INSTRUCTION MANUAL

FOR

DIGITAL GENSET CONTROLLER
DGC-2020

Basler Electric

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
- 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

WARNING!

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

NOTES

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

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

The DGC-2020 utilizes password protection that guards against unauthorized changing of DGC-2020 settings. Instructions for changing passwords are provided in Section 4, *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**

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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.

REVISION HISTORY

The following information provides a historical summary of the changes made to this instruction manual (9400200990), BESTCOMS*Plus* software, firmware package, and hardware of the DGC-2020.

Manual Revision and Date	Change
N, 04/10	• Revised to support firmware package version 1.10.00 (see firmware package version history) and BESTCOMS*Plus* version 2.07.00 (see BESTCOMS*Plus* version history). • Changed Battery Backup for Real-Time Clock to a standard feature. • Added Table 3-3, *J1939 Data Transmitted from the DGC-2020.* • Added Table 4-2, *Generator Parameter Transmit.*
M, 11/09	• Section 1: Under *Specifications, Metering, Power Factor,* changed calculation method from "PF = P (3-phase average) / S (3-phase average)" to "PF = Cosine of the Angle between Phase AB voltage (Vab) and Phase A current (Ia)". • Added "Diagnostics" to Figure 2-2, *Metering Screen Branches*. • Section 3: Updated MTU Fault Code list. • Added description for Logic Control Relays in Table 5-1. • Updated cutout dimensions in Figure 6-1, *Panel Cutting and Drilling Dimensions.* • Section 6: Added *Setting Up DGC-2020 Programmable Inputs and Outputs, Synchronizer,* and *Setting up a DGC-2020 and LSM-2020 for a Load Sharing and kW Control Application.* • Section 10: Added Maximum Consumption under *Specifications, Operating Power.* • Appendix B: Improved description for registers 40020, 43750, and 45754.

Manual Revision and Date	Change
L, 05/09	• Added information for CEM-2020H in Section 9.
	• Added CSA Certification in Sections 1 (DGC-2020), 8 (LSM-2020), 9 (CEM-2020), and 10 (AEM-2020).
	• Added DGC-2020 Setup in Section 6, *Installation.*
	• Added description of special strings displayed (NC, SF, NS, NA, UF) under *DGC-2020 Function Blocks, Communication Ports, CANbus* in Section 3.
	• Improved procedure for upgrading firmware in Section 4.
	• Expanded explanation of configurable elements in Section 4.
	• Added "P" (programmable) curves for overcurrent protection in Section 4.
	• Added Figure 4-51, *Synchronizer Screen,* and re-numbered remaining figures.
	• Clarified low-line scale factor on Bus Condition Detection and Pre-Alarms in Section 4.
	• Added "1/2 watt" for resistor in #1 in NOTE box for CANbus in Sections 1, 6, 8, 9, and 10.
	• In Figure 8-7, corrected LSM-2020 terminal numbering for AVR & GOV inputs.
	• Added Figure 8-9, additional method for interfacing an external control device with a DGC-2020 - LSM-2020 system.
	• Added "P" curve to Tables A-1 and A-2 in Appendix A, *Time Overcurrent Curves.*
	• Corrected bit numbering for registers 44812 through 45572 and added missing bits in Appendix B, *Modbus Communication.*
	• Added registers 44936 through 44946, 44982, and 44984 in Appendix B, *Modbus Communication.*
K, 01/09	• Updated manual to support firmware package 1.08.01 changes and BESTCOMS*Plus* version 2.03.00 changes. (See firmware package and BESTCOMS*Plus* revision history below for details.)
	• Removed duplicate Speed Controller Tuning Procedure from Appendix C.
	• In Appendix B, added additional information for registers 40436 - 40476.
J, 08/08	• Added Section 10, *AEM-2020 (Analog Expansion Module).*
	• Added information for Automatic Generator Detection in Section 4.
	• Improved CANbus diagrams and notes throughout manual.
	• Added information for Integrating Reset function in Section 4.
	• Added information for Configurable Protection in Section 4.
	• Improved definition of Emergency Stop Input in Section 6.
	• Added installation diagrams for MTU MDEC ECU in Section 6.
	• Added Typical LSM-2020 Interconnection Diagram in Section 8.
	• Enhanced Section 7, *Maintenance and Troubleshooting.*
	• Added *Synchronizer Operation* under *Breaker Management* in Section 3.
	• Improved *Communication* in Section 4.
	• Added Bits 6 through 10 to register 44822 in Appendix B.
	• Added Appendix C, *Tuning PID Settings.*
I, 07/08	• Changed Output Contacts 13 through 24 rating from 2 Adc to 1 Adc.
	• Changed Output Contacts 25 through 36 rating from 10 Adc to 4 Adc.

Manual Revision and Date	Change
H, 02/08	• Added Section 9, *CEM-2020 (Contact Expansion Module).*
G, 11/07	• Added Section 8, *LSM-2020 (Load Share Module).* • Updated HMI screens layout in Section 2. • Added BESTCOMS*Plus* Multigen Management screens.
F, 08/07	• Updated manual to support firmware package 1.02.00 changes and BESTCOMS*Plus* version 1.03.00 changes. (See firmware package and BESTCOMS*Plus* revision history below for details.)
E, 05/07	• Added description of *Clock Setup* screen in BESTCOMS*Plus.* • Updated several BESTCOMS*Plus* screen shots. • Increased Low Coolant Temp Pre-Alarm range to 30 - 150°F.
D, 03/07	• Removed International Modem option from *Style Chart* in Section 1. • Added coverage of part numbers 9400200105 and 9400200106.
C, 02/07	• Added *Event Recording* in Section 3, *Functional Description.* • Minor text edits throughout manual.
B, 11/06	• Initial release

BESTCOMS*Plus* Version and Date	Change
2.07.01, 04/10	• Updated to support firmware package version 1.10.00 (see firmware package version history). • Added *Export Metering*. • Added Windows® 7 64-bit compatibility and removed Windows® 2000 compatibility.
2.06.02, 01/10	• BESTCOMS*Plus* shell enhancements only. No changes were made to the DGC-2020 plug-in.
2.06.01, 12/09	• Added *Total Engine Run Time Minutes* on *Engine* and *Summary* screens in the Metering Explorer. • BESTCOMS*Plus* shell enhancements. • Added Windows® 7 32-bit compatibility.
2.05.00, 08/09	• Made a correction to announce a message that logic will not be saved if the maximum number of logic gates on any one level has been exceeded. • On the *Breaker Management, Breaker Hardware* screen, changed the Gen and Mains Breaker Closing Time from <u>0.1-600 in increments of 0.1</u> to <u>0-800 in increments of 5</u>. • Corrected Settings Compare error when there are remote outputs or logic control relay outputs in the logic diagram.
2.04.01, 07/09	• BESTCOMS*Plus* shell enhancements only. No changes were made to the DGC-2020 plug-in.
2.03.01, 04/09	• Added "P" (programmable) curve selection for the 51 function. • Improvement to allow spaces in Initializing Message 1 & 2 on *General Settings, Front Panel HMI* screen in the Settings Explorer. • Improved backwards compatibility. • Improved Commission Date setting on *Run Statistics* screen in the Metering Explorer.

