DGC-2020
Digital Genset Controller

Instruction Manual

(Firmware Version 3.XX.XX)

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INTRODUCTION

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

- General Information and Specifications
- Controls and Indicators
- Functional Description
- Graphical User Interface Operation
- Installation
- Setup
- Maintenance and Troubleshooting
- LSM-2020 (Load Share Module)
- CEM-2020 (Contact Expansion Module)
- AEM-2020 (Analog Expansion Module)
- Time Overcurrent Characteristic Curves
- Modbus® Communication
- PID Tuning Settings
- MTU Fault Codes
- Exhaust Treatment
- Yanmar Fault Codes

WARNING!

To avoid personal injury or equipment damage, only qualified personnel should perform the procedures in this manual.

NOTES

Check for the latest version of this instruction manual at www.basler.com.

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, *BESTCOMSPlus® Software, General Settings, Device Security Setup.* The default passwords are listed below.

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

BOX DEFINITIONS

Warning!

A warning box indicates a potentially hazardous situation which could result in death or injury.

Caution

A caution box indicates a potentially hazardous situation which could result in equipment or property damage.

Note

A note box provides helpful information.

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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. Should further information be required, contact Basler Electric.

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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 to download the latest hardware, firmware, and BESTCOMS*Plus*® revision histories.

Instruction Manual Revision History

Manual Revision and Date	Change
B, Oct-19	• Removed Rev Letter from all pages. • Removed firmware and hardware revision histories from Introduction. • In Section 1, updated Note 1 in Style Chart. • 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 BESTCOMS*Plu*s version 4.xx.xx. • In Appendix B, added notes about registers 45106 through 45168.
A1, Apr-19	• Added Proposition 65 statement.
A, Oct-18	• Minor text edits
—, Jul-18	• Initial release

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SECTION 1 • GENERAL INFORMATION

Description

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.

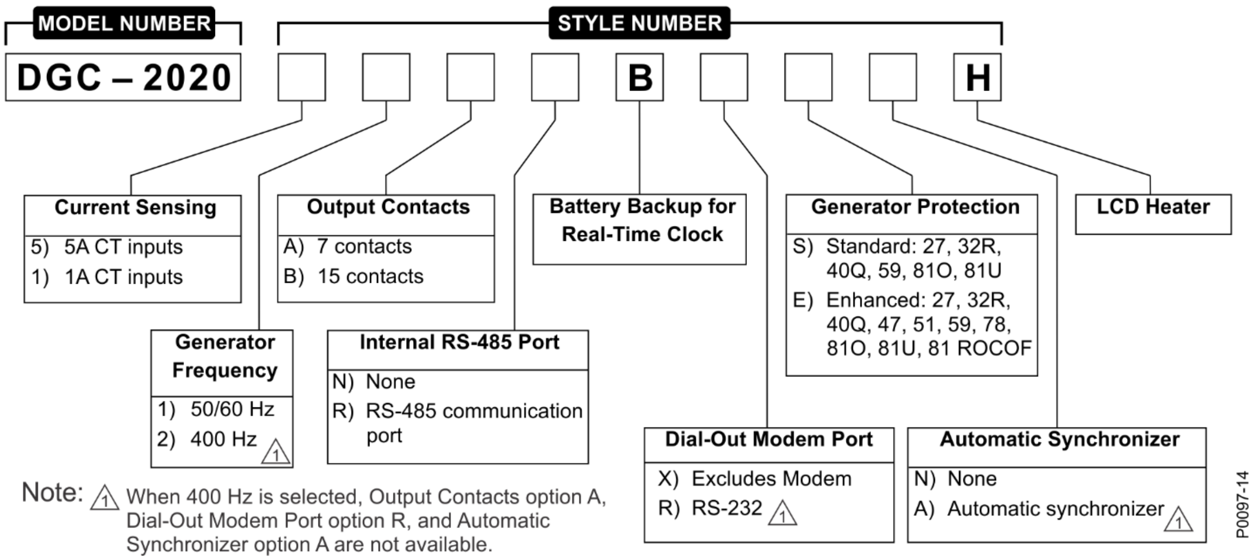

Figure 1-1. DGC-2020 Style Chart

For example, if a DGC-2020 style number were **51BNBREAH**, 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: $L_{max} = (240 - R_{device})$/(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 Ω nominal
Terminals... 9, 11 (sender common)
Accuracy... ±1.6 Ω or ±2% (whichever is greater) of actual resistance

Coolant Temperature Sensing

Resistance Range........................... 10 to 2,750 Ω nominal
Terminals... 10, 11 (sender common)
Accuracy... ±4.5 Ω or ±1.9% (whichever is greater) of actual resistance

Oil Pressure Sensing

Resistance Range........................... 0 to 250 Ω nominal
Terminals... 8, 11 (sender common)
Accuracy... ±1.4 Ω or ±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*....................................... ±1.0% of programmed rated current or ±2 Aac
Display Resolution .... 1 Aac

* Current metering indicates 0 A when generator current is below 2% of the full-scale rating.

Generator and Bus Frequency

Generator frequency is sensed through the generator voltage input.

Metering Range............................... 10 to 72 Hz (50/60 Hz)
10 to 480 (400 Hz)
Accuracy... ±0.25% or 0.05 Hz
Display Resolution .... 0.1 Hz

Apparent Power

Indicates total kVA and individual line kVA (4-wire, line-to-neutral or 3-wire, line-to-line).

Measurement/Calculation Methods

Total .... $kVA = (V_{L-L} \times I_L \times \sqrt{3}) \div 1000$
4-Wire, Line-to-Neutral..................... kVA calculated with respect to neutral

3-Wire, Line-to-Line.......................... A-phase kVA = $V_{AB} \times I_A \div 1000 \div \sqrt{3}$

B-phase kVA = $V_{BC} \times I_B \div 1000 \div \sqrt{3}$

C-phase kVA = $V_{CA} \times I_C \div 1000 \div \sqrt{3}$

Accuracy.. ±3% or the full-scale indication or ±2 kVA ∗†

∗ kVA metering indicates 0 kVA when the generator kVA is below 2% of the full-scale rating.

† Applies when temperature is between –40°C to +70°C.

Power Factor

Metering Range................................ 0.2 leading to 0.2 lagging
Calculation Method .... PF = cosine of the angle between phase AB voltage (Vab) and phase A current (Ia) *
Accuracy.. ±0.02 †

∗ In single-phase AC-connected machines, it is the cosine of the angle between phase CA voltage (Vca) and phase C current (Ic).

† Applies when temperature is between –40°C to +70°C (–40°F to +158°F).

Note

For the DGC-2020 to correctly meter power factor, the generator must be rotating clockwise (A-B-C).

Real Power

Indicates total kW and individual line kW (4-wire, line-to-neutral or 3-wire line-to-line)

Measurement/Calculation Methods

Total .... PF × Total kVA
4-Wire, Line-to-Neutral..................... kW calculated with respect to neutral

3-Wire, Line-to-Line.......................... A-phase kW = $V_{AB} \times I_A \times PF \div 1000 \div \sqrt{3}$

B-phase kW = $V_{BC} \times I_B \times PF \div 1000 \div \sqrt{3}$

C-phase kW = $V_{CA} \times I_C \times PF \div 1000 \div \sqrt{3}$

Accuracy.. ±3% of the full-scale indication or ±2 kW ∗†

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

† Applies when temperature is between –40°C to +70°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 Ω nominal
Sensing Accuracy .... ±1.4 Ω or ±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 Ω nominal
Sensing Accuracy .... ±4.5 Ω or ±1.9% (whichever is greater) of actual resistance

Battery Voltage

Metering Range................................ 6 to 32 Vdc
Accuracy.. ±3% of actual indication or ±0.2 Vdc
Display Resolution .... 0.1 Vdc

Engine RPM

Metering Range............................... 0 to 4,500 rpm
Accuracy*....................................... ±2% of actual indication or ±2 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... ±1% of actual indication or ±12 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... ±1% or actual indication or ±12 min
Display Resolution .... 1 minute

Fuel Level

Metering Range............................... 0 to 100%
Sensing Resistance Range............. 0 to 250 Ω nominal
Sensing Accuracy .... ±1.6 Ω or ±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, *Time Overcurrent Characteristic Curves*

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 the ambient temperature falls below 0°C (32°F). The heater turns off when the ambient temperature rises above 5°C (41°F). This range of operation implements 5°C (9°F) of hysteresis between heater turn on and turn off.

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°C to +115°C), vibration tests (of 5 to 50 G at +20°C), and temperature/vibration tests (tested at 40 G over a temperature range of –80°C to +90°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°C (–40 to +158°F)
Storage Temperature .... –40 to +85°C (–40 to +185°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 Devices (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.*

EAC Mark (Eurasian Conformity)

- TP TC 004/2011
- TP TC 020/2011

NFPA Compliance

Complies with NFPA Standard 110, *Standard for Emergency and Standby Power*.

Physical

Weight .... 4.40 lb (1.99 kg)
Dimensions...................................... See Section 6, *Installation*.

SECTION 2 • HUMAN-MACHINE INTERFACE

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SECTION 2 • HUMAN-MACHINE INTERFACE

Introduction

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.

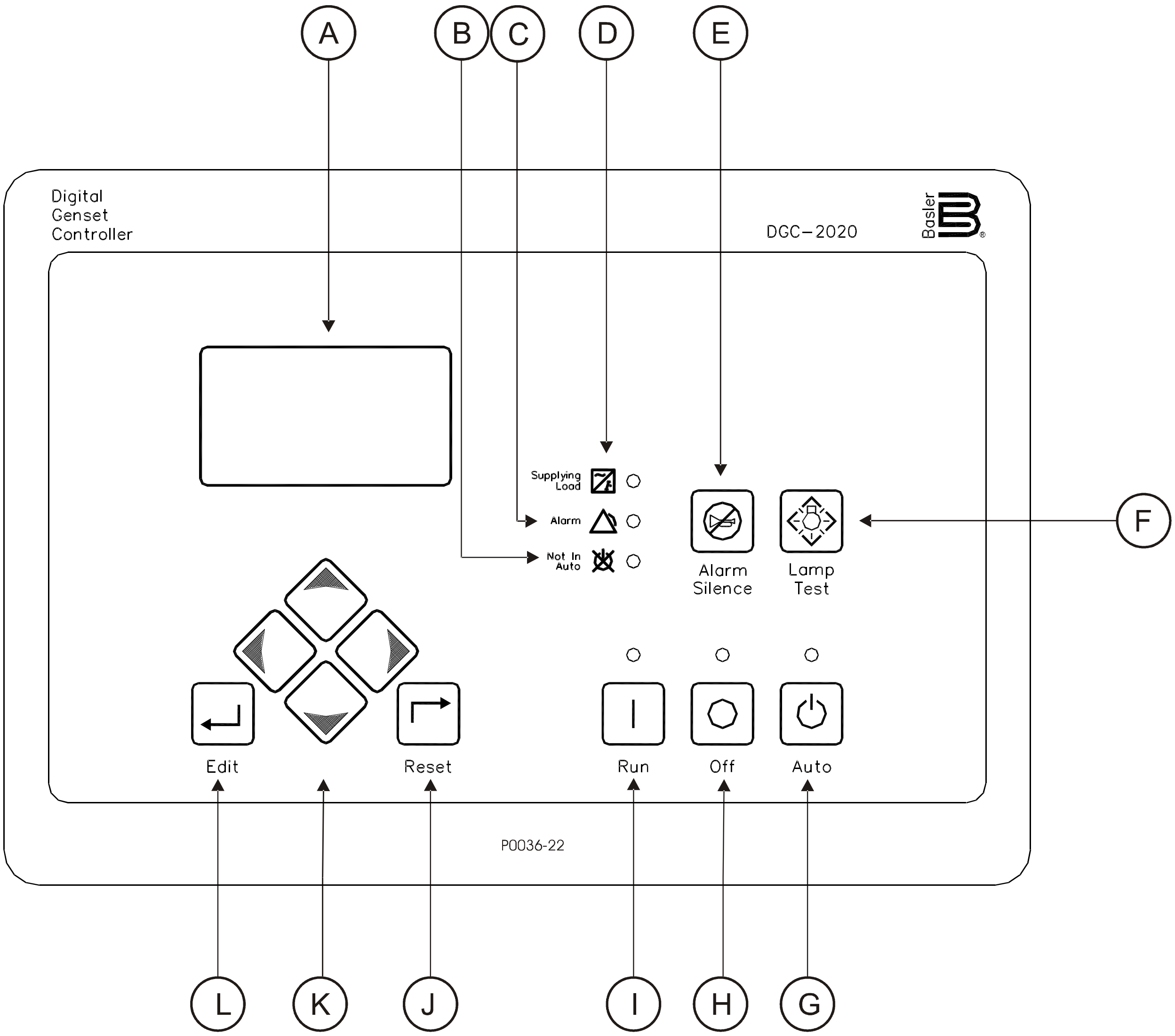


Figure 2-1. Front Panel HMI

Table 2-1. Front Panel HMI Descriptions

Locator	Description
A	*Liquid Crystal Display.* 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	*Not in Auto Indicator.* This red LED lights when the DGC-2020 is not operating in Auto mode.
C	*Alarm Indicator.* This red LED lights continuously during alarm conditions and flashes during pre-alarm conditions.
D	*Supplying Load Indicator.* This green LED lights when the generator current is greater than EPS threshold current.
E	*Alarm Silence Pushbutton.* Pressing this button opens the relay output programmed as the horn output.
F	*Lamp Test Pushbutton.* Pressing this button tests the DGC-2020 indicators by exercising all LCD pixels and lighting all LEDs.
G	*Auto Pushbutton and Mode Indicator.* Pressing the Auto button places the DGC-2020 in Auto mode. The green Auto mode LED lights when Auto mode is active.
H	*Off Pushbutton and Mode Indicator.* 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 MTU ECU Alarms.
I	*Run Pushbutton and Mode Indicator.* Pressing this button places the DGC-2020 in Run mode. The green Run mode LED lights when Run mode is active.
J	*Reset Pushbutton.* 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 MTU 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	*Arrow Pushbuttons.* These four buttons are used to navigate through the front panel display menus and modify settings. 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. 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. During a settings editing session, the up- and down-arrow buttons are used to raise and lower the value of the selected setting.
L	*Edit Pushbutton.* 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∗
- AMP∗
- PH∗
- Hz
- OIL
- FUEL/DEF†
- TEMP
- 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)
- BLANK (Shows nothing on this line)
- OIL P
- TEMP
- BATT V
- RPM
- RPM SRC
- FUEL
- RUN HRS
- GEN VAB
- GEN VBC
- GEN VCA
- GEN VAN
- GEN VBN
- GEN VCN
- BUS Hz
- BUS V
- GEN Hz
- GEN PF
- kWH
- GEN IA
- GEN IB
- GEN IC
- kW A
- kW B
- RTD IN X (X = 1 to 8) (with AEM-2020)
- THRM CPL X (X = 1 to 2) (with AEM-2020)
- FUEL DELV P
- kvar A
- kvar B
- kvar C
- kvar TOTAL
- INJ RAIL PRS
- TOTAL FUEL USED
- FUEL TEMP
- ENG OIL TEMP
- ENG INTCLR TEMP
- COOLANT PRESS
- 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

- kW C
- kW TOT
- kVA A
- kVA B
- kVA C
- kVA TOT
- ALG IN X (X = 1 to 8) (with AEM-2020)
- # UNITS
- SYS CAP
- SYS KW
- SY KVAR
- SYS TOTAL KW
- SYS GEN KW %

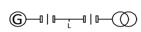
Sleep Mode

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, 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 can be enabled or disabled through the front panel or in BESTCOMS*Plus*.

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.

METERING

ENGINE
BATTERY CHARGER (Available when CAN Bus is enabled and a battery charger type is selected.)
GENERATOR
POWER
BIAS CONTROL (Available when LSM-2020 is enabled.)
RUN STATISTICS
ALARMS-STATUS
DIAGNOSTICS

P0090-37

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**
- **HRS TO MAINT**
- **DEF TANK 1 LVL %**
- **DEF TANK 2 LVL %**

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 SETTNGS (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
    - 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.)
        - CHRG 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
        - U2l 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.)
    - 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 CHRG 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 ACTVE
    - 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
    - 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
- **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.)
  - MAINSFAIL 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**

SETTINGS
GENERAL SETTINGS
COMMUNICATIONS
SYSTEM PARAMS
PROGRAMMABLE INPUTS
PROGRAMMABLE OUTPUTS
CONFIG PROTECTION
ALARM CONFIGURATION
GENERATOR PROTECTION
BREAKER MANAGEMENT
BIAS CONTROL
MULTIGEN MANAGEMENT (Available when LSM-2020 is enabled.)
LOGIC TIMERS
ENTER PASSWORD

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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 SCRN
  - BATT CHG 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.)
    - 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, or Yanmar.)
        - 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, or Yanmar.)
        - DPF REGENRATE SETUP (Visible when ECU is configured for Standard, Volvo Penta, MTU ADEC, GM/Doosan, Cummins, MTU Smart Connect, Daimler CPC4, or Yanmar.)
            - 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, or Yanmar.)
            - J1939 RPM ENABLE (Visible when ECU is configured for Standard, Volvo Penta, MTU ADEC, GM/Doosan, Cummins, MTU Smart Connect, Isuzu, Daimler CPC4, or Yanmar.)

            - 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, or Yanmar.)
            - 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.)
        - 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, or Yanmar.)
            - 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, or Yanmar.)
            - 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
  - 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
  - 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
  - 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
  - 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

- **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 BESTCOMS*Plus,* 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.

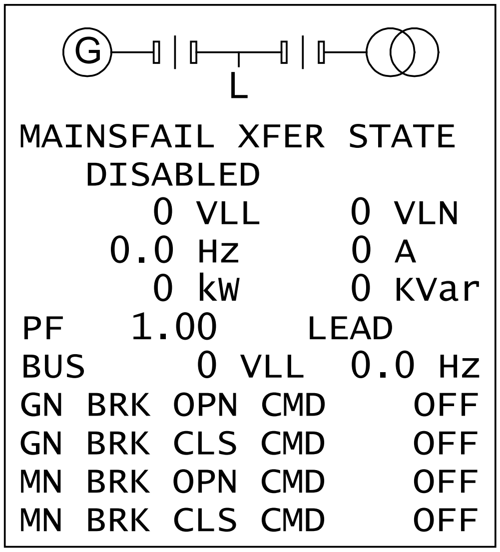
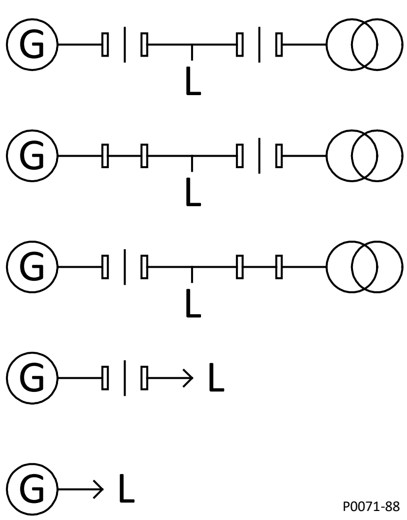


Figure 2-4. One-Line Diagram Menu Options (Available when One-Line Diagram is Enabled)



Generator and mains breakers are configured and both breakers are open.

Generator and mains breakers are configured. The generator breaker is closed and the mains breaker is open.

Generator and mains breakers are configured. The generator breaker is open and the mains breaker is closed.

Generator breaker is configured and open.

No breakers are configured.

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 BESTCOMS*Plus*.

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 BESTCOMS*Plus* 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.

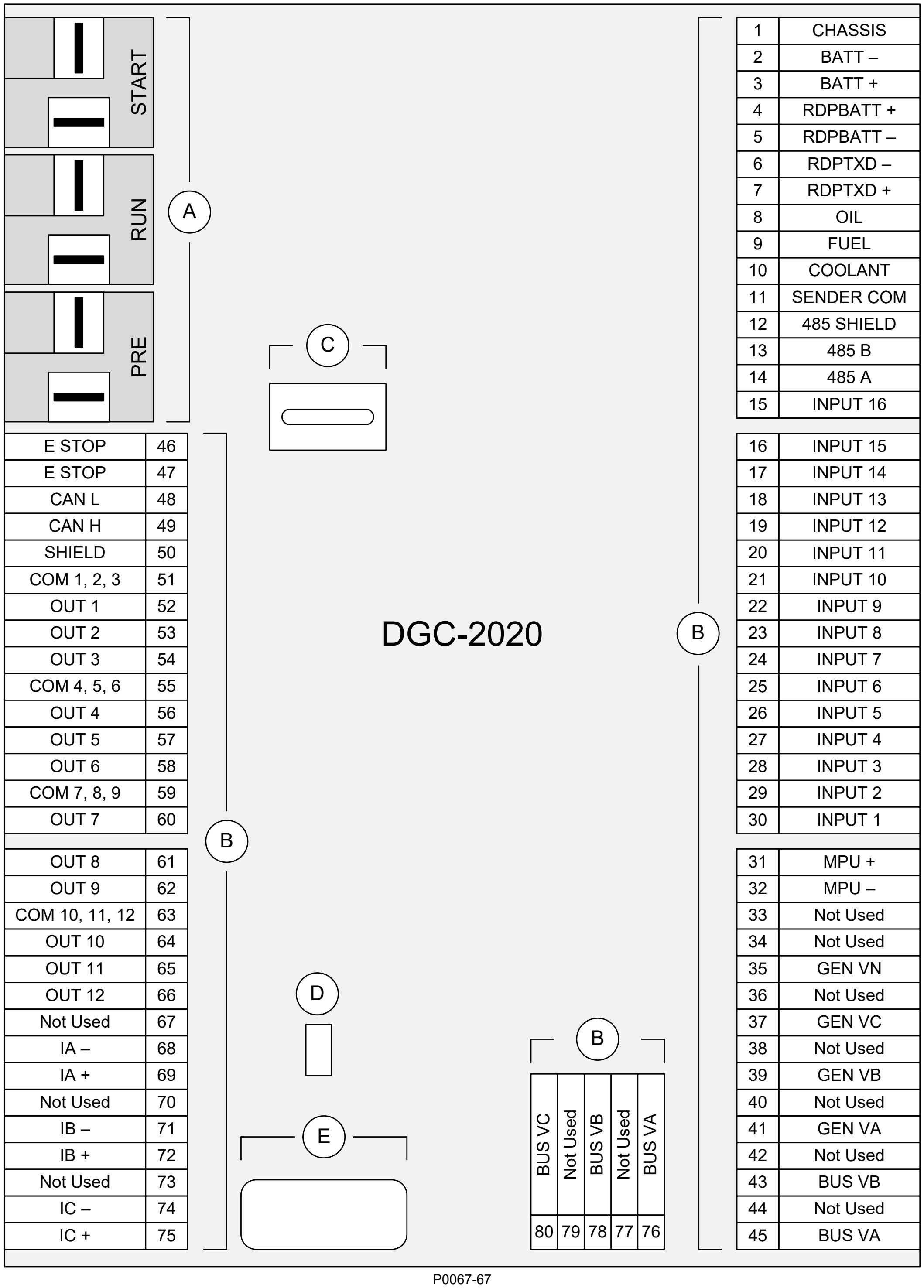


Figure 2-6. Rear Panel for DGC-2020

Table 2-2. Descriptions for Figure 2-6. Rear Panel for DGC-2020

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	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. 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.
C	The DGC-2020 provides a battery backup for the real-time clock. See Section 8, *Maintenance and Troubleshooting,* 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 BESTCOMS*Plus*® 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.

SECTION 3 • FUNCTIONAL DESCRIPTION

TABLE OF CONTENTS

Figures

Tables

SECTION 3 • FUNCTIONAL DESCRIPTION

Introduction

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, BESTCOMS*Plus*® *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.

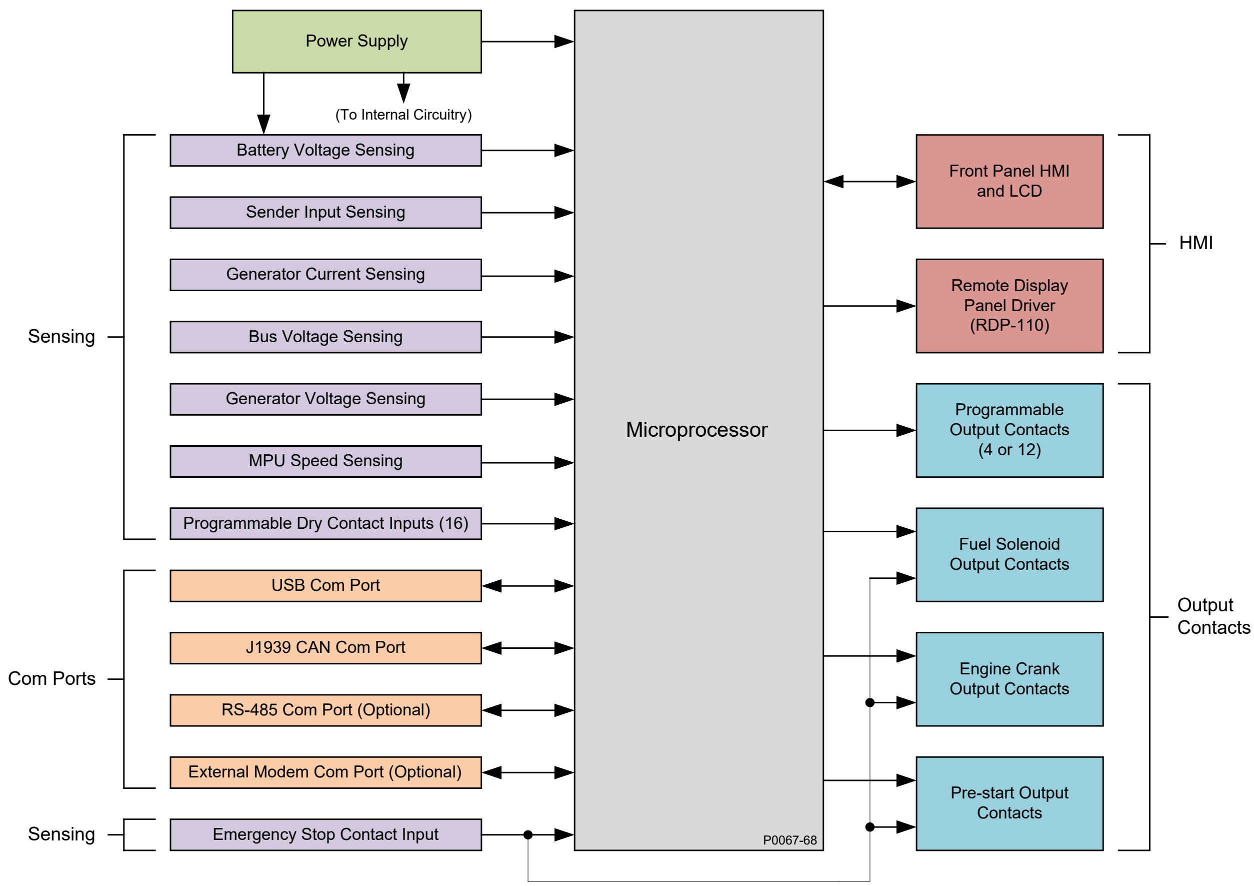


Figure 3-1. Function Block Diagram

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 1xxxxxxxx) accept a maximum current value of 1 Aac. DGC-2020 controllers with 5 ampere current sensing (style number 5xxxxxxxx) 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, BESTCOMS*Plus® 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. BESTCOMS*Plus®* software allows for the programming of sender characteristics. See Section 4, BESTCOMS*Plus® 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. BESTCOMS*Plus*® software allows for the programming of sender characteristics. See Section 4, BESTCOMS*Plus*® *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. BESTCOMS*Plus*® software allows for the programming of sender characteristics. See Section 4, BESTCOMS*Plus*® *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, BESTCOMS*Plus*® *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 BESTCOMS*Plus*® software. The DGC-2020 is connected to a PC using a standard USB cable. BESTCOMS*Plus*® is a Windows® based communication software package that is supplied with the DGC-2020. A detailed description of BESTCOMS*Plus*® 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. Table 3-1 lists the ECU parameters and Table 3-2 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 3-1 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. ECU Parameters Obtained from CAN Bus Interface

ECU Parameter	Metric Units	English Units	Update Rate	* SPN
Actual Engine Percent Torque	%	%	Engine Speed Dependent	513
Aftertreatment 1 Diesel Particulate Filter Intake Temperature (DOC Inlet Temperature)	°C	°F	500 ms	3242
Aftertreatment 1 Diesel Particulate Filter Intermediate Temperature (DOC Outlet Temperature)	°C	°F	500 ms	3250
Aftertreatment 1 Diesel Particulate Filter Outlet Temperature	°C	°F	500 ms	3246
Air Filter Differential Pressure	kPa	psi	500 ms	107
Air Inlet Temperature	kPa	°F	1 s	172
Alarm Reset Feedback	Binary (0 or 1)		1 s	2815
Ambient Air Temperature	°C	°F	1 s	171
Auxiliary Pressure 1	kPa	psi	On Request	1387
Auxiliary Pressure 2	kPa	psi	On Request	1388
Barometric Pressure	kPa	psi	1 s	108
Battery Charger 1 State	0 = Idle (not Connected to Battery) 1 = Charging 2 = Maintaining Battery Charge 3–12 = Reserved 13 = Battery Failure 14 = Charger Failure 15 = Not Available		1 s	4990

ECU Parameter	Metric Units	English Units	Update Rate	* SPN
Battery Charger 1 AC Line State	0 = Disconnected 1 = Connected 2 = Error 3 = N/A		1 s	4991
Battery Charger 1 Output Voltage	Vdc	Vdc	1 s	4992
Battery Charger 1 Output Current	Adc	Adc	1 s	4993
Battery Charger 2 State	0 = Idle (not Connected to Battery) 1 = Charging 2 = Maintaining Battery Charge 3–12 = Reserved 13 = Battery Failure 14 = Charger Failure 15 = Not Available		1 s	4994
Battery Charger 2 AC Line State	0 = Disconnected 1 = Connected 2 = Error 3 = N/A		1 s	4995
Battery Charger 2 Output Voltage	Vdc	Vdc	1 s	4996
Battery Charger 2 Output Current	Adc	Adc	1 s	4997
Battery 1 Temperature	°C	°F	1 s	1800
Battery 2 Temperature	°C	°F	1 s	1801
Battery Voltage	Vdc	Vdc	1 s	168
Boost Pressure	kPa	psi	500 ms	102
Charge Air Temperature	°C	°F	1 s	2629
Coolant Level	%	%	500 ms	111
Coolant Pressure	kPa	psi	500 ms	109
DEF Inducement Level - Level of Inducement Not to Run the Engine	%	%	1 s	5246
DEF Severity Level - Severity of Tank Low Level	%	%	1 s	5245
DEF Tank 1 Level	%	%	1 s	1761
DEF Tank 2 Level	%	%	1 s	4367
DPF Ash Level %	%	%	On Request	3720
DPF Soot Level %	%	%	On Request	3719
ECU Temperature	°C	°F	1 s	1136
Engine Coolant Preheated State	Binary (0 or 1)		500 ms	3552
Engine Coolant Temperature	°C	°F	1 s	110
Engine Desired Operating Speed	rpm	rpm	250 ms	515
Engine Intake Manifold #1 Absolute Pressure	kPa	psi	500 ms	3563
Engine Intercooler Coolant Level	%	%	500 ms	3668
Engine Intercooler Temperature	°C	°F	1 s	52
Engine Oil Level	%	%	500 ms	98
Engine Oil Pressure	kPa	psi	500 ms	100
Engine Oil Temperature	°C	°F	1 s	175
Engine Speed	rpm	rpm	Engine Speed Dependent	190
Exhaust Gas Temperature	°C	°F	500 ms	173
Exhaust Temperature A	°C	°F	500 ms	2433
Exhaust Temperature B	°C	°F	500 ms	2434

ECU Parameter	Metric Units	English Units	Update Rate	* SPN
Fuel Delivery Pressure	kPa	psi	500 ms	94
Fuel Leak Filter 1	Binary (0 or 1)		1 s	1239
Fuel Leak Filter 2	Binary (0 or 1)		1 s	1240
Fuel Rate	liter/hr	gal/hr	100 ms	183
Fuel Temperature	°C	°F	1 s	174
High Exhaust System Temp (HEST) Lamp/Indicator	—	—	500 ms	3698
Injection Control Pressure	MPa	psi	500 ms	164
Injector Metering Rail Pressure	MPa	psi	500 ms	157
Intake Manifold Temperature	°C	°F	500 ms	105
Particulate Filter (DPF) Lamp/Indicator	—	—	500 ms	3697
Percent Load at Current rpm	%	%	50 ms	92
Rated Power	watts	watts	On Request	166
Rated rpm	rpm	rpm	On Request	189
Regeneration Disabled (Inhibit) Lamp/Indicator	—	—	500 ms	3703
Shutdown from ECU	Binary (0 or 1)		1 s	1110
Switched Battery Voltage (at ECU)	Vdc	Vdc	1 s	158
Throttle (Accelerator Pedal) Position	%	%	50 ms	91
Total Engine Hours	hours	hours	Requested 1.5 s	247
Total Fuel Used	liters	gallons	Requested 1.5 s	250
Transmission Oil Pressure	kPa	psi	1 s	127
Transmission Oil Temperature	°C	°F	1 s	177
Trip Average Fuel Rate	liters	gallons	500 ms	1029
Trip Fuel	liters	gallons	Requested 1.5 s	182
Winding 1 Temperature	°C	°F	1 s	1124
Winding 2 Temperature	°C	°F	1 s	1125
Winding 3 Temperature	°C	°F	1 s	1126

* SPN is suspect parameter number.

Table 3-2. 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

ECU Parameter	Metric Units	English Units	Update Rate	* SPN
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 BESTCOMS*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 3-3 lists the J1939 data transmitted from the DGC-2020.

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

ECU Parameter	Update Rate	* SPN
Battle Override Switch	100 ms	1237
Speed Request	10 ms	898
Note: Requests from the DGC-2020 to the Engine ECU for various parameters are made by issuing the request.		
Address Claim Request	Once on power up, and any time a Global Request for Address Claim (GRAC) PGN is received.	NA
Currently Active Diagnostic Trouble Codes Request	Whenever a refresh of Currently Active Diagnostic Trouble Code Request is received.	NA
Previously Active Diagnostic Trouble Codes Request	2 s	NA
Clear Currently Active Diagnostic Trouble Codes Request	Whenever a request to reset Currently Active Diagnostic Trouble Code Request is made.	NA
Clear Previously Active Diagnostic Trouble Codes Request	Whenever a request to reset Previously Active Diagnostic Trouble Code Request is made.	NA
Engine Hours/Revolutions Request	2 s	NA
Fuel Consumption Request	2 s	NA
Electronic Engine Controller #4 (Rated Speed and Power) Request	2 s	NA
Auxiliary Analog Information	2 s	N/A

ECU Parameter	Update Rate	* SPN
Data Transmitted to Marathon DVR2000E+ Voltage Regulator		
Primary Voltage Setpoint	1 s	N/A
Alternate Voltage Setpoint	1 s	N/A
Voltage Adjustment Bandwidth	1 s	N/A
Field Current	1 s	N/A
Primary Underfrequency Knee-point	1 s	N/A
Alternate Underfrequency Knee-point	1 s	N/A
Underfrequency Slope	1 s	N/A

* SPN is suspect parameter number.

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. Table 3-4 lists the diagnostic information that the DGC-2020 obtains over the CAN Bus interface.

Table 3-4. 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 3-6. If the DGC-2020 recognizes an SPN in Table 3-6, but the FMI does not match the FMI in Table 3-6, then it displays the string from Table 3-6, corresponding to the table entry where the FMI is # and a second string corresponding to the FMI number listed in Table 3-5. 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”.

Yanmar ECU fault codes are listed in Appendix F.

Table 3-5. DTCs Displayed by the DGC-2020 (FMI Strings)

FMI	String 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.

FMI	String Displayed	Description
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	String indicating 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.
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	String Indicating 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 3-6. DTCs Displayed by the DGC-2020

SPN	FMI	String Displayed	Description
27	#	EGR1 VALVE POSITN	Caption Indicating EGR1 Valve Position
28	#	ACCEL PEDAL 3 POSITN	Caption string for accelerator pedal 3 position
28	3	Throttle Volt HI	Throttle Voltage High
28	4	Throttle Volt LO	Throttle Voltage Low
28	14	Throttle Volt OOR	Throttle Input Voltage Out of Range
29	#	ACCEL PEDAL 2 POSITN	Caption string for accelerator pedal 2 position
29	3	Throttle Volt HI	Throttle Voltage High
29	4	Throttle Volt LO	Throttle Voltage Low
29	14	Throttle Volt OOR	Throttle Input Voltage Out of Range
51	#	ENG THROTTLE POSITN	Caption Indicating Engine Throttle Position
52	#	INTERCOOLER TEMP	Engine Intercooler Temperature
52	15	INTERCOOLER TEMP HI	Engine Intercooler Temperature is above the HIGH threshold
69	#	TWO SPEED AXLE SWITCH	Caption Indicating Two Speed Axle Switch
70	#	PARKING BRAKE SWITCH	Caption Indicating Parking Brake Switch
84	#	VEHICLE SPEED	Caption string for vehicle speed signal
91	#	ACCEL POSITION	Caption string for Accelerator Position
91	3	Thr Pos Sns Volt HI	Throttle Position Sensor Input Voltage (High)
91	4	Thr Pos Sns Volt LO	Throttle Position Sensor Input Voltage (Low)
91	14	Thr Pos Sns Volt OOR	Throttle Voltage (Out of Range)
94	#	FUEL DELIVERY PRESS	Fuel Delivery Pressure
94	1	FUEL DELIV PRS LOW LOW	Engine Fuel Delivery Pressure is below the LOW LOW threshold
94	3	Fuel Pmp Prs Volt HI	Fuel Pump Pressure Input Voltage (High)
94	4	Fuel Pmp Prs Volt LO	Fuel Pump Pressure Input Voltage (Low)

SPN	FMI	String Displayed	Description
94	17	FUEL DELIV PRS LO	Fuel Supply Pressure (Low Least Severe)
95	#	FUEL FLT DF PRS	Fuel Filter Differential Pressure
96	#	FUEL LEVEL	Caption string for Fuel Level
97	#	Water In Fuel	Water In Fuel
97	3	Water In Fl Volt HI	Water In Fuel Signal Voltage High
97	4	Water In Fl Volt LO	Water In Fuel Signal Voltage Low
97	16	Water in Fuel	Water In Fuel Detected
98	#	ENG OIL LEVEL	Caption used on front panel for Display of J1939 Parameter
99	#	OIL FILTER DIFF PRESS	Caption string for oil filter differential pressure parameter
100	#	ENG OIL PRESS	Caption used on front panel for display of J1939 parameter
100	1	ENG OIL PRESS LO LO	Engine Oil Pressure is below the LOW LOW threshold
100	3	Oil Prs Snsr Volt HI	Oil Pressure Sensor Input Voltage (High)
100	4	Oil Prs Snsr Volt LO	Oil Pressure Sensor Input Voltage (Low)
100	17	ENG OIL PRESS LO	Engine Oil Pressure is below the LOW threshold
100	18	Oil Prs Snsr Volt MLO	Oil Pressure Sensor Input Voltage (Moderately Low)
100	31	Oil Pressure INVLD	Oil Pressure (Invalid)
101	#	CRANKCASE PRESSURE	Caption string for crankcase pressure
102	#	INTK MNFLD1 PRESSURE	Caption string for intake manifold 1 pressure
102	2	Manifld Air Prs INVD	Manifold Air Pressure Invalid
102	3	Mnfld AirP SnsVlt HI	Manifold Air Pressure Sensor Input Voltage High
102	4	Mnfld AirP SnsVlt LO	Manifold Air Pressure Sensor Input Voltage Low
103	#	TURBO CH1 SPEED	Turbo Speed
103	0	Trbo Overspd Severe	Turbo Overspeed (Most Severe)
103	2	Trbo Speed MisMatch	Turbo Speed (Mismatch)
103	5	Trbo Spd Sns Curr LO	Turbo Speed Sensor Current (Low)
103	6	Trbo Spd Sns Curr HI	Turbo Speed Sensor Current (High)
103	8	Trbo Speed INVLD	Turbo Speed (Invalid)
103	31	Trbo Speed MISSING	Turbo Speed (Missing)
104	#	TRBO CH OIL PRESS	Turbocharger Oil Pressure
105	#	INTAK MNFLD TMP	Intake Manifold Temperature
105	0	EGR Mixed Air Tmp HI	Exhaust Gas Recirculation Mixed Air High (Least Severe)
105	3	EGR Air Temp Vlt HI	Exhaust Gas Recirculation Mixed Air Temp Voltage (High)
105	4	EGR Air Temp Vlt LO	Exhaust Gas Recirculation Mixed Air Temp Voltage (Low)
105	15	EGR Mixed Air Tmp HI	Exhaust Gas Recirculation Mixed Air High (Least Severe)
105	16	EGR MxdAir Tmp MHI	Exhaust Gas Recirculation Mixed Air Temp (Moderately High)
106	#	INTAKE AIR PRESSR	Caption Indicating Intake Air Pressure
107	#	AIR FLTR DIF PRS	Air Filter Differential Pressure
107	0	Air Filt Restricted	Air Filter Restriction (High)
108	#	BAROMETRIC PRESS	Barometric Pressure
108	2	Barometrc Prs INVLD	Barometric Pressure (Invalid)
108	31	Barometrc Prs ERR	Barometric Pressure (Error)
109	#	COOLANT PRESS	Caption used on front panel for display of J1939 parameter
109	1	ENG COOLNT PRS LO LO	Engine Coolant Pressure is below the LOW LOW threshold
109	17	ENG COOLANT PRS LO	Engine Coolant Pressure is below the LOW threshold
110	#	COOLANT TEMP	Engine Coolant Temperature
110	0	ENG COOLNT TMP HI HI	Engine Coolant Temperature is above the HIGH HIGH threshold
110	3	Cool Tmp Sns Volt HI	Coolant Temp Sensor Input Voltage (High)
110	4	Cool Tmp Sns Volt LO	Coolant Temp Sensor Input Voltage (Low)
110	15	ENG COOLANT TEMP HI	Engine Coolant Temperature is above the HIGH threshold
110	16	Cool Temp MHI	Coolant Temp Sensor Input (Moderately High)
110	17	Cool Temp LO	Coolant Temp Sensor Input (Low Least Severe)
111	#	LOW COOL LEVEL	Low Coolant Level string used in event log and/or Alarm and Pre-Alarm annunciation

SPN	FMI	String Displayed	Description
111	1	Coolnt Lvl LO	Coolant Level (Low)
111	17	ENG COOLANT LVL LO	Engine Coolant Level is below the LOW threshold
157	#	INJ RAIL PRS	Fuel Injection Rail Pressure
157	3	Fuel Rail Prs Vlt HI	Fuel Rail Pressure Input Voltage (High)
157	4	Fuel Rail Prs Vlt LO	Fuel Rail Pressure Input Voltage (Low)
157	10	Fuel Rail Prs LOSS	Fuel Rail Pressure Loss Detected
157	17	Fuel Rl Prs NOT DEV	Fuel Rail Pressure Not Developed
158	#	KEY SW BATT VOLTAGE	Caption string for key switch battery potential
158	0	KSW BATT VOLTS HI HI	Key Switch Battery Potential is above the HIGH HIGH threshold
158	1	KSW BATT VOLTS LO LO	Key Switch Battery Potential is below the LOW LOW threshold
158	15	KSW BATT VOLTS HI	Key Switch Battery Potential is above the HIGH threshold
158	17	KSW BATT VOLTS LO	Key Switch Battery Potential is below the LOW threshold
161	#	TR INPUT SHAFT SPD	Caption Indicating Transmission Input Shaft Speed
167	#	CHARGING SYSTM VOLT	Charging System Voltage
168	#	LOW BATT VOLT	Low Battery Voltage string used in event log and/or Alarm and Pre-alarm annunciation
171	#	AMB AIR TEMP	Ambient Air Temperature
172	#	AIR INLET TEMP	Air Inlet Temperature
173	#	EXHAUST GAS TEMP	Exhaust Gas Temperature
174	#	FUEL TEMP	Fuel Temperature
174	0	Fuel Temp EXT HI	Fuel Temp (Extremely High)
174	3	Fuel Tmp Sns Volt HI	Fuel Temp Sensor Input Voltage (High)
174	4	Fuel Tmp Sns Volt LO	Fuel Temp Sensor Input Voltage (Low)
174	16	Fuel Temp MHI	Fuel Temp (Moderately High)
175	#	ENG OIL TEMP	Caption used on front panel for Display of J1939 Parameter
176	#	TRBO CH OIL TEMP	Turbo Charger Oil Temperature
188	#	IDLE SPEED	Idle Speed parameter
188	17	SPEED AT IDLE LO	Metering string for ECU trouble code metering indicates Engine Idle speed is below the LOW threshold
189	#	RATED SPEED	Engine Rated Speed
189	0	Engine Spd DERATE	Engine Speed Derate
190	#	ENGINE SPEED	Caption used on front panel for Display of J1939 Parameter
190	0	Engine OvrSpd EXTRM	Engine Overspeed (Extreme)
190	1	ENGINE SPEED LOW	Engine speed is below the LOW threshold
190	16	Engine OvrSpd MODRT	Engine Overspeed (Moderate)
190	17	SPEED AT IDLE LO	Engine Idle speed is below the LOW threshold
190	#	ENGINE SPEED	Caption used on front panel for Display of J1939 Parameter
191	#	TR OUTPUT SHAFT SPD	Caption Indicating Transmission Output Shaft Speed
237	2	VIN Data MisMatch	VIN Data Mismatch with other controllers
247	#	ENGINE HOURS	Engine Run Time in Hours
250	#	TOTAL FUEL USED	Total Fuel Usage
354	#	RELATIVE HUMIDITY	Caption Indicating Relative Humidity
412	#	EGR GAS TEMP	Caption string for Exhaust Gas Recirculation Valve Gas Temperature
412	0	EGR Temp EXT HI	Exhaust Gas Recirculation Temp (Extremely High)
412	3	EGR Temp In Vlt HI	Exhaust Gas Recirculation Temp Input Voltage (High)
412	4	EGR Temp In Vlt LO	Exhaust Gas Recirculation Temp Input Voltage (Low)
412	16	EGR Temp MHI	Exhaust Gas Recirculation Temp (Moderately High)
441	#	AUX TEMP 1	Caption Indicating Aux Temperature 1
442	#	AUX TEMP 2	Caption Indicating Aux Temperature 2
443	#	BATTERY VOLT 2	Caption Indicating Battery Voltage 2
444	#	AUX PRESSURE2	Caption Indicating Auxiliary Pressure 2
515	#	DESIRED SPEED	Caption string for parameter that indicates speed demand desired from the engine.

SPN	FMI	String Displayed	Description
520	#	RETARDER % TORQUE	Caption string for retarder % torque
523	#	TRANS CURRNT GEAR	Caption Indicating Transmission Current Gear
524	#	TRANS SELECTD GEAR	Caption Indicating Transmission Selected Gear
558	#	ACCEL PEDAL IDLE SW	Caption Indicating Accelerator Pedal Idle Switch
559	#	ACCEL PEDAL KICKDN SW	Caption Indicating Accelerator Pedal Kickdown Switch
563	#	ABS ACTIVE	Caption String for Antilock Brake System (ABS) active
573	#	TRQCNV LOCKUP ENGAGD	Caption Indicating Transmission Torque Converter Lockup Engaged
574	#	TR SHIFT IN PROGRESS	Caption Indicating Transmission Shift in Process
596	#	CRUISE CNTL ENABLE SW	Caption Indicating Cruise Control Enable Switch
597	#	BRAKE SWITCH	Caption Indicating Brake Switch
598	#	CLUTCH SWITCH	Caption Indicating Clutch Switch
599	#	CRUISE CNTL SET SW	Caption Indicating Cruise Control Set Switch
600	#	CRUISE CNTL COAST SW	Caption Indicating Cruise Control Coast (Decelerate) Switch
601	#	CRUISE CNTL RESUME SW	Caption Indicating Cruise Control Resume Switch
602	#	CRUISE CNTL ACCEL SW	Caption Indicating Cruise Control Accelerate Switch
609	#	CONTROLLER #2	Caption Indicating Controller Number 2
611	#	SYS DIAGNST CODE 1	Caption Indicating System Diagnostic Code 1
611	0	LOSS OF VOLTAGE SENSING	Loss of Voltage Sensing from Voltage Regulator over CAN Bus
611	3	Inj Short to PWR	Injector Wiring Shorted to Power
611	4	Inj Short to GND	Injector Wiring Shorted to Ground
612	14	EDM FAULT	Exciter Diode Monitor Fault Status from Voltage Regulator over CAN Bus
620	#	5 VOLT SUPPLY	Caption Indicating 5 Volt Supply
623	#	RED STOP LAMP	Caption Indicating Red Stop Lamp
624	#	DIAGNOSTIC LAMP	Caption String for Diagnostic Lamp
624	#	COMBINED YELLOW	Caption Indicating a Yellow Alarm from the Engine ECU
625	#	PROP COMM NETWK 1	Caption Indicating Proprietary Communications Network 1
627	1	Inj Spply Vlt Problm	Injector Supply Voltage Problem
627	13	ECU ERROR	ECU Error
627	16	ECU Power Volt HI	ECU Power High Voltage
627	18	ECU Power Volt LO	ECU Power Low Voltage
628	#	PROGRAM MEMORY	Caption Indicating Program Memory
629	#	CONTROLLER #1	Caption Indicating Controller 1
630	#	ECU INTERNAL ERROR	Caption string for ECU Internal Error
632	#	FUEL SHUT OFF 1	Engine Fuel Shutoff 1 Control
632	5	FUEL SHUTOFF OPEN/SHORT	Fuel shutoff is shorted or open
632	7	FUEL PRESSURE LOW	Fuel pressure is low
632	12	FUEL SHUTOFF MALFUNCTN	Fuel shutoff is shorted or open
633	#	THROTTLE ACT 1 CNTL	Throttle Actuator 1 Control
636	#	ENG POSITION SENSOR	Caption Indicating Engine Position Sensor
636	2	Pump Pos Sns Noisy	Pump Position Sensor Input Noise
636	5	Pump Pos Sns Curr LO	Pump Position Sensor Current (Low)
636	6	Pump Pos Sns Curr HI	Pump Position Sensor Current (High)
636	8	Pump Pos Sns In MSNG	Pump Position Sensor Input Missing
636	10	Pump Pos Sns In ERR	Pump Position Sensor Input Pattern Error
637	2	Crank Pos Sns Noisy	Crank Position Input Noise
637	5	Crank Pos Sns Curr LO	Crank Position Sensor Current (Low)
637	6	Crank Pos Sns Curr HI	Crank Position Sensor Current (High)
637	7	Crnk/Pmp Pos Tmg OOS	Crank/Pump Position Timing Moderately Out of Sync
637	8	Crank Pos Sns MSNG	Crank Position Missing

SPN	FMI	String Displayed	Description
637	10	Crank Pos Sns In ERR	Crank Position Input Pattern Error
639	#	J1939 NETWORK 1	Caption String for J1939 Network number 1
641	4	Trbo Actuator ERR	Turbo Actuator Error
641	12	ECU/Trbo Comm ERR	ECU/Turbo Communication Error
641	13	TrboAct Lrnd Val ERR	Turbo Actuator Learned Value Error
641	16	Trbo Act Temp MHI	Turbo Actuator Temp (Moderately High)
645	#	J1939 NETWORK 1	Caption String for J1939 Network number 1
651	#	CYLINDER 1 INJECTOR	Caption String for Cylinder 1 Injector
651	2	Cyl 1 EUI PN INVLD	Cylinder #1 EUI Part Number (Invalid)
651	5	Cyl 1 EUI Ckt OPEN	Cylinder #1 EUI Circuit (Open)
651	6	Cyl 1 EUI Ckt SHORT	Cylinder #1 EUI Circuit (Shorted)
651	7	Cyl 1 EUI Ckt MECH FL	Cylinder #1 EUI Circuit (Mechanical Failure)
651	13	Cyl 1 EUI QR INVLD	Cylinder #1 EUI Circuit QR Code (Invalid)
652	#	CYLINDER 2 INJECTOR	Caption String for Cylinder 2 Injector
652	2	Cyl 2 EUI PN INVLD	Cylinder #2 EUI Part Number (Invalid)
652	5	Cyl 2 EUI Ckt OPEN	Cylinder #2 EUI Circuit (Open)
652	6	Cyl 2 EUI Ckt SHORT	Cylinder #2 EUI Circuit (Shorted)
652	7	Cyl 2 EUI Ckt MECH FL	Cylinder #2 EUI Circuit (Mechanical Failure)
652	13	Cyl 2 EUI QR INVLD	Cylinder #2 EUI Circuit QR Code (Invalid)
653	#	CYLINDER 3 INJECTOR	Caption String for Cylinder 3 Injector
653	2	Cyl 3 EUI PN INVLD	Cylinder #3 EUI Part Number (Invalid)
653	5	Cyl 3 EUI Ckt OPEN	Cylinder #3 EUI Circuit (Open)
653	6	Cyl 3 EUI Ckt SHORT	Cylinder #3 EUI Circuit (Shorted)
653	7	Cyl 3 EUI Ckt MECH FL	Cylinder #3 EUI Circuit (Mechanical Failure)
653	13	Cyl 3 EUI QR INVLD	Cylinder #3 EUI Circuit QR Code (Invalid)
654	#	CYLINDER 4 INJECTOR	Caption String for Cylinder 4 Injector
654	2	Cyl 4 EUI PN INVLD	Cylinder #4 EUI Part Number (Invalid)
654	5	Cyl 4 EUI Ckt OPEN	Cylinder #4 EUI Circuit (Open)
654	6	Cyl 4 EUI Ckt SHORT	Cylinder #4 EUI Circuit (Shorted)
654	7	Cyl 4 EUI Ckt MECH FL	Cylinder #4 EUI Circuit (Mechanical Failure)
654	13	Cyl 4 EUI QR INVLD	Cylinder #4 EUI Circuit QR Code (Invalid)
655	#	CYLINDER 5 INJECTOR	Caption String for Cylinder 5 Injector
655	2	Cyl 5 EUI PN INVLD	Cylinder #5 EUI Part Number (Invalid)
655	5	Cyl 5 EUI Ckt OPEN	Cylinder #5 EUI Circuit (Open)
655	6	Cyl 5 EUI Ckt SHORT	Cylinder #5 EUI Circuit (Shorted)
655	7	Cyl 5 EUI Ckt MECH FL	Cylinder #5 EUI Circuit (Mechanical Failure)
655	13	Cyl 5 EUI QR INVLD	Cylinder #5 EUI Circuit QR Code (Invalid)
656	#	CYLINDER 6 INJECTOR	Caption String for Cylinder 6 Injector
656	2	Cyl 6 EUI PN INVLD	Cylinder #6 EUI Part Number (Invalid)
656	5	Cyl 6 EUI Ckt OPEN	Cylinder #6 EUI Circuit (Open)
656	6	Cyl 6 EUI Ckt SHORT	Cylinder #6 EUI Circuit (Shorted)
656	7	Cyl 6 EUI Ckt MECH FL	Cylinder #6 EUI Circuit (Mechanical Failure)
656	13	Cyl 6 EUI QR INVLD	Cylinder #6 EUI Circuit QR Code (Invalid)
657	#	CYLINDER 7 INJECTOR	Caption String for Cylinder 7 Injector
658	#	CYLINDER 8 INJECTOR	Caption String for Cylinder 8 Injector
659	#	CYLINDER 9 INJECTOR	Caption String for Cylinder 9 Injector
660	#	CYLINDER 10 INJECTOR	Caption String for Cylinder 10 Injector
661	#	CYLINDER 11 INJECTOR	Caption String for Cylinder 11 Injector
662	#	CYLINDER 12 INJECTOR	Caption String for Cylinder 12 Injector
663	#	CYLINDER 13 INJECTOR	Caption String for Cylinder 13 Injector
664	#	CYLINDER 14 INJECTOR	Caption String for Cylinder 14 Injector
665	#	CYLINDER 15 INJECTOR	Caption String for Cylinder 15 Injector
666	#	CYLINDER 16 INJECTOR	Caption String for Cylinder 16 Injector

SPN	FMI	String Displayed	Description
667	#	CYLINDER 17 INJECTOR	Caption String for Cylinder 17Injector
668	#	CYLINDER 18 INJECTOR	Caption String for Cylinder 18 Injector
669	#	CYLINDER 19 INJECTOR	Caption String for Cylinder 19 Injector
670	#	CYLINDER 20 INJECTOR	Caption String for Cylinder 20 Injector
671	#	CYLINDER 21 INJECTOR	Caption String for Cylinder 21 Injector
672	#	CYLINDER 22 INJECTOR	Caption String for Cylinder 22 Injector
673	#	CYLINDER 23 INJECTOR	Caption String for Cylinder 23 Injector
674	#	CYLINDER 24 INJECTOR	Caption String for Cylinder 24 Injector
675	#	ENG GLOW PLUG LAMP	Caption Indicating Glow Plug Lamp
676	#	ENG GLOW PLUG RELAY	Caption String for Engine Glow Plug Relay
677	#	ENGINE START RELAY	Caption String for Engine Start Relay
697	#	AUX PWM DRIVER 1	Caption Indicating Auxiliary PWM Driver 1
698	#	AUX PWM DRIVER 2	Caption Indicating Auxiliary PWM Driver 2
699	#	AUX PWM DRIVER 3	Caption Indicating Auxiliary PWM Driver 3
700	#	AUX PWM DRIVER 4	Caption Indicating Auxiliary PWM Driver 4
701	#	AUX I/O 1	Caption String for Auxiliary I/O 1
702	#	AUX I/O 2	Caption String for Auxiliary I/O 2
703	#	AUX I/O 3	Caption String for Auxiliary I/O 3
704	#	AUX I/O 4	Caption String for Auxiliary I/O 4
705	#	AUX I/O 5	Caption String for Auxiliary I/O 5
706	#	AUX I/O 6	Caption String for Auxiliary I/O 6
707	#	AUX I/O 7	Caption String for Auxiliary I/O 7
708	#	AUX I/O 8	Caption String for Auxiliary I/O 8
709	#	AUX I/O 9	Caption String for Auxiliary I/O 9
710	#	AUX I/O 10	Caption String for Auxiliary I/O 10
711	#	AUX I/O 11	Caption String for Auxiliary I/O 11
712	#	AUX I/O 12	Caption String for Auxiliary I/O 12
713	#	AUX I/O 13	Caption String for Auxiliary I/O 13
714	#	AUX I/O 14	Caption String for Auxiliary I/O 14
715	#	AUX I/O 15	Caption String for Auxiliary I/O 15
716	#	AUX I/O 16	Caption String for Auxiliary I/O 16
723	#	SPEED SENSOR #2	Caption Indicating Engine Speed Sensor #2
724	#	O2 SENSOR	Caption Indicating O2 Sensor
729	#	INTAKE HEATER #1	Caption Indicating Intake Air Heater #1
730	#	INTAKE HEATER #2	Caption Indicating Intake Air Heater #2
731	#	KNOCK SENSOR #1	Caption Indicating Knock Sensor 1
855	#	HEATER CIRCUIT 2	UEGO Heater Circuit #02
870	#	HEATER REGEN SYSTM	Caption Indicating Heater Regeneration System
898	#	ENGINE REQSTED SPEED	Caption String for Engine Requested Speed
898	2	REQ SPD DATA ERRATIC	Speed Demand Data is erratic
898	9	Spd/Trq Msg INVLD	Vehicle Speed/Torque Message Invalid
904	#	FRONT AXLE SPEED	Caption Indicating Front Axle Speed
920	#	AUDIBLE ALARM	Caption Indicating Audible Alarm
923	#	PWM OUTPUT	Caption String for Engine PWM Output
924	#	AUX OUT #1	Caption Indicating Auxiliary Output 1
925	#	AUX OUT #2	Caption Indicating Auxiliary Output 2
926	#	AUX OUT #3	Caption Indicating Auxiliary Output 3
966	31	ENGINE TST MD SW ON	Caption Indicating Engine Test Mode Switch On
970	2	Aux Eng SD SW INVLD	Auxiliary Engine Shutdown Switch (Invalid)
970	31	Aux Eng SD SW ACTV	Auxiliary Engine Shutdown Switch Active
971	31	Eng Derate SW ACTV	External Engine Derate Switch Active
973	#	ENG RETARDR SELECTN	Caption Indicating Engine Retarder Selection
974	#	REMOTE ACCEL PEDAL	Caption Indicating Remote Accelerator Pedal

SPN	FMI	String Displayed	Description
975	#	FAN SPEED	Caption String for Engine Fan Speed
977	#	FAN DRIVE STATE	Fan Drive State
986	#	REQSTD FAN SPEED	Caption Indicating Requested Fan Speed
1004	#	TRIP VEH IDLE FL USED	Caption Indicating Trip Vehicle Idle Fuel Used
1005	#	TRIP CRUISE FL USED	Caption Indicating Trip Cruise Fuel Used
1015	#	TRIP AVG LOAD FACTOR	Caption Indicating Trip Average Load Factor
1072	#	ENG BRAKE OUTPUT 1	Caption String for Engine Brake Output 1
1073	#	ENG COMPR BRK OUTPUT2	Caption Indicating Engine (Compression) Brake Output 2
1074	#	ENG EXHAUST BRAKE OUT	Caption String for Engine Exhaust Brake Output
1075	5	Fuel TR Pump Curr LO	Fuel Transfer Pump Current (Low)
1075	6	Fuel TR Pump Curr HI	Fuel Transfer Pump Current (High)
1075	12	Fuel TR Pump ERR	Fuel Transfer Pump (Error)
1079	#	SENSOR SUPPLY VOLTS 1	Caption String for Sensor Supply Voltage 1
1080	#	SENSOR SUPPLY VOLTS 2	Caption String for Sensor Supply Voltage 2
1080	3	Snsr Supp 1 Volt LO	Sensor Supply 1 Voltage (Low)
1080	4	Snsr Supp 1 Volt HI	Sensor Supply 1 Voltage (High)
1081	#	ENG WAIT TO START LMP	Caption String for Engine Wait to Start Lamp
1083	#	AUX I/O 1	Auxiliary I/O 1
1084	#	AUX I/O 2	Auxiliary I/O 2
1109	#	EPS SHUTDN APPROACHG	Caption String for indication that Engine Protective System Shutdown Is Approaching
1109	31	Eng Shutdown WARNING	Engine Shutdown Warning
1110	31	Eng Prot Shutdown	Engine Protection Shutdown
1127	#	TURBOCHG1 BOOST PRS	Caption Indicating Turbo Charger 1 Boost Pressure
1128	#	TURBOCHG2 BOOST PRS	Caption Indicating Turbo Charger 2 Boost Pressure
1129	#	TURBOCHG3 BOOST PRS	Caption Indicating Turbo Charger 3 Boost Pressure
1130	#	TURBOCHG4 BOOST PRS	Caption Indicating Turbo Charger 4 Boost Pressure
1131	#	INTK MNFLD2 TEMP	Caption Indicating Intake Manifold 2 Temperature
1132	#	INTK MNFLD3 TEMP	Caption Indicating Intake Manifold 3 Temperature
1133	#	INTK MNFLD4 TEMP	Caption Indicating Intake Manifold 4 Temperature
1136	#	ECU TEMP	Caption used on front panel for Display of J1939 Parameter
1136	0	ECU Temp EXT HI	ECU Temperature (Extremely High)
1136	15	ENG ECU TEMP HI	ECU Temperature has exceeded the HIGH level
1136	16	ECU Temp MHI	ECU Temperature (Moderately High)
1168	#	TRBO CH2 OIL PRESS	Turbo Charger 2 Oil Pressure
1169	#	TURBO CH2 SPEED	Turbo 2 Speed
1170	#	TURBO CH3 SPEED	Turbo 3 Speed
1171	#	TURBO CH4 SPEED	Turbo 4 Speed
1172	3	Trbo Cmp Tmp Volt HI	Turbo Compressor Inlet Temp Input Voltage (High)
1172	4	Trbo Cmp Tmp Volt LO	Turbo Compressor Inlet Temp Input Voltage (Low)
1172	16	Trbo Cmp In Tmp MHI	Turbo Compressor Inlet Temp (Moderately High)
1180	0	Trbo Trbn Tmp EXT HI	Turbo Turbine Inlet Temp (Extremely High)
1180	16	Trbo Trbn In Tmp MHI	Turbo Turbine Inlet Temp (Moderately High)
1184	#	TURBOCHG1 OUTLET TEMP	Caption Indicating Turbo Charger 1 Outlet Temperature
1185	#	TURBOCHG2 OUTLET TEMP	Caption Indicating Turbo Charger 2 Outlet Temperature
1186	#	TURBOCHG3 OUTLET TEMP	Caption Indicating Turbo Charger 3 Outlet Temperature
1187	#	TURBOCHG4 OUTLET TEMP	Caption Indicating Turbo Charger 4 Outlet Temperature
1188	#	TRBO WST GT ACT1 POS	Caption Indicating Turbo Waste Gate Actuator 1 Position
1189	#	TRBO WST GT ACT2 POS	Caption Indicating Turbo Waste Gate Actuator 2 Position
1192	#	TRBO WSTGT ACT AIR PR	Caption Indicating Engine Turbocharger Waste gate Actuator Control Air Pressure
1203	#	INTRCOOLER COOLNT PRS	Intercooler Coolant Pressure
1204	#	ELECTRICAL LOAD	Electrical Load
1208	#	PRE FLT OIL PRESSR	Oil Pressure Before Oil Filter

SPN	FMI	String Displayed	Description
1209	#	EXH PRESSURE	Exhaust Pressure
1213	#	MALFUNC LAMP	Caption string for the malfunction indicator lamp status that is broadcast by ECU as part of diagnostic trouble code information
1227	#	TEST LIMIT MAX	Caption Indicating Test Limit Maximum
1231	#	J1939 NETWORK 2	Caption String for J1939 Network number 2
1235	#	J1939 NETWORK 3	Caption String for J1939 Network number 3
1237	#	ENG SHUTDN ORIDE SW	Caption String for Engine Shutdown Override Switch
1237	31	AL OVERRIDE ON	Alarm Override is On
1239	#	FUEL LEAKAGE1	Caption Indicating Fuel Leakage 1 Parameter
1240	#	FUEL LEAKAGE2	Caption Indicating Fuel Leakage 2 Parameter
1247	#	ENGINE POWER	Engine Power
1268	#	IGNITION COIL 1	Caption Indicating Engine Ignition Coil 1
1269	#	IGNITION COIL 2	Caption Indicating Engine Ignition Coil 2
1270	#	IGNITION COIL 3	Caption Indicating Engine Ignition Coil 3
1271	#	IGNITION COIL 4	Caption Indicating Engine Ignition Coil 4
1272	#	IGNITION COIL 5	Caption Indicating Engine Ignition Coil 5
1273	#	IGNITION COIL 6	Caption Indicating Engine Ignition Coil 6
1274	#	IGNITION COIL 7	Caption Indicating Engine Ignition Coil 7
1275	#	IGNITION COIL 8	Caption Indicating Engine Ignition Coil 8
1276	#	IGNITION COIL 9	Caption Indicating Engine Ignition Coil 9
1277	#	IGNITION COIL 10	Caption Indicating Engine Ignition Coil 10
1278	#	IGNITION COIL 11	Caption Indicating Engine Ignition Coil 11
1279	#	IGNITION COIL 12	Caption Indicating Engine Ignition Coil 12
1280	#	IGNITION COIL 13	Caption Indicating Engine Ignition Coil 13
1281	#	IGNITION COIL 14	Caption Indicating Engine Ignition Coil 14
1282	#	IGNITION COIL 15	Caption Indicating Engine Ignition Coil 15
1283	#	IGNITION COIL 16	Caption Indicating Engine Ignition Coil 16
1284	#	IGNITION COIL 17	Caption Indicating Engine Ignition Coil 17
1285	#	IGNITION COIL 18	Caption Indicating Engine Ignition Coil 18
1286	#	IGNITION COIL 19	Caption Indicating Engine Ignition Coil 19
1287	#	IGNITION COIL 20	Caption Indicating Engine Ignition Coil 20
1288	#	IGNITION COIL 21	Caption Indicating Engine Ignition Coil 21
1289	#	IGNITION COIL 22	Caption Indicating Engine Ignition Coil 22
1290	#	IGNITION COIL 23	Caption Indicating Engine Ignition Coil 23
1291	#	IGNITION COIL 24	Caption Indicating Engine Ignition Coil 24
1321	#	STARTER LKOUT RLY DRV	Caption Indicating Engine Starter Solenoid Lockout Relay Driver Circuit
1322	#	MULTI CYL MISFIRE	Caption String for Misfire detected on multiple engine cylinders
1323	#	MISFIRE CYLINDER 1	Caption String for Misfire detected on a single engine cylinder
1324	#	MISFIRE CYLINDER 2	Caption String for Misfire detected on a single engine cylinder
1325	#	MISFIRE CYLINDER 3	Caption String for Misfire detected on a single engine cylinder
1326	#	MISFIRE CYLINDER 4	Caption String for Misfire detected on a single engine cylinder
1327	#	MISFIRE CYLINDER 5	Caption String for Misfire detected on a single engine cylinder
1328	#	MISFIRE CYLINDER 6	Caption String for Misfire detected on a single engine cylinder
1329	#	MISFIRE CYLINDER 7	Caption String for Misfire detected on a single engine cylinder
1330	#	MISFIRE CYLINDER 8	Caption String for Misfire detected on a single engine cylinder
1331	#	MISFIRE CYLINDER 9	Caption String for Misfire detected on a single engine cylinder
1332	#	MISFIRE CYLINDER 10	Caption String for Misfire detected on a single engine cylinder
1333	#	MISFIRE CYLINDER 11	Caption String for Misfire detected on a single engine cylinder
1334	#	MISFIRE CYLINDER 12	Caption String for Misfire detected on a single engine cylinder
1335	#	MISFIRE CYLINDER 13	Caption String for Misfire detected on a single engine cylinder
1336	#	MISFIRE CYLINDER 14	Caption String for Misfire detected on a single engine cylinder
1337	#	MISFIRE CYLINDER 15	Caption String for Misfire detected on a single engine cylinder

SPN	FMI	String Displayed	Description
1338	#	MISFIRE CYLINDER 16	Caption String for Misfire detected on a single engine cylinder
1339	#	MISFIRE CYLINDER 17	Caption String for Misfire detected on a single engine cylinder
1340	#	MISFIRE CYLINDER 18	Caption String for Misfire detected on a single engine cylinder
1341	#	MISFIRE CYLINDER 19	Caption String for Misfire detected on a single engine cylinder
1342	#	MISFIRE CYLINDER 20	Caption String for Misfire detected on a single engine cylinder
1343	#	MISFIRE CYLINDER 21	Caption String for Misfire detected on a single engine cylinder
1344	#	MISFIRE CYLINDER 22	Caption String for Misfire detected on a single engine cylinder
1345	#	MISFIRE CYLINDER 23	Caption String for Misfire detected on a single engine cylinder
1346	#	MISFIRE CYLINDER 24	Caption String for Misfire detected on a single engine cylinder
1347	#	FUEL PUMP ASSY #1	Caption Indicating Fuel Pump Pressurizing Assembly #1
1348	#	FUEL PUMP ASSY #2	Caption Indicating Fuel Pump Pressurizing Assembly #2
1349	#	INJ RAIL PRS2	Injection Metering Rail 2 Pressure
1350	#	TIME SINCE LST SERVC	Caption Indicating Time Since Last Service
1352	#	KNOCK LVL CYL 1	Engine Cylinder 1 Knock Level
1353	#	KNOCK LVL CYL 2	Engine Cylinder 2 Knock Level
1354	#	KNOCK LVL CYL 3	Engine Cylinder 3 Knock Level
1355	#	KNOCK LVL CYL 4	Engine Cylinder 4 Knock Level
1356	#	KNOCK LVL CYL 5	Engine Cylinder 5 Knock Level
1357	#	KNOCK LVL CYL 6	Engine Cylinder 6 Knock Level
1358	#	KNOCK LVL CYL 7	Engine Cylinder 7 Knock Level
1359	#	KNOCK LVL CYL 8	Engine Cylinder 8 Knock Level
1380	#	OIL RESVR LEVEL	Oil Reservoir Level
1384	#	J1939 COMANDED SHUTDN	Caption Indicating J1939 Commanded Shutdown
1385	#	AUX TEMP 1	Caption Indicating Aux Temperature 1
1386	#	AUX TEMP 2	Caption Indicating Aux Temperature 2
1387	#	AUX PRESSURE1	Caption Indicating Auxiliary Pressure 1
1388	#	AUX PRESSURE2	Caption Indicating Auxiliary Pressure 2
1390	#	FUEL VALVE1 INLET PRS	Caption Indicating Fuel Valve 1 Inlet Pressure
1391	#	FUEL VALVE 1 DIFF PRS	Engine Fuel Valve 1 Differential Pressure
1442	#	FUEL VALVE1 POSITN	Engine Fuel Valve 1 Position
1485	#	ECU MAIN RELAY	Caption Indicating ECM Main Relay
1557	#	FAN 2 DRIVE STATE	Fan 2 Drive State
1569	#	Engine Torque Derate	Engine Torque Derate
1569	31	Fuel Derate	Fuel Derate
1623	#	TACOGRPH OUT SHFT SPD	Caption Indicating Tachograph Output Shaft Speed
1624	#	TACOGRPH VEHICLE SPD	Caption Indicating Tachograph Vehicle Speed
1633	#	CRUISE CNTL PAUSE SW	Caption Indicating Cruise Control Pause Switch
1634	#	CALIB VERIFICATN NMBR	Caption Indicating Calibration Verification Number
1636	#	INTK MNFD1 TMP HI RES	Caption Indicating Intake Manifold 1 Air Temperature (High Resolution)
1638	#	HYDRAULIC TEMP	Caption String for Hydraulic Temperature
1639	#	FAN SPEED	Fan Speed
1639	1	Fan Speed Zero	Fan Speed Detected (Zero)
1639	16	Fan Speed HI	Fan Speed Detected (High)
1639	18	Fan Speed LO	Fan Speed Detected (Low)
1675	#	STARTER MODE	Engine Starter Mode
1692	#	INTKMNFLD1 DESIRD PR	Caption Indicating Engine Intake Manifold Desired Absolute Pressure
1695	#	EGO SNSR FUEL CORRCTN	Caption Indicating Exhaust Gas Oxygen Sensor Fueling Correction
1716	#	RETRDR SEL NON ENGINE	Caption Indicating Retarder Selection non-engine
1761	#	DEF 1 TANK LEVEL	Diesel Exhaust Fluid 1 Tank Level
1908	#	AUX VLV0 STATE CMD	Caption Indicating Aux Valve 0 State Command
2000	13	Security Violation	Security Violation

SPN	FMI	String Displayed	Description
2005	9	TSC CAN Msg NT RCV	TSC CAN Message Not Received
2030	9	AC Clutch Msg NT RCV	A/C Clutch Status CAN Message Not Received
2071	9	Tr Oil Can Msg NT RCV	Trans. Oil, Tier Size, Vehicle Speed CAN Message Not Received
2433	#	EXH GAS TMP RT MNFLD	Right Manifold Exhaust Gas Temperature
2434	#	EXH GAS TMP LFT MNFLD	Left Manifold Exhaust Gas Temperature
2436	#	GEN AVG FREQUENCY	Caption Indicating Generator Average AC Frequency
2440	#	GEN LL VOLTAGE	Generator Line to Line Voltage
2452	#	GEN TOTAL POWER	Generator Total Real Power
2456	#	TRBO 1 OUT TMP HI HI	Turbocharger 1 outlet pressure is above the HIGH HIGH threshold
2602	#	HYDRAULIC OIL LVL	Hydraulic Oil Level
2629	0	TRBO 1 OUT TMP HI HI	Turbocharger 1 outlet pressure is above the HIGH HIGH threshold
2629	15	TURBO 1 OUT TMP HI	Turbocharger 1 outlet pressure is above the HIGH threshold
2630	0	EGR FrAir Tmp EXT HI	Exhaust Gas Recirculation Fresh Air Temp (Extremely High)
2630	3	EGR FrAir Tmp Vlt HI	Exhaust Gas Recirculation Fresh Air Temp Input Voltage (High)
2630	4	EGR FrAir Tmp Vlt LO	Exhaust Gas Recirculation Fresh Air Temp Input Voltage (Low)
2630	15	EGR FrAir Tmp HI	Exhaust Gas Recirculation Fresh Air Temp (High Least Severe)
2630	16	EGR FrAir Tmp MHI	Exhaust Gas Recirculation Fresh Air Temp (Moderately High)
2634	#	POWER RELAY	Caption String for main Power Relay
2646	#	AUX OUT #4	Caption Indicating Auxiliary Output 4
2647	#	AUX OUT #5	Caption Indicating Auxiliary Output 5
2659	2	EGR Flo/Tmp MISMATCH	Exhaust Gas Recirculation Flow/Temp Mismatch
2659	15	EGR Flo Rt High	Exhaust Gas Recirculation Flow Rate (High Least Severe)
2659	17	EGR Flo Rt LO	Exhaust Gas Recirculation Flow Rate (Low Least Severe)
2790	16	Trbo Cmp Out Tmp HI	Turbo Compressor Outlet Temp (Moderately High)
2791	#	EGR VALVE CONTROL	Caption String for EGR Valve Control
2791	2	EGR Vlv Pos Invld	Exhaust Gas Recirculation Valve Position Invalid
2791	3	EGRVlv Pos In Vlt HI	Exhaust Gas Recirculation Valve Position Input Voltage (High)
2791	4	EGRVlv Pos In Vlt LO	Exhaust Gas Recirculation Valve Position Input Voltage (Low)
2791	13	EGR Vlv Control ERR	Exhaust Gas Recirculation Valve Control Error
2791	31	EGR Valve Cal ERR	Exhaust Gas Recirculation Valve Calibration Error
2795	7	Trbo Act Pos MSMATCH	Turbo Actuator Position Mismatch
2797	#	INJECTOR GROUP 1	Caption Indicating Engine Injector Group 1
2798	#	INJECTOR GROUP 2	Caption Indicating Engine Injector Group 2
2899	#	START ENABL DEV 1 CFG	Caption Indicating Engine Start Enable Device 1 Configuration
2950	#	INTK VALVE ACUATOR 1	Intake Valve Actuator 1
2951	#	INTK VALVE ACUATOR 2	Intake Valve Actuator 2
2980	#	FUEL PRESSR	Fuel Pressure
3031	#	DEF TEMP	DEF Temperature
3050	#	CATALYST SYSTM MONITR	Caption Indicating Catalyst 1 System Monitor
3056	#	EGO SENSOR MONITOR 1	Caption Indicating Exhaust Gas Oxygen Sensor 1 Monitor
3057	#	EGO SENSOR MONITOR 2	Caption Indicating Exhaust Gas Oxygen Sensor 2 Monitor
3217	#	AFTR TRT 1 INTK O2	Caption Indicating Aftertreatment 1 Intake O2
3218	#	AFT1 INTK SNSPWR IN RG	Caption Indicating Aftertreatment 1 Intake Gas Sensor Power In Range
3219	#	AFT1 INTK SNSR AT TMP	Caption Indicating Aftertreatment 1 Intake Gas Sensor at Temperature
3220	#	AFT1 INTK NOX STBL	Caption Indicating Aftertreatment 1 Intake NOx Reading Stable
3221	#	AFT1 INTK WR O2 STBL	Caption Indicating Aftertreatment 1 Intake Wide-Range Percent O2 Reading Stable
3222	#	AFT1 INTK SNS HTR FMI	Caption Indicating Aftertreatment 1 Intake Gas Sensor Heater Preliminary FMI

SPN	FMI	String Displayed	Description
3224	#	AFT1 INTK NOXSNSR FMI	Caption Indicating Aftertreatment 1 Intake NOx Sensor Preliminary FMI
3225	#	AFT1 INTK O2 SNSR FMI	Caption Indicating Aftertreatment 1 Intake O2 Sensor Preliminary FMI
3226	#	AFT 1 OUTLET NOX	Aftertreatment 1 Outlet Nox
3227	#	AFT 1 OUT OXYGN %	Aftertreatment 1 Outlet Percent O2
3232	#	AFT1 OUT SNS HTR FMI	Caption Indicating Aftertreatment 1 Outlet Gas Sensor Heater Preliminary FMI
3234	#	AFT1 OUT NOX SNSR FMI	Caption Indicating Aftertreatment 1 Outlet NOx Sensor Preliminary FMI
3242	#	AFT1 DPF IN TEMP	Aftertreatment1 DPF Intake Temperature
3246	#	AFT1 DPF OUT TEMP	Aftertreatment 1 DPF Outlet Temperature
3250	#	DPF INTRMED GAS TEMP	Caption Indicating Aftertreatment 1 Diesel Particulate Filter Intermediate Gas Temperature
3251	#	AFT1 DPF DIFF PRESSR	Aftertreatment 1 DPF Differential Pressure
3256	#	AFTR TRT 2 INTK O2	Caption Indicating Aftertreatment 2 Intake Percent O2
3257	#	AFT2 INTK SNSPWR IN RG	Caption Indicating Aftertreatment 2 Intake Gas Sensor Power In Range
3260	#	AFT2 INTK WR O2 STBL	Caption Indicating Aftertreatment 2 Intake Wide-Range Percent O2 Reading Stable
3261	#	AFT2 INTK SNS HTR FMI	Caption Indicating Aftertreatment 2 Intake Gas Sensor Heater Preliminary FMI
3264	#	AFT2 INTK O2 SNSR FMI	Caption Indicating Aftertreatment 2 Intake O2 Sensor Preliminary FMI
3271	#	AFT2 OUT SNS HTR FMI	Caption Indicating Aftertreatment 2 Outlet Gas Sensor Heater Preliminary FMI
3361	#	AFT1 CTLYST DOSE UNIT	Caption Indicating Aftertreatment 1 SCR Catalyst Dosing Unit
3363	#	AFT1 SCR TANK HTR	Caption Indicating Aftertreatment 1 SCR Tank Heater
3380	#	FIELD VOLTAGE	Field Voltage
3381	#	FIELD CURRENT	Field Current
3464	#	THROTTLE ACT 1 CNTL	Caption Indicating Throttle Actuator 1 Control
3465	#	THROTTLE ACT 2 CNTL	Caption Indicating Throttle Actuator 2 Control
3468	#	FUEL TEMP 2	Fuel Temperature 2
3485	#	AFT1 SUPPLY AIR PRESS	Caption Indicating Aftertreatment 1 Supply Air Pressure
3509	#	SENSOR SUPPLY VOLTS 1	Caption String for Sensor Supply Voltage 1
3510	#	SENSOR SUPPLY VOLTS 2	Caption String for Sensor Supply Voltage 2
3511	#	SNSR SUPPLY VOLT 3	Caption Indicating Sensor Supply Voltage 3
3512	#	SNSR SUPPLY VOLT 4	Caption Indicating Sensor Supply Voltage 4
3513	#	SNSR SUPPLY VOLT 5	Caption Indicating Sensor Supply Voltage 5
3514	#	SNSR SUPPLY VOLT 6	Caption Indicating Sensor Supply Voltage 6
3515	#	DEF TEMP	String for Diagnostic Trouble Code Indicating DEF Temperature
3516	#	DEF CONCENTRATION	Caption Indicating Aftertreatment 1 SCR Catalyst Reagent Concentration
3517	#	DEF TANK 2 LVL %	Diesel Exhaust Fluid Tank 2 Level %
3520	#	DEF QUALITY	Caption Indicating Aftertreatment 1 SCR Catalyst Reagent Properties Preliminary FMI
3563	#	INTK MNFLD1 PRESSURE	Intake Manifold 1 Pressure
3597	#	ECU SUPPLY VOLTAGE 1	Caption Indicating ECU Power Supply Voltage 1
3598	#	ECU SUPPLY VOLTAGE 2	Caption Indicating ECU Power Supply Voltage 2
3599	#	ECU SUPPLY VOLTAGE 3	Caption Indicating ECU Power Supply Voltage 3
3601	#	FUEL VLV LK TEST CTL	Caption Indicating Engine Fuel Shutoff Valve Leak Test Control
3605	#	COOLANT PUMP CTL	Caption Indicating Coolant Pump Control
3607	#	ENGINE SHUTDOWN	Caption Indicating Engine Shutdown
3609	#	DPF INTAKE PRESSR 1	Caption Indicating DPF Intake Pressure 1
3610	#	DPF OUTLET PRESSR 1	Caption Indicating DPF Outlet Pressure 1
3611	#	DPF INTAKE PRESSR 2	Caption Indicating DPF Intake Pressure 2

SPN	FMI	String Displayed	Description
3612	#	DPF OUTLET PRESSR 2	Caption Indicating DPF Outlet Pressure 2
3668	#	INTRCR CLNT LVL	Intercooler Coolant Level
3673	#	THROTTLE POSITION 2	Caption Indicating Engine Throttle 2 Position
3695	#	REGEN INHIBIT SWITCH	Regenerate Inhibit Switch
3703	#	DPF RGN INH DUE TO SW	DPF Regeneration Inhibited Due to Inhibit Switch
3719	#	DPF SOOT LEVEL %	String indicating level of soot in the Diesel Particulate Filter
3719	0	DPF SOOT LVL EXT HI	String for Diagnostic Trouble Code Indicating Diesel Particulate Filter Soot Level High - Most Severe Level
3719	15	DPF SOOT LVL HI	String for Diagnostic Trouble Code Indicating Diesel Particulate Filter Soot Level High - Least Severe Level
3719	16	DPF SOOT LVL MOD HI	String for Diagnostic Trouble Code Indicating Diesel Particulate Filter Soot Level High - Moderately Severe Level
3720	#	DPF ASH LEVEL %	DPF Ash Level Percent
3822	#	EGR1 VLV 2 POSITION	Caption Indicating Engine Exhaust Gas Recirculation 1 Valve 2 Position
3826	#	DEF AVG CONSUMPTION	Caption Indicating DEF Average Consumption
3828	#	DEF CURRNT CONSUMPTN	Caption Indicating DEF Current Consumption
3938	#	GOVERNING BIAS	Generator Governing Bias
4096	#	NOx HI DEF EMPTY	NOx Limits Exceeded Due to Diesel Exhaust Fluid Empty
4213	#	ENG CRNK WITHOUT_FUEL	Caption Indicating Engine Crank Without Fuel
4257	#	INJECTOR GROUP 3	Injector Group 3
4332	#	DEF SYSTEM STATE	Caption Indicating DEF System State
4334	#	DEF ABSOLUTE PRESSR	Caption Indicating DEF Absolute Pressure
4335	#	DEF DOSING AIR ABS PR	Caption Indicating DEF Dosing Air Assist Absolute Pressure
4336	#	AFT1 DOSE AIR ASSTVLV	Caption Indicating Aftertreatment 1 SCR Dosing Air Assist Valve
4348	#	AFT1 REQ DOSING QTY	Aftertreatment 1 Requested Dosing Reagent Quantity
4354	#	AFT1 DEF LINE HTR	Caption Indicating Aftertreatment 1 SCR Catalyst Reagent Line Heater 1
4360	#	AFTTRT1 INTK GAS TMP	Aftertreatment 1 Catalyst Intake Gas Temperature
4363	#	AFTTRT1 OUT GAS TMP	Aftertreatment 1 Catalyst Outlet Gas Temperature
4364	#	SCR CNVRSN EFFICIENCY	Caption Indicating SCR Conversion Efficiency
4375	#	AFTTRT1 PUMP DRV %	Aftertreatment 1 Catalyst Pump Drive Percentage
4401	#	AFT2 REQ DOSING QTY	Aftertreatment 2 Requested Dosing Reagent Quantity
4413	#	AFTTRT2 INTK GAS TMP	Aftertreatment 2 Catalyst Intake Gas Temperature
4415	#	AFTTRT2 OUT GAS TMP	Aftertreatment 2 Catalyst Outlet Gas Temperature
4441	#	AFTTRT2 PUMP DRV %	Aftertreatment 2 Catalyst Pump Drive Percentage
4490	#	SPECIFIC HUMIDITY	Specific Humidity
4755	#	AFT1 CTLYST DIFF PRS	Caption Indicating Aftertreatment 1 Gas Oxidation Catalyst Differential Pressure
4765	#	AFTTRT1 INTK GAS TMP	Aftertreatment 1 Catalyst Intake Gas Temperature
4794	#	AFT1 CTLYST SYS MSSNG	Caption Indicating Aftertreatment 1 SCR Catalyst System Missing
4809	#	AFT1 DEF WARM IN TMP	Caption Indicating Aftertreatment 1 Warm Up Diesel Oxidation Catalyst Inlet Temperature
4810	#	AFT1 DEF WARM OUT TMP	Caption Indicating Aftertreatment 1 Warm Up Diesel Oxidation Catalyst Outlet Temperature
4990	#	BATT CHARGER	Battery Charger
5078	#	AMBER WARNING	Engine Amber Warning Lamp Command
5246	#	SCR INDUCMT SEVERITY	Selective Catalytic Reduction Inducement Severity Level
5264	#	EGR2 VALVE 1 CONTROL	Caption Indicating Engine Exhaust Gas Recirculation 2 Valve 1 Control
5422	#	CHG AIR B PRESSURE	Charge Air B Pressure
5571	#	FUEL RTN PRESSURE	Fuel Return Path Pressure
10029	0	PURGE TIMEOUT ERROR	Purge did not complete within the maximum allowed time
516098	#	KNOCK SENSR 2	Knock Sensor 2

SPN	FMI	String Displayed	Description
516131	#	PROPANE/GAS LOCKOFF	Propane/Natural Gas Lockoff
520555	#	UEGO INRC	Manufacturer Assignable SPN – Contact Engine Manufacturer for details.
520556	#	EXH GAS SENSR 2	Exhaust Gas Sensor 2
520700	#	TSC1 MESSAGE	Torque/Speed Control 1 Message - Manufacturer Assignable SPN – Contact Engine Manufacturer for details.
520707	#	DIAG TOOL CAN NETWK 1	Diagnostic Tool CAN Bus Network #1 - Manufacturer Assignable SPN – Contact Engine Manufacturer for details.
520708	#	OHECS MESSAGE	Manufacturer Assignable SPN – Contact Engine Manufacturer for details.
520709	#	GTACP MESSAGE	Manufacturer Assignable SPN – Contact Engine Manufacturer for details.
520710	#	GC2 MESSAGE	Manufacturer Assignable SPN – Contact Engine Manufacturer for details.
520711	#	EBC1 MESSAGE	Manufacturer Assignable SPN – Contact Engine Manufacturer for details.
520712	#	ACS MESSAGE	Manufacturer Assignable SPN – Contact Engine Manufacturer for details.
520713	#	INTER ECU COMM MSG	Inter-ECU Communications Message - Manufacturer Assignable SPN – Contact Engine Manufacturer for details.
520714	#	CCVS MESSAGE	Manufacturer Assignable SPN – Contact Engine Manufacturer for details.
520837	1	STARTER SPEED LO LO	Starter Speed is below the LOW LOW threshold
520838	1	RUN UP SPEED LO LO	Run Up Speed is below the LOW LOW threshold
522192	12	MTU ENGINE BAD	Component failure of the MTU engine control ECU
523212	#	ENGPRT CAN MSG	Caption String for CAN Bus Message
523216	#	PREHTENCMD CAN MSG	Caption String for CAN Bus Message
523218	#	RxCCVS CAN MSG	Caption String for CAN Bus Message
523222	#	TC01 CAN MSG	Caption String for CAN Bus Message
523238	#	SWTOUT CAN MSG	Caption String for CAN Bus Message
523239	#	DECV1 CAN MSG	Caption String for CAN Bus Message
523240	#	FUNMODCTL CAN MSG	Caption String for CAN Bus Message
523350	#	CYL BANK 1 INJECTORS	Caption String for Cylinder Bank 1 Injectors
523351	#	CYL BANK 1 INJECTORS	Caption String for Cylinder Bank 1 Injectors
523352	#	CYL BANK 2 INJECTORS	Caption String for Cylinder Bank 2 Injectors
523353	#	CYL BANK 2 INJECTORS	Caption String for Cylinder Bank 2 Injectors
523354	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523355	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523370	#	RAIL PRESSURE	Caption String for Rail Pressure
523420	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523450	#	MULTI STATE SWITCH 1	Caption String for Multi State Switch 1
523451	#	MULTI STATE SWITCH 2	Caption String for Multi State Switch 2
523452	#	MULTI STATE SWITCH 3	Caption String for Multi State Switch 3
523470	#	RAIL PRESSURE LMT VLV	Caption String for Rail Pressure Limit Valve
523490	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523500	#	CAN MSG TIMEOUT	Caption String indicating Can Message Timeout has occurred
523550	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523561	#	INJECTN PERIOD CYL 1	Caption String for Single Cylinder Injection Period
523562	#	INJECTN PERIOD CYL 2	Caption String for Single Cylinder Injection Period
523563	#	INJECTN PERIOD CYL 3	Caption String for Single Cylinder Injection Period
523564	#	INJECTN PERIOD CYL 4	Caption String for Single Cylinder Injection Period
523565	#	INJECTN PERIOD CYL 5	Caption String for Single Cylinder Injection Period
523566	#	INJECTN PERIOD CYL 6	Caption String for Single Cylinder Injection Period
523567	#	INJECTN PERIOD CYL 7	Caption String for Single Cylinder Injection Period
523568	#	INJECTN PERIOD CYL 8	Caption String for Single Cylinder Injection Period

SPN	FMI	String Displayed	Description
523600	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523601	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523602	#	FAN SPEED	Caption String for Engine Fan Speed
523604	#	RXENGTMP CAN MSG	Caption String for CAN Bus Message
523605	#	TSC1-AE MSG MISSING	Caption String for CAN Bus Message
523606	#	TSC1-AR MSG MISSING	Caption String for CAN Bus Message
523607	#	TSC1-DE MSG MISSING	Caption String for CAN Bus Message
523608	#	TSC1-DR MSG MISSING	Caption String for CAN Bus Message
523609	#	TSC1-PE MSG MISSING	Caption String for CAN Bus Message
523610	#	TSC1-VE MSG MISSING	Caption String for CAN Bus Message
523611	#	TSC1-VR MSG MISSING	Caption String for CAN Bus Message
523612	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523613	#	RAIL PRESSURE	Caption String for Rail Pressure
523615	#	METERING UNIT VALVE	Caption String for Metering Unit Valve
523617	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error

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 BESTCOMS*Plus*® 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

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 BESTCOMS*Plus*®. 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 3-7 when starting and stopping the generator.

Table 3-7. 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.
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.

State	Description
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.
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. BESTCOMS*Plus*® is used to configure breaker management. Refer to Section 4, *BESTCOMSPlus® Software, Breaker Management,* for setting information.

Determining Breaker Status

The status of the breakers is determined by using BESTlogic*Plus* 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 BESTCOMS*Plus*® or the front panel HMI.
- Logic Request - generated from BESTlogic*Plus*.

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 BESTCOMS*Plus*® *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 BESTlogic*Plus*. The generator breaker can be manually controlled using contact inputs and outputs or the breaker buttons on the BESTCOMS*Plus*® *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 BESTCOMS*Plus*®. 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 BESTCOMS*Plus*®. 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 BESTCOMS*Plus*® 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 BESTCOMS*Plus*®. 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 BESTCOMS*Plus*®. 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 manger 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*Plus*® 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 3-8 lists all possible event strings (as shown in the event log), causes, and corrective actions.

Table 3-8. Event List

Event String	Event Description/Cause/Corrective Action
27-1 UNDVOLT TRP A	27-1 Undervoltage Trip (Alarm)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)

Event String	Event Description/Cause/Corrective Action
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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 P	51-2 Overcurrent Trip (Pre-Alarm)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)

Event String	Event Description/Cause/Corrective Action
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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 P	81 Rate of Change of Frequency DF/DT Trip (Pre-Alarm)
	Cause: 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.
	Corrective Action: 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.
81O OVRFREQ TRP A	81 Overfrequency Trip (Alarm)
	Cause: The generator frequency is above the 81 overfrequency threshold and the 81 Overfrequency element is configured as an alarm.
	Corrective Action: Check the Rated Frequency setting, the speed bias into the engine governor, the engine governor, and any load-sharing devices in multiple generator applications.
81O OVRFREQ TRP P	81 Overfrequency Trip (Pre-Alarm)
	Cause: The generator frequency is above the 81 overfrequency threshold and the 81 Overfrequency element is configured as a pre-alarm.
	Corrective Action: Check the Rated Frequency setting, the speed bias into the engine governor, the engine governor, and any load-sharing devices in multiple generator applications.
81U UNDFREQ TRP A	81 Underfrequency Trip (Alarm)
	Cause: The generator frequency is below the 81 underfrequency threshold and the 81 Underfrequency element is configured as an alarm.
	Corrective Action: Check the Rated Frequency setting, the speed bias into the engine governor, the engine governor, and any load-sharing devices in multiple generator applications.
81U UNDFREQ TRP P	81 Underfrequency Trip (Pre-Alarm)
	Cause: The generator frequency is below the 81 underfrequency threshold and the 81 Underfrequency element is configured as a pre-alarm.
	Corrective Action: Check the Rated Frequency setting, the speed bias into the engine governor, the engine governor, and any load-sharing devices in multiple generator applications.
AEM COMM FAIL P	AEM-2020 Communications Failure (Pre-Alarm)

Event String	Event Description/Cause/Corrective Action
	Cause: Communications with the AEM-2020 have failed. The machine will continue running, but annunciate the pre-alarm.
	Corrective Action: 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-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 AEM-2020.
AEM OUTX OUT RNG (X = 1 to 4)	User Configurable Analog Output X Out of Range (X = 1 to 4) (Status)
	Cause: 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.
	Corrective Action: 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 A (X = 1 to 4)	User Configurable Analog Output X Out of Range (X = 1 to 4) (Alarm)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: Bit Data (0 or 1) has been received from an MTU ECU indicating that the ECU is faulty.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.

Event String	Event Description/Cause/Corrective Action
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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 P (X = 1 to 8)	User Configurable Analog Input X Over 2 (X = 1 to 8) (Pre-Alarm)
	Cause: 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.
	Corrective Action: 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 OOR (X = 1 to 8)	User Configurable Analog Input X Out of Range (X = 1 to 8) (Status)
	Cause: 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.
	Corrective Action: 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.
ALG IN X OOR A (X = 1 to 8)	User Configurable Analog Input X Out of Range (X = 1 to 8) (Alarm)
	Cause: 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.
	Corrective Action: 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.
ALG IN X OOR P (X = 1 to 8)	User Configurable Analog Input X Out of Range (X = 1 to 8) (Pre-Alarm)
	Cause: 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.

Event String	Event Description/Cause/Corrective Action
	Corrective Action: 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.
ALG IN X U1 (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8) (Status)
	Cause: 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.
	Corrective Action: 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.
ALG IN X U1 A (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8) (Alarm)
	Cause: 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.
	Corrective Action: 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.
ALG IN X U1 P (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8) (Pre-Alarm)
	Cause: 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.
	Corrective Action: 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.
ALG IN X U2 (X = 1 to 8)	User Configurable Analog Input X Under 2 (X = 1 to 8) (Status)
	Cause: 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.
	Corrective Action: 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.
ALG IN X U2 A (X = 1 to 8)	User Configurable Analog Input X Under 2 (X = 1 to 8) (Alarm)
	Cause: 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.
	Corrective Action: 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.
ALG IN X U2 P (X = 1 to 8)	User Configurable Analog Input X Under 2 (X = 1 to 8) (Pre-Alarm)

Event String	Event Description/Cause/Corrective Action
	Cause: 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.
	Corrective Action: 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.
ATS INPUT CLOSED	ATS Input (Status)
	Cause: This indicates that the ATS input has transitioned from open to closed.
	Corrective Action: Correct operation. No corrective action necessary.
AUTO MODE	DGC-2020 has entered Auto mode (Status)
	Cause: This indicates that the DGC-2020 was put in Auto mode. This can be done through the front-panel buttons, Modbus communication, BESTCOMS*Plus* communication, or logic.
	Corrective Action: Correct operation. No corrective action necessary.
AUTO RESTART	Automatic Restart in Progress (Status)
	Cause: 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.
	Corrective Action: Correct operation. No corrective action necessary.
AUTO RESTART FAIL A	Automatic Restart Fail (Alarm)
	Cause: 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.
	Corrective Action: 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.
BATT CHRG FAIL A	Battery Charger Fail (Alarm)
	Cause: 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.
	Corrective Action: Correct battery charger issues.
BATT CHRG FAIL P	Battery Charger Fail (Pre-Alarm)
	Cause: 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.
	Corrective Action: Correct battery charger issues.
BATT OVERVOLT P	Battery Overvoltage (Pre-Alarm)
	Cause: Battery voltage is above the Battery Overvoltage pre-alarm threshold setting.
	Corrective Action: Correct issues with the system battery charger or charging alternator that cause battery voltage to increase above normal limits.
BATTLE OVERRIDE	Battle Override (Status)
	Cause: The contact input associated with the Battle Override programmable function is true.
	Corrective Action: Correct operation. No corrective action necessary.
BUS REV ROT	Bus Reverse Rotation (Pre-Alarm)
	Cause: 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.
	Corrective Action: 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.
CAN BUS OFF	CAN Bus entered Bus Off state (Status)
	Cause: 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.
	Corrective Action: 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.
CAN ERR PASSIVE	CAN Bus entered Error Passive state (Status)

Event String	Event Description/Cause/Corrective Action
	Cause: 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.
	Corrective Action: 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.
CEM COMM FAIL P	CEM-2020 Communications Failure (Pre-Alarm)
	Cause: Communication with the CEM-2020 has failed. A pre-alarm is annunciated, but the machine continues running.
	Corrective Action: 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 reseat the connectors on the CEM-2020.
CEM HW MISMATCH P	Connected CEM-2020 is wrong type (Pre-Alarm)
	Cause: The setting for number of CEM-2020 outputs does not match the number of outputs on the connected CEM-2020.
	Corrective Action: Change the setting to match the number of CEM-2020 outputs.
CHARGER1 AC OFF P	Battery Charger 1 AC Off (Pre-Alarm)
	Cause: The ac power to the battery charger is off or disconnected.
	Corrective Action: Restore ac power to the battery charger.
CHARGER1 BATT FAIL P	Battery Charger 1 Battery Failure (Pre-Alarm)
	Cause: Battery Charger 1 has detected that the battery has failed.
	Corrective Action: Check existing battery and associated wiring. Replace battery if necessary. Correct any issues with the battery harness wiring.
CHARGER1 COMMS FAIL P	Battery Charger 1 Communications Failure (Pre-Alarm)
	Cause: J1939 communications from the battery charger is expected, but not being received.
	Corrective Action: Check CAN Bus wiring and terminations. Verify that battery charger is set up for J1939 communications. Service or replace charger if necessary.
CHARGER1 FAILURE P	Battery Charger 1 Charger Failure (Pre-Alarm)
	Cause: The battery charger has detected that it has failed.
	Corrective Action: Service or replace charger and/or charging system wiring as necessary.
CHARGER1 HI DC VOLTS P	Battery Charger 1 High Output Voltage (Pre-Alarm)
	Cause: Battery charger has detected high output voltage.
	Corrective Action: 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.
CHARGER1 INVALID SETTINGS P	Battery Charger 1 Invalid Settings (Pre-Alarm)
	Cause: The battery charger has detected that some of its settings are invalid.
	Corrective Action: Correct battery charger settings.
CHARGER1 LO CRANKING V P	Battery Charger 1 Low Cranking Voltage (Pre-Alarm)
	Cause: Battery voltage during cranking has been detected to be low.
	Corrective Action: Check charger wiring and battery terminals and service where necessary. Service or replace charger if there are no wiring issues.
CHARGER1 LOW DC VOLTS P	Battery Charger 1 Low Output Voltage (Pre-Alarm)
	Cause: Battery charger has detected low output voltage.
	Corrective Action: 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.
CHARGER1 SINGLE UNIT FAIL P	Battery Charger 1 Single Unit Failure (Pre-Alarm)
	Cause: In chargers with multiple charging stages, one or more of the charging stages has failed.
	Corrective Action: Check charger wiring and battery terminals and service where necessary. Service or replace charger if there are no wiring issues.
CHARGER1 THERMAL LIMIT P	Battery Charger 1 Thermal Limit (Pre-Alarm)
	Cause: The charger has exceeded a thermal limit.

Event String	Event Description/Cause/Corrective Action
	Corrective Action: 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.
CHARGER2 AC OFF P	Battery Charger 2 AC Off (Pre-Alarm)
	Cause: The ac power to the battery charger is off or disconnected.
	Corrective Action: Restore ac power to the battery charger.
CHARGER2 BATT FAIL P	Battery Charger 2 Battery Failure (Pre-Alarm)
	Cause: Battery Charger 2 has detected that the battery has failed.
	Corrective Action: 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)
	Cause: J1939 communications from the battery charger is expected, but not being received.
	Corrective Action: 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)
	Cause: The battery charger has detected that it has failed.
	Corrective Action: Service or replace charger and/or charging system wiring as necessary.
CHARGER2 HI DC VOLTS P	Battery Charger 2 High Output Voltage (Pre-Alarm)
	Cause: Battery charger has detected high output voltage.
	Corrective Action: 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)
	Cause: The battery charger has detected that some of its settings are invalid.
	Corrective Action: Correct battery charger settings.
CHARGER2 LO CRANKING V P	Battery Charger 2 Low Cranking Voltage (Pre-Alarm)
	Cause: Battery voltage during cranking has been detected to be low.
	Corrective Action: 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)
	Cause: Battery charger has detected low output voltage.
	Corrective Action: 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)
	Cause: In chargers with multiple charging stages, one or more of the charging stages has failed.
	Corrective Action: 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)
	Cause: The charger has exceeded a thermal limit.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: This indicates that a combined red alarm has been received over the CAN Bus from an MTU engine ECU. This alarm will shut down the engine.
	Corrective Action: Consult the MTU fault code list to determine the cause of the combined red alarm. Perform the corrective actions recommended by MTU to address the issue indicated by the fault code.
COMBINED YELLOW P	Combined Yellow (Pre-Alarm)

Event String	Event Description/Cause/Corrective Action
	Cause: This indicates that a combined yellow alarm has been received over the CAN Bus from an MTU engine ECU. A pre-alarm is annunciated, but the machine continues running.
	Corrective Action: Consult the MTU fault code list to determine the cause of the combined yellow alarm. Perform the corrective actions recommended by MTU to address the issue indicated by the fault code.
CONF PROT X O1 (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Over Threshold 1 (Status)
	Cause: 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.
	Corrective Action: Examine causes for the parameter metered by Configurable Protection Element X to be above the programmed threshold.
CONF PROT X O1 A (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Over Threshold 1 (Alarm)
	Cause: 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.
	Corrective Action: Examine causes for the parameter metered by Configurable Protection Element X to be above the programmed threshold.
CONF PROT X O1 P (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Over Threshold 1 (Pre-Alarm)
	Cause: 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.
	Corrective Action: Examine causes for the parameter metered by Configurable Protection Element X to be above the programmed threshold.
CONF PROT X O2 (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Over Threshold 2 (Status)
	Cause: 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.
	Corrective Action: Examine causes for the parameter metered by Configurable Protection Element X to be above the programmed threshold.
CONF PROT X O2 A (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Over Threshold 2 (Alarm)
	Cause: 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.
	Corrective Action: Examine causes for the parameter metered by Configurable Protection Element X to be above the programmed threshold.
CONF PROT X O2 P (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Over Threshold 2 (Pre-Alarm)
	Cause: 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.
	Corrective Action: Examine causes for the parameter metered by Configurable Protection Element X to be above the programmed threshold.
CONF PROT X U1 (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Under Threshold 1 (Status)
	Cause: 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.
	Corrective Action: Examine causes for the parameter metered by Configurable Protection Element X to be below the programmed threshold.
CONF PROT X U1 A (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Under Threshold 1 (Alarm)
	Cause: 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.
	Corrective Action: Examine causes for the parameter metered by Configurable Protection Element X to be below the programmed threshold.
CONF PROT X U1 P (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Under Threshold 1 (Pre-Alarm)
	Cause: 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.
	Corrective Action: Examine causes for the parameter metered by Configurable Protection Element X to be below the programmed threshold.
CONF PROT X U2 (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Under Threshold 2 (Status)

Event String	Event Description/Cause/Corrective Action
	Cause: 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.
	Corrective Action: Examine causes for the parameter metered by Configurable Protection Element X to be below the programmed threshold.
CONF PROT X U2 A (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Under Threshold 2 (Alarm)
	Cause: 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.
	Corrective Action: Examine causes for the parameter metered by Configurable Protection Element X to be below the programmed threshold.
CONF PROT X U2 P (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Under Threshold 2 (Pre-Alarm)
	Cause: 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.
	Corrective Action: Examine causes for the parameter metered by Configurable Protection Element X to be below the programmed threshold.
CONFIG ELEMENT X A (X = 1 to 8)	Configurable Element X (X = 1 to 8) (Alarm)
	Cause: 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.
	Corrective Action: Refer to the programmable logic and perform corrective action for the conditions that have driven the configurable element true.
CONFIG ELEMENT X P (X = 1 to 8)	Configurable Element X (X = 1 to 8) (Pre-Alarm)
	Cause: 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.
	Corrective Action: Refer to the programmable logic and perform corrective action for the conditions that have driven the configurable element true.
COOL LVL SNDR FL A	Coolant Level Sender Fail (Alarm)
	Cause: 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.
	Corrective Action: 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.
COOL SNDR FAIL	Coolant Temperature Sender Fail (Status)
	Cause: 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.
	Corrective Action: Check the sender, the sender wiring, and the sender common wiring from the engine block to the DGC-2020 and/or the engine ECU.
COOL SNDR FAIL A	Coolant Temperature Sender Fail (Alarm)
	Cause: Coolant Temperature Sender Fail status is true and the Coolant Temperature Sender Fail alarm configuration is set for Alarm.
	Corrective Action: Check the sender, the sender wiring, and the sender common wiring from the engine block to the DGC-2020 and/or the engine ECU.
COOL SNDR FAIL P	Coolant Temperature Sender Fail (Pre-Alarm)
	Cause: Coolant Temperature Sender Fail status is true and the Coolant Temperature Sender Fail alarm configuration is set for Pre-Alarm.
	Corrective Action: Check the sender, the sender wiring, and the sender common wiring from the engine block to the DGC-2020 and/or the engine ECU.
DEFAULTS LOADED	Default settings were uploaded into the DGC (Status)
	Cause: Default settings were uploaded into the DGC, indicating either a successful firmware upload or a manual reset (UP and DOWN pushbuttons being held).
	Corrective Action: Correct operation. No corrective action necessary.
DEF FLUID EMPTY P	Diesel Exhaust Fluid Empty (Pre-Alarm)
	Cause: Diesel exhaust fluid level is critically low.
	Corrective Action: Add diesel exhaust fluid to the SCR system.
DEF FLUID LOW P	Diesel Exhaust Fluid Low (Pre-Alarm)
	Cause: Diesel exhaust fluid level is low.
	Corrective Action: Add diesel exhaust fluid to the SCR system.

Event String	Event Description/Cause/Corrective Action
DEF CONSUMPTN ERR P	Diesel Exhaust Fluid Consumption Incorrect (Pre-Alarm)
	Cause: 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.
	Corrective Action: Consult exhaust system documentation for recommended corrective actions or contact engine manufacturer or exhaust system manufacturer.
DEF INDUCEMENT P	Diesel Exhaust Fluid Inducement (Pre-Alarm)
	Cause: 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.
	Corrective Action: Check the diesel exhaust fluid level and quality. Correct any issues. Troubleshoot any other indicated SCR system issues.
DEF INDUCMT O-RIDE P	Diesel Exhaust Fluid Inducement Override (Pre-Alarm)
	Cause: 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.
	Corrective Action: Check the diesel exhaust fluid level and quality and correct any issue. Troubleshoot any other indicated SCR system issues.
DEF LOW SEVERE P	Diesel Exhaust Fluid Low Severe (Pre-Alarm)
	Cause: Diesel exhaust fluid level is critically low.
	Corrective Action: Add diesel exhaust fluid to the SCR system.
DEF PRESVR INDUCMT P	Diesel Exhaust Fluid Pre-Severe Inducement (Pre-Alarm)
	Cause: 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.
	Corrective Action: Check the diesel exhaust fluid level and quality and correct any issue. Troubleshoot any other indicated SCR system issues.
DEF QUALITY POOR P	Diesel Exhaust Fluid Quality Poor (Pre-Alarm)
	Cause: 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.
	Corrective Action: Drain out existing DEF if possible and replace with new DEF.
DEF SEVERE INDUCMT P	Diesel Exhaust Fluid Severe inducement (Pre-Alarm)
	Cause: 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.
	Corrective Action: Check the diesel exhaust fluid level and quality and correct any issue. Troubleshoot any other indicated SCR system issues.
DEF TAMPERING P	Diesel Exhaust Fluid Tampering (Pre-Alarm)
	Cause: The exhaust system controller has determined the DEF system has been tampered with. The DGC-2020 receives this information over J1939 CAN Bus.
	Corrective Action: Correct any modifications that have been made to the DEF system. Consult engine or exhaust system manufacturer.
DEF WARNING	Diesel Exhaust Fluid Pre-Inducement Warning Level 1 (Pre-Alarm)
	Cause: 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.
	Corrective Action: Check the diesel exhaust fluid level and quality and correct any issue. Troubleshoot any other indicated SCR system issues.
DEF WARNING LEVEL 2	Diesel Exhaust Fluid Pre-Inducement Warning Level 2 (Pre-Alarm)
	Cause: 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.
	Corrective Action: Check the diesel exhaust fluid level and quality and correct any issue. Troubleshoot any other indicated SCR system issues.
DEMAND START	Demand Start Request (Status)
	Cause: The DGC-2020 performed a demand-based start of the generator.
	Corrective Action: Correct operation. No corrective action necessary.
DEMAND STOP	Demand Stop Request (Status)
	Cause: The DGC-2020 performed a demand-based stop of the generator.
	Corrective Action: Correct operation. No corrective action necessary.

Event String	Event Description/Cause/Corrective Action
DGC HEARTBEAT FAIL P	DGC-2020 Heartbeat Fail (Pre-Alarm)
	Cause: An AEM-2020 or CEM-2020 is not receiving the periodic heartbeat message over CAN Bus from the DGC-2020.
	Corrective Action: 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)
	Cause: Diagnostic trouble codes have been received from the engine ECU and are active.
	Corrective Action: Consult the engine manufacturer's documentation to address any issues indicated by the diagnostic trouble codes.
DIAL OUT FAILED	Modem Dialout Failed (Status)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: Correct operation. No corrective action necessary.
DPF REGNRATE DISABLD P	Regeneration Disabled (Pre-Alarm)
	Cause: Pre-alarm from the Diesel Particulate Filter (DPF) system that regeneration of the filter has been disabled by request of the DGC-2020.
	Corrective Action: Enable DPF regeneration.
DPF REGEN REQD P	Regeneration Required (Pre-Alarm)
	Cause: Pre-alarm from the Diesel Particulate Filter (DPF) system that regeneration of the filter is necessary.
	Corrective Action: 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)
	Cause: Pre-alarm from the Diesel Particulate Filter (DPF) system indicating that the accumulated soot level is extremely high.
	Corrective Action: 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)
	Cause: Pre-alarm from the Diesel Particulate Filter (DPF) system indicating that the accumulated soot level is moderately high.
	Corrective Action: 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)
	Cause: The ECU has sent a shutdown indication to the DGC-2020 over CAN Bus indicating that the ECU has shut down the engine.
	Corrective Action: 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)
	Cause: A contact input has initiated the Emergency Stop programmable function or logic is driving the Emergency Stop logic element.
	Corrective Action: Correct operation. No corrective action necessary.
ENGINE RUN START	Engine Run logic element received a *start* request (Status)
	Cause: The engine was started due to a start request applied to the Engine Run logic element.
	Corrective Action: Correct operation. No corrective action necessary.
ENG kW OVRLD-1 P	Engine kW Overload 1 (Pre-Alarm)
	Cause: The kW output of the generator is above the threshold set for the kW Overload 1 protection element.

Event String	Event Description/Cause/Corrective Action
	Corrective Action: Check generator wiring, machine configuration, and load-sharing devices in multiple generator applications and the load. Shed some load if necessary.
ENG kW OVRLD-2 P	Engine kW Overload 2 (Pre-Alarm)
	Cause: The kW output of the generator is above the threshold set for the kW Overload 2 protection element.
	Corrective Action: Check generator wiring, machine configuration, and load-sharing devices in multiple generator applications and the load. Shed some load if necessary.
ENG kW OVRLD-3 P	Engine kW Overload 3 (Pre-Alarm)
	Cause: The kW output of the generator is above the threshold set for the kW Overload 3 protection element.
	Corrective Action: Check generator wiring, machine configuration, and load-sharing devices in multiple generator applications and the load. Shed some load if necessary.
ENGINE RUNNING	Engine Running (Status)
	Cause: Status indication that the engine is running.
	Corrective Action: Correct operation. No corrective action necessary.
ENTERED PROG MODE	DGC-2020 has entered programming mode (Status)
	Cause: The DGC-2020 has entered programming mode to upload firmware.
	Corrective Action: Correct operation. No corrective action necessary.
EPS SUPPLYING LOAD	Emergency Power System is Supplying Load (Status)
	Cause: 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.
	Corrective Action: Correct operation. No corrective action necessary.
FUEL FLT PRS HI P	Fuel Filter Differential Pressure High (Pre-Alarm)
	Cause: The ECU has detected high fuel filter differential pressure and sent a notification to the DGC-2020.
	Corrective Action: Check fuel filter for clogging. Check fuel pressure on both sides of the filter. Check for ECU related pre-alarms, status, and MTU fault codes. Contact the engine manufacturer if necessary.
FUEL LEAK 1 P	Fuel Filter 1 Leak (Pre-Alarm)
	Cause: The ECU has detected a leak in Fuel Filter 1 and sent a notification to the DGC-2020.
	Corrective Action: 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 MTU fault codes. Contact the engine manufacturer if necessary.
FUEL LEAK 2 P	Fuel Filter 2 Leak (Pre-Alarm)
	Cause: The ECU has detected a leak in Fuel Filter 2 and sent a notification to the DGC-2020.
	Corrective Action: 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 MTU fault codes. Contact the engine manufacturer if necessary.
FUEL LEAK DETECT A	Fuel Leak Detect (Alarm)
	Cause: 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.
	Corrective Action: 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.
FUEL LEAK DETECT P	Fuel Leak Detect (Pre-Alarm)
	Cause: 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.
	Corrective Action: 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.
FUEL LEVL SENDR A	Fuel Level Sender Fail (Alarm)
	Cause: 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.
	Corrective Action: Check the sender, the sender wiring, and the sender common wiring from the engine block to the DGC-2020.
FUEL LEVL SENDR FAIL	Fuel Level Sender Fail (Status)
	Cause: The input from the sender is beyond the valid range for the device and the Fuel Level Sender Fail is enabled.
	Corrective Action: Check the sender, the sender wiring, and the sender common wiring from the engine block to the DGC-2020.
FUEL LEVL SENDR P	Fuel Level Sender Fail (Pre-Alarm)
	Cause: 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.

