Fuel Contact  
☐ Pre-start Contact  
 Pulsing  
☐ Disable  
☒ Enable

**ECU Related Time Values**  
 Engine Shut Down (s)  

 Settling Time (ms)  

  
 Pulse Cycle Time (min)  

 Response Timeout (s)

Coolant Temperature Source  

  
 Oil Pressure Source  

  
 Engine Run Time Source

Figure 4-18. CAN Bus Setup

## ECU Setup

The DGC-2020 can be configured for Standard, Volvo Penta, *mtu* MDEC, *mtu* ADEC, *mtu* ECU7/ECU8, GM/Doosan, Cummins, *mtu* Smart Connect, Scania, John Deere, Isuzu, Daimler CPC4, Yanmar, Deutz, or Woodward PG Plus. When the Generator Parameter Transmit setting is enabled, the DGC-2020 broadcasts generator-metered parameters over CAN Bus as listed in Table 4-5. The Generator Parameter Transmit setting is not used when ECU Type is set for *mtu* MDEC, *mtu* ECU7/ECU8, or *mtu* Smart Connect. The Generator Total AC Power PGN (PGN 0x00FE05 65029) is broadcast at a user-selectable rate.

Table 4-5. Generator Parameter Transmit

| PGN Name                          | PGN (Hex)    | SPN  | Parameter                       | Units       | Scaling / Offset | Bytes Within PGN Data |
|-----------------------------------|--------------|------|---------------------------------|-------------|------------------|-----------------------|
| Generator Total AC Energy         | 65018 (FDFA) | 2468 | Generator Total kW Hours Export | kWh         | n/a              | 1 to 4                |
|                                   |              | 2469 | Generator Total kW Hours Import | kWh         | n/a              | 5 to 8                |
| Generator Total AC Reactive Power | 65028 (FE04) | 2456 | Generator Total Reactive Power  | vars        | n/a              | 1 to 4                |
|                                   |              | 2464 | Generator Overall Power Factor  | PF x 16,384 | -1 offset        | 5 to 6                |

| PGN Name                              | PGN (Hex)    | SPN  | Parameter                                                 | Units    | Scaling / Offset                                         | Bytes Within PGN Data |
|---------------------------------------|--------------|------|-----------------------------------------------------------|----------|----------------------------------------------------------|-----------------------|
|                                       |              | 2518 | Generator Overall Power Factor Lagging                    | n/a      | 00=leading<br>01=lagging<br>10=error<br>11=not available | 7, bits 1 & 2         |
| Generator Total AC Power              | 65029 (FE05) | 2452 | Generator Total Real Power                                | Watts    | n/a                                                      | 1 to 4                |
|                                       |              | 2460 | Generator Total Apparent Power                            | VA       | n/a                                                      | 5 to 8                |
| Generator Average Basic AC Quantities | 65030 (FE06) | 2440 | Generator Average L-L AC RMS Voltage                      | Volts    | n/a                                                      | 1 to 2                |
|                                       |              | 2444 | Generator Average L-N AC RMS Voltage                      | Volts    | n/a                                                      | 3 to 4                |
|                                       |              | 2436 | Generator Average AC Frequency                            | Hz x 128 | n/a                                                      | 5 to 6                |
|                                       |              | 2448 | Generator Average AC RMS Current                          | Amps     | n/a                                                      | 7 to 8                |
| Engine Temperature                    | 65262 (FEEE) | 110  | Engine Coolant Temperature (Not sent when CAN is enabled) | °C       | -40°C offset                                             | 1                     |
| Engine Fluid Level / Pressure         | 65263 (FEEF) | 100  | Engine Oil Pressure (Not sent when CAN is enabled)        | kPa x 4  | n/a                                                      | 4                     |
| Dash Display                          | 65276 (FEFC) | 96   | Fuel Level                                                | % x 2.5  | n/a                                                      | 2                     |

When the Engine Control Parameter Transmit setting is enabled, the DGC-2020 sends engine control commands such as Requested RPM, Start Request, Stop Request, and some proprietary control parameters over CAN Bus to the engine ECU. When the Engine Control Parameter Transmit setting is disabled, transmission of engine control commands from the DGC-2020 to the engine ECU are disabled, but the J1939 parameter communication from the engine ECU to the DGC-2020 still occurs.

### Start Mode

The Start mode specifies whether the engine should start normally or as rapidly as possible. When Normal mode is selected, the engine will go through a normal start sequence when started. When Rapid mode is selected, the engine will go through a rapid start sequence if the engine ECU is programmed for a rapid start. A normal start could be employed when starting the generator is not time critical. However, if there was a power outage, a rapid start could be employed to restore power as soon as possible.

### Volvo Penta

Configuring the DGC-2020 for Volvo Penta\* necessitates the configuration of two additional settings: Speed Select and Accelerator Position. The Speed Select setting configures the Volvo Penta ECU to operate the engine at the primary or secondary base speed. If the engine is configured by Volvo for 60 Hz applications, the primary base speed is 1,800 rpm and the secondary base speed is 1,500 rpm. If the

engine is configured by Volvo for 50 Hz applications, the primary base speed is 1,500 rpm and the secondary base speed is 1,800 rpm. The Accelerator Position setting is expressed as a percentage and tells the Volvo Penta ECU where to set the engine speed (trim) relative to the base speed. The range of the setting is the base speed  $\pm 120$  rpm. A setting of 0% will cause the engine to run at 120 rpm below the base speed, a setting of 50% will cause the engine to run at the base speed, and a setting of 100% will cause the engine to run at 120 rpm above the base speed. The Accelerator Position setting is linear with a gain of 2.4 rpm/percentage. This setting is not saved in nonvolatile memory and defaults back to 50% after DGC-2020 operating power is cycled.

The accelerator pedal position is set to zero (0) when the engine is not running or there is an idle request. This is specified by Volvo.

A checksum and counter value are sent along with accelerator pedal position data so the ECU can detect that accelerator pedal updates are occurring. If updates stop occurring, the engine speed will eventually revert to its configured idle RPM.

The DGC-2020 sends the following parameters to a Volvo Penta ECU through Volvo Proprietary J1939 communications:

- Start Request - sent when starting the engine.
- Stop Request - sent when shutting down the engine.
- Idle Request - sent when the Idle Request logic element is TRUE in *BESTlogicPlus*.
- Preheat Request - sent anytime the DGC-2020 would normally have its PRE relay closed for engines requiring a preheat contact.
- Accelerator Pedal Position - sent based on the Accelerator Position setting. If the Accelerator Pedal Position setting is left at the default 50%, this is calculated and sent based on the programmed Engine RPM setting to achieve the desired engine RPM. If an LSM-2020 is present and the DGC-2020 senses the generator breaker is closed, the DGC-2020 is in kW control mode and the Accelerator Pedal Position is sent based on the kW controller output to adjust engine throttle for kW control.
- Primary/Secondary Engine Speed - sent based on the Speed Select setting and the state of the Alternate Frequency Override element in *BESTlogicPlus*. Primary speed is sent when the Speed Select setting is set for Primary and Secondary speed is sent when the Speed Select setting is set for Secondary. However, these are reversed if the Alternate Frequency Override is TRUE. A setting of Primary results in Secondary being sent and a setting of Secondary results in Primary being sent when the Alternate Frequency Override is TRUE.

\* The Volvo Penta ECU configuration is applicable only to the EDC3 and EMS2 models of Volvo Penta engine controllers.

### Cummins

When Cummins is selected as the ECU type, the following parameters are sent to the engine via Cummins Proprietary J1939 communications:

- Start Request - sent when starting or running the engine.
- Stop Request - sent when stopping the engine.
- Idle Request - sent when the Idle Request logic element is TRUE in *BESTlogicPlus*.
- Rated Speed (50 or 60 Hz) - sent based on the Rated Speed setting of the DGC-2020. However, these are reversed if the Alternate Frequency Override is TRUE. A setting of 60 Hz Rated Speed results in 50 Hz being sent and a setting of 50 Hz Rated Speed results in 60 Hz being sent when the Alternate Frequency Override is TRUE.

A parameter is provided to configure generator control communications. If the standard PGNs for Generator Control One and Generator Control Two are broadcast by the generator, the Cummins ECU will use those. If they are not broadcast, the ECU will expect the Cummins Engine Governing PGN (0xFF69) and Cummins Generator Control PGN (0xFF73). If the user selects Standard for the Generator Control Communications setting, the DGC-2020 will not broadcast 0xFF69 and 0xFF73 in order to minimize loading on the CAN Bus.



### Diesel Particulate Filter (DPF)

The diesel particulate filter settings are used when the ECU is configured for Standard, Volvo Penta, *mtu* ADEC, GM/Doosan, Cummins, *mtu* Smart Connect, or Yanmar. The DGC-2020 supports the CAN bus parameters that are related to the diesel particulate filter implemented on certain engines to meet Tier 4 emission requirements. Three pre-alarms provide DPF status:

- DPF Regenerate Required pre-alarm – announced when the DPF lamp status broadcast over CAN Bus indicates that regeneration is required.
- DPF Regenerate Disabled pre-alarm – announced when the engine ECU reports via CAN bus that DPF regeneration is disabled.
- High Exhaust Temperature pre-alarm – announced when the ECU reports via CAN bus that a high exhaust temperature condition exists.

Two parameters are provided to initiate or disable DPF regeneration. The first, Manual Regeneration, is transmitted to the engine over CAN bus to initiate DPF regeneration. The second, Disable Regeneration, is transmitted to the engine over CAN bus to disable DPF regeneration. Extended operation with regeneration disabled is not recommended.

### *mtu*

If the engine is configured as *mtu* MDEC, the configuration of the following settings is necessary:

- MDEC Module Type - Specifies the type of MDEC module.
- Speed Demand Switch - Specifies speed demand source for the *mtu* engine ECU.
- NMT Alive Transmit Rate - Specifies the rate at which messages are transmitted to the *mtu* engine.

If the engine is configured as *mtu* ADEC, the configuration of the following settings is necessary:

- Speed Demand Switch - Specifies speed demand source for the *mtu* engine ECU.
- Overspeed Test - Temporarily drives an *mtu* ECU into overspeed for testing overspeed.
- Governor Param Switch Over - Specifies which governor parameters an *mtu* ECU should use.
- Trip Reset - Resets trip information such as trip fuel used, trip hours, trip idle time, etc.
- Int Oil Prime - Causes an *mtu* ECU engine to perform an internal lubrication cycle.
- CAN Start Stop Configuration – Specifies when to broadcast Start / Stop status.

When this setting is set to Constant, either start or stop is TRUE at all times. When set to On for Start/Stop, start is TRUE only while starting and stop is TRUE only while stopping. When set to Disabled, start and stop are implemented in the protocol, but are never set to TRUE. When set to Not Implemented, the J1939 boolean start and stop parameters are set to 0x03 (Not Implemented) for *mtu* ADEC and *mtu* Smart Connect ECUs, and neither start nor stop are sent in MCS5 Protocol for *mtu* ECU7/8 or MDEC ECUs.

If the engine is configured as *mtu* ECU7/ECU8, the configuration of the following settings is necessary:

- Speed Demand Switch - Specifies speed demand source for the *mtu* engine ECU.
- Overspeed Test - Temporarily drives an *mtu* ECU into overspeed for testing overspeed.
- Speed Up - Increases speed of the *mtu* ECU.
- Speed Down - Decreases speed of the *mtu* ECU.
- Idle Request - Turns the idle request on or off.
- Increased Idle - Sets the *mtu* ECU idle.
- Trip Reset - Resets trip information such as trip fuel used, trip hours, trip idle time, etc.
- Int Oil Prime - Causes an *mtu* ECU engine to perform an internal lubrication cycle.
- *mtu* 50 Hz 60 Hz Switch Setting - Set automatically based on rated frequency of the DGC-2020 and the state of the alternate frequency override.
- Engine Start Prime - Turns the engine start prime on or off.
- Fan Override - Turns the fan override on or off.
- Mode Switch - Turns the mode switch on or off.
- Governor Param Switch Over - Specifies which governor parameters an *mtu* ECU should use.



- Governor Param Set Select - Sets the governor parameter set select.
- CAN Rating Switch 1 & 2 - Turns the CAN rating switch 1 & 2 on or off.
- Cylinder Cutout Disable 1 & 2 - Turns the cylinder cutout disable 1 & 2 on or off.
- *mtu* ECU7/ECU8 Module Type - Specifies ECU7/ECU8 Module type.
- NMT Alive Transmit Rate - Specifies the rate at which messages are transmitted to the *mtu* engine.
- CAN Start Stop Configuration – Specifies when to broadcast Start / Stop status.

If the engine is configured as *mtu* Smart Connect, the configuration of the following settings is necessary:

- Speed Demand Switch - Specifies speed demand source for the *mtu* engine ECU.
- Overspeed Test - Temporarily drives an *mtu* ECU into overspeed for testing overspeed.
- Speed Up - Increases speed of the *mtu* ECU.
- Speed Down - Decreases speed of the *mtu* ECU.
- Idle Request - Turns the idle request on or off.
- Trip Reset - Resets trip information such as trip fuel used, trip hours, trip idle time, etc.
- Int Oil Prime - Causes an *mtu* ECU engine to perform an internal lubrication cycle.
- Governor Param Switch Over - Specifies which governor parameters an *mtu* ECU should use.
- Cylinder Cutout Disable 2 - Turns the cylinder cutout disable 2 on or off.
- Engine Operating Mode - Selects engine operating mode 1 or 2.

#### Scania Engine ECU Communications

The majority of CAN Bus parameters are sent from Scania Engine ECUs via standard J1939 communications. However, some additional proprietary parameters are sent via Scania proprietary J1939 communications. Proprietary Start, Stop, and Emergency Stop commands are sent from the DGC-2020 to the Scania ECU. The ECU communicates Diesel Exhaust Fluid (DEF) Levels, as well as DEF Fluid Low, DEF Low Severe, DEF Inducement, and DEF Severe Inducement Pre-Alarms to the DGC-2020 through Proprietary Scania parameters. Additional information on DEF related parameters can be found in Appendix E, *Exhaust Treatment*.

#### John Deere

The Regeneration Interlock setting enables John Deere proprietary parameters to be broadcast over the J1939 CAN Bus.

The Regeneration Interlock parameter is sent via the Stationary Regeneration/Cleaning CAN Lockout Message PGN, which is PGN 61194. When the DGC Regeneration Interlock value is set to Enabled, the DGC-2020 sends a value of 01 (binary) for the two-bit “Allowed” configuration, which allows regeneration to occur. When the DGC-2020 Regeneration Interlock value is set to Disabled, the DGC-2020 sends a value of 00 (binary) for the two-bit “Not Allowed” configuration, which inhibits regeneration.

The DGC-2020 sends starter engagement requests to the ECU via the SAE J1939 Engine Start Control PGN. When the DGC-2020 requests the starter to be engaged, it sends a value of 01 (binary) for the two-bit starter engagement parameter. Otherwise, the DGC-2020 sends a value of 00 (binary) for the two-bit starter engagement parameter.

#### Isuzu

When the ECU type is set for Isuzu, the Clear ECU Memory and Escape Mode Request buttons are operational. When the Clear ECU Memory button is clicked, it will remain on for five seconds and then turn off, sending a five-second long memory clear request to the engine ECU. When the Escape Mode Request button is clicked, a temporary override of inducement to not operate the engine is sent to the ECU.

#### Daimler CPC4

When the ECU type is set for Daimler CPC4, the DGC-2020 monitors the Torque Limit (LIM) Lamp Status broadcast via proprietary J1939 communications from the Daimler engine ECU to the DGC-2020. When the monitored LIM Lamp status indicates the lamp is on solid, the DGC-2020 annunciates a pre-alarm displaying the LIM symbol and text “Torque Limit”. When the monitored LIM Lamp status indicates the

lamp is flashing, the DGC-2020 annunciates a pre-alarm displaying the LIM symbol and text “Torque Limit Severe”. The DGC-2020 also displays the LIM symbol in the exhaust status display portion of the front panel display.

### Woodward PG Plus

When the ECU type is set for Woodward PG Plus, the Fuel Selection setting is operational. The ECU requests the value of this setting and uses it to control the engine with the proper fuel type.

The ECU Fuel Selection can be Diesel Fuel, Natural Gas, Liquid Propane, or Bi-Fuel NG or LP.

### Yanmar

Some DTC-FMI combinations report different Yanmar P Codes depending on whether the engine has three or four cylinders. The Number of Cylinders setting specifies how many cylinders exist in the engine.

The BESTCOMSPlus ECU Setup screen is illustrated in Figure 4-19.

**Figure 4-19. ECU Setup**

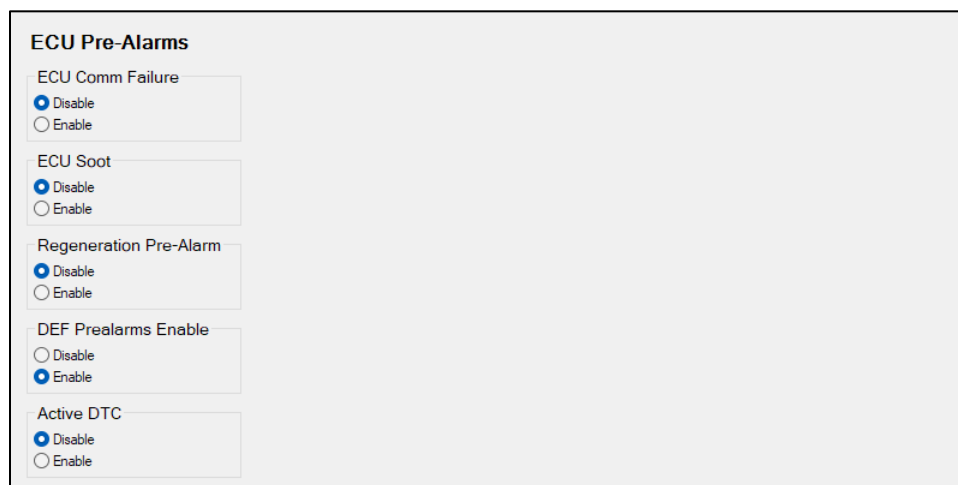
## **ECU Pre-Alarms**

A pre-alarm is annunciated when a condition programmed to trigger a pre-alarm is met. When a pre-alarm condition exists, it is annunciated (flashed) on the LCD, the front panel Alarm indicator flashes on and off, and the Horn output (if programmed and enabled) alternates between an energized and de-energized state. The audible alarm is reset by pressing the front panel Alarm Silence pushbutton. When the ECU broadcasts a message with data that clears the condition, all displayed annunciations are reset automatically.

Active pre-alarms are displayed on the main display of the LCD. The LCD annunciates an active pre-alarm by alternating the pre-alarm message with the normally displayed data. All pre-alarms are individually displayed, in sequence, by scrolling through the LCD pre-alarms list.

ECU pre-alarms are described in the following paragraphs. Pre-alarms can be enabled and adjusted in BESTCOMSPlus or through the front panel HMI.

The BESTCOMSPlus ECU Pre-Alarms screen is illustrated in Figure 4-20.



**ECU Pre-Alarms**

ECU Comm Failure  
☒ Disable  
☐ Enable

ECU Soot  
☒ Disable  
☐ Enable

Regeneration Pre-Alarm  
☒ Disable  
☐ Enable

DEF Prealarms Enable  
☐ Disable  
☒ Enable

Active DTC  
☒ Disable  
☐ Enable

Figure 4-20. ECU Pre-Alarms

### ECU Comm Failure

ECU communication failure pre-alarm settings consist of a single enable/disable setting. If enabled, an ECU communication failure pre-alarm is annunciated when the DGC-2020 detects a communication problem in the J1939 interface linking the DGC-2020 with the ECU (engine control unit).

### ECU Soot

Soot level pre-alarms can be enabled or disabled that are caused by any of the following conditions:

- Diagnostic trouble codes with SPN 3719 *Aftertreatment 1 Diesel Particulate Filter Soot Load Percent* with Failure Mode Indicator (FMI) values of 15 (Data High Least Severe), 16 (Data High Moderately Severe), or zero (0) (Data High Most Severe).
- The *Aftertreatment Diesel Particulate Filter Status* sent from an engine ECU as part of the PGN 0xFD7C Diesel Particulate Filter Status has a value of 4.

### Regeneration Pre-Alarm

Regeneration pre-alarms can be enabled or disabled that are caused by the *Aftertreatment Diesel Particulate Filter Status* sent from an engine ECU as part of the PGN 0xFD7C Diesel Particulate Filter Status when it has a value of 1 (Regeneration Needed, Lowest Level), 2 (Regeneration Needed, Moderate Level), or 3 (Regeneration Needed, Highest Level).

### DEF Pre-Alarms Enable

The DEF Pre-Alarms Enable setting allows the user to disable any DEF related pre-alarms in the DGC-2020. There have been occurrences where some engines that do not have DEF-based exhaust treatment systems send information over the J1939 CAN Bus that causes the DGC-2020 to annunciate DEF related pre-alarms. Since these pre-alarms are not applicable on this type of system, they can be disabled with this setting.

### Active DTC

Active DTC (diagnostic trouble code) pre-alarm settings consist of a single enable/disable setting. If CAN and DTC support are both enabled, an “active DTC” pre-alarm can be enabled to announce the presence of a condition that is causing a DTC to be sent from the ECU to the DGC-2020.

## **Speed Setup**

Speed control and kW load sharing over J1939 and ECU7/ECU8 is implemented over CAN Bus when the CAN Bus rpm Request setting is enabled for RPM Request or Governor Bias Control. This allows the user to select the preferred method of rpm control. This is implemented for all ECUs. The Engine rpm setting defines the nominal requested engine rpm.

### Engine RPM

The engine RPM setting will be sent as the requested RPM as the J1939 TSC1 Speed Request when the engine is running and the IDLE REQUEST logic element is FALSE.

### Remember Speed Adjustments

A Remember Speed Adjustments setting is provided to establish how RPM adjustments by raise/lower commands are saved. When Yes is selected, adjustments to RPM by raise/lower commands are saved to memory and used for all subsequent run sessions. This is TRUE even when power is cycled to the DGC-2020. When No is selected, adjustments to RPM by raise/lower commands are retained for the duration of only the current run session. The adjustments are discarded the next time the engine is run or the DGC-2020 is power cycled.

### Idle RPM

The Idle rpm setting is the requested rpm when the IDLE REQUEST logic element is TRUE. The idle RPM will be sent as the requested RPM as the J1939 TSC1 Speed Request when the engine is running and the IDLE REQUEST logic element is TRUE.

### RPM Bandwidth

The rpm Bandwidth setting defines the range of rpm in which the DGC-2020 will use to accomplish load sharing. For example, if the Engine rpm setting is 1800 and the RPM Bandwidth is set to 100, the rpm request can go from 1750 to 1850 rpm when load sharing is in effect.

### RPM Checksum

Some newer engine ECUs will not respond to TSC1 speed request when the speed is a constant value unless a Message Counter and Checksum are implemented. This setting enables or disables the Message Counter and RPM Checksum.

Figure 4-21. Speed Setup

## Voltage Regulator Setup

The DGC-2020 transmits voltage setpoint and underfrequency compensation parameters to Marathon DVR2000E+ voltage regulators. The Voltage Regulator Setup screen (Figure 4-22) is found in the BESTCOMSPPlus® Settings Explorer under the *Communications, CAN Bus* category. The CAN Bus Type setting allows the user to select which CAN Bus type is used to transmit parameters to the voltage regulator. The Primary Voltage Setpoint value represents the normal desired system voltage setpoint. Alternate Voltage Setpoint is the desired system voltage setpoint when low line override is TRUE. The range in which the DGC-2020 is allowed to bias voltage regulator var sharing and voltage trim is adjustable using the Voltage Adjust Bandwidth setting. When the DVR2000E+ is in Field Current Regulation (FCR) mode, the normal desired field current setpoint is adjusted using the Field Current Setting. The Primary Underfrequency Knee setting allows adjustment of the normal desired

underfrequency knee-point. When low line override is TRUE, the Alternate Underfrequency Knee becomes the active underfrequency knee-point. The desired Underfrequency Slope can also be specified.

| Voltage Regulator Setup             |                                                                  |
|-------------------------------------|------------------------------------------------------------------|
| CAN Bus Type<br>None                | Field Current Setting for Field Current Regulation Mode<br>0.000 |
| Primary Voltage Setpoint<br>120.0   | Primary Underfrequency Knee<br>58.8                              |
| Alternate Voltage Setpoint<br>120.0 | Alternate Underfrequency Knee<br>58.8                            |
| Voltage Adjust Bandwidth<br>10.00   | Underfrequency Slope<br>1.00                                     |

Figure 4-22. Voltage Regulator Setup

## Battery Charger Setup

Battery charger output voltage and current can be displayed on the front-panel overview screen and in BESTCOMS*Plus*. To enable battery charger display on the front-panel overview screen, navigate to Settings Explorer > General Settings > Front Panel HMI in BESTCOMS*Plus* and set Battery Charger Display to Enabled.

The CAN Bus Type can be set for Standard or Sens. Status and pre-alarm logic blocks are available in BESTlogic*Plus*. Different pre-alarms for each CAN Bus type are available.

Figure 4-23, Figure 4-24, and Figure 4-25 illustrate the BESTCOMS*Plus* Battery Charger Setup screens.

| Battery Charger Setup                         |                                           |
|-----------------------------------------------|-------------------------------------------|
| Battery Charger 1<br>CAN Bus Type<br>Standard | Battery Charger 2<br>CAN Bus Type<br>None |

Figure 4-23. Battery Charger Setup

| Battery Charger Pre-Alarms                                                                                                                                                                            |                                                                                                                                                                                                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Battery Charger 1</b><br>Comms Failure Pre-Alarm Enable<br>Enable<br>Battery Failure Pre-Alarm Enable<br>Enable<br>Charger Failure Pre-Alarm Enable<br>Enable<br>AC Off Pre-Alarm Enable<br>Enable | <b>Battery Charger 2</b><br>Comms Failure Pre-Alarm Enable<br>Enable<br>Battery Failure Pre-Alarm Enable<br>Enable<br>Charger Failure Pre-Alarm Enable<br>Enable<br>AC Off Pre-Alarm Enable<br>Enable |

Figure 4-24. Battery Charger Pre-Alarms

| Battery Charger 1                                | Battery Charger 2                                |
|--------------------------------------------------|--------------------------------------------------|
| Thermal Limit Pre-Alarm Enable<br>Enable         | Thermal Limit Pre-Alarm Enable<br>Disable        |
| High DC Voltage Pre-Alarm Enable<br>Enable       | High DC Voltage Pre-Alarm Enable<br>Disable      |
| Low DC Voltage Pre-Alarm Enable<br>Disable       | Low DC Voltage Pre-Alarm Enable<br>Disable       |
| Low Cranking Voltage Pre-Alarm Enable<br>Disable | Low Cranking Voltage Pre-Alarm Enable<br>Disable |
| Invalid Settings Pre-Alarm Enable<br>Disable     | Invalid Settings Pre-Alarm Enable<br>Disable     |
| Single Unit Failure Pre-Alarm Enable<br>Disable  | Single Unit Failure Pre-Alarm Enable<br>Disable  |

Figure 4-25. Sens Battery Charger Pre-Alarms

### Modem Setup (Optional)

DGC-2020 controllers with style number xxxxxRxxx are equipped with an RS-232 port. This port allows communication with an external, user-supplied modem with dial-in and dial-out capability.

A modem gives the DGC-2020 the ability to dial up to four telephone numbers and annunciate user-selected conditions to specified pagers. These user-selected conditions include:

- 27-1 Trip Alarm
- 27-2 Trip Alarm
- 32 Trip Alarm
- 40 Trip Alarm
- 47 Trip Alarm
- 51-1 Trip Alarm
- 51-2 Trip Alarm
- 51-3 Trip Alarm
- 59-1 Trip Alarm
- 59-2 Trip Alarm
- 81O Trip Alarm
- 81U Trip Alarm
- 27-1 Trip Pre-Alarm
- 27-2 Trip Pre-Alarm
- 32 Trip Pre-Alarm
- 40 Trip Pre-Alarm
- 47 Trip Pre-Alarm
- 51-1 Trip Pre-Alarm
- 51-2 Trip Pre-Alarm
- 51-3 Trip Pre-Alarm
- 59-1 Trip Pre-Alarm
- 59-2 Trip Pre-Alarm
- 78 Vector Shift Trip
- 81O Trip Pre-Alarm
- 81U Trip Pre-Alarm
- 81 ROCOF Trip
- AEM Comm Failure
- Auto Restart Failure Alarm
- Auxiliary Input X Closed (X = 1 to 16)
- DPF Regeneration Required
- DPF Soot Level High Pre-Alarm
- DPF Soot Lvl Moderately High Pre-Alarm
- DPF Soot Level Severely High Pre-Alarm
- Duplicate AEM Pre-Alarm
- Duplicate CEM Pre-Alarm
- Duplicate LSM Pre-Alarm
- ECU Shutdown Alarm
- Emergency Stop Alarm
- Engine Running
- Fuel Leak Detect Status
- Fuel Level Sender Fail Alarm
- Fuel Level Sender Fail Pre-Alarm
- GOV Output Limit
- High Coolant Temperature Alarm
- High Coolant Temp Pre-Alarm
- High Exhaust Temperature
- High Fuel Pre-Alarm
- ID Missing Pre-Alarm
- ID Repeat Pre-Alarm
- Intergenset Comms Failure
- kW Overload 1 Pre-Alarm
- kW Overload 2 Pre-Alarm
- kW Overload 3 Pre-Alarm
- Loss of ECU Coms Alarm
- Loss of ECU Coms Pre-Alarm
- Loss of Generator Voltage Sensing Alarm
- Low Battery Voltage Pre-Alarm
- Low Coolant Level Status

- AVR Output Limit
- Battery Charger Fail Status
- Battery Overvoltage Pre-Alarm
- CEM Comm Failure
- Common Alarm
- Common Pre-Alarm
- Config Element X Status (X = 1 to 8)
- Coolant Temp Sender Fail Alarm
- Coolant Temp Sender Fail Pre-Alarm
- Cool Down Timer Active
- DEF Fluid Low Pre-Alarm
- DEF Fluid Empty Pre-Alarm
- DEF Engine Derate Pre-Alarm
- DEF Pre-Severe Inducement Pre-Alarm
- DEF Severe Inducement Pre-Alarm
- DEF Inducement Override Pre-Alarm
- DPF Regeneration Inhibited
- Low Coolant Temp Pre-Alarm
- Low Fuel Alarm
- Low Fuel Pre-Alarm
- Low Oil Pressure Alarm
- Low Oil Pressure Pre-Alarm
- LSM Comm Failure
- MPU Speed Sender Fail Alarm
- Oil Pressure Sender Fail Alarm
- Oil Pressure Sender Fail Pre-Alarm
- Overcrank Alarm
- Overspeed Alarm
- Scheduled Maintenance Pre-Alarm
- Switch Not in Auto
- Transfer Fail Alarm
- Virtual Output X Status (X = 1 to 8)
- Unexpected Shutdown Alarm
- Weak Battery Voltage Pre-Alarm

### Dial-Out

The DGC-2020 uses telelocator alphanumeric protocol (TAP) version 1.7 when communicating with paging companies. This data format specifies seven data bits with even parity. If required, eight data bits with no parity can be specified.

The message string sent by the DGC-2020 can be limited to a length supported by the receiving pagers. If a message to be transmitted by the DGC-2020 exceeds the pager message limit, the DGC-2020 will make multiple calls to transmit the complete message.

Dial-out messages are sent by the DGC-2020 at a user-defined interval. This interval gives an operator the opportunity to dial into the DGC-2020. A second user-defined interval determines how frequently dial-out attempts are made following a dial-out failure.

You may need to include a "1" or the area code, or both. If you are not sure you need the extra numbers, dial the phone number on your telephone. If the modem handshake is heard, the number dialed is correct.

### Dial-In

When the DGC-2020 modem shares a line used for voice communication, the number of rings required for the modem to answer can be increased to allow time for an operator to answer an incoming telephone call. Additional settings can be adjusted by use of modem initialization string commands.

The BESTCOMSPlus® Modem Setup screen is illustrated in Figure 4-26.



**Modem Setup**

|                                                               |                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------------------------------------------------|-----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dial Out Number 1<br><input type="text" value="0"/>           | Pager ID 1<br><input type="text" value="0"/>  | <b>Dialout Conditions</b><br><input type="checkbox"/> High Coolant Temperature Alarm<br><input type="checkbox"/> Low Oil Pressure Alarm<br><input type="checkbox"/> Coolant Temp Sender Fail Alarm<br><input type="checkbox"/> Oil Pressure Sender Fail Alarm<br><input type="checkbox"/> Fuel Level Sender Fail Alarm<br><input type="checkbox"/> MPU Speed Sender Fail Alarm<br><input type="checkbox"/> Loss of Generator Voltage Sensing Alarm<br><input type="checkbox"/> Low Fuel Alarm<br><input type="checkbox"/> Low Coolant Level Status<br><input type="checkbox"/> Overcrank Alarm<br><input type="checkbox"/> Emergency Stop Alarm<br><input type="checkbox"/> Overspeed Alarm<br><input type="checkbox"/> Low Fuel Pre-Alarm<br><input type="checkbox"/> High Fuel Pre-Alarm<br><input type="checkbox"/> Low Coolant Temp Pre-Alarm<br><input type="checkbox"/> Coolant Temp Sender Fail Pre-Alarm<br><input type="checkbox"/> Oil Pressure Sender Fail Pre-Alarm<br><input type="checkbox"/> Fuel Level Sender Fail Pre-Alarm<br><input type="checkbox"/> Battery Overvoltage Pre-Alarm<br><input type="checkbox"/> kW Overload 1 Pre-Alarm<br><input type="checkbox"/> High Coolant Temp Pre-Alarm<br><input type="checkbox"/> Low Oil Pressure Pre-Alarm<br><input type="checkbox"/> Low Battery Voltage Pre-Alarm<br><input type="checkbox"/> Weak Battery Voltage Pre-Alarm<br><input type="checkbox"/> Scheduled Maintenance Pre-Alarm<br><input type="checkbox"/> Switch not in |
| Dial Out Number 2<br><input type="text" value="0"/>           | Pager ID 2<br><input type="text" value="0"/>  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Dial Out Number 3<br><input type="text" value="0"/>           | Pager ID 3<br><input type="text" value="0"/>  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Dial Out Number 4<br><input type="text" value="0"/>           | Pager ID 4<br><input type="text" value="0"/>  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Rings for Modem Answer<br><input type="text" value="2"/>      | Inter Dialout Activation Delay<br>15 Sec      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Modem Offline Delay (min)<br><input type="text" value="10"/>  | Pager Buffer Limit<br>80 Chars                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Modem Initialization String<br><input type="text" value="0"/> | Pager Coms Data Format<br>7 bit - Even Parity |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

**Figure 4-26. Modem Setup**

#### Modem Setup through the Front Panel HMI

If a USB or Ethernet connection is not available, the modem can be completely set up through the front-panel interface. Navigate to MAIN MENU > SETTINGS > COMMUNICATION > MODEM SETUP and enter parameters for Dialout Numbers, Pager IDs, Rings for Answer, Offline Delay, Dialout Delay, Pager Buffer Limit, and Pager Communication Data Format.

After the modem is set up properly, a modem connection between a computer running BESTCOMSP<sub>Plus</sub> and the DGC-2020 can be established.

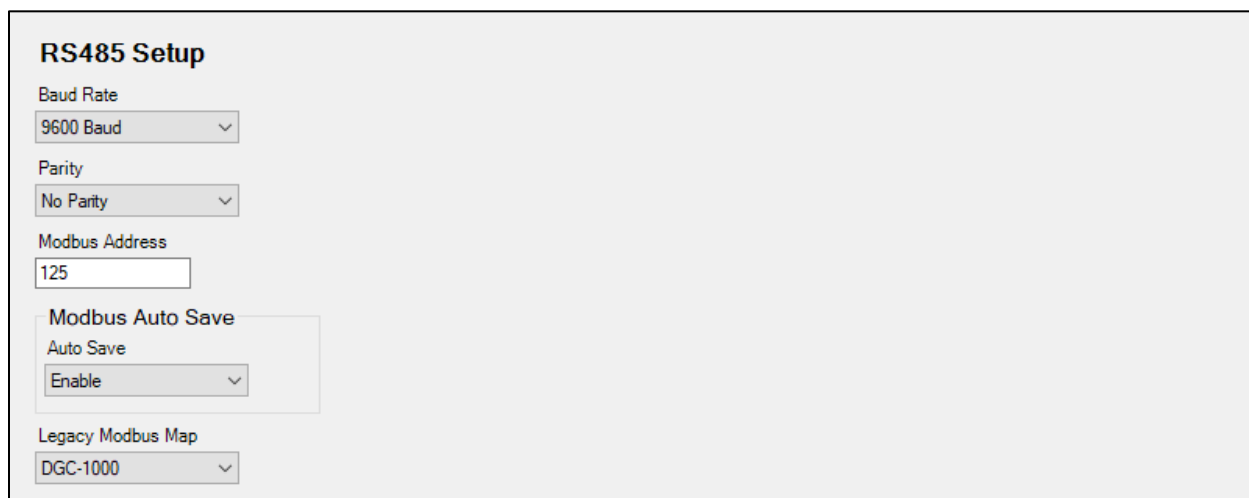
#### **RS485 Setup (Optional)**

DGC-2020 controllers with the optional RS-485 communication port (style number xxxRxxxxx) can be monitored and controlled via a polled network using the Modbus protocol. Adjustable RS-485 port settings include the baud rate, parity, port address, and legacy Modbus map. Fixed RS-485 port settings include the number of data bits (8) and stop bits (1).

When Auto Save is enabled, settings are automatically saved to nonvolatile memory after Modbus writes. Alternately, when Auto Save is disabled, you must write to the Save All Settings Modbus register to save settings.

Modbus register values for the DGC-2020 are listed and defined in Appendix B, *Modbus Communication*. The BESTCOMSP<sub>Plus</sub> RS485 Setup screen is illustrated in Figure 4-27.





**RS485 Setup**

Baud Rate  
9600 Baud

Parity  
No Parity

Modbus Address  
125

Modbus Auto Save  
Auto Save  
Enable

Legacy Modbus Map  
DGC-1000

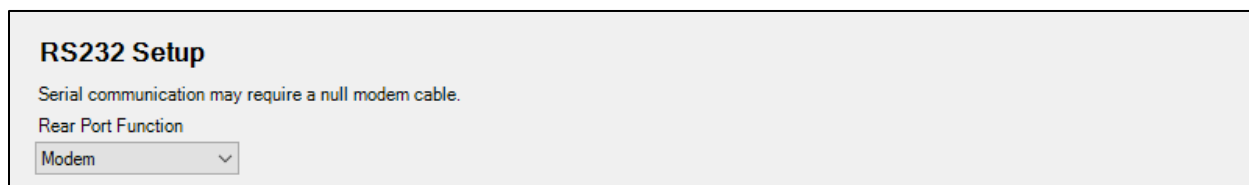
Figure 4-27. RS485 Setup

## RS232 Setup

DGC-2020 controllers with style number xxxxxExxx are equipped with an RS-232 port. This port allows communication with an external, user-supplied modem or directly through an RS232 serial cable from the DGC-2020 to a PC. The Rear Port Function is selected on the RS232 Setup screen.

| Note                                              |
|---------------------------------------------------|
| Serial communication requires a null model cable. |

The BESTCOMSP<sup>Plus</sup> RS232 Setup screen is illustrated in Figure 4-28.



**RS232 Setup**

Serial communication may require a null modem cable.

Rear Port Function  
Modem

Figure 4-28. RS232 Setup

## System Parameters

System parameters configure the DGC-2020 for operation with a specific application and are divided into eight categories: system settings and rated data, remote module setup, crank settings, automatic restart, exercise timer, sensing transformers, relay control, and auto config detection.

### System Settings and Rated Data

The following settings are used to configure the DGC-2020 for operation with a specific genset application. Refer to Figure 4-29, *System Settings*, and Figure 4-30, *Rated Data*. Click the *Edit* button on the *Rated Data* screen to make changes to rated data and click the *Save* button when finished. Sensing Transformers settings are described later in this section under *Sensing Transformers*.

#### Genset Electrical Parameters

Genset electrical parameters used by the DGC-2020 include the genset connection type, power rating, and voltage rating.

Genset connection types accommodated by the DGC-2020 include three, three-phase configurations (delta, wye, and four-wire delta) and two single-phase configurations (sensing across phases A and B or A and C).

Bus sensing connection types include Single-Phase and Three-Phase.

The Phase Rotation setting allows selection of ABC or CBA rotation according to the phase rotation connection of the machine. The DGC-2020 calculates the power angle as the angle between the Phase AB voltage and phase B current, and then applies an angle compensation factor determined by the phase rotation setting. If the actual phase rotation connection of the machine does not match the phase rotation setting, calculation of the power angle will be incorrect, which could result in a miscalculation of kW, kvar, and Power Factor.

The DGC-2020 is compatible with gensets having power ratings up to 9,999 kW and voltage ratings up to 99,999 Vac.

The System Type setting is used with dead bus breaker close arbitration. For more information, refer to Section 3, *Functional Description, Dead Bus Breaker Close Arbitration*.

The Alternate Frequency setting defines the rated machine speed for the speed trim function when the alternate frequency override logic element is TRUE. The DGC-2020 recalculates the speed trim setpoint as:

$$\text{Alternate Speed Trim Setpoint} = \text{Speed Trim Setpoint} \times \left( \frac{\text{Alternate Frequency Setting}}{\text{Rated Frequency Setting}} \right)$$

For example, a machine has a rated frequency of 60 Hz, the speed trim setpoint is set for 59.5 Hz, and the alternate frequency is set for 50 Hz. When the alternate frequency override logic element is TRUE, the DGC-2020 calculates the alternate speed trim setpoint to be  $59.5 \times (50/60) = 49.58$  Hz.

The 32 protection function uses the Genset KW Rating when determining pickup. The 40Q protection function uses the Rated kvar (which is calculated from the Genset KW Rating) and the Rated Power Factor setting when determining pickup.

#### Engine Speed Measurement

The DGC-2020 can be configured to detect engine speed from a magnetic pickup (MPU), the genset frequency, or both the MPU and genset frequency. On engines with CAN Bus ECUs, if MPU or MPU Freq is selected as the Speed Signal Source, the DGC-2020 uses CAN Bus as the speed source when CAN Bus is enabled. If Gen Freq is set as the Speed Signal Source, the DGC-2020 uses the generator frequency.

When engine speed is obtained from the genset frequency, the DGC-2020 uses the rated (nominal) genset frequency and nominal rpm rating when calculating engine rpm.

When engine speed is obtained from an MPU, the DGC-2020 uses the nominal rpm rating and the number of flywheel teeth when calculating engine rpm.

The speed signal from the MPU takes priority when both the genset frequency and MPU are selected as the engine speed source. If both MPU and genset frequency are selected and the MPU fails, the DGC-2020 will automatically switch to the genset frequency as the engine speed source.

When the CAN Bus interface is used, the speed signal source settings must be set at MPU or MPU\_Gen. This allows the DGC-2020 to receive the engine speed data sent by the ECU via the SAE J1939 protocol.

#### EPS Threshold

Indication that the emergency power system is supplying load is determined by a user-adjustable threshold setting expressed as a percentage of the genset CT (nominal) primary rating.

The Low Line Scale Factor setting is used to automatically adjust the EPS threshold setting in applications that might utilize more than one type of genset connection. The scale factor setting is implemented when the DGC-2020 senses a contact closure at a contact input programmed to activate scaling of the settings. The value of the scale factor setting serves as a multiplier for the threshold setting. For example, if a scale factor contact input is received by the DGC-2020 and the scale factor setting is 2.000, the threshold setting will be doubled (2.000 x Threshold setting).

### Measurement/Metering Units

The user can configure the DGC-2020 to display and report engine oil pressure and coolant temperature in English or metric units of measure. Engine oil pressure has an additional parameter for Metric Pressure Units.

### Meter Settings

The Minimum Generator Current for Metering setting defines the minimum current required for metering. The DGC-2020 will show zero (0) in metering for any current levels below this setpoint.

### Battery Voltage

The nominal voltage of the starter battery is used by the DGC-2020 to detect and annunciate battery overvoltage and low or weak battery voltage.

### NFPA Compliance Level

The DGC-2020 can be used in an application requiring compliance with NFPA Standard 110. Levels 1 and 2 of Standard 110 are supported. Selecting level 1 or 2 affects DGC-2020 operation in the following ways:

- The number of crank cycles is fixed at 3
- Crank cycle time is fixed at 15 seconds
- Continuous crank time is fixed at 45 seconds
- The low coolant temperature pre-alarm setting is fixed at 70°F

### Fuel Level

The Function setting allows the selection of four fuel types: Fuel Lvl, Natural Gas, Liquid Propane, or Disabled. Selecting a fuel type other than Fuel Lvl will disable any fuel level indication, alarm, and pre-alarm and disable the Fuel Level value on the Engine screen of the Metering Explorer in BESTCOMSP<sup>Plus</sup>. If the Function setting is set to disabled, RPM will display on the front-panel Overview screen rather than fuel level.

The use of a 0 - 10 V or 4 - 20 mA transducer is possible when an Analog Expansion Module (AEM-2020) is connected. Use the Source setting to select the AEM-2020 analog input tied to the transducer.

Set the maximum and minimum percentage range for the AEM-2020 analog inputs using the Maximum and Minimum percent settings. The maximum and minimum range of the AEM-2020 analog inputs are set separately. See *Programmable Inputs, Remote Analog Inputs*, below, for more information.

### Power Up Delay

In some cases, the ECU takes longer than the DGC-2020 to power up. The power up delay setting is used to delay the initial pulsing of the ECU for data on DGC-2020 power up.

### Generator Frequency

The generator frequency is defined by the DGC-2020 Style Number (Figure 4-15).

### Rated Power Factor

This is the power factor at which the Rated kW is specified.

### Genset kW Rating

This setting specifies the generator's kW rating at the rated power factor value.

### Alternate Genset kW Rating 1–4

In some cases, engines may have different fuel sources, and the Generator Rated KW may differ based on which fuel source is employed. Alternates can be selected in BESTlogic<sup>Plus</sup> using the Generator Alternate kW logic element.

### Calculated Rated Data

The calculated rated data parameters are listed below.

$$\text{Rated kVA} = \frac{\text{Rated kW}}{\text{Rated PF}}$$

$$\text{Rated kvar} = \text{Rated kVA} \sqrt{1 - \text{Rated PF}^2}$$

$$\text{Rated Phase Amps (3-phase machine)} = \frac{\text{Rated kVA}}{\text{Rated L-L Volts} \sqrt{3}}$$

$$\text{Rated Phase Amps (1-phase machine)} = \frac{\text{Rated kVA}}{\text{Rated L-L Volts}}$$

$$\text{Rated Secondary Volts} = \text{Rated Volts} \left( \frac{\text{Gen PT Secondary Volts}}{\text{Gen PT Primary Volts}} \right)$$

$$\text{Rated Secondary Phase Amps} = \text{Rated Phase Amps} \left( \frac{\text{CT Secondary Amps}}{\text{CT Primary Amps}} \right)$$

#### Rated Voltage Low Line Scale Factor

The rated voltage low line scale factor setting preserves the system gains when a machine is changed from high line (where the windings are typically in series) to low line (where the windings are typically in parallel) configuration. When the windings are in series, typically a given change in voltage regulator bias will result in twice the change in output voltage as the same change in bias on a low line configuration.

Correct use of the rated voltage setting and the rated voltage low line scale factor setting on a reconfigurable machine, is to set the rated voltage to the high line voltage of the machine and set the scale factor to 0.5 to adjust the rated voltage in the voltage trim calculation when the low line override is active.

**System Settings**

|                                                                                                                                                                                    |                                                                                                                                                                         |                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>System Type</b><br>Single Generator (dropdown)<br><b>Number Fly Wheel Teeth</b><br>126.0<br><b>Speed Signal Source</b><br>MPU_Freq (dropdown)<br><b>Power Up Delay (s)</b><br>1 | <b>Fuel Level Setup</b><br><b>Function</b><br>Fuel Lvl (dropdown)<br><b>Source</b><br>Sender (dropdown)<br><b>Maximum Percent</b><br>100<br><b>Minimum Percent</b><br>0 | <b>NFPA Level</b><br><input checked="" type="radio"/> Zero<br><input type="radio"/> One<br><input type="radio"/> Two<br><b>EPS Supplying Load</b><br><b>Low Line Scale Factor</b><br>1.000<br><b>EPS Threshold (% of CT Pri)</b><br>3 | <b>System Units</b><br><input checked="" type="radio"/> English<br><input type="radio"/> Metric<br><b>Metric Pressure Units</b><br><input checked="" type="radio"/> bar<br><input type="radio"/> kPa/MPa<br><b>Meter Settings</b><br><b>Minimum Generator Current for Meter (%)</b><br>2.0 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**Figure 4-29. System Settings**

**Rated Data**

**Sensing Transformers**

**Generator PT**

Gen PT Primary Volts (V)  
480

Gen PT Secondary Volts (V)  
480

**Bus PT**

Bus PT Primary Volts (V)  
480

Bus PT Secondary Volts (V)  
480

**Generator CT**

Current Sensing Input Type  
5A CTs

Gen CT Primary Amps (A)  
500

Gen CT Low Line Scale Factor  
1.000

**Rated Data**

Rated Volts (V L-L)  
480

Rated Secondary Volts (V L-L)  
480

Rated Volts (Low Line Scale Factor)  
1.000

Rated Phase Amps (A)  
451

Rated Secondary Phase Amps (A)  
4.51

Rated Power Factor  
0.800

Genset kW Rating (kW)  
300

Alternate Genset kW Rating 1 (kW)  
300

Alternate Genset kW Rating 2 (kW)  
300

Alternate Genset kW Rating 3 (kW)  
300

Alternate Genset kW Rating 4 (kW)  
300

Rated kVA  
375

Rated kvar  
225

Rated Engine RPM (rpm)  
1.800

**Frequency**

Generator Frequency  
50/60 Hz

Rated frequency of the unit  
60 Hz

Alternate Frequency (Hz)  
60.00

**Battery Volts**

☐ 12V  
☒ 24V

**Miscellaneous**

Generator Connection  
Wye

Bus Connection  
1 phase AB

Phase Rotation  
ABC

Cancel OK

Figure 4-30. Rated Data

## Remote Module Setup

The following settings are used to configure the LSM-2020, CEM-2020, and AEM-2020.

### Load Sharing Module

A J1939 Address must be entered when an optional LSM-2020 is enabled. Use the LSM Auxiliary Input Source setting to select the source of the input values used for controlling the DGC-2020. If *Local* is selected, the LSM-2020 uses its locally measured input values. If *System Manager* is selected, the LSM-2020 uses the input values received through inter-genset communications from the unit designated as the system manager. Note that the unit in the system with the lowest nonzero sequencing ID is the system manager.

### Contact Expansion Module

A J1939 Address must be entered when the optional CEM-2020 is enabled. Select number of CEM-2020 outputs.

### Analog Expansion Module

A J1939 Address must be entered when the optional AEM-2020 is enabled.

The BESTCOMSPlus Remote Module Setup screen is illustrated in Figure 4-31.

**Remote Module Setup**

| Load Share Module                                                        | Contact Expansion Module                                                 | Analog Expansion Module                                                  |
|--------------------------------------------------------------------------|--------------------------------------------------------------------------|--------------------------------------------------------------------------|
| <input type="radio"/> Disable<br><input checked="" type="radio"/> Enable | <input type="radio"/> Disable<br><input checked="" type="radio"/> Enable | <input type="radio"/> Disable<br><input checked="" type="radio"/> Enable |
| LSM J1939 Address<br>235                                                 | CEM J1939 Address<br>236                                                 | AEM J1939 Address<br>237                                                 |
| LSM Auxiliary Input Source<br>Local                                      | CEM Outputs<br>18 Outputs                                                |                                                                          |

**Figure 4-31. Remote Module Setup**

## Crank Settings

The DGC-2020 can be programmed for either cycle or continuous engine cranking. Cycle cranking provides multiple engine starting attempts. Each starting attempt consists of a fixed interval of engine cranking followed by a rest interval. Continuous cranking provides a single, extended engine-starting attempt.

The DGC-2020 uses the engine speed signal (supplied by a magnetic pickup (MPU) or the generator frequency) and the Crank Disconnect Limit setting to detect engine startup (and determine when engine cranking can be stopped). The Crank Disconnect Limit setting is expressed as a percentage of the nominal engine speed.

If desired, cycle or continuous cranking can be delayed after initiating engine startup. During this delay, the Pre-Start output closes to energize the engine glow plugs or pre-start lubrication pump. The Pre-Start output can be configured to open upon the conclusion of engine cranking or remain closed as long as the engine is running.

The Pre-Start output can be configured during the resting state. If Preheat Before Crank is selected, the Pre-Start output is closed for the duration of the Pre-crank Delay time prior to entering the first cranking state or any subsequent cranking state. If the Pre-crank Delay setting is longer than the rest interval, the Pre-Start output is closed for the entire duration of the rest time.

A Minimum Crank Time setting can help prevent premature crank disconnections by ignoring engine rpm broadcast data until the minimum crank time has elapsed.

For example, suppose Crank Cycle Time and Rest Time are 30 seconds, Pre-crank Delay time is 15 seconds, and Preheat Before Crank is selected. Then, when it is desired to start the engine, the following would occur:

- Pre-Crank Delay of 15 seconds
- Crank for 30 seconds
- Rest for 15 seconds
- Rest and Pre-Crank Delay for 15 seconds
- Crank for 30 seconds
- Rest and Pre-Crank Delay for 15 seconds
- Crank for 30 seconds
- Repeating until the engine starts or the maximum number of crank cycles has occurred.

For another example, suppose Crank Cycle Time and Rest Time are 30 seconds, Pre-crank Delay time is 60 seconds, and Preheat Before Crank is selected. Then, when it is desired to start the engine, the following would occur:

- Pre-Crank Delay of 60 seconds
- Crank for 30 seconds
- Rest and Pre-Crank Delay for 30 seconds (the Rest Time setting controls the duration of this state)
- Crank for 30 seconds

- Rest and Pre-Crank Delay for 30 seconds (the Rest Time setting controls the duration of this state)
- Crank for 30 seconds
- Repeating until the engine starts or the maximum number of crank cycles has occurred.

Under normal operation, engine rpm is used to determine crank disconnect. The Oil Pressure Crank Disconnect provides a secondary indication that the engine is running so that the starter will be disconnected even if no engine rpm sources are functioning. When enabled, oil pressure is used as a check of whether the engine is running. If the engine oil pressure is above the threshold, the starter will be disconnected from the engine.

### Engine Cool Down

After a genset's load is removed, the DGC-2020 implements a smart cool down function, which ensures proper engine and turbocharger cool down by maintaining engine operation for a user-specified duration. The cool down time delay is initiated for any one of the following conditions:

- Genset load is removed and engine shutdown is permitted while in Auto mode
- Auto transfer switch (ATS) opens while operating in Auto mode
- Remote shutdown is initiated while in Auto mode
- Off Mode Cool Down is initiated
- The Cool Down Request logic element is initiated
- The Cool and Stop Request logic element is initiated

Note that if the Cool Down Configuration setting is set for Only When Loaded, the DGC-2020 only goes through a cool down sequence if the generator has supplied load (i.e. there was enough current for the Supplying Load LED to illuminate on the front panel while the generator was running) and one of the above conditions occurs to initiate the cool down sequence. If the Cool Down Configuration setting is set for Always, the DGC-2020 goes through a cool down sequence after every run session regardless of load levels. In addition, cool down can occur during normal running before any of the above conditions occur. If the engine was loaded, then the load is removed during normal running and the cool down timer begins timing since cool down is occurring due to the absence of load. If one of the above conditions occurs after the load has been removed, there may be a shortened "normal" cool down period since some cooling has already occurred, or the cool down may be skipped if the cool down timer elapsed during normal engine running. This reduces unnecessary fuel expenditure going through a cool down cycle that is not required since partial or complete cool down has already occurred.

### Off Mode Cool Down

When Off Mode Cool Down is enabled, pressing the DGC-2020 front panel Off button one time will cause the unit to unload, open its breaker, and go through a cool down cycle for the duration of the No Load Cool Down Time. At the end of the cool down cycle, the unit will go to Off mode. If it is desired to stop the machine immediately, pressing the Off button twice will cause the unit to go to Off mode immediately. Furthermore, if an Off Mode Cool Down is in progress and the Off button is pressed, the unit will immediately shut down. If the unit was in Run mode when the Off button was pressed, it remains in Run for the remainder of the cool down cycle. If the machine was in the Auto mode when the Off button was pressed, it remains in Auto mode until the cool down and shutdown cycle are completed, or until the Off button is pressed a second time forcing the unit to Off mode. The Off LED will flash to indicate an off mode cool down is in progress. In addition, the unit will display "OFF MODE COOLDN" while the cool down timer is displayed.

If the Run button is pressed while an Off Mode Cool Down is in progress, the cool down will be aborted and the unit will go to Run mode.

If the Auto button is pressed while an Off Mode Cool Down is in progress, the Off Mode Cool Down is cleared and the unit returns to normal Auto operation. Thus, if conditions exist where the unit would normally run in Auto, it will resume running in Auto. If conditions exist where the unit would normally shut down in Auto, the unit will finish the remaining cool down cycle then stop and remain in AUTO.

If Off Mode Cool Down is not enabled, pressing the Off button once at any time will immediately force the unit to Off mode.



The Off Mode Cool Down feature works from the front panel HMI buttons only. Any Off command received through BESTlogicPlus or BESTCOMSPlus control result in an immediate transition of the machine to Off.

If the NFPA level setting is set for 1 or 2, the Off Mode Cool Down enable setting is cleared and Off mode cool down is not allowed.

### Restart

Attempting to start an engine after a normal shutdown before the engine RPM has settled to zero can stress an engine in certain situations. The Restart Delay inhibits attempts to start the engine immediately after a normal shutdown for the duration of the Restart Delay timer. This delay should allow an engine to properly spin down before attempting to restart.

The BESTCOMSPlus Crank Settings screen is illustrated in Figure 4-32.

**Crank Settings**

**Pre-Start**  
 Pre-crank Delay (s)  
  
 Pre Start Contact Config  
☒ Open After Disconnect  
☐ Closed While Running  
 Prestart Rest Configuration  
☐ Off During Rest  
☒ On During Rest  
☐ Preheat Before Crank  
 Restart  
 Restart Delay (s)

**Cranking**  
 Cranking Style  
☒ Cycle  
☐ Continuous  
 Cycle  
 Number of Crank Cycles  
  
 Cycle Crank Time (s)  
  
 Rest Time (s)  
  
 Continuous  
 Continuous Crank Time (s)  
  
 Minimum  
 Minimum Crank Time (s)

**Crank Disconnect**  
 Crank Disconnect Limit (%)  
  
 Oil Pressure Crank Disconnect Enable  
☒ Disable  
☐ Enable  
 Crank Disconnect Pressure (psi)

**Cool Down**  
 Off Mode Cool Down Enable  
  
 Cool Down Configuration  
  
 No Load Cool Down Time (min)

**Figure 4-32. Crank Settings**

### **Automatic Restart**

If the DGC-2020 has shut down due to an alarm condition, the automatic restart, when enabled, will automatically clear alarms. An attempt to restart the engine is made after a predetermined time delay if the ATS contact input is closed. If an ATS contact is not present, the unit will remain in READY state with its alarms cleared. A restart will not be attempted if a low fuel alarm or emergency stop is present. The number of restart attempts is programmable. Automatic restart attempts are recorded in the event log.

The BESTCOMSPlus Automatic Restart screen is illustrated in Figure 4-33.



**Automatic Restart**

Auto Restart Enable

Auto Restart Interval (min)

Auto Restart Attempts

Figure 4-33. Automatic Restart

## Exercise Timer

The exercise timer is used to start the genset at a predetermined time and run for a user-defined period. The mode defines how often the genset will run. If monthly is selected, the day of the month to start must also be selected. If weekly is selected, the day of the week to start must also be selected. If Weekday of Month is selected, Start Day of Week and Week of Month must also be selected. If N Week Intervals is selected, Start Day of Week, Week Interval, and Begin Date must also be selected. Settings for Start Hour and Start Minute can also be defined. The Run Period Hours and Minutes define how long the genset will run each session. The Start Hour and Run Period Hours settings accept values from 0 to 23, in increments of 1 hour. The Start Minute and Run Period Minutes settings accept values from 0 to 59, in increments of 1. If Run with Load is enabled, the DGC-2020 closes the generator breaker during the run time.

Contact inputs and outputs can be assigned to the function. Refer to Section 5, *BESTlogicPlus Programmable Logic*, for more information.

The BESTCOMSPlus Exercise Timer screen is illustrated in Figure 4-34.

**Exercise Timer**

Mode

Start Day Of Month

Start Day Of Week

Week of Month

Week Interval

Start Hour

Start Minute

Run Period Hours

Run Period Minutes

Run with Load

Begin Date  
 Month  
  
 Day  
  
 Year

Figure 4-34. Exercise Timer

## Sensing Transformers

Three sets of transformer settings configure the DGC-2020 for operation with a specific system. These settings, along with the generator voltage, generator current, and bus voltage detected by the DGC-2020,

enable the DGC-2020 to accurately meter system values, offer generator protection, and synchronize the generator with the bus (style number xxxxxxxAx only).

Click the *Rated Data* button on the *Sensing Transformers* screen to make changes to rated data and click the *Save* button when finished. Click the *Cancel* button to discard changes.

### Generator PT Settings

The generator PT settings establish the nominal primary (generator side) and secondary (DGC-2020 side) voltage levels at the generator voltage-sensing transformer.

### Bus Transformer Settings

Primary and secondary bus transformer ratings are used by the automatic transfer switch function, which monitors a single- or three-phase bus input to detect mains failure. Controllers equipped with an automatic synchronizer (style number xxxxxxxAx) also use the primary and secondary bus transformer ratings. The primary setting establishes the nominal voltage present at phases A and C of the bus. The secondary setting establishes the nominal voltage seen at the bus voltage input of the DGC-2020.

### Generator CT Settings

The generator CT setting establishes the nominal, primary (generator side) current level at the generator current sensing transformer. The secondary value of the generator CT is dictated by the style number of the controller. A DGC-2020 with a style number of 1xxxxxxx uses a nominal CT secondary rating of 1 Aac. A DGC-2020 with a style number of 5xxxxxxx uses a nominal CT secondary rating of 5 Aac.

The Gen CT Low Line Scale Factor setting is used to automatically adjust the Gen CT Primary Amps setting in applications that might utilize more than one type of genset connection. The scale factor setting is implemented when the DGC-2020 senses a contact closure at a contact input programmed to activate scaling of the settings. The value of the scale factor setting serves as a multiplier for the Gen CT Primary Amps setting. For example, if a scale factor contact input is received by the DGC-2020 and the scale factor setting is 2.000, the Gen CT Primary Amps setting will be doubled (2.000 x Gen CT Primary Amps setting).

The BESTCOMSPlus Sensing Transformers screen is illustrated in Figure 4-35.

**Sensing Transformers**

**Sensing Transformers**

**Generator PT**

Gen PT Primary Volts (V)  
480

Gen PT Secondary Volts (V)  
480

**Bus PT**

Bus PT Primary Volts (V)  
480

Bus PT Secondary Volts (V)  
480

**Generator CT**

Current Sensing Input Type  
5A CTs

Gen CT Primary Amps (A)  
500

Gen CT Low Line Scale Factor  
1.000

**Figure 4-35. Sensing Transformers**

## Relay Control

The default operational setting for the Start, Run, and Prestart relays is “Predefined” or standard. Any of these relays can be logic driven by selecting the “Programmable” setting. Logic driven (programmable) relays must be set up using BESTlogicPlus.

The BESTCOMSPlus Relay Control screen is illustrated in Figure 4-36.

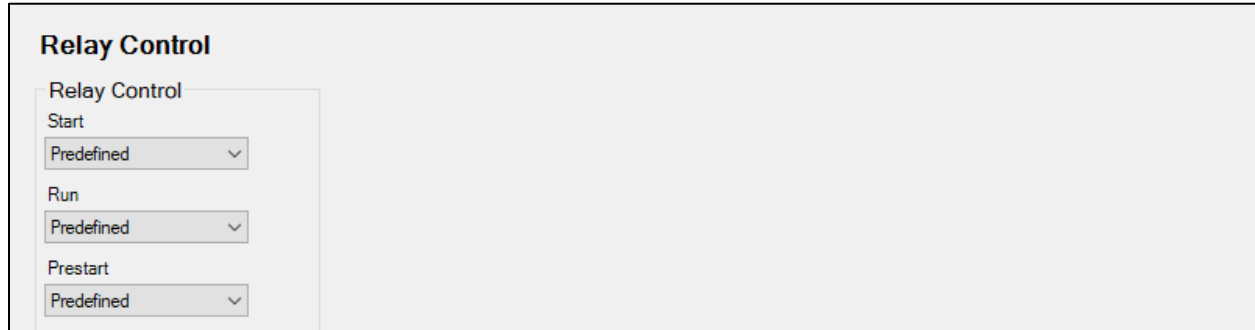


Figure 4-36. Relay Control

## Auto Config Detection

When enabled, this feature allows the DGC-2020 to automatically detect its sensing configuration in relation to the generator. The possible sensing configurations are three-phase, single-phase AB, and single-phase AC that are based upon line-to-line (L-L) voltage measurements.

Upon starting the genset, the configuration of the generator is automatically detected. Metering and generator protection are adjusted accordingly. Single Phase Override, Single Phase AC Sense Override, and Low Line Override programmable functions are set automatically as indicated by the detected Line-to-Line voltages.

When single-phase operation is detected, the DGC-2020 switches to single-phase A-B or single-phase A-C configuration, as specified by the Single Phase Detect Generator Connection setting.

There is a one-second delay in the detection to prevent the DGC-2020 from alternating between detected configurations. When the DGC-2020 is in the Off mode or the engine is not running, the Automatic Configuration Detection is disabled. The DGC-2020 is assumed to be in the last valid automatically detected configuration.

It is recommended that the following programmable functions and logic element are not mapped to contact inputs when Automatic Configuration Detection is enabled.

- Single Phase Override programmable function
- Single Phase AC Sense Override programmable function
- Low Line Override programmable function
- Single Phase Override logic element

**Single Phase Detect Threshold.** If the difference between the maximum and minimum L-L voltage exceeds this threshold, the unit will be auto detected to be in single-phase configuration. Single-phase detection sets the Single Phase Override programmable function and/or the Single Phase AC Override programmable function to force the DGC-2020 into the appropriate single-phase mode as specified by the *Single Phase Detection Generator Connection* setting. If contact inputs are also mapped to the Single Phase Override and Single Phase AC Sense Override programmable functions, the results of the Automatic Configuration Detection will be ORed with what is indicated by the contact inputs.

**Low Line Detect Threshold.** If the average of the valid L-L voltages for the detected configuration is above this threshold, the unit will be auto detected as being in a high line configuration. If the average is below this threshold, it will be auto detected as being in a low-line configuration. When detected to be in a low-line configuration, the detection will set the Low Line Override programmable function to force the DGC-2020 into the low-line configuration. If contact inputs are also mapped to the Single Phase Override and Low Line Override programmable function, the results of the Automatic Configuration Detection will be ORed with what is indicated by the contact inputs.

**Single Phase Detect Generator Connection.** This setting specifies whether the machine should go into a single-phase AC or single-phase AB configuration when the machine is detected to be in a single-phase configuration.

The BESTCOMSP<sub>Plus</sub> Auto Config Detection screen is illustrated in Figure 4-37.

**Auto Config Detection**

Auto Config Detection

Enable  
Enable

Single Phase Detect Threshold (V)  
40 V L-L

Low Line Detect Threshold (V)  
200 V L-L

Single Phase Detect Generator Connection  
A-B

Figure 4-37. Auto Config Detection

## Programmable Inputs

DGC-2020 programmable inputs can be assigned to trigger various functions and, when triggered, announce an alarm or pre-alarm. A user-assigned label can be assigned to each input to make identification easier. The description of these settings is organized as follows:

- Contact Inputs
- Programmable Functions
- Remote LSM Inputs (Available with an optional LSM-2020 (Load Share Module).
- Remote Contact Inputs (Available with an optional CEM-2020 (Contact Expansion Module).
- Remote Analog Inputs (Available with an optional AEM-2020 (Analog Expansion Module).
- Remote RTD Inputs (Available with an optional AEM-2020 (Analog Expansion Module).
- Remote Thermocouple Inputs (Available with an optional AEM-2020 (Analog Expansion Module).

### Contact Inputs

Each of the 16 contact inputs can be independently configured to announce an alarm or pre-alarm when the input senses a contact closure. A user-adjustable time delay can be set to delay generation of an alarm or pre-alarm when the input is configured as an alarm or pre-alarm. The status of the input is available immediately for BESTlogic<sub>Plus</sub> and on the Contact Inputs status screen on the front panel or in BESTCOMSP<sub>Plus</sub>. By default, all inputs are configured so that they do not trigger an alarm or pre-alarm.

To make identifying the contact inputs easier, a user-assigned name can be given to each input.

Contacts can be recognized always or while the engine is running only.

The contact inputs are incorporated into a BESTlogic<sub>Plus</sub> programmable logic scheme by selecting them from the I/O group in BESTlogic<sub>Plus</sub>. For more details, refer to Section 5, *BESTlogic<sub>Plus</sub> Programmable Logic*.

Contact input status is available in BESTlogic<sub>Plus</sub> Programmable Logic when “None” is selected for Alarm Configuration.

The BESTCOMSP<sub>Plus</sub> Contact Inputs screen is illustrated in Figure 4-38.

**Contact Inputs**

| Input #1                      | Input #2                      | Input #3                      | Input #4                      | Input #5                      | Input #6                      |
|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| Alarm Configuration<br>None   | Alarm Configuration<br>None   | Alarm Configuration<br>None   | Alarm Configuration<br>None   | Alarm Configuration<br>None   | Alarm Configuration<br>None   |
| Activation Delay (s)<br>0     | Activation Delay (s)<br>0     | Activation Delay (s)<br>0     | Activation Delay (s)<br>0     | Activation Delay (s)<br>0     | Activation Delay (s)<br>0     |
| Label Text<br>INPUT 1         | Label Text<br>INPUT 2         | Label Text<br>INPUT 3         | Label Text<br>INPUT 4         | Label Text<br>INPUT 5         | Label Text<br>INPUT 6         |
| Contact Recognition<br>Always | Contact Recognition<br>Always | Contact Recognition<br>Always | Contact Recognition<br>Always | Contact Recognition<br>Always | Contact Recognition<br>Always |

Figure 4-38. Contact Inputs

## Programmable Functions

Any of the 16 contact inputs can be programmed to recognize any one of nine function types:

- Automatic Transfer Switch (ATS) - When Input Mode is set to Single, the ATS function starts and runs the generator while the ATS input is TRUE and the DGC-2020 is in Auto mode. When Input Mode is set to Complementary, a Normally Open Input and a Normally Closed Input must be selected. While the Normally Open Input is closed, the Normally Closed Input is open, and the DGC-2020 is in Auto mode, the ATS function starts and runs the generator. If the Normally Open Input and the Normally Closed Inputs are in non-opposite states for a time interval greater than the duration of the Circuit Error Delay, an ATS Circuit Error Pre-alarm will occur. The Circuit Error Action setting dictates whether the generator should start or *not* start when an ATS Circuit Error Occurs.
- Grounded Delta Override - Uses Grounded Delta sensing if the generator connection is set for Delta.
- Battle Override - When a Battle Override condition is TRUE, the DGC-2020 annunciates a Battle Override Pre-Alarm and it is recorded in the event log. If an alarm occurs while a Battle Override condition is TRUE, the alarm is annunciated on the DGC-2020 front panel and recorded in the event log, but it will not stop the engine. The DGC-2020 monitors engine rpm during battle override. If the engine rpm drops to zero while an alarm is active during a Battle Override condition, the DGC-2020 proceeds to issue a normal shutdown to prevent fuel flow while the engine is not running. The Emergency Stop Alarm has priority over Battle Override. The engine will stop if the Emergency Stop is activated regardless of Battle Override status.
- Low-Line Override - The 51, 27, and 59 settings are scaled by the low-line scale factor setting.
- Single-Phase Override - The unit switches to single phase sensing configuration and uses the 1 Phase Override Sensing setting (A-B or A-C). (Note: Applies only when the Single-Phase Override (A-C) input is not invoked.)
- Single-Phase Override (A-C) - The unit switches to single phase A-C sensing configuration even if the 1 Phase Override Sensing setting is set for A-B. (Note: Applies only when the Single-Phase Override input is invoked.)
- Battery Charger Fail - When the selected input is invoked, a user selectable pre-alarm or alarm is annunciated after the activation delay.
- Low Coolant Level - When the selected input is invoked, a user selectable pre-alarm or alarm is annunciated after the activation delay.
- Fuel Leak Detect - When the selected input is invoked, a user selectable pre-alarm or alarm is annunciated after the activation delay.

An Alarm Configuration setting of “None” prevents a function from being triggered by a contact input. Programmable function status is available in BESTlogicPlus Programmable Logic when “None” is selected.

The BESTCOMSPlus Programmable Functions screen is illustrated in Figure 4-39.

**Programmable Functions**

|                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Auto Transfer Switch</b><br>Input Mode: <input type="text" value="Single"/><br>N. O. Input: <input type="text" value="None"/><br>N. C. Input: <input type="text" value="None"/><br>Circuit Error Delay (s): <input type="text" value="2.0"/><br>Circuit Error Action: <input type="text" value="None"/><br>Contact Recognition: <input type="text" value="Always"/> | <b>Grounded Delta Override</b><br>Input: <input type="text" value="None"/><br>Contact Recognition: <input type="text" value="Always"/>                                                                                                             | <b>Battle Override</b><br>Input: <input type="text" value="None"/><br>Contact Recognition: <input type="text" value="Always"/>                                                                                                                    |
| <b>Low Line Override</b><br>Input: <input type="text" value="None"/><br>Contact Recognition: <input type="text" value="Always"/>                                                                                                                                                                                                                                       | <b>Single Phase Override</b><br>Input: <input type="text" value="None"/><br>Contact Recognition: <input type="text" value="Always"/><br>Single Phase Override Sensing:<br><input checked="" type="radio"/> A-B <input type="radio"/> A-C           | <b>Single Phase AC Override</b><br>Input: <input type="text" value="None"/><br>Contact Recognition: <input type="text" value="Always"/>                                                                                                           |
| <b>Battery Charger Fail</b><br>Input: <input type="text" value="None"/><br>Alarm Configuration: <input type="text" value="None"/><br>Activation Delay (s): <input type="text" value="0"/><br>Contact Recognition: <input type="text" value="Always"/>                                                                                                                  | <b>Low Coolant Level</b><br>Input: <input type="text" value="None"/><br>Alarm Configuration: <input type="text" value="None"/><br>Activation Delay (s): <input type="text" value="0"/><br>Contact Recognition: <input type="text" value="Always"/> | <b>Fuel Leak Detect</b><br>Input: <input type="text" value="None"/><br>Alarm Configuration: <input type="text" value="None"/><br>Activation Delay (s): <input type="text" value="0"/><br>Contact Recognition: <input type="text" value="Always"/> |

**Figure 4-39. Programmable Functions**

## Remote LSM Inputs

An optional LSM-2020 (Load Share Module) provides one configurable analog input that can be used as a setpoint source for var, PF, or kW control. Settings are provided for min and max input voltage, and min and max input current. Refer to Bias Control Settings in this section for information selecting the LSM-2020 input as a setpoint source.

The remote LSM inputs are incorporated into a BESTlogicPlus programmable logic scheme by selecting them from the I/O group in BESTlogicPlus. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

The BESTCOMSPlus Remote LSM Inputs screen is illustrated in Figure 4-40.

**Remote LSM Inputs**

Input #1

Input Type  
Voltage

Min Input Voltage (V)  
0.0

Max Input Voltage (V)  
10.0

Min Input Current (mA)  
4.0

Max Input Current (mA)  
20.0

Figure 4-40. Remote LSM Inputs

## Remote Contact Inputs

An optional CEM-2020 (Contact Expansion Module) provides 10 contact inputs. Each of the 10 contact inputs can be independently configured to annunciate an alarm or pre-alarm when the input senses a contact closure. A user-adjustable time delay can be set to delay recognition of a contact input. By default, all inputs are configured so that they do not trigger an alarm or pre-alarm.

To make identifying the contact inputs easier, a user-assigned name can be given to each input.

Contacts can be recognized always or only while the engine is running.

The remote contact inputs are incorporated into a BESTlogicPlus programmable logic scheme by selecting them from the I/O group in BESTlogicPlus. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

Remote contact input status is available in BESTlogicPlus Programmable Logic when “None” is selected for Alarm Configuration.

The BESTCOMSPlus Remote Contact Inputs screen is illustrated in Figure 4-41.

**Remote Contact Inputs**

Input #17

Alarm Configuration  
None

Activation Delay (s)  
0

Label Text  
INPUT 17

Contact Recognition  
Always

Input #18

Alarm Configuration  
None

Activation Delay (s)  
0

Label Text  
INPUT 18

Contact Recognition  
Always

Input #19

Alarm Configuration  
None

Activation Delay (s)  
0

Label Text  
INPUT 19

Contact Recognition  
Always

Input #20

Alarm Configuration  
None

Activation Delay (s)  
0

Label Text  
INPUT 20

Contact Recognition  
Always

Input #21

Alarm Configuration  
None

Activation Delay (s)  
0

Label Text  
INPUT 21

Contact Recognition  
Always

Input #22

Alarm Configuration  
None

Activation Delay (s)  
0

Label Text  
INPUT 22

Contact Recognition  
Always

Figure 4-41. Remote Contact Inputs

## Remote Analog Inputs

An optional AEM-2020 (Analog Expansion Module) provides eight analog inputs. To make identifying the analog inputs easier, a user-assigned name can be given to each input.

Select the input type and amount of hysteresis. The analog inputs are always monitored and their status is displayed on the appropriate metering screens. A user-adjustable arming delay allows configuration of the analog input threshold monitoring in one of two ways. (1) When the arming delay is set to zero, threshold monitoring is performed all the time, whether the engine is running or not. (2) When the arming delay is set to a non-zero value, threshold monitoring begins when the arming delay time has expired after engine startup is complete. When enabled, an out of range alarm alerts the user of an open or damaged analog input wire.

Ranges must be set for the selected input type. Param Min correlates to Min Input Current or Min Input Voltage and Param Max correlates to Max Input Current or Max Input Voltage.

Each analog input can be independently configured to annunciate an alarm, pre-alarm, or status only when the analog input signal falls beyond the threshold. A user-adjustable activation delay setting delays alarm annunciation after the threshold has been exceeded.

The remote analog inputs are incorporated into a BESTlogicPlus programmable logic scheme by selecting them from the I/O group in BESTlogicPlus. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

A remote analog input is disabled when Alarm Configuration is set to "None". Remote analog input status is available in BESTlogicPlus Programmable Logic when "Status Only" is selected.

The BESTCOMSPlus Remote Analog Input #1 screen is illustrated in Figure 4-42.

**Remote Analog Input #1**

Label Text: ALG IN 1

Arming Delay (s): 0

Hysteresis (%): 2.0

Out Of Range Alarm Type: None

Input Type: Voltage

**Ranges**

| Param Min   | Min Input Current (mA) | Min Input Voltage (V) |
|-------------|------------------------|-----------------------|
| -999,999.00 | 4.0                    | 0.0                   |
| Param Max   | Max Input Current (mA) | Max Input Voltage (V) |
| 999,999.00  | 20.0                   | 10.0                  |

**Threshold #1**

| Under Threshold     | Over Threshold      | Activation Delay (s) |
|---------------------|---------------------|----------------------|
| 0.00                | 0.00                | 0                    |
| Alarm Configuration | Alarm Configuration |                      |
| None                | None                |                      |

**Threshold #2**

| Under Threshold     | Over Threshold      | Activation Delay (s) |
|---------------------|---------------------|----------------------|
| 0.00                | 0.00                | 0                    |
| Alarm Configuration | Alarm Configuration |                      |
| None                | None                |                      |

Figure 4-42. Remote Analog Input #1



## Remote RTD Inputs

An optional AEM-2020 (Analog Expansion Module) provides eight RTD inputs. To make identifying the RTD inputs easier, a user-assigned name can be given to each input.

Select the amount of hysteresis and RTD type. The RTD inputs are always monitored and their status is displayed on the appropriate metering screens. A user-adjustable arming delay allows configuration of the RTD input threshold monitoring in one of two ways. (1) When the arming delay is set to zero, threshold monitoring is performed all the time, whether the engine is running or not. (2) When the arming delay is set to a non-zero value, threshold monitoring begins when the arming delay time has expired after engine startup is complete. When enabled, an out of range alarm alerts the user of an open or damaged RTD input wire.

Each RTD input can be independently configured to annunciate an alarm, pre-alarm, or status only when the RTD input signal falls beyond the threshold. A user-adjustable activation delay setting delays alarm annunciation after the threshold has been exceeded.

The remote RTD inputs are incorporated into a BESTlogicPlus programmable logic scheme by selecting them from the I/O group in BESTlogicPlus. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

A remote RTD input is disabled when Alarm Configuration is set to “None”. Remote RTD input status is available in BESTlogicPlus Programmable Logic when “Status Only” is selected.

The BESTCOMSPlus Remote RTD Input #1 screen is illustrated in Figure 4-43.

**Remote RTD Input #1**

Label Text: RTD IN 1

Arming Delay (s): 0

Hysteresis (%): 2.0

Out Of Range Alarm Type: None

RTD Type: 100 Ohm Platinum

**Threshold #1**

Under Threshold (°F): 0

Over Threshold (°F): 0

Activation Delay (s): 0

Alarm Configuration: None

**Threshold #2**

Under Threshold (°F): 0

Over Threshold (°F): 0

Activation Delay (s): 0

Alarm Configuration: None

Figure 4-43. Remote RTD Input #1

## Remote Thermocouple Inputs

An optional AEM-2020 (Analog Expansion Module) provides two thermocouple inputs. To make identifying the thermocouple inputs easier, a user-assigned name can be given to each input.

Select the amount of hysteresis. The thermocouple inputs are always monitored and their status is displayed on the appropriate metering screens. A user-adjustable arming delay allows configuration of the thermocouple input threshold monitoring in one of two ways. (1) When the arming delay is set to zero,

threshold monitoring is performed all the time, whether the engine is running or not. (2) When the arming delay is set to a non-zero value, threshold monitoring begins when the arming delay time has expired after engine startup is complete.

Each thermocouple input can be independently configured to annunciate an alarm, pre-alarm, or status only when the thermocouple input signal falls beyond the threshold. A user-adjustable activation delay setting delays alarm annunciation after the threshold has been exceeded.

A remote thermocouple input is disabled when Alarm Configuration is set to “None”.

The remote thermocouple inputs are incorporated into a BESTlogicPlus programmable logic scheme by selecting them from the I/O group in BESTlogicPlus. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

Remote thermocouple input status is available in BESTlogicPlus Programmable Logic when “Status Only” is selected.

The BESTCOMSPlus Remote Thermocouple Input #1 screen is illustrated in Figure 4-44.

Figure 4-44. Remote Thermocouple Input #1

## Programmable Outputs

DGC-2020 programmable outputs include four user-programmable contact outputs if the style number is xxAxxxxxx. If the style number is xxBxxxxxx, 12 contact outputs are provided. An additional 24 contact outputs are provided with an optional CEM-2020 (Contact Expansion Module). An optional CEM-2020H (Contact Expansion Module - High Current) provides 18 contact outputs.

### Contact Outputs

To make identifying the contact outputs easier, each of the contact outputs can be given a user-assigned name with a maximum of 16 alphanumeric characters.

The contact outputs are incorporated into a BESTlogicPlus programmable logic scheme by selecting them from the I/O group in BESTlogicPlus. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

The BESTCOMSPlus Contact Outputs screen is illustrated in Figure 4-45.

| Contact Outputs                                                           |                                                                           |                                                                           |
|---------------------------------------------------------------------------|---------------------------------------------------------------------------|---------------------------------------------------------------------------|
| <b>Output #1</b><br>Label Text<br><input type="text" value="OUTPUT 1"/>   | <b>Output #2</b><br>Label Text<br><input type="text" value="OUTPUT 2"/>   | <b>Output #3</b><br>Label Text<br><input type="text" value="OUTPUT 3"/>   |
| <b>Output #4</b><br>Label Text<br><input type="text" value="OUTPUT 4"/>   | <b>Output #5</b><br>Label Text<br><input type="text" value="OUTPUT 5"/>   | <b>Output #6</b><br>Label Text<br><input type="text" value="OUTPUT 6"/>   |
| <b>Output #7</b><br>Label Text<br><input type="text" value="OUTPUT 7"/>   | <b>Output #8</b><br>Label Text<br><input type="text" value="OUTPUT 8"/>   | <b>Output #9</b><br>Label Text<br><input type="text" value="OUTPUT 9"/>   |
| <b>Output #10</b><br>Label Text<br><input type="text" value="OUTPUT 10"/> | <b>Output #11</b><br>Label Text<br><input type="text" value="OUTPUT 11"/> | <b>Output #12</b><br>Label Text<br><input type="text" value="OUTPUT 12"/> |

Figure 4-45. Contact Outputs

## Configurable Elements

Configurable elements are connected to the logic scheme as outputs. The configurable elements are incorporated into a BESTlogicPlus programmable logic scheme by selecting them from the *Elements* group in BESTlogicPlus. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*. Each of the eight elements can be independently configured to annunciate an alarm or pre-alarm. A user-adjustable time delay can be set to delay recognition of an element. By default, all elements are configured so that they do not trigger an alarm or pre-alarm. To make identifying the element easier, each of the elements can be given a user-assigned name. If used for an alarm or pre-alarm, the user-assigned name is what will appear in the alarm or pre-alarm annunciation and in the DGC-2020 event log. Elements can be recognized always or only while the engine is running. A user-adjustable arming delay disables the configurable element during engine startup. If the arming delay is set to zero, the configurable element is active at all times, including when the engine is not running. If the arming delay is set to a non-zero value, the configurable element is inactive when the engine is not running, and does not become active until after the engine is started and the arming delay has elapsed. Configurable element status is available in BESTlogicPlus Programmable Logic when “None” is selected for Alarm Configuration. Configurable element status can be used as logic inputs to drive other logic in the program, similar to logic control relays. In addition, the configurable element status can be used to generate modem dial outs which display the user-assigned name on modem equipped DGC-2020s.

The BESTCOMSPlus Configurable Elements screen is illustrated in Figure 4-46.

The screenshot displays a web interface titled "Configurable Elements". It contains six panels, each for a configurable element. Each panel has the following fields:

- Configurable Element #1** through **#6**
- Alarm Configuration**: A dropdown menu with "None" selected.
- Activation Delay (s)**: A text input field with "0" entered.
- Label Text**: A text input field containing "CONFIG ELEMENT 1" through "CONFIG ELEMENT 6".
- Contact Recognition**: A dropdown menu with "Always" selected.
- Arming Delay (s)**: A text input field with "0" entered.

Figure 4-46. Configurable Elements

## Remote Contact Outputs

To make identifying the contact outputs easier, each of the contact outputs can be given a user-assigned name.

The remote contact outputs are incorporated into a BESTlogicPlus programmable logic scheme by selecting them from the I/O group in BESTlogicPlus. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

The BESTCOMSPlus Remote Contact Outputs screen is illustrated in Figure 4-47.

The screenshot displays a web interface titled "Remote Contact Outputs". It contains 12 panels, each for a remote contact output. Each panel has the following fields:

- Output #13** through **#24**
- Label Text**: A text input field containing "OUTPUT 13" through "OUTPUT 24".

Figure 4-47. Remote Contact Outputs

## Remote Analog Outputs

An optional AEM-2020 (Analog Expansion Module) provides four analog outputs.

The Param Selection allows selection of a parameter to drive the output. Selectable parameters are listed below.

- Oil Pressure
- Coolant Temp
- Battery Volts
- RPM

- Fuel Level
- Gen VAB
- Gen VBC
- Gen VCA
- Gen VAN
- Gen VBN
- Gen VCN
- Bus Freq
- Bus Volts
- Gen Freq
- Gen PF
- Gen IA
- Gen IB
- Gen IC
- KW A
- KW B
- KW C
- KW Total
- KVA A
- KVA B
- KVA C
- KVA Total
- Analog Input 1
- Analog Input 2
- Analog Input 3
- Analog Input 4
- Analog Input 5
- Analog Input 6
- Analog Input 7
- Analog Input 8
- RTD Input 1
- RTD Input 2
- RTD Input 3
- RTD Input 4
- RTD Input 5
- RTD Input 6
- RTD Input 7
- RTD Input 8
- Thermocouple 1
- Thermocouple 2
- Fuel Delivery Pressure
- KVAR A
- KVAR B
- KVAR C
- KVAR Total
- Injector Metering Rail Pressure
- Total Fuel Used
- Fuel Temperature
- Engine Oil Temperature
- Engine Intercooler Temperature
- Coolant Pressure
- Fuel Rate
- Boost Pressure
- Intake Manifold Temperature
- Charge Air Temperature

- Engine Percent Load
- Bus VAB
- Bus VBC
- Bus VCA
- KW Load Percent
- Number of Units On Line
- System KW Capacity
- System Total Generated KW
- System Total Generated Kvar
- Number of Units
- DEF Tank 1 Level %
- DEF Tank 2 Level %
- System Offline KW Capacity
- System Total Generated KW Percent
- DPF Outlet Gas Temp
- Crankcase Pressure
- Fuel Filter Differential Pressure
- Oil Filter Differential Pressure
- Battery Charger 1 Voltage
- Battery Charger 1 Current
- Battery Charger 2 Voltage
- Battery Charger 2 Current
- Battery 1 Temperature
- Battery 2 Temperature
- DOC Inlet Temperature
- DOC Outlet Temperature
- Throttle Valve 1 Differential Pressure
- Gaseous Fuel Supply Pressure
- Engine Oil Level

Make a parameter selection and select the output type. When enabled, an out of range alarm alerts the user of an open or damaged analog output wire. An out of range activation delay setting delays alarm annunciation.

Ranges must be set for the selected output type. Param Min correlates to Min Output Current or Min Output Voltage and Param Max correlates to Max Output Current or Max Output Voltage.

A remote analog output is disabled when Alarm Configuration is set to "None". Remote analog output status is available in BESTlogic*Plus* Programmable Logic when "Status Only" is selected.

The remote analog outputs are incorporated into a BESTlogic*Plus* programmable logic scheme by selecting them from the I/O group in BESTlogic*Plus*. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

The BESTCOMS*Plus* Remote Analog Output #1 screen is illustrated in Figure 4-48.

### Remote Analog Output #1

Param Selection  
Oil Pressure

Output Type  
Voltage

Out Of Range Alarm Type  
None

Out Of Range Activation Delay (s)  
0

#### Ranges

|             |                         |                        |
|-------------|-------------------------|------------------------|
| Param Min   | Min Output Current (mA) | Min Output Voltage (V) |
| -999,999.00 | 4.0                     | 0.0                    |
| Param Max   | Max Output Current (mA) | Max Output Voltage (V) |
| 999,999.00  | 20.0                    | 10.0                   |

Figure 4-48. Remote Analog Output #1

## Configurable Protection

Configurable protection can be used when the standard protection available with the DGC-2020 does not meet the application needs. Eight configurable protection items are provided. To make identifying the items easier, each of the items can be given a user-assigned name.

The Param Selection allows selection of a parameter to monitor. Selectable parameters are listed below.

- Oil Pressure
- Coolant Temp
- Battery Volts
- RPM
- Fuel Level
- Gen VAB
- Gen VBC
- Gen VCA
- Gen VAN
- Gen VBN
- Gen VCN
- Bus Freq
- Bus Volts
- Gen Freq
- Gen PF
- Gen IA
- Gen IB
- Gen IC
- KW A
- KW B
- KW C
- KW Total
- KVA A
- KVA B
- KVA C
- KVA Total
- Analog Input 1
- Analog Input 2
- Analog Input 3
- Analog Input 4
- Analog Input 5
- Analog Input 6

- Analog Input 7
- Analog Input 8
- RTD Input 1
- RTD Input 2
- RTD Input 3
- RTD Input 4
- RTD Input 5
- RTD Input 6
- RTD Input 7
- RTD Input 8
- Thermocouple 1
- Thermocouple 2
- Fuel Delivery Pressure
- KVAR A
- KVARB
- KVAR C
- KVAR Total
- Injector Metering Rail Pressure
- Total Fuel Used
- Fuel Temperature
- Engine Oil Temperature
- Engine Intercooler Temperature
- Coolant Pressure
- Fuel Rate
- Boost Pressure
- Intake Manifold Temperature
- Charge Air Temperature
- Engine Percent Load
- Bus VAB
- Bus VBC
- Bus VCA
- KW Load Percent
- Number of Units On Line
- System KW Capacity
- System Total Generated KW
- System Total Generated Kvar
- Number of Units
- DEF Tank 1 Level %
- DEF Tank 2 Level %
- System Offline KW Capacity
- System Total Generated KW Percent
- DPF Outlet Gas Temp
- Crankcase Pressure
- Fuel Filter Differential Pressure
- Oil Filter Differential Pressure
- Battery Charger 1 Voltage
- Battery Charger 1 Current
- Battery Charger 2 Voltage
- Battery Charger 2 Current
- Battery 1 Temperature
- Battery 2 Temperature
- DOC Inlet Temperature
- DOC Outlet Temperature
- Throttle Valve 1 Differential Pressure



- Gaseous Fuel Supply Pressure
- Engine Oil Level

Select a parameter to monitor. A user-adjustable arming delay disables configurable protection during engine startup. If the arming delay is set to zero, the configurable protection is active at all times, including when the engine is not running. If the arming delay is set to a non-zero value, the configurable protection is inactive when the engine is not running, and does not become active until after the engine is started and the arming delay has elapsed. A setting is provided to adjust the hysteresis.

Each configurable protection item can be independently configured to annunciate an alarm, pre-alarm, or status only when the parameter selection falls beyond the threshold. A user-adjustable activation delay setting delays alarm annunciation after the threshold has been exceeded.

Configurable protection is disabled when Alarm Configuration is set to “None”.

| Note                                                                                                                                                                                                                                                                                                  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The Arming Delay should <u>not</u> be set to zero if <i>Oil Pressure</i> or <i>Battery Volts</i> is selected for configurable protection and the threshold alarm configuration is set to <i>Alarm</i> . Setting the arming delay to zero will cause an immediate alarm and the engine will not start. |

The configurable protection items are incorporated into a BESTlogic*Plus* programmable logic scheme by selecting them from the I/O group in BESTlogic*Plus*. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

Configurable Protection status is available in BESTlogic*Plus* Programmable Logic when “Status Only” is selected.

The BESTCOMS*Plus* Configurable Protection #1 screen is illustrated in Figure 4-49.

**Configurable Protection #1**

Label Text  
CONF PROT 1

Param Selection  
Oil Pressure

Arming Delay (s)  
0

Hysteresis (%)  
2.0

**Threshold #1**

Under  
Threshold (psi)  
0.00  
Alarm Configuration  
None

Over  
Threshold (psi)  
0.00  
Alarm Configuration  
None

Activation Delay (s)  
0

**Threshold #2**

Under  
Threshold (psi)  
0.00  
Alarm Configuration  
None

Over  
Threshold (psi)  
0.00  
Alarm Configuration  
None

Activation Delay (s)  
0

Figure 4-49. Configurable Protection #1

## Configurable Protection Scale Factors

The alternate frequency scale factor is used when Gen Freq or Bus Freq is selected as the parameter for configurable protection. The voltage low line scale factor is used when the parameter selection for configurable protection is set for Gen VAB, Gen VBC, Gen VCA, Gen VAN, Gen VBN, Gen VCN, or Bus Volts. The current low line scale factor is used when the parameter selection for configurable protection is set for Gen IA, Gen IB, or Gen IC.

The BESTCOMSPi<sup>us</sup> Scale Factors screen is illustrated in Figure 4-50.

**Scale Factors**

Alternate Frequency Scale Factor  
1.000

Voltage Low Line Scale Factor  
1.000

Current Low Line Scale Factor  
1.000

Figure 4-50. Scale Factors

## Alarm Configuration

DGC-2020 alarms and pre-alarms can be used to annunciate system, genset, and engine sender conditions. The description of the alarm configuration settings is organized as follows:

- Horn Configuration

- Pre-Alarms
- Alarms
- Sender Fail

## Horn Configuration

### Horn

An output contact configured (through programmable logic) to energize a horn can be enabled and disabled through *BESTCOMSPlus* or at the DGC-2020 front panel.

### Not In Auto Horn Enable

This setting allows the horn to annunciate when the DGC-2020 is not in Auto mode.

The *BESTCOMSPlus* Horn Configuration screen is illustrated in Figure 4-51.

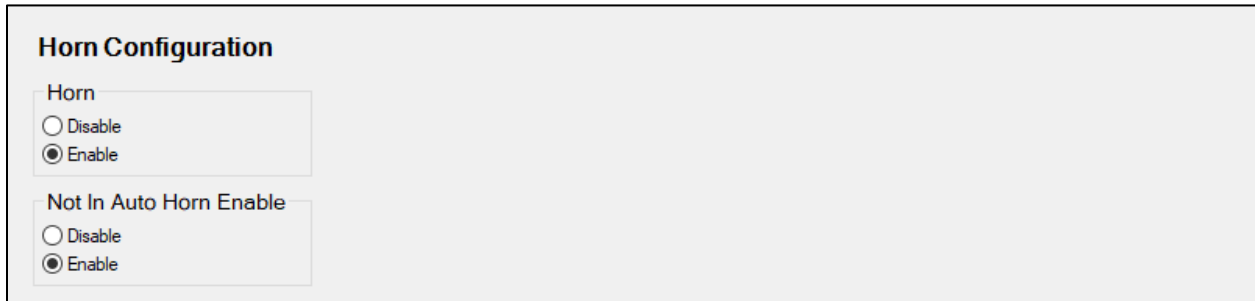


Figure 4-51. Horn Configuration

## Pre-Alarms

A pre-alarm is annunciated when a condition programmed to trigger a pre-alarm is met. When a pre-alarm condition exists, it is annunciated (flashed) on the LCD, the front panel Alarm indicator flashes on and off and the Horn output (if programmed and enabled) alternates between an energized and de-energized state. The audible alarm is reset by pressing the front panel Alarm Silence pushbutton. When a pre-alarm condition ceases to exist for most pre-alarms, all displayed annunciations are reset automatically. Certain pre-alarms do not clear automatically and must be cleared by either pressing the reset button on the front panel or providing an input to the Reset logic element in *BESTlogicPlus*. The following pre-alarms do not clear automatically:

- Weak Battery Pre-Alarm
- Breaker Close Fail Pre-Alarms
- Breaker Open Fail Pre-Alarms
- Synchronizer Fail Pre-Alarm
- 81 ROC DF/DT Rate of Change of Frequency Pre-Alarm
- 78 Vector Shift Pre-Alarm

Active pre-alarms are displayed on the main display of the LCD. The LCD annunciates an active pre-alarm by alternating the pre-alarm message with the normally displayed data. All pre-alarms are individually displayed, in sequence, by scrolling through the LCD pre-alarms list.

Each DGC-2020 pre-alarm is described in the following paragraphs. Pre-alarms can be enabled and adjusted in *BESTCOMSPlus* or through the front panel HMI.

The *BESTCOMSPlus* Pre-Alarms screen is illustrated in Figure 4-52.

Figure 4-52. Pre-Alarms

### High Fuel Level

High fuel level pre-alarm settings consist of an enable/disable setting, a threshold setting, and an activation delay. If enabled, a high fuel level pre-alarm occurs when the metered fuel level increases above the threshold setting. The hysteresis setting functions as a pre-alarm dropout by preventing rapid switching of the alarm annunciation.

### Low Battery Voltage

Low battery voltage pre-alarm settings consist of an enable/disable setting, a threshold setting, and an activation delay. If enabled, a low battery voltage pre-alarm occurs when the battery voltage decreases below the threshold setting for the duration of the activation time delay. The threshold setting range is based on the nominal battery voltage setting on the BESTCOMSPlus System Settings tab (DGC-2020, System Parameters, System Settings).

### Weak Battery Voltage

Weak battery voltage pre-alarm settings consist of an enable/disable setting, a threshold setting, and an activation time delay. If enabled, a weak battery voltage pre-alarm latches during engine cranking when the battery voltage decreases below the threshold setting for the duration of the activation delay. The threshold setting range is based on the nominal battery voltage setting on the BESTCOMSPlus System Settings tab (DGC-2020, System Parameters, System Settings).

A weak battery pre-alarm condition is reset through the front panel by navigating to the *Alarms-Status, Pre-Alarms* screen, scrolling through the list of pre-alarms until “Weak Battery” is displayed, and pressing the *Reset* key.

### Battery Overvoltage

Battery overvoltage pre-alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a battery overvoltage pre-alarm occurs when the battery voltage increases above the threshold setting for a duration of two seconds.

### Maintenance Interval

Maintenance interval pre-alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a maintenance interval pre-alarm is annunciated when the DGC-2020 maintenance timer counts down to zero from the threshold time setting. The maintenance interval pre-alarm can be reset through the DGC-2020 front panel or by using BESTCOMSPlus.

To reset the maintenance interval pre-alarm through the DGC-2020 front panel, navigate to the SETTINGS > SYSTEM PARAMS > SYSTEM SETTINGS > MAINT RESET screen. Operator, Settings, or OEM access level is required to reset the maintenance interval pre-alarm. If the maintenance interval pre-alarm is not enabled, the MAINT RESET parameter is not visible on the front panel.

To reset the maintenance interval pre-alarm by using BESTCOMSP<sup>Plus</sup>, use the Metering Explorer to open the Run Statistics screen and click on the *Reset Maintenance Interval* button.

#### Engine kW Overload

By comparing the genset power output with the rated genset output, the level of engine loading can be determined. Three engine overload pre-alarms are available that monitor three-phase real power when three-phase sensing is active or single-phase real power if single phase sensing is active. Settings for each pre-alarm consist of an enable/disable setting, three-phase threshold setting, three-phase hysteresis setting, single-phase threshold setting, single phase hysteresis setting, and low-line scale factor setting. If enabled, an engine overload pre-alarm occurs when the metered power level exceeds the threshold setting. The threshold setting is expressed as a percentage of the genset kW rating on the BESTCOMSP<sup>Plus</sup> System Settings tab (DGC-2020, System Parameters, System Settings). The hysteresis setting functions as a pre-alarm dropout by preventing rapid switching of the alarm annunciation. When the low-line override is active, the thresholds for three-phase and single-phase detection are multiplied by the low-line scale factor. The effect is that low-line threshold = three-phase or single-phase threshold setting x low-line scale factor.

#### Low Fuel Level

Low fuel level pre-alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a low fuel level pre-alarm occurs when the metered fuel level decreases below the threshold setting for a duration of two seconds. The hysteresis setting functions as a pre-alarm dropout by preventing rapid switching of the alarm annunciation. Once the Low Fuel Level pre-alarm has activated, it will not turn off until the fuel is increased to a level equal to the threshold plus the hysteresis setting.

#### High Coolant Temp

High coolant temperature pre-alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a high coolant temperature pre-alarm is annunciated when the engine coolant temperature exceeds the threshold setting for a fixed duration of four seconds. The arming delay disables the High Coolant Temp pre-alarm function for a user-adjustable time during engine startup. Delay duration is determined by the High Coolant Temp Alarm Arming Delay setting. System units are configured on the System Settings screen.

#### Low Coolant Temp

Low coolant temperature pre-alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a low coolant temperature pre-alarm occurs when the engine coolant temperature decreases below the threshold setting for four seconds. System units are configured on the System Settings screen.

#### Low Coolant Level

Low coolant level pre-alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a low coolant level pre-alarm occurs when the metered coolant level decreases below the threshold setting for two seconds.

#### Low Oil Pressure

Low oil pressure pre-alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a low oil pressure pre-alarm is triggered after a two second delay when the engine oil pressure decreases below the threshold setting. The arming delay disables the low oil pressure pre-alarm function for a user-adjustable time during engine startup. Delay duration is determined by the Low Oil Pressure Alarm Arming Delay setting. System units and metric pressure units are configured on the *System Settings* screen.

### AVR Bias Output Limit

AVR bias output limit settings consist of an enable/disable setting and an activation delay setting. If enabled, an AVR bias output limit pre-alarm is annunciated when the AVR bias output limit has been met and the activation delay has expired. This setting only applies when using the optional LSM-2020.

### GOV Bias Output Limit

GOV bias output limit settings consist of an enable/disable setting and an activation delay setting. If enabled, a GOV bias output limit pre-alarm is annunciated when the GOV bias output limit has been met and the activation delay has expired. This setting only applies when using the optional LSM-2020.

### Intergenset Comm Failure

Intergenset communication failure pre-alarm settings consist of a single enable/disable setting. If enabled, an Intergenset communication failure pre-alarm is annunciated when an individual generator detects that it had been connected to a generator network, but has lost the connection. This setting only applies when using an optional LSM-2020.

### LSM Comm Failure

LSM-2020 communication failure pre-alarm settings consist of a single enable/disable setting. If enabled, an LSM-2020 communication failure pre-alarm is annunciated when communication between an optional LSM-2020 and DGC-2020 is lost.

### ID Missing

ID missing pre-alarm settings consist of a single enable/disable setting. If enabled, an ID missing pre-alarm is annunciated when an expected sequence ID of an optional LSM-2020 is not detected on the network.

### ID Repeat

ID repeat pre-alarm settings consist of a single enable/disable setting. If enabled, an ID repeat pre-alarm is annunciated when two or more optional LSM-2020's report the same expected sequence ID.

### CEM Comm Failure

CEM-2020 communication failure pre-alarm settings consist of a single enable/disable setting. If enabled, a CEM-2020 communication failure pre-alarm is annunciated when communication between an optional CEM-2020 and DGC-2020 is lost.

### AEM Comm Failure

AEM-2020 communication failure pre-alarm settings consist of a single enable/disable setting. If enabled, an AEM-2020 communication failure pre-alarm is annunciated when communication between an optional AEM-2020 and DGC-2020 is lost.

### Checksum Failure

The checksum failure pre-alarm will occur whenever one of the internal checksum calculations used for data integrity purposes has failed. This indicates that some of the user settings or firmware code has been corrupted.

The checksum failure pre-alarm can be cleared by pressing the reset button on the front panel. However, the pre-alarm will reoccur the next time the checksum is verified if the data is still corrupted. Some checksum calculations are done only on power up, so this might not occur until the next time the unit's operating power is cycled.

If there are consistent checksum failure pre-alarms, attempt the following actions to correct the problem:

1. Load default settings by holding UP+DOWN on the front panel while cycling power. After loading defaults, upload settings file through BESTCOMS*Plus* if needed.

**Caution**

Loading default settings will erase all custom settings. All reports and events will be cleared. BESTCOMS*Plus* can be used to download settings and save to a file so that settings can be restored later.

2. If the problem still exists, reload the firmware file with BESTCOMS*Plus*.
3. If the problem still exists, contact Basler Electric Technical Support.

The checksum failure pre-alarm can be disabled with the Checksum Failure pre-alarm enable setting. Disabling this setting disables only the annunciation of the pre-alarm and does not correct any error conditions.

The checksum failure pre-alarm might occur after changing firmware versions through BESTCOMS*Plus*. The checksum failure pre-alarm is not indicative of an error in this case. The pre-alarm can be cleared with the reset button or by cycling power to the unit. If the pre-alarm reoccurs, then the pre-alarm is indicative of an error and corrective action should be attempted as described above.

#### Synchronizer Failure

Synchronizer failure pre-alarm settings consist of a single enable/disable setting. If enabled, a Synchronizer Failure pre-alarm is annunciated if the DGC-2020 is running the auto synchronizer to align the generator voltage and bus voltage to close a breaker, and the DGC-2020 does not receive feedback from the breaker status indicating it is closed before the sync fail activation delay time has elapsed.

#### Breaker Close Failure

Breaker Close failure pre-alarm settings consist of a single enable/disable setting and a monitor setting. If enabled, a Breaker Close Failure pre-alarm is annunciated if the DGC-2020 has issued a breaker close output, and has not received feedback from the breaker status indicating it is closed before the breaker close wait time has elapsed. The Monitor setting determines whether this condition is monitored only during transitions or always.

#### Breaker Open Failure

Breaker Open failure pre-alarm settings consist of a single enable/disable setting and a monitor setting. If enabled, a Breaker Open Failure pre-alarm is annunciated if the DGC-2020 has issued a breaker open output, and has not received feedback from the breaker status indicating it is open before the breaker close wait time has elapsed. The Monitor setting determines whether this condition is monitored only during transitions or always.

#### Reverse Rotation

Reverse Rotation pre-alarm settings consist of an enable/disable setting. If enabled, a Reverse Rotation pre-alarm is annunciated if the sensed generator or bus phase rotation differs from the phase rotation specified in the System Parameters > System Settings screen.

#### Rated Data and Per Unit Values

Settings, which are related to machine ratings, can be set either in native units or in per unit values. When a native unit is edited, BESTCOMS*Plus* automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the *System Parameters, Rated Data* screen) associated with it. When a per unit value is edited, BESTCOMS*Plus* automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, BESTCOMS*Plus* automatically recalculates all native unit settings based on the modified rated data parameters.

The following settings have native units of *Volts*, and the rated data associated with them is Battery Volts (on the *System Parameters, Rated Data* screen).

- Low Battery Voltage
- Weak Battery Voltage
- Battery Overvoltage

## Alarms

An alarm is annunciated when a condition programmed to trigger an alarm is detected. When an alarm condition exists, the front panel Alarm indicator lights, the Horn output (if programmed and enabled) energizes, and the cause of the alarm is displayed on the front panel LCD. An alarm condition stops the engine by opening the Fuel output contact. Alarms are reset when the DGC-2020 is set to Off mode.

Each DGC-2020 alarm is described in the following paragraphs. Alarms can be enabled and adjusted in BESTCOMS*Plus* or through the front panel HMI.

The BESTCOMS*Plus* Alarms screen is illustrated in Figure 4-53.

### High Coolant Temperature

High coolant temperature alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a high coolant temperature alarm is triggered after a four second delay when the engine coolant temperature exceeds the threshold setting. The arming delay disables the high coolant temperature alarm function for a user-adjustable time during engine startup. System units are configured on the System Settings screen.

### Low Oil Pressure

Low oil pressure alarm settings include an enable/disable setting, an arming time delay, and a threshold setting. If enabled, a low oil pressure alarm is triggered after a two second delay when the engine oil pressure decreases below the threshold setting. The arming delay disables the low oil pressure alarm function for a user-adjustable time during engine startup. System units and metric pressure units are configured on the System Settings screen.

### Overspeed

Overspeed alarm settings include an enable/disable setting, an activation delay, and a threshold setting. If enabled, an overspeed alarm occurs when the engine speed (in rpm) exceeds the threshold setting for the duration of the activation time delay.

### Low Fuel Level

Low fuel level alarm settings consist of an enable/disable setting, an activation delay setting, and a threshold setting. If enabled, a low fuel level alarm is triggered when the metered fuel level drops below the threshold setting for the duration of the activation time delay. The hysteresis setting functions as an alarm dropout by preventing rapid switching of the alarm annunciation.

### Low Coolant Level

Low coolant level alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a low coolant level alarm is triggered when the metered coolant drops below the threshold setting for two seconds.

Note that ECU Support must be enabled on the *Communications, CAN Bus Setup* screen before this alarm can be configured.

### CAN Bus Low Coolant Level

This setting enables or disables low coolant level alarm reporting from a Diagnostic Trouble Code (DTC) when CAN Bus is enabled.



### Alarms

#### High Coolant Temp

☐ Disable
 ☒ Enable

Threshold (°F)

Arming Delay (s)

#### Low Oil Pressure

☐ Disable
 ☒ Enable

Threshold (psi)

Arming Delay (s)

#### Overspeed

☐ Disable
 ☒ Enable

Threshold (%)

Activation Delay (ms)

#### Low Fuel Level

☐ Disable
 ☒ Enable

Threshold (%)

Activation Delay (s)

Hysteresis (%)

#### Low Coolant Level

☒ Disable
 ☐ Enable

Threshold (%)

#### CAN Bus Low Coolant Level

☐ Disable
 ☒ Enable

Figure 4-53. Alarms

## Sender Fail

The DGC-2020 can be configured to annunciate a pre-alarm or alarm when a loss of signal is detected at the coolant temperature, oil pressure, or fuel level sender input. Contact recognition can be set to Always or While Engine Running Only. Minimum and Maximum resistance values can be set. When the SF Display setting is set to Enable, “SF” is displayed instead of the measured parameter when the resistance value is outside the range specified by the Minimum and Maximum Resistance values. A loss of generator sensing voltage (when the DGC-2020 is operating in Run or Auto mode with the ATS closed) can also be configured to trigger a pre-alarm or alarm. The speed sender fail alarm is always enabled. A user-adjustable time delay is provided for each sender/sensing alarm/pre-alarm.

### Voltage Sensing Fail

The voltage sensing fail function monitors the generator line-to-neutral voltages. If any of the line-to-neutral voltages decreases below 2% of the CT secondary voltage for the duration of the Activation Delay, the DGC-2020 detects a Voltage Sensing Fail condition and annunciates an alarm based on the Alarm Configuration setting.

In a Grounded Delta configuration where one phase (A, B, or C) of the delta connection is grounded, it is likely a Voltage Sensing Fail condition will occur.

In Delta connected systems where the DGC-2020 neutral input is not connected, it is uncertain which line-to-neutral voltages will be monitored by the DGC-2020. Spurious Voltage Sensing Fail annunciations could occur.

It is recommended that Phase Imbalance detection be used to detect sensing issues in Delta and Grounded Delta configurations.

### Alarms and Pre-Alarms

Alarm and pre-alarm annunciations for loss of engine speed signals is not user-programmable and operates as follows. If the MPU (magnetic pickup) or generator frequency is programmed as the sole

engine speed source and that signal source fails, an alarm (and shutdown) is triggered. If the engine speed source is configured as MPU and generator frequency and a loss of one of the signal sources occurs, a pre-alarm is annunciated. An alarm (and shutdown) is triggered if both speed signals are lost.

The BESTCOMSP<sup>Plus</sup> Sender Fail screen is illustrated in Figure 4-54.

Figure 4-54. Sender Fail

## Generator Protection

Two tiers of generator protection are offered. DGC-2020 controllers with style number xxxxxxSxx offer standard protection consisting of undervoltage (27), overvoltage (59), overfrequency (81O), underfrequency (81U), reverse power (32R), and loss of excitation (40) elements. Controllers with style number xxxxxxExx offer enhanced protection, which consists of the standard protection elements *Plus* phase-sequence voltage (47), time overcurrent (51), vector shift (78), and ROCOF (81) elements.

The description of generator protection is organized as follows:

- Voltage (27, 59, 47)
- Frequency (81)
- Reverse Power (32R)
- Loss of Excitation (40Q)
- Overcurrent (51)
- Loss of MAINS Protection (78 Vector Shift and 81 ROCOF)

### Voltage Protection (27, 59, 47)

Voltage protection consists of two undervoltage elements, two overvoltage elements, and one phase-sequence voltage element (style number xxxxxxExx only).

#### Undervoltage (27-1, 27-2)

Two sets of undervoltage settings are provided for each element: one for three-phase generator connections and one for single-phase generator connections. The pickup setting entered is based on the VT secondary side (DGC-2020). When a single-phase override contact input is received, the DGC-2020 automatically switches from the three-phase undervoltage settings to the single-phase undervoltage settings.

An undervoltage condition is annunciated when the average of the three-phase (three-phase mode) or the line-to-line voltage (single-phase mode) decreases below the corresponding 27 pickup setting for the

duration of the corresponding 27 activation delay. An undervoltage annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). An undervoltage annunciation can also be user-configured to close a programmable output.

The hysteresis setting functions as an undervoltage dropout by preventing rapid switching of the pickup output.

A frequency-based inhibit setting prevents a 27 trip from occurring during an undervoltage condition associated with system startup.

A low-line scale factor setting is used to automatically adjust the undervoltage pickup settings in applications that might utilize more than one type of genset connection. The scale factor setting is implemented when the DGC-2020 senses a contact closure at a contact input programmed to activate scaling of the protection settings. The value of the scale factor setting serves as a multiplier for the pickup settings. For example, if a scale factor contact input is received by the DGC-2020 and the scale factor setting is 2.000, the pickup setting will be doubled ( $2.000 \times \text{PU}$ ).

A user-adjustable arming delay disables undervoltage protection during engine startup. The undervoltage protection is inactive when the engine is not running, and does not become active until after the engine is started and the arming delay has elapsed.

The element is disabled when Alarm Configuration is set to "None" or when the Block input of the Undervoltage logic element is TRUE. Element status is available in BESTlogicPlus Programmable Logic when "Status Only" is selected.

Settings which are related to machine ratings can be set in either actual units of voltage or in per unit values. When a native unit is edited, BESTCOMSPlus automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the *System Parameters, Rated Data* screen) associated with it. When a per unit value is edited, BESTCOMSPlus automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, BESTCOMSPlus automatically recalculates all native unit settings based on the modified rated data parameters.

The following settings have native units of *Secondary Volts*, and the rated data associated with them is *Rated Secondary Volts* (on the *System Parameters, Rated Data* screen).

- Undervoltage 27-1 Three-Phase Pickup
- Undervoltage 27-1 Single-Phase Pickup
- Undervoltage 27-2 Three-Phase Pickup
- Undervoltage 27-2 Single-Phase Pickup

The BESTCOMSPlus Undervoltage screen is illustrated in Figure 4-55. The 27-1 element is shown.

**Undervoltage**

27-1 Element

Low Line Scale Factor  
1.000

Arming Delay (s)  
0

**3 Phase**

Pickup (V L-L)  
95 V

0.198 Per Unit

Hysteresis (V)  
2

Activation Delay (s)  
1.0

Inhibit Frequency  
35 Hz

0.5833 Per Unit

Alarm Configuration  
None

**Single Phase**

Pickup (V L-L)  
95 V

0.198 Per Unit

Hysteresis (V)  
2

Activation Delay (s)  
1.0

Inhibit Frequency  
35 Hz

0.5833 Per Unit

Alarm Configuration  
None

Figure 4-55. Undervoltage

Overvoltage (59-1, 59-2)

Two sets of overvoltage settings are provided for each element: one for three-phase generator connections and one for single-phase generator connections. The pickup setting entered is based on the VT secondary side (DGC-2020). When a single-phase override contact input is received, the DGC-2020 automatically switches from the three-phase overvoltage settings to the single-phase overvoltage settings.

An overvoltage condition is annunciated when the average of the three-phase (three-phase mode) or the line-to-line voltage (single-phase mode) increases above the corresponding 59 pickup setting for the duration of the corresponding 59 activation delay. An overvoltage annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). An overvoltage annunciation can also be user-configured to close a programmable output.

The hysteresis setting functions as an undervoltage dropout by preventing rapid switching of the pickup output.

A low-line scale factor setting is used to automatically adjust the overvoltage pickup settings in applications that might utilize more than one type of genset connection. The scale factor setting is implemented when the DGC-2020 senses a contact closure at a contact input programmed to activate scaling of the protection settings. The value of the scale factor setting serves as a multiplier for the pickup settings. For example, if a scale factor contact input is received by the DGC-2020 and the scale factor setting is 2.000, the pickup setting will be doubled ( $2.000 \times \text{PU}$ ).

A user-adjustable arming delay disables overvoltage protection during engine startup. The overvoltage protection is inactive when the engine is not running, and does not become active until after the engine is started and the arming delay has elapsed.

The element is disabled when Alarm Configuration is set to “None” or when the Block input of the Overvoltage logic element is TRUE. Element status is available in BESTlogicPlus Programmable Logic when “Status Only” is selected.

Settings which are related to machine ratings can be set in either actual units of voltage or in per unit values. When a native unit is edited, BESTCOMSPlus automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the *System Parameters, Rated Data* screen) associated with it. When a per unit value is edited, BESTCOMSPlus automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, BESTCOMSPlus automatically recalculates all native unit settings based on the modified rated data parameters.

The following settings have native units of *Secondary Volts*, and the rated data associated with them is *Rated Secondary Volts* (on the *System Parameters, Rated Data* screen).

- Overvoltage 59-1 Three-Phase Pickup
- Overvoltage 59-1 Single-Phase Pickup
- Overvoltage 59-2 Three-Phase Pickup
- Overvoltage 59-2 Single-Phase Pickup

The BESTCOMS*Plus* Overvoltage screen is illustrated in Figure 4-56. The 59-1 element is shown.

Figure 4-56. Overvoltage

#### Phase Imbalance (47)

DGC-2020 controllers with enhanced generator protection (style number xxxxxxExx) are capable of protecting against voltage imbalances between any of the three phases. The pickup setting entered is based on the VT secondary side (DGC-2020). A phase imbalance condition is annunciated when the difference between any of the three phases of generator voltage increases above the 47 pickup setting for the duration of the 47 activation delay setting. A phase imbalance annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). A phase imbalance annunciation can also be user-configured to close a programmable output.

The hysteresis setting functions as a phase imbalance dropout by preventing rapid switching of the pickup output.

A low-line scale factor setting is used to automatically adjust the phase imbalance pickup setting in applications that might utilize more than one type of genset connection. The scale factor setting is implemented when the DGC-2020 senses a contact closure at a contact input programmed to activate scaling of the protection settings. The value of the scale factor setting serves as a multiplier for the pickup setting. For example, if a scale factor contact input is received by the DGC-2020 and the scale factor setting is 2.000, the pickup setting will be doubled ( $2.000 \times \text{PU}$ ).

A user-adjustable arming delay disables phase imbalance protection during engine startup. The phase imbalance protection is inactive when the engine is not running, and does not become active until after the engine is started and the arming delay has elapsed.

The element is disabled when Alarm Configuration is set to “None” or when the Block input of the Phase Imbalance logic element is TRUE. Element status is available in BESTlogic*Plus* Programmable Logic when “Status Only” is selected.

Settings which are related to machine ratings can be set in either actual units of voltage or in per unit values. When a native unit is edited, BESTCOMS*Plus* automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the *System Parameters, Rated Data* screen) associated with it. When a per unit value is edited, BESTCOMS*Plus* automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, BESTCOMS*Plus* automatically recalculates all native unit settings based on the modified rated data parameters.

The following setting has native units of *Secondary Volts*, and the rated data associated with it is *Rated Secondary Volts* (on the *System Parameters, Rated Data* screen).

- Phase Imbalance 47 Pickup

The BESTCOMSPPlus Phase Imbalance screen is illustrated in Figure 4-57.

**Phase Imbalance**

47 Element

Pickup

5 V

0.010 Per Unit

Hysteresis (V)

1

Activation Delay (s)

1.0

Alarm Configuration

None

Low Line Scale Factor

1.000

Arming Delay (s)

0

Figure 4-57. Phase Imbalance

## Frequency Protection (81O/U)

Two sets of frequency protection settings are provided: one for underfrequency (81U) and one for overfrequency (81O).

### Underfrequency (81U)

An underfrequency condition is annunciated when the generator frequency decreases below the 81U pickup setting for the duration of the 81U activation delay setting. An underfrequency annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). An underfrequency annunciation can also be user-configured to close a programmable output.

A voltage-based inhibit setting prevents an 81U trip from occurring during an underfrequency condition associated with system startup.

The hysteresis setting functions as an underfrequency dropout by preventing rapid switching of the pickup output.

The element is disabled when Alarm Configuration is set to "None". Element status is available in BESTlogicPlus Programmable Logic when "Status Only" is selected.

### Overfrequency (81O)

When the generator frequency increases above the 81O pickup setting for the duration of the 81O activation delay setting, an overfrequency condition is annunciated. An overfrequency annunciation can be user-selected to trigger a pre-alarm (warning) or alarm<sup>H</sup> (shutdown). An overfrequency condition can also be user configured to close a programmable output.

The hysteresis setting functions as an overfrequency dropout by preventing rapid switching of the pickup output.

The element is disabled when Alarm Configuration is set to "None" or when the Block input of the Frequency logic element is TRUE. Element status is available in BESTlogicPlus Programmable Logic when "Status Only" is selected.

### Arming Delay

A user-adjustable arming delay disables underfrequency and overfrequency protection during engine startup. The underfrequency and overfrequency protection is inactive when the engine is not running, and does not become active until after the engine is started and the arming delay has elapsed.

### Alternate Frequency Scale Factor

An alternate frequency scale factor setting is used for automatic adjustment of the frequency pickup settings in applications that might utilize more than one operating frequency. For example, a machine that is configurable between 50 or 60 Hz operation. The scale factor setting is implemented when the DGC-2020 senses a contact closure at a contact input that is connected to the Alternate Frequency Override logic element in BESTlogicPlus Programmable Logic. When the Alternate Frequency Override is TRUE, the scale factor setting serves as a multiplier for the pickup settings. For example, if a scale factor contact input is received by the DGC-2020 and the scale factor setting is 2.000, the pickup setting will be doubled (2.000 x PU).

### Per Unit

Settings which are related to machine ratings can be set in either actual units of hertz or in per unit values. Per unit settings are available for Pickup (81O/81U) and Inhibit Volts (81U). When a native unit is edited, BESTCOMSPlus automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the *System Parameters, Rated Data* screen) associated with it. When a per unit value is edited, BESTCOMSPlus automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, BESTCOMSPlus automatically recalculates all native unit settings based on the modified rated data parameters.

The following settings have native units of *Frequency in Hz*, and the rated data associated with them is *Rated Frequency* (on the *System Parameters, Rated Data* screen).

- 81 U Pickup
- 81 O Pickup

The following setting has native units of *Secondary Volts*, and the rated data associated with it is *Rated Secondary Volts* (on the *System Parameters, Rated Data* screen).

- 81 U Inhibit Voltage

The BESTCOMSPlus Frequency screen is illustrated in Figure 4-58.

The screenshot shows the 'Frequency' screen in the BESTCOMSPlus software. It is divided into three main sections: '81 Element', '81U', and '81O'. The '81 Element' section contains 'Alternate Frequency Scale Factor' (1.000) and 'Arming Delay (s)' (0). The '81U' section contains 'Pickup' (58.0 Hz), 'Per Unit' (0.9667), 'Hysteresis (Hz)' (0.5), 'Activation Delay (s)' (1.0), 'Inhibit Volts' (70 V), 'Per Unit' (0.146), and 'Alarm Configuration' (None). The '81O' section contains 'Pickup' (62.0 Hz), 'Per Unit' (1.0333), 'Hysteresis (Hz)' (0.5), 'Activation Delay (s)' (1.0), and 'Alarm Configuration' (None).

| Section    | Parameter                        | Value  | Unit |
|------------|----------------------------------|--------|------|
| 81 Element | Alternate Frequency Scale Factor | 1.000  |      |
|            | Arming Delay (s)                 | 0      |      |
| 81U        | Pickup                           | 58.0   | Hz   |
|            | Per Unit                         | 0.9667 |      |
|            | Hysteresis (Hz)                  | 0.5    |      |
|            | Activation Delay (s)             | 1.0    |      |
|            | Inhibit Volts                    | 70     | V    |
|            | Per Unit                         | 0.146  |      |
|            | Alarm Configuration              | None   |      |
| 81O        | Pickup                           | 62.0   | Hz   |
|            | Per Unit                         | 1.0333 |      |
|            | Hysteresis (Hz)                  | 0.5    |      |
|            | Activation Delay (s)             | 1.0    |      |
|            | Alarm Configuration              | None   |      |

Figure 4-58. Frequency



## Reverse Power Protection (32R)

Two sets of reverse power settings are provided: one for three-phase generator connections and one for single-phase generator connections. The pickup setting entered is based on the percentage of the Genset KW Rating on the Rated Data screen. When a single-phase override contact input is received by the DGC-2020, the reverse power protection settings automatically switch from the three-phase settings to the single-phase reverse power protection settings. The 32R element monitors three-phase real power when three-phase sensing is active or single-phase real power if single-phase sensing is active.

When the total wattage in the tripping direction (generator absorbing power) is greater than the pickup setting for the duration of the 32R activation delay setting, a reverse power condition is annunciated. A reverse power annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). A reverse power annunciation can also be user-configured to close a programmable output.

The hysteresis setting functions as a reverse power dropout by preventing rapid switching of the pickup output.

A user-adjustable arming delay disables reverse power protection during engine startup. If the arming delay is set to zero, the reverse power protection is active at all times, including when the engine is not running. If the arming delay is set to a non-zero value, the reverse power protection is inactive when the engine is not running, and does not become active until after the engine is started and the arming delay has elapsed.

The element is disabled when Alarm Configuration is set to “None” or when the Block input of the Reverse Power logic element is TRUE. Element status is available in BESTLogic*Plus* Programmable Logic when “Status Only” is selected.

The BESTCOMS*Plus* Reverse Power screen is illustrated in Figure 4-59.

**Reverse Power**

32R Element

Arming Delay (s)  
0

| 3 Phase                     | Single Phase                |
|-----------------------------|-----------------------------|
| Pickup (%)<br>-5.0          | Pickup (%)<br>-5.0          |
| Hysteresis (%)<br>1.0       | Hysteresis (%)<br>1.0       |
| Activation Delay (s)<br>1.0 | Activation Delay (s)<br>1.0 |
| Alarm Configuration<br>None | Alarm Configuration<br>None |

Figure 4-59. Reverse Power

## Loss of Excitation Protection (40Q)

Two sets of loss of excitation settings are provided: one for three-phase generator connections and one for single-phase generator connections. The pickup setting entered is based on the percentage of the machine Rated kvar on the Rated Data screen. When a single-phase override contact input is received by the DGC-2020, the loss of excitation protection settings automatically switch from the three-phase settings to the single-phase loss of excitation protection settings.

When a generator's excitation power is lost, the generator acts as a large inductor. The generator begins to absorb large quantities of vars. The 40Q acts on the principal that if a generator begins to absorb vars outside of its steady state capability curve, it has likely lost its normal excitation supply. The 40Q monitors three-phase reactive power when three-phase sensing is active or single-phase reactive power if single-phase sensing is active. It compares the reactive power to the 40Q response curve defined by the 40Q pickup setting. Refer to Figure 4-60.



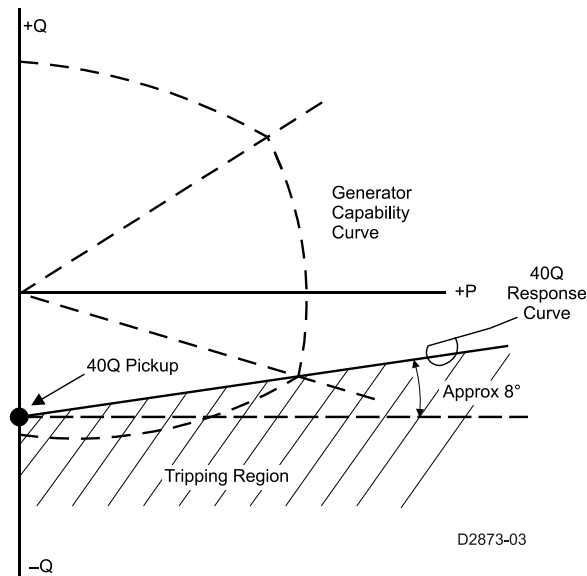


**Figure 4-60. Generator Capability Curve vs. 40Q Response**

If reactive power is within the 40Q tripping region for the duration of the 40Q activation delay setting, a loss of excitation condition is annunciated. A loss of excitation annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). A loss of excitation annunciation can also be user-configured to close a programmable output. The calculation used in the DGC-2020 for the approximate tripping region is given by:

$$\text{Tripping Region} = 40Q \text{ Pickup} + \left( \frac{1}{8} \right) * \left( \frac{\text{Actual Watts} * 100}{\text{Rated var}} \right)$$

where the units of the Tripping Region and the 40Q Pickup setting are percent of rated var.

The hysteresis setting functions as a loss of excitation dropout by preventing rapid switching of the pickup output.

Activation delays are recommended for tripping. Adding a small delay will help assure that FALSE alarms do not occur for transient fault conditions or swings in the power system.

A user-adjustable arming delay disables loss of excitation protection during engine startup. If the arming delay is set to zero, the loss of excitation protection is active at all times, including when the engine is not running. If the arming delay is set to a non-zero value, the loss of excitation protection is inactive when the engine is not running, and does not become active until after the engine is started and the arming delay has elapsed.

The element is disabled when Alarm Configuration is set to “None” or when the Block input of the Loss of Excitation logic element is TRUE. Element status is available in BESTlogicPlus Programmable Logic when “Status Only” is selected.

The BESTCOMSPlus Loss of Excitation (40Q) screen is illustrated in Figure 4-61.

Figure 4-61. Loss of Excitation (40Q)

### Overcurrent Protection (51-1, 51-2, 51-3)

Two sets of overcurrent settings are provided for each element: one for three-phase generator connections and one for single-phase generator connections. The pickup setting entered is based on the CT secondary side (DGC-2020). When a single-phase override contact input is received by the DGC-2020, the overcurrent protection settings automatically switch from the three-phase settings to the single-phase overcurrent protection settings.

When any of the phase currents increase above the pickup setting for the duration of the overcurrent time delay, an overcurrent condition is annunciated. An overcurrent annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). An overcurrent annunciation can also be user-configured to close a programmable output.

The overcurrent time delay is controlled by a time dial setting and a curve setting. The curve setting can be set at F (fixed), P (programmable), or one of 16 inverse time characteristic curves can be selected. When the fixed curve setting is selected, the time dial setting determines the overcurrent time delay with no regard to the generator current level. When one of the inverse time characteristic curves is selected, the time dial setting, along with the level of measured generator current, determines the overcurrent time delay. As overcurrent protection settings are entered in BESTCOMSP<sup>Plus</sup>, a plot of the settings is automatically created to illustrate the overcurrent pickup curve. The available time characteristic curves are listed below and illustrated in Appendix A, *Time Overcurrent Characteristic Curves*.

- A, standard inverse
- B, very inverse
- C, extremely inverse
- D, definite
- E1, extremely inverse
- E2, extremely inverse
- G, long inverse
- I1, inverse
- I2, inverse
- L1, long inverse
- L2, long inverse
- M, moderately inverse
- P, programmable
- S1, short inverse
- S2, short inverse
- V1, very inverse
- V2, very inverse

A low-line scale factor setting is used for automatic adjustment of the overcurrent pickup settings in applications that might utilize more than one type of genset connection. The scale factor setting is implemented when the DGC-2020 senses a contact closure at a contact input programmed to activate scaling of the protection settings. The value of the scale factor setting serves as a multiplier for the pickup settings. For example, if a scale factor contact input is received by the DGC-2020 and the scale factor setting is 2.000, the pickup setting will be doubled ( $2.000 \times \text{PU}$ ).

The graph can be set to display the 1 Phase or 3 Phase curve as determined by the settings on the left side of the chart.

Selection of integrated reset or instantaneous reset characteristics is also provided. Refer to Appendix A, *Time Overcurrent Characteristic Curves*, when calculating time to reset.

The element is disabled when Alarm Configuration is set to “None” or when the Block input of the Overcurrent logic element is TRUE. Element status is available in BESTlogicPlus Programmable Logic when “Status Only” is selected.

Settings which are related to machine ratings can be set in either actual units of current or in per unit values. When a native unit is edited, BESTCOMSPlus automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the *System Parameters, Rated Data* screen) associated with it. When a per unit value is edited, BESTCOMSPlus automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, BESTCOMSPlus automatically recalculates all native unit settings based on the modified rated data parameters.

The following settings have native units of *Secondary Amps*, and the rated data associated with them is *Rated Secondary Phase Amps* (on the *System Parameters, Rated Data* screen).

- Overcurrent 51-1 Three-Phase Pickup
- Overcurrent 51-1 Single-Phase Pickup
- Overcurrent 51-2 Three-Phase Pickup
- Overcurrent 51-2 Single-Phase Pickup
- Overcurrent 51-3 Three-Phase Pickup
- Overcurrent 51-3 Single-Phase Pickup

The BESTCOMSPlus Overcurrent screen is illustrated in Figure 4-62. The 51-1 element is shown.

#### Programmable Curves for Overcurrent Protection

Inverse overcurrent characteristics for trip and reset programmable curves are defined by Equation 4-1 and 4-2 respectively. These equations comply with IEEE Std C37.112-1996 - *IEEE Standard Inverse-Time Characteristic Equations for Overcurrent Relays*. The curve-specific coefficients are defined for the standard curves as listed in Appendix A, *Time Overcurrent Characteristic Curves*. When inverse time overcurrent characteristic curve P is selected, the coefficients used in the equation are those defined by the user. Definitions for these equations are provided in Table 4-6.

**Equation 4-1. Time OC Characteristics for Trip**

$$T_T = \frac{AD}{(M^N - C)^Q} + BD + K$$

**Equation 4-2. Time OC Characteristics for Reset**

$$T_R = \frac{RD}{|M^2 - 1|}$$

**Table 4-6. Definitions for Equations 4-1 and 4-2**

| Parameter      | Description                                            | Explanation                                                                                                                                                 |
|----------------|--------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| T <sub>T</sub> | Time to trip                                           | Time that the 51-x function will take to time out and trip.                                                                                                 |
| D              | Time dial setting                                      | Time dial setting for the 51-x function.                                                                                                                    |
| M              | Multiple of pickup                                     | Measured current in multiples of pickup. The timing algorithm has a dynamic range of 0 to 40 times pickup.                                                  |
| A              | Coefficient specific to selected curve                 | Affects the effective range of the time dial.                                                                                                               |
| B              | Coefficient specific to selected curve                 | Affects a constant term in the timing equation. Has greatest effect on curve shape at high multiples of pickup.                                             |
| C              | Coefficient specific to selected curve                 | Affects the multiple of pickup where the curve would approach infinity if allowed to continue below pickup. Has greatest effect on curve shape near pickup. |
| N              | Multiple of Pickup exponent specific to selected curve | Affects how inverse the characteristics are. Has greatest effect on curve shape at low to medium multiples of pickup.                                       |
| K              | Constant                                               | Characteristic minimum delay term. Fixed at 0.028.                                                                                                          |

| Parameter | Description                                      | Explanation                                                                        |
|-----------|--------------------------------------------------|------------------------------------------------------------------------------------|
| $T_R$     | Time to reset                                    | Relevant if 51-x function is set for integrating reset.                            |
| R         | Coefficient specific to selected curve           | Affects the speed of reset when integrating reset is selected.                     |
| Q         | Denominator exponent specific to selected curve. | Affects how inverse the characteristics are. Has greater affect as Q is increased. |

### Setting Programmable (P) Curves

Curve coefficients are entered using BESTCOMSPlus. Table 4-7 lists the programmable curve settings.

**Table 4-7. Programmable Time Current Characteristic Curve Coefficients**

| Setting       | Range      | Increment | Default |
|---------------|------------|-----------|---------|
| A Coefficient | 0 to 600   | 0.0001    | 0.2663  |
| B Coefficient | 0 to 25    | 0.0001    | 0.0339  |
| C Coefficient | 0 to 1     | 0.0001    | 1.0000  |
| N Coefficient | 0.5 to 2.5 | 0.0001    | 1.2969  |
| Q Coefficient | 0.1 to 10  | 0.0001    | 1.0000  |
| R Coefficient | 0 to 30    | 0.0001    | 0.5000  |

BESTCOMSPlus is used to set the 51-x Programmable Curve Constants. To program the Curve Constants, open the *Generator Protection/Current* tree branch and select the overcurrent element to be modified. Select *P* from the *Curve* pull-down menu and then enter the calculated values for each constant.

Programmable curve coefficients can only be entered when the *P* curve is chosen for the protection element from the *Curve* drop-down menu.

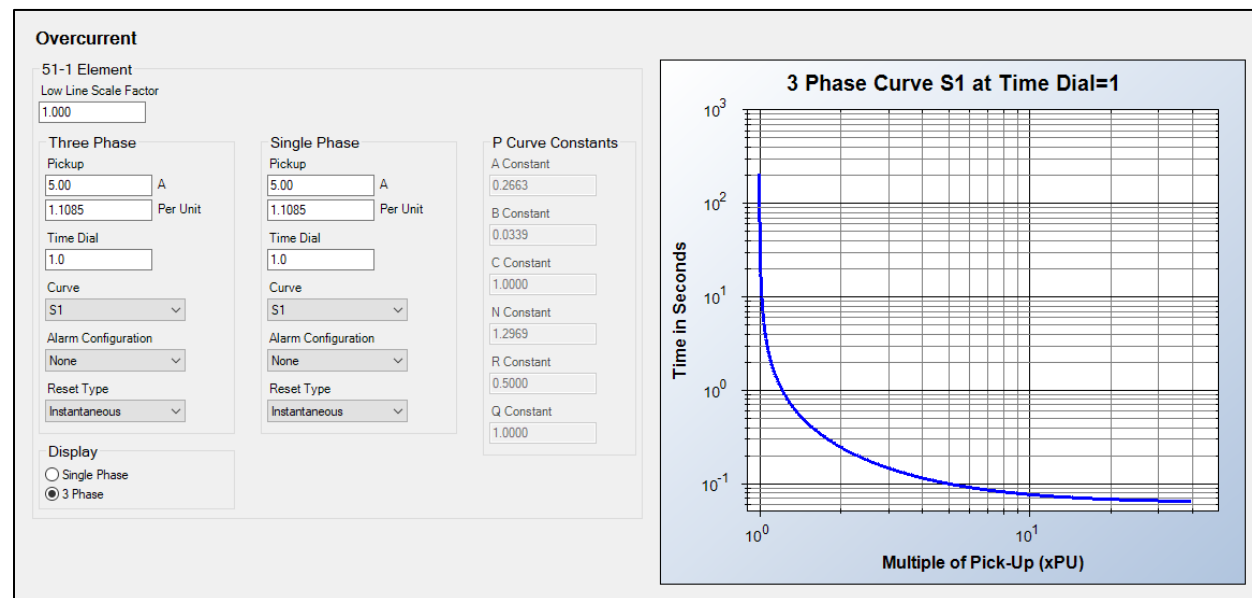


**Figure 4-62. Overcurrent**

### Loss of Mains Protection

Loss of mains protection consists of one vector shift element and one rate of change of frequency element (style number xxxxxxExx only). The functionality of these elements is similar in that they are both intended to disconnect the generator from the grid when a loss of mains or mains failure occurs, preventing the generator from remaining tied to the mains if the mains returns due to an external reclose device. When the mains is lost, it is likely that the generator load will shift abruptly since the generator is

driving everything between the generator output and the utility breaker that removed mains power. Such a load shift is likely to cause a speed shift, which might result in the generator being out of phase with the mains when a reclose occurs. If the generator is out of phase and connection with the mains is established, damage could occur.

Loss of mains protection is only active when the generator is paralleled to the mains as indicated when the Parallel To Mains logic element is TRUE in BESTlogicPlus. The protection is inhibited for five seconds after Parallel To Mains first becomes TRUE so that transients from closing onto the mains will not cause FALSE trips.

To minimize FALSE trips, loss of mains protection is disabled if any breakers are not closed.

### Vector Shift (78)

The vector shift element trips the breaker when it detects a phase shift in the generator voltage. A sudden change in generator phase angle often occurs when the grid is lost. This change of phase angle results in an earlier zero crossing of the generator voltage if the generator load decreases or a later zero crossing if the generator load increases. This shift of the zero crossing (vector shift) is expressed in degrees. A trip will occur if the vector shift exceeds the Pickup setting. A setting is provided to open the mains breaker or generator breaker on trip. An additional setting is provided to configure the protection for Alarm, Pre-Alarm, or Status annunciation when tripped. The trip status of the Vector Shift (78) element is available to BESTlogicPlus when configured for Alarm, Pre-Alarm, or Status.

This element is disabled when Alarm Configuration is set to “None” or when the Block input of the Vector Shift logic element is TRUE.

Vector Shift (78) trips are latched. They are cleared by pressing the *Reset* button on the front panel or by putting the DGC-2020 into Off mode.

The BESTCOMSPlus Vector Shift (78) screen is illustrated in Figure 4-63.

Figure 4-63. Vector Shift (78)

### ROCOF (81)

The ROCOF (rate of change of frequency) element trips the breaker when a change in frequency results from a sudden change in load. A trip will occur if the rate of change of frequency exceeds the Pickup setting and the Activation Delay has expired. A setting is provided to open the mains breaker or generator breaker on trip. An additional setting configures the protection for Alarm, Pre-Alarm, or Status annunciation when tripped. The trip status of the ROCOF (81) element is available to BESTlogicPlus when configured for Alarm, Pre-Alarm, or Status.

This element is disabled when Alarm Configuration is set to “None” or when the Block input of the ROCOF logic element is TRUE.

ROCOF (81) trips are latched. They are cleared by pressing the *Reset* button on the front panel or by putting the DGC-2020 into Off mode.

The BESTCOMSPlus ROCOF (81) screen is illustrated in Figure 4-64.

Figure 4-64. ROCOF (81)

## Breaker Management

DGC-2020 breaker management features include the control of two, continuous- or pulse-controlled breakers, load transfer upon detection of a mains failure, two modes of automatic genset synchronization, and settings for stable or dead bus detection. Open transitions are implemented in load transfers to and from the mains.

The description of breaker management is organized as follows:

- Breaker Hardware
- Mains Failure
- Bus Condition Detection
- Synchronizer

### Breaker Hardware

By default, one (generator) breaker is enabled for control and monitoring by the DGC-2020. In applications requiring control of a generator breaker and mains breaker, a second (mains) breaker can be enabled and configured.

Breakers controlled by pulse or continuous inputs are supported. Separate settings for each breaker's open and close pulse widths are provided as well as a transition delay. During the Transition Delay, open or close outputs are removed to allow any breaker interlocks to reset before a new open or close output is initialized. This setting accepts values from 0 to 1,000, in increments of 1 second.

During synchronization of the generator with the bus (Anticipatory mode only), the DGC-2020 uses the breaker closing time to calculate the optimum time to close the breaker.

When a close command is issued, the DGC-2020 monitors the breaker status and annunciates a breaker failure if the breaker does not close within the time defined by the breaker-close wait-time delay. Typically, this parameter is set to be longer than twice the breaker closing time.

The Breaker Fail Output Configuration setting dictates whether the breaker output is removed or maintained during the breaker open fail or breaker close fail pre-alarm condition.

After a breaker open or close failure occurs, the DGC-2020 can attempt to reopen or reclose the breaker a pre-defined number of times. The number of attempts to open or close the breaker and the duration of time between each attempt are user-programmable.

When an external device changes the state of the breaker, the External Status Change Action setting dictates how the DGC-2020 responds to the state change. The DGC-2020 can ignore external breaker state changes, always follow breaker state changes, or only follow breaker state changes when in Auto mode. When the DGC-2020 is following external breaker state changes, it issues outputs that correspond to the change in breaker state. If an external source opens the breaker, the DGC-2020 issues a breaker

open output. Likewise, if an external source closes the breaker, the DGC-2020 issues a breaker close output.

The dead bus close enable setting enables a machine to close its breaker onto a dead bus. This can be used to make sure only one machine can close onto a dead bus at a time, if desired, preventing multiple machines closing to the dead bus at the same time, potentially out of phase with each other. When this setting is disabled, a machine can only close onto a stable bus.

### Startup Synchronization

Startup synchronizing is a means of bringing up a system of generators, when the generator breakers are closed to a dead bus when the generator is stopped. After all breakers are closed, the gensets are started and pulled into sync when the AVR's are turned on. When enabled, the dead gen close enable parameter allows closure of the breaker to a dead bus when the generator is dead.

Normally, it is not possible to close the generator breaker when the generator is dead. However, in cases where it is required to connect a generator that is “dead” to a bus that is “dead” for purposes of startup synchronization, both the generator and the bus must be recognized as “dead”. To permit a close of the generator breaker from a “dead” generator to a “dead” bus, both the Dead Bus Close Enable setting and the Dead Gen Close Enable setting, in *Breaker Hardware* settings, must be set to enabled. After all breakers are closed, the gensets are started and pulled into sync when the AVR's are turned on. The user must develop logic to start the generators and turn on excitation in the voltage regulators at the correct time for orderly system startup.

### Caution

Use caution when connecting “dead” generators to a “dead” bus. Undesired operation or system damage could occur if the bus becomes “live” while “dead” generators are connected to it.

The BESTCOMS*Plus* Breaker Hardware screen is illustrated in Figure 4-65.

**Breaker Hardware**

**Generator Breaker Hardware**

Configured: ☐ No ☒ Yes

Dead Bus Close Enable: ☒ Disable ☐ Enable

Dead Gen Close Enable: ☒ Disable ☐ Enable

Contact Type: ☐ Pulse ☒ Continuous

Breaker Fail Output Configuration: ☒ Retain ☐ Remove

External Status Change Action: ☒ Ignore ☐ Follow Always ☐ Follow In Auto

Breaker Closing Time (ms): 100

Open Pulse Time (s): 0.01

Close Pulse Time (s): 0.01

Transition Delay (s): 0.00

Open Attempts: 1

Close Attempts: 1

Retry Delay (s): 5

**Gen and Mains Breaker**

Breaker Close Wait Time (s): 0.2

**Mains Breaker Hardware**

Configured: ☒ No ☐ Yes

Contact Type: ☐ Pulse ☒ Continuous

Breaker Fail Output Configuration: ☒ Retain ☐ Remove

External Status Change Action: ☒ Ignore ☐ Follow Always ☐ Follow In Auto

Breaker Closing Time (ms): 100

Open Pulse Time (s): 0.01

Close Pulse Time (s): 0.01

Transition Delay (s): 0.00

Open Attempts: 1

Close Attempts: 1

Retry Delay (s): 5

Figure 4-65. Breaker Hardware



### Breaker Hardware One-Line Diagram

A one-line diagram of the breaker hardware setup can be displayed on the front panel. This diagram changes in real time to reflect the current state of the configured breakers. See Section 2, *Human-Machine Interface* for details.

## **Mains Failure**

When two breakers are configured (enabled), the DGC-2020 can be enabled to automatically transfer load power from the mains to the genset during a mains failure. This feature also enables the DGC-2020 to transfer the load back to the mains once mains power is restored. Settings include a transfer delay, return delay, max transfer time, and max return time.

Automatic breaker operation can be disabled through BESTlogic*Plus* Programmable Logic. When the Auto Breaker Operation Inhibit element is set TRUE, it prevents all automatic breaker operation.

When Mains Fail Transfer is set to enabled, the machine is configured as a mains fail machine or standby power machine that takes over when utility power fails. There are two types of transitions between the generator and the utility that are set with the Mains Fail Transfer Type setting: (1) Open transitions in which the generator and mains breaker are never closed at the same time, and (2) Closed transitions in which the generator parallels to the utility for a short time to transfer load to the generator from the utility (a load takeover) or transfer the load from the generator to the utility.

The Mains Fail Transfer function can be disabled through BESTlogic*Plus* Programmable Logic. When the Mains Fail Transfer Inhibit element is set TRUE, it prevents automatic load transfer due to a mains failure.

In open transitions, when a mains failure occurs, the DGC-2020 starts the generator after the transfer time expires. The DGC-2020 opens the mains breaker either before the engine starts or after the generator is stable based on the Mains Breaker Open Configuration setting. After the mains breaker is open, the DGC-2020 closes its generator breaker to drive the load. When the mains power returns, after the Mains Fail Return Delay time expires, the generator opens its generator breaker and then closes the mains breaker. If the in-phase monitor is enabled and the Mains Fail Return Delay time has expired, the generator waits until it detects that the phases are aligned between the generator and the mains before performing the open transition from the generator back to the utility.

An Open Transition Delay is provided to allow a user-specified amount of time where both breakers are open. For example, this may be used to prevent damage to large motors in the load by allowing them to spin down completely during open transitions. The Open Transition Delay is active when both the generator and mains breakers are open, or when the mains breaker is closed and the mains bus is dead.

In closed transitions, when a mains failure occurs, the DGC-2020 starts the generator after the transfer time expires. The DGC-2020 opens the mains breaker either before the engine starts or after the generator becomes stable based on the Mains Breaker Open Configuration setting. After the mains breaker is open the DGC-2020 closes its generator breaker to drive the load. When the mains power returns, after the Mains Fail Return Delay time expires, the generator synchronizes to the utility and closes the mains breaker, paralleling the generator to the utility. While paralleled to the utility, the generator will ramp down load until the load is at or below the level of the Breaker Open Setpoint or until the generator has been paralleled to the utility for the maximum allowed time as specified by the Max Parallel Time setting. Finally, the generator opens its generator breaker, leaving the load on utility power, cools down, and stops. Since the kW output of the generator is ramped during closed transitions, a Load Sharing Module (LSM-2020) is generally required to provide governor bias signals to the engine governor.

Closed transition override can be enabled through BESTlogic*Plus* Programmable Logic. When the Closed Transition Override element is set TRUE, it forces a closed transition due to mains failure, overriding an *open* Mains Fail Transfer Type setting.

If the Alarm State Transfer to Mains setting is enabled, the DGC-2020 can transfer the load to a stable utility when in the alarm state. If this setting is disabled, the DGC-2020 will not perform any transitions of the load to or from the utility when in the alarm state.

When enabled, Reverse Rotation Inhibit prevents automatic load transfer due to a mains failure when the machine is determined to have reverse phase rotation.

The BESTCOMS*Plus* Mains Fail screen is illustrated in Figure 4-66.



### Mains Failure Logic Elements

Four logic elements are present in BESTlogicPlus Programmable Logic that can be used on a machine configured for mains fail operation to transition the load from the mains to the generator. These four logic elements are Mains Fail Test, Load Take Over, Stop kvar Ramp, and Stop kW Ramp.

The Mains Fail Test logic element, when TRUE, causes the generator to react exactly as if the mains has failed: the mains breaker opens, the Mains Fail Transfer Delay time expires, the generator starts, the generator becomes stable, and the generator closes its generator breaker to drive the load. When the Mains Fail Test logic element is FALSE, the generator reacts as if the mains has returned: the Mains Fail Return Delay time expires and the generator transitions the load from the generator back to the utility in an Open or Closed transition, according to the Mains Fail Transfer Type setting.

The Load Take Over logic element is similar, except that the machine does not act as if the mains has failed, and the transfer and return delay timers are ignored. If the Mains Fail Transition Type is set to Open and the Load Take Over logic element is TRUE, the mains breaker opens, the generator starts, the generator becomes stable, and the generator breaker closes to drive the load. When the Load Take Over logic element is FALSE, the generator opens its generator breaker and closes the mains breaker to transition the load back to the utility. If the In Phase Monitor function is enabled, the transition does not occur until generator and utility phases are aligned.

If the Mains Fail Transition Type is set to Closed and the Load Take Over logic element is TRUE, the generator starts, synchronizes to the utility, and closes the generator breaker. The generator will take on load until it is driving load at a level equal to the Base Load Level setting in the Governor Bias Control settings, or until the generator is paralleled to the utility for the maximum allowed time as specified by the Max Parallel Time setting. Once the load has reached the Base Load Level or the Max Parallel Time duration has expired, the mains breaker will open leaving the load on the generator. When the Load Take Over logic element is FALSE, the generator parallels to the utility. While paralleled to the utility, the generator ramps down load until the load is at or below the Breaker Open Setpoint or until the generator has been paralleled to the utility for the maximum allowed time as specified by the Max Parallel Time setting. Finally, the generator opens its generator breaker, leaving the load on utility power, cools down, and stops.

#### **Note**

The Parallel to Mains logic element must be TRUE any time the generator is in parallel with the utility. Parallel transitions to and from the mains will not operate properly if the Parallel to Mains logic element is not set correctly.

The Stop kW Ramp logic element, when TRUE, causes the generator to freeze the ramping of kW and maintain a constant output. For example, this can be used in closed transitions where an external device senses power flow across the mains breaker. When the external device senses zero power flow across the mains breaker, it sends an input to the DGC-2020. Through BESTlogicPlus, the Stop kW Ramp logic element receives the TRUE input and causes kW ramping to freeze. In this setup, the generator takes on load until one of the following conditions is TRUE:

- The Stop kW Ramp logic element becomes TRUE
- The Max Parallel time delay expires
- A breaker open request is received by the DGC-2020 from an external device

The Stop kvar Ramp logic element, when TRUE, causes the generator to freeze the ramping of kvar and maintain a constant output. This element has the same basic uses as the Stop kW Ramp element.

| Mains Fail                                                                                                       |                                                                                                                                       |                                                                            |
|------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| <b>Mains Fail Transfer</b><br><input checked="" type="radio"/> Disable<br><input type="radio"/> Enable           | <b>Mains Breaker Open Configuration</b><br><input checked="" type="radio"/> Generator Start<br><input type="radio"/> Generator Stable | <b>Mains Fail Transfer Delay (s)</b><br><input type="text" value="10"/>    |
| <b>Alarm State Transfer To Mains</b><br><input checked="" type="radio"/> Disable<br><input type="radio"/> Enable | <b>Reverse Rotation Inhibit</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable                           | <b>Mains Fail Return Delay (s)</b><br><input type="text" value="10"/>      |
| <b>Mains Fail Transfer Type</b><br><input type="radio"/> Closed<br><input checked="" type="radio"/> Open         | <b>In Phase Monitor</b><br><input checked="" type="radio"/> Disable<br><input type="radio"/> Enable                                   | <b>Mains Fail Max Transfer Time (s)</b><br><input type="text" value="30"/> |
|                                                                                                                  |                                                                                                                                       | <b>Mains Fail Max Return Time (s)</b><br><input type="text" value="30"/>   |
|                                                                                                                  |                                                                                                                                       | <b>Max Parallel Time (s)</b><br><input type="text" value="0.5"/>           |
|                                                                                                                  |                                                                                                                                       | <b>Open Transition Delay (s)</b><br><input type="text" value="0.0"/>       |

Figure 4-66 Mains Fail

## Bus Condition Detection

Bus condition detection settings are provided for generator sensing and bus sensing.

### Generator Sensing

DGC-2020 detection of dead generator voltages is controlled by a Dead Gen Threshold setting and a Dead Gen Activation Delay setting. A dead generator is recognized when the voltage of all phases decreases below the threshold setting for the duration of the time delay setting. Normally, it is not possible to close the generator breaker when the generator is dead. However, in cases where it is required to connect a generator that is “dead” to a bus that is “dead” for purposes of startup synchronization, both the generator and the bus must be recognized as “dead”. To permit a close of the generator breaker from a “dead” generator to a “dead” bus, both the Dead Bus Close Enable setting and the Dead Gen Close Enable setting, in *Breaker Hardware* settings, must be set to enabled.

### Caution

Use caution when connecting “dead” generators to a “dead” bus. Undesired operation or system damage could occur if the bus becomes “live” while “dead” generators are connected to it.

Before the DGC-2020 initiates a normal breaker closure (a stable generator is closed to a dead bus or stable bus), the generator voltage must be stable. The DGC-2020 uses several settings to determine voltage stability. These settings include pickup and dropout levels for overvoltage, undervoltage, overfrequency, and underfrequency. Recognition of generator stability is further controlled by two timers. Voltage conditions must meet the stability pickup and dropout settings for the duration of the Gen Stable Activation Delay. Breaker closure is not considered if the voltage conditions do not meet the stability pickup and dropout settings for the duration of the Gen Stable Activation Delay setting. When the generator does not meet the voltage or frequency criteria for the Gen Stable condition, the generator status is reported as Gen Failed (not stable) after the duration of the Gen Failed Activation Delay.

Generator status conditions are further defined below:

- Generator Stable becomes TRUE after the generator is within the frequency and voltage criteria in the Generator Stable settings for a time equal to the Generator Stable Activation Delay.
- Generator Stable becomes FALSE immediately (no delay) if the generator is outside of the frequency and voltage criteria in the Generator Stable settings.

- Generator Failed becomes TRUE after the generator is outside of the frequency or voltage criteria in the Generator Stable settings, but above the Generator Dead Voltage setting for a time equal to the Generator Failed Activation Delay.
- Generator Failed becomes FALSE immediately (no delay) if the generator is within the frequency and voltage criteria in the Generator Stable settings or the voltage is below the Generator Dead Voltage setting.
- Generator Dead becomes TRUE after the generator voltage is below the level of the Generator Dead Voltage setting for a time equal to the Generator Dead Activation Delay.
- Generator Dead becomes FALSE immediately (no delay) if the generator voltage is above the Generator Dead Voltage setting.

If it is desired in logic to drive an output TRUE when the generator is stable, but the output does not become FALSE until the generator is dead or failed, a Reset Priority Latch could be used as indicated in Figure 4-67.

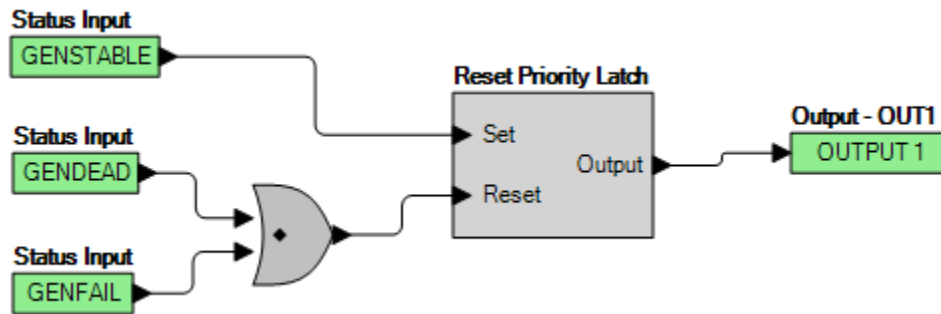


**Figure 4-67. Generator Conditions Logic with Reset Priority Latch**

The Gen Stable overvoltage and undervoltage detection elements have the low-line scale factor applied to them to enhance versatility for reconfigurable machines. When the low-line override is active, the thresholds for the overvoltage and undervoltage detection are multiplied by the low-line scale factor. The effect is that low-line threshold = element threshold setting x low-line scale factor.

An alternate frequency scale factor setting is used for automatic adjustment of the frequency pickup settings in applications that might utilize more than one operating frequency. For example, a machine that is configurable between 50 or 60 Hz operation. The scale factor setting is implemented when the DGC-2020 senses a contact closure at a contact input that is connected to the Alternate Frequency Override logic element in BESTlogicPlus Programmable Logic. When the Alternate Frequency Override is TRUE, the scale factor setting serves as a multiplier for the pickup settings. For example, if a scale factor contact input is received by the DGC-2020 and the scale factor setting is 2.000, the pickup setting will be doubled (2.000 x PU).

Settings, which are related to machine ratings, can be set in either actual units voltage or in per unit values. When a native unit is edited, BESTCOMSPlus automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the *System Parameters, Rated Data* screen) associated with it. When a per unit value is edited, BESTCOMSPlus automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, BESTCOMSPlus automatically recalculates all native unit settings based on the modified rated data parameters.

The following settings have native units of *Primary Volts*, and the rated data associated with them is *Rated Volts* (on the *System Parameters, Rated Data* screen).

- Dead Gen Threshold
- Gen Stable Overvoltage Pickup
- Gen Stable Overvoltage Dropout
- Gen Stable Undervoltage Pickup
- Gen Stable Undervoltage Dropout

The following settings have native units of *Frequency in Hz*, and the rated data associated with them is *Rated Frequency* (on the *System Parameters, Rated Data* screen).

- Gen Stable Overfrequency Pickup
- Gen Stable Overfrequency Dropout
- Gen Stable Underfrequency Pickup
- Gen Stable Underfrequency Dropout

### Bus Sensing

Dead bus detection is controlled by a Dead Bus Threshold setting and a Dead Bus Activation Delay setting. A dead bus is recognized when the voltage of all phases decreases below the threshold setting for the duration of the time delay setting.

Before the DGC-2020 initiates a breaker closure to a bus that is not dead, the voltage must be stable. The DGC-2020 uses several settings to determine voltage stability. These settings include pickup and dropout levels for overvoltage, undervoltage, overfrequency, and underfrequency. Recognition of bus stability is further controlled by two timers. Voltage conditions must meet the stability pickup and dropout settings for the duration of the Bus Stable Activation Delay. Breaker closure is not considered if the voltage conditions do not meet the stability pickup and dropout settings for the duration of the Bus Stable Activation Delay setting. When the bus does not meet the voltage or frequency criteria for the Bus Stable condition, the bus status is reported as Bus Failed (not stable) after the duration of the Bus Failed Activation Delay.

Bus status conditions are further defined below:

- Bus Stable becomes TRUE after the bus is within the frequency and voltage criteria in the Bus Stable settings for a time equal to the Bus Stable Activation Delay.
- Bus Stable becomes FALSE immediately (no delay) if the bus is outside of the frequency and voltage criteria in the Bus Stable settings.
- Bus Failed becomes TRUE after the bus is outside of the frequency or voltage criteria in the Bus Stable settings, but above the Bus Dead Voltage setting for a time equal to the Bus Failed Activation Delay.
- Bus Failed becomes FALSE immediately (no delay) if the bus is within the frequency and voltage criteria in the Bus Stable settings or the voltage is below the Bus Dead Voltage setting.
- Bus Dead becomes TRUE after the bus voltage is below the level of the Bus Dead Voltage setting for a time equal to the Bus Dead Activation Delay.
- Bus Dead becomes FALSE immediately (no delay) if the bus voltage is above the Bus Dead Voltage setting.

If it is desired in logic to drive an output TRUE when the bus is stable, but the output does not become FALSE until the bus is dead or failed, a Reset Priority Latch could be used as indicated in Figure 4-68.

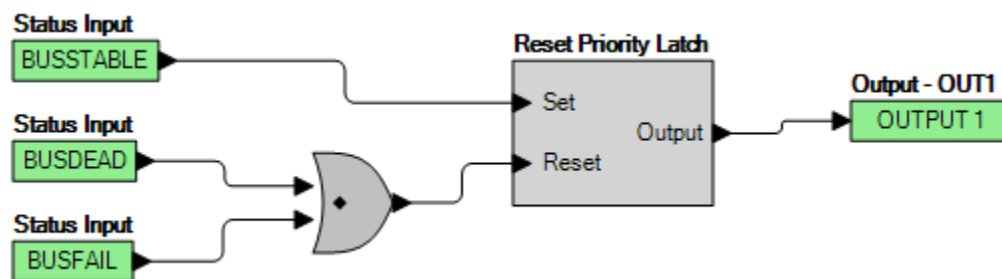


**Figure 4-68. Bus Conditions Logic with Reset Priority Latch**

The Bus Stable overvoltage and undervoltage detection elements have the low-line scale factor applied to them to enhance versatility for reconfigurable machines. When the low-line override is active, the thresholds for the overvoltage and undervoltage detection are multiplied by the low-line scale factor. The effect is that low-line threshold = element threshold setting x low-line scale factor.

An alternate frequency scale factor setting is used for automatic adjustment of the frequency pickup settings in applications that might utilize more than one operating frequency. For example, a machine that is configurable between 50 or 60 Hz operation. The scale factor setting is implemented when the DGC-2020 senses a contact closure at a contact input that is connected to the Alternate Frequency Override logic element in BESTlogicPlus Programmable Logic. When the Alternate Frequency Override is TRUE, the scale factor setting serves as a multiplier for the pickup settings. For example, if a scale factor contact input is received by the DGC-2020 and the scale factor setting is 2.000, the pickup setting will be doubled (2.000 x PU).

Settings which are related to machine ratings can be set in either actual units of voltage or in per unit values. When a native unit is edited, BESTCOMSPlus automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the *System Parameters, Rated Data* screen) associated with it. When a per-unit value is edited, BESTCOMSPlus automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, BESTCOMSPlus automatically recalculates all native unit settings based on the modified rated data parameters.

The following settings have native units of *Primary Volts*, and the rated data associated with them is *Rated Volts* (on the *System Parameters, Rated Data* screen).

- Dead Bus Threshold
- Bus Stable Overvoltage Pickup
- Bus Stable Overvoltage Dropout
- Bus Stable Undervoltage Pickup
- Bus Stable Undervoltage Dropout

The following settings have native units of *Frequency in Hz*, and the rated data associated with them is *Rated Frequency* (on the *System Parameters, Rated Data* screen).

- Bus Stable Overfrequency Pickup
- Bus Stable Overfrequency Dropout
- Bus Stable Underfrequency Pickup
- Bus Stable Underfrequency Dropout

The BESTCOMSPlus Bus Condition Detection screen is illustrated in Figure 4-69.

| <b>Note</b>                                                                                                                              |
|------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Voltage threshold and pickup settings on the Bus Condition Detection screen are entered in primary values (generator side of VT).</p> |

### Bus Condition Detection

#### Generator Sensing

##### Generator Condition Settings

|                    |                               |                                 |
|--------------------|-------------------------------|---------------------------------|
| Dead Gen Threshold | Dead Gen Activation Delay (s) | Gen Failed Activation Delay (s) |
| 30 V               | 0.1                           | 0.1                             |
| 0.063 Per Unit     |                               |                                 |

#### Generator Stable

##### Overvoltage Settings

|                |                |
|----------------|----------------|
| Pickup (V L-L) | Dropout        |
| 130 V          | 127 V          |
| 0.271 Per Unit | 0.265 Per Unit |

##### Undervoltage Settings

|                |                |
|----------------|----------------|
| Pickup (V L-L) | Dropout        |
| 115 V          | 117 V          |
| 0.240 Per Unit | 0.244 Per Unit |

##### Overfrequency Settings

|                 |                 |
|-----------------|-----------------|
| Pickup          | Dropout         |
| 62.00 Hz        | 61.80 Hz        |
| 1.0333 Per Unit | 1.0300 Per Unit |

##### Underfrequency Settings

|                 |                 |
|-----------------|-----------------|
| Pickup          | Dropout         |
| 58.00 Hz        | 58.20 Hz        |
| 0.9667 Per Unit | 0.9700 Per Unit |

|                                 |                       |                                  |
|---------------------------------|-----------------------|----------------------------------|
| Gen Stable Activation Delay (s) | Low Line Scale Factor | Alternate Frequency Scale Factor |
| 0.1                             | 1.000                 | 1.000                            |

#### Bus Sensing

##### Bus Condition Settings

|                    |                               |                                 |
|--------------------|-------------------------------|---------------------------------|
| Dead Bus Threshold | Dead Bus Activation Delay (s) | Bus Failed Activation Delay (s) |
| 30 V               | 0.1                           | 0.1                             |
| 0.063 Per Unit     |                               |                                 |

#### Bus Stable

##### Overvoltage Settings

|                |                |
|----------------|----------------|
| Pickup (V L-L) | Dropout        |
| 130 V          | 127 V          |
| 0.271 Per Unit | 0.265 Per Unit |

##### Undervoltage Settings

|                |                |
|----------------|----------------|
| Pickup (V L-L) | Dropout        |
| 115 V          | 117 V          |
| 0.240 Per Unit | 0.244 Per Unit |

##### Overfrequency Settings

|                 |                 |
|-----------------|-----------------|
| Pickup          | Dropout         |
| 62.00 Hz        | 61.80 Hz        |
| 1.0333 Per Unit | 1.0300 Per Unit |

##### Underfrequency Settings

|                 |                 |
|-----------------|-----------------|
| Pickup          | Dropout         |
| 58.00 Hz        | 58.20 Hz        |
| 0.9667 Per Unit | 0.9700 Per Unit |

|                                 |                       |                                  |
|---------------------------------|-----------------------|----------------------------------|
| Bus Stable Activation Delay (s) | Low Line Scale Factor | Alternate Frequency Scale Factor |
| 0.1                             | 1.000                 | 1.000                            |

Figure 4-69. Bus Condition Detection

### Automatic Synchronizer (Optional)

Two methods of generator synchronization are offered: phase lock loop and anticipatory. In both methods, the DGC-2020 adjusts the frequency and voltage of the generator to match that of the bus (mains) and then connects the generator to the bus by closing the breaker. Anticipatory mode has the added capability of compensating for the breaker closing time (the delay between when a breaker close command is issued and the breaker blades close). The DGC-2020 calculates the advance phase angle that is required to compensate for the breaker closure time by monitoring the frequency difference between the generator and the bus.

A synchronizer metering screen is available on the front panel HMI under *Metering, Generator, Synchronizer*. See Figure 4-70.

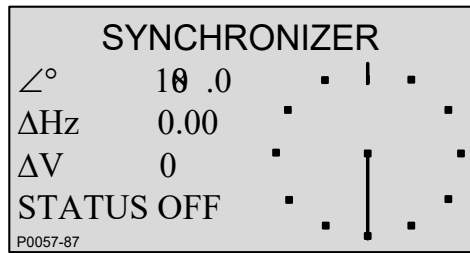


Figure 4-70. Synchronizer Screen

The BESTCOMSPlus Synchronizer screen is illustrated in Figure 4-72.

#### Frequency Correction

Generator frequency correction is defined by the slip frequency setting and further refined by the breaker closing angle setting. The slip frequency setting establishes the maximum allowable deviation of the generator speed (frequency) from the bus frequency. The Min Slip Control Limit setting and Max Slip Control Limit setting are used to calculate the slip frequency error and to provide continuous slip frequency control while in phase lock synchronization. If the slip frequency magnitude is above the Max Slip Control Limit, the error is set equal to the Max Error in the opposite polarity. If the slip frequency magnitude is below the Min Slip Control Limit, the slip frequency error is 0. When it is between the two limits, the error is calculated internally by the DGC-2020. Slip frequency error is shown in Figure 4-71. To minimize the impact on the bus during synchronization, the Fgen>Fbus setting can be enabled to force the generator frequency to exceed the bus frequency at the moment of breaker closure. If this is the case, the DGC-2020 will drive the generator frequency higher than the bus frequency before closing the breaker. The breaker closing angle setting defines the maximum allowable phase angle difference between the generator and the bus. For breaker closure to be considered, the slip angle must remain below this setting for the duration of the sync activation delay setting.

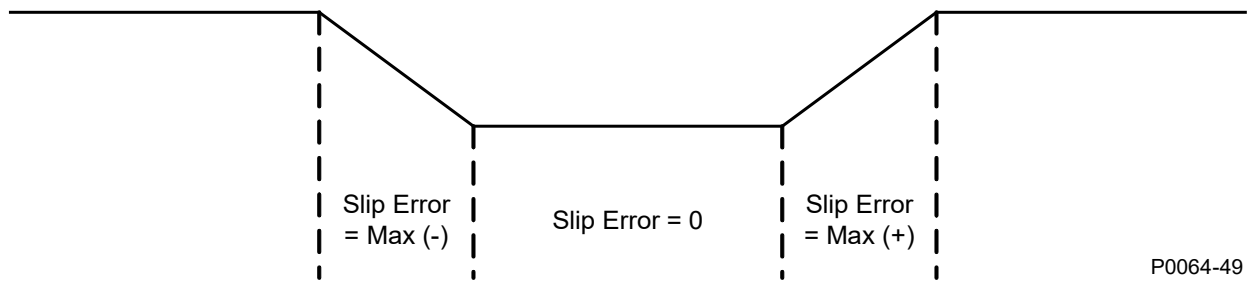


Figure 4-71. Slip Frequency Error

#### Voltage Correction

Generator voltage correction is defined by the voltage window setting. This setting, expressed as a percentage of the bus voltage, determines the band of generator voltage surrounding the bus voltage when breaker closure will be considered. If the Vgen>Vbus setting is enabled, the DGC-2020 will drive the generator voltage to be greater than the bus voltage by an amount equal to the regulation offset setting divided by two.

#### Breaker Closure

When the synchronization criteria are met, the DGC-2020 issues a breaker close output. If pulsed outputs are configured, the output is held for the duration of the Breaker Close Pulse Time. If constant outputs are configured, the close output is maintained constantly. If the synchronization criteria is not met after the breaker close output has been issued, after a 250 ms delay, the breaker close output is removed. Sometimes the “bump” to the system from the breaker closure causes the system to momentarily violate the synchronization criteria. The 250 ms delay allows time for the DGC-2020 to “ride through” the bump and receive a Breaker Closed status, preventing the possibility of premature breaker close output removal.



### Synchronization Failure

The maximum desired duration for synchronizing to take place is established by the sync fail activation delay setting. If synchronization (breaker closure) fails to occur within this time setting, generator synchronization will be aborted and a failure will be annunciated. Note that if either bus goes unstable, the synchronizer timers are reset.

### Gain Settings

Sync speed gain and sync voltage gain settings are provided to increase the loop gain of the automatic synchronizer. This allows the synchronizer function to be aggressive during synchronization and stable during speed trim operation.

### Notes

If the generator frequency is 400 Hz, the settings on the Synchronizer screen do NOT apply. In this case, BESTCOMSP<sup>Plus</sup> will not allow these settings to be changed.

When using the DGC-2020 synchronizer, it is recommended that local DGC-2020 relay outputs be used for breaker closing commands to minimize the possibility of closures outside of desired breaker closing angles.

**Synchronizer**

Sync Type: Phase Lock Loop (dropdown)

Slip Frequency (Hz): 0.30

Min Slip Control Limit (Hz): 0.00

Max Slip Control Limit (Hz): 0.30

Voltage Window (%): 2.0

Breaker Closing Angle (°): 10.0

Fgen > Fbus: ☐ Disable, ☒ Enable

Vgen > Vbus: ☒ Disable, ☐ Enable

Sync Activation Delay (s): 0.1

Sync Fail Activation Delay (s): 5.0

Sync Speed Gain: 1.000

Sync Voltage Gain: 1.000

Figure 4-72. Synchronizer

## **Bias Control Settings**

Settings are provided for AVR Bias Control and Governor Bias Control. Refer to Appendix C for instructions on Tuning Speed PID Settings and Load Control PID Settings.

### **AVR Bias Control Settings**

The bias control output type should be set to contact when operating without an optional LSM-2020.

The DGC-2020 adjusts the generator voltage and frequency by issuing voltage correction signals to the generator AVR (automatic voltage regulator). Correction signals are issued in the form of DGC-2020 output contact closures. These correction signals can be either continuous or proportional. Proportional correction uses control pulses of varying widths and intervals. Initially, long pulses are issued when the voltage and frequency differences are large. As the correction pulses take effect and the voltage and frequency differences become smaller, the correction pulse widths are proportionally decreased.



Proportional correction pulses are beneficial in applications where fixed correction pulses can result in overshooting the slip frequency and regulation offset targets.

When an optional LSM-2020 is connected, the bias control output type should be set to analog. This enables a voltage trim setting and a PID controller.

To achieve Ethernet var sharing among machines in an islanded system, the following conditions must be met:

- Var/PF control must be enabled on the AVR Bias Control Settings screen
- A connection between the DGC-2020 and LSM-2020 must be established
- LSM-2020s must be connected to each other via Ethernet on the inter-genset communications network

Section 9, *LSM-2020 (Load Share Module)* provides setup information and connection diagrams for load sharing.

### Voltage Trim

The voltage trim enable setting maintains system voltage at the setpoint while the system is in islanded var sharing mode. When Enable When Gen Breaker Closed is selected, voltage trim is enabled when the generator breaker is closed, but disabled when the generator breaker is open. This is the default value. When Enable Always is selected, voltage trim is always enabled.

The Voltage Trim error is calculated as the difference between the measured voltage and the voltage trim setpoint divided by the machine Rated Voltage. When this difference is less than the trim dead band setting, the voltage trim controller will treat this as zero error. If system operation appears "nervous" when voltage trim is enabled, setting a nonzero dead band may result in smoother system operation. In addition, if machines do not appear to share kvar equally when voltage trim is enabled, setting a nonzero dead band will likely result in improved kvar sharing. The Voltage Trim Dead Band is in units of Percent.

The voltage trim setpoint defines the source for voltage trim. Selections are Rated Voltage and Trim Voltage Setting.

The remote trim bias setting selects an analog input to use as a bias to the voltage trim setpoint. The remote trim bias (%) setting specifies the range, in percent, of the active voltage trim setpoint over which the voltage trim can be biased.

The trim voltage setting defines the voltage trim value in volts. The Alternate Voltage 1 through Alternate Voltage 4 settings define the voltage trim value when the corresponding Alternate Voltage Override logic element is TRUE in BESTlogicPlus programmable logic.

### PID Controller

The PID controller controls the voltage bias from the LSM-2020 to the voltage regulator. The controller adjusts the bias output to drive the error between desired generator voltage and measured generator voltage to zero. Settings are provided for proportional gain, integral gain, derivative gain, derivative filter constant, and loop gain of the PID controller.

### var/PF Control

The var/PF controller is used to implement var and Power Factor control of the generator when it is paralleled to the utility as indicated by the Parallel to Mains logic element in BESTlogicPlus. If var/PF control is enabled, the generator breaker is closed, the generator is stable, and the bias control output type is set to *analog* (requires LSM-2020) the var/PF controller will become active. If the Parallel to Mains logic element is TRUE, the var/PF controller will regulate the generator's kvar output to achieve desired kvar or power factor levels. When not paralleled to mains, the var/PF controller will control the kvar output to achieve reactive power sharing between all generators in the system through Intergenset communications. If the generator breaker is open or controller is disabled, the machine will operate in voltage droop.

When control is enabled and the control mode is set to var, the var setpoint can be derived from either a user setting or an analog input. The DGC-2020 calculates an operating kvar setpoint based on the kvar setpoint source setting. When this is set to User Setting, the operating kvar setpoint is equal to the configured kvar setpoint. When the kvar setpoint source setting is set to LSM-2020 input or an AEM-2020

input, the operating kvar setpoint is equal to the value calculated from the analog input. Parameters are available for kvar analog max and kvar analog min.

When control mode is set to PF, the PF setpoint can be derived either from a user setting or from an analog input. The DGC-2020 calculates an operating PF setpoint based on the PF setpoint source setting. When this is set to User Setting, the operating PF setpoint is equal to the configured PF setpoint. When the PF setpoint source setting is set to LSM-2020 input or an AEM-2020 input, the operating PF setpoint is equal to the value calculated from the analog input. Parameters are available for PF analog max and PF analog min.

When an optional LSM-2020 is connected, the bias control output type should be set to analog. This enables a PID controller that controls the var/PF bias from the LSM-2020 to the voltage regulator. The controller adjusts the bias output to drive the error between desired generator var/PF and measured generator var/PF to zero. Settings are provided for proportional gain, integral gain, derivative gain, derivative filter constant, loop gain, and parallel to mains gain of the PID controller.

The percent voltage droop to be used when the unit is in droop mode is determined by the droop percentage setting. Voltage droop mode is entered any time the generator breaker is open. Voltage droop is also the mode when the generator breaker is closed and var/PF control is disabled. If it is desired to disable voltage droop, set the droop percentage to 0. The voltage droop gain setting determines the gain factor applied to the voltage droop percentage to compensate for governor differences and achieve desired droop performance. In order to test the operation of droop, the unit must be loaded to full load and the resulting generator voltage should be compared to the desired droop. If it is not possible to load the unit to full load, the droop test can be performed at partial load. The expected voltage is determined by the following equation.

Expected voltage reduction in droop - (actual load/machine capacity) \* (droop percentage/100) \* rated voltage.

If the actual voltage drop does not match the expected value, calculate the error by dividing the expected drop by the actual drop, and putting the result in as the droop gain.

Ramp rate is defined as the rate, in percentage of machine capacity, at which the machine will ramp up its var/PF when loading or coming online. The machine also uses this rate to unload prior to cooling down. If a machine is the only machine online, ramping will not be in effect.

After ramping a generator's kvar output, to bring it online or offline, overshoot may occur. The likeliness of kvar overshoot increases as the ramp rate increases. Typically, overshoot is reduced by lowering the ramp rate to the slowest possible setting. If overshoot is still a problem, the Ramp Overshoot Reduction setting can be used. A setting of 0% overshoot reduction results in no change to the amount of overshoot. A setting of 100% provides maximum overshoot reduction. Ramp Overshoot Reduction must be tuned to the optimal level. Too little reduction may result in overshoot while too much reduction may result in undershoot.

The BESTCOMSP<sub>Plus</sub> AVR Bias Control Settings screen is illustrated in Figure 4-73.

**AVR Bias Control Settings**

Bias Control Output Type:  Correction Pulse Width (s):

Bias Control Contact Type:  Correction Pulse Interval (s):

**Voltage**

Kp Proportional Gain:  Trim Enable:

Ki Integral Gain:  Trim Deadband (%):

Kd Derivative Gain:  Voltage Trim Setpoint:

Td Derivative Filter Constant:  Remote Trim Bias:

Kg Loop Gain:  Remote Trim Bias (%):

**Trim Voltage Setting**

Trim Voltage (V L-L):

Alternate Voltage 1 (V L-L):

Alternate Voltage 2 (V L-L):

Alternate Voltage 3 (V L-L):

Alternate Voltage 4 (V L-L):

**var / PF**

Control Enable:

Control Mode:

Droop Percentage (%):

Voltage Droop Gain:

Ramp Rate (%/s):

Ramp Overshoot Reduction (%):

kvar Setpoint (%):

kvar Setpoint Source:

kvar Analog Max (%):

kvar Analog Min (%):

Parallel To Mains Gain:

**PF Setpoint Source**

PF Setpoint Source:

(- Leading / + Lagging)

PF Setpoint:

PF Analog Max:

PF Analog Min:

Figure 4-73. AVR Bias Control Settings

## Governor Bias Control Settings

The bias control output type should be set to contact when operating without an optional LSM-2020.

The DGC-2020 adjusts the generator voltage and frequency by issuing speed correction signals to the generator governor. Correction signals are issued in the form of DGC-2020 output contact closures. These correction signals can be either continuous or proportional. Proportional correction uses control pulses of varying widths and intervals. Initially, long pulses are issued when the voltage and frequency differences are large. As the correction pulses take effect and the voltage and frequency differences become smaller, the correction pulse widths are proportionally decreased. Proportional correction pulses are beneficial in applications where fixed correction pulses can result in overshooting the slip frequency and regulation offset targets.

When an optional LSM-2020 is connected, the bias control output type should be set to analog. This enables a PID controller that controls the bias signal from the LSM-2020 to the speed governor. The controller adjusts the bias output to drive the error between desired generator speed and measured generator speed to zero. Settings are provided for proportional gain, integral gain, derivative gain, derivative filter constant, and loop gain of the PID controller.

The speed trim enable setting sets speed trimming to the speed trim setpoint when the generator breaker is closed and the machine is not paralleled to the utility.

When the difference between the measured speed and the speed trim setpoint is less than the trim dead band, the speed trim controller will treat this as zero error. If system operation appears "nervous" when speed trim is enabled, setting a nonzero dead band may result in smoother system operation. In addition, if machines do not appear to share kW equally when speed trim is enabled, setting a nonzero dead band will likely result in improved kW sharing. The Speed Trim Dead Band is in units of Hz.

The Remote Speed Bias setting provides for biasing the speed of a group of generators on a bus, by as much as  $\pm 5\%$ , for synchronizing to the utility. When the Remote Speed Bias setting is configured for the LSM-2020 input or an AEM-2020 input, the speed trim setpoint is calculated based on the specific analog input. The Remote Speed Bias (%) setting corresponds to the maximum and minimum analog input range.

If speed trimming is enabled in all generators in an islanded system, it is ensured that the system will run at the speed trim setpoint. If it is not enabled in any units, the islanded system might deviate from the speed trim setpoint, depending on the initial speed settings of the isochronous governors. Speed trim should be enabled in all units or disabled in all units of an islanded system. If it is enabled in only a subset of the units, speed trimming and load sharing might conflict, resulting in unpredictable load sharing and system frequency.

The BESTCOMS*Plus* Governor Bias Control Settings screen is illustrated in Figure 4-74.

### kW Control - Real Power Control Settings

When enabled, the DGC-2020, used in conjunction with an optional LSM-2020, can accomplish kW sharing between similarly equipped generators. kW sharing can be performed via Ethernet or Analog lines. The communication method is selected using the Load Share Interface setting. When an optional LSM-2020 is not connected, kW control is disabled.

kW control is accomplished with a PID controller that controls the speed bias signal from the LSM-2020 to the speed governor. The controller adjusts the bias output to drive the error between desired kW generation and measured kW generation to zero.

Settings are provided for proportional gain, integral gain, derivative gain, derivative filter constant, loop gain, and Parallel To Mains Gain of the PID controller.

The percent speed droop to be used when the unit is in droop mode is determined by the droop percentage setting. Speed droop mode is entered any time the generator breaker is open. Speed droop is also the mode when the generator breaker is closed if kW load sharing is disabled. If it is desired to disable speed droop, set the droop percentage to 0. The speed droop gain setting determines the gain factor applied to the speed droop percentage to compensate for governor differences and achieve desired droop performance. In order to test the operation of droop, the unit must be loaded to full load and the resulting generator speed should be compared to the desired droop. If it is not possible to load

the unit to full load, the droop test can be performed at partial load. The expected speed is determined by the following equation.

Expected rpm reduction in droop - (actual load/machine capacity) \* (droop percentage/100) \* rated speed.

If the actual rpm drop does not match the expected value, calculate the error by dividing the expected drop by the actual drop, and putting the result in as the droop gain.

Ramp rate is defined as the rate, in percentage of machine capacity, at which the machine will ramp up its real power when loading or coming online. The machine also uses this rate to unload prior to cooling down. If a machine is the only machine online, ramping will not be in effect.

After ramping a generator's kW output, to bring it online or offline, overshoot may occur. The likeliness of kW overshoot increases as the ramp rate increases. Typically, overshoot is reduced by lowering the ramp rate to the slowest possible setting. If overshoot is still a problem, the Ramp Overshoot Reduction setting can be used. A setting of 0% overshoot reduction results in no change to the amount of overshoot. A setting of 100% provides maximum overshoot reduction. Ramp Overshoot Reduction must be tuned to the optimal level. Too little reduction may result in overshoot while too much reduction may result in undershoot.

When User Setting is selected for the base load level source, the base load level setting determines the percent of machine capacity at which the kW controller will regulate if the generator is paralleled to the utility. If paralleled to the utility, the Parallel to Mains logic element in BESTlogicPlus must be driven by logic or a contact input. If parallel to utility operation is undertaken and the Parallel to Mains logic element is not implemented, the DGC-2020 will remain in kW load share and will either move toward operation at 100% of capacity or 0 capacity resulting in damage to the machine or system.

When the base load level source is configured for LSM-2020 input or an AEM-2020 input, the operating kW controller setpoint is calculated based on the specific analog input. Parameters are available for baseload analog max and baseload analog min.

When the unit unloads, the generator breaker will open when the power generated by the unit falls below the breaker open setpoint.

**Governor Bias Control Settings**

|                                         |                                      |                                        |                                        |                                  |
|-----------------------------------------|--------------------------------------|----------------------------------------|----------------------------------------|----------------------------------|
| Bias Control Output Type<br>Contact     | Correction Pulse Width (s)<br>0.0    | kW<br>Load Control Enabled<br>Enable   | Droop Percentage (%)<br>0.000          | Breaker Open Setpoint (%)<br>0.0 |
| Bias Control Contact Type<br>Continuous | Correction Pulse Interval (s)<br>0.0 | Load Share Interface<br>Analog         | Speed Droop Gain<br>1.000              |                                  |
| Speed<br>Kp Proportional Gain<br>1.000  | Trim Enable<br>Enable                | Kp Proportional Gain<br>1.000          | Ramp Rate (%/s)<br>20.0                |                                  |
| Ki Integral Gain<br>0.100               | Trim Deadband (Hz)<br>0.10           | Ki Integral Gain<br>0.100              | Ramp Overshoot Reduction (%)<br>0      |                                  |
| Kd Derivative Gain<br>0.000             | Speed Trim Setpoint (Hz)<br>60.00    | Kd Derivative Gain<br>0.000            | Base Load Level (%)<br>0.0             |                                  |
| Td Derivative Filter Constant<br>0.000  | Remote Speed Bias<br>None            | Td Derivative Filter Constant<br>0.000 | Base Load Level Source<br>User Setting |                                  |
| Kg Loop Gain<br>0.100                   | Remote Speed Bias (%)<br>2.00        | Kg Loop Gain<br>0.100                  | Baseload Analog Max (%)<br>100.0       |                                  |
|                                         |                                      | Parallel To Mains Gain<br>1.000        | Baseload Analog Min (%)<br>0.0         |                                  |

Figure 4-74. Governor Bias Control Settings

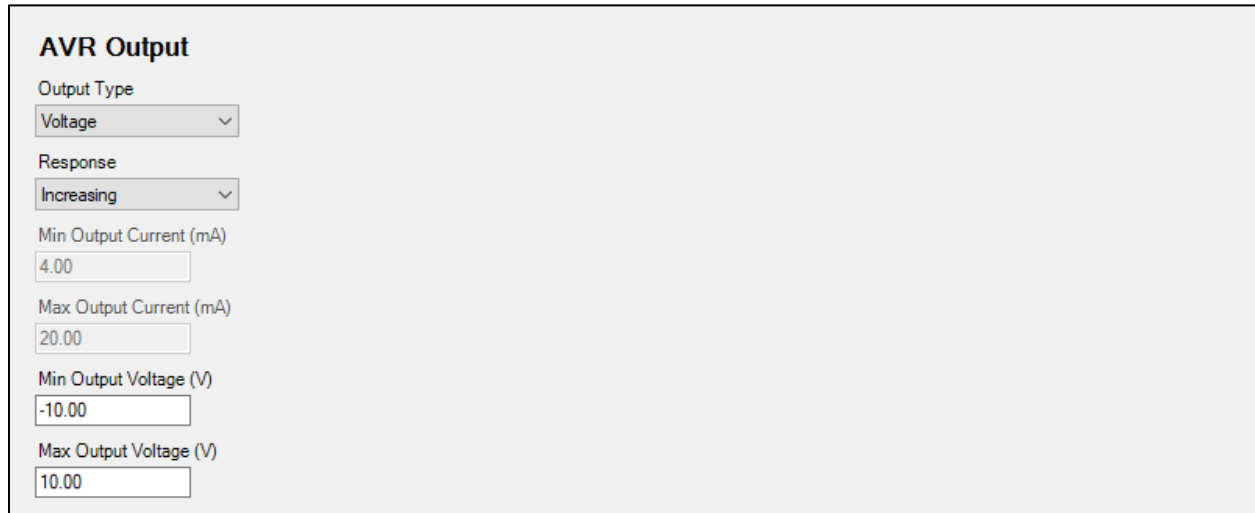
## Multigen Management

This group of settings is used when an optional LSM-2020 (Load Share Module) is connected to the DGC-2020. Multigen management settings consist of settings for AVR output, governor output, load share output, demand start/stop, generator sequencing, and network configuration.

## AVR Output

The AVR output of the LSM-2020 is used to change the voltage setpoint of the generator. If the response is set for increasing, an increased bias will cause higher voltage. If the response is set for decreasing, an increased bias will cause lower voltage. Settings are provided for minimum output current, maximum output current, minimum output voltage, and maximum output voltage.

The BESTCOMS*Plus* AVR Output screen is illustrated in Figure 4-75.



The screenshot shows the 'AVR Output' configuration window. It contains the following fields and controls:

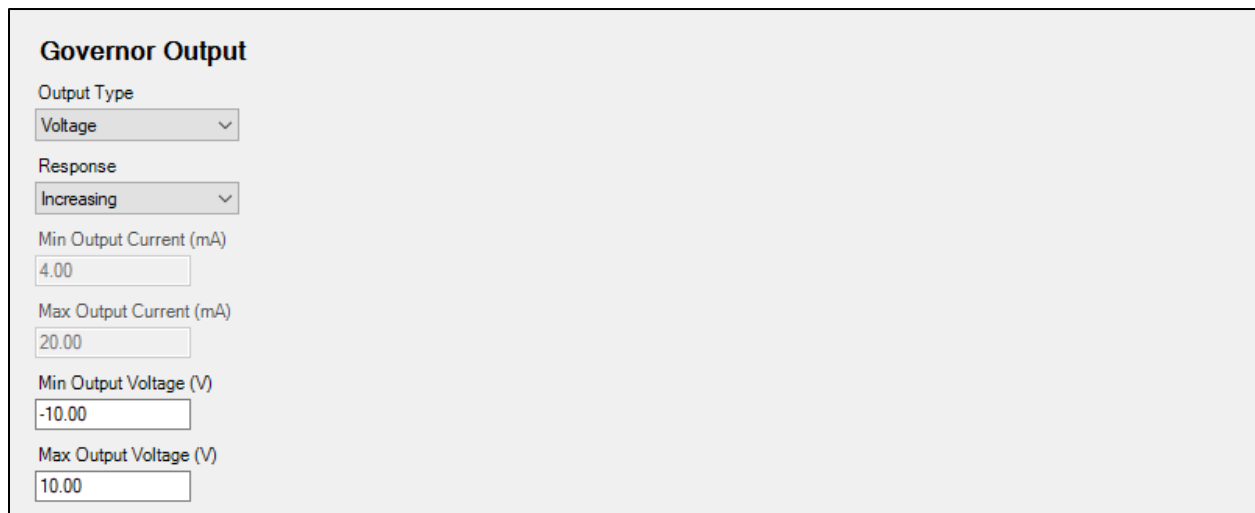
- Output Type:** A dropdown menu with 'Voltage' selected.
- Response:** A dropdown menu with 'Increasing' selected.
- Min Output Current (mA):** A text input field containing '4.00'.
- Max Output Current (mA):** A text input field containing '20.00'.
- Min Output Voltage (V):** A text input field containing '-10.00'.
- Max Output Voltage (V):** A text input field containing '10.00'.

Figure 4-75. AVR Output

## Governor Output

The governor output of the LSM-2020 is used to change the speed setpoint of the generator. If the response is set for increasing, an increased bias will cause faster speed. If the response is set for decreasing, an increased bias will cause slower speed. Settings are provided for minimum output current, maximum output current, minimum output voltage, and maximum output voltage.

The BESTCOMS*Plus* Governor Output screen is illustrated in Figure 4-76.



The screenshot shows the 'Governor Output' configuration window. It contains the following fields and controls:

- Output Type:** A dropdown menu with 'Voltage' selected.
- Response:** A dropdown menu with 'Increasing' selected.
- Min Output Current (mA):** A text input field containing '4.00'.
- Max Output Current (mA):** A text input field containing '20.00'.
- Min Output Voltage (V):** A text input field containing '-10.00'.
- Max Output Voltage (V):** A text input field containing '10.00'.

Figure 4-76. Governor Output

## Load Share Output

The generator uses the measured load share output to calculate per unitized average load level, and uses that as the setpoint for its kW controller. Settings are provided for maximum voltage and minimum voltage.

The BESTCOMS*Plus* Load Share Output screen is illustrated in Figure 4-77.



**Load Share Output**

Max Voltage (V)  
10.00

Min Voltage (V)  
-10.00

Figure 4-77. Load Share Output

## Demand Start/Stop

When enabled, Demand Start/Stop (DSS) issues start and stop requests based on per unitized system load. The primary function of DSS is to provide start and stop request information to the sequencing handler. Generator sequencing must be enabled in order for Demand Start/Stop to function. If system load is above a set level and the corresponding start level timeout has been exceeded, a corresponding start request is issued. If system load is below the delayed stop level and the stop timeout has been exceeded, a stop request is issued.

The BESTCOMS*Plus* Demand Start/Stop screen is illustrated in Figure 4-78.



**Demand Start/Stop**

Demand Start Stop Enable  
Disable

**Start 1**

Delayed Start Level 1 (PU) 0.000 Start Level 1 Timeout (s) 0.0

**Start 2**

Delayed Start Level 2 (PU) 0.000 Start Level 2 Timeout (s) 0.0

**Stop**

Delayed Stop Level (PU) 0.000 Stop Timeout (s) 0.0

Figure 4-78. Demand Start/Stop

## Generator Sequencing

Enabling sequencing on a networked group of load share units allows these units to manage load by starting and stopping appropriate units based on a factor of load demand and available capacity. The mode of operation is used to determine the order in which each generator in a group will contribute to the systems power production upon a demand start/stop request. The maximum start time setting defines the time to wait after a start request before demand start/stop can request the next priority unit to start. The maximum stop time defines the time to wait after a demand start/stop request before the next unit responds to a demand start/stop request.

Each LSM-2020 maintains its own start/stop status with respect to sequencing. When there is a change to generator sequencing mode on any one unit, this change will propagate to all connected units that are not in the disabled mode. All units on the network are notified of this mode change via the system. A unit is available for sequencing if it is in Auto mode and its sequencing mode is other than disabled.

If two or more units have the same sorting order parameter, the sequencing ID will be used to determine which unit has priority. For example, if the sequencing mode is set for largest size first and both are 100 kW machines, the unit with the lower sequencing ID will be given priority. In the event that both units have the same sequencing ID, the unit with the lower unit ID (based on the Mac address) will be given priority.

If a unit fails to sequence on, the next generator in the sequence will be requested. The generator that previously failed will be requested again in the next sequence cycle.



The last machine can be shut down if there is no load on the system by enabling Allow Last Unit Shutdown.

The BESTCOMSPlus Generator Sequencing screen is illustrated in Figure 4-79.

The available sequencing modes are defined in the following paragraphs.

#### Disabled

This is the only mode that can coexist with a different mode on a networked system. A unit configured as disabled does not participate in sequenced starting and stopping and does not respond to demand start/stop requests.

#### Staggered Service Time

If this mode is selected, units will seek to sort the start priority of all non-disabled networked units in ascending order of service hours remaining. In this configuration, a network of units will respond to a demand start request by starting the unit with the least number of service hours remaining first. If a unit is down to zero service hours remaining, it is moved to the lowest start priority position. In the event that two or more units have matching service hours remaining, the unit with the lowest sequencing ID is assigned highest start priority. Units in Auto Run mode with the highest number of service hours remaining respond to demand stop requests first.

#### Balanced Service Time

If this mode is selected, units will seek to sort the start priority of all non-disabled networked units in ascending order of service hours remaining. In this configuration, a network of units will respond to a demand start request by starting the unit with the greatest number of service hours remaining first. In the event that two or more units have matching service hours remaining, the unit with the lowest sequencing ID is assigned highest start priority. Units in Auto Run mode with the lowest number of service hours remaining respond to demand stop requests first.

#### Largest Size First

If this mode is selected, units will seek to sort the start priority of all non-disabled networked units in descending order of real load capacity. In this configuration, a network of units will respond to a demand start request by starting the unit with the largest load capacity first. In the event that two or more units have matching capacities, the unit with the lowest sequencing ID is assigned highest start priority. The stopping order will be the reverse of the starting order.

#### Smallest Size First

If this mode is selected, units will seek to sort the start priority of all non-disabled networked units in ascending order of real load capacity. In this configuration, a network of units will respond to a demand start request by starting the unit with the smallest load capacity first. In the event that two or more units have matching capacities, the unit with the lowest sequencing ID is assigned highest start priority. The stopping order will be the reverse of the starting order.

#### Smallest Unit ID

If this mode is selected, units will seek to sort the start priority of all non-disabled networked units in ascending order according to the sequencing ID. In this configuration, a network of units will respond to a demand start request by starting the unit with the smallest sequencing ID. Units must have unique sequencing IDs to be part of a network. The stopping order will be the reverse of the starting order.

#### Adopt System Mode

If this mode is selected, units will first check to see if a consistent mode is present on the currently networked controllers. If a consistent mode is found, that mode is adopted. If a consistent mode is not found, the unit enters a mode mismatch state. If a mode mismatch occurs, verify that all machines on the network are configured for the same generator sequencing mode.

**Generator Sequencing**

Mode  
Disabled

Sequencing ID  
0

Max Gen Start Time Sec (s)  
60

Max Gen Stop Time Sec (s)  
60

Allow Last Unit Shutdown  
Disable

Figure 4-79. Generator Sequencing

## Network Configuration

The sequencing ID of the unit being programmed and the sequencing IDs of all other units on a networked system should be entered in the expected sequence ID table. If the state of any unit changes to offline and the ID Missing pre-alarm is enabled, an ID Missing pre-alarm appears on the front panel HMI and BESTCOMS*Plus* metering screen. If an expected sequence ID is detected on two or more units and the ID Repeat pre-alarm is enabled, an ID Repeat pre-alarm appears on the front panel HMI and the BESTCOMS*Plus* metering screen.

The BESTCOMS*Plus* Network Configuration screen is illustrated in Figure 4-80.

**Network Configuration**

|                   |                    |
|-------------------|--------------------|
| Expected Seq Id 1 | Expected Seq Id 9  |
| 0                 | 0                  |
| Expected Seq Id 2 | Expected Seq Id 10 |
| 0                 | 0                  |
| Expected Seq Id 3 | Expected Seq Id 11 |
| 0                 | 0                  |
| Expected Seq Id 4 | Expected Seq Id 12 |
| 0                 | 0                  |
| Expected Seq Id 5 | Expected Seq Id 13 |
| 0                 | 0                  |
| Expected Seq Id 6 | Expected Seq Id 14 |
| 0                 | 0                  |
| Expected Seq Id 7 | Expected Seq Id 15 |
| 0                 | 0                  |
| Expected Seq Id 8 | Expected Seq Id 16 |
| 0                 | 0                  |

Figure 4-80. Network Configuration

## Programmable Senders

The sender inputs of the DGC-2020 can be customized to obtain maximum accuracy from the coolant temperature, oil pressure, and fuel level senders.

The characteristic curve of each sender input can be configured with up to 11 points. Each point can be assigned a resistance input value and a corresponding temperature (coolant temperature sender), pressure (oil pressure sender), or percentage (fuel level sender) value. A sender slope setting



automatically orders the values in the resistance column according to whether the sender requires a negative or positive slope. Sender curve points are automatically plotted on a curve in *BESTCOMSPlus*, which can be printed.

Sender curve points configured in *BESTCOMSPlus* can be saved in the configuration file. The data for all three senders is automatically saved with the DGC-2020 configuration file.

Any changes made in *BESTCOMSPlus* to the sender points, can be reverted to the factory-default values. A new settings file can also be created.

The *BESTCOMSPlus* Coolant Temperature programmable sender screen is illustrated in Figure 4-81. (The contents and layout of each *BESTCOMSPlus* programmable sender screen is identical.)

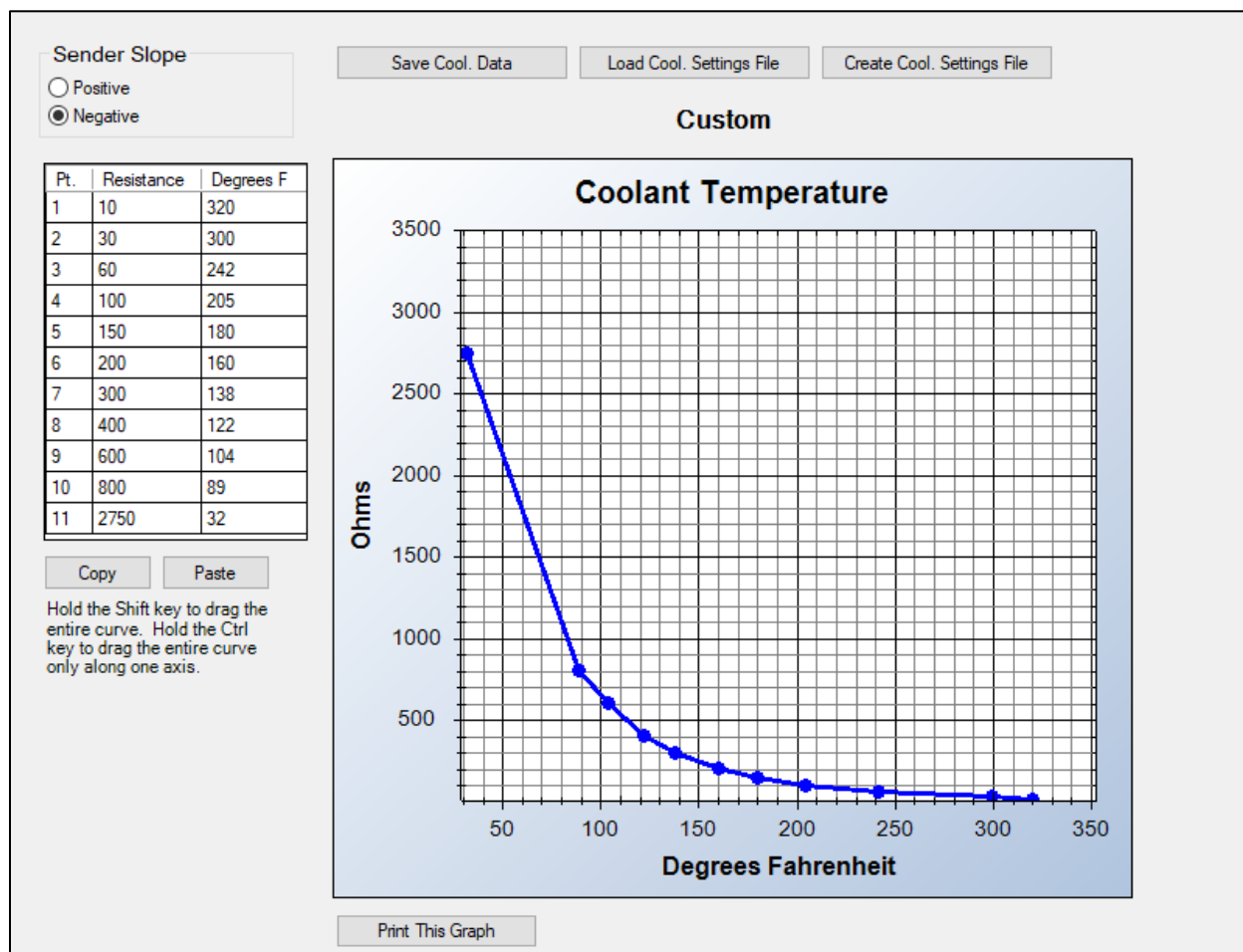


Figure 4-81. Coolant Temperature

## ***BESTlogic™ Plus Programmable Logic***

*BESTlogicPlus* Programmable Logic is used to set all logic functions in the DGC-2020. For detailed information on using *BESTlogicPlus*, refer to Section 5, *BESTlogicPlus Programmable Logic*.

### **Logic Timers**

Refer to Section 5, *BESTlogicPlus Programmable Logic*, for information on using logic timers.

## ***Settings File Management***

A settings file contains all DGC-2020 settings including logic.

A settings file created in BESTCOMSPlus will have one of three file extensions. Settings files created in version 4.00.00 and later are given an extension of “bst4”. Settings files created in versions 2.06.01 through 3.21.01 will have an extension of “bstx”. Settings files created in versions prior to 2.06.01 will have an extension of “bst”.

It is possible to save only the DGC-2020 logic displayed on the BESTlogicPlus Programmable Logic screen as a separate logic library file. This ability is helpful when similar logic is required for several DGC-2020 systems. The file extension of a logic file created in BESTCOMSPlus will be “bsl4” (version 4.00.00 and later), “bslx” (versions 2.06.01 through 3.21.01), or “bsl” (versions prior to 2.06.01).

It is important to note that settings and logic can be uploaded to the device separately or together, but are always downloaded together. For more information on logic files, refer to the *BESTlogicPlus* chapter.

#### Opening a Settings File

To open a DGC-2020 settings file with BESTCOMSPlus, pull down the *File* menu and choose *Open*. The *Open* dialog box appears. This dialog box allows you to use normal Windows techniques to select the file that you want to open. Select the file and choose *Open*. You can also open a file by clicking on the *Open File* button on the lower menu bar. If connected to a device, you will be asked to upload the settings and logic from the file to the current device. If you choose *Yes*, the settings displayed in BESTCOMSPlus will be overwritten with the settings of the opened file.

#### Saving a Settings File

Select *Save* or *Save As* from the *File* pull-down menu. A dialog box pops up allowing you to enter a filename and location to save the file. Select the *Save* button to complete the save.

#### Upload Settings and/or Logic to Device

To upload a settings file to the DGC-2020, open the file through BESTCOMSPlus or create the file using BESTCOMSPlus. Then pull down the *Communication* menu and select *Upload Settings and Logic to Device*. If you want to upload operational settings without logic, select *Upload Settings to Device*. If you want to upload logic without operational settings, select *Upload Logic to Device*. You are prompted to enter the password. The default password is “OEM”. If the password is correct, the upload begins and the progress bar is shown.

#### Download Settings and Logic from Device

To download settings and logic from the DGC-2020, pull down the *Communication* menu and select *Download Settings and Logic from Device*. If the settings in BESTCOMSPlus have changed, a dialog box will open asking if you want to save the current settings changes. You can choose *Yes* or *No*. After you have taken the required action to save or discard the current settings, downloading begins. BESTCOMSPlus will read all settings and logic from the DGC-2020 and load them into BESTCOMSPlus memory.

#### Printing a Settings File

To view a preview of the settings printout, select *Print Preview* from the *File* pull-down menu. To print the settings, select the printer icon in the upper left corner of the *Print Preview* screen.

You can skip the print preview and go directly to print by pulling down the *File* menu and selecting *Print*. A dialog box, *Print* opens with the typical Windows choice to setup the properties of printer. Execute this command, as necessary, and then select *Print*.

#### Comparing Settings Files

BESTCOMSPlus has the ability to compare two settings files. To compare files, pull down the *Tools* menu and select *Compare Settings Files*. The *BESTCOMSPlus Settings Compare Setup* dialog box appears (Figure 4-82). Select the location of the first file under *Left Settings Source* and select the location of the second file under *Right Settings Source*. If you are comparing a settings file located on your PC hard drive or portable media, click the folder button and navigate to the file. If you want to compare settings downloaded from a unit, click the *Select Unit* button to set up the communication port. Click the *Compare* button to compare the selected settings files.

A dialog box will appear and notify you if any differences were found. The *BESTCOMSPPlus Settings Compare* dialog box (Figure 4-83) is displayed where you can view all settings (*Show All Settings*), view only the differences (*Show Settings Differences*), view all logic (*Show All Logic Paths*), or view only logic differences (*Show Logic Path Differences*). Select *Close* when finished.

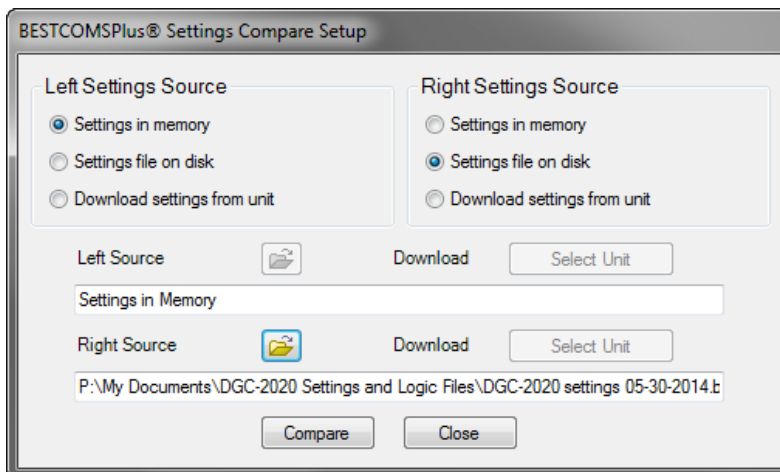


Figure 4-82. BESTCOMSPPlus Settings Compare Setup

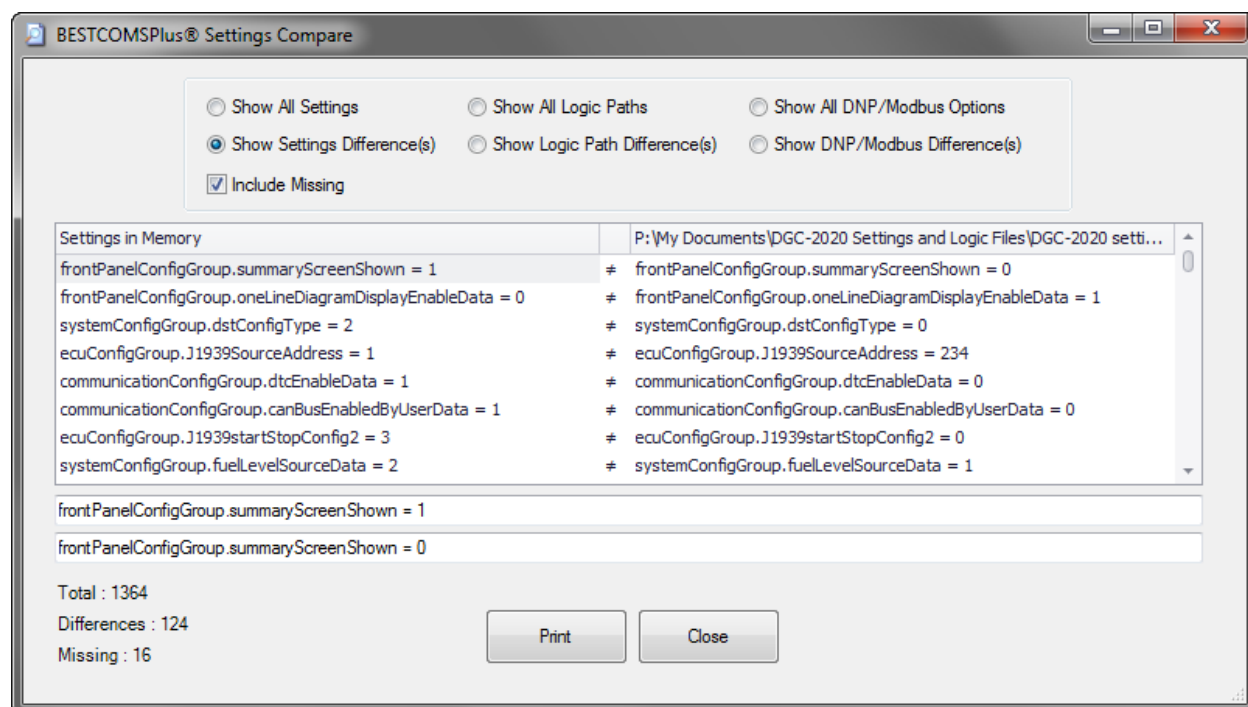


Figure 4-83. BESTCOMSPPlus Settings Compare

## Upgrading Firmware in the DGC-2020 and Expansion Modules

### Note

The latest version of BESTCOMSPPlus software should be downloaded from the Basler Electric website and installed before performing a firmware upgrade.

A device package contains firmware and a language module. Embedded firmware is the operating program that controls the actions of the DGC-2020. The DGC-2020 stores firmware in nonvolatile flash memory that can be reprogrammed through the communication ports. It is not necessary to replace EPROM chips when updating the firmware with a newer version.

Future enhancements to the DGC-2020 functionality will make a firmware update desirable. Because default settings are loaded when DGC-2020 firmware is updated, your settings should be saved in a file prior to upgrading firmware.

The language of the front panel LCD can be changed by uploading a different language module into the DGC-2020. The DGC-2020 stores the language module in nonvolatile flash memory; the language module contains all language translations for the DGC-2020. The language module can be reprogrammed through the communications port. In general, any time a firmware upgrade is made to the DGC-2020, the language module should be uploaded as well.

The DGC-2020 can be used in conjunction with several expansion modules that expand the DGC-2020 capabilities. DGC-2020 expansion modules include LSM-2020, CEM-2020, and AEM-2020. When upgrading the firmware in any component of this system, the firmware in ALL of the components of the system should be upgraded to ensure compatibility of communications between the various components.

### Caution

The order in which the components are upgraded is critical. Assuming a system of a DGC-2020 and expansion modules is in a state where the DGC-2020 is communicating with all of the system expansion modules, **the expansion modules must be upgraded before the DGC-2020**. This is required because the DGC-2020 must be able to communicate to the expansion module before the DGC-2020 can send firmware to it. If the DGC-2020 were upgraded first, and the new firmware included a change in the DGC-2020 to expansion module communication protocol, it is possible that the expansion modules could no longer communicate with the upgraded DGC-2020. Without communications between the DGC-2020 and the expansion modules, upgrading the expansion modules is not possible.

### Note

If power is lost or communication is interrupted during file transfer to the DGC-2020, the DGC-2020 will cease operating and will not recover automatically. If this occurs or if the front panel HMI becomes blank and all LEDs are flashing at a 2-second rate, the DGC-2020 will not have valid firmware installed and the firmware must be uploaded again. To accomplish this, cycle power to the DGC-2020 and activate the DGC-2020 plugin in BESTCOMSPlus. Select *Upload Device Files* from the *Communication* pull-down menu and proceed normally.

## Upgrading Firmware in Expansion Modules

The following procedure is used to upgrade firmware in DGC-2020 expansion modules. This must be completed before upgrading firmware in the DGC-2020. If no expansion modules are present, proceed to *Upgrading Firmware in the DGC-2020*.

1. Place the DGC-2020 in Off mode. This can be accomplished by clicking the *Off* button on the *Control* screen inside the Metering Explorer or by pressing the *Off* button on the DGC-2020 front panel.
2. Enable the expansion modules that are present in the system. If they have not already been enabled, enable the expansion modules on the SETTINGS > SYSTEM PARAMETERS > REMOTE MODULE SETUP screen.

3. Verify that the DGC-2020 and all associated expansion modules are communicating. This can be verified by examining the pre-alarm status using the Metering Explorer in BESTCOMS*Plus* or from the front panel by navigating to METERING > ALARMS-STATUS > PRE-ALARMS. There should be no *Loss of Comms* pre-alarms in the pre-alarm status when communications are functioning properly.
4. Connect to the DGC-2020 through the USB port if not already connected. Firmware upgrades cannot be accomplished through the Ethernet port, with the exception of the LSM-2020.
5. Select *Upload Device Files* from the Communication pull-down menu.
6. You will be asked to save the current settings file. Select *Yes* or *No*.
7. When the *Basler Electric Device Package Uploader* screen (Figure 4-84) appears, click on the *Open* button to browse for the device package you have received from Basler Electric. The *Package Files* along with *File Details* are listed. Place a check in the boxes next to the individual files you want to upload.

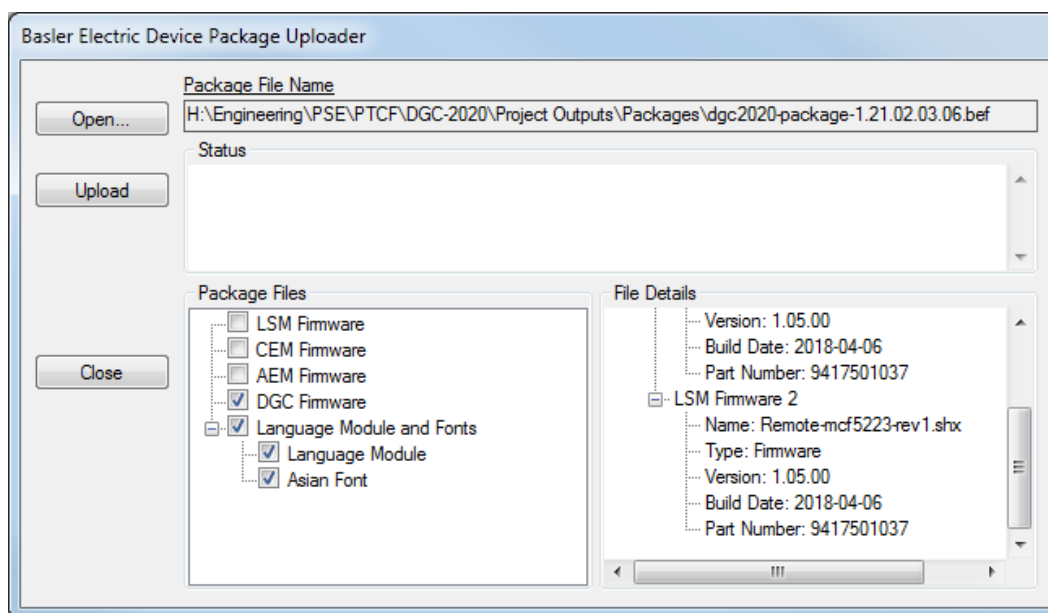


Figure 4-84. Basler Electric Device Package Uploader

8. Click on the *Upload* button and the *Proceed with Device Upload* screen will appear. Select *Yes* or *No*.
9. After selecting *Yes*, the *DGC-2020 Selection* screen will appear. Select the communication port to begin upload. Firmware updating is only possible locally through the USB port. Refer to Figure 4-85.

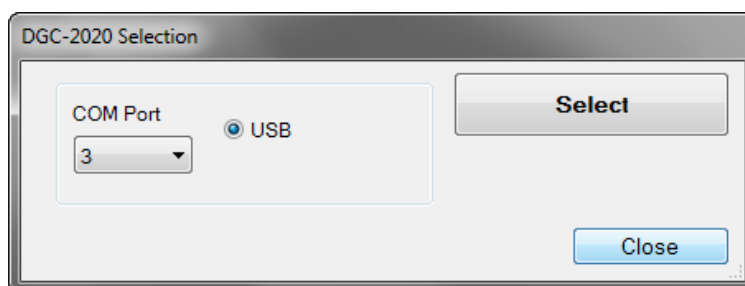


Figure 4-85. DGC-2020 Selection

10. The *Processing, Please Wait...* screen is displayed as file(s) are uploaded. See Figure 4-86.

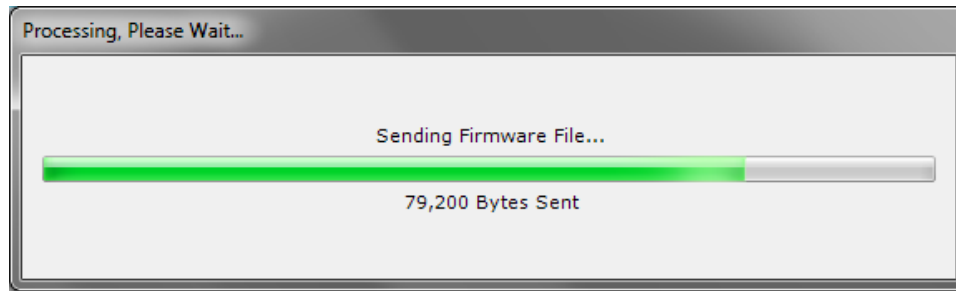


Figure 4-86. Processing, Please Wait...

11. After file(s) have been uploaded, click the *Close* button on the *Basler Electric Device Package Uploader* screen and disconnect communication to the DGC-2020.

## Upgrading Firmware in the DGC-2020

- A. Upgrade DGC-2020 firmware and then load a saved settings file.
  1. Upgrade the DGC-2020 firmware and language module.
    - a. Connect to the DGC-2020 with *BESTCOMSPlus*. Check the firmware Application Version on the GENERAL SETTINGS > VERSION INFO > DGC-2020 screen.
    - b. Select *Upload Device Files* from the *Communication* pull-down menu. You do not have to be connected to the DGC-2020 at this time. Save settings when prompted, if desired.
    - c. Open the desired device package file (\*\*\*\*DGC-2020-\*\*\*\*\*\_xxyyzz.bef, where \*\*\*\* may be additional descriptive text of varying length, and xx.yy.zz is the version number of the device package file.)
    - d. Check the boxes for *DGC-2020 Firmware* and *DGC-2020 Language Module*. Note the version number of the DGC-2020 firmware; this is the version that will be used to set the Application Version in the settings file in a later step. This is NOT the same as the version of the package file that is contained in the fields xx.yy.zz in the package file name.
    - e. Click the *Upload* button and follow the instructions that appear to begin the upgrade process.
    - f. After the upload is complete, disconnect communication to the DGC-2020.
  2. Load the saved settings file into the DGC-2020.
    - a. Close all settings files.
    - b. From the *File* pull-down menu, select *New, DGC-2020*.
    - c. Connect to the DGC-2020.
    - d. Once all settings have been read from the DGC-2020, open the saved settings file by selecting the file with *File, Open File* in the *BESTCOMSPlus* menu.
    - e. When *BESTCOMSPlus* asks if you wish to upload settings and logic to the device, click *Yes*.
    - f. If you are receiving upload failures and indications that the logic is incompatible with the firmware version, check that the DGC-2020 style number in the saved file matches that of the DGC-2020 into which the file is being uploaded. The style number in the settings file is found under GENERAL SETTINGS > STYLE NUMBER in *BESTCOMSPlus*.
    - g. If the style number of the settings file does not match that of the DGC-2020 into which it is to be loaded, disconnect from the DGC-2020, then modify the style number in the settings file. Then repeat the steps titled *Load the Settings File into the DGC-2020*.

**Note**

If the settings file was saved with a previous version of firmware, BESTCOMSP<sub>Plus</sub> will automatically perform a settings file conversion to make the settings file compatible with the new firmware.

## ***Metering Explorer***

The Metering Explorer is a convenient tool within BESTCOMSP<sub>Plus</sub> used to navigate through the following metering screens of the DGC-2020 plugin.

- Device Info
- Engine
- Battery Charger
- Generator
- Power
- Bias Control
- Run Statistics
- Status
- Inputs
  - Contact Inputs
  - Contact Inputs Timers
  - Remote LSM Inputs
  - Remote Contact Inputs
  - Remote Contact Inputs Timers
  - Remote Analog Inputs
  - Remote Analog Inputs Timers
  - Remote RTD Inputs
  - Remote RTD Inputs Timers
  - Remote Thermocouple Inputs
  - Remote Thermocouple Inputs Timers
  - Remote Analog Input Values
  - Logic Control Relays
- Outputs
  - Contact Outputs
  - Configurable Elements
  - Configurable Elements Timers
  - Remote Contact Outputs
  - Remote Analog Outputs
  - Remote Analog Outputs Timers
- Configurable Protection
  - Configurable Protection Status
  - Configurable Protection Timers
- Alarms
- Event Log
- Timers
  - Logic Timers
  - Generator Protection Timers
  - Pre-Alarm Timers
  - Alarm Timers
  - Sender Fail Timers
  - Cranking Timers
  - Automatic Restart Timers
  - Programmable Functions Timers
  - Synchronizer Timers
  - Exercise Timers



- J1939 ECU
  - ECU Data
  - Engine Configuration
  - Active DTC
  - Previously Active DTC
  - Yanmar Status
  - Isuzu Status
  - Deutz Status
- *mtu*
  - *mtu* Alarms
  - *mtu* Fault Codes
  - *mtu* Status
  - *mtu* Engine Status
- Summary
- Control
- Real Time Clock
- Generator Network Status
- Generator Sequencing
- Mains Fail Transfer Status
- Diagnostics
  - Control
  - Load Share
  - Sender Inputs

The Metering Explorer has a “Docking” feature allowing the user to arrange and dock metering screens. A blue transparent square representing the screen being moved, seven arrow buttons, and a tabs button appear when holding down the left mouse button on a metering tab and dragging it out. See Figure 4-87. Table 4-8 explains the call-outs on Figure 4-87.

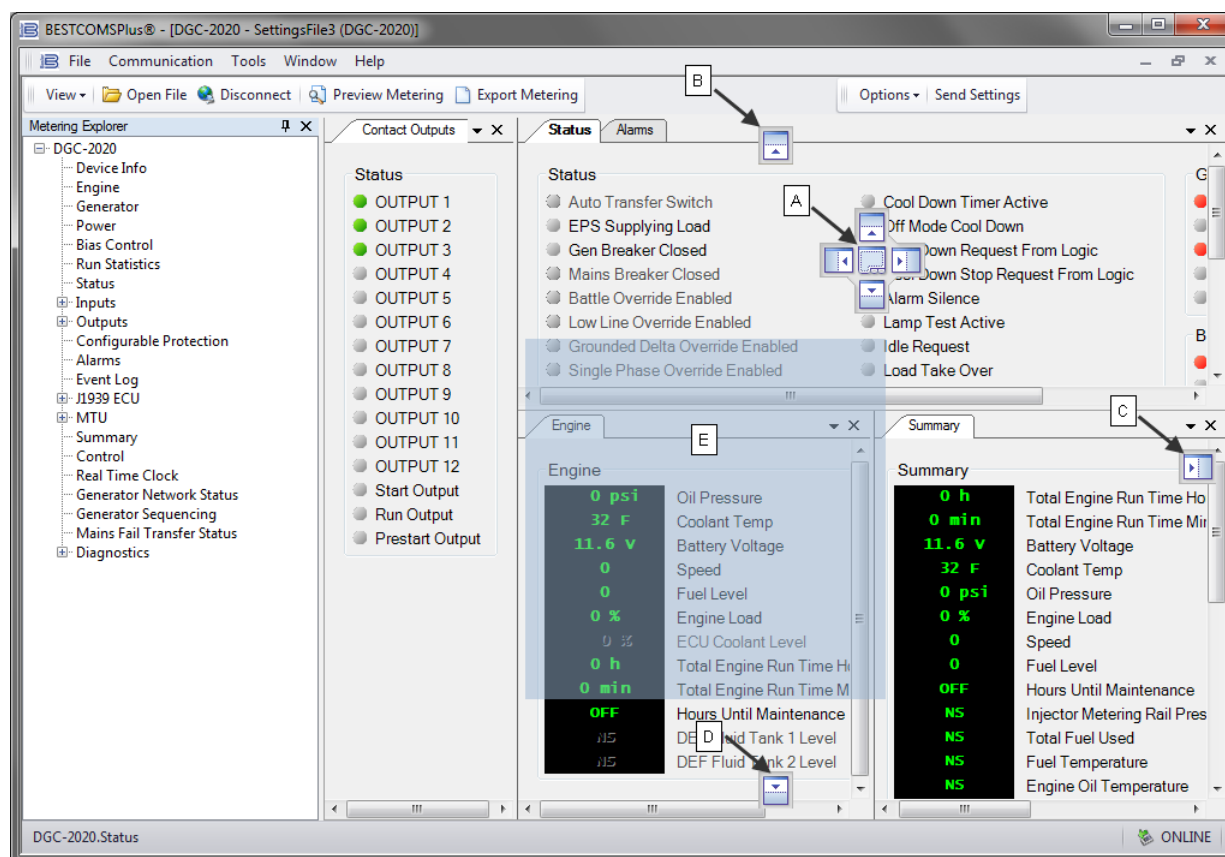
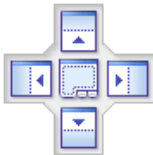


Figure 4-87. Metering, Docking Options



Table 4-8. Explanation of Call-Outs on Figure 4-87

| Call-Out | Symbol                                                                             | Explanation                                                                                                                                                                                                                                                                                                                                                                                          |
|----------|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A        |   | Holding the left mouse button down on a metering tab and dragging it to one of the four arrow boxes will place it inside the selected window on the location selected. To place the metering tab as a tab inside the selected window, drop it on the tabs button in the center of the arrow buttons.                                                                                                 |
| B        |   | Holding the left mouse button down on a metering tab and dragging it to this arrow box will place it across the top of the screen. Click on the  (thumbtack) to dock it on the top bar. To display a screen that is docked, simply use the mouse to hover the pointer over the tab on the top bar.                |
| C        |   | Holding the left mouse button down on a metering tab and dragging it to this arrow box will place it across the side of the screen. Click on the  (thumbtack) to dock it on the side bar. To display a screen that is docked, simply use the mouse to hover the pointer over the tab on the side bar.             |
| D        |   | Holding the left mouse button down on a metering tab and dragging it to this arrow box will place it across the bottom of the screen. Click on the  (thumbtack) to dock it on the bottom bar. To display a screen that is docked, simply use the mouse to hover the pointer over the tab on the bottom bar.       |
| E        |  | Holding the left mouse button down on a metering tab and dragging it to anywhere other than an arrow box will place it as a floating metering screen. This floating screen can later be closed by clicking on the  in the upper right corner. It can also be dragged to one of the arrow boxes used for docking. |

## Device Info

This screen provides device information for the DGC-2020, LSM-2020, CEM-2020, and AEM-2020. Refer to Figure 4-88.

**Device Info**

**DGC-2020**  
**DGC-2020-51BRXEAH**  
**E01537568**  
**3.20.01**  
**9400209021**  
**2018-02-21**  
**3.00.00**  
**9400201099**  
**5.07.01**  
**9400201075**  
**5.07.01.05.10**

Model Number  
Style Number  
Serial Number  
Application Version  
Application Part Number  
Application Build Date  
Boot Code Version  
Language Module Part Number  
Language Module Version  
Font Module Part Number  
Font Module Version

**Identification**  
Device ID  
DGC-2020

**Load Share Module**

Application Version  
Boot Code Version  
Application Build Date  
Serial Number  
Application Part Number  
Model Number

**Contact Expansion Module**

Application Version  
Boot Code Version  
Application Build Date  
Serial Number  
Application Part Number  
Model Number

**Analog Expansion Module**

Application Version  
Boot Code Version  
Application Build Date  
Serial Number  
Application Part Number  
Model Number

Figure 4-88. Metering, Device Info

## Engine

This screen provides information and metering of engine components. Refer to Figure 4-89.

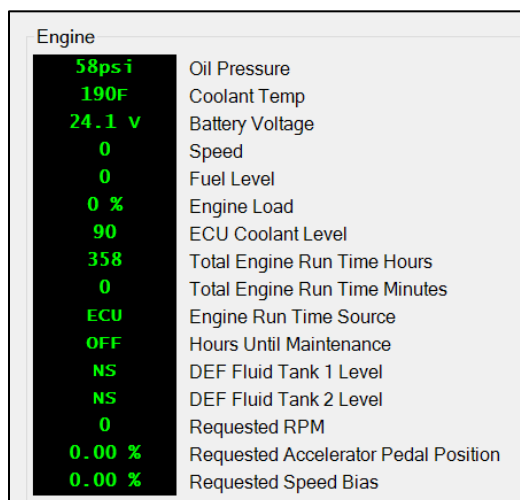


Figure 4-89. Metering, Engine

## Battery Charger

This screen provides information and metering for battery chargers 1 and 2. Refer to Figure 4-90.

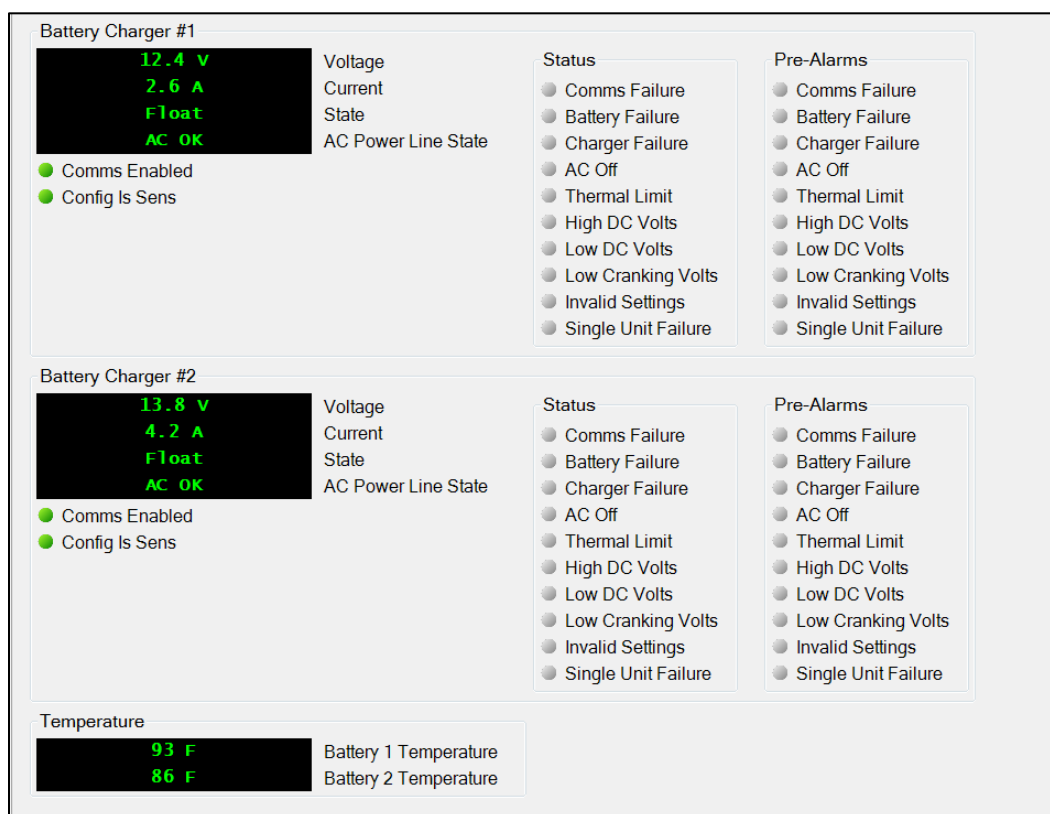


Figure 4-90. Metering, Battery Charger

## Generator

This screen provides metering of generator voltages and currents. Refer to Figure 4-91.