BESTCOMS*Plus* Version and Date	Change
2.03.00, 01/09	• Added support for CEM-2020H. • Added Export to File feature. • Added settings for Phase Toggle and Initializing Messages on *General Settings, Front Panel HMI* screen. • Re-arranged *CANbus Setup* screen and added *ECU Setup* screen under *Communications*. • Added settings for 51-3 element under *Generator Protection, Current*. • Added setting for Off Mode Cooldown on *System Parameters, System Settings* screen. • Added *Remote Module Setup* screen under *System Parameters*. • Added *Remote LSM Inputs* settings and metering screens under *Programmable Inputs*. • Added settings to *Bias Control* screens for Var/PF control. • Added kVar A, B, C, and Total to *Power* and *Summary* metering screens. • Re-arranged MTU metering screens. • Added *MTU Status* screen and *MTU Engine Status* screen. • Added BESTLogic*Plus* Input Objects for Configurable Elements, Configurable Protection, Front Panel Buttons, PF Mode Active, Pre Start Input, and Run Input. • Added BESTLogic*Plus* Pre-Alarms for Checksum Fail and CEM Hardware Mismatch. • Added BESTLogic*Plus* Elements for 51-3, COOLSTOPREQ, COOLDOWNREQ, EXTSTARTDEL, PRESTARTOUT, RUNOUTPUT, STARTDELBYP, and STARTOUTPUT. • Added Relay Control settings on *System Parameters, System Settings* screen.
2.01.00, 07/08	• Added settings for AEM-2020. • Added settings for Automatic Generator Protection. • Added settings for Integrating Reset on 51 function. • Added settings for Configurable Protection.
2.00.01, 04/08	• Added settings for CEM-2020.
1.04.01, 12/07	• Added settings for LSM-2020.
1.03.00, 08/07	• Added/Updated screens to support firmware package version 1.03.00. (See firmware package version history for details.) • Added password protection for portions of the programmable logic. • Made all status LEDs available as inputs for PLC logic.
1.02.00, 05/07	• Added Spanish language support. • Added *Clock Setup* screen. • Changed layout of several screens.
1.01.02, 04/07	• Removed International Modem option from Style Chart.
1.01.01, 02/07	• Added Chinese language support.
1.00.07, 11/06	• Initial release

Firmware Package Version and Date	Change
1.10.00, 04/10	• Added Loss of Mains Protection (78 Vector Shift and 81 ROCOF). • Added Dead Bus Breaker Close Arbitration. • Added GM and Cummins as settings for ECU type. • Added CANbus settings for MTU 50/60 Hz Switch, NMT Alive Transmit Rate, Generator Parameter Transmit, and Diesel Particulate Filter. • Added Modem Setup through the Front Panel HMI. • Added settings for Clock Not Set Warning, Gen CT Low Line Scale Factor, Horn Enable, Not in Auto Horn Enable, Low Line Scale Factor for 47 function, Alternate Frequency Scale Factors, Alternate Frequency, Metric Pressure Units, and Dead Gen Close Enable. • Added logic for Idle Request, Alternate Frequency Override, Mains Fail Test, Load Take Over, Alarm Silence, Lamp Test, Generator Protection, DPF Regeneration Disabled, DPF Regeneration Required, and High Exhaust Temperature. • Added ranges for hours and minutes of Logic Timers. • Moved Engine Cooldown, Horn, Single-Phase Override, Auto Config Detection, and Relay Control for organizational purposes.
1.09.00, 07/09	• Corrected transmittal of parameters to engine for MDEC module types 201, 302, and 303. • Implemented most recent MTU fault codes. • Engine Total Run Time in metering now displays hours and minutes. Engine Total Run Time previously displayed hours only. • Added front panel diagnostics to show Modbus Read Count, Modbus Write Count, and Serial Flash Write Count. • Modbus™ legacy registers 40019 and 40020 are now read/write. Previously these registers were write only. • Improved MCS5 parameter handling. • Fixed spurious High Charge Air Temp Pre-Alarm every time engine starts on MTU-ECU7 machines. • Accelerator pedal position is now sent to Volvo ECU for load sharing. • Modified generator breaker logic to allow closure of generator breaker from a dead gen to a dead bus (if Dead Bus Close Enable is selected). In previous versions of firmware, closure of the generator breaker from a dead generator was not possible.
1.08.01, 01/09	• Added support for CEM-2020H. • Changed time dial range of 51 element fixed time curve from 0-30 s to 0-7,200 s. • Added Phase Toggle Delay setting for front panel HMI. • Added Off Mode Cooldown feature. • Added 51-3 element. • Added Var/PF control. • Added LSM Input settings. • Added Checksum Fail and CEM Hardware Mismatch pre-alarms. • Added kVar A, B, C, and Total metering. • Added several MTU items to metering. • Re-arranged *CANbus Setup* screens and added *ECU Setup* screens on front panel HMI. • Added "P" (programmable) curve selection for the 51 function.
1.07.02, 09/08	• Finalized settings for AEM-2020.

Firmware Package Version and Date	Change
1.06.00, 07/08	• Added settings for AEM-2020. • Added settings for Automatic Generator Detection. • Added settings for Integrating Reset on 51 function. • Added settings for Configurable Protection.
1.05.00, 04/08	• Added settings for CEM-2020.
1.04.00, 12/07	• Added settings for LSM-2020.
1.03.00, 08/07	• Added 32 and 40Q protection functions. • Added Automatic Restart function and Exercise Timer. • Added dual settings for 51, 27, and 59 functions. • Added Oil Pressure Crank Disconnect Enable. • Modified Prestart operation during rest cycle. • Added 2 additional Engine kW Overload Pre-Alarms. • Added Low Line Scale Factor for EPS Supplying Load and Engine kW Overload Pre-Alarms. • Changed the metering range of coolant temperature to 32-410 F. • Changed the Low-Coolant Temp Pre-Alarm range to 32-150 F.
1.02.00, 05/07	• Added Spanish language support.
1.00.08, 03/07	• Minor firmware improvements.
1.00.07, 01/07	• Added Chinese language support.
1.00.06, 11/06	• Initial release

DGC-2020 Hardware Revision and Date	Change
U, 04/10	• Released firmware package 1.10.00 and BESTCOMS*Plus* 2.07.01.
T, 01/10	• Improved panel gasket.
S, 10/09	• Improved transient protection.
R, 07/09	• Added ribbon cable slot for front overlay to prevent cable damage.
P, 01/09	• Released firmware package 1.08.01 and BESTCOMS*Plus* 2.03.00.
N, 09/08	• Released firmware package 1.07.02.
M, 07/08	• Released firmware package 1.06.00 and BESTCOMS*Plus* 2.01.00.
L, 04/08	• Released firmware package 1.05.00 and BESTCOMS*Plus* 2.00.01.
K, 01/08	• Added definition of emergency stop input terminals.
J, 12/07	• Released firmware package 1.04.00 and BESTCOMS*Plus* 1.04.01.
H, 12/07	• Switched LCD heater types for manufacturability.
G, 08/07	• Released firmware package 1.03.00 and BESTCOMS*Plus* 1.03.00.
F, 04/07	• Released BESTCOMS*Plus* 1.02.00.
E, 03/07	• Released firmware 1.00.08 and changed LCD heater.
D, 02/07	• LCD heater and battery holder made as a standard feature.
C, 01/07	• Deleted, added, or changed components to enhance product.
B, 11/06	• Initial release