Event String	Event Description/Cause/Corrective Action
	Corrective Action: Check the sender, the sender wiring, and the sender common wiring from the engine block to the DGC-2020.
GEN REV ROT	Generator Reverse Rotation (Pre-Alarm)
	Cause: 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.
	Corrective Action: Check machine wiring and configuration and implement correct rotation and sensing.
GEN TEST LOADED	Generator Exerciser Test with Load (Status)
	Cause: 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 BESTCOMS*Plus*.
	Corrective Action: Correct operation. No corrective action necessary.
GEN TEST UNLOADED	Generator Exerciser Test without Load (Status)
	Cause: 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 BESTCOMS*Plus*.
	Corrective Action: Correct operation. No corrective action necessary.
GLBL SNDR FAIL A	Global Sender Fail (Alarm)
	Cause: 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.
	Corrective Action: Perform corrective action for the underlying Sender Fail alarm that is active while the Global Sender Fail alarm is active.
GN BKR CL FL P	Generator Breaker Fail to Close (Pre-Alarm)
	Cause: 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.
	Corrective Action: 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.
GN BKR OP FL P	Generator Breaker Fail to Open (Pre-Alarm)
	Cause: 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.
	Corrective Action: 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.
GN BKR SYN FL P	Generator Breaker Synchronization Fail (Pre-Alarm)
	Cause: 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.
	Corrective Action: 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.
HI COOLANT TMP A	High Coolant Temp (Alarm)
	Cause: The engine coolant temperature is above the threshold set for the High Coolant Temperature alarm.
	Corrective Action: 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)
	Cause: The engine coolant temperature is above the threshold set for the High Coolant Temperature pre-alarm.
	Corrective Action: Check the engine thermostat and coolant level. Verify that the coolant pump is operating properly. Check the coolant radiator and passages for obstructions.

Event String	Event Description/Cause/Corrective Action
HI DAY TANK LEVEL MTU P	High Day Tank Level (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the fuel level in the day tank is too high.
	Corrective Action: 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 MTU fault codes. Contact the engine manufacturer if necessary.
HI ECU VOLTS MTU A	High ECU Supply Voltage (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the ECU supply voltage is too high.
	Corrective Action: Troubleshoot the ECU power supply. Check for ECU related pre-alarms, status, and MTU fault codes. Contact the engine manufacturer if necessary.
HI EXHAUST B T MTU P	High Exhaust Temp B (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the Exhaust System B temperature is high.
	Corrective Action: Check for obstructions in the exhaust system. Check the fuel management and delivery system. Check for ECU related pre-alarms, status, and MTU fault codes. Contact the engine manufacturer if necessary.
HI EXHAUST A T MTU P	High Exhaust Temp A (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the Exhaust System A temperature is high.
	Corrective Action: Check for obstructions in the exhaust system. Check the fuel management and delivery system. Check for ECU related pre-alarms, status, and MTU fault codes. Contact the engine manufacturer if necessary.
HI PRESSURE IN 1 MTU P	High Pressure Input 1 (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the Input 1 pressure is too high.
	Corrective Action: Check the pressure at the input. Check the pump. Check the passage for leaks or restrictions. Check for ECU related pre-alarms, status, and MTU fault codes. Contact the engine manufacturer if necessary.
HI PRESSURE IN 2 MTU P	High Pressure Input 2 (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the Input 2 pressure is too high.
	Corrective Action: Check the pressure at the input. Check the pump. Check the passage for leaks or restrictions. Check for ECU related pre-alarms, status, and MTU fault codes. Contact the engine manufacturer if necessary.
HI SUPPLY VOLTS MTU P	High Voltage Supply (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the supply voltage is high.
	Corrective Action: Check batteries and cabling, battery charging system, and charging alternator. Check for ECU related pre-alarms, status, and MTU fault codes. Contact the engine manufacturer if necessary.
HI T FUEL MTU P	High Fuel Temp (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the fuel temperature is too high.
	Corrective Action: Check the tank temperature. Check for ECU related pre-alarms, status, and MTU fault codes. Contact the engine manufacturer if necessary.
HIGH AMB TEMP MTU P	High Ambient Temp (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the ambient temperature is too high.
	Corrective Action: Check the ambient temperature and verify that all devices maintaining temperature are operating correctly. Check for ECU related pre-alarms, status, and MTU fault codes. Contact the engine manufacturer if necessary.
HIGH CHARGE AIR TEMP MTU A	High Charge Air Temp (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU 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.
	Corrective Action: Check the Charge Air Cooler and the Charge Air Passages for obstructions. Check for sufficient cooing air for air-cooled-charge air coolers and sufficient engine coolant for water-cooled-charge air coolers. Consult MTU documentation for additional procedures to diagnose the cause of engine related issues.
HIGH CHARGE AIR TEMP MTU P	High Charge Air Temp (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU 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.

Event String	Event Description/Cause/Corrective Action
	Corrective Action: Check the Charge Air Cooler and the Charge Air Passages for obstructions. Check for sufficient cooing air for air-cooled-charge air coolers and sufficient engine coolant for water-cooled-charge air coolers. Consult MTU documentation for additional procedures to diagnose the cause of engine related issues.
HIGH COIL TEMP 1 MTU P	High Temp Coil 1 (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the temperature of Coil 1 is too high.
	Corrective Action: 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 MTU fault codes. Contact the engine manufacturer if necessary.
HIGH COIL TEMP 2 MTU P	High Temp Coil 2 (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the temperature of Coil 2 is too high.
	Corrective Action: 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 MTU fault codes. Contact the engine manufacturer if necessary.
HIGH COIL TEMP 3 MTU P	High Temp Coil 3 (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the temperature of Coil 3 is too high.
	Corrective Action: 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 MTU fault codes. Contact the engine manufacturer if necessary.
HIGH COOLANT TEMP A	High Coolant Temp (Alarm)
	Cause: The engine coolant temperature is above the threshold set for the High Coolant Temperature alarm.
	Corrective Action: 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)
	Cause: The engine coolant temperature is above the threshold set for the High Coolant Temperature pre-alarm.
	Corrective Action: 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 MTU P	High ECU Temp (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the ECU temperature is too high.
	Corrective Action: Check for adequate air flow or coolant circulation around the engine ECU. Check for ECU related pre-alarms, status, and MTU fault codes. Consult MTU 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)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU 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.
	Corrective Action: 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 MTU fault codes. Contact the engine manufacturer if necessary.
HIGH FUEL LEVEL P	High Fuel Level (Pre-Alarm)
	Cause: The fuel level reading is above the level specified in the High Fuel Level pre-alarm element.
	Corrective Action: 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.
HIGH FUEL RAIL PRESS MTU P	High Fuel Rail Pressure (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the fuel rail pressure is too high.

Event String	Event Description/Cause/Corrective Action
	Corrective Action: Check fuel filters, fuel lines, fuel rail, and fuel injectors for obstructions. Check the fuel pump for correct pump pressure. Consult MTU documentation for additional procedures to diagnose the causes of engine related issues.
HIGH INTRCOOLER TEMP MTU P	High Intercooler Temp (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the intercooler temperature is too high.
	Corrective Action: 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 MTU documentation for additional procedures to diagnose the causes of engine related issues.
HIGH OIL TEMPERATURE MTU P	High Oil Temp (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU 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.
	Corrective Action: 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 MTU documentation for additional procedures to diagnose the causes of engine related issues.
HIGH OIL TERMPERATURE MTU A	High Oil Temp (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU 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.
	Corrective Action: 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 MTU documentation for additional procedures to diagnose the causes of engine related issues.
HIGH STRG TANK LEVEL MTU P	High Storage Tank Level (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the fuel level in the storage tank is too high.
	Corrective Action: 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 MTU fault codes. Contact the engine manufacturer if necessary.
ID MISSING P	LSM-2020 ID Missing (Pre-Alarm)
	Cause: A DGC-2020 with an expected sequencing ID is not present on the intergenset communications network.
	Corrective Action: 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.
ID REPEAT P	LSM-2020 ID Repeated (Pre-Alarm)
	Cause: Two DGC-2020 units with the same nonzero sequencing ID's are present on the intergenset communications network at the same time.
	Corrective Action: Check the sequencing ID on as many units as necessary until all DGC-2020's on the network have unique nonzero sequencing IDs.
IDLE SPD LO MTU P	Idle Speed Low (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the idle speed is low.
	Corrective Action: Check the idle speed. Check for ECU related pre-alarms, status, and MTU fault codes. Contact the engine manufacturer if necessary.
INPUT X A (X = 1 to 40)	User Configurable Input X (X = 1 to 40) (Alarm)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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 MTU A	Low After Cooler Cool Level (Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the After Cooler coolant level is low.

Event String	Event Description/Cause/Corrective Action
	Corrective Action: Check the After Cooler coolant level. Check for ECU related pre-alarms, status, and MTU fault codes. Contact the engine manufacturer if necessary.
LO CHG AIR CLNT LVL MTU P	Low Charge Air Coolant Level (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the Charge Air Cooler coolant level is low.
	Corrective Action: Check the Charge Air coolant level. Check for ECU related pre-alarms, status, and MTU fault codes. Contact the engine manufacturer if necessary.
LO DAY TANK LEVEL MTU P	Low Day Tank Level (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the fuel level in the day tank is low.
	Corrective Action: 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 MTU fault codes. Contact the engine manufacturer if necessary.
LO ECU VOLTS MTU P	Low ECU Supply Voltage (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the ECU supply voltage is too low.
	Corrective Action: Troubleshoot the ECU power supply. Check for ECU related pre-alarms, status, and MTU fault codes. Contact the engine manufacturer if necessary.
LO FUEL DLV PRESSURE MTU A	Low Fuel Delivery Pressure (Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU 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.
	Corrective Action: Check the fuel filters and fuel lines for obstructions. Check the fuel pump for proper pressure. Consult MTU documentation for additional procedures to diagnose the cause of engine related issues.
LO SUPPLY VOLTS MTU P	Low Voltage Supply (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the supply voltage is low.
	Corrective Action: Check batteries and cabling, battery charging system, and charging alternator. Check for ECU related pre-alarms, status, and MTU fault codes. Contact the engine manufacturer if necessary.
LOAD TAKEOVER	Load Takeover (Status)
	Cause: 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.
	Corrective Action: Correct operation. No corrective action necessary.
LOGIC OUTPUT A	Logic Output (Alarm)
	Cause: The LOGICALM (Logic Alarm) logic element is true in the DGC-2020 programmable logic.
	Corrective Action: 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)
	Cause: The LOGICPALM (Logic Pre-Alarm) logic element is true in the DGC-2020 programmable logic.
	Corrective Action: Refer to the programmable logic and perform corrective action for the conditions that have driven the logic element true.
LOSS OF VOLT	Voltage Sensing Fail (Status)
	Cause: 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.
	Corrective Action: 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.
LOSS OF VOLT A	Voltage Sensing Fail (Alarm)
	Cause: 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.
	Corrective Action: 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.
LOSS OF VOLT P	Voltage Sensing Fail (Pre-Alarm)

Event String	Event Description/Cause/Corrective Action
	Cause: 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.
	Corrective Action: 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.
LOSS REM COMS P	Loss of Remote Module Communication (Pre-Alarm)
	Cause: 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.
	Corrective Action: 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.
LOST ECU COMM A	Loss of ECU Communication (Alarm)
	Cause: 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 basic. 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.
	Corrective Action: 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.
LOST ECU COMM P	Loss of ECU Communication (Pre-Alarm)
	Cause: 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 basic. 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.
	Corrective Action: 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.
LOW BATT VOLT P	Low Battery Voltage (Pre-Alarm)
	Cause: The battery voltage is below the level set for the Low Battery Voltage Pre-Alarm threshold.
	Corrective Action: Check batteries and cabling, battery charging system, and charging alternator. Check for ECU related pre-alarms, status, and MTU fault codes. Contact the engine manufacturer if necessary.
LOW CHARGE AIR PRESS MTU P	Low Charge Air Pressure (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the charge air pressure is too low.
	Corrective Action: Check the turbo charger. Check the charge air passages for obstructions. Check for ECU related pre-alarms, status, and MTU fault codes. Consult MTU documentation for additional procedures to diagnose the causes of engine related issues. Contact the engine manufacturer if necessary.
LOW COOL LEVEL A	Low Coolant Level (Alarm)
	Cause: 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.
	Corrective Action: Check the engine coolant level and add coolant if necessary. If the level is very low, check for and correct any coolant leaks.
LOW COOL LEVEL P	Low Coolant Level (Pre-Alarm)
	Cause: 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.
	Corrective Action: Check the engine coolant level and add coolant if necessary. If the level is very low, check for and correct any coolant leaks.
LOW COOL TMP A	Low Coolant Temperature (Alarm)

Event String	Event Description/Cause/Corrective Action
	Cause: 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.
	Corrective Action: Check the engine block heater or any other devices which maintain minimum coolant temperatures when the engine is not running.
LOW COOL TMP P	Low Coolant Temperature (Pre-Alarm)
	Cause: 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.
	Corrective Action: Check the engine block heater or any other devices which maintain minimum coolant temperatures when the engine is not running.
LOW COOLANT LEVEL MTU P	Low Coolant Level (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU 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.
	Corrective Action: 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 MTU fault codes. Consult MTU documentation for additional procedures to diagnose the causes of engine related issues. Contact the engine manufacturer if necessary.
LOW FUEL DELIV PRESS MTU P	Low Fuel Delivery Pressure (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU 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.
	Corrective Action: Check the fuel filters and fuel lines for obstructions. Check the fuel pump for proper pressure. Check for ECU related pre-alarms, status, and MTU fault codes. Consult MTU documentation for additional procedures to diagnose the causes of engine related issues. Contact the engine manufacturer if necessary.
LOW FUEL LEVEL A	Low Fuel Level (Alarm)
	Cause: The fuel level measured by the fuel level sender is below the Low Fuel Level Alarm threshold.
	Corrective Action: 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.
LOW FUEL LEVEL P	Low Fuel Level (Pre-Alarm)
	Cause: The fuel level measured by the fuel level sender is below the Low Fuel Level Pre-Alarm threshold.
	Corrective Action: 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.
LOW FUEL RAIL PRESS MTU P	Low Fuel Rail Pressure (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the fuel rail pressure is too low.
	Corrective Action: Check the fuel filters, fuel lines, fuel rail, and fuel injectors for obstructions. Check the fuel pump for proper pressure. Consult MTU documentation for additional procedures to diagnose the causes of engine related issues.
LOW OIL PRES A	Low Oil Pressure (Alarm)
	Cause: 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.
	Corrective Action: 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.
LOW OIL PRES P	Low Oil Pressure (Pre-Alarm)
	Cause: 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.
	Corrective Action: 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.
LOW OIL PRESSURE MTU A	Low Oil Pressure (Alarm)

Event String	Event Description/Cause/Corrective Action
	Cause: This alarm was sent to the DGC-2020 because an MTU engine ECU determined that the oil pressure is too low.
	Corrective Action: 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.
LOW OIL PRESSURE MTU P	Low Oil Pressure (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the oil pressure is too low.
	Corrective Action: 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.
LOW STRG TANK LEVEL P	Low Storage Tank Level (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the fuel level in the storage tank is too low.
	Corrective Action: 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 MTU fault codes. Contact the engine manufacturer if necessary.
LSM AVR OUT LMT P	LSM-2020 AVR Output Limit (Pre-Alarm)
	Cause: 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.
	Corrective Action: 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 & Troubleshooting section of this manual to verify that changing bias output voltage or current values will change the generator's output voltage as desired.
LSM COMMS FAIL P	LSM-2020 Communications Failure (Pre-Alarm)
	Cause: Communications with the LSM-2020 have failed. When configured as a pre-alarm, the machine will continue running and annunciate the pre-alarm.
	Corrective Action: 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.
LSM GOV OUT LMT P	LSM-2020 GOV Output Limit (Pre-Alarm)
	Cause: The governor bias output on the LSM-2020 is at either its maximum or minimum configured output value and cannot go beyond.
	Corrective Action: 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 *Maintenance and Troubleshooting* section of this manual to verify that changing bias output voltage or current values will change the generator's rpm as desired.
LSM HEARTBEAT FAIL P	LSM-2020 Heartbeat Failed (Pre-Alarm)
	Cause: The DGC-2020 is not receiving a heartbeat communication signal from the LSM-2020 through CAN Bus.
	Corrective Action: 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.
LSM INTERGEN COM FAIL P	LSM-2020 Intergenset Communications Failure (Pre-Alarm)
	Cause: The DGC-2020 lost communications with the other generators on the intergenset communications network.
	Corrective Action: 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.
MAINS FAIL TEST	Mains Fail Test (Status)

Event String	Event Description/Cause/Corrective Action
	Cause: 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.
	Corrective Action: Correct operation. No corrective action necessary.
MAINT INTERVAL P	Maintenance Interval (Pre-Alarm)
	Cause: The maintenance interval has expired. Service the unit.
	Corrective Action: Service the machine and then reset the pre-alarm on the front panel of the DGC-2020 under Settings > System Settings > 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 BESTCOMS*Plus* under Metering Explorer > Run Statistics by clicking the Reset Maintenance Interval button.
MF TRANSFER	Mains Fail Transfer Complete (Status)
	Cause: This status indicates successful completion of a mains fail transfer sequence.
	Corrective Action: Correct operation. No corrective action necessary.
MF TRANSFER FAIL	Mains Fail Transfer Fail (Status)
	Cause: This status indicates unsuccessful mains fail transfer sequence. This will usually coincide with a Transfer Fail alarm.
	Corrective Action: 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 BESTCOMS*Plus* or on the DGC-2020 front panel.
MN BKR CL FL P	Mains Breaker Fail to Close (Pre-Alarm)
	Cause: 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.
	Corrective Action: 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.
MN BKR OP FL P	Mains Breaker Fail to Open (Pre-Alarm)
	Cause: 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.
	Corrective Action: 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.
MN BKR SYN FL P	Mains Breaker Synchronization Fail (Pre-Alarm)
	Cause: 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.
	Corrective Action: 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.
MPU FAIL P	Magnetic Pickup Fail (Pre-Alarm)
	Cause: 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.

Event String	Event Description/Cause/Corrective Action
	Corrective Action: 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.
MULTIPLE AEM P	Multiple AEM-2020's (Pre-Alarm)
	Cause: More than one AEM-2020 is detected on the CAN Bus network.
	Corrective Action: Ensure that only one AEM-2020 is on the CAN Bus network.
MULTIPLE CEM P	Multiple CEM-2020's (Pre-Alarm)
	Cause: More than one CEM-2020 is detected on the CAN Bus network.
	Corrective Action: Ensure that only one CEM-2020 is on the CAN Bus network.
MULTIPLE LSM P	Multiple LSM-2020's (Pre-Alarm)
	Cause: More than one LSM-2020 is detected on the CAN Bus network.
	Corrective Action: Ensure that only one LSM-2020 is on the CAN Bus network.
NORM SHUTDOWN	Normal Shutdown (Status)
	Cause: The unit has transitioned from running to not running due to a normal shutdown sequence.
	Corrective Action: Correct operation. No corrective action necessary.
OFF MODE	DGC-2020 has entered Off mode (Status)
	Cause: This status indicates that the DGC-2020 entered Off mode.
	Corrective Action: Correct operation. No corrective action necessary.
OIL SNDR FAIL	Oil Pressure Sender Fail (Status)
	Cause: 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.
	Corrective Action: Check the sender, the sender wiring, and the sender common wiring from the engine block to the DGC-2020 and/or the engine ECU.
OIL SNDR FAIL A	Oil Pressure Sender Fail (Alarm)
	Cause: Oil Pressure Sender Fail status is true and the Oil Pressure Sender Fail alarm configuration is set for Alarm.
	Corrective Action: Check the sender, the sender wiring, and the sender common wiring from the engine block to the DGC-2020 and/or the engine ECU.
OIL SNDR FAIL P	Oil Pressure Sender Fail (Pre-Alarm)
	Cause: Oil Pressure Sender Fail status is true and the Oil Pressure Sender Fail alarm configuration is set for Pre-Alarm.
	Corrective Action: Check the sender, the sender wiring, and the sender common wiring from the engine block to the DGC-2020 and/or the engine ECU.
OVERCRANK A	Overcrank (Alarm)
	Cause: The engine exceeded the Cycle Crank Time or Number of Crank Cycles threshold and did not start.
	Corrective Action: 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.
OVERSPD TEST ON MTU P	Overspeed Test On (Pre-Alarm)
	Cause: This pre-alarm is sent to the DGC-2020 over CAN Bus when an MTU ECU is performing an overspeed test.
	Corrective Action: Correct operation. No corrective action necessary.
OVERSPEED MTU A	Overspeed (Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU 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.
	Corrective Action: Check the speed sensor and wiring. Ensure that electrical noise is not coupling into speed sender wiring. Check the engine governor and settings. Consult MTU documentation for additional procedures to diagnose the causes of engine and speed related issues.
PRIMING FAULT MTU P	Priming Fault (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU 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.
	Corrective Action: Check the priming fluid level and priming pump. Check the priming passages for restrictions or leaks. Check for ECU related pre-alarms, status, and MTU fault codes. Contact the engine manufacturer if necessary.

Event String	Event Description/Cause/Corrective Action
PROT SHUTDOWN	Protective Shutdown (Status)
	Cause: This status indicates that the DGC-2020 has undergone a protective shutdown.
	Corrective Action: Determine the associated alarm that caused the protective shutdown and perform the corrective actions for that alarm.
REMOTE START	Remote Start was requested via BESTCOMS*Plus* or Modbus (Status)
	Cause: This status indicates that a remote start request was received.
	Corrective Action: Correct operation. No corrective action necessary.
RESET	DGC-2020 has been reset (Status)
	Cause: 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.
	Corrective Action: 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.
RTD IN X O1 (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8) (Status)
	Cause: 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.
	Corrective Action: 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 O1 A (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8) (Alarm)
	Cause: 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.
	Corrective Action: 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 O1 P (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8) (Pre-Alarm)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: 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.

Event String	Event Description/Cause/Corrective Action
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: This indicates that the programmable RTD input is receiving a resistance value beyond the configured range. The alarm configuration is set for Alarm.
	Corrective Action: 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)
	Cause: This indicates that the programmable RTD input is receiving a resistance value beyond the configured range. The alarm configuration is set for Pre-Alarm.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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.
RTD IN X U1 A (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8) (Alarm)
	Cause: 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.
	Corrective Action: 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.
RTD IN X U1 P (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8) (Pre-Alarm)
	Cause: 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.
	Corrective Action: 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.
RTD IN X U2 (X = 1 to 8)	User Configurable Analog Input X Under 2 (X = 1 to 8) (Status)
	Cause: 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.
	Corrective Action: 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.
RTD IN X U2 A (X = 1 to 8)	User Configurable Analog Input X Under 2 (X = 1 to 8) (Alarm)
	Cause: 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.

Event String	Event Description/Cause/Corrective Action
	Corrective Action: 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.
RTD IN X U2 P (X = 1 to 8)	User Configurable Analog Input X Under 2 (X = 1 to 8) (Pre-Alarm)
	Cause: 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.
	Corrective Action: 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.
RUN MODE	DGC-2020 has entered Run mode (Status)
	Cause: This status indicates that the DGC-2020 has entered Run mode.
	Corrective Action: Correct operation. No corrective action necessary.
RUNUP SPD LO MTU P	Run Up Speed Low (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the runup speed is low.
	Corrective Action: Check the startup speed. Check the runup speed and the governor. Check for ECU related Diagnostic Trouble Codes, pre-alarms, status, and MTU fault codes. Contact the engine manufacturer if necessary.
RUN WITH LOAD START	Run with Load logic element received a start request (Status)
	Cause: This status indicates that the RUNWLOAD logic element has initiated a Run with Load Start request.
	Corrective Action: Correct operation. No corrective action necessary.
RUN WITH LOAD STOP	Run with Load logic element received a stop request (Status)
	Cause: This status indicates that the RUNWLOAD logic element has initiated a Run with Load Stop request.
	Corrective Action: Correct operation. No corrective action necessary.
SCREEN ERROR	Screen Error (Status)
	Cause: This status indicates that the processor attempted to display something on the front-panel LCD, but failed due to missing or corrupt data.
	Corrective Action: 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.
SERFLASH RD FAIL	Serial Flash Read Fail (Pre-Alarm)
	Cause: A serial flash read failure has occurred.
	Corrective Action: 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.
SETTINGS CHANGED	A setting was changed via BESTCOMS*Plus*, Modbus, or front-panel interface (Status)
	Cause: This status indicates that DGC-2020 settings were changed.
	Corrective Action: Correct operation. No corrective action necessary.
SPD SNDR FAIL	Speed Sender Fail (Status)
	Cause: 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.
	Corrective Action: 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.
SPD SNDR FAIL A	Speed Sender Fail (Alarm)
	Cause: 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.

Event String	Event Description/Cause/Corrective Action
	Corrective Action: 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.
SPEED DMD FL P	Speed Demand Fail (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the speed demand source or rpm data is invalid.
	Corrective Action: 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.
SPEED TOO LOW MTU P	Engine Speed Too Low (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the engine running speed is low.
	Corrective Action: 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 MTU fault codes. Contact the engine manufacturer if necessary.
SS OVERRIDE ON MTU P	Shutdown Override (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that a Safety System Shutdown Override is in effect.
	Corrective Action: 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 MTU P	Start Speed Low (Pre-Alarm)
	Cause: This pre-alarm was sent to the DGC-2020 because an MTU engine ECU determined that the Start Speed is low.
	Corrective Action: Check the startup speed and the governor. Check for ECU related Diagnostic Trouble Codes, pre-alarms, status, and MTU 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: This indicates that the programmable Thermocouple input is measuring a temperature above Over Threshold 1. The alarm configuration is set for Alarm.

Event String	Event Description/Cause/Corrective Action
	Corrective Action: 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)
	Cause: This indicates that the programmable Thermocouple input is measuring a temperature above Over Threshold 1. The alarm configuration is set for Pre-Alarm.
	Corrective Action: 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)
	Cause: 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.
	Corrective Action: 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)
	Cause: This indicates that the programmable Thermocouple input is measuring a temperature above Over Threshold 2. The alarm configuration is set for Alarm.
	Corrective Action: 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)
	Cause: This indicates that the programmable Thermocouple input is measuring a temperature above Over Threshold 2. The alarm configuration is set for Pre-Alarm.
	Corrective Action: 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 OOR (X = 1 to 2)	User Configurable Thermocouple Input X Out of Range (X = 1 to 2) (Status)
	Cause: 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.
	Corrective Action: 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.
THRM CPL X OOR A (X = 1 to 2)	User Configurable Thermocouple Input X Out of Range (X = 1 to 2) (Alarm)
	Cause: This indicates that the programmable Thermocouple input is measuring a temperature value beyond the configured range. The alarm configuration is set for Alarm.
	Corrective Action: 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.
THRM CPL X OOR P (X = 1 to 2)	User Configurable Thermocouple Input X Out of Range (X = 1 to 2) (Pre-Alarm)
	Cause: This indicates that the programmable Thermocouple input is measuring a temperature value beyond the configured range. The alarm configuration is set for Pre-Alarm.
	Corrective Action: 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.
THRM CPL X U1 (X = 1 to 2)	User Configurable Thermocouple Input X Under 1 (X = 1 to 2) (Status)
	Cause: 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.

Event String	Event Description/Cause/Corrective Action
	Corrective Action: 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.
THRM CPL X U1 A (X = 1 to 2)	User Configurable Thermocouple Input X Under 1 (X = 1 to 2) (Alarm)
	Cause: This indicates that the programmable Thermocouple input is measuring a temperature below Under Threshold 1. The alarm configuration is set for Alarm.
	Corrective Action: 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.
THRM CPL X U1 P (X = 1 to 2)	User Configurable Thermocouple Input X Under 1 (X = 1 to 2) (Pre-Alarm)
	Cause: This indicates that the programmable Thermocouple input is measuring a temperature below Under Threshold 1. The alarm configuration is set for Pre-Alarm.
	Corrective Action: 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.
THRM CPL X U2 (X = 1 to 2)	User Configurable Thermocouple Input X Under 2 (X = 1 to 2) (Status)
	Cause: 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.
	Corrective Action: 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.
THRM CPL X U2 A (X = 1 to 2)	User Configurable Thermocouple Input X Under 2 (X = 1 to 2) (Alarm)
	Cause: This indicates that the programmable Thermocouple input is measuring a temperature below Under Threshold 2. The alarm configuration is set for Alarm.
	Corrective Action: 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.
THRM CPL X U2 P (X = 1 to 2)	User Configurable Thermocouple Input X Under 2 (X = 1 to 2) (Pre-Alarm)
	Cause: This indicates that the programmable Thermocouple input is measuring a temperature below Under Threshold 2. The alarm configuration is set for Pre-Alarm.
	Corrective Action: 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.
UNKNOWN SHUTDOWN A	Unknown Shutdown (Alarm)
	Cause: 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.
	Corrective Action: Check Diagnostic Trouble Codes and/or connect Service Tool if the engine is an ECU equipped engine. Consult engine manufacturer for further information.
WEAK BATTERY P	Weak Battery (Pre-Alarm)
	Cause: The battery voltage measured while the engine is cranking is below the Weak Battery Voltage Pre-Alarm threshold.
	Corrective Action: 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.

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Introduction

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

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

BESTCOMS*Plus* uses plugins allowing the user to manage several different Basler Electric products. The DGC-2020 is a plugin for BESTCOMS*Plus* and must be activated before use.

The DGC-2020 plugin opens inside the BESTCOMS*Plus* 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™*Plus* 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 BESTCOMS*Plus*.

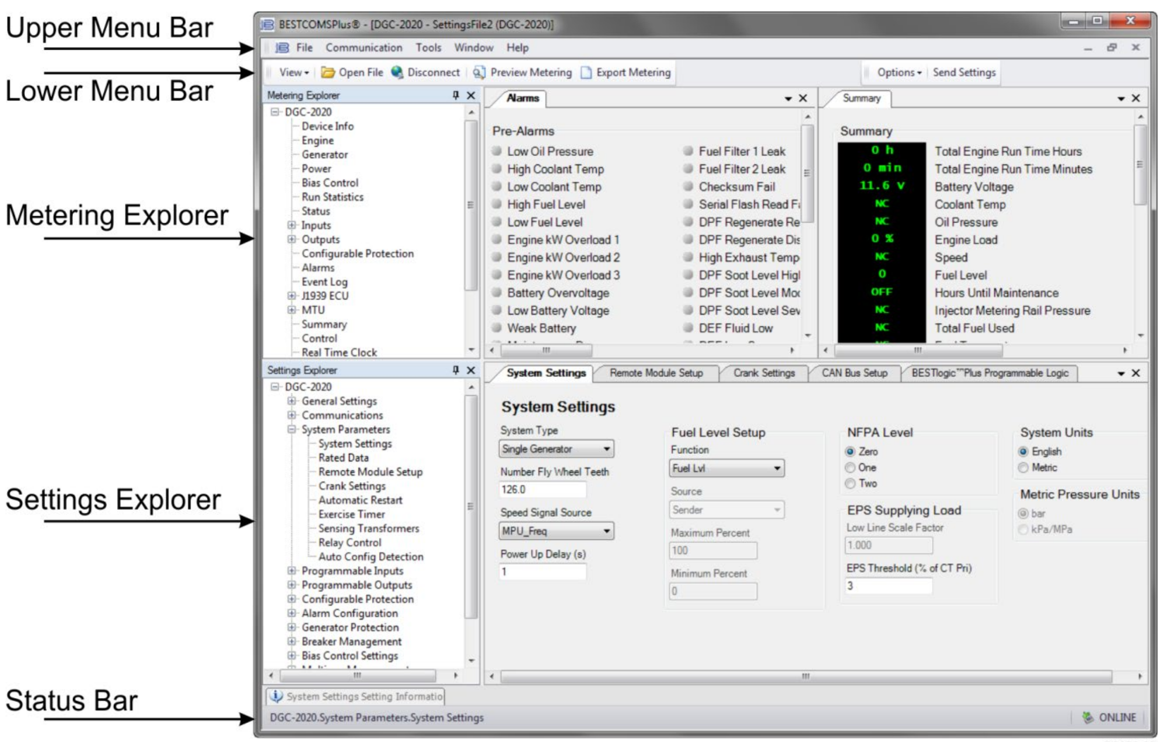


Figure 4-1. Typical User Interface Components

Installation

BESTCOMS*Plus* software is built on the Microsoft® .NET Framework. The setup utility that installs BESTCOMS*Plus* on your PC also installs the DGC-2020 plugin and the required version of .NET Framework (if not already installed). BESTCOMS*Plus* operates with systems using Windows® 7 SP1, Windows 8.1, and Windows 10 version 1607 (Anniversary Update) or later. Microsoft Internet Explorer 5.01 or later must be installed on your PC before installing BESTCOMS*Plus*. System recommendations for the .NET Framework and BESTCOMS*Plus* are listed in Table 4-1.

Table 4-1. System Recommendations for BESTCOMSPlus 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 BESTCOMS*Plus*, a Windows user must have Administrator rights. A Windows user with limited rights might not be permitted to save files in certain folders.

Installing BESTCOMS*Plus*®

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.

1. Insert the BESTCOMS*Plus* CD-ROM into the PC CD-ROM drive.
2. When the BESTCOMS*Plus* Setup and Documentation CD menu appears, click the *Install* button for the BESTCOMS*Plus* application. The setup utility installs BESTCOMS*Plus*, the .NET Framework (if not already installed), the USB driver, and the DGC-2020 plugin for BESTCOMS*Plus* on your PC.

When BESTCOMS*Plus* 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 BESTCOMS*Plus* when clicked.

Activate the DGC-2020 Plugin for BESTCOMSPlus®

The DGC-2020 plugin is a module that runs inside the BESTCOMS*Plus* shell. The DGC-2020 plugin contains specific operational and logic settings for only the DGC-2020. Uploading settings to the DGC-2020 is possible only after activating the DGC-2020 plugin.

The DGC-2020 plugin can be activated automatically or manually. Automatic activation is achieved by using a USB cable to establish communication between the DGC-2020 and BESTCOMS*Plus*. Manual activation is initiated by contacting Basler Electric for an activation key and entering the key into BESTCOMS*Plus*. Manual activation is useful if you want to create a settings file prior to receiving your DGC-2020. Refer to *Manual Activation of DGC-2020 Plugin.*

Connect a USB Cable

The USB driver was copied to your PC during BESTCOMS*Plus* 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 BESTCOMS*Plus*® and Activate DGC-2020 Plugin Automatically

To start BESTCOMS*Plus*, click the Windows *Start* button, point to *Programs*, *Basler Electric*, and then click the *BESTCOMSPlus* icon. During initial startup, the *BESTCOMSPlus Select Language* screen is displayed (Figure 4-2). You can choose to have this screen displayed each time BESTCOMS*Plus* 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.

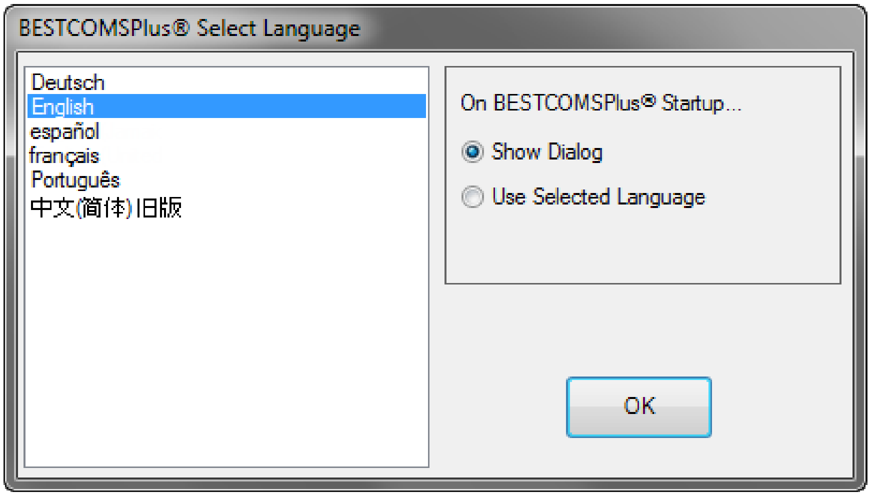


Figure 4-2. BESTCOMSPlus Select Language

The BESTCOMS*Plus* splash screen is shown for a brief time. See Figure 4-3.

Figure 4-3. Splash Screen

The BESTCOMS*Plus* platform window opens. Select *New Connection* from the *Communication* pull-down menu and select *DGC-2020*. See Figure 4-4. The DGC-2020 plugin is activated automatically after connecting to a DGC-2020.

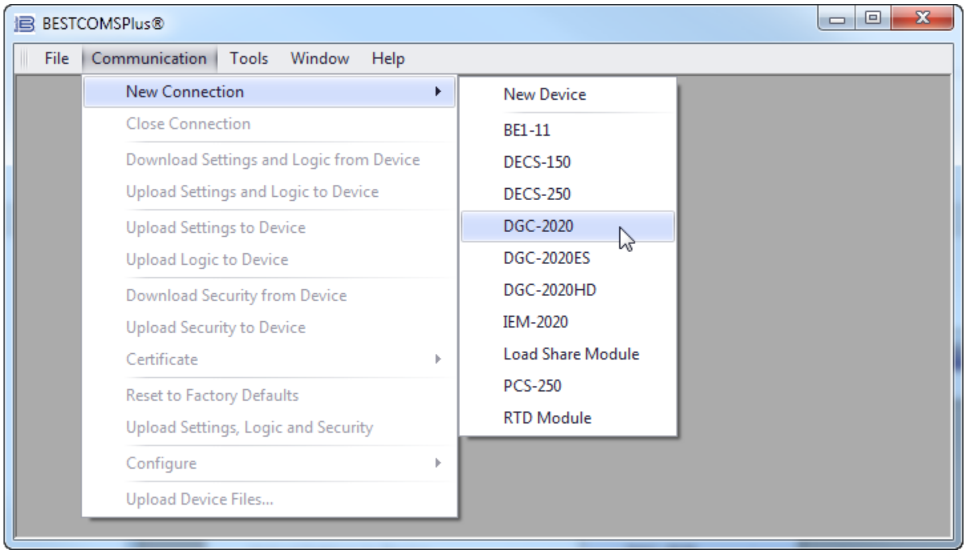


Figure 4-4. Communication Pull-Down Menu

The *DGC-2020 Connection* screen shown in Figure 4-5 will appear.

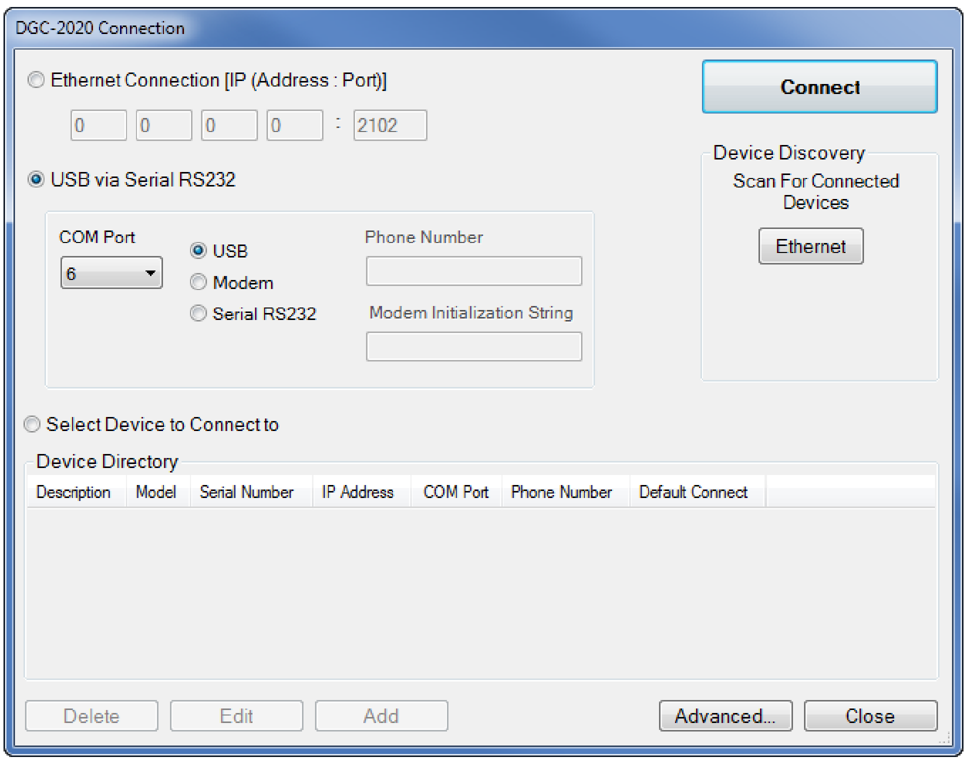


Figure 4-5. DGC-2020 Connection

Select *USB via Serial RS232, USB,* and enter *COM Port.* The USB drivers are installed automatically during the BESTCOMS*Plus* 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 4-6.

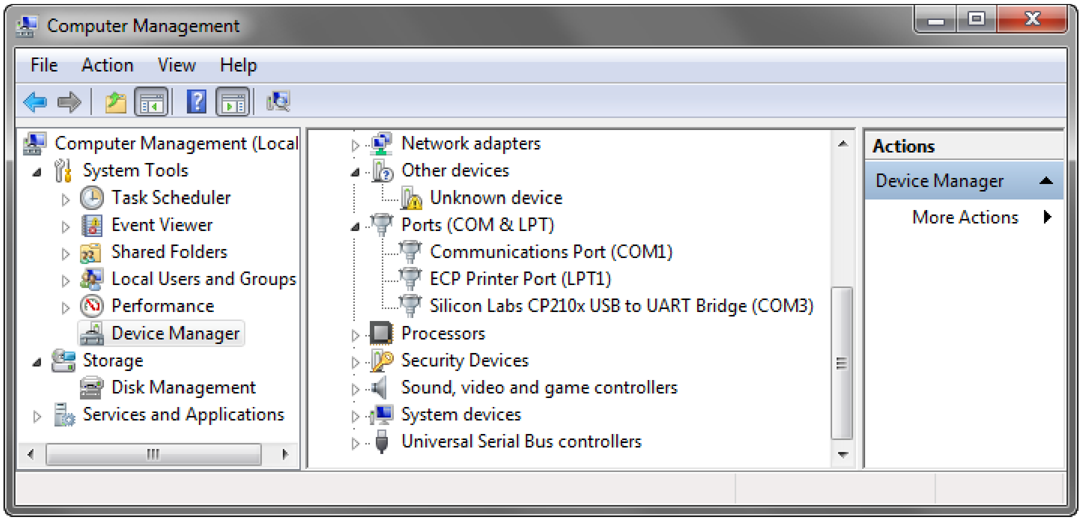


Figure 4-6. Device Manager

The DGC-2020 plugin opens indicating that activation was successful. You can now configure the DGC-2020 communication ports and other DGC-2020 settings.

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. Insert the CD-ROM labeled BESTCOMS*Plus* into the PC CD-ROM drive.
7. 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.

Manual Activation of the DGC-2020 Plugin

Manual activation of the DGC-2020 plugin is required only if your initial use of BESTCOMS*Plus* will be on a PC that is not connected to a DGC-2020. Manual activation is described in the following paragraphs.

Requesting an Activation Key

When initially running the DGC-2020 plugin, the *Activate Device Plugin* pop-up appears. You must contact Basler Electric for an activation key before you can activate the DGC-2020 plugin. You can request an activation key through email or the Basler Electric website. Click either the *Website* or *Email* button. Click the *Activate* button when you are ready to enter the activation key you received from Basler Electric. The *Activate Device Plugin* pop-up appears. Refer to Figure 4-7.

Entering an Activation Key

Select DGC-2020 from the *Device* pull-down menu. Enter your *Email Address* and *Activation Key* provided by Basler Electric. If you received an email containing the *Activation Key*, you can select all of the text in the email and copy it to the Windows clipboard using normal Windows techniques. The *Get Data* button will extract the *Device, Email Address,* and *Activation Key* from the Windows clipboard and paste it into the appropriate fields. Click the *Activate* button to continue. The *Activate Device Plugin* screen is also found by selecting *Activate Device* from the *Tools* pull-down menu of the BESTCOMS*Plus* main screen.

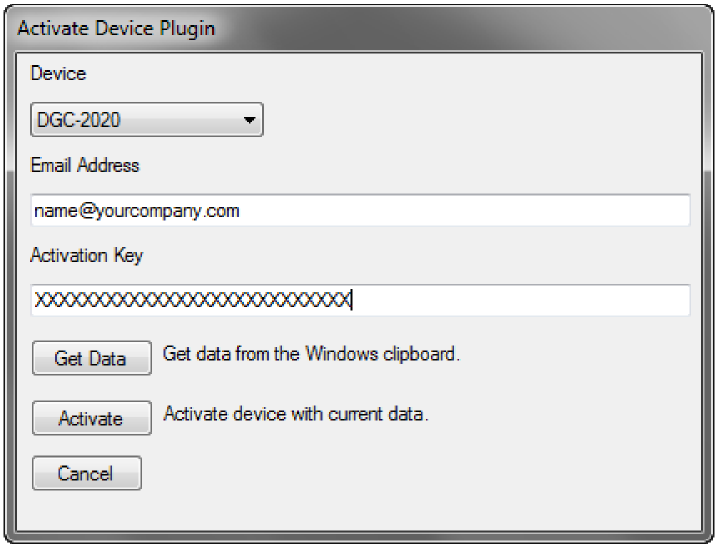


Figure 4-7. Activate Device Plugin

Communication

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 BESTCOMS*Plus,* 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 BESTCOMS*Plus* 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 BESTCOMS*Plus*, click the *Communication* drop-down menu and select *New Connection, Load Share Module.* The *Load Share Module Connection* screen appears. See Figure 4-8.

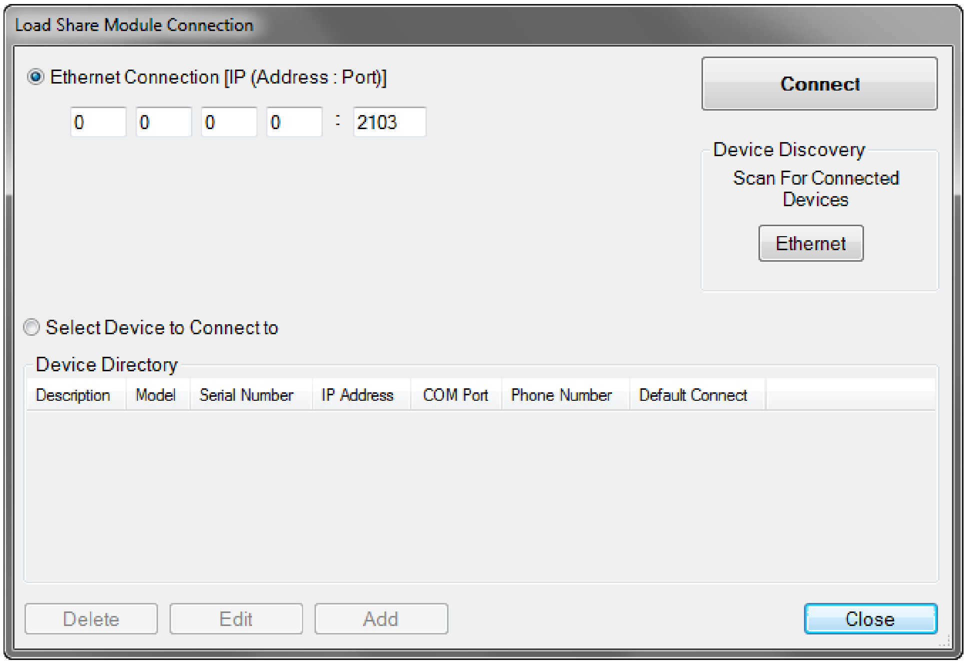


Figure 4-8. Load Share Module Connection

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 4-9.

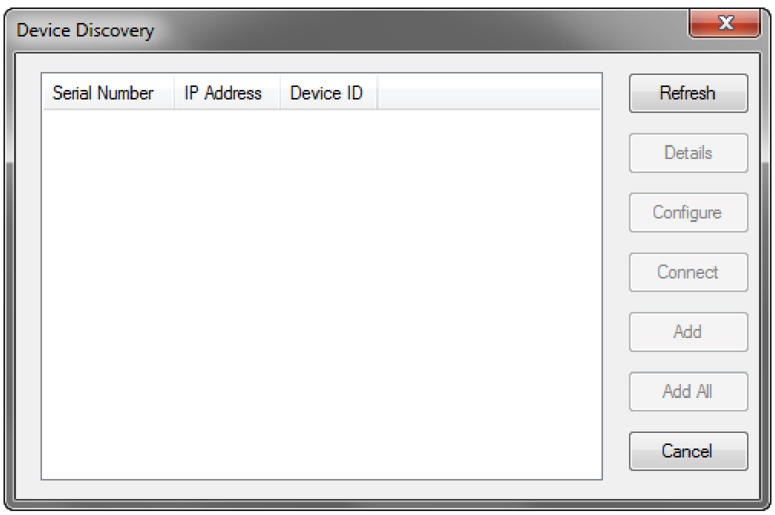


Figure 4-9. Device Discovery

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 4-10.

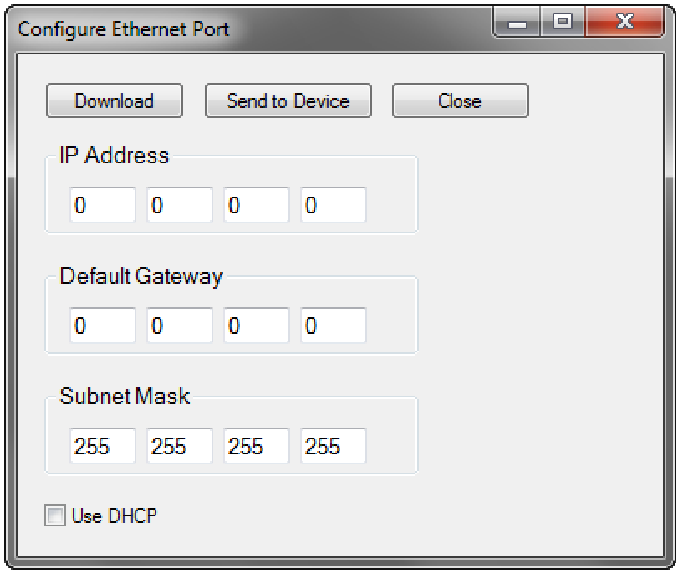


Figure 4-10. Configure Ethernet Port

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 BESTCOMS*Plus* 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:

IP Address:	Internet Protocol Address to be used by the LSM-2020.
Subnet Mask:	Mask used to determine the range of the current network subnet.
Gateway Address:	Default host to send data destined for a host not on the network subnet.
Use DHCP:	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 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 BESTCOMS*Plus* 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 4-11 will appear.

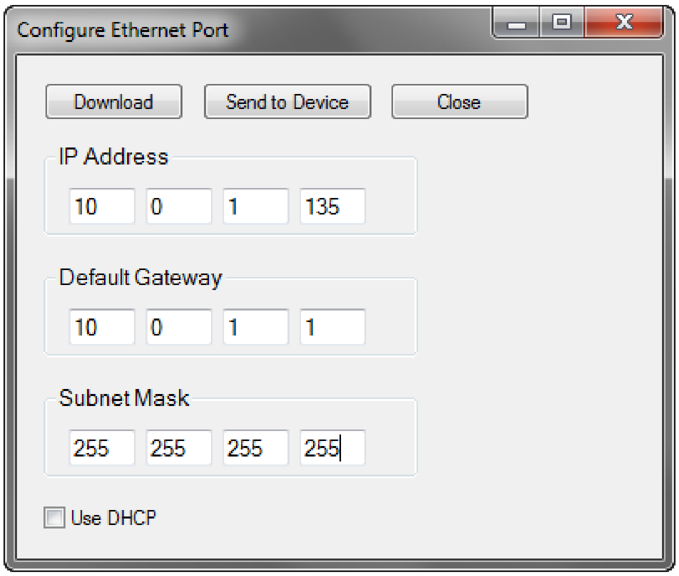


Figure 4-11. Configure Ethernet Port

Configurable options include:

IP Address:	Internet Protocol Address to be used by the LSM-2020.
Default Gateway:	Default host to send data destined for a host not on the network subnet.
Subnet Mask:	Mask used to determine the range of the current network subnet.
Use DHCP:	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 4-5 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 4-5) 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 4-12.

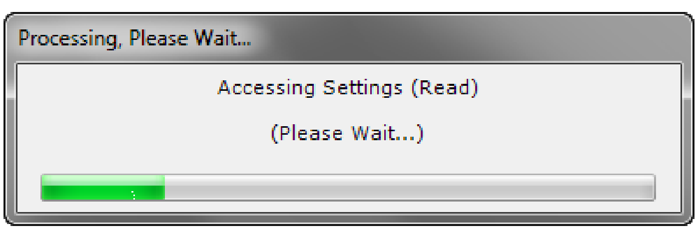


Figure 4-12. Accessing Settings, Please Wait…

Advanced Properties

Click the *Advanced* button on the *Connection* screen to display the *Advanced Properties* dialog. Default settings are shown in Figure 4-13.

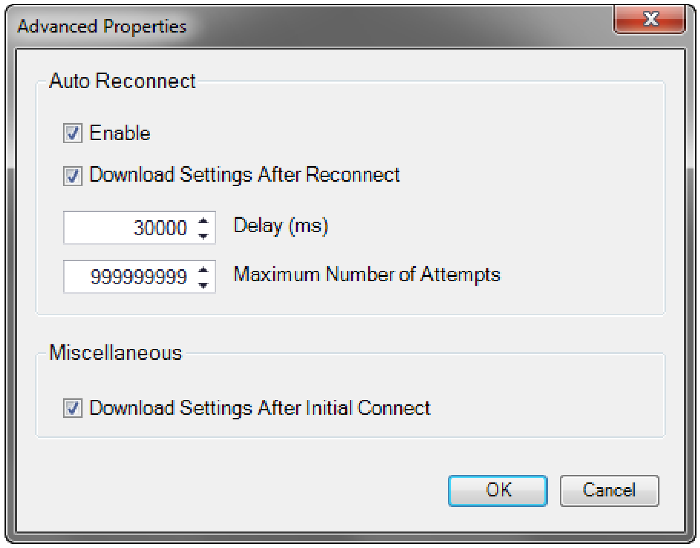


Figure 4-13. Advanced Properties

Menu Bars

The menu bars are located near the top of the BESTCOMS*Plus* 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 BESTCOMS*Plus* 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 (BESTCOMS*Plus*® Shell)

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

Table 4-2. Upper Menu Bar (BESTCOMSPlus Shell)

Menu Item	Description
File	
New	Create a new settings file
Open	Open an existing settings file
Open File As Text	Generic file viewer for *.csv, *,txt, etc. files
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
Properties	View properties of a settings file
History	View history of a settings file
Recent Files	Open a previously opened file
Exit	Close BESTCOMS*Plus* program
Communication	
New Connection	Choose new device or DGC-2020
Close Connection	Close communication between BESTCOMS*Plus* 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

Menu Item	Description
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
Tools	
Select Language	Select BESTCOMS*Plus* language
Activate Device	Activate the DGC-2020 plugin
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 BESTCOMS*Plus* event log
Event Log - Verbose Logging	Enable/disable verbose logging
Event Log - Verbose Communications Logging	Enable/disable verbose communications logging
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
Window	
Cascade All	Cascade all windows
Tile	Tile horizontally or vertically
Maximize All	Maximize all windows
Help	
Check for Updates	Check for BESTCOMS*Plus* 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
View ▾	Show or hide the Metering Panel, Settings Panel, or Settings Info Panel. Opens and saves workspaces. Customized workspaces make switching between tasks easier and more efficient.
Open File	Opens a saved settings file.
Connect	Connect: Opens the *DGC-2020 Connection* 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	Disconnect: Used to disconnect a connected DGC-2020. This button only appears when a DGC-2020 is connected.
Preview Metering	Displays the *Print Preview* screen where a preview of the Metering printout is shown. Click on the printer button to send to a printer.

Menu Button	Description
Export Metering	Enables all metering values to be exported into a *.csv file.
Options ▾	Displays an option entitled *Live Mode Settings* which enables *Live* mode where settings are automatically sent to the device in real time as they are changed.
Send Settings	Sends settings to the DGC-2020 when BESTCOMS*Plus*® 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 BESTCOMS*Plus* 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 BESTCOMS*Plus*, each setting is validated against prescribed limits. Entered settings that do not conform with the prescribed limits are accepted but flagged as noncompliant. Figure 4-14 illustrates an example of flagged, noncompliant settings (locator A) and the Setting Validation window (locator B) used to diagnose faulty settings.

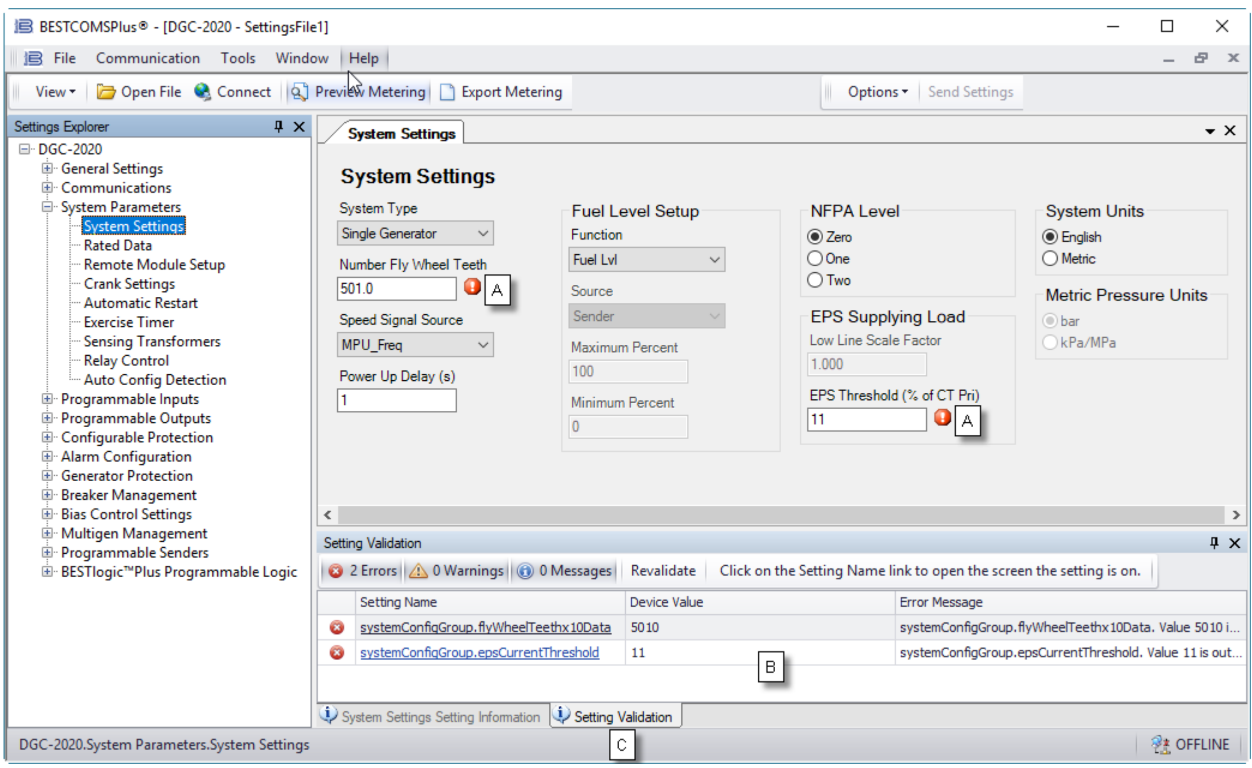


Figure 4-14. Flagged, Noncompliant Settings and the Seting Validation Window

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 BESTCOMS*Plus*. An example of a condition triggering a message is entry of a settings value with a resolution that exceeds the limit imposed by BESTCOMS*Plus*. 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 BESTCOMS*Plus* 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 contrast of the front panel LCD (liquid crystal display) can be adjusted to suit the viewing angle used or compensate for environmental conditions.

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*.

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.

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

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

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.

The Exhaust Status Display Screen setting defines where DEF 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.

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

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.

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.

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

The BESTCOMS*Plus* Front Panel HMI screen is illustrated in Figure 4-14.

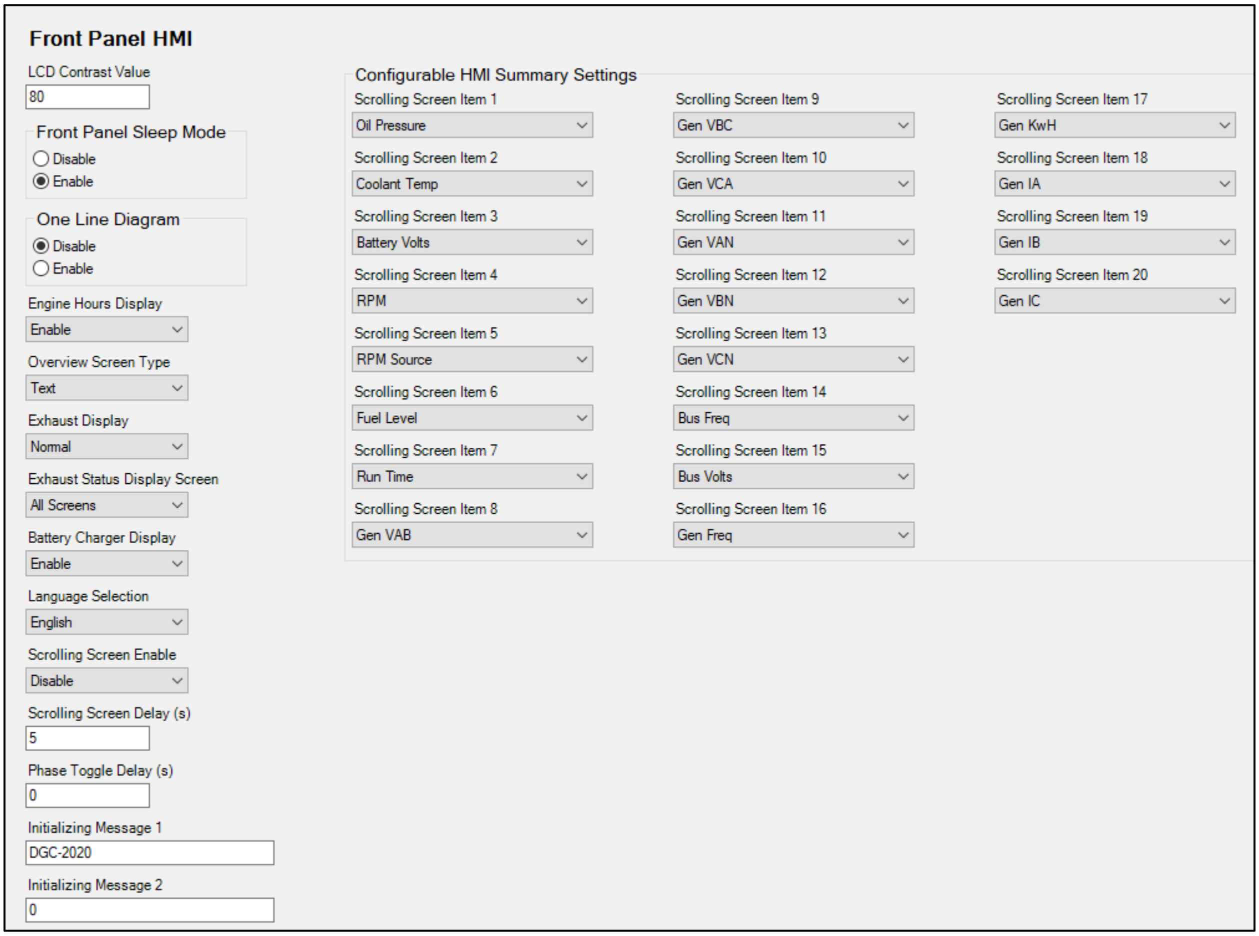


Figure 4-15. Front Panel HMI

Style Number

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

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

The BESTCOMS*Plus* Style Number screen is illustrated in Figure 4-15.

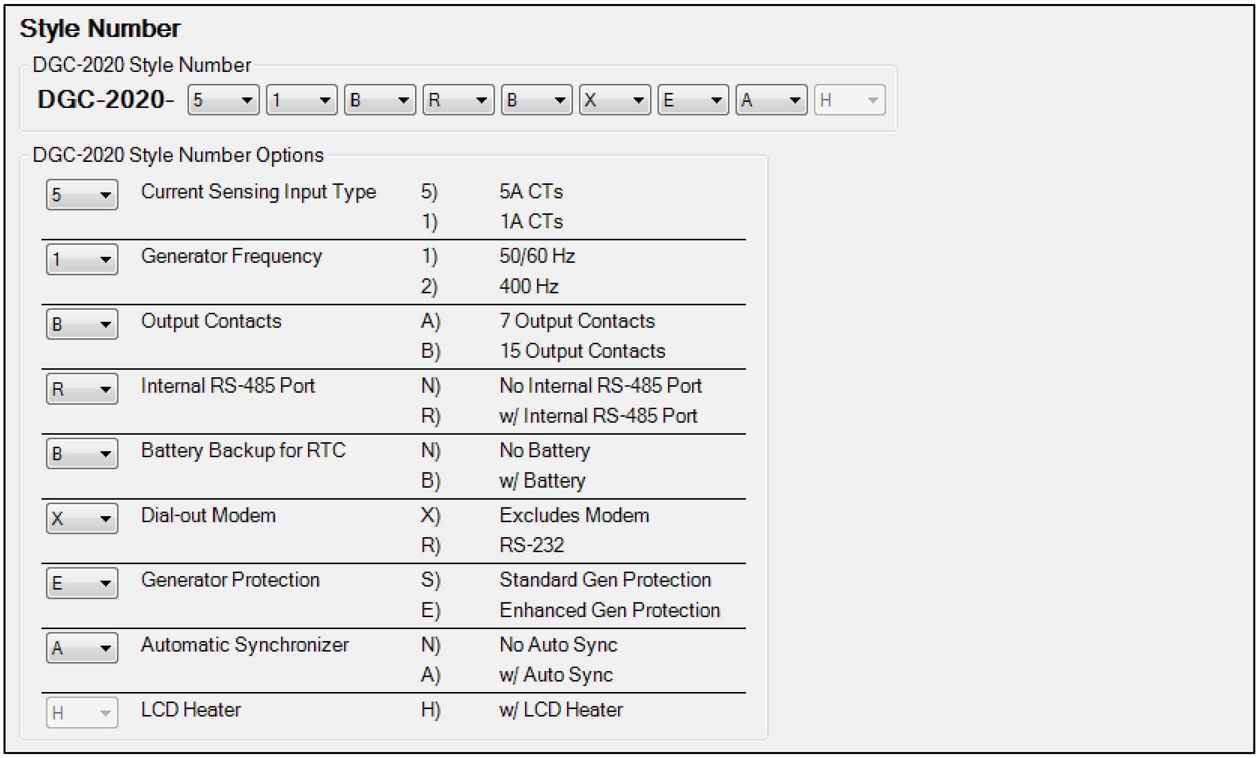


Figure 4-16. Style Number

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.

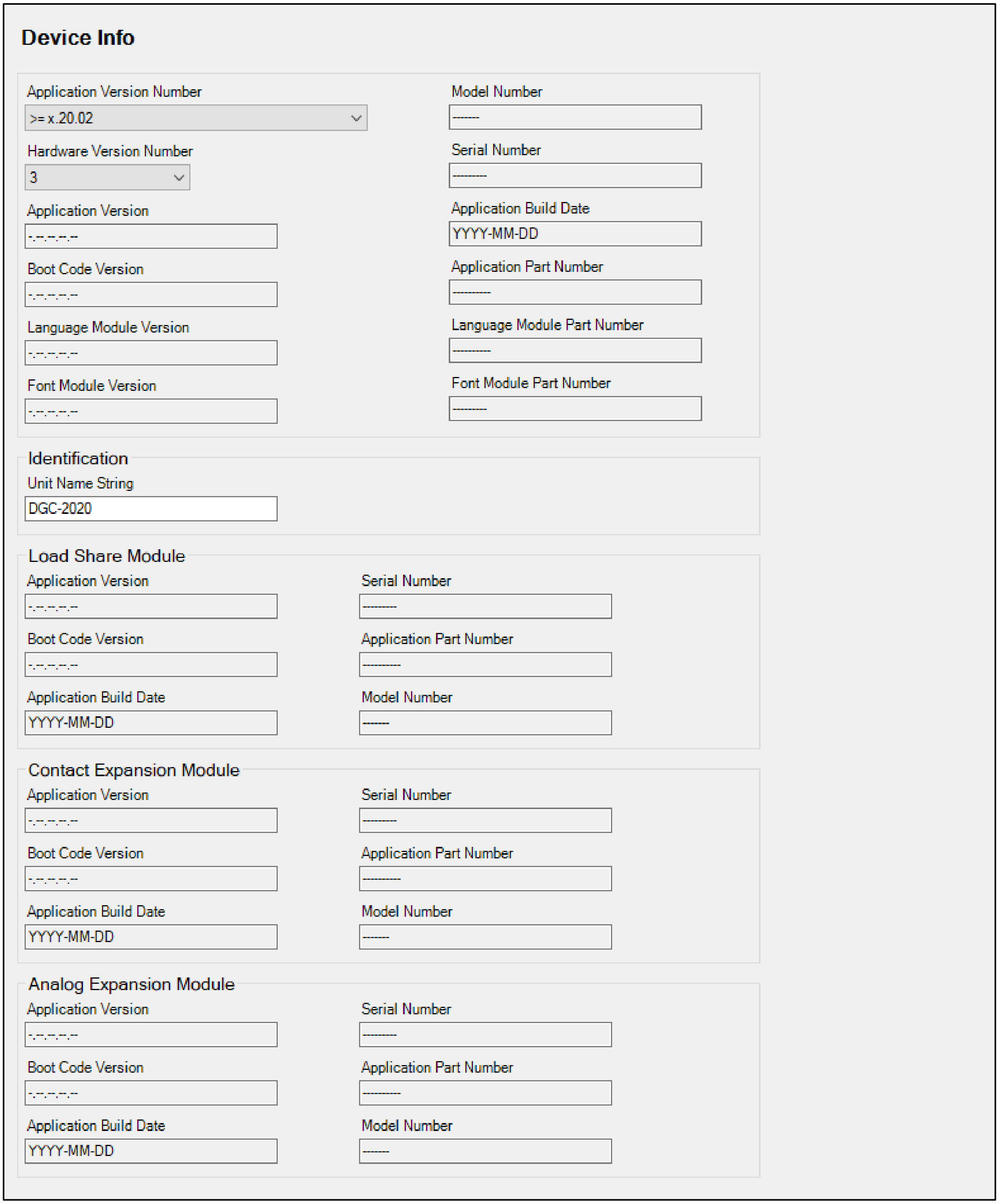


Figure 4-17. Device Info

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 BESTCOMS*Plus*

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 BESTCOMS*Plus* 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 BESTCOMS*Plus* 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.

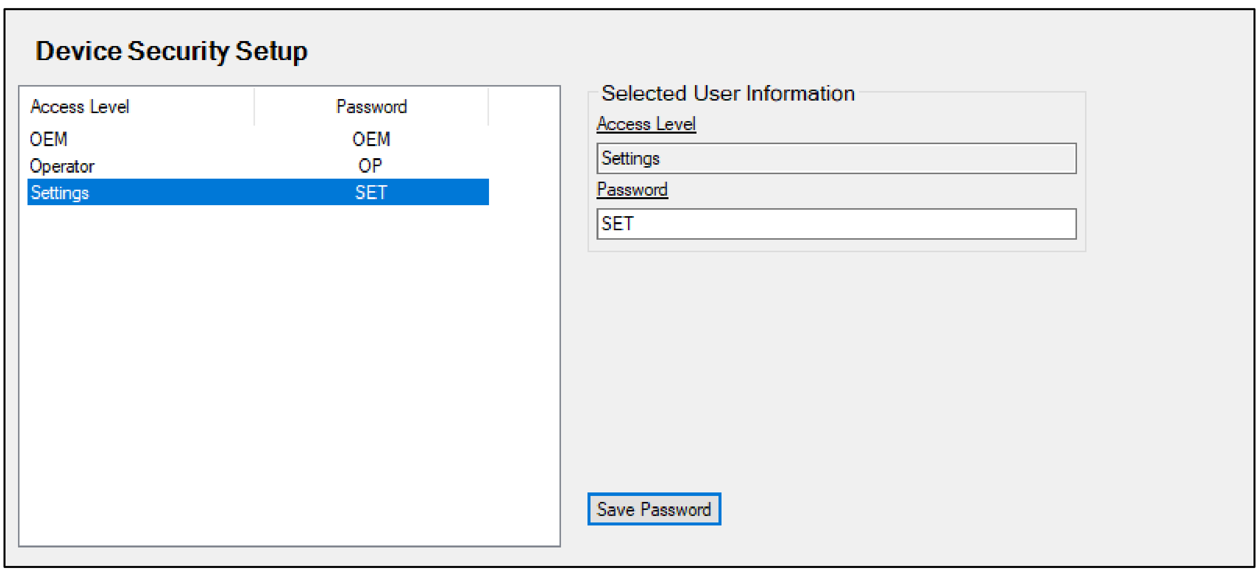


Figure 4-18. Device Security Setup

Saving Passwords in a DGC-2020 Settings File

The passwords can be modified while BESTCOMS*Plus* is connected to a DGC-2020, then the settings from the BESTCOMS*Plus* 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 BESTCOMS*Plus* is connected to a DGC-2020 (on line):

1. When connected to a DGC-2020 with BESTCOMS*Plus*, 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. BESTCOMS*Plus* 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 BESTCOMS*Plus* memory (it’s not in the DGC-2020 yet).
6. Repeat steps 4 and 5 for all password levels you with to modify.
7. Once all password modifications are complete, in the main menu of BESTCOMS*Plus*, 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 BESTCOMS*Plus*.
9. Re-open the *Device Security* tab in BESTCOMS*Plus*. 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 BESTCOMS*Plus*, 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. BESTCOMS*Plus* 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 BESTCOMS*Plus* memory.
6. Repeat steps 4 and 5 for all password levels you wish to modify.
7. Close the *Device Security* tab in BESTCOMS*Plus*.
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 BESTCOMS*Plus*.
10. Restart BESTCOMS*Plus* 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 BESTCOMSPlus.
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 4-18.

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.

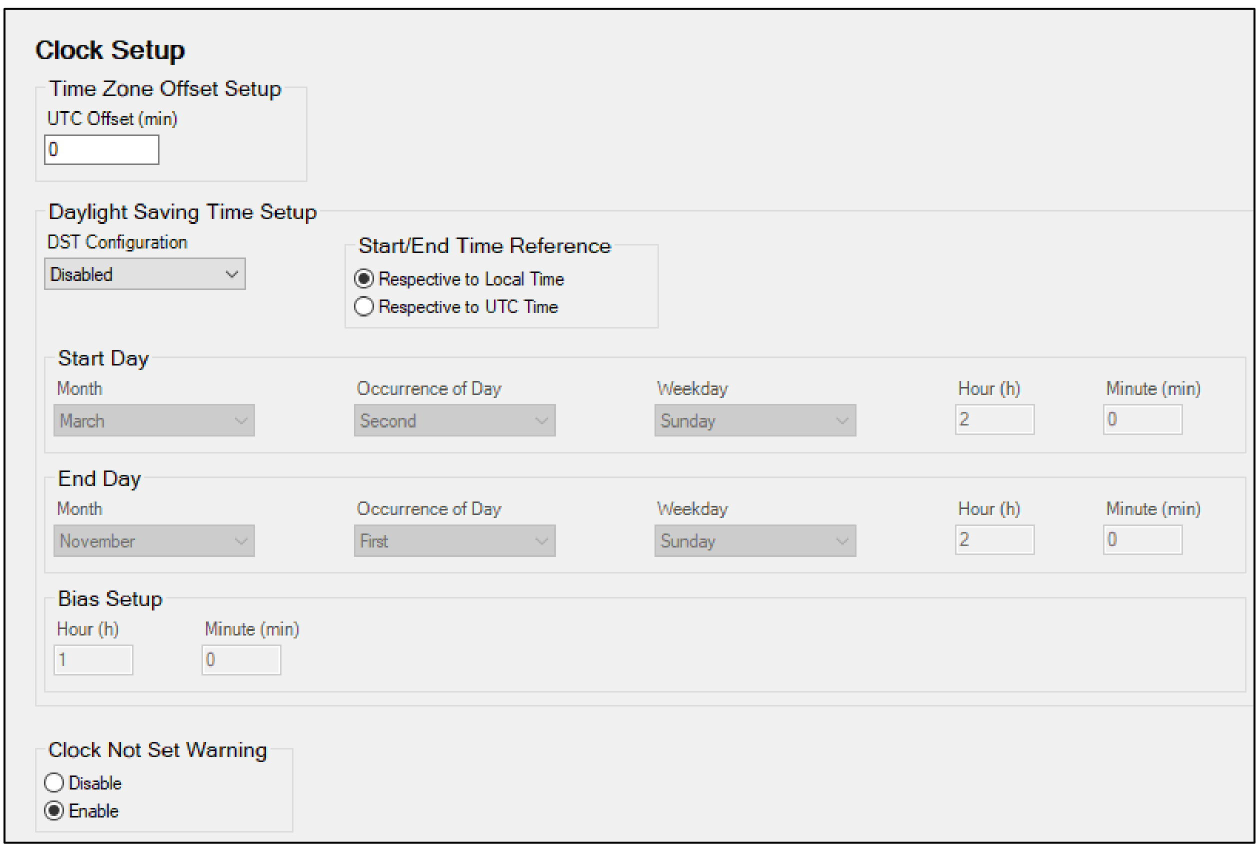


Figure 4-19. Clock Setup

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

ECU Type	CAN Bus Address
Standard	User-selectable
Volvo Penta	17
MTU MDEC	6
MTU ADEC	1
MTU ECU7/ECU8	6
GM/Doosan	User-selectable
Cummins	220
MTU Smart Connect	234
Scania	39
John Deere	User-selectable
Isuzu	User-selectable
Daimler CPC4	User-selectable
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. This setting specifies the ECU on the network to which the DGC-2020 should transmit data. 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.

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 BESTCOMS*Plus* CAN Bus Setup screen is illustrated in Figure 4-19.

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.
- *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 low and the ECU takes time to average out its own data values.
- *Response Timeout.* The time in seconds to attempt communication with the ECU when the DGC-2020 is in the pulsing state or connecting state.

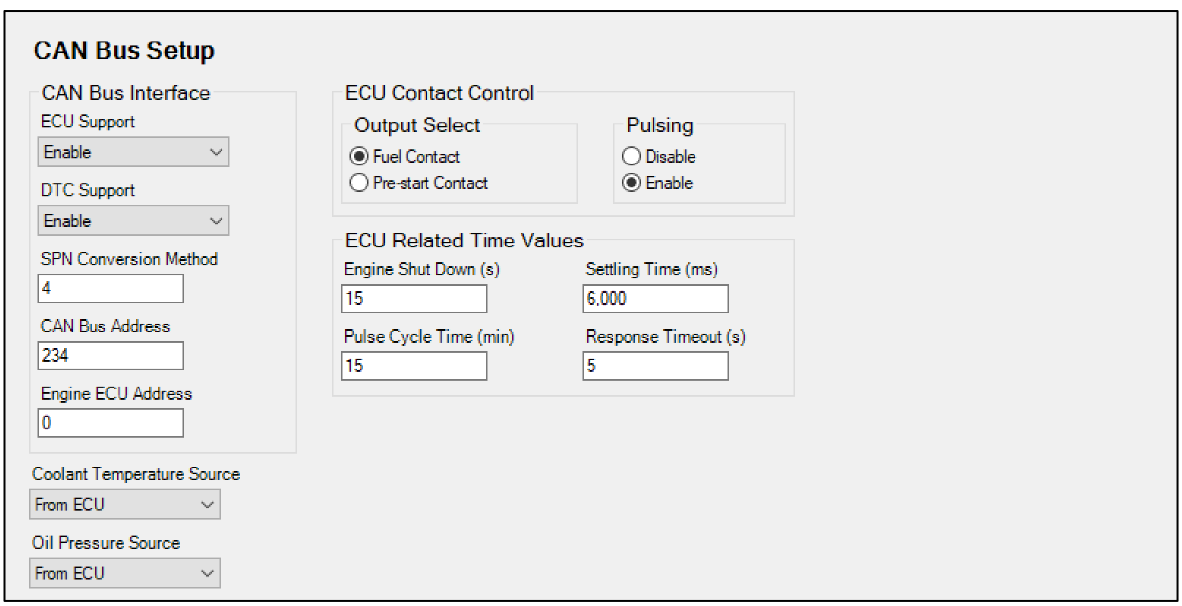


Figure 4-20. CAN Bus Setup

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, or Yanmar. 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.

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
		2518	Generator Overall Power Factor Lagging	n/a	00=leading 01=lagging 10=error 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 ±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 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 BESTlogic*Plus.*
- 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 BESTlogic*Plus*. 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 BESTlogic*Plus.*
- 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.

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.

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.

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 BESTCOMS*Plus* ECU Setup screen is illustrated in Figure 4-20.

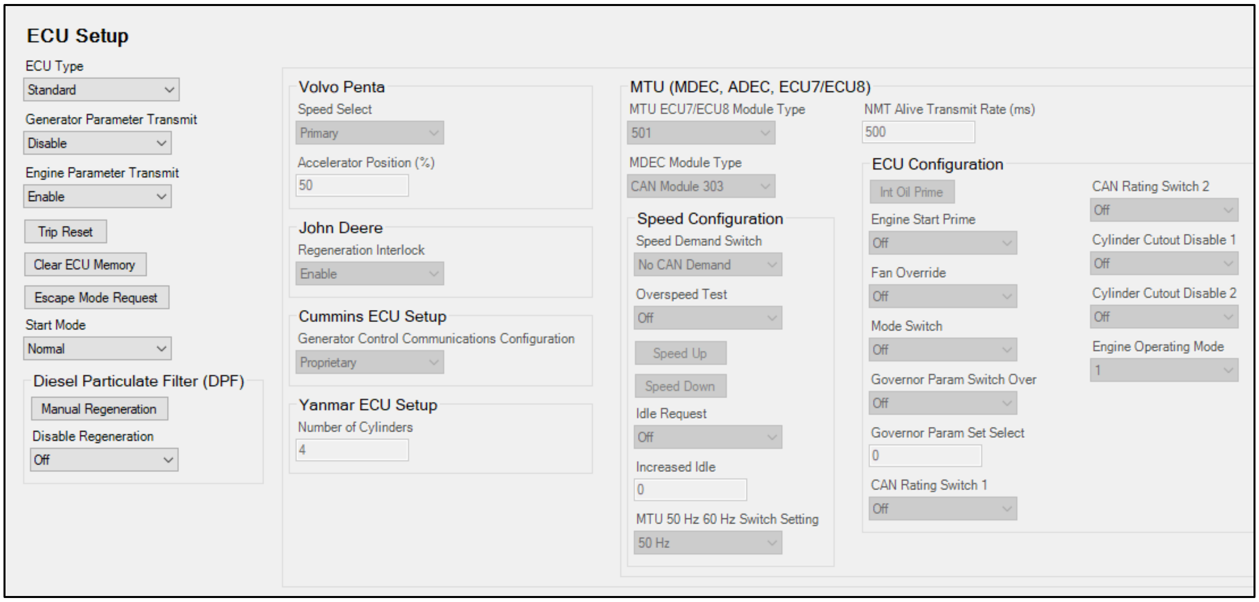


Figure 4-21. ECU Setup

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.

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.

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 4-22. 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 BESTCOMS*Plus*® 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.

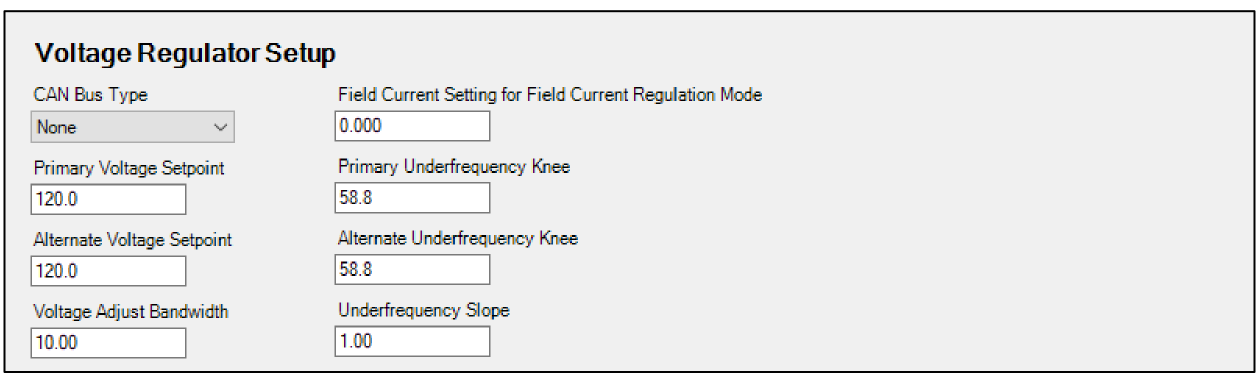


Figure 4-23. Voltage Regulator Setup

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 BESTlogicPlus. Different pre-alarms for each CAN Bus type are available.

Figure 4-24, Figure 4-25, and Figure 4-26 illustrate the BESTCOMS*Plus* Battery Charger Setup screens.

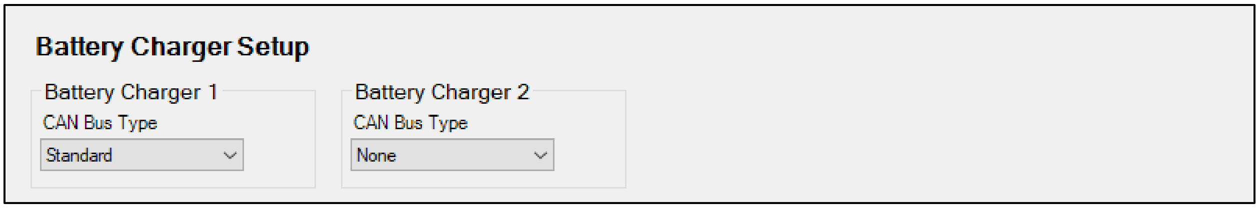


Figure 4-24. Battery Charger Setup

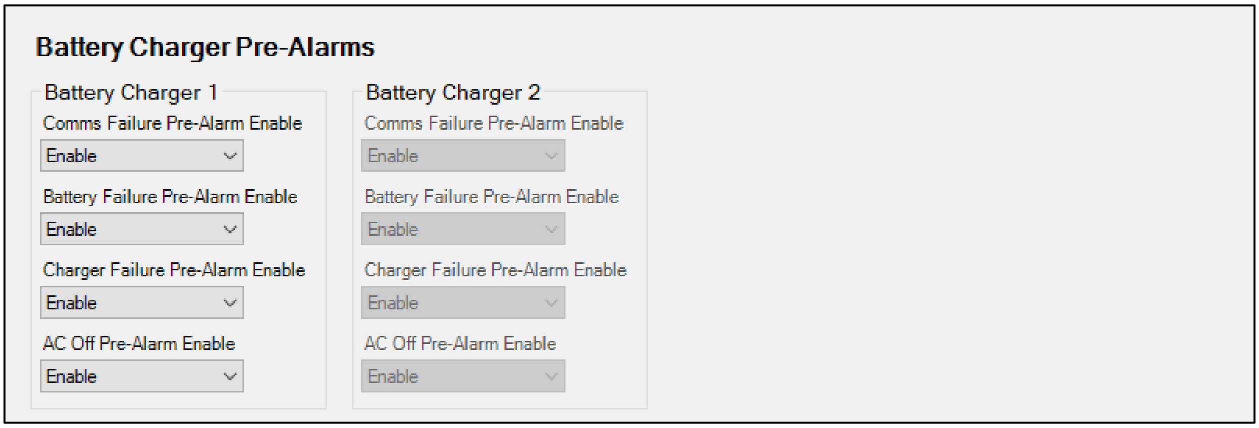


Figure 4-25. Battery Charger Pre-Alarms

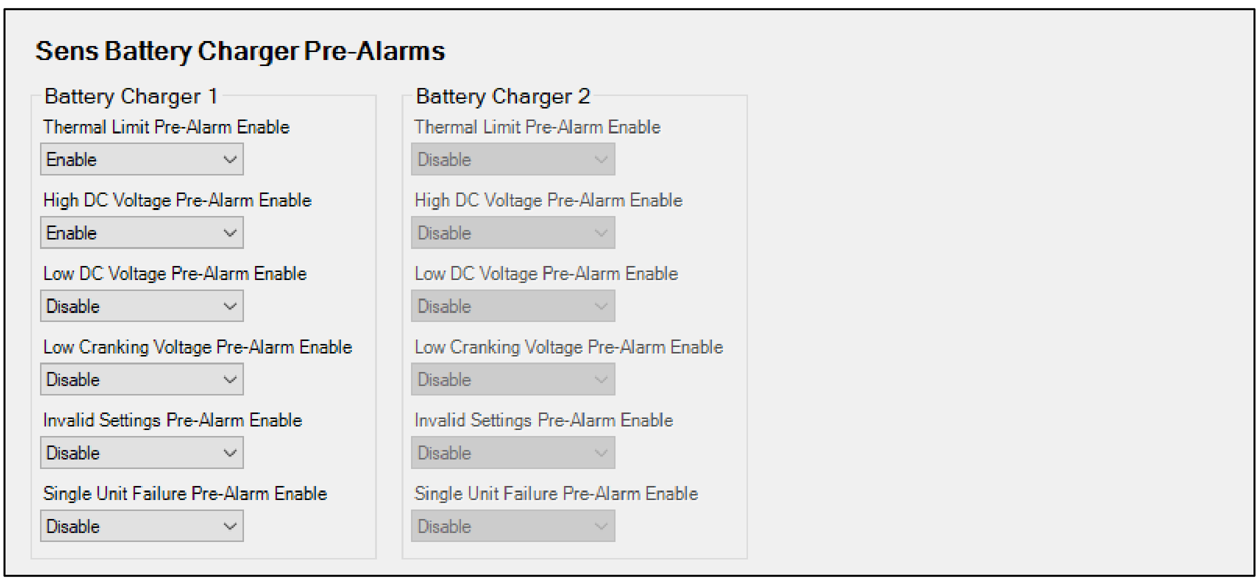


Figure 4-26. Sens Battery Charger Pre-Alarms

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
- 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

- 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)
- 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
- 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
- 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 BESTCOMS*Plus*® Modem Setup screen is illustrated in Figure 4-27.

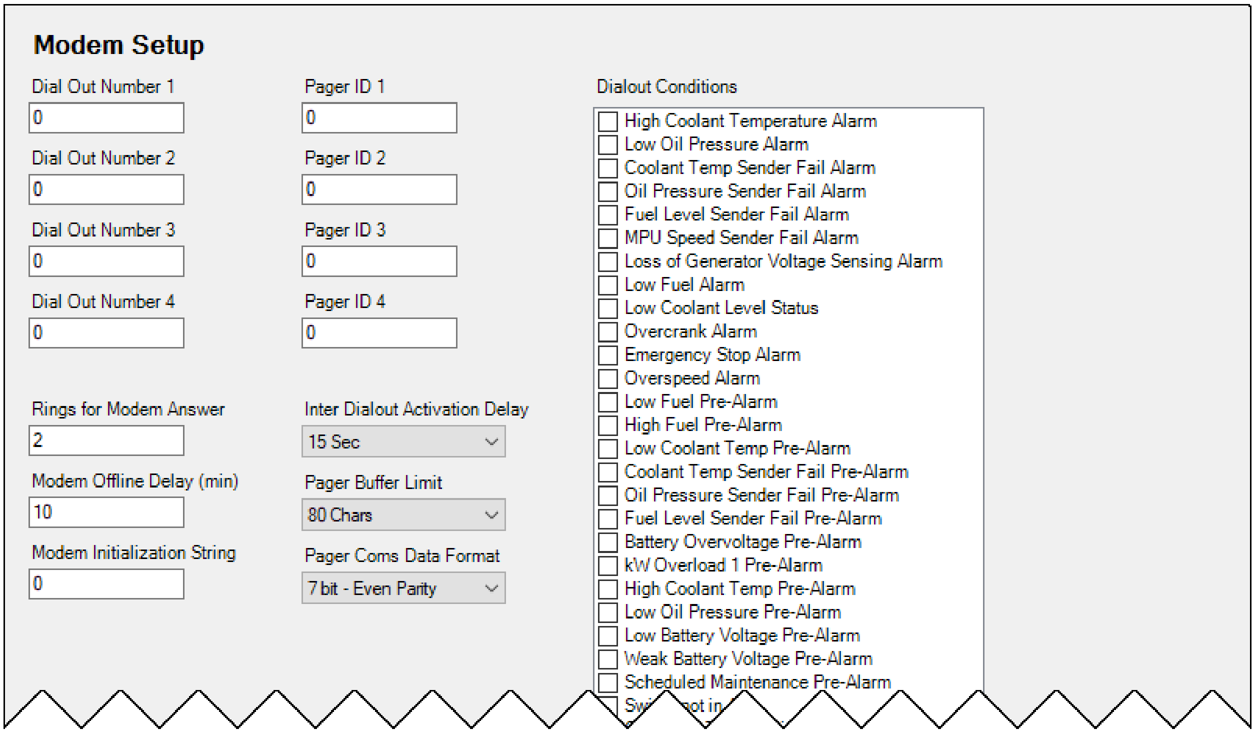


Figure 4-27. Modem Setup

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 BESTCOMS*Plus* 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 BESTCOMS*Plus* RS485 Setup screen is illustrated in Figure 4-28.

Figure 4-28. 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 BESTCOMS*Plus* RS232 Setup screen is illustrated in Figure 4-29.

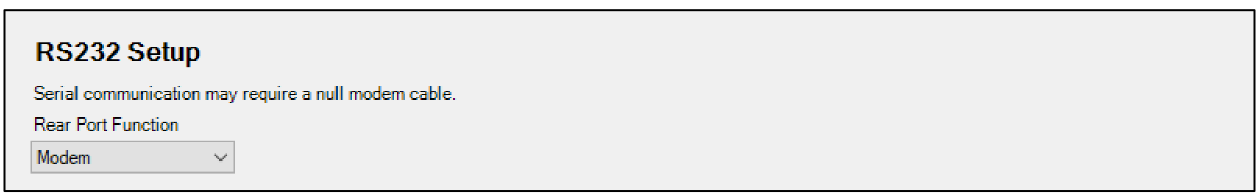


Figure 4-29. RS232 Setup

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 4-30, *System Settings*, and Figure 4-31, *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:

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

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 X (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.

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 BESTCOMS*Plus*.

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).

Calculated Rated Data

The calculated rated data parameters are listed below.

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

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

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

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

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

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

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.

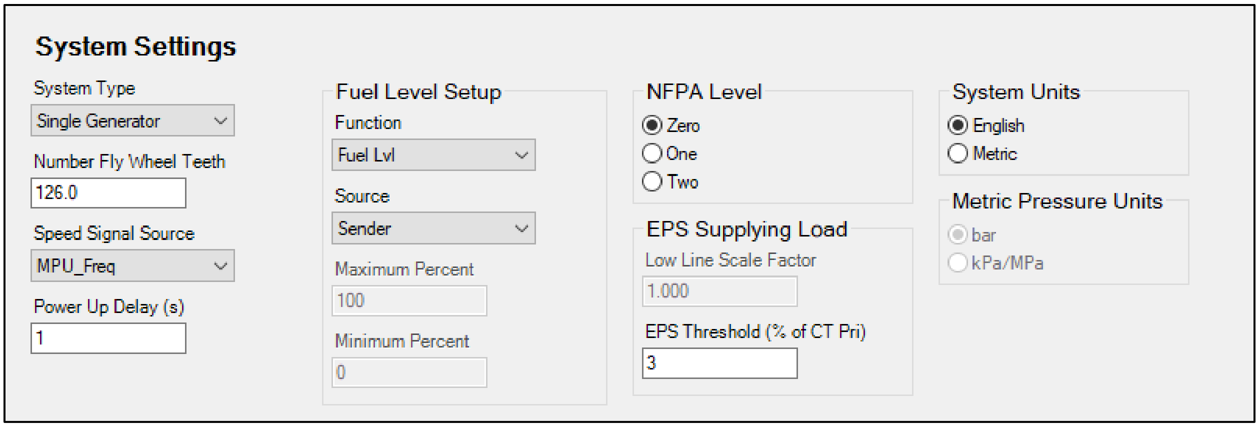


Figure 4-30. System Settings

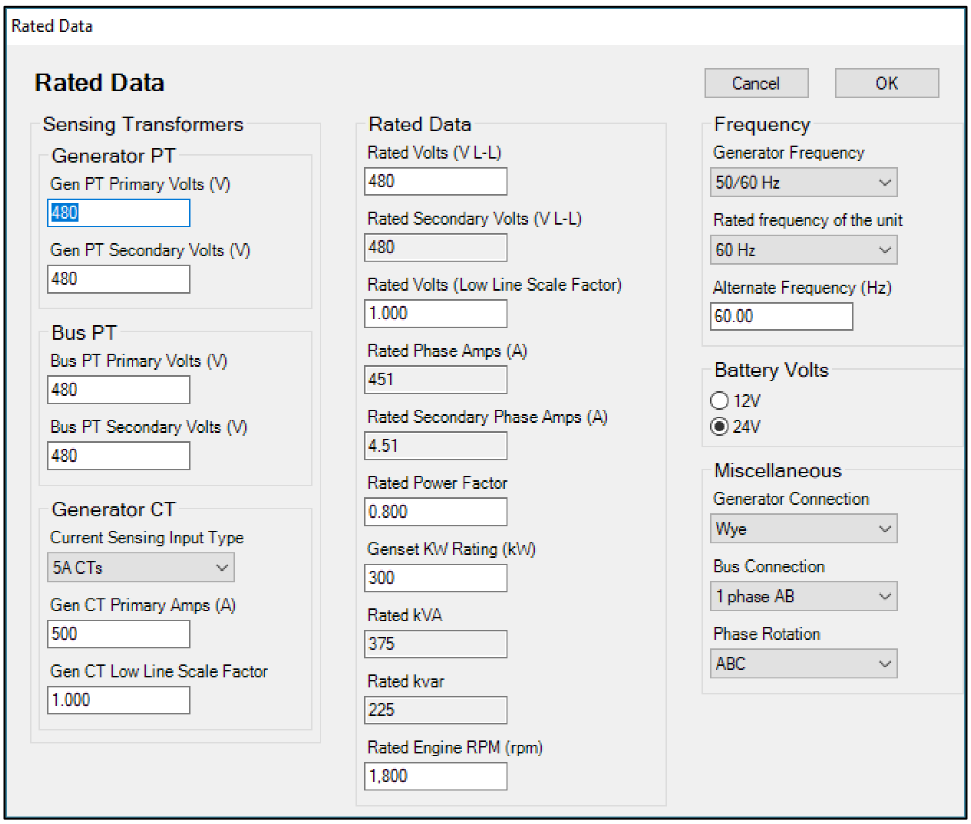


Figure 4-31. Rated Data

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 BESTCOMS*Plus* Remote Module Setup screen is illustrated in Figure 4-32.

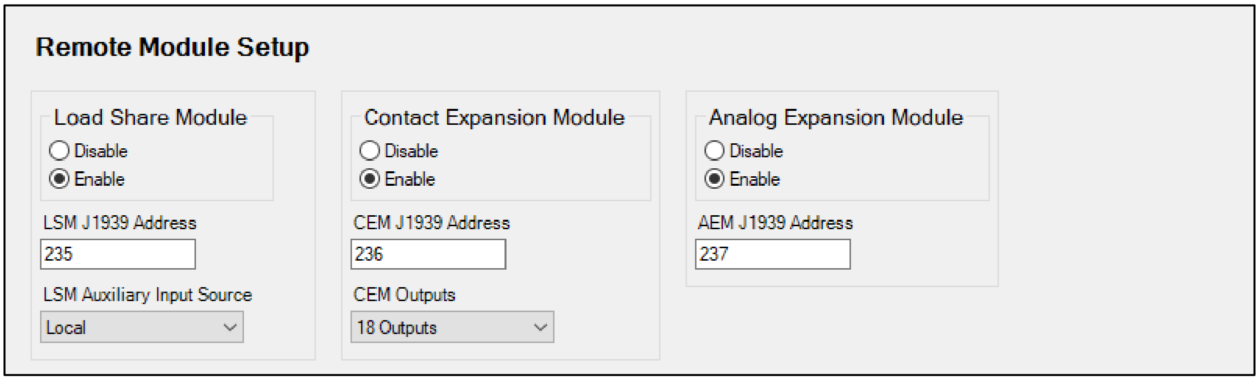


Figure 4-32. Remote Module Setup

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 can be configured during the resting state. If Preheat Before Crank is selected, the Pre-Start 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 Pre-Start output will be closed for the entire rest time.

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 BESTlogic*Plus* or BESTCOMS*Plus* 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 BESTCOMS*Plus* Crank Settings screen is illustrated in Figure 4-33.

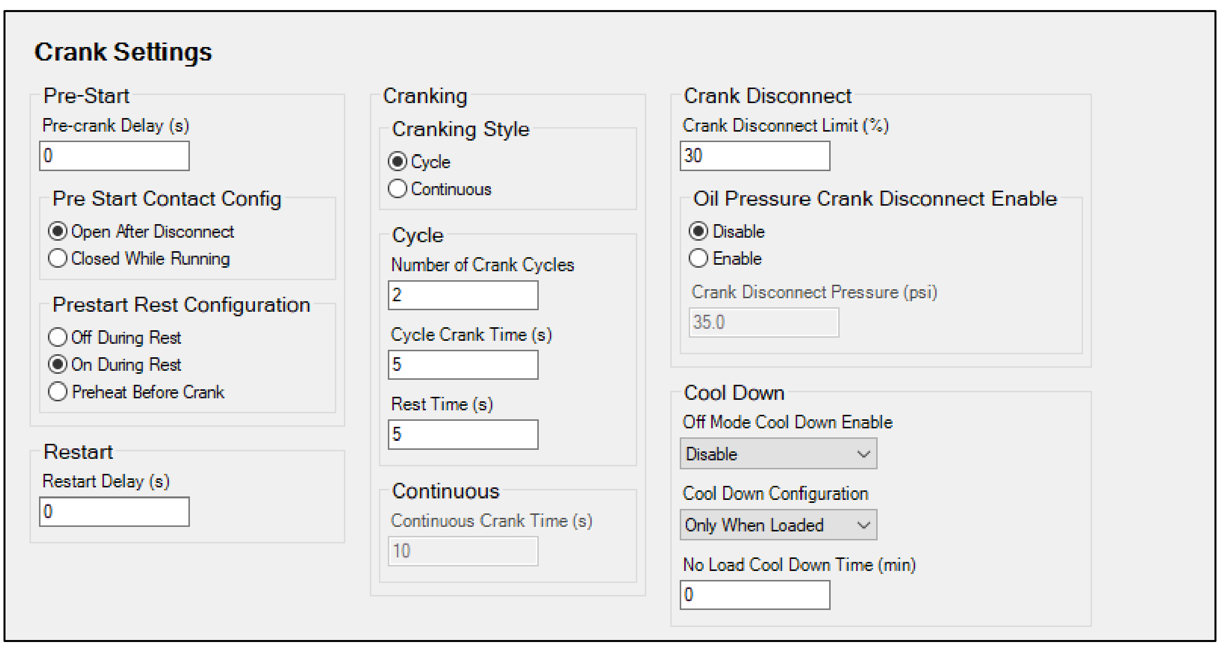


Figure 4-33. Crank Settings

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 BESTCOMS*Plus* Automatic Restart screen is illustrated in Figure 4-34.

Figure 4-34. Automatic Restart

Exercise Timer

The exercise timer is used to start the genset at a predetermined time and run for the user-defined period. The mode defines how often the genset will run. If monthly is selected, you must select the day of the month to start. If weekly is selected, you must select the day of the week to start. If Weekday of Month is selected, you must select Start Day of Week and Week of Month. Settings for Start Hour and Start Minutes can also be defined. The Run Period Hours and Minutes define how long the genset will run each time. If Run with Load is enabled, the DGC-2020 will close its GEN 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 BESTCOMS*Plus* Exercise Timer screen is illustrated in Figure 4-35.

Figure 4-35. 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 1xxxxxxxx uses a nominal CT secondary rating of 1 Aac. A DGC-2020 with a style number of 5xxxxxxxx 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 BESTCOMS*Plus* Sensing Transformers screen is illustrated in Figure 4-36.

Figure 4-36. 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 BESTlogic*Plus*.

The BESTCOMS*Plus* Relay Control screen is illustrated in Figure 4-37.

Figure 4-37. 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 BESTCOMS*Plus* Auto Config Detection screen is illustrated in Figure 4-38.

Figure 4-38. Auto Config Detection

Programmable Inputs

DGC-2020 programmable inputs can be assigned to trigger various functions and, when triggered, annunciate 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 annunciate 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*Plus* and on the Contact Inputs status screen on the front panel or in BESTCOMS*Plus*. 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*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*.

Contact input status is available in BESTlogic*Plus* Programmable Logic when “None” is selected for Alarm Configuration.

The BESTCOMS*Plus* Contact Inputs screen is illustrated in Figure 4-39.

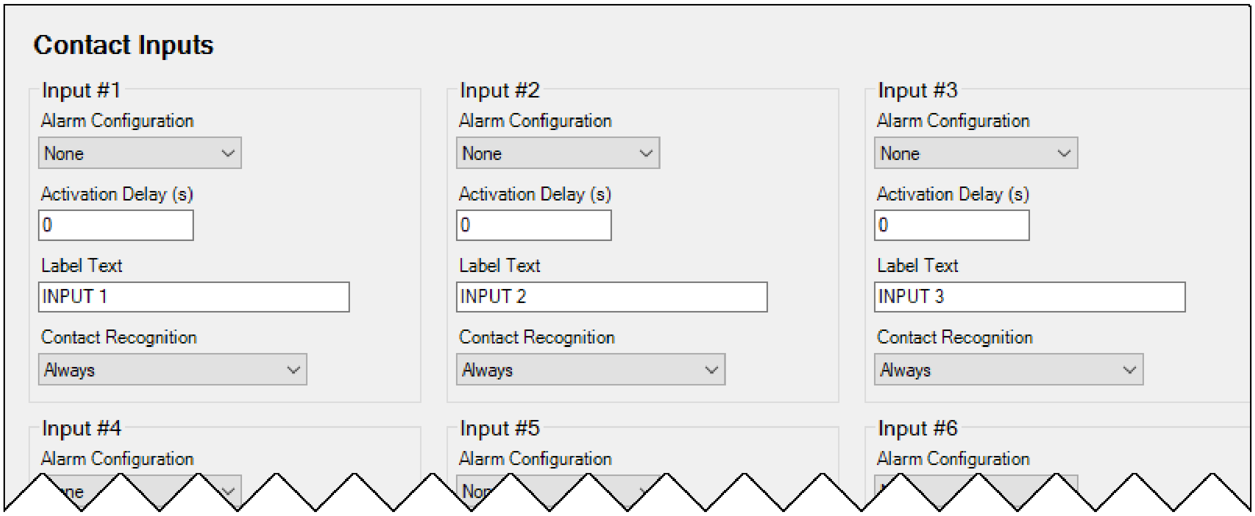


Figure 4-39. Contact Inputs

Programmable Functions

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

- Automatic Transfer Switch (ATS) - Disconnect from the mains and start the generator.
- 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.
- 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 BESTlogic*Plus* Programmable Logic when “None” is selected.

The BESTCOMS*Plus* Programmable Functions screen is illustrated in Figure 4-40.

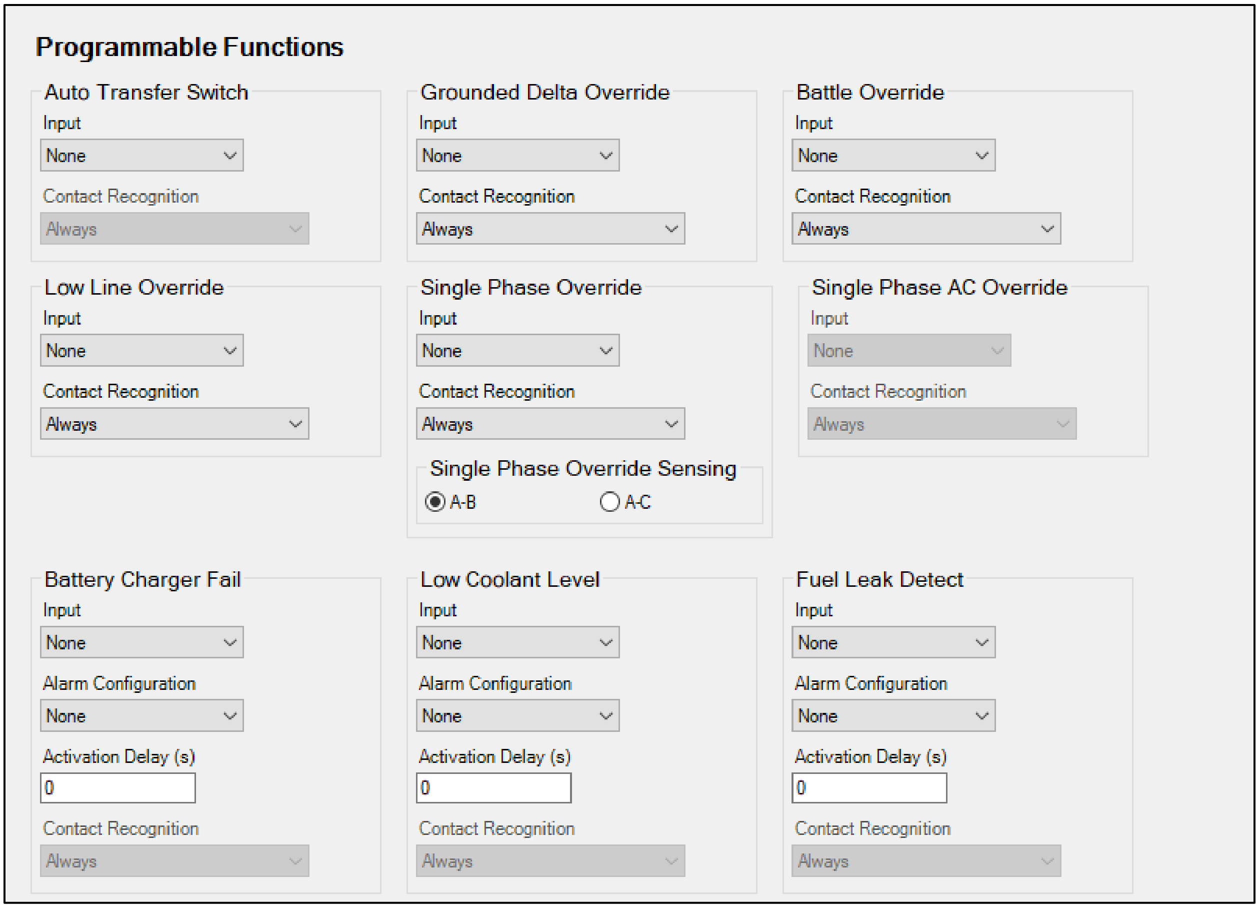


Figure 4-40. Programmable Functions

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 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 LSM Inputs screen is illustrated in Figure 4-41.

Figure 4-41. 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 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*.

Remote contact input status is available in BESTlogic*Plus* Programmable Logic when "None" is selected for Alarm Configuration.

The BESTCOMS*Plus* Remote Contact Inputs screen is illustrated in Figure 4-42.

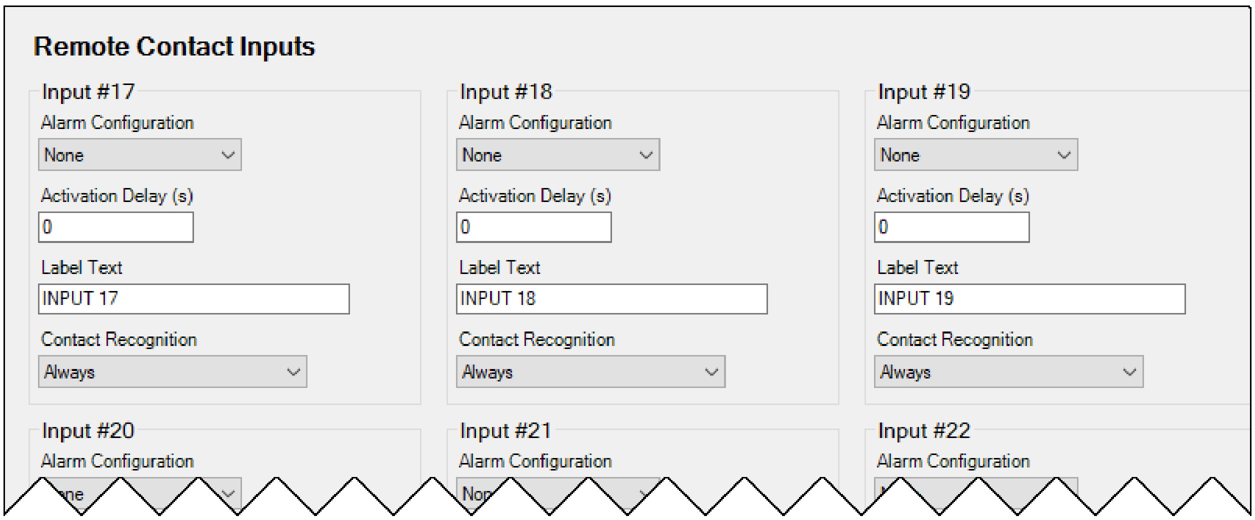


Figure 4-42. Remote Contact Inputs

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 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*.

A remote analog input is disabled when Alarm Configuration is set to "None". Remote analog input status is available in BESTlogic*Plus* Programmable Logic when "Status Only" is selected.

The BESTCOMS*Plus* Remote Analog Input #1 screen is illustrated in Figure 4-43.

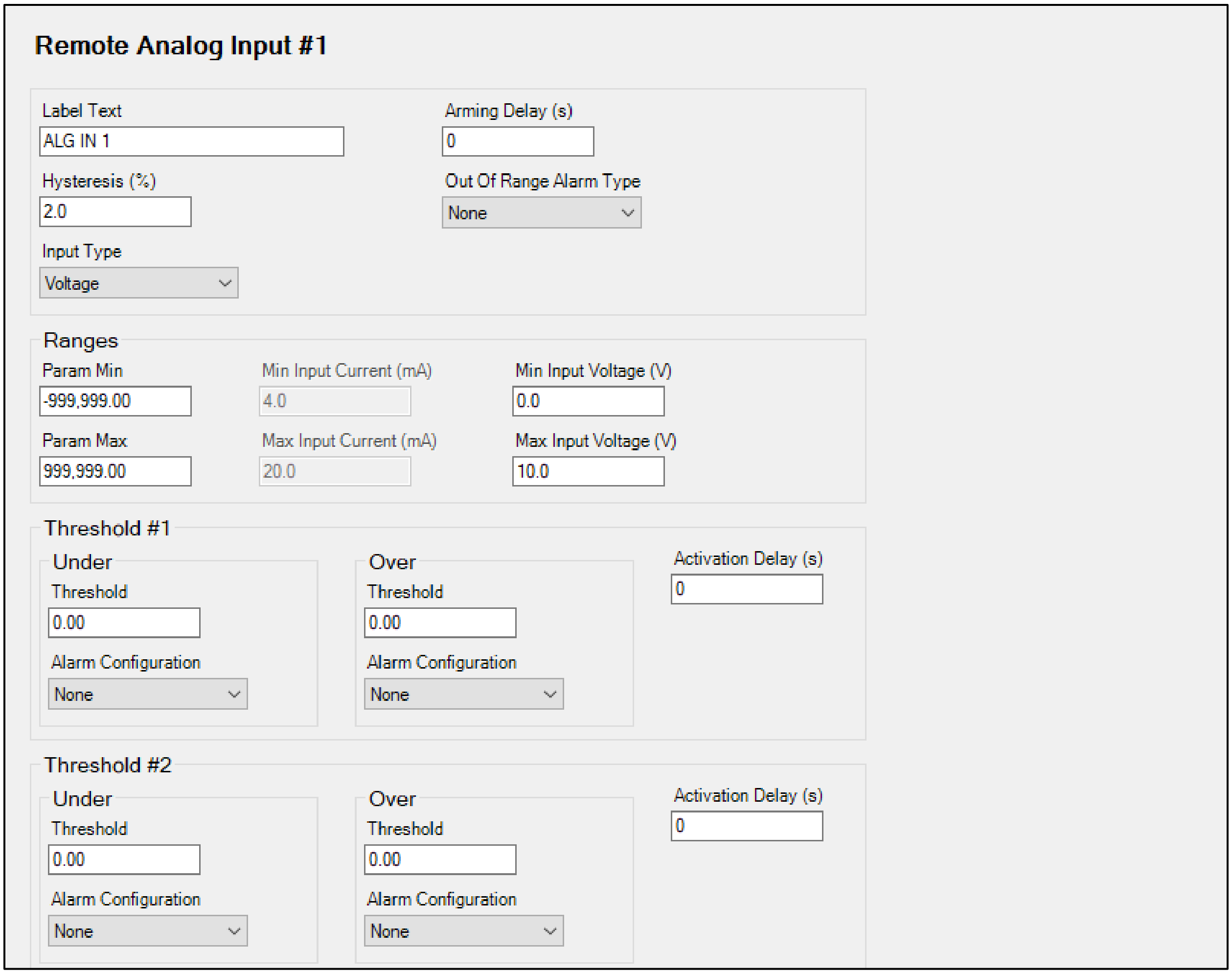


Figure 4-43. Remote Analog Input #1

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 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*.

A remote RTD input is disabled when Alarm Configuration is set to “None”. Remote RTD input status is available in BESTlogic*Plus* Programmable Logic when “Status Only” is selected.

The BESTCOMS*Plus* Remote RTD Input #1 screen is illustrated in Figure 4-44.

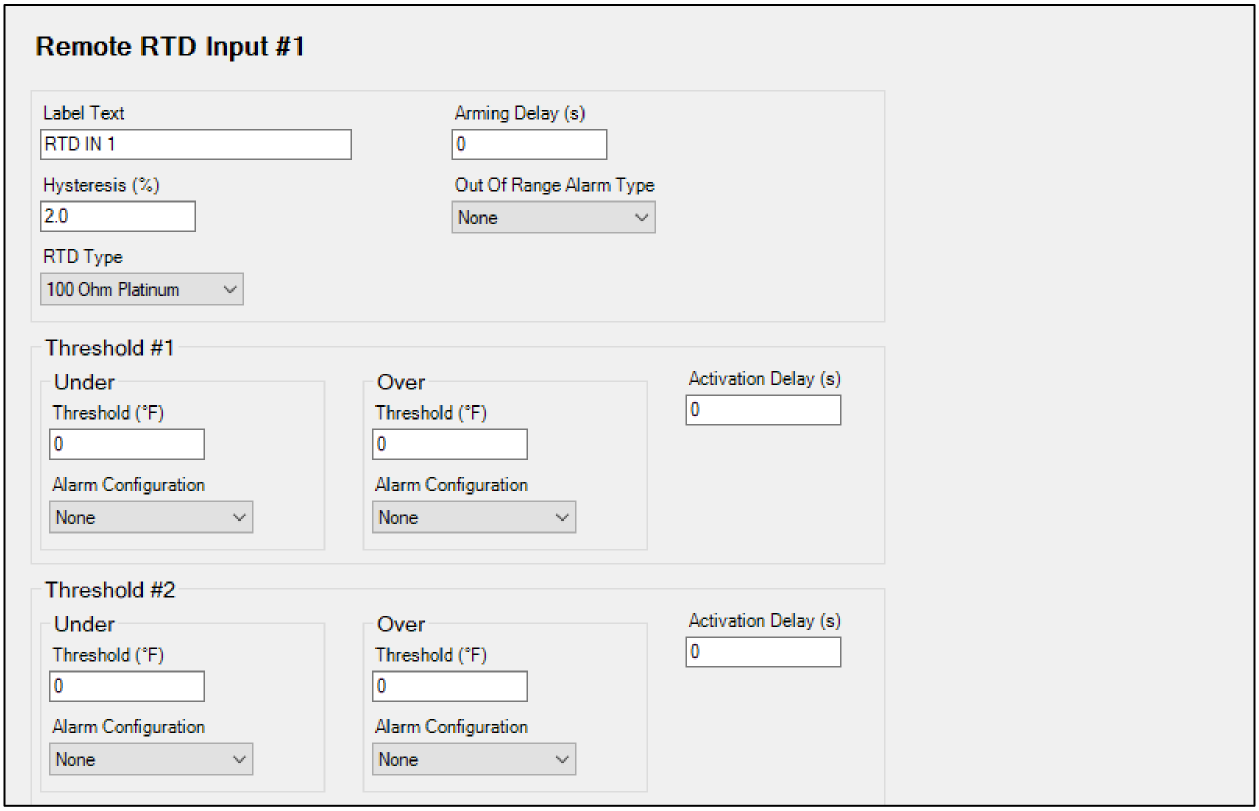


Figure 4-44. Remote RTD Input #1

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 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*.