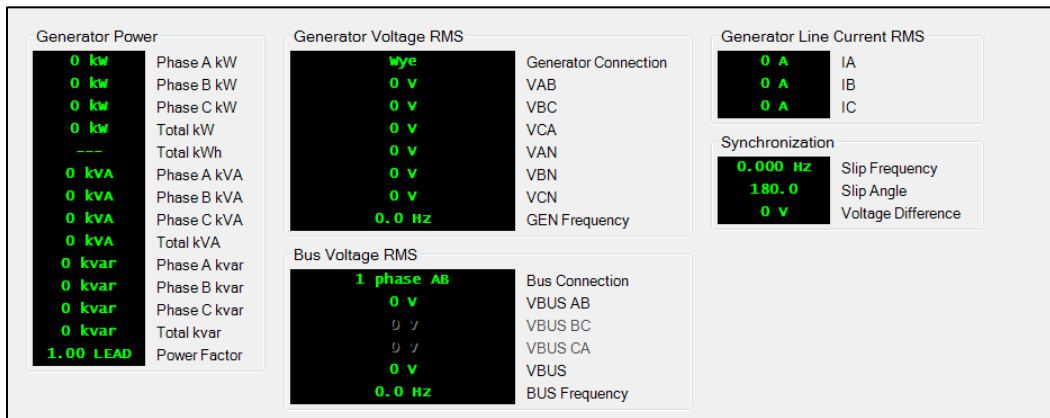


Figure 4-91. Metering, Generator

## Power

This screen provides metering of generator power and power factor. Refer to Figure 4-92.

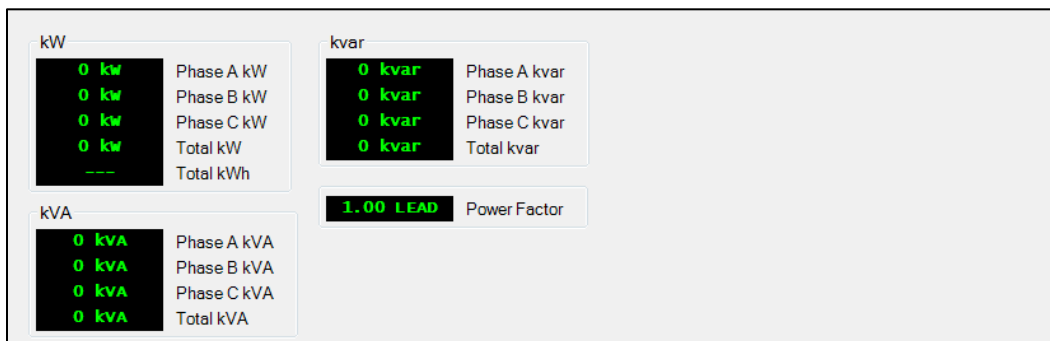


Figure 4-92. Metering, Power

## Bias Control

This screen provides var/PF mode status and operating levels. Refer to Figure 4-93.



Figure 4-93. Metering, Bias Control

## Run Statistics

This screen provides Cumulative Run Statistics, Session Run Statistics, and Commission Date. Refer to Figure 4-94.

The Hours Until Maintenance pre-alarm is configured on the Pre-Alarms screen in the Settings Explorer. The Hours Until Maintenance field will display "OFF" when the Maintenance Interval pre-alarm is disabled. Clicking Reset Maintenance Interval resets the Hours Until Maintenance to the value set for the Maintenance Interval pre-alarm on the Pre-Alarms screen in the Settings Explorer.

The Engine Run Time Source displays the source of engine hours (DGC or ECU).

To change the commission date, click *Edit DGC Commission Date*. The DGC Commission Date dialog box appears. Enter the new commission date and click *Upload Data to Device*. Click *Close*. Note that the Commission Date field on the BESTCOMSPlus screen updates after the *Close* button is clicked.

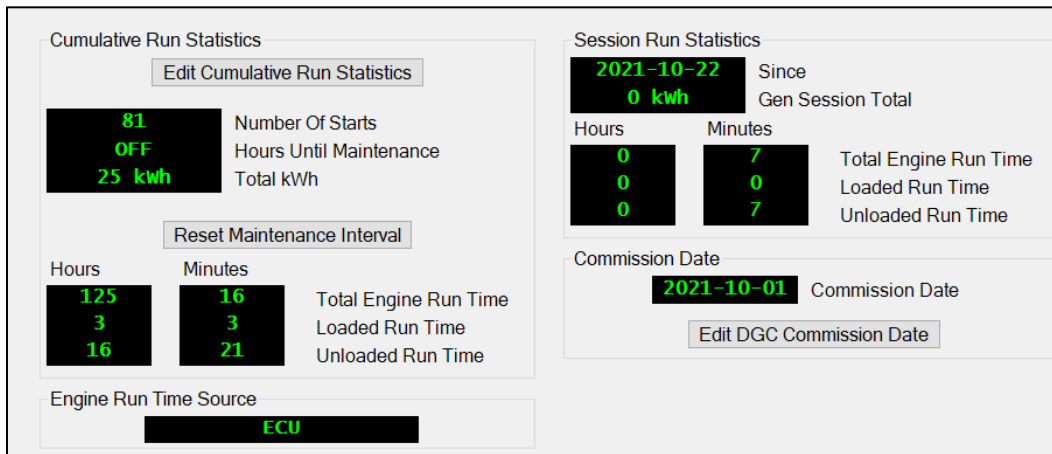


Figure 4-94. Metering, Run Statistics

## Status

This screen indicates status of breakers, modes, switches, and I/O connection status. The status is TRUE when the corresponding LED is red. Refer to Figure 4-95.

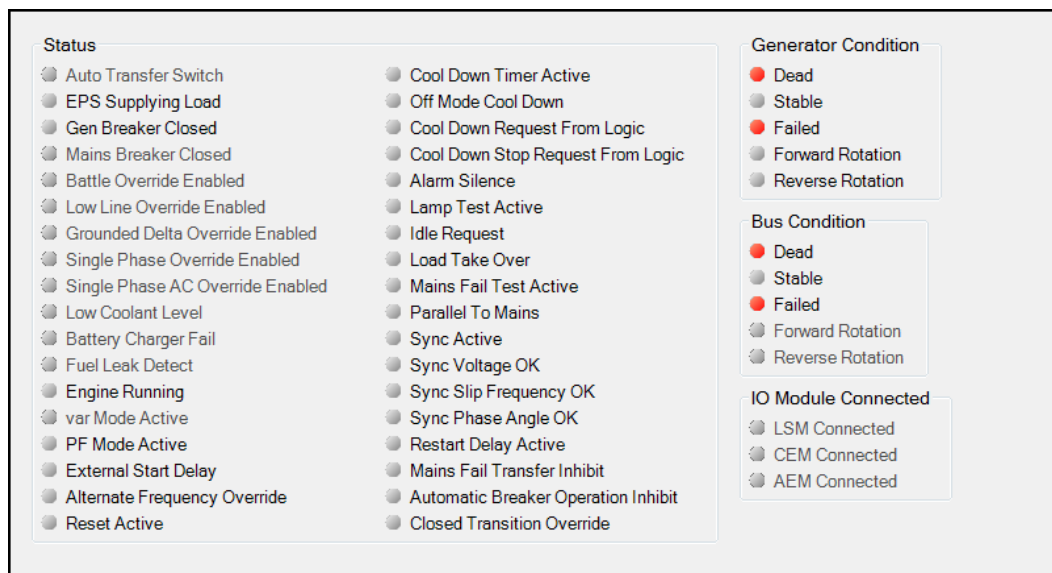


Figure 4-95. Metering, Status

## Inputs

### Contact Inputs

This screen indicates the status of contact inputs, contact input alarms, and contact input pre-alarms. The status is TRUE when the corresponding LED is red. Refer to Figure 4-96.

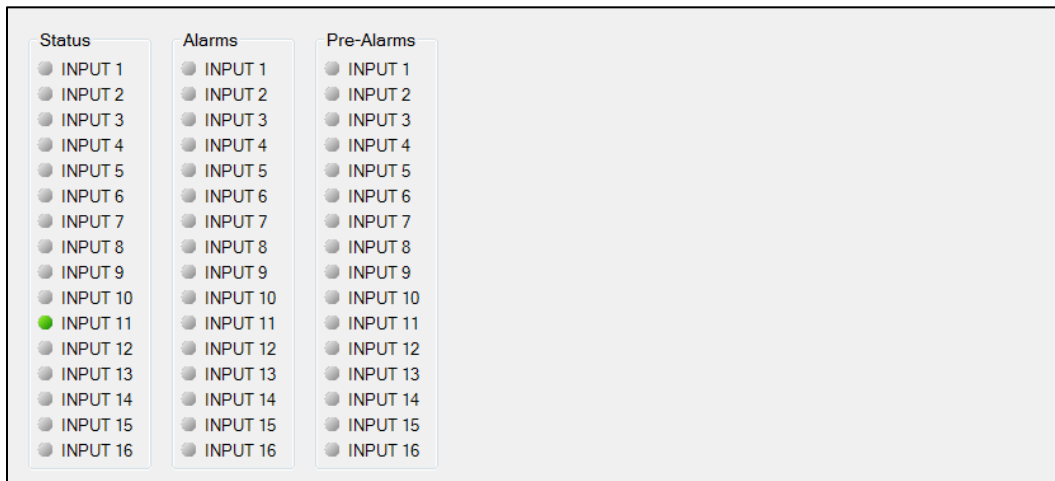


**Figure 4-96. Metering, Inputs, Contact Inputs**

### Contact Inputs Timers

This screen displays the current time (count) of the Activation Delays for the contact inputs. Refer to Figure 4-97.



**Figure 4-97. Contact Inputs Timers**

### Remote Contact Inputs Timers

This screen displays the current time (count) of the Activation Delays for the remote contact inputs. Refer to Figure 4-98.



**Figure 4-98. Remote Contact Inputs Timers**

### Remote LSM Inputs

When an optional LSM-2020 (Load Share Module) is connected, the value of the analog inputs is displayed on this screen. Voltage is displayed when the input is configured for voltage and current is displayed when the input is configured for current. Refer to Figure 4-99.



**Figure 4-99. Metering, Inputs, Remote LSM Inputs**

### Remote Contact Inputs

When an optional CEM-2020 (Contact Expansion Module) is connected, the status of the remote contact inputs, configurable remote contact input alarms, and remote contact input pre-alarms are shown on this screen. The status is TRUE when the corresponding LED is red. Refer to Figure 4-100.

| Status     | Alarms     | Pre-Alarms |
|------------|------------|------------|
| ● INPUT 17 | ● INPUT 17 | ● INPUT 17 |
| ● INPUT 18 | ● INPUT 18 | ● INPUT 18 |
| ● INPUT 19 | ● INPUT 19 | ● INPUT 19 |
| ● INPUT 20 | ● INPUT 20 | ● INPUT 20 |
| ● INPUT 21 | ● INPUT 21 | ● INPUT 21 |
| ● INPUT 22 | ● INPUT 22 | ● INPUT 22 |
| ● INPUT 23 | ● INPUT 23 | ● INPUT 23 |
| ● INPUT 24 | ● INPUT 24 | ● INPUT 24 |
| ● INPUT 25 | ● INPUT 25 | ● INPUT 25 |
| ● INPUT 26 | ● INPUT 26 | ● INPUT 26 |

**Figure 4-100. Metering, Inputs, Remote Contact Inputs**

### Remote Analog Inputs

When an optional AEM-2020 (Analog Expansion Module) is connected, the status of the remote analog inputs, remote analog input alarms, and remote analog input pre-alarms are shown on this screen. The status is TRUE when the corresponding LED is red. Refer to Figure 4-101. Remote Analog Input #1 is shown.

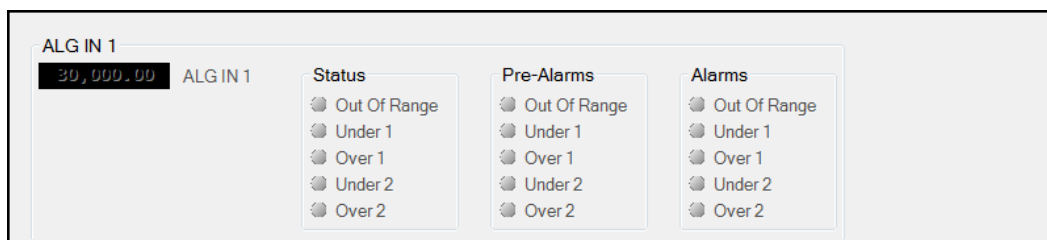


**Figure 4-101. Metering, Inputs, Remote Analog Inputs**

#### Remote Analog Inputs Timers

This screen displays the current time (count) of the Arming Delay and Activation Delays for the remote analog inputs. Refer to Figure 4-102.

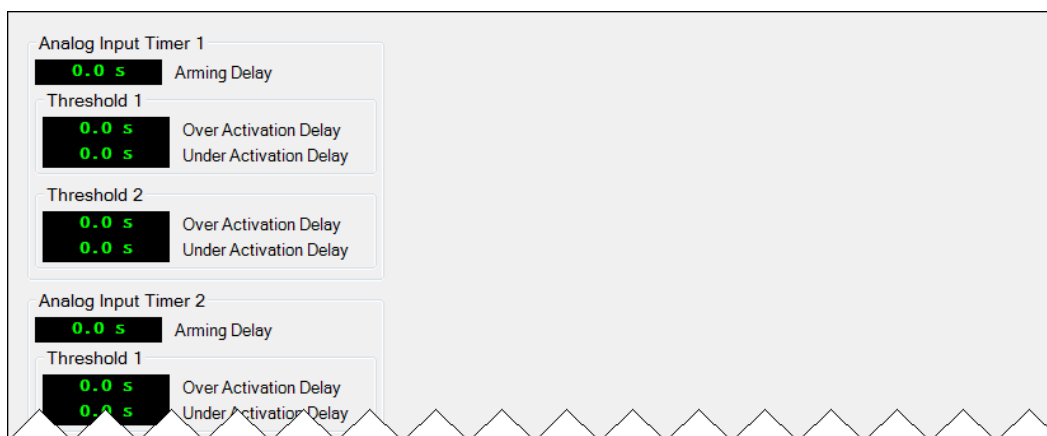


**Figure 4-102. Remote Analog Inputs Timers**

#### Remote RTD Inputs

When an optional AEM-2020 (Analog Expansion Module) is connected, the status of the remote RTD inputs, remote RTD input alarms, and remote RTD input pre-alarms are shown on this screen. The status is TRUE when the corresponding LED is red. Refer to Figure 4-103. Remote RTD Input #1 is shown.

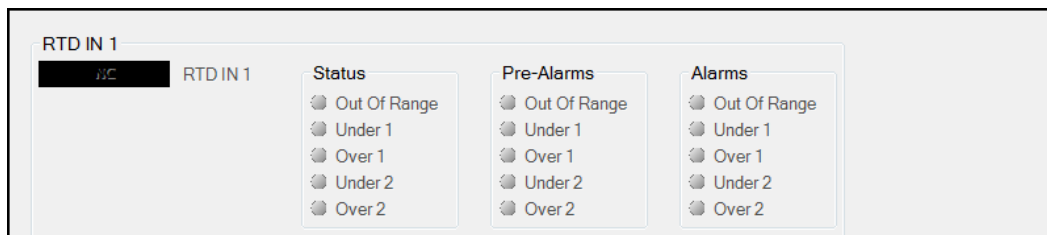


**Figure 4-103. Metering, Inputs, Remote RTD Inputs**

#### Remote RTD Inputs Timers

This screen displays the current time (count) of the Arming Delay and Activation Delays for the remote RTD inputs. Refer to Figure 4-104.

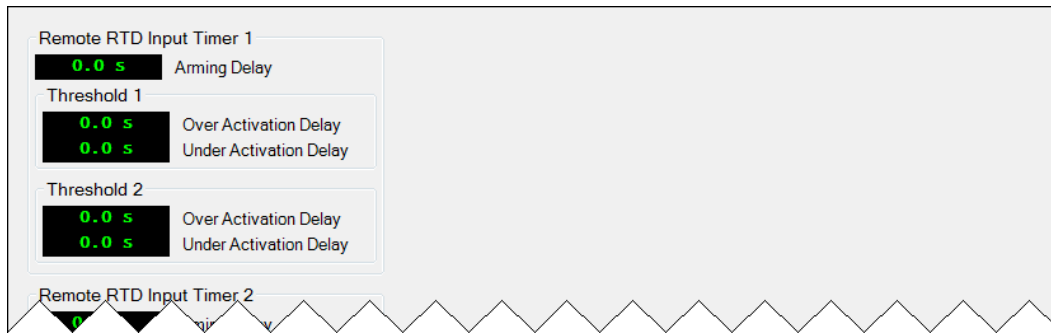


Figure 4-104. Remote RTD Inputs Timers

### Remote Thermocouple Inputs

When an optional AEM-2020 (Analog Expansion Module) is connected, the status of the remote thermocouple inputs, remote thermocouple input alarms, and remote thermocouple input pre-alarms are shown on this screen. The status is TRUE when the corresponding LED is red. Refer to Figure 4-105. Remote Thermocouple Input #1 is shown.

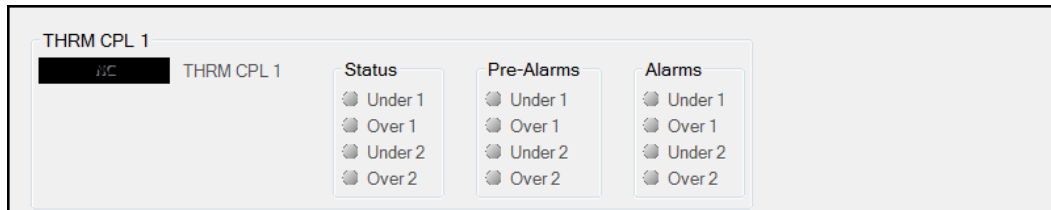


Figure 4-105. Metering, Inputs, Remote Thermocouple Inputs

### Remote Thermocouple Inputs Timers

This screen displays the current time (count) of the Arming Delay and Activation Delays for the remote thermocouple inputs. Refer to Figure 4-106.



Figure 4-106. Remote Thermocouple Inputs Timers

### Remote Analog Input Values

When an optional AEM-2020 (Analog Expansion Module) is connected, the values of the scaled analog inputs, raw analog inputs, RTD input temperatures, raw RTD inputs, thermocouple input temperatures, and raw thermocouple inputs are shown on this screen.

For each analog input, the raw metered input value is displayed along with the scaled metered input value. This is useful for checking if the AEM-2020 is seeing a valid raw input value (i.e. the raw 0 to 10 V voltage input or 4 to 20 mA current input). The scaled value is the raw input scaled up to the range specified by the Parameter Minimum and Parameter Maximum value parameters in the Remote Analog Input settings. Refer to Figure 4-107.



| Scaled Analog Inputs |          | Raw Analog Inputs |          |
|----------------------|----------|-------------------|----------|
| 30,000.00            | ALG IN 1 | NC                | ALG IN 1 |
| 30,000.00            | ALG IN 2 | NC                | ALG IN 2 |
| 30,000.00            | ALG IN 3 | NC                | ALG IN 3 |
| 30,000.00            | ALG IN 4 | NC                | ALG IN 4 |
| 30,000.00            | ALG IN 5 | NC                | ALG IN 5 |
| 30,000.00            | ALG IN 6 | NC                | ALG IN 6 |
| 30,000.00            | ALG IN 7 | NC                | ALG IN 7 |
| 30,000.00            | ALG IN 8 | NC                | ALG IN 8 |

| RTD Input Temperatures |          | Raw RTD Inputs |          |
|------------------------|----------|----------------|----------|
| NC                     | RTD IN 1 | NC             | RTD IN 1 |
| NC                     | RTD IN 2 | NC             | RTD IN 2 |
| NC                     | RTD IN 3 | NC             | RTD IN 3 |
| NC                     | RTD IN 4 | NC             | RTD IN 4 |
| NC                     | RTD IN 5 | NC             | RTD IN 5 |
| NC                     | RTD IN 6 | NC             | RTD IN 6 |
| NC                     | RTD IN 7 | NC             | RTD IN 7 |
| NC                     | RTD IN 8 | NC             | RTD IN 8 |

| Thermocouple Input Temperatures |            | Raw Thermocouple Inputs |            |
|---------------------------------|------------|-------------------------|------------|
| NC                              | THRM CPL 1 | NC                      | THRM CPL 1 |
| NC                              | THRM CPL 2 | NC                      | THRM CPL 2 |

Calibrate

**Figure 4-107. Metering, Inputs, Remote Analog Input Values**

The *Calibrate* button shown on the Remote Analog Input Values screen opens the Analog Input Temperature Calibration screen shown in Figure 4-108. This screen is used to calibrate RTD inputs 1 through 8 and thermocouple inputs 1 and 2.

|                                     |                           |        |
|-------------------------------------|---------------------------|--------|
| <input checked="" type="checkbox"/> | RTD Input #1 (F)          | 150.00 |
| <input checked="" type="checkbox"/> | RTD Input #2 (F)          | 160.00 |
| <input type="checkbox"/>            | RTD Input #3 (F)          | 0.00   |
| <input type="checkbox"/>            | RTD Input #4 (F)          | 0.00   |
| <input type="checkbox"/>            | RTD Input #5 (F)          | 0.00   |
| <input type="checkbox"/>            | RTD Input #6 (F)          | 0.00   |
| <input type="checkbox"/>            | RTD Input #7 (F)          | 0.00   |
| <input type="checkbox"/>            | RTD Input #8 (F)          | 0.00   |
| <input type="checkbox"/>            | Thermocouple Input #1 (F) | 0.00   |
| <input type="checkbox"/>            | Thermocouple Input #2 (F) | 0.00   |

Upload Data to Device      Close

**Figure 4-108. Analog Input Temperature Calibration**

### Logic Control Relays

This screen indicates the status of logic control relays. The status is TRUE when the corresponding LED is green. Refer to Figure 4-109.

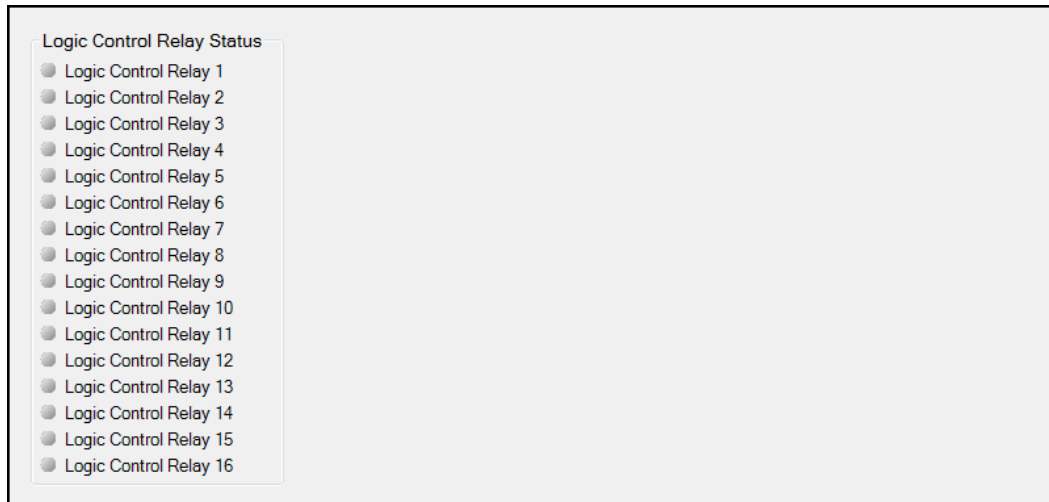


**Figure 4-109. Metering, Outputs, Logic Control Relays**

## **Outputs**

### Contact Outputs

This screen indicates the status of contact outputs. The status is TRUE when the corresponding LED is green. Refer to Figure 4-110.

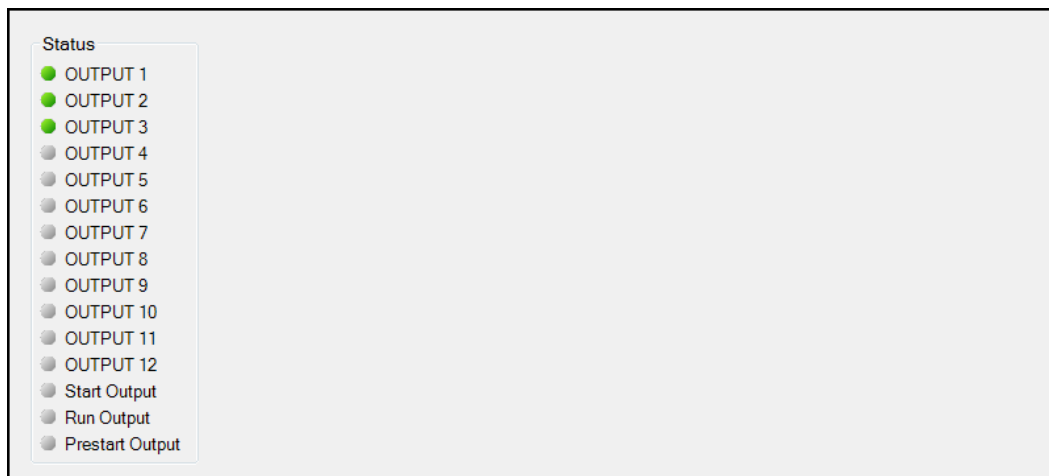


**Figure 4-110. Metering, Outputs, Contact Outputs**

### Configurable Elements

This screen indicates the status of configurable elements. It also indicates alarms and pre-alarms of configurable elements. The status is TRUE when the corresponding LED is green. Refer to Figure 4-111.

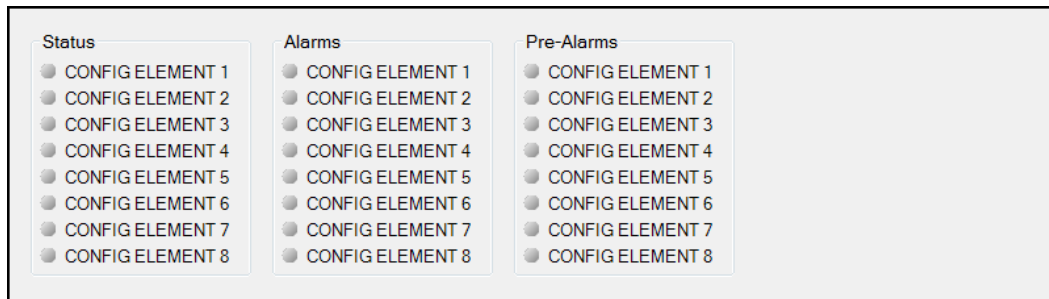


**Figure 4-111. Metering, Outputs, Configurable Elements**

### Configurable Elements Timers

This screen (Figure 4-112) displays the current time (count) of the Activation Delay and Arming Delay for the configurable elements.



**Figure 4-112. Metering Explorer, Diagnostics, Timers, Configurable Elements**

### Remote Contact Outputs

When an optional CEM-2020 (Contact Expansion Module) is connected, the status of the remote contact outputs is shown on this screen. The status is TRUE when the corresponding LED is green. Refer to Figure 4-113.

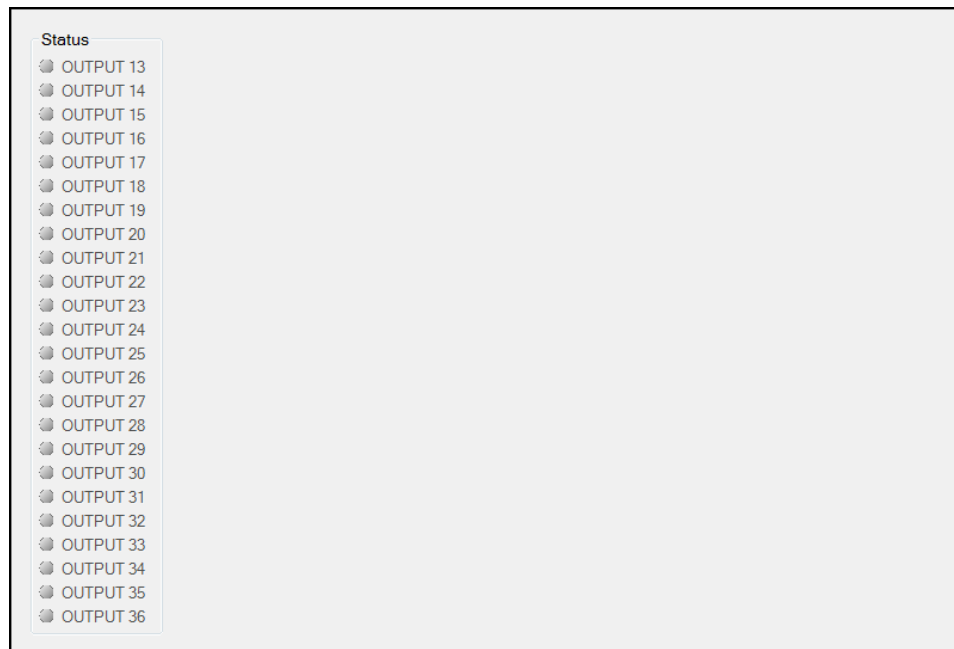


**Figure 4-113. Metering, Outputs, Remote Contact Outputs**

### Remote Analog Outputs

When an optional AEM-2020 (Analog Expansion Module) is connected, the status of the remote analog outputs, scaled analog output values, and raw analog output values are shown on this screen. The status is TRUE when the corresponding LED is red. Refer to Figure 4-114.

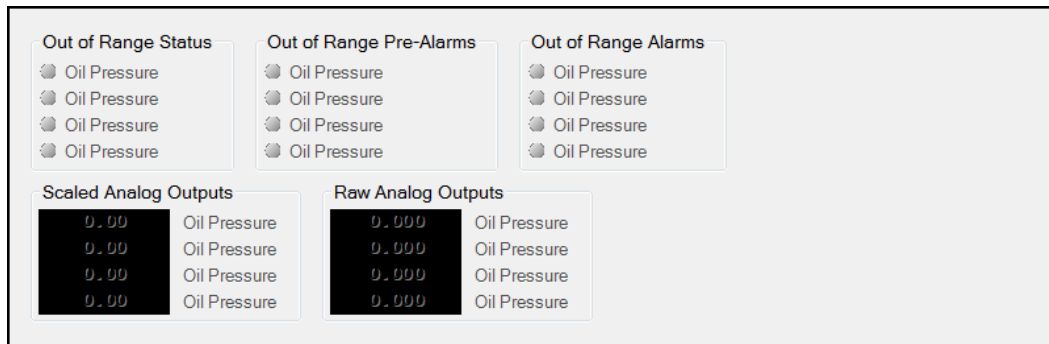


**Figure 4-114. Metering, Outputs, Remote Analog Outputs**

### Remote Analog Outputs Timers

This screen (Figure 4-115) displays the current time (count) of the Activation Delays for the remote analog outputs timers.



**Figure 4-115. Remote Analog Outputs Timers**

## **Configurable Protection**

### Configurable Protection Status

This screen indicates the status of configurable protection. The status is TRUE when the corresponding LED is green. Refer to Figure 4-116.



**Figure 4-116. Metering, Configurable Protection**

### Configurable Protection Timers

This screen (Figure 4-117) displays the current time (count) of the Arming Delay and Over/Under Thresholds for the configurable protection elements.

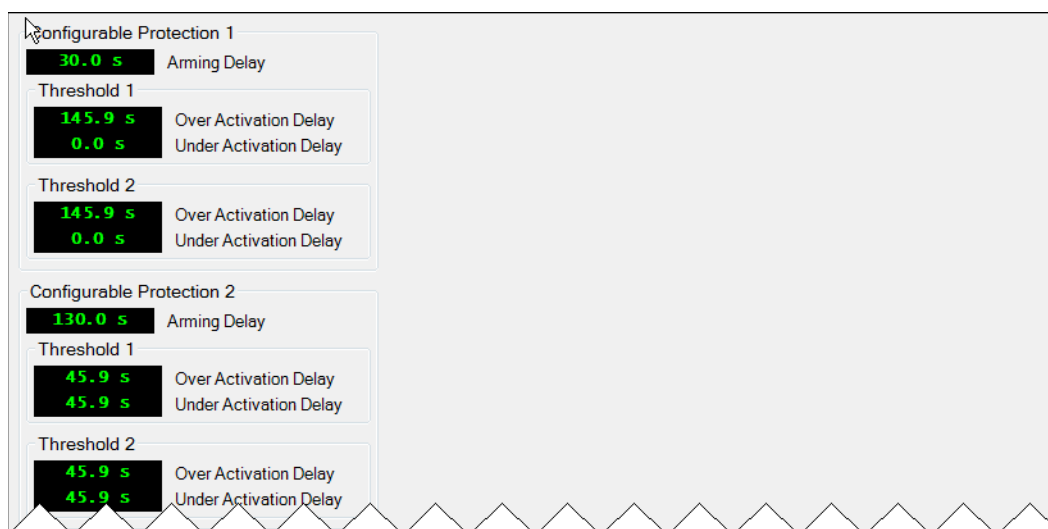


Figure 4-117. Metering Explorer, Diagnostics, Timers, Configurable Protection

## Alarms

This screen indicates the status of Alarms, Pre-Alarms, Sender Fail, and Generator Protection. The status is TRUE when the corresponding LED is red. Alarms and pre-alarms are reset when the DGC-2020 is set to the Off mode. The Sync Fail at Gen Breaker, Gen Breaker Fail to Open, Gen Breaker Fail to Close, Sync Fail at Mains Breaker, Mains Breaker Fail to Open, and Mains Breaker Fail to Close pre-alarms can be reset by pressing the *Reset* key on the front panel HMI. Refer to Figure 4-118.



Figure 4-118. Metering, Alarms

## Timers

### Logic Timers

This screen (Figure 4-119) displays the current time (count) of the logic timers.



Figure 4-119. Logic Timers

### Generator Protection Timers

This screen (Figure 4-120) displays the current time (count) of the Activation Delays and Arming Delays for the generator protection timers.



Figure 4-120. Generator Protection Timers

### Pre-Alarm Timers

This screen (Figure 4-121) displays the current time (count) of the Activation Delays for the pre-alarm timers.



Figure 4-121. Pre-Alarm Timers

### Alarm Timers

This screen (Figure 4-122) displays the current time (count) of the Activation Delays for the alarm timers.



Figure 4-122. Alarm Timers

### Sender Fail Timers

This screen (Figure 4-123) displays the current time (count) of the Activation Delays for the sender fail timers.



**Figure 4-123. Sender Fail Timers**

### Cranking Timers

This screen (Figure 4-124) displays the current time (count) of the cranking timers.

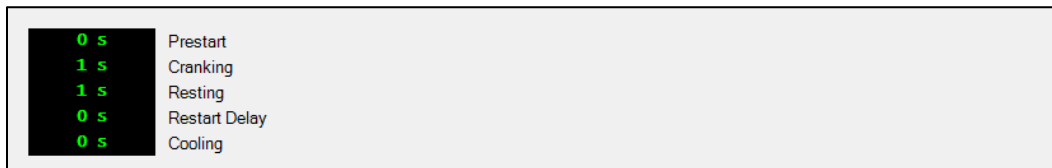


**Figure 4-124. Cranking Timers**

### Automatic Restart Timers

This screen (Figure 4-125) displays the current time (count) of the automatic restart timers.



**Figure 4-125. Automatic Restart Timers**

### Programmable Functions Timers

This screen (Figure 4-126) displays the current time (count) of the programmable functions timers.



**Figure 4-126. Programmable Functions Timers**

### Synchronizer Timers

This screen (Figure 4-127) displays the current time (count) of the activation delays for the synchronizer timers.



**Figure 4-127. Synchronizer Timers**

### Exercise Timers

This screen (Figure 4-128) displays the current time (count) of the session length, session elapsed, and time to next start for the exerciser timers.

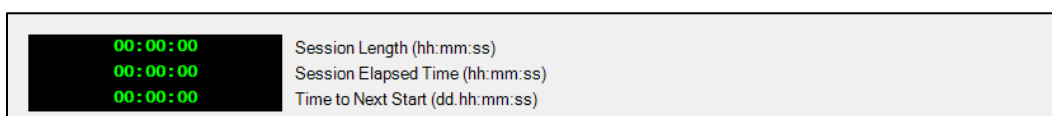


**Figure 4-128. Exerciser Timers**

## Event Log

The event log provides a historical record of event occurrences detected by the DGC-2020. It is saved in nonvolatile memory so that it will not be affected if power is removed. Thirty event records are retained and each record contains a time stamp of the first and last event occurrence, and the number of occurrences for each event. In addition, each record contains details of the time, date, and engine hours for the most recent 30 occurrences of the event. The number of occurrences stops incrementing at 99. If an event occurs which is of a type that differs from those in the 30 records in memory, the record that has the oldest “last” event occurrence is removed from the log, and the new category takes its place. Since 30 event records with up to 99 occurrences each are retained in memory, a history of nearly 3,000 specific events are retained in the DGC-2020. Detailed occurrence information is retained for the most recent 30 occurrences of each event record, and there are 30 event records; thus the time, date and engine hours details for up to 900 specific event occurrences is retained in the event log.

The user can download the event log data into BESTCOMSP<sup>Plus</sup> for viewing, and then save the event logs as files. The *Options* button is used to save the entire event log to a file, or to save the list to the computer clipboard making it available for insertion into other software applications. It is possible to copy a portion of the log to the computer clipboard by selecting the desired portion with the mouse then using the Options->Copy Selection feature. The *Download* button refreshes the event log list by performing a fresh download of the list from the DGC-2020. The *Clear* button gives the user the option of clearing selected or all event logs. Refer to Figure 4-129.

| Options ▼ Refresh Clear ▼ Toggle Sorting Sorting: Enabled |                  |            |                     |               |
|-----------------------------------------------------------|------------------|------------|---------------------|---------------|
| Event ID                                                  | Description      | Occurrence | Date                | Eng Hrs (H:m) |
| 9                                                         | OFF MODE         | 70         | 2014-09-22 09:11:33 | 00:00         |
| 7                                                         | DGC RESET        | 67         | 2014-09-22 09:11:31 | 00:00         |
| 1                                                         | EMERGENCY STOP A | 99         | 2014-09-22 09:11:23 | 00:00         |
| 9                                                         | OFF MODE         | 69         | 2014-09-19 16:58:38 | 00:00         |
| 9                                                         | OFF MODE         | 68         | 2014-09-19 16:58:37 | 00:00         |
| 12                                                        | AUTO MODE        | 2          | 2014-09-19 16:58:37 | 00:00         |
| 9                                                         | OFF MODE         | 67         | 2014-09-19 16:58:36 | 00:00         |
| 13                                                        | RUN MODE         | 1          | 2014-09-19 16:58:36 | 00:00         |
| 12                                                        | AUTO MODE        | 1          | 2014-09-19 16:58:34 | 00:00         |
| 9                                                         | OFF MODE         | 66         | 2014-09-19 16:48:39 | 00:00         |
| 7                                                         | DGC RESET        | 66         | 2014-09-19 16:48:37 | 00:00         |
| 8                                                         | DEFAULTS LOADED  | 12         | 2014-09-19 16:48:37 | 00:00         |

Figure 4-129. Metering, Event Log, Sorted by Date

When viewed with BESTCOMSP<sup>Plus</sup>, the event log can be sorted by Event ID, Description, Occurrence, Date, or Engine Hours. Selecting event log sorted by Date yields a list of all event occurrences in sequential order. This is a view that one would see in a typical “sequence of events” type of event log. Figure 4-129 shows the sequential list resulting from sorting by Date. Sorting by engine hours also results in a sequential list, where the sequence is in terms of engine hours rather than calendar date and time. Selecting sorting by Event ID or Description allows one to view all the occurrences of a particular event type in their order of occurrence. In this view, one can see at a glance the times and dates of the occurrences of one type of event. For example, from Figure 4-130, if one wanted to know when all occurrences of Speed Sender Failures occurred, the information readily available without having to sift through all the occurrences of unrelated events as would have to be done in a rolling log implementation. This is apparent in Figure 4-129.



| Options ▼ Refresh Clear ▼ Toggle Sorting Sorting: Enabled |                 |            |                     |               |  |
|-----------------------------------------------------------|-----------------|------------|---------------------|---------------|--|
| EventID                                                   | Description     | Occurrence | Date                | Eng Hrs (H:m) |  |
| 7                                                         | DGC RESET       | 41         | 2014-06-10 14:30:58 | 00:00         |  |
| 7                                                         | DGC RESET       | 40         | 2014-06-10 13:19:02 | 00:00         |  |
| 7                                                         | DGC RESET       | 39         | 2014-06-10 12:53:14 | 00:00         |  |
| 7                                                         | DGC RESET       | 38         | 2014-06-10 11:09:14 | 00:00         |  |
| 7                                                         | DGC RESET       | 1          | 2013-10-17 13:55:26 | 00:00         |  |
| 8                                                         | DEFAULTS LOADED | 12         | 2014-09-19 16:48:37 | 00:00         |  |
| 8                                                         | DEFAULTS LOADED | 11         | 2014-09-10 09:56:55 | 00:00         |  |
| 8                                                         | DEFAULTS LOADED | 10         | 2014-09-09 14:18:26 | 00:00         |  |
| 8                                                         | DEFAULTS LOADED | 9          | 2014-09-09 14:04:08 | 00:00         |  |
| 8                                                         | DEFAULTS LOADED | 8          | 2014-06-18 15:51:53 | 00:00         |  |
| 8                                                         | DEFAULTS LOADED | 7          | 2014-06-18 15:50:26 | 00:00         |  |

Figure 4-130. Metering, Event Log, Sorted by Event ID

## J1939 ECU

The ECU reports operating information to the DGC-2020 through the CAN Bus interface. Operating parameters and diagnostic information, if supported by the ECU, are decoded and displayed on these screens.

### ECU Data

This screen displays ECU Lamp Status and ECU Data. The status is TRUE when the corresponding LED is red. Refer to Figure 4-131.

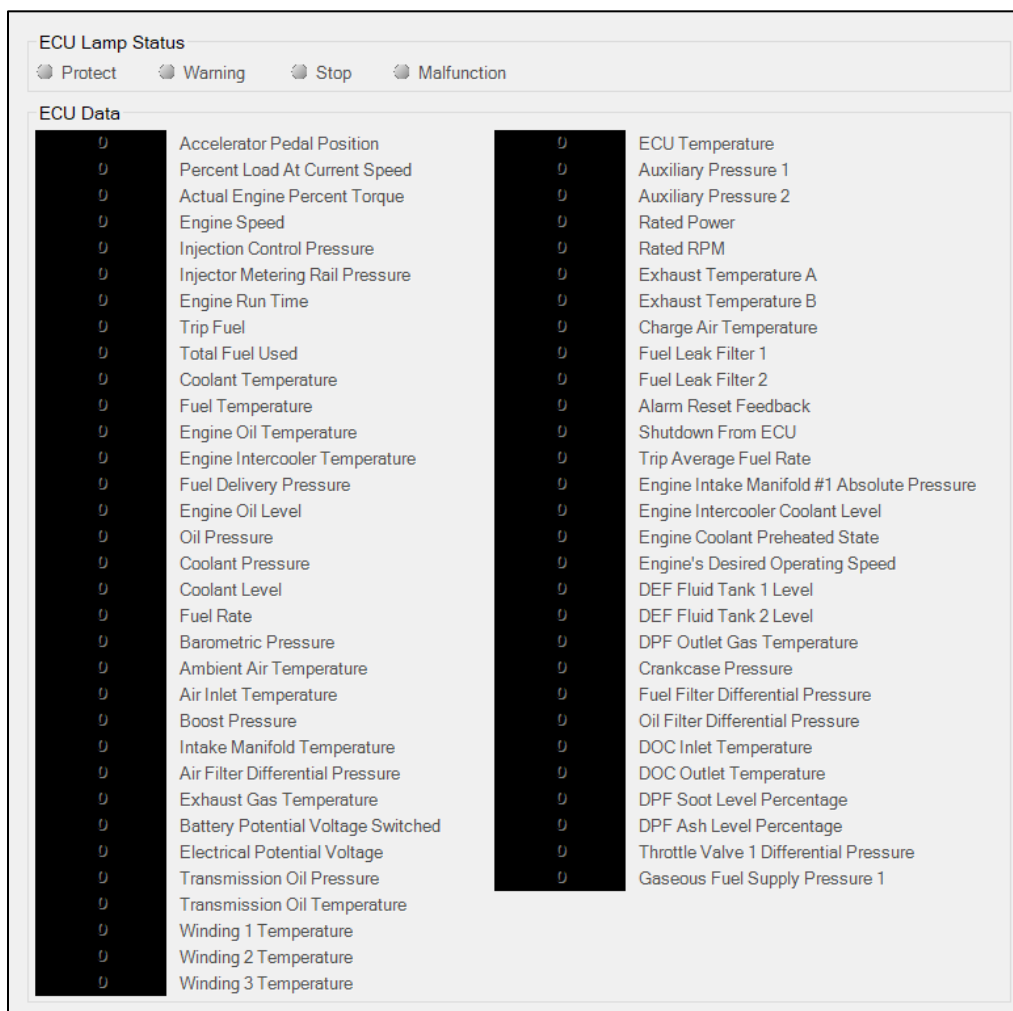


Figure 4-131. Metering, J1939 ECU, ECU Data

### Engine Configuration

This screen displays Engine Configuration. Refer to Figure 4-132.

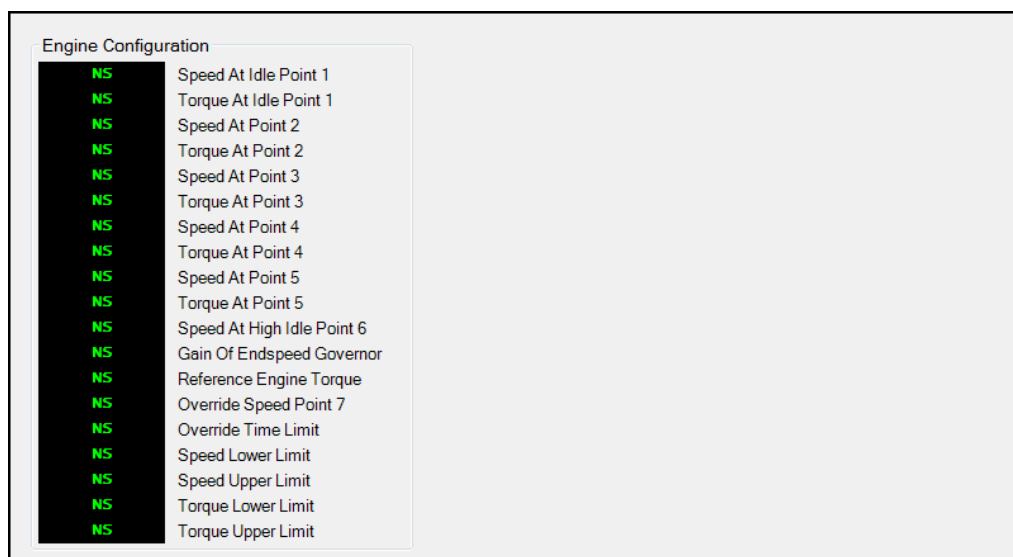


Figure 4-132. Metering, J1939 ECU, Engine Configuration

### Active DTC and Previously Active DTC

This screen is used for viewing, downloading, and clearing DTC (Diagnostic Trouble Codes). Refer to Figure 4-133.

| Options |     | Download |             | Clear |
|---------|-----|----------|-------------|-------|
| DTC ID  | SPN | FMI      | Occurrences |       |
| 1       | 94  | 3        | 5           |       |
| 2       | 98  | 3        | 7           |       |
| 3       | 99  | 3        | 9           |       |
| 4       | 100 | 3        | 11          |       |
| 5       | 101 | 3        | 13          |       |
| 6       | 109 | 3        | 15          |       |
| 7       | 110 | 3        | 17          |       |

**Figure 4-133. Metering, J1939 ECU, Download DTC**

### Yanmar Status

This screen (Figure 4-134) displays Yanmar ECU status.

Regeneration State

unknown Regen State

None

None

None

DPF Regeneration State  
Manual Regeneration Request State  
Manual Regeneration Status Annunciation State  
Manual Regeneration Inhibit Pulse State

Regeneration Status

☐ Regen Interlock Status from ECU  
☐ Engine Has Been Running 15 Minutes or More

NS

 Ambient Air Temperature  

NS

 Intake Manifold Pressure  

NS

 Exhaust Manifold Pressure  

NS

 DOC Inlet Temperature  

NS

 DOC Outlet Temperature  

NS

 DPF Soot Level Percentage  

NS

 DPF Ash Level Percentage  

NS

 DPF Regeneration Mode Status  

NS

 DPF Regeneration Request Flag  

NS

 DPF Regeneration Progress  

NS

 DPF Ash Cleaning Request  

0 %

 Regeneration Completion Progress

Regeneration Pre-Alarms

☐ Cannot Regen - Low Coolant Temperature  
☐ Cannot Regen - Interlock Fail  
☐ Cannot Regen - Less Than 50 Hours Since Last Regen

EGR Status

NS

 Time Remaining at Present Inducement Level  

NS

 Pending Inducement Severity  

NS

 Inducement Lamp State  

NS

 Operator Inducement Severity

EGR Pre-Alarms

☐ EGR Inducement Warning  
☐ EGR Inducement Level Low  
☐ EGR Inducement Severe

**Figure 4-134. Metering J1939 ECU, Yanmar Status**

### Isuzu Status

This screen (Figure 4-135) displays Isuzu ECU status.

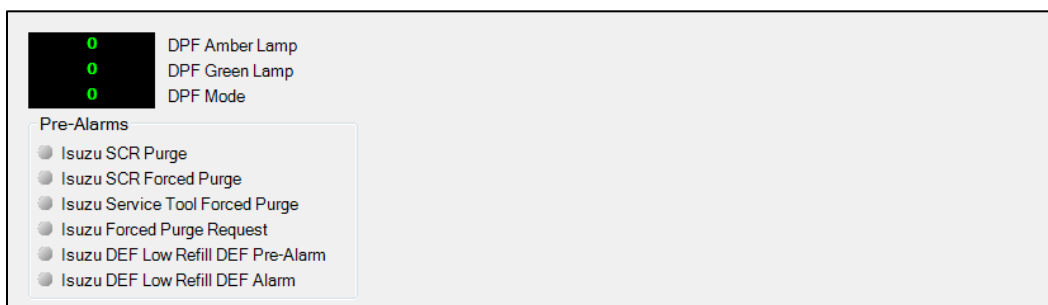


Figure 4-135. Metering J1939 ECU, Isuzu Status

### Deutz Status

This screen (Figure 4-136) displays the following Deutz ECU parameters:

#### **EPA1 PGN: Restriction Due to DEF Level**

This field displays the restriction level according to DEF (Diesel Exhaust Fluid) tank level. The value is expressed as a number.

- 0 = No restriction
- 1 = Level 1 (i.e. Warning < 5% DEF Level, power reduction after a delay time is possible)
- 2 = Level 2 torque reduction Step 1 (early inducement)
- 3 = Level 3 torque reduction Step 2 (severe inducement)

#### **EPA1 PGN: DEF Level**

This field displays the DEF tank level. The value is expressed as a number. Thresholds are application parameters set by Deutz.

- 1 = Level > Threshold 1 (15%)
- 2 = Threshold 1 > Level > Threshold 2 (10%)
- 3 = Threshold 2 > Level > Threshold 3 (5%)
- 4 = Threshold 3 > Level

#### **EPA2 PGN: Restriction Due to DEF Quality**

This field displays the restriction level according to SCR efficiency rate / DEF Quality. The value is expressed as a number.

- 0 = No restriction
- 1 = Level 1 Warning, power reduction after a delay time is possible
- 2 = Level 2 torque reduction Step 1 (early inducement)
- 3 = Level 3 torque reduction Step 2 (severe inducement)

#### **EPA3 PGN: Inducement Reason**

This field displays the after treatment SCR (Selective Catalytic Reduction) Operator Inducement reason. The value is expressed as a number.

- 0 = No inducement active
- 1 = Reagent Level Low
- 2 = Incorrect Quality
- 3 = Incorrect Consumption (not available)
- 4 = Tampering
- 5 = Spare (not available)
- 6 = Error (Hardware Failure) – displays as “SF”
- 7 = Not Available / Not Supported (No SCR system mounted) – displays as “NA”

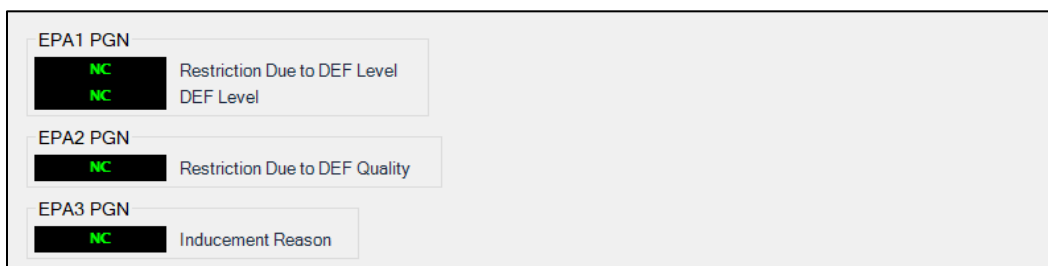


Figure 4-136. Metering J1939 ECU, Deutz Status

### ***mtu***

The *mtu* reports operating information to the DGC-2020 through the CAN Bus interface when the ECU is configured for *mtu*. Operating parameters and diagnostic information, if supported by the *mtu*, are decoded and displayed on these screens.

### **mtu Alarms**

*mtu* fault codes are displayed in a scrolling window. *mtu* Alarms and *mtu* Pre-Alarms are also reported on this screen. The status is TRUE when the corresponding LED is red. Refer to Figure 4-137.

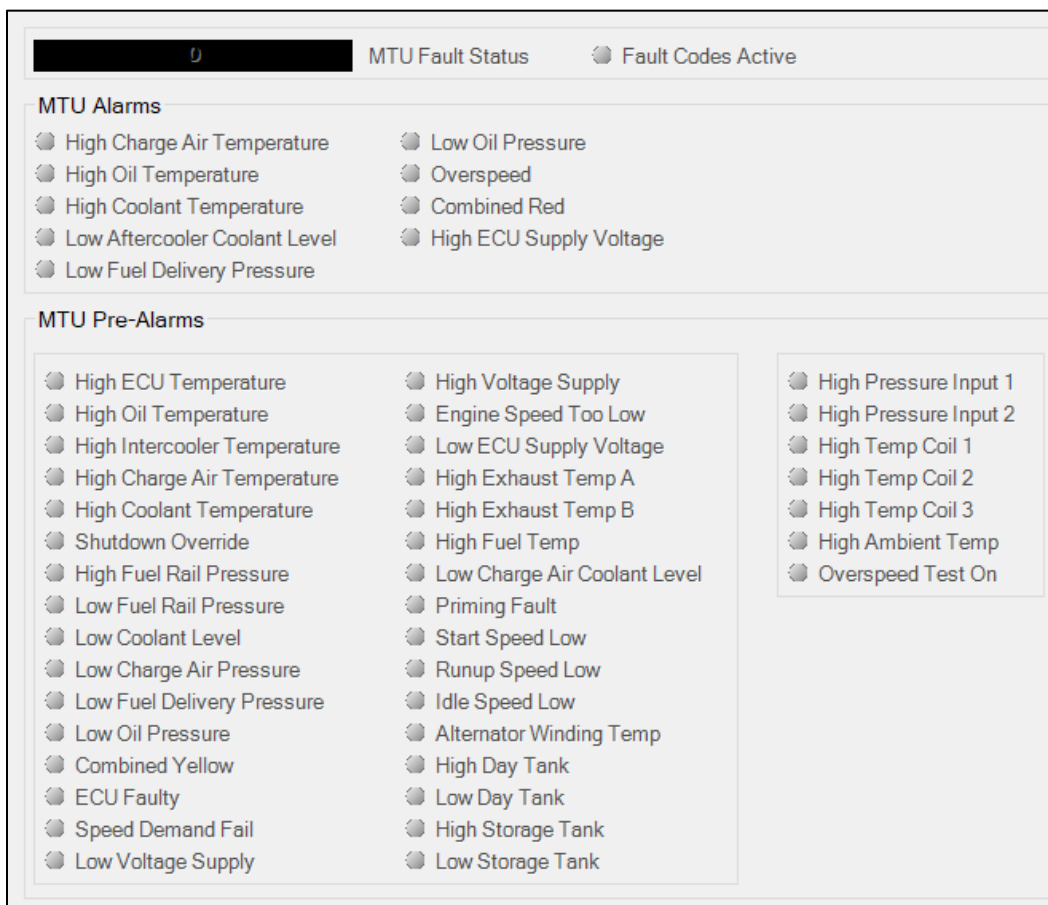


Figure 4-137. Metering, *mtu*, *mtu* Alarms

### **mtu Fault Codes**

*mtu* Fault Codes can be viewed and downloaded on this screen. Refer to Figure 4-138.

| Options Download |             |                   |
|------------------|-------------|-------------------|
| Fault ID         | Fault Codes | Description       |
| 1                | 4           | NO TEXT AVAILABLE |
| 2                | 201         | SD T-COOLANT      |

Figure 4-138. Metering, mtu, mtu Fault Codes

mtu Status

mtu Status is reported on this screen. The status is TRUE when the corresponding LED is red. Refer to Figure 4-139.

|                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>NMT Alive Status</b><br><div>NS MTU Sps Node Byte</div> <div>NS MTU Sw Type Byte</div> <div>NS MTU Sw Var Byte</div> <div>NS MTU Sw Ed 1 Byte</div> <div>NS MTU Sw Ed 2 Byte</div> <div>NS MTU Sw Rev Byte</div> <div>NS MTU Sw Mod Byte</div>                                                                                                                                                     | <b>Signal Feedback</b><br><input type="radio"/> ECU Override<br><input type="radio"/> External Stop Active<br><input type="radio"/> Speed Increase<br><input type="radio"/> Speed Decrease<br><input type="radio"/> Can Mode Feedback<br><input type="radio"/> Cylinder Cutout | <b>Limits</b><br><div>0 psi Oil Pressure</div> <div>NS Lube Oil Pressure Limit Low</div> <div>NS Lube Oil Pressure Limit Low Low</div> <div>NS Coolant Temperature</div> <div>NS Coolant Temperature Limit Hi</div> <div>NS Coolant Temperature Limit Hi Hi</div> <div>NS Charge Air Temperature</div> <div>NS Charge Air Temperature Limit Hi</div> <div>NS Battery Potential Voltage Switched</div> <div>NS ECU Power Supply Volts Lower Limit 1</div> <div>NS ECU Power Supply Volts Lower Limit 2</div> <div>NS ECU Power Supply Volts Upper Limit 1</div> <div>NS ECU Power Supply Volts Upper Limit 2</div> <div>NS Engine Intercooler Temperature</div> <div>NS Intercooler Temperature Limit Hi</div> |
| <b>Trip/Fuel</b><br><div>NS Trip Operating Time</div> <div>NS Trip Idle Time</div> <div>NS Fuel Rate</div> <div>NS Average Trip Fuel Consumption</div> <div>0 h Total Engine Run Time Hours</div> <div>NS Daily Fuel Consumption</div> <div>NS Total Fuel Used</div> <div>NS Day Tank Fill Percent</div> <div>NS Storage Tank Fill Percent</div>                                                      | <b>Diagnostics</b><br><input type="radio"/> ECU Shutdown<br><div>NS Alarm PowerAmp 1 Fail Bit Field</div> <div>NS Alarm PowerAmp 2 Fail Bit Field</div> <div>NS Alarm Transistor Out Bit Field</div> <div>NS Transistor Out Bit Field</div>                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Speed</b><br><input type="radio"/> Speed Demand Fail Mode<br><div>NS Rated RPM</div> <div>0 Speed</div> <div>NS Camshaft RPM</div> <div>NS Speed At Idle Point 1</div> <div>NS Speed Demand Source</div> <div>NS Selected Speed Demand</div> <div>NS Effective Set Speed</div> <div>NS CAN Bus Speed Demand Fdbk</div> <div>NS Analog Speed Demand Fdbk</div> <div>NS Frequency Speed Demand</div> | <b>CAN Bus</b><br><input type="radio"/> Can Mode Feedback<br><div>NS Nodes On CAN Bus</div> <div>NS Lost Nodes On CAN Bus</div>                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

Figure 4-139. Metering, mtu, mtu Status

### mtu Engine Status

mtu Engine Status is reported on this screen. The status is TRUE when the corresponding LED is red. Refer to Figure 4-140.

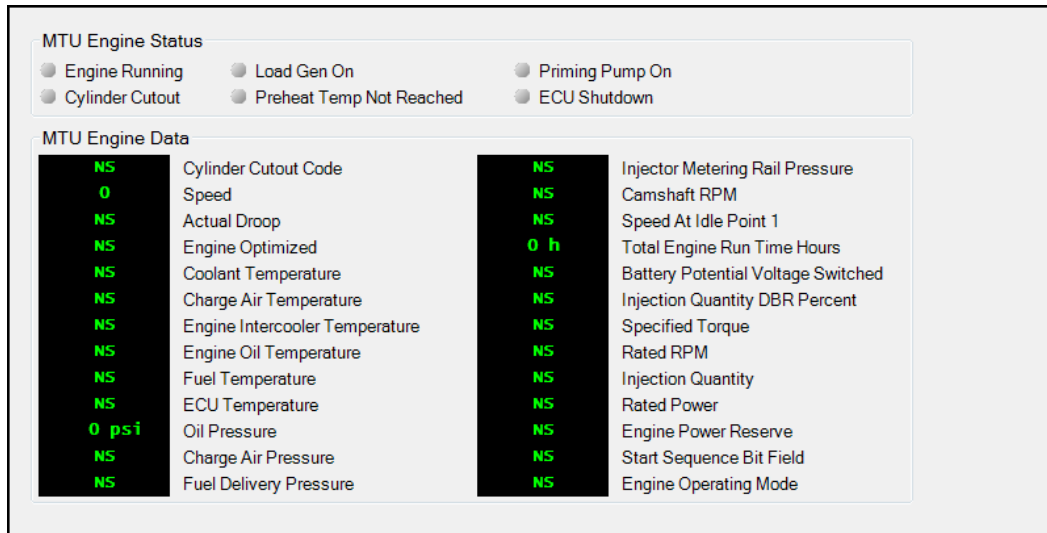


Figure 4-140. Metering, mtu, mtu Engine Status

### Summary

This screen displays a metering summary. Refer to Figure 4-141.

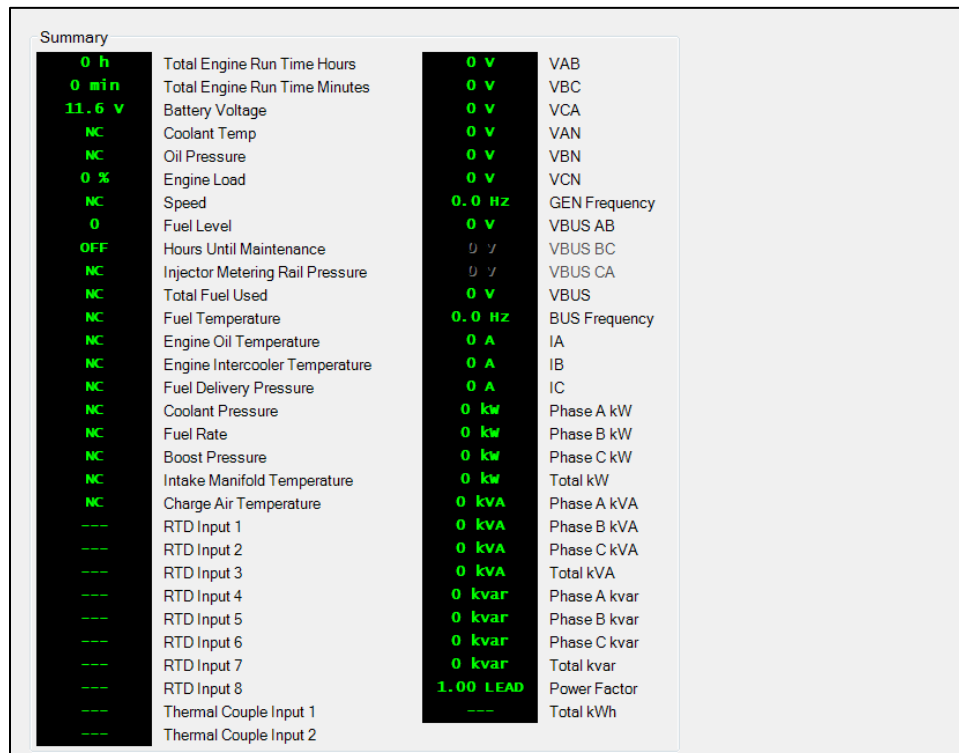


Figure 4-141. Metering, Summary

### Control

Controls for stopping/starting the engine, opening/closing breakers, and for opening/closing switches are accessed using BESTCOMSPlus through the *Metering Explorer, Control Panel* screen. This set of controls is especially useful when commissioning the DGC-2020. The computer running BESTCOMSPlus

must be connected to the DGC-2020 through a communications port. The Control Panel screen is shown in Figure 4-142.

### Emergency Stop

The generator can be put into an Emergency Stop state from BESTCOMS*Plus* by clicking the Emergency Stop button on the Control Panel. When an emergency stop initiated from BESTCOMS*Plus* is active, the button will be labeled “Emergency Reset” and the indicator next to the button will be red. Clicking the button when it is labeled “Emergency Reset” removes the BESTCOMS*Plus* emergency stop condition and the indicator next to the button turns gray.

| Note                                                                                                                                                                                                                                                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| An emergency stop initiated from BESTCOMS <i>Plus</i> must be cleared before disconnecting BESTCOMS <i>Plus</i> communications. Without BESTCOMS <i>Plus</i> , the only way to clear the Emergency Stop state from the DGC-2020 is to cycle battery power. |

### Engine Control

The engine can be started and stopped by clicking on the *Start* and *Stop* buttons if the DGC-2020 is in Auto mode. If the DGC-2020 is in Off mode or Run mode, these buttons have no effect.

### Run, Auto, Off

The operating mode can be set to Run, Auto, or Off.

### Generator and Mains Breakers

Controls for opening and closing the system breakers are provided. A breaker is open when the corresponding indicator is green and closed when it is red. When in Run mode, breakers can be closed manually using contact inputs according to how the breaker logic block has been configured and connected.

### Switches 1 through 4

Switches 1 through 4 can be opened or closed by clicking on the *Open* or *Close* buttons. A switch is closed when the corresponding indicator is red.



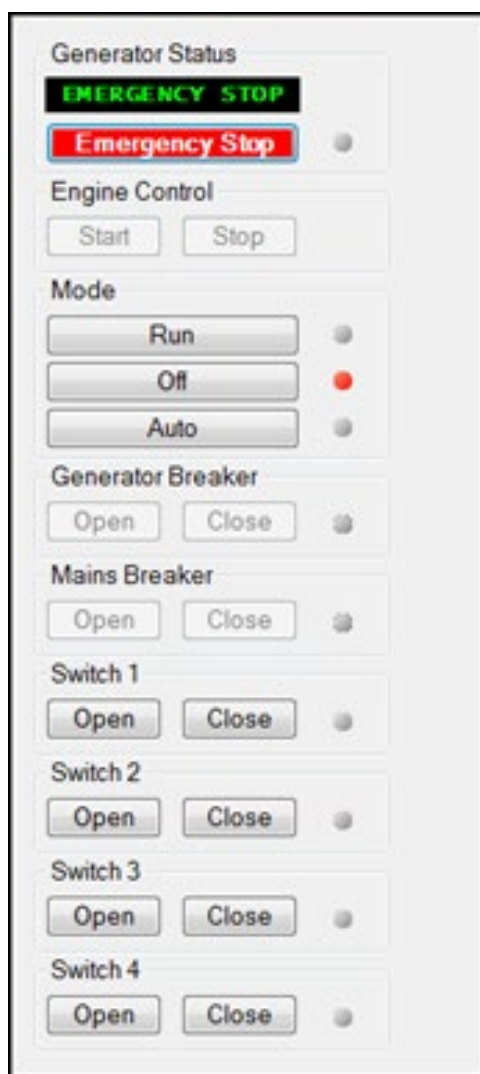


Figure 4-142. Metering, Control

### Real Time Clock

Settings for Date and Time are made here. Refer to Figure 4-143.

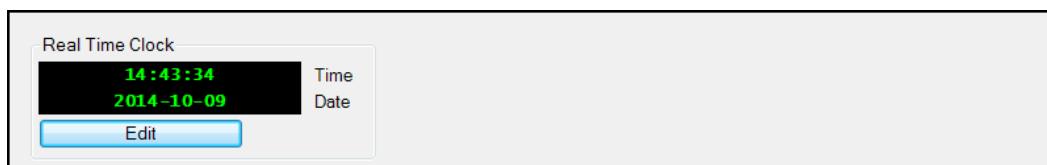


Figure 4-143. Metering, Real Time Clock

### Generator Network Status

This screen (Figure 4-144) displays the designated system manager, total number of units, number of units on line, system online kW capacity, system total kW capacity, system generated kW, system generated kW percent, system total generated kvar, and sequencing IDs of the LSM-2020's on the network. This can only be accomplished when an optional LSM-2020 (Load Share Module) is connected to the DGC-2020 and actively communicating to the generator network.

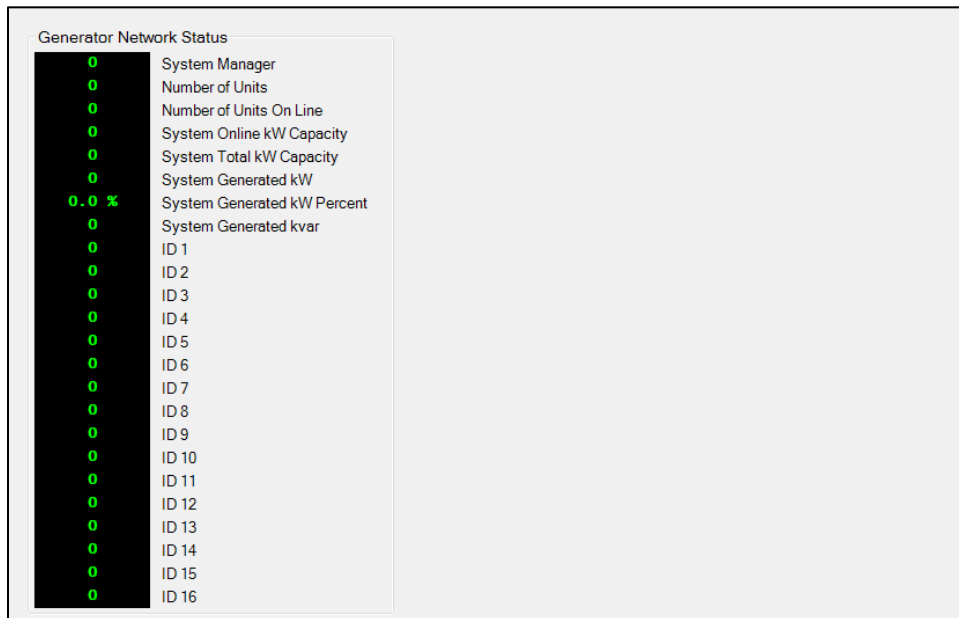


Figure 4-144. Metering, Generator Network Status

## Generator Sequencing

This screen (Figure 4-145) displays the sequencing status of the generator network. The start/stop threshold, start/stop time delay, actual watt demand, and current sequencing mode are shown. Also, the sequencing ID numbers of the unit currently being monitored, the next unit to start/stop, and the unit designated as the system manager are indicated.

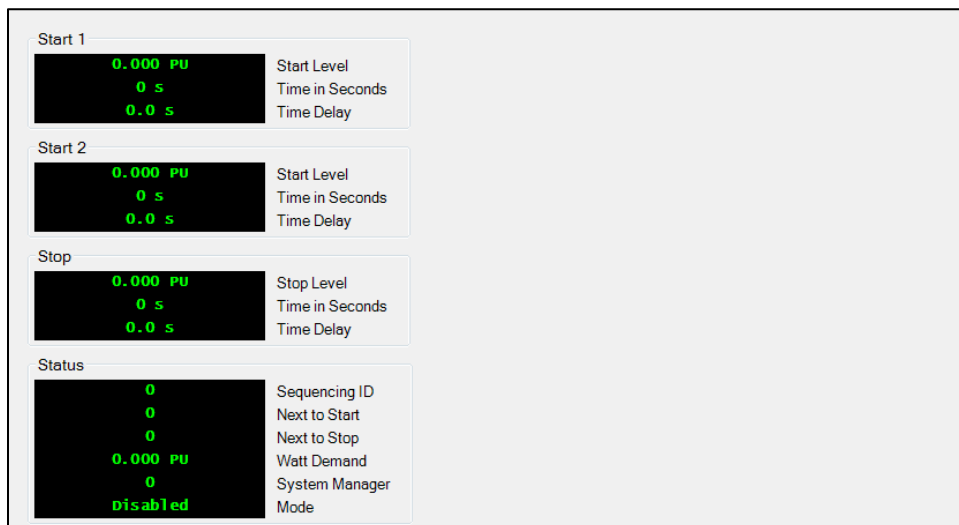


Figure 4-145. Metering, Generator Sequencing

## Mains Fail Transfer Status

The Mains Fail Transfer Status screen (Figure 4-146) displays the Mains Fail Transfer State and any timers relevant to the mains fail transfer process. These parameters are listed below.

**Mains Fail Transfer State:** The different mains fail transfer states are described below.

*Power From Mains:* Power is being supplied to the load from the mains bus.

*Transfer Timer Active:* Transfer Delay timer is actively counting.

*Transferring to Gens:* Load is being transferred to the generator bus.

**Power From Gens:** Power is being supplied to the load from the generator bus.

**Return Timer Active:** Return Delay timer is actively counting.

**Transferring to Mains:** Load is being transferred to the mains bus.

**Disabled:** DGC-2020 is in the OFF or RUN operating mode or in the alarm state.

**Remaining Transfer Delay:** Displays the current timer value in seconds.

**Remaining Return Delay:** Displays the current timer value in seconds.

**Remaining Max Parallel Time:** Displays the current timer value in seconds.

**Remaining Max Transfer Time:** Displays the current timer value in seconds.

**Remaining Open Transition Delay Time:** Displays the current timer value in seconds.

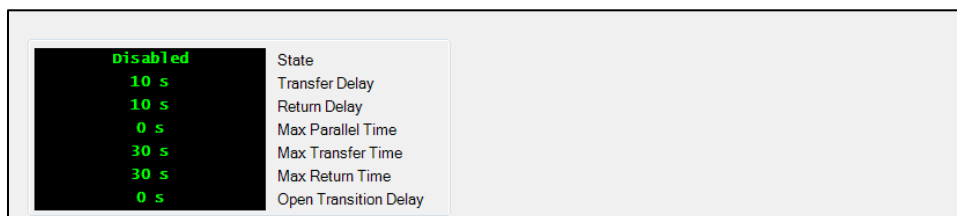


Figure 4-146. Metering, Mains Fail Transfer Status

## Diagnostics

Diagnostics provide metering for kW and var control and load share parameters.

### Control

Figure 4-147 illustrates the BESTCOMSPlus Control screen.

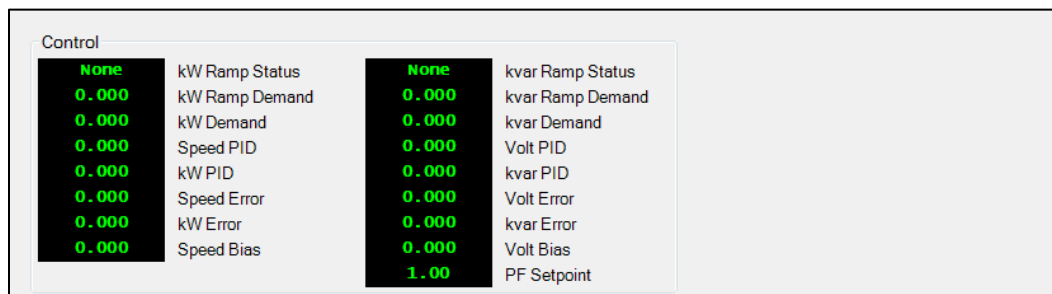


Figure 4-147. Metering Explorer, Diagnostics, Control Screen

### Load Share

Figure 4-148 illustrates the BESTCOMSPlus Load Share screen.



Figure 4-148. Metering Explorer, Diagnostics, Load Share Screen

### Sender Inputs

Figure 4-149 illustrates the BESTCOMSPlus Sender Inputs Screen.

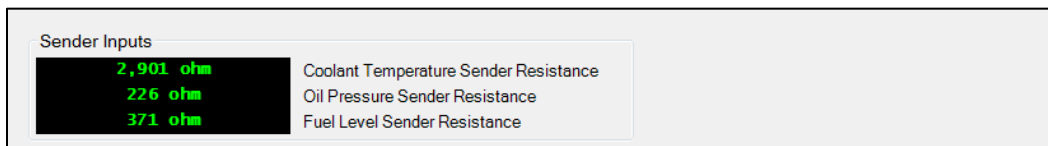


Figure 4-149. Metering Explorer, Diagnostics, Sender Inputs

## BESTCOMSPlus® Updates

Ongoing DGC-2020 functionality enhancements may make future DGC-2020 firmware updates desirable. Enhancements to DGC-2020 firmware typically coincide with enhancements to the DGC-2020 plugin for BESTCOMSPlus. When a DGC-2020 is updated with the latest version of firmware, the latest version of BESTCOMSPlus should also be obtained.

- You can check for BESTCOMSPlus updates by visiting [www.basler.com](http://www.basler.com).
- BESTCOMSPlus automatically checks for updates when Check Automatically is selected on the Check for Updates User Settings screen. This screen is accessed under the Help drop-down menu. (An internet connection is required.)
- You can use the manual “check for updates” function in BESTCOMSPlus to ensure that the latest version is installed by selecting *Check for Updates* in the Help drop-down menu. (An internet connection is required.)

## Auto Export Metering

The auto export metering function automatically exports metering data over a user-defined period when a DGC-2020 connection is active. The user specifies the *Number of Exports* and the *Interval* between each export. Enter a filename for the metering data and a folder in which to save. The first export is performed immediately after clicking the *Start* button. Click the *Filter* button to select specific metering screens. Figure 4-150 illustrates the *Auto Export Metering* screen.

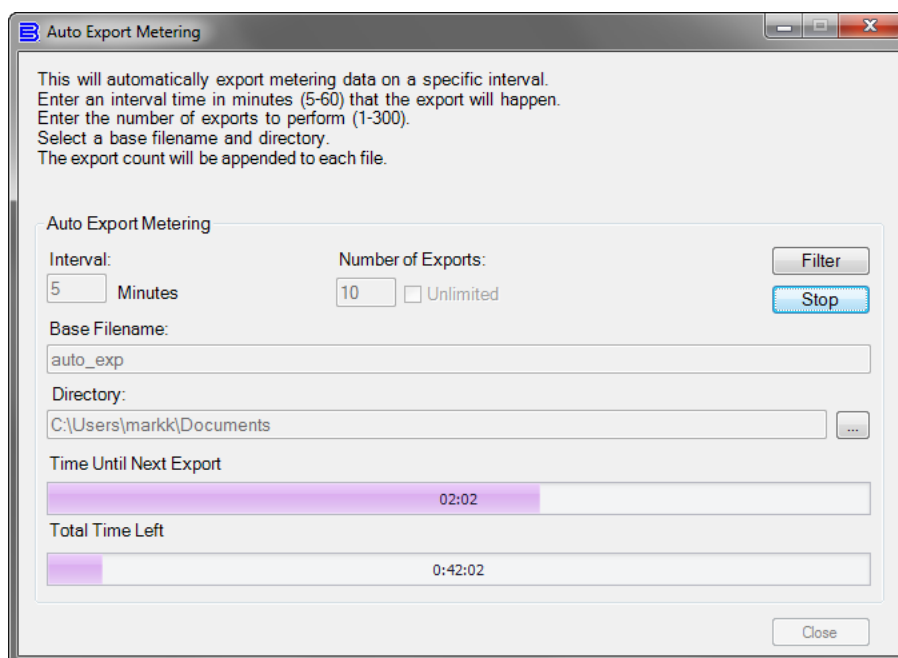


Figure 4-150. Auto Export Metering

## 5 • BESTlogic™ *Plus* Programmable Logic

BESTlogic™ *Plus* Programmable Logic is a programming method used for managing the input, output, protection, control, monitoring, and reporting capabilities of Basler Electric's DGC-2020 Digital Genset Controller. Each DGC-2020 has multiple, self-contained logic blocks that have all of the inputs and outputs of its discrete component counterpart. Each independent logic block interacts with control inputs and hardware outputs based on logic variables defined in equation form with BESTlogic*Plus*.

BESTlogic*Plus* equations entered and saved in the DGC-2020 system's nonvolatile memory integrate (electronically wire) the selected or enabled protection and control blocks with control inputs and hardware outputs. A group of logic equations defining the logic of the DGC-2020 is called a logic scheme.

One default active logic scheme is pre-loaded into the DGC-2020. This scheme is configured for a typical protection and control application and virtually eliminates the need for "start-from-scratch" programming. BESTCOMSP*Plus*® can be used to open a logic scheme that was previously saved as a file and upload it to the DGC-2020. The default logic scheme can also be customized to suit your application. Detailed information about logic schemes is provided later in this section.

BESTlogic*Plus* is not used to define the operating settings (modes, pickup thresholds, and time delays) of the individual protection and control functions. Operating settings and logic settings are interdependent but separately programmed functions. Changing logic settings is similar to rewiring a panel and is separate and distinct from making the operating settings that control the pickup thresholds and time delays of a DGC-2020. Detailed information about operating settings is provided in Section 4, *BESTCOMSP*Plus*® Software*.

### Caution

This product contains one or more *nonvolatile memory* devices. Nonvolatile memory is used to store information (such as settings) that needs to be preserved when the product is power-cycled or otherwise restarted. Established nonvolatile memory technologies have a physical limit on the number of times they can be erased and written. In this product, the limit is 100,000 erase/write cycles. During product application, consideration should be given to communications, logic, and other factors that may cause frequent/repeated writes of settings or other information that is retained by the product. Applications that result in such frequent/repeated writes may reduce the useable product life and result in loss of information and/or product inoperability.

### Overview of BESTlogic™ *Plus*

Use BESTCOMSP*Plus* to make BESTlogic*Plus* settings. Use the Settings Explorer to open the *BESTlogicPlus Programmable Logic* tree branch as shown in Figure 5-1.

The *BESTlogicPlus Programmable Logic* screen contains a logic library for opening and saving logic files, tools for creating and editing logic documents, and protection settings.

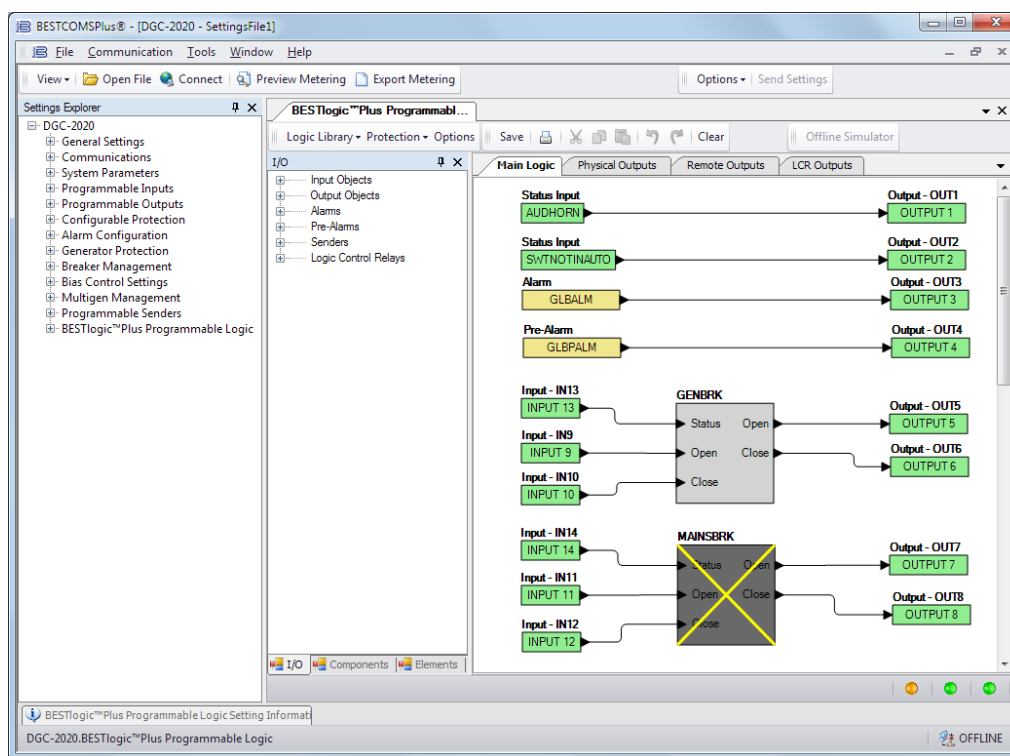


Figure 5-1. BESTlogicPlus Programmable Logic Tree Branch

### BESTlogic™ Plus Composition

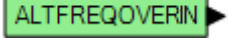
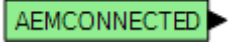
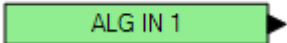
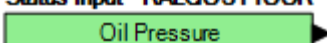
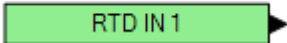
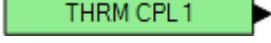
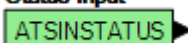
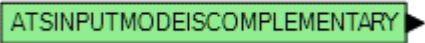
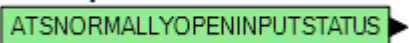
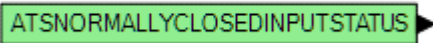
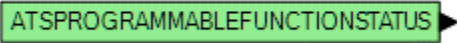
There are three main groups of objects used for programming BESTlogicPlus. These groups are *I/O*, *Components*, and *Elements*. For details on how these objects are used to program BESTlogicPlus, see the paragraphs on *Programming BESTlogicPlus*.

#### I/O

This group contains Input Objects, Output Objects, Alarms, Pre-Alarms, Senders, and Logic Control Relays. Table 5-1 lists the names and descriptions of the objects in the I/O group.

Table 5-1. I/O Group, Names and Descriptions

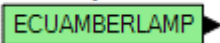
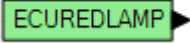
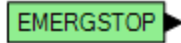
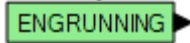
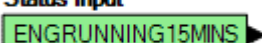
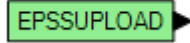
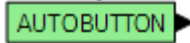
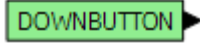
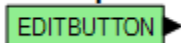
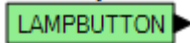
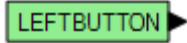
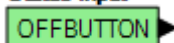
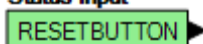
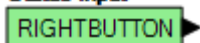
| Name                                           | Description                                                                                | Symbol                            |
|------------------------------------------------|--------------------------------------------------------------------------------------------|-----------------------------------|
| <b>Input Objects</b>                           |                                                                                            |                                   |
| Logic 0                                        | Always FALSE (Low).                                                                        | Fixed 0                           |
| Logic 1                                        | Always TRUE (High).                                                                        | Fixed 1                           |
| <i>Physical Inputs</i><br>IN1 - IN16           | TRUE when Physical Input x is active.                                                      | Input - IN1<br>INPUT 1            |
| <i>Remote Inputs</i><br>IN17 - IN26            | TRUE when Remote Input x is active.<br>(Available when an optional CEM-2020 is connected.) | Input - IN17<br>INPUT 17          |
| <i>Virtual Inputs</i><br>VIN1 - VIN4           | TRUE when Virtual Input x is active.                                                       | Input - VIN1<br>VIN1              |
| <i>Status Input</i><br>Active DTC's<br>Present | TRUE when Diagnostic Trouble Codes are present.                                            | Status Input<br>ACTIVEDTCSPRESENT |

| Name                                                      | Description                                                                                                                                                                                                                                                                                                                                     | Symbol                                                                                                           |
|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| Status Input<br>Alarm Silence                             | TRUE when the Alarm Silence logic element is TRUE or the Alarm Silence button is pressed on the front panel.                                                                                                                                                                                                                                    | Status Input<br>               |
| Status Input<br>Alternate Frequency Override              | TRUE when the Alternate Frequency Override logic element is TRUE.                                                                                                                                                                                                                                                                               | Status Input<br>               |
| Status Input<br>Analog Expansion Module                   | Analog Expansion Module Connected. TRUE when an optional AEM-2020 is connected to the DGC-2020.                                                                                                                                                                                                                                                 | Status Input<br>               |
| Analog Expansion Module<br>Remote Analog Inputs 1-8       | TRUE when Over 1, Over 2, Under 1, Under 2, or Out of Range is configured as Status Only and the threshold has been exceeded. (Over 1 shown.)                                                                                                                                                                                                   | Status Input - RALGIN101<br>   |
| Analog Expansion Module<br>Remote Analog Outputs 1-4      | TRUE when the analog output connection is open and the Out of Range Alarm Configuration is set to Status Only.                                                                                                                                                                                                                                  | Status Input - RALGOUT100R<br> |
| Analog Expansion Module<br>Remote RTD Inputs 1-8          | TRUE when Over 1, Over 2, Under 1, Under 2, or Out of Range is configured as Status Only and the threshold has been exceeded. (Over 1 shown.)                                                                                                                                                                                                   | Status Input - RRTDIN101<br>   |
| Analog Expansion Module<br>Remote Thermocouple Inputs 1-2 | TRUE when Over 1, Over 2, Under 1, Under 2, or Out of Range is configured as Status Only and the threshold has been exceeded. (Over 1 shown.)                                                                                                                                                                                                   | Status Input - RTCIN101<br>  |
| Status Input<br>ATS Input                                 | TRUE when the ATS (Auto Transfer Switch) input is TRUE or the ATS logic element is TRUE.                                                                                                                                                                                                                                                        | Status Input<br>             |
| Status Input<br>ATS Input Mode is Complementary           | TRUE when the Auto Transfer Switch Programmable Function Input Mode is set for Complementary. FALSE when it is set for Single.                                                                                                                                                                                                                  | Status Input<br>             |
| Status Input<br>ATS Normally Open Input                   | TRUE when the input mapped to the ATS N.O. input is TRUE.                                                                                                                                                                                                                                                                                       | Status Input<br>             |
| Status Input<br>ATS Normally Closed Input                 | TRUE when the input mapped to the ATS N.C. input is TRUE.                                                                                                                                                                                                                                                                                       | Status Input<br>             |
| Status Input<br>ATS Status                                | TRUE when the ATS Programmable Function detects a TRUE status. When the ATS Input Mode is set for Single, it is TRUE when the input mapped to the ATS N.O. input is TRUE. When the ATS Input Mode is set for Complementary, it is TRUE when the input mapped to the ATS N.O. input is TRUE and the input mapped to the ATS N.C. input is FALSE. | Status Input<br>             |

| Name                                                  | Description                                                                                                                                                            | Symbol                                                                                                                          |
|-------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| Status Input<br>Audible Horn                          | TRUE when the Audible Horn is active.                                                                                                                                  | Status Input<br>AUDHORN                      |
| Status Input<br>Auto Mode                             | TRUE when the DGC-2020 is in Auto Mode or the Auto Mode logic element is TRUE.                                                                                         | Status Input<br>AUTOMODE                     |
| Status Input<br>Auto Restart                          | TRUE when the Automatic Restart function is active.                                                                                                                    | Status Input<br>AUTORESTART                  |
| Status Input<br>Battery Charger<br>AC Off             | TRUE when the ac power to the battery charger is off. (Battery Charger 1 shown.)                                                                                       | Status Input<br>BCH1ACOFFSTATUS              |
| Status Input<br>Battery Charger<br>Battery Failure    | TRUE when the battery charger has detected that the battery has failed. (Battery Charger 1 shown.)                                                                     | Status Input<br>BCH1BATTERYFAILURESTATUS     |
| Status Input<br>Battery Charger<br>Comms Fail         | TRUE when the battery charger has detected a J1939 communications failure. (Battery Charger 1 shown.)                                                                  | Status Input<br>BCH1COMMSFAILSTATUS          |
| Status Input<br>Battery Charger<br>Fail               | TRUE when the battery charger has failed. (Battery Charger 1 shown.)                                                                                                   | Status Input<br>BCH1CHARGERFAILSTATUS        |
| Status Input<br>Battery Charger<br>High Output Volts  | TRUE when the battery charger output voltage is too high. (Battery Charger 1 shown.)                                                                                   | Status Input<br>BCH1HIOUTPUTVOLTSSTATUS      |
| Status Input<br>Battery Charger<br>Invalid Settings   | TRUE when the battery charger has detected settings that are not valid. (Battery Charger 1 shown.)                                                                     | Status Input<br>BCH1INVALIDSETTINGSSTATUS  |
| Status Input<br>Battery Charger<br>Low Cranking Volts | TRUE when the battery charger has detected that the voltage while the engine is cranking has dipped too low. (Battery Charger 1 shown.)                                | Status Input<br>BCH1LOCRANKINGVOLTSSTATUS  |
| Status Input<br>Battery Charger<br>Low Output Volts   | TRUE when the battery charger output voltage is too low. (Battery Charger 1 shown.)                                                                                    | Status Input<br>BCH1LOOUTPUTVOLTSSTATUS    |
| Status Input<br>Battery Charger<br>Single Unit Fail   | TRUE when the battery charger has detected one or more charging output stages in a charger with multiple charging output stages has failed. (Battery Charger 1 shown.) | Status Input<br>BCH1SINGLEUNITFAILSTATUS   |
| Status Input<br>Battery Charger<br>Thermal Limit      | TRUE when the battery charger temperature is beyond the thermal limit. (Battery Charger 1 shown.)                                                                      | Status Input<br>BCH1THERMALLIMITSTATUS     |
| Status Input<br>Battery Charger<br>Fail               | TRUE when the Battery Charger Fail input is TRUE.                                                                                                                      | Status Input<br>BATTCHRGFAIL               |
| Status Input<br>Battle Override                       | TRUE when the Battle Override input is TRUE.                                                                                                                           | Status Input<br>BATTLORIDE                 |
| Status Input<br>Bus Dead                              | TRUE when the Bus Dead condition settings have been exceeded.                                                                                                          | Status Input<br>BUSDEAD                    |



| Name                                        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Symbol                                                                                                                        |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| Status Input<br>Bus Fail                    | TRUE when the Bus Fail condition settings have been exceeded.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Status Input<br>BUSFAIL                    |
| Status Input<br>Bus Forward Rotation Status | TRUE when the sensed bus phase rotation matches the bus phase rotation specified in the system settings.                                                                                                                                                                                                                                                                                                                                                                                                                                           | Status Input<br>BUSFORWARDROTATIONSTATUS   |
| Status Input<br>Bus Reverse Rotation Status | TRUE when the sensed bus phase rotation differs from the bus phase rotation specified in the system settings.                                                                                                                                                                                                                                                                                                                                                                                                                                      | Status Input<br>BUSREVERSEROTATIONSTATUS   |
| Status Input<br>Bus Stable                  | TRUE when the Bus Stable condition settings have been exceeded.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Status Input<br>BUSSTABLE                  |
| Status Input<br>CAN Bus Bus Off             | TRUE when the CAN Bus bus is off.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Status Input<br>CANSBUSOFF                 |
| Status Input<br>CAN Bus Error Passive       | TRUE when a passive error is annunciated by the CAN Bus.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Status Input<br>CANBUSERRORPASSIVE         |
| Status Input<br>Configurable Elements 1-8   | TRUE when the Configurable Element x logic element is TRUE.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Status Input<br>CONFIGELEMENT1             |
| Status Input<br>Configurable Protection 1-8 | TRUE when the Configurable Protection x Over Threshold #1 is TRUE. (Over 1 shown.)                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Status Input - CONFPROT101<br>CONF PROT 1  |
| Status Input<br>Contact Expansion Module    | Contact Expansion Module Connected. TRUE when an optional CEM-2020 is connected to the DGC-2020.                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Status Input<br>CEMCONNECTED             |
| Status Input<br>Cool Down Timer Active      | TRUE when the Cool Down Timer is timing out. The Cool Down Timer is TRUE under two circumstances: <ol style="list-style-type: none"> <li>1. The unit is in auto and ATS is removed, causing the DGC-2020 to go into a cooldown state.</li> <li>2. The engine is running (in Run or Auto mode with ATS applied) and the load has been removed (i.e. the EPSSUPLOAD status input is FALSE due to small load). If the load is reapplied, the Cool Down Timer stops and resets, and it will restart when the load is removed the next time.</li> </ol> | Status Input<br>CDOWNTMRCT               |
| Status Input<br>DPF Lamp Command            | TRUE when DPF lamp is lit. This status input mimics the state of the DPF lamp. It remains TRUE when the DPF lamp is constantly lit and toggles TRUE and FALSE at a rate of 1 Hz when DPF lamp is blinking.                                                                                                                                                                                                                                                                                                                                         | Status Input<br>DPFLAMPCOMMAND           |
| Status Input<br>DPF Manual Regen Request    | TRUE when the Diesel Particulate Filter (DPF) lamp status broadcast over CAN Bus indicates that DPF regeneration is required.                                                                                                                                                                                                                                                                                                                                                                                                                      | Status Input<br>DPFMANUALREGENREQ        |
| Status Input<br>DPF Regen Inhibit Request   | TRUE when the Diesel Particulate Filter (DPF) lamp status broadcast over CAN Bus indicates that DPF regeneration is inhibited.                                                                                                                                                                                                                                                                                                                                                                                                                     | Status Input<br>DPFREGENINHIBITREQ       |

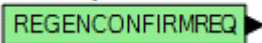
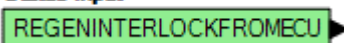
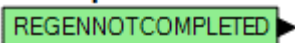
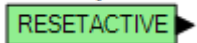
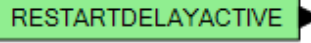
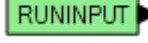
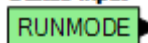
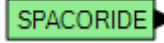
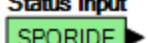
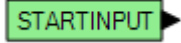
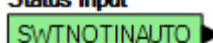
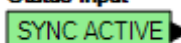
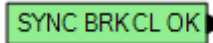
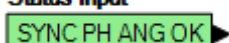
| Name                                             | Description                                                                                                                                                                                                                                                                                                         | Symbol                                                                                                      |
|--------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| <i>Status Input</i><br>ECU Amber Lamp            | TRUE when the engine ECU sends ECU Amber Lamp (Warning Lamp) status as part of J1939 Diagnostic Trouble Code (DTC) communications. It may be off, on, or flashing. If the installation requires annunciation of engine warning and fault lamps, this may be connected to an output in logic to drive an amber lamp. | <b>Status Input</b><br>   |
| <i>Status Input</i><br>ECU Red Lamp              | TRUE when the engine ECU sends ECU Red Lamp (Fault Lamp) status as part of J1939 Diagnostic Trouble Code (DTC) communications. It may be off, on, or flashing. If the installation requires annunciation of engine warning and fault lamps, this may be connected to an output in logic to drive a red lamp.        | <b>Status Input</b><br>   |
| <i>Status Input</i><br>Emergency Stop            | TRUE when the Emergency Stop button has been pressed.                                                                                                                                                                                                                                                               | <b>Status Input</b><br>   |
| <i>Status Input</i><br>Engine Running            | TRUE while the Engine is Running.                                                                                                                                                                                                                                                                                   | <b>Status Input</b><br>   |
| <i>Status Input</i><br>Engine Running 15 Minutes | TRUE when the engine is presently running and has been running 15 minutes or more since the most recent start.                                                                                                                                                                                                      | <b>Status Input</b><br>   |
| <i>Status Input</i><br>EPS Supplying Load        | TRUE while the EPS is supplying load.                                                                                                                                                                                                                                                                               | <b>Status Input</b><br> |
| <i>Status Input</i><br>Front Panel Buttons       | TRUE while the <i>AUTO</i> front panel button is pressed.                                                                                                                                                                                                                                                           | <b>Status Input</b><br> |
| <i>Status Input</i><br>Front Panel Buttons       | TRUE while the <i>DOWN</i> front panel button is pressed.                                                                                                                                                                                                                                                           | <b>Status Input</b><br> |
| <i>Status Input</i><br>Front Panel Buttons       | TRUE while the <i>EDIT</i> front panel button is pressed.                                                                                                                                                                                                                                                           | <b>Status Input</b><br> |
| <i>Status Input</i><br>Front Panel Buttons       | TRUE while the <i>LAMP TEST</i> front panel button is pressed.                                                                                                                                                                                                                                                      | <b>Status Input</b><br> |
| <i>Status Input</i><br>Front Panel Buttons       | TRUE while the <i>LEFT</i> front panel button is pressed.                                                                                                                                                                                                                                                           | <b>Status Input</b><br> |
| <i>Status Input</i><br>Front Panel Buttons       | TRUE while the <i>OFF</i> front panel button is pressed.                                                                                                                                                                                                                                                            | <b>Status Input</b><br> |
| <i>Status Input</i><br>Front Panel Buttons       | TRUE while the <i>RESET</i> front panel button is pressed.                                                                                                                                                                                                                                                          | <b>Status Input</b><br> |
| <i>Status Input</i><br>Front Panel Buttons       | TRUE while the <i>RIGHT</i> front panel button is pressed.                                                                                                                                                                                                                                                          | <b>Status Input</b><br> |

| Name                                           | Description                                                                                                               | Symbol                                                                                                                         |
|------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| Status Input<br>Front Panel<br>Buttons         | TRUE while the <i>RUN</i> front panel button is pressed.                                                                  | Status Input<br>RUNBUTTON                   |
| Status Input<br>Front Panel<br>Buttons         | TRUE while the <i>ALARM SILENCE</i> front panel button is pressed.                                                        | Status Input<br>SILENCEBUTTON               |
| Status Input<br>Front Panel<br>Buttons         | TRUE while the <i>UP</i> front panel button is pressed.                                                                   | Status Input<br>UPBUTTON                    |
| Status Input<br>Fuel Leak                      | TRUE when the Fuel Leak Detect input is TRUE.                                                                             | Status Input<br>FUELLEAK                    |
| Status Input<br>Generator<br>Breaker Status    | TRUE when the generator breaker is closed.                                                                                | Status Input<br>GENBRKSTA                   |
| Status Input<br>Generator Dead                 | TRUE when the Gen Dead condition settings have been exceeded.                                                             | Status Input<br>GENDEAD                     |
| Status Input<br>Generator Fail                 | TRUE when the Gen Fail condition settings have been exceeded.                                                             | Status Input<br>GENFAIL                     |
| Status Input<br>Gen Forward<br>Rotation Status | TRUE when the sensed generator phase rotation matches the generator phase rotation specified in the system settings.      | Status Input<br>GENFORWARDROTATIONSTATUS    |
| Status Input<br>Gen Reverse<br>Rotation Status | TRUE when the sensed generator phase rotation differs from the generator phase rotation specified in the system settings. | Status Input<br>GENREVERSEROTATIONSTATUS  |
| Status Input<br>Generator<br>Protection        | TRUE when the 27-1 element is tripped.                                                                                    | Status Input<br>27-1TRIP                  |
| Status Input<br>Generator<br>Protection        | TRUE when the 27-2 element is tripped.                                                                                    | Status Input<br>27-2TRIP                  |
| Status Input<br>Generator<br>Protection        | TRUE when the 59-1 element is tripped.                                                                                    | Status Input<br>59-1TRIP                  |
| Status Input<br>Generator<br>Protection        | TRUE when the 59-2 element is tripped.                                                                                    | Status Input<br>59-2TRIP                  |
| Status Input<br>Generator<br>Protection        | TRUE when the 32 element is tripped.                                                                                      | Status Input<br>32RTRIP                   |
| Status Input<br>Generator<br>Protection        | TRUE when the 40 element is tripped.                                                                                      | Status Input<br>40TRIP                    |
| Status Input<br>Generator<br>Protection        | TRUE when the 47 element is tripped.                                                                                      | Status Input<br>47TRIP                    |
| Status Input<br>Generator<br>Protection        | TRUE when the 51-1 element is tripped.                                                                                    | Status Input<br>51-1TRIP                  |

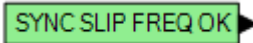
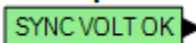
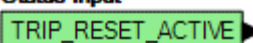
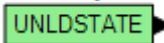
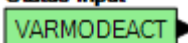
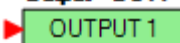
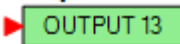
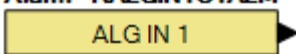
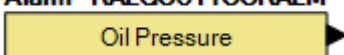
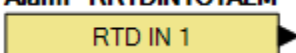
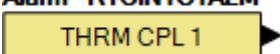
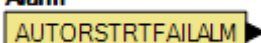
| Name                                     | Description                                                                           | Symbol                                                                                                                  |
|------------------------------------------|---------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| Status Input<br>Generator Protection     | TRUE when the 51-2 element is tripped.                                                | Status Input<br>51-2TRIP             |
| Status Input<br>Generator Protection     | TRUE when the 51-3 element is tripped.                                                | Status Input<br>51-3TRIP             |
| Status Input<br>Generator Protection     | TRUE when the 78 element is tripped.                                                  | Status Input<br>78TRIP               |
| Status Input<br>Generator Protection     | TRUE when the 81 ROCOF element is tripped.                                            | Status Input<br>81ROCOFTRIP          |
| Status Input<br>Generator Protection     | TRUE when the 81 Over element is tripped.                                             | Status Input<br>81OTRIP              |
| Status Input<br>Generator Protection     | TRUE when the 81 Under element is tripped.                                            | Status Input<br>81UTRIP              |
| Status Input<br>Generator Stable         | TRUE when the Gen Stable condition settings have been exceeded.                       | Status Input<br>GENSTABLE            |
| Status Input<br>Generator Test Loaded    | TRUE when the Exercise Timer has started the generator and run with load is selected. | Status Input<br>GENTESTLOADED        |
| Status Input<br>Generator Test           | TRUE when the Exercise Timer has started the generator.                               | Status Input<br>GENTEST            |
| Status Input<br>Global Low Coolant Level | TRUE when the Low Coolant Level input is TRUE.                                        | Status Input<br>GLBLOWCOOLLVL      |
| Status Input<br>Ground Delta Override    | TRUE when the Grounded Delta Override input is TRUE.                                  | Status Input<br>GNDDLTAAORIDE      |
| Status Input<br>Idle Request             | TRUE when the Idle Request logic element is TRUE.                                     | Status Input<br>IDLEREQUESTIN      |
| Status Input<br>In Alarm State           | TRUE when the DGC-2020 is in the alarm state.                                         | Status Input<br>INALARMSTATE       |
| Status Input<br>In Connecting State      | TRUE when the DGC-2020 is in the connecting state.                                    | Status Input<br>INCONNECTINGSTATE  |
| Status Input<br>In Cooling State         | TRUE when the DGC-2020 is in the cooling state.                                       | Status Input<br>INCOOLINGSTATE     |
| Status Input<br>In Cranking State        | TRUE when the DGC-2020 is in the cranking state.                                      | Status Input<br>INCRANKINGSTATE    |
| Status Input<br>In Disconnect State      | TRUE when the DGC-2020 is in the disconnect state.                                    | Status Input<br>INDISCONNECTSTATE  |

| Name                                                | Description                                                                                                                                                                                                                                         | Symbol                                                                                                                   |
|-----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| Status Input<br>In Prestart State                   | TRUE when the DGC-2020 is in the pre-start state.                                                                                                                                                                                                   | Status Input<br>INPRESTARTSTATE       |
| Status Input<br>In Pulsing State                    | TRUE when the DGC-2020 is in the pulsing state.                                                                                                                                                                                                     | Status Input<br>INPULSINGSTATE        |
| Status Input<br>In Ready State                      | TRUE when the DGC-2020 is in the ready state.                                                                                                                                                                                                       | Status Input<br>INREADYSTATE          |
| Status Input<br>In Resting State                    | TRUE when the DGC-2020 is in the resting state.                                                                                                                                                                                                     | Status Input<br>INRESTINGSTATE        |
| Status Input<br>In Running State                    | TRUE when the DGC-2020 is in the running state.                                                                                                                                                                                                     | Status Input<br>INRUNNINGSTATE        |
| Status Input<br>Lamp Test                           | TRUE when the Lamp Test logic element is TRUE or the Lamp Test button is pressed on the front panel.                                                                                                                                                | Status Input<br>LAMPTESTIN            |
| Status Input<br>Load Share Module                   | Load Share Module AVR Output Limit. TRUE when the LSM-2020 AVR Output Limit settings have been exceeded.                                                                                                                                            | Status Input<br>LSMAVROUTLMT          |
| Status Input<br>Load Share Module                   | Load Share Module Connected. TRUE when an optional LSM-2020 is connected to the DGC-2020.                                                                                                                                                           | Status Input<br>LSMCONNECTED          |
| Status Input<br>Load Share Module                   | Load Share Module Governor Output Limit. TRUE when the LSM-2020 Governor Output Limit settings have been exceeded.                                                                                                                                  | Status Input<br>LSMGOVOUTLMT          |
| Status Input<br>Load Take Over                      | TRUE when the Load Take Over logic element is TRUE.                                                                                                                                                                                                 | Status Input<br>LOADTAKEOVERIN       |
| Status Input<br>Low Line Override                   | TRUE when the Low Line Override input is TRUE.                                                                                                                                                                                                      | Status Input<br>LOWLINEORIDE        |
| Status Input<br>Mains Breaker Status                | TRUE when the mains breaker is closed.                                                                                                                                                                                                              | Status Input<br>MAINSBRKSTA         |
| Status Input<br>Mains Fail Test                     | TRUE when the Mains Fail Test logic element is TRUE.                                                                                                                                                                                                | Status Input<br>MAINSFAILIN         |
| Status Input<br>Mains Fail Transfer Complete        | TRUE when the DGC-2020 is configured for mains fail transfers and has successfully transferred to the generator from the utility. It remains TRUE until the utility power is deemed good and the DGC-2020 transfers the load back to utility power. | Status Input<br>MAINSFLTRCOMPLETE   |
| Status Input<br>Mains Fail Transfer Disabled        | TRUE when the Mains Fail Transfer Functionality is not enabled or when the DGC-2020 is operating in the Off or Run modes or in the alarm state.                                                                                                     | Status Input<br>MFXFRDISABLED       |
| Status Input<br>Mains Fail Transfer Power from Gens | TRUE when mains fail transfer function detects the load is powered from the generator bus.                                                                                                                                                          | Status Input<br>MFXFRPOWERFROMGENS  |

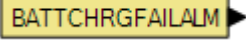
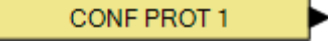
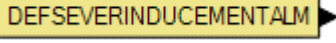
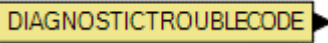
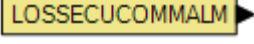
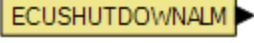
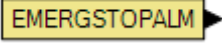
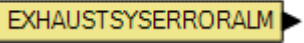
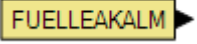
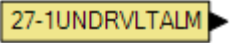
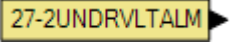
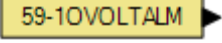
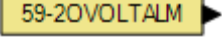
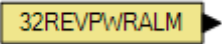
| Name                                                               | Description                                                                                                                                            | Symbol                                                                                                                       |
|--------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| Status Input<br>Mains Fail<br>Transfer<br>Power from<br>Mains      | TRUE when mains fail transfer function detects the load is powered from the mains bus.                                                                 | Status Input<br>MFXFRPOWERFROMMAINS       |
| Status Input<br>Mains Fail<br>Transfer<br>Return Timer<br>Active   | TRUE when mains fail transfer return delay timer is actively counting.                                                                                 | Status Input<br>MFXFRRETURNTIMERACTIVE    |
| Status Input<br>Mains Fail<br>Transfer<br>Transfer Timer<br>Active | TRUE when the mains fail transfer delay timer is actively counting.                                                                                    | Status Input<br>MFXFRTRANSFERTIMERACTIVE  |
| Status Input<br>Mains Fail<br>Transfer<br>Transferring to<br>Gens  | TRUE when mains fail transfer is transferring load to the generator bus.                                                                               | Status Input<br>MFXFRTRANSFERRINGTOGENS   |
| Status Input<br>Mains Fail<br>Transfer<br>Transferring to<br>Mains | TRUE when mains fail transfer is transferring load to the mains bus.                                                                                   | Status Input<br>MFXFRTRANSFERRINGTOMAINS  |
| Status Input<br>Off Mode                                           | TRUE when the DGC-2020 is in Off Mode or the Off Mode logic element is TRUE.                                                                           | Status Input<br>OFFMODE                 |
| Status Input<br>Off Mode<br>Cooldown                               | TRUE when the DGC-2020 is in Off Mode and cooling down.                                                                                                | Status Input<br>OFFMODECOOL             |
| Status Input<br>Open Transition<br>Delay                           | TRUE when the open transition delay is actively counting.                                                                                              | Status Input<br>OPENTRANSITIONDELAY     |
| Status Input<br>Parallel To Mains                                  | TRUE when the Parallel To Mains logic element is TRUE, indicating that the generator is operating in parallel with the utility.                        | Status Input<br>PARTOMAINS              |
| Status Input<br>PF Mode Active                                     | TRUE when PF mode is active.                                                                                                                           | Status Input<br>PFMODEACT               |
| Status Input<br>Pre Start<br>Condition in<br>Effect                | TRUE while in the Pre Start state.                                                                                                                     | Status Input<br>PRESTCONDINEFFECT       |
| Status Input<br>Pre Start Input                                    | TRUE when the DGC-2020 is indicating that the Pre Start relay should be closed.                                                                        | Status Input<br>PRESTARTINPUT           |
| Status Input<br>Regen<br>Completed                                 | TRUE for 30 seconds after a Yanmar ECU goes back into passive mode when the status of the DPF Active Regeneration Forced Status is "Regen Successful". | Status Input<br>REGENCOMPLETED          |

| Name                                             | Description                                                                                                                                                                                                                                                                               | Symbol                                                                                               |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| Status Input<br>Regen Confirmation Requested     | TRUE after a manual exhaust regeneration has been requested on a Yanmar ECU. Once in this state, another regen request must be issued to confirm manual regeneration.                                                                                                                     | Status Input<br>   |
| Status Input<br>Regen Interlock from ECU         | TRUE when John Deere proprietary parameters are broadcast over the J1939 CAN Bus.                                                                                                                                                                                                         | Status Input<br>   |
| Status Input<br>Regen Not Completed              | TRUE for 30 seconds after a Yanmar ECU goes back into passive mode when the status of the DPF Active Regeneration Forced Status is "Regen Not Successful".                                                                                                                                | Status Input<br>   |
| Status Input<br>Reset Active                     | TRUE when the Reset logic element is TRUE or when the Reset key on the front panel is pressed.                                                                                                                                                                                            | Status Input<br>   |
| Status Input<br>Restart Delay Active             | TRUE when the restart delay is currently active.                                                                                                                                                                                                                                          | Status Input<br>   |
| Status Input<br>Run Input                        | TRUE when the DGC-2020 is indicating that the Run relay should be closed.                                                                                                                                                                                                                 | Status Input<br>   |
| Status Input<br>Run Mode                         | TRUE when the DGC-2020 is in Run Mode or the Run Mode logic element is TRUE.                                                                                                                                                                                                              | Status Input<br>   |
| Status Input<br>Single Phase AC Sensing Override | TRUE when the Single Phase AC Override input is TRUE.                                                                                                                                                                                                                                     | Status Input<br>  |
| Status Input<br>Single Phase Connection Override | TRUE when the Single Phase Override input is TRUE.                                                                                                                                                                                                                                        | Status Input<br> |
| Status Input<br>Start Input                      | TRUE when the DGC-2020 is indicating that the Start relay should be closed to start the engine.                                                                                                                                                                                           | Status Input<br> |
| Status Input<br>Switch not in Auto               | TRUE when the DGC-2020 is not in Auto Mode.                                                                                                                                                                                                                                               | Status Input<br> |
| Status Input<br>Sync Active                      | TRUE when the auto synchronizer is active to align the generator input and bus input voltages and phases.                                                                                                                                                                                 | Status Input<br> |
| Status Input<br>Sync Breaker Close OK            | TRUE when the auto synchronizer is running and determines that the voltage difference between bus and generator voltages, slip frequency, and phase angle are within specified limits so that it is okay to issue a breaker close command.                                                | Status Input<br> |
| Status Input<br>Sync Phase Angle OK              | TRUE when the auto synchronizer is running and the phase angle between the bus voltage input and the generator voltage input are within the limits indicated by the phase angle setting for phase lock synchronization, or the calculated advance angle for anticipatory synchronization. | Status Input<br> |

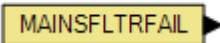
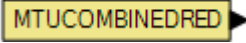
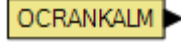
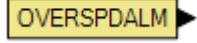
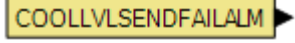
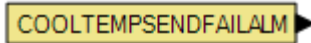
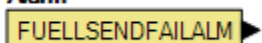
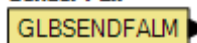
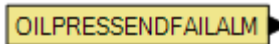
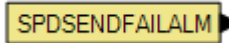
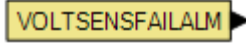
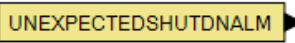
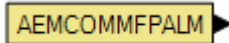


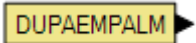
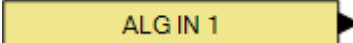
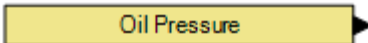
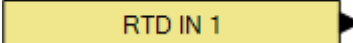
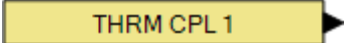
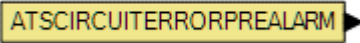
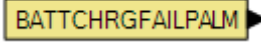
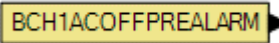
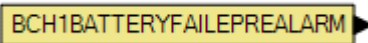
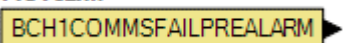
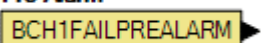
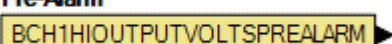
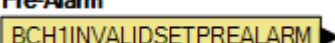
| Name                                                                   | Description                                                                                                                                                                                                | Symbol                                                                                                                |
|------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| <i>Status Input</i><br>Sync Slip<br>Frequency OK                       | TRUE when the auto synchronizer is running and the slip frequency between the bus voltage input and the generator voltage input are within the limits indicated by the slip frequency setting.             | <b>Status Input</b><br>             |
| <i>Status Input</i><br>Sync Voltage OK                                 | TRUE when the auto synchronizer is running and the voltage difference between the bus voltage input and the generator voltage input are within the limits indicated by the voltage window setting.         | <b>Status Input</b><br>             |
| <i>Status Input</i><br>Trip Reset Active                               | TRUE when a trip reset has been initiated from BESTCOMSPi.us, BESTlogicPi.us, or the front panel.                                                                                                          | <b>Status Input</b><br>             |
| <i>Status Input</i><br>Unloading State                                 | TRUE when the DGC-2020 is operating in parallel with other generators or is in parallel to the utility and the DGC-2020 is reducing the kW output of the generator prior to opening the generator breaker. | <b>Status Input</b><br>             |
| <i>Status Input</i><br>var Mode Active                                 | TRUE when var mode is active.                                                                                                                                                                              | <b>Status Input</b><br>             |
| <b>Output Objects</b>                                                  |                                                                                                                                                                                                            |                                                                                                                       |
| <i>Physical Outputs</i><br>OUT1 - OUTx                                 | Physical Outputs 1 through 7 (style xxAxxxxxx) or 1 through 15 (style xxBxxxxxx).                                                                                                                          | <b>Output - OUT1</b><br>            |
| <i>Remote Outputs</i><br>OUT13 - OUT36                                 | Remote Outputs 13 through 36.<br>(Available when an optional CEM-2020 is connected.)                                                                                                                       | <b>Output - OUT13</b><br>         |
| <b>Alarms</b>                                                          |                                                                                                                                                                                                            |                                                                                                                       |
| <i>Analog Expansion Module</i><br>Remote Analog<br>Inputs 1-8          | TRUE when Over 1, Over 2, Under 1, Under 2, or Out of Range is configured as an alarm and the threshold has been exceeded. (Over 1 shown.)                                                                 | <b>Alarm - RALGIN101ALM</b><br>   |
| <i>Analog Expansion Module</i><br>Remote Analog<br>Outputs 1-4         | TRUE when the analog output connection is open and the Out of Range Alarm Configuration is set to Alarm.                                                                                                   | <b>Alarm - RALGOUT10ORALM</b><br> |
| <i>Analog Expansion Module</i><br>Remote RTD<br>Inputs 1-8             | TRUE when Over 1, Over 2, Under 1, Under 2, or Out of Range is configured as an alarm and the threshold has been exceeded. (Over 1 shown.)                                                                 | <b>Alarm - RRTDIN101ALM</b><br>   |
| <i>Analog Expansion Module</i><br>Remote<br>Thermocouple<br>Inputs 1-2 | TRUE when Over 1, Over 2, Under 1, Under 2, or Out of Range is configured as an alarm and the threshold has been exceeded. (Over 1 shown.)                                                                 | <b>Alarm - RTCIN101ALM</b><br>    |
| Auto Restart Fail                                                      | TRUE after the Automatic Restart function fails to restart the generator.                                                                                                                                  | <b>Alarm</b><br>                  |

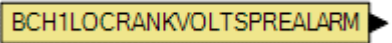
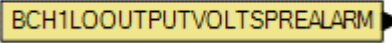
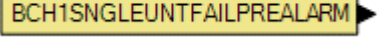
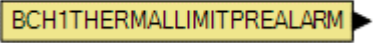
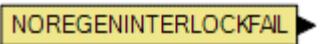
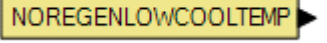
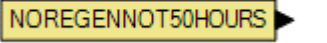
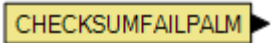
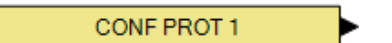
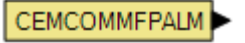
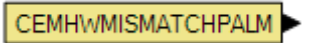
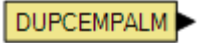
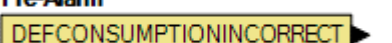


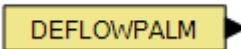
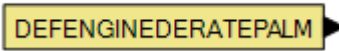
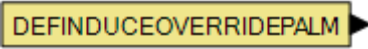
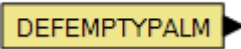
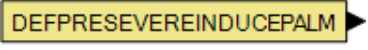
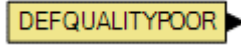
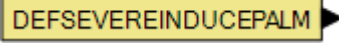
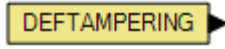
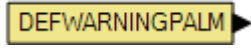
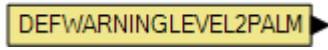
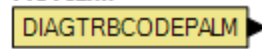
| Name                                             | Description                                                                                                                                                                                                                                                                                                                                                                                                    | Symbol                                                                                                              |
|--------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| Battery Charger Fail                             | TRUE when the Battery Charger Fail function is configured as an alarm and the activation delay has expired.                                                                                                                                                                                                                                                                                                    | <b>Alarm</b><br>                  |
| <i>Configurable Protection</i><br>Protection 1-8 | TRUE when Over 1, Over 2, Under 1, or Under 2 is configured as an alarm and the threshold has been exceeded. (Over 1 shown.)                                                                                                                                                                                                                                                                                   | <b>Alarm - CONFPROT101ALM</b><br> |
| DEF Severe Inducement                            | This alarm indicates the highest level of inducement not to operate the engine due to low or poor quality Diesel Exhaust Fluid (DEF), or a malfunction in the Exhaust After Treatment System (EATS). The engine may operate in a reduced power mode, or for a limited time, or may be prevented from starting by the ECU until the problem is corrected. A service tool may be required to restart the engine. | <b>Alarm</b><br>                  |
| Diagnostic Trouble Code                          | TRUE when a Diagnostic Trouble Code exists.                                                                                                                                                                                                                                                                                                                                                                    | <b>Alarm</b><br>                  |
| ECU Comm Loss                                    | TRUE when communication to ECU has been lost.                                                                                                                                                                                                                                                                                                                                                                  | <b>Alarm</b><br>                  |
| ECU Shutdown                                     | TRUE when ECU has shut down the engine.                                                                                                                                                                                                                                                                                                                                                                        | <b>Alarm</b><br>                  |
| Emergency Stop                                   | TRUE when the Emergency Stop button has been pressed.                                                                                                                                                                                                                                                                                                                                                          | <b>Alarm</b><br>                |
| Exhaust System Error                             | This alarm annunciates when the DEF Inducement Level is greater than or equal to 3, the Isuzu Exhaust System lamp is on, and the Isuzu No Power lamp is on. The Exhaust System Error alarm appears in conjunction with a DEF Severe Inducement alarm to indicate why the machine has entered the severe inducement state due to SCR system malfunction.                                                        | <b>Alarm</b><br>                |
| Fuel Leak                                        | TRUE when the Fuel Leak Detect function is configured as an alarm and the activation delay has expired.                                                                                                                                                                                                                                                                                                        | <b>Alarm</b><br>                |
| <i>Generator Protection</i><br>27-1              | TRUE when the 27-1 element is configured as an alarm and has tripped.                                                                                                                                                                                                                                                                                                                                          | <b>Alarm</b><br>                |
| <i>Generator Protection</i><br>27-2              | TRUE when the 27-2 element is configured as an alarm and has tripped.                                                                                                                                                                                                                                                                                                                                          | <b>Alarm</b><br>                |
| <i>Generator Protection</i><br>59-1              | TRUE when the 59-1 element is configured as an alarm and has tripped.                                                                                                                                                                                                                                                                                                                                          | <b>Alarm</b><br>                |
| <i>Generator Protection</i><br>59-2              | TRUE when the 59-2 element is configured as an alarm and has tripped.                                                                                                                                                                                                                                                                                                                                          | <b>Alarm</b><br>                |
| <i>Generator Protection</i><br>32                | TRUE when the 32 element is configured as an alarm and has tripped.                                                                                                                                                                                                                                                                                                                                            | <b>Alarm</b><br>                |

| Name                          | Description                                                                                                                                                                                                     | Symbol                                                                                                              |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| Generator Protection 40       | TRUE when the 40 element is configured as an alarm and has tripped.                                                                                                                                             | Alarm<br>40LOSSEXCALM            |
| Generator Protection 47       | TRUE when the 47 element is configured as an alarm and has tripped.                                                                                                                                             | Alarm<br>47PH_IMBLALM            |
| Generator Protection 51-1     | TRUE when the 51-1 element is configured as an alarm and has tripped.                                                                                                                                           | Alarm<br>51-1OCURRALM            |
| Generator Protection 51-2     | TRUE when the 51-2 element is configured as an alarm and has tripped.                                                                                                                                           | Alarm<br>51-2OCURRALM            |
| Generator Protection 51-3     | TRUE when the 51-3 element is configured as an alarm and has tripped.                                                                                                                                           | Alarm<br>51-3OCURRALM            |
| Generator Protection 78       | TRUE when the 78 element is configured as an alarm and has tripped.                                                                                                                                             | Alarm<br>78VECSHFTALM            |
| Generator Protection 81 ROCOF | TRUE when the 81 ROCOF element is configured as an alarm and has tripped.                                                                                                                                       | Alarm<br>81ROCOFALM              |
| Generator Protection 81 Over  | TRUE when the 81 Over element is configured as an alarm and has tripped.                                                                                                                                        | Alarm<br>81OFRQALM              |
| Generator Protection 81 Under | TRUE when the 81 Under element is configured as an alarm and has tripped.                                                                                                                                       | Alarm<br>81UFRQALM             |
| Global Alarm                  | TRUE when one or more alarms are set.                                                                                                                                                                           | Alarm<br>GLBALM                |
| Hi Coolant Temp               | TRUE when the High Coolant Temp Alarm settings have been exceeded.                                                                                                                                              | Alarm<br>HITEMPALM             |
| Isuzu DEF Low Refill DEF      | TRUE when an Isuzu engine ECU has detected low DEF level and indicated the DEF symbol should be displayed, and the Isuzu No Power Lamp is active indicating that the engine has been shut down.                 | Alarm<br>ISUZUDEFLOWREFILLALM  |
| Low Coolant Level             | TRUE when the Low Coolant Level function is configured as an alarm and the activation delay has expired. In addition, TRUE when CAN Bus is enabled and the Low Coolant Level Alarm threshold has been exceeded. | Alarm<br>LOWCOOLLVLALM         |
| Low Fuel Level                | TRUE when the Low Fuel Level Alarm settings have been exceeded.                                                                                                                                                 | Alarm<br>LOWFUELLALM           |
| Low Oil Pressure              | TRUE when the Low Oil Pressure Alarm settings have been exceeded.                                                                                                                                               | Alarm<br>LOWOILPRALM           |

| Name                                                                | Description                                                                                                                                                                                                                                                                                                                                     | Symbol                                                                                                     |
|---------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| Mains Fail Transfer Failed                                          | TRUE when a mains fail transfer fail alarm occurs. The alarm occurs when the DGC-2020 is configured for mains fail transfers, but has not transferred to the generator from the utility before the Mains Fail Max Transfer Time has expired. It remains TRUE until the alarm is cleared by pressing the <i>Reset</i> button on the front panel. | <b>Alarm</b><br>         |
| <i>mtu</i> Combined Red                                             | This is an indication from the <i>mtu</i> Engine ECU that a Red Alarm has occurred. If any Red Alarm occurs, a Combined Red Alarm occurs.                                                                                                                                                                                                       | <b>Alarm</b><br>         |
| Overcrank                                                           | TRUE when an Overcrank condition exists.                                                                                                                                                                                                                                                                                                        | <b>Alarm</b><br>         |
| Overspeed                                                           | TRUE when the Overspeed Alarm settings have been exceeded.                                                                                                                                                                                                                                                                                      | <b>Alarm</b><br>         |
| <i>Sender Fail</i> Coolant Level Sender Fail                        | TRUE when a low coolant level error status code is received from the ECU. CAN Bus must be enabled.                                                                                                                                                                                                                                              | <b>Alarm</b><br>         |
| <i>Sender Fail</i> Coolant Temp Sender Fail                         | TRUE when the Coolant Temp Sender Fail is configured as an alarm and the activation delay has expired.                                                                                                                                                                                                                                          | <b>Alarm</b><br>         |
| <i>Sender Fail</i> Fuel Level Sender Fail                           | TRUE when the Fuel Level Sender Fail is configured as an alarm and the activation delay has expired.                                                                                                                                                                                                                                            | <b>Alarm</b><br>        |
| <i>Sender Fail</i> Global Sender Fail                               | TRUE when one or more of the Sender Fails are configured as alarms and are TRUE.                                                                                                                                                                                                                                                                | <b>Sender Fail</b><br> |
| <i>Sender Fail</i> Oil Pressure Sender Fail                         | TRUE when the Oil Pressure Sender Fail is configured as an alarm and the activation delay has expired.                                                                                                                                                                                                                                          | <b>Alarm</b><br>       |
| <i>Sender Fail</i> Speed Sender Fail                                | TRUE when the Speed Sender Fail activation delay has expired.                                                                                                                                                                                                                                                                                   | <b>Alarm</b><br>       |
| <i>Sender Fail</i> Voltage Sensing Fail                             | TRUE when the Voltage Sensing Fail is configured as an alarm and the activation delay has expired.                                                                                                                                                                                                                                              | <b>Alarm</b><br>       |
| Unexpected Shutdown                                                 | TRUE when the metered engine speed (RPM) unexpectedly drops to 0 while the engine is running.                                                                                                                                                                                                                                                   | <b>Alarm</b><br>       |
| <b>Pre-Alarms</b>                                                   |                                                                                                                                                                                                                                                                                                                                                 |                                                                                                            |
| <i>Analog Expansion Module</i><br>Analog Expansion Module Comm Fail | TRUE when communication from the AEM-2020 to the DGC-2020 has been lost.                                                                                                                                                                                                                                                                        | <b>Pre-Alarm</b><br>   |

| Name                                                                         | Description                                                                                                                                                              | Symbol                                                                                                                   |
|------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| <i>Analog Expansion Module</i><br>Multiple Analog Expansion Modules Detected | TRUE when more than one AEM-2020 is connected.                                                                                                                           | <b>Pre-Alarm</b><br>                   |
| <i>Analog Expansion Module</i><br>Remote Analog Inputs 1-8                   | TRUE when Over 1, Over 2, Under 1, Under 2, or Out of Range is configured as a pre-alarm and the threshold has been exceeded. (Over 1 shown.)                            | <b>Pre-Alarm - RALGIN101PALM</b><br>   |
| <i>Analog Expansion Module</i><br>Remote Analog Outputs 1-4                  | TRUE when the analog output connection is open and the Out of Range Alarm Configuration is set to pre-alarm.                                                             | <b>Pre-Alarm - RALGOUT10ORPALM</b><br> |
| <i>Analog Expansion Module</i><br>Remote RTD Inputs 1-8                      | TRUE when Over 1, Over 2, Under 1, Under 2, or Out of Range is configured as a pre-alarm and the threshold has been exceeded. (Over 1 shown.)                            | <b>Pre-Alarm - RRTDIN101PALM</b><br>   |
| <i>Analog Expansion Module</i><br>Remote Thermocouple Inputs 1-2             | TRUE when Over 1, Over 2, Under 1, or Under 2 is configured as a pre-alarm and the threshold has been exceeded. (Over 1 shown.)                                          | <b>Pre-Alarm - RTCIN101PALM</b><br>    |
| ATS Circuit Error                                                            | TRUE when the input mapped to the ATS N.O. input and the input mapped to the ATS N.C. input are not opposite for a time longer than the ATS Circuit Error Delay setting. | <b>Pre-Alarm</b><br>                 |
| Battery Charger Fail                                                         | TRUE when the Battery Charger Fail function is configured as a pre-alarm and the activation delay has expired.                                                           | <b>Pre-Alarm</b><br>                 |
| <i>Battery Charger</i><br>AC Off                                             | TRUE when the ac power to the battery charger is off. (Battery Charger 1 shown.)                                                                                         | <b>Pre-Alarm</b><br>                 |
| <i>Battery Charger</i><br>Battery Failure                                    | TRUE when the battery charger has detected that the battery has failed. (Battery Charger 1 shown.)                                                                       | <b>Pre-Alarm</b><br>                 |
| <i>Battery Charger</i><br>Comms Fail                                         | TRUE when the battery charger has detected a J1939 communications failure. (Battery Charger 1 shown.)                                                                    | <b>Pre-Alarm</b><br>                 |
| <i>Battery Charger</i><br>Fail                                               | TRUE when the battery charger has failed. (Battery Charger 1 shown.)                                                                                                     | <b>Pre-Alarm</b><br>                 |
| <i>Battery Charger</i><br>High Output Volts                                  | TRUE when the battery charger output voltage is too high. (Battery Charger 1 shown.)                                                                                     | <b>Pre-Alarm</b><br>                 |
| <i>Battery Charger</i><br>Invalid Settings                                   | TRUE when the battery charger has detected invalid settings. (Battery Charger 1 shown.)                                                                                  | <b>Pre-Alarm</b><br>                 |

| Name                                                                            | Description                                                                                                                                                                    | Symbol                                                                                                                     |
|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| <i>Battery Charger</i><br>Low Cranking Volts                                    | TRUE when the battery charger has detected that the voltage while the engine is cranking has dipped too low. (Battery Charger 1 shown.)                                        | <b>Pre-Alarm</b><br>                     |
| <i>Battery Charger</i><br>Low Output Volts                                      | TRUE when the battery charger output voltage is too low. (Battery Charger 1 shown.)                                                                                            | <b>Pre-Alarm</b><br>                     |
| <i>Battery Charger</i><br>Single Unit Fail                                      | TRUE when the battery charger has detected one or more charging output stages in a charger with multiple charging output stages has failed. (Battery Charger 1 shown.)         | <b>Pre-Alarm</b><br>                     |
| <i>Battery Charger</i><br>Thermal Limit                                         | TRUE when the battery charger temperature is beyond the thermal limit. (Battery Charger 1 shown.)                                                                              | <b>Pre-Alarm</b><br>                     |
| Cannot Regen - Interlock Fail                                                   | TRUE when the regeneration interlock has failed on a Yanmar ECU. Manual regeneration is blocked.                                                                               | <b>Pre-Alarm</b><br>                     |
| Cannot Regen - Low Coolant Temp                                                 | TRUE when the coolant temp is low on a Yanmar ECU. Manual regeneration is blocked.                                                                                             | <b>Pre-Alarm</b><br>                     |
| Cannot Regen - Not 50 Hours Since Last Regen                                    | TRUE when 50 hours has not elapsed since last regeneration on a Yanmar ECU. Manual regeneration is blocked.                                                                    | <b>Pre-Alarm</b><br>                     |
| Checksum Failure                                                                | TRUE when some of the user settings or firmware code has been corrupted. Refer to Section 4, <i>BESTCOMSPi+® Software, Alarm Configuration, Pre-Alarms</i> , for more details. | <b>Pre-Alarm</b><br>                    |
| <i>Configurable Protection</i><br>Protection 1-8                                | TRUE when Over 1, Over 2, Under 1, or Under 2 is configured as a pre-alarm and the threshold has been exceeded. (Over 1 shown.)                                                | <b>Pre-Alarm - CONFPROT101PALM</b><br> |
| <i>Contact Expansion Module</i><br>Contact Expansion Module Comm Fail           | TRUE when communication from the CEM-2020 to the DGC-2020 has been lost.                                                                                                       | <b>Pre-Alarm</b><br>                   |
| <i>Contact Expansion Module</i><br>Contact Expansion Modules Hardware Mismatch  | TRUE when the connected CEM-2020 does not have the same number of outputs as defined on the <i>System Parameters, Remote Module Setup</i> screen in <i>BESTCOMSPi+®</i> .      | <b>Pre-Alarm</b><br>                   |
| <i>Contact Expansion Module</i><br>Multiple Contact Expansion Modules Connected | TRUE when more than one CEM-2020 is connected.                                                                                                                                 | <b>Pre-Alarm</b><br>                   |
| DEF Consumption Incorrect                                                       | TRUE when the engine ECU reports via CAN Bus that DEF Consumption is incorrect.                                                                                                | <b>Pre-Alarm</b><br>                   |

| Name                      | Description                                                                                                                                                                                                                                                                                                                                                                                                        | Symbol                                                                                                   |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| DEF Fluid Low             | TRUE when the engine ECU reports via CAN Bus that the Diesel Exhaust Fluid (DEF) is at a level between 8 and 23%.                                                                                                                                                                                                                                                                                                  | <b>Pre-Alarm</b><br>   |
| DEF Inducement            | This is the lowest level of inducement not to operate the engine when Diesel Exhaust Fluid (DEF) is low or of poor quality or there is a problem with the Exhaust After Treatment System (EATS). The engine is operating in a reduced power mode. Eventually the level of inducement will be increased unless the problem with the DEF or malfunction in the EATS is corrected.                                    | <b>Pre-Alarm</b><br>   |
| DEF Inducement Override   | This pre-alarm indicates a temporary override of inducement not to operation the engine. This is set by the ECU and is not a user setting.                                                                                                                                                                                                                                                                         | <b>Pre-Alarm</b><br>   |
| DEF Low Severe            | TRUE when the engine ECU reports via CAN bus that Diesel Exhaust Fluid (DEF) is at a level below 8%.                                                                                                                                                                                                                                                                                                               | <b>Pre-Alarm</b><br>   |
| DEF Pre-severe Inducement | This pre-alarm indicates a high level of inducement not to operate the engine due to low or poor quality Diesel Exhaust Fluid (DEF), or a malfunction in the Exhaust After Treatment System (EATS). The engine may operate in a reduced power mode, or for a limited time, after which it will enter a state of severe inducement unless the problem with the DEF or malfunction in the EATS is corrected.         | <b>Pre-Alarm</b><br>   |
| DEF Quality Poor          | TRUE when the engine ECU reports "DEF Quality Poor" via CAN Bus.                                                                                                                                                                                                                                                                                                                                                   | <b>Pre-Alarm</b><br> |
| DEF Severe Inducement     | This pre-alarm indicates the highest level of inducement not to operate the engine due to low or poor quality Diesel Exhaust Fluid (DEF), or a malfunction in the Exhaust After Treatment System (EATS). The engine may operate in a reduced power mode, or for a limited time, or may be prevented from starting by the ECU until the problem is corrected. A service tool may be required to restart the engine. | <b>Pre-Alarm</b><br> |
| DEF Tampering             | TRUE when the engine ECU reports "DEF Tampering" via CAN Bus.                                                                                                                                                                                                                                                                                                                                                      | <b>Pre-Alarm</b><br> |
| DEF Warning               | This pre-alarm indicates the first level of warning when EATS is not functioning properly or DEF quality or level is not sufficient for proper operation.                                                                                                                                                                                                                                                          | <b>Pre-Alarm</b><br> |
| DEF Warning Level 2       | This pre-alarm indicates the second level of warning when EATS is not functioning properly or DEF quality or level is not sufficient for proper operation.                                                                                                                                                                                                                                                         | <b>Pre-Alarm</b><br> |
| Diag Trouble Code         | TRUE when a Diagnostic Trouble Code exists and the Active DTC pre-alarm is enabled.                                                                                                                                                                                                                                                                                                                                | <b>Pre-Alarm</b><br> |

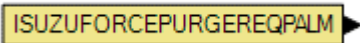
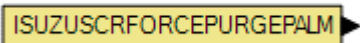
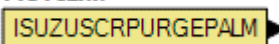
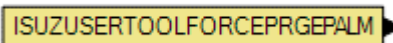
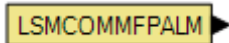
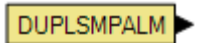
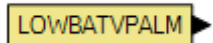
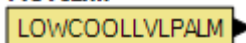
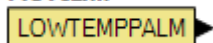
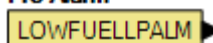
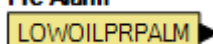
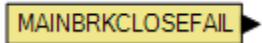


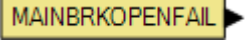
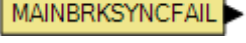
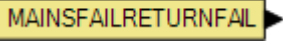
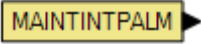
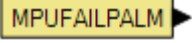
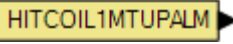
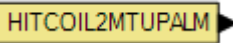
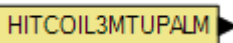
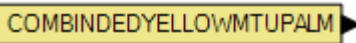
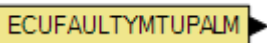
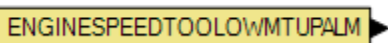
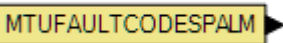
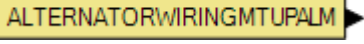
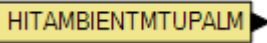
| Name                           | Description                                                                                                                                                                                                                                                                                                                                                                | Symbol                                                                                                                        |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| DPF Regenerate Disabled        | TRUE when the Diesel Particulate Filter (DPF) lamp status broadcast over CAN bus indicates that DPF regeneration is inhibited.                                                                                                                                                                                                                                             | <b>Pre-Alarm</b><br>DPFREGENDISABLPALM     |
| DPF Regenerate Required        | TRUE when the Diesel Particulate Filter (DPF) lamp status broadcast over CAN bus indicates that DPF regeneration is required.                                                                                                                                                                                                                                              | <b>Pre-Alarm</b><br>DPFREGENREQPALM        |
| DPF Soot Level High            | TRUE when the engine ECU reports via CAN bus that Diesel Particulate Filter (DPF) soot level is high.                                                                                                                                                                                                                                                                      | <b>Pre-Alarm</b><br>DPFSOOTHIPALM          |
| DPF Soot Level Moderately High | TRUE when Diesel Particulate Filter (DPF) lamp status (yellow warning) broadcast over CAN bus indicates that the soot level is moderately high.                                                                                                                                                                                                                            | <b>Pre-Alarm</b><br>DPFSOOTMODHIPALM       |
| DPF Soot Level Severely High   | TRUE when Diesel Particulate Filter (DPF) lamp status (red warning) broadcast over CAN bus indicates that the soot level is severely high.                                                                                                                                                                                                                                 | <b>Pre-Alarm</b><br>DPFSOOTEXTHIPALM       |
| DTC Low Coolant Level          | A DTC Low Coolant Level Pre-Alarm becomes active if a Diagnostic Trouble Code (DTC) with a Suspect Parameter Number (SPN) of 111 and a Failure Mode Identifier (FMI) of 1 is received from the engine ECU. SPN 111 indicates the Engine Coolant Level as the parameter, FMI 1 indicates the failure is: DATA VALID BUT BELOW NORMAL OPERATIONAL RANGE - MOST SEVERE LEVEL. | <b>Pre-Alarm</b><br>DTCLOWCOOLLEV          |
| ECU Comm Loss                  | TRUE when communication to the ECU has been lost.                                                                                                                                                                                                                                                                                                                          | <b>Pre-Alarm</b><br>LOSSECUCOMMPALM      |
| EGR Inducement Level Low       | TRUE when an issue has been detected in the Exhaust Gas Recirculation (EGR) system. This is the second level of inducement to correct the issue. There should also be Diagnostic Trouble Codes providing additional information about the issue.                                                                                                                           | <b>Pre-Alarm</b><br>EGRINDUCEMENTLVLOW   |
| EGR Inducement Severe          | TRUE when an issue has been detected in the Exhaust Gas Recirculation (EGR) system. This is the third level of inducement to correct the issue. If not corrected, engine power derating or shutdown may occur. There should also be Diagnostic Trouble Codes providing additional information about the issue.                                                             | <b>Pre-Alarm</b><br>EGRINDUCEMENTSEVERE  |
| EGR Inducement Warning         | TRUE when an issue has been detected in the Exhaust Gas Recirculation (EGR) system. This is the first level of inducement to correct the issue. There should also be Diagnostic Trouble Codes providing additional information about the issue.                                                                                                                            | <b>Pre-Alarm</b><br>EGRINDUCEMENTWARN    |
| Engine kW Over Load 1          | TRUE when the Engine kW Overload 1 Pre-Alarm settings have been exceeded.                                                                                                                                                                                                                                                                                                  | <b>Pre-Alarm</b><br>ENGKWOVRLD1PALM      |
| Engine kW Over Load 2          | TRUE when the Engine kW Overload 2 Pre-Alarm settings have been exceeded.                                                                                                                                                                                                                                                                                                  | <b>Pre-Alarm</b><br>ENGKWOVRLD2PALM      |

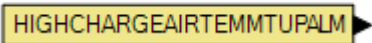
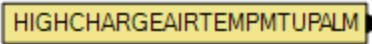
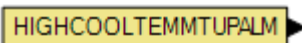
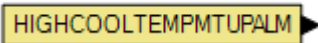
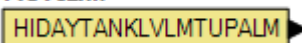
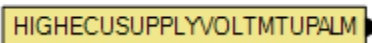
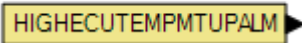
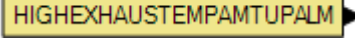
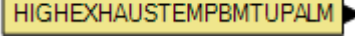
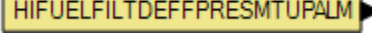
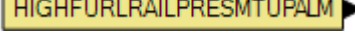
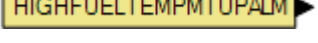
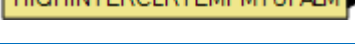
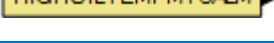
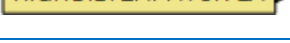
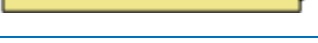
| Name                         | Description                                                                                                                                                                                                                                                                               | Symbol                                                                                                                     |
|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| Engine kW Over Load 3        | TRUE when the Engine kW Overload 3 Pre-Alarm settings have been exceeded.                                                                                                                                                                                                                 | <b>Pre-Alarm</b><br>ENGKWOVRD3PALM      |
| Fuel Filter 1 Leak           | This logic status input indicates that the engine ECU has detected a leak in fuel filter 1, and has communicated this to the DGC-2020 over CAN Bus.                                                                                                                                       | <b>Pre-Alarm</b><br>FUELFILTER1LEAK     |
| Fuel Filter 2 Leak           | This logic status input indicates that the engine ECU has detected a leak in fuel filter 2, and has communicated this to the DGC-2020 over CAN Bus.                                                                                                                                       | <b>Pre-Alarm</b><br>FUELFILTER2LEAK     |
| Fuel Leak                    | TRUE when the Fuel Leak Detect function is configured as a pre-alarm and the activation delay has expired.                                                                                                                                                                                | <b>Pre-Alarm</b><br>FUELLEAKPALM        |
| Generator Breaker Close Fail | TRUE when a generator breaker close fail pre-alarm occurs. The pre-alarm occurs when the DGC-2020 has issued a generator breaker close output but does not receive a generator breaker status input that indicates the breaker has closed before the breaker close wait time has expired. | <b>Pre-Alarm</b><br>GENBRKCLOSEFAIL     |
| Generator Breaker Open Fail  | TRUE when a generator breaker open fail pre-alarm occurs. The pre-alarm occurs when the DGC-2020 has issued a generator breaker open output but does not receive a generator breaker status input that indicates the breaker has opened before the breaker close wait time has expired.   | <b>Pre-Alarm</b><br>GENBRKOPENFAIL      |
| Generator Breaker Sync Fail  | TRUE when a generator breaker sync fail pre-alarm occurs. The pre-alarm occurs when the synchronizer is running and attempting to close the generator breaker but the sync fail activation delay expires prior to achieving breaker closure.                                              | <b>Pre-Alarm</b><br>GENBRKSYNCFAIL    |
| Generator Protection 27-1    | TRUE when the 27-1 element is configured as a pre-alarm and has tripped.                                                                                                                                                                                                                  | <b>Pre-Alarm</b><br>27-1UNDRVLT PALM  |
| Generator Protection 27-2    | TRUE when the 27-2 element is configured as a pre-alarm and has tripped.                                                                                                                                                                                                                  | <b>Pre-Alarm</b><br>27-2UNDRVLT PALM  |
| Generator Protection 59-1    | TRUE when the 59-1 element is configured as a pre-alarm and has tripped.                                                                                                                                                                                                                  | <b>Pre-Alarm</b><br>59-1OVOLTPALM     |
| Generator Protection 59-2    | TRUE when the 59-2 element is configured as a pre-alarm and has tripped.                                                                                                                                                                                                                  | <b>Pre-Alarm</b><br>59-2OVOLTPALM     |
| Generator Protection 32      | TRUE when the 32 element is configured as a pre-alarm and has tripped.                                                                                                                                                                                                                    | <b>Pre-Alarm</b><br>32REVPWRPALM      |
| Generator Protection 40      | TRUE when the 40 element is configured as a pre-alarm and has tripped.                                                                                                                                                                                                                    | <b>Pre-Alarm</b><br>40LOSSEXCPALM     |
| Generator Protection 47      | TRUE when the 47 element is configured as a pre-alarm and has tripped.                                                                                                                                                                                                                    | <b>Pre-Alarm</b><br>47PH_IMBPALM      |

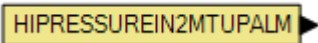
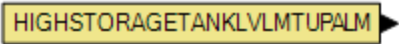
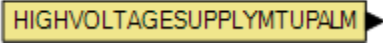
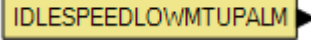
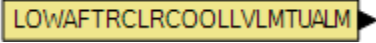
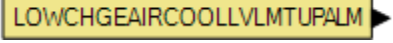
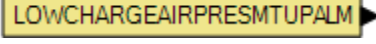
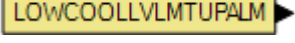
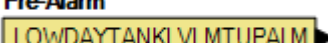
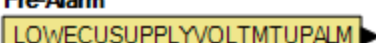
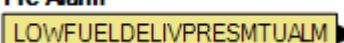
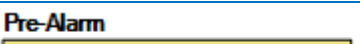


| Name                                   | Description                                                                                                                                                                                                                             | Symbol                                                                                                                           |
|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| Generator Protection 51-1              | TRUE when the 51-1 element is configured as a pre-alarm and has tripped.                                                                                                                                                                | <b>Pre-Alarm</b><br>51-1OCURRPALM             |
| Generator Protection 51-2              | TRUE when the 51-2 element is configured as a pre-alarm and has tripped.                                                                                                                                                                | <b>Pre-Alarm</b><br>51-2OCURRPALM             |
| Generator Protection 51-3              | TRUE when the 51-3 element is configured as a pre-alarm and has tripped.                                                                                                                                                                | <b>Pre-Alarm</b><br>51-3OCURRPALM             |
| Generator Protection 78                | TRUE when the 78 element is configured as a pre-alarm and has tripped.                                                                                                                                                                  | <b>Pre-Alarm</b><br>78VECSHIFTPALM            |
| Generator Protection 81 ROCOF          | TRUE when the 81 ROCOF element is configured as a pre-alarm and has tripped.                                                                                                                                                            | <b>Pre-Alarm</b><br>81ROCOFPALM               |
| Generator Protection 81 Overfrequency  | TRUE when the 81 Over element is configured as a pre-alarm and has tripped.                                                                                                                                                             | <b>Pre-Alarm</b><br>81OFRQPALM                |
| Generator Protection 81 Underfrequency | TRUE when the 81 Under element is configured as a pre-alarm and has tripped.                                                                                                                                                            | <b>Pre-Alarm</b><br>81UFRQPALM                |
| Global Pre-Alarm                       | TRUE when one or more pre-alarms are set.                                                                                                                                                                                               | <b>Pre-Alarm</b><br>GLBPALM                 |
| Heating for Exhaust Regen              | A manual or automatic exhaust regeneration request has occurred, but the exhaust system is not hot enough for regeneration to occur. The ECU feeds fuel into the exhaust stream to increase the temperature to accomplish regeneration. | <b>Pre-Alarm</b><br>HEATINGFOREXHAUSTREGEN  |
| High Battery Voltage                   | TRUE when the High Battery Voltage pre-alarm threshold has been exceeded.                                                                                                                                                               | <b>Pre-Alarm</b><br>BATOVOLTPALM            |
| Hi Coolant Temp                        | TRUE when the High Coolant Temp Pre-Alarm threshold has been exceeded.                                                                                                                                                                  | <b>Pre-Alarm</b><br>HITEMPPALM              |
| High Exhaust Temperature               | TRUE when Diesel Particulate Filter (DPF) lamp status broadcast over CAN Bus indicates high exhaust temperature.                                                                                                                        | <b>Pre-Alarm</b><br>HIGHEXHTEMPPALM         |
| High Fuel Level                        | TRUE when the High Fuel Level Pre-Alarm settings have been exceeded.                                                                                                                                                                    | <b>Pre-Alarm</b><br>HIFUELLPALM             |
| Inter Generator Comm Fail              | TRUE when an individual generator detects that it had been connected to a generator network, but has lost the connection.                                                                                                               | <b>Pre-Alarm</b><br>INTERGENCOMFPALM        |
| Isuzu DEF Low Refill DEF               | TRUE when an Isuzu engine ECU has detected low DEF level and has indicated the DEF symbol should be displayed.                                                                                                                          | <b>Pre-Alarm</b><br>ISUZUDEFLOW/REFILLPALM  |

| Name                                                      | Description                                                                                                                                                                                                                                                                   | Symbol                                                                                                   |
|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| Isuzu Forced Purge Request                                | TRUE when a forced purge has been requested by momentarily pressing the Manual Regeneration button or setting the DPF Regen setting on the front panel, or setting the DPF Manual Regenerate button in BESTCOMSP <sup>lus</sup> .                                             | <b>Pre-Alarm</b><br>   |
| Isuzu SCR Forced Purge                                    | TRUE when a forced purge is in progress after having been requested.                                                                                                                                                                                                          | <b>Pre-Alarm</b><br>   |
| Isuzu SCR Purge                                           | TRUE when a normal SCR Purge is in progress. Normal purges occur during normal operation if the engine load is sufficient to allow purge to occur.                                                                                                                            | <b>Pre-Alarm</b><br>   |
| Isuzu Service Tool Forced Purge Request                   | TRUE when a forced purge has been requested through the Isuzu Service Tool. This will remain TRUE until the forced purge cycle begins.                                                                                                                                        | <b>Pre-Alarm</b><br>   |
| Load Share Module<br>Load Share Module Comm Fail          | TRUE when communication from the LSM-2020 to the DGC-2020 has been lost.                                                                                                                                                                                                      | <b>Pre-Alarm</b><br>   |
| Load Share Module<br>Multiple Load Share Modules Detected | TRUE when more than one LSM-2020 is connected.                                                                                                                                                                                                                                | <b>Pre-Alarm</b><br>   |
| Low Battery Voltage                                       | TRUE when the Low Battery Voltage Pre-Alarm settings have been exceeded.                                                                                                                                                                                                      | <b>Pre-Alarm</b><br> |
| Low Coolant Level                                         | TRUE when the Low Coolant Level function is configured as a pre-alarm and the activation delay has expired. In addition, TRUE when CAN Bus is enabled and the Low Coolant Level Pre-Alarm threshold has been exceeded.                                                        | <b>Pre-Alarm</b><br> |
| Low Coolant Temp                                          | TRUE when the Low Coolant Temp Pre-Alarm threshold has been exceeded.                                                                                                                                                                                                         | <b>Pre-Alarm</b><br> |
| Low Fuel Level                                            | TRUE when the Low Fuel Level Pre-Alarm threshold has been exceeded.                                                                                                                                                                                                           | <b>Pre-Alarm</b><br> |
| Low Oil Pressure                                          | TRUE when the Low Oil Pressure Pre-Alarm threshold has been exceeded.                                                                                                                                                                                                         | <b>Pre-Alarm</b><br> |
| Mains Breaker Close Fail                                  | TRUE when a mains breaker close fail pre-alarm occurs. The pre-alarm occurs when the DGC-2020 has issued a mains breaker close output but does not receive a mains breaker status input that indicates the breaker has closed before the breaker close wait time has expired. | <b>Pre-Alarm</b><br> |

| Name                                                         | Description                                                                                                                                                                                                                                                                               | Symbol                                                                                                   |
|--------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| Mains Breaker Open Fail                                      | TRUE when a mains breaker open fail pre-alarm occurs. The pre-alarm occurs when the DGC-2020 has issued a mains breaker open output but does not receive a mains breaker status input that indicates the breaker has opened before the breaker close wait time has expired.               | <b>Pre-Alarm</b><br>   |
| Mains Breaker Sync Fail                                      | TRUE when a mains breaker sync fail pre-alarm has occurred. The pre-alarm occurs when the synchronizer is running and attempting to close the mains breaker but the sync fail activation delay expires prior to achieving breaker closure.                                                | <b>Pre-Alarm</b><br>   |
| Mains Fail Return Failed                                     | TRUE when a mains fail return fail pre-alarm has occurred. The pre-alarm occurs when the DGC-2020 is attempting to transfer from generator power to mains power after mains returns, but has not returned to the mains from the generator before the Mains Fail Return Delay has expired. | <b>Pre-Alarm</b><br>   |
| Maintenance Interval                                         | TRUE when the Maintenance Interval Pre-Alarm threshold has been exceeded.                                                                                                                                                                                                                 | <b>Pre-Alarm</b><br>   |
| MPU Fail                                                     | TRUE when the MPU has failed.                                                                                                                                                                                                                                                             | <b>Pre-Alarm</b><br>   |
| <i>mtu Pre-Alarms</i><br>Coil 1 High Temperature             | TRUE when a High Coil Temperature 1 Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                                                                                                                                                                                            | <b>Pre-Alarm</b><br> |
| <i>mtu Pre-Alarms</i><br>Coil 2 High Temperature             | TRUE when a High Coil Temperature 2 Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                                                                                                                                                                                            | <b>Pre-Alarm</b><br> |
| <i>mtu Pre-Alarms</i><br>Coil 3 High Temperature             | TRUE when a High Coil Temperature 3 Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                                                                                                                                                                                            | <b>Pre-Alarm</b><br> |
| <i>mtu Pre-Alarms</i><br>Combined Yellow                     | TRUE when a Combined Yellow Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                                                                                                                                                                                                    | <b>Pre-Alarm</b><br> |
| <i>mtu Pre-Alarms</i><br>ECU Faulty                          | TRUE when an ECU Fault Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                                                                                                                                                                                                         | <b>Pre-Alarm</b><br> |
| <i>mtu Pre-Alarms</i><br>Engine Speed Too Low                | TRUE when a Low Engine Speed Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                                                                                                                                                                                                   | <b>Pre-Alarm</b><br> |
| <i>mtu Pre-Alarms</i><br>Fault Codes                         | TRUE whenever the presence of <i>mtu</i> Fault Codes is detected.                                                                                                                                                                                                                         | <b>Pre-Alarm</b><br> |
| <i>mtu Pre-Alarms</i><br>High Alternator Winding Temperature | TRUE when a High Temperature In the Alternator Windings Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                                                                                                                                                                        | <b>Pre-Alarm</b><br> |
| <i>mtu Pre-Alarms</i><br>High Ambient Temperature            | TRUE when a High Ambient Temperature Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                                                                                                                                                                                           | <b>Pre-Alarm</b><br> |

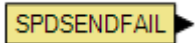
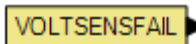
| Name                                                               | Description                                                                                                                  | Symbol                                                                                                   |
|--------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| <i>mtu Pre-Alarms</i><br>High Charge Air Temp <i>mtu</i> Alarm     | TRUE when a High Charge Air Temperature Alarm has been received from an <i>mtu</i> Engine ECU.                               | <b>Pre-Alarm</b><br>   |
| <i>mtu Pre-Alarms</i><br>High Charge Air Temp <i>mtu</i> Pre-Alarm | TRUE when a High Charge Air Temperature Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                           | <b>Pre-Alarm</b><br>   |
| <i>mtu Pre-Alarms</i><br>High Coolant Temp <i>mtu</i> Alarm        | TRUE when a High Coolant Temperature Alarm has been received from an <i>mtu</i> Engine ECU.                                  | <b>Pre-Alarm</b><br>   |
| <i>mtu Pre-Alarms</i><br>High Coolant Temp <i>mtu</i> Pre-Alarm    | TRUE when a High Coolant Temperature Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                              | <b>Pre-Alarm</b><br>   |
| <i>mtu Pre-Alarms</i><br>High Day Tank Level                       | TRUE when a High Fuel Level in the Day Tank Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                       | <b>Pre-Alarm</b><br>   |
| <i>mtu Pre-Alarms</i><br>High ECU Supply Voltage                   | TRUE when a High ECU Supply Voltage Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                               | <b>Pre-Alarm</b><br>   |
| <i>mtu Pre-Alarms</i><br>High ECU Temp                             | TRUE when a High ECU Temperature Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                                  | <b>Pre-Alarm</b><br>   |
| <i>mtu Pre-Alarms</i><br>High Exhaust Temp A                       | TRUE when a High Exhaust Temperature in Exhaust System TRUE when aPre-Alarm has been received from an <i>mtu</i> Engine ECU. | <b>Pre-Alarm</b><br> |
| <i>mtu Pre-Alarms</i><br>High Exhaust Temp B                       | TRUE when a High Exhaust Temperature in Exhaust System B Pre-Alarm has been received from an <i>mtu</i> Engine ECU.          | <b>Pre-Alarm</b><br> |
| <i>mtu Pre-Alarms</i><br>High Fuel Filter Diff Pressure            | TRUE when a High Fuel Filter Differential Pressure Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                | <b>Pre-Alarm</b><br> |
| <i>mtu Pre-Alarms</i><br>High Fuel Rail Pressure                   | TRUE when a High Fuel Rail Pressure Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                               | <b>Pre-Alarm</b><br> |
| <i>mtu Pre-Alarms</i><br>High Fuel Temp                            | TRUE when a High Fuel Temperature Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                                 | <b>Pre-Alarm</b><br> |
| <i>mtu Pre-Alarms</i><br>High Intercooler Temperature              | TRUE when a High Intercooler Temperature Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                          | <b>Pre-Alarm</b><br> |
| <i>mtu Pre-Alarms</i><br>High Oil Temp <i>mtu</i> Alarm            | TRUE when a High Oil Temperature Alarm has been received from an <i>mtu</i> Engine ECU.                                      | <b>Pre-Alarm</b><br> |
| <i>mtu Pre-Alarms</i><br>High Oil Temp <i>mtu</i> Pre-Alarm        | TRUE when a High Oil Temperature Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                                  | <b>Pre-Alarm</b><br> |
| <i>mtu Pre-Alarms</i><br>High Pressure In 1                        | TRUE when a High Pressure Level in Pressure Input 1 Pre-Alarm has been received from an <i>mtu</i> Engine ECU.               | <b>Pre-Alarm</b><br> |

| Name                                                                     | Description                                                                                                    | Symbol                                                                                                   |
|--------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| <i>mtu Pre-Alarms</i><br>High Pressure In 2                              | TRUE when a High Pressure Level in Pressure Input 2 Pre-Alarm has been received from an <i>mtu</i> Engine ECU. | <b>Pre-Alarm</b><br>   |
| <i>mtu Pre-Alarms</i><br>High Storage Tank Level                         | TRUE when a High Fuel Level in the Storage Tank Pre-Alarm has been received from an <i>mtu</i> Engine ECU.     | <b>Pre-Alarm</b><br>   |
| <i>mtu Pre-Alarms</i><br>High Voltage Supply                             | TRUE when a High System Power Supply Voltage Pre-Alarm has been received from an <i>mtu</i> Engine ECU.        | <b>Pre-Alarm</b><br>   |
| <i>mtu Pre-Alarms</i><br>Idle Speed Low                                  | TRUE when a Low Idle Speed Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                          | <b>Pre-Alarm</b><br>   |
| <i>mtu Pre-Alarms</i><br>Low After Cooler Coolant Level                  | TRUE when a Low Aftercooler Coolant level Alarm has been received from an <i>mtu</i> Engine ECU.               | <b>Pre-Alarm</b><br>   |
| <i>mtu Pre-Alarms</i><br>Low Charge Air Coolant Level                    | TRUE when a Low Charge Air Coolant Level Pre-Alarm has been received from an <i>mtu</i> Engine ECU.            | <b>Pre-Alarm</b><br>   |
| <i>mtu Pre-Alarms</i><br>Low Charge Air Pressure                         | TRUE when a Low Charge Air Pressure Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                 | <b>Pre-Alarm</b><br>   |
| <i>mtu Pre-Alarms</i><br>Low Coolant Level <i>mtu</i> Pre-Alarm          | TRUE when a Low Coolant Level Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                       | <b>Pre-Alarm</b><br>   |
| <i>mtu Pre-Alarms</i><br>Low Day Tank Level                              | TRUE when a Low Fuel Level in the Day Tank Pre-Alarm has been received from an <i>mtu</i> Engine ECU.          | <b>Pre-Alarm</b><br> |
| <i>mtu Pre-Alarms</i><br>Low ECU Supply Voltage                          | TRUE when a Low ECU Supply Voltage Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                  | <b>Pre-Alarm</b><br> |
| <i>mtu Pre-Alarms</i><br>Low Fuel Delivery Pressure <i>mtu</i> Alarm     | TRUE when a Low Fuel Delivery Pressure Alarm has been received from an <i>mtu</i> Engine ECU.                  | <b>Pre-Alarm</b><br> |
| <i>mtu Pre-Alarms</i><br>Low Fuel Delivery Pressure <i>mtu</i> Pre-Alarm | TRUE when a Low Fuel Delivery Pressure Pre-Alarm has been received from an <i>mtu</i> Engine ECU.              | <b>Pre-Alarm</b><br> |
| <i>mtu Pre-Alarms</i><br>Low Fuel Rail Pressure                          | TRUE when a Low Fuel Rail Pressure Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                  | <b>Pre-Alarm</b><br> |
| <i>mtu Pre-Alarms</i><br>Low Oil Pressure <i>mtu</i> Alarm               | TRUE when a Low Oil Pressure Alarm has been received from an <i>mtu</i> Engine ECU.                            | <b>Pre-Alarm</b><br> |
| <i>mtu Pre-Alarms</i><br>Low Oil Pressure <i>mtu</i> Pre-Alarm           | TRUE when a Low Oil Pressure Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                        | <b>Pre-Alarm</b><br> |
| <i>mtu Pre-Alarms</i><br>Low Storage Tank Level                          | TRUE when a Low Fuel Level in the Storage Tank Pre-Alarm has been received from an <i>mtu</i> Engine ECU.      | <b>Pre-Alarm</b><br> |

| Name                                           | Description                                                                                                                                                           | Symbol                                                                                                                           |
|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| <i>mtu Pre-Alarms</i><br>Low Voltage Supply    | TRUE when a Low System Power Supply Voltage Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                                                                | <b>Pre-Alarm</b><br>LOWVOLTAGESUPPLYMTUPALM   |
| <i>mtu Pre-Alarms</i><br>Overspeed             | TRUE when an Overspeed Alarm has been received from an <i>mtu</i> Engine ECU.                                                                                         | <b>Pre-Alarm</b><br>OVERSPEEDMTUALM           |
| <i>mtu Pre-Alarms</i><br>Priming Fault         | TRUE when a Fault in the Engine Priming System Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                                                             | <b>Pre-Alarm</b><br>PRIMINGFAULTMTUPALM       |
| <i>mtu Pre-Alarms</i><br>Run-Up Speed Low      | TRUE when a Low Runup Speed Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                                                                                | <b>Pre-Alarm</b><br>RUNUPSPEEDLOWMTUPALM      |
| <i>mtu Pre-Alarms</i><br>Shutdown Override     | TRUE when a Shutdown Override Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                                                                              | <b>Pre-Alarm</b><br>SHUTDOWNNOVERRIDEMTUPALM  |
| <i>mtu Pre-Alarms</i><br>Speed Demand Fail     | TRUE when a Speed Demand Fail Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                                                                              | <b>Pre-Alarm</b><br>SPEEDDEMANFAILMTUPALM     |
| <i>mtu Pre-Alarms</i><br>Start Speed Low       | TRUE when a Low Start Speed Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                                                                                | <b>Pre-Alarm</b><br>STARTSPEEDLOWMTUPALM      |
| <i>mtu Pre-Alarms</i><br>Test Overspeed Active | TRUE when an Overspeed Test Active Pre-Alarm has been received from an <i>mtu</i> Engine ECU.                                                                         | <b>Pre-Alarm</b><br>TESTOVRSPDACTIVEMTUPALM   |
| Network ID Missing Error                       | TRUE if an expected sequence ID of an optional LSM-2020 is not detected on the network. Expected sequence IDs are entered on the <i>Network Configuration</i> screen. | <b>Pre-Alarm</b><br>IDMISSINGPALM           |
| Network ID Repeat Error                        | TRUE if two or more optional LSM-2020's report the same expected sequence ID. Expected sequence IDs are entered on the <i>Network Configuration</i> screen.           | <b>Pre-Alarm</b><br>IDREPEATPALM            |
| Regenerate Active                              | TRUE when an exhaust system regeneration is in progress.                                                                                                              | <b>Pre-Alarm</b><br>EXHREGENACTIVE          |
| <i>Sender Fail</i><br>Coolant Temp Sender Fail | TRUE when the Coolant Temp Sender Fail is configured as a pre-alarm and the activation delay has expired.                                                             | <b>Pre-Alarm</b><br>COOLTEMPSENFFAILPALM    |
| <i>Sender Fail</i><br>Fuel Level Sender Fail   | TRUE when the Fuel Level Sender Fail is configured as a pre-alarm and the activation delay has expired.                                                               | <b>Pre-Alarm</b><br>FUELLESENFFAILPALM      |
| <i>Sender Fail</i><br>Oil Pressure Sender Fail | TRUE when the Oil Pressure Sender Fail is configured as a pre-alarm and the activation delay has expired.                                                             | <b>Pre-Alarm</b><br>OILPRESSENFFAILPALM     |
| <i>Sender Fail</i><br>Voltage Sensing Fail     | TRUE when the Voltage Sensing Fail is configured as a pre-alarm and the activation delay has expired.                                                                 | <b>Pre-Alarm</b><br>VOLTSENSENFFAILPALM     |



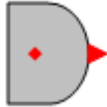
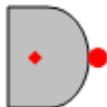
| Name                           | Description                                                                                                                                                                                                                                                                                                                                                                                            | Symbol                                        |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|
| Serial Flash Read Failure      | When the DGC-2020 reads data from the serial flash, the data is read twice and then compared to verify that the data matches. If it does not match, the read cycle is repeated. After the second attempt, if the data does not match, the DGC-2020 annunciates a serial flash read failure pre-alarm. This status input to logic indicates that the DGC-2020 has detected a serial flash read failure. | <b>Pre-Alarm</b><br>SERIALFLASHREADFAIL       |
| Service Tool Forced Regenerate | A manual or forced regeneration is in progress and was initiated from a manufacturer's service tool. This indication is received from the engine ECU over J1939 CAN Bus as SPN 4175 Diesel Particulate Filter Active Regeneration Forced Status or SPN 6934 SCR System Cleaning Forced Status. When the value is 2, a Service Tool Forced Regenerate pre-alarm is annunciated.                         | <b>Pre-Alarm</b><br>EXHREGENFORCEDSERVICETOOL |
| Switch Forced Regenerate       | A manual or forced regeneration is in progress and was initiated from a manual regeneration switch. This indication is received from the engine ECU over J1939 CAN Bus as SPN 4175 Diesel Particulate Filter Active Regeneration Forced Status or SPN 6934 SCR System Cleaning Forced Status. When the value is 1, a Switch Forced Regenerate pre-alarm is annunciated.                                | <b>Pre-Alarm</b><br>EXHREGENFORCEDSWITCH      |
| Torque Limit                   | TRUE while the engine is running in a reduced torque mode due to exhaust system issues such as Low DEF, Purge Required, Exhaust System Error, etc. This reflects the status of the exhaust system Torque Limit lamp, which is communicated from the Engine ECU to the DGC-2020 via J1939 CAN Bus communications.                                                                                       | <b>Pre-Alarm</b><br>TORQUELIMIT               |
| Torque Limit Severe            | TRUE while the engine is running in a severely reduced torque mode due to exhaust system issues such as Low DEF, Purge Required, Exhaust System Error, etc. This reflects the status of the exhaust system Torque Limit lamp, which is communicated from the Engine ECU to the DGC-2020 via J1939 CAN Bus communications.                                                                              | <b>Pre-Alarm</b><br>TORQUELIMITSEVERE         |
| Weak Battery                   | TRUE when the Weak Battery Voltage Pre-Alarm settings have been exceeded.                                                                                                                                                                                                                                                                                                                              | <b>Pre-Alarm</b><br>WEAKBATPALM               |
| <b>Senders</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                        |                                               |
| Coolant Temp Sender Fail       | TRUE when the Coolant Temp Sender Fail is configured as either a pre-alarm or alarm and the activation delay has expired.                                                                                                                                                                                                                                                                              | <b>Sender Fail</b><br>COOLTEMPSSENDFAIL       |
| Fuel Level Sender Fail         | TRUE when the Fuel Level Sender Fail is configured as either a pre-alarm or alarm and the activation delay has expired.                                                                                                                                                                                                                                                                                | <b>Sender Fail</b><br>FUELLSENDFAIL           |
| Oil Pressure Sender Fail       | TRUE when the Oil Pressure Sender Fail is configured as either a pre-alarm or alarm and the activation delay has expired.                                                                                                                                                                                                                                                                              | <b>Sender Fail</b><br>OILPRESSENDFAIL         |

| Name                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Description                                                                                                           | Symbol                                                                                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| Speed Sender Fail                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | TRUE when the Speed Sender Fail activation delay has expired.                                                         | <b>Sender Fail</b><br> |
| Voltage Sensing Fail                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | TRUE when the Voltage Sensing Fail is configured as either a pre-alarm or alarm and the activation delay has expired. | <b>Sender Fail</b><br> |
| <b>Logic Control Relays</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                       |                                                                                                          |
| <p>The logic control relays (LCR) consist of LCR outputs and LCR inputs. You can use the output to terminate the “output” end of a logic network, and then use the corresponding input as an input to logic elsewhere in the logic scheme. When a given LCR output is TRUE the corresponding LCR input is TRUE. In other words, when LCR Output N (N being a number from 1 to 16) becomes TRUE, then LCR Input N is TRUE also.</p> <p>If you get a “too many logic levels” error while building a logic network, LCR outputs and inputs can be used as a solution to this problem. Place an LCR output on the end of the partial logic network and then use the corresponding LCR input to build more logic than was previously possible.</p> |                                                                                                                       |                                                                                                          |
| Inputs<br>Input 1-16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | See description above.                                                                                                | <b>LCR Input</b><br>   |
| Outputs<br>Output 1-16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | See description above.                                                                                                | <b>LCR Output</b><br>  |

### Components

This group contains Logic Gates, Pickup and Dropout Timers, Latches, and Comment Blocks. Table 5-2 lists the names and descriptions of the objects in the *Components* group.

**Table 5-2. Components Group, Names and Descriptions**

| Name        | Description |       |   |        | Symbol                                                                                |
|-------------|-------------|-------|---|--------|---------------------------------------------------------------------------------------|
| Logic Gates |             |       |   |        |                                                                                       |
| AND         |             | Input |   | Output |  |
|             |             | 0     | 0 | 0      |                                                                                       |
|             |             | 0     | 1 | 0      |                                                                                       |
|             |             | 1     | 0 | 0      |                                                                                       |
|             |             | 1     | 1 | 1      |                                                                                       |
| NAND        |             | Input |   | Output |  |
|             |             | 0     | 0 | 1      |                                                                                       |
|             |             | 0     | 1 | 1      |                                                                                       |
|             |             | 1     | 0 | 1      |                                                                                       |
|             |             | 1     | 1 | 0      |                                                                                       |
| OR          |             | Input |   | Output |  |
|             |             | 0     | 0 | 0      |                                                                                       |
|             |             | 0     | 1 | 1      |                                                                                       |
|             |             | 1     | 0 | 1      |                                                                                       |
|             |             | 1     | 1 | 1      |                                                                                       |
| NOR         |             | Input |   | Output |  |
|             |             | 0     | 0 | 1      |                                                                                       |
|             |             | 0     | 1 | 0      |                                                                                       |
|             |             | 1     | 0 | 0      |                                                                                       |
|             |             | 1     | 1 | 0      |                                                                                       |



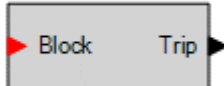
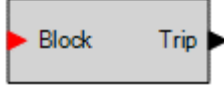
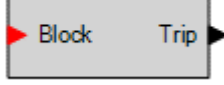
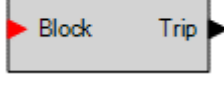
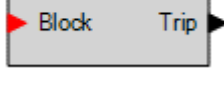
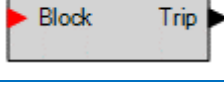
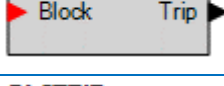
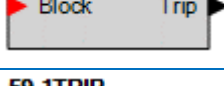
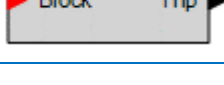
| Name                      | Description                                                                                                                                                                                                                                                                                                                                                                                  | Symbol                                                              |        |        |   |   |   |   |   |   |   |   |   |   |   |   |  |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|--------|--------|---|---|---|---|---|---|---|---|---|---|---|---|--|
| XOR                       | <table><tr><th colspan="2">Input</th><th>Output</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table> <p>When an XOR gate has more than 2 inputs, the output is TRUE whenever an odd number of inputs are TRUE.</p>                                                  | Input                                                               |        | Output | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |  |
| Input                     |                                                                                                                                                                                                                                                                                                                                                                                              | Output                                                              |        |        |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 0                         | 0                                                                                                                                                                                                                                                                                                                                                                                            | 0                                                                   |        |        |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 0                         | 1                                                                                                                                                                                                                                                                                                                                                                                            | 1                                                                   |        |        |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1                         | 0                                                                                                                                                                                                                                                                                                                                                                                            | 1                                                                   |        |        |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1                         | 1                                                                                                                                                                                                                                                                                                                                                                                            | 0                                                                   |        |        |   |   |   |   |   |   |   |   |   |   |   |   |  |
| XNOR                      | <table><tr><th colspan="2">Input</th><th>Output</th></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table> <p>When an XNOR gate has more than 2 inputs, the output is TRUE whenever an even number of inputs are TRUE. The output is also TRUE if no inputs are TRUE.</p> | Input                                                               |        | Output | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |  |
| Input                     |                                                                                                                                                                                                                                                                                                                                                                                              | Output                                                              |        |        |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 0                         | 0                                                                                                                                                                                                                                                                                                                                                                                            | 1                                                                   |        |        |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 0                         | 1                                                                                                                                                                                                                                                                                                                                                                                            | 0                                                                   |        |        |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1                         | 0                                                                                                                                                                                                                                                                                                                                                                                            | 0                                                                   |        |        |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1                         | 1                                                                                                                                                                                                                                                                                                                                                                                            | 1                                                                   |        |        |   |   |   |   |   |   |   |   |   |   |   |   |  |
| NOT<br>(INVERTER)         | <table><tr><th>Input</th><th>Output</th></tr><tr><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td></tr></table>                                                                                                                                                                                                                                                                              | Input                                                               | Output | 0      | 1 | 1 | 0 |   |   |   |   |   |   |   |   |   |  |
| Input                     | Output                                                                                                                                                                                                                                                                                                                                                                                       |                                                                     |        |        |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 0                         | 1                                                                                                                                                                                                                                                                                                                                                                                            |                                                                     |        |        |   |   |   |   |   |   |   |   |   |   |   |   |  |
| 1                         | 0                                                                                                                                                                                                                                                                                                                                                                                            |                                                                     |        |        |   |   |   |   |   |   |   |   |   |   |   |   |  |
| Pickup and Dropout Timers |                                                                                                                                                                                                                                                                                                                                                                                              |                                                                     |        |        |   |   |   |   |   |   |   |   |   |   |   |   |  |
| Drop Out Timer            | Used to set a delay in the logic.<br>For more information, refer to <i>Programming BESTlogicPlus, Pickup and Dropout Timers</i> , later in this section.                                                                                                                                                                                                                                     | <b>Drop Out Timer (1)</b><br><b>TIMER_1</b><br><b>Delay = 1</b><br> |        |        |   |   |   |   |   |   |   |   |   |   |   |   |  |
| Pick Up Timer             | Used to set a delay in the logic.<br>For more information, refer to <i>Programming BESTlogicPlus, Pickup and Dropout Timers</i> , later in this section.                                                                                                                                                                                                                                     | <b>Pick Up Timer (1)</b><br><b>TIMER_1</b><br><b>Delay = 1</b><br>  |        |        |   |   |   |   |   |   |   |   |   |   |   |   |  |
| Latches                   |                                                                                                                                                                                                                                                                                                                                                                                              |                                                                     |        |        |   |   |   |   |   |   |   |   |   |   |   |   |  |
| Reset Priority Latch      | When the Set input is on and the Reset input is off, the latch will go to the SET (ON) state. When the Reset input is on and the Set input is off, the latch will go to the RESET (OFF) state. If both the Set and Reset inputs are on at the same time, a reset priority latch will go to the RESET (OFF) state.                                                                            | <b>Reset Priority Latch</b><br>                                     |        |        |   |   |   |   |   |   |   |   |   |   |   |   |  |
| Set Priority Latch        | When the Set input is on and the Reset input is off, the latch will go to the SET (ON) state. When the Reset input is on and the Set input is off, the latch will go to the RESET (OFF) state. If both the Set and Reset inputs are on at the same time, a set priority latch will go to the SET (ON) state.                                                                                 | <b>Set Priority Latch</b><br>                                       |        |        |   |   |   |   |   |   |   |   |   |   |   |   |  |

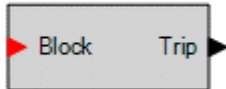
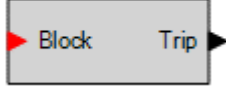
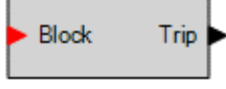
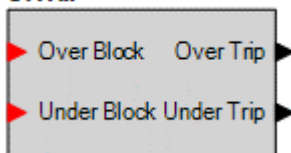
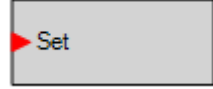
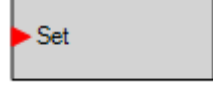
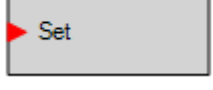
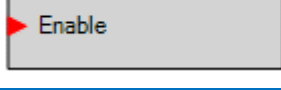
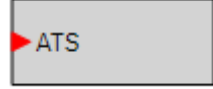
| Name          | Description          | Symbol                                                                              |
|---------------|----------------------|-------------------------------------------------------------------------------------|
| <b>Other</b>  |                      |                                                                                     |
| Comment Block | Enter user comments. |  |

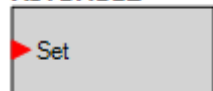
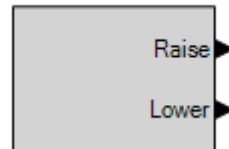
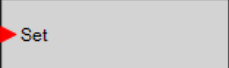
### Elements

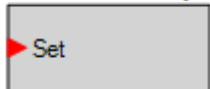
Table 5-3 lists the names and descriptions of the elements in the *Elements* group.

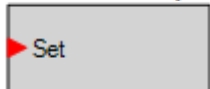
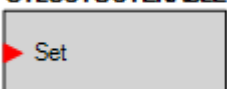
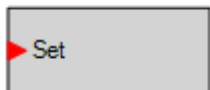
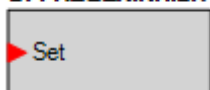
**Table 5-3. Elements Group, Names and Descriptions**

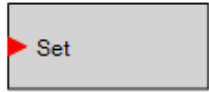
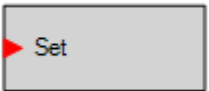
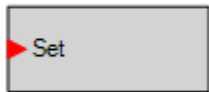
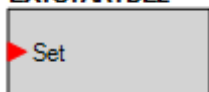
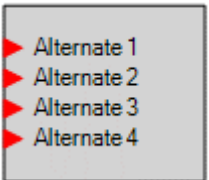
| Name                   | Description                                                                                                                                                                          | Symbol                                                                                |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <b>Protection</b>      |                                                                                                                                                                                      |                                                                                       |
| 27-1TRIP               | When the Block input is TRUE, the 27-1 element is disabled. The Trip output is TRUE when the 27-1 undervoltage element is in a trip condition. Connect to another logic block input. |    |
| 27-2TRIP               | When the Block input is TRUE, the 27-2 element is disabled. The Trip output is TRUE when the 27-2 undervoltage element is in a trip condition. Connect to another logic block input. |    |
| 32TRIP                 | When the Block input is TRUE, the 32 element is disabled. The Trip output is TRUE when the 32 reverse power is in a trip condition. Connect to another logic block input.            |   |
| 40TRIP                 | When the Block input is TRUE, the 40 element is disabled. The Trip output is TRUE when the 40Q loss of excitation is in a trip condition. Connect to another logic block input.      |  |
| 47TRIP<br>(Optional)   | When the Block input is TRUE, the 47 element is disabled. The Trip output is TRUE when the 47 phase imbalance is in a trip condition. Connect to another logic block input.          |  |
| 51-1TRIP<br>(Optional) | When the Block input is TRUE, the 51-1 element is disabled. The Trip output is TRUE when the 51-1 overcurrent is in a trip condition. Connect to another logic block input.          |  |
| 51-2TRIP<br>(Optional) | When the Block input is TRUE, the 51-2 element is disabled. The Trip output is TRUE when the 51-2 overcurrent is in a trip condition. Connect to another logic block input.          |  |
| 51-3TRIP<br>(Optional) | When the Block input is TRUE, the 51-3 element is disabled. The Trip output is TRUE when the 51-3 overcurrent is in a trip condition. Connect to another logic block input.          |  |
| 59-1TRIP               | When the Block input is TRUE, the 59-1 element is disabled. The Trip output is TRUE when the 59-1 overvoltage is in a trip condition. Connect to another logic block input.          |  |

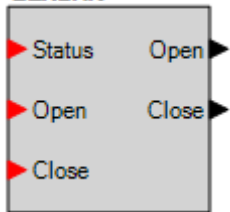
| Name                                         | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Symbol                                                                                                             |
|----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| 59-2TRIP                                     | When the Block input is TRUE, the 59-2 element is disabled. The Trip output is TRUE when the 59-2 overvoltage is in a trip condition. Connect to another logic block input.                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>59-2TRIP</b><br>             |
| 78TRIP                                       | When the Block input is TRUE, the 78 element is disabled. The Trip output is TRUE when the 78 vector shift is in a trip condition. Connect to another logic block input.                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>78TRIP</b><br>               |
| 81ROCOFTRIP                                  | When the Block input is TRUE, the 81 ROCOF element is disabled. The Trip output is TRUE when the 81 ROCOF is in a trip condition. Connect to another logic block input.                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>81ROCOFTRIP</b><br>          |
| 81TRIP                                       | When the Block input is TRUE, the 81 element is disabled. The Trip output is TRUE when the 81 frequency is in a trip condition. Connect to another logic block input.                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>81TRIP</b><br>               |
| <b>Other</b>                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                    |
| Alarm Silence                                | The alarm will be silenced when this element is TRUE. The alarm can also be silenced by pressing the Alarm Silence button on the front panel of the DGC-2020.                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>ALARMSILENCE</b><br>         |
| Alternate Frequency Override                 | When this logic element is TRUE, protection and bus condition detection is forced to operate at the Alternate Frequency instead of the Rated Frequency.                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>ALTFREQOVER</b><br>        |
| Alternate Voltage Override                   | When this logic element is TRUE and the voltage trim setpoint source is set for Trim Voltage, the alternate voltage setting becomes the active set point for the voltage trim controller.                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>ALTVOLT10VR</b><br>        |
| Analog Load Share Override                   | When the Set input is TRUE, the DGC-2020 utilizes analog load share lines, rather than Ethernet, for load sharing.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>ANALOGLOADSHAREOVR</b><br> |
| ATS                                          | When this logic element is TRUE, and the DGC-2020 is in Auto mode, the generator will run. This can be used in place of the ATS programmable function if it is desired to generate the ATS signal as a combination of programmable logic rather than a simple contact input. If either the ATS logic element is TRUE <u>or</u> the contact mapped to the ATS programmable function is TRUE, <u>and</u> the DGC-2020 is in Auto mode, the generator will run. If <u>both</u> the ATS logic element <u>and</u> the ATS programmable function are FALSE, and the DGC-2020 is in Auto mode, the generator will cool down and stop. | <b>ATS</b><br>                |
| Automatic Breaker Operation Inhibit from PLC | Automatic breaker operation is inhibited when the Set input is TRUE.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>AUTOBRKOPINHIBIT</b><br>   |

| Name                                | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Symbol                                                                                                                              |
|-------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| Auto Mode                           | When this input is TRUE, and the DGC-2020 is in Off mode, the DGC-2020 will switch to Auto mode. This is a pulsed input. It does not need to be held after the desired mode switch has occurred.                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>AUTOMODE</b><br>                              |
| AVR                                 | Can be connected to inputs of other logic blocks. When the AVR is being raised, the Raise output is TRUE. When being lowered, the Lower output is TRUE.                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>AVR</b><br>                                   |
| Closed Transition Override from PLC | All mains fail transfers are forced to be closed transitions, even if <i>Mains Fail Transfer Type</i> is set to <i>Open</i> , when the Set input is TRUE.                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>CLOSEDTRANSITIONOVR</b><br>                   |
| Configurable Element                | Configurable elements (CONFELMNT1-8) are connected to the logic scheme as outputs. These elements are configurable in BESTCOMSPlus under <i>Programmable Outputs, Configurable Elements</i> . The user can assign a string of up to 16 characters, configure whether the element should generate an alarm or pre-alarm. If used for alarm or pre-alarm, the user's text is what will appear in the alarm or pre-alarm annunciation and in the DGC-2020 event log. In addition, the configurable element status can be used to generate modem dial outs which display the user's text on modem equipped DGC-2020's. | <b>CONFELMNT1</b><br><b>CONFIG ELEMENT 1</b><br> |

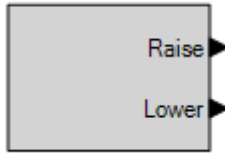
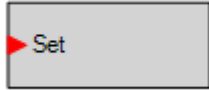
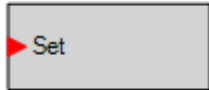
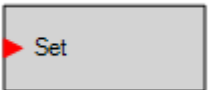
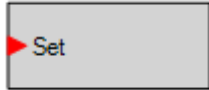
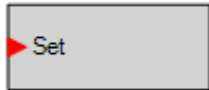
| Name              | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Symbol                                                                                                        |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| Cool Down Request | <p><u>RUN Mode</u></p> <p>If the unit is in Run mode when the Cool Down Request is received, the unit is forced to unload and open its breaker and then go into a cooldown cycle. While in the cool down cycle, the unit will display “COOLDOWN REQ” in addition to displaying the cooldown timer. After the cooldown timer expires, the unit will remain running in Run mode. The Cool Down Request must be removed before the breaker can be closed again; this element blocks breaker closures.</p> <p>If the Cool Down Request is removed during the cool down process, the unit will remain running in Run mode. Furthermore, if a condition occurs that normally causes the unit to close its breaker in Run mode, the unit will close its breaker and reload.</p> <p><u>Auto Mode</u></p> <p>If the unit is in Auto mode and the Cool Down Request is received, the unit is forced to unload and open its breaker and go into a cooldown cycle. While in the cooldown cycle, the unit will display “COOLDOWN REQ” in addition to displaying the cooldown timer. After the cool down timer expires, the unit will remain running in Auto mode, unless there are no conditions that cause the unit to run in Auto mode, in which case it will shut down and remain in Auto mode. The Cool Down Request must be removed before the breaker can be closed again; this element blocks breaker closures.</p> <p>If the Cool Down Request is removed during the cool down process and some condition that would normally cause the unit to run in Auto mode is TRUE, the unit will remain running in Auto mode. Furthermore, if a condition occurs that normally causes the unit to close its breaker, the unit will close its breaker and reload.</p> | <p><b>COOLDOWNREQ</b></p>  |

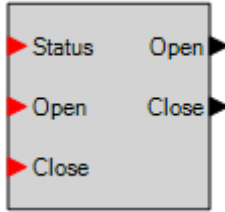
| Name                                           | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Symbol                                                                                                              |
|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| Cool Down and Stop Request                     | <p><u>Run Mode</u></p> <p>If the unit is in Run mode when the Cool Stop Request is received, the unit will unload, open its breaker, and go into a cooldown cycle. While in the cooldown cycle, the unit will display "COOL &amp; STOP REQ" in addition to displaying the cooldown timer. After the cooldown timer expires, the unit will go to Off mode. The Cool Stop Request must be removed before the unit can be run again.</p> <p>If the Cool Stop Request is removed during the cooldown process, the unit will remain running. Furthermore, if a condition occurs that normally causes the unit to close its breaker in RUN mode, the unit will close its breaker and reload.</p> <p><u>Auto Mode</u></p> <p>If the unit is in Auto mode when the Cool Stop Request is received, all conditions that would normally cause the unit to run in Auto mode are cleared. Since all conditions that cause the unit to run have been removed, the unit will unload, open its breaker, and go into a cooldown cycle. While in the cooldown cycle, the unit will display "COOL &amp; STOP REQ" in addition to displaying the cooldown timer. After the cooldown timer expires, the unit will shut down, remaining in Auto. The Cool Stop Request must be removed before the unit can be run again.</p> <p>If the Cool Stop Request is removed during the cooldown process and some condition that would normally cause the unit to run in Auto mode is TRUE, the unit will remain running. Furthermore, if a condition occurs that normally causes the unit to close its breaker, the unit will close its breaker and reload.</p> | <p><b>COOLSTOPREQ</b></p>        |
| Cylinder Cutout Enable Override                | <p>When TRUE, cylinder cutout is enabled. When FALSE, cylinder cutout is disabled when any of the following are TRUE:</p> <ul style="list-style-type: none"> <li>• Synchronization is in progress.</li> <li>• The machine is operating with the generator breaker closed.</li> <li>• The Cylinder Cutout Disable setting is TRUE.</li> <li>• The Cylinder Cutout Disable logic element is TRUE.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <p><b>CYLCUTOUTENABLE</b></p>  |
| Diesel Particulate Filter Manual Regeneration  | <p>Diesel Particulate Filter Regeneration is forced manually when the Set input is TRUE.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <p><b>DPFMANREGEN</b></p>      |
| Diesel Particulate Filter Regeneration Inhibit | <p>Diesel Particulate Filter Regeneration is inhibited when the Set input is TRUE.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <p><b>DPFREGENINHIBIT</b></p>  |

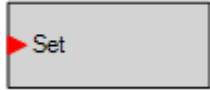
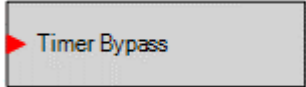
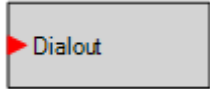
| Name                                   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Symbol                                                                                                           |
|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| Droop Override                         | When the droop override logic element is TRUE, the speed and voltage trim functions are disabled. The machine operates in speed droop and voltage droop to accomplish kW and kvar sharing. This is useful when it is desired to operate a system in droop rather than isochronous load sharing.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>DROOPOVERRIDE</b><br>      |
| ECU Connect Override                   | When TRUE, a Key On signal is applied to the ECU and CAN Bus data is updated any time except during the Disconnecting state.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>ECUCONNECTOVERRIDE</b><br> |
| Engine Run                             | The Start input starts the generator. No load is applied. The breaker remains open. The Stop input stops the generator. The DGC-2020 only responds to this logic element when in Auto mode.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>ENGINERUN</b><br>          |
| EPS Supplying Load                     | <p>When TRUE, the Set input forces a supplying load indication. This is useful when it is necessary for the supplying load indication to be TRUE during test runs, but the system load is not enough to light the supplying load indication.</p> <p>A supplying load indication is TRUE when the supplying load logic element is TRUE and the generator is stable (voltage and frequency are within the limits programmed under DGC-2020 &gt; BREAKER MANAGEMENT &gt; BUS CONDITION DETECTION &gt; GEN CONDITION DETECTION in the Settings Explorer in BESTCOMSP<sub>Plus</sub>.) This is OR'ed with the traditional supplying load criteria that supplying load is TRUE when the generator current is above a percentage of CT primary current (typically 3% minimum).</p> <p>When the supplying load indication has been driven from logic or from generator current levels, the DGC-2020 enters a cool down cycle when the DGC-2020 is in Auto mode and the ATS contact has been removed.</p> | <b>EPSSUPPLYINGLD</b><br>     |
| Emergency Stop                         | When TRUE, an Emergency Shutdown alarm is annunciated and the Emergency Stop LED on the RDP-110 is illuminated.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>ESTOP</b><br>            |
| External Start Delay                   | If the Set input is TRUE while the DGC-2020 is in the Pre Start state, the DGC-2020 will remain in the Pre Start state until the Set input is FALSE.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>EXTSTARTDEL</b><br>      |
| Generator Alternate Rated kW Selection | There are cases where the kW rating of a machine can change based on system conditions. An example is an engine that can run on multiple fuels; there could be different kW ratings based on fuel type. Another example might be operating in parallel with utility power or other machines vs. stand-alone operation. The alternates can be selected in BESTlogic <sub>Plus</sub> using this logic element.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>GENALTKW</b><br>         |

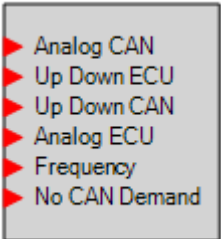
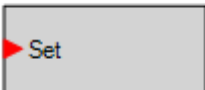
| Name              | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Symbol                                                                                                   |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| Generator Breaker | <p>This element is used to connect the breaker open and close output signals from the DGC-2020 to physical output contacts to open and close the generator breaker, and map breaker status feedback to a contact input. In addition, contact inputs can be mapped to allow switches to be implemented to manually initiate breaker open and close requests.</p> <p><b>Inputs</b></p> <p><i>Status:</i> This input allows a contact input to be mapped that will provide breaker status feedback to the DGC-2020. When the contact input is closed, the breaker is indicated to be closed. When the contact input is open, the breaker is indicated to be open.</p> <p><i>Open:</i> This input allows a contact input to be mapped that can be used to initiate a manual breaker open request. When this input is pulsed closed while the DGC-2020 is in Run or Auto mode, the breaker will open.</p> <p><i>Close:</i> This input allows a contact input to be mapped that can be used to initiate a manual breaker close request. When this input is pulsed and the DGC-2020 is in Auto or Run mode, and the generator is stable, a close request will be initiated. If the Dead Bus Close Enable parameter is TRUE, and the bus is dead, the breaker will close. If the bus is stable, the DGC-2020 will synchronize the generator to the bus, and then close the breaker. If the synchronizer option is not available, the DGC-2020 can still close the breaker if some external means is employed to synchronize the generator to the bus.</p> <p><b>Outputs</b></p> <p>The outputs must be mapped to the contact outputs of the DGC-2020 that will be used to drive the breaker.</p> <p><i>Open:</i> This output is pulsed TRUE (closes the output contact it is mapped to) when the DGC-2020 is providing a signal to the breaker to open. It will be a pulse if the Breaker Output Contact Type is set to Pulse on the Breaker Hardware screen under Breaker Management in the Settings Explorer, and the length is determined by the Open Pulse Time. It will be a constant output if the Generator Breaker Hardware Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually open before the pulse is removed.</p> <p><i>Close:</i> This output is pulsed TRUE (closes the output contact it is mapped to) when the DGC-2020 is providing a signal to the breaker to close. It will be a pulse if the Breaker Output Contact Type is set to Pulse on the Breaker Hardware screen under Breaker Management in the Settings Explorer, and the length is determined by the Open Pulse Time. It will be a constant output if the Generator Breaker Hardware Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually open before the pulse is removed.</p> <p style="text-align: center;"><b>Note</b></p> <p>When using the DGC-2020 synchronizer, it is recommended that local DGC-2020 relay outputs be used for breaker closing commands to minimize the possibility of closures outside of desired breaker closing angles.</p> <p>If remote (CEM-2020) outputs are to be used for breaker close commands, it is recommended that the anticipatory synchronizer type be used, and the breaker close wait time be adjusted to account for possible CEM-2020 output delays (typically 50 ms) to achieve desired breaker closing angles.</p> | <p><b>GENBRK</b></p>  |

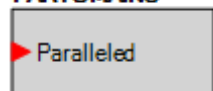
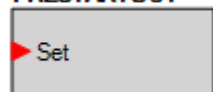
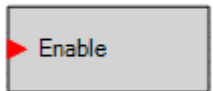
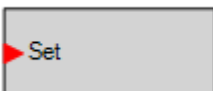
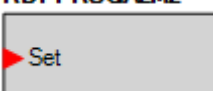
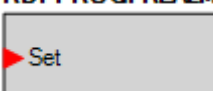


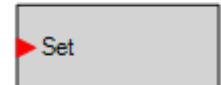
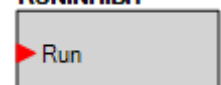
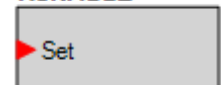
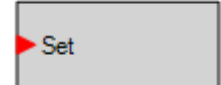
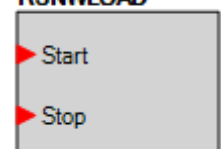
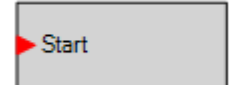
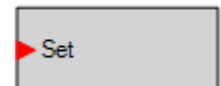
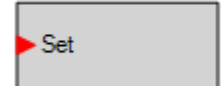
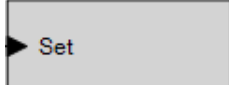
| Name               | Description                                                                                                                                                                                                                                                                                                                                                                                                                                 | Symbol                                                                                                      |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| Governor Control   | Can be connected to inputs of other logic blocks. When the Governor is being raised, the Raise output is TRUE. When being lowered, the Lower output is TRUE.                                                                                                                                                                                                                                                                                | <b>GOVR</b><br>          |
| Idle Request       | When this element is TRUE, the DGC-2020 RPM requested from the engine ECU over Can Bus will be equal to the Idle RPM setting. When it is not TRUE and the engine is running, a value equal to the Engine RPM setting is sent to the engine ECU. In addition, when Idle Request is TRUE, the DGC-2020 will send an RPM request CAN Bus parameter to the engine ECU for ECU's that are equipped to receive a separate Idle request parameter. | <b>IDLEREQUEST</b><br>   |
| Lamp Test          | The lamp test will be performed when this element is TRUE. The lamp test can also be accomplished by pressing the Lamp Test button on the front panel of the DGC-2020.                                                                                                                                                                                                                                                                      | <b>LAMPTEST</b><br>      |
| Load Take Over     | When this logic element is TRUE, the generator is forced to start, assume load, and disconnect from the mains, either in a closed or open transition. The Parallel to Mains logic element must be TRUE any time the generator is in parallel with the utility. Parallel transitions to and from the mains will not operate properly if the Parallel to Mains logic element is not set correctly.                                            | <b>LOADTAKEOVER</b><br>  |
| Logic Alarm        | When this input is TRUE, the DGC-2020 goes into an alarm condition.                                                                                                                                                                                                                                                                                                                                                                         | <b>LOGICALM</b><br>    |
| Logic Pre-Alarm    | When this input is TRUE, the DGC-2020 goes into a Pre-alarm condition.                                                                                                                                                                                                                                                                                                                                                                      | <b>LOGICPALM</b><br>   |
| Low Fuel Pre-Alarm | When this element is TRUE, a Low Fuel Pre-Alarm is annunciated and the Low Fuel Level LED on the RDP-110 is illuminated.                                                                                                                                                                                                                                                                                                                    | <b>LOWFUELPALM</b><br> |

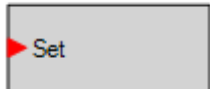
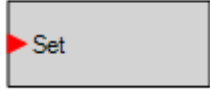
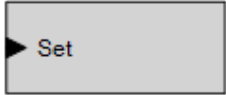
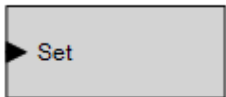
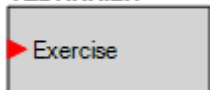
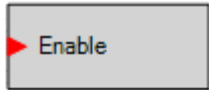
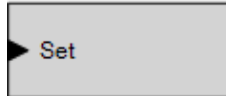
|                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                            |
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| <p>Mains Breaker</p> | <p>This element is used to connect the breaker open and close output signals from the DGC-2020 to physical output contacts to open and close the mains breaker and map breaker status feedback to a contact input. In addition, contact inputs can be mapped to allow switches to be implemented to manually initiate breaker open and close requests.</p> <p>This element is only available when the Mains Breaker Hardware is configured on the <i>Breaker Hardware</i> screen via the <i>Breaker Management</i> tree branch.</p> <p><u>Inputs</u></p> <p><b>Status:</b> This input allows a contact input to be mapped that will provide breaker status feedback to the DGC-2020. When the contact input is closed, the breaker is indicated to be closed. When the contact input is open, the breaker is indicated to be open.</p> <p><b>Open:</b> This input allows a contact input to be mapped that can be used to initiate a manual breaker open request. When this input is pulsed closed while the DGC-2020 is in RUN or AUTO mode, the breaker will open.</p> <p><b>Close:</b> This input allows a contact input to be mapped that can be used to initiate a manual breaker close request. When this input is pulsed and the DGC-2020 is in AUTO or RUN mode, and the generator is stable, a close request will be initiated. If the Dead Bus Close Enable parameter is TRUE, and the bus is dead, the breaker will close. If the bus is stable, the DGC-2020 will synchronize the generator to the bus, and then close the breaker. If the synchronizer option is not available, the DGC-2020 can still close the breaker if some external means is employed to synchronize the generator to the bus.</p> <p><u>Outputs</u></p> <p>The outputs must be mapped to the contact outputs of the DGC-2020 that will be used to drive the breaker.</p> <p><b>Open:</b> This output is pulsed TRUE (closes the output contact it is mapped to) when the DGC-2020 is providing a signal to the breaker to open. It will be a pulse if the Breaker Output Contact Type is set to Pulse on the Breaker Hardware screen under Breaker Management in the Settings Explorer, and the length is determined by the Open Pulse Time. It will be a constant output if the Mains Breaker Hardware Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually open before the pulse is removed.</p> <p><b>Close:</b> This output is pulsed TRUE (closes the output contact it is mapped to) when the DGC-2020 is providing a signal to the breaker to close. It will be a pulse if the Breaker Output Contact Type is set to Pulse on the Breaker Hardware screen under Breaker Management in the Settings Explorer, and the length is determined by the Open Pulse Time. It will be a constant output if the Mains Breaker Hardware Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually open before the pulse is removed.</p> <div> <p style="text-align: center;"><b>NOTE</b></p> <p>When using the DGC-2020 synchronizer, it is recommended that local DGC-2020 relay outputs be used for breaker closing commands to minimize the possibility of closures outside of desired breaker closing angles.</p> <p>If remote (CEM-2020) outputs are to be used for breaker close commands, it is recommended that the anticipatory synchronizer type be used, and the breaker close wait time be adjusted to account for possible CEM-2020 output delays (typically 50 ms) to achieve desired breaker closing angles.</p> </div> | <p><b>MAINSBRK</b></p>  |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|

| Name                                    | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Symbol                                                                                                             |
|-----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| Mains Fail Test                         | When this element is TRUE, the DGC-2020 will exercise its mains fail transfer function exactly as it would if the mains were to fail on a mains fail machine. This can be used as a test of the mains fail transfer capability of the unit without having to cause a TRUE mains failure.                                                                                                                                                                          | <b>MAINSFAILTEST</b><br>        |
| Mains Fail Transfer Inhibit from PLC    | The mains fail transfer function is inhibited when the Set input is TRUE.                                                                                                                                                                                                                                                                                                                                                                                         | <b>MAINSFLTRINHIBIT</b><br>     |
| Mains Fail Transfer Return Timer Bypass | The return timer is skipped when the input is TRUE.                                                                                                                                                                                                                                                                                                                                                                                                               | <b>MAINSFAILRTNTRBYPASS</b><br> |
| Modem Control (Optional)                | Connect the input to the output of another logic block. When TRUE, the modem dials out.                                                                                                                                                                                                                                                                                                                                                                           | <b>MODEM</b><br>                |
| <i>mtu</i> Cylinder Cutout Disable      | When this logic element is TRUE, Cylinder Cutout Disable 1 and Cylinder Cutout Disable 2 are both sent to the engine ECU with TRUE status. When this logic element is FALSE, Cylinder Cutout Disable 1 and Cylinder Cutout Disable 2 are sent to the engine ECU with states set by the values programmed for the Cylinder Cutout Disable 1 and Cylinder Cutout Disable 2 DGC-2020 settings which are configured on the ECU Setup screen in BESTCOMS <i>Plus</i> . | <b>MTUCYLCUTOUTDISABLE</b><br>  |

| Name                | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Symbol                                                                                                       |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| Speed Demand Switch | <p>This logic element can be used to specify the Speed Demand Source parameter value that is sent to an <i>mtu</i> Engine ECU. When no input is TRUE, the value sent to the engine ECU is the value specified in the Speed Demand Source setting in the ECU configuration setting. If an input on this logic element is TRUE, the selected Speed Demand Source will be sent rather than the value specified by the Speed Demand Source setting.</p> <p>If multiple inputs are TRUE at the same time, the input that is closest to the top of the logic element symbol will specify the Speed Demand Source parameter value that is sent to the ECU.</p> <p>Analog CAN: This input configures the <i>mtu</i> ECU to accept speed bias requests over J1939 CAN Bus from the DGC-2020.</p> <p>Up Down ECU: This input configures the <i>mtu</i> ECU to accept speed raise/lower commands via contact inputs on the ECU.</p> <p>Up Down CAN: This input configures the <i>mtu</i> ECU to accept speed raise/lower commands via communications over J1939 CAN bus.</p> <p>Analog ECU: This input configures the <i>mtu</i> ECU to accept speed bias via bias voltage input connections on the ECU.</p> <p>Frequency: This configures the <i>mtu</i> ECU to accept speed commands via a frequency signal input on the ECU. The mapping of input signal frequency to machine speed is configured in a curve within the engine ECU.</p> <p>No CAN Demand: This input configures the <i>mtu</i> ECU to disregard all speed requests or speed raise/lower requests from J1939 CAN bus.</p> | <p><b>MTUSPDDMSW</b></p>  |
| Off Mode            | <p>When this input is TRUE, the DGC-2020 will switch to Off mode. This is a pulsed input. It does not need to be held after the desired mode switch has occurred.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <p><b>OFFMODE</b></p>   |

| Name                         | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Symbol                                                                                                         |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| Paralleled to Mains          | <p>Setting this logic element to TRUE indicates to the DGC-2020 that it is paralleled to a utility.</p> <p>When paralleled to the utility, the kW controller will regulate the machine's kW output at the Base Load Level (%) that is set on the <i>Governor Bias Control Settings</i> screen, where the Base Load Level is in percent of machines rated kW.</p> <p>Otherwise, the kW controller will implement kW load sharing when part of a load sharing system. If a load sharing system is not implemented, the speed controller can be set up to implement speed droop.</p> <p>When paralleled to the utility, the var/PF controller will regulate the machine's reactive power output according to the control mode setting. If the control mode is var Controller, the output will be regulated to the kvar Setpoint (%) that is set on the <i>AVR Bias Control Settings</i> screen, where the kvar Setpoint (%) is in percentage of the machines rated kvar. If the control mode is PF Control, the reactive power output is regulated to a level that maintains the machines power factor at the value specified by the PF setting on the <i>AVR Bias Control Settings</i> screen. When var/PF control is not active or not enabled, the voltage controller can be set up to implement voltage droop.</p> | <b>PARTOMAINS</b><br>       |
| Prestart Output              | <p>This element is used to drive the prestart output relay from logic when the Prestart Output Relay configuration is set to "Programmable". When the Prestart Output Relay configuration is set to "Programmable", the prestart relay will not close unless logic is used to drive this element. When the Prestart Output Relay configuration is set to "Predefined", the prestart relay is closed according to the predefined prestart functionality of the DGC-2020. When the "Predefined" functionality is selected, the relay will not respond to this element.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>PRESTARTOUT</b><br>     |
| Rapid Start Override         | <p>When TRUE, this element sets the Start mode to Rapid regardless of the Start mode setting.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>RAPIDSTARTOVR</b><br>  |
| RDP Programmable Alarm 1     | <p>When TRUE, this element illuminates the <i>Fuel Leak/Sender Failure</i> LED on the Remote Display Panel RDP-110. When this element is connected in logic, it overrides all other commands to the LED. Otherwise, the LED operates as normal.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>RDPPROGALM1</b><br>    |
| RDP Programmable Alarm 2     | <p>When TRUE, this element illuminates the <i>Sender Failure</i> LED on the Remote Display Panel RDP-110. When this element is connected in logic, it overrides all other commands to the LED. Otherwise, the LED operates as normal.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>RDPPROGALM2</b><br>    |
| RDP Programmable Pre-Alarm 1 | <p>When TRUE, this element illuminates the <i>Battery Overvoltage</i> LED on the Remote Display Panel RDP-110. When this element is connected in logic, it overrides all other commands to the LED. Otherwise, the LED operates as normal.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>RDPPROGPREALM1</b><br> |

| Name                         | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Symbol                                                                                                           |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| RDP Programmable Pre-Alarm 2 | When TRUE, this element illuminates the <i>Battery Charger Failure</i> LED on the Remote Display Panel RDP-110. When this element is connected in logic, it overrides all other commands to the LED. Otherwise, the LED operates as normal.                                                                                                                                                                                                                                                                                    | <b>RDPPROGPREALM2</b><br>     |
| Reset                        | Reset will be active when this element is TRUE. Reset can also be accomplished by pressing the Reset button on the front panel of the DGC-2020.                                                                                                                                                                                                                                                                                                                                                                                | <b>RESET</b><br>              |
| Run Inhibit                  | When this logic element is TRUE, the DGC-2020 is prevented from starting and running the generator, regardless of any condition that would normally cause the generator to run. If this element is FALSE and there is <u>any</u> condition in effect which will cause the generator to run, the DGC-2020 will start and run the generator.                                                                                                                                                                                     | <b>RUNINHIBIT</b><br>         |
| Run Mode                     | When this input is TRUE, and the DGC-2020 is in Off mode, the DGC-2020 will switch to Run mode. This is a pulsed input. It does not need to be held after the desired mode switch has occurred.                                                                                                                                                                                                                                                                                                                                | <b>RUNMODE</b><br>            |
| Run Output                   | This element is used to drive the run output relay from logic when the Run Output Relay configuration is set to "Programmable". When the Run Output Relay configuration is set to "Programmable", the run relay will not close unless logic is used to drive this element. When the Run Output Relay configuration is set to "Predefined", the run relay is closed according to the predefined run functionality of the DGC-2020. When the "Predefined" functionality is selected, the relay will not respond to this element. | <b>RUNOUTPUT</b><br>          |
| Run with Load                | The Start input starts the generator and closes the Gen breaker. The Stop input stops the generator and opens the Gen breaker. The DGC-2020 only responds to this logic element when in Auto mode.                                                                                                                                                                                                                                                                                                                             | <b>RUNWLOAD</b><br>         |
| Sequenced System Startup     | When TRUE, this element starts a sequenced system when no machines are running. This starts the first unit in a multiple unit system based on the sequencing criterion.                                                                                                                                                                                                                                                                                                                                                        | <b>SEQSYSTEMSTART</b><br>   |
| Speed Lower                  | This element lowers the speed setting of the DGC-2020 by up to 2 rpm per second. After the speed has not been lowered for 30 seconds, the modified speed is saved to nonvolatile memory.                                                                                                                                                                                                                                                                                                                                       | <b>SPEEDLOWER</b><br>       |
| Speed Raise                  | This element raises the speed setting of the DGC-2020 by up to 2 rpm per second. After the speed has not been raised for 30 seconds, the modified speed is saved to nonvolatile memory.                                                                                                                                                                                                                                                                                                                                        | <b>SPEEDRAISE</b><br>       |
| Speed Trim Inhibit           | When TRUE, this element inhibits operation of the DGC-2020 speed trim PID controller. For example, speed trim is not desired in multiple generator systems during start up synchronization until the generators are stable.                                                                                                                                                                                                                                                                                                    | <b>SPEEDTRIMINHIBIT</b><br> |

| Name                   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Symbol                                                                                                          |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| Start Delay Bypass     | This element allows the Pre Start state to be skipped based on logic. For example, a start delay may not be necessary when the engine is warm. This also allows an external device, such as an ECU, to control the pre start interval.                                                                                                                                                                                                                                                                                                       | <b>STARTDELBY</b><br>        |
| Start Output           | This element is used to drive the start output relay from logic when the Start Output Relay configuration is set to "Programmable". When the Start Output Relay configuration is set to "Programmable", the start relay will not close unless logic is used to drive this element. When the Start Output Relay configuration is set to "Predefined", the start relay is closed according to the predefined start functionality of the DGC-2020. When the "Predefined" functionality is selected, the relay will not respond to this element. | <b>STARTOUTPUT</b><br>       |
| Stop kvar Ramp         | The Stop kvar Ramp logic element, when TRUE, causes the generator to freeze the ramping of kvar and maintain a constant output.                                                                                                                                                                                                                                                                                                                                                                                                              | <b>STOPKVARRAMP</b><br>      |
| Stop kW Ramp           | The Stop kW Ramp logic element, when TRUE, causes the generator to freeze the ramping of kW and maintain a constant output.                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>STOPKWRAMP</b><br>        |
| Test Inhibit           | When this logic element is TRUE, the generator exercise timer cannot start the generator. If the TESTINHIBIT logic function is FALSE during an exercise period, or transitions from TRUE to FALSE at any time during an exercise period, the DGC-2020 will start and run the generator for the duration of the exercise period.                                                                                                                                                                                                              | <b>TESTINHIBIT</b><br>      |
| Voltage Droop Override | When TRUE, this element causes the DGC-2020 to switch from kvar sharing over Ethernet to voltage droop mode.                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>VOLTDROOPVR</b><br>     |
| Voltage Trim Inhibit   | When TRUE, this element inhibits operation of the DGC-2020 voltage trim PID controller. For example, voltage trim is not desired in multiple generator systems during start up synchronization until the generators are stable.                                                                                                                                                                                                                                                                                                              | <b>VOLTTRIMINHIBIT</b><br> |

## Logic Schemes

A logic scheme is a group of logic variables written in equation form that defines the operation of a DGC-2020 Digital Genset Controller. Each logic scheme is given a unique name. This gives you the ability to select a specific scheme and be confident that the selected scheme is in operation. One logic scheme is configured for typical control applications and is the default active logic scheme. Only one logic scheme can be active at a given time. In most applications, preprogrammed logic schemes eliminate the need for custom programming. Preprogrammed logic schemes may provide more inputs, outputs, or features than are needed for a particular application. This is because a preprogrammed scheme is designed for a large number of applications with no special programming required. Unneeded logic block outputs may be left open to disable a function or a function block can be disabled through operating settings.

When a custom logic scheme is required, programming time is reduced by modifying the default logic scheme.

## The Active Logic Scheme

Digital Genset Controllers must have an active logic scheme in order to function. All Basler Electric DGC-2020's are delivered with a default, active logic scheme pre-loaded in memory. If the function block configuration and output logic of the default logic scheme meets the requirements of your application, then only the operating settings (power system parameters and threshold settings) need to be adjusted before placing the DGC-2020 in service.

## Copying and Renaming Preprogrammed Logic Schemes

Copying a saved logic scheme to the active logic (*Logic Name*) and assigning a unique name is accomplished by loading the saved logic scheme into *BESTCOMSPlus* and then typing over the logic scheme's name. Changes are not activated until the new settings have been saved and uploaded to the device.

## Sending and Retrieving Logic Schemes

### Retrieving a Logic Scheme from the DGC-2020

To retrieve settings from the DGC-2020, the DGC-2020 must be connected to a computer through a communications port. Once the necessary connections are made, settings can be downloaded from the DGC-2020 by selecting *Download Settings and Logic* on the *Communication* pull-down menu.

### Sending a Logic Scheme to the DGC-2020

To send settings to the DGC-2020, the DGC-2020 must be connected to a computer through a communications port. Once the necessary connections are made, settings can be uploaded to the DGC-2020 by selecting *Upload Settings and Logic* on the *Communication* pull-down menu.

### Caution

Always remove the DGC-2020 from service prior to changing or modifying the active logic scheme. Attempting to modify a logic scheme while the DGC-2020 is in service could generate unexpected or unwanted outputs.

Modifying a logic scheme in *BESTCOMSPlus* does not automatically make that scheme active in the DGC-2020. The modified scheme must be uploaded into the DGC-2020.

## Programming *BESTlogic™ Plus*

Use *BESTCOMSPlus* to program *BESTlogicPlus*. Using *BESTCOMSPlus* is analogous to physically attaching wire between discrete DGC-2020 terminals. To program *BESTlogicPlus*, use the Settings Explorer within *BESTCOMSPlus* to open the *BESTlogicPlus Programmable Logic* tree branch as shown in Figure 5-1.

The drag and drop method is used to connect a variable or series of variables to the logic inputs, outputs, components, and elements. To draw a wire/link from port to port (triangles), click the left mouse button on a port, pull the wire onto another port, and release the left mouse button. A red port indicates that a connection to the port is required or missing. A black port indicates that a connection to the port is not required. Drawing wires/links from input to input or output to output is not allowed. Only one wire/link can be connected to any one output. If the proximity of the endpoint of the wire/link is not exact, it may attach to an unintended port.

If an object or element is disabled, it will have a yellow X on it. To enable the element, navigate to the settings page for that element. A red X indicates that an object or element is not available per the style number of the DGC-2020.

The view of the Main Logic, Physical Outputs, Remote Outputs, and LCR Outputs can be automatically arranged by clicking the right mouse button on the window and selecting *Auto-Layout*.



The following must be met before BESTCOMSP<sub>Plus</sub> will allow logic to be uploaded to the DGC-2020:

- A minimum of two inputs and a maximum of four inputs on any multi-port (AND, OR, NAND, NOR, XOR, and XNOR) gate.
- A maximum of nine logic levels for any particular path. A path being an input block or an output side of an element block through gates to an output block or an input side of an element block. This is to include any OR gates on the Physical Output or Remote Output tab/pages, but not the matched pairs of Physical Output blocks or Remote Output blocks.
- Only 30 gates per logic level. All output blocks and input sides of element blocks are at the maximum logic level of the diagram. All gates are pushed forward/upwards in logic levels and buffered to reach the final output block or element block if needed. A maximum of 150 gates allowed per diagram.
- At all levels there can only be 96 used link/wired or endpoints. Endpoints being inputs, outputs, both sides of element blocks.

Three status LEDs are located in the lower right corner of the BESTlogicP<sub>Plus</sub> window. These LEDs show the *Logic Save Status*, *Logic Diagram Status*, and *Logic Layer Status*. Table 5-4 defines the colors for each LED.

**Table 5-4. Status LEDs**

| LED                                  | Color    | Definition                             |
|--------------------------------------|----------|----------------------------------------|
| Logic Save Status<br>(Left LED)      | ● Orange | Logic has changed since last save.     |
|                                      | ● Green  | Logic has NOT changed since last save. |
| Logic Diagram Status<br>(Center LED) | ● Red    | Requirements NOT met as listed above.  |
|                                      | ● Green  | Requirements met as listed above.      |
| Logic Layer Status<br>(Right LED)    | ● Red    | Requirements NOT met as listed above.  |
|                                      | ● Green  | Requirements met as listed above.      |

### Pickup and Dropout Timers

A pickup timer produces a TRUE output when the elapsed time is greater than or equal to the Pickup Time setting after a FALSE to TRUE transition occurs on the Initiate input from the connected logic. Whenever the Initiate input status transitions to FALSE, the output transitions to FALSE immediately.

A drop out timer produces a TRUE output when the elapsed time is greater than or equal to the Dropout Time setting after a TRUE to FALSE transition occurs on the Initiate input from the connected logic. Whenever the Initiate input transitions to TRUE, the output transitions to FALSE immediately.

Refer to Figure 5-2, *Pickup and Dropout Logic Timer Blocks*.

To program logic timer settings, use the Settings Explorer within BESTCOMSP<sub>Plus</sub> to open the *BESTlogicPlus Programmable Logic/Logic Timers* tree branch. Enter a *Name* label that you want to appear on the timer logic block. The *Time Delay* value range is 0 to 250 hours in 1 hour increments, 0 to 250 minutes in 1 minute increments, or 0 to 1,800 seconds in 0.1 second increments.

Next, open the *Components* tab inside the BESTlogicP<sub>Plus</sub> window and drag a timer onto the program grid. Right click on the timer to select the timer you want to use that was previously set on the *Logic Timers* tree branch. The *Logic Timer Properties Dialog Box* will appear. Select the timer you want to use.

Timing accuracy is  $\pm 15$  milliseconds.

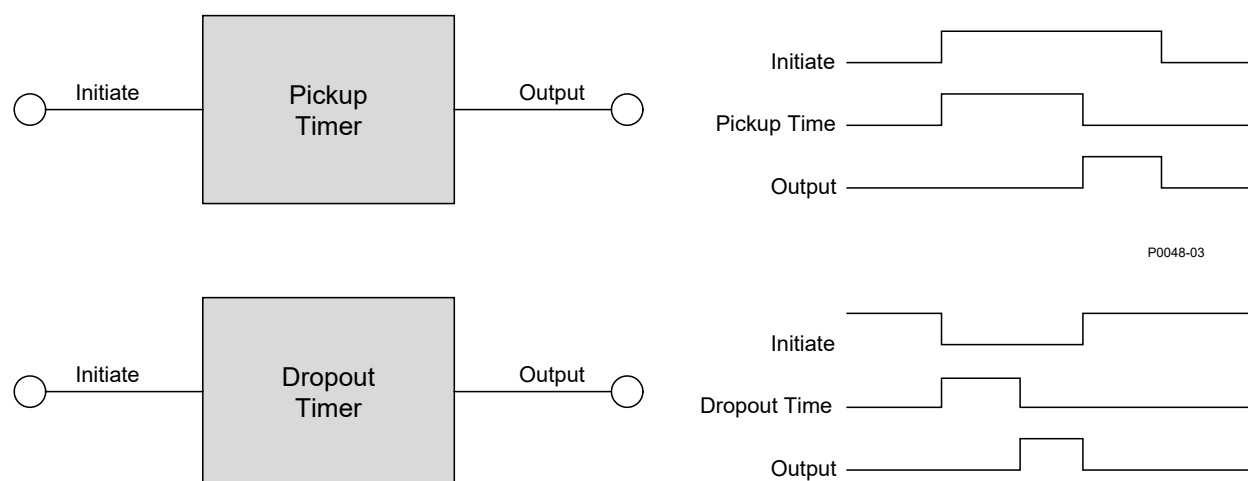


Figure 5-2. Pickup and Dropout Timer Logic Blocks

## Offline Logic Simulator

The offline logic simulator allows you to change the state of various logic elements to illustrate how that state travels through the system. Before running the logic simulator, you must click the Save button on the BESTlogicPlus toolbar to save the logic to memory. Changes to the logic (other than changing the state) are disabled when the simulator is enabled. Colors are selected by clicking the Options button on the BESTlogicPlus toolbar. By default, Logic 0 is red and Logic 1 is green. Using your mouse, double-click on a logic element to change its state.

An example of the offline logic simulator is shown in Figure 5-3. Output 1 is Logic 0 (red) when Virtual Switch 1 is Logic 0 (red) and Fixed 1 is Logic 1 (green).

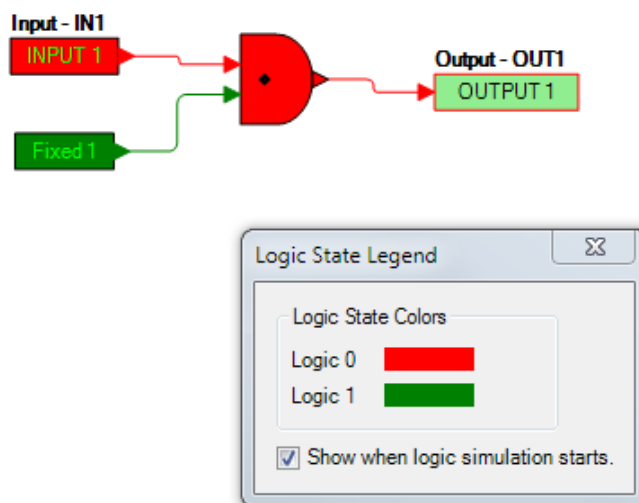


Figure 5-3. Offline Logic Simulator Example

## BESTlogic™ Plus File Management

To manage BESTlogicPlus files, use the Settings Explorer to open the *BESTlogicPlus Programmable Logic* tree branch. Use the BESTlogicPlus Programmable Logic toolbar to manage BESTlogicPlus files. Refer to Figure 5-4. For information on Settings Files management, refer to Section 4, *BESTCOMSPPlus® Software*.



Figure 5-4. BESTlogicPlus Programmable Logic Toolbar

#### Saving a BESTlogic™ Plus File

After programming BESTlogicPlus settings, click on the *Save* button to save the settings to memory.

Before the new BESTlogicPlus settings can be uploaded to the DGC-2020, you must select *Save* from the *File* pull-down menu located at the top of the BESTCOMSPlus main shell. This step will save both the BESTlogicPlus settings and the operating settings to a file.

The user also has the option to save the BESTlogicPlus settings to a unique file that contains only BESTlogicPlus settings. Click on the *Logic Library* drop-down button and select *Save Logic Library File*. Use normal Windows® techniques to browse to the folder where you want to save the file and enter a filename to save as.

#### Opening a BESTlogic™ Plus File

To open a saved BESTlogicPlus file, click on the *Logic Library* drop-down button on the BESTlogicPlus Programmable Logic toolbar and select *Open Logic Library File*. Use normal Windows techniques to browse to the folder where the file is located.

#### Protecting a BESTlogic™ Plus File

Objects in a logic diagram can be locked so that when the logic document is protected these objects cannot be changed. Locking and protecting is useful when sending logic files to other personnel to be modified. The locked object(s) cannot be changed. To view the lock status of the object(s), select *Show Lock Status* from the *Protection* drop-down menu. To lock object(s), use the mouse to select object(s) to be locked. Right click on the selected object(s) and select *Lock Object(s)*. The gold colored padlock next to the object(s) will change from an open to a locked state. To protect a logic document, select *Protect Logic Document* from the *Protection* drop-down button. A password is optional.

#### Uploading a BESTlogic™ Plus File

To upload a BESTlogicPlus file to the DGC-2020, you must first open the file through BESTCOMSPlus or create the file using BESTCOMSPlus. Then pull down the *Communication* menu and select *Upload Logic*.

#### Downloading a BESTlogic™ Plus File

To download a BESTlogicPlus file from the DGC-2020, you must pull down the *Communication* menu and select *Download Logic*. If the logic in your BESTCOMSPlus has changed, a dialog box will open asking you if you want to save the current logic changes. You may choose *Yes* or *No*. After you have taken the required action to save or not save the current logic, the downloading is executed.

#### Printing a BESTlogic™ Plus File

To view a preview of the printout, click on the *Print Preview* icon located on the BESTlogicPlus Programmable Logic toolbar. If you wish to print to a printer, select the printer icon in the upper left corner of the *Print Preview* screen.

You may skip the print preview and go directly to print by clicking on the *Printer* icon on the BESTlogicPlus Programmable Logic toolbar. A dialog box, *Select Views to Print* opens allowing you to check which views you would like to print. Next, the *Print* dialog box opens with the typical Windows choice to setup the properties of printer. Execute this command, as necessary, and then select *Print*.

A *Page Setup* icon is also provided on the BESTlogicPlus Programmable Logic toolbar allowing you to select *Paper Size*, *Paper Source*, *Orientation*, and *Margins*.

#### Clearing the On-Screen Logic Diagram

Click on the *Clear* button to clear the on-screen logic diagram and start over.

## BESTlogic™ Plus Examples

### Example 1 - AVR Logic Block Connections

Figure 5-5 illustrates the AVR logic block and two output logic blocks. Output 6 is active while the AVR is being raised and Output 9 is active while the AVR is being lowered.

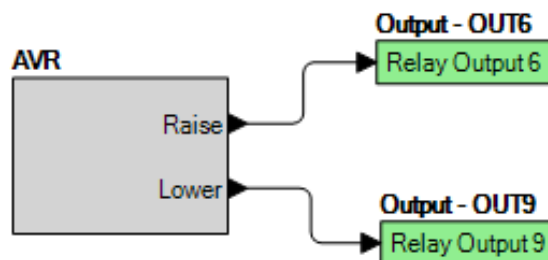


Figure 5-5. Example 1 - AVR Logic Block Connections

### Example 2 - AND Gate Connections

Figure 5-6 illustrates a typical AND gate connection. In this example, Output 11 will become active when the Low Fuel alarm AND the Low Oil Pressure alarm are TRUE.

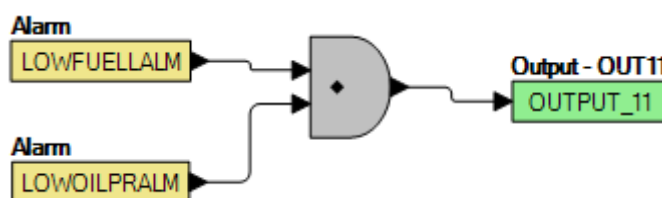


Figure 5-6. Example 2 - AND Gate Connections

### Example 3 - Multiple Logic Connections

In this example, there are two comment boxes, which may be placed on the logic diagram. Double-click a comment box to modify the inside text. Output 5 will become TRUE when the 27TRIP is TRUE. Output 7 will become TRUE when the Cool Temp Sender Fail is TRUE. Output 1 will become TRUE when the DGC-2020 is in Run mode (Run Mode TRUE). Refer to Figure 5-7.

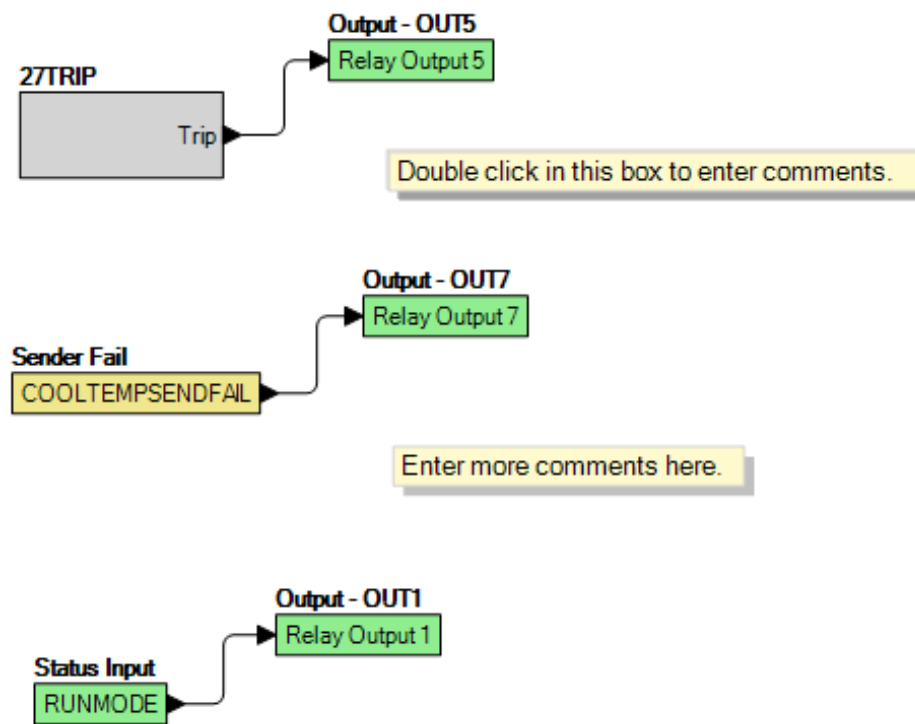


Figure 5-7. Example 3 - Multiple Logic Connections



## 6 • Installation

DGC-2020 controllers are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a unit, check the part number against the requisition and packing list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify the Basler Electric regional sales office or your sales representative.

If the device is not installed immediately, store it in the original shipping package in a moisture- and dust-free environment.

### Hardware

DGC-2020 controllers are packaged for mounting in any top-mount enclosure. The front panel is resistant to moisture, salt fog, humidity, dust, dirt, and chemical contaminants. DGC-2020 controllers are mounted using the four permanently attached 10-24 studs. The torque applied to the mounting hardware should not exceed 25 inch-pounds (2.8 Newton meters).

### Mounting

Panel cutting and drilling dimensions are shown in Figure 6-1. The horizontal drilling measurement of 10.75 inches has a tolerance of  $+0.01/-0.01$  inches. The horizontal cutout measurement of 10.38 inches has a tolerance of  $+0.04/-0$  inches. The vertical drilling measurement of 7.25 inches has a tolerance of  $+0.01/-0.01$  inches. The vertical cutout measurement of 6.88 inches has a tolerance of  $+0.04/-0$ . Overall dimensions are shown in Figure 6-2. All dimensions are shown in inches with millimeters in parenthesis.