DGC-2020 / LSM-2020 / CEM-2020 / CEM-2020H / AEM-2020
Firmware Release History

Package File Version	DGC-2020 Application Code Version & P/N	DGC-2020 Flash Language Module Version & P/N	Lang.*	LSM-2020 CANbus Application Version & P/N	LSM-2020 Ethernet Application Version & P/N	CEM-2020 Version & P/N	CEM-2020H Version & P/N	AEM-2020 Version & P/N
1.10.00	1.09.00 03/05/10 9400201043/-044	4.03.00 03/05/10 9400201045	E,C,S	1.01.00 02/04/10 9417501014	1.01.00 02/04/10 9417501015	1.01.00 12/09/08 9421001009	1.01.00 12/09/08 9421001009	1.00.01 12/09/08 9421101009
1.09.00	1.08.00 06/24/09 9400201039/-040	4.02.00 06/24/09 9400201041	E,C,S	1.00.05 12/09/08 9417501012	1.00.05 12/09/08 9417501013	1.01.00 12/09/08 9421001009	1.01.00 12/09/08 9421001009	1.00.01 12/09/08 9421101009
1.08.01	1.07.01 01/14/09 9400201036/-035	4.00.01 01/14/09 9400201037	E,C,S	1.00.05 12/09/08 9417501012	1.00.05 12/09/08 9417501013	1.01.00 12/09/08 9421001009	1.01.00 12/09/08 9421001009	1.00.01 12/09/08 9421101009
1.07.02	1.06.01 07/05/08 9400201030	3.00.03 07/16/08 9400201031	E,C,S	1.00.04 07/22/08 9417501010	1.00.04 07/22/08 9417501011	1.00.03 07/22/08 9421001007	N/A	1.00.00 07/22/08 9421101007
1.06.00	1.05.00 05/19/08 9400201028	3.00.00 08/19/08 9400201029	E,C,S	1.00.03 05/19/08 9417501008	1.00.03 05/19/08 9417501009	1.00.01 05/19/08 9421001005	N/A	N/A
1.05.00	1.04.00 01/15/08 9400201025	2.03.00 01/15/08 9400201026	E,C,S	1.00.02 01/02/08 9417501006	1.00.02 01/02/08 9417501007	1.00.00 01/02/08 9421001004	N/A	N/A
1.04.00	1.03.00 11/21/07 9400201022	2.01.00 11/15/07 9400201023	E,C,S	1.00.00 11/21/07 9417501005	1.00.00 11/21/07 9417501004	N/A	N/A	N/A
1.03.00	1.02.00 08/14/07 9400201020	2.01.00 08/09/07 9400201021	E,C,S	N/A	N/A	N/A	N/A	N/A
1.02.00	1.01.00 05/02/07 9400201016	2.00.00 05/01/07 9400201017	E,C,S	N/A	N/A	N/A	N/A	N/A
N/A	1.00.08 9400201015	†	†	N/A	N/A	N/A	N/A	N/A
N/A	1.00.07 9400201013	1.00.00/1.00.00 9400201011/-012	E,C	N/A	N/A	N/A	N/A	N/A

* E = English, C = Chinese, S = Spanish

† Uses previously released flash language modules.

N/A = Not applicable

Package File Version	DGC-2020			LSM-2020		CEM-2020	CEM-2020H	AEM-2020
	Application Code	Flash Language Module		CANbus Application	Ethernet Application			
	Version & P/N	Version & P/N	Lang. *	Version & P/N	Version & P/N	Version & P/N	Version & P/N	Version & P/N
N/A	1.00.06 9400201008	N/A	N/A	N/A	N/A	N/A	N/A	N/A

* E = English, C = Chinese, S = Spanish

† Uses previously released flash language modules.

N/A = Not applicable

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SECTION 1 • GENERAL INFORMATION

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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.

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
- Integrated RS485
- 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-phase Bus input. A mains failure is established when any one of the following conditions are met:

- Bus voltage falls below dead bus threshold
- Bus voltage unstable due to overvoltage or undervoltage
- 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 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.

Communication

Standard DGC-2020 communication features include a standard USB port and SAE J1939 interface. Optional communication features include a 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.

CANbus Interface

A CANbus 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 CANbus 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.

Dial-Out Modem

The optional 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 CANbus interface. Refer to Section 10, *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 CANbus interface. Refer to Section 9, *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 8, *LSM-2020 (Load Share Module),* for more information.

STYLE AND PART NUMBERS

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.
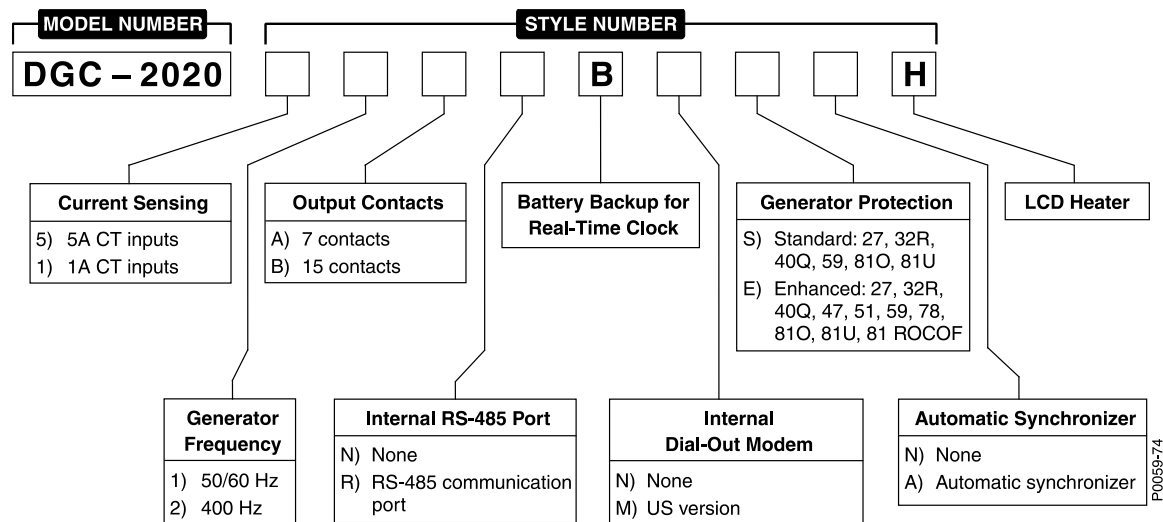
Figure 1-1. DGC-2020 Style Chart

For example, if a DGC-2020 style number were **51BNBMEAH**, 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
M Internal dial-out modem—US version
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

Part Numbers

A ten-digit part number specifies the electrical characteristics and operational features of special-order DGC-2020 controllers. Table 1-1 lists the special-order DGC-2020 controllers available along with descriptions of their operating features.

Table 1-1. Special-Order DGC-2020 Controllers

Part Number	Style Number	Special Features
9400200105	51ANBNSNH001	cURus recognized for use in hazardous locations.
9400200106	11ANBNSNH001	

SPECIFICATIONS

Operating Power

Nominal..12 or 24 Vdc
Range ....6 to 32 Vdc (Withstands cranking ride-through down to 6 Vdc
                                               for 500 ms)
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

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

Configuration ....Line-to-line or line-to-neutral
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....................45 (A-phase)
                                     43 (B-phase)

Contact Sensing

Contact sensing inputs include 1 emergency stop input and 16 programmable inputs. The emergency stop input accepts normally closed, dry contacts. All programmable inputs accept normally open, dry contacts.

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.

Fuel Level Sensing

Resistance Range .... 33 to 240 Ω nominal
Terminals .... 9, 11 (sender common)

Coolant Temperature Sensing

Resistance Range .... 62.6 to 637.5 Ω nominal
Terminals .... 10, 11 (sender common)

Oil Pressure Sensing

Resistance Range .... 34 to 240 Ω nominal
Terminals .... 8, 11 (sender common)

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—make, break, and carry ∗

Programmable Relays (12)

Rating .... 2 Adc at 30 Vdc—make, break, and carry
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)

∗ Contact rating is reduced to 3 A for part numbers 9400200105 and 9400200106 when used in a hazardous location.

† 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 Voltage (rms)

Metering Range ....0 to 576 Vac (direct measurement)
577 to 9,999 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 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
Accuracy .... ±3% of actual indication or ±2 psi, ±0.12, or ±12 kPa (subject to
                                             accuracy of sender)
Display Resolution: 1 psi, 0.1 Bar, or 1 kPa

Coolant Temperature

Metering Range .... 32 to 410°F or 0 to 204°C
Accuracy .... ±3% of actual indication or ±2° (subject to accuracy of sender)

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 99,999 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%
Accuracy .... ±2% (subject to accuracy of sender)
Display Resolution 1.0%

Generator Protection Functions

Overvoltage (59) and Undervoltage (27)

Pickup Range .... 70 to 576 Vac
Pickup Increment .... 1 Vac
Inhibit Frequency Range .... 20 to 400 Hz (27 function only)
Activation Delay Range .... 0 to 30 s
Activation Delay Increment .... 0.1 s

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)
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%
Pickup Increment 0.1%
Hysteresis Range .... 1 to 10%
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%
Pickup Increment 0.1%
Hysteresis Range .... 1 to 10%
Hysteresis Increment 0.1%
Activation Delay Range .... 0 to 30 s
Activation Delay Increment .... 0.1 s

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
Activation Delay Range .... 0 to 30 s
Activation Delay Increment .... 0.1 s

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

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

Communication Interface

USB

Specification Compatibility .... USB 2.0
Data Transfer Speed .... 9600 baud
Connector Type .... Mini-B jack

RS-485 (Optional)

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

CANbus

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)

NOTES

1.) If the DGC-2020 is providing one end of the J1939 bus, a 120 Ω, 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.