Remote thermocouple input status is available in BESTlogic*Plus* Programmable Logic when “Status Only” is selected.

The BESTCOMS*Plus* Remote Thermocouple Input #1 screen is illustrated in Figure 4-45.

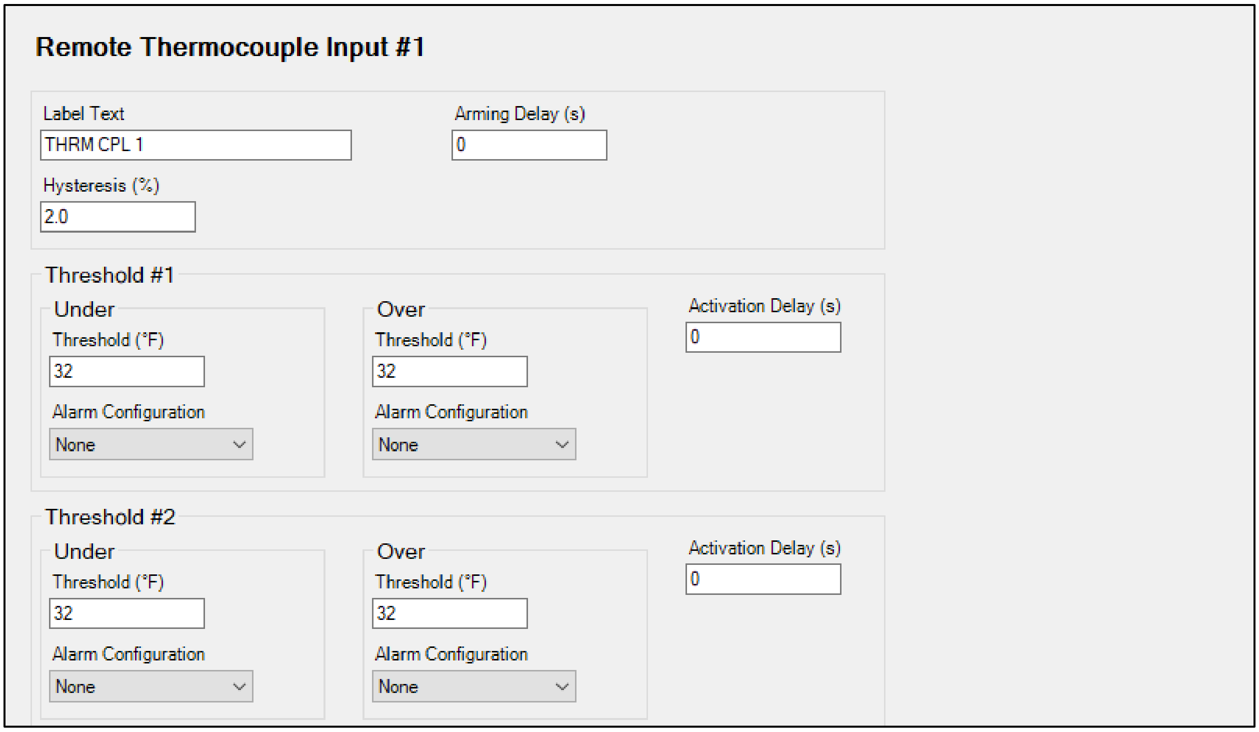


Figure 4-45. Remote Thermocouple Input #1

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 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* Contact Outputs screen is illustrated in Figure 4-46.

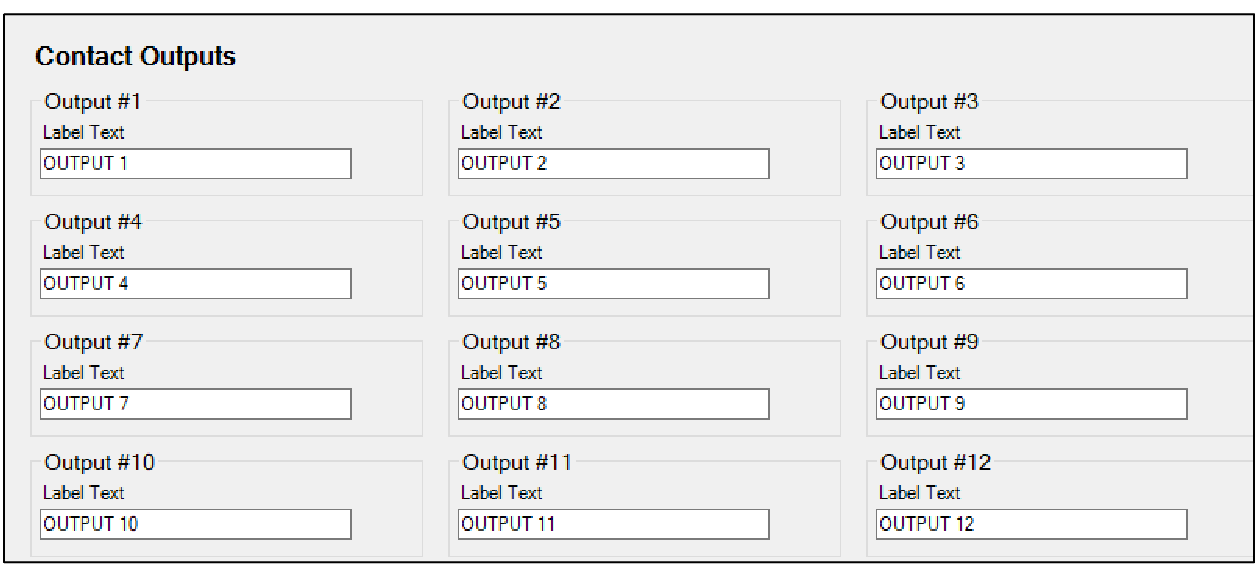


Figure 4-46. Contact Outputs

Configurable Elements

Configurable elements are connected to the logic scheme as outputs. The configurable elements are incorporated into a BESTlogic*Plus* programmable logic scheme by selecting them from the *Elements* group in BESTlogic*Plus*. 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 BESTlogic*Plus* 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 BESTCOMS*Plus* Configurable Elements screen is illustrated in Figure 4-47.

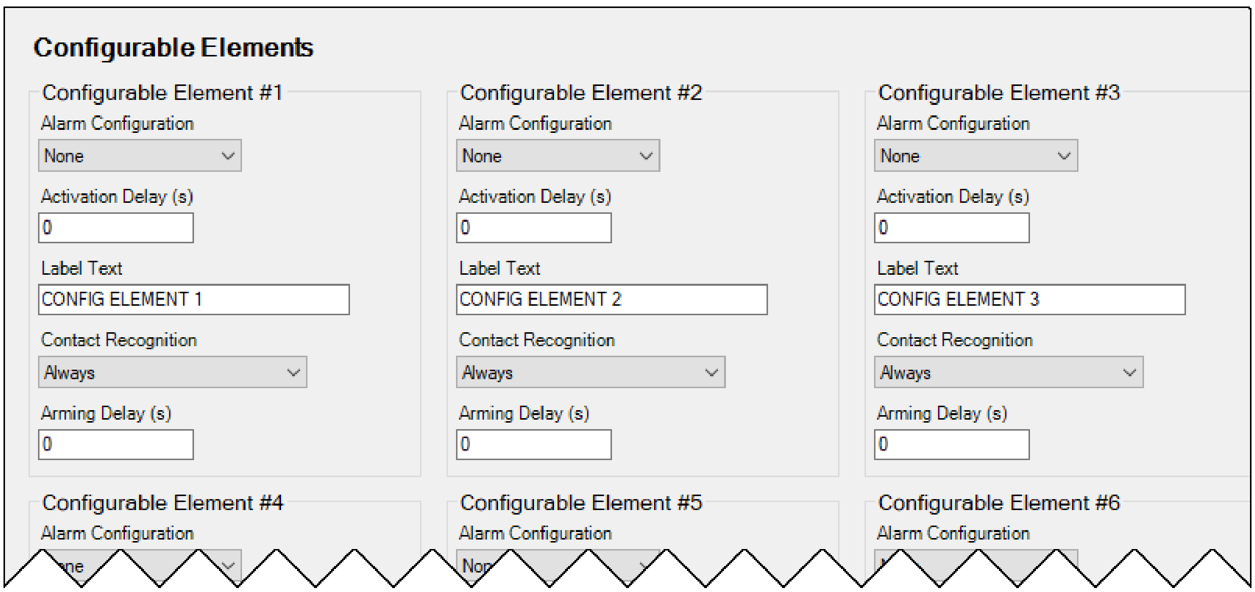


Figure 4-47. Configurable Elements

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 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 Contact Outputs screen is illustrated in Figure 4-48.

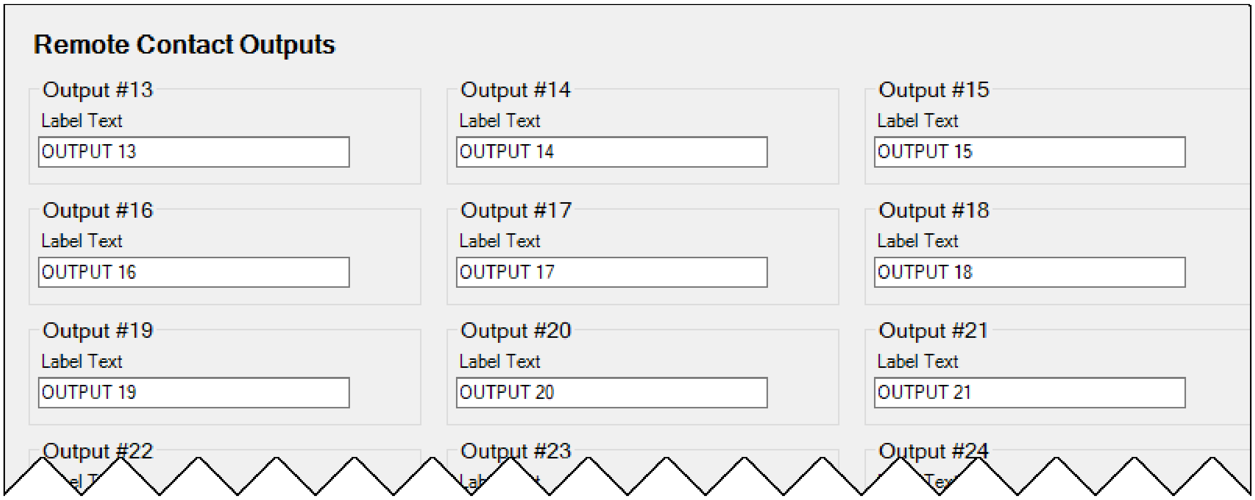


Figure 4-48. Remote Contact Outputs

Remote Analog Outputs

An optional AEM-2020 (Analog Expansion Module) provides four analog outputs.

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 4-49.

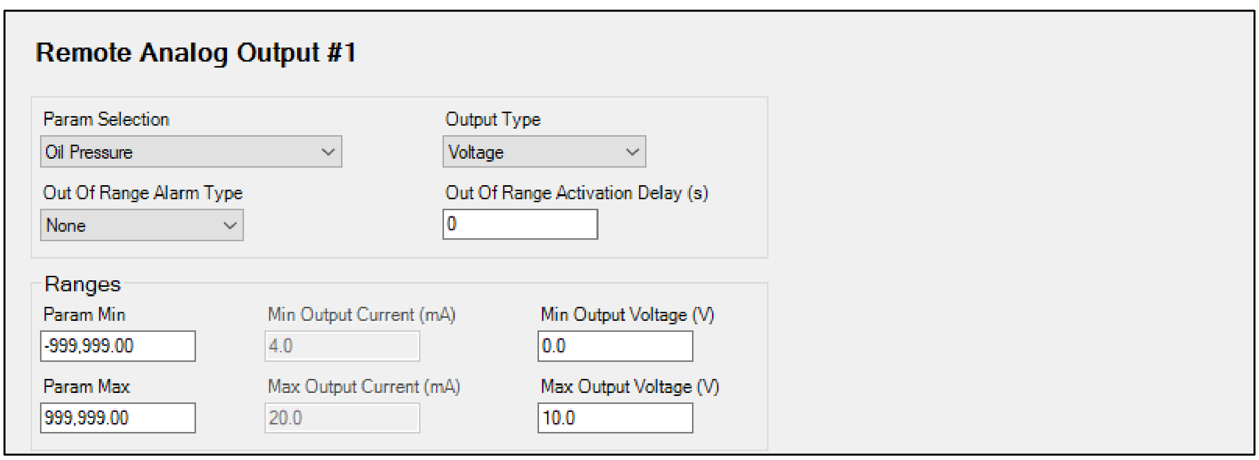


Figure 4-49. Remote Analog Output #1

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.

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 *Oil Pressure* or *Battery Volts* is selected for configurable protection and the threshold alarm configuration is set to *Alarm*. 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 4-50.

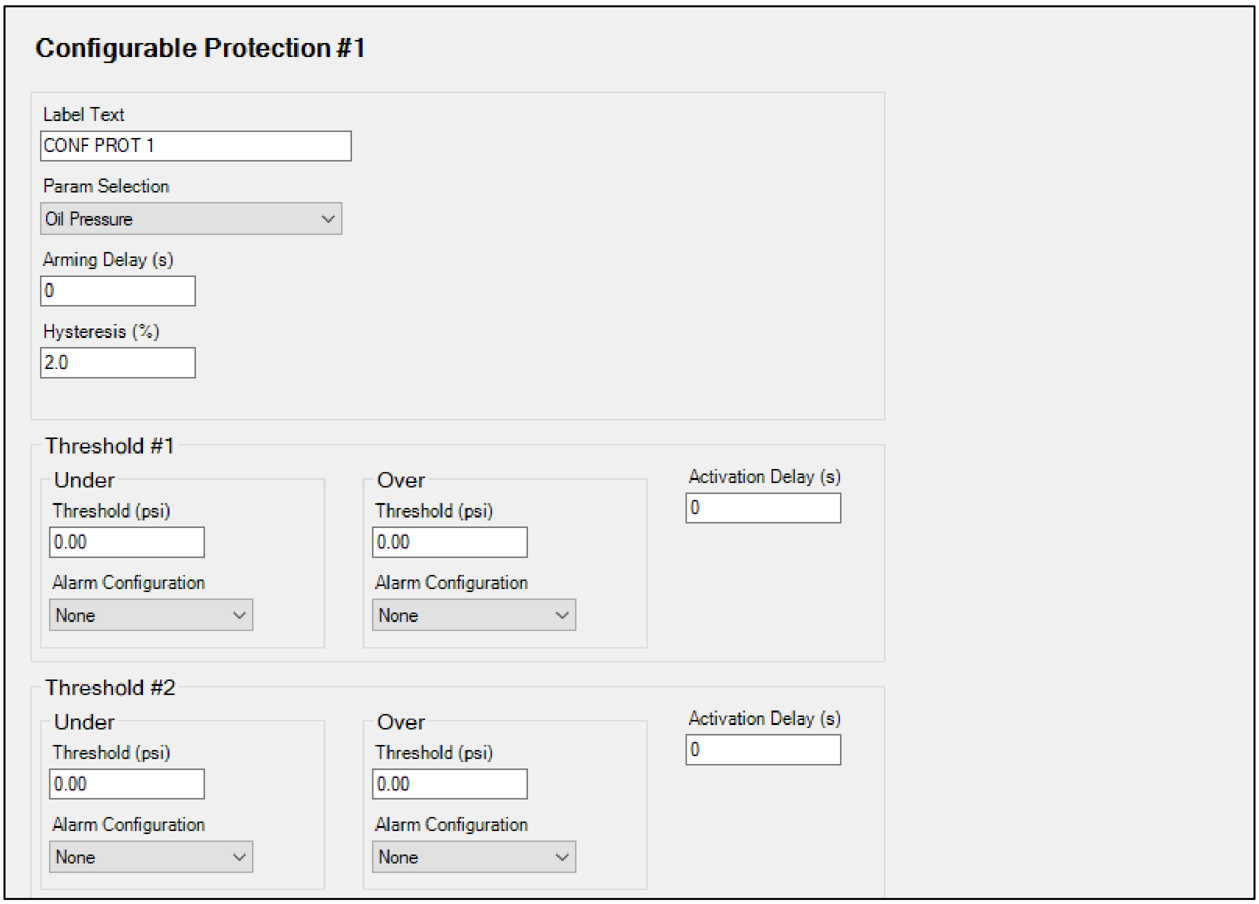


Figure 4-50. Configurable Protection #1

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 BESTCOMS*Plus* Scale Factors screen is illustrated in Figure 4-51.

Figure 4-51. 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 BESTCOMS*Plus* 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 BESTCOMS*Plus* Horn Configuration screen is illustrated in Figure 4-52.

Figure 4-52. 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 BESTlogic*Plus*. 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 BESTCOMS*Plus* or through the front panel HMI.

The BESTCOMS*Plus* Pre-Alarms screen is illustrated in Figure 4-53.

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 BESTCOMS*Plus* 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 BESTCOMS*Plus* 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 BESTCOMS*Plus*.

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 BESTCOMS*Plus*, 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 BESTCOMS*Plus* 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.

ECU Coms Fail

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).

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.

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

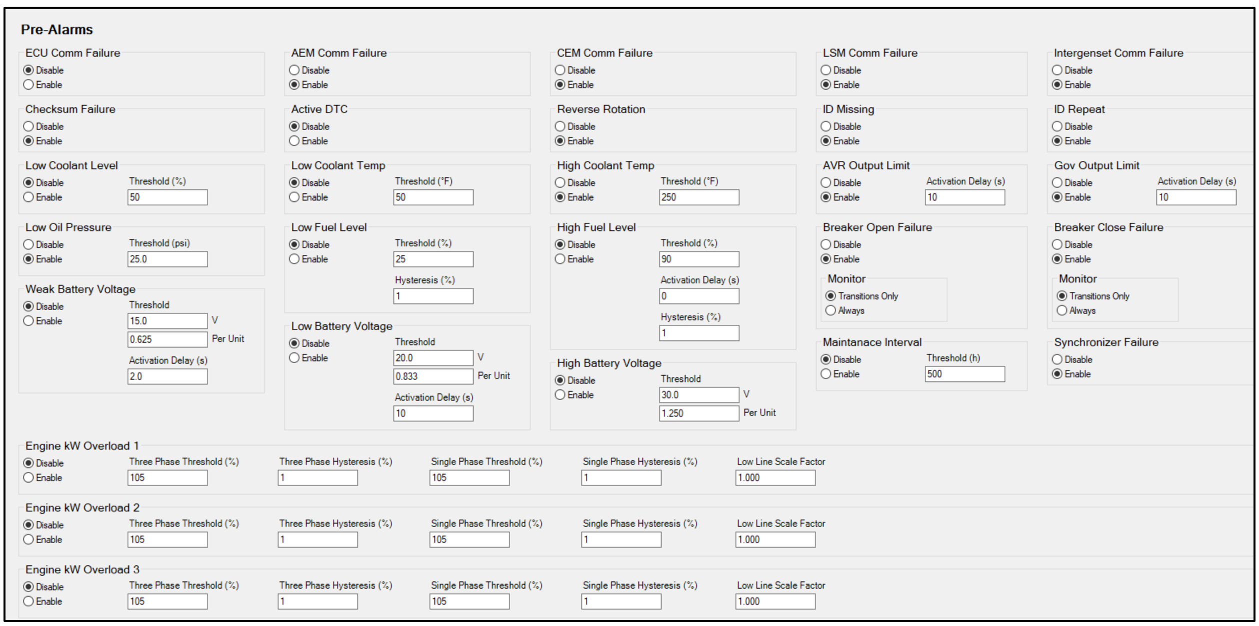


Figure 4-53. Pre-Alarms

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 4-54.

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.

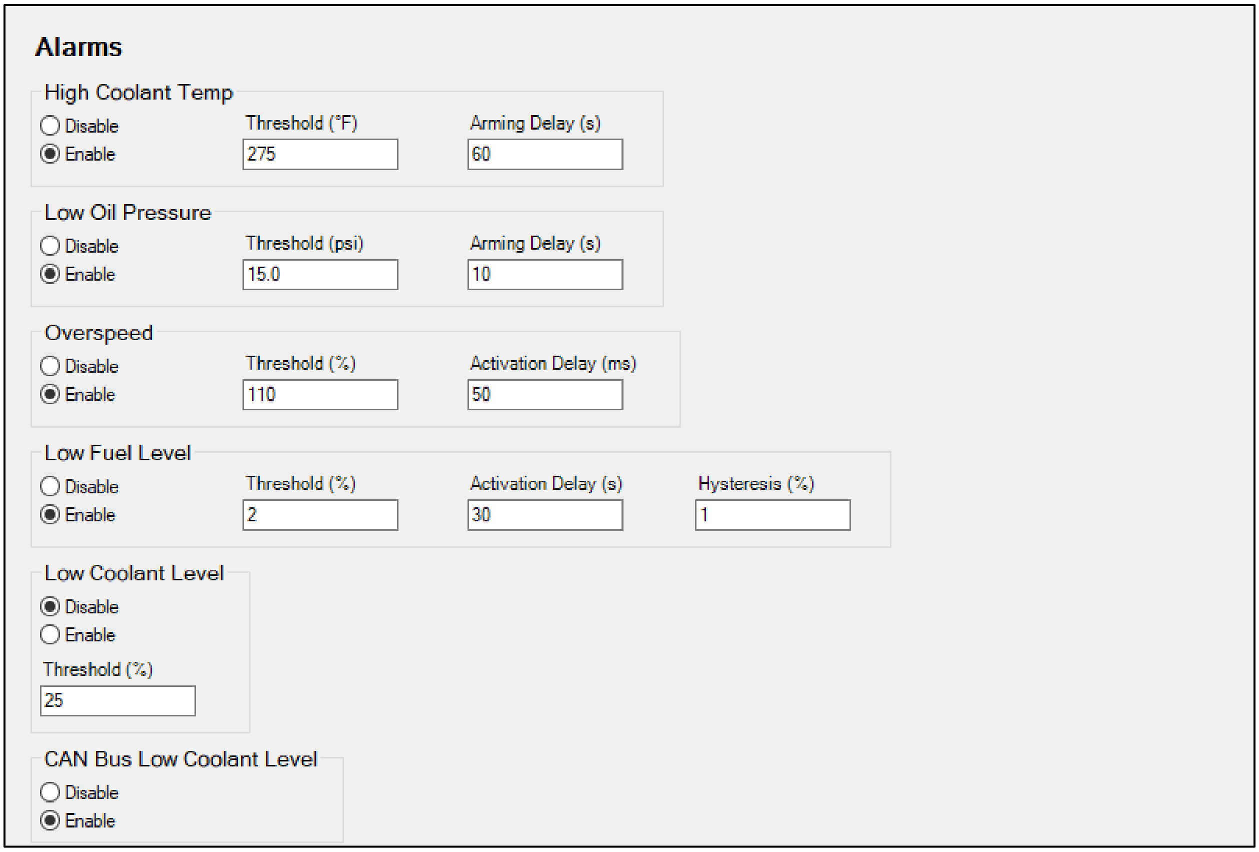


Figure 4-54. Alarms

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 BESTCOMS*Plus* Sender Fail screen is illustrated in Figure 4-55.

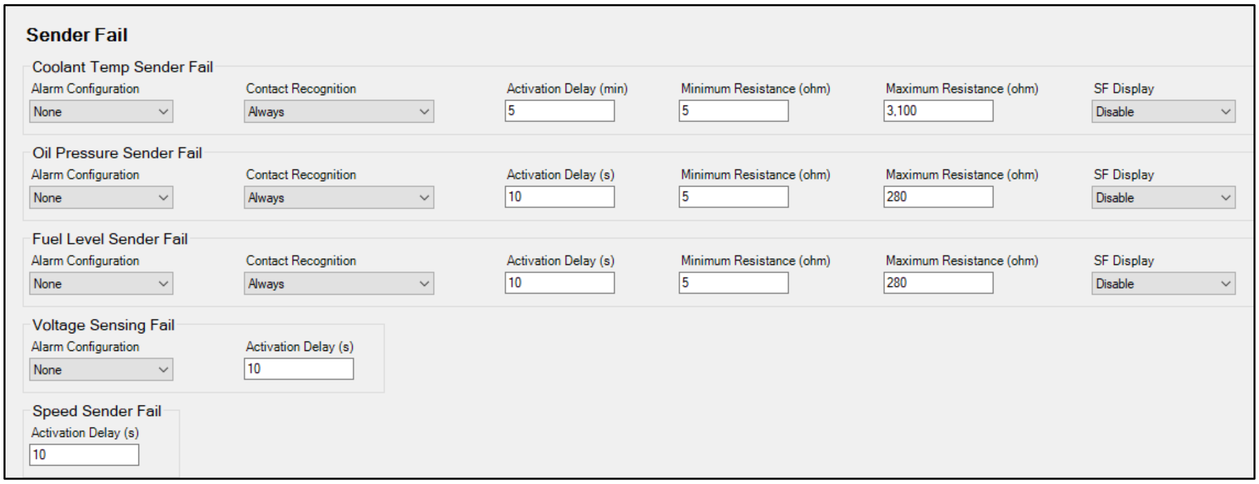


Figure 4-55. Sender Fail

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 × 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 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 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 BESTCOMS*Plus* Undervoltage screen is illustrated in Figure 4-56. The 27-1 element is shown.

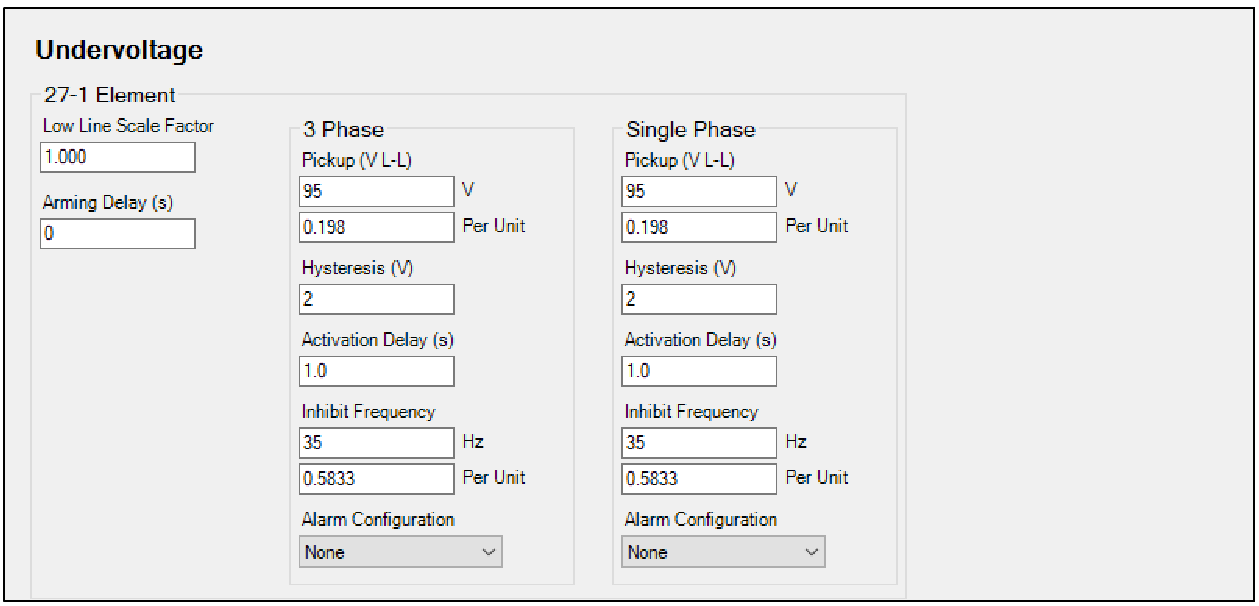


Figure 4-56. Undervoltage

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 × 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 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 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 4-57. The 59-1 element is shown.

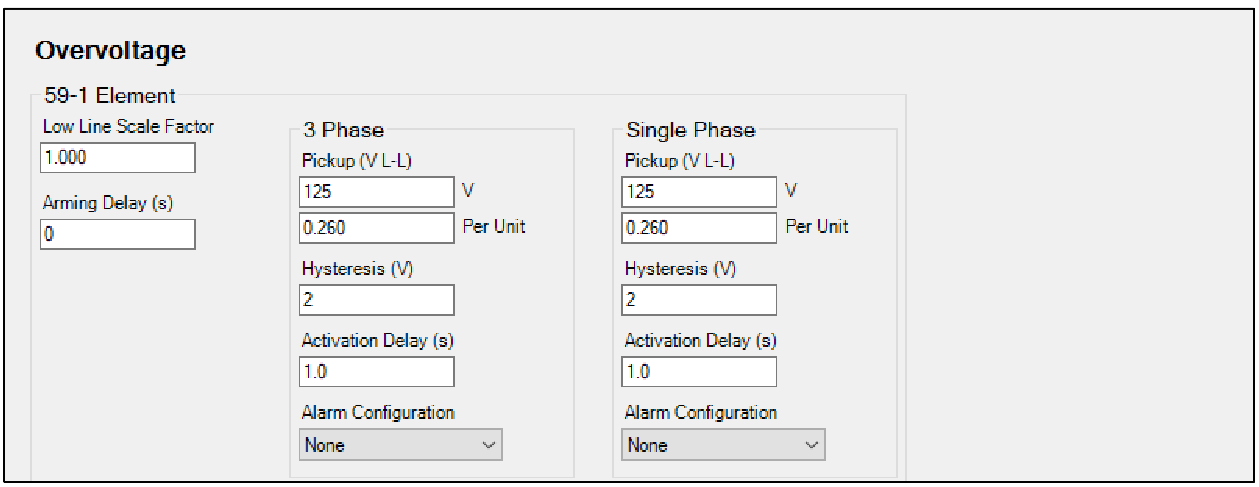


Figure 4-57. Overvoltage

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 × 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 BESTCOMS*Plus* Phase Imbalance screen is illustrated in Figure 4-58.

Figure 4-58. 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 BESTlogic*Plus* 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[H] (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 BESTlogic*Plus* 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 BESTlogic*Plus* 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, 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 *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 BESTCOMS*Plus* Frequency screen is illustrated in Figure 4-59.

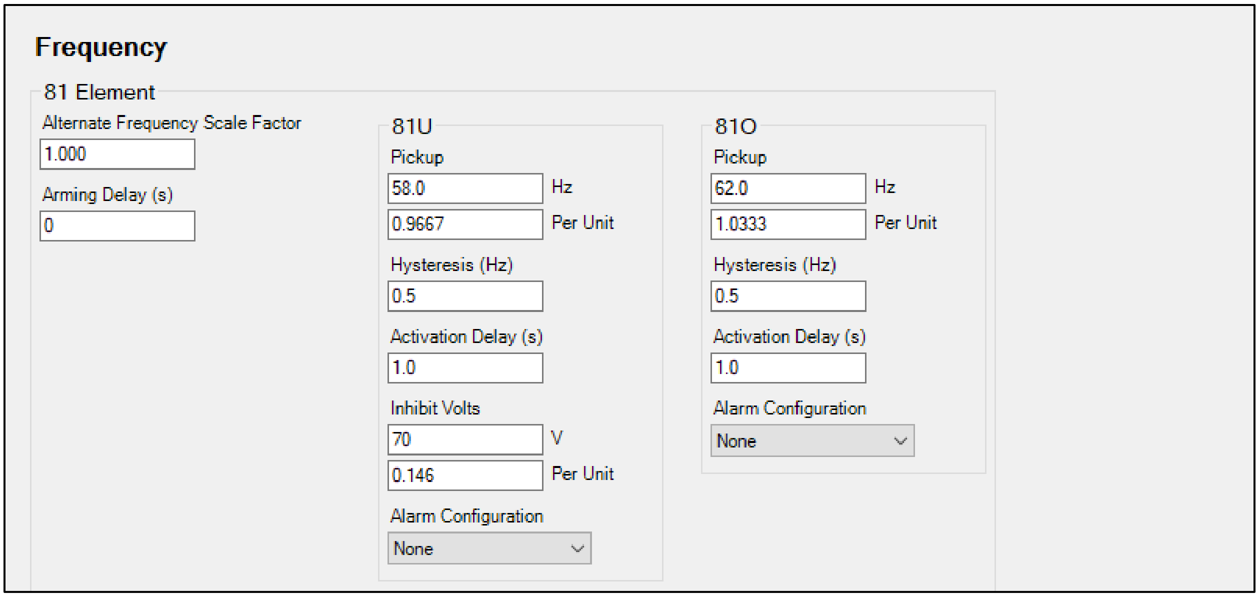


Figure 4-59. Frequency

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 4-60.

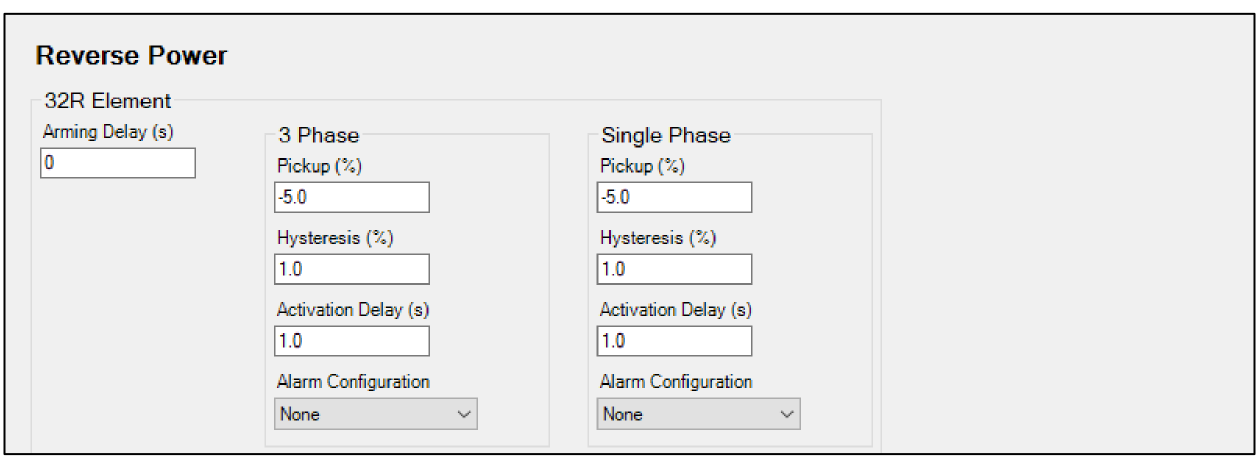


Figure 4-60. Reverse Power

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 4-61.

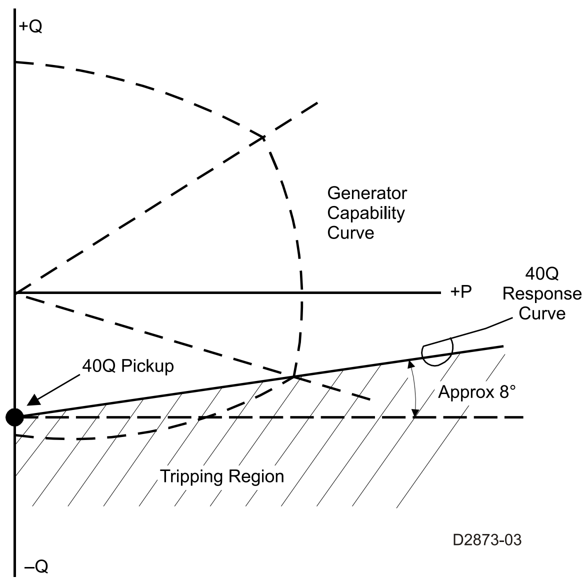


Figure 4-61. Generator Capability Curve vs. 40Q Response

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:

$$Tripping\ Region = 40Q\ Pickup + \left(\frac{1}{8}\right) * \left(\frac{Actual\ Watts * 100}{Rated\ var}\right)$$

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 BESTlogic*Plus* Programmable Logic when "Status Only" is selected.

The BESTCOMS*Plus* Loss of Excitation (40Q) screen is illustrated in Figure 4-62.

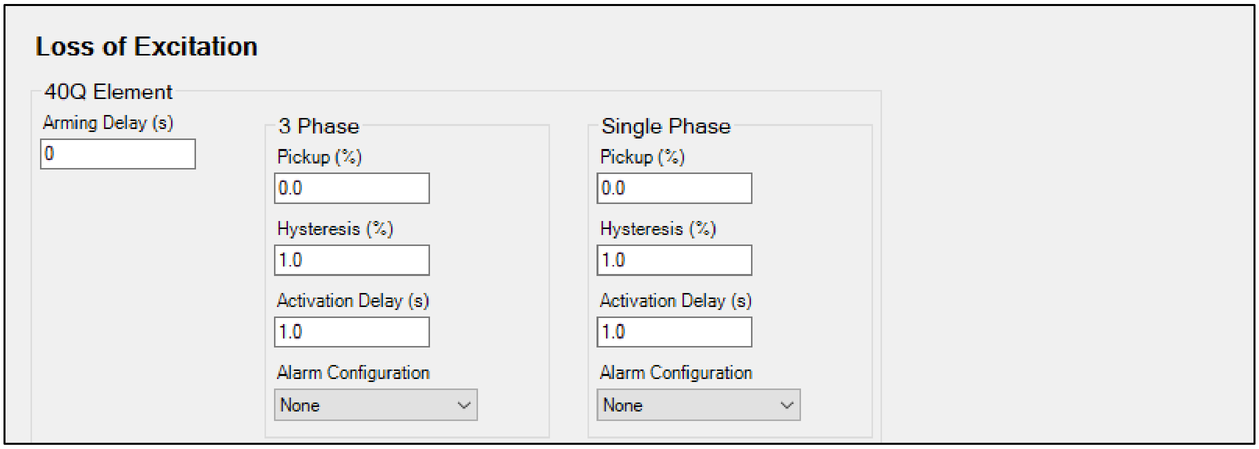


Figure 4-62. Loss of Excitation (40Q)

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 BESTCOMS*Plus*, 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 × 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 BESTlogic*Plus* 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, 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 *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 BESTCOMS*Plus* Overcurrent screen is illustrated in Figure 4-63. 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

$$T_T = \frac{AD}{\left(M^N - C\right)^Q} + BD + K$$

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_T	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.
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 BESTCOMS*Plus*. 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

BESTCOMS*Plus* 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.

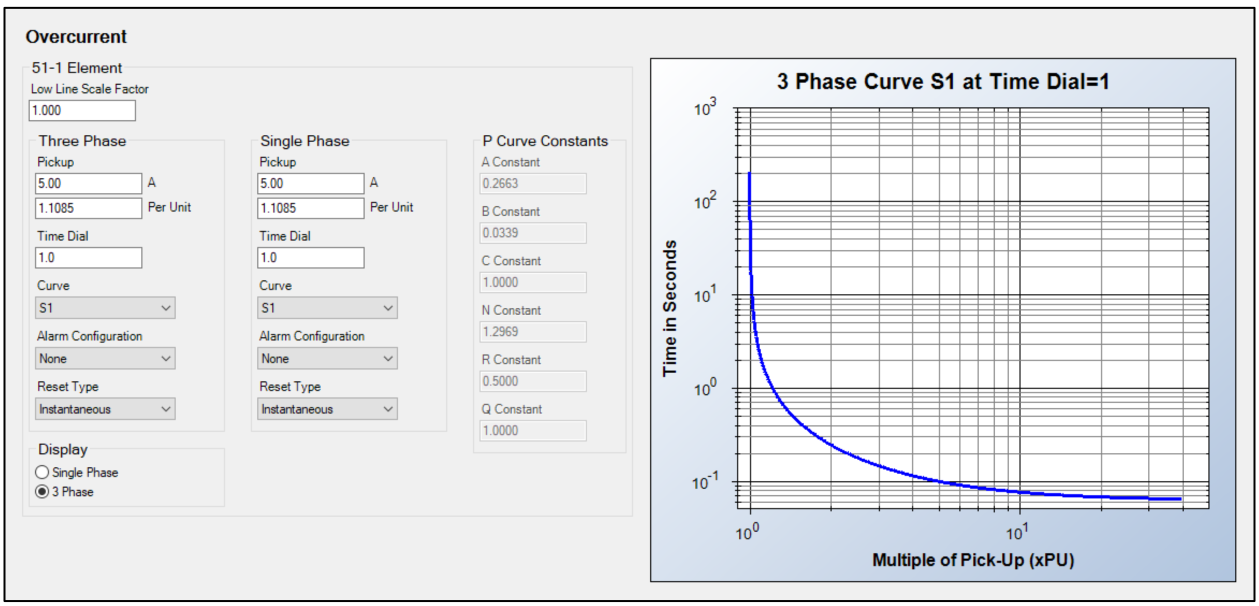


Figure 4-63. Overcurrent

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 BESTlogic*Plus*. 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 BESTlogic*Plus* 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 BESTCOMS*Plus* Vector Shift (78) screen is illustrated in Figure 4-64.

Figure 4-64. 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 BESTlogic*Plus* 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 BESTCOMS*Plus* ROCOF (81) screen is illustrated in Figure 4-65.

Figure 4-65. 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 AVRs 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 AVRs 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 4-66.

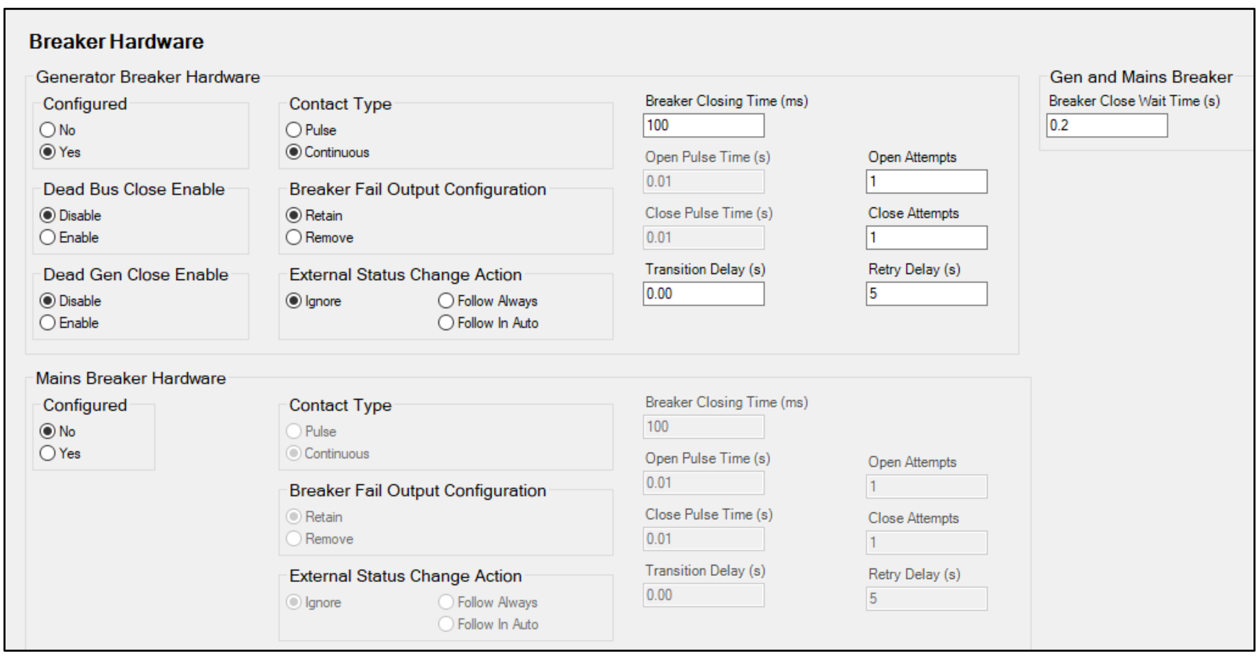


Figure 4-66. Breaker Hardware

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 4-67.

Mains Failure Logic Elements

Four logic elements are present in BESTlogic*Plus* 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 BESTlogic*Plus*, 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.

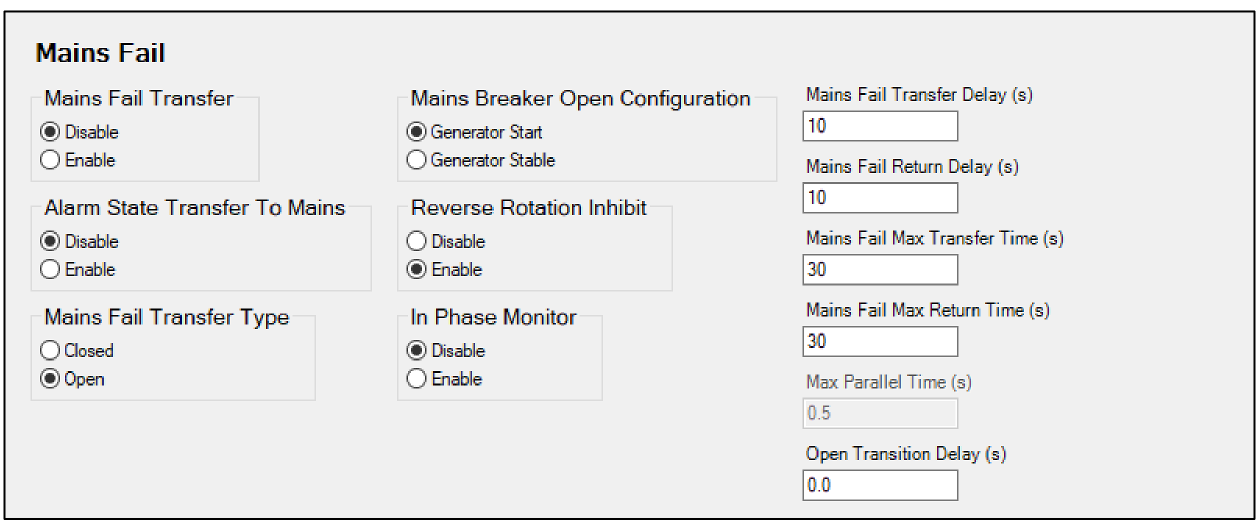


Figure 4-67 Mains Fail

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.

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 BESTlogic*Plus* 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, 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 *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.

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 BESTlogic*Plus* 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, 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 *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 BESTCOMS*Plus* Bus Condition Detection screen is illustrated in Figure 4-68.

Note
Voltage threshold and pickup settings on the Bus Condition Detection screen are entered in primary values (generator side of VT).

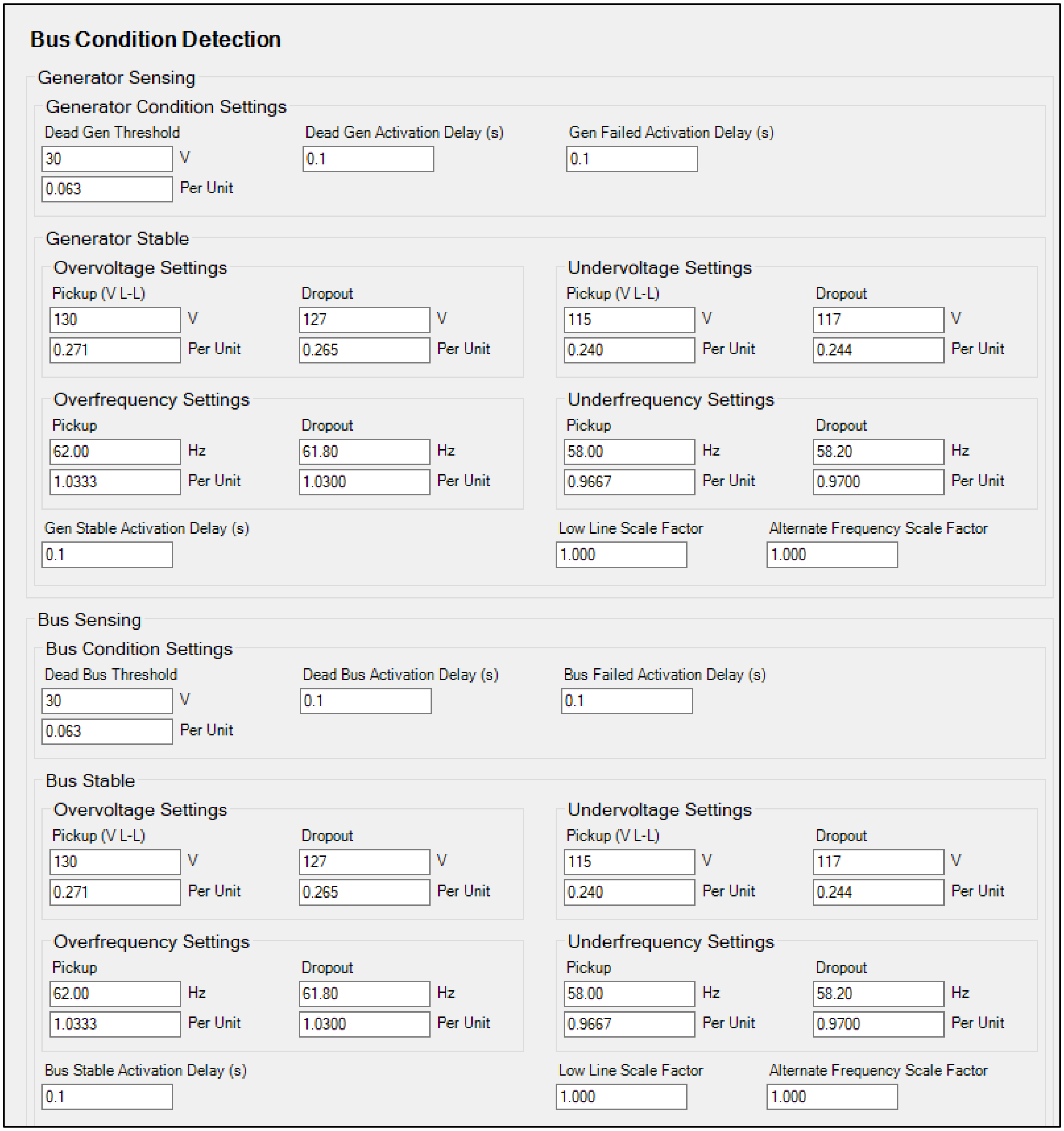


Figure 4-68. Bus Condition Detection

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 4-69.

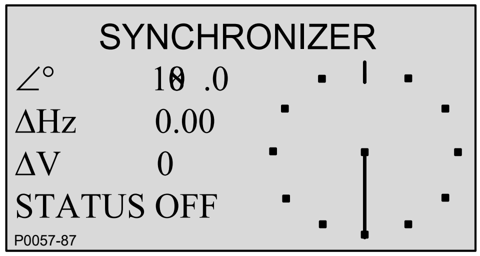


Figure 4-69. Synchronizer Screen

The BESTCOMS*Plus* Synchronizer screen is illustrated in Figure 4-71.

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 4-70. 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.

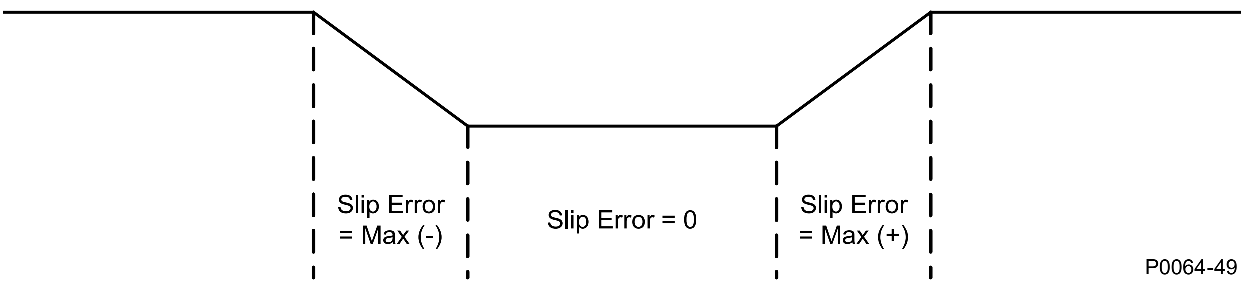


Figure 4-70. Slip Frequency Error

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, BESTCOMS*Plus* 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.

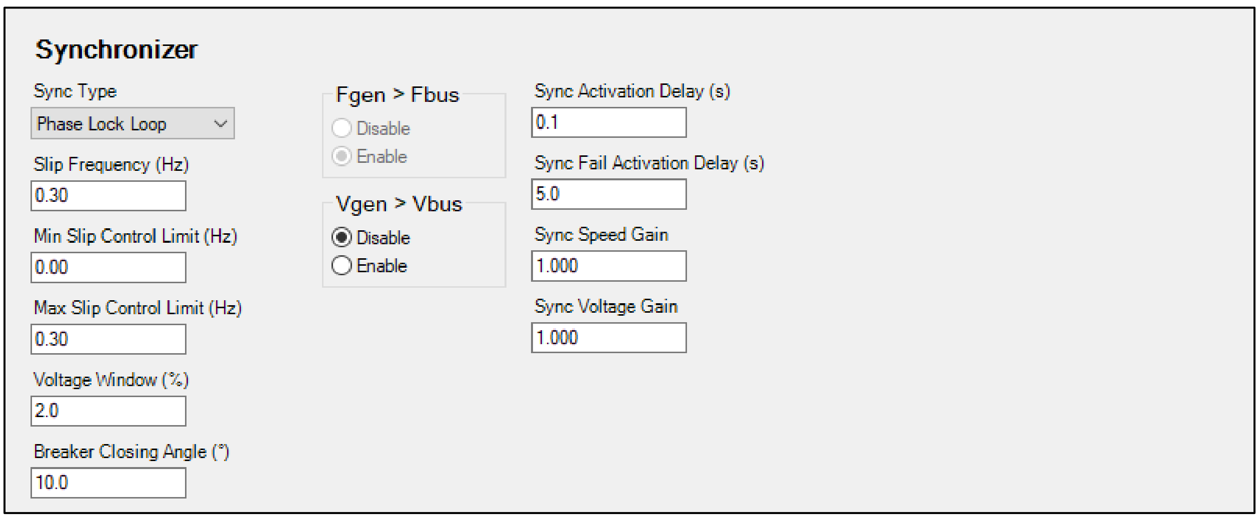


Figure 4-71. Synchronizer

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 BESTlogic*Plus* 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 BESTlogic*Plus*. 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 BESTCOMS*Plus* AVR Bias Control Settings screen is illustrated in Figure 4-72.

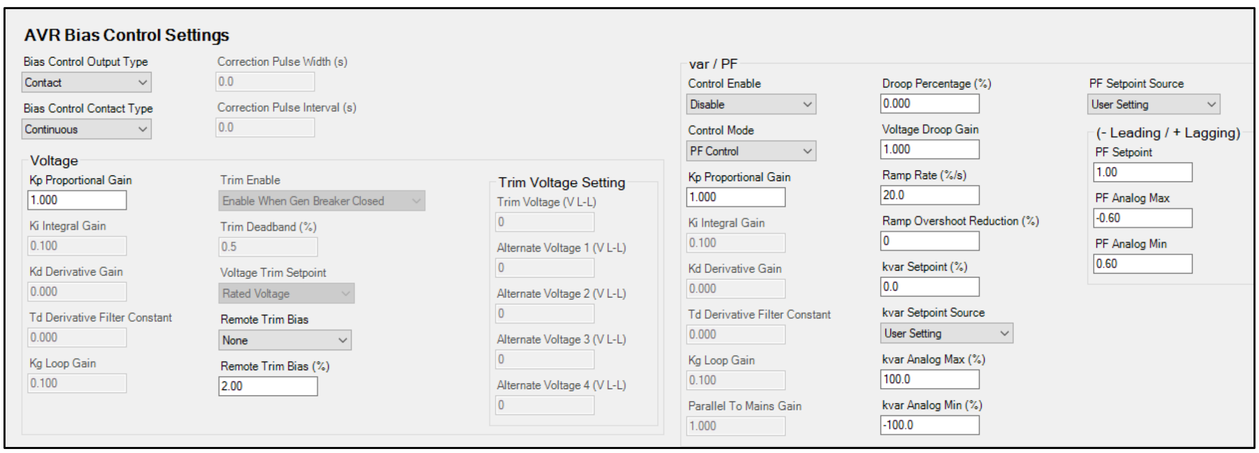


Figure 4-72. AVR Bias Control Settings

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 ±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 4-73.

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 BESTlogic*Plus* 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.

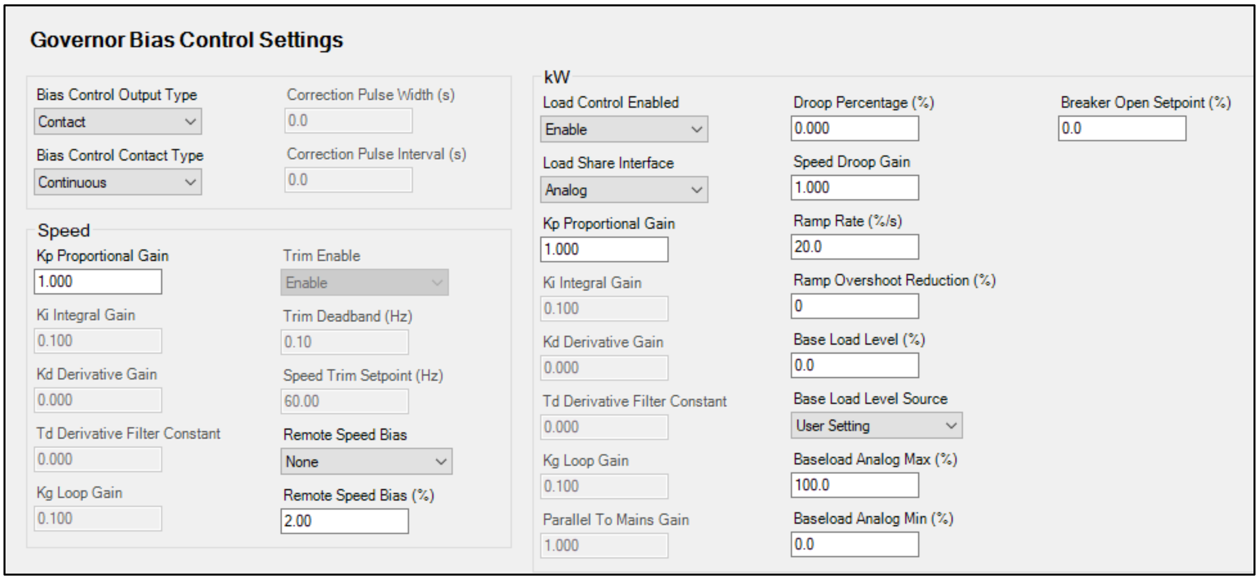


Figure 4-73. Governor Bias Control Settings

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 4-74.

Figure 4-74. 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 4-75.

Figure 4-75. 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 4-76.

Figure 4-76. 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 4-77.

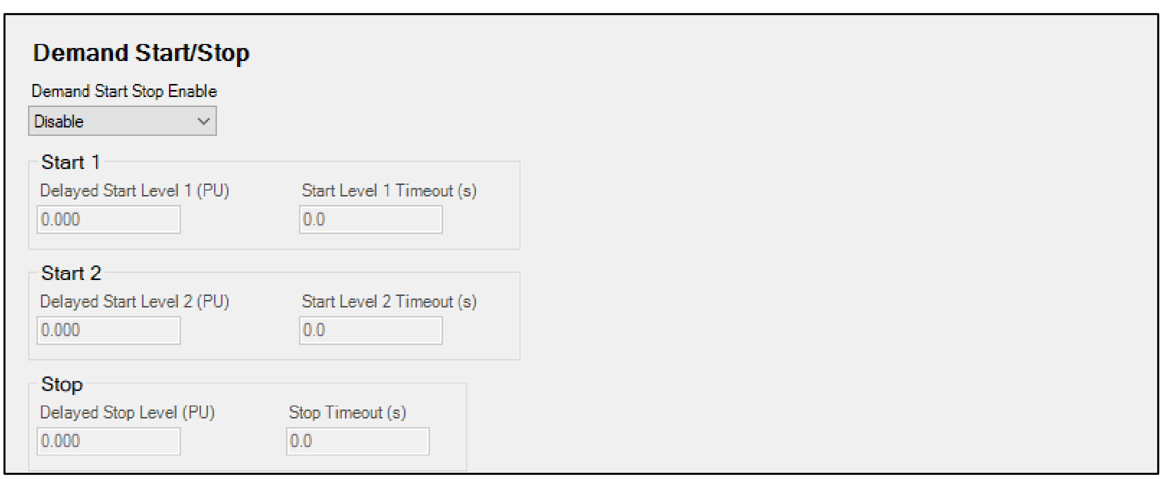


Figure 4-77. Demand Start/Stop

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 BESTCOMS*Plus* Generator Sequencing screen is illustrated in Figure 4-78.

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.

Figure 4-78. 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 4-79.

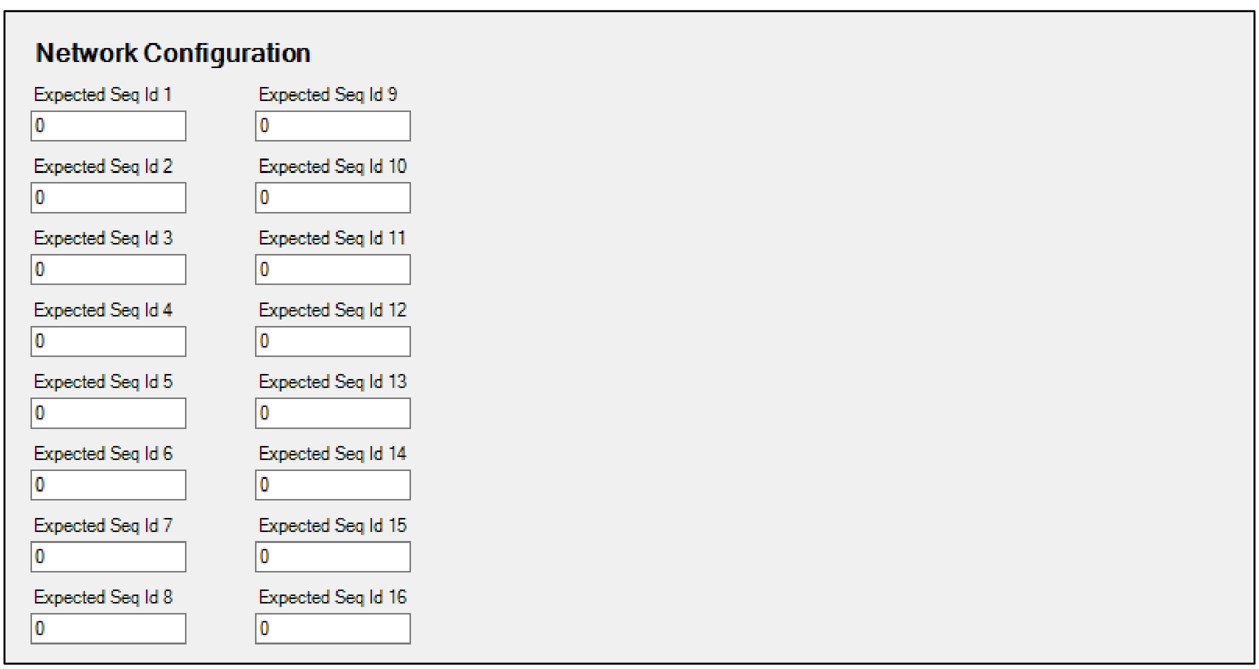


Figure 4-79. Network Configuration

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 BESTCOMS*Plus*, which can be printed.

Sender curve points configured in BESTCOMS*Plus* 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 BESTCOMS*Plus* to the sender points, can be reverted to the factory-default values. A new settings file can also be created.

The BESTCOMS*Plus* Coolant Temperature programmable sender screen is illustrated in Figure 4-80. (The contents and layout of each BESTCOMS*Plus* programmable sender screen is identical.)

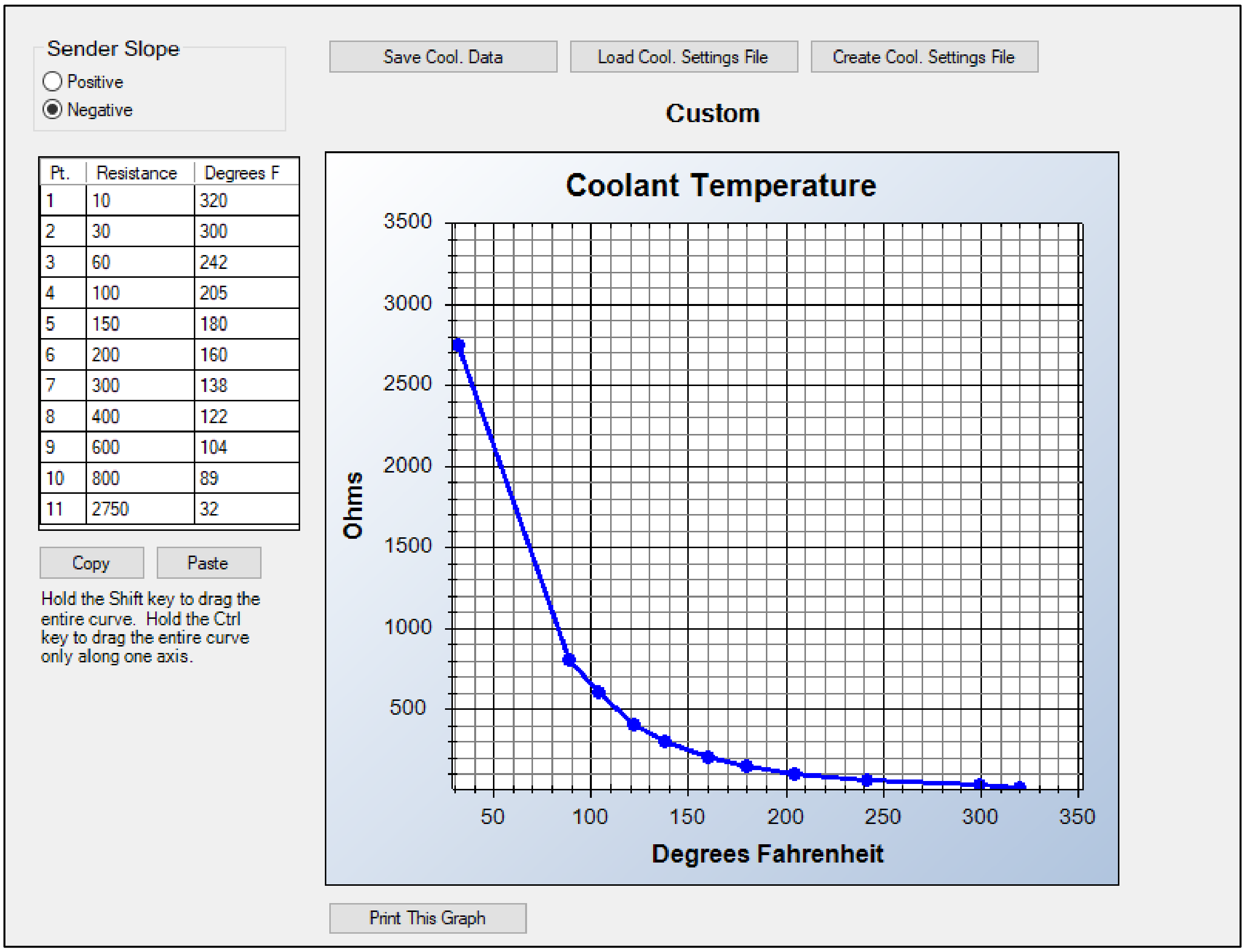


Figure 4-80. Coolant Temperature

BESTlogic™Plus Programmable Logic

BESTlogic*Plus* Programmable Logic is used to set all logic functions in the DGC-2020. For detailed information on using BESTlogic*Plus*, 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 BESTCOMS*Plus* 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 BESTlogic*Plus* 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 BESTCOMS*Plus* 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 BESTCOMS*Plus*, 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 BESTCOMS*Plus* or create the file using BESTCOMS*Plus*. 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 BESTCOMS*Plus* 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. BESTCOMS*Plus* will read all settings and logic from the DGC-2020 and load them into BESTCOMS*Plus* 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

BESTCOMS*Plus* 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 4-81). 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 *BESTCOMSPlus Settings Compare* dialog box (Figure 4-82) 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.

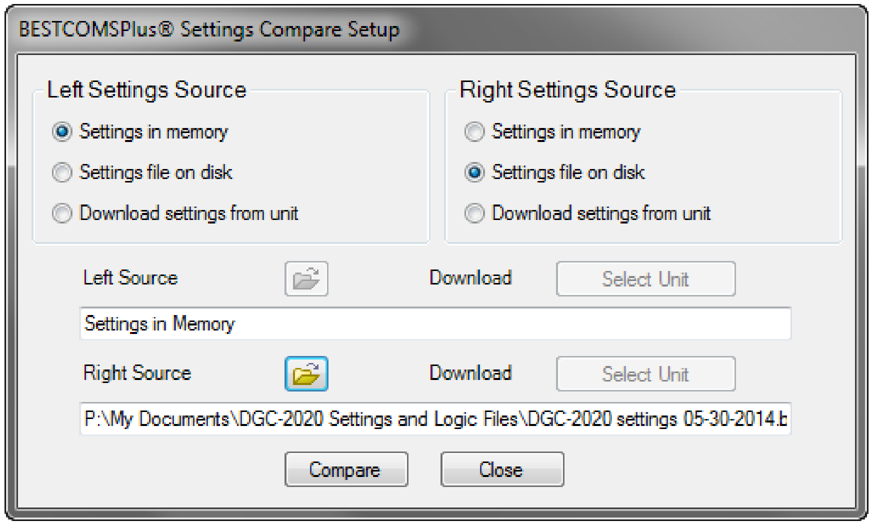


Figure 4-81. BESTCOMSPlus Settings Compare Setup

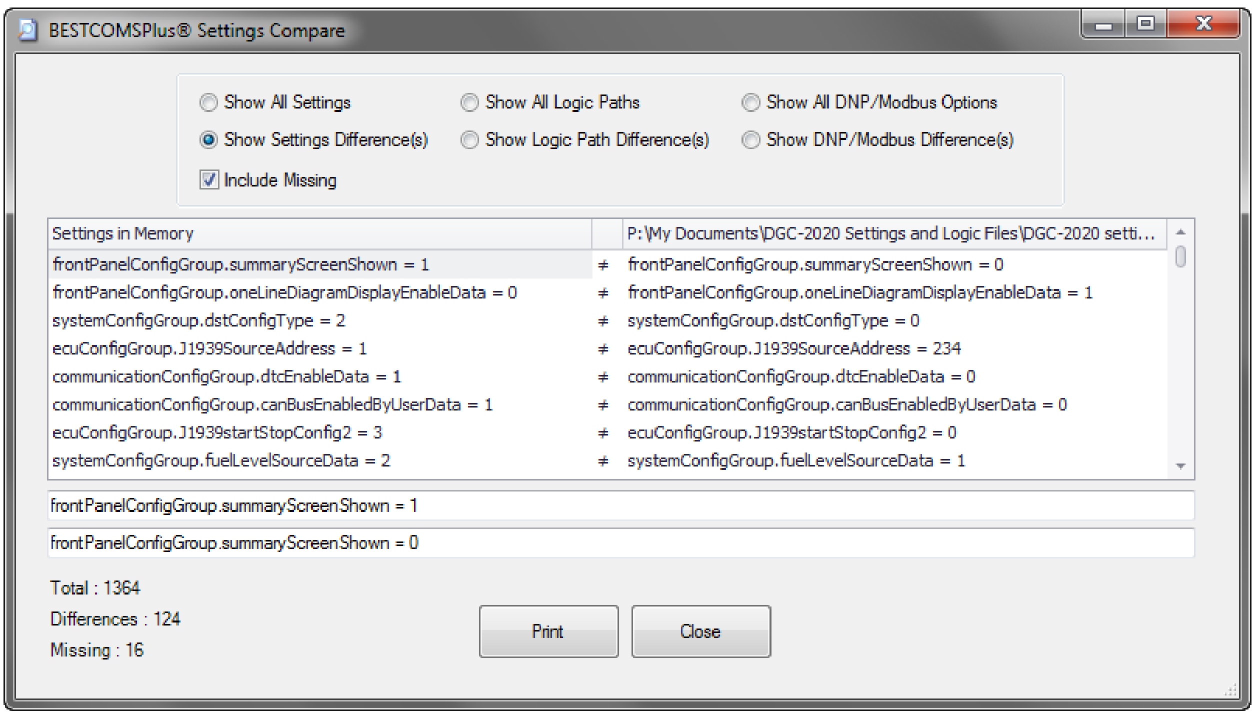


Figure 4-82. BESTCOMSPlus Settings Compare

Upgrading Firmware in the DGC-2020 and Expansion Modules

Note
The latest version of BESTCOMS*Plus* 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 BESTCOMS*Plus*. 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 4-83) 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.

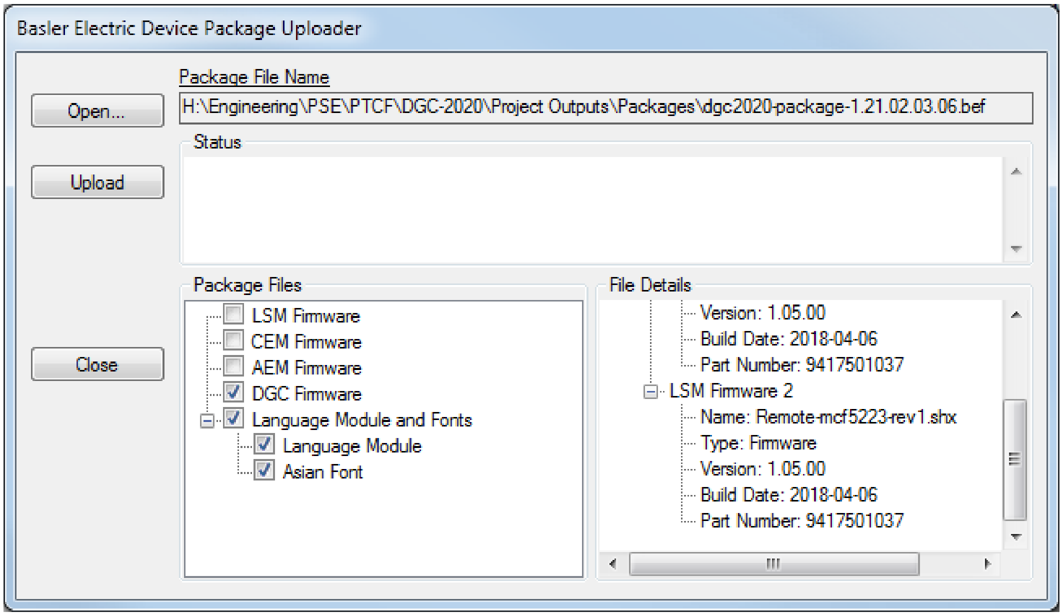


Figure 4-83. Basler Electric Device Package Uploader

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 4-84.

Figure 4-84. DGC-2020 Selection

10. The *Processing, Please Wait…* screen is displayed as file(s) are uploaded. See Figure 4-85.

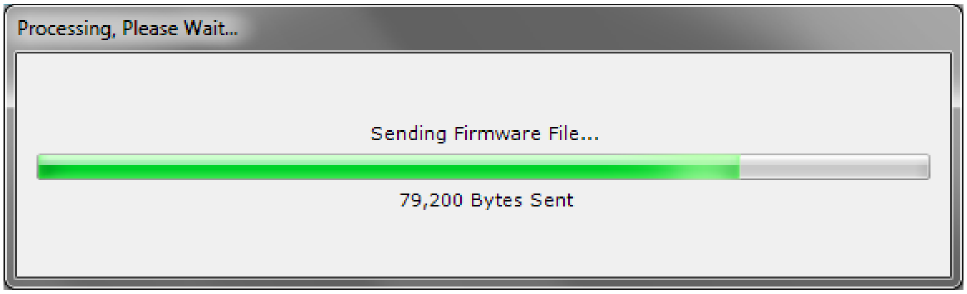


Figure 4-85. Processing, Please Wait…

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 BESTCOMS*Plus*. 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 BESTCOMS*Plus* menu.
    e. When BESTCOMS*Plus* 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 BESTCOMS*Plus*.
    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, BESTCOMS*Plus* 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 BESTCOMS*Plus* 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
- 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 4-86. Table 4-8 explains the call-outs on Figure 4-86.

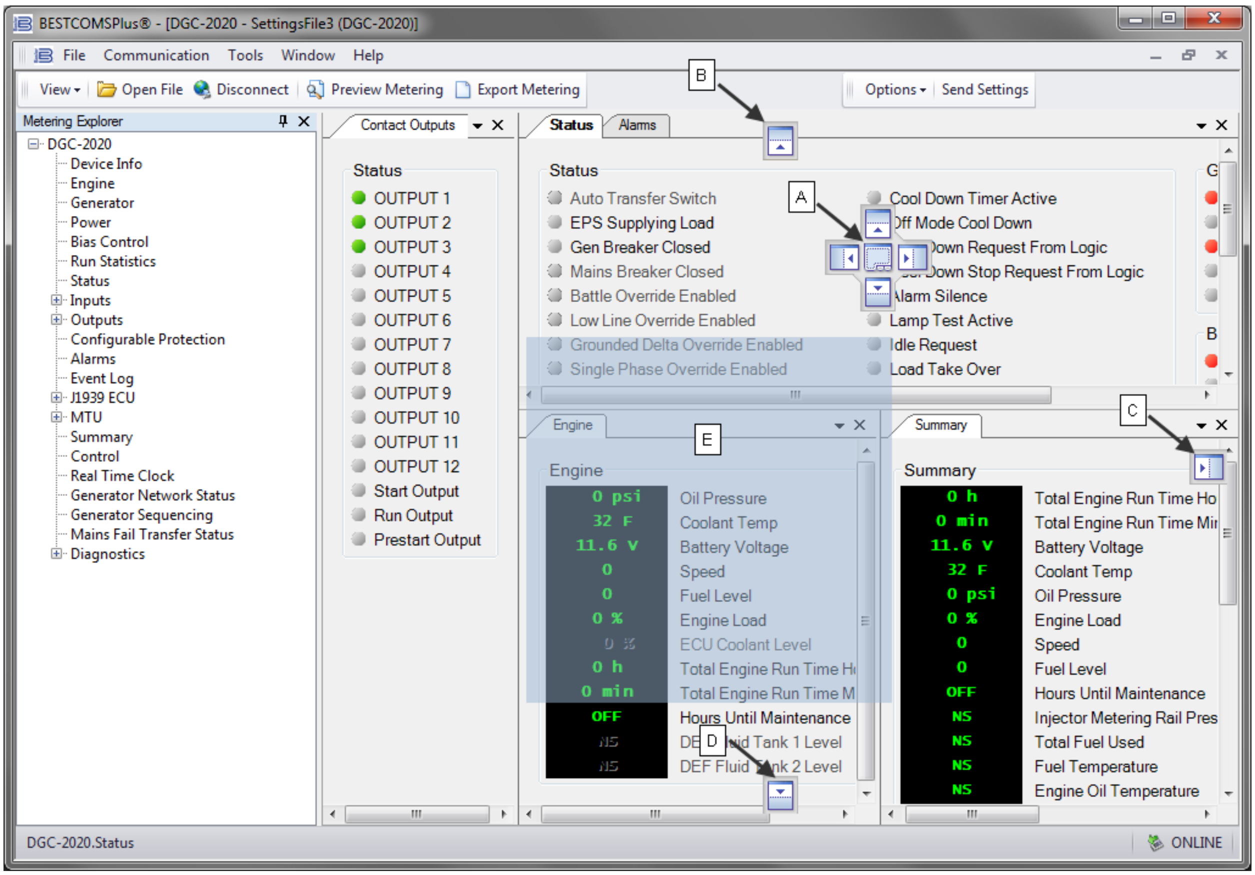
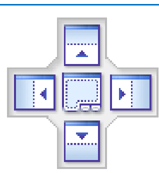
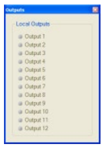


Figure 4-86. Metering, Docking Options

Table 4-8. Explanation of Call-Outs on Figure 4-86

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.

Call-Out	Symbol	Explanation
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 4-87.

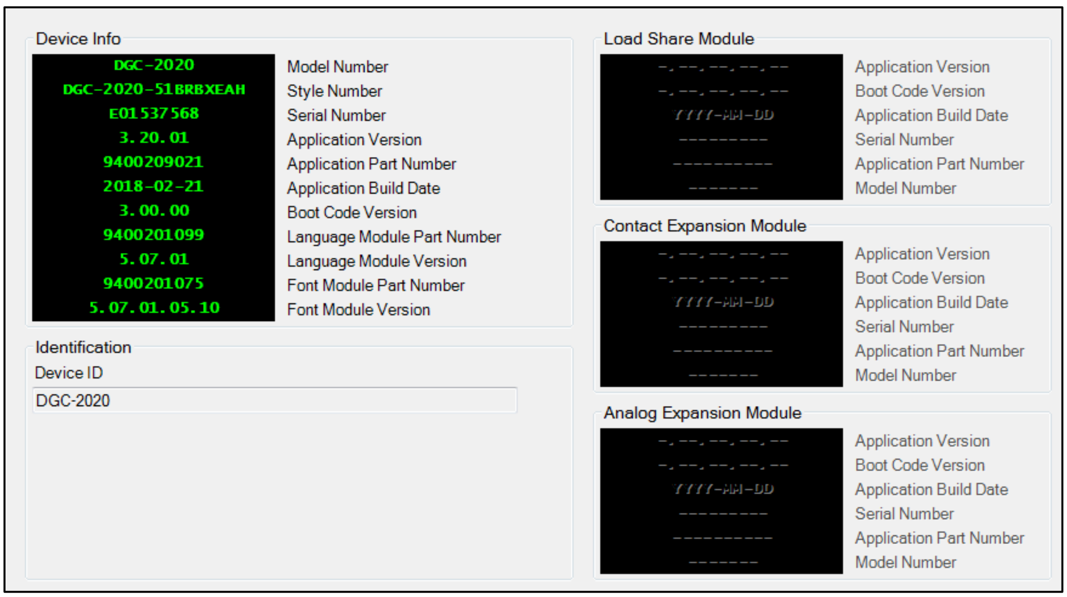


Figure 4-87. Metering, Device Info

Engine

This screen provides information and metering of engine components. Refer to Figure 4-88.

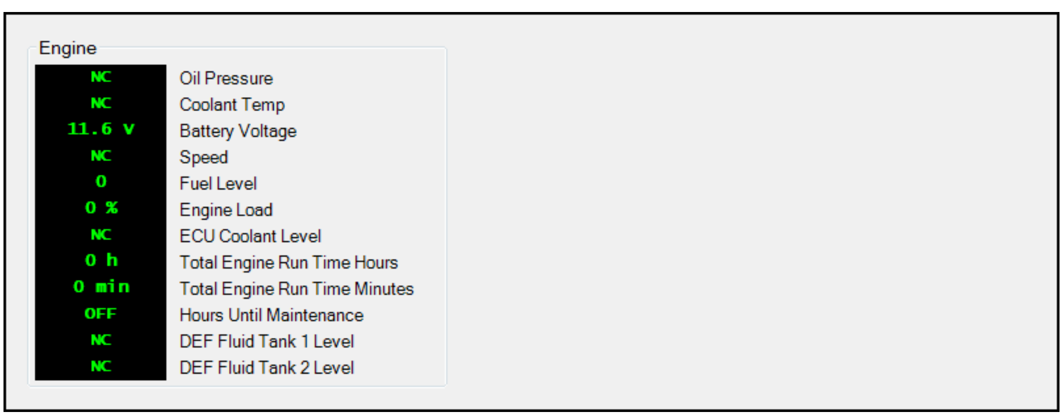


Figure 4-88. Metering, Engine

Battery Charger

This screen provides information and metering for battery chargers 1 and 2. Refer to Figure 4-89.

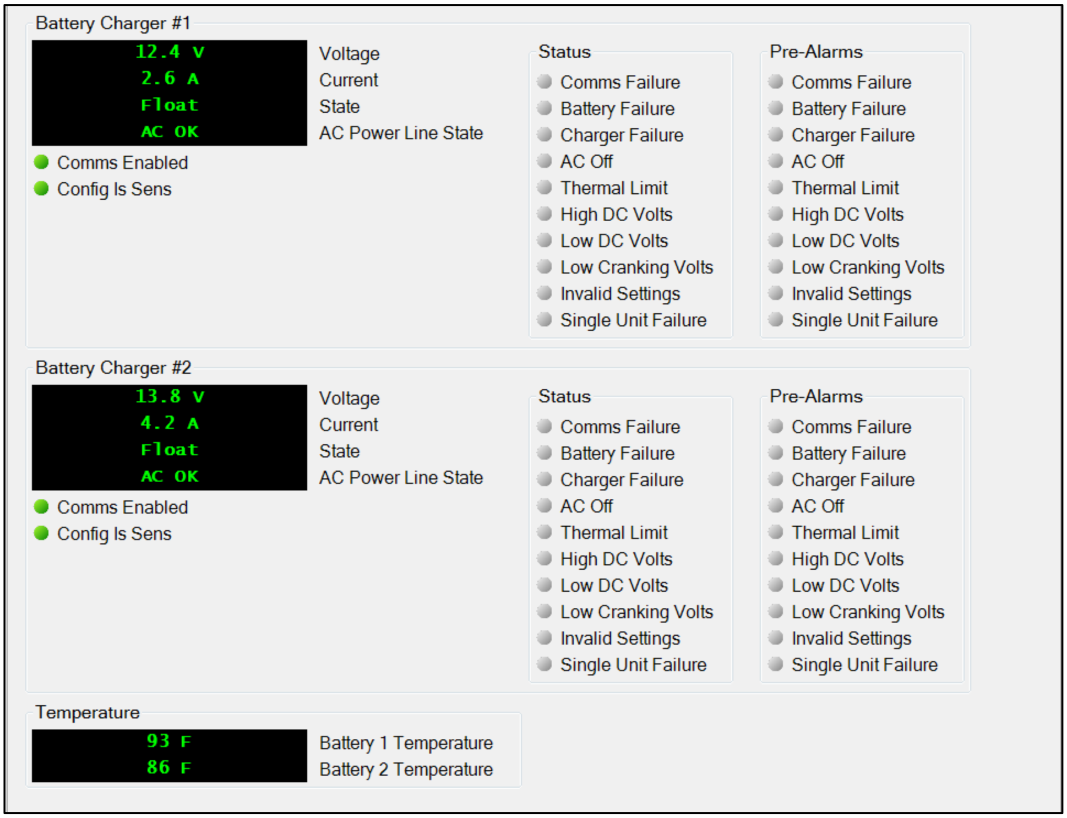


Figure 4-89. Metering, Battery Charger

Generator

This screen provides metering of generator voltages and currents. Refer to Figure 4-90.

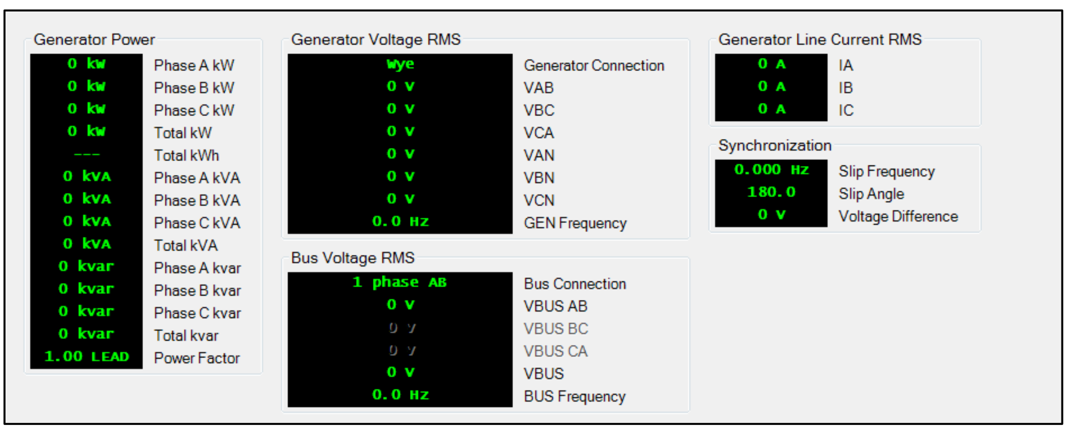


Figure 4-90. Metering, Generator

Power

This screen provides metering of generator power and power factor. Refer to Figure 4-91.

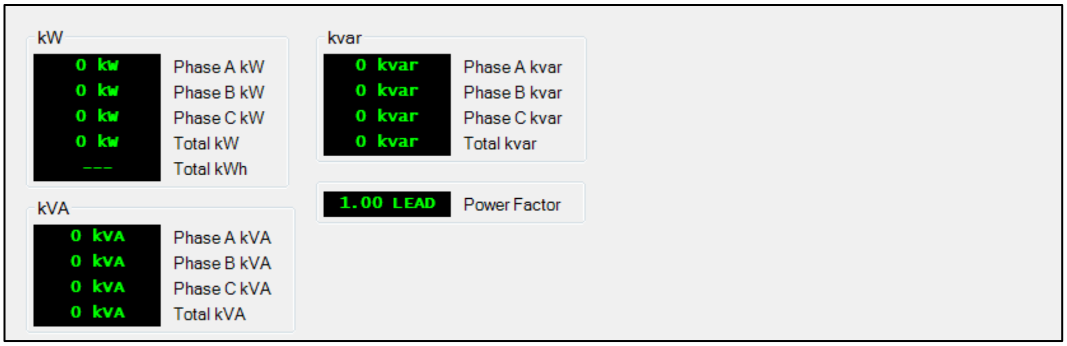


Figure 4-91. Metering, Power

Bias Control

This screen provides var/PF mode status and operating levels. Refer to Figure 4-92.

Figure 4-92. Metering, Bias Control

Run Statistics

This screen provides Cumulative Run Statistics, Session Run Statistics, and Commission Date. Refer to Figure 4-93.

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.

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 BESTCOMS*Plus* screen updates after the *Close* button is clicked.

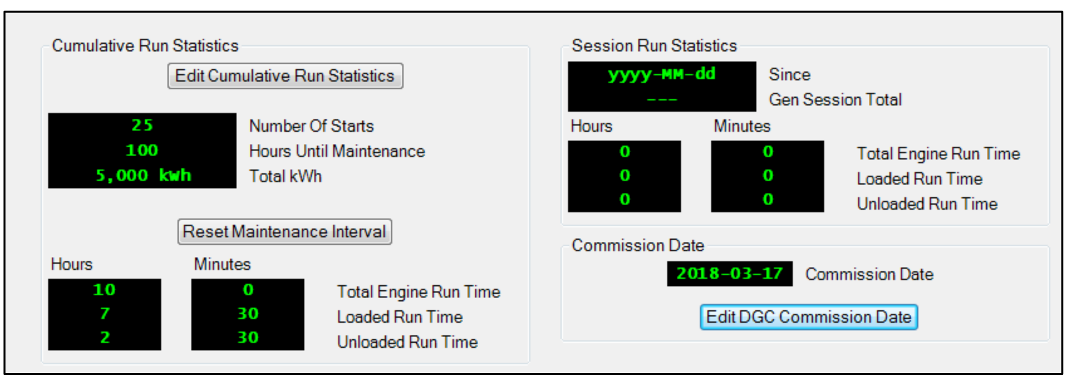


Figure 4-93. Metering, Run Statistics

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 4-94.

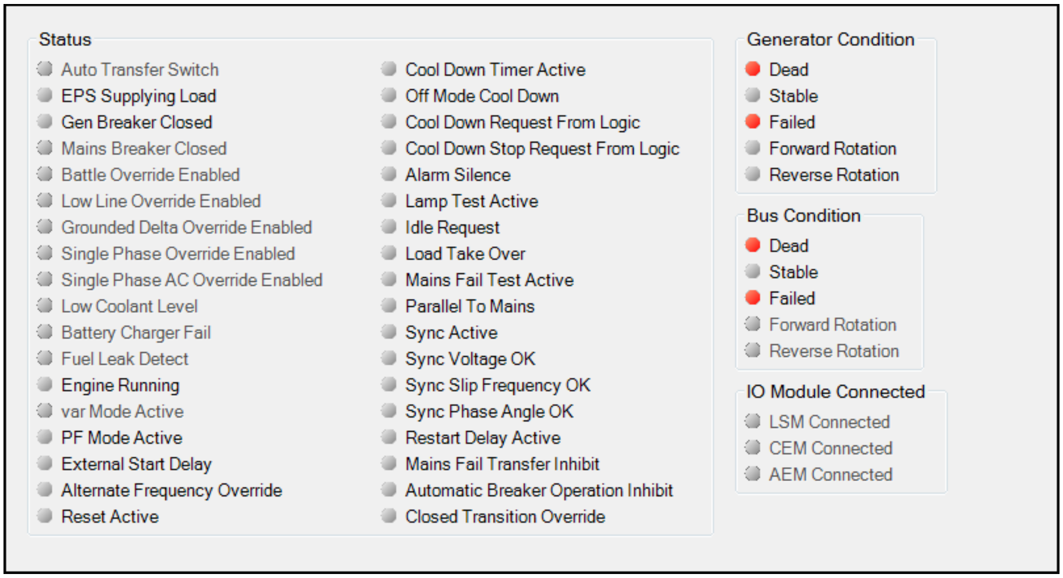


Figure 4-94. Metering, Status

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 4-95.

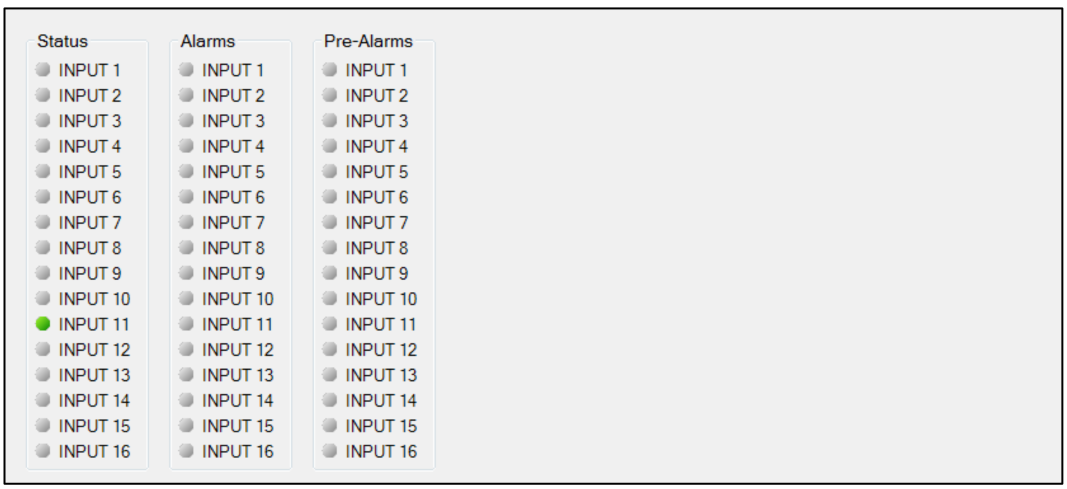


Figure 4-95. Metering, Inputs, Contact Inputs

Contact Inputs Timers

This screen displays the current time (count) of the Activation Delays for the contact inputs. Refer to Figure 4-96.

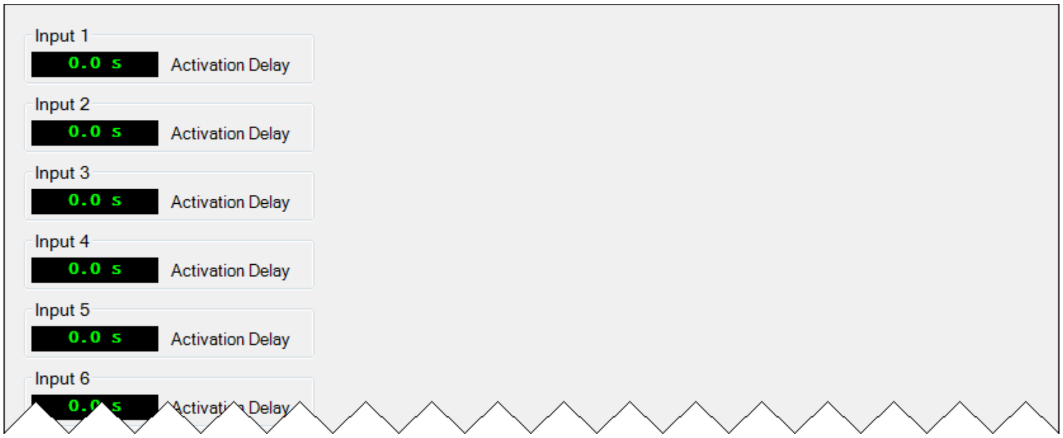


Figure 4-96. Contact Inputs Timers

Remote Contact Inputs Timers

This screen displays the current time (count) of the Activation Delays for the remote contact inputs. Refer to Figure 4-97.

Figure 4-97. 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 4-98.

Figure 4-98. 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 4-99.

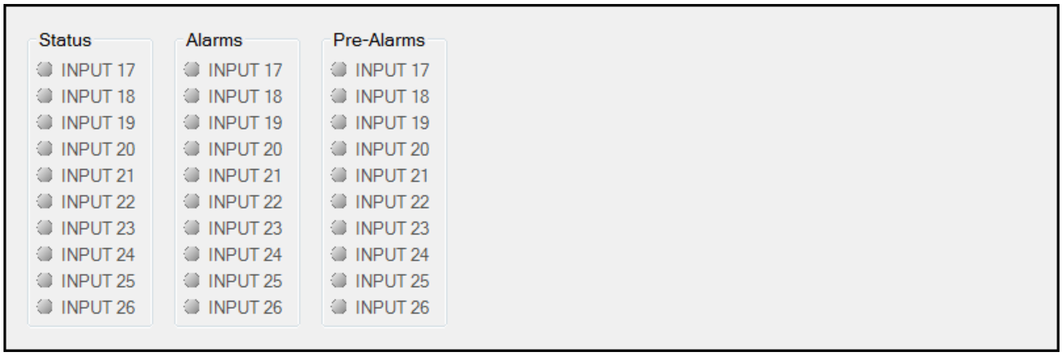


Figure 4-99. Metering, Inputs, Remote Contact Inputs

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 4-100. Remote Analog Input #1 is shown.

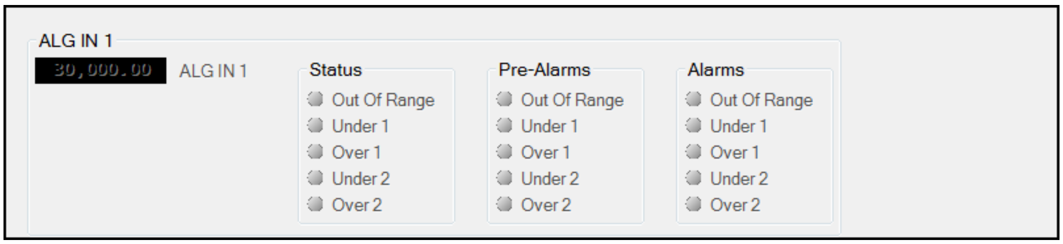


Figure 4-100. Metering, Inputs, Remote Analog Inputs

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 4-101.

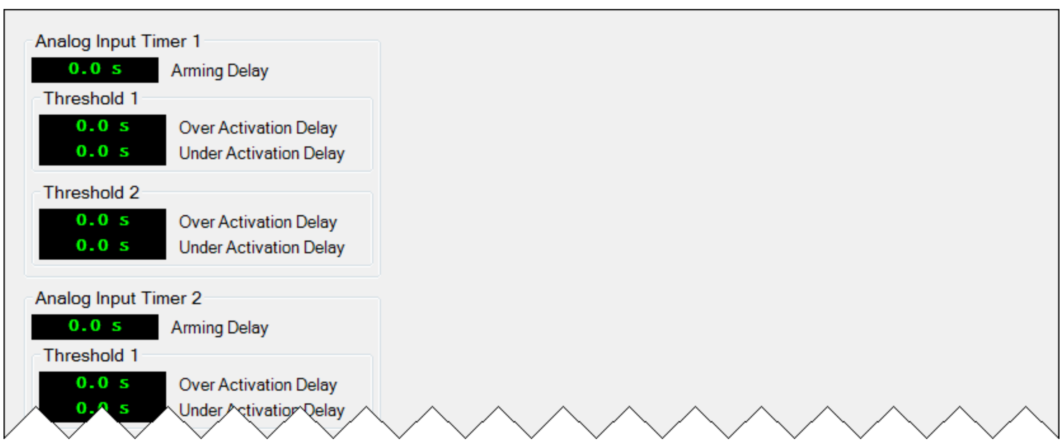


Figure 4-101. Remote Analog Inputs Timers

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 4-102. Remote RTD Input #1 is shown.

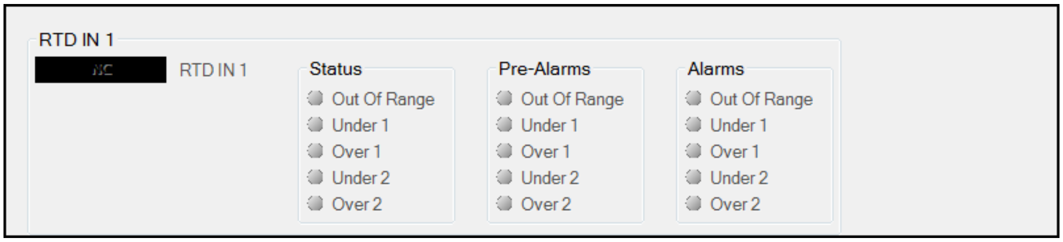


Figure 4-102. Metering, Inputs, Remote RTD Inputs

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 4-103.

Figure 4-103. 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 4-104. Remote Thermocouple Input #1 is shown.

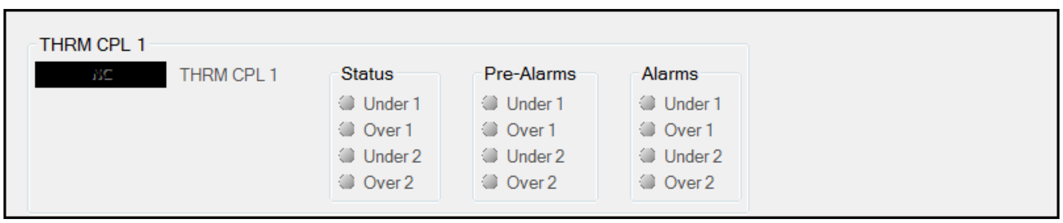


Figure 4-104. Metering, Inputs, Remote Thermocouple Inputs

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 4-105.

Figure 4-105. 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 4-106.

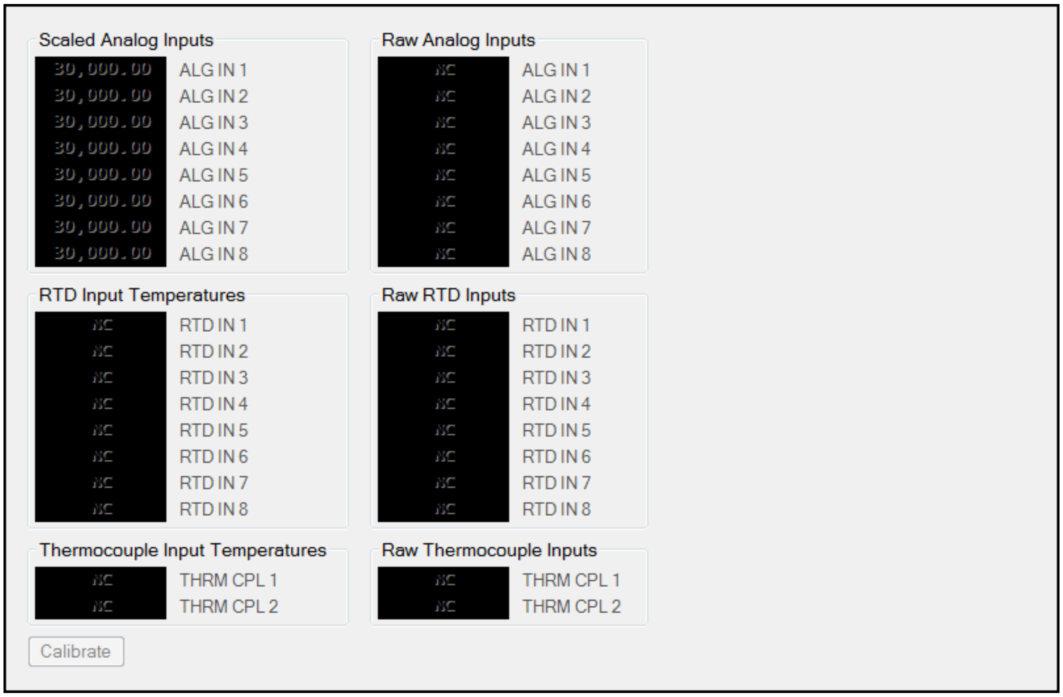


Figure 4-106. Metering, Inputs, Remote Analog Input Values

The *Calibrate* button shown on the Remote Analog Input Values screen opens the Analog Input Temperature Calibration screen shown in Figure 4-107. This screen is used to calibrate RTD inputs 1 through 8 and thermocouple inputs 1 and 2.

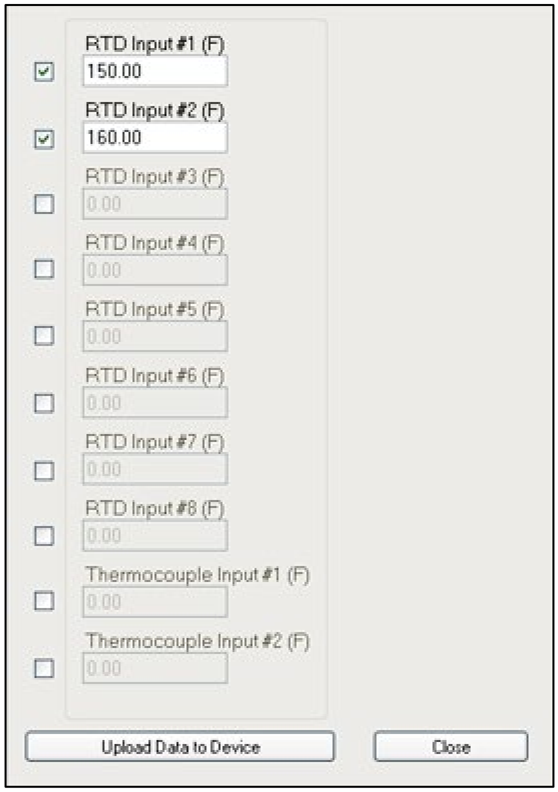


Figure 4-107. Analog Input Temperature Calibration

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 4-108.

Figure 4-108. 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 4-109.

Figure 4-109. 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 4-110.

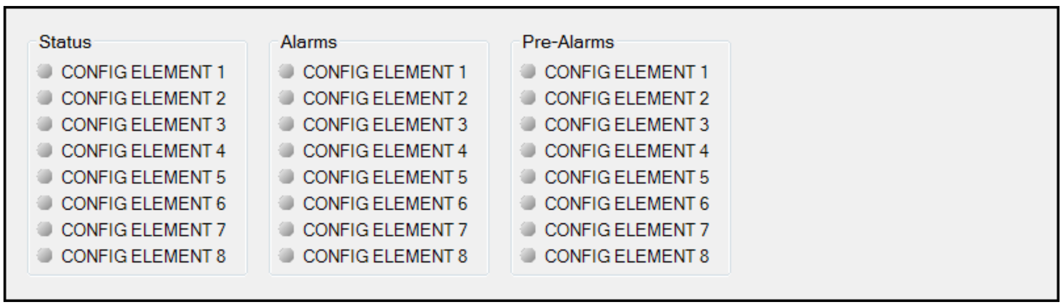


Figure 4-110. Metering, Outputs, Configurable Elements

Configurable Elements Timers

This screen (Figure 4-111) displays the current time (count) of the Activation Delay and Arming Delay for the configurable elements.

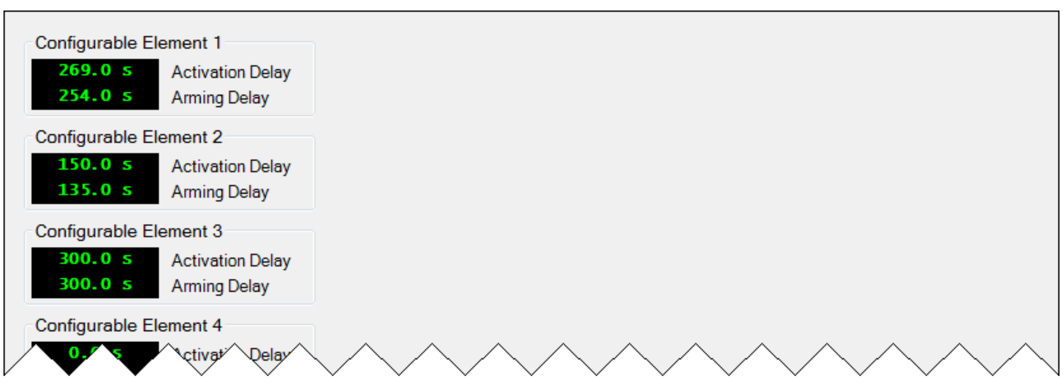


Figure 4-111. Metering Explorer, Diagnostics, Timers, Configurable Elements

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 4-112.

Figure 4-112. 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 4-113.

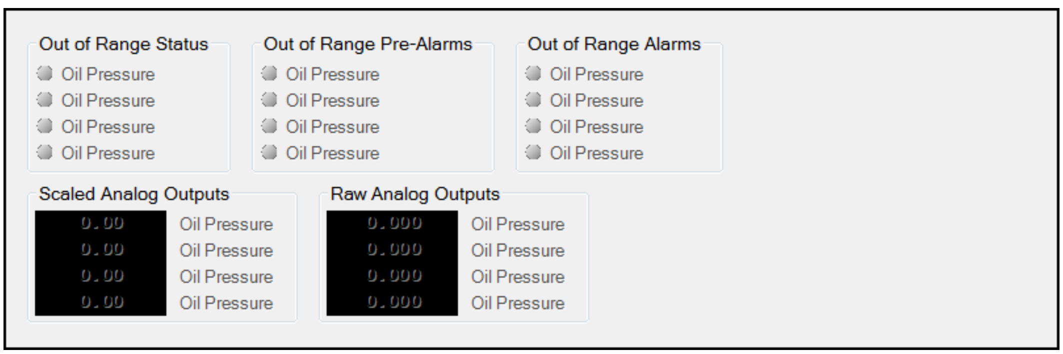


Figure 4-113. Metering, Outputs, Remote Analog Outputs

Remote Analog Outputs Timers

This screen (Figure 4-114) displays the current time (count) of the Activation Delays for the remote analog outputs timers.

Figure 4-114. 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 4-115.

Figure 4-115. Metering, Configurable Protection

Configurable Protection Timers

This screen (Figure 4-116) displays the current time (count) of the Arming Delay and Over/Under Thresholds for the configurable protection elements.

Figure 4-116. 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 4-117.

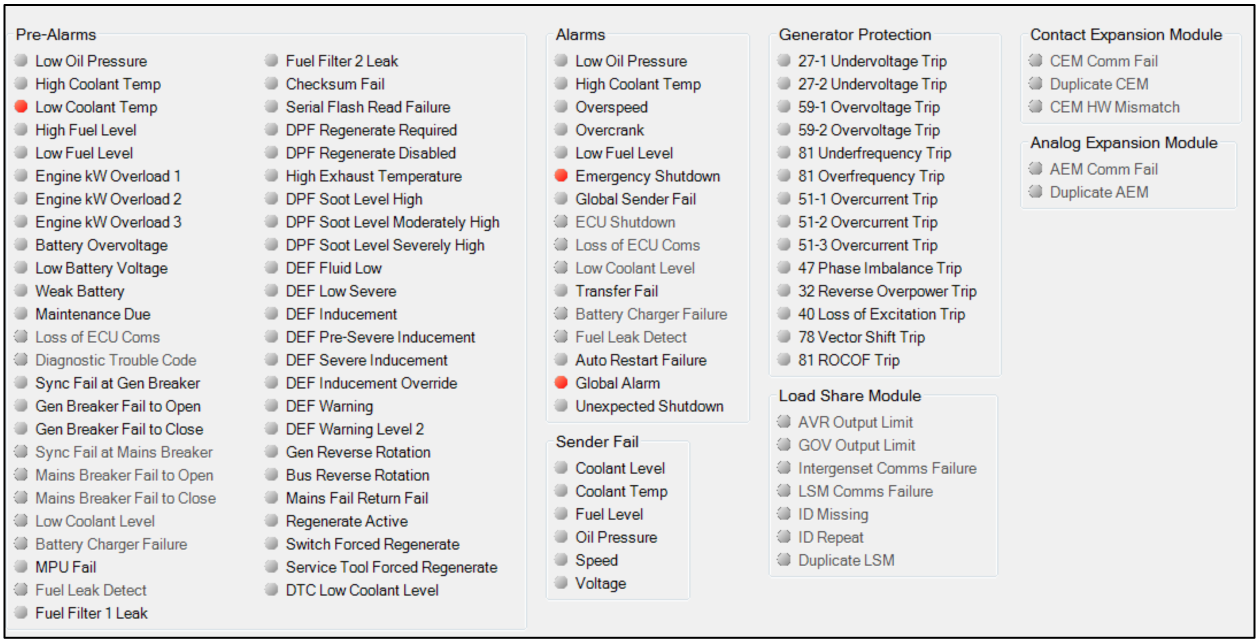


Figure 4-117. Metering, Alarms

Timers

Logic Timers

This screen (Figure 4-118) displays the current time (count) of the logic timers.

Figure 4-118. Metering Explorer, Diagnostics, Timers, Logic Timers

Generator Protection Timers

This screen (Figure 4-119) displays the current time (count) of the Activation Delays and Arming Delays for the generator protection timers.

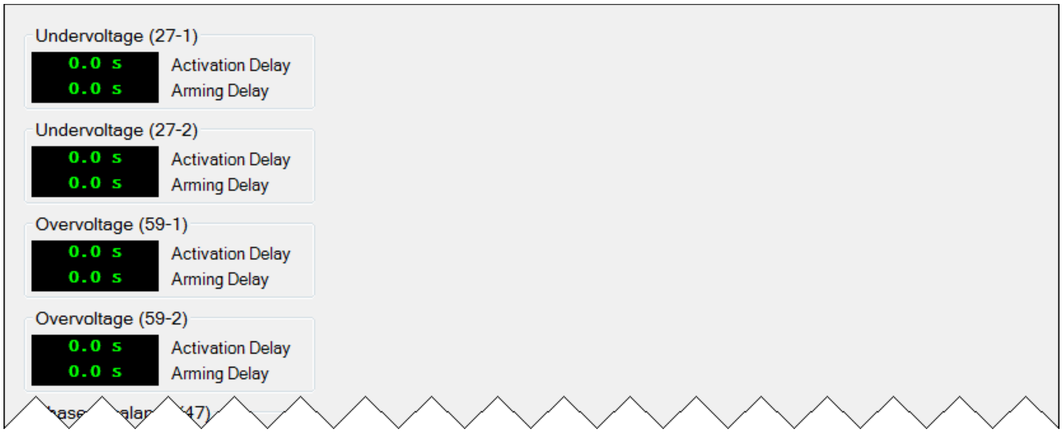


Figure 4-119. Generator Protection Timers

Pre-Alarm Timers

This screen (Figure 4-120) displays the current time (count) of the Activation Delays for the pre-alarm timers.

Figure 4-120. Pre-Alarm Timers

Alarm Timers

This screen (Figure 4-121) displays the current time (count) of the Activation Delays for the alarm timers.

Figure 4-121. Alarm Timers

Sender Fail Timers

This screen (Figure 4-122) displays the current time (count) of the Activation Delays for the sender fail timers.

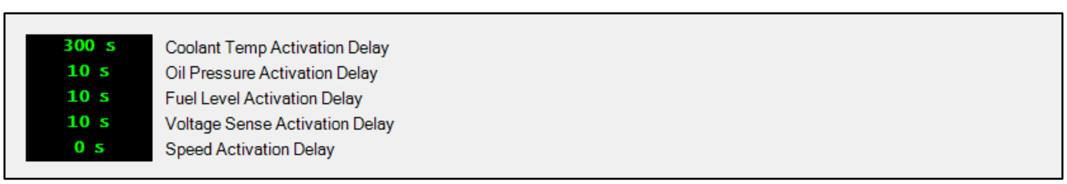


Figure 4-122. Sender Fail Timers

Cranking Timers

This screen (Figure 4-123) displays the current time (count) of the cranking timers.

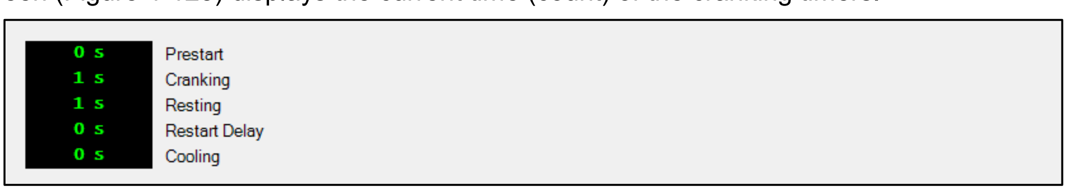


Figure 4-123. Cranking Timers

Automatic Restart Timers

This screen (Figure 4-124) displays the current time (count) of the automatic restart timers.

Figure 4-124. Automatic Restart Timers

Programmable Functions Timers

This screen (Figure 4-125) displays the current time (count) of the programmable functions timers.

Figure 4-125. Programmable Functions Timers

Synchronizer Timers

This screen (Figure 4-126) displays the current time (count) of the activation delays for the synchronizer timers.

Figure 4-126. Synchronizer Timers

Exercise Timers

This screen (Figure 4-127) displays the current time (count) of the session length, session elapsed, and time to next start for the exerciser timers.

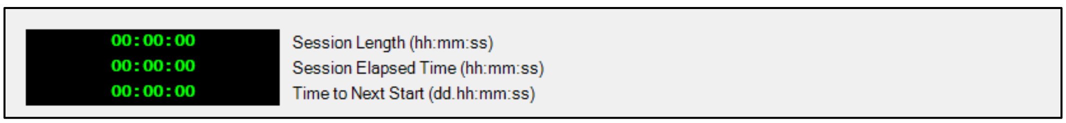


Figure 4-127. Exerciser Timers

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 is 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 BESTCOMS*Plus* 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 4-128.

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 4-128. Metering, Event Log, Sorted by Date

When viewed with BESTCOMS*Plus*, 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 4-128 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 4-129, 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 4-128.

Options | Refresh | Clear | Toggle Sorting | Sorting: Enabled

Event ID	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 4-129. Metering, Event Log, Sorted by Event ID

J1939 ECU

The ECU reports operating information to the DGC-2020 through the CAN Bus interface when the ECU is configured for Volvo Penta. 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 4-130.