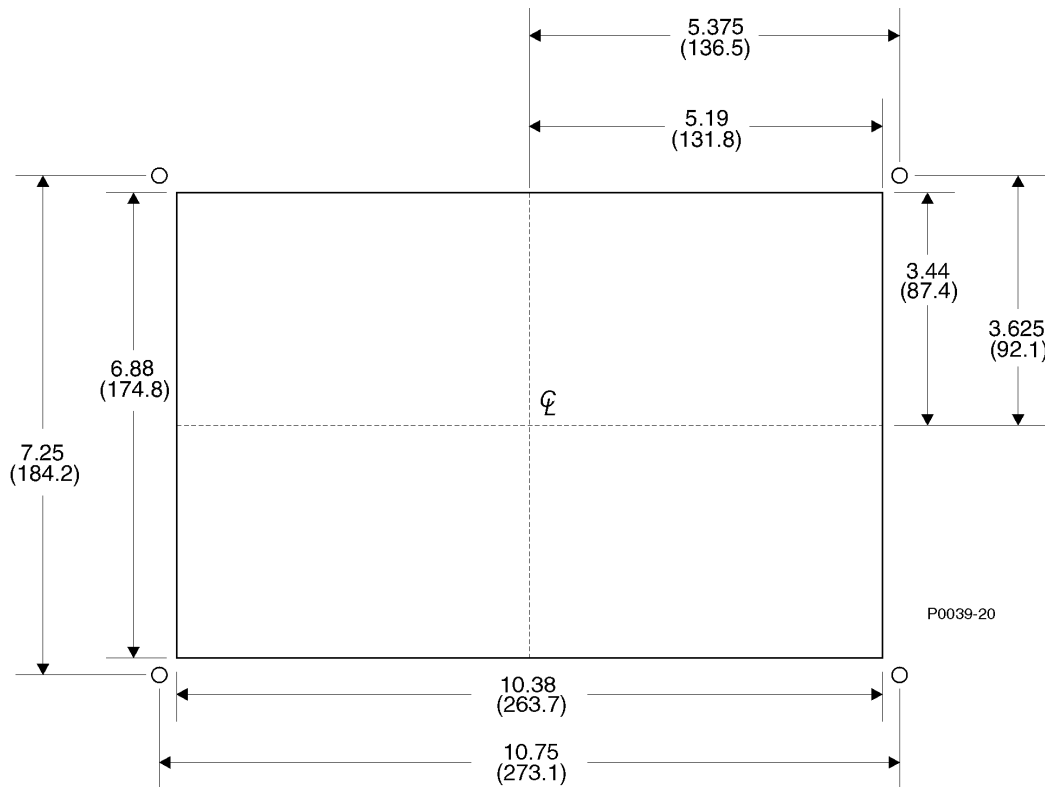


Figure 6-1. Panel Cutting and Drilling Dimensions

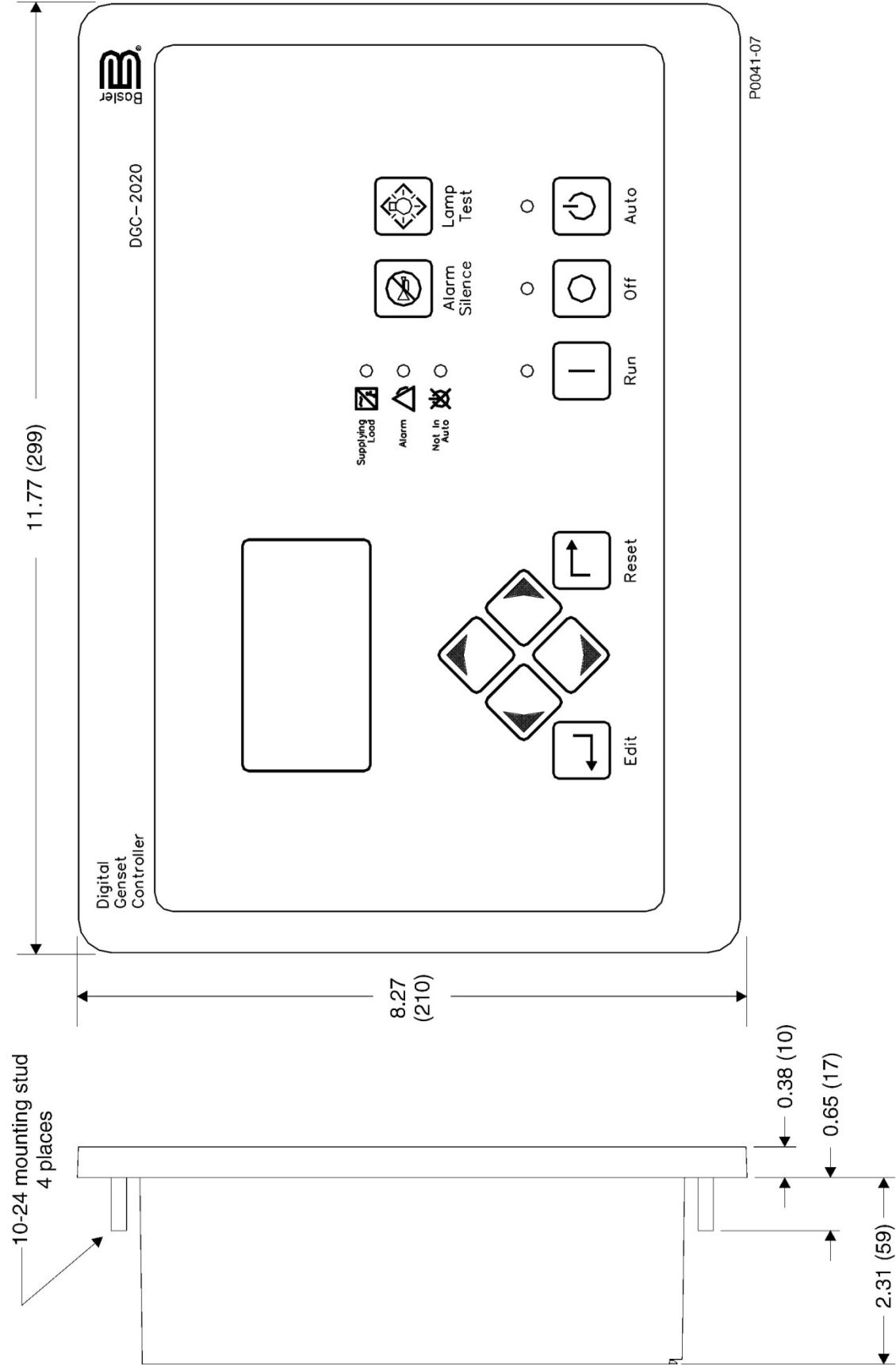


Figure 6-2. Overall Dimensions



## Connections

DGC-2020 connections are dependent on the application. Incorrect wiring may result in damage to the controller.

### Notes

Be sure that the DGC-2020 is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the chassis ground terminal (terminal 1) on the rear of the controller.

Operating power from the battery must be of the correct polarity. Although reverse polarity will not cause damage, the DGC-2020 will not operate.

For the DGC-2020 to correctly meter power factor, the generator must be rotating clockwise (A-B-C).

## Terminations

All DGC-2020 terminals are located on the rear panel of the controller. There are three types of interface terminals: a mini-B USB socket, plug-in connectors with screw-down compression terminals, and quarter-inch, male, quick-connect terminals. DGC-2020 controllers with style number xxxxxExxx are equipped with an RS-232 port. This port allows communication with an external, user-supplied modem with dial-in and dial-out capability.

The mini-B USB socket mates with a standard USB cable and provides local communication between the DGC-2020 and a PC running BESTCOMSP<sup>Plus</sup>® software.

The majority of DGC-2020 connections are made with 15-position connectors with screw-down compression terminals. These connectors plug into headers on the DGC-2020. The connectors and headers have a dovetailed edge that ensures proper connector orientation. Each connector and header is uniquely keyed to ensure that a connector mates only with the correct header. Connector screw terminals accept a maximum wire size of 12 AWG. Maximum screw torque is four inch-pounds (0.45 N•m).

Connections to the DGC-2020 starter, fuel solenoid, and glow plug output contacts are made directly to each relay through quarter-inch, male, quick-connect terminals. Amp part numbers 154718-3 (positive-lock receptacle) and 154719-1 (nylon housing) are the recommended components for making connections at these terminals.

DGC-2020 terminal groups are described in the following paragraphs.

### Operating Power

The DGC-2020 operating power input accepts either 12 Vdc or 24 Vdc and tolerates voltage over the range of 6 to 32 Vdc. Operating power must be of the correct polarity. Although reverse polarity will not cause damage, the DGC-2020 will not operate. Operating power terminals are listed in Table 6-1.

To follow UL guidelines, a 5A maximum, 32 Vdc supplementary fuse must be implemented in the battery input circuit to the DGC-2020.

**Table 6-1. Operating Power Terminals**

| Terminal    | Description                            |
|-------------|----------------------------------------|
| 1 (CHASSIS) | Chassis ground connection              |
| 2 (BATT-)   | Negative side of operating power input |
| 3 (BATT+)   | Positive side of operating power input |

### Generator Current Sensing

The DGC-2020 has sensing inputs for A-phase, B-phase, and C-phase generator current. Depending on the style number, a DGC-2020 will have a nominal sensing current rating of 1 Aac or 5 Aac. A style number of 1xxxxxxx indicates 1 Aac nominal current sensing and a style number of 5xxxxxxx indicates 5 Aac nominal current sensing. Generator current sensing terminals are listed in Table 6-2.

**Table 6-2. Generator Current Sensing Terminals**

| Terminal | Description                   |
|----------|-------------------------------|
| 68 (IA–) | A-phase current sensing input |
| 69 (IA+) |                               |
| 71 (IB–) | B-phase current sensing input |
| 72 (IB+) |                               |
| 74 (IC–) | C-phase current sensing input |
| 75 (IC+) |                               |

#### **NOTE**

Unused current sensing inputs should be shorted to minimize noise pickup.

### Generator Voltage Sensing

The DGC-2020 accepts either line-to-line or line-to-neutral generator sensing voltage over the range of 12 to 576 volts, rms line-to-line. Depending on the style number, a DGC-2020 will have a nominal generator frequency rating of 50/60 hertz or 400 hertz. A style number of x1xxxxxx indicates 50/60 hertz generator voltage and a style number of x2xxxxxx indicates 400-hertz generator voltage. Generator voltage sensing terminals are listed in Table 6-3.

**Table 6-3. Generator Voltage Sensing Terminals**

| Terminal    | Description                             |
|-------------|-----------------------------------------|
| 35 (GEN VN) | Neutral generator voltage sensing input |
| 37 (GEN VC) | C-phase generator voltage sensing input |
| 39 (GEN VB) | B-phase generator voltage sensing input |
| 41 (GEN VA) | A-phase generator voltage sensing input |

### Installation in an Ungrounded System Application

When the DGC-2020 is controlling equipment that is part of an ungrounded system, it is recommended that potential transformers be employed on the voltage sensing inputs to provide full isolation between the DGC-2020 and monitored voltage phases.

### Bus Voltage Sensing

Sensing of bus voltage enables the DGC-2020 to detect failures of the mains (utility). Controllers with style number xxxxxxxAx use bus voltage sensing to perform automatic synchronization of the generator with the bus (style number xxxxxxxAx only). The DGC-2020 senses single- or three-phase bus voltage.

Sensing voltage is applied to terminals 76 (A-phase), 78 (B-phase), and 80 (C-phase). Terminal 45 is internally tied to 76 and terminal 43 is internally tied to 78. This accommodates the use of connectors wired for legacy DGC-2020 versions. Bus voltage sensing terminals are listed in Table 6-4.

**Table 6-4. Bus Voltage Sensing Terminals**

| Terminal        | Description                       |
|-----------------|-----------------------------------|
| 76, 45 (BUS VA) | A-phase bus voltage sensing input |
| 78, 43 (BUS VB) | B-phase bus voltage sensing input |
| 80 (BUS VC)     | C-phase bus voltage sensing input |

**Installation in an Ungrounded System Application**

When the DGC-2020 is controlling equipment that is part of an ungrounded system, it is recommended that potential transformers be employed on the voltage sensing inputs to provide full isolation between the DGC-2020 and monitored voltage phases.

**Analog Engine Sender Inputs**

Inputs are provided for oil pressure, fuel level, and coolant temperature senders.

Sender input terminals are listed in Table 6-5.

**Table 6-5. Sender Input Terminals**

| Terminal        | Description                      |
|-----------------|----------------------------------|
| 8 (OIL)         | Oil pressure sender input        |
| 9 (FUEL)        | Fuel level sender input          |
| 10 (COOLANT)    | Coolant temperature sender input |
| 11 (SENDER COM) | Sender return terminal           |

**Emergency Stop Input**

The emergency stop input is intended for use with a normally closed switch and recognizes an emergency stop input when the connection from terminal 46 (ESTOP) to ground is removed. See Figure 6-3. The ESTOP can be up to 75 ft (22 m) away from the DGC-2020 using a maximum wire length of 150 ft (45 m). Emergency stop input terminals are listed in Table 6-6. Terminal 47 is only used in the *Optional Wiring Method* below.

**Table 6-6. Emergency Stop Input Terminals**

| Terminal   | Description                  |
|------------|------------------------------|
| 46 (ESTOP) | Emergency stop contact input |
| 47 (ESTOP) |                              |

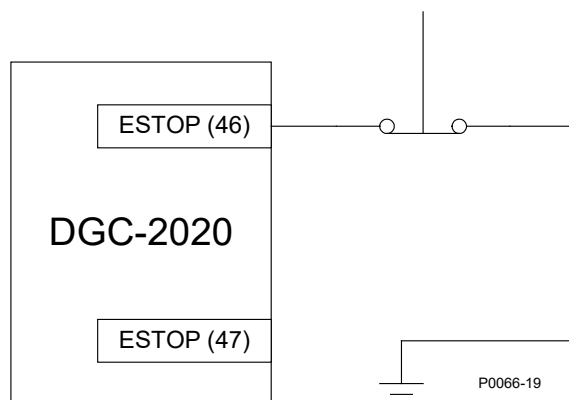


**Figure 6-3. Emergency Stop Input Connections**

### Optional ESTOP Wiring Method

The following describes an optional wiring method for the emergency stop input. This method is no longer preferred. The emergency stop input is intended for use with a normally closed switch and recognizes an emergency stop input when the short-circuit across the input is removed. See Figure 6-4. The ESTOP can be up to 75 ft (22 m) away from the DGC-2020 using a maximum wire length of 150 ft (45 m). Emergency stop input terminals are listed in Table 6-6.

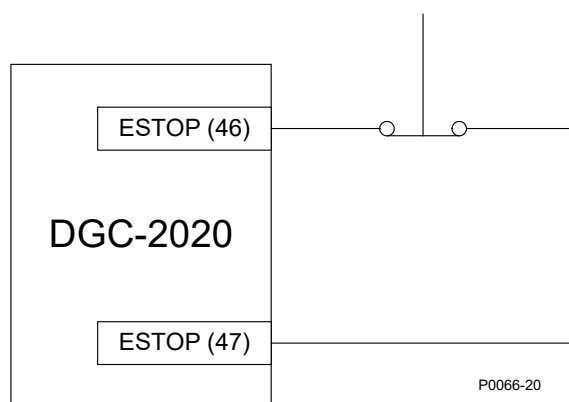


**Figure 6-4. Emergency Stop Input Connections (Optional Wiring Method)**

### Magnetic Pickup Input

The magnetic pickup input accepts a speed signal over the range of 3 to 35 volts peak and 32 to 10,000 hertz. Magnetic pickup input terminals are listed in Table 6-7.

**Table 6-7. Magnetic Pickup Input Terminals**

| Terminal  | Description                    |
|-----------|--------------------------------|
| 31 (MPU+) | Magnetic pickup positive input |
| 32 (MPU-) | Magnetic pickup return input   |

### Contact Sensing Inputs

Contact sensing inputs consist of 1 emergency stop input and 16 programmable inputs.

The programmable inputs accept normally open, dry contacts. Terminal 2 (BATT–) serves as the common return line for the programmable inputs. Information about configuring the programmable inputs is provided in Section 4, *BESTCOMSPlus® Software*.

Contact sensing input terminals are listed in Table 6-8.

**Table 6-8. Contact Sensing Inputs**

| Terminal      | Description                                        |
|---------------|----------------------------------------------------|
| 2 (BATT–)     | Common return line for programmable contact inputs |
| 15 (INPUT 16) | Programmable contact input 16                      |
| 16 (INPUT 15) | Programmable contact input 15                      |
| 17 (INPUT 14) | Programmable contact input 14                      |
| 18 (INPUT 13) | Programmable contact input 13                      |
| 19 (INPUT 12) | Programmable contact input 12                      |
| 20 (INPUT 11) | Programmable contact input 11                      |
| 21 (INPUT 10) | Programmable contact input 10                      |
| 22 (INPUT 9)  | Programmable contact input 9                       |
| 23 (INPUT 8)  | Programmable contact input 8                       |
| 24 (INPUT 7)  | Programmable contact input 7                       |
| 25 (INPUT 6)  | Programmable contact input 6                       |
| 26 (INPUT 5)  | Programmable contact input 5                       |
| 27 (INPUT 4)  | Programmable contact input 4                       |
| 28 (INPUT 3)  | Programmable contact input 3                       |
| 29 (INPUT 2)  | Programmable contact input 2                       |
| 30 (INPUT 1)  | Programmable contact input 1                       |

### Output Contacts

The DGC-2020 has three sets of fixed-function output contacts: Pre, Start, and Run. The Pre contacts supply battery power to the engine glow plugs, the Start contacts supply power to the start solenoid, and the Run contacts supply power to the fuel solenoid. Connections to the three sets of contacts are made directly at each relay using female, quarter-inch, quick-connect terminals. Amp part numbers 154718-3 (positive-lock receptacle) and 154719-1 (nylon housing) are the recommended components for making connections at each relay. For the location of the Pre, Start, and Run relays refer to Figure 2-2.

Depending on the style number of the DGC-2020, either 4 or 12 sets of programmable output contacts are provided. Four programmable outputs are provided on DGC-2020 controllers with a style number of xxAxxxxxx. Twelve programmable outputs are provided on controllers with a style number of xxBxxxxxx. Programmable output contact terminals are listed in Table 6-9.

### **Note**

It is recommended in all applications where contact outputs drive relay coils that a reverse biased diode be implemented in parallel with the relay coil for EMI suppression.

**Table 6-9. Programmable Output Contact Terminals**

| Terminal         | Description                               |
|------------------|-------------------------------------------|
| 51 (COM 1, 2, 3) | Common connection for outputs 1, 2, and 3 |

| Terminal            | Description                                  |
|---------------------|----------------------------------------------|
| 52 (OUT 1)          | Programmable output 1                        |
| 53 (OUT 2)          | Programmable output 2                        |
| 54 (OUT 3)          | Programmable output 3                        |
| 55 (COM 4, 5, 6)    | Common connection for outputs 4, 5, and 6    |
| 56 (OUT 4)          | Programmable output 4                        |
| 57 (OUT 5)          | Programmable output 5                        |
| 58 (OUT 6)          | Programmable output 6                        |
| 59 (COM 7, 8, 9)    | Common connection for outputs 7, 8, and 9    |
| 60 (OUT 7)          | Programmable output 7                        |
| 61 (OUT 8)          | Programmable output 8                        |
| 62 (OUT 9)          | Programmable output 9                        |
| 63 (COM 10, 11, 12) | Common connection for outputs 10, 11, and 12 |
| 64 (OUT 10)         | Programmable output 10                       |
| 65 (OUT 11)         | Programmable output 11                       |
| 66 (OUT 12)         | Programmable output 12                       |

### USB Interface

A mini-B USB socket enables local communication with a PC running BESTCOMSP<sup>Plus</sup> software. The DGC-2020 is connected to a PC using a standard USB cable equipped with a type A plug on one end (PC termination) and a mini-B plug on the other end (DGC-2020 termination).

### RS-485 Communication Port

DGC-2020 controllers with the optional RS-485 communication port (style number xxxRxxxxx) are equipped for polled communication over a Modbus<sup>®</sup> network. Twisted-pair, shielded cable is recommended for RS-485 port connections. RS-485 communication port terminals are listed in Table 6-10.

**Table 6-10. RS-485 Communication Port Terminals**

| Terminal        | Description                        |
|-----------------|------------------------------------|
| 12 (485 SHIELD) | Shield connection for RS-485 cable |
| 13 (485B)       | RS-485 send/receive B connection   |
| 14 (485A)       | RS-485 send/receive A connection   |

### CAN Bus Interface

These terminals provide communication using the SAE J1939 protocol or the *mtu* protocol and provide high-speed communication between the DGC-2020 and an *mtu* engine ECU on an electronically controlled engine. Connections between the *mtu* engine ECU and DGC-2020 should be made with twisted-pair, shielded cable. CAN Bus interface terminals are listed in Table 6-11. Refer to Figure 6-5 and Figure 6-6.

**Table 6-11. CAN Bus Interface Terminals**

| Terminal    | Description          |
|-------------|----------------------|
| 48 (CAN L)  | CAN low connection   |
| 49 (CAN H)  | CAN high connection  |
| 50 (SHIELD) | CAN drain connection |

**Notes**

1. If the DGC-2020 is providing one end of the J1939 bus, a 120-ohm  $\frac{1}{2}$  watt terminating resistor should be installed across terminals 48 (CANL) and 49 (CANH).
2. If the DGC-2020 is not part of the J1939 bus, the stub connecting the DGC-2020 to the bus should not exceed 914 mm (3 ft) in length.
3. The maximum bus length, not including stubs, is 40 m (131 ft).
4. The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the DGC-2020.

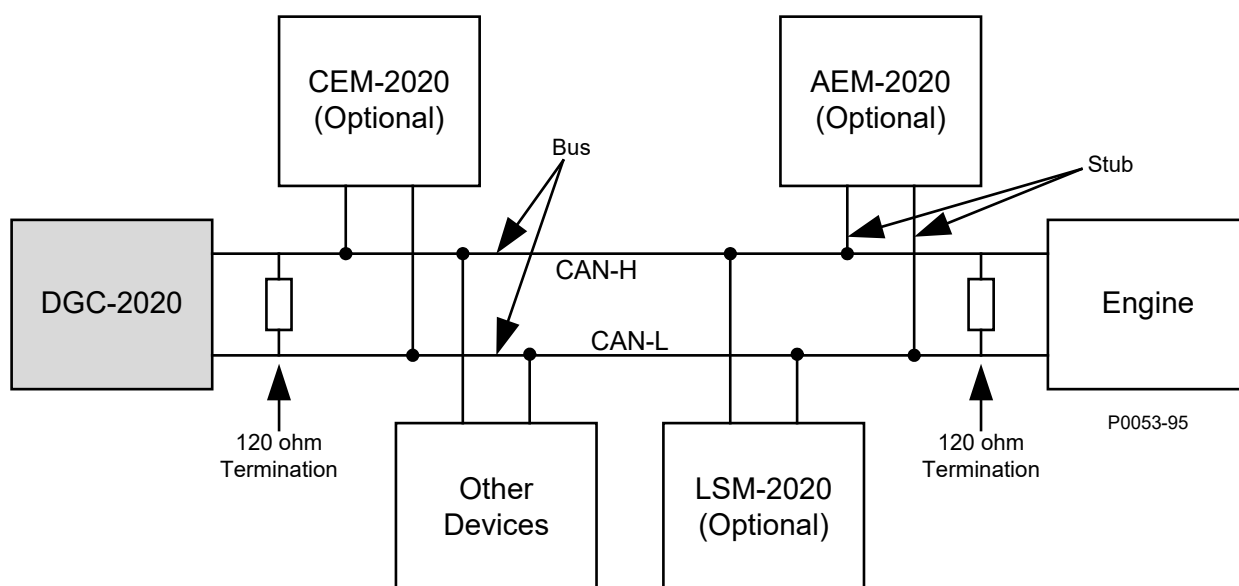


**Figure 6-5. CAN Bus Interface with DGC-2020 providing One End of the Bus**

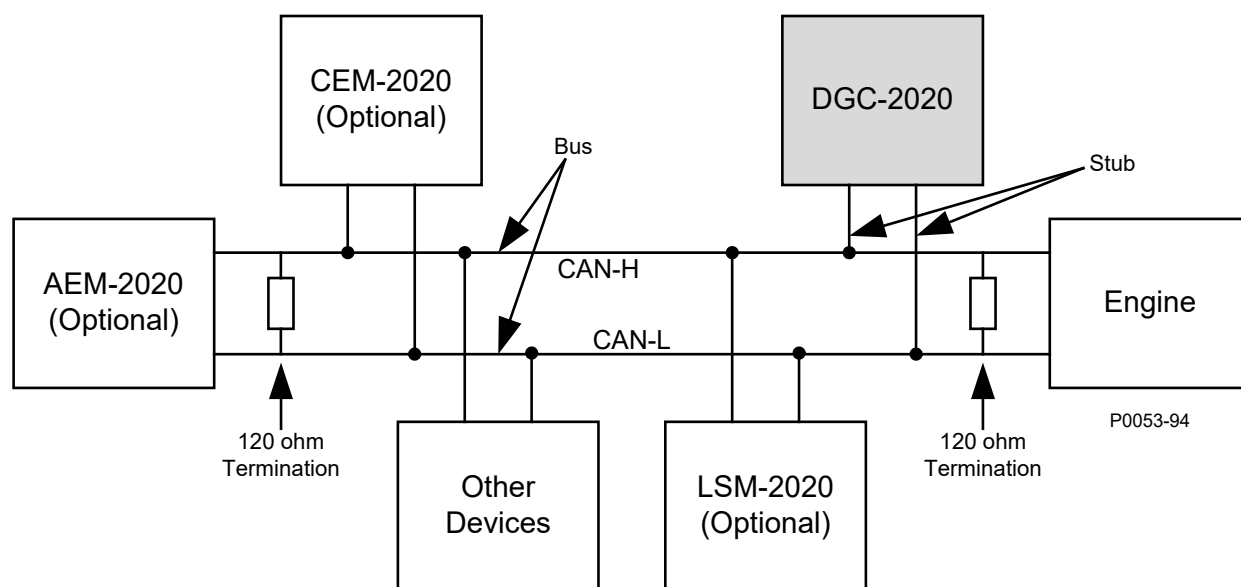


**Figure 6-6. CAN Bus Interface with Optional AEM-200 providing One End of the Bus**

### Modem

DGC-200 controllers with style number xxxxxExxx are equipped with an RS-232 port. This port allows communication with an external, user-supplied modem with dial-in and dial-out capability. The modem connects to a standard-device telephone line through a USOC RJ-11C jack.

### RDP-110 Connections

Terminals are provided for connection with the optional RDP-110 remote display panel. These terminals provide dc operating power to the RDP-110 and enable communication between the DGC-200 and RDP-110. Twisted-pair conductors are recommended for connecting the communication terminals of the DGC-200 and RDP-110. Communication may become unreliable if the connection wires exceed 4,000 feet.

Table 6-12 lists the DGC-200 terminals that connect to the RDP-110.

**Table 6-12. RDP-110 Interface Terminals**

| Terminal      | Connects To:            |
|---------------|-------------------------|
| 4 (RDP BATT+) | RDP-110 terminal 12/24  |
| 5 (RDP BATT-) | RDP-110 terminal DC COM |
| 6 (RDP TXD-)  | RDP-110 terminal 485-   |
| 7 (RDP TXD+)  | RDP-110 485+            |

## **Connections for Typical Applications**

### Generator Breaker Control Applications

Generator voltage sensing, generator current sensing, and bus voltage sensing connections in three-phase wye, three-phase delta, grounded delta, single-phase A-B and single-phase A-C configurations for Generator Breaker Control applications are shown in Figures 6-9 through 6-13.

### Generator and Mains Breaker Control Applications

Generator voltage sensing, generator current sensing, and bus voltage sensing connections in a three-phase wye configuration for Generator and Mains Breaker Control applications are shown in Figure 6-12.



Although three-phase wye sensing connections are shown in the generator and mains breaker control diagram, other generator and bus voltage sensing configurations may be used instead.

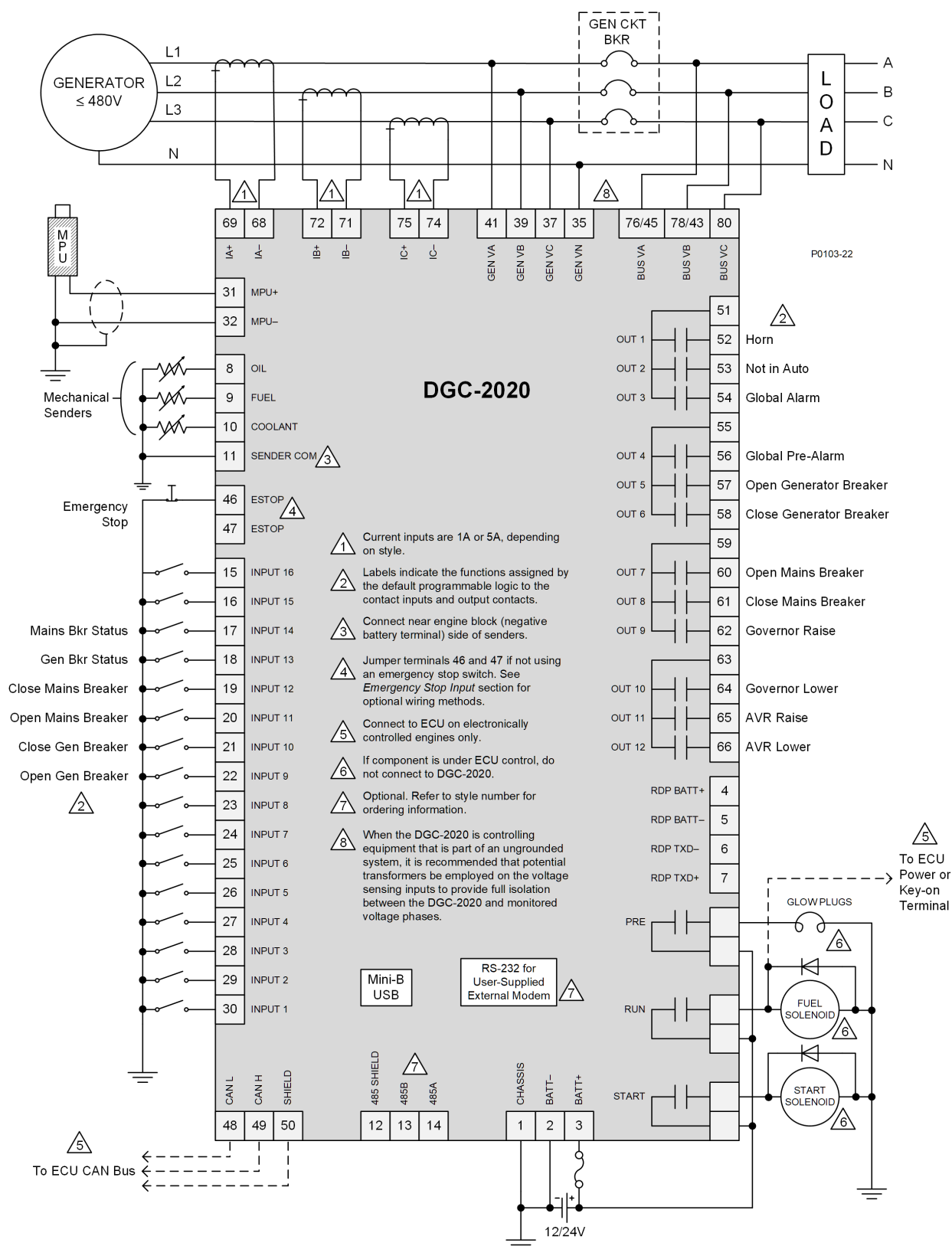


Figure 6-7. Three-Phase Wye Connections for Generator Breaker Control Applications

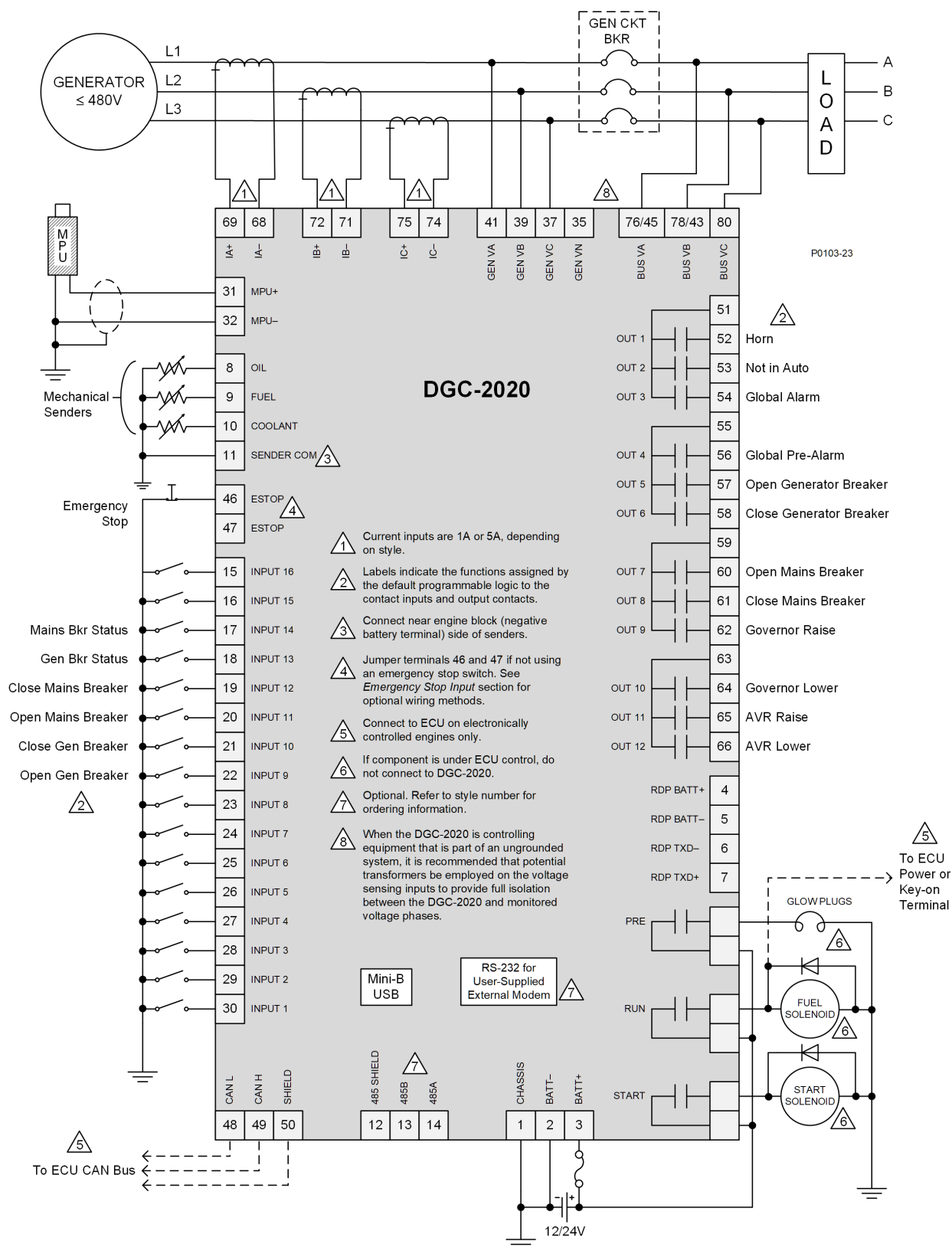


**Figure 6-8. Three-Phase Delta Connections for Generator Breaker Control Applications**

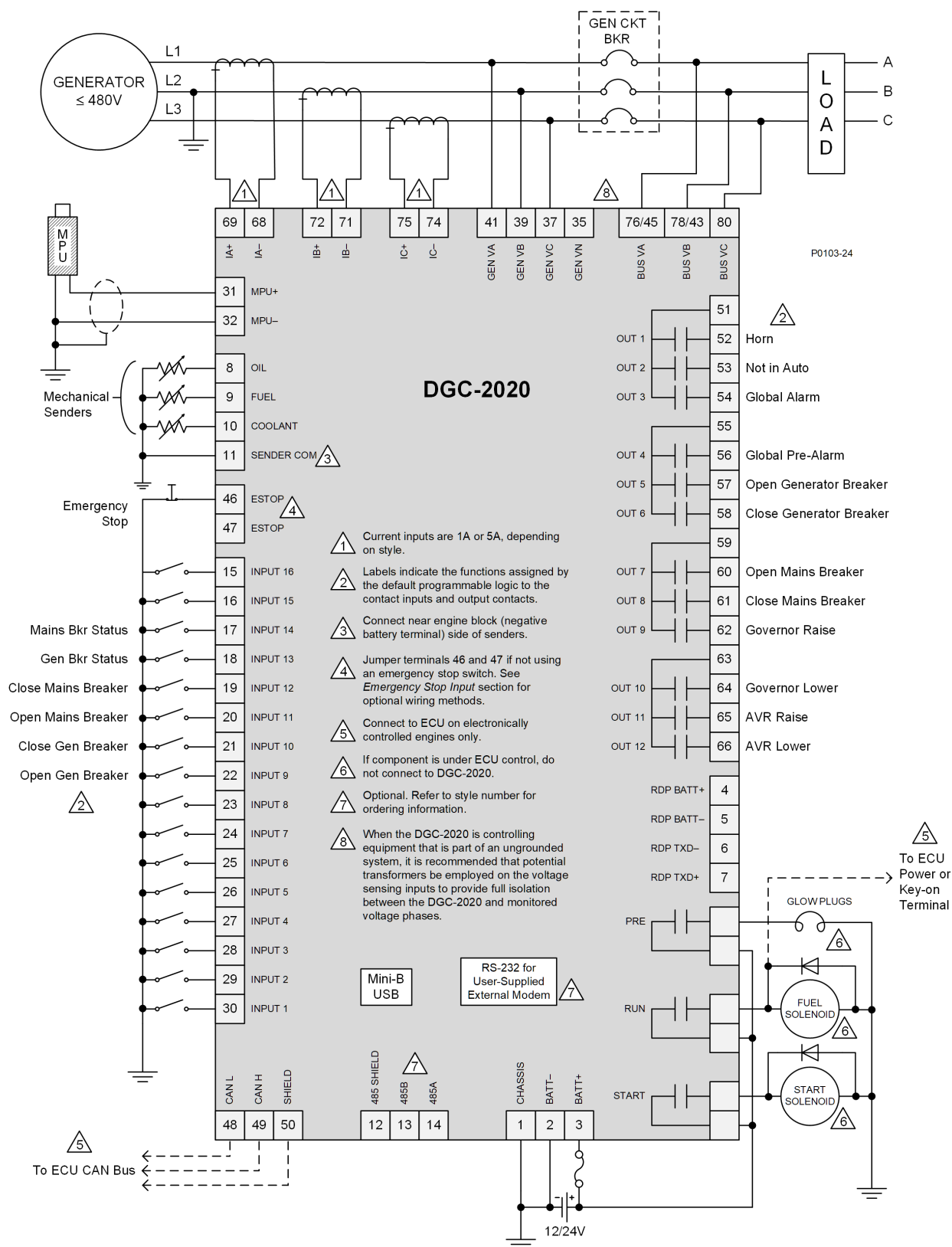


Figure 6-9. Grounded Delta Connections for Generator Breaker Control Applications

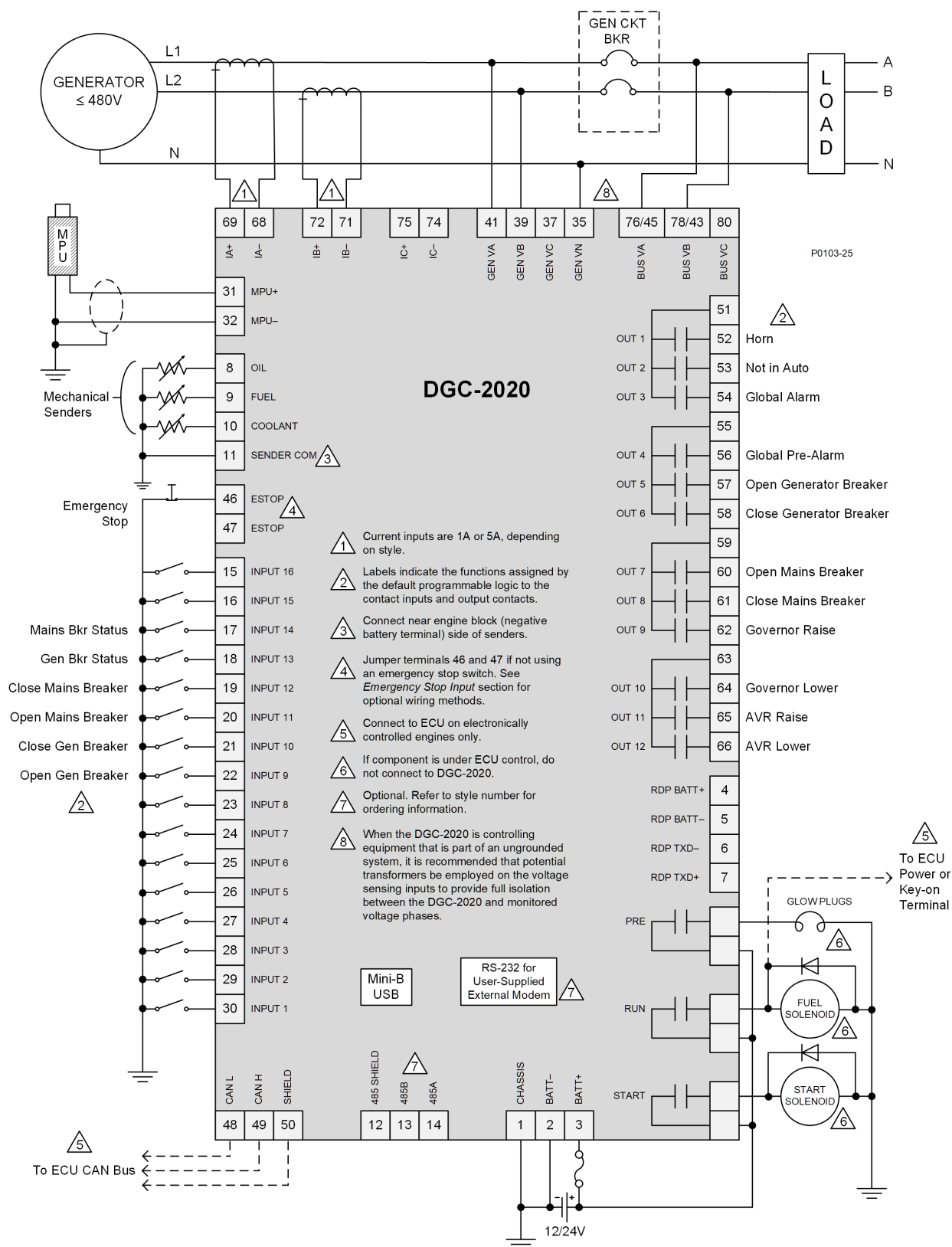


**Figure 6-10. Single-Phase A-B Connections for Generator Breaker Control Applications**

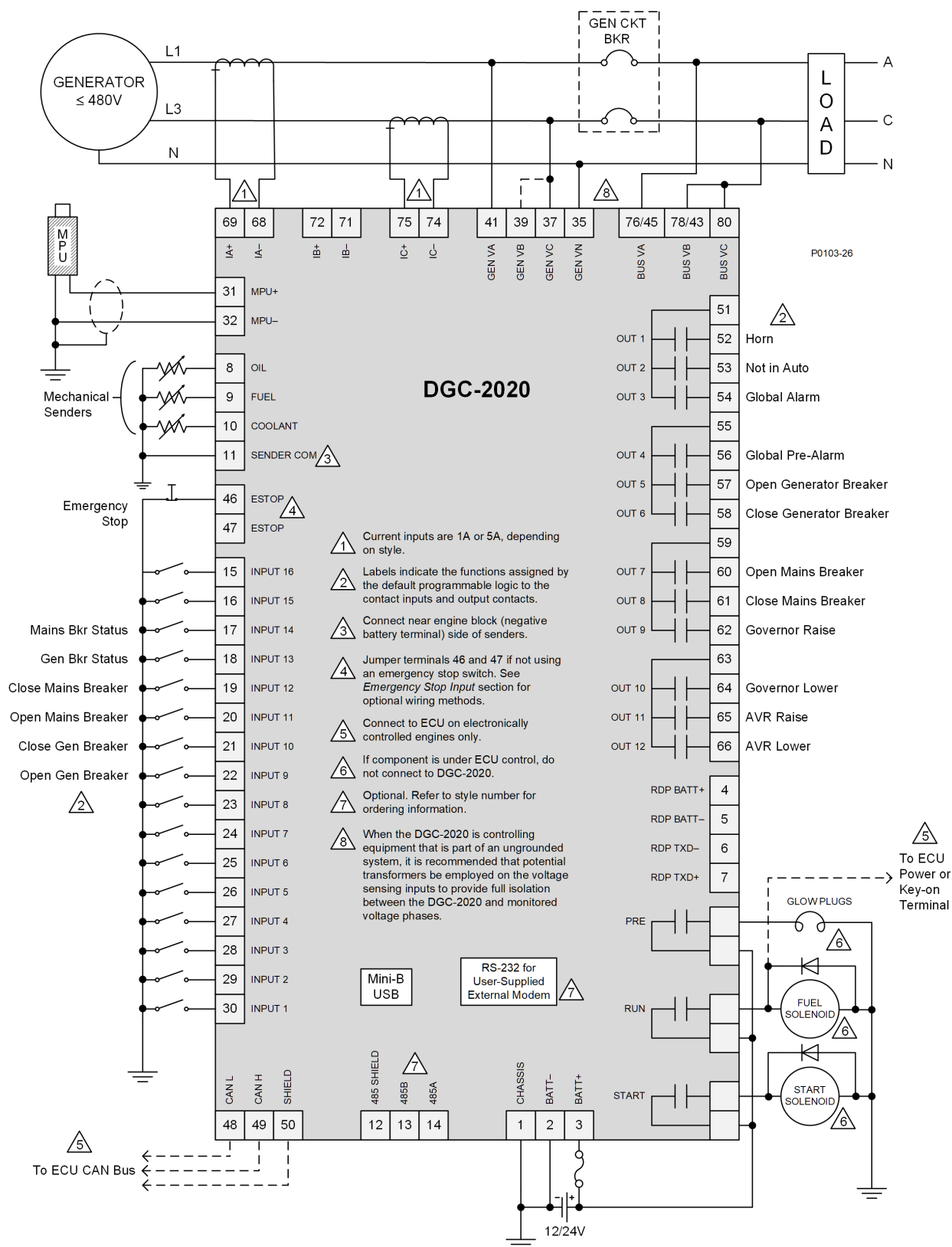


**Figure 6-11. Single-Phase A-C Connections for Generator Breaker Control Applications**



## Connections with AEM-2020, CEM-2020, and LSM-2020

The AEM-2020 (Analog Expansion Module), CEM-2020 (Contact Expansion Module), and LSM-2020 (Load Share Module) are optional modules that may be installed with the DGC-2020. These modules interface to the DGC-2020 via CAN Bus, thus the CAN Bus terminals are the only common connections (Figure 6-13) between the DGC-2020, AEM-2020, CEM-2020, and LSM-2020. Refer to Section 9, *LSM-2020 (Load Share Module)*, for independent LSM-2020 connections. Refer to Section 10, *CEM-2020 (Contact Expansion Module)*, for independent CEM-2020 connections. Refer to Section 11, *AEM-2020 (Analog Expansion Module)*, for independent AEM-2020 connections. Refer to *Connections, CAN Bus Interface*, in this section for details on DGC-2020 CAN Bus connections.

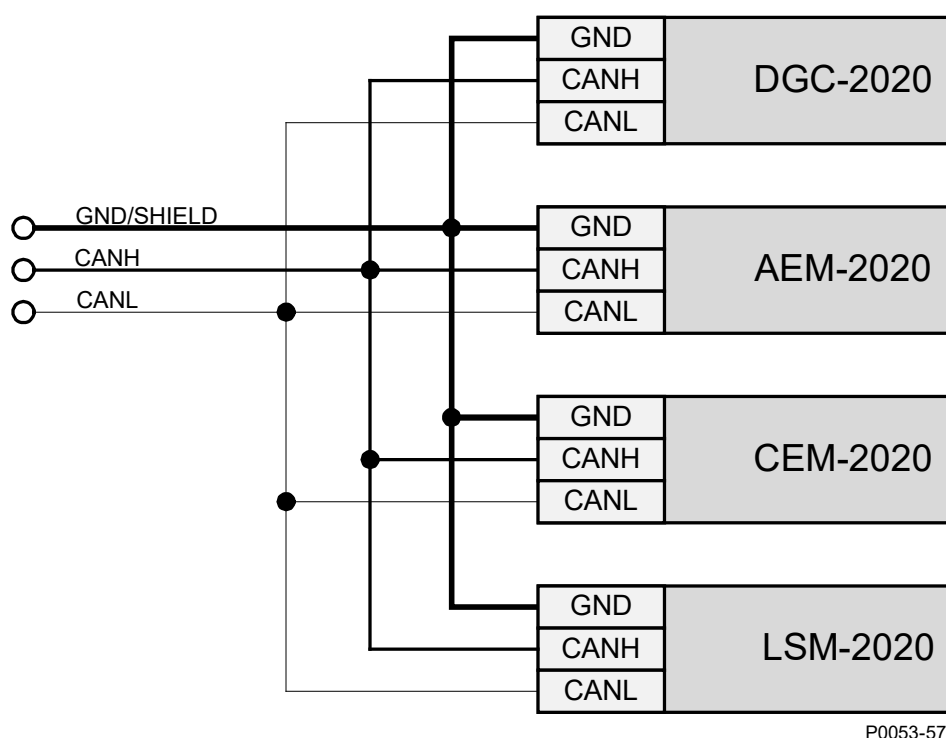


Figure 6-13. DGC-2020, AEM-2020, CEM-2020, LSM-2020 CAN Bus Connections

## Installation for CE Systems

For CE compliant systems, it may be required to route ac voltage and current sensing wires separately from other wires.

## Installation in a Salt Fog Environment

If the DGC-2020 will be installed in a salt-fog environment, it is recommended that the backup battery for the real-time clock be removed. Salt fog is known to be conductive and may short-circuit the battery.

Information on removing the backup battery for the real-time clock can be found in Section 8, *Maintenance and Troubleshooting*.

## Installation in an Ungrounded System Application

When the DGC-2020 is controlling equipment that is part of an ungrounded system, it is recommended that potential transformers be employed on the voltage sensing inputs to provide full isolation between the DGC-2020 and monitored voltage phases.





## 7 • Setup

The following paragraphs provide information for DGC-2020 initial setup, setting up DGC-2020 programmable inputs and outputs, generator and bus breaker control, synchronizer, setting up a DGC-2020 and LSM-2020 for a load sharing and kW control application, and mains fail transfer.

### ***DGC-2020 Initial Setup***

---

The DGC-2020 must be set up with parameters specific to the controlled machine in order to provide the desired machine control and protection. The following parameters must be configured prior to starting the machine. They are listed according to where they are found in BESTCOMSP<sup>Plus</sup>® in the Settings Explorer. These parameters can also be set through the front panel of the DGC-2020, but BESTCOMSP<sup>Plus</sup>® is generally more convenient.

In BESTCOMSP<sup>Plus</sup>®, if you are connected to the DGC-2020 and communicating with it, after changing settings you must click the *Send Settings* button in BESTCOMSP<sup>Plus</sup>® to send the settings to the DGC-2020. If you do not do this, or you do not save the modified settings to a settings file, setting information may be lost.

#### **Initial Setup Required to Operate Unit**

Once the following parameters are configured in the DGC-2020, it should be possible to run the machine. Only those parameters required are presented in this discussion.

##### General Settings

##### Style Number

Connect BESTCOMSP<sup>Plus</sup>® to the DGC-2020. Check the style number of the DGC-2020 unit and verify that it has all the features required for the machine being configured. For example, if it is expected that the machine perform synchronization, the synchronizer option must exist in the style number. See Figure 7-1. [Front Panel Navigation Path: SETTINGS > GENERAL SETTINGS > VERSION INFO > DGC-2020 > STYLE CODE](#)

**Style Number**  
DGC-2020 Style Number  
**DGC-2020-**
5 1 B R B X E A H

DGC-2020 Style Number Options

|   |                            |    |                         |
|---|----------------------------|----|-------------------------|
| 5 | Current Sensing Input Type | 5) | 5A CTs                  |
|   |                            | 1) | 1A CTs                  |
| 1 | Generator Frequency        | 1) | 50/60 Hz                |
|   |                            | 2) | 400 Hz                  |
| B | Output Contacts            | A) | 7 Output Contacts       |
|   |                            | B) | 15 Output Contacts      |
| R | Internal RS-485 Port       | N) | No Internal RS-485 Port |
|   |                            | R) | w/ Internal RS-485 Port |
| B | Battery Backup for RTC     | N) | No Battery              |
|   |                            | B) | w/ Battery              |
| X | Dial-out Modem             | X) | Excludes Modem          |
|   |                            | R) | RS-232                  |
| E | Generator Protection       | S) | Standard Gen Protection |
|   |                            | E) | Enhanced Gen Protection |
| A | Automatic Synchronizer     | N) | No Auto Sync            |
|   |                            | A) | w/ Auto Sync            |
| H | LCD Heater                 | H) | w/ LCD Heater           |

**Figure 7-1. Settings Explorer, General Settings, Style Number Screen**

### Communications

If the engine has an ECU (electronic control unit) and the DGC-2020 is to communicate with it, the communications must be set up.

### CAN Bus Setup (Figure 7-2)

Front Panel Navigation Path: **SETTINGS > COMMUNICATIONS > CAN Bus SETUP**

1. Enable ECU Support - Set to Enabled for the DGC-2020 to communicate with the ECU.
2. Enable DTC (Diagnostic Trouble Code) Support - If the ECU is a J1939 ECU, enable DTC support. If the engine ECU does not support it, no diagnostic trouble codes will be logged by the DGC-2020.
3. SPN Conversion Method - When this bit is a zero, the conversion method is indicated as version 4. The DGC-2020 will automatically set the conversion method to 4 when the CM bit is zero; this occurs for most engine types. However, if the CM bit is 1, indicating the SPN conversion method is NOT 4, the user will have to consult the engine manufacturer to learn the correct method of SPN conversion, and set the SPN Conversion Method setting in the DGC-2020 accordingly.
4. CAN Bus Address - This parameter sets a unique address number for the DGC-2020 operating on a CAN Bus network. The CAN Bus Address is set internally by the DGC-2020 when certain types of ECUs are selected on the ECU Setup screen, and in this case, the user-entered value does not apply.
5. Engine ECU Address - Set the Engine ECU Address to the address claimed by the Engine ECU operating on the J1939 communications network. In certain cases, there is more than one ECU transmitting data on the J1939 network. This setting specifies the ECU on the network to which the DGC-2020 should transmit data.
6. Coolant Temperature Source - Select From ECU to receive temperature data from the ECU or select From DGC to receive temperature data from the coolant temperature engine sender input.
7. Oil Pressure Source - Select From ECU to receive oil pressure data from the ECU or select From DGC to receive oil pressure data from the oil pressure engine sender input.
8. Engine Run Time Source – Select ECU or DGC. With ECU selected, the DGC-2020 accepts engine hours data from the ECU on CAN 2 (ECU). With DGC selected, the DGC-2020 uses internally tracked engine hours.

9. ECU Contact Control - Output Select - Select whether the RUN output relay or the PRE (Prestart) output relay will close to give the ECU its “energize to run” signal. In some implementations, this relay may actually be providing ECU power.
10. ECU Contact Control - Pulsing Enable - Select if the ECU is not to be on line at all times. Often ECUs are allowed to go “off line” to conserve battery drain when the engine is not running. The DGC-2020 will “pulse” it periodically to force it to be active to allow the DGC-2020 to read data such as coolant temperature and coolant level. This is required if the DGC-2020 is to report low coolant temperature conditions (which may indicate a failure of a block heater), or low coolant level conditions (if a leak occurs while the machine is not running). Pulsing is also used to check the integrity of CAN Bus communications when the machine is not running.
11. ECU Related Time Values - Engine Shut Down - Set this parameter for a value longer than the duration required to stop the engine after being shut down. The ECU is pulsed after this time expires. If the time is too short, the pulse may occur while the engine is still turning which could cause a brief re-start and possibly damage the flywheel and starter system.
12. ECU Related Time Values - Pulse Cycle Time - Set this parameter for the desired time between ECU pulse cycles.
13. ECU Related Time Values - Settling Time - This parameter is the duration of the “on line” time of the pulse cycle during which the DGC-2020 reads data from the ECU. The settling time should be set long enough so that any ECU parameters that require time to “settle down” after the ECU is on line can do so. Since the DGC-2020 may use some of the ECU data for alarm or pre-alarm annunciation, it is important that the data have time to settle.
14. ECU Related Time Values - Response Timeout - This setting defines the amount of time that the DGC-2020 will wait to receive data from the ECU during a pulse cycle or start attempt. If no data is received during this time in a pulse cycle, a LOSS OF ECU COMMS pre-alarm is annunciated. If no data is received in this time during an engine starting attempt, a LOSS OF ECU COMMS alarm is annunciated.

**CAN Bus Setup**

**CAN Bus Interface**

ECU Support  
Enable

DTC Support  
Disable

SPN Conversion Method  
4

CAN Bus Address  
234

Engine ECU Address  
0

**ECU Contact Control**

Output Select  
☒ Fuel Contact  
☐ Pre-start Contact

Pulsing  
☐ Disable  
☒ Enable

**ECU Related Time Values**

Engine Shut Down (s)  
15

Settling Time (ms)  
6,000

Pulse Cycle Time (min)  
15

Response Timeout (s)  
5

Coolant Temperature Source  
ECU

Oil Pressure Source  
ECU

Engine Run Time Source  
ECU

Figure 7-2. Settings Explorer, Communications, CAN Bus Setup Screen

#### ECU Setup (Figure 7-3)

Front Panel Navigation Path: **SETTINGS > COMMUNICATIONS > CAN Bus SETUP > ECU SETUP**

1. ECU Type - For most engines, select *Standard*. However, there are exceptions. If your engine is a Volvo, select *Volvo-Penta*. If you have an *mtu* MDEC, ADEC, ECU-7/ECU8, GM/Doosan, Cummins, *mtu* Smart Connect, Scania, John Deere, Isuzu, Daimler CPC4, Yanmar, or Deutz, make the appropriate selection. Depending on the ECU type selected, some parameters may become enabled, allowing you to configure them for the specific engine. No modification of these parameters is required for the initial setup. Refer to the appropriate paragraphs in Section 4, *BESTCOMSPi<sup>®</sup> Software*, for additional information.

**ECU Setup**

ECU Type  
Standard

Generator Parameter Transmit  
Disable

Engine Parameter Transmit  
Enable

Trip Reset

Clear ECU Memory

Escape Mode Request

Start Mode  
Normal

Diesel Particulate Filter (DPF)  
Manual Regeneration

Disable Regeneration  
Off

**Volvo Penta**

Speed Select  
Primary

Accelerator Position (%)  
50

**John Deere**

Regeneration Interlock  
Enable

**Cummins ECU Setup**

Generator Control Communications Configuration  
Proprietary

**Yanmar ECU Setup**

Number of Cylinders  
4

**MTU (MDEC, ADEC, ECU7/ECU8)**

MTU ECU7/ECU8 Module Type  
501

MDEC Module Type  
CAN Module 303

NMT Alive Transmit Rate (ms)  
500

**Speed Configuration**

Speed Demand Switch  
No CAN Demand

Overspeed Test  
Off

Speed Up

Speed Down

Idle Request  
Off

Increased Idle  
0

MTU 50 Hz 60 Hz Switch Setting  
50 Hz

**ECU Configuration**

Int Oil Prime

Engine Start Prime  
Off

Fan Override  
Off

Mode Switch  
Off

Governor Param Switch Over  
Off

Governor Param Set Select  
0

CAN Rating Switch 1  
Off

CAN Rating Switch 2  
Off

Cylinder Cutout Disable 1  
Off

Cylinder Cutout Disable 2  
Off

Engine Operating Mode  
1

CAN Start Stop Configuration  
Constant

Figure 7-3. Settings Explorer, Communications, ECU Setup Screen

## System Parameters

### System Settings (Figure 7-4)

Front Panel Navigation Path: **SETTINGS > SYSTEM PARAMS > SYSTEM SETTINGS**

1. System Type - This setting is used with dead bus breaker close arbitration. For more information, refer to Section 3, *Functional Description, Dead Bus Breaker Close Arbitration*.
2. Fuel Level Function - This parameter selects the fuel type of the machine. If a fuel level sender is available in a tank, select *FUEL LVL*. If liquid propane or natural gas is used, set accordingly. Otherwise, select *Disable*. When *Disable* is selected, the DGC-2020 will display RPM instead of fuel level on the front-panel Overview screen.

The use of a 0 – 10 Vdc or 4 – 20 mA transducer is possible when an Analog Expansion Module (AEM-2020) is connected. Use the Source setting to select the AEM-2020 analog input tied to the transducer.

Set the maximum and minimum percentage range for the AEM-2020 analog inputs using the Maximum and Minimum percent settings. The maximum and minimum ranges of the AEM-2020 analog inputs are set separately. See *Programmable Inputs, Remote Analog Inputs*, below, for more information.

3. System Units - Select *English* or *Metric*.
4. Metric Pressure Units - Select *bar* or *kPa/MPa*.
5. Number of Flywheel Teeth - This setting defines the number of teeth on the flywheel for engines equipped with a magnetic pickup sensor (MPU) for engine speed detection.
6. Speed Signal Source - Select whether the rpm source for the DGC-2020 should be the magnetic pickup sensor (MPU), the generator frequency, or both (MPU-GEN). If MPU or generator frequency is selected as the rpm source, and the DGC-2020 cannot detect engine rpm, an MPU FAIL alarm will be announced. If MPU-GEN is selected as rpm source, if the MPU input does not provide valid speed information, the DGC-2020 will switch to generator frequency as the rpm source, announce an MPU FAIL pre-alarm, and continue running.
7. NFPA Level - Set this if NFPA level 1 or 2 compliance is required for the machine.

**System Settings**

System Type:

Number Fly Wheel Teeth:

Speed Signal Source:

Power Up Delay (s):

**Fuel Level Setup**

Function:

Source:

Maximum Percent:

Minimum Percent:

**NFPA Level**

☒ Zero  
☐ One  
☐ Two

**EPS Supplying Load**

Low Line Scale Factor:

EPS Threshold (% of CT Pri):

**System Units**

☐ English  
☒ Metric

**Metric Pressure Units**

☒ bar  
☐ kPa/MPa

**Figure 7-4. Settings Explorer, System Parameters, System Settings Screen**

Rated Data (Figure 7-5) Note: Click the *Edit* button to change settings.

Front Panel Navigation Path: **SETTINGS > SYSTEM PARAMS > SYSTEM SETTINGS**

1. Generator Connection - Select *WYE*, *DELTA*, *1 PHASE A-B*, *1 PHASE A-C*, or *GROUNDED DELTA* etc. based on the generator configuration.
2. Genset kW Rating - This parameter defines the kW rating of the machine.
3. Rated Volts - This parameter defines the voltage rating of the machine.
4. Rated Frequency - This parameter defines the frequency rating of the machine.
5. Rated Engine RPM - This parameter defines the engine rpm rating of the machine.
6. Rated Power Factor - This parameter defines the power factor rating of the machine.
7. Battery Voltage - Select 12 or 24.

Figure 7-5. Settings Explorer, System Parameters, Rated Data

#### Remote Module Setup (Figure 7-6)

Front Panel Navigation Path: **SETTINGS > SYSTEM PARAMS > REMOTE MODULE SETUP**

This screen is used to enable any I/O modules that are to be used with the DGC-2020. Refer to the appropriate sections in the DGC-2020 manual for more details regarding the individual I/O modules. Disable all if no modules are present.

Figure 7-6. Settings Explorer, System Parameters, Remote Module Setup Screen

#### Crank Settings (Figure 7-7)

Front Panel Navigation Path: **SETTINGS > SYSTEM PARAMS > CRANK SETTINGS**

1. Crank Disconnect Limit - This parameter defines the engine rpm threshold in percentage of rated rpm at which engine cranking should cease.
2. Pre-Crank Delay - This setting specifies the amount of time for pre-cranking to occur. The PRE relay is closed during this time. This setting is typically used for engine preheating and/or pre-lubrication.
3. Prestart Contact Config - Select whether the PRE relay should remain closed after the engine starts, or if it should open.
4. Prestart Rest Configuration - There may be situations where it is desired to have the PRE relay closed during engine cranking but open for all or part of a crank resting cycle. Configure this accordingly. Refer to the appropriate paragraphs in Section 4, *BESTCOMSPlus® Software*, for additional information.

5. Oil Pressure Crank Disconnect - This setting provides an alternate method of determining conditions under which crank disconnect should occur. If the machine has no magnetic pick up (MPU) for rpm detection or a failed, MPU, and the DGC-2020 cannot read generator frequency to obtain rpm information, it will use oil pressure as criterion for crank disconnect. This will prevent long starter engagement if the engine starts but the DGC-2020 cannot determine engine speed for crank disconnect purposes.
6. Cranking Style - Select Cycle Cranking or Continuous Cranking.
  - a. Cycle
    - i. Number of Crank Cycles - This parameter defines the number of crank cycles if *Cycle* is selected as the crank style. Note if NFPA level 1 or 2 has been selected under SYSTEM PARAMETERS > NFPA LEVEL, this cannot be programmed; it is set to a fixed value to satisfy the NFPA compliance.
    - ii. Crank Cycle Time: This parameter defines the length of the crank cycle if *Cycle* is selected as the crank style. Note if NFPA level 1 or 2 has been selected under SYSTEM PARAMETERS > FPA LEVEL, this cannot be programmed; it is set to a fixed value to satisfy the NFPA compliance.
    - iii. Rest Time: This parameter defines the duration of the rest time if *Cycle* is selected as the crank style. Note if NFPA level 1 or 2 has been selected under SYSTEM PARAMETERS > NFPA LEVEL, this cannot be programmed; it is set to a fixed value to satisfy the NFPA compliance.
  - b. Continuous
    - i. Continuous Crank Time - This parameter defines the length of the crank cycle if *Continuous Cranking* is selected as the crank style.
7. Minimum Crank Time - This setting helps prevent premature crank disconnections by ignoring engine rpm broadcast data until the minimum crank time has elapsed.
8. Off Mode Cooldown Enable - When this setting is disabled, pushing the Off button stops the unit immediately. When enabled, pushing the Off button once will start a cool down cycle and the Run LED will flash. The unit will complete the cool down cycle and stop in Off mode. If the Off button is pushed a second time, the unit stops immediately.
9. Restart Delay - This setting specifies the amount of time to delay restarting an engine after a normal shutdown. This setting is used to prevent stress from attempting to start while the engine is still spinning down.

**Crank Settings**

**Pre-Start**  
 Pre-crank Delay (s)  
  
 Pre Start Contact Config  
☒ Open After Disconnect  
☐ Closed While Running  
 Prestart Rest Configuration  
☐ Off During Rest  
☒ On During Rest  
☐ Preheat Before Crank  
 Restart  
 Restart Delay (s)

**Cranking**  
 Cranking Style  
☒ Cycle  
☐ Continuous  
 Cycle  
 Number of Crank Cycles  
  
 Cycle Crank Time (s)  
  
 Rest Time (s)  
  
 Continuous  
 Continuous Crank Time (s)  
  
 Minimum  
 Minimum Crank Time (s)

**Crank Disconnect**  
 Crank Disconnect Limit (%)  
  
 Oil Pressure Crank Disconnect Enable  
☒ Disable  
☐ Enable  
 Crank Disconnect Pressure (psi)  
  
 Cool Down  
 Off Mode Cool Down Enable  
  
 Cool Down Configuration  
  
 No Load Cool Down Time (min)

**Figure 7-7. Settings Explorer, System Parameters, Crank Settings Screen**

Sensing Transformers (Figure 7-8) Note: Click the *Rated Data* button to make changes.  
 Front Panel Navigation Path: **SETTINGS > SYSTEM PARAMS > SENSING TRANS**

1. Generator PT Primary Volts - This parameter defines the voltage of the potential transformer (PT) primary. If no PT is used, leave this parameter at its default value.
2. Generator PT Secondary Volts - This setting defines the voltage of the potential transformer (PT) secondary. The parameter must be less than 576 Vac because that is the maximum voltage that can be metered by the DGC-2020 voltage inputs. If no PT is used, leave this parameter at its default value.
3. Bus PT Primary Volts - This parameter defines the voltage of the potential transformer (PT) primary. If no PT is used, leave this parameter at its default value.
4. Bus PT Secondary Volts - This parameter defines the voltage of the potential transformer (PT) secondary. This must be less than 576 Vac because that is the maximum voltage that can be metered by the DGC-2020 voltage inputs. If no PT is used, leave this parameter at its default value.
5. Generator CT Primary Amps - This parameter defines the current transformer (CT) primary current in amps. The secondary must be 1A or 5A, and is determined by the DGC-2020 configuration as indicated in the DGC-2020 style code.
6. Gen CT Low Line Scale Factor - This setting is used to automatically adjust the Gen CT Primary Amps setting in applications that may utilize more than one type of genset connection.



**Sensing Transformers**

**Rated Data**

**Sensing Transformers**

**Generator PT**

Gen PT Primary Volts (V)  
480

Gen PT Secondary Volts (V)  
480

**Bus PT**

Bus PT Primary Volts (V)  
480

Bus PT Secondary Volts (V)  
480

**Generator CT**

Current Sensing Input Type  
5A CTs

Gen CT Primary Amps (A)  
500

Gen CT Low Line Scale Factor  
1.000

**Figure 7-8. Settings Explorer, System Parameters, Sensing Transformers Screen**

### Relay Control

Front Panel Navigation Path: [SETTINGS > SYSTEM PARAMS > RELAY CONTROL](#)

These drop-down menus select the operating mode for the PRE, START, and RUN relays on the back of the DGC-2020. In general, most machines will use preconfigured functionality; more advanced users may select programmable. Refer to the appropriate paragraphs in Section 4, *BESTCOMSPlus® Software*, for additional information. See Figure 7-9.

**Relay Control**

**Relay Control**

Start  
Predefined

Run  
Predefined

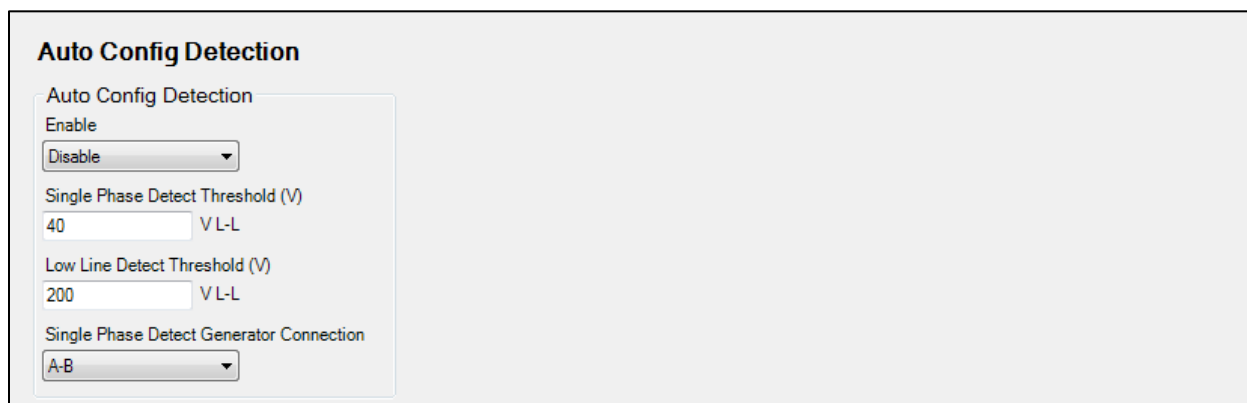
Prestart  
Predefined

**Figure 7-9. Settings Explorer, System Parameters, Relay Control Screen**

### Auto Config Detection

Front Panel Navigation Path: [SETTINGS > SYSTEM PARAMS > AUTO CONFIG DETECT](#)

If the machine connection type is not reconfigurable, disregard this setting. However, if a machine is reconfigurable, these parameters define how automatic detection of the generator connection type for some machines is accomplished. Refer to the appropriate paragraphs in Section 4, *BESTCOMSPlus® Software*, for additional information. See Figure 7-10.



**Auto Config Detection**

Auto Config Detection

Enable

Disable

Single Phase Detect Threshold (V)

40 V L-L

Low Line Detect Threshold (V)

200 V L-L

Single Phase Detect Generator Connection

A-B

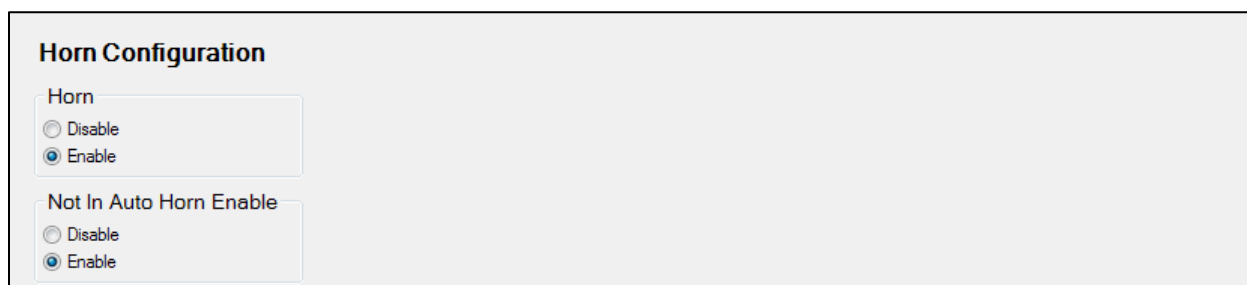
**Figure 7-10. Settings Explorer, System Parameters, Auto Config Detection Screen**

### Alarm Configuration

Horn Configuration (Figure 7-11)

Front Panel Navigation Path: SETTINGS > ALARM CONFIGURATION > HORN CONFIGURATION

1. Horn Enable - This setting enables or disables the output for the external alarm horn.
2. Not In Auto Horn Enable - This setting enables or disables the horn when not in Auto mode.



**Horn Configuration**

Horn

Disable

Enable

Not In Auto Horn Enable

Disable

Enable

**Figure 7-11. Settings Explorer, Alarm Configuration, Horn Configuration Screen**

### Pre-Alarms

Front Panel Navigation Path: SETTINGS > ALARM CONFIGURATION > PRE-ALARMS

Examine each of the pre-alarms. Pre-alarm setup is not required to operate the machine, but is likely to be desired to provide warnings for machine protection. Enable any desired pre-alarms and enter an appropriate threshold. Set the activation delay and hysteresis where possible. The activation delay is the duration that a condition remains in effect before annunciating a pre-alarm. Refer to the appropriate paragraphs in Section 4, *BESTCOMSPlus® Software*, for additional information regarding pre-alarm configuration. See Figure 7-12.

| Pre-Alarms                                                                                                                                                                                                                                                                 |                                                                                                                                                                         |                                                                                                                                                                      |                                                                                                                                                                                                         |                                                                                                                                                                                                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>ECU Comm Failure</b><br><input checked="" type="radio"/> Disable<br><input type="radio"/> Enable                                                                                                                                                                        | <b>AEM Comm Failure</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable                                                                     | <b>CEM Comm Failure</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable                                                                  | <b>LSM Comm Failure</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable                                                                                                     | <b>Intergenet Comm Failure</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable                                                                                               |
| <b>Checksum Failure</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable                                                                                                                                                                        | <b>Active DTC</b><br><input checked="" type="radio"/> Disable<br><input type="radio"/> Enable                                                                           | <b>Reverse Rotation</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable                                                                  | <b>ID Missing</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable                                                                                                           | <b>ID Repeat</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable                                                                                                             |
| <b>Low Coolant Level</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable<br>Threshold (%) 50                                                                                                                                                   | <b>Low Coolant Temp</b><br><input checked="" type="radio"/> Disable<br><input type="radio"/> Enable<br>Threshold (°F) 50                                                | <b>High Coolant Temp</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable<br>Threshold (°F) 250                                           | <b>AVR Output Limit</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable<br>Activation Delay (s) 10                                                                          | <b>Gov Output Limit</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable<br>Activation Delay (s) 10                                                                           |
| <b>Low Oil Pressure</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable<br>Threshold (psi) 25.0                                                                                                                                                | <b>Low Fuel Level</b><br><input checked="" type="radio"/> Disable<br><input type="radio"/> Enable<br>Threshold (%) 25<br>Hysteresis (%) 1                               | <b>High Fuel Level</b><br><input checked="" type="radio"/> Disable<br><input type="radio"/> Enable<br>Threshold (%) 90<br>Activation Delay (s) 0<br>Hysteresis (%) 1 | <b>Breaker Open Failure</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable<br>Monitor<br><input checked="" type="radio"/> Transitions Only<br><input type="radio"/> Always | <b>Breaker Close Failure</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable<br>Monitor<br><input checked="" type="radio"/> Transitions Only<br><input type="radio"/> Always |
| <b>Weak Battery Voltage</b><br><input checked="" type="radio"/> Disable<br><input type="radio"/> Enable<br>Threshold 15.0 V<br>0.625 Per Unit<br>Activation Delay (s) 2.0                                                                                                  | <b>Low Battery Voltage</b><br><input checked="" type="radio"/> Disable<br><input type="radio"/> Enable<br>Threshold 20.0 V<br>0.833 Per Unit<br>Activation Delay (s) 10 | <b>High Battery Voltage</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable<br>Threshold 30.0 V<br>1.250 Per Unit                        | <b>Maintenance Interval</b><br><input checked="" type="radio"/> Disable<br><input type="radio"/> Enable<br>Threshold (h) 500                                                                            | <b>Synchronizer Failure</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable                                                                                                  |
| <b>DEF Prealarms Enable</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable                                                                                                                                                                    |                                                                                                                                                                         |                                                                                                                                                                      |                                                                                                                                                                                                         |                                                                                                                                                                                                          |
| <b>Engine kW Overload 1</b><br><input checked="" type="radio"/> Disable<br><input type="radio"/> Enable<br>Three Phase Threshold (%) 105<br>Three Phase Hysteresis (%) 1<br>Single Phase Threshold (%) 105<br>Single Phase Hysteresis (%) 1<br>Low Line Scale Factor 1.000 |                                                                                                                                                                         |                                                                                                                                                                      |                                                                                                                                                                                                         |                                                                                                                                                                                                          |
| <b>Engine kW Overload 2</b><br><input checked="" type="radio"/> Disable<br><input type="radio"/> Enable<br>Three Phase Threshold (%) 105<br>Three Phase Hysteresis (%) 1<br>Single Phase Threshold (%) 105<br>Single Phase Hysteresis (%) 1<br>Low Line Scale Factor 1.000 |                                                                                                                                                                         |                                                                                                                                                                      |                                                                                                                                                                                                         |                                                                                                                                                                                                          |
| <b>Engine kW Overload 3</b><br><input checked="" type="radio"/> Disable<br><input type="radio"/> Enable<br>Three Phase Threshold (%) 105<br>Three Phase Hysteresis (%) 1<br>Single Phase Threshold (%) 105<br>Single Phase Hysteresis (%) 1<br>Low Line Scale Factor 1.000 |                                                                                                                                                                         |                                                                                                                                                                      |                                                                                                                                                                                                         |                                                                                                                                                                                                          |

Figure 7-12. Settings Explorer, Alarm Configuration, Pre-Alarms Screen

## Alarms

Front Panel Navigation Path: SETTINGS > ALARM CONFIGURATION > ALARMS

Examine each of the alarms. Alarm setup is not required to operate the machine, but is likely to be desired to provide shutdowns for machine protection. Enable any desired alarms and enter an appropriate threshold. Set the *Activation Delay* where possible. The activation delay is the duration that a condition remains in effect before annunciating an alarm. Refer to the appropriate paragraphs in Section 4, *BESTCOMSPi<sup>®</sup> Software*, for additional information regarding alarm configuration. See Figure 7-13.

| Alarms                                                                                                                                                              |  |  |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|--|
| <b>High Coolant Temp</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable<br>Threshold (°F) 275<br>Arming Delay (s) 60                   |  |  |  |
| <b>Low Oil Pressure</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable<br>Threshold (psi) 15.0<br>Arming Delay (s) 10                  |  |  |  |
| <b>Overspeed</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable<br>Threshold (%) 110<br>Activation Delay (ms) 50                       |  |  |  |
| <b>Low Fuel Level</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable<br>Threshold (%) 2<br>Activation Delay (s) 30<br>Hysteresis (%) 1 |  |  |  |
| <b>Low Coolant Level</b><br><input checked="" type="radio"/> Disable<br><input type="radio"/> Enable<br>Threshold (%) 25                                            |  |  |  |
| <b>CAN Bus Low Coolant Level</b><br><input type="radio"/> Disable<br><input checked="" type="radio"/> Enable                                                        |  |  |  |

Figure 7-13. Settings Explorer, Alarm Configuration, Alarms Screen

## Sender Fail

Front Panel Navigation Path: **SETTINGS > ALARM CONFIGURATION > SENDER FAIL**

Enable each sender type as desired by configuring it as an alarm or pre-alarm. Set contact recognition to Always or While Engine Running Only. Set an activation delay. The activation delay is the duration that the condition remains in effect before annunciating an alarm or pre-alarm. Set the minimum and maximum resistance. When the SF Display setting is set to Enable, "SF" is displayed instead of the measured parameter when the sender resistance is outside the range specified by the minimum and maximum resistance settings. Refer to the appropriate paragraphs in Section 4, *BESTCOMSPlus® Software*, for additional information regarding sender fail configuration. If a DGC-2020 is receiving engine information from an engine ECU, the sender fail for coolant temperature and oil pressure do not need configured because they have no effect. They are appropriate for resistive senders only. See Figure 7-14.

| Sender Fail                     |                      |                        |                          |                          |            |
|---------------------------------|----------------------|------------------------|--------------------------|--------------------------|------------|
| <b>Coolant Temp Sender Fail</b> |                      |                        |                          |                          |            |
| Alarm Configuration             | Contact Recognition  | Activation Delay (min) | Minimum Resistance (ohm) | Maximum Resistance (ohm) | SF Display |
| None                            | Always               | 5                      | 5                        | 3,100                    | Disable    |
| <b>Oil Pressure Sender Fail</b> |                      |                        |                          |                          |            |
| Alarm Configuration             | Contact Recognition  | Activation Delay (s)   | Minimum Resistance (ohm) | Maximum Resistance (ohm) | SF Display |
| None                            | Always               | 10                     | 5                        | 280                      | Disable    |
| <b>Fuel Level Sender Fail</b>   |                      |                        |                          |                          |            |
| Alarm Configuration             | Contact Recognition  | Activation Delay (s)   | Minimum Resistance (ohm) | Maximum Resistance (ohm) | SF Display |
| None                            | Always               | 10                     | 5                        | 280                      | Disable    |
| <b>Voltage Sensing Fail</b>     |                      |                        |                          |                          |            |
| Alarm Configuration             | Activation Delay (s) |                        |                          |                          |            |
| None                            | 10                   |                        |                          |                          |            |
| <b>Speed Sender Fail</b>        |                      |                        |                          |                          |            |
| Activation Delay (s)            |                      |                        |                          |                          |            |
| 10                              |                      |                        |                          |                          |            |

**Figure 7-14. Settings Explorer, Alarm Configuration, Sender Fail Screen**

## Programmable Senders

If a DGC-2020 receives engine information from an engine ECU, the programmable sender parameters for the coolant temperature and oil pressure senders do not need to be configured because they have no effect. They are appropriate for resistive senders only.

### Coolant Temperature (Figure 7-15)

1. The coolant temperature sender can be configured by selecting one of the sender types that come as a part of the BESTCOMSPlus® sender library by clicking on *Load Cool Settings File* and selecting the appropriate sender.
2. If no sender file matches the sender being used, the individual points that map resistance points to coolant temperature may be modified by setting numeric values in the table, or by dragging the points of the graph to the desired characteristic. Information on sender characteristics should be obtained from the sender manufacturer.
3. Select *Positive* or *Negative* sender slope as required for the desired sender graph.
4. Click *Save Cool Data* to save the data in the current settings file.
5. If you want to save newly entered sender data as a sender library file, click *Create Cool Settings File* and enter a file name and location to save the file.
6. Click the *Send Settings* button in BESTCOMSPlus® to send the sender settings to the DGC-2020.

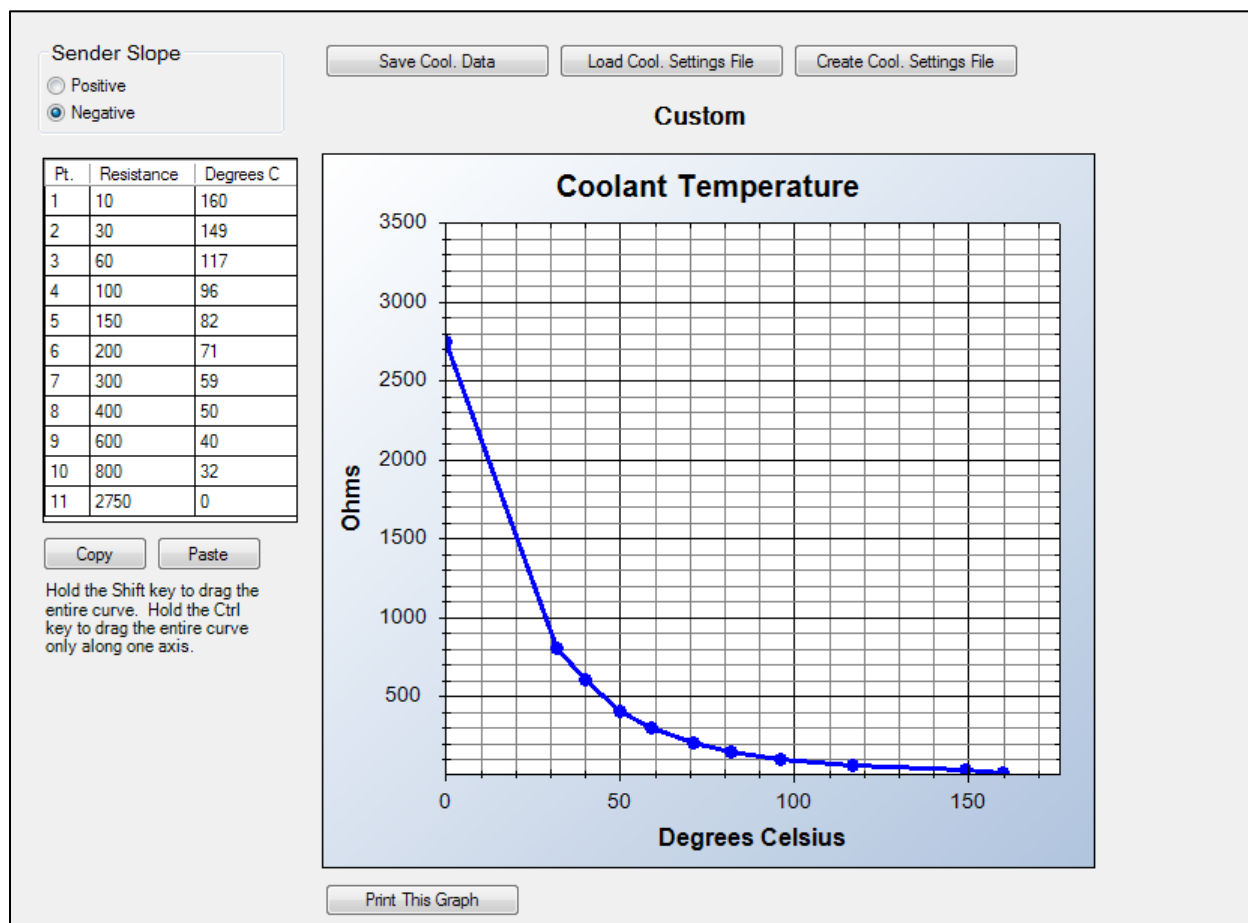


**Figure 7-15. Settings Explorer, Programmable Senders, Coolant Temperature Screen**

#### Oil Pressure (Figure 7-16)

1. The oil pressure sender can be configured by selecting one of the sender types that come as a part of the BESTCOMSPUs® sender library by clicking on *Load Oil Settings File* and selecting the appropriate sender.
2. If no sender file matches the sender being used, the individual points that map resistance points to oil pressure may be modified by setting numeric values in the table, or dragging the points of the graph to the desired characteristic. Information on sender characteristics should be obtained from the sender manufacturer.
3. Select *Positive* or *Negative* sender slope as required for the desired sender graph.
4. Click *Save Oil Data* to save the data in the current settings file.
5. If you want to save newly entered sender data as a sender library file, click *Create Oil Settings File* and enter a file name and location to save the file.
6. Click the *Send Settings* button in BESTCOMSPUs® to send the sender settings to the DGC-2020.

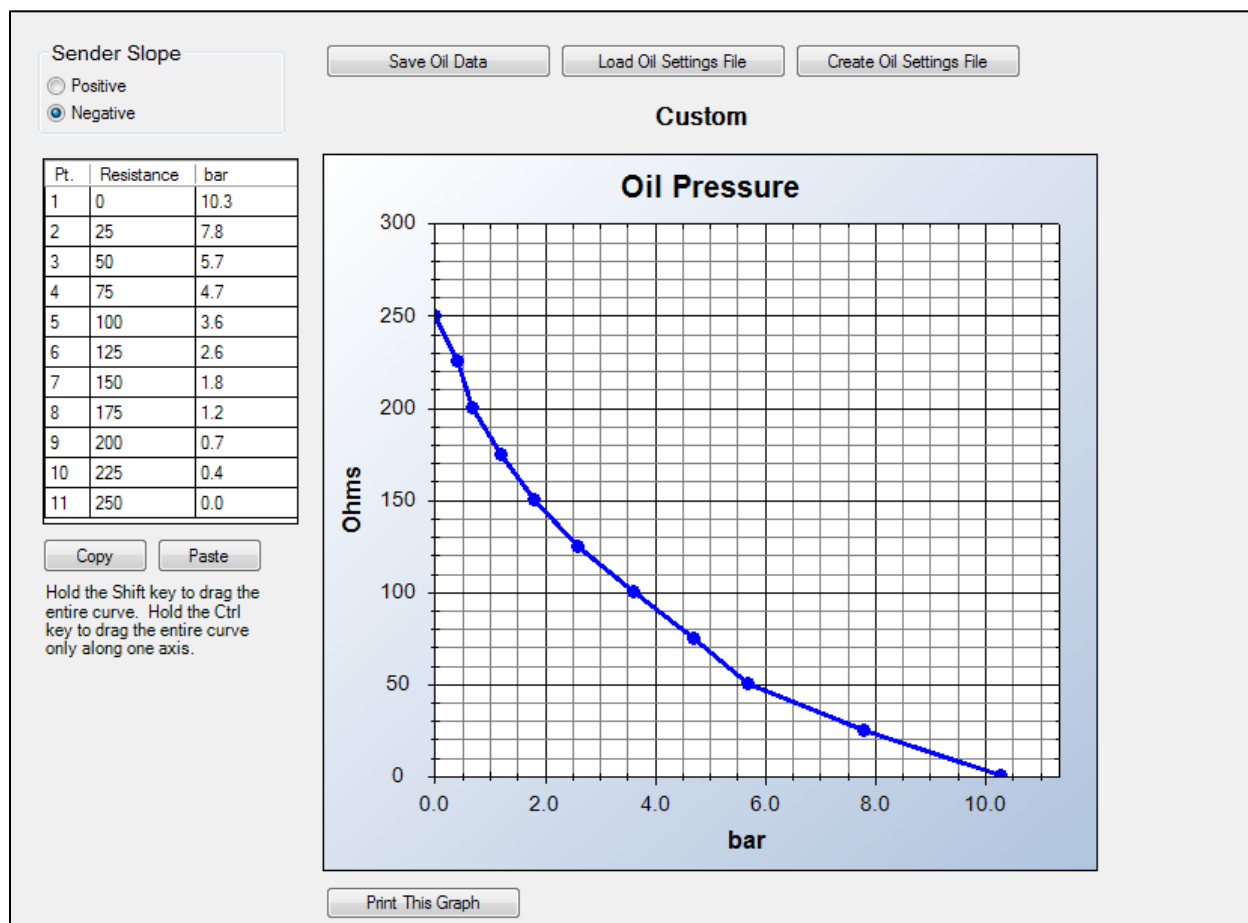


Figure 7-16. Settings Explorer, Programmable Senders, Oil Pressure Screen

#### Percent Fuel Level (Figure 7-17)

1. The percent fuel level sender is configured by selecting one of the sender types that come as a part of the BESTCOMSPlus® sender library by clicking on *Load Fuel Settings File* and selecting the appropriate sender.
2. If no sender file matches the sender being used, the individual points that map resistance points to fuel level may be modified by setting numeric values in the table, or dragging the points of the graph to the desired characteristic. Information on sender characteristics should be obtained from the sender manufacturer.
3. Select *Positive* or *Negative* sender slope as required for the desired sender graph.
4. Click *Save Fuel Data* to save the data in the current settings file.
5. If you want to save newly entered sender data as a sender library file, click *Create Fuel Settings File* and enter a file name and location to save the file.
6. Click the *Send Settings* button in BESTCOMSPlus® to send the sender settings to the DGC-2020.

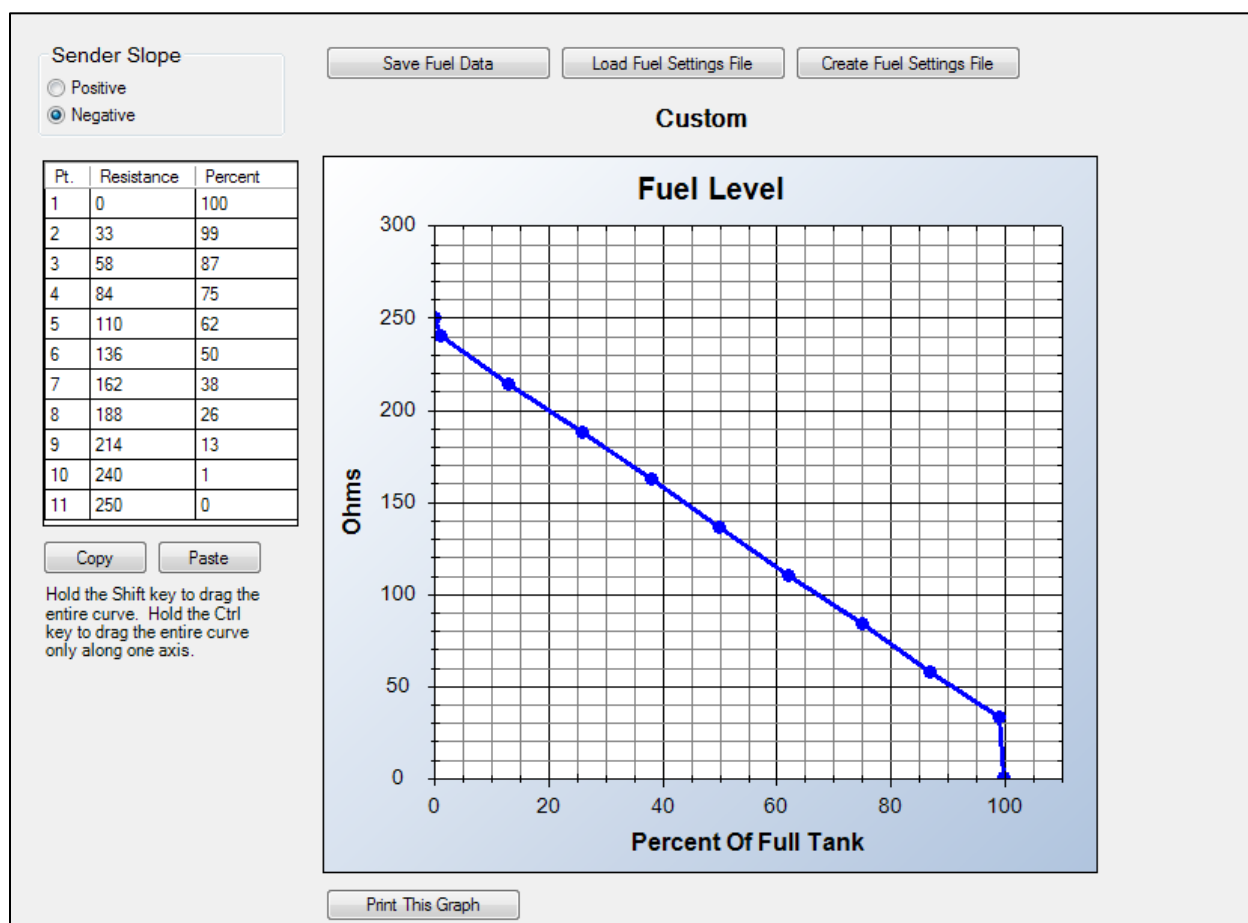


**Figure 7-17. Settings Explorer, Programmable Senders, Fuel Level Screen**

This completes the discussion of initial DGC-2020 setup parameters that are required prior to running a unit.

## Initial Setup (Optional)

This section discusses some of the basic setup parameters that are not required to start and run the unit, but may be set up to further customize the DGC-2020 to the application. This discussion is not comprehensive; it presents some of the basic setup parameters. Advanced users can customize the DGC-2020 through the BESTlogic™ *Plus* Programmable Logic, configurable inputs, configurable protection, configurable elements, and a numerous other features designed for DGC-2020 configurability.

The parameters are listed according to how they are listed in the Settings Explorer of BESTCOMSPi<sup>®</sup>. These parameters can also be set from the front panel of the DGC-2020.

### General Settings

#### Front Panel HMI (Figure 7-18)

Front Panel Navigation Path: **SETTINGS > GENERAL SETTINGS > FRONT PANEL HMI**

1. LCD Contrast - Change this setting if the contrast needs adjusted.
2. Front Panel Sleep Mode - Select enable if desired. In sleep mode, the LEDs and LCD backlight turn off after 15 minutes of inactivity on the front panel to minimize battery drain.
3. Language Selection - Select the desired language.
4. Engine Hours Display - Select Enable to display engine run-time hours on the front-panel Overview screen.
5. Overview Screen Type - Set to Text to display parameters on the Overview screen in text or select Symbolic to display parameters as symbols.

6. Exhaust Display - When set to Inverted, the LCD background at the bottom of the screen, where exhaust status is displayed, is dark with light text when an exhaust system condition annunciation is in effect.
7. Exhaust Status Display Screen - Select Overview Screen to show the DEF level and the exhaust status display on the Overview screen or select All Operating Screens to show the DEF level and the exhaust status display on all screens that automatically appear during normal operation.
8. Battery Charger Display - Enable to display battery charger output voltage and current on the front-panel Overview screen. This will alternate with the Battery Voltage display.
9. Display Fuel Level Below - Fuel level will be displayed on the front-panel Overview screen when the level drops below the percentage set. Note the Fuel Level Function must be set to Fuel Level for fuel level percentage to be displayed on the front-panel Overview screen.
10. DEF Display Enable - This setting enables or disables the display of DEF levels on the Front panel overview screen. Some engines that do not actually employ DEF based exhaust treatment still broadcast a DEF level. Since the level is meaningless, this setting allows the user to remove the display of DEF level from the front panel.
11. Battery and RPM Display - This setting selects whether battery voltage and/or rpm is displayed on the front panel overview screen. If the Alternate option is selected, the display will alternate between battery voltage and rpm.
12. Scrolling Screens - These settings are not accessible via the front panel. If a different overview screen for the front panel LCD is desired, specify the scrolling screens in which parameters are configured to appear on the front panel LCD display.
  - a. Configure the *Configurable HMI Summary Settings*.
  - b. Set the *Scrolling Screen Enable* to *Enable*.
  - c. Set the *Scrolling Screen Scroll Delay* parameter to the desired value.
13. Phase Toggle Delay - Set the phase toggle delay to a nonzero value if automatic scrolling through the phase information in the standard overview screen on the front panel is desired. If it is left at zero, scrolling through phase information is accomplished using the up and down arrow buttons.
14. Initializing Message 1 - This parameter defines the first line of text that appears on the front panel of the DGC-2020 as it is going through its power up and initializing sequence.
15. Initializing Message 2 - This parameter defines the second line of text that appears on the front panel of the DGC-2020 as it is going through its power up and initializing sequence.



### Front Panel HMI

LCD Contrast Value  
80

Front Panel Sleep Mode  
☐ Disable  
☒ Enable

One Line Diagram  
☒ Disable  
☐ Enable

Engine Hours Display  
Enable

Overview Screen Type  
Text

Exhaust Display  
Normal

Exhaust Status Display Screen  
All Screens

Battery Charger Display  
Enable

Display Fuel Level Below (%)  
100

DEF Display Enable  
Enable

Battery and RPM Display  
Battery

Language Selection  
English

Scrolling Screen Enable  
Disable

Scrolling Screen Delay (s)  
5

Phase Toggle Delay (s)  
0

Initializing Message 1  
DGC-2020

Initializing Message 2  
0

### Configurable HMI Summary Settings

|                                          |                                       |                                     |
|------------------------------------------|---------------------------------------|-------------------------------------|
| Scrolling Screen Item 1<br>Oil Pressure  | Scrolling Screen Item 9<br>Gen VBC    | Scrolling Screen Item 17<br>Gen KwH |
| Scrolling Screen Item 2<br>Coolant Temp  | Scrolling Screen Item 10<br>Gen VCA   | Scrolling Screen Item 18<br>Gen IA  |
| Scrolling Screen Item 3<br>Battery Volts | Scrolling Screen Item 11<br>Gen VAN   | Scrolling Screen Item 19<br>Gen IB  |
| Scrolling Screen Item 4<br>RPM           | Scrolling Screen Item 12<br>Gen VBN   | Scrolling Screen Item 20<br>Gen IC  |
| Scrolling Screen Item 5<br>RPM Source    | Scrolling Screen Item 13<br>Gen VCN   |                                     |
| Scrolling Screen Item 6<br>Fuel Level    | Scrolling Screen Item 14<br>Bus Freq  |                                     |
| Scrolling Screen Item 7<br>Run Time      | Scrolling Screen Item 15<br>Bus Volts |                                     |
| Scrolling Screen Item 8<br>Gen VAB       | Scrolling Screen Item 16<br>Gen Freq  |                                     |

**Figure 7-18. Settings Explorer, General Settings, Front Panel HMI Screen**

### Device Security Setup

If passwords other than default are desired, use BESTCOMSP<sup>Plus</sup>® to connect to the DGC-2020 and change the passwords. Click on *Upload Security* from the Communications pull-down menu to load the new passwords. See Figure 7-19.

| Access Level | Password |
|--------------|----------|
| OEM          | OEM      |
| Operator     | OP       |
| Settings     | SET      |

Selected User Information

Access Level

OEM

Password

OEM

Save Password

Figure 7-19. Settings Explorer, General Settings, Device Security Setup Screen

### Clock Setup

Front Panel Navigation Path: SETTINGS > GENERAL SETTINGS > CONFIGURE DATE/TIME

Configure the date and time for the DGC-2020. The daylight-savings time parameters are also configured on this screen. See Figure 7-20.

**Clock Setup**

Time Zone Offset Setup

UTC Offset (min)

0

Daylight Saving Time Setup

DST Configuration

Disabled

Start/End Time Reference

☒ Respective to Local Time

☐ Respective to UTC Time

Start Day

Month: March

Occurrence of Day: Second

Weekday: Sunday

Hour (h): 2

Minute (min): 0

End Day

Month: November

Occurrence of Day: First

Weekday: Sunday

Hour (h): 2

Minute (min): 0

Bias Setup

Hour (h): 1

Minute (min): 0

Clock Not Set Warning

☐ Disable

☒ Enable

Figure 7-20. Settings Explorer, General Settings, Clock Setup Screen

This completes the discussion of optional DGC-2020 setup parameters. This discussion is not comprehensive; it presents some of the basic setup parameters. Advanced users can customize the DGC-2020 through the BESTlogic*Plus* Programmable Logic, configurable inputs, configurable protection, configurable elements, and numerous other features designed for DGC-2020 configurability.

## Setting Up DGC-2020 Programmable Inputs and Outputs

The DGC-2020 along with the CEM-2020 (Contact Expansion Module) and AEM-2020 (Analog Expansion Module) provide a variety of programmable input and output capabilities. The DGC-2020 and the CEM-2020 include contact inputs that are configurable as pre-alarms or alarms and are available as inputs to BESTlogicPlus Programmable Logic. They also contain dry contact relay outputs, which are driven by the BESTlogicPlus Programmable Logic.

The AEM-2020 has eight analog inputs, eight resistive temperature device (RTD) inputs, two thermocouple inputs, and four analog outputs. Each analog input is configurable as a 4 to 20 mA current input or a 0 to 10 Vdc voltage input to accommodate most readily available industrial transducers; the RTD and thermocouple inputs are pre-configured for temperature measurement. Each analog, RTD, and/or thermocouple input can be programmed with a user adjustable range and assignable label along with up to four thresholds to implement protective schemes or BESTlogicPlus Programmable Logic programming utilizing the measured parameter. This allows for enhanced protection of the engine and generator, and protection of external devices.

The analog outputs can be configured as 4 to 20 mA current outputs or 0 to 10 Vdc voltage outputs. Each output can be mapped to metered parameters in the DGC-2020 to implement meter driver functionality, or provide signals for analog inputs of other equipment.

Instructions regarding configuration and setup of each type of programmable input and output are presented in the following paragraphs, along with instructions for enabling the expansion modules.

### Enable LSM-2020, CEM-2020, and AEM-2020

Front Panel Navigation Path: [SETTINGS > SYSTEM PARAMS > REMOTE MODULE SETUP](#)

The parameters for remote inputs and remote outputs are disabled and cannot be configured in BESTCOMSPlus® until after the appropriate module has been enabled. Thus, expansion modules connected to the DGC-2020 must be enabled before the associated parameters can be modified. See Figure 7-21.

| Module Type              | Enable/Disable                          | J1939 Address | Auxiliary Input Source |
|--------------------------|-----------------------------------------|---------------|------------------------|
| Load Share Module        | <input checked="" type="radio"/> Enable | 235           | Local                  |
| Contact Expansion Module | <input checked="" type="radio"/> Enable | 236           | 18 Outputs             |
| Analog Expansion Module  | <input checked="" type="radio"/> Enable | 237           |                        |

Figure 7-21. Settings Explorer, System Parameters, Remote Module Setup Screen

Configure the following parameters:

1. Load Share Module Enable/Disable - Select *Enable* if a load share module is present in the system.
2. LSM J1939 Address - Enter the J1939 address to be used by the LSM-2020. Normally this will not have to be changed unless the address is already in use elsewhere on the CAN Bus network.
3. LSM Auxiliary Input Source – Select *Local* if locally measured input values are to be used. Select *System Manager* if the measured input values of the unit designated as the system manager are to be used.
4. Contact Expansion Module Enable/Disable - Select *Enable* if a contact expansion module is present in the system.
5. CEM J1939 Address - Set the J1939 address to be used by the CEM-2020. Normally this will not have to be changed unless the address is already in use elsewhere on the CAN Bus network.

6. CEM Outputs - This setting defines the number of output relays on the CEM-2020. Select *18* or *24*. Refer to the style chart in Section 1, *General Information*, of the DGC-2020 instruction manual to determine if you have 18 or 24 output relays on the CEM-2020.

## **Programmable Inputs**

The programmable inputs consist of:

- Contact inputs on the DGC-2020.
- Programmable functions on the DGC-2020. The programmable functions allow mapping of particular inputs to certain functions. For example, one can select an input for the ATS (Automatic Transfer Switch) input function, or a Low Fuel Level indication function.
- Remote LSM inputs on the LSM-2020. The LSM-2020 has one analog input.
- Remote contact inputs on the CEM-2020.
- Remote analog inputs on the AEM-2020.
- Remote RTD inputs on the AEM-2020.
- Remote thermocouple inputs on the AEM-2020.

### Configuration Instructions

Configuring contact inputs on the DGC-2020 (See Figure 7-22.)

Front Panel Navigation Path: **SETTINGS > PROGRAMMABLE INPUTS > CONFIGURABLE INPUTS**

### Contact Inputs

|                                                                                                                                         |                                                                                                                                         |                                                                                                                                         |
|-----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| <b>Input #1</b><br>Alarm Configuration<br>None<br>Activation Delay (s)<br>0<br>Label Text<br>INPUT 1<br>Contact Recognition<br>Always   | <b>Input #2</b><br>Alarm Configuration<br>None<br>Activation Delay (s)<br>0<br>Label Text<br>INPUT 2<br>Contact Recognition<br>Always   | <b>Input #3</b><br>Alarm Configuration<br>None<br>Activation Delay (s)<br>0<br>Label Text<br>INPUT 3<br>Contact Recognition<br>Always   |
| <b>Input #4</b><br>Alarm Configuration<br>None<br>Activation Delay (s)<br>0<br>Label Text<br>INPUT 4<br>Contact Recognition<br>Always   | <b>Input #5</b><br>Alarm Configuration<br>None<br>Activation Delay (s)<br>0<br>Label Text<br>INPUT 5<br>Contact Recognition<br>Always   | <b>Input #6</b><br>Alarm Configuration<br>None<br>Activation Delay (s)<br>0<br>Label Text<br>INPUT 6<br>Contact Recognition<br>Always   |
| <b>Input #7</b><br>Alarm Configuration<br>None<br>Activation Delay (s)<br>0<br>Label Text<br>INPUT 7<br>Contact Recognition<br>Always   | <b>Input #8</b><br>Alarm Configuration<br>None<br>Activation Delay (s)<br>0<br>Label Text<br>INPUT 8<br>Contact Recognition<br>Always   | <b>Input #9</b><br>Alarm Configuration<br>None<br>Activation Delay (s)<br>0<br>Label Text<br>INPUT 9<br>Contact Recognition<br>Always   |
| <b>Input #10</b><br>Alarm Configuration<br>None<br>Activation Delay (s)<br>0<br>Label Text<br>INPUT 10<br>Contact Recognition<br>Always | <b>Input #11</b><br>Alarm Configuration<br>None<br>Activation Delay (s)<br>0<br>Label Text<br>INPUT 11<br>Contact Recognition<br>Always | <b>Input #12</b><br>Alarm Configuration<br>None<br>Activation Delay (s)<br>0<br>Label Text<br>INPUT 12<br>Contact Recognition<br>Always |
| <b>Input #13</b><br>Alarm Configuration<br>None<br>Activation Delay (s)<br>0<br>Label Text<br>INPUT 13<br>Contact Recognition<br>Always | <b>Input #14</b><br>Alarm Configuration<br>None<br>Activation Delay (s)<br>0<br>Label Text<br>INPUT 14<br>Contact Recognition<br>Always | <b>Input #15</b><br>Alarm Configuration<br>None<br>Activation Delay (s)<br>0<br>Label Text<br>INPUT 15<br>Contact Recognition<br>Always |
| <b>Input #16</b><br>Alarm Configuration<br>None<br>Activation Delay (s)<br>0<br>Label Text<br>INPUT 16<br>Contact Recognition<br>Always |                                                                                                                                         |                                                                                                                                         |

Figure 7-22. Settings Explorer, Programmable Inputs, Contact Inputs Screen

For each contact input, configure the following parameters:

1. **Alarm Configuration** - Select *None*, *Alarm*, or *Pre-Alarm*. When an alarm occurs, the horn output annunciates with a constant beep and the engine shuts down. When a pre-alarm occurs, the horn output annunciates with an alternating on and off beep and the engine remains running. If *None* is selected, the input is status only. The status is available to BESTlogicPlus Programmable Logic regardless of *Alarm Configuration* setting.
2. **Activation Delay** - This parameter defines the duration that the input remains on before any annunciation occurs.
3. **Label Text** - Enter descriptive text that signifies the use of the input. This text appears next to the input in BESTlogicPlus Programmable Logic and in the event log if the input is configured as an alarm or pre-alarm.
4. **Contact Recognition** - Select whether the contact input should be recognized always, or only while the engine is running. For example, a switch closes when oil pressure is low while the engine is running. Such a switch would be closed when the engine is not running but a low oil pressure alarm or pre-alarm should not be annunciated unless the switch is closed while the engine is running. A selection of *While Engine Running Only* prevents spurious annunciation when the engine is not running.

Configurable Programmable Functions on the DGC-2020 (See Figure 7-23)

Front Panel Navigation Path: SETTINGS > PROGRAMMABLE INPUTS > PROG FUNCTIONS

Programmable functions are pre-defined functions in the DGC-2020 and are initiated by a contact input. An input must be mapped to a programmable function for that function to operate. Furthermore, some of the programmable functions can be configured as alarms or pre-alarms and cause annunciation to occur on the RDP-110 (Remote Display Panel).

**Programmable Functions**

**Auto Transfer Switch**  
 Input Mode:   
 N. O. Input:   
 N. C. Input:   
 Circuit Error Delay (s):   
 Circuit Error Action:   
 Contact Recognition:

**Grounded Delta Override**  
 Input:   
 Contact Recognition:

**Battle Override**  
 Input:   
 Contact Recognition:

**Low Line Override**  
 Input:   
 Contact Recognition:

**Single Phase Override**  
 Input:   
 Contact Recognition:   
 Single Phase Override Sensing: ☒ A-B ☐ A-C

**Single Phase AC Override**  
 Input:   
 Contact Recognition:

**Battery Charger Fail**  
 Input:   
 Alarm Configuration:   
 Activation Delay (s):   
 Contact Recognition:

**Low Coolant Level**  
 Input:   
 Alarm Configuration:   
 Activation Delay (s):   
 Contact Recognition:

**Fuel Leak Detect**  
 Input:   
 Alarm Configuration:   
 Activation Delay (s):   
 Contact Recognition:

**Figure 7-23. Settings Explorer, Programmable Inputs, Programmable Functions Screen**

Configure the following parameters:

1. Auto Transfer Switch
  - a. Input Mode - When Input Mode is set to Single, the ATS function starts and runs the generator while the ATS input is true and the DGC-2020 is in Auto mode. When Input Mode is set to Complementary, a Normally Open Input and a Normally Closed Input must be selected.
  - b. N.O. / N.C. Input - When Input Mode is set to Complementary, a Normally Open Input and a Normally Closed Input must be selected. While the Normally Open Input is closed, the Normally Closed Input is open, and the DGC-2020 is in Auto mode, the ATS function starts and runs the generator.
  - c. Circuit Error Delay - If the Normally Open Input and the Normally Closed Inputs are in non-opposite states for a time interval greater than the duration of the Circuit Error Delay, an ATS Circuit Error Pre-alarm will occur.
  - d. Circuit Error Action - The Circuit Error Action setting dictates whether the generator should start or *not* start when an ATS Circuit Error Occurs.
  - e. Contact Recognition - Select *Always*.

## 2. Grounded Delta Override

- a. Input - If a reconfigurable machine will operate sometimes in a grounded delta configuration and sometimes in other configurations, select an input for this function to indicate to the DGC-2020 when the machine is in the grounded delta configuration. When the machine is grounded delta, the DGC-2020 will display line-to-neutral as well as line-to-line voltages. In normal delta, the line-to-neutral voltages are not displayed. Select *None* to disable the programmable function.
- b. Contact Recognition - Select *Always*.

## 3. Battle Override

- a. Input - Select an input for this function if a battle override initiated from a contact input is required. For some very critical applications, the ability to remove all system shutdowns may be a requirement. Selecting battle override will prevent all alarms from stopping the engine. Extreme caution should be taken before selecting this option as machine warranties can be voided if enabled. Select *None* to disable the programmable function.
- b. Contact Recognition - Select *Always*.

## 4. Low Line Override

- a. Input - If a reconfigurable machine will operate sometimes in a low line configuration machine and sometimes as high line, select an input for this function to indicate to the DGC-2020 that the machine is in low line operation. When this is in effect, the *Low Line Scale Factor* settings (found in various protection elements and bus stable/failed detection elements) will be applied to the metered parameter used for the protection. Select *None* to disable the programmable function.
- b. Contact Recognition - Select *Always*.

## 5. Single-Phase Override

- a. Input - If a reconfigurable machine operates sometimes in a single-phase configuration and sometimes as three-phase, select an input for this function to indicate to the DGC-2020 that the machine is in single-phase operation. When this is in effect, single-phase settings apply in the generator protection elements and only single-phase voltages and currents are displayed on the front panel. Select *None* to disable the programmable function.
- b. Contact Recognition - Select *Always*.
- c. Single-Phase Override Sensing - If the machine connection type is not reconfigurable, disregard this setting. However, if a machine is a reconfigurable machine, this setting defines how to interpret a single-phase override contact input. Refer to the appropriate paragraphs in Section 4, *BESTCOMSPPlus® Software*, for additional information.

## 6. Single-Phase AC Override

- a. Input - If a reconfigurable machine operates sometimes in a single-phase AC (as opposed to single-phase AB) configuration and sometimes as a three-phase or single-phase AB configuration, select an input for this function to indicate to the DGC-2020 that the machine is in single-phase AC operation. When this is in effect and the single-phase override is in effect, single-phase settings apply in the generator protection elements and the metering uses phase C current and phase AC voltage for power factor calculations. Otherwise, phase A current and phase AB voltage are used for power factor calculations. Select *None* to disable the programmable function.
- b. Contact Recognition - Select *Always*.

## 7. Battery Charger Fail

- a. Input - Select an input for this function to indicate a battery charger failure. When this input is true, an alarm or pre-alarm will be annunciated based on alarm configuration, and the *Battery Charger Fail* indicator on the RDP-110 (Remote Display Panel) will illuminate. Select *None* to disable the programmable function.
- b. Alarm Configuration - Select *None*, *Alarm*, or *Pre-Alarm* for the desired behavior of this function. Regardless of the selection, the indicator on the RDP-110 will illuminate if an input has been assigned and the input is on.



- c. Activation Delay - Set the delay for which the input must be true before the alarm or pre-alarm will be annunciated. This can be used to prevent “glitches” on the input from causing spurious annunciation.
8. Low Coolant Level
- a. Input - Select an input for this function to indicate a low coolant level. When this input is true, an alarm or pre-alarm is annunciated based on the alarm configuration, and the *Low Coolant Level* indicator on the RDP-110 (Remote Display Panel) will illuminate. Select *None* to disable the programmable function.
  - b. Alarm Configuration - Select *None*, *Alarm*, or *Pre-Alarm* for the desired behavior of this function. Regardless of the selection, the indicator on the RDP-110 will illuminate if an input has been assigned and the input is on.
  - c. Activation Delay - Set the delay for which the input must remain true before the alarm or pre-alarm is annunciated. This can be used to prevent “glitches” on the input from causing spurious annunciation.
9. Fuel Leak Detect
- a. Input - Select an input for this function to indicate when a fuel leakage condition has been detected. When this input is true, an alarm or pre-alarm is announced based on the alarm configuration and the *Fuel Leak* indicator on the RDP-110 (Remote Display Panel) will illuminate. Select *None* to disable the programmable function.
  - b. Alarm Configuration - Select *None*, *Alarm*, or *Pre-Alarm* for the desired behavior of this function. Regardless of the selection, the indicator on the RDP-110 will illuminate if an input has been assigned and the input is on.
  - c. Activation Delay - Set the delay for which the input must remain true before the alarm or pre-alarm will be annunciated. This can be used to prevent “glitches” on the input from causing spurious annunciation.

#### Configuring Remote LSM Inputs on the LSM-2020 (Load Share Module)

Front Panel Navigation Path: **SETTINGS > PROGRAMMABLE INPUTS > LSM INPUTS**

The LSM-2020 has one analog input. It is reserved for use with kW and/or kvar control and can be used as a source for the *kW Base Load (%)* setting, the *kvar Setpoint (%)* setting, or the *PF Setpoint* setting. However, the input type (4-20 mA or 0-10 Vdc) and the input range must be set on the *Remote LSM Inputs* screen in BESTCOMSPlus®. See Figure 7-24.

**Remote LSM Inputs**

Input #1

Input Type  
Voltage

Min Input Voltage (V)  
0.0

Max Input Voltage (V)  
10.0

Min Input Current (mA)  
4.0

Max Input Current (mA)  
20.0

**Figure 7-24. Settings Explorer, Programmable Inputs, Remote LSM Inputs Screen**

The parameters to be configured are:

1. Input Type - Select *Voltage* for a 0-10 Vdc input or *Current* for a 4-20 mA current input.
2. Min Input Voltage (V) - This setting defines the minimum valid voltage expected from the transducer or device connected to the analog input. Voltage below this threshold will be limited to this value. The Min Input Voltage setting can be set only when *Voltage* is selected as the *Input Type*.

3. Max Input Voltage (V) - This setting defines the maximum valid voltage expected from the transducer or device connected to the analog input. Voltage above this threshold will be limited to this value. The Max Input Voltage setting can be set only when *Voltage* is selected as the *Input Type*.
4. Min Input Current (mA) - This setting defines the minimum valid current expected from the transducer or device connected to the analog input. Current below this threshold will be limited to this value. The Min Input Current setting can be set only when *Current* is selected as the *Input Type*.
5. Max Input Current (mA) - This setting defines the maximum valid current expected from the transducer or device connected to the analog input. Current above this threshold will be limited to this value. The Max Input Current can be set only when *Current* is selected as the *Input Type*.

#### Configuring Remote Contact Inputs on the CEM-2020 (See Figure 7-25)

Front Panel Navigation Path: [SETTINGS > PROGRAMMABLE INPUTS > CONFIGURABLE INPUTS](#)

The settings of this screen are disabled unless the CEM-2020 (Contact Expansion Module) has been enabled as previously explained.

For each contact input, configure the following parameters:

1. Alarm Configuration - Select an alarm configuration of *None*, *Alarm*, or *Pre-Alarm*. When an alarm occurs, the horn output annunciates with a constant beep and the engine shuts down. When a pre-alarm occurs, the horn output annunciates with an alternating on and off beep and the engine remains running. If *None* is selected, the input is status only. The status is available to BESTlogicPlus Programmable Logic regardless of the *Alarm Configuration* selection.
2. Activation Delay - This parameter defines how long the input remains on before any annunciation occurs.
3. Label Text - Enter descriptive text that signifies the use of the input. This text appears next to the input in BESTlogicPlus Programmable Logic and in the event log if the input is configured as an *Alarm* or *Pre-Alarm*.
4. Contact Recognition - Select whether the contact input should be recognized always, or only while the engine is running. For example, a switch closes when the oil pressure is low and the engine is running. This type of switch will be closed when the engine is not running and it should be blocked. However, a low oil pressure alarm or pre-alarm is annunciated when a low oil pressure occurs and the switch is closed while the engine is running. A selection of *While Engine Running Only* prevents spurious annunciation when the engine is not running.

**Remote Contact Inputs**

**Input #17**  
 Alarm Configuration: None  
 Activation Delay (s): 0  
 Label Text: INPUT 17  
 Contact Recognition: Always

**Input #18**  
 Alarm Configuration: None  
 Activation Delay (s): 0  
 Label Text: INPUT 18  
 Contact Recognition: Always

**Input #19**  
 Alarm Configuration: None  
 Activation Delay (s): 0  
 Label Text: INPUT 19  
 Contact Recognition: Always

**Input #20**  
 Alarm Configuration: None  
 Activation Delay (s): 0  
 Label Text: INPUT 20  
 Contact Recognition: Always

**Input #21**  
 Alarm Configuration: None  
 Activation Delay (s): 0  
 Label Text: INPUT 21  
 Contact Recognition: Always

**Input #22**  
 Alarm Configuration: None  
 Activation Delay (s): 0  
 Label Text: INPUT 22  
 Contact Recognition: Always

**Input #23**  
 Alarm Configuration: None  
 Activation Delay (s): 0  
 Label Text: INPUT 23  
 Contact Recognition: Always

**Input #24**  
 Alarm Configuration: None  
 Activation Delay (s): 0  
 Label Text: INPUT 24  
 Contact Recognition: Always

**Input #25**  
 Alarm Configuration: None  
 Activation Delay (s): 0  
 Label Text: INPUT 25  
 Contact Recognition: Always

**Input #26**  
 Alarm Configuration: None  
 Activation Delay (s): 0  
 Label Text: INPUT 26  
 Contact Recognition: Always

**Figure 7-25. Settings Explorer, Programmable Inputs, Remote Contact Inputs Screen**

#### Configuring Remote Analog Inputs on the AEM-2020

Front Panel Navigation Path: **SETTINGS > PROGRAMMABLE INPUTS > ANALOG INPUTS**

Each input is configured with a user-assignable string and parameter range to map the analog input signal range to a user-defined parameter range. Thus, external conditions are metered and displayed on the DGC-2020. Each input is configured with up to four thresholds (two over thresholds and two under thresholds) which make their status available to BESTlogic*Plus* Programmable Logic. In addition, each threshold can trigger alarms or pre-alarms to protect the generator and associated equipment based on these measured external conditions. See Figure 7-26.

**Remote Analog Input #1**

Label Text: ALG IN 1

Arming Delay (s): 0

Hysteresis (%): 2.0

Out Of Range Alarm Type: None

Input Type: Voltage

**Ranges**

| Param Min   | Min Input Current (mA) | Min Input Voltage (V) |
|-------------|------------------------|-----------------------|
| -999,999.00 | 4.0                    | 0.0                   |
| Param Max   | Max Input Current (mA) | Max Input Voltage (V) |
| 999,999.00  | 20.0                   | 10.0                  |

**Threshold #1**

Under Threshold: 0.00

Over Threshold: 0.00

Alarm Configuration: None

Activation Delay (s): 0

**Threshold #2**

Under Threshold: 0.00

Over Threshold: 0.00

Alarm Configuration: None

Activation Delay (s): 0

**Figure 7-26. Settings Explorer, Programmable Inputs, Remote Analog Inputs Screen**

Configure the following parameters:

1. **Label Text** - Enter descriptive text that signifies the use of the input. This text appears next to the threshold status and associated alarm and pre-alarm status in BESTlogicPlus Programmable Logic and in the event log if any of the input thresholds are configured as an *Alarm* or *Pre-Alarm*.
2. **Hysteresis (%)** - Enter a value for the desired hysteresis for threshold detection. This helps prevent intermittent detection of thresholds.
3. **Input Type** - Select *Voltage* for 0-10 Vdc inputs or *Current* for 4-20 mA current inputs.
4. **Arming Delay** - The *Arming Delay* is the wait time after engine startup, before input monitoring begins. Set the arming delay to zero if constant monitoring is desired, including while the engine is not running. Nonzero values direct the input to be monitored after the programmed time has elapsed after engine startup.
5. **Out-of-Range Alarm Type** - When the analog input falls outside of its programmed range (as determined by the *Min* and *Max Input* voltage or current settings) an out-of-range indication is annunciated. If *Alarm* or *Pre-Alarm* is selected, annunciation will occur. If *Status Only* is selected, the status will be available to BESTlogicPlus Programmable Logic but no annunciation will occur.
6. **Parameter Minimum (Param Min)** - This setting defines the value that the measured parameter assumes when the analog input is at its programmed minimum level. If the analog input is below its programmed minimum level, the measured parameter is limited to this *Parameter Minimum* setting. However, the raw analog input value displays the actual voltage or current measured at the analog input as long as it is within the voltage or current range detected by the input circuit.

7. **Parameter Maximum (Param Max)** - This setting defines the value that the measured parameter assumes when the analog input is at its programmed maximum level. If the analog input is above its programmed maximum level, the measured parameter is limited to this *Parameter Maximum* setting. However, the raw analog input value displays the actual voltage or current measured at the analog input as long as it is within the voltage or current range detected by the input circuit.
8. **Min Input Current (mA)** - This setting defines the minimum input current level expected for the input. When the input current falls below this level, the out-of-range condition is annunciated if it is configured as alarm or pre-alarm. If the *Input Type* is set for *Voltage*, this setting is disabled.
9. **Max Input Current (mA)** - This setting defines the maximum input current level expected for the input. When the input current rises above this level, the out-of-range condition is annunciated if it is configured as alarm or pre-alarm. If the *Input Type* is set for *Voltage*, this setting is disabled.
10. **Min Input Voltage (V)** - This setting defines the minimum input voltage level expected for the input. When the input falls below this level, the out-of-range condition is annunciated if it is configured as alarm or pre-alarm. If the *Input Type* is set for *Current*, this setting is disabled.
11. **Max Input Voltage (V)** - This setting defines the maximum input voltage level expected for the input. When the input rises above this level, the out-of-range condition is annunciated if it is configured as alarm or pre-alarm. If the *Input Type* is set for *Current*, this setting is disabled.

Four thresholds can be set for each analog input. There can be two “over” thresholds and two “under” thresholds. Each analog input can be configured as an *Alarm*, *Pre-Alarm*, or as *Status Only*. If any type other than *None* is selected, the threshold status is available to BESTlogicPlus Programmable Logic. This allows the user to set up an over and under pre-alarm threshold, and over and under alarm threshold.

An *Activation Delay* can be set for the thresholds. Over Threshold 1 and Under Threshold 1 share a common activation delay. Similarly, Over Threshold 2 and Under Threshold 2 share a second activation delay. See Figure 7-26.

#### 12. Threshold 1

- a. **Under Threshold** - This parameter defines when Status, Alarm, or Pre-Alarm is annunciated.
- b. **Under Threshold Alarm Configuration** - Select *None* to disable, *Status Only* to make the threshold status available to BESTlogicPlus Programmable Logic, *Pre-Alarm* to annunciate a pre-alarm, or *Alarm* to annunciate an alarm.
- c. **Over Threshold** - This parameter defines when Status, Alarm, or Pre-Alarm is annunciated.
- d. **Over Threshold Alarm Configuration** - Select *None* to disable, *Status Only* to make the threshold status available to BESTlogicPlus Programmable Logic, *Pre-Alarm* to annunciate a pre-alarm, or *Alarm* to annunciate an alarm.
- e. **Activation Delay(s)** - This setting defines how long a Threshold 1 condition must be true before an alarm or pre-alarm is annunciated. This time is shared by both Over Threshold 1 and Under Threshold 1 detection.

#### 13. Threshold 2

- f. **Under Threshold** - This parameter defines when Status, Alarm, or Pre-Alarm is annunciated.
- g. **Under Threshold Alarm Configuration** - Select *None* to disable, *Status Only* to make the threshold status available to BESTlogicPlus Programmable Logic, *Pre-Alarm* to annunciate a pre-alarm, or *Alarm* to annunciate an alarm.
- h. **Over Threshold** - This parameter defines when Status, Alarm, or Pre-Alarm annunciation is desired.
- i. **Over Threshold Alarm Configuration** - Select *None* to disable, *Status Only* to make the threshold status available to BESTlogicPlus Programmable Logic, *Pre-Alarm* to annunciate a pre-alarm, or *Alarm* to annunciate an alarm.
- j. **Activation Delay(s)** - This setting defines the duration that a Threshold 2 condition must be true before an alarm or pre-alarm is annunciated. This setting is shared by both Over Threshold 2 and Under Threshold 2 detection.

### Configuring Remote RTD Inputs on the AEM-2020

Front Panel Navigation Path: SETTINGS > PROGRAMMABLE INPUTS > THERMAL INPUTS > RTD IN 1 to 8

Many of the settings for the Remote RTD Inputs are similar to the settings for Remote Analog Inputs. See Figure 7-27.

**Remote RTD Input #1**

Label Text: RTD IN 1

Arming Delay (s): 0

Hysteresis (%): 2.0

Out Of Range Alarm Type: None

RTD Type: 100 Ohm Platinum

**Threshold #1**

Under Threshold (C): -18

Over Threshold (C): -18

Activation Delay (s): 0

Alarm Configuration: None

**Threshold #2**

Under Threshold (C): -18

Over Threshold (C): -18

Activation Delay (s): 0

Alarm Configuration: None

**Figure 7-27. Settings Explorer, Programmable Inputs, Remote RTD Inputs Screen**

Configure the following parameters:

1. **Label Text** - Enter descriptive text that signifies the use of the input. This text appears next to the threshold status and associated alarm and pre-alarm status in BESTlogicPlus Programmable Logic and in the event log if any of the input thresholds are configured as an *Alarm* or *Pre-Alarm*.
2. **Hysteresis (%)** - Enter a value for the desired hysteresis for threshold detection. This will help prevent intermittent detection of thresholds.
3. **RTD Type** - Select *100 Ohm Platinum* or *10 Ohm Copper* to match the RTD that is driving the input.
4. **Arming Delay** - The *Arming Delay* is the wait time after engine startup, before input monitoring begins. Set the arming delay to zero if constant monitoring desired, even when the engine is not running. Nonzero values direct the input to be monitored after the programmed time has elapsed after engine startup.
5. **Out-of-Range Alarm Type** - An out-of-range condition occurs when the DGC-2020 detects that the input is outside of the normal range of what is detected for the RTD type. Primarily this provides indication of an open or shorted RTD circuit. If *Alarm* or *Pre-Alarm* is selected, annunciation will occur. If *Status Only* is selected, the status is available to BESTlogicPlus Programmable Logic but annunciation will not occur.
6. **Threshold 1 and Threshold 2** - These settings are identical to those for the Remote Analog Inputs. Refer to the setup instructions in the paragraphs titled *Configuring Remote Analog Inputs on the AEM-2020* to configure these thresholds.

### Configuring Remote Thermocouple Inputs on the AEM-2020

Many settings for the Remote Thermocouple Inputs are similar to the settings for Remote Analog Inputs. See Figure 7-28.

Front Panel Navigation Path: SETTINGS > PROGRAMMABLE INPUTS > THERMAL INPUTS > THRM CPL 1 and 2

**Figure 7-28. Settings Explorer, Programmable Inputs, Remote Thermocouple Inputs Screen**

Configure the following parameters:

1. **Label Text** - Enter descriptive text that signifies the use of the input. This text appears next to the input status and associated alarm and pre-alarm status in *BESTlogicPlus* Programmable Logic and in the event log when the input thresholds are configured as an *Alarm* or *Pre-Alarm*.
2. **Hysteresis (%)** - Enter a value for the desired hysteresis for threshold detection. Hysteresis helps prevent intermittent detection of thresholds.
3. **Arming Delay** - The arming delay is the wait time after engine startup, before input monitoring begins. Set the arming delay to zero if constant monitoring is desired, even when the engine is not running. Nonzero values cause input monitoring after the programmed time has elapsed after engine startup.
4. **Threshold 1 and Threshold 2** - These settings are identical to those for Remote Analog Inputs. Refer to the setup instructions in the paragraphs titled *Configuring Remote Analog Inputs on the AEM-2020* to configure these thresholds.

### Programmable Outputs

The programmable outputs consist of:

- Contact outputs internal to the DGC-2020
  - Programmable contact outputs
  - Run relay, Pre-Start relay, and Start relay outputs
- Remote contact outputs on the CEM-2020
- Remote analog outputs on the AEM-2020
- Configurable elements in the DGC-2020. Configurable elements allow one to take an output from *BESTlogicPlus* Programmable Logic and set it up as a pre-alarm or alarm condition, as well as an input for subsequent logic in the PLC program.

### Configuring Contact Outputs on the DGC-2020

Programmable Contact Outputs (See Figure 7-29)

Front Panel Navigation Path: SETTINGS > PROGRAMMABLE OUTPUTS > OUTPUTS

The screenshot displays the 'Contact Outputs' configuration screen. It features a grid of 12 output settings, arranged in 4 rows and 3 columns. Each output is represented by a box containing a label 'Output #X' (where X is the output number), a 'Label Text' field, and a text input field. The input fields are pre-filled with 'OUTPUT 1' through 'OUTPUT 12' respectively.

| Output #   | Label Text | Output Value |
|------------|------------|--------------|
| Output #1  |            | OUTPUT 1     |
| Output #2  |            | OUTPUT 2     |
| Output #3  |            | OUTPUT 3     |
| Output #4  |            | OUTPUT 4     |
| Output #5  |            | OUTPUT 5     |
| Output #6  |            | OUTPUT 6     |
| Output #7  |            | OUTPUT 7     |
| Output #8  |            | OUTPUT 8     |
| Output #9  |            | OUTPUT 9     |
| Output #10 |            | OUTPUT 10    |
| Output #11 |            | OUTPUT 11    |
| Output #12 |            | OUTPUT 12    |

Figure 7-29. Settings Explorer, Programmable Outputs, Contact Outputs Screen

Each output can be programmed with a text label describing its use; this label appears in BESTlogicPlus Programmable Logic where the output is used to aid in program clarity and ease of programming.

Run Relay, Pre-Start Relay, and Start Relay

Front Panel Navigation Path: SETTINGS > SYSTEM PARAMS > RELAY CONTROL

In some systems, it may be beneficial to modify the standard functionality implemented by the DGC-2020 for the Run, Pre-Start, or Start relays. If your generator does not require a pre-start function, it may be desired to use the 30A relay assigned to it for other purposes. These relays can be configured in one of two ways. The first is to operate under their predefined functionality, making them a dedicated output. The second way is to select them to be programmable, in which case they become available to BESTlogicPlus Programmable Logic to be used in the same manner as the programmable relay outputs.

Figure 7-30 shows the *Relay Control* screen used to set the operation of these relays to predefined or programmable operation.

The screenshot displays the 'Relay Control' configuration screen. It contains three sections, each with a label and a dropdown menu. The 'Start' section has a dropdown set to 'Predefined'. The 'Run' section has a dropdown set to 'Predefined'. The 'Prestart' section has a dropdown set to 'Predefined'.

| Relay Control | Start      | Run        | Prestart   |
|---------------|------------|------------|------------|
|               | Predefined | Predefined | Predefined |

Figure 7-30. Settings Explorer, System Parameters, Relay Control Screen

For each relay (Start, Run, and Pre-Start), select whether it should use its predefined functionality or be made programmable.

When *Programmable* is selected for a relay, it becomes available to BESTlogicPlus Programmable Logic as a logic element. The elements are titled *Start Output*, *PreStart Out*, and *Run Output*. The predefined functionality is available as an input to the logic. If *Programmable* is selected as the relay control mode, connect the corresponding predefined input function to the relay and it functions as if *Predefined* were selected as its relay control type. However, other logic can be combined with it to create operation that is



more versatile. If *Programmable* is selected for a relay, but it is not used in the logic, that relay will never close.

A logic example connecting the predefined inputs directly to the “programmable” relay outputs for all three relays is shown in Figure 7-31.

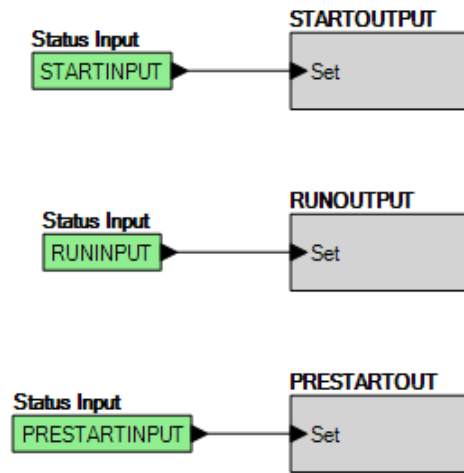


**Figure 7-31. Logic Example of Programmable Relays**

#### Setting Up Configurable Elements in the DGC-2020.

Configurable elements are used with BESTlogicPlus Programmable Logic to allow a user to implement logic that causes an alarm or pre-alarm. This can be used to build protection that is not part of the standard protection in the DGC-2020. See Figure 7-32.

**Front Panel Navigation Path:** [SETTINGS > PROGRAMMABLE OUTPUTS > CONFIG ELEMENTS](#)

The parameters for configurable elements are similar to those for programmable inputs. Set the following parameters for each configurable element:

1. **Alarm Configuration** - Select *None*, *Alarm*, or *Pre-Alarm*. When an alarm occurs, the horn annunciates with a constant high-pitched sound and the engine stops. When a pre-alarm occurs, the horn annunciates with an alternating on and off beep and the engine remains running. If *None* is selected, the element is status only. The status is available as an input to BESTlogicPlus Programmable Logic regardless of the setting of the *Alarm Configuration*.
2. **Activation Delay** - This setting defines the duration that the configurable element is true before alarm or pre-alarm annunciation.
3. **Label Text** - Enter descriptive text describing how the configurable element is used. This text appears next to the configurable element status in BESTlogicPlus Programmable Logic and in the event log if the *Alarm Configuration* is set as an *Alarm* or *Pre-Alarm*.
4. **Contact Recognition** - Select whether the configurable element is recognized always or only while the engine is running. A selection of *While Engine Running Only* prevents spurious annunciation when the engine is stopped.
5. **Arming Delay** - Set the arming delay to disable the configurable element during engine startup. If the arming delay is set to zero, the configurable element is active at all times, including when the engine is not running. If the arming delay is set to a nonzero value, the configurable element is inactive when the engine is not running, and does not become active until after the engine is started and the arming delay has elapsed.

For example, if the door of the generator room is opened a pre-alarm should occur to alert the control room that someone is in the generator room. In addition, suppose for safety reasons, any running machines should be stopped any time someone enters the generator room. Assume Input 5 is set up to indicate “DOOR OPEN” and it is configured as a *Pre-Alarm*. In BESTlogicPlus Programmable Logic, Input 5 could be ANDed with ENGINE RUNNING to drive Configurable Element 1, which is configured as an alarm. The logic diagram is shown in Figure 7-33.

Input 5, configured as a *Pre-Alarm*, triggers a pre-alarm if the door is opened whether the engine is running or stopped. Configurable Element 1, configured as an *Alarm*, triggers an alarm if the door is opened while the engine is running.

### Configurable Elements

| Configurable Element #1        | Configurable Element #2        | Configurable Element #3        |
|--------------------------------|--------------------------------|--------------------------------|
| Alarm Configuration<br>None    | Alarm Configuration<br>None    | Alarm Configuration<br>None    |
| Activation Delay (s)<br>0      | Activation Delay (s)<br>0      | Activation Delay (s)<br>0      |
| Label Text<br>CONFIG ELEMENT 1 | Label Text<br>CONFIG ELEMENT 2 | Label Text<br>CONFIG ELEMENT 3 |
| Contact Recognition<br>Always  | Contact Recognition<br>Always  | Contact Recognition<br>Always  |
| Arming Delay (s)<br>0          | Arming Delay (s)<br>0          | Arming Delay (s)<br>0          |

| Configurable Element #4        | Configurable Element #5        | Configurable Element #6        |
|--------------------------------|--------------------------------|--------------------------------|
| Alarm Configuration<br>None    | Alarm Configuration<br>None    | Alarm Configuration<br>None    |
| Activation Delay (s)<br>0      | Activation Delay (s)<br>0      | Activation Delay (s)<br>0      |
| Label Text<br>CONFIG ELEMENT 4 | Label Text<br>CONFIG ELEMENT 5 | Label Text<br>CONFIG ELEMENT 6 |
| Contact Recognition<br>Always  | Contact Recognition<br>Always  | Contact Recognition<br>Always  |
| Arming Delay (s)<br>0          | Arming Delay (s)<br>0          | Arming Delay (s)<br>0          |

| Configurable Element #7        | Configurable Element #8        |
|--------------------------------|--------------------------------|
| Alarm Configuration<br>None    | Alarm Configuration<br>None    |
| Activation Delay (s)<br>0      | Activation Delay (s)<br>0      |
| Label Text<br>CONFIG ELEMENT 7 | Label Text<br>CONFIG ELEMENT 8 |
| Contact Recognition<br>Always  | Contact Recognition<br>Always  |
| Arming Delay (s)<br>0          | Arming Delay (s)<br>0          |

Figure 7-32. Settings Explorer, Programmable Outputs, Configurable Elements Screen

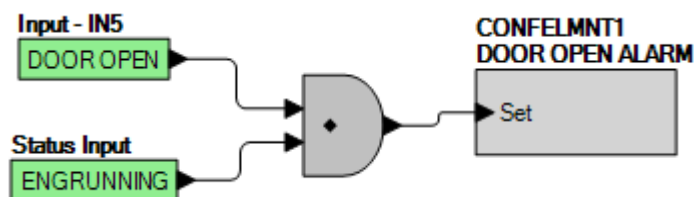


Figure 7-33. Using a Configurable Element Logic Diagram

### Configuring Remote Contact Outputs on the CEM-2020 (See Figure 7-34)

Front Panel Navigation Path: [SETTINGS > PROGRAMMABLE OUTPUTS > OUTPUTS](#)

Each output can be programmed with a text label describing its use; this label appears in BESTlogicPlus Programmable Logic where the output is used to aid in program clarity and ease of programming.

| Output #   | Label Text |
|------------|------------|
| Output #13 | OUTPUT 13  |
| Output #14 | OUTPUT 14  |
| Output #15 | OUTPUT 15  |
| Output #16 | OUTPUT 16  |
| Output #17 | OUTPUT 17  |
| Output #18 | OUTPUT 18  |
| Output #19 | OUTPUT 19  |
| Output #20 | OUTPUT 20  |
| Output #21 | OUTPUT 21  |
| Output #22 | OUTPUT 22  |
| Output #23 | OUTPUT 23  |
| Output #24 | OUTPUT 24  |
| Output #25 | OUTPUT 25  |
| Output #26 | OUTPUT 26  |
| Output #27 | OUTPUT 27  |
| Output #28 | OUTPUT 28  |
| Output #29 | OUTPUT 29  |
| Output #30 | OUTPUT 30  |
| Output #31 | OUTPUT 31  |
| Output #32 | OUTPUT 32  |
| Output #33 | OUTPUT 33  |
| Output #34 | OUTPUT 34  |
| Output #35 | OUTPUT 35  |
| Output #36 | OUTPUT 36  |

**Figure 7-34. Settings Explorer, Programmable Outputs, Remote Contact Outputs Screen**

### Configuring Remote Analog Outputs on the AEM-2020

Front Panel Navigation Path: [SETTINGS > PROGRAMMABLE OUTPUTS > ANALOG OUTPUTS](#)

There are four remote analog outputs, each configured on its own screen in BESTCOMSPlus®. Parameters metered by the DGC-2020 are mapped to these outputs, enabling them to be used as meter drivers or they can drive analog inputs of external equipment. Ranges for the metered parameter and the analog output are set up so that when the metered parameter is at the minimum of the parameter range, the analog output is at the minimum of its output range. Similarly, when the metered parameter is at the maximum of the parameter range, the analog output is at the maximum of its output range. The parameters for Remote Analog Output 1 are shown in Figure 7-35.

**Remote Analog Output #1**

Param Selection: Oil Pressure  
Output Type: Voltage  
Out Of Range Alarm Type: None  
Out Of Range Activation Delay (s): 0

**Ranges**

| Param Min   | Min Output Current (mA) | Min Output Voltage (V) |
|-------------|-------------------------|------------------------|
| -999,999.00 | 4.0                     | 0.0                    |
| Param Max   | Max Output Current (mA) | Max Output Voltage (V) |
| 999,999.00  | 20.0                    | 10.0                   |

**Figure 7-35. Settings Explorer, Programmable Outputs, Remote Analog Outputs Screen**

Configure the following parameters:

1. **Parameter Selection** - This setting defines the metered parameter within the DGC-2020 (e.g. oil pressure, coolant temperature, etc.) that is assigned to drive the analog output. The parameter range and the output range are configured so that the range of the metered parameter is scaled to the range of the analog output. Thus, when the metered parameter is at the minimum of the parameter range, the analog output is at the minimum of its output range. Similarly, when the metered parameter is at the maximum of the parameter range, the analog output is at the maximum of its output range.
2. **Output Type** - Select *Voltage* or *Current* as the analog output type.
3. **Out-of-Range Alarm Type** - Select to annunciate an alarm or pre-alarm if the metered parameter is outside of the range assigned by the parameter minimum and parameter maximum settings.
4. **Out-of-Range Alarm Activation Delay** - This setting defines the time delay for which an out-of-range condition must be true before annunciating an *Alarm* or *Pre-Alarm*.
5. **Parameter Minimum** - This setting defines the minimum value that occurs on the parameter being metered.
6. **Parameter Maximum** - This setting defines the maximum value that occurs on the parameter being metered.
7. **Min Output Current (mA)** - If *Analog Output Type* is configured as *Current*, enter the output current level to be sourced when the metered parameter is at its minimum level. This setting is disabled when the output type is set to *Voltage*.
8. **Max Output Current (mA)** - If the *Analog Output Type* is configured as *Current*, enter the output current level to be sourced when the metered parameter is at its maximum level. This setting is disabled when the output type is set to *Voltage*.
9. **Min Output Voltage (V)** - If the *Analog Output Type* is configured as *Voltage*, enter the output voltage to be sourced when the metered parameter is at its minimum level. This setting is disabled when the output type is set to *Current*.
10. **Max Output Voltage (V)** - If the *Analog Output Type* is configured as *Voltage*, enter the output voltage level to be sourced when the metered parameter is at its maximum level. This setting is disabled when the output type is set to *Current*.

## Generator and Bus Breaker Control

The DGC-2020 has the ability to automatically control the generator breaker. Users have the ability to control the breaker through physical inputs by using BESTlogic*Plus* programmable logic. Physical inputs can also be configured through logic to implement open and close commands for the generator breaker.

The DGC-2020 can automatically control the generator breaker under the following conditions.

- The unit is in AUTO and one of the following is true:

1. The RUN WITH LOAD logic element is implemented in the logic and it is true.
2. A Run session has been initiated by the exercise timer and the *Run With Load* check box in the generator exercise timer parameters is checked.
3. Mains Fail Transfer is enabled and utility power has failed.

The mains fail transfer is discussed in detail under *Mains Fail Transfer*.

- When the DGC-2020 controls a breaker, the following criteria must be satisfied for the generator breaker to change state:

1. A breaker cannot be closed unless generator voltage is stable and bus voltage is stable or dead. A breaker will not close to a dead bus unless the *Dead Bus Close Enable* parameter found in BESTCOMSPlus® under SETTINGS EXPLORER → BREAKER MANAGEMENT → BREAKER HARDWARE is enabled.

Front Panel Navigation Path: [SETTINGS > BREAKER MANAGEMENT > BREAKER HARDWARE > GEN BREAKER](#)

2. A breaker will not change state if it receives conflicting commands. In other words, if an input is indicating an open command at the same time another input is indicating a close command, the breaker will not change state.

Breaker status for a breaker is communicated to the DGC-2020 by having only the breaker element (either gen breaker or mains breaker) in the logic diagram and a physical input (contact from the breaker indicating breaker status) must be connected to the *Status* input of the breaker block.

### Steps Required to Configure a DGC-2020 for Generator Breaker Control

1. Connect the DGC-2020 according to the appropriate figure in Section 6, *Installation* under *Connections* for the type of generator connection desired (WYE, DELTA, etc.).
2. Set up the basic system parameters that will govern engine operation and alarm and pre-alarm annunciation. Details can be found in the paragraphs titled *DGC-2020 Initial Setup*. Additional details of individual settings can be found in Section 4, *BESTCOMSPlus® Software*.
3. Configure the generator breaker parameters under SETTINGS EXPLORER > BREAKER MANAGEMENT > BREAKER HARDWARE. See Figure 7-36.

Front Panel Navigation Path: [SETTINGS > BREAKER MANAGEMENT > BREAKER HARDWARE > GEN BREAKER](#)

**Breaker Hardware**

**Generator Breaker Hardware**

Configured  
☐ No  
☒ Yes

Dead Bus Close Enable  
☒ Disable  
☐ Enable

Dead Gen Close Enable  
☒ Disable  
☐ Enable

Contact Type  
☐ Pulse  
☒ Continuous

Breaker Fail Output Configuration  
☒ Retain  
☐ Remove

External Status Change Action  
☒ Ignore  
☐ Follow Always  
☐ Follow In Auto

Breaker Closing Time (ms)  
 100

Open Pulse Time (s)  
 0.01

Close Pulse Time (s)  
 0.01

Transition Delay (s)  
 0.00

Open Attempts  
 1

Close Attempts  
 1

Retry Delay (s)  
 5

**Gen and Mains Breaker Breaker Close Wait Time (s)**  
 0.2

**Mains Breaker Hardware**

Configured  
☒ No  
☐ Yes

Contact Type  
☐ Pulse  
☒ Continuous

Breaker Fail Output Configuration  
☒ Retain  
☐ Remove

External Status Change Action  
☒ Ignore  
☐ Follow Always  
☐ Follow In Auto

Breaker Closing Time (ms)  
 100

Open Pulse Time (s)  
 0.01

Close Pulse Time (s)  
 0.01

Transition Delay (s)  
 0.00

Open Attempts  
 1

Close Attempts  
 1

Retry Delay (s)  
 5

**Figure 7-36. Settings Explorer, Breaker Management, Breaker Hardware Screen**

- a. Breaker Close Wait Time. This is a time interval in which it is expected that the breaker will transition from open to closed or closed to open. If it does not change state within that time, either a Gen Breaker Close Fail or Gen Breaker Open Fail will be annunciated for generator breaker failures, and/or Mains Breaker Close Fail or Mains Breaker Open Fail will be annunciated for mains breaker failures.
  - b. Generator Breaker.
    - i. Enable Dead Bus Close if it is desired to close to a dead bus.
    - ii. Set the contact type and pulse times if pulsed contacts are used.
    - iii. Set the breaker close time. This is the time used by the anticipatory synchronizer to calculate the advance angle before 0 degrees slip angle that a breaker close command will be issued.
  - c. Mains Breaker.
  - d. Set the Mains Breaker as *Configured* if it is used, otherwise do not configure these settings.
    - i. If the mains breaker is configured, set the contact type and pulse times if pulsed contacts are used.
    - ii. If the mains breaker is configured, set the breaker close time. This is the time used by the anticipatory synchronizer to calculate the advance angle at which a breaker close command will be issued.
4. Set up the Gen Breaker in BESTlogicPlus Programmable Logic under SETTINGS EXPLORER > BESTlogicPlus PROGRAMMABLE LOGIC. See Figure 7-37.

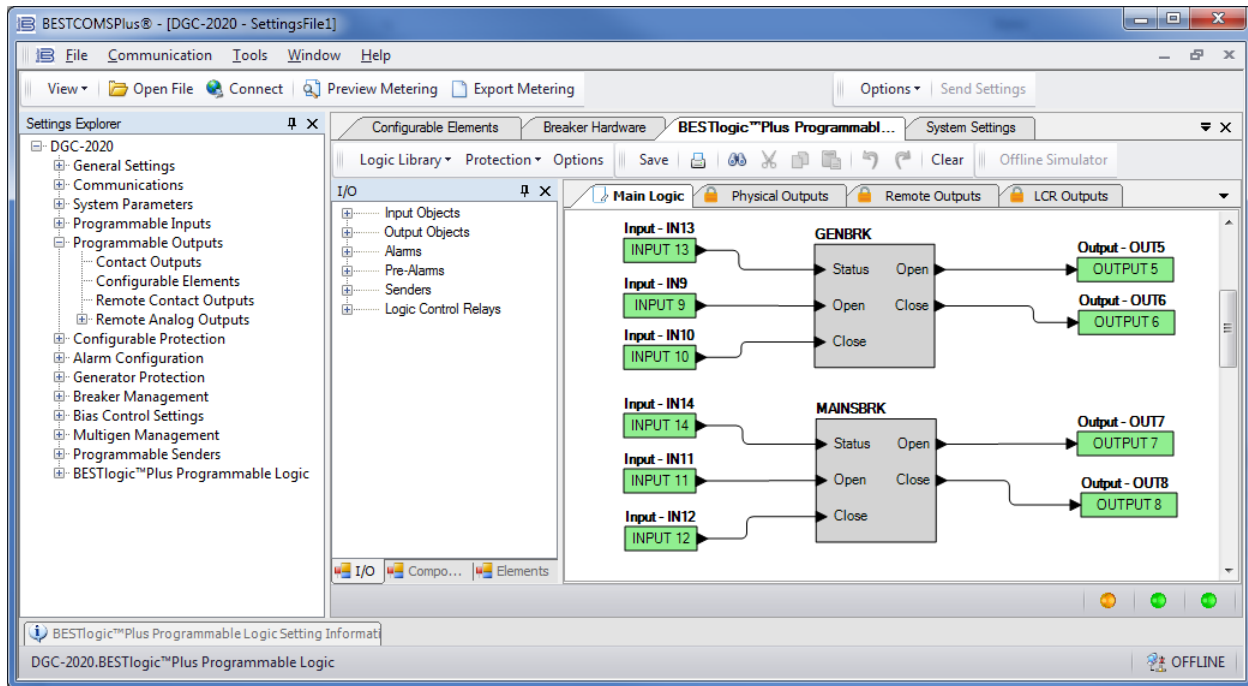


**Figure 7-37. Settings Explorer, BESTlogicPlus Programmable Logic Settings**

**a. Generator Breaker**

- i. Drag the Gen Breaker element into the logic diagram.
- ii. Connect the breaker element open and close output to the contact outputs that will drive the breaker.
- iii. Connect the physical input or remote input that has the breaker status (closed if breaker is closed, open when breaker is open) to the *Status* input of the breaker element. This is the only way to indicate breaker status to the DGC-2020.
- iv. If it is desired to have physical inputs that can request breaker open and close commands, connect the desired inputs to the open and close command inputs of the breaker element. These inputs should be pulsed. If they both close at the same time, the breaker will not change state. If it is not desired to have inputs for breaker commands, connect a "Logic 0" input object to the open and close command inputs of the breaker block.

**b. Mains Breaker (if configured)**

- i. Drag the Mains Breaker element into the logic diagram.
- ii. Connect the breaker element open and close outputs to the contact outputs that will drive the breaker.
- iii. Connect the physical input or remote input that has the breaker status (closed if breaker is closed, open when breaker is open) to the *Status* input of the breaker element. This is the only way to indicate breaker status to the DGC-2020.
- iv. If it is desired to have physical inputs that can request breaker open and close commands, connect the desired inputs to the open and close command inputs of the breaker element. Note these are to be pulsed inputs; if they are both closed at the same time, the breaker will not change state. If it is not desired to have inputs for breaker commands, connect a "Logic 0" input object to the open and close command inputs of the breaker block.

**c. Click the *Save* button when the logic is complete.**

**d. From the *Communication* pull-down menu, select *Upload Logic* to load the logic into the DGC-2020 if you are connected to it, or save the settings file if you are working off line.**

5. Set the parameters for detecting stable and failed bus and generator under SETTINGS EXPLORER > BREAKER MANAGEMENT > BUS CONDITION DETECTION.

Front Panel Navigation Path: [SETTINGS > BREAKER MANAGEMENT > BUS CONDITION DETECT](#)

- a. Generator Sensing. See Figure 7-38.

**Bus Condition Detection**

**Generator Sensing**

**Generator Condition Settings**

Dead Gen Threshold: 30 V, 0.063 Per Unit

Dead Gen Activation Delay (s): 0.1

Gen Failed Activation Delay (s): 0.1

**Generator Stable**

**Overvoltage Settings**

Pickup (V L-L): 130 V, 0.271 Per Unit

Dropout: 127 V, 0.265 Per Unit

**Undervoltage Settings**

Pickup (V L-L): 115 V, 0.240 Per Unit

Dropout: 117 V, 0.244 Per Unit

**Overfrequency Settings**

Pickup: 62.00 Hz, 1.0333 Per Unit

Dropout: 61.80 Hz, 1.0300 Per Unit

**Underfrequency Settings**

Pickup: 58.00 Hz, 0.9667 Per Unit

Dropout: 58.20 Hz, 0.9700 Per Unit

Gen Stable Activation Delay (s): 0.1

Low Line Scale Factor: 1.000

Alternate Frequency Scale Factor: 1.000

**Bus Sensing**

**Bus Condition Settings**

Dead Bus Threshold: 30 V, 0.063 Per Unit

Dead Bus Activation Delay (s): 0.1

Bus Failed Activation Delay (s): 0.1

**Bus Stable**

**Overvoltage Settings**

Pickup (V L-L): 130 V, 0.271 Per Unit

Dropout: 127 V, 0.265 Per Unit

**Undervoltage Settings**

Pickup (V L-L): 115 V, 0.240 Per Unit

Dropout: 117 V, 0.244 Per Unit

**Overfrequency Settings**

Pickup: 62.00 Hz, 1.0333 Per Unit

Dropout: 61.80 Hz, 1.0300 Per Unit

**Underfrequency Settings**

Pickup: 58.00 Hz, 0.9667 Per Unit

Dropout: 58.20 Hz, 0.9700 Per Unit

Bus Stable Activation Delay (s): 0.1

Low Line Scale Factor: 1.000

Alternate Frequency Scale Factor: 1.000

**Figure 7-38. Settings Explorer, Breaker Management, Bus Condition Detection**

- i. Dead Bus Voltage Threshold and Activation Delay. When the voltage of the generator is below this threshold for the duration equal to the activation delay, the generator is deemed “Dead”.
- ii. Gen Stable Over and Under Voltage thresholds and Over and Under Frequency thresholds and the Bus Stable and Bus Failed Activation Delay times. When the generator voltage and frequencies are within the specified ranges for the duration



equal to the *Bus Stable Activation Delay*, the generator is deemed “Stable”. Otherwise, it is deemed “Failed”.

- b. Bus Sensing. See Figure 7-38.
  - i. Dead Bus Voltage Threshold and Activation Delay. When the voltage of the bus is below this threshold for the duration equal to the activation delay, the bus is deemed “Dead”.
  - ii. Bus Stable Over and Under Voltage thresholds and Over and Under Frequency thresholds and the Bus Stable and Bus Failed Activation Delay times. When the bus voltage and frequencies are within the specified ranges for the duration equal to the *Bus Stable Activation Delay*, the bus is deemed “Stable”. Otherwise, it is deemed “Failed”.

### Caution

The bus condition parameters are critical because they determine when a breaker can be closed. The generator breaker can be closed when any one of the following is true:

- The generator is stable and both breakers are open
- The generator is stable and the bus is stable
- The generator is stable, the bus is dead, and the dead bus close enable setting is set to enabled
- The generator is dead, the dead gen close enable setting is set to enabled, the bus is dead, and the dead bus close enable setting is set to enabled

The mains breaker can be closed only when the generator is stable and both breakers are open, or the generator is stable and the bus is stable.

6. Place the unit in Auto. The unit is now configured for generator breaker control. It can be tested by driving the RUN WITH LOAD logic element true, or setting up the exercise timer for a loaded test, or by starting the unit in Run or Auto mode and giving it CLOSE and OPEN commands from the physical inputs if they are available for breaker control.

## Synchronizer

Some applications require a generator set that is paralleled with other generators or a utility bus. In order to parallel the generator, the speed and the voltage of the generator must be properly matched to the source that the generator is being paralleled to. This is done by properly adjusting the generator's speed control governor and automatic voltage regulator. Synchronization can be achieved manually by an operator or by the use of an automatic synchronizer.

The DGC-2020 digital genset controller has an integrated automatic synchronizer as an option to perform synchronization. The controller monitors the voltages, frequencies, and phase relationships of both the generator and the bus. It then sends a signal to the governor to increase or decrease the speed of the engine to match the frequency and match the generator phase angle to the bus phase angle. It will also send a signal to the voltage regulator to match the voltage levels. Once all of these conditions are met, the controller will send a breaker close signal to the generator circuit breaker.

There are two types of automatic synchronizers available. A phase lock type of automatic synchronizer controls the frequency of the generator and brings it into the predetermined phase angle window. After a time delay expires while in the window, the close signal is given to the generator circuit breaker. The anticipatory style of automatic synchronizer controls the slip frequency between the generator and the bus. The synchronizer calculates the timing of the closing signal to allow the generator breaker to be

closed when the phase angle between the two sources is at 0 degrees. This calculation takes into account the slip rate, generator breaker closing time, and the phase angle difference.

In order to minimize the effects of I/O communications delays on synchronization, it is recommended that local I/O on the DGC-2020, rather than remote I/O on the CEM-2020, be used for generator breaker open and close commands, generator breaker status, voltage raise and lower contacts, and speed raise and lower contacts.

## Steps Required to Configure a DGC-2020 Automatic Synchronizer

The following steps describe how to configure the DGC-2020 automatic synchronizer using BESTCOMSPlus®:

1. Under the Settings Explorer, click on *General Settings* and then *Style Number*. Verify the unit you are communicating with has the *Automatic Synchronizer* option present. See Figure 7-39.

Front Panel Navigation Path: [SETTINGS > GENERAL SETTINGS > VERSION INFO > DGC-2020 > STYLE CODE](#)

| DGC-2020 Style Number Options |                            |                                                          |
|-------------------------------|----------------------------|----------------------------------------------------------|
| 5                             | Current Sensing Input Type | 5) 5A CTs<br>1) 1A CTs                                   |
| 1                             | Generator Frequency        | 1) 50/60 Hz<br>2) 400 Hz                                 |
| B                             | Output Contacts            | A) 7 Output Contacts<br>B) 15 Output Contacts            |
| R                             | Internal RS-485 Port       | N) No Internal RS-485 Port<br>R) w/ Internal RS-485 Port |
| B                             | Battery Backup for RTC     | N) No Battery<br>B) w/ Battery                           |
| X                             | Dial-out Modem             | X) Excludes Modem<br>R) RS-232                           |
| E                             | Generator Protection       | S) Standard Gen Protection<br>E) Enhanced Gen Protection |
| A                             | Automatic Synchronizer     | N) No Auto Sync<br>A) w/ Auto Sync                       |
| H                             | LCD Heater                 | H) w/ LCD Heater                                         |

Figure 7-39. Settings Explorer, General Settings, Style Number Screen

2. If using a remote module to control the governor or voltage regulator i.e. LSM-2020 or CEM-2020, click on *System Parameters* then *Remote Module Setup*. Enable the applicable module. This step is not necessary if you are using the DGC-2020's available contact outputs for AVR and governor control. See Figure 7-40.

Front Panel Navigation Path: [SETTINGS > SYSTEM PARAMS > REMOTE MODULE SETUP](#)

**Remote Module Setup**

| Load Share Module                                                        | Contact Expansion Module                                                 | Analog Expansion Module                                                  |
|--------------------------------------------------------------------------|--------------------------------------------------------------------------|--------------------------------------------------------------------------|
| <input type="radio"/> Disable<br><input checked="" type="radio"/> Enable | <input type="radio"/> Disable<br><input checked="" type="radio"/> Enable | <input type="radio"/> Disable<br><input checked="" type="radio"/> Enable |
| LSM J1939 Address<br>235                                                 | CEM J1939 Address<br>236                                                 | AEM J1939 Address<br>237                                                 |
| LSM Auxiliary Input Source<br>Local                                      | CEM Outputs<br>18 Outputs                                                |                                                                          |

**Figure 7-40. Settings Explorer, System Parameters, Remote Module Setup Screen**

- Next, click *Programmable Inputs*, then *Contact Inputs* to label the Breaker Status input (Input 13 is the default). See Figure 7-41.

Front Panel Navigation Path: [SETTINGS > PROGRAMMABLE INPUTS > CONFIGURABLE INPUTS](#)

| Input # | Label Text     | Contact Recognition | Alarm Configuration | Activation Delay (s) |
|---------|----------------|---------------------|---------------------|----------------------|
| 7       | INPUT 7        | Always              |                     |                      |
| 8       | INPUT 8        | Always              |                     |                      |
| 9       | INPUT 9        | Always              |                     |                      |
| 10      | INPUT 10       | Always              | None                | 0                    |
| 11      | INPUT 11       | Always              | None                | 0                    |
| 12      | INPUT 12       | Always              | None                | 0                    |
| 13      | Breaker Status | Always              | None                | 0                    |
| 14      | INPUT 14       | Always              | None                | 0                    |
| 15      | INPUT 15       | Always              | None                | 0                    |

**Figure 7-41. Settings Explorer, Programmable Inputs, Contact Inputs Screen**

- Click on *Programmable Outputs* then *Contact Outputs*. Select and label the appropriate outputs for Breaker Close (Output 5 is the default) and Breaker Open (Output 6 is the default). If using contact outputs on the DGC-2020 for Governor and Voltage Regulator control, the contact outputs can be labeled here as well. Default logic is Output 9 = GOV Raise, Output 10 = GOV Lower, Output 11 = AVR Raise, and Output 12 = AVR Lower. See Figure 7-42.

Front Panel Navigation Path: [SETTINGS > PROGRAMMABLE OUTPUTS > OUTPUTS](#)

| Contact Outputs                              |                                                  |                                                |
|----------------------------------------------|--------------------------------------------------|------------------------------------------------|
| <b>Output #1</b><br>Label Text<br>OUTPUT 1   | <b>Output #2</b><br>Label Text<br>OUTPUT 2       | <b>Output #3</b><br>Label Text<br>OUTPUT 3     |
| <b>Output #4</b><br>Label Text<br>OUTPUT 4   | <b>Output #5</b><br>Label Text<br>Breaker Closed | <b>Output #6</b><br>Label Text<br>Breaker Open |
| <b>Output #7</b><br>Label Text<br>OUTPUT 7   | <b>Output #8</b><br>Label Text<br>OUTPUT 8       | <b>Output #9</b><br>Label Text<br>GOV Raise    |
| <b>Output #10</b><br>Label Text<br>GOV Lower | <b>Output #11</b><br>Label Text<br>AVR Raise     | <b>Output #12</b><br>Label Text<br>AVR Lower   |

**Figure 7-42. Settings Explorer, Programmable Outputs, Contact Outputs Screen**

5. Click on *Breaker Management* then *Breaker Hardware*. On this screen, (Figure 7-43), enter the settings for the following parameters:

Front Panel Navigation Path: **SETTINGS > BREAKER MANAGEMENT > BREAKER HARDWARE**

- a. Breaker Close Wait Time. This is an interval in which it is expected that the breaker will transition from open to closed or closed to open. If it does not change state within the specified time, either a Gen Breaker Close Fail or Gen Breaker Open Fail is annunciated as generator breaker failures, and/or Mains Breaker Close Fail or Mains Breaker Open Fail is annunciated as mains breaker failures.
- b. Generator Breaker:
  - i. Enable the *Dead Bus Close Enable* parameter if it is desired to close to a dead bus.
  - ii. Set the contact type and pulse times if pulsed contacts are used.
  - iii. Set the breaker close time. This is the time used by the anticipatory synchronizer to calculate the advance angle before 0 degrees slip angle at which to issue the breaker close command.
- c. Mains Breaker (if configured):
  - i. Set the mains breaker as configured if used otherwise leave it not configured.
  - ii. If the mains breaker is configured, set the contact type and pulse times if pulsed contacts are used.
  - iii. If the mains breaker is configured, set the breaker close time. This is the time used by the anticipatory synchronizer to calculate the advance angle before 0 degrees slip angle at which to issue the breaker close command.

**Breaker Hardware**

**Generator Breaker Hardware**

Configured  
☐ No  
☒ Yes

Dead Bus Close Enable  
☒ Disable  
☐ Enable

Dead Gen Close Enable  
☒ Disable  
☐ Enable

Contact Type  
☒ Pulse  
☐ Continuous

Breaker Fail Output Configuration  
☒ Retain  
☐ Remove

External Status Change Action  
☒ Ignore  
☐ Follow Always  
☐ Follow In Auto

Breaker Closing Time (ms)  
 100

Open Pulse Time (s)  
 0.01

Close Pulse Time (s)  
 0.01

Transition Delay (s)  
 0.00

Open Attempts  
 1

Close Attempts  
 1

Retry Delay (s)  
 5

**Gen and Mains Breaker Breaker Close Wait Time (s)**  
 0.2

**Mains Breaker Hardware**

Configured  
☐ No  
☒ Yes

Contact Type  
☒ Pulse  
☐ Continuous

Breaker Fail Output Configuration  
☒ Retain  
☐ Remove

External Status Change Action  
☒ Ignore  
☐ Follow Always  
☐ Follow In Auto

Breaker Closing Time (ms)  
 100

Open Pulse Time (s)  
 0.01

Close Pulse Time (s)  
 0.01

Transition Delay (s)  
 0.00

Open Attempts  
 1

Close Attempts  
 1

Retry Delay (s)  
 5

**Figure 7-43. Settings Explorer, Breaker Management, Breaker Hardware Screen**

6. Click on *Bus Condition Detection* under the *Breaker Management* portion of the Settings Explorer. This is where the parameters are set for detecting stable and failed bus and generator conditions. **The generator and bus condition parameters are critical since a breaker can be closed only when (1) the generator is stable and (2) the bus is either stable or dead.** See Figure 7-44.

Front Panel Navigation Path: [SETTINGS > BREAKER MANAGEMENT > BUS CONDITION DETECT](#)

- a. Dead Bus Voltage Threshold and Activation Delay. When the voltage of either the generator or bus is below this threshold for the duration equal to the activation delay, the generator or bus is deemed “Dead”.
- b. Gen Stable Over and Under Voltage Thresholds, and Over and Under Frequency Thresholds, and the Bus Stable and Bus Failed Activation Delay. When the generator voltage and frequencies are within the specified ranges for the duration equal to the Bus Stable Activation Delay, the generator is deemed “Stable”. Otherwise it is deemed “Failed”.
- c. Bus Stable Over and Under Voltage Thresholds and Over and Under Frequency Thresholds. When the bus input voltage and frequencies are within the specified ranges for the duration equal to the Bus Stable Activation Delay, the bus input is deemed “Stable”. Otherwise it is deemed “Failed”.

### Bus Condition Detection

#### Generator Sensing

##### Generator Condition Settings

|                    |                               |                                 |
|--------------------|-------------------------------|---------------------------------|
| Dead Gen Threshold | Dead Gen Activation Delay (s) | Gen Failed Activation Delay (s) |
| 30 V               | 0.1                           | 0.1                             |
| 0.063 Per Unit     |                               |                                 |

#### Generator Stable

##### Overvoltage Settings

|                |                |
|----------------|----------------|
| Pickup (V L-L) | Dropout        |
| 130 V          | 127 V          |
| 0.271 Per Unit | 0.265 Per Unit |

##### Undervoltage Settings

|                |                |
|----------------|----------------|
| Pickup (V L-L) | Dropout        |
| 115 V          | 117 V          |
| 0.240 Per Unit | 0.244 Per Unit |

##### Overfrequency Settings

|                 |                 |
|-----------------|-----------------|
| Pickup          | Dropout         |
| 62.00 Hz        | 61.80 Hz        |
| 1.0333 Per Unit | 1.0300 Per Unit |

##### Underfrequency Settings

|                 |                 |
|-----------------|-----------------|
| Pickup          | Dropout         |
| 58.00 Hz        | 58.20 Hz        |
| 0.9667 Per Unit | 0.9700 Per Unit |

|                                 |                       |                                  |
|---------------------------------|-----------------------|----------------------------------|
| Gen Stable Activation Delay (s) | Low Line Scale Factor | Alternate Frequency Scale Factor |
| 0.1                             | 1.000                 | 1.000                            |

#### Bus Sensing

##### Bus Condition Settings

|                    |                               |                                 |
|--------------------|-------------------------------|---------------------------------|
| Dead Bus Threshold | Dead Bus Activation Delay (s) | Bus Failed Activation Delay (s) |
| 30 V               | 0.1                           | 0.1                             |
| 0.063 Per Unit     |                               |                                 |

#### Bus Stable

##### Overvoltage Settings

|                |                |
|----------------|----------------|
| Pickup (V L-L) | Dropout        |
| 130 V          | 127 V          |
| 0.271 Per Unit | 0.265 Per Unit |

##### Undervoltage Settings

|                |                |
|----------------|----------------|
| Pickup (V L-L) | Dropout        |
| 115 V          | 117 V          |
| 0.240 Per Unit | 0.244 Per Unit |

##### Overfrequency Settings

|                 |                 |
|-----------------|-----------------|
| Pickup          | Dropout         |
| 62.00 Hz        | 61.80 Hz        |
| 1.0333 Per Unit | 1.0300 Per Unit |

##### Underfrequency Settings

|                 |                 |
|-----------------|-----------------|
| Pickup          | Dropout         |
| 58.00 Hz        | 58.20 Hz        |
| 0.9667 Per Unit | 0.9700 Per Unit |

|                                 |                       |                                  |
|---------------------------------|-----------------------|----------------------------------|
| Bus Stable Activation Delay (s) | Low Line Scale Factor | Alternate Frequency Scale Factor |
| 0.1                             | 1.000                 | 1.000                            |

**Figure 7-44. Settings Explorer, Breaker Management, Bus Condition Detection Screen**

- Next, click on *Synchronizer* under the *Breaker Management* section of the Settings Explorer. See Figure 7-45.

Front Panel Navigation Path: SETTINGS > BREAKER MANAGEMENT > SYNCHRONIZER

**Synchronizer**

Sync Type

Slip Frequency (Hz)

Min Slip Control Limit (Hz)

Max Slip Control Limit (Hz)

Voltage Window (%)

Breaker Closing Angle (°)

Fgen > Fbus  
☐ Disable  
☒ Enable

Vgen > Vbus  
☒ Disable  
☐ Enable

Sync Activation Delay (s)

Sync Fail Activation Delay (s)

Sync Speed Gain

Sync Voltage Gain

**Figure 7-45. Settings Explorer, Breaker Management, Synchronizer Screen**

#### Anticipatory vs. Phase Lock Synchronizer

If *Phase Lock Loop* synchronization is selected, the synchronizer will drive the angle between the generator and bus toward zero, and will drive the voltage between the generator and the bus so that the difference is less than the allowed difference set by the user.

If *Anticipatory* synchronization is selected, the synchronizer controls the slip frequency between the generator and the bus. The synchronizer calculates the timing of the closing signal that allows the generator breaker to be closed when the phase angle between the two sources is at 0 degrees. This calculation takes into account the slip rate, the generator breaker closing time, and the phase angle difference.

For either synchronizer type, you will need to enter settings for the following parameters:

- a. Sync Type - Select either *Anticipatory* or *Phase Lock Loop* as the synchronizer type.
- b. Slip Frequency - The slip frequency setting is the maximum slip frequency that is in effect for a breaker close to occur.
- c. Voltage Window - The regulation offset is the maximum allowed percentage voltage difference between the generator and the bus that is in effect for a breaker close to occur. This is sometimes referred to as “voltage window”.
- d. Min/Max Slip Control Limit - (Phase lock synchronizer only.) These settings provide continuous slip frequency control while in phase lock synchronization.
- e. Breaker Close Angle - (Phase lock synchronizer only.) The breaker close angle is the maximum phase angle from the 0-degree phase angle that is in effect for a breaker close to occur. This is sometimes referred to as the “angle window” or “phase window”.
- f. Sync Activation Delay - The Sync Activation Delay is the length of time that the conditions for synchronization must be met. Generator voltage and bus voltage must be within the acceptable range for the duration of the sync activation delay. Additionally, the following condition must be met when in Phase Lock mode. Generator and bus phase angles must be within the acceptable breaker closing angle range for the duration of the sync activation delay.
- g. Sync Fail Delay - The sync fail delay is the maximum time allowed for synchronization to occur. If the sync fail delay expires before the breaker closure occurs, a Sync Fail pre-alarm is annunciated, and the synchronizer is reset. The synchronization attempt is aborted if the sync fail delay expires. This is set to allow ample time for synchronization and breaker closure to occur.
- h. Gen Frequency > Bus Frequency - Enable gen frequency > bus frequency if desired. Enabling gen frequency > bus frequency will force kW to be pushed out of the generator when the breaker is closed.

- i. Gen Voltage > Bus Voltage - Enable gen voltage > bus voltage if desired. Enabling gen voltage > bus voltage will ensure vars flow out of the generator when the breaker is closed.
8. Click on *Bias Control Settings* then *AVR Bias Control Settings* in the Settings Explorer. If using the DGC-2020 only, select *Contact* as the bias control output type. Then select either *Continuous* or *Proportional* as the bias control output type.

If using the DGC-2020 in conjunction with an LSM-2020, you may choose to select *Analog* as the bias control output type. If this is chosen, you will also be required to enter gains and loop gains of the voltage PID controller. These settings may have to be adjusted to achieve the desired response from the voltage regulator. Controller tuning procedures may be found in Appendix C, *Tuning PID Settings*. See Figure 7-46.

Front Panel Navigation Path: **SETTINGS > BIAS CONTROL > AVR BIAS CONTROL**

**Figure 7-46. Settings Explorer, Bias Control Settings, AVR Bias Control Settings Screen**

9. Next, click on the *Governor Bias Control Settings* screen. The parameters for the governor bias control are similar to those of the AVR bias control, and are set in a similar manner. Follow the same steps as for the AVR bias control setup. See Figure 7-47.

Front Panel Navigation Path: **SETTINGS > BIAS CONTROL > GOV BIAS CONTROL**

**Figure 7-47. Settings Explorer, Bias Control Settings, Governor Bias Control Settings Screen**

10. If using the LSM-2020 to control the voltage regulator with an analog signal, click on *Multigen Management* and then *AVR Output*. On this screen, you must select the bias output parameters and levels as required by your voltage regulator. See Figure 7-48.



Front Panel Navigation Path: [SETTINGS > MULTIGEN MANAGEMENT > AVR ANALOG OUTPUT](#)

**AVR Output**

Output Type  
Voltage

Response  
Increasing

Min Output Current (mA)  
4.00

Max Output Current (mA)  
20.00

Min Output Voltage (V)  
-10.00

Max Output Voltage (V)  
10.00

**Figure 7-48. Settings Explorer, Multigen Management, AVR Output Screen**

Settings should be entered for each of the following parameters when appropriate:

- a. Output Type - Select whether the AVR bias signal should be *Voltage* or *Current*.
  - b. Response - Select *Increasing* or *Decreasing*. Increasing should be selected if an increase in the output parameter results in an increase of generator output voltage.
  - c. Min Output Current (mA) and Max Output Current (mA) - If the *Output Type* is *Current*, these parameters must be configured. Set the minimum and maximum current to a range equal to the voltage bias input range for the voltage regulator. The range on these parameters is 4 ma to 20 ma.
  - d. Min Output Voltage (V) and Max Output Voltage (V) - If the *Output Type* is *Voltage*, these parameters must be configured. Set the minimum and maximum voltage to a range equal to the voltage bias input range for the voltage regulator. The range on these parameters is -10V to +10V.
11. Next click on *Governor Output* and select the appropriate bias output parameters as required by the speed governor. These parameters are identical to those of the AVR output, and should be set in a similar manner. See Figure 7-49.

Front Panel Navigation Path: [SETTINGS > MULTIGEN MANAGEMENT > GOV ANALOG OUTPUT](#)

**Governor Output**

Output Type  
Voltage

Response  
Increasing

Min Output Current (mA)  
4.00

Max Output Current (mA)  
20.00

Min Output Voltage (V)  
-10.00

Max Output Voltage (V)  
10.00

**Figure 7-49. Settings Explorer, Multigen Management, Governor Output Screen**

12. Set up programmable logic to allow the DGC-2020 to synchronize the generator and close the generator breaker. In the BESTlogicPlus Programmable Logic, click on the *Elements* tab and drag the Gen Breaker element into your main logic. See Figure 7-50.

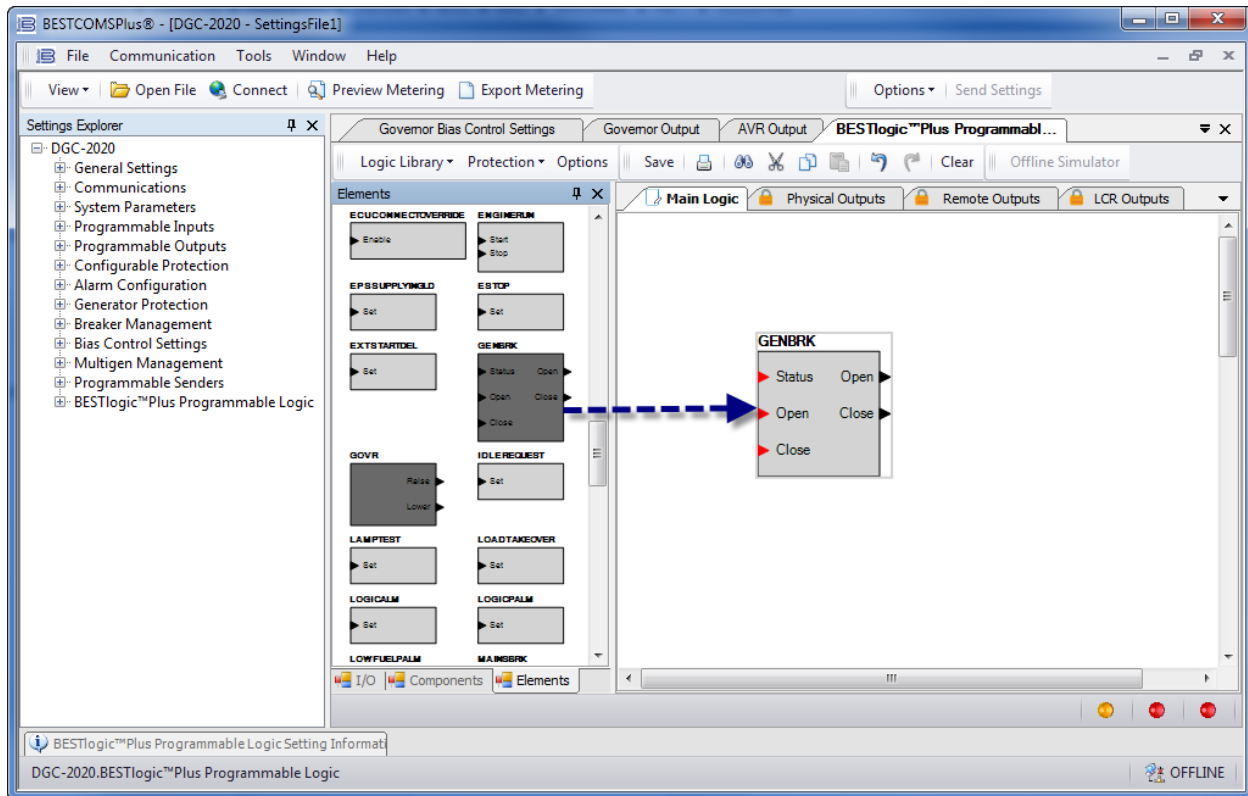


Figure 7-50. Settings Explorer, BESTlogicPlus Programmable Logic (Step 12)

13. Next, click on the I/O tab, drag the inputs assigned in step 3 above to the main logic, and connect them to the appropriate input or output of the Generator Breaker block. Note the “Open Gen Breaker” and “Close Gen Breaker” are inputs to the generator breaker block, and are used to request a breaker open or close through contact inputs. The “Gen 52 Open” and “Gen 52 Close” are outputs from the DGC-2020 to the physical breaker. The DGC-2020 opens or closes the generator breaker through these control signals. See Figure 7-51.

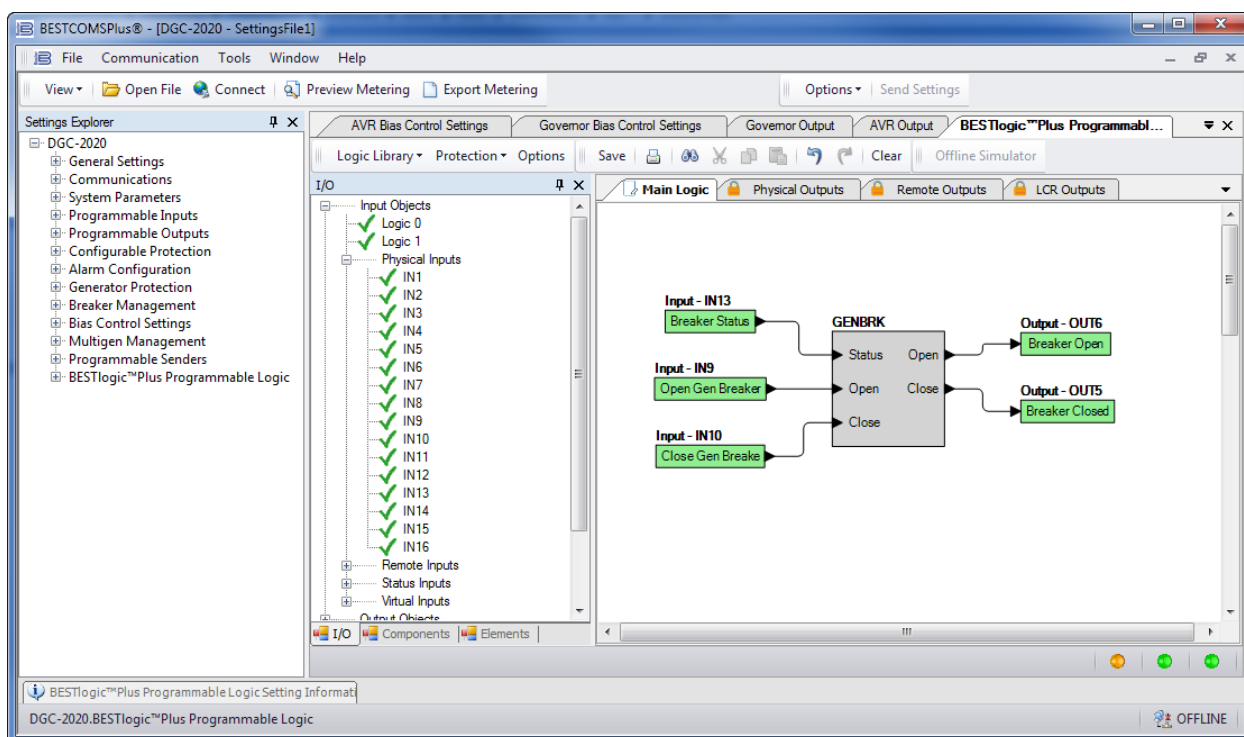


Figure 7-51. Settings Explorer, BESTlogicPlus Programmable Logic (Step 13)

14. If using the LSM-2020 to bias the voltage regulator and governor, no further setup is necessary. If using contact outputs, the output contacts should be set up to drive these functions. In the programmable logic, click on the *Elements* tab. Locate and drag the Governor and AVR logic blocks into the main logic. See Figure 7-52.

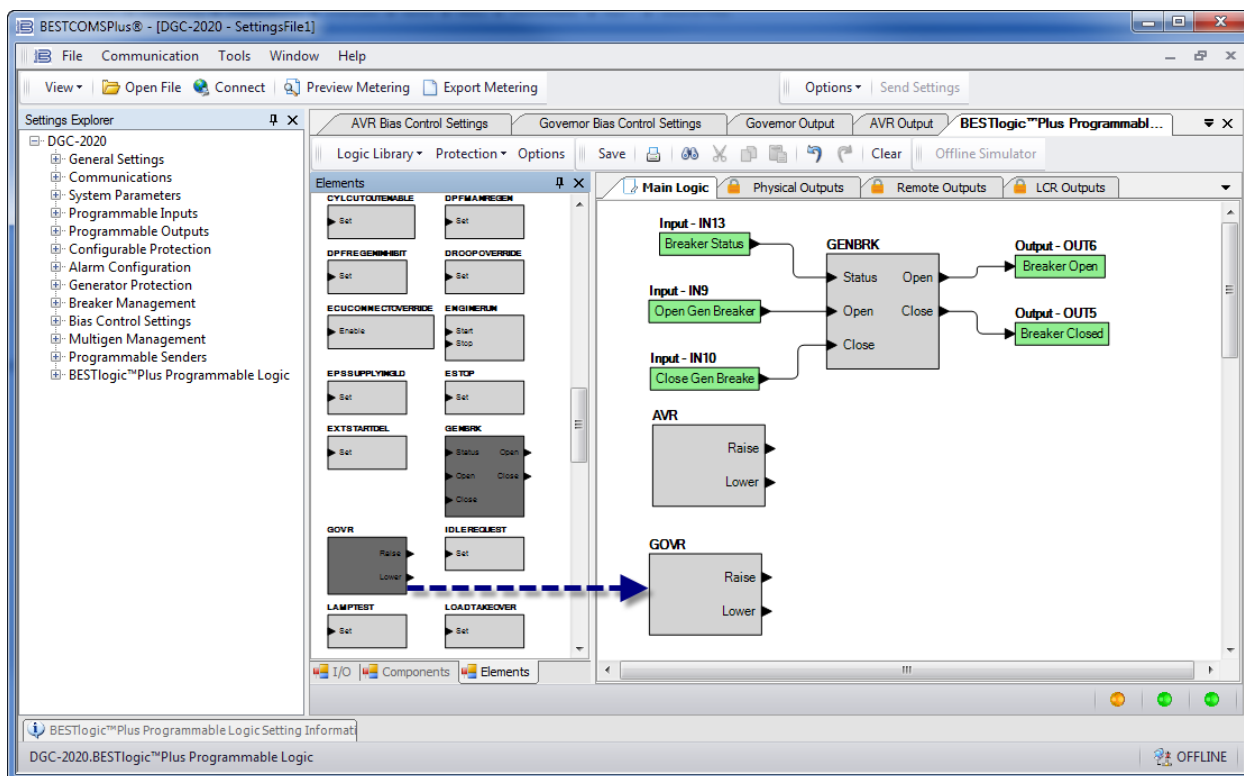


Figure 7-52. Settings Explorer, BESTlogicPlus Programmable Logic (Step 14)

15. Next, click on the I/O tab and drag the selected output contacts into the main logic. Connect the Governor and AVR blocks to the appropriate outputs. This concludes implementation of the automatic synchronizer. See Figure 7-53.

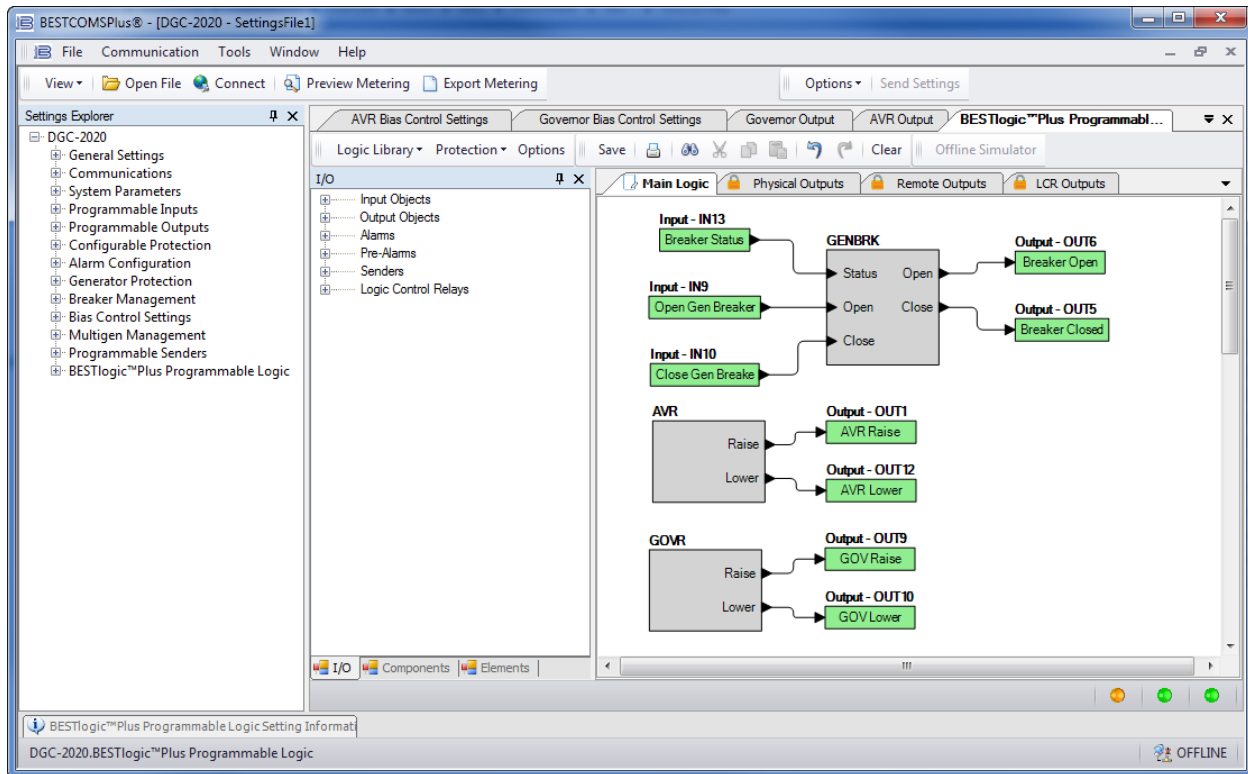


Figure 7-53. Settings Explorer, BESTlogicPlus Programmable Logic (Step 15)

## Setting up a DGC-2020 and LSM-2020 for a Load Sharing and kW Control Application

The following paragraphs provide information and setup procedures for load sharing and kvar control using the DGC-2020 and LSM-2020.

### Load Sharing Overview and Theory of Operation in the DGC-2020

Load sharing is necessary when multiple generators are tied to a common bus driving a load and not connected to the utility; the generators are the only power source. Such a system is referred to as an "Islanded System". Load sharing is sometimes accomplished by putting all of the governors in speed droop mode; however, when speed droop is employed, the system speed and frequency may not be maintained. As load increases, system speed drops. The throttles can be adjusted to resume desired speed, but if the load varies, it can be difficult to maintain the speed of the system. In systems where speed and frequency deviation is problematic, speed droop control is not the most appropriate load sharing method.

Isochronous (constant speed) load sharing can be accomplished using a system load share line or communications between generator controllers. The load sharing electronics provide a bias to the governors' analog bias inputs to implement sharing of kW among the machines. In such systems, all machines share load equally on a percentage of capacity basis. Furthermore, many load sharing devices include a speed trim feature, which actively controls the speed of each generator in the island system to maintain desired system frequency.

The heart of the load sharing system is the load share line. The voltage on the load share line will range between some minimum values, indicating the system is not loaded, to some maximum value, indicating the system is fully loaded. By measuring the load share line voltage, the user can determine the amount

of system load. If the voltage is halfway between the minimum and maximum load share voltages, it is indicated that the average system load is 50 percent capacity.

Each load share device must drive the load share line with a voltage that is proportional to its percentage of load. The load share line outputs from all devices are connected together. Therefore, each load share device must contain an internal resistor between the voltage driver and the load share line output to limit the current from the voltage driver. The voltage on the connection point is the average of the load share line voltages contributed by each unit. This average voltage is proportional to the average percentage load of the machines.

The goal of a load sharing system is for all machines to share equally on a percentage of capacity basis. To accomplish this, each machine contains a load controller or kW controller, which provides regulation of the machine's kW output. The setting for each kW controller is derived from the system load share line voltage. The load share line voltage is measured, scaled, and fed back to the machine's kW controller. Thus, the setting for the kW controller is the average percentage load of the system. Thus, each machine's kW controller is driving the machine's kW output to a level equal to the average percentage kW load of the system. The result in a properly tuned system is that all machines share kW equally on a percentage of capacity basis.

While some newer systems replace the load share line using communication between the generators (inter-genset communications) many existing load share implementations use an analog load share line. Figure 7-54 shows a diagram of an analog load share line as presented in this document.

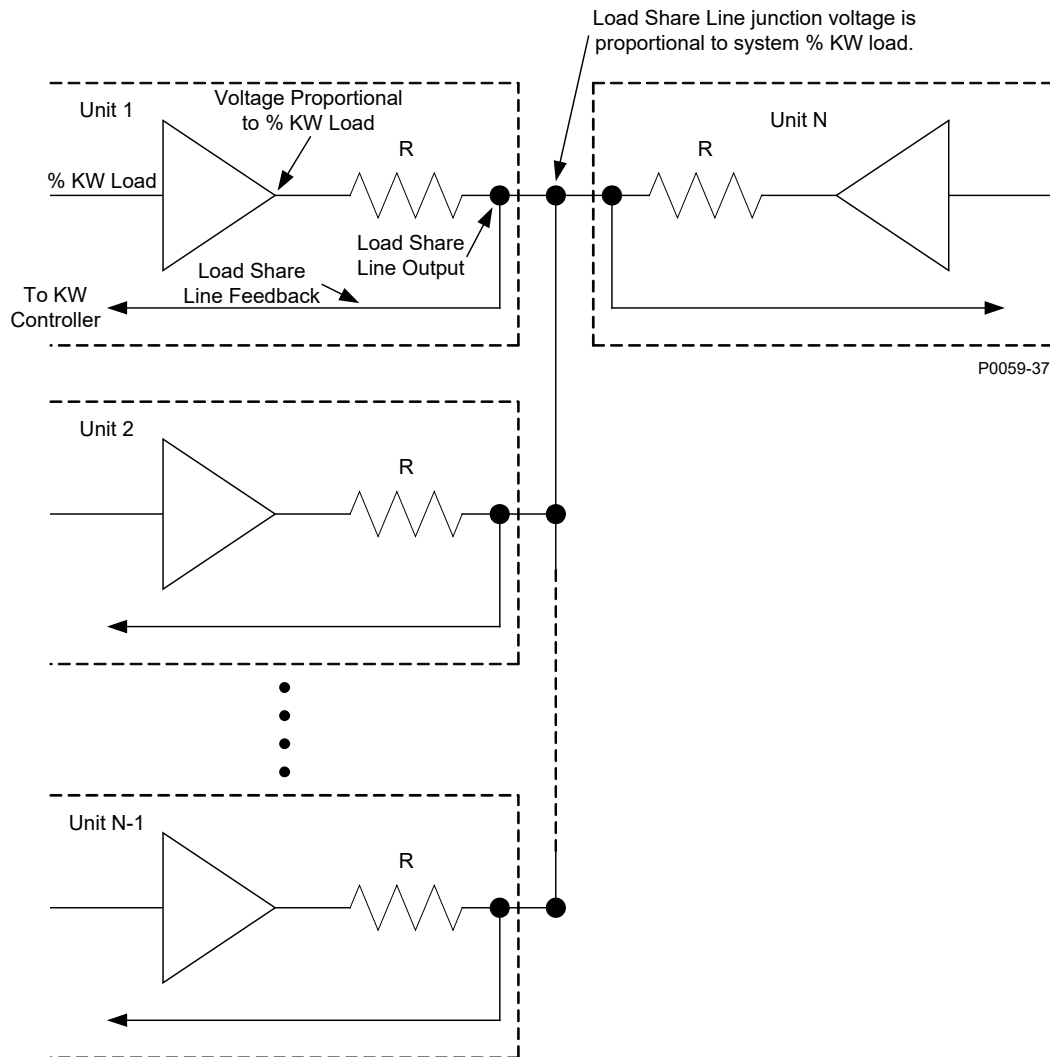


**Figure 7-54. Load Share Line Implementation on a System of N Machines**

If a unit or set of units is paralleled to the utility, they derive their kW control setting from the Base Load Level (%) setting, and disregard the load share line input. The Parallel to Mains (ParToMains) logic element in BESTlogicPlus Programmable Logic is used to indicate to the DGC-2020 that it is paralleled to the utility.

In short, when the generator breaker is open, the kW controller is disabled. When the generator breaker is closed and the unit is not paralleled to the utility, the kW controller's set point is derived from the load share line. When the generator breaker is closed and the machine is paralleled to the utility, the kW controller uses the Base Load Level (%) setting as its set point. Generator breaker status is communicated to the DGC-2020 through the status input on the generator breaker block in BESTlogicPlus Programmable Logic.

Settings are provided to allow a generator to ramp up its kW generation to minimize system disruption when it transitions onto a system that is load sharing. A similar ramp down transition is also implemented when the generator is brought off line.

Each load share module has a set of internal contacts that physically disconnects it from the load share line circuit when the generator is off line. These contacts are open whenever the unit's generator breaker is open.

In systems that employ communications to implement load sharing, each generator on the system broadcasts its loading on a per-unit basis. A machine that is running at a kW level equal to 80% of its Rated kW is loaded to a level of 0.8 per unit. Each machine then calculates the average per-unit load of the system and sets the kW controller setpoint to that level. Thus, all machines will share equally on a per-unit basis.

### **kvar Control Overview and Theory of Operation in the DGC-2020**

The DGC-2020 and LSM-2020 can provide system kvar control. When the generator breaker is open, the unit operates in voltage droop mode. When the generator breaker is closed and the generator is part of an island system (the system is not paralleled to the utility), the unit shares kvar with the other machines in the system through intergenset communications. Each generator on the system broadcasts its kvar loading on a per-unit basis. A machine that is running at a kvar level equal to 80% of its Rated kW multiplied by its Rated Power Factor (i.e. Rated kvar) is loaded to a level of 0.8 per unit. Each machine then calculates the average per-unit kvar load of the system and sets the kvar controller setpoint to that level. Thus, all machines will share equally on a per-unit basis.

When the generator is paralleled to the utility, the kvar controller is enabled; either power factor or kvar control is implemented according to the VAR/PF control mode setting. Generator breaker status is communicated to the DGC-2020 through the status input on the generator breaker block in BESTlogicPlus Programmable Logic.

When var control mode is selected and the generator is paralleled to the utility, the kvar controller's set point is equal to the kvar Setpoint (%) setting. The setting is in units of percentage of the machine's rated kvar, which is calculated from the rated kW and rated Power Factor.

When power factor control mode is selected and the generator is paralleled to the utility, the var controller's set point is calculated as the percentage of rated kvar, which will maintain the power factor of the machine at the PF Setpoint setting. The Parallel to Mains (ParToMains) logic element in BESTlogicPlus Programmable Logic is used to indicate to the DGC-2020 that it is paralleled to the utility.

### **Setup of the DGC-2020 and the LSM-2020 for Load Sharing and/or kW Control**

The setup of a load sharing and kW control system requires several steps:

1. Wire the DGC-2020, LSM-2020, and any external devices that interact with the DGC-2020 or the LSM-2020.
2. Set all DGC-2020 settings related to Initial Machine Setup.
3. Configure DGC-2020 breaker control.
4. Configure the synchronizer function (if used).
5. Configure the parameters related to load sharing and kW control:

- a. Enable the load share module
- b. Configure the load share line voltage range
- c. Configure the AVR bias output voltage or current range and polarity
- d. Configure the governor bias output voltage or current range and polarity
- e. Configure the kW and speed control parameters
- f. Change the voltage and kvar control parameters
- g. Configure demand start/stop related parameters (if demand start/stop is used)
  - i. Configure demand start/stop parameters
  - ii. Configure generator sequencing parameters
  - iii. Configure the generator network parameters
  - iv. Configure the LSM-2020 Ethernet parameters
- h. Tune the kW, kvar, speed, and voltage controllers

Setup of some of these parameters are already covered in other sections of the DGC-2020 instruction manual; you will be directed to appropriate sections of this manual when this is the case. Detailed setup procedures are presented for those that are not addressed elsewhere.

#### Step by Step Setup Procedures

1. Wire the DGC-2020, LSM-2020, and any external devices that interact with the DGC-2020 or the LSM-2020. Descriptions of DGC-2020 connections and diagrams showing typical wiring schemes for a DGC-2020 on a generator in various connection schemes (single-phase AB, single-phase AC, Wye, Delta, etc.) are found under *Connections*.

Descriptions of the LSM-2020 connections and diagrams showing typical wiring schemes for connecting DGC-2020s and LSM-2020s on several machines which parallel together to form a load sharing system are found under *Installation* in Section 9, *LSM-2020 (Load Share Module)*.

2. Set all DGC-2020 settings related to Initial Machine Setup. Initial machine setup should be performed according to the paragraphs titled *DGC-2020 Initial Setup*.
3. Configure DGC-2020 breaker control. If the DGC-2020 is controlling the generator breaker in the system, it should be configured according to the paragraphs titled *Generator and Mains Breaker Control*. If the breaker is controlled by external switchgear, most of this may be omitted. However, it is still necessary to implement a contact input to the generator breaker block in the DGC-2020 BESTlogicPlus Programmable Logic to indicate generator breaker status to the DGC-2020. The DGC-2020 will not load share or control kW or kvar unless it receives an indication that the generator breaker is closed.
4. Configure the synchronizer function. If the synchronizer option in the DGC-2020 is used to synchronize the DGC-2020 to the generator bus or to the utility, it should be configured according to the paragraphs titled *Synchronizer Setup*. If an external synchronizer is used for synchronization and the DGC-2020 load sharing is also configured, special wiring consideration is required to prevent both the LSM-2020 and the external synchronizer from trying to drive the AVR bias and the Governor bias at the same time. Examples of such wiring schemes are presented in the paragraphs titled *Interfacing an External Control Device with a DGC-2020 – LSM-2020 System* under *Application* in Section 9, *LSM-2020 (Load Share Module)*.
5. Configure the parameters related to load sharing and kW control.
  - a. Enable the load share module. The load share module setup is found in BESTCOMSPlus® under SETTINGS EXPLORER > DGC-2020 > SYSTEM SETTINGS > REMOTE MODULE SETUP. See Figure 7-55.

Front Panel Navigation Path: **SETTINGS > SYSTEM PARAMS > REMOTE MODULE SETUP**



- i. Enable the load share module by clicking *Enable* under the load share module settings.
- ii. LSM J1939 Address - Enter the J1939 address to be used by the LSM-2020. Normally this will not have to be changed unless the address is already in use elsewhere on the CAN Bus network.
- iii. LSM Auxiliary Input Source - Select *Local* if locally measured input values are to be used. Select *System Manager* if the measured input values of the unit designated as the system manager are to be used.

**Figure 7-55. Settings Explorer, System Parameters, Remote Module Setup Screen**

- b. Configure the load share line voltage range. If load sharing to equipment not produced by Basler Electric, the range of load share voltage utilized by the equipment must be determined. If the voltage range set up in the DGC-2020 does not match that of the devices, correct load sharing will not occur. If all devices are Basler Electric devices, a range of 0 to 10 V is a convenient range. The settings for the load share line voltage range are found in BESTCOMSP<sup>Plus</sup>® under SETTINGS EXPLORER > DGC-2020 > MULTIGEN MANAGEMENT > LOAD SHARE OUTPUT. See Figure 7-56.

Front Panel Navigation Path: [SETTINGS > MULTIGEN MANAGEMENT > LOAD SHARE LINE](#)

**Figure 7-56. Settings Explorer, Multigen Management, Load Share Output Screen**

- i. Max Voltage (V) - This setting defines the voltage value that represents 100% kW loading of the system.
  - ii. Min Voltage (V) - This setting defines the voltage that represents 0% loading or no loading of the system. Be careful not to interchange the min and max. If the min and max were interchanged on all machines, the system would probably work; otherwise, the machines configured correctly will try to motor those with min and max interchanged.
  - iii. Once the machine is set up and operating properly, the load share line voltage can be measured to determine system loading. If the voltage is 33% of the range above the minimum, the system is 33% loaded. If it is 75% above the minimum, the system is 75% loaded. This shows why a range of 0 to 10 volts is convenient. For example, multiply the voltage by 10 to determine the system percentage load. 7.5 volts is 75% load.
- c. Configure the AVR bias output voltage or current range and polarity. Prior to this, the voltage or current range of the AVR bias input signal must be determined. If the programmed range



does not match what is used by the AVR bias input, unpredictable or undesirable system behavior is likely to occur.

Settings for AVR bias output voltage or current range and polarity are found in BESTCOMS<sup>Plus</sup>® under SETTINGS EXPLORER > DGC-2020 > MULTIGEN MANAGEMENT > AVR OUTPUT. See Figure 7-57.

Front Panel Navigation Path: [SETTINGS > MULTIGEN MANAGEMENT > AVR ANALOG OUTPUT](#)

**Figure 7-57. Settings Explorer, Multigen Management, AVR Output Screen**

- i. Output Type - Select *Voltage* or *Current*, depending on the output type.
  - ii. Response - Select *Increasing* if a higher level of bias causes the AVR to increase generator output voltage; select *Decreasing* if a higher level of bias causes the AVR to decrease generator output voltage.
  - iii. Min Output Current (mA) - This setting defines the minimum AVR bias current level if the bias *Output Type* is set to *Current*.
  - iv. Max Output Current (mA) - This setting defines the maximum AVR bias current level if the bias *Output Type* is set to *Current*.
  - v. Min Output Voltage (V) - This setting defines the minimum AVR bias voltage level if the bias *Output Type* is set to *Voltage*.
  - vi. Max Output Voltage (V) - This setting defines the maximum AVR bias voltage level if the bias *Output Type* is set to *Voltage*.
- d. Configure the governor bias output voltage or current range and polarity.

Before this can be done, the voltage or current range of the governor bias input signal must be determined. If the programmed range does not match what is used by the governor bias input, unpredictable or undesired system behavior could occur.

Settings for Governor Bias Output voltage or current range and polarity are found in BESTCOMS<sup>Plus</sup>® under SETTINGS EXPLORER > DGC-2020 > MULTIGEN MANAGEMENT > GOVERNOR OUTPUT. See Figure 7-58.

Front Panel Navigation Path: [SETTINGS > MULTIGEN MANAGEMENT > GOV ANALOG OUTPUT](#)

- i. Output Type - Select *Voltage* or *Current*, depending on the output type.
- ii. Response - Select *Increasing* if a higher level of bias causes the governor to increase generator output voltage; select *Decreasing* if a higher level of bias causes the governor to decrease generator output voltage.
- iii. Min Output Current (mA) - This setting defines the minimum governor bias current level if the bias *Output Type* is set to *Current*.

- iv. Max Output Current (mA) - This setting defines the maximum governor bias current level if the bias *Output Type* is set to *Current*.
- v. Min Output Voltage (V) - This setting defines the minimum governor bias voltage level if the bias *Output Type* is set to *Voltage*.
- vi. Max Output Voltage (V) - This setting defines the maximum governor bias voltage level if the bias *Output Type* is set to *Voltage*.

**Governor Output**

Output Type  
Voltage

Response  
Increasing

Min Output Current (mA)  
4.00

Max Output Current (mA)  
20.00

Min Output Voltage (V)  
-10.00

Max Output Voltage (V)  
10.00

**Figure 7-58. Settings Explorer, Multigen Management, Governor Output Screen**

- e. Configure the kW and speed control parameters.

The settings for the kW and speed control parameters are found in BESTCOMS*Plus*® under SETTINGS EXPLORER > DGC-2020 > BIAS CONTROL SETTINGS > GOVERNOR BIAS CONTROL SETTINGS. See Figure 7-59.

Front Panel Navigation Path: SETTINGS > BIAS CONTROL > GOV BIAS CONTROL

**Governor Bias Control Settings**

Bias Control Output Type  
Contact

Bias Control Contact Type  
Continuous

Correction Pulse Width (s)  
0.0

Correction Pulse Interval (s)  
0.0

**Speed**

Kp Proportional Gain  
1.000

Ki Integral Gain  
0.100

Kd Derivative Gain  
0.000

Td Derivative Filter Constant  
0.000

Kg Loop Gain  
0.100

Trim Enable  
Enable

Trim Deadband (Hz)  
0.10

Speed Trim Setpoint (Hz)  
60.00

Remote Speed Bias  
None

Remote Speed Bias (%)  
2.00

**kW**

Load Control Enabled  
Enable

Load Share Interface  
Analog

Kp Proportional Gain  
1.000

Ki Integral Gain  
0.100

Kd Derivative Gain  
0.000

Td Derivative Filter Constant  
0.000

Kg Loop Gain  
0.100

Parallel To Mains Gain  
1.000

Droop Percentage (%)  
0.000

Speed Droop Gain  
1.000

Ramp Rate (%/s)  
20.0

Ramp Overshoot Reduction (%)  
0

Base Load Level (%)  
0.0

Base Load Level Source  
User Setting

Baseload Analog Max (%)  
100.0

Baseload Analog Min (%)  
0.0

Breaker Open Setpoint (%)  
0.0

**Figure 7-59. Settings Explorer, Bias Control Settings, Governor Bias Control Settings Screen**

- i. Bias Control Output Type - Select *Contact* or *Analog*, according to the machine's implementation.
- ii. Bias Control Contact Type - Select *Continuous* or *Proportional*, depending on the contact output type. Proportional is a PWM based implementation. The duty cycle increases when more control output is required. This parameter cannot be

programmed if the *Bias Control Output Type* is set to *Analog* since it is not applicable to analog outputs.

- iii. **Correction Pulse Interval** - This parameter defines the duration in seconds between output pulses for proportional contact outputs. This parameter cannot be programmed if the *Bias Control Output Type* is set to *Analog* or the *Bias Control Contact Type* is set to *Continuous* since it is not applicable in either case. The pulse interval along with the pulse width specifies how often a new pulse occurs. The total time between pulses is the pulse width plus the pulse interval.
- iv. **Correction Pulse Width** - Set the maximum width of a contact output pulse for proportional contact outputs. This is the maximum "On" time allowable for the proportional outputs. This parameter cannot be programmed if the *Bias Control Output Type* is set to *Analog* or the *Bias Control Contact Type* is set to *Continuous* since it is not applicable in either case.
- v. **Speed Trim Enable** - Speed trim maintains the system at the speed trim set point when the generator breaker is closed and the generator is part of an islanded system, i.e. not paralleled to the utility. This maintains the frequency of the island system to compensate for speed deviations occurring from possible system "bumps" as machines go on and off the bus. It is generally recommended that speed trim be enabled. However, if an external speed POT is used for customer speed control, the speed trim function will maintain the speed trim set point regardless of the POT position. Effectively the speed POT is disabled.

The speed controller is active under two sets of circumstances: (1) the synchronizer is active and biasing engine speed to accomplish alignment of the AC phases across the breaker that is being synchronized or (2) the generator breaker is closed and *Speed Trim Enable* is set to *Enabled* and the generator is NOT paralleled to the utility as indicated by the parallel to mains (ParToMains) logic element in BESTlogicPlus Programmable Logic.

- vi. **Speed Controller Gains (Kp, Ki, Kd, Td, Kg)** - There are four Proportional - Integral - Derivative (PID) controllers involved when a DGC-2020 and LSM-2020 are used in a load sharing or load control system. The gains of the controllers involved with speed control are discussed below. Controller gains are configured as part of the controller tuning procedure. The tuning procedures for all PID controllers are presented in Appendix C, *Tuning PID Settings*. Controller tuning is performed after all other settings have been configured and is the last step in setting up a DGC-2020 and LSM-2020 for load sharing or load control.

The speed controller gains are:

- (1) Speed Controller Kp - Proportional Gain
- (2) Speed Controller Ki - Integral Gain
- (3) Speed Controller Kd - Derivative Gain
- (4) Speed Controller Td - Derivative filter time constant
- (5) Speed Controller Kg - Loop Gain, must be nonzero for control to occur
- vii. **Speed Trim Setpoint (Hz)** - When speed trim is enabled, the speed trim controller maintains system speed at the level specified by this setting.
- viii. **Speed Trim Deadband** - When the difference between the measured speed and the speed trim set point is less than the trim dead band, the speed trim controller will treat this as zero error. If system operation appears "nervous" when speed trim is enabled, setting a nonzero dead band may result in smoother system operation. In addition, if machines do not appear to share kW equally when speed trim is enabled, setting a nonzero dead band will likely result in improved kW sharing.
- ix. **Remote Speed Bias** - The Remote Speed Bias setting provides for biasing the speed of a group of generators on a bus, by as much as  $\pm 5\%$ , for synchronizing to the utility.

When the Remote Speed Bias setting is configured for the LSM-2020 input or an AEM-2020 input, the speed trim setpoint is calculated based on the specific analog input.

- x. Remote Speed Bias (%) - The Remote Speed Bias (%) setting corresponds to the maximum and minimum analog input range.
- xi. kW Load Control Enabled - Select *Enabled* when load sharing and kW control are required.
- xii. kW Controller Gains (Kp, Ki, Kd, Td, Kg) - There are four Proportional - Integral - Derivative (PID) controllers involved when a DGC-2020 and LSM-2020 are used in a load sharing or load control system. The gains of the controllers involved with kW control are discussed below. All controller gains are configured as part of the controller tuning procedure. The tuning procedures for all PID controllers are presented in Appendix C, *Tuning PID Settings*. Controller tuning is performed after all other settings have been configured and is the last step in setting up a DGC-2020 and LSM-2020 for load sharing or load control.

The kW controller gains are:

- (1) kW Controller Kp - Proportional Gain
- (2) kW Controller Ki - Integral Gain
- (3) kW Controller Kd - Derivative Gain
- (4) kW Controller Td - Derivative filter time constant
- (5) kW Controller Kg - Loop Gain, must be nonzero for control to occur

- xiii. Droop Percentage (%) - This is the percentage of speed droop that is desired when the DGC-2020 is operating in speed droop mode. Setting this to the default setting of zero disables speed droop.
- xiv. Speed Droop Gain - This gain factor is used to compensate for variations in governors and their tuning. After controller tuning has occurred, if a nonzero speed droop percentage is desired, set the value of droop percentage accordingly. Perform a test by exporting kW, and observe the speed droop. If the observed droop does not match the *Droop Percentage* setting, set the droop gain as a scale factor to achieve the desired droop. For instance, if the observed droop was only half of what is desired, set the droop gain to two. Then, the observed droop should correspond to the *Droop Percentage* Setting.
- xv. Ramp Rate (%) - This rate is in terms of percentage of the machine's Rated kW at which the generator's kW output will ramp from 0 kW to the required kW demand level when the generator breaker is closed and the generator is paralleled to the utility. Paralleled to utility status is indicated to the DGC-2020 by the parallel to mains (ParToMains) logic element in BESTlogicPlus Programmable Logic. As an example, assume that the *Ramp Rate* is set at 10% per second. If the demand is 50% of the machine's capacity, and the generator breaker is closed to parallel the generator to the utility, it will take 5 seconds for the output to come up to the required level. If the demand is 80 percent, it will take 8 seconds to come up, etc. This is also the rate at which the machine will ramp down when going off line in a normal machine stop.
- xvi. Base Load Level (%) - When the kW controller is active, this setting defines the level of the machines rated kW capacity that the DGC-2020 will regulate when the generator is paralleled to the utility as indicated by the parallel to mains (ParToMains) logic element in BESTlogicPlus Programmable Logic.
- xvii. Base Load Level Source - The set point for the kW controller (when enabled) can either be the level set in the *Base Load Level (%)* setting, or it can be derived from an analog input on the LSM-2020 or AEM-2020 (Analog Expansion Module). Set this to *User Setting* or to an available analog input on the LSM-2020 or AEM-2020 as required for machine implementation.

- xviii. Base Load Analog Max (%) - This setting defines the value of kW indicated when the *Base Load Level Source* is set to an analog input and the input is at its maximum. This parameter cannot be configured when *Base Load Level Source* is set for *User Setting*.
  - xix. Base Load Analog Min (%) - This setting is the value of kW indicated when the *Base Load Level Source* is set to an analog input and the input is at its minimum.
  - xx. Breaker Open Setpoint (%) - This setting specifies the maximum kW level at which the DGC-2020 will open the generator breaker after unloading prior to stopping the machine on a normal machine stop in Auto mode.
- f. Configure the voltage and kvar control parameters.

The settings for the voltage and kvar control parameters are found in BESTCOMSPUs® under SETTINGS EXPLORER > DGC-2020 > BIAS CONTROL SETTINGS > AVR BIAS CONTROL SETTINGS. See Figure 7-60.

Front Panel Navigation Path: SETTINGS > BIAS CONTROL > AVR BIAS CONTROL

Figure 7-60. Settings Explorer, Bias Control Settings, AVR Bias Control Settings Screen

- i. Bias Control Output Type - Select *Contact* or *Analog*, according to the machine's implementation.
- ii. Bias Control Contact Type - Select *Continuous* or *Proportional*, depending on the contact output type. Proportional is a PWM based implementation. The duty cycle increases when more control output is required. This parameter cannot be programmed if the *Bias Control Output Type* is set to *Analog* since it is not applicable to analog outputs.
- iii. Correction Pulse Interval - This setting defines the duration in seconds between output pulses for proportional contact outputs. This is the inverse of the frequency of the pulses. This parameter cannot be programmed if the *Bias Control Output Type* is set to *Analog* or the *Bias Control Contact Type* is set to *Continuous* since it is not applicable in either case.
- iv. Correction Pulse Width - This setting defines the maximum width of a contact output pulse for proportional contact outputs. This is the maximum "On" time allowable for the proportional outputs. This parameter cannot be programmed if the *Bias Control Output Type* is set to *Analog* or the *Bias Control Contact Type* is set to *Continuous* since it is not applicable in either case.
- v. Voltage Controller Gains (Kp, Ki, Kd, Td, Kg) - There are four Proportional - Integral - Derivative (PID) controllers involved when a DGC-2020 and LSM-2020 are used in a load sharing or load control system. The gains of the controllers involved with voltage control are discussed below. Controller gains are configured as part of the controller tuning procedure. The tuning procedures for all PID controllers are presented in Appendix C, *Tuning PID Settings*. Controller tuning is performed after all other

settings have been configured and is the last step in setting up a DGC-2020 and LSM-2020 for load sharing or load control.

The voltage controller gains are:

- (1) Voltage Controller Kp - Proportional Gain
  - (2) Voltage Controller Ki - Integral Gain
  - (3) Voltage Controller Kd - Derivative Gain
  - (4) Voltage Controller Td - Derivative filter time constant
  - (5) Voltage Controller Kg - Loop Gain, must be nonzero for control to occur
- vi. Voltage Trim Deadband - The Voltage Trim error is calculated as the difference between the measured voltage and the voltage trim set point divided by the machine Rated Voltage. When this difference is less than the trim dead band setting, the voltage trim controller will treat this as zero error. If system operation appears "nervous" when voltage trim is enabled, setting a nonzero dead band may result in smoother system operation. In addition, if machines do not appear to share kvar equally when voltage trim is enabled, setting a nonzero dead band will likely result in improved kvar sharing.
  - vii. Remote Trim Bias - The remote trim bias setting selects an analog input to use as a bias to the voltage trim set point.
  - viii. Remote Trim Bias (%) - The remote trim bias (%) setting specifies the range, in percent, of the active voltage trim set point over which the voltage trim can be biased.
  - ix. Trim Voltage - The trim voltage setting defines the voltage trim value in volts.
  - x. Alternate Voltage 1 through 4 - The Alternate Voltage 1 through Alternate Voltage 4 settings define the voltage trim value when the corresponding Alternate Voltage Override logic element is true in BESTlogicPlus programmable logic.
  - xi. Var/PF Control Enable - Select *Enable* to turn on the kvar / Power Factor controller. Note that Var/PF control occurs only when the generator is paralleled to the utility as indicated by the parallel to mains (ParToMains) logic element in BESTlogicPlus Programmable Logic. When Var/PF control is enabled, the generator breaker is closed, and the generator is not paralleled to the utility as indicated by the Parallel To Mains logic element, the DGC-2020 will control the kvar to achieve kvar sharing with the other generators in the system through intergenset communications. When the generator breaker is open, the DGC-2020 will control the kvar to achieve voltage droop for kvar sharing.
  - xii. Control Mode - Select *Var Control* or *PF Control* as the control mode. The controller will operate in this mode when the generator is paralleled to the utility as indicated by the parallel to mains (ParToMains) logic element in BESTlogicPlus Programmable Logic.
  - xiii. Var/PF Controller Gains (Kp, Ki, Kd, Td, Kg) - There are four Proportional - Integral - Derivative (PID) controllers involved when a DGC-2020 and LSM-2020 are used in a load sharing or load control system. The gains of the controllers involved with Var/PF control are discussed below. Controller gains are configured as part of the controller tuning procedure. The tuning procedures for all PID controllers are presented in Appendix C, *Tuning PID Settings*. Controller tuning is performed after all other settings have been configured and is the last step in setting up a DGC-2020 and LSM-2020 for load sharing or load control.

The Var/PF controller gains are:

- (1) Var/PF Controller Kp - Proportional Gain
- (2) Var/PF Controller Ki - Integral Gain
- (3) Var/PF Controller Kd - Derivative Gain



- (4) Var/PF Controller Td - Derivative filter time constant
- (5) Var/PF Controller Kg - Loop Gain, must be nonzero for control to occur
- xiv. Droop Percentage (%) - This setting defines the percentage of voltage droop that is desired when the DGC-2020 is operating in voltage droop mode. The default setting of zero effectively disables voltage droop.
- xv. Voltage Droop Gain - This gain factor is used to compensate for variations in AVRs and their tuning. After tuning the controller, if a nonzero voltage droop percentage is desired, set the value of droop percentage accordingly. Perform a test by exporting kvar, and observe the voltage droop. If the observed droop does not match the *Droop Percentage* setting, set the droop gain as a scale factor to achieve the desired droop. For instance, if the observed droop was only half what is desired, set the droop gain to two. Then, the observed droop should correspond to the *Droop Percentage* setting.
- xvi. Ramp Rate (%) - This rate is in terms of percentage of the machine's Rated kvar Capacity (calculated from Rated kW and Rated Power Factor) at which the generator's kvar output will ramp from 0 kvar to the required kvar demand level when the generator breaker is closed and the generator is paralleled to the utility. Paralleled to utility status is indicated to the DGC-2020 by the parallel to mains (ParToMains) logic element in BESTlogicPlus Programmable Logic. As an example, assume the *Ramp Rate* is set at 10% per second. If the demand is 50% of the machine's capacity, and the generator breaker is closed to parallel the generator to the utility, it will take 5 seconds for the output to come up to the required level. If the demand is 80 percent, it will take 8 seconds to come up, etc. This is also the rate at which the machine will ramp down when going off line in a normal machine stop.
- xvii. kvar Setpoint (%) - When the kvar controller is in Var Control Mode, this setting defines the level of the machine's Rated kvar Capacity (calculated from Rated kW and Rated Power Factor) that the DGC-2020 will regulate when the generator is paralleled to the utility as indicated by the parallel to mains (ParToMains) logic element in BESTlogicPlus Programmable Logic.
- xviii. kvar Setpoint Source - The set point for the kvar controller when it is in kvar control mode can either be the level set in the *kvar Setpoint (%)* setting, or it can be derived from an analog input on the LSM-2020, or the AEM-2020 (Analog Expansion Module). Set this parameter to *User Setting* or to an available analog input on the LSM-2020 or AEM-2020 as required for machine implementation.
- xix. kvar Analog Max (%) - This setting defines the value of kvar that is requested when the *kvar Setpoint Source* is set to an analog input and the input is at its maximum. This parameter cannot be configured when the *kvar Setpoint Source* is set for *User Setting*.
- xx. kvar Analog Min (%) - This setting defines the value of kvar that is requested when the *kvar Setpoint Source* is set to an analog input and the input is at its minimum. This parameter cannot be configured when the *kvar Setpoint Source* is set for *User Setting*.
- xxi. PF Setpoint Source - The set point for the kvar controller when it is in power factor control mode can either be the level set in the *PF Setpoint* setting, or it can be derived from an analog input on the LSM-2020, or the AEM-2020 (Analog Expansion Module). Set this to *User Setting* or to an available analog input on the LSM-2020 or AEM-2020 as required for the machine implementation.
- xxii. PF Setpoint - The set point for the kvar controller when it is in power factor control mode and the *PF Setpoint Source* is set for *User Setting*. The DGC-2020 will maintain this power factor when the generator is paralleled to the utility as indicated by the parallel to mains (ParToMains) logic element in BESTlogicPlus Programmable Logic. Note that a negative setting is used to specify leading PF and a positive setting specifies lagging PF.

- xxiii. PF Analog Max - This setting defines the value of PF that is requested when the *PF Setpoint Source* is set to an analog input and the input is at its maximum. This parameter cannot be configured when the *PF Setpoint Source* is set for *User Setting*. Note that a negative setting is used to specify leading PF and a positive setting specifies lagging PF.
  - xxiv. PF Analog Min - This setting defines the value of PF that is requested when the *PF Setpoint Source* is set to an analog input and the input is at its maximum. This parameter cannot be configured when the *PF Setpoint Source* is set for *User Setting*. Note that a negative setting is used to specify leading PF and a positive setting specifies lagging PF.
- g. Configure Demand Start/Stop related parameters (if Demand Start/Stop is used)
- i. Configure Demand Start/Stop parameters.

The Demand Start/Stop parameters are found in BESTCOMSPlus® under SETTINGS EXPLORER > DGC-2020 > MULTIGEN MANAGEMENT > DEMAND START/STOP. See Figure 7-61.

Front Panel Navigation Path: SETTINGS > MULTIGEN MANAGEMENT > DEMAND START STOP

**Demand Start/Stop**

Demand Start Stop Enable  
Enable

**Start 1**  
Delayed Start Level 1 (PU) 0.000 Start Level 1 Timeout (s) 0.0

**Start 2**  
Delayed Start Level 2 (PU) 0.000 Start Level 2 Timeout (s) 0.0

**Stop**  
Delayed Stop Level (PU) 0.000 Stop Timeout (s) 0.0

**Figure 7-61. Settings Explorer, Multigen Management, Demand Start/Stop Screen**

There are two demand start levels and timeouts. This allows the user to set up a lower system power level with a long timeout for normal generator starts, but if the system power level exceeds a higher level for a shorter time (e.g. a machine has an alarm shut down or some other abnormal system power phenomenon occurs) machines can be brought on quickly.

Set up the individual parameters according to:

- (1) Demand Start/Stop Enable - Select *Enable* to turn on the demand start/stop functionality.
- (2) Delayed Start Level 1 (PU) - This setting defines the level (in Per Unit) at which the sequence for starting another machine should occur. Once the *Start Level 1 Timeout* has expired, another machine will be started.
- (3) Start Level 1 Timeout - Set setting defines the desired delay before starting a machine when the system per unit power level has exceeded *Delayed Start Level 1*.
- (4) Delayed Start Level 2 (PU) - This setting defines the level (in Per Unit) at which the sequence for starting another machine should occur. Once the *Start Level 2 Timeout* has expired, another machine will be started.



- (5) Start Level 2 Timeout - This setting defines the desired delay before starting a machine when the system per unit power level has exceeded *Delayed Start Level 2*.
- (6) Delayed Stop Level (PU) - This setting defines the level (in Per Unit) at which the sequence for stopping another machine should occur. Once the *Stop Level Timeout* has expired, another machine will be shut down.
- (7) Stop Level Timeout - This setting defines the desired delay before stopping a machine when the system per unit power level has been less than *Delayed Stop Level*.

ii. Configure Generator Sequencing parameters.

The Generator Sequencing parameters are found in BESTCOMS<sup>Plus</sup>® under SETTINGS EXPLORER > DGC-2020 > MULTIGEN MANAGEMENT > GENERATOR SEQUENCING. See Figure 7-62.

Front Panel Navigation Path: [SETTINGS > MULTIGEN MANAGEMENT > SEQUENCING](#)

**Figure 7-62. Settings Explorer, Multigen Management, Generator Sequencing Screen**

Set up the individual parameters according to:

- (1) Mode - Select the desired generator-sequencing mode. Selections include *Disabled*, *Staggered Service Time*, *Balanced Service Time*, *Largest Size First*, *Smallest Size First*, *Smallest Unit ID First*, and *Adopt System Mode*.

When *Disabled*, the unit does not participate in sequencing. When any mode other than *Disabled* or *Adopt System Mode* is selected, all machines on the inter-genset communications network will switch to the newly programmed mode. If generator sequencing is being set up before an inter-genset communications network is in place, the same mode should be set for all machines. If a machine is added to the inter-genset communications network and *Adopt System Mode* is selected, the machine's sequencing mode will switch to the mode of the rest of the machines on the network.

- (2) Sequence ID - Enter a number for sequence ID. The ID must be a unique nonzero number for each machine that is to participate in generator sequencing. Any machines with zero for a sequence ID will not participate in generator sequencing. In addition, machines with zero for a sequence ID will not be considered when network status is checked for the ID Missing and ID Repeat pre-alarms. These are discussed in detail in the paragraphs titled *Configure the Generator Network parameters* below.
- (3) Max Gen Start Time (s) - This setting defines the maximum time in seconds that generator sequencing will allow for a machine to start. If a successful start does not occur within the allotted time, generator sequencing will move to the

next machine in the priority order and try to start it. This should be set to allow ample time for a normal start to occur.

- (4) Max Gen Stop Time (s) - This setting defines the maximum time in seconds that generator sequencing will allow for a machine to stop. If a successful stop does not occur within the allotted time, generator sequencing will move to the next machine in the priority order and try to stop it. This should be set to allow ample time for a normal stop to occur.
- (5) Allow Last Unit Shutdown - Set to enable or disable to allow the last unit to shut down if there is no load on the system.

iii. Configure the Generator Network parameters.

The Generator Network Configuration parameters are found in BESTCOMSPlus® under SETTINGS EXPLORER > DGC-2020 > MULTIGEN MANAGEMENT > NETWORK CONFIGURATION. See Figure 7-63.

Front Panel Navigation Path: [SETTINGS > MULTIGEN MANAGEMENT > NETWORK CONFIG](#)

| Network Configuration |                    |
|-----------------------|--------------------|
| Expected Seq Id 1     | Expected Seq Id 9  |
| 0                     | 0                  |
| Expected Seq Id 2     | Expected Seq Id 10 |
| 0                     | 0                  |
| Expected Seq Id 3     | Expected Seq Id 11 |
| 0                     | 0                  |
| Expected Seq Id 4     | Expected Seq Id 12 |
| 0                     | 0                  |
| Expected Seq Id 5     | Expected Seq Id 13 |
| 0                     | 0                  |
| Expected Seq Id 6     | Expected Seq Id 14 |
| 0                     | 0                  |
| Expected Seq Id 7     | Expected Seq Id 15 |
| 0                     | 0                  |
| Expected Seq Id 8     | Expected Seq Id 16 |
| 0                     | 0                  |

**Figure 7-63. Settings Explorer, Multigen Management, Network Configuration**

These settings are the nonzero sequence IDs of all units that are on the inter-genset communications network. This allows the DGC-2020s to annunciate a pre-alarm if a machine is missing (ID Missing pre-alarm) or if an ID is repeated (ID Repeat pre-alarm) on the network. These pre-alarms help in diagnosing problems with the inter-genset communications network. If these pre-alarms are not desired, set all expected sequence IDs to zero. If you want to prevent the pre-alarm for a particular machine because it is off line, replace its sequence ID with zero in the *Expected Sequence ID* settings.

Set the number corresponding to the nonzero sequence ID of each machine participating in the inter-genset communications network. If you have N machines, put the nonzero sequence IDs for the N units into the first N *Expected Seq ID* setting positions. Additional *Expected Seq ID* positions should be set to zero.

It is likely that these pre-alarms will sound on multiple machines at the same time. If the cable falls out of a unit, all the units remaining on the network should annunciate ID Missing pre-alarms. In addition, the unit that the cable fell out of should annunciate the pre-alarm as well, since it does not see the IDs of the other machines in its network.

Network status can be viewed in BESTCOMSPlus® under METERING EXPLORER > GC-2020 > GENERATOR NETWORK STATUS.

iv. Configure the LSM-2020 Ethernet parameters.

Generators communicate with each other for demand start/stop functionality through inter-genset communications over the Ethernet ports on the LSM-2020s in the system. The *IP address*, *Subnet Mask*, and *Default Gateway* settings for each LSM-2020 must be configured in order for communication to occur. Instructions for configuring the LSM-2020 Ethernet parameters are found in the paragraphs titled *Ethernet Communications* under *Communications* in Section 4, BESTCOMSPlus® *Software*.

h. Tune the kW, kvar, speed, and voltage controllers.

Controller tuning is performed after all other settings have been configured and is the last step in setting up a DGC-2020 and LSM-2020 for load sharing or load control. There are four Proportional - Integral - Derivative (PID) controllers involved when a DGC-2020 and LSM-2020 are used in a load sharing or load control system. Each PID controller has settings for the following parameters: Kp, Ki, Kd, Td, and Kg. The controller parameters are configured as part of the controller tuning procedure. The tuning procedures for all PID controllers are presented in Appendix C, *Tuning PID Settings*.

## Mains Fail Transfer

The DGC-2020 has an internal ATS feature which allows it to monitor the utility, and when the utility fails, opens the mains breaker, starts the generator, then closes the generator breaker to drive the load. When the utility returns and is deemed stable, it will return the load to the utility power. When using the mains fail transfer feature, the DGC-2020 will control the breakers to open and close them to achieve the transition from the utility to the generator. Physical inputs can be configured through logic to implement open and close commands for the generator and mains breakers.

Breaker status from a breaker is communicated to the DGC-2020 only by having the breaker element (either gen breaker or mains breaker) in the logic diagram and a physical input must be connected to the *Status* input of the breaker block.

When the DGC-2020 controls a breaker, the following criteria must be met for a breaker to change state:

1. A gen or mains breaker cannot be closed unless the generator voltage is stable, and the bus voltage is stable or dead. A breaker will not close to a dead bus unless the *Dead Bus Close Enable* parameter found in BESTCOMSPlus® under SETTINGS EXPLORER > BREAKER MANAGEMENT > BREAKER HARDWARE is enabled.
2. A breaker will not change state if it receives conflicting commands. In other words, if a physical input is indicating an open command the same time another physical input is indicating a close command, the breaker will not change state.

### Steps Required to Configure a DGC-2020 for Mains Fail Transfer

1. Connect the DGC-2020 according to the appropriate figure in Section 6, *Installation* under *Connections* for the type of connection desired (WYE, DELTA, etc.).
2. Set up the system parameters that will govern engine operation and the alarm and pre-alarm annunciation. Details can be found in the paragraphs titled *DGC-2020 Initial Setup*. Additional details of individual settings can be found in Section 4, BESTCOMSPlus® *Software*.
3. Configure main and gen breaker parameters in BESTCOMSPlus® under SETTINGS EXPLORER > BREAKER MANAGEMENT > BREAKER HARDWARE. See Figure 7-64.