Modem (Optional)

Connector Type .... RJ-11 jack

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

NOTE

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

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.

Type Tests

Shock and Vibration EN60068-2-6
Dielectric Strength .... IEC 255-5
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 closed proximity to an unshielded, unsuppressed Altronic DISN 800 Ignition System.

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
Salt Fog ....ASTM B 17-73, IEC 68-2-11
Ingress Protection...........................IEC IP54 for front panel

UL Approval

"cURus" recognized to UL Standard 508 & CSA Standard 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.

Part Numbers 9400200105 and 9400200106

"cURus" recognized per Standard 1604, *Electrical Equipment for Use in Class I and II, Division 2, and Class III Hazardous (Classified) Locations,* Class I, Division 2, Zone 2, Groups A, B, C, D, Temperature Code - T4.

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, D, or non-hazardous locations only.

WARNING! - EXPLOSION HAZARD

(9400200105 and 9400200106 only)

Substitution of components may impair suitability for Class I, Division 2.

Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

CSA Certification

CSA certified to Standard C22.2 No. 14.

NFPA Compliance

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

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

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

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.
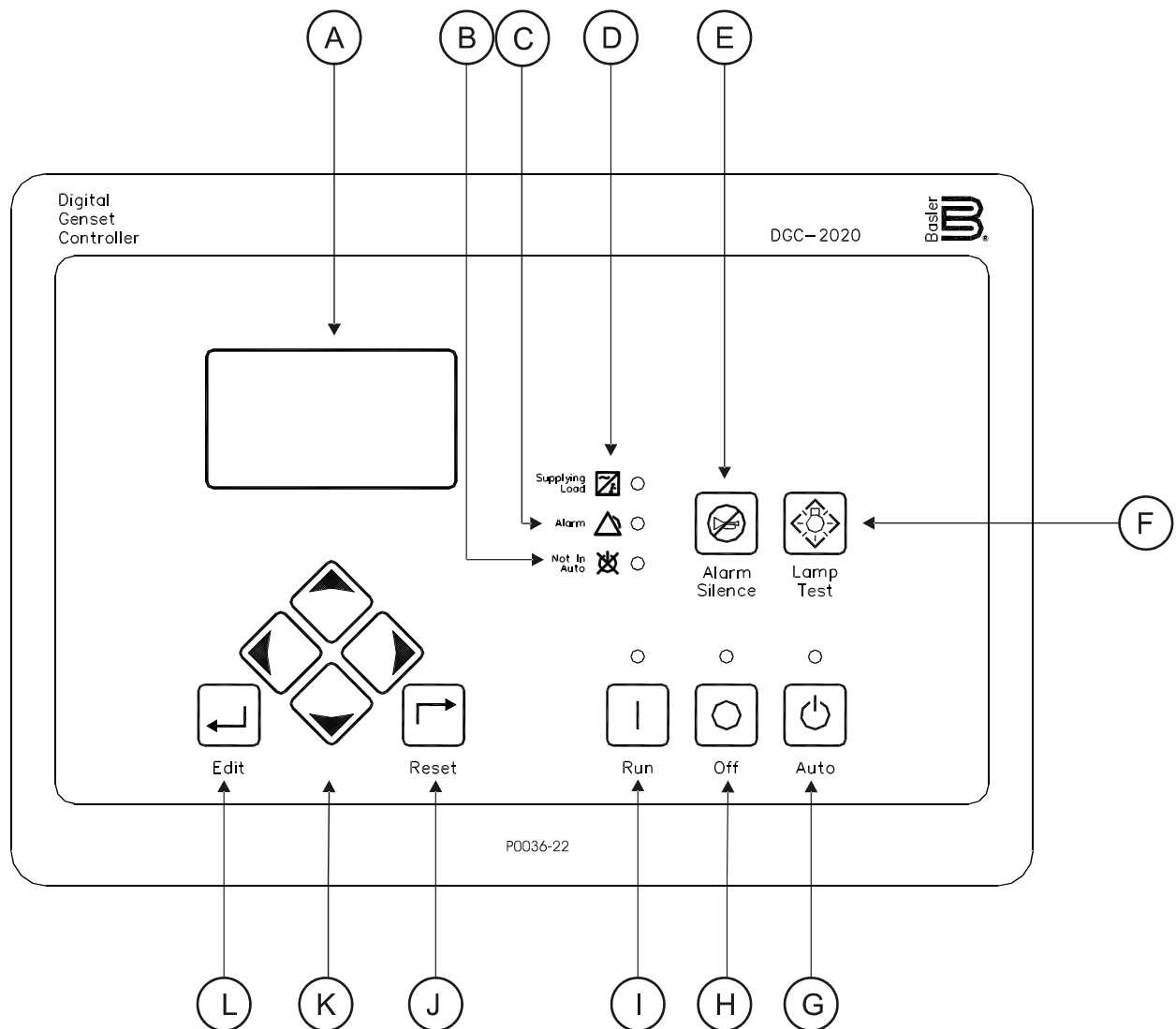
Figure 2-1. Front Panel HMI

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.
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, this button also resets the Breaker Management Pre-Alarms.
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 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
- 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 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
- kW C
- kW TOT
- kVA A
- kVA B
- kVA C
- kVA TOT
- ALG_IN_X (X = 1 to 8) (with AEM-2020)
- RTD_IN_X (X = 1 to 8) (with AEM-2020)
- THRM_CPL_X (X = 1 to 2) (with AEM-2020)

Sleep Mode

Sleep mode serves as a power saving feature. If the DGC-2020 is in Off mode or Auto mode not running and a key is not pressed for more than 15 minutes, the front panel LCD backlight and LCD heater are turned off. The DGC-2020 resumes normal display operation when any front panel button is pressed or the genset is started remotely via the ATS input. The DGC-2020 will not go to sleep while in an Alarm state. If needed, Sleep mode can be permanently disabled via BESTCOMS*Plus* or the front panel.

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 and SETTINGS. 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.

```
┌─────────────────────────────────────────────────────┐
│                    METERING                          │
│                                                      │
│  ENGINE                                              │
│  GENERATOR                                           │
│  POWER                                               │
│  BIAS CONTROL (Available when LSM-2020 is enabled.)  │
│  RUN STATISTICS                                      │
│  ALARMS-STATUS                                       │
│  DIAGNOSTICS                                         │
│                                                      │
└─────────────────────────────────────────────────────┘
```
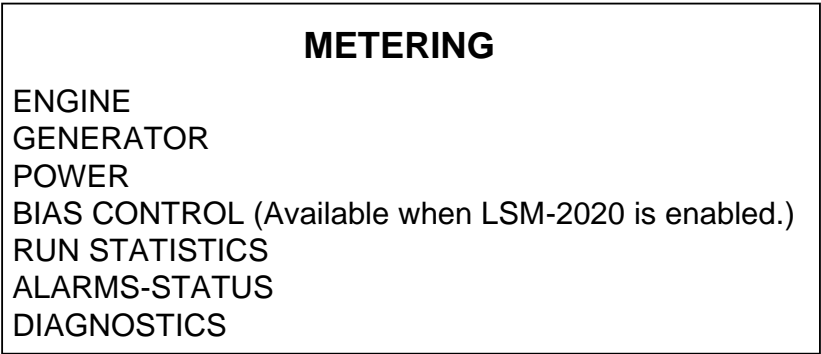
P0059-83

Figure 2-2. Metering Screen Branches

ENGINE

- **OIL PRESSURE**
- **COOLANT TMP**
- **BATTERY VOLT**
- **RPM**
- **SPEED SRC**
- **FUEL LEVEL**
- **ENGINE LOAD**
- **COOLANT LEVL (Visible when CANBUS is enabled.)**
- **TOTAL RUN TM**
- **HRS TO MAINT**