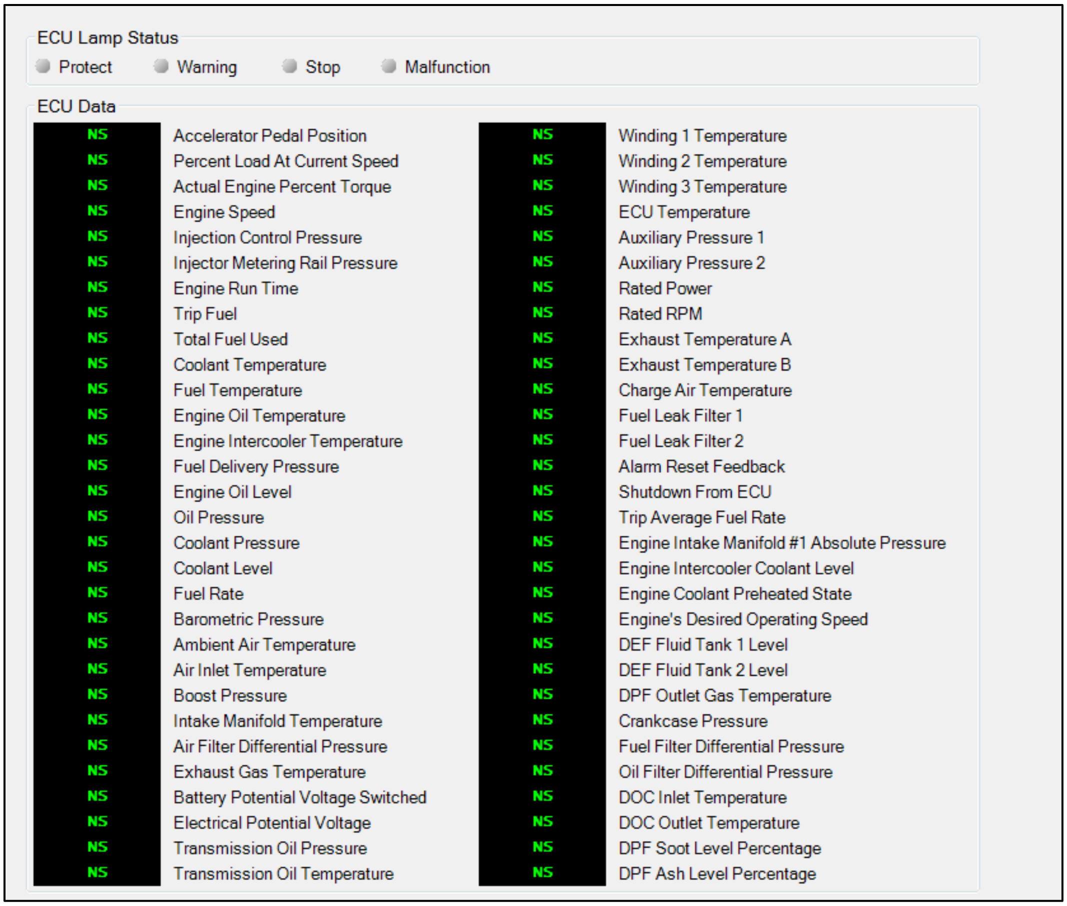


Figure 4-130. Metering, J1939 ECU, ECU Data

Engine Configuration

This screen displays Engine Configuration. Refer to Figure 4-131.

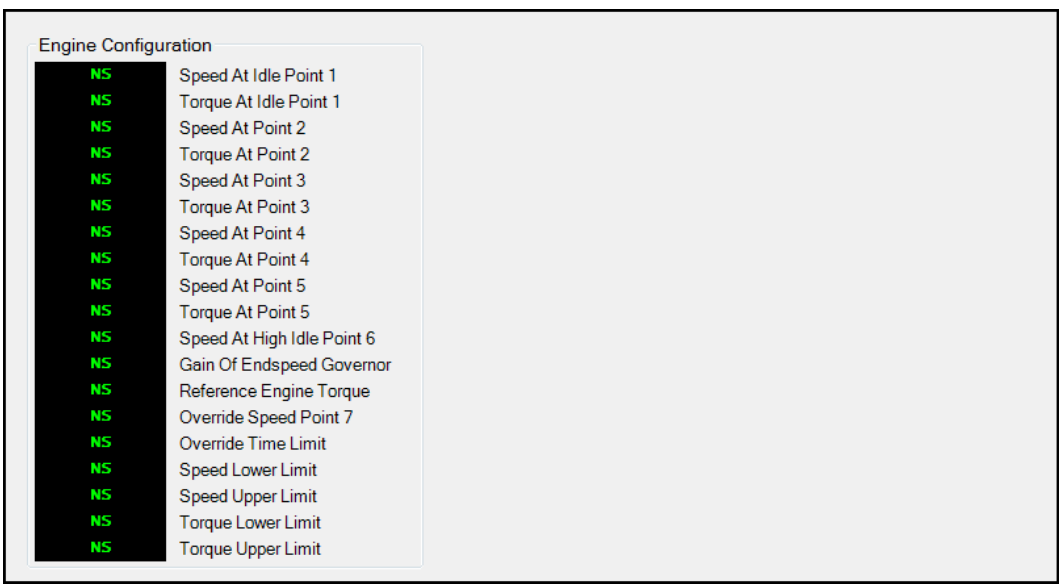
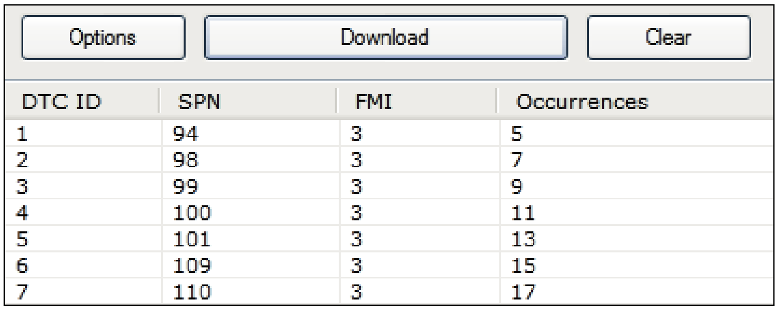


Figure 4-131. Metering, J1939 ECU, Engine Configuration

Active DTC and Previously Active DTC

This screen is used for viewing, downloading, and clearing DTC (Diagnostic Trouble Codes). Refer to Figure 4-132.



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 4-132. Metering, J1939 ECU, Download DTC

Yanmar Status

This screen (Figure 4-133) displays Yanmar ECU status.

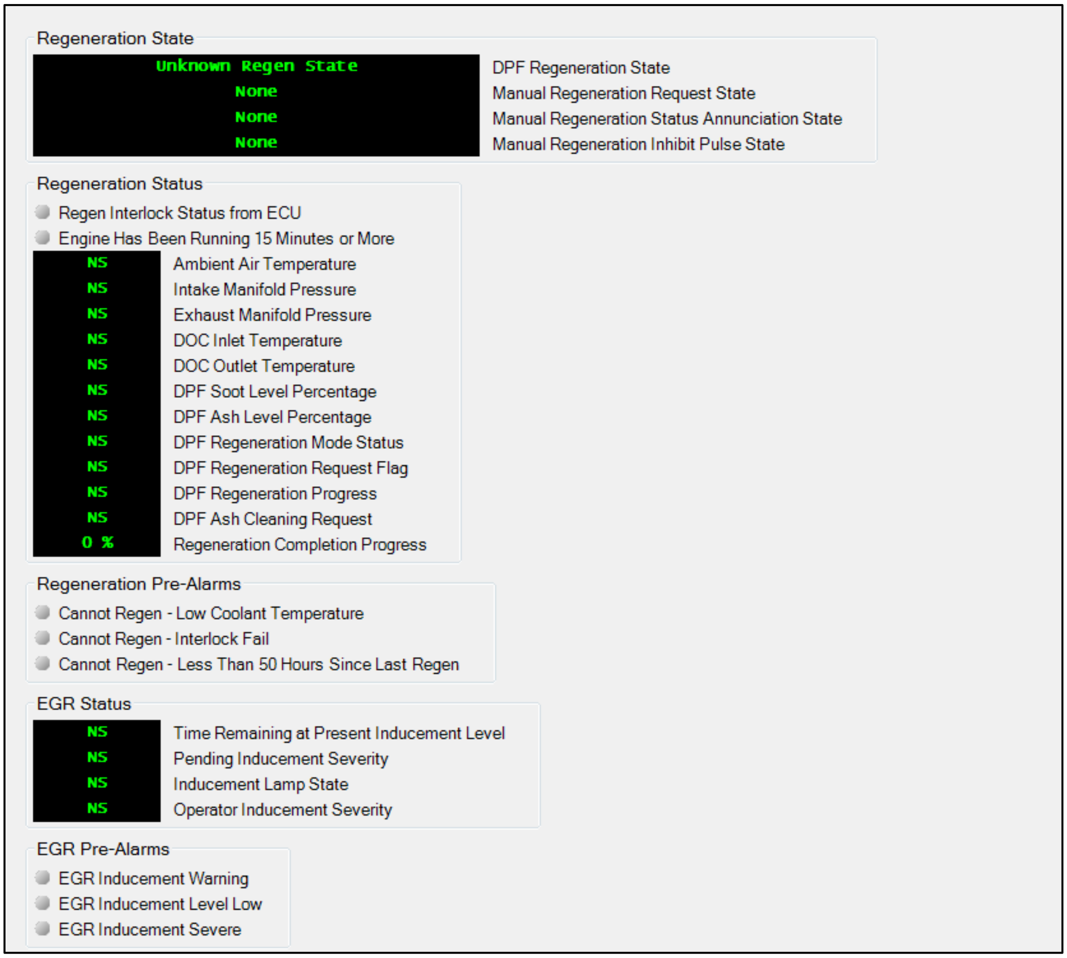


Figure 4-133. Metering J1939 ECU, Yanmar Status

Isuzu Status

This screen (Figure 4-135) displays Isuzu ECU status.

Figure 4-134. Metering J1939 ECU, Isuzu 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 4-135.

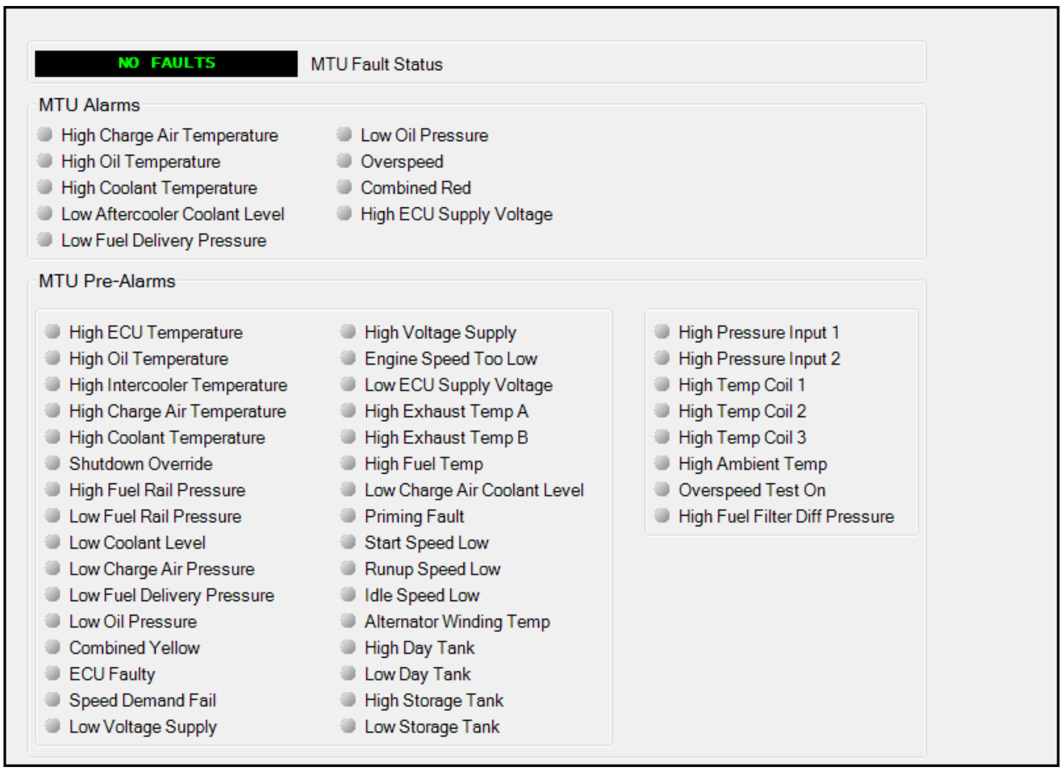


Figure 4-135. Metering, MTU, MTU Alarms

MTU Fault Codes

MTU Fault Codes can be viewed and downloaded on this screen. Refer to Figure 4-136.

Figure 4-136. 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 4-137.

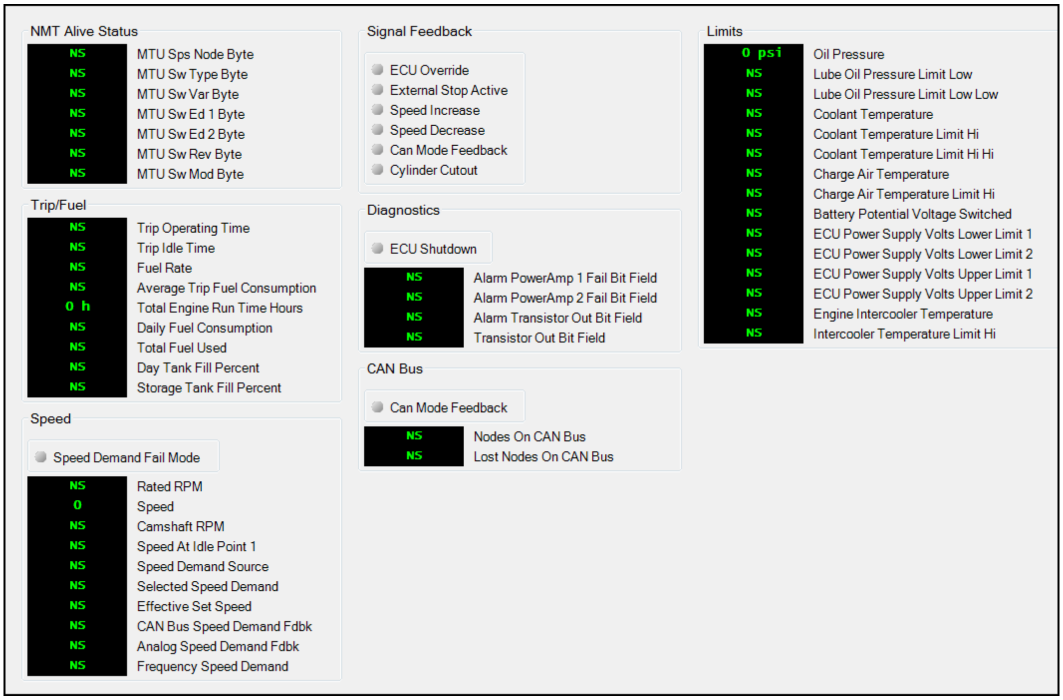


Figure 4-137. Metering, MTU, MTU Status

MTU Engine Status

MTU Engine Status is reported on this screen. The status is true when the corresponding LED is red. Refer to Figure 4-138.

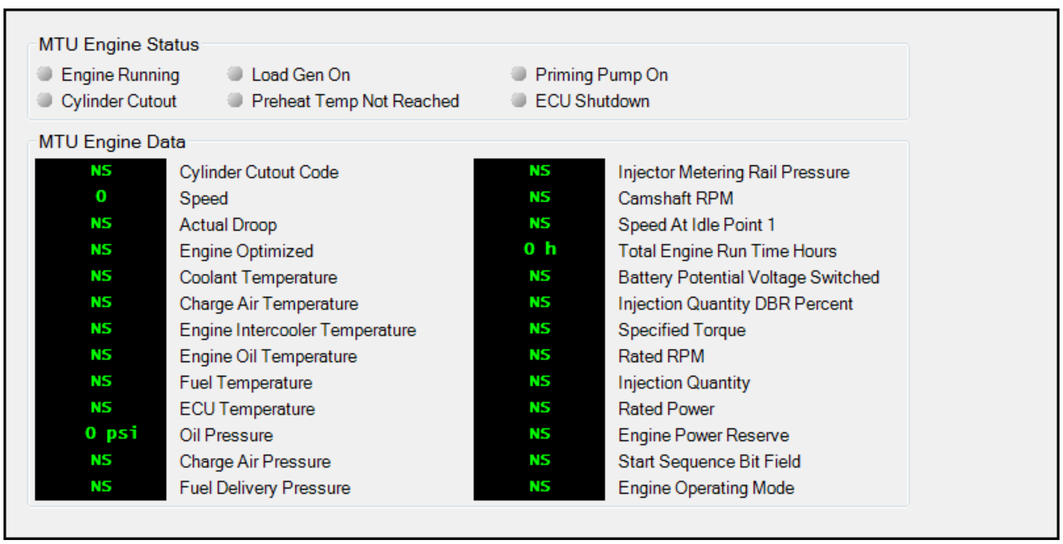


Figure 4-138. Metering, MTU, MTU Engine Status

Summary

This screen displays a metering summary. Refer to Figure 4-139.

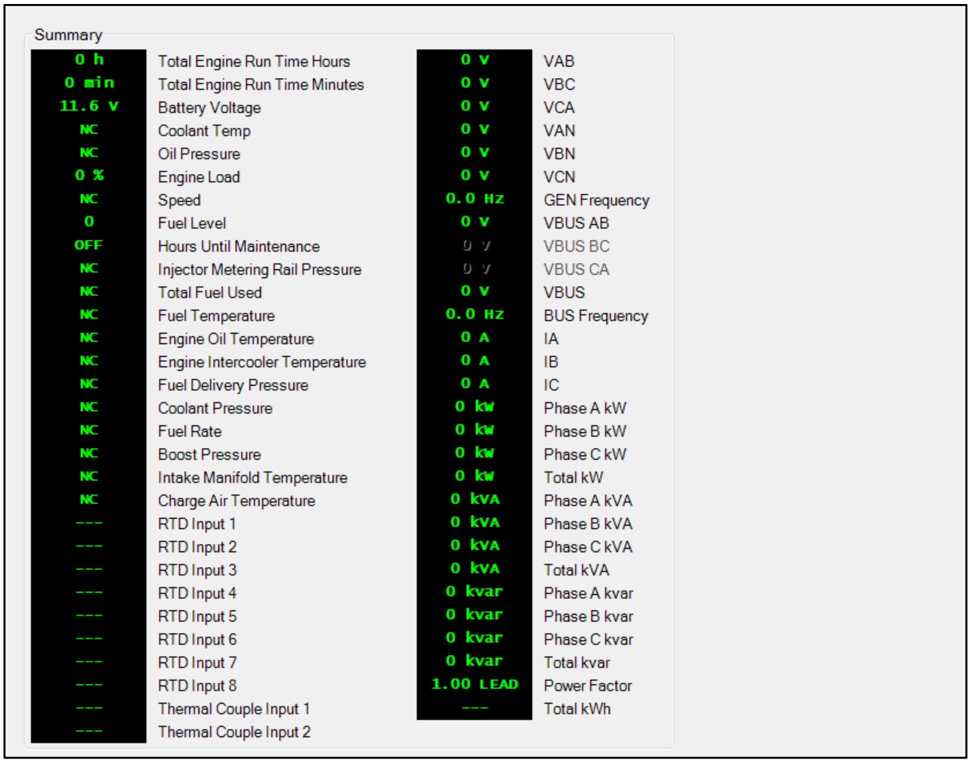


Figure 4-139. Metering, Summary

Control

Controls for stopping/starting the engine, controls for opening/closing breakers, and controls for opening/closing switches are accessed through the *Control* branch.

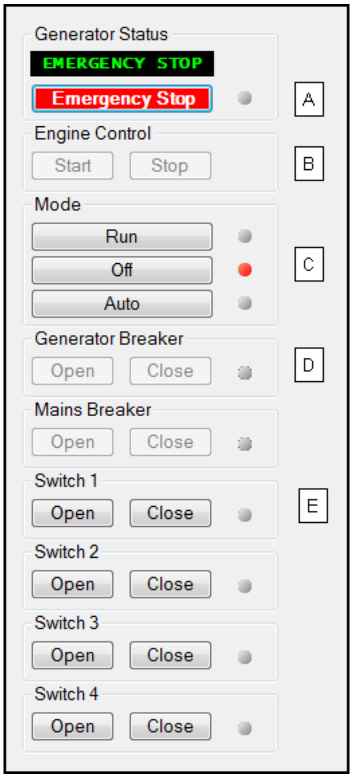


Figure 4-140. Metering, Control

The following controls are available by using the Metering Explorer in BESTCOMS*Plus* to open the *Control* branch. Refer to Figure 4-140.

A. The user has control to stop the generator in case of emergency by clicking on the *Emergency Stop* button. If the Generator Status displays Emergency Stop after the ESTOP signal is removed, the DGC-2020 must be cycled to OFF through BESTCOMS*Plus* or the front panel before it can be started again.

B. The engine can be started and stopped by clicking on the *Start* and *Stop* buttons.

C. The engine can be set to Run, Auto, or Off.

D. There are controls for opening and closing the generator breaker and mains breaker. The breaker is open when the corresponding LED is green and closed when red.

E. Switches 1 through 4 can be opened or closed by clicking on the *Open* or *Close* buttons. The switch is closed when the corresponding LED is red.

When running BESTCOMS*Plus* in *Live* mode, these buttons will interact with the DGC-2020 in real time.

Real Time Clock

Settings for Date and Time are made here. Refer to Figure 4-141.

Figure 4-141. Metering, Real Time Clock

Generator Network Status

This screen (Figure 4-142) 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.

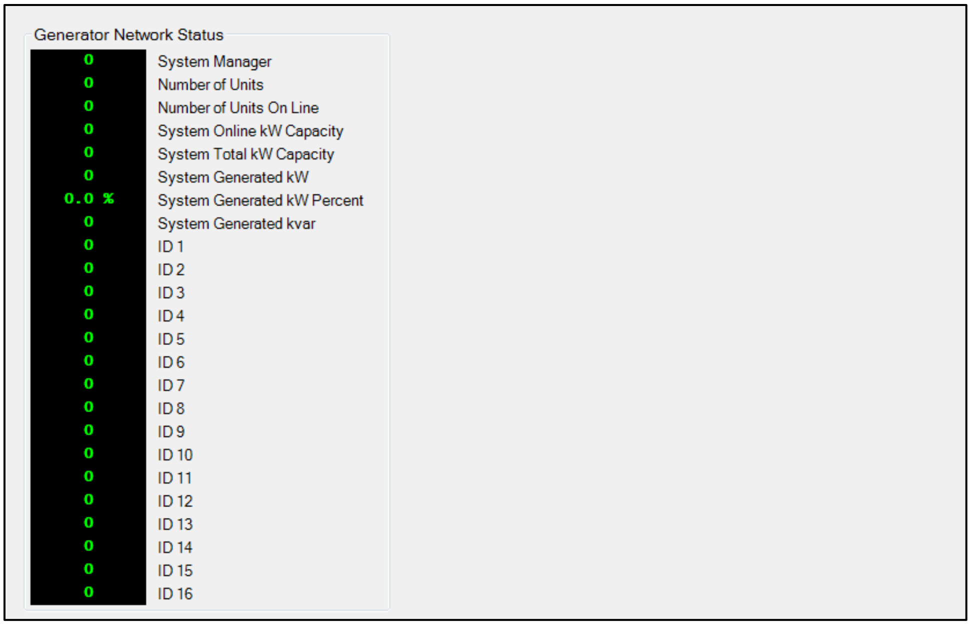


Figure 4-142. Metering, Generator Network Status

Generator Sequencing

This screen (Figure 4-143) 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 4-143. Metering, Generator Sequencing

Mains Fail Transfer Status

The Mains Fail Transfer Status screen (Figure 4-144) 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.

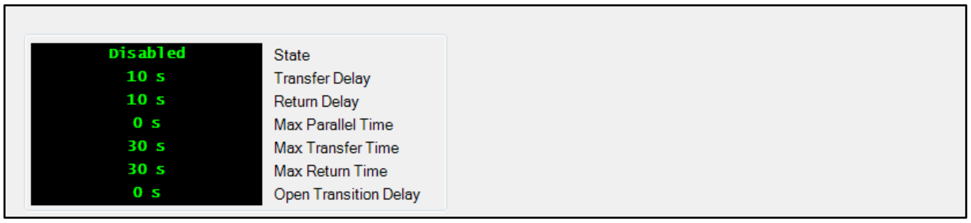


Figure 4-144. Metering, Mains Fail Transfer Status

Diagnostics

Diagnostics provide metering for kW and var control and load share parameters.

Control

Figure 4-145 illustrates the BESTCOMS*Plus Control* screen.

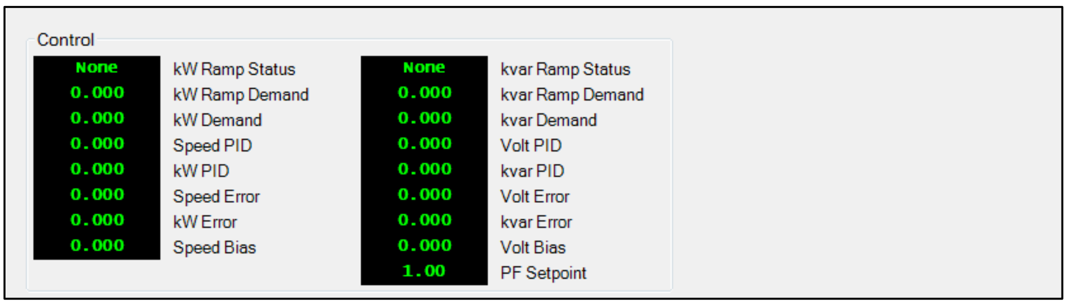


Figure 4-145. Metering Explorer, Diagnostics, Control Screen

Load Share

Figure 4-146 illustrates the BESTCOMS*Plus* Load Share screen.

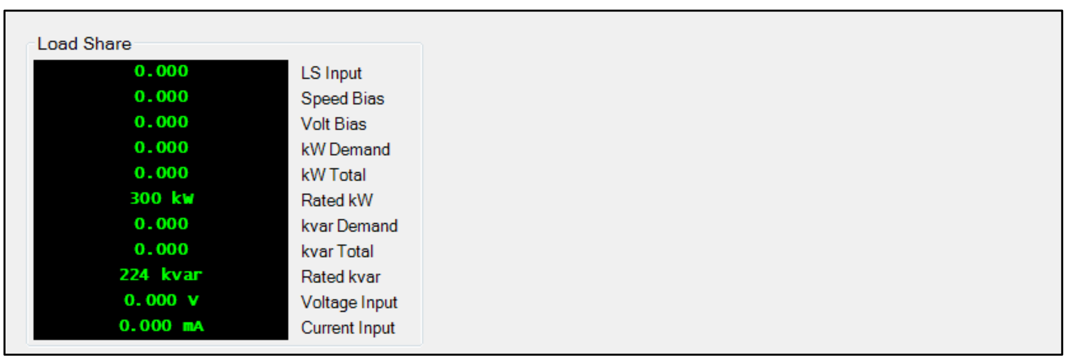


Figure 4-146. Metering Explorer, Diagnostics, Load Share Screen

Sender Inputs

Figure 4-147 illustrates the BESTCOMSPlus Sender Inputs Screen.

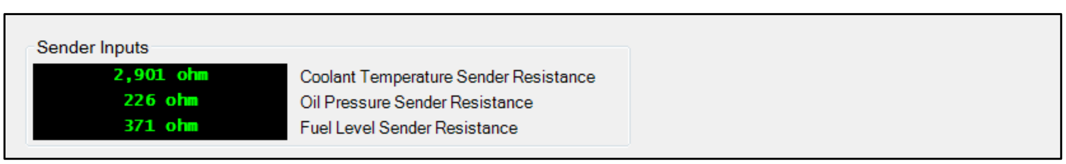


Figure 4-147. Metering Explorer, Diagnostics, Sender Inputs

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 BESTCOMS*Plus*. When a DGC-2020 is updated with the latest version of firmware, the latest version of BESTCOMS*Plus* should also be obtained.

- If you obtained a CD-ROM containing a firmware update from Basler Electric, then that CD-ROM will also contain the corresponding version of BESTCOMS*Plus* software.
- You can check for BESTCOMS*Plus* updates by visiting www.basler.com.
- You can use the manual "check for updates" function in BESTCOMS*Plus* 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 4-148 illustrates the *Auto Export Metering* screen.

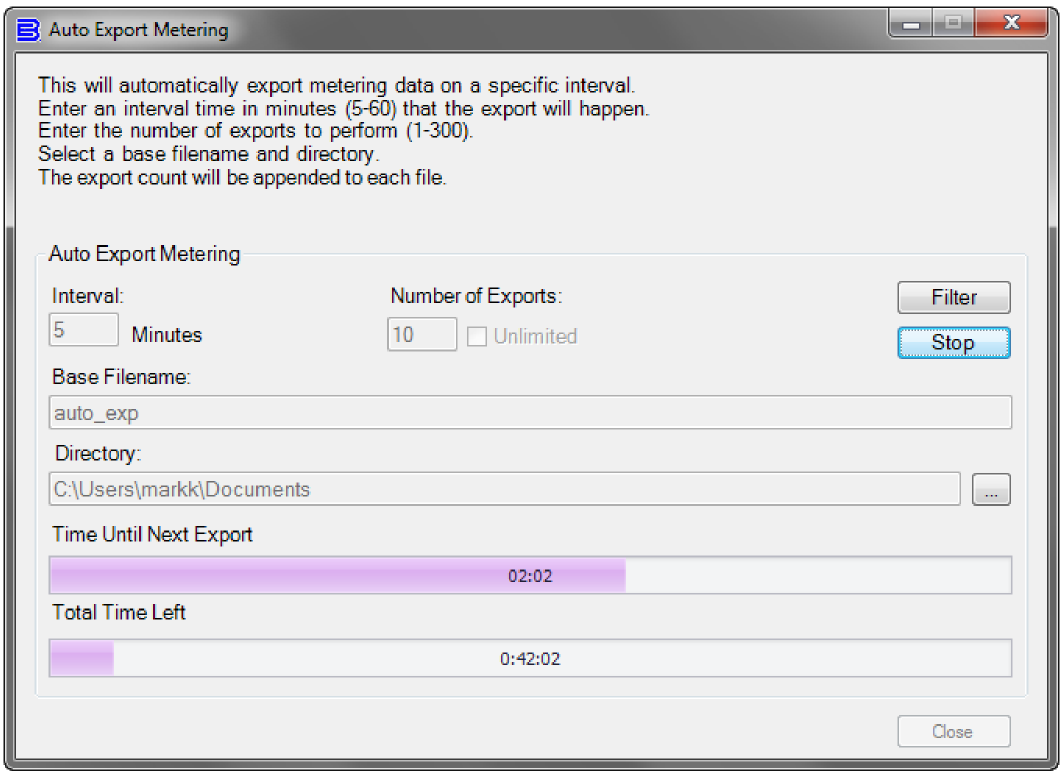


Figure 4-148. Auto Export Metering

SECTION 5 • BESTlogic™*Plus* PROGRAMMABLE LOGIC

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SECTION 5 • BESTlogic™*Plus* PROGRAMMABLE LOGIC

Introduction

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. BESTCOMS*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, *BESTCOMSPlus® 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 BESTCOMSPlus 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.

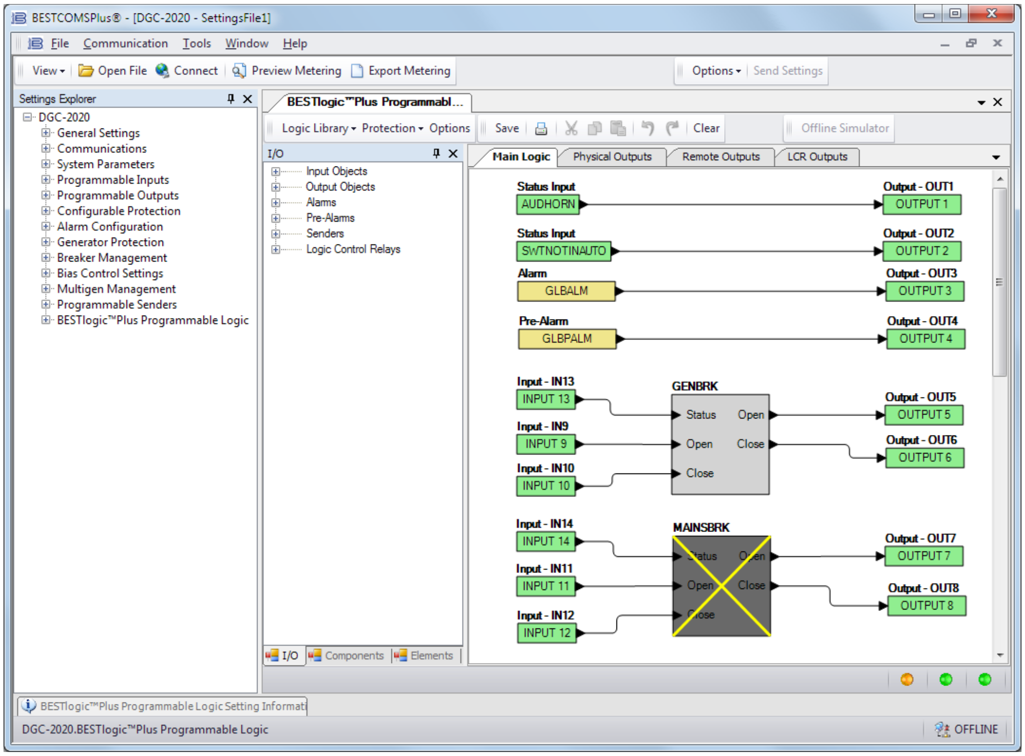


Figure 5-1. BESTlogicPlus Programmable Logic Tree Branch

BESTlogic™Plus Composition

There are three main groups of objects used for programming BESTlogic*Plus*. These groups are *I/O, Components,* and *Elements*. For details on how these objects are used to program BESTlogic*Plus*, 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
Input Objects		
Logic 0	Always false (Low).	Fixed 0
Logic 1	Always true (High).	Fixed 1
Physical Inputs IN1 - IN16	True when Physical Input x is active.	Input - IN1 INPUT 1
Remote Inputs IN17 - IN26	True when Remote Input x is active. (Available when an optional CEM-2020 is connected.)	Input - IN17 INPUT 17
Virtual Inputs VIN1 - VIN4	True when Virtual Input x is active.	Input - VIN1 VIN1
Status Input Active DTC's Present	True when Diagnostic Trouble Codes are present.	Status Input ACTIVEDTCSPRESENT
Status Input Alarm Silence	True when the Alarm Silence logic element is true or the Alarm Silence button is pressed on the front panel.	Status Input ALARMSILENCEIN

Name	Description	Symbol
Status Input Alternate Frequency Override	True when the Alternate Frequency Override logic element is true.	Status Input ALTFREQOVERIN
Status Input Analog Expansion Module	Analog Expansion Module Connected. True when an optional AEM-2020 is connected to the DGC-2020.	Status Input AEMCONNECTED
Analog Expansion Module 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 - RALGIN1O1 ALG IN 1
Analog Expansion Module 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 - RALGOUT1OOR Oil Pressure
Analog Expansion Module 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 - RRTDIN1O1 RTD IN 1
Analog Expansion Module 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 - RTCIN1O1 THRM CPL 1
Status Input ATS Input	True when the ATS (Auto Transfer Switch) input is true or the ATS logic element is true.	Status Input ATSINSTATUS
Status Input Audible Horn	True when the Audible Horn is active.	Status Input AUDHORN
Status Input Auto Mode	True when the DGC-2020 is in Auto Mode or the Auto Mode logic element is true.	Status Input AUTOMODE
Status Input Auto Restart	True when the Automatic Restart function is active.	Status Input AUTORESTART
Status Input Battery Charger AC Off	True when the ac power to the battery charger is off. (Battery Charger 1 shown.)	Status Input BCH1ACOFFSTATUS
Status Input Battery Charger Battery Failure	True when the battery charger has detected that the battery has failed. (Battery Charger 1 shown.)	Status Input BCH1BATTERYFAILURESTATUS
Status Input Battery Charger Comms Fail	True when the battery charger has detected a J1939 communications failure. (Battery Charger 1 shown.)	Status Input BCH1COMMSFAILSTATUS
Status Input Battery Charger Fail	True when the battery charger has failed. (Battery Charger 1 shown.)	Status Input BCH1CHARGERFAILSTATUS
Status Input Battery Charger High Output Volts	True when the battery charger output voltage is too high. (Battery Charger 1 shown.)	Status Input BCH1HIOUTPUTVOLTSSTATUS
Status Input Battery Charger Invalid Settings	True when the battery charger has detected settings that are not valid. (Battery Charger 1 shown.)	Status Input BCH1INVALIDSETTINGSSTATUS

Name	Description	Symbol
Status Input Battery Charger 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 BCH1LOCRANKINGVOLTSSTATUS
Status Input Battery Charger Low Output Volts	True when the battery charger output voltage is too low. (Battery Charger 1 shown.)	Status Input BCH1LOOUTPUTVOLTSSTATUS
Status Input Battery Charger 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 BCH1SINGLEUNITFAILSTATUS
Status Input Battery Charger Thermal Limit	True when the battery charger temperature is beyond the thermal limit. (Battery Charger 1 shown.)	Status Input BCH1THERMALLIMITSTATUS
Status Input Battery Charger Fail	True when the Battery Charger Fail input is true.	Status Input BATTCHRGFAIL
Status Input Battle Override	True when the Battle Override input is true.	Status Input BATTLORIDE
Status Input Bus Dead	True when the Bus Dead condition settings have been exceeded.	Status Input BUSDEAD
Status Input Bus Fail	True when the Bus Fail condition settings have been exceeded.	Status Input BUSFAIL
Status Input Bus Forward Rotation Status	True when the sensed bus phase rotation matches the bus phase rotation specified in the system settings.	Status Input BUSFORWARDROTATIONSTATUS
Status Input Bus Reverse Rotation Status	True when the sensed bus phase rotation differs from the bus phase rotation specified in the system settings.	Status Input BUSREVERSEROTATIONSTATUS
Status Input Bus Stable	True when the Bus Stable condition settings have been exceeded.	Status Input BUSSTABLE
Status Input *CAN Bus Bus Off*	True when the CAN Bus bus is off.	Status Input CANBUSBUSOFF
Status Input *CAN Bus Error Passive*	True when a passive error is annunciated by the CAN Bus.	Status Input CANBUSERRORPASSIVE
Status Input Configurable Elements 1-8	True when the Configurable Element x logic element is true.	Status Input CONFIGELEMENT1
Status Input Configurable Protection 1-8	True when the Configurable Protection x Over Threshold #1 is true. (Over 1 shown.)	Status Input - CONFPROT1O1 CONF PROT 1
Status Input Contact Expansion Module	Contact Expansion Module Connected. True when an optional CEM-2020 is connected to the DGC-2020.	Status Input CEMCONNECTED

Name	Description	Symbol
Status Input Cool Down Timer Active	True when the Cool Down Timer is timing out. The Cool Down Timer is true under two circumstances: 1. The unit is in auto and ATS is removed, causing the DGC-2020 to go into a cooldown state. 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.	Status Input CDOWNTMRACT
Status Input 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 DPFLAMPCOMMAND
Status Input 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 DPFMANUALREGENREQ
Status Input 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 DPFREGENINHIBITREQ
Status Input 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.	Status Input ECUAMBERLAMP
Status Input 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.	Status Input ECUREDLAMP
Status Input Emergency Stop	True when the Emergency Stop button has been pressed.	Status Input EMERGSTOP
Status Input Engine Running	True while the Engine is Running.	Status Input ENGRUNNING
Status Input Engine Running 15 Minutes	True when the engine is presently running and has been running 15 minutes or more since the most recent start.	Status Input ENGRUNNING15MINS
Status Input EPS Supplying Load	True while the EPS is supplying load.	Status Input EPSSUPLOAD
Status Input Front Panel Buttons	True while the *AUTO* front panel button is pressed.	Status Input AUTOBUTTON
Status Input Front Panel Buttons	True while the *DOWN* front panel button is pressed.	Status Input DOWNBUTTON

Name	Description	Symbol
Status Input Front Panel Buttons	True while the *EDIT* front panel button is pressed.	Status Input EDITBUTTON
Status Input Front Panel Buttons	True while the *LAMP TEST* front panel button is pressed.	Status Input LAMPBUTTON
Status Input Front Panel Buttons	True while the *LEFT* front panel button is pressed.	Status Input LEFTBUTTON
Status Input Front Panel Buttons	True while the *OFF* front panel button is pressed.	Status Input OFFBUTTON
Status Input Front Panel Buttons	True while the *RESET* front panel button is pressed.	Status Input RESETBUTTON
Status Input Front Panel Buttons	True while the *RIGHT* front panel button is pressed.	Status Input RIGHTBUTTON
Status Input Front Panel Buttons	True while the *RUN* front panel button is pressed.	Status Input RUNBUTTON
Status Input Front Panel Buttons	True while the *ALARM SILENCE* front panel button is pressed.	Status Input SILENCEBUTTON
Status Input Front Panel Buttons	True while the *UP* front panel button is pressed.	Status Input UPBUTTON
Status Input Fuel Leak	True when the Fuel Leak Detect input is true.	Status Input FUELLEAK
Status Input Generator Breaker Status	True when the generator breaker is closed.	Status Input GENBRKSTA
Status Input Generator Dead	True when the Gen Dead condition settings have been exceeded.	Status Input GENDEAD
Status Input Generator Fail	True when the Gen Fail condition settings have been exceeded.	Status Input GENFAIL
Status Input Gen Forward Rotation Status	True when the sensed generator phase rotation matches the generator phase rotation specified in the system settings.	Status Input GENFORWARDROTATIONSTATUS
Status Input Gen Reverse Rotation Status	True when the sensed generator phase rotation differs from the generator phase rotation specified in the system settings.	Status Input GENREVERSEROTATIONSTATUS
Status Input Generator Protection	True when the 27-1 element is tripped.	Status Input 27-1TRIP
Status Input Generator Protection	True when the 27-2 element is tripped.	Status Input 27-2TRIP

Name	Description	Symbol
Status Input Generator Protection	True when the 59-1 element is tripped.	Status Input 59-1TRIP
Status Input Generator Protection	True when the 59-2 element is tripped.	Status Input 59-2TRIP
Status Input Generator Protection	True when the 32 element is tripped.	Status Input 32RTRIP
Status Input Generator Protection	True when the 40 element is tripped.	Status Input 40TRIP
Status Input Generator Protection	True when the 47 element is tripped.	Status Input 47TRIP
Status Input Generator Protection	True when the 51-1 element is tripped.	Status Input 51-1TRIP
Status Input Generator Protection	True when the 51-2 element is tripped.	Status Input 51-2TRIP
Status Input Generator Protection	True when the 51-3 element is tripped.	Status Input 51-3TRIP
Status Input Generator Protection	True when the 78 element is tripped.	Status Input 78TRIP
Status Input Generator Protection	True when the 81 ROCOF element is tripped.	Status Input 81ROCOFTRIP
Status Input Generator Protection	True when the 81 Over element is tripped.	Status Input 81OTRIP
Status Input Generator Protection	True when the 81 Under element is tripped.	Status Input 81UTRIP
Status Input Generator Stable	True when the Gen Stable condition settings have been exceeded.	Status Input GENSTABLE
Status Input Generator Test Loaded	True when the Exercise Timer has started the generator and run with load is selected.	Status Input GENTESTLOADED
Status Input Generator Test	True when the Exercise Timer has started the generator.	Status Input GENTEST
Status Input Global Low Coolant Level	True when the Low Coolant Level input is true.	Status Input GLBLOWCOOLLVL
Status Input Ground Delta Override	True when the Grounded Delta Override input is true.	Status Input GNDDLTAORIDE

Name	Description	Symbol
Status Input Idle Request	True when the Idle Request logic element is true.	Status Input IDLEREQUESTIN
Status Input In Alarm State	True when the DGC-2020 is in the alarm state.	Status Input INALARMSTATE
Status Input In Connecting State	True when the DGC-2020 is in the connecting state.	Status Input INCONNECTINGSTATE
Status Input In Cooling State	True when the DGC-2020 is in the cooling state.	Status Input INCOOLINGSTATE
Status Input In Cranking State	True when the DGC-2020 is in the cranking state.	Status Input INCRANKINGSTATE
Status Input In Disconnect State	True when the DGC-2020 is in the disconnect state.	Status Input INDISCONNECTSTATE
Status Input In Prestart State	True when the DGC-2020 is in the pre-start state.	Status Input INPRESTARTSTATE
Status Input In Pulsing State	True when the DGC-2020 is in the pulsing state.	Status Input INPULSINGSTATE
Status Input In Ready State	True when the DGC-2020 is in the ready state.	Status Input INREADYSTATE
Status Input In Resting State	True when the DGC-2020 is in the resting state.	Status Input INRESTINGSTATE
Status Input In Running State	True when the DGC-2020 is in the running state.	Status Input INRUNNINGSTATE
Status Input Lamp Test	True when the Lamp Test logic element is true or the Lamp Test button is pressed on the front panel.	Status Input LAMPTESTIN
Status Input Load Share Module	Load Share Module AVR Output Limit. True when the LSM-2020 AVR Output Limit settings have been exceeded.	Status Input LSMAVROUTLMT
Status Input Load Share Module	Load Share Module Connected. True when an optional LSM-2020 is connected to the DGC-2020.	Status Input LSMCONNECTED
Status Input Load Share Module	Load Share Module Governor Output Limit. True when the LSM-2020 Governor Output Limit settings have been exceeded.	Status Input LSMGOVOUTLMT
Status Input Load Take Over	True when the Load Take Over logic element is true.	Status Input LOADTAKEOVERIN
Status Input Low Line Override	True when the Low Line Override input is true.	Status Input LOWLINEORIDE
Status Input Mains Breaker Status	True when the mains breaker is closed.	Status Input MAINSBRKSTA
Status Input Mains Fail Test	True when the Mains Fail Test logic element is true.	Status Input MAINSFAILIN

Name	Description	Symbol
Status Input 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 MAINSFLTRCOMPLETE
Status Input 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 MFXFRDISABLED
Status Input Mains Fail Transfer Power from Gens	True when mains fail transfer function detects the load is powered from the generator bus.	Status Input MFXFRPOWERFROMGENS
Status Input Mains Fail Transfer Power from Mains	True when mains fail transfer function detects the load is powered from the mains bus.	Status Input MFXFRPOWERFROMMAINS
Status Input Mains Fail Transfer Return Timer Active	True when mains fail transfer return delay timer is actively counting.	Status Input MFXFRRETURNTIMERACTIVE
Status Input Mains Fail Transfer Transfer Timer Active	True when the mains fail transfer delay timer is actively counting.	Status Input MFXFRTRANSFERTIMERACTIVE
Status Input Mains Fail Transfer Transferring to Gens	True when mains fail transfer is transferring load to the generator bus.	Status Input MFXFRTRANSFERRINGTOGENS
Status Input Mains Fail Transfer Transferring to Mains	True when mains fail transfer is transferring load to the mains bus.	Status Input MFXFRTRANSFERRINGTOMAINS
Status Input Off Mode	True when the DGC-2020 is in Off Mode or the Off Mode logic element is true.	Status Input OFFMODE
Status Input Off Mode Cooldown	True when the DGC-2020 is in Off Mode and cooling down.	Status Input OFFMODECOOL
Status Input Open Transition Delay	True when the open transition delay is actively counting.	Status Input OPENTRANSITIONDELAY
Status Input 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 PARTOMAINS
Status Input PF Mode Active	True when PF mode is active.	Status Input PFMODEACT
Status Input Pre Start Condition in Effect	True while in the Pre Start state.	Status Input PRESTCONDINEFFECT

Name	Description	Symbol
Status Input Pre Start Input	True when the DGC-2020 is indicating that the Pre Start relay should be closed.	Status Input PRESTARTINPUT
Status Input Regen 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 REGENCOMPLETED
Status Input 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 REGENCONFIRMREQ
Status Input Regen Interlock from ECU	True when John Deere proprietary parameters are broadcast over the J1939 CAN Bus.	Status Input REGENINTERLOCKFROMECU
Status Input 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 REGENNOTCOMPLETED
Status Input Reset Active	True when the Reset logic element is true or when the Reset key on the front panel is pressed.	Status Input RESETACTIVE
Status Input Restart Delay Active	True when the restart delay is currently active.	Status Input RESTARTDELAYACTIVE
Status Input Run Input	True when the DGC-2020 is indicating that the Run relay should be closed.	Status Input RUNINPUT
Status Input Run Mode	True when the DGC-2020 is in Run Mode or the Run Mode logic element is true.	Status Input RUNMODE
Status Input Single Phase AC Sensing Override	True when the Single Phase AC Override input is true.	Status Input SPACORIDE
Status Input Single Phase Connection Override	True when the Single Phase Override input is true.	Status Input SPORIDE
Status Input Start Input	True when the DGC-2020 is indicating that the Start relay should be closed to start the engine.	Status Input STARTINPUT
Status Input Switch not in Auto	True when the DGC-2020 is not in Auto Mode.	Status Input SWTNOTINAUTO
Status Input Sync Active	True when the auto synchronizer is active to align the generator input and bus input voltages and phases.	Status Input SYNC ACTIVE
Status Input 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 SYNC BRKCL OK
Status Input 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 SYNC PH ANG OK

Name	Description	Symbol
Status Input Sync Slip 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.	Status Input SYNC SLIP FREQ OK
Status Input 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.	Status Input SYNC VOLT OK
Status Input 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.	Status Input UNLDSTATE
Status Input var Mode Active	True when var mode is active.	Status Input VARMODEACT
Output Objects		
Physical Outputs OUT1 - OUTx	Physical Outputs 1 through 7 (style xxAxxxxxx) or 1 through 15 (style xxBxxxxxx).	Output - OUT1 OUTPUT 1
Remote Outputs OUT13 - OUT36	Remote Outputs 13 through 36. (Available when an optional CEM-2020 is connected.)	Output - OUT13 OUTPUT 13
Alarms		
Analog Expansion Module Remote Analog 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.)	Alarm - RALGIN1O1ALM ALG IN 1
Analog Expansion Module Remote Analog Outputs 1-4	True when the analog output connection is open and the Out of Range Alarm Configuration is set to Alarm.	Alarm - RALGOUT1OORALM Oil Pressure
Analog Expansion Module Remote RTD 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.)	Alarm - RRTDIN1O1ALM RTD IN 1
Analog Expansion Module Remote Thermocouple 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.)	Alarm - RTCIN1O1ALM THRM CPL 1
Auto Restart Fail	True after the Automatic Restart function fails to restart the generator.	Alarm AUTORSTRTFAILALM
Battery Charger Fail	True when the Battery Charger Fail function is configured as an alarm and the activation delay has expired.	Alarm BATTCHRGFAILALM
Configurable Protection 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.)	Alarm - CONFPROT1O1ALM CONF PROT 1

Name	Description	Symbol
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.	Alarm DEFSEVERINDUCEMENTALM
Diagnostic Trouble Code	True when a Diagnostic Trouble Code exists.	Alarm DIAGNOSTICTROUBLECODE
ECU Comm Loss	True when communication to ECU has been lost.	Alarm LOSSECUCOMMALM
ECU Shutdown	True when ECU has shut down the engine.	Alarm ECUSHUTDOWNALM
Emergency Stop	True when the Emergency Stop button has been pressed.	Alarm EMERGSTOPALM
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.	Alarm EXHAUSTSYSERRORALM
Fuel Leak	True when the Fuel Leak Detect function is configured as an alarm and the activation delay has expired.	Alarm FUELLEAKALM
Generator Protection 27-1	True when the 27-1 element is configured as an alarm and has tripped.	Alarm 27-1UNDRVLTALM
Generator Protection 27-2	True when the 27-2 element is configured as an alarm and has tripped.	Alarm 27-2UNDRVLTALM
Generator Protection 59-1	True when the 59-1 element is configured as an alarm and has tripped.	Alarm 59-1OVOLTALM
Generator Protection 59-2	True when the 59-2 element is configured as an alarm and has tripped.	Alarm 59-2OVOLTALM
Generator Protection 32	True when the 32 element is configured as an alarm and has tripped.	Alarm 32REVPWRALM
Generator Protection 40	True when the 40 element is configured as an alarm and has tripped.	Alarm 40LOSSEXCALM
Generator Protection 47	True when the 47 element is configured as an alarm and has tripped.	Alarm 47PH_IMBLALM
Generator Protection 51-1	True when the 51-1 element is configured as an alarm and has tripped.	Alarm 51-1OCURRALM

Name	Description	Symbol
Generator Protection 51-2	True when the 51-2 element is configured as an alarm and has tripped.	Alarm 51-2OCURRALM
Generator Protection 51-3	True when the 51-3 element is configured as an alarm and has tripped.	Alarm 51-3OCURRALM
Generator Protection 78	True when the 78 element is configured as an alarm and has tripped.	Alarm 78VECSHFTALM
Generator Protection 81 ROCOF	True when the 81 ROCOF element is configured as an alarm and has tripped.	Alarm 81ROCOFALM
Generator Protection 81 Over	True when the 81 Over element is configured as an alarm and has tripped.	Alarm 81OFRQALM
Generator Protection 81 Under	True when the 81 Under element is configured as an alarm and has tripped.	Alarm 81UFRQALM
Global Alarm	True when one or more alarms are set.	Alarm GLBALM
Hi Coolant Temp	True when the High Coolant Temp Alarm settings have been exceeded.	Alarm 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 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 LOWCOOLLVLALM
Low Fuel Level	True when the Low Fuel Level Alarm settings have been exceeded.	Alarm LOWFUELLALM
Low Oil Pressure	True when the Low Oil Pressure Alarm settings have been exceeded.	Alarm LOWOILPRALM
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 *Reset* button on the front panel.	Alarm MAINSFLTRFAIL
MTU Combined Red	This is an indication from the MTU Engine ECU that a Red Alarm has occurred. If any Red Alarm occurs, a Combined Red Alarm occurs.	Alarm MTUCOMBINEDRED
Overcrank	True when an Overcrank condition exists.	Alarm OCRANKALM
Overspeed	True when the Overspeed Alarm settings have been exceeded.	Alarm OVERSPDALM

Name	Description	Symbol
Sender Fail Coolant Level Sender Fail	True when a low coolant level error status code is received from the ECU. CAN Bus must be enabled.	Alarm COOLLVLSENDFAILALM
Sender Fail Coolant Temp Sender Fail	True when the Coolant Temp Sender Fail is configured as an alarm and the activation delay has expired.	Alarm COOLTEMPSENDFAILALM
Sender Fail Fuel Level Sender Fail	True when the Fuel Level Sender Fail is configured as an alarm and the activation delay has expired.	Alarm FUELLSENDFAILALM
Sender Fail Global Sender Fail	True when one or more of the Sender Fails are configured as alarms and are true.	Sender Fail GLBSENDFALM
Sender Fail Oil Pressure Sender Fail	True when the Oil Pressure Sender Fail is configured as an alarm and the activation delay has expired.	Alarm OILPRESSENDFAILALM
Sender Fail Speed Sender Fail	True when the Speed Sender Fail activation delay has expired.	Alarm SPDSENDFAILALM
Sender Fail Voltage Sensing Fail	True when the Voltage Sensing Fail is configured as an alarm and the activation delay has expired.	Alarm VOLTSENSFAILALM
Unexpected Shutdown	True when the metered engine speed (RPM) unexpectedly drops to 0 while the engine is running.	Alarm UNEXPECTEDSHUTDNALM
Pre-Alarms		
Analog Expansion Module Analog Expansion Module Comm Fail	True when communication from the AEM-2020 to the DGC-2020 has been lost.	Pre-Alarm AEMCOMMFPALM
Analog Expansion Module Multiple Analog Expansion Modules Detected	True when more than one AEM-2020 is connected.	Pre-Alarm DUPAEMPALM
Analog Expansion Module 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.)	Pre-Alarm - RALGIN1O1PALM ALG IN 1
Analog Expansion Module 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.	Pre-Alarm - RALGOUT1OORPALM Oil Pressure
Analog Expansion Module 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.)	Pre-Alarm - RRTDIN1O1PALM RTD IN 1
Analog Expansion Module 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.)	Pre-Alarm - RTCIN1O1PALM THRM CPL 1

Name	Description	Symbol
Battery Charger Fail	True when the Battery Charger Fail function is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm BATTCHRGFAILPALM
Battery Charger AC Off	True when the ac power to the battery charger is off. (Battery Charger 1 shown.)	Pre-Alarm BCH1ACOFFPREALARM
Battery Charger Battery Failure	True when the battery charger has detected that the battery has failed. (Battery Charger 1 shown.)	Pre-Alarm BCH1BATTERYFAILEPREALARM
Battery Charger Comms Fail	True when the battery charger has detected a J1939 communications failure. (Battery Charger 1 shown.)	Pre-Alarm BCH1COMMSFAILPREALARM
Battery Charger Fail	True when the battery charger has failed. (Battery Charger 1 shown.)	Pre-Alarm BCH1FAILPREALARM
Battery Charger High Output Volts	True when the battery charger output voltage is too high. (Battery Charger 1 shown.)	Pre-Alarm BCH1HIOUTPUTVOLTSPREALARM
Battery Charger Invalid Settings	True when the battery charger has detected invalid settings. (Battery Charger 1 shown.)	Pre-Alarm BCH1INVALIDSETPREALARM
Battery Charger 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.)	Pre-Alarm BCH1LOCRANKVOLTSPREALARM
Battery Charger Low Output Volts	True when the battery charger output voltage is too low. (Battery Charger 1 shown.)	Pre-Alarm BCH1LOOUTPUTVOLTSPREALARM
Battery Charger 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.)	Pre-Alarm BCH1SNGLEUNTFAILPREALARM
Battery Charger Thermal Limit	True when the battery charger temperature is beyond the thermal limit. (Battery Charger 1 shown.)	Pre-Alarm BCH1THERMALLIMITPREALARM
Cannot Regen - Interlock Fail	True when the regeneration interlock has failed on a Yanmar ECU. Manual regeneration is blocked.	Pre-Alarm NOREGENINTERLOCKFAIL
Cannot Regen - Low Coolant Temp	True when the coolant temp is low on a Yanmar ECU. Manual regeneration is blocked.	Pre-Alarm NOREGENLOWCOOLTEMP
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.	Pre-Alarm NOREGENNOT50HOURS
Checksum Failure	True when some of the user settings or firmware code has been corrupted. Refer to Section 4, *BESTCOMSPlus® Software, Alarm Configuration, Pre-Alarms,* for more details.	Pre-Alarm CHECKSUMFAILPALM
Configurable Protection 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.)	Pre-Alarm - CONFPROT1O1PALM CONF PROT 1

Name	Description	Symbol
Contact Expansion Module Contact Expansion Module Comm Fail	True when communication from the CEM-2020 to the DGC-2020 has been lost.	Pre-Alarm CEMCOMMFPALM
Contact Expansion Module Contact Expansion Modules Hardware Mismatch	True when the connected CEM-2020 does not have the same number of outputs as defined on the *System Parameters, Remote Module Setup* screen in BESTCOMS*Plus*.	Pre-Alarm CEMHWMISMATCHPALM
Contact Expansion Module Multiple Contact Expansion Modules Connected	True when more than one CEM-2020 is connected.	Pre-Alarm DUPCEMPALM
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%.	Pre-Alarm DEFLOWPALM
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.	Pre-Alarm DEFENGINEDERATEPALM
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.	Pre-Alarm DEFINDUCEOVERRIDEPALM
DEF Low Severe	True when the engine ECU reports via CAN bus that Diesel Exhaust Fluid (DEF) is at a level below 8%.	Pre-Alarm DEFEMPTYPALM
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.	Pre-Alarm DEFPRESEVEREINDUCEPALM
DEF Quality Poor	True when the engine ECU reports "DEF Quality Poor" via CAN Bus.	Pre-Alarm DEFQUALITYPOOR
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.	Pre-Alarm DEFSEVEREINDUCEPALM

Name	Description	Symbol
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.	Pre-Alarm DEFWARNINGPALM
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.	Pre-Alarm DEFWARNINGLEVEL2PALM
Diag Trouble Code	True when a Diagnostic Trouble Code exists and the Active DTC pre-alarm is enabled.	Pre-Alarm DIAGTRBCODEPALM
DPF Regenerate Disabled	True when the Diesel Particulate Filter (DPF) lamp status broadcast over CAN bus indicates that DPF regeneration is inhibited.	Pre-Alarm DPFREGENDISABLDPALM
DPF Regenerate Required	True when the Diesel Particulate Filter (DPF) lamp status broadcast over CAN bus indicates that DPF regeneration is required.	Pre-Alarm DPFREGENREQPALM
DPF Soot Level High	True when the engine ECU reports via CAN bus that Diesel Particulate Filter (DPF) soot level is high.	Pre-Alarm 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.	Pre-Alarm 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.	Pre-Alarm 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.	Pre-Alarm DTCLOWCOOLLEVL
ECU Comm Loss	True when communication to the ECU has been lost.	Pre-Alarm 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.	Pre-Alarm EGRINDUCEMENTLVLLOW
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.	Pre-Alarm 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.	Pre-Alarm EGRINDUCEMENTWARN
Engine kW Over Load 1	True when the Engine kW Overload 1 Pre-Alarm settings have been exceeded.	Pre-Alarm ENGKWOVRLD1PALM

Name	Description	Symbol
Engine kW Over Load 2	True when the Engine kW Overload 2 Pre-Alarm settings have been exceeded.	Pre-Alarm ENGKWOVRLD2PALM
Engine kW Over Load 3	True when the Engine kW Overload 3 Pre-Alarm settings have been exceeded.	Pre-Alarm ENGKWOVRLD3PALM
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.	Pre-Alarm 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.	Pre-Alarm FUELFILTER2LEAK
Fuel Leak	True when the Fuel Leak Detect function is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm 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.	Pre-Alarm 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.	Pre-Alarm 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.	Pre-Alarm GENBRKSYNCFAIL
Generator Protection 27-1	True when the 27-1 element is configured as a pre-alarm and has tripped.	Pre-Alarm 27-1UNDRVLTPALM
Generator Protection 27-2	True when the 27-2 element is configured as a pre-alarm and has tripped.	Pre-Alarm 27-2UNDRVLTPALM
Generator Protection 59-1	True when the 59-1 element is configured as a pre-alarm and has tripped.	Pre-Alarm 59-1OVOLTPALM
Generator Protection 59-2	True when the 59-2 element is configured as a pre-alarm and has tripped.	Pre-Alarm 59-2OVOLTPALM
Generator Protection 32	True when the 32 element is configured as a pre-alarm and has tripped.	Pre-Alarm 32REVPWRPALM
Generator Protection 40	True when the 40 element is configured as a pre-alarm and has tripped.	Pre-Alarm 40LOSSEXCPALM
Generator Protection 47	True when the 47 element is configured as a pre-alarm and has tripped.	Pre-Alarm 47PH_IMBPALM

Name	Description	Symbol
Generator Protection 51-1	True when the 51-1 element is configured as a pre-alarm and has tripped.	Pre-Alarm 51-1OCURRPALM
Generator Protection 51-2	True when the 51-2 element is configured as a pre-alarm and has tripped.	Pre-Alarm 51-2OCURRPALM
Generator Protection 51-3	True when the 51-3 element is configured as a pre-alarm and has tripped.	Pre-Alarm 51-3OCURRPALM
Generator Protection 78	True when the 78 element is configured as a pre-alarm and has tripped.	Pre-Alarm 78VECSHIFTPALM
Generator Protection 81 ROCOF	True when the 81 ROCOF element is configured as a pre-alarm and has tripped.	Pre-Alarm 81ROCOFPALM
Generator Protection 81 Overfrequency	True when the 81 Over element is configured as a pre-alarm and has tripped.	Pre-Alarm 81OFRQPALM
Generator Protection 81 Underfrequency	True when the 81 Under element is configured as a pre-alarm and has tripped.	Pre-Alarm 81UFRQPALM
Global Pre-Alarm	True when one or more pre-alarms are set.	Pre-Alarm 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.	Pre-Alarm HEATINGFOREXHAUSTREGEN
High Battery Voltage	True when the High Battery Voltage pre-alarm threshold has been exceeded.	Pre-Alarm BATOVOLTPALM
Hi Coolant Temp	True when the High Coolant Temp Pre-Alarm threshold has been exceeded.	Pre-Alarm HITEMPPALM
High Exhaust Temperature	True when Diesel Particulate Filter (DPF) lamp status broadcast over CAN Bus indicates high exhaust temperature.	Pre-Alarm HIGHEXHTEMPPALM
High Fuel Level	True when the High Fuel Level Pre-Alarm settings have been exceeded.	Pre-Alarm 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.	Pre-Alarm 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.	Pre-Alarm ISUZUDEFLOWREFILLPALM
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 BESTCOMS*Plus*.	Pre-Alarm ISUZUFORCEPURGEREQPALM
Isuzu SCR Forced Purge	True when a forced purge is in progress after having been requested.	Pre-Alarm ISUZUSCRFORCEPURGEPALM

Name	Description	Symbol
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.	Pre-Alarm ISUZUSCRPURGEPALM
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.	Pre-Alarm ISUZUSERTOOLFORCEPRGEPALM
Load Share Module Load Share Module Comm Fail	True when communication from the LSM-2020 to the DGC-2020 has been lost.	Pre-Alarm LSMCOMMFPALM
Load Share Module Multiple Load Share Modules Detected	True when more than one LSM-2020 is connected.	Pre-Alarm DUPLSMPALM
Low Battery Voltage	True when the Low Battery Voltage Pre-Alarm settings have been exceeded.	Pre-Alarm LOWBATVPALM
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.	Pre-Alarm LOWCOOLLVLPALM
Low Coolant Temp	True when the Low Coolant Temp Pre-Alarm threshold has been exceeded.	Pre-Alarm LOWTEMPPALM
Low Fuel Level	True when the Low Fuel Level Pre-Alarm threshold has been exceeded.	Pre-Alarm LOWFUELLPALM
Low Oil Pressure	True when the Low Oil Pressure Pre-Alarm threshold has been exceeded.	Pre-Alarm LOWOILPRPALM
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.	Pre-Alarm MAINBRKCLOSEFAIL
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.	Pre-Alarm MAINBRKOPENFAIL
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.	Pre-Alarm MAINBRKSYNCFAIL
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.	Pre-Alarm MAINSFAILRETURNFAIL

Name	Description	Symbol
Maintenance Interval	True when the Maintenance Interval Pre-Alarm threshold has been exceeded.	Pre-Alarm MAINTINTPALM
MPU Fail	True when the MPU has failed.	Pre-Alarm MPUFAILPALM
MTU Pre-Alarms Coil 1 High Temperature	True when a High Coil Temperature 1 Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm HITCOIL1MTUPALM
MTU Pre-Alarms Coil 2 High Temperature	True when a High Coil Temperature 2 Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm HITCOIL2MTUPALM
MTU Pre-Alarms Coil 3 High Temperature	True when a High Coil Temperature 3 Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm HITCOIL3MTUPALM
MTU Pre-Alarms Combined Yellow	True when a Combined Yellow Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm COMBINDEDYELLOWMTUPALM
MTU Pre-Alarms ECU Faulty	True when an ECU Fault Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm ECUFAULTYMTUPALM
MTU Pre-Alarms Engine Speed Too Low	True when a Low Engine Speed Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm ENGINESPEEDTOOLOWMTUPALM
MTU Pre-Alarms High Alternator Winding Temperature	True when a High Temperature In the Alternator Windings Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm ALTERNATORWIRINGMTUPALM
MTU Pre-Alarms High Ambient Temperature	True when a High Ambient Temperature Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm HITAMBIENTMTUPALM
MTU Pre-Alarms High Charge Air Temp MTU Alarm	True when a High Charge Air Temperature Alarm has been received from an MTU Engine ECU.	Pre-Alarm HIGHCHARGEAIRTEMMTUPALM
MTU Pre-Alarms High Charge Air Temp MTU Pre-Alarm	True when a High Charge Air Temperature Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm HIGHCHARGEAIRTEMPMTUPALM
MTU Pre-Alarms High Coolant Temp MTU Alarm	True when a High Coolant Temperature Alarm has been received from an MTU Engine ECU.	Pre-Alarm HIGHCOOLTEMMTUPALM
MTU Pre-Alarms High Coolant Temp MTU Pre-Alarm	True when a High Coolant Temperature Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm HIGHCOOLTEMPMTUPALM
MTU Pre-Alarms High Day Tank Level	True when a High Fuel Level in the Day Tank Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm HIDAYTANKLVLMTUPALM
MTU Pre-Alarms High ECU Supply Voltage	True when a High ECU Supply Voltage Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm HIGHECUSUPPLYVOLTMTUPALM
MTU Pre-Alarms High ECU Temp	True when a High ECU Temperature Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm HIGHECUTEMPMTUPALM

Name	Description	Symbol
MTU Pre-Alarms High Exhaust Temp A	True when a High Exhaust Temperature in Exhaust System True when aPre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm HIGHEXHAUSTEMPAMTUPALM
MTU Pre-Alarms High Exhaust Temp B	True when a High Exhaust Temperature in Exhaust System B Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm HIGHEXHAUSTEMPBMTUPALM
MTU Pre-Alarms High Fuel Filter Diff Pressure	True when a High Fuel Filter Differential Pressure Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm HIFUELFILTDEFFPRESMTUPALM
MTU Pre-Alarms High Fuel Rail Pressure	True when a High Fuel Rail Pressure Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm HIGHFURLRAILPRESMTUPALM
MTU Pre-Alarms High Fuel Temp	True when a High Fuel Temperature Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm HIGHFUELTEMPMTUPALM
MTU Pre-Alarms High Intercooler Temperature	True when a High Intercooler Temperature Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm HIGHINTERCLRTEMPMTUPALM
MTU Pre-Alarms High Oil Temp MTU Alarm	True when a High Oil Temperature Alarm has been received from an MTU Engine ECU.	Pre-Alarm HIGHOILTEMPMTUALM
MTU Pre-Alarms High Oil Temp MTU Pre-Alarm	True when a High Oil Temperature Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm HIGHOILTEMPMTUPALM
MTU Pre-Alarms High Pressure In 1	True when a High Pressure Level in Pressure Input 1 Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm HIPRESSUREIN1MTUPALM
MTU Pre-Alarms High Pressure In 2	True when a High Pressure Level in Pressure Input 2 Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm HIPRESSUREIN2MTUPALM
MTU Pre-Alarms High Storage Tank Level	True when a High Fuel Level in the Storage Tank Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm HIGHSTORAGETANKLVLMTUPALM
MTU Pre-Alarms High Voltage Supply	True when a High System Power Supply Voltage Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm HIGHVOLTAGESUPPLYMTUPALM
MTU Pre-Alarms Idle Speed Low	True when a Low Idle Speed Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm IDLESPEEDLOWMTUPALM
MTU Pre-Alarms Low After Cooler Coolant Level	True when a Low Aftercooler Coolant level Alarm has been received from an MTU Engine ECU.	Pre-Alarm LOWAFTRCLRCOOLLVLMTUALM
MTU Pre-Alarms Low Charge Air Coolant Level	True when a Low Charge Air Coolant Level Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm LOWCHGEAIRCOOLLVLMTUPALM
MTU Pre-Alarms Low Charge Air Pressure	True when a Low Charge Air Pressure Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm LOWCHARGEAIRPRESMTUPALM
MTU Pre-Alarms Low Coolant Level MTU Pre-Alarm	True when a Low Coolant Level Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm LOWCOOLLVLMTUPALM

Name	Description	Symbol
MTU Pre-Alarms Low Day Tank Level	True when a Low Fuel Level in the Day Tank Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm LOWDAYTANKLVLMTUPALM
MTU Pre-Alarms Low ECU Supply Voltage	True when a Low ECU Supply Voltage Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm LOWECUSUPPLYVOLTMTUPALM
MTU Pre-Alarms Low Fuel Delivery Pressure MTU Alarm	True when a Low Fuel Delivery Pressure Alarm has been received from an MTU Engine ECU.	Pre-Alarm LOWFUELDELIVPRESMTUALM
MTU Pre-Alarms Low Fuel Delivery Pressure MTU Pre-Alarm	True when a Low Fuel Delivery Pressure Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm LOWFUELDELIVPRESMTUPALM
MTU Pre-Alarms Low Fuel Rail Pressure	True when a Low Fuel Rail Pressure Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm LOWFUELRAILPRESMTUPALM
MTU Pre-Alarms Low Oil Pressure MTU Alarm	True when a Low Oil Pressure Alarm has been received from an MTU Engine ECU.	Pre-Alarm LOWOILPRESSUREMTUALM
MTU Pre-Alarms Low Oil Pressure MTU Pre-Alarm	True when a Low Oil Pressure Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm LOWOILPRESSUREMTUPALM
MTU Pre-Alarms Low Storage Tank Level	True when a Low Fuel Level in the Storage Tank Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm LOWSTORAGETANKLVLMTUPALM
MTU Pre-Alarms Low Voltage Supply	True when a Low System Power Supply Voltage Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm LOWVOLTAGESUPPLYMTUPALM
MTU Pre-Alarms Overspeed	True when an Overspeed Alarm has been received from an MTU Engine ECU.	Pre-Alarm OVERSPEEDMTUALM
MTU Pre-Alarms Priming Fault	True when a Fault in the Engine Priming System Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm PRIMINGFAULTMTUPALM
MTU Pre-Alarms Run-Up Speed Low	True when a Low Runup Speed Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm RUNUPSPEEDLOWMTUPALM
MTU Pre-Alarms Shutdown Override	True when a Shutdown Override Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm SHUTDOWNOVERRIDEMTUPALM
MTU Pre-Alarms Speed Demand Fail	True when a Speed Demand Fail Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm SPEEDDEMANFAILMTUPALM
MTU Pre-Alarms Start Speed Low	True when a Low Start Speed Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm STARTSPEEDLOWMTUPALM
MTU Pre-Alarms Test Overspeed Active	True when an Overspeed Test Active Pre-Alarm has been received from an MTU Engine ECU.	Pre-Alarm 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 *Network Configuration* screen.	Pre-Alarm IDMISSINGPALM

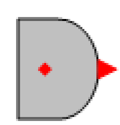
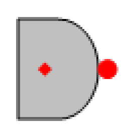
Name	Description	Symbol
Network ID Repeat Error	True if two or more optional LSM-2020's report the same expected sequence ID. Expected sequence IDs are entered on the *Network Configuration* screen.	Pre-Alarm IDREPEATPALM
Regenerate Active	True when an exhaust system regeneration is in progress.	Pre-Alarm EXHREGENACTIVE
Sender Fail Coolant Temp Sender Fail	True when the Coolant Temp Sender Fail is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm COOLTEMPSENDFAILPALM
Sender Fail Fuel Level Sender Fail	True when the Fuel Level Sender Fail is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm FUELLSENDFAILPALM
Sender Fail Oil Pressure Sender Fail	True when the Oil Pressure Sender Fail is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm OILPRESSENDFAILPALM
Sender Fail Voltage Sensing Fail	True when the Voltage Sensing Fail is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm VOLTSENSFAILPALM
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.	Pre-Alarm 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.	Pre-Alarm 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.	Pre-Alarm 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.	Pre-Alarm 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.	Pre-Alarm TORQUELIMITSEVERE

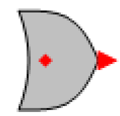
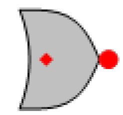
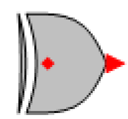
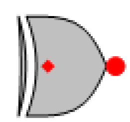
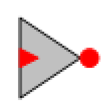
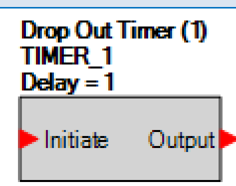
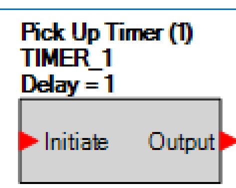
Name	Description	Symbol
Weak Battery	True when the Weak Battery Voltage Pre-Alarm settings have been exceeded.	Pre-Alarm WEAKBATPALM
Senders		
Coolant Temp Sender Fail	True when the Coolant Temp Sender Fail is configured as either a pre-alarm or alarm and the activation delay has expired.	Sender Fail COOLTEMPSENDFAIL
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.	Sender Fail 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.	Sender Fail OILPRESSENDFAIL
Speed Sender Fail	True when the Speed Sender Fail activation delay has expired.	Sender Fail SPDSENDFAIL
Voltage Sensing Fail	True when the Voltage Sensing Fail is configured as either a pre-alarm or alarm and the activation delay has expired.	Sender Fail VOLTSENSFAIL
Logic Control Relays		
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. 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.		
Inputs Input 1-16	See description above.	LCR Input LCRINPUT1
Outputs Output 1-16	See description above.	LCR Output LCROUTPUT1

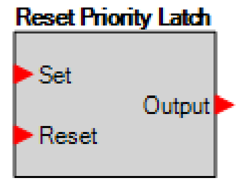
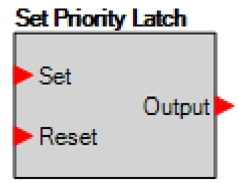
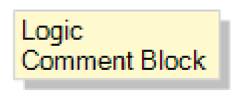
Components

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	

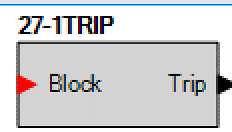
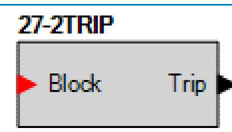
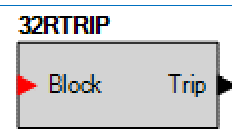
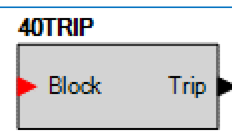
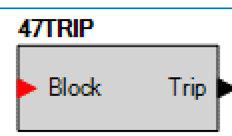
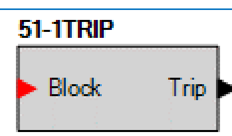
<table>
<tr><th>Name</th><th>Description</th><th>Symbol</th></tr>
<tr><td>OR</td><td><table><tr><th colspan="2">Input</th><th>Output</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table></td><td></td></tr>
<tr><td>NOR</td><td><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>0</td></tr></table></td><td></td></tr>
<tr><td>XOR</td><td><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>When an XOR gate has more than 2 inputs, the output is true whenever an odd number of inputs are true.</td><td></td></tr>
<tr><td>XNOR</td><td><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>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.</td><td></td></tr>
<tr><td>NOT
(INVERTER)</td><td><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></td><td></td></tr>
<tr><td colspan="3">Pickup and Dropout Timers</td></tr>
<tr><td>Drop Out
Timer</td><td>Used to set a delay in the logic.
For more information, refer to Programming BESTlogicPlus, Pickup and Dropout Timers, later in this section.</td><td>
</td></tr>
<tr><td>Pick Up Timer</td><td>Used to set a delay in the logic.
For more information, refer to Programming BESTlogicPlus, Pickup and Dropout Timers, later in this section.</td><td>
</td></tr>
</table>

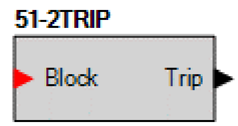
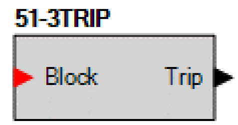
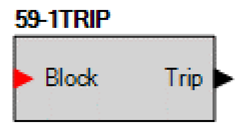
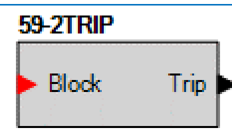
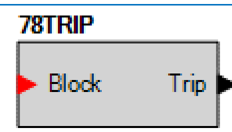
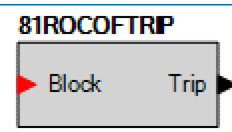
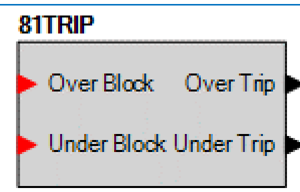
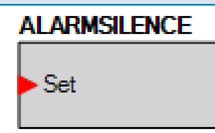
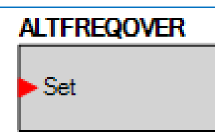
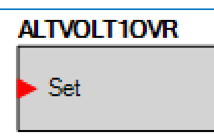
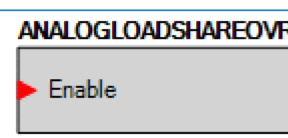
Name	Description	Symbol
Latches		
Reset Priority Latch	When the Set input is on and the Reset input is off, the latch will go to the SET (ON) state. When the Reset input is on and the Set input is off, the latch will go to the RESET (OFF) state. If both the Set and Reset inputs are on at the same time, a reset priority latch will go to the RESET (OFF) state.	
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.	
Other		
Comment Block	Enter user comments.	

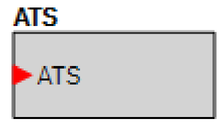
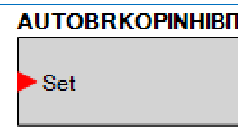
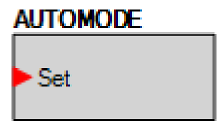
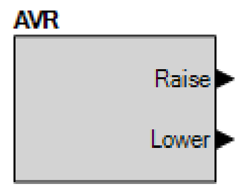
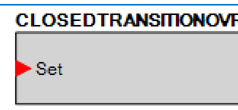
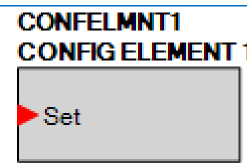
Elements

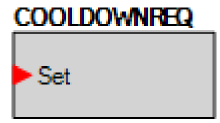
Table 5-3 lists the names and descriptions of the elements in the *Elements* group.

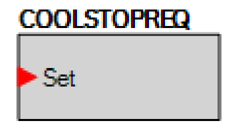
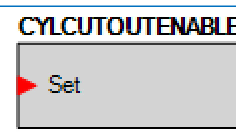
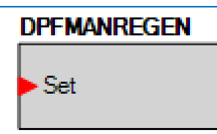
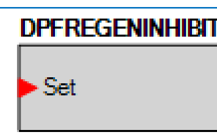
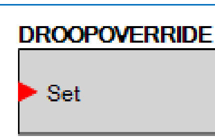
Table 5-3. Elements Group, Names and Descriptions

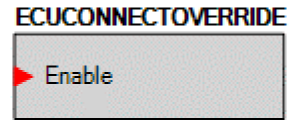
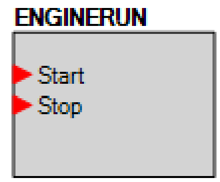
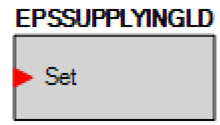
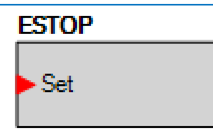
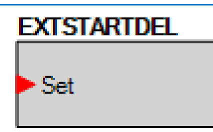
Name	Description	Symbol
Protection		
27-1TRIP	When the Block input is true, the 27-1 element is disabled. The Trip output is true when the 27-1 undervoltage element is in a trip condition. Connect to another logic block input.	
27-2TRIP	When the Block input is true, the 27-2 element is disabled. The 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 (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 (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.	

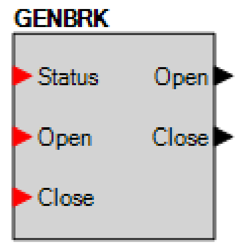
Name	Description	Symbol
51-2TRIP (Optional)	When the Block input is true, the 51-2 element is disabled. The Trip output is true when the 51-2 overcurrent is in a trip condition. Connect to another logic block input.	
51-3TRIP (Optional)	When the Block input is true, the 51-3 element is disabled. The 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.	
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.	
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.	
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.	
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.	
Other		
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.	
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.	
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.	
Analog Load Share Override	When the Set input is true, the DGC-2020 utilizes analog load share lines, rather than Ethernet, for load sharing.	

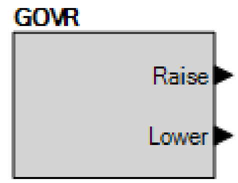
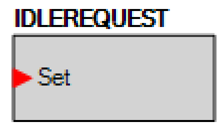
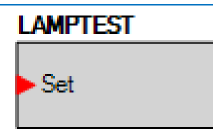
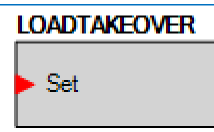
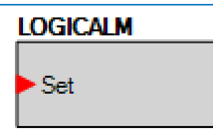
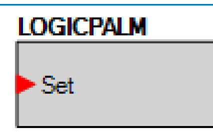
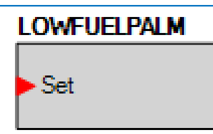
Name	Description	Symbol
ATS	When this logic element is true, and the DGC-2020 is in Auto mode, the generator will run. This can be used in place of the ATS programmable function if it is desired to generate the ATS signal as a combination of programmable logic rather than a simple contact input. If either the ATS logic element is true or the contact mapped to the ATS programmable function is true, and the DGC-2020 is in Auto mode, the generator will run. If both the ATS logic element and the ATS programmable function are false, and the DGC-2020 is in Auto mode, the generator will cool down and stop.	
Automatic Breaker Operation Inhibit from PLC	Automatic breaker operation is inhibited when the Set input is true.	
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.	
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.	
Closed Transition Override from PLC	All mains fail transfers are forced to be closed transitions, even if *Mains Fail Transfer Type* is set to *Open*, when the Set input is true.	
Configurable Element	Configurable elements (CONFELMNT1-8) are connected to the logic scheme as outputs. These elements are configurable in BESTCOMS*Plus* under *Programmable Outputs, Configurable Elements.* 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.	

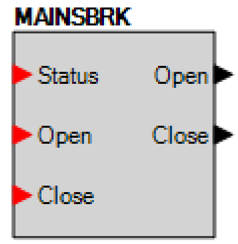
Name	Description	Symbol
Cool Down Request	<u>RUN Mode</u> If the unit is in Run mode when the Cool Down Request is received, the unit is forced to unload and open its breaker and then go into a cooldown cycle. While in the cool down cycle, the unit will display “COOLDOWN REQ” in addition to displaying 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. 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. <u>Auto Mode</u> 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. 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.	

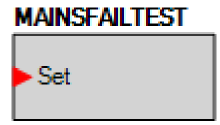
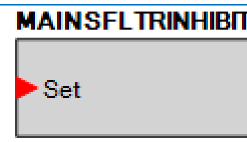
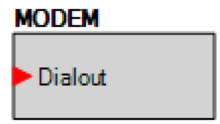
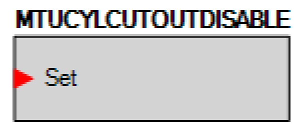
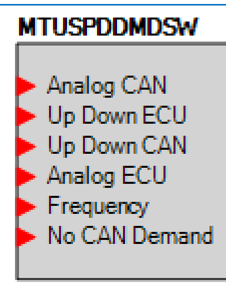
Name	Description	Symbol
Cool Down and Stop Request	Run Mode If the unit is in Run mode when the Cool Stop Request is received, the unit will unload, open its breaker, and go into a cooldown cycle. While in the cooldown cycle, the unit will display “COOL & STOP REQ” in addition to displaying the cooldown 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. 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. Auto Mode 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 goes into a cooldown cycle. While in the cooldown cycle, the unit will display “COOL & 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. 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.	
Cylinder Cutout Enable Override	When true, cylinder cutout is enabled. When false, cylinder cutout is disabled when any of the following are true: • Synchronization is in progress. • The machine is operating with the generator breaker closed. • The Cylinder Cutout Disable setting is true. • The Cylinder Cutout Disable logic element is true.	
Diesel Particulate Filter Manual Regeneration	Diesel Particulate Filter Regeneration is forced manually when the Set input is true.	
Diesel Particulate Filter Regeneration Inhibit	Diesel Particulate Filter Regeneration is inhibited when the Set input is true.	
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.	

Name	Description	Symbol
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.	
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.	
EPS Supplying Load	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. 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 > BREAKER MANAGEMENT > BUS CONDITION DETECTION > GEN CONDITION DETECTION in the Settings Explorer in BESTCOMS*Plus*.) 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). 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.	
Emergency Stop	When true, an Emergency Shutdown alarm is annunciated and the Emergency Stop LED on the RDP-110 is illuminated.	
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.	

Generator Breaker	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. Inputs *Status:* 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. *Open:* 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. *Close:* 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. Outputs The outputs must be mapped to the contact outputs of the DGC-2020 that will be used to drive the breaker. *Open:* 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. *Close:* 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. **Note** 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.	

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.	
Idle Request	When this element is true, the DGC-2020 will send an idle request to the engine ECU on J1939 engines that are equipped to receive such a request. At this time, only Volvo and Cummins are implemented. If the engine is not equipped to respond to idle requests, or the engine is not one of the listed J1939 engine types, this will have no effect.	
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.	
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.	
Logic Alarm	When this input is true, the DGC-2020 goes into an alarm condition.	
Logic Pre-Alarm	When this input is true, the DGC-2020 goes into a Pre-alarm condition.	
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.	

Name	Description	Symbol
Mains Breaker	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. This element is only available when the Mains Breaker Hardware in configured on the *Breaker Hardware* screen via the *Breaker Management* tree branch. Inputs *Status:* 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. *Open:* 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. *Close:* 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. Outputs The outputs must be mapped to the contact outputs of the DGC-2020 that will be used to drive the breaker. *Open:* 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. *Close:* 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. **NOTE** 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.	

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.	
Mains Fail Transfer Inhibit from PLC	The mains fail transfer function is inhibited when the Set input is true.	
Modem Control (Optional)	Connect the input to the output of another logic block. When true, the modem dials out.	
MTU 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*Plus*.	
Speed Demand Switch	This logic element can be used to specify the Speed Demand Source parameter value that is sent to an MTU 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. 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. Analog CAN: This input configures the MTU ECU to accept speed bias requests over J1939 CAN Bus from the DGC-2020. Up Down ECU: This input configures the MTU ECU to accept speed raise/lower commands via contact inputs on the ECU. Up Down CAN: This input configures the MTU ECU to accept speed raise/lower commands via communications over J1939 CAN bus. Analog ECU: This input configures the MTU ECU to accept speed bias via bias voltage input connections on the ECU. Frequency: This configures the MTU 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. No CAN Demand: This input configures the MTU ECU to disregard all speed requests or speed raise/lower requests from J1939 CAN bus.	

Name	Description	Symbol
Off Mode	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.	OFFMODE Set
Paralleled to Mains	Setting this logic element to true indicates to the DGC-2020 that it is paralleled to a utility. 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 *Governor Bias Control Settings* screen, where the Base Load Level is in percent of machines rated kW. 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. 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 AVR *Bias Control Settings* 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 AVR *Bias Control Settings* screen. When var/PF control is not active or not enabled, the voltage controller can be set up to implement voltage droop.	PARTOMAINS Paralleled
Prestart Output	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.	PRESTARTOUT Set
Rapid Start Override	When true, this element sets the Start mode to Rapid regardless of the Start mode setting.	RAPIDSTARTOVR Enable
RDP Programmable Alarm 1	When true, this element illuminates the *Fuel Leak/Sender Failure* 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.	RDPPROGALM1 Set
RDP Programmable Alarm 2	When true, this element illuminates the *Sender Failure* 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.	RDPPROGALM2 Set
RDP Programmable Pre-Alarm 1	When true, this element illuminates the *Battery Overvoltage* 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.	RDPPROGPREALM1 Set

Name	Description	Symbol
RDP Programmable Pre-Alarm 2	When true, this element illuminates the *Battery Charger Failure* 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.	RDPPROGPREALM2 Set
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.	RESET Set
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.	RUNINHIBIT Run
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.	RUNMODE Set
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.	RUNOUTPUT Set
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.	RUNWLOAD Start Stop
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.	SEQSYSTEMSTART Start
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.	SPEEDLOWER Set
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.	SPEEDRAISE Set
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.	SPEEDTRIMINHIBIT Set

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.	STARTDELBYP Set
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.	STARTOUTPUT Set
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.	STOPKVARRAMP Set
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.	STOPKWRAMP Set
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.	TESTINHIBIT Exercise
Voltage Droop Override	When true, this element causes the DGC-2020 to switch from kvar sharing over Ethernet to voltage droop mode.	VOLTDROOPOVR Enable
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.	VOLTTRIMINHIBIT Set

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 BESTCOMS*Plus* 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 BESTCOMS*Plus* 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 BESTCOMS*Plus* to program BESTlogic*Plus*. Using BESTCOMS*Plus* is analogous to physically attaching wire between discrete DGC-2020 terminals. To program BESTlogic*Plus*, use the Settings Explorer within BESTCOMS*Plus* 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 BESTCOMS*Plus* 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 BESTlogic*Plus* 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 (Left LED)	Orange	Logic has changed since last save.
	Green	Logic has NOT changed since last save.
Logic Diagram Status (Center LED)	Red	Requirements NOT met as listed above.
	Green	Requirements met as listed above.
Logic Layer Status (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 BESTCOMS*Plus* 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 BESTlogic*Plus* 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 ±15 milliseconds.

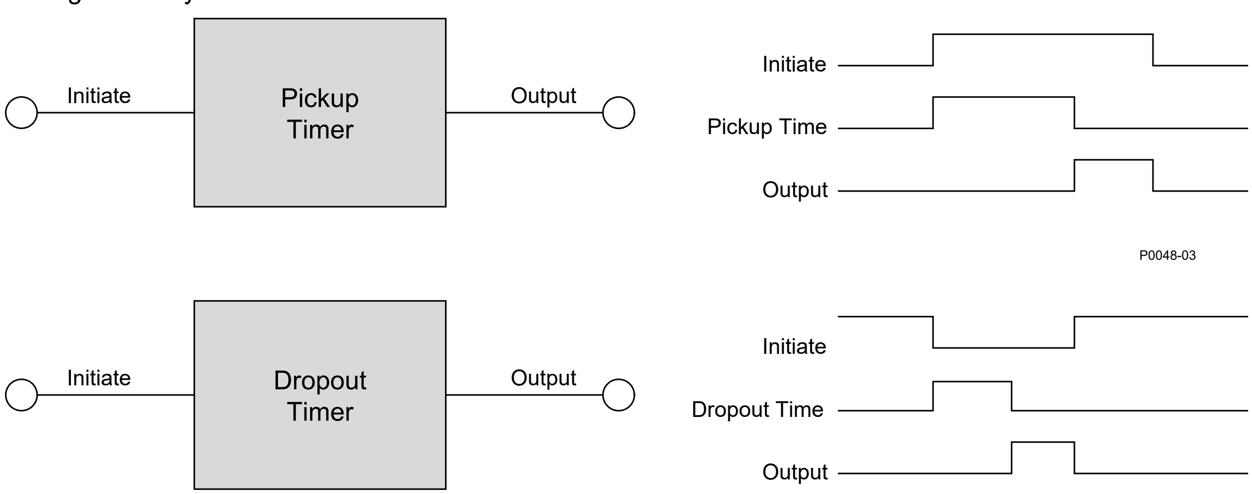


Figure 5-2. Pickup and Dropout Timer Logic Blocks

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 BESTlogic*Plus* 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 BESTlogic*Plus* 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).

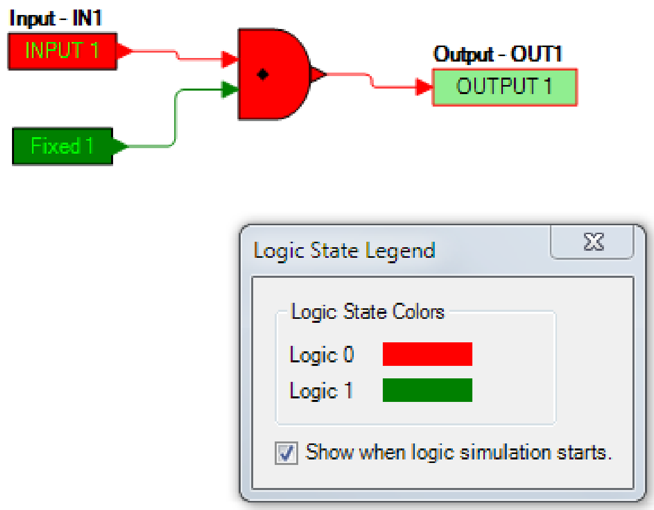


Figure 5-3. Offline Logic Simulator Example

BESTlogic™Plus File Management

To manage BESTlogic*Plus* files, use the Settings Explorer to open the *BESTlogicPlus Programmable Logic* tree branch. Use the BESTlogic*Plus* Programmable Logic toolbar to manage BESTlogic*Plus* files. Refer to Figure 5-4. For information on Settings Files management, refer to Section 4, *BESTCOMSPlus® Software.*

Figure 5-4. BESTlogicPlus Programmable Logic Toolbar

Saving a BESTlogic™Plus File

After programming BESTlogic*Plus* settings, click on the *Save* button to save the settings to memory.

Before the new BESTlogic*Plus* settings can be uploaded to the DGC-2020, you must select *Save* from the *File* pull-down menu located at the top of the BESTCOMS*Plus* main shell. This step will save both the BESTlogic*Plus* settings and the operating settings to a file.

The user also has the option to save the BESTlogic*Plus* settings to a unique file that contains only BESTlogic*Plus* 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 BESTlogic*Plus* file, click on the *Logic Library* drop-down button on the BESTlogic*Plus* 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 BESTlogic*Plus* file to the DGC-2020, you must first open the file through BESTCOMS*Plus* or create the file using BESTCOMS*Plus*. Then pull down the *Communication* menu and select *Upload Logic.*

Downloading a BESTlogic™Plus File

To download a BESTlogic*Plus* file from the DGC-2020, you must pull down the *Communication* menu and select *Download Logic*. If the logic in your BESTCOMS*Plus* has changed, a dialog box will open asking you if 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 BESTlogic*Plus* 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 BESTlogic*Plus* 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 BESTlogic*Plus* 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.

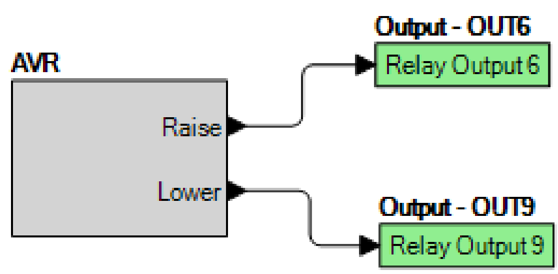


Figure 5-5. Example 1 - AVR Logic Block Connections

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.

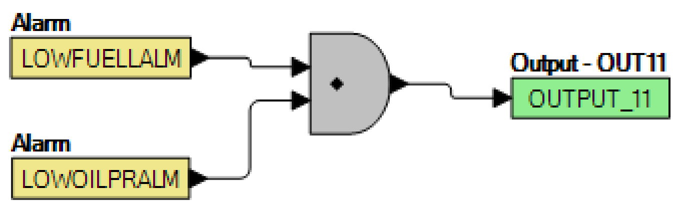


Figure 5-6. Example 2 - AND Gate Connections

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.

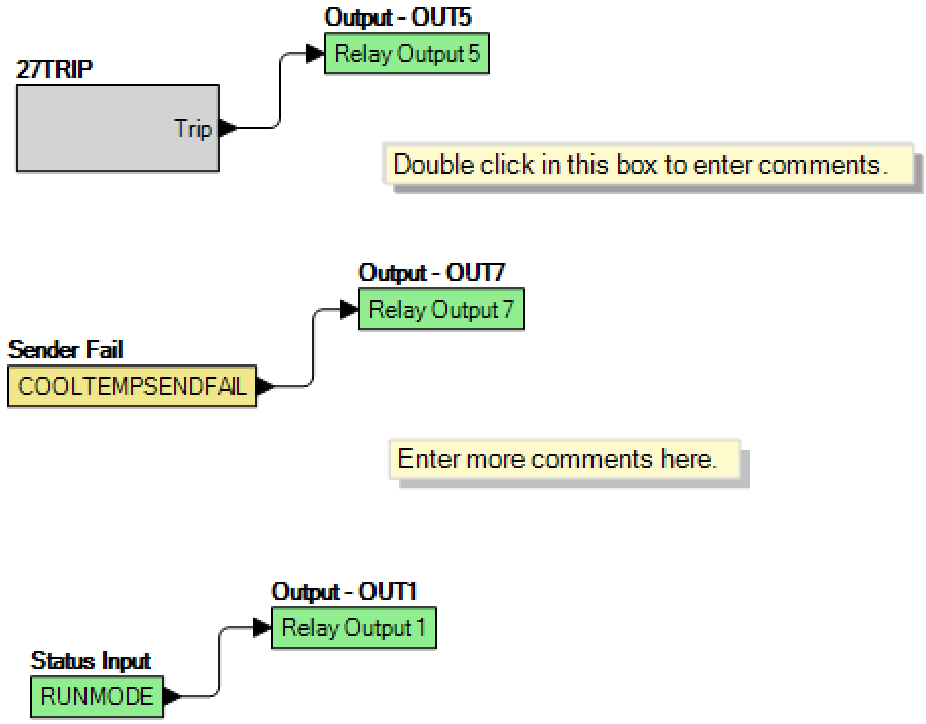


Figure 5-7. Example 3 - Multiple Logic Connections

SECTION 6 • INSTALLATION

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General

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.

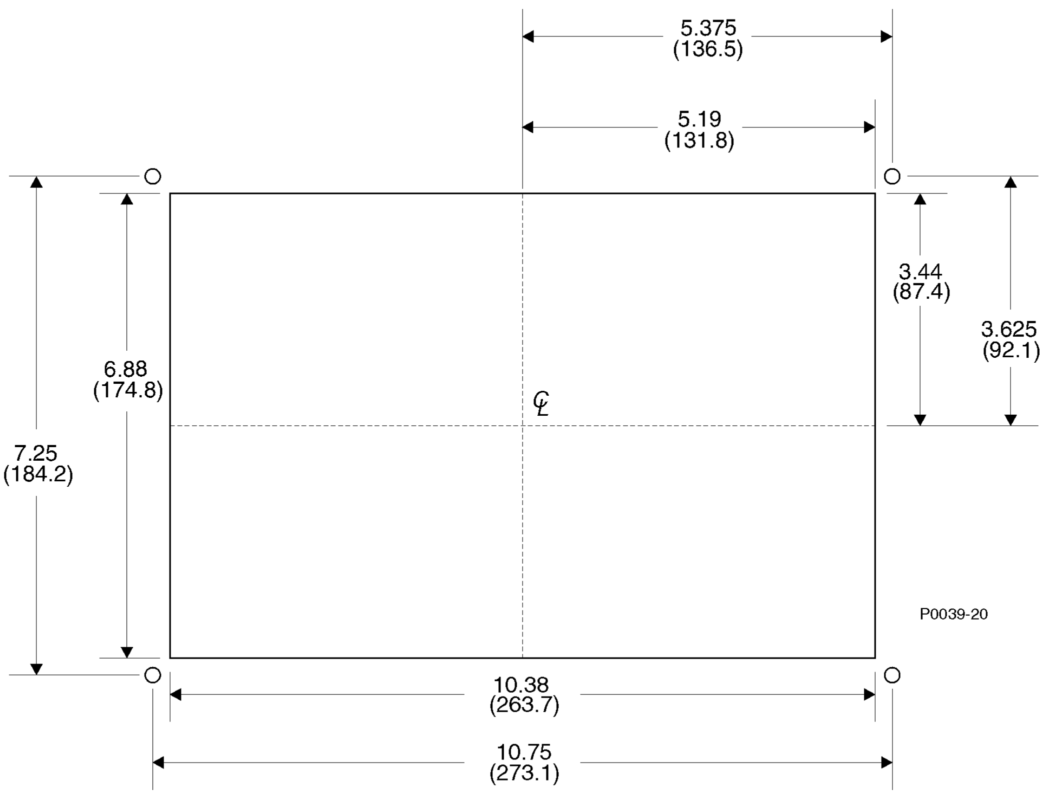

Figure 6-1. Panel Cutting and Drilling Dimensions

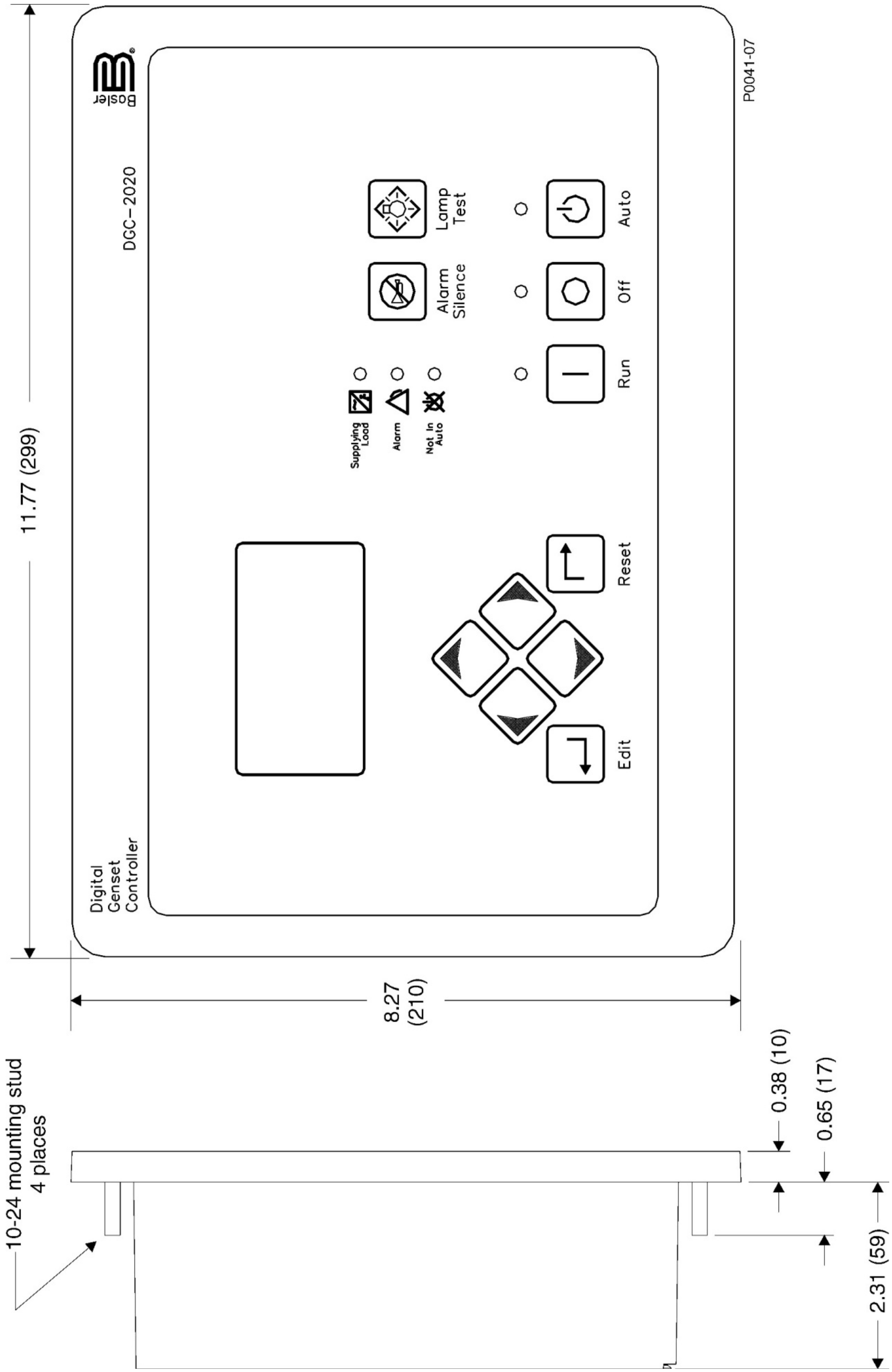

Figure 6-2. Overall Dimensions

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 BESTCOMS*Plus*® 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 1xxxxxxxx indicates 1 Aac nominal current sensing and a style number of 5xxxxxxxx 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 x1xxxxxxx indicates 50/60 hertz generator voltage and a style number of x2xxxxxxx 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)	

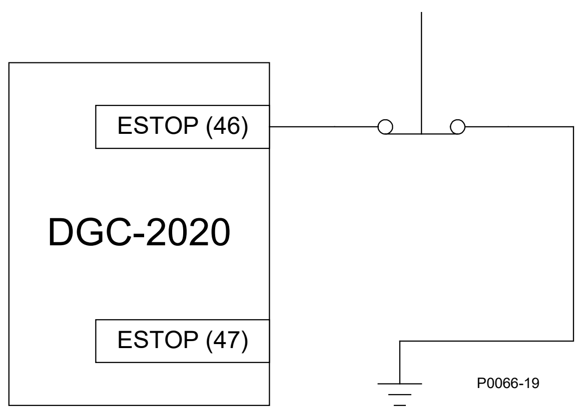

Figure 6-3. Emergency Stop Input Connections

Note

Units with a board number (located on back of the unit) lower than 9400201139 may experience problems associated with ESTOP wire lengths greater than 2 feet (0.6 m). An interposing relay, connected as shown in Figure 6-4, alleviates potential problems.

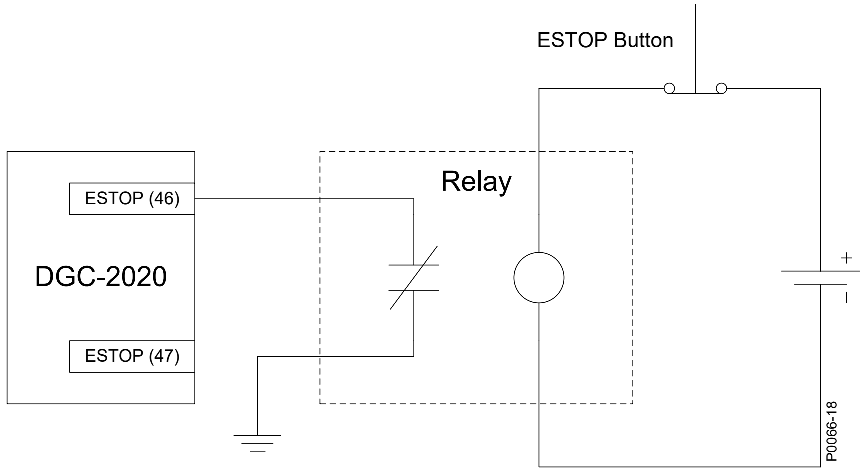

Figure 6-4. Interposing Relay Diagram

The relay is the type that when the coil is NOT energized, the contacts are open. When the coil is energized, the relay contacts are closed. The ESTOP button is normally closed (i.e. closed when it is NOT pushed). The relay coil is always energized when the ESTOP switch is closed (NOT pushed), so relay contacts are closed in normal operation. When the ESTOP button is pushed, the ESTOP switch opens, so relay contacts open, shutting down the unit.

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 6-5. 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.

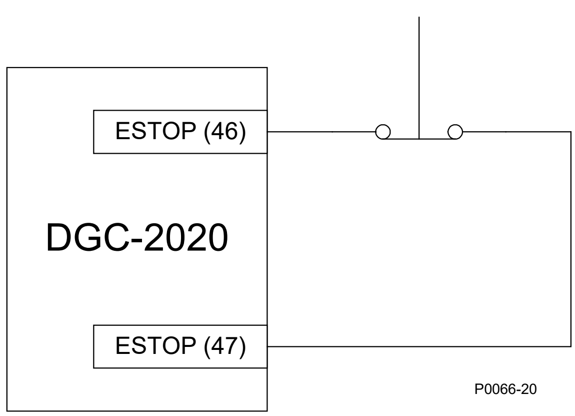

Figure 6-5. Emergency Stop Input Connections (Optional Wiring Method)

Note

Units with a board number (located on back of the unit) lower than 9400201139 may experience problems associated with ESTOP wire lengths greater than 2 feet (0.6 m). An interposing relay, connected as shown in Figure 6-6, alleviates potential problems.

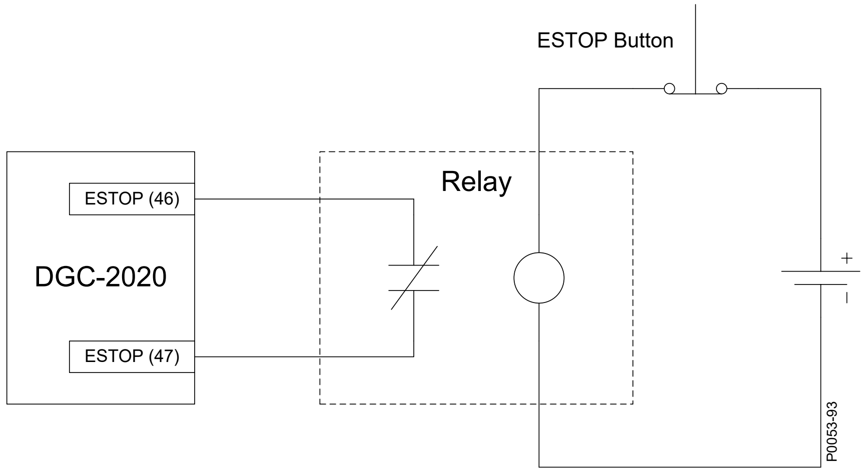

Figure 6-6. Interposing Relay Diagram (Optional ESTOP Wiring Method)

The relay is the type that when the coil is NOT energized, the contacts are open. When the coil is energized, the relay contacts are closed. The ESTOP button is normally closed (i.e. closed when it is NOT pushed). The relay coil is always energized when the ESTOP switch is closed (NOT pushed), so relay contacts are closed in normal operation. When the ESTOP button is pushed, the ESTOP switch opens, so relay contacts open, shutting down the unit.

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

Terminal	Description
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
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

Terminal	Description
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 BESTCOMS*Plus* 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® 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 6-7 and Figure 6-8.

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 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.

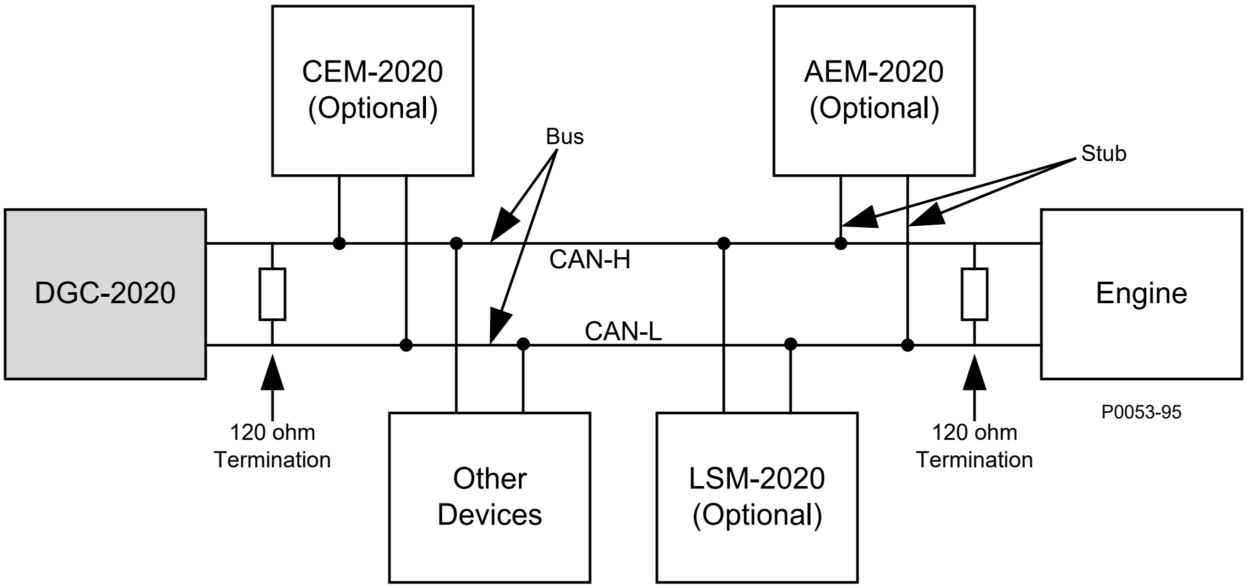

Figure 6-7. CAN Bus Interface with DGC-2020 providing One End of the Bus

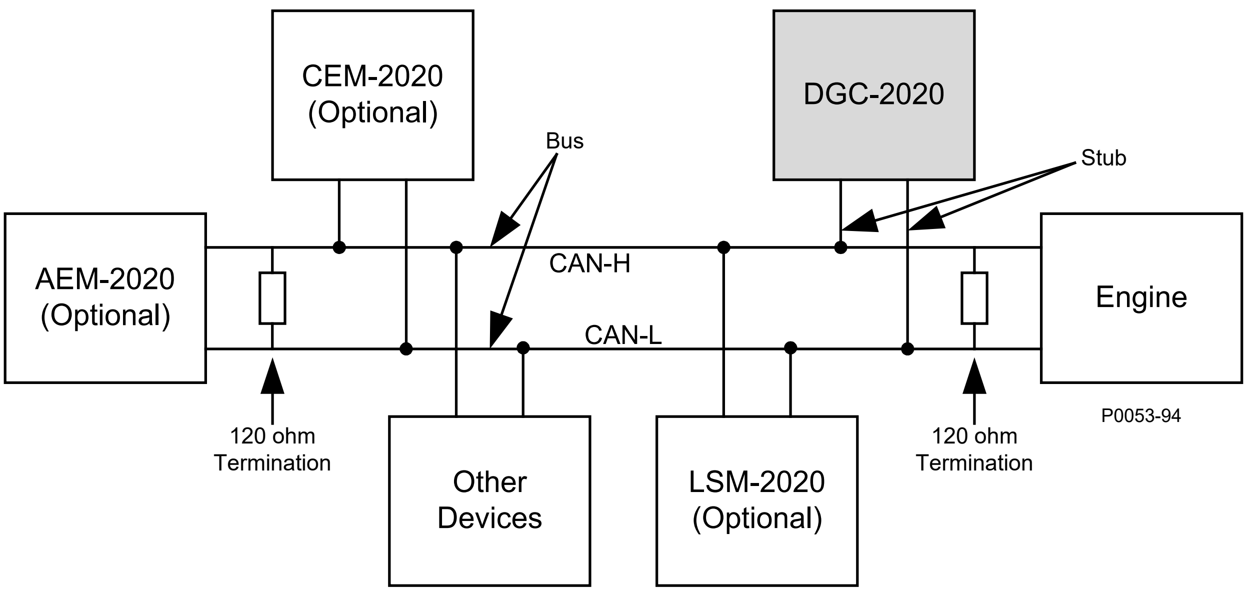

Figure 6-8. CAN Bus Interface with Optional AEM-2020 providing One End of the Bus

Modem

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 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-2020 and RDP-110. Twisted-pair conductors are recommended for connecting the communication terminals of the DGC-2020 and RDP-110. Communication may become unreliable if the connection wires exceed 4,000 feet.

Table 6-12 lists the DGC-2020 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

Connection diagrams for typical applications are shown on the following pages.