Front Panel Navigation Path: SETTINGS > BREAKER MANAGEMENT > BREAKER HARDWARE

**Breaker Hardware**

**Generator Breaker Hardware**

Configured  
☐ No  
☒ Yes

Dead Bus Close Enable  
☒ Disable  
☐ Enable

Dead Gen Close Enable  
☒ Disable  
☐ Enable

Contact Type  
☒ Pulse  
☐ Continuous

Breaker Fail Output Configuration  
☒ Retain  
☐ Remove

External Status Change Action  
☒ Ignore  
☐ Follow Always  
☐ Follow In Auto

Breaker Closing Time (ms)  
 100

Open Pulse Time (s)  
 0.01

Close Pulse Time (s)  
 0.01

Transition Delay (s)  
 0.00

Open Attempts  
 1

Close Attempts  
 1

Retry Delay (s)  
 5

**Gen and Mains Breaker Breaker Close Wait Time (s)**  
 0.2

**Mains Breaker Hardware**

Configured  
☐ No  
☒ Yes

Contact Type  
☒ Pulse  
☐ Continuous

Breaker Fail Output Configuration  
☒ Retain  
☐ Remove

External Status Change Action  
☒ Ignore  
☐ Follow Always  
☐ Follow In Auto

Breaker Closing Time (ms)  
 100

Open Pulse Time (s)  
 0.01

Close Pulse Time (s)  
 0.01

Transition Delay (s)  
 0.00

Open Attempts  
 1

Close Attempts  
 1

Retry Delay (s)  
 5

**Figure 7-64. Settings Explorer, Breaker Management, Breaker Hardware Screen**

- a. Configure Mains Fail Transfer parameters in BESTCOMS<sup>Plus</sup> under SETTINGS EXPLORER > BREAKER MANAGEMENT > MAINS FAIL. See Figure 7-65.

Front Panel Navigation Path: **SETTINGS > BREAKER MANAGEMENT > BREAKER HARDWARE > MAINS FAIL TRANSFER**

- i. Enable Mains Fail Transfer
  - ii. Enter the transfer and return delays
  - iii. Enter the max transfer time. This is the maximum duration allowed for the transfer to be accomplished. If this time is exceeded, a mains fail transfer pre-alarm is annunciated.
  - iv. Configure the Mains Fail Transfer Type setting for open or closed transitions. In open transitions, the generator is not connected directly to the utility at any time. In closed transitions, when transitioning the load from the generator to the utility, the generator will synchronize to the utility, close the mains breaker, then open the generator breaker when the generator has unloaded, or when the max parallel time has expired, whichever occurs first.
  - v. Set the Max parallel Time if closed transitions are configured. This is the maximum amount of time that the generator is paralleled to the utility when the load is transitioned from the generator back to the utility power.
  - vi. Set the In Phase Monitor setting to Enable or Disable if open transitions are selected. When enabled, the DGC-2020 initiates an open transition of the load from generator power back to utility power when an alignment phase angle between the generator and the utility passes through zero degrees. This can be less disruptive to certain types of load than transitioning at arbitrary phase angles.
- b. Breaker Close Wait Time. (See Figure 7-64) This is a time interval in which it is expected that the breaker will transition from open to closed or closed to open. If it does not change state in that time, either a Gen Breaker Close Fail or Gen Breaker Open Fail is annunciated for Generator breaker failures, and/or Mains Breaker Close Fail or Mains Breaker Open Fail is annunciated for mains breaker failures.
  - c. Generator Breaker (See Figure 7-64)
    - i. Set Dead Bus Close Enable to *Enabled*.

- ii. Select the contact type and enter pulse times if pulsed contacts are used.
  - iii. Enter the breaker close time. This time is used by the anticipatory synchronizer to calculate the advance angle before 0 degrees slip angle at which to issue the breaker close command.
- d. Mains Breaker (See Figure 7-64)
- i. Select *Configured* for the mains breaker.
  - ii. Select the contact type and enter pulse times if pulsed contacts are used.
  - iii. Enter the breaker close time. This time is used by the anticipatory synchronizer to calculate the advance angle before 0 degrees slip angle at which to issue the breaker close command.

**Mains Fail**

**Mains Fail Transfer**  
☒ Disable  
☐ Enable

**Alarm State Transfer To Mains**  
☒ Disable  
☐ Enable

**Mains Fail Transfer Type**  
☐ Closed  
☒ Open

**Mains Breaker Open Configuration**  
☒ Generator Start  
☐ Generator Stable

**Reverse Rotation Inhibit**  
☐ Disable  
☒ Enable

**In Phase Monitor**  
☒ Disable  
☐ Enable

**Mains Fail Transfer Delay (s)**

**Mains Fail Return Delay (s)**

**Mains Fail Max Transfer Time (s)**

**Mains Fail Max Return Time (s)**

**Max Parallel Time (s)**

**Open Transition Delay (s)**

**Figure 7-65. Settings Explorer, Breaker Management, Mains Fail Screen**

4. Set up the Mains Breaker and Gen Breaker in BESTCOMSP<sup>Plus</sup>® under Settings Explorer > BESTlogic<sup>Plus</sup> Programmable Logic. See Figure 7-66.
  - a. Mains Breaker
    - i. Drag the Mains Breaker element into the logic diagram.
    - ii. Connect the breaker element open and close outputs to the contact outputs that will drive the breaker.
    - iii. Connect the physical input or remote input that has the breaker status (closed if breaker is closed, open when breaker is open) to the *Status* input of the breaker element. This is the only way to indicate breaker status to the DGC-2020.
    - iv. If it is desired to have physical inputs that can request breaker open and close commands, connect the desired inputs to the open and close command inputs of the breaker element. Note these are to be pulsed inputs; if they are both closed at the same time, the breaker will not change state. If it is not desired to have inputs for breaker commands, connect a "Logic 0" input object to the open and close command inputs of the breaker block.
  - b. Generator Breaker
    - i. Drag the Gen Breaker element into the logic diagram.
    - ii. Connect the breaker element open and close outputs to the contact outputs that will drive the breaker.
    - iii. Connect the physical input or remote input that has the breaker status (closed if breaker is closed, open when breaker is open) to the *Status* input of the breaker element. This is the only way to indicate breaker status to the DGC-2020.

- iv. If it is desired to have physical inputs that can request breaker open and close commands, connect the desired inputs to the open and close command inputs of the breaker element. Note these are to be pulsed inputs; if they are both closed at the same time, the breaker will not change state. If it is not desired to have inputs for breaker commands, connect a “Logic 0” input object to the open and close command inputs of the breaker block.
- c. Click the **Save** button when the logic is complete.
- d. From the **Communication** pull-down menu, select **Upload Logic** to load the logic into the DGC-2020 if connected, or save the settings to a file if working off line.

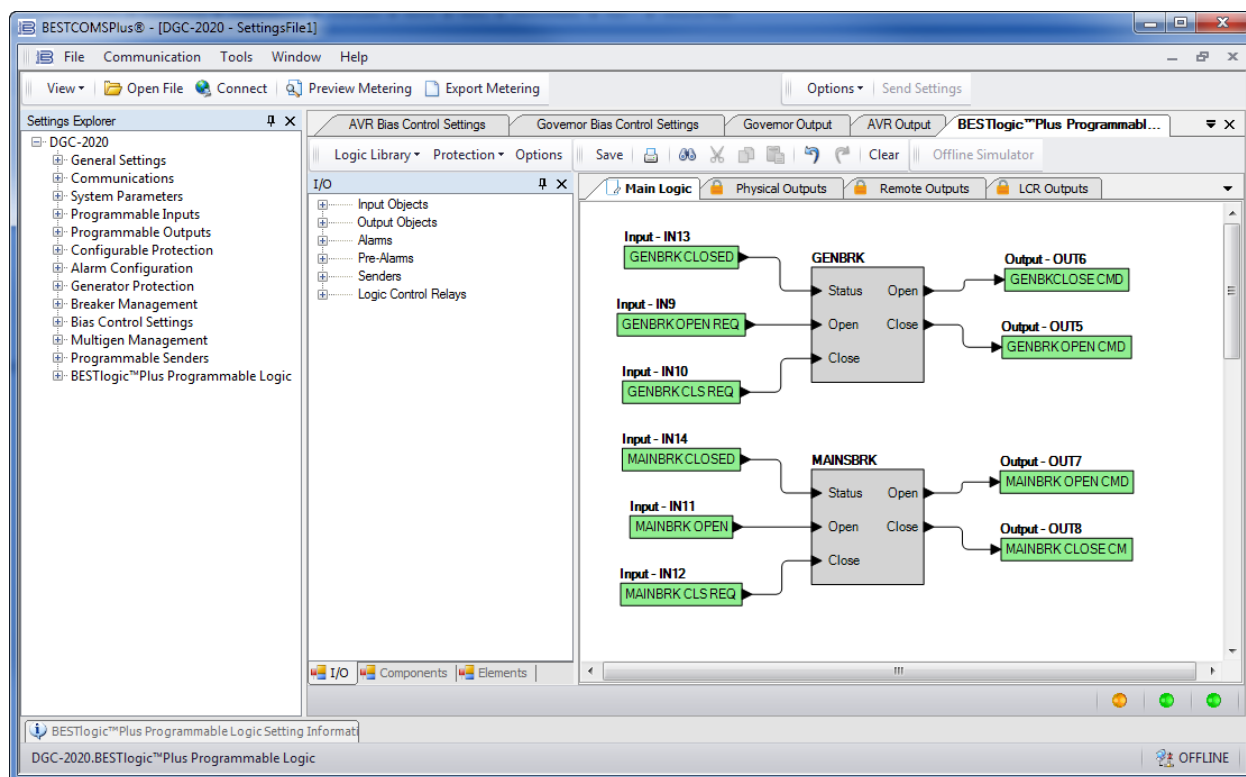


**Figure 7-66. Settings Explorer, BESTlogicPlus Programmable Logic**

- 5. Set the parameters for detecting stable and failed bus and generator under **SETTINGS EXPLORER > BREAKER MANAGEMENT > BUS CONDITION DETECTION**.

- a. Generator Sensing. See Figure 7-67.

**Front Panel Navigation Path: SETTINGS > BREAKER MANAGEMENT > BUS CONDITION DETECT**

- i. Dead Bus Voltage Threshold and Activation Delay. When the voltage of either the generator or bus is below this threshold for the duration equal the activation delay, the generator or bus is deemed “Dead”.
- ii. Gen Stable Over and Under Voltage Thresholds and Over and Under Frequency Thresholds and the Bus Stable and Bus Failed Activation Delay. When the generator voltage and frequencies are within the specified ranges for the duration equal to the Bus Stable Activation Delay, the generator is deemed “Stable”. Otherwise it is deemed “Failed”.

- b. Bus Sensing. See Figure 7-67.

- i. Bus Stable Over and Under Voltage Thresholds and Over and Under Frequency Thresholds. When the bus input voltage and frequencies are within the specified ranges for the duration equal to the *Bus Stable Activation Delay*, the bus input is deemed “Stable”. Otherwise, it is deemed “Failed”.

6. Place the unit in AUTO. The unit is now configured for mains fail transfer operation. It can be tested by removing the input to the bus input terminals, or temporarily modifying the bus condition parameter for the bus input to indicate the bus input has failed. After the mains fail transfer delay has expired, the mains breaker opens, the generator starts, and the gen breaker closes. When the bus is reapplied or the bus condition parameters are re-adjusted to indicate a stable bus input, after the mains fail return delay has expired, the unit opens the generator breaker, closes the mains breaker, cools down, and stops.

### Caution

The bus condition parameters are critical because they determine when a breaker can be closed. The generator breaker can be closed when any one of the following is true:

- The generator is stable and both breakers are open
- The generator is stable and the bus is stable
- The generator is stable, the bus is dead, and the dead bus close enable setting is set to enabled
- The generator is dead, the dead gen close enable setting is set to enabled, the bus is dead, and the dead bus close enable setting is set to enabled

The mains breaker can be closed only when the generator is stable and both breakers are open, or the generator is stable and the bus is stable.

### Bus Condition Detection

#### Generator Sensing

##### Generator Condition Settings

|                    |                               |                                 |
|--------------------|-------------------------------|---------------------------------|
| Dead Gen Threshold | Dead Gen Activation Delay (s) | Gen Failed Activation Delay (s) |
| 30 V               | 0.1                           | 0.1                             |
| 0.063 Per Unit     |                               |                                 |

#### Generator Stable

##### Overvoltage Settings

|                |                |
|----------------|----------------|
| Pickup (V L-L) | Dropout        |
| 130 V          | 127 V          |
| 0.271 Per Unit | 0.265 Per Unit |

##### Undervoltage Settings

|                |                |
|----------------|----------------|
| Pickup (V L-L) | Dropout        |
| 115 V          | 117 V          |
| 0.240 Per Unit | 0.244 Per Unit |

##### Overfrequency Settings

|                 |                 |
|-----------------|-----------------|
| Pickup          | Dropout         |
| 62.00 Hz        | 61.80 Hz        |
| 1.0333 Per Unit | 1.0300 Per Unit |

##### Underfrequency Settings

|                 |                 |
|-----------------|-----------------|
| Pickup          | Dropout         |
| 58.00 Hz        | 58.20 Hz        |
| 0.9667 Per Unit | 0.9700 Per Unit |

|                                 |                       |                                  |
|---------------------------------|-----------------------|----------------------------------|
| Gen Stable Activation Delay (s) | Low Line Scale Factor | Alternate Frequency Scale Factor |
| 0.1                             | 1.000                 | 1.000                            |

#### Bus Sensing

##### Bus Condition Settings

|                    |                               |                                 |
|--------------------|-------------------------------|---------------------------------|
| Dead Bus Threshold | Dead Bus Activation Delay (s) | Bus Failed Activation Delay (s) |
| 30 V               | 0.1                           | 0.1                             |
| 0.063 Per Unit     |                               |                                 |

#### Bus Stable

##### Overvoltage Settings

|                |                |
|----------------|----------------|
| Pickup (V L-L) | Dropout        |
| 130 V          | 127 V          |
| 0.271 Per Unit | 0.265 Per Unit |

##### Undervoltage Settings

|                |                |
|----------------|----------------|
| Pickup (V L-L) | Dropout        |
| 115 V          | 117 V          |
| 0.240 Per Unit | 0.244 Per Unit |

##### Overfrequency Settings

|                 |                 |
|-----------------|-----------------|
| Pickup          | Dropout         |
| 62.00 Hz        | 61.80 Hz        |
| 1.0333 Per Unit | 1.0300 Per Unit |

##### Underfrequency Settings

|                 |                 |
|-----------------|-----------------|
| Pickup          | Dropout         |
| 58.00 Hz        | 58.20 Hz        |
| 0.9667 Per Unit | 0.9700 Per Unit |

|                                 |                       |                                  |
|---------------------------------|-----------------------|----------------------------------|
| Bus Stable Activation Delay (s) | Low Line Scale Factor | Alternate Frequency Scale Factor |
| 0.1                             | 1.000                 | 1.000                            |

Figure 7-67. Settings Explorer, Breaker Management, Bus Condition Detection Screen



## 8 • Maintenance and Troubleshooting

### **Maintenance**

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Preventative maintenance consists of periodic replacement of the backup battery and periodically checking that the connections between the DGC-2020 and the system are clean and tight. DGC-2020 units are manufactured using state-of-the-art, surface-mount technology. As such, Basler Electric recommends that no repair procedures be attempted by anyone other than Basler Electric personnel.

#### **Backup Battery for the Real Time Clock**

The backup battery for the real time clock is a standard feature for the DGC-2020 Digital Genset Controller. A 3.0 Vdc, 195-mAh lithium battery (type Rayovac BR2032) is used to maintain clock function during loss of power supply voltage. In mobile substation and generator applications, the primary battery system that supplies the DGC-2020 power supply may be disconnected for extended periods (weeks, months) between uses. Without battery backup for the real time clock, clock functions will cease if battery input power is removed.

The backup battery has a life expectancy of approximately 10 years. After this time, you should contact Basler Electric to order a new battery, Basler Electric P/N 38526.

Battery access is located on the rear side of the DGC-2020.

#### **Caution**

Replacement of the backup battery for the real-time clock should be performed only by qualified personnel.

Do not short-circuit the battery, reverse battery polarity, or attempt to recharge the battery. Observe polarity markings on the battery socket while inserting a new battery. The battery polarity must be correct in order to provide backup for the real-time clock.

It is recommended that the battery be removed if the DGC-2020 is to be operated in a salt-fog environment. Salt fog is known to be conductive and may short-circuit the battery.

#### **Note**

Failure to replace the battery with Basler Electric P/N 38526 may void the warranty.

### **Storage**

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This device contains long-life aluminum electrolytic capacitors. For devices that are not in service (spares in storage), the life of these capacitors can be maximized by energizing the device for 30 minutes once per year.

### **Troubleshooting**

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If you do not get the results that you expect from the DGC-2020, first check the programmable settings for the appropriate function. Use the following troubleshooting procedures when difficulties are encountered in the operation of your genset control system.

## Communications

### Ethernet Port Does Not Operate Properly

- Step 1. Verify that the proper port of your computer is being used. For more information, refer to Section 4, *BESTCOMSPlus® Software, Communication*.
- Step 2. Verify the network configuration of the LSM-2020 and DGC-2020 are set up properly. For more information, refer to Section 4, *BESTCOMSPlus® Software, Communication*.
- Step 3. Verify that all Ethernet devices comply with IEC 61000-4 series of specifications for Industrial Ethernet Devices. Commercial devices are not recommended and may result in erratic network communications.

### USB Port Does Not Operate Properly

- Step 1. Verify that the proper port of your computer is being used. For more information, refer to Section 4, *BESTCOMSPlus® Software, Communication*.

### CAN Bus Communication Does Not Operate Properly

- Step 1: Verify that there is a 120-ohm termination resistor on each end of the bus section of the wiring, and that there are not any termination resistors at any node connections that are on stubs from the main bus.
- Step 2: Check all CAN Bus wiring for loose connections, and verify that the CAN H and CAN L wires have not gotten switched somewhere on the network.
- Step 3: Verify that the cable length of the bus section of the wiring does not exceed 40 meters (131 feet), and verify that any stubs from the main bus do not exceed 3 meters (10 feet) in length.
- Step 4: If the Engine ECU is a Volvo or *mtu* ECU, verify that the ECU Configuration setting is set to match the ECU configuration.

## Inputs and Outputs

### Programmable Inputs Do Not Operate as Expected

- Step 1. Verify that all wiring is properly connected. Refer to Section 6, *Installation, Connections*.
- Step 2. Confirm that the inputs are programmed properly.
- Step 3. Ensure that the input at the DGC-2020 is actually connected to the BATT– terminal (2).

### Programmable Outputs Do Not Operate as Expected

- Step 1. Verify that all wiring is properly connected. Refer to Section 6, *Installation, Connections*.
- Step 2. Confirm that the outputs are programmed properly.

## Metering/Display

### Incorrect Display of Battery Voltage, Coolant Temperature, Oil Pressure, or Fuel Level

- Step 1. Verify that all wiring is properly connected. Refer to Section 6, *Installation, Connections*.
- Step 2. Confirm that the SENDER COM terminal (11) is connected to the negative battery terminal and the engine-block side of the senders. Current from other devices sharing this connection can cause erroneous readings.
- Step 3. If the displayed battery voltage is incorrect, ensure that the proper voltage is present between the BATT+ terminal (3) and the SENDER COM terminal (11).
- Step 4. Verify that the correct senders are being used.
- Step 5. Use a voltmeter connected between the BATT-terminal (2) and the SENDER COM terminal (11) on the DGC 2020 to verify that there is no voltage difference at any time. Any voltage differences

may manifest themselves as erratic sender readings. Wiring should be corrected so that no differences exist.

- Step 6: Check the sender wiring and isolate sender wiring from any of the AC wiring in the system. The sender wiring should be located away from any power AC wiring from the generator and any ignition wiring. Separate conduits should be used for sender wiring and any AC wiring.

#### Incorrect Display of Generator Voltage

- Step 1. Verify that all wiring is properly connected. Refer to Section 6, *Installation, Connections*.
- Step 2. Ensure that the proper voltage is present at the DGC-2020 voltage sensing inputs (41, 39, 37, and 35).
- Step 3. Verify that the voltage transformer ratio and sensing configuration is correct.
- Step 4. Confirm that the voltage sensing transformers are correct and properly installed.

#### Incorrect Measurement or Display of Generator Current

- Step 1. Verify that all wiring is properly connected. Refer to Section 6, *Installation, Connections*.
- Step 2. Ensure that the proper current is present at the DGC-2020 current sensing inputs 68/69, 71/72, and 74/75.
- Step 3. Verify that the current sensing transformer ratios are correct.
- Step 4. Confirm that the current sensing transformers are correct and properly installed.

#### Incorrect Display of Engine RPM

- Step 1. Verify that all wiring is properly connected. Refer to Section 6, *Installation, Connections*.
- Step 2. Verify that the flywheel teeth setting is correct.
- Step 3. Verify that the prime mover governor is operating properly.
- Step 4. Verify that the measured frequency of the voltage at the MPU input (31 and 32) is correct.
- Step 5. If the MPU is shared with the governor, verify that the polarity of the MPU input to the governor matches the polarity of the MPU input to the DGC-2020.

#### DGC-2020 Indicates Incorrect Power Factor

Check the rotation of the machine and the labeling of the A-B-C terminals. The machine must be rotating in clockwise (A-B-C) phase sequence for correct power factor metering. A power factor indication of 0.5 with resistive load present is a symptom of incorrect phase rotation.

#### LCD is Blank and all LEDs are Flashing at Approximately 2 Second Intervals

This indicates that the DGC-2020 does not detect that valid application firmware is installed. The unit is running its boot loader program, waiting to accept a firmware upload.

- Step 1. Start BESTCOMSP<sup>Plus</sup>®. Use the top pull-down menu and select FILE > NEW > DGC-2020.
- Step 2. Select COMMUNICATIONS > UPLOAD DEVICE FILES and select the device package file that contains the firmware and language you want to upload.
- Step 3. Check the boxes for DGC-2020 Firmware and DGC-2020 Language Module. Click the UPLOAD button to start the upload process.

### **Ground Faults Detected in Ungrounded System Applications**

- Step 1: Verify that there is no connection from the neutral connection of the generator to the system ground.
- Step 2: Perform insulation resistance tests on the system wiring to check for insulation integrity in the overall system.

- Step 3: If ground faults are detected on a DGC-2020 in an ungrounded system application, it is recommended that potential transformers be employed on the voltage sensing inputs to provide full isolation between the DGC-2020 and monitored voltage phases.
- Step 4: If potential transformers are in place, remove the connectors from the DGC-2020 one at a time. If removal of a connector removes the ground fault, check the system wiring to that connector and out into the system to verify that connections are secure and all wiring insulation is in good condition.

## Generator Breaker and Mains Breaker

### Generator Breaker Will Not Close to a Dead Bus

- Step 1: Review the description of how the generator breaker logic element functions contained in the GENBRK logic element description in Section 5, *BESTlogic™ Plus Programmable Logic*.
- Step 2: Review the section on breaker close requests in Section 3, *Functional Description, Breaker Management*.
- Step 3: Navigate to the SETTINGS > BREAKER MANAGEMENT > BREAKER HARDWARE > GEN BREAKER screen and set DEAD BUS CL ENBL to ENABLE.
- Step 4: Verify that the Generator status is stable. The breaker will not close if the generator status is not stable. Check status by using the Metering Explorer in BESTCOMSP<sup>Plus</sup>® and verify that when the generator is running, the GEN STABLE status LED is lit. If necessary, modify the settings on the SETTINGS > BREAKER MANAGEMENT > BUS CONDITION DETECTION screen.
- Step 5: Verify the bus status is DEAD. Check status by using the Metering Explorer in BESTCOMSP<sup>Plus</sup>® and verify that when the generator is running, the BUS DEAD status LED is lit. If necessary, modify the settings on the SETTINGS > BREAKER MANAGEMENT > BUS CONDITION DETECTION screen.
- Step 6: Verify the connections in BESTlogic<sup>Plus</sup> Programmable Logic to the generator breaker logic element. The *Status* input must be driven by an “A” or normally open contact from the generator breaker. The OPEN and CLOSE command inputs on the left side of the logic block are inputs for open and close commands. These can be wired to physical inputs if it is desired to have open and close command switches. If they are wired, they must either be pulsed inputs, or some logic must be employed so that the open and close command inputs are never driven at the same time. If these are both driven at the same time, the breaker is receiving open and close commands simultaneously. The breaker will not change state if it is being commanded to open and close at the same time.
- Step 7: Verify the breaker is receiving a close command. Breaker close command sources are:
- The DGC-2020 itself when the RUN WITH LOAD logic element receives a *Start* pulse in the programmable logic.
  - The DGC-2020 itself when started from a Demand Start as part of demand start/stop and sequencing.
  - The DGC-2020 itself when started from the Exercise Timer and the Run with Load box is checked in the Generator Exerciser settings.
  - Manual Breaker Close Input Contacts applied to the Open and Close inputs on the left side of the Generator Breaker logic element in the programmable logic.
- Step 8: Verify the wiring to the breaker from the DGC-2020. If it seems OK, you can do a manual close and open by modifying the programmable logic. Map some unused outputs to the OPEN and CLOSE outputs from the Gen Breaker Block in the programmable logic. Map a virtual switch to the logic output that would normally be the breaker close output. Map another virtual switch to the logic output that would normally be the breaker close output. Connect with BESTCOMSP<sup>Plus</sup>®, and exercise the virtual switches using the Control panel located in the Metering Explorer. Never turn open and close on at the same time. This could damage the breaker and/or motor operator. If everything is working as expected, restore the logic to its original diagram.

### Generator Breaker Will Not Close to a Live Bus

- Step 1: Review the description of how the generator breaker logic element functions contained in the GENBRK logic element description in Section 5, *BESTlogicPlus Programmable Logic*.
- Step 2: Review the section on breaker close requests in Section 3, *Functional Description, Breaker Management*.
- Step 3: Verify that the Generator status is stable. The breaker will not close if the generator status is not stable. Check status using the Metering Explorer in BESTCOMSPlus® and verify that when the generator is running, the GEN STABLE status LED is lit. If necessary, modify the settings on the SETTINGS > BREAKER MANAGEMENT > BUS CONDITION DETECTION screen.
- Step 4: Verify that the Bus status is stable. The breaker will not close if the bus is not stable, check status using the Metering Explorer in BESTCOMSPlus® and verify that when the generator is running, the BUS STABLE status LED is lit. If necessary, modify the settings on the SETTINGS > BREAKER MANAGEMENT > BUS CONDITION DETECTION screen.
- Step 5: Verify the connections in BESTlogicPlus Programmable Logic to the generator breaker logic element. The *Status* input must be driven by an “A” or normally open contact from the generator breaker. The OPEN and CLOSE command inputs on the left side of the logic block are inputs for open and close commands. These can be wired to physical inputs if it is desired to have open and close command switches. If they are wired, they must either be pulsed inputs, or some logic must be employed so that the open and close command inputs are never driven at the same time. If these are both driven at the same time, the breaker is receiving open and close commands simultaneously. The breaker will not change state if it is being commanded to open and close at the same time.
- Step 6: Verify the breaker is receiving a close command. Breaker close command sources are:
- The DGC-2020 itself when the automatic transfer (ATS) feature is enabled.
  - The DGC-2020 itself when the RUN WITH LOAD logic element receives a *Start* pulse in the programmable logic.
  - The DGC-2020 itself when started from a Demand Start as part of demand start/stop and sequencing.
  - The DGC-2020 itself when started from the Exercise Timer and the Run with Load box is checked in the Generator Exerciser settings.
  - Manual Breaker Close Input Contacts applied to the Open and Close inputs on the left side of the Generator Breaker logic element in the programmable logic.
- Step 7: Verify the synchronizer is operating properly; refer to the synchronizer portion of the troubleshooting steps.
- Step 8: Verify the wiring to the breaker from the DGC-2020. If it seems OK, you can do a manual close and open by modifying the programmable logic. Map some unused outputs to the OPEN and CLOSE outputs from the Gen Breaker Block in the programmable logic. Map a virtual switch to the logic output that would normally be the breaker close output. Map another virtual switch to the logic output that would normally be the breaker close output. Connect with BESTCOMSPlus®, and exercise the virtual switches using the Control panel located in the Metering Explorer. Never turn open and close on at the same time. This could damage the breaker and/or motor operator. If everything is working as expected, restore the logic to its original diagram.

### Generator Breaker Does Not Open When It Should

- Step 1: Review the description of how the generator breaker logic element functions contained in the GENBRK logic element description in Section 5, *BESTlogicPlus Programmable Logic*.
- Step 2: Review the section on breaker close requests in Section 3, *Functional Description, Breaker Management*.
- Step 3: Verify the connections in BESTlogicPlus Programmable Logic to the generator breaker logic element. The *Status* input must be driven by an “A” or normally open contact from the generator breaker. The OPEN and CLOSE command inputs on the left side of the logic block are inputs

for open and close commands. These can be wired to physical inputs if it is desired to have open and close command switches. If they are wired, either they must be pulsed inputs or some logic must be employed so that the open and close command inputs are never driven at the same time. If these are both driven at the same time, the breaker is receiving open and close commands simultaneously. The breaker will not change state if it is being commanded to open and close at the same time.

Step 4: Verify the breaker is receiving a close command. Breaker close command sources are:

- The DGC-2020 itself when the automatic transfer (ATS) feature is enabled.
- The DGC-2020 itself when the RUN WITH LOAD logic element receives a *Start* pulse in the programmable logic.
- The DGC-2020 itself when started from a Demand Start as part of demand start/stop and sequencing.
- The DGC-2020 itself when started from the Exercise Timer and the *Run with Load* box is checked in the Generator Exerciser settings.
- Manual Breaker Close Input Contacts applied to the Open and Close inputs on the left side of the Generator Breaker logic element in the programmable logic.

Step 5: Verify the wiring to the breaker from the DGC-2020. If it seems OK, you can do a manual close and open by modifying the programmable logic. Map some unused outputs to the OPEN and CLOSE outputs from the Gen Breaker Block in the programmable logic. Map a virtual switch to the logic output that would normally be the breaker close output. Map another virtual switch to the logic output that would normally be the breaker close output. Connect with BESTCOMSPlus®, and exercise the virtual switches using the Control panel located in the Metering Explorer. Never turn open and close on at the same time. This could damage the breaker and/or motor operator. If everything is working as expected, restore the logic to its original diagram.

#### Mains Breaker Does Not Open When Mains Fails

Step 1: Verify that a Mains Breaker has been configured by examining the settings on the SETTINGS > BREAKER MANAGEMENT > BREAKER HARDWARE screen.

Step 2: Verify the mains breaker has been correctly included in the programmable logic.

Step 3: Verify that the MAINS FAIL TRANSFER parameter is set to ENABLE on the SETTINGS > BREAKER MANAGEMENT > BREAKER HARDWARE screen.

Step 4: Verify that a failure of the mains is detected by the DGC-2020. Check status using the Metering Explorer in BESTCOMSPlus® and verify that the MAINS FAIL status LED is lit when the power on the DGC-2020 bus voltage input is either out of voltage or frequency range. If necessary, modify the settings on the SETTINGS > BREAKER MANAGEMENT > BUS CONDITION DETECTION screen to achieve correct detection.

Step 5: Verify the wiring to the breaker from the DGC-2020. If it seems OK, you can do a manual close and open by modifying the programmable logic. Map some unused outputs to the OPEN and CLOSE outputs from the Gen Breaker Block in the programmable logic. Map a virtual switch to the logic output that would normally be the breaker close output. Map another virtual switch to the logic output that would normally be the breaker close output. Connect with BESTCOMSPlus®, and exercise the virtual switches using the Control panel located in the Metering Explorer. Never turn open and close on at the same time. This could damage the breaker and/or motor operator. If everything is working as expected, restore the logic to its original diagram.

#### Mains Breaker Does Not Close After Mains Returns

Step 1: Verify that a Mains Breaker has been configured by examining the settings on the SETTINGS > BREAKER MANAGEMENT > BREAKER HARDWARE screen.

Step 2: Verify the mains breaker has been correctly included in the programmable logic.

Step 3: Verify that the MAINS FAIL TRANSFER parameter is set to ENABLE on the SETTINGS > BREAKER MANAGEMENT > BREAKER HARDWARE screen.



- Step 4: Verify that stable mains power is detected by the DGC-2020. Check status using the Metering Explorer in BESTCOMSPlus® and verify that the MAINS STABLE status LED is lit when the power on the DGC-2020 bus voltage input is good. If necessary, modify the settings on the SETTINGS > BREAKER MANAGEMENT > BUS CONDITION DETECTION screen to achieve correct detection.
- Step 5: Verify the wiring to the breaker from the DGC-2020. If it seems OK, you can do a manual close and open by modifying the programmable logic. Map some unused outputs to the OPEN and CLOSE outputs from the Gen Breaker Block in the programmable logic. Map a virtual switch to the logic output that would normally be the breaker close output. Map another virtual switch to the logic output that would normally be the breaker close output. Connect with BESTCOMSPlus®, and exercise the virtual switches using the Control panel located in the Metering Explorer. Never turn open and close on at the same time. This could damage the breaker and/or motor operator. If everything is working as expected, restore the logic to its original diagram.

Generator stays in cooling state when attempting to shut down in Auto mode after Cool Down Timer counts down to zero seconds or when No Load Cool Down time is set to zero

If the unit is in AUTO mode and attempting a normal shutdown, it will always go through the cool down state. It will remain there until the cool down timer counts down to zero, and the generator breaker status is open.

If the unit stays in the cool down state after the cool down timer has counted down to zero, it is likely because it has a generator breaker status of closed. This can be checked on the front panel under Metering > Status > Gen Breaker or in BESTCOMSPlus under Metering Explorer > DGC-2020 > Status > Breakers. The generator will not leave the cooling state until it has an open generator breaker status.

If the Generator Breaker Logic Element is present in logic and the Status Input is TRUE, the breaker status will be reported as closed even if that breaker block has a large yellow X through it indicating it is not configured.

## Synchronizer

### Determining if the Synchronizer is Active

- Step 1: Disable the speed trim function.
- Step 2: Initiate a breaker close request by one of the methods listed in Section 3, *Functional Description, Breaker Management*.
- Step 3: Check for raise and/or lower pulses coming from the DGC-2020 if the governor or AVR bias control output type is contact.
- Step 4: Check the governor and/or AVR bias analog outputs on the load share module with a volt meter if the governor or AVR bias control output type is analog.
- Step 5: The voltages or raise/lower pulses should be changing when the synchronizer is active. If there are no raise/lower pulses, or if the analog bias voltages do not change, the synchronizer is not active.

### Synchronizer Not Active

- Step 1: Check style number to verify that the DGC-2020 has the synchronizer option. If the synchronizer option does not exist in the style number, you may contact Basler Electric and request a style number change.
- Step 2: Check status using the Metering Explorer in BESTCOMSPlus® and verify that when the generator is running, the GEN STABLE status LED is lit and the BUS STABLE LED is lit. Adjust the Bus Condition Detection settings accordingly. The synchronizer will never activate if the Bus is Dead or Failed (i.e. not stable).
- Step 3: Check that the DGC-2020 is trying to initiate a breaker closure. To determine the sources of breaker close requests, refer to Section 3, *Functional Description, Breaker Management*.

### Synchronizer Active for a Short Time, Then Stops

- Step 1: Check if a Sync Fail pre-alarm or a Breaker Close Fail pre-alarm is occurring or has occurred. The synchronizer stops acting when such a pre-alarm occurs. Press the *Off* button or the *Reset* button on the DGC-2020 front panel to clear these pre-alarms.
- Step 2: Verify that the Sync Fail Activation delay is sufficiently long to allow the synchronizer to complete the synchronization process.
- Step 3: Verify that the Breaker Close Wait time is not too short causing a pre-alarm to occur before the breaker closes when a breaker close is initiated by the DGC-2020.

### Synchronizer Does Not Lower Engine Speed Allowing Alignment of Bus and Generator

- Step 1: Using the front panel HMI, navigate to the SETTINGS > MULTIGEN MANAGEMENT > GOV ANALOG OUTPUT screen and set SPD RESPONSE to DECREASING.

### Synchronizer Does Not Raise Engine Speed Allowing Alignment of Bus and Generator

- Step 1: Using the front panel HMI, navigate to the SETTINGS > MULTIGEN MANAGEMENT > GOV ANALOG OUTPUT screen and set SPD RESPONSE to DECREASING.

### Synchronizer Does Not Lower the Generator Voltage to Achieve Matching of Bus and Generator Voltages

- Step 1: Navigate to the SETTINGS > MULTIGEN MANAGEMENT > AVR ANALOG OUTPUT screen and set VOLT RESPONSE to DECREASING.

### Synchronizer Does Not Raise Generator Voltage to Achieve Matching of Bus and Generator Voltages

- Step 1: Navigate to the SETTINGS > MULTIGEN MANAGEMENT > AVR ANALOG OUTPUT screen and set VOLT RESPONSE to DECREASING.

## **Speed Bias**

### Engine Speed Does Not Change When Speed Bias Voltage Changes

- Step 1: Verify that the engine speed will change when the speed bias changes. As a test, you can force a voltage on the speed bias output by setting the Min Output Voltage and Max Output Voltage to the same value by navigating to SETTINGS > MULTIGEN MANAGEMENT > GOV ANALOG OUTPUT. If the bias is current based, you can force a fixed current by setting the Governor Output Current Minimum and Maximum to the same value by navigating to SETTINGS > MULTIGEN MANAGEMENT > GOV ANALOG OUTPUT.

If the speed still does not change when varying the bias:

- Verify that the governor or ECU is equipped and configured to accept bias inputs.
- Check connections to verify the wiring to the governor bias is correct.
- If you have an engine with an ECU, check ECU programming to verify it is set up to accept a speed bias input.

### Engine Speed Decreases When Speed Bias is Increased

- Step 1: Navigate to the SETTINGS > MULTIGEN MANAGEMENT > GOV ANALOG OUTPUT screen and set SPD RESPONSE to DECREASING.

### Engine Speed Increases When Speed Bias is Decreased

- Step 1: Navigate to the SETTINGS > MULTIGEN MANAGEMENT > GOV ANALOG OUTPUT screen and set SPD RESPONSE to DECREASING.

## **Voltage Bias**

### Generator Voltage Does Not Change When Voltage Bias Changes

- Step 1: As a test, you can force a voltage on the AVR bias output by setting the Min Output Voltage and Max Output Voltage to the same value by navigating to SETTINGS > MULTIGEN



MANAGEMENT > AVR OUTPUT. If the bias is current based, you can force a fixed current by setting the Min Output Current and Max Output Current to the same value by navigating to SETTINGS > MULTIGEN MANAGEMENT > AVR OUTPUT.

If the voltage still does not change when varying the bias:

- Verify that the AVR is equipped and configured to accept bias inputs.
- Check connections to verify the wiring to the AVR bias is correct.
- If you have digital voltage regulator, verify it set up and programmed to accept a voltage bias input.

#### Generator Voltage Decreases When AVR Speed Bias is Increased

Step 1: Navigate to the SETTINGS > MULTIGEN MANAGEMENT > AVR OUTPUT screen and set VOLT RESPONSE to DECREASING.

#### Generator Voltage Increases When Speed Bias is Decreased

Step 1: Navigate to the SETTINGS > MULTIGEN MANAGEMENT > AVR OUTPUT screen and set VOLT RESPONSE to DECREASING.

### **Load Sharing**

#### Generator Breaker Status is not being received by the DGC-2020

- Step 1: Close the generator breaker. Verify that the DGC-2020 sees the status indicating the generator breaker is closed. This is found on the front panel or in BESTCOMSPlus® under METERING > STATUS > GEN BREAKER.
- Step 2: If the status is not correct, check the digital input status on the DGC-2020 through which the breaker status is fed by examining the input with BESTCOMSPlus® under METERING > INPUTS > CONTACT INPUTS or METERING > INPUTS > REMOTE CONTACT INPUTS.
- Step 3: If the input status is correct, but the Gen Breaker status under METERING→STATUS is not, check the PLC logic, and verify that the Gen Breaker is fed into the DGC-2020 is tied in logic to the *Status* input on the Gen Breaker logic element.
- Step 4: Make any corrections and re-check that the status is received correctly.

#### Generator Runs at Incorrect Speed when Generator Breaker is Closed

- Step 1: Verify generator breaker status is being correctly received as described in *Generator Breaker Status is not being received by the DGC-2020*. If the status is correct, proceed to the steps below.
- Step 2: Check the range set for the LSM-2020 Governor Bias output by examining the Min. and Max. Output voltage or current settings under MULTIGEN MANAGEMENT > GOVERNOR BIAS OUTPUT. Verify that this range is valid for the governor or engine specified.
- Step 3: Perform the tests in Step 1 of *Speed Bias* in this section to verify that setting the output to different values within its range causes engine speed to vary in the desired manner.
- Step 4: Measure the voltage or current on the governor analog bias signal from the LSM-2020. This signal is found on terminals P2-14 (GOV-) and P2-15 (GOV+). If the output is at the midpoint of its range, the generator should run at rated speed.
- Step 5: Check the SPEED BIAS parameter in the LSM DEBUG screen found on the front panel at SETTINGS > SYSTEM PARAMS > REMOTE MODULE SETUP > LSM SETUP > LOAD SHARE DEBUG. Check if the normalized value from the LSM DEBUG screen corresponds to the value measured at LSM-2020 terminals P2-14 (GOV-) and P2-15 (GOV+). If the normalized value is 0.00, the output should be in the midpoint of its range. If the normalized value is 1.00, the output should be in the maximum point of its range. If the normalized value is -1.00, the output should be in the minimum point of its range. Any other values are scaled within the range. If the normalized value and the measured output do not match up, either there are wiring errors, or some external device is driving the governor bias signal at the same time as the LSM-2020. Correct this conflicting situation if it exists.

- Step 6: Check that the signal being measured at the LSM-2020 terminals P2-14 (GOV–) and P2-15 (GOV+) is carried to the actual governor bias inputs on the engine governor. Measurements should be the same as they were on the LSM-2020. If not, correct the wiring errors.
- Step 7: Check if there are any relay contacts in the path between the LSM-2020 governor bias outputs and the engine governor's bias input. Any relay contacts that are used to switch load share lines, governor analog speed bias signals, or voltage regulator analog voltage bias signals must use a relay intended for low voltage, low current applications to preserve signal integrity. Signal relays, not power relays, must be used for this application. Verify the relay contacts are not affecting the signal.
- Step 8: If speed trim is enabled, verify that the speed trim set point is at the correct value for desired operation.

#### Generators Do Not Share Load Equally

- Step 1: Verify that load sharing is enabled in SETTINGS > BIAS CONTROL SETTINGS > GOVERNOR BIAS CONTROL SETTINGS > LOAD CONTROL ENABLED.
- Step 2: Verify generator breaker status is being correctly received as described in *Generator Breaker Status is not being received by the DGC-2020*. If the status is correct, proceed to Step 3.
- Step 3: Check the Load Share Line operating voltage range by examining the Min. and Max. Voltage parameters found in BESTCOMSP<sup>Plus</sup>® under SETTINGS > MULTIGEN MANAGEMENT > LOAD SHARE OUTPUT. The range must be the same for all machines in the load share system.
- Step 4: Measure the Load Share line voltage at terminals P2-5 (LS–) and P2-6 (LS+) on the LSM-2020. The same voltage should be present on each LSM-2020. If not, correct any issues.
- Step 5: Examine the FDBK VOLT on the front panel of the DGC-2020 under SETTINGS > SYSTEM PARAMS > REMOTE MODULE SETUP > LSM SETUP > LSM DEBUG. This is the voltage read from the load share lines by the DGC-2020. Verify this voltage matches the voltage read with a voltmeter across LSM-2020 terminals P2-5 (LS–) and P2-6 (LS+). Verify the same FDBK VOLT is present on all the machines in the load share system. If they are not equal, examine the load share line wiring and correct any issues.
- Step 6: Check if there are any contacts in the load share line path between the LSM-2020s. Any relay contacts that are used to switch load share lines, governor analog bias signals, or voltage regulator analog voltage bias signals must use a relay intended for low voltage, low current applications to preserve signal integrity. Signal relays, not power relays, must be used for this application. Verify the relay contacts are not affecting the signal.
- Step 7: If there are still issues, disconnect the load share line from the LSM-2020. Run the single machine with load, and verify that it loads and unloads correctly, and runs at the correct speed. Repeat for each machine.
- Step 8: Re-attach load share lines to all LSM-2020s that are part of the load sharing system. Run the SINGLE machine with load, and verify that it loads and unloads correctly, and runs at the correct speed. If the machine slows down when the generator breaker is closed, check the load share line voltage. It should be equal, on a normalized basis, to the normalized kW produced by the generator. As an example, if the generator is loaded to 50% capacity, the Load Share Line voltage should be at the midpoint of the range. If it is not, something is driving the load share line that should not be. The single unit should be the only device driving the load share lines.
- Step 9: Disconnect the load share lines from each non-running machine and see if the speed of the running machine is correct. If a particular LSM-2020 on a non-running machine seems to affect the performance of the running machine, that LSM-2020 may be damaged such that the Load Share Line contacts are sticking, causing the LSM-2020 to drive the load share line even though the generator breaker is open. Tap the relays to see if the problem clears up. If so, a faulty LSM-2020 relay is indicated. Replace the LSM-2020, or wire in external contacts to remove the LSM-2020 from the load share system when the generator breaker is closed.

Step 10: If it appears that something is driving the load share line but it is not the LSM-2020 on one of the non-running units, search for an external device that is driving or loading down the load share lines.

Step 11: Repeat the preceding 3 steps for each machine.

#### Load Sharing Works Correctly, but a Single Unit Slows Down

With all units running, load sharing works correctly, but a single unit slows down after the generator breaker is closed.

- Step 1: Disconnect the load share line from the LSM-2020. Run the single machine with load, and verify that it loads and unloads correctly, and runs at the correct speed. Repeat for each machine.
- Step 2: Re-attach load share lines to all LSM-2020s that are part of the load sharing system. Run the SINGLE machine with load, and verify that it loads and unloads correctly, and runs at the correct speed. If the machine slows down when the generator breaker is closed, check the load share line voltage. It should be equal, on a normalized basis, to the normalized kW produced by the generator. As an example, if the generator is loaded to 50% capacity, the Load Share Line voltage should be at the midpoint of the range. If it is not, something is driving the load share line that should not be. The single unit should be the only device driving the load share lines.
- Step 3: Disconnect the load share lines from each non-running machine and see if the speed of the running machine is correct. If a particular LSM-2020 on a non-running machine seems to affect the performance of the running machine, that LSM-2020 may be damaged such that the Load Share Line contacts are sticking, causing the LSM-2020 to drive the load share line even though the generator breaker is open. Tap the relays to see if the problem clears up. If so, a faulty LSM-2020 relay is indicated. Replace the LSM-2020, or wire in external contacts to remove the LSM-2020 from the load share system when the generator breaker is closed.
- Step 4: If it appears that something is driving the load share line but it is not the LSM-2020 on one of the non-running units, search for an external device that is driving or loading down the load share lines.
- Step 5: Repeat the preceding 3 steps for each machine.

### **DGC-2020 Front Panel Debug Screens**

There are several debug screens in the DGC-2020 that can be useful for debugging load sharing issues and I/O module related issues. The following debug screens are available: LOAD SHARE DEBUG, CONTROL DEBUG, CEM DEBUG, and AEM DEBUG.

#### LOAD SHARE DEBUG

This screen is useful for debugging load share related issues, and kW and var control related issues. It gives visibility into the parameters metered and controlled by the LSM-2020.

The LOAD SHARE DEBUG screen is located on the front panel at SETTINGS > SYSTEM PARAMS > REMOTE MODULE SETUP > LSM SETUP > LOAD SHARE DEBUG.

The following parameters are visible on the LOAD SHARE DEBUG screen:

- **FDBK VOLT:** Voltage the LSM-2020 sees on its load share line input. Terminals P2-5 (LS-) and P2-6 (LS+). This measurement is useful for debugging load share issues. Normally, all machines that have their generator breakers closed should measure the same voltage for FDBK VOLT. If this voltage differs, check for wiring errors, or problems with any relay contacts in the load share line wiring. Any relay contacts that are used to switch load share lines, governor analog speed bias signals, or voltage regulator analog bias signals must use a relay intended for low voltage, low current applications to preserve signal integrity. Signal relays, not power relays, must be used for this application.
- **AUX VOLT:** Voltage the LSM-2020 sees on its analog input. Terminals P2-8 (IN-) and P2-9 (V+).

- **AUX CURRENT:** Current the LSM-2020 sees on its analog input. Terminals P2-7 (IN+) and P2-8 (IN-).
- **SPEED BIAS:** This is the normalized value to which the LSM-2020 drives the governor analog bias output. If the value is  $-1.0$ , the output will be driven to the minimum value of the governor bias output range. If the value is  $1.0$ , the output will be driven to the maximum value of the governor bias output range. If the value is  $0.000$ , the output will be driven to the midpoint value (i.e. half way between maximum and minimum values) of the governor bias output range. If the generator breaker is open, or if the generator breaker is closed and speed trim and kW control are disabled, the output from the LSM-2020 will be the midpoint of the range, indicating the generator should run at rated speed. Any relay contacts that are used to switch load share lines, governor analog speed bias signals, or voltage regulator analog voltage bias signals must use a relay intended for low voltage, low current applications to preserve signal integrity. Signal relays, not power relays, must be used for this application.
- **VOLT BIAS:** This is the normalized value to which the LSM-2020 drives the voltage regulator analog bias output. If the value is  $-0.1$ , the output will be driven to the minimum value of the voltage regulator bias output range. If the value is  $1.0$ , the output will be driven to the maximum value of the voltage regulator bias output range. If the value is  $0.00$ , the output will be driven to the midpoint value (i.e. half way between maximum and minimum values) of the voltage regulator bias output range. If the generator breaker is open, voltage trim and kvar control are disabled, so the output from the LSM-2020 will be the midpoint of the range, indicating the voltage regulator should operate at rated voltage. Any relay contacts that are used to switch load share lines, governor analog speed bias signal, or voltage regulator analog voltage bias signals must use a relays intended for low voltage, low current applications to preserve signal integrity. Signal relays, not power relays, must be used for this application.
- **WATT DEMAND:** This is the normalized kW demand requested by the LSM-2020. It is the desired amount of power that the generator produces. It is normalized such that  $1.0$  indicates the full kW capacity of the generator,  $0.5$  indicates 50% of the generator's capacity, etc. When the generator breaker is closed, and the kW controller is enabled, the WATT DEMAND indicates what level of power should be generated. In an island load share system, this will correspond to the value read on the load share lines. If the load share lines are at the 50% point of the load share voltage range, the WATT DEMAND will be  $0.50$ . If the generator breaker is closed, and the PARALLEL TO MAINS logic element is true, the WATT DEMAND will be equal to the base load set point. When the generator breaker is open or the kW controller is disabled, the WATT DEMAND will always be equal to the value calculated from the voltage that the LSM-2020 sees on its load share line.
- **kW TOTAL:** This is the normalized kW being produced by the generator.  $1.0$  represents full machine capacity,  $0.5$  represents 50% of machine capacity, etc.
- **RATED kW:** This is the rated kW of the machine that should be equal to the RATED kW setting under SETTINGS > SYSTEM PARAMS > SYSTEM SETTINGS.
- **var DEMAND:** This is the normalized var demand requested by the LSM-2020. It is the desired amount of var that the generator should produce. It is normalized such that  $1.0$  indicates the full var capacity of the generator,  $0.5$  indicates 50% of the generator's capacity, etc. When the generator breaker is closed, and the var/PF controller is enabled, the var demand indicates what level of reactive power should be generated. If the generator breaker is closed, and the PARALLEL TO MAINS logic element is true, the var DEMAND will be equal to the kvar set point (%) if the controller is in var control mode, or will equal the var value that will maintain the machine Power Factor at the PF set point if the controller is in Power Factor mode. When the generator breaker is open or the var/PF controller is disabled, the var DEMAND will always be  $0.0$ . When running with the generator breaker closed and the PARALLEL TO MAINS logic element is false (i.e. the generators are an islanded system), the var DEMAND will be  $0.0$  as well. The DGC-2020 runs in var DROOP when on an island system.
- **kvar TOTAL:** This is the normalized kvar being produced by the generator.  $1.0$  represents full machine capacity,  $0.5$  represents 50% of machine capacity, etc.

- **RATED kvar:** This is the calculated rated kvar of the machine, calculated from the Rated kW of the machine and the Rated Power Factor of the machine according to  $\text{var} = \sqrt{\text{VA}^2 - \text{WATT}^2}$ .
- **LSM\_RT\_BIN:** LSM-2020 Real Time Binary Points. This is a 32-bit, bit packed number representing the binary points transmitted between the LSM-2020 and DGC-2020. Debug at this level is not necessary.

### CONTROL DEBUG

This screen is useful for debugging load share related issues, and kW and var control related issues. It gives visibility into the states of the kW, kvar, Speed Trim, and Voltage controllers in the DGC-2020.

The CONTROL DEBUG screen is located on the front panel at SETTINGS > BIAS CONTROL > CONTROL DEBUG.

The following parameters are visible on the CONTROL DEBUG screen:

- **kW RAMP:** This indicates the current kW ramp direction as NONE, UP, or DOWN.
- **kW RAMP DEMAND:** This is the normalized kW demand that is ramped from the initial kW loading upon generator breaker closure to the desired kW set point. The rate at which the ramp occurs is set by the Ramp Rate (%) in the Governor Bias Control settings. Note the rate is in terms of percentage of machine capacity, it is not the time to ramp from zero up to the current desired kW level. Thus, at low loading it may appear that the ramp is skipped. If the system is loaded to only 10% and a unit is brought on line, and the ramp rate is 10% per second, it takes only one second to be up to 10% so the ramp time may be quite short.
- **WATT DEMAND:** This is the normalized requested kW demand on the generator. It is normalized such that 1.0 indicates the full kW capacity of the generator, 0.5 indicates 50% of the generator's capacity, etc. When the generator breaker is closed, and the kW controller is enabled, the WATT DEMAND indicates what level of power should be generated. In an island load share system, this will correspond to the normalized value read on the load share lines. If the load share lines are at the 50% point of the load share voltage range, the WATT DEMAND will be 0.5. If the generator breaker is closed, and the PARALLEL TO MAINS logic element is true, the WATT DEMAND will be equal to the base load set point. When the generator breaker is open or the kW controller is disabled, the WATT DEMAND will always be equal to the value calculated from the voltage that the LSM-2020 sees on its load share line.
- **SPEED PID:** This is the output value of the SPEED PID controller. It will normally range between -1.0 and 1.0, and will be zero any time the generator breaker is open, unless synchronization is in progress. If the Speed Trim is enabled, the SPEED PID will be nonzero when the generator breaker is closed if there is any difference between the machine speed and the Speed Trip Set Point parameter.
- **kW PID:** This is the output value of the kW PID controller. It will normally range between -1.0 and 1.0, and will be zero any time the generator breaker is open. If the kW Controller is enabled, the kW PID will be nonzero when the generator breaker is closed if there is any difference between the normalized kW generation and the WATT DEMAND value of the machine. If the kW controller is disabled, the kW PID will always be zero.
- **SPEED ERR:** This is the normalized difference between the measured generator frequency and the Speed Trip Set Point. A value of 1.0 means the difference is equal to the speed trip set point; a value of -1.0 means the difference is equal to the negative of the speed trim set point. When the generator breaker is open, or if Speed Trim is disabled, this will always be 0.000 unless synchronization is in progress. When speed trip is enabled, and the generator breaker is closed, this will typically be 0.000 or some relatively small number and move a small amount above and below 0.000 as the speed trim controller corrects for any speed errors.
- **kW ERROR:** This is the normalized difference between the measured generator kW generation and the WATT DEMAND described above. A value of 1.0 means the difference is equal to the Rated kW of the machine; a value of -1.0 means the difference is equal to the negative of the Rated kW of the machine. When the generator breaker is open, or if kW control is disabled, this will always be 0.000. When kW control is enabled, and the generator breaker is closed, this will



typically be 0.000 or some relatively small number and move a small amount above and below 0.000 as the kW controller corrects for kW errors. If a load is added or dropped from the system, the error will be nonzero until the kW controller brings the kW generation to the desired level.

- **SPEED BIAS:** This is the normalized value to which the governor analog bias output of the LSM-2020 will be driven to accomplish desired kW and speed trim control. It is equal to the sum of the kW PID and the SPEED PID. If the value is  $-1.0$ , the speed bias output will be driven to the minimum value of the governor bias output range. If the value is  $0.00$ , the output will be driven to the midpoint value (i.e. half way between maximum and minimum values) of the governor bias output range. If the generator breaker is open, or if the generator breaker is closed and speed trim and kW control are disabled, the SPEED BIAS value will be  $0.00$ , driving the bias output to the midpoint of the governor bias output range indicating the generator should run at rated speed.
- **PF SETPOINT:** This is the power factor setpoint that will be used by the kvar controller when it is in the Power Factor regulation mode.
- **kvar RAMP:** This indicates the current kvar ramp direction as NONE, UP, or DOWN.
- **var RAMP DEMAND:** This is the normalized var demand that is ramped from the initial var loading upon generator breaker closure to the desired var output. The rate at which the ramp occurs is set by the Ramp Rate (%) parameter in the AVR Bias Control settings. Note the rate is in terms of percentage of machine capacity, it is not the time to ramp from zero up to the current desired var level. Thus, at low var loading it may appear that the ramp is skipped. If the system is loaded to only 10% and a unit is brought on line, and the load rate is 10% per second, it takes only one second to be up to 10% so the ramp time may be short.
- **var DEMAND:** This is the normalized requested kvar demand on the generator. It is normalized such that 1.0 indicates the full kvar capacity of the generator, 0.5 indicates 50% of the generator's capacity, etc. When the generator breaker is closed, and the var/PF controller is enabled, the var DEMAND indicates what level of reactive power should be generated. In an island load share system, this will be determined by the droop characteristics set by the Droop Percentage and Voltage Droop Gain parameters. If the generator breaker is closed, and the PARALLEL TO MAINS logic element is true, the var DEMAND will be equal to the kvar set point if the var/PF controller is in var mode or it will be calculated from the amount of kW being generated to maintain desired machine Power Factor when the var/PF controller is in Power Factor control mode. When the generator breaker is open, or the var/PF controller is disabled, the var DEMAND will be zero.
- **VOLT PID:** This is the current output value of the Voltage PID controller. It will normally range between  $-1.0$  and  $1.0$ , and will generally be zero at all times unless synchronization is in progress.
- **kvar PID:** This is the current output value of the kvar PID controller. It will normally range between  $-1.0$  and  $1.0$ , and will be zero any time the generator breaker is open. If the var/PF controller is enabled, the kvar PID will be nonzero when the generator breaker is closed if there is any difference between the normalized kvar generation and the var DEMAND value of the machine. If the var/PF controller is disabled, the kvar PID will always be zero.
- **VOLT ERROR:** This is the normalized difference between the measured generator voltage and the voltage to which the DGC-2020 is trying to synchronize. It will be  $0.00$  at all times except when the DGC-2020 is trying to synchronize its generator inputs to its bus input. When synchronizing, this will typically be  $0.000$  or some relatively small number and move a small amount above and below  $0.000$  as voltage controller corrects for any voltage errors.
- **kvar ERROR:** This is the normalized difference between the measured generator kvar generation and the var DEMAND described above. A value of  $1.0$  means the difference is equal to the Rated kvar of the machine; a value of  $-1.0$  means the difference is equal to the negative of the Rated kvar of the machine. When the generator breaker is open, or if var/PF controller is disabled, this will always be  $0.000$ . When var/PF control is enabled, and the generator breaker is closed, this will typically be  $0.000$  or some relatively small number and move a small amount above and below  $0.000$  as the var/PF controller corrects for var errors. If a reactive load is added or dropped

from the system, the error will be nonzero until the var/PF controller brings the var generation to the desired level.

- **VOLT BIAS:** This is the normalized value to which the voltage regulator analog bias output of the LSM-2020 will be driven to accomplish desired kvar and Voltage control. It is equal to the sum of the VOLT PID and the kvar PID. If the value is  $-1.0$ , the voltage bias output will be driven to the minimum value of the voltage regulator analog bias output range. If the value is  $1.0$ , the output will be driven to the maximum value of the voltage regulator analog bias output range. If the value is  $0.000$ , the output will be driven to the midpoint value (i.e. half way between maximum and minimum values) of the voltage regulator analog bias output range. If the generator breaker is open, or if the generator breaker is closed and kvar control is disabled, the VOLT BIAS value will be  $0.00$ , driving the bias output to the midpoint of the voltage regulator analog bias output range indicating the voltage regulator should operate the generator at rated voltage.

### CEM DEBUG

This screen shows the binary data that is being sent between the CEM-2020 (Contact Expansion Module) and the DGC-2020.

The CEM DEBUG screen is located on the front panel at **SETTINGS > SYSTEM PARAMS > REMOTE MODULE SETUP > CEM SETUP > CEM DEBUG MENU**.

The following parameters are visible on the CEM DEBUG screen:

- **DGC TO CEM BP:** DGC-2020 to CEM-2020 Binary Points. This is the status of the CEM-2020 output relays being transmitted from the DGC-2020 to the CEM-2020. This is a 32-bit, bit packed number representing the desired states of the CEM-2020 outputs. The left most bit is the first output, etc.
- **CEM TO DGC BP:** CEM-2020 to DGC-2020 Binary Points. This is the status of the CEM-2020 inputs being transmitted from the CEM-2020 to the DGC-2020. This is a 32-bit, bit packed number representing the metered states of the CEM-2020 inputs. The left most bit is the first input, etc.

### AEM DEBUG

This screen shows the binary data that is being sent between the AEM-2020 (Analog Expansion Module) and the DGC-2020.

The AEM DEBUG screen is located on the front panel at **SETTINGS > SYSTEM PARAMS > REMOTE MODULE SETUP > AEM SETUP > AEM DEBUG MENU**.

The following parameters are visible on the AEM DEBUG screen:

- **DGC TO AEM BP:** DGC-2020 to AEM-2020 Binary Points. This is a 32-bit, bit packed number representing the binary points transmitted from the DGC-2020 to the AEM-2020. Debug at this level is not necessary.
- **AEM TO DGC BP:** AEM-2020 to DGC-2020 Binary Points. This is a 32-bit, bit packed number representing the binary points transmitted from the AEM-2020 to the DGC-2020. Debug at this level is not necessary.
- **ANALOG INPUTS:** For each analog input, the raw metered input value is displayed, and the scaled metered input value. This is useful to check if the AEM-2020 is seeing a valid raw input value (i.e. the raw 0 to 10 volt voltage input or 4 to 20 ma current input). The scaled value is the raw input scaled up to the range specified by the Parameter Minimum and Parameter Maximum value parameters in the Remote Analog Input settings.
- **THERMAL INPUTS:** For each RTD input, the resistance in ohms measured by the RTD input is displayed as well as the temperature calculated from the resistance measurement. For each thermocouple input, the voltage in millivolts is displayed as well as the temperature calculated from the resistance measurement.





## 9 • LSM-2020 (Load Share Module)

The LSM-2020 is a remote auxiliary device that interfaces to the DGC-2020 and provides analog outputs to the power system in the form of analog bias signals to the voltage regulator and speed governor. When the breaker is closed and Load Sharing is enabled, the LSM-2020 will share real power load proportionally with the other generators on the Analog or Ethernet Load Share Lines.

Refer to Section 7, *Setup*, for instructions on setting up a DGC-2020 and LSM-2020 for a load sharing and kW control application.

### Features

LSM-2020s have the following features:

- A Ramping Function to load and unload generators smoothly
- Communications via Ethernet or CAN bus
- Demand Start/Stop and Generator Sequencing
- kW Load/var Control
- kW Load/var Sharing via analog and Ethernet load share lines

### Specifications

#### Operating Power

|                           |                                                                          |
|---------------------------|--------------------------------------------------------------------------|
| Nominal .....             | 12 or 24 Vdc                                                             |
| Range.....                | 8 to 32 Vdc (Withstands cranking ride-through down to 6 Vdc for 500 ms.) |
| Maximum Consumption ..... | 4 W                                                                      |
| Terminals.....            | P2-3 (–), P2-2 (+), P2-1 (chassis ground)                                |

#### Analog Inputs

|                            |                                   |
|----------------------------|-----------------------------------|
| Voltage Configuration..... | 0-10 Vdc                          |
| Current Configuration..... | 4-20 mAdc                         |
| Terminals.....             | P2-7 (IN+), P2-8 (IN–), P2-9 (V+) |

#### Burden

|                    |                        |
|--------------------|------------------------|
| 4 to 20 mAdc ..... | 470 $\Omega$ maximum   |
| $\pm 10$ Vdc ..... | 9.65k $\Omega$ minimum |

#### Analog Outputs

|                   |                                                                                     |
|-------------------|-------------------------------------------------------------------------------------|
| Burden Data ..... | 4-20 mAdc = 500 $\Omega$ maximum burden, $\pm 10$ Vdc = 667 $\Omega$ minimum burden |
|-------------------|-------------------------------------------------------------------------------------|

#### Voltage Regulator Bias Output

|                                                                                    |                                          |
|------------------------------------------------------------------------------------|------------------------------------------|
| 4-20 mA or $\pm 10$ Vdc isolated output signal. (Selectable in increments of 0.1.) |                                          |
| Isolated to 1,500 Vdc between outputs and ground.                                  |                                          |
| Terminals.....                                                                     | P2-18 (AVR+), P2-17 (AVR–), P2-16 (AVR') |

#### Governor Bias Output

4-20 mA,  $\pm 10$  Vdc isolated output signal. (Selectable in increments of 0.1.)

Isolated to 500 Vdc between outputs and ground.

Terminals.....P2-15 (GOV+), P2-14 (GOV–), P2-13 (GOV')

**Load Share Line Output**

0-10 Vdc isolated output signal. (Selectable in increments of 0.1 Vdc.

Isolated to 500 Vdc between outputs and ground.

Terminals.....P2-6 (LS+), P2-5 (LS–), P2-4 (LS')

**Communication Interface****CAN Bus**

Differential Bus Voltage.....1.5 to 3 Vdc

Maximum Voltage .....–32 to +32 Vdc with respect to negative battery terminal

Communication Rate.....250 kb/s

Terminals.....P2-12 (low), P2-11 (high), and P2-10 (shield)

**Ethernet**

Type .....10/100BASE-T

Industrial Ethernet devices designed to comply with IEC 61000-4 series of specifications are recommended.

**Type Tests****Shock**

Withstands 15 G in 3 perpendicular planes.

**Vibration**

Swept over the following ranges for 12 sweeps in each of three mutually perpendicular planes with each 15-minute sweep consisting of the following:

5 to 29 to 5 Hz.....1.5 G peak for 5 min.

29 to 52 to 29 Hz.....0.036" Double Amplitude for 2.5 min.

52 to 500 to 52 Hz.....5 G peak for 7.5 min.

**Ignition System**

Tested in closed proximity to an unshielded, unsuppressed Altronic DISN 800 ignition system.

**HALT (Highly Accelerated Life Testing)**

HALT is used by Basler Electric to prove that our products will provide the user with many years of reliable service. HALT subjects the device to extremes in temperature, shock, and vibration to simulate years of operation, but in a much shorter period. HALT allows Basler Electric to evaluate all possible design elements that will add to the life of this device. As an example of some of the extreme testing conditions, the LSM-2020 was subjected to temperature tests (tested over a temperature range of –80°C to +130°C), vibration tests (of 5 to 50 G at +25°C), and temperature/vibration tests (tested at 10 to 20 G over a temperature range of –60°C to +100°C). Combined temperature and vibration testing at these extremes proves that the LSM-2020 is expected to provide long-term operation in a rugged environment. Note that the vibration and temperature extremes listed in this paragraph are specific to HALT and do not reflect recommended operation levels. These operational ratings are included in this section.

**Environment**

Temperature

Operating .....–40 to +70°C (–40 to +158°F)

Storage.....–40 to +85°C (–40 to +185°F)

Humidity .....IEC 68-2-38

## Agency Information

### UL Certification

The LSM-2020 is a Recognized Component applicable to Canadian and US safety standards and requirements by UL.

Standards used for evaluation:

File E97035 CCN# FTPM2 / FTPM8

- UL 6200
- CSA Standard C22.2 No.14

### EU Compliance

This product has been evaluated and complies with the requirements set forth by the EU legislation:

- Low Voltage Directive (LVD) – 2014/35/EU
- Electromagnetic Compatibility (EMC) – 2014/30/EU

Harmonized Standards used for evaluation:

- EN 50178: *Electronic Equipment for use in Power Installations*
- EN 61000-6-4: *Electromagnetic Compatibility (EMC), Generic Standards, Emission Standard for Industrial Environments*
- EN 61000-6-2: *Electromagnetic Compatibility (EMC), Generic Standards, Immunity for Industrial Environments*

### NFPA Compliance

Complies with NFPA Standard 110, *Standard for Emergency and Standby Power*.

## Physical

Weight ..... 1.45 lb (657 g)

Dimensions..... See *Installation* later in this section.

## Functional Description

### Analog Inputs

The analog inputs can be configured to accept voltage or current. These inputs can be used for var, PF, or kW control. The inputs are configured by using the Settings Explorer in BESTCOMSPlus® to open the *Programmable Input, LSM Input screen*. To set the LSM Analog Input as the control source, use the Settings Explorer in BESTCOMSPlus® to open the *Bias Control Settings* screens.

### Analog Outputs

There are three analog outputs: AVR control, GOV control, and Load Share Line. Each output is described in the following paragraphs.

#### Output for Voltage Regulator Control

The AVR output provides remote control of the generator voltage setpoint.

#### Output for Governor Control

The GOV output provides remote control of the generator speed setpoint.

#### Load Share Line Output

The generator uses the measured LS (Load Share Line) output to calculate per unitized average load level, and uses that as the set point for its kW controller.

## Generator Sequencing

Machines can be added or removed from the power system based on load demand. The following criteria should be considered before adding or removing a machine:

- Machine Priority
- Engine Run Time
- Machine Size
- kW% of the load/demand
- Out of Service machines

## Communications

The LSM-2020 communication ports include CAN terminals and an Ethernet port.

### CAN Bus

A Control Area Network (CAN) is a standard interface that enables communication between the LSM-2020 and the DGC-2020.

### Ethernet Port

An Ethernet port provides both inter-genset communications and remote communications between a PC and the LSM-2020 or connected DGC-2020 via BESTCOMSPlus®. Ethernet communication between LSM-2020s allows for generator sequencing, load sharing, and kvar sharing on an islanded system. Firmware updates to the LSM-2020 are made through the Ethernet port. Firmware updates to the DGC-2020 are only available through the USB port of the DGC-2020. Refer to Section 4, *BESTCOMSPlus® Software*, for information on configuring Ethernet communication and updating firmware in the DGC-2020.

Industrial Ethernet devices designed to comply with IEC 61000-4 series of specifications are recommended.

To achieve Ethernet var sharing among machines in an islanded system, the following conditions must be met:

- Var/PF control must be enabled on the AVR Bias Control Settings screen
- A connection between the DGC-2020 and LSM-2020 must be established
- LSM-2020s must be connected to each other via Ethernet on the inter-genset communications network

## Status LED

This red LED flashes to indicate that the LSM-2020 is powered up and functioning properly. The LED lights solid during power up. When the power-up sequence is complete, this LED flashes. If the LED does not flash after power up, contact Basler Electric.

## ***BESTCOMSPlus® Software***

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BESTCOMSPlus® provides the user with a point-and-click means to set and monitor the LSM-2020. Installation and operation of BESTCOMSPlus® is described in Section 4, *BESTCOMSPlus® Software*.

### **LSM-2020 Plugin for BESTCOMSPlus®**

The setup utility that installs BESTCOMSPlus® on your PC also installs the LSM-2020 plug-in. Refer to Section 4, *BESTCOMSPlus® Software*, for information on activating the plugin.

The LSM-2020 plugin is used to set device security and view device information such as firmware version and serial number.

LSM-2020 operational settings are found in the DGC-2020 plugin for BESTCOMSPlus®. Refer to Section 4, *BESTCOMSPlus® Software*, for a detailed description of each setting.

The LSM-2020 plugin has two screens: *Device Info* and *Device Security Setup*.

### Device Info

Information about a LSM-2020 communicating with BESTCOMSPlus® can be obtained on the Device Info tab of BESTCOMSPlus®.

Select application version when configuring LSM-2020 settings off-line. When on-line, read-only information includes application version, boot code version, application build, serial number, application part number, and model number.

BESTCOMSPlus® device information values and settings are illustrated in Figure 9-1.

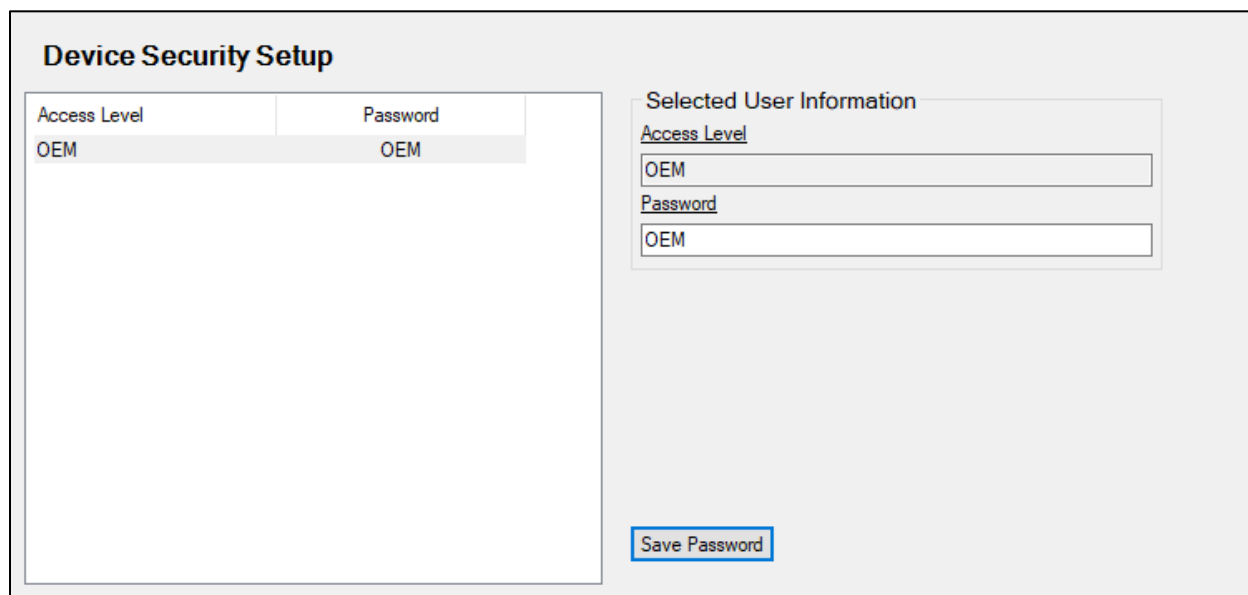
**Figure 9-1. Device Info Screen**

### Device Security Setup

Password protection guards against unauthorized changing of LSM-2020 communication settings. Passwords are case sensitive. *OEM Access* is the only level of password protection available. This password level allows access to all settings made using the LSM-2020 plugin for BESTCOMSPlus®. The default, OEM-access password is **OEM**.

Passwords can be changed only after communication between the PC and LSM-2020 is established. A change to the password is made through the *Device Security Setup* screen. Use the Settings Explorer in BESTCOMSPlus® to open the *General Settings, Device Security Setup* screen. See Figure 9-2.

A password is changed by clicking on the access level, entering the new password, and then clicking on the *Save Password* button.



The screenshot shows the 'Device Security Setup' interface. On the left, there is a table with two columns: 'Access Level' and 'Password'. The first row contains the value 'OEM' in both columns. Below this table is a large empty rectangular area. To the right of the table, under the heading 'Selected User Information', there are two input fields. The first field is labeled 'Access Level' and contains the text 'OEM'. The second field is labeled 'Password' and also contains the text 'OEM'. At the bottom right of the interface is a button labeled 'Save Password'.

| Access Level | Password |
|--------------|----------|
| OEM          | OEM      |

Selected User Information

Access Level  
OEM

Password  
OEM

Save Password

Figure 9-2. Device Security Setup Screen

## Installation

LSM-2020's are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a module, check the part number against the requisition and packing list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify the Basler Electric regional sales office or your sales representative.

If the device is not installed immediately, store it in the original shipping package in a moisture- and dust-free environment.

## Mounting

LSM-2020's are contained in a potted plastic case and may be mounted in any convenient position. The construction of an LSM-2020 is durable enough to mount directly on a genset using ¼-inch hardware. Hardware selection should be based on any expected shipping/transportation and operating conditions. The torque applied to the mounting hardware should not exceed 65 in-lb (7.34 N•m).

See Figure 9-3 for LSM-2020 overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.

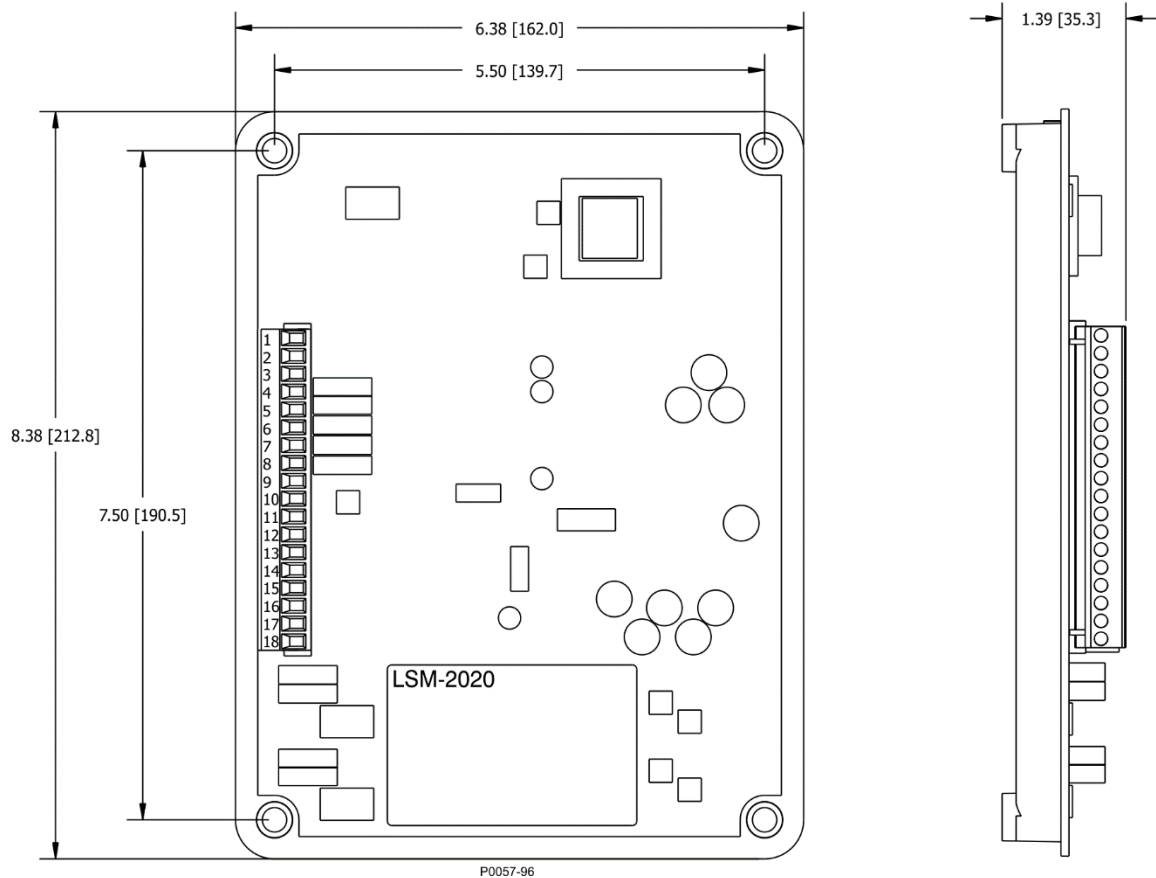


Figure 9-3. LSM-2020 Overall Dimensions

## Connections

LSM-2020 connections are dependent on the application. Incorrect wiring may result in damage to the module.

### Notes

Operating power from the battery must be of the correct polarity. Although reverse polarity will not cause damage, the LSM-2020 will not operate.

Be sure that the LSM-2020 is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the chassis ground terminal on the module.

### Terminations

There are two types of interface terminals: plug-in connectors with screw-down compression terminals and an RJ-45 socket.

The RJ-45 socket mates with a standard Ethernet cable and provides local communication between the LSM-2020 and a PC running BESTCOMSP<sup>Plus</sup>® software. This allows for setting of the LSM-2020 and for the DGC-2020 that the module is connected to.

LSM-2020 connections are made with an 18-position connector with screw-down compression terminals. This connector plugs into a header on the LSM-2020. The connector and header have a dovetailed edge that ensures proper connector orientation. Also, the connector and header are uniquely keyed to ensure that the connector mates only with the correct header.

### Caution

By mating conductors of dissimilar metals, galvanic corrosion could occur which may lead to signal loss.

Connectors and headers may contain tin- or gold-plated conductors. Tin-plated conductors are housed in a black plastic casing and gold-plated conductors are housed in an orange plastic casing. Mate connectors to headers of the same color only.

Connector screw terminals accept a maximum wire size of 12 AWG. Maximum screw torque is 4 in-lb (0.45 N•m).

### Operating Power

The LSM-2020 operating power input accepts either 12 Vdc or 24 Vdc and tolerates voltage over the range of 6 to 32 Vdc. Operating power must be of the correct polarity. Although reverse polarity will not cause damage, the LSM-2020 will not operate. Operating power terminals are listed in Table 9-1.

It is recommended that a fuse be added for additional protection for the wiring to the battery input of the LSM-2020. A Bussmann ABC-7 fuse or equivalent is recommended.

**Table 9-1. Operating Power Terminals**

| Terminal       | Description                            |
|----------------|----------------------------------------|
| P2-1 (CHASSIS) | Chassis ground connection              |
| P2-2 (BATT+)   | Positive side of operating power input |
| P2-3 (BATT–)   | Negative side of operating power input |

### Note

To comply with the requirements of EN 55011 (Radiated Emission), wiring connected to LSM-2020 terminals BATT+ and BATT– must be shielded. Shielding must be grounded at one end.

### Analog Inputs

These inputs can be used for var, PF, or kW control. Analog input terminals are listed in Table 9-2. Current input connections are shown in Figures 9-4 through 9-6 and voltage input connections are shown in Figure 9-7.

**Table 9-2. Analog Input Terminals**

| Terminal   | Description                                    |
|------------|------------------------------------------------|
| P2-9 (V+)  | Voltage input used for var, PF, or kW control. |
| P2-8 (IN–) | Common for voltage or current.                 |
| P2-7 (I+)  | Current input used for var, PF, or kW control. |



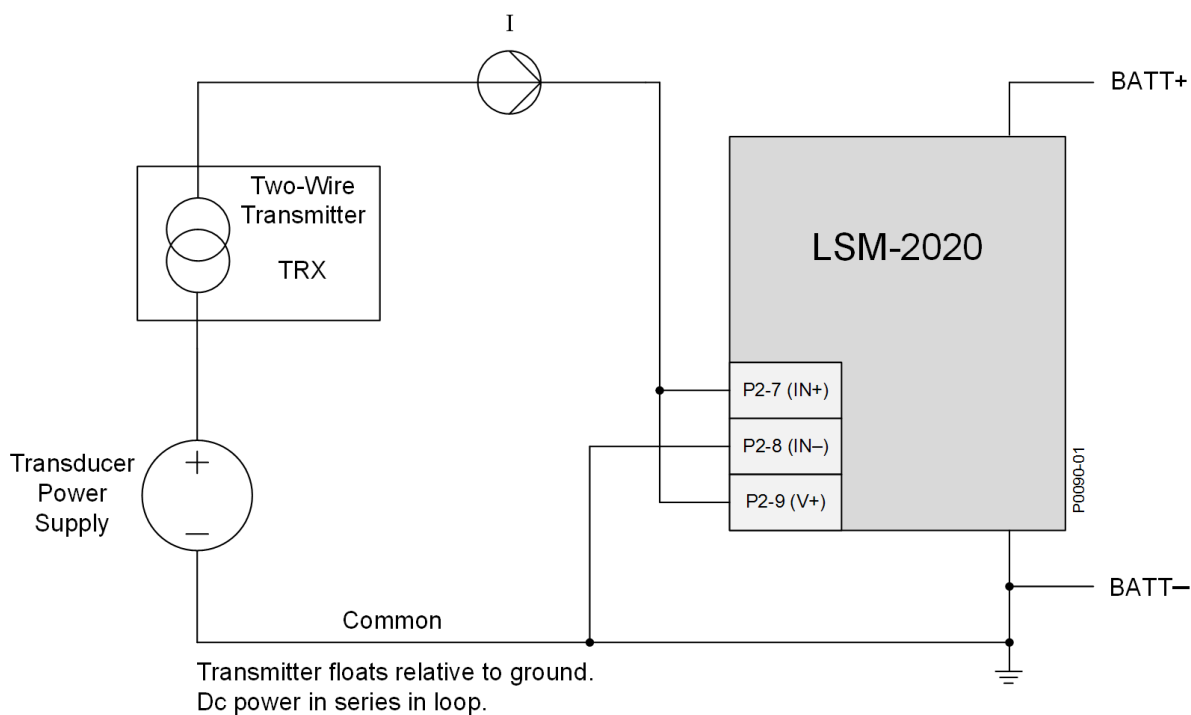


**Figure 9-4. Analog Inputs - Current Input Connections, Type II 2-Wire Circuit**

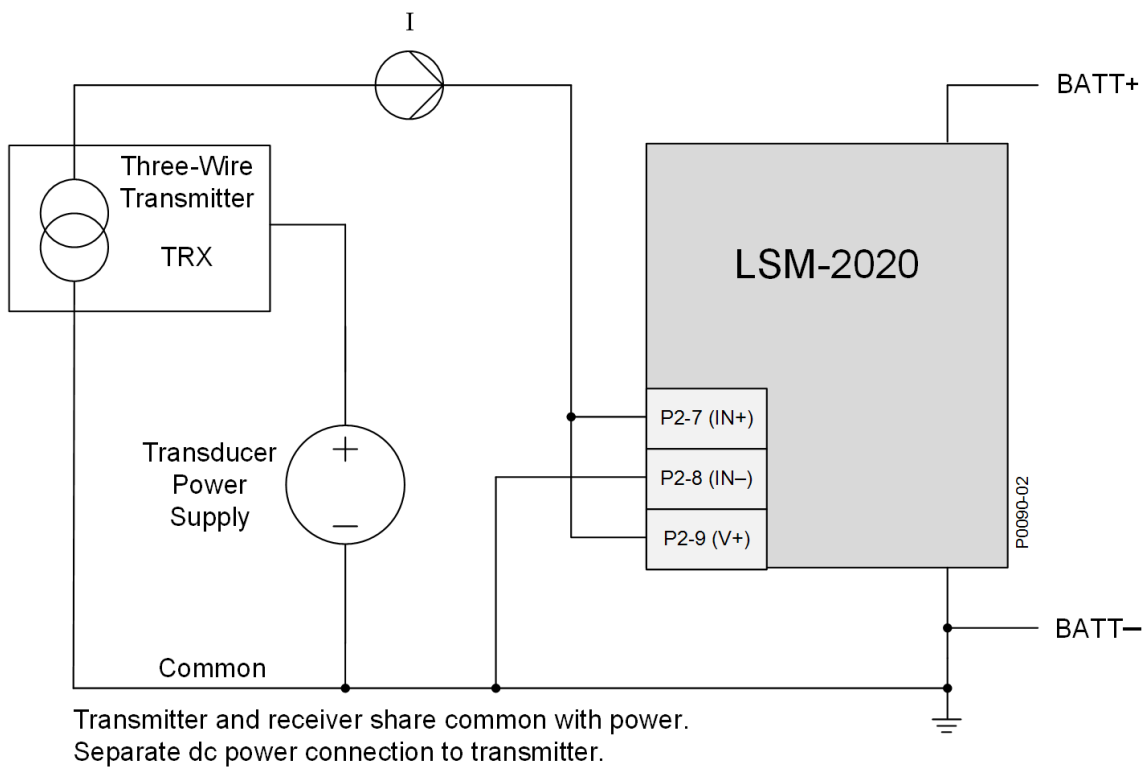


**Figure 9-5. Analog Inputs - Current Input Connections, Type III 2-Wire Circuit**

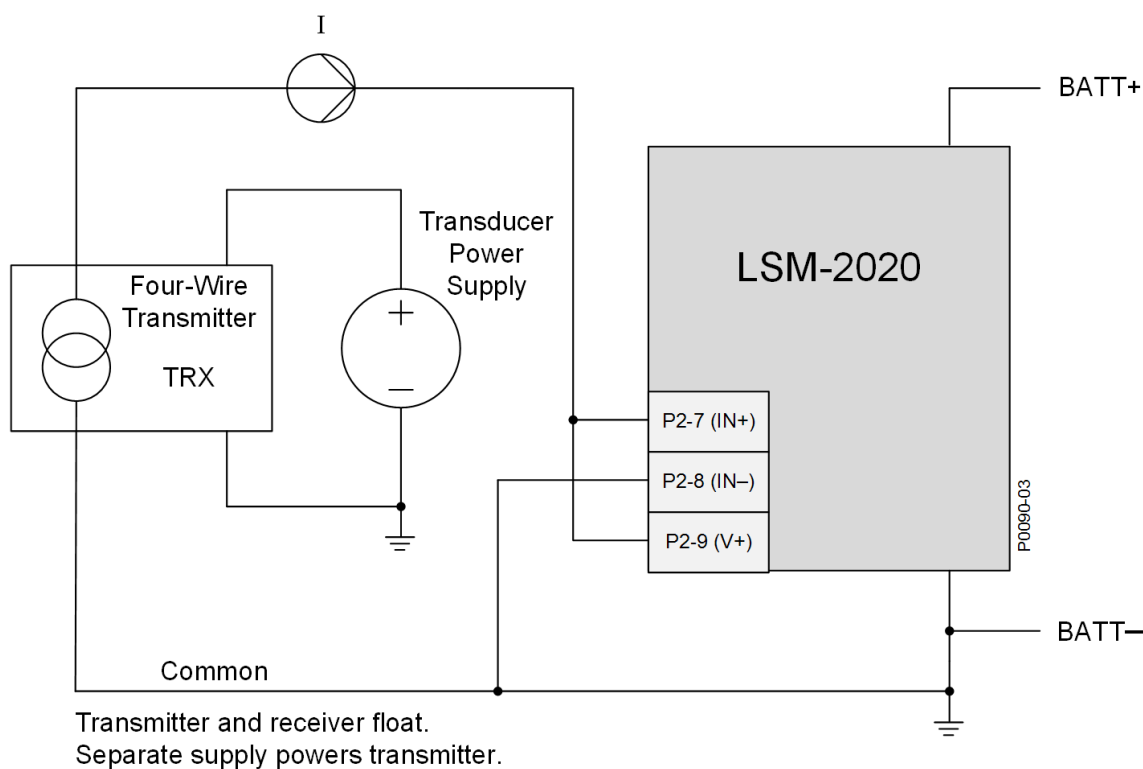


**Figure 9-6. Analog Inputs - Current Input Connections, Type IV 2-Wire Circuit**

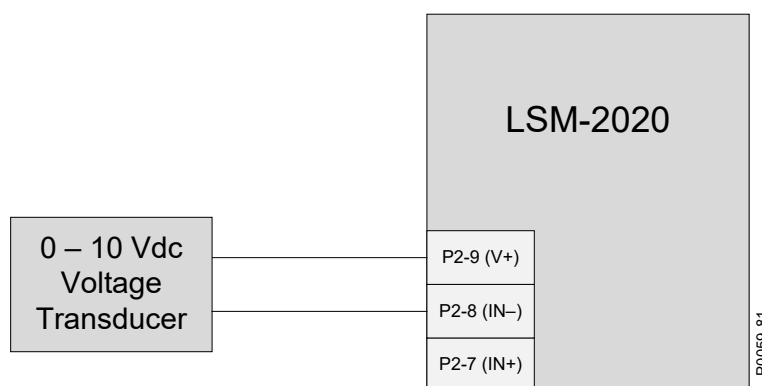


**Figure 9-7. Analog Inputs - Voltage Input Connections**

### Analog Outputs

The LSM-2020 has three sets of analog output contacts: AVR control, GOV control, and Load Share Line. The AVR control output contacts provide remote control of the generator voltage setpoint. The GOV control output contacts provide remote control of the generator speed (RPM) setpoint. The generator uses the measured LS (Load Share Line) output to calculate the per unitized average load level, and uses that as the set point for its kW controller. Analog input terminals are listed in Table 9-3.

### Note

To comply with the requirements of EN 61000-4-6 (RF Conducted Immunity), wiring connected to LSM-2020 terminals GOV+ and GOV– must be routed away from the LSM-2020 unit, making no contact with any part of it except the GOV+ and GOV– terminals. If this is not possible, the wiring must either be shielded or twisted pair. If shielding is used, it is not required to be grounded. If the wires are a twisted pair, two turns per inch are required.

**Table 9-3. Analog Output Terminals**

| Terminal     | Description                                             |
|--------------|---------------------------------------------------------|
| P2-18 (AVR+) | AVR control output positive                             |
| P2-17 (AVR–) | AVR control output negative                             |
| P2-16 (AVR') | Provides additional landing point for external resistor |
| P2-15 (GOV+) | GOV control output positive                             |
| P2-14 (GOV–) | GOV control output negative                             |
| P2-13 (GOV') | Provides additional landing point for external resistor |
| P2-6 (LS+)   | Load share line positive                                |
| P2-5 (LS–)   | Load share line negative                                |
| P2-4 (LS')   | Provides additional landing point for external resistor |

### CAN Bus Interface

These terminals provide communication using the SAE J1939 protocol and provide high-speed communication between the LSM-2020 and the DGC-2020. Connections between the LSM-2020 and DGC-2020 should be made with twisted-pair, shielded cable. CAN Bus interface terminals are listed in Table 9-4. Refer to Figure 9-8 and Figure 9-9.

**Table 9-4. CAN Bus Interface Terminals**

| Terminal       | Description                       |
|----------------|-----------------------------------|
| P2-12 (CAN L)  | CAN low connection (green wire)   |
| P2-11 (CAN H)  | CAN high connection (yellow wire) |
| P2-10 (SHIELD) | CAN drain connection              |

### Notes

1. If the LSM-2020 is providing one end of the J1939 bus, a 120-ohm, ½ watt terminating resistor should be installed across terminals P2-12 (CANL) and P2-11 (CANH).
2. If the LSM-2020 is not part of the J1939 bus, the stub connecting the LSM-2020 to the bus should not exceed 914 mm (3 ft) in length.
3. The maximum bus length, not including stubs, is 40 m (131 ft).
4. The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the LSM-2020.

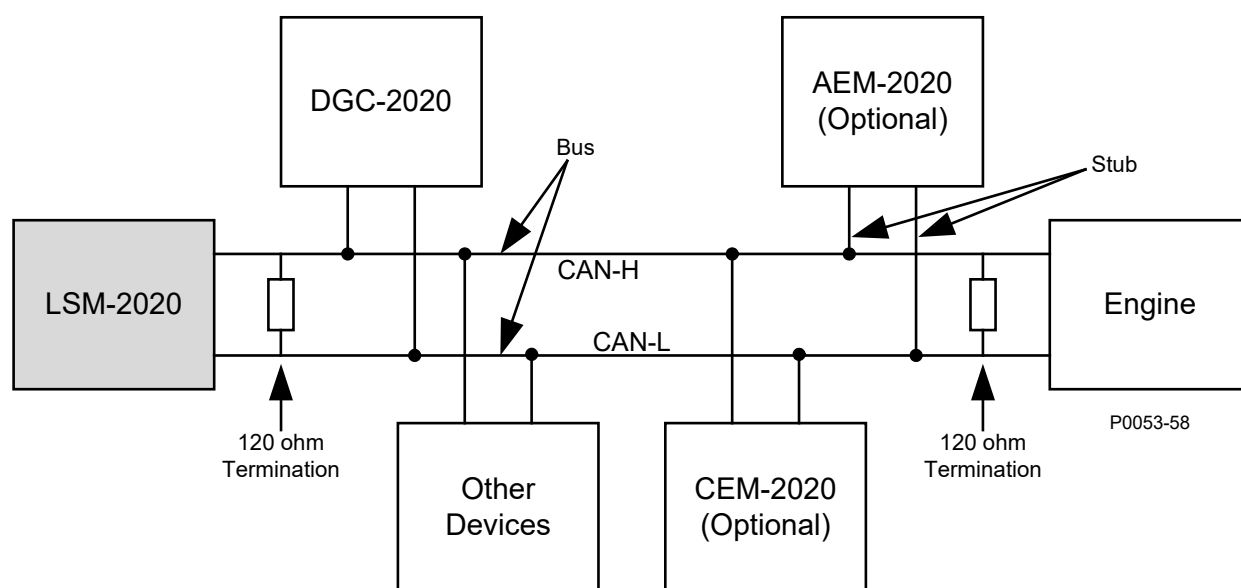


Figure 9-8. CAN Bus Interface with LSM-2020 providing One End of the Bus

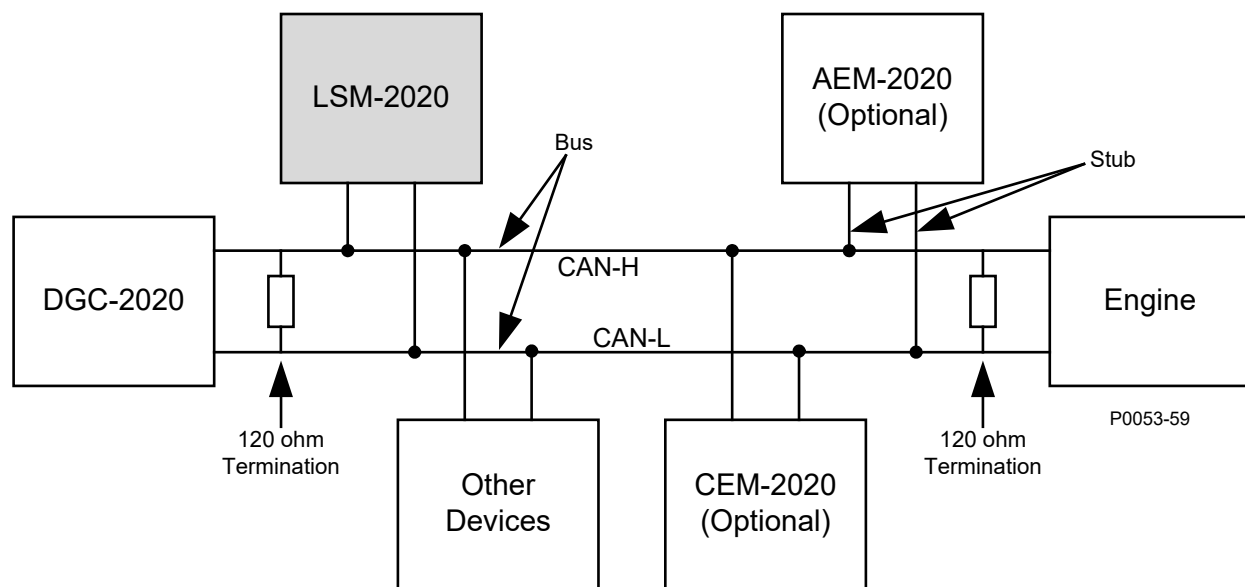


**Figure 9-9. CAN Bus Interface with DGC-2020 providing One End of the Bus**

### Ethernet Port

The LSM-2020 has Ethernet capability. The LSM-2020 connects to a PC through a RJ-45 jack (J3).

Industrial Ethernet devices designed to comply with IEC 61000-4 series of specifications are recommended.

### **Connections for Typical Applications**

Figure 9-10 illustrates typical LSM-2020 connections. Figure 9-11 illustrates a typical interconnection of three systems tied together via separate Load Share Modules.

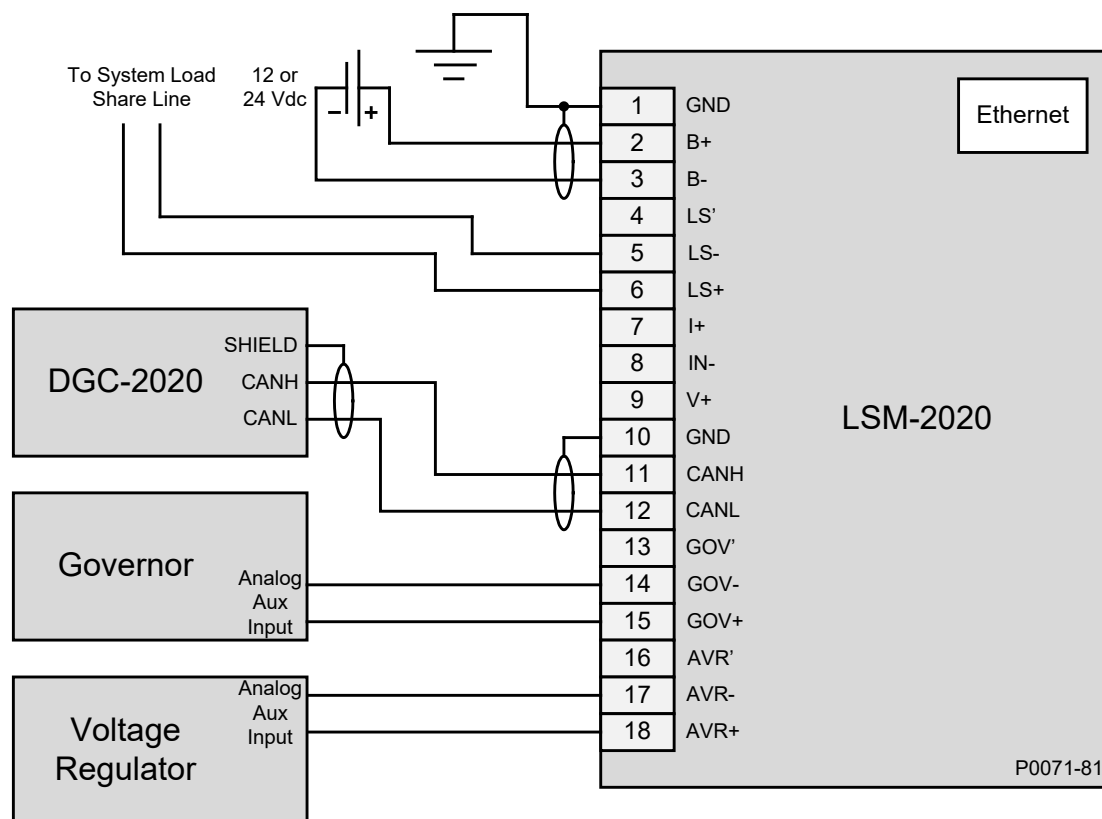


Figure 9-10. Typical LSM-2020 Connections

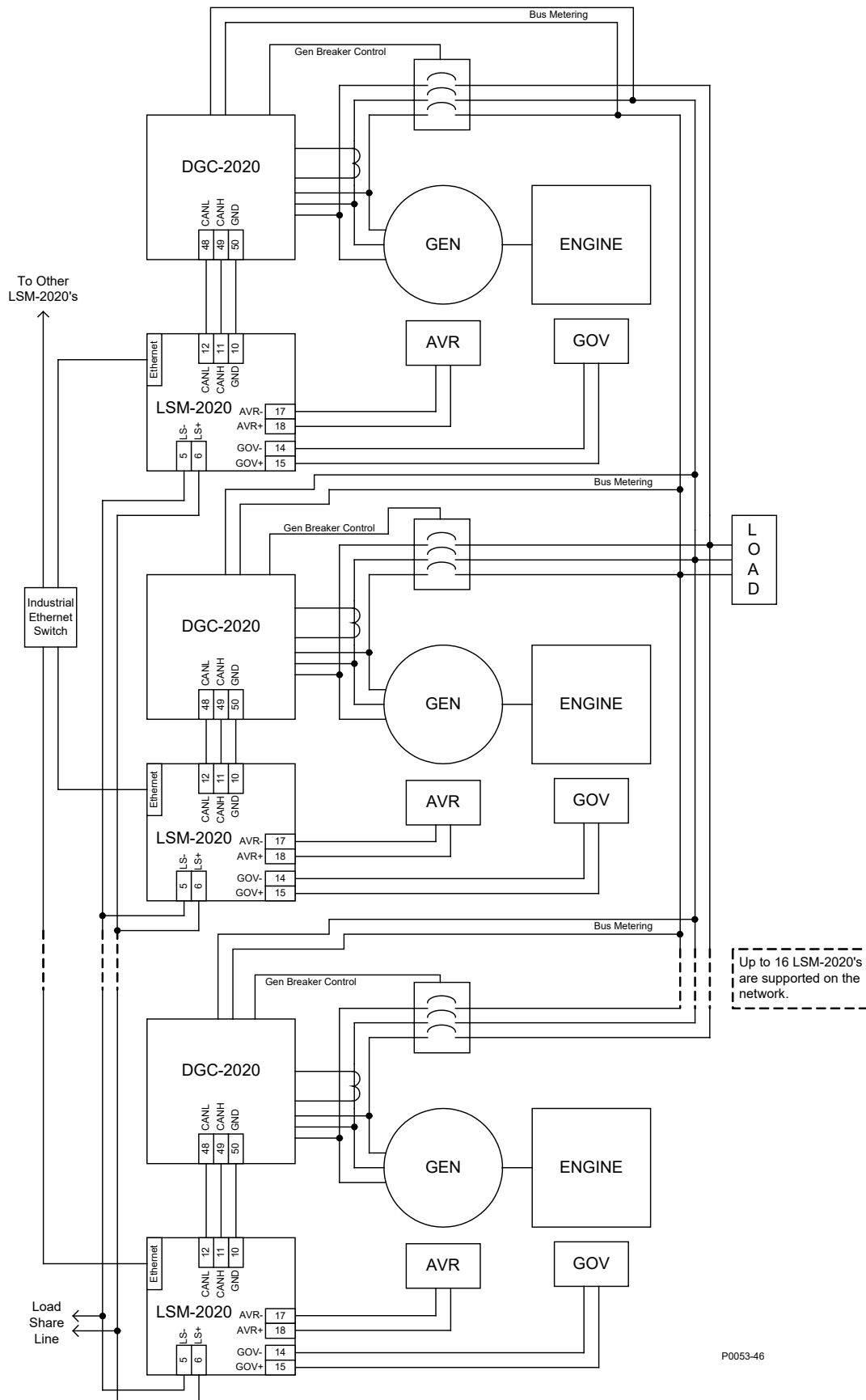


Figure 9-11. Typical LSM-2020 Interconnection Diagram

## Connections using AVR', GOV', and LS'

Additional terminals provide a landing point to add series resistance to the GOV, AVR, and LS analog outputs. These terminals are not internally connected to the LSM-2020. Figure 9-12 illustrates connections using the additional AVR' terminal as a landing point.

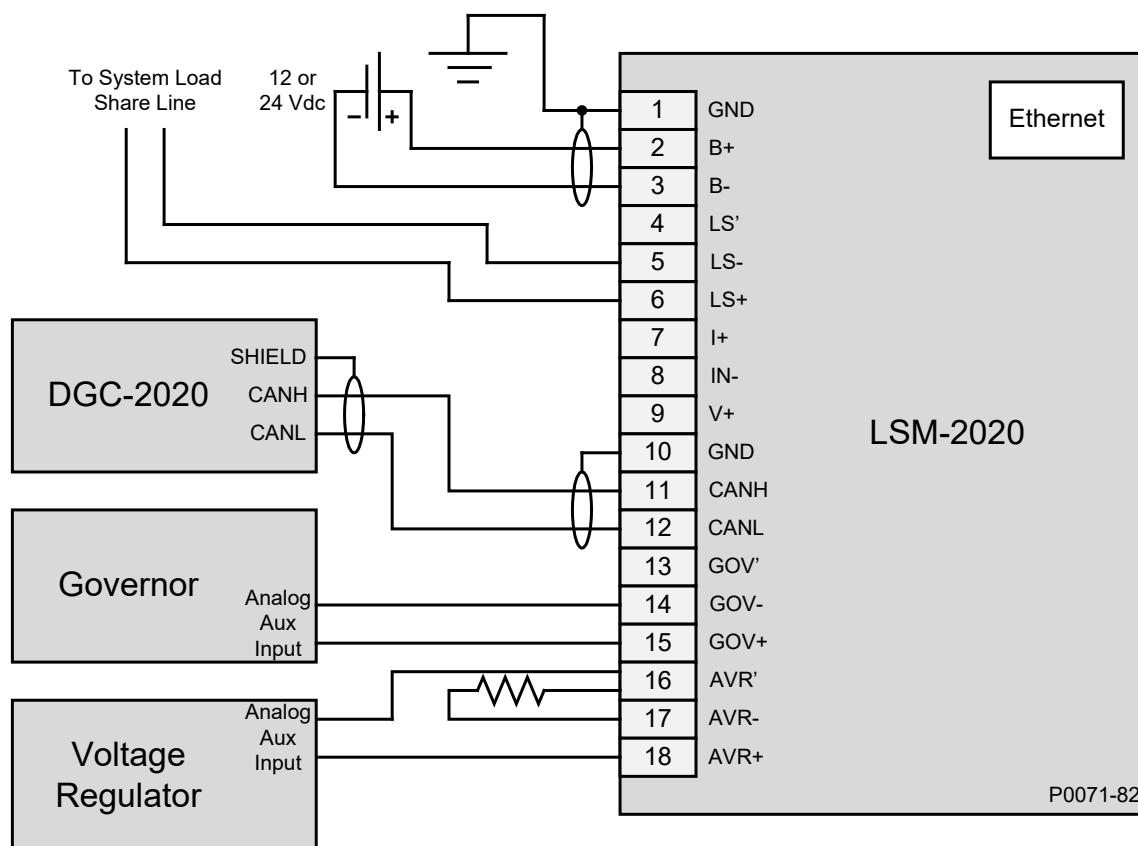


Figure 9-12. Connections using the AVR', GOV', and LS' Terminals

## Application

### Interfacing an External Control Device with a DGC-2020 – LSM-2020 System

#### Method 1

In some cases, it may be necessary to interface an external device, such as a synchronizer, to a DGC-2020 - LSM-2020 system where the LSM-2020 controls the analog bias inputs to the AVR and governor. If an external synchronizer is used in conjunction with the LSM-2020 to drive the governor analog speed bias signal, contacts that indicate generator breaker status can be used to switch the analog speed bias signal between the two devices as shown in Figure 9-13.

#### Note

Any relay contacts which are used to switch load share lines, governor analog speed bias signals, or voltage regulator analog voltage bias signals must use a relay intended for low voltage, low current applications to preserve signal integrity. Signal relays, not power relays, must be used for this application. It is recommended that relays having gold contacts are used.



The “A” contact is a normally open contact which is open when the generator breaker is open, and is closed when the generator breaker is closed. The “B” contact is a normally-closed contact that is closed when the generator breaker is open, and is open when the generator breaker is closed. The contact arrangement shown in Figure 9-13 gives the external device control of the analog speed bias signal when the generator breaker is open, and the LSM-200 has control when the generator breaker is closed.

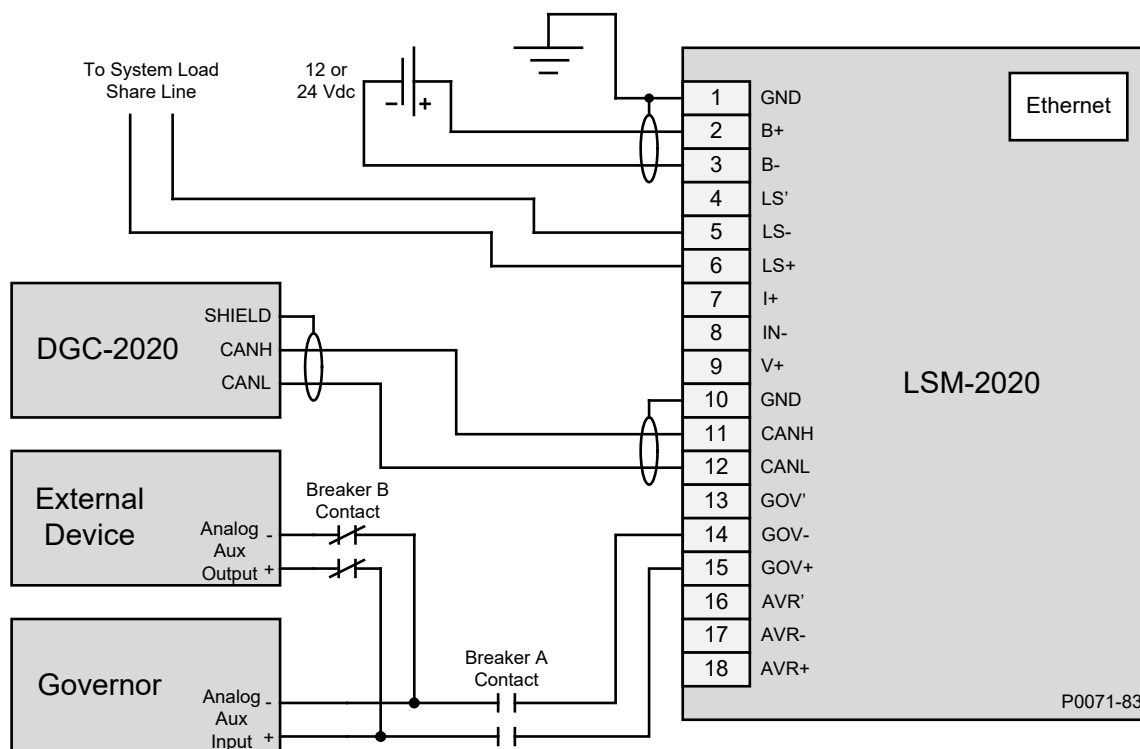


**Figure 9-13. External Control Device with DGC-2020 — LSM-2020 System, Method 1**

### Method 2

An alternate method of interfacing the DGC-2020 and an external device to drive the governor bias voltage can be done by placing the bias output of the LSM-2020 and the bias output of the external device in series. If the output of the LSM-2020 is connected in series with the bias output of the external synchronizer as shown in Figure 9-14, both devices will be allowed to exercise control over the bias input of the governor.

Be sure the LSM and the external device are never in a situation where they oppose each other. Both devices should not be trying to exercise dynamic control at the same time. For example, an external synchronizer should only be used with a DGC-2020 that does not have the synchronizer option, or has the synchronizer function disabled.

In addition, be sure the analog voltage range limits of the governor or AVR inputs are not exceeded. Exceeding these limits may result in undesired system operation, or force a device into an error or fault state.

If it is desired to have raise/lower inputs to control speed, use a motor operated potentiometer, as the external device. Note that if speed trim is enabled in the DGC-2020 and the generator's breaker is closed, the DGC-2020 will drive the system to the speed trim setpoint regardless of the presence of the external device. When the generator breaker is open, speed trim is disabled, and the external device will control machine speed.

A similar arrangement may be used for the bias input of an AVR if an external device is required for voltage control.

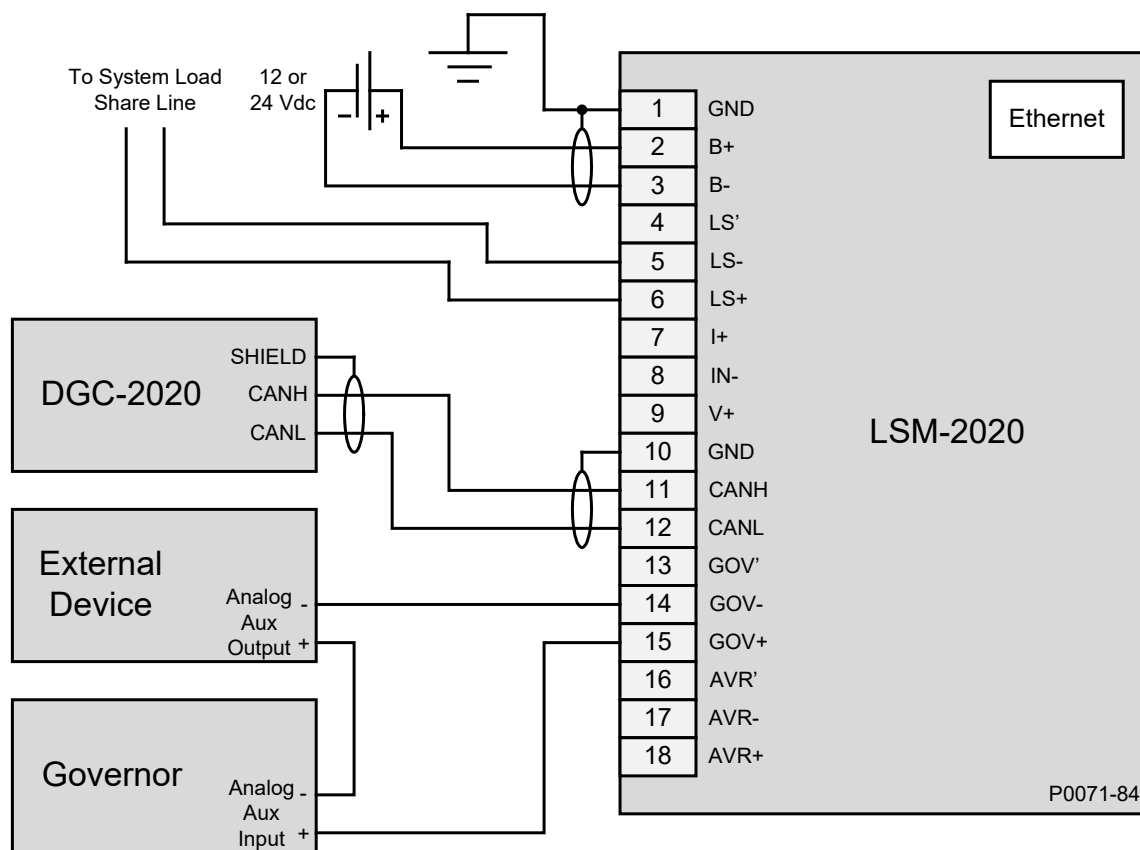


Figure 9-14. External Control Device with DGC-2020 — LSM-2020 System, Method 2

## Maintenance

Preventive maintenance consists of periodically checking that the connections between the LSM-2020 and the system are clean and tight. LSM-2020s are manufactured using state-of-the-art surface-mount technology. As such, Basler Electric recommends that no repair procedures be attempted by anyone other than Basler Electric personnel.

# 10 • CEM-2020 (Contact Expansion Module)

The optional CEM-2020 is a remote auxiliary device that provides additional DGC-2020 contact inputs and outputs. Two types of modules are available. A low current module (CEM-2020) provides 24 contact outputs and a high current module (CEM-2020H) provides 18 contact outputs.

## Features

CEM-2020s have the following features:

- 10 Contact Inputs
- 18 Contact Outputs (CEM-2020H) or 24 Contact Outputs (CEM-2020)
- Functionality of Inputs and Outputs assigned by BESTlogic*Plus* programmable logic
- Communications via CAN Bus

## Specifications

### Control Power

|                     |                                                                         |
|---------------------|-------------------------------------------------------------------------|
| Nominal .....       | 12 or 24 Vdc                                                            |
| Range.....          | 8 to 32 Vdc (Withstands cranking ride-through down to 6 Vdc for 500 ms) |
| Maximum Consumption |                                                                         |
| CEM-2020.....       | 14 W                                                                    |
| CEM-2020H .....     | 8 W                                                                     |

### Contact Inputs

The CEM-2020 contains 10 programmable inputs that accept dry contacts.

Time from a CEM-2020 input application to:

- Shutdown the generator via an alarm = 700 ms max
- Close a relay on board the DGC-2020 = 300 ms max
- Close a relay on board the CEM-2020 = 550 ms max

### Notes

A CEM-2020 contact input is true (on) if the input is connected to battery ground with a resistance of less than 200 ohms.

The maximum length of wire that can be accommodated depends on the resistance of the wire, and the resistance of the contacts of the device driving the input at the far end of the wire.

The maximum wire length can be calculated as follows:

$$L_{\max} = (200 - R_{\text{device}}) / (\text{Resistance per Foot of Desired Wire})$$

### Contact Outputs

Ratings

CEM-2020

Outputs 13 through 24 .. 1 Adc at 30 Vdc, Form C \*

Outputs 25 through 36 .. 4 Adc at 30 Vdc, Form C – 1.2 A Pilot Duty †

CEM-2020H

Outputs 13 through 24 .. 2 Adc at 30 Vdc, Form C \*

Outputs 25 through 30 .. 10 Adc at 30 Vdc, Form C – 1.2 A Pilot Duty †

\* Gold contacts intended for low voltage signaling to dry circuits. Not rated for inductive loads or pilot duty.

† For pilot duty, the load must be in parallel with a diode rated at least 3 x the coil current and 3 x the coil voltage.

## Communication Interface

### CAN Bus

Differential Bus Voltage..... 1.5 to 3 Vdc

Maximum Voltage ..... -32 to +32 Vdc with respect to negative battery terminal

Communication Rate..... 250 kb/s

## Type Tests

### Shock

Withstands 15 G in 3 perpendicular planes.

### Vibration

Swept over the following ranges for 12 sweeps in each of three mutually perpendicular planes with each 15-minute sweep consisting of the following:

5 to 29 to 5 Hz ..... 1.5 G peak for 5 min.

29 to 52 to 29 Hz ..... 0.036" Double Amplitude for 2.5 min.

52 to 500 to 52 Hz ..... 5 G peak for 7.5 min.

### Ignition System

Tested in closed proximity to an unshielded, unsuppressed Altronic DISN 800 ignition system.

### HALT (Highly Accelerated Life Testing)

HALT is used by Basler Electric to prove that our products will provide the user with many years of reliable service. HALT subjects the device to extremes in temperature, shock, and vibration to simulate years of operation, but in a much shorter period span. HALT allows Basler Electric to evaluate all possible design elements that will add to the life of this device. As an example of some of the extreme testing conditions, the CEM-2020 was subjected to temperature tests (tested over a temperature range of -80°C to +130°C), vibration tests (of 5 to 50 G at +25°C), and temperature/vibration tests (tested at 10 to 20 G over a temperature range of -60°C to +100°C). Combined temperature and vibration testing at these extremes proves that the CEM-2020 is expected to provide long-term operation in a rugged environment. Note that the vibration and temperature extremes listed in this paragraph are specific to HALT and do not reflect recommended operation levels. These operational ratings are included in this section.

## Environment

### Temperature

Operating ..... -40 to +70°C (-40 to +158°F)

Storage ..... -40 to +85°C (-40 to +185°F)

Humidity ..... IEC 68-2-38

## Agency Information

### UL Approval

The CEM-2020 is a Recognized Component for the US and Canada under UL file E97035

(CCN-FTPM2/FTPM8) covered under the Standards below:

- UL 6200:2019
- CSA C22.2 No.14-13

### CE and UKCA Compliance

This product has been evaluated and complies with the requirements set forth by the EU legislation and UK Parliament.

**EC Directives:**

- Low Voltage Directive (LVD) - 73/23/EEC as amended by 93/68/EEC
- Electromagnetic Compatibility (EMC) - 89/336/EEC as amended by 92/31/EEC and 93/68/EEC
- Hazardous Substances (RoHS 2) - 2011/65/EU

**Harmonized Standards used for evaluation:**

- EN 50178:1997 - *Electronic Equipment for use in Power Installations*
- EN 61000-6-4:2001 - *Electromagnetic Compatibility (EMC), Generic Standards, Emission Standard for Industrial Environments*
- EN 61000-6-2:2001 - *Electromagnetic Compatibility (EMC), Generic Standards, Immunity for Industrial Environments*
- EN 50581:2012, Ed. 12 - *Technical Documentation for the Assessment of Electrical and Electronic Products with respect to the Restriction of Hazardous Substances.*

**FCC Requirements**

This product complies with FCC 47 CFR Part 15.

**NFPA Compliance**

This product complies with NFPA Standard 110, *Standard for Emergency and Standby Power*.

**Maritime Recognition**

American Bureau of Shipping (ABS) – For current certificates, see [www.basler.com](http://www.basler.com).

### China RoHS

The following table serves as the declaration of hazardous substances for China in accordance with PRC standard SJ/T 11364-2014. The EFUP (Environment Friendly Use Period) for this product is 40 years.

| PRODUCT: CEM-2020                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                              |                   |                   |                                                |                                        |                                                |                                     |                                          |                                               |                                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-------------------|-------------------|------------------------------------------------|----------------------------------------|------------------------------------------------|-------------------------------------|------------------------------------------|-----------------------------------------------|------------------------------------------|
| 零件名称<br>Part Name                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 有害物质<br>Hazardous Substances |                   |                   |                                                |                                        |                                                |                                     |                                          |                                               |                                          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 铅<br>Lead (Pb)               | 汞<br>Mercury (Hg) | 镉<br>Cadmium (Cd) | 六价铬<br>Hexavalent Chromium (Cr <sup>6+</sup> ) | 多溴联苯<br>Polybrominated Biphenyls (PBB) | 多溴二苯醚<br>Polybrominated Diphenyl Ethers (PBDE) | 邻苯二甲酸二丁酯<br>Dibutyl Phthalate (DBP) | 邻苯二甲酸丁苄酯<br>Benzyl butyl phthalate (BBP) | 邻苯二甲酸二酯<br>Bis(2-ethylhexyl) phthalate (BEHP) | 邻苯二甲酸二异丁酯<br>Diisobutyl phthalate (DIBP) |
| 金属零件<br>Metal parts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | O                            | O                 | O                 | O                                              | O                                      | O                                              | O                                   | O                                        | O                                             | O                                        |
| 聚合物<br>Polymers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | O                            | O                 | O                 | O                                              | O                                      | O                                              | O                                   | O                                        | O                                             | O                                        |
| 电子产品<br>Electronics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | X                            | O                 | X                 | O                                              | O                                      | O                                              | O                                   | O                                        | O                                             | O                                        |
| 电缆和互连配件<br>Cables & interconnect accessories                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | O                            | O                 | O                 | O                                              | O                                      | O                                              | O                                   | O                                        | O                                             | O                                        |
| 绝缘材料<br>Insulation material                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | O                            | O                 | O                 | O                                              | O                                      | O                                              | O                                   | O                                        | O                                             | O                                        |
| <p>本表格依据 SJ/T11364 的规定编制。</p> <p>O: 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。</p> <p>X: 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求。</p> <p>This form was prepared according to the provisions of standard SJ/T11364.</p> <p>O: Indicates that the hazardous substance content in all homogenous materials of this part is below the limit specified in standard GB/T 26572.</p> <p>X: Indicates that the hazardous substance content in at least one of the homogenous materials of this part exceeds the limit specified in standard GB/T 26572.</p> |                              |                   |                   |                                                |                                        |                                                |                                     |                                          |                                               |                                          |

### Physical

#### Weight

CEM-2020.....2.25 lb (1.02 kg)

CEM-2020H.....1.90 lb (0.86 kg)

Dimensions.....See *Installation* later in this section.

## Functional Description

### Contact Inputs

The CEM-2020 provides 10 programmable contact inputs with the same functionality as the contact inputs on the DGC-2020. The label text of each contact input is customizable.

### Contact Outputs

#### CEM-2020

The CEM-2020 provides 24 programmable contact outputs with the same functionality as the contact outputs on the DGC-2020. Outputs 13 through 24 can carry 1 A. Outputs 25 through 36 can carry 4 A. The label text of each contact output is customizable.

**CEM-2020H**

The CEM-2020H provides 18 programmable contact outputs with the same functionality as the contact outputs on the DGC-2020. Outputs 13 through 24 can carry 2 A. Outputs 25 through 30 can carry 10 A. The label text of each contact output is customizable.

| Notes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>When using the DGC-2020 synchronizer, it is recommended that local relay outputs on the DGC-2020 be used for breaker close commands to minimize the possibility of closures outside of desired breaker closing angles.</p> <p>If remote (CEM-2020) outputs are to be used for breaker close commands, it is recommended that the anticipatory synchronizer type be used, and the breaker close wait time be adjusted to account for possible CEM-2020 output delays (typically 50 ms) to achieve desired breaker closing angles.</p> |

**Communications****CAN Bus**

A Control Area Network (CAN) is a standard interface that enables communication between the CEM-2020 and the DGC-2020.

**Status LED**

This red LED flashes to indicate that the CEM-2020 is powered up and functioning properly. The LED lights solid during power up. When the power-up sequence is complete, this LED flashes. If the LED does not flash after power up, contact Basler Electric.

***BESTCOMSPlus® Software***

BESTCOMSPlus® provides the user with a point-and-click means to set and monitor the Contact Expansion Module. Installation and operation of BESTCOMSPlus® is described in Section 4, *BESTCOMSPlus® Software*.

***Installation***

Contact Expansion Modules are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a module, check the part number against the requisition and packing list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify the Basler Electric regional sales office or your sales representative.

If the device is not installed immediately, store it in the original shipping package in a moisture- and dust-free environment.

**Mounting**

Contact Expansion Modules are contained in a potted plastic case and may be mounted in any convenient position. The construction of a Contact Expansion Module is durable enough to mount directly on a genset using ¼-inch hardware. Hardware selection should be based on any expected shipping/transportation and operating conditions. The torque applied to the mounting hardware should not exceed 65 in-lb (7.34 N•m).

See Figure 10-1 for CEM-2020 overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.

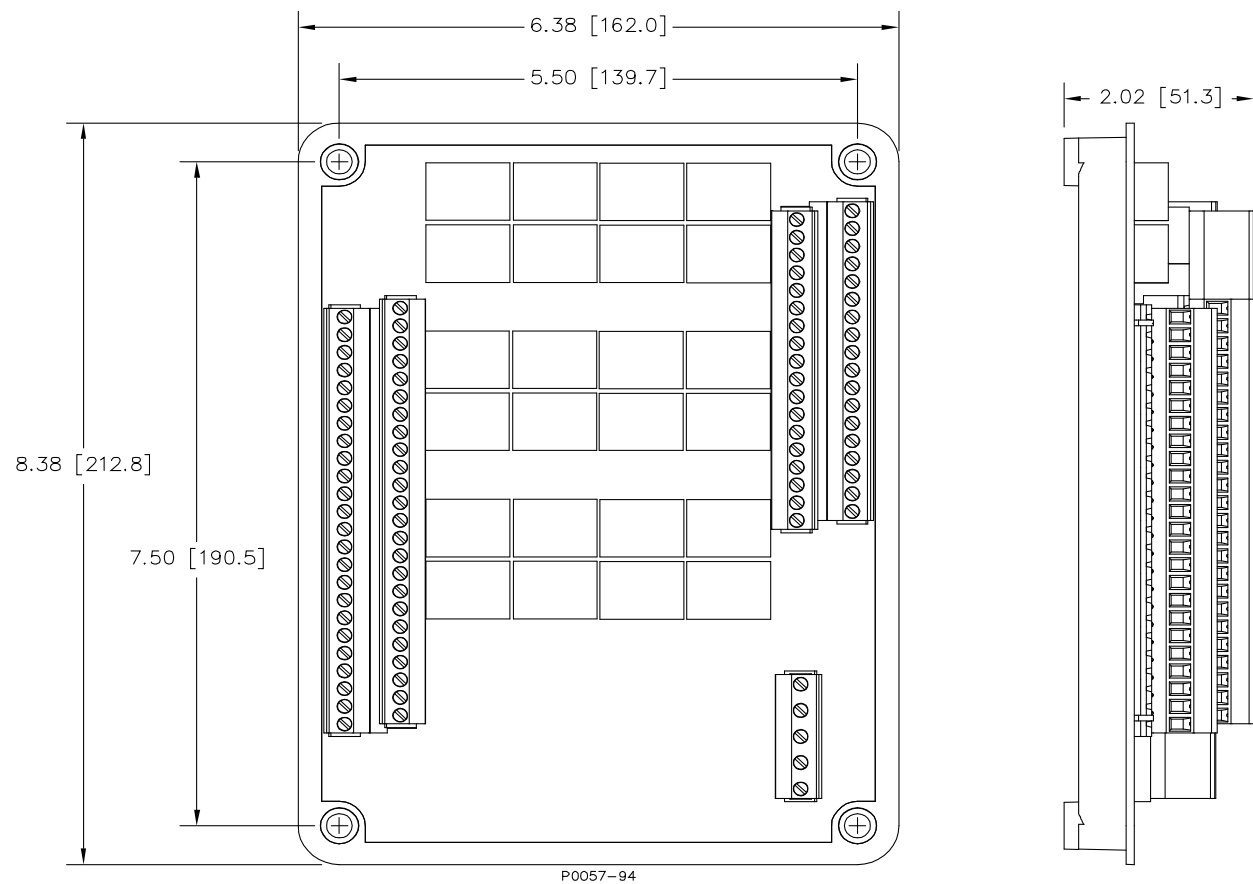


**Figure 10-1. CEM-2020 Overall Dimensions**

See Figure 10-2 for CEM-2020H overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.



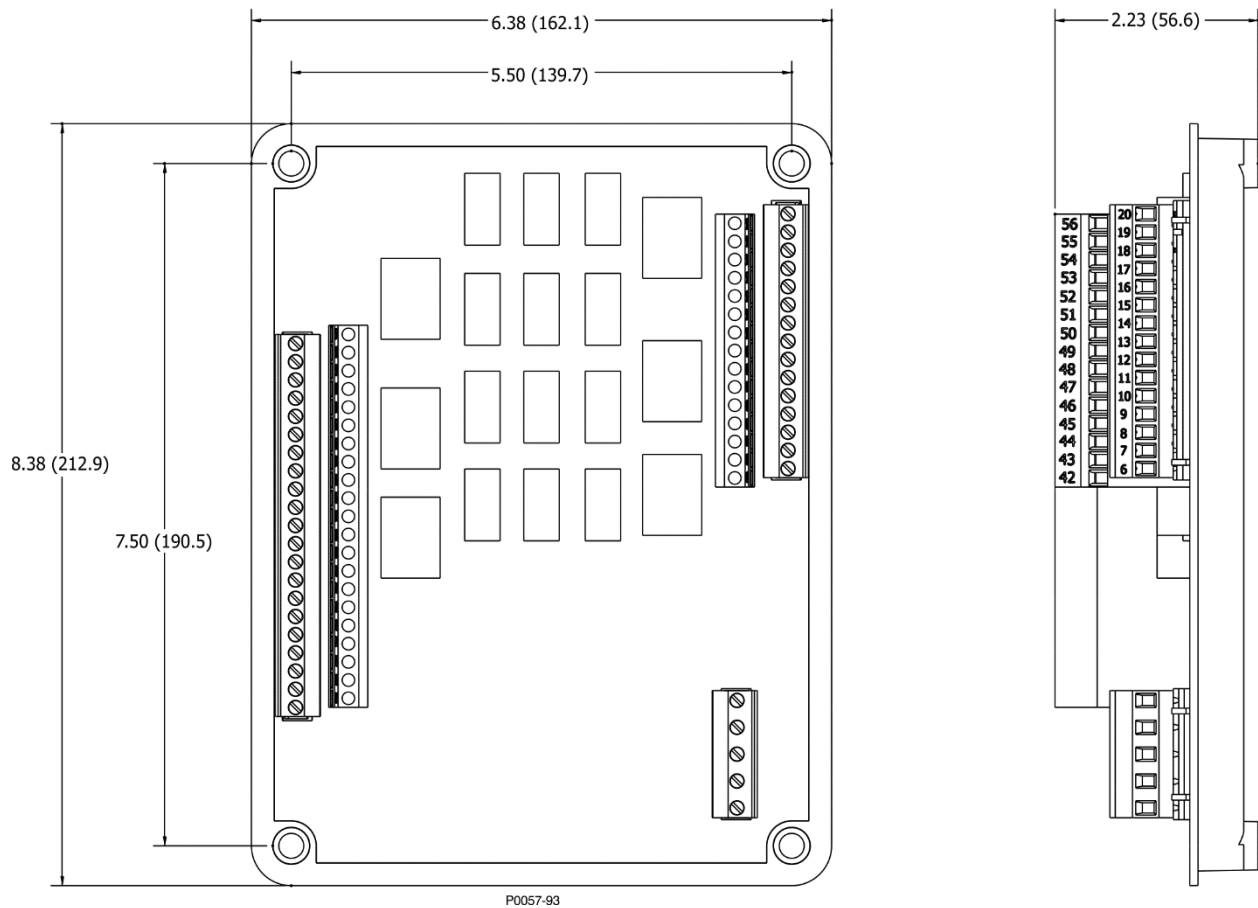


**Figure 10-2. CEM-2020H Overall Dimensions**

## Connections

Contact Expansion Module connections are dependent on the application. Incorrect wiring may result in damage to the module.

### Notes

Control power from the battery must be of the correct polarity. Although reverse polarity will not cause damage, the CEM-2020 will not operate.

Be sure that the CEM-2020 is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the chassis ground terminal on the module.

It is recommended to minimize the vibration load on the connector plug by ensuring that wires are well-constrained, with no more than 6 to 8 inches of unconstrained wire length near the connector plugs.

### Terminations

The terminal interface consists of plug-in connectors with screw-down compression terminals.

CEM-2020 connections are made with one 5-position connector, two 18-position connectors, and two 24-position connectors with screw-down compression terminals. These connectors plug into headers on the CEM-2020. The connectors and headers have dovetailed edges that ensure proper connector orientation. Also, the connectors and headers are uniquely keyed to ensure that the connectors mate only with the correct headers.

### Caution

By mating conductors of dissimilar metals, galvanic corrosion could occur which may lead to signal loss.

Connectors and headers may contain tin- or gold-plated conductors. Tin-plated conductors are housed in a black plastic casing and gold-plated conductors are housed in an orange plastic casing. Mate connectors to headers of the same color only.

Connector screw terminals accept a maximum wire size of 12 AWG. Maximum screw torque is 5 inch-pounds (0.56 N•m).

#### Control Power

The Contact Expansion Module control power input accepts either 12 Vdc or 24 Vdc and tolerates voltage over the range of 6 to 32 Vdc. Control power must be of the correct polarity. Although reverse polarity will not cause damage, the CEM-2020 will not operate. Control power terminals are listed in Table 10-1.

It is recommended that a fuse be added for additional protection for the wiring to the battery input of the Contact Expansion Module. A Bussmann ABC-7 fuse or equivalent is recommended.

**Table 10-1. Control Power Terminals**

| Terminal                                                                                       | Description                          |
|------------------------------------------------------------------------------------------------|--------------------------------------|
| P1-  (SHIELD) | Chassis ground connection            |
| P1- – (BATT–)                                                                                  | Negative side of control power input |
| P1- + (BATT+)                                                                                  | Positive side of control power input |

#### Contact Inputs and Contact Outputs

The CEM-2020 (Figure 10-3) has 10 contact inputs and 24 contact outputs. The CEM-2020H (Figure 10-4) has 10 contact inputs and 18 contact outputs.

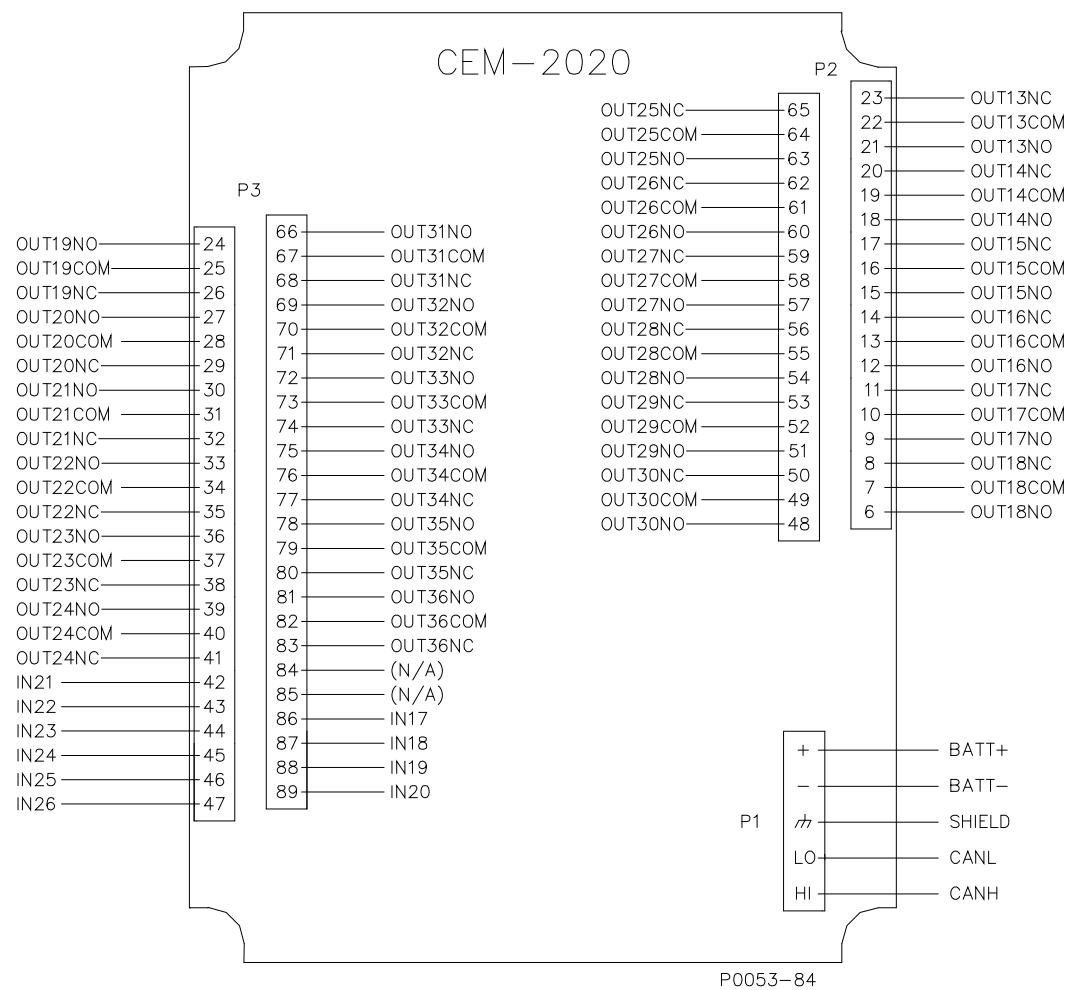


Figure 10-3. CEM-2020 Contact Input and Contact Output Terminals

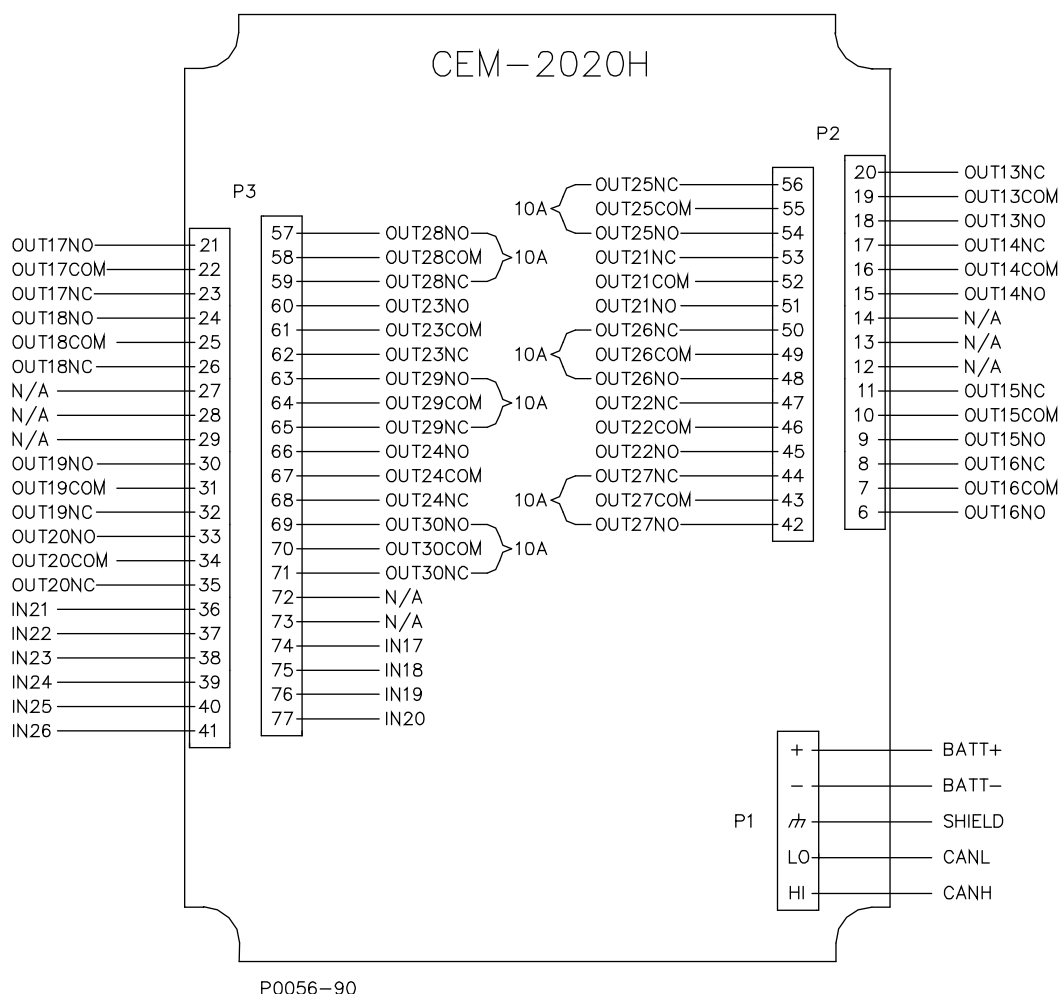


**Figure 10-4. CEM-2020H Contact Input and Contact Output Terminals**

### CAN Bus Interface

These terminals provide communication using the SAE J1939 protocol and provide high-speed communication between the Contact Expansion Module and the DGC-2020. Connections between the CEM-2020 and DGC-2020 should be made with twisted-pair, shielded cable. CAN bus interface terminals are listed in Table 10-2. Refer to Figure 10-5 and Figure 10-6.

**Table 10-2. CAN Bus Interface Terminals**

| Terminal                                                                                         | Description                       |
|--------------------------------------------------------------------------------------------------|-----------------------------------|
| P1- HI (CAN H)                                                                                   | CAN high connection (yellow wire) |
| P1- LO (CAN L)                                                                                   | CAN low connection (green wire)   |
| P1-  (SHIELD) | CAN drain connection              |

### Notes

1. If the CEM-2020 is providing one end of the J1939 bus, a 120-ohm, ½ watt terminating resistor should be installed across terminals P1- LO (CANL) and P1- HI (CANH).
2. If the CEM-2020 is not part of the J1939 bus, the stub connecting the CEM-2020 to the bus should not exceed 914 mm (3 ft) in length.
3. The maximum bus length, not including stubs, is 40 m (131 ft).
4. The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the CEM-2020.

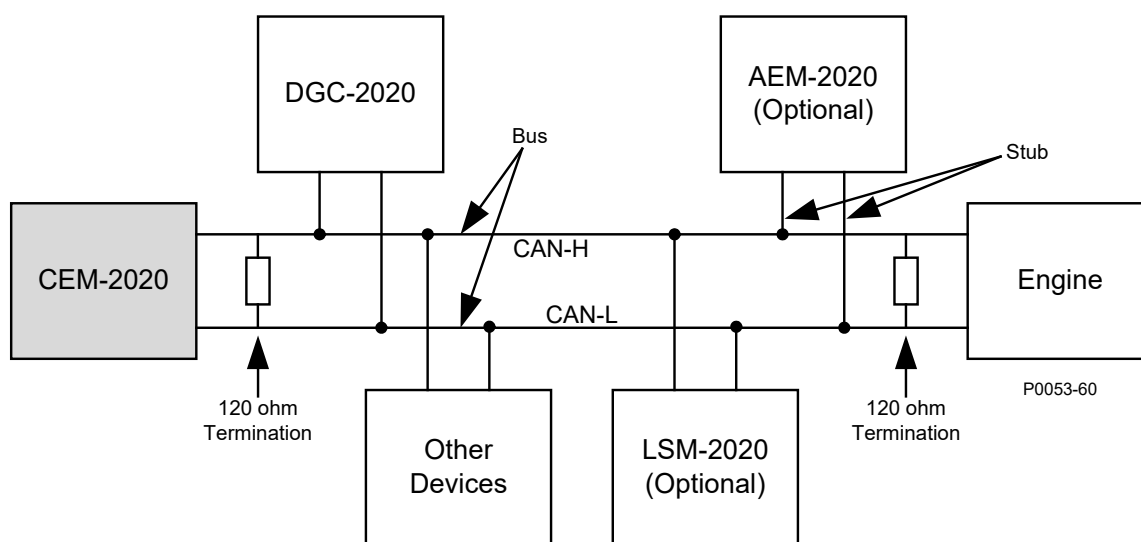


Figure 10-5. CAN Bus Interface with CEM-2020 providing One End of the Bus

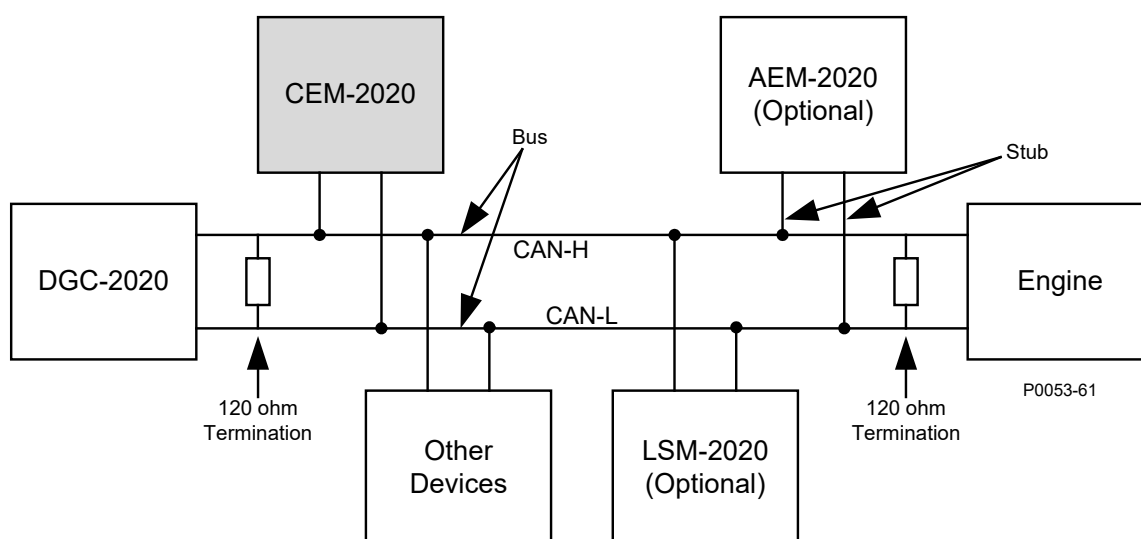


Figure 10-6. CAN Bus Interface with DGC-2020 providing One End of the Bus

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## ***Maintenance***

---

Preventive maintenance consists of periodically checking that the connections between the CEM-2020 and the system are clean and tight. Contact Expansion Modules are manufactured using state-of-the-art surface-mount technology. As such, Basler Electric recommends that no repair procedures be attempted by anyone other than Basler Electric personnel.

# 11 • AEM-2020 (Analog Expansion Module)

The optional AEM-2020 is a remote auxiliary device that provides additional DGC-2020 analog inputs and outputs.

## Features

AEM-2020s have the following features:

- 8 Analog Inputs
- 8 RTD Inputs
- 2 Thermocouple Inputs
- 4 Analog Outputs
- Functionality of Inputs and Outputs assigned by BESTlogic*Plus* programmable logic
- Communications via CAN Bus

## Specifications

### Operating Power

Nominal ..... 12 or 24 Vdc  
 Range ..... 8 to 32 Vdc (Withstands cranking ride-through down to 6 Vdc for 500 ms.)  
 Maximum Consumption ..... 5.1 W

### Analog Inputs

The AEM-2020 contains eight programmable analog inputs.

Rating ..... 4 to 20 mA<sub>dc</sub> or 0 to 10 V<sub>dc</sub> (user-selectable)

#### Burden

4 to 20 mA ..... 470  $\Omega$  maximum  
 $\pm 10$  V<sub>dc</sub> ..... 9.65k  $\Omega$  minimum

### RTD Inputs

The AEM-2020 contains eight programmable RTD inputs.

Rating ..... 100  $\Omega$  Platinum or 10  $\Omega$  Copper (user-selectable)

Setting Range ..... -50 to +250°C or -58 to +482°F

Accuracy (10  $\Omega$  Copper) .....  $\pm 0.044 \Omega$  @ 25°C,  $\pm 0.005 \Omega/^{\circ}\text{C}$  drift over ambient temperature

Accuracy (100  $\Omega$  Platinum) .....  $\pm 0.39 \Omega$  @ 25°C,  $\pm 0.047 \Omega/^{\circ}\text{C}$  drift over ambient temperature

### Thermocouple Inputs

The AEM-2020 contains two thermocouple inputs.

Rating ..... 2 K Type Thermocouples

Setting Range ..... 0 to 1,375°C or 32 to 2,507°F

Display Range ..... Ambient to 1,375°C or Ambient to 2,507°F

Accuracy .....  $\pm 40 \mu\text{V}$  @ 25°C,  $\pm 5 \mu\text{V}/^{\circ}\text{C}$  drift over ambient temperature

### Analog Outputs

The AEM-2020 contains four programmable analog outputs.

Rating ..... 4 to 20 mA<sub>dc</sub> or 0 to 10 V<sub>dc</sub> (user-selectable)

## Communication Interface

### CAN Bus

Differential Bus Voltage..... 1.5 to 3 Vdc  
Maximum Voltage ..... -32 to +32 Vdc with respect to negative battery terminal  
Communication Rate..... 250 kb/s

## Type Tests

### Shock

Withstands 15 G in 3 perpendicular planes.

### Vibration

Swept over the following ranges for 12 sweeps in each of three mutually perpendicular planes with each 15-minute sweep consisting of the following:

5 to 29 to 5 Hz ..... 1.5 G peak for 5 min.  
29 to 52 to 29 Hz ..... 0.036" Double Amplitude for 2.5 min.  
52 to 500 to 52 Hz ..... 5 G peak for 7.5 min.

### Ignition System

Tested in closed proximity to an unshielded, unsuppressed Altronic DISN 800 ignition system.

### HALT (Highly Accelerated Life Testing)

HALT is used by Basler Electric to prove that our products will provide the user with many years of reliable service. HALT subjects the device to extremes in temperature, shock, and vibration to simulate years of operation, but in a much shorter period span. HALT allows Basler Electric to evaluate all possible design elements that will add to the life of this device. As an example of some of the extreme testing conditions, the AEM-2020 was subjected to temperature tests (tested over a temperature range of -80°C to +130°C), vibration tests (of 5 to 50 G at +25°C), and temperature/vibration tests (tested at 10 to 20 G over a temperature range of -60°C to +100°C). Combined temperature and vibration testing at these extremes proves that the AEM-2020 is expected to provide long-term operation in a rugged environment. Note that the vibration and temperature extremes listed in this paragraph are specific to HALT and do not reflect recommended operation levels. These operational ratings are included in this section.

## Environment

Temperature  
Operating ..... -40 to +70°C (-40 to +158°F)  
Storage ..... -40 to +85°C (-40 to +185°F)  
Humidity ..... IEC 68-2-38

## Agency Information

### UL Approval

The AEM-2020 is a Recognized Component for the US and Canada under UL file E97035 (CCN-FTPM2/FTPM8) covered under the Standards below:

- UL 6200:2019
- CSA C22.2 No.14-13

### CE and UKCA Compliance

This product has been evaluated and complies with the requirements set forth by the EU legislation and UK Parliament.



## EC Directives:

- Low Voltage Directive (LVD) - 73/23/EEC as amended by 93/68/EEC
- Electromagnetic Compatibility (EMC) - 89/336/EEC as amended by 92/31/EEC and 93/68/EEC
- Hazardous Substances (RoHS 2) -2011/65/EU

## Harmonized Standards used for evaluation:

- EN 50178:1997 - *Electronic Equipment for use in Power Installations*
- EN 61000-6-4:2001 - *Electromagnetic Compatibility (EMC), Generic Standards, Emission Standard for Industrial Environments*
- EN 61000-6-2:2001 - *Electromagnetic Compatibility (EMC), Generic Standards, Immunity for Industrial Environments*
- EN 50581:2012, Ed. 12 - *Technical Documentation for the Assessment of Electrical and Electronic Products with respect to the Restriction of Hazardous Substances.*

FCC Requirements

This product complies with FCC 47 CFR Part 15

NFPA Compliance

This product complies with NFPA Standard 110, *Standard for Emergency and Standby Power.*

Maritime Recognition

American Bureau of Shipping (ABS) – For current certificates, see [www.basler.com](http://www.basler.com).

China RoHS

The following table serves as the declaration of hazardous substances for China in accordance with PRC standard SJ/T 11364-2014. The EFUP (Environment Friendly Use Period) for this product is 40 years.

| PRODUCT: AEM-2020                                                                                                                                                                                            |                              |                   |                   |                                                |                                        |                                                |                                     |                                          |                                                       |                                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|-------------------|-------------------|------------------------------------------------|----------------------------------------|------------------------------------------------|-------------------------------------|------------------------------------------|-------------------------------------------------------|------------------------------------------|
| 零件名称<br>Part Name                                                                                                                                                                                            | 有害物质<br>Hazardous Substances |                   |                   |                                                |                                        |                                                |                                     |                                          |                                                       |                                          |
|                                                                                                                                                                                                              | 铅<br>Lead (Pb)               | 汞<br>Mercury (Hg) | 镉<br>Cadmium (Cd) | 六价铬<br>Hexavalent Chromium (Cr <sup>6+</sup> ) | 多溴联苯<br>Polybrominated Biphenyls (PBB) | 多溴二苯醚<br>Polybrominated Diphenyl Ethers (PBDE) | 邻苯二甲酸二丁酯<br>Dibutyl Phthalate (DBP) | 邻苯二甲酸丁苄酯<br>Benzyl butyl phthalate (BBP) | 邻苯二甲酸二(2-乙基己基)酯<br>Bis(2-ethylhexyl) phthalate (BEHP) | 邻苯二甲酸二异丁酯<br>Diisobutyl phthalate (DIBP) |
| 金属零件<br>Metal parts                                                                                                                                                                                          | O                            | O                 | O                 | O                                              | O                                      | O                                              | O                                   | O                                        | O                                                     | O                                        |
| 聚合物<br>Polymers                                                                                                                                                                                              | O                            | O                 | O                 | O                                              | O                                      | O                                              | O                                   | O                                        | O                                                     | O                                        |
| 电子产品<br>Electronics                                                                                                                                                                                          | X                            | O                 | O                 | O                                              | O                                      | O                                              | O                                   | O                                        | O                                                     | O                                        |
| 电缆和互连配件<br>Cables & interconnect accessories                                                                                                                                                                 | X                            | O                 | O                 | O                                              | O                                      | O                                              | O                                   | O                                        | O                                                     | O                                        |
| 绝缘材料<br>Insulation material                                                                                                                                                                                  | O                            | O                 | O                 | O                                              | O                                      | O                                              | O                                   | O                                        | O                                                     | O                                        |
| 本表格依据 SJ/T11364 的规定编制。<br>O: 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。<br>X: 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求。<br>This form was prepared according to the provisions of standard SJ/T11364. |                              |                   |                   |                                                |                                        |                                                |                                     |                                          |                                                       |                                          |

|                                                                                                                                                                |                              |                |                   |                   |                                                |                                        |                                                |                                     |                                          |                                                       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|----------------|-------------------|-------------------|------------------------------------------------|----------------------------------------|------------------------------------------------|-------------------------------------|------------------------------------------|-------------------------------------------------------|
| PRODUCT: AEM-2020                                                                                                                                              |                              |                |                   |                   |                                                |                                        |                                                |                                     |                                          |                                                       |
|                                                                                                                                                                | 有害物质<br>Hazardous Substances |                |                   |                   |                                                |                                        |                                                |                                     |                                          |                                                       |
|                                                                                                                                                                | 零件名称<br>Part Name            | 铅<br>Lead (Pb) | 汞<br>Mercury (Hg) | 镉<br>Cadmium (Cd) | 六价铬<br>Hexavalent Chromium (Cr <sup>6+</sup> ) | 多溴联苯<br>Polybrominated Biphenyls (PBB) | 多溴二苯醚<br>Polybrominated Diphenyl Ethers (PBDE) | 邻苯二甲酸二丁酯<br>Dibutyl Phthalate (DBP) | 邻苯二甲酸丁苄酯<br>Benzyl butyl phthalate (BBP) | 邻苯二甲酸二(2-乙基己基)酯<br>Bis(2-ethylhexyl) phthalate (BEHP) |
| O: Indicates that the hazardous substance content in all homogenous materials of this part is below the limit specified in standard GB/T 26252.                |                              |                |                   |                   |                                                |                                        |                                                |                                     |                                          |                                                       |
| X: Indicates that the hazardous substance content in at least one of the homogenous materials of this part exceeds the limit specified in standard GB/T 26572. |                              |                |                   |                   |                                                |                                        |                                                |                                     |                                          |                                                       |

## Physical

Weight ..... 1.80 lb (816 g)

Dimensions..... See *Installation* later in this section.

## Functional Description

A functional description of the AEM-2020's inputs and outputs is provided below.

### Analog Inputs

The AEM-2020 provides eight analog inputs that are user-selectable for 4 to 20 mAdc or 0 to 10 Vdc. Each analog input has under/over thresholds that can be configured as status only, alarm, or pre-alarm. When enabled, an out of range alarm alerts the user of an open or damaged analog input wire. The label text of each analog input is customizable.

### RTD Inputs

The AEM-2020 provides eight user-configurable RTD inputs for monitoring genset temperature. Each RTD input can be configured as status only, alarm, or pre-alarm to protect against high or low temperature conditions. When enabled, an out of range alarm alerts the user of an open or damaged RTD input wire. The label text of each RTD input is customizable.

### Thermocouple Inputs

The AEM-2020 provides two thermocouple inputs for monitoring genset temperature. Each thermocouple input can be configured as status only, alarm, or pre-alarm to protect against high or low temperature conditions. The label text of each thermocouple input is customizable.

### Analog Outputs

The AEM-2020 provides four analog outputs that are user-selectable for 4 to 20 mAdc or 0 to 10 Vdc. A wide selection of parameters including oil pressure, fuel level, generator voltage, and bus voltage can be configured as analog outputs. Refer to Section 4, *BESTCOMSPPlus™ Software*, for a full list of parameter selections.

### Communications

#### CAN Bus

A Control Area Network (CAN) is a standard interface that enables communication between the AEM-2020 and the DGC-2020.

## Status LED

This red LED flashes to indicate that the AEM-2020 is powered up and functioning properly. The LED lights solid during power up. When the power-up sequence is complete, this LED flashes. If the LED does not flash after power up, contact Basler Electric.

## ***BESTCOMSPlus® Software***

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BESTCOMSPlus® provides the user with a point-and-click means to set and monitor the Analog Expansion Module. Installation and operation of BESTCOMSPlus® is described in Section 4, *BESTCOMSPlus® Software*.

## ***Installation***

---

Analog Expansion Modules are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a module, check the part number against the requisition and packing list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify the Basler Electric regional sales office or your sales representative.

If the device is not installed immediately, store it in the original shipping package in a moisture- and dust-free environment.

## Mounting

Analog Expansion Modules are contained in a potted plastic case and may be mounted in any convenient position. The construction of an Analog Expansion Module is durable enough to mount directly on a genset using ¼-inch hardware. Hardware selection should be based on any expected shipping/transportation and operating conditions. The torque applied to the mounting hardware should not exceed 65 in-lb (7.34 N•m).

See Figure 11-1 for AEM-2020 overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.

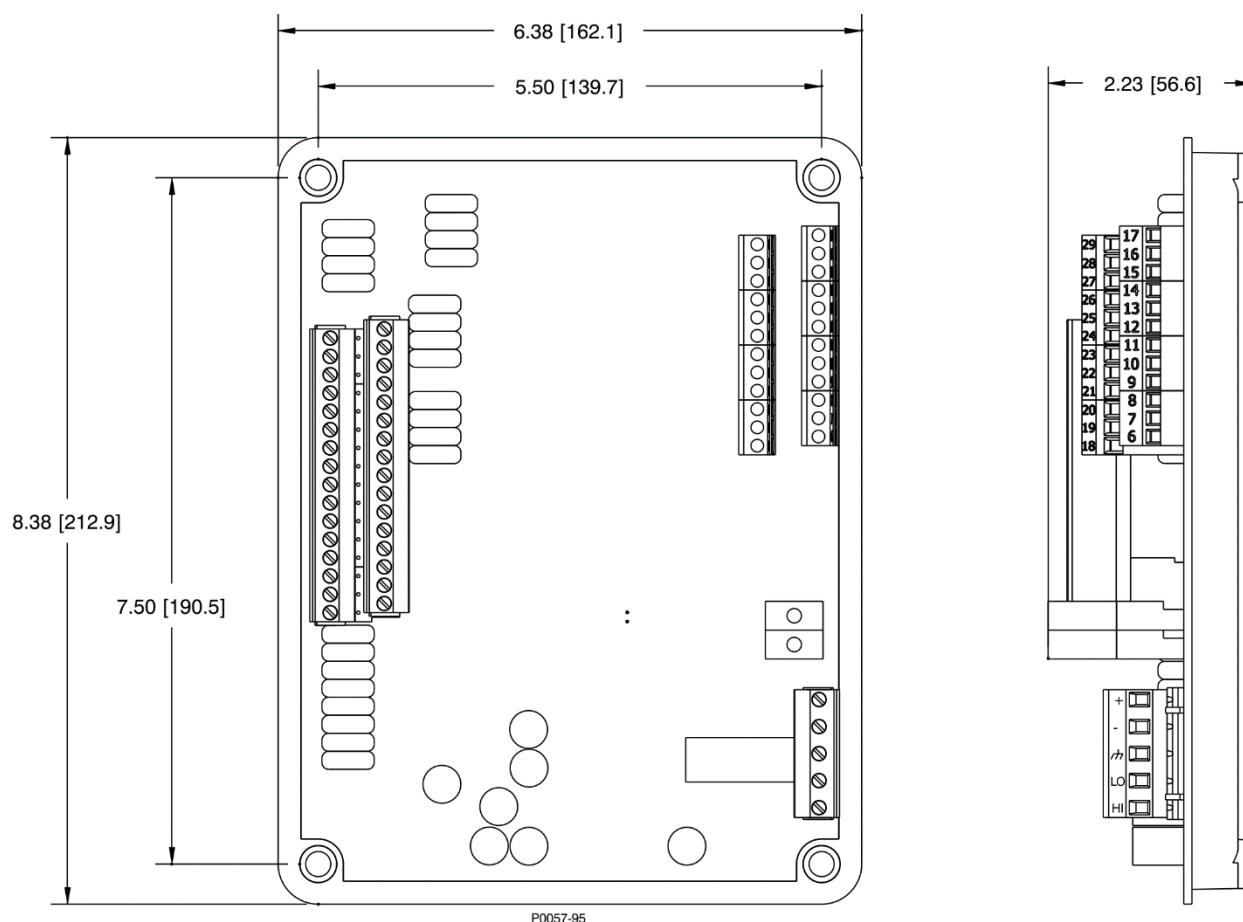


**Figure 11-1. AEM-2020 Overall Dimensions**

## Connections

Analog Expansion Module connections are dependent on the application. Incorrect wiring may result in damage to the module.

### Notes

Operating power from the battery must be of the correct polarity. Although reverse polarity will not cause damage, the AEM-2020 will not operate.

Be sure that the AEM-2020 is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the chassis ground terminal on the module.

It is recommended to minimize the vibration load on the connector plug by ensuring that wires are well-constrained, with no more than 6 to 8 inches of unconstrained wire length near the connector plugs.

### Terminations

The terminal interface consists of both plug-in connectors and a permanently mounted connector with screw-down compression terminals.

AEM-2020 connections are made with one 5-position connector, two 12-position connectors, two 16-position connectors, and two 2-position thermocouple connectors. The 16, 5, and 2-position connectors plug into headers on the AEM-2020. The connectors and headers have dovetailed edges that ensure proper connector orientation. Also, the connectors and headers are uniquely keyed to ensure that the

connectors mate only with the correct headers. The 12-position connector is not a plug-in connector and is mounted permanently to the board.

### Caution

By mating conductors of dissimilar metals, galvanic corrosion could occur which may lead to signal loss.

Connectors and headers may contain tin- or gold-plated conductors. Tin-plated conductors are housed in a black plastic casing and gold-plated conductors are housed in an orange plastic casing. Mate connectors to headers of the same color only.

Connector screw terminals accept a maximum wire size of 12 AWG. Thermocouple connectors accept a maximum thermocouple wire diameter of 0.177 inches (4.5 mm). Maximum screw torque is 5 inch-pounds (0.56 N•m).

### Operating Power

The Analog Expansion Module operating power input accepts either 12 Vdc or 24 Vdc and tolerates voltage over the range of 6 to 32 Vdc. Operating power must be of the correct polarity. Although reverse polarity will not cause damage, the AEM-2020 will not operate. Operating power terminals are listed in Table 11-1.

It is recommended that a fuse be added for additional protection for the wiring to the battery input of the Analog Expansion Module. A Bussmann ABC-7 fuse or equivalent is recommended.

**Table 11-1. Operating Power Terminals**

| Terminal                                                                                         | Description                            |
|--------------------------------------------------------------------------------------------------|----------------------------------------|
| P1-  (SHIELD) | Chassis ground connection              |
| P1- – (BATT–)                                                                                    | Negative side of operating power input |
| P1- + (BATT+)                                                                                    | Positive side of operating power input |

### AEM-2020 Inputs and Outputs

Input and output terminals are shown in Figure 11-2 and listed in Table 11-2.

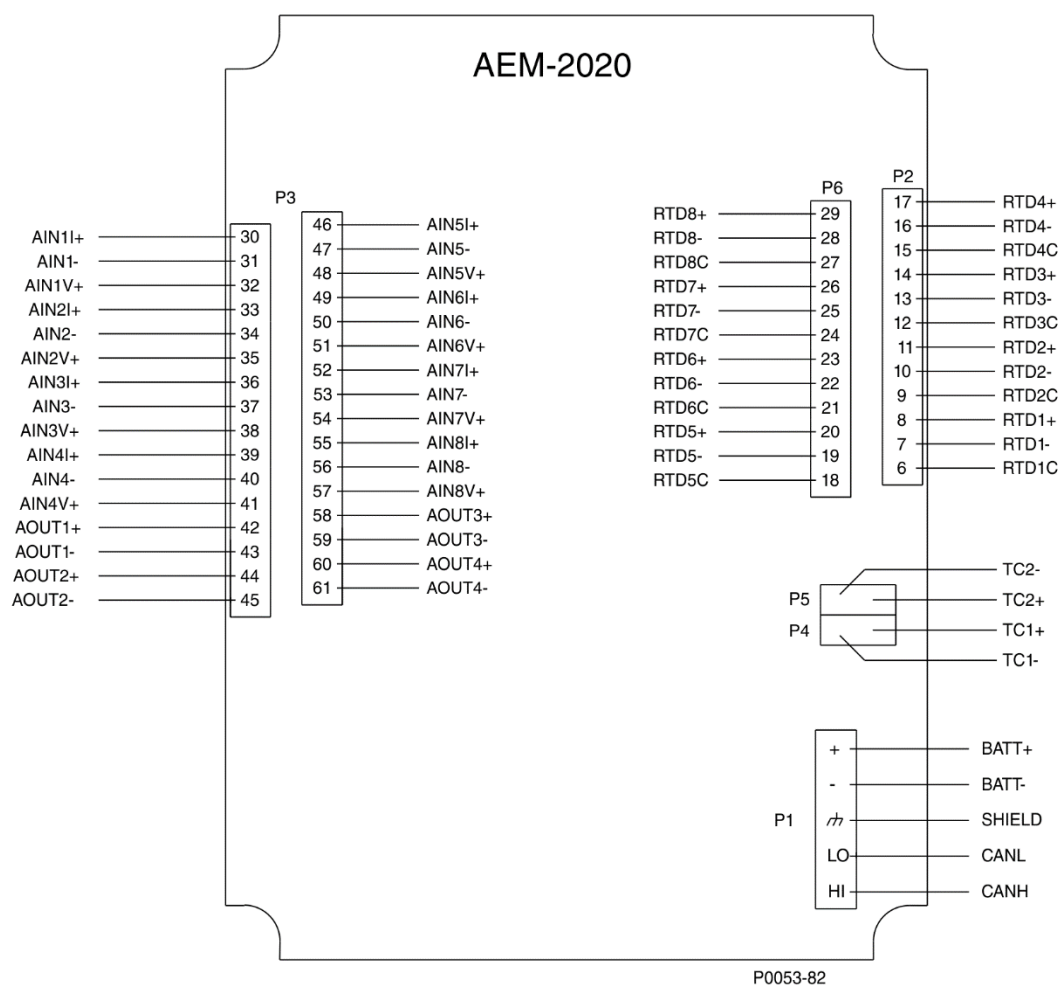


Figure 11-2. Input and Output Terminals

Table 11-2. Input and Output Terminals

| Connector | Description                                  |
|-----------|----------------------------------------------|
| P1        | Operating Power and CAN Bus                  |
| P2        | RTD Inputs 1 - 4                             |
| P3        | Analog Inputs 1 - 8 and Analog Outputs 1 - 4 |
| P4        | Thermocouple 1 Input                         |
| P5        | Thermocouple 2 Input                         |
| P6        | RTD Inputs 5 - 8                             |

### External Analog Input Connections

Voltage input connections are shown in Figure 11-3 and current input connections are shown in Figures 11-4 through 11-6. When using the current input, AIN V+ and AIN I+ must be tied together.

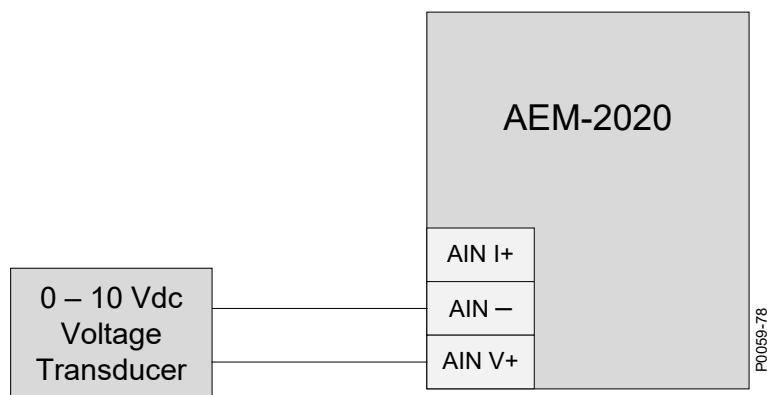


**Figure 11-3. Analog Inputs - Voltage Input Connections**

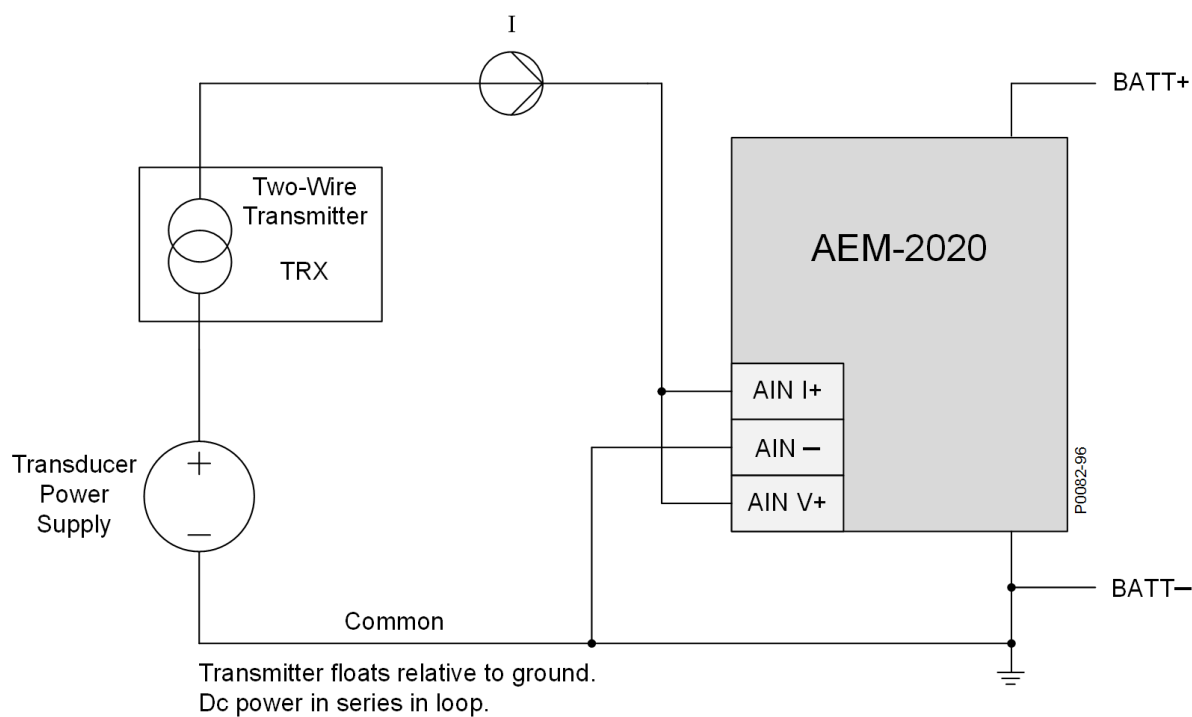


**Figure 11-4. Analog Inputs - Current Input Connections, Type II 2-Wire Circuit**

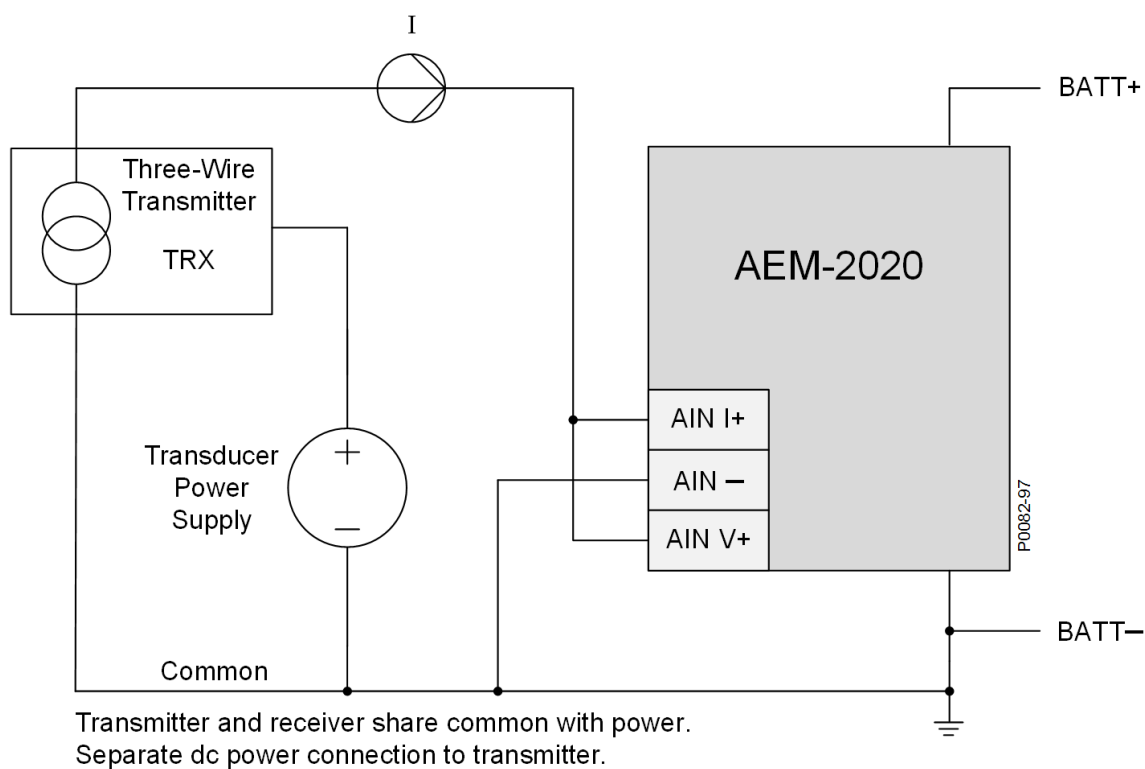


Figure 11-5. Analog Inputs - Current Input Connections, Type III 2-Wire Circuit

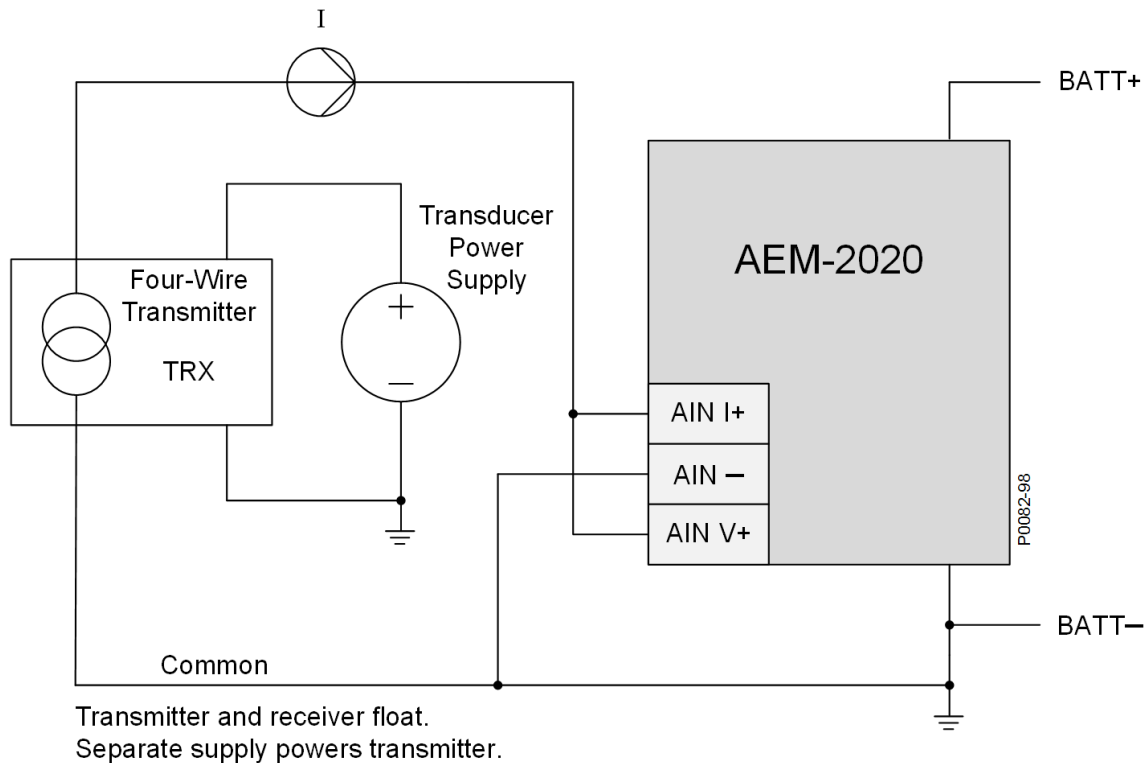


Figure 11-6. Analog Inputs - Current Input Connections, Type IV 2-Wire Circuit



### External RTD Input Connections

External 2-wire RTD input connections are shown in Figure 11-7. Figure 11-8 shows external 3-wire RTD input connections. RTD cable shields should connect to ground as close to the AEM-2020 as possible with as short a lead as practical.

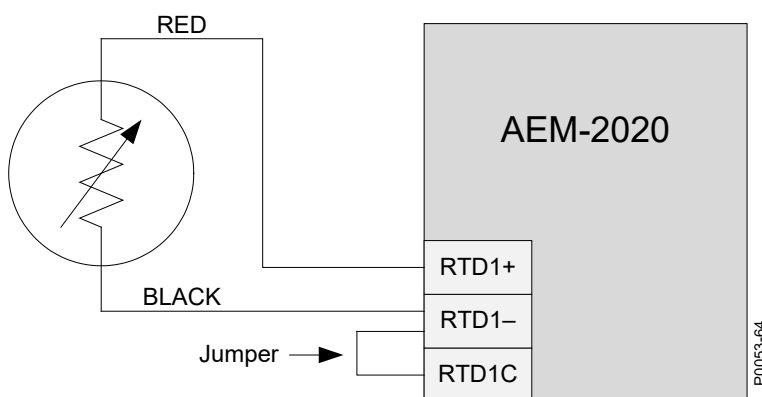


**Figure 11-7. External Two-Wire RTD Input Connections**

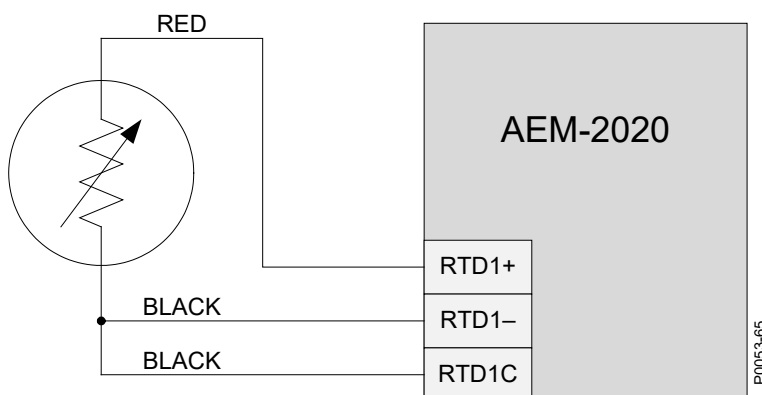


**Figure 11-8. External Three-Wire RTD Input Connections**

### CAN Bus Interface

These terminals provide communication using the SAE J1939 protocol and provide high-speed communication between the Analog Expansion Module and the DGC-2020. Connections between the AEM-2020 and DGC-2020 should be made with twisted-pair, shielded cable. CAN Bus interface terminals are listed in Table 11-3. Refer to Figure 11-9 and Figure 11-10.

**Table 11-3. CAN Bus Interface Terminals**

| Terminal                                                                                         | Description                       |
|--------------------------------------------------------------------------------------------------|-----------------------------------|
| P1- HI (CAN H)                                                                                   | CAN high connection (yellow wire) |
| P1- LO (CAN L)                                                                                   | CAN low connection (green wire)   |
| P1-  (SHIELD) | CAN drain connection              |

### Notes

1. If the AEM-2020 is providing one end of the J1939 bus, a 120-ohm, ½ watt terminating resistor should be installed across terminals P1- LO (CANL) and P1- HI (CANH).
2. If the AEM-2020 is not part of the J1939 bus, the stub connecting the AEM-2020 to the bus should not exceed 914 mm (3 ft) in length.
3. The maximum bus length, not including stubs, is 40 m (131 ft).
4. The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the AEM-2020.

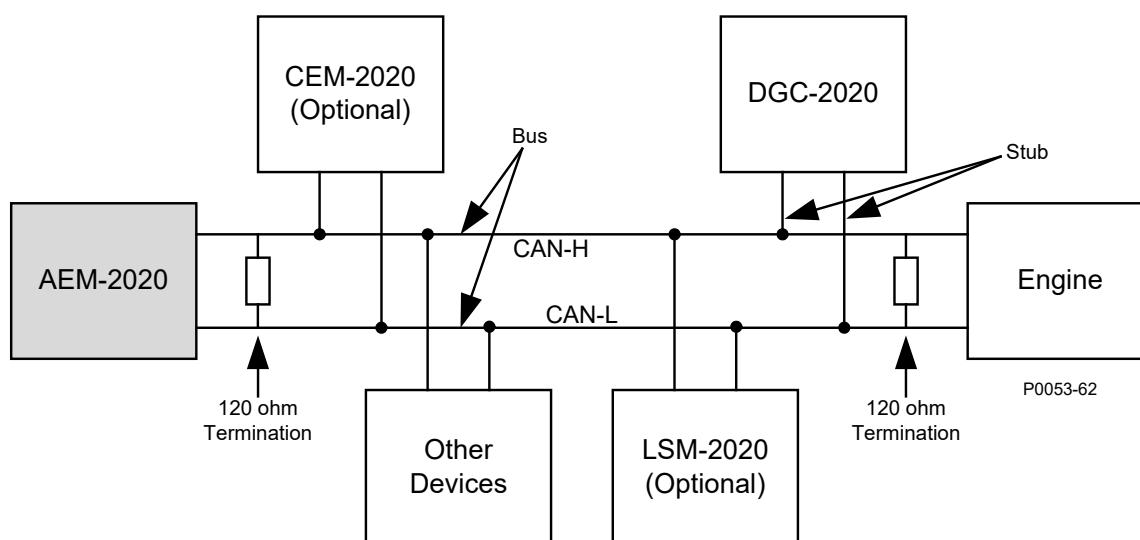


Figure 11-9. CAN Bus Interface with AEM-2020 providing One End of the Bus

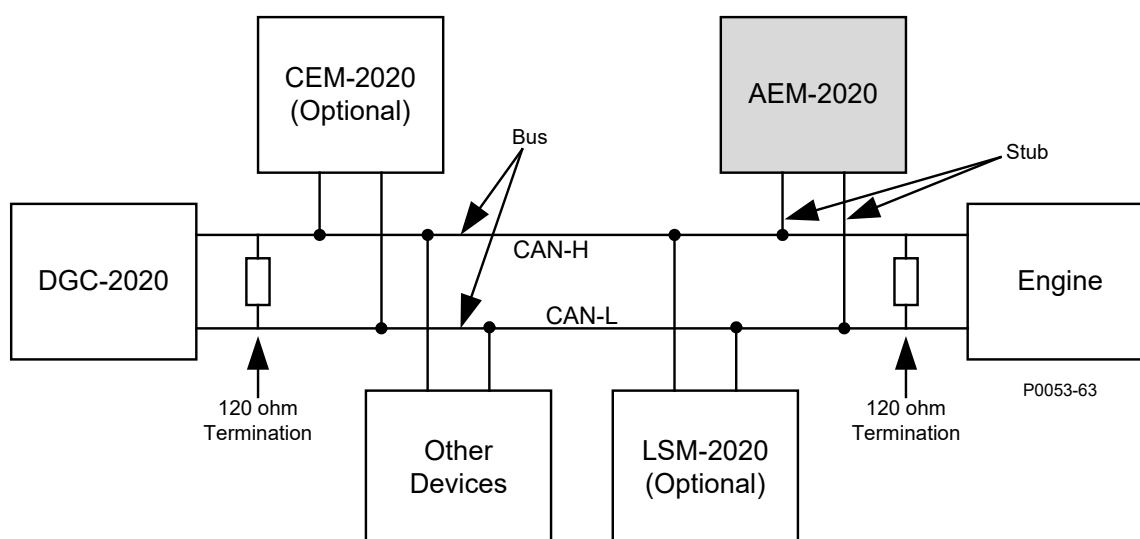


Figure 11-10. CAN Bus Interface with DGC-2020 providing One End of the Bus

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## ***Maintenance***

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Preventive maintenance consists of periodically checking that the connections between the AEM-2020 and the system are clean and tight. Analog Expansion Modules are manufactured using state-of-the-art surface-mount technology. As such, Basler Electric recommends that no repair procedures be attempted by anyone other than Basler Electric personnel.



# A • Time Overcurrent Characteristic Curves

The inverse time overcurrent characteristic curves provided by the DGC-2020 (style xxxxxExx only) closely emulate most of the common electromechanical, induction-disk, overcurrent relays sold in North America. To further improve proper relay coordination, selection of integrated reset or instantaneous reset characteristics is also provided.

## Curve Specifications

Timing Accuracy:

Within  $\pm 500$  milliseconds of indicated operating point.

Sixteen inverse time functions, one fixed time function, and one programmable time function can be selected. Characteristic curves for the inverse and definite time functions are defined by the following equation:

$$T_T = \frac{AD}{(M^N - C)^Q} + BD + K$$

Equation A-1

$$T_R = \frac{RD}{|M^2 - 1|}$$

Equation A-2

$T_T$  = Time to trip when  $M \geq 1$

$T_R$  = Time to reset if relay is set for integrating reset when  $M < 1$ . Otherwise, reset is 50 milliseconds or less

D = TIME DIAL setting (0.0 to 9.9) \*

M = Multiple of PICKUP setting (0 to 40)

A, B, C, N, K = Constants for the particular curve

R = Constant defining the reset time

This equation complies with IEEE Std C37.112 - 1996 - *IEEE Standard Inverse-Time Characteristic Equations for Overcurrent Relays*.

\* Timing range is 0.0 to 7,200 seconds when the F (fixed) curve is selected.

Table A-1 lists time characteristic curve constants. See Figures A-1 through A-16 for graphs of the characteristics.

Table A-1. 51 Time Characteristic Curve Constants

| Curve Selection | Curve Name                   | Trip Characteristic Constants |         |        |            |        |   | Reset † |
|-----------------|------------------------------|-------------------------------|---------|--------|------------|--------|---|---------|
|                 |                              | A                             | B       | C      | N          | K      | Q | R       |
| <b>S1</b>       | Short Inverse                | 0.2663                        | 0.03393 | 1      | 1.2969     | 0.028  | 1 | 0.5     |
| <b>S2</b>       | Short Inverse                | 0.0286                        | 0.0208  | 1      | 0.9844     | 0.028  | 1 | 0.094   |
| <b>L1</b>       | Long Inverse                 | 5.6143                        | 2.18592 | 1      | 1          | 0.028  | 1 | 15.75   |
| <b>L2</b>       | Long Inverse                 | 2.3955                        | 0       | 1      | 0.3125     | 0.028  | 1 | 7.8001  |
| <b>D</b>        | Definite Time                | 0.4797                        | 0.21359 | 1      | 1.5625     | 0.028  | 1 | 0.875   |
| <b>M</b>        | Moderately Inverse           | 0.3022                        | 0.1284  | 1      | 0.5        | 0.028  | 1 | 1.75    |
| <b>I1</b>       | Inverse Time                 | 8.9341                        | 0.17966 | 1      | 2.0938     | 0.028  | 1 | 9       |
| <b>I2</b>       | Inverse Time                 | 0.2747                        | 0.10426 | 1      | 0.4375     | 0.028  | 1 | 0.8868  |
| <b>V1</b>       | Very Inverse                 | 5.4678                        | 0.10814 | 1      | 2.0469     | 0.028  | 1 | 5.5     |
| <b>V2</b>       | Very Inverse                 | 4.4309                        | 0.0991  | 1      | 1.9531     | 0.028  | 1 | 5.8231  |
| <b>E1</b>       | Extremely Inverse            | 7.7624                        | 0.02758 | 1      | 2.0938     | 0.028  | 1 | 7.75    |
| <b>E2</b>       | Extremely Inverse            | 4.9883                        | 0.0129  | 1      | 2.0469     | 0.028  | 1 | 4.7742  |
| <b>A</b>        | Standard Inverse             | 0.01414                       | 0       | 1      | 0.02       | 0.028  | 1 | 2       |
| <b>B</b>        | Very Inverse ( $I^2t$ )      | 1.4636                        | 0       | 1      | 1.0469     | 0.028  | 1 | 3.25    |
| <b>C</b>        | Extremely Inverse ( $I^2t$ ) | 8.2506                        | 0       | 1      | 2.0469     | 0.028  | 1 | 8       |
| <b>G</b>        | Long Time Inverse ( $I^2t$ ) | 12.1212                       | 0       | 1      | 1          | 0.028  | 1 | 29      |
| <b>F</b>        | Fixed Time *                 | 0                             | 1       | 0      | 0          | 0.028  | 1 | 1       |
| <b>P</b>        | User Programmable ‡          | 0 to 600                      | 0 to 25 | 0 to 1 | 0.5 to 2.5 | 0.0280 | 1 | 0 to 30 |

\* Curve F has a fixed delay of one second times the Time Dial setting.

† Instantaneous or integrating reset is selected on the *Overcurrent* setup screen in BESTCOMSPUs®.

‡ The programmable curve allows for four significant digits after the decimal place for every variable.

## Time Overcurrent Characteristic Curve Graphs

Figures A-1 through A-16 illustrate the characteristic curves of the DGC-2020. Table A-2 cross-references each curve to existing electromechanical relay characteristics. Equivalent time dial settings were calculated at a value of five times pickup.

**Table A-2. Characteristic Curve Cross-Reference**

| <b>Curve</b> | <b>Curve Name</b>            | <b>Similar To</b> |
|--------------|------------------------------|-------------------|
| <b>S1</b>    | Short Inverse                | ABB CO-2          |
| <b>S2</b>    | Short Inverse                | GE IAC-55         |
| <b>L1</b>    | Long Inverse                 | ABB CO-5          |
| <b>L2</b>    | Long Inverse                 | GE IAC-66         |
| <b>D</b>     | Definite Time                | ABB CO-6          |
| <b>M</b>     | Moderately Inverse           | ABB CO-7          |
| <b>I1</b>    | Inverse Time                 | ABB CO-8          |
| <b>I2</b>    | Inverse Time                 | GE IAC-51         |
| <b>V1</b>    | Very Inverse                 | ABB CO-9          |
| <b>V2</b>    | Very Inverse                 | GE IAC-53         |
| <b>E1</b>    | Extremely Inverse            | ABB CO-11         |
| <b>E2</b>    | Extremely Inverse            | GE IAC-77         |
| <b>A</b>     | Standard Inverse             | BS 142            |
| <b>B</b>     | Very Inverse ( $I^2t$ )      | BS 142            |
| <b>C</b>     | Extremely Inverse ( $I^2t$ ) | BS 142            |
| <b>G</b>     | Long Time Inverse ( $I^2t$ ) | BS 142            |
| <b>F</b>     | Fixed Time                   | N/A               |
| <b>P</b>     | User Programmable            | N/A               |

### Time Dial Setting Cross-Reference

Although the time characteristic curve shapes have been optimized for the DGC-2020, the DGC-2020 time dial settings are not identical to the settings of electromechanical induction disk overcurrent relays. Table A-3 helps you convert the time dial settings of induction disk relays to the equivalent setting for the DGC-2020.

#### Using Table A-3

Cross-reference table values were obtained by inspection of published electromechanical time current characteristic curves. The time delay for a current of five times tap was entered into the time dial calculator function for each time dial setting. The equivalent DGC-2020 time dial setting was then entered into the cross-reference table.

If your electromechanical relay time dial setting is between the values provided in the table, it will be necessary to interpolate (estimate the correct intermediate value) between the electromechanical setting and the Basler Electric setting.

The DGC-2020 has a maximum time dial setting of 9.9. When the F (fixed) curve is selected, the maximum timing range is 7,200 seconds. The Basler Electric equivalent time dial setting for the electromechanical maximum setting is provided in the cross-reference table even if it exceeds 9.9. This allows interpolation as noted above.

Basler Electric time current characteristics are determined by a linear mathematical equation. The induction disk of an electromechanical relay has a certain degree of non linearity due to inertial and friction effects. For this reason, even though every effort has been made to provide characteristic curves with minimum deviation from the published electromechanical curves, slight deviations can exist between them.

In applications where the time coordination between curves is extremely close, we recommend that you choose the optimal time dial setting by inspection of the coordination study. In applications where

coordination is tight, it is recommended that you retrofit your circuits with Basler Electric electronic relays to ensure high timing accuracy.

**Table A-3 .Time Dial Setting Cross-Reference**

| Curve     | Equivalent To | Electromechanical Relay Time Dial Setting    |     |     |     |     |     |     |     |     |     |      |      |
|-----------|---------------|----------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
|           |               | 0.5                                          | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0 | 11.0 |
|           |               | Basler Electric Equivalent Time Dial Setting |     |     |     |     |     |     |     |     |     |      |      |
| <b>S1</b> | ABB CO-2      | 0.3                                          | 0.8 | 1.7 | 2.4 | 3.4 | 4.2 | 5.0 | 5.8 | 6.7 | 7.7 | 8.6  | 9.7  |
| <b>L1</b> | ABB CO-5      | 0.4                                          | 0.8 | 1.5 | 2.3 | 3.3 | 4.2 | 5.0 | 6.0 | 7.0 | 7.8 | 8.8  | 9.9  |
| <b>D</b>  | ABB CO-6      | 0.5                                          | 1.1 | 2.0 | 2.9 | 3.7 | 4.5 | 5.0 | 5.9 | 7.2 | 8.0 | 8.9  | 10.1 |
| <b>M</b>  | ABB CO-7      | 0.4                                          | 0.8 | 1.7 | 2.5 | 3.3 | 4.3 | 5.3 | 6.1 | 7.0 | 8.0 | 9.0  | 9.8  |
| <b>I1</b> | ABB CO-8      | 0.3                                          | 0.7 | 1.5 | 2.3 | 3.2 | 4.0 | 5.0 | 5.8 | 6.8 | 7.6 | 8.7  | 10.0 |
| <b>V1</b> | ABB CO-9      | 0.3                                          | 0.7 | 1.4 | 2.1 | 3.0 | 3.9 | 4.8 | 5.7 | 6.7 | 7.8 | 8.7  | 9.6  |
| <b>E1</b> | ABB CO-11     | 0.3                                          | 0.7 | 1.5 | 2.4 | 3.2 | 4.2 | 5.0 | 5.7 | 6.6 | 7.8 | 8.5  | 10.3 |
| <b>I2</b> | GE IAC-51     | 0.6                                          | 1.0 | 1.9 | 2.7 | 3.7 | 4.8 | 5.7 | 6.8 | 8.0 | 9.3 | 10.6 | N/A  |
| <b>V2</b> | GE IAC-53     | 0.4                                          | 0.8 | 1.6 | 2.4 | 3.4 | 4.3 | 5.1 | 6.3 | 7.2 | 8.4 | 9.6  | N/A  |
| <b>S2</b> | GE IAC-55     | 0.2                                          | 1.0 | 2.0 | 3.1 | 4.0 | 4.9 | 6.1 | 7.2 | 8.1 | 8.9 | 9.8  | N/A  |
| <b>L2</b> | GE IAC-66     | 0.4                                          | 0.9 | 1.8 | 2.7 | 3.9 | 4.9 | 6.3 | 7.2 | 8.5 | 9.7 | 10.9 | N/A  |
| <b>E2</b> | GE IAC-77     | 0.5                                          | 1.0 | 1.9 | 2.7 | 3.5 | 4.3 | 5.2 | 6.2 | 7.4 | 8.2 | 9.9  | N/A  |



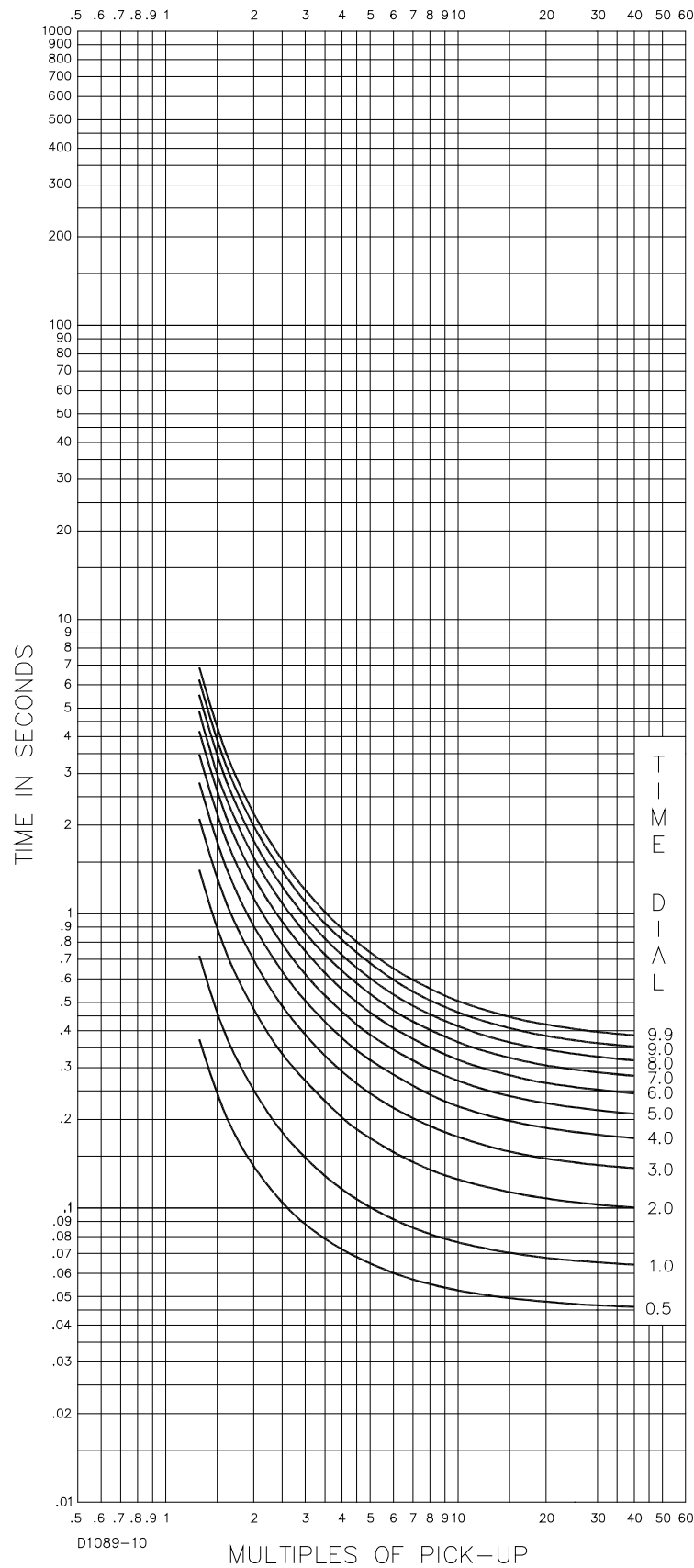


Figure A-1. Time Characteristic Curve S1, Short Inverse (Similar to ABB CO-2)

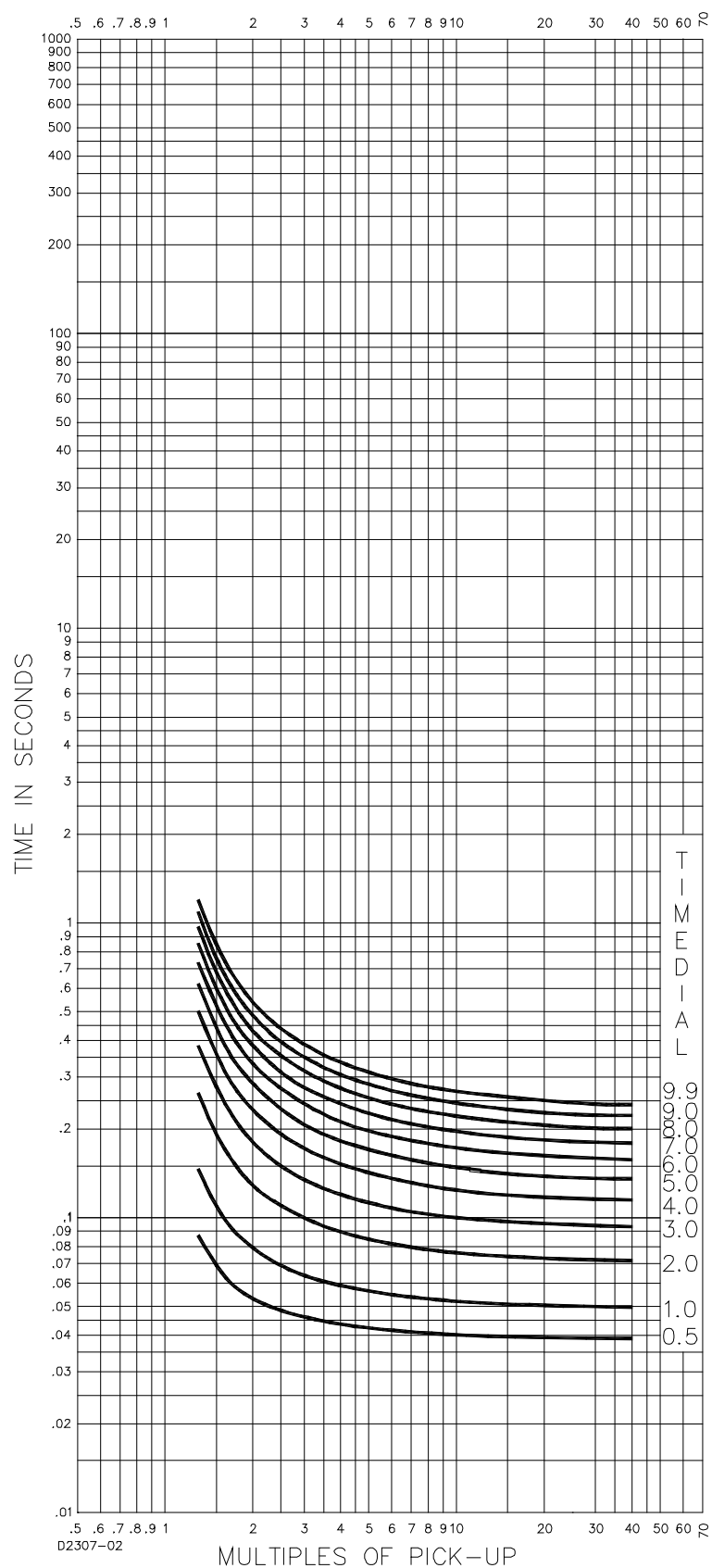


Figure A-2. Time Characteristic Curve S2, Short Inverse (Similar To GE IAC-55)

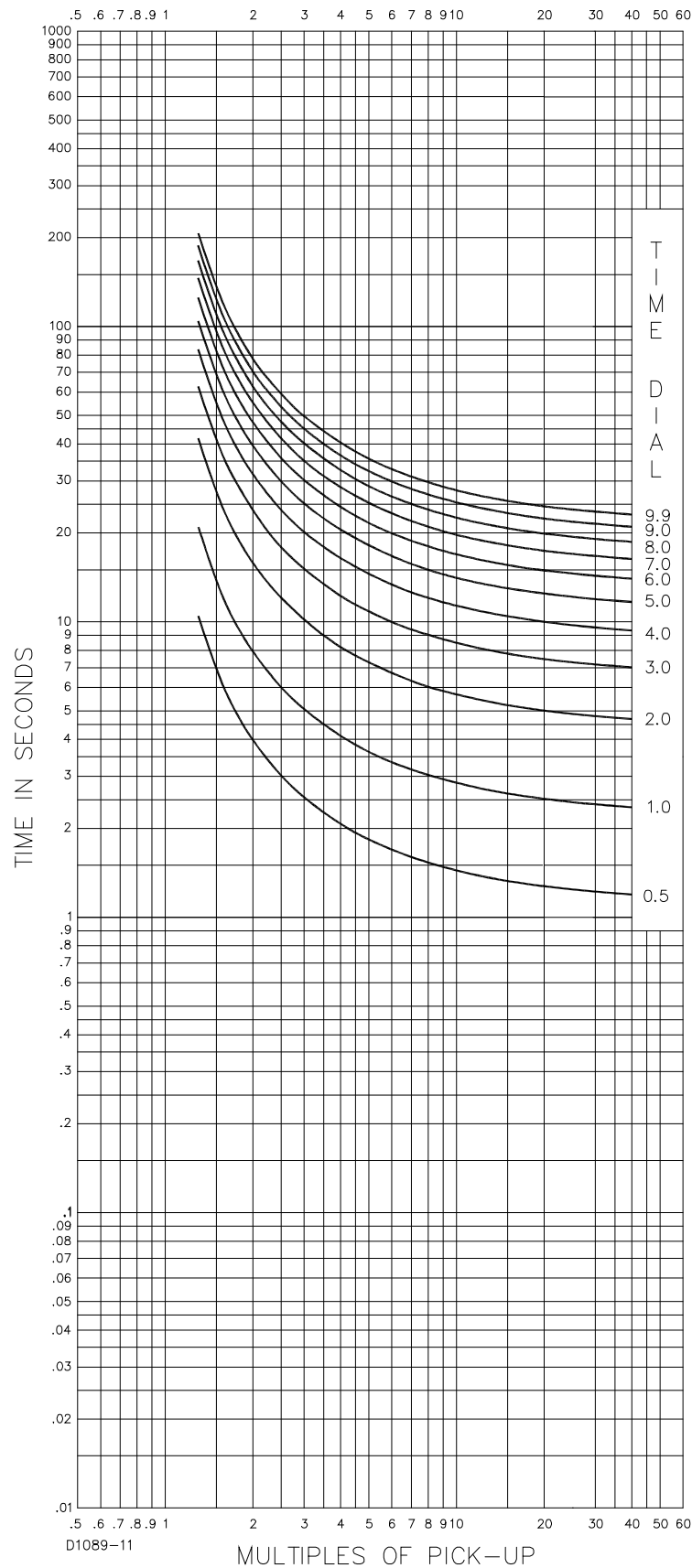


Figure A-3. Time Characteristic Curve L1, Long Inverse (Similar to ABB CO-5)

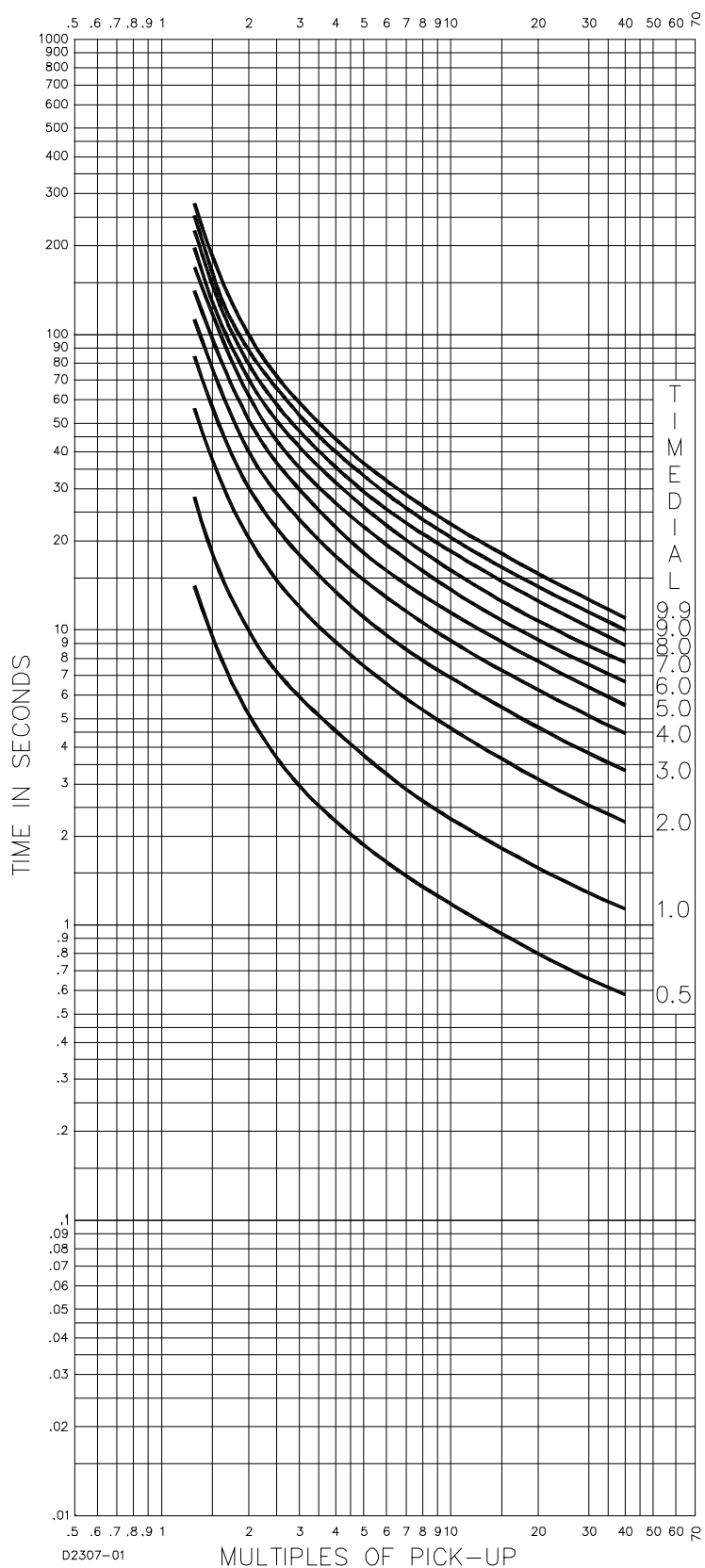


Figure A-4. Time Characteristic Curve L2, Long Inverse (Similar To GE IAC-66)

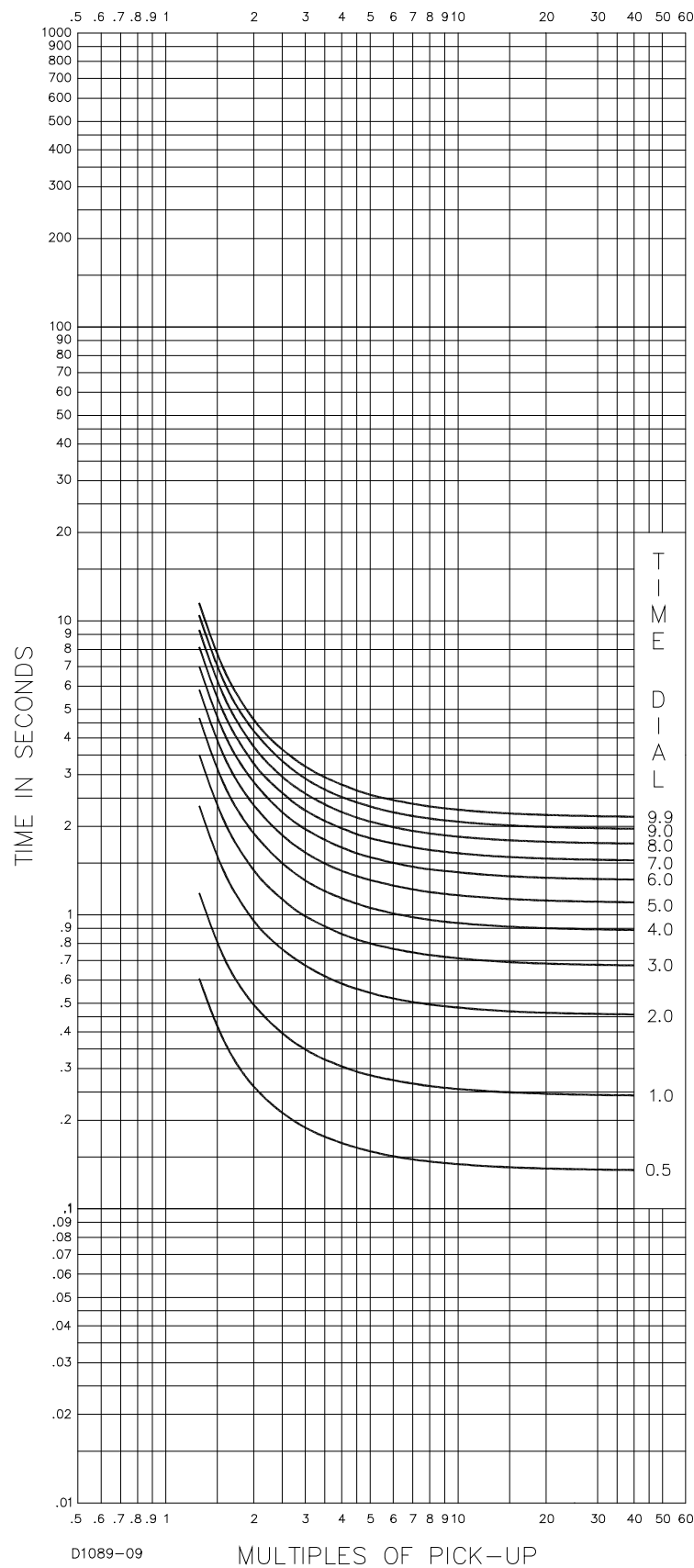


Figure A-5. Time Characteristic Curve D, Definite Time (Similar To ABB CO-6)

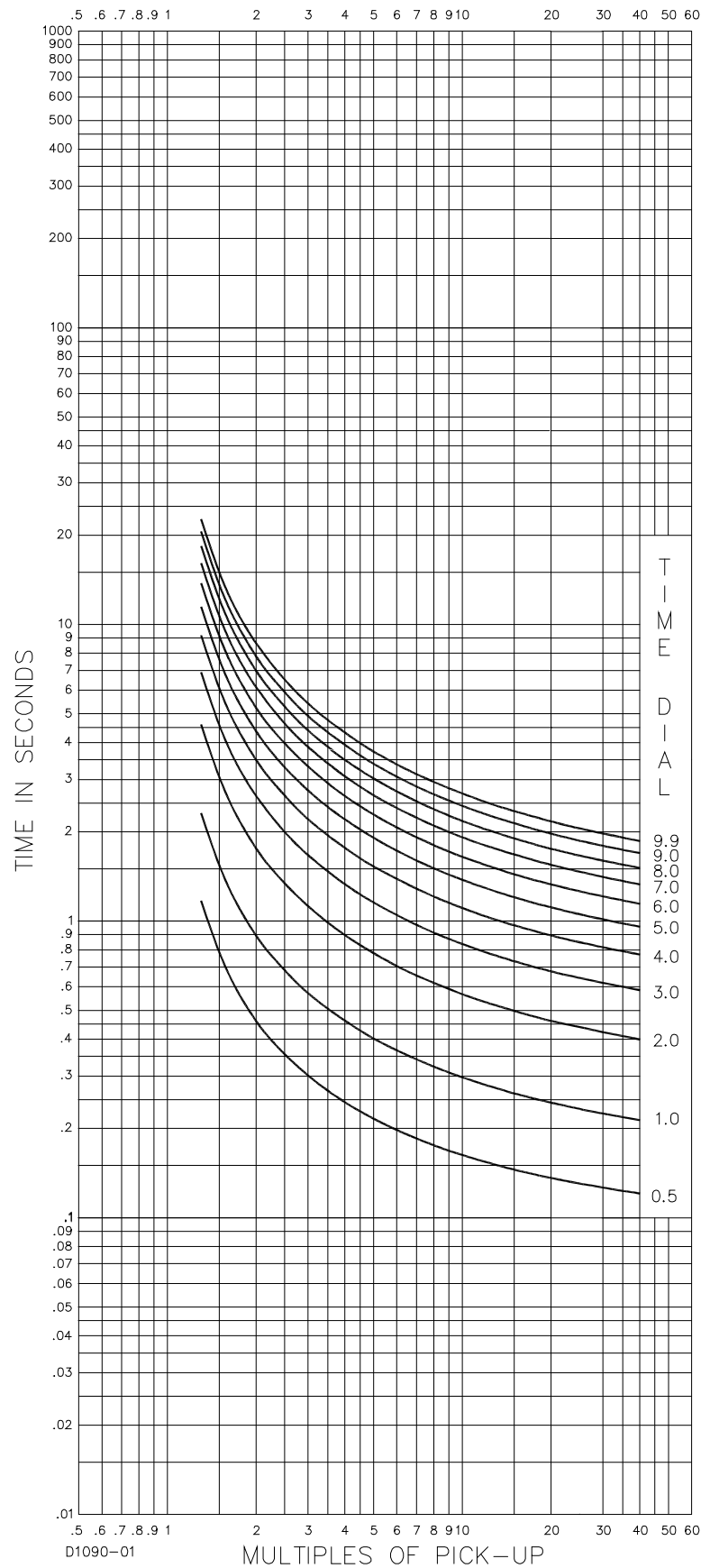


Figure A-6. Time Characteristic Curve M, Moderately Inverse (Similar to ABB CO-7)

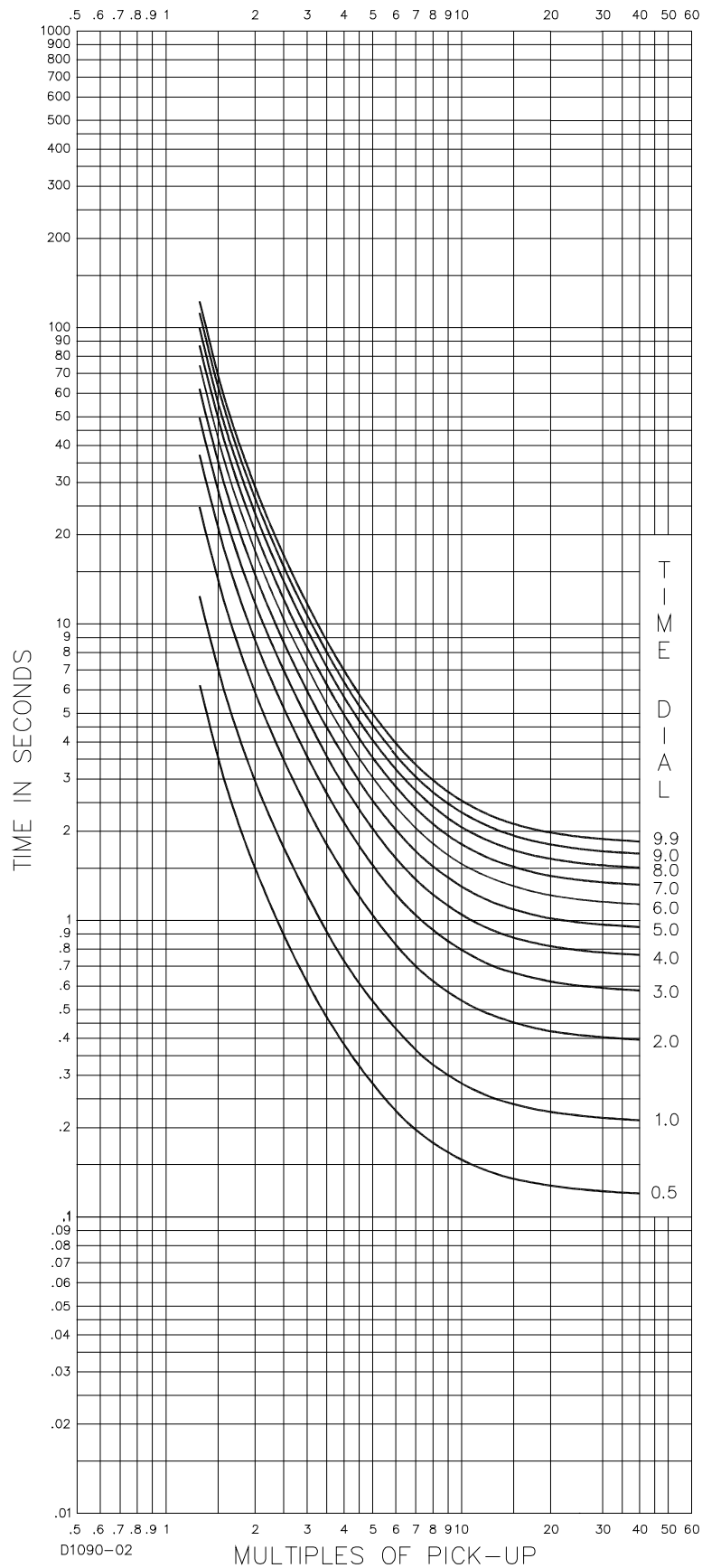


Figure A-7. Time Characteristic Curve I1, Inverse Time (Similar to ABB CO-8)

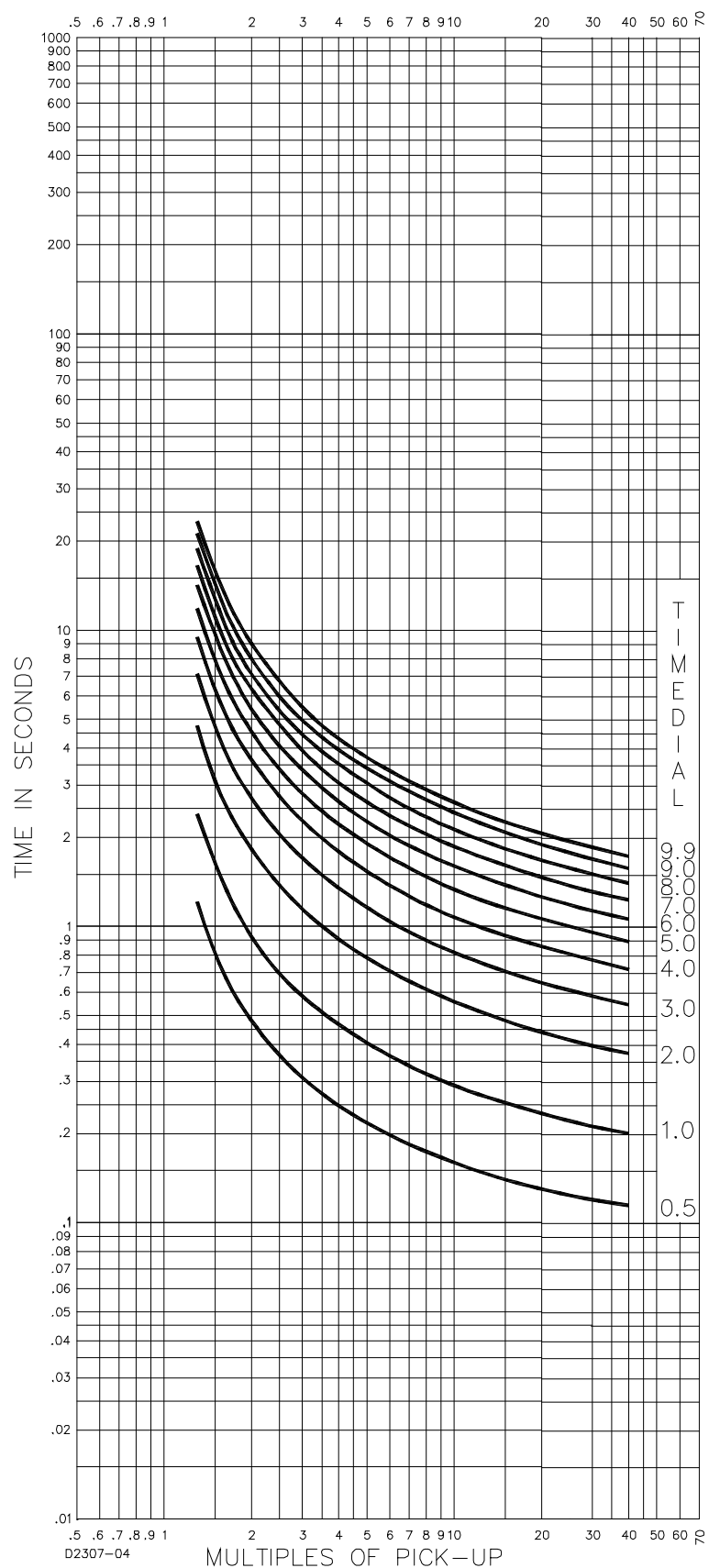


Figure A-8. Time Characteristic Curve I2, Inverse Time (Similar to GE IAC-51)



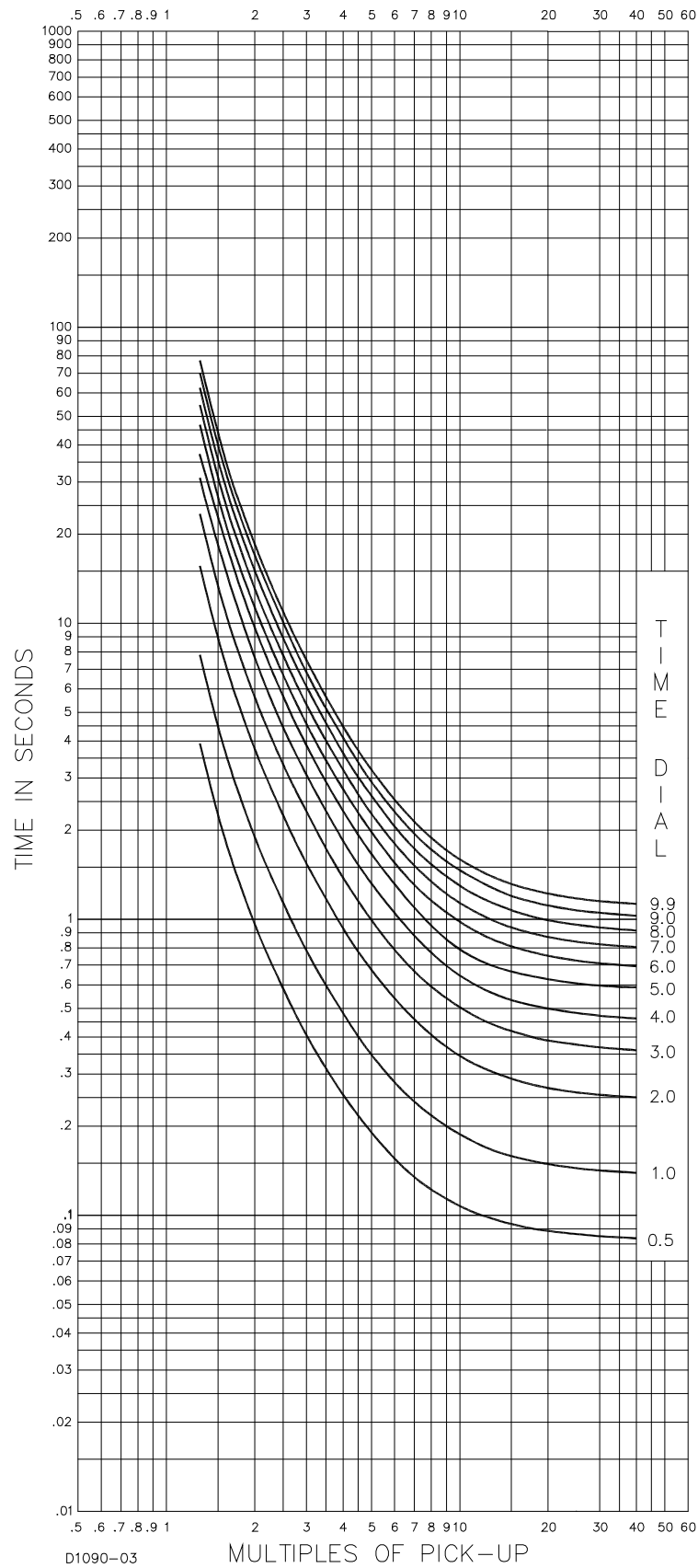


Figure A-9. Time Characteristic Curve V1, Very Inverse (Similar to ABB CO-9)

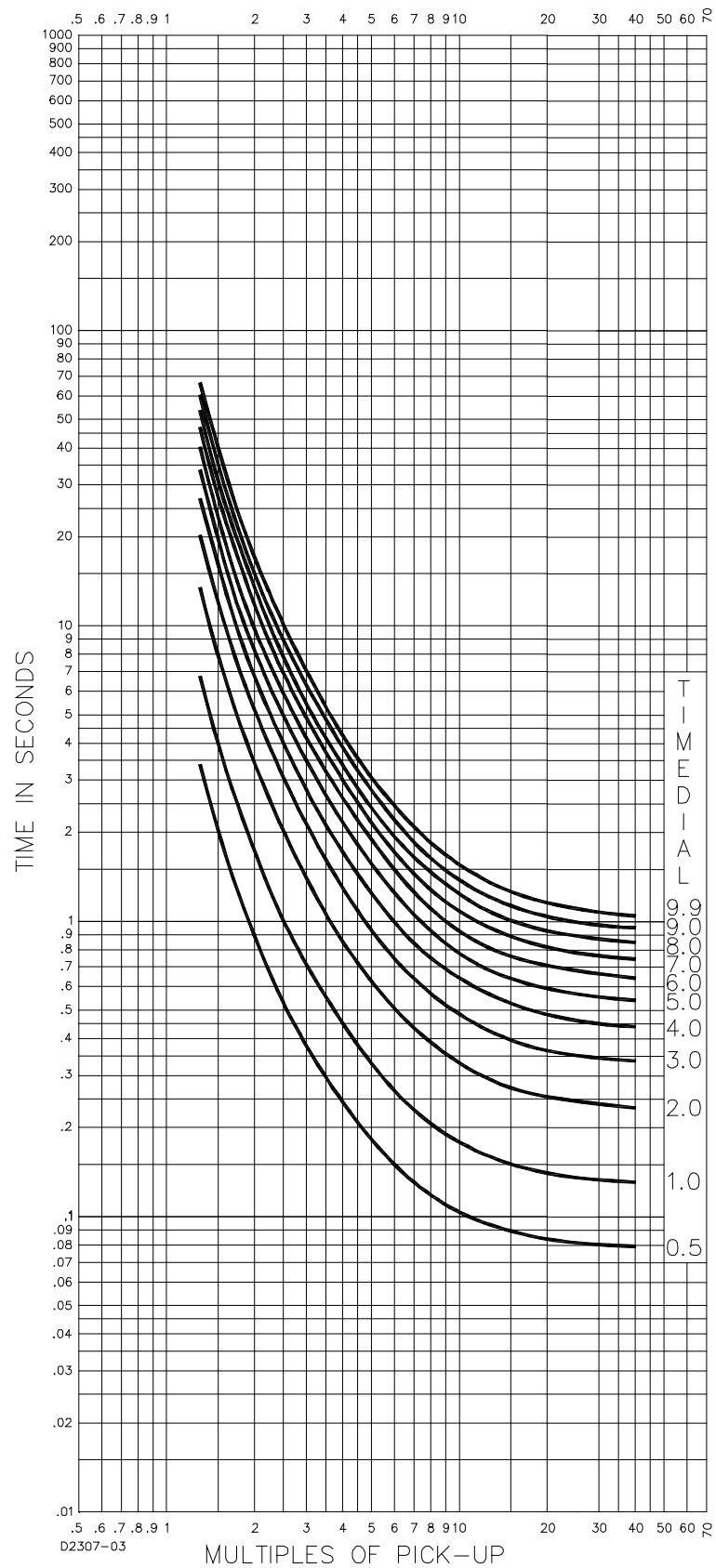


Figure A-10. Time Characteristic Curve V2, Very Inverse (Similar to GE IAC-53)

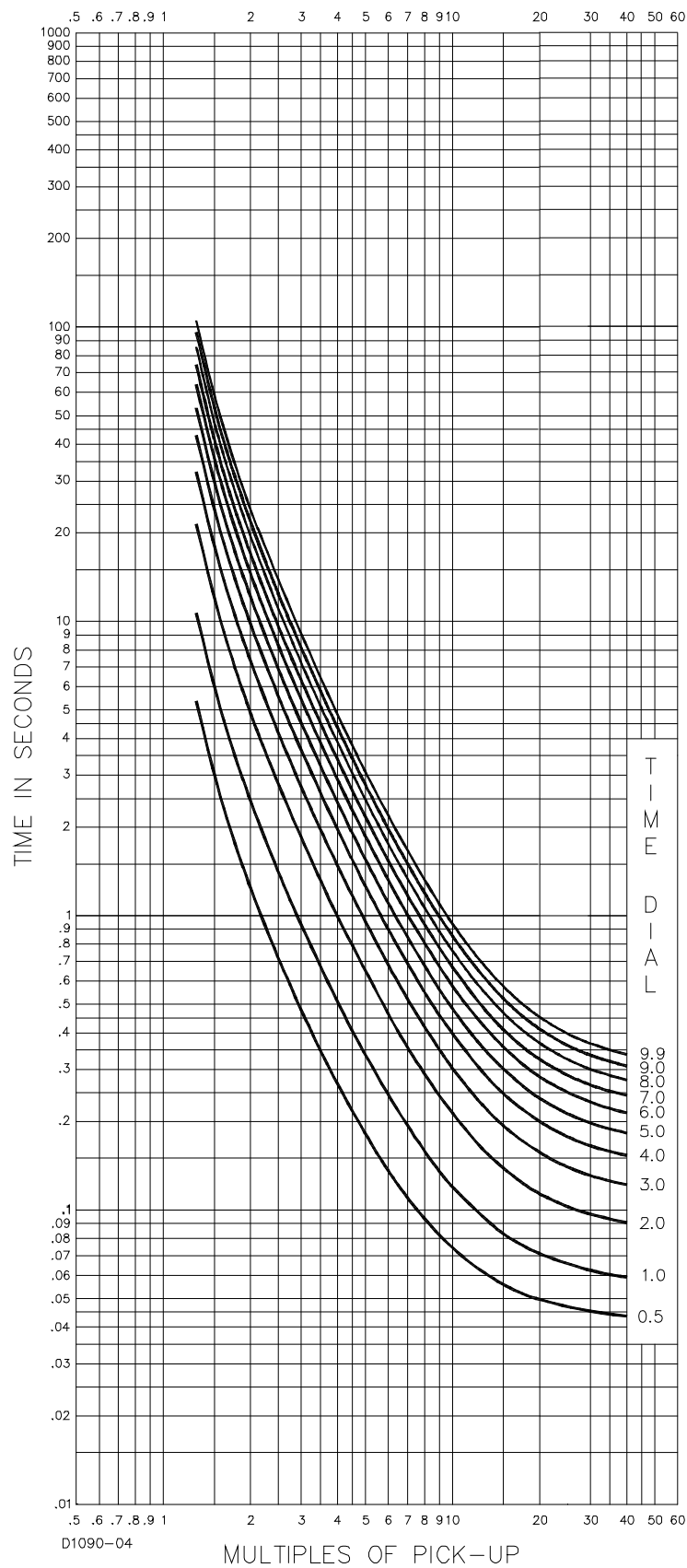


Figure A-11. Time Characteristic Curve E1, Extremely Inverse (Similar to ABB CO-11)

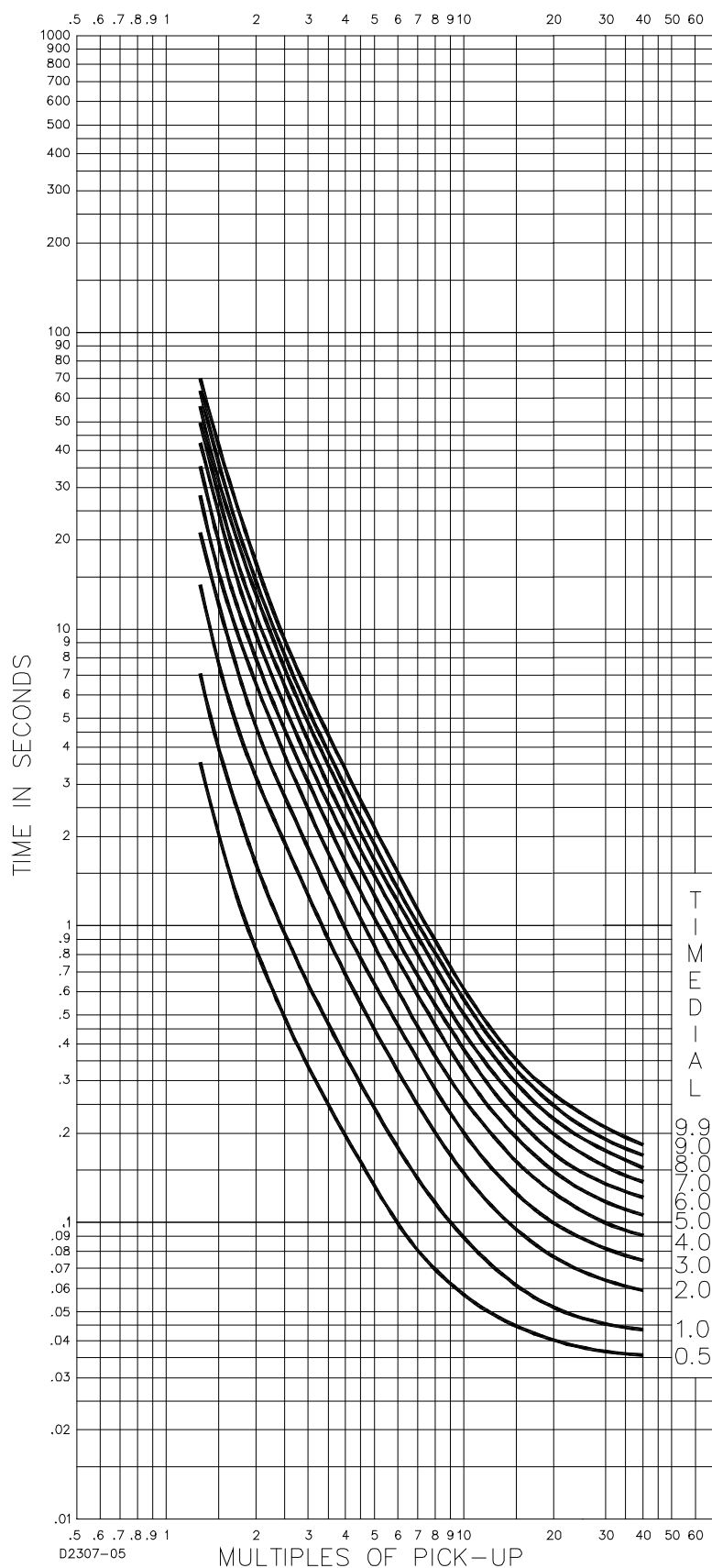


Figure A-12. Time Characteristic Curve E2, Extremely Inverse (Similar to GE IAC-77)

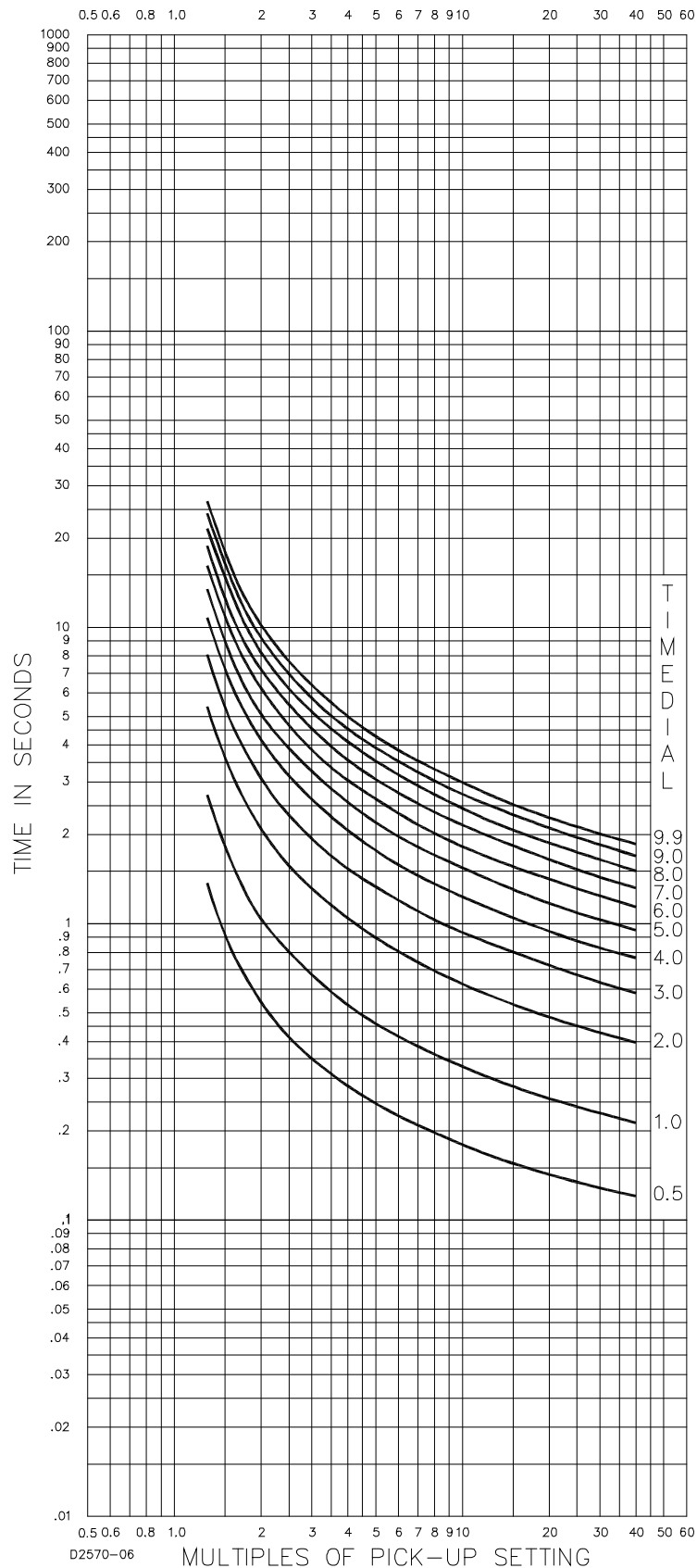


Figure A-13. Time Characteristic Curve A, Standard Inverse (BS 142)

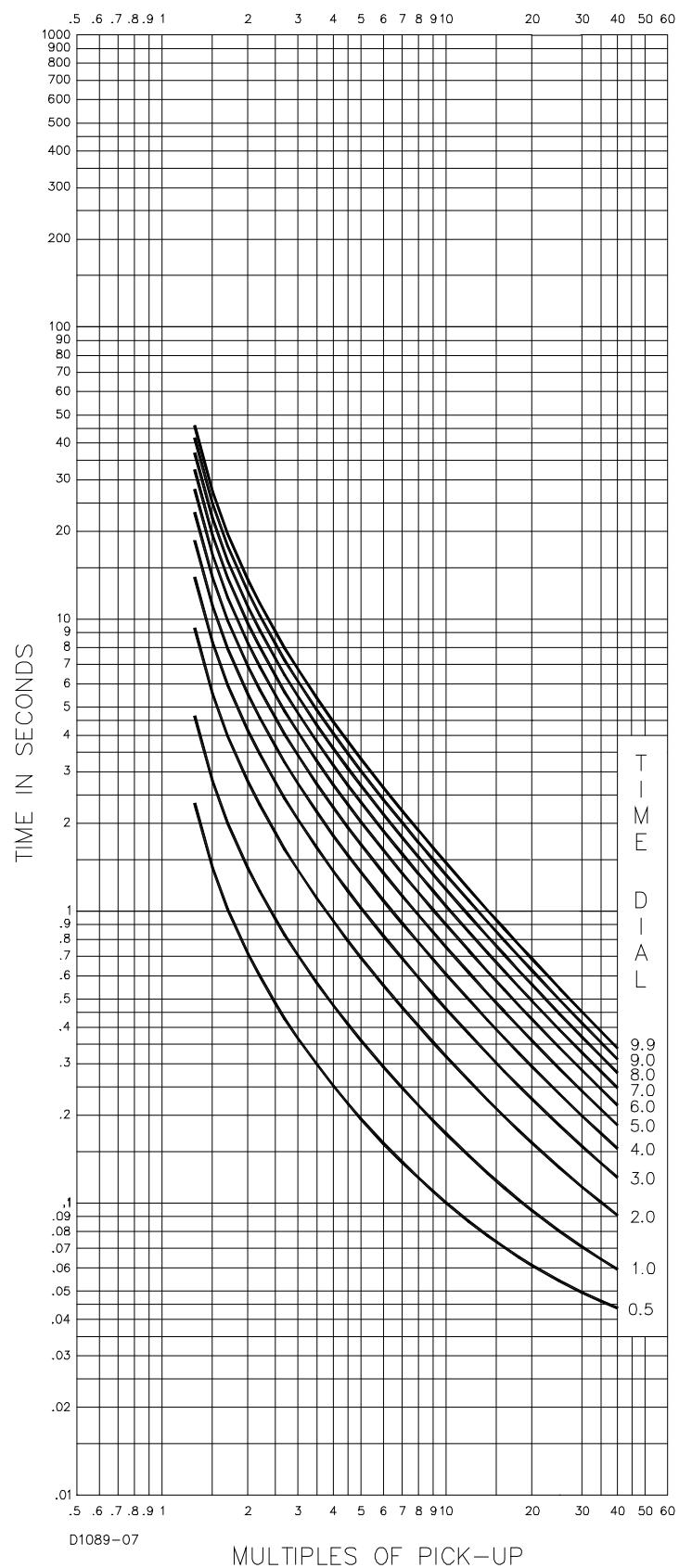


Figure A-14. Time Characteristic Curve B, Very Inverse (BS 142)

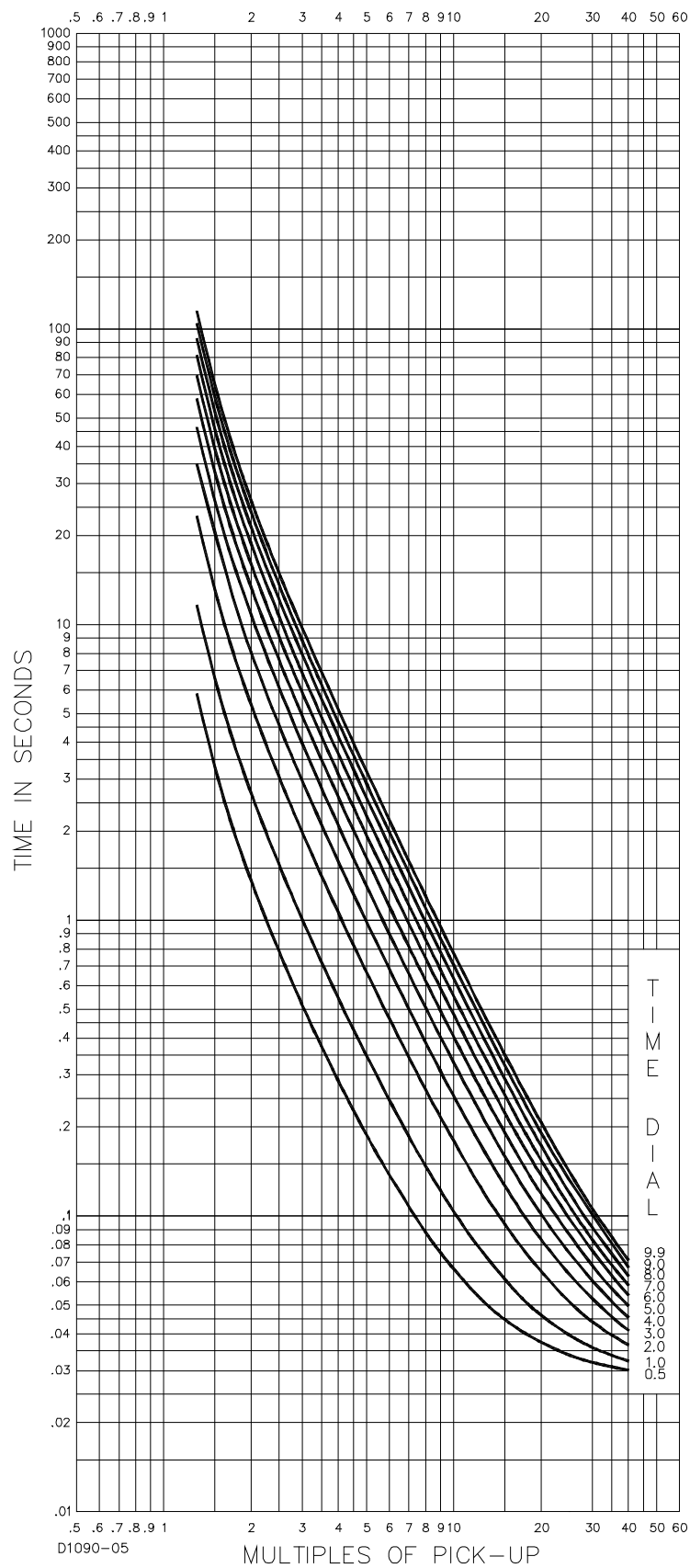


Figure A-15. Time Characteristic Curve C, Extremely Inverse (BS 142)

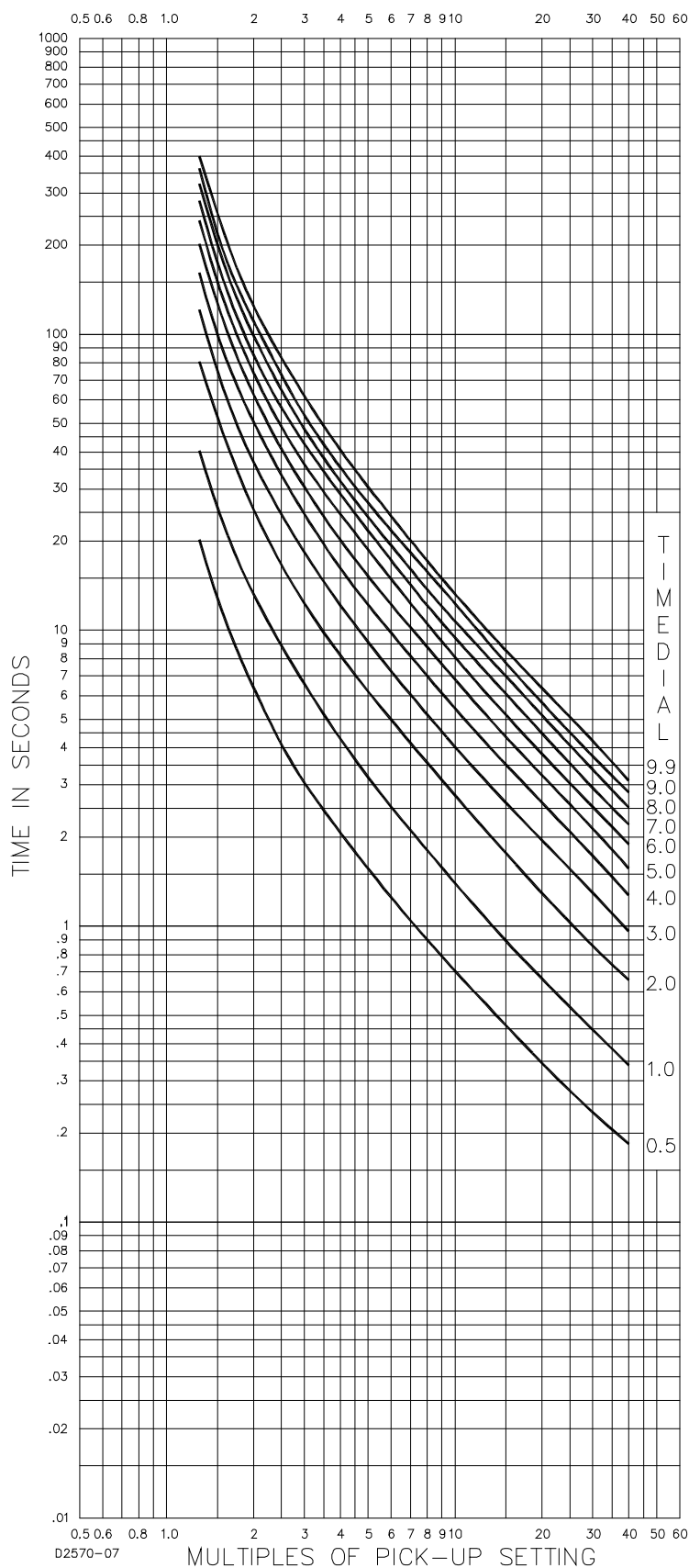


Figure A-16. Time Characteristic Curve G, Long Time Inverse (BS 142)



# B • Modbus® Communication

## General Overview

An optional feature of the DGC-2020 performs Modbus® communications by emulating a subset of the Modicon 984 Programmable Controller. This document describes the Modbus communications protocol employed by the DGC-2020 and how to exchange information with the DGC-2020 over a Modbus network.