GENERATOR

- **GEN VAB**
- **GEN VBC**
- **GEN VCA**
- **GEN VAN**
- **GEN VBN**
- **GEN VCN**
- **GEN FREQ**
- **GEN AMPS A**
- **GEN AMPS B**
- **GEN AMPS C**
- **BUS V**
- **BUS FREQ**
- **SYNCHRONIZER**
    — SLIP ANGLE
    — DELTA HERTZ
    — DELTA VOLTS
    — STATUS
- **MAX VECT SHIFT**

- **MAX ROCOF**
- **ROCOF**

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**
- **PRE-ALARMS**
- **MTU FAULT CODES (Visible when ECU is configured for MTU MDEC, MTU ADEC, or MTU ECU7.)**
- **MTU STATUS (Visible when ECU is configured for MTU MDEC, MTU ADEC, or MTU ECU7.)**
  — NMT-ALIVE STATUS (Visible when ECU is configured for MTU MDEC or MTU ECU7.)
    - o SPS_NODE
    - o SW_TYP
    - o SW_VAR
    - o SW_ED1
    - o SW_ED2
    - o REV
    - o SW_MOD
  — TRIP FUEL (Visible when ECU is configured for MTU ECU7.)
    - o TRIP HRS
    - o TRIP IDLE HRS
    - o FUEL RATE
    - o TRIP FL RATE
    - o TOTAL RUN TM
    - o DAILY FUEL
    - o TOTAL FUEL
  — FUEL (Visible when ECU is configured for MTU ADEC.)
    - o DAY TANK LVL
    - o STORE TANK LVL
  — ENGINE STATUS (Visible when ECU is configured for MTU ADEC or MTU ECU7.)
    - o MTU FAULT CODES
    - o ENG RUNNING
    - o CYL CUTOUT
    - o ENG OPTIMIZED
    - o PREHT NT RCHD
    - o SPEC TORQUE
    - o SPD DMD FL MD (Visible when ECU is configured for MTU ADEC.)
    - o CURR P DEGREE (Visible when ECU is configured for MTU ADEC.)
    - o LOAD GEN ON (Visible when ECU is configured for MTU ADEC.)
    - o PRIME PUMP ON (Visible when ECU is configured for MTU ADEC.)
    - o RUNUP SPD LO (Visible when ECU is configured for MTU ADEC.)
    - o IDLE SPD LO (Visible when ECU is configured for MTU ADEC.)
    - o CYL CUTOUT CD (Visible when ECU is configured for MTU ECU7.)
    - o RPM (Visible when ECU is configured for MTU ECU7.)
    - o DROOP % (Visible when ECU is configured for MTU ECU7.)
    - o ENG COOL TEMP (Visible when ECU is configured for MTU ECU7.)
    - o CHRG AIR TMP (Visible when ECU is configured for MTU ECU7.)
    - o INTRCOOLR TEMP (Visible when ECU is configured for MTU ECU7.)
    - o ENG OIL TEMP (Visible when ECU is configured for MTU ECU7.)
    - o FUEL TEMP (Visible when ECU is configured for MTU ECU7.)
    - o ECU TEMP (Visible when ECU is configured for MTU ECU7.)
    - o OIL PRESSURE (Visible when ECU is configured for MTU ECU7.)
    - o CHG AIR P (Visible when ECU is configured for MTU ECU7.)
    - o FUEL DELV P (Visible when ECU is configured for MTU ECU7.)
    - o FL RAIL P (Visible when ECU is configured for MTU ECU7.)
    - o CAMSHAFT RPM (Visible when ECU is configured for MTU ECU7.)
    - o IDLE RPM (Visible when ECU is configured for MTU ECU7.)
    - o ECU SHUTDOWN (Visible when ECU is configured for MTU ECU7.)
    - o TOTAL RUN TM (Visible when ECU is configured for MTU ECU7.)
    - o LOAD GEN ON (Visible when ECU is configured for MTU ECU7.)
    - o ECU SUPP VOLTS (Visible when ECU is configured for MTU ECU7.)
    - o INJCT DBR % (Visible when ECU is configured for MTU ECU7.)
    - o RATED RPM (Visible when ECU is configured for MTU ECU7.)
    - o INJCT QTY (Visible when ECU is configured for MTU ECU7.)
    - o RATED KW (Visible when ECU is configured for MTU ECU7.)
    - o RESRV PWR % (Visible when ECU is configured for MTU ECU7.)
    - o START SEQ (Visible when ECU is configured for MTU ECU7.)
  — SPEED (Visible when ECU is configured for MTU ADEC or MTU ECU7.)
    - o SEL SPD DMD
    - o EFF SET SPEED
    - o CAN SPD DMD

- o ANLG SPD DMD
- o SPD DMD FL MD
- o RATED RPM (Visible when ECU is configured for MTU ECU7.)
- o RPM (Visible when ECU is configured for MTU ECU7.)
- o CAMSHAFT RPM (Visible when ECU is configured for MTU ECU7.)
- o IDLE RPM (Visible when ECU is configured for MTU ECU7.)
- o SPD DMD SRC (Visible when ECU is configured for MTU ECU7.)
- o FREQ RPM DMD (Visible when ECU is configured for MTU ECU7.)
- — SIGNL FEEDBK (Visible when ECU is configured for MTU ADEC or MTU ECU7.)
    - o ECU_OVRD_FDBK
    - o EXT STOP
    - o SPD UP IN
    - o SPD DN IN
    - o CAN MODE FDBK
    - o CYL CUTOUT (Visible when ECU is configured for MTU ECU7.)
- — DIAGNOSTICS (Visible when ECU is configured for MTU ECU7.)
    - o AL PWR AMP 1
    - o AL PWR AMP 2
    - o XSTR OUT AL
    - o XSTR OUT STS
    - o ECU SHUTDOWN
- — CANBUS (Visible when ECU is configured for MTU ECU7.)
    - o CAN MODE FDBK
    - o CAN NODES
    - o LOST NODES
- — LIMITS (Visible when ECU is configured for MTU ECU7.)
    - o OIL PRESSURE
    - o LO LIM OILP
    - o LOLOLIM OILP
    - o ENG COOL TEMP
    - o CLNT LMT HI
    - o CLNT LMT HIHI
    - o CHRG AIR TMP
    - o CHG AIR LMT HI
    - o ECU SUPP VOLTS
    - o L1L ECU VOLTS
    - o L2L ECU VOLTS
    - o U1L ECU VOLTS
    - o U2I ECU VOLTS
    - o INTRCOOLR TMP
    - o 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
    - — GEN DEAD

- — GEN STABLE
- — GEN FAILED
- — 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
- — LSM CONNECTED
- — CEM CONNECTED
- — AEM CONNECTED
- **INPUTS**
  - — INPUT X (X = 1 to 16, (17 to 26 optional))
- **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.)**
  - — RAW
    - o LSM IN
- **ANALOG INPUTS (Visible when AEM-2020 is enabled.)**
  - — SCALED
    - o ALG IN X (X = 1 to 8)
  - — RAW
    - o ALG IN X (X = 1 to 8)
- **THERMAL INPUTS (Visible when AEM-2020 is enabled.)**
  - — SCALED
    - o RTD IN X (X = 1 to 8)
    - o THRM CPL X (X = 1 to 2)
  - — RAW
    - o RTD IN X (X = 1 to 8)
    - o THRM CPL X (X = 1 to 2)
- **ANALOG OUTPUTS (Visible when AEM-2020 is enabled.)**
  - — SCALED
    - o ALG OUT X (X = 1 to 4)
  - — RAW
    - o ALG OUT X (X = 1 to 4)
- **ANALOG STATUS (Visible when AEM-2020 is enabled.)**
- **CONF ELEMENTS**
  - — CONFIG ELEMENT X (X = 1 to 8)
- **CONF PROT STATUS**
- **EVENT LOG**
  - — [EVENT NAME]
    - o ACTIVE
    - o OCCURRENCE COUNT
    - o FIRST DATE
    - o FIRST TIME
    - o LAST DATE
    - o LAST TIME
    - o FIRST ENG HRS
    - o LAST ENG HRS

- o DETAILS
  - ♦ OCCURRENCE (Use the *Edit/Up/Down* keys to change the occurrence.)
  - ♦ DATE
  - ♦ TIME
  - ♦ ENG HRS
- o CLEAR EVENT (Visible when logged in through the front panel.)
- **J1939 DATA (Visible when CANbus is enabled and ECU is configured for Standard or Volvo Penta.)**
  - — 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
- **J1939 ENGINE CONFIG (Visible when ECU is configured for Standard or Volvo Penta.)**
  - — 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 ACTIVE DTC (Visible when DTC support is enabled and any ECU type is selected.)**
  - — CLEAR DTCs
- **J1939 PREV DTC (Visible when DTC support is enabled and any ECU type is selected.)**
  - — CLEAR DTCs
- **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.)