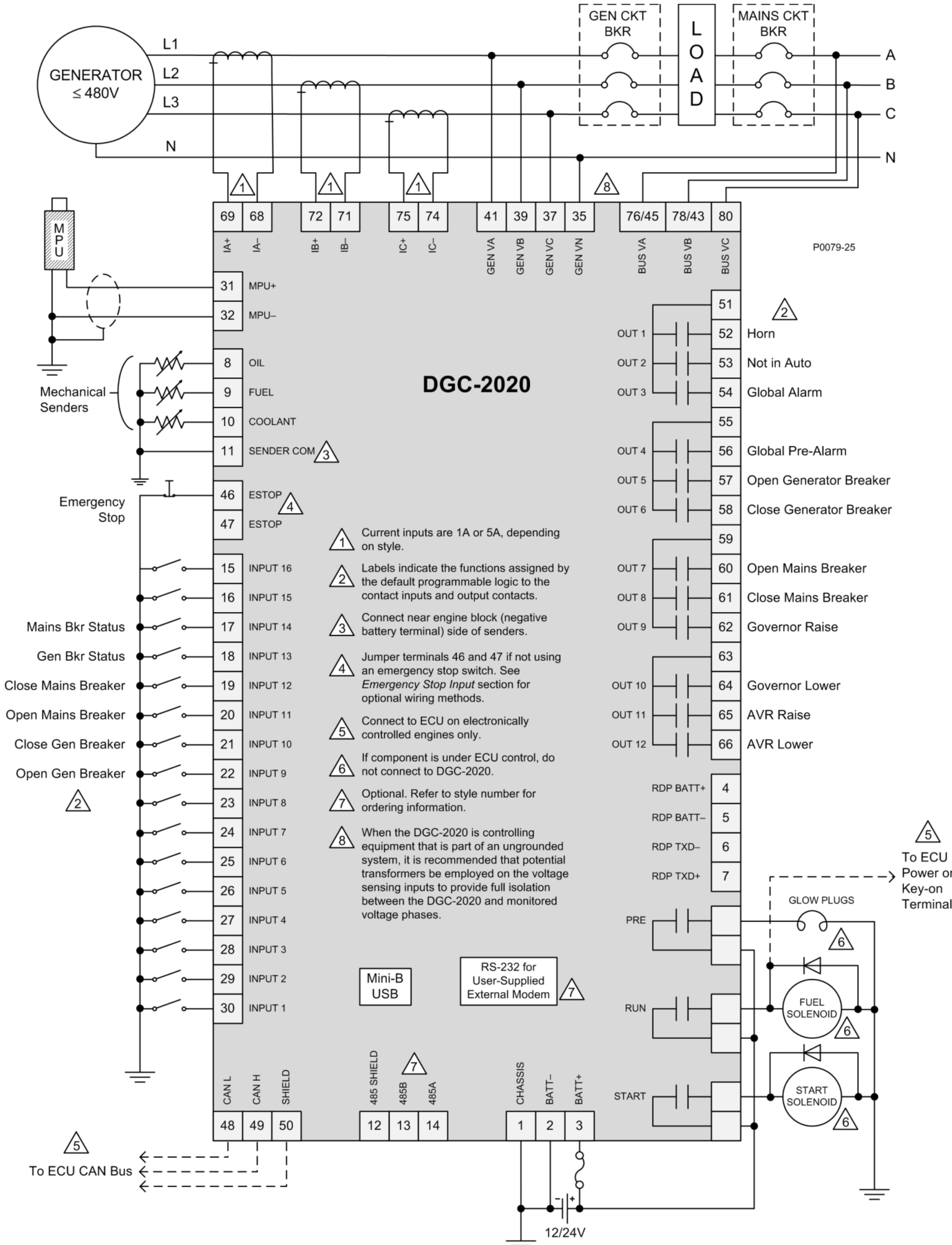

Figure 6-9. Three-Phase Wye Connections for Typical Applications

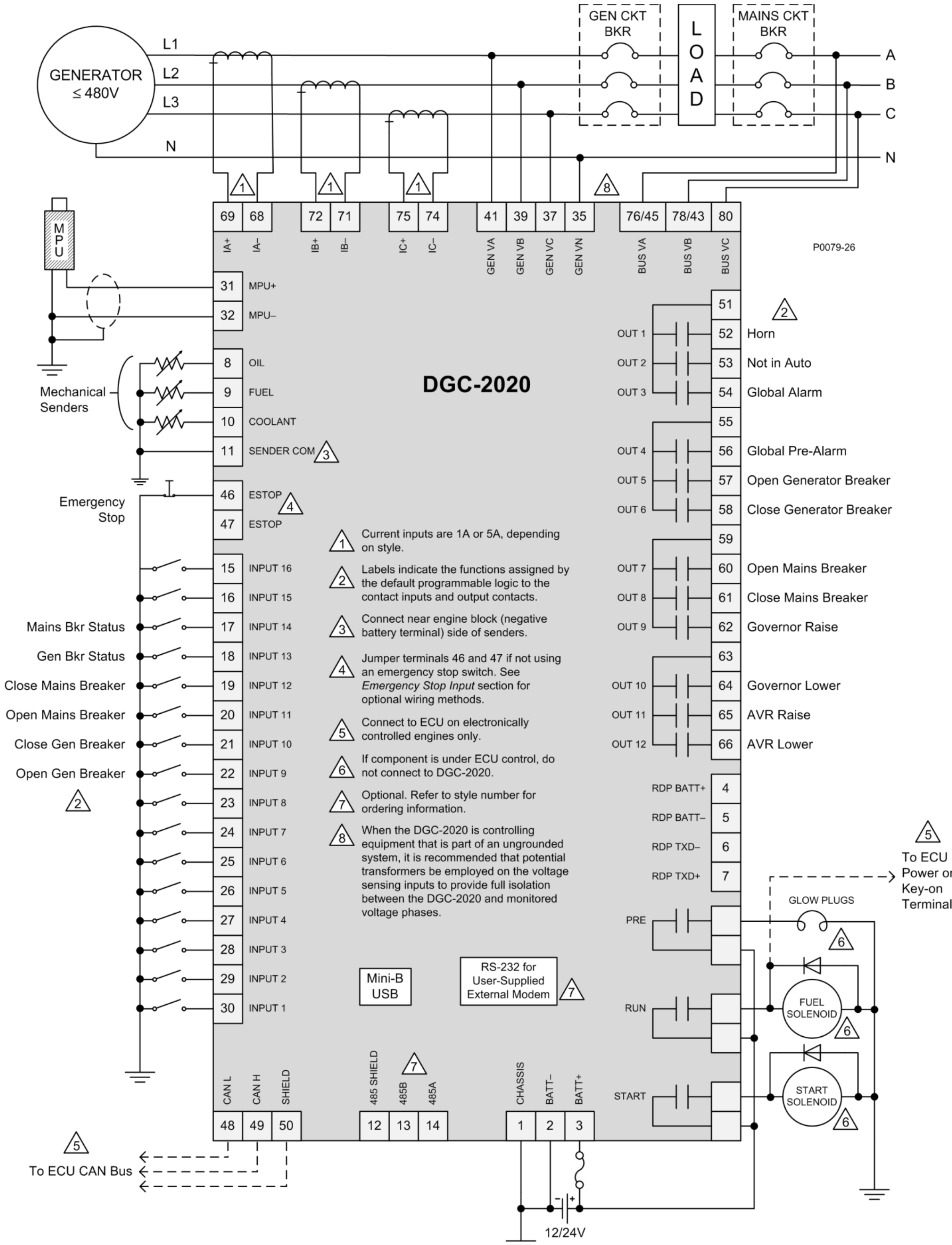

Figure 6-10. Three-Phase Delta Connections for Typical Applications

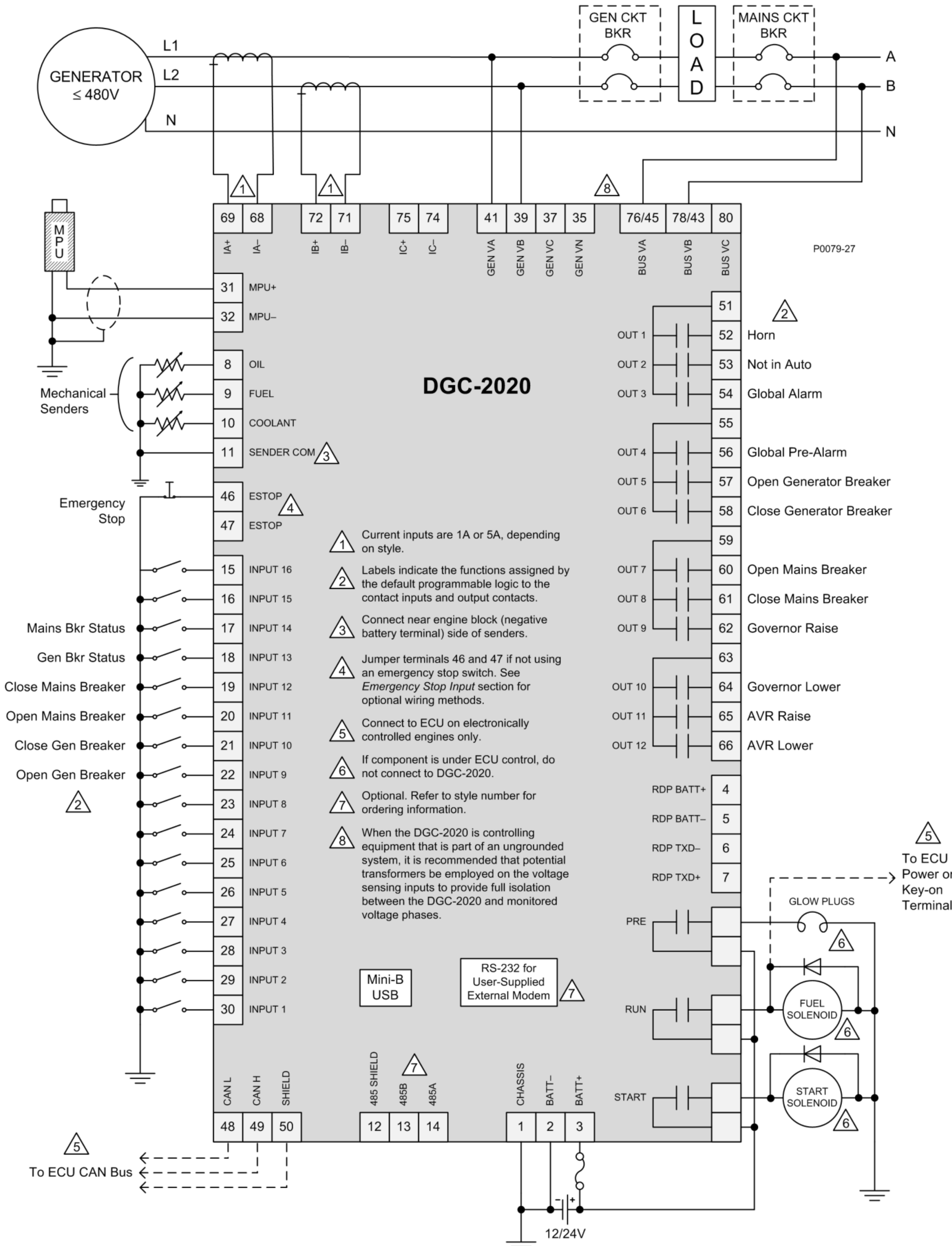

Figure 6-11. Single-Phase A-B Connections for Typical Applications

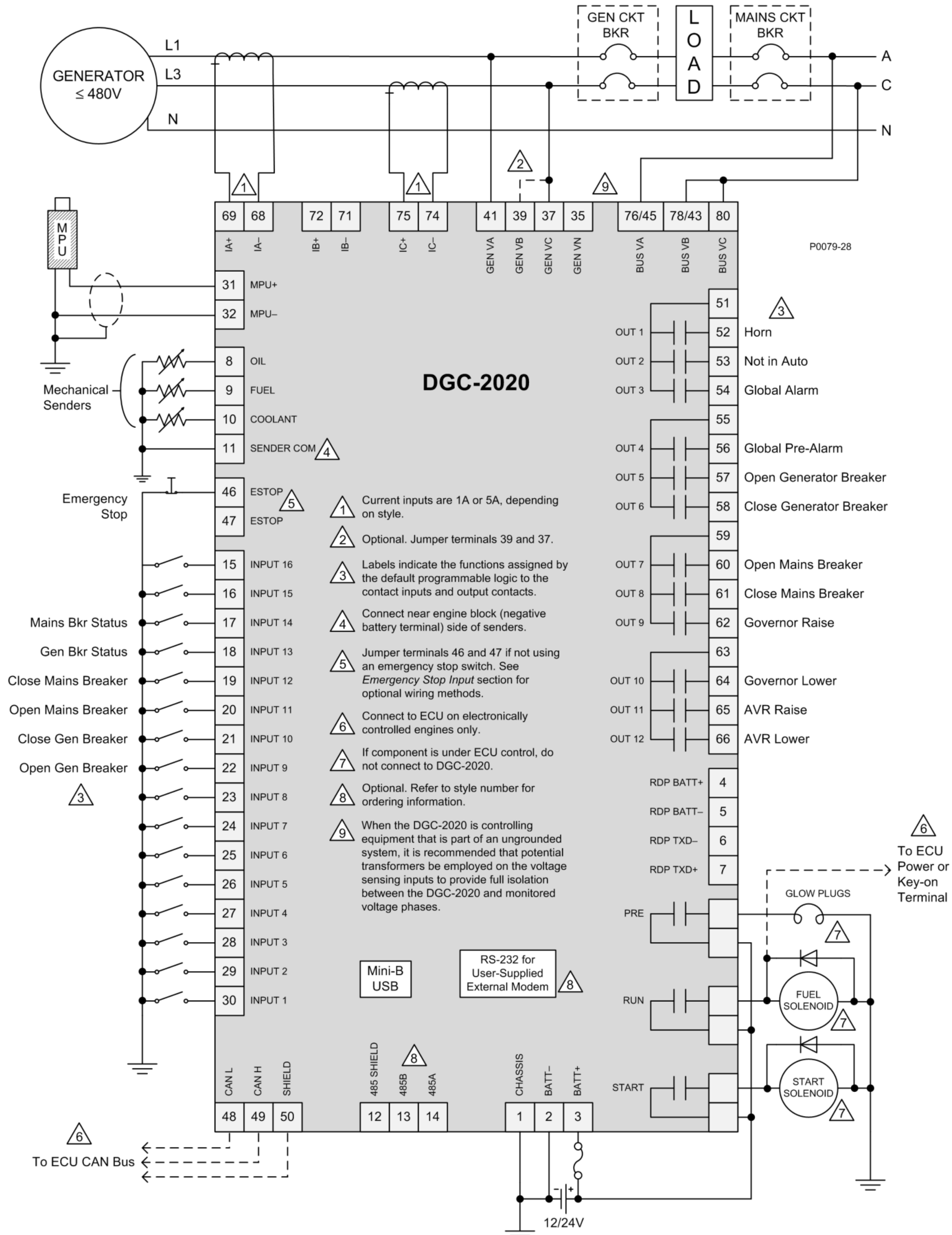

Figure 6-12. Single-Phase A-C Connections for Typical Applications

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.

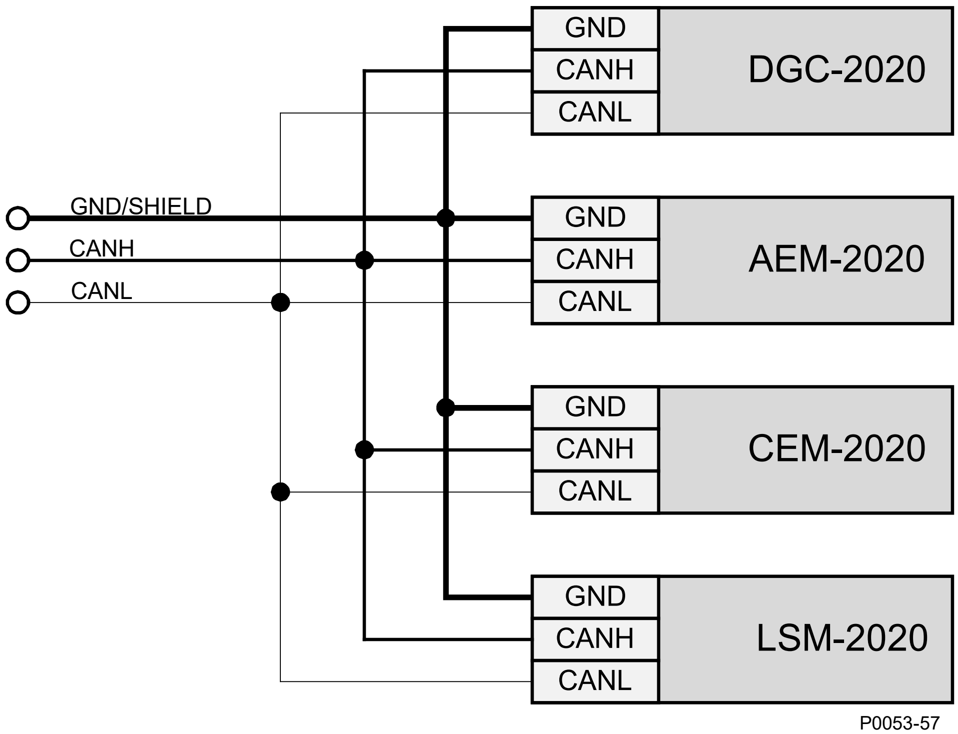

Figure 6-13. DGC-2020, AEM-2020, CEM-2020, LSM-2020 CAN Bus Connections

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.

SECTION 7 • SETUP

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SECTION 7 • SETUP

Introduction

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 BESTCOMS*Plus*® in the Settings Explorer. These parameters can also be set through the front panel of the DGC-2020, but BESTCOMS*Plus*® is generally more convenient.

In BESTCOMS*Plus*®, if you are connected to the DGC-2020 and communicating with it, after changing settings you must click the *Send Settings* button in BESTCOMS*Plus*® 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 BESTCOMS*Plus*® 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

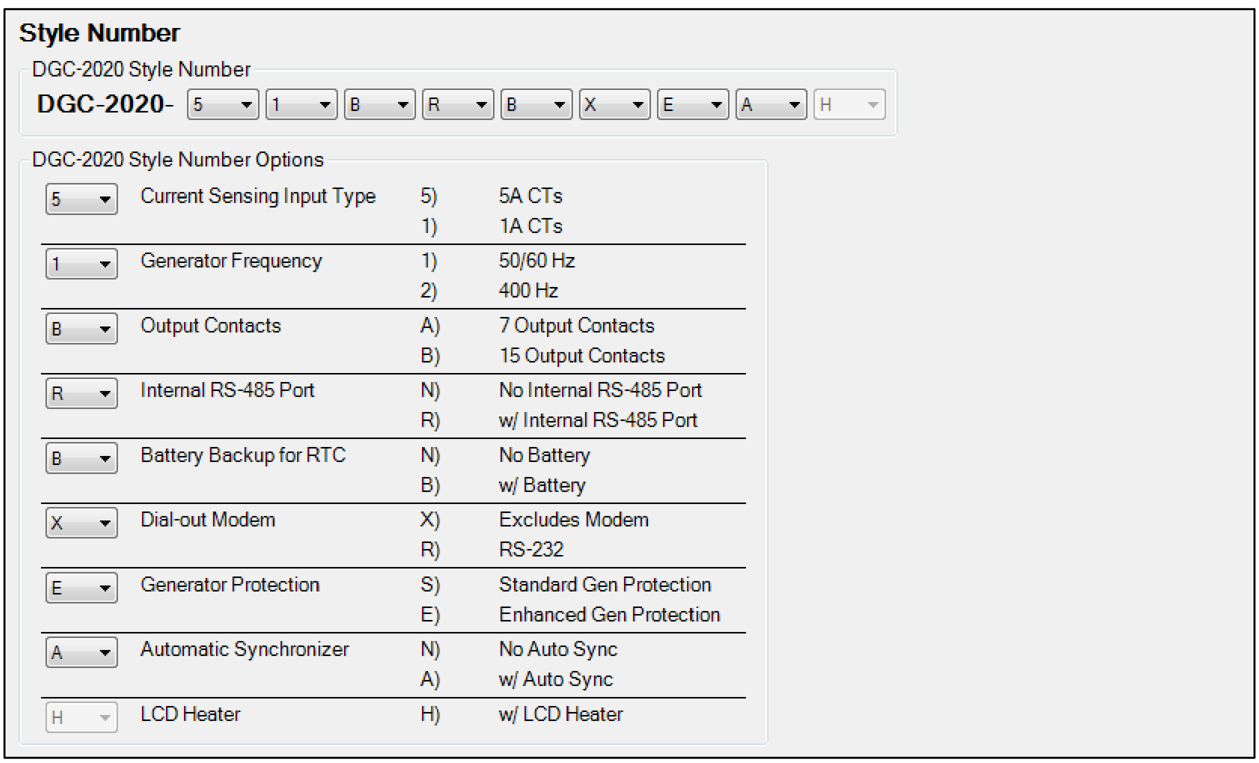

Figure 7-1. Settings Explorer, General Settings, Style Number Screen

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. 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.
9. 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.
10. 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.
11. ECU Related Time Values - Pulse Cycle Time - Set this parameter for the desired time between ECU pulse cycles.
12. 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.
13. 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.

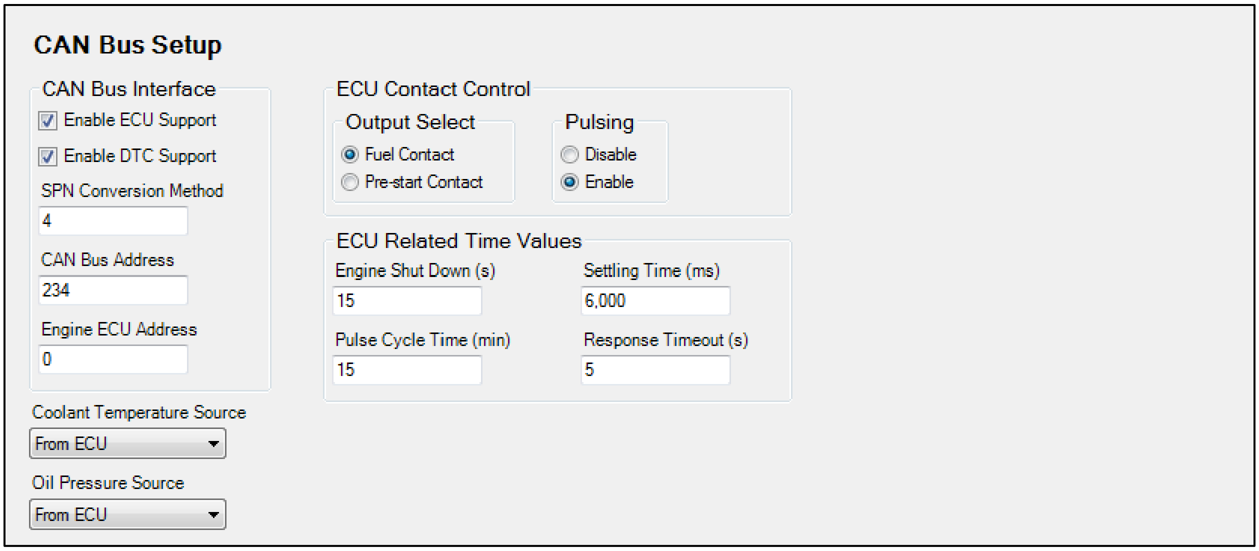

Figure 7-2. Settings Explorer, Communications, CAN Bus Setup Screen

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, or Yanmar, 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, *BESTCOMSPlus® Software*, for additional information.

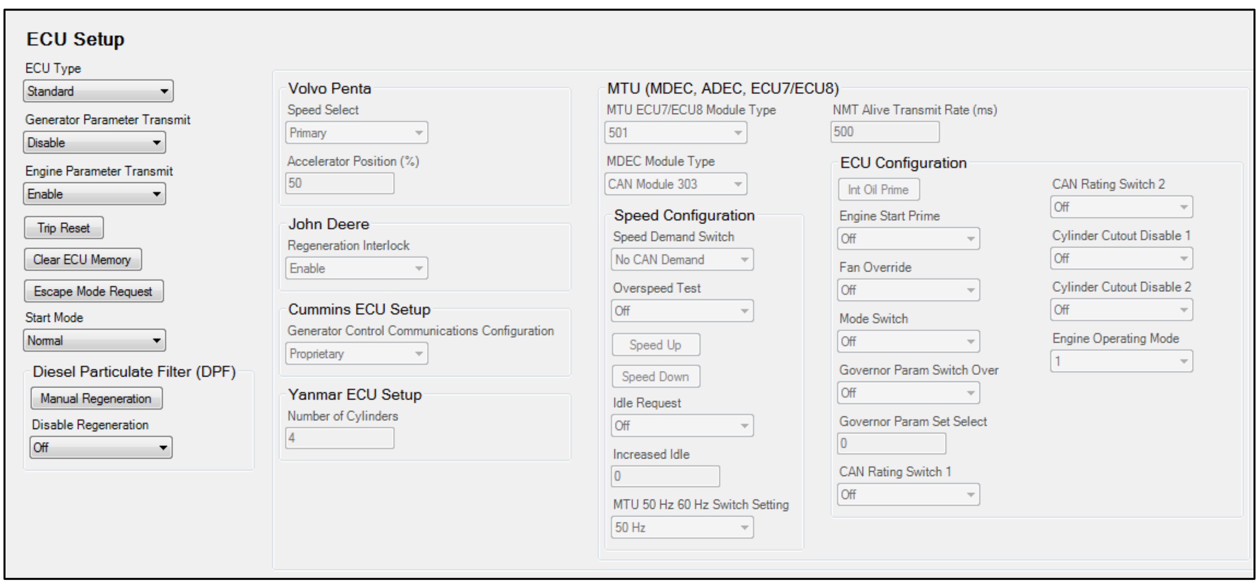

Figure 7-3. Settings Explorer, Communications, ECU Setup Screen

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*. This informs the DGC-2020 to display N/A for fuel level on the 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, annunciate 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.

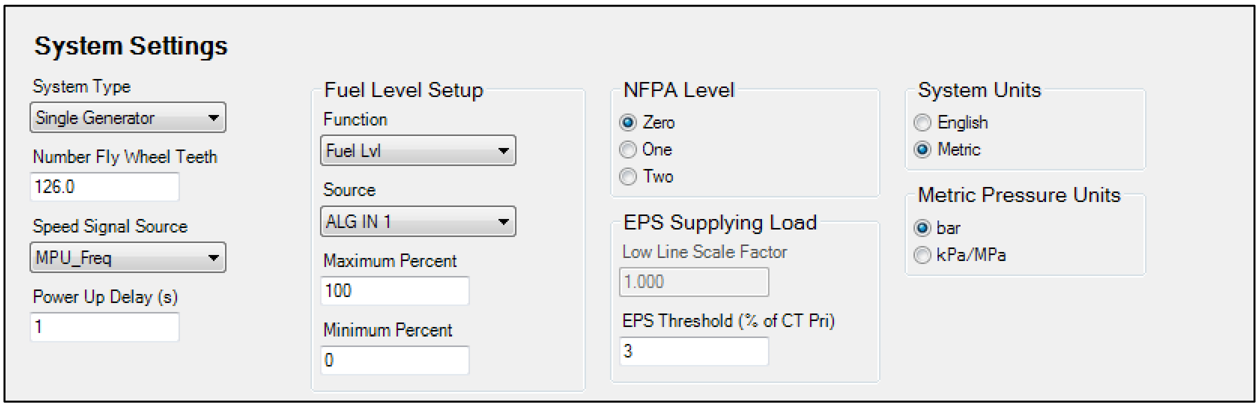

Figure 7-4. Settings Explorer, System Parameters, System Settings Screen

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*.

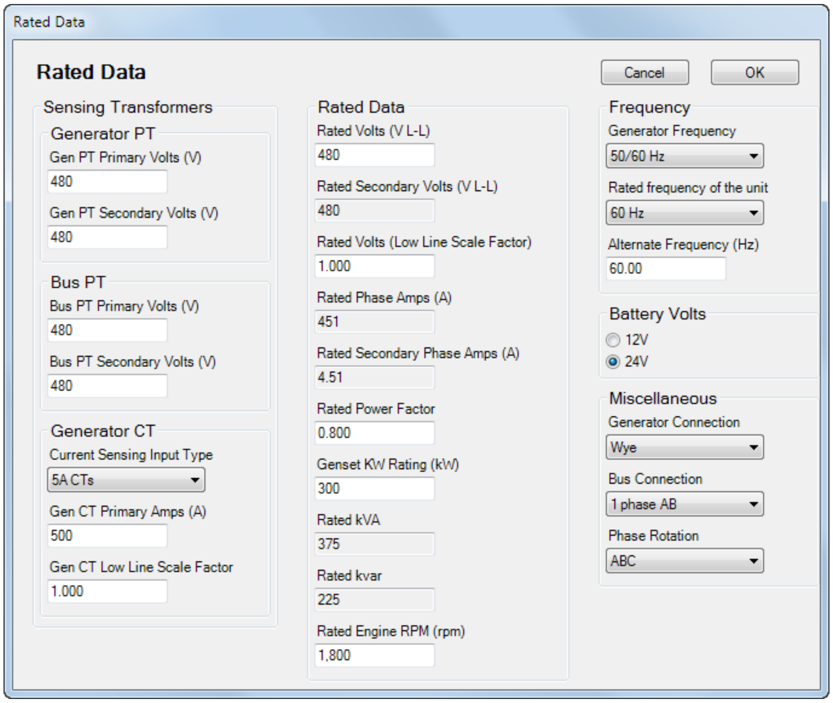

Figure 7-5. Settings Explorer, System Parameters, Rated Data

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.

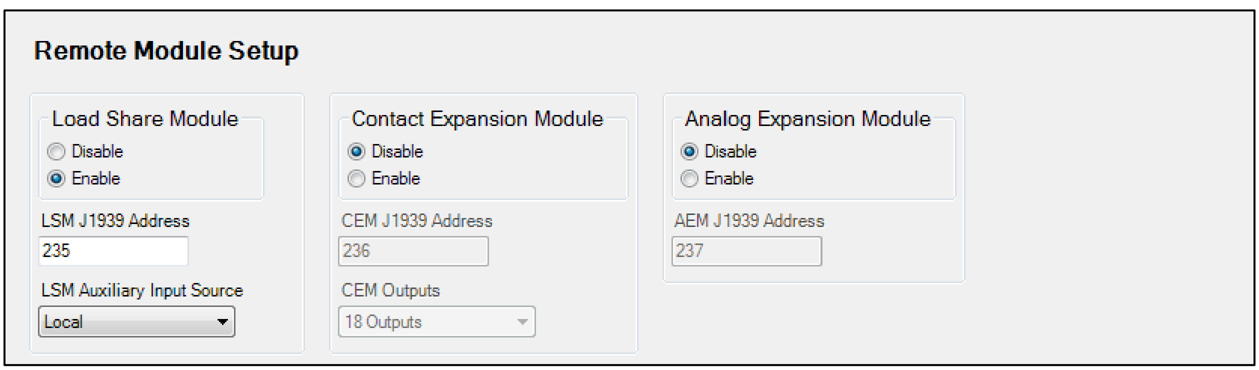

Figure 7-6. Settings Explorer, System Parameters, Remote Module Setup Screen

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. 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.
8. 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.

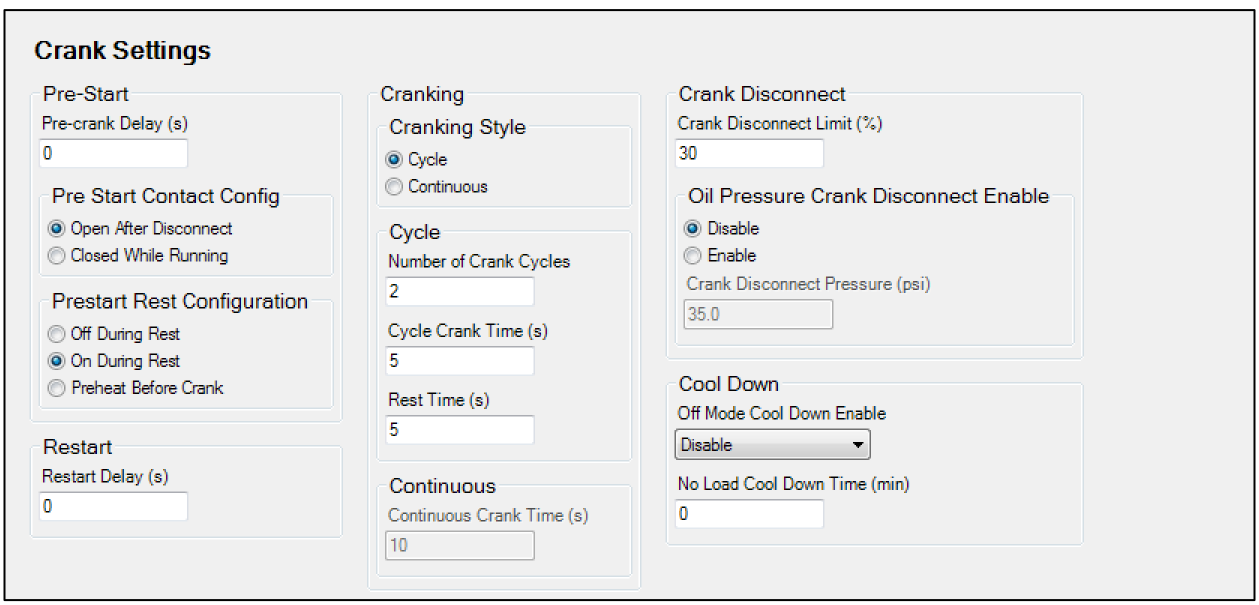

Figure 7-7. Settings Explorer, System Parameters, Crank Settings Screen

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.

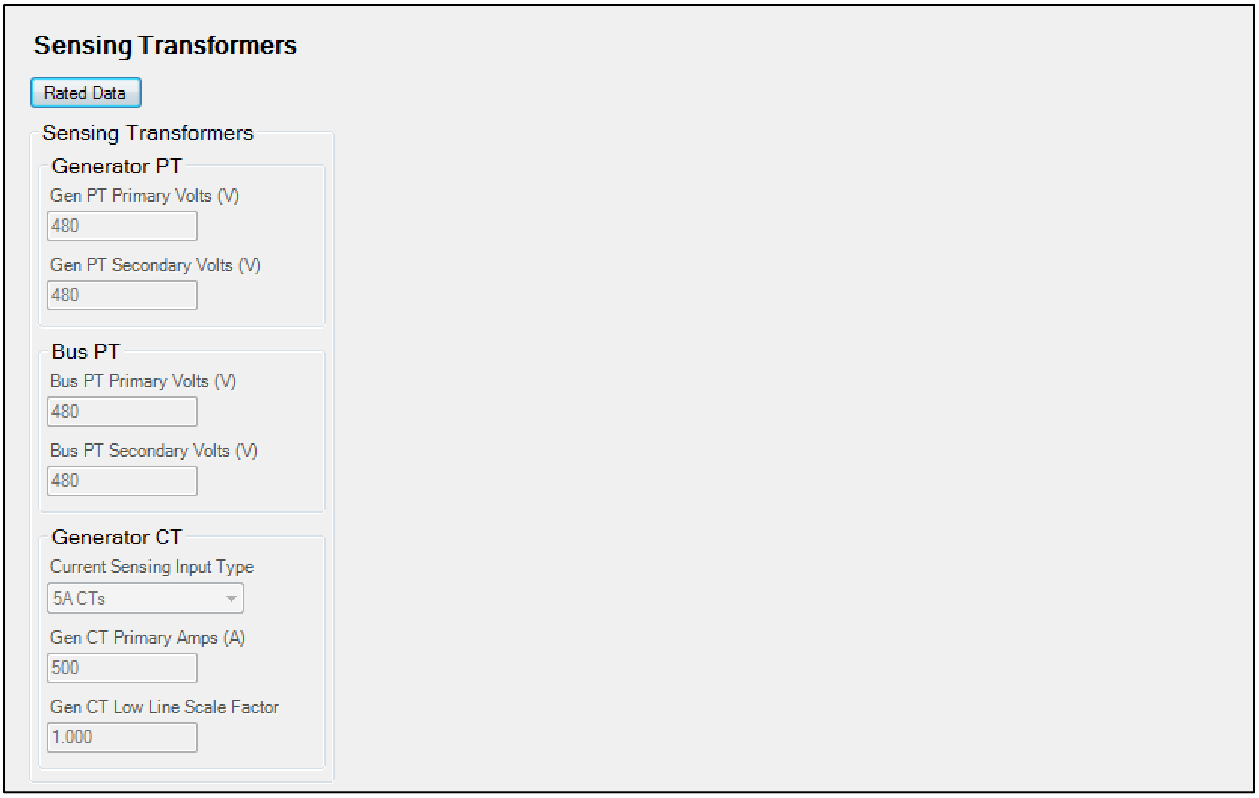

Figure 7-8. Settings Explorer, System Parameters, Sensing Transformers Screen

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.

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.

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.

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.

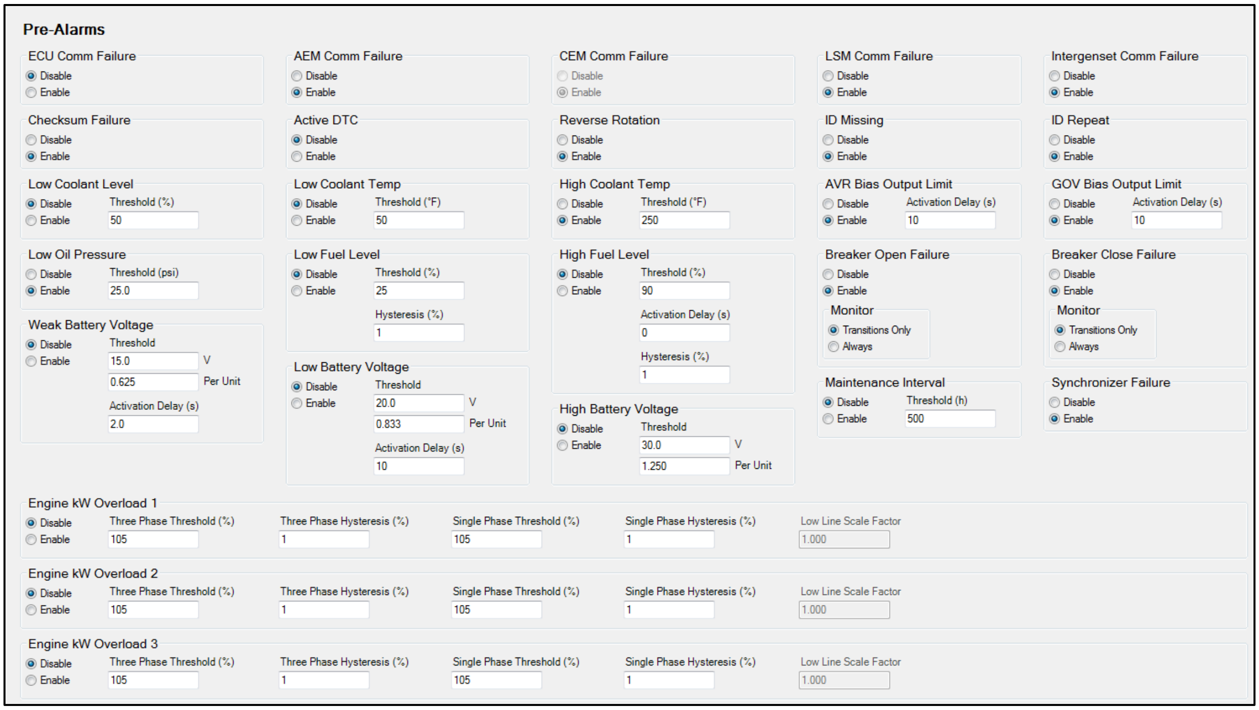

Figure 7-12. Settings Explorer, Alarm Configuration, Pre-Alarms Screen

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, *BESTCOMSPlus® Software,* for additional information regarding alarm configuration. See Figure 7-13.

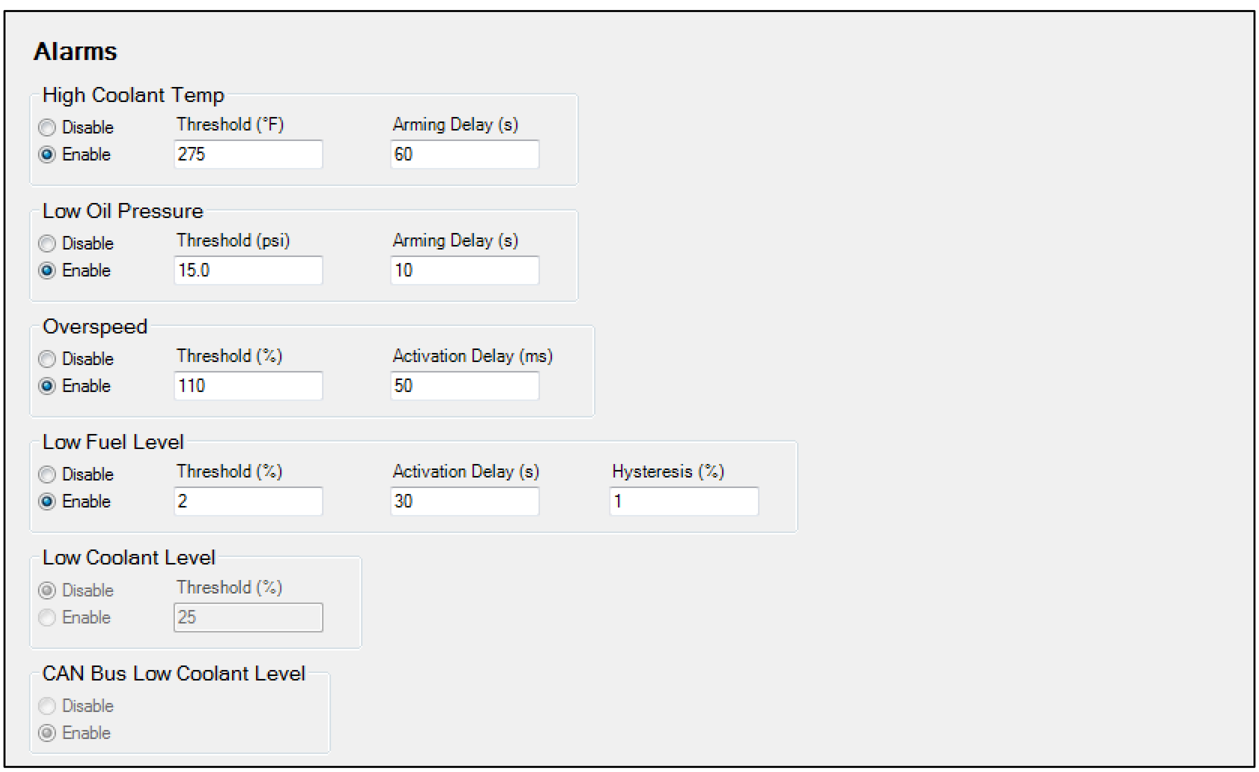

Figure 7-13. Settings Explorer, Alarm Configuration, Alarms Screen

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.

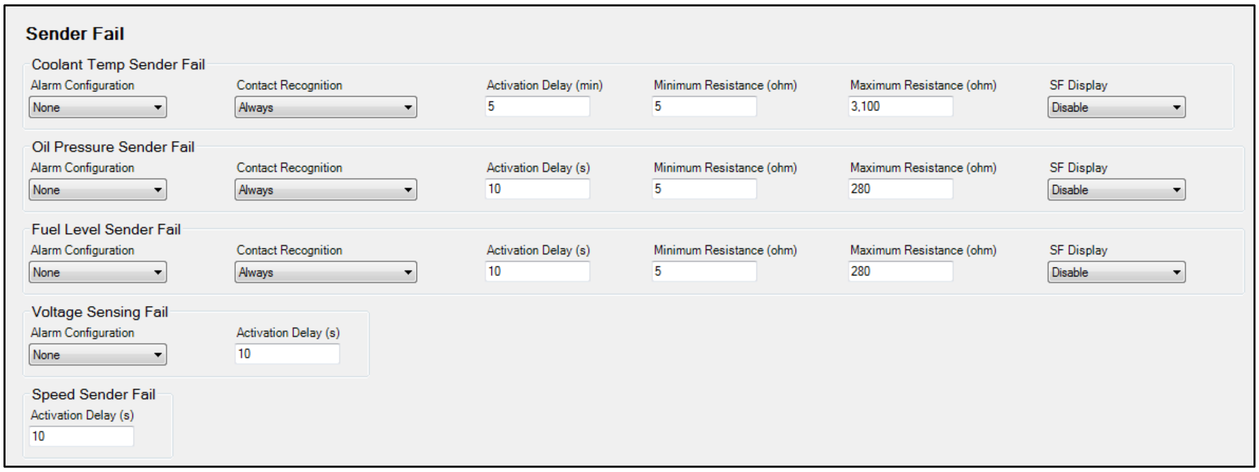

Figure 7-14. Settings Explorer, Alarm Configuration, Sender Fail Screen

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 BESTCOMS*Plus*® 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 BESTCOMS*Plus*® to send the sender settings to the DGC-2020.

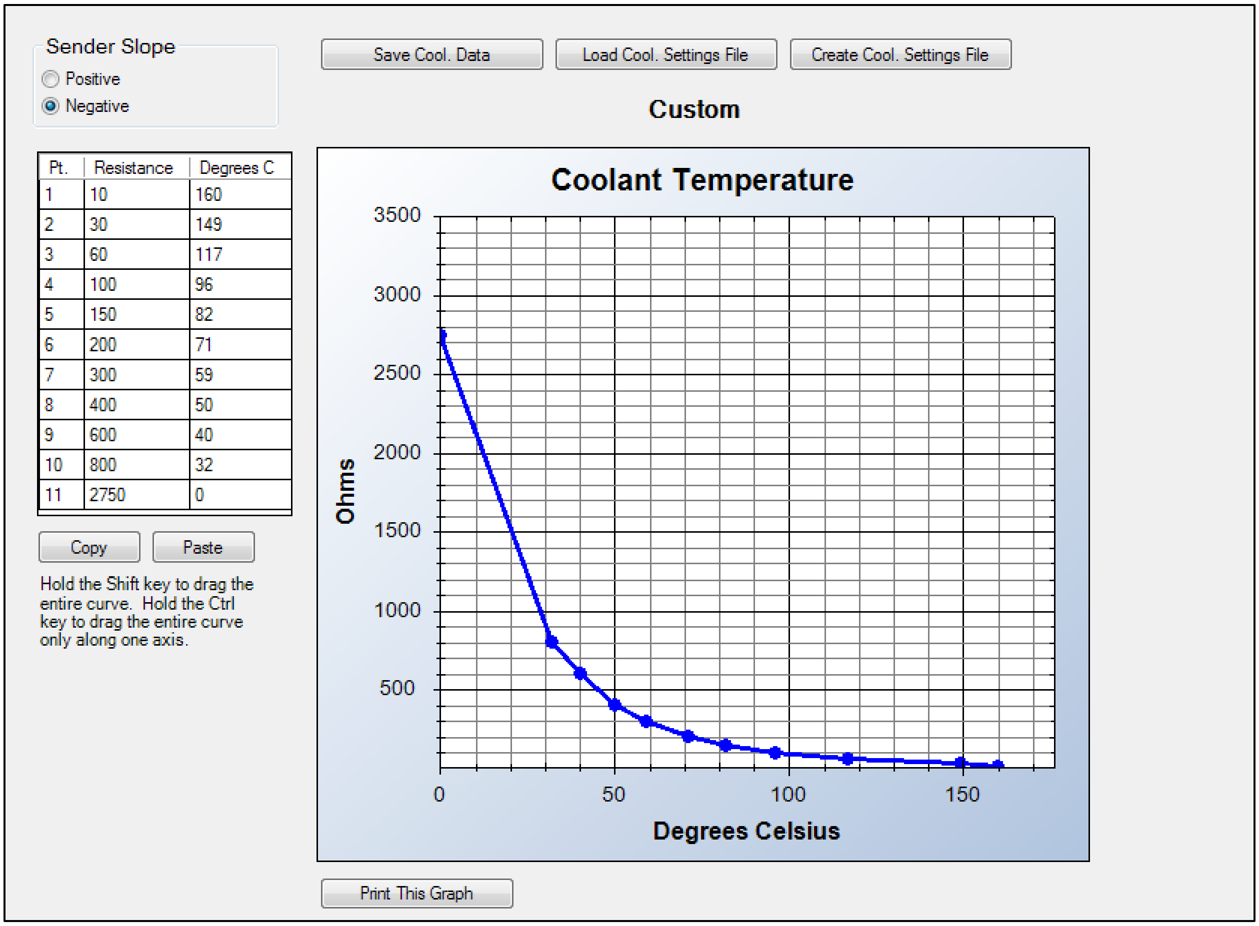

Figure 7-15. Settings Explorer, Programmable Senders, Coolant Temperature Screen

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 BESTCOMS*Plus*® 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 BESTCOMS*Plus*® to send the sender settings to the DGC-2020.

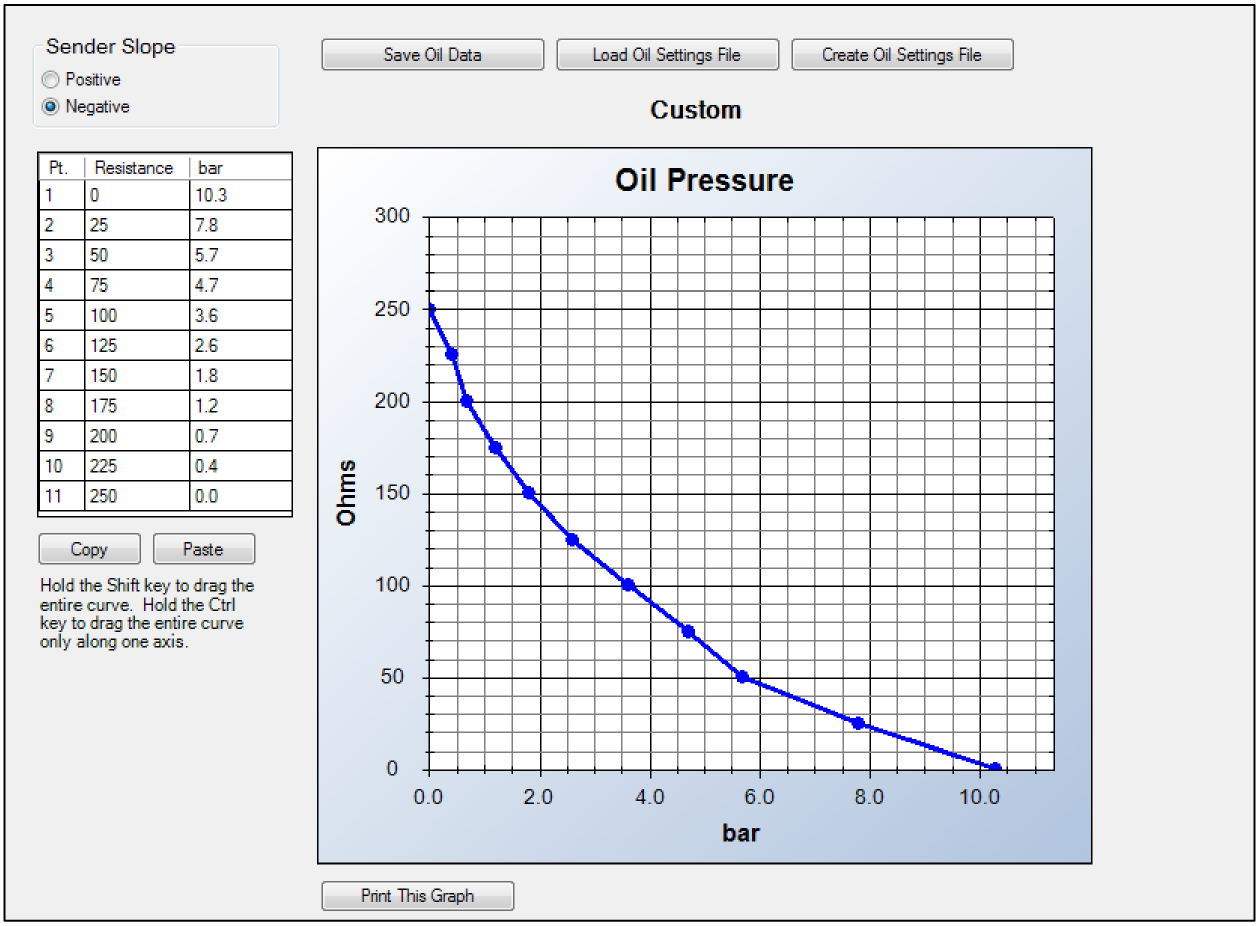

Figure 7-16. Settings Explorer, Programmable Senders, Oil Pressure Screen

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 BESTCOMS*Plus*® 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 BESTCOMS*Plus*® to send the sender settings to the DGC-2020.

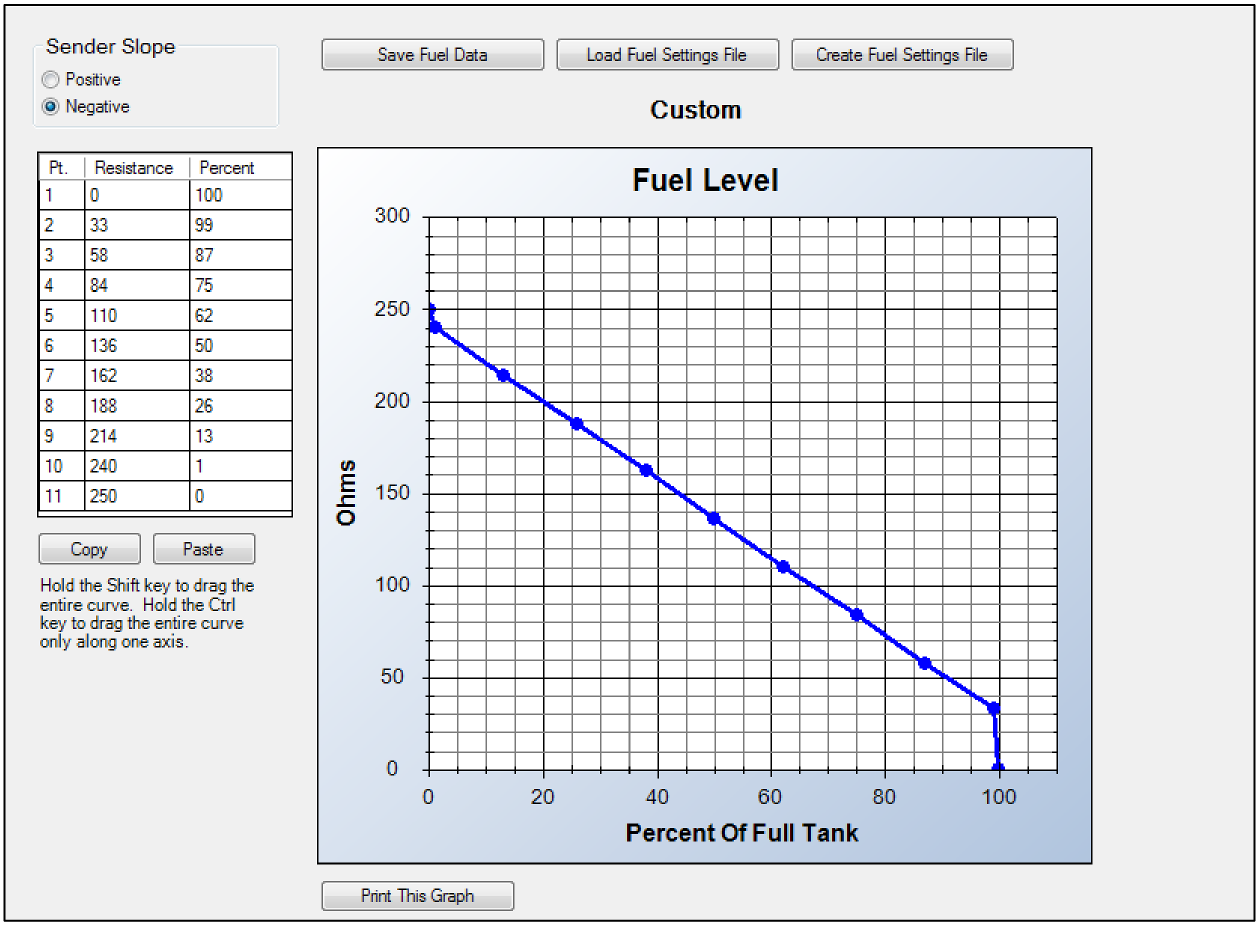

Figure 7-17. Settings Explorer, Programmable Senders, Fuel Level Screen

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 BESTCOMS*Plus*®. 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 ono 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. 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.
10. 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.
11. 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.
12. 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.

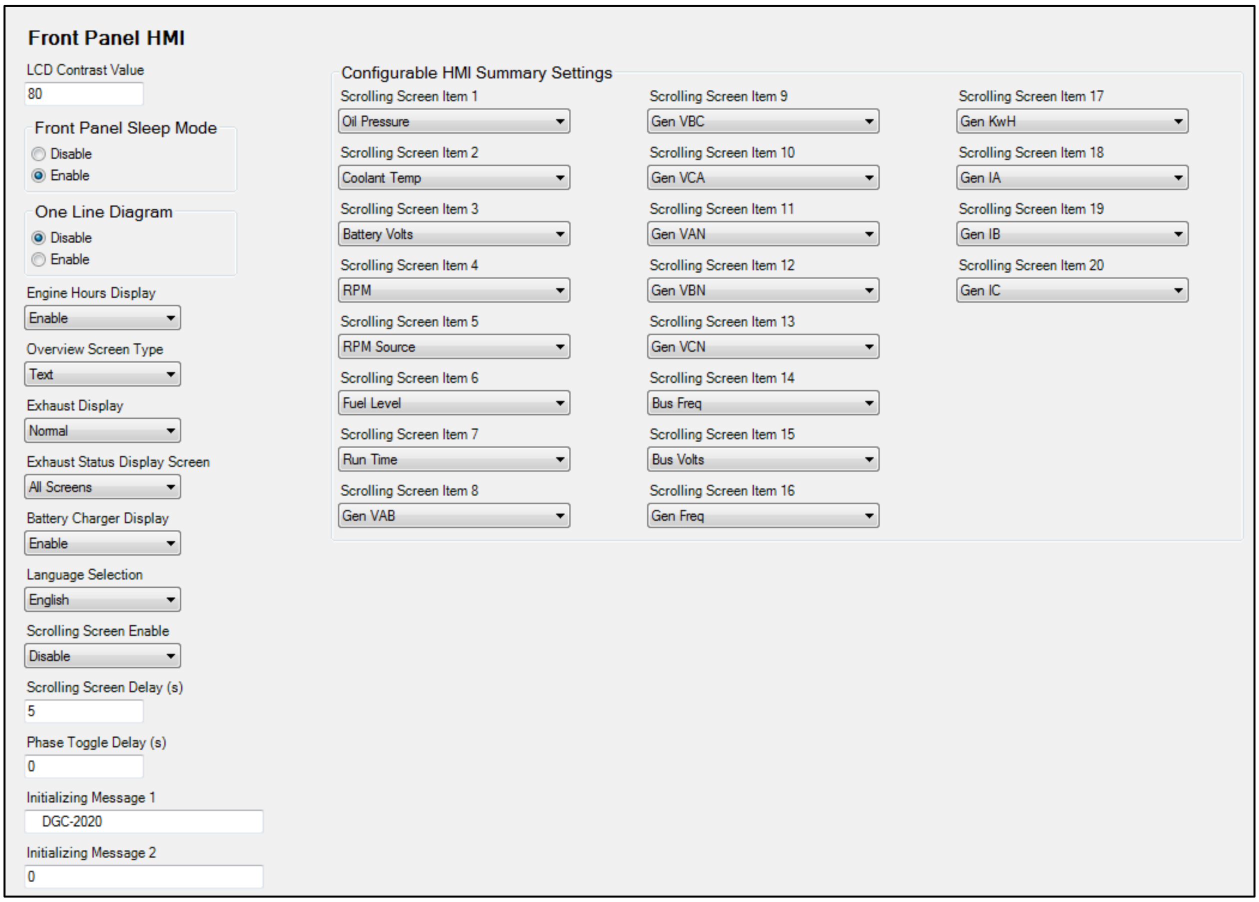

Figure 7-18. Settings Explorer, General Settings, Front Panel HMI Screen

Device Security Setup

If passwords other than default are desired, use BESTCOMS*Plus*® 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.

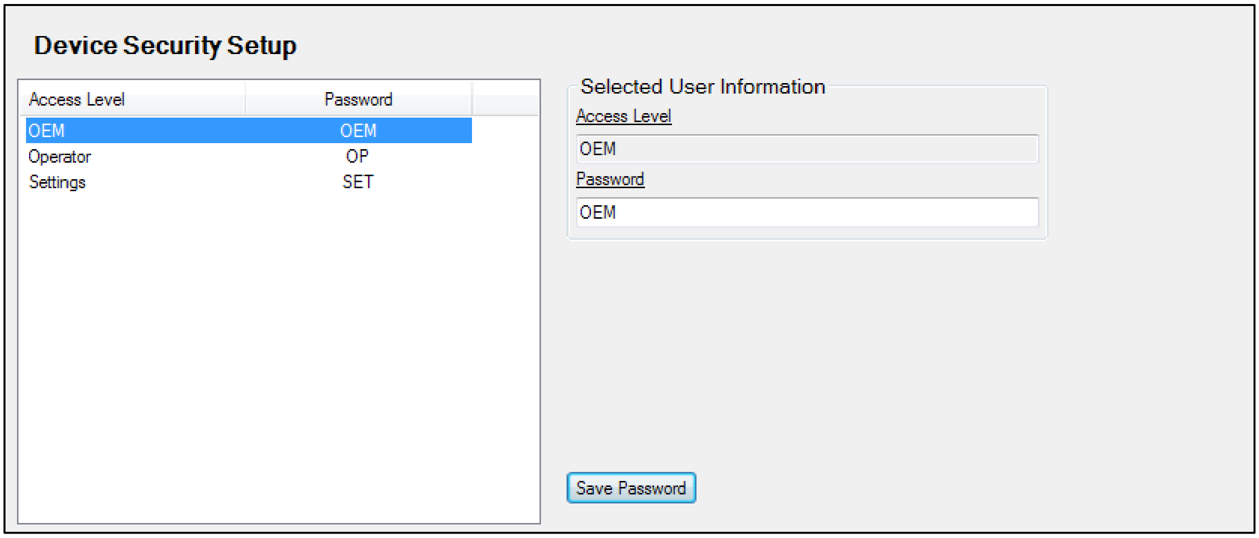

Figure 7-19. Settings Explorer, General Settings, Device Security Setup Screen

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.

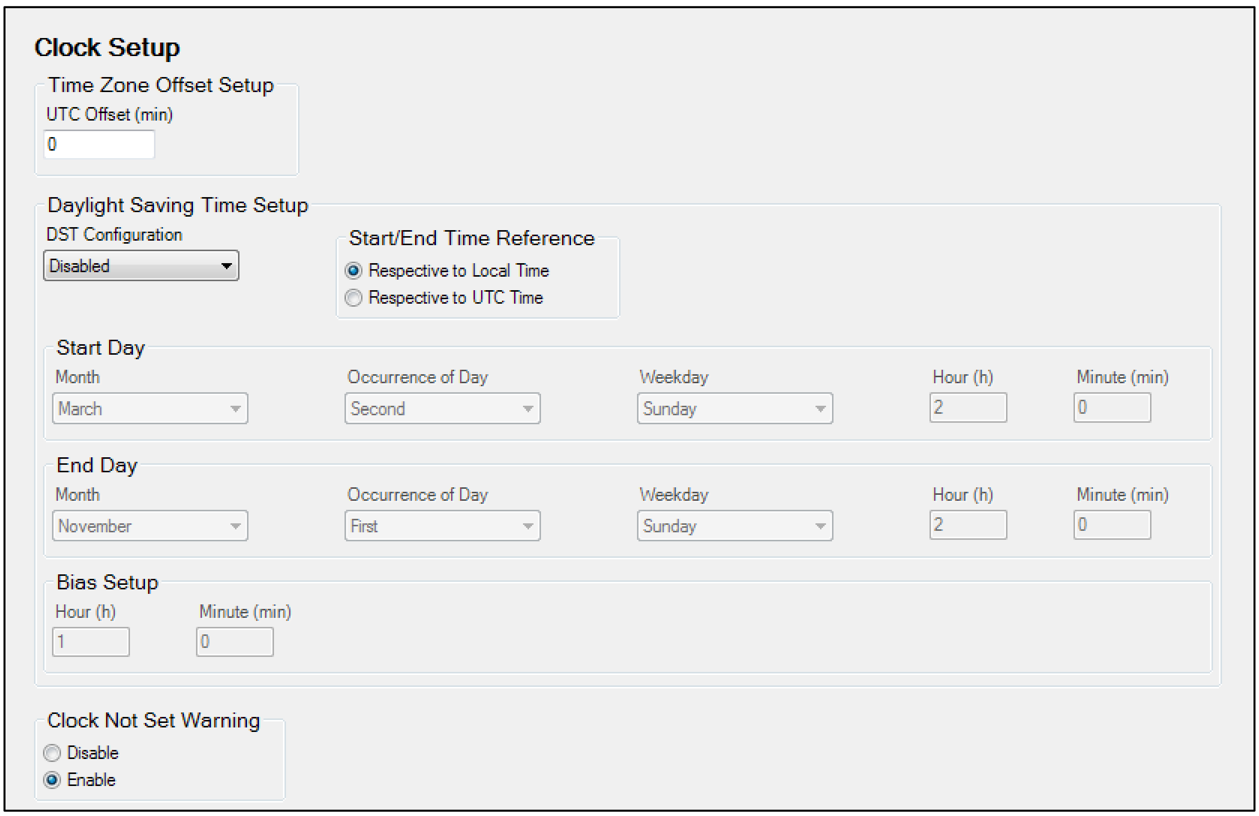

Figure 7-20. Settings Explorer, General Settings, Clock Setup Screen

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 BESTlogic*Plus* Programmable Logic. They also contain dry contact relay outputs, which are driven by the BESTlogic*Plus* 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 BESTlogic*Plus* 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 BESTCOMS*Plus*® 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.

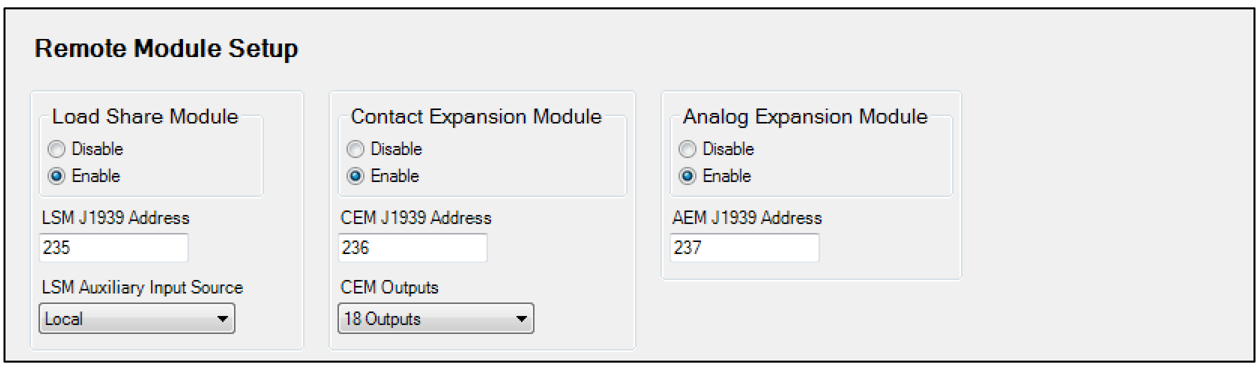

Figure 7-21. Settings Explorer, System Parameters, Remote Module Setup Screen

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

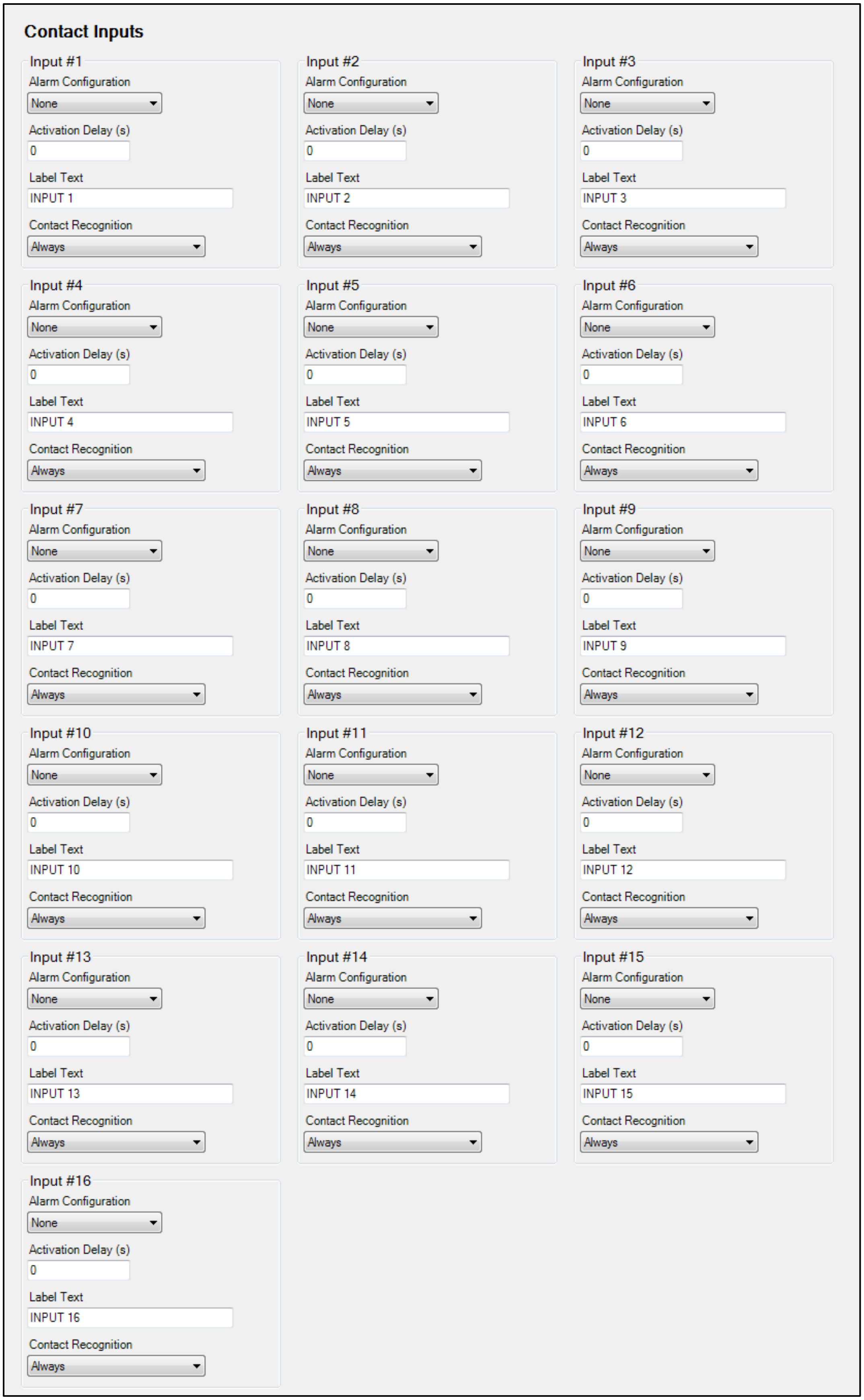

Figure 7-22. Settings Explorer, Programmable Inputs, Contact Inputs Screen

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 BESTlogic*Plus* 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 BESTlogic*Plus* 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).

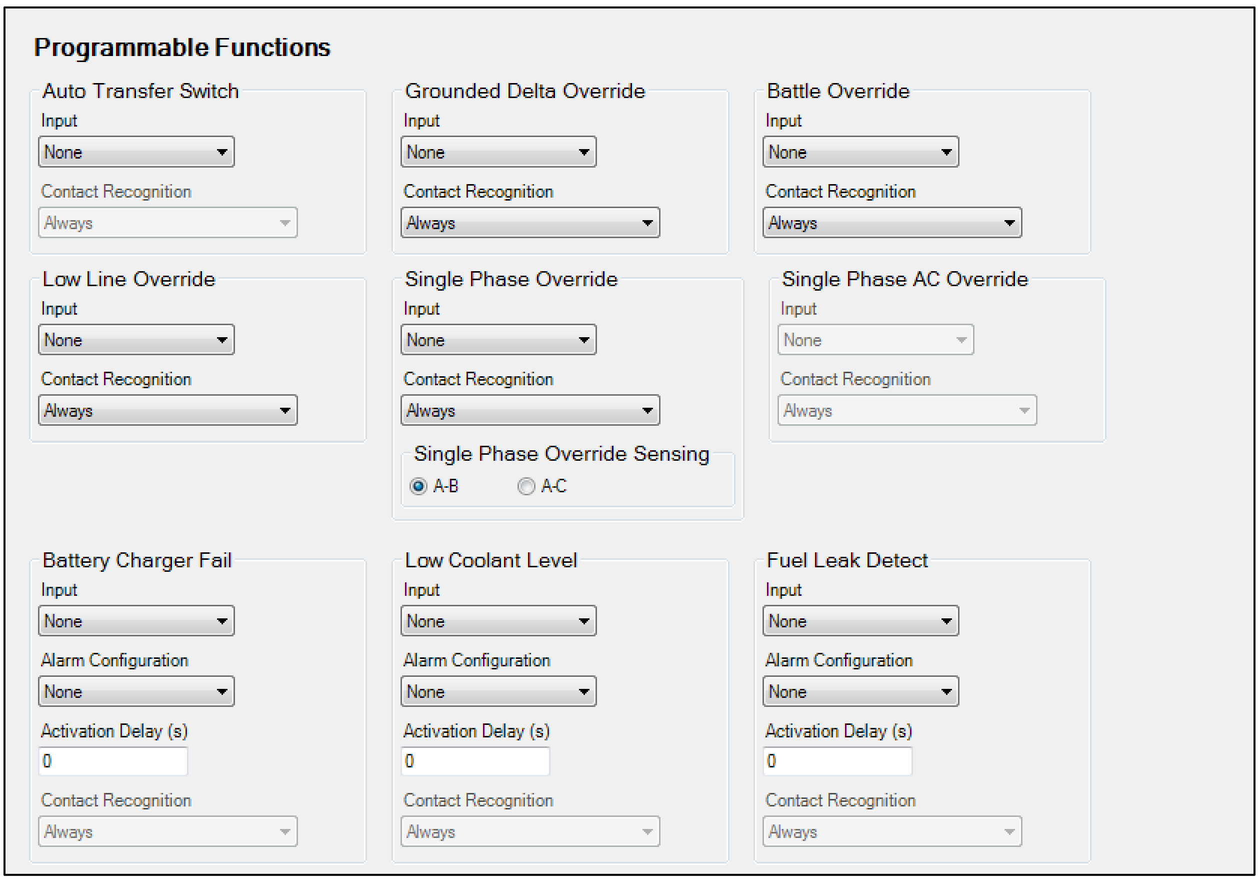

Figure 7-23. Settings Explorer, Programmable Inputs, Programmable Functions Screen

Configure the following parameters:

1. Auto Transfer Switch
    a. Input - This function is used to start the generator from a contact input when the DGC-2020 is in Auto mode. Select the desired input or select *None* to disable the programmable function.
    b. 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, *BESTCOMSPlus® 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 BESTCOMS*Plus*®. See Figure 7-24.

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 BESTlogic*Plus* 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 BESTlogic*Plus* 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.

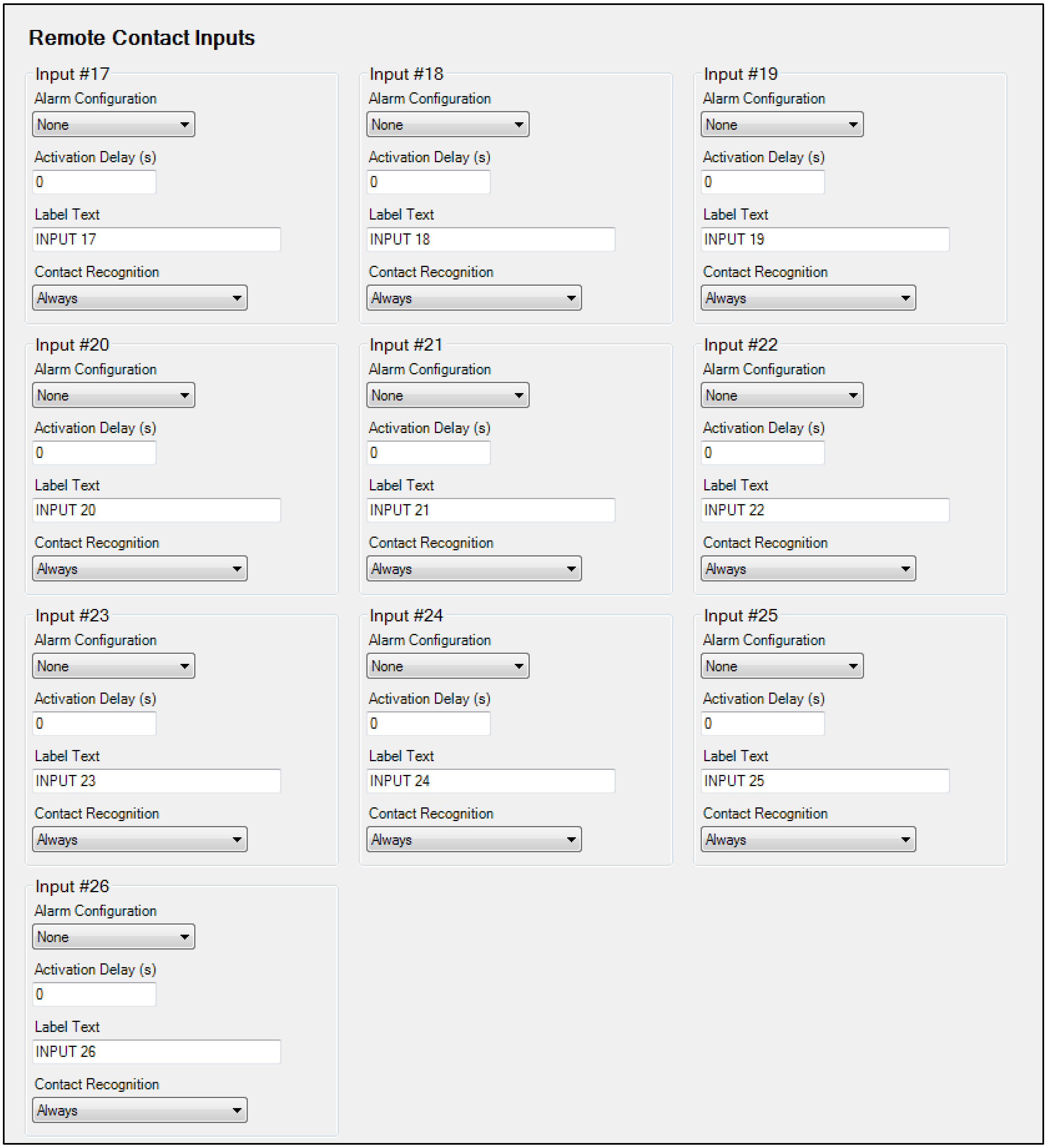

Figure 7-25. Settings Explorer, Programmable Inputs, Remote Contact Inputs Screen

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.

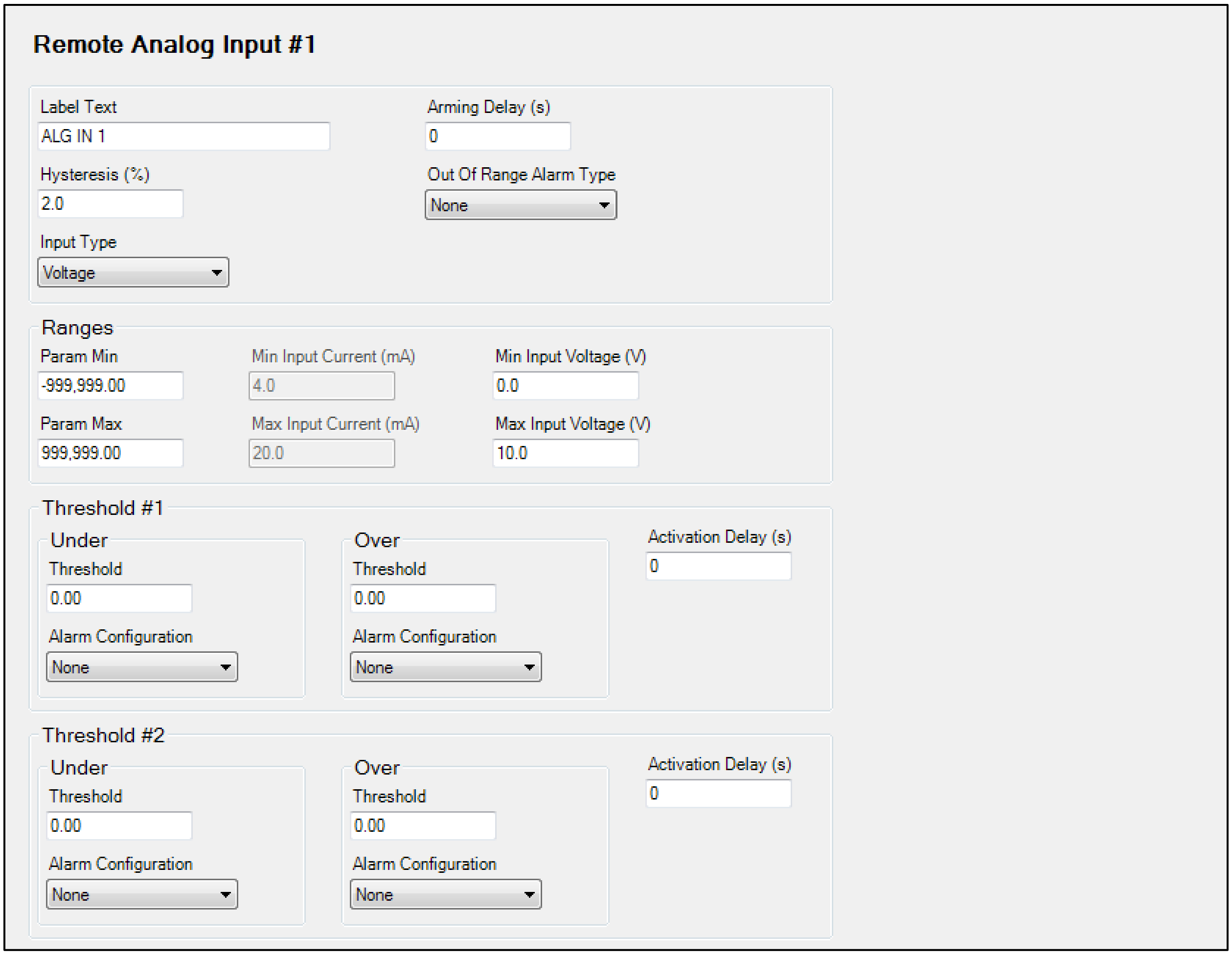

Figure 7-26. Settings Explorer, Programmable Inputs, Remote Analog Inputs Screen

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 BESTlogic*Plus* 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 BESTlogic*Plus* 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 BESTlogic*Plus* 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 BESTlogic*Plus* 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 BESTlogic*Plus* 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 BESTlogic*Plus* 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 BESTlogic*Plus* 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.

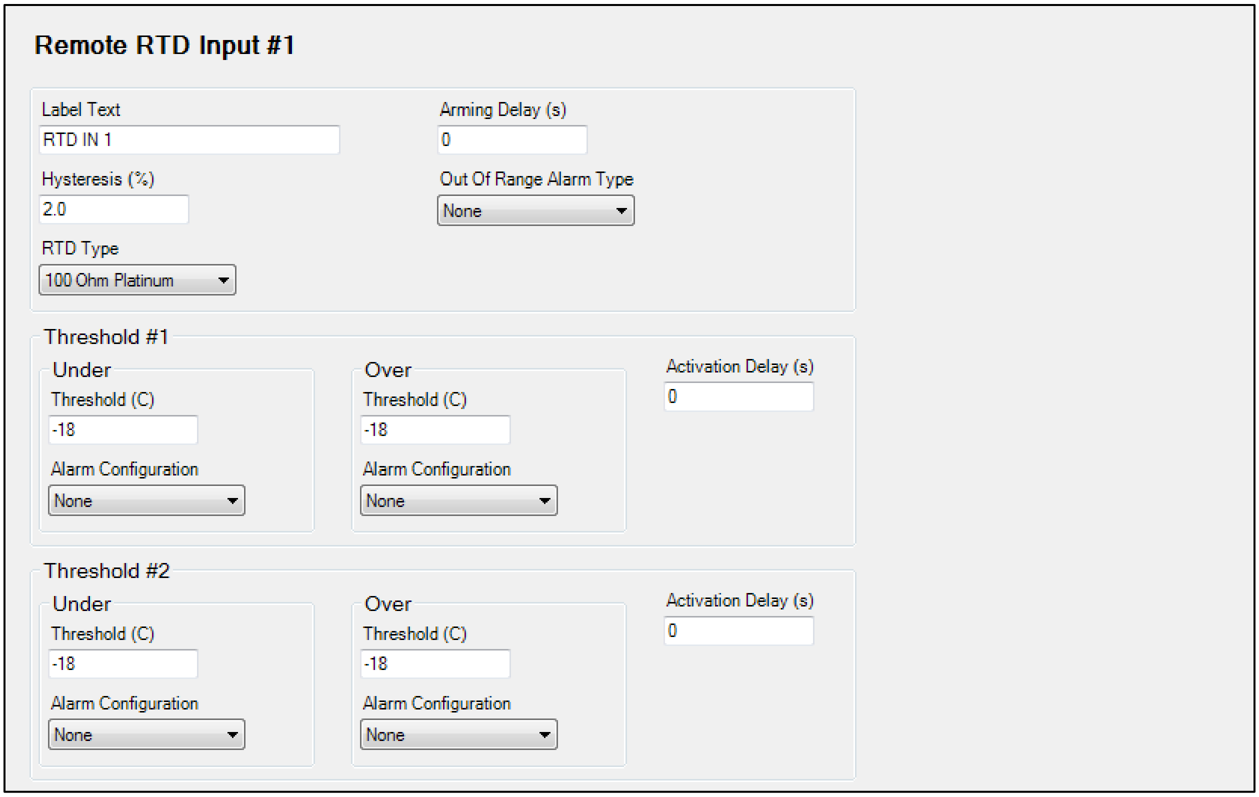

Figure 7-27. Settings Explorer, Programmable Inputs, Remote RTD Inputs Screen

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 BESTlogic*Plus* 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 BESTlogic*Plus* 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

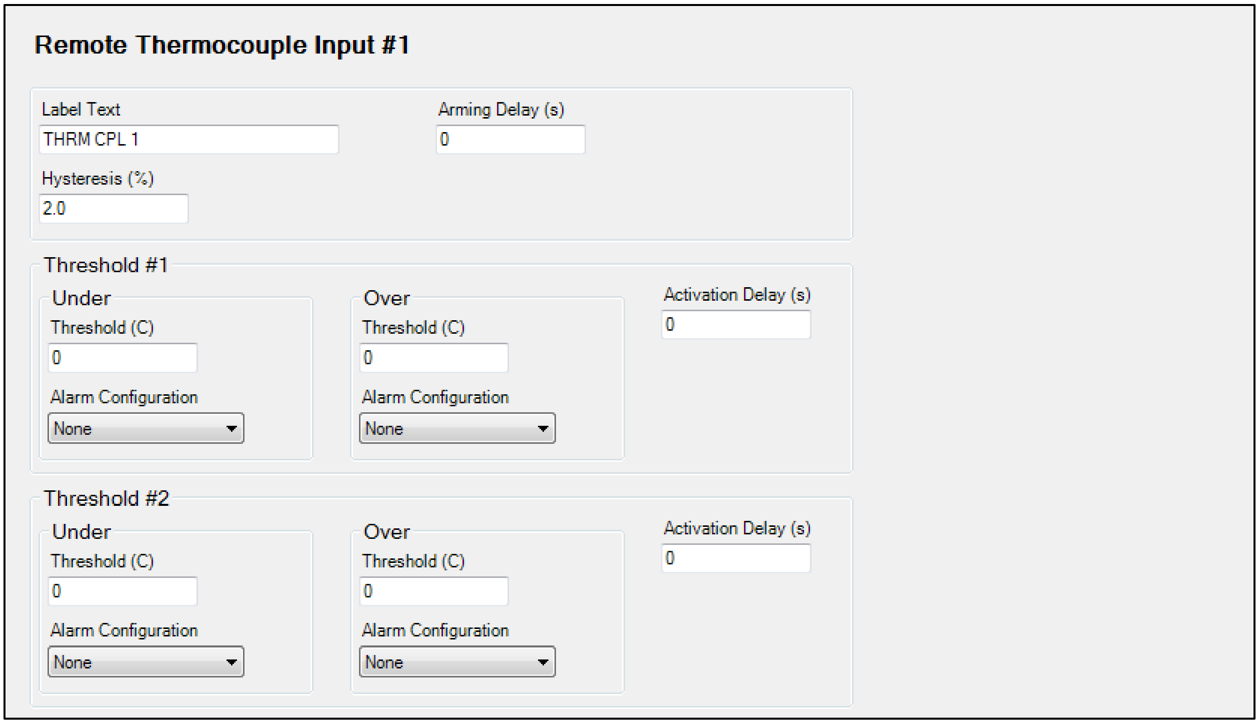

Figure 7-28. Settings Explorer, Programmable Inputs, Remote Thermocouple Inputs Screen

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 BESTlogic*Plus* 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 BESTlogic*Plus* 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

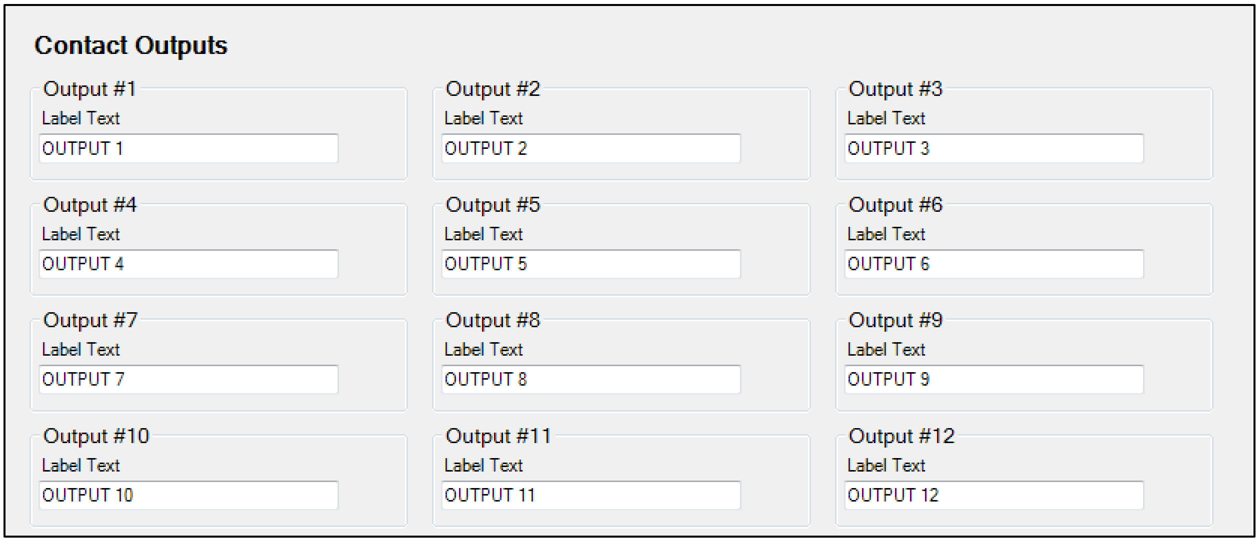

Figure 7-29. Settings Explorer, Programmable Outputs, Contact Outputs Screen

Each output can be programmed with a text label describing its use; this label appears in BESTlogic*Plus* 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 BESTlogic*Plus* 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.

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 BESTlogic*Plus* 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.

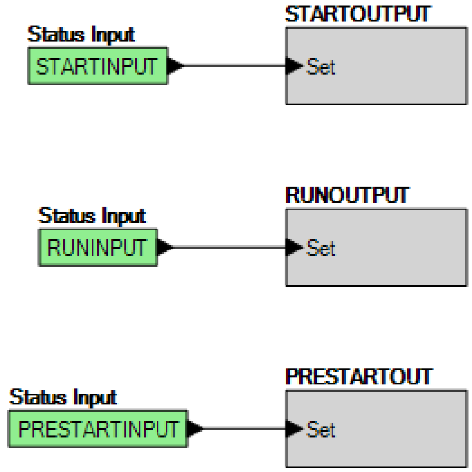

Figure 7-31. Logic Example of Programmable Relays

Setting Up Configurable Elements in the DGC-2020.

Configurable elements are used with BESTlogic*Plus* 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 BESTlogic*Plus* 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 BESTlogic*Plus* 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 BESTlogic*Plus* 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.

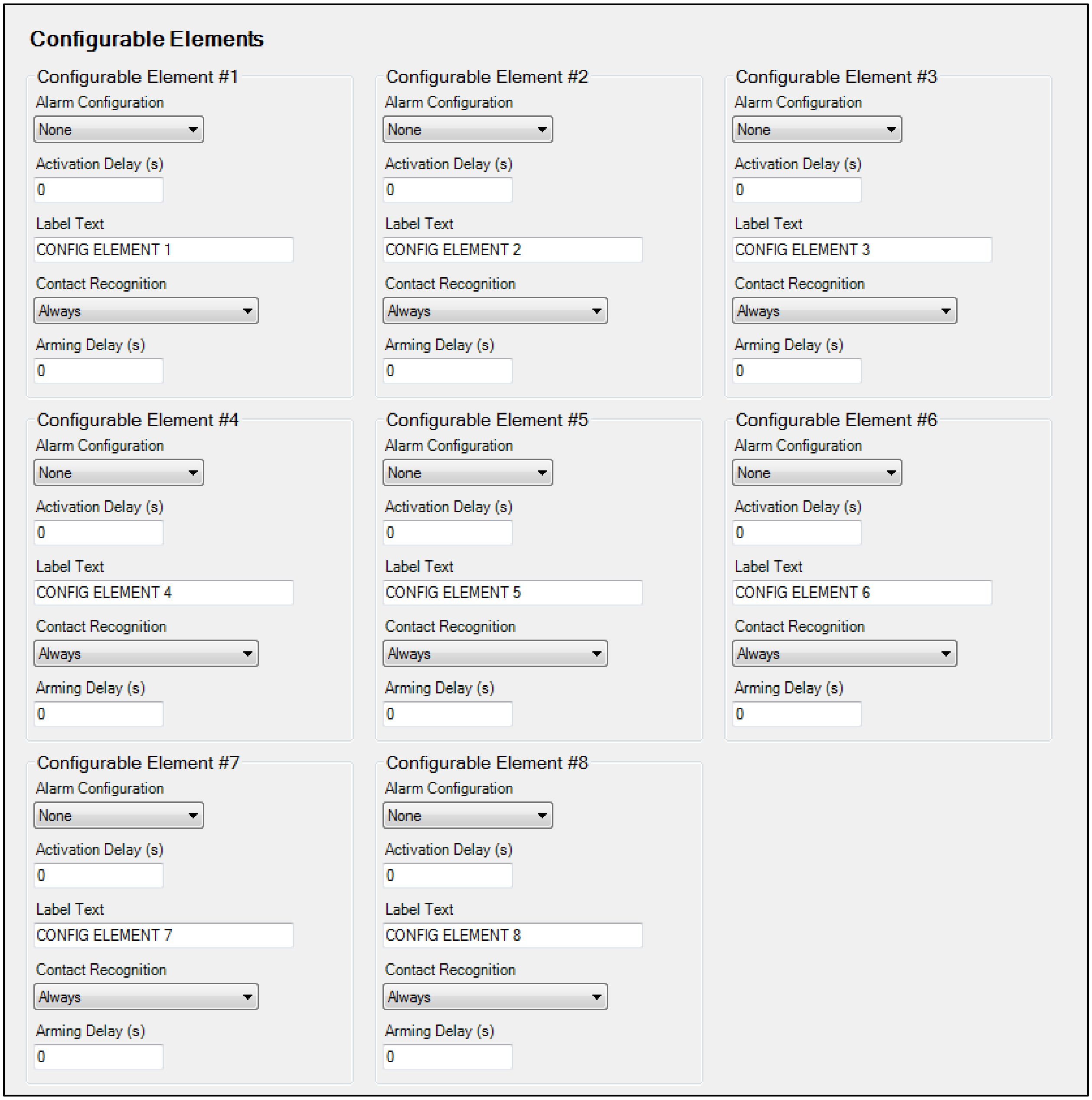

Figure 7-32. Settings Explorer, Programmable Outputs, Configurable Elements Screen

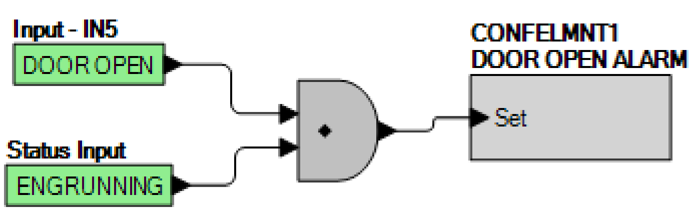

Figure 7-33. Using a Configurable Element Logic Diagram

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 BESTlogic*Plus* Programmable Logic where the output is used to aid in program clarity and ease of programming.

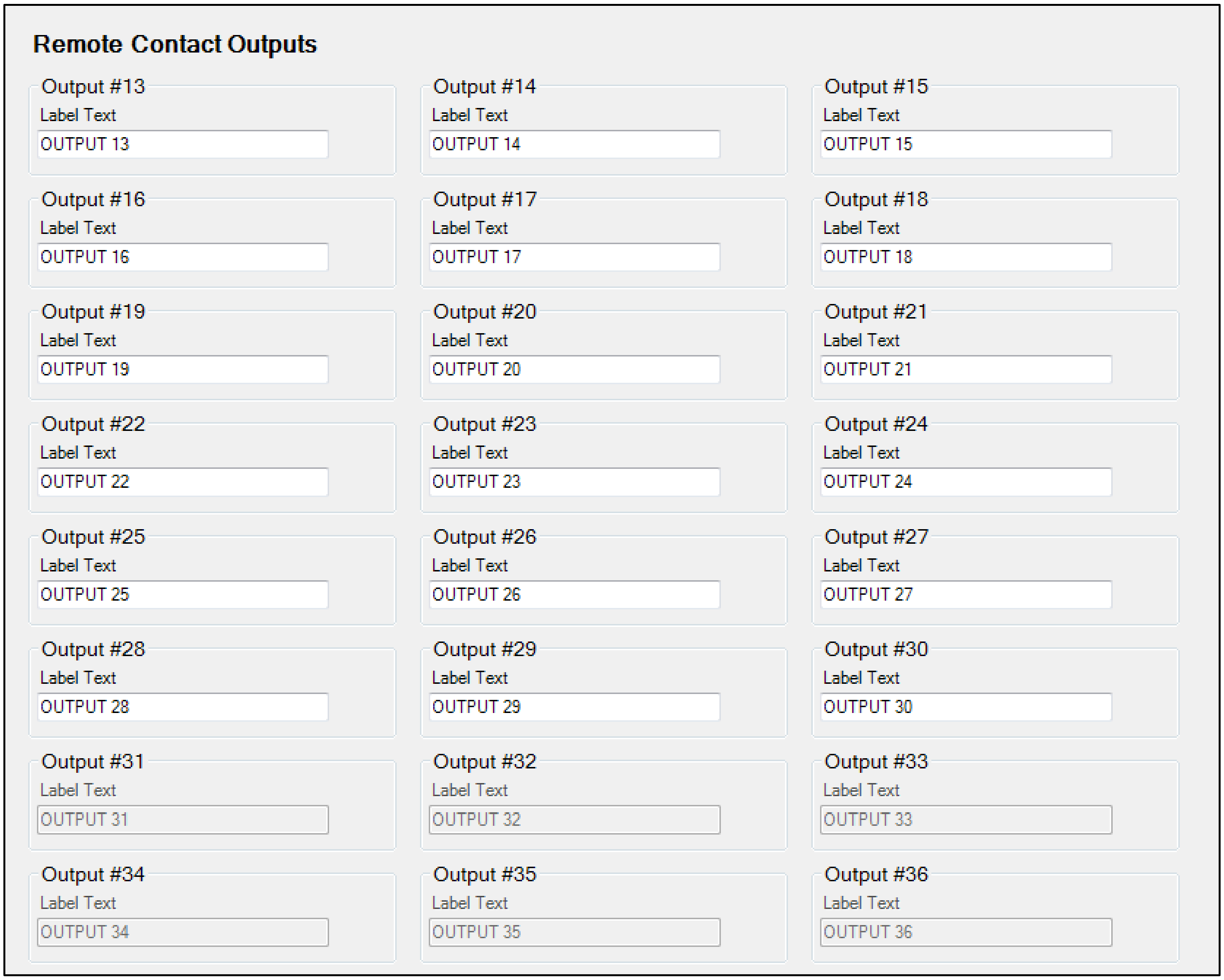

Figure 7-34. Settings Explorer, Programmable Outputs, Remote Contact Outputs Screen

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 BESTCOMS*Plus*®. 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.

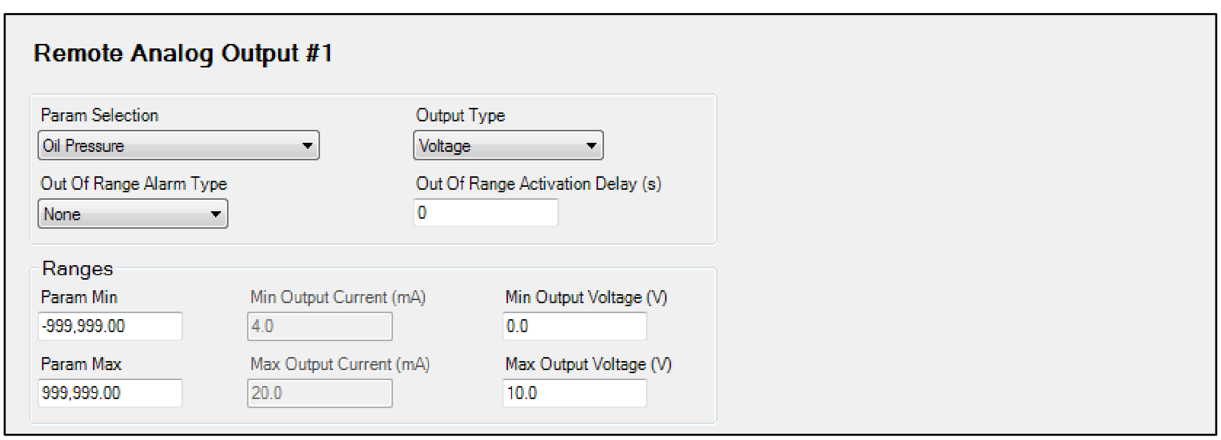

Figure 7-35. Settings Explorer, Programmable Outputs, Remote Analog Outputs Screen

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 BESTCOMS*Plus*® 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

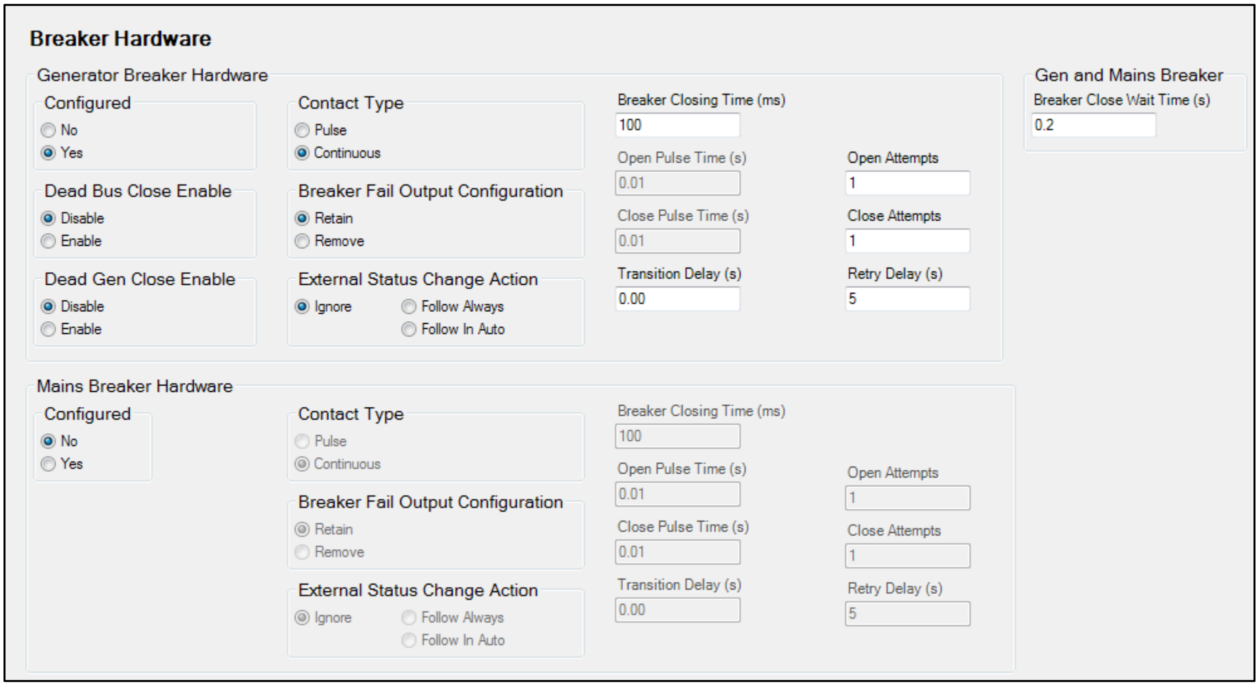

Figure 7-36. Settings Explorer, Breaker Management, Breaker Hardware Screen

   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 BESTlogic*Plus* Programmable Logic under SETTINGS EXPLORER > BESTlogic*Plus* PROGRAMMABLE LOGIC. See Figure 7-37.

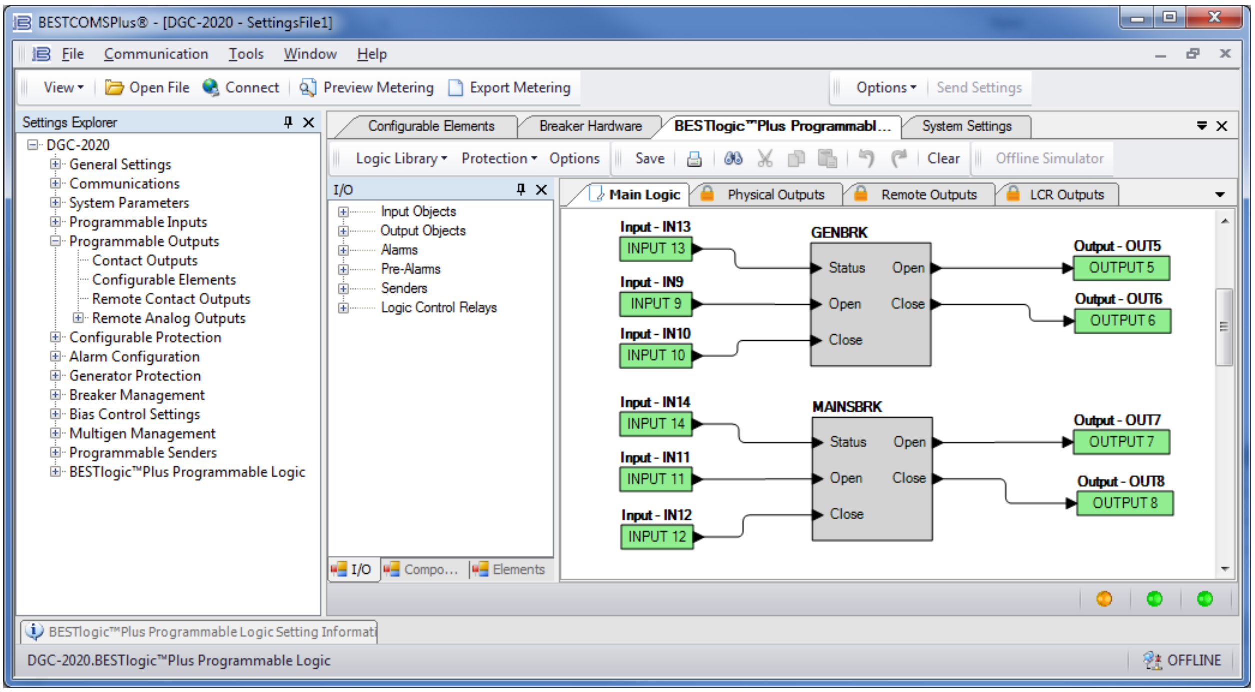

Figure 7-37. Settings Explorer, BESTlogicPlus Programmable Logic Settings

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.

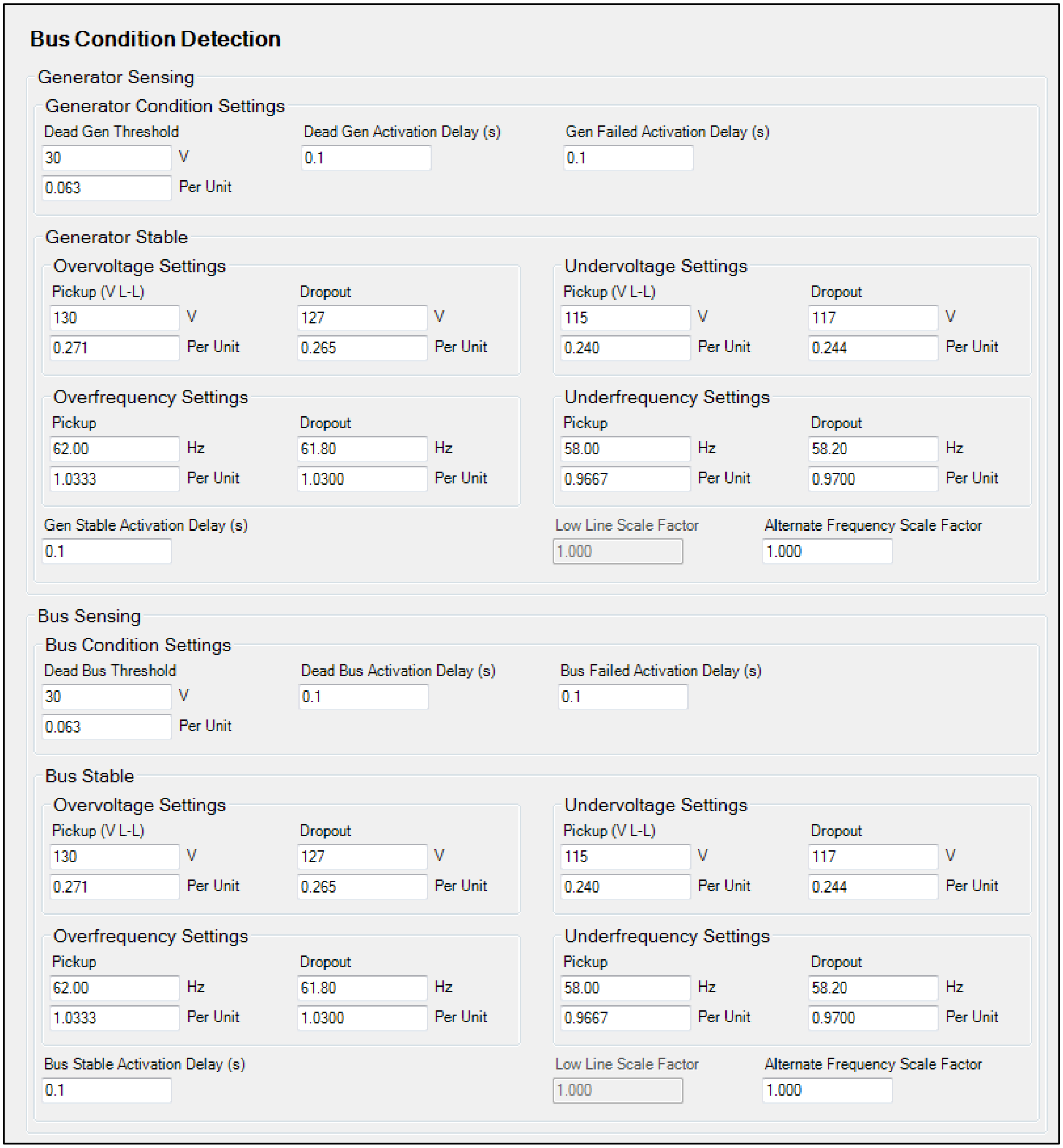

Figure 7-38. Settings Explorer, Breaker Management, Bus Condition Detection

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 BESTCOMS*Plus*®:

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

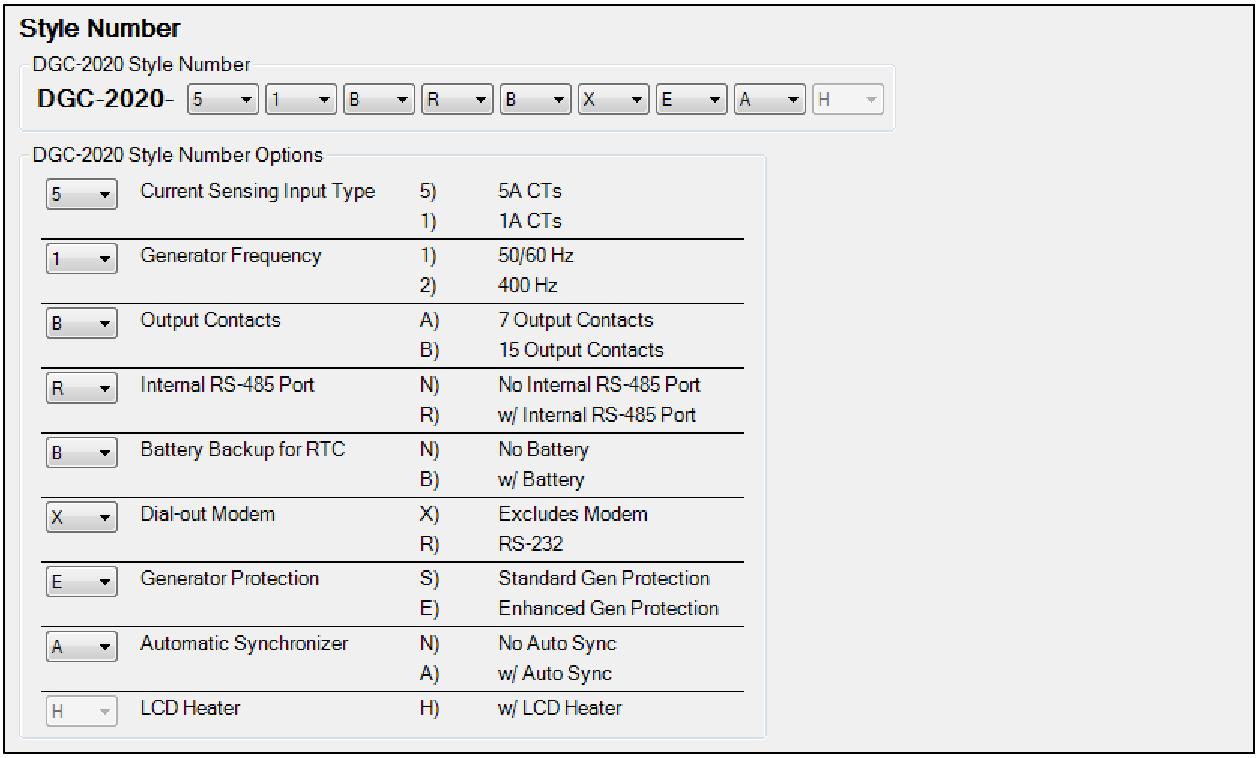

Figure 7-39. Settings Explorer, General Settings, Style Number Screen

2. If using a remote module to control the governor or voltage regulator i.e. LSM-2020 or CEM-2020, click on *System Parameter*s 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

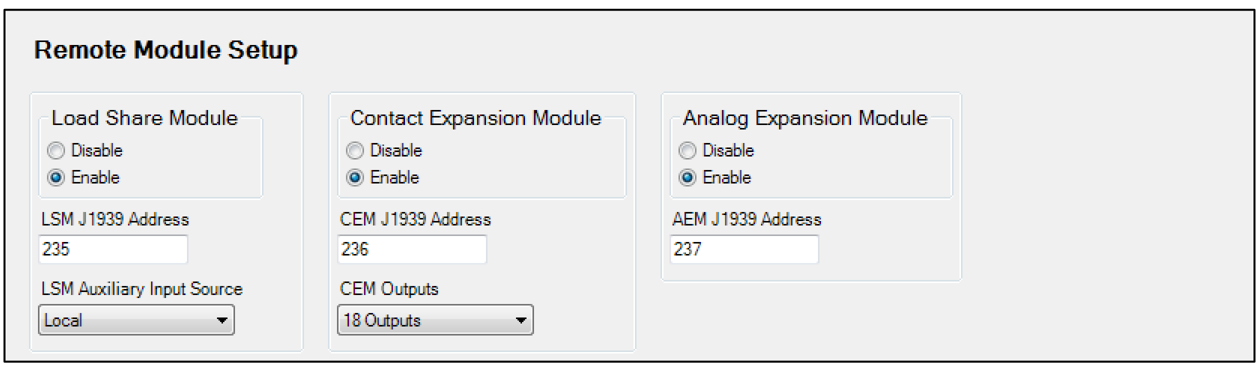

Figure 7-40. Settings Explorer, System Parameters, Remote Module Setup Screen

3. 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

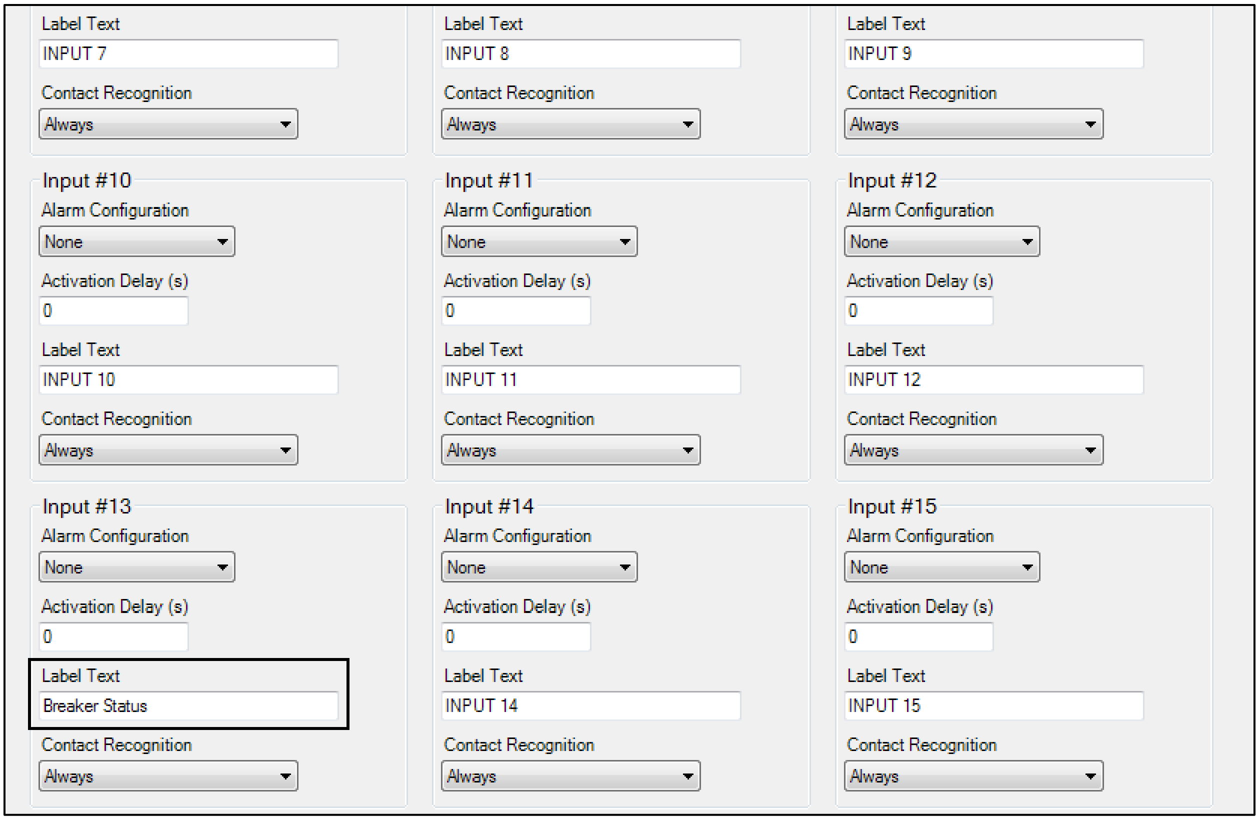

Figure 7-41. Settings Explorer, Programmable Inputs, Contact Inputs Screen

4. 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

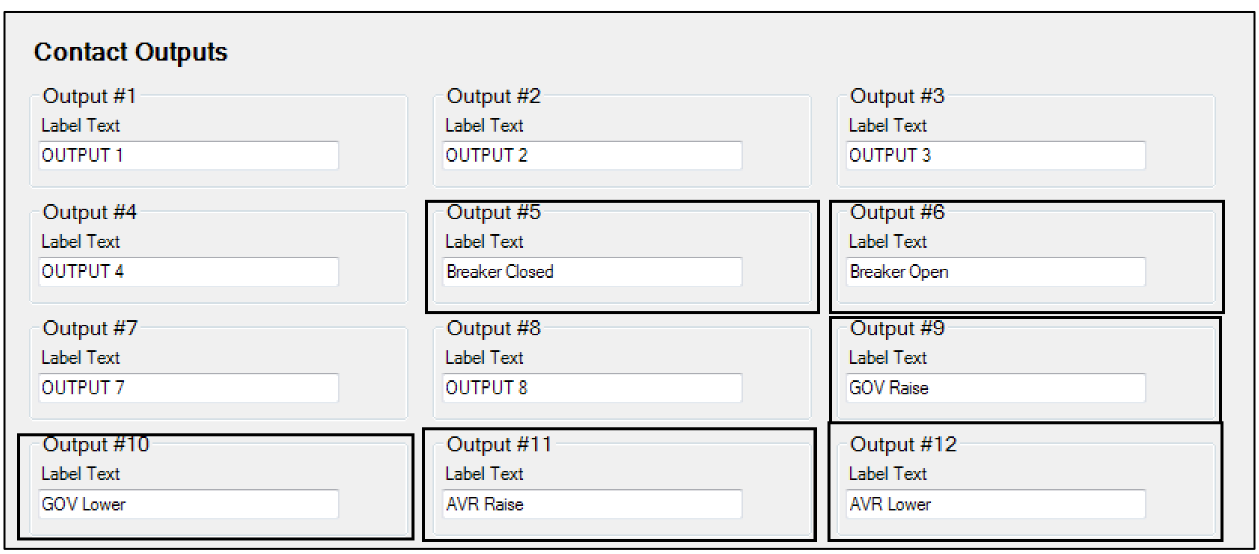

Figure 7-42. Settings Explorer, Programmable Outputs, Contact Outputs Screen

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.