### Caution

This product contains one or more *nonvolatile memory* devices. Nonvolatile memory is used to store information (such as settings) that needs to be preserved when the product is power-cycled or otherwise restarted. Established nonvolatile memory technologies have a physical limit on the number of times they can be erased and written. In this product, the limit is 10,000 erase/write cycles for Rev. 1 hardware and 100,000 erase/write cycles for Rev. 2 or 3 hardware. During product application, consideration should be given to communications, logic, and other factors that may cause frequent/repeated writes of settings or other information that is retained by the product. Applications that result in such frequent/repeated writes may reduce the useable product life and result in loss of information and/or product inoperability.

The DGC-2020 maps all parameters into the Modicon 984 Holding Register address space (4XXXX). Refer to *MAPPING - DGC 2020 Parameters into MODICON ADDRESS SPACE* in this section.

### Notes

For applications where a DGC-2020 is replacing a DGC-500, DGC-1000, or DGC-2000, registers 40000 - 41999 are identical to the data that was present in those products for a seamless transition. There is some overlap between the sets of registers which constitutes having two separate legacy register tables, one for both DGC-500 and DGC-1000 and another for DGC-2000.

The 42XXX registers contain all information included in the DGC-2020 and should be used for any new Modbus applications

## Intended Use of the Communications Protocol

This document provides the necessary information for 3rd party OEMs to develop in-house software to communicate with the DGC-2020 via Modbus protocol. This will allow the exchange of setup information and measured data between a Modbus Master Station and the DGC-2020.

The DGC-2020 data supported for remote access is listed in *MAPPING - DGC 2020 Parameters into MODICON ADDRESS SPACE* in this section.

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## ***Detailed Description of DGC-2020 Modbus® Protocol***

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### **Modbus® Protocol Overview**

Modbus communications use a master-slave technique in which only the master can initiate a transaction, called a query. The slave addressed by the query will respond by either supplying the requested data to the master or by performing the requested action. A slave device never initiates communications on the Modbus, and will always generate a response to the query unless certain error conditions occur. The DGC-2020 is designed to communicate on the Modbus only as a slave device.

A master can query slaves individually or query all slaves collectively by initiating a broadcast message. A slave does not send a response message to a broadcast query.

If a query requests actions unable to be performed by the slave, the slave response message will contain an Exception Response Code defining the error detected.

Query and response messages share the same message structure. Each message is comprised of four message fields: the Device Address, the Function Code, the Data Block, and the Error Check field. Subsequent sections in this document detail each message field and the corresponding functionality supported by the DGC-2020.

Query / Response Message Structure:

- Device Address
- Function Code
- Eight-Bit Data Bytes
- Error Check

#### **Device Address Field**

The Device Address field contains the unique Modbus address of the slave being queried. The addressed slave will repeat its address in the Device Address field of the response message. This field is 1 byte.

#### **Function Code Field**

The Function Code field in the Query message defines the action to be taken by the addressed slave. This field is echoed in the Response message, and will be altered by setting the MSB of the field to "1" if the response is an error response. This field is 1 byte.

#### **Data Block Field**

The query Data block contains additional information needed by the slave to perform the requested function. The response Data block contains data collected by the slave for the queried function. An error response will substitute an Exception Response Code for the Data Block. The length of this field varies with each query.

#### **Error Check Field**

The Error Check field provides a method for the slave to validate the integrity of the query message contents and allows the master to confirm the validity of response message contents. This field is 2 bytes.

### **Serial Transmission Details**

A standard Modbus network offers 2 transmission modes for communication: ASCII or RTU. The DGC-2020 supports only the RTU (Remote Terminal Unit) mode.

Each 8-bit byte in a message contains two 4-bit hexadecimal characters. The message is transmitted in a continuous stream with the LSB of each byte of data transmitted first. Transmission of each 8-bit data byte occurs with 1 start bit and 1 stop bit. A ninth data bit is added when parity is selected. Parity checking is user-configurable to even, odd or none. The transmission baud rate is also user-configurable, and both parity and baud rate can be altered during real-time operation. If altered, the new baud rate and / or parity will not be enforced until the response message to the current query has completed. The DGC-2020 supported baud rates are 9600, 4800, 2400, and 1200.

## Message Framing / Timing Considerations

When receiving a message, the DGC-2020 will allow maximum inter-byte latency up to 3.5 - 4.0 character times before considering the message complete.

Once a valid query is received, the DGC-2020 waits 10 msec. before responding.

## Error Handling and Exception Responses

Any query received that contains a non-existent device address, a framing error or CRC error will be ignored - no response will be transmitted. Queries addressed to a DGC-2020 with an unsupported function code, unsupported register references, or illegal values in the data block will result in an error response message with an Exception Response Code. The Exception Response codes supported by the DGC-2020 are listed in Table B-1.

**Table B-1. Exception Response Codes**

| Code | Name                 | Meaning                                                                                                                              |
|------|----------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| 01   | Illegal Function     | The query Function/Subfunction Code is unsupported; query read of more than 125 registers; query preset of more than 100 registers   |
| 02   | Illegal Data Address | A register referenced in the data block does not support queried read/write; query preset of a subset of a numerical register group. |
| 03   | Illegal Data Value   | A preset register data block contains an incorrect number of bytes or one or more data values out of range.                          |

## Detailed DGC-2020 Message Definition

### Device Address

The DGC-2020 Device Address can be any value in the Modbus protocol Device Address range (1 - 247). A query with a Device Address of 0 signifies a Broadcast message to all slaves - the connected DGC-2020s will not respond to the broadcast query.

### Function Code and Data Block

The DGC-2020 maps all parameters into the Modicon 984 Holding Register address space (4XXXX) and supports the following Function Codes:

- Function 01 – Read Coils
- Function 03 - Read Holding Registers
- Function 06 - Preset Single Register, Non-Broadcast & Broadcast
- Function 08 - Subfunction 00 - Diagnostics: Return Query Data
- Function 16 - Preset Multiple Registers, Non-Broadcast & Broadcast

The only Broadcast query supported by the DGC-2020 is the Preset Multiple Registers query.

### Read Coils

#### Query

This query message requests a coil or coils to be read. The data block contains the starting coil address and the quantity of coils to be read. A coil address of N will read coil N+1. If the query is a broadcast (device address = 0), no response message is returned.

Device Address

Function Code = 01 (hex)

Starting Address Hi

Starting Address Lo

No. of Coils Hi

No. of Coils Lo

CRC Hi error check

CRC Lo error check

The number of coils cannot exceed 2000 without causing an error response with the exception code for an illegal function.

### Response

The response message contains the data queried. The data block contains the block length in bytes followed by the data (one Data Hi byte and one Data Lo byte) for each requested coil.

Device Address

Function Code = 01 (hex)

No. of Coils Hi

No. of Coils Lo

Data Hi (For each requested coil, there is one Data Hi and one Data Lo.)

Data Lo

.

.

Data Hi

Data Lo

The Read Coils are listed in *Appendix I, Modbus Read Coils*.

### Read Holding Registers

#### *Read Holding Registers - General*

#### QUERY:

This query message requests a register or block of registers to be read. The data block contains the starting register address and the quantity of registers to be read. A register address of N will read Holding Register N+1.

Device Address

Function Code 03 (hex)

Starting Address Hi

Starting Address Lo

No. of Registers Hi

No. of Registers Lo

CRC Error Check

The number of registers cannot exceed 125 without causing an error response with Exception Code "Illegal Function".

Queries to read Write Only or unsupported registers result in an error response with Exception Code of "Illegal Data Address".

#### RESPONSE:

The response message contains the data queried, respectively. The data block contains the block length in bytes followed by the data for each requested register. Attempting to read an unused register or a register which does not support read results in an error response with Exception Code of "Illegal Data Address".

Device Address

Function Code 03 (hex)

Byte Count

Data Hi

Data Lo

.

.

.

Data Hi

Data Lo  
CRC Error Check

### Return Query Data

This query contains data to be returned (looped back) in the response. The response and query messages should be identical.

Device Address  
Function Code 08 (hex)  
Subfunction Hi 00 (hex)  
Subfunction Lo 00 (hex)  
Data Hi  
Data Lo  
CRC Error Check

### Preset Multiple Registers, Non-Broadcast & Broadcast

#### *Preset Multiple Registers - General*

#### QUERY:

This query message requests a register or block of registers to be written. The data block contains the starting address and the quantity of registers to be written, followed by the Data Block byte count and data. A device address is 0 for a broadcast query.

A register address of N will write Holding Register N+1.

No query data will be written (non-broadcast or broadcast) if any of the following exceptions occur:

- Queries writing to Read Only or unsupported registers result in an error response with Exception Code of "Illegal Data Address".
- Queries attempting to write more than 100 registers cause an error response with Exception Code "Illegal Function".
- An incorrect Byte Count will result in an error response with Exception Code of "Illegal Data Value".
- There are several instances of registers that are grouped together (signified as DP or TP) to collectively represent a single numerical (vs. ASCII string) DGC-2020 parameter value. A query to write a subset of such a register group will result in an error response with Exception Code "Illegal Data Address".
- A query to write an unacceptable value (out of range) to a register results in an error response with Exception Code of "Illegal Data Value".

Device Address  
Function Code 10 (hex)  
Starting Address Hi  
Starting Address Lo  
No. of Registers Hi  
No. of Registers Lo  
Byte Count  
Data Hi  
Data Lo  
.  
.  
.  
Data Hi  
Data Lo  
CRC Error Check

**RESPONSE:**

The response message echoes the starting address and the number of registers. There is no response message when the query is broadcast.

|                     |          |
|---------------------|----------|
| Device Address      |          |
| Function Code       | 10 (hex) |
| Starting Address Hi |          |
| Starting Address Lo |          |
| No. of Registers Hi |          |
| No. of Registers Lo |          |
| CRC Error Check     |          |

**Preset Single Register, Non-Broadcast & Broadcast****QUERY:**

This query message requests a register to be written. A device address is 0 for a broadcast query.

No query data will be written (non-broadcast or broadcast) if any of the following exceptions occur:

- Queries writing to Read Only or unsupported registers result in an error response with Exception Code of "Illegal Data Address".
- There are several instances of registers that are grouped together (signified as DP or TP) to collectively represent a single numerical (vs. ASCII string) DGC-2020 parameter value. A query to write a subset of such a register group will result in an error response with Exception Code "Illegal Data Address".
- A query to write an unacceptable value (out of range) to a register results in an error response with Exception Code of "Illegal Data Value".

|                 |          |
|-----------------|----------|
| Device Address  |          |
| Function Code   | 06 (hex) |
| Address Hi      |          |
| Address Lo      |          |
| Data Hi         |          |
| Data Lo         |          |
| CRC Error Check |          |

**RESPONSE:**

The response message echoes the address and the value written. There is no response message when the query is broadcast.

|                 |          |
|-----------------|----------|
| Device Address  |          |
| Function Code   | 06 (hex) |
| Address Hi      |          |
| Address Lo      |          |
| Data Hi         |          |
| Data Lo         |          |
| CRC Error Check |          |

**Data Formats****Short Integer Data Format (INT8)**

The Modbus short integer data format uses a single holding register to represent an 8 bit data value. The holding register high byte will always be zero.

Example: The value 132 represented in short integer format is hexadecimal 0x84. This number will read from a holding register as follows:

| <u>Holding Register</u> | <u>Value</u> |
|-------------------------|--------------|
| K (Hi Byte)             | hex 00       |
| K (Lo Byte)             | hex 84       |

The same byte alignments are required to write.

### Integer Data Format (INT16)

The Modbus integer data format uses a single holding register to represent a 16-bit data value.

Example: The value 4660 represented in integer format is hexadecimal 0x1234. This number will read from a holding register as follows:

| <u>Holding Register</u> | <u>Value</u> |
|-------------------------|--------------|
| K (Hi Byte)             | hex 12       |
| K (Lo Byte)             | hex 34       |

The same byte alignments are required to write.

### Long Integer Data Format (INT32)

The Modbus long integer data format uses two consecutive holding registers to represent a 32-bit data value. The first register contains the low-order 16 bits and the second register contains the high-order 16 bits.

Example: The value 95,800 represented in long integer format is hexadecimal 0x00017638. This number will read from two consecutive holding registers as follows:

| <u>Holding Register</u> | <u>Value</u> |
|-------------------------|--------------|
| K (Hi Byte)             | hex 76       |
| K (Lo Byte)             | hex 38       |
| K+1 (Hi Byte)           | hex 00       |
| K+1 (Lo Byte)           | hex 01       |

The same byte alignments are required to write.

### 32-bit Bit-Mapped Parameter Mapping

The register arrangement for 32-bit bit-mapped parameters is illustrated in Figure B-1. The Alarm Metering registers (44812/44813) are shown as an example. In this example, Bit 25 is set indicating an Overcrank condition and Bit 17 is set indicating a Global Alarm.

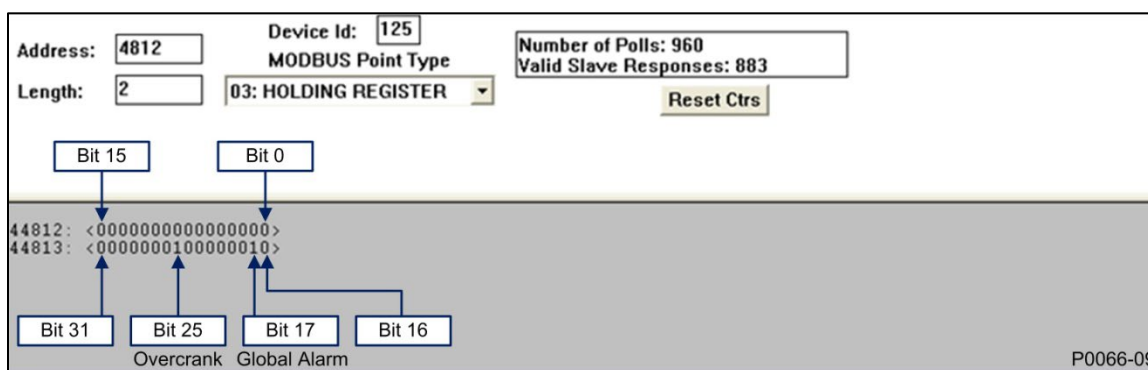


Figure B-1. 32-Bit Bit-Mapped Parameter Mapping

The Alarm Metering register bits are defined as follows:

- Bit 0 through Bit 16 = Not Used
- Bit 17 = Global Alarm
- Bit 18 = Auto Restart Failure
- Bit 19 = Fuel Leak Detect
- Bit 20 = Battery Charger Failure
- Bit 21 = Transfer Fail
- Bit 22 = Low Coolant Level
- Bit 23 = ECU Shutdown
- Bit 24 = Emergency Shutdown
- Bit 25 = Overcrank
- Bit 26 = Loss of ECU Comms
- Bit 27 = Global Sender Fail
- Bit 28 = Low Fuel Level
- Bit 29 = Low Oil Pressure
- Bit 30 = Hi Coolant Temp
- Bit 31 = Overspeed

### Floating Point Data Format

The Modbus floating point data format uses two consecutive holding registers to represent a data value. The first register contains the low-order 16 bits of the following 32-bit format:

- MSB is the sign bit for the floating-point value (0 = positive).
- The next 8 bits are the exponent biased by 127 decimal.
- The 23 LSBs comprise the normalized mantissa. The most-significant bit of the mantissa is always assumed to be 1 and is not explicitly stored, yielding an effective precision of 24 bits.

The value of the floating-point number is obtained by multiplying the binary mantissa times two raised to the power of the unbiased exponent. The assumed bit of the binary mantissa has the value of 1.0, with the remaining 23 bits providing a fractional value. Table B-2 shows the floating-point format.

Table B-2. Floating Point Format

| Sign  | Exponent + 127 | Mantissa |
|-------|----------------|----------|
| 1 bit | 8 bits         | 23 bits  |

The floating-point format allows for values ranging from approximately  $8.43 \times 10^{-37}$  to  $3.38 \times 10^{38}$ . A floating-point value of all zeroes is the value zero. A floating-point value of all ones (not a number) signifies a value currently not applicable or disabled.

**Example:** The value 95,800 represented in floating point format is hexadecimal 47BB1C00. This number will read from two consecutive holding registers as follows:

| Holding Register | Value  |
|------------------|--------|
| K (Hi Byte)      | hex 1C |
| K (Lo Byte)      | hex 00 |



|               |        |
|---------------|--------|
| K+1 (Hi Byte) | hex 47 |
| K+1 (Lo Byte) | hex BB |

The same byte alignments are required to write.

### Double Precision Data Format (DP)

The Modbus Double Precision data format (DP) uses 2 consecutive registers to represent a data value. The first register contains the high-order 16 bits of double precision data, and is the actual data value / 10,000.

The second register contains the low-order 16 bits of double precision data, and is the actual data value modulus 10,000.

### Triple Precision Data Format (TP)

The Modbus Triple Precision data format (TP) uses 3 consecutive registers to represent a data value. The first register contains the high-order 16 bits of triple precision data, and is the actual data value / 100,000,000. The modulus from this operation is divided by 10,000 to arrive at the value of the second register, and the modulus of this last operation is the value of the third register (the low-order 16 bits of triple precision).

### Error Check

This field contains a 2-byte CRC value for transmission error detection. The master first calculates the CRC and appends it to the query message. The DGC-2020 recalculates the CRC value for the received query and performs a comparison to the query CRC value to determine if a transmission error has occurred. If so, no response message is generated. Otherwise, the slave calculates a new CRC value for the response message and appends it to the message for transmission.

Reference the "Modicon Modbus Protocol Reference Guide", PI-MBUS-300 Rev. E, pages 112 - 115 for an excellent explanation and implementation of the CRC-16 algorithm.

The CRC calculation is performed using all bytes of the Device Address, Function Code, and Data Block fields. A 16-bit CRC-register is initialized to all 1's. Then each 8-bit byte of the message is used in the following algorithm:

First, exclusive-OR the message byte with the low-order byte of the CRC-register. The result, stored in the CRC-register, will then be right-shifted 8 times. The CRC-register MSB is zero-filled with each shift. After each shift the CRC-register LSB is examined: if 1, the CRC-register is then exclusive-ORed with the fixed polynomial value A001 (hex) prior to the next shift. Once all bytes of the message have undergone the above algorithm, the CRC-register will contain the message CRC value to be placed in the Error Check field.

### Interdependence of Preset Multiple Register Data

Preset Multiple Register data is collectively written only after the query has been determined to be legal, which includes a range-check of the entire data block. Therefore, data which must be written prior to other data must use a separate query. For example, a Preset Multiple Register Query of the entire Contiguous Write Block (40023-40055) to set the Battery Overvoltage Pre-alarm Threshold atop the 24V range and change the Battery Volts from 12V to 24V will fail. The change to 24V would occur simultaneously to setting the Pre-alarm Threshold, and the threshold value range-check will use the current 12V range.

## Mapping - DGC-2020 Parameters into Modicon Address Space

### Current Parameter Table

The DGC-2020 maps all non-legacy parameters into the Holding Register address space (42000 and above). Query address N will access the Holding Register N+1.

| Register | Description                                    | Type  | Units       | Scaling Factor | R/W | Range                                                 |
|----------|------------------------------------------------|-------|-------------|----------------|-----|-------------------------------------------------------|
| 42000    | Gen Breaker Configured                         | Int32 | N/A         | N/A            | RW  | 0 = Not Configured<br>1 = Configured                  |
| 42002    | Gen Breaker Open Pulse Time                    | Int32 | Centisecond | Centi          | RW  | 1–80                                                  |
| 42004    | Gen Breaker Close Pulse Time                   | Int32 | Centisecond | Centi          | RW  | 1–80                                                  |
| 42006    | Gen Breaker Contact Type                       | Int32 | N/A         | N/A            | RW  | 0 = Pulse<br>1 = Continuous                           |
| 42008    | Gen Breaker Close Time                         | Int32 | Millisecond | N/A            | RW  | 0–800                                                 |
| 42010    | RESERVED                                       |       |             |                |     |                                                       |
| 42012    | Mains Breaker Configured                       | Int32 | N/A         | N/A            | RW  | 0 = Not Configured<br>1 = Configured                  |
| 42014    | Mains Breaker Open Pulse Time                  | Int32 | Centisecond | Centi          | RW  | 1–80                                                  |
| 42016    | Mains Breaker Close Pulse Time                 | Int32 | Centisecond | Centi          | RW  | 1–80                                                  |
| 42018    | Mains Breaker Output Continuous                | Int32 | N/A         | N/A            | RW  | 0 = Pulse<br>1 = Continuous                           |
| 42020    | Mains Breaker Close Time                       | Int32 | Millisecond | N/A            | RW  | 0–800                                                 |
| 42022    | RESERVED                                       |       |             |                |     |                                                       |
| 42024    | Synchronizer Type                              | Int32 | N/A         | N/A            | RW  | 1 = Anticipatory<br>2 = Phase Lock Loop               |
| 42026    | RESERVED                                       |       |             |                |     |                                                       |
| 42028    | Slip Frequency                                 | Int32 | CentiHertz  | Centi          | RW  | 1–50                                                  |
| 42030    | Breaker Closing Angle                          | Int32 | DeciDegree  | Deci           | RW  | 30–200                                                |
| 42032    | Regulation Offset                              | Int32 | DeciPercent | Deci           | RW  | 20–150                                                |
| 42034    | Vgen > Vbus                                    | Int32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable                             |
| 42036    | Fgen > Fbus                                    | Int32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable                             |
| 42038–40 | RESERVED                                       |       |             |                |     |                                                       |
| 42042    | Breaker Close Wait Time                        | Float | Second      | N/A            | RW  | 0.1–600                                               |
| 42044    | Sync Time Delay                                | Float | Second      | N/A            | RW  | 0.1–0.8                                               |
| 42046    | Sync Fail Time Delay                           | Float | Second      | N/A            | RW  | 0.1–600                                               |
| 42048    | Mains Fail Transfer Enable                     | Int32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable                             |
| 42050    | Gen Breaker Status                             | Int32 | N/A         | N/A            | R   | 0 = Open<br>1 = Closed                                |
| 42052    | Mains Breaker Status                           | Int32 | N/A         | N/A            | R   | 0 = Open<br>1 = Closed                                |
| 42054    | Mains Fail Transfer Delay                      | Int32 | Second      | N/A            | RW  | 0–300                                                 |
| 42056    | Mains Fail Return Delay                        | Int32 | Second      | N/A            | RW  | 0–9999                                                |
| 42058    | Mains Fail Max Transfer Time                   | Int32 | Second      | N/A            | RW  | 1–120                                                 |
| 42060    | RESERVED                                       |       |             |                |     |                                                       |
| 42062    | Dead Bus Close Enable                          | Int32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable                             |
| 42064    | Sync Speed Gain                                | Float | N/A         | N/A            | RW  | 0.001–1000                                            |
| 42066    | Sync Voltage Gain                              | Float | N/A         | N/A            | RW  | 0.001–1000                                            |
| 42068    | Max Parallel Time                              | Int32 | Second      | Deci           | RW  | 1–100000                                              |
| 42070    | Mains Fail Transfer Type                       | Int32 | N/A         | N/A            | RW  | 0 = Open<br>1 = Close                                 |
| 42072    | In Phase Monitor Enable                        | Int32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable                             |
| 42074    | Dead Gen Close Enable                          | Int32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable                             |
| 42076    | RESERVED                                       |       |             |                |     |                                                       |
| 42078    | Min Slip Control Limit                         | Int32 | N/A         | Centi          | RW  | 0–1000                                                |
| 42080    | Max Slip Control Limit                         | Int32 | N/A         | Centi          | RW  | 0–1000                                                |
| 42082    | Rev. Rotation Mains Fail Inhibit               | Int32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable                             |
| 42084    | Gen Breaker External Status Change Action Data | Int32 | N/A         | N/A            | RW  | 0 = Ignore<br>1 = Follow Always<br>2 = Follow In Auto |
| 42086    | Gen Breaker Fail Output Config Data            | Int32 | N/A         | N/A            | RW  | 0 = Retain<br>1 = Remove                              |

| Register  | Description                                            | Type  | Units       | Scaling Factor | R/W | Range                                                 |
|-----------|--------------------------------------------------------|-------|-------------|----------------|-----|-------------------------------------------------------|
| 42088     | Mains Fail Mains Breaker Open Config Data              | Int32 | N/A         | N/A            | RW  | 0 = Generator Start<br>1 = Generator Stable           |
| 42090     | Mains Fail Allow Transfer To Mains In Alarm State Data | Int32 | N/A         | N/A            | RW  | 1 = Enable<br>2 = Disable                             |
| 42092     | Mains Breaker External Status Change Action Data       | Int32 | N/A         | N/A            | RW  | 0 = Ignore<br>1 = Follow Always<br>2 = Follow In Auto |
| 42094     | Mains Breaker Fail Output                              | Int32 | N/A         | N/A            | RW  | 0 = Retain<br>1 = Remove                              |
| 42096     | Gen Breaker Transition Delay Data                      | Int32 | Centisecond | Centi          | RW  | 0-1000                                                |
| 42098     | Mains Breaker Transition Delay Data                    | Int32 | Centisecond | Centi          | RW  | 0-1000                                                |
| 42100     | Mains Breaker Open Attempts Data                       | Int32 | N/A         | N/A            | RW  | 1-20                                                  |
| 42102     | Mains Breaker Close Attempts Data                      | Int32 | N/A         | N/A            | RW  | 1-20                                                  |
| 42104     | Mains Breaker Retry Delay Data                         | Int32 | Second      | N/A            | RW  | 0-1200                                                |
| 42106     | Gen Breaker Open Attempts Data                         | Int32 | N/A         | N/A            | RW  | 1-20                                                  |
| 42108     | Gen Breaker Close Attempts Data                        | Int32 | N/A         | N/A            | RW  | 1-20                                                  |
| 42110     | Gen Breaker Retry Delay Data                           | Int32 | Second      | N/A            | RW  | 10-3700                                               |
| 42112     | Open Transition Delay Data                             | Int32 | Decisecond  | Deci           | RW  | 0-36000                                               |
| 42114     | Max Return Time Data                                   | Int32 | Second      | N/A            | RW  | 10-20000                                              |
| 42116-248 | FUTURE USE                                             |       |             |                |     |                                                       |
| 42250     | AVR Kp Proportional Gain                               | Float | N/A         | N/A            | RW  | 0-1000                                                |
| 42252     | AVR Ki Integral Gain                                   | Float | N/A         | N/A            | RW  | 0-1000                                                |
| 42254     | AVR Kd Derivative Gain                                 | Float | N/A         | N/A            | RW  | 0-1000                                                |
| 42256     | AVR Td Filter Constant                                 | Float | N/A         | N/A            | RW  | 0-1                                                   |
| 42258     | AVR Kg Loop Gain                                       | Float | N/A         | N/A            | RW  | 0-1000                                                |
| 42260     | AVR Windup Limit                                       | Int32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable                             |
| 42262     | AVR Integrator Limit Plus                              | Float | N/A         | N/A            | RW  | 0-1000                                                |
| 42264     | AVR Integrator Limit Minus                             | Float | N/A         | N/A            | RW  | -1000 to 0                                            |
| 42266     | AVR Output Upper Limit                                 | Float | N/A         | N/A            | RW  | 0-1000                                                |
| 42268     | AVR Output Lower Limit                                 | Float | N/A         | N/A            | RW  | -1000 to 0                                            |
| 42270     | RESERVED                                               |       |             |                |     |                                                       |
| 42272     | Governor Kp Proportional Gain                          | Float | N/A         | N/A            | RW  | 0-1000                                                |
| 42274     | Governor Ki Integral Gain                              | Float | N/A         | N/A            | RW  | 0-1000                                                |
| 42276     | Governor Kd Derivative Gain                            | Float | N/A         | N/A            | RW  | 0-1000                                                |
| 42278     | Governor Td Filter Constant                            | Float | N/A         | N/A            | RW  | 0-1                                                   |
| 42280     | Governor Loop Gain                                     | Float | N/A         | N/A            | RW  | 0-1000                                                |
| 42282     | Governor Windup Limit                                  | Int32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable                             |
| 42284     | Governor Integrator Limit Plus                         | Float | N/A         | N/A            | RW  | 0-1000                                                |
| 42286     | Governor Integrator Limit Minus                        | Float | N/A         | N/A            | RW  | -1000 to 0                                            |
| 42288     | Governor Output Upper Limit                            | Float | N/A         | N/A            | RW  | 0-1000                                                |
| 42290     | Governor Output Lower Limit                            | Float | N/A         | N/A            | RW  | -1000 to 0                                            |
| 42292     | RESERVED                                               |       |             |                |     |                                                       |
| 42294     | kvar Kp                                                | Float | N/A         | N/A            | RW  | 0-1000                                                |
| 42296     | kvar Ki                                                | Float | N/A         | N/A            | RW  | 0-1000                                                |
| 42298     | kvar Kd                                                | Float | N/A         | N/A            | RW  | 0-1000                                                |
| 42300     | kvar Td                                                | Float | N/A         | N/A            | RW  | 0-1                                                   |
| 42302     | kvar Loop Gain                                         | Float | N/A         | N/A            | RW  | 0-1000                                                |
| 42304     | kvar Windup Limit                                      | Int32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable                             |
| 42306     | kvar Integrator Limit Plus                             | Float | N/A         | N/A            | RW  | 0-1000                                                |
| 42308     | kvar Integrator Limit Minus                            | Float | N/A         | N/A            | RW  | -1000 to 0                                            |
| 42310     | kvar Output Upper Limit                                | Float | N/A         | N/A            | RW  | 0-1000                                                |
| 42312     | kvar Output Lower Limit                                | Float | N/A         | N/A            | RW  | -1000 to 0                                            |
| 42314     | RESERVED                                               |       |             |                |     |                                                       |
| 42316     | kW Kp                                                  | Float | N/A         | N/A            | RW  | 0-1000                                                |
| 42318     | kW Ki                                                  | Float | N/A         | N/A            | RW  | 0-1000                                                |
| 42320     | kW Kd                                                  | Float | N/A         | N/A            | RW  | 0-1000                                                |

| Register | Description                       | Type   | Units     | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                      |
|----------|-----------------------------------|--------|-----------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 42322    | kW Td                             | Float  | N/A       | N/A            | RW  | 0–1                                                                                                                                                                                                                                                        |
| 42324    | kW Loop Gain                      | Float  | N/A       | N/A            | RW  | 0–1000                                                                                                                                                                                                                                                     |
| 42326    | kW Windup Limit                   | Int32  | N/A       | N/A            | RW  | 0 = Disable<br>1 = Enable                                                                                                                                                                                                                                  |
| 42328    | kW Integrator Limit Plus          | Float  | N/A       | N/A            | RW  | 0–1000                                                                                                                                                                                                                                                     |
| 42330    | kW Integrator Limit Minus         | Float  | N/A       | N/A            | RW  | -1000 to 0                                                                                                                                                                                                                                                 |
| 42332    | kW Output Upper Limit             | Float  | N/A       | N/A            | RW  | 0–1000                                                                                                                                                                                                                                                     |
| 42334    | kW Output Lower Limit             | Float  | N/A       | N/A            | RW  | -1000 to 0                                                                                                                                                                                                                                                 |
| 42336    | RESERVED                          |        |           |                |     |                                                                                                                                                                                                                                                            |
| 42338    | Droop Percent                     | Float  | Percent   | N/A            | RW  | 0–10                                                                                                                                                                                                                                                       |
| 42340    | Load Control                      | Int32  | N/A       | N/A            | RW  | 0 = Disable<br>1 = Enable                                                                                                                                                                                                                                  |
| 42342    | kW Load Rate                      | Int32  | N/A       | Deci           | RW  | 0–1000                                                                                                                                                                                                                                                     |
| 42344    | Breaker Open Setpoint             | Int32  | N/A       | Deci           | RW  | 0–1000                                                                                                                                                                                                                                                     |
| 42346    | AVR Bias Control Output Type      | Int32  | N/A       | N/A            | RW  | 0 = Contact<br>1 = Analog                                                                                                                                                                                                                                  |
| 42348    | Governor Bias Control Output Type | Int32  | N/A       | N/A            | RW  | 0 = Contact<br>1 = Analog                                                                                                                                                                                                                                  |
| 42350    | Speed Droop Gain                  | Float  | N/A       | N/A            | RW  | 0–1000                                                                                                                                                                                                                                                     |
| 42352    | Voltage Droop Gain                | Float  | N/A       | N/A            | RW  | 0–1000                                                                                                                                                                                                                                                     |
| 42354    | Speed Trim Enable                 | Int32  | N/A       | N/A            | RW  | 0 = Disable<br>1 = Enable                                                                                                                                                                                                                                  |
| 42356    | Voltage Trim Enable               | Int32  | N/A       | N/A            | RW  | 0 = Disable<br>1 = Enable                                                                                                                                                                                                                                  |
| 42358    | Ramped Watt Demand Per Unit       | Float  | N/A       | N/A            | R   | 0–100                                                                                                                                                                                                                                                      |
| 42360    | Watt Demand Per Unit              | Float  | N/A       | N/A            | R   | 0–100                                                                                                                                                                                                                                                      |
| 42362    | Speed PID Output                  | Float  | N/A       | N/A            | R   | 0–100                                                                                                                                                                                                                                                      |
| 42364    | kW PID Output                     | Float  | N/A       | N/A            | R   | 0–100                                                                                                                                                                                                                                                      |
| 42366    | Volt PID Output                   | Float  | N/A       | N/A            | R   | 0–100                                                                                                                                                                                                                                                      |
| 42368    | Speed Trim Setpoint               | Uint32 | DeciHertz | Centi          | RW  | 4700–44000                                                                                                                                                                                                                                                 |
| 42370    | var Control Enable                | Int32  | N/A       | N/A            | RW  | 0 = Disable<br>1 = Enable                                                                                                                                                                                                                                  |
| 42372    | kvar Load Rate                    | Uint32 | N/A       | Deci           | RW  | 1–1000                                                                                                                                                                                                                                                     |
| 42374    | Base Load Level Source            | Uint32 | N/A       | N/A            | RW  | 0 = User Setting<br>1 = LSM Analog Input 1<br>2 = AEM Analog Input 1<br>3 = AEM Analog Input 2<br>4 = AEM Analog Input 3<br>5 = AEM Analog Input 4<br>6 = AEM Analog Input 5<br>7 = AEM Analog Input 6<br>8 = AEM Analog Input 7<br>9 = AEM Analog Input 8 |
| 42376    | kvar Setpoint Source              | Uint32 | N/A       | N/A            | RW  | 0 = User Setting<br>1 = LSM Analog Input 1<br>2 = AEM Analog Input 1<br>3 = AEM Analog Input 2<br>4 = AEM Analog Input 3<br>5 = AEM Analog Input 4<br>6 = AEM Analog Input 5<br>7 = AEM Analog Input 6<br>8 = AEM Analog Input 7<br>9 = AEM Analog Input 8 |
| 42378    | PF Setpoint Source                | Uint32 | N/A       | N/A            | RW  | 0 = User Setting<br>1 = LSM Analog Input 1<br>2 = AEM Analog Input 1<br>3 = AEM Analog Input 2<br>4 = AEM Analog Input 3<br>5 = AEM Analog Input 4<br>6 = AEM Analog Input 5<br>7 = AEM Analog Input 6<br>8 = AEM Analog Input 7<br>9 = AEM Analog Input 8 |

| Register  | Description                                | Type   | Units        | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                      |
|-----------|--------------------------------------------|--------|--------------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 42380–84  | RESERVED                                   |        |              |                |     |                                                                                                                                                                                                                                                            |
| 42386     | Baseload Analog Max                        | Int32  | Percent      | Deci           | RW  | 0–1000                                                                                                                                                                                                                                                     |
| 42388     | Baseload Analog Min                        | Int32  | Percent      | Deci           | RW  | 0–1000                                                                                                                                                                                                                                                     |
| 42390     | kvar Analog Max                            | Int32  | Percent      | Deci           | RW  | -1000 to 1000                                                                                                                                                                                                                                              |
| 42392     | kvar Analog Min                            | Int32  | Percent      | Deci           | RW  | -1000 to 1000                                                                                                                                                                                                                                              |
| 42394     | PF Analog Max                              | Int32  | N/A          | Centi          | RW  | 160–240                                                                                                                                                                                                                                                    |
| 42396     | PF Analog Min                              | Int32  | N/A          | Centi          | RW  | 160–240                                                                                                                                                                                                                                                    |
| 42398     | var Droop Percentage                       | Float  | Percent      | N/A            | RW  | 0–10                                                                                                                                                                                                                                                       |
| 42400–06  | RESERVED                                   |        |              |                |     |                                                                                                                                                                                                                                                            |
| 42408     | Base Load Level                            | Float  | Percent      | N/A            | RW  | 0–100                                                                                                                                                                                                                                                      |
| 42410     | kvar Setpoint                              | Float  | Percent      | N/A            | RW  | -100 to 100                                                                                                                                                                                                                                                |
| 42412     | PF Setpoint                                | Int32  | N/A          | Centi          | RW  | 160–240                                                                                                                                                                                                                                                    |
| 42414     | var Control Mode                           | Int32  | N/A          | N/A            | RW  | 0 = var Control<br>1 = PF Control                                                                                                                                                                                                                          |
| 42416     | Load Share Interface                       | Int32  | N/A          | N/A            | RW  | 0 = Analog Load Share Line<br>1 = Ethernet Comms                                                                                                                                                                                                           |
| 42418     | Remote Speed Bias Source                   | Int32  | N/A          | N/A            | RW  | 0 = User Setting<br>1 = LSM Analog Input 1<br>2 = AEM Analog Input 1<br>3 = AEM Analog Input 2<br>4 = AEM Analog Input 3<br>5 = AEM Analog Input 4<br>6 = AEM Analog Input 5<br>7 = AEM Analog Input 6<br>8 = AEM Analog Input 7<br>9 = AEM Analog Input 8 |
| 42420–22  | RESERVED                                   |        |              |                |     |                                                                                                                                                                                                                                                            |
| 42424     | LSM Aux Input Source                       | Int32  | N/A          | N/A            | RW  | 0 = LSM Local Aux Input<br>1 = LSM System Manager                                                                                                                                                                                                          |
| 42426     | kW Ramp Status                             | Int32  | N/A          | N/A            | R   | 0 = none<br>1 = up<br>2 = down                                                                                                                                                                                                                             |
| 42428     | kvar Ramp Status                           | Int32  | N/A          | N/A            | R   | 0 = none<br>1 = up<br>2 = down                                                                                                                                                                                                                             |
| 42430     | Speed Trim Bias Range Percent x 100 Data   | Int32  | CentiPercent | Centi          | RW  | 0–500                                                                                                                                                                                                                                                      |
| 42432     | kW Ramp Overshoot Reduction Percent Data   | Int32  | Percent      | N/A            | RW  | 0–100                                                                                                                                                                                                                                                      |
| 42434     | kvar Ramp Overshoot Reduction Percent Data | Int32  | Percent      | N/A            | RW  | 0–100                                                                                                                                                                                                                                                      |
| 42436     | Speed Trim Deadband                        | Uint32 | CentiHertz   | Centi          | RW  | 0–100                                                                                                                                                                                                                                                      |
| 42438     | Volt Trim Deadband                         | Uint32 | DeciPercent  | Deci           | RW  | 0–20                                                                                                                                                                                                                                                       |
| 42440     | kW Parallel To Mains Gain                  | Float  | N/A          | N/A            | RW  | 0–1000                                                                                                                                                                                                                                                     |
| 42442     | kvar Parallel To Mains Gain                | Float  | N/A          | N/A            | RW  | 0–1000                                                                                                                                                                                                                                                     |
| 42444     | Trim Voltage                               | Uint32 | Volts L-L    | N/A            | RW  | 0–999999                                                                                                                                                                                                                                                   |
| 42446     | Alternate Trim Voltage 1                   | Uint32 | Volts L-L    | N/A            | RW  | 0–999999                                                                                                                                                                                                                                                   |
| 42448     | Alternate Trim Voltage 2                   | Uint32 | Volts L-L    | N/A            | RW  | 0–999999                                                                                                                                                                                                                                                   |
| 42450     | Alternate Trim Voltage 3                   | Uint32 | Volts L-L    | N/A            | RW  | 0–999999                                                                                                                                                                                                                                                   |
| 42452     | Alternate Trim Voltage 4                   | Uint32 | Volts L-L    | N/A            | RW  | 0–999999                                                                                                                                                                                                                                                   |
| 42454–498 | FUTURE USE                                 |        |              |                |     |                                                                                                                                                                                                                                                            |
| 42500     | AVR Correction Pulse Width                 | Int32  | Decisecond   | Deci           | RW  | 0–999                                                                                                                                                                                                                                                      |
| 42502     | AVR Correction Pulse Interval              | Int32  | Decisecond   | Deci           | RW  | 0–999                                                                                                                                                                                                                                                      |
| 42504     | AVR Bias Contact Type                      | Int32  | N/A          | N/A            | RW  | 0 = Continuous<br>1 = Proportional                                                                                                                                                                                                                         |
| 42506     | RESERVED                                   |        |              |                |     |                                                                                                                                                                                                                                                            |
| 42508     | Governor Correction Pulse Width            | Int32  | Decisecond   | Deci           | RW  | 0–999                                                                                                                                                                                                                                                      |
| 42510     | Governor Correction Pulse Interval         | Int32  | Decisecond   | Deci           | RW  | 0–999                                                                                                                                                                                                                                                      |
| 42512     | Governor Bias Contact Type                 | Int32  | Decisecond   | Deci           | RW  | 0 = Continuous<br>1 = Proportional                                                                                                                                                                                                                         |

| Register   | Description                                 | Type   | Units      | Scaling Factor | R/W | Range     |
|------------|---------------------------------------------|--------|------------|----------------|-----|-----------|
| 42514      | RESERVED                                    |        |            |                |     |           |
| 42516–748  | FUTURE USE                                  |        |            |                |     |           |
| 42750      | Gen Sensing Dead Bus Pickup                 | Int32  | Volt       | N/A            | RW  | 0–4800    |
| 42752      | Gen Sensing Dead Bus Time Delay             | Int32  | Decisecond | Deci           | RW  | 1–6000    |
| 42754      | RESERVED                                    |        |            |                |     |           |
| 42756      | Gen Sensing Stable Undervoltage Pickup      | Int32  | Volt       | N/A            | RW  | 10–999999 |
| 42758      | Gen Sensing Stable Undervoltage Dropout     | Int32  | Volt       | N/A            | RW  | 10–999999 |
| 42760      | Gen Sensing Stable Overvoltage              | Int32  | Volt       | N/A            | RW  | 10–999999 |
| 42762      | Gen Sensing Stable Overvoltage Dropout      | Int32  | Volt       | N/A            | RW  | 10–999999 |
| 42764      | Gen Sensing Stable Underfrequency Pickup    | Int32  | CentiHertz | Centi          | RW  | 4600–6400 |
| 42766      | Gen Sensing Stable Underfrequency Dropout   | Int32  | CentiHertz | Centi          | RW  | 4600–6400 |
| 42768      | Gen Sensing Stable Overfrequency Pickup     | Int32  | CentiHertz | Centi          | RW  | 4600–6400 |
| 42770      | Gen Sensing Stable Overfrequency Dropout    | Int32  | CentiHertz | Centi          | RW  | 4600–6400 |
| 42772      | Gen Sensing Fail Time Delay                 | Int32  | Decisecond | Deci           | RW  | 1–6000    |
| 42774      | Gen Sensing Stable Time Delay               | Int32  | Decisecond | Deci           | RW  | 1–6000    |
| 42776      | RESERVED                                    |        |            |                |     |           |
| 42778      | Bus Sensing Dead Bus Pickup                 | Int32  | Volt       | N/A            | RW  | 0–4800    |
| 42780      | Bus Sensing Dead Bus Time Delay             | Int32  | Decisecond | Deci           | RW  | 1–6000    |
| 42782      | RESERVED                                    |        |            |                |     |           |
| 42784      | Bus Sensing Stable Undervoltage Pickup      | Int32  | Volt       | N/A            | RW  | 10–999999 |
| 42786      | Bus Sensing Stable Undervoltage Dropout     | Int32  | Volt       | N/A            | RW  | 10–999999 |
| 42788      | Bus Sensing Stable Overvoltage Pickup       | Int32  | Volt       | N/A            | RW  | 10–999999 |
| 42790      | Bus Sensing Stable Overvoltage Dropout      | Int32  | Volt       | N/A            | RW  | 10–999999 |
| 42792      | Bus Sensing Stable Underfrequency Pickup    | Int32  | CentiHertz | Centi          | RW  | 4600–6400 |
| 42794      | Bus Sensing Stable Underfrequency Dropout   | Int32  | CentiHertz | Centi          | RW  | 4600–6400 |
| 42796      | Bus Sensing Stable Overfrequency Pickup     | Int32  | CentiHertz | Centi          | RW  | 4600–6400 |
| 42798      | Bus Sensing Stable Overfrequency Dropout    | Int32  | CentiHertz | Centi          | RW  | 4600–6400 |
| 42800      | Bus Sensing Fail Time Delay                 | Int32  | Decisecond | Deci           | RW  | 1–6000    |
| 42802      | Bus Sensing Stable Time Delay               | Int32  | Decisecond | Deci           | RW  | 1–6000    |
| 42804      | RESERVED                                    |        |            |                |     |           |
| 42806      | Gen Dead Status                             | Int32  | N/A        | N/A            | R   | 0–1       |
| 42808      | Gen Stable Status                           | Int32  | N/A        | N/A            | R   | 0–1       |
| 42810      | Gen Fail Status                             | Int32  | N/A        | N/A            | R   | 0–1       |
| 42812      | Bus Dead Status                             | Int32  | N/A        | N/A            | R   | 0–1       |
| 42814      | Bus Stable Status                           | Int32  | N/A        | N/A            | R   | 0–1       |
| 42816      | Bus Fail Status                             | Int32  | N/A        | N/A            | R   | 0–1       |
| 42818      | Gen Stable Low Line Scale Factor            | Float  | N/A        | N/A            | RW  | 0.001–3   |
| 42820      | Bus Stable Low Line Scale Factor            | Float  | N/A        | N/A            | RW  | 0.001–3   |
| 42822      | Gen Stable Alternate Frequency Scale Factor | Float  | N/A        | N/A            | RW  | 0.001–100 |
| 42824      | Bus Stable Alternate Frequency Scale Factor | Float  | N/A        | N/A            | RW  | 0.001–100 |
| 42826–2999 | FUTURE USE                                  |        |            |                |     |           |
| 43000      | PLC Timer 1 Metering Seconds                | Int32  | Second     | N/A            | R   | 0–1800    |
| 43002      | PLC Timer 1 Metering Minutes                | UInt32 | Second     | N/A            | R   | 0–250     |
| 43004      | PLC Timer 1 Metering Hours                  | UInt32 | Second     | N/A            | R   | 0–250     |

| Register | Description                                                | Type   | Units  | Scaling Factor | R/W | Range   |
|----------|------------------------------------------------------------|--------|--------|----------------|-----|---------|
| 43006    | PLC Timer 2 Metering Seconds                               | Int32  | Second | N/A            | R   | 0–1800  |
| 43008    | PLC Timer 2 Metering Minutes                               | UInt32 | Second | N/A            | R   | 0–250   |
| 43010    | PLC Timer 2 Metering Hours                                 | UInt32 | Second | N/A            | R   | 0–250   |
| 43012    | PLC Timer 3 Metering Seconds                               | Int32  | Second | N/A            | R   | 0–1800  |
| 43014    | PLC Timer 3 Metering Minutes                               | UInt32 | Second | N/A            | R   | 0–250   |
| 43016    | PLC Timer 3 Metering Hours                                 | UInt32 | Second | N/A            | R   | 0–250   |
| 43018    | PLC Timer 4 Metering Seconds                               | Int32  | Second | N/A            | R   | 0–1800  |
| 43020    | PLC Timer 4 Metering Minutes                               | UInt32 | Second | N/A            | R   | 0–250   |
| 43022    | PLC Timer 4 Metering Hours                                 | UInt32 | Second | N/A            | R   | 0–250   |
| 43024    | PLC Timer 5 Metering Seconds                               | Int32  | Second | N/A            | R   | 0–1800  |
| 43026    | PLC Timer 5 Metering Minutes                               | UInt32 | Second | N/A            | R   | 0–250   |
| 43028    | PLC Timer 5 Metering Hours                                 | UInt32 | Second | N/A            | R   | 0–250   |
| 43030    | PLC Timer 6 Metering Seconds                               | Int32  | Second | N/A            | R   | 0–1800  |
| 43032    | PLC Timer 6 Metering Minutes                               | UInt32 | Second | N/A            | R   | 0–250   |
| 43034    | PLC Timer 6 Metering Hours                                 | UInt32 | Second | N/A            | R   | 0–250   |
| 43036    | PLC Timer 7 Metering Seconds                               | Int32  | Second | N/A            | R   | 0–1800  |
| 43038    | PLC Timer 7 Metering Minutes                               | UInt32 | Second | N/A            | R   | 0–250   |
| 43040    | PLC Timer 7 Metering Hours                                 | UInt32 | Second | N/A            | R   | 0–250   |
| 43042    | PLC Timer 8 Metering Seconds                               | Int32  | Second | N/A            | R   | 0–1800  |
| 43044    | PLC Timer 8 Metering Minutes                               | UInt32 | Second | N/A            | R   | 0–250   |
| 43046    | PLC Timer 8 Metering Hours                                 | UInt32 | Second | N/A            | R   | 0–250   |
| 43048    | PLC Timer 9 Metering Seconds                               | Int32  | Second | N/A            | R   | 0–1800  |
| 43050    | PLC Timer 9 Metering Minutes                               | UInt32 | Second | N/A            | R   | 0–250   |
| 43052    | PLC Timer 9 Metering Hours                                 | UInt32 | Second | N/A            | R   | 0–250   |
| 43054    | PLC Timer 10 Metering Seconds                              | Int32  | Second | N/A            | R   | 0–1800  |
| 43056    | PLC Timer 10 Metering Minutes                              | UInt32 | Second | N/A            | R   | 0–250   |
| 43058    | PLC Timer 10 Metering Hours                                | UInt32 | Second | N/A            | R   | 0–250   |
| 43060    | Configurable Element 1 Arming Delay Metering               | Int32  | Second | Deci           | R   | 0–3000  |
| 43062    | Configurable Element 1 Activation Delay Metering           | Int32  | Second | Deci           | R   | 0–3000  |
| 43064    | Configurable Element 2 Arming Delay Metering               | Int32  | Second | Deci           | R   | 0–3000  |
| 43066    | Configurable Element 2 Activation Delay Metering           | Int32  | Second | Deci           | R   | 0–3000  |
| 43068    | Configurable Element 3 Arming Delay Metering               | Int32  | Second | Deci           | R   | 0–3000  |
| 43070    | Configurable Element 3 Activation Delay Metering           | Int32  | Second | Deci           | R   | 0–3000  |
| 43072    | Configurable Element 4 Arming Delay Metering               | Int32  | Second | Deci           | R   | 0–3000  |
| 43074    | Configurable Element 4 Activation Delay Metering           | Int32  | Second | Deci           | R   | 0–3000  |
| 43076    | Configurable Element 5 Arming Delay Metering               | Int32  | Second | Deci           | R   | 0–3000  |
| 43078    | Configurable Element 5 Activation Delay Metering           | Int32  | Second | Deci           | R   | 0–3000  |
| 43080    | Configurable Element 6 Arming Delay Metering               | Int32  | Second | Deci           | R   | 0–3000  |
| 43082    | Configurable Element 6 Activation Delay Metering           | Int32  | Second | Deci           | R   | 0–3000  |
| 43084    | Configurable Element 7 Arming Delay Metering               | Int32  | Second | Deci           | R   | 0–3000  |
| 43086    | Configurable Element 7 Activation Delay Metering           | Int32  | Second | Deci           | R   | 0–3000  |
| 43088    | Configurable Element 8 Arming Delay Metering               | Int32  | Second | Deci           | R   | 0–3000  |
| 43090    | Configurable Element 8 Activation Delay Metering           | Int32  | Second | Deci           | R   | 0–3000  |
| 43092    | Configurable Protection 1 Arming Delay Metering            | Int32  | Second | Deci           | R   | 0–3000  |
| 43094    | Configurable Protection 1 Activation Delay Over 1 Metering | UInt32 | Second | Deci           | R   | 0–99990 |



| Register | Description                                                 | Type   | Units  | Scaling Factor | R/W | Range   |
|----------|-------------------------------------------------------------|--------|--------|----------------|-----|---------|
| 43096    | Configurable Protection 1 Activation Delay Under 1 Metering | Uint32 | Second | Deci           | R   | 0–99990 |
| 43098    | Configurable Protection 1 Activation Delay Over 2 Metering  | Uint32 | Second | Deci           | R   | 0–99990 |
| 43100    | Configurable Protection 1 Activation Delay Under 2 Metering | Uint32 | Second | Deci           | R   | 0–99990 |
| 43102    | Configurable Protection 2 Arming Delay Metering             | Int32  | Second | Deci           | R   | 0–3000  |
| 43104    | Configurable Protection 2 Activation Delay Over 1 Metering  | Uint32 | Second | Deci           | R   | 0–99990 |
| 43106    | Configurable Protection 2 Activation Delay Under 1 Metering | Uint32 | Second | Deci           | R   | 0–99990 |
| 43108    | Configurable Protection 2 Activation Delay Over 2 Metering  | Uint32 | Second | Deci           | R   | 0–99990 |
| 43110    | Configurable Protection 2 Activation Delay Under 2 Metering | Uint32 | Second | Deci           | R   | 0–99990 |
| 43112    | Configurable Protection 3 Arming Delay Metering             | Int32  | Second | Deci           | R   | 0–3000  |
| 43114    | Configurable Protection 3 Activation Delay Over 1 Metering  | Uint32 | Second | Deci           | R   | 0–99990 |
| 43116    | Configurable Protection 3 Activation Delay Under 1 Metering | Uint32 | Second | Deci           | R   | 0–99990 |
| 43118    | Configurable Protection 3 Activation Delay Over 2 Metering  | Uint32 | Second | Deci           | R   | 0–99990 |
| 43120    | Configurable Protection 3 Activation Delay Under 2 Metering | Uint32 | Second | Deci           | R   | 0–99990 |
| 43122    | Configurable Protection 4 Arming Delay Metering             | Int32  | Second | Deci           | R   | 0–3000  |
| 43124    | Configurable Protection 4 Activation Delay Over 1 Metering  | Uint32 | Second | Deci           | R   | 0–99990 |
| 43126    | Configurable Protection 4 Activation Delay Under 1 Metering | Uint32 | Second | Deci           | R   | 0–99990 |
| 43128    | Configurable Protection 4 Activation Delay Over 2 Metering  | Uint32 | Second | Deci           | R   | 0–99990 |
| 43130    | Configurable Protection 4 Activation Delay Under 2 Metering | Uint32 | Second | Deci           | R   | 0–99990 |
| 43132    | Configurable Protection 5 Arming Delay Metering             | Int32  | Second | Deci           | R   | 0–3000  |
| 43134    | Configurable Protection 5 Activation Delay Over 1 Metering  | Uint32 | Second | Deci           | R   | 0–99990 |
| 43136    | Configurable Protection 5 Activation Delay Under 1 Metering | Uint32 | Second | Deci           | R   | 0–99990 |
| 43138    | Configurable Protection 5 Activation Delay Over 2 Metering  | Uint32 | Second | Deci           | R   | 0–99990 |
| 43140    | Configurable Protection 5 Activation Delay Under 2 Metering | Uint32 | Second | Deci           | R   | 0–99990 |
| 43142    | Configurable Protection 6 Arming Delay Metering             | Int32  | Second | Deci           | R   | 0–3000  |
| 43144    | Configurable Protection 6 Activation Delay Over 1 Metering  | Uint32 | Second | Deci           | R   | 0–99990 |
| 43146    | Configurable Protection 6 Activation Delay Under 1 Metering | Uint32 | Second | Deci           | R   | 0–99990 |
| 43148    | Configurable Protection 6 Activation Delay Over 2 Metering  | Uint32 | Second | Deci           | R   | 0–99990 |
| 43150    | Configurable Protection 6 Activation Delay Under 2 Metering | Uint32 | Second | Deci           | R   | 0–99990 |
| 43152    | Configurable Protection 7 Arming Delay Metering             | Int32  | Second | Deci           | R   | 0–3000  |
| 43154    | Configurable Protection 7 Activation Delay Over 1 Metering  | Uint32 | Second | Deci           | R   | 0–99990 |
| 43156    | Configurable Protection 7 Activation Delay Under 1 Metering | Uint32 | Second | Deci           | R   | 0–99990 |
| 43158    | Configurable Protection 7 Activation Delay Over 2 Metering  | Uint32 | Second | Deci           | R   | 0–99990 |
| 43160    | Configurable Protection 7 Activation Delay Under 2 Metering | Uint32 | Second | Deci           | R   | 0–99990 |



| Register | Description                                                 | Type   | Units  | Scaling Factor | R/W | Range   |
|----------|-------------------------------------------------------------|--------|--------|----------------|-----|---------|
| 43162    | Configurable Protection 8 Arming Delay Metering             | Int32  | Second | Deci           | R   | 0–3000  |
| 43164    | Configurable Protection 8 Activation Delay Over 1 Metering  | UInt32 | Second | Deci           | R   | 0–99990 |
| 43166    | Configurable Protection 8 Activation Delay Under 1 Metering | UInt32 | Second | Deci           | R   | 0–99990 |
| 43168    | Configurable Protection 8 Activation Delay Over 2 Metering  | UInt32 | Second | Deci           | R   | 0–99990 |
| 43170    | Configurable Protection 8 Activation Delay Under 2 Metering | UInt32 | Second | Deci           | R   | 0–99990 |
| 43172    | Contact Input 1 Activation Delay Metering                   | Int32  | Second | Deci           | R   | 0–3000  |
| 43174    | Contact Input 2 Activation Delay Metering                   | Int32  | Second | Deci           | R   | 0–3000  |
| 43176    | Contact Input 3 Activation Delay Metering                   | Int32  | Second | Deci           | R   | 0–3000  |
| 43178    | Contact Input 4 Activation Delay Metering                   | Int32  | Second | Deci           | R   | 0–3000  |
| 43180    | Contact Input 5 Activation Delay Metering                   | Int32  | Second | Deci           | R   | 0–3000  |
| 43182    | Contact Input 6 Activation Delay Metering                   | Int32  | Second | Deci           | R   | 0–3000  |
| 43184    | Contact Input 7 Activation Delay Metering                   | Int32  | Second | Deci           | R   | 0–3000  |
| 43186    | Contact Input 8 Activation Delay Metering                   | Int32  | Second | Deci           | R   | 0–3000  |
| 43188    | Contact Input 9 Activation Delay Metering                   | Int32  | Second | Deci           | R   | 0–3000  |
| 43190    | Contact Input 10 Activation Delay Metering                  | Int32  | Second | Deci           | R   | 0–3000  |
| 43192    | Contact Input 11 Activation Delay Metering                  | Int32  | Second | Deci           | R   | 0–3000  |
| 43194    | Contact Input 12 Activation Delay Metering                  | Int32  | Second | Deci           | R   | 0–3000  |
| 43196    | Contact Input 13 Activation Delay Metering                  | Int32  | Second | Deci           | R   | 0–3000  |
| 43198    | Contact Input 14 Activation Delay Metering                  | Int32  | Second | Deci           | R   | 0–3000  |
| 43200    | Contact Input 15 Activation Delay Metering                  | Int32  | Second | Deci           | R   | 0–3000  |
| 43202    | Contact Input 16 Activation Delay Metering                  | Int32  | Second | Deci           | R   | 0–3000  |
| 43204    | Contact Input 17 Activation Delay Metering                  | Int32  | Second | Deci           | R   | 0–3000  |
| 43206    | Contact Input 18 Activation Delay Metering                  | Int32  | Second | Deci           | R   | 0–3000  |
| 43208    | Contact Input 19 Activation Delay Metering                  | Int32  | Second | Deci           | R   | 0–3000  |
| 43210    | Contact Input 20 Activation Delay Metering                  | Int32  | Second | Deci           | R   | 0–3000  |
| 43212    | Contact Input 21 Activation Delay Metering                  | Int32  | Second | Deci           | R   | 0–3000  |
| 43214    | Contact Input 22 Activation Delay Metering                  | Int32  | Second | Deci           | R   | 0–3000  |
| 43216    | Contact Input 23 Activation Delay Metering                  | Int32  | Second | Deci           | R   | 0–3000  |
| 43218    | Contact Input 24 Activation Delay Metering                  | Int32  | Second | Deci           | R   | 0–3000  |
| 43220    | Contact Input 25 Activation Delay Metering                  | Int32  | Second | Deci           | R   | 0–3000  |
| 43222    | Contact Input 26 Activation Delay Metering                  | Int32  | Second | Deci           | R   | 0–3000  |
| 43224    | Battery Charger Fail Activation Delay Metering              | Int32  | Second | Deci           | R   | 0–3000  |
| 43226    | Low Coolant Level Activation Delay Metering                 | Int32  | Second | Deci           | R   | 0–3000  |

| Register  | Description                                               | Type   | Units  | Scaling Factor | R/W | Range                                  |
|-----------|-----------------------------------------------------------|--------|--------|----------------|-----|----------------------------------------|
| 43228     | Fuel Leak Activation Delay Metering                       | Int32  | Second | Deci           | R   | 0–3000                                 |
| 43230     | Weak Battery Voltage Pre-alarm Activation Delay Metering  | Uint32 | Second | Sec * 5        | R   | 0–50 counts = 0–10 seconds             |
| 43232     | Low Battery Voltage Pre-alarm Activation Delay Metering   | Uint32 | Second | Sec * 5        | R   | 0–300 counts = 0–60 seconds            |
| 43234     | High Fuel Level Pre-alarm Activation Delay Metering       | Uint32 | Second | Sec * 5        | R   | 0–150 counts = 0–30 seconds            |
| 43236     | AVR Bias Output Limit Pre-alarm Activation Delay Metering | Int32  | Second | Deci           | R   | 0–150                                  |
| 43238     | GOV Bias Output Limit Pre-alarm Activation Delay Metering | Int32  | Second | Deci           | R   | 0–1500                                 |
| 43240     | High Coolant Temp Alarm Arming Delay Metering             | Uint32 | Second | Deci           | R   | 0–1500                                 |
| 43242     | High Coolant Temp Alarm Activation Delay Metering         | Uint32 | Second | Deci           | R   | 0–40                                   |
| 43244     | Low Oil Pressure Alarm Arming Delay Metering              | Uint32 | Second | Deci           | R   | 0–600                                  |
| 43246     | Low Oil Pressure Alarm Activation Delay Metering          | Uint32 | Second | Deci           | R   | 0–20                                   |
| 43248     | Low Fuel Level Alarm Activation Delay Metering            | Uint32 | Second | Deci           | R   | 0–300                                  |
| 43250–251 | FUTURE USE                                                |        |        |                |     |                                        |
| 43252     | User Configurable Input 1 Config Type                     | Int32  | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm |
| 43254     | User Configurable Input 1 Time Delay                      | Int32  | Second | N/A            | RW  | 0–300                                  |
| 43258     | RESERVED                                                  |        |        |                |     |                                        |
| 43260     | User Configurable Input 2 Config Type                     | Int32  | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm |
| 43262     | User Configurable Input 2 Time Delay                      | Int32  | Second | N/A            | RW  | 0–300                                  |
| 43266     | RESERVED                                                  |        |        |                |     |                                        |
| 43268     | User Configurable Input 3 Config Type                     | Int32  | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm |
| 43270     | User Configurable Input 3 Time Delay                      | Int32  | Second | N/A            | RW  | 0–300                                  |
| 43272–74  | RESERVED                                                  |        |        |                |     |                                        |
| 43276     | User Configurable Input 4 Config Type                     | Int32  | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm |
| 43278     | User Configurable Input 4 Time Delay                      | Int32  | Second | N/A            | RW  | 0–300                                  |
| 43282     | RESERVED                                                  |        |        |                |     |                                        |
| 43284     | User Configurable Input 5 Config Type                     | Int32  | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm |
| 43286     | User Configurable Input 5 Time Delay                      | Int32  | Second | N/A            | RW  | 0–300                                  |
| 43288–90  | RESERVED                                                  |        |        |                |     |                                        |
| 43292     | User Configurable Input 6 Config Type                     | Int32  | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm |
| 43294     | User Configurable Input 6 Time Delay                      | Int32  | Second | N/A            | RW  | 0–300                                  |
| 43298     | RESERVED                                                  |        |        |                |     |                                        |
| 43300     | User Configurable Input 7 Config Type                     | Int32  | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm |
| 43302     | User Configurable Input 7 Time Delay                      | Int32  | Second | N/A            | RW  | 0–300                                  |
| 43304–06  | RESERVED                                                  |        |        |                |     |                                        |
| 43308     | User Configurable Input 8 Config Type                     | Int32  | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm |

| Register  | Description                            | Type  | Units  | Scaling Factor | R/W | Range                                  |
|-----------|----------------------------------------|-------|--------|----------------|-----|----------------------------------------|
| 43310     | User Configurable Input 8 Time Delay   | Int32 | Second | N/A            | RW  | 0–300                                  |
| 43312–14  | RESERVED                               |       |        |                |     |                                        |
| 43316     | User Configurable Input 9 Config Type  | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm |
| 43318     | User Configurable Input 9 Time Delay   | Int32 | Second | N/A            | RW  | 0–300                                  |
| 43322     | RESERVED                               |       |        |                |     |                                        |
| 43324     | User Configurable Input 10 Config Type | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm |
| 43326     | User Configurable Input 10 Time Delay  | Int32 | Second | N/A            | RW  | 0–300                                  |
| 43328–30  | RESERVED                               |       |        |                |     |                                        |
| 43332     | User Configurable Input 11 Config Type | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm |
| 43334     | User Configurable Input 11 Time Delay  | Int32 | Second | N/A            | RW  | 0–300                                  |
| 43338     | RESERVED                               |       |        |                |     |                                        |
| 43340     | User Configurable Input 12 Config Type | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm |
| 43342     | User Configurable Input 12 Time Delay  | Int32 | Second | N/A            | RW  | 0–300                                  |
| 43344–46  | RESERVED                               |       |        |                |     |                                        |
| 43348     | User Configurable Input 13 Config Type | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm |
| 43350     | User Configurable Input 13 Time Delay  | Int32 | Second | N/A            | RW  | 0–300                                  |
| 43352–54  | RESERVED                               |       |        |                |     |                                        |
| 43356     | User Configurable Input 14 Config Type | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm |
| 43358     | User Configurable Input 14 Time Delay  | Int32 | Second | N/A            | RW  | 0–300                                  |
| 43360–62  | RESERVED                               |       |        |                |     |                                        |
| 43364     | User Configurable Input 15 Config Type | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm |
| 43366     | User Configurable Input 15 Time Delay  | Int32 | Second | N/A            | RW  | 0–300                                  |
| 43368–70  | RESERVED                               |       |        |                |     |                                        |
| 43372     | User Configurable Input 16 Config Type | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm |
| 43374     | User Configurable Input 16 Time Delay  | Int32 | Second | N/A            | RW  | 0–300                                  |
| 43376–408 | RESERVED                               |       |        |                |     |                                        |

| Register | Description                                    | Type  | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                  |
|----------|------------------------------------------------|-------|-------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 43410    | ATS Contact Input                              | Int32 | N/A   | N/A            | RW  | -1 = None<br>0 = Input 1<br>1 = Input 2<br>2 = Input 3<br>3 = Input 4<br>4 = Input 5<br>5 = Input 6<br>6 = Input 7<br>7 = Input 8<br>8 = Input 9<br>9 = Input 10<br>10 = Input 11<br>11 = Input 12<br>12 = Input 13<br>13 = Input 14<br>14 = Input 15<br>15 = Input 16 |
| 43412    | RESERVED                                       |       |       |                |     |                                                                                                                                                                                                                                                                        |
| 43414    | Single Phase Connection Override Contact Input | Int32 | N/A   | N/A            | RW  | -1 = None<br>0 = Input 1<br>1 = Input 2<br>2 = Input 3<br>3 = Input 4<br>4 = Input 5<br>5 = Input 6<br>6 = Input 7<br>7 = Input 8<br>8 = Input 9<br>9 = Input 10<br>10 = Input 11<br>11 = Input 12<br>12 = Input 13<br>13 = Input 14<br>14 = Input 15<br>15 = Input 16 |
| 43416    | RESERVED                                       |       |       |                |     |                                                                                                                                                                                                                                                                        |
| 43418    | Single Phase AC Sense Override Contact Input   | Int32 | N/A   | N/A            | RW  | -1 = None<br>0 = Input 1<br>1 = Input 2<br>2 = Input 3<br>3 = Input 4<br>4 = Input 5<br>5 = Input 6<br>6 = Input 7<br>7 = Input 8<br>8 = Input 9<br>9 = Input 10<br>10 = Input 11<br>11 = Input 12<br>12 = Input 13<br>13 = Input 14<br>14 = Input 15<br>15 = Input 16 |
| 43420    | RESERVED                                       |       |       |                |     |                                                                                                                                                                                                                                                                        |

| Register | Description                                        | Type  | Units  | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                  |
|----------|----------------------------------------------------|-------|--------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 43422    | High/Low Line Contact Input                        | Int32 | N/A    | N/A            | RW  | -1 = None<br>0 = Input 1<br>1 = Input 2<br>2 = Input 3<br>3 = Input 4<br>4 = Input 5<br>5 = Input 6<br>6 = Input 7<br>7 = Input 8<br>8 = Input 9<br>9 = Input 10<br>10 = Input 11<br>11 = Input 12<br>12 = Input 13<br>13 = Input 14<br>14 = Input 15<br>15 = Input 16 |
| 43424    | RESERVED                                           |       |        |                |     |                                                                                                                                                                                                                                                                        |
| 43426    | Battle Override Contact Input                      | Int32 | N/A    | N/A            | RW  | -1 = None<br>0 = Input 1<br>1 = Input 2<br>2 = Input 3<br>3 = Input 4<br>4 = Input 5<br>5 = Input 6<br>6 = Input 7<br>7 = Input 8<br>8 = Input 9<br>9 = Input 10<br>10 = Input 11<br>11 = Input 12<br>12 = Input 13<br>13 = Input 14<br>14 = Input 15<br>15 = Input 16 |
| 43428    | RESERVED                                           |       |        |                |     |                                                                                                                                                                                                                                                                        |
| 43430    | Grounded Delta Override Contact Input              | Int32 | N/A    | N/A            | RW  | -1 = None<br>0 = Input 1<br>1 = Input 2<br>2 = Input 3<br>3 = Input 4<br>4 = Input 5<br>5 = Input 6<br>6 = Input 7<br>7 = Input 8<br>8 = Input 9<br>9 = Input 10<br>10 = Input 11<br>11 = Input 12<br>12 = Input 13<br>13 = Input 14<br>14 = Input 15<br>15 = Input 16 |
| 43432    | RESERVED                                           |       |        |                |     |                                                                                                                                                                                                                                                                        |
| 43434    | Coolant Temperature Sender Fail Configuration Type | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm                                                                                                                                                                                                                                 |
| 43436    | Coolant Temperature Sender Fail Activation Delay   | Int32 | Minute | N/A            | RW  | 5–30                                                                                                                                                                                                                                                                   |
| 43438    | Oil Pressure Sender Fail Configuration Type        | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm                                                                                                                                                                                                                                 |
| 43440    | Oil Pressure Sender Fail Activation Delay          | Int32 | Second | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                  |
| 43442    | Fuel Level Sender Fail Configuration Type          | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm                                                                                                                                                                                                                                 |

| Register | Description                             | Type  | Units  | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                  |
|----------|-----------------------------------------|-------|--------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 43444    | Fuel Level Sender Fail Activation Delay | Int32 | Second | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                  |
| 43446    | Voltage Sensing Fail Configuration Type | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm                                                                                                                                                                                                                                 |
| 43448    | Voltage Sensing Fail Activation Delay   | Int32 | Second | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                  |
| 43450    | Low Coolant Level Contact Input         | Int32 | N/A    | N/A            | RW  | -1 = None<br>0 = Input 1<br>1 = Input 2<br>2 = Input 3<br>3 = Input 4<br>4 = Input 5<br>5 = Input 6<br>6 = Input 7<br>7 = Input 8<br>8 = Input 9<br>9 = Input 10<br>10 = Input 11<br>11 = Input 12<br>12 = Input 13<br>13 = Input 14<br>14 = Input 15<br>15 = Input 16 |
| 43452    | Low Coolant Level Config Type           | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm                                                                                                                                                                                                                                 |
| 43454    | Low Coolant Level Time Delay            | Int32 | Second | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                  |
| 43456    | Battery Charge Failed Contact Input     | Int32 | N/A    | N/A            | RW  | -1 = None<br>0 = Input 1<br>1 = Input 2<br>2 = Input 3<br>3 = Input 4<br>4 = Input 5<br>5 = Input 6<br>6 = Input 7<br>7 = Input 8<br>8 = Input 9<br>9 = Input 10<br>10 = Input 11<br>11 = Input 12<br>12 = Input 13<br>13 = Input 14<br>14 = Input 15<br>15 = Input 16 |
| 43458    | Battery Charge Failed Config Type       | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm                                                                                                                                                                                                                                 |
| 43460    | Battery Charge Failed Time Delay        | Int32 | Second | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                  |
| 43462    | Fuel Leak Detect Contact Input          | Int32 | N/A    | N/A            | RW  | -1 = None<br>0 = Input 1<br>1 = Input 2<br>2 = Input 3<br>3 = Input 4<br>4 = Input 5<br>5 = Input 6<br>6 = Input 7<br>7 = Input 8<br>8 = Input 9<br>9 = Input 10<br>10 = Input 11<br>11 = Input 12<br>12 = Input 13<br>13 = Input 14<br>14 = Input 15<br>15 = Input 16 |

| Register | Description                                | Type  | Units  | Scaling Factor | R/W | Range                                                 |
|----------|--------------------------------------------|-------|--------|----------------|-----|-------------------------------------------------------|
| 43464    | Fuel Leak Detect Config Type               | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm                |
| 43466    | Fuel Leak Detect Time Delay                | Int32 | Second | N/A            | RW  | 0–300                                                 |
| 43468    | User Configurable Input 1 Engine Run Only  | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only           |
| 43470    | User Configurable Input 2 Engine Run Only  | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only           |
| 43472    | User Configurable Input 3 Engine Run Only  | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only           |
| 43474    | User Configurable Input 4 Engine Run Only  | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only           |
| 43476    | User Configurable Input 5 Engine Run Only  | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only           |
| 43478    | User Configurable Input 6 Engine Run Only  | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only           |
| 43480    | User Configurable Input 7 Engine Run Only  | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only           |
| 43482    | User Configurable Input 8 Engine Run Only  | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only           |
| 43484    | User Configurable Input 9 Engine Run Only  | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only           |
| 43486    | User Configurable Input 10 Engine Run Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only           |
| 43488    | User Configurable Input 11 Engine Run Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only           |
| 43490    | User Configurable Input 12 Engine Run Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only           |
| 43492    | User Configurable Input 13 Engine Run Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only           |
| 43494    | User Configurable Input 14 Engine Run Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only           |
| 43496    | User Configurable Input 15 Engine Run Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only           |
| 43498    | User Configurable Input 16 Engine Run Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only           |
| 43500    | Rated Volts                                | Float | Volt   | N/A            | RW  | 1–999999                                              |
| 43502    | Pre-Start Contact Config                   | Int32 | N/A    | N/A            | RW  | 0 = Open After Disconnect<br>1 = Closed While Running |
| 43504    | System Units                               | Int32 | N/A    | N/A            | RW  | 0 = English<br>1 = Metric                             |
| 43506    | Battery Volts                              | Int32 | N/A    | N/A            | RW  | 0 = 12V<br>1 = 24V                                    |
| 43508    | Off Mode Status                            | Int32 | N/A    | N/A            | R   | 0 = Disable<br>1 = Enable                             |
| 43510    | Run Mode Status                            | Int32 | N/A    | N/A            | R   | 0 = Disable<br>1 = Enable                             |
| 43512    | Auto Mode Status                           | Int32 | N/A    | N/A            | R   | 0 = Disable<br>1 = Enable                             |

| Register | Description                   | Type   | Units              | Scaling Factor | R/W | Range                                                                          |
|----------|-------------------------------|--------|--------------------|----------------|-----|--------------------------------------------------------------------------------|
| 43514    | Virtual Input 1 Status        | Int32  | N/A                | N/A            | R   | 0 = Disable<br>1 = Enable                                                      |
| 43516    | Virtual Input 2 Status        | Int32  | N/A                | N/A            | R   | 0 = Disable<br>1 = Enable                                                      |
| 43518    | Virtual Input 3 Status        | Int32  | N/A                | N/A            | R   | 0 = Disable<br>1 = Enable                                                      |
| 43520    | Virtual Input 4 Status        | Int32  | N/A                | N/A            | R   | 0 = Disable<br>1 = Enable                                                      |
| 43522    | RTC Clock Hour                | Int32  | Hour               | N/A            | RW  | 0–23                                                                           |
| 43524    | RTC Minute                    | Int32  | Minute             | N/A            | RW  | 0–59                                                                           |
| 43526    | RTC Second                    | Int32  | Second             | N/A            | RW  | 0–59                                                                           |
| 43528    | RTC Month                     | Int32  | N/A                | N/A            | RW  | 1–12                                                                           |
| 43530    | RTC Day                       | Int32  | N/A                | N/A            | RW  | 1–31                                                                           |
| 43532    | RTC Year                      | Int32  | N/A                | N/A            | RW  | 0–99                                                                           |
| 43534    | RTC DST Enable                | Int32  | N/A                | N/A            | RW  | 0 = Disable<br>1 = Enable                                                      |
| 43536    | Gen PT Primary                | Int32  | Volt               | N/A            | RW  | 1–999999                                                                       |
| 43538    | Gen PT Secondary              | Int32  | Volt               | N/A            | RW  | 1–480                                                                          |
| 43540    | Gen CT Primary                | Int32  | Amp                | N/A            | RW  | 1–9999                                                                         |
| 43542    | Bus PT Primary                | Int32  | Volt               | N/A            | RW  | 1–999999                                                                       |
| 43544    | Bus PT Secondary              | Int32  | Volt               | N/A            | RW  | 1–80                                                                           |
| 43546    | Cranking Style                | UInt32 | N/A                | N/A            | RW  | 0 = Continuous<br>1 = Cycle                                                    |
| 43548    | Number of Crank Cycles        | UInt32 | N/A                | N/A            | RW  | 1–7                                                                            |
| 43550    | Cycle Crank Time              | Unit32 | Second             | N/A            | RW  | 1–300                                                                          |
| 43552    | Continuous Crank Time         | Unit32 | Second             | N/A            | RW  | 1–300                                                                          |
| 43554    | Crank Disconnect Limit        | UInt32 | Percent            | N/A            | RW  | 10–100                                                                         |
| 43556    | Pre Crank Delay               | UInt32 | Second             | N/A            | RW  | 0–30                                                                           |
| 43558    | Configured Gen Connection     | UInt32 | N/A                | N/A            | RW  | 0 = Delta<br>1 = Wye<br>2 = 1-phase AB<br>3 = 1-phase AC<br>4 = Grounded Delta |
| 43560    | Gen Rated Frequency           | Int32  | Hertz              | N/A            | RW  | 0 = 50 Hz<br>1 = 60 Hz                                                         |
| 43562    | Rated kW                      | UInt32 | kilowatt           | N/A            | RW  | 5–9999                                                                         |
| 43564    | Rated Engine RPM              | UInt32 | RPM                | N/A            | RW  | 25–3600                                                                        |
| 43566    | No Load Cool Down Time        | UInt32 | Minute             | N/A            | RW  | 0–60                                                                           |
| 43568    | EPS Current Threshold         | Int32  | Percent CT Primary | N/A            | RW  | 3–10                                                                           |
| 43570    | Fuel Level Function           | UInt32 | N/A                | N/A            | RW  | 0 = Disable<br>1 = Fuel Level<br>2 = Natural Gas<br>3 = Propane                |
| 43572    | Number Flywheel Teeth         | UInt32 | N/A                | N/A            | RW  | 1–500                                                                          |
| 43574    | Speed Signal Source           | UInt32 | N/A                | N/A            | RW  | 1 = MPU<br>2 = Gen Freq<br>3 = MPU Freq                                        |
| 43576    | NFPA Level                    | UInt32 | N/A                | N/A            | RW  | 0 = Zero<br>1 = One<br>2 = Two                                                 |
| 43578    | Horn Enable                   | Int32  | N/A                | N/A            | RW  | 0 = Disabled<br>1 = Enabled                                                    |
| 43580    | Single Phase Override Sensing | UInt32 | N/A                | N/A            | RW  | 0 = AB<br>1 = AC                                                               |
| 43582    | RESERVED                      |        |                    |                |     |                                                                                |
| 43584    | LCD Contrast Value            | UInt32 | N/A                | N/A            | RW  | 0–100                                                                          |
| 43586    | Front Panel Sleep Mode        | UInt32 | N/A                | N/A            | RW  | 0 = Disabled<br>1 = Enabled                                                    |
| 43588    | RESERVED                      |        |                    |                |     |                                                                                |
| 43590    | UTC Offset                    | Int32  | Minute             | N/A            | RW  | -1440 to 1440                                                                  |
| 43592    | DST Configuration             | Int32  | N/A                | N/A            | RW  | 0 = Disabled<br>1 = Floating<br>2 = Fixed                                      |



| Register | Description                      | Type   | Units        | Scaling Factor | R/W | Range                                                                                                                                                                     |
|----------|----------------------------------|--------|--------------|----------------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 43594    | Start/End Time Reference         | Int32  | N/A          | N/A            | RW  | 0 = Local Time<br>1 = UTC Time                                                                                                                                            |
| 43596    | DST Bias Hours                   | Int32  | N/A          | N/A            | RW  | 0–23                                                                                                                                                                      |
| 43598    | DSP Bias Minutes                 | Int32  | N/A          | N/A            | RW  | 0–59                                                                                                                                                                      |
| 43600    | DST Start Month                  | Int32  | N/A          | N/A            | RW  | 1 = January<br>2 = February<br>3 = March<br>4 = April<br>5 = May<br>6 = June<br>7 = July<br>8 = August<br>9 = September<br>10 = October<br>11 = November<br>12 = December |
| 43602    | DST Start Day                    | Int32  | N/A          | N/A            | RW  | 1–31                                                                                                                                                                      |
| 43604    | DST Start Week of Month          | Int32  | N/A          | N/A            | RW  | 0 = First<br>1 = Second<br>2 = Third<br>3 = Fourth<br>4 = Last                                                                                                            |
| 43606    | DST Start Day of Week            | Int32  | N/A          | N/A            | RW  | 0 = Sunday<br>1 = Monday<br>2 = Tuesday<br>3 = Wednesday<br>4 = Thursday<br>5 = Friday<br>6 = Saturday                                                                    |
| 43608    | DST Start Hour                   | Int32  | N/A          | N/A            | RW  | 0–23                                                                                                                                                                      |
| 43610    | DST Start Minute                 | Int32  | N/A          | N/A            | RW  | 0–59                                                                                                                                                                      |
| 43612    | DST End Month                    | Int32  | N/A          | N/A            | RW  | 1 = January<br>2 = February<br>3 = March<br>4 = April<br>5 = May<br>6 = June<br>7 = July<br>8 = August<br>9 = September<br>10 = October<br>11 = November<br>12 = December |
| 43614    | DST End Day                      | Int32  | N/A          | N/A            | RW  | 1–31                                                                                                                                                                      |
| 43616    | DST End Week of Month            | Int32  | N/A          | N/A            | RW  | 0 = First<br>1 = Second<br>2 = Third<br>3 = Fourth<br>4 = Last                                                                                                            |
| 43618    | DST End Day of Week              | Int32  | N/A          | N/A            | RW  | 0 = Sunday<br>1 = Monday<br>2 = Tuesday<br>3 = Wednesday<br>4 = Thursday<br>5 = Friday<br>6 = Saturday                                                                    |
| 43620    | DST End Hour                     | Int32  | N/A          | N/A            | RW  | 0–23                                                                                                                                                                      |
| 43622    | DST End Minute                   | Int32  | N/A          | N/A            | RW  | 0–59                                                                                                                                                                      |
| 43624    | EPS Low Line Scale Factor        | Float  | N/A          | N/A            | RW  | 0.001–3                                                                                                                                                                   |
| 43626    | Rated Power Factor               | Float  | Power Factor | N/A            | RW  | -1 to 1                                                                                                                                                                   |
| 43628    | Prestart Rest Configuration      | Int32  | N/A          | N/A            | RW  | 0 = Off During Rest<br>1 = On During Rest<br>2 = Preheat before Crank                                                                                                     |
| 43630    | Oil Pressure Crank Disconnect    | UInt32 | N/A          | N/A            | RW  | 0 = Disable<br>1 = Enable                                                                                                                                                 |
| 43632    | Crank Disconnect Pressure        | UInt32 | PSI          | Deci           | RW  | 29–1500                                                                                                                                                                   |
| 43634    | Crank Disconnect Pressure in kPa | UInt32 | kPa          | Deci           | RW  | 200–10345                                                                                                                                                                 |
| 43636    | Power-Up Delay                   | UInt32 | Second       | N/A            | RW  | 0–60                                                                                                                                                                      |

| Register | Description                                         | Type   | Units  | Scaling Factor | R/W | Range                                                                                                           |
|----------|-----------------------------------------------------|--------|--------|----------------|-----|-----------------------------------------------------------------------------------------------------------------|
| 43638    | Auto Config Detect Enable                           | Int32  | N/A    | N/A            | RW  | 0 = Disable<br>1 = Enable                                                                                       |
| 43640    | Low Line Detect Threshold                           | Int32  | Volt   | N/A            | RW  | 0–480                                                                                                           |
| 43642    | Single Phase Detect Threshold                       | Int32  | Volt   | N/A            | RW  | 0–480                                                                                                           |
| 43644    | Start Relay Control                                 | UInt32 | N/A    | N/A            | RW  | 0 = Predefined<br>1 = Programmable                                                                              |
| 43646    | Run Relay Control                                   | UInt32 | N/A    | N/A            | RW  | 0 = Predefined<br>1 = Programmable                                                                              |
| 43648    | Prestart Relay Control                              | UInt32 | N/A    | N/A            | RW  | 0 = Predefined<br>1 = Programmable                                                                              |
| 43650    | Single Phase Connect Generator Detection            | Int32  | N/A    | N/A            | RW  | 0 = A-B<br>1 = A-C                                                                                              |
| 43652    | Off Mode Cool Down Enable                           | UInt32 | N/A    | N/A            | RW  | 0 = Disable<br>1 = Enable                                                                                       |
| 43654    | RESERVED                                            |        |        |                |     |                                                                                                                 |
| 43656    | Not In Auto Horn Enable                             | UInt32 | N/A    | N/A            | RW  | 0 = Disable<br>1 = Enable                                                                                       |
| 43658    | Clock Not Set Warning Enable                        | UInt32 | N/A    | N/A            | RW  | 0 = Disable<br>1 = Enable                                                                                       |
| 43660    | Alternate Frequency                                 | Int32  | Hertz  | Centi          | RW  | 1000–45000                                                                                                      |
| 43662    | Generator System Type                               | Int32  | N/A    | N/A            | RW  | 0 = Single Generator<br>1 = Multiple Generator                                                                  |
| 43664    | Gen CT Low Line Scale Factor                        | Float  | N/A    | N/A            | RW  | 0.001–3                                                                                                         |
| 43666    | Metric Pressure Units                               | Int32  | N/A    | N/A            | RW  | 0 = Bar<br>1 = kPa                                                                                              |
| 43668    | System Units                                        | Int32  | N/A    | N/A            | RW  | 0 = English<br>1 = Metric                                                                                       |
| 43670    | Kpa bar Config Data                                 | Int32  | N/A    | N/A            | RW  | 0 = Bar<br>1 = Kpa                                                                                              |
| 43672    | Crank Disconnect Pressure Bar Data                  | Int32  | Bar    | Deci           | RW  | 2–103                                                                                                           |
| 43674    | RPM Bandwidth Data                                  | Int32  | N/A    | N/A            | RW  | 0–1000                                                                                                          |
| 43676    | Number Flywheel Teeth                               | UInt32 | N/A    | Deci           | RW  | 10–5000                                                                                                         |
| 43678    | Phase Rotation                                      | Int32  | N/A    | N/A            | RW  | 0 = ACB<br>1 = ABC                                                                                              |
| 43680    | Restart Delay                                       | Int32  | Second | N/A            | RW  | 0–120                                                                                                           |
| 43682    | Configured Bus Connection                           | UInt32 | N/A    | N/A            | RW  | 0 = Single Phase<br>1 = Three Phase                                                                             |
| 43684    | Fuel Level Source                                   | Int32  | N/A    | N/A            | RW  | 1–9                                                                                                             |
| 43686    | Fuel Level Percent Max                              | Int32  | N/A    | N/A            | RW  | 0–150                                                                                                           |
| 43688    | Fuel Level Percent Min                              | Int32  | N/A    | N/A            | RW  | 0–150                                                                                                           |
| 43690    | Cycle Rest Time                                     | UInt32 | Second | N/A            | RW  | 1–300                                                                                                           |
| 43692    | Rated Volts - Low Line Scale Factor Data            | Float  | N/A    | N/A            | RW  | 0.001–3                                                                                                         |
| 43694    | Rear Port Function                                  | Int32  | N/A    | N/A            | RW  | 0 = Modem Functionality<br>1 = Standard UART Functionality                                                      |
| 43696    | Save Speed Adjustments                              | UInt32 | N/A    | N/A            | RW  | 0 = No<br>1 = Yes                                                                                               |
| 43698    | Coolant Temp Source                                 | UInt32 | N/A    | N/A            | RW  | 0 = From ECU<br>1 = From DGC Sender Input                                                                       |
| 43700    | Oil Pressure Source                                 | UInt32 | N/A    | N/A            | RW  | 0 = From ECU<br>1 = From DGC Sender Input                                                                       |
| 43702    | Cooldown Configuration                              | UInt32 | N/A    | N/A            | RW  | 0 = Cool down only if engine has been loaded<br>1 = Cool down after every run session regardless of load levels |
| 43704    | Coolant Temperature Sender Fail Minimum Resistance  | UInt32 | Ohm    | N/A            | RW  | 0–3500                                                                                                          |
| 43706    | Coolant Temperature Sender Fail Maximum Resistance  | UInt32 | Ohm    | N/A            | RW  | 0–3500                                                                                                          |
| 43708    | Coolant Temperature Sender Fail Contact Recognition | Int32  | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only                                                                     |

| Register | Description                                                                                                                        | Type   | Units   | Scaling Factor | R/W | Range                                       |
|----------|------------------------------------------------------------------------------------------------------------------------------------|--------|---------|----------------|-----|---------------------------------------------|
| 43710    | Oil Pressure Sender Fail Minimum Resistance                                                                                        | Uint32 | Ohm     | N/A            | RW  | 0–300                                       |
| 43712    | Oil Pressure Sender Fail Maximum Resistance                                                                                        | Uint32 | Ohm     |                | RW  | 0–300                                       |
| 43714    | Oil Pressure Sender Fail Contact Recognition                                                                                       | Int32  | N/A     | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only |
| 43716    | Fuel Level Sender Fail Minimum Resistance                                                                                          | Uint32 | Ohm     | N/A            | RW  | 0–300                                       |
| 43718    | Fuel Level Sender Fail Maximum Resistance                                                                                          | Uint32 | Ohm     | N/A            | RW  | 0–300                                       |
| 43720    | Fuel Level Sender Fail Contact Recognition                                                                                         | Int32  | N/A     | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only |
| 43722    | Coolant Temperature Sender Fail SF Display                                                                                         | Uint32 | N/A     | N/A            | RW  | 0 = Disable<br>1 = Enable                   |
| 43724    | Oil Pressure Sender Fail SF Display                                                                                                | Uint32 | N/A     | N/A            | RW  | 0 = Disable<br>1 = Enable                   |
| 43726    | Fuel Level Sender Fail SF Display                                                                                                  | Uint32 | N/A     | N/A            | RW  | 0 = Disable<br>1 = Enable                   |
| 43728    | Engine Run Time Source Data                                                                                                        | Uint32 | N/A     | N/A            | RW  | 0 = From ECU<br>1 = From DGC                |
| 43730    | Minimum Crank Time                                                                                                                 | Uint32 | Second  | Deci           | RW  | 0–30                                        |
| 43732    | Minimum Current for Metering                                                                                                       | Float  | Percent | N/A            | RW  | 1–10                                        |
| 43734    | Active Rated kW                                                                                                                    | Int32  | N/A     | N/A            | R   | 0–1000000                                   |
| 43736    | Active Rated kvar                                                                                                                  | Int32  | N/A     | N/A            | R   | 0–1000000                                   |
| 43738    | Active Rated kVA                                                                                                                   | Int32  | N/A     | N/A            | R   | 0–1000000                                   |
| 43740    | Selected Rated kW Alternate                                                                                                        | Int32  | N/A     | N/A            | R   | 0–4                                         |
| 43742    | Rated kW Alternate 1                                                                                                               | Uint32 | N/A     | N/A            | RW  | 5–9999                                      |
| 43744    | Rated kW Alternate 2                                                                                                               | Uint32 | N/A     | N/A            | RW  | 5–9999                                      |
| 43746    | Rated kW Alternate 3                                                                                                               | Uint32 | N/A     | N/A            | RW  | 5–9999                                      |
| 43748    | Rated kW Alternate 4                                                                                                               | Uint32 | N/A     | N/A            | RW  | 5–9999                                      |
| 43750    | Emergency Stop: Writing a 1 will toggle emergency stop from off to on. Writing a 1 again will toggle emergency stop from on to off | Int32  | N/A     | N/A            | RW  | 1 = Toggle On/Off                           |
| 43752    | Remote Start                                                                                                                       | Int32  | N/A     | N/A            | RW  | 0 = Disable<br>1 = Enable                   |
| 43754    | Remote Stop                                                                                                                        | Int32  | N/A     | N/A            | RW  | 0 = Disable<br>1 = Enable                   |
| 43756    | Run Mode                                                                                                                           | Int32  | N/A     | N/A            | RW  | 0 = Disable<br>1 = Enable                   |
| 43758    | Off Mode                                                                                                                           | Int32  | N/A     | N/A            | RW  | 0 = Disable<br>1 = Enable                   |
| 43760    | Auto Mode                                                                                                                          | Int32  | N/A     | N/A            | RW  | 0 = Disable<br>1 = Enable                   |
| 43762    | Alarm Reset                                                                                                                        | Int32  | N/A     | N/A            | RW  | 0 = Disable<br>1 = Enable                   |
| 43764    | Gen Breaker Open                                                                                                                   | Int32  | N/A     | N/A            | RW  | 0 = Disable<br>1 = Enable                   |
| 43766    | Gen Breaker Close                                                                                                                  | Int32  | N/A     | N/A            | RW  | 0 = Disable<br>1 = Enable                   |
| 43768    | Mains Breaker Open                                                                                                                 | Int32  | N/A     | N/A            | RW  | 0 = Disable<br>1 = Enable                   |
| 43770    | Mains Breaker Close                                                                                                                | Int32  | N/A     | N/A            | RW  | 0 = Disable<br>1 = Enable                   |
| 43772    | FUTURE USE                                                                                                                         |        |         |                |     |                                             |
| 43774    | Virtual Input 1 Close                                                                                                              | Int32  | N/A     | N/A            | RW  | 0 = Disable<br>1 = Enable                   |
| 43776    | Virtual Input 1 Open                                                                                                               | Int32  | N/A     | N/A            | RW  | 0 = Disable<br>1 = Enable                   |
| 43778    | Virtual Input 2 Close                                                                                                              | Int32  | N/A     | N/A            | RW  | 0 = Disable<br>1 = Enable                   |
| 43780    | Virtual Input 2 Open                                                                                                               | Int32  | N/A     | N/A            | RW  | 0 = Disable<br>1 = Enable                   |

| Register       | Description                          | Type  | Units  | Scaling Factor | R/W | Range                                                           |
|----------------|--------------------------------------|-------|--------|----------------|-----|-----------------------------------------------------------------|
| 43782          | Virtual Input 3 Close                | Int32 | N/A    | N/A            | RW  | 0 = Disable<br>1 = Enable                                       |
| 43784          | Virtual Input 3 Open                 | Int32 | N/A    | N/A            | RW  | 0 = Disable<br>1 = Enable                                       |
| 43786          | Virtual Input 4 Close                | Int32 | N/A    | N/A            | RW  | 0 = Disable<br>1 = Enable                                       |
| 43788          | Virtual Input 4 Open                 | Int32 | N/A    | N/A            | RW  | 0 = Disable<br>1 = Enable                                       |
| 43790          | ESTOP Latch Status                   | Int32 | N/A    | N/A            | R   | 0 = Disabled<br>1 = Enabled                                     |
| 43792          | Gen Breaker Open                     | Int32 | N/A    | N/A            | RW  | 1 = Operate (non-latching)                                      |
| 43794          | Gen Breaker Close                    | Int32 | N/A    | N/A            | RW  | 1 = Operate (non-latching)                                      |
| 43796          | Mains Breaker Open                   | Int32 | N/A    | N/A            | RW  | 1 = Operate (non-latching)                                      |
| 43798          | Mains Breaker Close                  | Int32 | N/A    | N/A            | RW  | 1 = Operate (non-latching)                                      |
| 43800–<br>4006 | FUTURE USE                           |       |        |                |     |                                                                 |
| 44008          | RESERVED                             |       |        |                |     |                                                                 |
| 44010–<br>16   | FUTURE USE                           |       |        |                |     |                                                                 |
| 44018          | Modem Inter Dialout Activation Delay | Int32 | Second | N/A            | RW  | 0 = 15<br>1 = 30<br>2 = 60<br>3 = 120                           |
| 44020          | Modem Pager Buffer Limit             | Int32 | N/A    | N/A            | RW  | 0 = 80 Chars<br>1 = 120 Chars<br>2 = 160 Chars<br>3 = 200 Chars |
| 44022          | Modem Pager Coms Data Format         | Int32 | N/A    | N/A            | RW  | 0 = 8 bit, no parity<br>1 = 7 bit, even parity                  |

| Register | Description                | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|----------|----------------------------|--------|-------|----------------|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44024–25 | Modem Dialout Conditions 1 | Uint32 | N/A   | N/A            | RW  | Bit 0 = Aux Input 5 Closed<br>Bit 1 = Aux Input 4 Closed<br>Bit 2 = Aux Input 3 Closed<br>Bit 3 = Aux Input 2 Closed<br>Bit 4 = Aux Input 1 Closed<br>Bit 5 = Cooldown Timer Active<br>Bit 6 = Switch Not In Auto<br>Bit 7 = Scheduled Maintenance Pre-Alarm<br>Bit 8 = Weak Battery Voltage Pre-Alarm<br>Bit 9 = Low Battery Voltage Pre-Alarm<br>Bit 10 = Low Oil Pressure Pre-Alarm<br>Bit 11 = High Coolant Temp Pre-Alarm<br>Bit 12 = kW Overload 1 Pre-Alarm<br>Bit 13 = Battery Overvoltage Pre-Alarm<br>Bit 14 = Fuel Level Sender Fail Pre-Alarm<br>Bit 15 = Oil Pressure Sender Fail Pre-Alarm<br>Bit 16 = Coolant Temp Sender Fail Pre-Alarm<br>Bit 17 = Low Coolant Temp Pre-Alarm<br>Bit 18 = High Fuel Pre-Alarm<br>Bit 19 = Low Fuel Pre-Alarm<br>Bit 20 = Overspeed Alarm<br>Bit 21 = Emergency Stop Alarm<br>Bit 22 = Overcrank Alarm<br>Bit 23 = Low Coolant Level Status<br>Bit 24 = Low Fuel Alarm<br>Bit 25 = Loss of Gen Volt Sensing Alarm<br>Bit 26 = MPU Speed Sender Fail Alarm<br>Bit 27 = Fuel Level Sender Fail Alarm<br>Bit 28 = Oil Pressure Sender Fail Alarm<br>Bit 29 = Coolant Temp Sender Fail Alarm<br>Bit 30 = Low Oil Pressure Alarm<br>Bit 31 = High Coolant Temp Alarm |

| Register     | Description                | Type   | Units  | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------|----------------------------|--------|--------|----------------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44026–<br>27 | Modem Dialout Conditions 2 | Uint32 | N/A    | N/A            | RW  | Bit 0 = 59-2 Trip Alarm<br>Bit 1 = 27-2 Trip Alarm<br>Bit 2 = 51-2 Trip Alarm<br>Bit 3 = Engine Running<br>Bit 4 = Battery Charger Fail Status<br>Bit 5 = Fuel Leak Detect Status<br>Bit 6 = Transfer Fail Alarm<br>Bit 7 = 81U Trip Pre-Alarm<br>Bit 8 = 81O Trip Pre-Alarm<br>Bit 9 = 59-1 Trip Pre-Alarm<br>Bit 10 = 27-1 Trip Pre-Alarm<br>Bit 11 = 47 Trip Pre-Alarm<br>Bit 12 = 51-1 Trip Pre-Alarm<br>Bit 13 = 81U Trip Alarm<br>Bit 14 = 81O Trip Alarm<br>Bit 15 = 59-1 Trip Alarm<br>Bit 16 = 27-1 Trip Alarm<br>Bit 17 = 47 Trip Alarm<br>Bit 18 = 51-1 Trip Alarm<br>Bit 19 = Loss of ECU Coms Pre-Alarm<br>Bit 20 = Loss of ECU Coms Alarm<br>Bit 21 = Aux Input 16 Closed<br>Bit 22 = Aux Input 15 Closed<br>Bit 23 = Aux Input 14 Closed<br>Bit 24 = Aux Input 13 Closed<br>Bit 25 = Aux Input 12 Closed<br>Bit 26 = Aux Input 11 Closed<br>Bit 27 = Aux Input 10 Closed<br>Bit 28 = Aux Input 9 Closed<br>Bit 29 = Aux Input 8 Closed<br>Bit 30 = Aux Input 7 Closed<br>Bit 31 = Aux Input 6 Closed |
| 44028–<br>30 | RESERVED                   |        |        |                |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 44032        | CAN Bus Enable             | Int32  | N/A    | N/A            | RW  | 0 = Disable<br>1 = Enable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 44034        | DTC Enable                 | Int32  | N/A    | N/A            | RW  | 0 = Disable<br>1 = Enable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 44036        | Rings for Modem Answer     | Int32  | N/A    | N/A            | RW  | 1–9                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 44038        | Modem Offline Delay        | Int32  | Minute | N/A            | RW  | 1–240                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 44040        | Modbus Baud Rate           | Int32  | N/A    | N/A            | RW  | 0 = 9600 Baud<br>1 = 4800 Baud<br>2 = 2400 Baud<br>3 = 1200 Baud                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 44042        | Modbus Parity              | Int32  | N/A    | N/A            | RW  | 0 = No Parity<br>1 = Odd Parity<br>2 = Even Parity                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 44044        | Modbus Address             | Int32  | N/A    | N/A            | RW  | 1–247                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

| Register | Description                | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------|----------------------------|--------|-------|----------------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44046–47 | Modem Dialout Conditions 3 | Uint32 | N/A   | N/A            | RW  | Bit 0 = 78 Vector Shift Trip<br>Bit 1 = 51-3 Trip Pre-Alarm<br>Bit 2 = 51-3 Trip Alarm<br>Bit 3 = Duplicate AEM<br>Bit 4 = AEM Comms Failure<br>Bit 5 = Duplicate CEM<br>Bit 6 = CEM Comms Failure<br>Bit 7 = Duplicate LSM<br>Bit 8 = Config Element 8 Status<br>Bit 9 = Config Element 7 Status<br>Bit 10 = Config Element 6 Status<br>Bit 11 = Config Element 5 Status<br>Bit 12 = Config Element 4 Status<br>Bit 13 = Config Element 3 Status<br>Bit 14 = Config Element 2 Status<br>Bit 15 = Config Element 1 Status<br>Bit 16 = ID Repeat<br>Bit 17 = ID Missing<br>Bit 18 = LSM Comms Failure<br>Bit 19 = Intergenset Comms Failure<br>Bit 20 = GOV Output Limit<br>Bit 21 = AVR Output Limit<br>Bit 22 = Auto Restart Fail Alarm<br>Bit 23 = kW Overload 3 Pre-Alarm<br>Bit 24 = kW Overload 2 Pre-Alarm<br>Bit 25 = 40 Trip Pre-Alarm<br>Bit 26 = 32 Trip Pre-Alarm<br>Bit 27 = 59-2 Trip Pre-Alarm<br>Bit 28 = 27-2 Trip Pre-Alarm<br>Bit 29 = 51-2 Trip Pre-Alarm<br>Bit 30 = 40 Trip Alarm<br>Bit 31 = 32 Trip Alarm |
| 44048    | LSM-2020 Enable            | Int32  | N/A   | N/A            | RW  | 0 = Disable<br>1 = Enable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 44050    | DHCP Enabled               | Uint32 | N/A   | N/A            | R   | 0 = Disabled<br>1 = Enabled                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 44052–56 | RESERVED                   |        |       |                |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 44058    | CEM-2020 Enable            | Int32  | N/A   | N/A            | RW  | 0 = Disable<br>1 = Enable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 44060    | RESERVED                   |        |       |                |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 44062    | AEM-2020 Enable            | Int32  | N/A   | N/A            | RW  | 0 = Disable<br>1 = Enable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 44064    | CEM Outputs                | Int32  | N/A   | N/A            | RW  | 0 = 18 Outputs<br>1 = 24 Outputs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

| Register  | Description                              | Type   | Units    | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------|------------------------------------------|--------|----------|----------------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44066–67  | Modem Dialout Conditions 4               | Uint32 | N/A      | N/A            | RW  | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Common Pre-Alarm<br>Bit 16 = Common Alarm<br>Bit 17 = Unexpected Shutdown Alarm<br>Bit 18 = ECU Shutdown<br>Bit 19 = DEF Inducement Override Pre-Alarm<br>Bit 20 = DEF Severe Inducement Pre-Alarm<br>Bit 21 = DEF Pre-Severe Inducement Pre-Alarm<br>Bit 22 = DEF Engine Derate Pre-Alarm<br>Bit 23 = DEF Fluid Empty Pre-Alarm<br>Bit 24 = DEF Fluid Low Pre-Alarm<br>Bit 25 = DPF Soot Level Severely High Pre-Alarm<br>Bit 26 = DPF Soot Level Moderately High Pre-Alarm<br>Bit 27 = DPF Soot Level High Pre-Alarm<br>Bit 28 = High Exhaust Temp Pre-Alarm<br>Bit 29 = DPF Regeneration Inhibited Pre-Alarm<br>Bit 30 = DPF Regeneration Required Pre-Alarm<br>Bit 31 = 81 ROCOF DF/DT Trip |
| 44068     | Active IP Address                        | Uint32 | N/A      | N/A            | R   | 0–4294967295                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 44070     | Gateway IP Address                       | Uint32 | N/A      | N/A            | R   | 0–4294967295                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 44072     | Subnet Mask                              | Uint32 | N/A      | N/A            | R   | 0–4294967295                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 44074–76  | Reserved                                 |        |          |                |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 44078     | Auto Save to memory after a Modbus write | Uint32 | N/A      | N/A            | RW  | 0 = No<br>1 = Yes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 44080     | Save all settings                        | Uint32 | N/A      | N/A            | RW  | 1 = Write Parameters to memory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 44082–248 | FUTURE USE                               |        |          |                |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 44250     | 3 Phase Overcurrent Pickup (51-1)        | Uint32 | CentiAmp | Centi          | RW  | 18–775                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 44252     | 3 Phase Overcurrent Time Dial (51-1)     | Uint32 | DeciUnit | Deci           | RW  | 0–72000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |



| Register | Description                                     | Type   | Units      | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                             |
|----------|-------------------------------------------------|--------|------------|----------------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44254    | 3 Phase Overcurrent Curve (51-1)                | Uint32 | N/A        | N/A            | RW  | 0 = S1 Curve<br>1 = S2 Curve<br>2 = L1 Curve<br>3 = L2 Curve<br>4 = D Curve<br>5 = M Curve<br>6 = I1 Curve<br>7 = I2 Curve<br>8 = V1 Curve<br>9 = V2 Curve<br>10 = E1 Curve<br>11 = E2 Curve<br>12 = A Curve<br>13 = B Curve<br>14 = C Curve<br>15 = G Curve<br>16 = F Curve<br>17 = Programmable |
| 44256    | 3 Phase Overcurrent Alarm Configuration (51-1)  | Uint32 | N/A        | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                         |
| 44258    | 1 Phase Overcurrent Pickup (51-1)               | Uint32 | CentiAmp   | Centi          | RW  | 18–775                                                                                                                                                                                                                                                                                            |
| 44260    | 1 Phase Overcurrent Time Dial (51-1)            | Uint32 | DeciUnit   | Deci           | RW  | 0–72000                                                                                                                                                                                                                                                                                           |
| 44262    | 1 Phase Overcurrent Curve (51-1)                | Uint32 | N/A        | N/A            | RW  | 0 = S1 Curve<br>1 = S2 Curve<br>2 = L1 Curve<br>3 = L2 Curve<br>4 = D Curve<br>5 = M Curve<br>6 = I1 Curve<br>7 = I2 Curve<br>8 = V1 Curve<br>9 = V2 Curve<br>10 = E1 Curve<br>11 = E2 Curve<br>12 = A Curve<br>13 = B Curve<br>14 = C Curve<br>15 = G Curve<br>16 = F Curve<br>17 = Programmable |
| 44264    | 1 Phase Overcurrent Alarm Configuration (51-1)  | Uint32 | N/A        | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                         |
| 44266    | Phase Imbalance Pickup                          | Uint32 | Volt       | N/A            | RW  | 5–100                                                                                                                                                                                                                                                                                             |
| 44268    | Phase Imbalance Activation Delay                | Uint32 | Decisecond | Deci           | RW  | 0–300                                                                                                                                                                                                                                                                                             |
| 44270    | Phase Imbalance Alarm Configuration             | Uint32 | N/A        | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                         |
| 44272    | 3 Phase Undervoltage Pickup (27-1)              | Uint32 | Volt       | N/A            | RW  | 70–1000                                                                                                                                                                                                                                                                                           |
| 44274    | 3 Phase Undervoltage Activation Delay (27-1)    | Uint32 | Decisecond | Deci           | RW  | 0–300                                                                                                                                                                                                                                                                                             |
| 44276    | 3 Phase Undervoltage Inhibit Frequency (27-1)   | Uint32 | Hertz      | N/A            | RW  | 20–400                                                                                                                                                                                                                                                                                            |
| 44278    | 3 Phase Undervoltage Alarm Configuration (27-1) | Uint32 | N/A        | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                         |
| 44280    | 1 Phase Undervoltage Pickup (27-1)              | Uint32 | Volt       | N/A            | RW  | 70–1000                                                                                                                                                                                                                                                                                           |
| 44282    | 1 Phase Undervoltage Activation Delay (27-1)    | Uint32 | Decisecond | Deci           | RW  | 0–300                                                                                                                                                                                                                                                                                             |
| 44284    | 1 Phase Undervoltage Inhibit Frequency (27-1)   | Uint32 | Hertz      | N/A            | RW  | 20–400                                                                                                                                                                                                                                                                                            |
| 44286    | 1 Phase Undervoltage Alarm Configuration (27-1) | Uint32 | N/A        | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                         |

| Register | Description                                    | Type   | Units      | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                             |
|----------|------------------------------------------------|--------|------------|----------------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44288    | 3 Phase Overvoltage Pickup (59-1)              | Uint32 | Volt       | N/A            | RW  | 70–1000                                                                                                                                                                                                                                                                                           |
| 44290    | 3 Phase Overvoltage Activation Delay (59-1)    | Uint32 | Decisecond | Deci           | RW  | 0–300                                                                                                                                                                                                                                                                                             |
| 44292    | 3 Phase Overvoltage Alarm Configuration (59-1) | Uint32 | N/A        | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                         |
| 44294    | 1 Phase Overvoltage Pickup (59-1)              | Uint32 | Volt       | N/A            | RW  | 70–1000                                                                                                                                                                                                                                                                                           |
| 44296    | 1 Phase Overvoltage Activation Delay (59-1)    | Uint32 | Decisecond | Deci           | RW  | 0–300                                                                                                                                                                                                                                                                                             |
| 44298    | 1 Phase Overvoltage Alarm Configuration (59-1) | Uint32 | N/A        | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                         |
| 44300    | Underfrequency Pickup                          | Uint32 | DeciHertz  | Deci           | RW  | 450–4400                                                                                                                                                                                                                                                                                          |
| 44302    | Underfrequency Activation Delay                | Uint32 | Decisecond | Deci           | RW  | 0–300                                                                                                                                                                                                                                                                                             |
| 44304    | Underfrequency Inhibit Voltage                 | Uint32 | Volt       | N/A            | RW  | 70–576                                                                                                                                                                                                                                                                                            |
| 44306    | Underfrequency Alarm Configuration             | Uint32 | N/A        | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                         |
| 44308    | Overfrequency Pickup                           | Uint32 | DeciHertz  | Deci           | RW  | 450–4400                                                                                                                                                                                                                                                                                          |
| 44310    | Overfrequency Activation Delay                 | Uint32 | Decisecond | Deci           | RW  | 0 – 300                                                                                                                                                                                                                                                                                           |
| 44312    | Overfrequency Alarm Configuration              | Uint32 | N/A        | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                         |
| 44314    | Overcurrent Low Line Scale Factor (51-1)       | Float  | N/A        | N/A            | RW  | 0.001–3                                                                                                                                                                                                                                                                                           |
| 44316    | Overvoltage Low Line Scale Factor (59-1)       | Float  | N/A        | N/A            | RW  | 0.001–3                                                                                                                                                                                                                                                                                           |
| 44318    | Undervoltage Low Line Scale Factor (27-1)      | Float  | N/A        | N/A            | RW  | 0.001–3                                                                                                                                                                                                                                                                                           |
| 44320    | 3 Phase Overcurrent Pickup (51-2)              | Uint32 | CentiAmp   | Centi          | RW  | 18–775                                                                                                                                                                                                                                                                                            |
| 44322    | 3 Phase Overcurrent Time Dial (51-2)           | Uint32 | DeciUnit   | Deci           | RW  | 0–72000                                                                                                                                                                                                                                                                                           |
| 44324    | 3 Phase Overcurrent Curve (51-2)               | Uint32 | N/A        | N/A            | RW  | 0 = S1 Curve<br>1 = S2 Curve<br>2 = L1 Curve<br>3 = L2 Curve<br>4 = D Curve<br>5 = M Curve<br>6 = I1 Curve<br>7 = I2 Curve<br>8 = V1 Curve<br>9 = V2 Curve<br>10 = E1 Curve<br>11 = E2 Curve<br>12 = A Curve<br>13 = B Curve<br>14 = C Curve<br>15 = G Curve<br>16 = F Curve<br>17 = Programmable |
| 44326    | 3 Phase Overcurrent Alarm Configuration (51-2) | Uint32 | N/A        | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                         |
| 44328    | 1 Phase Overcurrent Pickup (51-2)              | Uint32 | CentiAmp   | Centi          | RW  | 18–775                                                                                                                                                                                                                                                                                            |
| 44330    | 1 Phase Overcurrent Time Dial (51-2)           | Uint32 | DeciUnit   | Deci           | RW  | 0–72000                                                                                                                                                                                                                                                                                           |

| Register | Description                                     | Type   | Units      | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                             |
|----------|-------------------------------------------------|--------|------------|----------------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44332    | 1 Phase Overcurrent Curve (51-2)                | Uint32 | N/A        | N/A            | RW  | 0 = S1 Curve<br>1 = S2 Curve<br>2 = L1 Curve<br>3 = L2 Curve<br>4 = D Curve<br>5 = M Curve<br>6 = I1 Curve<br>7 = I2 Curve<br>8 = V1 Curve<br>9 = V2 Curve<br>10 = E1 Curve<br>11 = E2 Curve<br>12 = A Curve<br>13 = B Curve<br>14 = C Curve<br>15 = G Curve<br>16 = F Curve<br>17 = Programmable |
| 44334    | 1 Phase Overcurrent Alarm Configuration (51-2)  | Uint32 | N/A        | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                         |
| 44336    | 3 Phase Undervoltage Pickup (27-2)              | Uint32 | Volt       | N/A            | RW  | 70–1000                                                                                                                                                                                                                                                                                           |
| 44338    | 3 Phase Undervoltage Activation Delay (27-2)    | Uint32 | Decisecond | Deci           | RW  | 0–300                                                                                                                                                                                                                                                                                             |
| 44340    | 3 Phase Undervoltage Inhibit Frequency (27-2)   | Uint32 | Hertz      | N/A            | RW  | 20–400                                                                                                                                                                                                                                                                                            |
| 44342    | 3 Phase Undervoltage Alarm Configuration (27-2) | Uint32 | N/A        | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                         |
| 44344    | 1 Phase Undervoltage Pickup (27-2)              | Uint32 | Volt       | N/A            | RW  | 70–1000                                                                                                                                                                                                                                                                                           |
| 44346    | 1 Phase Undervoltage Activation Delay (27-2)    | Uint32 | Decisecond | Deci           | RW  | 0–300                                                                                                                                                                                                                                                                                             |
| 44348    | 1 Phase Undervoltage Inhibit Frequency (27-2)   | Uint32 | Hertz      | N/A            | RW  | 20–400                                                                                                                                                                                                                                                                                            |
| 44350    | 1 Phase Undervoltage Alarm Configuration (27-2) | Uint32 | N/A        | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                         |
| 44352    | 3 Phase Overvoltage Pickup (59-2)               | Uint32 | Volt       | N/A            | RW  | 70–1000                                                                                                                                                                                                                                                                                           |
| 44354    | 3 Phase Overvoltage Activation Delay (59-2)     | Uint32 | Decisecond | Deci           | RW  | 0–300                                                                                                                                                                                                                                                                                             |
| 44356    | 3 Phase Overvoltage Alarm Configuration (59-2)  | Uint32 | N/A        | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                         |
| 44358    | 1 Phase Overvoltage Pickup (59-2)               | Uint32 | Volt       | N/A            | RW  | 70–1000                                                                                                                                                                                                                                                                                           |
| 44360    | 1 Phase Overvoltage Activation Delay (59-2)     | Uint32 | Decisecond | Deci           | RW  | 0–300                                                                                                                                                                                                                                                                                             |
| 44362    | 1 Phase Overvoltage Alarm Configuration (59-2)  | Uint32 | N/A        | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                         |
| 44364    | Overcurrent Low Line Scale Factor (51-2)        | Float  | N/A        | N/A            | RW  | 0.001–3                                                                                                                                                                                                                                                                                           |
| 44366    | Overvoltage Low Line Scale Factor (59-2)        | Float  | N/A        | N/A            | RW  | 0.001–3                                                                                                                                                                                                                                                                                           |
| 44368    | Undervoltage Low Line Scale Factor (27-2)       | Float  | N/A        | N/A            | RW  | 0.001–3                                                                                                                                                                                                                                                                                           |
| 44370    | Phase Imbalance Hysteresis                      | Uint32 | Volt       | N/A            | RW  | 1–5                                                                                                                                                                                                                                                                                               |
| 44372    | 3 Phase Undervoltage Hysteresis (27-1)          | Uint32 | Volt       | N/A            | RW  | 1–60                                                                                                                                                                                                                                                                                              |
| 44374    | 1 Phase Undervoltage Hysteresis (27-1)          | Uint32 | Volt       | N/A            | RW  | 1–60                                                                                                                                                                                                                                                                                              |
| 44376    | 3 Phase Overvoltage Hysteresis (59-1)           | Uint32 | Volt       | N/A            | RW  | 1–60                                                                                                                                                                                                                                                                                              |
| 44378    | 1 Phase Overvoltage Hysteresis (59-1)           | Uint32 | Volt       | N/A            | RW  | 1–60                                                                                                                                                                                                                                                                                              |

| Register | Description                                    | Type   | Units       | Scaling Factor | R/W | Range                                                     |
|----------|------------------------------------------------|--------|-------------|----------------|-----|-----------------------------------------------------------|
| 44380    | Underfrequency Hysteresis                      | Uint32 | DeciHertz   | Deci           | RW  | 1–400                                                     |
| 44382    | Overfrequency Hysteresis                       | Uint32 | DeciHertz   | Deci           | RW  | 1–400                                                     |
| 44384    | 3 Phase Undervoltage Hysteresis (27-2)         | Uint32 | Volt        | N/A            | RW  | 1–60                                                      |
| 44386    | 1 Phase Undervoltage Hysteresis (27-2)         | Uint32 | Volt        | N/A            | RW  | 1–60                                                      |
| 44388    | 3 Phase Overvoltage Hysteresis (59-2)          | Uint32 | Volt        | N/A            | RW  | 1–60                                                      |
| 44390    | 1 Phase Overvoltage Hysteresis (59-2)          | Uint32 | Volt        | N/A            | RW  | 1–60                                                      |
| 44392    | 3 Phase Reverse Power Pickup                   | Int32  | DeciPercent | Deci           | RW  | -500 to 50                                                |
| 44394    | 3 Phase Reverse Power Activation Delay         | Uint32 | Decisecond  | Deci           | RW  | 0–300                                                     |
| 44396    | 3 Phase Reverse Power Alarm Configuration      | Uint32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 44398    | 3 Phase Reverse Power Hysteresis               | Int32  | DeciPercent | Deci           | RW  | 10–100                                                    |
| 44400    | 1 Phase Reverse Power Pickup                   | Int32  | DeciPercent | Deci           | RW  | -500 to 50                                                |
| 44402    | 1 Phase Reverse Power Activation Delay         | Uint32 | Decisecond  | Deci           | RW  | 0–300                                                     |
| 44404    | 1 Phase Reverse Power Alarm Configuration      | Uint32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 44406    | 1 Phase Reverse Power Hysteresis               | Int32  | DeciPercent | Deci           | RW  | 10–100                                                    |
| 44408    | 3 Phase Loss of Excitation Pickup              | Int32  | DeciPercent | Deci           | RW  | -1500 to 0                                                |
| 44410    | 3 Phase Loss of Excitation Activation Delay    | Uint32 | Decisecond  | Deci           | RW  | 0–300                                                     |
| 44412    | 3 Phase Loss of Excitation Alarm Configuration | Uint32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 44414    | 3 Phase Loss of Excitation Hysteresis          | Int32  | DeciPercent | Deci           | RW  | 10–100                                                    |
| 44416    | 1 Phase Loss of Excitation Pickup              | Int32  | DeciPercent | Deci           | RW  | -1500 to 0                                                |
| 44418    | 1 Phase Loss of Excitation Activation Delay    | Uint32 | Decisecond  | Deci           | RW  | 0–300                                                     |
| 44420    | 1 Phase Loss of Excitation Alarm Configuration | Uint32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 44422    | 1 Phase Loss of Excitation Hysteresis          | Int32  | DeciPercent | Deci           | RW  | 10–100                                                    |
| 44424    | 3 Phase Overcurrent Reset Type (51-1)          | Int32  | N/A         | N/A            | RW  | 0 = Instantaneous<br>1 = Integrating                      |
| 44426    | 1 Phase Overcurrent Reset Type (51-1)          | Int32  | N/A         | N/A            | RW  | 0 = Instantaneous<br>1 = Integrating                      |
| 44428    | 3 Phase Overcurrent Reset Type (51-2)          | Int32  | N/A         | N/A            | RW  | 0 = Instantaneous<br>1 = Integrating                      |
| 44430    | 1 Phase Overcurrent Reset Type (51-2)          | Int32  | N/A         | N/A            | RW  | 0 = Instantaneous<br>1 = Integrating                      |
| 44432    | 51-1 Curve Constant A                          | Float  | N/A         | N/A            | RW  | 0–600                                                     |
| 44434    | 51-1 Curve Constant B                          | Float  | N/A         | N/A            | RW  | 0–25                                                      |
| 44436    | 51-1 Curve Constant C                          | Float  | N/A         | N/A            | RW  | 0–1                                                       |
| 44438    | 51-1 Curve Constant N                          | Float  | N/A         | N/A            | RW  | 0.5–2.5                                                   |
| 44440    | 51-1 Curve Constant R                          | Float  | N/A         | N/A            | RW  | 0–30                                                      |
| 44442    | 51-2 Curve Constant A                          | Float  | N/A         | N/A            | RW  | 0–600                                                     |
| 44444    | 51-2 Curve Constant B                          | Float  | N/A         | N/A            | RW  | 0–25                                                      |
| 44446    | 51-2 Curve Constant C                          | Float  | N/A         | N/A            | RW  | 0–1                                                       |
| 44448    | 51-2 Curve Constant N                          | Float  | N/A         | N/A            | RW  | 0.5–2.5                                                   |
| 44450    | 51-2 Curve Constant R                          | Float  | N/A         | N/A            | RW  | 0–30                                                      |
| 44452    | 3 Phase Overcurrent Pickup (51-3)              | Uint32 | CentiAmp    | Centi          | RW  | 18–775                                                    |
| 44454    | 3 Phase Overcurrent Time Dial (51-3)           | Uint32 | DeciUnit    | Deci           | RW  | 0–72000                                                   |

| Register | Description                                    | Type   | Units     | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                             |
|----------|------------------------------------------------|--------|-----------|----------------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44456    | 3 Phase Overcurrent Curve (51-3)               | Uint32 | N/A       | N/A            | RW  | 0 = S1 Curve<br>1 = S2 Curve<br>2 = L1 Curve<br>3 = L2 Curve<br>4 = D Curve<br>5 = M Curve<br>6 = I1 Curve<br>7 = I2 Curve<br>8 = V1 Curve<br>9 = V2 Curve<br>10 = E1 Curve<br>11 = E2 Curve<br>12 = A Curve<br>13 = B Curve<br>14 = C Curve<br>15 = G Curve<br>16 = F Curve<br>17 = Programmable |
| 44458    | 3 Phase Overcurrent Alarm Configuration (51-3) | Uint32 | N/A       | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                         |
| 44460    | 1 Phase Overcurrent Pickup (51-3)              | Uint32 | CentiAmp  | Centi          | RW  | 18–775                                                                                                                                                                                                                                                                                            |
| 44462    | 1 Phase Overcurrent Time Dial (51-3)           | Uint32 | DeciUnit  | Deci           | RW  | 0–72000                                                                                                                                                                                                                                                                                           |
| 44464    | 1 Phase Overcurrent Curve (51-3)               | Uint32 | N/A       | N/A            | RW  | 0 = S1 Curve<br>1 = S2 Curve<br>2 = L1 Curve<br>3 = L2 Curve<br>4 = D Curve<br>5 = M Curve<br>6 = I1 Curve<br>7 = I2 Curve<br>8 = V1 Curve<br>9 = V2 Curve<br>10 = E1 Curve<br>11 = E2 Curve<br>12 = A Curve<br>13 = B Curve<br>14 = C Curve<br>15 = G Curve<br>16 = F Curve<br>17 = Programmable |
| 44466    | 1 Phase Overcurrent Alarm Configuration (51-3) | Uint32 | N/A       | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                         |
| 44468    | Overcurrent Low Line Scale Factor (51-3)       | Float  | N/A       | N/A            | RW  | 0.001–3                                                                                                                                                                                                                                                                                           |
| 44470    | 3 Phase Overcurrent Reset Type (51-3)          | Int32  | N/A       | N/A            | RW  | 0 = Instantaneous<br>1 = Integrating                                                                                                                                                                                                                                                              |
| 44472    | 1 Phase Overcurrent Reset Type (51-3)          | Int32  | N/A       | N/A            | RW  | 0 = Instantaneous<br>1 = Integrating                                                                                                                                                                                                                                                              |
| 44474    | 51-3 Curve Constant A                          | Float  | N/A       | N/A            | RW  | 0–600                                                                                                                                                                                                                                                                                             |
| 44476    | 51-3 Curve Constant B                          | Float  | N/A       | N/A            | RW  | 0–25                                                                                                                                                                                                                                                                                              |
| 44478    | 51-3 Curve Constant C                          | Float  | N/A       | N/A            | RW  | 0–1                                                                                                                                                                                                                                                                                               |
| 44480    | 51-3 Curve Constant N                          | Float  | N/A       | N/A            | RW  | 0.5–2.5                                                                                                                                                                                                                                                                                           |
| 44482    | 51-3 Curve Constant R                          | Float  | N/A       | N/A            | RW  | 0–30                                                                                                                                                                                                                                                                                              |
| 44484    | 78 Vector Shift Alarm Config                   | Uint32 | N/A       | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                         |
| 44486    | 78 Vector Shift Pickup                         | Int32  | Degree    | N/A            | RW  | 2–90                                                                                                                                                                                                                                                                                              |
| 44488    | 78 Open Mains Breaker on Trip                  | Int32  | N/A       | N/A            | RW  | 0 = Disable<br>1 = Enable                                                                                                                                                                                                                                                                         |
| 44490    | 81 ROCOF Alarm Config                          | Uint32 | N/A       | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                         |
| 44492    | 81 ROCOF Pickup                                | Uint32 | Hz/Second | Deci           | RW  | 2–100                                                                                                                                                                                                                                                                                             |

| Register | Description                                  | Type   | Units       | Scaling Factor | R/W | Range                     |
|----------|----------------------------------------------|--------|-------------|----------------|-----|---------------------------|
| 44494    | 81 ROCOF Activation Delay                    | Uint32 | Second      | Milli          | RW  | 0–10000                   |
| 44496    | 81 ROCOF Open Mains Breaker on Trip          | Int32  | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable |
| 44498    | Alternate Frequency Scale Factor             | Float  | N/A         | N/A            | RW  | 0.001–100                 |
| 44500    | High Coolant Temp Alarm Enable               | Uint32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable |
| 44502    | High Coolant Temp Alarm Threshold            | Uint32 | Deg F       | N/A            | RW  | 100–280                   |
| 44504    | Metric High Coolant Temp Alarm Threshold     | Int32  | Deg C       | N/A            | RW  | 38–138                    |
| 44506    | High Coolant Temp Alarm Activation Delay     | Uint32 | Second      | N/A            | RW  | 0–150                     |
| 44508    | Low Oil Press. Alarm Enable                  | Uint32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable |
| 44510    | Low Oil Press. Alarm Threshold               | Uint32 | PSI         | Deci           | RW  | 29–1500                   |
| 44512    | Metric Low Oil Press. Alarm Threshold        | Uint32 | kPa         | Deci           | RW  | 200–10345                 |
| 44514    | Low Oil Press. Alarm Arming Delay            | Uint32 | Second      | N/A            | RW  | 5–60                      |
| 44516    | Overspeed Alarm Enable                       | Uint32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable |
| 44518    | Overspeed Alarm Threshold                    | Uint32 | Percent     | N/A            | RW  | 105–140                   |
| 44520    | Overspeed Alarm Activation Delay             | Uint32 | Millisecond | Milli          | RW  | 0–500                     |
| 44522    | Low Fuel Level Alarm Enable                  | Uint32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable |
| 44524    | Low Fuel Level Alarm Threshold               | Uint32 | Percent     | N/A            | RW  | 0–100                     |
| 44526    | Low Fuel Level Alarm Activation Delay        | Int32  | Second      | N/A            | RW  | 0–30                      |
| 44528    | High Coolant Temp Pre-Alarm Enable           | Uint32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable |
| 44530    | High Coolant Temp Pre-Alarm Threshold        | Uint32 | Deg F       | N/A            | RW  | 100–280                   |
| 44532    | Metric High Coolant Temp Pre-Alarm Threshold | Int32  | Deg C       | N/A            | RW  | 38–138                    |
| 44534    | Low Coolant Temp Pre-Alarm Enable            | Uint32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable |
| 44536    | Low Coolant Temp Pre-Alarm Threshold         | Uint32 | Deg F       | N/A            | RW  | 35–151                    |
| 44538    | Metric Low Coolant Temp Pre-Alarm Threshold  | Int32  | Deg C       | N/A            | RW  | 2–66                      |
| 44540    | High Fuel Level Pre-Alarm Threshold          | Int32  | Percent     | N/A            | RW  | 0–150                     |
| 44542    | High Fuel Level Pre-Alarm Enable             | Int32  | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable |
| 44544    | High Fuel Level Pre-Alarm Activation Delay   | Int32  | Second      | N/A            | RW  | 0–30                      |
| 44546    | Low Fuel Level Pre-Alarm Enable              | Uint32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable |
| 44548    | Low Fuel Level Pre-Alarm Threshold           | Uint32 | Percent     | N/A            | RW  | 10–100                    |
| 44550    | Low Battery Pre-Alarm Enable                 | Uint32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable |
| 44552    | Low Battery Pre-Alarm Threshold              | Uint32 | DeciVolt    | Deci           | RW  | 60–280                    |
| 44554    | Low Battery Pre-Alarm Activation Delay       | Uint32 | Second      | N/A            | RW  | 1–60                      |
| 44556    | Weak Battery Pre-Alarm Enable                | Uint32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable |
| 44558    | Weak Battery Pre-Alarm Threshold             | Uint32 | DeciVolt    | Deci           | RW  | 40–280                    |
| 44560    | Weak Battery Pre-Alarm Activation Delay      | Uint32 | Second      | Deci           | RW  | 0–100                     |
| 44562    | Battery Overvoltage Pre-Alarm Enable         | Uint32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable |
| 44564    | Low Oil Press. Pre-Alarm Enable              | Uint32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable |
| 44566    | Low Oil Press. Pre-Alarm Threshold           | Uint32 | PSI         | Deci           | RW  | 29–1500                   |
| 44568    | Metric Low Oil Press. Pre-Alarm Threshold    | Int32  | kPa         | Deci           | RW  | 20–10345                  |
| 44570    | Engine Overload 1 Pre-Alarm Enable           | Uint32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable |

| Register | Description                                               | Type   | Units    | Scaling Factor | R/W | Range                     |
|----------|-----------------------------------------------------------|--------|----------|----------------|-----|---------------------------|
| 44572    | Engine Overload 1 Pre-Alarm Threshold                     | Int32  | Percent  | N/A            | RW  | 0–200                     |
| 44574    | ECU Comms Fail Pre-Alarm Enable                           | Int32  | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable |
| 44576    | Active DTC Pre-Alarm Enable                               | Int32  | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable |
| 44578    | Maintenance Interval Pre-Alarm Enable                     | Uint32 | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable |
| 44580    | Maintenance Interval Pre-Alarm Threshold                  | Uint32 | Hour     | N/A            | RW  | 0–5000                    |
| 44582    | Speed Sender Fail Activation Delay                        | Int32  | Second   | N/A            | RW  | 0–300                     |
| 44584    | ECU Low Coolant Level Alarm Enable                        | Uint32 | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable |
| 44586    | ECU Low Coolant Level Alarm Threshold                     | Uint32 | Percent  | N/A            | RW  | 1–99                      |
| 44588    | ECU Low Coolant Level Pre-Alarm Enable                    | Uint32 | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable |
| 44590    | ECU Low Coolant Level Pre-Alarm Threshold                 | Uint32 | Percent  | N/A            | RW  | 1–99                      |
| 44592    | Battery Overvoltage Alarm Threshold                       | Int32  | DeciVolt | Deci           | RW  | 120–320                   |
| 44594    | Engine Overload 1 Pre-Alarm 3 Phase Hysteresis            | Int32  | DeciVolt | Deci           | RW  | 1–10                      |
| 44596    | Engine Overload 1 Pre-Alarm 1 Phase Threshold             | Int32  | Percent  | N/A            | RW  | 0–200                     |
| 44598    | Engine Overload 1 Pre-Alarm 1 Phase Hysteresis            | Int32  | Percent  | N/A            | RW  | 1–10                      |
| 44600    | Engine Overload 1 Pre-Alarm 1 Phase Low Line Scale Factor | Float  | N/A      | N/A            | RW  | 0.001–3                   |
| 44602    | Engine Overload 2 Pre-Alarm Enable                        | Int32  | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable |
| 44604    | Engine Overload 2 Pre-Alarm 3 Phase Threshold             | Int32  | Percent  | N/A            | RW  | 0–200                     |
| 44606    | Engine Overload 2 Pre-Alarm 3 Phase Hysteresis            | Int32  | Percent  | N/A            | RW  | 1–10                      |
| 44608    | Engine Overload 2 Pre-Alarm 1 Phase Threshold             | Int32  | Percent  | N/A            | RW  | 0–200                     |
| 44610    | Engine Overload 2 Pre-Alarm 1 Phase Hysteresis            | Int32  | Percent  | N/A            | RW  | 1–10                      |
| 44612    | Engine Overload 2 Pre-Alarm 1 Phase Low Line Scale Factor | Float  | N/A      | N/A            | RW  | 0.001–3                   |
| 44614    | Engine Overload 3 Pre-Alarm Enable                        | Int32  | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable |
| 44616    | Engine Overload 3 Pre-Alarm 3 Phase Threshold             | Int32  | Percent  | N/A            | RW  | 0–200                     |
| 44618    | Engine Overload 3 Pre-Alarm 3 Phase Hysteresis            | Int32  | Percent  | N/A            | RW  | 1–10                      |
| 44620    | Engine Overload 3 Pre-Alarm 1 Phase Threshold             | Int32  | Percent  | N/A            | RW  | 0–200                     |
| 44622    | Engine Overload 3 Pre-Alarm 1 Phase Hysteresis            | Int32  | Percent  | N/A            | RW  | 1–10                      |
| 44624    | Engine Overload 3 Pre-Alarm 1 Phase Low Line Scale Factor | Float  | N/A      | N/A            | RW  | 0.001–3                   |
| 44626    | LSM Comm Failure Pre-alarm Enable                         | Int32  | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable |
| 44628    | Intergenset Comm Failure Pre-alarm Enable                 | Int32  | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable |
| 44630    | AVR Bias Output Limit Pre-alarm Activation Delay          | Int32  | Second   | N/A            | RW  | 1–15                      |
| 44632    | AVR Bias Output Limit Pre-alarm Enable                    | Int32  | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable |
| 44634    | GOV Bias Output Limit Pre-alarm Activation Delay          | Int32  | Second   | N/A            | RW  | 1–15                      |
| 44636    | GOV Bias Output Limit Pre-alarm Enable                    | Int32  | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable |

| Register  | Description                                               | Type   | Units    | Scaling Factor | R/W | Range                              |
|-----------|-----------------------------------------------------------|--------|----------|----------------|-----|------------------------------------|
| 44638     | ID Missing Pre-alarm Enable                               | Int32  | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable          |
| 44640     | ID Repeat Pre-alarm Enable                                | Int32  | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable          |
| 44642     | CEM Comm Failure Pre-alarm Enable                         | Int32  | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable          |
| 44644     | AEM Comm Failure Pre-alarm Enable                         | Int32  | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable          |
| 44646     | Checksum Failure Pre-alarm Enable                         | Int32  | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable          |
| 44648     | Low Oil Pressure Alarm (metric pressure units is Bar)     | Int32  | Bar      | Deci           | RW  | 2–103                              |
| 44650     | Low Oil Pressure Pre-Alarm (metric pressure units is Bar) | Int32  | Bar      | Deci           | RW  | 2–103                              |
| 44652     | Sync Fail Pre-alarm Enable                                | Int32  | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable          |
| 44654     | Breaker Close Fail Pre-Alarm Enable                       | Int32  | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable          |
| 44656     | Breaker Open Fail Pre-Alarm Enable                        | Int32  | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable          |
| 44658     | Breaker Close Fail Pre-Alarm Monitor                      | Int32  | N/A      | N/A            | RW  | 0 = Transitions Only<br>1 = Always |
| 44660     | Breaker Open Fail Pre-Alarm Monitor                       | Int32  | N/A      | N/A            | RW  | 0 = Transitions Only<br>1 = Always |
| 44662     | Reverse Rotation Pre-Alarm Enable                         | Uint32 | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable          |
| 44664     | CAN Bus Low Coolant Level Alarm                           | Uint32 | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable          |
| 44666     | Low Fuel Level Alarm Hysteresis                           | Uint32 | Percent  | N/A            | RW  | 0–20                               |
| 44668     | Low Fuel Level Pre-Alarm Hysteresis                       | Uint32 | Percent  | N/A            | RW  | 0–20                               |
| 44670     | High Fuel Level Pre-Alarm Hysteresis                      | Uint32 | Percent  | N/A            | RW  | 0–20                               |
| 44672     | DEF Pre-Alarms Enable                                     | Uint32 | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable          |
| 44674     | Soot Pre-Alarms Enable                                    | Uint32 | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable          |
| 44676     | Regeneration Pre-Alarms Enable                            | Uint32 | N/A      | N/A            | RW  | 0 = Disable<br>1 = Enable          |
| 44678–749 | FUTURE USE                                                |        |          |                |     |                                    |
| 44750     | Gen VAB Metering                                          | Int32  | Volt     | N/A            | R   | -2147483648 to 2147483647          |
| 44752     | Gen VBC Metering                                          | Int32  | Volt     | N/A            | R   | -2147483648 to 2147483647          |
| 44754     | Gen VCA Metering                                          | Int32  | Volt     | N/A            | R   | -2147483648 to 2147483647          |
| 44756     | Gen VAN Metering                                          | Int32  | Volt     | N/A            | R   | -2147483648 to 2147483647          |
| 44758     | Gen VBN Metering                                          | Int32  | Volt     | N/A            | R   | -2147483648 to 2147483647          |
| 44760     | Gen VCN Metering                                          | Int32  | Volt     | N/A            | R   | -2147483648 to 2147483647          |
| 44762     | Bus Voltage Metering                                      | Int32  | Volt     | N/A            | R   | -2147483648 to 2147483647          |
| 44764     | Gen IA Metering                                           | Int32  | Amp      | N/A            | R   | -32768 to 32767                    |
| 44766     | Gen IB Metering                                           | Int32  | Amp      | N/A            | R   | -32768 to 32767                    |
| 44768     | Gen IC Metering                                           | Int32  | Amp      | N/A            | R   | -32768 to 32767                    |
| 44770     | Gen kVA A Metering                                        | Int32  | KiloVA   | N/A            | R   | -2147483648 to 2147483647          |
| 44772     | Gen kVA B Metering                                        | Int32  | KiloVA   | N/A            | R   | -2147483648 to 2147483647          |
| 44774     | Gen kVA C Metering                                        | Int32  | KiloVA   | N/A            | R   | -2147483648 to 2147483647          |
| 44776     | Gen kVA Total Metering                                    | Int32  | KiloVA   | N/A            | R   | -2147483648 to 2147483647          |
| 44778     | Gen kW A Metering                                         | Int32  | Kilowatt | N/A            | R   | -2147483648 to 2147483647          |
| 44780     | Gen kW B Metering                                         | Int32  | Kilowatt | N/A            | R   | -2147483648 to 2147483647          |
| 44782     | Gen kW C Metering                                         | Int32  | Kilowatt | N/A            | R   | -2147483648 to 2147483647          |
| 44784     | Gen kW Total Metering                                     | Int32  | Kilowatt | N/A            | R   | -2147483648 to 2147483647          |
| 44786     | Power Factor Metering                                     | Float  | N/A      | N/A            | R   | -1 to 1                            |
| 44788     | Gen PF Lagging                                            | Int32  | N/A      | N/A            | R   | 0 = leading, 1 = lagging           |
| 44790     | Gen Frequency Metering                                    | Float  | Hertz    | N/A            | R   | 45–440                             |
| 44792     | Bus Frequency Metering                                    | Float  | Hertz    | N/A            | R   | 45–440                             |



| Register | Description                | Type   | Units    | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------|----------------------------|--------|----------|----------------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44794    | Active Speed Source        | Uint32 | N/A      | N/A            | R   | 0 = None<br>1 = MPU<br>2 = Gen Freq<br>4 = CAN Bus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 44796    | Engine Speed Metering      | Uint32 | RPM      | N/A            | R   | 0–65535                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 44798    | Engine Load Metering       | Int32  | Percent  | N/A            | R   | -32768 to 32767                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 44800    | Coolant Temp. Metering     | Int32  | Deg F    | N/A            | R   | -32768 to 32767                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 44802    | Oil Pressure Metering      | Int32  | PSI      | N/A            | R   | -32768 to 32767                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 44804    | Battery Voltage Metering   | Int32  | DeciVolt | N/A            | R   | -32768 to 32767                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 44806    | Fuel Level Metering        | Int32  | N/A      | N/A            | R   | -32768 to 32767                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 44808    | ECU Coolant Level Metering | Uint32 | N/A      | N/A            | R   | 0–255                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 44810    | Cool Down Time Remaining   | Int32  | Minute   | N/A            | R   | -128 to 127                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 44812–13 | Alarm Metering             | Int32  | N/A      | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = DEF Severe Inducement<br>Bit 14 = Diagnostic Trouble Code<br>Bit 15 = Exhaust System Error<br>Bit 16 = Unexpected Shutdown<br>Bit 17 = Global Alarm<br>Bit 18 = Auto Restart Failure<br>Bit 19 = Fuel Leak Detect<br>Bit 20 = Battery Charger Failure<br>Bit 21 = Transfer Fail<br>Bit 22 = Low Coolant Level<br>Bit 23 = ECU Shutdown<br>Bit 24 = Emergency Shutdown<br>Bit 25 = Overcrank<br>Bit 26 = Loss of ECU Comms<br>Bit 27 = Global Sender Fail<br>Bit 28 = Low Fuel Level<br>Bit 29 = Low Oil Pressure<br>Bit 30 = Hi Coolant Temp<br>Bit 31 = Overspeed |

| Register | Description          | Type  | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|----------|----------------------|-------|-------|----------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44814–15 | Pre-Alarm Metering 1 | Int32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Serial Flash Read Failure<br>Bit 3 = Checksum Fail<br>Bit 4 = Global Pre-Alarm<br>Bit 5 = Fuel Filter 2 Leak<br>Bit 6 = Fuel Filter 1 Leak<br>Bit 7 = Engine kW Overload 3<br>Bit 8 = Engine kW Overload 2<br>Bit 9 = MPU Fail<br>Bit 10 = Fuel Leak Detect<br>Bit 11 = Battery Charger Failure<br>Bit 12 = Low Coolant Level<br>Bit 13 = Mains Breaker Fail to Open<br>Bit 14 = Mains Breaker Fail to Close<br>Bit 15 = Sync Fail at Mains Breaker<br>Bit 16 = Gen Breaker Fail to Open<br>Bit 17 = Gen Breaker Fail to Close<br>Bit 18 = Sync Fail at Gen Breaker<br>Bit 19 = High Fuel Level<br>Bit 20 = Loss of Rem. Mod. Com<br>Bit 21 = Engine kW Overload<br>Bit 22 = Diagnostic Trouble Code<br>Bit 23 = Loss of ECU Comms<br>Bit 24 = Maintenance Due<br>Bit 25 = Battery Overvoltage<br>Bit 26 = Weak Battery<br>Bit 27 = Low Battery Voltage<br>Bit 28 = Low Coolant Temp<br>Bit 29 = Low Fuel Level<br>Bit 30 = Low Oil Pressure<br>Bit 31 = Hi Coolant Temp |

| Register | Description        | Type  | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------|--------------------|-------|-------|----------------|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44816–17 | mtu Alarm Metering | Int32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Not Used<br>Bit 23 = High ECU Supply<br>Bit 24 = Combined Red<br>Bit 25 = Overspeed<br>Bit 26 = Low Oil Pressure<br>Bit 27 = Low Fuel Delivery Press.<br>Bit 28 = Low Aftercooler Coolant Level<br>Bit 29 = High Coolant Temp<br>Bit 30 = High Oil Temp<br>Bit 31 = High Charge Air Temp |

| Register | Description            | Type  | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|----------|------------------------|-------|-------|----------------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44818–19 | mtu Pre-Alarm Metering | Int32 | N/A   | N/A            | R   | Bit 0 = Low Storage Tank<br>Bit 1 = High Storage Tank<br>Bit 2 = Low Day Tank<br>Bit 3 = High Day Tank<br>Bit 4 = Alternator Winding Temp<br>Bit 5 = Idle Speed Low<br>Bit 6 = Run Up Speed Low<br>Bit 7 = Start Speed Low<br>Bit 8 = Priming Fault<br>Bit 9 = Low Charge Air Coolant Level<br>Bit 10 = High Fuel Temp.<br>Bit 11 = High Exhaust Temp. B<br>Bit 12 = High Exhaust Temp. A<br>Bit 13 = Low ECU Supply Voltage<br>Bit 14 = Engine Speed Too Low<br>Bit 15 = High Voltage Supply<br>Bit 16 = Low Voltage Supply<br>Bit 17 = Speed Demand Fail<br>Bit 18 = ECU Faulty<br>Bit 19 = Combined Yellow<br>Bit 20 = Low Oil Press.<br>Bit 21 = Low Fuel Delivery Press.<br>Bit 22 = Low Charge Air Press.<br>Bit 23 = Low Coolant Level<br>Bit 24 = Low Fuel Rail Press.<br>Bit 25 = High Fuel Rail Press.<br>Bit 26 = Shutdown Override<br>Bit 27 = High Coolant Temp.<br>Bit 28 = High Charge Air Temp.<br>Bit 29 = High Intercooler Temp.<br>Bit 30 = High Oil Temp.<br>Bit 31 = High ECU Temp. |

| Register | Description                                                                 | Type  | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------|-----------------------------------------------------------------------------|-------|-------|----------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44820–21 | Sender Fail Alarm Metering                                                  | Int32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Not Used<br>Bit 23 = Not Used<br>Bit 24 = Not Used<br>Bit 25 = Not Used<br>Bit 26 = Coolant Level<br>Sender Fail<br>Bit 27 = Generator Voltage<br>Bit 28 = Fuel Level<br>Bit 29 = Coolant Temp<br>Bit 30 = Oil Pressure<br>Bit 31 = Speed                                                                                             |
| 44822    | Gen Protect Status (The contents of this register and 44934 are identical.) | Int32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = 81 ROC DF/DT Trip<br>Bit 19 = 78 Vector Shift Trip<br>Bit 20 = 51-3 Overcurrent<br>Bit 21 = 40Q Loss of Excitation<br>Bit 22 = 32 Reverse Power<br>Bit 23 = 59-2 Overvoltage<br>Bit 24 = 27-2 Undervoltage<br>Bit 25 = 51-2 Overcurrent<br>Bit 26 = 81 Underfrequency<br>Bit 27 = 81 Overfrequency<br>Bit 28 = 59-1 Overvoltage<br>Bit 29 = 27-1 Undervoltage<br>Bit 30 = 47 Phase Imbalance<br>Bit 31 = 51-1 Overcurrent |

| Register | Description                                                                                                                                                                                                                                                            | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-------|----------------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44824    | Gen Protect Pre-alarms – This register contains legacy (i.e. same as DGC-500 and/or DGC-1000) generator protection pre-alarm status. This is just a subset of what is currently in the DGC-2020 generator protection. It is recommended to use register 45596 instead. | Uint32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Not Used<br>Bit 23 = Not Used<br>Bit 24 = Not Used<br>Bit 25 = Not Used<br>Bit 26 = Gen Phase Imbalance<br>Bit 27 = Gen Overcurrent<br>Bit 28 = Gen Underfrequency<br>Bit 29 = Gen Overfrequency<br>Bit 30 = Gen Undervoltage<br>Bit 31 = Gen Overvoltage |
| 44826    | Gen Protect Alarms – This register contains legacy (i.e. same as DGC-500 and/or DGC-1000) generator protection alarm status. This is just a subset of what is currently in the DGC-2020 generator protection. It is recommended to use register 45598 instead.         | Uint32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Not Used<br>Bit 23 = Not Used<br>Bit 24 = Not Used<br>Bit 25 = Not Used<br>Bit 26 = Gen Phase Imbalance<br>Bit 27 = Gen Overcurrent<br>Bit 28 = Gen Underfrequency<br>Bit 29 = Gen Overfrequency<br>Bit 30 = Gen Undervoltage<br>Bit 31 = Gen Overvoltage |

| Register | Description           | Type  | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------|-----------------------|-------|-------|----------------|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44828–29 | Local Input Metering  | Int32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Input 16<br>Bit 17 = Input 15<br>Bit 18 = Input 14<br>Bit 19 = Input 13<br>Bit 20 = Input 12<br>Bit 21 = Input 11<br>Bit 22 = Input 10<br>Bit 23 = Input 9<br>Bit 24 = Input 8<br>Bit 25 = Input 7<br>Bit 26 = Input 6<br>Bit 27 = Input 5<br>Bit 28 = Input 4<br>Bit 29 = Input 3<br>Bit 30 = Input 2<br>Bit 31 = Input 1                           |
| 44830–31 | Local Output Metering | Int32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Pre Start Output<br>Bit 18 = Run Output<br>Bit 19 = Start Output<br>Bit 20 = Output 12<br>Bit 21 = Output 11<br>Bit 22 = Output 10<br>Bit 23 = Output 9<br>Bit 24 = Output 8<br>Bit 25 = Output 7<br>Bit 26 = Output 6<br>Bit 27 = Output 5<br>Bit 28 = Output 4<br>Bit 29 = Output 3<br>Bit 30 = Output 2<br>Bit 31 = Output 1 |

| Register | Description                        | Type   | Units           | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|----------|------------------------------------|--------|-----------------|----------------|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44832–33 | Status Metering 1                  | Int32  | N/A             | N/A            | R   | Bit 0 = Idle Request<br>Bit 1 = Lamp Test<br>Bit 2 = Alarm Silence<br>Bit 3 = Reset<br>Bit 4 = Alternate Frequency Override<br>Bit 5 = Start Delay Bypass<br>Bit 6 = Cooldown and Stop Request from Logic<br>Bit 7 = Cooldown Request from Logic<br>Bit 8 = External Start Delay<br>Bit 9 = Off Mode Cooldown<br>Bit 10 = PF Mode Active<br>Bit 11 = Var Mode Active<br>Bit 12 = Cooldown Timer Active<br>Bit 13 = Engine Running<br>Bit 14 = Fuel Leak Detect<br>Bit 15 = Battery Charger Failure<br>Bit 16 = Low Coolant Level<br>Bit 17 = Gen Failed<br>Bit 18 = Gen Stable<br>Bit 19 = Gen Dead<br>Bit 20 = Bus Failed<br>Bit 21 = Bus Stable<br>Bit 22 = Bus Dead<br>Bit 23 = Gen Breaker Closed<br>Bit 24 = Mains Breaker Closed<br>Bit 25 = Grounded Delta Override<br>Bit 26 = Battle Override<br>Bit 27 = Auto Transfer Switch<br>Bit 28 = Low Line Override<br>Bit 29 = Single Phase AC Override<br>Bit 30 = Single Phase Override<br>Bit 31 = EPS Supplying Load |
| 44834    | Hours until Maintenance            | Int32  | N/A             | N/A            | RW  | 0–5000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 44836    | Cum. Total Engine Run Hrs.         | Int32  | Hour            | N/A            | R   | 0–1000000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 44838    | Cum. Total Engine Run Min.         | Int32  | N/A             | N/A            | R   | 0–59                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 44840    | Cum. Loaded Engine Run Hrs.        | Int32  | N/A             | N/A            | R   | 0–1000000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 44842    | Cum. Loaded Engine Run Min.        | Int32  | N/A             | N/A            | R   | 0–59                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 44844    | Cum. Unloaded Engine Run Hrs.      | Int32  | Hour            | N/A            | R   | 0–1000000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 44846    | Cum. Unloaded Engine Run Min.      | Int32  | N/A             | N/A            | R   | 0–59                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 44848    | Cum. Total kW-Hours                | UInt32 | Kilowatt Hour   | N/A            | R   | 0–999999999                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 44850    | Cum. Total kW-Minutes              | UInt32 | Kilowatt Minute | N/A            | R   | 0–4294967295                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 44852    | Commission Date Month              | UInt32 | N/A             | N/A            | RW  | 1–12                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 44854    | Commission Date Day                | UInt32 | N/A             | N/A            | RW  | 1–31                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 44856    | Commission Date Year               | UInt32 | N/A             | N/A            | RW  | 0–99                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 44858    | Session Total Engine Run Hrs.      | Int32  | Hour            | N/A            | R   | 0–1000000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 44860    | Session Total Engine Run Min.      | Int32  | N/A             | N/A            | R   | 0–59                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 44862    | Session Loaded Engine Run Hrs.     | Int32  | Hour            | N/A            | R   | 0–1000000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 44864    | Session Loaded Engine Run Min.     | Int32  | N/A             | N/A            | R   | 0–59                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 44866    | Session Unloaded Engine Run Hrs.   | Int32  | Hour            | N/A            | R   | 0–1000000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 44868    | Session Unloaded Engine Run Min.   | Int32  | N/A             | N/A            | R   | 0–59                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 44870    | Session kW Hours                   | Int32  | Kilowatt Hour   | N/A            | R   | 0–999999999                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 44872    | Cumulative Number of Engine Starts | UInt32 | N/A             | N/A            | RW  | 0–65535                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 44874    | Session Start Date Month           | UInt32 | N/A             | N/A            | RW  | 1–12                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 44876    | Session Start Date Day             | UInt32 | N/A             | N/A            | RW  | 1–31                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 44878    | Session Start Date Year            | UInt32 | N/A             | N/A            | RW  | 0–99                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |



| Register | Description      | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------|------------------|--------|-------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44880    | Generator Status | Uint32 | N/A   | N/A            | R   | 0 = RESET State<br>1 = READY State<br>2 = CRANKING State<br>3 = RESTING State<br>4 = RUNNING State<br>5 = ALARM State<br>6 = PRESTART State<br>7 = COOLING State<br>8 = CONNECTING State<br>9 = DISCONNECT State<br>10 = PULSING State<br>11 = UNLOADING State<br>Note: Generator states are described in Section 3, <i>Functional Description, Operating States</i> .                                                                                                                                                                                                                                                                                                 |
| 44882    | Contact Status   | Uint32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Input 16<br>Bit 13 = Input 15<br>Bit 14 = Input 14<br>Bit 15 = Input 13<br>Bit 16 = Input 12<br>Bit 17 = Input 11<br>Bit 18 = Input 10<br>Bit 19 = Input 9<br>Bit 20 = Input 8<br>Bit 21 = Input 7<br>Bit 22 = Input 6<br>Bit 23 = Input 5<br>Bit 24 = Input 4<br>Bit 25 = Input 3<br>Bit 26 = Input 2<br>Bit 27 = Input 1<br>Bit 28 = Reserved<br>Bit 29 = Estop<br>Bit 30 = Not Used<br>Bit 31 = Not Used |

| Register  | Description              | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------|--------------------------|--------|-------|----------------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44884     | Main and Aux Relay Image | Uint32 | N/A   | N/A            | R   | Bit 0 = Start<br>Bit 1 = Run<br>Bit 2 = Prestart<br>Bit 3 = Reserved<br>Bit 4 = Output 1<br>Bit 5 = Output 2<br>Bit 6 = Output 3<br>Bit 7 = Output 4<br>Bit 8 = Output 5<br>Bit 9 = Output 6<br>Bit 10 = Output 7<br>Bit 11 = Output 8<br>Bit 12 = Output 9<br>Bit 13 = Output 10<br>Bit 14 = Output 11<br>Bit 15 = Output 12<br>Bit 16 = Output 13<br>Bit 17 = Output 14<br>Bit 18 = Output 15<br>Bit 19 = Output 16<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22= Not Used<br>Bit 23= Not Used<br>Bit 24= Not Used<br>Bit 25= Not Used<br>Bit 26= Not Used<br>Bit 27= Not Used<br>Bit 28= Not Used<br>Bit 29 = Not Used<br>Bit 30 = Not Used<br>Bit 31= Not Used |
| 44886–918 | RESERVED                 |        |       |                |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 44920–32  | FUTURE USE               |        |       |                |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

| Register | Description                                                                                      | Type   | Units  | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------|--------------------------------------------------------------------------------------------------|--------|--------|----------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44934–35 | Generator Protection Status Metering<br>(The contents of this register and 44822 are identical.) | Int32  | N/A    | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = 81 ROC DF/DT Trip<br>Bit 19 = 78 Vector Shift Trip<br>Bit 20 = 51-3 Overcurrent<br>Bit 21 = 40Q Loss of Excitation<br>Bit 22 = 32 Reverse Power<br>Bit 23 = 59-2 Overvoltage<br>Bit 24 = 27-2 Undervoltage<br>Bit 25 = 51-2 Overcurrent<br>Bit 26 = 81 Underfrequency<br>Bit 27 = 81 Overfrequency<br>Bit 28 = 59-1 Overvoltage<br>Bit 29 = 27-1 Undervoltage<br>Bit 30 = 47 Phase Imbalance<br>Bit 31 = 51-1 Overcurrent |
| 44936    | Cumulative Stats - Total Run Minutes                                                             | UInt32 | Minute | N/A            | RW  | 0–60000000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 44938    | Cumulative Stats - Loaded Run Minutes                                                            | UInt32 | Minute | N/A            | RW  | 0–60000000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 44940    | Cumulative Stats - Unloaded Run Minutes                                                          | UInt32 | Minute | N/A            | RW  | 0–60000000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 44942    | Run Stats - Total Run Minutes                                                                    | UInt32 | Minute | N/A            | RW  | 0–60000000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 44944    | Run Stats - Loaded Run Minutes                                                                   | UInt32 | Minute | N/A            | RW  | 0–60000000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 44946    | Run Stats - Unloaded Run Minutes                                                                 | UInt32 | Minute | N/A            | RW  | 0–60000000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

| Register | Description      | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------|------------------|--------|-------|----------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44948–49 | LSM Alarm Bits   | Uint32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Not Used<br>Bit 23 = Not Used<br>Bit 24 = Not Used<br>Bit 25 = Duplicate LSM<br>Bit 26 = ID Repeat<br>Bit 27 = ID Missing<br>Bit 28 = LSM Comms Failure<br>Bit 29 = Intergenset Comms Failure<br>Bit 30 = GOV Output Limit<br>Bit 31 = AVR Output Limit |
| 44950    | Global Alarm     | Uint32 | N/A   | N/A            | R   | Bit 0 = No system alarms in effect<br>Bit 1 = System alarm(s) in effect                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 44952    | Global Pre-Alarm | Uint32 | N/A   | N/A            | R   | Bit 0 = No system pre-alarms in effect<br>Bit 1 = System pre-alarm(s) in effect                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

| Register | Description                              | Type  | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|----------|------------------------------------------|-------|-------|----------------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44954–55 | Local Configurable Inputs Pre-Alarm Bits | Int32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Input 16<br>Bit 17 = Input 15<br>Bit 18 = Input 14<br>Bit 19 = Input 13<br>Bit 20 = Input 12<br>Bit 21 = Input 11<br>Bit 22 = Input 10<br>Bit 23 = Input 9<br>Bit 24 = Input 8<br>Bit 25 = Input 7<br>Bit 26 = Input 6<br>Bit 27 = Input 5<br>Bit 28 = Input 4<br>Bit 29 = Input 3<br>Bit 30 = Input 2<br>Bit 31 = Input 1 |
| 44956–57 | Local Configurable Inputs Alarm Bits     | Int32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Input 16<br>Bit 17 = Input 15<br>Bit 18 = Input 14<br>Bit 19 = Input 13<br>Bit 20 = Input 12<br>Bit 21 = Input 11<br>Bit 22 = Input 10<br>Bit 23 = Input 9<br>Bit 24 = Input 8<br>Bit 25 = Input 7<br>Bit 26 = Input 6<br>Bit 27 = Input 5<br>Bit 28 = Input 4<br>Bit 29 = Input 3<br>Bit 30 = Input 2<br>Bit 31 = Input 1 |

| Register | Description                          | Type  | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
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| 44958–59 | Configurable Elements Status Bits    | Int32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Not Used<br>Bit 23 = Not Used<br>Bit 24 = Config Element 8<br>Bit 25 = Config Element 7<br>Bit 26 = Config Element 6<br>Bit 27 = Config Element 5<br>Bit 28 = Config Element 4<br>Bit 29 = Config Element 3<br>Bit 30 = Config Element 2<br>Bit 31 = Config Element 1 |
| 44960–61 | Configurable Elements Pre-Alarm Bits | Int32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Not Used<br>Bit 23 = Not Used<br>Bit 24 = Config Element 8<br>Bit 25 = Config Element 7<br>Bit 26 = Config Element 6<br>Bit 27 = Config Element 5<br>Bit 28 = Config Element 4<br>Bit 29 = Config Element 3<br>Bit 30 = Config Element 2<br>Bit 31 = Config Element 1 |

| Register | Description                      | Type  | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
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| 44962–63 | Configurable Elements Alarm Bits | Int32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Not Used<br>Bit 23 = Not Used<br>Bit 24 = Config Element 8<br>Bit 25 = Config Element 7<br>Bit 26 = Config Element 6<br>Bit 27 = Config Element 5<br>Bit 28 = Config Element 4<br>Bit 29 = Config Element 3<br>Bit 30 = Config Element 2<br>Bit 31 = Config Element 1       |
| 44964–65 | Remote Inputs Status Bits        | Int32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Remote Input 26<br>Bit 23 = Remote Input 25<br>Bit 24 = Remote Input 24<br>Bit 25 = Remote Input 23<br>Bit 26 = Remote Input 22<br>Bit 27 = Remote Input 21<br>Bit 28 = Remote Input 20<br>Bit 29 = Remote Input 19<br>Bit 30 = Remote Input 18<br>Bit 31 = Remote Input 17 |

| Register | Description                | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
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| 44966–67 | Remote Outputs Status Bits | Int32  | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Remote Output 36<br>Bit 9 = Remote Output 35<br>Bit 10 = Remote Output 34<br>Bit 11 = Remote Output 33<br>Bit 12 = Remote Output 32<br>Bit 13 = Remote Output 31<br>Bit 14 = Remote Output 30<br>Bit 15 = Remote Output 29<br>Bit 16 = Remote Output 28<br>Bit 17 = Remote Output 27<br>Bit 18 = Remote Output 26<br>Bit 19 = Remote Output 25<br>Bit 20 = Remote Output 24<br>Bit 21 = Remote Output 23<br>Bit 22 = Remote Output 22<br>Bit 23 = Remote Output 21<br>Bit 24 = Remote Output 20<br>Bit 25 = Remote Output 19<br>Bit 26 = Remote Output 18<br>Bit 27 = Remote Output 17<br>Bit 28 = Remote Output 16<br>Bit 29 = Remote Output 15<br>Bit 30 = Remote Output 14<br>Bit 31 = Remote Output 13 |
| 44968–69 | CEM Alarm Bits             | UInt32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Not Used<br>Bit 23 = Not Used<br>Bit 24 = Not Used<br>Bit 25 = Not Used<br>Bit 26 = Not Used<br>Bit 27 = Not Used<br>Bit 28 = Not Used<br>Bit 29 = CEM Hardware Mismatch<br>Bit 30 = Duplicate CEM<br>Bit 31 = CEM Comm Fail                                                                                                                                                                          |



| Register | Description                               | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|----------|-------------------------------------------|--------|-------|----------------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44970–71 | Remote Configurable Inputs Pre-Alarm Bits | Uint32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Remote Input 26<br>Bit 23 = Remote Input 25<br>Bit 24 = Remote Input 24<br>Bit 25 = Remote Input 23<br>Bit 26 = Remote Input 22<br>Bit 27 = Remote Input 21<br>Bit 28 = Remote Input 20<br>Bit 29 = Remote Input 19<br>Bit 30 = Remote Input 18<br>Bit 31 = Remote Input 17 |
| 44972–73 | Remote Configurable Inputs Alarm Bits     | Uint32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Remote Input 26<br>Bit 23 = Remote Input 25<br>Bit 24 = Remote Input 24<br>Bit 25 = Remote Input 23<br>Bit 26 = Remote Input 22<br>Bit 27 = Remote Input 21<br>Bit 28 = Remote Input 20<br>Bit 29 = Remote Input 19<br>Bit 30 = Remote Input 18<br>Bit 31 = Remote Input 17 |

| Register | Description        | Type   | Units    | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------|--------------------|--------|----------|----------------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44974–75 | AEM Alarm Bits     | Uint32 | N/A      | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Not Used<br>Bit 23 = Not Used<br>Bit 24 = Not Used<br>Bit 25 = Not Used<br>Bit 26 = Not Used<br>Bit 27 = Not Used<br>Bit 28 = Not Used<br>Bit 29 = Not Used<br>Bit 30 = Duplicate AEM<br>Bit 31 = AEM Comm Fail |
| 44976    | Slip Frequency     | Int32  | Hertz    | Centi          | R   | -32768 to 32767                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 44978    | Slip Angle         | Int32  | DeciUnit | Deci           | R   | -32768 to 32767                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 44980    | Voltage Difference | Int32  | Volt     | N/A            | R   | -2147483648 to 2147483647                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

| Register | Description     | Type  | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------|-----------------|-------|-------|----------------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44982–83 | MDEC Pre-Alarms | Int32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Not Used<br>Bit 23 = Not Used<br>Bit 24 = High Fuel Filter Diff Pressure<br>Bit 25 = Overspeed Test On<br>Bit 26 = Ambient Temp<br>Bit 27 = High Temp Coil 3<br>Bit 28 = High Temp Coil 2<br>Bit 29 = High Temp Coil 1<br>Bit 30 = High Pressure Input 2<br>Bit 31 = High Pressure Input 1 |

| Register | Description         | Type  | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------|---------------------|-------|-------|----------------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 44984–85 | mtu Status          | Int32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = ECU Shutdown<br>Bit 21 = Priming Pump ON<br>Bit 22 = CAN Mode Feedback<br>Bit 23 = Preheat Temp Not Reached<br>Bit 24 = Load Gen On<br>Bit 25 = Cylinder Cutout<br>Bit 26 = Engine Running<br>Bit 27 = Speed Decrease<br>Bit 28 = Speed Increase<br>Bit 29 = Speed Demand Fail Mode<br>Bit 30 = External Stop Active<br>Bit 31 = ECU Override |
| 44986    | Generator Frequency | Int32 | Hertz | Deci           | R   | 0–4400                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 44988    | Bus Frequency       | Int32 | Hertz | Deci           | R   | 0–4400                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 44990    | Power Factor        | Int32 | N/A   | Centi          | R   | -100 to 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 44992    | Slip Frequency      | Int32 | N/A   | Milli          | R   | -450000 to 450000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 44994    | Bus VAB             | Int32 | Volt  | N/A            | R   | -2147483648 to 2147483647                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 44996    | Bus VBC             | Int32 | Volt  | N/A            | R   | -2147483648 to 2147483647                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 44998    | Bus VCA             | Int32 | Volt  | N/A            | R   | -2147483648 to 2147483647                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

| Register | Description                                             | Type  | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|----------|---------------------------------------------------------|-------|-------|----------------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45000–01 | ECU Lamp Status                                         | Int32 | N/A   | N/A            | R   | Bit 0 = Protect<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Warning<br>Bit 4 = Stop<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Malfunction<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Not Used<br>Bit 23 = Not Used<br>Bit 24 = Not Used<br>Bit 25 = Not Used<br>Bit 26 = Not Used<br>Bit 27 = Not Used<br>Bit 28 = Not Used<br>Bit 29 = Not Used<br>Bit 30 = Not Used<br>Bit 31 = Not Used |
| 45002    | DTC Lamp Status Note: Odd bits are always a zero value. | Int32 | N/A   | N/A            | R   | The data in register 45002 is bit-packed data, shown below. The data is actually repeated twice. Bits 0 through 7 and Bits 8 through 15 are identical.<br>Bit 0 = Protect Lamp<br>Bit 1 = 0<br>Bit 2 = Amber Warning Lamp<br>Bit 3 = 0<br>Bit 4 = Red Stop Lamp<br>Bit 5 = 0<br>Bit 6 = Malfunction Indicator Lamp<br>Bit 7 = 0<br>Bit 8 = Protect Lamp<br>Bit 9 = 0<br>Bit 10 = Amber Warning Lamp<br>Bit 11 = 0<br>Bit 12 = Red Stop Lamp<br>Bit 13 = 0<br>Bit 14 = Malfunction Indicator Lamp<br>Bit 15 = 0<br>The two bytes in register 45003 contain zeros.                                                                                                                |

| Register | Description                         | Type   | Units                     | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|----------|-------------------------------------|--------|---------------------------|----------------|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45004    | Number of DTC's                     | Int32  | N/A                       | N/A            | R   | The Active DTC count is stored in the lower byte of register 45004.<br>The Previously Active DTC count is stored in the upper byte of register 45004.<br>The two bytes in register 45005 contain zeros.<br>The Active DTC count is also available in register 45170.<br>The Previously Active DTC count data is also available in register 45172. Please refer to the descriptions of those registers for more information.                                                                                                                                                                                                                                                                                                                               |
| 45006–07 | RESERVED                            |        |                           |                |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 45008    | CAN Communications Diagnostics      | Int32  | N/A                       | N/A            | R   | Bit 0 = CAN ECU Offline<br>Bit 1 = Active DTC Clear Fail<br>Bit 2 = Previously Active DTC Clear Fail<br>Bit 3 = DTC Values Changed<br>Bit 4 = ECU Comms Failed<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = CAN Hardware Pass<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Not Used<br>Bit 23 = Not Used<br>Bit 24 = Not Used<br>Bit 25 = Not Used<br>Bit 26 = Not Used<br>Bit 27 = Not Used<br>Bit 28 = Not Used<br>Bit 29 = Not Used<br>Bit 30 = Not Used<br>Bit 31 = Not Used |
| 45010    | RESERVED                            |        |                           |                |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 45012    | ECU Accelerator Pedal Position      | UInt32 | 0.4%/bit gain, 0% offset  | N/A            | R   | 0–100%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45014    | ECU Percent Load at Current Speed   | UInt32 | 1%/bit gain, 0% offset    | N/A            | R   | 0–125%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45016    | ECU Actual Engine Percent Torque    | UInt32 | 1%/bit gain, -125% offset | N/A            | R   | 0–125%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45018    | ECU Engine Speed                    | UInt32 | RPM (0.125rpm/bit gain)   | N/A            | R   | 0–8031.875 rpm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 45020    | ECU Injection Control Pressure      | UInt32 | 1/256 MPa/bit, 0 Offset   | N/A            | R   | 0 to +251 MPa                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 45022    | ECU Injector Metering Rail Pressure | UInt32 | 1/256 MPa/bit, 0 Offset   | N/A            | R   | 0 to +251 MPa                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

| Register | Description                            | Type   | Units                               | Scaling Factor | R/W | Range                   |
|----------|----------------------------------------|--------|-------------------------------------|----------------|-----|-------------------------|
| 45024    | ECU Engine Run Time                    | Uint32 | 0.05 h/bit gain, 0 h offset         | N/A            | R   | 0 to +210,554, 060.75 h |
| 45026    | ECU Trip Fuel                          | Uint32 | 0.5 L per bit gain, 0 L offset      | N/A            | R   | 0 to +2,105,540, 608 L  |
| 45028    | ECU Total Fuel Used                    | Uint32 | 0.5 L per bit gain, 0 L offset      | N/A            | R   | 0 to +2,105,540, 608 L  |
| 45030    | ECU Coolant Temperature                | Uint32 | 1 °C/bit gain, -40 °C offset        | N/A            | R   | -40 to +210 °C          |
| 45032    | ECU Fuel Temperature                   | Uint32 | 1 °C/bit gain, -40 °C offset        | N/A            | R   | -40 to +210 °C          |
| 45034    | ECU Engine Oil Temperature             | Uint32 | 0.03125 °C/bit gain, -273 °C offset | N/A            | R   | -273 to +1735.0 °C      |
| 45036    | ECU Engine Intercooler Temperature     | Uint32 | 1 °C/bit gain, -40 °C offset        | N/A            | R   | -40 to +210 °C          |
| 45038    | ECU Fuel Delivery Pressure             | Uint32 | 4 kPa/bit gain, 0 kPa offset        | N/A            | R   | 0 to +1000 kPa          |
| 45040    | ECU Engine Oil Level                   | Uint32 | 0.4 %/bit gain, 0 % offset          | N/A            | R   | 0 to +100 %             |
| 45042    | ECU Oil Pressure                       | Uint32 | 4 kPa/bit gain, 0 kPa offset        | N/A            | R   | 0 to +1000 kPa          |
| 45044    | ECU Coolant Pressure                   | Uint32 | 2 kPa/bit gain, 0 kPa offset        | N/A            | R   | 0 to +500 kPa           |
| 45046    | ECU Coolant Level                      | Uint32 | 0.4 %/bit gain, 0 % offset          | N/A            | R   | 0 to +100 %             |
| 45048    | ECU Fuel Rate                          | Uint32 | 0.05 L/h per bit, 0 offset          | N/A            | R   | 0 to +3212.75 L/h       |
| 45050    | ECU Barometric Pressure                | Uint32 | 0.5 kPa/bit gain, 0 kPa offset      | N/A            | R   | 0 to +125 kPa           |
| 45052    | ECU Ambient Air Temperature            | Uint32 | 0.03125 °C/bit gain, -273 °C offset | N/A            | R   | -273 to +1735.0 °C      |
| 45054    | ECU Air Inlet Temperature              | Uint32 | 1 °C/bit gain, -40 °C offset        | N/A            | R   | -40 to +210 °C          |
| 45056    | ECU Boost Pressure                     | Uint32 | 2 kPa/bit gain, 0 kPa offset        | N/A            | R   | 0 to +500 kPa           |
| 45058    | ECU Intake Manifold Temperature        | Uint32 | 1 °C/bit gain, -40 °C offset        | N/A            | R   | -40 to +210 °C          |
| 45060    | ECU Air Filter Differential Pressure   | Uint32 | 0.05 kPa/bit gain, 0 kPa offset     | N/A            | R   | 0 to +12.5 kPa          |
| 45062    | ECU Exhaust Gas Temperature            | Uint32 | 0.03125 °C/bit gain, -273 °C offset | N/A            | R   | -273 to +1735.0 °C      |
| 45062    | J1939-ADEC AL Power Amp 1 Fail Bit Fld | Uint32 | Bit Packed Data                     | N/A            | R   | 0–4294967295            |
| 45064    | ECU Electrical Potential Voltage       | Uint32 | 0.05 V/bit gain, 0 V offset         | N/A            | R   | 0 to +3212.75 V         |
| 45066    | ECU Battery Potential Voltage Switched | Uint32 | 0.05 V/bit gain, 0 V offset         | N/A            | R   | 0 to +3212.75 V         |
| 45068    | ECU Speed at Idle Point 1              | Uint32 | 0.125 rpm/bit, 0 rpm offset         | N/A            | R   | 0–8031.875 rpm          |
| 45070    | ECU Torque at Idle Point 1             | Uint32 | 1%/bit gain, -125% offset           | N/A            | R   | 0 to +125 %             |
| 45072    | ECU Speed at Idle Point 2              | Uint32 | 0.125 rpm/bit, 0 rpm offset         | N/A            | R   | 0–8031.875 rpm          |

| Register | Description                    | Type   | Units                                        | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                   |
|----------|--------------------------------|--------|----------------------------------------------|----------------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45074    | ECU Torque at Idle Point 2     | Uint32 | 1%/bit gain, -125% offset                    | N/A            | R   | 0 to +125 %                                                                                                                                                                                                                                                             |
| 45076    | ECU Speed at Idle Point 3      | Uint32 | 0.125 rpm/bit, 0 rpm offset                  | N/A            | R   | 0–8031.875 rpm                                                                                                                                                                                                                                                          |
| 45078    | ECU Torque at Idle Point 3     | Uint32 | 1%/bit gain, -125% offset                    | N/A            | R   | 0 to +125 %                                                                                                                                                                                                                                                             |
| 45080    | ECU Speed at Idle Point 4      | Uint32 | 0.125 rpm/bit, 0 rpm offset                  | N/A            | R   | 0–8031.875 rpm                                                                                                                                                                                                                                                          |
| 45082    | ECU Torque at Idle Point 4     | Uint32 | 1%/bit gain, -125% offset                    | N/A            | R   | 0 to +125 %                                                                                                                                                                                                                                                             |
| 45084    | ECU Speed at Idle Point 5      | Uint32 | 0.125 rpm/bit, 0 rpm offset                  | N/A            | R   | 0–8031.875 rpm                                                                                                                                                                                                                                                          |
| 45086    | ECU Torque at Idle Point 5     | Uint32 | 1%/bit gain, -125% offset                    | N/A            | R   | 0 to +125 %                                                                                                                                                                                                                                                             |
| 45088    | ECU Speed at High Idle Point 6 | Uint32 | 0.125 rpm/bit, 0 rpm offset                  | N/A            | R   | 0–8031.875 rpm                                                                                                                                                                                                                                                          |
| 45090    | ECU Gain of End Speed Governor | Uint32 | 0.0007813%ref trq/rpm per bit gain, 0 Offset | N/A            | R   | 0–50.2 %/rpm                                                                                                                                                                                                                                                            |
| 45092    | ECU Reference Engine Torque    | Uint32 | 1 Nm/bit gain, 0 Nm offset                   | N/A            | R   | 0–64255 Nm                                                                                                                                                                                                                                                              |
| 45094    | ECU Override Speed Point 7     | Uint32 | 0.125 rpm/bit, 0 rpm offset                  | N/A            | R   | 0–8031.875 rpm                                                                                                                                                                                                                                                          |
| 45096    | ECU Override Time Limit        | Uint32 | 0.1 s/bit gain, 0 s offset                   | N/A            | R   | 0–25 s                                                                                                                                                                                                                                                                  |
| 45098    | ECU Speed Lower Limit          | Uint32 | 10 rpm/bit gain, 0 rpm offset                | N/A            | R   | 0–2500 rpm                                                                                                                                                                                                                                                              |
| 45100    | ECU Speed Upper Limit          | Uint32 | 10 rpm/bit gain, 0 rpm offset                | N/A            | R   | 0–2500 rpm                                                                                                                                                                                                                                                              |
| 45102    | ECU Torque Lower Limit         | Uint32 | 1%/bit gain, -125% offset                    | N/A            | R   | 0–125%                                                                                                                                                                                                                                                                  |
| 45104    | ECU Torque Upper Limit         | Uint32 | 1%/bit gain, -125% offset                    | N/A            | R   | 0–125%                                                                                                                                                                                                                                                                  |
| 45106    | Active DTC 1                   | Uint32 | N/A                                          | N/A            | R   | <p>Suppose the 32 bits of DTC Data is in Register N and N+1.</p> <p>SPN = (Register N: Most Significant 3 bits * 65536) + (Register N+1: LS Byte * 256) + (Register N+1: MS Byte)</p> <p>FMI = Register N: Bits 8–12</p> <p>Occurrence Count = Register N: Bits 0–6</p> |
| 45108    | Active DTC 2                   | Uint32 | N/A                                          | N/A            | R   | See description above.                                                                                                                                                                                                                                                  |
| 45110    | Active DTC 3                   | Uint32 | N/A                                          | N/A            | R   | See description above.                                                                                                                                                                                                                                                  |
| 45112    | Active DTC 4                   | Uint32 | N/A                                          | N/A            | R   | See description above.                                                                                                                                                                                                                                                  |
| 45114    | Active DTC 5                   | Uint32 | N/A                                          | N/A            | R   | See description above.                                                                                                                                                                                                                                                  |
| 45116    | Active DTC 6                   | Uint32 | N/A                                          | N/A            | R   | See description above.                                                                                                                                                                                                                                                  |
| 45118    | Active DTC 7                   | Uint32 | N/A                                          | N/A            | R   | See description above.                                                                                                                                                                                                                                                  |
| 45120    | Active DTC 8                   | Uint32 | N/A                                          | N/A            | R   | See description above.                                                                                                                                                                                                                                                  |
| 45122    | Active DTC 9                   | Uint32 | N/A                                          | N/A            | R   | See description above.                                                                                                                                                                                                                                                  |
| 45124    | Active DTC 10                  | Uint32 | N/A                                          | N/A            | R   | See description above.                                                                                                                                                                                                                                                  |
| 45126    | Active DTC 11                  | Uint32 | N/A                                          | N/A            | R   | See description above.                                                                                                                                                                                                                                                  |
| 45128    | Active DTC 12                  | Uint32 | N/A                                          | N/A            | R   | See description above.                                                                                                                                                                                                                                                  |
| 45130    | Active DTC 13                  | Uint32 | N/A                                          | N/A            | R   | See description above.                                                                                                                                                                                                                                                  |
| 45132    | Active DTC 14                  | Uint32 | N/A                                          | N/A            | R   | See description above.                                                                                                                                                                                                                                                  |
| 45134    | Active DTC 15                  | Uint32 | N/A                                          | N/A            | R   | See description above.                                                                                                                                                                                                                                                  |
| 45136    | Active DTC 16                  | Uint32 | N/A                                          | N/A            | R   | See description above.                                                                                                                                                                                                                                                  |
| 45138    | Previously Active DTC 1        | Uint32 | N/A                                          | N/A            | R   | See description above.                                                                                                                                                                                                                                                  |



| Register                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Description                             | Type   | Units | Scaling Factor | R/W | Range                  |
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| 45140                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Previously Active DTC 2                 | Uint32 | N/A   | N/A            | R   | See description above. |
| 45142                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Previously Active DTC 3                 | Uint32 | N/A   | N/A            | R   | See description above. |
| 45144                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Previously Active DTC 4                 | Uint32 | N/A   | N/A            | R   | See description above. |
| 45146                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Previously Active DTC 5                 | Uint32 | N/A   | N/A            | R   | See description above. |
| 45148                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Previously Active DTC 6                 | Uint32 | N/A   | N/A            | R   | See description above. |
| 45150                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Previously Active DTC 7                 | Uint32 | N/A   | N/A            | R   | See description above. |
| 45152                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Previously Active DTC 8                 | Uint32 | N/A   | N/A            | R   | See description above. |
| 45154                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Previously Active DTC 9                 | Uint32 | N/A   | N/A            | R   | See description above. |
| 45156                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Previously Active DTC 10                | Uint32 | N/A   | N/A            | R   | See description above. |
| 45158                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Previously Active DTC 11                | Uint32 | N/A   | N/A            | R   | See description above. |
| 45160                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Previously Active DTC 12                | Uint32 | N/A   | N/A            | R   | See description above. |
| 45162                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Previously Active DTC 13                | Uint32 | N/A   | N/A            | R   | See description above. |
| 45164                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Previously Active DTC 14                | Uint32 | N/A   | N/A            | R   | See description above. |
| 45166                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Previously Active DTC 15                | Uint32 | N/A   | N/A            | R   | See description above. |
| 45168                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Previously Active DTC 16                | Uint32 | N/A   | N/A            | R   | See description above. |
| <p>Notes for parsing out the SPN, FMI, and Occurrence Count Components of the DTC (registers 45138 through 45168):</p> <p>Let NN represent the the 32 bit number represented in Registers N and N+1, where N is the least significant register.<br/> We can extract The SPN, FMI and Occurrence count by ANDing Hex Numbers and bit shifting as indicated below.<br/> Where &amp; is a bitwise AND operation, and &gt;&gt; or &lt;&lt; is a bit shift operation. "0x" in front of a number indicates it is in Hexadecimal (Hex) format.</p> <p>OCCURRENCE COUNT = NN &amp; 0x0000003F;</p> <p>SPN = ((NN &amp; 0xFF000000) &gt;&gt; 24) + ((NN &amp; 0x00FF0000) &gt;&gt; 8) + ((NN &amp; 0x0000E000) &lt;&lt; 3);</p> <p>FMI = (NN &amp; 0x00001F00) &gt;&gt; 8;</p> <p>-----</p> <p>Example: Suppose Register N contains the Hex Value of 0xE903 and Register N+1 contains the Hex Value 0x68F9.<br/> Then the 32-bit number is 0x68F9E903 since the DGC implements 32 bit numbers with the least significant register first.</p> <p>Occurrence Count = (0x68F9E903 &amp; 0x0000001F) = 0x00000003;</p> <p>FMI = ((NN &amp; 00001F00) &gt;&gt; 8) = (0x00000900 &gt;&gt; 8) = 0x00000009;</p> <p>SPN = ((NN &amp; 0x0xFF000000) &gt;&gt; 24) + ((NN &amp; 0x00FF0000) &gt;&gt; 8) + ((NN &amp; 0x0000E000) &lt;&lt; 3)<br/> = ((0x68F9E903 &amp; 0xFF000000) &gt;&gt; 24) + ((0x68F9E903 &amp; 0x00EE0000) &gt;&gt; 8) + ( (0x68F9E903 &amp; 0x0000E000) &lt;&lt; 3)<br/> = (0x68000000 &gt;&gt; 24) + (0x00F90000 &gt;&gt; 8) + (0x0000E000 &lt;&lt; 3)<br/> = 0x00000068 + 0x0000F900 + 0x00070000<br/> = 0x0007F968<br/> = 522600</p> |                                         |        |       |                |     |                        |
| 45170                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Active DTC Count Data                   | Uint32 | N/A   | N/A            | R   | 0–16                   |
| 45172                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Previously Active DTC Count Data        | Uint32 | N/A   | N/A            | R   | 0–16                   |
| 45174                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Active <i>mtu</i> Fault Code Count Data | Uint32 | N/A   | N/A            | R   | 0–20                   |
| 45176                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Engine ECU Address                      | Uint32 | N/A   | N/A            | R   | 0–254                  |

| Register | Description      | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------|------------------|--------|-------|----------------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45178    | Tier 4 ECU Lamps | Uint32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Exhaust System Malfunction<br>Bit 23 = Torque Limit<br>Bit 24 = Wait to Start<br>Bit 25 = High Exhaust Temperature<br>Bit 26 = DPF Inhibited<br>Bit 27 = DPF Lamp<br>Bit 28 = Red Stop<br>Bit 29 = Check Engine<br>Bit 30 = Amber Warning<br>Bit 31 = DEF |

| Register | Description                                         | Type   | Units                             | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------|-----------------------------------------------------|--------|-----------------------------------|----------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45180    | J1939 Boolean Points Sub Mask Data                  | Uint32 | N/A                               | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = High Exhaust Temperature<br>Bit 20 = Fuel Filter<br>Bit 21 = Fuel Filter 1 Leak<br>Bit 22 = DPF Regenerate Inhibit Status from CAN Bus<br>Bit 23 = DPF Regenerate Inhibit Due to Switch<br>Bit 24 = Isuzu Exhaust System Lamp<br>Bit 25 = Isuzu Escape Mode Lamp<br>Bit 26 = Isuzu No Power Lamp<br>Bit 27 = SCR Clean Inhibit Due to Switch<br>Bit 28 = Wait to Start Lamp<br>Bit 29 = Engine Coolant Preheated State<br>Bit 30 = Alarm Reset Feedback<br>Bit 31 = Shutdown |
| 45182    | J1939 Instantaneous Fuel Economy                    | Uint32 | 1/512 km/L per bit gain, 0 offset | N/A            | R   | 0–125.498046875 Km/liter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 45184    | J1939 Average Fuel Economy                          | Uint32 | 1/512 km/L per bit gain, 0 offset | N/A            | R   | 0–125.498046875 Km/liter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 45186    | J1939 DPF Lamp                                      | Uint32 | N/A                               | N/A            | R   | 0 = Off<br>1 = On Solid<br>4 = On – Fast Blink (1 Hz)<br>Others Reserved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 45188    | J1939 Trip Average Fuel Rate                        | Uint32 | 0.05 L/h per bit gain, 0 offset   | N/A            | R   | 0–3,212.75 L/h                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 45190    | J1939 Intake Manifold One Absolute Pressure         | Uint32 | 2 kPa per bit gain, 0 offset      | N/A            | R   | 0–500 kPa                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 45192    | J1939 Intercooler Coolant Level                     | Uint32 | 0.4 %/bit gain, 0% offset         | N/A            | R   | 0–100%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 45194    | J1939 Engine Desired Operating Speed                | Uint32 | 1/8 rpm per bit gain, 0 offset    | N/A            | R   | 0–8031,875 rpm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 45196    | J1939 <i>mtu</i> ECU8 SMC Requested Absolute Torque | Uint32 | 1 Nm/bit gain, -32000 offset      | N/A            | R   | -32000 – 32000 Nm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 45198    | J1939 <i>mtu</i> ECU8 SMC Actual Droop              | Uint32 | 0.4%/bit gain, 0 offset           | N/A            | R   | 0–100%                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

| Register | Description                                            | Type   | Units                                                               | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                               |
|----------|--------------------------------------------------------|--------|---------------------------------------------------------------------|----------------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45200    | J1939 <i>mtu</i> ECU8 SMC Status of Start Procedure    | Uint32 | Proprietary Bit Field Data: Consult engine manufacturer for Details | N/A            | R   | 0–4294967295                                                                                                                                                                                                                                                                        |
| 45202    | J1939 <i>mtu</i> ECU8 SMC Engine Operating Mode        | Uint32 | Consult manufacturer for details of each operating mode.            | N/A            | R   | 0 = Operating Mode 1<br>1 = Operating Mode 2                                                                                                                                                                                                                                        |
| 45204    | J1939 <i>mtu</i> ECU8 SMC Speed Demand Feedback        | Uint32 | 1/8 rpm per bit gain, 0 offset                                      | N/A            | R   | 0–8031,875 rpm                                                                                                                                                                                                                                                                      |
| 45206    | J1939 <i>mtu</i> ECU8 SMC Speed Demand Source          | Uint32 | N/A                                                                 | N/A            | R   | 0 = CAN demand<br>1 = Up/Dn ECU<br>2 = CAN Up/Down<br>3 = ECU Speed Demand Input<br>4 = Reserved<br>5 = ECU Speed Demand Frequency Input                                                                                                                                            |
| 45208    | J1939 <i>mtu</i> ECU8 SMC CAN Speed Demand Feedback    | Uint32 | 1/8 rpm per bit gain, 0 offset                                      | N/A            | R   | 0–8031,875 rpm                                                                                                                                                                                                                                                                      |
| 45210    | J1939 <i>mtu</i> ECU8 SMC Analog Speed Demand Feedback | Uint32 | 1/8 rpm per bit gain, 0 offset                                      | N/A            | R   | 0–8031,875 rpm                                                                                                                                                                                                                                                                      |
| 45212    | J1939 DEF Tank 1 Level Percent                         | Uint32 | 0.4%/bit gain, 0 offset                                             | N/A            | R   | 0–100%                                                                                                                                                                                                                                                                              |
| 45214    | J1939 DEF Tank 2 Level Percent                         | Uint32 | 0.4%/bit gain, 0 offset                                             | N/A            | R   | 0–100%                                                                                                                                                                                                                                                                              |
| 45216    | J1939 DEF Severity Level                               | Uint32 | N/A                                                                 | N/A            | R   | 0 = No Warning<br>1 = Low DEF Level – Lamp on Solid<br>4 = DEF Low Severe – DEF Lamp Blinking at 1Hz rate<br>Other values are Reserved for SAE Assignment                                                                                                                           |
| 45218    | J1939 DEF Inducement Level                             | Uint32 | N/A                                                                 | N/A            | R   | 0 = No Inducement<br>1 = DEF Warning<br>2 = DEF Warning Level 2<br>3 = Inducement<br>4 = Pre-Severe Inducement<br>5 = Severe Inducement<br>6 = Temporary Override of Inducement                                                                                                     |
| 45220    | J1939 DPF Status                                       | Uint32 | N/A                                                                 | N/A            | R   | 0 = Regeneration not needed<br>1 = Regeneration needed - lowest level<br>2 = Regeneration needed - moderate level<br>3 = Regeneration needed - highest level<br>4 = Soot Critically High<br>5 = reserved for SAE assignment<br>6 = reserved for SAE assignment<br>7 = not available |
| 45222    | J1939 Scania Urea (DEF) Level                          | Uint32 | 0.4 % per bit gain, 0 offset                                        | N/A            | R   | 0–100 %                                                                                                                                                                                                                                                                             |
| 45224    | J1939 Scania Urea (DEF) Level Inducement State         | Unit32 | N/A                                                                 | N/A            | R   | 0 = Urea Level OK<br>1 = Low Urea Level<br>2 = Urea Level Very Low<br>3 = Urea Tank Empty<br>4–5 Reserved<br>6 = Error<br>7 = Not Available                                                                                                                                         |

| Register | Description                                         | Type   | Units                                | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                      |
|----------|-----------------------------------------------------|--------|--------------------------------------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45226    | J1939 Scania OBD Inducement State                   | Uint32 | Raw ECU Parameter Data               | N/A            | R   | 0 = No Inducement<br>1 = Active Torque Limit Due to Urea Level<br>2 = Active Speed Limit Due to Urea Level<br>3 = Active Torque Limit Due to SCR Failure<br>4 = Active Speed Limit Due to SCR Failure<br>5–13 Reserved<br>14 = Error<br>15 = Not Available |
| 45228    | J1939 DPF Outlet Gas Temperature                    | Uint32 | 0.03125 °C/bit gain, - 273 °C offset | N/A            | R   | -273 to +1735.0 °C                                                                                                                                                                                                                                         |
| 45230    | J1939 ECU Amber Lamp from DLCC1 PGN                 | Uint32 | N/A                                  | N/A            | R   | 0 = Lamp Off<br>1 = Lamp On<br>2 = Reserved<br>3 = Not available                                                                                                                                                                                           |
| 45232    | J1939 ECU Red Stop Lamp from DLCC1 PGN              | Uint32 | N/A                                  | N/A            | R   | 0 = Lamp Off<br>1 = Lamp On<br>2 = Reserved<br>3 = Not available                                                                                                                                                                                           |
| 45234    | J1939 OBD Malfunction Indicator Lamp from DLCC1 PGN | Uint32 | N/A                                  | N/A            | R   | 0 - Lamp Off<br>1 - Lamp On<br>2 – Reserved<br>3 - Not available                                                                                                                                                                                           |
| 45236    | J1939 DPF Active Regen Status                       | Uint32 | N/A                                  | N/A            | R   | 0 = Not Active<br>1 = Active<br>2 = regeneration needed – automatically initiated active regeneration imminent<br>3 = not available                                                                                                                        |
| 45238    | J1939 DPF Regen Forced Status                       | Uint32 | N/A                                  | N/A            | R   | 0 = Off<br>1 = Active – Forced by Switch<br>2 = Active – Forced by Service Tool<br>3 = reserved for SAE assignment<br>4 = On – fast blink (1 HZ)<br>5 = reserved for SAE assignment<br>6 = reserved for SAE assignment<br>7 = not available                |
| 45240    | J1939 SCR Cleaning Lamp Command                     | Uint32 | N/A                                  | N/A            | R   | 0 = Off<br>1 = On – solid<br>2 = reserved for SAE assignment<br>3 = reserved for SAE assignment<br>4 = On – fast blink (1 HZ)<br>5 = reserved for SAE assignment<br>6 = reserved for SAE assignment<br>7 = not available                                   |
| 45242    | J1939 SCR Cleaning Status                           | Uint32 | N/A                                  | N/A            | R   | 0 = Not Active<br>1 = Active<br>2 = SCR system cleaning is needed – automatically initiated SCR system cleaning imminent<br>3 = not available                                                                                                              |

| Register | Description                               | Type   | Units       | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                             |
|----------|-------------------------------------------|--------|-------------|----------------|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45244    | J1939 SCR Cleaning Forced Status          | Uint32 | N/A         | N/A            | R   | 0 = Not Active<br>1 = Active Forced by Switch<br>2 = Active Forced by Service Tool<br>3–6 Reserved for SAE Assignment<br>7 = Not Available                                                                                                                                        |
| 45246    | J1939 Volvo SCR Inducement Severity       | Uint32 | N/A         | N/A            | R   | 0 = Not Active<br>1 = Inducement Warning<br>2 = Not Used<br>3 = Derate Active<br>4 = Pre-Severe Derate Warning<br>5 = Severe Derate<br>6 = Temporary Override of Derate<br>7 = Not Available                                                                                      |
| 45248    | J1939 Volvo SCR Inducement Reason         | Uint32 | N/A         | N/A            | R   | 0 = OK<br>1 = Reagent Level Low<br>2 = Incorrect Quality<br>3 = Incorrect Consumption<br>4 = Tampering<br>5 = Not Used<br>6 = Error<br>7 = Not Available                                                                                                                          |
| 45250    | CAN Bus Enabled by User Data              | Int32  | N/A         | N/A            | RW  | 0–1                                                                                                                                                                                                                                                                               |
| 45252    | DTC Enable Data                           | Int32  | N/A         | N/A            | RW  | 0–1                                                                                                                                                                                                                                                                               |
| 45254    | J1939 Source Address                      | Int32  | N/A         | N/A            | RW  | 1–253                                                                                                                                                                                                                                                                             |
| 45256    | ECU Control Output                        | Uint32 | N/A         | N/A            | RW  | 0 = Fuel Relay Controls<br>1 = Preheat Relay Controls                                                                                                                                                                                                                             |
| 45258    | Pulsing Enable                            | Uint32 | N/A         | N/A            | RW  | 1 = Enable<br>2 = Disable                                                                                                                                                                                                                                                         |
| 45260    | MDEC Module Type                          | Uint32 | N/A         | N/A            | RW  | 1 = CAN Module 201<br>2 = CAN Module 302<br>3 = CAN Module 303<br>4 = CAN Module 304                                                                                                                                                                                              |
| 45262    | MDEC Speed Demand Source                  | Uint32 | N/A         | N/A            | RW  | 0 = Analog CAN<br>1 = Up Down ECU<br>2 = Up Down CAN<br>3 = Analog ECU<br>4 = Frequency<br>5 = No CAN Demand                                                                                                                                                                      |
| 45264    | MDEC Engine RPM Request                   | Uint32 | N/A         | N/A            | RW  | 25–2000                                                                                                                                                                                                                                                                           |
| 45266    | Volvo Accelerator Pedal Position          | Uint32 | N/A         | N/A            | RW  | 0–100                                                                                                                                                                                                                                                                             |
| 45268    | Volvo RPM Select                          | Uint32 | N/A         | N/A            | RW  | 0 = Primary<br>1 = Secondary                                                                                                                                                                                                                                                      |
| 45270    | J1939 Start Stop Config                   | Uint32 | N/A         | N/A            | RW  | 0 = Standard<br>1 = Volvo Penta<br>2 = <i>mtu</i> MDEC<br>3 = <i>mtu</i> ADEC<br>4 = <i>mtu</i> ECU7<br>5 = GM<br>6 = Cummins<br>7 = <i>mtu</i> Smart Connect<br>8 = Scania<br>9 = John Deere<br>10 = Isuzu<br>11 = Daimler<br>12 = Yanmar<br>13 = Deutz<br>14 = Woodward PG Plus |
| 45272    | ECU Settling Time                         | Uint32 | Millisecond | Milli          | RW  | 5500–150000                                                                                                                                                                                                                                                                       |
| 45274    | ECU Pulse Cycle Time                      | Uint32 | Minute      | N/A            | RW  | 1–1440                                                                                                                                                                                                                                                                            |
| 45276    | ECU Disconnect Time                       | Uint32 | Second      | N/A            | RW  | 1–60                                                                                                                                                                                                                                                                              |
| 45278    | ECU Connect Time                          | Uint32 | Second      | N/A            | RW  | 1–60                                                                                                                                                                                                                                                                              |
| 45280    | <i>mtu</i> Request Test Overspeed         | Uint32 | N/A         | N/A            | RW  | 0 = Off<br>1 = On                                                                                                                                                                                                                                                                 |
| 45282    | <i>mtu</i> Governor Switchover Parameters | Uint32 | N/A         | N/A            | RW  | 0–1                                                                                                                                                                                                                                                                               |

| Register | Description                                        | Type   | Units       | Scaling Factor | R/W | Range                                                   |
|----------|----------------------------------------------------|--------|-------------|----------------|-----|---------------------------------------------------------|
| 45284    | <i>mtu</i> Intermittent Oil Prime Request          | Uint32 | N/A         | N/A            | RW  | 0 = Off<br>1 = On                                       |
| 45286    | <i>mtu</i> Trip Info Reset Request                 | Uint32 | N/A         | N/A            | RW  | 0 = Off<br>1 = On                                       |
| 45288    | <i>mtu</i> Speed Increase                          | Uint32 | N/A         | N/A            | RW  | 0 = Off<br>1 = On                                       |
| 45290    | <i>mtu</i> Speed Decrease                          | Uint32 | N/A         | N/A            | RW  | 0 = Off<br>1 = On                                       |
| 45292    | <i>mtu</i> Speed Demand Limit Boolean              | Uint32 | N/A         | N/A            | RW  | 0 = Off<br>1 = On                                       |
| 45294    | <i>mtu</i> Mode Switch                             | Uint32 | N/A         | N/A            | RW  | 0–1000                                                  |
| 45296    | <i>mtu</i> Increased Idle                          | Uint32 | N/A         | N/A            | RW  | 0–1000                                                  |
| 45298    | <i>mtu</i> Governor Parameter Set Select           | Uint32 | N/A         | N/A            | RW  | 0 = Off<br>1 = On                                       |
| 45300    | <i>mtu</i> Fan Override                            | Uint32 | N/A         | N/A            | RW  | 0 = Off<br>1 = On                                       |
| 45302    | <i>mtu</i> Prime On Engine Start                   | Uint32 | N/A         | N/A            | RW  | 0 = Off<br>1 = On                                       |
| 45304    | <i>mtu</i> CAN Rating SW1                          | Uint32 | N/A         | N/A            | RW  | 0 = Off<br>1 = On                                       |
| 45306    | <i>mtu</i> CAN Rating SW2                          | Uint32 | N/A         | N/A            | RW  | 0 = Off<br>1 = On                                       |
| 45308    | <i>mtu</i> Disable Cylinder Cutout 1               | Uint32 | N/A         | N/A            | RW  | 0 = Off<br>1 = On                                       |
| 45310    | <i>mtu</i> Cylinder Cutout 2                       | Uint32 | N/A         | N/A            | RW  | 0 = Off<br>1 = On                                       |
| 45312    | <i>mtu</i> ECU7 Module Type Data                   | Int32  | N/A         | N/A            | RW  | 0 = Off<br>1 = On                                       |
| 45314    | RESERVED                                           |        |             |                |     |                                                         |
| 45316    | <i>mtu</i> NMT Alive Repeat Milliseconds           | Int32  | Millisecond | N/A            | RW  | 100–500                                                 |
| 45318    | Generator Parameter Transmit Enable Data           | Int32  | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable                               |
| 45320    | DPF Manual Regenerate Data                         | Int32  | N/A         | N/A            | RW  | 0 = Off<br>1 = On                                       |
| 45322    | DPF Regenerate Disable Data                        | Int32  | N/A         | N/A            | RW  | 0 = Off<br>1 = On                                       |
| 45324    | J1939 Speed Torque Transmit Enable Data            | Int32  | N/A         | N/A            | RW  | 0 = Off<br>1 = RPM Request<br>2 = Governor Bias Request |
| 45326    | Engine Idle RPM Data                               | Int32  | N/A         | N/A            | RW  | 25–2000                                                 |
| 45328    | Engine Parameter Transmit Enable                   | Int32  | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable                               |
| 45330    | Requested <i>mtu</i> SMC ENG Operating Mode        | Int32  | N/A         | N/A            | RW  | 1–2                                                     |
| 45332    | SPN Conversion Method                              | Int32  | N/A         | N/A            | RW  | 1–4                                                     |
| 45334    | John Deere Regeneration Interlock                  | Uint32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable                               |
| 45336    | Expected Engine ECU Address                        | Uint32 | N/A         | N/A            | RW  | 0–254                                                   |
| 45338    | Battery Charger 1 CAN Bus Type                     | Uint32 | N/A         | N/A            | RW  | 0 = None<br>1 = Standard<br>2 = Sens                    |
| 45340    | Battery Charger 2 CAN Bus Type                     | Uint32 | N/A         | N/A            | RW  | 0 = None<br>1 = Standard<br>2 = Sens                    |
| 45342    | Battery Charger 1 Comms Fail Pre-Alarm Enable      | Uint32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable                               |
| 45344    | Battery Charger 1 Battery Fail Pre-Alarm Enable    | Uint32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable                               |
| 45346    | Battery Charger 1 Charger Fail Pre-Alarm Enable    | Uint32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable                               |
| 45348    | Battery Charger 1 ac Off Pre-Alarm Enable          | Uint32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable                               |
| 45350    | Battery Charger 1 Thermal Limit Pre-Alarm Enable   | Uint32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable                               |
| 45352    | Battery Charger 1 High dc Voltage Pre-Alarm Enable | Uint32 | N/A         | N/A            | RW  | 0 = Disable<br>1 = Enable                               |

| Register | Description                                             | Type   | Units | Scaling Factor | R/W | Range                                                                                 |
|----------|---------------------------------------------------------|--------|-------|----------------|-----|---------------------------------------------------------------------------------------|
| 45354    | Battery Charger 1 Low dc Voltage Pre-Alarm Enable       | Uint32 | N/A   | N/A            | RW  | 0 = Disable<br>1 = Enable                                                             |
| 45356    | Battery Charger 1 Low Cranking Voltage Pre-Alarm Enable | Uint32 | N/A   | N/A            | RW  | 0 = Disable<br>1 = Enable                                                             |
| 45358    | Battery Charger 1 Invalid Settings Pre-Alarm Enable     | Uint32 | N/A   | N/A            | RW  | 0 = Disable<br>1 = Enable                                                             |
| 45360    | Battery Charger 1 Single Unit Fail Pre-Alarm Enable     | Uint32 | N/A   | N/A            | RW  | 0 = Disable<br>1 = Enable                                                             |
| 45362    | Battery Charger 2 Comms Fail Pre-Alarm Enable           | Uint32 | N/A   | N/A            | RW  | 0 = Disable<br>1 = Enable                                                             |
| 45364    | Battery Charger 2 Battery Fail Pre-Alarm Enable         | Int32  | N/A   | N/A            | RW  | 0 = Disable<br>1 = Enable                                                             |
| 45366    | Battery Charger 2 Charger Fail Pre-Alarm Enable         | Int32  | N/A   | N/A            | RW  | 0 = Disable<br>1 = Enable                                                             |
| 45368    | Battery Charger 2 ac Off Pre-Alarm Enable               | Int32  | N/A   | N/A            | RW  | 0 = Disable<br>1 = Enable                                                             |
| 45370    | Battery Charger 2 Thermal Limit Pre-Alarm Enable        | Int32  | N/A   | N/A            | RW  | 0 = Disable<br>1 = Enable                                                             |
| 45372    | Battery Charger 2 High dc Voltage Pre-Alarm Enable      | Int32  | N/A   | N/A            | RW  | 0 = Disable<br>1 = Enable                                                             |
| 45374    | Battery Charger 2 Low dc Voltage Pre-Alarm Enable       | Int32  | N/A   | N/A            | RW  | 0 = Disable<br>1 = Enable                                                             |
| 45376    | Battery Charger 2 Low Cranking Voltage Pre-Alarm Enable | Int32  | N/A   | N/A            | RW  | 0 = Disable<br>1 = Enable                                                             |
| 45378    | Battery Charger 2 Invalid Settings Pre-Alarm Enable     | Int32  | N/A   | N/A            | RW  | 0 = Disable<br>1 = Enable                                                             |
| 45380    | Battery Charger 2 Single Unit Fail Pre-Alarm Enable     | Int32  | N/A   | N/A            | RW  | 0 = Disable<br>1 = Enable                                                             |
| 45382    | Engine Start Mode                                       | Uint32 | N/A   | N/A            | RW  | 0 = Normal Engine Start Requested<br>1 = Rapid Engine Start Requested                 |
| 45384    | RPM Checksum Enable                                     | Uint32 | N/A   | N/A            | RW  | 0 = Disable<br>1 = Enable                                                             |
| 45386    | Cummins Generator Control Communications Configuration  | Int32  | N/A   | N/A            | RW  | 0 = Proprietary<br>1 = Standard                                                       |
| 45388    | Yanmar Number of Cycles                                 | Uint32 | N/A   | N/A            | RW  | 1–20                                                                                  |
| 45390    | Isuzu Memory Clear Request                              | Uint32 | N/A   | N/A            | RW  | 0 = Off<br>1 = On                                                                     |
| 45392    | Isuzu Escape Mode Request                               | Uint32 | N/A   | N/A            | RW  | 0 = Off<br>1 = On                                                                     |
| 45394    | CAN Bus Start/Stop Configuration                        | Int32  | N/A   | N/A            | RW  | 0 = Constant<br>1 = While Starting or Stopping<br>2 = Disabled<br>3 = Not Implemented |
| 45396    | Can Bus Bit Rate Source                                 | Uint32 | N/A   | N/A            | RW  | 0 = ECU Configuration<br>1 = User Setting                                             |
| 45398    | CAN Bus Bit Rate Selection                              | Uint32 | N/A   | N/A            | RW  | 0 = 125 kbit<br>1 = 250 kbit<br>2 = 500 kbit<br>3 = 1000 kbit                         |
| 45400    | Secondary Engine ECU Address                            | Uint32 | N/A   | N/A            | RW  | 0–254                                                                                 |
| 45402    | Fuel Selection                                          | Uint32 | N/A   | N/A            | RW  | 0 = Diesel Fuel<br>1 = Natural Gas<br>2 = Liquid Propane<br>3 = Bi-Fuel, NG or LP     |



| Register | Description                                                 | Type   | Units      | Scaling Factor | R/W | Range                                                                                                                                                                                      |
|----------|-------------------------------------------------------------|--------|------------|----------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45404    | Total AC Power PGN Transmit Rate                            | Uint32 | N/A        | N/A            | RW  | 10 = 10 ms<br>20 = 20 ms<br>30 = 30 ms<br>40 = 40 ms<br>50 = 50 ms<br>60 = 60 ms<br>70 = 70 ms<br>80 = 80 ms<br>90 = 90 ms<br>100 = 100 ms<br>150 = 150 ms<br>200 = 200 ms<br>250 = 250 ms |
| 45406    | Volvo Accelerator Pedal Checksum Enable                     | Uint32 | N/A        | N/A            | RW  | 0 = Disable<br>1 = Enable                                                                                                                                                                  |
| 45408-82 | FUTURE USE                                                  |        |            |                |     |                                                                                                                                                                                            |
| 45484    | Voltage Regulator CAN Bus Parameter Transmit Enable Data    | Int32  | N/A        | N/A            | RW  | 0 = None<br>1 = Marathon<br>2 = Basler<br>3 = J1939                                                                                                                                        |
| 45486    | Voltage Regulator Primary Volt Setpoint in DeciVolts Data   | Int32  | DeciUnit   | Deci           | RW  | 1000–9999990                                                                                                                                                                               |
| 45488    | Voltage Regulator Alternate Volt Setpoint in DeciVolts Data | Int32  | DeciUnit   | Deci           | RW  | 1000–9999990                                                                                                                                                                               |
| 45490    | Voltage Regulator Volt Adjust Bandwidth CentiVolts Data     | Int32  | CentiUnit  | Centi          | RW  | 0–3000                                                                                                                                                                                     |
| 45492    | Voltage Regulator Field Current in Milliamps Data           | Int32  | MilliUnit  | Milli          | RW  | 0–30000                                                                                                                                                                                    |
| 45494    | Voltage Regulator Primary UF Knee in DeciHertz Data         | Int32  | DeciUnit   | Deci           | RW  | 400–700                                                                                                                                                                                    |
| 45496    | Voltage Regulator Alternate UF Knee in DeciHertz Data       | Int32  | DeciUnit   | Deci           | RW  | 400–700                                                                                                                                                                                    |
| 45498    | Voltage Regulator Underfrequency Slope in CentiUnits        | Int32  | CentiUnit  | Centi          | RW  | 100–500                                                                                                                                                                                    |
| 45500    | Analog Input 1 Metering Value                               | Int32  | CentiUnit  | Centi          | R   | -100000000 to 99999900                                                                                                                                                                     |
| 45502    | Analog Input 2 Metering Value                               | Int32  | CentiUnit  | Centi          | R   | -100000000 to 99999900                                                                                                                                                                     |
| 45504    | Analog Input 3 Metering Value                               | Int32  | CentiUnit  | Centi          | R   | -100000000 to 99999900                                                                                                                                                                     |
| 45506    | Analog Input 4 Metering Value                               | Int32  | CentiUnit  | Centi          | R   | -100000000 to 99999900                                                                                                                                                                     |
| 45508    | Analog Input 5 Metering Value                               | Int32  | CentiUnit  | Centi          | R   | -100000000 to 99999900                                                                                                                                                                     |
| 45510    | Analog Input 6 Metering Value                               | Int32  | CentiUnit  | Centi          | R   | -100000000 to 99999900                                                                                                                                                                     |
| 45512    | Analog Input 7 Metering Value                               | Int32  | CentiUnit  | Centi          | R   | -100000000 to 99999900                                                                                                                                                                     |
| 45514    | Analog Input 8 Metering Value                               | Int32  | CentiUnit  | Centi          | R   | -100000000 to 99999900                                                                                                                                                                     |
| 45516    | RTD Input 1 Metering Value                                  | Int32  | CentiDeg F | Centi          | R   | -100000000 to 99999900                                                                                                                                                                     |
| 45518    | RTD Input 2 Metering Value                                  | Int32  | CentiDeg F | Centi          | R   | -100000000 to 99999900                                                                                                                                                                     |
| 45520    | RTD Input 3 Metering Value                                  | Int32  | CentiDeg F | Centi          | R   | -100000000 to 99999900                                                                                                                                                                     |
| 45522    | RTD Input 4 Metering Value                                  | Int32  | CentiDeg F | Centi          | R   | -100000000 to 99999900                                                                                                                                                                     |
| 45524    | RTD Input 5 Metering Value                                  | Int32  | CentiDeg F | Centi          | R   | -100000000 to 99999900                                                                                                                                                                     |
| 45526    | RTD Input 6 Metering Value                                  | Int32  | CentiDeg F | Centi          | R   | -100000000 to 99999900                                                                                                                                                                     |
| 45528    | RTD Input 7 Metering Value                                  | Int32  | CentiDeg F | Centi          | R   | -100000000 to 99999900                                                                                                                                                                     |
| 45530    | RTD Input 8 Metering Value                                  | Int32  | CentiDeg F | Centi          | R   | -100000000 to 99999900                                                                                                                                                                     |
| 45532    | Thermocouple Input 1 Metering Value                         | Int32  | CentiDeg F | Centi          | R   | -100000000 to 99999900                                                                                                                                                                     |
| 45534    | Thermocouple Input 2 Metering Value                         | Int32  | CentiDeg F | Centi          | R   | -100000000 to 99999900                                                                                                                                                                     |

| Register | Description                                | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|----------|--------------------------------------------|--------|-------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45536–37 | AEM Input Threshold Status Bits Register 1 | Uint32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Analog Input 6 Under 2<br>Bit 3 = Analog Input 6 Under 1<br>Bit 4 = Analog Input 6 Over 2<br>Bit 5 = Analog Input 6 Over 1<br>Bit 6 = Analog Input 6 Out of Range<br>Bit 7 = Analog Input 5 Under 2<br>Bit 8 = Analog Input 5 Under 1<br>Bit 9 = Analog Input 5 Over 2<br>Bit 10 = Analog Input 5 Over 1<br>Bit 11 = Analog Input 5 Out of Range<br>Bit 12 = Analog Input 4 Under 2<br>Bit 13 = Analog Input 4 Under 1<br>Bit 14 = Analog Input 4 Over 2<br>Bit 15 = Analog Input 4 Over 1<br>Bit 16 = Analog Input 4 Out of Range<br>Bit 17 = Analog Input 3 Under 2<br>Bit 18 = Analog Input 3 Under 1<br>Bit 19 = Analog Input 3 Over 2<br>Bit 20 = Analog Input 3 Over 1<br>Bit 21 = Analog Input 3 Out of Range<br>Bit 22 = Analog Input 2 Under 2<br>Bit 23 = Analog Input 2 Under 1<br>Bit 24 = Analog Input 2 Over 2<br>Bit 25 = Analog Input 2 Over 1<br>Bit 26 = Analog Input 2 Out of Range<br>Bit 27 = Analog Input 1 Under 2<br>Bit 28 = Analog Input 1 Under 1<br>Bit 29 = Analog Input 1 Over 2<br>Bit 30 = Analog Input 1 Over 1<br>Bit 31 = Analog Input 1 Out of Range |