DIAGNOSTICS

- **MODBUS RD**
- **MODBUS WR**
- **FLASH WR**

```
                        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
```
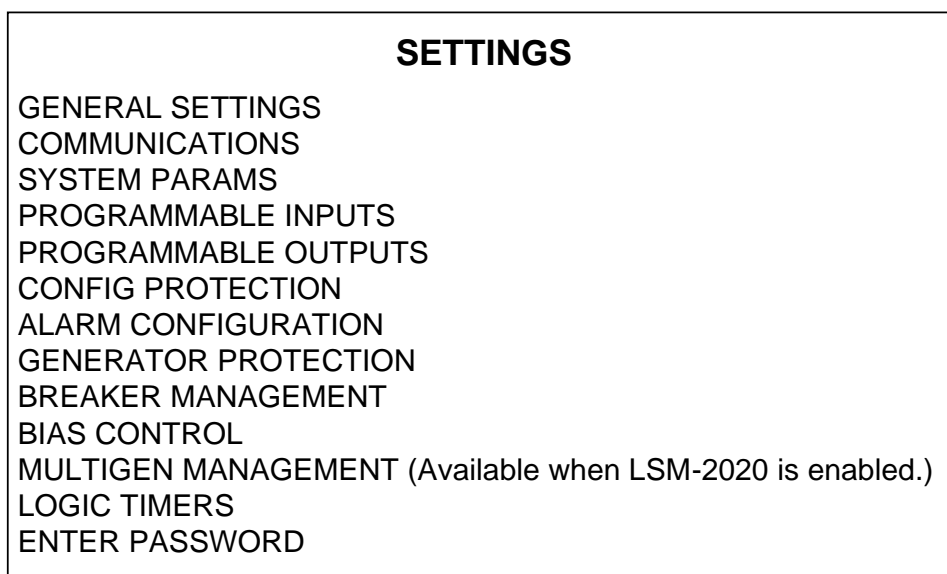
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Figure 2-3. Settings Screen Branches

GENERAL SETTINGS

- **FRONT PANEL HMI**
  - — SUMMARY VIEW
  - — SCROLL DELAY
  - — PH TOG DELAY
  - — LCD CONTRAST
  - — SLEEP MODE
  - — LANGUAGE
  - — CONFIGURABLE METERING
    - o ITEM X (X = 1 to 20)
- **CONFIGURE DATE/TIME**
  - — YEAR
  - — MONTH
  - — DAY
  - — HOURS
  - — MINUTES
  - — SECONDS
  - — UTC OFFSET
  - — DST ENABLED
  - — CLK NOT SET WRN

- **VIEW DATE/TIME**
- **VERSION INFO**
    — DGC-2020
        o FIRMWARE VERSION
        o BOOT CODE VERSION
        o SERIAL NUMBER
        o PART NUMBER
        o MODEL NUMBER
        o LANGUAGE VERSION
        o LANGUAGE PART NUM
        o STYLE CODE
    — LSM-2020 (Visible when LSM-2020 is enabled.)
        o VERSION INFO
            • FIRMWARE VERSION
            • BOOT CODE VERSION
        o TCP/IP SETTINGS
            • IP ADDRESS
            • SUBNET MASK
            • GATEWAY ADDRESS
            • DHCP ENABLE
    — CEM-2020 (Visible when CEM-2020 is enabled.)
        o FIRMWARE VERSION
        o BOOT CODE VERSION
        o SERIAL NUMBER
        o PART NUMBER
        o MODEL NUMBER
        o BUILD DATE
    — AEM-2020 (Visible when AEM-2020 is enabled.)
        o FIRMWARE VERSION
        o BOOT CODE VERSION
        o SERIAL NUMBER
        o PART NUMBER
        o MODEL NUMBER
        o BUILD DATE

COMMUNICATIONS

- **CANBUS SETUP**
    — CANBUS SETUP
        o CANBUS ENABLE
        o DTC ENABLE (Visible when CANBUS is enabled.)
        o CANBUS ADDR (Visible when CANBUS is enabled.)
        o ECU OPT SLCT (Visible when CANBUS is enabled.)
        o ECU PULSING (Visible when CANBUS is enabled.)
        o ENG SHTDN TM (Visible when CANBUS is enabled.)
        o PLS CYCL TM (Visible when CANBUS is enabled.)
        o ECU SET TM (Visible when CANBUS is enabled.)
        o RESP TIMEOUT (Visible when CANBUS is enabled.)
    — ECU SETUP (Visible when CANBUS is enabled.)
        o ECU CONF
        o GEN DATA TRANSMIT
        o DPF REGENRATE SETUP (Visible when ECU is configured for Standard, Volvo Penta, MTU ADEC, GM, or CUMMINS.)
            ♦ DPF MANUAL REGEN
            ♦ DPF REGEN DISABLE
        o SPEED SELECT PRIMARY (Visible when ECU is configured for Volvo Penta.)
        o ACCEL POSITION (Visible when ECU is configured for Volvo Penta.)
        o MODULE TYPE (Visible when ECU is configured for MTU MDEC or MTU ECU7.)
        o ALIVE MSG (Visible when ECU is configured for MTU MDEC or MTU ECU7.)
        o SPD DMAND SRC (Visible when ECU is configured for MTU MDEC.)
        o ENGINE RPM (Visible when ECU is configured for MTU MDEC or GM.)
        o SPEED SETUP (Visible when ECU is configured for MTU ADEC or MTU ECU7.)
            ♦ SPD DMAND SRC
            ♦ ENGNE RPM
            ♦ TEST OVRSPEED
            ♦ SPEED UP

- ♦ SPEED DN
- ♦ 50-60 Hz SEL (Visible when ECU is configured for MTU ECU7.)
- ♦ IDLE REQUEST (Visible when ECU is configured for MTU ECU7.)
- ♦ INCREASE IDLE (Visible when ECU is configured for MTU ECU7.)
  - o ECU SETUP (Visible when ECU is configured for MTU ADEC or MTU ECU7.)
    - ♦ TRIP RESET
    - ♦ INT OIL PRIME
    - ♦ GOV PRM SW (Visible when ECU is configured for MTU ADEC.)
    - ♦ ENG STRT PRIME (Visible when ECU is configured for MTU ECU7.)
    - ♦ FAN OVERRIDE (Visible when ECU is configured for MTU ECU7.)
    - ♦ MODE SWITCH (Visible when ECU is configured for MTU ECU7.)
    - ♦ GOV PARAM SET (Visible when ECU is configured for MTU ECU7.)
    - ♦ CAN RATING SW 1 (Visible when ECU is configured for MTU ECU7.)
    - ♦ CAN RATING SW 2 (Visible when ECU is configured for MTU ECU7.)
    - ♦ DIS CYL CUT 1 (Visible when ECU is configured for MTU ECU7.)
    - ♦ DID CYL CUT 2 (Visible when ECU is configured for MTU ECU7.)