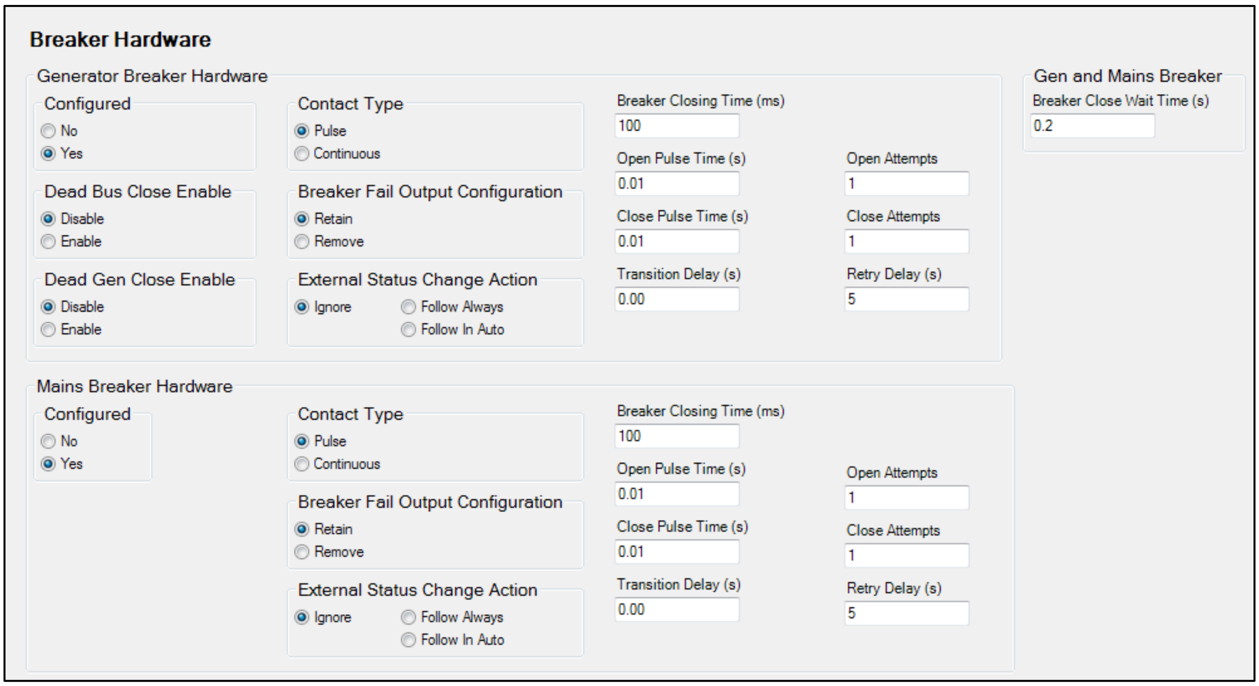

Figure 7-43. Settings Explorer, Breaker Management, Breaker Hardware Screen

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".

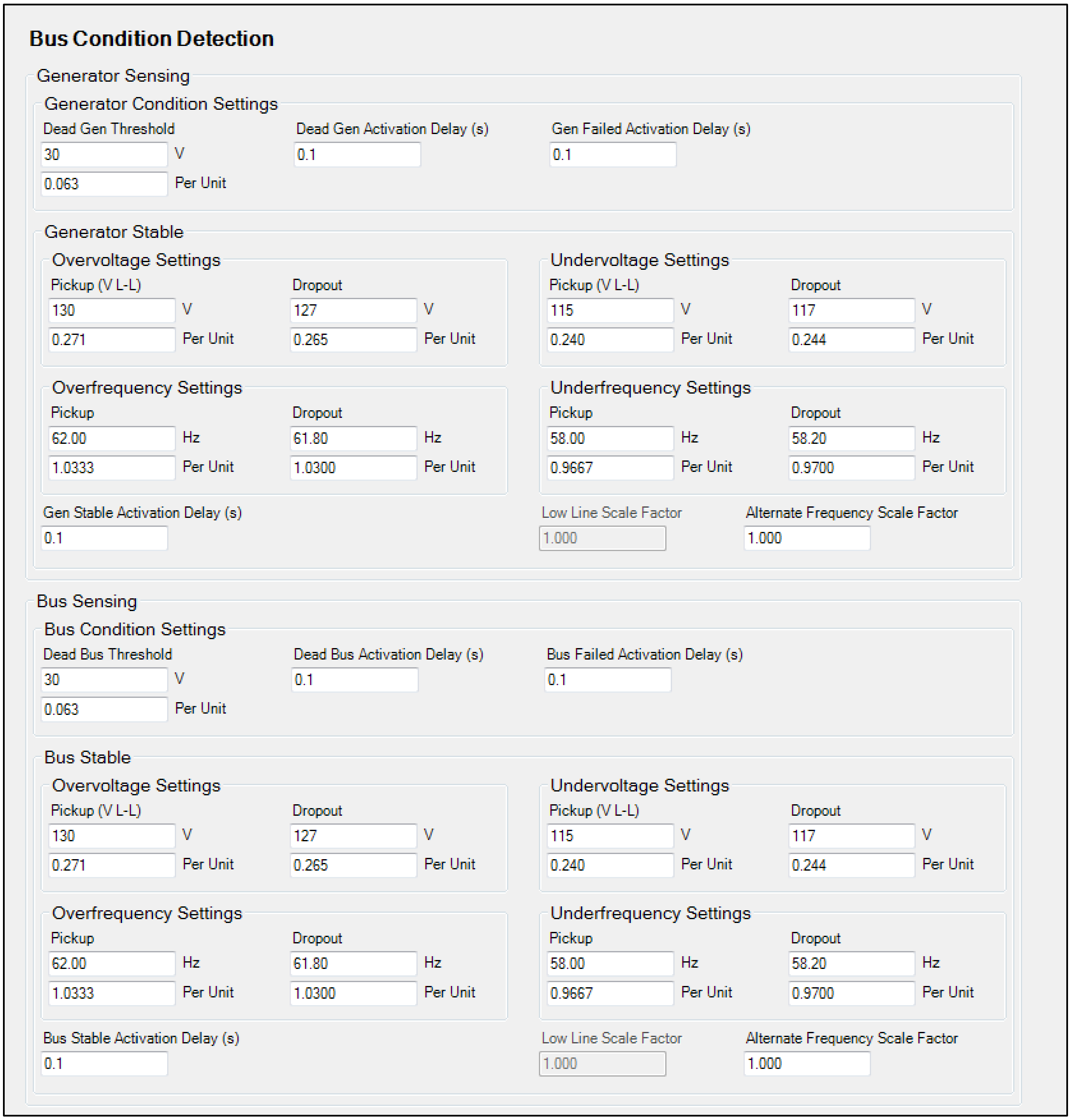

Figure 7-44. Settings Explorer, Breaker Management, Bus Condition Detection Screen

7. 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

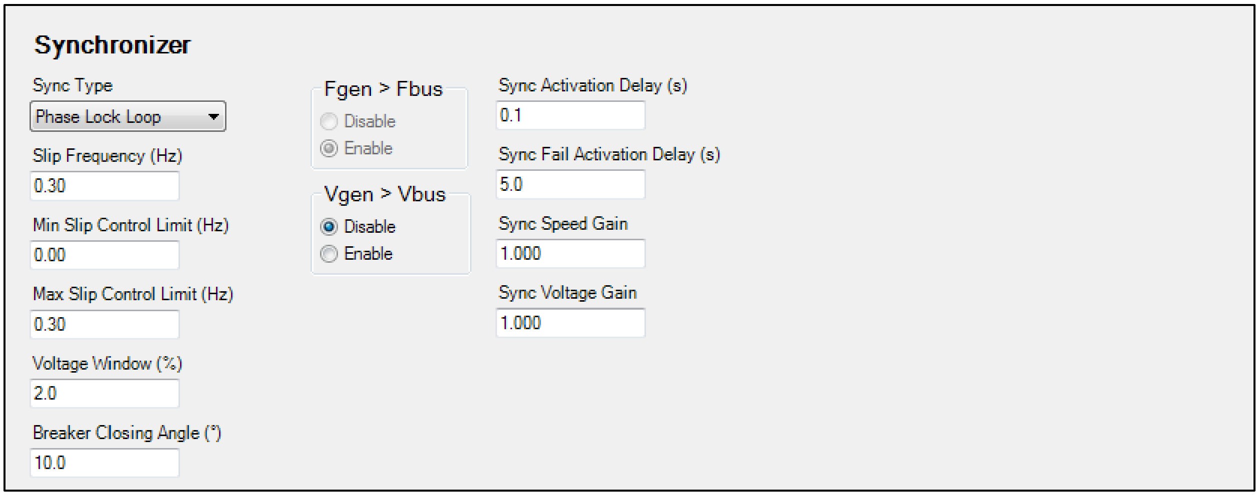

Figure 7-45. Settings Explorer, Breaker Management, Synchronizer Screen

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

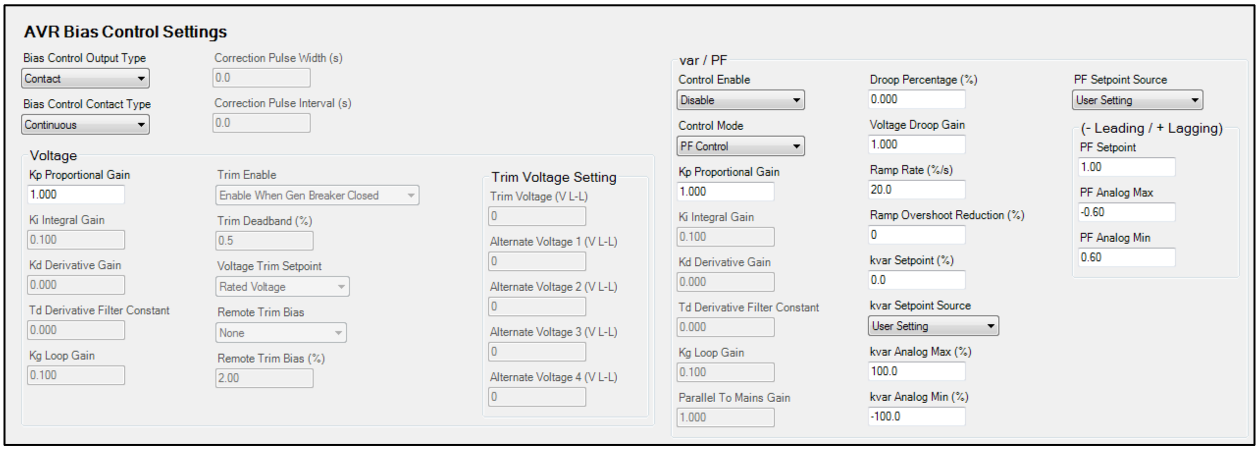

Figure 7-46. Settings Explorer, Bias Control Settings, AVR Bias Control Settings Screen

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

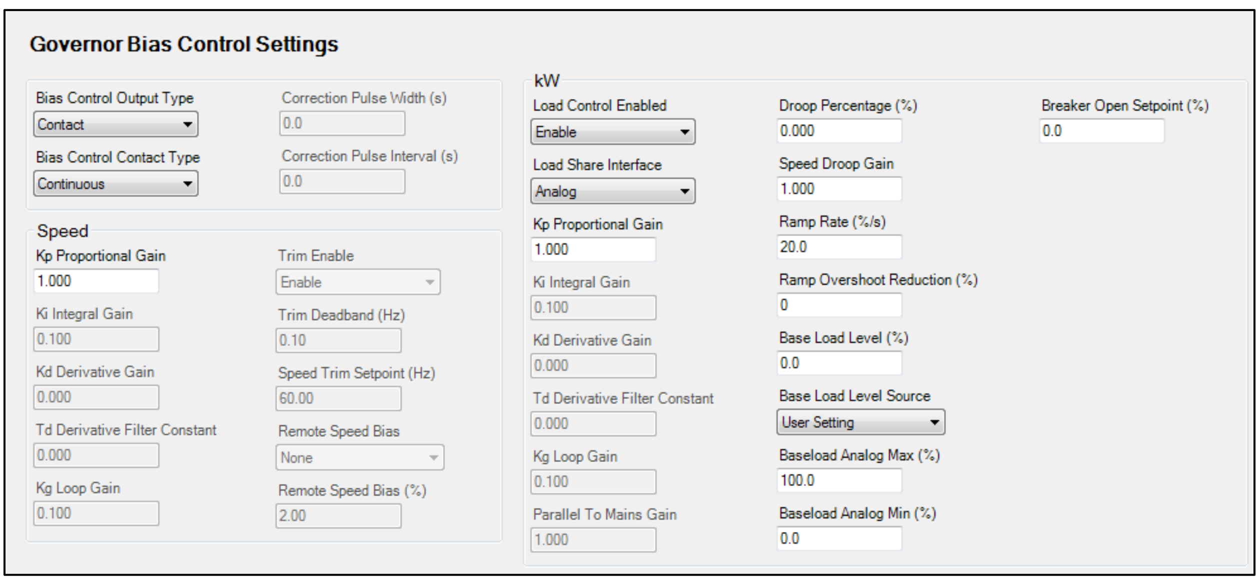

Figure 7-47. Settings Explorer, Bias Control Settings, Governor Bias Control Settings Screen

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

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

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 BESTlogic*Plus* Programmable Logic, click on the *Elements* tab and drag the Gen Breaker element into your main logic. See Figure 7-50.

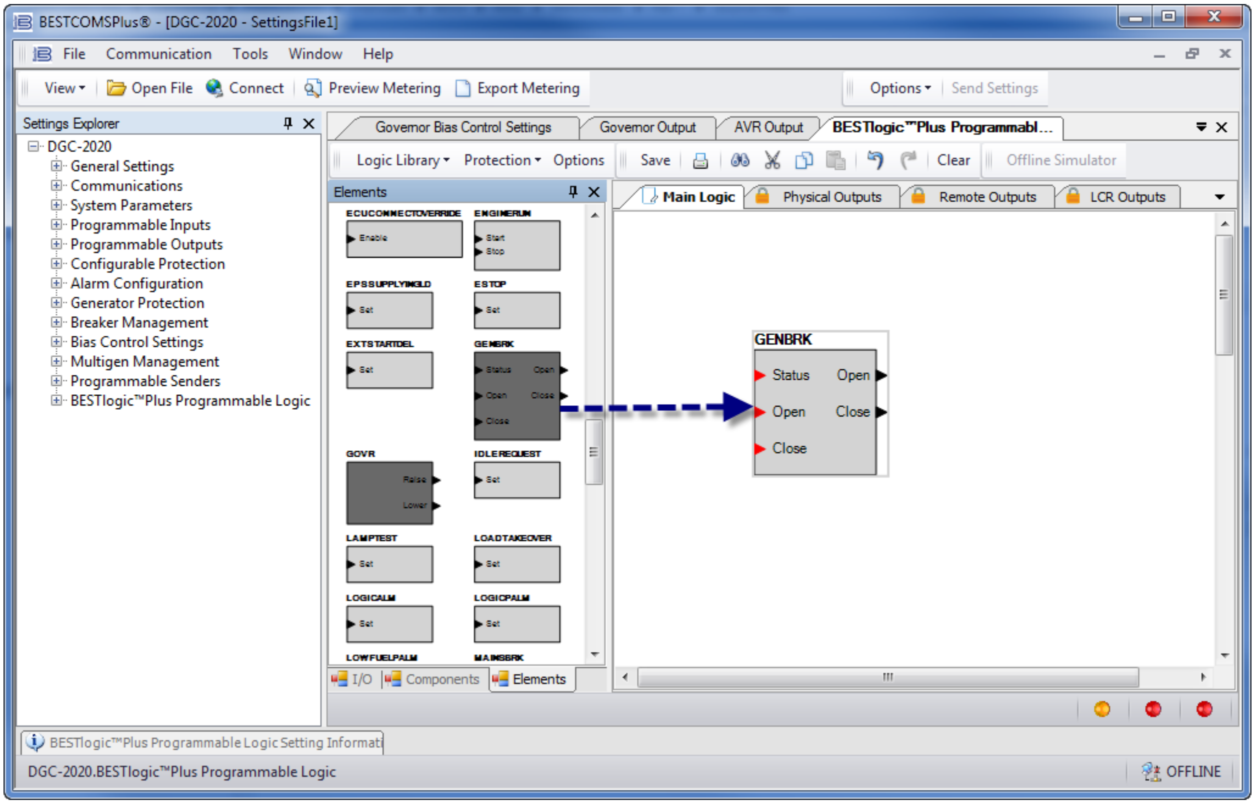

Figure 7-50. Settings Explorer, BESTlogicPlus Programmable Logic (Step 12)

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.

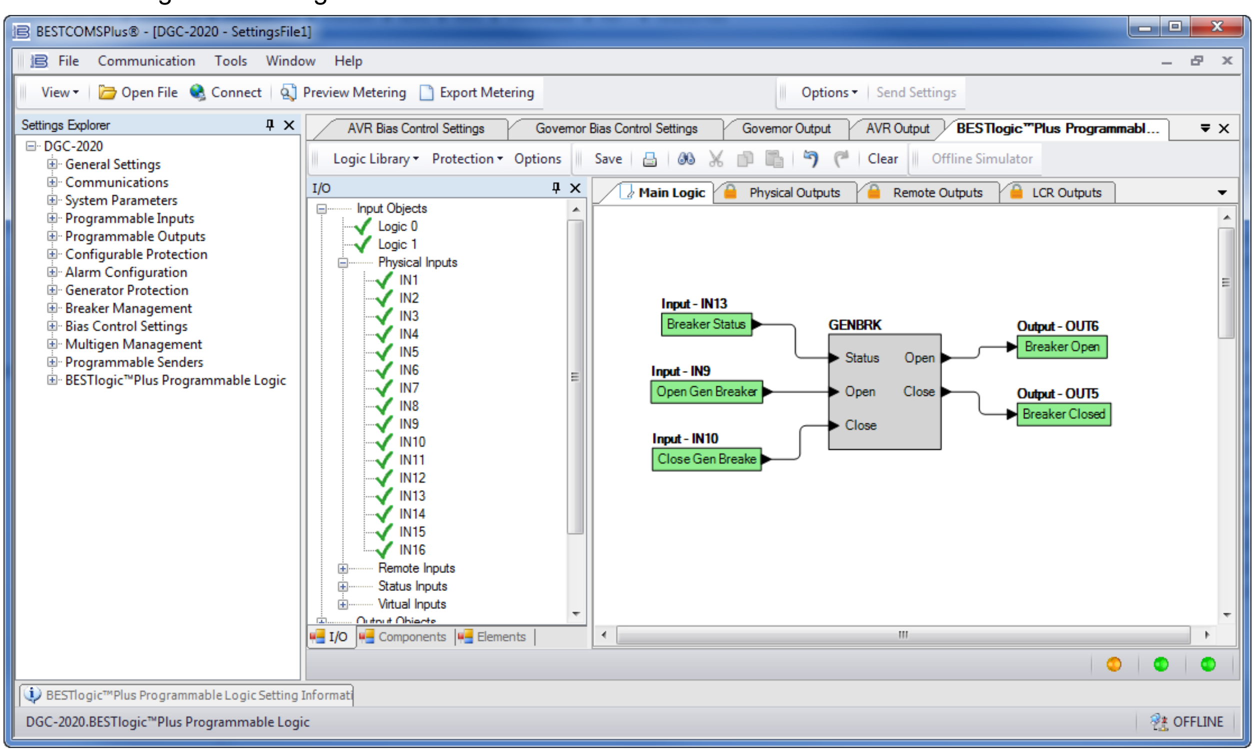

Figure 7-51. Settings Explorer, BESTlogicPlus Programmable Logic (Step 13)

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.

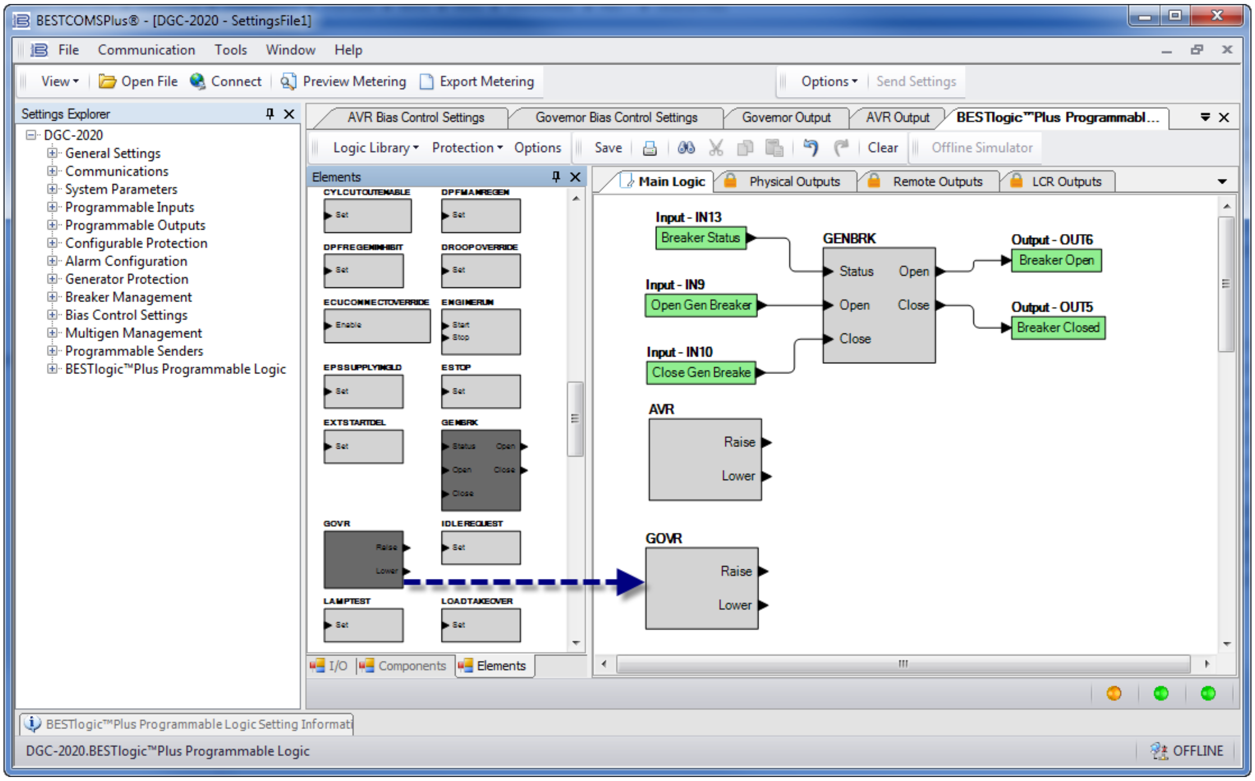

Figure 7-52. Settings Explorer, BESTlogicPlus Programmable Logic (Step 14)

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.

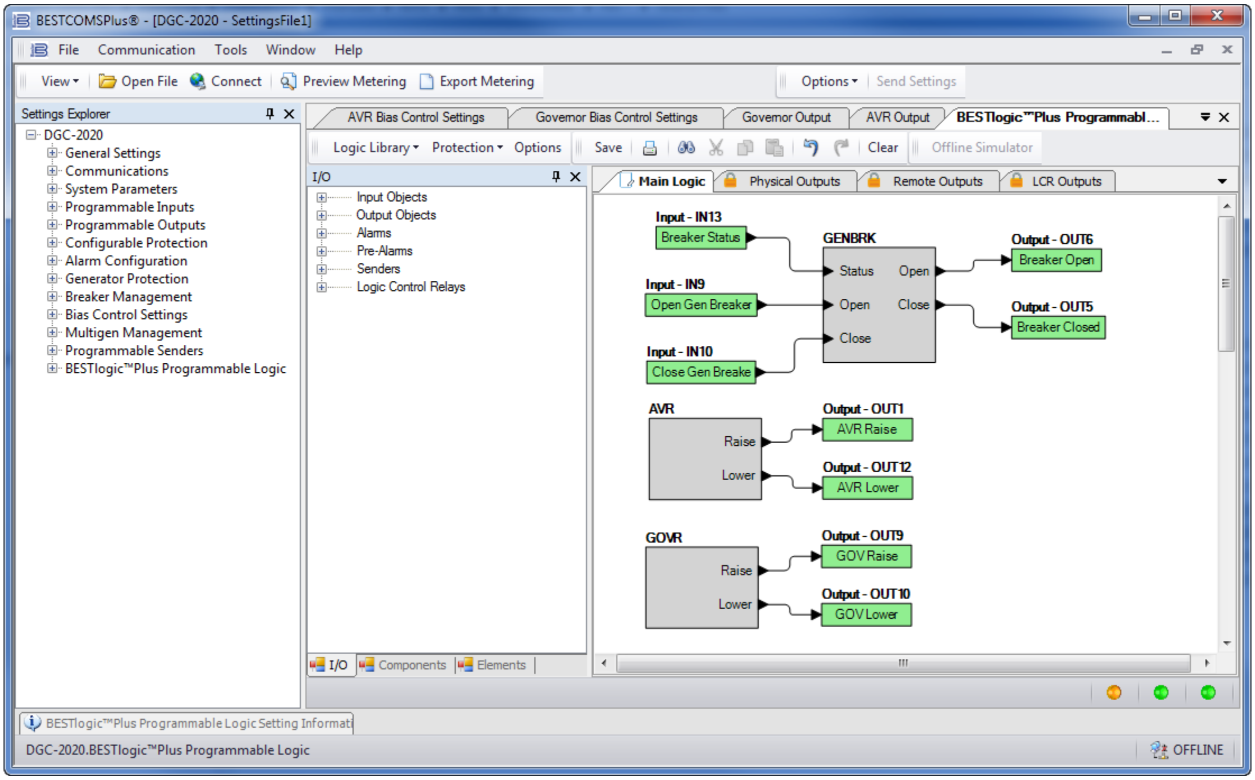

Figure 7-53. Settings Explorer, BESTlogicPlus Programmable Logic (Step 15)

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.

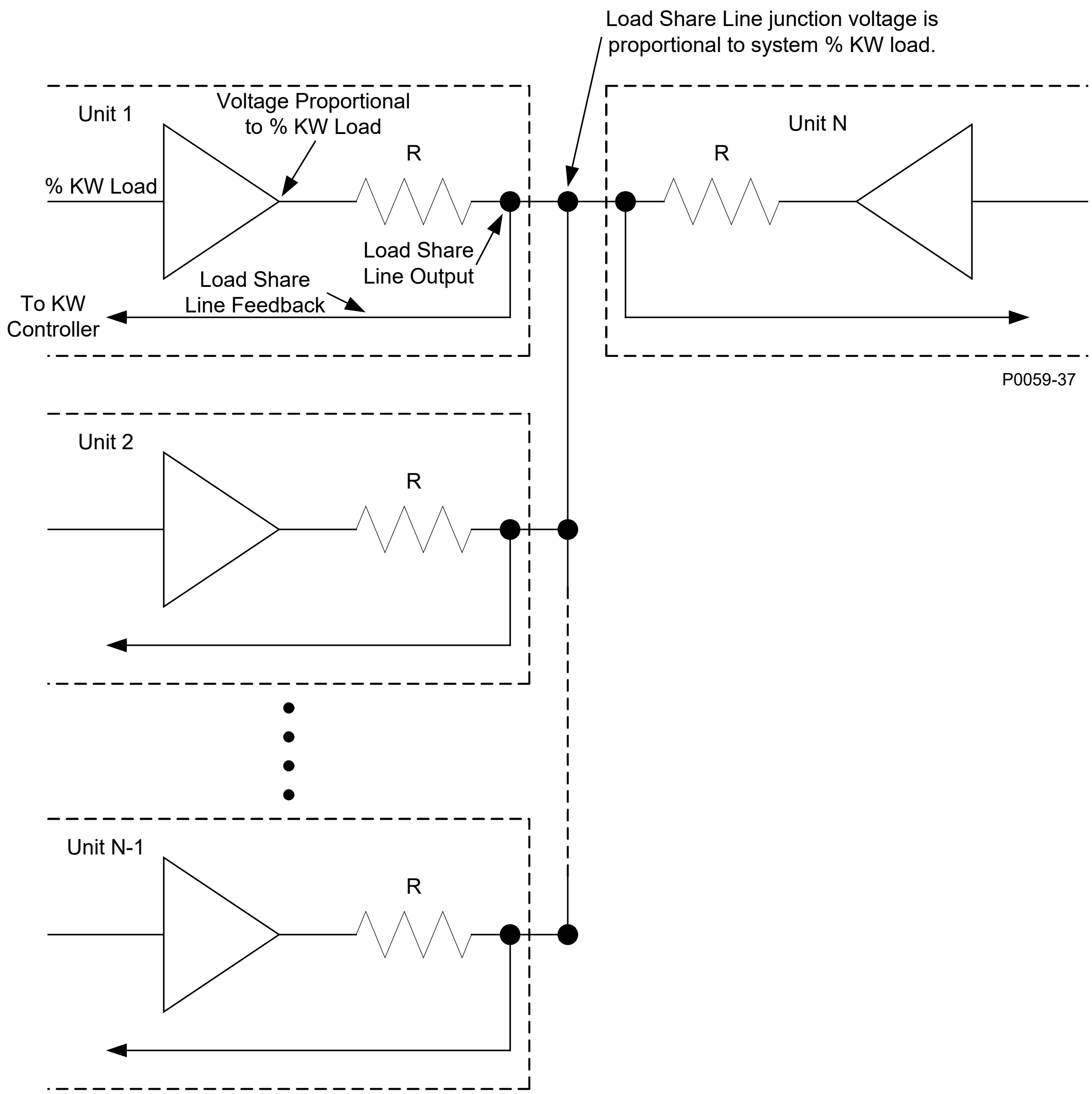

Figure 7-54. Load Share Line Implementation on a System of N Machines

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 BESTlogic*Plus* Programmable Logic is used to indicate to the DGC-2020 that is it 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 BESTlogic*Plus* 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 BESTlogic*Plus* 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 BESTlogic*Plus* 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 BESTlogic*Plus* 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 BESTCOMS*Plus*® 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.

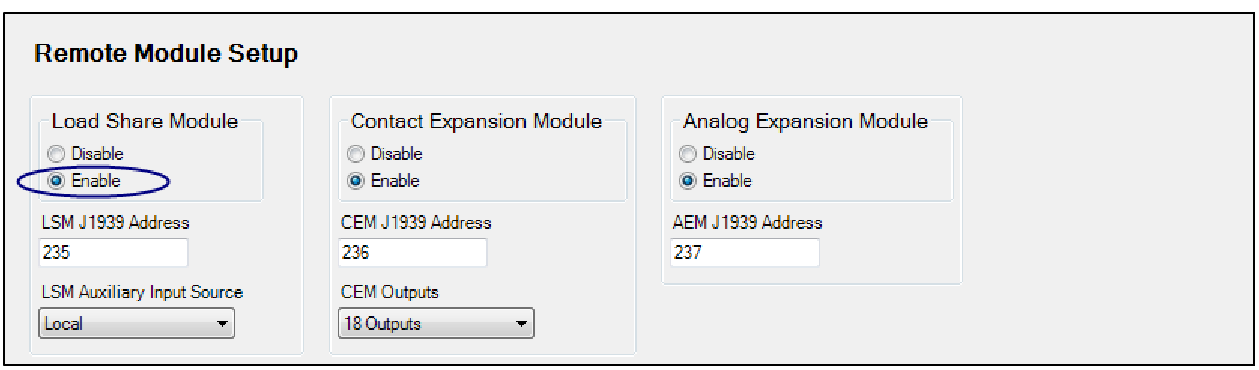

Figure 7-55. Settings Explorer, System Parameters, Remote Module Setup Screen

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 BESTCOMS*Plus*® 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*Plus*® 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*Plus*® 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*.

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

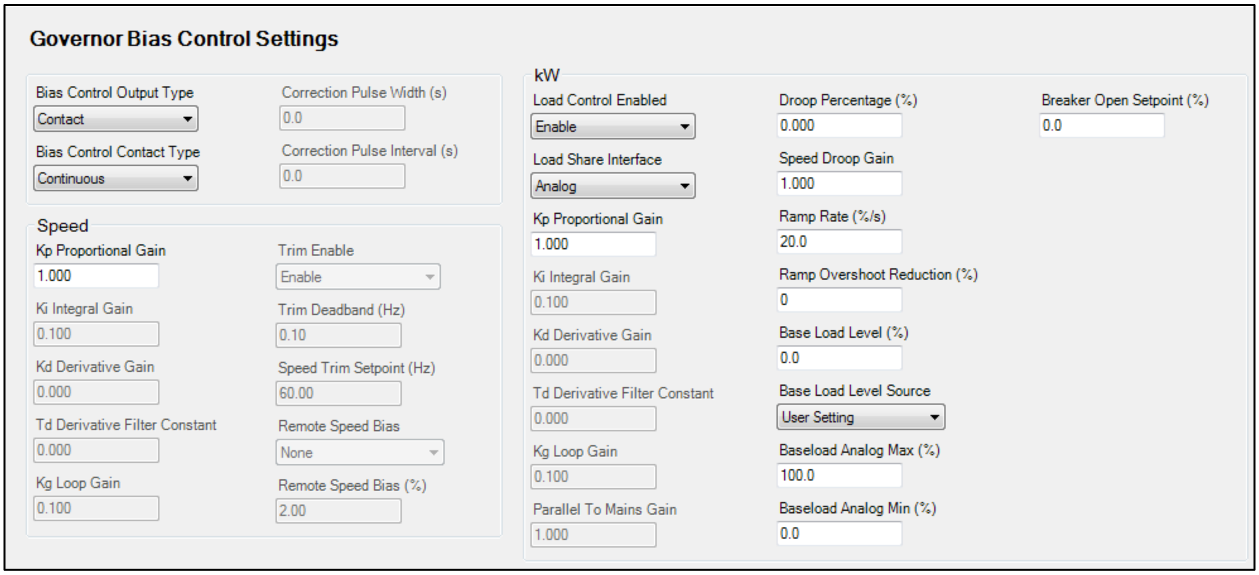

Figure 7-59. Settings Explorer, Bias Control Settings, Governor Bias Control Settings Screen

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 BESTlogic*Plus* 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 ±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 BESTlogic*Plus* 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 BESTlogic*Plus* 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 BESTCOMS*Plus*® 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

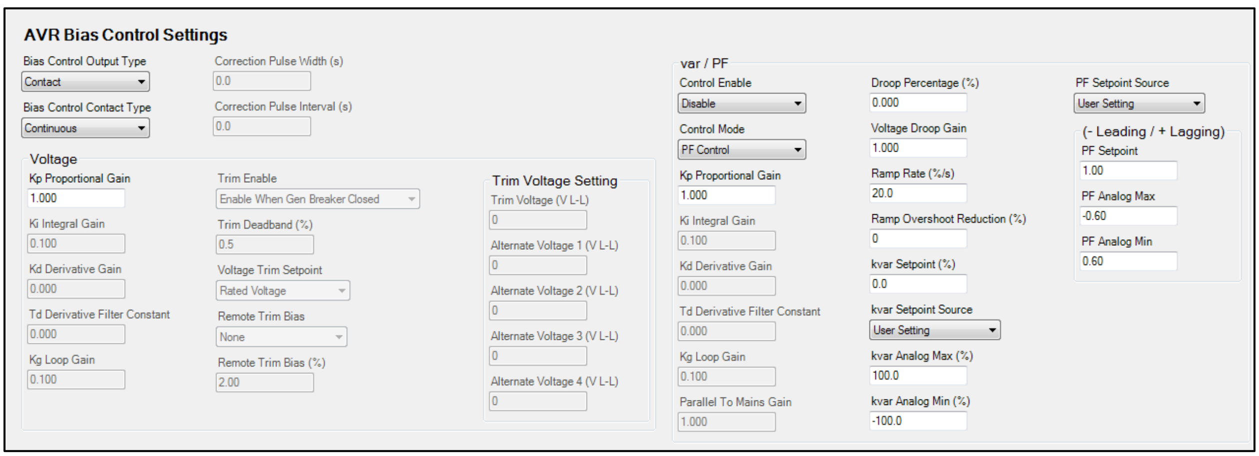

Figure 7-60. Settings Explorer, Bias Control Settings, AVR Bias Control Settings Screen

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 BESTlogic*Plus* 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 BESTlogic*Plus* 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 BESTlogic*Plus* 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 BESTlogic*Plus* 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 BESTlogic*Plus* 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 BESTlogic*Plus* 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 BESTCOMS*Plus*® under SETTINGS EXPLORER > DGC-2020 > MULTIGEN MANAGEMENT > DEMAND START/STOP. See Figure 7-61.

Front Panel Navigation Path: SETTINGS > MULTIGEN MANAGEMENT > DEMAND START STOP

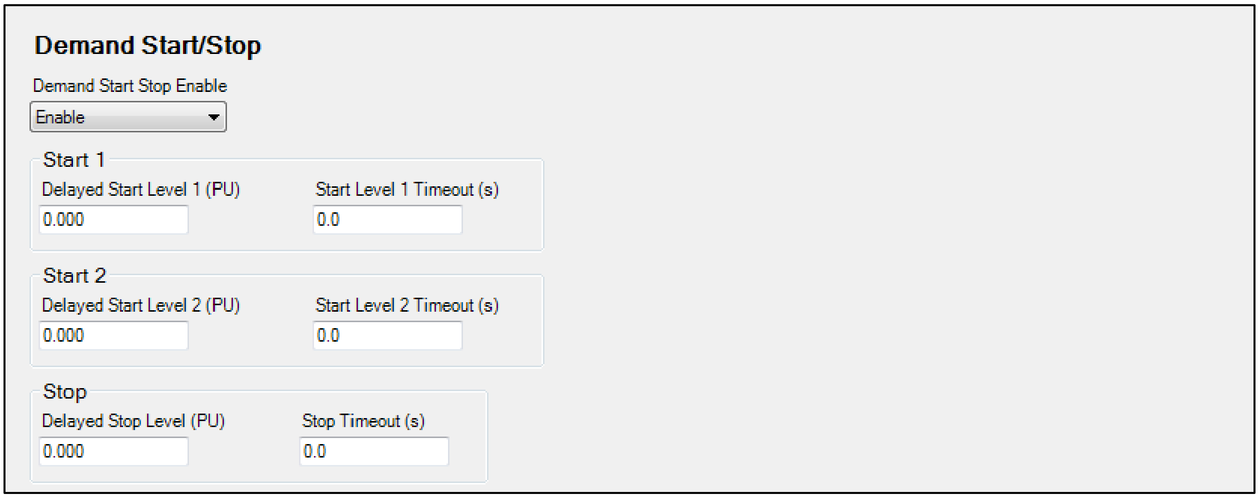

Figure 7-61. Settings Explorer, Multigen Management, Demand Start/Stop Screen

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*Plus*® 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 BESTCOMS*Plus*® under SETTINGS EXPLORER > DGC-2020 > MULTIGEN MANAGEMENT > NETWORK CONFIGURATION. See Figure 7-63.

Front Panel Navigation Path: SETTINGS > MULTIGEN MANAGEMENT > NETWORK CONFIG

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 BESTCOMS*Plus*® under METERING EXPLORER > GC-2020 > ENERATOR 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 BESTCOMS*Plus*® under SETTINGS EXPLORER > BREAKER MANAGEMANT > 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 BESTCOMS*Plus*® under SETTINGS EXPLORER > BREAKER MANAGEMENT > BREAKER HARDWARE. See Figure 7-64.

   Front Panel Navigation Path: SETTINGS > BREAKER MANAGEMENT > BREAKER HARDWARE

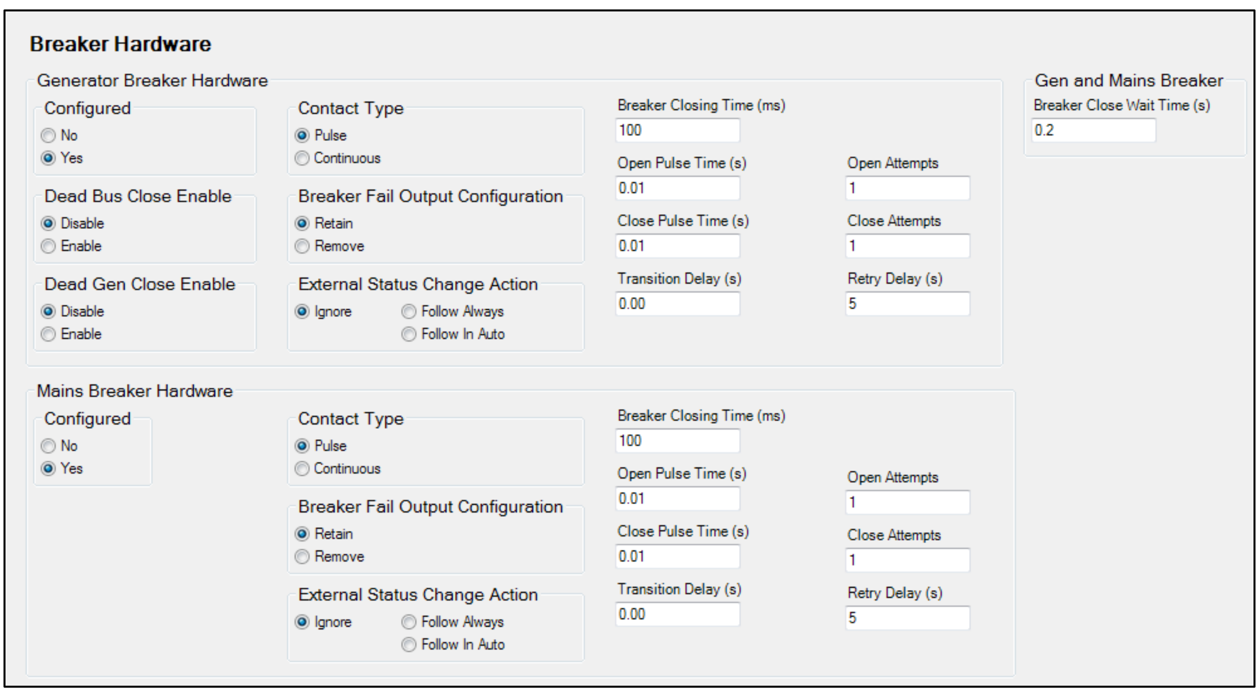

Figure 7-64. Settings Explorer, Breaker Management, Breaker Hardware Screen

a. Configure Mains Fail Transfer parameters in BESTCOMS*Plus* 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.

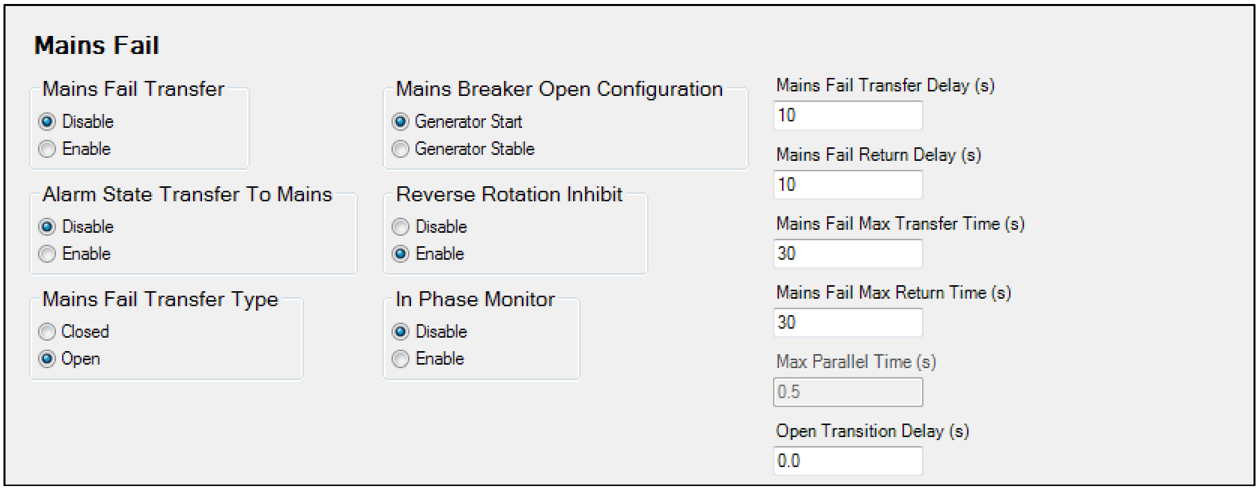

Figure 7-65. Settings Explorer, Breaker Management, Mains Fail Screen

4. Set up the Mains Breaker and Gen Breaker in BESTCOMS*Plus*® under Settings Explorer > BESTlogic*Plus* 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.

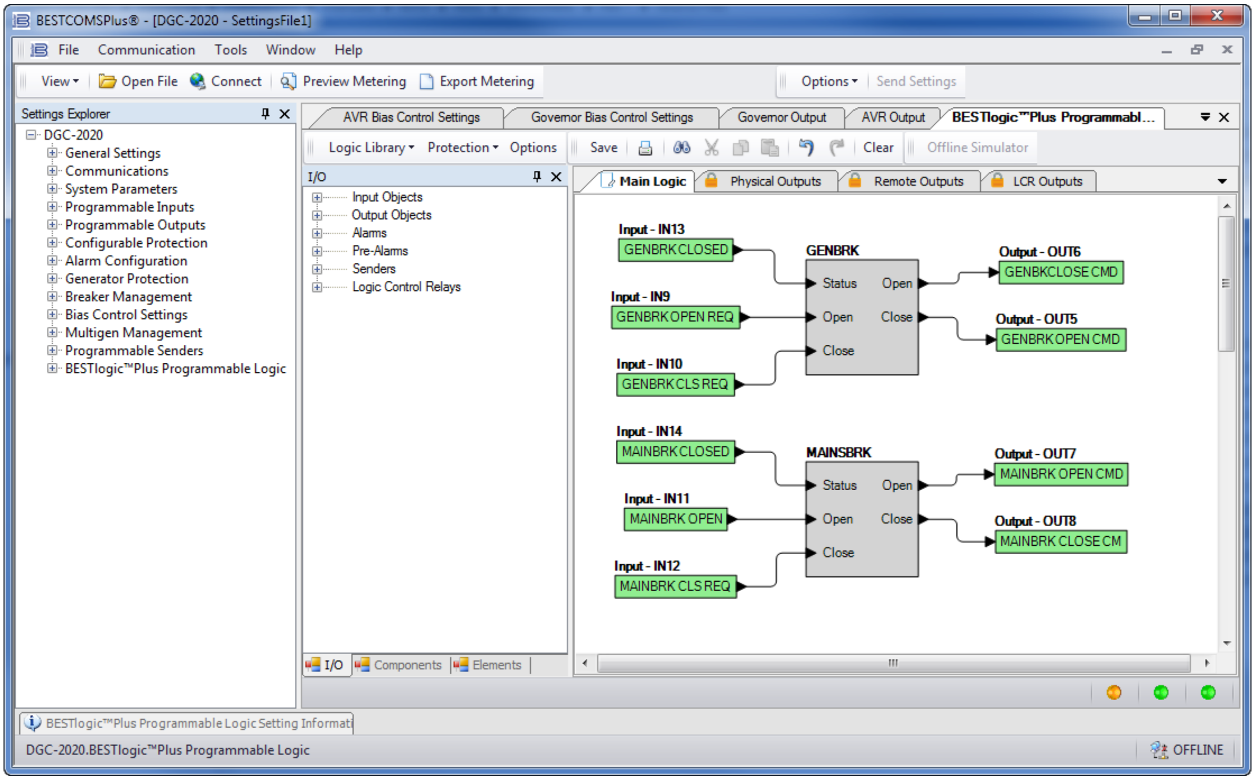

Figure 7-66. Settings Explorer, BESTlogicPlus Programmable Logic

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.

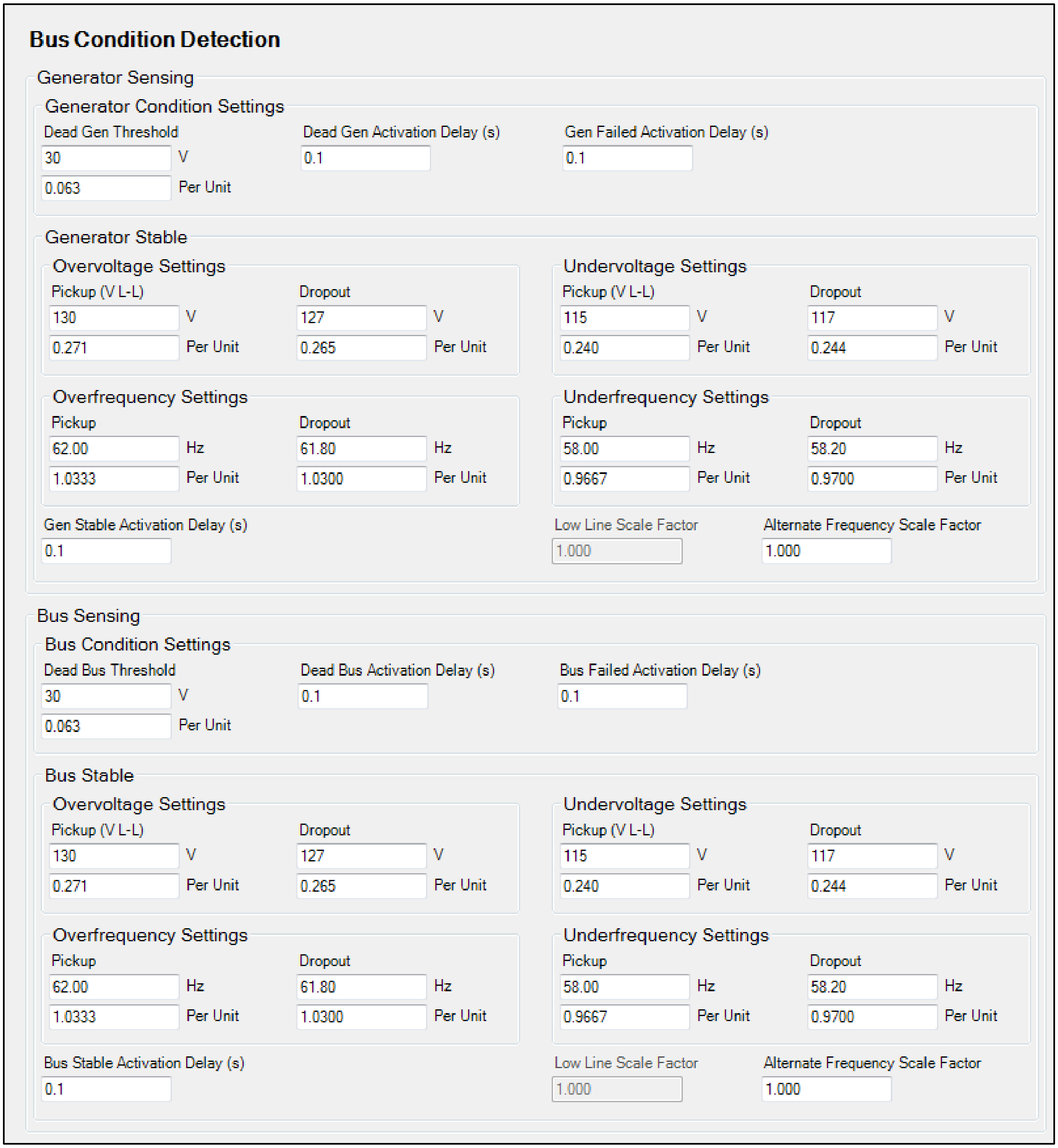

Figure 7-67. Settings Explorer, Breaker Management, Bus Condition Detection Screen

SECTION 8 • MAINTENANCE AND TROUBLESHOOTING

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SECTION 8 • MAINTENANCE AND TROUBLESHOOTING

Maintenance

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

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

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 BESTCOMS*Plus*®. 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 BESTCOMS*Plus*® 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 BESTCOMS*Plus*® 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*Plus* 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 BESTCOMS*Plus*®, 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 BESTCOMS*Plus*® 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 BESTCOMS*Plus*® 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 BESTlogic*Plus* 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 BESTCOMS*Plus*®, 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 BESTlogic*Plus* 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 BESTCOMS*Plus*®, 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 BESTCOMS*Plus*® 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 BESTCOMS*Plus*®, 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 BESTCOMS*Plus*® 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 BESTCOMS*Plus*®, 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.

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 BESTCOMS*Plus*® 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 OUPUT. 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 BESTCOMS*Plus*® 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 BESTCOMS*Plus*® 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 BESTCOMS*Plus*® 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 var is equal to the square root of (VA^2 – $WATT^2$).
- 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.

SECTION 9 • LSM-2020 (LOAD SHARE MODULE)

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SECTION 9 • LSM-2020 (LOAD SHARE MODULE)

General Information

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 Ω maximum
±10 Vdc .... 9.65k Ω minimum

Analog Outputs

Burden Data.............................. 4-20 mAdc = 500 Ω maximum burden, ±10 Vdc = 667 Ω minimum burden

Voltage Regulator Bias Output

4-20 mA or ±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, ±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

File E470837 CCN# FTWD2 / FTWD8

- ISA 12.12.01 Class I and II, Division 2, and Class III, Divisions 1 and 2 Hazardous Locations
- C22.2 No. 213-M1987 Class I, Division 2 Hazardous Locations.

CSA Certification

The LSM-2020 was tested and has met the certification requirements for electrical, plumbing and/or mechanical products.

Standards used for evaluation:

- CSA C22.2 No. 14

EU Compliance

This product has been evaluated and complies with the requirements set forth by the EU legislation:

- Low Voltage Devices (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*

EAC Mark (Eurasian Conformity)

- TP TC 004/2011
- TP TC 020/2011

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 BESTCOMS*Plus*® to open the *Programmable Input, LSM Input screen.* To set the LSM Analog Input as the control source, use the Settings Explorer in BESTCOMS*Plus*® 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 BESTCOMS*Plus*®. 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

BESTCOMS*Plus*® provides the user with a point-and-click means to set and monitor the LSM-2020. Installation and operation of BESTCOMS*Plus*® is described in Section 4, *BESTCOMSPlus® Software.*

LSM-2020 Plugin for BESTCOMS*Plus*®

The setup utility that installs BESTCOMS*Plus*® 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 BESTCOMS*Plus*®. 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 BESTCOMS*Plus*® can be obtained on the Device Info tab of BESTCOMS*Plus*®.

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.

BESTCOMS*Plus*® device information values and settings are illustrated in Figure 9-1.

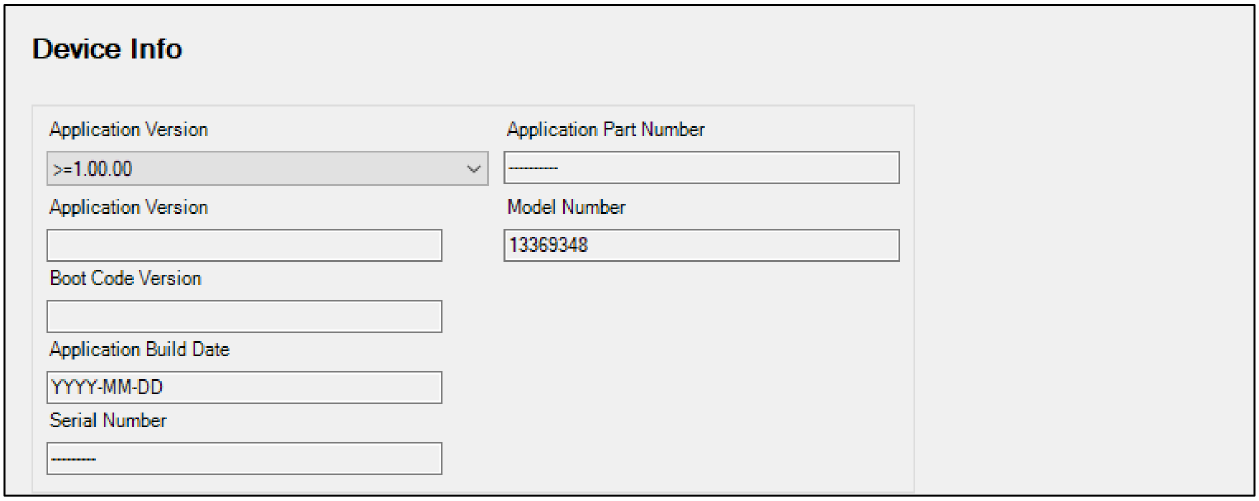

Figure 9-1. Device Info Screen

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 BESTCOMS*Plus*®. 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 BESTCOMS*Plus*® 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.

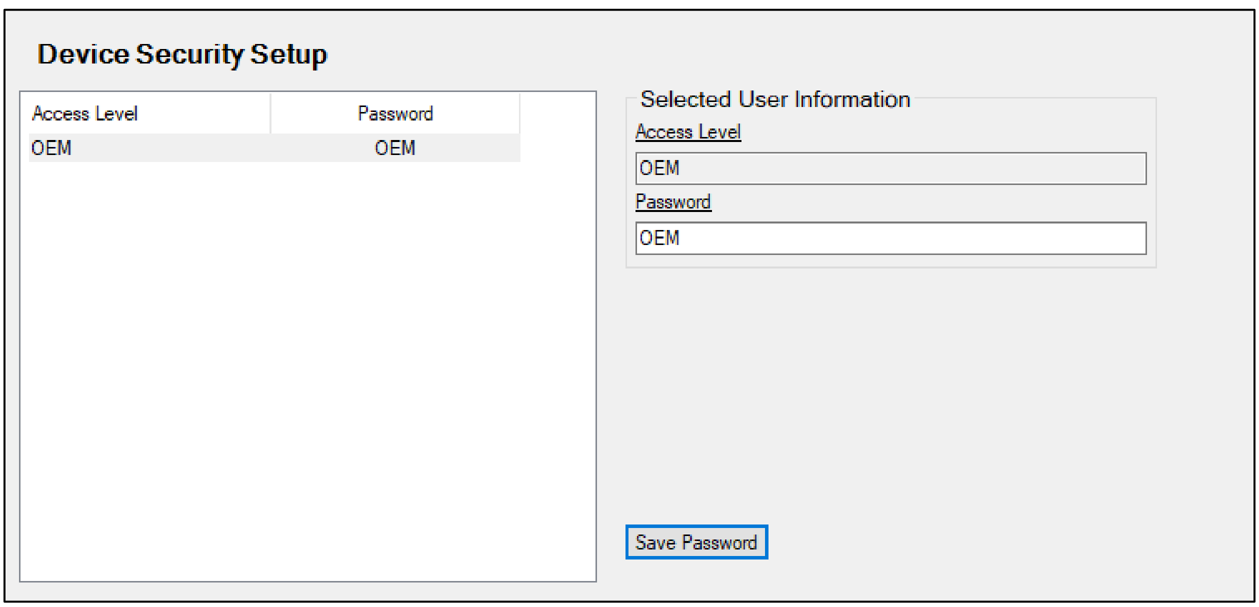

Figure 9-2. Device Security Setup Screen

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.

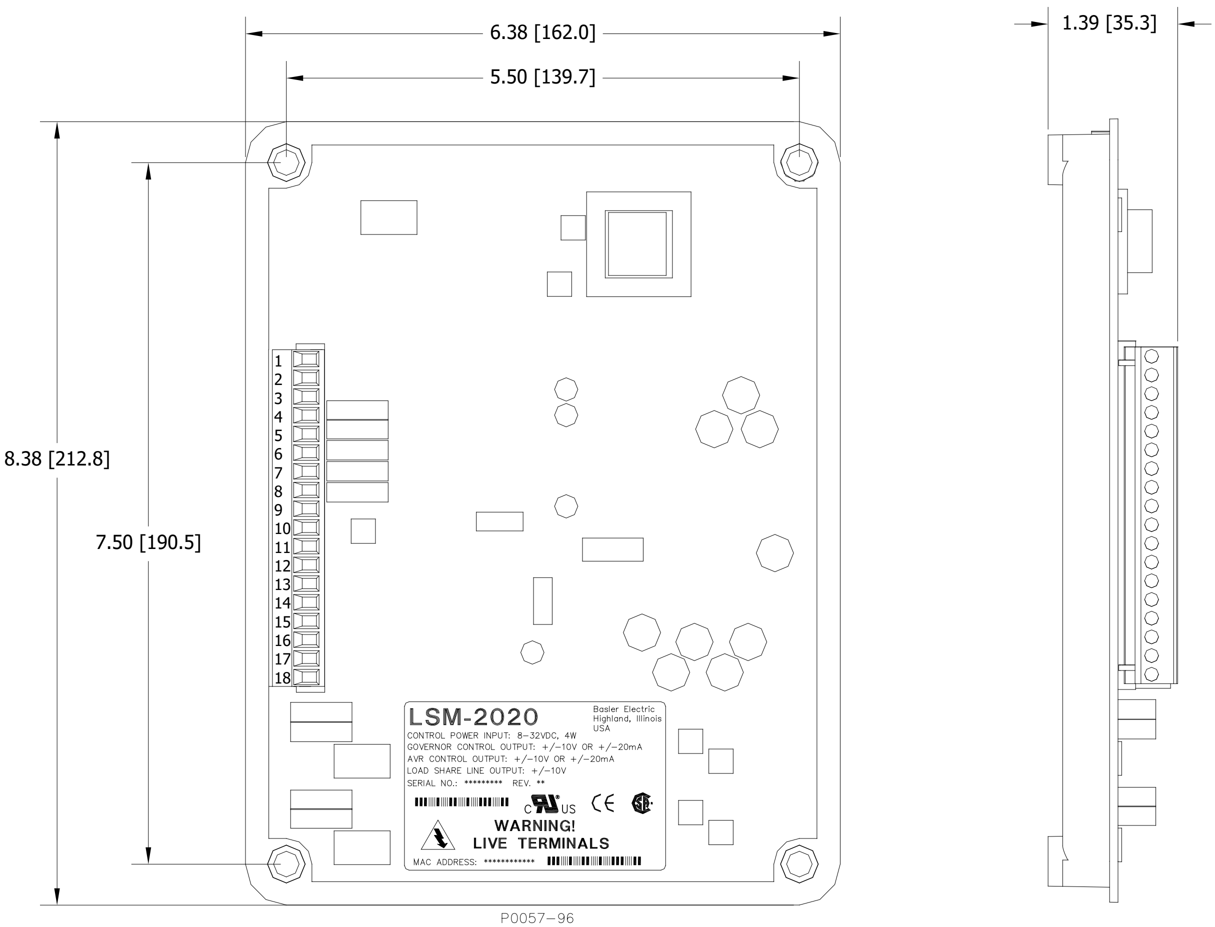

Figure 9-3. LSM-2020 Overall Dimensions

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 BESTCOMS*Plus*® 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.

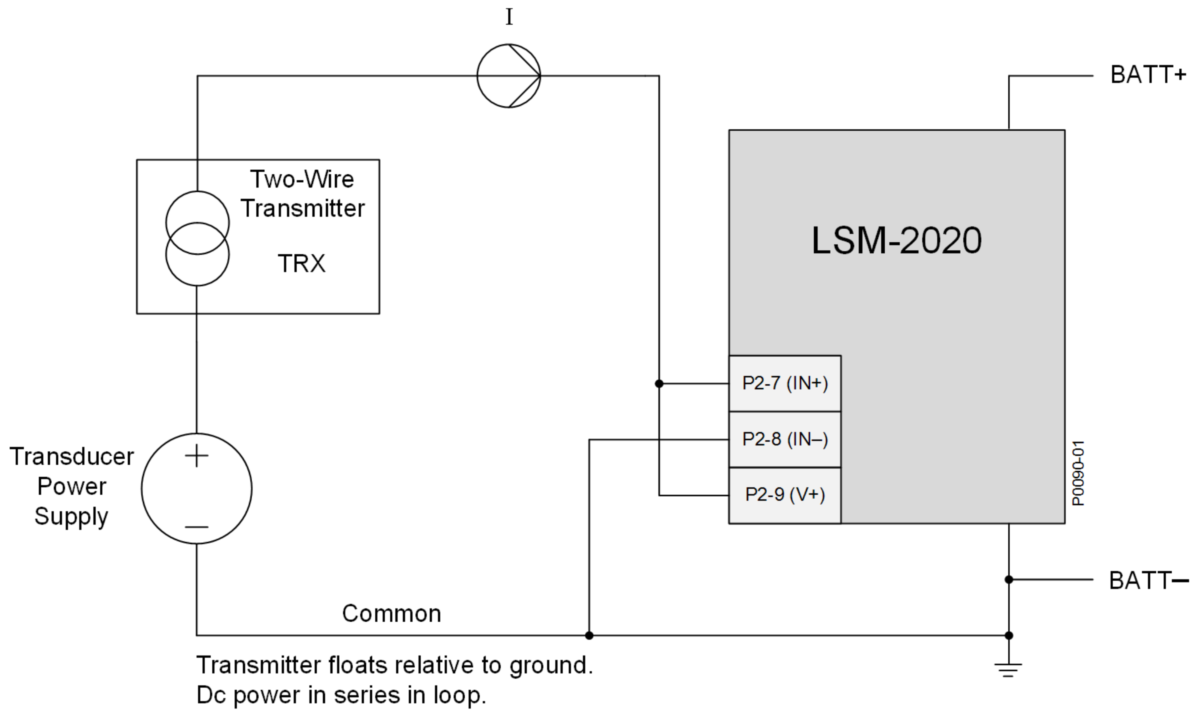

Figure 9-4. Analog Inputs - Current Input Connections, Type II 2-Wire Circuit

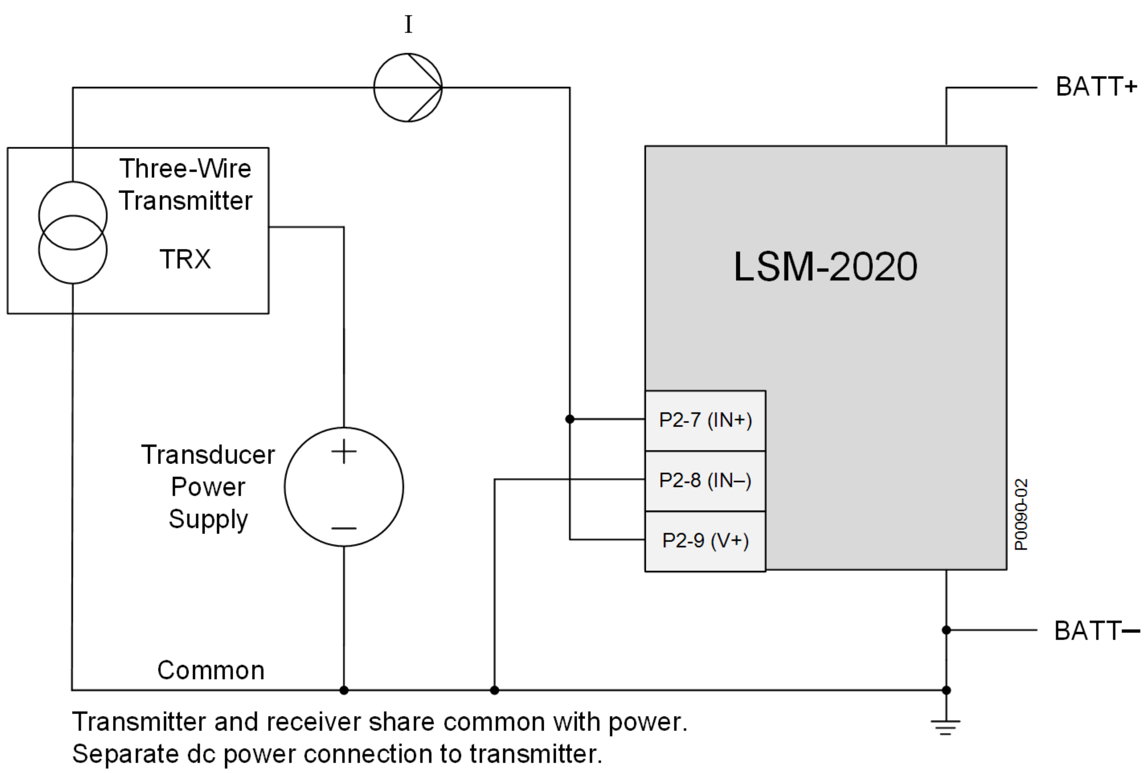

Figure 9-5. Analog Inputs - Current Input Connections, Type III 2-Wire Circuit

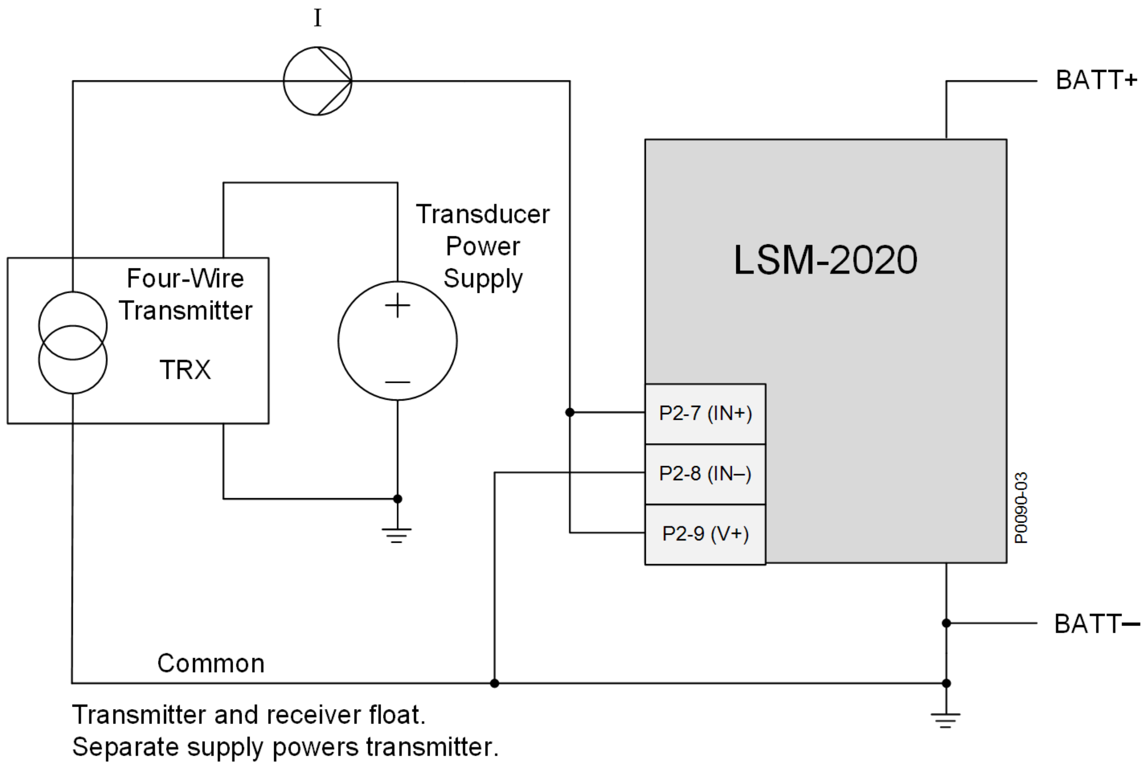

Figure 9-6. Analog Inputs - Current Input Connections, Type IV 2-Wire Circuit

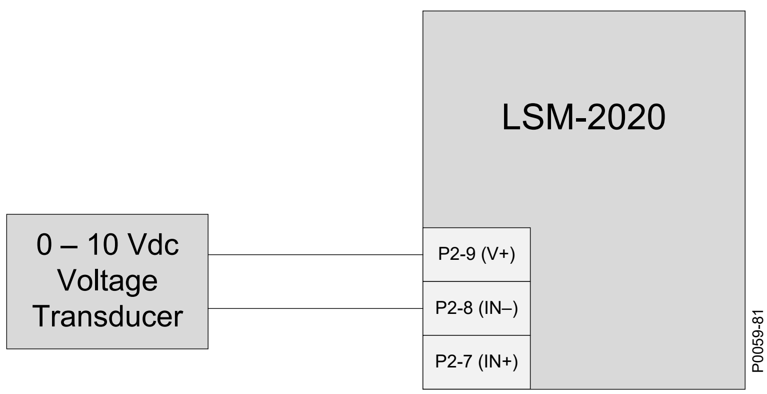

Figure 9-7. Analog Inputs - Voltage Input Connections

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.

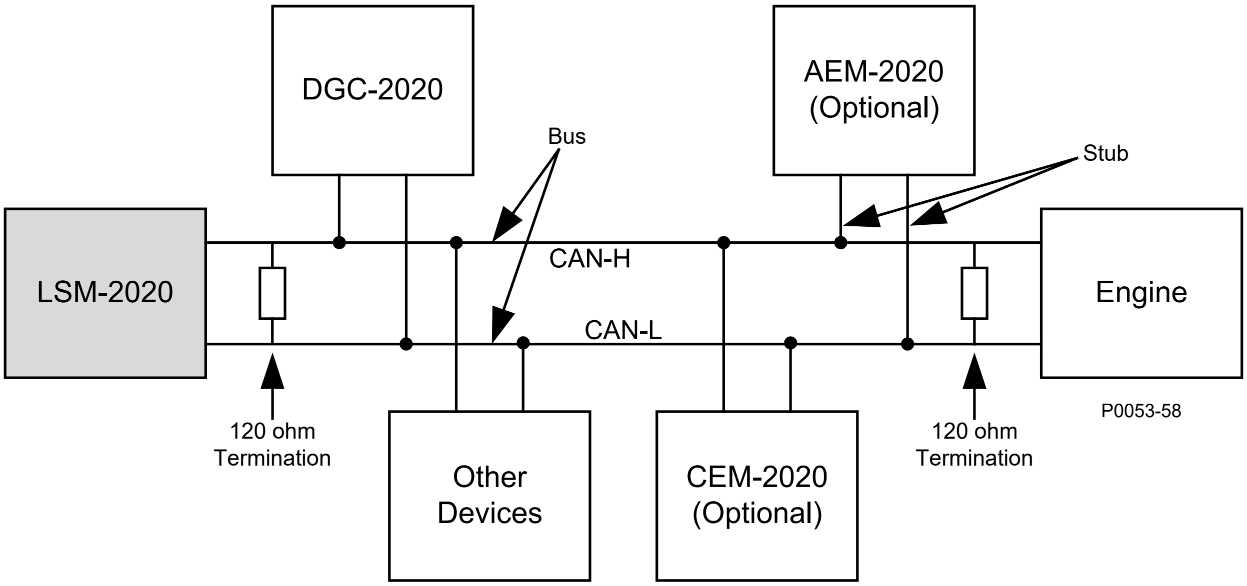

Figure 9-8. CAN Bus Interface with LSM-2020 providing One End of the Bus

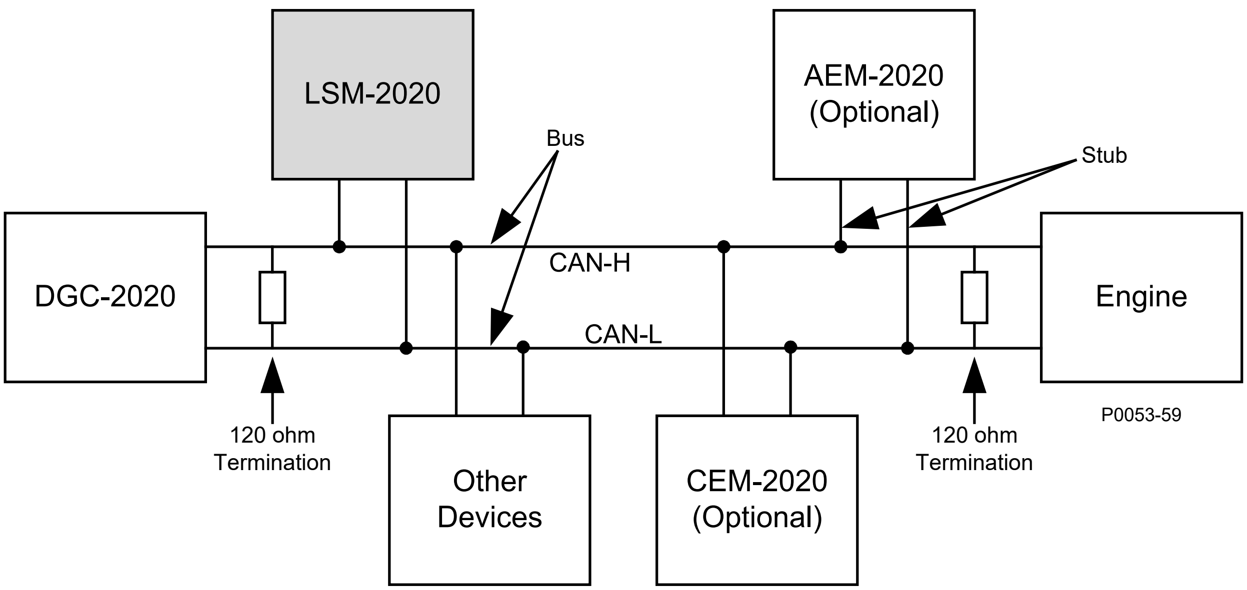

Figure 9-9. CAN Bus Interface with DGC-2020 providing One End of the Bus

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.

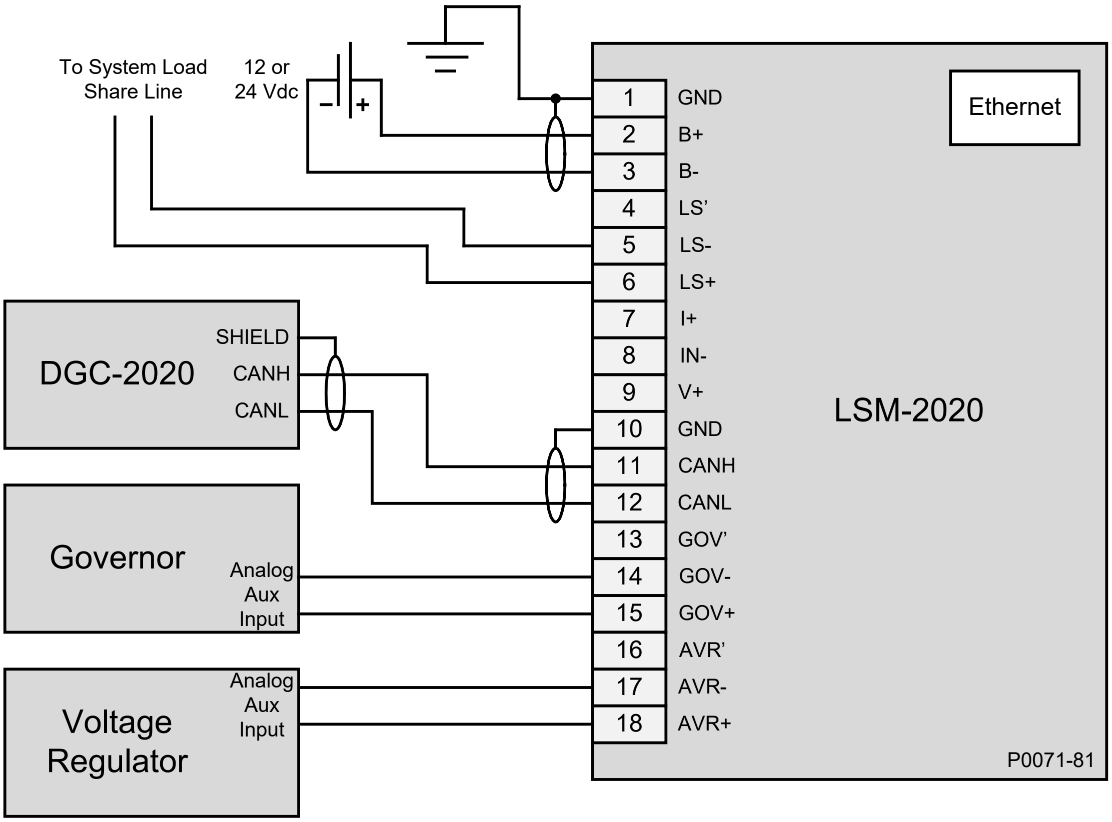

Figure 9-10. Typical LSM-2020 Connections

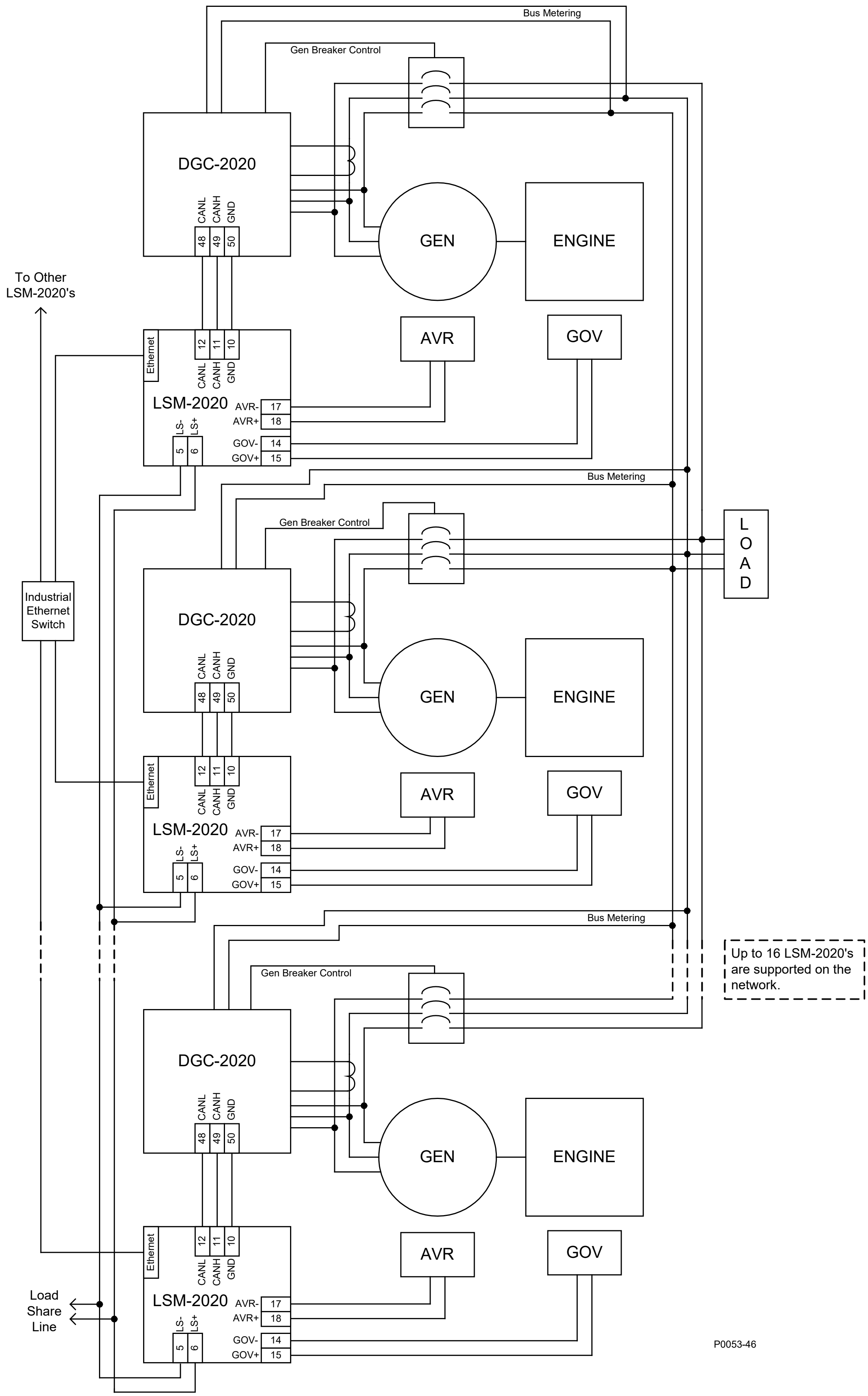

Figure 9-11. Typical LSM-2020 Interconnection Diagram

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.

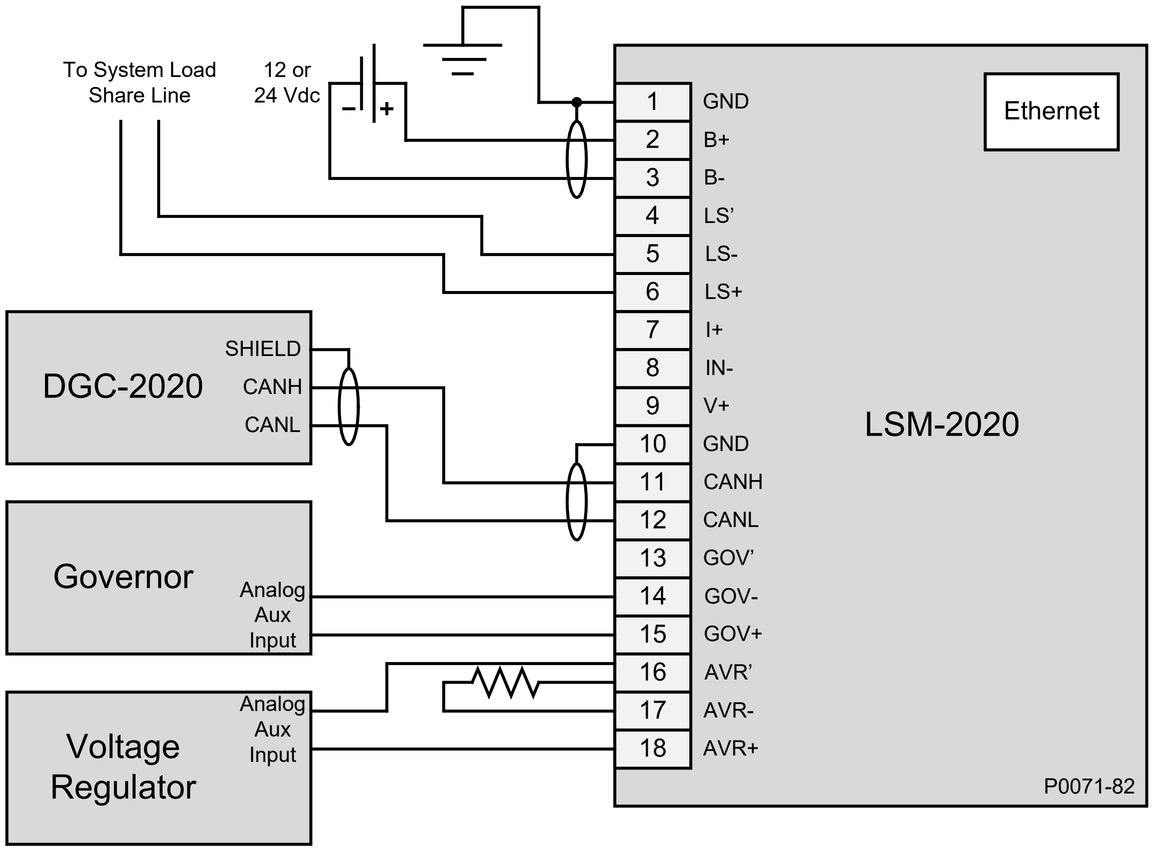

Figure 9-12. Connections using the AVR', GOV', and LS' Terminals

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-2020 has control when the generator breaker is closed.

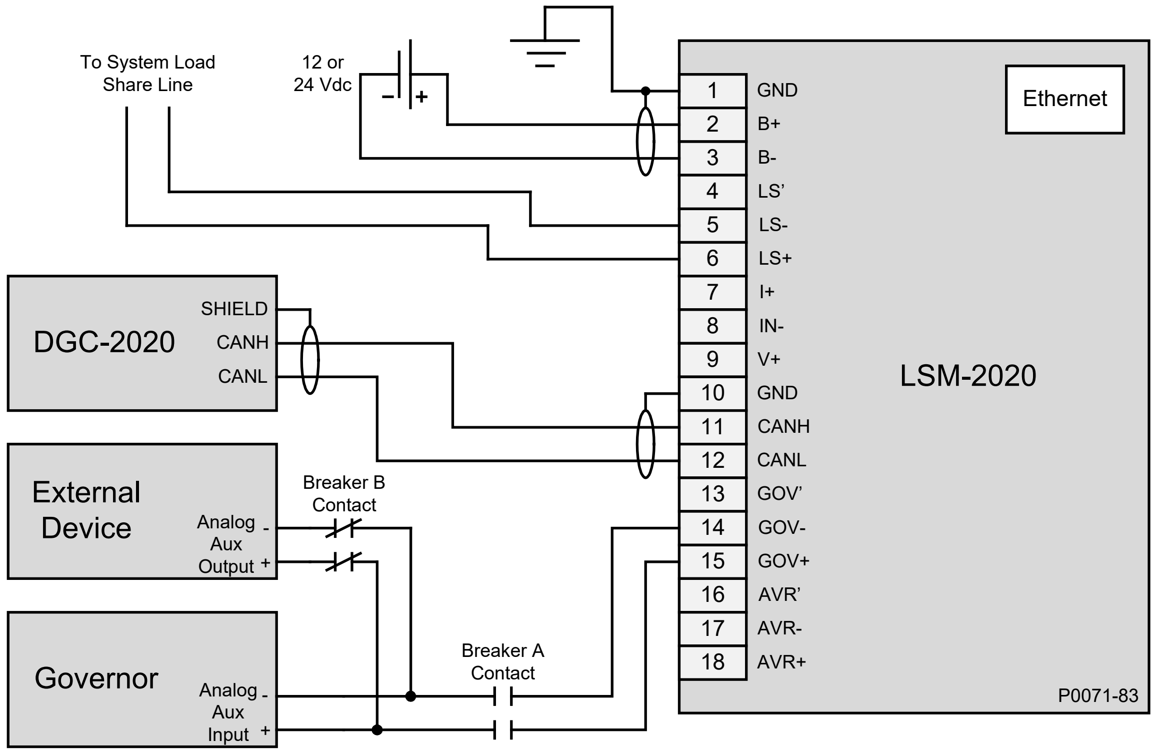

Figure 9-13. External Control Device with DGC-2020 — LSM-2020 System, Method 1

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.

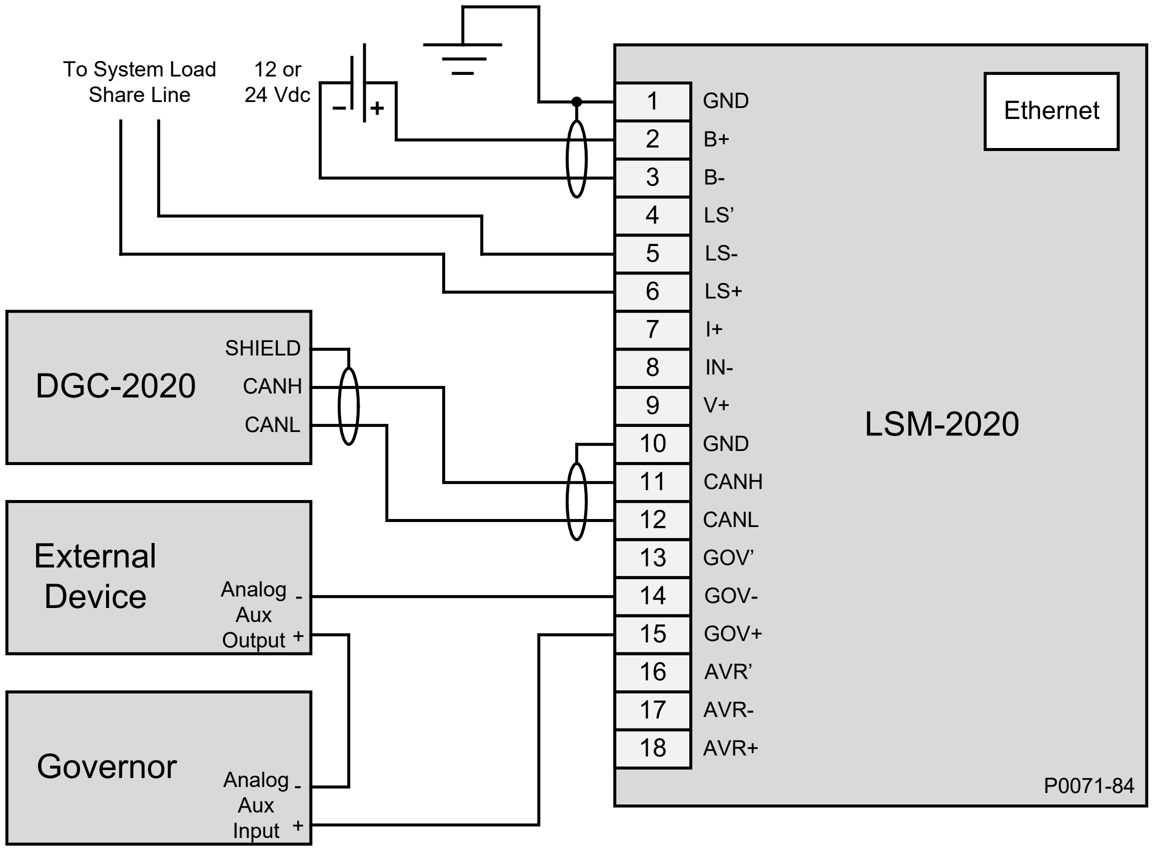

Figure 9-14. External Control Device with DGC-2020 — LSM-2020 System, Method 2

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.

SECTION 10 • CEM-2020 (CONTACT EXPANSION MODULE)

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SECTION 10 • CEM-2020 (CONTACT EXPANSION MODULE)

General Information

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

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
    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:
$L_{max} = (200 - R_{device})$/(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
- CSA C22.2 No.14-13

CSA Approval

The CEM-2020 is covered under CSA file 1042505 (LR23131-138S).

- CSA C22.2 No. 14-13

CE Compliance

This product complies with the requirements of the following 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

This product conforms to the following Harmonized Standards:

- 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*.

EAC Mark (Eurasian Conformity)

- TP TC 004/2011
- TP TC 020/2011

NFPA Compliance

Complies with NFPA Standard 110, *Standard for Emergency and Standby Power*.

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

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.

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.

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

BESTCOMS*Plus*® provides the user with a point-and-click means to set and monitor the Contact Expansion Module. Installation and operation of BESTCOMS*Plus*® 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.

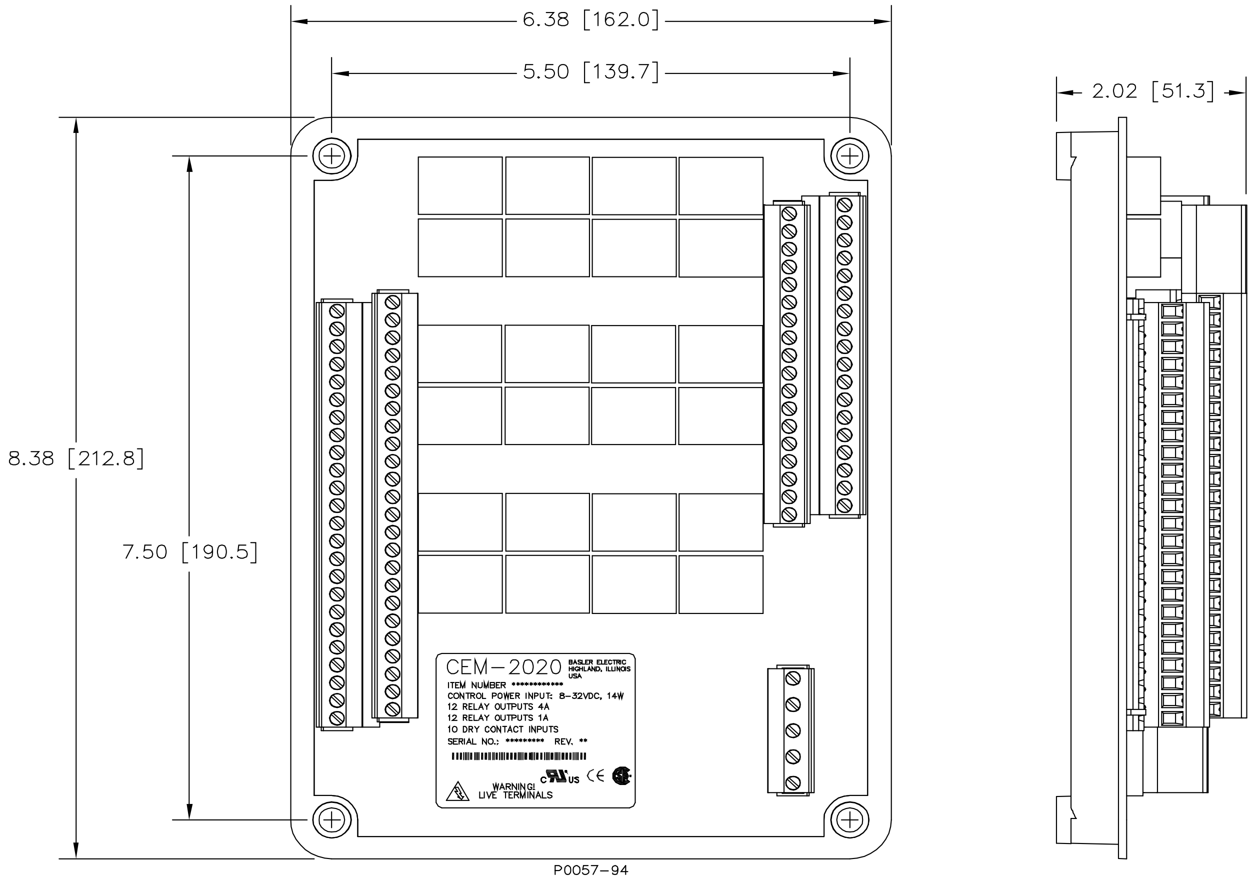

Figure 10-1. CEM-2020 Overall Dimensions

See Figure 10-2 for CEM-2020H overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.

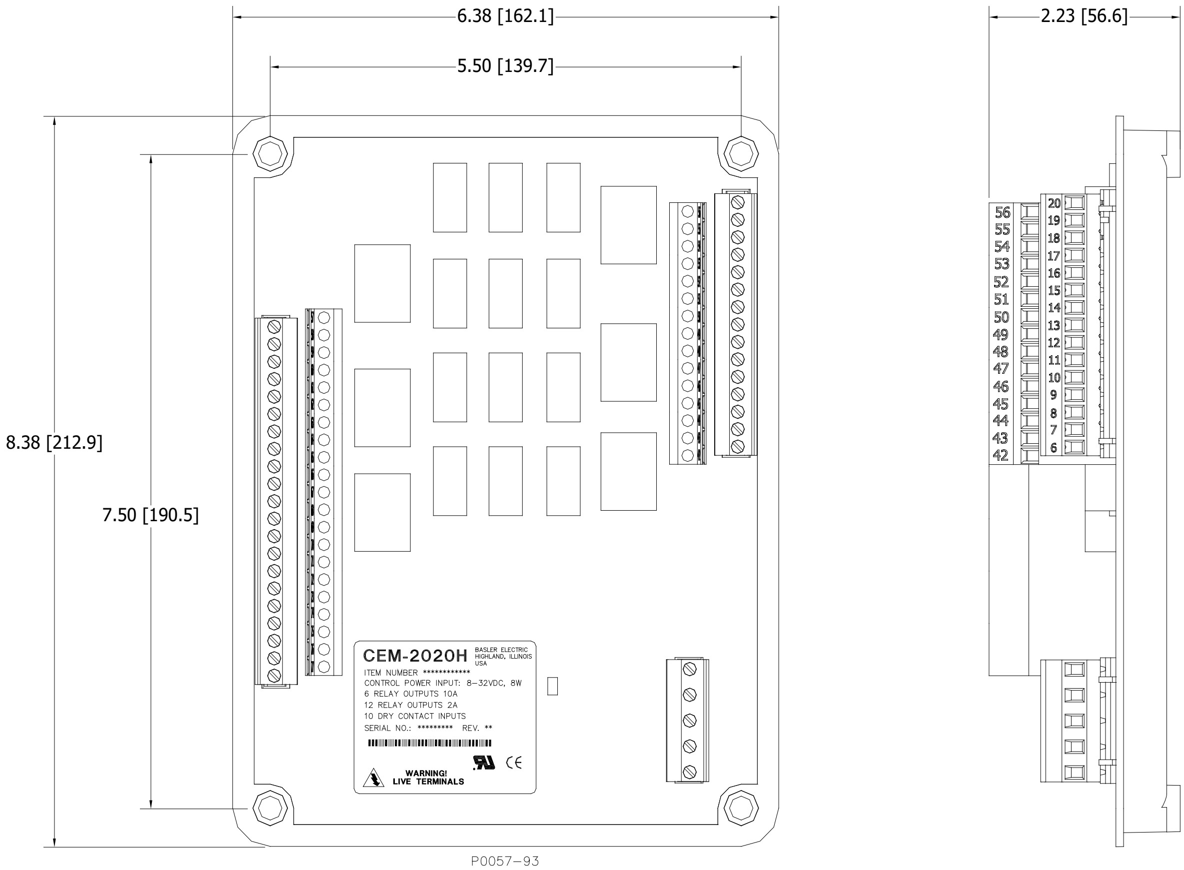

Figure 10-2. CEM-2020H Overall Dimensions

Connections

Contact Expansion Module connections are dependent on the application. Incorrect wiring may result in damage to the module.

Notes
Operating 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.

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).

Operating Power

The Contact 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 CEM-2020 will not operate. Operating 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. 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

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.

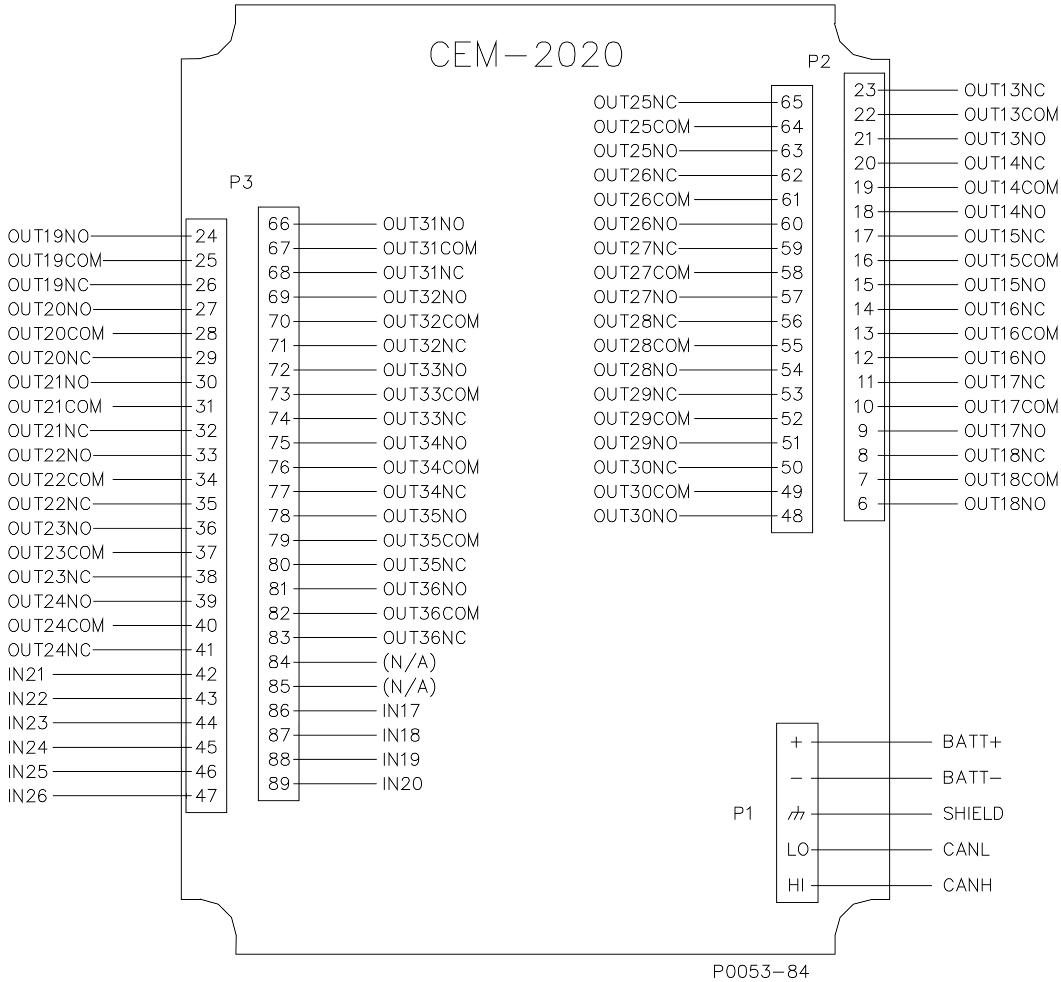

Figure 10-3. CEM-2020 Contact Input and Contact Output Terminals

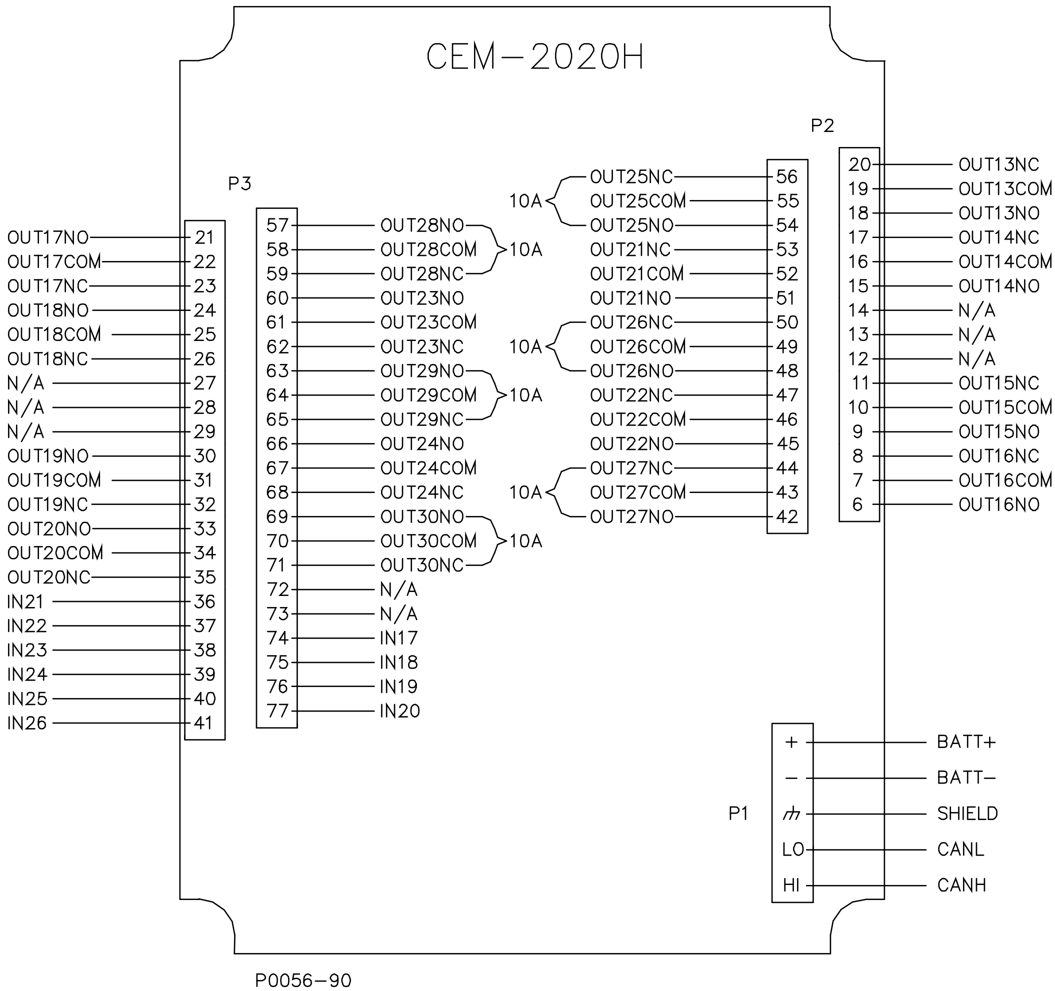

Figure 10-4. CEM-2020H Contact Input and Contact Output Terminals

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.

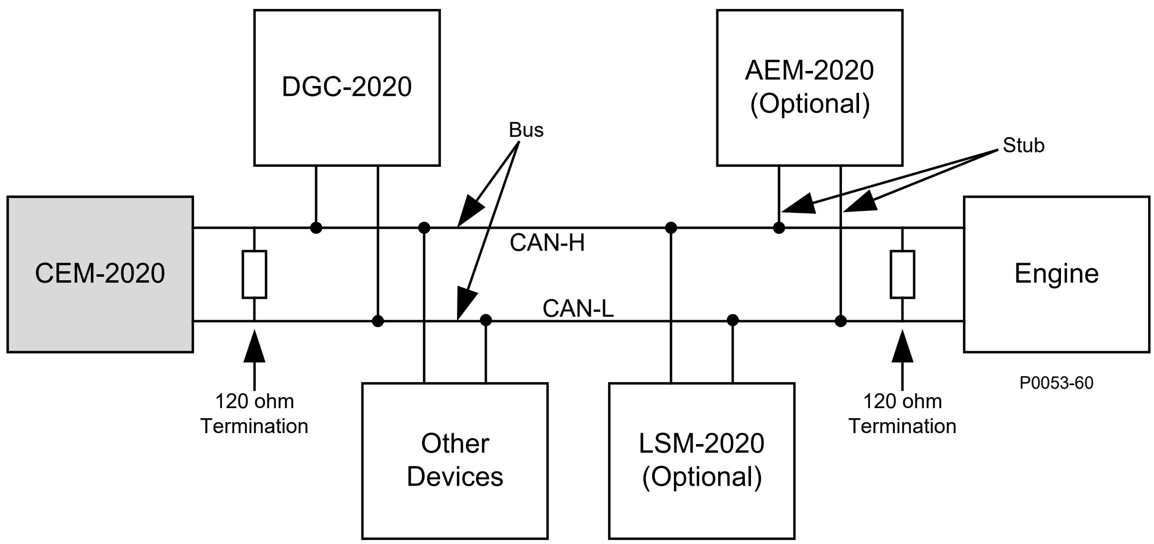

Figure 10-5. CAN Bus Interface with CEM-2020 providing One End of the Bus

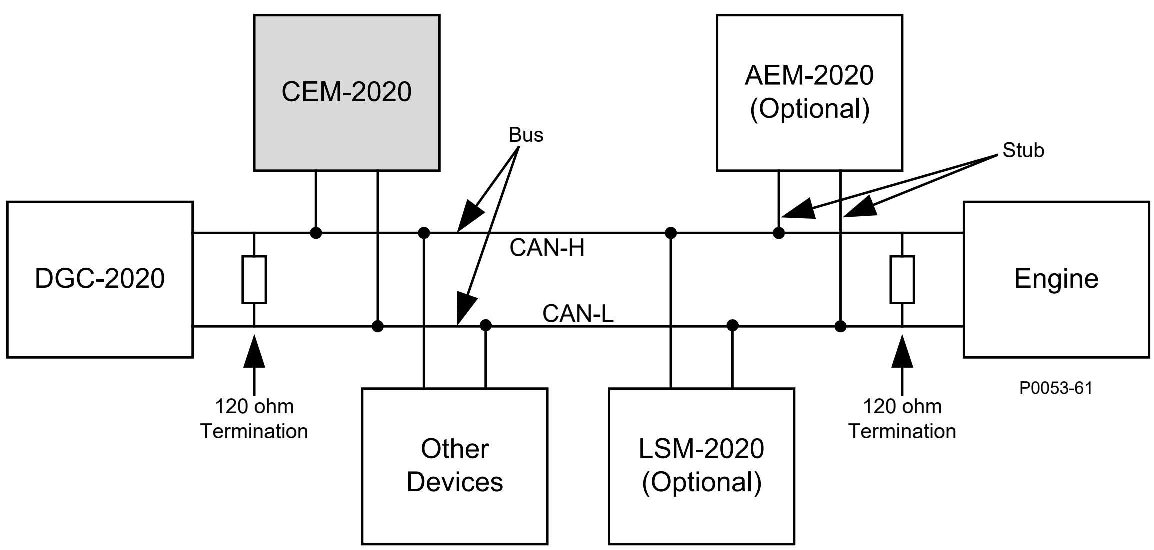

Figure 10-6. CAN Bus Interface with DGC-2020 providing One End of the Bus

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.

SECTION 11 • AEM-2020 (ANALOG EXPANSION MODULE)

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SECTION 11 • AEM-2020 (ANALOG EXPANSION MODULE)

General Information

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 mAdc or 0 to 10 Vdc (user-selectable)

Burden

4 to 20 mA .... 470 Ω maximum
±10 Vdc............................... 9.65k Ω minimum

RTD Inputs

The AEM-2020 contains eight programmable RTD inputs.

Rating .... 100 Ω Platinum or 10 Ω Copper (user-selectable)
Setting Range .... –50 to +250°C or –58 to +482°F
Accuracy (10 Ω Copper)............. ±0.044 Ω @ 25°C, ±0.005 Ω/°C drift over ambient temperature
Accuracy (100 Ω Platinum)......... ±0.39 Ω @ 25°C, ±0.047Ω/°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.................................... ±40uV @ 25°C, ±5 uV/°C drift over ambient temperature

Analog Outputs

The AEM-2020 contains four programmable analog outputs.

Rating .... 4 to 20 mAdc or 0 to 10 Vdc (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
- CSA C22.2 No.14-13

The AEM-2020 is a Recognized Component for the US and Canada under UL file E470837

(CCN-FTWD2/FTWD8) for use in Hazardous Locations:

- Class I Division 2
- Groups A, B, C & D

CSA Approval

The AEM-2020 is covered under CSA file 1042505 (LR23131-138S).

- CSA C22.2 No. 14-13

CE Compliance

This product complies with the requirements of the following 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

This product conforms to the following Harmonized Standards:

- 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 Substan*ces.

EAC Mark (Eurasian Conformity)

- TP TC 004/2011
- TP TC 020/2011

NFPA Compliance

Complies with NFPA Standard 110, *Standard for Emergency and Standby Power*.

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, *BESTCOMSPlus™ 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

BESTCOMS*Plus®* provides the user with a point-and-click means to set and monitor the Analog Expansion Module. Installation and operation of BESTCOMS*Plus®* 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.

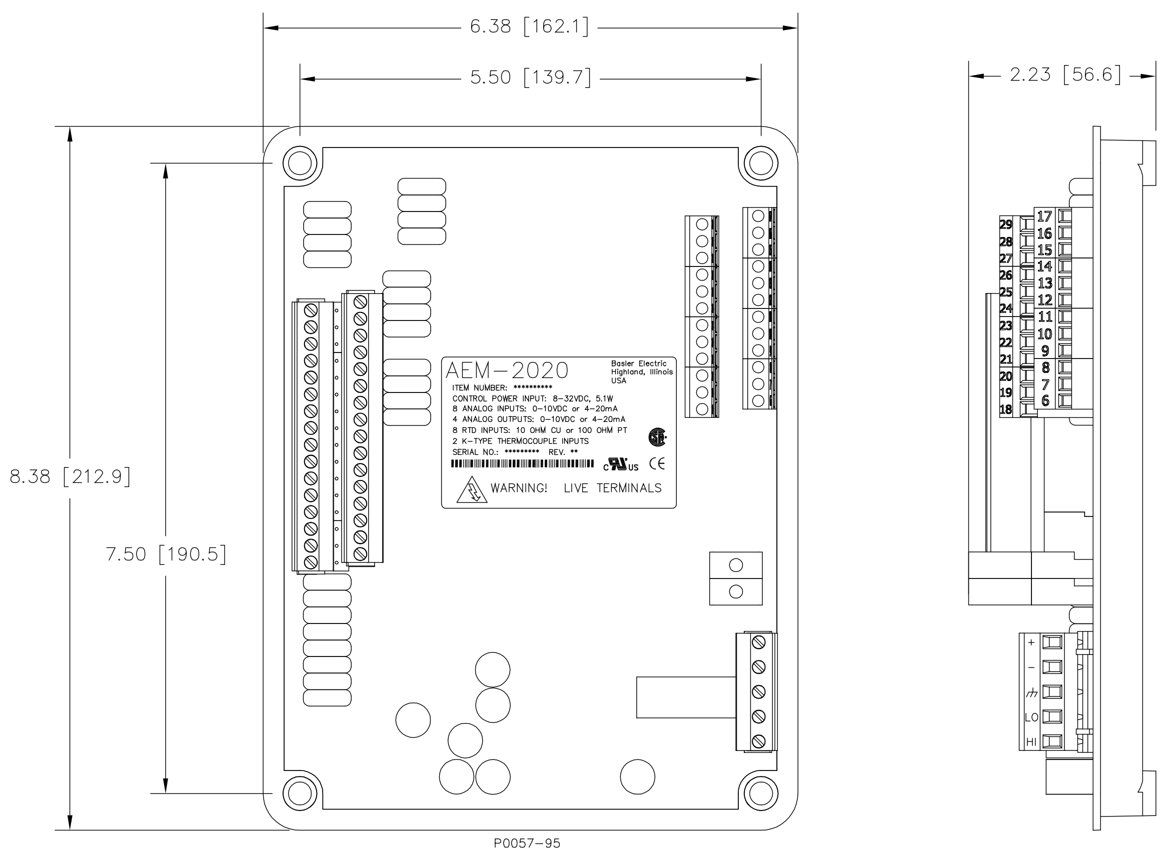

Figure 11-1. AEM-2020 Overall Dimensions

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.

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*.