| Register | Description                                | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------|--------------------------------------------|--------|-------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45538–39 | AEM Input Threshold Status Bits Register 2 | Uint32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = RTD Input 4 Under 2<br>Bit 3 = RTD Input 4 Under 1<br>Bit 4 = RTD Input 4 Over 2<br>Bit 5 = RTD Input 4 Over 1<br>Bit 6 = RTD Input 4 Out of Range<br>Bit 7 = RTD Input 3 Under 2<br>Bit 8 = RTD Input 3 Under 1<br>Bit 9 = RTD Input 3 Over 2<br>Bit 10 = RTD Input 3 Over 1<br>Bit 11 = RTD Input 3 Out of Range<br>Bit 12 = RTD Input 2 Under 2<br>Bit 13 = RTD Input 2 Under 1<br>Bit 14 = RTD Input 2 Over 2<br>Bit 15 = RTD Input 2 Over 1<br>Bit 16 = RTD Input 2 Out of Range<br>Bit 17 = RTD Input 1 Under 2<br>Bit 18 = RTD Input 1 Under 1<br>Bit 19 = RTD Input 1 Over 2<br>Bit 20 = RTD Input 1 Over 1<br>Bit 21 = RTD Input 1 Out of Range<br>Bit 22 = Analog Input 8 Under 2<br>Bit 23 = Analog Input 8 Under 1<br>Bit 24 = Analog Input 8 Over 2<br>Bit 25 = Analog Input 8 Over 1<br>Bit 26 = Analog Input 8 Out of Range<br>Bit 27 = Analog Input 7 Under 2<br>Bit 28 = Analog Input 7 Under 1<br>Bit 29 = Analog Input 7 Over 2<br>Bit 30 = Analog Input 7 Over 1<br>Bit 31 = Analog Input 7 Out of Range |

| Register | Description                                | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------|--------------------------------------------|--------|-------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45540–41 | AEM Input Threshold Status Bits Register 3 | Uint32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Thermocouple 2 Under 2<br>Bit 3 = Thermocouple 2 Under 1<br>Bit 4 = Thermocouple 2 Over 2<br>Bit 5 = Thermocouple 2 Over 1<br>Bit 6 = Thermocouple 2 Out of Range<br>Bit 7 = Thermocouple 1 Under 2<br>Bit 8 = Thermocouple 1 Under 1<br>Bit 9 = Thermocouple 1 Over 2<br>Bit 10 = Thermocouple 1 Over 1<br>Bit 11 = Thermocouple 1 Out of Range<br>Bit 12 = RTD Input 8 Under 2<br>Bit 13 = RTD Input 8 Under 1<br>Bit 14 = RTD Input 8 Over 2<br>Bit 15 = RTD Input 8 Over 1<br>Bit 16 = RTD Input 8 Out of Range<br>Bit 17 = RTD Input 7 Under 2<br>Bit 18 = RTD Input 7 Under 1<br>Bit 19 = RTD Input 7 Over 2<br>Bit 20 = RTD Input 7 Over 1<br>Bit 21 = RTD Input 7 Out of Range<br>Bit 22 = RTD Input 6 Under 2<br>Bit 23 = RTD Input 6 Under 1<br>Bit 24 = RTD Input 6 Over 2<br>Bit 25 = RTD Input 6 Over 1<br>Bit 26 = RTD Input 6 Out of Range<br>Bit 27 = RTD Input 5 Under 2<br>Bit 28 = RTD Input 5 Under 1<br>Bit 29 = RTD Input 5 Over 2<br>Bit 30 = RTD Input 5 Over 1<br>Bit 31 = RTD Input 5 Out of Range |

| Register | Description                                | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------|--------------------------------------------|--------|-------|----------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45542–43 | AEM Input Threshold Status Bits Register 4 | Uint32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Not Used<br>Bit 23 = Not Used<br>Bit 24 = Not Used<br>Bit 25 = Not Used<br>Bit 26 = Not Used<br>Bit 27 = Not Used<br>Bit 28 = Analog Output 4 Out of Range<br>Bit 29 = Analog Output 3 Out of Range<br>Bit 30 = Analog Output 2 Out of Range<br>Bit 31 = Analog Output 1 Out of Range |

| Register | Description                               | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|----------|-------------------------------------------|--------|-------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45544–45 | AEM Input Threshold Alarm Bits Register 1 | Uint32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Analog Input 6 Under 2<br>Bit 3 = Analog Input 6 Under 1<br>Bit 4 = Analog Input 6 Over 2<br>Bit 5 = Analog Input 6 Over 1<br>Bit 6 = Analog Input 6 Out of Range<br>Bit 7 = Analog Input 5 Under 2<br>Bit 8 = Analog Input 5 Under 1<br>Bit 9 = Analog Input 5 Over 2<br>Bit 10 = Analog Input 5 Over 1<br>Bit 11 = Analog Input 5 Out of Range<br>Bit 12 = Analog Input 4 Under 2<br>Bit 13 = Analog Input 4 Under 1<br>Bit 14 = Analog Input 4 Over 2<br>Bit 15 = Analog Input 4 Over 1<br>Bit 16 = Analog Input 4 Out of Range<br>Bit 17 = Analog Input 3 Under 2<br>Bit 18 = Analog Input 3 Under 1<br>Bit 19 = Analog Input 3 Over 2<br>Bit 20 = Analog Input 3 Over 1<br>Bit 21 = Analog Input 3 Out of Range<br>Bit 22 = Analog Input 2 Under 2<br>Bit 23 = Analog Input 2 Under 1<br>Bit 24 = Analog Input 2 Over 2<br>Bit 25 = Analog Input 2 Over 1<br>Bit 26 = Analog Input 2 Out of Range<br>Bit 27 = Analog Input 1 Under 2<br>Bit 28 = Analog Input 1 Under 1<br>Bit 29 = Analog Input 1 Over 2<br>Bit 30 = Analog Input 1 Over 1<br>Bit 31 = Analog Input 1 Out of Range |

| Register | Description                               | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------|-------------------------------------------|--------|-------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45546–47 | AEM Input Threshold Alarm Bits Register 2 | Uint32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = RTD Input 4 Under 2<br>Bit 3 = RTD Input 4 Under 1<br>Bit 4 = RTD Input 4 Over 2<br>Bit 5 = RTD Input 4 Over 1<br>Bit 6 = RTD Input 4 Out of Range<br>Bit 7 = RTD Input 3 Under 2<br>Bit 8 = RTD Input 3 Under 1<br>Bit 9 = RTD Input 3 Over 2<br>Bit 10 = RTD Input 3 Over 1<br>Bit 11 = RTD Input 3 Out of Range<br>Bit 12 = RTD Input 2 Under 2<br>Bit 13 = RTD Input 2 Under 1<br>Bit 14 = RTD Input 2 Over 2<br>Bit 15 = RTD Input 2 Over 1<br>Bit 16 = RTD Input 2 Out of Range<br>Bit 17 = RTD Input 1 Under 2<br>Bit 18 = RTD Input 1 Under 1<br>Bit 19 = RTD Input 1 Over 2<br>Bit 20 = RTD Input 1 Over 1<br>Bit 21 = RTD Input 1 Out of Range<br>Bit 22 = Analog Input 8 Under 2<br>Bit 23 = Analog Input 8 Under 1<br>Bit 24 = Analog Input 8 Over 2<br>Bit 25 = Analog Input 8 Over 1<br>Bit 26 = Analog Input 8 Out of Range<br>Bit 27 = Analog Input 7 Under 2<br>Bit 28 = Analog Input 7 Under 1<br>Bit 29 = Analog Input 7 Over 2<br>Bit 30 = Analog Input 7 Over 1<br>Bit 31 = Analog Input 7 Out of Range |

| Register | Description                               | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------|-------------------------------------------|--------|-------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45548–49 | AEM Input Threshold Alarm Bits Register 3 | UInt32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Thermocouple 2 Under 2<br>Bit 3 = Thermocouple 2 Under 1<br>Bit 4 = Thermocouple 2 Over 2<br>Bit 5 = Thermocouple 2 Over 1<br>Bit 6 = Thermocouple 2 Out of Range<br>Bit 7 = Thermocouple 1 Under 2<br>Bit 8 = Thermocouple 1 Under 1<br>Bit 9 = Thermocouple 1 Over 2<br>Bit 10 = Thermocouple 1 Over 1<br>Bit 11 = Thermocouple 1 Out of Range<br>Bit 12 = RTD Input 8 Under 2<br>Bit 13 = RTD Input 8 Under 1<br>Bit 14 = RTD Input 8 Over 2<br>Bit 15 = RTD Input 8 Over 1<br>Bit 16 = RTD Input 8 Out of Range<br>Bit 17 = RTD Input 7 Under 2<br>Bit 18 = RTD Input 7 Under 1<br>Bit 19 = RTD Input 7 Over 2<br>Bit 20 = RTD Input 7 Over 1<br>Bit 21 = RTD Input 7 Out of Range<br>Bit 22 = RTD Input 6 Under 2<br>Bit 23 = RTD Input 6 Under 1<br>Bit 24 = RTD Input 6 Over 2<br>Bit 25 = RTD Input 6 Over 1<br>Bit 26 = RTD Input 6 Out of Range<br>Bit 27 = RTD Input 5 Under 2<br>Bit 28 = RTD Input 5 Under 1<br>Bit 29 = RTD Input 5 Over 2<br>Bit 30 = RTD Input 5 Over 1<br>Bit 31 = RTD Input 5 Out of Range |



| Register | Description                               | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------|-------------------------------------------|--------|-------|----------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45550–51 | AEM Input Threshold Alarm Bits Register 4 | Uint32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Not Used<br>Bit 23 = Not Used<br>Bit 24 = Not Used<br>Bit 25 = Not Used<br>Bit 26 = Not Used<br>Bit 27 = Not Used<br>Bit 28 = Analog Output 4 Out of Range<br>Bit 29 = Analog Output 3 Out of Range<br>Bit 30 = Analog Output 2 Out of Range<br>Bit 31 = Analog Output 1 Out of Range |

| Register | Description                                   | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|----------|-----------------------------------------------|--------|-------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45552–53 | AEM Input Threshold Pre-Alarm Bits Register 1 | Uint32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Analog Input 6 Under 2<br>Bit 3 = Analog Input 6 Under 1<br>Bit 4 = Analog Input 6 Over 2<br>Bit 5 = Analog Input 6 Over 1<br>Bit 6 = Analog Input 6 Out of Range<br>Bit 7 = Analog Input 5 Under 2<br>Bit 8 = Analog Input 5 Under 1<br>Bit 9 = Analog Input 5 Over 2<br>Bit 10 = Analog Input 5 Over 1<br>Bit 11 = Analog Input 5 Out of Range<br>Bit 12 = Analog Input 4 Under 2<br>Bit 13 = Analog Input 4 Under 1<br>Bit 14 = Analog Input 4 Over 2<br>Bit 15 = Analog Input 4 Over 1<br>Bit 16 = Analog Input 4 Out of Range<br>Bit 17 = Analog Input 3 Under 2<br>Bit 18 = Analog Input 3 Under 1<br>Bit 19 = Analog Input 3 Over 2<br>Bit 20 = Analog Input 3 Over 1<br>Bit 21 = Analog Input 3 Out of Range<br>Bit 22 = Analog Input 2 Under 2<br>Bit 23 = Analog Input 2 Under 1<br>Bit 24 = Analog Input 2 Over 2<br>Bit 25 = Analog Input 2 Over 1<br>Bit 26 = Analog Input 2 Out of Range<br>Bit 27 = Analog Input 1 Under 2<br>Bit 28 = Analog Input 1 Under 1<br>Bit 29 = Analog Input 1 Over 2<br>Bit 30 = Analog Input 1 Over 1<br>Bit 31 = Analog Input 1 Out of Range |

| Register | Description                                   | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------|-----------------------------------------------|--------|-------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45554–55 | AEM Input Threshold Pre-Alarm Bits Register 2 | Uint32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = RTD Input 4 Under 2<br>Bit 3 = RTD Input 4 Under 1<br>Bit 4 = RTD Input 4 Over 2<br>Bit 5 = RTD Input 4 Over 1<br>Bit 6 = RTD Input 4 Out of Range<br>Bit 7 = RTD Input 3 Under 2<br>Bit 8 = RTD Input 3 Under 1<br>Bit 9 = RTD Input 3 Over 2<br>Bit 10 = RTD Input 3 Over 1<br>Bit 11 = RTD Input 3 Out of Range<br>Bit 12 = RTD Input 2 Under 2<br>Bit 13 = RTD Input 2 Under 1<br>Bit 14 = RTD Input 2 Over 2<br>Bit 15 = RTD Input 2 Over 1<br>Bit 16 = RTD Input 2 Out of Range<br>Bit 17 = RTD Input 1 Under 2<br>Bit 18 = RTD Input 1 Under 1<br>Bit 19 = RTD Input 1 Over 2<br>Bit 20 = RTD Input 1 Over 1<br>Bit 21 = RTD Input 1 Out of Range<br>Bit 22 = Analog Input 8 Under 2<br>Bit 23 = Analog Input 8 Under 1<br>Bit 24 = Analog Input 8 Over 2<br>Bit 25 = Analog Input 8 Over 1<br>Bit 26 = Analog Input 8 Out of Range<br>Bit 27 = Analog Input 7 Under 2<br>Bit 28 = Analog Input 7 Under 1<br>Bit 29 = Analog Input 7 Over 2<br>Bit 30 = Analog Input 7 Over 1<br>Bit 31 = Analog Input 7 Out of Range |

| Register | Description                                   | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------|-----------------------------------------------|--------|-------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45556–57 | AEM Input Threshold Pre-Alarm Bits Register 3 | Uint32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Thermocouple 2 Under 2<br>Bit 3 = Thermocouple 2 Under 1<br>Bit 4 = Thermocouple 2 Over 2<br>Bit 5 = Thermocouple 2 Over 1<br>Bit 6 = Thermocouple 2 Out of Range<br>Bit 7 = Thermocouple 1 Under 2<br>Bit 8 = Thermocouple 1 Under 1<br>Bit 9 = Thermocouple 1 Over 2<br>Bit 10 = Thermocouple 1 Over 1<br>Bit 11 = Thermocouple 1 Out of Range<br>Bit 12 = RTD Input 8 Under 2<br>Bit 13 = RTD Input 8 Under 1<br>Bit 14 = RTD Input 8 Over 2<br>Bit 15 = RTD Input 8 Over 1<br>Bit 16 = RTD Input 8 Out of Range<br>Bit 17 = RTD Input 7 Under 2<br>Bit 18 = RTD Input 7 Under 1<br>Bit 19 = RTD Input 7 Over 2<br>Bit 20 = RTD Input 7 Over 1<br>Bit 21 = RTD Input 7 Out of Range<br>Bit 22 = RTD Input 6 Under 2<br>Bit 23 = RTD Input 6 Under 1<br>Bit 24 = RTD Input 6 Over 2<br>Bit 25 = RTD Input 6 Over 1<br>Bit 26 = RTD Input 6 Out of Range<br>Bit 27 = RTD Input 5 Under 2<br>Bit 28 = RTD Input 5 Under 1<br>Bit 29 = RTD Input 5 Over 2<br>Bit 30 = RTD Input 5 Over 1<br>Bit 31 = RTD Input 5 Out of Range |

| Register | Description                                   | Type   | Units     | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------|-----------------------------------------------|--------|-----------|----------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45558–59 | AEM Input Threshold Pre-Alarm Bits Register 4 | UInt32 | N/A       | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Not Used<br>Bit 23 = Not Used<br>Bit 24 = Not Used<br>Bit 25 = Not Used<br>Bit 26 = Not Used<br>Bit 27 = Not Used<br>Bit 28 = Analog Output 4 Out of Range<br>Bit 29 = Analog Output 3 Out of Range<br>Bit 30 = Analog Output 2 Out of Range<br>Bit 31 = Analog Output 1 Out of Range |
| 45560    | Analog Output 1 Metering Value                | Int32  | CentiUnit | Centi          | R   | -100000000 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 45562    | Analog Output 2 Metering Value                | Int32  | CentiUnit | Centi          | R   | -100000000 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 45564    | Analog Output 3 Metering Value                | Int32  | CentiUnit | Centi          | R   | -100000000 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 45566    | Analog Output 4 Metering Value                | Int32  | CentiUnit | Centi          | R   | -100000000 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

| Register | Description                                   | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------|-----------------------------------------------|--------|-------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45568–69 | Configurable Protection Threshold Status Bits | Uint32 | N/A   | N/A            | R   | Bit 0 = Conf Protection 8 Under 2<br>Bit 1 = Conf Protection 8 Under 1<br>Bit 2 = Conf Protection 8 Over 2<br>Bit 3 = Conf Protection 8 Over 1<br>Bit 4 = Conf Protection 7 Under 2<br>Bit 5 = Conf Protection 7 Under 1<br>Bit 6 = Conf Protection 7 Over 2<br>Bit 7 = Conf Protection 7 Over 1<br>Bit 8 = Conf Protection 6 Under 2<br>Bit 9 = Conf Protection 6 Under 1<br>Bit 10 = Conf Protection 6 Over 2<br>Bit 11 = Conf Protection 6 Over 1<br>Bit 12 = Conf Protection 5 Under 2<br>Bit 13 = Conf Protection 5 Under 1<br>Bit 14 = Conf Protection 5 Over 2<br>Bit 15 = Conf Protection 5 Over 1<br>Bit 16 = Conf Protection 4 Under 2<br>Bit 17 = Conf Protection 4 Under 1<br>Bit 18 = Conf Protection 4 Over 2<br>Bit 19 = Conf Protection 4 Over 1<br>Bit 20 = Conf Protection 3 Under 2<br>Bit 21 = Conf Protection 3 Under 1<br>Bit 22 = Conf Protection 3 Over 2<br>Bit 23 = Conf Protection 3 Over 1<br>Bit 24 = Conf Protection 2 Under 2<br>Bit 25 = Conf Protection 2 Under 1<br>Bit 26 = Conf Protection 2 Over 2<br>Bit 27 = Conf Protection 2 Over 1<br>Bit 28 = Conf Protection 1 Under 2<br>Bit 29 = Conf Protection 1 Under 1<br>Bit 30 = Conf Protection 1 Over 2<br>Bit 31 = Conf Protection 1 Over 1 |

| Register | Description                        | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------|------------------------------------|--------|-------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45570–71 | Configurable Protection Alarm Bits | Uint32 | N/A   | N/A            | R   | Bit 0 = Conf Protection 8 Under 2<br>Bit 1 = Conf Protection 8 Under 1<br>Bit 2 = Conf Protection 8 Over 2<br>Bit 3 = Conf Protection 8 Over 1<br>Bit 4 = Conf Protection 7 Under 2<br>Bit 5 = Conf Protection 7 Under 1<br>Bit 6 = Conf Protection 7 Over 2<br>Bit 7 = Conf Protection 7 Over 1<br>Bit 8 = Conf Protection 6 Under 2<br>Bit 9 = Conf Protection 6 Under 1<br>Bit 10 = Conf Protection 6 Over 2<br>Bit 11 = Conf Protection 6 Over 1<br>Bit 12 = Conf Protection 5 Under 2<br>Bit 13 = Conf Protection 5 Under 1<br>Bit 14 = Conf Protection 5 Over 2<br>Bit 15 = Conf Protection 5 Over 1<br>Bit 16 = Conf Protection 4 Under 2<br>Bit 17 = Conf Protection 4 Under 1<br>Bit 18 = Conf Protection 4 Over 2<br>Bit 19 = Conf Protection 4 Over 1<br>Bit 20 = Conf Protection 3 Under 2<br>Bit 21 = Conf Protection 3 Under 1<br>Bit 22 = Conf Protection 3 Over 2<br>Bit 23 = Conf Protection 3 Over 1<br>Bit 24 = Conf Protection 2 Under 2<br>Bit 25 = Conf Protection 2 Under 1<br>Bit 26 = Conf Protection 2 Over 2<br>Bit 27 = Conf Protection 2 Over 1<br>Bit 28 = Conf Protection 1 Under 2<br>Bit 29 = Conf Protection 1 Under 1<br>Bit 30 = Conf Protection 1 Over 2<br>Bit 31 = Conf Protection 1 Over 1 |

| Register | Description                            | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------|----------------------------------------|--------|-------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45572–73 | Configurable Protection Pre-Alarm Bits | Uint32 | N/A   | N/A            | R   | Bit 0 = Conf Protection 8 Under 2<br>Bit 1 = Conf Protection 8 Under 1<br>Bit 2 = Conf Protection 8 Over 2<br>Bit 3 = Conf Protection 8 Over 1<br>Bit 4 = Conf Protection 7 Under 2<br>Bit 5 = Conf Protection 7 Under 1<br>Bit 6 = Conf Protection 7 Over 2<br>Bit 7 = Conf Protection 7 Over 1<br>Bit 8 = Conf Protection 6 Under 2<br>Bit 9 = Conf Protection 6 Under 1<br>Bit 10 = Conf Protection 6 Over 2<br>Bit 11 = Conf Protection 6 Over 1<br>Bit 12 = Conf Protection 5 Under 2<br>Bit 13 = Conf Protection 5 Under 1<br>Bit 14 = Conf Protection 5 Over 2<br>Bit 15 = Conf Protection 5 Over 1<br>Bit 16 = Conf Protection 4 Under 2<br>Bit 17 = Conf Protection 4 Under 1<br>Bit 18 = Conf Protection 4 Over 2<br>Bit 19 = Conf Protection 4 Over 1<br>Bit 20 = Conf Protection 3 Under 2<br>Bit 21 = Conf Protection 3 Under 1<br>Bit 22 = Conf Protection 3 Over 2<br>Bit 23 = Conf Protection 3 Over 1<br>Bit 24 = Conf Protection 2 Under 2<br>Bit 25 = Conf Protection 2 Under 1<br>Bit 26 = Conf Protection 2 Over 2<br>Bit 27 = Conf Protection 2 Over 1<br>Bit 28 = Conf Protection 1 Under 2<br>Bit 29 = Conf Protection 1 Under 1<br>Bit 30 = Conf Protection 1 Over 2<br>Bit 31 = Conf Protection 1 Over 1 |
| 45574    | Gen kvar A                             | Int32  | kvar  | N/A            | R   | -2147483648 to 2147483647                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 45576    | Gen kvar B                             | Int32  | kvar  | N/A            | R   | -2147483648 to 2147483647                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 45578    | Gen kvar C                             | Int32  | kvar  | N/A            | R   | -2147483648 to 2147483647                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 45580    | Gen kvar Total                         | Int32  | kvar  | N/A            | R   | -2147483648 to 2147483647                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 45582    | FUTURE USE                             |        |       |                |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |



| Register | Description                | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|----------|----------------------------|--------|-------|----------------|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45584–85 | Logic Control Relay Status | Uint32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Logic Control Relay 16<br>Bit 17 = Logic Control Relay 15<br>Bit 18 = Logic Control Relay 14<br>Bit 19 = Logic Control Relay 13<br>Bit 20 = Logic Control Relay 12<br>Bit 21 = Logic Control Relay 11<br>Bit 22 = Logic Control Relay 10<br>Bit 23 = Logic Control Relay 9<br>Bit 24 = Logic Control Relay 8<br>Bit 25 = Logic Control Relay 7<br>Bit 26 = Logic Control Relay 6<br>Bit 27 = Logic Control Relay 5<br>Bit 28 = Logic Control Relay 4<br>Bit 29 = Logic Control Relay 3<br>Bit 30 = Logic Control Relay 2<br>Bit 31 = Logic Control Relay 1 |

| Register | Description           | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|----------|-----------------------|--------|-------|----------------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45586–87 | I/O Modules Connected | Uint32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Not Used<br>Bit 23 = Not Used<br>Bit 24 = Not Used<br>Bit 25 = Not Used<br>Bit 26 = Not Used<br>Bit 27 = Not Used<br>Bit 28 = Not Used<br>Bit 29 = AEM Connected<br>Bit 30 = CEM Connected<br>Bit 31 = LSM Connected |
| 45588    | Max Vector Shift      | Int32  | N/A   | Centi          | R   | 0–100000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 45590    | Max DF/DT             | Int32  | N/A   | Centi          | R   | 0–100000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 45592    | Current DF/DT         | Int32  | N/A   | Centi          | R   | 0–100000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

| Register | Description       | Type  | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
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| 45594–95 | Status Metering 2 | Int32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Engine has been Running 15 Minutes or more<br>Bit 9 = Regen Interlock Status from ECU<br>Bit 10 = DPF Manual Regen Request<br>Bit 11 = DPF Regen Inhibit Request<br>Bit 12 = Alternate Voltage Override 4<br>Bit 13 = Alternate Voltage Override 3<br>Bit 14 = Alternate Voltage Override 2<br>Bit 15 = Alternate Voltage Override 1<br>Bit 16 = Bus Reverse Rotation<br>Bit 17 = Bus Forward Rotation<br>Bit 18 = Gen Reverse Rotation<br>Bit 19 = Gen Forward Rotation<br>Bit 20 = Closed Transition Override<br>Bit 21 = Auto Breaker Operation Inhibit<br>Bit 22 = Mains Fail Transfer Inhibit<br>Bit 23 = Restart Delay Active<br>Bit 24 = Synchronizer Break Close OK<br>Bit 25 = Synchronizer Angle OK<br>Bit 26 = Synchronizer Slip Freq OK<br>Bit 27 = Synchronizer Volt Match OK<br>Bit 28 = Synchronizer Active<br>Bit 29 = Parallel To Mains<br>Bit 30 = Mains Fail Test<br>Bit 31 = Take Over Load |

| Register | Description                  | Type  | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
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| 45596–97 | Gen Protect Pre-Alarm Status | Int32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = 81 ROC DF/DT Trip<br>Bit 19 = 78 Vector Shift Trip<br>Bit 20 = 51-3 Overcurrent Trip<br>Bit 21 = 40 Loss of Excitation Trip<br>Bit 22 = 32 Reverse Overpower Trip<br>Bit 23 = 59-2 Overvoltage Trip<br>Bit 24 = 27-2 Undervoltage Trip<br>Bit 25 = 51-2 Overcurrent Trip<br>Bit 26 = 81 Underfrequency Trip<br>Bit 27 = 81 Overfrequency Trip<br>Bit 28 = 59-1 Overvoltage Trip<br>Bit 29 = 27-1 Undervoltage Trip<br>Bit 30 = 47 Phase Imbalance Trip<br>Bit 31 = 51-1 Overcurrent Trip |

| Register | Description              | Type  | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
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| 45598–99 | Gen Protect Alarm Status | Int32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = 81 ROC DF/DT Trip<br>Bit 19 = 78 Vector Shift Trip<br>Bit 20 = 51-3 Overcurrent Trip<br>Bit 21 = 40 Loss of Excitation Trip<br>Bit 22 = 32 Reverse Overpower Trip<br>Bit 23 = 59-2 Overvoltage Trip<br>Bit 24 = 27-2 Undervoltage Trip<br>Bit 25 = 51-2 Overcurrent Trip<br>Bit 26 = 81 Underfrequency Trip<br>Bit 27 = 81 Overfrequency Trip<br>Bit 28 = 59-1 Overvoltage Trip<br>Bit 29 = 27-1 Undervoltage Trip<br>Bit 30 = 47 Phase Imbalance Trip<br>Bit 31 = 51-1 Overcurrent Trip |

| Register | Description                           | Type  | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
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| 45600–01 | Pre-Alarm Metering 2                  | Int32 | N/A   | N/A            | R   | Bit 0 = Cannot Regen – Less than 50 Hours Since Last Regen<br>Bit 1 = Cannot Regen – Interlock Fail<br>Bit 2 = Cannot Regen – Low Coolant Temperature<br>Bit 3 = Regen Completed<br>Bit 4 = Regen Not Completed<br>Bit 5 = Confirm Regeneration<br>Bit 6 = DEF Tampering<br>Bit 7 = DEF Consumption Incorrect<br>Bit 8 = DEF Quality Poor<br>Bit 9 = Torque Limit Severe<br>Bit 10 = Torque Limit<br>Bit 11 = Regenerate Forced by Service Tool<br>Bit 12 = Regeneration Forced by Switch<br>Bit 13 = DPF Regenerate Active<br>Bit 14 = DTC Low Coolant Level<br>Bit 15 = Return Fail<br>Bit 16 = DEF Warning Level 2<br>Bit 17 = DEF Warning<br>Bit 18 = Bus Reverse Rotation<br>Bit 19 = Gen Reverse Rotation<br>Bit 20 = DEF Inducement Override<br>Bit 21 = DEF Severe Inducement<br>Bit 22 = DEF Pre-Severe Inducement<br>Bit 23 = DEF Engine Derate<br>Bit 24 = DEF Fluid Level Empty<br>Bit 25 = DEF Fluid Level Low<br>Bit 26 = DPF Soot Level Severely High<br>Bit 27 = DPF Soot Level Moderately High<br>Bit 28 = DPF Soot Level High<br>Bit 29 = High Exhaust Temperature<br>Bit 30 = DPF Regenerate Disabled<br>Bit 31 = DPF Regenerate Required |
| 45602    | Operating Units Config Data           | Int32 | N/A   | N/A            | R   | 0–3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 45604    | kW Rate of Change Data                | Int32 | N/A   | Centi          | R   | 0–10000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 45606    | Generator Network System Manager Data | Int32 | N/A   | N/A            | R   | -1 to 255                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45608    | Generator Network Unit ID 1           | Int32 | N/A   | N/A            | R   | -1 to 255                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45610    | Generator Network Unit ID 2           | Int32 | N/A   | N/A            | R   | -1 to 255                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45612    | Generator Network Unit ID 3           | Int32 | N/A   | N/A            | R   | -1 to 255                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45614    | Generator Network Unit ID 4           | Int32 | N/A   | N/A            | R   | -1 to 255                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45616    | Generator Network Unit ID 5           | Int32 | N/A   | N/A            | R   | -1 to 255                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45618    | Generator Network Unit ID 6           | Int32 | N/A   | N/A            | R   | -1 to 255                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45620    | Generator Network Unit ID 7           | Int32 | N/A   | N/A            | R   | -1 to 255                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45622    | Generator Network Unit ID 8           | Int32 | N/A   | N/A            | R   | -1 to 255                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45624    | Generator Network Unit ID 9           | Int32 | N/A   | N/A            | R   | -1 to 255                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45626    | Generator Network Unit ID 10          | Int32 | N/A   | N/A            | R   | -1 to 255                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45628    | Generator Network Unit ID 11          | Int32 | N/A   | N/A            | R   | -1 to 255                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

| Register | Description                                       | Type  | Units       | Scaling Factor  | R/W | Range                                                                          |
|----------|---------------------------------------------------|-------|-------------|-----------------|-----|--------------------------------------------------------------------------------|
| 45630    | Generator Network Unit ID 12                      | Int32 | N/A         | N/A             | R   | -1 to 255                                                                      |
| 45632    | Generator Network Unit ID 13                      | Int32 | N/A         | N/A             | R   | -1 to 255                                                                      |
| 45634    | Generator Network Unit ID 14                      | Int32 | N/A         | N/A             | R   | -1 to 255                                                                      |
| 45636    | Generator Network Unit ID 15                      | Int32 | N/A         | N/A             | R   | -1 to 255                                                                      |
| 45638    | Generator Network Unit ID 16                      | Int32 | N/A         | N/A             | R   | -1 to 255                                                                      |
| 45640    | Generator Network Number of Units                 | Int32 | N/A         | N/A             | R   | 0–16                                                                           |
| 45642    | LSM Input Data                                    | Int32 | CentiUnit   | Centi           | R   | -100000000 to 99999900                                                         |
| 45644    | Generator Network Number of Units Online          | Int32 | N/A         | N/A             | R   | 0–16                                                                           |
| 45646    | Generator Network Total System kW Capacity        | Int32 | N/A         | N/A             | R   | 0–16777216                                                                     |
| 45648    | Generator Network Total Generated kW              | Int32 | N/A         | N/A             | R   | 0–16777216                                                                     |
| 45650    | Generator Network Total Generated kvar            | Int32 | N/A         | N/A             | R   | 0–16777216                                                                     |
| 45652    | Sequencing Mode Feedback from LSM                 | Int32 | N/A         | N/A             | R   | -2147483648 to 2147483647                                                      |
| 45654    | Next Unit to Start from LSM                       | Int32 | N/A         | N/A             | R   | -1 to 255                                                                      |
| 45656    | Next Unit to Stop from LSM                        | Int32 | N/A         | N/A             | R   | -1 to 255                                                                      |
| 45658    | Start Timer 1 Sec from LSM                        | Int32 | N/A         | N/A             | R   | 0–32767                                                                        |
| 45660    | Start Timer 2 Sec from LSM                        | Int32 | N/A         | N/A             | R   | 0–32767                                                                        |
| 45662    | Stop Timer Sec from LSM                           | Int32 | N/A         | N/A             | R   | 0–32767                                                                        |
| 45664    | Gen Connection for Metering Data                  | Int32 | N/A         | N/A             | R   | 0 = Delta<br>1 = Wye<br>2 = 1 phase AB<br>3 = 1 phase AC<br>4 = Grounded Delta |
| 45666    | Bus Connection for Metering Data                  | Int32 | N/A         | N/A             | R   | 0 = 1 phase AB<br>1 = 3 phase<br>2 = 1 phase AC                                |
| 45668    | Gen Average Line to Line Voltage Data             | Int32 | N/A         | N/A             | R   | -2147483648 to 2147483647                                                      |
| 45670    | Gen Average Line to Neutral Voltage Data          | Int32 | N/A         | N/A             | R   | -2147483648 to 2147483647                                                      |
| 45672    | Gen Average Current Data                          | Int32 | N/A         | N/A             | R   | -2147483648 to 2147483647                                                      |
| 45674    | Remaining Transfer Delay Data                     | Int32 | N/A         | Sec x 67 to sec | R   | -2147483648 to 2147483647                                                      |
| 45676    | Remaining Return Delay Data                       | Int32 | N/A         | Sec x 67 to sec | R   | -2147483648 to 2147483647                                                      |
| 45678    | Remaining Max Transfer Time Data                  | Int32 | N/A         | Sec x 67 to sec | R   | -2147483648 to 2147483647                                                      |
| 45680    | Remaining Max Parallel Time Data                  | Int32 | N/A         | Sec x 67 to sec | R   | -2147483648 to 2147483647                                                      |
| 45682    | Remaining Open Transition Delay Data              | Int32 | N/A         | Sec x 67 to sec | R   | -2147483648 to 2147483647                                                      |
| 45684    | Remaining Max Return Time Data                    | Int32 | N/A         | Sec x 67 to sec | R   | -2147483648 to 2147483647                                                      |
| 45686    | Generator Network System Total kW Capacity Data   | Int32 | N/A         | N/A             | R   | -8388608 to 8388607                                                            |
| 45688    | Generator Network Total Generated kW Percent Data | Int32 | DeciPercent | Deci            | R   | -8388608 to 8388607                                                            |

| Register | Description                     | Type  | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------|---------------------------------|-------|-------|----------------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45690    | Battery Charger 1 Status Points | Int32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Single Unit Fail<br>Bit 21 = Invalid Settings<br>Bit 22 = Low Cranking Voltage<br>Bit 23 = Low Output Voltage<br>Bit 24 = High Output Voltage<br>Bit 25 = Thermal Limit<br>Bit 26 = AC Off<br>Bit 27 = Charger Fail<br>Bit 28 = Battery Fail<br>Bit 29 = Charger Comms Status<br>Bit 30 = Charger Config is Sens<br>Bit 31 = Charger Comms Enabled |



| Register | Description                  | Type  | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------|------------------------------|-------|-------|----------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45692    | Battery Charger 1 Pre-Alarms | Int32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Single Unit Fail<br>Bit 23 = Invalid Settings<br>Bit 24 = Low Cranking Voltage<br>Bit 25 = Low Output Voltage<br>Bit 26 = High Output Voltage<br>Bit 27 = Thermal Limit<br>Bit 28 = AC Disconnected<br>Bit 29 = Charger Fail<br>Bit 30 = Battery Failure<br>Bit 31 = Comms Fail |

| Register | Description                     | Type  | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
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| 45694    | Battery Charger 2 Status Points | Int32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Single Unit Fail Status<br>Bit 21 = Invalid Settings Status<br>Bit 22 = Low Cranking Voltage Status<br>Bit 23 = Low Output Voltage Status<br>Bit 24 = High Output Voltage Status<br>Bit 25 = Thermal Limit Status<br>Bit 26 = AC Off Status<br>Bit 27 = Charger Fail Status<br>Bit 28 = Battery Fail Status<br>Bit 29 = Charger Comms Fail Status<br>Bit 30 = Charger Config is Sens<br>Bit 31 = Charger Comms Enabled |

| Register | Description                                | Type  | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------|--------------------------------------------|-------|-------|----------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45696    | Battery Charger 2 Pre-Alarms               | Int32 | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Single Unit Fail<br>Bit 23 = Invalid Settings<br>Bit 24 = Low Cranking Voltage<br>Bit 25 = Low Output Voltage<br>Bit 26 = High Output Voltage<br>Bit 27 = Thermal Limit<br>Bit 28 = AC Disconnected<br>Bit 29 = Charger Fail<br>Bit 30 = Battery Failure<br>Bit 31 = Comms Fail |
| 45698    | Coolant Temperature Sender Resistance Data | Int32 | N/A   | N/A            | R   | 0–5000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45700    | Oil Pressure Sender Resistance Data        | Int32 | N/A   | N/A            | R   | 0–5000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45702    | Fuel Level Sender Resistance Data          | Int32 | N/A   | N/A            | R   | 0–5000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

| Register | Description                   | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------|-------------------------------|--------|-------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45704    | Yanmar DPF Regeneration State | Uint32 | N/A   | N/A            | R   | Bit 0 = Yanmar Regeneration State Unknown<br>Bit 1 = Yanmar Regeneration Passive State<br>Bit 2 = Yanmar Regeneration Assist State<br>Bit 3 = Yanmar Regeneration Reset Standby State<br>Bit 4 = Yanmar Regeneration Reset State<br>Bit 5 = Yanmar Regeneration Stationary by Allow Standby State<br>Bit 6 = Yanmar Regeneration Stationary by Allow State<br>Bit 7 = Yanmar Regeneration Stationary by Emergency Standby State<br>Bit 8 = Yanmar Regeneration Stationary by Emergency State<br>Bit 9 = Yanmar Regeneration Recovery Standby State<br>Bit 10 = Yanmar Regeneration Recovery State<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Not Used<br>Bit 23 = Not Used<br>Bit 24 = Not Used<br>Bit 25 = Not Used<br>Bit 26 = Not Used<br>Bit 27 = Not Used<br>Bit 28 = Not Used<br>Bit 29 = Not Used<br>Bit 30 = Not Used<br>Bit 31 = Not Used |

| Register | Description                      | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|----------|----------------------------------|--------|-------|----------------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45706    | Yanmar Manual Regeneration State | Uint32 | N/A   | N/A            | R   | Bit 0 = No Manual Regeneration Request<br>Bit 1 = Manual Regeneration Request Pending<br>Bit 2 = Manual Regeneration Request Waiting for Confirmation<br>Bit 3 = Manual Regeneration Request Waiting for Stationary Regeneration<br>Bit 4 = Manual Regeneration Request Aborting<br>Bit 5 = Manual Regeneration Request Timed Out<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Not Used<br>Bit 23 = Not Used<br>Bit 24 = Not Used<br>Bit 25 = Not Used<br>Bit 26 = Not Used<br>Bit 27 = Not Used<br>Bit 28 = Not Used<br>Bit 29 = Not Used<br>Bit 30 = Not Used<br>Bit 31 = Not Used |

| Register | Description                                          | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------|------------------------------------------------------|--------|-------|----------------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45708    | Yanmar Manual Regeneration Status Annunciation State | UInt32 | N/A   | N/A            | R   | Bit 0 = Regeneration Status None<br>Bit 1 = Regeneration Status Regeneration In Progress<br>Bit 2 = Regeneration Status Regeneration Not Completed<br>Bit 3 = Regeneration Status Regeneration Completed<br>Bit 4 = Regeneration Status Regeneration In Progress<br>Bit 5 = Regeneration Status Regeneration Not Completed<br>Bit 6 = Regeneration Status Regeneration Completed<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Not Used<br>Bit 23 = Not Used<br>Bit 24 = Not Used<br>Bit 25 = Not Used<br>Bit 26 = Not Used<br>Bit 27 = Not Used<br>Bit 28 = Not Used<br>Bit 29 = Not Used<br>Bit 30 = Not Used<br>Bit 31 = Not Used |

| Register | Description                                    | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|----------|------------------------------------------------|--------|-------|----------------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45710    | Yanmar Manual Regeneration Inhibit Pulse State | UInt32 | N/A   | N/A            | R   | Bit 0 = No Inhibit Pulse Generation Occurring<br>Bit 1 = Inhibit Pulse Asserted<br>Bit 2 = Inhibit Pulse Complete<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Not Used<br>Bit 12 = Not Used<br>Bit 13 = Not Used<br>Bit 14 = Not Used<br>Bit 15 = Not Used<br>Bit 16 = Not Used<br>Bit 17 = Not Used<br>Bit 18 = Not Used<br>Bit 19 = Not Used<br>Bit 20 = Not Used<br>Bit 21 = Not Used<br>Bit 22 = Not Used<br>Bit 23 = Not Used<br>Bit 24 = Not Used<br>Bit 25 = Not Used<br>Bit 26 = Not Used<br>Bit 27 = Not Used<br>Bit 28 = Not Used<br>Bit 29 = Not Used<br>Bit 30 = Not Used<br>Bit 31 = Not Used |

| Register  | Description                             | Type   | Units | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------|-----------------------------------------|--------|-------|----------------|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45712     | Pre-Alarm Metering 3                    | Int32  | N/A   | N/A            | R   | Bit 0 = Not Used<br>Bit 1 = Not Used<br>Bit 2 = Not Used<br>Bit 3 = Not Used<br>Bit 4 = Not Used<br>Bit 5 = Not Used<br>Bit 6 = Not Used<br>Bit 7 = Not Used<br>Bit 8 = Not Used<br>Bit 9 = Not Used<br>Bit 10 = Not Used<br>Bit 11 = Soot Critically High Pre-alarm<br>Bit 12 = Regeneration Needed Highest Level Pre-alarm<br>Bit 13 = Regeneration Needed Medium Level Pre-alarm<br>Bit 14 = Regeneration Needed Lowest Level Pre-alarm<br>Bit 15 = Global Sender Fail Pre-Alarm<br>Bit 16 = Coolant Level Sender Fail Pre-Alarm<br>Bit 17 = ATS Circuit Error Pre-alarm<br>Bit 18 = mtu Fault Codes Pre-alarm<br>Bit 19 = Heating for Regeneration Pre-Alarm<br>Bit 20 = Low DPF Temp Add Load Pre-alarm<br>Bit 21 = Isuzu DEF Low Refill DEF Alarm<br>Bit 22 = Isuzu DEF Low Refill DEF Pre-alarm<br>Bit 23 = Isuzu Forced Purge Request Pre-alarm<br>Bit 24 = Isuzu Service Tool Forced Purge Pre-alarm<br>Bit 25 = Escape Mode Pre-alarm<br>Bit 26 = Exhaust System Error Pre-alarm<br>Bit 27 = Isuzu SCR Forced Purge Pre-alarm<br>Bit 28 = Isuzu SCR Purge Pre-alarm<br>Bit 29 = EGR Inducement Severe<br>Bit 30 = EGR Inducement Level Low<br>Bit 31 = EGR Inducement Warning |
| 45714–748 | FUTURE USE                              |        |       |                |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 45750     | Device Address                          | Int32  | N/A   | N/A            | RW  | -128 to 127                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 45752     | pc Emergency Stop                       | UInt32 | N/A   | N/A            | RW  | 0 = Stop<br>1 = Start                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 45754     | pc Relay Closed: Runs when in Auto mode | UInt32 | N/A   | N/A            | RW  | 0 = Stop<br>1 = Start                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 45756     | Test Buttons Image                      | UInt32 | N/A   | N/A            | RW  | 0–255                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 45758–60  | RESERVED                                |        |       |                |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 45762     | Embedded Code Version Number            | UInt32 | N/A   | N/A            | R   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 45764     | Boot Code Version Number                | Int32  | N/A   | N/A            | R   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 45766     | Model Number                            | UInt32 | N/A   | N/A            | R   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |



| Register | Description               | Type   | Units | Scaling Factor | R/W | Range |
|----------|---------------------------|--------|-------|----------------|-----|-------|
| 45768    | Embedded Code Part Number | Uint32 | N/A   | N/A            | R   |       |

|       |                          |        |     |     |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
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| 45770 | Conf Prot 1 Param Select | Unit32 | N/A | N/A | RW | 0 = Oil Pressure<br>1 = Coolant Temp<br>2 = Battery Volts<br>3 = RPM<br>4 = Fuel Level<br>5 = Gen VAB<br>6 = Gen VBC<br>7 = Gen VCA<br>8 = Gen VAN<br>9 = Gen VBN<br>10 = Gen VCN<br>11 = Bus Freq<br>12 = Bus Volts<br>13 = Gen Freq<br>14 = Gen PF<br>15 = Gen IA<br>16 = Gen IB<br>17 = Gen IC<br>18 = kW A<br>19 = kW B<br>20 = kW C<br>21 = kW Total<br>22 = kVA A<br>23 = kVA B<br>24 = kVA C<br>25 = kVA Total<br>26 = Analog Input 1<br>27 = Analog Input 2<br>28 = Analog Input 3<br>29 = Analog Input 4<br>30 = Analog Input 5<br>31 = Analog Input 6<br>32 = Analog Input 7<br>33 = Analog Input 8<br>34 = RTD Input 1<br>35 = RTD Input 2<br>36 = RTD Input 3<br>37 = RTD Input 4<br>38 = RTD Input 5<br>39 = RTD Input 6<br>40 = RTD Input 7<br>41 = RTD Input 8<br>42 = Thermocouple 1<br>43 = Thermocouple 2<br>44 = Fuel Delivery Pressure<br>45 = kvar A<br>46 = kvar B<br>47 = kvar C<br>48 = kvar Total<br>49 = Injector Metering Rail Pressure<br>50 = Total Fuel Used<br>51 = Fuel Temperature<br>52 = Engine Oil Temperature<br>53 = Engine Intercooler Temperature<br>54 = Coolant Pressure<br>55 = Fuel Rate<br>56 = Boost Pressure<br>57 = Intake Manifold Temperature<br>58 = Charge Air Temperature<br>59 = Engine Percent Load<br>60 = Bus VAB<br>61 = Bus VBC<br>62 = Bus VCA<br>63 = kW Load Percent<br>64 = Number of Units Online<br>65 = System kW Capacity |
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| Register | Description                                            | Type  | Units   | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
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|          |                                                        |       |         |                |     | 66 = System Total Generated kW<br>67 = System Total Generated kvar<br>68 = Number of Units<br>69 = DEF Tank 1 Level %<br>70 = DEF Tank 2 Level %<br>71 = System Offline kW Capacity<br>72 = System Total Generated kW Percent<br>73 = DPF Outlet Gas Temperature<br>74 = Crankcase Pressure<br>75 = Fuel Filter Differential Pressure<br>76 = Oil Filter Differential Pressure<br>77 = Battery Charger 1 Voltage<br>78 = Battery Charger 1 Current<br>79 = Battery Charger 2 Voltage<br>80 = Battery Charger 2 Current<br>81 = Battery 1 Temperature<br>82 = Battery 2 Temperature<br>83 = DOC Inlet Temperature<br>84 = DOC Outlet Temperature<br>85 = Throttle Valve 1 Differential Pressure<br>86 = Gaseous Fuel Supply Pressure<br>87 = Engine Oil Level |
| 45772    | Configurable Protection 1 Hysteresis                   | Int32 | Percent | Deci           | RW  | 0–1000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45774    | Configurable Protection 1 Arming Delay                 | Int32 | Second  | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45776    | Configurable Protection 1 Threshold 1 Activation Delay | Int32 | Second  | N/A            | RW  | 0–9999                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45778    | Configurable Protection 1 Threshold 2 Activation Delay | Int32 | Second  | N/A            | RW  | 0–9999                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45780    | Configurable Protection 1 Over 1 Threshold             | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45782    | Configurable Protection 1 Over 2 Threshold             | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45784    | Configurable Protection 1 Under 1 Threshold            | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45786    | Configurable Protection 1 Under 2 Threshold            | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45788    | Configurable Protection 1 Over 1 Alarm Type            | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45790    | Configurable Protection 1 Over 2 Alarm Type            | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45792    | Configurable Protection 1 Under 1 Alarm Type           | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45794    | Configurable Protection 1 Under 2 Alarm Type           | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

|       |                                        |        |     |     |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
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| 45796 | Configurable Protection 2 Param Select | Unit32 | N/A | N/A | RW | 0 = Oil Pressure<br>1 = Coolant Temp<br>2 = Battery Volts<br>3 = RPM<br>4 = Fuel Level<br>5 = Gen VAB<br>6 = Gen VBC<br>7 = Gen VCA<br>8 = Gen VAN<br>9 = Gen VBN<br>10 = Gen VCN<br>11 = Bus Freq<br>12 = Bus Volts<br>13 = Gen Freq<br>14 = Gen PF<br>15 = Gen IA<br>16 = Gen IB<br>17 = Gen IC<br>18 = kW A<br>19 = kW B<br>20 = kW C<br>21 = kW Total<br>22 = kVA A<br>23 = kVA B<br>24 = kVA C<br>25 = kVA Total<br>26 = Analog Input 1<br>27 = Analog Input 2<br>28 = Analog Input 3<br>29 = Analog Input 4<br>30 = Analog Input 5<br>31 = Analog Input 6<br>32 = Analog Input 7<br>33 = Analog Input 8<br>34 = RTD Input 1<br>35 = RTD Input 2<br>36 = RTD Input 3<br>37 = RTD Input 4<br>38 = RTD Input 5<br>39 = RTD Input 6<br>40 = RTD Input 7<br>41 = RTD Input 8<br>42 = Thermocouple 1<br>43 = Thermocouple 2<br>44 = Fuel Delivery Pressure<br>45 = kvar A<br>46 = kvar B<br>47 = kvar C<br>48 = kvar Total<br>49 = Injector Metering Rail Pressure<br>50 = Total Fuel Used<br>51 = Fuel Temperature<br>52 = Engine Oil Temperature<br>53 = Engine Intercooler Temperature<br>54 = Coolant Pressure<br>55 = Fuel Rate<br>56 = Boost Pressure<br>57 = Intake Manifold Temperature<br>58 = Charge Air Temperature<br>59 = Engine Percent Load<br>60 = Bus VAB<br>61 = Bus VBC<br>62 = Bus VCA<br>63 = kW Load Percent<br>64 = Number of Units Online<br>65 = System kW Capacity |
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| Register | Description                                            | Type  | Units   | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
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|          |                                                        |       |         |                |     | 66 = System Total Generated kW<br>67 = System Total Generated kvar<br>68 = Number of Units<br>69 = DEF Tank 1 Level %<br>70 = DEF Tank 2 Level %<br>71 = System Offline kW Capacity<br>72 = System Total Generated kW Percent<br>73 = DPF Outlet Gas Temperature<br>74 = Crankcase Pressure<br>75 = Fuel Filter Differential Pressure<br>76 = Oil Filter Differential Pressure<br>77 = Battery Charger 1 Voltage<br>78 = Battery Charger 1 Current<br>79 = Battery Charger 2 Voltage<br>80 = Battery Charger 2 Current<br>81 = Battery 1 Temperature<br>82 = Battery 2 Temperature<br>83 = DOC Inlet Temperature<br>84 = DOC Outlet Temperature<br>85 = Throttle Valve 1 Differential Pressure<br>86 = Gaseous Fuel Supply Pressure<br>87 = Engine Oil Level |
| 45798    | Configurable Protection 2 Hysteresis                   | Int32 | Percent | Deci           | RW  | 0–1000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45800    | Configurable Protection 2 Arming Delay                 | Int32 | Second  | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45802    | Configurable Protection 2 Threshold 1 Activation Delay | Int32 | Second  | N/A            | RW  | 0–9999                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45804    | Configurable Protection 2 Threshold 2 Activation Delay | Int32 | Second  | N/A            | RW  | 0–9999                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45806    | Configurable Protection 2 Over 1 Threshold             | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45808    | Configurable Protection 2 Over 2 Threshold             | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45810    | Configurable Protection 2 Under 1 Threshold            | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45812    | Configurable Protection 2 Under 2 Threshold            | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45814    | Configurable Protection 2 Over 1 Alarm Type            | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45816    | Configurable Protection 2 Over 2 Alarm Type            | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45818    | Configurable Protection 2 Under 1 Alarm Type           | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45820    | Configurable Protection 2 Under 2 Alarm Type           | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

|       |                                        |        |     |     |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
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| 45822 | Configurable Protection 3 Param Select | Uint32 | N/A | N/A | RW | 0 = Oil Pressure<br>1 = Coolant Temp<br>2 = Battery Volts<br>3 = RPM<br>4 = Fuel Level<br>5 = Gen VAB<br>6 = Gen VBC<br>7 = Gen VCA<br>8 = Gen VAN<br>9 = Gen VBN<br>10 = Gen VCN<br>11 = Bus Freq<br>12 = Bus Volts<br>13 = Gen Freq<br>14 = Gen PF<br>15 = Gen IA<br>16 = Gen IB<br>17 = Gen IC<br>18 = kW A<br>19 = kW B<br>20 = kW C<br>21 = kW Total<br>22 = kVA A<br>23 = kVA B<br>24 = kVA C<br>25 = kVA Total<br>26 = Analog Input 1<br>27 = Analog Input 2<br>28 = Analog Input 3<br>29 = Analog Input 4<br>30 = Analog Input 5<br>31 = Analog Input 6<br>32 = Analog Input 7<br>33 = Analog Input 8<br>34 = RTD Input 1<br>35 = RTD Input 2<br>36 = RTD Input 3<br>37 = RTD Input 4<br>38 = RTD Input 5<br>39 = RTD Input 6<br>40 = RTD Input 7<br>41 = RTD Input 8<br>42 = Thermocouple 1<br>43 = Thermocouple 2<br>44 = Fuel Delivery Pressure<br>45 = kvar A<br>46 = kvar B<br>47 = kvar C<br>48 = kvar Total<br>49 = Injector Metering Rail Pressure<br>50 = Total Fuel Used<br>51 = Fuel Temperature<br>52 = Engine Oil Temperature<br>53 = Engine Intercooler Temperature<br>54 = Coolant Pressure<br>55 = Fuel Rate<br>56 = Boost Pressure<br>57 = Intake Manifold Temperature<br>58 = Charge Air Temperature<br>59 = Engine Percent Load<br>60 = Bus VAB<br>61 = Bus VBC<br>62 = Bus VCA<br>63 = kW Load Percent<br>64 = Number of Units Online<br>65 = System kW Capacity |
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| Register | Description                                            | Type  | Units   | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
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|          |                                                        |       |         |                |     | 66 = System Total Generated kW<br>67 = System Total Generated kvar<br>68 = Number of Units<br>69 = DEF Tank 1 Level %<br>70 = DEF Tank 2 Level %<br>71 = System Offline kW Capacity<br>72 = System Total Generated kW Percent<br>73 = DPF Outlet Gas Temperature<br>74 = Crankcase Pressure<br>75 = Fuel Filter Differential Pressure<br>76 = Oil Filter Differential Pressure<br>77 = Battery Charger 1 Voltage<br>78 = Battery Charger 1 Current<br>79 = Battery Charger 2 Voltage<br>80 = Battery Charger 2 Current<br>81 = Battery 1 Temperature<br>82 = Battery 2 Temperature<br>83 = DOC Inlet Temperature<br>84 = DOC Outlet Temperature<br>85 = Throttle Valve 1 Differential Pressure<br>86 = Gaseous Fuel Supply Pressure<br>87 = Engine Oil Level |
| 45824    | Configurable Protection 3 Hysteresis                   | Int32 | Percent | Deci           | RW  | 1–1000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45826    | Configurable Protection 3 Arming Delay                 | Int32 | Second  | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45828    | Configurable Protection 3 Threshold 1 Activation Delay | Int32 | Second  | N/A            | RW  | 0–9999                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45830    | Configurable Protection 3 Threshold 2 Activation Delay | Int32 | Second  | N/A            | RW  | 0–9999                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45832    | Configurable Protection 3 Over 1 Threshold             | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45834    | Configurable Protection 3 Over 2 Threshold             | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45836    | Configurable Protection 3 Under 1 Threshold            | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45838    | Configurable Protection 3 Under 2 Threshold            | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45840    | Configurable Protection 3 Over 1 Alarm Type            | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45842    | Configurable Protection 3 Over 2 Alarm Type            | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45844    | Configurable Protection 3 Under 1 Alarm Type           | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45846    | Configurable Protection 3 Under 2 Alarm Type           | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

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| 45848 | Configurable Protection 4 Param Select | Uint32 | N/A | N/A | RW | 0 = Oil Pressure<br>1 = Coolant Temp<br>2 = Battery Volts<br>3 = RPM<br>4 = Fuel Level<br>5 = Gen VAB<br>6 = Gen VBC<br>7 = Gen VCA<br>8 = Gen VAN<br>9 = Gen VBN<br>10 = Gen VCN<br>11 = Bus Freq<br>12 = Bus Volts<br>13 = Gen Freq<br>14 = Gen PF<br>15 = Gen IA<br>16 = Gen IB<br>17 = Gen IC<br>18 = kW A<br>19 = kW B<br>20 = kW C<br>21 = kW Total<br>22 = kVA A<br>23 = kVA B<br>24 = kVA C<br>25 = kVA Total<br>26 = Analog Input 1<br>27 = Analog Input 2<br>28 = Analog Input 3<br>29 = Analog Input 4<br>30 = Analog Input 5<br>31 = Analog Input 6<br>32 = Analog Input 7<br>33 = Analog Input 8<br>34 = RTD Input 1<br>35 = RTD Input 2<br>36 = RTD Input 3<br>37 = RTD Input 4<br>38 = RTD Input 5<br>39 = RTD Input 6<br>40 = RTD Input 7<br>41 = RTD Input 8<br>42 = Thermocouple 1<br>43 = Thermocouple 2<br>44 = Fuel Delivery Pressure<br>45 = kvar A<br>46 = kvar B<br>47 = kvar C<br>48 = kvar Total<br>49 = Injector Metering Rail Pressure<br>50 = Total Fuel Used<br>51 = Fuel Temperature<br>52 = Engine Oil Temperature<br>53 = Engine Intercooler Temperature<br>54 = Coolant Pressure<br>55 = Fuel Rate<br>56 = Boost Pressure<br>57 = Intake Manifold Temperature<br>58 = Charge Air Temperature<br>59 = Engine Percent Load<br>60 = Bus VAB<br>61 = Bus VBC<br>62 = Bus VCA<br>63 = kW Load Percent<br>64 = Number of Units Online<br>65 = System kW Capacity |
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| Register | Description                                            | Type  | Units   | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------|--------------------------------------------------------|-------|---------|----------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |                                                        |       |         |                |     | 66 = System Total Generated kW<br>67 = System Total Generated kvar<br>68 = Number of Units<br>69 = DEF Tank 1 Level %<br>70 = DEF Tank 2 Level %<br>71 = System Offline kW Capacity<br>72 = System Total Generated kW Percent<br>73 = DPF Outlet Gas Temperature<br>74 = Crankcase Pressure<br>75 = Fuel Filter Differential Pressure<br>76 = Oil Filter Differential Pressure<br>77 = Battery Charger 1 Voltage<br>78 = Battery Charger 1 Current<br>79 = Battery Charger 2 Voltage<br>80 = Battery Charger 2 Current<br>81 = Battery 1 Temperature<br>82 = Battery 2 Temperature<br>83 = DOC Inlet Temperature<br>84 = DOC Outlet Temperature<br>85 = Throttle Valve 1 Differential Pressure<br>86 = Gaseous Fuel Supply Pressure<br>87 = Engine Oil Level |
| 45850    | Configurable Protection 4 Hysteresis                   | Int32 | Percent | Deci           | RW  | 1–1000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45852    | Configurable Protection 4 Arming Delay                 | Int32 | Second  | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45854    | Configurable Protection 4 Threshold 1 Activation Delay | Int32 | Second  | N/A            | RW  | 0–9999                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45856    | Configurable Protection 4 Threshold 2 Activation Delay | Int32 | Second  | N/A            | RW  | 0–9999                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45858    | Configurable Protection 4 Over 1 Threshold             | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45860    | Configurable Protection 4 Over 2 Threshold             | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45862    | Configurable Protection 4 Under 1 Threshold            | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45864    | Configurable Protection 4 Under 2 Threshold            | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45866    | Configurable Protection 4 Over 1 Alarm Type            | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45868    | Configurable Protection 4 Over 2 Alarm Type            | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45870    | Configurable Protection 4 Under 1 Alarm Type           | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45872    | Configurable Protection 4 Under 2 Alarm Type           | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

|       |                                        |        |     |     |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
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| 45874 | Configurable Protection 5 Param Select | Uint32 | N/A | N/A | RW | 0 = Oil Pressure<br>1 = Coolant Temp<br>2 = Battery Volts<br>3 = RPM<br>4 = Fuel Level<br>5 = Gen VAB<br>6 = Gen VBC<br>7 = Gen VCA<br>8 = Gen VAN<br>9 = Gen VBN<br>10 = Gen VCN<br>11 = Bus Freq<br>12 = Bus Volts<br>13 = Gen Freq<br>14 = Gen PF<br>15 = Gen IA<br>16 = Gen IB<br>17 = Gen IC<br>18 = kW A<br>19 = kW B<br>20 = kW C<br>21 = kW Total<br>22 = kVA A<br>23 = kVA B<br>24 = kVA C<br>25 = kVA Total<br>26 = Analog Input 1<br>27 = Analog Input 2<br>28 = Analog Input 3<br>29 = Analog Input 4<br>30 = Analog Input 5<br>31 = Analog Input 6<br>32 = Analog Input 7<br>33 = Analog Input 8<br>34 = RTD Input 1<br>35 = RTD Input 2<br>36 = RTD Input 3<br>37 = RTD Input 4<br>38 = RTD Input 5<br>39 = RTD Input 6<br>40 = RTD Input 7<br>41 = RTD Input 8<br>42 = Thermocouple 1<br>43 = Thermocouple 2<br>44 = Fuel Delivery Pressure<br>45 = kvar A<br>46 = kvar B<br>47 = kvar C<br>48 = kvar Total<br>49 = Injector Metering Rail Pressure<br>50 = Total Fuel Used<br>51 = Fuel Temperature<br>52 = Engine Oil Temperature<br>53 = Engine Intercooler Temperature<br>54 = Coolant Pressure<br>55 = Fuel Rate<br>56 = Boost Pressure<br>57 = Intake Manifold Temperature<br>58 = Charge Air Temperature<br>59 = Engine Percent Load<br>60 = Bus VAB<br>61 = Bus VBC<br>62 = Bus VCA<br>63 = kW Load Percent<br>64 = Number of Units Online<br>65 = System kW Capacity |
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| Register | Description                                            | Type  | Units   | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
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|          |                                                        |       |         |                |     | 66 = System Total Generated kW<br>67 = System Total Generated kvar<br>68 = Number of Units<br>69 = DEF Tank 1 Level %<br>70 = DEF Tank 2 Level %<br>71 = System Offline kW Capacity<br>72 = System Total Generated kW Percent<br>73 = DPF Outlet Gas Temperature<br>74 = Crankcase Pressure<br>75 = Fuel Filter Differential Pressure<br>76 = Oil Filter Differential Pressure<br>77 = Battery Charger 1 Voltage<br>78 = Battery Charger 1 Current<br>79 = Battery Charger 2 Voltage<br>80 = Battery Charger 2 Current<br>81 = Battery 1 Temperature<br>82 = Battery 2 Temperature<br>83 = DOC Inlet Temperature<br>84 = DOC Outlet Temperature<br>85 = Throttle Valve 1 Differential Pressure<br>86 = Gaseous Fuel Supply Pressure<br>87 = Engine Oil Level |
| 45876    | Configurable Protection 5 Hysteresis                   | Int32 | Percent | Deci           | RW  | 1–1000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45878    | Configurable Protection 5 Arming Delay                 | Int32 | Second  | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45880    | Configurable Protection 5 Threshold 1 Activation Delay | Int32 | Second  | N/A            | RW  | 0–9999                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45882    | Configurable Protection 5 Threshold 2 Activation Delay | Int32 | Second  | N/A            | RW  | 0–9999                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45884    | Configurable Protection 5 Over 1 Threshold             | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45886    | Configurable Protection 5 Over 2 Threshold             | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45888    | Configurable Protection 5 Under 1 Threshold            | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45890    | Configurable Protection 5 Under 2 Threshold            | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45892    | Configurable Protection 5 Over 1 Alarm Type            | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45894    | Configurable Protection 5 Over 2 Alarm Type            | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45896    | Configurable Protection 5 Under 1 Alarm Type           | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45898    | Configurable Protection 5 Under 2 Alarm Type           | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

|       |                                        |        |     |     |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
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| 45900 | Configurable Protection 6 Param Select | Uint32 | N/A | N/A | RW | 0 = Oil Pressure<br>1 = Coolant Temp<br>2 = Battery Volts<br>3 = RPM<br>4 = Fuel Level<br>5 = Gen VAB<br>6 = Gen VBC<br>7 = Gen VCA<br>8 = Gen VAN<br>9 = Gen VBN<br>10 = Gen VCN<br>11 = Bus Freq<br>12 = Bus Volts<br>13 = Gen Freq<br>14 = Gen PF<br>15 = Gen IA<br>16 = Gen IB<br>17 = Gen IC<br>18 = kW A<br>19 = kW B<br>20 = kW C<br>21 = kW Total<br>22 = kVA A<br>23 = kVA B<br>24 = kVA C<br>25 = kVA Total<br>26 = Analog Input 1<br>27 = Analog Input 2<br>28 = Analog Input 3<br>29 = Analog Input 4<br>30 = Analog Input 5<br>31 = Analog Input 6<br>32 = Analog Input 7<br>33 = Analog Input 8<br>34 = RTD Input 1<br>35 = RTD Input 2<br>36 = RTD Input 3<br>37 = RTD Input 4<br>38 = RTD Input 5<br>39 = RTD Input 6<br>40 = RTD Input 7<br>41 = RTD Input 8<br>42 = Thermocouple 1<br>43 = Thermocouple 2<br>44 = Fuel Delivery Pressure<br>45 = kvar A<br>46 = kvar B<br>47 = kvar C<br>48 = kvar Total<br>49 = Injector Metering Rail Pressure<br>50 = Total Fuel Used<br>51 = Fuel Temperature<br>52 = Engine Oil Temperature<br>53 = Engine Intercooler Temperature<br>54 = Coolant Pressure<br>55 = Fuel Rate<br>56 = Boost Pressure<br>57 = Intake Manifold Temperature<br>58 = Charge Air Temperature<br>59 = Engine Percent Load<br>60 = Bus VAB<br>61 = Bus VBC<br>62 = Bus VCA<br>63 = kW Load Percent<br>64 = Number of Units Online<br>65 = System kW Capacity |
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| Register | Description                                            | Type  | Units   | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
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|          |                                                        |       |         |                |     | 66 = System Total Generated kW<br>67 = System Total Generated kvar<br>68 = Number of Units<br>69 = DEF Tank 1 Level %<br>70 = DEF Tank 2 Level %<br>71 = System Offline kW Capacity<br>72 = System Total Generated kW Percent<br>73 = DPF Outlet Gas Temperature<br>74 = Crankcase Pressure<br>75 = Fuel Filter Differential Pressure<br>76 = Oil Filter Differential Pressure<br>77 = Battery Charger 1 Voltage<br>78 = Battery Charger 1 Current<br>79 = Battery Charger 2 Voltage<br>80 = Battery Charger 2 Current<br>81 = Battery 1 Temperature<br>82 = Battery 2 Temperature<br>83 = DOC Inlet Temperature<br>84 = DOC Outlet Temperature<br>85 = Throttle Valve 1 Differential Pressure<br>86 = Gaseous Fuel Supply Pressure<br>87 = Engine Oil Level |
| 45902    | Configurable Protection 6 Hysteresis                   | Int32 | Percent | Deci           | RW  | 1–1000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45904    | Configurable Protection 6 Arming Delay                 | Int32 | Second  | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45906    | Configurable Protection 6 Threshold 1 Activation Delay | Int32 | Second  | N/A            | RW  | 0–9999                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45908    | Configurable Protection 6 Threshold 2 Activation Delay | Int32 | Second  | N/A            | RW  | 0–9999                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45910    | Configurable Protection 6 Over 1 Threshold             | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45912    | Configurable Protection 6 Over 2 Threshold             | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45914    | Configurable Protection 6 Under 1 Threshold            | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45916    | Configurable Protection 6 Under 2 Threshold            | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45918    | Configurable Protection 6 Over 1 Alarm Type            | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45920    | Configurable Protection 6 Over 2 Alarm Type            | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45922    | Configurable Protection 6 Under 1 Alarm Type           | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45924    | Configurable Protection 6 Under 2 Alarm Type           | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

|       |                                        |        |     |     |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------|----------------------------------------|--------|-----|-----|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45926 | Configurable Protection 7 Param Select | Uint32 | N/A | N/A | RW | 0 = Oil Pressure<br>1 = Coolant Temp<br>2 = Battery Volts<br>3 = RPM<br>4 = Fuel Level<br>5 = Gen VAB<br>6 = Gen VBC<br>7 = Gen VCA<br>8 = Gen VAN<br>9 = Gen VBN<br>10 = Gen VCN<br>11 = Bus Freq<br>12 = Bus Volts<br>13 = Gen Freq<br>14 = Gen PF<br>15 = Gen IA<br>16 = Gen IB<br>17 = Gen IC<br>18 = kW A<br>19 = kW B<br>20 = kW C<br>21 = kW Total<br>22 = kVA A<br>23 = kVA B<br>24 = kVA C<br>25 = kVA Total<br>26 = Analog Input 1<br>27 = Analog Input 2<br>28 = Analog Input 3<br>29 = Analog Input 4<br>30 = Analog Input 5<br>31 = Analog Input 6<br>32 = Analog Input 7<br>33 = Analog Input 8<br>34 = RTD Input 1<br>35 = RTD Input 2<br>36 = RTD Input 3<br>37 = RTD Input 4<br>38 = RTD Input 5<br>39 = RTD Input 6<br>40 = RTD Input 7<br>41 = RTD Input 8<br>42 = Thermocouple 1<br>43 = Thermocouple 2<br>44 = Fuel Delivery Pressure<br>45 = kvar A<br>46 = kvar B<br>47 = kvar C<br>48 = kvar Total<br>49 = Injector Metering Rail Pressure<br>50 = Total Fuel Used<br>51 = Fuel Temperature<br>52 = Engine Oil Temperature<br>53 = Engine Intercooler Temperature<br>54 = Coolant Pressure<br>55 = Fuel Rate<br>56 = Boost Pressure<br>57 = Intake Manifold Temperature<br>58 = Charge Air Temperature<br>59 = Engine Percent Load<br>60 = Bus VAB<br>61 = Bus VBC<br>62 = Bus VCA<br>63 = kW Load Percent<br>64 = Number of Units Online<br>65 = System kW Capacity |
|-------|----------------------------------------|--------|-----|-----|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

| Register | Description                                            | Type  | Units   | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------|--------------------------------------------------------|-------|---------|----------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |                                                        |       |         |                |     | 66 = System Total Generated kW<br>67 = System Total Generated kvar<br>68 = Number of Units<br>69 = DEF Tank 1 Level %<br>70 = DEF Tank 2 Level %<br>71 = System Offline kW Capacity<br>72 = System Total Generated kW Percent<br>73 = DPF Outlet Gas Temperature<br>74 = Crankcase Pressure<br>75 = Fuel Filter Differential Pressure<br>76 = Oil Filter Differential Pressure<br>77 = Battery Charger 1 Voltage<br>78 = Battery Charger 1 Current<br>79 = Battery Charger 2 Voltage<br>80 = Battery Charger 2 Current<br>81 = Battery 1 Temperature<br>82 = Battery 2 Temperature<br>83 = DOC Inlet Temperature<br>84 = DOC Outlet Temperature<br>85 = Throttle Valve 1 Differential Pressure<br>86 = Gaseous Fuel Supply Pressure<br>87 = Engine Oil Level |
| 45928    | Configurable Protection 7 Hysteresis                   | Int32 | Percent | Deci           | RW  | 1–1000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45930    | Configurable Protection 7 Arming Delay                 | Int32 | Second  | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45932    | Configurable Protection 7 Threshold 1 Activation Delay | Int32 | Second  | N/A            | RW  | 0–9999                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45934    | Configurable Protection 7 Threshold 2 Activation Delay | Int32 | Second  | N/A            | RW  | 0–9999                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45936    | Configurable Protection 7 Over 1 Threshold             | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45938    | Configurable Protection 7 Over 2 Threshold             | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45940    | Configurable Protection 7 Under 1 Threshold            | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45942    | Configurable Protection 7 Under 2 Threshold            | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45944    | Configurable Protection 7 Over 1 Alarm Type            | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45946    | Configurable Protection 7 Over 2 Alarm Type            | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45948    | Configurable Protection 7 Under 1 Alarm Type           | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45950    | Configurable Protection 7 Under 2 Alarm Type           | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

|       |                                        |        |     |     |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------|----------------------------------------|--------|-----|-----|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45952 | Configurable Protection 8 Param Select | Uint32 | N/A | N/A | RW | 0 = Oil Pressure<br>1 = Coolant Temp<br>2 = Battery Volts<br>3 = RPM<br>4 = Fuel Level<br>5 = Gen VAB<br>6 = Gen VBC<br>7 = Gen VCA<br>8 = Gen VAN<br>9 = Gen VBN<br>10 = Gen VCN<br>11 = Bus Freq<br>12 = Bus Volts<br>13 = Gen Freq<br>14 = Gen PF<br>15 = Gen IA<br>16 = Gen IB<br>17 = Gen IC<br>18 = kW A<br>19 = kW B<br>20 = kW C<br>21 = kW Total<br>22 = kVA A<br>23 = kVA B<br>24 = kVA C<br>25 = kVA Total<br>26 = Analog Input 1<br>27 = Analog Input 2<br>28 = Analog Input 3<br>29 = Analog Input 4<br>30 = Analog Input 5<br>31 = Analog Input 6<br>32 = Analog Input 7<br>33 = Analog Input 8<br>34 = RTD Input 1<br>35 = RTD Input 2<br>36 = RTD Input 3<br>37 = RTD Input 4<br>38 = RTD Input 5<br>39 = RTD Input 6<br>40 = RTD Input 7<br>41 = RTD Input 8<br>42 = Thermocouple 1<br>43 = Thermocouple 2<br>44 = Fuel Delivery Pressure<br>45 = kvar A<br>46 = kvar B<br>47 = kvar C<br>48 = kvar Total<br>49 = Injector Metering Rail Pressure<br>50 = Total Fuel Used<br>51 = Fuel Temperature<br>52 = Engine Oil Temperature<br>53 = Engine Intercooler Temperature<br>54 = Coolant Pressure<br>55 = Fuel Rate<br>56 = Boost Pressure<br>57 = Intake Manifold Temperature<br>58 = Charge Air Temperature<br>59 = Engine Percent Load<br>60 = Bus VAB<br>61 = Bus VBC<br>62 = Bus VCA<br>63 = kW Load Percent<br>64 = Number of Units Online<br>65 = System kW Capacity |
|-------|----------------------------------------|--------|-----|-----|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|



| Register | Description                                            | Type  | Units   | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------|--------------------------------------------------------|-------|---------|----------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |                                                        |       |         |                |     | 66 = System Total Generated kW<br>67 = System Total Generated kvar<br>68 = Number of Units<br>69 = DEF Tank 1 Level %<br>70 = DEF Tank 2 Level %<br>71 = System Offline kW Capacity<br>72 = System Total Generated kW Percent<br>73 = DPF Outlet Gas Temperature<br>74 = Crankcase Pressure<br>75 = Fuel Filter Differential Pressure<br>76 = Oil Filter Differential Pressure<br>77 = Battery Charger 1 Voltage<br>78 = Battery Charger 1 Current<br>79 = Battery Charger 2 Voltage<br>80 = Battery Charger 2 Current<br>81 = Battery 1 Temperature<br>82 = Battery 2 Temperature<br>83 = DOC Inlet Temperature<br>84 = DOC Outlet Temperature<br>85 = Throttle Valve 1 Differential Pressure<br>86 = Gaseous Fuel Supply Pressure<br>87 = Engine Oil Level |
| 45954    | Configurable Protection 8 Hysteresis                   | Int32 | Percent | Deci           | RW  | 1–1000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45956    | Configurable Protection 8 Arming Delay                 | Int32 | Second  | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45958    | Configurable Protection 8 Threshold 1 Activation Delay | Int32 | Second  | N/A            | RW  | 0–9999                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45960    | Configurable Protection 8 Threshold 2 Activation Delay | Int32 | Second  | N/A            | RW  | 0–9999                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 45962    | Configurable Protection 8 Over 1 Threshold             | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45964    | Configurable Protection 8 Over 2 Threshold             | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45966    | Configurable Protection 8 Under 1 Threshold            | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45968    | Configurable Protection 8 Under 2 Threshold            | Int32 | N/A     | Centi          | RW  | -99999900 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 45970    | Configurable Protection 8 Over 1 Alarm Type            | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45972    | Configurable Protection 8 Over 2 Alarm Type            | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45974    | Configurable Protection 8 Under 1 Alarm Type           | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 45976    | Configurable Protection 8 Under 2 Alarm Type           | Int32 | N/A     | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

| Register  | Description                          | Type   | Units                                                                                          | Scaling Factor | R/W | Range                                    |
|-----------|--------------------------------------|--------|------------------------------------------------------------------------------------------------|----------------|-----|------------------------------------------|
| 45978–999 | FUTURE USE                           |        |                                                                                                |                |     |                                          |
| 46000     | J1939-Transmission Oil Pressure      | Uint32 | 16 kPa/bit, 0 offset                                                                           | N/A            | R   | 0–4000 kPa (0–580 psi)                   |
| 46002     | J1939-Transmission Oil Temp          | Uint32 | 0.03125 Deg C/bit Offset - 273 Deg C                                                           | N/A            | R   | -273 to +1735.0 °C (-459.4 to 3155.0 °F) |
| 46004     | J1939-Winding 1 Temp                 | Uint32 | 1 Deg C Per Bit Offset -40 Deg C                                                               | N/A            | R   | -40 to +210 °C (-40 to 410 °F)           |
| 46006     | J1939-Winding 2 Temp                 | Uint32 | 1 Deg C Per Bit Offset -40 Deg C                                                               | N/A            | R   | -40 to +210 °C (-40 to 410 °F)           |
| 46008     | J1939-Winding 3 Temp                 | Uint32 | 1 Deg C Per Bit Offset -40 Deg C                                                               | N/A            | R   | -40 to +210 °C (-40 to 410 °F)           |
| 46010     | J1939-ECU Temp                       | Uint32 | 0.03125 Deg C/bit Offset - 273 Deg C                                                           | N/A            | R   | -273 to 1734.96875 °C                    |
| 46012     | J1939-Aux Pressure 1                 | Uint32 | 16 kPa/bit 0 Offset                                                                            | N/A            | R   | 0–4000 kPa                               |
| 46014     | J1939-Aux Pressure 2                 | Uint32 | 16 kPa/bit 0 Offset                                                                            | N/A            | R   | 0–4000 kPa                               |
| 46016     | J1939-Rated Power                    | Uint32 | 0.5 kW/bit 0 Offset                                                                            | N/A            | R   | 0–32,127.5 kW                            |
| 46018     | J1939-Rated RPM                      | Uint32 | 0.125 rpm/bit 0 Offset                                                                         | N/A            | R   | 0–8,031.875 rpm                          |
| 46020     | J1939-Exhaust Temp A                 | Uint32 | 0.03125 °C/bit Offset - 273 °C                                                                 | N/A            | R   | -273 to 1734.96875 °C                    |
| 46022     | J1939-Exhaust Temp B                 | Uint32 | 0.03125 °C/bit Offset - 273 °C                                                                 | N/A            | R   | -273 to 1734.96875 °C                    |
| 46024     | J1939-Charge Air Temp                | Uint32 | 0.03125 °C/bit Offset - 273 °C                                                                 | N/A            | R   | -273 to 1734.96875 °C                    |
| 46026     | J1939-ADEC ECU Error Code            | Uint32 | No Scale or Offset                                                                             | N/A            | R   | 0–65535                                  |
| 46028     | J1939-ADEC Selected Speed Demand     | Uint32 | 0.125 rpm/bit, 0 rpm offset                                                                    | N/A            | R   | 0–8031.875                               |
| 46030     | J1939-ADEC Effective Set Speed       | Uint32 | 0.125 rpm/bit, 0 rpm offset                                                                    | N/A            | R   | 0–8031.875                               |
| 46032     | J1939-ADEC CANBus Speed Demand       | Uint32 | 0.125 rpm/bit, 0 rpm offset                                                                    | N/A            | R   | 0–8031.875                               |
| 46034     | J1939-ADEC Analog Speed Demand       | Uint32 | 0.125 rpm/bit, 0 rpm offset                                                                    | N/A            | R   | 0–8031.875                               |
| 46036     | J1939-ADEC Speed Demand Source       | Uint32 | 0 = ANALOG_CAN, 1 = UP_DN_ECU, 2 = UP_DN_CAN, 3 = ANALOG_ECU, 5 = FREQUENCY, 7 = NO_CAN_DEMAND | N/A            | R   | 0–7                                      |
| 46038     | J1939-ADEC Specified Torque          | Uint32 | 1 Nm/Bit, 0 Offset                                                                             | N/A            | R   | 0–64255 Nm                               |
| 46040     | J1939-ADEC Engine Optimized          | Uint32 | No Scale or Offset                                                                             | N/A            | R   | 0–64255                                  |
| 46042     | J1939-ADEC Current P Degree          | Uint32 | 0.0025%/Bit, 0 offset                                                                          | N/A            | R   | 0–160.7375%                              |
| 46044     | J1939-ADEC Day Tank Fill Percent     | Uint32 | 0.4%/Bit, 0 offset                                                                             | N/A            | R   | 0–100%                                   |
| 46046     | J1939-ADEC Storage Tank Fill Percent | Uint32 | 0.4%/Bit, 0 offset                                                                             | N/A            | R   | 0–4294967295                             |

| Register | Description                              | Type   | Units                       | Scaling Factor | R/W | Range             |
|----------|------------------------------------------|--------|-----------------------------|----------------|-----|-------------------|
| 46048    | J1939-ADEC Injection Quantity            | Uint32 | 0.1 mm2 per bit             | N/A            | R   | 0–429496729.5     |
| 46050    | J1939-ADEC Engine Power Reserve          | Uint32 | 0.001% per bit              | N/A            | R   | 0–4294967.295     |
| 46052    | J1939-ADEC Cylinder Cutout Code          | Uint32 | No Scale or Offset          | N/A            | R   | 0–4294967295      |
| 46054    | J1939-ADEC Start Sequence Bit Field      | Uint32 | Bit Packed Data             | N/A            | R   | 0–4294967295      |
| 46056    | J1939-ADEC P Lube Oil Limit LO           | Uint32 | binary on or off            | N/A            | R   | 0–1               |
| 46058    | J1939-ADEC P Lube Oil Limit LO LO        | Uint32 | binary on or off            | N/A            | R   | 0–1               |
| 46060    | J1939-ADEC P Charge Air Pressure         | Uint32 | 0.01 mbar/bit, 0 offset     | N/A            | R   | 0–42949672.5 mbar |
| 46064    | J1939-ADEC AL Power Amp 2 Fail Bit Fld   | Uint32 | Bit Packed Data             | N/A            | R   | 0–4294967295      |
| 46066    | J1939-ADEC AL Transistor Out Bit FI      | Uint32 | Bit Packed Data             | N/A            | R   | 0–4294967295      |
| 46068    | J1939-ADEC Camshaft RPM                  | Uint32 | 0.1 rpm/bit, 0 offset       | N/A            | R   | 0–429496729.5 rpm |
| 46070    | J1939-ADEC Daily Fuel Consumption        | Uint32 | 0.0001 m3 per bit, 0 offset | N/A            | R   | 0–429496.7295 m3  |
| 46072    | J1939-ADEC Frequency Speed Demand.       | Uint32 | 0.1 rpm/bit, 0 offset       | N/A            | R   | 0–429496729.5 rpm |
| 46074    | J1939-ADEC Average Trip Fuel Consumption | Uint32 | 0.001 L/h/bit, 0 offset     | N/A            | R   | 0–4294967.295 L/h |
| 46076    | J1939-ADEC Injection Quantity DBR Pct    | Uint32 | 0.01% /bit, 0 offset        | N/A            | R   | 0–42949672.95 %   |
| 46078    | J1939-ADEC Actual Droop                  | Uint32 | 0.001%/bit, 0 offset        | N/A            | R   | 0–4294967.295 %   |
| 46080    | J1939-ADEC Nodes On CAN Bus              | Uint32 | No Scale or Offset          | N/A            | R   | 0–4294967295      |
| 46082    | J1939-ADEC Lost Nodes on CAN Bus         | Uint32 | No Scale or Offset          | N/A            | R   | 0–4294967295      |
| 46084    | J1939-ADEC Trip Operating Time           | Uint32 | No Scale or Offset          | N/A            | R   | 0–4294967295 h    |
| 46086    | J1939-ADEC Transistor Out Bit Field      | Uint32 | Bit Packed Data             | N/A            | R   | 0–4294967295      |
| 46088    | J1939-ADEC L1L ECU Power Supply Volts    | Uint32 | 0.001 V/bit                 | N/A            | R   | 0–4294967.295     |
| 46090    | J1939-ADEC L2L ECU Power Supply Volts    | Uint32 | 0.001 V/bit                 | N/A            | R   | 0–4294967.295     |
| 46092    | J939-ADEC U1LECU Power Supply Volts      | Uint32 | 0.001 V/bit                 | N/A            | R   | 0–4294967.295     |
| 46094    | J1939-ADEC U2L ECU Power Supply Volts    | Uint32 | 0.001 V/bit                 | N/A            | R   | 0–4294967295      |
| 46096    | J1939-ADEC Trip Idle Time                | Uint32 | 1 sec per bit, 0 offset     | N/A            | R   | 0–4294967295 sec  |
| 46098    | J1939-ADEC T Coolant Limit Hi            | Uint32 | 0.01 °C/Bit, 0 offset       | N/A            | R   | 0–42949672.95     |
| 46100    | J1939-ADEC T Coolant Limit Hi Hi         | Uint32 | 0.01 °C/Bit, 0 offset       | N/A            | R   | 0–42949672.95     |
| 46102    | J1939-ADEC T Charge Air Limit Hi         | Uint32 | 0.01 °C/Bit, 0 offset       | N/A            | R   | 0–42949672.95     |
| 46104    | J1939-ADEC T Intercooler Limit Hi        | Uint32 | 0.01 °C/Bit, 0 offset       | N/A            | R   | 0–42949672.95     |
| 46106    | J1939-mtu Sps Node                       | Uint32 | No Scale or Offset          | N/A            | R   | 0–255             |
| 46108    | J1939-mtu Sw Type                        | Uint32 | No Scale or Offset          | N/A            | R   | 0–255             |
| 46110    | J1939-mtu Sw Var                         | Uint32 | No Scale or Offset          | N/A            | R   | 0–255             |
| 46112    | J1939-mtu Sw Ed 1                        | Uint32 | No Scale or Offset          | N/A            | R   | 0–255             |

| Register | Description                                | Type   | Units                                                                                                   | Scaling Factor | R/W | Range                                                                                                                                                                |
|----------|--------------------------------------------|--------|---------------------------------------------------------------------------------------------------------|----------------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 46114    | J1939-mtu Sw Ed2                           | Uint32 | No Scale or Offset                                                                                      | N/A            | R   | 0–255                                                                                                                                                                |
| 46116    | J1939-mtu Rev                              | Uint32 | No Scale or Offset                                                                                      | N/A            | R   | 0–255                                                                                                                                                                |
| 46118    | J1939-mtu Sw Mod                           | Uint32 | No Scale or Offset                                                                                      | N/A            | R   | 0–255                                                                                                                                                                |
| 46120    | J1939-ECU Protect Lamp Status Data         | Uint32 | N/A                                                                                                     | N/A            | R   | 0 = Off<br>1 = On<br>2 = Slow Flash<br>3 = Fast Flash                                                                                                                |
| 46122    | J1939-ECU Warning Lamp Status Data         | Uint32 | N/A                                                                                                     | N/A            | R   | 0 = Off<br>1 = On<br>2 = Slow Flash<br>3 = Fast Flash                                                                                                                |
| 46124    | J1939-ECU Red Stop Lamp Status Data        | Uint32 | N/A                                                                                                     | N/A            | R   | 0 = Off<br>1 = On<br>2 = Slow Flash<br>3 = Fast Flash                                                                                                                |
| 46126    | J1939-ECU Malfunction Status Data          | Uint32 | N/A                                                                                                     | N/A            | R   | 0 = Off<br>1 = On<br>2 = Slow Flash<br>3 = Fast Flash                                                                                                                |
| 46128    | J1939 Scania OBD Inducement Failure Reason | Unit32 | N/A                                                                                                     | N/A            | R   | 0 = No Failure<br>1 = Dosing Error<br>2 = Urea Quality<br>3 = Monitor Failure<br>4 = Nox Failure<br>5–6 Not Used<br>7 = Error<br>8–14 Not Used<br>15 = Not Available |
| 46130    | J1939 Daimler DEF Lamp Request             | Uint32 | N/A                                                                                                     | N/A            | R   | 0 = Off<br>1 = On<br>2 = Slow Blinking (1Hz)<br>3 = Fast Blinking (2Hz)<br>4–13 Reserved<br>14 = Error<br>15 = Not Available                                         |
| 46132    | J1939 Daimler Torque Limit Lamp Request    | Uint32 | N/A                                                                                                     | N/A            | R   | 0 = Off<br>1 = On<br>2 = Slow Blinking (1Hz)<br>3 = Fast Blinking (2Hz)<br>4–13 Reserved<br>14 = Error<br>15 = Not Available                                         |
| 46134    | J1939 Auxiliary I/O Channel 1              | Uint32 | Raw ECU Parameter Data                                                                                  | N/A            | R   | 0–65535. This is just a register with 16 bit value that is bit packed data. Usage is manufacturer specific.                                                          |
| 46136    | J1939 Isuzu Urea (DEF) Tank Level 1        | Uint32 | 0.4 %/bit gain, 0% offset                                                                               | N/A            | R   | 0–102%                                                                                                                                                               |
| 46138    | J1939 Isuzu Inducement Level               | Uint32 | N/A                                                                                                     | N/A            | R   | 0 = Normal Operation<br>1 = Warning<br>2 = Early Inducement<br>3 = (Not Defined)<br>4 = Final Inducement                                                             |
| 46140    | J1939 Isuzu Refill DEF Lamp                | Uint32 | N/A                                                                                                     | N/A            | R   | 0 = Lamp Off<br>1 = Lamp On                                                                                                                                          |
| 46142    | J1939 Isuzu DPF Mode                       | Uint32 | DPF Mode indicates the progress of the DPF Purge Process. Consult manufacturer for further information. | N/A            | R   | 0–999                                                                                                                                                                |

| Register | Description                              | Type   | Units                                      | Scaling Factor | R/W | Range                                                                                                                                                                                                         |
|----------|------------------------------------------|--------|--------------------------------------------|----------------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 46144    | J1939 Yanmar DPF Regen Mode Status       | Uint32 | N/A                                        | N/A            | R   | 0 = Normal Operation<br>1 = Assist Regeneration<br>2 = Reset Regeneration<br>3 = Stationary Regeneration<br>4 = Recovery Regeneration<br>5–15 Not Used                                                        |
| 46146    | J1939 Yanmar DPF Regen Request Flag      | Uint32 | N/A                                        | N/A            | R   | 0 = No Stationary Regeneration Request<br>1 = Stationary Regeneration Request by Operator Commanded<br>2 = Stationary Regeneration Request by emergency<br>3 = Recovery Regeneration Request<br>4–15 Not Used |
| 46148    | J1939 Yanmar DPF Regen Progress PCT      | Uint32 | 1 %/bit gain<br>0 offset                   | N/A            | R   | 0–100%                                                                                                                                                                                                        |
| 46150    | J1939 Yanmar DPF Ash Clean Request       | Uint32 | Raw ECU Parameter Data                     | N/A            | R   | 0 = No Request<br>1 = Ash Cleaning Request (Low Priority)<br>2 = Ash Cleaning Request (High Priority)<br>3–15 Not Used                                                                                        |
| 46152    | J1939 DPF Soot Load Percent              | Uint32 | 1 %/bit gain<br>0 offset                   | N/A            | R   | 0–250%                                                                                                                                                                                                        |
| 46154    | J1939 DPF Ash Load Percent               | Uint32 | 1 %/bit gain<br>0 offset                   | N/A            | R   | 0–250%                                                                                                                                                                                                        |
| 46156    | J1939 Crank Case Pressure                | Uint32 | 0.0078125 kPa/bit gain,<br>-250 kPa offset | N/A            | R   | -250 to +251.99 kPa                                                                                                                                                                                           |
| 46158    | J1939 Fuel Filter Diff Pressure          | Uint32 | 2 kPa/bit gain, 0 offset                   | N/A            | R   | 0–500 kPa                                                                                                                                                                                                     |
| 46160    | J1939 Oil Filter Diff Pressure           | Uint32 | 0.5 kPa/bit gain,<br>0 offset              | N/A            | R   | 0–125 kPa                                                                                                                                                                                                     |
| 46162    | J1939 Battery Charger 1 Voltage          | Uint32 | 0.05 Volt/bit<br>0 Volt Offset             | N/A            | R   | 0–3212.75 Vdc                                                                                                                                                                                                 |
| 46164    | J1939 Battery Charger 1 Current          | Uint32 | 0.05Amps/bit<br>1600 Amps Offset           | N/A            | R   | -1600.00 – 1612.75 A                                                                                                                                                                                          |
| 46166    | J1939 Battery Charger 1 State            | Uint32 | N/A                                        | N/A            | R   | 0 = Idle (Output Off)<br>1 = Charging (Boost)<br>2 = Maintenance (Float)<br>3–12 Not Used<br>13 = Battery Failure<br>14 = Charger Failure<br>15 = No Status Available                                         |
| 46168    | J1939 Battery Charger 1 Power Line State | Uint32 | N/A                                        | N/A            | R   | 0 = Fail<br>1 = OK<br>2 = Internal Error<br>3 = No Status Available                                                                                                                                           |
| 46170    | J1939 Battery charger 2 Voltage          | Uint32 | 0.05 Volt/Bit<br>0 Volt Offset             | N/A            | R   | 0–3212.75 Vdc                                                                                                                                                                                                 |
| 46172    | J1939 Battery Charger 2 Current          | Uint32 | 0.05 Amps/Bit<br>1600 Amps Offset          | N/A            | R   | -1600.00 - 1612.75 A                                                                                                                                                                                          |
| 46174    | J1939 Battery Charger 2 State            | Uint32 | N/A                                        | N/A            | R   | 0 = Idle (Output Off)<br>1 = Charging (Boost)<br>2 = Maintenance (Float)<br>3–12 Not Used<br>13 = Battery Failure<br>14 = Charger Failure<br>15 = No Status Available                                         |

| Register | Description                                                | Type   | Units                         | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                            |
|----------|------------------------------------------------------------|--------|-------------------------------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 46176    | J1939 Battery Charger 2 Power Line State                   | Uint32 | N/A                           | N/A            | R   | 0 = Fail<br>1 = OK<br>2 = Internal Error<br>3 = No Status Available                                                                                                                                                                                                                                              |
| 46178    | J1939 Battery 1 Temperature                                | Uint32 | 1°C/bit<br>40°C offset        | N/A            | R   | -40 – 210°C                                                                                                                                                                                                                                                                                                      |
| 46180    | J1939 Battery 2 Temperature                                | Uint32 | 1°C/bit<br>40°C offset        | N/A            | R   | -40 – 210°C                                                                                                                                                                                                                                                                                                      |
| 46182    | J1939 Isuzu DPF Amber Lamp Status                          | Uint32 | N/A                           | N/A            | R   | 0 = OFF (normal operation)<br>1 = On<br>2 = Slow Flash<br>3 = Fast Flash                                                                                                                                                                                                                                         |
| 46184    | J1939 Isuzu DPF Green Lamp Status                          | Uint32 | N/A                           | N/A            | R   | 0 = Off<br>1 = On (In Automatic Purge)                                                                                                                                                                                                                                                                           |
| 46186    | J1939 DOC Inlet Temperature                                | Uint32 | 0.03125°C/bit<br>273°C offset | N/A            | R   | -275 – 1735°C                                                                                                                                                                                                                                                                                                    |
| 46188    | J1939 DOC Outlet Temperature                               | Uint32 | 0.03125°C/bit<br>273°C offset | N/A            | R   | -275 – 1735°C                                                                                                                                                                                                                                                                                                    |
| 46190    | J1939 Calculated Yanmar Regeneration Completion Percentage | Uint32 | 1% / bit                      | N/A            | R   | 0–100%                                                                                                                                                                                                                                                                                                           |
| 46192    | J1939 Yanmar Intake Manifold Pressure                      | Uint32 | 0.1 kPa/bit                   | N/A            | R   | 0–6425.5 kPa                                                                                                                                                                                                                                                                                                     |
| 46194    | J1939 Yanmar Exhaust Manifold Pressure                     | Uint32 | 0.1 kPa/bit                   | N/A            | R   | 0–6425.5 kPa                                                                                                                                                                                                                                                                                                     |
| 46196    | Active Engine Run Time Source Data                         | Uint32 | N/A                           | N/A            | R   | 0 = From ECU<br>1 = From DGC                                                                                                                                                                                                                                                                                     |
| 46198    | Requested Engine RPM                                       | Int32  | N/A                           | N/A            | R   | 0–5000                                                                                                                                                                                                                                                                                                           |
| 46200    | Requested Volvo Accel Pedal Position                       | Float  | Percent                       | N/A            | R   | 0–5000                                                                                                                                                                                                                                                                                                           |
| 46202    | Requested Cummins Speed Bias                               | Float  | Percent                       | N/A            | R   | -250 – 250                                                                                                                                                                                                                                                                                                       |
| 46204    | J1939 Deutz Restriction Level Due to DEF Level             | Int32  | N/A                           | N/A            | R   | 0 = No restriction<br>1 = Level 1 (i.e. Warning < 5% DEF Level, power reduction after a delay time possible)<br>2 = Level 2 torque reduction Step 1 (early inducement)<br>3 = Level 3 torque reduction Step 2 (severe inducement)                                                                                |
| 46206    | J1939 Deutz DEF Tank Level Threshold                       | Int32  | N/A                           | N/A            | R   | 1 = Level > Threshold 1 (15%)<br>2 = Threshold 1 > Level > Threshold 2 (10%)<br>3 = Threshold 2 > Level > Threshold 3 (5%)<br>4 = Threshold 3 > Level                                                                                                                                                            |
| 46208    | J1939 Deutz Restriction Due to DEF Quality                 | Int32  | N/A                           | N/A            | R   | 0 = No restriction<br>1 = Level 1 Warning, power reduction after a delay time possible<br>2 = Level 2 torque reduction Step 1 (early inducement)<br>3 = Level 3 torque reduction Step 2 (severe inducement)                                                                                                      |
| 46210    | J1939 Deutz Inducement Reason                              | Int32  | N/A                           | N/A            | R   | 0 = No inducement active<br>1 = Reagent Level Low<br>2 = Incorrect Quality<br>3 = Incorrect Consumption (not available)<br>4 = Tampering<br>5 = Spare (not available)<br>6 = Error (Hardware Failure) – will display as “SF”<br>7 = Not Available / Not Supported (No SCR system mounted) – will display as “NA” |

| Register  | Description                              | Type   | Units         | Scaling Factor | R/W | Range                                                                 |
|-----------|------------------------------------------|--------|---------------|----------------|-----|-----------------------------------------------------------------------|
| 46212     | ECU Start Request                        | Int32  | N/A           | N/A            | R   | 0 = Off<br>1 = On                                                     |
| 46214     | ECU Stop Request                         | Int32  | N/A           | N/A            | R   | 0 = Off<br>1 = On                                                     |
| 46216     | Engine Start Mode for Metering           | Int32  | N/A           | N/A            | R   | 0 = Normal Engine Start Requested<br>1 = Rapid Engine Start Requested |
| 46218     | Engine Shutdown Mode                     | Int32  | N/A           | N/A            | R   | 0 = Normal Shutdown<br>1 = Rapid Shutdown<br>2 = Emergency Shutdown   |
| 46220–248 | RESERVED                                 |        |               |                |     |                                                                       |
| 46250     | PLC Timer 1 Seconds                      | Int32  | Second        | Deci           | RW  | 0–18000                                                               |
| 46252     | PLC Timer 2 Seconds                      | Int32  | Second        | Deci           | RW  | 0–18000                                                               |
| 46254     | PLC Timer 3 Seconds                      | Int32  | Second        | Deci           | RW  | 0–18000                                                               |
| 46256     | PLC Timer 4 Seconds                      | Int32  | Second        | Deci           | RW  | 0–18000                                                               |
| 46258     | PLC Timer 5 Seconds                      | Int32  | Second        | Deci           | RW  | 0–18000                                                               |
| 46260     | PLC Timer 6 Seconds                      | Int32  | Second        | Deci           | RW  | 0–18000                                                               |
| 46262     | PLC Timer 7 Seconds                      | Int32  | Second        | Deci           | RW  | 0–18000                                                               |
| 46264     | PLC Timer 8 Seconds                      | Int32  | Second        | Deci           | RW  | 0–18000                                                               |
| 46266     | PLC Timer 9 Seconds                      | Int32  | Second        | Deci           | RW  | 0–18000                                                               |
| 46268     | PLC Timer 10 Seconds                     | Int32  | Second        | Deci           | RW  | 0–18000                                                               |
| 46270     | PLC Timer 1 Minutes                      | Uint32 | Minute        | N/A            | RW  | 0–250                                                                 |
| 46272     | PLC Timer 2 Minutes                      | Uint32 | Minute        | N/A            | RW  | 0–250                                                                 |
| 46274     | PLC Timer 3 Minutes                      | Uint32 | Minute        | N/A            | RW  | 0–250                                                                 |
| 46276     | PLC Timer 4 Minutes                      | Uint32 | Minute        | N/A            | RW  | 0–250                                                                 |
| 46278     | PLC Timer 5 Minutes                      | Uint32 | Minute        | N/A            | RW  | 0–250                                                                 |
| 46280     | PLC Timer 6 Minutes                      | Uint32 | Minute        | N/A            | RW  | 0–250                                                                 |
| 46282     | PLC Timer 7 Minutes                      | Uint32 | Minute        | N/A            | RW  | 0–250                                                                 |
| 46284     | PLC Timer 8 Minutes                      | Uint32 | Minute        | N/A            | RW  | 0–250                                                                 |
| 46286     | PLC Timer 9 Minutes                      | Uint32 | Minute        | N/A            | RW  | 0–250                                                                 |
| 46288     | PLC Timer 10 Minutes                     | Uint32 | Minute        | N/A            | RW  | 0–250                                                                 |
| 46290     | PLC Timer 1 Hours                        | Uint32 | Hour          | N/A            | RW  | 0–250                                                                 |
| 46292     | PLC Timer 2 Hours                        | Uint32 | Hour          | N/A            | RW  | 0–250                                                                 |
| 46294     | PLC Timer 3 Hours                        | Uint32 | Hour          | N/A            | RW  | 0–250                                                                 |
| 46296     | PLC Timer 4 Hours                        | Uint32 | Hour          | N/A            | RW  | 0–250                                                                 |
| 46298     | PLC Timer 5 Hours                        | Uint32 | Hour          | N/A            | RW  | 0–250                                                                 |
| 46300     | PLC Timer 6 Hours                        | Uint32 | Hour          | N/A            | RW  | 0–250                                                                 |
| 46302     | PLC Timer 7 Hours                        | Uint32 | Hour          | N/A            | RW  | 0–250                                                                 |
| 46304     | PLC Timer 8 Hours                        | Uint32 | Hour          | N/A            | RW  | 0–250                                                                 |
| 46306     | PLC Timer 9 Hours                        | Uint32 | Hour          | N/A            | RW  | 0–250                                                                 |
| 46308     | PLC Timer 10 Hours                       | Uint32 | Hour          | N/A            | RW  | 0–250                                                                 |
| 46310     | AEM Input 1 Max Voltage                  | Int32  | Deci Volt     | Deci           | RW  | 0–100                                                                 |
| 46312     | AEM Input 1 Max Current                  | Int32  | Milliamp x 10 | Deci           | RW  | 40–200                                                                |
| 46314     | AEM Input 1 Min Voltage                  | Int32  | Deci Volt     | Deci           | RW  | 0–100                                                                 |
| 46316     | AEM Input 1 Min Current                  | Int32  | Milliamp x 10 | Deci           | RW  | 40–200                                                                |
| 46318     | AEM Input 1 Param Max                    | Int32  | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                                |
| 46320     | AEM Input 1 Param Min                    | Int32  | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                                |
| 46322     | AEM Input 1 Hysteresis                   | Int32  | Deci Percent  | Deci           | RW  | 0–1000                                                                |
| 46324     | AEM Input 1 Arming Delay                 | Int32  | Second        | N/A            | RW  | 0–300                                                                 |
| 46326     | AEM Input 1 Threshold 1 Activation Delay | Int32  | Second        | N/A            | RW  | 0–300                                                                 |
| 46328     | AEM Input 1 Threshold 2 Activation Delay | Int32  | Second        | N/A            | RW  | 0–300                                                                 |
| 46330     | AEM Input 1 Over 1 Threshold             | Int32  | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                                |
| 46332     | AEM Input 1 Over 2 Threshold             | Int32  | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                                |
| 46334     | AEM Input 1 Under 1 Threshold            | Int32  | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                                |
| 46336     | AEM Input 1 Under 2 Threshold            | Int32  | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                                |

| Register | Description                              | Type  | Units         | Scaling Factor | R/W | Range                                                     |
|----------|------------------------------------------|-------|---------------|----------------|-----|-----------------------------------------------------------|
| 46338    | AEM Input 1 Over 1 Alarm Type            | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46340    | AEM Input 1 Over 2 Alarm Type            | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46342    | AEM Input 1 Under 1 Alarm Type           | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46344    | AEM Input 1 Under 2 Alarm Type           | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46346    | AEM Input 1 Out of Range Alarm Type      | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46348    | AEM Input 2 Max Voltage                  | Int32 | DeciVolt      | Deci           | RW  | 0–100                                                     |
| 46350    | AEM Input 2 Max Current                  | Int32 | Milliamp x 10 | Deci           | RW  | 40–200                                                    |
| 46352    | AEM Input 2 Min Voltage                  | Int32 | DeciVolt      | Deci           | RW  | 0–100                                                     |
| 46354    | AEM Input 2 Min Current                  | Int32 | Milliamp x 10 | Deci           | RW  | 40–200                                                    |
| 46356    | AEM Input 2 Param Max                    | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 999999900                                   |
| 46358    | AEM Input 2 Param Min                    | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 999999900                                   |
| 46360    | AEM Input 2 Hysteresis                   | Int32 | Deci Percent  | Deci           | RW  | 0–1000                                                    |
| 46362    | AEM Input 2 Arming Delay                 | Int32 | Second        | N/A            | RW  | 0–300                                                     |
| 46364    | AEM Input 2 Threshold 1 Activation Delay | Int32 | Second        | N/A            | RW  | 0–300                                                     |
| 46366    | AEM Input 2 Threshold 2 Activation Delay | Int32 | Second        | N/A            | RW  | 0–300                                                     |
| 46368    | AEM Input 2 Over 1 Threshold             | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 999999900                                   |
| 46370    | AEM Input 2 Over 2 Threshold             | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 999999900                                   |
| 46372    | AEM Input 2 Under 1 Threshold            | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 999999900                                   |
| 46374    | AEM Input 2 Under 2 Threshold            | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 999999900                                   |
| 46376    | AEM Input 2 Over 1 Alarm Type            | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46378    | AEM Input 2 Over 2 Alarm Type            | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46380    | AEM Input 2 Under 1 Alarm Type           | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46382    | AEM Input 2 Under 2 Alarm Type           | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46384    | AEM Input 2 Out of Range Alarm Type      | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46386    | AEM Input 3 Max Voltage                  | Int32 | Deci Volt     | Deci           | RW  | 0–100                                                     |
| 46388    | AEM Input 3 Max Current                  | Int32 | Milliamp x 10 | Deci           | RW  | 40–200                                                    |
| 46390    | AEM Input 3 Min Voltage                  | Int32 | DeciVolt      | Deci           | RW  | 0–100                                                     |
| 46392    | AEM Input 3 Min Current                  | Int32 | Milliamp x 10 | Deci           | RW  | 40–200                                                    |
| 46394    | AEM Input 3 Param Max                    | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 999999900                                   |
| 46396    | AEM Input 3 Param Min                    | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 999999900                                   |
| 46398    | AEM Input 3 Hysteresis                   | Int32 | Deci Percent  | Deci           | RW  | 0–1000                                                    |



| Register | Description                              | Type  | Units         | Scaling Factor | R/W | Range                                                     |
|----------|------------------------------------------|-------|---------------|----------------|-----|-----------------------------------------------------------|
| 46400    | AEM Input 3 Arming Delay                 | Int32 | Second        | N/A            | RW  | 0–300                                                     |
| 46402    | AEM Input 3 Threshold 1 Activation Delay | Int32 | Second        | N/A            | RW  | 0–300                                                     |
| 46404    | AEM Input 3 Threshold 2 Activation Delay | Int32 | Second        | N/A            | RW  | 0–300                                                     |
| 46406    | AEM Input 3 Over 1 Threshold             | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46408    | AEM Input 3 Over 2 Threshold             | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46410    | AEM Input 3 Under 1 Threshold            | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46412    | AEM Input 3 Under 2 Threshold            | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46414    | AEM Input 3 Over 1 Alarm Type            | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46416    | AEM Input 3 Over 2 Alarm Type            | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46418    | AEM Input 3 Under 1 Alarm Type           | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46420    | AEM Input 3 Under 2 Alarm Type           | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46422    | AEM Input 3 Out of Range Alarm Type      | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46424    | AEM Input 4 Max Voltage                  | Int32 | Deci Volt     | Deci           | RW  | 0–100                                                     |
| 46426    | AEM Input 4 Max Current                  | Int32 | Milliamp x 10 | Deci           | RW  | 40–200                                                    |
| 46428    | AEM Input 4 Min Voltage                  | Int32 | Deci Volt     | Deci           | RW  | 0–100                                                     |
| 46430    | AEM Input 4 Min Current                  | Int32 | Milliamp x 10 | Deci           | RW  | 40–200                                                    |
| 46432    | AEM Input 4 Param Max                    | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46434    | AEM Input 4 Param Min                    | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46436    | AEM Input 4 Hysteresis                   | Int32 | Deci Percent  | Deci           | RW  | 0–1000                                                    |
| 46438    | AEM Input 4 Arming Delay                 | Int32 | Second        | N/A            | RW  | 0–300                                                     |
| 46440    | AEM Input 4 Threshold 1 Activation Delay | Int32 | Second        | N/A            | RW  | 0–300                                                     |
| 46442    | AEM Input 4 Threshold 2 Activation Delay | Int32 | Second        | N/A            | RW  | 0–300                                                     |
| 46444    | AEM Input 4 Over 1 Threshold             | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46446    | AEM Input 4 Over 2 Threshold             | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46448    | AEM Input 4 Under 1 Threshold            | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46450    | AEM Input 4 Under 2 Threshold            | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46452    | AEM Input 4 Over 1 Alarm Type            | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46454    | AEM Input 4 Over 2 Alarm Type            | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46456    | AEM Input 4 Under 1 Alarm Type           | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46458    | AEM Input 4 Under 2 Alarm Type           | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |

| Register    | Description                              | Type  | Units         | Scaling Factor | R/W | Range                                                     |
|-------------|------------------------------------------|-------|---------------|----------------|-----|-----------------------------------------------------------|
| 46460       | AEM Input 4 Out of Range Alarm Type      | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46462–46498 | FUTURE USE                               |       |               |                |     |                                                           |
| 46500       | AEM Input 5 Max Voltage                  | Int32 | Deci Volt     | Deci           | RW  | 0–100                                                     |
| 46502       | AEM Input 5 Max Current                  | Int32 | Milliamp x 10 | Deci           | RW  | 40–200                                                    |
| 46504       | AEM Input 5 Min Voltage                  | Int32 | Deci Volt     | Deci           | RW  | 0–100                                                     |
| 46506       | AEM Input 5 Min Current                  | Int32 | Milliamp x 10 | Deci           | RW  | 40–200                                                    |
| 46508       | AEM Input 5 Param Max                    | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46510       | AEM Input 5 Param Min                    | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46512       | AEM Input 5 Hysteresis                   | Int32 | Deci Percent  | Deci           | RW  | 0–1000                                                    |
| 46514       | AEM Input 5 Arming Delay                 | Int32 | Second        | N/A            | RW  | 0–300                                                     |
| 46516       | AEM Input 5 Threshold 1 Activation Delay | Int32 | Second        | N/A            | RW  | 0–300                                                     |
| 46518       | AEM Input 5 Threshold 2 Activation Delay | Int32 | Second        | N/A            | RW  | 0–300                                                     |
| 46520       | AEM Input 5 Over 1 Threshold             | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46522       | AEM Input 5 Over 2 Threshold             | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46524       | AEM Input 5 Under 1 Threshold            | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46526       | AEM Input 5 Under 2 Threshold            | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46528       | AEM Input 5 Over 1 Alarm Type            | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46530       | AEM Input 5 Over 2 Alarm Type            | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46532       | AEM Input 5 Under 1 Alarm Type           | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46534       | AEM Input 5 Under 2 Alarm Type           | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46536       | AEM Input 5 Out of Range Alarm Type      | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46538       | AEM Input 6 Max Voltage                  | Int32 | Deci Volt     | Deci           | RW  | 0–100                                                     |
| 46540       | AEM Input 6 Max Current                  | Int32 | Milliamp x 10 | Deci           | RW  | 40–200                                                    |
| 46542       | AEM Input 6 Min Voltage                  | Int32 | Deci Volt     | Deci           | RW  | 0–100                                                     |
| 46544       | AEM Input 6 Min Current                  | Int32 | Milliamp x 10 | Deci           | RW  | 40–200                                                    |
| 46546       | AEM Input 6 Param Max                    | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46548       | AEM Input 6 Param Min                    | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46550       | AEM Input 6 Hysteresis                   | Int32 | Deci Percent  | Deci           | RW  | 0–1000                                                    |
| 46552       | AEM Input 6 Arming Delay                 | Int32 | Second        | N/A            | RW  | 0–300                                                     |
| 46554       | AEM Input 6 Threshold 1 Activation Delay | Int32 | Second        | N/A            | RW  | 0–300                                                     |
| 46556       | AEM Input 6 Threshold 2 Activation Delay | Int32 | Second        | N/A            | RW  | 0–300                                                     |
| 46558       | AEM Input 6 Over 1 Threshold             | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46560       | AEM Input 6 Over 2 Threshold             | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46562       | AEM Input 6 Under 1 Threshold            | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46564       | AEM Input 6 Under 2 Threshold            | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46566       | AEM Input 6 Over 1 Alarm Type            | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |

| Register | Description                              | Type  | Units         | Scaling Factor | R/W | Range                                                     |
|----------|------------------------------------------|-------|---------------|----------------|-----|-----------------------------------------------------------|
| 46568    | AEM Input 6 Over 2 Alarm Type            | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46570    | AEM Input 6 Under 1 Alarm Type           | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46572    | AEM Input 6 Under 2 Alarm Type           | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46574    | AEM Input 6 Out of Range Alarm Type      | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46576    | AEM Input 7 Max Voltage                  | Int32 | Deci Volt     | Deci           | RW  | 0–100                                                     |
| 46578    | AEM Input 7 Max Current                  | Int32 | Milliamp x 10 | Deci           | RW  | 40–200                                                    |
| 46580    | AEM Input 7 Min Voltage                  | Int32 | Deci Volt     | Deci           | RW  | 0–100                                                     |
| 46582    | AEM Input 7 Min Current                  | Int32 | Milliamp x 10 | Deci           | RW  | 40–200                                                    |
| 46584    | AEM Input 7 Param Max                    | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46586    | AEM Input 7 Param Min                    | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46588    | AEM Input 7 Hysteresis                   | Int32 | Deci Percent  | Deci           | RW  | 0–1000                                                    |
| 46590    | AEM Input 7 Arming Delay                 | Int32 | Second        | N/A            | RW  | 0–300                                                     |
| 46592    | AEM Input 7 Threshold 1 Activation Delay | Int32 | Second        | N/A            | RW  | 0–300                                                     |
| 46594    | AEM Input 7 Threshold 2 Activation Delay | Int32 | Second        | N/A            | RW  | 0–300                                                     |
| 46596    | AEM Input 7 Over 1 Threshold             | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46598    | AEM Input 7 Over 2 Threshold             | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46600    | AEM Input 7 Under 1 Threshold            | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46602    | AEM Input 7 Under 2 Threshold            | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46604    | AEM Input 7 Over 1 Alarm Type            | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46606    | AEM Input 7 Over 2 Alarm Type            | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46608    | AEM Input 7 Under 1 Alarm Type           | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46610    | AEM Input 7 Under 2 Alarm Type           | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46612    | AEM Input 7 Out of Range Alarm Type      | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46614    | AEM Input 8 Max Voltage                  | Int32 | Deci Volt     | Deci           | RW  | 0–100                                                     |
| 46616    | AEM Input 8 Max Current                  | Int32 | Milliamp x 10 | Deci           | RW  | 40–200                                                    |
| 46618    | AEM Input 8 Min Voltage                  | Int32 | Deci Volt     | Deci           | RW  | 0–100                                                     |
| 46620    | AEM Input 8 Min Current                  | Int32 | Milliamp x 10 | Deci           | RW  | 40–200                                                    |
| 46622    | AEM Input 8 Param Max                    | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46624    | AEM Input 8 Param Min                    | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46626    | AEM Input 8 Hysteresis                   | Int32 | Deci Percent  | Deci           | RW  | 0–1000                                                    |
| 46628    | AEM Input 8 Arming Delay                 | Int32 | Second        | N/A            | RW  | 0–300                                                     |
| 46630    | AEM Input 8 Threshold 1 Activation Delay | Int32 | Second        | N/A            | RW  | 0–300                                                     |

| Register | Description                              | Type  | Units         | Scaling Factor | R/W | Range                                                     |
|----------|------------------------------------------|-------|---------------|----------------|-----|-----------------------------------------------------------|
| 46632    | AEM Input 8 Threshold 2 Activation Delay | Int32 | Second        | N/A            | RW  | 0–300                                                     |
| 46634    | AEM Input 8 Over 1 Threshold             | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46636    | AEM Input 8 Over 2 Threshold             | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46638    | AEM Input 8 Under 1 Threshold            | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46640    | AEM Input 8 Under 2 Threshold            | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46642    | AEM Input 8 Over 1 Alarm Type            | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46644    | AEM Input 8 Over 2 Alarm Type            | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46646    | AEM Input 8 Under 1 Alarm Type           | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46648    | AEM Input 8 Under 2 Alarm Type           | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46650    | AEM Input 8 Out of Range Alarm Type      | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only |
| 46652    | AEM Output 1 Max Voltage                 | Int32 | Deci Volt     | Deci           | RW  | 0–100                                                     |
| 46654    | AEM Output 1 Max Current                 | Int32 | Milliamp x 10 | Deci           | RW  | 40–200                                                    |
| 46656    | AEM Output 1 Min Voltage                 | Int32 | Deci Volt     | Deci           | RW  | 0–100                                                     |
| 46658    | AEM Output 1 Min Current                 | Int32 | Milliamp x 10 | Deci           | RW  | 40–200                                                    |
| 46660    | AEM Output 1 Param Max                   | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |
| 46662    | AEM Output 1 Param Min                   | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                    |

|       |                              |        |     |     |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------|------------------------------|--------|-----|-----|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 46664 | AEM Output 1 Param Selection | Uint32 | N/A | N/A | RW | 0 = Oil Pressure<br>1 = Coolant Temp<br>2 = Battery Volts<br>3 = RPM<br>4 = Fuel Level<br>5 = Gen VAB<br>6 = Gen VBC<br>7 = Gen VCA<br>8 = Gen VAN<br>9 = Gen VBN<br>10 = Gen VCN<br>11 = Bus Freq<br>12 = Bus Volts<br>13 = Gen Freq<br>14 = Gen PF<br>15 = Gen IA<br>16 = Gen IB<br>17 = Gen IC<br>18 = kW A<br>19 = kW B<br>20 = kW C<br>21 = kW Total<br>22 = kVA A<br>23 = kVA B<br>24 = kVA C<br>25 = kVA Total<br>26 = Analog Input 1<br>27 = Analog Input 2<br>28 = Analog Input 3<br>29 = Analog Input 4<br>30 = Analog Input 5<br>31 = Analog Input 6<br>32 = Analog Input 7<br>33 = Analog Input 8<br>34 = RTD Input 1<br>35 = RTD Input 2<br>36 = RTD Input 3<br>37 = RTD Input 4<br>38 = RTD Input 5<br>39 = RTD Input 6<br>40 = RTD Input 7<br>41 = RTD Input 8<br>42 = Thermocouple 1<br>43 = Thermocouple 2<br>44 = Fuel Delivery Pressure<br>45 = kvar A<br>46 = kvar B<br>47 = kvar C<br>48 = kvar Total<br>49 = Injector Metering Rail Pressure<br>50 = Total Fuel Used<br>51 = Fuel Temperature<br>52 = Engine Oil Temperature<br>53 = Engine Intercooler Temperature<br>54 = Coolant Pressure<br>55 = Fuel Rate<br>56 = Boost Pressure<br>57 = Intake Manifold Temperature<br>58 = Charge Air Temperature<br>59 = Engine Percent Load<br>60 = Bus VAB<br>61 = Bus VBC<br>62 = Bus VCA<br>63 = kW Load Percent<br>64 = Number of Units Online<br>65 = System kW Capacity |
|-------|------------------------------|--------|-----|-----|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

| Register | Description                          | Type  | Units         | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------|--------------------------------------|-------|---------------|----------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |                                      |       |               |                |     | 66 = System Total Generated kW<br>67 = System Total Generated kvar<br>68 = Number of Units<br>69 = DEF Tank 1 Level %<br>70 = DEF Tank 2 Level %<br>71 = System Offline kW Capacity<br>72 = System Total Generated kW Percent<br>73 = DPF Outlet Gas Temperature<br>74 = Crankcase Pressure<br>75 = Fuel Filter Differential Pressure<br>76 = Oil Filter Differential Pressure<br>77 = Battery Charger 1 Voltage<br>78 = Battery Charger 1 Current<br>79 = Battery Charger 2 Voltage<br>80 = Battery Charger 2 Current<br>81 = Battery 1 Temperature<br>82 = Battery 2 Temperature<br>83 = DOC Inlet Temperature<br>84 = DOC Outlet Temperature<br>85 = Throttle Valve 1 Differential Pressure<br>86 = Gaseous Fuel Supply Pressure<br>87 = Engine Oil Level |
| 46666    | AEM Output 1 Out of Range Alarm Type | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 46668    | AEM Output 1 Out of Range Time Delay | Int32 | Second        | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 46670    | AEM Output 2 Max Voltage             | Int32 | Deci Volt     | Deci           | RW  | 0–100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 46672    | AEM Output 2 Max Current             | Int32 | Milliamp x 10 | Deci           | RW  | 40–200                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 46674    | AEM Output 2 Min Voltage             | Int32 | Deci Volt     | Deci           | RW  | 0–100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 46676    | AEM Output 2 Min Current             | Int32 | Milliamp x 10 | Deci           | RW  | 40–200                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 46678    | AEM Output 2 Param Max               | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 46680    | AEM Output 2 Param Min               | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

|       |                              |        |     |     |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------|------------------------------|--------|-----|-----|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 46682 | AEM Output 2 Param Selection | Uint32 | N/A | N/A | RW | 0 = Oil Pressure<br>1 = Coolant Temp<br>2 = Battery Volts<br>3 = RPM<br>4 = Fuel Level<br>5 = Gen VAB<br>6 = Gen VBC<br>7 = Gen VCA<br>8 = Gen VAN<br>9 = Gen VBN<br>10 = Gen VCN<br>11 = Bus Freq<br>12 = Bus Volts<br>13 = Gen Freq<br>14 = Gen PF<br>15 = Gen IA<br>16 = Gen IB<br>17 = Gen IC<br>18 = kW A<br>19 = kW B<br>20 = kW C<br>21 = kW Total<br>22 = kVA A<br>23 = kVA B<br>24 = kVA C<br>25 = kVA Total<br>26 = Analog Input 1<br>27 = Analog Input 2<br>28 = Analog Input 3<br>29 = Analog Input 4<br>30 = Analog Input 5<br>31 = Analog Input 6<br>32 = Analog Input 7<br>33 = Analog Input 8<br>34 = RTD Input 1<br>35 = RTD Input 2<br>36 = RTD Input 3<br>37 = RTD Input 4<br>38 = RTD Input 5<br>39 = RTD Input 6<br>40 = RTD Input 7<br>41 = RTD Input 8<br>42 = Thermocouple 1<br>43 = Thermocouple 2<br>44 = Fuel Delivery Pressure<br>45 = kvar A<br>46 = kvar B<br>47 = kvar C<br>48 = kvar Total<br>49 = Injector Metering Rail Pressure<br>50 = Total Fuel Used<br>51 = Fuel Temperature<br>52 = Engine Oil Temperature<br>53 = Engine Intercooler Temperature<br>54 = Coolant Pressure<br>55 = Fuel Rate<br>56 = Boost Pressure<br>57 = Intake Manifold Temperature<br>58 = Charge Air Temperature<br>59 = Engine Percent Load<br>60 = Bus VAB<br>61 = Bus VBC<br>62 = Bus VCA<br>63 = kW Load Percent<br>64 = Number of Units Online<br>65 = System kW Capacity |
|-------|------------------------------|--------|-----|-----|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

| Register | Description                          | Type  | Units         | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------|--------------------------------------|-------|---------------|----------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |                                      |       |               |                |     | 66 = System Total Generated kW<br>67 = System Total Generated kvar<br>68 = Number of Units<br>69 = DEF Tank 1 Level %<br>70 = DEF Tank 2 Level %<br>71 = System Offline kW Capacity<br>72 = System Total Generated kW Percent<br>73 = DPF Outlet Gas Temperature<br>74 = Crankcase Pressure<br>75 = Fuel Filter Differential Pressure<br>76 = Oil Filter Differential Pressure<br>77 = Battery Charger 1 Voltage<br>78 = Battery Charger 1 Current<br>79 = Battery Charger 2 Voltage<br>80 = Battery Charger 2 Current<br>81 = Battery 1 Temperature<br>82 = Battery 2 Temperature<br>83 = DOC Inlet Temperature<br>84 = DOC Outlet Temperature<br>85 = Throttle Valve 1 Differential Pressure<br>86 = Gaseous Fuel Supply Pressure<br>87 = Engine Oil Level |
| 46684    | AEM Output 2 Out of Range Alarm Type | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 46686    | AEM Output 2 Out of Range Time Delay | Int32 | Second        | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 46688    | AEM Output 3 Max Voltage             | Int32 | Deci Volt     | Deci           | RW  | 0–100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 46690    | AEM Output 3 Max Current             | Int32 | Milliamp x 10 | Deci           | RW  | 40–200                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 46692    | AEM Output 3 Min Voltage             | Int32 | Deci Volt     | Deci           | RW  | 0–100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 46694    | AEM Output 3 Min Current             | Int32 | Milliamp x 10 | Deci           | RW  | 40–200                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 46696    | AEM Output 3 Param Max               | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 46698    | AEM Output 3 Param Min               | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |



|       |                              |        |     |     |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------|------------------------------|--------|-----|-----|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 46700 | AEM Output 3 Param Selection | Uint32 | N/A | N/A | RW | 0 = Oil Pressure<br>1 = Coolant Temp<br>2 = Battery Volts<br>3 = RPM<br>4 = Fuel Level<br>5 = Gen VAB<br>6 = Gen VBC<br>7 = Gen VCA<br>8 = Gen VAN<br>9 = Gen VBN<br>10 = Gen VCN<br>11 = Bus Freq<br>12 = Bus Volts<br>13 = Gen Freq<br>14 = Gen PF<br>15 = Gen IA<br>16 = Gen IB<br>17 = Gen IC<br>18 = kW A<br>19 = kW B<br>20 = kW C<br>21 = kW Total<br>22 = kVA A<br>23 = kVA B<br>24 = kVA C<br>25 = kVA Total<br>26 = Analog Input 1<br>27 = Analog Input 2<br>28 = Analog Input 3<br>29 = Analog Input 4<br>30 = Analog Input 5<br>31 = Analog Input 6<br>32 = Analog Input 7<br>33 = Analog Input 8<br>34 = RTD Input 1<br>35 = RTD Input 2<br>36 = RTD Input 3<br>37 = RTD Input 4<br>38 = RTD Input 5<br>39 = RTD Input 6<br>40 = RTD Input 7<br>41 = RTD Input 8<br>42 = Thermocouple 1<br>43 = Thermocouple 2<br>44 = Fuel Delivery Pressure<br>45 = kvar A<br>46 = kvar B<br>47 = kvar C<br>48 = kvar Total<br>49 = Injector Metering Rail Pressure<br>50 = Total Fuel Used<br>51 = Fuel Temperature<br>52 = Engine Oil Temperature<br>53 = Engine Intercooler Temperature<br>54 = Coolant Pressure<br>55 = Fuel Rate<br>56 = Boost Pressure<br>57 = Intake Manifold Temperature<br>58 = Charge Air Temperature<br>59 = Engine Percent Load<br>60 = Bus VAB<br>61 = Bus VBC<br>62 = Bus VCA<br>63 = kW Load Percent<br>64 = Number of Units Online<br>65 = System kW Capacity |
|-------|------------------------------|--------|-----|-----|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

| Register | Description                          | Type  | Units         | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------|--------------------------------------|-------|---------------|----------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |                                      |       |               |                |     | 66 = System Total Generated kW<br>67 = System Total Generated kvar<br>68 = Number of Units<br>69 = DEF Tank 1 Level %<br>70 = DEF Tank 2 Level %<br>71 = System Offline kW Capacity<br>72 = System Total Generated kW Percent<br>73 = DPF Outlet Gas Temperature<br>74 = Crankcase Pressure<br>75 = Fuel Filter Differential Pressure<br>76 = Oil Filter Differential Pressure<br>77 = Battery Charger 1 Voltage<br>78 = Battery Charger 1 Current<br>79 = Battery Charger 2 Voltage<br>80 = Battery Charger 2 Current<br>81 = Battery 1 Temperature<br>82 = Battery 2 Temperature<br>83 = DOC Inlet Temperature<br>84 = DOC Outlet Temperature<br>85 = Throttle Valve 1 Differential Pressure<br>86 = Gaseous Fuel Supply Pressure<br>87 = Engine Oil Level |
| 46702    | AEM Output 3 Out of Range Alarm Type | Int32 | N/A           | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 46704    | AEM Output 3 Out of Range Time Delay | Int32 | Second        | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 46706    | AEM Output 4 Max Voltage             | Int32 | Deci Volt     | Deci           | RW  | 0–100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 46708    | AEM Output 4 Max Current             | Int32 | Milliamp x 10 | Deci           | RW  | 40–200                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 46710    | AEM Output 4 Min Voltage             | Int32 | Deci Volt     | Deci           | RW  | 0–100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 46712    | AEM Output 4 Min Current             | Int32 | Milliamp x 10 | Deci           | RW  | 40–200                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 46714    | AEM Output 4 Param Max               | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 46716    | AEM Output 4 Param Min               | Int32 | Centi Unit    | Centi          | RW  | -100000000 to 99999900                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

|       |                              |        |     |     |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------|------------------------------|--------|-----|-----|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 46718 | AEM Output 4 Param Selection | Uint32 | N/A | N/A | RW | 0 = Oil Pressure<br>1 = Coolant Temp<br>2 = Battery Volts<br>3 = RPM<br>4 = Fuel Level<br>5 = Gen VAB<br>6 = Gen VBC<br>7 = Gen VCA<br>8 = Gen VAN<br>9 = Gen VBN<br>10 = Gen VCN<br>11 = Bus Freq<br>12 = Bus Volts<br>13 = Gen Freq<br>14 = Gen PF<br>15 = Gen IA<br>16 = Gen IB<br>17 = Gen IC<br>18 = kW A<br>19 = kW B<br>20 = kW C<br>21 = kW Total<br>22 = kVA A<br>23 = kVA B<br>24 = kVA C<br>25 = kVA Total<br>26 = Analog Input 1<br>27 = Analog Input 2<br>28 = Analog Input 3<br>29 = Analog Input 4<br>30 = Analog Input 5<br>31 = Analog Input 6<br>32 = Analog Input 7<br>33 = Analog Input 8<br>34 = RTD Input 1<br>35 = RTD Input 2<br>36 = RTD Input 3<br>37 = RTD Input 4<br>38 = RTD Input 5<br>39 = RTD Input 6<br>40 = RTD Input 7<br>41 = RTD Input 8<br>42 = Thermocouple 1<br>43 = Thermocouple 2<br>44 = Fuel Delivery Pressure<br>45 = kvar A<br>46 = kvar B<br>47 = kvar C<br>48 = kvar Total<br>49 = Injector Metering Rail Pressure<br>50 = Total Fuel Used<br>51 = Fuel Temperature<br>52 = Engine Oil Temperature<br>53 = Engine Intercooler Temperature<br>54 = Coolant Pressure<br>55 = Fuel Rate<br>56 = Boost Pressure<br>57 = Intake Manifold Temperature<br>58 = Charge Air Temperature<br>59 = Engine Percent Load<br>60 = Bus VAB<br>61 = Bus VBC<br>62 = Bus VCA<br>63 = kW Load Percent<br>64 = Number of Units Online<br>65 = System kW Capacity |
|-------|------------------------------|--------|-----|-----|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

| Register    | Description                             | Type  | Units  | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-------------|-----------------------------------------|-------|--------|----------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|             |                                         |       |        |                |     | 66 = System Total Generated kW<br>67 = System Total Generated kvar<br>68 = Number of Units<br>69 = DEF Tank 1 Level %<br>70 = DEF Tank 2 Level %<br>71 = System Offline kW Capacity<br>72 = System Total Generated kW Percent<br>73 = DPF Outlet Gas Temperature<br>74 = Crankcase Pressure<br>75 = Fuel Filter Differential Pressure<br>76 = Oil Filter Differential Pressure<br>77 = Battery Charger 1 Voltage<br>78 = Battery Charger 1 Current<br>79 = Battery Charger 2 Voltage<br>80 = Battery Charger 2 Current<br>81 = Battery 1 Temperature<br>82 = Battery 2 Temperature<br>83 = DOC Inlet Temperature<br>84 = DOC Outlet Temperature<br>85 = Throttle Valve 1 Differential Pressure<br>86 = Gaseous Fuel Supply Pressure<br>87 = Engine Oil Level |
| 46720       | AEM Output 4 Out of Range Alarm Type    | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm<br>3 = Status Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 46722       | AEM Output 4 Out of Range Time Delay    | Int32 | Second | N/A            | RW  | 0-300                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 46724-46748 | FUTURE USE                              |       |        |                |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 46750       | User Config Input 1 Config Type         | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 46752       | User Config Input 1 Time Delay          | Int32 | Second | N/A            | RW  | 0-300                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 46754       | User Config Input 1 Engine Running Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 46756       | User Config Input 2 Config Type         | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 46758       | User Config Input 2 Time Delay          | Int32 | Second | N/A            | RW  | 0-300                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 46760       | User Config Input 2 Engine Running Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 46762       | User Config Input 3 Config Type         | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 46764       | User Config Input 3 Time Delay          | Int32 | Second | N/A            | RW  | 0-300                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 46766       | User Config Input 3 Engine Running Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 46768       | User Config Input 4 Config Type         | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

| Register | Description                              | Type  | Units  | Scaling Factor | R/W | Range                                       |
|----------|------------------------------------------|-------|--------|----------------|-----|---------------------------------------------|
| 46770    | User Config Input 4 Time Delay           | Int32 | Second | N/A            | RW  | 0–300                                       |
| 46772    | User Config Input 4 Engine Running Only  | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only |
| 46774    | User Config Input 5 Config Type          | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm      |
| 46776    | User Config Input 5 Time Delay           | Int32 | Second | N/A            | RW  | 0–300                                       |
| 46778    | User Config Input 5 Engine Running Only  | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only |
| 46780    | User Config Input 6 Config Type          | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm      |
| 46782    | User Config Input 6 Time Delay           | Int32 | Second | N/A            | RW  | 0–300                                       |
| 46784    | User Config Input 6 Engine Running Only  | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only |
| 46786    | User Config Input 7 Config Type          | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm      |
| 46788    | User Config Input 7 Time Delay           | Int32 | Second | N/A            | RW  | 0–300                                       |
| 46790    | User Config Input 7 Engine Running Only  | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only |
| 46792    | User Config Input 8 Config Type          | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm      |
| 46794    | User Config Input 8 Time Delay           | Int32 | Second | N/A            | RW  | 0–300                                       |
| 46796    | User Config Input 8 Engine Running Only  | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only |
| 46798    | User Config Input 9 Config Type          | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm      |
| 46800    | User Config Input 9 Time Delay           | Int32 | Second | N/A            | RW  | 0–300                                       |
| 46802    | User Config Input 9 Engine Running Only  | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only |
| 46804    | User Config Input 10 Config Type         | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm      |
| 46806    | User Config Input 10 Time Delay          | Int32 | Second | N/A            | RW  | 0–300                                       |
| 46808    | User Config Input 10 Engine Running Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only |
| 46810    | User Config Input 11 Config Type         | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm      |
| 46812    | User Config Input 11 Time Delay          | Int32 | Second | N/A            | RW  | 0–300                                       |
| 46814    | User Config Input 11 Engine Running Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only |
| 46816    | User Config Input 12 Config Type         | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm      |
| 46818    | User Config Input 12 Time Delay          | Int32 | Second | N/A            | RW  | 0–300                                       |
| 46820    | User Config Input 12 Engine Running Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only |
| 46822    | User Config Input 13 Config Type         | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm      |
| 46824    | User Config Input 13 Time Delay          | Int32 | Second | N/A            | RW  | 0–300                                       |

| Register | Description                              | Type  | Units  | Scaling Factor | R/W | Range                                       |
|----------|------------------------------------------|-------|--------|----------------|-----|---------------------------------------------|
| 46826    | User Config Input 13 Engine Running Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only |
| 46828    | User Config Input 14 Config Type         | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm      |
| 46830    | User Config Input 14 Time Delay          | Int32 | Second | N/A            | RW  | 0–300                                       |
| 46832    | User Config Input 14 Engine Running Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only |
| 46834    | User Config Input 15 Config Type         | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm      |
| 46836    | User Config Input 15 Time Delay          | Int32 | Second | N/A            | RW  | 0–300                                       |
| 46838    | User Config Input 15 Engine Running Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only |
| 46840    | User Config Input 16 Config Type         | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm      |
| 46842    | User Config Input 16 Time Delay          | Int32 | Second | N/A            | RW  | 0–300                                       |
| 46844    | User Config Input 16 Engine Running Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only |
| 46846    | User Config Input 17 Config Type         | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm      |
| 46848    | User Config Input 17 Time Delay          | Int32 | Second | N/A            | RW  | 0–300                                       |
| 46850    | User Config Input 17 Engine Running Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only |
| 46852    | User Config Input 18 Config Type         | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm      |
| 46854    | User Config Input 18 Time Delay          | Int32 | Second | N/A            | RW  | 0–300                                       |
| 46856    | User Config Input 18 Engine Running Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only |
| 46858    | User Config Input 19 Config Type         | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm      |
| 46860    | User Config Input 19 Time Delay          | Int32 | Second | N/A            | RW  | 0–300                                       |
| 46862    | User Config Input 19 Engine Running Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only |
| 46864    | User Config Input 20 Config Type         | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm      |
| 46866    | User Config Input 20 Time Delay          | Int32 | Second | N/A            | RW  | 0–300                                       |
| 46868    | User Config Input 20 Engine Running Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only |
| 46870    | User Config Input 21 Config Type         | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm      |
| 46872    | User Config Input 21 Time Delay          | Int32 | Second | N/A            | RW  | 0–300                                       |
| 46874    | User Config Input 21 Engine Running Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only |
| 46876    | User Config Input 22 Config Type         | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm      |
| 46878    | User Config Input 22 Time Delay          | Int32 | Second | N/A            | RW  | 0–300                                       |

| Register | Description                              | Type  | Units  | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                  |
|----------|------------------------------------------|-------|--------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 46880    | User Config Input 22 Engine Running Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only                                                                                                                                                                                                                            |
| 46882    | User Config Input 23 Config Type         | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm                                                                                                                                                                                                                                 |
| 46884    | User Config Input 23 Time Delay          | Int32 | Second | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                  |
| 46886    | User Config Input 23 Engine Running Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only                                                                                                                                                                                                                            |
| 46888    | User Config Input 24 Config Type         | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm                                                                                                                                                                                                                                 |
| 46890    | User Config Input 24 Time Delay          | Int32 | Second | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                  |
| 46892    | User Config Input 24 Engine Running Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only                                                                                                                                                                                                                            |
| 46894    | User Config Input 25 Config Type         | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm                                                                                                                                                                                                                                 |
| 46896    | User Config Input 25 Time Delay          | Int32 | Second | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                  |
| 46898    | User Config Input 25 Engine Running Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only                                                                                                                                                                                                                            |
| 46900    | User Config Input 26 Config Type         | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm                                                                                                                                                                                                                                 |
| 46902    | User Config Input 26 Time Delay          | Int32 | Second | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                  |
| 46904    | User Config Input 26 Engine Running Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only                                                                                                                                                                                                                            |
| 46906    | ATS Contact Input                        | Int32 | N/A    | N/A            | RW  | -1 = None<br>0 = Input 1<br>1 = Input 2<br>2 = Input 3<br>3 = Input 4<br>4 = Input 5<br>5 = Input 6<br>6 = Input 7<br>7 = Input 8<br>8 = Input 9<br>9 = Input 10<br>10 = Input 11<br>11 = Input 12<br>12 = Input 13<br>13 = Input 14<br>14 = Input 15<br>15 = Input 16 |
| 46908    | ATS Time Delay                           | Int32 | Second | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                  |
| 46910    | ATS Engine Running Only                  | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only                                                                                                                                                                                                                            |

| Register | Description                           | Type  | Units  | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                  |
|----------|---------------------------------------|-------|--------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 46912    | Battle Override Contact Input         | Int32 | N/A    | N/A            | RW  | -1 = None<br>0 = Input 1<br>1 = Input 2<br>2 = Input 3<br>3 = Input 4<br>4 = Input 5<br>5 = Input 6<br>6 = Input 7<br>7 = Input 8<br>8 = Input 9<br>9 = Input 10<br>10 = Input 11<br>11 = Input 12<br>12 = Input 13<br>13 = Input 14<br>14 = Input 15<br>15 = Input 16 |
| 46914    | Battle Override Time Delay            | Int32 | Second | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                  |
| 46916    | Battle Override Engine Running Only   | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only                                                                                                                                                                                                                            |
| 46918    | Low Coolant Level Contact Input       | Int32 | N/A    | N/A            | RW  | -1 = None<br>0 = Input 1<br>1 = Input 2<br>2 = Input 3<br>3 = Input 4<br>4 = Input 5<br>5 = Input 6<br>6 = Input 7<br>7 = Input 8<br>8 = Input 9<br>9 = Input 10<br>10 = Input 11<br>11 = Input 12<br>12 = Input 13<br>13 = Input 14<br>14 = Input 15<br>15 = Input 16 |
| 46920    | Low Coolant Level Config Type         | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm                                                                                                                                                                                                                                 |
| 46922    | Low Coolant Level Time Delay          | Int32 | Second | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                  |
| 46924    | Low Coolant Level Engine Running Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only                                                                                                                                                                                                                            |
| 46926    | Battery Charge Failed Contact Input   | Int32 | N/A    | N/A            | RW  | -1 = None<br>0 = Input 1<br>1 = Input 2<br>2 = Input 3<br>3 = Input 4<br>4 = Input 5<br>5 = Input 6<br>6 = Input 7<br>7 = Input 8<br>8 = Input 9<br>9 = Input 10<br>10 = Input 11<br>11 = Input 12<br>12 = Input 13<br>13 = Input 14<br>14 = Input 15<br>15 = Input 16 |
| 46928    | Battery Charge Failed Config Type     | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm                                                                                                                                                                                                                                 |
| 46930    | Battery Charge Failed Time Delay      | Int32 | Second | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                  |



| Register | Description                                          | Type  | Units  | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                  |
|----------|------------------------------------------------------|-------|--------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 46932    | Battery Charge Failed Engine Running Only            | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only                                                                                                                                                                                                                            |
| 46934    | Fuel Leak Detect Contact Input                       | Int32 | N/A    | N/A            | RW  | -1 = None<br>0 = Input 1<br>1 = Input 2<br>2 = Input 3<br>3 = Input 4<br>4 = Input 5<br>5 = Input 6<br>6 = Input 7<br>7 = Input 8<br>8 = Input 9<br>9 = Input 10<br>10 = Input 11<br>11 = Input 12<br>12 = Input 13<br>13 = Input 14<br>14 = Input 15<br>15 = Input 16 |
| 46936    | Fuel Leak Detect Config Type                         | Int32 | N/A    | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-Alarm                                                                                                                                                                                                                                 |
| 46938    | Fuel Leak Detect Time Delay                          | Int32 | Second | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                  |
| 46940    | Fuel Leak Detect Engine Running Only                 | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only                                                                                                                                                                                                                            |
| 46942    | Single Phase Connection Override Contact Input       | Int32 | N/A    | N/A            | RW  | -1 = None<br>0 = Input 1<br>1 = Input 2<br>2 = Input 3<br>3 = Input 4<br>4 = Input 5<br>5 = Input 6<br>6 = Input 7<br>7 = Input 8<br>8 = Input 9<br>9 = Input 10<br>10 = Input 11<br>11 = Input 12<br>12 = Input 13<br>13 = Input 14<br>14 = Input 15<br>15 = Input 16 |
| 46944    | Single Phase Connection Override Time Delay          | Int32 | Second | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                  |
| 46946    | Single Phase Connection Override Engine Running Only | Int32 | N/A    | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only                                                                                                                                                                                                                            |
| 46948    | Single Phase AC Sense Override Contact Input         | Int32 | N/A    | N/A            | RW  | -1 = None<br>0 = Input 1<br>1 = Input 2<br>2 = Input 3<br>3 = Input 4<br>4 = Input 5<br>5 = Input 6<br>6 = Input 7<br>7 = Input 8<br>8 = Input 9<br>9 = Input 10<br>10 = Input 11<br>11 = Input 12<br>12 = Input 13<br>13 = Input 14<br>14 = Input 15<br>15 = Input 16 |

| Register | Description                                        | Type  | Units        | Scaling Factor | R/W | Range                                                                                                                                                                                                                                                                  |
|----------|----------------------------------------------------|-------|--------------|----------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 46950    | Single Phase AC Sense Override Time Delay          | Int32 | Second       | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                  |
| 46952    | Single Phase AC Sense Override Engine Running Only | Int32 | N/A          | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only                                                                                                                                                                                                                            |
| 46954    | Hi/Lo Line Contact Input                           | Int32 | N/A          | N/A            | RW  | -1 = None<br>0 = Input 1<br>1 = Input 2<br>2 = Input 3<br>3 = Input 4<br>4 = Input 5<br>5 = Input 6<br>6 = Input 7<br>7 = Input 8<br>8 = Input 9<br>9 = Input 10<br>10 = Input 11<br>11 = Input 12<br>12 = Input 13<br>13 = Input 14<br>14 = Input 15<br>15 = Input 16 |
| 46956    | Hi/Lo Line Time Delay                              | Int32 | Second       | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                  |
| 46958    | Hi/Lo Line Engine Running Only                     | Int32 | N/A          | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only                                                                                                                                                                                                                            |
| 46960    | Grounded Delta Override Contact Input              | Int32 | N/A          | N/A            | RW  | -1 = None<br>0 = Input 1<br>1 = Input 2<br>2 = Input 3<br>3 = Input 4<br>4 = Input 5<br>5 = Input 6<br>6 = Input 7<br>7 = Input 8<br>8 = Input 9<br>9 = Input 10<br>10 = Input 11<br>11 = Input 12<br>12 = Input 13<br>13 = Input 14<br>14 = Input 15<br>15 = Input 16 |
| 46962    | Grounded Delta Override Time Delay                 | Int32 | Second       | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                  |
| 46964    | Grounded Delta Override Engine Running Only        | Int32 | N/A          | N/A            | RW  | 0 = Always<br>1 = While Engine Running Only                                                                                                                                                                                                                            |
| 47000    | AEM RTD1 Hysteresis                                | Int32 | Deci Percent | Deci           | RW  | 0–1000                                                                                                                                                                                                                                                                 |
| 47002    | AEM RTD1 Arming Delay                              | Int32 | Second       | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                  |
| 47004    | AEM RTD1 Threshold1 Activation Delay               | Int32 | Second       | N/A            | RW  | 0–300                                                                                                                                                                                                                                                                  |
| 47006    | AEM RTD1 Threshold2 Activation Delay               | Int32 | Second       | N/A            | RW  | 0–2                                                                                                                                                                                                                                                                    |
| 47008    | AEM RTD1 Over1 Threshold                           | Int32 | Deg F        | N/A            | RW  | -58 to 482                                                                                                                                                                                                                                                             |
| 47010    | AEM RTD1 Over2 Threshold                           | Int32 | Deg F        | N/A            | RW  | -58 to 482                                                                                                                                                                                                                                                             |
| 47012    | AEM RTD1 Under1 Threshold                          | Int32 | Deg F        | N/A            | RW  | -58 to 482                                                                                                                                                                                                                                                             |
| 47014    | AEM RTD1 Under2 Threshold                          | Int32 | Deg F        | N/A            | RW  | -58 to 482                                                                                                                                                                                                                                                             |
| 47016    | AEM RTD1 Over1 Alarm Type                          | Int32 | N/A          | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only                                                                                                                                                                                                              |
| 47018    | AEM RTD1 Over2 Alarm Type                          | Int32 | N/A          | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only                                                                                                                                                                                                              |

| Register | Description                          | Type  | Units        | Scaling Factor | R/W | Range                                                     |
|----------|--------------------------------------|-------|--------------|----------------|-----|-----------------------------------------------------------|
| 47020    | AEM RTD1 Under1 Alarm Type           | Int32 | N/A          | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47022    | AEM RTD1 Under2 Alarm Type           | Int32 | N/A          | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47024    | AEM RTD1 Out of Range Alarm Type     | Int32 | N/A          | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47026    | AEM RTD2 Hysteresis                  | Int32 | Deci Percent | Deci           | RW  | 0–1000                                                    |
| 47028    | AEM RTD2 Arming Delay                | Int32 | Second       | N/A            | RW  | 0–300                                                     |
| 47030    | AEM RTD2 Threshold1 Activation Delay | Int32 | Second       | N/A            | RW  | 0–300                                                     |
| 47032    | AEM RTD2 Threshold2 Activation Delay | Int32 | Second       | N/A            | RW  | 0–2                                                       |
| 47034    | AEM RTD2 Over1 Threshold             | Int32 | Deg F        | N/A            | RW  | -58 to 482                                                |
| 47036    | AEM RTD2 Over2 Threshold             | Int32 | Deg F        | N/A            | RW  | -58 to 482                                                |
| 47038    | AEM RTD2 Under1 Threshold            | Int32 | Deg F        | N/A            | RW  | -58 to 482                                                |
| 47040    | AEM RTD2 Under2 Threshold            | Int32 | Deg F        | N/A            | RW  | -58 to 482                                                |
| 47042    | AEM RTD2 Over1 Alarm Type            | Int32 | N/A          | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47044    | AEM RTD2 Over2 Alarm Type            | Int32 | N/A          | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47046    | AEM RTD2 Under1 Alarm Type           | Int32 | N/A          | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47048    | AEM RTD2 Under2 Alarm Type           | Int32 | N/A          | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47050    | AEM RTD2 Out of Range Alarm Type     | Int32 | N/A          | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47052    | AEM RTD3 Hysteresis                  | Int32 | Deci Percent | Deci           | RW  | 0–1000                                                    |
| 47054    | AEM RTD3 Arming Delay                | Int32 | Second       | N/A            | RW  | 0–300                                                     |
| 47056    | AEM RTD3 Threshold1 Activation Delay | Int32 | Second       | N/A            | RW  | 0–300                                                     |
| 47058    | AEM RTD3 Threshold2 Activation Delay | Int32 | Second       | N/A            | RW  | 0–2                                                       |
| 47060    | AEM RTD3 Over1 Threshold             | Int32 | Deg F        | N/A            | RW  | -58 to 482                                                |
| 47062    | AEM RTD3 Over2 Threshold             | Int32 | Deg F        | N/A            | RW  | -58 to 482                                                |
| 47064    | AEM RTD3 Under1 Threshold            | Int32 | Deg F        | N/A            | RW  | -58 to 482                                                |
| 47066    | AEM RTD3 Under2 Threshold            | Int32 | Deg F        | N/A            | RW  | -58 to 482                                                |
| 47068    | AEM RTD3 Over1 Alarm Type            | Int32 | N/A          | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47070    | AEM RTD3 Over2 Alarm Type            | Int32 | N/A          | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47072    | AEM RTD3 Under1 Alarm Type           | Int32 | N/A          | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |

| Register | Description                          | Type  | Units       | Scaling Factor | R/W | Range                                                     |
|----------|--------------------------------------|-------|-------------|----------------|-----|-----------------------------------------------------------|
| 47074    | AEM RTD3 Under2 Alarm Type           | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47076    | AEM RTD3 Out of Range Alarm Type     | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47078    | AEM RTD4 Hysteresis                  | Int32 | DeciPercent | Deci           | RW  | 0-1000                                                    |
| 47080    | AEM RTD4 Arming Delay                | Int32 | Second      | N/A            | RW  | 0-300                                                     |
| 47082    | AEM RTD4 Threshold1 Activation Delay | Int32 | Second      | N/A            | RW  | 0-300                                                     |
| 47084    | AEM RTD4 Threshold2 Activation Delay | Int32 | Second      | N/A            | RW  | 0-2                                                       |
| 47086    | AEM RTD4 Over1 Threshold             | Int32 | Deg F       | N/A            | RW  | -58 to 482                                                |
| 47088    | AEM RTD4 Over2 Threshold             | Int32 | Deg F       | N/A            | RW  | -58 to 482                                                |
| 47090    | AEM RTD4 Under1 Threshold            | Int32 | Deg F       | N/A            | RW  | -58 to 482                                                |
| 47092    | AEM RTD4 Under2 Threshold            | Int32 | Deg F       | N/A            | RW  | -58 to 482                                                |
| 47094    | AEM RTD4 Over1 Alarm Type            | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47096    | AEM RTD4 Over2 Alarm Type            | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47098    | AEM RTD4 Under1 Alarm Type           | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47100    | AEM RTD4 Under2 Alarm Type           | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47102    | AEM RTD4 Out of Range Alarm Type     | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47104    | AEM RTD5 Hysteresis                  | Int32 | DeciPercent | Deci           | RW  | 0-1000                                                    |
| 47106    | AEM RTD5 Arming Delay                | Int32 | Second      | N/A            | RW  | 0-300                                                     |
| 47108    | AEM RTD5 Threshold1 Activation Delay | Int32 | Second      | N/A            | RW  | 0-300                                                     |
| 47110    | AEM RTD5 Threshold2 Activation Delay | Int32 | Second      | N/A            | RW  | 0-2                                                       |
| 47112    | AEM RTD5 Over1 Threshold             | Int32 | Deg F       | N/A            | RW  | -58 to 482                                                |
| 47114    | AEM RTD5 Over2 Threshold             | Int32 | Deg F       | N/A            | RW  | -58 to 482                                                |
| 47116    | AEM RTD5 Under1 Threshold            | Int32 | Deg F       | N/A            | RW  | -58 to 482                                                |
| 47118    | AEM RTD5 Under2 Threshold            | Int32 | Deg F       | N/A            | RW  | -58 to 482                                                |
| 47120    | AEM RTD5 Over1 Alarm Type            | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47122    | AEM RTD5 Over2 Alarm Type            | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47124    | AEM RTD5 Under1 Alarm Type           | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47126    | AEM RTD5 Under2 Alarm Type           | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |

| Register | Description                          | Type  | Units       | Scaling Factor | R/W | Range                                                     |
|----------|--------------------------------------|-------|-------------|----------------|-----|-----------------------------------------------------------|
| 47128    | AEM RTD5 Out of Range Alarm Type     | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47130    | AEM RTD6 Hysteresis                  | Int32 | DeciPercent | Deci           | RW  | 0-1000                                                    |
| 47132    | AEM RTD6 Arming Delay                | Int32 | Second      | N/A            | RW  | 0-300                                                     |
| 47134    | AEM RTD6 Threshold1 Activation Delay | Int32 | Second      | N/A            | RW  | 0-300                                                     |
| 47136    | AEM RTD6 Threshold2 Activation Delay | Int32 | Second      | N/A            | RW  | 0-2                                                       |
| 47138    | AEM RTD6 Over1 Threshold             | Int32 | Deg F       | N/A            | RW  | -58 to 482                                                |
| 47140    | AEM RTD6 Over2 Threshold             | Int32 | Deg F       | N/A            | RW  | -58 to 482                                                |
| 47142    | AEM RTD6 Under1 Threshold            | Int32 | Deg F       | N/A            | RW  | -58 to 482                                                |
| 47144    | AEM RTD6 Under2 Threshold            | Int32 | Deg F       | N/A            | RW  | -58 to 482                                                |
| 47146    | AEM RTD6 Over1 Alarm Type            | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47148    | AEM RTD6 Over2 Alarm Type            | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47150    | AEM RTD6 Under1 Alarm Type           | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47152    | AEM RTD6 Under2 Alarm Type           | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47154    | AEM RTD6 Out of Range Alarm Type     | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47156    | AEM RTD7 Hysteresis                  | Int32 | DeciPercent | Deci           | RW  | 0-1000                                                    |
| 47158    | AEM RTD7 Arming Delay                | Int32 | Second      | N/A            | RW  | 0-300                                                     |
| 47160    | AEM RTD7 Threshold1 Activation Delay | Int32 | Second      | N/A            | RW  | 0-300                                                     |
| 47162    | AEM RTD7 Threshold2 Activation Delay | Int32 | Second      | N/A            | RW  | 0-2                                                       |
| 47164    | AEM RTD7 Over1 Threshold             | Int32 | Deg F       | N/A            | RW  | -58 to 482                                                |
| 47166    | AEM RTD7 Over2 Threshold             | Int32 | Deg F       | N/A            | RW  | -58 to 482                                                |
| 47168    | AEM RTD7 Under1 Threshold            | Int32 | Deg F       | N/A            | RW  | -58 to 482                                                |
| 47170    | AEM RTD7 Under2 Threshold            | Int32 | Deg F       | N/A            | RW  | -58 to 482                                                |
| 47172    | AEM RTD7 Over1 Alarm Type            | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47174    | AEM RTD7 Over2 Alarm Type            | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47176    | AEM RTD7 Under1 Alarm Type           | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47178    | AEM RTD7 Under2 Alarm Type           | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47180    | AEM RTD7 Out of Range Alarm Type     | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |

| Register | Description                                   | Type  | Units       | Scaling Factor | R/W | Range                                                     |
|----------|-----------------------------------------------|-------|-------------|----------------|-----|-----------------------------------------------------------|
| 47182    | AEM RTD8 Hysteresis                           | Int32 | DeciPercent | Deci           | RW  | 0–1000                                                    |
| 47184    | AEM RTD8 Arming Delay                         | Int32 | Second      | N/A            | RW  | 0–300                                                     |
| 47186    | AEM RTD8 Threshold1 Activation Delay          | Int32 | Second      | N/A            | RW  | 0–300                                                     |
| 47188    | AEM RTD8 Threshold2 Activation Delay          | Int32 | Second      | N/A            | RW  | 0–2                                                       |
| 47190    | AEM RTD8 Over1 Threshold                      | Int32 | Deg F       | N/A            | RW  | -58 to 482                                                |
| 47192    | AEM RTD8 Over2 Threshold                      | Int32 | Deg F       | N/A            | RW  | -58 to 482                                                |
| 47194    | AEM RTD8 Under1 Threshold                     | Int32 | Deg F       | N/A            | RW  | -58 to 482                                                |
| 47196    | AEM RTD8 Under2 Threshold                     | Int32 | Deg F       | N/A            | RW  | -58 to 482                                                |
| 47198    | AEM RTD8 Over1 Alarm Type                     | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47200    | AEM RTD8 Over2 Alarm Type                     | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47202    | AEM RTD8 Under1 Alarm Type                    | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47204    | AEM RTD8 Under2 Alarm Type                    | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47206    | AEM RTD8 Out of Range Alarm Type              | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47208–48 | RESERVED                                      |       |             |                |     |                                                           |
| 47250    | AEM Thermocouple1 Hysteresis                  | Int32 | DeciPercent | Deci           | RW  | 0–1000                                                    |
| 47252    | AEM Thermocouple1 Arming Delay                | Int32 | Second      | N/A            | RW  | 0–300                                                     |
| 47254    | AEM Thermocouple1 Threshold1 Activation Delay | Int32 | Second      | N/A            | RW  | 0–300                                                     |
| 47256    | AEM Thermocouple1 Threshold2 Activation Delay | Int32 | Second      | N/A            | RW  | 0–300                                                     |
| 47258    | AEM Thermocouple1 Over1 Threshold             | Int32 | Deg F       | N/A            | RW  | 32–2507                                                   |
| 47260    | AEM Thermocouple1 Over2 Threshold             | Int32 | Deg F       | N/A            | RW  | 32–2507                                                   |
| 47262    | AEM Thermocouple1 Under1 Threshold            | Int32 | Deg F       | N/A            | RW  | 32–2507                                                   |
| 47264    | AEM Thermocouple1 Under2 Threshold            | Int32 | Deg F       | N/A            | RW  | 32–2507                                                   |
| 47266    | AEM Thermocouple1 Over1 Alarm Type            | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47268    | AEM Thermocouple1 Over2 Alarm Type            | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47270    | AEM Thermocouple1 Under1 Alarm Type           | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47272    | AEM Thermocouple1 Under 2 Alarm Type          | Int32 | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |

| Register  | Description                                          | Type   | Units       | Scaling Factor | R/W | Range                                                     |
|-----------|------------------------------------------------------|--------|-------------|----------------|-----|-----------------------------------------------------------|
| 47274     | AEM Thermocouple1 Out of Range Alarm Type            | Int32  | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47276     | AEM Thermocouple2 Hysteresis                         | Int32  | DeciPercent | Deci           | RW  | 0–1000                                                    |
| 47278     | AEM Thermocouple2 Arming Delay                       | Int32  | Second      | N/A            | RW  | 0–300                                                     |
| 47280     | AEM Thermocouple2 Threshold1 Activation Delay        | Int32  | Second      | N/A            | RW  | 0–300                                                     |
| 47282     | AEM Thermocouple2 Threshold2 Activation Delay        | Int32  | Second      | N/A            | RW  | 0–300                                                     |
| 47284     | AEM Thermocouple2 Over1 Threshold                    | Int32  | Deg F       | N/A            | RW  | 32–2507                                                   |
| 47286     | AEM Thermocouple2 Over2 Threshold                    | Int32  | Deg F       | N/A            | RW  | 32–2507                                                   |
| 47288     | AEM Thermocouple2 Under1 Threshold                   | Int32  | Deg F       | N/A            | RW  | 32–2507                                                   |
| 47290     | AEM Thermocouple2 Under2 Threshold                   | Int32  | Deg F       | N/A            | RW  | 32–2507                                                   |
| 47292     | AEM Thermocouple2 Over1 Alarm Type                   | Int32  | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47294     | AEM Thermocouple2 Over2 Alarm Type                   | Int32  | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47296     | AEM Thermocouple2 Under1 Alarm Type                  | Int32  | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47298     | AEM Thermocouple2 Under 2 Alarm Type                 | Int32  | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47300     | AEM Thermocouple2 Out of Range Alarm Type            | Int32  | N/A         | N/A            | RW  | 0 = None<br>1 = Alarm<br>2 = Pre-alarm<br>3 = Status Only |
| 47302–498 | FUTURE USE                                           |        |             |                |     |                                                           |
| 47500     | AEM Analog Input 1 Arming Delay Metering             | Int32  | N/A         | Sec * 2        | R   | 0–600 counts = 0–300 seconds                              |
| 47502     | AEM Analog Input 1 Activation Delay Over 1 Metering  | UInt32 | N/A         | Sec * 2        | R   | 0–600 counts = 0–300 seconds                              |
| 47504     | AEM Analog Input 1 Activation Delay Under 1 Metering | UInt32 | N/A         | Sec * 2        | R   | 0–600 counts = 0–300 seconds                              |
| 47506     | AEM Analog Input 1 Activation Delay Over 2 Metering  | UInt32 | N/A         | Sec * 2        | R   | 0–600 counts = 0–300 seconds                              |
| 47508     | AEM Analog Input 1 Activation Delay Under 2 Metering | UInt32 | N/A         | Sec * 2        | R   | 0–600 counts = 0–300 seconds                              |
| 47510     | AEM Analog Input 2 Arming Delay Metering             | Int32  | N/A         | Sec * 2        | R   | 0–600 counts = 0–300 seconds                              |
| 47512     | AEM Analog Input 2 Activation Delay Over 1 Metering  | UInt32 | N/A         | Sec * 2        | R   | 0–600 counts = 0–300 seconds                              |
| 47514     | AEM Analog Input 2 Activation Delay Under 1 Metering | UInt32 | N/A         | Sec * 2        | R   | 0–600 counts = 0–300 seconds                              |
| 47516     | AEM Analog Input 2 Activation Delay Over 2 Metering  | UInt32 | N/A         | Sec * 2        | R   | 0–600 counts = 0–300 seconds                              |
| 47518     | AEM Analog Input 2 Activation Delay Under 2 Metering | UInt32 | N/A         | Sec * 2        | R   | 0–600 counts = 0–300 seconds                              |
| 47520     | AEM Analog Input 3 Arming Delay Metering             | Int32  | N/A         | Sec * 2        | R   | 0–600 counts = 0–300 seconds                              |
| 47522     | AEM Analog Input 3 Activation Delay Over 1 Metering  | UInt32 | N/A         | Sec * 2        | R   | 0–600 counts = 0–300 seconds                              |
| 47524     | AEM Analog Input 3 Activation Delay Under 1 Metering | UInt32 | N/A         | Sec * 2        | R   | 0–600 counts = 0–300 seconds                              |

| Register | Description                                          | Type   | Units | Scaling Factor | R/W | Range                        |
|----------|------------------------------------------------------|--------|-------|----------------|-----|------------------------------|
| 47526    | AEM Analog Input 3 Activation Delay Over 2 Metering  | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47528    | AEM Analog Input 3 Activation Delay Under 2 Metering | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47530    | AEM Analog Input 4 Arming Delay Metering             | Int32  | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47532    | AEM Analog Input 4 Activation Delay Over 1 Metering  | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47534    | AEM Analog Input 4 Activation Delay Under 1 Metering | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47536    | AEM Analog Input 4 Activation Delay Over 2 Metering  | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47538    | AEM Analog Input 4 Activation Delay Under 2 Metering | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47540    | AEM Analog Input 5 Arming Delay Metering             | Int32  | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47542    | AEM Analog Input 5 Activation Delay Over 1 Metering  | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47544    | AEM Analog Input 5 Activation Delay Under 1 Metering | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47546    | AEM Analog Input 5 Activation Delay Over 2 Metering  | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47548    | AEM Analog Input 5 Activation Delay Under 2 Metering | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47550    | AEM Analog Input 6 Arming Delay Metering             | Int32  | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47552    | AEM Analog Input 6 Activation Delay Over 1 Metering  | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47554    | AEM Analog Input 6 Activation Delay Under 1 Metering | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47556    | AEM Analog Input 6 Activation Delay Over 2 Metering  | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47558    | AEM Analog Input 6 Activation Delay Under 2 Metering | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47560    | AEM Analog Input 7 Arming Delay Metering             | Int32  | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47562    | AEM Analog Input 7 Activation Delay Over 1 Metering  | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47564    | AEM Analog Input 7 Activation Delay Under 1 Metering | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47566    | AEM Analog Input 7 Activation Delay Over 2 Metering  | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47568    | AEM Analog Input 7 Activation Delay Under 2 Metering | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47570    | AEM Analog Input 8 Arming Delay Metering             | Int32  | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47572    | AEM Analog Input 8 Activation Delay Over 1 Metering  | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47574    | AEM Analog Input 8 Activation Delay Under 1 Metering | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47576    | AEM Analog Input 8 Activation Delay Over 2 Metering  | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47578    | AEM Analog Input 8 Activation Delay Under 2 Metering | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47580    | AEM RTD Input 1 Arming Delay Metering                | Int32  | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47582    | AEM RTD Input 1 Activation Delay Over 1 Metering     | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47584    | AEM RTD Input 1 Activation Delay Under 1 Metering    | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47586    | AEM RTD Input 1 Activation Delay Over 2              | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47588    | AEM RTD Input 1 Activation Delay Under 2             | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47590    | AEM RTD Input 2 Arming Delay Metering                | Int32  | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |



| Register | Description                                       | Type   | Units | Scaling Factor | R/W | Range                        |
|----------|---------------------------------------------------|--------|-------|----------------|-----|------------------------------|
| 47592    | AEM RTD Input 2 Activation Delay Over 1 Metering  | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47594    | AEM RTD Input 2 Activation Delay Under 1 Metering | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47596    | AEM RTD Input 2 Activation Delay Over 2           | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47598    | AEM RTD Input 2 Activation Delay Under 2          | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47600    | AEM RTD Input 3 Arming Delay Metering             | Int32  | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47602    | AEM RTD Input 3 Activation Delay Over 1 Metering  | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47604    | AEM RTD Input 3 Activation Delay Under 1 Metering | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47606    | AEM RTD Input 3 Activation Delay Over 2           | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47608    | AEM RTD Input 3 Activation Delay Under 2          | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47610    | AEM RTD Input 4 Arming Delay Metering             | Int32  | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47612    | AEM RTD Input 4 Activation Delay Over 1 Metering  | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47614    | AEM RTD Input 4 Activation Delay Under 1 Metering | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47616    | AEM RTD Input 4 Activation Delay Over 2           | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47618    | AEM RTD Input 4 Activation Delay Under 2          | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47620    | AEM RTD Input 5 Arming Delay Metering             | Int32  | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47622    | AEM RTD Input 5 Activation Delay Over 1 Metering  | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47624    | AEM RTD Input 5 Activation Delay Under 1 Metering | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47626    | AEM RTD Input 5 Activation Delay Over 2           | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47628    | AEM RTD Input 5 Activation Delay Under 2          | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47630    | AEM RTD Input 6 Arming Delay Metering             | Int32  | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47632    | AEM RTD Input 6 Activation Delay Over 1 Metering  | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47634    | AEM RTD Input 6 Activation Delay Under 1 Metering | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47636    | AEM RTD Input 6 Activation Delay Over 2           | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47638    | AEM RTD Input 6 Activation Delay Under 2          | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47640    | AEM RTD Input 7 Arming Delay Metering             | Int32  | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47642    | AEM RTD Input 7 Activation Delay Over 1 Metering  | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47644    | AEM RTD Input 7 Activation Delay Under 1 Metering | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47646    | AEM RTD Input 7 Activation Delay Over 2           | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47648    | AEM RTD Input 7 Activation Delay Under 2          | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47650    | AEM RTD Input 8 Arming Delay Metering             | Int32  | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47652    | AEM RTD Input 8 Activation Delay Over 1 Metering  | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47654    | AEM RTD Input 8 Activation Delay Under 1 Metering | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |
| 47656    | AEM RTD Input 8 Activation Delay Over 2           | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds |

| Register | Description                                                | Type   | Units | Scaling Factor | R/W | Range                         |
|----------|------------------------------------------------------------|--------|-------|----------------|-----|-------------------------------|
| 47658    | AEM RTD Input 8 Activation Delay Under 2                   | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds  |
| 47660    | AEM Thermocouple Input 1 Arming Delay Metering             | Int32  | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds  |
| 47662    | AEM Thermocouple Input 1 Activation Delay Over 1 Metering  | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds  |
| 47664    | AEM Thermocouple Input 1 Activation Delay Under 1 Metering | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds  |
| 47666    | AEM Thermocouple Input 1 Activation Delay Over 2 Metering  | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds  |
| 47668    | AEM Thermocouple Input 1 Activation Delay Under 2 Metering | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds  |
| 47670    | AEM Thermocouple Input 2 Arming Delay Metering             | Int32  | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds  |
| 47672    | AEM Thermocouple Input 2 Activation Delay Over 1 Metering  | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds  |
| 47674    | AEM Thermocouple Input 2 Activation Delay Under 1 Metering | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds  |
| 47676    | AEM Thermocouple Input 2 Activation Delay Over 2 Metering  | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds  |
| 47678    | AEM Thermocouple Input 2 Activation Delay Under 2 Metering | Uint32 | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds  |
| 47680    | AEM Analog Output 1 Activation Delay Metering              | Int32  | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds  |
| 47682    | AEM Analog Output 2 Activation Delay Metering              | Int32  | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds  |
| 47684    | AEM Analog Output 3 Activation Delay Metering              | Int32  | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds  |
| 47686    | AEM Analog Output 4 Activation Delay Metering              | Int32  | N/A   | Sec * 2        | R   | 0–600 counts = 0–300 seconds  |
| 47688    | 27-1 Arming Delay Metering                                 | Uint32 | N/A   | Sec * 30.76923 | R   | 0–9230 counts = 0–300 seconds |
| 47690    | 27-1 Activation Delay Metering                             | Uint32 | N/A   | Sec * 30.76923 | R   | 0–923 counts = 0–30 seconds   |
| 47692    | 27-2 Arming Delay Metering                                 | Uint32 | N/A   | Sec * 30.76923 | R   | 0–9230 counts = 0–300 seconds |
| 47694    | 27-2 Activation Delay Metering                             | Uint32 | N/A   | Sec * 30.76923 | R   | 0–923 counts = 0–30 seconds   |
| 47696    | 59-1 Arming Delay Metering                                 | Uint32 | N/A   | Sec * 30.76923 | R   | 0–9230 counts = 0–300 seconds |
| 47698    | 59-1 Activation Delay Metering                             | Uint32 | N/A   | Sec * 30.76923 | R   | 0–923 counts = 0–30 seconds   |
| 47700    | 59-2 Arming Delay Metering                                 | Uint32 | N/A   | Sec * 30.76923 | R   | 0–9230 counts = 0–300 seconds |
| 47702    | 59-2 Activation Delay Metering                             | Uint32 | N/A   | Sec * 30.76923 | R   | 0–923 counts = 0–30 seconds   |
| 47704    | 47 Arming Delay Metering                                   | Uint32 | N/A   | Sec * 30.76923 | R   | 0–9230 counts = 0–300 seconds |
| 47706    | 47 Activation Delay Metering                               | Uint32 | N/A   | Sec * 30.76923 | R   | 0–923 counts = 0–30 seconds   |
| 47708    | 81O Arming Delay Metering                                  | Uint32 | N/A   | Sec * 30.76923 | R   | 0–9230 counts = 0–300 seconds |
| 47710    | 81O Activation Delay Metering                              | Uint32 | N/A   | Sec * 30.76923 | R   | 0–923 counts = 0–30 seconds   |
| 47712    | 81U Arming Delay Metering                                  | Uint32 | N/A   | Sec * 30.76923 | R   | 0–9230 counts = 0–300 seconds |
| 47714    | 81U Activation Delay Metering                              | Uint32 | N/A   | Sec * 30.76923 | R   | 0–923 counts = 0–30 seconds   |
| 47716    | 32R Arming Delay Metering                                  | Uint32 | N/A   | Sec * 30.76923 | R   | 0–9230 counts = 0–300 seconds |
| 47718    | 32R Activation Delay Metering                              | Uint32 | N/A   | Sec * 30.76923 | R   | 0–923 counts = 0–30 seconds   |
| 47720    | 40Q Arming Delay Metering                                  | Uint32 | N/A   | Sec * 30.76923 | R   | 0–9230 counts = 0–300 seconds |

| Register | Description                                      | Type   | Units  | Scaling Factor | R/W | Range                          |
|----------|--------------------------------------------------|--------|--------|----------------|-----|--------------------------------|
| 47722    | 40Q Activation Delay Metering                    | Uint32 | N/A    | Sec * 30.76923 | R   | 0–923 counts = 0–30 seconds    |
| 47724    | ROCOF Activation Delay Metering                  | Uint32 | N/A    | Sec * 67       | R   | 0–666 counts = 0–10            |
| 47726    | Pre-Crank Timer Metering                         | Int32  | Second | Deci           | R   | 0–300                          |
| 47728    | Crank Timer Metering                             | Int32  | Second | Deci           | R   | 0–3000                         |
| 47730    | Resting Timer Metering                           | Int32  | Second | Deci           | R   | 0–3000                         |
| 47732    | Restart Delay Timer Metering                     | Int32  | Second | Deci           | R   | 0–1200                         |
| 47734    | Cooldown Timer Metering                          | Uint32 | Second | Deci           | R   | 0–36000                        |
| 47736    | Auto Restart Timer Metering                      | Uint32 | Second | N/A            | R   | 0–1800                         |
| 47738    | Cool Temp Sender Fail Timer Metering             | Int32  | Second | Deci           | R   | 0–18000                        |
| 47740    | Oil Pressure Sender Fail Timer Metering          | Int32  | Second | Deci           | R   | 0–3000                         |
| 47742    | Fuel Level Sender Fail Timer Metering            | Int32  | Second | Deci           | R   | 0–3000                         |
| 47744    | Voltage Sensing Sender Fail Timer Metering       | Int32  | Second | Deci           | R   | 0–3000                         |
| 47746    | Speed Sender Fail Timer Metering                 | Int32  | Second | Deci           | R   | 0–3000                         |
| 47748    | Sync Fail Timer Metering                         | Int32  | N/A    | Sec * 30.76923 | R   | 0–18462 counts = 0–600 seconds |
| 47750    | Generator Exerciser Session Elapsed Seconds Data | Uint32 | Second | N/A            | R   | 0–4294967295                   |
| 47752    | Generator Exerciser Seconds to Next Start Data   | Uint32 | Second | N/A            | R   | 0–4294967295                   |
| 47754    | Generator Exerciser Session Duration Data        | Uint32 | Second | N/A            | R   | 0–4294967295                   |
| 47756    | Configurable Protection 1 Parameter Value        | Int32  | Unit   | Centi          | R   | –99999900–99999900             |
| 47758    | Configurable Protection 1 Parameter Value        | Int32  | N/A    | Centi          | R   | –99999900–99999900             |
| 47760    | Configurable Protection 2 Parameter Value        | Int32  | N/A    | Centi          | R   | –99999900–99999900             |
| 47762    | Configurable Protection 3 Parameter Value        | Int32  | N/A    | Centi          | R   | –99999900–99999900             |
| 47764    | Configurable Protection 4 Parameter Value        | Int32  | N/A    | Centi          | R   | –99999900–99999900             |
| 47766    | Configurable Protection 5 Parameter Value        | Int32  | N/A    | Centi          | R   | –99999900–99999900             |
| 47768    | Configurable Protection 6 Parameter Value        | Int32  | N/A    | Centi          | R   | –99999900–99999900             |
| 47770    | Configurable Protection 7 Parameter Value        | Int32  | N/A    | Centi          | R   | –99999900–99999900             |

### Legacy Parameter Table for DGC-500 and DGC-1000

The DGC-2020 maps all legacy parameters previously associated with the DGC-500 and DGC-1000 into the Holding Register address space (40000 to 41999). Query address N will access the Holding Register N+1. The Data Format is Integer type data unless identified otherwise in the Data Format column.

| Holding Register          | Parameter                                   | Range | Read/Write Supported | Data Format           | Units |
|---------------------------|---------------------------------------------|-------|----------------------|-----------------------|-------|
| 40001–18                  | RESERVED                                    |       |                      |                       |       |
| <b>PARAMETER SETTINGS</b> |                                             |       |                      |                       |       |
| 40019                     | Emergency Stop                              | 0–1   | R W                  | 0 = Off<br>1 = Stop   |       |
| 40020                     | Remote Start / Stop: Runs when in Auto mode | 0–1   | R W                  | 0 = Stop<br>1 = Start |       |
| 40021–22                  | RESERVED                                    |       |                      |                       |       |

| Holding Register                      | Parameter                       | Range                         | Read/Write Supported | Data Format                               | Units       |
|---------------------------------------|---------------------------------|-------------------------------|----------------------|-------------------------------------------|-------------|
| <b>SYSTEM PARAMETERS</b>              |                                 |                               |                      |                                           |             |
| 40023                                 | Default Generator Connection    | 0–2                           | R W                  | 0 = 3ph L-L<br>1 = 3ph L-N<br>2 = 1ph A-B |             |
| 40024                                 | NFPA Level                      | 0–2                           | R W                  | 0 = Off<br>1 = Level 1<br>2 = Level 2     |             |
| 40025                                 | RESERVED                        |                               |                      |                                           |             |
| 40026                                 | Rated Engine RPM                | 25–3600                       | R W                  |                                           | RPM         |
| 40027                                 | Number Flywheel Teeth           | 50–500                        | R W                  |                                           |             |
| 40028                                 | Genset kW Rating                | 25–9999                       | R W                  |                                           | Kilowatt    |
| 40029                                 | No Load Cool Down Time          | 0–60                          | R W                  |                                           | Minutes     |
| <b>GENERATOR PT PRIMARY</b>           |                                 |                               |                      |                                           |             |
| 40030                                 | Voltage(a)                      | 1–15000                       | R W                  | DP                                        | Vac x10000  |
| 40031                                 | Voltage(b)                      |                               | R W                  | DP                                        | Vac         |
| <b>GENERATOR PT SECONDARY</b>         |                                 |                               |                      |                                           |             |
| 40032                                 | Voltage                         | 1–480                         | R W                  |                                           | Vac         |
| <b>GENERATOR CT PRIMARY</b>           |                                 |                               |                      |                                           |             |
| 40033                                 | Current                         | 1–5000                        | R W                  |                                           | Aac         |
| <b>LOW FUEL ALARM</b>                 |                                 |                               |                      |                                           |             |
| 40034                                 | Enable                          | 0–1                           | R W                  | 0 = Off<br>1 = On                         |             |
| 40035                                 | Threshold                       | 2–50                          | R W                  |                                           | % Full Tank |
| <b>LOW FUEL PRE-ALARM</b>             |                                 |                               |                      |                                           |             |
| 40036                                 | Enable                          | 0–1                           | R W                  | 0 = Off<br>1 = On                         |             |
| 40037                                 | Threshold                       | 10–100                        | R W                  |                                           | % Full Tank |
| <b>LOW COOLANT TEMP PRE-ALARM</b>     |                                 |                               |                      |                                           |             |
| 40038                                 | Enable                          | 0–1                           | R W                  | 0 = Off<br>1 = On                         |             |
| 40039                                 | Threshold                       | 32–150                        | R W                  |                                           | Degrees F   |
| <b>BATTERY OVERVOLTAGE PRE-ALARM</b>  |                                 |                               |                      |                                           |             |
| 40040                                 | Enable                          | 0–1                           | R W                  | 0 = Off<br>1 = On                         |             |
| 40041                                 | RESERVED                        |                               |                      |                                           |             |
| <b>MAINTENANCE INTERVAL PRE-ALARM</b> |                                 |                               |                      |                                           |             |
| 40042                                 | Enable                          | 0–1                           | R W                  | 0 = Off<br>1 = On                         |             |
| 40043                                 | Threshold                       | 0–5000                        | R W                  |                                           | Hours       |
| <b>ENGINE KW OVERLOAD PRE-ALARM</b>   |                                 |                               |                      |                                           |             |
| 40044                                 | Enable                          | 0–1                           | R W                  | 0 = Off<br>1 = On                         |             |
| 40045                                 | Threshold                       | 95–140                        | R W                  |                                           | % of Rated  |
| <b>HIGH COOLANT TEMP PRE-ALARM</b>    |                                 |                               |                      |                                           |             |
| 40046                                 | Enable                          | 0–1                           | R W                  | 0 = Off<br>1 = On                         |             |
| 40047                                 | Threshold                       | 100–280                       | R W                  |                                           | Degrees F   |
| <b>LOW OIL PRESSURE PRE-ALARM</b>     |                                 |                               |                      |                                           |             |
| 40048                                 | Enable                          | 0–1                           | R W                  | 0 = Off<br>1 = On                         |             |
| 40049                                 | Threshold                       | 3–100                         | R W                  |                                           | PSI         |
| <b>LOW BATTERY VOLTAGE PRE-ALARM</b>  |                                 |                               |                      |                                           |             |
| 40050                                 | Enable                          | 0–1                           | R W                  | 0 = Off<br>1 = On                         |             |
| 40051                                 | Threshold                       | 60–120 (12V)<br>120–240 (24V) | R W                  |                                           | 0.1 Vdc     |
| 40052                                 | Pre-alarm Activation Time Delay | 1–10                          | R W                  |                                           | Seconds     |

| Holding Register                      | Parameter                           | Range                       | Read/Write Supported | Data Format                                                                                                                                                                                                    | Units        |
|---------------------------------------|-------------------------------------|-----------------------------|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>WEAK BATTERY VOLTAGE PRE-ALARM</b> |                                     |                             |                      |                                                                                                                                                                                                                |              |
| 40053                                 | Enable                              | 0–1                         | R W                  | 0 = Off<br>1 = On                                                                                                                                                                                              |              |
| 40054                                 | Threshold                           | 40–80 (12V)<br>80–160 (24V) | R W                  |                                                                                                                                                                                                                | 0.1 Vdc      |
| 40055                                 | Pre-alarm Activation Time Delay     | 1–10                        | R W                  |                                                                                                                                                                                                                | Seconds      |
| 40056-59                              | RESERVED                            |                             |                      |                                                                                                                                                                                                                |              |
| <b>HIGH COOLANT TEMP ALARM</b>        |                                     |                             |                      |                                                                                                                                                                                                                |              |
| 40060                                 | Enable                              | 0–1                         | R W                  | 0 = Off<br>1 = On                                                                                                                                                                                              |              |
| 40061                                 | Threshold                           | 100–280                     | R W                  |                                                                                                                                                                                                                | Degrees F    |
| 40062                                 | Arming Delay after Crank Disconnect | 60                          | R W                  |                                                                                                                                                                                                                | Seconds      |
| <b>LOW OIL PRESSURE ALARM</b>         |                                     |                             |                      |                                                                                                                                                                                                                |              |
| 40063                                 | Enable                              | 0–1                         | R W                  | 0 = Off<br>1 = On                                                                                                                                                                                              |              |
| 40064                                 | Threshold                           | 3–100                       | R W                  |                                                                                                                                                                                                                | PSI          |
| 40065                                 | Arming Delay after Crank Disconnect | 5–15                        | R W                  |                                                                                                                                                                                                                | Seconds      |
| <b>OVERSPEED ALARM</b>                |                                     |                             |                      |                                                                                                                                                                                                                |              |
| 40066                                 | Enable                              | 0–1                         | R W                  | 0 = Off<br>1 = On                                                                                                                                                                                              |              |
| 40067                                 | Threshold                           | 105–140                     | R W                  |                                                                                                                                                                                                                | % of Rated   |
| 40068                                 | Alarm Activation Time Delay         | 0–500                       | R W                  |                                                                                                                                                                                                                | Milliseconds |
| 40069-71                              | RESERVED                            |                             |                      |                                                                                                                                                                                                                |              |
| <b>CRANKING PARAMETERES</b>           |                                     |                             |                      |                                                                                                                                                                                                                |              |
| 40072                                 | Cranking Style                      | 0–1                         | R W                  | 0 = Continuous<br>1 = Cycle                                                                                                                                                                                    |              |
| 40073                                 | Number of Crank Cycles              | 1–7                         | R W                  |                                                                                                                                                                                                                |              |
| 40074                                 | Cycle Crank Time                    | 5–15                        | R W                  |                                                                                                                                                                                                                | Seconds      |
| 40075                                 | Continuous Crank Time               | 1–60                        | R W                  |                                                                                                                                                                                                                | Seconds      |
| 40076                                 | Crank Disconnect Limit              | 10–100                      | R W                  |                                                                                                                                                                                                                | % of Rated   |
| 40077                                 | Pre-crank Delay                     | 0–30                        | R W                  |                                                                                                                                                                                                                | Seconds      |
| <b>SYSTEM MONITOR</b>                 |                                     |                             |                      |                                                                                                                                                                                                                |              |
| 40078                                 | Remaining Cooldown Time             | 0–60                        | R                    |                                                                                                                                                                                                                | Minutes      |
| 40079                                 | RESERVED                            |                             |                      |                                                                                                                                                                                                                |              |
| 40080                                 | Active Speed Signal Sources         | 1–4                         | R                    | 0 = None<br>1 = MPU<br>2 = Gen Freq<br>4 = CAN Bus                                                                                                                                                             |              |
| 40081                                 | Sender Failure Alarm Code           | individual bits are 0 or 1  | R                    | b0 = High Coolant Temperature<br>b1 = Oil Pressure<br>b2 = Fuel Level<br>b3 = Magnetic Pick-up<br>b4 = Generator Voltage Sensing<br>b5 = Battery Charger Fail<br>b6 = Coolant Level Sender Fail<br>b7 not used |              |

| Holding Register         | Parameter                        | Range                      | Read/Write Supported | Data Format                                                                                                                                                                                                                                                                                                                                                              | Units            |
|--------------------------|----------------------------------|----------------------------|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| 40082                    | Alarm Codes                      | individual bits are 0 or 1 | R                    | b0=High Coolant Temperature Alarm<br>b1=Low Coolant Level Alarm<br>b2=Low Fuel Level Alarm<br>b3=Emergency Stop Alarm<br>b4=Global Sender Fail Alarm<br>b5=Over Crank Alarm<br>b6=Over Speed Alarm<br>b7=Low Oil Pressure Alarm<br>b8=Loss of ECU Communication Alarm<br>b9=Unexpected Shutdown Alarm BP<br>b10=Fuel Leak Detect Alarm<br>b11=Battery Charger Fail Alarm |                  |
| 40083                    | Pre-Alarm Codes                  | individual bits are 0 or 1 | R                    | b0=High Coolant Temperature<br>b1=Low Coolant Temperature<br>b2=Weak Battery<br>b3=Low Battery<br>b4=Battery Overvoltage<br>b5=Battery Charger Fail<br>b6=Maintenance Interval<br>b7=Engine Overload<br>Rev. 3.04 Added:<br>b8 = DTC<br>b9 = CAN Fail                                                                                                                    |                  |
| 40084                    | Pre-Alarm Codes, Group 2         | individual bits are 0 or 1 | R                    | b0=Low Oil Pressure<br>b1=Low Fuel Level<br>b2=Magnetic Pick-up Fail<br>b3=Fuel Level Sender Fail<br>b4=Aux Input 1<br>b5=Aux Input 2<br>b6=Aux Input 3<br>b7=Aux Input 4                                                                                                                                                                                                |                  |
| 40085                    | Engine Coolant Temperature       |                            | R                    |                                                                                                                                                                                                                                                                                                                                                                          | Degrees F        |
| 40086                    | Engine Oil Pressure              |                            | R                    |                                                                                                                                                                                                                                                                                                                                                                          | PSI              |
| 40087                    | Battery Voltage                  |                            | R                    |                                                                                                                                                                                                                                                                                                                                                                          | 0.1 Vdc          |
| 40088                    | Fuel Level                       |                            | R                    |                                                                                                                                                                                                                                                                                                                                                                          | % Full Tank      |
| 40089                    | Time Remaining until Maintenance |                            | R                    |                                                                                                                                                                                                                                                                                                                                                                          | Hours            |
| 40090                    | Accumulated Engine Runtime(a)    |                            | R W                  | DP                                                                                                                                                                                                                                                                                                                                                                       | Minutes x 10000  |
| 40091                    | Accumulated Engine Runtime(b)    |                            | R W                  | DP                                                                                                                                                                                                                                                                                                                                                                       | Minutes          |
| 40092                    | Not Currently Used               |                            | R W                  | DP                                                                                                                                                                                                                                                                                                                                                                       |                  |
| 40093                    | Not Currently Used               |                            | R W                  | DP                                                                                                                                                                                                                                                                                                                                                                       |                  |
| 40094                    | Engine Speed(a)                  |                            | R                    | DP                                                                                                                                                                                                                                                                                                                                                                       | RPM x10000       |
| 40095                    | Engine Speed(b)                  |                            | R                    | DP                                                                                                                                                                                                                                                                                                                                                                       | RPM              |
| 40096                    | Engine Load(a)                   |                            | R                    | DP                                                                                                                                                                                                                                                                                                                                                                       |                  |
| 40097                    | Engine Load(b)                   |                            | R                    | DP                                                                                                                                                                                                                                                                                                                                                                       | % of Rated Load  |
| <b>GENERATOR MONITOR</b> |                                  |                            |                      |                                                                                                                                                                                                                                                                                                                                                                          |                  |
| 40098                    | Phase a-b RMS Voltage(a)         |                            | R                    | DP                                                                                                                                                                                                                                                                                                                                                                       | RMS Volt x 10000 |
| 40099                    | Phase a-b RMS Voltage(b)         |                            | R                    | DP                                                                                                                                                                                                                                                                                                                                                                       | RMS Volt         |
| 40100                    | Phase b-c RMS Voltage(a)         |                            | R                    | DP                                                                                                                                                                                                                                                                                                                                                                       | RMS Volt x 10000 |
| 40101                    | Phase b-c RMS Voltage(b)         |                            | R                    | DP                                                                                                                                                                                                                                                                                                                                                                       | RMS Volt         |
| 40102                    | Phase c-a RMS Voltage(a)         |                            | R                    | DP                                                                                                                                                                                                                                                                                                                                                                       | RMS Volt x 10000 |
| 40103                    | Phase c-a RMS Voltage(b)         |                            | R                    | DP                                                                                                                                                                                                                                                                                                                                                                       | RMS Volt         |
| 40104                    | Phase a-n RMS Voltage(a)         |                            | R                    | DP                                                                                                                                                                                                                                                                                                                                                                       | RMS Volt x 10000 |
| 40105                    | Phase a-n RMS Voltage(b)         |                            | R                    | DP                                                                                                                                                                                                                                                                                                                                                                       | RMS Volt         |
| 40106                    | Phase b-n RMS Voltage(a)         |                            | R                    | DP                                                                                                                                                                                                                                                                                                                                                                       | RMS Volt x 10000 |
| 40107                    | Phase b-n RMS Voltage(b)         |                            | R                    | DP                                                                                                                                                                                                                                                                                                                                                                       | RMS Volt         |

| Holding Register | Parameter                        | Range                      | Read/Write Supported | Data Format                                                                                                                                                                          | Units               |
|------------------|----------------------------------|----------------------------|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| 40108            | Phase c-n RMS Voltage(a)         |                            | R                    | DP                                                                                                                                                                                   | RMS Volt x 10000    |
| 40109            | Phase c-n RMS Voltage(b)         |                            | R                    | DP                                                                                                                                                                                   | RMS Volt            |
| 40110            | Phase a RMS Current              |                            | R                    |                                                                                                                                                                                      | RMS Amps            |
| 40111            | Phase b RMS Current              |                            | R                    |                                                                                                                                                                                      | RMS Amps            |
| 40112            | Phase c RMS Current              |                            | R                    |                                                                                                                                                                                      | RMS Amps            |
| 40113            | Phase a Apparent Power(a)        |                            | R                    | DP                                                                                                                                                                                   | KVA x 10000         |
| 40114            | Phase a Apparent Power(b)        |                            | R                    | DP                                                                                                                                                                                   | KVA                 |
| 40115            | Phase b Apparent Power(a)        |                            | R                    | DP                                                                                                                                                                                   | KVA x 10000         |
| 40116            | Phase b Apparent Power(b)        |                            | R                    | DP                                                                                                                                                                                   | KVA                 |
| 40117            | Phase c Apparent Power(a)        |                            | R                    | DP                                                                                                                                                                                   | KVA x 10000         |
| 40118            | Phase c Apparent Power(b)        |                            | R                    | DP                                                                                                                                                                                   | KVA                 |
| 40119            | 3 Phase Apparent Power(a)        |                            | R                    | DP                                                                                                                                                                                   | KVA x 10000         |
| 40120            | 3 Phase Apparent Power(b)        |                            | R                    | DP                                                                                                                                                                                   | KVA                 |
| 40121            | Phase a Power(a)                 |                            | R                    | DP                                                                                                                                                                                   | KWatt x 10000       |
| 40122            | Phase a Power(b)                 |                            | R                    | DP                                                                                                                                                                                   | KWatt               |
| 40123            | Phase b Power(a)                 |                            | R                    | DP                                                                                                                                                                                   | KWatt x 10000       |
| 40124            | Phase b Power(b)                 |                            | R                    | DP                                                                                                                                                                                   | KWatt               |
| 40125            | Phase c Power(a)                 |                            | R                    | DP                                                                                                                                                                                   | KWatt x 10000       |
| 40126            | Phase c Power(b)                 |                            | R                    | DP                                                                                                                                                                                   | KWatt               |
| 40127            | 3 Phase power(a)                 |                            | R                    | DP                                                                                                                                                                                   | KWatt x 10000       |
| 40128            | 3 Phase power(b)                 |                            | R                    | DP                                                                                                                                                                                   | KWatt               |
| 40129            | 3 Phase Total kW-Hours(a)        |                            | R W                  | TP                                                                                                                                                                                   | KWH x 10000 x 10000 |
| 40130            | 3 Phase Total kW-Hours(b)        |                            | R W                  | TP                                                                                                                                                                                   | KWH x 10000         |
| 40131            | 3 Phase Total kW-Hours(x)        |                            | R W                  | TP                                                                                                                                                                                   | KWH                 |
| 40132            | Power Factor                     | 0–100                      | R                    |                                                                                                                                                                                      | 0.01                |
| 40133            | Frequency                        |                            | R                    |                                                                                                                                                                                      | 0.1 Hertz           |
| 40134            | Present Total kW-minutes (a)     |                            | R W                  | TP                                                                                                                                                                                   | kWm x 10000 x 10000 |
| 40135            | Present Total kW-minutes (b)     |                            | R W                  | TP                                                                                                                                                                                   | kWm x 10000         |
| 40136            | Present Total kW-minutes (c)     |                            | R W                  | TP                                                                                                                                                                                   | kWm                 |
| 40137            | Generator Speed Mode             | individual bits are 0 or 1 | R W                  | <u>active spd signals:</u><br>b0 =mag. pick-up or CAN's ECU engine's speed.<br>b1 =generator                                                                                         |                     |
| 40138–39         | RESERVED                         |                            |                      |                                                                                                                                                                                      |                     |
| 40140            | Power Factor State               | 0–3                        | R                    | 0 = leading, 1 = lagging                                                                                                                                                             |                     |
| 40141–272        | RESERVED                         |                            |                      |                                                                                                                                                                                      |                     |
| 40273            | Input Contacts States            | individual bits are 0 or 1 | R                    | b0 = coolant level,<br>b1 = ATS,<br>b2 = E-stop,<br>b3 = charger failed,<br>b4 = aux. input 1,<br>b5 = aux. input 2,<br>b6 = aux. input 3,<br>b7 = aux. input 4.<br>aux. input 4. */ |                     |
| 40274            | BESTCOMSPUs® Test Buttons States | individual bits are 0 or 1 | R W                  | b0 = button #1,<br>b1 = button #2,<br>b2 = button #3,<br>b3 = button #4,<br>b4-b7 are not used.                                                                                      |                     |
| 40275–80         | RESERVED                         |                            |                      |                                                                                                                                                                                      |                     |
| 40281            | Embedded Code Version Number (a) | 0–99                       | R                    |                                                                                                                                                                                      |                     |
| 40282            | Embedded Code Version Number (b) | 0–9999                     | R                    |                                                                                                                                                                                      |                     |

| Holding Register                      | Parameter                                    | Range                      | Read/Write Supported | Data Format                                                                                                                                                                                                                                                                                                                                                                                                                                 | Units |
|---------------------------------------|----------------------------------------------|----------------------------|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 40283                                 | Embedded Code Version Number (c)             | 0–9999                     | R                    |                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| 40287-97                              | RESERVED                                     |                            |                      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| 40298                                 | Read Relay Image of both Main and Aux Output | individual bits are 0 or 1 | R                    | Main is in lower byte and Aux is in upper byte.<br>b0 = Aux Output 1,<br>b1 = Aux Output 2,<br>b2 = Aux Output 3,<br>b3 = Aux Output 4,<br>b4 = Aux Output 5,<br>b5 = Aux Output 6,<br>b6 = Aux Output 7,<br>b7 = Aux Output 8.<br>b8 = Master Start Relay,<br>b9 = Fuel Solenoid Relay,<br>b10 = PreHeat PreLube Relay,<br>b11 = Alarm Relay,<br>b12 = UNASSIGNED,<br>b13 = Buzzer On,<br>b14 = EPS Loaded Relay,<br>b15 = PreAlarm Relay, |       |
| 40299                                 | RESERVED                                     |                            |                      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| <b>J1939 DIAGNOSTIC TROUBLE CODES</b> |                                              |                            |                      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| 40300                                 | Active DTC Number 16 – Lower Two Bytes       | 0–65535                    | R                    | Suppose the 32 bits of DTC Data is in Register N and N+1.<br><br>$SPN = (\text{Register N: Most Significant 3 bits} * 65536) + (\text{Register N+1: LS Byte} * 256) + (\text{Register N+1: MS Byte})$<br><br>FMI = Register N: Bits 8-12<br><br>Occurrence Count = Register N: Bits 0–6                                                                                                                                                     |       |
| 40301                                 | Active DTC Number 16 – Upper Two Bytes       | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| 40302                                 | Active DTC Number 15 – Lower Two Bytes       | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| 40303                                 | Active DTC Number 15 – Upper Two Bytes       | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| 40304                                 | Active DTC Number 14 – Lower Two Bytes       | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| 40305                                 | Active DTC Number 14 – Upper Two Bytes       | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| 40306                                 | Active DTC Number 13 – Lower Two Bytes       | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| 40307                                 | Active DTC Number 13 – Upper Two Bytes       | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| 40308                                 | Active DTC Number 12 – Lower Two Bytes       | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| 40309                                 | Active DTC Number 12 – Upper Two Bytes       | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| 40310                                 | Active DTC Number 11 – Lower Two Bytes       | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| 40311                                 | Active DTC Number 11 – Upper Two Bytes       | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| 40312                                 | Active DTC Number 10 – Lower Two Bytes       | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| 40313                                 | Active DTC Number 10 – Upper Two Bytes       | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| 40314                                 | Active DTC Number 9 – Lower Two Bytes        | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| 40315                                 | Active DTC Number 9 – Upper Two Bytes        | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| 40316                                 | Active DTC Number 8 – Lower Two Bytes        | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| 40317                                 | Active DTC Number 8 – Upper Two Bytes        | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
| 40318                                 | Active DTC Number 7 – Lower Two Bytes        | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |



| Holding Register | Parameter                               | Range   | Read/Write Supported | Data Format                                                                                                                                                                                                                                                             | Units |
|------------------|-----------------------------------------|---------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 40319            | Active DTC Number 7 – Upper Two Bytes   | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40320            | Active DTC Number 6 – Lower Two Bytes   | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40321            | Active DTC Number 6 – Upper Two Bytes   | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40322            | Active DTC Number 5 – Lower Two Bytes   | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40323            | Active DTC Number 5 – Upper Two Bytes   | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40324            | Active DTC Number 4 – Lower Two Bytes   | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40325            | Active DTC Number 4 – Upper Two Bytes   | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40326            | Active DTC Number 3 – Lower Two Bytes   | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40327            | Active DTC Number 3 – Upper Two Bytes   | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40328            | Active DTC Number 2 – Lower Two Bytes   | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40329            | Active DTC Number 2 – Upper Two Bytes   | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40330            | Active DTC Number 1 – Lower Two Bytes   | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40331            | Active DTC Number 1 – Upper Two Bytes   | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40332            | Previous DTC Number 1 – Lower Two Bytes | 0–65535 | R                    | <p>Suppose the 32 bits of DTC Data is in Register N and N+1.</p> <p>SPN = (Register N+1: Most Significant 3 bits * 65536) + (Register N: LS Byte * 256) + (Register N: MS Byte)</p> <p>FMI = Register N+1: Bits 8–12</p> <p>Occurrence Count = Register N: Bits 0–6</p> |       |
| 40333            | Previous DTC Number 1 – Upper Two Bytes | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40334            | Previous DTC Number 2 – Lower Two Bytes | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40335            | Previous DTC Number 2 – Upper Two Bytes | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40336            | Previous DTC Number 3 – Lower Two Bytes | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40337            | Previous DTC Number 3 – Upper Two Bytes | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40338            | Previous DTC Number 4 – Lower Two Bytes | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40339            | Previous DTC Number 4 – Upper Two Bytes | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40340            | Previous DTC Number 5 – Lower Two Bytes | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40341            | Previous DTC Number 5 – Upper Two Bytes | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40342            | Previous DTC Number 6 – Lower Two Bytes | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40343            | Previous DTC Number 6 – Upper Two Bytes | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40344            | Previous DTC Number 7 – Lower Two Bytes | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40345            | Previous DTC Number 7 – Upper Two Bytes | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40346            | Previous DTC Number 8 – Lower Two Bytes | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40347            | Previous DTC Number 8 – Upper Two Bytes | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40348            | Previous DTC Number 9 – Lower Two Bytes | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |
| 40349            | Previous DTC Number 9 – Upper Two Bytes | 0–65535 | R                    |                                                                                                                                                                                                                                                                         |       |

| Holding Register | Parameter                                                   | Range                      | Read/Write Supported | Data Format                                                                                                                                                                                                                                                                                                                                                                         | Units |
|------------------|-------------------------------------------------------------|----------------------------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 40350            | Previous DTC Number 10 – Lower Two Bytes                    | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                     |       |
| 40351            | Previous DTC Number 10 – Upper Two Bytes                    | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                     |       |
| 40352            | Previous DTC Number 11 – Lower Two Bytes                    | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                     |       |
| 40353            | Previous DTC Number 11 – Upper Two Bytes                    | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                     |       |
| 40354            | Previous DTC Number 12 – Lower Two Bytes                    | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                     |       |
| 40355            | Previous DTC Number 12 – Upper Two Bytes                    | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                     |       |
| 40356            | Previous DTC Number 13 – Lower Two Bytes                    | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                     |       |
| 40357            | Previous DTC Number 13 – Upper Two Bytes                    | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                     |       |
| 40358            | Previous DTC Number 14 – Lower Two Bytes                    | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                     |       |
| 40359            | Previous DTC Number 14 – Upper Two Bytes                    | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                     |       |
| 40360            | Previous DTC Number 15 – Lower Two Bytes                    | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                     |       |
| 40361            | Previous DTC Number 15 – Upper Two Bytes                    | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                     |       |
| 40362            | Previous DTC Number 16 – Lower Two Bytes                    | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                     |       |
| 40363            | Previous DTC Number 16 – Upper Two Bytes                    | 0–65535                    | R                    |                                                                                                                                                                                                                                                                                                                                                                                     |       |
| 40364            | RESERVED                                                    |                            |                      |                                                                                                                                                                                                                                                                                                                                                                                     |       |
| 40365            | RESERVED                                                    |                            |                      |                                                                                                                                                                                                                                                                                                                                                                                     |       |
| 40366            | RESERVED                                                    |                            |                      |                                                                                                                                                                                                                                                                                                                                                                                     |       |
| 40367            | RESERVED                                                    |                            |                      |                                                                                                                                                                                                                                                                                                                                                                                     |       |
| 40368            | DTC Lamp Status<br>NOTE: Even bits are Always a Zero Value. | individual bits are 0 or 1 | R                    | Active stored in upper byte – Previous stored in lower byte.<br>b0 = 0,<br>b1 = Protect Lamp,<br>b2 = 0,<br>b3 = Amber Warning Lamp,<br>b4 = 0,<br>b5 = Red Stop Lamp,<br>b6 = 0,<br>b7 = Malfunction Indicator Lamp,<br>b8 = 0,<br>b9 = Protect Lamp,<br>b10 = 0,<br>b11 = Amber Warning Lamp,<br>b12 = 0,<br>b13 = Red Stop Lamp,<br>b14 = 0,<br>b15 = Malfunction Indicator Lamp |       |
| 40369            | Number of DTC's                                             | 0–65535                    | R                    | Active stored in upper byte – Previous stored in lower byte.                                                                                                                                                                                                                                                                                                                        |       |
| 40370            | CAN Bus Results Register                                    | individual bits are 0 or 1 | R                    | b0 = CAN Comms. Fail,<br>b1 = Active DTC Clear Fail,<br>b2 = Previous DTC Clear Fail,<br>b3 = DTC Values Changed,<br>b4 = CAN Hardware Test Pass,<br>b5 = UNASSIGNED,<br>b6 = UNASSIGNED,<br>b7 = UNASSIGNED                                                                                                                                                                        |       |
| 40371            | CAN Related Parameter: Percent Coolant Level                | 0–100                      | R                    | Percent                                                                                                                                                                                                                                                                                                                                                                             |       |

| Holding Register | Parameter                                                   | Range                      | Read/Write Supported | Data Format                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Units |
|------------------|-------------------------------------------------------------|----------------------------|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 40372            | CAN Communications Diagnostics for use when CAN is enabled. | individual bits are 0 or 1 | R                    | Bit 12 - Engine Run Time<br>Bit 11 - Data Failure Status Previous Active DTCs Cleared<br>Bit 10 - Active DTCs Cleared<br>Bit 9 - Previous Active DTCs<br>Bit 8 - Current Active DTCs<br>Bit 7 - Coolant Level<br>Bit 6 - Oil Pressure<br>Bit 5 - Coolant Temp<br>Bit 4 - Engine Speed<br>Bit 3 - Can Error Status tx err passive<br>Bit 2 - Can Error Status rx err passive<br>Bit 1 - Can Error Status driver sleep status<br>Bit 0 - Can Error Status bus off |       |
| 40373            | System Config                                               | individual bits are 0 or 1 | R W                  | Bit 0 - RUN<br>Bit 1 - OFF<br>Bit 2 - AUTO_RUN<br>Bit 3 - AUTO_OFF<br>Bit 4 - AUTO_ANY                                                                                                                                                                                                                                                                                                                                                                          |       |
| 40374            | System Status                                               | 0-10                       | R                    | 0 = RESET<br>1 = READY<br>2 = CRANKING<br>3 = RESTING<br>4 = RUNNING<br>5 = ALARM<br>6 = PRESTART<br>7 = COOLING<br>8 = CONNECTING<br>9 = DISCONNECT<br>10 = PULSING<br>11 = UNLOADING                                                                                                                                                                                                                                                                          |       |
| 40375            | Used to display Value, NC, NS, NA, and SF                   |                            | R                    | Bits 0-2: coolant level<br>Bits 3-5: coolant temperature<br>Bits 6-8: oil pressure<br>Bits 9-11: engine speed<br>Bits 12-14: engine run time<br>Bit 15: NOT USED<br><br><u>3-Bit Status Flag Values:</u><br>000 for Valid Data<br>001 for No Comms<br>010 for Not Sent<br>011 for Not Supp<br>100 for Sender Error                                                                                                                                              |       |
| 40380-81         | FUTURE USE                                                  |                            |                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |
| 40382            | <i>mtu</i> module type                                      | 1-4                        | R W                  | 1 = module type 201<br>2 = module type 302<br>3 = module type 303<br>4 = module type 304                                                                                                                                                                                                                                                                                                                                                                        |       |
| 40383            | <i>mtu</i> speed demand switch                              | 0-7                        | R W                  | 0 = ANALOG_CAN<br>1 = UP_DN_ECU<br>2 = UP_DN_CAN<br>3 = ANALOG_ECU<br>5 = FREQUENCY<br>7 = NO_CAN_DEMAND                                                                                                                                                                                                                                                                                                                                                        |       |
| 40384            | <i>mtu</i> RPM request for engine                           | 1400-2000                  | R W                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |
| 40385            | Volvo Accelerator Pedal Position (Trim)                     | 0-100                      | R W                  | 0 = Rated speed - 120rpm;<br>50 = Rated speed;<br>100 = Rated speed + 120rpm.                                                                                                                                                                                                                                                                                                                                                                                   |       |
| 40386            | Volvo Engine RPM Select                                     | 0-1                        | R W                  | 0 = Primary,<br>1 = Secondary                                                                                                                                                                                                                                                                                                                                                                                                                                   |       |
| 40387            | J1939 source address for this unit                          | 0-253                      | R W                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |       |

| Holding Register  | Parameter                                                                                                                        | Range                                          | Read/Write Supported | Data Format                                                                                            | Units |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|----------------------|--------------------------------------------------------------------------------------------------------|-------|
| 40388             | CAN Bus ECU Configuration                                                                                                        | 0–65535                                        | R W                  | 0 = Not configured;<br>1 = Volvo Penta EDC3;<br>2 = <i>mtu</i> MDEC<br>3 = <i>mtu</i> ADEC             |       |
| 40395             | ECU Settling Time                                                                                                                | 0–65535                                        | R W                  | Milliseconds                                                                                           |       |
| 40396             | ECU Pulse Cycle Time - The amount of time unit is to wait in OFF between Pulse Cycles.                                           | 0–65535                                        | R W                  | Minutes                                                                                                |       |
| 40397             | ECU Disconnect Time - The amount of time ECU is kept powered off.                                                                | 0–65535                                        | R W                  | Seconds                                                                                                |       |
| 40398             | ECU Connect Time - The amount of time ECU is powered when connecting (unit tries to run). Also used for the Pulse duration time. | 0–65535                                        | R W                  | Seconds                                                                                                |       |
| 40399–420         | FUTURE USE                                                                                                                       |                                                |                      |                                                                                                        |       |
| <b>J1939 DATA</b> |                                                                                                                                  |                                                |                      |                                                                                                        |       |
| 40421             | Accelerator Pedal Position                                                                                                       | 0–100%                                         | R                    | 0.4%/bit gain, 0% offset                                                                               |       |
| 40422             | Percent Load At Current Speed                                                                                                    | 0–125%                                         | R                    | 1%/bit gain, 0% offset                                                                                 |       |
| 40423             | Actual Engine Percent Torque                                                                                                     | 0–125%                                         | R                    | 1%/bit gain, -125% offset                                                                              |       |
| 40424             | Engine Speed                                                                                                                     | 0–8031.875                                     | R                    | RPM (0.125rpm/bit gain)                                                                                |       |
| 40425             | Injection Control Pressure                                                                                                       | 0 to +251 MPa                                  | R                    | 1/256 MPa/bit, 0 Offset                                                                                |       |
| 40426             | Injector Metering Rail Pressure                                                                                                  | 0 to +251 MPa<br>(0 to 36404 psi)              | R                    | 1/256 MPa/bit gain, 0 MPa offset                                                                       |       |
| 40427             | Engine Run Time                                                                                                                  | 0 to +210,554,<br>060.75 h                     | R                    | 0.05 h/bit gain, 0 h offset                                                                            |       |
| 40428             | Engine Run Time                                                                                                                  |                                                | R                    |                                                                                                        |       |
| 40429             | Engine Run Time                                                                                                                  |                                                | R                    |                                                                                                        |       |
| 40430             | Trip Fuel                                                                                                                        | Data Range: 0<br>to +2,105,540,<br>608 L       | R                    | 0.5 L per bit gain, 0 L offset                                                                         |       |
| 40431             | Trip Fuel                                                                                                                        |                                                | R                    |                                                                                                        |       |
| 40432             | Trip Fuel                                                                                                                        |                                                | R                    |                                                                                                        |       |
| 40433             | Total Fuel Used                                                                                                                  | Data Range: 0<br>to +2,105,540,<br>608 L       | R                    | 0.5 L per bit gain, 0 L offset                                                                         |       |
| 40434             | Total Fuel Used                                                                                                                  |                                                | R                    |                                                                                                        |       |
| 40435             | Total Fuel Used                                                                                                                  |                                                | R                    |                                                                                                        |       |
| 40436             | Coolant Temperature                                                                                                              | -40 to +210 °C<br>(-40 to 410 °F)              | R                    | Raw ECU Parameter Data<br>1 °C/bit gain, -40 °C offset                                                 |       |
| 40437             | Fuel Temperature                                                                                                                 | -40 to +210 °C<br>(-40 to 410 °F)              | R                    | Raw ECU Parameter Data<br>1 °C/bit gain, -40 °C offset                                                 |       |
| 40438             | Engine Oil Temperature                                                                                                           | -273 to +1735.0<br>°C (-459.4 to<br>3155.0 °F) | R                    | Raw ECU Parameter Data<br>0.03125 °C/bit gain, -273 °C offset                                          |       |
| 40439             | Engine Intercooler Temperature                                                                                                   | -40 to +210 °C<br>(-40 to 410 °F)              | R                    | Raw ECU Parameter Data<br>1 °C/bit gain, -40 °C offset                                                 |       |
| 40440             | Fuel Delivery Pressure                                                                                                           | 0–1000 kPa (0–<br>145 psi)                     | R                    | Raw ECU Parameter Data<br>4 kPa/bit gain, 0 kPa offset                                                 |       |
| 40441             | Engine Oil Level                                                                                                                 | 0–100 %                                        | R                    | Raw ECU Parameter Data<br>0.4 %/bit gain, 0 % offset                                                   |       |
| 40442             | Engine Oil Pressure                                                                                                              | 0–1000 kPa (0–<br>145 psi)                     | R                    | Raw ECU Parameter Data<br>4 kPa/bit gain, 0 kPa offset                                                 |       |
| 40443             | Coolant Pressure                                                                                                                 | 0 to +500 kPa<br>(0 to 72.5 psi)               | R                    | Raw ECU Parameter Data<br>2 kPa/bit gain, 0 kPa offset                                                 |       |
| 40444             | Coolant Level                                                                                                                    | 0–100 %                                        | R                    | Raw ECU Parameter Data<br>0.4 %/bit gain, 0 % offset                                                   |       |
| 40445             | Fuel Rate                                                                                                                        | 0–3212.75 L/h                                  | R                    | Raw ECU Parameter Data<br>0.05 L/h per bit gain, 0 L/h offset (13.9 x<br>10 <sup>-6</sup> L/s per bit) |       |

| Holding Register | Parameter                          | Range                                       | Read/Write Supported | Data Format                                                                                                            | Units |
|------------------|------------------------------------|---------------------------------------------|----------------------|------------------------------------------------------------------------------------------------------------------------|-------|
| 40446            | Barometric Pressure                | 0–125 kPa<br>(0–18.1 psi)                   | R                    | Raw ECU Parameter Data<br>0.5 kPa/bit gain, 0 kPa offset                                                               |       |
| 40447            | Ambient Air Temperature            | -273 to +1735.0 °C<br>(-459.4 to 3155.0 °F) | R                    | Raw ECU Parameter Data<br>0.03125 °C/bit gain, -273 °C offset                                                          |       |
| 40448            | Air Inlet Temperature              | -40 to +210 °C<br>(-40 to 410 °F)           | R                    | Raw ECU Parameter Data<br>1 °C/bit gain, -40 °C offset                                                                 |       |
| 40449            | Boost Pressure                     | 0–500 kPa<br>(0–72.5 psi)                   | R                    | Raw ECU Parameter Data<br>2 kPa/bit gain, 0 kPa offset                                                                 |       |
| 40450            | Intake Manifold Temperature        | -40 to +210 °C<br>(-40 to 410 °F)           | R                    | Raw ECU Parameter Data<br>1 °C/bit gain, -40 °C offset                                                                 |       |
| 40451            | Air Filter Differential Pressure   | 0–12.5 kPa (0–1.8 psi)                      | R                    | Raw ECU Parameter Data<br>0.05 kPa/bit gain, 0 kPa offset                                                              |       |
| 40452            | Exhaust Gas Temperature            | -273 to +1735.0 °C<br>(-459.4 to 3155.0 °F) | R                    | Raw ECU Parameter Data<br>0.03125 °C/bit gain, -273 °C offset                                                          |       |
| 40453            | Electrical Potential Voltage       | 0–3212.75 V                                 | R                    | Raw ECU Parameter Data<br>0.05 V/bit gain, 0 V offset                                                                  |       |
| 40454            | Battery Potential Voltage Switched | Data Range: 0–3212.75 V                     | R                    | Raw ECU Parameter Data<br>0.05 V/bit gain, 0 V offset                                                                  |       |
| 40455            | Speed At Idle Point 1              | 0–8031.875 rpm                              | R                    | Raw ECU Parameter Data<br>0.125 rpm/bit, 0 rpm offset                                                                  |       |
| 40456            | Torque At Idle Point 1             | 0–125%                                      | R                    | Raw ECU Parameter Data<br>1%/bit gain, -125% offset                                                                    |       |
| 40457            | Speed At Idle Point 2              | 0–8031.875 rpm                              | R                    | Raw ECU Parameter Data<br>0.125 rpm/bit, 0 rpm offset                                                                  |       |
| 40458            | Torque At Idle Point 2             | 0–125%                                      | R                    | Raw ECU Parameter Data<br>1%/bit gain, -125% offset                                                                    |       |
| 40459            | Speed At Idle Point 3              | 0–8031.875 rpm                              | R                    | Raw ECU Parameter Data<br>0.125 rpm/bit, 0 rpm offset                                                                  |       |
| 40460            | Torque At Idle Point 3             | 0–125%                                      | R                    | Raw ECU Parameter Data<br>1%/bit gain, -125% offset                                                                    |       |
| 40461            | Speed At Idle Point 4              | 0–8031.875 rpm                              | R                    | Raw ECU Parameter Data<br>0.125 rpm/bit, 0 rpm offset                                                                  |       |
| 40462            | Torque At Idle Point 4             | 0–125%                                      | R                    | Raw ECU Parameter Data<br>1%/bit gain, -125% offset                                                                    |       |
| 40463            | Speed At Idle Point 5              | 0–8031.875 rpm                              | R                    | Raw ECU Parameter Data<br>0.125 rpm/bit, 0 rpm offset                                                                  |       |
| 40464            | Torque At Idle Point 5             | 0–125%                                      | R                    | Raw ECU Parameter Data<br>1%/bit gain, -125% offset                                                                    |       |
| 40465            | Speed At High Idle Point 6         | 0–8031.875 rpm                              | R                    | Raw ECU Parameter Data<br>0.125 rpm/bit, 0 rpm offset                                                                  |       |
| 40466            | Gain Of End speed governor         | 0–50.2 %/rpm                                | R                    | Raw ECU Parameter Data<br>0.0007813 % engine reference torque/rpm per bit gain (normalized),<br>0 %/rpm per bit offset |       |
| 40467            | Reference Engine Torque            | 0–64 255 Nm                                 | R                    | Raw ECU Parameter Data<br>1 Nm/bit gain, 0 Nm offset                                                                   |       |
| 40468            | Override Speed Point 7             | 0–8031.875 rpm                              | R                    | Raw ECU Parameter Data<br>0.125 rpm/bit, 0 rpm offset                                                                  |       |
| 40469            | Override Time Limit                | 0–25 s                                      | R                    | Raw ECU Parameter Data<br>0.1 s/bit gain, 0 s offset                                                                   |       |
| 40470            | Speed Lower Limit                  | 0–2500 rpm                                  | R                    | Raw ECU Parameter Data<br>10 rpm/bit gain, 0 rpm offset                                                                |       |
| 40471            | Speed Upper Limit                  | 0–2500 rpm                                  | R                    | Raw ECU Parameter Data<br>10 rpm/bit gain, 0 rpm offset                                                                |       |
| 40472            | Torque Lower Limit                 | 0–125%                                      | R                    | Raw ECU Parameter Data<br>1%/bit gain, -125% offset                                                                    |       |
| 40473            | Torque Upper Limit                 | 0–125%                                      | R                    | Raw ECU Parameter Data<br>1%/bit gain, -125% offset                                                                    |       |

| Holding Register   | Parameter                                                                                                           | Range                      | Read/Write Supported | Data Format                                                                                                                                                                                                                                                                                                                                                                                                                                  | Units   |
|--------------------|---------------------------------------------------------------------------------------------------------------------|----------------------------|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
| 40474              | Crankcase Pressure                                                                                                  | -250 to +251.99 kPa        | R                    | Raw ECU Parameter Data<br>0.0078125 kPa/bit gain,<br>-250 kPa offset                                                                                                                                                                                                                                                                                                                                                                         |         |
| 40475              | Oil Filter Differential Pressure                                                                                    | 0–125 kPa                  | R                    | Raw ECU Parameter Data<br>0.5 kPa/bit gain, 0 offset                                                                                                                                                                                                                                                                                                                                                                                         |         |
| 40476              | Fuel Filter Differential Pressure                                                                                   | 0–500 kPa                  | R                    | Raw ECU Parameter Data<br>2 kPa/bit gain, 0 offset                                                                                                                                                                                                                                                                                                                                                                                           |         |
| 40477–82           | FUTURE USE                                                                                                          |                            |                      |                                                                                                                                                                                                                                                                                                                                                                                                                                              |         |
| 40493–99           | FUTURE USE                                                                                                          |                            |                      |                                                                                                                                                                                                                                                                                                                                                                                                                                              |         |
| 40500              | DGC-2020 product series identifier                                                                                  | 2020                       | R                    |                                                                                                                                                                                                                                                                                                                                                                                                                                              |         |
| 40501              | Firmware Part Number - 2nd most significant digit. NOTE: The most significant digit is always 9, but is not mapped. | 0–9                        | R                    |                                                                                                                                                                                                                                                                                                                                                                                                                                              |         |
| 40502              | Firmware Part Number - 3rd-6th most significant digits                                                              | 0000–9999                  | R                    |                                                                                                                                                                                                                                                                                                                                                                                                                                              |         |
| 40503              | Firmware Part Number - four least significant digits                                                                | 0000–9999                  | R                    |                                                                                                                                                                                                                                                                                                                                                                                                                                              |         |
| 40504              | LED Status                                                                                                          | individual bits are 0 or 1 | R                    | Bits indicate status of LED's:<br>b0 = RUN<br>b1 = OFF<br>b2 = AUTO<br>b3 = ALARM<br>b4 = LOAD<br>b5 = NOT IN AUTO                                                                                                                                                                                                                                                                                                                           |         |
| 40507              | Read Relay Image of both Main and Aux Output (Duplicate of 40298)                                                   | individual bits are 0 or 1 | R                    | Main is in lower byte and Aux is in upper byte.<br>b0 = Aux Output 1,<br>b1 = Aux Output 2,<br>b2 = Aux Output 3,<br>b3 = Aux Output 4,<br>b4 = Aux Output 5,<br>b5 = Aux Output 6,<br>b6 = Aux Output 7,<br>b7 = Aux Output 8.<br>b8 = Master Start Relay,<br>b9 = Fuel Solenoid Relay,<br>b10 = Preheat Prelube Relay,<br>b11 = Alarm Relay,<br>b12 = UNASSIGNED,<br>b13 = Buzzer On,<br>b14 = EPS Loaded Relay,<br>b15 = Pre-alarm Relay, |         |
| 40508              | Input Contacts States (Duplicate of 40273)                                                                          | individual bits are 0 or 1 | R                    | b0 = coolant level,<br>b1 = ATS,<br>b2 = E-stop,<br>b3 = charger failed,<br>b4 = aux. input 1,<br>b5 = aux. input 2,<br>b6 = aux. input 3,<br>b7 = aux. input 4.<br>aux. input 4. */                                                                                                                                                                                                                                                         | /* b7 = |
| 40509–604          | RESERVED                                                                                                            |                            |                      |                                                                                                                                                                                                                                                                                                                                                                                                                                              |         |
| <b>OVERCURRENT</b> |                                                                                                                     |                            |                      |                                                                                                                                                                                                                                                                                                                                                                                                                                              |         |
| 40605              | 51 Pick-up – 3-phase                                                                                                | 18–118,<br>90–775          | R W                  | 0.18–1.18 Aac for 1A CTs,<br>0.90–7.75 Aac for 5A CTs                                                                                                                                                                                                                                                                                                                                                                                        |         |
| 40606              | 51 Time Dial – 3-phase                                                                                              | 0–99,<br>0–300             | R W                  | 0.0–9.9 for 40607=0-15 (inverse),<br>0.0–30.0s for 40607=16 (fixed)                                                                                                                                                                                                                                                                                                                                                                          |         |
| 40607              | 51 Curve – 3-phase                                                                                                  | 0–16                       | R W                  | 0–15 for inverse, 16 for fixed                                                                                                                                                                                                                                                                                                                                                                                                               |         |
| 40608              | 51 Alarm Config. – 3-phase                                                                                          | 0–2                        | R W                  | 0=None, 1=Pre-Alarm, 2=Alarm                                                                                                                                                                                                                                                                                                                                                                                                                 |         |

| Holding Register                   | Parameter                                 | Range                             | Read/Write Supported | Data Format                                                                                                                                                                                                           | Units |
|------------------------------------|-------------------------------------------|-----------------------------------|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 40609                              | 51 Pick-up – 1-phase                      | 18–118,<br>90–775                 | R W                  | 0.18–1.18 Aac for 1A CTs,<br>0.90–7.75 Aac for 5A CTs                                                                                                                                                                 |       |
| 40610                              | 51 Time Dial – 1-phase                    | 0–99,<br>0–300                    | R W                  | 0.0–9.9 for 40607=0-15 (inverse),<br>0.0–30.0s for 40607=16 (fixed)                                                                                                                                                   |       |
| 40611                              | 51 Curve – 1-phase                        | 0–16                              | R W                  | 0-15 for inverse, 16 for fixed                                                                                                                                                                                        |       |
| 40612                              | 51 Alarm Config. – 1-phase                | 0–2                               | R W                  | 0=None, 1=Pre-Alarm, 2=Alarm                                                                                                                                                                                          |       |
| <b>PHASE IMBALANCE</b>             |                                           |                                   |                      |                                                                                                                                                                                                                       |       |
| 40613                              | 47 Pick-up                                | 5–100                             | R W                  | Volts AC                                                                                                                                                                                                              |       |
| 40614                              | 47 Time Delay                             | 0–300                             | R W                  | 0.0–30.0 seconds                                                                                                                                                                                                      |       |
| 40615                              | 47 Alarm Configuration                    | 0–2                               | R W                  | 0=None, 1=Pre-Alarm, 2=Alarm                                                                                                                                                                                          |       |
| <b>UNDERVOLTAGE</b>                |                                           |                                   |                      |                                                                                                                                                                                                                       |       |
| 40616                              | 27 Pick-up – 3-phase                      | 70–576                            | R W                  | Volts AC                                                                                                                                                                                                              |       |
| 40617                              | 27 Time Delay – 3-phase                   | 0–300                             | R W                  | 0.0–30.0 seconds                                                                                                                                                                                                      |       |
| 40618                              | 27 Inhibit Frequency- 3-ph.               | 20–400                            | R W                  | Hertz                                                                                                                                                                                                                 |       |
| 40619                              | 27 Alarm Config. – 3-phase                | 0–2                               | R W                  | 0=None, 1=Pre-Alarm, 2=Alarm                                                                                                                                                                                          |       |
| 40620                              | 27 Pick-up – 1-phase                      | 70–576                            | R W                  | Volts AC                                                                                                                                                                                                              |       |
| 40621                              | 27 Time Delay – 1-phase                   | 0–300                             | R W                  | 0.0–30.0 seconds                                                                                                                                                                                                      |       |
| 40622                              | 27 Inhibit Frequency – 1-ph.              | 20–400                            | R W                  | Hertz                                                                                                                                                                                                                 |       |
| 40623                              | 27 Alarm Config. – 1-phase                | 0–2                               | R W                  | 0=None, 1=Pre-Alarm, 2=Alarm                                                                                                                                                                                          |       |
| <b>OVERVOLTAGE</b>                 |                                           |                                   |                      |                                                                                                                                                                                                                       |       |
| 40624                              | 59 Pick-up – 3-phase                      | 70–576                            | R W                  | Volts AC                                                                                                                                                                                                              |       |
| 40625                              | 59 Time Delay – 3-phase                   | 0–300                             | R W                  | 0.0–30.0 seconds                                                                                                                                                                                                      |       |
| 40626                              | 59 Alarm Config. – 3-phase                | 0–2                               | R W                  | 0=None, 1=Pre-Alarm, 2=Alarm                                                                                                                                                                                          |       |
| 40627                              | 59 Pick-up – 1-phase                      | 70–576                            | R W                  | Volts AC                                                                                                                                                                                                              |       |
| 40628                              | 59 Time Delay – 1-phase                   | 0–300                             | R W                  | 0.0–30.0 seconds                                                                                                                                                                                                      |       |
| 40629                              | 59 Alarm Config. – 1-phase                | 0–2                               | R W                  | 0=None, 1=Pre-Alarm, 2=Alarm                                                                                                                                                                                          |       |
| <b>UNDERFREQUENCY</b>              |                                           |                                   |                      |                                                                                                                                                                                                                       |       |
| 40630                              | 81U Pickup                                | 450–550,<br>550–650,<br>3600–4400 | R W                  | 45.0–55.0 Hz for 50-Hz config,<br>55.0–65.0 Hz for 60-Hz config,<br>360.0–440.0 Hz for 400-Hz unit                                                                                                                    |       |
| 40631                              | 81U Time Delay                            | 0–300                             | R W                  | 0.0–30.0 seconds                                                                                                                                                                                                      |       |
| 40632                              | 81U Inhibit Voltage                       | 70–576                            | R W                  | Volts AC                                                                                                                                                                                                              |       |
| 40633                              | 81U Alarm Configuration                   | 0–2                               | R W                  | 0=None, 1=Pre-Alarm, 2=Alarm                                                                                                                                                                                          |       |
| <b>OVERFREQUENCY</b>               |                                           |                                   |                      |                                                                                                                                                                                                                       |       |
| 40634                              | 81O Pickup                                | 450–550,<br>550–650,<br>3600–4400 | R W                  | 45.0–55.0 Hz for 50-Hz config,<br>55.0–65.0 Hz for 60-Hz config,<br>360.0–440.0 Hz for 400-Hz unit                                                                                                                    |       |
| 40635                              | 81O Time Delay                            | 0–300                             | R W                  | 0.0–30.0 seconds                                                                                                                                                                                                      |       |
| 40636                              | 81O Alarm Configuration                   | 0–2                               | R W                  | 0=None, 1=Pre-Alarm, 2=Alarm                                                                                                                                                                                          |       |
| <b>GENERATOR PROTECTION STATUS</b> |                                           |                                   |                      |                                                                                                                                                                                                                       |       |
| 40637                              | Gen Protection Status (upper 16 bits)     | 0–65535                           | R                    | b16–b31 UNASSIGNED                                                                                                                                                                                                    |       |
| 40638                              | Gen Protection Status (lower 16 bits)     | 0–65535                           | R                    | b0 = overvoltage trip,<br>b1 = undervoltage trip,<br>b2 = overfrequency trip,<br>b3 = underfrequency trip,<br>b4 = overcurrent trip,<br>b5 = phase imbalance trip,<br>b6–b15 UNASSIGNED                               |       |
| 40639                              | Gen Protection Pre-Alarms (upper 16 bits) | 0–65535                           | R                    | b16–b31 UNASSIGNED                                                                                                                                                                                                    |       |
| 40640                              | Gen Protection Pre-Alarms (lower 16 bits) | 0–65535                           | R                    | b0 = overvoltage pre-alarm,<br>b1 = undervoltage pre-alarm,<br>b2 = overfrequency pre-alarm,<br>b3 = underfrequency pre-alarm,<br>b4 = overcurrent pre-alarm,<br>b5 = phase imbalance pre-alarm,<br>b6–b15 UNASSIGNED |       |

| Holding Register | Parameter                             | Range        | Read/Write Supported | Data Format                                                                                                                                                                                                                       | Units |
|------------------|---------------------------------------|--------------|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 40641            | Gen Protection Alarms (upper 16 bits) | 0–65535      | R                    | b16–b31 UNASSIGNED                                                                                                                                                                                                                |       |
| 40642            | Gen Protection Alarms (lower 16 bits) | 0–65535      | R                    | b0 = overvoltage alarm,<br>b1 = undervoltage alarm,<br>b2 = overfrequency alarm,<br>b3 = underfrequency alarm,<br>b4 = overcurrent alarm,<br>b5 = phase imbalance alarm,<br>b6–b15 UNASSIGNED                                     |       |
| REAL TIME CLOCK  |                                       |              |                      |                                                                                                                                                                                                                                   |       |
| 40700            | Hours                                 | 0–23         | R W                  |                                                                                                                                                                                                                                   |       |
| 40701            | Minutes                               | 0–59         | R W                  |                                                                                                                                                                                                                                   |       |
| 40702            | Seconds                               | 0–59         | R W                  |                                                                                                                                                                                                                                   |       |
| 40703            | Month                                 | 1–12         | R W                  |                                                                                                                                                                                                                                   |       |
| 40704            | Day                                   | 1–31         | R W                  |                                                                                                                                                                                                                                   |       |
| 40705            | Year                                  |              | R W                  |                                                                                                                                                                                                                                   |       |
| 40706            | Daylight Savings Time Enable          | 0–1          | R W                  | 0 = Off<br>1 = On                                                                                                                                                                                                                 |       |
| 40707–33         | RESERVED                              |              |                      |                                                                                                                                                                                                                                   |       |
| RUN STATISTICS   |                                       |              |                      |                                                                                                                                                                                                                                   |       |
| 40734            | Maintenance Interval Hours            | 0–5000       | R W                  |                                                                                                                                                                                                                                   | hours |
| 40735            | Hours Until Maintenance               | 0–5000       | R W                  |                                                                                                                                                                                                                                   | hours |
| 40737            | Commission Start Month                | 1–12         | R W                  |                                                                                                                                                                                                                                   | month |
| 40738            | Commission Start Day                  | 1–31         | R W                  |                                                                                                                                                                                                                                   | day   |
| 40739            | Commission Start Year                 | 0–99         | R W                  |                                                                                                                                                                                                                                   | year  |
| 40740–41         | Cumulative Run Hours x 60             | 0–4294967295 | R W                  | DP                                                                                                                                                                                                                                | hours |
| 40742–43         | Cumulative Loaded Run Hours x 60      | 0–4294967295 | R W                  | DP                                                                                                                                                                                                                                | hours |
| 40744–45         | Cumulative Unloaded Run Hours x 60    | 0–4294967295 | R W                  | DP                                                                                                                                                                                                                                | hours |
| 40746            | Start Count                           | 0–65535      | R W                  |                                                                                                                                                                                                                                   |       |
| 40747            | Session Start Month                   | 1–12         | R W                  |                                                                                                                                                                                                                                   | month |
| 40748            | Session Start Day                     | 1–31         | R W                  |                                                                                                                                                                                                                                   | day   |
| 40749            | Session Start Year                    | 0–99         | R W                  |                                                                                                                                                                                                                                   | year  |
| 40750–51         | Session Run Hours x 60                | 0–4294967295 | R W                  | DP                                                                                                                                                                                                                                | hours |
| 40752–53         | Session Loaded Run Hours x 60         | 0–4294967295 | R W                  | DP                                                                                                                                                                                                                                | hours |
| 40754–55         | Session Unloaded Run Hours x 60       | 0–4294967295 | R W                  | DP                                                                                                                                                                                                                                | hours |
| CAN Bus ECU      |                                       |              |                      |                                                                                                                                                                                                                                   |       |
| 40758            | ECU Control Output Select             | 0–1          | R W                  | 0 = fuel solenoid relay,<br>1 = pre-start relay                                                                                                                                                                                   |       |
| 40759            | ECU Pulsing Enable                    | 0–1          | R W                  | 0 = pulsing is enabled,<br>1 = pulsing is disabled                                                                                                                                                                                |       |
| 40760            | MDEC Alarms                           | 0–65535      | R                    | b0 = High Charge Air Temp,<br>b1 = High Oil Temp,<br>b2 = High Coolant Temp,<br>b3 = Low Aftercooler Level,<br>b4 = Low Fuel Delivery Press,<br>b5 = Low Oil Press,<br>b6 = Overspeed,<br>b7 = Combined Red,<br>b8–b15 UNASSIGNED |       |



| Holding Register | Parameter      | Range   | Read/Write Supported | Data Format                                                                                                                                                                                                                                                                                                                                                                                          | Units |
|------------------|----------------|---------|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| 40761            | mtu Pre-alarms | 0–65535 | R                    | b0 = High ECU Temp,<br>b1 = High Oil Temp,<br>b2 = High Intercooler Temp,<br>b3 = High Charge Air Temp,<br>b4 = High Coolant Temp,<br>b5 = Shutdown Override,<br>b6 = High Fuel Rail Press,<br>b7 = Low Fuel Rail Press,<br>b8 = Low Coolant Level,<br>b9 = Low Charge Air Pressure,<br>b10 = Low Fuel Delivery Pressure,<br>b11 = Low Oil Pressure,<br>b12 = Combined Yellow,<br>b13–b15 UNASSIGNED |       |