- **MODEM SETUP**
  - — 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

SYSTEM PARAMS

- **SYSTEM SETTINGS**
  - — GEN CONNECT
  - — RATED kW
  - — RATED VOLTS
  - — RATED FREQ
  - — ALTRNATE FRQ
  - — RATED RPM
  - — RATED PF
  - — SYSTEM TYPE
  - — EPS
    - o EPS THRESHLD
    - o LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
  - — FUEL LVL TYP
  - — 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
    - o ENABLE
    - o CANBUS ADDRESS (Visible when LSM-2020 is enabled.)
    - o VERSION INFO (Visible when LSM-2020 is enabled.)
      - ♦ FIRMWARE VERSION
      - ♦ BOOT CODE VERSION
    - o TCP/IP SETTINGS (Visible when LSM-2020 is enabled.)
      - ♦ IP ADDRESS
      - ♦ SUBNET MASK
      - ♦ GATEWAY ADDRESS
      - ♦ DHCP ENABLE

- o 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
  - o ENABLE
  - o OUTPUTS (Visible when CEM-2020 is enabled.)
  - o CANBUS ADDR (Visible when CEM-2020 is enabled.)
  - o VERSION INFO (Visible when CEM-2020 is enabled.)
    - ♦ FIRMWARE VERSION
    - ♦ BOOT CODE VERSION
    - ♦ SERIAL NUMBER
    - ♦ PART NUMBER
    - ♦ MODEL NUMBER
    - ♦ BUILD DATE
  - o CEM DEBUG MENU (Visible when CEM-2020 is enabled.)
    - ♦ DGC TO CEM BP
    - ♦ CEM TO DGC BP
- — AEM SETUP
  - o ENABLE
  - o CANBUS ADDR (Visible when AEM-2020 is enabled.)
  - o VERSION INFO (Visible when AEM-2020 is enabled.)
    - ♦ FIRMWARE VERSION
    - ♦ BOOT CODE VERSION
    - ♦ SERIAL NUMBER
    - ♦ PART NUMBER
    - ♦ MODEL NUMBER
    - ♦ BUILD DATE
  - o AEM DEBUG MENU (Visible when AEM-2020 is enabled.)
    - ♦ DGC TO AEM BP
    - ♦ AEM TO DGC BP
    - ♦ ANALOG INPUTS
      - o SCALED
        - ▪ ALG IN X (X = 1 TO 8)
      - o RAW
        - ▪ ALG IN X (X = 1 TO 8)
    - ♦ THERMAL INPUTS
      - o SCALED
        - ▪ RTD IN X (X = 1 TO 8
        - ▪ THRM CPL X (X = 1 TO 2)
        - ▪ AMBIENT
      - o RAW
        - ▪ RTD IN X (X = 1 TO 8)
        - ▪ THRM CPL X (X = 1 TO 2)
    - ♦ ANALOG OUTPUTS
      - o SCALED
        - ▪ ALG OUT X (X = 1 TO 4)
      - o RAW
        - ▪ ALG OUT X (X = 1 TO 4)
- **CRANK SETTINGS**
  - — DISCNCT LMIT
  - — PRECRNK DELY
  - — PRESTRT CNTCT
  - — STYLE
  - — # CYCLES

- — CYCLE TIME
- — COOLDWN TIME
- — OFF MODE COOLDN
- — PRESTART REST CONFIG
  - o CONF
- — OIL PRS CRANK DISC
  - o ENABLE
  - o CRANK DISC PRS
- **AUTOMATIC RESTART**
  - — ENABLE
  - — ATTEMPTS
  - — INTERVAL
- **EXERCISE TIMER**
  - — MODE
  - — RUN WITH LOAD
  - — START HOUR
  - — START MINUTE
  - — RUN HOURS
  - — RUN MINUTES
- **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)
    - o ALARM CONFIG
    - o ACTIVATN DLY
    - o RECOGNITION
    - o NAME
- **PROG FUNCTIONS**
  - — AUTO XFER SWITCH
    - o INPUT
    - o RECOGNITION (Visible when an INPUT is selected.)
  - — GRND DELTA O-RIDE
    - o INPUT
    - o RECOGNITION (Visible when an INPUT is selected.)
  - — BATTLE OVERRIDE
    - o INPUT
    - o RECOGNITION (Visible when an INPUT is selected.)
  - — LOW LINE OVERRIDE
    - o INPUT
    - o RECOGNITION (Visible when an INPUT is selected.)

- — 1 PHASE O-RIDE
  - o INPUT
  - o RECOGNITION (Visible when an INPUT is selected.)
  - o 1 PH O-RIDE CFG (Visible when an INPUT is selected.)
- — 1 PHASE AC O-RIDE
  - o INPUT
  - o RECOGNITION (Visible when an INPUT is selected.)
- — BATT CHRG FAIL
  - o INPUT
  - o ALARM CONFIG (Visible when an INPUT is selected.)
  - o ACTIVATN DLY (Visible when an INPUT is selected.)
  - o RECOGNITION (Visible when an INPUT is selected.)
- — LOW COOL LEVEL
  - o INPUT
  - o ALARM CONFIG (Visible when an INPUT is selected.)
  - o ACTIVATN DLY (Visible when an INPUT is selected.)
  - o RECOGNITION (Visible when an INPUT is selected.)
- — FUEL LEAK DETECT
  - o INPUT
  - o ALARM CONFIG (Visible when an INPUT is selected.)
  - o ACTIVATN DLY (Visible when an INPUT is selected.)
  - o RECOGNITION (Visible when an INPUT is selected.)
- **LSM INPUTS (Visible when LSM-2020 is enabled.)**
  - — ALG IN 1
    - o INPUT TYPE
    - o MIN VOLTAGE
    - o MAX VOLTAGE
    - o MIN CURRENT
    - o MAX CURRENT
- **ANALOG INPUTS (Visible when AEM-2020 is enabled.)**
  - — ALG IN X (X = 1 to 8)
    - o INPUT TYPE
    - o MIN VOLTAGE
    - o MAX VOLTAGE
    - o MIN CURRENT
    - o MAX CURRENT
    - o PARAM MIN
    - o PARAM MAX
    - o OVER 1
      - ♦ THRESHOLD
      - ♦ ALARM CONFIG
    - o OVER 2
      - ♦ THRESHOLD
      - ♦ ALARM CONFIG
    - o UNDER 1
      - ♦ THRESHOLD
      - ♦ ALARM CONFIG
    - o UNDER 2
      - ♦ THRESHOLD
      - ♦ ALARM CONFIG
    - o ARMING DELAY
    - o THR1 ACT DLY
    - o THR2 ACT DLY
    - o HYSTERESIS
    - o OOR ALM CFG
    - o NAME
- **THERMAL INPUTS (Visible when AEM-2020 is enabled.)**
  - — RTD IN X (X = 1 to 8)
    - o TYPE
    - o OVER 1
      - ♦ THRESHOLD
      - ♦ ALARM CONFIG
    - o OVER 2
      - ♦ THRESHOLD
      - ♦ ALARM CONFIG

- o UNDER 1
  - ♦ THRESHOLD
  - ♦ ALARM CONFIG
- o UNDER 2
  - ♦ THRESHOLD
  - ♦ ALARM CONFIG
- o ARMING DELAY
- o THR1 ACT DLY
- o THR2 ACT DLY
- o HYSTERESIS
- o OOR ALM CFG
- o NAME
— THRM CPL X (X = 1 to 2)
  - o OVER 1
    - ♦ THRESHOLD
    - ♦ ALARM CONFIG
  - o OVER 2
    - ♦ THRESHOLD
    - ♦ ALARM CONFIG
  - o UNDER 1
    - ♦ THRESHOLD
    - ♦ ALARM CONFIG
  - o UNDER 2
    - ♦ THRESHOLD
    - ♦ ALARM CONFIG
  - o ARMING DELAY
  - o THR1 ACT DLY
  - o THR2 ACT DLY
  - o HYSTERESIS
  - o OOR ALM CFG
  - o NAME

PROGRAMMABLE OUTPUTS

- **OUTPUTS**
  - — OUTPUT X (X = 1 to 12) (X = 1 to 30 when CEM-2020 is enabled.)
    - o NAME
- **ANALOG OUTPUTS**
  - — ANALOG OUTPUT X (X = 1 to 4)
    - o OUTPUT TYPE
    - o MIN VOLTAGE
    - o MAX VOLTAGE
    - o MIN CURRENT
    - o MAX CURRENT
    - o PARAM MIN
    - o PARAM MAX
    - o OOR ALM CFG
    - o OOR ACT DLY
    - o PARAM
    - o NAME