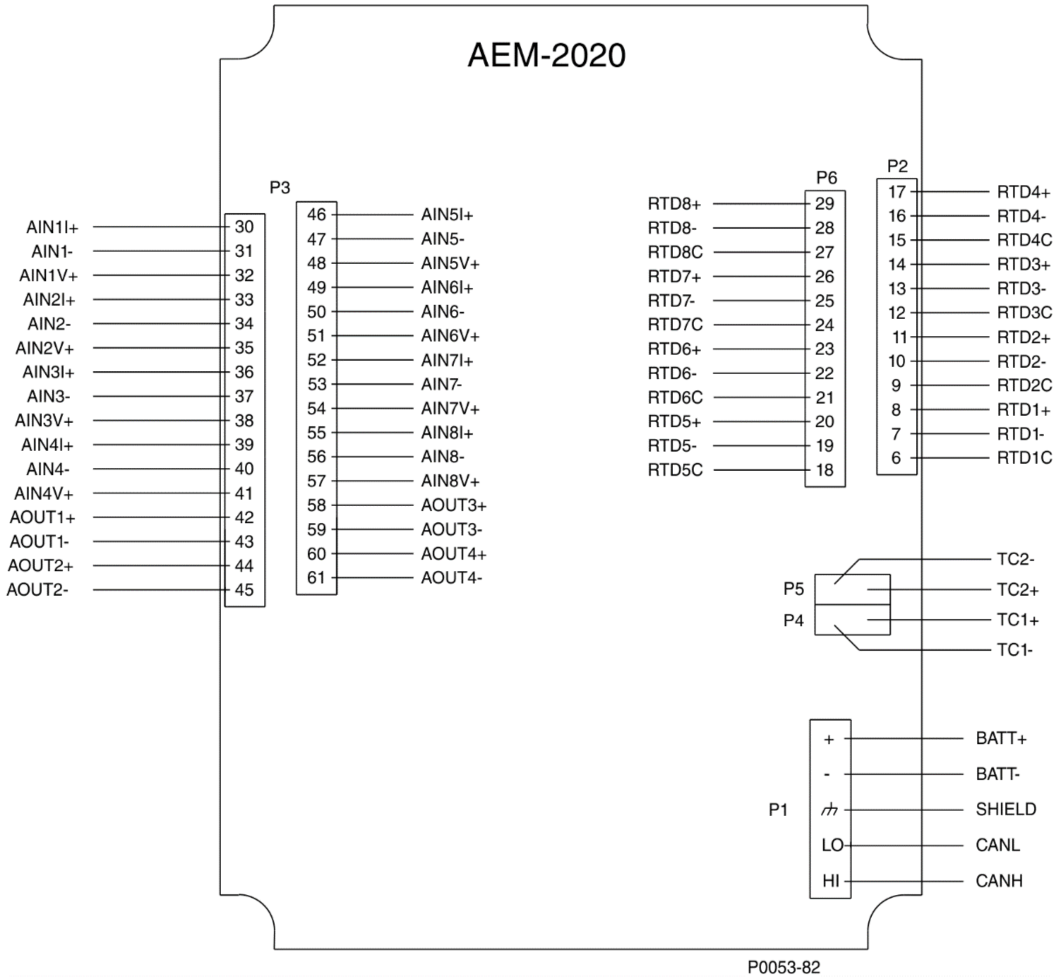

Figure 11-2. Input and Output Terminals

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.

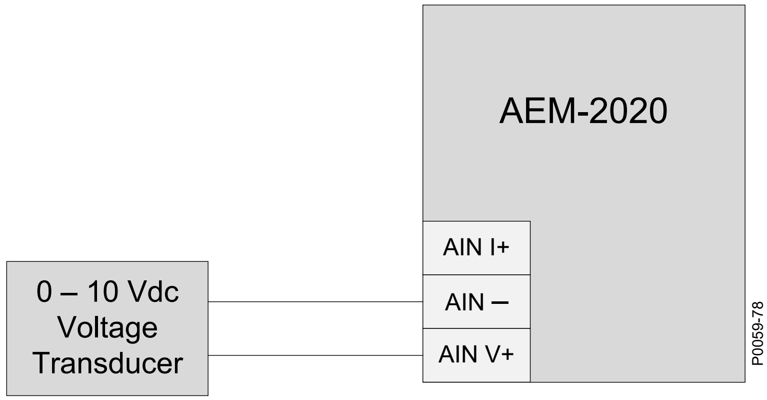

Figure 11-3. Analog Inputs - Voltage Input Connections

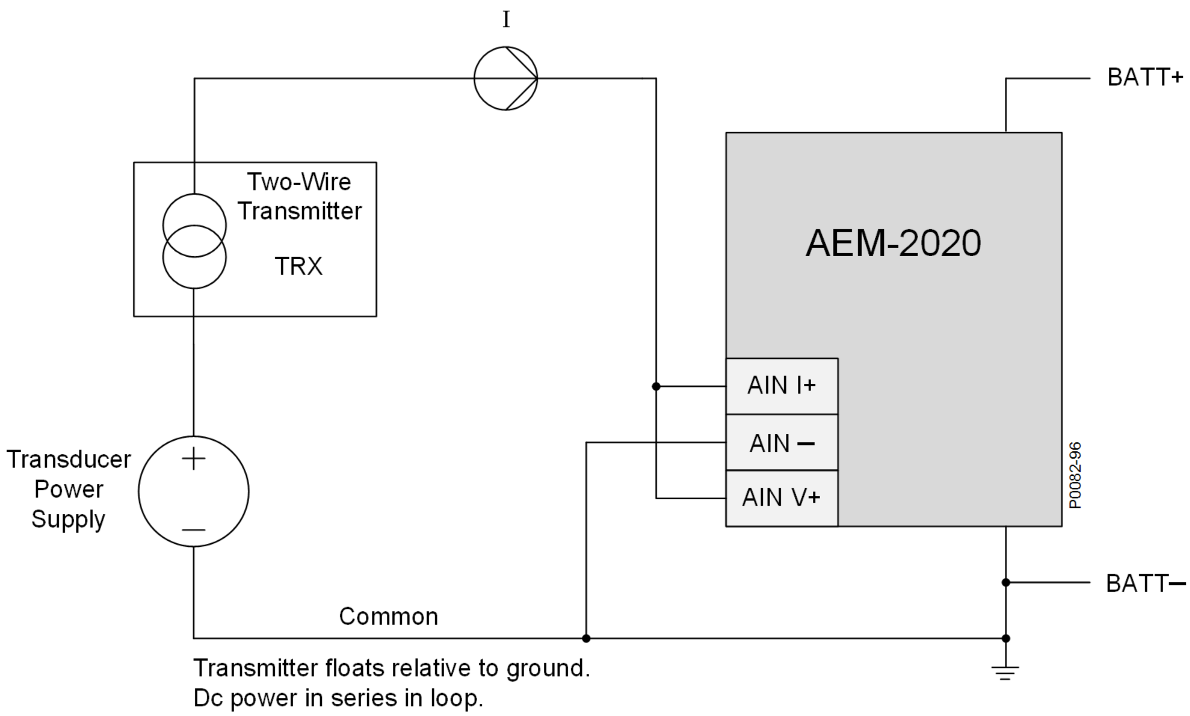

Figure 11-4. Analog Inputs - Current Input Connections, Type II 2-Wire Circuit

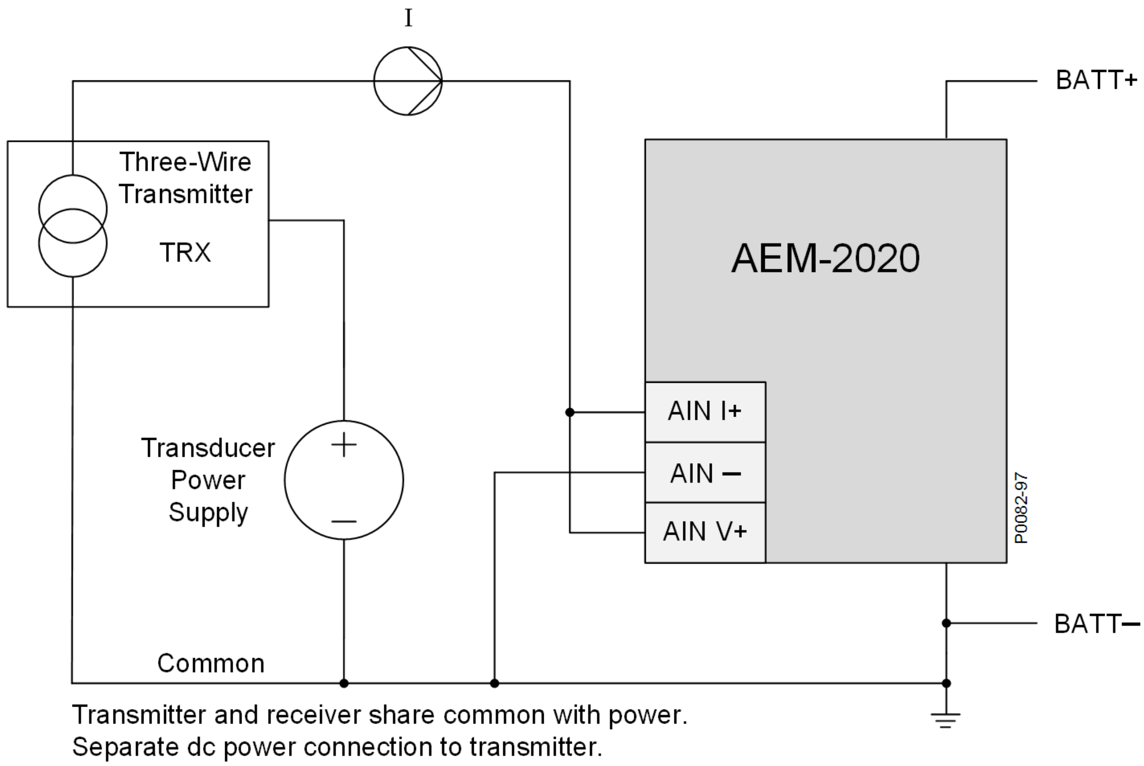

Figure 11-5. Analog Inputs - Current Input Connections, Type III 2-Wire Circuit

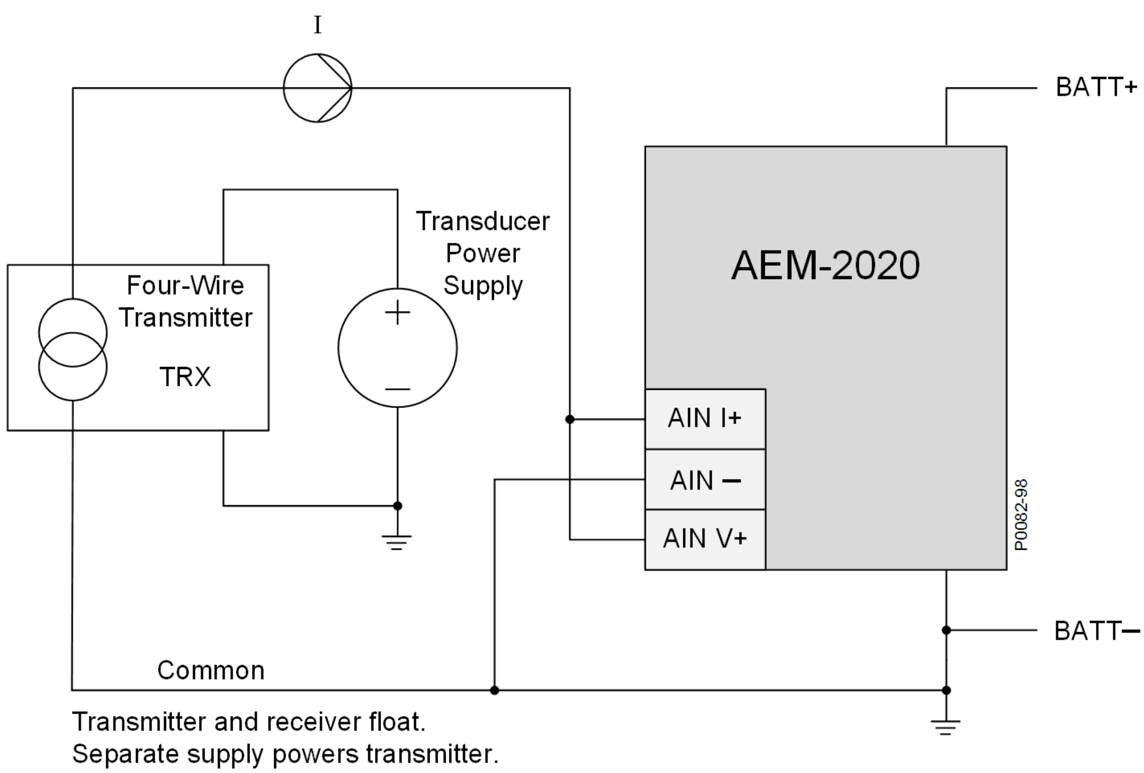

Figure 11-6. Analog Inputs - Current Input Connections, Type IV 2-Wire Circuit

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.

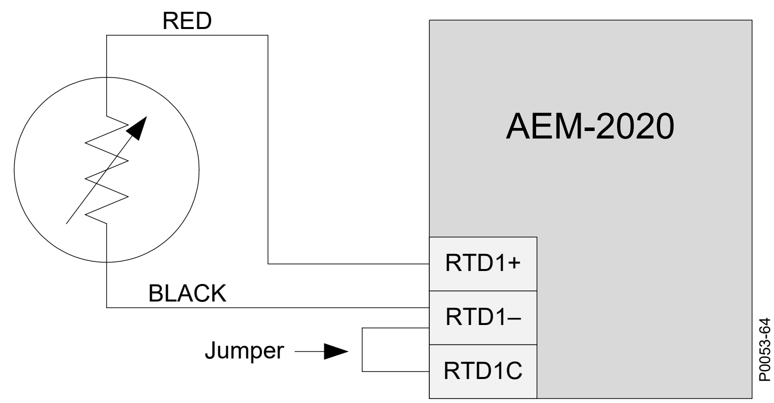

Figure 11-7. External Two-Wire RTD Input Connections

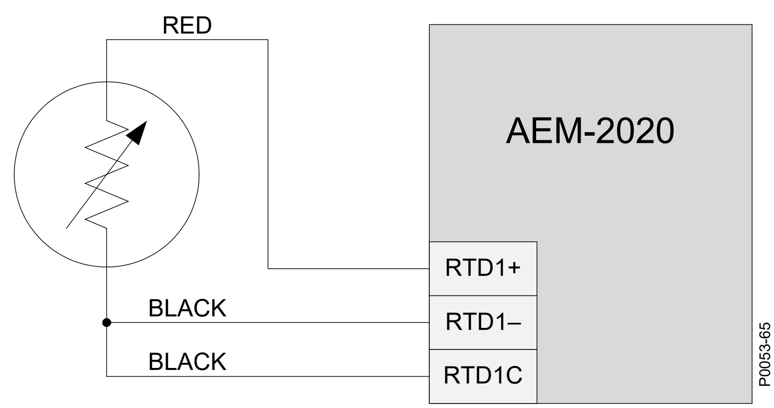

Figure 11-8. External Three-Wire RTD Input Connections

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.

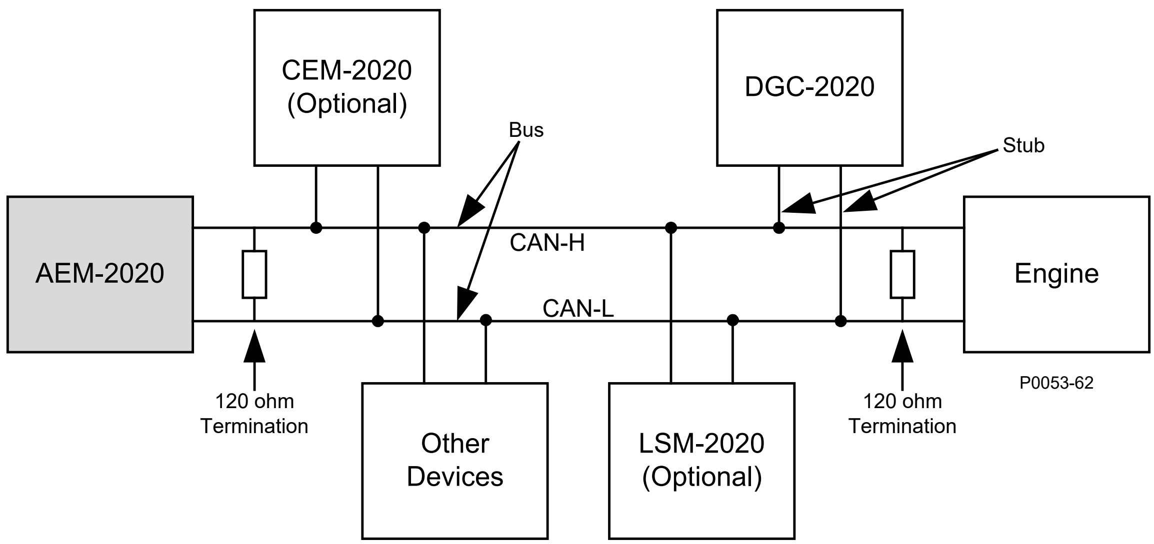

Figure 11-9. CAN Bus Interface with AEM-2020 providing One End of the Bus

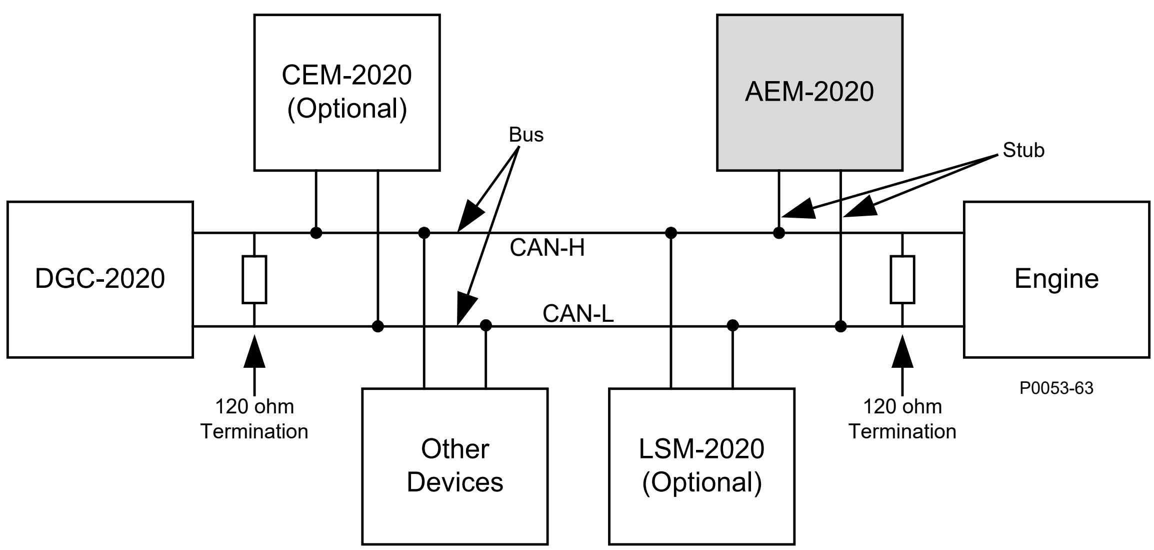

Figure 11-10. CAN Bus Interface with DGC-2020 providing One End of the Bus

Maintenance

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.

APPENDIX A • TIME OVERCURRENT CHARACTERISTIC CURVES

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APPENDIX A • TIME OVERCURRENT CHARACTERISTIC CURVES

Introduction

The inverse time overcurrent characteristic curves provided by the DGC-2020 (style xxxxxxExx 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 ±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

$$T_R = \frac{RD}{\left| M^2 - 1 \right|}$$

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
S1	Short Inverse	0.2663	0.03393	1	1.2969	0.028	1	0.5
S2	Short Inverse	0.0286	0.0208	1	0.9844	0.028	1	0.094
L1	Long Inverse	5.6143	2.18592	1	1	0.028	1	15.75
L2	Long Inverse	2.3955	0	1	0.3125	0.028	1	7.8001
D	Definite Time	0.4797	0.21359	1	1.5625	0.028	1	0.875
M	Moderately Inverse	0.3022	0.1284	1	0.5	0.028	1	1.75
I1	Inverse Time	8.9341	0.17966	1	2.0938	0.028	1	9
I2	Inverse Time	0.2747	0.10426	1	0.4375	0.028	1	0.8868
V1	Very Inverse	5.4678	0.10814	1	2.0469	0.028	1	5.5
V2	Very Inverse	4.4309	0.0991	1	1.9531	0.028	1	5.8231
E1	Extremely Inverse	7.7624	0.02758	1	2.0938	0.028	1	7.75
E2	Extremely Inverse	4.9883	0.0129	1	2.0469	0.028	1	4.7742
A	Standard Inverse	0.01414	0	1	0.02	0.028	1	2
B	Very Inverse (I^2t)	1.4636	0	1	1.0469	0.028	1	3.25
C	Extremely Inverse (I^2t)	8.2506	0	1	2.0469	0.028	1	8
G	Long Time Inverse (I^2t)	12.1212	0	1	1	0.028	1	29
F	Fixed Time ∗	0	1	0	0	0.028	1	1
P	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 BESTCOMS*Plus*®.

‡ 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

Curve	Curve Name	Similar To
S1	Short Inverse	ABB CO-2
S2	Short Inverse	GE IAC-55
L1	Long Inverse	ABB CO-5
L2	Long Inverse	GE IAC-66
D	Definite Time	ABB CO-6
M	Moderately Inverse	ABB CO-7
I1	Inverse Time	ABB CO-8
I2	Inverse Time	GE IAC-51
V1	Very Inverse	ABB CO-9
V2	Very Inverse	GE IAC-53
E1	Extremely Inverse	ABB CO-11
E2	Extremely Inverse	GE IAC-77
A	Standard Inverse	BS 142
B	Very Inverse (I^2t)	BS 142
C	Extremely Inverse (I^2t)	BS 142
G	Long Time Inverse (I^2t)	BS 142
F	Fixed Time	N/A
P	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											
S1	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
L1	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
D	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
M	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
I1	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
V1	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
E1	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
I2	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
V2	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
S2	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
L2	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
E2	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

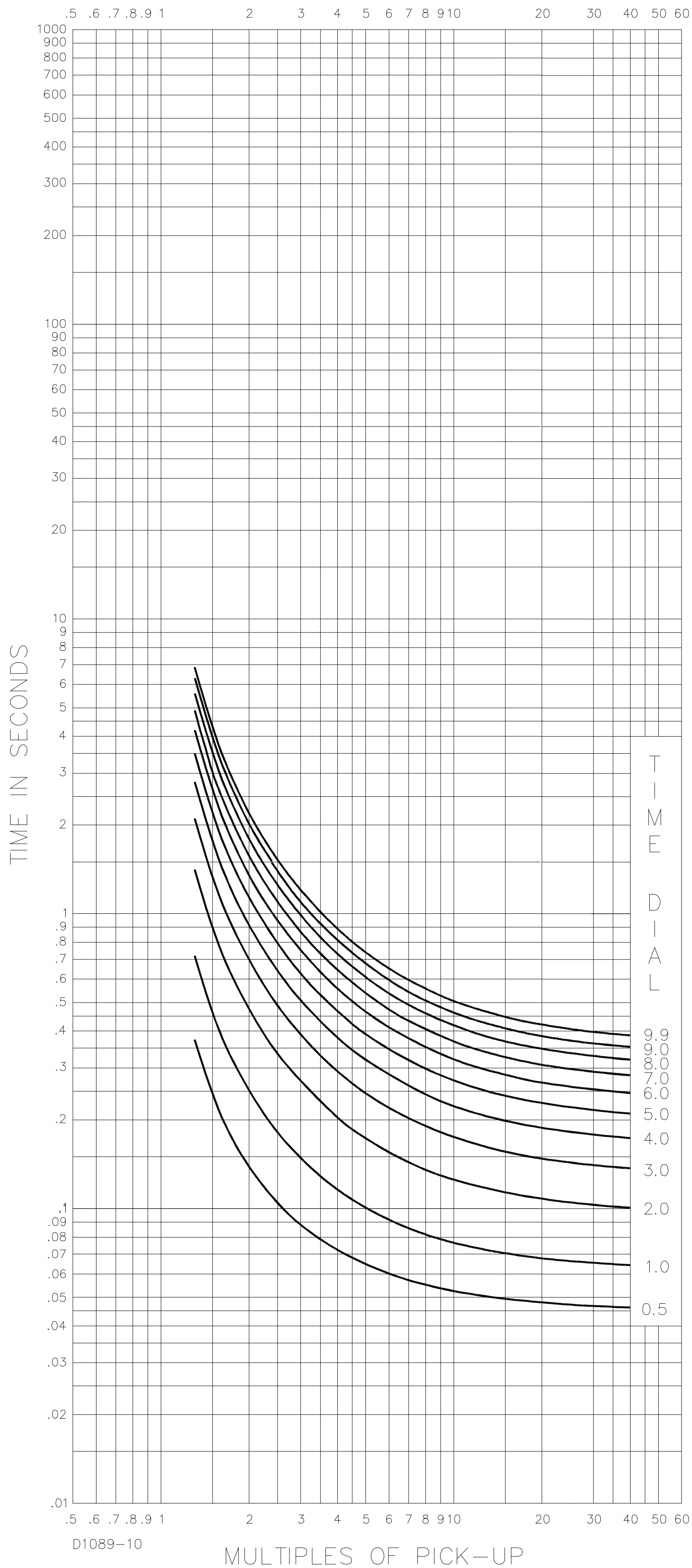

Figure A-1. Time Characteristic Curve S1, Short Inverse (Similar to ABB CO-2)

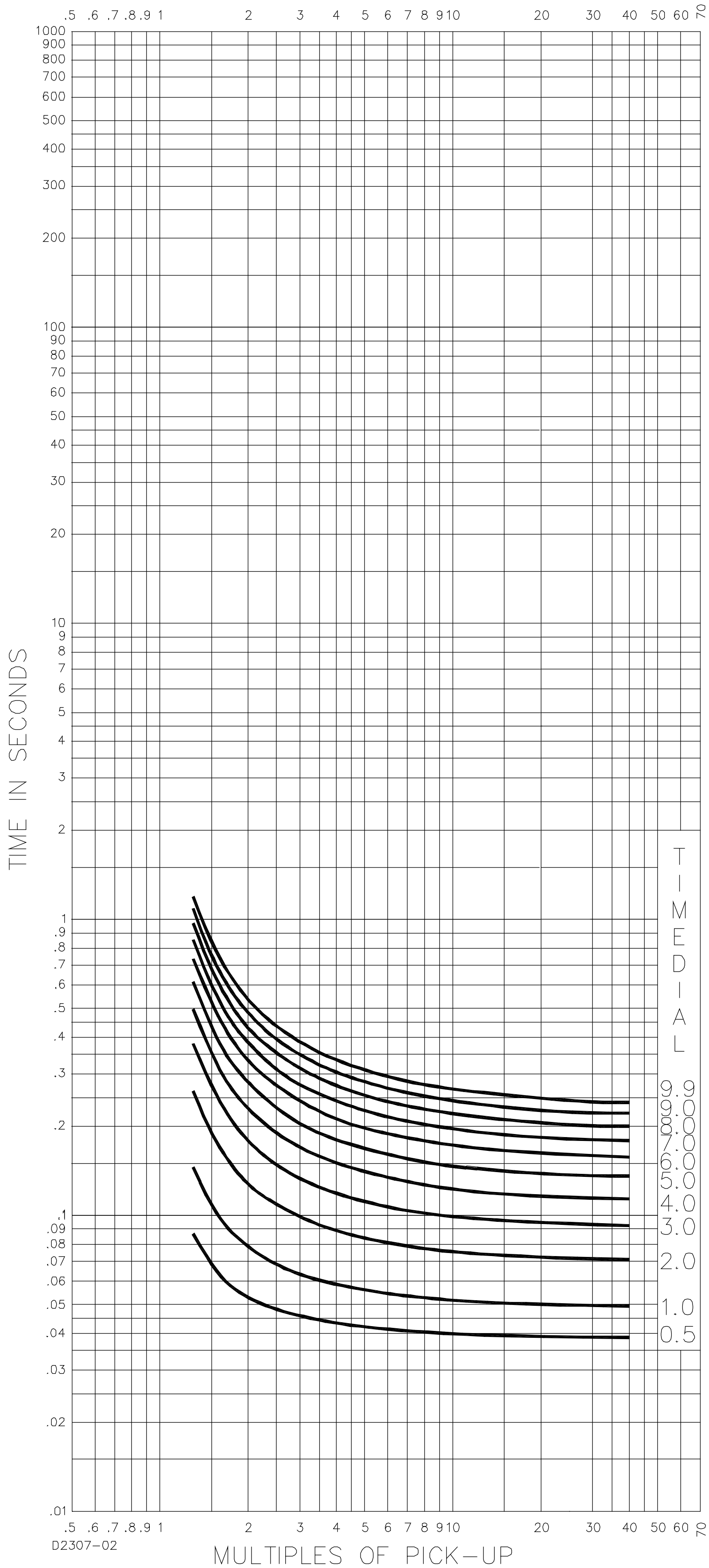

Figure A-2. Time Characteristic Curve S2, Short Inverse (Similar To GE IAC-55)

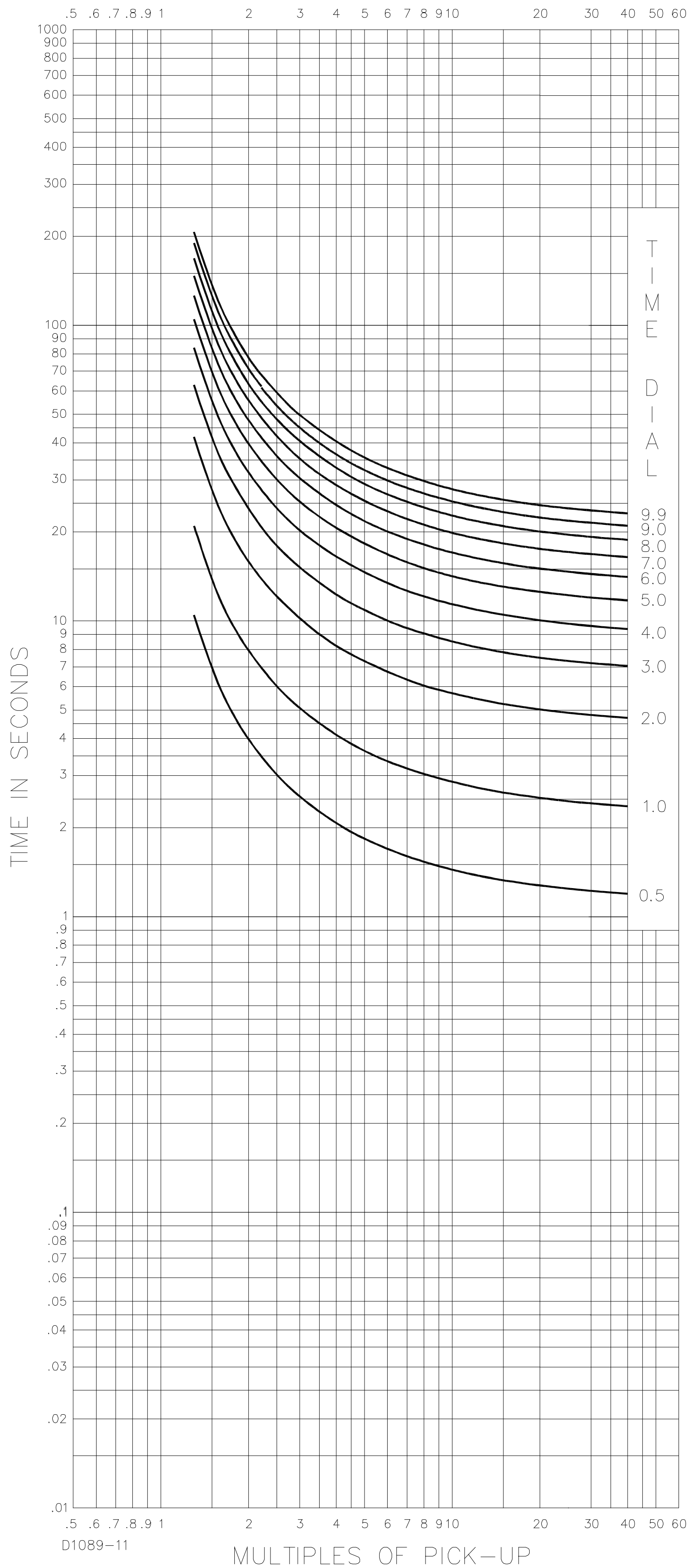

Figure A-3. Time Characteristic Curve L1, Long Inverse (Similar to ABB CO-5)

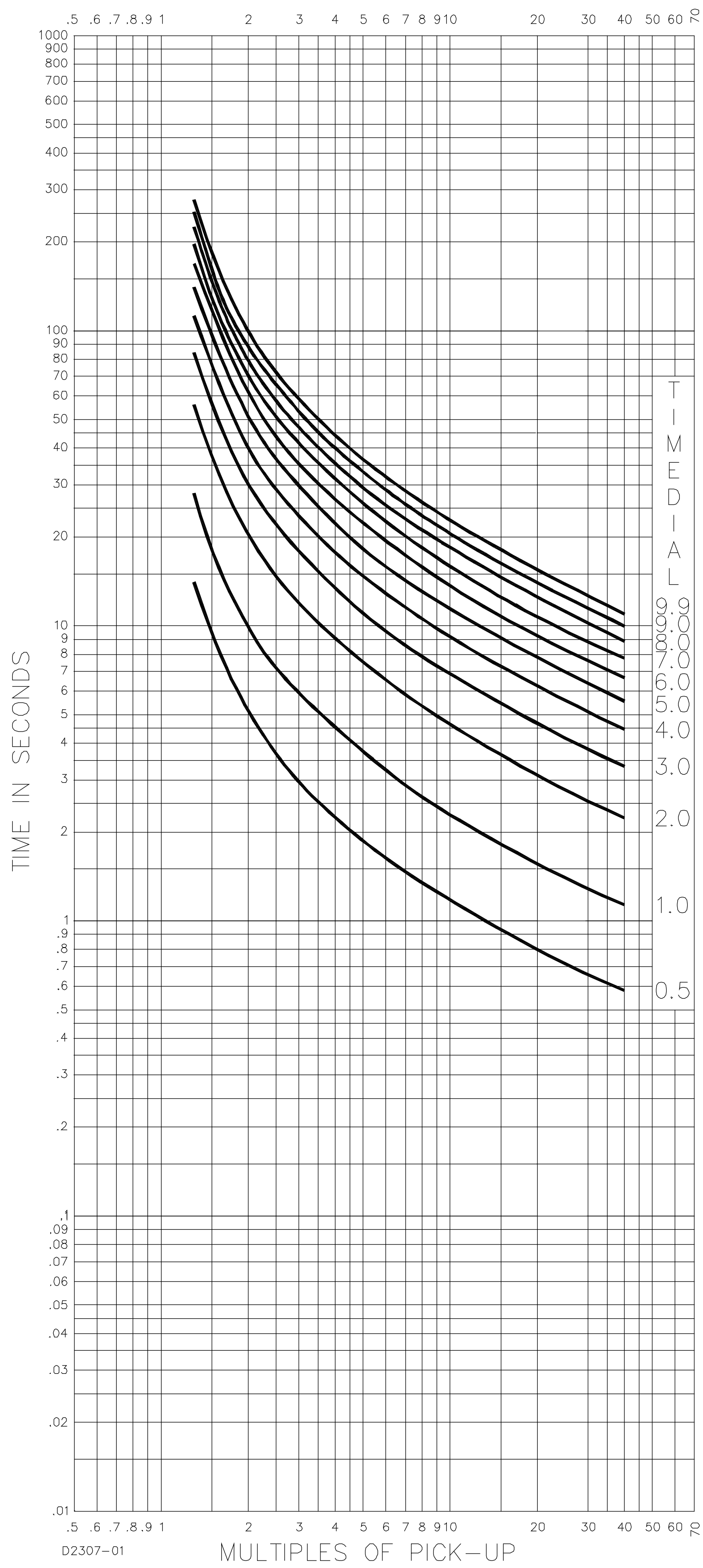

Figure A-4. Time Characteristic Curve L2, Long Inverse (Similar To GE IAC-66)

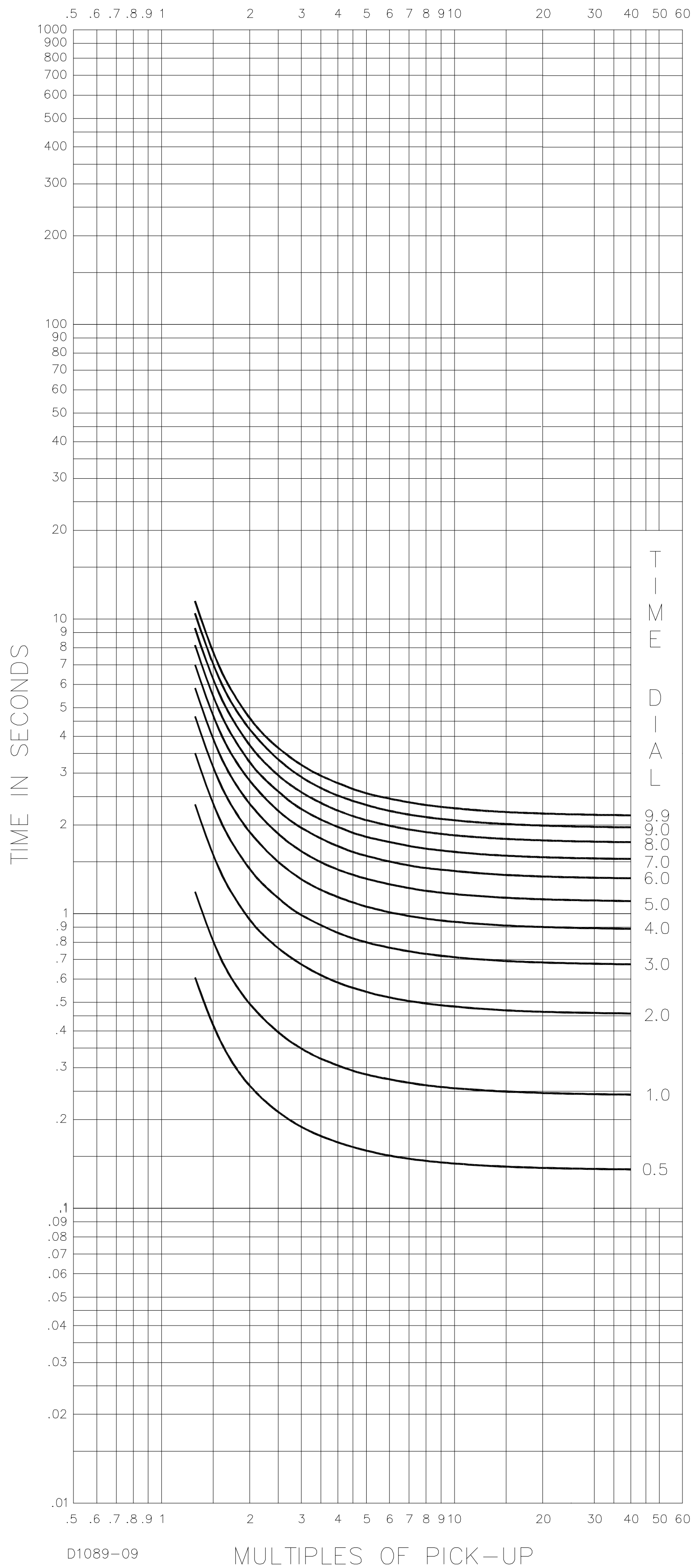

Figure A-5. Time Characteristic Curve D, Definite Time (Similar To ABB CO-6)

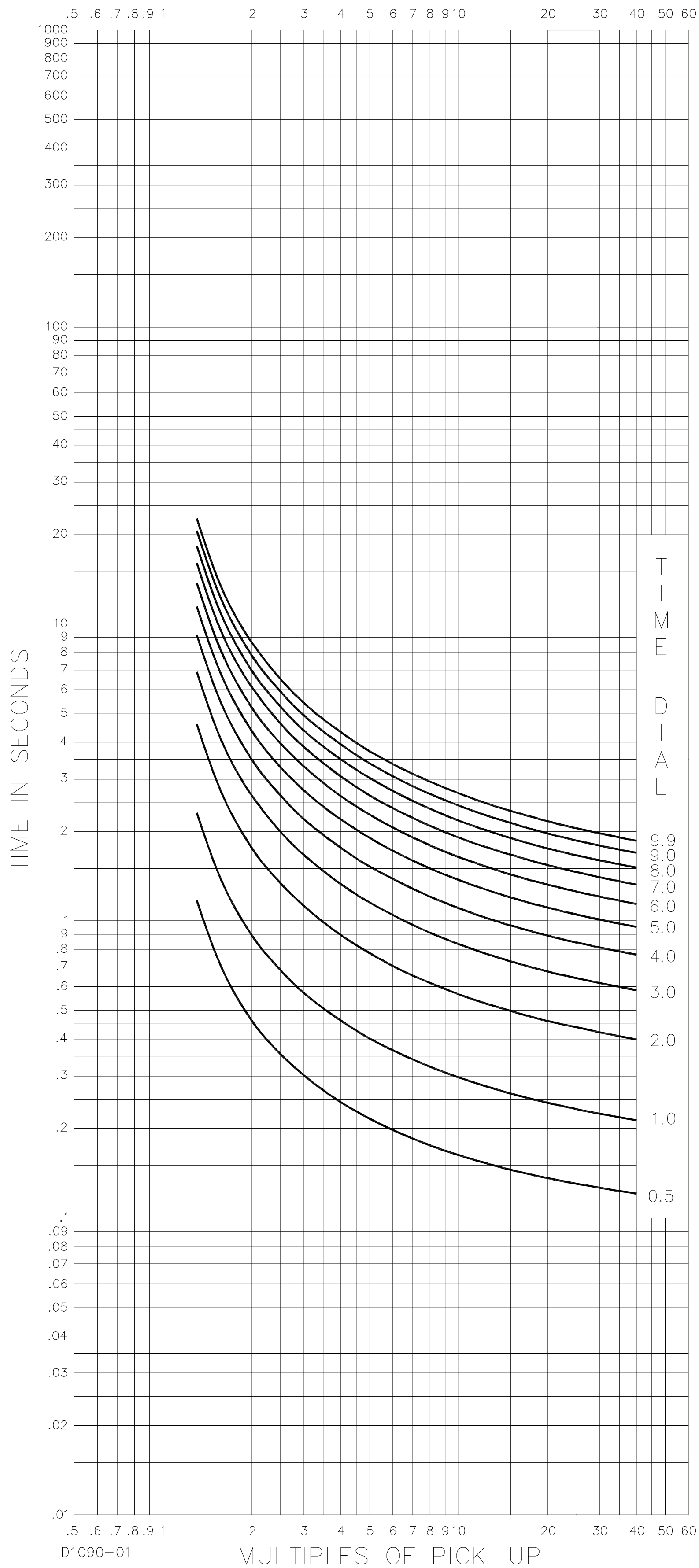

Figure A-6. Time Characteristic Curve M, Moderately Inverse (Similar to ABB CO-7)

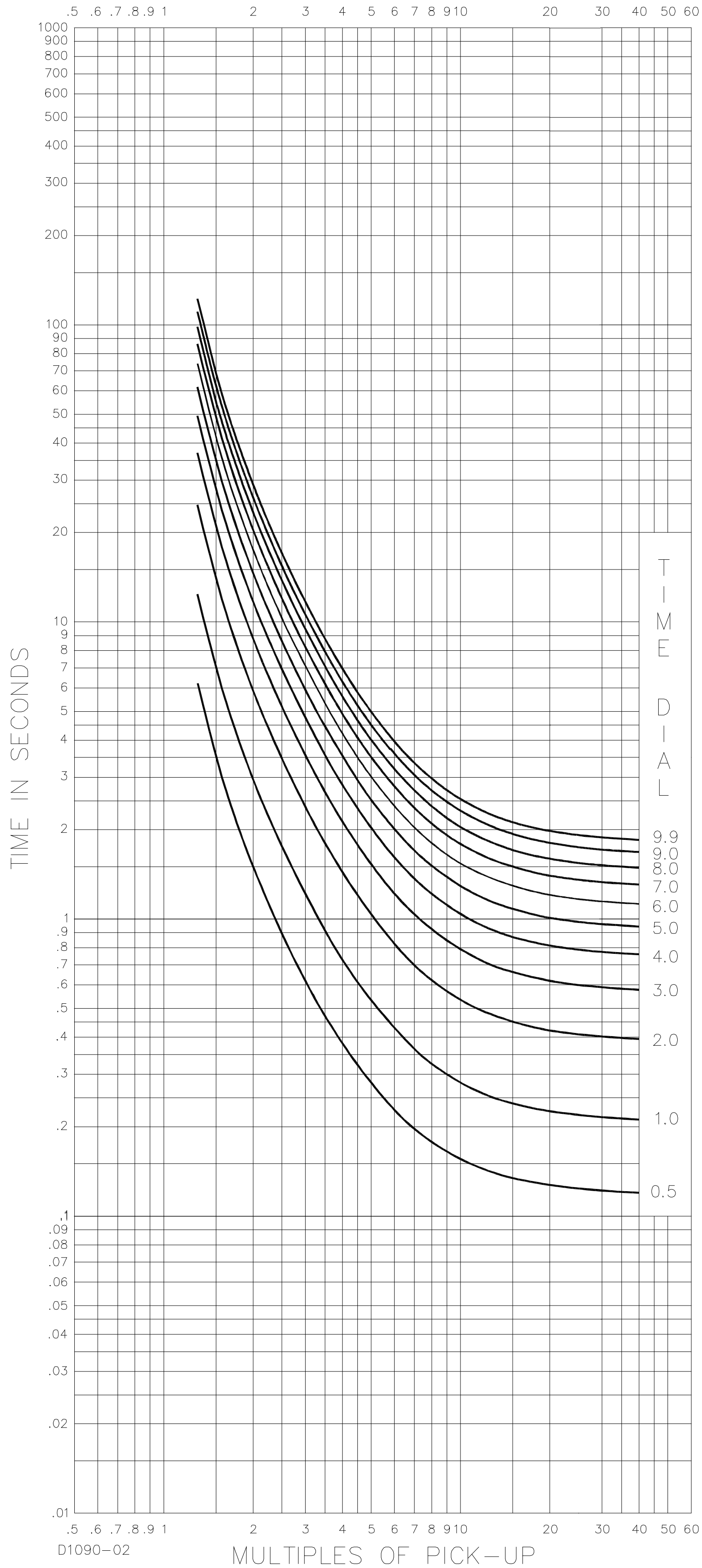

Figure A-7. Time Characteristic Curve I1, Inverse Time (Similar to ABB CO-8)

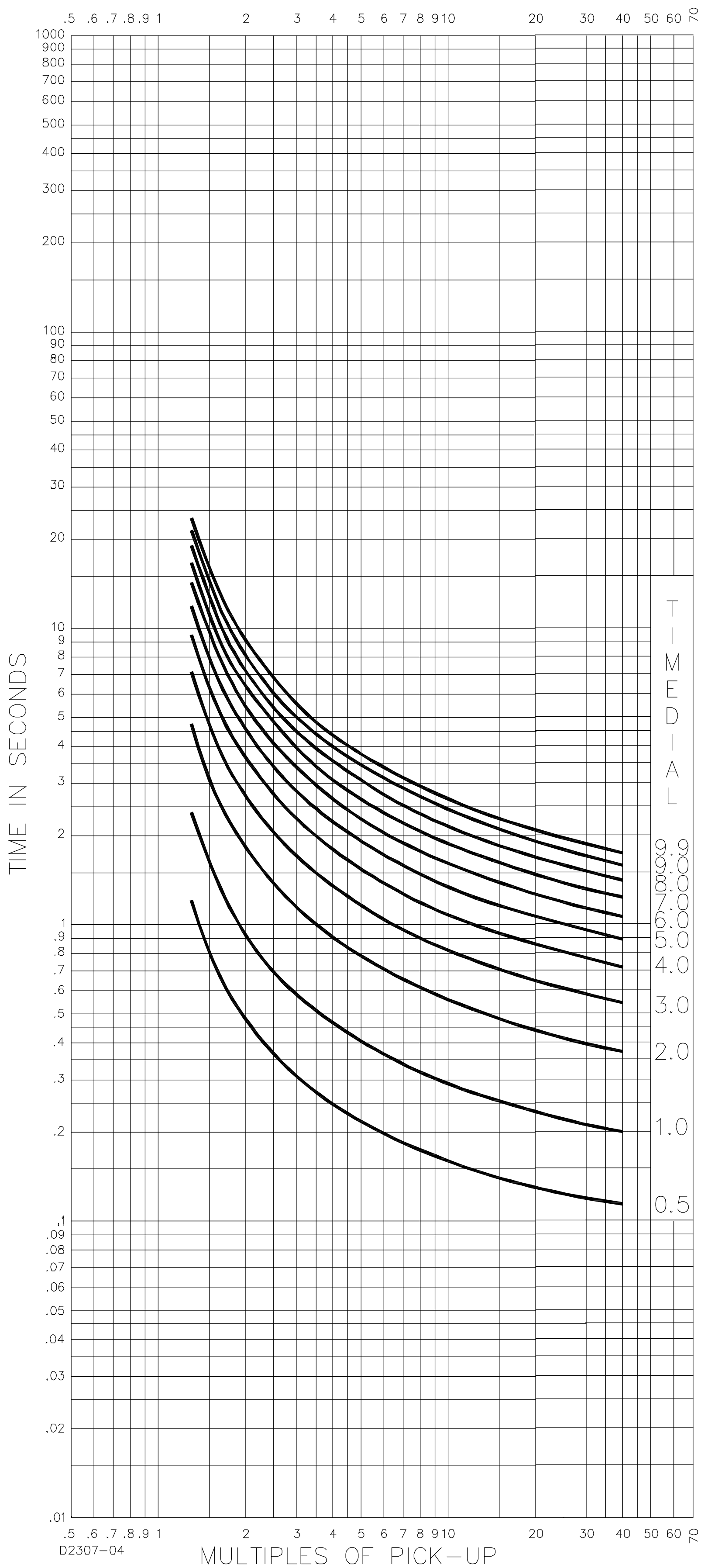

Figure A-8. Time Characteristic Curve I2, Inverse Time (Similar to GE IAC-51)

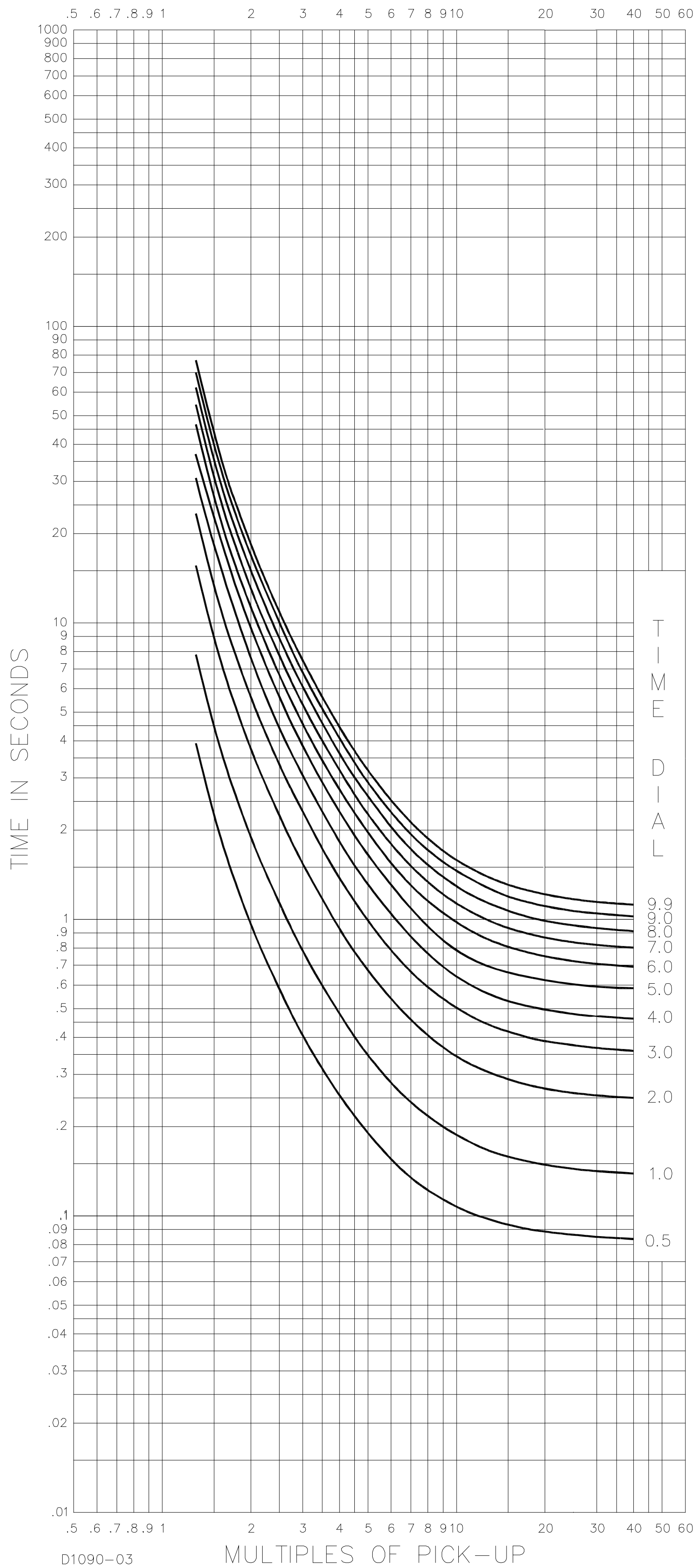

Figure A-9. Time Characteristic Curve V1, Very Inverse (Similar to ABB CO-9)

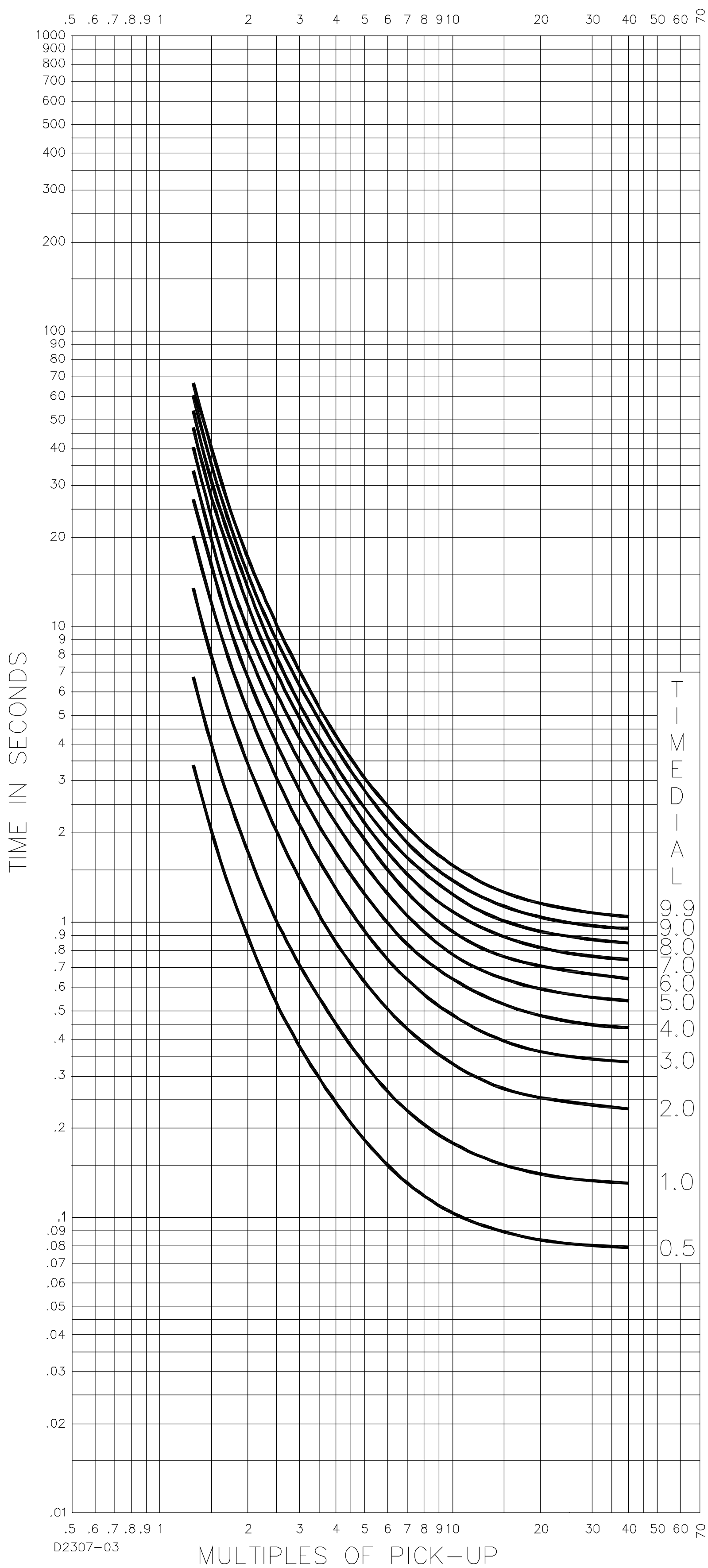

Figure A-10. Time Characteristic Curve V2, Very Inverse (Similar to GE IAC-53)

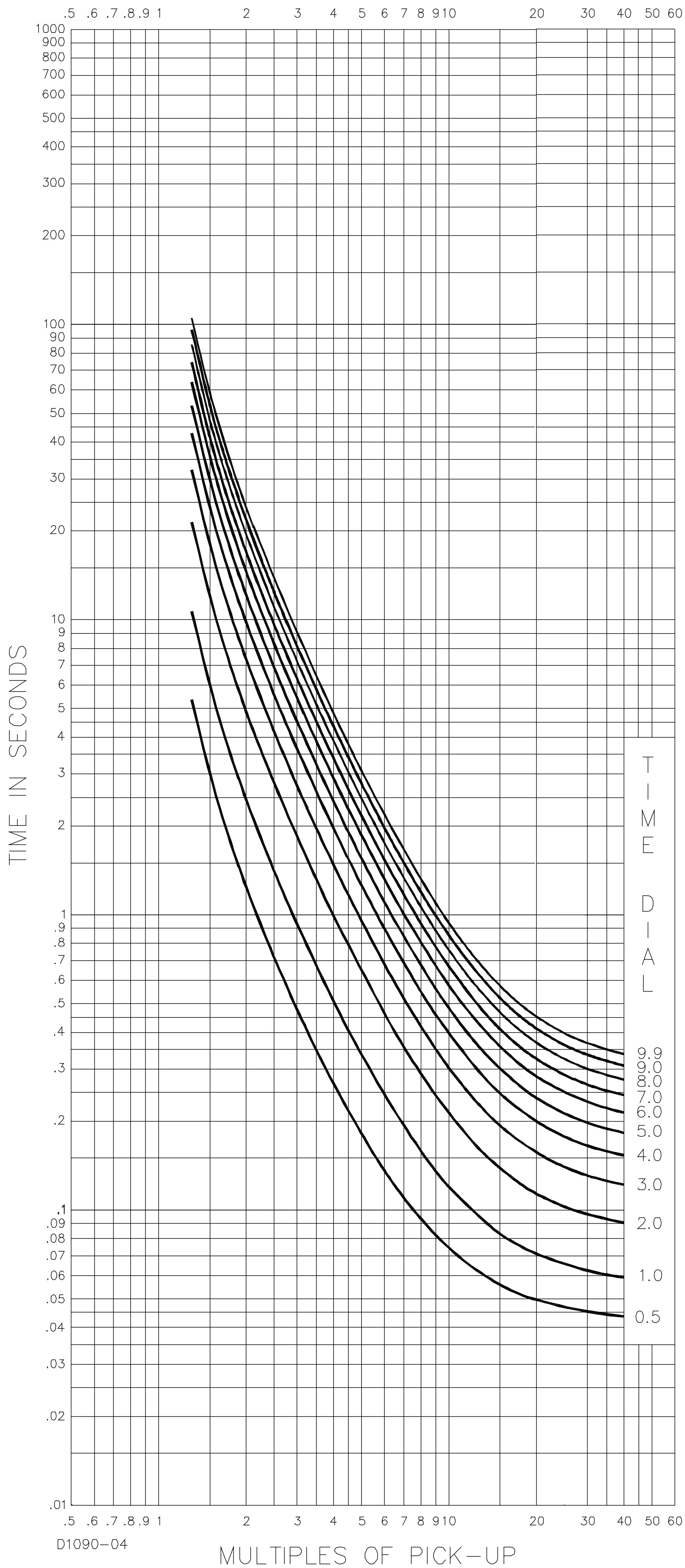

Figure A-11. Time Characteristic Curve E1, Extremely Inverse (Similar to ABB CO-11)

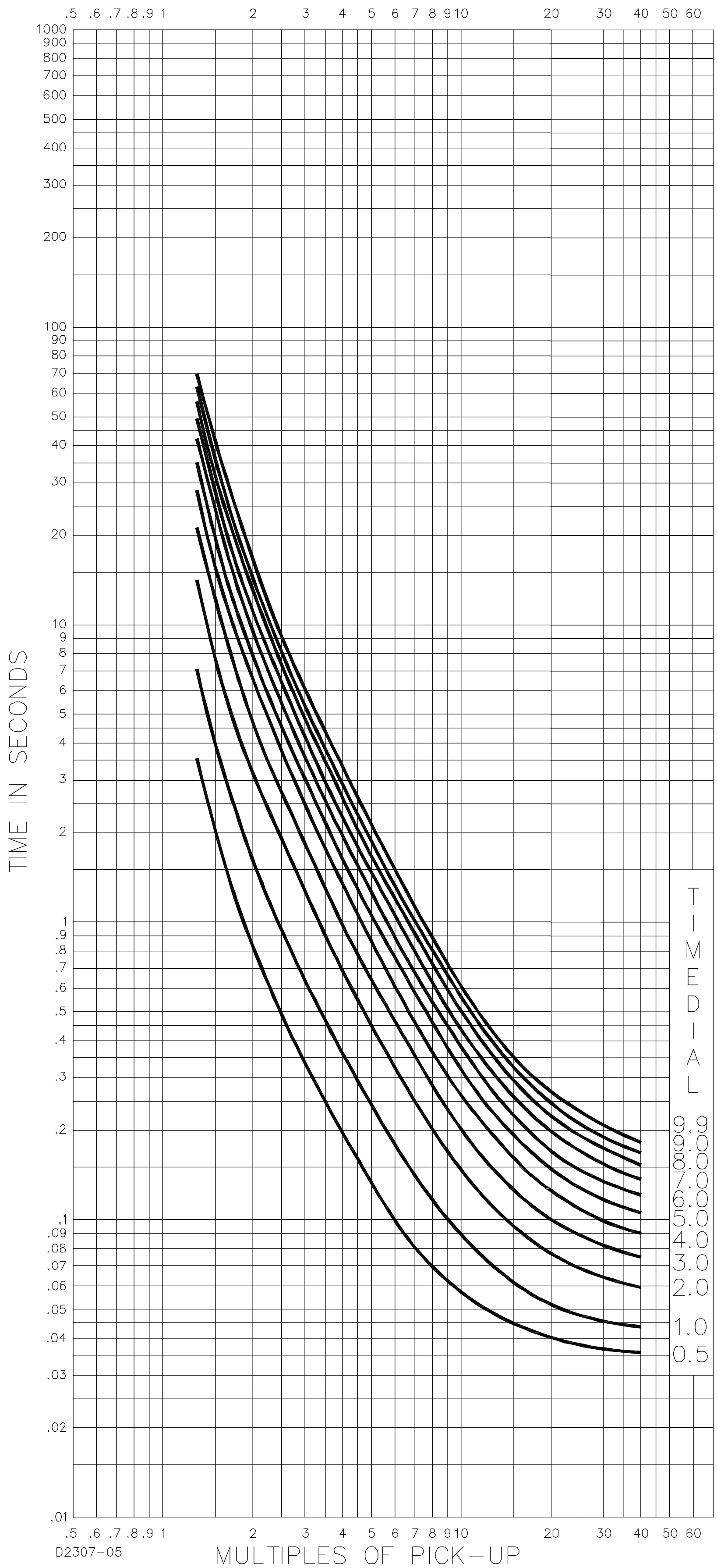

Figure A-12. Time Characteristic Curve E2, Extremely Inverse (Similar to GE IAC-77)

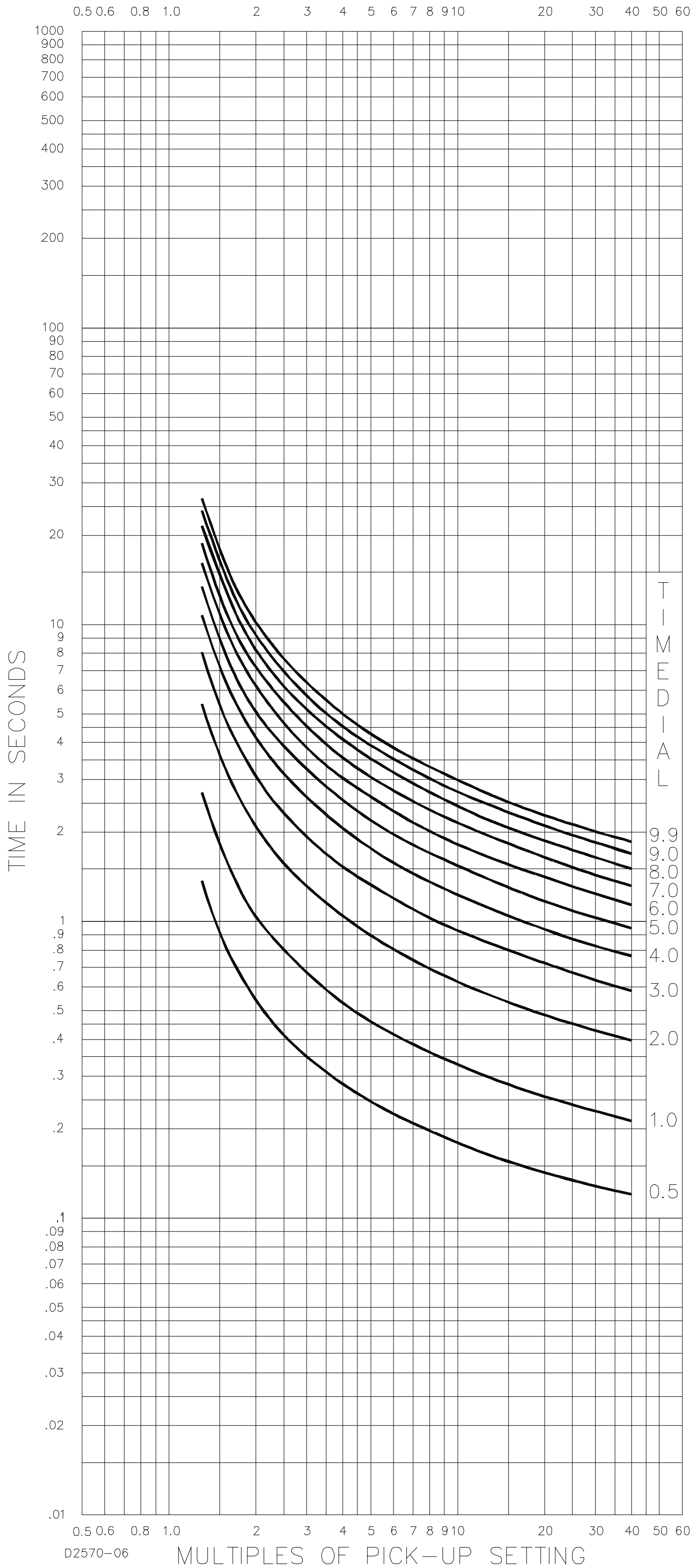

Figure A-13. Time Characteristic Curve A, Standard Inverse (BS 142)

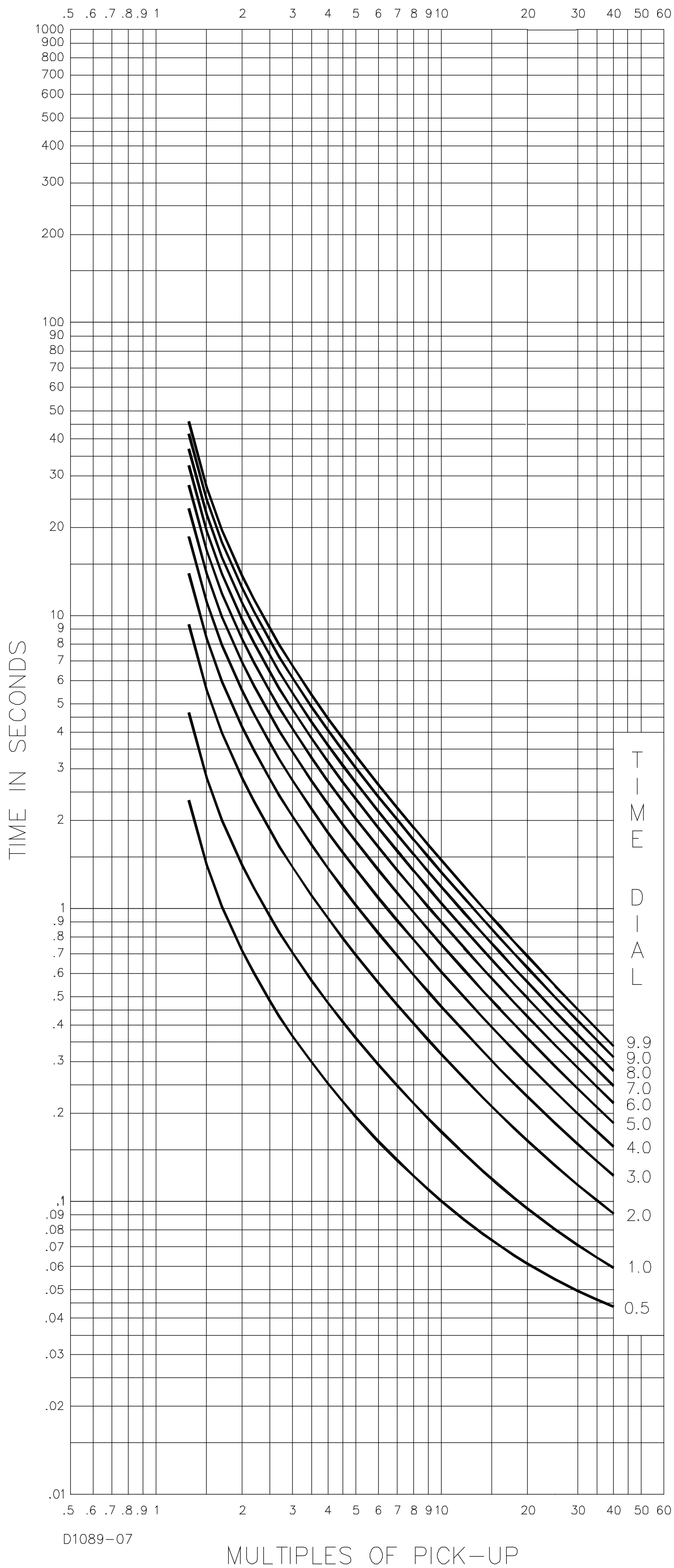

Figure A-14. Time Characteristic Curve B, Very Inverse (BS 142)

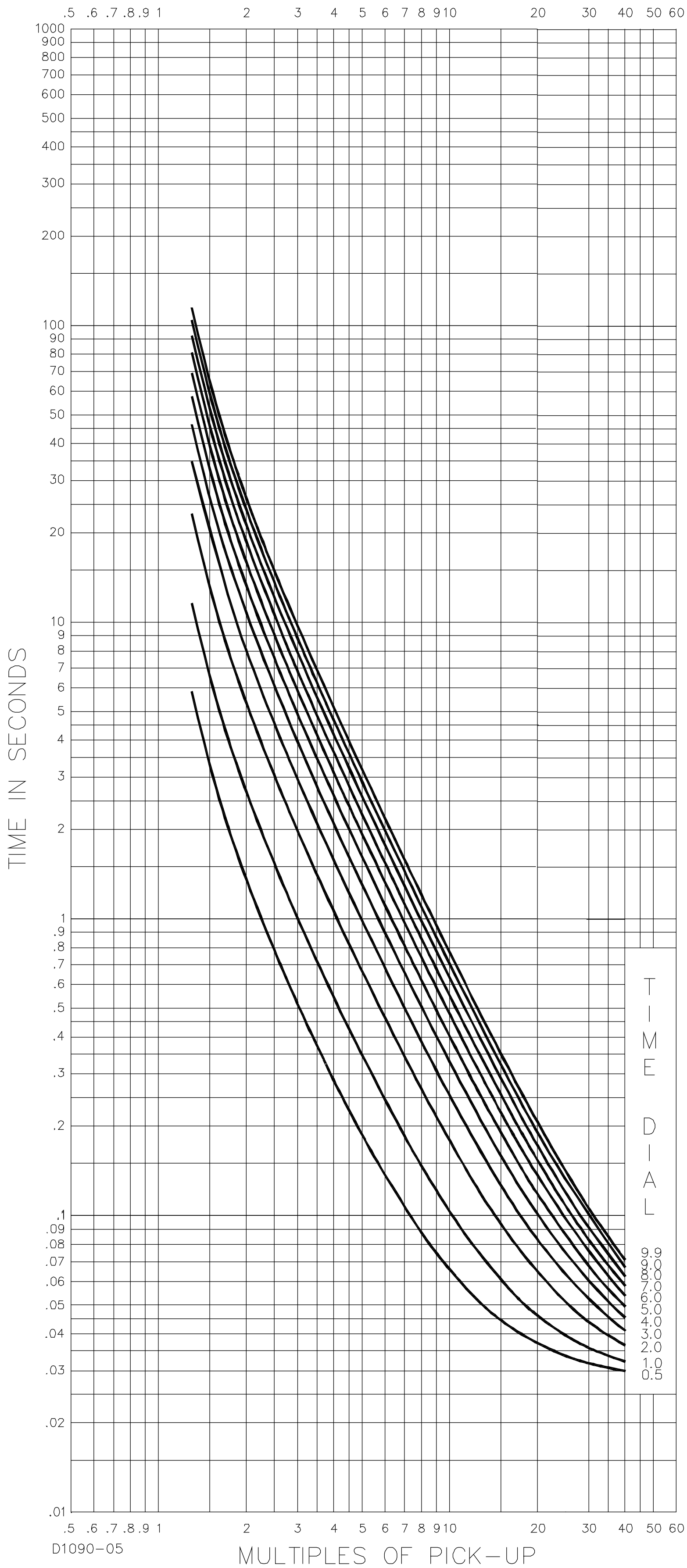

Figure A-15. Time Characteristic Curve C, Extremely Inverse (BS 142)

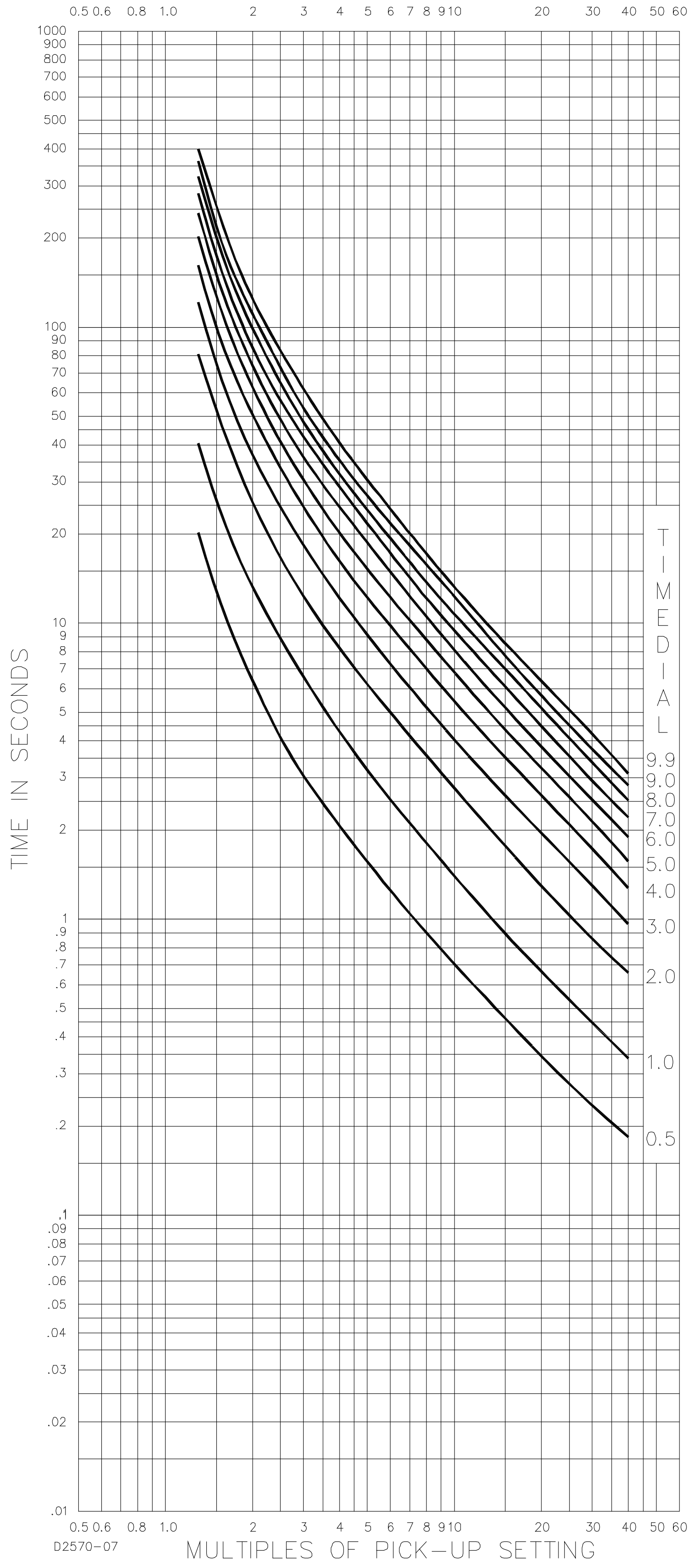

Figure A-16. Time Characteristic Curve G, Long Time Inverse (BS 142)

APPENDIX B • MODBUS® COMMUNICATION

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APPENDIX B • MODBUS® COMMUNICATION

Introduction

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.

Detailed Description of DGC-2020 Modbus® Protocol

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 03 - Read Holding Registers
- Function 6 - 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 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:

Holding Register	Value
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:

Holding Register	Value
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:

Holding Register	Value
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.

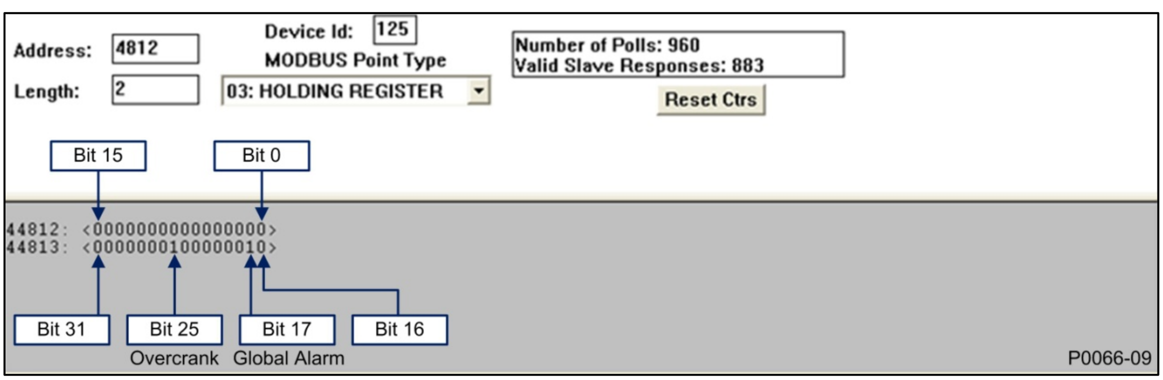

Figure B-1. 32-Bit Bit-Mapped Parameter Mapping

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 $8.43X10^{-37}$ to $3.38X10^{38}$. 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 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 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 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 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 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 1 = Enable
42036	Fgen > Fbus	Int32	N/A	N/A	RW	0 = Disable 1 = Enable

Register	Description	Type	Units	Scaling Factor	R/W	Range
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 1 = Enable
42050	Gen Breaker Status	Int32	N/A	N/A	R	0 = Open 1 = Closed
42052	Mains Breaker Status	Int32	N/A	N/A	R	0 = Open 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 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 1 = Close
42072	In Phase Monitor Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
42074	Dead Gen Close Enable	Int32	N/A	N/A	RW	0 = Disable 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 1 = Enable
42084	Gen Breaker External Status Change Action Data	Int32	N/A	N/A	RW	0 = Ignore 1 = Follow Always 2 = Follow In Auto
42086	Gen Breaker Fail Output Config Data	Int32	N/A	N/A	RW	0 = Retain 1 = Remove
42088	Mains Fail Mains Breaker Open Config Data	Int32	N/A	N/A	RW	0 = Generator Start 1 = Generator Stable
42090	Mains Fail Allow Transfer To Mains In Alarm State Data	Int32	N/A	N/A	RW	1 = Enable 2 = Disable
42092	Mains Breaker External Status Change Action Data	Int32	N/A	N/A	RW	0 = Ignore 1 = Follow Always 2 = Follow In Auto
42094	Mains Breaker Fail Output	Int32	N/A	N/A	RW	0 = Retain 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 1 = Enable
42262	AVR Integrator Limit Plus	Float	N/A	N/A	RW	0–1000

Register	Description	Type	Units	Scaling Factor	R/W	Range
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 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 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
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 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 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 1 = Analog
42348	Governor Bias Control Output Type	Int32	N/A	N/A	RW	0 = Contact 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 1 = Enable
42356	Voltage Trim Enable	Int32	N/A	N/A	RW	0 = Disable 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 1 = Enable

Register	Description	Type	Units	Scaling Factor	R/W	Range
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 1 = LSM Analog Input 1 2 = AEM Analog Input 1 3 = AEM Analog Input 2 4 = AEM Analog Input 3 5 = AEM Analog Input 4 6 = AEM Analog Input 5 7 = AEM Analog Input 6 8 = AEM Analog Input 7 9 = AEM Analog Input 8
42376	kvar Setpoint Source	Uint32	N/A	N/A	RW	0 = User Setting 1 = LSM Analog Input 1 2 = AEM Analog Input 1 3 = AEM Analog Input 2 4 = AEM Analog Input 3 5 = AEM Analog Input 4 6 = AEM Analog Input 5 7 = AEM Analog Input 6 8 = AEM Analog Input 7 9 = AEM Analog Input 8
42378	PF Setpoint Source	Uint32	N/A	N/A	RW	0 = User Setting 1 = LSM Analog Input 1 2 = AEM Analog Input 1 3 = AEM Analog Input 2 4 = AEM Analog Input 3 5 = AEM Analog Input 4 6 = AEM Analog Input 5 7 = AEM Analog Input 6 8 = AEM Analog Input 7 9 = AEM Analog Input 8
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 1 = PF Control
42416	Load Share Interface	Int32	N/A	N/A	RW	0 = Analog Load Share Line 1 = Ethernet Comms
42418	Remote Speed Bias Source	Int32	N/A	N/A	RW	0 = User Setting 1 = LSM Analog Input 1 2 = AEM Analog Input 1 3 = AEM Analog Input 2 4 = AEM Analog Input 3 5 = AEM Analog Input 4 6 = AEM Analog Input 5 7 = AEM Analog Input 6 8 = AEM Analog Input 7 9 = AEM Analog Input 8
42420–22	RESERVED					
42424	LSM Aux Input Source	Int32	N/A	N/A	RW	0 = LSM Local Aux Input 1 = LSM System Manager
42426	kW Ramp Status	Int32	N/A	N/A	R	0 = none 1 = up 2 = down
42428	kvar Ramp Status	Int32	N/A	N/A	R	0 = none 1 = up 2 = down

Register	Description	Type	Units	Scaling Factor	R/W	Range
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 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 1 = Proportional
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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 1 = Alarm 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 1 = Alarm 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 1 = Alarm 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 1 = Alarm 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 1 = Alarm 2 = Pre-alarm
43286	User Configurable Input 5 Time Delay	Int32	Second	N/A	RW	0–300

Register	Description	Type	Units	Scaling Factor	R/W	Range
43288–90	RESERVED					
43292	User Configurable Input 6 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = Alarm 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 1 = Alarm 2 = Pre-alarm
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 1 = Alarm 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 1 = Alarm 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 1 = Alarm 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 1 = Alarm 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 1 = Alarm 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 1 = Alarm 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 1 = Alarm 2 = Pre-alarm
43366	User Configurable Input 15 Time Delay	Int32	Second	N/A	RW	0–300
43368–70	RESERVED					

Register	Description	Type	Units	Scaling Factor	R/W	Range
43372	User Configurable Input 16 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm
43374	User Configurable Input 16 Time Delay	Int32	Second	N/A	RW	0–300
43376–408	RESERVED					
43410	ATS Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43412	RESERVED					
43414	Single Phase Connection Override Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43416	RESERVED					
43418	Single Phase AC Sense Override Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 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 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43424	RESERVED					
43426	Battle Override Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43428	RESERVED					
43430	Grounded Delta Override Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43432	RESERVED					
43434	Coolant Temperature Sender Fail Configuration Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = Alarm 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 1 = Alarm 2 = Pre-Alarm
43444	Fuel Level Sender Fail Activation Delay	Int32	Second	N/A	RW	0–300

Register	Description	Type	Units	Scaling Factor	R/W	Range
43446	Voltage Sensing Fail Configuration Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43452	Low Coolant Level Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43458	Battery Charge Failed Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43464	Fuel Leak Detect Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43466	Fuel Leak Detect Time Delay	Int32	Second	N/A	RW	0–300

Register	Description	Type	Units	Scaling Factor	R/W	Range
43468	User Configurable Input 1 Engine Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43470	User Configurable Input 2 Engine Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43472	User Configurable Input 3 Engine Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43474	User Configurable Input 4 Engine Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43476	User Configurable Input 5 Engine Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43478	User Configurable Input 6 Engine Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43480	User Configurable Input 7 Engine Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43482	User Configurable Input 8 Engine Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43484	User Configurable Input 9 Engine Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43486	User Configurable Input 10 Engine Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43488	User Configurable Input 11 Engine Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43490	User Configurable Input 12 Engine Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43492	User Configurable Input 13 Engine Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43494	User Configurable Input 14 Engine Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43496	User Configurable Input 15 Engine Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43498	User Configurable Input 16 Engine Run Only	Int32	N/A	N/A	RW	0 = Always 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 1 = Closed While Running
43504	System Units	Int32	N/A	N/A	RW	0 = English 1 = Metric
43506	Battery Volts	Int32	N/A	N/A	RW	0 = 12V 1 = 24V
43508	Off Mode Status	Int32	N/A	N/A	R	0 = Disable 1 = Enable
43510	Run Mode Status	Int32	N/A	N/A	R	0 = Disable 1 = Enable
43512	Auto Mode Status	Int32	N/A	N/A	R	0 = Disable 1 = Enable
43514	Virtual Input 1 Status	Int32	N/A	N/A	R	0 = Disable 1 = Enable
43516	Virtual Input 2 Status	Int32	N/A	N/A	R	0 = Disable 1 = Enable
43518	Virtual Input 3 Status	Int32	N/A	N/A	R	0 = Disable 1 = Enable
43520	Virtual Input 4 Status	Int32	N/A	N/A	R	0 = Disable 1 = Enable

Register	Description	Type	Units	Scaling Factor	R/W	Range
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 1 = Enable
43536	Gen PT Primary	Int32	Volt	N/A	RW	1–99999
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	1–99999
43544	Bus PT Secondary	Int32	Volt	N/A	RW	1–80
43546	Cranking Style	Uint32	N/A	N/A	RW	0 = Continuous 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 1 = Wye 2 = 1-phase AB 3 = 1-phase AC 4 = Grounded Delta
43560	Gen Rated Frequency	Int32	Hertz	N/A	RW	0 = 50 Hz 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 1 = Fuel Level 2 = Natural Gas 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 2 = Gen Freq 3 = MPU Freq
43576	NFPA Level	Uint32	N/A	N/A	RW	0 = Zero 1 = One 2 = Two
43578	Horn Enable	Int32	N/A	N/A	RW	0 = Disabled 1 = Enabled
43580	Single Phase Override Sensing	Uint32	N/A	N/A	RW	0 = AB 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 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 1 = Floating 2 = Fixed
43594	Start/End Time Reference	Int32	N/A	N/A	RW	0 = Local Time 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

Register	Description	Type	Units	Scaling Factor	R/W	Range
43600	DST Start Month	Int32	N/A	N/A	RW	1 = January 2 = February 3 = March 4 = April 5 = May 6 = June 7 = July 8 = August 9 = September 10 = October 11 = November 12 = December
43602	DST Start Day	Int32	N/A	N/A	RW	1–31
43604	DST Start Week of Month	In32	N/A	N/A	RW	0 = First 1 = Second 2 = Third 3 = Fourth 4 = Last
43606	DST Start Day of Week	Int32	N/A	N/A	RW	0 = Sunday 1 = Monday 2 = Tuesday 3 = Wednesday 4 = Thursday 5 = Friday 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 2 = February 3 = March 4 = April 5 = May 6 = June 7 = July 8 = August 9 = September 10 = October 11 = November 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 1 = Second 2 = Third 3 = Fourth 4 = Last
43618	DST End Day of Week	Int32	N/A	N/A	RW	0 = Sunday 1 = Monday 2 = Tuesday 3 = Wednesday 4 = Thursday 5 = Friday 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 1 = On During Rest 2 = Preheat before Crank
43630	Oil Pressure Crank Disconnect	UInt32	N/A	N/A	RW	0 = Disable 1 = Enable
43632	Crank Disconnect Pressure	Uint32	PSI	Deci	RW	29–1500
43634	Crank Disconnect Pressure in kPa	Uin32	kPa	Deci	RW	200–10345
43636	Power-Up Delay	Uint32	Second	N/A	RW	0–60
43638	Auto Config Detect Enable	Int32	N/A	N/A	RW	0 = Disable 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 1 = Programmable
43646	Run Relay Control	Uint32	N/A	N/A	RW	0 = Predefined 1 = Programmable

Register	Description	Type	Units	Scaling Factor	R/W	Range
43648	Prestart Relay Control	Uint32	N/A	N/A	RW	0 = Predefined 1 = Programmable
43650	Single Phase Connect Generator Detection	Int32	N/A	N/A	RW	0 = A-B 1 = A-C
43652	Off Mode Cool Down Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
43654	RESERVED					
43656	Not In Auto Horn Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
43658	Clock Not Set Warning Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
43660	Alternate Frequency	Int32	Hertz	Centi	RW	1000–45000
43662	Generator System Type	Int32	N/A	N/A	RW	0 = Single Generator 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 1 = kPa
43668	System Units	Int32	N/A	N/A	RW	0 = English 1 = Metric
43670	Kpa bar Config Data	Int32	N/A	N/A	RW	0 = Bar 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 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 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 1 = Standard UART Functionality
43696	Save Speed Adjustments	Uint32	N/A	N/A	RW	0 = No 1 = Yes
43698	Coolant Temp Source	Uint32	N/A	N/A	RW	0 = From ECU 1 = From DGC Sender Input
43700	Oil Pressure Source	Uint32	N/A	N/A	RW	0 = From ECU 1 = From DGC Sender Input
43702	Cooldown Configuration	Uint32	N/A	N/A	RW	0 = Cool down only if engine has been loaded 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 1 = While Engine Running Only
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 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

Register	Description	Type	Units	Scaling Factor	R/W	Range
43720	Fuel Level Sender Fail Contact Recognition	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43722	Coolant Temperature Sender Fail SF Display	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
43724	Oil Pressure Sender Fail SF Display	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
43726	Fuel Level Sender Fail SF Display	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
43728–748	FUTURE USE					
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 1 = Enable
43754	Remote Stop	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43756	Run Mode	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43758	Off Mode	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43760	Auto Mode	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43762	Alarm Reset	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43764	Gen Breaker Open	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43766	Gen Breaker Close	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43768	Mains Breaker Open	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43770	Mains Breaker Close	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43772	FUTURE USE					
43774	Virtual Input 1 Close	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43776	Virtual Input 1 Open	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43778	Virtual Input 2 Close	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43780	Virtual Input 2 Open	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43782	Virtual Input 3 Close	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43784	Virtual Input 3 Open	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43786	Virtual Input 4 Close	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43788	Virtual Input 4 Open	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
43790	ESTOP Latch Status	Int32	N/A	N/A	R	0 = Disabled 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)
43800–4006	FUTURE USE					
44008	RESERVED					
44010–16	FUTURE USE					
44018	Modem Inter Dialout Activation Delay	Int32	Second	N/A	RW	0 = 15 1 = 30 2 = 60 3 = 120

Register	Description	Type	Units	Scaling Factor	R/W	Range
44020	Modem Pager Buffer Limit	Int32	N/A	N/A	RW	0 = 80 Chars 1 = 120 Chars 2 = 160 Chars 3 = 200 Chars
44022	Modem Pager Coms Data Format	Int32	N/A	N/A	RW	0 = 8 bit, no parity 1 = 7 bit, even parity
44024–25	Modem Dialout Conditions 1	Uint32	N/A	N/A	RW	Bit 0 = Aux Input 5 Closed Bit 1 = Aux Input 4 Closed Bit 2 = Aux Input 3 Closed Bit 3 = Aux Input 2 Closed Bit 4 = Aux Input 1 Closed Bit 5 = Cooldown Timer Active Bit 6 = Switch Not In Auto Bit 7 = Scheduled Maintenance Pre-Alarm Bit 8 = Weak Battery Voltage Pre-Alarm Bit 9 = Low Battery Voltage Pre-Alarm Bit 10 = Low Oil Pressure Pre-Alarm Bit 11 = High Coolant Temp Pre-Alarm Bit 12 = kW Overload 1 Pre-Alarm Bit 13 = Battery Overvoltage Pre-Alarm Bit 14 = Fuel Level Sender Fail Pre-Alarm Bit 15 = Oil Pressure Sender Fail Pre-Alarm Bit 16 = Coolant Temp Sender Fail Pre-Alarm Bit 17 = Low Coolant Temp Pre-Alarm Bit 18 = High Fuel Pre-Alarm Bit 19 = Low Fuel Pre-Alarm Bit 20 = Overspeed Alarm Bit 21 = Emergency Stop Alarm Bit 22 = Overcrank Alarm Bit 23 = Low Coolant Level Status Bit 24 = Low Fuel Alarm Bit 25 = Loss of Gen Volt Sensing Alarm Bit 26 = MPU Speed Sender Fail Alarm Bit 27 = Fuel Level Sender Fail Alarm Bit 28 = Oil Pressure Sender Fail Alarm Bit 29 = Coolant Temp Sender Fail Alarm Bit 30 = Low Oil Pressure Alarm Bit 31 = High Coolant Temp Alarm

Register	Description	Type	Units	Scaling Factor	R/W	Range
44026–27	Modem Dialout Conditions 2	Uint32	N/A	N/A	RW	Bit 0 = 59-2 Trip Alarm Bit 1 = 27-2 Trip Alarm Bit 2 = 51-2 Trip Alarm Bit 3 = Engine Running Bit 4 = Battery Charger Fail Status Bit 5 = Fuel Leak Detect Status Bit 6 = Transfer Fail Alarm Bit 7 = 81U Trip Pre-Alarm Bit 8 = 81O Trip Pre-Alarm Bit 9 = 59-1 Trip Pre-Alarm Bit 10 = 27-1 Trip Pre-Alarm Bit 11 = 47 Trip Pre-Alarm Bit 12 = 51-1 Trip Pre-Alarm Bit 13 = 81U Trip Alarm Bit 14 = 81O Trip Alarm Bit 15 = 59-1 Trip Alarm Bit 16 = 27-1 Trip Alarm Bit 17 = 47 Trip Alarm Bit 18 = 51-1 Trip Alarm Bit 19 = Loss of ECU Coms Pre-Alarm Bit 20 = Loss of ECU Coms Alarm Bit 21 = Aux Input 16 Closed Bit 22 = Aux Input 15 Closed Bit 23 = Aux Input 14 Closed Bit 24 = Aux Input 13 Closed Bit 25 = Aux Input 12 Closed Bit 26 = Aux Input 11 Closed Bit 27 = Aux Input 10 Closed Bit 28 = Aux Input 9 Closed Bit 29 = Aux Input 8 Closed Bit 30 = Aux Input 7 Closed Bit 31 = Aux Input 6 Closed
44028–30	RESERVED					
44032	CAN Bus Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44034	DTC Enable	Int32	N/A	N/A	RW	0 = Disable 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 1 = 4800 Baud 2 = 2400 Baud 3 = 1200 Baud
44042	Modbus Parity	Int32	N/A	N/A	RW	0 = No Parity 1 = Odd Parity 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 Bit 1 = 51-3 Trip Pre-Alarm Bit 2 = 51-3 Trip Alarm Bit 3 = Duplicate AEM Bit 4 = AEM Comms Failure Bit 5 = Duplicate CEM Bit 6 = CEM Comms Failure Bit 7 = Duplicate LSM Bit 8 = Config Element 8 Status Bit 9 = Config Element 7 Status Bit 10 = Config Element 6 Status Bit 11 = Config Element 5 Status Bit 12 = Config Element 4 Status Bit 13 = Config Element 3 Status Bit 14 = Config Element 2 Status Bit 15 = Config Element 1 Status Bit 16 = ID Repeat Bit 17 = ID Missing Bit 18 = LSM Comms Failure Bit 19 = Intergenset Comms Failure Bit 20 = GOV Output Limit Bit 21 = AVR Output Limit Bit 22 = Auto Restart Fail Alarm Bit 23 = kW Overload 3 Pre-Alarm Bit 24 = kW Overload 2 Pre-Alarm Bit 25 = 40 Trip Pre-Alarm Bit 26 = 32 Trip Pre-Alarm Bit 27 = 59-2 Trip Pre-Alarm Bit 28 = 27-2 Trip Pre-Alarm Bit 29 = 51-2 Trip Pre-Alarm Bit 30 = 40 Trip Alarm Bit 31 = 32 Trip Alarm
44048	LSM-2020 Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44050	DHCP Enabled	Uint32	N/A	N/A	R	0 = Disabled 1 = Enabled
44052–56	RESERVED					
44058	CEM-2020 Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44060	RESERVED					
44062	AEM-2020 Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44064	CEM Outputs	Int32	N/A	N/A	RW	0 = 18 Outputs 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 Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Common Pre-Alarm Bit 16 = Common Alarm Bit 17 = Unexpected Shutdown Alarm Bit 18 = ECU Shutdown Bit 19 = DEF Inducement Override Pre-Alarm Bit 20 = DEF Severe Inducement Pre-Alarm Bit 21 = DEF Pre-Severe Inducement Pre-Alarm Bit 22 = DEF Engine Derate Pre-Alarm Bit 23 = DEF Fluid Empty Pre-Alarm Bit 24 = DEF Fluid Low Pre-Alarm Bit 25 = DPF Soot Level Severely High Pre-Alarm Bit 26 = DPF Soot Level Moderately High Pre-Alarm Bit 27 = DPF Soot Level High Pre-Alarm Bit 28 = High Exhaust Temp Pre-Alarm Bit 29 = DPF Regeneration Inhibited Pre-Alarm Bit 30 = DPF Regeneration Required Pre-Alarm 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 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 1 = S2 Curve 2 = L1 Curve 3 = L2 Curve 4 = D Curve 5 = M Curve 6 = I1 Curve 7 = I2 Curve 8 = V1 Curve 9 = V2 Curve 10 = E1 Curve 11 = E2 Curve 12 = A Curve 13 = B Curve 14 = C Curve 15 = G Curve 16 = F Curve 17 = Programmable
44256	3 Phase Overcurrent Alarm Configuration (51-1)	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 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 1 = S2 Curve 2 = L1 Curve 3 = L2 Curve 4 = D Curve 5 = M Curve 6 = I1 Curve 7 = I2 Curve 8 = V1 Curve 9 = V2 Curve 10 = E1 Curve 11 = E2 Curve 12 = A Curve 13 = B Curve 14 = C Curve 15 = G Curve 16 = F Curve 17 = Programmable
44264	1 Phase Overcurrent Alarm Configuration (51-1)	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 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 1 = Alarm 2 = Pre-Alarm 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 1 = Alarm 2 = Pre-Alarm 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 1 = Alarm 2 = Pre-Alarm 3 = Status Only
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
44292	3 Phase Overvoltage Alarm Configuration (59-1)	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 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 1 = Alarm 2 = Pre-Alarm 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 1 = Alarm 2 = Pre-Alarm 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 1 = Alarm 2 = Pre-Alarm 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 1 = S2 Curve 2 = L1 Curve 3 = L2 Curve 4 = D Curve 5 = M Curve 6 = I1 Curve 7 = I2 Curve 8 = V1 Curve 9 = V2 Curve 10 = E1 Curve 11 = E2 Curve 12 = A Curve 13 = B Curve 14 = C Curve 15 = G Curve 16 = F Curve 17 = Programmable
44326	3 Phase Overcurrent Alarm Configuration (51-2)	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 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 1 = S2 Curve 2 = L1 Curve 3 = L2 Curve 4 = D Curve 5 = M Curve 6 = I1 Curve 7 = I2 Curve 8 = V1 Curve 9 = V2 Curve 10 = E1 Curve 11 = E2 Curve 12 = A Curve 13 = B Curve 14 = C Curve 15 = G Curve 16 = F Curve 17 = Programmable
44334	1 Phase Overcurrent Alarm Configuration (51-2)	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 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 1 = Alarm 2 = Pre-Alarm 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 1 = Alarm 2 = Pre-Alarm 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 1 = Alarm 2 = Pre-Alarm 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 1 = Alarm 2 = Pre-Alarm 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
44380	Underfrequency Hysteresis	Uint32	DeciHertz	Deci	RW	1–400
44382	Overfrequency Hysteresis	Uint32	DeciHertz	Deci	RW	1–400

Register	Description	Type	Units	Scaling Factor	R/W	Range
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 1 = Alarm 2 = Pre-Alarm 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 1 = Alarm 2 = Pre-Alarm 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 1 = Alarm 2 = Pre-Alarm 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 1 = Alarm 2 = Pre-Alarm 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 1 = Integrating
44426	1 Phase Overcurrent Reset Type (51-1)	Int32	N/A	N/A	RW	0 = Instantaneous 1 = Integrating
44428	3 Phase Overcurrent Reset Type (51-2)	Int32	N/A	N/A	RW	0 = Instantaneous 1 = Integrating
44430	1 Phase Overcurrent Reset Type (51-2)	Int32	N/A	N/A	RW	0 = Instantaneous 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 1 = S2 Curve 2 = L1 Curve 3 = L2 Curve 4 = D Curve 5 = M Curve 6 = I1 Curve 7 = I2 Curve 8 = V1 Curve 9 = V2 Curve 10 = E1 Curve 11 = E2 Curve 12 = A Curve 13 = B Curve 14 = C Curve 15 = G Curve 16 = F Curve 17 = Programmable
44458	3 Phase Overcurrent Alarm Configuration (51-3)	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 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 1 = S2 Curve 2 = L1 Curve 3 = L2 Curve 4 = D Curve 5 = M Curve 6 = I1 Curve 7 = I2 Curve 8 = V1 Curve 9 = V2 Curve 10 = E1 Curve 11 = E2 Curve 12 = A Curve 13 = B Curve 14 = C Curve 15 = G Curve 16 = F Curve 17 = Programmable
44466	1 Phase Overcurrent Alarm Configuration (51-3)	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 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 1 = Integrating
44472	1 Phase Overcurrent Reset Type (51-3)	Int32	N/A	N/A	RW	0 = Instantaneous 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 1 = Alarm 2 = Pre-Alarm 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 1 = Enable
44490	81 ROCOF Alarm Config	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
44492	81 ROCOF Pickup	Uint32	Hz/Second	Deci	RW	2–100
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 1 = Enable

Register	Description	Type	Units	Scaling Factor	R/W	Range
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 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 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 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 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 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 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 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 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 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 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 1 = Enable
44564	Low Oil Press. Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 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 1 = Enable
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 1 = Enable
44576	Active DTC Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable

Register	Description	Type	Units	Scaling Factor	R/W	Range
44578	Maintenance Interval Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 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 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 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 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 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 1 = Enable
44628	Intergenset Comm Failure Pre-alarm Enable	Int32	N/A	N/A	RW	0 = Disable 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 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 1 = Enable
44638	ID Missing Pre-alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44640	ID Repeat Pre-alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44642	CEM Comm Failure Pre-alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44644	AEM Comm Failure Pre-alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable

Register	Description	Type	Units	Scaling Factor	R/W	Range
44646	Checksum Failure Pre-alarm Enable	Int32	N/A	N/A	RW	0 = Disable 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 1 = Enable
44654	Breaker Close Fail Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44656	Breaker Open Fail Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44658	Breaker Close Fail Pre-Alarm Monitor	Int32	N/A	N/A	RW	0 = Transitions Only 1 = Always
44660	Breaker Open Fail Pre-Alarm Monitor	Int32	N/A	N/A	RW	0 = Transitions Only 1 = Always
44662	Reverse Rotation Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44664	CAN Bus Low Coolant Level Alarm	Uint32	N/A	N/A	RW	0 = Disable 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
44672–748	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
44794	Active Speed Source	Uint32	N/A	N/A	R	0 = None 1 = MPU 2 = Gen Freq 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

Register	Description	Type	Units	Scaling Factor	R/W	Range
44812–13	Alarm Metering	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = DEF Severe Inducement Bit 14 = Diagnostic Trouble Code Bit 15 = Exhaust System Error Bit 16 = Unexpected Shutdown 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

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 Bit 1 = Not Used Bit 2 = Serial Flash Read Failure Bit 3 = Checksum Fail Bit 4 = Global Pre-Alarm Bit 5 = Fuel Filter 2 Leak Bit 6 = Fuel Filter 1 Leak Bit 7 = Engine kW Overload 3 Bit 8 = Engine kW Overload 2 Bit 9 = MPU Fail Bit 10 = Fuel Leak Detect Bit 11 = Battery Charger Failure Bit 12 = Low Coolant Level Bit 13 = Mains Breaker Fail to Open Bit 14 = Mains Breaker Fail to Close Bit 15 = Sync Fail at Mains Breaker Bit 16 = Gen Breaker Fail to Open Bit 17 = Gen Breaker Fail to Close Bit 18 = Sync Fail at Gen Breaker Bit 19 = High Fuel Level Bit 20 = Loss of Rem. Mod. Com Bit 21 = Engine kW Overload Bit 22 = Diagnostic Trouble Code Bit 23 = Loss of ECU Comms Bit 24 = Maintenance Due Bit 25 = Battery Overvoltage Bit 26 = Weak Battery Bit 27 = Low Battery Voltage Bit 28 = Low Coolant Temp Bit 29 = Low Fuel Level Bit 30 = Low Oil Pressure 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 Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = High ECU Supply Bit 24 = Combined Red Bit 25 = Overspeed Bit 26 = Low Oil Pressure Bit 27 = Low Fuel Delivery Press. Bit 28 = Low Aftercooler Coolant Level Bit 29 = High Coolant Temp Bit 30 = High Oil Temp 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 Bit 1 = High Storage Tank Bit 2 = Low Day Tank Bit 3 = High Day Tank Bit 4 = Alternator Winding Temp Bit 5 = Idle Speed Low Bit 6 = Run Up Speed Low Bit 7 = Start Speed Low Bit 8 = Priming Fault Bit 9 = Low Charge Air Coolant Level Bit 10 = High Fuel Temp. Bit 11 = High Exhaust Temp. B Bit 12 = High Exhaust Temp. A Bit 13 = Low ECU Supply Voltage Bit 14 = Engine Speed Too Low Bit 15 = High Voltage Supply Bit 16 = Low Voltage Supply Bit 17 = Speed Demand Fail Bit 18 = ECU Faulty Bit 19 = Combined Yellow Bit 20 = Low Oil Press. Bit 21 = Low Fuel Delivery Press. Bit 22 = Low Charge Air Press. Bit 23 = Low Coolant Level Bit 24 = Low Fuel Rail Press. Bit 25 = High Fuel Rail Press. Bit 26 = Shutdown Override Bit 27 = High Coolant Temp. Bit 28 = High Charge Air Temp. Bit 29 = High Intercooler Temp. Bit 30 = High Oil Temp. 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 Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Generator Voltage Bit 28 = Fuel Level Bit 29 = Coolant Temp Bit 30 = Oil Pressure 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 Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = 81 ROC DF/DT Trip Bit 19 = 78 Vector Shift Trip Bit 20 = 51-3 Overcurrent Bit 21 = 40Q Loss of Excitation Bit 22 = 32 Reverse Power Bit 23 = 59-2 Overvoltage Bit 24 = 27-2 Undervoltage Bit 25 = 51-2 Overcurrent Bit 26 = 81 Underfrequency Bit 27 = 81 Overfrequency Bit 28 = 59-1 Overvoltage Bit 29 = 27-1 Undervoltage Bit 30 = 47 Phase Imbalance 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 Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Gen Phase Imbalance Bit 27 = Gen Overcurrent Bit 28 = Gen Underfrequency Bit 29 = Gen Overfrequency Bit 30 = Gen Undervoltage 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 Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Gen Phase Imbalance Bit 27 = Gen Overcurrent Bit 28 = Gen Underfrequency Bit 29 = Gen Overfrequency Bit 30 = Gen Undervoltage 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 Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Input 16 Bit 17 = Input 15 Bit 18 = Input 14 Bit 19 = Input 13 Bit 20 = Input 12 Bit 21 = Input 11 Bit 22 = Input 10 Bit 23 = Input 9 Bit 24 = Input 8 Bit 25 = Input 7 Bit 26 = Input 6 Bit 27 = Input 5 Bit 28 = Input 4 Bit 29 = Input 3 Bit 30 = Input 2 Bit 31 = Input 1
44830–31	Local Output Metering	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Pre Start Output Bit 18 = Run Output Bit 19 = Start Output Bit 20 = Output 12 Bit 21 = Output 11 Bit 22 = Output 10 Bit 23 = Output 9 Bit 24 = Output 8 Bit 25 = Output 7 Bit 26 = Output 6 Bit 27 = Output 5 Bit 28 = Output 4 Bit 29 = Output 3 Bit 30 = Output 2 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 Bit 1 = Lamp Test Bit 2 = Alarm Silence Bit 3 = Reset Bit 4 = Alternate Frequency Override Bit 5 = Start Delay Bypass Bit 6 = Cooldown and Stop Request from Logic Bit 7 = Cooldown Request from Logic Bit 8 = External Start Delay Bit 9 = Off Mode Cooldown Bit 10 = PF Mode Active Bit 11 = Var Mode Active Bit 12 = Cooldown Timer Active Bit 13 = Engine Running Bit 14 = Fuel Leak Detect Bit 15 = Battery Charger Failure Bit 16 = Low Coolant Level Bit 17 = Gen Failed Bit 18 = Gen Stable Bit 19 = Gen Dead Bit 20 = Bus Failed Bit 21 = Bus Stable Bit 22 = Bus Dead Bit 23 = Gen Breaker Closed Bit 24 = Mains Breaker Closed Bit 25 = Grounded Delta Override Bit 26 = Battle Override Bit 27 = Auto Transfer Switch Bit 28 = Low Line Override Bit 29 = Single Phase AC Override Bit 30 = Single Phase Override 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 1 = READY State 2 = CRANKING State 3 = RESTING State 4 = RUNNING State 5 = ALARM State 6 = PRESTART State 7 = COOLING State 8 = CONNECTING State 9 = DISCONNECT State 10 = PULSING State 11 = UNLOADING State Note: Generator states are described in Section 3, *Functional Description, Operating States*.
44882	Contact Status	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Input 16 Bit 13 = Input 15 Bit 14 = Input 14 Bit 15 = Input 13 Bit 16 = Input 12 Bit 17 = Input 11 Bit 18 = Input 10 Bit 19 = Input 9 Bit 20 = Input 8 Bit 21 = Input 7 Bit 22 = Input 6 Bit 23 = Input 5 Bit 24 = Input 4 Bit 25 = Input 3 Bit 26 = Input 2 Bit 27 = Input 1 Bit 28 = Reserved Bit 29 = Estop Bit 30 = Not Used 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 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Output 16 Bit 13 = Output 15 Bit 14 = Output 14 Bit 15 = Output 13 Bit 16 = Output 12 Bit 17 = Output 11 Bit 18 = Output 10 Bit 19 = Output 9 Bit 20 = Output 8 Bit 21 = Output 7 Bit 22 = Output 6 Bit 23 = Output 5 Bit 24 = Output 4 Bit 25 = Output 3 Bit 26 = Output 2 Bit 27 = Output 1 Bit 28 = Reserved Bit 29 = Prestart Bit 30 = Run Bit 31 = Start
44886–918	RESERVED					
44920–32	FUTURE USE					
44934–35	Generator Protection Status Metering (The contents of this register and 44822 are identical.)	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = 81 ROC DF/DT Trip Bit 19 = 78 Vector Shift Trip Bit 20 = 51-3 Overcurrent Bit 21 = 40Q Loss of Excitation Bit 22 = 32 Reverse Power Bit 23 = 59-2 Overvoltage Bit 24 = 27-2 Undervoltage Bit 25 = 51-2 Overcurrent Bit 26 = 81 Underfrequency Bit 27 = 81 Overfrequency Bit 28 = 59-1 Overvoltage Bit 29 = 27-1 Undervoltage Bit 30 = 47 Phase Imbalance Bit 31 = 51-1 Overcurrent
44936	Cumulative Stats - Total Run Minutes	Uint32	Minute	N/A	RW	0–60000000

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
44948–49	LSM Alarm Bits	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Duplicate LSM Bit 26 = ID Repeat Bit 27 = ID Missing Bit 28 = LSM Comms Failure Bit 29 = Intergenset Comms Failure Bit 30 = GOV Output Limit Bit 31 = AVR Output Limit
44950	Global Alarm	Uint32	N/A	N/A	R	Bit 0 = No system alarms in effect 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 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 Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Input 16 Bit 17 = Input 15 Bit 18 = Input 14 Bit 19 = Input 13 Bit 20 = Input 12 Bit 21 = Input 11 Bit 22 = Input 10 Bit 23 = Input 9 Bit 24 = Input 8 Bit 25 = Input 7 Bit 26 = Input 6 Bit 27 = Input 5 Bit 28 = Input 4 Bit 29 = Input 3 Bit 30 = Input 2 Bit 31 = Input 1
44956–57	Local Configurable Inputs Alarm Bits	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Input 16 Bit 17 = Input 15 Bit 18 = Input 14 Bit 19 = Input 13 Bit 20 = Input 12 Bit 21 = Input 11 Bit 22 = Input 10 Bit 23 = Input 9 Bit 24 = Input 8 Bit 25 = Input 7 Bit 26 = Input 6 Bit 27 = Input 5 Bit 28 = Input 4 Bit 29 = Input 3 Bit 30 = Input 2 Bit 31 = Input 1

Register	Description	Type	Units	Scaling Factor	R/W	Range
44958–59	Configurable Elements Status Bits	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Config Element 8 Bit 25 = Config Element 7 Bit 26 = Config Element 6 Bit 27 = Config Element 5 Bit 28 = Config Element 4 Bit 29 = Config Element 3 Bit 30 = Config Element 2 Bit 31 = Config Element 1
44960–61	Configurable Elements Pre-Alarm Bits	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Config Element 8 Bit 25 = Config Element 7 Bit 26 = Config Element 6 Bit 27 = Config Element 5 Bit 28 = Config Element 4 Bit 29 = Config Element 3 Bit 30 = Config Element 2 Bit 31 = Config Element 1

Register	Description	Type	Units	Scaling Factor	R/W	Range
44962–63	Configurable Elements Alarm Bits	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Config Element 8 Bit 25 = Config Element 7 Bit 26 = Config Element 6 Bit 27 = Config Element 5 Bit 28 = Config Element 4 Bit 29 = Config Element 3 Bit 30 = Config Element 2 Bit 31 = Config Element 1
44964–65	Remote Inputs Status Bits	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Remote Input 26 Bit 23 = Remote Input 25 Bit 24 = Remote Input 24 Bit 25 = Remote Input 23 Bit 26 = Remote Input 22 Bit 27 = Remote Input 21 Bit 28 = Remote Input 20 Bit 29 = Remote Input 19 Bit 30 = Remote Input 18 Bit 31 = Remote Input 17

Register	Description	Type	Units	Scaling Factor	R/W	Range
44966–67	Remote Outputs Status Bits	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Remote Output 36 Bit 9 = Remote Output 35 Bit 10 = Remote Output 34 Bit 11 = Remote Output 33 Bit 12 = Remote Output 32 Bit 13 = Remote Output 31 Bit 14 = Remote Output 30 Bit 15 = Remote Output 29 Bit 16 = Remote Output 28 Bit 17 = Remote Output 27 Bit 18 = Remote Output 26 Bit 19 = Remote Output 25 Bit 20 = Remote Output 24 Bit 21 = Remote Output 23 Bit 22 = Remote Output 22 Bit 23 = Remote Output 21 Bit 24 = Remote Output 20 Bit 25 = Remote Output 19 Bit 26 = Remote Output 18 Bit 27 = Remote Output 17 Bit 28 = Remote Output 16 Bit 29 = Remote Output 15 Bit 30 = Remote Output 14 Bit 31 = Remote Output 13
44968–69	CEM Alarm Bits	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Not Used Bit 29 = CEM Hardware Mismatch Bit 30 = Duplicate CEM 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 Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Remote Input 26 Bit 23 = Remote Input 25 Bit 24 = Remote Input 24 Bit 25 = Remote Input 23 Bit 26 = Remote Input 22 Bit 27 = Remote Input 21 Bit 28 = Remote Input 20 Bit 29 = Remote Input 19 Bit 30 = Remote Input 18 Bit 31 = Remote Input 17
44972–73	Remote Configurable Inputs Alarm Bits	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Remote Input 26 Bit 23 = Remote Input 25 Bit 24 = Remote Input 24 Bit 25 = Remote Input 23 Bit 26 = Remote Input 22 Bit 27 = Remote Input 21 Bit 28 = Remote Input 20 Bit 29 = Remote Input 19 Bit 30 = Remote Input 18 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 Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Not Used Bit 29 = Not Used Bit 30 = Duplicate AEM 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
44982–83	MDEC Pre-Alarms	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = High Fuel Filter Diff Pressure Bit 25 = Overspeed Test On Bit 26 = Ambient Temp Bit 27 = High Temp Coil 3 Bit 28 = High Temp Coil 2 Bit 29 = High Temp Coil 1 Bit 30 = High Pressure Input 2 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 Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = ECU Shutdown Bit 21 = Priming Pump ON Bit 22 = CAN Mode Feedback Bit 23 = Preheat Temp Not Reached Bit 24 = Load Gen On Bit 25 = Cylinder Cutout Bit 26 = Engine Running Bit 27 = Speed Decrease Bit 28 = Speed Increase Bit 29 = Speed Demand Fail Mode Bit 30 = External Stop Active 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 Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Warning Bit 4 = Stop Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Malfunction Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Not Used Bit 29 = Not Used Bit 30 = Not Used 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. Bit 0 = Protect Lamp Bit 1 = 0 Bit 2 = Amber Warning Lamp Bit 3 = 0 Bit 4 = Red Stop Lamp Bit 5 = 0 Bit 6 = Malfunction Indicator Lamp Bit 7 = 0 Bit 8 = Protect Lamp Bit 9 = 0 Bit 10 = Amber Warning Lamp Bit 11 = 0 Bit 12 = Red Stop Lamp Bit 13 = 0 Bit 14 = Malfunction Indicator Lamp Bit 15 = 0 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. The Previously Active DTC count is stored in the upper byte of register 45004. The two bytes in register 45005 contain zeros. The Active DTC count is also available in register 45170. 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 Bit 1 = Active DTC Clear Fail Bit 2 = Previously Active DTC Clear Fail Bit 3 = DTC Values Changed Bit 4 = ECU Comms Failed Bit 5 = Not Used Bit 6 = Not Used Bit 7 = CAN Hardware Pass Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Not Used Bit 29 = Not Used Bit 30 = Not Used 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
45024	ECU Engine Run Time	Uint32	0.05 h/bit gain, 0 h offset	N/A	R	0 to +210,554, 060.75 h

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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 %

Register	Description	Type	Units	Scaling Factor	R/W	Range
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	Suppose the 32 bits of DTC Data is in Register N and N+1. SPN = (Register N: Most Significant 3 bits * 65536) + (Register N+1: LS Byte * 256) + (Register N+1: MS Byte) FMI = Register N: Bits 8–12 Occurrence Count = Register N: Bits 0–6
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.
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.

Register	Description	Type	Units	Scaling Factor	R/W	Range
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.