### Legacy Parameter Table for DGC-2000

The DGC-2020 maps all legacy parameters previously associated with the DGC-2000 into the Holding Register address space (40000 to 41999). Some of these registers overlap the registers of the DGC-500 and DGC-1000 which constitutes a separate register table. Query address N will access the Holding Register N+1. The Data Format is Integer type data unless identified otherwise in the Data Format column.

| Holding Register                  | Parameter                   | Range                                                 | Read/Write Supported | Data Format                                   | Units           |
|-----------------------------------|-----------------------------|-------------------------------------------------------|----------------------|-----------------------------------------------|-----------------|
| <b>PRODUCT ACCESS INFORMATION</b> |                             |                                                       |                      |                                               |                 |
| 40252                             | <Reserved>                  |                                                       |                      |                                               |                 |
| 40253                             | User Ltd Access Password(a) | 'A'-'Z', 'a'-'z', ' ', '0'-'9'                        | W                    |                                               |                 |
| 40254                             | User Ltd Access Password(b) |                                                       | W                    |                                               |                 |
| 40255                             | User Ltd Access Password(c) |                                                       | W                    |                                               |                 |
| 40256                             | User Ltd Access Password(d) |                                                       | W                    |                                               |                 |
| 40257                             | <Reserved>                  |                                                       |                      |                                               |                 |
| 40006                             | Front Panel Password(a)     | All front panel pushbuttons except for RUN, OFF, AUTO | R                    |                                               |                 |
| 40007                             | Front Panel Password(b)     |                                                       | R                    |                                               |                 |
| 40008                             | Front Panel Password(c)     |                                                       | R                    |                                               |                 |
| 40009                             | Front Panel Password(d)     |                                                       | R                    |                                               |                 |
| 40010–13                          | <Reserved>                  |                                                       |                      |                                               |                 |
| 40014                             | User Ttl Access Password(a) | 'A'-'Z', 'a'-'z', ' ', '0'-'9'                        | W                    |                                               |                 |
| 40015                             | User Ttl Access Password(b) |                                                       | W                    |                                               |                 |
| 40016                             | User Ttl Access Password(c) |                                                       | W                    |                                               |                 |
| 40017                             | User Ttl Access Password(d) |                                                       | W                    |                                               |                 |
| 40030                             | <Reserved>                  |                                                       |                      |                                               |                 |
| 40031                             | Logoff                      | Data = Don't Care                                     |                      |                                               |                 |
| 40032                             | <Reserved>                  |                                                       |                      |                                               |                 |
| <b>COMMUNICATION PARAMETERS</b>   |                             |                                                       |                      |                                               |                 |
| 40051                             | Comm Baud Rate              | 0                                                     | R W                  | 0 = 9600                                      | Baud            |
| 40052                             | Remote Delay Time           | 0–20                                                  | R W                  | 0 = Min.<br>1 = 10<br>2 = 20 etc.<br>20 = 200 | Milliseconds 10 |

| Holding Register          | Parameter                          | Range             | Read/Write Supported | Data Format                               | Units             |
|---------------------------|------------------------------------|-------------------|----------------------|-------------------------------------------|-------------------|
| 40053                     | Comm Parity                        | 0–2               | R W                  | 0 = None<br>1 = Odd<br>2 = Even           |                   |
| 40054                     | Device Address                     | 1–247             | R W                  |                                           |                   |
| 40055                     | Modern Time Delay                  | 0–9999            | R W                  |                                           | Microseconds      |
| 40056                     | Embedded Code Version No.          | 100–9999          | R                    |                                           | Version No. x 100 |
| <b>PARAMETER SETTINGS</b> |                                    |                   |                      |                                           |                   |
| 40078                     | Remote (PC) Emergency Stop         | 0–1               | W                    | 0 = Off<br>1 = Stop                       |                   |
| 40079                     | Remote Start / Stop                | 0–1               | W                    | 0 = Stop<br>1 = Start                     |                   |
| 40080                     | <Reserved>                         |                   |                      |                                           |                   |
| 40081                     | Settings Source                    | 0–2               | R W                  | 0 = Factory<br>1 = OEM<br>2 = User        |                   |
| 40082                     | Save Settings                      | Data = Don't Care | W                    |                                           |                   |
| 40083                     | <Reserved>                         |                   |                      |                                           |                   |
| <b>SYSTEM PARAMETERS</b>  |                                    |                   |                      |                                           |                   |
| 40091                     | Generator Connection               | 0–2               | R W                  | 0 = 3ph L-L<br>1 = 3ph L-N<br>2 = 1ph A-B |                   |
| 40092                     | NFPA Level                         | 0–2               | R W                  | 0 = Off<br>1 = Level 1<br>2 = Level 2     |                   |
| 40093                     | Unit System                        | 0–1               | R W                  | 0 = English<br>1 = Metric                 |                   |
| 40094                     | Battery Volts                      | 0–1               | R W                  | 0 = 12 Vdc<br>1 = 24 Vdc                  |                   |
| 40095                     | Generator Frequency                | 0–1               | R W                  | 0 = 50 Hz<br>1 = 60 Hz                    |                   |
| 40096                     | Rated Engine RPM                   | 25–3600           | R W                  |                                           | RPM               |
| 40097                     | Rated Engine RPM Minimum           | 750               | R                    |                                           | RPM               |
| 40098                     | Rated Engine RPM Maximum           | 3600              | R                    |                                           | RPM               |
| 40099                     | Rated Engine RPM Stepsize          | 50                | R                    |                                           | RPM               |
| 40100                     | Number Flywheel Teeth              | 50–500            | R W                  |                                           |                   |
| 40101                     | Number Flywheel Teeth Minimum      | 50                | R                    |                                           |                   |
| 40102                     | Number Flywheel Teeth Maximum      | 500               | R                    |                                           |                   |
| 40103                     | Number Flywheel Teeth Stepsize     | 1                 | R                    |                                           |                   |
| 40104                     | Genset kW Rating                   | 25–9999           | R W                  |                                           | Kilowatt          |
| 40105                     | Genset kW Rating Minimum           | 25                | R                    |                                           | Kilowatt          |
| 40106                     | Genset kW Rating Maximum           | 9999              | R                    |                                           | Kilowatt          |
| 40107                     | Genset kW Rating Stepsize          | 1                 | R                    |                                           | Kilowatt          |
| 40108                     | No Load Cool Down Time             | 0–60              | R W                  |                                           | Minutes           |
| 40109                     | No Load Cool Down Time Minimum     | 0                 | R                    |                                           | Minutes           |
| 40110                     | No Load Cool Down Time Maximum     | 60                | R                    |                                           | Minutes           |
| 40111                     | No Load Cool Down Time Stepsize    | 5                 | R                    |                                           | Minutes           |
| 40112                     | Alternator Frequency Rated         | 100–900           | R W                  |                                           | Hertz             |
| 40113                     | Alternator Frequency Rated Minimum | 100               | R                    |                                           | Hertz             |
| 40114                     | Alternator Frequency Rated Maximum | 900               | R                    |                                           | Hertz             |

| Holding Register               | Parameter                           | Range   | Read/Write Supported | Data Format       | Units       |
|--------------------------------|-------------------------------------|---------|----------------------|-------------------|-------------|
| 40115                          | Alternator Frequency Rated Stepsize | 1       | R                    |                   | Hertz       |
| <b>GENERATOR PT PRIMARY</b>    |                                     |         |                      |                   |             |
| 40121                          | Voltage(a)                          | 1–15000 | R W                  | DP                | Vac x 10000 |
| 40122                          | Voltage(b)                          |         | R W                  | DP                | Vac         |
| 40123                          | Voltage Minimum(a)                  | 1       | R                    | DP                | Vac x 10000 |
| 40124                          | Voltage Minimum(b)                  |         | R                    | DP                | Vac         |
| 40125                          | Voltage Maximum(a)                  | 15000   | R                    | DP                | Vac x 10000 |
| 40126                          | Voltage Maximum(b)                  |         | R                    | DP                | Vac         |
| 40127                          | Voltage Stepsize(a)                 | 1       | R                    | DP                | Vac x 10000 |
| 40128                          | Voltage Stepsize(b)                 |         | R                    | DP                | Vac         |
| <b>GENERATOR PT SECONDARY</b>  |                                     |         |                      |                   |             |
| 40129                          | Voltage                             | 1–480   | R W                  |                   | Vac         |
| 40130                          | Voltage Minimum                     | 1       | R                    |                   | Vac         |
| 40131                          | Voltage Maximum                     | 480     | R                    |                   | Vac         |
| 40132                          | Voltage Stepsize                    | 1       | R                    |                   | Vac         |
| <b>GENERATOR CT PRIMARY</b>    |                                     |         |                      |                   |             |
| 40133                          | Current                             | 1–5000  | R W                  |                   | Aac         |
| 40134                          | Current Minimum                     | 1       | R                    |                   | Aac         |
| 40135                          | Current Maximum                     | 5000    | R                    |                   | Aac         |
| 40136                          | Current Stepsize                    | 1       | R                    |                   | Aac         |
| <b>BUS PT PRIMARY</b>          |                                     |         |                      |                   |             |
| 40141                          | Voltage(a)                          | 1–15000 | R W                  | DP                | Vac x 10000 |
| 40142                          | Voltage(b)                          |         | R W                  | DP                | Vac         |
| 40143                          | Voltage Minimum(a)                  | 1       | R                    | DP                | Vac x 10000 |
| 40144                          | Voltage Minimum(b)                  |         | R                    | DP                | Vac         |
| 40145                          | Voltage Maximum(a)                  | 15000   | R                    | DP                | Vac x 10000 |
| 40146                          | Voltage Maximum(b)                  |         | R                    | DP                | Vac         |
| 40147                          | Voltage Stepsize(a)                 | 1       | R                    | DP                | Vac x 10000 |
| 40148                          | Voltage Stepsize(b)                 |         | R                    | DP                | Vac         |
| <b>BUS PT SECONDARY</b>        |                                     |         |                      |                   |             |
| 40149                          | Voltage                             | 1–480   | R W                  |                   | Vac         |
| 40150                          | Voltage Minimum                     | 1       | R                    |                   | Vac         |
| 40151                          | Voltage Maximum                     | 480     | R                    |                   | Vac         |
| 40152                          | Voltage Stepsize                    | 1       | R                    |                   | Vac         |
| <b>LOW FUEL PRE-ALARM</b>      |                                     |         |                      |                   |             |
| 40181                          | Enable                              | 0–1     | R W                  | 0 = Off<br>1 = On |             |
| 40182                          | Threshold                           | 10–100  | R W                  |                   | % Full Tank |
| 40183                          | Minimum                             | 10      | R                    |                   | % Full Tank |
| 40184                          | Maximum                             | 100     | R                    |                   | % Full Tank |
| 40185                          | Stepsize                            | 1       | R                    |                   | % Full Tank |
| <b>LOW COOL TEMP PRE-ALARM</b> |                                     |         |                      |                   |             |
| 40186                          | Enable                              | 0–1     | R W                  | 0 = Off<br>1 = On |             |
| 40187                          | Threshold                           | 40–100  | R W                  |                   | Deg F       |

| Holding Register                          | Parameter                       | Range                            | Read/Write Supported | Data Format       | Units      |
|-------------------------------------------|---------------------------------|----------------------------------|----------------------|-------------------|------------|
| 40188                                     | Minimum                         | 40                               | R                    |                   | Deg F      |
| 40189                                     | Maximum                         | 100                              | R                    |                   | Deg F      |
| 40190                                     | Stepsize                        | 1                                | R                    |                   | Deg F      |
| <b>BATTERY OVERVOLTAGE PRE-ALARM</b>      |                                 |                                  |                      |                   |            |
| 40191                                     | Enable                          | 0–1                              | R W                  | 0 = Off<br>1 = On |            |
| 40192                                     | Threshold                       | 140–160 (12 V)<br>240–320 (24 V) | R W                  |                   | 0.1 Vdc    |
| 40193                                     | Minimum                         | 140 / 240                        | R                    |                   | 0.1 Vdc    |
| 40194                                     | Maximum                         | 160 / 320                        | R                    |                   | 0.1 Vdc    |
| 40195                                     | Stepsize                        | 1                                | R                    |                   | 0.1 Vdc    |
| <b>MAINTENANCE INTERVAL PRE-ALARM</b>     |                                 |                                  |                      |                   |            |
| 40196                                     | Enable                          | 0–1                              | R W                  | 0 = Off<br>1 = On |            |
| 40197                                     | Threshold                       | 0–5000                           | R W                  |                   | Hours      |
| 40198                                     | Minimum                         | 0                                | R                    |                   | Hours      |
| 40199                                     | Maximum                         | 5000                             | R                    |                   | Hours      |
| 40200                                     | Stepsize                        | 10                               | R                    |                   | Hours      |
| <b>ENGINE KW OVERLOAD PRE-ALARM</b>       |                                 |                                  |                      |                   |            |
| 40201                                     | Enable                          | 0–1                              | R W                  | 0 = Off<br>1 = On |            |
| 40202                                     | Threshold                       | 95–140                           | R W                  |                   | % of Rated |
| 40203                                     | Minimum                         | 95                               | R                    |                   | % of Rated |
| 40204                                     | Maximum                         | 140                              | R                    |                   | % of Rated |
| 40205                                     | Stepsize                        | 1                                | R                    |                   | % of Rated |
| <b>HIGH COOLANT TEMPERATURE PRE-ALARM</b> |                                 |                                  |                      |                   |            |
| 40206                                     | Enable                          | 0–1                              | R W                  | 0 = Off<br>1 = On |            |
| 40207                                     | Threshold                       | 100–280                          | R W                  |                   | Deg F      |
| 40208                                     | Minimum                         | 100                              | R                    |                   | Deg F      |
| 40209                                     | Maximum                         | 280                              | R                    |                   | Deg F      |
| 40210                                     | Stepsize                        | 1                                | R                    |                   | Deg F      |
| <b>LOW OIL PRESSURE PRE-ALARM</b>         |                                 |                                  |                      |                   |            |
| 40211                                     | Enable                          | 0–1                              | R W                  | 0 = Off<br>1 = On |            |
| 40212                                     | Threshold                       | 3–100                            | R W                  |                   | PSI        |
| 40213                                     | Minimum                         | 3                                | R                    |                   | PSI        |
| 40214                                     | Maximum                         | 100                              | R                    |                   | PSI        |
| 40215                                     | Stepsize                        | 1                                | R                    |                   | PSI        |
| <b>LOW BATTERY VOLTAGE PRE-ALARM</b>      |                                 |                                  |                      |                   |            |
| 40216                                     | Enable                          | 0–1                              | R W                  | 0 = Off<br>1 = On |            |
| 40217                                     | Threshold                       | 60–120 (12 V)<br>120–240 (24 V)  | R W                  |                   | 0.1 Vdc    |
| 40218                                     | Minimum                         | 60 / 120                         | R                    |                   | 0.1 Vdc    |
| 40219                                     | Maximum                         | 120 / 240                        | R                    |                   | 0.1 Vdc    |
| 40220                                     | Stepsize                        | 1 (0.1 Vdc)                      | R                    |                   | 0.1 Vdc    |
| 40221                                     | Pre-alarm Activation Time Delay | 1–10                             | R W                  |                   | Seconds    |

| Holding Register                      | Parameter                           | Range                         | Read/Write Supported | Data Format       | Units      |
|---------------------------------------|-------------------------------------|-------------------------------|----------------------|-------------------|------------|
| 40222                                 | Activation Time Delay Minimum       | 1                             | R                    |                   | Seconds    |
| 40223                                 | Activation Time Delay Maximum       | 10                            | R                    |                   | Seconds    |
| 40224                                 | Activation Time Delay Stepsize      | 1                             | R                    |                   | Seconds    |
| <b>WEAK BATTERY VOLTAGE PRE-ALARM</b> |                                     |                               |                      |                   |            |
| 40225                                 | Enable                              | 0–1                           | R W                  | 0 = Off<br>1 = On |            |
| 40226                                 | Threshold                           | 40–80 (12 V)<br>80–160 (24 V) | R W                  |                   | 0.1 Vdc    |
| 40227                                 | Minimum                             | 40 / 80                       | R                    |                   | 0.1 Vdc    |
| 40228                                 | Maximum                             | 80 / 160                      | R                    |                   | 0.1 Vdc    |
| 40229                                 | Stepsize                            | 1 (0.1 Vdc)                   | R                    |                   | 0.1 Vdc    |
| 40230                                 | Pre-alarm Activation Time Delay     | 1–10                          | R W                  |                   | Seconds    |
| 40231                                 | Activation Time Delay Minimum       | 1                             | R                    |                   | Seconds    |
| 40232                                 | Activation Time Delay Maximum       | 10                            | R                    |                   | Seconds    |
| 40233                                 | Activation Time Delay Stepsize      | 1                             | R                    |                   | Seconds    |
| <b>LOGON PASSWORD (40252–7)</b>       |                                     |                               |                      |                   |            |
| <b>HIGH COOLANT TEMPERATURE ALARM</b> |                                     |                               |                      |                   |            |
| 40281                                 | Enable                              | 0–1                           | R W                  | 0 = Off<br>1 = On |            |
| 40282                                 | Shutdown Enable                     | 0–1                           | R W                  | 0 = Off<br>1 = On |            |
| 40283                                 | Threshold                           | 100–280                       | R W                  |                   | Deg F      |
| 40284                                 | Minimum                             | 100                           | R                    |                   | Deg F      |
| 40285                                 | Maximum                             | 280                           | R                    |                   | Deg F      |
| 40286                                 | Stepsize                            | 1                             | R                    |                   | Deg F      |
| 40287                                 | Arming Delay after Crank Disconnect | 60                            | R W                  |                   | Seconds    |
| 40288                                 | Arming Delay Minimum                | 60                            | R                    |                   | Seconds    |
| 40289                                 | Arming Delay Maximum                | 60                            | R                    |                   | Seconds    |
| 40290                                 | Arming Delay Stepsize               | 0                             | R                    |                   | Seconds    |
| <b>LOW OIL PRESSURE ALARM</b>         |                                     |                               |                      |                   |            |
| 40291                                 | Enable                              | 0–1                           | R W                  | 0 = Off<br>1 = On |            |
| 40292                                 | Shutdown Enable                     | 0–1                           | R W                  | 0 = Off<br>1 = On |            |
| 40293                                 | Threshold                           | 3–100                         | R W                  |                   | PSI        |
| 40294                                 | Minimum                             | 3                             | R                    |                   | PSI        |
| 40295                                 | Maximum                             | 100                           | R                    |                   | PSI        |
| 40296                                 | Stepsize                            | 1                             | R                    |                   | PSI        |
| 40297                                 | Arming Delay after Crank Disconnect | 5–15                          | R W                  |                   | Seconds    |
| 40298                                 | Arming Delay Minimum                | 5                             | R                    |                   | Seconds    |
| 40299                                 | Arming Delay Maximum                | 15                            | R                    |                   | Seconds    |
| 40300                                 | Arming Delay Stepsize               | 1                             | R                    |                   | Seconds    |
| <b>OVERSPEED ALARM</b>                |                                     |                               |                      |                   |            |
| 40301                                 | Enable                              | 0–1                           | R W                  | 0 =Off<br>1 =On   |            |
| 40302                                 | Shutdown Enable                     | 0–1                           | R W                  | 0 =Off<br>1 =On   |            |
| 40303                                 | Threshold                           | 105–140                       | R W                  |                   | % of Rated |

| Holding Register           | Parameter                                                 | Range                      | Read/Write Supported | Data Format                 | Units       |
|----------------------------|-----------------------------------------------------------|----------------------------|----------------------|-----------------------------|-------------|
| 40304                      | Minimum                                                   | 105                        | R                    |                             | % of Rated  |
| 40305                      | Maximum                                                   | 140                        | R                    |                             | % of Rated  |
| 40306                      | Stepsize                                                  | 1                          | R                    |                             | % of Rated  |
| 40307                      | Alarm Activation Time Delay                               | 0–500                      | R W                  |                             | Millisecond |
| 40308                      | Activation Time Delay Minimum                             | 0                          | R                    |                             | Millisecond |
| 40309                      | Activation Time Delay Maximum                             | 500                        | R                    |                             | Millisecond |
| 40310                      | Activation Time Delay Stepsize                            | 10                         | R                    |                             | Millisecond |
| <b>SENDER FAIL ALARMS</b>  |                                                           |                            |                      |                             |             |
| 40311                      | Coolant Temperature Sender Failure Alarm Enable           | 0–1                        | R W                  | 0 = Off<br>1 = On           |             |
| 40312                      | Oil Pressure Sender Failure Alarm Enable                  | 0–1                        | R W                  | 0 = Off<br>1 = On           |             |
| 40314                      | Magnetic Pick-up Failure Alarm Enable                     | 0–1                        | R W                  | 0 = Off<br>1 = On           |             |
| 40315                      | Loss of Generator Voltage Alarm Enable                    | 0–1                        | R W                  | 0 = Off<br>1 = On           |             |
| 40316                      | Pre-alarm Buzzer Enable                                   | 0–1                        | R W                  | 0 = Off<br>1 = On           |             |
| 40317                      | Battery Charger Failure Pre-alarm Enable                  | 0–1                        | R W                  | 0 = Off<br>1 = On           |             |
| 40318                      | Global Sender Failure Alarm Time Delay                    | 1–10                       | R W                  |                             | Seconds     |
| 40319                      | Coolant Temperature Sender Failure Alarm Activation Delay | 5–30 (increment size of 5) | R W                  |                             | Minutes     |
| <b>CRANKING PARAMETERS</b> |                                                           |                            |                      |                             |             |
| 40351                      | Cranking Style                                            | 0–1                        | R W                  | 0 = Continuous<br>1 = Cycle |             |
| 40352                      | Number of Crank Cycles                                    | 1–7                        | R W                  |                             |             |
| 40353                      | Number of Crank Cycles Minimum                            | 1                          | R                    |                             |             |
| 40354                      | Number of Crank Cycles Maximum                            | 7                          | R                    |                             |             |
| 40355                      | Number of Crank Cycles Stepsize                           | 1                          | R                    |                             |             |
| 40356                      | Cycle Crank Time                                          | 5–15                       | R W                  |                             | Seconds     |
| 40357                      | Cycle Crank Time Minimum                                  | 5                          | R                    |                             | Seconds     |
| 40358                      | Cycle Crank Time Maximum                                  | 15                         | R                    |                             | Seconds     |
| 40359                      | Cycle Crank Time Stepsize                                 | 1                          | R                    |                             | Seconds     |
| 40360                      | Continuous Crank Time                                     | 1–60                       | R W                  |                             | Seconds     |
| 40361                      | Continuous Crank Time Minimum                             | 1                          | R                    |                             | Seconds     |
| 40362                      | Continuous Crank Time Maximum                             | 60                         | R                    |                             | Seconds     |
| 40363                      | Continuous Crank Time Stepsize                            | 1                          | R                    |                             | Seconds     |
| 40364                      | Crank Disconnect Limit                                    | 10–100                     | R W                  |                             | % of Rated  |
| 40365                      | Crank Disconnect Limit Minimum                            | 10                         | R                    |                             | % of Rated  |
| 40366                      | Crank Disconnect Limit Maximum                            | 100                        | R                    |                             | % of Rated  |
| 40367                      | Crank Disconnect Limit Stepsize                           | 1                          | R                    |                             | % of Rated  |
| 40368                      | Pre-crank Delay                                           | 0–30                       | R W                  |                             | Seconds     |
| 40369                      | Pre-crank Delay Minimum                                   | 0                          | R                    |                             | Seconds     |
| 40370                      | Pre-crank Delay Maximum                                   | 30                         | R                    |                             | Seconds     |
| 40371                      | Pre-crank Delay Stepsize                                  | 1                          | R                    |                             | Seconds     |

| Holding Register         | Parameter                              | Range | Read/Write Supported | Data Format                                                                                                                                               | Units           |
|--------------------------|----------------------------------------|-------|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| 40372                    | Pre-crank Contact after Disconnect     | 0–1   | R W                  | 0 = Open<br>1 = Closed                                                                                                                                    |                 |
| <b>SYSTEM MONITOR</b>    |                                        |       |                      |                                                                                                                                                           |                 |
| 40374                    | Remaining Cooldown Time                | 0–60  | R                    |                                                                                                                                                           | Minutes         |
| 40375                    | <Reserved>                             |       |                      |                                                                                                                                                           |                 |
| 40376                    | Active Speed Signal Sources            | 1–4   | R                    | 1 = MPU<br>2 = ALT<br>3 = GEN<br>4 = NONE                                                                                                                 |                 |
| 40377                    | Sender Failure Alarm Codes             |       | R                    | b0 = Cool Temp<br>b1 = Oil Press<br>b2 = Reserved<br>b3 = Spd Signal<br>b4 = Gen Volt<br>b5–b7 Not Used                                                   |                 |
| 40378                    | Alarm Codes                            |       | R                    | b0 = Hi Cool Temp<br>b1 = Low Coolant Level<br>b2 = Airbox<br>b3 = E-Stop<br>b4 = Sender Fail<br>b5 = Over-crank<br>b6 = Over-speed<br>b7 = Low Oil Press |                 |
| 40379                    | Pre-Alarm Codes                        |       | R                    | b0 = Hi Cool Temp<br>b1 = Low Cool Temp<br>b2 = Weak Batt<br>b3 = Low Batt<br>b4 = Batt ov<br>b5 = Charger Fail<br>b6 = Service Due<br>b7 = kW Overload   |                 |
| 40380                    | Pre-Alarm Codes, Group 2               |       | R                    | b0 = Low Oil Press<br>b1 = Low Fuel<br>b2 = Reserved<br>b3 = Reserved<br>b4–b7 Not Used                                                                   |                 |
| 40381                    | Engine Coolant Temperature             |       | R                    |                                                                                                                                                           | Deg F           |
| 40382                    | Engine Oil Pressure                    |       | R                    |                                                                                                                                                           | PSI             |
| 40383                    | Battery Voltage                        |       | R                    |                                                                                                                                                           | 0.1 Vdc         |
| 40384                    | Fuel Level                             |       | R                    |                                                                                                                                                           | % Full Tank     |
| 40385                    | Time Remaining until Maintenance       |       | R                    |                                                                                                                                                           | Hours           |
| 40386                    | Accumulated Engine Runtime(a)          |       | R                    | DP                                                                                                                                                        | Minutes x 10000 |
| 40387                    | Accumulated Engine Runtime(b)          |       | R                    | DP                                                                                                                                                        | Minutes         |
| 40388                    | Accumulated Engine Runtime Warranty(a) |       | R W                  | DP                                                                                                                                                        | Minutes x 10000 |
| 40389                    | Accumulated Engine Runtime Warranty(b) |       | R W                  | DP                                                                                                                                                        | Minutes         |
| 40390                    | Engine Speed(a)                        |       | R                    | DP                                                                                                                                                        | RPM x 10000     |
| 40391                    | Engine Speed(b)                        |       | R                    | DP                                                                                                                                                        | RPM             |
| 40392                    | Engine Load(a)                         |       | R                    | DP                                                                                                                                                        | %               |
| 40393                    | Engine Load(b)                         |       | R                    | DP                                                                                                                                                        | %               |
| <b>GENERATOR MONITOR</b> |                                        |       |                      |                                                                                                                                                           |                 |

| Holding Register                                     | Parameter                            | Range | Read/Write Supported | Data Format                               | Units               |
|------------------------------------------------------|--------------------------------------|-------|----------------------|-------------------------------------------|---------------------|
| 40394                                                | Phase a-b RMS Voltage(a)             |       | R                    | DP                                        | RMS Volt x 10000    |
| 40395                                                | Phase a-b RMS Voltage(b)             |       | R                    | DP                                        | RMS Volt            |
| 40396                                                | Phase b-c RMS Voltage(a)             |       | R                    | DP                                        | RMS Volt x 10000    |
| 40397                                                | Phase b-c RMS Voltage(b)             |       | R                    | DP                                        | RMS Volt            |
| 40398                                                | Phase c-a RMS Voltage(a)             |       | R                    | DP                                        | RMS Volt x 10000    |
| 40399                                                | Phase c-a RMS Voltage(b)             |       | R                    | DP                                        | RMS Volt            |
| 40400                                                | Phase a-n RMS Voltage(a)             |       | R                    | DP                                        | RMS Volt x 10000    |
| 40401                                                | Phase a-n RMS Voltage(b)             |       | R                    | DP                                        | RMS Volt            |
| 40402                                                | Phase b-n RMS Voltage(a)             |       | R                    | DP                                        | RMS Volt x 10000    |
| 40403                                                | Phase b-n RMS Voltage(b)             |       | R                    | DP                                        | RMS Volt            |
| 40404                                                | Phase c-n RMS Voltage(a)             |       | R                    | DP                                        | RMS Volt x 10000    |
| 40405                                                | Phase c-n RMS Voltage(b)             |       | R                    | DP                                        | RMS Volt            |
| 40406                                                | Bus RMS Voltage(a)                   |       | R                    | DP                                        | RMS Volt x 10000    |
| 40407                                                | Bus RMS Voltage(b)                   |       | R                    | DP                                        | RMS Volt            |
| 40408                                                | Phase a RMS Current                  |       | R                    |                                           | RMS Amps            |
| 40409                                                | Phase b RMS Current                  |       | R                    |                                           | RMS Amps            |
| 40410                                                | Phase c RMS Current                  |       | R                    |                                           | RMS Amps            |
| 40411                                                | Phase a Apparent Power(a)            |       | R                    | DP                                        | KVA x 10000         |
| 40412                                                | Phase a Apparent Power(b)            |       | R                    | DP                                        | KVA                 |
| 40413                                                | Phase b Apparent Power(a)            |       | R                    | DP                                        | KVA x 10000         |
| 40414                                                | Phase b Apparent Power(b)            |       | R                    | DP                                        | KVA                 |
| 40415                                                | Phase c Apparent Power(a)            |       | R                    | DP                                        | KVA x 10000         |
| 40416                                                | Phase c Apparent Power(b)            |       | R                    | DP                                        | KVA                 |
| 40417                                                | 3 Phase Apparent Power(a)            |       | R                    | DP                                        | KVA x 10000         |
| 40418                                                | 3 Phase Apparent Power(b)            |       | R                    | DP                                        | KVA                 |
| 40419                                                | Phase a Power(a)                     |       | R                    | DP                                        | KWatt x 10000       |
| 40420                                                | Phase a Power(b)                     |       | R                    | DP                                        | KWatt               |
| 40421                                                | Phase b Power(a)                     |       | R                    | DP                                        | KWatt x 10000       |
| 40422                                                | Phase b Power(b)                     |       | R                    | DP                                        | KWatt               |
| 40423                                                | Phase c Power(a)                     |       | R                    | DP                                        | KWatt x 10000       |
| 40424                                                | Phase c Power(b)                     |       | R                    | DP                                        | KWatt               |
| 40425                                                | 3 Phase power(a)                     |       | R                    | DP                                        | KWatt x 10000       |
| 40426                                                | 3 Phase power(b)                     |       | R                    | DP                                        | KWatt               |
| 40427                                                | Total kW-Hours saved in EE (a)       |       | R W                  | TP                                        | KWH x 10000 x 10000 |
| 40428                                                | Total kW-Hours saved in EE (b)       |       | R W                  | TP                                        | KWH x 10000         |
| 40429                                                | Total kW-Hours saved in EE (x)       |       | R W                  | TP                                        | KWH                 |
| 40430                                                | Power Factor                         |       | R                    |                                           | 0.01                |
| 40431–32                                             | <Reserved>                           |       |                      |                                           |                     |
| 40433                                                | Generator Frequency                  |       | R                    |                                           | 0.1 Hertz           |
| 40434                                                | Bus Frequency                        |       | R                    |                                           | 0.1 Hertz           |
| 40435                                                | Total kW-Minutes since last save (a) |       | R                    |                                           | kWm x 10000 x 10000 |
| 40436                                                | Total kW-Minutes since last save (b) |       | R                    |                                           | kWm x 10000         |
| 40437                                                | Total kW-Minutes since last save (x) |       | R                    |                                           | kWm                 |
| <b>CONTIGUOUS WRITE BLOCK (REGROUPED PARAMETERS)</b> |                                      |       |                      |                                           |                     |
| 40441                                                | Generator Connection                 | 0–2   | R W                  | 0 = 3ph L-L<br>1 = 3ph L-N<br>2 = 1ph A-B |                     |
| 40442                                                | NFPA Level                           | 0–2   | R W                  |                                           |                     |
| 40443                                                | Unit System                          | 0–1   | R W                  | 0 = English<br>1 = Metric                 |                     |



| Holding Register                      | Parameter                  | Range                            | Read/Write Supported | Data Format              | Units                                                                                                                                                                                     |
|---------------------------------------|----------------------------|----------------------------------|----------------------|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 40444                                 | Nominal Battery Voltage    | 0–1                              | R W                  | 0 = 12 Vdc<br>1 = 24 Vdc |                                                                                                                                                                                           |
| 40445                                 | Generator Frequency        | 0–1                              | R W                  | 0 = 50 Hz<br>1 = 60 Hz   |                                                                                                                                                                                           |
| 40446                                 | Rated Engine RPM           | 25–3600                          | R W                  |                          | RPM                                                                                                                                                                                       |
| 40447                                 | Number Flywheel Teeth      | 50–500                           | R W                  |                          |                                                                                                                                                                                           |
| 40448                                 | Genset KW Rating           | 25–9999                          | R W                  |                          | Kilowatt                                                                                                                                                                                  |
| 40449                                 | No Load Cool Down Time     | 0–60                             | R W                  |                          | Minutes                                                                                                                                                                                   |
| 40450                                 | Alternator Frequency Rated | 100–900                          | R W                  |                          | Hertz                                                                                                                                                                                     |
| 40451                                 | Generator Speed Mode       | Individual Bits are 0 or 1       | R W                  |                          | Active Speed Signals<br>b0=mag pick-up<br>b1=generator<br>b2=chg. alt.<br>Gen. Phase Rotation<br>b4=0 for A-B-C<br>b4=1 for A-C-B<br>Maintenance Timer<br>b5=0 is active<br>b5=1 to reset |
| <b>GENERATOR PT PRIMARY</b>           |                            |                                  |                      |                          |                                                                                                                                                                                           |
| 40452                                 | Voltage(a)                 | 1–15000                          | R W                  | DP                       | Vac x 10000                                                                                                                                                                               |
| 40453                                 | Voltage(b)                 |                                  | R W                  | DP                       | Vac                                                                                                                                                                                       |
| <b>GENERATOR PT SECONDARY</b>         |                            |                                  |                      |                          |                                                                                                                                                                                           |
| 40454                                 | Voltage                    | 1–480                            | R W                  |                          | Vac                                                                                                                                                                                       |
| <b>GENERATOR CT PRIMARY</b>           |                            |                                  |                      |                          |                                                                                                                                                                                           |
| 40455                                 | Current                    | 1–5000                           | R W                  |                          | Aac                                                                                                                                                                                       |
| 40456                                 | <Reserved>                 |                                  |                      |                          |                                                                                                                                                                                           |
| <b>BUS PT PRIMARY</b>                 |                            |                                  |                      |                          |                                                                                                                                                                                           |
| 40457                                 | Voltage(a)                 | 1–15000                          | R W                  | DP                       | Vac x 10000                                                                                                                                                                               |
| 40458                                 | Voltage(b)                 |                                  | R W                  | DP                       | Vac                                                                                                                                                                                       |
| <b>BUS PT SECONDARY</b>               |                            |                                  |                      |                          |                                                                                                                                                                                           |
| 40459                                 | Voltage                    | 1–480                            | R W                  |                          | Vac                                                                                                                                                                                       |
| <b>LOW FUEL PRE-ALARM</b>             |                            |                                  |                      |                          |                                                                                                                                                                                           |
| 40460                                 | Enable                     | 0–1                              | R W                  | 0 = Off<br>1 = On        |                                                                                                                                                                                           |
| 40461                                 | Threshold                  | 10–100                           | R W                  |                          | % Full Tank                                                                                                                                                                               |
| <b>LOW COOL TEMP PRE-ALARM</b>        |                            |                                  |                      |                          |                                                                                                                                                                                           |
| 40462                                 | Enable                     | 0–1                              | R W                  | 0 = Off<br>1 = On        |                                                                                                                                                                                           |
| 40463                                 | Threshold                  | 40–100                           | R W                  |                          | Deg F                                                                                                                                                                                     |
| <b>BATTERY OVERVOLTAGE PRE-ALARM</b>  |                            |                                  |                      |                          |                                                                                                                                                                                           |
| 40464                                 | Enable                     | 0–1                              | R W                  | 0 = Off<br>1 = On        |                                                                                                                                                                                           |
| 40465                                 | Threshold                  | 140–160 (12 V)<br>240–320 (24 V) | R W                  |                          | .01 Vdc                                                                                                                                                                                   |
| <b>MAINTENANCE INTERVAL PRE-ALARM</b> |                            |                                  |                      |                          |                                                                                                                                                                                           |
| 40466                                 | Enable                     | 0–1                              | R W                  | 0 = Off<br>1 = On        |                                                                                                                                                                                           |
| 40467                                 | Threshold                  | 0–5000                           | R W                  |                          | Hours                                                                                                                                                                                     |

| Holding Register                          | Parameter                                       | Range                           | Read/Write Supported | Data Format       | Units       |
|-------------------------------------------|-------------------------------------------------|---------------------------------|----------------------|-------------------|-------------|
| <b>ENGINE KW OVERLOAD PRE-ALARM</b>       |                                                 |                                 |                      |                   |             |
| 40468                                     | Enable                                          | 0–1                             | R W                  | 0 = Off<br>1 = On |             |
| 40469                                     | Threshold                                       | 95–140                          | R W                  |                   | % of Rated  |
| <b>HIGH COOLANT TEMPERATURE PRE-ALARM</b> |                                                 |                                 |                      |                   |             |
| 40470                                     | Enable                                          | 0–1                             | R W                  | 0 = Off<br>1 = On |             |
| 40471                                     | Threshold                                       | 100–280                         | R W                  |                   | Deg F       |
| <b>LOW OIL PRESSURE PRE-ALARM</b>         |                                                 |                                 |                      |                   |             |
| 40472                                     | Enable                                          | 0–1                             | R W                  | 0 = Off<br>1 = On |             |
| 40473                                     | Threshold                                       | 3–100                           | R W                  |                   | PSI         |
| <b>LOW BATTERY VOLTAGE PRE-ALARM</b>      |                                                 |                                 |                      |                   |             |
| 40474                                     | Enable                                          | 0–1                             | R W                  | 0 = Off<br>1 = On |             |
| 40475                                     | Threshold                                       | 60–120 (12 V)<br>120–240 (24 V) | R W                  |                   | 0.1 Vdc     |
| 40476                                     | Pre-alarm Activation Time Delay                 | 1–10                            | R W                  |                   | Seconds     |
| <b>WEAK BATTERY VOLTAGE PRE-ALARM</b>     |                                                 |                                 |                      |                   |             |
| 40477                                     | Enable                                          | 0–1                             | R W                  | 0 = Off<br>1 = On |             |
| 40478                                     | Threshold                                       | 40–80 (12 V)<br>80–160 (24 V)   | R W                  |                   | 0.1 Vdc     |
| 40479                                     | Pre-alarm Activation Time Delay                 | 1–10                            | R W                  |                   | Seconds     |
| <b>HIGH COOLANT TEMPERATURE ALARM</b>     |                                                 |                                 |                      |                   |             |
| 40480                                     | Enable                                          | 0–1                             | R W                  | 0 = Off<br>1 = On |             |
| 40481                                     | Shutdown Enable                                 | 0–1                             | R W                  | 0 = Off<br>1 = On |             |
| 40482                                     | Threshold                                       | 100–280                         | R W                  |                   | Deg F       |
| 40483                                     | Arming Delay after Crank Disconnect             | 60                              | R W                  |                   | Seconds     |
| <b>LOW OIL PRESSURE ALARM</b>             |                                                 |                                 |                      |                   |             |
| 40484                                     | Enable                                          | 0–1                             | R W                  | 0 = Off<br>1 = On |             |
| 40485                                     | Shutdown Enable                                 | 0–1                             | R W                  | 0 = Off<br>1 = On |             |
| 40486                                     | Threshold                                       | 3–100                           | R W                  |                   | PSI         |
| 40487                                     | Arming Delay after Crank Disconnect             | 5–15                            | R W                  |                   | Seconds     |
| <b>OVERSPEED ALARM</b>                    |                                                 |                                 |                      |                   |             |
| 40488                                     | Enable                                          | 0–1                             | R W                  | 0 = Off<br>1 = On |             |
| 40489                                     | Shutdown Enable                                 | 0–1                             | R W                  | 0 = Off<br>1 = On |             |
| 40490                                     | Threshold                                       | 105–140                         | R W                  |                   | % of Rated  |
| 40491                                     | Alarm Activation Time Delay                     | 0–500                           | R W                  |                   | Millisecond |
| <b>SENDER FAIL ALARMS</b>                 |                                                 |                                 |                      |                   |             |
| 40492                                     | Coolant Temperature Sender Failure Alarm Enable | 0–1                             | R W                  | 0 = Off<br>1 = On |             |
| 40493                                     | Oil Pressure Sender Failure Alarm Enable        | 0–1                             | R W                  | 0 = Off<br>1 = On |             |
| 40495                                     | Magnetic Pick-up Failure Alarm Enable           | 0–1                             | R W                  | 0 = Off<br>1 = On |             |

| Holding Register           | Parameter                                | Range  | Read/Write Supported | Data Format             | Units           |
|----------------------------|------------------------------------------|--------|----------------------|-------------------------|-----------------|
| 40496                      | Loss of Generator Voltage Alarm Enable   | 0–1    | R W                  | 0 = Off<br>1 = On       |                 |
| 40497                      | Pre-alarm Buzzer Enable                  | 0–1    | R W                  | 0 = Off<br>1 = On       |                 |
| 40498                      | Battery Charger Failure Pre-alarm Enable | 0–1    | R W                  | 0 = Off<br>1 = On       |                 |
| 40499                      | Global Sender Failure Alarm Time Delay   | 0–10   | R W                  |                         | Seconds         |
| <b>CRANKING PARAMETERS</b> |                                          |        |                      |                         |                 |
| 40500                      | Cranking Style                           | 0–1    | R W                  | 0=Continuous<br>1=Cycle |                 |
| 40501                      | Number of Crank Cycles                   | 1–7    | R W                  |                         |                 |
| 40502                      | Cycle Crank Time                         | 5–15   | R W                  |                         | Seconds         |
| 40503                      | Continuous Crank Time                    | 1–60   | R W                  |                         | Seconds         |
| 40504                      | Crank Disconnect Limit                   | 10–100 | R W                  |                         | % of Rated      |
| 40505                      | Pre-crank Delay                          | 0–30   | R W                  |                         | Seconds         |
| 40506                      | Pre-crank Contact after Disconnect       | 0–1    | R W                  | 0 = Open<br>1 = Closed  |                 |
| <b>SYSTEM MONITOR</b>      |                                          |        |                      |                         |                 |
| 40507                      | Accumulated Engine Runtime Warranty(a)   |        | R W                  | DP                      | Minutes x 10000 |
| 40508                      | Accumulated Engine Runtime Warranty(b)   |        | R W                  | DP                      | Minutes         |
| <b>CALIBRATION</b>         |                                          |        |                      |                         |                 |
| 40509                      | Voltage Calibration A(a)                 |        | R W                  | DP                      | x 10000         |
| 40510                      | Voltage Calibration A(b)                 |        | R W                  | DP                      | x 1             |
| 40511                      | Voltage Calibration B(a)                 |        | R W                  | DP                      | x 10000         |
| 40512                      | Voltage Calibration B(b)                 |        | R W                  | DP                      | x 1             |
| 40513                      | Voltage Calibration C(a)                 |        | R W                  | DP                      | x 10000         |
| 40514                      | Voltage Calibration C(b)                 |        | R W                  | DP                      | x 1             |
| 40515                      | Voltage Calibration N(a)                 |        | R W                  | DP                      | x 10000         |
| 40516                      | Voltage Calibration N(b)                 |        | R W                  | DP                      | x 1             |
| 40517                      | Current Calibration A(a)                 |        | R W                  | DP                      | x 10000         |
| 40518                      | Current Calibration A(b)                 |        | R W                  | DP                      | x 1             |
| 40519                      | Current Calibration B(a)                 |        | R W                  | DP                      | x 10000         |
| 40520                      | Current Calibration B(b)                 |        | R W                  | DP                      | x 1             |
| 40521                      | Current Calibration C(a)                 |        | R W                  | DP                      | x 10000         |
| 40522                      | Current Calibration C(b)                 |        | R W                  | DP                      | x 1             |
| 40523                      | Current Calibration N(a)                 |        | R W                  | DP                      | x 10000         |
| 40524                      | Current Calibration N(b)                 |        | R W                  | DP                      | x 1             |
| 40525                      | Coolant Temperature 0(a)                 |        | R W                  | DP                      | x 10000         |
| 40526                      | Coolant Temperature 0(b)                 |        | R W                  | DP                      | x 1             |
| 40527                      | Coolant Temperature 1(a)                 |        | R W                  | DP                      | x 10000         |
| 40528                      | Coolant Temperature 1(b)                 |        | R W                  | DP                      | x 1             |
| 40529                      | Coolant Temperature 2(a)                 |        | R W                  | DP                      | x 10000         |
| 40530                      | Coolant Temperature 2(b)                 |        | R W                  | DP                      | x 1             |
| 40531                      | Coolant Temperature 3(a)                 |        | R W                  | DP                      | x 10000         |
| 40532                      | Coolant Temperature 3(b)                 |        | R W                  | DP                      | x 1             |
| 40533                      | Coolant Temperature 4(a)                 |        | R W                  | DP                      | x 10000         |
| 40534                      | Coolant Temperature 4(b)                 |        | R W                  | DP                      | x 1             |
| 40535                      | Coolant Temperature 5(a)                 |        | R W                  | DP                      | x 10000         |
| 40536                      | Coolant Temperature 5(b)                 |        | R W                  | DP                      | x 1             |
| 40537                      | Coolant Temperature 6(a)                 |        | R W                  | DP                      | x 10000         |

| Holding Register                     | Parameter                 | Range       | Read/Write Supported | Data Format                                                             | Units   |
|--------------------------------------|---------------------------|-------------|----------------------|-------------------------------------------------------------------------|---------|
| 40538                                | Coolant Temperature 6(b)  |             | R W                  | DP                                                                      | x 1     |
| 40539                                | Coolant Temperature 7(a)  |             | R W                  | DP                                                                      | x 10000 |
| 40540                                | Coolant Temperature 7(b)  |             | R W                  | DP                                                                      | x 1     |
| 40541                                | Coolant Temperature 8(a)  |             | R W                  | DP                                                                      | x 10000 |
| 40542                                | Coolant Temperature 8(b)  |             | R W                  | DP                                                                      | x 1     |
| 40543                                | Coolant Temperature 9(a)  |             | R W                  | DP                                                                      | x 10000 |
| 40544                                | Coolant Temperature 9(b)  |             | R W                  | DP                                                                      | x 1     |
| 40545                                | Coolant Temperature 10(a) |             | R W                  | DP                                                                      | x 10000 |
| 40546                                | Coolant Temperature 10(b) |             | R W                  | DP                                                                      | x 1     |
| 40547                                | Coolant Temperature 11(a) |             | R W                  | DP                                                                      | x 10000 |
| 40548                                | Coolant Temperature 11(b) |             | R W                  | DP                                                                      | x 1     |
| 40549                                | Coolant Temperature 12(a) |             | R W                  | DP                                                                      | x 10000 |
| 40550                                | Coolant Temperature 12(b) |             | R W                  | DP                                                                      | x 1     |
| 40551                                | Coolant Temperature 13(a) |             | R W                  | DP                                                                      | x 10000 |
| 40552                                | Coolant Temperature 13(b) |             | R W                  | DP                                                                      | x 1     |
| 40553                                | Oil Pressure 0(a)         |             | R W                  | DP                                                                      | x 10000 |
| 40554                                | Oil Pressure 0(b)         |             | R W                  | DP                                                                      | x 1     |
| 40555                                | Oil Pressure 1(a)         |             | R W                  | DP                                                                      | x 10000 |
| 40556                                | Oil Pressure 1(b)         |             | R W                  | DP                                                                      | x 1     |
| 40557                                | Oil Pressure 2(a)         |             | R W                  | DP                                                                      | x 10000 |
| 40558                                | Oil Pressure 2(b)         |             | R W                  | DP                                                                      | x 1     |
| 40559                                | Oil Pressure 3(a)         |             | R W                  | DP                                                                      | x 10000 |
| 40560                                | Oil Pressure 3(b)         |             | R W                  | DP                                                                      | x 1     |
| 40561                                | Oil Pressure 4(a)         |             | R W                  | DP                                                                      | x 10000 |
| 40562                                | Oil Pressure 4(b)         |             | R W                  | DP                                                                      | x 1     |
| 40563                                | Oil Pressure 5(a)         |             | R W                  | DP                                                                      | x 10000 |
| 40564                                | Oil Pressure 5(b)         |             | R W                  | DP                                                                      | x 1     |
| 40565                                | Oil Pressure 6(a)         |             | R W                  | DP                                                                      | x 10000 |
| 40566                                | Oil Pressure 6(b)         |             | R W                  | DP                                                                      | x 1     |
| 40567                                | Oil Pressure 7(a)         |             | R W                  | DP                                                                      | x 10000 |
| 40568                                | Oil Pressure 7(b)         |             | R W                  | DP                                                                      | x 1     |
| 40569                                | Oil Pressure 8(a)         |             | R W                  | DP                                                                      | x 10000 |
| 40570                                | Oil Pressure 8(b)         |             | R W                  | DP                                                                      | x 1     |
| 40571                                | Oil Pressure 9(a)         |             | R W                  | DP                                                                      | x 10000 |
| 40572                                | Oil Pressure 9(b)         |             | R W                  | DP                                                                      | x 1     |
| 40573                                | Oil Pressure 10(a)        |             | R W                  | DP                                                                      | x 10000 |
| 40574                                | Oil Pressure 10(b)        |             | R W                  | DP                                                                      | x 1     |
| 40575                                | Oil Pressure 11(a)        |             | R W                  | DP                                                                      | x 10000 |
| 40576                                | Oil Pressure 11(b)        |             | R W                  | DP                                                                      | x 1     |
| 40577                                | Oil Pressure 12(a)        |             | R W                  | DP                                                                      | x 10000 |
| 40578                                | Oil Pressure 12(b)        |             | R W                  | DP                                                                      | x 1     |
| 40579                                | Oil Pressure 13(a)        |             | R W                  | DP                                                                      | x 10000 |
| 40580                                | Oil Pressure 13(b)        |             | R W                  | DP                                                                      | x 1     |
| <b>SYSTEM MONITOR - Continuation</b> |                           |             |                      |                                                                         |         |
| 40581                                | System Configuration      | 32, 64, 128 | R W                  | 32 = AUTO<br>64 = OFF<br>128 = RUN                                      |         |
| 40582                                | System State              | 0–5         | R                    | 0 = RESET<br>1 = READY<br>2 = CRANK<br>3 = REST<br>4 = RUN<br>5 = ALARM |         |

| Holding Register                        | Parameter          | Range | Read/Write Supported | Data Format                                    | Units |
|-----------------------------------------|--------------------|-------|----------------------|------------------------------------------------|-------|
| <b>CALIBRATION - Continuation</b>       |                    |       |                      |                                                |       |
| 40583                                   | Phase angle (a)    |       | R W                  | DP                                             |       |
| 40584                                   | Phase angle (b)    |       | R W                  | DP                                             |       |
| <b>GENERATOR MONITOR - Continuation</b> |                    |       |                      |                                                |       |
| 40585                                   | Power Factor State | 0–3   | R                    | 0 = +LAG<br>1 = -LEAD<br>2 = -LAG<br>3 = +LEAD |       |



## C • Tuning PID Settings

The LSM-2020 (Load Share Module) and DGC-2020 utilize four controllers to accomplish synchronization, load sharing, reactive power sharing, speed trim, and voltage trim functions. The controllers are a voltage controller, a var/PF controller, a speed controller, and a kW load controller. The voltage and speed controllers are in effect when the DGC-2020 is synchronizing the generator to a bus. When synchronizing, these controllers adjust the speed and voltage output of the generator to match that of the bus. After the generator is paralleled to a bus that is not connected to utility power, the kW load controller controls the kW output of the machine to share real power equally on a percentage basis with the other generators on the bus. All generators participating in load sharing are connected together with analog load share lines or Ethernet inter-genset communications which are used to communicate load share information between the machines. When the generator is not paralleled to the utility, the var/PF controller utilizes inter-genset communications to accomplish reactive power sharing where each machine shares reactive power equally on a percentage basis with the other generators on the bus. When the generator is paralleled to the utility, the kW load controller causes the unit to produce wattage at a level equal to the base load set point. The var/PF controller can operate in either var or PF control mode when the generator is paralleled to the utility. When operating in var control mode, the machine will produce reactive power at a level equal to the kvar Setpoint setting. When in PF control mode, the var/PF controller will regulate the reactive power output of the machine to maintain the power factor specified by the PF Setpoint setting. The kW base load set point, the kvar set point, and the PF set point can be derived from either a user setting, or an analog input.

When the generator is paralleled to an islanded bus and load sharing is enabled, the speed trim function, if enabled in all machines on the bus, will ensure that the bus frequency is maintained at the frequency set by the speed trim setting. Speed trim is in effect only in the situation where the generator breaker is closed to an islanded bus and load control and speed trim are enabled. Speed trim is not in effect when the breaker is open, since the default mode when the breaker is open is droop, and speed trim would counteract droop. Speed trim is not in effect when the breaker is closed unless load control is enabled. When load control is enabled, it is possible that integral action in PID controller for kW Load control could cause the system frequency to drift, and speed trim can be employed to counteract the drift.

When the generator is paralleled to an islanded bus and the kvar controller is enabled to accomplish kvar sharing, the voltage trim function, if enabled in all machines on the bus, will ensure that the bus voltage of the system is maintained at a voltage equal to the Rated Voltage Setpoint of the machines. Voltage trim is in effect only in the situation where the generator breaker is closed to an islanded bus and kvar control and voltage trim are enabled. Voltage trim is not in effect when the breaker is open, since the default mode when the breaker is open is droop, and voltage trim would counteract droop. Voltage trim is not in effect when the breaker is closed unless kvar control is enabled. When kvar control is enabled, it is possible that integrator action in PID controller for kvar control could cause the system voltage to drift, and voltage trim can be employed to counteract the drift.

The load share module utilizes PID (Proportional, Integral, Derivative) Control to accomplish kW and kvar load sharing, speed control, and voltage control. A brief description of the three 3 main tuning parameters, and their effects on system behavior, is presented below.

- **$K_p$  - Proportional Gain** - The proportional term makes a change to the output that is proportional to the current error value. The proportional response can be adjusted by multiplying the error by a constant  $K_p$ , called the proportional gain. Larger  $K_p$  typically means faster response since the larger the error, the larger the feedback to compensate. An excessively large proportional gain will lead to process instability.
- **$K_i$  - Integral Gain** - The contribution from the integral term is proportional to both the magnitude of the error and the duration of the error. Some integral gain is required in order for the system to achieve zero steady-state error. The integral term (when added to the proportional term) accelerates the movement of the process towards the set point and eliminates the residual steady-state error that occurs with a proportional only controller. Larger  $K_i$  implies steady state errors are eliminated more quickly. The tradeoff is larger overshoot: any negative error integrated during transient response must be integrated away by positive error before reaching steady state.
- **$K_d$  - Derivative Gain** - The derivative term slows the rate of change of the controller output and is used to reduce the magnitude of the overshoot produced by the integral component and improve

the combined controller-process stability. However, differentiation of a signal amplifies noise in the signal, and thus, this term in the controller may be sensitive to noise in the error term, and can cause a process to become unstable if the noise and the derivative gain are sufficiently large. Larger  $K_d$  decreases overshoot, but slows down transient response and may lead to instability. In general  $K_d$  is not recommended in the DGC controllers unless testing shows that it benefits system performance.

Table C-1 shows the effects of increasing parameters.

**Table C-1. Effects of Increasing Parameters**

| Parameter | Rise Time    | Overshoot | Setting Time | Steady State Error |
|-----------|--------------|-----------|--------------|--------------------|
| $K_p$     | Decrease     | Increase  | Small Change | Decrease           |
| $K_i$     | Decrease     | Increase  | Increase     | Eliminate          |
| $K_d$     | Small Change | Decrease  | Decrease     | None               |

## Tuning Procedures

Prior to performing any controller tuning, it is strongly recommended that Generator Protection, in particular Reverse Power protection and Loss of Excitation protection, should be configured to protect the machine in case any reverse power or reverse var situations occur during the tuning process.

### Voltage Controller Tuning Procedure

The voltage controller is tuned prior to the speed controller. Set all  $K_p$ ,  $K_i$ , and  $K_d$  gains in the voltage controller, speed controller, kW load controller and var/PF controller to 0. Set the  $K_g$  values to 0.1.

The voltage controller is active during synchronization when the DGC-2020 is trying to close the generator breaker, and also when the generator breaker is closed and the generator is not paralleled to utility power and the voltage trim function is enabled. In order to tune the voltage controller, the unit is operated with the generator breaker closed and voltage trim enabled. We can then change the rated voltage of the machine to change the voltage controller set point and observe the response. Set the Voltage Trim function and the var/PF controller to enabled, and verify in logic that when the generator breaker is closed, the Parallel to mains logic element is not true. When the engine is running and the generator breaker is closed, the voltage controller should be operating to accomplish voltage trim, driving the system voltage to the level set by the Rated Voltage setting in the system ratings.

#### $K_p$ - Proportional Gain

Each time  $K_p$  is set, we will modify the rated voltage setting in the Rated Data and observe how the generator output voltage responds to the change.

Set an initial value of 1 for  $K_p$ . Start the generator and close the generator breaker to the dead bus.

Verify that the generator's output approaches the Rated Voltage in a stable manner. Since  $K_i$  is zero at this point, there may be a difference between the generator's output and the Rated Voltage set point. The important thing is that the generator's output behaves in a stable manner. If it is not stable, lower the value of  $K_p$  and repeat.

Now modify the Rated Voltage setting to a level that is 3% to 5% higher than the initial setting. Verify that the generator's output approaches the new value in a stable manner. Set the Rated Voltage Setting back to its original value and observe the generator's output. Next, modify the Rated Voltage setting to a level that is 3% to 5% lower than the initial setting observe the generator output voltage. Finally, set the Rated Voltage back to its initial value, and observe the generator output voltage to verify it operates in a stable manner.

Repeat this procedure, raising  $K_p$  until the system begins to operate in an unstable manner, and then lower it back to the highest value where stable operation was achieved. Note that if the generator output is not coming very close to the set point value, it is often an indication that the value of  $K_p$  is too low.



If it is not possible to obtain stable voltage operation, it may be necessary to reduce the control gains in the voltage regulator which has its analog bias input driven by the LSM-2020.

#### $K_i$ - Integral Gain

Set the initial value of  $K_i$  to be a tenth of the value set for  $K_p$ . Start the generator and close the generator breaker to the dead bus.

Next, modify the Rated Voltage setting to a level that is 3% to 5% higher than the initial setting. Verify that the generator's output approaches the new value in a stable manner. Set the Rated Voltage Setting back to its original value and observe the generator's output. Next, modify the Rated Voltage setting to a level that is 3% to 5% lower than the initial setting observe the generator output voltage. Finally, set the Rated Voltage back to its initial value, and observe the generator output voltage to verify it operates in a stable manner. If stable operation is not achievable, it may be necessary to lower the value for  $K_i$ . Repeat this procedure, raising  $K_i$  until the system is unstable, and then lower it to the highest value that achieved stable operation.

#### $K_d$ - Derivative Gain

If the performance with  $K_p$  and  $K_i$  alone is satisfactory, it is recommended  $K_d$  be left at a value of zero.  $K_d$  can amplify noise in a system so it should be used with great care. Otherwise  $K_d$ , the derivative controller gain, can be used in conjunction with  $T_d$ , the noise filter constant, to reduce overshoot obtained with PI control. Setting  $K_d$  and  $T_d$  is an iterative process.

Tuning of  $K_d$  can be achieved through the following steps. Set an initial value of  $K_d$  that is  $1/10^{\text{th}}$  the value of  $K_p$  or  $1/10^{\text{th}}$  the value of  $K_i$ , whichever is smaller. Start the generator and close the generator breaker to the dead bus.

Modify the Rated Voltage setting to a level that is 3% to 5% higher than the initial setting. Verify that the generator's output approaches the new value in a stable manner. Set the Rated Voltage Setting back to its original value and observe the generator's output. Next, modify the Rated Voltage setting to a level that is 3% to 5% lower than the initial setting observe the generator output voltage. Finally, set the Rated Voltage back to its initial value, and observe the generator output voltage to verify it operates in a stable manner. Repeat with higher values of  $K_d$  until the system begins to be unstable, then enter half this value as the  $K_d$  gain.

If high frequency noise seems to be entering the system,  $T_d$  is the constant of the low pass filter which filters the controller input to reduce the effects of such interference when derivative control is employed.  $T_d$  ranges from 0 to 1 with an increment of 0.001.  $T_d=0$  is no filtering,  $T_d=1$  is heaviest filtering. If  $T_d$  adjustment is necessary, set  $T_d$  to 0.001 and see if the noise induced behavior is reduced. Raise  $T_d$  until desired reduction of noise behavior is achieved. Once  $T_d$  has been set, tune  $K_d$  again. If noise again appears to be a problem, adjust  $T_d$  until desired behavior is achieved, then retune  $K_d$ .

### **Speed Controller Tuning Procedure**

The speed controller is tuned prior to the kW load controller. Set Load Control to enabled, and speed trim to enabled. Set all  $K_p$ ,  $K_i$ , and  $K_d$  gains in both speed controller and kW load controller to 0. Set the  $K_g$  values to 0.1.

#### $K_p$ - Proportional Gain

Set an initial value of 1 for  $K_p$ . Start the generator and close the breaker to the dead bus.

Each time  $K_p$  is set, execute step responses in the following manner to observe the machine's response to the change in the Speed Trim set point.

Next, modify the Speed Trim set point to a level that is one or two hertz higher than the initial setting. Verify that the generator's output frequency approaches the new value in a stable manner. Set the Speed Trim set point back to its original value and observe the generator's output frequency. Next, modify the Speed Trim set point to a level that is one or two hertz lower than the initial setting observe the generator output frequency. Finally, set the Speed Trim set point back to its initial value, and observe the generator frequency to verify it operates in a stable manner.

Since  $K_i$  is zero at this point, there may be some difference between the generator's output and the speed it is trying to reach. The important thing is that the generator's output behaves in a stable manner. If the system is unstable, lower  $K_p$  and repeat.

Repeat this procedure, raising  $K_p$  until the system begins to operate in an unstable manner, and then lower it back to the highest value where stable operation is attained. Note that if the generator output is not coming very close to the set point value, it is often an indication that the value of  $K_p$  is too low.

If it is not possible to obtain stable speed operation, it may be necessary to reduce the control gains in the governor which has its analog bias input driven by the LSM-2020.

#### $K_i$ - Integral Gain

Set the initial value of  $K_i$  to be a tenth of the value set for  $K_p$ . Start the generator and close the breaker to the dead bus.

Next, modify the Speed Trim set point to a level that is one or two hertz higher than the initial setting. Verify that the generator's output frequency approaches the new value in a stable manner. Set the Speed Trim set point back to its original value and observe the generator's output frequency. Next, modify the Speed Trim set point to a level that is one or two hertz lower than the initial setting observe the generator output frequency. Finally, set the Speed Trim set point back to its initial value, and observe the generator output frequency to verify it operates in a stable manner. If stable operation is not achievable it may be necessary to lower the value for  $K_i$ . Repeat this procedure, raising  $K_i$  until the system is unstable, and then lower it to the highest value that achieved stable operation.

#### $K_d$ - Derivative Gain

If the performance with  $K_p$  and  $K_i$  alone is satisfactory, it is recommended you leave  $K_d$  at a value of zero.  $K_d$  can amplify noise in a system so it should be used with great care. Otherwise  $K_d$ , the derivative controller gain, can be used in conjunction with  $T_d$ , the noise filter constant, to reduce overshoot obtained with  $P_i$  control. Setting  $K_d$  and  $T_d$  is an iterative process which can be accomplished by performing the following steps.

Set an initial value of  $K_d$  that is  $1/10^{\text{th}}$  the value of  $K_p$  or  $1/10^{\text{th}}$  the value of  $K_i$ , whichever is smaller.

Modify the Speed Trim set point to a level that is one or two hertz higher than the initial setting. Verify that the generator's output approaches the new value in a stable manner. Set the Speed Trim set point back to its original value and observe the generator's output frequency. Next, modify the Speed Trim set point to a level that is one or two hertz lower than the initial setting observe the generator output frequency. Finally, set the Speed Trim set point back to its initial value, and observe the generator output frequency to verify it operates in a stable manner. Repeat with higher values of  $K_d$  until the system begins to be unstable, and then enter half this value as the  $K_d$  gain.

If high frequency noise seems to be entering the system,  $T_d$  is the constant of the low pass filter which filters the controller input to reduce the effects of such interference when derivative control is employed.  $T_d$  ranges from 0 to 1 with an increment of 0.001.  $T_d=0$  is no filtering,  $T_d=1$  is heaviest filtering. If  $T_d$  adjustment is necessary, set  $T_d$  to 0.001 and see if the noise induced behavior is reduced. Raise  $T_d$  until desired reduction of noise behavior is achieved. Once  $T_d$  has been set, tune  $K_d$  again. If noise again appears to be a problem, adjust  $T_d$  until desired behavior is achieved, then retune  $K_d$ .

### **var/PF Controller Tuning Procedure**

Once desired voltage controller performance is obtained, the var/PF controller can be tuned. Two tuning methods are presented, one where the machine is paralleled to the utility to tune systems that are used for utility parallel operation and a second method where machines are paralleled together to tune systems employing island parallel operation.

#### **var/PF Controller Tuning Procedure Using Parallel to Mains Operation**

In Parallel to Mains operation the var/PF controller regulates the kvar output of the machine at a level specified by the kvar Setpoint % setting when the control mode is kvar control, or it regulates the kvar output to maintain the power factor specified by the PF Setpoint setting when the control mode is set to PF control.

Set the  $K_p$ ,  $K_i$ , and  $K_d$  gains in the var/PF controller to 0. Set the  $K_g$  value to 0.1. Enable the var/PF controller, and set the control mode to Var Control. The generator must be paralleled to the utility (as indicated by the Parallel to Mains element in logic) in any of the tuning steps where the system is being tested for stable operation.

#### $K_p$ - Proportional Gain

Set an initial value of  $K_p = 1$  in the var/PF Controller. Enable the var/PF controller, and set the control mode to Var Control.

Set  $K_p$  on var/PF controller. Synchronize the generator to the utility so that var control becomes active. Verify that stable var control occurs. If the var control seems unstable, lower  $K_p$  and try again. Assuming operation appears stable, change the var setpoint in 10% steps and check for stable operation. Since  $K_i$  is zero at this point, there may be some error. Most importantly, verify that stable var control is achieved.

Raise  $K_p$  and repeat the test until unstable operation occurs. Then lower  $K_p$  to the highest value where stable operation was attained.

If it is not possible to obtain stable var controller operation, it may be necessary to reduce the control gains in the voltage regulator which has its bias input driven by the LSM-2020.

#### $K_i$ - Integral Gain

Set the initial value of  $K_i$  to be a tenth of the value set for  $K_p$ .

Each time  $K_i$  is set, synchronize the generator to the utility so that var control becomes active. Check that operation appears stable. Change the var setpoint in 10% steps and check for stable operation. If the system is not stable, lower  $K_i$  and repeat the test.

Repeat this procedure, raising  $K_i$  until the system is unstable, and then lower it to the highest value for which stable operation is achieved.

#### $K_d$ - Derivative Gain

If the performance with  $K_p$  and  $K_i$  alone is satisfactory, it is recommended  $K_d$  be left at a value of zero.  $K_d$  can amplify noise in a system so it should be used with great care. Otherwise  $K_d$ , the derivative controller gain, can be used in conjunction with  $T_d$ , the noise filter constant, to reduce overshoot obtained with PI control. Setting  $K_d$  and  $T_d$  is an iterative process. Start with small values of  $K_d$  such as  $1/10^{\text{th}}$  the value of  $K_p$  or  $1/10^{\text{th}}$  the value of  $K_i$ , whichever is smaller.

Tuning of  $K_d$  can be achieved through the following steps. Set an initial value of  $K_d$ , then synchronize the generator to the utility so that var control becomes active, and check for stability. Change the var setpoint in 10% steps and check for stable operation. Raise  $K_d$ , repeating the tests until the system is unstable, and then lower it to half the value where instability is first attained.

If high frequency noise seems to be entering the system,  $T_d$  is the constant of the low pass filter which filters the controller input to reduce the effects of such interference when derivative control is employed.  $T_d$  ranges from 0 to 1 with an increment of .001.  $T_d=0$  is no filtering,  $T_d=1$  is heaviest filtering. If  $T_d$  adjustment is necessary, set  $T_d$  to 0.001 and see if the noise induced behavior is reduced. Raise  $T_d$  until desired reduction of noise behavior is achieved. Once  $T_d$  has been set, tune  $K_d$  again. If noise again appears to be a problem, adjust  $T_d$  until desired behavior is achieved, then retune  $K_d$ .

### **var/PF Controller Tuning Procedure Using Multiple Machines in Island Parallel operation**

In Island Parallel operation the var/PF controller regulates the kvar output of the machine to a level determined from inter-genset communications to accomplish kvar sharing with the other machines in the system. When properly tuned, the var/PF controller regulates the kvar output of the machine to a level equal to the average system kvar load, on a percentage of capacity basis. Thus, each machine will share kvar equally on a percentage of capacity basis.

The procedure below is written for the case where you have two machines that need to be tuned. Thus, any time a PID gain change is made, the change should be replicated in both machines before any testing for stability.

If a machine is available that is already tuned, but another one needs tuned against it, the following procedure still applies, except that PID values in the machine that have already been tuned should not be changed.

### $K_p$ - Proportional Gain

On both machines set the  $K_p$ ,  $K_i$ , and  $K_d$  gains in var/PF controller to 0. Set the  $K_g$  value to 0.1. Set an initial value of 1 for  $K_p$ .

Close the breaker of the first machine onto a load. Parallel the second generator and check for stable kvar sharing between the two machines. Then, open the generator breaker on the second generator and check that both units are still stable. Since  $K_i$  is zero at this point, there may be some error in the kvar sharing. The important thing is to verify stable sharing is achieved. Repeat for various levels of kvar load if a means of varying kvar load is available.

Raise  $K_p$  in both machines and repeat the test until unstable operation occurs. Lower  $K_p$  to the highest value yielding stable operation. If one machine becomes unstable before the other as gains are raised, it may be necessary to do any further gain increases in only one machine. If the machines are not similar, you may end up with different gains in each machine. If it is not possible to obtain stable kvar sharing, it may be necessary to reduce the control gains in the AVR which has its analog bias input driven by the LSM-2020.

### $K_i$ - Integral Gain

Set the initial value of  $K_i$  to be a tenth of the value set for  $K_p$  in both machines.

Each time  $K_i$  is set in both machines, parallel the machines and check for stable kvar sharing. Then, open the generator breaker on the second generator and check that both units are still stable. If the system is not stable, lower  $K_i$  and repeat the test.

Repeat this procedure, raising  $K_i$  in both machines until the system is unstable, and then lower it to the highest value yielding stable operation.

Repeat for various levels of kvar load if a means of varying kvar load is available.

### $K_d$ -Derivative Gain

If the performance with  $K_p$  and  $K_i$  alone is satisfactory, it is recommended  $K_d$  be left at a value of zero.  $K_d$  can amplify noise in a system so it should be used with great care. Otherwise  $K_d$ , the derivative controller gain, can be used in conjunction with  $T_d$ , the noise filter constant, to reduce overshoot obtained with PI control. Setting  $K_d$  and  $T_d$  is an iterative process.

In both machines start with small values of  $K_d$  that are  $1/10^{\text{th}}$   $K_p$  or  $1/10^{\text{th}}$   $K_i$ , whichever is smaller. Tuning of  $K_d$  can be achieved through the following steps. Set kvar control  $K_d$  in both machines, parallel them together, and check for stability. Then, drop the second generator and check that both units are still stable. Raise  $K_d$  in both machines until the system is unstable, and then lower it to half the value where instability is first attained. Test at various levels of kvar load if a means of varying kvar load is available.

If high frequency noise seems to be entering the system,  $T_d$  is the constant of the low pass filter which filters the controller input to reduce the effects of such interference when derivative control is employed.  $T_d$  ranges from 0 to 1 with an increment of 0.001.  $T_d=0$  is no filtering,  $T_d=1$  is heaviest filtering. If  $T_d$  adjustment is necessary, set  $T_d$  to 0.001 and see if the noise induced behavior is reduced. Raise  $T_d$  until desired reduction of noise behavior is achieved. Once  $T_d$  has been set, tune  $K_d$  again. If noise again appears to be a problem, adjust  $T_d$  until desired behavior is achieved, then retune  $K_d$ .

## **kW Load Controller Tuning Procedure**

Once desired voltage and speed controller performance is obtained, the kW load controller can be tuned.

Two tuning methods are presented, one where the machine is paralleled to the utility to tune systems that are used for utility parallel operation and a second method where machines are paralleled together to tune systems employing island parallel operation.

## **kW Load Controller Tuning Procedure Using Parallel to Mains Operation**

In Parallel to Mains operation the kW Load Controller regulates the kW output of the machine to the level of kW indicated by the Base Load Level setting.

Set the  $K_p$ ,  $K_i$ , and  $K_d$  gains in the kW Load Controller to 0. Set the  $K_g$  value to 0.1. Enable the kW Load Controller. The generator must be paralleled to the utility (as indicated by the Parallel to Mains element in logic) in any of the tuning steps where the system is being tested for stable operation.

### $K_p$ - Proportional Gain

Set an initial value of  $K_p = 1$  in the kW Load Controller.

Set  $K_p$  on kW Load Controller. Synchronize the generator to the utility so that kW control becomes active. Verify that stable kW control occurs. If the kW control seems unstable, lower  $K_p$  and try again. Assuming operation appears stable, change the base load setpoint in 10% steps and check for stable operation. Since  $K_i$  is zero at this point, there may be some error. Most importantly, verify stable kW control is achieved.

Raise  $K_p$  and repeat the test until unstable operation occurs. Then lower  $K_p$  to the highest value where stable operation was attained.

If it is not possible to obtain stable kW controller operation, it may be necessary to reduce the control gains in the engine governor which has its bias input driven by the LSM-2020.

### $K_i$ - Integral Gain

Set the initial value of  $K_i$  to be a tenth of the value set for  $K_p$ .

Each time  $K_i$  is set, synchronize the generator to the utility so that kW control becomes active. Check that operation appears stable. Change the base load setpoint in 10% steps and check for stable operation. If the system is not stable, lower  $K_i$  and repeat the test.

Repeat this procedure, raising  $K_i$  until the system is unstable, and then lower it to the highest value yielding stable operation.

### $K_d$ - Derivative Gain

If the performance with  $K_p$  and  $K_i$  alone is satisfactory, it is recommended  $K_d$  be left at a value of zero.  $K_d$  can amplify noise in a system so it should be used with great care. Otherwise  $K_d$ , the derivative controller gain, can be used in conjunction with  $T_d$ , the noise filter constant, to reduce overshoot obtained with  $P_i$  control. Setting  $K_d$  and  $T_d$  is an iterative process. Start with small values of  $K_d$  such as  $1/10^{\text{th}}$  the value of  $K_p$  or  $1/10^{\text{th}}$  the value of  $K_i$ , whichever is smaller.

Tuning of  $K_d$  can be achieved through the following steps. Set an initial value of  $K_d$ , then synchronize the generator to the utility so that kW control becomes active, and check for stability. Change the base load setpoint in 10% steps and check for stable operation. Raise  $K_d$ , repeating the tests until the system is unstable, and then lower it to half the value where instability is first attained.

If high frequency noise seems to be entering the system,  $T_d$  is the constant of the low pass filter which filters the controller input to reduce the effects of such interference when derivative control is employed.  $T_d$  ranges from 0 to 1 with an increment of 0.001.  $T_d=0$  is no filtering,  $T_d=1$  is heaviest filtering. If  $T_d$  adjustment is necessary, set  $T_d$  to 0.001 and see if the noise induced behavior is reduced. Raise  $T_d$  until desired reduction of noise behavior is achieved. Once  $T_d$  has been set, tune  $K_d$  again. If noise again appears to be a problem, adjust  $T_d$  until desired behavior is achieved, then retune  $K_d$ .

## **kW Load Controller Tuning Procedure Using Multiple Machines in Island Parallel Operation**

In Island Parallel operation the kW Load Controller regulates the kW output of the machine to a level determined from the analog load share line or inter-genset communications to accomplish kW sharing with the other machines in the system. When properly tuned, the kW controller regulates the kW output of the machine to a level equal to the average system kW load, on a percentage of capacity basis. Thus, each machine will share kW equally on a percentage of capacity basis.

The procedure below is written for the case where two machines need to be tuned. Thus, any time a PID gain change is made, the change should be replicated in both machines before any testing for stability. If a machine is available that is already tuned, but you need to tune another one against it, the following procedure still applies, except that PID values in the machine that has already been tuned should not be changed.

### *K<sub>p</sub> - Proportional Gain*

Disable the Speed Trim function in all machines when tuning the kW load controller gains.

On both machines set the  $K_p$ ,  $K_i$ , and  $K_d$  gains in kW load controller to 0. Set the  $K_g$  value to 0.1. Set an initial value of 1 for  $K_p$ .

Close the breaker of the first machine onto a load. Parallel the second generator and check for stable load sharing between the two machines. Then open the generator breaker on the second generator and check that both units are still stable. Since  $K_i$  is zero at this point, there may be error in the load sharing. The important thing is to verify stable load sharing is achieved.

Raise  $K_p$  in both machines and repeat the test until unstable operation occurs. Lower  $K_p$  to the highest value yielding stable operation. If one machine becomes unstable before the other as gains are raised, it may be necessary to do any further gain increases in only one machine. If the machines are not similar, you may end up with different gains in each machine. If it is not possible to obtain stable kW operation, it may be necessary to reduce the control gains in the governor which has its analog bias input driven by the LSM-2020. Test at various levels of kW load if a means of varying kW load is available.

### *K<sub>i</sub> - Integral Gain*

Set the initial value of  $K_i$  to be a tenth of the value set for  $K_p$  in both machines.

Each time  $K_i$  is set in both machines, parallel the machines and check for stable load sharing then open the generator breaker on the second generator and check that both units are still stable. If the system is not stable, lower  $K_i$  and repeat the test. Test at various levels of kW load if a means of varying kW load is available. Repeat this procedure, raising  $K_i$  in both machines until the system is unstable, and then lower it to the highest value yielding stable operation.

### *K<sub>d</sub>-Derivative Gain*

If the performance with  $K_p$  and  $K_i$  alone is satisfactory, it is recommended  $K_d$  be left at a value of zero.  $K_d$  can amplify noise in a system so it should be used with great care. Otherwise  $K_d$ , the derivative controller gain, can be used in conjunction with  $T_d$ , the noise filter constant, to reduce overshoot obtained with PI control. Setting  $K_d$  and  $T_d$  is an iterative process. In both machines start with small values of  $K_d$  that are  $1/10^{\text{th}}$   $K_p$  or  $1/10^{\text{th}}$   $K_i$ , whichever is smaller.

Tuning of  $K_d$  can be achieved through the following steps. Set load control  $K_d$  in both machines, parallel them together, and check for stability. Then, drop the second generator and check that both units are still stable. Raise  $K_d$  in both machines until the system is unstable, and then lower it to half the value where instability is first attained. Test at various levels of kW load if a means of varying kW load is available.

If high frequency noise seems to be entering the system,  $T_d$  is the constant of the low pass filter which filters the controller input to reduce the effects of such interference when derivative control is employed.  $T_d$  ranges from 0 to 1 with an increment of 0.001.  $T_d=0$  is no filtering,  $T_d=1$  is heaviest filtering. If  $T_d$  adjustment is necessary, set  $T_d$  to 0.001 and see if the noise induced behavior is reduced. Raise  $T_d$  until desired reduction of noise behavior is achieved. Once  $T_d$  has been set, tune  $K_d$  again. If noise again appears to be a problem, adjust  $T_d$  until desired behavior is achieved, then retune  $K_d$ .

## **Generic Gains for Multiple Machine Types**

The following method is suggested for determining generic gains for multiple machine types:

- 1) Decide what levels of reverse power and reverse var (loss of excitation) protection are needed.
- 2) Once the criteria of step 1 have been established, tune a unit so that one machine can be paralleled to another unit at no load and not cause any trips.



- 3) Parallel two machines onto a load, and verify that acceptable load sharing occurs.
- 4) Add and drop loads with machines paralleled to verify acceptable load sharing occurs, and no trips occur.
- 5) Once the settings are deemed “good”, save them as initial settings for a given machine configuration for all future jobs. The settings shouldn’t need changed unless there is tripping or load sharing characteristics need to be changed.
- 6) Test the units paralleled under no load and verify that no trips occur.
- 7) Parallel two machines onto a load, and verify that acceptable load sharing occurs.
- 8) Add and drop loads with machines paralleled to verify acceptable load sharing occurs and no trips occur.
- 9) If the settings for a particular machine type need to be modified, keep those settings to be used as initial settings for all future machines of that type.
- 10) Test every machine with steps 6, 7, and 8.

It is not expected that one set of numbers works for all machines, but it is probable to have 6 to 12 sets of settings that cover a wide range of machine sizes and engine manufacturers. However, once a set of gains has been determined for a particular machine type, the same gains should work in all identical machines.





## D • *mtu* Fault Codes

*mtu* fault codes displayed by the DGC-2020 are listed in Table D-1.

**Table D-1. *mtu* Fault Codes**

| Fault Code Number | String                 | Description                                                                     |
|-------------------|------------------------|---------------------------------------------------------------------------------|
| 3                 | HI T FUEL              | Fuel temperature too high (limit 1).                                            |
| 4                 | SS T FUEL              | Fuel temperature too high (limit 2).                                            |
| 5                 | HI T CHRG AIR          | Charge air temperature too high (limit 1).                                      |
| 6                 | SS T CHRG AIR          | Air temperature too high (limit 2).                                             |
| 9                 | HI T INTERCOOLER       | Coolant temperature of InterCooler too high (limit 1).                          |
| 10                | SS T INTERCOOLER       | Coolant temperature of InterCooler too high (limit 2).                          |
| 15                | LO P LUBE OIL          | Pressure of lube oil too low (limit 1).                                         |
| 16                | SS P LUBE OIL          | Pressure of lube oil too low (limit 2).                                         |
| 19                | HI T EXHAUST A         | Exhaust gas temperature (A-side) too high (limit 1).                            |
| 20                | SS T EXHAUST A         | Exhaust gas temperature (A-side) too high (limit 2).                            |
| 21                | HIT T EXHAUST B        | Exhaust gas temperature (B-side) too high (limit 1).                            |
| 22                | SS T EXHAUST B         | Exhaust gas temperature (B-side) too high (limit 2).                            |
| 23                | LO COOLANT LEVEL       | Coolant level too low (limit 1).                                                |
| 24                | SS COOLANT LEVEL       | Coolant level too low (limit 2).                                                |
| 25                | HI P DIFF LUBE OIL     | Differential pressure of oil filter too high (limit 1).                         |
| 26                | SS P DIFF LUBE OIL     | Differential pressure of oil filter too high (limit 2).                         |
| 27                | HI LEVEL LEAKAGE FUEL  | Level of leakage fuel too high (limit 1).                                       |
| 29                | HI ETC IDLE SPD TOO HI | Idle speed of one of the switchable chargers too high.                          |
| 30                | SS ENGINE OVERSPEED    | Engine overspeed (limit 2).                                                     |
| 31                | HI ETC1 OVERSPEED      | Speed of basic charger too high (limit 1).                                      |
| 32                | SS ETC1 OVERSPEED      | Speed of basic charger too high (limit 2).                                      |
| 33                | L1 P FUELFLT DIF       | Differential pressure of fuel filter too high (limit 1).                        |
| 36                | HI ETC2 OVERSPEED      | Speed of 1 <sup>st</sup> switchable charger too high (limit 1).                 |
| 37                | SS ETC2 OVERSPEED      | Speed of 1 <sup>st</sup> switchable charger too high (limit 2).                 |
| 38                | AL ETC SPEED DEVIATION | Speed deviation between basic turbo charger and one of the switchable chargers. |
| 39                | AL ETC2 CUTIN FAIL     | Switching of charger ETC2 failed.                                               |
| 44                | LO LEVEL INTRCLR       | Coolant level of intercooler too low (limit 1).                                 |
| 45                | FAULT L2 LEVEL INTRCLR | Coolant level of intercooler too low (limit 2).                                 |
| 51                | HI T LUBE OIL          | Lube oil temperature too high (limit 1).                                        |
| 52                | SS T LUBE OIL          | Lube oil temperature too high (limit 2).                                        |
| 53                | HI T INTAKE AIR        | Air intake temperature high (Limit 1).                                          |
| 54                | HIHI T INTAKE AIR      | Air intake temperature high (Limit 2).                                          |
| 57                | LO P COOLANT           | Coolant pressure too low (limit 1).                                             |
| 58                | SS P COOLANT           | Coolant pressure too low (limit 2).                                             |
| 59                | SS T COOLANT L3        | Coolant temperature too high/too low (limit 3).                                 |
| 60                | SS T COOLANT L4        | Coolant temperature too high/too low (limit 4).                                 |
| 61                | HI P ADCRANK CS L1     | AdCrankCase pressure too high (Limit 1).                                        |
| 62                | HI P ADCRANK CS L2     | AdCrankCase pressure too high (Limit 2).                                        |
| 63                | HI P CRANKCASE         | Crankcase pressure too high (limit 1).                                          |
| 64                | SS P CRANK CASE        | Crankcase pressure too high (limit 2).                                          |
| 65                | LO P FUEL              | Fuel supply pressure too low (limit 1).                                         |

| Fault Code Number | String                | Description                                                                                                                                                                                                                                   |
|-------------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 66                | SS P FUEL             | Fuel supply pressure too low (limit 2).                                                                                                                                                                                                       |
| 67                | HI T COOLANT          | Coolant temperature too high (limit 1).                                                                                                                                                                                                       |
| 68                | SS T COOLANT          | Coolant temperature too high (limit 2).                                                                                                                                                                                                       |
| 69                | L1 T EXTERN 1         | Limit 1, out of range.                                                                                                                                                                                                                        |
| 70                | L2 T EXTERN 1         | Limit 2, out of range.                                                                                                                                                                                                                        |
| 71                | L1 T EXTERN 2         | Limit 1, out of range.                                                                                                                                                                                                                        |
| 72                | L2 T EXTERN 2         | Limit 2, out of range.                                                                                                                                                                                                                        |
| 73                | L1 P EXTERN 1         | Limit 1, out of range.                                                                                                                                                                                                                        |
| 74                | L2 P EXTERN 1         | Limit 2, out of range.                                                                                                                                                                                                                        |
| 75                | L1 P EXTERN 2         | Limit 1, out of range.                                                                                                                                                                                                                        |
| 76                | L2 P EXTERN 2         | Limit 2, out of range.                                                                                                                                                                                                                        |
| 77                | LIM EXT CLNT LEV      | Binary signal 1 Plant active.                                                                                                                                                                                                                 |
| 78                | LIM INTERCLR LEV      | Binary signal 2 Plant active.                                                                                                                                                                                                                 |
| 79                | L BIN EXTERN 3        | Binary signal 3 Plant active.                                                                                                                                                                                                                 |
| 80                | L BIN EXTERN 4        | Binary signal 4 Plant active.                                                                                                                                                                                                                 |
| 81                | AL RAIL LEAKAGE       | Rail pressure gradient too low for Start or too high for Stop.                                                                                                                                                                                |
| 82                | HI P FUEL COMON RAIL  | Rail pressure > setpoint value.                                                                                                                                                                                                               |
| 83                | LO P FUEL COMMON RAIL | Rail pressure < setpoint value.                                                                                                                                                                                                               |
| 85                | HI T UMBLASSEN        | 'Umblasen' temperature too high (limit 1).                                                                                                                                                                                                    |
| 86                | SS T UMBLASSEN        | 'Umblasen' temperature too high (limit 2).                                                                                                                                                                                                    |
| 89                | SS SPEED TOO LOW      | Engine is being stalled. The engine speed of the normally operating engine dropped below the limit from parameter 2.2500.027 Limit Engine Speed Low without any stop request. For safety reason the engine is stopped when this event occurs. |
| 90                | SS IDLE SPEED LOW     | Idle speed not reached.                                                                                                                                                                                                                       |
| 91                | SS RELEASE SPEED LO   | Acceleration speed not reached.                                                                                                                                                                                                               |
| 92                | SS STARTER SPEED LO   | Starter speed not reached.                                                                                                                                                                                                                    |
| 93                | SS PREHT TMP          | Preheat temperature too low (limit 2).                                                                                                                                                                                                        |
| 94                | LO PREHT TMP          | Preheat temperature too low (limit 1).                                                                                                                                                                                                        |
| 95                | AL PRELUBE FAULT      | Prelubrication fault.                                                                                                                                                                                                                         |
| 99                | DUMMY FAULT           | Dummy fault - this is not a real fault, but is used on some ECU's to test the fault reporting mechanism.                                                                                                                                      |
| 100               | EDM NOT VALID         | Checksum fault EDM.                                                                                                                                                                                                                           |
| 101               | IDM NOT VALID         | Checksum fault IDM.                                                                                                                                                                                                                           |
| 102               | INVLD FUEL CNS 1      | Fuel consumption counter defect.                                                                                                                                                                                                              |
| 103               | INVLD FUEL CNS 2      | Consumption monitoring 2 not valid.                                                                                                                                                                                                           |
| 104               | ENG HRS INVALID 1     | Engine Hours Counter defect.                                                                                                                                                                                                                  |
| 105               | ENG HRS INVALID 2     | Checksum fault.                                                                                                                                                                                                                               |
| 106               | ERR REC1 INVALID      | Checksum fault.                                                                                                                                                                                                                               |
| 107               | ERR REC2 INVALID      | Checksum fault.                                                                                                                                                                                                                               |
| 118               | LO ECU SUPPLY VOLTS   | Power supply voltage too low (limit 1).                                                                                                                                                                                                       |
| 119               | LOLO ECU SUPPLY VOLTS | Power supply voltage too low (limit 2).                                                                                                                                                                                                       |
| 120               | HI ECU SUPPLY VOLTS   | Power supply voltage too high (limit 1).                                                                                                                                                                                                      |
| 121               | HIHI ECU SUPPLY VOLTS | Power supply voltage too high (limit 2).                                                                                                                                                                                                      |
| 122               | HI T ECU              | Temperature of electronic too high (limit 1).                                                                                                                                                                                                 |
| 134               | 15v POSECU DEFCT      | Internal electronic fault.                                                                                                                                                                                                                    |
| 136               | 15V NEGECU DEFCT      | Internal electronic fault.                                                                                                                                                                                                                    |
| 137               | L1 5V BUFR TEST       | Pressure-sensor fault, pressure-sensor wiring, or internal electronic fault.                                                                                                                                                                  |

| Fault Code Number | String                  | Description                                                                                                                                                               |
|-------------------|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 138               | SENSOR PWR DEFCT        | Pressure-sensor fault, pressure-sensor wiring, or internal electronic fault.                                                                                              |
| 139               | L1 TE BUFFR TEST        | Internal electronic fault.                                                                                                                                                |
| 140               | TE BUF ECU DEFCT        | Internal electronic fault.                                                                                                                                                |
| 141               | AL POWER TOO HIGH       | AL power too high.                                                                                                                                                        |
| 142               | MCR EXCEEDED 1 HR STR   | AL MCR exceeded 1 hour.                                                                                                                                                   |
| 143               | BANK1 ECU DEFECT        | Internal electronic fault.                                                                                                                                                |
| 144               | BANK2 ECU DEFECT        | Internal electronic fault.                                                                                                                                                |
| 145               | 15V GOODECU DFCT        | Internal electronic fault.                                                                                                                                                |
| 147               | AD TST1ECU DEFCT        | Internal electronic fault.                                                                                                                                                |
| 149               | AD TST2ECU DEFCT        | Internal electronic fault.                                                                                                                                                |
| 151               | AD TST3ECU DEFCT        | Internal electronic fault.                                                                                                                                                |
| 170               | MI MODULE FAIL          | Module in maintenance indicator defect.                                                                                                                                   |
| 171               | MI NOT ACTIVE           | WI not active anymore.                                                                                                                                                    |
| 172               | TBO EXPIRED             | TBO expired.                                                                                                                                                              |
| 173               | MODL WRITE LIMIT        | EEPROM write limit reached.                                                                                                                                               |
| 176               | AL LIFE DATA NA         | No (fitting) LifeData-Backup-System is available within a delay time after ECU Reset.                                                                                     |
| 177               | AL LIFE DATA INCPLT     | If the ADEC has to restore the LifeData from the backup-system and at least one checksum is wrong after the upload or the upload is incomplete, then this failure is set. |
| 180               | AL CAN1 NODE LOST       | Connection to a node on CAN 1 lost.                                                                                                                                       |
| 181               | AL CAN2 NODE LOST       | Connection to a node on CAN 2 lost.                                                                                                                                       |
| 182               | AL CAN WRONG PARAMS     | Incorrect CAN parameter values have been entered.                                                                                                                         |
| 183               | AL CAN NO PU DATA       | A CAN mode is selected which the communication is initialized aided of the PU data module. However, required PU data module is not present or is not valid.               |
| 184               | AL CAN PUDATA ERR       | During attempt to copy a received PU data module to Flash module, a program error occurred.                                                                               |
| 185               | CAN LESS MAILBXS        | CAN less mailboxes.                                                                                                                                                       |
| 186               | AL CAN1 BUS OFF         | CAN controller 1 is in "Bus Off" state.                                                                                                                                   |
| 187               | AL CAN1 ERR PASSV       | CAN controller 1 has signaled a warning.                                                                                                                                  |
| 188               | AL CAN2 BUS OFF         | CAN controller 2 is in "Bus Off" state.                                                                                                                                   |
| 189               | AL CAN2 ERROR PASSV     | CAN controller 2 has signaled a warning.                                                                                                                                  |
| 190               | AL EMU PARAM NO SUPPORT | EMU parameters are not supported.                                                                                                                                         |
| 198               | AL COMB ALM YEL         | Combined Yellow Alarm - a yellow alarm is a warning and does generally not result in engine shutdown.                                                                     |
| 201               | SD T COOLANT            | Coolant temperature-sensor defect.                                                                                                                                        |
| 202               | SD T FUEL               | Fuel temperature-sensor defect.                                                                                                                                           |
| 203               | SD T CHARGE AIR         | Charge air temperature-sensor defect.                                                                                                                                     |
| 205               | SD T CLNT INTERC        | Intercooler coolant temperature-sensor defect.                                                                                                                            |
| 206               | SD T EXHAUST A          | Exhaust gas temperature-sensor on A-side defect.                                                                                                                          |
| 207               | SD T EXHAUST B          | Exhaust gas temperature-sensor on B-side defect.                                                                                                                          |
| 208               | SD P CHARGE AIR         | Charge air pressure-sensor defect.                                                                                                                                        |
| 211               | SD P LUBE OIL           | Lube oil pressure-sensor defect.                                                                                                                                          |
| 212               | SD P COOLANT            | Coolant pressure-sensor defect.                                                                                                                                           |
| 213               | SD P COOLANT INTRCOOLR  | Intercooler coolant pressure-sensor defect.                                                                                                                               |
| 214               | SD P CRANKCASE          | Crankcase pressure-sensor defect.                                                                                                                                         |
| 215               | SD P HD                 | Rail pressure-sensor defect.                                                                                                                                              |

| Fault Code Number | String                 | Description                                                       |
|-------------------|------------------------|-------------------------------------------------------------------|
| 216               | SD T LUBE OIL          | Lube oil temperature-sensor defect.                               |
| 219               | SD T INTAKE AIR        | Intake air temperature-sensor defect.                             |
| 220               | SD COOLANT LEVEL       | Sensor for coolant level defect.                                  |
| 221               | SD P DIFF LUBE OIL     | Sensor for differential pressure of lube oil defect.              |
| 222               | SL LVL LKG FUEL        | Sensor for leakage level of fuel defect.                          |
| 223               | SD LVL INTERCLR        | Sensor for coolant level of intercooler defect.                   |
| 227               | SD PRE FILT P LUBE OIL | Pressure sensor for lube oil before filter defect.                |
| 228               | SD P FL PRE FILTR      | Sensor defect on the fuel pre-filter pressure sensor.             |
| 229               | AL SD CAM STOP         | Sensor of Camshaft defect and sensor of crankshaft defect before. |
| 230               | SD CRANKSHFT SPD       | Sensor defect on crankshaft.                                      |
| 231               | SD CAMSHAFT SPD        | Sensor defect on camshaft.                                        |
| 232               | SD CHARGER1 SPEED      | Speed-sensor of basic charger defect.                             |
| 233               | SD CHARGER2 SPEED      | Speed-sensor of switching charger defect.                         |
| 239               | SD P DIFF FUEL         | Sensor defect in the fuel filter differential pressure sensor.    |
| 240               | SD P FUEL              | Fuel pressure-sensor defect.                                      |
| 241               | SD T UMBLASSEN         | Temperature-sensor of recirculated charge air defect.             |
| 242               | SD T COOLANT R         | Redundant coolant temperature-sensor defect.                      |
| 244               | SD P LUBE OIL R        | Redundant pressure sensor for lube oil defect.                    |
| 245               | SD POWER SUPPLY        | Internal ECU error.                                               |
| 246               | SD T ELECTRONIC        | Internal ECU fault.                                               |
| 249               | SD CAN STOP            | Missing data CAN.                                                 |
| 250               | SD CAN SPD DEMND       | Missing data CAN.                                                 |
| 251               | SD CAN UP DOWN         | Missing data CAN.                                                 |
| 252               | SD CAN NOTCH POS       | Missing data CAN.                                                 |
| 253               | SD CAN OVERRIDE        | Missing data CAN.                                                 |
| 254               | SD CAN TST OVRSP       | Missing data CAN.                                                 |
| 255               | SD CAN ENGAGE SIG      | Missing data CAN.                                                 |
| 256               | SD CAN CYL CUTOUT      | Missing data CAN.                                                 |
| 257               | SD CAN LOCAL           | Missing data CAN.                                                 |
| 258               | SD CAN RCS ENGAGE      | Missing data CAN.                                                 |
| 259               | SD CAN RCS CYL CT      | Missing data CAN.                                                 |
| 260               | SD 15V POS SPPLY       | Internal ECU fault.                                               |
| 261               | 15V POS SPPLY          | Internal ECU fault.                                               |
| 262               | SD 5V BUFR TEST        | Internal ECU fault.                                               |
| 263               | SD TE BUFR TEST        | Internal ECU fault.                                               |
| 264               | SD BANK 1 TEST         | Internal ECU fault.                                               |
| 265               | SD BANK 2 TEST         | Internal ECU fault.                                               |
| 266               | SD SPD DEMAND AN       | Analog speed demand defect.                                       |
| 267               | SD SPDTEST BNCH        | Short circuit, cable breakage.                                    |
| 268               | SD SPINUT              | Analog spinning value defect.                                     |
| 269               | SD LOAD ANLG FLT       | Filtered analog load pulse signal not available.                  |
| 270               | SD FREQUENCY INPUT     | Frequency input defect.                                           |
| 271               | SD T EXTERN 1          | Missing data CAN.                                                 |
| 272               | SD T EXTERN 2          | Missing data CAN.                                                 |
| 273               | SD P EXTERN 1          | Missing data CAN.                                                 |
| 274               | SD P EXTERN 2          | Missing data CAN.                                                 |
| 275               | SD EXT CLNT LVL        | Missing data CAN.                                                 |

| Fault Code Number | String            | Description                                                          |
|-------------------|-------------------|----------------------------------------------------------------------|
| 276               | SD INTERCLER LVL  | Missing data CAN.                                                    |
| 277               | SD BIN EXT3       | Missing data CAN.                                                    |
| 278               | SD BIN EXT4       | Missing data CAN.                                                    |
| 279               | SD CANRES TRIPFL  | Missing data CAN.                                                    |
| 280               | SD CAN ALRM RST   | Missing data CAN.                                                    |
| 281               | SD ADTEST1 SPPLY  | Internal ECU fault.                                                  |
| 282               | SD ADTEST 2 SPPLY | Internal ECU fault.                                                  |
| 283               | SD ADTEST3 SPPLY  | Internal ECU fault.                                                  |
| 284               | SD CAN LAMP TEST  | Missing data CAN.                                                    |
| 285               | SD CAN IDLE RQ SR | Missing data CAN.                                                    |
| 286               | SD CAN IDLE REQ   | Missing data CAN.                                                    |
| 287               | SD CAN IDLE REQ   | Missing data CAN.                                                    |
| 288               | SD CAN TRBOSW LCK | Missing data CAN.                                                    |
| 301               | TIMING CYLNDR A1  | Error in timing of injector cylinder A1: timing value too low/high.  |
| 302               | TIMING CYLNDR A2  | Error in timing of injector cylinder A2: timing value too low/high.  |
| 303               | TIMING CYLNDR A3  | Error in timing of injector cylinder A3: timing value too low/high.  |
| 304               | TIMING CYLNDR A4  | Error in timing of injector cylinder A4: timing value too low/high.  |
| 305               | TIMING CYLNDR A5  | Error in timing of injector cylinder A5: timing value too low/high.  |
| 306               | TIMING CYLNDR A6  | Error in timing of injector cylinder A6: timing value too low/high.  |
| 307               | TIMING CYLNDR A7  | Error in timing of injector cylinder A7: timing value too low/high.  |
| 308               | TIMING CYLNDR A8  | Error in timing of injector cylinder A8: timing value too low/high.  |
| 309               | TIMING CYLNDR A9  | Error in timing of injector cylinder A9: timing value too low/high.  |
| 310               | TIMING CYLNDR A10 | Error in timing of injector cylinder A10: timing value too low/high. |
| 311               | TIMING CYLNDR B1  | Error in timing of injector cylinder B1: timing value too low/high.  |
| 312               | TIMING CYLNDR B2  | Error in timing of injector cylinder B2: timing value too low/high.  |
| 313               | TIMING CYLNDR B3  | Error in timing of injector cylinder B3: timing value too low/high.  |
| 314               | TIMING CYLNDR B4  | Error in timing of injector cylinder B4: timing value too low/high.  |
| 315               | TIMING CYLNDR B5  | Error in timing of injector cylinder B5: timing value too low/high.  |
| 316               | TIMING CYLNDR B6  | Error in timing of injector cylinder B6: timing value too low/high.  |
| 317               | TIMING CYLNDR B7  | Error in timing of injector cylinder B7: timing value too low/high.  |
| 318               | TIMING CYLNDR B8  | Error in timing of injector cylinder B8: timing value too low/high.  |
| 319               | TIMING CYLNDR B9  | Error in timing of injector cylinder B9: timing value too low/high.  |
| 320               | TIMING CYLNDR B10 | Error in timing of injector cylinder B10: timing value too low/high. |
| 321               | WIRING CYLNDR A1  | Short circuit in injector cable of cylinder A1.                      |
| 322               | WIRING CYLNDR A2  | Short circuit in injector cable of cylinder A2.                      |
| 323               | WIRING CYLNDR A3  | Short circuit in injector cable of cylinder A3.                      |
| 324               | WIRING CYLNDR A4  | Short circuit in injector cable of cylinder A4.                      |
| 325               | WIRING CYLNDR A5  | Short circuit in injector cable of cylinder A5.                      |
| 326               | WIRING CYLNDR A6  | Short circuit in injector cable of cylinder A6.                      |
| 327               | WIRING CYLNDR A7  | Short circuit in injector cable of cylinder A7.                      |
| 328               | WIRING CYLNDR A8  | Short circuit in injector cable of cylinder A8.                      |
| 329               | WIRING CYLNDR A9  | Short circuit in injector cable of cylinder A9.                      |
| 330               | WIRING CYLNDR A10 | Short circuit in injector cable of cylinder A10.                     |
| 331               | WIRING CYLNDR B1  | Short circuit in injector cable of cylinder B1.                      |
| 332               | WIRING CYLNDR B2  | Short circuit in injector cable of cylinder B2.                      |
| 333               | WIRING CYLNDR B3  | Short circuit in injector cable of cylinder B3.                      |
| 334               | WIRING CYLNDR B4  | Short circuit in injector cable of cylinder B4.                      |

| Fault Code Number | String                | Description                                                      |
|-------------------|-----------------------|------------------------------------------------------------------|
| 335               | WIRING CYLNR B5       | Short circuit in injector cable of cylinder B5.                  |
| 336               | WIRING CYLNR B6       | Short circuit in injector cable of cylinder B6.                  |
| 337               | WIRING CYLNR B7       | Short circuit in injector cable of cylinder B7.                  |
| 338               | WIRING CYLNR B8       | Short circuit in injector cable of cylinder B8.                  |
| 339               | WIRING CYLNR B9       | Short circuit in injector cable of cylinder B9.                  |
| 340               | WIRING CYLNR B10      | Short circuit in injector cable of cylinder B10.                 |
| 341               | OPN LD CYLNR A1       | Open load in injector cable of cylinder A1.                      |
| 342               | OPN LD CYLNR A2       | Open load in injector cable of cylinder A2.                      |
| 343               | OPN LD CYLNR A3       | Open load in injector cable of cylinder A3.                      |
| 344               | OPN LD CYLNR A4       | Open load in injector cable of cylinder A4.                      |
| 345               | OPN LD CYLNR A5       | Open load in injector cable of cylinder A5.                      |
| 346               | OPN LD CYLNR A6       | Open load in injector cable of cylinder A6.                      |
| 347               | OPN LD CYLNR A7       | Open load in injector cable of cylinder A7.                      |
| 348               | OPN LD CYLNR A8       | Open load in injector cable of cylinder A8.                      |
| 349               | OPN LD CYLNR A9       | Open load in injector cable of cylinder A9.                      |
| 350               | OPN LD CYLNR A10      | Open load in injector cable of cylinder A10.                     |
| 351               | OPN LD CYLNR B1       | Open load in injector cable of cylinder B1.                      |
| 352               | OPN LD CYLNR B2       | Open load in injector cable of cylinder B2.                      |
| 353               | OPN LD CYLNR B3       | Open load in injector cable of cylinder B3.                      |
| 354               | OPN LD CYLNR B4       | Open load in injector cable of cylinder B4.                      |
| 355               | OPN LD CYLNR B5       | Open load in injector cable of cylinder B5.                      |
| 356               | OPN LD CYLNR B6       | Open load in injector cable of cylinder B6.                      |
| 357               | OPN LD CYLNR B7       | Open load in injector cable of cylinder B7.                      |
| 358               | OPN LD CYLNR B8       | Open load in injector cable of cylinder B8.                      |
| 359               | OPN LD CYLNR B9       | Open load in injector cable of cylinder B9.                      |
| 360               | OPN LD CYLNR B10      | Open load in injector cable of cylinder B10.                     |
| 361               | AL POWER STAGE LOW    | Internal error of electronic.                                    |
| 362               | AL POWER STAGE HIGH   | Internal error of electronic.                                    |
| 363               | AL STOP POWER STAGE   | Internal error of electronic.                                    |
| 364               | AL STOP POWER STAGE 2 | Internal error of electronic.                                    |
| 365               | AL MV WIRING GND      | Cable line error.                                                |
| 371               | AL WIRING TO 1        | Short circuit or open load on transistor output 1 (TO 1).        |
| 372               | AL WIRING TO 2        | Short circuit or open load on transistor output 2 (TO 2).        |
| 373               | AL WIRING TO 3        | Short circuit or open load on transistor output 3 (TO 3).        |
| 374               | AL WIRING TO 4        | Short circuit or open load on transistor output 4 (TO 4).        |
| 381               | AL WIRING TOP 1       | Short circuit or open load on transistor output plant 1 (TOP 1). |
| 382               | AL WIRING TOP 2       | Short circuit or open load on transistor output plant 2 (TOP 2). |
| 383               | AL WIRING TOP 3       | Short circuit or open load on transistor output plant 3 (TOP 3). |
| 384               | AL WIRING TOP 4       | Short circuit or open load on transistor output plant 4 (TOP 4). |
| 385               | AL WIRING TOP 5       | Short circuit or open load on transistor output plant 5 (TOP 5). |
| 386               | AL WIRING TOP 6       | Short circuit or open load on transistor output plant 6 (TOP 6). |
| 390               | AL MCR EXCEEDED       | DBR/MCR Function: MCR (Maximum Continuous Rating) in exceeded.   |
| 392               | HI T COOLNT R         | Redundant coolant temperature too high (limit 1).                |
| 393               | SS T COOLNT R         | Redundant coolant temperature too high (limit 2).                |
| 394               | LO P LUBE OIL R       | Redundant pressure of lube oil too low (limit 1).                |
| 395               | SS P LUBE OIL R       | Redundant pressure of lube oil too low (limit 2).                |
| 396               | TD T COOLANT          | Maximum deviation of T-Coolant sensors.                          |

| Fault Code Number | String                  | Description                                                                   |
|-------------------|-------------------------|-------------------------------------------------------------------------------|
| 397               | TD P LUBE OIL           | Maximum deviation of P-Oil sensors.                                           |
| 399               | AL INTERFACE ECU        | Interface ECU.                                                                |
| 400               | AL OPN LD DIGIN 1       | Open load on digital input 1.                                                 |
| 401               | AL OPN LD DIGIN 2       | Open load on digital input 2.                                                 |
| 402               | AL OPN LD DIGIN 3       | Open load on digital input 3.                                                 |
| 403               | AL OPN LD DIGIN 4       | Open load on digital input 4.                                                 |
| 404               | AL OPN LD DIGIN 5       | Open load on digital input 5.                                                 |
| 405               | AL OPN LD DIGIN 6       | Open load on digital input 6.                                                 |
| 406               | AL OPN LD DIGIN 7       | Open load on digital input 7.                                                 |
| 407               | AL OPN LD DIGIN 8       | Open load on digital input 8.                                                 |
| 408               | AL OPN LD E STOP        | Open load on input for emergency stop.                                        |
| 410               | LO U PDU                | Power driver voltage (injectors) too low (limit 1).                           |
| 411               | LOLO U PDU              | Power driver voltage (injectors) too low (limit 2).                           |
| 412               | HI U PDU                | Power driver voltage (injectors) too high (limit 1).                          |
| 413               | HIHI U PDU              | Power driver voltage (injectors) too high (limit 2).                          |
| 414               | HI L WATER FUEL PREFILT | Water level of fuel prefilter too high (limit 1).                             |
| 415               | LO P COOLANT INTRCOOLR  | Coolant pressure of InterCooler too low (limit 1).                            |
| 416               | SS P COOLANT INTRCOOLR  | Coolant pressure of InterCooler too low (limit 2).                            |
| 417               | SD L WATER FUEL PREFILT | Water level-sensor of fuel prefilter defect.                                  |
| 418               | SD INTAKE AIR B         | Sensor defect of the Intake Air B temperature sensor.                         |
| 419               | SD PRE_ENG T COOL       | Sensor defect in the Coolant Temperature Sensor before engine coolant intake. |
| 420               | AL L1 AUX 1             | Input of Aux 1 injured limit 1.                                               |
| 421               | AL L2 AUX 1             | Input of Aux 1 injured limit 2.                                               |
| 422               | SD T CHRGR AIR B        | Sensor defect in the Charge Air B Temperature Sensor.                         |
| 423               | LO P COOLANT DIFF       | Low Coolant Differential Pressure.                                            |
| 424               | AL L1 AUX 2             | Auxiliary 2 Alarm Level 1 Alarm.                                              |
| 425               | AL L2 AUX 2             | Auxiliary 2 Alarm Level 2 Alarm.                                              |
| 426               | SD AIR MASS A           | Sensor defect in Air Mass Sensor A.                                           |
| 427               | SD AIR MASS B           | Sensor defect in Air Mass Sensor B.                                           |
| 428               | AL L1 T AUX 1           | Temperature input of Aux 1 injured limit 1.                                   |
| 429               | HI P COOLANT            | High Coolant Pressure.                                                        |
| 430               | LO PRE ENG P COOLNT     | Low Pre-Engine Coolant Pressure (Limit 1).                                    |
| 431               | SS PRE ENG P COOLNT     | Low Pre-Engine Coolant Pressure (Limit 2).                                    |
| 432               | AL L1 T AUX2            | Auxiliary Temperature 2 Level 1 Alarm.                                        |
| 433               | AL L2 T AUX2            | Auxiliary Temperature 2 Level 2 Alarm.                                        |
| 434               | HI PRE ENG T COOLNT     | High Pre-Engine Coolant Temperature (Limit 1).                                |
| 435               | SS PRE ENG T COOLNT     | High Pre-Engine Coolant Temperature (Limit 2).                                |
| 436               | AL L1 P AUX 2           | Auxiliary Pressure 2 Level 1 Alarm.                                           |
| 437               | AL L2 P AUX 2           | Auxiliary Pressure 2 Level 2 Alarm.                                           |
| 438               | LO P FUEL RAIL 2 STR    | Low pressure on fuel rail 2.                                                  |
| 439               | HI P FUEL RAIL 2 STR    | Hi pressure on fuel rail 2.                                                   |
| 440               | AL L1 P AUX 1           | Pressure input of Aux 1 injured limit 1.                                      |
| 441               | AL RAIL 2 LEAKAGE STR   | Alarm fuel rail 2 leak detected.                                              |
| 442               | AL L2 P AUX 1           | Pressure input of Aux 1 injured limit 2.                                      |
| 443               | HI P CHG MIX DIFF       | High Charge Mix Differential Pressure.                                        |



| Fault Code Number | String              | Description                                                                |
|-------------------|---------------------|----------------------------------------------------------------------------|
| 444               | SD U PDU            | Sensor defect of Injector Power driver unit.                               |
| 445               | SD P AMBIENT AIR    | Ambient air pressure-sensor defect.                                        |
| 446               | SD P HD2            | Sensor Defect In HD 2 Pressure Sensor.                                     |
| 447               | HIHI P CHG MIX DIFF | Charge Mixture Differential Pressure High (Limit 2).                       |
| 448               | HI P CHARGE AIR     | Pressure of charge air too high (limit 1).                                 |
| 449               | SS P CHARGE AIR     | Pressure of charge air too high (limit 2).                                 |
| 450               | SD IDLE END TRQ IN  | Input of Idle/End-Torque defect                                            |
| 451               | HI T CHARGE MIX     | High Charge Mixture Temperature (Limit 1).                                 |
| 452               | HI HI T CHARGE MIX  | High Charge Mixture Temperature (Limit 2).                                 |
| 453               | LO T CHARGE MIX     | Low Charge Mixture Temperature.                                            |
| 454               | SS PWR RED ACT      | Power Reduction is activated.                                              |
| 455               | AL L1 AUX1 PLANT    | Input of Aux 1 (plant) injured limit 1.                                    |
| 456               | AL L2 AUX1 PLANT    | Input of Aux 1 (plant) injured limit 2.                                    |
| 457               | LO T INTAKE AIR     | Low Intake Air Temperature (Limit 1).                                      |
| 458               | LO LO T INTAKE AIR  | Low Intake Air Temperature (Limit 2).                                      |
| 459               | SD P CLNT B ENG     | Sensor Defect In the Coolant Before Engine Pressure Sensor.                |
| 460               | HI T EXHAUST EMU    | Exhaust gas temperature of EMU too high (limit 1).                         |
| 461               | LO T EXHAUST EMU    | Exhaust gas temperature of EMU too low (limit 1).                          |
| 462               | HI T COOLANT EMU    | Coolant temperature of EMU injured limit 1.                                |
| 463               | SD AUX 2            | Sensor defect on Aux 2.                                                    |
| 464               | SD P AUX 1          | Analog input for pressure Aux 1 defect.                                    |
| 465               | SD P AUX 2          | Sensor Defect in the Auxiliary 2 Pressure Sensor.                          |
| 466               | SD T AUX 2          | Sensor Defect in the Auxiliary 2 Temperature Sensor.                       |
| 467               | AL L2 T AUX 1       | Temperature input of Aux 1 injured limit 2.                                |
| 468               | SD T AUX 1          | Analog input for Temperature Aux 1 defect.                                 |
| 469               | SD AUX 1            | Analog input for Aux 1 defect.                                             |
| 470               | SD T ECU            | ECU temperature-sensor defect.                                             |
| 471               | SD COIL CURRENT     | Coil Current sensor defect.                                                |
| 472               | AL STOP SD          | Engine stop, because critical channel has sensor defect.                   |
| 473               | AL WIRING PWM CM2   | Open load or short circuit on channel PWM CM2.                             |
| 474               | AL WIRING FREQ OUT  | Open load or short circuit on frequency output (FO) channel.               |
| 475               | AL CR TRIG ENG ST   | Released in case of an engine stop in order to trigger the crash recorder. |
| 476               | AL CRASH REC ERR    | Initial error of crash recorder.                                           |
| 477               | WRT MISTK BIN VAL   | Binary Data Write Error.                                                   |
| 478               | AL COMB ALM YEL     | Combined Alarm YELLOW (Plant).                                             |
| 479               | AL COMB ALM RED     | Combined Alarm RED (Plant).                                                |
| 480               | AL EXT ENG PROT     | External Engine Protection function active.                                |
| 481               | SD COIL CURRENT 2   | Sensor Defect In Coil Current 2 Sensor.                                    |
| 482               | SD T EXHAUST C      | Sensor Defect In Exhaust System C Temperature Sensor.                      |
| 483               | SD T EXHAUST D      | Sensor Defect In Exhaust System D Temperature Sensor.                      |
| 484               | HI T EXHAUST C      | High Exhaust C Temperature (Limit 1).                                      |
| 485               | SS T EXHAUST C      | High Exhaust C Temperature (Limit 2).                                      |
| 486               | HI T EXHAUST D      | High Exhaust D Temperature.                                                |
| 487               | SS T EXHAUST D      | Shutdown due to High Exhaust D Temperature.                                |
| 488               | HI ETC 3 OVERSPD    | High Turbo Charger ETC 3 Overspeed (Limit 1).                              |
| 489               | SS ETC 3 OVERSPD    | High Turbo Charger ETC 3 Overspeed (Limit 2).                              |
| 490               | HI ETC 4 OVERSPD    | High Turbo Charger ETC 4 Overspeed (Limit 1).                              |



| Fault Code Number | String                  | Description                                                             |
|-------------------|-------------------------|-------------------------------------------------------------------------|
| 491               | SS ETC 4 OVERSPD        | High Turbo Charger ETC 4 Overspeed (Limit 2).                           |
| 492               | HI ETC 4 CUTIN FAIL     | High Turbo Charger ETC 4 Cut In Failure (Limit 1).                      |
| 493               | HI ETC 3 CUTIN FAIL     | High Turbo Charger ETC 3 Cut In Failure (Limit 2).                      |
| 494               | SD THROTL A FDBK        | Sensor Defect In Throttle A Feedback Sensor.                            |
| 495               | SD THROTL B FDBK        | Sensor Defect In Throttle B Feedback Sensor.                            |
| 496               | SD P CHARGE MIX A       | Sensor Defect In Charge Mix A Pressure Sensor.                          |
| 497               | SD P CHARGE MIX B       | Sensor Defect In Charge Mix B Pressure Sensor.                          |
| 498               | SD P CHRG MIX DIFF      | Sensor Defect In Charge Mix Differential Pressure Sensor.               |
| 499               | SD P CHARGE MIX         | Sensor Defect In Charge Mix Pressure Sensor.                            |
| 500               | AL WIRING POM STARTER 1 | A wiring fault has been detected in the connection of starter 1 of POM. |
| 501               | AL WIRING POM STARTER 2 | A wiring fault has been detected in the connection of starter 2 of POM. |
| 502               | AL OPEN LD POM ALTRNATR | An open load on POM's alternator output has been detected.              |
| 503               | AL BATT NOT CHARGING    | Battery is not being charged by alternator.                             |
| 504               | AL CAN POM NODE LOST    | POM is missing on CAN Bus.                                              |
| 505               | AL NEW POM FOUND        | New POM found.                                                          |
| 506               | AL LOW STARTER VOLTS    | Battery voltage is too low for starting.                                |
| 507               | AL POM ERROR            | A general POM error has been detected.                                  |
| 508               | AL WRONG POM ID         | POM sends a different identification number (ID) than expected.         |
| 509               | AL CHECK POM FUSE       | Check POM fuse.                                                         |
| 510               | AL OVERRIDE APPLIED     | Override applied.                                                       |
| 511               | HIHI P CHG MIX A        | Hi Charge Air Mix A Pressure (Limit 2).                                 |
| 512               | HIHI P CHG MIX B        | Hi Charge Air Mix B Pressure (Limit 2).                                 |
| 513               | SD P COOLNT DIFF        | Sensor Defect In Coolant Differential Pressure Sensor.                  |
| 514               | WRITE ERR FLASH         | Write Error Occurred when writing data to Flash Memory.                 |
| 515               | STARTER NOT ENGAGED     | Starter of POM could not be engaged.                                    |
| 516               | OILNIVEAU CAL ERR       | Remote Oil Level Watchman Calibration Error.                            |
| 517               | SD CHG MX PR THRT       | Sensor Defect In Charge Pre-Throttle Mix Pressure Sensor.               |
| 518               | SD THROT BYPASS FDBK    | Sensor Defect In Throttle Feedback Bypass Sensor.                       |
| 519               | OIL LVL CAL ERROR       | Oil Level Calibration Error.                                            |
| 520               | SD P IN AIR AFT FLT A   | Sensor Defect In Intake Air After Filter A Pressure Sensor.             |
| 521               | SD P OIL MID VAL        | Lube Oil Pressure Middle Value (Limit 2).                               |
| 522               | SD P IN AIR AFT FLT B   | Sensor Defect In Intake Air After Filter B Pressure Sensor.             |
| 523               | SD T COOL RED MIDVL     | Coolant Temperature Mid value (Limit 2).                                |
| 524               | SS ENG OVRSPD MIDVL     | Engine Speed Middle Value too high (Limit 2).                           |
| 525               | SD P LUBE OIL R2        | Sensor Defect In Lube Oil Pressure (R2) Sensor.                         |
| 526               | SD T COOL OIL R2        | Sensor Defect In Oil Coolant Temperature (R2) Sensor.                   |
| 527               | TD ENG SPD SNS DEV      | Engine Speed Sensor Deviation.                                          |
| 528               | SD ENG SPD SENSR 3      | Sensor Defect in Engine Speed Third Sensor.                             |
| 529               | SS T COOL RED 2         | Coolant Temperature Red 2 Alarm (Limit 2).                              |
| 530               | SS P LUBE OIL RED 2     | Lube Oil Pressure Red 2 Alarm (Limit 2).                                |
| 531               | AL WIRING PWM CM1       | PWM CM1 Wiring Issue.                                                   |
| 532               | AL WIRING PWM1          | PWM 1 Wiring Issue.                                                     |
| 533               | AL WIRING PWM2          | PWM 2 Wiring Issue.                                                     |
| 534               | HIHI POWER DIFF         | Power Difference High (Limit 2).                                        |
| 535               | LOLO POWER DIFF         | Power Difference Low (Limit 2).                                         |

| Fault Code Number | String                | Description                                                                                                                                                                                                                                                                           |
|-------------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 536               | AL WIRING PWM1 CM1    | PWM CM1 Wiring Issue.                                                                                                                                                                                                                                                                 |
| 537               | SD P VNTRI DLTA SD A  | Sensor Defect In Venture Side A Delta Pressure Sensor.                                                                                                                                                                                                                                |
| 538               | SD P VNTRI DLTA SD B  | Sensor Defect In Venture Side B Delta Pressure Sensor.                                                                                                                                                                                                                                |
| 539               | SD P EGR VNTRI STATIC | Sensor Defect In EGR Venture Static Pressure Sensor.                                                                                                                                                                                                                                  |
| 540               | SD T EGR              | Sensor Defect In EGR Temperature Sensor.                                                                                                                                                                                                                                              |
| 541               | AL L1 T EGR           | EGR Temperature (Limit 1) Alarm.                                                                                                                                                                                                                                                      |
| 542               | AL L2 T EGR           | EGR Temperature (Limit 2) Alarm.                                                                                                                                                                                                                                                      |
| 543               | MULTIPLE FDH SLAVES   | There is more than one device which is configured as Backup for FDH-Functionality.                                                                                                                                                                                                    |
| 544               | CONFIGURATION CHANGED | Gets active in case of changing system configuration e.g. by changing ECU- or SAM-Device. Remains until undo procedure or data is transferred by a valid maintenance case. Is cancelled automatically.                                                                                |
| 545               | AL L1 P EXT PLNT1     | External Plant 1 Pressure Alarm (Limit 1).                                                                                                                                                                                                                                            |
| 546               | AL L1 P EXT PLNT2     | External Plant 2 Pressure Alarm (Limit 1).                                                                                                                                                                                                                                            |
| 547               | AL L1 T EXT PLNT1     | External Plant 1 Temperature Alarm (Limit 1).                                                                                                                                                                                                                                         |
| 548               | AL L1 T EXT PLNT2     | External Plant 2 Temperature Alarm (Limit 1).                                                                                                                                                                                                                                         |
| 549               | AL PWR CUTOFF DET     | Power Cutoff Detected.                                                                                                                                                                                                                                                                |
| 550               | SS ENG OVRSP RED2     | Engine Overspeed Red2 (Limit 1) Alarm.                                                                                                                                                                                                                                                |
| 551               | SS ENG OVRSPD CAMSFT  | Engine Overspeed Camshaft (Limit 1) Alarm.                                                                                                                                                                                                                                            |
| 552               | AL GAS CTRL CHK FLT   | Gas Control Check Fault Alarm.                                                                                                                                                                                                                                                        |
| 553               | AL AUX DEVICES FLT    | Auxiliary Devices Alarm.                                                                                                                                                                                                                                                              |
| 554               | AL IGNITION FAULT     | Ignition Fault Alarm.                                                                                                                                                                                                                                                                 |
| 555               | AL CALL FIELD SERVICE | Gets active in case of completing a maintenance-case which manipulates Engine-Parameters. Remains also after switching on-off ECU until a valid release code is entered via Display- and Button-Control of SAM-Device. Release Code is available via Internet by a special procedure. |
| 556               | AL GAS VALVE FLT      | Gas Valve Fault Alarm.                                                                                                                                                                                                                                                                |
| 557               | AL ENG SPD COLL. FLT  | Engine Speed Collapse Fault Alarm.                                                                                                                                                                                                                                                    |
| 558               | AL WIRING PWM CM2     | PWM CM2 Wiring Issue.                                                                                                                                                                                                                                                                 |
| 559               | AL MIX THRT A FLT     | Throttle A Mixture Fault Alarm.                                                                                                                                                                                                                                                       |
| 560               | AL MIX THRT B FLT     | Throttle B Mixture Fault Alarm.                                                                                                                                                                                                                                                       |
| 561               | AL LIM EXT PLNT BIN1  | External Plant Bin 1Limit Alarm.                                                                                                                                                                                                                                                      |
| 562               | AL LIM EXT PLNT BIN2  | External Plant Bin 1Limit Alarm.                                                                                                                                                                                                                                                      |
| 563               | AL LIM EXT PLNT BIN3  | External Plant Bin 1Limit Alarm.                                                                                                                                                                                                                                                      |
| 564               | AL LIM EXT PLNT BIN4  | External Plant Bin 1Limit Alarm.                                                                                                                                                                                                                                                      |
| 565               | L1 P AFTER AIR FLT A  | Intake A Air Pressure After Filter (Limit 1).                                                                                                                                                                                                                                         |
| 566               | L2 P AFTER AIR FLT A  | Intake A Air Pressure After Filter (Limit 2).                                                                                                                                                                                                                                         |
| 567               | L1 P AFTER AIR FLT B  | Intake B Air Pressure After Filter (Limit 1).                                                                                                                                                                                                                                         |
| 568               | L2 P AFTER AIR FLT B  | Intake B Air Pressure After Filter (Limit 2).                                                                                                                                                                                                                                         |
| 569               | AL SAM MSG DATA FLT   | SAM Module Missing Data Fault.                                                                                                                                                                                                                                                        |
| 570               | L1 CAN MAX TIMG RETRD | Maximum Timing Retard from CAN (Limit 1).                                                                                                                                                                                                                                             |
| 571               | L2 CAN MAX TIMG RETRD | Maximum Timing Retard from CAN (Limit 2).                                                                                                                                                                                                                                             |
| 572               | L3 CAN MAX TIMG RETRD | Maximum Timing Retard from CAN (Limit 3).                                                                                                                                                                                                                                             |
| 573               | SD P DIFF STR VS VRD  | Sensor Defect in Pressure Differential Sensor Pitot Tube vs. Pressure.                                                                                                                                                                                                                |
| 574               | SD M AIR EGR BEF CLR  | Sensor Defect In Air Mass Sensor before EGR Cooler.                                                                                                                                                                                                                                   |
| 575               | SD M INTAKE AIR       | Sensor Defect In Intake Air Mass Sensor.                                                                                                                                                                                                                                              |
| 576               | AL ESCM OVERRIDE STR  | Exceeding of the corrected current MCR - odr DBR/MCR value.                                                                                                                                                                                                                           |
| 577               | SD T LUBE OIL PAN     | Sensor Defect In Oil Pan Lube Oil Temperature Sensor.                                                                                                                                                                                                                                 |
| 578               | AL L1 T LUBOIL PAN    | Lube Oil Pan Temperature (Limit 1).                                                                                                                                                                                                                                                   |

| Fault Code Number | String                         | Description                                                            |
|-------------------|--------------------------------|------------------------------------------------------------------------|
| 579               | AL MD CANRQ IDLE SPD           | MD Idle Speed Request over Can Bus.                                    |
| 580               | AL CAN SPD LIMIT               | MD Speed Limitation From Can Bus.                                      |
| 581               | AL PWM CM3                     | PWM CM3 Alarm.                                                         |
| 582               | AL EMERG STOP FL               | Emergency Stop Failed Alarm.                                           |
| 583               | AL BRKR CLOSED                 | Circuit Breaker Closed Alarm.                                          |
| 584               | AL CAN STRTCLR FL              | Start Clearance from Can Bus Fail Alarm.                               |
| 585               | AS MOTORSTRT BL                | Engine Start Blocked Alarm.                                            |
| 586               | LO P OIL REFILL PMP            | Refill Pump Lower Oil Pressure.                                        |
| 587               | AL WIRING PWM CM4              | PWM CM4 Wiring Issue.                                                  |
| 588               | SD P OIL REFILL PUMP           | Sensor Defect In Refill Pump Oil Pressure Sensor.                      |
| 589               | SD T EGR SIDE B                | Side B EGR Temperature Alarm.                                          |
| 590               | SD P DLTA EXHAUST A            | Sensor Defect In Exhaust A Pressure Delta Sensor.                      |
| 591               | SD P EGRB VNTRI STATC          | Sensor Defect In Side B EGR Venture Static Pressure Sensor.            |
| 592               | AS P DLTA EXH B                | Sensor Defect In Exhaust B Pressure Delta Sensor.                      |
| 593               | SD OIL T J1939                 | Sensor Defect in Lube Oil Pan Temperature Sensor.                      |
| 594               | AL L1 PRV 1 DEFECT STR         | Yellow alarm pressure relief valve first rail.                         |
| 595               | AL L2 PRV 1 DEFECT STR         | Red alarm pressure relief valve first rail.                            |
| 596               | DEVELOP PR SET                 | Develop PR Set Alarm.                                                  |
| 597               | AL WIRING PWM CM5              | PWM CM5 Wiring Issue.                                                  |
| 598               | AL L1 PRV 2 DEFECT STR         | Yellow alarm pressure relief valve second rail.                        |
| 599               | AL L2 PRV 2 DEFECT STR         | Red alarm pressure relief valve second rail.                           |
| 600               | SD T EXG A+B                   | Sensor Defect In Exhaust A Plus B Temperature Sensor.                  |
| 601               | SD ETC1 + EC2                  | Turbo Charger Speed Sensors 1 and 2 Faulty.                            |
| 602               | AK CAB ENG STRT LOCK           | Engine Start Lock from Can Alarm.                                      |
| 603               | SD AIR HUMIDITY                | Sensor Defect In Air Humidity Sensor.                                  |
| 604               | AL HUT CHGSPD MAX              | HUT Speed Change Maximum Limit Alarm.                                  |
| 605               | AL HUT DEV TOO HI              | HUT DEV too high limit alarm.                                          |
| 606               | AL DBL NODES LOST 1+2          | Nodes Lost on Can1 and Can2 Alarm.                                     |
| 607               | AL MD CAN STOP                 | MD Can Stop Alarm.                                                     |
| 608               | AL WIRING PWM CM6              | PWM CM6 Wiring Issue.                                                  |
| 609               | AL WIRING PWM CM7              | PWM CM7 Wiring Issue.                                                  |
| 610               | AL WIRING SUCK RESTRCT 1 STR   | Open load or short circuit on PWM HP fuel control block channel.       |
| 611               | AL WIRING SUCK RESTRCT 2 STR   | Open load or short circuit on PWM HP fuel control block channel 2.     |
| 612               | AL WIRING PRESS CTRL VLV 1 STR | Open load or short circuit on PWM pressure regulating valve channel.   |
| 613               | AL WIRING PRESS CTRL VLV 2 STR | Open load or short circuit on PWM pressure regulating valve channel 2. |
| 614               | L1 P FUEL SEC FLTDIFF          | Secondary Filter Fuel Pressure Limit 1 Alarm.                          |
| 615               | AL EIL PROTECTION STR          | Alarm for Protection Module in response to faulty or manipulated EIL.  |
| 616               | AL EIL ERROR STR               | EIL Error.                                                             |
| 617               | LO ACTUAL HU VAL               | HU Actual Value Low (Limit 1).                                         |
| 618               | LOLO ACTUAL HU VAL             | HU Actual Value Low (Limit 2).                                         |
| 619               | HI ACTUAL HU VAL               | HU Actual Value High (Limit 1).                                        |
| 620               | HIHI ACTUAL HU VAL             | HU Actual Value High (Limit 2).                                        |
| 621               | LO NOX VALUE                   | NOX Value Low (Limit 1).                                               |
| 622               | LOLO NOX VALUE                 | NOX Value Low (Limit 2).                                               |

| Fault Code Number | String                | Description                                                                            |
|-------------------|-----------------------|----------------------------------------------------------------------------------------|
| 623               | HI NOX VALUE          | NOX Value High (Limit 1).                                                              |
| 624               | HIHI NOX VALUE        | NOX Value High (Limit 2).                                                              |
| 625               | SD P FUEL ADD SEC FLT | Sensor Defect in Pressure Sensor that meters Fuel Pressure Before supplemental Filter. |
| 626               | AL WIRING PWM CM8     | PWM CM8 Wiring Issue.                                                                  |
| 627               | AL WIRING PWM CM9     | PWM CM9 Wiring Issue.                                                                  |
| 628               | AL WIRING PWM CM10    | PWM CM10 Wiring Issue.                                                                 |
| 629               | EGR THOTTLE A DFCT    | EGR Throttle EGR Defect.                                                               |
| 630               | EGR THOTTLE B DFCT    | EGR Throttle EGR Defect.                                                               |
| 631               | AL BYPASS THROT DFCT  | Bypass Throttle Defect.                                                                |
| 632               | AL DISPNS THRTL DFCT  | Dispenser Throttle Defect.                                                             |
| 633               | SD P AMBAIR HDT2800   | Sensor Defect in Ambient HD2800 Air Pressure Sensor.                                   |
| 634               | SD T AMBAIR HDT2800   | Sensor Defect in Ambient HD2800 Air Temperature Sensor.                                |
| 635               | SD H AMBAIR HDT2800   | Sensor Defect in Ambient HD2800 Air Humidity Sensor.                                   |
| 636               | SD OIL LVL J1939      | Sensor Defect in J1939 Lube Oil Level Sensor.                                          |
| 637               | SD OIL T J1939        | Sensor Defect in J1939 Lube Oil Temperature Sensor.                                    |
| 638               | AL WIRING PWM SIG1    | PWM SIG1 Wiring Issue.                                                                 |
| 639               | AL WIRING PWM SIG2    | PWM SIG2 Wiring Issue.                                                                 |
| 640               | SD SM NOX O2 FACTR    | Sensor Defect In Smart NOX Oxidation Factor Sensor.                                    |
| 641               | AS SYS WATCHDG RST    | System Restart by Watchdog Detected.                                                   |
| 642               | SD ELCT ENG PWR AI2   | Sensor Defect In Engine Power AI2 Electronic Sensor.                                   |
| 643               | SP P FUEL BOF         | Sensor Defect in BOF Fuel Pressure Sensor.                                             |
| 644               | AL L1 P FUEL BOF      | BOF Fuel Pressure Limit 1.                                                             |
| 645               | AL L2 P FUEL BOF      | BOF Fuel Pressure Limit 2.                                                             |
| 646               | AL KNOCK INTNSTY      | Knock Intensity Too High.                                                              |
| 647               | SD P EXH LAMBDA       | Sensor Defect in Exhaust Lambda Pressure Sensor.                                       |
| 648               | SD P CHRGR AIR B      | Sensor Defect In Charge Air B Pressure Sensor.                                         |
| 649               | AL REQ ANGL THRT A    | Throttle A Angle Alarm.                                                                |
| 650               | AL REQ ANGL THRT B    | Throttle B Angle Alarm.                                                                |
| 651               | AL PREHT ERROR        | Preheating Error Alarm.                                                                |
| 652               | AL GET COM LOST       | GET Communications Lost.                                                               |
| 653               | AL IX92X COMM LOST    | IC92X Communications Lost.                                                             |
| 654               | AL FSERIES COMM LOST  | F Series Communications Lost.                                                          |
| 655               | AL TECJET COMM LOST   | TECJET Communications Lost.                                                            |
| 656               | AL PROACT A COMM LST  | PROACT A Communications Lost.                                                          |
| 657               | AL PROACT B COMM LST  | PROACT B Communications Lost.                                                          |
| 658               | AL NOXA COMM LOST     | NOX A Communications Lost.                                                             |
| 659               | AL NOXB COMM LOST     | NOX B Communications Lost.                                                             |
| 660               | AL PHYTRNA COM LST    | PHYTRON A Communications Lost.                                                         |
| 661               | AL PHYTRNB COM LST    | PHYTRON B Communications Lost.                                                         |
| 662               | SD SMRT NOX HTR       | Sensor Defect in Smart NOX Heater Element Sensor.                                      |
| 663               | SD SMRT NOX CONC.     | Sensor Defect in Smart NOX Concentration Sensor.                                       |
| 664               | AL OIL REFILL ERR     | Oil Refill Error.                                                                      |
| 665               | AL GET YELLOW         | GET Yellow Alarm.                                                                      |
| 666               | AL IC92X YELLOW       | IC92X Yellow Alarm.                                                                    |
| 667               | AL FSERIES YELLOW     | F Series Yellow Alarm.                                                                 |
| 668               | AL TECJET YELLOW      | TECJET Yellow Alarm.                                                                   |

| <b>Fault Code Number</b> | <b>String</b>                | <b>Description</b>                              |
|--------------------------|------------------------------|-------------------------------------------------|
| 669                      | AL PROACTA YELLOW            | PROACT A Yellow Alarm.                          |
| 670                      | AL PROACTB YELLOW            | PROACT B Yellow Alarm.                          |
| 671                      | AL NOXA YELLOW               | NOX A Yellow Alarm.                             |
| 672                      | AL NOXB YELLOW               | NOX B Yellow Alarm.                             |
| 673                      | AL PHYA YELLOW               | PHYTRON A Yellow Alarm.                         |
| 674                      | AL PHYB YELLOW               | PHYTRON B Yellow Alarm.                         |
| 675                      | AL GET RED                   | GET Red Alarm.                                  |
| 676                      | AL IC92X RED                 | IC92X Red Alarm.                                |
| 677                      | AL FSERIES RED               | F Series Red Alarm.                             |
| 678                      | AL TECJET RED                | TECJET Red Alarm.                               |
| 679                      | AL PROACTA RED               | PROACT A Red Alarm.                             |
| 680                      | AL PROACTB RED               | PROACT B Red Alarm.                             |
| 681                      | AL NOXA RED                  | NOX A Red Alarm.                                |
| 682                      | AL NOXB RED                  | NOX B Red Alarm.                                |
| 683                      | AL PHYA RED                  | PHYTRON A Red Alarm.                            |
| 684                      | AL PHYB RED                  | PHYTRON B Red Alarm.                            |
| 685                      | AL LUBE OIL MIN              | Lube Oil Minimum.                               |
| 686                      | AL LUBE OIL MAX              | Lube Oil Maximum.                               |
| 687                      | AL LUBEOIL LVL SW            | Lube Oil Level Switch is Faulty.                |
| 688                      | LO OIL REFILL                | Low Oil Refill.                                 |
| 689                      | HI OIL REFILL                | High Oil Refill.                                |
| 690                      | AL LUBEOIL LVL LO            | Lube Oil Level Low.                             |
| 691                      | HI LUBEOIL LVL REFILL        | Lube Oil Refill Level High.                     |
| 692                      | AL ECU PWR OFF ON REQ STR    | ECU configuration changed, switch power off/on. |
| 693                      | AL MB VALVE ERR              | MB Valve Error.                                 |
| 694                      | SD T GAS                     | Sensor Defect in Gas Temperature Sensor.        |
| 695                      | AL EGR FAILURE               | EGR Failure Alarm.                              |
| 696                      | AL SMARTCONCT USB ERR STR    | Alarm configuration parameter.                  |
| 697                      | AL SMARTCONCT RS485 ERR STR  | Alarm configuration parameter.                  |
| 698                      | AL SD STOP BUTTON STR        | Channel signals open load or internal error.    |
| 700                      | AL SD START BUTTON STR       | Channel signals open load.                      |
| 701                      | AL SD UP BUTTON STR          | Channel signals open load.                      |
| 702                      | AL SD DN BUTTON STR          | Channel signals open load or internal error.    |
| 703                      | AL SD EXT SPEED DMD SW STR   | Channel signals open load.                      |
| 704                      | AL SD SPEED DMD INCREASE STR | Channel signals open load or internal error.    |
| 705                      | AL SD BINARY SPD DMD LMT STR | Channel signals open load or internal error.    |
| 706                      | AL SD DROOP 2 SWITCH STR     | Channel signals open load or internal error.    |
| 707                      | AL SD FREQUENCY SWITCH STR   | Channel signals open load or internal error.    |
| 709                      | AL SD OVERRIDE BUTTON STR    | Channel signals open load or internal error.    |
| 710                      | AL SD ALARM RESET STR        | Channel signals open load or internal error.    |

| Fault Code Number | String                         | Description                                                          |
|-------------------|--------------------------------|----------------------------------------------------------------------|
| 711               | AL SD CYLINDER CUTOUT STR      | Channel signals open load or internal error.                         |
| 712               | AL SD RQST BIN OUT TST STR     | Channel signals open load or internal error.                         |
| 713               | AL SD EXT ENGINE PROTECTN STR  | Channel signals open load or internal error.                         |
| 714               | AL SD PRELUBE SIGNAL STR       | Channel signals open load.                                           |
| 715               | AL SD EXT INC IDLE BIN STR     | Channel signals open load.                                           |
| 716               | AL SD EXT INC IDLE BIN BRK STR | Channel signals open load.                                           |
| 717               | AL SD RQST PLANT DBR STR       | Channel signals open load.                                           |
| 718               | INTK AIR THRTL DFCT            | Intake Air Throttle Defect.                                          |
| 719               | AL T GAS L1                    | Gas Temperature Limit Alarm (Limit 1).                               |
| 720               | AL T GAS L2                    | Gas Temperature Limit Alarm (Limit 2).                               |
| 721               | AL T GAS L3                    | Gas Temperature Limit Alarm (Limit 3).                               |
| 722               | AL T GAS L4                    | Gas Temperature Limit Alarm (Limit 4).                               |
| 723               | SD T EXH BEF DOC A             | Sensor Defect Exhaust Temperature Sensor before DOC.                 |
| 724               | SD T EXH BEF DPF A             | Sensor Defect Exhaust Temperature Sensor before DPF.                 |
| 725               | SD T EXH AFTR DPF A            | Sensor Defect Exhaust Temperature Sensor after DPF.                  |
| 726               | SD P DELTA EXH DPF A           | Sensor Defect in DPF Exhaust Pressure Delta Sensor.                  |
| 727               | L1 DELTA T_NT INTRCLR          | NT Intercooler NT Temperature (Limit 1) Alarm.                       |
| 728               | L2 DELTA T_NT INTRCLR          | NT Intercooler NT Temperature (Limit 2) Alarm.                       |
| 729               | L1 T EXH BEF DOC               | Exhaust Temperature Before DOC (Limit 1) Alarm.                      |
| 730               | L2 T EXH BEF DOC               | Exhaust Temperature Before DOC (Limit 2) Alarm.                      |
| 731               | L2 T EXH BEF DOC               | Exhaust Temperature Before DPF (Limit 1) Alarm.                      |
| 732               | L2 T EXH BEF DPF               | Exhaust Temperature Before DPF (Limit 2) Alarm.                      |
| 733               | L1 T EXH AFTR DPF              | Exhaust Temperature After DPF (Limit 1) Alarm.                       |
| 734               | L2 T EXH AFTR DPF              | Exhaust Temperature After DPF (Limit 2) Alarm.                       |
| 735               | L1 P_DPF DIFF                  | DPF Exhaust Pressure Difference Alarm (Limit 1) Alarm.               |
| 736               | L2 P_DPF DIFF                  | DPF Exhaust Pressure Difference Alarm (Limit 2) Alarm.               |
| 737               | L1 P_DPF NORM DIFF             | DPF Normal Difference Pressure (Limit 1) Alarm.                      |
| 738               | L2 P_DPF NORM DIFF             | DPF Normal Difference Pressure (Limit 2) Alarm.                      |
| 739               | L3 P_DPF NORM DIFF             | DPF Normal Difference Pressure (Limit 3) Alarm.                      |
| 740               | L4 P_DPF NORM DIFF             | DPF Normal Difference Pressure (Limit 4) Alarm.                      |
| 741               | DPF RIGOROUS TM ABORT          | DPF Rigorous TM Aborted Alarm.                                       |
| 742               | DPF PER RIGOROUS TM            | DPF Periodic Rigorous TM Alarm.                                      |
| 743               | DPF RIG TM SUPPR               | DPF Rigorous TM Suppressed Alarm.                                    |
| 744               | DPF FLASH READ ERR             | DPF Flash Memory Read Error Alarm.                                   |
| 745               | AL EMISSN FLT                  | Emission Fault Alarm.                                                |
| 746               | AL EMISSN FLT2                 | Emission Fault 2 Alarm.                                              |
| 747               | SD P INTK AIRFLT DIFF          | Sensor Defect in the Intake Air Filter Differential Pressure Sensor. |
| 748               | SD T EXH BEF SCR F1            | Sensor Defect in Exhaust Temperature Sensor Before SCR Filter 1.     |
| 749               | SD T EXH BEF SCR F2            | Sensor Defect in Exhaust Temperature Sensor Before SCR Filter 2.     |
| 750               | SD T EXH AFTR SCR F1           | Sensor Defect in Exhaust Temperature Sensor Before SCR Filter 1.     |
| 751               | SD T EXH AFTR SCR F2           | Sensor Defect in Exhaust Temperature Sensor Before SCR Filter 2.     |
| 752               | SD DEF TANK LVL                | Sensor Defect in DEF Tank Level Sensor.                              |

| Fault Code Number | String                 | Description                                                            |
|-------------------|------------------------|------------------------------------------------------------------------|
| 753               | SD T RM TANK           | Sensor Defect in RM Tank Temperature Sensor.                           |
| 754               | SD BOSCH LSU LMBDA SNS | Sensor Defect In Bosch LSU Lambda Sensor.                              |
| 755               | SELCTD MODE NOT VLD    | Selected Mode Not Valid Alarm.                                         |
| 756               | NO VLD MODE SW SGNL    | No Valid Mode Switch Alarm.                                            |
| 757               | AL LIM T COOL LT FAN   | Coolant LT Fan Limit (Limit 1) Alarm.                                  |
| 758               | DEF NOZZLE DAMG        | DEF Nozzle Damage Alarm.                                               |
| 759               | L1 T FUEL B ENGINE     | Fuel Temperature Before Engine too high (Limit 1) Alarm.               |
| 760               | L2 T FUEL B ENGINE     | Fuel Temperature Before Engine too high (Limit 2) Alarm.               |
| 761               | SD T FUEL B ENGINE     | Sensor Defect In Sensor metering Fuel Temperature Before Engine Alarm. |
| 762               | AL SMRT CNCT LOST      | Smart Connect Lost Alarm.                                              |
| 763               | AL OL ASO FLP FDBK B   | OL ASO Flap B Feedback Alarm.                                          |
| 764               | ASO FLP B CLSD A FL    | ASO Flap B Closed A Failed Alarm.                                      |
| 765               | AL OL ASO FLP FDBK A   | OL ASO Flap A Feedback Alarm.                                          |
| 766               | ASO FLP A CLSD B FL    | ASO Flap A Closed B Failed Alarm.                                      |
| 767               | ASP FLAPS CLOSED       | ASO Flaps Closed Alarm.                                                |
| 768               | ST T EXH V HPTURBN A1  | Sensor Defect In Exhaust V HP Turbine A1 Temperature Sensor.           |
| 769               | SD T EXH AFTR ENG      | Sensor Defect In Exhaust Temperature After Engine Sensor.              |
| 770               | SD T SEA WATER PUMP    | Sensor Defect In Sea Water After Pump Temperature Sensor.              |
| 771               | SD T FUEL B            | Sensor Defect In Fuel Temperature B Sensor.                            |
| 772               | SD LVL OIL REFILL TNK  | Sensor Defect In Refill Tank Oil Level Sensor.                         |
| 773               | SD P FUEL RTN PATH     | Sensor Defect In Return Path Fuel Pressure Sensor.                     |
| 774               | SD P FUEL BEFR ENG     | Sensor Defect In Fuel Pressure Before Engine Sensor.                   |
| 775               | SD P SCHM AFT LVL PMP  | Sensor Defect In After Level Pump Oil Pressure Sensor.                 |
| 776               | SD P SCHM AT HPPUMP A  | Sensor Defect In Oil Pressure at HP Pump A Sensor.                     |
| 777               | SD P SCHM AT HPPUMP B  | Sensor Defect In Oil Pressure at HP Pump B Sensor.                     |
| 778               | ASO FLPS OPN FL TO CLS | ASO Flaps Open, Failed to Close Alarm.                                 |
| 779               | WRONG NOX SNSR E1      | NOX Sensor E1 Wrong Position Alarm.                                    |
| 780               | WRONG NOX SNSR E2      | NOX Sensor E2 Wrong Position Alarm.                                    |
| 781               | WRONG NOX SNSR E3      | NOX Sensor E3 Wrong Position Alarm.                                    |
| 782               | SD P LUBOIL ETC A      | Turbo Charger A Lube Oil Pressure Too High.                            |
| 783               | SD T EXH BEFR SCR F3   | Sensor Defect In Before SCR Exhaust Temperature Sensor.                |
| 784               | SD T EXH AFTR SCR F3   | Sensor Defect In After SCR Exhaust Temperature Sensor.                 |
| 785               | L1 P OIL BEF HD PMP A  | Oil Pressure Before HD PUMP A (Limit 1) Alarm.                         |
| 786               | L1 P OIL BEF HD PMP B  | Oil Pressure Before HD PUMP B (Limit 1) Alarm.                         |
| 787               | L1 P OILNIV PUMP       | Oil Pressure in Oil Niveaux Pump (Limit 1) Alarm.                      |
| 788               | ETC SPD FL DETECT      | Turbo Charger Speed Failure Detected.                                  |
| 789               | WRONG POS TMP SNS E1   | Temperature Sensor E1 Wrong Position Alarm.                            |
| 790               | WRONG POS TMP SNS E2   | Temperature Sensor E2 Wrong Position Alarm.                            |
| 791               | WRONG POS TMP SNS E3   | Temperature Sensor E3 Wrong Position Alarm.                            |
| 792               | L1 P CHARGE AIR B      | Charge Air B Pressure (Limit 1) Alarm.                                 |
| 793               | L2 P CHARGE AIR B      | Charge Air B Pressure (Limit 2) Alarm.                                 |
| 794               | L1 P FL BEFR ENGN      | Fuel Pressure Before Engine (Level 1) Alarm.                           |
| 795               | L1 P FUEL RTN          | Fuel Pressure in Return Path (Limit 1) Alarm.                          |
| 796               | HI T CHARGE AIR B      | High Charge Air B Temperature (Limit 1) Alarm.                         |
| 797               | HIHI T CHRGR AIR B     | High Charge Air B Temperature (Limit 2) Alarm.                         |
| 798               | L1T EXH BEF HPTRBN A1  | Exhaust Temperature Before HP Turbine A1 (Limit 1) Alarm.              |
| 799               | L2T EXH BEF HPTRBN A1  | Exhaust Temperature Before HP Turbine A1 (Limit 2) Alarm.              |



| Fault Code Number | String                 | Description                                                  |
|-------------------|------------------------|--------------------------------------------------------------|
| 800               | L1 T EXH AFTR ENGINE   | Exhaust Temperature After Engine (Limit 1) Alarm.            |
| 801               | L1T RAW WATR AFTR PMP  | Raw Water After Pump Temperature (Limit 1) Alarm.            |
| 802               | L1T FUEL BEFR ENGINE   | Fuel Temperature Before Engine (Limit 1) Alarm.              |
| 803               | HI T FUEL B            | High Fuel B Temperature (Limit 1) Alarm.                     |
| 804               | SS T FUEL B            | High Fuel B Temperature (Limit 2) Alarm.                     |
| 805               | LO OIL LVL REFILL      | Refill Oil Level Low Alarm.                                  |
| 806               | SD CHARGR 3 SPD        | Sensor Defect In Turbo Charger 3 Speed Sensor.               |
| 807               | SD CHARGR 4 SPD        | Sensor Defect In Turbo Charger 4 Speed Sensor.               |
| 808               | SD CHARGR 5 SPD        | Sensor Defect In Turbo Charger 5 Speed Sensor.               |
| 809               | SD F1 NOX BEFOR SCR    | Sensor Defect In F1 NOX Before SCR sensor.                   |
| 810               | NO COMS F1NOX BF SCR   | Communications Lost with F1 NOX Before SCR sensor.           |
| 811               | SD F1 NOX AFTR SCR     | Sensor Defect In F1 NOX After SCR sensor.                    |
| 812               | NO COMS F1NOX AF SCR   | F1 NOX After SCR Communications lost alarm.                  |
| 813               | SD F2 NOX BEFOR SCR    | Sensor Defect In F2 NOX Before SCR sensor.                   |
| 814               | NO COMS F2NOX BF SCR   | F2 NOX Before SCR Communications lost alarm.                 |
| 815               | SD F2 NOX AFTR SCR     | Sensor Defect In F2 NOX After SCR sensor.                    |
| 816               | NO COMS F2NOX AF SCR   | F2 NOX After SCR Communications lost alarm.                  |
| 817               | SD F3 NOX BEFOR SCR    | Sensor Defect In F3 NOX Before SCR sensor.                   |
| 818               | NO COMS F3NOX BF SCR   | F3 NOX Before SCR Communications lost alarm.                 |
| 819               | SD F3 NOX AFTR SCR     | Sensor Defect In F3 NOX After SCR sensor.                    |
| 820               | NO COMS F3NOX AF SCR   | F3 NOX After SCR Communications lost alarm.                  |
| 821               | HI ETC1 IDLE SPEED     | Turbo Charger 1 Speed at Idle Too High.                      |
| 822               | HI ETC2 IDLE SPEED     | Turbo Charger 2 Speed at Idle Too High.                      |
| 823               | HI ETC3 IDLE SPEED     | Turbo Charger 3 Speed at Idle Too High.                      |
| 824               | HI ETC4 IDLE SPEED     | Turbo Charger 4 Speed at Idle Too High.                      |
| 825               | HI ETC5 IDLE SPEED     | Turbo Charger 5 Speed at Idle Too High.                      |
| 826               | AL ETC1 SPD DEVTN      | Turbo Charger 1 Speed Deviation.                             |
| 827               | AL ETC2 SPD DEVTN      | Turbo Charger 2 Speed Deviation.                             |
| 828               | AL ETC3 SPD DEVTN      | Turbo Charger 3 Speed Deviation.                             |
| 829               | AL ETC4 SPD DEVTN      | Turbo Charger 4 Speed Deviation.                             |
| 830               | AL ETC5 SPD DEVTN      | Turbo Charger 5 Speed Deviation.                             |
| 831               | AL ETC JOB ROTATN      | Turbo Charger Job Rotation Alarm.                            |
| 832               | EIL DIFF ENG NUMBR     | EIL Different Engine Number Alarm.                           |
| 833               | AL EMISSION WRN        | Emission Warning Alarm.                                      |
| 834               | AL GAS PATH WRN        | Gas Path Warning Alarm.                                      |
| 835               | AL GAST PATH FLT       | Gas Path Fault Alarm.                                        |
| 836               | AL SPEED DMD FAIL      | Speed Demand Failure Alarm.                                  |
| 837               | BYPASS VLV DEFCET      | Bypass Valve Defect Alarm.                                   |
| 838               | AL ASH VOLUME          | Ash Volume Alarm.                                            |
| 839               | ECU NT CLS ECO FLAP A  | ASO Flap A not closed by ECU Alarm.                          |
| 840               | ECU NT CLS ECO FLAP B  | ASO Flap B not closed by ECU Alarm.                          |
| 841               | SD P GASLN COM RL      | Sensor Defect in Gasoline Common Rail Pressure Sensor.       |
| 842               | AL ACT FL VLV POS L1   | ACT Fuel Valve Position (Limit 1) Alarm.                     |
| 843               | SD T CHRGR AIR BEF EGR | Sensor Defect in Charge Air Before EGR Temperature Sensor.   |
| 844               | HI T CHRGR AIR BEF EGR | Charge Air Before EGR High Temperature (Limit 1) Alarm.      |
| 845               | HIHI T CHRGAIR BF EGR  | Charge Air Before EGR High Temperature (Limit 2) Alarm.      |
| 846               | HI T CHRGR AIR DIFF AB | Charge Air Differential AB High Temperature (Limit 1) Alarm. |



| Fault Code Number | String                 | Description                                                  |
|-------------------|------------------------|--------------------------------------------------------------|
| 847               | HIHI T CHRGR AIR DF AB | Charge Air Differential AB High Temperature (Limit 2) Alarm. |
| 848               | AL REL HUMIDTY L1      | Relative Humidity (Limit 1) Alarm.                           |
| 849               | AL IBT FUNCT ACTV      | IBT Function Active Alarm.                                   |
| 850               | SD ALIVE FIP           | Sensor Defect in ALIVE FIP sensor.                           |
| 851               | AL EXT STRT HD HI      | External Start and HD Too High Alarm.                        |
| 852               | MAX BLNK SH TM EXP     | Max Blank Shot Time Expired Alarm.                           |
| 853               | HSB1 COMMS LOST        | HSB1 Communications Lost Alarm.                              |
| 854               | HSB1 ACUTATR DEFCT     | HSB1 Actuator Defect Alarm.                                  |
| 855               | BYPASS THR2 DEFCT      | Bypass Throttle 2 Defect Alarm.                              |
| 856               | SD P LUBOIL ETC B      | Sensor Defect In Turbo Charger Oil Pressure Sensor.          |
| 857               | NOX ATO1 SENSR DEFCT   | NOX ATO 1 Sensor Defect Alarm.                               |
| 858               | L1 P LUBOIL ETC B      | Turbo Charger B Oil Pressure Low (Limit 1).                  |
| 859               | HSB2 COMMS LOST        | HSB2 Communications Lost Alarm.                              |
| 860               | HSB2 ACUTATR DEFCT     | HSB2 Actuator Defect Alarm.                                  |
| 861               | DEF IN PIPE S_ACT SYS  | DEF in DEF Pipe in ACT system Alarm.                         |
| 862               | DEF TNK HT SNS_ACT SD  | DEF Tank ACT Sensor Defect.                                  |
| 863               | HSB3 COMMS LOST        | HSB3 Communications Lost Alarm.                              |
| 864               | HSB3 ACUTATR DEFCT     | HSB3 Actuator Defect Alarm.                                  |
| 865               | HSB4 COMMS LOST        | HSB4 Communications Lost Alarm.                              |
| 866               | HSB4 ACUTATR DEFCT     | HSB4 Actuator Defect Alarm.                                  |
| 867               | L1 P LUBOIL ETC A      | Turbo Charger A Oil Pressure Low (Limit 1).                  |
| 868               | L2 P LUBOIL ETC A      | Turbo Charger A Oil Pressure Low (Limit 2).                  |
| 869               | L2 P LUBOIL ETC B      | Turbo Charger B Oil Pressure Low (Limit 2).                  |
| 870               | AL MB VLV DEFCT 2      | MB Valve Defect 2 Alarm.                                     |
| 871               | NOX ATO1 COMS LOST     | NOX ATO 1 Communications Lost Alarm.                         |
| 872               | EGR A REF LEARN FAIL   | EGR Reference Learning Algorithm Failure Alarm.              |
| 873               | DEF TNK LVL EMPTY      | DEF Tank Level Empty Alarm.                                  |
| 874               | SCR FAIL               | SCR Failure Alarm.                                           |
| 875               | ADBLUE TANK LOW        | ADBLUE (DEF) Tank Level Low Alarm.                           |
| 876               | EGR B REF LEARN FAIL   | EGR B Reference Learning Algorithm Failure Alarm.            |
| 877               | BYP A REF LEARN FAIL   | Bypass A Reference Learning Algorithm Failure Alarm.         |
| 878               | BYPASS B FAST LRN FL   | Bypass B Fast Learn Algorithm Failure Alarm.                 |
| 879               | DISPNSR REF LRN FL     | Dispenser Reference Learn Algorithm Failure Alarm.           |
| 880               | INTAKEAIR REF LRN FL   | Intake Air Reference Learn Algorithm Failure Alarm.          |
| 881               | AL UREA QLTY RELEASE   | Urea Quality Release Alarm.                                  |
| 882               | SCR F1 SU REVLTN RNG   | SCR F1 SU Revolution Range Alarm.                            |
| 883               | SCR F2 SU REVLTN RNG   | SCR F2 SU Revolution Range Alarm.                            |
| 884               | SCR F1 SU ADBLUE QNTY  | SCR F1 SU ADBLUE Quantity.                                   |
| 885               | SCR F2 SU ADBLUE QNTY  | SCR F2 SU ADBLUE Quantity.                                   |
| 886               | SCR ADBLUE PRESSR      | SCR ADBLUE Pressure Alarm.                                   |
| 887               | SCR SU PRIME REQUEST   | SCR SU Priming Request Alarm.                                |
| 888               | SCR SU ADBLUE PRESSR   | SCR SU ADBLUE Pressure Alarm.                                |
| 889               | SD T LUBEOIL ETC       | Sensor Defect In Turbo Charger Oil Temperature Sensor.       |
| 890               | L2 T LUBEOIL ETC       | Lube Oil Temperature Too High (Limit 2).                     |
| 891               | AL TURNING ACTIVATED   | Turning Activation Alarm.                                    |
| 892               | FLO1 SPPLYUNT1 COM LS  | Lost Communications with Air Flow 1 Supply Unit 1.           |
| 893               | FLO1 SPPLYUNT2 COM LS  | Lost Communications with Air Flow 1 Supply Unit 2.           |

| Fault Code Number | String                | Description                                                |
|-------------------|-----------------------|------------------------------------------------------------|
| 894               | FLO2 SPPLYUNT1 COM LS | Lost Communications with Air Flow 2 Supply Unit 1.         |
| 895               | FLO2 SPPLYUNT2 COM LS | Lost Communications with Air Flow 2 Supply Unit 2.         |
| 896               | FLO3 SPPLYUNT1 COM LS | Lost Communications with Air Flow 3 Supply Unit 1.         |
| 897               | FLO3 SPPLYUNT2 COM LS | Lost Communications with Air Flow 3 Supply Unit 2.         |
| 898               | TRICAN COMMS LOST     | Communications Lost on TRICAN network.                     |
| 899               | OLT COMMS LOST        | Communications to OLT Lost.                                |
| 900               | SCR F3 SU REV RNG     | SCR F3 SU Revolution Range Alarm.                          |
| 901               | SCR F3 SU ADBLUE QTY  | SCR F3 SU Adblue Quantity Low.                             |
| 902               | HI TCOOL CYL HEAD     | High Cylinder Head Coolant Temperature (Limit 1).          |
| 903               | SD TCOOL CYL HEAD     | Sensor Defect in Cylinder Head Coolant Temperature Sensor. |
| 904               | SS TCOOL CYL HEAD     | High Cylinder Head Coolant Temperature (Limit 2).          |
| 905               | ADBLUE EXP CNS FL     | ADBLUE Expected Consumption Failure Alarm.                 |
| 906               | ADBLUE BALANCE FL     | ADBLUE Balance Failed Alarm.                               |
| 907               | NOX RAW EMISSN FL     | NOX Raw Gas Emission Failed Alarm.                         |
| 908               | APPRCH NOX DOS STP FL | Approach NOX Dosing Stop Failed Alarm.                     |
| 909               | SCR TEXH BTW FLOWS FL | Exhaust Temperature Between SCR Flows Failed Alarm.        |
| 910               | EXP TEXH BFR SCR FL   | Expected Exhaust Temperature Before SCR Failure Alarm.     |
| 911               | EXP TEXH AFT SCR FL   | Expected Exhaust Temperature After SCR Failure Alarm.      |
| 912               | SCR F1 TEXH BFR GRDNT | SCR F1 Exhaust Temperature Before Gradient Alarm.          |
| 913               | SCR F2 TEXH BFR GRDNT | SCR F2 Exhaust Temperature Before Gradient Alarm.          |
| 914               | SCR F3 TEXH BFR GRDNT | SCR F3 Exhaust Temperature Before Gradient Alarm.          |
| 915               | SCR F1 TEXH AFT GRDNT | SCR F1 Exhaust Temperature After Gradient Alarm.           |
| 916               | SCR F2 TEXH AFT GRDNT | SCR F2 Exhaust Temperature After Gradient Alarm.           |
| 917               | SCR F3 TEXH AFT GRDNT | SCR F3 Exhaust Temperature After Gradient Alarm.           |
| 918               | L1 T LUBEOIL ETC      | Turbo Charger Lube Oil Temperature High (Limit 1).         |
| 919               | ENERGY CNTR DEFCT     | Energy Counter Defect Alarm.                               |
| 920               | L1 TEXH BFR SCRF1     | Exhaust Temperature Before SCR F1 (Limit 1) Alarm.         |
| 921               | L2 TEXH BFR SCRF1     | Exhaust Temperature Before SCR F1 (Limit 2) Alarm.         |
| 922               | L1 TEXH AFT SCRF1     | Exhaust Temperature After SCR F1 (Limit 1) Alarm.          |
| 923               | L2 TEXH AFT SCRF1     | Exhaust Temperature After SCR F1 (Limit 2) Alarm.          |
| 924               | L1 TEXH BFR SCRF2     | Exhaust Temperature Before SCR F2 (Limit 1) Alarm.         |
| 925               | L2 TEXH BFR SCRF2     | Exhaust Temperature Before SCR F2 (Limit 2) Alarm.         |
| 926               | L1 TEXH AFT SCRF2     | Exhaust Temperature After SCR F2 (Limit 1) Alarm.          |
| 927               | L2 TEXH AFT SCRF2     | Exhaust Temperature After SCR F2 (Limit 2) Alarm.          |
| 928               | L1 TEXH BFR SCRF3     | Exhaust Temperature Before SCR F3 (Limit 1) Alarm.         |
| 929               | L2 TEXH BFR SCRF3     | Exhaust Temperature Before SCR F3 (Limit 2) Alarm.         |
| 930               | L1 TEXH AFT SCRF3     | Exhaust Temperature After SCR F3 (Limit 1) Alarm.          |
| 931               | L2 TEXH AFT SCRF3     | Exhaust Temperature After SCR F3 (Limit 2) Alarm.          |
| 932               | AL MIC5 YELLOW        | MIC 5 Yellow Alarm.                                        |
| 933               | AL MIC5 RED           | MIC 5 Red Alarm.                                           |
| 934               | AL MIC5 COMM LOST     | MIC 5 Comms Lost Alarm.                                    |
| 935               | LO F1 TEXH BFR SCR    | F1 Exhaust Temperature before SCR Too Low Alarm.           |
| 936               | LO F2 TEXH BFR SCR    | F2 Exhaust Temperature before SCR Too Low Alarm.           |
| 937               | LO F3 TEXH BFR SCR    | F3 Exhaust Temperature before SCR Too Low Alarm.           |
| 938               | LO F1 TEXH AFT SCR    | F1 Exhaust Temperature after SCR Too Low Alarm.            |
| 939               | LO F2 TEXH AFT SCR    | F2 Exhaust Temperature after SCR Too Low Alarm.            |
| 940               | LO F3 TEXH AFT SCR    | F3 Exhaust Temperature after SCR Too Low Alarm.            |

| Fault Code Number | String                | Description                                           |
|-------------------|-----------------------|-------------------------------------------------------|
| 941               | LO SCR OPRATING T     | SCR Operating Temperature Too Low Alarm.              |
| 942               | CATLY CONV LO F1      | Catalytic Conversion Too Low F1 Alarm.                |
| 943               | CATLY CONV LO F2      | Catalytic Conversion Too Low F2 Alarm.                |
| 944               | CATLY CONV LO F3      | Catalytic Conversion Too Low F3 Alarm.                |
| 945               | L1 L VOLTAGE ASO      | Low ASO Voltage (Limit 1) Alarm.                      |
| 946               | L2 L VOLTAGE ASO      | Low ASO Voltage (Limit 2) Alarm.                      |
| 947               | INVALID LSI CHANL CFG | Invalid LSI Channel Configuration Alarm.              |
| 948               | AL ESI ACTIVATED      | ESI Activated Alarm.                                  |
| 949               | SD VOLTAGE ASO        | Sensor Defect in ASO Voltage Sensor.                  |
| 950               | SCR SU FLT S EXST F1  | SCR SU Fault S F1 Exists alarm.                       |
| 951               | ETC0 CUTIN FAIL       | Turbo Charger 0 Cut In Failure.                       |
| 952               | ETC1 CUTIN FAIL       | Turbo Charger 1 Cut In Failure.                       |
| 953               | LAMBDA VALUE INVALID  | Lambda Value Invalid Alarm.                           |
| 954               | NOX VALUE INVALID     | NOX Value Invalid Alarm.                              |
| 955               | THRML MANGMT ACTV     | Thermal Management Active Alarm.                      |
| 956               | P5 CNTVAR LIM MN ACTV | P5 Control Variable Minimum Limit Active Alarm.       |
| 957               | P5 CV MAX BOI MN ACT  | P5 Control Variable Max BOI Minimum Active Alarm.     |
| 958               | LMDA CTLVR LMT MN ACT | Lambda Control Variable Minimum Limit Active Alarm.   |
| 959               | LMDA CV MX BOI MN ACT | Lambda Control Variable Max BOI Minimum Active Alarm. |
| 960               | NOXP5 MN BOI MX ACTV  | NOX P5 Minimum BOI Maximum Active.                    |
| 961               | NOXP5 MX BOI MN ACTV  | NOX P5 Maximum BOI Minimum Active.                    |
| 962               | GPS LMDA CV MAX ACTV  | GPS Lambda Control Variable Maximum Active Alarm.     |
| 963               | GPS P5 CV MAX ACTV    | GPS P5 Control Variable Maximum Active Alarm.         |
| 964               | GPS P5 CV MIN ACTV    | GPS P5 Control Variable Minimum Active Alarm.         |
| 965               | SCR SU FLT S EXIST F2 | SCR SU Fault S F2 Exists Alarm.                       |
| 966               | SCR SU FLT S EXIST F3 | SCR SU Fault S F3 Exists Alarm.                       |
| 967               | SCR SU PRIM REQ F1    | SCR SU Priming Request F1 Alarm.                      |
| 968               | SCR SU PRIM REQ F2    | SCR SU Priming Request F2 Alarm.                      |
| 969               | SCR SU PRIM REQ F3    | SCR SU Priming Request F3 Alarm.                      |
| 970               | SD P EXHAUST          | Sensor Defect in Exhaust Pressure Sensor.             |
| 971               | COLD ENGINE ALARM     | Cold Engine Alarm.                                    |
| 972               | MIC5 SINGATURE DIFF   | MIC5 Signature Difference Alarm.                      |
| 973               | AL CHECKSUM IIG       | IIG Check Sum Alarm.                                  |
| 974               | AL CAN3 BUS OFF       | Can3 Bus Off Alarm.                                   |
| 975               | CAN3 ERR PASSIVE      | Can3 Error Passive Alarm.                             |
| 976               | AL CAN4 BUS OFF       | Can4 Bus Off Alarm.                                   |
| 977               | CAN4 ERR PASSIVE      | Can4 Error Passive Alarm.                             |
| 978               | HI ETC5 OVERSPEED     | Turbo Charger 5 Overspeed (Limit 1).                  |
| 979               | SS ETC5 OVERSPEED     | Turbo Charger 5 Overspeed (Limit 2).                  |
| 980               | ADBLUE TEMP HI F1     | ADBLUE (DEF) Temperature Too High F1 Alarm.           |
| 981               | ADBLUE TEMP HI F2     | ADBLUE (DEF) Temperature Too High F2 Alarm.           |
| 982               | ADBLUE TEMP HI F3     | ADBLUE (DEF) Temperature Too High F3 Alarm.           |
| 983               | STOP ON TRIG CRSHRECR | Stop on Crash Recorder Trigger Alarm.                 |
| 984               | NOX ATO2 SNSR DEFCT   | NOX ATO2 Sensor Defect Alarm.                         |
| 985               | NOX ATO2 SNS COM LOST | NOX ATO 2 Communications Lost Alarm.                  |
| 1000              | SD LVL DEF TNK B      | Sensor Defect In DEF Tank B Level Sensor.             |
| 1001              | SD LVL COOL WTR       | Sensor Defect In Coolant Water Level Sensor.          |

| Fault Code Number | String                | Description                                             |
|-------------------|-----------------------|---------------------------------------------------------|
| 1002              | SD LVL HYD OIL        | Sensor Defect In Hydraulic Oil Level Sensor.            |
| 1003              | L1 LVL COOL WTR       | Coolant Water Level (Limit 1) Alarm.                    |
| 1004              | L2 LVL COOL WTR       | Coolant Water Level (Limit 2) Alarm.                    |
| 1005              | L1 LVL HYD OIL        | Hydraulic Oil Level (Limit 1) Alarm.                    |
| 1006              | L2 LVL HYD OIL        | Hydraulic Oil Level (Limit 2) Alarm.                    |
| 1007              | L1 LVL LUBEOIL J1939  | J1939 Lube Oil Level (Limit 1) Alarm.                   |
| 1008              | L2 LVL LUBEOIL J1939  | J1939 Lube Oil Level (Limit 2) Alarm.                   |
| 1009              | SD P FLTR MONITR      | Sensor Defect In Fuel Filter Pressure Sensor.           |
| 1010              | L1 P FLTR MONITR      | Fuel Filter Pressure (Limit 1) Alarm.                   |
| 1011              | DEF TANK LVL LO       | DEF Tank Level Low Alarm.                               |
| 1012              | MIC5 PARM DNLOAD ACTV | MIC5 Parameter Download Active Alarm.                   |
| 1013              | HI DELTA NOX AB       | HI Delta NOX A-B (Limit 1) Alarm.                       |
| 1014              | HIHI DLTA NOX AB      | HI Delta NOX A-B (Limit 2) Alarm.                       |
| 1015              | TTL BKDN NOX SNRS     | NOX Sensors Total Breakdown alarm.                      |
| 1016              | REDUND LOSS NOX SNRS  | NOX Sensors Redundancy Loss Alarm.                      |
| 1017              | HI DELTA P5 FOR NOX   | High Delta P5 for NOX Alarm.                            |
| 1018              | F1 DEF CONSUMPT ERROR | F1 DEF Consumption Error Alarm.                         |
| 1019              | F1 DEF BALANCE ERROR  | F1 DEF Balance Error Alarm.                             |
| 1020              | F1 RAW GAS EMSN ERROR | F1 Raw Gas Emission Error Alarm.                        |
| 1021              | F1 NOX ANNHRG ERROR   | F1 NOX Approaching Error Condition Alarm.               |
| 1022              | TEX BEF SCR BET F1&F2 | Exhaust Temperature Before SCR Between F1 and F2 Alarm. |
| 1023              | TEX AFT SCR BET F1&F2 | Exhaust Temperature After SCR Between F1 and F2 Alarm.  |
| 1024              | LOLO P FUEL COMM RL A | Fuel Common Rail A Low Fuel Pressure (Limit 2) Alarm.   |
| 1025              | LOLO P FUEL COMM RL B | Fuel Common Rail B Low Fuel Pressure (Limit 2) Alarm.   |
| 1026              | IAP COMMS LOST        | IAP Communications Lost Alarm.                          |
| 1027              | ENGN COLD ACTIV       | Engine Cold Active Alarm.                               |
| 1028              | F1EXP TEX BFR SCR ERR | F1 Expected Exhaust Temperature Before SCR Error Alarm. |
| 1029              | IAP MISSNG ENERG DATA | IAP Missing Energization Data Error.                    |
| 1030              | LO P CRANK CASE       | Low Crankcase Pressure (Limit 1) Alarm.                 |
| 1031              | LOLO P CRK CASE       | Low Crankcase Pressure (Limit 2) Alarm.                 |
| 1032              | INJ DRIFT LMT1 CYL A1 | Cylinder A1 Injector Drift Limit 1 Alarm.               |
| 1033              | INJ DRIFT LMT1 CYL A2 | Cylinder A2 Injector Drift Limit 1 Alarm.               |
| 1034              | INJ DRIFT LMT1 CYL A3 | Cylinder A3 Injector Drift Limit 1 Alarm.               |
| 1035              | INJ DRIFT LMT1 CYL A4 | Cylinder A4 Injector Drift Limit 1 Alarm.               |
| 1036              | INJ DRIFT LMT1 CYL A5 | Cylinder A5 Injector Drift Limit 1 Alarm.               |
| 1037              | INJ DRIFT LMT1 CYL A6 | Cylinder A6 Injector Drift Limit 1 Alarm.               |
| 1038              | INJ DRIFT LMT1 CYL A7 | Cylinder A7 Injector Drift Limit 1 Alarm.               |
| 1039              | INJ DRIFT LMT1 CYL A8 | Cylinder A8 Injector Drift Limit 1 Alarm.               |
| 1040              | INJ DRIFT LMT1 CYL A9 | Cylinder A9 Injector Drift Limit 1 Alarm.               |
| 1041              | INJ DRFT LMT1 CYL A10 | Cylinder A10 Injector Drift Limit 1 Alarm.              |
| 1042              | INJ DRIFT LMT1 CYL B1 | Cylinder B1 Injector Drift Limit 1 Alarm.               |
| 1043              | INJ DRIFT LMT1 CYL B2 | Cylinder B2 Injector Drift Limit 1 Alarm.               |
| 1044              | INJ DRIFT LMT1 CYL B3 | Cylinder B3 Injector Drift Limit 1 Alarm.               |
| 1045              | INJ DRIFT LMT1 CYL B4 | Cylinder B4 Injector Drift Limit 1 Alarm.               |
| 1046              | INJ DRIFT LMT1 CYL B5 | Cylinder B5 Injector Drift Limit 1 Alarm.               |
| 1047              | INJ DRIFT LMT1 CYL B6 | Cylinder B6 Injector Drift Limit 1 Alarm.               |
| 1048              | INJ DRIFT LMT1 CYL B7 | Cylinder B7 Injector Drift Limit 1 Alarm.               |

| Fault Code Number | String                | Description                                             |
|-------------------|-----------------------|---------------------------------------------------------|
| 1049              | INJ DRIFT LMT1 CYL B8 | Cylinder B8 Injector Drift Limit 1 Alarm.               |
| 1050              | INJ DRIFT LMT1 CYL B9 | Cylinder B9 Injector Drift Limit 1 Alarm.               |
| 1051              | INJ DRFT LMT1 CYL B10 | Cylinder B10 Injector Drift Limit 1 Alarm.              |
| 1052              | INJ DRIFT LMT2 CYL A1 | Cylinder A1 Injector Drift Limit 2 Alarm.               |
| 1053              | INJ DRIFT LMT2 CYL A2 | Cylinder A2 Injector Drift Limit 2 Alarm.               |
| 1054              | INJ DRIFT LMT2 CYL A3 | Cylinder A3 Injector Drift Limit 2 Alarm.               |
| 1055              | INJ DRIFT LMT2 CYL A4 | Cylinder A4 Injector Drift Limit 2 Alarm.               |
| 1056              | INJ DRIFT LMT2 CYL A5 | Cylinder A5 Injector Drift Limit 2 Alarm.               |
| 1057              | INJ DRIFT LMT2 CYL A6 | Cylinder A6 Injector Drift Limit 2 Alarm.               |
| 1058              | INJ DRIFT LMT2 CYL A7 | Cylinder A7 Injector Drift Limit 2 Alarm.               |
| 1059              | INJ DRIFT LMT2 CYL A8 | Cylinder A8 Injector Drift Limit 2 Alarm.               |
| 1060              | INJ DRIFT LMT2 CYL A9 | Cylinder A9 Injector Drift Limit 2 Alarm.               |
| 1061              | INJ DRFT LMT2 CYL A10 | Cylinder A10 Injector Drift Limit 2 Alarm.              |
| 1062              | INJ DRIFT LMT2 CYL B1 | Cylinder B1 Injector Drift Limit 2 Alarm                |
| 1063              | INJ DRIFT LMT2 CYL B2 | Cylinder B2 Injector Drift Limit 2 Alarm.               |
| 1064              | INJ DRIFT LMT2 CYL B3 | Cylinder B3 Injector Drift Limit 2 Alarm.               |
| 1065              | INJ DRIFT LMT2 CYL B4 | Cylinder B4 Injector Drift Limit 2 Alarm.               |
| 1066              | INJ DRIFT LMT2 CYL B5 | Cylinder B5 Injector Drift Limit 2 Alarm.               |
| 1067              | INJ DRIFT LMT2 CYL B6 | Cylinder B6 Injector Drift Limit 2 Alarm.               |
| 1068              | INJ DRIFT LMT2 CYL B7 | Cylinder B7 Injector Drift Limit 2 Alarm.               |
| 1069              | INJ DRIFT LMT2 CYL B8 | Cylinder B8 Injector Drift Limit 2 Alarm.               |
| 1070              | INJ DRIFT LMT2 CYL B9 | Cylinder B9 Injector Drift Limit 2 Alarm.               |
| 1071              | INJ DRFT LMT2 CYL B10 | Cylinder B10 Injector Drift Limit 2 Alarm.              |
| 1072              | F1EXP TEX AFT SCR ERR | F1 Expected Exhaust Temperature After SCR Error Alarm.  |
| 1073              | F1GRD TEX BFR SCR ERR | F1 Exhaust Temperature Gradient Before SCR Error Alarm. |
| 1074              | F1GRD TEX AFT SCR ERR | F1 Exhaust Temperature Gradient After SCR Error Alarm.  |
| 1075              | F1 T DEF TOO HI       | F1 DEF Temperature Too High Alarm.                      |
| 1076              | LO F1 TEXH BFR SCR    | F1 Exhaust Temperature before SCR Too Low Alarm.        |
| 1077              | LO F1 TEXH AFT SCR    | F1 Exhaust Temperature after SCR Too Low Alarm.         |
| 1078              | F2 DEF CONSMPT ERR    | F2 DEF Consumption Error Alarm.                         |
| 1079              | F2 DEF BALNC ERR      | F2 DEF Balance Error Alarm.                             |
| 1080              | F2 RAW GAS EMISN ERR  | F2 Raw Gas Emission Error Alarm.                        |
| 1081              | F2 NOX ANNHRG ERROR   | F2 NOX Approaching Error Condition Alarm.               |
| 1082              | F2EXP TEX BFR SCR ERR | F2 Expected Exhaust Temperature Before SCR Error Alarm. |
| 1083              | F2EXP TEX AFT SCR ERR | F2 Expected Exhaust Temperature After SCR Error Alarm.  |
| 1084              | F2GRD TEX BFR SCR ERR | F2 Exhaust Temperature Gradient Before SCR Error Alarm. |
| 1085              | F2GRD TEX AFT SCR ERR | F2 Exhaust Temperature Gradient After SCR Error Alarm.  |
| 1086              | F2 T DEF TOO HI       | F2 DEF Temperature Too High Alarm.                      |
| 1087              | LO F2 TEXH BFR SCR    | F2 Exhaust Temperature before SCR Too Low Alarm.        |
| 1088              | LO F2 TEXH AFT SCR    | F2 Exhaust Temperature after SCR Too Low Alarm.         |



# E • Exhaust Treatment

## ***Diesel Particulate Filter (DPF)***

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In order to meet Tier 4 emission requirements, some engine manufacturers are applying Diesel Particulate Filters (DPF) to the exhaust system of the engine. A Diesel Particulate Filter traps particulate matter contained in diesel exhaust and prevents it from distributing into the air. The particulate matter is later burned off during a regeneration process.

The DGC-2020 communicates DPF control and status information to and from the engine ECU via J1939 communications in the form of various Parameter Group Numbers (PGN) and Suspect Parameter Numbers (SPN). These are summarized in the following paragraphs.

### **Regeneration**

Regeneration is accomplished by operating the engine at elevated exhaust temperatures where the accumulated particulate is burned off. If, in normal operation, the engine can be loaded to a high enough level to achieve the elevated exhaust temperature, then regeneration can occur as a part of normal operation. This is known as *passive regeneration*.

High exhaust temperatures can also be accomplished by methods such as providing dampers in the exhaust stream or heating the exhaust through the burning of fuel. This is known as *active regeneration* since it is outside of normal engine operation.

Heavily loaded engines will seldom require active regeneration. A lightly loaded engine will likely undergo active regeneration when required.

### **DPF Control**

DPF control information is sent from the DGC-2020 to the Engine ECU through PGN Number 57244 (0xE000). A manual regeneration request is sent using SPN 3696, Diesel Particulate Filter Regeneration Force Switch. Regeneration can be inhibited by SPN 3695, Diesel Particulate Filter Regeneration Inhibit Switch.

#### Manual Regeneration

The operator can force a regeneration cycle by turning on the Manual Regeneration setting found on the front panel under Settings>Communication>CAN Bus Setup>ECU Setup>DPF Regenerate Setup. The parameter will remain on for a few seconds then go off. The ECU will respond to the momentary setting by logging the request to force a manual regeneration. A continuous request is not used because this can be problematic for some engine ECUs.

Manual regeneration can also be initiated by clicking the *Manual Regeneration* button on the ECU Setup screen in BESTCOMSPlus®. BESTlogic™ Plus programmable logic can also be used to initiate manual regeneration by setting the DPF Manual Regeneration (DPFMANREGEN) logic element true.

#### Regeneration Inhibit

The operator can inhibit regeneration by turning on the DPF Regeneration Disable setting found on the ECU Setup screen in BESTCOMSPlus.

Regeneration can also be disabled by turning on the Disable Regeneration setting on the ECU Setup screen in BESTCOMSPlus.

BESTlogicPlus programmable logic can also be used to inhibit regeneration by setting the DPF Regeneration Inhibit (DPFREGENINHIBIT) logic element true.

## DPF Status and Pre-Alarms

The DGC-2020 receives DPF status information which is broadcast from the engine ECU in various Parameter Group Numbers (PGN) and Suspect Parameter Numbers (SPN). This information is displayed on the front panel and in BESTCOMSP<sub>Plus</sub>, via DPF related pre-alarms. The J1939 parameters and the resulting DGC-2020 pre-alarms are summarized in the following paragraphs.

- PGN 64892 (0xFD7C) Diesel Particulate Filter Control 1

- SPN 3697, Diesel Particulate Filter Lamp Command

REGEN REQUIRED Pre-Alarm: When SPN 3697 has a value of 1 or 4 indicating the DPF lamp is on, the DGC-2020 will annunciate a pre-alarm with text of REGEN REQUIRED. The DPF symbol, shown to the right, will accompany the text when the pre-alarm appears on the DGC-2020 front panel.



- SPN 3698, Exhaust System High Temperature Lamp Command

HIGH EXHAUST TEMP Pre-Alarm: When SPN 3698 has a value of 1 indicating the high exhaust temperature lamp is on, the DGC-2020 will annunciate a pre-alarm with text of HIGH EXHAUST TEMP. The high exhaust temperature symbol, shown to the right, will accompany the text when the pre-alarm appears on the DGC-2020 front panel.



- SPN 3701 Aftertreatment Diesel Particulate Filter Status

SPN 3701 indicates that regeneration is required at the lowest level, moderate level, or most severe level. The DGC-2020 uses this parameter for DPF Soot Level Pre-alarms, which are described in the following paragraphs.

- SPN 3703 Diesel Particulate Filter Active Regeneration Inhibited Due to Inhibit Switch

DPF REGEN INHIBITED Pre-Alarm: When SPN 3703 has a value of 1 indicating the DPF Regeneration is inhibited due to the inhibit switch being set, the DGC-2020 will annunciate a pre-alarm with text of DPF REGEN INHBTD. The DPF regeneration inhibited symbol, shown to the right, will accompany the text when the pre-alarm appears on the DGC-2020 front panel.



- DPF Soot Level Annunciation

The DGC-2020 annunciates DPF Soot Level pre-alarms which are described in the following paragraphs.

- SOOT LEVEL HIGH Pre-Alarm

This pre-alarm is annunciated when one of the following occurs.

- A DTC is received with SPN 3719 (Diesel Particulate Filter Soot Load Percent) with FMI = 15 (*Data Valid But Above Normal Operating Range Least Severe Level*)
- SPN 3701 (Aftertreatment Diesel Particulate Filter Status) is received with a value of 001 (*regeneration is needed – lowest level*)

The pre-alarm text is SOOT LVL HI.

The DPF symbol, shown to the right, accompanies the text when the pre-alarm appears on the DGC-2020 front panel.



- SOOT LEVEL MODERATELY HIGH Pre-Alarm

This pre-alarm is annunciated when one of the following occurs.

- A DTC is received with SPN 3719 (Diesel Particulate Filter Soot Load Percent) with FMI = 16 (*Data Valid But Above Normal Operating Range Moderately Severe Level*)
- SPN 3701 (Aftertreatment Diesel Particulate Filter Status) is received with a value of 010 (*regeneration is needed – moderate level*)



The pre-alarm text is SOOT LVL MOD HI.

The DPF warning symbol, shown to the right, accompanies the text when the pre-alarm appears on the DGC-2020 front panel.



- SOOT LEVEL EXTREMELY HIGH Pre-Alarm

This pre-alarm is annunciated when one of the following occurs.

- A DTC is received with SPN 3719 (Diesel Particulate Filter Soot Load Percent) with FMI = 0 (*Data Valid But Above Normal Operating Range Most Severe Level*)
- SPN 3701 (Aftertreatment Diesel Particulate Filter Status) is received with a value of 011 (*regeneration is needed – highest level*)

The pre-alarm text is SOOT LVL EXT HI.

The DPF stop symbol, shown to the right, accompanies the text when the pre-alarm appears on the DGC-2020 front panel. If the DPF soot level reaches the most severe level, the engine ECU may shut the engine down, preventing it from running, or allow it to run, but at a reduced power level. The DGC-2020 only indicates a pre-alarm, it does not prevent the engine from running or cause operation at a reduced power level. However, the operator should be aware that the engine ECU or after treatment system may cause such behavior.



## Exhaust After Treatment Systems (EATS)

In order to meet Tier 4 emission requirements, some engine manufacturers are adding Exhaust After Treatment Systems (EATS) which treat the engine exhaust within the exhaust system to reduce particulate matter and harmful contaminants prior to releasing the exhaust into the atmosphere. One such system uses urea-based Diesel Exhaust Fluid (DEF) catalyst which is combined with the exhaust gases in the EATS to bring the emissions to acceptable levels.

The DGC-2020 meters EATS information from the engine ECU via J1939 CAN Bus and displays the DEF level within the DEF tank(s), and also displays several pre-alarms related to the EATS system. Any DEF related pre-alarms annunciated on the front panel display the symbol used for DEF functions which is shown to the right.



Most systems will contain one DEF tank, while some may contain two tanks. The DGC-2020 front panel displays the level of DEF in each tank under Metering > Alarms-Status > J1939 Status > DEF Tank1 LVL% and Metering > Alarms-Status > J1939 Status > DEF Tank2 LVL%. The tank 1 level is sent from the ECU via SPN 1761 in J1939 PGN 65110 - After Treatment 1 Reagent Tank 1 Information. The tank 2 level is sent from the ECU via SPN 4367 in J1939 PGN 64829 - After Treatment 1 Reagent Tank 2 Information. The tank levels are expressed in units of percent.

### Pre-Alarms

The ECU sends DEF level diagnostics to the DGC as SPNs 5245 and 5246 in PGN 65110 (the AT1TI PGN). SPN 5245 communicated DEF level diagnostics, whereas SPN 5246 communicates DEF inducement level status.

There are several pre-alarms related to the EATS which annunciate DEF level diagnostics and DEF inducement level status. They are always enabled and will annunciate when received from the engine ECU. Each of them contains the symbol for DEF functions when annunciated on the front panel; however it will not be displayed in BESTCOMSP<sub>lus</sub>. The pre-alarms are summarized in the following paragraphs.

- DEF FLUID LOW: This pre-alarm displays when SPN 5245 has a value of 1, indicating that the DEF tank level is low. The exact DEF levels which constitute a low DEF condition vary among manufacturers.
- DEF LOW SEVERE: This pre-alarm displays when SPN 5245 has a value of 4, indicating that the DEF tank level is severely low or empty. The exact DEF levels which constitute a severely low DEF

condition vary among manufacturers. When this occurs and is not remedied, the engine ECU may enter a mode of inducement not to operate the engine where some of the conditions in the pre-alarm descriptions below may occur.

- **DEF WARNING:** This pre-alarm displays when SPN 5246 has a value of 1. This is the lowest level of warning which indicates the EATS is not functioning properly or DEF quality or level is insufficient for proper operation.
- **DEF WARNING LVL2:** This pre-alarm displays when SPN 5246 has a value of 2. This is a higher level of warning which indicates the EATS is not functioning properly or DEF quality or level is insufficient for proper operation. If the problem causing this warning is not corrected, the system will eventually enter the DEF inducement states. In these states, the engine power or operating speed may be derated depending on the engine manufacturer and engine application.
- **DEF INDUCEMENT:** This pre-alarm displays when SPN 5246 has a value of 3, indicating the first level of inducement. The engine power or operating speed may be derated at this level of inducement depending on engine manufacturer and engine application. This is the lowest level of inducement and is caused by either the EATS not functioning properly or insufficient DEF quality or level for proper operation.
- **DEF PRESEVERE INDUCEMENT:** This pre-alarm displays when SPN 5246 has a value of 4, indicating the Pre-Severe Inducement level of inducement. This indicates that the engine has entered the second highest level of inducement not to operate. This is caused by either the EATS not functioning properly or insufficient DEF quality or level for proper operation. The engine power or operating speed may be derated at this level of inducement depending on engine manufacturer and engine application. The ECU will allow the engine to run for a limited time in this condition after which the engine will enter the severe inducement state.
- **DEF SEVERE INDUCEMENT:** This pre-alarm displays when SPN 5246 has a value of 5, indicating the Severe Inducement level of inducement. This is caused by either the EATS not functioning properly or insufficient DEF quality or level for proper operation. In this condition, the engine may either operate with reduced power or RPM or be shut down depending on manufacturer or engine application. The engine will remain at this level of inducement until the problem causing the inducement is resolved.
- **DEF INDUCEMENT OVERRIDE:** This pre-alarm displays when SPN 5246 has a value of 6, indicating the Temporary Override of inducement. This indicates DEF inducement is temporarily overridden. The engine may operate with reduced power, or for a limited time, after which time it may re-enter the SEVERE INDUCEMENT state.



## ***Exhaust System Status Annunciation***

When an exhaust system condition requires annunciation, the DGC-2020 displays the exhaust system information across the bottom of the front panel screen. The parameters and symbols in the Exhaust System Status Display are listed below. The symbol images below are the actual bit-mapped images that are viewed on the front panel screen of the DGC-2020.

**DEF Tank Level** – The DEF Tank Level is the level of Diesel Exhaust Fluid (DEF) in the DEF Tank. When the DEF Level is getting low and DEF related conditions require annunciation, the caption of the DEF Tank level will change from “DEF” to the DEF symbol. Details of the DEF symbol are described below.



**DEF Symbol** – When the symbol is on solid, it indicates that DEF is low or there is an issue with the Selective Catalytic Reduction (SCR) system. When it is flashing, it indicates the DEF level is critically low or there is a critical issue with the SCR system.



**DPF Symbol** – When the DPF symbol is on solid, it indicates that the Diesel Particulate Filter (DPF) or exhaust system filter requires regeneration. When flashing it indicates a more urgent need for regeneration. Some manufacturers also show this symbol along with the High Exhaust Temperature Symbol when a Regeneration is in process.



**Regeneration Inhibited Symbol** – When this symbol is visible, it indicates that Regeneration is Inhibited. Operation with Regeneration Inhibited is not recommended. If Regeneration is not allowed when required, eventually the machine may shut down and cannot be restarted without a service call from the engine manufacturer. However, ample warning is given through various pre-alarms to allow removal of the inhibit so regeneration can occur and prevent an unwanted exhaust related shutdown condition.



**Exhaust System Malfunction Symbol** – When this symbol is visible, an exhaust system malfunction is in effect. Pre-alarms and/or Diagnostic Trouble Codes (DTC's) will provide additional information. It may be necessary to contact the engine manufacturer if the pre-alarms and DTC's do not provide sufficient failure information.



**High Exhaust Temperature Symbol** – This is visible when the exhaust system temperature has been elevated to perform a DPF Regeneration and typically indicates a DPF Regeneration is active. Some manufacturers also show this symbol when there is a mechanism to heat the exhaust stream and it is in the process of heating in preparation for a DPF Regeneration.



**Check Engine Symbol** – This is visible when Active Diagnostic Trouble Codes (DTCs) are present.



**Torque Limit Symbol** – This symbol is visible when operating in a Limited Torque mode due to exhaust system issues. When on solid, it indicates torque reduction. When flashing, it indicates increased torque reduction.



**Amber Warning Lamp Symbol**– This symbol indicates the engine ECU is lighting the Amber Warning Lamp. When flashing, it indicates a higher degree of severity.



**Red Lamp Symbol** – This symbol indicates the engine ECU is lighting the Red Warning Lamp. When flashing, it indicates a higher degree of severity. An engine shutdown may accompany this symbol.



**Wait To Start Symbol** – This symbol is visible when the engine is in a state of preparation for starting the engine. Examples include engine pre-heating or engine pre-lubrication.



## F • J1939 Diagnostic Trouble Codes

The DGC-2020 receives unsolicited messages of currently active diagnostic trouble codes (DTCs). Previously active DTCs are available upon request. Active and previously active DTCs can be cleared on request. Table F-1 lists the diagnostic information that the DGC-2020 obtains over the CAN Bus interface.

**Table F-1. Diagnostic Information Obtained Over the CAN Bus Interface**

| Parameter                                 | Transmission Repetition Rate |
|-------------------------------------------|------------------------------|
| Active diagnostic trouble code            | 1 s                          |
| Lamp status                               | 1 s                          |
| Previously active diagnostic trouble code | On request                   |
| Request to clear active DTCs              | On request                   |
| Request to clear previously active DTCs   | On request                   |

DTCs are reported in coded diagnostic information that includes the Suspect Parameter Number (SPN), Failure Mode Identifier (FMI), and Occurrence Count (OC). All parameters have an SPN and are used to display or identify the items for which diagnostics are being reported. The FMI defines the type of failure detected in the subsystem identified by an SPN. The reported problem may not be an electrical failure but a subsystem condition needing to be reported to an operator or technician. The OC contains the number of times that a fault has gone from active to previously active.

For certain DTCs, if the DGC-2020 recognizes a pair of SPN and FMI numbers, it displays a single string as listed in Table F-3. If the DGC-2020 recognizes an SPN in Table F-3, but the FMI does not match the FMI in Table F-3, then it displays the text string from Table F-3 corresponding to the table entry where the FMI is # and a second text string corresponding to the FMI number listed in Table F-2. For example, if the DGC-2020 receives SPN 29 and FMI 13, it displays ACCEL PEDAL 2 POSITN and OUT OF CALIBRATION. If the DGC-2020 does not have descriptive information about an SPN and FMI that was received, the description will display as "NO TEXT AVAILABLE".

The Yanmar Fault Code designator consists of a letter and a four-digit number in the form LNNNN, where L is either a U or a P, and NNNN is a four-digit hexadecimal number. This code uniquely identifies the Yanmar fault information. Consult the Yanmar engine documentation or contact Yanmar to determine the corrected action that will remedy the fault.

**Table F-2. DTCs Displayed by the DGC-2020 (FMI Strings)**

| FMI | Text Displayed        | Description                                                                                                   |
|-----|-----------------------|---------------------------------------------------------------------------------------------------------------|
| 0   | DATA HI MOST SEVERE   | Data is higher than expected at the most severe level                                                         |
| 1   | DATA LO MOST SEVERE   | Data is lower than expected at the most severe level                                                          |
| 2   | DATA ERRATIC OR BAD   | Data is erratic, intermittent, or incorrect                                                                   |
| 3   | VOLTS HI OR SHORTED   | Measured voltage is higher than expected or shorted to a high source                                          |
| 4   | VOLTS LO OR SHORTED   | Measured voltage is lower than expected or shorted to a low source                                            |
| 5   | CURRENT LO OR OPEN    | Measured current is lower than expected or the circuit is open                                                |
| 6   | CURRENT HI OR SHORTED | Measured current is higher than expected or shorted                                                           |
| 7   | MECHANICAL SYSTM ERR  | Mechanical system error                                                                                       |
| 8   | FREQ OR PWM ERROR     | Error in frequency, pulse width or period of any frequency or PWM signal is outside its predetermined limits. |
| 9   | ABNORMAL UPDATE RATE  | Update rate of parameter is abnormal.                                                                         |
| 10  | DATA RT OF CHG ERR    | Rate of change of data is abnormal.                                                                           |
| 11  | FAILURE CAUSE UNKNOWN | Failure cause is unknown.                                                                                     |
| 12  | BAD INTELLIGNT DEVICE | Engine ECU is reporting that an intelligent device or component failure has been detected.                    |
| 13  | OUT OF CALIBRATION    | Device or parameter is out of calibration.                                                                    |
| 14  | CONSULT ENG MFG DATA  | User should consult engine manufacturer's data.                                                               |
| 15  | DATA HI LST SEVERE    | Data is higher than expected at the least severe level.                                                       |
| 16  | DATA HI MODERATE SVR  | Data is higher than expected at a moderately severe level.                                                    |

| FMI | Text Displayed        | Description                                                                                                                                                                                                                     |
|-----|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 17  | DATA LO LST SEVERE    | Data is lower than expected at the least severe level.                                                                                                                                                                          |
| 18  | DATA LO MODERATE SVR  | Data is lower than expected at a moderately severe level.                                                                                                                                                                       |
| 19  | NETWORK DATA ERR      | Network Data contained an error indication.                                                                                                                                                                                     |
| 20  | DATA DRIFTED HI       | Data has drifted to a value higher than the maximum valid value.                                                                                                                                                                |
| 21  | DATA DRIFTED LO       | Data has drifted to a value lower than the minimum valid value.                                                                                                                                                                 |
| 22  | FMI RESERVED BY SAE   | This FMI is reserved by the Society of Automotive Engineers.                                                                                                                                                                    |
| 23  | FMI RESERVED BY SAE   | This FMI is reserved by the Society of Automotive Engineers.                                                                                                                                                                    |
| 24  | FMI RESERVED BY SAE   | This FMI is reserved by the Society of Automotive Engineers.                                                                                                                                                                    |
| 25  | FMI RESERVED BY SAE   | This FMI is reserved by the Society of Automotive Engineers.                                                                                                                                                                    |
| 26  | FMI RESERVED BY SAE   | This FMI is reserved by the Society of Automotive Engineers.                                                                                                                                                                    |
| 27  | FMI RESERVED BY SAE   | This FMI is reserved by the Society of Automotive Engineers.                                                                                                                                                                    |
| 28  | FMI RESERVED BY SAE   | This FMI is reserved by the Society of Automotive Engineers.                                                                                                                                                                    |
| 29  | FMI RESERVED BY SAE   | This FMI is reserved by the Society of Automotive Engineers.                                                                                                                                                                    |
| 30  | FMI RESERVED BY SAE   | This FMI is reserved by the Society of Automotive Engineers.                                                                                                                                                                    |
| 31  | CONDTN EXST OR FMI NA | If the SPN refers to a parameter with status of ON or OFF, an FMI of 31 indicates ON. If the SPN refers to a parameter with a numeric value, an FMI of 31 indicates that there is no FMI to describe the parameter's condition. |