Notes for parsing out the SPN, FMI, and Occurrence Count Components of the DTC (registers 45138 through 45168):

Let NN represent the the 32 bit number represented in Registers N and N+1, where N is the least significant register.
We can extract The SPN, FMI and Occurrence count by ANDing Hex Numbers and bit shifting as indicated below.
Where & is a bitwise AND operation, and >> or << is a bit shift operation. “0x” in front of a number indicates it is in Hexadecimal (Hex) format.

OCCURRENCE COUNT = NN & 0x0000003F;

SPN = ((NN & 0xFF000000) >> 24) + ((NN & 0x00FF0000) >> 8) + ((NN & 0x0000E000) << 3);

FMI = (NN & 0x00001F00) >> 8;

Example: Suppose Register N contains the Hex Value of 0xE903 and Register N+1 contains the Hex Value 0x68F9.
Then the 32-bit number is 0x68F9E903 since the DGC implements 32 bit numbers with the least significant register first.

Occurrence Count = (0x68F9E903 & 0x0000001F) = 0x00000003;

FMI = ((NN & 00001F00) >> 8) = (0x00000900 >> 8) = 0x00000009;

SPN = ((NN & 0x0xFF000000) >> 24) + ((NN & 0x00FF0000) >> 8) + ((NN & 0x0000E000) << 3)
= ((0x68F9E903 & 0xFF000000) >> 24) + ((0x68F9E903 & 0x00EE0000) >> 8) +((0x68F9E903 & 0x0000E000) << 3)
= (0x68000000 >> 24) + (0x00F90000 >> 8) + (0x0000E000 << 3)
= 0x00000068 + 0x0000F900 + 0x00070000
= 0x0007F968
= 522600

Register	Description	Type	Units	Scaling Factor	R/W	Range
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 MTU 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 Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Exhaust System Malfunction Bit 23 = Torque Limit Bit 24 = Wait to Start Bit 25 = High Exhaust Temperature Bit 26 = DPF Inhibited Bit 27 = DPF Lamp Bit 28 = Red Stop Bit 29 = Check Engine Bit 30 = Amber Warning 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 Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = High Exhaust Temperature Bit 20 = Fuel Filter Bit 21 = Fuel Filter 1 Leak Bit 22 = DPF Regenerate Inhibit Status from CAN Bus Bit 23 = DPF Regenerate Inhibit Due to Switch Bit 24 = Isuzu Exhaust System Lamp Bit 25 = Isuzu Escape Mode Lamp Bit 26 = Isuzu No Power Lamp Bit 27 = SCR Clean Inhibit Due to Switch Bit 28 = Wait to Start Lamp Bit 29 = Engine Coolant Preheated State Bit 30 = Alarm Reset Feedback 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 1 = On Solid 4 = On – Fast Blink (1 Hz) 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 MTU ECU8 SMC Requested Absolute Torque	Uint32	1 Nm/bit gain, -32000 offset	N/A	R	-32000 – 32000 Nm
45198	J1939 MTU ECU8 SMC Actual Droop	Uint32	0.4%/bit gain, 0 offset	N/A	R	0–100%
45200	J1939 MTU ECU8 SMC Status of Start Procedure	Uint32	Proprietary Bit Field Data: Consult engine manufacturer for Details	N/A	R	0–4294967295

Register	Description	Type	Units	Scaling Factor	R/W	Range
45202	J1939 MTU ECU8 SMC Engine Operating Mode	Uint32	Consult manufacturer for details of each operating mode.	N/A	R	0 = Operating Mode 1 1 = Operating Mode 2
45204	J1939 MTU ECU8 SMC Speed Demand Feedback	Uint32	1/8 rpm per bit gain, 0 offset	N/A	R	0–8031,875 rpm
45206	J1939 MTU ECU8 SMC Speed Demand Source	Uint32	N/A	N/A	R	0 = CAN demand 1 = Up/Dn ECU 2 = CAN Up/Down 3 = ECU Speed Demand Input 4 = Reserved 5 = ECU Speed Demand Frequency Input
45208	J1939 MTU ECU8 SMC CAN Speed Demand Feedback	Uint32	1/8 rpm per bit gain, 0 offset	N/A	R	0–8031,875 rpm
45210	J1939 MTU 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 1 = Low DEF Level – Lamp on Solid 4 = DEF Low Severe – DEF Lamp Blinking at 1Hz rate Other values are Reserved for SAE Assignment
45218	J1939 DEF Inducement Level	Uint32	N/A	N/A	R	0 = No Inducement 1 = DEF Warning 2 = DEF Warning Level 2 3 = Inducement 4 = Pre-Severe Inducement 5 = Severe Inducement 6 = Temporary Override of Inducement
45220	J1939 DPF Status	Uint32	N/A	N/A	R	0 = Regeneration not needed 1 = Regeneration needed - lowest level 2 = Regeneration needed - moderate level 3 = Regeneration needed - highest level 4 = reserved for SAE assignment 5 = reserved for SAE assignment 6 = reserved for SAE assignment 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 1 = Low Urea Level 2 = Urea Level Very Low 3 = Urea Tank Empty 4–5 Reserved 6 = Error 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 1 = Active Torque Limit Due to Urea Level 2 = Active Speed Limit Due to Urea Level 3 = Active Torque Limit Due to SCR Failure 4 = Active Speed Limit Due to SCR Failure 5–13 Reserved 14 = Error 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 1 = Lamp On 2 = Reserved 3 = Not available
45232	J1939 ECU Red Stop Lamp from DLCC1 PGN	Uint32	N/A	N/A	R	0 = Lamp Off 1 = Lamp On 2 = Reserved 3 = Not available
45234	J1939 OBD Malfunction Indicator Lamp from DLCC1 PGN	Uint32	N/A	N/A	R	0 - Lamp Off 1 - Lamp On 2 – Reserved 3 - Not available
45236	J1939 DPF Active Regen Status	Uint32	N/A	N/A	R	0 = Not Active 1 = Active 2 = regeneration needed – automatically initiated active regeneration imminent 3 = not available
45238	J1939 DPF Regen Forced Status	Uint32	N/A	N/A	R	0 = Off 1 = Active – Forced by Switch 2 = Active – Forced by Service Tool 3 = reserved for SAE assignment 4 = On – fast blink (1 HZ) 5 = reserved for SAE assignment 6 = reserved for SAE assignment 7 = not available
45240	J1939 SCR Cleaning Lamp Command	Uint32	N/A	N/A	R	0 = Off 1 = On – solid 2 = reserved for SAE assignment 3 = reserved for SAE assignment 4 = On – fast blink (1 HZ) 5 = reserved for SAE assignment 6 = reserved for SAE assignment 7 = not available
45242	J1939 SCR Cleaning Status	Uint32	N/A	N/A	R	0 = Not Active 1 = Active 2 = SCR system cleaning is needed – automatically initiated SCR system cleaning imminent 3 = not available
45244	J1939 SCR Cleaning Forced Status	Uint32	N/A	N/A	R	0 = Not Active 1 = Active Forced by Switch 2 = Active Forced by Service Tool 3–6 Reserved for SAE Assignment 7 = Not Available

Register	Description	Type	Units	Scaling Factor	R/W	Range
45246	J1939 Volvo SCR Inducement Severity	Uint32	N/A	N/A	R	0 = Not Active 1 = Inducement Warning 2 = Not Used 3 = Derate Active 4 = Pre-Severe Derate Warning 5 = Severe Derate 6 = Temporary Override of Derate 7 = Not Available
45248	J1939 Volvo SCR Inducement Reason	Uint32	N/A	N/A	R	0 = OK 1 = Reagent Level Low 2 = Incorrect Quality 3 = Incorrect Consumption 4 = Tampering 5 = Not Used 6 = Error 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 1 = Preheat Relay Controls
45258	Pulsing Enable	Uint32	N/A	N/A	RW	1 = Enable 2 = Disable
45260	MDEC Module Type	Uint32	N/A	N/A	RW	1 = CAN Module 201 2 = CAN Module 302 3 = CAN Module 303 4 = CAN Module 304
45262	MDEC Speed Demand Source	Uint32	N/A	N/A	RW	0 = Analog CAN 1 = Up Down ECU 2 = Up Down CAN 3 = Analog ECU 4 = Frequency 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 1 = Secondary
45270	J1939 Start Stop Config	Uint32	N/A	N/A	RW	0 = Standard 1 = Volvo Penta 2 = MTU MDEC 3 = MTU ADEC 4 = MTU ECU7 5 = GM 6 = Cummins 7 = MTU Smart Connect 8 = Scania 9 = John Deere 10 = Isuzu 11 = Daimler 12 = Yanmar
45272	ECU Settling Time	Uint32	Millisecond	Milli	RW	5500–30000
45274	ECU Pulse Cycle Time	Uint32	Minute	N/A	RW	1–60
45276	ECU Disconnect Time	Uint32	Second	N/A	RW	1–60
45278	ECU Connect Time	Uint32	Second	N/A	RW	1–60
45280	MTU Request Test Overspeed	Uint32	N/A	N/A	RW	0 = Off 1 = On
45282	MTU Governor Switchover Parameters	Uint32	N/A	N/A	RW	0–1
45284	MTU Intermittent Oil Prime Request	Uint32	N/A	N/A	RW	0 = Off 1 = On
45286	MTU Trip Info Reset Request	Uint32	N/A	N/A	RW	0 = Off 1 = On
45288	MTU Speed Increase	Uint32	N/A	N/A	RW	0 = Off 1 = On
45290	MTU Speed Decrease	Uint32	N/A	N/A	RW	0 = Off 1 = On
45292	MTU Speed Demand Limit Boolean	Uint32	N/A	N/A	RW	0 = Off 1 = On

Register	Description	Type	Units	Scaling Factor	R/W	Range
45294	MTU Mode Switch	Uint32	N/A	N/A	RW	0–1000
45296	MTU Increased Idle	Uint32	N/A	N/A	RW	0–1000
45298	MTU Governor Parameter Set Select	Uint32	N/A	N/A	RW	0 = Off 1 = On
45300	MTU Fan Override	Uint32	N/A	N/A	RW	0 = Off 1 = On
45302	MTU Prime On Engine Start	Uint32	N/A	N/A	RW	0 = Off 1 = On
45304	MTU CAN Rating SW1	Uint32	N/A	N/A	RW	0 = Off 1 = On
45306	MTU CAN Rating SW2	Uint32	N/A	N/A	RW	0 = Off 1 = On
45308	MTU Disable Cylinder Cutout 1	Uint32	N/A	N/A	RW	0 = Off 1 = On
45310	MTU Cylinder Cutout 2	Uint32	N/A	N/A	RW	0 = Off 1 = On
45312	MTU ECU7 Module Type Data	Int32	N/A	N/A	RW	0 = Off 1 = On
45314	RESERVED					
45316	MTU 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 1 = Enable
45320	DPF Manual Regenerate Data	Int32	N/A	N/A	RW	0 = Off 1 = On
45322	DPF Regenerate Disable Data	Int32	N/A	N/A	RW	0 = Off 1 = On
45324	J1939 Speed Torque Transmit Enable Data	Int32	N/A	N/A	RW	0 = Off 1 = RPM Request 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 1 = Enable
45330	Requested MTU 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 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 1 = Standard 2 = Sens
45340	Battery Charger 2 CAN Bus Type	Uint32	N/A	N/A	RW	0 = None 1 = Standard 2 = Sens
45342	Battery Charger 1 Comms Fail Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
45344	Battery Charger 1 Battery Fail Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
45346	Battery Charger 1 Charger Fail Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
45348	Battery Charger 1 ac Off Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
45350	Battery Charger 1 Thermal Limit Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
45352	Battery Charger 1 High dc Voltage Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
45354	Battery Charger 1 Low dc Voltage Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
45356	Battery Charger 1 Low Cranking Voltage Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
45358	Battery Charger 1 Invalid Settings Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
45360	Battery Charger 1 Single Unit Fail Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
45362	Battery Charger 2 Comms Fail Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
45364	Battery Charger 2 Battery Fail Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable

Register	Description	Type	Units	Scaling Factor	R/W	Range
45366	Battery Charger 2 Charger Fail Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
45368	Battery Charger 2 ac Off Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
45370	Battery Charger 2 Thermal Limit Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
45372	Battery Charger 2 High dc Voltage Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
45374	Battery Charger 2 Low dc Voltage Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
45376	Battery Charger 2 Low Cranking Voltage Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
45378	Battery Charger 2 Invalid Settings Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
45380	Battery Charger 2 Single Unit Fail Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
45382	Engine Start Mode	Uint32	N/A	N/A	RW	0 = Normal Engine Start Requested 1 = Rapid Engine Start Requested
45384	RPM Checksum Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
45386	Cummins Generator Control Communications Configuration	Int32	N/A	N/A	RW	0 = Proprietary 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 1 = On
45392	Isuzu Escape Mode Request	Uint32	N/A	N/A	RW	0 = Off 1 = On
45394–483	FUTURE USE					
45484	Voltage Regulator CAN Bus Parameter Transmit Enable Data	Int32	N/A	N/A	RW	0 = None 1 = Marathon 2 = Basler 3 = J1939
45486	Voltage Regulator Primary Volt Setpoint in DeciVolts Data	Int32	DeciUnit	Deci	RW	1000–6000
45488	Voltage Regulator Alternate Volt Setpoint in DeciVolts Data	Int32	DeciUnit	Deci	RW	1000–6000
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
45534	Thermocouple Input 2 Metering Value	Int32	CentiDeg F	Centi	R	-100000000 to 99999900
45536–37	AEM Input Threshold Status Bits Register 1	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Analog Input 6 Under 2 Bit 3 = Analog Input 6 Under 1 Bit 4 = Analog Input 6 Over 2 Bit 5 = Analog Input 6 Over 1 Bit 6 = Analog Input 6 Out of Range Bit 7 = Analog Input 5 Under 2 Bit 8 = Analog Input 5 Under 1 Bit 9 = Analog Input 5 Over 2 Bit 10 = Analog Input 5 Over 1 Bit 11 = Analog Input 5 Out of Range Bit 12 = Analog Input 4 Under 2 Bit 13 = Analog Input 4 Under 1 Bit 14 = Analog Input 4 Over 2 Bit 15 = Analog Input 4 Over 1 Bit 16 = Analog Input 4 Out of Range Bit 17 = Analog Input 3 Under 2 Bit 18 = Analog Input 3 Under 1 Bit 19 = Analog Input 3 Over 2 Bit 20 = Analog Input 3 Over 1 Bit 21 = Analog Input 3 Out of Range Bit 22 = Analog Input 2 Under 2 Bit 23 = Analog Input 2 Under 1 Bit 24 = Analog Input 2 Over 2 Bit 25 = Analog Input 2 Over 1 Bit 26 = Analog Input 2 Out of Range Bit 27 = Analog Input 1 Under 2 Bit 28 = Analog Input 1 Under 1 Bit 29 = Analog Input 1 Over 2 Bit 30 = Analog Input 1 Over 1 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 Bit 1 = Not Used Bit 2 = RTD Input 4 Under 2 Bit 3 = RTD Input 4 Under 1 Bit 4 = RTD Input 4 Over 2 Bit 5 = RTD Input 4 Over 1 Bit 6 = RTD Input 4 Out of Range Bit 7 = RTD Input 3 Under 2 Bit 8 = RTD Input 3 Under 1 Bit 9 = RTD Input 3 Over 2 Bit 10 = RTD Input 3 Over 1 Bit 11 = RTD Input 3 Out of Range Bit 12 = RTD Input 2 Under 2 Bit 13 = RTD Input 2 Under 1 Bit 14 = RTD Input 2 Over 2 Bit 15 = RTD Input 2 Over 1 Bit 16 = RTD Input 2 Out of Range Bit 17 = RTD Input 1 Under 2 Bit 18 = RTD Input 1 Under 1 Bit 19 = RTD Input 1 Over 2 Bit 20 = RTD Input 1 Over 1 Bit 21 = RTD Input 1 Out of Range Bit 22 = Analog Input 8 Under 2 Bit 23 = Analog Input 8 Under 1 Bit 24 = Analog Input 8 Over 2 Bit 25 = Analog Input 8 Over 1 Bit 26 = Analog Input 8 Out of Range Bit 27 = Analog Input 7 Under 2 Bit 28 = Analog Input 7 Under 1 Bit 29 = Analog Input 7 Over 2 Bit 30 = Analog Input 7 Over 1 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 Bit 1 = Not Used Bit 2 = Thermocouple 2 Under 2 Bit 3 = Thermocouple 2 Under 1 Bit 4 = Thermocouple 2 Over 2 Bit 5 = Thermocouple 2 Over 1 Bit 6 = Thermocouple 2 Out of Range Bit 7 = Thermocouple 1 Under 2 Bit 8 = Thermocouple 1 Under 1 Bit 9 = Thermocouple 1 Over 2 Bit 10 = Thermocouple 1 Over 1 Bit 11 = Thermocouple 1 Out of Range Bit 12 = RTD Input 8 Under 2 Bit 13 = RTD Input 8 Under 1 Bit 14 = RTD Input 8 Over 2 Bit 15 = RTD Input 8 Over 1 Bit 16 = RTD Input 8 Out of Range Bit 17 = RTD Input 7 Under 2 Bit 18 = RTD Input 7 Under 1 Bit 19 = RTD Input 7 Over 2 Bit 20 = RTD Input 7 Over 1 Bit 21 = RTD Input 7 Out of Range Bit 22 = RTD Input 6 Under 2 Bit 23 = RTD Input 6 Under 1 Bit 24 = RTD Input 6 Over 2 Bit 25 = RTD Input 6 Over 1 Bit 26 = RTD Input 6 Out of Range Bit 27 = RTD Input 5 Under 2 Bit 28 = RTD Input 5 Under 1 Bit 29= RTD Input 5 Over 2 Bit 30 = RTD Input 5 Over 1 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 Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Analog Output 4 Out of Range Bit 29 = Analog Output 3 Out of Range Bit 30 = Analog Output 2 Out of Range 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 Bit 1 = Not Used Bit 2 = Analog Input 6 Under 2 Bit 3 = Analog Input 6 Under 1 Bit 4 = Analog Input 6 Over 2 Bit 5 = Analog Input 6 Over 1 Bit 6 = Analog Input 6 Out of Range Bit 7 = Analog Input 5 Under 2 Bit 8 = Analog Input 5 Under 1 Bit 9 = Analog Input 5 Over 2 Bit 10 = Analog Input 5 Over 1 Bit 11 = Analog Input 5 Out of Range Bit 12 = Analog Input 4 Under 2 Bit 13 = Analog Input 4 Under 1 Bit 14 = Analog Input 4 Over 2 Bit 15 = Analog Input 4 Over 1 Bit 16 = Analog Input 4 Out of Range Bit 17 = Analog Input 3 Under 2 Bit 18 = Analog Input 3 Under 1 Bit 19 = Analog Input 3 Over 2 Bit 20 = Analog Input 3 Over 1 Bit 21 = Analog Input 3 Out of Range Bit 22 = Analog Input 2 Under 2 Bit 23 = Analog Input 2 Under 1 Bit 24 = Analog Input 2 Over 2 Bit 25 = Analog Input 2 Over 1 Bit 26 = Analog Input 2 Out of Range Bit 27 = Analog Input 1 Under 2 Bit 28 = Analog Input 1 Under 1 Bit 29 = Analog Input 1 Over 2 Bit 30 = Analog Input 1 Over 1 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 Bit 1 = Not Used Bit 2 = RTD Input 4 Under 2 Bit 3 = RTD Input 4 Under 1 Bit 4 = RTD Input 4 Over 2 Bit 5 = RTD Input 4 Over 1 Bit 6 = RTD Input 4 Out of Range Bit 7 = RTD Input 3 Under 2 Bit 8 = RTD Input 3 Under 1 Bit 9 = RTD Input 3 Over 2 Bit 10 = RTD Input 3 Over 1 Bit 11 = RTD Input 3 Out of Range Bit 12 = RTD Input 2 Under 2 Bit 13 = RTD Input 2 Under 1 Bit 14 = RTD Input 2 Over 2 Bit 15 = RTD Input 2 Over 1 Bit 16 = RTD Input 2 Out of Range Bit 17 = RTD Input 1 Under 2 Bit 18 = RTD Input 1 Under 1 Bit 19 = RTD Input 1 Over 2 Bit 20 = RTD Input 1 Over 1 Bit 21 = RTD Input 1 Out of Range Bit 22 = Analog Input 8 Under 2 Bit 23 = Analog Input 8 Under 1 Bit 24 = Analog Input 8 Over 2 Bit 25 = Analog Input 8 Over 1 Bit 26 = Analog Input 8 Out of Range Bit 27 = Analog Input 7 Under 2 Bit 28 = Analog Input 7 Under 1 Bit 29 = Analog Input 7 Over 2 Bit 30 = Analog Input 7 Over 1 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 Bit 1 = Not Used Bit 2 = Thermocouple 2 Under 2 Bit 3 = Thermocouple 2 Under 1 Bit 4 = Thermocouple 2 Over 2 Bit 5 = Thermocouple 2 Over 1 Bit 6 = Thermocouple 2 Out of Range Bit 7 = Thermocouple 1 Under 2 Bit 8 = Thermocouple 1 Under 1 Bit 9 = Thermocouple 1 Over 2 Bit 10 = Thermocouple 1 Over 1 Bit 11 = Thermocouple 1 Out of Range Bit 12 = RTD Input 8 Under 2 Bit 13 = RTD Input 8 Under 1 Bit 14 = RTD Input 8 Over 2 Bit 15 = RTD Input 8 Over 1 Bit 16 = RTD Input 8 Out of Range Bit 17 = RTD Input 7 Under 2 Bit 18 = RTD Input 7 Under 1 Bit 19 = RTD Input 7 Over 2 Bit 20 = RTD Input 7 Over 1 Bit 21 = RTD Input 7 Out of Range Bit 22 = RTD Input 6 Under 2 Bit 23 = RTD Input 6 Under 1 Bit 24 = RTD Input 6 Over 2 Bit 25 = RTD Input 6 Over 1 Bit 26 = RTD Input 6 Out of Range Bit 27 = RTD Input 5 Under 2 Bit 28 = RTD Input 5 Under 1 Bit 29= RTD Input 5 Over 2 Bit 30 = RTD Input 5 Over 1 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 Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Analog Output 4 Out of Range Bit 29 = Analog Output 3 Out of Range Bit 30 = Analog Output 2 Out of Range 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 Bit 1 = Not Used Bit 2 = Analog Input 6 Under 2 Bit 3 = Analog Input 6 Under 1 Bit 4 = Analog Input 6 Over 2 Bit 5 = Analog Input 6 Over 1 Bit 6 = Analog Input 6 Out of Range Bit 7 = Analog Input 5 Under 2 Bit 8 = Analog Input 5 Under 1 Bit 9 = Analog Input 5 Over 2 Bit 10 = Analog Input 5 Over 1 Bit 11 = Analog Input 5 Out of Range Bit 12 = Analog Input 4 Under 2 Bit 13 = Analog Input 4 Under 1 Bit 14 = Analog Input 4 Over 2 Bit 15 = Analog Input 4 Over 1 Bit 16 = Analog Input 4 Out of Range Bit 17 = Analog Input 3 Under 2 Bit 18 = Analog Input 3 Under 1 Bit 19 = Analog Input 3 Over 2 Bit 20 = Analog Input 3 Over 1 Bit 21 = Analog Input 3 Out of Range Bit 22 = Analog Input 2 Under 2 Bit 23 = Analog Input 2 Under 1 Bit 24 = Analog Input 2 Over 2 Bit 25 = Analog Input 2 Over 1 Bit 26 = Analog Input 2 Out of Range Bit 27 = Analog Input 1 Under 2 Bit 28 = Analog Input 1 Under 1 Bit 29 = Analog Input 1 Over 2 Bit 30 = Analog Input 1 Over 1 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 Bit 1 = Not Used Bit 2 = RTD Input 4 Under 2 Bit 3 = RTD Input 4 Under 1 Bit 4 = RTD Input 4 Over 2 Bit 5 = RTD Input 4 Over 1 Bit 6 = RTD Input 4 Out of Range Bit 7 = RTD Input 3 Under 2 Bit 8 = RTD Input 3 Under 1 Bit 9 = RTD Input 3 Over 2 Bit 10 = RTD Input 3 Over 1 Bit 11 = RTD Input 3 Out of Range Bit 12 = RTD Input 2 Under 2 Bit 13 = RTD Input 2 Under 1 Bit 14 = RTD Input 2 Over 2 Bit 15 = RTD Input 2 Over 1 Bit 16 = RTD Input 2 Out of Range Bit 17 = RTD Input 1 Under 2 Bit 18 = RTD Input 1 Under 1 Bit 19 = RTD Input 1 Over 2 Bit 20 = RTD Input 1 Over 1 Bit 21 = RTD Input 1 Out of Range Bit 22 = Analog Input 8 Under 2 Bit 23 = Analog Input 8 Under 1 Bit 24 = Analog Input 8 Over 2 Bit 25 = Analog Input 8 Over 1 Bit 26 = Analog Input 8 Out of Range Bit 27 = Analog Input 7 Under 2 Bit 28 = Analog Input 7 Under 1 Bit 29 = Analog Input 7 Over 2 Bit 30 = Analog Input 7 Over 1 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 Bit 1 = Not Used Bit 2 = Thermocouple 2 Under 2 Bit 3 = Thermocouple 2 Under 1 Bit 4 = Thermocouple 2 Over 2 Bit 5 = Thermocouple 2 Over 1 Bit 6 = Thermocouple 2 Out of Range Bit 7 = Thermocouple 1 Under 2 Bit 8 = Thermocouple 1 Under 1 Bit 9 = Thermocouple 1 Over 2 Bit 10 = Thermocouple 1 Over 1 Bit 11 = Thermocouple 1 Out of Range Bit 12 = RTD Input 8 Under 2 Bit 13 = RTD Input 8 Under 1 Bit 14 = RTD Input 8 Over 2 Bit 15 = RTD Input 8 Over 1 Bit 16 = RTD Input 8 Out of Range Bit 17 = RTD Input 7 Under 2 Bit 18 = RTD Input 7 Under 1 Bit 19 = RTD Input 7 Over 2 Bit 20 = RTD Input 7 Over 1 Bit 21 = RTD Input 7 Out of Range Bit 22 = RTD Input 6 Under 2 Bit 23 = RTD Input 6 Under 1 Bit 24 = RTD Input 6 Over 2 Bit 25 = RTD Input 6 Over 1 Bit 26 = RTD Input 6 Out of Range Bit 27 = RTD Input 5 Under 2 Bit 28 = RTD Input 5 Under 1 Bit 29= RTD Input 5 Over 2 Bit 30 = RTD Input 5 Over 1 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 Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Analog Output 4 Out of Range Bit 29 = Analog Output 3 Out of Range Bit 30 = Analog Output 2 Out of Range 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 Bit 1 = Conf Protection 8 Under 1 Bit 2 = Conf Protection 8 Over 2 Bit 3 = Conf Protection 8 Over 1 Bit 4 = Conf Protection 7 Under 2 Bit 5 = Conf Protection 7 Under 1 Bit 6 = Conf Protection 7 Over 2 Bit 7 = Conf Protection 7 Over 1 Bit 8 = Conf Protection 6 Under 2 Bit 9 = Conf Protection 6 Under 1 Bit 10 = Conf Protection 6 Over 2 Bit 11 = Conf Protection 6 Over 1 Bit 12 = Conf Protection 5 Under 2 Bit 13 = Conf Protection 5 Under 1 Bit 14 = Conf Protection 5 Over 2 Bit 15 = Conf Protection 5 Over 1 Bit 16 = Conf Protection 4 Under 2 Bit 17 = Conf Protection 4 Under 1 Bit 18 = Conf Protection 4 Over 2 Bit 19 = Conf Protection 4 Over 1 Bit 20 = Conf Protection 3 Under 2 Bit 21 = Conf Protection 3 Under 1 Bit 22 = Conf Protection 3 Over 2 Bit 23 = Conf Protection 3 Over 1 Bit 24 = Conf Protection 2 Under 2 Bit 25 = Conf Protection 2 Under 1 Bit 26 = Conf Protection 2 Over 2 Bit 27 = Conf Protection 2 Over 1 Bit 28 = Conf Protection 1 Under 2 Bit 29 = Conf Protection 1 Under 1 Bit 30 = Conf Protection 1 Over 2 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 Bit 1 = Conf Protection 8 Under 1 Bit 2 = Conf Protection 8 Over 2 Bit 3 = Conf Protection 8 Over 1 Bit 4 = Conf Protection 7 Under 2 Bit 5 = Conf Protection 7 Under 1 Bit 6 = Conf Protection 7 Over 2 Bit 7 = Conf Protection 7 Over 1 Bit 8 = Conf Protection 6 Under 2 Bit 9 = Conf Protection 6 Under 1 Bit 10 = Conf Protection 6 Over 2 Bit 11 = Conf Protection 6 Over 1 Bit 12 = Conf Protection 5 Under 2 Bit 13 = Conf Protection 5 Under 1 Bit 14 = Conf Protection 5 Over 2 Bit 15 = Conf Protection 5 Over 1 Bit 16 = Conf Protection 4 Under 2 Bit 17 = Conf Protection 4 Under 1 Bit 18 = Conf Protection 4 Over 2 Bit 19 = Conf Protection 4 Over 1 Bit 20 = Conf Protection 3 Under 2 Bit 21 = Conf Protection 3 Under 1 Bit 22 = Conf Protection 3 Over 2 Bit 23 = Conf Protection 3 Over 1 Bit 24 = Conf Protection 2 Under 2 Bit 25 = Conf Protection 2 Under 1 Bit 26 = Conf Protection 2 Over 2 Bit 27 = Conf Protection 2 Over 1 Bit 28 = Conf Protection 1 Under 2 Bit 29 = Conf Protection 1 Under 1 Bit 30 = Conf Protection 1 Over 2 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 Bit 1 = Conf Protection 8 Under 1 Bit 2 = Conf Protection 8 Over 2 Bit 3 = Conf Protection 8 Over 1 Bit 4 = Conf Protection 7 Under 2 Bit 5 = Conf Protection 7 Under 1 Bit 6 = Conf Protection 7 Over 2 Bit 7 = Conf Protection 7 Over 1 Bit 8 = Conf Protection 6 Under 2 Bit 9 = Conf Protection 6 Under 1 Bit 10 = Conf Protection 6 Over 2 Bit 11 = Conf Protection 6 Over 1 Bit 12 = Conf Protection 5 Under 2 Bit 13 = Conf Protection 5 Under 1 Bit 14 = Conf Protection 5 Over 2 Bit 15 = Conf Protection 5 Over 1 Bit 16 = Conf Protection 4 Under 2 Bit 17 = Conf Protection 4 Under 1 Bit 18 = Conf Protection 4 Over 2 Bit 19 = Conf Protection 4 Over 1 Bit 20 = Conf Protection 3 Under 2 Bit 21 = Conf Protection 3 Under 1 Bit 22 = Conf Protection 3 Over 2 Bit 23 = Conf Protection 3 Over 1 Bit 24 = Conf Protection 2 Under 2 Bit 25 = Conf Protection 2 Under 1 Bit 26 = Conf Protection 2 Over 2 Bit 27 = Conf Protection 2 Over 1 Bit 28 = Conf Protection 1 Under 2 Bit 29 = Conf Protection 1 Under 1 Bit 30 = Conf Protection 1 Over 2 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 Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Logic Control Relay 16 Bit 17 = Logic Control Relay 15 Bit 18 = Logic Control Relay 14 Bit 19 = Logic Control Relay 13 Bit 20 = Logic Control Relay 12 Bit 21 = Logic Control Relay 11 Bit 22 = Logic Control Relay 10 Bit 23 = Logic Control Relay 9 Bit 24 = Logic Control Relay 8 Bit 25 = Logic Control Relay 7 Bit 26 = Logic Control Relay 6 Bit 27 = Logic Control Relay 5 Bit 28 = Logic Control Relay 4 Bit 29 = Logic Control Relay 3 Bit 30 = Logic Control Relay 2 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 Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Not Used Bit 29 = AEM Connected Bit 30 = CEM Connected 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
45594–95	Status Metering 2	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Engine has been Running 15 Minutes or more Bit 9 = Regen Interlock Status from ECU Bit 10 = DPF Manual Regen Request Bit 11 = DPF Regen Inhibit Request Bit 12 = Alternate Voltage Override 4 Bit 13 = Alternate Voltage Override 3 Bit 14 = Alternate Voltage Override 2 Bit 15 = Alternate Voltage Override 1 Bit 16 = Bus Reverse Rotation Bit 17 = Bus Forward Rotation Bit 18 = Gen Reverse Rotation Bit 19 = Gen Forward Rotation Bit 20 = Closed Transition Override Bit 21 = Auto Breaker Operation Inhibit Bit 22 = Mains Fail Transfer Inhibit Bit 23 = Restart Delay Active Bit 24 = Synchronizer Break Close OK Bit 25 = Synchronizer Angle OK Bit 26 = Synchronizer Slip Freq OK Bit 27 = Synchronizer Volt Match OK Bit 28 = Synchronizer Active Bit 29 = Parallel To Mains Bit 30 = Mains Fail Test Bit 31 = Take Over Load

Register	Description	Type	Units	Scaling Factor	R/W	Range
45596–97	Gen Protect Pre-Alarm Status	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = 81 ROC DF/DT Trip Bit 19 = 78 Vector Shift Trip Bit 20 = 51-3 Overcurrent Trip Bit 21 = 40 Loss of Excitation Trip Bit 22 = 32 Reverse Overpower Trip Bit 23 = 59-2 Overvoltage Trip Bit 24 = 27-2 Undervoltage Trip Bit 25 = 51-2 Overcurrent Trip Bit 26 = 81 Underfrequency Trip Bit 27 = 81 Overfrequency Trip Bit 28 = 59-1 Overvoltage Trip Bit 29 = 27-1 Undervoltage Trip Bit 30 = 47 Phase Imbalance Trip Bit 31 = 51-1 Overcurrent Trip

Register	Description	Type	Units	Scaling Factor	R/W	Range
45598–99	Gen Protect Alarm Status	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = 81 ROC DF/DT Trip Bit 19 = 78 Vector Shift Trip Bit 20 = 51-3 Overcurrent Trip Bit 21 = 40 Loss of Excitation Trip Bit 22 = 32 Reverse Overpower Trip Bit 23 = 59-2 Overvoltage Trip Bit 24 = 27-2 Undervoltage Trip Bit 25 = 51-2 Overcurrent Trip Bit 26 = 81 Underfrequency Trip Bit 27 = 81 Overfrequency Trip Bit 28 = 59-1 Overvoltage Trip Bit 29 = 27-1 Undervoltage Trip Bit 30 = 47 Phase Imbalance Trip Bit 31 = 51-1 Overcurrent Trip

Register	Description	Type	Units	Scaling Factor	R/W	Range
45600–01	Pre-Alarm Metering 2	Int32	N/A	N/A	R	Bit 0 = Cannot Regen – Less than 50 Hours Since Last Regen Bit 1 = Cannot Regen – Interlock Fail Bit 2 = Cannot Regen – Low Coolant Temperature Bit 3 = Regen Completed Bit 4 = Regen Not Completed Bit 5 = Confirm Regeneration Bit 6 = DEF Tampering Bit 7 = DEF Consumption Incorrect Bit 8 = DEF Quality Poor Bit 9 = Torque Limit Severe Bit 10 = Torque Limit Bit 11 = Regenerate Forced by Service Tool Bit 12 = Regeneration Forced by Switch Bit 13 = DPF Regenerate Active Bit 14 = DTC Low Coolant Level Bit 15 = Return Fail Bit 16 = DEF Warning Level 2 Bit 17 = DEF Warning Bit 18 = Bus Reverse Rotation Bit 19 = Gen Reverse Rotation Bit 20 = DEF Inducement Override Bit 21 = DEF Severe Inducement Bit 22 = DEF Pre-Severe Inducement Bit 23 = DEF Engine Derate Bit 24 = DEF Fluid Level Empty Bit 25 = DEF Fluid Level Low Bit 26 = DPF Soot Level Severely High Bit 27 = DPF Soot Level Moderately High Bit 28 = DPF Soot Level High Bit 29 = High Exhaust Temperature Bit 30 = DPF Regenerate Disabled 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
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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 1 = Wye 2 = 1 phase AB 3 = 1 phase AC 4 = Grounded Delta
45666	Bus Connection for Metering Data	Int32	N/A	N/A	R	0 = 1 phase AB 1 = 3 phase 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 Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Single Unit Fail Bit 21 = Invalid Settings Bit 22 = Low Cranking Voltage Bit 23 = Low Output Voltage Bit 24 = High Output Voltage Bit 25 = Thermal Limit Bit 26 = AC Off Bit 27 = Charger Fail Bit 28 = Battery Fail Bit 29 = Charger Comms Status Bit 30 = Charger Config is Sens Bit 31 = Charger Comms Enabled
45692	Battery Charger 1 Pre-Alarms	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Single Unit Fail Bit 23 = Invalid Settings Bit 24 = Low Cranking Voltage Bit 25 = Low Output Voltage Bit 26 = High Output Voltage Bit 27 = Thermal Limit Bit 28 = AC Disconnected Bit 29 = Charger Fail Bit 30 = Battery Failure Bit 31 = Comms Fail

Register	Description	Type	Units	Scaling Factor	R/W	Range
45694	Battery Charger 2 Status Points	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Single Unit Fail Status Bit 21 = Invalid Settings Status Bit 22 = Low Cranking Voltage Status Bit 23 = Low Output Voltage Status Bit 24 = High Output Voltage Status Bit 25 = Thermal Limit Status Bit 26 = AC Off Status Bit 27 = Charger Fail Status Bit 28 = Battery Fail Status Bit 29 = Charger Comms Fail Status Bit 30 = Charger Config is Sens 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 Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Single Unit Fail Bit 23 = Invalid Settings Bit 24 = Low Cranking Voltage Bit 25 = Low Output Voltage Bit 26 = High Output Voltage Bit 27 = Thermal Limit Bit 28 = AC Disconnected Bit 29 = Charger Fail Bit 30 = Battery Failure 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 Bit 1 = Yanmar Regeneration Passive State Bit 2 = Yanmar Regeneration Assist State Bit 3 = Yanmar Regeneration Reset Standby State Bit 4 = Yanmar Regeneration Reset State Bit 5 = Yanmar Regeneration Stationary by Allow Standby State Bit 6 = Yanmar Regeneration Stationary by Allow State Bit 7 = Yanmar Regeneration Stationary by Emergency Standby State Bit 8 = Yanmar Regeneration Stationary by Emergency State Bit 9 = Yanmar Regeneration Recovery Standby State Bit 10 = Yanmar Regeneration Recovery State Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Not Used Bit 29 = Not Used Bit 30 = Not Used 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 Bit 1 = Manual Regeneration Request Pending Bit 2 = Manual Regeneration Request Waiting for Confirmation Bit 3 = Manual Regeneration Request Waiting for Stationary Regeneration Bit 4 = Manual Regeneration Request Aborting Bit 5 = Manual Regeneration Request Timed Out Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Not Used Bit 29 = Not Used Bit 30 = Not Used 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 Bit 1 = Regeneration Status Regeneration In Progress Bit 2 = Regeneration Status Regeneration Not Completed Bit 3 = Regeneration Status Regeneration Completed Bit 4 = Regeneration Status Regeneration In Progress Bit 5 = Regeneration Status Regeneration Not Completed Bit 6 = Regeneration Status Regeneration Completed Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Not Used Bit 29 = Not Used Bit 30 = Not Used 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 Bit 1 = Inhibit Pulse Asserted Bit 2 = Inhibit Pulse Complete Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Not Used Bit 29 = Not Used Bit 30 = Not Used 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 Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Heating for Regeneration Pre-Alarm Bit 20 = Low DPF Temp Add Load Pre-alarm Bit 21 = Isuzu DEF Low Refill DEF Alarm Bit 22 = Isuzu DEF Low Refill DEF Pre-alarm Bit 23 = Isuzu Forced Purge Request Pre-alarm Bit 24 = Isuzu Service Tool Forced Purge Pre-alarm Bit 25 = Escape Mode Pre-alarm Bit 26 = Exhaust System Error Pre-alarm Bit 27 = Isuzu SCR Forced Purge Pre-alarm Bit 28 = Isuzu SCR Purge Pre-alarm Bit 29 = EGR Inducement Severe Bit 30 = EGR Inducement Level Low 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 1 = Start
45754	pc Relay Closed: Runs when in Auto mode	Uint32	N/A	N/A	RW	0 = Stop 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	
45768	Embedded Code Part Number	Uint32	N/A	N/A	R	

45770	Conf Prot 1 Param Select	Unit32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar

Register	Description	Type	Units	Scaling Factor	R/W	Range
						68 = Number of Units 69 = DEF Tank 1 Level % 70 = DEF Tank 2 Level % 71 = System Offline kW Capacity 72 = System Total Generated kW Percent 73 = DPF Outlet Gas Temperature 74 = Crankcase Pressure 75 = Fuel Filter Differential Pressure 76 = Oil Filter Differential Pressure 77 = Battery Charger 1 Voltage 78 = Battery Charger 1 Current 79 = Battery Charger 2 Voltage 80 = Battery Charger 2 Current 81 = Battery 1 Temperature 82 = Battery 2 Temperature 83 = DOC Inlet Temperature 84 = DOC Outlet Temperature
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 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45790	Configurable Protection 1 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45792	Configurable Protection 1 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45794	Configurable Protection 1 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only

45796	Configurable Protection 2 Param Select	Unit32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar

Register	Description	Type	Units	Scaling Factor	R/W	Range
						68 = Number of Units 69 = DEF Tank 1 Level % 70 = DEF Tank 2 Level % 71 = System Offline kW Capacity 72 = System Total Generated kW Percent 73 = DPF Outlet Gas Temperature 74 = Crankcase Pressure 75 = Fuel Filter Differential Pressure 76 = Oil Filter Differential Pressure 77 = Battery Charger 1 Voltage 78 = Battery Charger 1 Current 79 = Battery Charger 2 Voltage 80 = Battery Charger 2 Current 81 = Battery 1 Temperature 82 = Battery 2 Temperature 83 = DOC Inlet Temperature 84 = DOC Outlet Temperature
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 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45816	Configurable Protection 2 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45818	Configurable Protection 2 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45820	Configurable Protection 2 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only

45822	Configurable Protection 3 Param Select	Uint32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar

Register	Description	Type	Units	Scaling Factor	R/W	Range
						68 = Number of Units 69 = DEF Tank 1 Level % 70 = DEF Tank 2 Level % 71 = System Offline kW Capacity 72 = System Total Generated kW Percent 73 = DPF Outlet Gas Temperature 74 = Crankcase Pressure 75 = Fuel Filter Differential Pressure 76 = Oil Filter Differential Pressure 77 = Battery Charger 1 Voltage 78 = Battery Charger 1 Current 79 = Battery Charger 2 Voltage 80 = Battery Charger 2 Current 81 = Battery 1 Temperature 82 = Battery 2 Temperature 83 = DOC Inlet Temperature 84 = DOC Outlet Temperature
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 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45842	Configurable Protection 3 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45844	Configurable Protection 3 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45846	Configurable Protection 3 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only

45848	Configurable Protection 4 Param Select	Uint32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar

Register	Description	Type	Units	Scaling Factor	R/W	Range
						68 = Number of Units 69 = DEF Tank 1 Level % 70 = DEF Tank 2 Level % 71 = System Offline kW Capacity 72 = System Total Generated kW Percent 73 = DPF Outlet Gas Temperature 74 = Crankcase Pressure 75 = Fuel Filter Differential Pressure 76 = Oil Filter Differential Pressure 77 = Battery Charger 1 Voltage 78 = Battery Charger 1 Current 79 = Battery Charger 2 Voltage 80 = Battery Charger 2 Current 81 = Battery 1 Temperature 82 = Battery 2 Temperature 83 = DOC Inlet Temperature 84 = DOC Outlet Temperature
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 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45868	Configurable Protection 4 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45870	Configurable Protection 4 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45872	Configurable Protection 4 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only

45874	Configurable Protection 5 Param Select	Uint32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar

Register	Description	Type	Units	Scaling Factor	R/W	Range
						68 = Number of Units 69 = DEF Tank 1 Level % 70 = DEF Tank 2 Level % 71 = System Offline kW Capacity 72 = System Total Generated kW Percent 73 = DPF Outlet Gas Temperature 74 = Crankcase Pressure 75 = Fuel Filter Differential Pressure 76 = Oil Filter Differential Pressure 77 = Battery Charger 1 Voltage 78 = Battery Charger 1 Current 79 = Battery Charger 2 Voltage 80 = Battery Charger 2 Current 81 = Battery 1 Temperature 82 = Battery 2 Temperature 83 = DOC Inlet Temperature 84 = DOC Outlet Temperature
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 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45894	Configurable Protection 5 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45896	Configurable Protection 5 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45898	Configurable Protection 5 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only

45900	Configurable Protection 6 Param Select	Uint32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar

Register	Description	Type	Units	Scaling Factor	R/W	Range
						68 = Number of Units 69 = DEF Tank 1 Level % 70 = DEF Tank 2 Level % 71 = System Offline kW Capacity 72 = System Total Generated kW Percent 73 = DPF Outlet Gas Temperature 74 = Crankcase Pressure 75 = Fuel Filter Differential Pressure 76 = Oil Filter Differential Pressure 77 = Battery Charger 1 Voltage 78 = Battery Charger 1 Current 79 = Battery Charger 2 Voltage 80 = Battery Charger 2 Current 81 = Battery 1 Temperature 82 = Battery 2 Temperature 83 = DOC Inlet Temperature 84 = DOC Outlet Temperature
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 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45920	Configurable Protection 6 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45922	Configurable Protection 6 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45924	Configurable Protection 6 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only

45926	Configurable Protection 7 Param Select	Uint32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar

Register	Description	Type	Units	Scaling Factor	R/W	Range
						68 = Number of Units 69 = DEF Tank 1 Level % 70 = DEF Tank 2 Level % 71 = System Offline kW Capacity 72 = System Total Generated kW Percent 73 = DPF Outlet Gas Temperature 74 = Crankcase Pressure 75 = Fuel Filter Differential Pressure 76 = Oil Filter Differential Pressure 77 = Battery Charger 1 Voltage 78 = Battery Charger 1 Current 79 = Battery Charger 2 Voltage 80 = Battery Charger 2 Current 81 = Battery 1 Temperature 82 = Battery 2 Temperature 83 = DOC Inlet Temperature 84 = DOC Outlet Temperature
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 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45946	Configurable Protection 7 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45948	Configurable Protection 7 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45950	Configurable Protection 7 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only

45952	Configurable Protection 8 Param Select	Uint32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar

Register	Description	Type	Units	Scaling Factor	R/W	Range
						68 = Number of Units 69 = DEF Tank 1 Level % 70 = DEF Tank 2 Level % 71 = System Offline kW Capacity 72 = System Total Generated kW Percent 73 = DPF Outlet Gas Temperature 74 = Crankcase Pressure 75 = Fuel Filter Differential Pressure 76 = Oil Filter Differential Pressure 77 = Battery Charger 1 Voltage 78 = Battery Charger 1 Current 79 = Battery Charger 2 Voltage 80 = Battery Charger 2 Current 81 = Battery 1 Temperature 82 = Battery 2 Temperature 83 = DOC Inlet Temperature 84 = DOC Outlet Temperature
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 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45972	Configurable Protection 8 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45974	Configurable Protection 8 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45976	Configurable Protection 8 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
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)

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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 Fl	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
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 1 = On 2 = Slow Flash 3 = Fast Flash
46122	J1939-ECU Warning Lamp Status Data	Uint32	N/A	N/A	R	0 = Off 1 = On 2 = Slow Flash 3 = Fast Flash
46124	J1939-ECU Red Stop Lamp Status Data	Uint32	N/A	N/A	R	0 = Off 1 = On 2 = Slow Flash 3 = Fast Flash

Register	Description	Type	Units	Scaling Factor	R/W	Range
46126	J1939-ECU Malfunction Status Data	Uint32	N/A	N/A	R	0 = Off 1 = On 2 = Slow Flash 3 = Fast Flash
46128	J1939 Scania OBD Inducement Failure Reason	Unit32	N/A	N/A	R	0 = No Failure 1 = Dosing Error 2 = Urea Quality 3 = Monitor Failure 4 = Nox Failure 5–6 Not Used 7 = Error 8–14 Not Used 15 = Not Available
46130	J1939 Daimler DEF Lamp Request	Uint32	N/A	N/A	R	0 = Off 1 = On 2 = Slow Blinking (1Hz) 3 = Fast Blinking (2Hz) 4–13 Reserved 14 = Error 15 = Not Available
46132	J1939 Daimler Torque Limit Lamp Request	Uint32	N/A	N/A	R	0 = Off 1 = On 2 = Slow Blinking (1Hz) 3 = Fast Blinking (2Hz) 4–13 Reserved 14 = Error 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 1 = Warning 2 = Early Inducement 3 = (Not Defined) 4 = Final Inducement
46140	J1939 Isuzu Refill DEF Lamp	Uint32	N/A	N/A	R	0 = Lamp Off 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
46144	J1939 Yanmar DPF Regen Mode Status	Uint32	N/A	N/A	R	0 = Normal Operation 1 = Assist Regeneration 2 = Reset Regeneration 3 = Stationary Regeneration 4 = Recovery Regeneration 5–15 Not Used
46146	J1939 Yanmar DPF Regen Request Flag	Uint32	N/A	N/A	R	0 = No Stationary Regeneration Request 1 = Stationary Regeneration Request by Operator Commanded 2 = Stationary Regeneration Request by emergency 3 = Recovery Regeneration Request 4–15 Not Used
46148	J1939 Yanmar DPF Regen Progress PCT	Uint32	1 %/bit gain 0 offset	N/A	R	0–100%

Register	Description	Type	Units	Scaling Factor	R/W	Range
46150	J1939 Yanmar DPF Ash Clean Request	Uint32	Raw ECU Parameter Data	N/A	R	0 = No Request 1 = Ash Cleaning Request (Low Priority) 2 = Ash Cleaning Request (High Priority) 3–15 Not Used
46152	J1939 DPF Soot Load Percent	Uint32	1 %/bit gain 0 offset	N/A	R	0–250%
46154	J1939 DPF Ash Load Percent	Uint32	1 %/bit gain 0 offset	N/A	R	0–250%
46156	J1939 Crank Case Pressure	Uint32	0.0078125 kPa/bit gain, -250 kPa offset	N/A	R	-250 to +251.99 kPa
46158	J1939 Fuel Filter Diff Pressure	Uint32	0.5 kPa/bit gain, 0 offset	N/A	R	0 – 125 kPa
46160	J1939 Oil Filter Diff Pressure	Uint32	0.0078125 kPa/bit gain, -250 kPa offset	N/A	R	-250 to +251.99 kPa
46162	J1939 Battery Charger 1 Voltage	Uint32	0.05 Volt/bit 0 Volt Offset	N/A	R	0–-3212.75 Vdc
46164	J1939 Battery Charger 1 Current	Uint32	0.05Amps/bit 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) 1 = Charging (Boost) 2 = Maintenance (Float) 3–12 Not Used 13 = Battery Failure 14 = Charger Failure 15 = No Status Available
46168	J1939 Battery Charger 1 Power Line State	Uint32	N/A	N/A	R	0 = Fail 1 = OK 2 = Internal Error 3 = No Status Available
46170	J1939 Battery charger 2 Voltage	Uint32	0.05 Volt/Bit 0 Volt Offset	N/A	R	0–-3212.75 Vdc
46172	J1939 Battery Charger 2 Current	Uint32	0.05 Amps/Bit 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) 1 = Charging (Boost) 2 = Maintenance (Float) 3–12 Not Used 13 = Battery Failure 14 = Charger Failure 15 = No Status Available
46176	J1939 Battery Charger 2 Power Line State	Uint32	N/A	N/A	R	0 = Fail 1 = OK 2 = Internal Error 3 = No Status Available
46178	J1939 Battery 1 Temperature	Uint32	1°C/bit 40°C offset	N/A	R	-40 – 210°C
46180	J1939 Battery 2 Temperature	Uint32	1°C/bit 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) 1 = On 2 = Slow Flash 3 = Fast Flash
46184	J1939 Isuzu DPF Green Lamp Status	Uint32	N/A	N/A	R	0 = Off 1 = On (In Automatic Purge)
46186	J1939 DOC Inlet Temperature	Uint32	0.03125°C/bit 273°C offset	N/A	R	-275 – 1735°C
46188	J1939 DOC Outlet Temperature	Uint32	0.03125°C/bit 273°C offset	N/A	R	-275 – 1735°C
46190	J1939 Calculated Yanmar Regeneration Completion Percentage	Uint32	1% / bit	N/A	R	0–100%

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
46196–248	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 1Over 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 1Under 2 Threshold	Int32	Centi Unit	Centi	RW	-100000000 to 99999900
46338	AEM Input 1 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46340	AEM Input 1 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46342	AEM Input 1 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
46344	AEM Input 1 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46346	AEM Input 1 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 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 99999900
46358	AEM Input 2 Param Min	Int32	Centi Unit	Centi	RW	-100000000 to 99999900
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 99999900
46370	AEM Input 2Over 2 Threshold	Int32	Centi Unit	Centi	RW	-100000000 to 99999900
46372	AEM Input 2 Under 1 Threshold	Int32	Centi Unit	Centi	RW	-100000000 to 99999900
46374	AEM Input 2Under 2 Threshold	Int32	Centi Unit	Centi	RW	-100000000 to 99999900
46376	AEM Input 2 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46378	AEM Input 2 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46380	AEM Input 2 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46382	AEM Input 2 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46384	AEM Input 2 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 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 99999900
46396	AEM Input 3 Param Min	Int32	Centi Unit	Centi	RW	-100000000 to 99999900
46398	AEM Input 3 Hysteresis	Int32	Deci Percent	Deci	RW	0–1000
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 3Over 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 3Under 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 1 = Alarm 2 = Pre-Alarm 3 = Status Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
46416	AEM Input 3 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46418	AEM Input 3 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46420	AEM Input 3 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46422	AEM Input 3 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 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 4Over 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 4Under 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 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46454	AEM Input 4 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46456	AEM Input 4 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46458	AEM Input 4 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46460	AEM Input 4 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 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

Register	Description	Type	Units	Scaling Factor	R/W	Range
46520	AEM Input 5 Over 1 Threshold	Int32	Centi Unit	Centi	RW	-100000000 to 99999900
46522	AEM Input 5Over 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 5Under 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 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46530	AEM Input 5 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46532	AEM Input 5 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46534	AEM Input 5 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46536	AEM Input 5 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 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 6Over 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 6Under 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 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46568	AEM Input 6 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46570	AEM Input 6 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46572	AEM Input 6 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46574	AEM Input 6 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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 7Over 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 7Under 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 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46606	AEM Input 7 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46608	AEM Input 7 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46610	AEM Input 7 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46612	AEM Input 7 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 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	DeciVolt	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
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 8Over 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 8Under 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 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46644	AEM Input 8 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46646	AEM Input 8 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46648	AEM Input 8 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46650	AEM Input 8 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
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 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar

Register	Description	Type	Units	Scaling Factor	R/W	Range
						68 = Number of Units 69 = DEF Tank 1 Level % 70 = DEF Tank 2 Level % 71 = System Offline kW Capacity 72 = System Total Generated kW Percent 73 = DPF Outlet Gas Temperature 74 = Crankcase Pressure 75 = Fuel Filter Differential Pressure 76 = Oil Filter Differential Pressure 77 = Battery Charger 1 Voltage 78 = Battery Charger 1 Current 79 = Battery Charger 2 Voltage 80 = Battery Charger 2 Current 81 = Battery 1 Temperature 82 = Battery 2 Temperature
46666	AEM Output 1 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 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 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar

Register	Description	Type	Units	Scaling Factor	R/W	Range
						68 = Number of Units 69 = DEF Tank 1 Level % 70 = DEF Tank 2 Level % 71 = System Offline kW Capacity 72 = System Total Generated kW Percent 73 = DPF Outlet Gas Temperature 74 = Crankcase Pressure 75 = Fuel Filter Differential Pressure 76 = Oil Filter Differential Pressure 77 = Battery Charger 1 Voltage 78 = Battery Charger 1 Current 79 = Battery Charger 2 Voltage 80 = Battery Charger 2 Current 81 = Battery 1 Temperature 82 = Battery 2 Temperature
46684	AEM Output 2 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 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 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar

Register	Description	Type	Units	Scaling Factor	R/W	Range
						68 = Number of Units 69 = DEF Tank 1 Level % 70 = DEF Tank 2 Level % 71 = System Offline kW Capacity 72 = System Total Generated kW Percent 73 = DPF Outlet Gas Temperature 74 = Crankcase Pressure 75 = Fuel Filter Differential Pressure 76 = Oil Filter Differential Pressure 77 = Battery Charger 1 Voltage 78 = Battery Charger 1 Current 79 = Battery Charger 2 Voltage 80 = Battery Charger 2 Current 81 = Battery 1 Temperature 82 = Battery 2 Temperature
46702	AEM Output 3 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 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 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar

Register	Description	Type	Units	Scaling Factor	R/W	Range
						68 = Number of Units 69 = DEF Tank 1 Level % 70 = DEF Tank 2 Level % 71 = System Offline kW Capacity 72 = System Total Generated kW Percent 73 = DPF Outlet Gas Temperature 74 = Crankcase Pressure 75 = Fuel Filter Differential Pressure 76 = Oil Filter Differential Pressure 77 = Battery Charger 1 Voltage 78 = Battery Charger 1 Current 79 = Battery Charger 2 Voltage 80 = Battery Charger 2 Current 81 = Battery 1 Temperature 82 = Battery 2 Temperature
46720	AEM Output 4 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 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 1 = Alarm 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 1 = While Engine Running Only
46756	User Config Input 2 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = While Engine Running Only
46762	User Config Input 3 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = While Engine Running Only
46768	User Config Input 4 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
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 1 = While Engine Running Only
46774	User Config Input 5 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = While Engine Running Only
46780	User Config Input 6 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm

Register	Description	Type	Units	Scaling Factor	R/W	Range
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 1 = While Engine Running Only
46786	User Config Input 7 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = While Engine Running Only
46792	User Config Input 8 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = While Engine Running Only
46798	User Config Input 9 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = While Engine Running Only
46804	User Config Input 10 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = While Engine Running Only
46810	User Config Input 11 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = While Engine Running Only
46816	User Config Input 12 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = While Engine Running Only
46822	User Config Input 13 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46824	User Config Input 13 Time Delay	Int32	Second	N/A	RW	0–300
46826	User Config Input 13 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46828	User Config Input 14 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = While Engine Running Only
46834	User Config Input 15 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = While Engine Running Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
46840	User Config Input 16 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = While Engine Running Only
46846	User Config Input 17 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = While Engine Running Only
46852	User Config Input 18 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = While Engine Running Only
46858	User Config Input 19 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = While Engine Running Only
46864	User Config Input 20 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = While Engine Running Only
46870	User Config Input 21 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = While Engine Running Only
46876	User Config Input 22 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46878	User Config Input 22 Time Delay	Int32	Second	N/A	RW	0–300
46880	User Config Input 22 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46882	User Config Input 23 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = While Engine Running Only
46888	User Config Input 24 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = While Engine Running Only
46894	User Config Input 25 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46896	User Config Input 25 Time Delay	Int32	Second	N/A	RW	0–300

Register	Description	Type	Units	Scaling Factor	R/W	Range
46898	User Config Input 25 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46900	User Config Input 26 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = While Engine Running Only
46906	ATS Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 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 1 = While Engine Running Only
46912	Battle Override Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 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 1 = While Engine Running Only
46918	Low Coolant Level Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16

Register	Description	Type	Units	Scaling Factor	R/W	Range
46920	Low Coolant Level Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = While Engine Running Only
46926	Battery Charge Failed Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
46928	Battery Charge Failed Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46930	Battery Charge Failed Time Delay	Int32	Second	N/A	RW	0–300
46932	Battery Charge Failed Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46934	Fuel Leak Detect Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
46936	Fuel Leak Detect Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 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 1 = While Engine Running Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
46942	Single Phase Connection Override Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 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 1 = While Engine Running Only
46948	Single Phase AC Sense Override Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
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 1 = While Engine Running Only
46954	Hi/Lo Line Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 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 1 = While Engine Running Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
46960	Grounded Delta Override Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 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 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 1 = Alarm 2 = Pre-alarm 3 = Status Only
47018	AEM RTD1 Over2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47020	AEM RTD1 Under1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47022	AEM RTD1 Under2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47024	AEM RTD1 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 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 1 = Alarm 2 = Pre-alarm 3 = Status Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
47044	AEM RTD2 Over2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47046	AEM RTD2 Under1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47048	AEM RTD2 Under2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47050	AEM RTD2 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 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 1 = Alarm 2 = Pre-alarm 3 = Status Only
47070	AEM RTD3 Over2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47072	AEM RTD3 Under1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47074	AEM RTD3 Under2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47076	AEM RTD3 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 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 1 = Alarm 2 = Pre-alarm 3 = Status Only
47096	AEM RTD4 Over2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
47098	AEM RTD4 Under1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47100	AEM RTD4 Under2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47102	AEM RTD4 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 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 1 = Alarm 2 = Pre-alarm 3 = Status Only
47122	AEM RTD5 Over2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47124	AEM RTD5 Under1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47126	AEM RTD5 Under2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47128	AEM RTD5 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 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 1 = Alarm 2 = Pre-alarm 3 = Status Only
47148	AEM RTD6 Over2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47150	AEM RTD6 Under1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
47152	AEM RTD6 Under2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47154	AEM RTD6 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 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 1 = Alarm 2 = Pre-alarm 3 = Status Only
47174	AEM RTD7 Over2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47176	AEM RTD7 Under1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47178	AEM RTD7 Under2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47180	AEM RTD7 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
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 1 = Alarm 2 = Pre-alarm 3 = Status Only
47200	AEM RTD8 Over2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47202	AEM RTD8 Under1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47204	AEM RTD8 Under2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
47206	AEM RTD8 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 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 1 = Alarm 2 = Pre-alarm 3 = Status Only
47268	AEM Thermocouple1 Over2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47270	AEM Thermocouple1 Under1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47272	AEM Thermocouple1 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47274	AEM Thermocouple1 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 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 1 = Alarm 2 = Pre-alarm 3 = Status Only
47294	AEM Thermocouple2 Over2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47296	AEM Thermocouple2 Under1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
47298	AEM Thermocouple2 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 3 = Status Only
47300	AEM Thermocouple2 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-alarm 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
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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

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				
PARAMETER SETTINGS					
40019	Emergency Stop	0–1	R W	0 = Off 1 = Stop	
40020	Remote Start / Stop: Runs when in Auto mode	0–1	R W	0 = Stop 1 = Start	
40021–22	RESERVED				
SYSTEM PARAMETERS					
40023	Default Generator Connection	0–2	R W	0 = 3ph L-L 1 = 3ph L-N 2 = 1ph A-B	
40024	NFPA Level	0–2	R W	0 = Off 1 = Level 1 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
GENERATOR PT PRIMARY					
40030	Voltage(a)	1–15000	R W	DP	Vac x10000
40031	Voltage(b)		R W	DP	Vac
GENERATOR PT SECONDARY					
40032	Voltage	1–480	R W		Vac
GENERATOR CT PRIMARY					
40033	Current	1-–5000	R W		Aac
LOW FUEL ALARM					
40034	Enable	0–1	R W	0 = Off 1 = On	
40035	Threshold	2–50	R W		% Full Tank
LOW FUEL PRE-ALARM					
40036	Enable	0–1	R W	0 = Off 1 = On	
40037	Threshold	10–100	R W		% Full Tank
LOW COOLANT TEMP PRE-ALARM					
40038	Enable	0–1	R W	0 = Off 1 = On	
40039	Threshold	32–150	R W		Degrees F
BATTERY OVERVOLTAGE PRE-ALARM					
40040	Enable	0–1	R W	0 = Off 1 = On	
40041	RESERVED				
MAINTENANCE INTERVAL PRE-ALARM					
40042	Enable	0–1	R W	0 = Off 1 = On	
40043	Threshold	0–5000	R W		Hours
ENGINE KW OVERLOAD PRE-ALARM					
40044	Enable	0–1	R W	0 = Off 1 = On	
40045	Threshold	95–140	R W		% of Rated
HIGH COOLANT TEMP PRE-ALARM					
40046	Enable	0–1	R W	0 = Off 1 = On	
40047	Threshold	100–280	R W		Degrees F
LOW OIL PRESSURE PRE-ALARM					

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40048	Enable	0–1	R W	0 = Off 1 = On	
40049	Threshold	3–100	R W		PSI
LOW BATTERY VOLTAGE PRE-ALARM					
40050	Enable	0–1	R W	0 = Off 1 = On	
40051	Threshold	60–120 (12V) 120–240 (24V)	R W		0.1 Vdc
40052	Pre-alarm Activation Time Delay	1–10	R W		Seconds
WEAK BATTERY VOLTAGE PRE-ALARM					
40053	Enable	0–1	R W	0 = Off 1 = On	
40054	Threshold	40–80 (12V) 80–160 (24V)	R W		0.1 Vdc
40055	Pre-alarm Activation Time Delay	1–10	R W		Seconds
40056-59	RESERVED				
HIGH COOLANT TEMP ALARM					
40060	Enable	0–1	R W	0 = Off 1 = On	
40061	Threshold	100–280	R W		Degrees F
40062	Arming Delay after Crank Disconnect	60	R W		Seconds
LOW OIL PRESSURE ALARM					
40063	Enable	0–1	R W	0 = Off 1 = On	
40064	Threshold	3–100	R W		PSI
40065	Arming Delay after Crank Disconnect	5–15	R W		Seconds
OVERSPEED ALARM					
40066	Enable	0–1	R W	0 = Off 1 = On	
40067	Threshold	105–140	R W		% of Rated
40068	Alarm Activation Time Delay	0–500	R W		Milliseconds
40069-71	RESERVED				
CRANKING PARAMETERES					
40072	Cranking Style	0–1	R W	0 = Continuous 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
SYSTEM MONITOR					
40078	Remaining Cooldown Time	0–60	R		Minutes
40079	RESERVED				
40080	Active Speed Signal Sources	1–4	R	0 = None 1 = MPU 2 = Gen Freq 4 = CAN Bus	
40081	Sender Failure Alarm Code	individual bits are 0 or 1	R	b0 = High Coolant Temperature b1 = Oil Pressure b2 = Fuel Level b3 = Magnetic Pick-up b4 = Generator Voltage Sensing b5 = Battery Charger Fail b6 = Coolant Level Sender Fail 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 b1=Low Coolant Level Alarm b2=Low Fuel Level Alarm b3=Emergency Stop Alarm b4=Global Sender Fail Alarm b5=Over Crank Alarm b6=Over Speed Alarm b7=Low Oil Pressure Alarm b8=Loss of ECU Communication Alarm b9=Unexpected Shutdown Alarm BP b10=Fuel Leak Detect Alarm b11=Battery Charger Fail Alarm	
40083	Pre-Alarm Codes	individual bits are 0 or 1	R	b0=High Coolant Temperature b1=Low Coolant Temperature b2=Weak Battery b3=Low Battery b4=Battery Overvoltage b5=Battery Charger Fail b6=Maintenance Interval b7=Engine Overload Rev. 3.04 Added: b8 = DTC b9 = CAN Fail	
40084	Pre-Alarm Codes, Group 2	individual bits are 0 or 1	R	b0=Low Oil Pressure b1=Low Fuel Level b2=Magnetic Pick-up Fail b3=Fuel Level Sender Fail b4=Aux Input 1 b5=Aux Input 2 b6=Aux Input 3 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
GENERATOR MONITOR					
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
40108	Phase c-n RMS Voltage(a)		R	DP	RMS Volt x 10000
40109	Phase c-n RMS Voltage(b)		R	DP	RMS Volt

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
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> b0 =mag. pick-up or CAN's ECU engine's speed. 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, b1 = ATS, b2 = E-stop, b3 = charger failed, b4 = aux. input 1, b5 = aux. input 2, b6 = aux. input 3, b7 = aux. input 4. /* b7 = aux. input 4. */	
40274	BESTCOMS*Plus*® Test Buttons States	individual bits are 0 or 1	R W	b0 = button #1, b1 = button #2, b2 = button #3, b3 = button #4, 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		
40283	Embedded Code Version Number (c)	0–9999	R		
40287-97	RESERVED				

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
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. b0 = Aux Output 1, b1 = Aux Output 2, b2 = Aux Output 3, b3 = Aux Output 4, b4 = Aux Output 5, b5 = Aux Output 6, b6 = Aux Output 7, b7 = Aux Output 8. b8 = Master Start Relay, b9 = Fuel Solenoid Relay, b10 = PreHeat PreLube Relay, b11 = Alarm Relay, b12 = UNASSIGNED, b13 = Buzzer On, b14 = EPS Loaded Relay, b15 = PreAlarm Relay,	
40299	RESERVED				
J1939 DIAGNOSTIC TROUBLE CODES					
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. SPN = (Register N: Most Significant 3 bits * 65536) + (Register N+1: LS Byte * 256) + (Register N+1: MS Byte) FMI = Register N: Bits 8-12 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		
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		

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
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	Suppose the 32 bits of DTC Data is in Register N and N+1. SPN = (Register N+1: Most Significant 3 bits * 65536) + (Register N: LS Byte * 256) + (Register N: MS Byte) FMI = Register N+1: Bits 8–12 Occurrence Count = Register N: Bits 0–6	
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		
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		

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
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 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. b0 = 0, b1 = Protect Lamp, b2 = 0, b3 = Amber Warning Lamp, b4 = 0, b5 = Red Stop Lamp, b6 = 0, b7 = Malfunction Indicator Lamp, b8 = 0, b9 = Protect Lamp, b10 = 0, b11 = Amber Warning Lamp, b12 = 0, b13 = Red Stop Lamp, b14 = 0, 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, b1 = Active DTC Clear Fail, b2 = Previous DTC Clear Fail, b3 = DTC Values Changed, b4 = CAN Hardware Test Pass, b5 = UNASSIGNED, b6 = UNASSIGNED, 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 Bit 11 – Data Failure Status Previous Active DTCs Cleared Bit 10 – Active DTCs Cleared Bit 9 - Previous Active DTCs Bit 8 - Current Active DTCs Bit 7 – Coolant Level Bit 6 - Oil Pressure Bit 5 - Coolant Temp Bit 4 - Engine Speed Bit 3 – Can Error Status tx err passive Bit 2 – Can Error Status rx err passive Bit 1 – Can Error Status driver sleep status Bit 0 – Can Error Status bus off	
40373	System Config	individual bits are 0 or 1	R W	Bit 0 – RUN Bit 1 – OFF Bit 2 – AUTO_RUN Bit 3 – AUTO_OFF Bit 4 – AUTO_ANY	
40374	System Status	0–10	R	0 = RESET 1 = READY 2 = CRANKING 3 = RESTING 4 = RUNNING 5 = ALARM 6 = PRESTART 7 = COOLING 8 = CONNECTING 9 = DISCONNECT 10 = PULSING 11 = UNLOADING	
40375	Used to display Value, NC, NS, NA, and SF		R	Bits 0-2: coolant level Bits 3-5: coolant temperature Bits 6-8: oil pressure Bits 9-11: engine speed Bits 12-14: engine run time Bit 15: NOT USED 3-Bit Status Flag Values: 000 for Valid Data 001 for No Comms 010 for Not Sent 011 for Not Supp 100 for Sender Error	
40380–81	FUTURE USE				
40382	MTU module type	1–4	R W	1 = module type 201 2 = module type 302 3 = module type 303 4 = module type 304	
40383	MTU speed demand switch	0–7	R W	0 = ANALOG_CAN 1 = UP_DN_ECU 2 = UP_DN_CAN 3 = ANALOG_ECU 5 = FREQUENCY 7 = NO_CAN_DEMAND	
40384	MTU RPM request for engine	1400–2000	R W		
40385	Volvo Accelerator Pedal Position (Trim)	0–100	R W	0 = Rated speed – 120rpm; 50 = Rated speed; 100 = Rated speed + 120rpm.	
40386	Volvo Engine RPM Select	0–1	R W	0 = Primary, 1 = Secondary	
40387	J1939 source address for this unit	0–253	R W		
40388	CAN Bus ECU Configuration	0–65535	R W	0 = Not configured; 1 = Volvo Penta EDC3; 2 = MTU MDEC 3 = MTU ADEC	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
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				
J1939 DATA					
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 (0 to 36404 psi)	R	1/256 MPa/bit gain, 0 MPa offset	
40427	Engine Run Time	0 to +210,554, 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 to +2,105,540, 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 to +2,105,540, 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 (-40 to 410 °F)	R	Raw ECU Parameter Data 1 °C/bit gain, -40 °C offset	
40437	Fuel Temperature	-40 to +210 °C (-40 to 410 °F)	R	Raw ECU Parameter Data 1 °C/bit gain, -40 °C offset	
40438	Engine Oil Temperature	-273 to +1735.0 °C (-459.4 to 3155.0 °F)	R	Raw ECU Parameter Data 0.03125 °C/bit gain, -273 °C offset	
40439	Engine Intercooler Temperature	-40 to +210 °C (-40 to 410 °F)	R	Raw ECU Parameter Data 1 °C/bit gain, -40 °C offset	
40440	Fuel Delivery Pressure	0–1000 kPa (0–145 psi)	R	Raw ECU Parameter Data 4 kPa/bit gain, 0 kPa offset	
40441	Engine Oil Level	0–100 %	R	Raw ECU Parameter Data 0.4 %/bit gain, 0 % offset	
40442	Engine Oil Pressure	0–1000 kPa (0–145 psi)	R	Raw ECU Parameter Data 4 kPa/bit gain, 0 kPa offset	
40443	Coolant Pressure	0 to +500 kPa (0 to 72.5 psi)	R	Raw ECU Parameter Data 2 kPa/bit gain, 0 kPa offset	
40444	Coolant Level	0–100 %	R	Raw ECU Parameter Data 0.4 %/bit gain, 0 % offset	
40445	Fuel Rate	0–3212.75 L/h	R	Raw ECU Parameter Data 0.05 L/h per bit gain, 0 L/h offset (13.9 x 10-6 L/s per bit)	
40446	Barometric Pressure	0–125 kPa (0–18.1 psi)	R	Raw ECU Parameter Data 0.5 kPa/bit gain, 0 kPa offset	
40447	Ambient Air Temperature	-273 to +1735.0 °C (-459.4 to 3155.0 °F)	R	Raw ECU Parameter Data 0.03125 °C/bit gain, -273 °C offset	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40448	Air Inlet Temperature	-40 to +210 °C (-40 to 410 °F)	R	Raw ECU Parameter Data 1 °C/bit gain, -40 °C offset	
40449	Boost Pressure	0–500 kPa (0–72.5 psi)	R	Raw ECU Parameter Data 2 kPa/bit gain, 0 kPa offset	
40450	Intake Manifold Temperature	-40 to +210 °C (-40 to 410 °F)	R	Raw ECU Parameter Data 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 0.05 kPa/bit gain, 0 kPa offset	
40452	Exhaust Gas Temperature	-273 to +1735.0 °C (-459.4 to 3155.0 °F)	R	Raw ECU Parameter Data 0.03125 °C/bit gain, -273 °C offset	
40453	Electrical Potential Voltage	0–3212.75 V	R	Raw ECU Parameter Data 0.05 V/bit gain, 0 V offset	
40454	Battery Potential Voltage Switched	Data Range: 0–3212.75 V	R	Raw ECU Parameter Data 0.05 V/bit gain, 0 V offset	
40455	Speed At Idle Point 1	0–8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40456	Torque At Idle Point 1	0–125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40457	Speed At Idle Point 2	0–8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40458	Torque At Idle Point 2	0–125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40459	Speed At Idle Point 3	0–8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40460	Torque At Idle Point 3	0–125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40461	Speed At Idle Point 4	0–8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40462	Torque At Idle Point 4	0–125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40463	Speed At Idle Point 5	0–8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40464	Torque At Idle Point 5	0–125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40465	Speed At High Idle Point 6	0–8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40466	Gain Of End speed governor	0–50.2 %/rpm	R	Raw ECU Parameter Data 0.0007813 % engine reference torque/rpm per bit gain (normalized), 0 %/rpm per bit offset	
40467	Reference Engine Torque	0–64 255 Nm	R	Raw ECU Parameter Data 1 Nm/bit gain, 0 Nm offset	
40468	Override Speed Point 7	0–8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40469	Override Time Limit	0–25 s	R	Raw ECU Parameter Data 0.1 s/bit gain, 0 s offset	
40470	Speed Lower Limit	0–2500 rpm	R	Raw ECU Parameter Data 10 rpm/bit gain, 0 rpm offset	
40471	Speed Upper Limit	0–2500 rpm	R	Raw ECU Parameter Data 10 rpm/bit gain, 0 rpm offset	
40472	Torque Lower Limit	0–125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40473	Torque Upper Limit	0–125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40474	Crankcase Pressure	-250 to +251.99 kPa	R	Raw ECU Parameter Data 0.0078125 kPa/bit gain, -250 kPa offset	
40475	Oil Filter Differential Pressure	0–125 kPa	R	Raw ECU Parameter Data 0.5 kPa/bit gain, 0 offset	
40476	Fuel Filter Differential Pressure	0–500 kPa	R	Raw ECU Parameter Data 2 kPa/bit gain, 0 offset	
40477–82	FUTURE USE				
40493–99	FUTURE USE				

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
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: b0 = RUN b1 = OFF b2 = AUTO b3 = ALARM b4 = LOAD 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. b0 = Aux Output 1, b1 = Aux Output 2, b2 = Aux Output 3, b3 = Aux Output 4, b4 = Aux Output 5, b5 = Aux Output 6, b6 = Aux Output 7, b7 = Aux Output 8. b8 = Master Start Relay, b9 = Fuel Solenoid Relay, b10 = Preheat Prelube Relay, b11 = Alarm Relay, b12 = UNASSIGNED, b13 = Buzzer On, b14 = EPS Loaded Relay, b15 = Pre-alarm Relay,	
40508	Input Contacts States (Duplicate of 40273)	individual bits are 0 or 1	R	b0 = coolant level, b1 = ATS, b2 = E-stop, b3 = charger failed, b4 = aux. input 1, b5 = aux. input 2, b6 = aux. input 3, b7 = aux. input 4. /* b7 = aux. input 4. */	
40509–604	RESERVED				
OVERCURRENT					
40605	51 Pick-up – 3-phase	18–118, 90–775	R W	0.18–1.18 Aac for 1A CTs, 0.90–7.75 Aac for 5A CTs	
40606	51 Time Dial – 3-phase	0–99, 0–300	R W	0.0–9.9 for 40607=0-15 (inverse), 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	
40609	51 Pick-up – 1-phase	18–118, 90–775	R W	0.18–1.18 Aac for 1A CTs, 0.90–7.75 Aac for 5A CTs	
40610	51 Time Dial – 1-phase	0–99, 0–300	R W	0.0–9.9 for 40607=0-15 (inverse), 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	
PHASE IMBALANCE					
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	
UNDERVOLTAGE					

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
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	
OVERVOLTAGE					
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	
UNDERFREQUENCY					
40630	81U Pickup	450–550, 550–650, 3600–4400	R W	45.0–55.0 Hz for 50-Hz config, 55.0–65.0 Hz for 60-Hz config, 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	
OVERFREQUENCY					
40634	81O Pickup	450–-550, 550–650, 3600–4400	R W	45.0–55.0 Hz for 50-Hz config, 55.0–65.0 Hz for 60-Hz config, 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	
GENERATOR PROTECTION STATUS					
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, b1 = undervoltage trip, b2 = overfrequency trip, b3 = underfrequency trip, b4 = overcurrent trip, b5 = phase imbalance trip, 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, b1 = undervoltage pre-alarm, b2 = overfrequency pre-alarm, b3 = underfrequency pre-alarm, b4 = overcurrent pre-alarm, b5 = phase imbalance pre-alarm, b6–b15 UNASSIGNED	
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, b1 = undervoltage alarm, b2 = overfrequency alarm, b3 = underfrequency alarm, b4 = overcurrent alarm, b5 = phase imbalance alarm, 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		

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40704	Day	1–31	R W		
40705	Year		R W		
40706	Daylight Savings Time Enable	0–1	R W	0 = Off 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, 1 = pre-start relay	
40759	ECU Pulsing Enable	0–1	R W	0 = pulsing is enabled, 1 = pulsing is disabled	
40760	MDEC Alarms	0–65535	R	b0 = High Charge Air Temp, b1 = High Oil Temp, b2 = High Coolant Temp, b3 = Low Aftercooler Level, b4 = Low Fuel Delivery Press, b5 = Low Oil Press, b6 = Overspeed, b7 = Combined Red, b8–b15 UNASSIGNED	
40761	MTU Pre-alarms	0–65535	R	b0 = High ECU Temp, b1 = High Oil Temp, b2 = High Intercooler Temp, b3 = High Charge Air Temp, b4 = High Coolant Temp, b5 = Shutdown Override, b6 = High Fuel Rail Press, b7 = Low Fuel Rail Press, b8 = Low Coolant Level, b9 = Low Charge Air Pressure, b10 = Low Fuel Delivery Pressure, b11 = Low Oil Pressure, b12 = Combined Yellow, 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
PRODUCT ACCESS INFORMATION					
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>				
COMMUNICATION PARAMETERS					
40051	Comm Baud Rate	0	R W	0 = 9600	Baud
40052	Remote Delay Time	0–20	R W	0 = Min. 1 =10 2 = 20 etc. 20 = 200	Milliseconds 10
40053	Comm Parity	0–2	R W	0 = None 1 = Odd 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
PARAMETER SETTINGS					
40078	Remote (PC) Emergency Stop	0–1	W	0 = Off 1 = Stop	
40079	Remote Start / Stop	0–1	W	0 = Stop 1 = Start	
40080	<Reserved>				
40081	Settings Source	0–2	R W	0 = Factory 1 = OEM 2 = User	
40082	Save Settings	Data = Don't Care	W		
40083	<Reserved>				
SYSTEM PARAMETERS					
40091	Generator Connection	0–2	R W	0 = 3ph L-L 1 = 3ph L-N 2 = 1ph A-B	
40092	NFPA Level	0–2	R W	0 = Off 1 = Level 1 2 = Level 2	
40093	Unit System	0–1	R W	0 = English 1 = Metric	
40094	Battery Volts	0–1	R W	0 = 12 Vdc 1 = 24 Vdc	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40095	Generator Frequency	0–1	R W	0 = 50 Hz 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
40115	Alternator Frequency Rated Stepsize	1	R		Hertz
GENERATOR PT PRIMARY					
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
GENERATOR PT SECONDARY					
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
GENERATOR CT PRIMARY					
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
BUS PT PRIMARY					
40141	Voltage(a)	1–15000	R W	DP	Vac x 10000

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
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
BUS PT SECONDARY					
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
LOW FUEL PRE-ALARM					
40181	Enable	0–1	R W	0 = Off 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
LOW COOL TEMP PRE-ALARM					
40186	Enable	0–1	R W	0 = Off 1 = On	
40187	Threshold	40–100	R W		Deg F
40188	Minimum	40	R		Deg F
40189	Maximum	100	R		Deg F
40190	Stepsize	1	R		Deg F
BATTERY OVERVOLTAGE PRE-ALARM					
40191	Enable	0–1	R W	0 = Off 1 = On	
40192	Threshold	140–160 (12 V) 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
MAINTENANCE INTERVAL PRE-ALARM					
40196	Enable	0–1	R W	0 = Off 1 = On	
40197	Threshold	0–5000	R W		Hours
40198	Minimum	0	R		Hours
40199	Maximum	5000	R		Hours
40200	Stepsize	10	R		Hours
ENGINE KW OVERLOAD PRE-ALARM					
40201	Enable	0–1	R W	0 = Off 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

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
HIGH COOLANT TEMPERATURE PRE-ALARM					
40206	Enable	0–1	R W	0 = Off 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
LOW OIL PRESSURE PRE-ALARM					
40211	Enable	0–1	R W	0 = Off 1 = On	
40212	Threshold	3–100	R W		PSI
40213	Minimum	3	R		PSI
40214	Maximum	100	R		PSI
40215	Stepsize	1	R		PSI
LOW BATTERY VOLTAGE PRE-ALARM					
40216	Enable	0–1	R W	0 = Off 1 = On	
40217	Threshold	60–120 (12 V) 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
40222	Activation Time Delay Minimum	1	R		Seconds
40223	Activation Time Delay Maximum	10	R		Seconds
40224	Activation Time Delay Stepsize	1	R		Seconds
WEAK BATTERY VOLTAGE PRE-ALARM					
40225	Enable	0–1	R W	0 = Off 1 = On	
40226	Threshold	40–80 (12 V) 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
LOGON PASSWORD (40252–7)					
HIGH COOLANT TEMPERATURE ALARM					
40281	Enable	0–1	R W	0 = Off 1 = On	
40282	Shutdown Enable	0–1	R W	0 = Off 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

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40290	Arming Delay Stepsize	0	R		Seconds
LOW OIL PRESSURE ALARM					
40291	Enable	0–1	R W	0 = Off 1 = On	
40292	Shutdown Enable	0–1	R W	0 = Off 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
OVERSPEED ALARM					
40301	Enable	0–1	R W	0 =Off 1 =On	
40302	Shutdown Enable	0–1	R W	0 =Off 1 =On	
40303	Threshold	105–140	R W		% of Rated
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
SENDER FAIL ALARMS					
40311	Coolant Temperature Sender Failure Alarm Enable	0–1	R W	0 = Off 1 = On	
40312	Oil Pressure Sender Failure Alarm Enable	0–1	R W	0 = Off 1 = On	
40314	Magnetic Pick-up Failure Alarm Enable	0–1	R W	0 = Off 1 = On	
40315	Loss of Generator Voltage Alarm Enable	0–1	R W	0 = Off 1 = On	
40316	Pre-alarm Buzzer Enable	0–1	R W	0 = Off 1 = On	
40317	Battery Charger Failure Pre-alarm Enable	0–1	R W	0 = Off 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
CRANKING PARAMETERS					
40351	Cranking Style	0–1	R W	0 = Continuous 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		

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
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
40372	Pre-crank Contact after Disconnect	0–1	R W	0 = Open 1 = Closed	
SYSTEM MONITOR					
40374	Remaining Cooldown Time	0–60	R		Minutes
40375	<Reserved>				
40376	Active Speed Signal Sources	1–4	R	1 = MPU 2 = ALT 3 = GEN 4 = NONE	
40377	Sender Failure Alarm Codes		R	b0 = Cool Temp b1 = Oil Press b2 = Reserved b3 = Spd Signal b4 = Gen Volt b5–b7 Not Used	
40378	Alarm Codes		R	b0 = Hi Cool Temp b1 = Low Coolant Level b2 = Airbox b3 = E-Stop b4 = Sender Fail b5 = Over-crank b6 = Over-speed b7 = Low Oil Press	
40379	Pre-Alarm Codes		R	b0 = Hi Cool Temp b1 = Low Cool Temp b2 = Weak Batt b3 = Low Batt b4 = Batt ov b5 = Charger Fail b6 = Service Due b7 = kW Overload	
40380	Pre-Alarm Codes, Group 2		R	b0 = Low Oil Press b1 = Low Fuel b2 = Reserved b3 = Reserved b4–b7 Not Used	
40381	Engine Coolant Temperature		R		Deg F

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
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	%
GENERATOR MONITOR					
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

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
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
CONTIGUOUS WRITE BLOCK (REGROUPED PARAMETERS)					
40441	Generator Connection	0–2	R W	0 = 3ph L-L 1 = 3ph L-N 2 = 1ph A-B	
40442	NFPA Level	0–2	R W		
40443	Unit System	0–1	R W	0 = English 1 = Metric	
40444	Nominal Battery Voltage	0–1	R W	0 = 12 Vdc 1 = 24 Vdc	
40445	Generator Frequency	0–1	R W	0 = 50 Hz 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 b0=mag pick-up b1=generator b2=chg. alt. Gen. Phase Rotation b4=0 for A-B-C b4=1 for A-C-B Maintenance Timer b5=0 is active b5=1 to reset
GENERATOR PT PRIMARY					
40452	Voltage(a)	1–15000	R W	DP	Vac x 10000
40453	Voltage(b)		R W	DP	Vac
GENERATOR PT SECONDARY					
40454	Voltage	1–480	R W		Vac
GENERATOR CT PRIMARY					
40455	Current	1–5000	R W		Aac
40456	<Reserved>				
BUS PT PRIMARY					
40457	Voltage(a)	1–15000	R W	DP	Vac x 10000
40458	Voltage(b)		R W	DP	Vac
BUS PT SECONDARY					
40459	Voltage	1–480	R W		Vac
LOW FUEL PRE-ALARM					
40460	Enable	0–1	R W	0 = Off 1 = On	
40461	Threshold	10–100	R W		% Full Tank
LOW COOL TEMP PRE-ALARM					
40462	Enable	0–1	R W	0 = Off 1 = On	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40463	Threshold	40–100	R W		Deg F
BATTERY OVERVOLTAGE PRE-ALARM					
40464	Enable	0–1	R W	0 = Off 1 = On	
40465	Threshold	140–160 (12 V) 240–320 (24 V)	R W		.01 Vdc
MAINTENANCE INTERVAL PRE-ALARM					
40466	Enable	0–1	R W	0 = Off 1 = On	
40467	Threshold	0–5000	R W		Hours
ENGINE KW OVERLOAD PRE-ALARM					
40468	Enable	0–1	R W	0 = Off 1 = On	
40469	Threshold	95–140	R W		% of Rated
HIGH COOLANT TEMPERATURE PRE-ALARM					
40470	Enable	0–1	R W	0 = Off 1 = On	
40471	Threshold	100–280	R W		Deg F
LOW OIL PRESSURE PRE-ALARM					
40472	Enable	0–1	R W	0 = Off 1 = On	
40473	Threshold	3–100	R W		PSI
LOW BATTERY VOLTAGE PRE-ALARM					
40474	Enable	0–1	R W	0 = Off 1 = On	
40475	Threshold	60–120 (12 V) 120–240 (24 V)	R W		0.1 Vdc
40476	Pre-alarm Activation Time Delay	1-10	R W		Seconds
WEAK BATTERY VOLTAGE PRE-ALARM					
40477	Enable	0–1	R W	0 = Off 1 = On	
40478	Threshold	40–80 (12 V) 80–160 (24 V)	R W		0.1 Vdc
40479	Pre-alarm Activation Time Delay	1-10	R W		Seconds
HIGH COOLANT TEMPERATURE ALARM					
40480	Enable	0–1	R W	0 = Off 1 = On	
40481	Shutdown Enable	0–1	R W	0 = Off 1 = On	
40482	Threshold	100–280	R W		Deg F
40483	Arming Delay after Crank Disconnect	60	R W		Seconds
LOW OIL PRESSURE ALARM					
40484	Enable	0–1	R W	0 = Off 1 = On	
40485	Shutdown Enable	0–1	R W	0 = Off 1 = On	
40486	Threshold	3–100	R W		PSI
40487	Arming Delay after Crank Disconnect	5–15	R W		Seconds
OVERSPEED ALARM					
40488	Enable	0–1	R W	0 = Off 1 = On	
40489	Shutdown Enable	0–1	R W	0 = Off 1 = On	
40490	Threshold	105–140	R W		% of Rated

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40491	Alarm Activation Time Delay	0–500	R W		Millisecond
SENDER FAIL ALARMS					
40492	Coolant Temperature Sender Failure Alarm Enable	0–1	R W	0 = Off 1 = On	
40493	Oil Pressure Sender Failure Alarm Enable	0–1	R W	0 = Off 1 = On	
40495	Magnetic Pick-up Failure Alarm Enable	0–1	R W	0 = Off 1 = On	
40496	Loss of Generator Voltage Alarm Enable	0–1	R W	0 = Off 1 = On	
40497	Pre-alarm Buzzer Enable	0–1	R W	0 = Off 1 = On	
40498	Battery Charger Failure Pre-alarm Enable	0–1	R W	0 = Off 1 = On	
40499	Global Sender Failure Alarm Time Delay	0–10	R W		Seconds
CRANKING PARAMETERS					
40500	Cranking Style	0–1	R W	0=Continuous 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 1 = Closed	
SYSTEM MONITOR					
40507	Accumulated Engine Runtime Warranty(a)		R W	DP	Minutes x 10000
40508	Accumulated Engine Runtime Warranty(b)		R W	DP	Minutes
CALIBRATION					
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

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
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
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
SYSTEM MONITOR - Continuation					
40581	System Configuration	32, 64, 128	R W	32 = AUTO 64 = OFF 128 = RUN	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40582	System State	0–5	R	0 = RESET 1 = READY 2 = CRANK 3 = REST 4 = RUN 5 = ALARM	
CALIBRATION - Continuation					
40583	Phase angle (a)		R W	DP	
40584	Phase angle (b)		R W	DP	
GENERATOR MONITOR - Continuation					
40585	Power Factor State	0–3	R	0 = +LAG 1 = -LEAD 2 = -LAG 3 = +LEAD	

APPENDIX C • TUNING PID SETTINGS

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APPENDIX C • TUNING PID SETTINGS

Introduction

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 1/10th the value of K_p or 1/10th 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 Td is an iterative process which can be accomplished by performing the following steps.

Set an initial value of K_d that is 1/10th the value of K_p or 1/10th 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 1/10th the value of K_p or 1/10th 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 mall values of K_d that are 1/10th K_p or 1/10th 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 1/10th the value of K_p or 1/10th 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_p - 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_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 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_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 1/10th K_p or 1/10th 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.

APPENDIX D • MTU FAULT CODES

Introduction

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 1st switchable charger too high (limit 1).
37	SS ETC2 OVERSPEED	Speed of 1st 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 detect.
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 BUFFR TEST	Pressure-sensor fault, pressure-sensor wiring, or internal electronic fault.
138	SENSOR PWR DEFCT	Pressure-sensor fault, pressure-sensor wiring, or internal electronic fault.
139	L1 TE BUFFR TEST	Internal electronic fault.

Fault Code Number	String	Description
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.
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.

Fault Code Number	String	Description
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 BUFFR TEST	Internal ECU fault.
263	SD TE BUFFR 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 SPDMTEST 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.
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.

Fault Code Number	String	Description
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.
335	WIRING CYLNDR B5	Short circuit in injector cable of cylinder B5.
336	WIRING CYLNDR B6	Short circuit in injector cable of cylinder B6.
337	WIRING CYLNDR B7	Short circuit in injector cable of cylinder B7.
338	WIRING CYLNDR B8	Short circuit in injector cable of cylinder B8.
339	WIRING CYLNDR B9	Short circuit in injector cable of cylinder B9.
340	WIRING CYLNDR B10	Short circuit in injector cable of cylinder B10.
341	OPN LD CYLNDR A1	Open load in injector cable of cylinder A1.
342	OPN LD CYLNDR A2	Open load in injector cable of cylinder A2.

Fault Code Number	String	Description
343	OPN LD CYLNDR A3	Open load in injector cable of cylinder A3.
344	OPN LD CYLNDR A4	Open load in injector cable of cylinder A4.
345	OPN LD CYLNDR A5	Open load in injector cable of cylinder A5.
346	OPN LD CYLNDR A6	Open load in injector cable of cylinder A6.
347	OPN LD CYLNDR A7	Open load in injector cable of cylinder A7.
348	OPN LD CYLNDR A8	Open load in injector cable of cylinder A8.
349	OPN LD CYLNDR A9	Open load in injector cable of cylinder A9.
350	OPN LD CYLNDR A10	Open load in injector cable of cylinder A10.
351	OPN LD CYLNDR B1	Open load in injector cable of cylinder B1.
352	OPN LD CYLNDR B2	Open load in injector cable of cylinder B2.
353	OPN LD CYLNDR B3	Open load in injector cable of cylinder B3.
354	OPN LD CYLNDR B4	Open load in injector cable of cylinder B4.
355	OPN LD CYLNDR B5	Open load in injector cable of cylinder B5.
356	OPN LD CYLNDR B6	Open load in injector cable of cylinder B6.
357	OPN LD CYLNDR B7	Open load in injector cable of cylinder B7.
358	OPN LD CYLNDR B8	Open load in injector cable of cylinder B8.
359	OPN LD CYLNDR B9	Open load in injector cable of cylinder B9.
360	OPN LD CYLNDR 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.
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.

Fault Code Number	String	Description
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 CHRG 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.
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.

Fault Code Number	String	Description
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).
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.

Fault Code Number	String	Description
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).
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.

Fault Code Number	String	Description
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).
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.

Fault Code Number	String	Description
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).
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.

Fault Code Number	String	Description
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 CHRG 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.
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.

Fault Code Number	String	Description
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.
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.

Fault Code Number	String	Description
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.
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.

Fault Code Number	String	Description
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 CHRG 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.
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.

Fault Code Number	String	Description
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 CHRG AIR BEF EGR	Sensor Defect in Charge Air Before EGR Temperature Sensor.
844	HI T CHRG 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 CHRG AIR DIFF AB	Charge Air Differential AB High Temperature (Limit 1) Alarm.
847	HIHI T CHRG 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.

Fault Code Number	String	Description
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.
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	SCRF3 SU REV RNG	SCR F3 SU Revolution Range Alarm.
901	SCRF3 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.

Fault Code Number	String	Description
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.
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	INVALD 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.

Fault Code Number	String	Description
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.
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.

Fault Code Number	String	Description
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.
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.

Fault Code Number	String	Description
1088	LO F2 TEXH AFT SCR	F2 Exhaust Temperature after SCR Too Low Alarm.

APPENDIX E • EXHAUST TREATMENT

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APPENDIX E • EXHAUST TREATMENT

Diesel Particulate Filter (DPF)

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 BESTCOMS*Plus*®. 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 BESTCOMS*Plus*.

Regeneration can also be disabled by turning on the Disable Regeneration setting on the ECU Setup screen in BESTCOMS*Plus*.

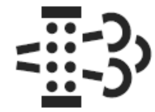
BESTlogicPlus programmable logic can also be used to inhibit regeneration by setting the DPF Regeneration Inhibit (DPFREGENINHIBIT) logic element true.

DPF Status and Pre-Alarms

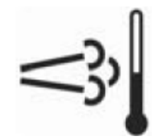
The DGC-2020 receives DPF status information which is broadcast from the engine ECU in various Parameter Group Numbers (PGN) and Suspect Parameter Numbers (SPN). This information is displayed on the front panel and in BESTCOMS*Plus*, via DPF related pre-alarms. The J1939 parameters and the resulting 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 3703 Diesel Particulate Filter Status*

      SPN 3703 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.
- 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 3703 (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 3703 (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 3703 (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 gasses 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.

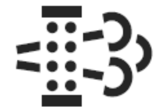
Pre-Alarms

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 BESTCOMS*Plus*. 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-alarms 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.



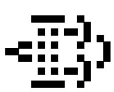
- DEF INDUCEMENT OVERRIDE: This pre-alarm displays when SPN 5246 has a value of 6, indicating the Temporary Override of inducement. This indicates DEF inducement is temporarily overridden. The engine may operate with reduced power, or for a limited time, after which time it may re-enter the SEVERE INDUCEMENT 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.

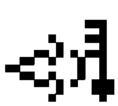
DEF Symbol – When the symbol is on solid, it indicates that DEF is low or there is an issue with the Selective Catalytic Reduction (SCR) system. When it is flashing, it indicates the DEF level is critically low or there is a critical issue with the SCR system.



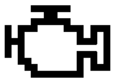
DPF Symbol – When the DPF symbol is on solid, it indicates that the Diesel Particulate Filter (DPF) or exhaust system filter requires regeneration. When flashing it indicates a more urgent need for regeneration. Some manufacturers also show this symbol along with the High Exhaust Temperature Symbol when 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.

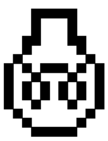


Check Engine Symbol – This is visible when Active Diagnostic Trouble Codes (DTCs) are present.

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.

APPENDIX F • YANMAR FAULT CODES

The Yanmar fault codes are actually J1939 Diagnostic Trouble Codes with an additional Yanmar Fault Code designator.

The DGC-2020 obtains Yanmar diagnostic engine information from the Yanmar engine control unit (ECU). The DGC-2020 will receive an unsolicited message of a 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	String indicating failure cause is unknown.

FMI	Text Displayed	Description
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.
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	String Indicating 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 Yanmar Fault Code Designators Displayed by the DGC-2020

SPN	FMI	Text Displayed	Description	Yanmar Code
28	0	ACCEL PEDAL 3 POSITN	Caption text for accelerator pedal 3 position	P1126
28	1	ACCEL PEDAL 3 POSITN	Caption text for accelerator pedal 3 position	P1125
28	3	ACCEL PEDAL 2 POSITN	Caption text for accelerator pedal 2 position	P0223
28	4	ACCEL PEDAL 2 POSITN	Caption text for accelerator pedal 2 position	P0222
29	3	ACCEL PEDAL 3 POSITN	Caption text for accelerator pedal 3 position	P0228
29	4	ACCEL PEDAL 3 POSITN	Caption text for accelerator pedal 3 position	P0227
29	8	ACCEL PEDAL 2 POSITN	Caption text for accelerator pedal 2 position	P1227
51	3	ENG THROTTLE POSITN	Text for Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Throttle Position	P02E9
51	4	ENG THROTTLE POSITN	Text for Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Throttle Position	P02E8
91	3	ACCEL POSITION	Accelerator Position Setting parameter caption used on front panel	P0123
91	4	ACCEL POSITION	Accelerator Position Setting parameter caption used on front panel	P0122
100	1	ENG OIL PRESS	Metering parameter caption used on front panel for Display of J1939 Parameter	P1198
100	4	ENG OIL PRESS	Metering parameter caption used on front panel for Display of J1939 Parameter	P1192
102	3	INTK MANFLD P SNS BAD	Caption text for intake manifold pressure sensor malfunction	P0238
102	4	INTK MANFLD P SNS BAD	Caption text for intake manifold pressure sensor malfunction	P0237
102	10	INTK MANFLD P SNS BAD	Caption text for intake manifold pressure sensor malfunction	P1673

SPN	FMI	Text Displayed	Description	Yanmar Code
102	13	INTK MANFLD P SNS BAD	Caption text for intake manifold pressure sensor malfunction	P0236
105	3	INTK MANFLD T SNS BAD	Caption text indicating an Intake Manifold Temperature Sensor Malfunction	P040D
105	4	INTK MANFLD T SNS BAD	Caption text indicating an Intake Manifold Temperature Sensor Malfunction	P040C
105	10	INTK MANFLD T SNS BAD	Caption text indicating an Intake Manifold Temperature Sensor Malfunction	P1676
108	3	ATMOSPHERIC P SNS BAD	Caption string indicating Atmospheric Pressure Sensor Malfunction	P2229
108	4	ATMOSPHERIC P SNS BAD	Caption string indicating Atmospheric Pressure Sensor Malfunction	P2228
108	10	ATMOSPHERIC P SNS BAD	Caption string indicating Atmospheric Pressure Sensor Malfunction	P1231
110	0	COOLANT TMP	Engine Coolant Temperature Metering Label Caption Used on Front Panel	P0217
110	3	COOLANT TMP SENSR BAD	Caption text indicating Engine Coolant Temperature Sensor Malfunction	P0118
110	4	COOLANT TMP SENSR BAD	Caption text indicating Engine Coolant Temperature Sensor Malfunction	P0117
110	10	COOLANT TMP SENSR BAD	Caption text indicating Engine Coolant Temperature Sensor Malfunction	P1674
157	0	INJ RAIL PRS	Metering parameter caption used on front panel for Display of J1939 Parameter	P0088
157	3	INJ RAIL PRS	Metering parameter caption used on front panel for Display of J1939 Parameter	P0193
157	4	INJ RAIL PRS	Metering parameter caption used on front panel for Display of J1939 Parameter	P0192
157	15	INJ RAIL PRS	Metering parameter caption used on front panel for Display of J1939 Parameter	P0093
157	16	INJ RAIL PRS	Metering parameter caption used on front panel for Display of J1939 Parameter	P000F
157	18	INJ RAIL PRS	Metering parameter caption used on front panel for Display of J1939 Parameter	P0094
167	1	CHARGING SYSTM VOLT	Caption text designating Charging System Voltage	P1568
167	5	CHARGING SYSTM VOLT	Caption text designating Charging System Voltage	P1562
172	3	AIR INLET TEMP	Metering parameter caption used on front panel for Display of J1939 Parameter	P0113
172	4	AIR INLET TEMP	Metering parameter caption used on front panel for Display of J1939 Parameter	P0112
173	3	EXH MANFLD T SNS BAD	Caption text indicating an Exhaust Manifold Temperature Sensor Malfunction	P0546
173	4	EXH MANFLD T SNS BAD	Caption text indicating an Exhaust Manifold Temperature Sensor Malfunction	P0545
173	10	EXH MANFLD T SNS BAD	Caption text indicating an Exhaust Manifold Temperature Sensor Malfunction	P1677
174	0	FUEL TEMP	Metering parameter caption used on front panel for Display of J1939 Parameter	P0168
174	3	FUEL TEMP	Metering parameter caption used on front panel for Display of J1939 Parameter	P0183
174	4	FUEL TEMP	Metering parameter caption used on front panel for Display of J1939 Parameter	P0182
190	0	ENGINE SPEED	Metering parameter caption used on front panel for Display of J1939 Parameter	P0219
237	13	CAN 2	Caption text for Can Bus 2	U3002
237	31	CAN 2	Caption text for Can Bus 2	U0168

SPN	FMI	Text Displayed	Description	Yanmar Code
412	3	EGR GAS TMP SNSR BAD	Caption text indicating an EGR Gas Temperature Sensor Malfunction	P041D
412	4	EGR GAS TMP SNSR BAD	Caption text indicating an EGR Gas Temperature Sensor Malfunction	P041C
412	10	EGR GAS TMP SNSR BAD	Caption text indicating an EGR Gas Temperature Sensor Malfunction	P1675
630	12	EE PROM	Caption text designating the EEPROM memory inside the engine ECU	P0601
633	3	SCV (MPROP)	Proprietary caption text for YANMAR Diagnostic Trouble Codes	P0629
633	5	SCV (MPROP)	Proprietary caption text for YANMAR Diagnostic Trouble Codes	P0627
633	6	SCV (MPROP)	Proprietary caption text for YANMAR Diagnostic Trouble Codes	P1642
651	3	CYLINDER 4 INJECTOR	Caption text for Cylinder 4 Injector	P1271
651	5	CYLINDER 4 INJECTOR	Caption text for Cylinder 4 Injector	P0204
651	6	CYLINDER 4 INJECTOR	Caption text for Cylinder 4 Injector	P0271
651	11	CYLINDER 4 INJECTOR	Caption text for Cylinder 4 Injector	P1272
652	3	CYLINDER 3 INJECTOR	Caption text for Cylinder 3 Injector	P1268
652	5	CYLINDER 3 INJECTOR	Caption text for Cylinder 3 Injector	P0203
652	6	CYLINDER 3 INJECTOR	Caption text for Cylinder 3 Injector	P0268
652	11	CYLINDER 3 INJECTOR	Caption text for Cylinder 3 Injector	P1269
653	3	CYLINDER 2 INJECTOR	Caption text for Cylinder 2 Injector	P1265
653	5	CYLINDER 2 INJECTOR	Caption text for Cylinder 2 Injector	P0202
653	6	CYLINDER 2 INJECTOR	Caption text for Cylinder 2 Injector	P0265
653	11	CYLINDER 2 INJECTOR	Caption text for Cylinder 2 Injector	P1266
654	3	CYLINDER 1 INJECTOR	Caption text for Cylinder 1 Injector	P1262
654	5	CYLINDER 1 INJECTOR	Caption text for Cylinder 1 Injector	P0201
654	6	CYLINDER 1 INJECTOR	Caption text for Cylinder 1 Injector	P0262
654	11	CYLINDER 1 INJECTOR	Caption text for Cylinder 1 Injector	P1263
1209	3	EXH MANFLD P SNS BAD	Caption text indicating an Exhaust Manifold Pressure Sensor Malfunction	P0473
1209	4	EXH MANFLD P SNS BAD	Caption text indicating an Exhaust Manifold Pressure Sensor Malfunction	P0472
1209	10	EXH MANFLD P SNS BAD	Caption text indicating an Exhaust Manifold Pressure Sensor Malfunction	P1679
1209	13	EXH MANFLD P SNS BAD	Caption text indicating an Exhaust Manifold Pressure Sensor Malfunction	P0471
1485	2	ECU MAIN RELAY	Text for Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating ECM Main Relay	P068A
1485	7	ECU MAIN RELAY	Text for Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating ECM Main Relay	P068B
2791	0	EGR VALVE MALFUNCTN	Caption text indicating an Exhaust Gas Recirculation (EGR) Malfunction	P0404
2791	1	EGR VALVE MALFUNCTN	Caption text indicating an Exhaust Gas Recirculation (EGR) Malfunction	P1404
2791	7	EGR VALVE MALFUNCTN	Caption text indicating an Exhaust Gas Recirculation (EGR) Malfunction	P1409
2791	9	EGR VALVE MALFUNCTN	Caption text indicating an Exhaust Gas Recirculation (EGR) Malfunction	U0401
2791	12	EGR VALVE MALFUNCTN	Caption text indicating an Exhaust Gas Recirculation (EGR) Malfunction	P0403
2797	6	INJECTOR GROUP 1	Text for Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Injector Group 1	P1146

SPN	FMI	Text Displayed	Description	Yanmar Code
2798	6	INJECTOR GROUP 2	Text for Diagnostic Trouble Code Suspect Parameter Number (SPN) Description Indicating Engine Injector Group 2	P1149
2950	3	INTK THROTTL DRV CKT	Caption text designating the Engine Intake Throttle Drive Circuit	P1658
2950	4	INTK THROTTL DRV CKT	Caption text designating the Engine Intake Throttle Drive Circuit	P1659
2950	5	INTK THROTTL DRV CKT	Caption text designating the Engine Intake Throttle Drive Circuit	P0660
2950	6	INTK THROTTL DRV CKT	Caption text designating the Engine Intake Throttle Drive Circuit	P1660
2951	3	INTK THROTTL DRV CKT	Caption text designating the Engine Intake Throttle Drive Circuit	P1661
2951	4	INTK THROTTL DRV CKT	Caption text designating the Engine Intake Throttle Drive Circuit	P1662
3242	0	DPF INLET T SENSR BAD	Caption text indicating Diesel Particulate Filter (DPF) Inlet Temperature Sensor Malfunction	P1436
3242	3	DPF INLET T SENSR BAD	Caption text indicating Diesel Particulate Filter (DPF) Inlet Temperature Sensor Malfunction	P1428
3242	4	DPF INLET T SENSR BAD	Caption text indicating Diesel Particulate Filter (DPF) Inlet Temperature Sensor Malfunction	P1427
3242	10	DPF INLET T SENSR BAD	Caption text indicating Diesel Particulate Filter (DPF) Inlet Temperature Sensor Malfunction	P167E
3250	0	DPF INTRMED GAS TEMP	Caption text indicating Diesel Particulate Filter (DPF) Intermediate Temperature Sensor Malfunction	P1426
3250	1	DPF INTRMD T SNS BAD	Caption text indicating Diesel Particulate Filter (DPF) Intermediate Temperature Sensor Malfunction	P0420
3250	3	DPF INTRMD T SNS BAD	Caption text indicating Diesel Particulate Filter (DPF) Intermediate Temperature Sensor Malfunction	P1434
3250	4	DPF INTRMD T SNS BAD	Caption text indicating Diesel Particulate Filter (DPF) Intermediate Temperature Sensor Malfunction	P1435
3250	10	DPF INTRMD T SNS BAD	Caption text indicating Diesel Particulate Filter (DPF) Intermediate Temperature Sensor Malfunction	P167A
3251	0	DPF DIFF PRS SNSR BAD	Caption text indicating Diesel Particulate Filter (DPF) Differential Pressure Sensor Malfunction	P2452
3251	3	DPF DIFF PRS SNSR BAD	Caption text indicating Diesel Particulate Filter (DPF) Differential Pressure Sensor Malfunction	P2455
3251	4	DPF DIFF PRS SNSR BAD	Caption text indicating Diesel Particulate Filter (DPF) Differential Pressure Sensor Malfunction	P2454
3251	10	DPF DIFF PRS SNSR BAD	Caption text indicating Diesel Particulate Filter (DPF) Differential Pressure Sensor Malfunction	P167B
3251	13	DPF DIFF PRS SNSR BAD	Caption text indicating Diesel Particulate Filter (DPF) Differential Pressure Sensor Malfunction	P2453
3609	3	DPF HIGH PRS SNS BAD	Caption text indicating Diesel Particulate Filter (DPF) High Pressure Sensor Malfunction	P1455
3609	4	DPF HIGH PRS SNS BAD	Caption text indicating Diesel Particulate Filter (DPF) High Pressure Sensor Malfunction	P1454
3609	10	DPF HIGH PRS SNS BAD	Caption text indicating Diesel Particulate Filter (DPF) High Pressure Sensor Malfunction	P167C
3695	14	REGEN INHIBITED	Text announcing that diesel particulate filter regeneration is disabled	P1425
3719	0	DPF SOOT LEVEL %	Caption text designating the level of soot in the Diesel Particulate Filter	P1424

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3719	7	DPF SOOT LEVEL %	Caption text designating the level of soot in the Diesel Particulate Filter	P1446
3719	9	DPF SOOT LEVEL %	Caption text designating the level of soot in the Diesel Particulate Filter	P1445
3719	16	DPF SOOT LEVEL %	Caption text designating the level of soot in the Diesel Particulate Filter	P1421
3720	0	DPF ASH LEVEL %	Caption text designating the level of ash in the Diesel Particulate Filter	P1420
3720	16	DPF ASH LEVEL %	Caption text designating the level of ash in the Diesel Particulate Filter	P242F
4257	12	INJECTOR COMMON	Caption text used by YANMAR engine company to denote the common injector	P0611
4795	31	DPF SUBSTRATE REMOVED	Caption text indicating the substrate has been removed from the Diesel Particulate Filter (DPF)	P226D
522243	5	ENGINE START RELAY	Caption text for Engine Start Relay	P0543
522243	6	ENGINE START RELAY	Caption text for Engine Start Relay	P0541
522323	0	AIR CLEANER SWITCH	Caption text for the Air Cleaner Switch	P1101
522329	0	OIL/WATER SEPARATOR	Caption text for the Oil/Water Separator Device	P1151
522400	2	CRANKSHAFT SENSOR	Caption text for Crankshaft Sensor	P0336
522400	5	CRANKSHAFT SENSOR	Caption text for Crankshaft Sensor	P0337
522401	2	CAMSHAFT SENSOR	Caption text for Camshaft Sensor	P0341
522401	5	CAMSHAFT SENSOR	Caption text for Camshaft Sensor	P0342
522401	7	CAMSHAFT SENSOR	Caption text for Camshaft Sensor	P1341
522571	3	SCV (MPROP)	Proprietary caption text for YANMAR Diagnostic Trouble Codes	P1641
522571	6	SCV (MPROP)	Proprietary caption text for YANMAR Diagnostic Trouble Codes	P1643
522572	6	SCV (MPROP)	Proprietary caption text for YANMAR Diagnostic Trouble Codes	P062A
522572	11	SCV (MPROP)	Proprietary caption text for YANMAR Diagnostic Trouble Codes	P1645
522573	0	DPF	Diesel Particulate Filter	P2463
522574	0	DPF	Diesel Particulate Filter	P1463
522575	7	DPF	Diesel Particulate Filter	P2458
522576	12	EE PROM	Caption text designating the EEPROM memory inside the engine ECU	P160E
522577	11	DPF	Diesel Particulate Filter	P2459
522578	12	EE PROM	Caption text designating the EEPROM memory inside the engine ECU	P160F
522579	12	EGR VALVE MALFUNCTN	Caption text indicating an Exhaust Gas Recirculation (EGR) Malfunction	P1405
522580	12	EGR VALVE MALFUNCTN	Caption text indicating an Exhaust Gas Recirculation (EGR) Malfunction	P0488
522581	7	EGR VALVE MALFUNCTN	Caption text indicating an Exhaust Gas Recirculation (EGR) Malfunction	P148A
522582	7	EGR VALVE MALFUNCTN	Caption text indicating an Exhaust Gas Recirculation (EGR) Malfunction	P049D
522583	1	EGR VALVE MALFUNCTN	Caption text indicating an Exhaust Gas Recirculation (EGR) Malfunction	P1410
522584	1	EGR VALVE MALFUNCTN	Caption text indicating an Exhaust Gas Recirculation (EGR) Malfunction	P1411
522585	12	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1613
522588	12	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1608
522589	12	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1617
522590	12	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1609
522591	12	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1618

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522592	12	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1619
522596	9	CAN 2	Caption text for Can Bus 2	U0292
522597	9	CAN 2	Caption text for Can Bus 2	U1301
522599	9	CAN 2	Caption text for Can Bus 2	U1292
522600	9	CAN 2	Caption text for Can Bus 2	U1293
522601	9	CAN 2	Caption text for Can Bus 2	U1294
522603	9	CAN 2	Caption text for Can Bus 2	U1296
522605	9	CAN 2	Caption text for Can Bus 2	U1298
522609	9	CAN 2	Caption text for Can Bus 2	U1300
522610	9	EGR VALVE MALFUNCTN	Caption text indicating an Exhaust Gas Recirculation (EGR) Malfunction	U010B
522611	9	EXHAUST THROTTLE	Caption text for the Exhaust Throttle	U1107
522617	12	EGR VALVE MALFUNCTN	Caption text indicating an Exhaust Gas Recirculation (EGR) Malfunction	U1401
522618	9	CAN 2	Caption text for Can Bus 2	U1302
522619	9	CAN 2	Caption text for Can Bus 2	U1303
522623	7	ACCELERTN SNSR 1 / 2	Caption text for Acceleration Sensor 1 or Acceleration Sensor 2	P1647
522624	7	ACCELERTN SNSR 1 / 2	Caption text for Acceleration Sensor 1 or Acceleration Sensor 2	P1646
522744	4	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1626
522746	12	EXHAUST THROTTLE	Caption text for the Exhaust Throttle	P1438
522747	12	EXHAUST THROTTLE	Caption text for the Exhaust Throttle	P1439
522748	12	EXHAUST THROTTLE	Caption text for the Exhaust Throttle	P1440
522749	12	EXHAUST THROTTLE	Caption text for the Exhaust Throttle	P1441
522750	12	EXHAUST THROTTLE	Caption text for the Exhaust Throttle	P1442
522751	19	EXHAUST THROTTLE	Caption text for the Exhaust Throttle	P1443
522994	4	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1633
523249	5	CRANK/CAM SENSOR	Caption text identifying the Crankshaft Sensor or the Camshaft sensor as the component to which a fault code applies	P0008
523460	7	RAIL PRESSURE SENSOR	Caption text for the Fuel Rail Pressure Sensor	P1670
523462	13	QR DATA	YANMAR specific caption text for fault code	P1648
523463	13	QR DATA	YANMAR specific caption text for fault code	P1649
523464	13	QR DATA	YANMAR specific caption text for fault code	P1650
523456	13	QR DATA	YANMAR specific caption text for fault code	P1651
523468	9	RAIL PRESSURE SENSOR	Caption text for the Fuel Rail Pressure Sensor	P1665
523469	0	RAIL PRESSURE SENSOR	Caption text for the Fuel Rail Pressure Sensor	P1666
523470	0	RAIL PRESSURE SENSOR	Caption text for the Fuel Rail Pressure Sensor	P1667
523471	6	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1467
523473	12	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1469
523474	12	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1470
523475	12	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1471
523476	12	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1472
523477	12	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1473
523478	12	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1474
523479	12	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1475
523480	12	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1476
523481	12	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1477
523482	12	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1478
523483	12	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1479

SPN	FMI	Text Displayed	Description	Yanmar Code
523484	12	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1480
523485	12	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1481
523486	12	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1482
523487	12	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1483
523488	0	ECU INTERNAL ERROR	Caption text for ECU Internal Error	P1484
523489	0	RAIL PRESSURE SENSOR	Caption text for the Fuel Rail Pressure Sensor	P1668
523491	0	RAIL PRESSURE SENSOR	Caption text for the Fuel Rail Pressure Sensor	P1669

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