Table F-3. DTCs with Fault Code Designators Displayed by the DGC-2020

| SPN | FMI | Text Displayed             | Description                                                                                            | ECU Configuration | Yanmar Code |
|-----|-----|----------------------------|--------------------------------------------------------------------------------------------------------|-------------------|-------------|
| 0   | 3   | AUX ALG 2/3 PULLDN VOLT HI | Aux Analog 2 or 3 Pulldown Voltage High                                                                | GM                |             |
| 0   | 4   | AUX ALG 2/3 PULLDN VOLT LO | Aux Analog 2 or 3 Pulldown Voltage Low                                                                 | GM                |             |
| 0   | 31  | RS485 ERROR                | RS485 Error                                                                                            | GM                |             |
| 27  | -1  | EGR1 VALVE POSITN          | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating EGR1 Valve Position      |                   |             |
| 28  | 0   | ACCEL PEDAL 3 POSITN       | Accelerator pedal 3 position                                                                           | Yanmar            | P1126       |
| 28  | 1   | ACCEL PEDAL 3 POSITN       | Accelerator pedal 3 position                                                                           | Yanmar            | P1125       |
| 28  | 3   | ACCEL PEDAL 2 POSITN       | Accelerator pedal 2 position                                                                           | Yanmar            | P0223       |
| 28  | 3   | Throttle Volt HI           | Diagnostic Trouble Code Indicating Throttle Voltage High                                               |                   |             |
| 28  | 4   | ACCEL PEDAL 2 POSITN       | Accelerator pedal 2 position                                                                           | Yanmar            | P0222       |
| 28  | 4   | Throttle Volt LO           | Diagnostic Trouble Code Indicating Throttle Voltage Low                                                |                   |             |
| 28  | 14  | Throttle Volt OOR          | Diagnostic Trouble Code Indicating Throttle Input Voltage Out of Range                                 |                   |             |
| 28  | -1  | ACCEL PEDAL 3 POSITN       | Accelerator pedal 3 position                                                                           |                   |             |
| 29  | 3   | ACCEL PEDAL 3 POSITN       | Accelerator pedal 3 position                                                                           | Yanmar            | P0228       |
| 29  | 3   | Throttle Volt HI           | Diagnostic Trouble Code Indicating Throttle Voltage High                                               |                   |             |
| 29  | 4   | ACCEL PEDAL 3 POSITN       | Accelerator pedal 3 position                                                                           | Yanmar            | P0227       |
| 29  | 4   | Throttle Volt LO           | Diagnostic Trouble Code Indicating Throttle Voltage Low                                                |                   |             |
| 29  | 8   | ACCEL PEDAL 2 POSITN       | Accelerator pedal 2 position                                                                           | Yanmar            | P1227       |
| 29  | 14  | Throttle Volt OOR          | Diagnostic Trouble Code Indicating Throttle Input Voltage Out of Range                                 |                   |             |
| 29  | -1  | ACCEL PEDAL 2 POSITN       | Accelerator pedal 2 position                                                                           |                   |             |
| 51  | 3   | ENG THROTTLE POSITN        | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Throttle Position | Yanmar            | P02E9       |
| 51  | 4   | ENG THROTTLE POSITN        | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Throttle Position | Yanmar            | P02E8       |
| 51  | -1  | ENG THROTTLE POSITN        | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Throttle Position |                   |             |
| 52  | 15  | INTERCOOLER TEMP HI        | ECU trouble code metering indicates Engine Intercooler Temperature is above the HIGH threshold         |                   |             |
| 52  | -1  | INTRCOOLR TMP              | Caption used on front panel for Display of J1939 Parameter                                             |                   |             |
| 69  | -1  | 2 SPEED AXLE SWITCH        | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Two Speed Axle Switch    |                   |             |
| 70  | -1  | PARKING BRAKE SWITCH       | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Parking Brake Switch     |                   |             |

| SPN | FMI | Text Displayed        | Description                                                                                      | ECU Configuration | Yanmar Code |
|-----|-----|-----------------------|--------------------------------------------------------------------------------------------------|-------------------|-------------|
| 84  | -1  | VEHICLE SPEED         | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Vehicle Speed      |                   |             |
| 91  | 3   | ACCEL POSITION        | Accelerator Position Setting parameter caption used on front panel (Volvo only)                  | Yanmar            | P0123       |
| 91  | 3   | Thr Pos Sns Volt HI   | Diagnostic Trouble Code Indicating Throttle Position Sensor Input Voltage (High)                 |                   |             |
| 91  | 4   | ACCEL POSITION        | Accelerator Position Setting parameter caption used on front panel (Volvo only)                  | Yanmar            | P0122       |
| 91  | 4   | Thr Pos Sns Volt LO   | Diagnostic Trouble Code Indicating Throttle Position Sensor Input Voltage (Low)                  |                   |             |
| 91  | 14  | Thr Pos Sns Volt OOR  | Diagnostic Trouble Code Indicating Throttle Voltage (Out of Range)                               |                   |             |
| 91  | -1  | ACCEL POSITION        | Accelerator Position Setting parameter caption used on front panel (Volvo only)                  |                   |             |
| 94  | 1   | FUEL DELIV PRS LO LO  | ECU trouble code metering indicates Engine Fuel Delivery Pressure is below the LOW LOW threshold |                   |             |
| 94  | 3   | Fuel Pmp Prs Volt HI  | Diagnostic Trouble Code Indicating Fuel Pump Pressure Input Voltage (High)                       |                   |             |
| 94  | 4   | Fuel Pmp Prs Volt LO  | Diagnostic Trouble Code Indicating Fuel Pump Pressure Input Voltage (Low)                        |                   |             |
| 94  | 17  | FUEL DELIV PRS LO     | ECU trouble code metering indicates Engine Fuel Delivery Pressure is below the LOW threshold     |                   |             |
| 94  | -1  | FUEL DELV P           | Caption used on front panel for Display of J1939 Parameter                                       |                   |             |
| 95  | -1  | FUEL FLT DF PRS       | Diagnostic Trouble Code Indicating Fuel Filter Differential Pressure                             |                   |             |
| 96  | -1  | FUEL LEVEL            | Fuel Level Caption used on front panel                                                           |                   |             |
| 97  | 3   | Water In FI Volt HI   | Diagnostic Trouble Code Indicating Water in Fuel Signal Voltage High                             |                   |             |
| 97  | 4   | Water In FI Volt LO   | Diagnostic Trouble Code Indicating Water in Fuel Signal Voltage Low                              |                   |             |
| 97  | 16  | Water In Fuel         | Diagnostic Trouble Code Indicating Water in Fuel Detected                                        |                   |             |
| 97  | -1  | Water In Fuel         | Diagnostic Trouble Code Indicating Water In Fuel Detected                                        |                   |             |
| 98  | -1  | ENG OIL LEVEL         | Caption used on front panel for Display of J1939 Parameter                                       |                   |             |
| 99  | -1  | OIL FLTR DIFF PRS     | Oil filter differential pressure parameter                                                       |                   |             |
| 100 | 1   | ENG OIL PRESS         | Caption used on front panel for Display of J1939 Parameter                                       | Yanmar            | P1198       |
| 100 | 1   | ENG OIL PRESS LO LO   | ECU trouble code metering indicates Engine Oil Pressure is below the LOW LOW threshold           |                   |             |
| 100 | 3   | Oil Prs Snr Volt HI   | Diagnostic Trouble Code Indicating Oil Pressure Sensor Input Voltage (High)                      |                   |             |
| 100 | 4   | ENG OIL PRESS         | Caption used on front panel for Display of J1939 Parameter                                       | Yanmar            | P1192       |
| 100 | 4   | Oil Prs Snr Volt LO   | Diagnostic Trouble Code Indicating Oil Pressure Sensor Input Voltage (Low)                       |                   |             |
| 100 | 17  | ENG OIL PRESS LO      | ECU trouble code metering indicates Engine Oil Pressure is below the LOW threshold               |                   |             |
| 100 | 18  | Oil Prs Snr Volt MLO  | Diagnostic Trouble Code Indicating Oil Pressure Sensor Input Voltage (Moderately Low)            |                   |             |
| 100 | 31  | Oil Pressure INVLD    | Diagnostic Trouble Code Indicating Oil Pressure (Invalid)                                        |                   |             |
| 100 | -1  | ENG OIL PRESS         | Caption used on front panel for Display of J1939 Parameter                                       |                   |             |
| 101 | -1  | CRANKCASE PRESSURE    | Crankcase pressure                                                                               |                   |             |
| 102 | 2   | Manifld Air Prs INVLD | Diagnostic Trouble Code Indicating Manifold Air Pressure Invalid                                 |                   |             |
| 102 | 3   | INTK MANFLD P SNS BAD | Intake Manifold Pressure Sensor Malfunction                                                      | Yanmar            | P0238       |
| 102 | 3   | Mnflld AirP SnsVlt HI | Diagnostic Trouble Code Indicating Manifold Air Pressure Sensor Input Voltage High               |                   |             |
| 102 | 4   | INTK MANFLD P SNS BAD | Intake Manifold Pressure Sensor Malfunction                                                      | Yanmar            | P0237       |
| 102 | 4   | Mnflld AirP SnsVlt LO | Diagnostic Trouble Code Indicating Manifold Air Pressure Sensor Input Voltage Low                |                   |             |
| 102 | 10  | INTK MANFLD P SNS BAD | Intake Manifold Pressure Sensor Malfunction                                                      | Yanmar            | P1673       |
| 102 | 13  | INTK MANFLD P SNS BAD | Intake Manifold Pressure Sensor Malfunction                                                      | Yanmar            | P0236       |
| 102 | -1  | INTK MNFLD1 PRESSURE  | Intake Manifold 1 Pressure                                                                       |                   |             |
| 103 | 0   | Trbo Overspd Severe   | Diagnostic Trouble Code Indicating Turbo Overspeed (Most Severe)                                 |                   |             |
| 103 | 2   | Trbo Speed MisMatch   | Diagnostic Trouble Code Indicating Turbo Speed (Mismatch)                                        |                   |             |



| SPN | FMI | Text Displayed        | Description                                                                                       | ECU Configuration | Yanmar Code |
|-----|-----|-----------------------|---------------------------------------------------------------------------------------------------|-------------------|-------------|
| 103 | 5   | Trbo Spd Sns Curr LO  | Diagnostic Trouble Code Indicating Turbo Speed Sensor Current (Low)                               |                   |             |
| 103 | 6   | Trbo Spd Sns Curr HI  | Diagnostic Trouble Code Indicating Turbo Speed Sensor Current (High)                              |                   |             |
| 103 | 8   | Trbo Speed INVLD      | Diagnostic Trouble Code Indicating Turbo Speed (Invalid)                                          |                   |             |
| 103 | 31  | Trbo Speed MISSING    | Diagnostic Trouble Code Indicating Turbo Speed (Missing)                                          |                   |             |
| 103 | -1  | TURBO CH1 SPEED       | Diagnostic Trouble Code Indicating Turbo Speed                                                    |                   |             |
| 104 | -1  | TRBO CH OIL PRESS     | Diagnostic Trouble Code Indicating Turbo Charger 1 Oil Pressure                                   |                   |             |
| 105 | 0   | EGR Mixed Air Tmp HI  | Diagnostic Trouble Code Indicating Exhaust Gas Recirculation Mixed Air High (Least Severe)        |                   |             |
| 105 | 3   | INTK MANFLD T SNS BAD | Intake Manifold Temperature Sensor Malfunction                                                    | Yanmar            | P040D       |
| 105 | 3   | EGR Air Temp Vlt HI   | Diagnostic Trouble Code Indicating Exhaust Gas Recirculation Mixed Air Temp Voltage (High)        |                   |             |
| 105 | 4   | INTK MANFLD T SNS BAD | Intake Manifold Temperature Sensor Malfunction                                                    | Yanmar            | P040C       |
| 105 | 4   | EGR Air Temp Vlt LO   | Diagnostic Trouble Code Indicating Exhaust Gas Recirculation Mixed Air Temp Voltage (Low)         |                   |             |
| 105 | 10  | INTK MANFLD T SNS BAD | Intake Manifold Temperature Sensor Malfunction                                                    | Yanmar            | P1676       |
| 105 | 15  | EGR Mixed Air Tmp HI  | Diagnostic Trouble Code Indicating Exhaust Gas Recirculation Mixed Air High (Least Severe)        |                   |             |
| 105 | 16  | EGR MxdAir Tmp MHI    | Diagnostic Trouble Code Indicating Exhaust Gas Recirculation Mixed Air Temp (Moderately High)     |                   |             |
| 105 | -1  | INTAK MNFLD TMP       | Caption used on front panel for Display of J1939 Parameter                                        |                   |             |
| 106 | -1  | INTAKE AIR PRESSR     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Intake Air Pressure |                   |             |
| 107 | 0   | Air Filt Restricted   | Diagnostic Trouble Code Indicating Air Filter Restriction (High)                                  |                   |             |
| 107 | -1  | AIR FLTR DIF PRS      | Caption used on front panel for Display of J1939 Parameter (Air filter Differential Pressure)     |                   |             |
| 108 | 2   | Barometrc Prs INVLD   | Diagnostic Trouble Code Indicating Barometric Pressure (Invalid)                                  |                   |             |
| 108 | 3   | ATMOSPHERIC P SNS BAD | Atmospheric Pressure Sensor Malfunction                                                           | Yanmar            | P2229       |
| 108 | 4   | ATMOSPHERIC P SNS BAD | Atmospheric Pressure Sensor Malfunction                                                           | Yanmar            | P2228       |
| 108 | 10  | ATMOSPHERIC P SNS BAD | Atmospheric Pressure Sensor Malfunction                                                           | Yanmar            | P1231       |
| 108 | 31  | Barometrc Prs ERR     | Diagnostic Trouble Code Indicating Barometric Pressure (Error)                                    |                   |             |
| 108 | -1  | BAROMETRIC PRESS      | Caption used on front panel for Display of J1939 Parameter                                        |                   |             |
| 109 | 1   | ENG COOLNT PRS LO LO  | ECU trouble code metering indicates Engine Coolant Pressure is below the LOW LOW threshold        |                   |             |
| 109 | 17  | ENG COOLANT PRS LO    | ECU trouble code metering indicates Engine Coolant Pressure is below the LOW threshold            |                   |             |
| 109 | -1  | COOLANT PRESS         | Caption used on front panel for Display of J1939 Parameter                                        |                   |             |
| 110 | 0   | COOLANT TMP           | Engine Coolant Temperature Metering Label Caption Used on Front Panel                             | Yanmar            | P0217       |
| 110 | 0   | ENG COOLNT TMP HI HI  | ECU trouble code metering indicates engine coolant temperature is above the HIGH HIGH threshold   |                   |             |
| 110 | 3   | COOLANT TMP SENSR BAD | Engine Coolant Temperature Sensor Malfunction                                                     | Yanmar            | P0118       |
| 110 | 3   | Cool Tmp Sns Volt HI  | Diagnostic Trouble Code Indicating Coolant Temp Sensor Input Voltage (High)                       |                   |             |
| 110 | 4   | COOLANT TMP SENSR BAD | Engine Coolant Temperature Sensor Malfunction                                                     | Yanmar            | P0117       |
| 110 | 4   | Cool Tmp Sns Volt LO  | Diagnostic Trouble Code Indicating Coolant Temp Sensor Input Voltage (Low)                        |                   |             |
| 110 | 10  | COOLANT TMP SENSR BAD | Engine Coolant Temperature Sensor Malfunction                                                     | Yanmar            | P1674       |
| 110 | 15  | ENG COOLANT TEMP HI   | ECU trouble code metering indicates engine coolant temperature is above the HIGH threshold        |                   |             |
| 110 | 16  | Cool Temp MHI         | Diagnostic Trouble Code Indicating Coolant Temp Sensor Input (Moderately High)                    |                   |             |
| 110 | 17  | Cool Temp LO          | Diagnostic Trouble Code Indicating Coolant Temp Sensor Input (Low Least Severe)                   |                   |             |
| 110 | -1  | COOLANT TMP           | Engine Coolant Temperature Metering Label Caption Used on Front Panel                             |                   |             |
| 111 | 1   | Coolnt Lvl LO         | Diagnostic Trouble Code Indicating Coolant Level (Low)                                            |                   |             |
| 111 | 17  | ENG COOLANT LVL LO    | ECU trouble code metering indicates engine coolant level is below the LOW threshold               |                   |             |



| SPN | FMI | Text Displayed       | Description                                                                                                  | ECU Configuration | Yanmar Code |
|-----|-----|----------------------|--------------------------------------------------------------------------------------------------------------|-------------------|-------------|
| 111 | -1  | COOLANT LEVEL        | Caption used on front panel for Display of J1939 Parameter                                                   |                   |             |
| 157 | 0   | INJ RAIL PRS         | Caption used on front panel for Display of J1939 Parameter                                                   | Yanmar            | P0088       |
| 157 | 3   | INJ RAIL PRS         | Caption used on front panel for Display of J1939 Parameter                                                   | Yanmar            | P0193       |
| 157 | 3   | Fuel Rail Prs Vlt HI | Diagnostic Trouble Code Indicating Fuel Rail Pressure Input Voltage (High)                                   |                   |             |
| 157 | 4   | INJ RAIL PRS         | Caption used on front panel for Display of J1939 Parameter                                                   | Yanmar            | P0192       |
| 157 | 4   | Fuel Rail Prs Vlt LO | Diagnostic Trouble Code Indicating Fuel Rail Pressure Input Voltage (Low)                                    |                   |             |
| 157 | 10  | Fuel Rail Prs LOSS   | Diagnostic Trouble Code Indicating Fuel Rail Pressure Loss Detected                                          |                   |             |
| 157 | 15  | INJ RAIL PRS         | Caption used on front panel for Display of J1939 Parameter                                                   | Yanmar            | P0093       |
| 157 | 16  | INJ RAIL PRS         | Caption used on front panel for Display of J1939 Parameter                                                   | Yanmar            | P000F       |
| 157 | 17  | Fuel RI Prs NOT DEV  | Diagnostic Trouble Code Indicating Fuel Rail Pressure Not Developed                                          |                   |             |
| 157 | 18  | INJ RAIL PRS         | Caption used on front panel for Display of J1939 Parameter                                                   | Yanmar            | P0094       |
| 157 | -1  | INJ RAIL PRS         | Caption used on front panel for Display of J1939 Parameter                                                   |                   |             |
| 158 | 0   | KSW BATT VOLTS HI HI | ECU trouble code metering indicates Key Switch Battery Potential is above the HIGH HIGH threshold            |                   |             |
| 158 | 1   | KSW BATT VOLTS LO LO | ECU trouble code metering indicates Key Switch Battery Potential is below the LOW LOW threshold              |                   |             |
| 158 | 15  | KSW BATT VOLTS HI    | ECU trouble code metering indicates Key Switch Battery Potential is above the HIGH threshold                 |                   |             |
| 158 | 17  | KSW BATT VOLTS LO    | ECU trouble code metering indicates Key Switch Battery Potential is below the LOW threshold                  |                   |             |
| 158 | -1  | KEY SW BATT VOLTAGE  | Key switch battery potential                                                                                 |                   |             |
| 161 | -1  | TR INPUT SHAFT SPD   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Transmission Input Shaft Speed |                   |             |
| 167 | 1   | CHARGING SYSTM VOLT  | Charging System Voltage                                                                                      | Yanmar            | P1568       |
| 167 | 5   | CHARGING SYSTM VOLT  | Charging System Voltage                                                                                      | Yanmar            | P1562       |
| 167 | -1  | CHARGING SYSTM VOLT  | Charging System Voltage                                                                                      |                   |             |
| 168 | -1  | BATTERY VOLTAGE      | Caption used on front panel for Display of J1939 Parameter                                                   |                   |             |
| 171 | -1  | AMB AIR TEMP         | Caption used on front panel for Display of J1939 Parameter                                                   |                   |             |
| 172 | 3   | AIR INLET TEMP       | Caption used on front panel for Display of J1939 Parameter                                                   | Yanmar            | P0113       |
| 172 | 4   | AIR INLET TEMP       | Caption used on front panel for Display of J1939 Parameter                                                   | Yanmar            | P0112       |
| 172 | -1  | AIR INLET TEMP       | Caption used on front panel for Display of J1939 Parameter                                                   |                   |             |
| 173 | 3   | EXH MANFLD T SNS BAD | Exhaust Manifold Temperature Sensor Malfunction                                                              | Yanmar            | P0546       |
| 173 | 4   | EXH MANFLD T SNS BAD | Exhaust Manifold Temperature Sensor Malfunction                                                              | Yanmar            | P0545       |
| 173 | 10  | EXH MANFLD T SNS BAD | Exhaust Manifold Temperature Sensor Malfunction                                                              | Yanmar            | P1677       |
| 173 | -1  | EXHAUST GAS TEMP     | Caption used on front panel for Display of J1939 Parameter                                                   |                   |             |
| 174 | 0   | FUEL TEMP            | Caption used on front panel for Display of J1939 Parameter                                                   | Yanmar            | P0168       |
| 174 | 0   | Fuel Temp EXT HI     | Diagnostic Trouble Code Indicating Fuel Temp (Extremely High)                                                |                   |             |
| 174 | 3   | FUEL TEMP            | Caption used on front panel for Display of J1939 Parameter                                                   | Yanmar            | P0183       |
| 174 | 3   | Fuel Tmp Sns Volt HI | Diagnostic Trouble Code Indicating Fuel Temp Sensor Input Voltage (High)                                     |                   |             |
| 174 | 4   | FUEL TEMP            | Caption used on front panel for Display of J1939 Parameter                                                   | Yanmar            | P0182       |
| 174 | 4   | Fuel Tmp Sns Volt LO | Diagnostic Trouble Code Indicating Fuel Temp Sensor Input Voltage (Low)                                      |                   |             |
| 174 | 16  | Fuel Temp MHI        | Diagnostic Trouble Code Indicating Fuel Temp (Moderately High)                                               |                   |             |
| 174 | -1  | FUEL TEMP            | Caption used on front panel for Display of J1939 Parameter                                                   |                   |             |
| 175 | -1  | ENG OIL TEMP         | Caption used on front panel for Display of J1939 Parameter                                                   |                   |             |

| SPN | FMI | Text Displayed         | Description                                                                                                   | ECU Configuration | Yanmar Code |
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| 176 | -1  | TRBO CH OIL TEMP       | Diagnostic Trouble Code Indicating Turbo Charger Oil Temperature                                              |                   |             |
| 188 | 17  | SPEED AT IDLE LO       | ECU trouble code metering indicates Engine Idle speed is below the LOW threshold                              |                   |             |
| 188 | -1  | IDLE SPEED             | Idle Speed Parameter                                                                                          |                   |             |
| 189 | 0   | Engine Spd DERATE      | Diagnostic Trouble Code Indicating Engine Speed Derate                                                        |                   |             |
| 189 | -1  | RATED SPEED            | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Rated Speed                     |                   |             |
| 190 | 0   | ENGINE SPEED           | Caption used on front panel for Display of J1939 Parameter                                                    | Yanmar            | P0219       |
| 190 | 0   | Engine OvrSpd EXTRM    | Diagnostic Trouble Code Indicating Engine Overspeed (Extreme)                                                 |                   |             |
| 190 | 1   | ENGINE SPEED LOW       | ECU trouble code metering indicates Engine speed is below the LOW threshold                                   |                   |             |
| 190 | 16  | Engine OvrSpd MODRT    | Diagnostic Trouble Code Indicating Engine Overspeed (Moderate)                                                |                   |             |
| 190 | 17  | ENGINE SPEED LOW       | ECU trouble code metering indicates Engine speed is below the LOW threshold                                   |                   |             |
| 190 | -1  | ENGINE SPEED           | Caption used on front panel for Display of J1939 Parameter                                                    |                   |             |
| 191 | -1  | TR OUTPUT SHAFT SPD    | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Transmission Output Shaft Speed |                   |             |
| 237 | 2   | VIN Data MisMatch      | Diagnostic Trouble Code Indicating VIN Data Mismatch with Other Controllers                                   |                   |             |
| 237 | 13  | CAN 2                  | CAN Bus 2                                                                                                     | Yanmar            | P40003002   |
| 237 | 31  | CAN 2                  | CAN Bus 2                                                                                                     | Yanmar            | P40000168   |
| 247 | -1  | ENGINE HOURS           | Caption used on front panel for Display of J1939 Parameter                                                    |                   |             |
| 250 | -1  | TOTAL FUEL USED        | Caption used on front panel for Display of J1939 Parameter                                                    |                   |             |
| 354 | -1  | RELATIVE HUMIDITY      | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Relative Humidity               |                   |             |
| 411 | -1  | EGR1 DIFF PRESSURE     | EGR1 Differential Pressure                                                                                    |                   |             |
| 412 | 0   | EGR Temp EXT HI        | Diagnostic Trouble Code Indicating Exhaust Gas Recirculation Temp (Extremely High)                            |                   |             |
| 412 | 3   | EGR GAS TMP SNSR BAD   | EGR Gas Temperature Sensor Malfunction                                                                        | Yanmar            | P041D       |
| 412 | 3   | EGR Temp In Vlt HI     | Diagnostic Trouble Code Indicating Exhaust Gas Recirculation Temp Input Voltage (High)                        |                   |             |
| 412 | 4   | EGR GAS TMP SNSR BAD   | EGR Gas Temperature Sensor Malfunction                                                                        | Yanmar            | P041C       |
| 412 | 4   | EGR Temp In Vlt LO     | Diagnostic Trouble Code Indicating Exhaust Gas Recirculation Temp Input Voltage (Low)                         |                   |             |
| 412 | 10  | EGR GAS TMP SNSR BAD   | EGR Gas Temperature Sensor Malfunction                                                                        | Yanmar            | P1675       |
| 412 | 16  | EGR Temp MHI           | Diagnostic Trouble Code Indicating Exhaust Gas Recirculation Temp (Moderately High)                           |                   |             |
| 412 | -1  | EGR GAS TEMP           | Exhaust Gas Recirculation Valve Gas Temperature.                                                              |                   |             |
| 430 | 12  | STARTER CNTRL SHRT/OPN | Starter Control Short or Open                                                                                 | Woodward PG Plus  |             |
| 441 | -1  | AUX TEMP 1             | Diagnostic Trouble Code Indicating Aux Temperature 1                                                          |                   |             |
| 442 | -1  | AUX TEMP 2             | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aux Temperature 2               |                   |             |
| 443 | -1  | AUX PRESSURE2          | Caption used on front panel for Display of J1939 Parameter                                                    |                   |             |
| 444 | -1  | BATTERY VOLT 2         | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Battery Voltage 2               |                   |             |
| 512 | 20  | APP BRAKE MISMATCH     | APP Brake Mismatch                                                                                            | Woodward PG Plus  |             |
| 515 | -1  | DESIRED SPEED          | Speed demand desired from the engine.                                                                         |                   |             |
| 520 | -1  | RETARDER % TORQUE      | Retarder % torque                                                                                             |                   |             |
| 523 | -1  | TRANS CURRNT GEAR      | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Transmission Current Gear       |                   |             |
| 524 | -1  | TRANS SELECTD GEAR     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Transmission Selected Gear      |                   |             |
| 558 | -1  | ACCEL PEDAL IDLE SW    | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Accelerator Pedal Idle Switch   |                   |             |

| SPN | FMI | Text Displayed          | Description                                                                                                                | ECU Configuration | Yanmar Code |
|-----|-----|-------------------------|----------------------------------------------------------------------------------------------------------------------------|-------------------|-------------|
| 559 | -1  | ACCEL PEDAL KICKDN SW   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Accelerator Pedal Kickdown Switch            |                   |             |
| 563 | -1  | ABS ACTIVE              | Antilock Brake System (ABS) active                                                                                         |                   |             |
| 573 | -1  | TRQCNV LOCKUP ENGAGD    | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Transmission Torque Converter Lockup Engaged |                   |             |
| 574 | -1  | TR SHIFT IN PROGRESS    | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Transmission Shift in Process                |                   |             |
| 596 | -1  | CRUISE CNTL ENABLE SW   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Cruise Control Enable Switch                 |                   |             |
| 597 | -1  | BRAKE SWITCH            | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Brake Switch                                 |                   |             |
| 598 | -1  | CLUTCH SWITCH           | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Clutch Switch                                |                   |             |
| 599 | -1  | CRUISE CNTL SET SW      | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Cruise Control Set Switch                    |                   |             |
| 600 | -1  | CRUISE CNTL COAST SW    | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Cruise Control Coast (Decelerate) Switch     |                   |             |
| 601 | -1  | CRUISE CNTL RESUME SW   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Cruise Control Resume Switch                 |                   |             |
| 602 | -1  | CRUISE CNTL ACCEL SW    | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Cruise Control Accelerate Switch             |                   |             |
| 604 | -1  | TRANS NEUTRAL SW        | Transmission Neutral Switch                                                                                                |                   |             |
| 609 | -1  | CONTROLLER #2           | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Controller Number 2                          |                   |             |
| 611 | 0   | LOSS OF VOLTAGE SENISNG | Loss of Voltage Sensing from Voltage Regulator over CAN Bus                                                                |                   |             |
| 611 | 3   | Inj Short to PWR        | Diagnostic Trouble Code Indicating Injector Wiring Shorted to Power                                                        |                   |             |
| 611 | 4   | Inj Short to GND        | Diagnostic Trouble Code Indicating Injector Wiring Shorted to Ground                                                       |                   |             |
| 611 | -1  | SYS DIAGNST CODE 1      | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating System Diagnostic Code 1                     |                   |             |
| 612 | 14  | EDM FAULT               | Exciter Diode Monitor Fault Status from Voltage Regulator over CAN Bus                                                     |                   |             |
| 620 | -1  | 5 VOLT SUPPLY           | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating 5 Volt Supply                                |                   |             |
| 623 | -1  | RED STOP LAMP           | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Red Stop Lamp                                |                   |             |
| 624 | -1  | DIAGNOSTIC LAMP         | Diagnostic Lamp                                                                                                            |                   |             |
| 625 | -1  | PROP COMM NETWK 1       | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Proprietary Communications Network 1         |                   |             |
| 627 | 1   | Inj Sply Vlt Problm     | Diagnostic Trouble Code Indicating Injector Supply Voltage Problem                                                         |                   |             |
| 627 | 13  | ECU ERROR               | Diagnostic Trouble Code Indicating ECU Error                                                                               |                   |             |
| 627 | 16  | ECU Power Volt HI       | Diagnostic Trouble Code Indicating ECU Power High Voltage                                                                  |                   |             |
| 627 | 18  | ECU Power Volt LO       | Diagnostic Trouble Code Indicating ECU Power Low Voltage                                                                   |                   |             |
| 628 | -1  | PROGRAM MEMORY          | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Program Memory                               |                   |             |
| 629 | -1  | CONTROLLER #1           | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Controller 1                                 |                   |             |
| 630 | 12  | EE PROM                 | EEPROM memory inside the engine ECU.                                                                                       | Yanmar            | P0601       |
| 630 | -1  | ECU INTERNAL ERROR      | ECU Internal Error                                                                                                         |                   |             |
| 632 | 5   | FUEL SHUTOFF OPEN/SHORT | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Fuel Shutoff is open or shorted              |                   |             |
| 632 | 7   | FUEL PRESSURE LOW       | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Fuel Pressure is Low                         |                   |             |
| 632 | 12  | FUEL SHUTOFF MALFUNCTN  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Fuel Shutoff Malfunction                     |                   |             |
| 632 | -1  | FUEL SHUT OFF 1         | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Fuel Shutoff 1                               |                   |             |
| 633 | 3   | SCV (MPROP)             | Proprietary YANMAR Diagnostic Trouble Codes.                                                                               | Yanmar            | P0629       |

| SPN | FMI | Text Displayed        | Description                                                                                               | ECU Configuration | Yanmar Code |
|-----|-----|-----------------------|-----------------------------------------------------------------------------------------------------------|-------------------|-------------|
| 633 | 5   | SCV (MPROP)           | Proprietary YANMAR Diagnostic Trouble Codes.                                                              | Yanmar            | P0627       |
| 633 | 6   | SCV (MPROP)           | Proprietary YANMAR Diagnostic Trouble Codes.                                                              | Yanmar            | P1642       |
| 633 | -1  | THROTTLE ACT 1 CNTL   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Throttle Actuator 1 Control |                   |             |
| 636 | 2   | Pump Pos Sns Noisy    | Diagnostic Trouble Code Indicating Pump Position Sensor Input Noise                                       |                   |             |
| 636 | 5   | Pump Pos Sns Curr LO  | Diagnostic Trouble Code Indicating Pump Position Sensor Current (Low)                                     |                   |             |
| 636 | 6   | Pump Pos Sns Curr HI  | Diagnostic Trouble Code Indicating Pump Position Sensor Current (High)                                    |                   |             |
| 636 | 8   | Pump Pos Sns In MSNG  | Diagnostic Trouble Code Indicating Pump Position Sensor Input Missing                                     |                   |             |
| 636 | 10  | Pump Pos Sns In ERR   | Diagnostic Trouble Code Indicating Pump Position Sensor Input Pattern Error                               |                   |             |
| 636 | -1  | ENG POSITION SENSOR   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Position Sensor      |                   |             |
| 637 | 2   | Crank Pos Sns Noisy   | Diagnostic Trouble Code Indicating Crank Position Input Noise                                             |                   |             |
| 637 | 5   | Crank Pos Sns Curr LO | Diagnostic Trouble Code Indicating Crank Position Sensor Current (Low)                                    |                   |             |
| 637 | 6   | Crank Pos Sns Curr HI | Diagnostic Trouble Code Indicating Crank Position Sensor Current (High)                                   |                   |             |
| 637 | 7   | Crnk/Pmp Pos Tmg OOS  | Diagnostic Trouble Code Indicating Crank/Pump Position Timing Moderately Out of Sync                      |                   |             |
| 637 | 8   | Crank Pos Sns MSNG    | Diagnostic Trouble Code Indicating Crank Position Missing                                                 |                   |             |
| 637 | 10  | Crank Pos Sns In ERR  | Diagnostic Trouble Code Indicating Crank Position Input Pattern Error                                     |                   |             |
| 639 | -1  | J1939 NETWORK 1       | J1939 Network number 1                                                                                    |                   |             |
| 641 | 4   | Trbo Actuator ERR     | Diagnostic Trouble Code Indicating Turbo Actuator Error                                                   |                   |             |
| 641 | 12  | ECU/Trbo Comm ERR     | Diagnostic Trouble Code Indicating ECU/Turbo Communication Error                                          |                   |             |
| 641 | 13  | TrboAct Lrnd Val ERR  | Diagnostic Trouble Code Indicating Turbo Actuator Learned Value Error                                     |                   |             |
| 641 | 16  | Trbo Act Temp MHI     | Diagnostic Trouble Code Indicating Turbo Actuator Temp (Moderately High)                                  |                   |             |
| 645 | -1  | TACHOMETER SIGNAL     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Tachometer Signal           |                   |             |
| 651 | 2   | Cyl 1 EUI PN INVLD    | Diagnostic Trouble Code Indicating Cylinder #1 EUI Part Number (Invalid)                                  |                   |             |
| 651 | 3   | CYLINDER 4 INJECTOR   | Cylinder 4 Injector                                                                                       | Yanmar            | P1271       |
| 651 | 5   | CYLINDER 4 INJECTOR   | Cylinder 4 Injector                                                                                       | Yanmar            | P0204       |
| 651 | 5   | Cyl 1 EUI Ckt OPEN    | Diagnostic Trouble Code Indicating Cylinder #1 EUI Circuit (Open)                                         |                   |             |
| 651 | 6   | CYLINDER 4 INJECTOR   | Cylinder 4 Injector                                                                                       | Yanmar            | P0271       |
| 651 | 6   | Cyl 1 EUI Ckt SHORT   | Diagnostic Trouble Code Indicating Cylinder #1 EUI Circuit (Shorted)                                      |                   |             |
| 651 | 7   | Cyl1 EUI Ckt MECH FL  | Diagnostic Trouble Code Indicating Cylinder #1 EUI Circuit (Mechanical Failure)                           |                   |             |
| 651 | 11  | CYLINDER 4 INJECTOR   | Cylinder 4 Injector                                                                                       | Yanmar            | P1272       |
| 651 | 13  | Cyl 1 EUI QR INVLD    | Diagnostic Trouble Code Indicating Cylinder #1 EUI Circuit QR Code (Invalid)                              |                   |             |
| 651 | -1  | CYLINDER 1 INJECTOR   | Cylinder 1 Injector                                                                                       |                   |             |
| 652 | 2   | Cyl 2 EUI PN INVLD    | Diagnostic Trouble Code Indicating Cylinder #2 EUI Part Number (Invalid)                                  |                   |             |
| 652 | 3   | CYLINDER 3 INJECTOR   | Cylinder 3 Injector                                                                                       | Yanmar            | P1268       |
| 652 | 5   | CYLINDER 3 INJECTOR   | Cylinder 3 Injector                                                                                       | Yanmar            | P0203       |
| 652 | 5   | Cyl 2 EUI Ckt OPEN    | Diagnostic Trouble Code Indicating Cylinder #2 EUI Circuit (Open)                                         |                   |             |
| 652 | 6   | CYLINDER 3 INJECTOR   | Cylinder 3 Injector                                                                                       | Yanmar            | P0268       |
| 652 | 6   | Cyl 2 EUI Ckt SHORT   | Diagnostic Trouble Code Indicating Cylinder #2 EUI Circuit (Shorted)                                      |                   |             |
| 652 | 7   | Cyl2 EUI Ckt MECH FL  | Diagnostic Trouble Code Indicating Cylinder #2 EUI Circuit (Mechanical Failure)                           |                   |             |
| 652 | 11  | CYLINDER 3 INJECTOR   | Cylinder 3 Injector                                                                                       | Yanmar            | P1269       |
| 652 | 13  | Cyl 2 EUI QR INVLD    | Diagnostic Trouble Code Indicating Cylinder #2 EUI Circuit QR Code (Invalid)                              |                   |             |

| SPN | FMI | Text Displayed       | Description                                                                     | ECU Configuration | Yanmar Code |
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| 652 | -1  | CYLINDER 2 INJECTOR  | Cylinder 2 Injector                                                             |                   |             |
| 653 | 2   | Cyl 3 EUI PN INVLD   | Diagnostic Trouble Code Indicating Cylinder #3 EUI Part Number (Invalid)        |                   |             |
| 653 | 3   | CYLINDER 2 INJECTOR  | Cylinder 2 Injector                                                             | Yanmar            | P1265       |
| 653 | 5   | CYLINDER 2 INJECTOR  | Cylinder 2 Injector                                                             | Yanmar            | P0202       |
| 653 | 5   | Cyl 3 EUI Ckt OPEN   | Diagnostic Trouble Code Indicating Cylinder #3 EUI Circuit (Open)               |                   |             |
| 653 | 6   | CYLINDER 2 INJECTOR  | Cylinder 2 Injector                                                             | Yanmar            | P0265       |
| 653 | 6   | Cyl 3 EUI Ckt SHORT  | Diagnostic Trouble Code Indicating Cylinder #3 EUI Circuit (Shorted)            |                   |             |
| 653 | 7   | Cyl3 EUI Ckt MECH FL | Diagnostic Trouble Code Indicating Cylinder #3 EUI Circuit (Mechanical Failure) |                   |             |
| 653 | 11  | CYLINDER 2 INJECTOR  | Cylinder 2 Injector                                                             | Yanmar            | P1266       |
| 653 | 13  | Cyl 3 EUI QR INVLD   | Diagnostic Trouble Code Indicating Cylinder #3 EUI Circuit QR Code (Invalid)    |                   |             |
| 653 | -1  | CYLINDER 3 INJECTOR  | Cylinder 3 Injector                                                             |                   |             |
| 654 | 2   | Cyl 4 EUI PN INVLD   | Diagnostic Trouble Code Indicating Cylinder #4 EUI Part Number (Invalid)        |                   |             |
| 654 | 3   | CYLINDER 1 INJECTOR  | Cylinder 1 Injector                                                             | Yanmar            | P1262       |
| 654 | 5   | CYLINDER 1 INJECTOR  | Cylinder 1 Injector                                                             | Yanmar            | P0201       |
| 654 | 5   | Cyl 4 EUI Ckt OPEN   | Diagnostic Trouble Code Indicating Cylinder #4 EUI Circuit (Open)               |                   |             |
| 654 | 6   | CYLINDER 1 INJECTOR  | Cylinder 1 Injector                                                             | Yanmar            | P0262       |
| 654 | 6   | Cyl 4 EUI Ckt SHORT  | Diagnostic Trouble Code Indicating Cylinder #4 EUI Circuit (Shorted)            |                   |             |
| 654 | 7   | Cyl4 EUI Ckt MECH FL | Diagnostic Trouble Code Indicating Cylinder #4 EUI Circuit (Mechanical Failure) |                   |             |
| 654 | 11  | CYLINDER 1 INJECTOR  | Cylinder 1 Injector                                                             | Yanmar            | P1263       |
| 654 | 13  | Cyl 4 EUI QR INVLD   | Diagnostic Trouble Code Indicating Cylinder #4 EUI Circuit QR Code (Invalid)    |                   |             |
| 654 | -1  | CYLINDER 4 INJECTOR  | Cylinder 4 Injector                                                             |                   |             |
| 655 | 2   | Cyl 5 EUI PN INVLD   | Diagnostic Trouble Code Indicating Cylinder #5 EUI Part Number (Invalid)        |                   |             |
| 655 | 5   | Cyl 5 EUI Ckt OPEN   | Diagnostic Trouble Code Indicating Cylinder #5 EUI Circuit (Open)               |                   |             |
| 655 | 6   | Cyl 5 EUI Ckt SHORT  | Diagnostic Trouble Code Indicating Cylinder #5 EUI Circuit (Shorted)            |                   |             |
| 655 | 7   | Cyl5 EUI Ckt MECH FL | Diagnostic Trouble Code Indicating Cylinder #5 EUI Circuit (Mechanical Failure) |                   |             |
| 655 | 13  | Cyl 5 EUI QR INVLD   | Diagnostic Trouble Code Indicating Cylinder #5 EUI Circuit QR Code (Invalid)    |                   |             |
| 655 | -1  | CYLINDER 5 INJECTOR  | Cylinder 5 Injector                                                             |                   |             |
| 656 | 2   | Cyl 6 EUI PN INVLD   | Diagnostic Trouble Code Indicating Cylinder #6 EUI Part Number (Invalid)        |                   |             |
| 656 | 5   | Cyl 6 EUI Ckt OPEN   | Diagnostic Trouble Code Indicating Cylinder #6 EUI Circuit (Open)               |                   |             |
| 656 | 6   | Cyl 6 EUI Ckt SHORT  | Diagnostic Trouble Code Indicating Cylinder #6 EUI Circuit (Shorted)            |                   |             |
| 656 | 7   | Cyl6 EUI Ckt MECH FL | Diagnostic Trouble Code Indicating Cylinder #6 EUI Circuit (Mechanical Failure) |                   |             |
| 656 | 13  | Cyl 6 EUI QR INVLD   | Diagnostic Trouble Code Indicating Cylinder #6 EUI Circuit QR Code (Invalid)    |                   |             |
| 656 | -1  | CYLINDER 6 INJECTOR  | Cylinder 6 Injector                                                             |                   |             |
| 657 | -1  | CYLINDER 7 INJECTOR  | Cylinder 7 Injector                                                             |                   |             |
| 658 | -1  | CYLINDER 8 INJECTOR  | Cylinder 8 Injector                                                             |                   |             |
| 659 | -1  | CYLINDER 9 INJECTOR  | Cylinder 9 Injector                                                             |                   |             |
| 660 | -1  | CYLINDER 10 INJECTOR | Cylinder 10 Injector                                                            |                   |             |
| 661 | -1  | CYLINDER 11 INJECTOR | Cylinder 11 Injector                                                            |                   |             |
| 662 | -1  | CYLINDER 12 INJECTOR | Cylinder 12 Injector                                                            |                   |             |
| 663 | -1  | CYLINDER 13 INJECTOR | Cylinder 13 Injector                                                            |                   |             |
| 664 | -1  | CYLINDER 14 INJECTOR | Cylinder 14 Injector                                                            |                   |             |

| SPN | FMI | Text Displayed       | Description                                                                                                 | ECU Configuration | Yanmar Code |
|-----|-----|----------------------|-------------------------------------------------------------------------------------------------------------|-------------------|-------------|
| 665 | -1  | CYLINDER 15 INJECTOR | Cylinder 15 Injector                                                                                        |                   |             |
| 666 | -1  | CYLINDER 16 INJECTOR | Cylinder 16 Injector                                                                                        |                   |             |
| 667 | -1  | CYLINDER 17 INJECTOR | Cylinder 17 Injector                                                                                        |                   |             |
| 668 | -1  | CYLINDER 18 INJECTOR | Cylinder 18 Injector                                                                                        |                   |             |
| 669 | -1  | CYLINDER 19 INJECTOR | Cylinder 19 Injector                                                                                        |                   |             |
| 670 | -1  | CYLINDER 20 INJECTOR | Cylinder 20 Injector                                                                                        |                   |             |
| 671 | -1  | CYLINDER 21 INJECTOR | Cylinder 21 Injector                                                                                        |                   |             |
| 672 | -1  | CYLINDER 22 INJECTOR | Cylinder 22 Injector                                                                                        |                   |             |
| 673 | -1  | CYLINDER 23 INJECTOR | Cylinder 23 Injector                                                                                        |                   |             |
| 674 | -1  | CYLINDER 24 INJECTOR | Cylinder 24 Injector                                                                                        |                   |             |
| 675 | -1  | ENG GLOW PLUG LAMP   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Glow Plug Lamp                |                   |             |
| 676 | -1  | ENG GLOW PLUG RELAY  | Engine Glow Plug Relay                                                                                      |                   |             |
| 677 | -1  | ENGINE START RELAY   | Engine Start Relay                                                                                          |                   |             |
| 695 | 20  | TSC1-BRK MISMATCH    | Tsc1 And Brake Mismatch                                                                                     | Woodward PG Plus  |             |
| 697 | -1  | AUX PWM DRIVER 1     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Auxiliary PWM Driver 1        |                   |             |
| 698 | -1  | AUX PWM DRIVER 2     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Auxiliary PWM Driver 2        |                   |             |
| 699 | -1  | AUX PWM DRIVER 3     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Auxiliary PWM Driver 3        |                   |             |
| 700 | -1  | AUX PWM DRIVER 4     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Auxiliary PWM Driver 4        |                   |             |
| 701 | -1  | AUX I/O 1            | Auxiliary I/O 1                                                                                             |                   |             |
| 702 | -1  | AUX I/O 2            | Auxiliary I/O 2                                                                                             |                   |             |
| 703 | -1  | AUX I/O 3            | Auxiliary I/O 3                                                                                             |                   |             |
| 704 | -1  | AUX I/O 4            | Auxiliary I/O 4                                                                                             |                   |             |
| 705 | -1  | AUX I/O 5            | Auxiliary I/O 5                                                                                             |                   |             |
| 706 | -1  | AUX I/O 6            | Auxiliary I/O 6                                                                                             |                   |             |
| 707 | -1  | AUX I/O 7            | Auxiliary I/O 7                                                                                             |                   |             |
| 708 | -1  | AUX I/O 8            | Auxiliary I/O 8                                                                                             |                   |             |
| 709 | -1  | AUX I/O 9            | Auxiliary I/O 9                                                                                             |                   |             |
| 710 | -1  | AUX I/O 10           | Auxiliary I/O 10                                                                                            |                   |             |
| 711 | -1  | AUX I/O 11           | Auxiliary I/O 11                                                                                            |                   |             |
| 712 | -1  | AUX I/O 12           | Auxiliary I/O 12                                                                                            |                   |             |
| 713 | -1  | AUX I/O 13           | Auxiliary I/O 13                                                                                            |                   |             |
| 714 | -1  | AUX I/O 14           | Auxiliary I/O 14                                                                                            |                   |             |
| 715 | -1  | AUX I/O 15           | Auxiliary I/O 15                                                                                            |                   |             |
| 716 | -1  | AUX I/O 16           | Auxiliary I/O 16                                                                                            |                   |             |
| 723 | -1  | SPEED SENSOR #2      | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Speed Sensor #2        |                   |             |
| 724 | -1  | O2 SENSOR            | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating O2 Sensor                     |                   |             |
| 729 | -1  | INTAKE HEATER #1     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Intake Air Heater #1          |                   |             |
| 730 | -1  | INTAKE HEATER #2     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Intake Air Heater #2          |                   |             |
| 731 | -1  | KNOCK SENSOR #1      | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Knock Sensor 1                |                   |             |
| 855 | -1  | HEATER CIRCUIT 2     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Fuel Valve 1 Heater Circuit 2 |                   |             |



| SPN  | FMI | Text Displayed        | Description                                                                                                       | ECU Configuration | Yanmar Code |
|------|-----|-----------------------|-------------------------------------------------------------------------------------------------------------------|-------------------|-------------|
| 870  | -1  | HEATER REGEN SYSTM    | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Heater Regeneration System          |                   |             |
| 898  | 2   | REQ SPD DATA ERRATIC  | ECU trouble code metering indicates speed demand data is erratic                                                  |                   |             |
| 898  | 9   | Spd/Trq Msg INVLD     | Diagnostic Trouble Code Indicating Vehicle Speed/Torque Message Invalid                                           |                   |             |
| 898  | -1  | ENGINE REQSTED SPEED  | Engine Requested Speed                                                                                            |                   |             |
| 904  | -1  | FRONT AXLE SPEED      | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Front Axle Speed                    |                   |             |
| 920  | -1  | AUDIBLE ALARM         | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Audible Alarm                       |                   |             |
| 923  | -1  | PWM OUTPUT            | Engine PWM Output                                                                                                 |                   |             |
| 924  | -1  | AUX OUT #1            | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Auxiliary Output 1                  |                   |             |
| 925  | -1  | AUX OUT #2            | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Auxiliary Output 2                  |                   |             |
| 926  | -1  | AUX OUT #3            | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Auxiliary Output 3                  |                   |             |
| 966  | 31  | ENGINE TST MD SW ON   | Diagnostic Trouble Code Indicating Engine Test Mode Switch On                                                     |                   |             |
| 970  | 2   | Aux Eng SD SW INVLD   | Diagnostic Trouble Code Indicating Auxiliary Engine Shutdown Switch (Invalid)                                     |                   |             |
| 970  | 31  | Aux Eng SD SW ACTV    | Diagnostic Trouble Code Indicating Auxiliary Engine Shutdown Switch Active                                        |                   |             |
| 971  | 31  | Eng Derate SW ACTV    | Diagnostic Trouble Code Indicating External Engine Derate Switch Active                                           |                   |             |
| 973  | -1  | ENG RETARDR SELECTN   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Retarder Selection           |                   |             |
| 974  | -1  | REMOTE ACCEL PEDAL    | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Remote Accelerator Pedal            |                   |             |
| 975  | -1  | FAN SPEED             | Engine Fan Speed                                                                                                  |                   |             |
| 977  | -1  | FAN DRIVE STATE       | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Fan Drive State                     |                   |             |
| 986  | -1  | REQSTD FAN SPEED      | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Requested Fan Speed                 |                   |             |
| 1004 | -1  | TRIP VEH IDLE FL USED | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Trip Vehicle Idle Fuel Used         |                   |             |
| 1005 | -1  | TRIP CRUISE FL USED   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Trip Cruise Fuel Used               |                   |             |
| 1015 | -1  | TRIP AVG LOAD FACTOR  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Trip Average Load Factor            |                   |             |
| 1072 | -1  | ENG BRAKE OUTPUT 1    | Engine Brake Output 1                                                                                             |                   |             |
| 1073 | -1  | ENG COMPR BRK OUTPUT2 | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine (Compression) Brake Output 2 |                   |             |
| 1074 | -1  | ENG EXHAUST BRAKE OUT | Engine Exhaust Brake Output                                                                                       |                   |             |
| 1075 | 5   | Fuel TR Pump Curr LO  | Diagnostic Trouble Code Indicating Fuel Transfer Pump Current (Low)                                               |                   |             |
| 1075 | 6   | Fuel TR Pump Curr HI  | Diagnostic Trouble Code Indicating Fuel Transfer Pump Current (High)                                              |                   |             |
| 1075 | 12  | Fuel TR Pump ERR      | Diagnostic Trouble Code Indicating Fuel Transfer Pump (Error)                                                     |                   |             |
| 1079 | -1  | SENSOR SUPPLY VOLTS 1 | Sensor Supply Voltage 1                                                                                           |                   |             |
| 1080 | 3   | Snsr Supp 1 Volt LO   | Diagnostic Trouble Code Indicating Sensor Supply 1 Voltage (Low)                                                  |                   |             |
| 1080 | 4   | Snsr Supp 1 Volt HI   | Diagnostic Trouble Code Indicating Sensor Supply 1 Voltage (High)                                                 |                   |             |
| 1080 | -1  | SENSOR SUPPLY VOLTS 2 | Sensor Supply Voltage 2                                                                                           |                   |             |
| 1081 | -1  | ENG WAIT TO START LMP | Engine Wait to Start Lamp                                                                                         |                   |             |
| 1083 | -1  | AUX I/O 1             | Auxiliary I/O 1                                                                                                   |                   |             |
| 1084 | -1  | AUX I/O 2             | Auxiliary I/O 2                                                                                                   |                   |             |
| 1109 | 31  | Eng Shutdown WARNING  | Diagnostic Trouble Code Indicating Engine Shutdown Warning                                                        |                   |             |
| 1109 | -1  | EPS SHUTDN APPROACHG  | Engine Protective System Shutdown Is Approaching                                                                  |                   |             |
| 1110 | 31  | Eng Prot Shutdown     | Diagnostic Trouble Code Indicating Engine Protection Shutdown                                                     |                   |             |
| 1118 | 12  | PRECAT O2 LO ACTIVITY | Precat O2 Low Activity                                                                                            | Woodward PG Plus  |             |

| SPN  | FMI | Text Displayed         | Description                                                                                                                                | ECU Configuration | Yanmar Code |
|------|-----|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------|
| 1118 | 15  | PRECAT O2 FL RICH      | PreCat O2 Fail Rich                                                                                                                        | Woodward PG Plus  |             |
| 1118 | 17  | PRECAT O2 FL LN        | PreCat O2 FailLean                                                                                                                         | Woodward PG Plus  |             |
| 1119 | 3   | PRECAT O2 VOLTS HI     | PreCat O2 Voltage High                                                                                                                     | Woodward PG Plus  |             |
| 1119 | 4   | PRECAT O2 VOLTS LO     | PreCat O2 Voltage Low                                                                                                                      | Woodward PG Plus  |             |
| 1119 | 12  | PRECAT O2 HTR OPN/SHRT | Precat O2 Heater Short or Open                                                                                                             | Woodward PG Plus  |             |
| 1127 | -1  | TURBOCHG1 BOOST PRS    | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Turbo Charger 1 Boost Pressure                               |                   |             |
| 1128 | -1  | TURBOCHG2 BOOST PRS    | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Turbo Charger 2 Boost Pressure                               |                   |             |
| 1129 | -1  | TURBOCHG3 BOOST PRS    | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Turbo Charger 3 Boost Pressure                               |                   |             |
| 1130 | -1  | TURBOCHG4 BOOST PRS    | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Turbo Charger 4 Boost Pressure                               |                   |             |
| 1131 | -1  | INTK MNFLD2 TEMP       | Intake manifold 2 temperature                                                                                                              |                   |             |
| 1132 | -1  | INTK MNFLD3 TEMP       | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Intake Manifold 3 Temperature                                |                   |             |
| 1133 | -1  | INTK MNFLD4 TEMP       | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Intake Manifold 3 Temperature                                |                   |             |
| 1136 | 0   | ECU Temp EXT HI        | Diagnostic Trouble Code Indicating ECU Temperature (Extremely High)                                                                        |                   |             |
| 1136 | 15  | ENG ECU TEMP HI        | ECU trouble code metering indicates ECU Temperature has exceeded the HIGH level                                                            |                   |             |
| 1136 | 16  | ECU Temp MHI           | Diagnostic Trouble Code Indicating ECU Temperature (Moderately High)                                                                       |                   |             |
| 1136 | -1  | ECU TEMP               | Caption used on front panel for Display of J1939 Parameter                                                                                 |                   |             |
| 1168 | -1  | TRBO CH2 OIL PRESS     | Diagnostic Trouble Code Indicating Turbo Charger2 Oil Pressure                                                                             |                   |             |
| 1169 | -1  | TURBO CH2 SPEED        | Diagnostic Trouble Code Indicating Turbo2 Speed                                                                                            |                   |             |
| 1170 | -1  | TURBO CH3 SPEED        | Diagnostic Trouble Code Indicating Turbo3 Speed                                                                                            |                   |             |
| 1171 | -1  | TURBO CH4 SPEED        | Diagnostic Trouble Code Indicating Turbo4 Speed                                                                                            |                   |             |
| 1172 | 3   | Trbo Cmp Tmp Volt HI   | Diagnostic Trouble Code Indicating Turbo Compressor Inlet Temp Input Voltage (High)                                                        |                   |             |
| 1172 | 4   | Trbo Cmp Tmp Volt LO   | Diagnostic Trouble Code Indicating Turbo Compressor Inlet Temp Input Voltage (Low)                                                         |                   |             |
| 1172 | 16  | Trbo Cmp In Tmp MHI    | Diagnostic Trouble Code Indicating Turbo Compressor Inlet Temp (Moderately High)                                                           |                   |             |
| 1180 | 0   | Trbo Trbn Tmp EXT HI   | Diagnostic Trouble Code Indicating Turbo Turbine Inlet Temp (Extremely High)                                                               |                   |             |
| 1180 | 16  | Trbo Trbn In Tmp MHI   | Diagnostic Trouble Code Indicating Turbo Turbine Inlet Temp (Moderately High)                                                              |                   |             |
| 1184 | -1  | TURBOCHG1 OUTLET TEMP  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Turbo Charger 1 Outlet Temperature                           |                   |             |
| 1185 | -1  | TURBOCHG2 OUTLET TEMP  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Turbo Charger 2 Outlet Temperature                           |                   |             |
| 1186 | -1  | TURBOCHG3 OUTLET TEMP  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Turbo Charger 3 Outlet Temperature                           |                   |             |
| 1187 | -1  | TURBOCHG4 OUTLET TEMP  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Turbo Charger 4 Outlet Temperature                           |                   |             |
| 1188 | -1  | TRBO WST GT ACT1 POS   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Turbo Waste Gate Actuator 1 Postion                          |                   |             |
| 1189 | -1  | TRBO WST GT ACT2 POS   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Turbo Waste Gate Actuator 2 Postion                          |                   |             |
| 1192 | -1  | TRBO WSTGT ACT AIR PR  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Turbocharger Waste gate Actuator Control Air Pressure |                   |             |
| 1203 | -1  | INTRCOOLER COOLNT PRS  | Diagnostic Trouble Code Indicating Intercooler Coolant Pressure                                                                            |                   |             |
| 1204 | -1  | ELECTRICAL LOAD        | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Electrical Load                                              |                   |             |



| SPN  | FMI | Text Displayed       | Description                                                                                                       | ECU Configuration | Yanmar Code |
|------|-----|----------------------|-------------------------------------------------------------------------------------------------------------------|-------------------|-------------|
| 1208 | -1  | PRE FLT OIL PRESSR   | Diagnostic Trouble Code Indicating Oil Pressure Before Oil Filter                                                 |                   |             |
| 1209 | 3   | EXH MANFLD P SNS BAD | Exhaust Manifold Pressure Sensor Malfunction                                                                      | Yanmar            | P0473       |
| 1209 | 4   | EXH MANFLD P SNS BAD | Exhaust Manifold Pressure Sensor Malfunction                                                                      | Yanmar            | P0472       |
| 1209 | 10  | EXH MANFLD P SNS BAD | Exhaust Manifold Pressure Sensor Malfunction                                                                      | Yanmar            | P1679       |
| 1209 | 13  | EXH MANFLD P SNS BAD | Exhaust Manifold Pressure Sensor Malfunction                                                                      | Yanmar            | P0471       |
| 1209 | -1  | EXH PRESSURE         | Exhaust Pressure                                                                                                  |                   |             |
| 1213 | -1  | MALFUNC LAMP         | The malfunction indicator lamp status that is broadcast by ECU as part of diagnostic trouble code information     |                   |             |
| 1227 | -1  | TEST LIMIT MAX       | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Test Limit Maximum                  |                   |             |
| 1231 | -1  | J1939 NETWORK 2      | J1939 Network number 2                                                                                            |                   |             |
| 1235 | -1  | J1939 NETWORK 3      | J1939 Network number 3                                                                                            |                   |             |
| 1237 | 31  | AL OVERRIDE ON       | MTU Fault used on Front Panel and BESTCOMSP <sup>Plus</sup> for MTU Fault Code List. These are proprietary to MTU |                   |             |
| 1237 | -1  | ENG SHUTDN ORIDE SW  | Engine Shutdown Override Switch                                                                                   |                   |             |
| 1239 | -1  | FUEL LEAKAGE1        | Caption used on front panel for Display of J1939 Parameter                                                        |                   |             |
| 1240 | -1  | FUEL LEAKAGE2        | Caption used on front panel for Display of J1939 Parameter                                                        |                   |             |
| 1247 | -1  | ENGINE POWER         | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Power Output                 |                   |             |
| 1268 | -1  | IGNITION COIL 1      | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 1              |                   |             |
| 1269 | -1  | IGNITION COIL 2      | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 2              |                   |             |
| 1270 | -1  | IGNITION COIL 3      | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 3              |                   |             |
| 1271 | -1  | IGNITION COIL 4      | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 4              |                   |             |
| 1272 | -1  | IGNITION COIL 5      | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 5              |                   |             |
| 1273 | -1  | IGNITION COIL 6      | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 6              |                   |             |
| 1274 | -1  | IGNITION COIL 7      | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 7              |                   |             |
| 1275 | -1  | IGNITION COIL 8      | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 8              |                   |             |
| 1276 | -1  | IGNITION COIL 9      | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 9              |                   |             |
| 1277 | -1  | IGNITION COIL 10     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 10             |                   |             |
| 1278 | -1  | IGNITION COIL 11     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 11             |                   |             |
| 1279 | -1  | IGNITION COIL 12     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 12             |                   |             |
| 1280 | -1  | IGNITION COIL 13     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 13             |                   |             |
| 1281 | -1  | IGNITION COIL 14     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 14             |                   |             |
| 1282 | -1  | IGNITION COIL 15     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 15             |                   |             |
| 1283 | -1  | IGNITION COIL 16     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 16             |                   |             |
| 1284 | -1  | IGNITION COIL 17     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 17             |                   |             |
| 1285 | -1  | IGNITION COIL 18     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 18             |                   |             |
| 1286 | -1  | IGNITION COIL 19     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 19             |                   |             |
| 1287 | -1  | IGNITION COIL 20     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 20             |                   |             |
| 1288 | -1  | IGNITION COIL 21     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 21             |                   |             |
| 1289 | -1  | IGNITION COIL 22     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 22             |                   |             |
| 1290 | -1  | IGNITION COIL 23     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 23             |                   |             |
| 1291 | -1  | IGNITION COIL 24     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Ignition Coil 24             |                   |             |

| SPN  | FMI | Text Displayed        | Description                                                                                                                        | ECU Configuration | Yanmar Code |
|------|-----|-----------------------|------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------|
| 1321 | -1  | STARTER LKOUT RLY DRV | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Starter Solenoid Lockout Relay Driver Circuit |                   |             |
| 1322 | -1  | MULTI CYL MISFIRE     | Misfire detected on multiple engine cylinders                                                                                      |                   |             |
| 1323 | -1  | MISFIRE CYLINDER 1    | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1324 | -1  | MISFIRE CYLINDER 2    | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1325 | -1  | MISFIRE CYLINDER 3    | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1326 | -1  | MISFIRE CYLINDER 4    | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1327 | -1  | MISFIRE CYLINDER 5    | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1328 | -1  | MISFIRE CYLINDER 6    | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1329 | -1  | MISFIRE CYLINDER 7    | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1330 | -1  | MISFIRE CYLINDER 8    | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1331 | -1  | MISFIRE CYLINDER 9    | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1332 | -1  | MISFIRE CYLINDER 10   | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1333 | -1  | MISFIRE CYLINDER 11   | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1334 | -1  | MISFIRE CYLINDER 12   | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1335 | -1  | MISFIRE CYLINDER 13   | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1336 | -1  | MISFIRE CYLINDER 14   | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1337 | -1  | MISFIRE CYLINDER 15   | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1338 | -1  | MISFIRE CYLINDER 16   | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1339 | -1  | MISFIRE CYLINDER 17   | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1340 | -1  | MISFIRE CYLINDER 18   | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1341 | -1  | MISFIRE CYLINDER 19   | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1342 | -1  | MISFIRE CYLINDER 20   | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1343 | -1  | MISFIRE CYLINDER 21   | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1344 | -1  | MISFIRE CYLINDER 22   | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1345 | -1  | MISFIRE CYLINDER 23   | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1346 | -1  | MISFIRE CYLINDER 24   | Misfire detected on a single engine cylinder                                                                                       |                   |             |
| 1347 | -1  | FUEL PUMP ASSY #1     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Fuel Pump Pressurizing Assembly #1                   |                   |             |
| 1348 | -1  | FUEL PUMP ASSY #2     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Fuel Pump Pressurizing Assembly #2                   |                   |             |
| 1349 | -1  | INJ RAIL PRS2         | Diagnostic Trouble Code Indicating Injection Metering Rail 2 Pressure                                                              |                   |             |
| 1350 | -1  | TIME SINCE LST SERVC  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Time Since Last Service                              |                   |             |
| 1352 | -1  | KNOCK LVL CYL 1       | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Knock Level Cylinder 1                               |                   |             |
| 1353 | -1  | KNOCK LVL CYL 2       | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Knock Level Cylinder 2                               |                   |             |
| 1354 | -1  | KNOCK LVL CYL 3       | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Knock Level Cylinder 3                               |                   |             |
| 1355 | -1  | KNOCK LVL CYL 4       | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Knock Level Cylinder 4                               |                   |             |
| 1356 | -1  | KNOCK LVL CYL 5       | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Knock Level Cylinder 5                               |                   |             |
| 1357 | -1  | KNOCK LVL CYL 6       | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Knock Level Cylinder 6                               |                   |             |
| 1358 | -1  | KNOCK LVL CYL 7       | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Knock Level Cylinder 7                               |                   |             |
| 1359 | -1  | KNOCK LVL CYL 8       | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Knock Level Cylinder 8                               |                   |             |
| 1380 | -1  | OIL RESVR LEVEL       | Diagnostic Trouble Code Indicating Oil Reservoir Level                                                                             |                   |             |

| SPN  | FMI | Text Displayed          | Description                                                                                                                       | ECU Configuration | Yanmar Code |
|------|-----|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------|
| 1384 | -1  | J1939 COMANDED SHUTDOWN | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating J1939 Commanded Shutdown                            |                   |             |
| 1385 | -1  | AUX TEMP 1              | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aux Temperature 1                                   |                   |             |
| 1386 | -1  | AUX TEMP 2              | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aux Temperature 2                                   |                   |             |
| 1387 | -1  | AUX PRESSURE1           | Caption used on front panel for Display of J1939 Parameter                                                                        |                   |             |
| 1388 | -1  | AUX PRESSURE2           | Caption used on front panel for Display of J1939 Parameter                                                                        |                   |             |
| 1390 | -1  | FUEL VALVE1 INLET PRS   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Fuel Valve 1 Inlet Pressure                         |                   |             |
| 1391 | -1  | FUEL VALVE 1 DIFF PRS   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Fuel Valve 1 Differential Pressure                  |                   |             |
| 1442 | -1  | FUEL VALVE1 POSITN      | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Fuel Valve 1 Position                               |                   |             |
| 1485 | 2   | ECU MAIN RELAY          | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating ECM Main Relay                                      | Yanmar            | P068A       |
| 1485 | 7   | ECU MAIN RELAY          | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating ECM Main Relay                                      | Yanmar            | P068B       |
| 1485 | -1  | ECU MAIN RELAY          | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating ECM Main Relay                                      |                   |             |
| 1557 | -1  | FAN 2 DRIVE STATE       | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Fan 2 Drive State                                   |                   |             |
| 1569 | 31  | FUEL DERATE             | Fuel Derate                                                                                                                       |                   |             |
| 1569 | -1  | ENG PROT TORQ DERATE    | Diagnostic Trouble Code Indicating Nox Levels are High due to DEF tank being empty                                                |                   |             |
| 1620 | 12  | TACHO SHORT/OPEN        | Tacho Short or Open                                                                                                               | Woodward PG Plus  |             |
| 1623 | -1  | TACOGPH OUT SHFT SPD    | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Tachograph Output Shaft Speed                       |                   |             |
| 1624 | -1  | TACOGPH VEHICLE SPD     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Tachograph Vehicle Speed                            |                   |             |
| 1633 | -1  | CRUISE CNTL PAUSE SW    | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Cruise Control Pause Switch                         |                   |             |
| 1634 | -1  | CALIB VERIFICATN NMBR   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Calibration Verification Number                     |                   |             |
| 1636 | -1  | INTK MNFD1 TMP HI RES   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Intake Manifold 1 Air Temperature (High Resolution) |                   |             |
| 1638 | -1  | HYDRAULIC TEMP          | Hydraulic Temperature                                                                                                             |                   |             |
| 1639 | 1   | Fan Speed Zero          | Diagnostic Trouble Code Indicating Fan Speed Detected (Zero)                                                                      |                   |             |
| 1639 | 16  | Fan Speed HI            | Diagnostic Trouble Code Indicating Fan Speed Detected (High)                                                                      |                   |             |
| 1639 | 18  | Fan Speed LO            | Diagnostic Trouble Code Indicating Fan Speed Detected (Low)                                                                       |                   |             |
| 1639 | -1  | FAN SPEED               | Engine Fan Speed                                                                                                                  |                   |             |
| 1675 | -1  | STARTER MODE            | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Starter Mode                                        |                   |             |
| 1692 | -1  | INTKMNF1D1 DESIRD PR    | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Intake Manifold Desired Absolute Pressure    |                   |             |
| 1695 | -1  | EGO SNSR FUEL CORRCTN   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Exhaust Gas Oxygen Sensor Fueling Correction        |                   |             |
| 1716 | -1  | RETRDR SEL NON ENGINE   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Retarder Selection non-engine                       |                   |             |
| 1761 | -1  | DEF TANK 1 LVL %        | Diesel Exhaust Fluid Tank 1 Level in Percent                                                                                      |                   |             |
| 1908 | -1  | AUX VLV0 STATE CMD      | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aux Valve 0 State Command                           |                   |             |
| 2000 | 13  | Security Violation      | Diagnostic Trouble Code Indicating Security Violation                                                                             |                   |             |
| 2003 | 9   | TRANS1 MSG TIMEOUT      | Transmission 1 Message Timeout                                                                                                    | Woodward PG Plus  |             |
| 2003 | 19  | TRANS1 DATA INVALID     | Transmission 1 Data Invalid                                                                                                       | Woodward PG Plus  |             |
| 2004 | 9   | EGR MSG TIMEOUT         | EGR Message Timeout                                                                                                               | Woodward PG Plus  |             |

| SPN  | FMI | Text Displayed              | Description                                                                                                  | ECU Configuration | Yanmar Code |
|------|-----|-----------------------------|--------------------------------------------------------------------------------------------------------------|-------------------|-------------|
| 2004 | 14  | ECGR2 MESSAGE               | EGR2 Message                                                                                                 | Woodward PG Plus  |             |
| 2005 | 9   | TSC CAN Msg NT RCV          | Diagnostic Trouble Code Indicating TSC CAN Message Not Received                                              |                   |             |
| 2011 | 9   | BRK CTL MSG TIMEOUT         | Brake Controller Message Timeout                                                                             | Woodward PG Plus  |             |
| 2011 | 14  | HR WHEEL SPD MSG            | High Resolution Wheel Speed Message                                                                          | Woodward PG Plus  |             |
| 2030 | 9   | AC Clutch Msg NT RCV        | Diagnostic Trouble Code Indicating A/C Clutch Status CAN Message Not Received                                |                   |             |
| 2071 | 9   | Tr Oil Can Msg NT RCV       | Diagnostic Trouble Code Indicating Transmission Oil Tier Size Vehicle Speed CAN Message Not Received         |                   |             |
| 2237 | 9   | ECT2 RX TIMEOUT             | ETC2 Rx Timeout Fault                                                                                        | Woodward PG Plus  |             |
| 2238 | 9   | TACHO MSG TIMEOUT           | Tachograph Message Timeout                                                                                   | Woodward PG Plus  |             |
| 2238 | 19  | TACHO DATA INVALID          | Tachograph Data Invalid                                                                                      | Woodward PG Plus  |             |
| 2239 | 9   | TSC1 RX/HYB ISG MSG TIMEOUT | TSC1 Rx / Hybrid ISG Message Timeout                                                                         | Woodward PG Plus  |             |
| 2240 | 9   | BRK CTL MSG TIMEOUT         | Brake Controller Message Timeout                                                                             | Woodward PG Plus  |             |
| 2240 | 19  | BRK CTL DATA INVALID        | Brake Controller Data Invalid                                                                                | Woodward PG Plus  |             |
| 2433 | -1  | EXH GAS TMP RT MNFLD        | Diagnostic Trouble Code Indicating Right Manifold Exhaust Gas Temperature                                    |                   |             |
| 2434 | -1  | EXH GAS TMP LFT MNFLD       | Diagnostic Trouble Code Indicating Left Manifold Exhaust Gas Temperature                                     |                   |             |
| 2436 | -1  | GEN AVG FREQUENCY           | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Generator Average AC Frequency |                   |             |
| 2440 | -1  | GEN LL VOLTAGE              | Generator Line to Line Voltage                                                                               |                   |             |
| 2452 | -1  | GEN TOTAL POWER             | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Generator Total Power Output   |                   |             |
| 2456 | -1  | GEN VAR                     | Generator Var Reactive Power                                                                                 |                   |             |
| 2602 | -1  | HYDRAULIC OIL LVL           | Diagnostic Trouble Code Indicating Hydraulic Oil Level                                                       |                   |             |
| 2629 | 0   | TRBO 1 OUT TMP HI HI        | ECU trouble code metering indicates Turbocharger 1 outlet pressure is above the HIGH HIGH threshold          |                   |             |
| 2629 | 15  | TURBO 1 OUT TMP HI          | ECU trouble code metering indicates Turbocharger 1 outlet pressure is above the HIGH threshold               |                   |             |
| 2630 | 0   | EGR FrAir Tmp EXT HI        | Diagnostic Trouble Code Indicating Exhaust Gas Recirculation Fresh Air Temp (Extremely High)                 |                   |             |
| 2630 | 3   | EGR FrAir Tmp Vlt HI        | Diagnostic Trouble Code Indicating Exhaust Gas Recirculation Fresh Air Temp Input Voltage (High)             |                   |             |
| 2630 | 4   | EGR FrAir Tmp Vlt LO        | Diagnostic Trouble Code Indicating Exhaust Gas Recirculation Fresh Air Temp Input Voltage (Low)              |                   |             |
| 2630 | 15  | EGR FrAir Tmp HI            | Diagnostic Trouble Code Indicating Exhaust Gas Recirculation Fresh Air Temp (High Least Severe)              |                   |             |
| 2630 | 16  | EGR FrAir Tmp MHI           | Diagnostic Trouble Code Indicating Exhaust Gas Recirculation Fresh Air Temp (Moderately High)                |                   |             |
| 2634 | -1  | POWER RELAY                 | Main Power Relay                                                                                             |                   |             |
| 2646 | -1  | AUX OUT #4                  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Auxiliary Output 4             |                   |             |
| 2647 | -1  | AUX OUT #5                  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Auxiliary Output 5             |                   |             |
| 2659 | 0   | EGR FLOW HIGH               | EGR Flow High                                                                                                |                   |             |
| 2659 | 1   | EGR FLOW LOW                | EGR Flow Low                                                                                                 |                   |             |
| 2659 | 2   | EGR Flo/Tmp MISMATCH        | Diagnostic Trouble Code Indicating Exhaust Gas Recirculation Flow/Temp Mismatch                              |                   |             |
| 2659 | 15  | EGR Flo Rt High             | Diagnostic Trouble Code Indicating Exhaust Gas Recirculation Flow Rate (High Least Severe)                   |                   |             |
| 2659 | 17  | EGR Flo Rt LO               | Diagnostic Trouble Code Indicating Exhaust Gas Recirculation Flow Rate (Low Least Severe)                    |                   |             |
| 2790 | 16  | Trbo Cmp Out Tmp HI         | Diagnostic Trouble Code Indicating Turbo Compressor Outlet Temp (Moderately High)                            |                   |             |
| 2791 | 0   | EGR VALVE MALFUNCTN         | Exhaust Gas Recirculation (EGR) Malfunction                                                                  | Yanmar            | P0404       |
| 2791 | 1   | EGR VALVE MALFUNCTN         | Exhaust Gas Recirculation (EGR) Malfunction                                                                  | Yanmar            | P1404       |
| 2791 | 2   | EGR Vlv Pos Invl            | Diagnostic Trouble Code Indicating Exhaust Gas Recirculation Valve Position Invalid                          |                   |             |
| 2791 | 3   | EGRVlv Pos In Vlt HI        | Diagnostic Trouble Code Indicating Exhaust Gas Recirculation Valve Position Input Voltage (High)             |                   |             |

| SPN  | FMI | Text Displayed         | Description                                                                                                                                | ECU Configuration | Yanmar Code |
|------|-----|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------|
| 2791 | 4   | EGRVlv Pos In Vlt LO   | Diagnostic Trouble Code Indicating Exhaust Gas Recirculation Valve Position Input Voltage (Low)                                            |                   |             |
| 2791 | 7   | EGR VALVE MALFUNCTN    | Exhaust Gas Recirculation (EGR) Malfunction                                                                                                | Yanmar            | P1409       |
| 2791 | 9   | EGR VALVE MALFUNCTN    | Exhaust Gas Recirculation (EGR) Malfunction                                                                                                | Yanmar            | P40000401   |
| 2791 | 12  | EGR VALVE MALFUNCTN    | Exhaust Gas Recirculation (EGR) Malfunction                                                                                                | Yanmar            | P0403       |
| 2791 | 13  | EGR Vlv Control ERR    | Diagnostic Trouble Code Indicating Exhaust Gas Recirculation Valve Control Error                                                           |                   |             |
| 2791 | 31  | EGR Valve Cal ERR      | Diagnostic Trouble Code Indicating Exhaust Gas Recirculation Valve Calibration Error                                                       |                   |             |
| 2791 | -1  | EGR VALVE CONTROL      | EGR Valve Control                                                                                                                          |                   |             |
| 2795 | 7   | Trbo Act Pos MSMATCH   | Diagnostic Trouble Code Indicating Turbo Actuator Position Mismatch                                                                        |                   |             |
| 2797 | 6   | INJECTOR GROUP 1       | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Injector Group 1                                      | Yanmar            | P1146       |
| 2797 | -1  | INJECTOR GROUP 1       | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Injector Group 1                                      |                   |             |
| 2798 | 6   | INJECTOR GROUP 2       | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Injector Group 2                                      | Yanmar            | P1149       |
| 2798 | -1  | INJECTOR GROUP 2       | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Injector Group 2                                      |                   |             |
| 2899 | -1  | START ENABL DEV 1 CFG  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Start Enable Device 1 Configuration                   |                   |             |
| 2950 | 3   | INTK THROTTLE DRV CKT  | Engine Intake Throttle Drive Circuit                                                                                                       | Yanmar            | P1658       |
| 2950 | 4   | INTK THROTTLE DRV CKT  | Engine Intake Throttle Drive Circuit                                                                                                       | Yanmar            | P1659       |
| 2950 | 5   | INTK THROTTLE DRV CKT  | Engine Intake Throttle Drive Circuit                                                                                                       | Yanmar            | P0660       |
| 2950 | 6   | INTK THROTTLE DRV CKT  | Engine Intake Throttle Drive Circuit                                                                                                       | Yanmar            | P1660       |
| 2950 | -1  | INTK VALVE ACUATOR 1   | Engine Intake Valve Actuator #1                                                                                                            |                   |             |
| 2951 | 3   | INTK THROTTLE DRV CKT  | Engine Intake Throttle Drive Circuit                                                                                                       | Yanmar            | P1661       |
| 2951 | 4   | INTK THROTTLE DRV CKT  | Engine Intake Throttle Drive Circuit                                                                                                       | Yanmar            | P1662       |
| 2951 | -1  | INTK VALVE ACUATOR 2   | Engine Intake Valve Actuator #2                                                                                                            |                   |             |
| 2980 | -1  | FUEL PRESSR            | Caption used on front panel for Display of J1939 Parameter                                                                                 |                   |             |
| 3031 | -1  | DEF TEMP               | Diagnostic Trouble Code Indicating DEF Temperature                                                                                         |                   |             |
| 3050 | -1  | CATALYST SYSTM MONITR  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Catalyst 1 System Monitor                                    |                   |             |
| 3056 | -1  | EGO SENSOR MONITOR 1   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Exhaust Gas Oxygen Sensor 1 Monitor                          |                   |             |
| 3057 | -1  | EGO SENSOR MONITOR 2   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Exhaust Gas Oxygen Sensor 2 Monitor                          |                   |             |
| 3217 | -1  | AFT1 TRT 1 INTK O2     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 1 Intake O2                                   |                   |             |
| 3218 | -1  | AFT1 INTK SNSPWR IN RG | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 1 Intake Gas Sensor Power In Range            |                   |             |
| 3219 | -1  | AFT1 INTK SNSR AT TMP  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 1 Intake Gas Sensor at Temperature            |                   |             |
| 3220 | -1  | AFT1 INTK NOX STBL     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 1 Intake NOx Reading Stable                   |                   |             |
| 3221 | -1  | AFT1 INTK WR O2 STBL   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 1 Intake Wide-Range Percent O2 Reading Stable |                   |             |
| 3222 | -1  | AFT1 INTK SNS HTR FMI  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 1 Intake Gas Sensor Heater Preliminary FMI    |                   |             |
| 3224 | -1  | AFT1 INTK NOXSNSR FMI  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 1 Intake NOx Sensor Preliminary FMI           |                   |             |
| 3225 | -1  | AFT1 INTK O2 SNSR FMI  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 1 Intake O2 Sensor Preliminary FMI            |                   |             |
| 3226 | -1  | AFT 1 OUTLET NOX       | Diagnostic Trouble Code Indicating Aftertreatment 1 Outlet Nox                                                                             |                   |             |

| SPN  | FMI | Text Displayed         | Description                                                                                                                                           | ECU Configuration | Yanmar Code |
|------|-----|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------|
| 3227 | -1  | AFT 1 OUT OXYGN %      | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 1 Outlet Oxygen Percent                                  |                   |             |
| 3232 | -1  | AFT1 OUT SNS HTR FMI   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 1 Outlet Gas Sensor Heater Preliminary FMI               |                   |             |
| 3234 | -1  | AFT1 OUT NOX SNSR FMI  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 1 Outlet NOx Sensor Preliminary FMI                      |                   |             |
| 3242 | 0   | DPF INLET T SENSR BAD  | Diesel Particulate Filter (DPF) Inlet Temperature Sensor Malfunction                                                                                  | Yanmar            | P1436       |
| 3242 | 3   | DPF INLET T SENSR BAD  | Diesel Particulate Filter (DPF) Inlet Temperature Sensor Malfunction                                                                                  | Yanmar            | P1428       |
| 3242 | 4   | DPF INLET T SENSR BAD  | Diesel Particulate Filter (DPF) Inlet Temperature Sensor Malfunction                                                                                  | Yanmar            | P1427       |
| 3242 | 10  | DPF INLET T SENSR BAD  | Diesel Particulate Filter (DPF) Inlet Temperature Sensor Malfunction                                                                                  | Yanmar            | P167E       |
| 3242 | -1  | AFT1 DPF IN TEMP       | Diagnostic Trouble Code Indicating Aftertreatment 1 DPF Intake Temperature                                                                            |                   |             |
| 3246 | -1  | AFT1 DPF OUT TEMP      | Diagnostic Trouble Code Indicating Aftertreatment 1 DPF Outlet Temperature                                                                            |                   |             |
| 3250 | 0   | DPF INTRMD T SNS BAD   | Diesel Particulate Filter (DPF) Intermediate Temperature Sensor Malfunction                                                                           | Yanmar            | P1426       |
| 3250 | 1   | DPF INTRMD T SNS BAD   | Diesel Particulate Filter (DPF) Intermediate Temperature Sensor Malfunction                                                                           | Yanmar            | P0420       |
| 3250 | 3   | DPF INTRMD T SNS BAD   | Diesel Particulate Filter (DPF) Intermediate Temperature Sensor Malfunction                                                                           | Yanmar            | P1434       |
| 3250 | 4   | DPF INTRMD T SNS BAD   | Diesel Particulate Filter (DPF) Intermediate Temperature Sensor Malfunction                                                                           | Yanmar            | P1435       |
| 3250 | 10  | DPF INTRMD T SNS BAD   | Diesel Particulate Filter (DPF) Intermediate Temperature Sensor Malfunction                                                                           | Yanmar            | P167A       |
| 3250 | -1  | DPF INTRMED GAS TEMP   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 1 Diesel Particulate Filter Intermediate Gas Temperature |                   |             |
| 3251 | 0   | DPF DIFF PRS SNSR BAD  | Diesel Particulate Filter (DPF) Differential Pressure Sensor Malfunction                                                                              | Yanmar            | P2452       |
| 3251 | 3   | DPF DIFF PRS SNSR BAD  | Diesel Particulate Filter (DPF) Differential Pressure Sensor Malfunction                                                                              | Yanmar            | P2455       |
| 3251 | 4   | DPF DIFF PRS SNSR BAD  | Diesel Particulate Filter (DPF) Differential Pressure Sensor Malfunction                                                                              | Yanmar            | P2454       |
| 3251 | 10  | DPF DIFF PRS SNSR BAD  | Diesel Particulate Filter (DPF) Differential Pressure Sensor Malfunction                                                                              | Yanmar            | P167B       |
| 3251 | 13  | DPF DIFF PRS SNSR BAD  | Diesel Particulate Filter (DPF) Differential Pressure Sensor Malfunction                                                                              | Yanmar            | P2453       |
| 3251 | -1  | AFT1 DPF DIFF PRESSR   | Diagnostic Trouble Code Indicating Aftertreatment 1 DPF Differential Pressure                                                                         |                   |             |
| 3256 | -1  | AFTR TRT 2 INTK O2     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 2 Intake Percent O2                                      |                   |             |
| 3257 | -1  | AFT2 INTK SNSPWR IN RG | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 2 Intake Gas Sensor Power In Range                       |                   |             |
| 3260 | -1  | AFT2 INTK WR O2 STBL   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 2 Intake Wide-Range Percent O2 Reading Stable            |                   |             |
| 3261 | -1  | AFT2 INTK SNS HTR FMI  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 2 Intake Gas Sensor Heater Preliminary FMI               |                   |             |
| 3264 | -1  | AFT2 INTK O2 SNSR FMI  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 2 Intake O2 Sensor Preliminary FMI                       |                   |             |
| 3271 | -1  | AFT2 OUT SNS HTR FMI   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 2 Outlet Gas Sensor Heater Preliminary FMI               |                   |             |
| 3353 | 12  | ALTERNATOR FAULT       | Alternator Fault                                                                                                                                      |                   |             |
| 3353 | -1  | ALTERNATOR 1           | Alternator 1                                                                                                                                          |                   |             |
| 3361 | -1  | AFT1 CTLYST DOSE UNIT  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 1 SCR Catalyst Dosing Unit                               |                   |             |
| 3363 | -1  | AFT1 SCR TANK HTR      | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 1 SCR Tank Heater                                        |                   |             |
| 3380 | -1  | FIELD VOLTAGE          | Generator Exciter Field Voltage                                                                                                                       |                   |             |
| 3381 | -1  | FIELD CURRENT          | Generator Exciter Field Current                                                                                                                       |                   |             |
| 3464 | -1  | THROTTLE ACT 1 CNTL    | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Throttle Actuator 1 Control                                             |                   |             |



| SPN  | FMI | Text Displayed        | Description                                                                                                                                    | ECU Configuration | Yanmar Code |
|------|-----|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------|
| 3465 | -1  | THROTTLE ACT 2 CNTL   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Throttle Actuator 2 Control                                      |                   |             |
| 3468 | -1  | FUEL TEMP 2           | Diagnostic Trouble Code Indicating Fuel Temperature 2                                                                                          |                   |             |
| 3485 | -1  | AFT1 SUPPLY AIR PRESS | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 1 Supply Air Pressure                             |                   |             |
| 3509 | -1  | SENSOR SUPPLY VOLTS 1 | Sensor Supply Voltage 1                                                                                                                        |                   |             |
| 3510 | -1  | SENSOR SUPPLY VOLTS 2 | Sensor Supply Voltage 2                                                                                                                        |                   |             |
| 3511 | -1  | SNSR SUPPLY VOLT 3    | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Sensor Supply Voltage 3                                          |                   |             |
| 3512 | -1  | SNSR SUPPLY VOLT 4    | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Sensor Supply Voltage 4                                          |                   |             |
| 3513 | -1  | SNSR SUPPLY VOLT 5    | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Sensor Supply Voltage 5                                          |                   |             |
| 3514 | -1  | SNSR SUPPLY VOLT 6    | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Sensor Supply Voltage 6                                          |                   |             |
| 3515 | -1  | DEF TEMP              | Diagnostic Trouble Code Indicating DEF Temperature                                                                                             |                   |             |
| 3516 | -1  | DEF CONCENTRATION     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 1 SCR Catalyst Reagent Concentration              |                   |             |
| 3517 | -1  | DEF TANK 2 LVL %      | Diesel Exhaust Fluid Tank 2 Level in Percent                                                                                                   |                   |             |
| 3520 | -1  | DEF QUALITY           | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 1 SCR Catalyst Reagent Properties Preliminary FMI |                   |             |
| 3563 | -1  | INTK MNFLD1 PRESSURE  | Intake manifold 1 pressure                                                                                                                     |                   |             |
| 3597 | -1  | ECU SUPPLY VOLTAGE 1  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating ECU Power Supply Voltage 1                                       |                   |             |
| 3598 | -1  | ECU SUPPLY VOLTAGE 2  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating ECU Power Supply Voltage 2                                       |                   |             |
| 3599 | -1  | ECU SUPPLY VOLTAGE 3  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating ECU Power Supply Voltage 3                                       |                   |             |
| 3601 | -1  | FUEL VLV LK TEST CTL  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Fuel Shutoff Valve Leak Test Control                      |                   |             |
| 3605 | -1  | COOLANT PUMP CTL      | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Coolant Pump Control                                             |                   |             |
| 3607 | -1  | ENGINE SHUTDOWN       | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Shutdown Indication                                       |                   |             |
| 3609 | 3   | DPF HIGH PRS SNS BAD  | Diesel Particulate Filter (DPF) High Pressure Sensor Malfunction                                                                               | Yanmar            | P1455       |
| 3609 | 4   | DPF HIGH PRS SNS BAD  | Diesel Particulate Filter (DPF) High Pressure Sensor Malfunction                                                                               | Yanmar            | P1454       |
| 3609 | 10  | DPF HIGH PRS SNS BAD  | Diesel Particulate Filter (DPF) High Pressure Sensor Malfunction                                                                               | Yanmar            | P167C       |
| 3609 | -1  | DPF INTAKE PRESSR 1   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating DPF Intake Pressure 1                                            |                   |             |
| 3610 | -1  | DPF OUTLET PRESSR 1   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating DPF Outlet Pressure 1                                            |                   |             |
| 3611 | -1  | DPF INTAKE PRESSR 2   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating DPF Intake Pressure 2                                            |                   |             |
| 3612 | -1  | DPF OUTLET PRESSR 2   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating DPF Outlet Pressure 2                                            |                   |             |
| 3668 | -1  | INTRCR CLNT LVL       | Parameter that indicates intercooler coolant level                                                                                             |                   |             |
| 3673 | -1  | THROTTLE POSITION 2   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Throttle 2 Position                                       |                   |             |
| 3695 | 14  | REGEN INHIBITED       | Diesel particulate filter regeneration is disabled. This is a pre-alarm                                                                        | Yanmar            | P1425       |
| 3695 | -1  | REGEN INHIBIT SWITCH  | Designating the Aftertreatment Regeneration Inhibit Switch                                                                                     |                   |             |
| 3703 | -1  | DPF RGN INH DUE TO SW | Diagnostic Trouble Code Indicating DPF Regeneration Inhibited Due to Inhibit Switch                                                            |                   |             |
| 3719 | 0   | DPF SOOT LEVEL %      | Level of soot in the Diesel Particulate Filter                                                                                                 | Yanmar            | P1424       |
| 3719 | 0   | SOOT LVL EXT HI       | Diagnostic Trouble Code Indicating Diesel Particulate Filter Soot Level High Most Severe Level                                                 |                   |             |
| 3719 | 7   | DPF SOOT LEVEL %      | Level of soot in the Diesel Particulate Filter                                                                                                 | Yanmar            | P1446       |
| 3719 | 9   | DPF SOOT LEVEL %      | Level of soot in the Diesel Particulate Filter                                                                                                 | Yanmar            | P1445       |
| 3719 | 15  | SOOT LVL HI           | Diagnostic Trouble Code Indicating Diesel Particulate Filter Soot Level High - Least Severe Level                                              |                   |             |

| SPN  | FMI | Text Displayed        | Description                                                                                                                                        | ECU Configuration | Yanmar Code |
|------|-----|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------|
| 3719 | 16  | DPF SOOT LEVEL %      | Level of soot in the Diesel Particulate Filter                                                                                                     | Yanmar            | P1421       |
| 3719 | 16  | SOOT LVL MOD HI       | Diagnostic Trouble Code Indicating Diesel Particulate Filter Soot Level High Moderately Severe Level                                               |                   |             |
| 3719 | -1  | DPF SOOT LEVEL %      | Level of soot in the Diesel Particulate Filter                                                                                                     |                   |             |
| 3720 | 0   | DPF ASH LEVEL %       | Level of ash in the Diesel Particulate Filter                                                                                                      | Yanmar            | P1420       |
| 3720 | 16  | DPF ASH LEVEL %       | Level of ash in the Diesel Particulate Filter                                                                                                      | Yanmar            | P242F       |
| 3720 | -1  | DPF ASH LEVEL %       | Level of ash in the Diesel Particulate Filter                                                                                                      |                   |             |
| 3822 | -1  | EGR1 VLV 2 POSITION   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Exhaust Gas Recirculation 1 Valve 2 Position                  |                   |             |
| 3826 | -1  | DEF AVG CONSUMPTION   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating DEF Average Consumption                                              |                   |             |
| 3828 | -1  | DEF CURRNT CONSUMPTN  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating DEF Current Consumption                                              |                   |             |
| 3938 | -1  | GOVERNING BIAS        | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Governing Bias                                                       |                   |             |
| 4096 | -1  | NOX HI - DEF EMPTY    | Diagnostic Trouble Code Indicating Nox Levels are High due to DEF tank being empty                                                                 |                   |             |
| 4213 | -1  | ENG CRNK WITHOUT FUEL | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Crank Without Fuel                                            |                   |             |
| 4257 | 12  | INJECTOR COMMON       | Used by YANMAR engine company to denote the common injector                                                                                        | Yanmar            | P0611       |
| 4257 | -1  | INJECTOR GROUP 3      | Parameters relating to the third group of fuel injectors.                                                                                          |                   |             |
| 4332 | -1  | DEF SYSTEM STATE      | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating DEF System State                                                     |                   |             |
| 4334 | -1  | DEF ABSOLUTE PRESSR   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating DEF Absolute Pressure                                                |                   |             |
| 4335 | -1  | DEF DOSING AIR ABS PR | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating DEF Dosing Air Assist Absolute Pressure                              |                   |             |
| 4336 | -1  | AFT1 DOSE AIR ASSTVLV | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 1 SCR Dosing Air Assist Valve                         |                   |             |
| 4348 | -1  | AFT1 REQ DOSING QTY   | Diagnostic Trouble Code Indicating After treatment 1 Requested Dosing Reagent Quantity                                                             |                   |             |
| 4354 | -1  | AFT1 DEF LINE HTR     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 1 SCR Catalyst Reagent Line Heater 1                  |                   |             |
| 4360 | -1  | AFTTRT1 INTK GAS TMP  | Diagnostic Trouble Code Indicating After treatment 1 Catalyst Intake Gas Temperature                                                               |                   |             |
| 4363 | -1  | AFTTRT1 OUT GAS TMP   | Diagnostic Trouble Code Indicating After treatment 1 Catalyst Outlet Gas Temperature                                                               |                   |             |
| 4364 | -1  | SCR CNVRSN EFFICIENCY | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating SCR Conversion Efficiency                                            |                   |             |
| 4375 | -1  | AFTTRT1 PUMP DRV %    | Diagnostic Trouble Code Indicating After treatment 1 Catalyst Pump Drive Percentage                                                                |                   |             |
| 4401 | -1  | AFT2 REQ DOSING QTY   | Diagnostic Trouble Code Indicating After treatment 2 Requested Dosing Reagent Quantity                                                             |                   |             |
| 4413 | -1  | AFTTRT2 INTK GAS TMP  | Diagnostic Trouble Code Indicating After treatment 2 Catalyst Intake Gas Temperature                                                               |                   |             |
| 4415 | -1  | AFTTRT2 OUT GAS TMP   | Diagnostic Trouble Code Indicating After treatment 2 Catalyst Outlet Gas Temperature                                                               |                   |             |
| 4441 | -1  | AFTTRT2 PUMP DRV %    | Diagnostic Trouble Code Indicating After treatment 2 Catalyst Pump Drive Percentage                                                                |                   |             |
| 4490 | -1  | SPECIFIC HUMIDITY     | Diagnostic Trouble Code Indicating Specific Humidity                                                                                               |                   |             |
| 4750 | 11  | EGR COOLING FAULT     | EGR Cooling Fault                                                                                                                                  |                   |             |
| 4750 | -1  | EGR COOLER 1 TEMP     | EGR 1 Cooler Intake Temperature                                                                                                                    |                   |             |
| 4755 | -1  | AFT1 CTLYST DIFF PRS  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 1 Gas Oxidation Catalyst Differential Pressure        |                   |             |
| 4765 | -1  | AFTTRT1 INTK GAS TMP  | Diagnostic Trouble Code Indicating After treatment 1 Catalyst Intake Gas Temperature                                                               |                   |             |
| 4794 | -1  | AFT1 CTLYST SYS MSSNG | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 1 SCR Catalyst System Missing                         |                   |             |
| 4795 | 31  | DPF SUBSTRATE REMOVED | The substrate has been removed from the Diesel Particulate Filter (DPF)                                                                            | Yanmar            | P226D       |
| 4809 | -1  | AFT1 DEF WARM IN TMP  | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 1 Warm Up Diesel Oxidation Catalyst Inlet Temperature |                   |             |



| SPN    | FMI | Text Displayed          | Description                                                                                                                                         | ECU Configuration | Yanmar Code |
|--------|-----|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------|
| 4810   | -1  | AFT1 DEF WARM OUT TMP   | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Aftertreatment 1 Warm Up Diesel Oxidation Catalyst Outlet Temperature |                   |             |
| 4990   | -1  | BATT CHARGER            | Diagnostic Trouble Code Indicating Battery Charger                                                                                                  |                   |             |
| 5078   | -1  | AMBER WARNING           | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Amber Warning Indication                                       |                   |             |
| 5081   | 1   | ENGINE BRAKE LAMP       | Engine Brake Lamp                                                                                                                                   |                   |             |
| 5081   | 12  | ENGINE BRK LMP SHT/OPEN | Engine Brake Lamp Short or Open                                                                                                                     |                   |             |
| 5100   | 12  | OVERHT LAMP SHORT/OPEN  | Overheat Lamp Short or Open                                                                                                                         |                   |             |
| 5100   | -1  | OVERHEAT LAMP           | Overheat Lamp                                                                                                                                       |                   |             |
| 5246   | -1  | SCR INDUCEMENT LEVEL    | Diagnostic Trouble Code Indicating Selective Catalytic Reduction System Inducement Level                                                            |                   |             |
| 5264   | -1  | EGR2 VALVE 1 CONTROL    | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Exhaust Gas Recirculation 2 Valve 1 Control                    |                   |             |
| 5422   | -1  | CHG AIR B PRESSURE      | Diagnostic Trouble Code Indicating Charge Air B Pressure                                                                                            |                   |             |
| 5571   | -1  | FUEL RTN PRESSURE       | Diagnostic Trouble Code Indicating Fuel Return Path Pressure                                                                                        |                   |             |
| 10029  | 0   | PURGE TIMEOUT ERROR     | Caption Diagnostic Trouble Code indicating that purge timeout has occurred for Isuzu Engines.                                                       |                   |             |
| 516098 | -1  | KNOCK SENSR 2           | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Knock Sensor 2                                                        |                   |             |
| 516131 | -1  | PROPANE/GAS LOCKOFF     | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Propane/Gas fuel lock off switch                                      |                   |             |
| 520200 | 0   | GASOLINE BANK1 LRN HI   | Gasoline Bank1 Learn High                                                                                                                           | GM                |             |
| 520200 | 1   | GASOLINE BANK1 LRN LO   | Gasoline Bank1 Learn Low                                                                                                                            | GM                |             |
| 520201 | 0   | GASOLINE BANK2 LRN HI   | Gasoline Bank2 Learn High                                                                                                                           | GM                |             |
| 520201 | 1   | GASOLINE BANK2 LRN LO   | Gasoline Bank2 Learn Low                                                                                                                            | GM                |             |
| 520202 | 0   | LP LEARN HIGH           | LPG Learn High                                                                                                                                      | GM                |             |
| 520202 | 1   | LP LEARN LOW            | LPG Learn Low                                                                                                                                       | GM                |             |
| 520203 | 0   | NATGAS LEARN HIGH       | Natural Gas Learn High                                                                                                                              | GM                |             |
| 520203 | 1   | NATGAS LEARN LOW        | Natural Gas Learn Low                                                                                                                               | GM                |             |
| 520204 | 0   | CL LOOP GAS BANK1 HI    | Closed Loop Gasoline Bank1 High                                                                                                                     | GM                |             |
| 520204 | 1   | CL LOOP GAS BANK1 LO    | Closed Loop Gasoline Bank1 Low                                                                                                                      | GM                |             |
| 520205 | 0   | CL LOOP GAS BANK2 HI    | Closed Loop Gasoline Bank2 High                                                                                                                     | GM                |             |
| 520205 | 1   | CL LOOP GAS BANK2 LO    | Closed Loop Gasoline Bank2 Low                                                                                                                      | GM                |             |
| 520206 | 0   | CLOSED LOOP LP HIGH     | Closed Loop LP Gas High                                                                                                                             | GM                |             |
| 520206 | 1   | CLOSED LOOP LP LOW      | Closed Loop LP Gas Low                                                                                                                              | GM                |             |
| 520207 | 0   | CL LOOP NATGAS HI       | Closed Loop Natural Gas High                                                                                                                        | GM                |             |
| 520207 | 1   | CL LOOP NATGAS LO       | Closed Loop Natural Gas Low                                                                                                                         | GM                |             |
| 520208 | 10  | EGO2 OPEN OR LAZY       | EGO2 Open or Lazy                                                                                                                                   | GM                |             |
| 520209 | 10  | EGO3 OPEN OR LAZY       | EGO3 Open or Lazy                                                                                                                                   | GM                |             |
| 520210 | 10  | EGO4 OPEN OR LAZY       | EGO4 Open or Lazy                                                                                                                                   | GM                |             |
| 520211 | 10  | GASBNK1 CATALYST INACTV | Gasoline Bank1 Catalyst Inactive                                                                                                                    | GM                |             |
| 520212 | 10  | GASBNK2 CATALYST INACTV | Gasoline Bank2 Catalyst Inactive                                                                                                                    | GM                |             |
| 520213 | 10  | LP GAS CATALYST INACTV  | LPG Catalyst Inactive                                                                                                                               | GM                |             |
| 520214 | 10  | NATGAS CATALYST INACTV  | Natural Gas Catalyst Inactive                                                                                                                       | GM                |             |
| 520215 | 3   | AUX ALG1 PULLDN VOLT HI | Aux Analog 1 Pulldown Voltage High                                                                                                                  | GM                |             |
| 520215 | 4   | AUX ALG1 PULLDN VOLT LO | Aux Analog 1 Pulldown Voltage Low                                                                                                                   | GM                |             |

| SPN    | FMI | Text Displayed          | Description                            | ECU Configuration | Yanmar Code |
|--------|-----|-------------------------|----------------------------------------|-------------------|-------------|
| 520216 | 3   | AUX ALG1 PULLUP VOLT HI | Aux Analog 1 Pullup Voltage High       | GM                |             |
| 520216 | 4   | AUX ALG1 PULLUP VOLT LO | Aux Analog 1 Pullup Voltage Low        | GM                |             |
| 520217 | 3   | AUX ALG2 PULLUP VOLT HI | Aux Analog 2 Pullup Voltage High       | GM                |             |
| 520217 | 4   | AUX ALG2 PULLUP VOLT LO | Aux Analog 2 Pullup Voltage Low        | GM                |             |
| 520218 | 3   | AUX ALG3 PULLUP VOLT HI | Aux Analog 3 Pullup Voltage High       | GM                |             |
| 520218 | 4   | AUX ALG3 PULLUP VOLT LO | Aux Analog 3 Pullup Voltage Low        | GM                |             |
| 520219 | 3   | AUX ALG1 PULLUPDN V HI  | Aux Analog 1 Pullup/Down Voltage High  | GM                |             |
| 520219 | 4   | AUX ALG1 PULLUPDN V LO  | Aux Analog 1 Pull Up/Down Voltage Low  | GM                |             |
| 520220 | 3   | AUX ALG2 PULLUPDN V HI  | Aux Analog 2 Pull Up/Down Voltage High | GM                |             |
| 520220 | 4   | AUX ALG2 PULLUPDN V LO  | Aux Analog 2 Pull Up/Down Voltage Low  | GM                |             |
| 520221 | 3   | AUX ALG3 PULLUPDN V HI  | Aux Analog 3 Pull Up/Down Voltage High | GM                |             |
| 520221 | 4   | AUX ALG3 PULLUPDN V LO  | Aux Analog 3 Pull Up/Down Voltage Low  | GM                |             |
| 520222 | 3   | AUX DIGITAL1 VOLTS HI   | Aux Digital 1 High Voltage             | GM                |             |
| 520222 | 4   | AUX DIGITAL1 VOLTS LO   | Aux Digital 1 Low Voltage              | GM                |             |
| 520223 | 3   | AUX DIGITAL2 VOLTS HI   | Aux Digital 2 High Voltage             | GM                |             |
| 520223 | 4   | AUX DIGITAL2 VOLTS LO   | Aux Digital 2 Low Voltage              | GM                |             |
| 520224 | 3   | AUX DIGITAL3 VOLTS HI   | Aux Digital 3 High Voltage             | GM                |             |
| 520224 | 4   | AUX DIGITAL3 VOLTS LO   | Aux Digital 3 Low Voltage              | GM                |             |
| 520226 | 3   | SHFTACTUATOR FDBK OOR   | Shift Actuator Feedback Out of Range   | GM                |             |
| 520226 | 7   | CAN'T RCH DESIRED GEAR  | Shift Unable to Reach Desired Gear     | GM                |             |
| 520226 | 31  | SHFTACTUATOR CIRCUIT FL | Shift Actuator Circuit Failed          | GM                |             |
| 520230 | 5   | PWM5 OPEN/GND SHORT     | PWM5 Open or Ground Short              | GM                |             |
| 520230 | 6   | PWM5 SHORT TO POWER     | PWM5 Short to Power                    | GM                |             |
| 520240 | 3   | FUELTEMP SENSR HI V     | Fuel Temp Sensor High Voltage          | GM                |             |
| 520240 | 4   | FUELTEMP SENSR LO V     | Fuel Temp Sensor Low Voltage           | GM                |             |
| 520241 | 2   | KNOCK2 ERRATIC SIGNAL   | Knock 2 Erratic Signal                 | GM                |             |
| 520241 | 4   | KNOCK SNSR OPEN         | Knock Sensor Open or Not Present       | GM                |             |
| 520250 | 31  | FPP 1/2 ERROR           | FPP1_2_Error                           | GM                |             |
| 520250 | 31  | FPP 1/2 ERROR           | FPP1_2_Error                           | GM                |             |
| 520250 | 31  | FPP 1/2 ERROR           | FPP1_2_Error                           | GM                |             |
| 520251 | 3   | TPS2 VOLTAGE HIGH       | TPS2 Voltage High                      | GM                |             |
| 520251 | 4   | TPS2 VOLTAGE LOW        | TPS2 Voltage Low                       | GM                |             |
| 520252 | 5   | IAC COIL OPEN/SHORT     | IAC Coil Open or Short                 | GM                |             |
| 520252 | 6   | IAC GROUND SHORT        | IAC Ground Short                       | GM                |             |
| 520260 | 0   | MEGAJECTOR PRESSR HI    | Megajector Pressure High               | GM                |             |
| 520260 | 1   | MEGAJECTOR PRESSR LO    | Megajector Pressure Low                | GM                |             |
| 520260 | 3   | MEGAJECTOR VOLTS HI     | Megajector Voltage Supply High         | GM                |             |
| 520260 | 4   | MEGAJECTOR VOLTS LOW    | Megajector Voltage Supply Low          | GM                |             |
| 520260 | 12  | MEGAJECTOR INTERNL FLT  | Megajector Internal Fault              | GM                |             |
| 520260 | 31  | MEGAJECTOR COMM LOSS    | Megajector Communications Lost         | GM                |             |
| 520270 | 31  | GOV1/2/3 INTERLOCK FL   | Governor 1 or 2 or 3 Interlock Failure | GM                |             |
| 520401 | 0   | HIGH FUEL IMPURITY      | High Fuel Impurity                     | GM                |             |

| SPN    | FMI | Text Displayed        | Description                                                                                                      | ECU Configuration | Yanmar Code |
|--------|-----|-----------------------|------------------------------------------------------------------------------------------------------------------|-------------------|-------------|
| 520555 | -1  | UEGO INRC             | Diagnostic Trouble Code                                                                                          |                   |             |
| 520556 | -1  | EXH GAS SENSR 2       | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating EXH Gas Sensor 2                   |                   |             |
| 520700 | -1  | TSC1 MESSAGE          | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating TSC1 Message                       |                   |             |
| 520707 | -1  | DIAG TOOL CAN NETWK 1 | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Diagnostic Tool CAN Bus Network #1 |                   |             |
| 520708 | -1  | OHECS MESSAGE         | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating OHECS Message                      |                   |             |
| 520709 | -1  | GTACP MESSAGE         | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating GTACP Message                      |                   |             |
| 520710 | -1  | GC2 MESSAGE           | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating GC2 Message                        |                   |             |
| 520711 | -1  | EBC1 MESSAGE          | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating EBC1 Message                       |                   |             |
| 520712 | -1  | ACS MESSAGE           | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating ACS Message                        |                   |             |
| 520713 | -1  | INTER ECU COMM MSG    | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Inter ECU Comm Msg                 |                   |             |
| 520714 | -1  | CCVS MESSAGE          | Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating CCVS Message                       |                   |             |
| 520800 | 7   | INTK CAM POSITION ERR | Intake Cam Position Error                                                                                        | GM                |             |
| 520801 | 7   | EXH CAM POSITION ERR  | Exhaust Cam Position Error                                                                                       | GM                |             |
| 520803 | 31  | MEGAJECTOR FAILURE    | Megajector Failure                                                                                               | GM                |             |
| 520837 | 1   | STARTER SPEED LO LO   | ECU trouble code metering indicates Starter Speed is below the LOW LOW threshold                                 |                   |             |
| 520838 | 1   | RUN UP SPEED LO LO    | ECU trouble code metering indicates Runup Speed is below the LOW LOW threshold                                   |                   |             |
| 522192 | 12  | MTU ENGINE ECU BAD    | ECU trouble code metering indicates component failure of the MTU engine control ECU                              |                   |             |
| 522243 | 5   | ENGINE START RELAY    | Engine Start Relay                                                                                               | Yanmar            | P0543       |
| 522243 | 6   | ENGINE START RELAY    | Engine Start Relay                                                                                               | Yanmar            | P0541       |
| 522323 | 0   | AIR CLEANER SWITCH    | Air Cleaner Switch                                                                                               | Yanmar            | P1101       |
| 522329 | 0   | OIL/WATER SEPARATOR   | Oil/Water Separator Device                                                                                       | Yanmar            | P1151       |
| 522400 | 2   | CRANKSHAFT SENSOR     | Crankshaft Sensor                                                                                                | Yanmar            | P0336       |
| 522400 | 5   | CRANKSHAFT SENSOR     | Crankshaft Sensor                                                                                                | Yanmar            | P0337       |
| 522401 | 2   | CAMSHAFT SENSOR       | Camshaft Sensor                                                                                                  | Yanmar            | P0341       |
| 522401 | 5   | CAMSHAFT SENSOR       | Camshaft Sensor                                                                                                  | Yanmar            | P0342       |
| 522401 | 7   | CAMSHAFT SENSOR       | Camshaft Sensor                                                                                                  | Yanmar            | P1341       |
| 522571 | 3   | SCV (MPROP)           | Proprietary YANMAR Diagnostic Trouble Codes.                                                                     | Yanmar            | P1641       |
| 522571 | 6   | SCV (MPROP)           | Proprietary YANMAR Diagnostic Trouble Codes.                                                                     | Yanmar            | P1643       |
| 522572 | 6   | SCV (MPROP)           | Proprietary YANMAR Diagnostic Trouble Codes.                                                                     | Yanmar            | P062A       |
| 522572 | 11  | SCV (MPROP)           | Proprietary YANMAR Diagnostic Trouble Codes.                                                                     | Yanmar            | P1645       |
| 522573 | 0   | DPF                   | Abbreviation for Diesel Particulate Filter                                                                       | Yanmar            | P2463       |
| 522574 | 0   | DPF                   | Abbreviation for Diesel Particulate Filter                                                                       | Yanmar            | P1463       |
| 522575 | 7   | DPF                   | Abbreviation for Diesel Particulate Filter                                                                       | Yanmar            | P2458       |
| 522576 | 12  | EE PROM               | EEPROM memory inside the engine ECU.                                                                             | Yanmar            | P160E       |
| 522577 | 11  | DPF                   | Abbreviation for Diesel Particulate Filter                                                                       | Yanmar            | P2459       |
| 522578 | 12  | EE PROM               | EEPROM memory inside the engine ECU.                                                                             | Yanmar            | P160F       |
| 522579 | 12  | EGR VALVE MALFUNCTN   | Exhaust Gas Recirculation (EGR) Malfunction                                                                      | Yanmar            | P1405       |
| 522580 | 12  | EGR VALVE MALFUNCTN   | Exhaust Gas Recirculation (EGR) Malfunction                                                                      | Yanmar            | P0488       |
| 522581 | 7   | EGR VALVE MALFUNCTN   | Exhaust Gas Recirculation (EGR) Malfunction                                                                      | Yanmar            | P148A       |
| 522582 | 7   | EGR VALVE MALFUNCTN   | Exhaust Gas Recirculation (EGR) Malfunction                                                                      | Yanmar            | P049D       |

| SPN    | FMI | Text Displayed       | Description                                                                              | ECU Configuration | Yanmar Code |
|--------|-----|----------------------|------------------------------------------------------------------------------------------|-------------------|-------------|
| 522583 | 1   | EGR VALVE MALFUNCTN  | Exhaust Gas Recirculation (EGR) Malfunction                                              | Yanmar            | P1410       |
| 522584 | 1   | EGR VALVE MALFUNCTN  | Exhaust Gas Recirculation (EGR) Malfunction                                              | Yanmar            | P1411       |
| 522585 | 12  | ECU INTERNAL ERROR   | ECU Internal Error                                                                       | Yanmar            | P1613       |
| 522588 | 12  | ECU INTERNAL ERROR   | ECU Internal Error                                                                       | Yanmar            | P1608       |
| 522589 | 12  | ECU INTERNAL ERROR   | ECU Internal Error                                                                       | Yanmar            | P1617       |
| 522590 | 12  | ECU INTERNAL ERROR   | ECU Internal Error                                                                       | Yanmar            | P1609       |
| 522591 | 12  | ECU INTERNAL ERROR   | ECU Internal Error                                                                       | Yanmar            | P1618       |
| 522592 | 12  | ECU INTERNAL ERROR   | ECU Internal Error                                                                       | Yanmar            | P1619       |
| 522596 | 9   | CAN 2                | CAN Bus 2                                                                                | Yanmar            | P40000292   |
| 522597 | 9   | CAN 2                | CAN Bus 2                                                                                | Yanmar            | P40001301   |
| 522599 | 9   | CAN 2                | CAN Bus 2                                                                                | Yanmar            | P40001292   |
| 522600 | 9   | CAN 2                | CAN Bus 2                                                                                | Yanmar            | P40001293   |
| 522601 | 9   | CAN 2                | CAN Bus 2                                                                                | Yanmar            | P40001294   |
| 522603 | 9   | CAN 2                | CAN Bus 2                                                                                | Yanmar            | P40001296   |
| 522605 | 9   | CAN 2                | CAN Bus 2                                                                                | Yanmar            | P40001298   |
| 522609 | 9   | CAN 2                | CAN Bus 2                                                                                | Yanmar            | P40001300   |
| 522610 | 9   | EGR VALVE MALFUNCTN  | Exhaust Gas Recirculation (EGR) Malfunction                                              | Yanmar            | P4000010B   |
| 522611 | 9   | EXHAUST THROTTLE     | Exhaust Throttle                                                                         | Yanmar            | P40001107   |
| 522617 | 12  | EGR VALVE MALFUNCTN  | Exhaust Gas Recirculation (EGR) Malfunction                                              | Yanmar            | P40001401   |
| 522618 | 9   | CAN 2                | CAN Bus 2                                                                                | Yanmar            | P40001302   |
| 522619 | 9   | CAN 2                | CAN Bus 2                                                                                | Yanmar            | P40001303   |
| 522623 | 7   | ACCELERTN SNSR 1 / 2 | Acceleration Sensor 1 or Acceleration Sensor 2                                           | Yanmar            | P1647       |
| 522624 | 7   | ACCELERTN SNSR 1 / 2 | Acceleration Sensor 1 or Acceleration Sensor 2                                           | Yanmar            | P1646       |
| 522744 | 4   | ECU INTERNAL ERROR   | ECU Internal Error                                                                       | Yanmar            | P1626       |
| 522746 | 12  | EXHAUST THROTTLE     | Exhaust Throttle                                                                         | Yanmar            | P1438       |
| 522747 | 12  | EXHAUST THROTTLE     | Exhaust Throttle                                                                         | Yanmar            | P1439       |
| 522748 | 12  | EXHAUST THROTTLE     | Exhaust Throttle                                                                         | Yanmar            | P1440       |
| 522749 | 12  | EXHAUST THROTTLE     | Exhaust Throttle                                                                         | Yanmar            | P1441       |
| 522750 | 12  | EXHAUST THROTTLE     | Exhaust Throttle                                                                         | Yanmar            | P1442       |
| 522751 | 19  | EXHAUST THROTTLE     | Exhaust Throttle                                                                         | Yanmar            | P1443       |
| 522994 | 4   | ECU INTERNAL ERROR   | ECU Internal Error                                                                       | Yanmar            | P1633       |
| 523212 | -1  | ENGPRT CAN MSG       | CAN Bus Message                                                                          |                   |             |
| 523216 | -1  | PREHTENCMD CAN MSG   | CAN Bus Message                                                                          |                   |             |
| 523218 | -1  | RxCCVS CAN MSG       | CAN Bus Message                                                                          |                   |             |
| 523222 | -1  | TC01 CAN MSG         | CAN Bus Message                                                                          |                   |             |
| 523238 | -1  | SWTOUT CAN MSG       | CAN Bus Message                                                                          |                   |             |
| 523239 | -1  | DECV1 CAN MSG        | CAN Bus Message                                                                          |                   |             |
| 523240 | -1  | FUNMODCTL CAN MSG    | CAN Bus Message                                                                          |                   |             |
| 523249 | 5   | CRANK/CAM SENSOR     | Crankshaft Sensor or the Camshaft sensor as the component to which a fault code applies. | Yanmar            | P0008       |
| 523350 | -1  | CYL BANK 1 INJECTORS | Cylinder Bank 1 Injectors                                                                |                   |             |
| 523351 | -1  | CYL BANK 1 INJECTORS | Cylinder Bank 1 Injectors                                                                |                   |             |
| 523352 | -1  | CYL BANK 2 INJECTORS | Cylinder Bank 2 Injectors                                                                |                   |             |

| SPN    | FMI | Text Displayed        | Description                                  | ECU Configuration | Yanmar Code |
|--------|-----|-----------------------|----------------------------------------------|-------------------|-------------|
| 523353 | -1  | CYL BANK 2 INJECTORS  | Cylinder Bank 2 Injectors                    |                   |             |
| 523354 | -1  | ECU ERROR             | Diagnostic Trouble Code Indicating ECU Error |                   |             |
| 523355 | -1  | ECU ERROR             | Diagnostic Trouble Code Indicating ECU Error |                   |             |
| 523370 | -1  | RAIL PRESSURE         | Rail Pressure                                |                   |             |
| 523420 | -1  | ECU ERROR             | Diagnostic Trouble Code Indicating ECU Error |                   |             |
| 523450 | -1  | MULTI STATE SWITCH 1  | Multi State Switch 1                         |                   |             |
| 523451 | -1  | MULTI STATE SWITCH 2  | Multi State Switch 2                         |                   |             |
| 523452 | -1  | MULTI STATE SWITCH 3  | Multi State Switch 3                         |                   |             |
| 523460 | 7   | RAIL PRESSURE SENSOR  | Fuel Rail Pressure Sensor                    | Yanmar            | P1670       |
| 523462 | 13  | QR DATA               | YANMAR specific                              | Yanmar            | P1648       |
| 523463 | 13  | QR DATA               | YANMAR specific                              | Yanmar            | P1649       |
| 523464 | 13  | QR DATA               | YANMAR specific                              | Yanmar            | P1650       |
| 523465 | 13  | QR DATA               | YANMAR specific                              | Yanmar            | P1651       |
| 523468 | 9   | RAIL PRESSURE SENSOR  | Fuel Rail Pressure Sensor                    | Yanmar            | P1665       |
| 523469 | 0   | RAIL PRESSURE SENSOR  | Fuel Rail Pressure Sensor                    | Yanmar            | P1666       |
| 523470 | 0   | RAIL PRESSURE SENSOR  | Fuel Rail Pressure Sensor                    | Yanmar            | P1667       |
| 523470 | -1  | RAIL PRESSURE LMT VLV | Rail Pressure Limit Valve                    |                   |             |
| 523471 | 6   | ECU INTERNAL ERROR    | ECU Internal Error                           | Yanmar            | P1467       |
| 523473 | 12  | ECU INTERNAL ERROR    | ECU Internal Error                           | Yanmar            | P1469       |
| 523474 | 12  | ECU INTERNAL ERROR    | ECU Internal Error                           | Yanmar            | P1470       |
| 523475 | 12  | ECU INTERNAL ERROR    | ECU Internal Error                           | Yanmar            | P1471       |
| 523476 | 12  | ECU INTERNAL ERROR    | ECU Internal Error                           | Yanmar            | P1472       |
| 523477 | 12  | ECU INTERNAL ERROR    | ECU Internal Error                           | Yanmar            | P1473       |
| 523478 | 12  | ECU INTERNAL ERROR    | ECU Internal Error                           | Yanmar            | P1474       |
| 523479 | 12  | ECU INTERNAL ERROR    | ECU Internal Error                           | Yanmar            | P1475       |
| 523480 | 12  | ECU INTERNAL ERROR    | ECU Internal Error                           | Yanmar            | P1476       |
| 523481 | 12  | ECU INTERNAL ERROR    | ECU Internal Error                           | Yanmar            | P1477       |
| 523482 | 12  | ECU INTERNAL ERROR    | ECU Internal Error                           | Yanmar            | P1478       |
| 523483 | 12  | ECU INTERNAL ERROR    | ECU Internal Error                           | Yanmar            | P1479       |
| 523484 | 12  | ECU INTERNAL ERROR    | ECU Internal Error                           | Yanmar            | P1480       |
| 523485 | 12  | ECU INTERNAL ERROR    | ECU Internal Error                           | Yanmar            | P1481       |
| 523486 | 12  | ECU INTERNAL ERROR    | ECU Internal Error                           | Yanmar            | P1482       |
| 523487 | 12  | ECU INTERNAL ERROR    | ECU Internal Error                           | Yanmar            | P1483       |
| 523488 | 0   | ECU INTERNAL ERROR    | ECU Internal Error                           | Yanmar            | P1484       |
| 523489 | 0   | RAIL PRESSURE SENSOR  | Fuel Rail Pressure Sensor                    | Yanmar            | P1668       |
| 523490 | -1  | ECU ERROR             | Diagnostic Trouble Code Indicating ECU Error |                   |             |
| 523491 | 0   | RAIL PRESSURE SENSOR  | Fuel Rail Pressure Sensor                    | Yanmar            | P1669       |
| 523500 | -1  | CAN MSG TIMEOUT       | Can Message Timeout has occurred.            |                   |             |
| 523550 | -1  | ECU ERROR             | Diagnostic Trouble Code Indicating ECU Error |                   |             |
| 523561 | -1  | INJECTN PERIOD CYL 1  | Single Cylinder Injection Period             |                   |             |
| 523562 | -1  | INJECTN PERIOD CYL 2  | Single Cylinder Injection Period             |                   |             |
| 523563 | -1  | INJECTN PERIOD CYL 3  | Single Cylinder Injection Period             |                   |             |

| SPN    | FMI | Text Displayed       | Description                                  | ECU Configuration | Yanmar Code |
|--------|-----|----------------------|----------------------------------------------|-------------------|-------------|
| 523564 | -1  | INJECTN PERIOD CYL 4 | Single Cylinder Injection Period             |                   |             |
| 523565 | -1  | INJECTN PERIOD CYL 5 | Single Cylinder Injection Period             |                   |             |
| 523566 | -1  | INJECTN PERIOD CYL 6 | Single Cylinder Injection Period             |                   |             |
| 523567 | -1  | INJECTN PERIOD CYL 7 | Single Cylinder Injection Period             |                   |             |
| 523568 | -1  | INJECTN PERIOD CYL 8 | Single Cylinder Injection Period             |                   |             |
| 523600 | -1  | ECU ERROR            | Diagnostic Trouble Code Indicating ECU Error |                   |             |
| 523601 | -1  | ECU ERROR            | Diagnostic Trouble Code Indicating ECU Error |                   |             |
| 523602 | -1  | FAN SPEED            | Engine Fan Speed                             |                   |             |
| 523604 | -1  | RXENGTMP CAN MSG     | CAN Bus Message                              |                   |             |
| 523605 | -1  | TSC1-AE MSG MISSING  | CAN Bus Message                              |                   |             |
| 523606 | -1  | TSC1-AR MSG MISSING  | CAN Bus Message                              |                   |             |
| 523607 | -1  | TSC1-DE MSG MISSING  | CAN Bus Message                              |                   |             |
| 523608 | -1  | TSC1-DR MSG MISSING  | CAN Bus Message                              |                   |             |
| 523609 | -1  | TSC1-PE MSG MISSING  | CAN Bus Message                              |                   |             |
| 523610 | -1  | TSC1-VE MSG MISSING  | CAN Bus Message                              |                   |             |
| 523611 | -1  | TSC1-VR MSG MISSING  | CAN Bus Message                              |                   |             |
| 523612 | -1  | ECU ERROR            | Diagnostic Trouble Code Indicating ECU Error |                   |             |
| 523613 | -1  | RAIL PRESSURE        | Rail Pressure                                |                   |             |
| 523615 | -1  | METERING UNIT VALVE  | Metering Unit Valve                          |                   |             |
| 523617 | -1  | ECU ERROR            | Diagnostic Trouble Code Indicating ECU Error |                   |             |

# G • J1939 Parameters Received

Table G-1 lists parameters the DGC-2020 receives over CAN Bus.

**Table G-1. J1939 Parameters Received over CAN Bus Interface**

|                                           |                         |                 |              |         |                            |         |                          |  |
|-------------------------------------------|-------------------------|-----------------|--------------|---------|----------------------------|---------|--------------------------|--|
| <b>Electronic Engine Controller 2</b>     | <b>PGN 0xF003 61443</b> | <b>Standard</b> |              |         |                            |         |                          |  |
| J1939 Parameter Name                      | SPN                     | Byte Position   | Bit Position | Length  | Scale Factor               | Offset  | Data Range               |  |
| Accelerator Pedal Position                | 91                      | 2               | 2.1          | 1 Byte  | 0.4 % per bit              | 0 %     | 0 to 100 %               |  |
| Percent Load at Current Speed             | 92                      | 3               | 3.1          | 1 Byte  | 1 % per bit                | 0 %     | 0 to 250 %               |  |
|                                           |                         |                 |              |         |                            |         |                          |  |
| <b>Electronic Engine Controller 1</b>     | <b>PGN 0xF004 61444</b> | <b>Standard</b> |              |         |                            |         |                          |  |
| J1939 Parameter Name                      | SPN                     | Byte Position   | Bit Position | Length  | Scale Factor               | Offset  | Data Range               |  |
| Engine Percent Torque                     | 513                     | 3               | 3.1          | 1 byte  | 1 % per bit                | -125 %  | -125 to 125 %            |  |
| Engine Speed (Engine RPM)                 | 190                     | 4-5             | 4.1          | 2 bytes | 0.125 rpm per bit          | 0 rpm   | 0 to 8 031.875 rpm       |  |
|                                           |                         |                 |              |         |                            |         |                          |  |
| <b>Engine Configuration 1</b>             | <b>PGN 0xFEE3 65251</b> | <b>Standard</b> |              |         |                            |         |                          |  |
| J1939 Parameter Name                      | SPN                     | Byte Position   | Bit Position | Length  | Scale Factor               | Offset  | Data Range               |  |
| Engine Speed at Idle, Point 1             | 188                     | 01-02           | 1.1          | 2 bytes | 0.125 rpm per bit          | 0 rpm   | 0 to 8 031.875 rpm       |  |
| Engine Percent Torque at Idle, Point 1    | 539                     | 03              | 3.1          | 1 byte  | 1 % per bit                | -125 %  | -125 to 125 %            |  |
| Engine Speed at Point 2                   | 528                     | 04-05           | 4.1          | 2 bytes | 0.125 rpm per bit          | 0 rpm   | 0 to 8 031.875 rpm       |  |
| Engine Percent Torque at Point 2          | 540                     | 06              | 6.1          | 1 byte  | 1 % per bit                | -125 %  | -125 to 125 %            |  |
| Engine Speed at Point 3                   | 529                     | 07-08           | 7.1          | 2 bytes | 0.125 rpm per bit          | 0 rpm   | 0 to 8 031.875 rpm       |  |
| Engine Percent Torque at Point 3          | 541                     | 09              | 9.1          | 1 byte  | 1 % per bit                | -125 %  | -125 to 125 %            |  |
| Engine Speed at Point 4                   | 530                     | 10-11           | 10.1         | 2 bytes | 0.125 rpm per bit          | 0 rpm   | 0 to 8 031.875 rpm       |  |
| Engine Percent Torque at Point 4          | 542                     | 12              | 12.1         | 1 byte  | 1 % per bit                | -125 %  | -125 to 125 %            |  |
| Engine Speed at Point 5                   | 531                     | 13-14           | 13.1         | 2 bytes | 0.125 rpm per bit          | 0 rpm   | 0 to 8 031.875 rpm       |  |
| Engine Percent Torque at Point 5          | 543                     | 15              | 15.1         | 1 byte  | 1 % per bit                | -125 %  | -125 to 125 %            |  |
| Engine Speed at High Idle, Point 6        | 532                     | 16-17           | 16.1         | 2 bytes | 0.125 rpm per bit          | 0 rpm   | 0 to 8 031.875 rpm       |  |
| Engine Gain (kp) of the Endspped Governor | 545                     | 18-19           | 18.1         | 2 bytes | 0.000 781 25 %/rpm per bit | 0 %/rpm | 0 to 50.199 218 75 %/rpm |  |
| Engine Reference Torque                   | 544                     | 20-21           | 20.1         | 2 bytes | 1 Nm per bit               | 0 Nm    | 0 to 64 255 Nm           |  |

|                                                   |                         |                 |              |         |                     |         |                            |  |
|---------------------------------------------------|-------------------------|-----------------|--------------|---------|---------------------|---------|----------------------------|--|
| Engine Maximum Momentary Override Speed, Point 7  | 533                     | 22-23           | 22.1         | 2 bytes | 0.125 rpm per bit   | 0 rpm   | 0 to 8 031.875 rpm         |  |
| Engine Maximum Momentary Override Time Limit      | 534                     | 24              | 24.1         | 1 byte  | 0.1 s per bit       | 0 s     | 0 to 25 s                  |  |
| Engine Requested Speed Control Range Lower Limit  | 535                     | 25              | 25.1         | 1 byte  | 10 rpm per bit      | 0 rpm   | 0 to 2 500 rpm             |  |
| Engine Requested Speed Control Range Upper Limit  | 536                     | 26              | 26.1         | 1 byte  | 10 rpm per bit      | 0 rpm   | 0 to 2 500 rpm             |  |
| Engine Requested Torque Control Range Lower Limit | 537                     | 27              | 27.1         | 1 byte  | 1 % per bit         | -125 %  | -125 to 125 %              |  |
| Engine Requested Torque Control Range Upper Limit | 538                     | 28              | 28.1         | 1 byte  | 1 % per bit         | -125 %  | -125 to 125 %              |  |
|                                                   |                         |                 |              |         |                     |         |                            |  |
| <b>Engine Hours, Revolutions</b>                  | <b>PGN 0xFEE5 65253</b> | <b>Standard</b> |              |         |                     |         |                            |  |
| J1939 Parameter Name                              | SPN                     | Byte Position   | Bit Position | Length  | Scale Factor        | Offset  | Data Range                 |  |
| Engine Total Hours of Operation                   | 247                     | 1-4             | 1.1          | 4 bytes | 0.05 h per bit      | 0 h     | 0 to 210 554 060.75 h      |  |
|                                                   |                         |                 |              |         |                     |         |                            |  |
| <b>Fuel Consumption (Liquid) 1</b>                | <b>PGN 0xFEE9 65257</b> | <b>Standard</b> |              |         |                     |         |                            |  |
| J1939 Parameter Name                              | SPN                     | Byte Position   | Bit Position | Length  | Scale Factor        | Offset  | Data Range                 |  |
| Engine Trip Fuel                                  | 182                     | 1-4             | 1.1          | 4 bytes | 0.5 liter per bit   | 0 liter | 0 to 2 105 540 607.5 liter |  |
| Engine Total Fuel Used                            | 250                     | 5-8             | 5.1          | 4 bytes | 0.5 liter per bit   | 0 liter | 0 to 2 105 540 607.5 liter |  |
|                                                   |                         |                 |              |         |                     |         |                            |  |
| <b>Engine Temperature 1</b>                       | <b>PGN 0xFEEE 65262</b> | <b>Standard</b> |              |         |                     |         |                            |  |
| J1939 Parameter Name                              | SPN                     | Byte Position   | Bit Position | Length  | Scale Factor        | Offset  | Data Range                 |  |
| Engine Coolant Temperature                        | 110                     | 1               | 1.1          | 1 byte  | 1 °C per bit        | -40 °C  | -40 to 210 °C              |  |
| Engine Fuel 1 Temperature 1                       | 174                     | 2               | 2.1          | 1 byte  | 1 °C per bit        | -40 °C  | -40 to 210 °C              |  |
| Engine Oil Temperature 1                          | 175                     | 3-4             | 3.1          | 2 bytes | 0.031 25 °C per bit | -273 °C | -273 to 1 734.968 75 °C    |  |
| Engine Intercooler Temperature                    | 52                      | 7               | 7.1          | 1 byte  | 1 °C per bit        | -40 °C  | -40 to 210 °C              |  |
|                                                   |                         |                 |              |         |                     |         |                            |  |
| <b>Engine Fluid Level/Pressure 1</b>              | <b>PGN 0xFEEF 65263</b> | <b>Standard</b> |              |         |                     |         |                            |  |
| J1939 Parameter Name                              | SPN                     | Byte Position   | Bit Position | Length  | Scale Factor        | Offset  | Data Range                 |  |



|                                                 |                         |                 |              |         |                            |          |                           |  |
|-------------------------------------------------|-------------------------|-----------------|--------------|---------|----------------------------|----------|---------------------------|--|
| Engine Fuel Delivery Pressure                   | 94                      | 1               | 1.1          | 1 byte  | 4 kPa per bit              | 0 kPa    | 0 to 1 000 kPa            |  |
| Engine Oil Level                                | 98                      | 3               | 3.1          | 1 byte  | 0.4 % per bit              | 0 %      | 0 to 100 %                |  |
| Engine Oil Pressure 1                           | 100                     | 4               | 4.1          | 1 byte  | 4 kPa per bit              | 0 kPa    | 0 to 1 000 kPa            |  |
| Engine Crankcase Pressure 1                     | 101                     | 5-6             | 5.1          | 2 bytes | 0.007 812 5 kPa per bit    | -250 kPa | -250 to 251.992 187 5 kPa |  |
| Engine Coolant Pressure 1                       | 109                     | 7               | 7.1          | 1 byte  | 2 kPa per bit              | 0 kPa    | 0 to 500 kPa              |  |
| Engine Coolant Level 1                          | 111                     | 8               | 8.1          | 1 byte  | 0.4 % per bit              | 0 %      | 0 to 100 %                |  |
|                                                 |                         |                 |              |         |                            |          |                           |  |
| <b>Engine Fluid Level/Pressure 2</b>            | <b>PGN 0xFEDB 65243</b> | <b>Standard</b> |              |         |                            |          |                           |  |
| J1939 Parameter Name                            | SPN                     | Byte Position   | Bit Position | Length  | Scale Factor               | Offset   | Data Range                |  |
| Engine Fuel Injection Control Pressure          | 164                     | 1-2             | 1.1          | 2 bytes | 0.003 906 25 MPa per bit   | 0 MPa    | 0 to 250.996 093 75 MPa   |  |
| Engine Fuel 1 Injector Metering Rail 1 Pressure | 157                     | 3-4             | 3.1          | 2 bytes | 0.003 906 25 MPa per bit   | 0 MPa    | 0 to 250.996 093 75 MPa   |  |
|                                                 |                         |                 |              |         |                            |          |                           |  |
| <b>Fuel Economy (Liquid)</b>                    | <b>PGN 0xFEFE 65266</b> | <b>Standard</b> |              |         |                            |          |                           |  |
| J1939 Parameter Name                            | SPN                     | Byte Position   | Bit Position | Length  | Scale Factor               | Offset   | Data Range                |  |
| Engine Fuel Rate                                | 183                     | 1-2             | 1.1          | 2 bytes | 0.05 l/h per bit           | 0 l/h    | 0 to 3 212.75 l/h         |  |
| Engine Instantaneous Fuel Economy               | 184                     | 3-4             | 3.1          | 2 bytes | 0.001 953 125 km/L per bit | 0 km/L   | 0 to 125.498 046 875 km/L |  |
| Engine Average Fuel Economy                     | 185                     | 5-6             | 5.1          | 2 bytes | 0.001 953 125 km/L per bit | 0 km/L   | 0 to 125.498 046 875 km/L |  |
|                                                 |                         |                 |              |         |                            |          |                           |  |
| <b>Ambient Conditions</b>                       | <b>PGN 0xFEFE 65269</b> | <b>Standard</b> |              |         |                            |          |                           |  |
| J1939 Parameter Name                            | SPN                     | Byte Position   | Bit Position | Length  | Scale Factor               | Offset   | Data Range                |  |
| Barometric Pressure                             | 108                     | 1               | 1.1          | 1 byte  | 0.5 kPa per bit            | 0 kPa    | 0 to 125 kPa              |  |
| Ambient Air Temperature                         | 171                     | 4-5             | 4.1          | 2 bytes | 0.031 25 °C per bit        | -273 °C  | -273 to 1 734.968 75 °C   |  |
| Engine Intake 1 Air Temperature                 | 172                     | 6               | 6.1          | 1 byte  | 1 °C per bit               | -40 °C   | -40 to 210 °C             |  |
|                                                 |                         |                 |              |         |                            |          |                           |  |
| <b>Intake/Exhaust Conditions 1</b>              | <b>PGN 0xFEFE 65270</b> | <b>Standard</b> |              |         |                            |          |                           |  |
| J1939 Parameter Name                            | SPN                     | Byte Position   | Bit Position | Length  | Scale Factor               | Offset   | Data Range                |  |
| Engine Intake Manifold #1 Pressure              | 102                     | 2               | 2.1          | 1 byte  | 2 kPa per bit              | 0 kPa    | 0 to 500 kPa              |  |
| Engine Intake Manifold 1 Temperature            | 105                     | 3               | 3.1          | 1 byte  | 1 °C per bit               | -40 °C   | -40 to 210 °C             |  |
| Engine Air Filter 1 Differential Pressure       | 107                     | 5               | 5.1          | 1 byte  | 0.05 kPa per bit           | 0 kPa    | 0 to 12.5 kPa             |  |
| Engine Exhaust Temperature                      | 173                     | 6-7             | 6.1          | 2 bytes | 0.031 25 °C per bit        | -273 °C  | -273 to 1 734.968 75 °C   |  |

|                                         |                         |                 |              |         |                     |         |                         |                                                                                  |
|-----------------------------------------|-------------------------|-----------------|--------------|---------|---------------------|---------|-------------------------|----------------------------------------------------------------------------------|
| <b>Vehicle Electrical Power 1</b>       | <b>PGN 0xFE7 65271</b>  | <b>Standard</b> |              |         |                     |         |                         |                                                                                  |
| J1939 Parameter Name                    | SPN                     | Byte Position   | Bit Position | Length  | Scale Factor        | Offset  | Data Range              |                                                                                  |
| Battery Potential / Power Input 1       | 168                     | 5-6             | 5.1          | 2 bytes | 0.05 V per bit      | 0 V     | 0 to 3 212.75 V         |                                                                                  |
| Key Switch Battery Potential            | 158                     | 7-8             | 7.1          | 2 bytes | 0.05 V per bit      | 0 V     | 0 to 3 212.75 V         |                                                                                  |
|                                         |                         |                 |              |         |                     |         |                         |                                                                                  |
| <b>Transmission Fluids 1</b>            | <b>PGN 0xFE8 65272</b>  | <b>Standard</b> |              |         |                     |         |                         |                                                                                  |
| J1939 Parameter Name                    | SPN                     | Byte Position   | Bit Position | Length  | Scale Factor        | Offset  | Data Range              |                                                                                  |
| Transmission 1 Oil Pressure             | 127                     | 4               | 4.1          | 1 byte  | 16 kPa per bit      | 0 kPa   | 0 to 4 000 kPa          |                                                                                  |
| Transmission Oil Temperature 1          | 177                     | 5-6             | 5.1          | 2 bytes | 0.031 25 °C per bit | -273 °C | -273 to 1 734.968 75 °C |                                                                                  |
|                                         |                         |                 |              |         |                     |         |                         |                                                                                  |
| <b>Alternator Temperature 1</b>         | <b>PGN 0xFE9 65191</b>  | <b>Standard</b> |              |         |                     |         |                         |                                                                                  |
| J1939 Parameter Name                    | SPN                     | Byte Position   | Bit Position | Length  | Scale Factor        | Offset  | Data Range              |                                                                                  |
| Engine Alternator Winding 1 Temperature | 1124                    | 3               | 3.1          | 1 byte  | 1 °C per bit        | -40 °C  | -40 to 210 °C           |                                                                                  |
| Engine Alternator Winding 2 Temperature | 1125                    | 4               | 4.1          | 1 byte  | 1 °C per bit        | -40 °C  | -40 to 210 °C           |                                                                                  |
| Engine Alternator Winding 3 Temperature | 1126                    | 5               | 5.1          | 1 byte  | 1 °C per bit        | -40 °C  | -40 to 210 °C           |                                                                                  |
|                                         |                         |                 |              |         |                     |         |                         |                                                                                  |
| <b>Engine Temperature 2</b>             | <b>PGN 0xFE4 65188</b>  | <b>Standard</b> |              |         |                     |         |                         |                                                                                  |
| J1939 Parameter Name                    | SPN                     | Byte Position   | Bit Position | Length  | Scale Factor        | Offset  | Data Range              |                                                                                  |
| Engine ECU Temperature                  | 1136                    | 3-4             | 3.1          | 2 bytes | 0.031 25 °C per bit | -273 °C | -273 to 1 734.968 75 °C |                                                                                  |
|                                         |                         |                 |              |         |                     |         |                         |                                                                                  |
| <b>Fuel Leakage</b>                     | <b>PGN 0xFE91 65169</b> | <b>Standard</b> |              |         |                     |         |                         |                                                                                  |
| J1939 Parameter Name                    | SPN                     | Byte Position   | Bit Position | Length  | Scale Factor        | Offset  | Data Range              |                                                                                  |
| Engine Fuel Leakage 1                   | 1239                    | 1.1             | 1.1          | 2 bits  | 4 states            | 0       | 0 to 3                  | 00b = no leakage detected 01b = leakage detected 10b = Error 11b = Not available |
| Engine Fuel Leakage 2                   | 1240                    | 1.3             | 1.3          | 2 bits  | 4 states            | 0       | 0 to 3                  | 00b = no leakage detected 01b = leakage detected 10b = Error 11b = Not available |
|                                         |                         |                 |              |         |                     |         |                         |                                                                                  |
| <b>Auxiliary Analog Information</b>     | <b>PGN 0xFE8C 65164</b> | <b>Standard</b> |              |         |                     |         |                         |                                                                                  |

| J1939<br>Parameter<br>Name                                      | SPN                             | Byte<br>Position                | Bit<br>Position | Length  | Scale<br>Factor        | Offset  | Data<br>Range              |                                                                                                   |
|-----------------------------------------------------------------|---------------------------------|---------------------------------|-----------------|---------|------------------------|---------|----------------------------|---------------------------------------------------------------------------------------------------|
| Auxiliary<br>Pressure #1                                        | 1387                            | 3                               | 3.1             | 1 byte  | 16 kPa per bit         | 0 kPa   | 0 to 4 000 kPa             |                                                                                                   |
| Auxiliary<br>Pressure #2                                        | 1388                            | 4                               | 4.1             | 1 byte  | 16 kPa per bit         | 0 kPa   | 0 to 4 000 kPa             |                                                                                                   |
|                                                                 |                                 |                                 |                 |         |                        |         |                            |                                                                                                   |
| <b>Electronic<br/>Engine<br/>Controller 4</b>                   | <b>PGN<br/>0xFE0E<br/>65214</b> | <b>Standard</b>                 |                 |         |                        |         |                            |                                                                                                   |
| J1939<br>Parameter<br>Name                                      | SPN                             | Byte<br>Position                | Bit<br>Position | Length  | Scale<br>Factor        | Offset  | Data<br>Range              |                                                                                                   |
| Engine Rated<br>Power                                           | 166                             | 1-2                             | 1.1             | 2 bytes | 0.5 kW per bit         | 0 kW    | 0 to 32 127.5 kW           |                                                                                                   |
| Engine Rated<br>Speed                                           | 189                             | 3-4                             | 3.1             | 2 bytes | 0.125 rpm per bit      | 0 rpm   | 0 to 8 031.875 rpm         |                                                                                                   |
|                                                                 |                                 |                                 |                 |         |                        |         |                            |                                                                                                   |
| <b>Exhaust<br/>Temperature</b>                                  | <b>PGN<br/>0xFE07<br/>65031</b> | <b>Standard</b>                 |                 |         |                        |         |                            |                                                                                                   |
| J1939<br>Parameter<br>Name                                      | SPN                             | Byte<br>Position                | Bit<br>Position | Length  | Scale<br>Factor        | Offset  | Data<br>Range              |                                                                                                   |
| Engine Exhaust<br>Manifold Bank 2<br>Temperature 1              | 2433                            | 1-2                             | 1.1             | 2 bytes | 0.031 25 °C per<br>bit | -273 °C | -273 to 1 734.968<br>75 °C |                                                                                                   |
| Engine Exhaust<br>Manifold Bank 1<br>Temperature 1              | 2434                            | 3-4                             | 3.1             | 2 bytes | 0.031 25 °C per<br>bit | -273 °C | -273 to 1 734.968<br>75 °C |                                                                                                   |
|                                                                 |                                 |                                 |                 |         |                        |         |                            |                                                                                                   |
| <b>Turbocharger<br/>Information 6</b>                           | <b>PGN<br/>0xFDD3<br/>64979</b> | <b>Standard</b>                 |                 |         |                        |         |                            |                                                                                                   |
| J1939<br>Parameter<br>Name                                      | SPN                             | Byte<br>Position                | Bit<br>Position | Length  | Scale<br>Factor        | Offset  | Data<br>Range              |                                                                                                   |
| Engine<br>Turbocharger 1<br>Compressor<br>Outlet<br>Temperature | 2629                            | 1-2                             | 1.1             | 2 bytes | 0.031 25 °C per<br>bit | -273 °C | -273 to 1 734.968<br>75 °C |                                                                                                   |
|                                                                 |                                 |                                 |                 |         |                        |         |                            |                                                                                                   |
| <b>Shutdown</b>                                                 | <b>PGN<br/>0xFEE4<br/>65252</b> | <b>Standard</b>                 |                 |         |                        |         |                            |                                                                                                   |
| J1939<br>Parameter<br>Name                                      | SPN                             | Byte<br>Position                | Bit<br>Position | Length  | Scale<br>Factor        | Offset  | Data<br>Range              |                                                                                                   |
| Engine Alarm<br>Acknowledge                                     | 2815                            | 7.1                             | 7.1             | 2 bits  | 4 states               | 0       | 0 to 3                     | 00b = Acknowledge<br>Not Active 01b =<br>Acknowledge Active<br>10b = Error 11b =<br>Not Available |
| Engine<br>Protection<br>System has<br>Shutdown<br>Engine        | 1110                            | 5.1                             | 5.1             | 2 bits  | 4 states               | 0       | 0 to 3                     | 00b = No 01b = Yes<br>10b = Error 11b =<br>Not available                                          |
| Engine Wait to<br>Start Lamp                                    | 1081                            | 4.1                             | 4.1             | 2 bits  | 4 states               | 0       | 0 to 3                     | 00b = Off 01b = On<br>10b = Error 11b =<br>Not available                                          |
|                                                                 |                                 |                                 |                 |         |                        |         |                            |                                                                                                   |
| <b>Parameter<br/>group number:<br/>65284 (0xFF04)</b>           | <b>PGN0xF<br/>F04<br/>65284</b> | <b>Proprietary MTU<br/>ADEC</b> |                 |         |                        |         |                            |                                                                                                   |
| J1939<br>Parameter<br>Name                                      | SPN                             | Byte<br>Position                | Bit<br>Position | Length  | Scale<br>Factor        | Offset  | Data<br>Range              |                                                                                                   |

|                                                |                         |                             |              |         |               |        |                    |  |
|------------------------------------------------|-------------------------|-----------------------------|--------------|---------|---------------|--------|--------------------|--|
| ECU error codes                                | N/A                     | 1                           | 1.1          | 2 bytes | 1 digit/bit   | 0      | 0 to 64255 digits  |  |
|                                                |                         |                             |              |         |               |        |                    |  |
| <b>Parameter group number: 65310 (0xFF1E)</b>  | <b>PGN 0xFF1E 65310</b> | <b>Proprietary MTU ADEC</b> |              |         |               |        |                    |  |
| J1939 Parameter Name                           | SPN                     | Byte Position               | Bit Position | Length  | Scale Factor  | Offset | Data Range         |  |
| Selected speed demand                          | N/A                     | 5                           | 5.1          | 2 bytes | 0.125 rpm/bit | 0      | 0 to 8031.875 rpm  |  |
| Effective set speed                            | N/A                     | 7                           | 7.1          | 2 bytes | 0.125 rpm/bit | 0      | 0 to 8031.875 rpm  |  |
|                                                |                         |                             |              |         |               |        |                    |  |
| <b>Parameter group number: 65316 (0xFF24)</b>  | <b>PGN 0xFF24 65316</b> | <b>Proprietary MTU ADEC</b> |              |         |               |        |                    |  |
| J1939 Parameter Name                           | SPN                     | Byte Position               | Bit Position | Length  | Scale Factor  | Offset | Data Range         |  |
| Feedback Speed Demand Analog Can               | N/A                     | 3                           | 3.1          | 2 bytes | 0.125 rpm/bit | 0      | 0 to 8031.875 rpm  |  |
| Feedback Speed Demand Analog                   | N/A                     | 5                           | 6.1          | 2 bytes | 0.125 rpm/bit | 0      | 0 to 8031.875 rpm  |  |
|                                                |                         |                             |              |         |               |        |                    |  |
| <b>Parameter group number: 65317 (0xFF25)</b>  | <b>PGN 0xFF25 65317</b> | <b>Proprietary MTU ADEC</b> |              |         |               |        |                    |  |
| J1939 Parameter Name                           | SPN                     | Byte Position               | Bit Position | Length  | Scale Factor  | Offset | Data Range         |  |
| Speed demand source                            | N/A                     | 1                           | 1.1          | 4 bits  | 1             | 0      | 0-7                |  |
|                                                |                         |                             |              |         |               |        |                    |  |
| <b>Parameter group number: 65318 (0xFF26)</b>  | <b>PGN 0xFF26 65318</b> | <b>Proprietary MTU ADEC</b> |              |         |               |        |                    |  |
| J1939 Parameter Name                           | SPN                     | Byte Position               | Bit Position | Length  | Scale Factor  | Offset | Data Range         |  |
| Specified torque                               | N/A                     | 3                           | 3.1          | 2 bytes | 1 Nm/bit      | 0      | 0 to 64,255 Nm     |  |
|                                                |                         |                             |              |         |               |        |                    |  |
| <b>Parameter group number: 65320 (0xFF28)</b>  | <b>PGN 0xFF28 65320</b> | <b>Proprietary MTU ADEC</b> |              |         |               |        |                    |  |
| J1939 Parameter Name                           | SPN                     | Byte Position               | Bit Position | Length  | Scale Factor  | Offset | Data Range         |  |
| Engine optimized                               | N/A                     | 7                           | 7.1          | 2 bytes | 1 digit/bit   | 0      | 0 to 64,255 digits |  |
|                                                |                         |                             |              |         |               |        |                    |  |
| <b>ADEC_STORAGE_TANK_STATUS_PROPRIETARY_PG</b> |                         | <b>Proprietary MTU ADEC</b> |              |         |               |        |                    |  |
| J1939 Parameter Name                           | SPN                     | Byte Position               | Bit Position | Length  | Scale Factor  | Offset | Data Range         |  |
| Current P degree                               | N/A                     | 1                           | 1.1          | 2 bytes | 0.0025 %/bit  | 0      | 0 to 160.6375 %    |  |
| Fill level of day tank %                       | N/A                     | 4                           | 4.1          | 1 byte  | 0.4 %/bit     | 0      | 0 to 100 %         |  |
| Fill level of storage tank %                   | N/A                     | 3                           | 3.1          | 1 byte  | 0.4 %/bit     | 0      | 0 to 100 %         |  |

| <b>Diesel Particulate Filter Control 1</b>                                    | <b>PGN 0xFD7C 64892</b> | <b>Standard</b> |              |        |              |        |            |                                                                                                                                                                                                                                                                         |
|-------------------------------------------------------------------------------|-------------------------|-----------------|--------------|--------|--------------|--------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| J1939 Parameter Name                                                          | SPN                     | Byte Position   | Bit Position | Length | Scale Factor | Offset | Data Range |                                                                                                                                                                                                                                                                         |
| Diesel Particulate Filter Lamp Command                                        | 3697                    | 1.1             | 1.1          | 3 bits | 8 states     | 0      | 0 to 7     | 000b=Off 001b=On solid 010b=reserved 011b=reserved 100b=On-fast blink (1 Hz) 101b=On-very fast blink 110b=reserved 111b=not available                                                                                                                                   |
| Aftertreatment Diesel Particulate Filter Status                               | 3701                    | 2.5             | 2.5          | 3 bits | 8 states     | 0      | 0 to 7     | 000b=Regeneration not needed 001b=Regeneration needed-lowest level 010b=Regeneration needed-moderate level 011b=Regeneration needed-highest level 100b=reserved for SAE assignment 101b=reserved for SAE assignment 110b=reserved for SAE assignment 111b=not available |
| Exhaust System High Temperature Lamp Command                                  | 3698                    | 7.3             | 7.3          | 3 bits | 8 states     | 0      | 0 to 7     | 000b=Off 001b=On-solid 010b-110b reserved 111b = not available                                                                                                                                                                                                          |
| Diesel Particulate Filter Active Regeneration Inhibited Status                | 3702                    | 3.1             | 3.1          | 2 bits | 4 states     | 0      | 0 to 3     | 00b=not inhibited 01b=inhibited 10b=reserved 11b=not available                                                                                                                                                                                                          |
| Diesel Particulate Filter Active Regeneration Inhibited Due to Inhibit Switch | 3703                    | 3.3             | 3.3          | 2 bits | 4 states     | 0      | 0 to 3     | 00b=not inhibited 01b=inhibited 10b=reserved 11b=not available                                                                                                                                                                                                          |
| Aftertreatment Diesel Particulate Filter Active Regeneration Status           | 3700                    | 2.3             | 2.3          | 2 bits | 4 states     | 0      | 0 to 3     | 00b=not active 01b=active 10b=regeneration needed-automatically initiated active regeneration imminent 11b = not available                                                                                                                                              |
| Diesel Particulate Filter Active Regeneration Forced Status                   | 4715                    | 7.6             | 7.6          | 3 bits | 8 states     | 0      | 0 to 7     | 000b=Not Active 001b=Active-Forced by Switch (See SPN 3696) 010b=Active-Forced by Service Tool 011b=110b Reserved 111b=not available                                                                                                                                    |

|                                                                                        |                         |                                            |              |         |                   |        |                    |                                                                                                                                                                        |
|----------------------------------------------------------------------------------------|-------------------------|--------------------------------------------|--------------|---------|-------------------|--------|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Diesel Particulate Filter Active Regeneration Inhibited Due to Low Exhaust Temperature | 3711                    | 5.3                                        | 5.3          | 2 bits  | 4 states          | 0      | 0 to 3             | 00b=not inhibited<br>01b=inhibited<br>10b=reserved<br>11b=not available                                                                                                |
| <b>Fuel Information 1 (Liquid)</b>                                                     | <b>PGN 0xFEB3 65203</b> | <b>Standard</b>                            |              |         |                   |        |                    |                                                                                                                                                                        |
| J1939 Parameter Name                                                                   | SPN                     | Byte Position                              | Bit Position | Length  | Scale Factor      | Offset | Data Range         |                                                                                                                                                                        |
| Trip Average Fuel Rate                                                                 | 1029                    | 5-6                                        | 5.1          | 2 bytes | 0.05 l/h per bit  | 0 l/h  | 0 to 3 212.75 l/h  |                                                                                                                                                                        |
| <b>Intake/Exhaust Conditions 2</b>                                                     | <b>PGN 0xFDD0 64976</b> | <b>Standard</b>                            |              |         |                   |        |                    |                                                                                                                                                                        |
| J1939 Parameter Name                                                                   | SPN                     | Byte Position                              | Bit Position | Length  | Scale Factor      | Offset | Data Range         |                                                                                                                                                                        |
| Engine Intake Manifold #1 Absolute Pressure                                            | 3563                    | 5                                          | 5.1          | 1 byte  | 2 kPa per bit     | 0 kPa  | 0 to 500 kPa       |                                                                                                                                                                        |
| <b>Engine Fluid Level/Pressure 4</b>                                                   | <b>PGN 0xFDAA 64938</b> | <b>Standard</b>                            |              |         |                   |        |                    |                                                                                                                                                                        |
| J1939 Parameter Name                                                                   | SPN                     | Byte Position                              | Bit Position | Length  | Scale Factor      | Offset | Data Range         |                                                                                                                                                                        |
| Engine Charge Air Cooler Coolant Level                                                 | 3668                    | 6                                          | 6.1          | 1 byte  | 0.4 % per bit     | 0 %    | 0 to 100 %         |                                                                                                                                                                        |
| <b>Engine Fuel/Lube Systems</b>                                                        | <b>PGN 0xFE6A 65130</b> | <b>Standard</b>                            |              |         |                   |        |                    |                                                                                                                                                                        |
| J1939 Parameter Name                                                                   | SPN                     | Byte Position                              | Bit Position | Length  | Scale Factor      | Offset | Data Range         |                                                                                                                                                                        |
| Engine Coolant Pre-Heated State                                                        | 3553                    | 6.7                                        | 6.7          | 2 bits  | 4 states          | 0      | 0 to 3             | 00b=Not sufficiently pre-heated<br>01b=Sufficiently pre-heated<br>10b=Unable to determine engine coolant pre-heated sufficiently<br>11b=Not available or not installed |
| <b>Electronic Engine Controller 3</b>                                                  | <b>PGN 0xFEDF 65247</b> | <b>Standard</b>                            |              |         |                   |        |                    |                                                                                                                                                                        |
| J1939 Parameter Name                                                                   | SPN                     | Byte Position                              | Bit Position | Length  | Scale Factor      | Offset | Data Range         |                                                                                                                                                                        |
| Engine's Desired Operating Speed                                                       | 515                     | 2-3                                        | 2.1          | 2 bytes | 0.125 rpm per bit | 0 rpm  | 0 to 8 031.875 rpm |                                                                                                                                                                        |
| <b>MTU Engine Controller 1 (MEC1)</b>                                                  | <b>PGN 0xFF50 65360</b> | <b>Proprietary MTU Smart Connect (SMC)</b> |              |         |                   |        |                    |                                                                                                                                                                        |
| J1939 Parameter Name                                                                   | SPN                     | Byte Position                              | Bit Position | Length  | Scale Factor      | Offset | Data Range         |                                                                                                                                                                        |
| MTU Requested Absolute Torque                                                          | 520843                  | 6                                          | 6.1          | 2 Bytes | 1 nM/bit          | -32000 | -32000 - 32255 Nm  |                                                                                                                                                                        |

|                                                                   |                                 |                                            |              |         |               |        |                |                                                                                                        |
|-------------------------------------------------------------------|---------------------------------|--------------------------------------------|--------------|---------|---------------|--------|----------------|--------------------------------------------------------------------------------------------------------|
| Current Engine Operating Mode                                     | 520840                          | 5                                          | 5.7          | 2 bits  | 1/bit         | 0      | 0 – 1          |                                                                                                        |
|                                                                   |                                 |                                            |              |         |               |        |                |                                                                                                        |
|                                                                   | <b>PGN<br/>0xFF51<br/>65361</b> | <b>Proprietary MTU Smart Connect (SMC)</b> |              |         |               |        |                |                                                                                                        |
| J1939 Parameter Name                                              | SPN                             | Byte Position                              | Bit Position | Length  | Scale Factor  | Offset | Data Range     |                                                                                                        |
| Engine Demanded Operating Speed                                   | 520707                          | 1                                          | 1.1          | 2 Bytes | 0.125 rpm/bit | 0      | 0 – 8031.875   |                                                                                                        |
| Source of Current Speed Demand                                    | 520263                          | 4                                          | 4.1          | 1 Byte  | 1             | 0      | 0 – 5          | 0=Analog Can<br>1=Up/Down ECU<br>2=Up/Down Can<br>3=Analog ECU<br>4=Analog ECU Relative<br>5=Frequency |
| Feedback of Speed Demand CAN                                      | 520828                          | 5                                          | 5.1          | 2 Bytes | 0.125 rpm/bit | 0      | 0 – 8031.875   |                                                                                                        |
| Feedback of Speed Demand Analog Input                             | 520829                          | 7                                          | 7.1          | 2 Bytes | 0.125 rpm/bit | 0      | 0 – 8031.875   |                                                                                                        |
|                                                                   |                                 |                                            |              |         |               |        |                |                                                                                                        |
|                                                                   | <b>PGN<br/>0xFF04<br/>65284</b> | <b>Proprietary MTU Smart Connect (SMC)</b> |              |         |               |        |                |                                                                                                        |
| J1939 Parameter Name                                              | SPN                             | Byte Position                              | Bit Position | Length  | Scale Factor  | Offset | Data Range     |                                                                                                        |
| MTU Engine Controller Error Codes                                 | 520256                          | 1                                          | 1.1          | 2 Bytes | 1             | 0      | 0 – 64255      |                                                                                                        |
| Actual Droop                                                      | 520831                          | 7                                          | 7.1          | 1 Byte  | 0.4%/bit      | 0      | 0 – 100%       |                                                                                                        |
|                                                                   |                                 |                                            |              |         |               |        |                |                                                                                                        |
|                                                                   | <b>PGN<br/>0xFF57<br/>65367</b> | <b>Proprietary MTU Smart Connect (SMC)</b> |              |         |               |        |                |                                                                                                        |
| J1939 Parameter Name                                              | SPN                             | Byte Position                              | Bit Position | Length  | Scale Factor  | Offset | Data Range     |                                                                                                        |
| Engine Status of Start Procedure                                  | 520241                          | 3                                          | 3.1          | 4 bytes | 1             | 0      | 0 – 4294967295 |                                                                                                        |
|                                                                   |                                 |                                            |              |         |               |        |                |                                                                                                        |
| <b>Aftertreatment 1 Diesel Exhaust Fluid Tank 1 Information 1</b> | <b>PGN<br/>0xFE56<br/>65110</b> | <b>Standard</b>                            |              |         |               |        |                |                                                                                                        |
| J1939 Parameter Name                                              | SPN                             | Byte Position                              | Bit Position | Length  | Scale Factor  | Offset | Data Range     |                                                                                                        |
| Aftertreatment 1 Diesel Exhaust Fluid Tank Volume                 | 1761                            | 1                                          | 1.1          | 1 byte  | 0.4 % per bit | 0 %    | 0 to 100 %     |                                                                                                        |

|                                                              |                         |                           |              |        |               |        |            |                                                                                                                                                                                                                                                                                           |
|--------------------------------------------------------------|-------------------------|---------------------------|--------------|--------|---------------|--------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Aftertreatment Diesel Exhaust Fluid Tank Low Level Indicator | 5245                    | 5.6                       | 5.6          | 3 bits | 8 states      | 0      | 0 to 7     | 000b=Off-indicates adequate DEF level<br>001b=On solid-indicates low DEF level<br>010b=reserved<br>011b=reserved 100b On fast blink (1 Hz) - lower DEF Level<br>101b=reserved<br>110b=reserved<br>111b=not available                                                                      |
| Aftertreatment SCR Operator Inducement Severity              | 5246                    | 6.6                       | 6.6          | 3 bits | 8 states      | 0      | 0 to 7     | 000b=Warning<br>001b=Inducement Level 1<br>010b=Inducement Level 2<br>011b=Inducement Level 3<br>100b=Inducement Level 4<br>101b=Inducement Level 5<br>110b=Temporary Override of Inducement - The SCR inducement has been temporarily interrupted.<br>111b=Not Available / Not Supported |
|                                                              |                         |                           |              |        |               |        |            |                                                                                                                                                                                                                                                                                           |
| <b>Aftertreatment 1 SCR Reagent Tank 2 Information</b>       | <b>PGN 0xFD3D 64829</b> | <b>Standard</b>           |              |        |               |        |            |                                                                                                                                                                                                                                                                                           |
| J1939 Parameter Name                                         | SPN                     | Byte Position             | Bit Position | Length | Scale Factor  | Offset | Data Range |                                                                                                                                                                                                                                                                                           |
| Aftertreatment 1 Diesel Exhaust Fluid Quick Thaw Tank Volume | 4367                    | 1                         | 1.1          | 1 byte | 0.4 % per bit | 0 %    | 0 to 100 % |                                                                                                                                                                                                                                                                                           |
|                                                              |                         |                           |              |        |               |        |            |                                                                                                                                                                                                                                                                                           |
| <b>DLN7</b>                                                  | <b>PGN 0xFF87 65415</b> | <b>Proprietary Scania</b> |              |        |               |        |            |                                                                                                                                                                                                                                                                                           |
| J1939 Parameter Name                                         | SPN                     | Byte Position             | Bit Position | Length | Scale Factor  | Offset | Data Range |                                                                                                                                                                                                                                                                                           |
| Urea Level                                                   | N/A                     | 1                         | 1.1          | 1 Byte | 0.4%/bit      | 0      | 0 – 100%   |                                                                                                                                                                                                                                                                                           |
|                                                              |                         |                           |              |        |               |        |            |                                                                                                                                                                                                                                                                                           |
| <b>DLN8</b>                                                  | <b>PGN 0xFF88 65416</b> | <b>Proprietary Scania</b> |              |        |               |        |            |                                                                                                                                                                                                                                                                                           |
| J1939 Parameter Name                                         | SPN                     | Byte Position             | Bit Position | Length | Scale Factor  | Offset | Data Range |                                                                                                                                                                                                                                                                                           |
| Urea level inducement state                                  | N/A                     | 8                         | 8,1          | 3 bits | 8 states      | 0      | 0-7        | 000b-Urea Level Ok<br>001b-Low Urea Level<br>010b-Fill Up Urea<br>011b-Urea Tank Empty<br>100b-101b-Reserved<br>110b-Error<br>111b-Not Available                                                                                                                                          |



|                                                               |                         |                 |              |         |                     |         |                         |                                                                                                                                                                                                                                                          |
|---------------------------------------------------------------|-------------------------|-----------------|--------------|---------|---------------------|---------|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Emission OBD inducement state                                 | N/A                     | 6               | 6.4          | 4 bits  | 16 states           | 0       | 0-15                    | 0000b-No Inducement 0001b-Active Torque Limit Due To Urea Level 0010b-Active Speed Limit Due To Urea Level 0011b-Active Torque Limit Due To SCR Failure 0100b-Active Speed Limit Due To SCR Failure 0101b-1101b Reserved 1110b Error 1111b Not Available |
| Emission-OBd inducement reason                                | N/A                     | 8               | 8.4          | 4 bits  | 16 states           | 0       | 0-15                    | 000b-No Failure 0001b-Dosing Error 0010b-Urea Quality 0011b-Monitor Failure 0100b-Nox Failure 0101b-1101b Reserved 1110b Error 1111b Not Available                                                                                                       |
|                                                               |                         |                 |              |         |                     |         |                         |                                                                                                                                                                                                                                                          |
| <b>Aftertreatment 1 Outlet Gas 2</b>                          | <b>PGN 0xFDB3 64947</b> | <b>Standard</b> |              |         |                     |         |                         |                                                                                                                                                                                                                                                          |
| J1939 Parameter Name                                          | SPN                     | Byte Position   | Bit Position | Length  | Scale Factor        | Offset  | Data Range              |                                                                                                                                                                                                                                                          |
| Aftertreatment 1 Diesel Particulate Filter Outlet Temperature | 3246                    | 3-4             | 3.1          | 2 bytes | 0.031 25 °C per bit | -273 °C | -273 to 1 734.968 75 °C |                                                                                                                                                                                                                                                          |
|                                                               |                         |                 |              |         |                     |         |                         |                                                                                                                                                                                                                                                          |
| <b>Direct Lamp Control Command 1</b>                          | <b>PGN 0xFD07 64775</b> | <b>Standard</b> |              |         |                     |         |                         |                                                                                                                                                                                                                                                          |
| J1939 Parameter Name                                          | SPN                     | Byte Position   | Bit Position | Length  | Scale Factor        | Offset  | Data Range              |                                                                                                                                                                                                                                                          |
| Engine Amber Warning Lamp Command                             | 5078                    | 1.3             | 1.3          | 2 bits  | 4 states            | 0       | 0 to 3                  | 0b=Lamp Off<br>01b=Lamp On<br>10b=Reserved<br>11b=Not available                                                                                                                                                                                          |
| Engine Red Stop Lamp Command                                  | 5079                    | 1.5             | 1.5          | 2 bits  | 4 states            | 0       | 0 to 3                  | 0b=Lamp Off<br>01b=Lamp On<br>10b=Reserved<br>11b=Not available                                                                                                                                                                                          |
| OBD Malfunction Indicator Lamp Command                        | 5080                    | 1.7             | 1.7          | 2 bits  | 4 states            | 0       | 0 to 3                  | 0b=Lamp Off<br>01b=Lamp On<br>10b=Reserved<br>11b=Not available                                                                                                                                                                                          |
|                                                               |                         |                 |              |         |                     |         |                         |                                                                                                                                                                                                                                                          |
| <b>SCR System Cleaning</b>                                    | <b>PGN 0xFC4A 64586</b> | <b>Standard</b> |              |         |                     |         |                         |                                                                                                                                                                                                                                                          |
| J1939 Parameter Name                                          | SPN                     | Byte Position   | Bit Position | Length  | Scale Factor        | Offset  | Data Range              |                                                                                                                                                                                                                                                          |

|                                                     |                         |                            |              |        |              |        |            |                                                                                                                                                                                          |
|-----------------------------------------------------|-------------------------|----------------------------|--------------|--------|--------------|--------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SCR System Cleaning Lamp Command                    | 6915                    | 1.1                        | 1.1          | 3 bits | 8 states     | 0      | 0 to 7     | 000b=Off 001b=On solid 010b=reserved 011b=reserved 100b=On-fast blink (1 Hz) 101b=On-very fast blink 110b=reserved 111b=not available                                                    |
| SCR System Cleaning Status                          | 6916                    | 2.3                        | 2.3          | 2 bits | 4 states     | 0      | 0 to 3     | 00b=not active 01b=active 10b=SCR system cleaning is needed - automatic cleaning imminent 11b=not available                                                                              |
| SCR System Cleaning Inhibited Due to Inhibit Switch | 6918                    | 3.3                        | 3.3          | 2 bits | 4 states     | 0      | 0 to 3     | 000b=Not Active 001b=Active-Forced by Switch 010b=Active-Forced by Service Tool 011b - 110b Reserved 111b = not available                                                                |
| SCR System Cleaning Forced Status                   | 6934                    | 7.6                        | 7.6          | 3 bits | 8 states     | 0      | 0 to 7     |                                                                                                                                                                                          |
|                                                     |                         |                            |              |        |              |        |            |                                                                                                                                                                                          |
| <b>VP191 – OBD Information</b>                      | <b>PGN 0xFFBF 65471</b> | <b>Proprietary Volvo</b>   |              |        |              |        |            |                                                                                                                                                                                          |
| J1939 Parameter Name                                | SPN                     | Byte Position              | Bit Position | Length | Scale Factor | Offset | Data Range |                                                                                                                                                                                          |
|                                                     | N/A                     | 2                          | 2.2          | 3 bits | 8 States     | 0      | 0 – 7      | 000b= No inducement 001b=Inducement warning 010b=Not available 011b=Derate active 100b=Pre severe derate warning 101b=Severe derate 110b=Temporary override of derate 111b=Not available |
|                                                     | N/A                     | 3                          | 3.5          | 3 bits | 8 States     | 0      | 0 – 7      | 000b=OK 001b=Reagent tank level low 010b=Incorrect reagent quality 011b=Absence of reagent dosing 100b=Tampering 101b-111b=Not available                                                 |
|                                                     |                         |                            |              |        |              |        |            |                                                                                                                                                                                          |
| <b>PropB0A</b>                                      | <b>PGN 0xFF0A 65290</b> | <b>Proprietary Daimler</b> |              |        |              |        |            |                                                                                                                                                                                          |
| J1939 Parameter Name                                | SPN                     | Byte Position              | Bit Position | Length | Scale Factor | Offset | Data Range |                                                                                                                                                                                          |

|                                                                   |                         |                          |              |         |                 |         |                   |                                                                                                                                                                      |
|-------------------------------------------------------------------|-------------------------|--------------------------|--------------|---------|-----------------|---------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Tier4DefLampReq                                                   | N/A                     | 2                        | 2.5          | 4 bits  | 16 states       | 0       | 0 – 15            | 0=Off 1=On 2=Slow Blinking (1Hz)<br>3=Fast Blinking (2Hz)<br>4..13=reserved<br>14=Error (ERR)<br>15=Signal not available (SNA)                                       |
| LimLampReq                                                        | N/A                     | 3                        | 3.1          | 4 bits  | 16 states       | 0       | 0 – 15            | 0=Off 1=On 2=Slow Blinking (1Hz)<br>3=Fast Blinking (2Hz)<br>4..13=reserved<br>14=Error (ERR)<br>15=Signal not available (SNA)                                       |
|                                                                   |                         |                          |              |         |                 |         |                   |                                                                                                                                                                      |
|                                                                   |                         |                          |              |         |                 |         |                   |                                                                                                                                                                      |
| <b>Auxiliary Input/Output Status 1</b>                            | <b>PGN 0xFED9 65241</b> | <b>Standard</b>          |              |         |                 |         |                   |                                                                                                                                                                      |
| J1939 Parameter Name                                              | SPN                     | Byte Position            | Bit Position | Length  | Scale Factor    | Offset  | Data Range        |                                                                                                                                                                      |
| Auxiliary I/O Channel #1                                          | 1083                    | 5-6                      | 5.1          | 2 bytes | 1 count per bit | 0 count | 0 to 64 255 count |                                                                                                                                                                      |
| Auxiliary I/O Channel #1 (Isuzu specific use – Amber lamp status) | N/A                     | 6                        | 6.5          | 2 bits  | 4 states        | 0       | 0 – 3             | 00b=Normal Operation 01b=On (During Manual Purge) 10b=Slow Blink (During Manual Purge Request by Service Tool) 0011b=Quick Lamp Blinks (During Manual Purge Request) |
| Auxiliary I/O Channel #1 (Isuzu specific use – green lamp status) | N/A                     | 6                        | 6.7          | 2 bits  | 2 states        | 0       | 0 – 1             | 00b=Off 01b=On                                                                                                                                                       |
|                                                                   |                         |                          |              |         |                 |         |                   |                                                                                                                                                                      |
| <b>DCU Monitor #1</b>                                             | <b>PGN 0xFFE8 65512</b> | <b>Proprietary Isuzu</b> |              |         |                 |         |                   |                                                                                                                                                                      |
|                                                                   | SPN                     | Byte Position            | Bit Position | Length  | Scale Factor    | Offset  | Data Range        |                                                                                                                                                                      |
| Filtered Urea Level                                               | N/A                     | 1                        | 1.1          | 1 byte  | 0.4%/bit        | 0       | 0-102%            |                                                                                                                                                                      |
|                                                                   |                         |                          |              |         |                 |         |                   |                                                                                                                                                                      |
| <b>Inducement Control Related Can Signals</b>                     | <b>PGN 0xFFE2 65506</b> | <b>Proprietary Isuzu</b> |              |         |                 |         |                   |                                                                                                                                                                      |
| J1939 Parameter Name                                              | SPN                     | Byte Position            | Bit Position | Length  | Scale Factor    | Offset  | Data Range        |                                                                                                                                                                      |
| Refill DEF Lamp                                                   | N/A                     | 3                        | 3.4          | 2 bits  | 2 values        | 0       | 0 – 1             | 00b=Lamp Off 01b=Lamp On                                                                                                                                             |
| Exhaust System Lamp                                               | N/A                     | 7                        | 7.5          | 2 bits  | 2 values        | 0       | 0 – 1             | 00b=Lamp Off 01b=Lamp On                                                                                                                                             |

|                                                                   |                         |                           |              |         |              |        |            |                                                                                                                                                               |
|-------------------------------------------------------------------|-------------------------|---------------------------|--------------|---------|--------------|--------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Inducement Level                                                  | N/A                     | 6                         | 6.1          | 4 bits  | 4 values     | 0      | 0 – 4      | 0000b=Normal Operation<br>0001b=Warning<br>0010b=Early Inducement<br>0011b=(Not Defined)<br>0100b=Final Inducement                                            |
| No Power Lamp                                                     | N/A                     | 6                         | 6.7          | 2 bits  | 2 values     | 0      | 0 – 1      | 00b=Lamp Off<br>01b=Lamp On                                                                                                                                   |
| Escape Mode Lamp                                                  | N/A                     | 6                         | 6.5          | 2 bits  | 2 values     | 0      | 0 – 1      | 00b=Lamp Off<br>01b=Lamp On                                                                                                                                   |
|                                                                   |                         |                           |              |         |              |        |            |                                                                                                                                                               |
| <b>Engine Monitor #3</b>                                          | <b>PGN 0xFF03 65283</b> | <b>Proprietary Isuzu</b>  |              |         |              |        |            |                                                                                                                                                               |
| J1939 Parameter Name                                              | SPN                     | Byte Position             | Bit Position | Length  | Scale Factor | Offset | Data Range |                                                                                                                                                               |
| DPF Mode - Variable indicating the current state of purge control | N/A                     | 7                         | 7.1          | 2 bytes | 1            | 0      | 0-999      |                                                                                                                                                               |
|                                                                   |                         |                           |              |         |              |        |            |                                                                                                                                                               |
| <b>Aftertreatment 1 Service 1</b>                                 | <b>PGN 0xFD7B 64891</b> | <b>Standard</b>           |              |         |              |        |            |                                                                                                                                                               |
| J1939 Parameter Name                                              | SPN                     | Byte Position             | Bit Position | Length  | Scale Factor | Offset | Data Range |                                                                                                                                                               |
| Aftertreatment 1 Diesel Particulate Filter Soot Load Percent      | 3719                    | 1                         | 1.1          | 1 byte  | 1 % per bit  | 0 %    | 0 to 250 % |                                                                                                                                                               |
| Aftertreatment 1 Diesel Particulate Filter Ash Load Percent       | 3720                    | 2                         | 2.1          | 1 byte  | 1 % per bit  | 0 %    | 0 to 250 % |                                                                                                                                                               |
|                                                                   |                         |                           |              |         |              |        |            |                                                                                                                                                               |
| <b>YANMAR_PROPRIETARY_Y_ATF_PG</b>                                | <b>PGN 0xFF2A 65322</b> | <b>Proprietary Yanmar</b> |              |         |              |        |            |                                                                                                                                                               |
| J1939 Parameter Name                                              | SPN                     | Byte Position             | Bit Position | Length  | Scale Factor | Offset | Data Range |                                                                                                                                                               |
| DPF Regeneration Mode Status                                      | N/A                     | 1                         | 1.1          | 4 bits  | 16 values    | 0      | 0-15       | 0=Normal Operation<br>1=Assist Regeneration<br>2=Reset Regeneration<br>3=Stationary Regeneration<br>4=Recovery Regeneration<br>5-14=Unused 15=Not Implemented |

|                                          |                         |                                    |              |         |                 |          |                      |                                                                                                                                                                                         |
|------------------------------------------|-------------------------|------------------------------------|--------------|---------|-----------------|----------|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Stationary Regeneration Request Flag     | N/A                     | 2                                  | 2.5          | 4 bits  | 16 values       | 0        | 0-15                 | 0=No Regeneration Request 1=Operator Commanded Stations Regeneration Request 2=Emergency Stationary Regeneration Request 3=Recovery Regeneration Request 4-15=Unused 15=Not Implemented |
| Ash Cleaning Request Flag                | N/A                     | 3                                  | 3.1          | 4 bits  | 16 values       | 0        | 0-15                 | 0=No Ash Cleaning Request 1=Low Priority Ash Cleaning Request 2=High Priority Ash Cleaning Request 3-14=Unused 15=Not Implemented                                                       |
| Regeneration Progress Percentage         | N/A                     | 8                                  | 8.1          | 1 byte  | 1%/bit          | 0        | 0-100%               |                                                                                                                                                                                         |
|                                          |                         |                                    |              |         |                 |          |                      |                                                                                                                                                                                         |
| <b>Dash Display 1</b>                    | <b>PGN 0xFEFC 65276</b> | <b>Standard</b>                    |              |         |                 |          |                      |                                                                                                                                                                                         |
| J1939 Parameter Name                     | SPN                     | Byte Position                      | Bit Position | Length  | Scale Factor    | Offset   | Data Range           |                                                                                                                                                                                         |
| Engine Fuel Filter Differential Pressure | 95                      | 3                                  | 3.1          | 1 byte  | 2 kPa per bit   | 0 kPa    | 0 to 500 kPa         |                                                                                                                                                                                         |
| Engine Oil Filter Differential Pressure  | 99                      | 4                                  | 4.1          | 1 byte  | 0.5 kPa per bit | 0 kPa    | 0 to 125 kPa         |                                                                                                                                                                                         |
|                                          |                         |                                    |              |         |                 |          |                      |                                                                                                                                                                                         |
| <b>Battery Charger 1</b>                 | <b>PGN 0xFD15 64789</b> | <b>Standard + SENS Proprietary</b> |              |         |                 |          |                      |                                                                                                                                                                                         |
| J1939 Parameter Name                     | SPN                     | Byte Position                      | Bit Position | Length  | Scale Factor    | Offset   | Data Range           |                                                                                                                                                                                         |
| Battery Charger 1 Output Voltage         | 4992                    | 2-3                                | 2.1          | 2 bytes | 0.05 V per bit  | 0 V      | 0 to 3 212.75 V      |                                                                                                                                                                                         |
| Battery Charger 1 Output Current         | 4993                    | 4-5                                | 4.1          | 2 bytes | 0.05 A per bit  | -1 600 A | -1 600 to 1 612.75 A |                                                                                                                                                                                         |
| Battery Charger 1 State                  | 4990                    | 1.1                                | 1.1          | 4 bits  | 16 states       | 0        | 0 to 15              | 0=Idling 1=Charging 2=Stand-by or maintaining charge 3 to 12 = Reserved 13=Battery failure 14=Charger failure 15=Not available                                                          |
| Battery Charger 1 Power Line State       | 4991                    | 1.4                                | 1.4          | 2 bits  | 4 states        | 0        | 0 to 3               |                                                                                                                                                                                         |

|                                                |                         |                                    |              |         |                |        |                 |                                                                                                                                                                               |
|------------------------------------------------|-------------------------|------------------------------------|--------------|---------|----------------|--------|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SENS Thermal Limit                             | N/A                     | 1.6                                | 1.6          | 2 bits  | 4 states       | 0      | 0 to 3          | Sens Proprietary<br>Usage 0=Full Output Available 1=Output Reduced by Thermal Limit Protector 2= Internal Error 3= No Status Available<br>SENS Custom Definitions Not Enabled |
| SENS High DC Alarm                             | N/A                     | 5.3                                | 5.3          | 2 bits  | 4 states       | 0      | 0 to 3          | Sens Proprietary<br>Usage 0=No Alarm 1=Alarm Active 2=internal Error 3=No Status Available<br>SENS Custom Definitions Not Enabled                                             |
| SENS Low DC Alarm                              | N/A                     | 5.5                                | 5.5          | 2 bits  | 4 states       | 0      | 0 to 3          | Sens Proprietary<br>Usage 0=No Alarm 1=Alarm Active 2=internal Error 3=No Status Available<br>SENS Custom Definitions Not Enabled                                             |
| SENS Low Cranking Voltage Alarm                | N/A                     | 5.7                                | 5.7          | 2 bits  | 4 states       | 0      | 0 to 3          | Sens Proprietary<br>Usage 0=No Alarm 1=Alarm Active 2=internal Error 3=No Status Available<br>SENS Custom Definitions Not Enabled                                             |
| SENS Jumper Status                             | N/A                     | 6.1                                | 6.1          | 2 bits  | 4 states       | 0      | 0 to 3          | Sens Proprietary<br>Usage 0=Jumper Settings Valid 1=Invalid Jumper settings (Charger Disabled) 2=internal Error 3=No Status Available<br>SENS Custom Definitions Not Enabled  |
| Single Unit Fault (Multi-charger systems only) | N/A                     | 6.3                                | 6.3          | 2 bits  | 4 states       | 0      | 0 to 3          | Sens Proprietary<br>Usage 0=All Chargers Functioning 1= On or more units not functioning properly 2= internal error 3=No Status Available (single Charger)                    |
|                                                |                         |                                    |              |         |                |        |                 |                                                                                                                                                                               |
| <b>Battery Charger 2</b>                       | <b>PGN 0xFD14 64788</b> | <b>Standard + SENS Proprietary</b> |              |         |                |        |                 |                                                                                                                                                                               |
| J1939 Parameter Name                           | SPN                     | Byte Position                      | Bit Position | Length  | Scale Factor   | Offset | Data Range      |                                                                                                                                                                               |
| Battery Charger 2 Output Voltage               | 4994                    | 2-3                                | 2.1          | 2 bytes | 0.05 V per bit | 0 V    | 0 to 3 212.75 V |                                                                                                                                                                               |

|                                          |      |     |     |         |                |             |                         |                                                                                                                                                                                                    |
|------------------------------------------|------|-----|-----|---------|----------------|-------------|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Battery Charger<br>2 Output<br>Current   | 4995 | 4-5 | 4.1 | 2 bytes | 0.05 A per bit | -1 600<br>A | -1 600 to 1 612.75<br>A |                                                                                                                                                                                                    |
| Battery Charger<br>2 State               | 4996 | 1.1 | 1.1 | 4 bits  | 16 states      | 0           | 0 to 15                 | 0=Idling 1=Charging<br>2=Stand-by or<br>maintaining charge 3<br>to 12 = Reserved<br>13=Battery failure<br>14=Charger failure<br>15=Not available                                                   |
| Battery Charger<br>2 Power Line<br>State | 4997 | 1.5 | 1.5 | 2 bits  | 4 states       | 0           | 0 to 3                  |                                                                                                                                                                                                    |
| SENS Thermal<br>Limit                    | N/A  | 1.6 | 1.6 | 2 bits  | 4 states       | 0           | 0 to 3                  | Sens Proprietary<br>Usage 0=Full Output<br>Available 1=Output<br>Reduced by Thermal<br>Limit Protector 2=<br>Internal Error 3= No<br>Status Available<br>SENS Custom<br>Definitions Not<br>Enabled |
| SENS High DC<br>Alarm                    | N/A  | 5.3 | 5.3 | 2 bits  | 4 states       | 0           | 0 to 3                  | Sens Proprietary<br>Usage 0=No Alarm<br>1=Alarm Active<br>2=internal Error<br>3=No Status<br>Available SENS<br>Custom Definitions<br>Not Enabled                                                   |
| SENS Low DC<br>Alarm                     | N/A  | 5.5 | 5.5 | 2 bits  | 4 states       | 0           | 0 to 3                  | Sens Proprietary<br>Usage 0=No Alarm<br>1=Alarm Active<br>2=internal Error<br>3=No Status<br>Available SENS<br>Custom Definitions<br>Not Enabled                                                   |
| SENS Low<br>Cranking<br>Voltage Alarm    | N/A  | 5.7 | 5.7 | 2 bits  | 4 states       | 0           | 0 to 3                  | Sens Proprietary<br>Usage 0=No Alarm<br>1=Alarm Active<br>2=internal Error<br>3=No Status<br>Available SENS<br>Custom Definitions<br>Not Enabled                                                   |
| SENS Jumper<br>Status                    | N/A  | 6.1 | 6.1 | 2 bits  | 4 states       | 0           | 0 to 3                  | Sens Proprietary<br>Usage 0=Jumper<br>Settings Valid<br>1=Invalid Jumper<br>settings (Charger<br>Disabled) 2=internal<br>Error 3=No Status<br>Available SENS<br>Custom Definitions<br>Not Enabled  |

|                                                      |                                 |                           |                 |         |                 |        |                 |                                                                                                                                                                                                                                                                |
|------------------------------------------------------|---------------------------------|---------------------------|-----------------|---------|-----------------|--------|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Single Unit Fault<br>(Multi-charger<br>systems only) | N/A                             | 6.3                       | 6.3             | 2 bits  | 4 states        | 0      | 0 to 3          | Sens Proprietary<br>Usage 0=All<br>Chargers<br>Functioning 1= On or<br>more units not<br>functioning properly<br>2= internal error<br>3=No Status<br>Available (single<br>Charger)                                                                             |
| <b>Battery<br/>Temperature</b>                       | <b>PGN<br/>0xFE50<br/>65104</b> | <b>Standard</b>           |                 |         |                 |        |                 |                                                                                                                                                                                                                                                                |
| J1939<br>Parameter<br>Name                           | SPN                             | Byte<br>Position          | Bit<br>Position | Length  | Scale<br>Factor | Offset | Data<br>Range   |                                                                                                                                                                                                                                                                |
| SLI Battery 1<br>Temperature                         | 1800                            | 1                         | 1.1             | 1 byte  | 1 °C per bit    | -40 °C | -40 to 210 °C   |                                                                                                                                                                                                                                                                |
| SLI Battery 2<br>Temperature                         | 1801                            | 2                         | 2.1             | 1 byte  | 1 °C per bit    | -40 °C | -40 to 210 °C   |                                                                                                                                                                                                                                                                |
| <b>YANMAR_PRO<br/>PRIETARY_Y_I<br/>OS_PG</b>         | <b>PGN<br/>0xFF11<br/>65297</b> | <b>Proprietary Yanmar</b> |                 |         |                 |        |                 |                                                                                                                                                                                                                                                                |
| J1939<br>Parameter<br>Name                           | SPN                             | Byte<br>Position          | Bit<br>Position | Length  | Scale<br>Factor | Offset | Data<br>Range   |                                                                                                                                                                                                                                                                |
|                                                      | N/A                             | 5                         | 5.1             | 1 byte  | 1               | 0      | 0-4             | 0 = Off 1=DPF<br>Regeneration<br>Request Switch 2=<br>DPF Regeneration<br>Inhibit Switch 3=<br>Regeneration<br>Interlock Switch                                                                                                                                |
| <b>YANMAR_PRO<br/>PRIETARY_Y_<br/>EGRIS_PG</b>       | <b>PGN<br/>0xFFF8<br/>65528</b> | <b>Proprietary Yanmar</b> |                 |         |                 |        |                 |                                                                                                                                                                                                                                                                |
| J1939<br>Parameter<br>Name                           | SPN                             | Byte<br>Position          | Bit<br>Position | Length  | Scale<br>Factor | Offset | Data<br>Range   |                                                                                                                                                                                                                                                                |
| Time Remaining<br>at Present<br>Inducement           | N/A                             | 3                         | 3.1             | 2 bytes | 0.001sec/bit    | 0      | 0 – 642.550 sec |                                                                                                                                                                                                                                                                |
| Pending EGR<br>Inducement<br>Severity                | N/A                             | 5                         | 5.1             | 3 bits  | 8 States        | 0      | 0 – 7           | 000b=Off<br>001b=Pending<br>inducement Level<br>Warning 010b=Not<br>Used 011=Pending<br>Inducement Level<br>Low Inducement<br>100b=Not Used<br>101b=Pending<br>Inducement level<br>Severe<br>101b=Temporary<br>Override of<br>Inducement<br>111b=Not Available |
| Inducement<br>Lamp State                             | N/A                             | 5                         | 5.7             | 2 bits  | 4 states        | 0      | 0 – 3           | 00b=off 01b=On<br>Solis 10b=On Fast<br>Blink 11b=Not<br>Defined                                                                                                                                                                                                |



|                                                                     |                         |                           |              |         |                     |         |                         |                                                                                                                                                                             |
|---------------------------------------------------------------------|-------------------------|---------------------------|--------------|---------|---------------------|---------|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| EGR Operator Inducement Severity                                    | N/A                     | 6                         | 6.6          | 3 bits  | 8 States            | 0       | 0 – 7                   | 000b=Off 001b=Warning 010b=Not Used 011=Inducement Level Low Inducement 100b=Not Used 101b=Inducement level Severe 101b=Temporary Override of Inducement 111b=Not Available |
| <b>ECU History</b>                                                  | <b>PGN 0xFEB1 65201</b> | <b>Standard</b>           |              |         |                     |         |                         |                                                                                                                                                                             |
| J1939 Parameter Name                                                | SPN                     | Byte Position             | Bit Position | Length  | Scale Factor        | Offset  | Data Range              |                                                                                                                                                                             |
| Total ECU Run Time                                                  | 1032                    | 1-4                       | 1.1          | 4 bytes | 0.05 h per bit      | 0 h     | 0 to 210 554 060.75 h   |                                                                                                                                                                             |
| <b>Aftertreatment 1 Intermediate Gas</b>                            | <b>PGN 0xFDB2 64946</b> | <b>Standard</b>           |              |         |                     |         |                         |                                                                                                                                                                             |
| J1939 Parameter Name                                                | SPN                     | Byte Position             | Bit Position | Length  | Scale Factor        | Offset  | Data Range              |                                                                                                                                                                             |
| Aftertreatment 1 Diesel Particulate Filter Intermediate Temperature | 3250                    | 3-4                       | 3.1          | 2 bytes | 0.031 25 °C per bit | -273 °C | -273 to 1 734.968 75 °C |                                                                                                                                                                             |
| <b>Aftertreatment 1 Intake Gas 2</b>                                | <b>PGN 0xFDB4 64948</b> | <b>Standard</b>           |              |         |                     |         |                         |                                                                                                                                                                             |
| J1939 Parameter Name                                                | SPN                     | Byte Position             | Bit Position | Length  | Scale Factor        | Offset  | Data Range              |                                                                                                                                                                             |
| Aftertreatment 1 Diesel Particulate Filter Intake Temperature       | 3242                    | 3-4                       | 3.1          | 2 bytes | 0.031 25 °C per bit | -273 °C | -273 to 1 734.968 75 °C |                                                                                                                                                                             |
| <b>YANMAR_PROPRIETARY_Y_MPR_PG</b>                                  | <b>PGN 0xFF00 65280</b> | <b>Proprietary Yanmar</b> |              |         |                     |         |                         |                                                                                                                                                                             |
| J1939 Parameter Name                                                | SPN                     | Byte Position             | Bit Position | Length  | Scale Factor        | Offset  | Data Range              |                                                                                                                                                                             |
|                                                                     | N/A                     | 3                         | 3.1          | 2 bytes | 0.1 kPa/bit         | 0       | 0 – 6425.5 kPa          |                                                                                                                                                                             |
|                                                                     | N/A                     | 1                         | 1.1          | 2 bytes | 0.1 kPa/bit         | 0       | 0 – 6425.5 kPa          |                                                                                                                                                                             |
| <b>EPA1</b>                                                         | <b>PGN 0xFF4E 65358</b> | <b>Proprietary Deutz</b>  |              |         |                     |         |                         |                                                                                                                                                                             |
| PGN                                                                 | SPN                     | Byte Position             | Bit Position | Length  | Scale Factor        | Offset  | Data Range              |                                                                                                                                                                             |

|                                                                  |                         |                          |              |        |              |        |            |                                                                                                                                                                                                                                                                                     |
|------------------------------------------------------------------|-------------------------|--------------------------|--------------|--------|--------------|--------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Restriction level according to DEF tank level                    | N/A                     | 1.1                      | 1.1          | 2 bits | 4 states     | 0      | 0 to 3     | 0b00-no restriction<br>0b01-Level 1 (i.e. Warning < 5% DEF Level)<br>0b10-Level 2 torque reduction step 1 (Early Inducement)<br>0b11-Level 3 torque reduction step 2(severe inducement)                                                                                             |
| DEF-Tank level                                                   | N/A                     | 1.3                      | 1.3          | 2 bits | 4 states     | 0      | 0 to 3     | 0b00-Level > Threshold 1 (15%)<br>0b01-Threshold 1 > Level > Threshold 2 (10%)<br>0b10-Threshold 2 > Level > Threshold 3 (5 %)<br>0b11-Threshold 3 > Level<br>Thresholds are application parameters set by DEUTZ                                                                    |
| <b>EPA2</b>                                                      | <b>PGN 0xFF4F 65359</b> | <b>Proprietary Deutz</b> |              |        |              |        |            |                                                                                                                                                                                                                                                                                     |
| J1939 Parameter Name                                             | SPN                     | Byte Position            | Bit Position | Length | Scale Factor | Offset | Data Range |                                                                                                                                                                                                                                                                                     |
| Restriction level according to SCR efficiency rate / DEF Quality | N/A                     | 1.1                      | 1.1          | 2 bits | 4 states     | 0      | 0 to 3     | 0b00-no restriction<br>0b01-Level 1 Warning, power reduction after a delay time possible<br>0b10-Level 2 torque reduction step 1 (early inducement)<br>0b11-Level 3 torque reduction step 2 (severe inducement)                                                                     |
| <b>EPA 3</b>                                                     | <b>PGN 0xFF2E 65326</b> | <b>Proprietary Deutz</b> |              |        |              |        |            |                                                                                                                                                                                                                                                                                     |
| J1939 Parameter Name                                             | SPN                     | Byte Position            | Bit Position | Length | Scale Factor | Offset | Data Range |                                                                                                                                                                                                                                                                                     |
| Aftertreatment SCR Operator Inducement Reason                    | N/A                     | 1.1                      | 1.1          | 3 bits | 8 states     | 0      | 0 to 7     | 0b000-No inducement active<br>0b001-Reagent Level Low<br>0b010-Incorrect Quality<br>0b011-Incorrect Consumption (not available)<br>0b100-Tampering<br>0b101-Spare (not available)<br>0b110-Error (Hardware –Failure)<br>0b111-Not Available / Not Supported (No SCR system mounted) |
| <b>Alternate Fuel 1</b>                                          | <b>PGN 0xFEFD 65277</b> | <b>Standard</b>          |              |        |              |        |            |                                                                                                                                                                                                                                                                                     |

| J1939<br>Parameter<br>Name                             | SPN                             | Byte<br>Position | Bit<br>Position | Length  | Scale<br>Factor | Offset | Data<br>Range     |  |
|--------------------------------------------------------|---------------------------------|------------------|-----------------|---------|-----------------|--------|-------------------|--|
| Engine Gaseous<br>Fuel Supply<br>Pressure 1            | 159                             | 2-3              | 2.1             | 2 bytes | 0.5 kPa per bit | 0 kPa  | 0 to 32 127.5 kPa |  |
|                                                        |                                 |                  |                 |         |                 |        |                   |  |
| <b>Engine Fluid<br/>Level/Pressure<br/>3</b>           | <b>PGN<br/>0xFDC1<br/>64961</b> | <b>Standard</b>  |                 |         |                 |        |                   |  |
| J1939<br>Parameter<br>Name                             | SPN                             | Byte<br>Position | Bit<br>Position | Length  | Scale<br>Factor | Offset | Data<br>Range     |  |
| Engine Throttle<br>Valve 1<br>Differential<br>Pressure | 5631                            | 7-8              | 7.1             | 2 bytes | 0.1 kPa per bit | 0 kPa  | 0 to 6 425.5 kPa  |  |



# H • Modbus® Coils

| Coil Number | Binary Point Name                    | R/W |
|-------------|--------------------------------------|-----|
| 1           | J1939BCH1_COMMS_FAIL_PREALARM        | R   |
| 2           | J1939BCH1_BATTERY_FAILURE_PREALARM   | R   |
| 3           | J1939BCH1_FAIL_PREALARM              | R   |
| 4           | J1939BCH1_AC_OFF_PREALARM            | R   |
| 5           | J1939BCH1_THERMAL_LIMIT_PREALARM     | R   |
| 6           | J1939BCH1_HI_OUTPUT_VOLTS_PREALARM   | R   |
| 7           | J1939BCH1_LO_OUTPUT_VOLTS_PREALARM   | R   |
| 8           | J1939BCH1_LO_CRANKING_VOLTS_PREALARM | R   |
| 9           | J1939BCH1_INVALID_SETTINGS_PREALARM  | R   |
| 10          | J1939BCH1_SINGLE_UNIT_FAIL_PREALARM  | R   |
| 11          | J1939BCH1_CHARGER_COMMS_ENABLED      | R   |
| 12          | J1939BCH1_CHARGER_CONFIG_IS_SENS     | R   |
| 13          | J1939BCH1_COMMS_FAIL_STATUS          | R   |
| 14          | J1939BCH1_BATTERY_FAILURE_STATUS     | R   |
| 15          | J1939BCH1_CHARGER_FAIL_STATUS        | R   |
| 16          | J1939BCH1_AC_OFF_STATUS              | R   |
| 17          | J1939BCH1_THERMAL_LIMIT_STATUS       | R   |
| 18          | J1939BCH1_HI_OUTPUT_VOLTS_STATUS     | R   |
| 19          | J1939BCH1_LO_OUTPUT_VOLTS_STATUS     | R   |
| 20          | J1939BCH1_LO_CRANKING_VOLTS_STATUS   | R   |
| 21          | J1939BCH1_INVALID_SETTINGS_STATUS    | R   |
| 22          | J1939BCH1_SINGLE_UNIT_FAIL_STATUS    | R   |
| 23          | J1939BCH2_COMMS_FAIL_PREALARM        | R   |
| 24          | J1939BCH2_BATTERY_FAILURE_PREALARM   | R   |
| 25          | J1939BCH2_FAIL_PREALARM              | R   |
| 26          | J1939BCH2_AC_OFF_PREALARM            | R   |
| 27          | J1939BCH2_THERMAL_LIMIT_PREALARM     | R   |
| 28          | J1939BCH2_HI_OUTPUT_VOLTS_PREALARM   | R   |
| 29          | J1939BCH2_LO_OUTPUT_VOLTS_PREALARM   | R   |
| 30          | J1939BCH2_LO_CRANKING_VOLTS_PREALARM | R   |
| 31          | J1939BCH2_INVALID_SETTINGS_PREALARM  | R   |
| 32          | J1939BCH2_SINGLE_UNIT_FAIL_PREALARM  | R   |
| 33          | J1939BCH2_CHARGER_COMMS_ENABLED      | R   |
| 34          | J1939BCH2_CHARGER_CONFIG_IS_SENS     | R   |
| 35          | J1939BCH2_COMMS_FAIL_STATUS          | R   |
| 36          | J1939BCH2_BATTERY_FAILURE_STATUS     | R   |
| 37          | J1939BCH2_CHARGER_FAIL_STATUS        | R   |
| 38          | J1939BCH2_AC_OFF_STATUS              | R   |
| 39          | J1939BCH2_THERMAL_LIMIT_STATUS       | R   |
| 40          | J1939BCH2_HI_OUTPUT_VOLTS_STATUS     | R   |
| 41          | J1939BCH2_LO_OUTPUT_VOLTS_STATUS     | R   |
| 42          | J1939BCH2_LO_CRANKING_VOLTS_STATUS   | R   |
| 43          | J1939BCH2_INVALID_SETTINGS_STATUS    | R   |
| 44          | J1939BCH2_SINGLE_UNIT_FAIL_STATUS    | R   |
| 45          | ACTIVE_DTC_EXISTS1                   | R   |
| 46          | ACTIVE_DTC_EXISTS2                   | R   |
| 47          | ACTIVE_DTC_EXISTS3                   | R   |
| 48          | ACTIVE_DTC_EXISTS4                   | R   |
| 49          | ACTIVE_DTC_EXISTS5                   | R   |
| 50          | ACTIVE_DTC_EXISTS6                   | R   |
| 51          | ACTIVE_DTC_EXISTS7                   | R   |
| 52          | ACTIVE_DTC_EXISTS8                   | R   |
| 53          | ACTIVE_DTC_EXISTS9                   | R   |
| 54          | ACTIVE_DTC_EXISTS10                  | R   |

|     |                                |   |
|-----|--------------------------------|---|
| 55  | ACTIVE DTC EXISTS11            | R |
| 56  | ACTIVE DTC EXISTS12            | R |
| 57  | ACTIVE DTC EXISTS13            | R |
| 58  | ACTIVE DTC EXISTS14            | R |
| 59  | ACTIVE DTC EXISTS15            | R |
| 60  | ACTIVE DTC EXISTS16            | R |
| 61  | AEM INPUT 1 OUT OF RANGE_ALARM | R |
| 62  | AEM INPUT 1 O1_ALARM           | R |
| 63  | AEM INPUT 1 O2_ALARM           | R |
| 64  | AEM INPUT 1 U1_ALARM           | R |
| 65  | AEM INPUT 1 U2_ALARM           | R |
| 66  | AEM INPUT 2 OUT OF RANGE_ALARM | R |
| 67  | AEM INPUT 2 O1_ALARM           | R |
| 68  | AEM INPUT 2 O2_ALARM           | R |
| 69  | AEM INPUT 2 U1_ALARM           | R |
| 70  | AEM INPUT 2 U2_ALARM           | R |
| 71  | AEM INPUT 3 OUT OF RANGE_ALARM | R |
| 72  | AEM INPUT 3 O1_ALARM           | R |
| 73  | AEM INPUT 3 O2_ALARM           | R |
| 74  | AEM INPUT 3 U1_ALARM           | R |
| 75  | AEM INPUT 3 U2_ALARM           | R |
| 76  | AEM INPUT 4 OUT OF RANGE_ALARM | R |
| 77  | AEM INPUT 4 O1_ALARM           | R |
| 78  | AEM INPUT 4 O2_ALARM           | R |
| 79  | AEM INPUT 4 U1_ALARM           | R |
| 80  | AEM INPUT 4 U2_ALARM           | R |
| 81  | AEM INPUT 5 OUT OF RANGE_ALARM | R |
| 82  | AEM INPUT 5 O1_ALARM           | R |
| 83  | AEM INPUT 5 O2_ALARM           | R |
| 84  | AEM INPUT 5 U1_ALARM           | R |
| 85  | AEM INPUT 5 U2_ALARM           | R |
| 86  | AEM INPUT 6 OUT OF RANGE_ALARM | R |
| 87  | AEM INPUT 6 O1_ALARM           | R |
| 88  | AEM INPUT 6 O2_ALARM           | R |
| 89  | AEM INPUT 6 U1_ALARM           | R |
| 90  | AEM INPUT 6 U2_ALARM           | R |
| 91  | AEM INPUT 7 OUT OF RANGE_ALARM | R |
| 92  | AEM INPUT 7 O1_ALARM           | R |
| 93  | AEM INPUT 7 O2_ALARM           | R |
| 94  | AEM INPUT 7 U1_ALARM           | R |
| 95  | AEM INPUT 7 U2_ALARM           | R |
| 96  | AEM INPUT 8 OUT OF RANGE_ALARM | R |
| 97  | AEM INPUT 8 O1_ALARM           | R |
| 98  | AEM INPUT 8 O2_ALARM           | R |
| 99  | AEM INPUT 8 U1_ALARM           | R |
| 100 | AEM INPUT 8 U2_ALARM           | R |
| 101 | RTD INPUT 1 OUT OF RANGE_ALARM | R |
| 102 | RTD INPUT 1 O1_ALARM           | R |
| 103 | RTD INPUT 1 O2_ALARM           | R |
| 104 | RTD INPUT 1 U1_ALARM           | R |
| 105 | RTD INPUT 1 U2_ALARM           | R |
| 106 | RTD INPUT 2 OUT OF RANGE_ALARM | R |
| 107 | RTD INPUT 2 O1_ALARM           | R |
| 108 | RTD INPUT 2 O2_ALARM           | R |
| 109 | RTD INPUT 2 U1_ALARM           | R |
| 110 | RTD INPUT 2 U2_ALARM           | R |
| 111 | RTD INPUT 3 OUT OF RANGE_ALARM | R |
| 112 | RTD INPUT 3 O1_ALARM           | R |
| 113 | RTD INPUT 3 O2_ALARM           | R |

|     |                                     |   |
|-----|-------------------------------------|---|
| 114 | RTD INPUT 3 U1 ALARM                | R |
| 115 | RTD INPUT 3 U2 ALARM                | R |
| 116 | RTD INPUT 4 OUT OF RANGE ALARM      | R |
| 117 | RTD INPUT 4 O1 ALARM                | R |
| 118 | RTD INPUT 4 O2 ALARM                | R |
| 119 | RTD INPUT 4 U1 ALARM                | R |
| 120 | RTD INPUT 4 U2 ALARM                | R |
| 121 | RTD INPUT 5 OUT OF RANGE ALARM      | R |
| 122 | RTD INPUT 5 O1 ALARM                | R |
| 123 | RTD INPUT 5 O2 ALARM                | R |
| 124 | RTD INPUT 5 U1 ALARM                | R |
| 125 | RTD INPUT 5 U2 ALARM                | R |
| 126 | RTD INPUT 6 OUT OF RANGE ALARM      | R |
| 127 | RTD INPUT 6 O1 ALARM                | R |
| 128 | RTD INPUT 6 O2 ALARM                | R |
| 129 | RTD INPUT 6 U1 ALARM                | R |
| 130 | RTD INPUT 6 U2 ALARM                | R |
| 131 | RTD INPUT 7 OUT OF RANGE ALARM      | R |
| 132 | RTD INPUT 7 O1 ALARM                | R |
| 133 | RTD INPUT 7 O2 ALARM                | R |
| 134 | RTD INPUT 7 U1 ALARM                | R |
| 135 | RTD INPUT 7 U2 ALARM                | R |
| 136 | RTD INPUT 8 OUT OF RANGE ALARM      | R |
| 137 | RTD INPUT 8 O1 ALARM                | R |
| 138 | RTD INPUT 8 O2 ALARM                | R |
| 139 | RTD INPUT 8 U1 ALARM                | R |
| 140 | RTD INPUT 8 U2 ALARM                | R |
| 141 | THERMAL COUPLE 1 OUT OF RANGE ALARM | R |
| 142 | THERMAL COUPLE 1 O1 ALARM           | R |
| 143 | THERMAL COUPLE 1 O2 ALARM           | R |
| 144 | THERMAL COUPLE 1 U1 ALARM           | R |
| 145 | THERMAL COUPLE 1 U2 ALARM           | R |
| 146 | THERMAL COUPLE 2 OUT OF RANGE ALARM | R |
| 147 | THERMAL COUPLE 2 O1 ALARM           | R |
| 148 | THERMAL COUPLE 2 O2 ALARM           | R |
| 149 | THERMAL COUPLE 2 U1 ALARM           | R |
| 150 | THERMAL COUPLE 2 U2 ALARM           | R |
| 151 | AEM OUTPUT 1 OUT OF RANGE ALARM     | R |
| 152 | AEM OUTPUT 2 OUT OF RANGE ALARM     | R |
| 153 | AEM OUTPUT 3 OUT OF RANGE ALARM     | R |
| 154 | AEM OUTPUT 4 OUT OF RANGE ALARM     | R |
| 155 | AEM COMMS FAILURE                   | R |
| 156 | DUP AEM PREALARM                    | R |
| 157 | AEM INPUT 1 OUT OF RANGE PREALARM   | R |
| 158 | AEM INPUT 1 O1 PREALARM             | R |
| 159 | AEM INPUT 1 O2 PREALARM             | R |
| 160 | AEM INPUT 1 U1 PREALARM             | R |
| 161 | AEM INPUT 1 U2 PREALARM             | R |
| 162 | AEM INPUT 2 OUT OF RANGE PREALARM   | R |
| 163 | AEM INPUT 2 O1 PREALARM             | R |
| 164 | AEM INPUT 2 O2 PREALARM             | R |
| 165 | AEM INPUT 2 U1 PREALARM             | R |
| 166 | AEM INPUT 2 U2 PREALARM             | R |
| 167 | AEM INPUT 3 OUT OF RANGE PREALARM   | R |
| 168 | AEM INPUT 3 O1 PREALARM             | R |
| 169 | AEM INPUT 3 O2 PREALARM             | R |
| 170 | AEM INPUT 3 U1 PREALARM             | R |
| 171 | AEM INPUT 3 U2 PREALARM             | R |
| 172 | AEM INPUT 4 OUT OF RANGE PREALARM   | R |

|     |                                   |   |
|-----|-----------------------------------|---|
| 173 | AEM INPUT 4 O1 PREALARM           | R |
| 174 | AEM INPUT 4 O2 PREALARM           | R |
| 175 | AEM INPUT 4 U1 PREALARM           | R |
| 176 | AEM INPUT 4 U2 PREALARM           | R |
| 177 | AEM INPUT 5 OUT OF RANGE PREALARM | R |
| 178 | AEM INPUT 5 O1 PREALARM           | R |
| 179 | AEM INPUT 5 O2 PREALARM           | R |
| 180 | AEM INPUT 5 U1 PREALARM           | R |
| 181 | AEM INPUT 5 U2 PREALARM           | R |
| 182 | AEM INPUT 6 OUT OF RANGE PREALARM | R |
| 183 | AEM INPUT 6 O1 PREALARM           | R |
| 184 | AEM INPUT 6 O2 PREALARM           | R |
| 185 | AEM INPUT 6 U1 PREALARM           | R |
| 186 | AEM INPUT 6 U2 PREALARM           | R |
| 187 | AEM INPUT 7 OUT OF RANGE PREALARM | R |
| 188 | AEM INPUT 7 O1 PREALARM           | R |
| 189 | AEM INPUT 7 O2 PREALARM           | R |
| 190 | AEM INPUT 7 U1 PREALARM           | R |
| 191 | AEM INPUT 7 U2 PREALARM           | R |
| 192 | AEM INPUT 8 OUT OF RANGE PREALARM | R |
| 193 | AEM INPUT 8 O1 PREALARM           | R |
| 194 | AEM INPUT 8 O2 PREALARM           | R |
| 195 | AEM INPUT 8 U1 PREALARM           | R |
| 196 | AEM INPUT 8 U2 PREALARM           | R |
| 197 | RTD INPUT 1 OUT OF RANGE PREALARM | R |
| 198 | RTD INPUT 1 O1 PREALARM           | R |
| 199 | RTD INPUT 1 O2 PREALARM           | R |
| 200 | RTD INPUT 1 U1 PREALARM           | R |
| 201 | RTD INPUT 1 U2 PREALARM           | R |
| 202 | RTD INPUT 2 OUT OF RANGE PREALARM | R |
| 203 | RTD INPUT 2 O1 PREALARM           | R |
| 204 | RTD INPUT 2 O2 PREALARM           | R |
| 205 | RTD INPUT 2 U1 PREALARM           | R |
| 206 | RTD INPUT 2 U2 PREALARM           | R |
| 207 | RTD INPUT 3 OUT OF RANGE PREALARM | R |
| 208 | RTD INPUT 3 O1 PREALARM           | R |
| 209 | RTD INPUT 3 O2 PREALARM           | R |
| 210 | RTD INPUT 3 U1 PREALARM           | R |
| 211 | RTD INPUT 3 U2 PREALARM           | R |
| 212 | RTD INPUT 4 OUT OF RANGE PREALARM | R |
| 213 | RTD INPUT 4 O1 PREALARM           | R |
| 214 | RTD INPUT 4 O2 PREALARM           | R |
| 215 | RTD INPUT 4 U1 PREALARM           | R |
| 216 | RTD INPUT 4 U2 PREALARM           | R |
| 217 | RTD INPUT 5 OUT OF RANGE PREALARM | R |
| 218 | RTD INPUT 5 O1 PREALARM           | R |
| 219 | RTD INPUT 5 O2 PREALARM           | R |
| 220 | RTD INPUT 5 U1 PREALARM           | R |
| 221 | RTD INPUT 5 U2 PREALARM           | R |
| 222 | RTD INPUT 6 OUT OF RANGE PREALARM | R |
| 223 | RTD INPUT 6 O1 PREALARM           | R |
| 224 | RTD INPUT 6 O2 PREALARM           | R |
| 225 | RTD INPUT 6 U1 PREALARM           | R |
| 226 | RTD INPUT 6 U2 PREALARM           | R |
| 227 | RTD INPUT 7 OUT OF RANGE PREALARM | R |
| 228 | RTD INPUT 7 O1 PREALARM           | R |
| 229 | RTD INPUT 7 O2 PREALARM           | R |
| 230 | RTD INPUT 7 U1 PREALARM           | R |
| 231 | RTD INPUT 7 U2 PREALARM           | R |



|     |                                        |   |
|-----|----------------------------------------|---|
| 232 | RTD INPUT 8 OUT OF RANGE PREALARM      | R |
| 233 | RTD INPUT 8 O1 PREALARM                | R |
| 234 | RTD INPUT 8 O2 PREALARM                | R |
| 235 | RTD INPUT 8 U1 PREALARM                | R |
| 236 | RTD INPUT 8 U2 PREALARM                | R |
| 237 | THERMAL COUPLE 1 OUT OF RANGE PREALARM | R |
| 238 | THERMAL COUPLE 1 O1 PREALARM           | R |
| 239 | THERMAL COUPLE 1 O2 PREALARM           | R |
| 240 | THERMAL COUPLE 1 U1 PREALARM           | R |
| 241 | THERMAL COUPLE 1 U2 PREALARM           | R |
| 242 | THERMAL COUPLE 2 OUT OF RANGE PREALARM | R |
| 243 | THERMAL COUPLE 2 O1 PREALARM           | R |
| 244 | THERMAL COUPLE 2 O2 PREALARM           | R |
| 245 | THERMAL COUPLE 2 U1 PREALARM           | R |
| 246 | THERMAL COUPLE 2 U2 PREALARM           | R |
| 247 | AEM OUTPUT 1 OUT OF RANGE PREALARM     | R |
| 248 | AEM OUTPUT 2 OUT OF RANGE PREALARM     | R |
| 249 | AEM OUTPUT 3 OUT OF RANGE PREALARM     | R |
| 250 | AEM OUTPUT 4 OUT OF RANGE PREALARM     | R |
| 251 | AEM INPUT 1 OUT OF RANGE STATUS        | R |
| 252 | AEM INPUT 1 O1 STATUS                  | R |
| 253 | AEM INPUT 1 O2 STATUS                  | R |
| 254 | AEM INPUT 1 U1 STATUS                  | R |
| 255 | AEM INPUT 1 U2 STATUS                  | R |
| 256 | AEM INPUT 2 OUT OF RANGE STATUS        | R |
| 257 | AEM INPUT 2 O1 STATUS                  | R |
| 258 | AEM INPUT 2 O2 STATUS                  | R |
| 259 | AEM INPUT 2 U1 STATUS                  | R |
| 260 | AEM INPUT 2 U2 STATUS                  | R |
| 261 | AEM INPUT 3 OUT OF RANGE STATUS        | R |
| 262 | AEM INPUT 3 O1 STATUS                  | R |
| 263 | AEM INPUT 3 O2 STATUS                  | R |
| 264 | AEM INPUT 3 U1 STATUS                  | R |
| 265 | AEM INPUT 3 U2 STATUS                  | R |
| 266 | AEM INPUT 4 OUT OF RANGE STATUS        | R |
| 267 | AEM INPUT 4 O1 STATUS                  | R |
| 268 | AEM INPUT 4 O2 STATUS                  | R |
| 269 | AEM INPUT 4 U1 STATUS                  | R |
| 270 | AEM INPUT 4 U2 STATUS                  | R |
| 271 | AEM INPUT 5 OUT OF RANGE STATUS        | R |
| 272 | AEM INPUT 5 O1 STATUS                  | R |
| 273 | AEM INPUT 5 O2 STATUS                  | R |
| 274 | AEM INPUT 5 U1 STATUS                  | R |
| 275 | AEM INPUT 5 U2 STATUS                  | R |
| 276 | AEM INPUT 6 OUT OF RANGE STATUS        | R |
| 277 | AEM INPUT 6 O1 STATUS                  | R |
| 278 | AEM INPUT 6 O2 STATUS                  | R |
| 279 | AEM INPUT 6 U1 STATUS                  | R |
| 280 | AEM INPUT 6 U2 STATUS                  | R |
| 281 | AEM INPUT 7 OUT OF RANGE STATUS        | R |
| 282 | AEM INPUT 7 O1 STATUS                  | R |
| 283 | AEM INPUT 7 O2 STATUS                  | R |
| 284 | AEM INPUT 7 U1 STATUS                  | R |
| 285 | AEM INPUT 7 U2 STATUS                  | R |
| 286 | AEM INPUT 8 OUT OF RANGE STATUS        | R |
| 287 | AEM INPUT 8 O1 STATUS                  | R |
| 288 | AEM INPUT 8 O2 STATUS                  | R |
| 289 | AEM INPUT 8 U1 STATUS                  | R |
| 290 | AEM INPUT 8 U2 STATUS                  | R |

|     |                                      |   |
|-----|--------------------------------------|---|
| 291 | RTD_INPUT_1_OUT_OF_RANGE_STATUS      | R |
| 292 | RTD_INPUT_1_O1_STATUS                | R |
| 293 | RTD_INPUT_1_O2_STATUS                | R |
| 294 | RTD_INPUT_1_U1_STATUS                | R |
| 295 | RTD_INPUT_1_U2_STATUS                | R |
| 296 | RTD_INPUT_2_OUT_OF_RANGE_STATUS      | R |
| 297 | RTD_INPUT_2_O1_STATUS                | R |
| 298 | RTD_INPUT_2_O2_STATUS                | R |
| 299 | RTD_INPUT_2_U1_STATUS                | R |
| 300 | RTD_INPUT_2_U2_STATUS                | R |
| 301 | RTD_INPUT_3_OUT_OF_RANGE_STATUS      | R |
| 302 | RTD_INPUT_3_O1_STATUS                | R |
| 303 | RTD_INPUT_3_O2_STATUS                | R |
| 304 | RTD_INPUT_3_U1_STATUS                | R |
| 305 | RTD_INPUT_3_U2_STATUS                | R |
| 306 | RTD_INPUT_4_OUT_OF_RANGE_STATUS      | R |
| 307 | RTD_INPUT_4_O1_STATUS                | R |
| 308 | RTD_INPUT_4_O2_STATUS                | R |
| 309 | RTD_INPUT_4_U1_STATUS                | R |
| 310 | RTD_INPUT_4_U2_STATUS                | R |
| 311 | RTD_INPUT_5_OUT_OF_RANGE_STATUS      | R |
| 312 | RTD_INPUT_5_O1_STATUS                | R |
| 313 | RTD_INPUT_5_O2_STATUS                | R |
| 314 | RTD_INPUT_5_U1_STATUS                | R |
| 315 | RTD_INPUT_5_U2_STATUS                | R |
| 316 | RTD_INPUT_6_OUT_OF_RANGE_STATUS      | R |
| 317 | RTD_INPUT_6_O1_STATUS                | R |
| 318 | RTD_INPUT_6_O2_STATUS                | R |
| 319 | RTD_INPUT_6_U1_STATUS                | R |
| 320 | RTD_INPUT_6_U2_STATUS                | R |
| 321 | RTD_INPUT_7_OUT_OF_RANGE_STATUS      | R |
| 322 | RTD_INPUT_7_O1_STATUS                | R |
| 323 | RTD_INPUT_7_O2_STATUS                | R |
| 324 | RTD_INPUT_7_U1_STATUS                | R |
| 325 | RTD_INPUT_7_U2_STATUS                | R |
| 326 | RTD_INPUT_8_OUT_OF_RANGE_STATUS      | R |
| 327 | RTD_INPUT_8_O1_STATUS                | R |
| 328 | RTD_INPUT_8_O2_STATUS                | R |
| 329 | RTD_INPUT_8_U1_STATUS                | R |
| 330 | RTD_INPUT_8_U2_STATUS                | R |
| 331 | THERMAL_COUPLE_1_OUT_OF_RANGE_STATUS | R |
| 332 | THERMAL_COUPLE_1_O1_STATUS           | R |
| 333 | THERMAL_COUPLE_1_O2_STATUS           | R |
| 334 | THERMAL_COUPLE_1_U1_STATUS           | R |
| 335 | THERMAL_COUPLE_1_U2_STATUS           | R |
| 336 | THERMAL_COUPLE_2_OUT_OF_RANGE_STATUS | R |
| 337 | THERMAL_COUPLE_2_O1_STATUS           | R |
| 338 | THERMAL_COUPLE_2_O2_STATUS           | R |
| 339 | THERMAL_COUPLE_2_U1_STATUS           | R |
| 340 | THERMAL_COUPLE_2_U2_STATUS           | R |
| 341 | AEM_OUTPUT_1_OUT_OF_RANGE_STATUS     | R |
| 342 | AEM_OUTPUT_2_OUT_OF_RANGE_STATUS     | R |
| 343 | AEM_OUTPUT_3_OUT_OF_RANGE_STATUS     | R |
| 344 | AEM_OUTPUT_4_OUT_OF_RANGE_STATUS     | R |
| 345 | OVERSPEED_ALARM                      | R |
| 346 | HI_COOLANT_TEMP_ALARM                | R |
| 347 | LOW_OIL_PRESSURE_ALARM               | R |
| 348 | LOW_FUEL_LEVEL_ALARM                 | R |
| 349 | GLOBAL_SENDER_FAIL_ALARM             | R |

|     |                               |   |
|-----|-------------------------------|---|
| 350 | LOSS OF ECU COMM_ALARM        | R |
| 351 | OVERCRANK_ALARM               | R |
| 352 | EMERGENCY_STOP_ALARM          | R |
| 353 | ECU_SHUTDOWN_ALARM            | R |
| 354 | LOW_COOLANT_LEVEL_ALARM       | R |
| 355 | MAINS_FAIL_TRANSFER_FAIL      | R |
| 356 | BATT_CHRG_FAIL_ALARM          | R |
| 357 | FUEL_LEAK_DETECT_ALARM        | R |
| 358 | AUTO_RESTART_FAIL_ALARM       | R |
| 359 | GLOBAL_ALARM                  | R |
| 360 | UNEXPECTED_SHUTDOWN_ALARM_BP  | R |
| 361 | EXHAUST_SYSTEM_ERROR_ALARM    | R |
| 362 | DIAGNOSTIC_TROUBLE_CODE_ALARM | R |
| 363 | DEF_SEVERE_INDUCEMENT_ALARM   | R |
| 364 | COOL_LEVEL_SENDER_FAIL_ALARM  | R |
| 365 | CEM_COMMS_FAILURE             | R |
| 366 | DUP_CEM_PREALARM              | R |
| 367 | CEM_HW_MISMATCH               | R |
| 368 | CONF_PROT_1_O1_ALARM          | R |
| 369 | CONF_PROT_1_O2_ALARM          | R |
| 370 | CONF_PROT_1_U1_ALARM          | R |
| 371 | CONF_PROT_1_U2_ALARM          | R |
| 372 | CONF_PROT_2_O1_ALARM          | R |
| 373 | CONF_PROT_2_O2_ALARM          | R |
| 374 | CONF_PROT_2_U1_ALARM          | R |
| 375 | CONF_PROT_2_U2_ALARM          | R |
| 376 | CONF_PROT_3_O1_ALARM          | R |
| 377 | CONF_PROT_3_O2_ALARM          | R |
| 378 | CONF_PROT_3_U1_ALARM          | R |
| 379 | CONF_PROT_3_U2_ALARM          | R |
| 380 | CONF_PROT_4_O1_ALARM          | R |
| 381 | CONF_PROT_4_O2_ALARM          | R |
| 382 | CONF_PROT_4_U1_ALARM          | R |
| 383 | CONF_PROT_4_U2_ALARM          | R |
| 384 | CONF_PROT_5_O1_ALARM          | R |
| 385 | CONF_PROT_5_O2_ALARM          | R |
| 386 | CONF_PROT_5_U1_ALARM          | R |
| 387 | CONF_PROT_5_U2_ALARM          | R |
| 388 | CONF_PROT_6_O1_ALARM          | R |
| 389 | CONF_PROT_6_O2_ALARM          | R |
| 390 | CONF_PROT_6_U1_ALARM          | R |
| 391 | CONF_PROT_6_U2_ALARM          | R |
| 392 | CONF_PROT_7_O1_ALARM          | R |
| 393 | CONF_PROT_7_O2_ALARM          | R |
| 394 | CONF_PROT_7_U1_ALARM          | R |
| 395 | CONF_PROT_7_U2_ALARM          | R |
| 396 | CONF_PROT_8_O1_ALARM          | R |
| 397 | CONF_PROT_8_O2_ALARM          | R |
| 398 | CONF_PROT_8_U1_ALARM          | R |
| 399 | CONF_PROT_8_U2_ALARM          | R |
| 400 | CONF_PROT_1_O1_PREALARM       | R |
| 401 | CONF_PROT_1_O2_PREALARM       | R |
| 402 | CONF_PROT_1_U1_PREALARM       | R |
| 403 | CONF_PROT_1_U2_PREALARM       | R |
| 404 | CONF_PROT_2_O1_PREALARM       | R |
| 405 | CONF_PROT_2_O2_PREALARM       | R |
| 406 | CONF_PROT_2_U1_PREALARM       | R |
| 407 | CONF_PROT_2_U2_PREALARM       | R |
| 408 | CONF_PROT_3_O1_PREALARM       | R |

|     |                         |   |
|-----|-------------------------|---|
| 409 | CONF_PROT_3_O2_PREALARM | R |
| 410 | CONF_PROT_3_U1_PREALARM | R |
| 411 | CONF_PROT_3_U2_PREALARM | R |
| 412 | CONF_PROT_4_O1_PREALARM | R |
| 413 | CONF_PROT_4_O2_PREALARM | R |
| 414 | CONF_PROT_4_U1_PREALARM | R |
| 415 | CONF_PROT_4_U2_PREALARM | R |
| 416 | CONF_PROT_5_O1_PREALARM | R |
| 417 | CONF_PROT_5_O2_PREALARM | R |
| 418 | CONF_PROT_5_U1_PREALARM | R |
| 419 | CONF_PROT_5_U2_PREALARM | R |
| 420 | CONF_PROT_6_O1_PREALARM | R |
| 421 | CONF_PROT_6_O2_PREALARM | R |
| 422 | CONF_PROT_6_U1_PREALARM | R |
| 423 | CONF_PROT_6_U2_PREALARM | R |
| 424 | CONF_PROT_7_O1_PREALARM | R |
| 425 | CONF_PROT_7_O2_PREALARM | R |
| 426 | CONF_PROT_7_U1_PREALARM | R |
| 427 | CONF_PROT_7_U2_PREALARM | R |
| 428 | CONF_PROT_8_O1_PREALARM | R |
| 429 | CONF_PROT_8_O2_PREALARM | R |
| 430 | CONF_PROT_8_U1_PREALARM | R |
| 431 | CONF_PROT_8_U2_PREALARM | R |
| 432 | CONF_PROT_1_O1_STATUS   | R |
| 433 | CONF_PROT_1_O2_STATUS   | R |
| 434 | CONF_PROT_1_U1_STATUS   | R |
| 435 | CONF_PROT_1_U2_STATUS   | R |
| 436 | CONF_PROT_2_O1_STATUS   | R |
| 437 | CONF_PROT_2_O2_STATUS   | R |
| 438 | CONF_PROT_2_U1_STATUS   | R |
| 439 | CONF_PROT_2_U2_STATUS   | R |
| 440 | CONF_PROT_3_O1_STATUS   | R |
| 441 | CONF_PROT_3_O2_STATUS   | R |
| 442 | CONF_PROT_3_U1_STATUS   | R |
| 443 | CONF_PROT_3_U2_STATUS   | R |
| 444 | CONF_PROT_4_O1_STATUS   | R |
| 445 | CONF_PROT_4_O2_STATUS   | R |
| 446 | CONF_PROT_4_U1_STATUS   | R |
| 447 | CONF_PROT_4_U2_STATUS   | R |
| 448 | CONF_PROT_5_O1_STATUS   | R |
| 449 | CONF_PROT_5_O2_STATUS   | R |
| 450 | CONF_PROT_5_U1_STATUS   | R |
| 451 | CONF_PROT_5_U2_STATUS   | R |
| 452 | CONF_PROT_6_O1_STATUS   | R |
| 453 | CONF_PROT_6_O2_STATUS   | R |
| 454 | CONF_PROT_6_U1_STATUS   | R |
| 455 | CONF_PROT_6_U2_STATUS   | R |
| 456 | CONF_PROT_7_O1_STATUS   | R |
| 457 | CONF_PROT_7_O2_STATUS   | R |
| 458 | CONF_PROT_7_U1_STATUS   | R |
| 459 | CONF_PROT_7_U2_STATUS   | R |
| 460 | CONF_PROT_8_O1_STATUS   | R |
| 461 | CONF_PROT_8_O2_STATUS   | R |
| 462 | CONF_PROT_8_U1_STATUS   | R |
| 463 | CONF_PROT_8_U2_STATUS   | R |
| 464 | CONFIG_ELEMENT_1_ALARM  | R |
| 465 | CONFIG_ELEMENT_2_ALARM  | R |
| 466 | CONFIG_ELEMENT_3_ALARM  | R |
| 467 | CONFIG_ELEMENT_4_ALARM  | R |

|     |                               |   |
|-----|-------------------------------|---|
| 468 | CONFIG_ELEMENT_5_ALARM        | R |
| 469 | CONFIG_ELEMENT_6_ALARM        | R |
| 470 | CONFIG_ELEMENT_7_ALARM        | R |
| 471 | CONFIG_ELEMENT_8_ALARM        | R |
| 472 | CONFIG_ELEMENT_1_PREALARM     | R |
| 473 | CONFIG_ELEMENT_2_PREALARM     | R |
| 474 | CONFIG_ELEMENT_3_PREALARM     | R |
| 475 | CONFIG_ELEMENT_4_PREALARM     | R |
| 476 | CONFIG_ELEMENT_5_PREALARM     | R |
| 477 | CONFIG_ELEMENT_6_PREALARM     | R |
| 478 | CONFIG_ELEMENT_7_PREALARM     | R |
| 479 | CONFIG_ELEMENT_8_PREALARM     | R |
| 480 | CONFIG_ELEMENT_1_STATUS       | R |
| 481 | CONFIG_ELEMENT_2_STATUS       | R |
| 482 | CONFIG_ELEMENT_3_STATUS       | R |
| 483 | CONFIG_ELEMENT_4_STATUS       | R |
| 484 | CONFIG_ELEMENT_5_STATUS       | R |
| 485 | CONFIG_ELEMENT_6_STATUS       | R |
| 486 | CONFIG_ELEMENT_7_STATUS       | R |
| 487 | CONFIG_ELEMENT_8_STATUS       | R |
| 488 | USER_CONFIGURABLE_1_ALARM     | R |
| 489 | USER_CONFIGURABLE_2_ALARM     | R |
| 490 | USER_CONFIGURABLE_3_ALARM     | R |
| 491 | USER_CONFIGURABLE_4_ALARM     | R |
| 492 | USER_CONFIGURABLE_5_ALARM     | R |
| 493 | USER_CONFIGURABLE_6_ALARM     | R |
| 494 | USER_CONFIGURABLE_7_ALARM     | R |
| 495 | USER_CONFIGURABLE_8_ALARM     | R |
| 496 | USER_CONFIGURABLE_9_ALARM     | R |
| 497 | USER_CONFIGURABLE_10_ALARM    | R |
| 498 | USER_CONFIGURABLE_11_ALARM    | R |
| 499 | USER_CONFIGURABLE_12_ALARM    | R |
| 500 | USER_CONFIGURABLE_13_ALARM    | R |
| 501 | USER_CONFIGURABLE_14_ALARM    | R |
| 502 | USER_CONFIGURABLE_15_ALARM    | R |
| 503 | USER_CONFIGURABLE_16_ALARM    | R |
| 504 | USER_CONFIGURABLE_1_PREALARM  | R |
| 505 | USER_CONFIGURABLE_2_PREALARM  | R |
| 506 | USER_CONFIGURABLE_3_PREALARM  | R |
| 507 | USER_CONFIGURABLE_4_PREALARM  | R |
| 508 | USER_CONFIGURABLE_5_PREALARM  | R |
| 509 | USER_CONFIGURABLE_6_PREALARM  | R |
| 510 | USER_CONFIGURABLE_7_PREALARM  | R |
| 511 | USER_CONFIGURABLE_8_PREALARM  | R |
| 512 | USER_CONFIGURABLE_9_PREALARM  | R |
| 513 | USER_CONFIGURABLE_10_PREALARM | R |
| 514 | USER_CONFIGURABLE_11_PREALARM | R |
| 515 | USER_CONFIGURABLE_12_PREALARM | R |
| 516 | USER_CONFIGURABLE_13_PREALARM | R |
| 517 | USER_CONFIGURABLE_14_PREALARM | R |
| 518 | USER_CONFIGURABLE_15_PREALARM | R |
| 519 | USER_CONFIGURABLE_16_PREALARM | R |
| 520 | EVENT_SLOT_FILLED1            | R |
| 521 | EVENT_SLOT_FILLED2            | R |
| 522 | EVENT_SLOT_FILLED3            | R |
| 523 | EVENT_SLOT_FILLED4            | R |
| 524 | EVENT_SLOT_FILLED5            | R |
| 525 | EVENT_SLOT_FILLED6            | R |
| 526 | EVENT_SLOT_FILLED7            | R |

|     |                             |   |
|-----|-----------------------------|---|
| 527 | EVENT_SLOT_FILLED8          | R |
| 528 | EVENT_SLOT_FILLED9          | R |
| 529 | EVENT_SLOT_FILLED10         | R |
| 530 | EVENT_SLOT_FILLED11         | R |
| 531 | EVENT_SLOT_FILLED12         | R |
| 532 | EVENT_SLOT_FILLED13         | R |
| 533 | EVENT_SLOT_FILLED14         | R |
| 534 | EVENT_SLOT_FILLED15         | R |
| 535 | EVENT_SLOT_FILLED16         | R |
| 536 | EVENT_SLOT_FILLED17         | R |
| 537 | EVENT_SLOT_FILLED18         | R |
| 538 | EVENT_SLOT_FILLED19         | R |
| 539 | EVENT_SLOT_FILLED20         | R |
| 540 | EVENT_SLOT_FILLED21         | R |
| 541 | EVENT_SLOT_FILLED22         | R |
| 542 | EVENT_SLOT_FILLED23         | R |
| 543 | EVENT_SLOT_FILLED24         | R |
| 544 | EVENT_SLOT_FILLED25         | R |
| 545 | EVENT_SLOT_FILLED26         | R |
| 546 | EVENT_SLOT_FILLED27         | R |
| 547 | EVENT_SLOT_FILLED28         | R |
| 548 | EVENT_SLOT_FILLED29         | R |
| 549 | EVENT_SLOT_FILLED30         | R |
| 550 | EVENT_SLOT_FILLED31         | R |
| 551 | EVENT_SLOT_FILLED32         | R |
| 552 | EVENT_SLOT_FILLED33         | R |
| 553 | EVENT_SLOT_FILLED34         | R |
| 554 | EVENT_SLOT_FILLED35         | R |
| 555 | EVENT_SLOT_FILLED36         | R |
| 556 | EVENT_SLOT_FILLED37         | R |
| 557 | EVENT_SLOT_FILLED38         | R |
| 558 | EVENT_SLOT_FILLED39         | R |
| 559 | EVENT_SLOT_FILLED40         | R |
| 560 | EVENT_SLOT_FILLED41         | R |
| 561 | EVENT_SLOT_FILLED42         | R |
| 562 | EVENT_SLOT_FILLED43         | R |
| 563 | EVENT_SLOT_FILLED44         | R |
| 564 | EVENT_SLOT_FILLED45         | R |
| 565 | EVENT_SLOT_FILLED46         | R |
| 566 | EVENT_SLOT_FILLED47         | R |
| 567 | EVENT_SLOT_FILLED48         | R |
| 568 | EVENT_SLOT_FILLED49         | R |
| 569 | EVENT_SLOT_FILLED50         | R |
| 570 | FACTORY_EVENT_SLOT_FILLED1  | R |
| 571 | FACTORY_EVENT_SLOT_FILLED2  | R |
| 572 | FACTORY_EVENT_SLOT_FILLED3  | R |
| 573 | FACTORY_EVENT_SLOT_FILLED4  | R |
| 574 | FACTORY_EVENT_SLOT_FILLED5  | R |
| 575 | FACTORY_EVENT_SLOT_FILLED6  | R |
| 576 | FACTORY_EVENT_SLOT_FILLED7  | R |
| 577 | FACTORY_EVENT_SLOT_FILLED8  | R |
| 578 | FACTORY_EVENT_SLOT_FILLED9  | R |
| 579 | FACTORY_EVENT_SLOT_FILLED10 | R |
| 580 | _51_TRIP_ALARM              | R |
| 581 | _47_TRIP_ALARM              | R |
| 582 | _27_TRIP_ALARM              | R |
| 583 | _59_TRIP_ALARM              | R |
| 584 | _81O_TRIP_ALARM             | R |
| 585 | _81U_TRIP_ALARM             | R |

|     |                                           |   |
|-----|-------------------------------------------|---|
| 586 | 151 TRIP ALARM                            | R |
| 587 | 127 TRIP ALARM                            | R |
| 588 | 159 TRIP ALARM                            | R |
| 589 | 32 TRIP ALARM                             | R |
| 590 | 40 TRIP ALARM                             | R |
| 591 | 251 TRIP ALARM                            | R |
| 592 | 78 TRIP ALARM                             | R |
| 593 | 81 ROC DFDT TRIP ALARM                    | R |
| 594 | 51 TRIP PREALARM                          | R |
| 595 | 47 TRIP PREALARM                          | R |
| 596 | 27 TRIP PREALARM                          | R |
| 597 | 59 TRIP PREALARM                          | R |
| 598 | 81O TRIP PREALARM                         | R |
| 599 | 81U TRIP PREALARM                         | R |
| 600 | 151 TRIP PREALARM                         | R |
| 601 | 127 TRIP PREALARM                         | R |
| 602 | 159 TRIP PREALARM                         | R |
| 603 | 32 TRIP PREALARM                          | R |
| 604 | 40 TRIP PREALARM                          | R |
| 605 | 251 TRIP PREALARM                         | R |
| 606 | 78 TRIP LATCHED PREALARM                  | R |
| 607 | 81 ROC DFDT TRIP LATCHED PREALARM         | R |
| 608 | 51 TRIP                                   | R |
| 609 | 47 TRIP                                   | R |
| 610 | 27 TRIP                                   | R |
| 611 | 59 TRIP                                   | R |
| 612 | 81O TRIP                                  | R |
| 613 | 81U TRIP                                  | R |
| 614 | 151 TRIP                                  | R |
| 615 | 127 TRIP                                  | R |
| 616 | 159 TRIP                                  | R |
| 617 | 32 TRIP                                   | R |
| 618 | 40 TRIP                                   | R |
| 619 | 251 TRIP                                  | R |
| 620 | 78 TRIP                                   | R |
| 621 | 81 ROC DFDT TRIP                          | R |
| 622 | LSM CONNECTED                             | R |
| 623 | CEM 1 CONNECTED                           | R |
| 624 | AEM 1 CONNECTED                           | R |
| 625 | SHUTDOWN BP                               | R |
| 626 | ALARM RESET FEEDBACK BP                   | R |
| 627 | BP_J1939 ENG COOLANT PREHEAT STATUS       | R |
| 628 | J1939 ENGINE WAIT TO START LAMP BP        | R |
| 629 | SCR CLEAN INHBT DUE TO SWITCH BP          | R |
| 630 | ISUZU NO POWER LAMP BP                    | R |
| 631 | ISUZU ESCAPE MODE LAMP BP                 | R |
| 632 | ISUZU EXHAUST SYSTEM LAMP BP              | R |
| 633 | DPF REGENERATE INHIBITED DUE TO SWITCH BP | R |
| 634 | DPF REGEN INHIBIT STATUS FROM CANBUS      | R |
| 635 | FUEL FILTER 1 LEAK BP                     | R |
| 636 | FUEL FILTER 2 LEAK BP                     | R |
| 637 | HIGH EXHAUST TEMP BP                      | R |
| 638 | CONTACT INPUT 1                           | R |
| 639 | CONTACT INPUT 2                           | R |
| 640 | CONTACT INPUT 3                           | R |
| 641 | CONTACT INPUT 4                           | R |
| 642 | CONTACT INPUT 5                           | R |
| 643 | CONTACT INPUT 6                           | R |
| 644 | CONTACT INPUT 7                           | R |

|     |                                      |   |
|-----|--------------------------------------|---|
| 645 | CONTACT INPUT 8                      | R |
| 646 | CONTACT INPUT 9                      | R |
| 647 | CONTACT INPUT 10                     | R |
| 648 | CONTACT INPUT 11                     | R |
| 649 | CONTACT INPUT 12                     | R |
| 650 | CONTACT INPUT 13                     | R |
| 651 | CONTACT INPUT 14                     | R |
| 652 | CONTACT INPUT 15                     | R |
| 653 | CONTACT INPUT 16                     | R |
| 654 | RELAY OUTPUT 1                       | R |
| 655 | RELAY OUTPUT 2                       | R |
| 656 | RELAY OUTPUT 3                       | R |
| 657 | RELAY OUTPUT 4                       | R |
| 658 | RELAY OUTPUT 5                       | R |
| 659 | RELAY OUTPUT 6                       | R |
| 660 | RELAY OUTPUT 7                       | R |
| 661 | RELAY OUTPUT 8                       | R |
| 662 | RELAY OUTPUT 9                       | R |
| 663 | RELAY OUTPUT 10                      | R |
| 664 | RELAY OUTPUT 11                      | R |
| 665 | RELAY OUTPUT 12                      | R |
| 666 | START RELAY OUTPUT                   | R |
| 667 | RUN RELAY OUTPUT                     | R |
| 668 | PRESTART RELAY OUTPUT                | R |
| 669 | LOGIC CONTROL RELAY OUTPUT 1         | R |
| 670 | LOGIC CONTROL RELAY OUTPUT 2         | R |
| 671 | LOGIC CONTROL RELAY OUTPUT 3         | R |
| 672 | LOGIC CONTROL RELAY OUTPUT 4         | R |
| 673 | LOGIC CONTROL RELAY OUTPUT 5         | R |
| 674 | LOGIC CONTROL RELAY OUTPUT 6         | R |
| 675 | LOGIC CONTROL RELAY OUTPUT 7         | R |
| 676 | LOGIC CONTROL RELAY OUTPUT 8         | R |
| 677 | LOGIC CONTROL RELAY OUTPUT 9         | R |
| 678 | LOGIC CONTROL RELAY OUTPUT 10        | R |
| 679 | LOGIC CONTROL RELAY OUTPUT 11        | R |
| 680 | LOGIC CONTROL RELAY OUTPUT 12        | R |
| 681 | LOGIC CONTROL RELAY OUTPUT 13        | R |
| 682 | LOGIC CONTROL RELAY OUTPUT 14        | R |
| 683 | LOGIC CONTROL RELAY OUTPUT 15        | R |
| 684 | LOGIC CONTROL RELAY OUTPUT 16        | R |
| 685 | AVR BIAS OUTPUT LIMIT PREALARM       | R |
| 686 | GOV BIAS OUTPUT LIMIT PREALARM       | R |
| 687 | LSM INTERGENSET COMMS FAIL           | R |
| 688 | LSM COMMS FAILURE                    | R |
| 689 | ID MISSING PREALARM                  | R |
| 690 | ID REPEAT PREALARM                   | R |
| 691 | DUP LSM PREALARM                     | R |
| 692 | MD HIGH CHARGE AIR TEMP ALARM BIT    | R |
| 693 | MD HIGH OIL TEMP ALARM BIT           | R |
| 694 | MD HIGH COOLANT TEMP ALARM BIT       | R |
| 695 | MD LOW AFTRCLR COOL LVL ALM BIT      | R |
| 696 | MD LOW FUEL DELIVERY PRES ALM BIT    | R |
| 697 | MD LOW OIL PRESSURE ALARM BIT        | R |
| 698 | MD OVERSPEED ALARM BIT               | R |
| 699 | MTU COMBINED RED ALARM BIT           | R |
| 700 | BP HIGH ECU SUPPLY VOLTAGE ALARM BIT | R |
| 701 | BP HI PRESSURE IN 1 PREALARM BIT     | R |
| 702 | BP HI PRESSURE IN 2 PREALARM BIT     | R |
| 703 | BP HI TCOIL 1 PREALARM BIT           | R |



|     |                                              |   |
|-----|----------------------------------------------|---|
| 704 | BP_HI_TCOIL_2_PREALARM_BIT                   | R |
| 705 | BP_HI_TCOIL_3_PREALARM_BIT                   | R |
| 706 | BP_HI_T_AMBIENT_PREALARM_BIT                 | R |
| 707 | MD_TEST_OVRSPD_ACTIVE_PALARM_BIT             | R |
| 708 | MD_HI_FUEL_FILTER_DIFF_PRESSURE_PALARM_BIT   | R |
| 709 | MD_HIGH_ECU_TEMP_PREALARM_BIT                | R |
| 710 | MD_HIGH_OIL_TEMP_PREALARM_BIT                | R |
| 711 | MD_HIGH_INTERCLR_TEMP_PREALM_BIT             | R |
| 712 | MD_HIGH_CHARGE_AIR_TMP_PREALM_BIT            | R |
| 713 | MD_HIGH_COOLANT_TMP_PREALM_BIT               | R |
| 714 | MD_SHUTDOWN_OVERRIDE_PREALM_BIT              | R |
| 715 | MD_HIGH_FUEL_RAIL_PRES_PREALM_BIT            | R |
| 716 | MD_LOW_FUEL_RAIL_PRES_PREALM_BIT             | R |
| 717 | MD_LOW_COOLANT_LEVEL_PREALM_BIT              | R |
| 718 | MD_LOW_CHARGE_AIR_PRES_PREALM_BIT            | R |
| 719 | MD_LOW_FUEL_DELIVERY_PRES_PREALM_BIT         | R |
| 720 | MD_LOW_OIL_PRESSURE_PREALARM_BIT             | R |
| 721 | MD_COMBINED_YELLOW_PREALARM_BIT              | R |
| 722 | BP_ECU_FAULTY_PREALARM_BIT                   | R |
| 723 | BP_SPEED_DEMAND_FAIL_PREALARM_BIT            | R |
| 724 | BP_LOW_VOLTAGE_SUPPLY_PREALARM_BIT           | R |
| 725 | BP_HIGH_VOLTAGE_SUPPLY_PREALARM_BIT          | R |
| 726 | BP_ENGINE_SPEED_TOO_LOW_PREALARM_BIT         | R |
| 727 | BP_LOW_ECU_SUPPLY_VOLTAGE_PREALARM_BIT       | R |
| 728 | BP_HIGH_EXHAUST_TEMP_A_PREALARM_BIT          | R |
| 729 | BP_HIGH_EXHAUST_TEMP_B_PREALARM_BIT          | R |
| 730 | BP_HIGH_FUEL_TEMP_PREALARM_BIT               | R |
| 731 | BP_LOW_CHARGE_AIR_COOLANT_LEVEL_PREALARM_BIT | R |
| 732 | BP_PRIMING_FAULT_PREALARM_BIT                | R |
| 733 | BP_START_SPEED_LOW_PREALARM_BIT              | R |
| 734 | BP_RUNUP_SPEED_LOW_PREALARM_BIT              | R |
| 735 | BP_IDLE_SPEED_LOW_PREALARM_BIT               | R |
| 736 | BP_T_ALTERNATOR_WIRING_PREALARM_BIT          | R |
| 737 | BP_HI_DAY_TANK_LEVEL_PREALARM_BIT            | R |
| 738 | BP_LOW_DAY_TANK_LEVEL_PREALARM_BIT           | R |
| 739 | BP_HIGH_STORAGE_TANK_LEVEL_PREALARM_BIT      | R |
| 740 | BP_LOW_STORAGE_TANK_LEVEL_PREALARM_BIT       | R |
| 741 | BP_ECU_OVERRIDE_FEEDBACK_STATUS_BIT          | R |
| 742 | BP_EXTERNAL_STOP_ACTIVE_STATUS_BIT           | R |
| 743 | BP_SPEED_DEMAND_FAIL_MODE_STATUS_BIT         | R |
| 744 | BP_SPEED_INC_FEEDBACK_STATUS_BIT             | R |
| 745 | BP_SPEED_DEC_FEEDBACK_STATUS_BIT             | R |
| 746 | BP_ENGINE_RUNNING_STATUS_BIT                 | R |
| 747 | BP_CYLINDER_CUTOFF_STATUS_BIT                | R |
| 748 | BP_LOAD_GEN_ON_STATUS_BIT                    | R |
| 749 | BP_PREHEAT_TEMP_NOT_REACHED_STATUS_BIT       | R |
| 750 | BP_CAN_MODE_FEEDBACK_STATUS_BIT              | R |
| 751 | BP_PRIMING_PUMP_ON_STATUS_BIT                | R |
| 752 | ADEC_MCS5_SHUTDOWN_FEEDBACK_BIT              | R |
| 753 | HI_COOLANT_TEMP_PREALARM                     | R |
| 754 | LOW_OIL_PRESSURE_PREALARM                    | R |
| 755 | LOW_FUEL_LEVEL_PREALARM                      | R |
| 756 | LOW_COOLANT_TEMP_PREALARM                    | R |
| 757 | LOW_BATTERY_VOLTAGE_PREALARM                 | R |
| 758 | WEAK_BATTERY_PREALARM                        | R |
| 759 | BATTERY_OVERVOLTAGE_PREALARM                 | R |
| 760 | MAINTENANCE_INTERVAL_PREALARM                | R |
| 761 | LOSS_OF_ECU_COMM_PREALARM                    | R |
| 762 | DIAGNOSTIC_TROUBLE_CODE_PREALARM             | R |

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|-----|--------------------------------------------------|---|
| 763 | ENGINE KW OVERLOAD1 PREALARM                     | R |
| 764 | LOSS OF REMOTE MODULE COMMUNICATION              | R |
| 765 | HIGH FUEL LEVEL PREALARM                         | R |
| 766 | GEN BREAKER SYNC FAIL                            | R |
| 767 | GEN BREAKER FAIL TO CLOSE                        | R |
| 768 | GEN BREAKER FAIL TO OPEN                         | R |
| 769 | MAINS BREAKER SYNC FAIL                          | R |
| 770 | MAINS BREAKER FAIL TO CLOSE                      | R |
| 771 | MAINS BREAKER FAIL TO OPEN                       | R |
| 772 | LOW COOLANT LEVEL PREALARM                       | R |
| 773 | BATT CHRG FAIL PREALARM                          | R |
| 774 | FUEL LEAK DETECT PREALARM                        | R |
| 775 | MPU FAIL PREALARM                                | R |
| 776 | ENGINE KW OVERLOAD2 PREALARM                     | R |
| 777 | ENGINE KW OVERLOAD3 PREALARM                     | R |
| 778 | FUEL FILTER 1 LEAK PREALARM BIT                  | R |
| 779 | FUEL FILTER 2 LEAK PREALARM BIT                  | R |
| 780 | GLOBAL PREALARM                                  | R |
| 781 | CHECKSUM FAIL PREALARM                           | R |
| 782 | SERIALFLASH READ FAILURE                         | R |
| 783 | EGR INDUCEMENT WARNING                           | R |
| 784 | EGR INDUCEMENT LEVEL LOW                         | R |
| 785 | EGR INDUCEMENT SEVERE                            | R |
| 786 | ISUZU SCR PURGE PREALARM                         | R |
| 787 | ISUZU SCR FORCED PURGE PREALARM                  | R |
| 788 | EXHAUST SYSTEM ERROR PREALARM                    | R |
| 789 | ESCAPE MODE PREALARM                             | R |
| 790 | ISUZU SERVICE TOOL FORCED PURGE REQUEST PREALARM | R |
| 791 | ISUZU FORCED PURGE REQUEST PREALARM              | R |
| 792 | ISUZU DEF LOW REFILL DEF PREALARM                | R |
| 793 | ISUZU DEF LOW REFILL DEF ALARM                   | R |
| 794 | LOW DPF TEMP ADD LOAD                            | R |
| 795 | HEATING FOR EXHAUST REGEN                        | R |
| 796 | MTU FAULT CODES PREALARM                         | R |
| 797 | ATS CIRCUIT ERROR PREALARM                       | R |
| 798 | COOL LEVEL SENDER FAIL PREALARM                  | R |
| 799 | GLOBAL SENDER FAIL PREALARM                      | R |
| 800 | REGEN NEEDED LOW LVL PREALARM                    | R |
| 801 | REGEN NEEDED MED LVL PREALARM                    | R |
| 802 | REGEN NEEDED HIGH LVL PREALARM                   | R |
| 803 | SOOT CRITICAL PREALARM                           | R |
| 804 | DPF REGENERATE REQUIRED BP                       | R |
| 805 | DPF REGENERATE DISABLED BP                       | R |
| 806 | HIGH EXHAUST TEMP PREALARM BIT                   | R |
| 807 | DPF SOOT LEVEL HIGH LEAST SEVERE BP              | R |
| 808 | DPF SOOT LEVEL HIGH MODERATELY SEVERE BP         | R |
| 809 | DPF SOOT LEVEL HIGH MOST SEVERE BP               | R |
| 810 | DEF LOW BP                                       | R |
| 811 | DEF EMPTY BP                                     | R |
| 812 | DEF ENGINE DERATE BP                             | R |
| 813 | DEF PRESEVERE INDUCEMENT BP                      | R |
| 814 | DEF SEVERE INDUCEMENT BP                         | R |
| 815 | DEF INDUCEMENT OVERRIDE BP                       | R |
| 816 | GEN REVERSE ROTATION PREALARM                    | R |
| 817 | BUS REVERSE ROTATION PREALARM                    | R |
| 818 | DEF WARNING BP                                   | R |
| 819 | DEF WARNING LEVEL 2 BP                           | R |
| 820 | MAINS FAIL RETURN FAIL                           | R |
| 821 | LOW COOLANT LEVEL ALARM FROM DTC                 | R |

|     |                                                  |   |
|-----|--------------------------------------------------|---|
| 822 | EXHAUST REGENERATE_ACTIVE                        | R |
| 823 | EXHAUST REGENERATE FORCED BY SWITCH_ACTIVE       | R |
| 824 | EXHAUST REGENERATE FORCED BY SERVICE TOOL_ACTIVE | R |
| 825 | TORQUE_LIMIT                                     | R |
| 826 | TORQUE_LIMIT_SEVERE                              | R |
| 827 | DEF_QUALITY_POOR_BP                              | R |
| 828 | DEF_CONSUMPTION_INCORRECT_BP                     | R |
| 829 | DEF_TAMPERING_BP                                 | R |
| 830 | REGEN_CONFIRMATION_REQUIRED                      | R |
| 831 | REGEN_STOPPED                                    | R |
| 832 | REGEN_COMPLETED                                  | R |
| 833 | CANNOT REGEN DUE TO LOW COOLANT TEMP_BP          | R |
| 834 | CANNOT REGEN DUE TO INTERLOCK FAIL_BP            | R |
| 835 | CANNOT REGEN NOT 50_HR SINCE LAST REGEN_BP       | R |
| 836 | PREVIOUS_DTC_EXISTS1                             | R |
| 837 | PREVIOUS_DTC_EXISTS2                             | R |
| 838 | PREVIOUS_DTC_EXISTS3                             | R |
| 839 | PREVIOUS_DTC_EXISTS4                             | R |
| 840 | PREVIOUS_DTC_EXISTS5                             | R |
| 841 | PREVIOUS_DTC_EXISTS6                             | R |
| 842 | PREVIOUS_DTC_EXISTS7                             | R |
| 843 | PREVIOUS_DTC_EXISTS8                             | R |
| 844 | PREVIOUS_DTC_EXISTS9                             | R |
| 845 | PREVIOUS_DTC_EXISTS10                            | R |
| 846 | PREVIOUS_DTC_EXISTS11                            | R |
| 847 | PREVIOUS_DTC_EXISTS12                            | R |
| 848 | PREVIOUS_DTC_EXISTS13                            | R |
| 849 | PREVIOUS_DTC_EXISTS14                            | R |
| 850 | PREVIOUS_DTC_EXISTS15                            | R |
| 851 | PREVIOUS_DTC_EXISTS16                            | R |
| 852 | USER_CONFIGURABLE_17_ALARM                       | R |
| 853 | USER_CONFIGURABLE_18_ALARM                       | R |
| 854 | USER_CONFIGURABLE_19_ALARM                       | R |
| 855 | USER_CONFIGURABLE_20_ALARM                       | R |
| 856 | USER_CONFIGURABLE_21_ALARM                       | R |
| 857 | USER_CONFIGURABLE_22_ALARM                       | R |
| 858 | USER_CONFIGURABLE_23_ALARM                       | R |
| 859 | USER_CONFIGURABLE_24_ALARM                       | R |
| 860 | USER_CONFIGURABLE_25_ALARM                       | R |
| 861 | USER_CONFIGURABLE_26_ALARM                       | R |
| 862 | USER_CONFIGURABLE_17_PREALARM                    | R |
| 863 | USER_CONFIGURABLE_18_PREALARM                    | R |
| 864 | USER_CONFIGURABLE_19_PREALARM                    | R |
| 865 | USER_CONFIGURABLE_20_PREALARM                    | R |
| 866 | USER_CONFIGURABLE_21_PREALARM                    | R |
| 867 | USER_CONFIGURABLE_22_PREALARM                    | R |
| 868 | USER_CONFIGURABLE_23_PREALARM                    | R |
| 869 | USER_CONFIGURABLE_24_PREALARM                    | R |
| 870 | USER_CONFIGURABLE_25_PREALARM                    | R |
| 871 | USER_CONFIGURABLE_26_PREALARM                    | R |
| 872 | CONTACT_INPUT_17                                 | R |
| 873 | CONTACT_INPUT_18                                 | R |
| 874 | CONTACT_INPUT_19                                 | R |
| 875 | CONTACT_INPUT_20                                 | R |
| 876 | CONTACT_INPUT_21                                 | R |
| 877 | CONTACT_INPUT_22                                 | R |
| 878 | CONTACT_INPUT_23                                 | R |
| 879 | CONTACT_INPUT_24                                 | R |
| 880 | CONTACT_INPUT_25                                 | R |

|     |                                         |   |
|-----|-----------------------------------------|---|
| 881 | CONTACT INPUT 26                        | R |
| 882 | REMOTE CONTACT INPUT 11                 | R |
| 883 | REMOTE CONTACT INPUT 12                 | R |
| 884 | REMOTE CONTACT INPUT 13                 | R |
| 885 | REMOTE CONTACT INPUT 14                 | R |
| 886 | REMOTE CONTACT INPUT 15                 | R |
| 887 | REMOTE CONTACT INPUT 16                 | R |
| 888 | REMOTE CONTACT INPUT 17                 | R |
| 889 | REMOTE CONTACT INPUT 18                 | R |
| 890 | REMOTE CONTACT INPUT 19                 | R |
| 891 | REMOTE CONTACT INPUT 20                 | R |
| 892 | REMOTE CONTACT INPUT 21                 | R |
| 893 | REMOTE CONTACT INPUT 22                 | R |
| 894 | REMOTE CONTACT INPUT 23                 | R |
| 895 | REMOTE CONTACT INPUT 24                 | R |
| 896 | RELAY OUTPUT 13                         | R |
| 897 | RELAY OUTPUT 14                         | R |
| 898 | RELAY OUTPUT 15                         | R |
| 899 | RELAY OUTPUT 16                         | R |
| 900 | RELAY OUTPUT 17                         | R |
| 901 | RELAY OUTPUT 18                         | R |
| 902 | RELAY OUTPUT 19                         | R |
| 903 | RELAY OUTPUT 20                         | R |
| 904 | RELAY OUTPUT 21                         | R |
| 905 | RELAY OUTPUT 22                         | R |
| 906 | RELAY OUTPUT 23                         | R |
| 907 | RELAY OUTPUT 24                         | R |
| 908 | RELAY OUTPUT 25                         | R |
| 909 | RELAY OUTPUT 26                         | R |
| 910 | RELAY OUTPUT 27                         | R |
| 911 | RELAY OUTPUT 28                         | R |
| 912 | RELAY OUTPUT 29                         | R |
| 913 | RELAY OUTPUT 30                         | R |
| 914 | RELAY OUTPUT 31                         | R |
| 915 | RELAY OUTPUT 32                         | R |
| 916 | RELAY OUTPUT 33                         | R |
| 917 | RELAY OUTPUT 34                         | R |
| 918 | RELAY OUTPUT 35                         | R |
| 919 | RELAY OUTPUT 36                         | R |
| 920 | SPEED SENDER FAIL STATUS                | R |
| 921 | OIL PRESSURE SENDER FAIL STATUS         | R |
| 922 | COOLANT TEMP SENDER FAIL STATUS         | R |
| 923 | FUEL LEVEL SENDER FAIL STATUS           | R |
| 924 | VOLTAGE SENSING FAIL STATUS             | R |
| 925 | COOL LEVEL SENDER FAIL STATUS           | R |
| 926 | GLOBAL SENDER FAIL STATUS               | R |
| 927 | EPS SUPPLYING LOAD                      | R |
| 928 | SINGLE PHASE CONNECTION OVERRIDE STATUS | R |
| 929 | SINGLE PHASE AC SENSE OVERRIDE STATUS   | R |
| 930 | HI LOW LINE INPUT STATUS                | R |
| 931 | ATS INPUT STATUS                        | R |
| 932 | BATTLE OVERRIDE STATUS                  | R |
| 933 | GROUNDED DELTA OVERRIDE STATUS          | R |
| 934 | MAINS BREAKER STATUS                    | R |
| 935 | GEN BREAKER STATUS                      | R |
| 936 | BUS DEAD                                | R |
| 937 | BUS STABLE                              | R |
| 938 | BUS FAILED                              | R |
| 939 | GEN DEAD                                | R |

|     |                                              |   |
|-----|----------------------------------------------|---|
| 940 | GEN STABLE                                   | R |
| 941 | GEN FAILED                                   | R |
| 942 | GLOBAL LOW COOLANT LEVEL STATUS              | R |
| 943 | BATT_CHRG_FAIL_STATUS                        | R |
| 944 | FUEL LEAK DETECT STATUS                      | R |
| 945 | ENGINE RUNNING                               | R |
| 946 | COOLDOWN_TIMER_ACTIVE                        | R |
| 947 | VAR_MODE_ACTIVE_BP                           | R |
| 948 | PF_MODE_ACTIVE_BP                            | R |
| 949 | OFF_MODE_COOLDOWN                            | R |
| 950 | EXIERNAL_START_DELAY_FROM_PLC                | R |
| 951 | COOLDOWN_REQUEST_FROM_LOGIC                  | R |
| 952 | COOLDOWN_AND_STOP_REQUEST_FROM_LOGIC         | R |
| 953 | START_DELAY_BYPASS                           | R |
| 954 | ALTERNATE_FREQUENCY_OVERRIDE_ACTIVE          | R |
| 955 | RESET_ACTIVE                                 | R |
| 956 | ALARM_SILENCE_ACTIVE                         | R |
| 957 | LAMP_TEST_ACTIVE                             | R |
| 958 | IDLE_REQUEST_ACTIVE                          | R |
| 959 | MAINS_FAIL_RETURN_TIMER_BYPASS_FROM_LOGIC    | R |
| 960 | TRIP_RESET_FROM_LOGIC                        | R |
| 961 | TRIP_RESET_ACTIVE                            | R |
| 962 | TAKE_OVER_LOAD_ACTIVE                        | R |
| 963 | MAINS_FAIL_TEST_ACTIVE                       | R |
| 964 | PARALLELED_TO_MAINS                          | R |
| 965 | SYNC_ACTIVE                                  | R |
| 966 | SYNC_VOLT_OK                                 | R |
| 967 | SYNC_FREQ_OK                                 | R |
| 968 | SYNC_PHASE_OK                                | R |
| 969 | SYNC_BREAKER_CLOSE_OK                        | R |
| 970 | RESTART_DELAY_ACTIVE                         | R |
| 971 | MAINS_FAIL_TRANSFER_INHIBIT_FROM_PLC         | R |
| 972 | AUTOMATIC_BREAKER_OPERATION_INHIBIT_FROM_PLC | R |
| 973 | CLOSED_TRANSITION_OVERRIDE_FROM_PLC          | R |
| 974 | GEN_FORWARD_ROTATION_STATUS                  | R |
| 975 | GEN_REVERSE_ROTATION_STATUS                  | R |
| 976 | BUS_FORWARD_ROTATION_STATUS                  | R |
| 977 | BUS_REVERSE_ROTATION_STATUS                  | R |
| 978 | ALTERNATE_VOLTAGE_OVERRIDE_1_BP              | R |
| 979 | ALTERNATE_VOLTAGE_OVERRIDE_2_BP              | R |
| 980 | ALTERNATE_VOLTAGE_OVERRIDE_3_BP              | R |
| 981 | ALTERNATE_VOLTAGE_OVERRIDE_4_BP              | R |
| 982 | DGC_DPF_REGEN_INHIBIT_REQUEST                | R |
| 983 | DGC_DPF_MANUAL_REGEN_REQUEST                 | R |
| 984 | REGEN_INTERLOCK_STATUS_FROM_ECU              | R |
| 985 | ENGINE_HAS_BEEN_RUNNING_FIFTEEN_MINUTES      | R |
| 986 | LOW_FUEL_LEVEL_STATUS                        | R |
| 987 | ATS_INPUT_MODE_IS_COMPLEMENTARY              | R |
| 988 | ATS_NORMALLY_OPEN_INPUT_STATUS               | R |
| 989 | ATS_NORMALLY_CLOSED_INPUT_STATUS             | R |
| 990 | ALTERNATE_RATED_KW_1_SELECTED_FROM_LOGIC     | R |
| 991 | ALTERNATE_RATED_KW_2_SELECTED_FROM_LOGIC     | R |
| 992 | ALTERNATE_RATED_KW_3_SELECTED_FROM_LOGIC     | R |
| 993 | ALTERNATE_RATED_KW_4_SELECTED_FROM_LOGIC     | R |
| 994 | SHOW_DEF_SYMBOL                              | R |
| 995 | SHOW_ENGINE_WARNING_AMBER_LAMP_SYMBOL        | R |
| 996 | SHOW_CHECK_ENGINE_LAMP_SYMBOL                | R |
| 997 | SHOW_ENGINE_STOP_RED_LAMP_SYMBOL             | R |
| 998 | SHOW_DPF_SYMBOL                              | R |

|      |                                        |   |
|------|----------------------------------------|---|
| 999  | SHOW DPF INHIBITED SYMBOL              | R |
| 1000 | SHOW HIGH EXHAUST TEMP. SYMBOL         | R |
| 1001 | SHOW WAIT TO START SYMBOL              | R |
| 1002 | SHOW TORQUE LIMIT SYMBOL               | R |
| 1003 | SHOW EXHAUST SYSTEM MALFUNCTION SYMBOL | R |





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