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
    - o THRESHOLD
    - o ALARM CONFIG
  - — OVER 2
    - o THRESHOLD
    - o ALARM CONFIG

- — UNDER 1
    - o THRESHOLD
    - o ALARM CONFIG
- — UNDER 2
    - o THRESHOLD
    - o 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
        - o ENABLE
        - o THRESHOLD
    - — LOW COOLANT TEMP
        - o ENABLE
        - o THRESHOLD
    - — LOW OIL PRESSURE
        - o ENABLE
        - o THRESHOLD
    - — LOW FUEL LEVEL
        - o ENABLE
        - o THRESHOLD
    - — ENGINE OVERLOAD
        - o 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
                - o THRESHOLD
                - o HYSTERESIS
            - ♦ 1 PHASE SETTINGS
                - o THRESHOLD
                - o HYSTERESIS
    - — MAINTENANCE INTERVAL
        - o ENABLE
        - o THRESHOLD
    - — BATTERY OVERVOLTAGE
        - o ENABLE
        - o THRESHOLD
    - — LOW BATTERY VOLTAGE
        - o ENABLE
        - o THRESHOLD
        - o ACTIVATN DLY
    - — WEAK BATTERY VOLTAGE
        - o ENABLE
        - o THRESHOLD
        - o ACTIVATN DLY
    - — HIGH FUEL LEVEL
        - o ENABLE
        - o THRESHOLD
        - o ACTIVATN DLY
    - — ACTIVE DTC (Visible when DTC is enabled.)
        - o ENABLE
    - — ECU COMMS FAIL (Visible when CANBUS is enabled.)
        - o ENABLE
    - — COOLANT LEVEL (Visible when CANBUS is enabled.)
        - o ENABLE
        - o THRESHOLD

- — AVR OUTPUT LIMIT (Visible when LSM-2020 is enabled.)
  - o ENABLE
  - o ACTIVATN DLY
- — GOV OUTPUT LIMIT (Visible when LSM-2020 is enabled.)
  - o ENABLE
  - o ACTIVATN DLY
- — INTERGENSET COMM FAIL (Visible when LSM-2020 is enabled.)
  - o ENABLE
- — LSM COMM FAIL (Visible when LSM-2020 is enabled.)
  - o ENABLE
- — CEM COMM FAIL (Visible when CEM-2020 is enabled.)
  - o ENABLE
- — AEM COMM FAIL (Visible when AEM-2020 is enabled.)
  - o ENABLE
- — ID MISSING (Visible when LSM-2020 is enabled.)
  - o ENABLE
- — ID REPEAT (Visible when LSM-2020 is enabled.)
  - o ENABLE
- — CHECKSUM FAIL
  - o ENABLE
- **ALARMS**
  - — HIGH COOLANT TEMP
    - o ENABLE
    - o THRESHOLD
    - o ARMING DELAY
  - — LOW OIL PRESSURE
    - o ENABLE
    - o THRESHOLD
    - o ARMING DELAY
  - — LOW FUEL LEVEL
    - o ENABLE
    - o THRESHOLD
    - o ACTIVATN DLY
  - — OVERSPEED
    - o ENABLE
    - o THRESHOLD
    - o ACTIVATN DLY
  - — COOLANT LEVEL (Visible when CANbus is enabled.)
    - o ENABLE
    - o THRESHOLD

NOTE

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

- **SENDER FAIL**
  - — COOL TEMP SENDR FAIL
    - o CONFIG TYPE
    - o ACTIVATN DLY
  - — OIL PRESS SENDR FAIL
    - o CONFIG TYPE
    - o ACTIVATN DLY
  - — FUEL LEVL SENDR FAIL
    - o CONFIG TYPE
    - o ACTIVATN DLY
  - — VOLTAGE SENSE FAIL
    - o CONFIG TYPE
    - o ACTIVATN DLY
  - — SPEED SENDR FAIL
    - o TIME DELAY

- **27 UNDERVOLTAGE**
  — 27-1 / 27-2
    o LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
    o 3 / 1 PHASE SETTINGS
      ♦ PICKUP
      ♦ HYSTERESIS
      ♦ TIME DELAY
      ♦ FREQ INHIBIT
      ♦ ALARM CONFIG
- **59 OVERVOLTAGE**
  — 59-1 / 59-2
    o LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
    o 3 / 1 PHASE SETTINGS
      ♦ PICKUP
      ♦ HYSTERESIS
      ♦ TIME DELAY
      ♦ ALARM CONFIG
- **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.)
- **81 O/U FREQUENCY**
  — UNDERFREQUENCY
    o INHIBIT VOLTS
    o PICKUP
    o HYSTERESIS
    o TIME DELAY
    o ALARM CONFIG
  — OVERFREQUENCY
    o PICKUP
    o HYSTERESIS
    o TIME DELAY
    o ALARM CONFIG
  — ALTRNT FRQ SCALE FCTR
    o ALT FREQ SF
- **51 OVERCURRENT (Optional)**
  — 51-1 / 51-2 / 51-3
    o LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
    o 3 / 1 PHASE SETTINGS
      ♦ PICKUP
      ♦ TIME DIAL
      ♦ CURVE
      ♦ ALARM CONFIG
      ♦ RESET TYPE
    o PROG CURVE CONSTANTS
      ♦ A
      ♦ B
      ♦ C
      ♦ N
      ♦ R
- **32 REVERSE POWER**
  — 3 / 1 PHASE SETTINGS
    o PICKUP
    o HYSTERESIS
    o TIME DELAY
    o ALARM CONFIG

- **40 LOSS OF EXCITATION**
    - — 3 / 1 PHASE SETTINGS
        - o PICKUP
        - o HYSTERESIS
        - o TIME DELAY
        - o ALARM CONFIG
- **LOSS OF MAINS PROTECT (Optional)**
    - — 78 VECTOR SHIFT
        - o PICKUP
        - o ALARM CONFIG
        - o OPEN MAINS ON TRP
        - o OPEN GEN ON TRP
    - — 81 ROCOF
        - o PICKUP
        - o TIME DELAY
        - o ALARM CONFIG
        - o OPEN MAINS ON TRP
        - o OPEN GEN ON TRP

BREAKER MANAGEMENT

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

- — BUS STABLE
  - o OV PICKUP
  - o OV DROPOUT
  - o UV PICKUP
  - o UV DROPOUT
  - o OF PICKUP
  - o OF DROPOUT
  - o UF PICKUP
  - o UF DROPOUT
  - o TIME DELAY
  - o LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
  - o ALT FREQ SF
- — BUS FAILED
  - o TIME DELAY
- **SYNCHRONIZER**
  - — TYPE
  - — SLIP FREQ
  - — VOLT WINDOW
  - — CLOSING ANGLE
  - — VG>VB
  - — TIME DELAY
  - — FAIL DELAY
  - — VOLT GAIN
  - — SPEED GAIN

BIAS CONTROL

- **AVR BIAS CONTROL**
  - — OUTPUT (Visible when LSM-2020 is enabled.)
    - o TYPE
  - — CONTACT (Visible when LSM-2020 is disabled or when LSM-2020 is enabled and OUTPUT TYPE = CONTACT.)
    - o TYPE
    - o CORRECTION PULSE (Visible when OUTPUT TYPE = CONTACT and CONTACT TYPE = PROPORTIONAL.)
      - ♦ WIDTH
      - ♦ INTERVAL
  - — var CTRL
    - o DROOP
    - o DROOP GAIN
    - o var CTRL ENABLE (Visible when LSM-2020 is enabled.)
    - o var CTRL MODE (Visible when LSM-2020 is enabled.)
    - o KP (Visible when LSM-2020 is enabled.)
    - o RAMP RATE (Visible when LSM-2020 is enabled.)
    - o kvar SETPT (Visible when LSM-2020 is enabled.)
    - o kvar SRC (Visible when LSM-2020 is enabled.)
    - o kvar ALG MAX (Visible when LSM-2020 is enabled.)
    - o kvar ALG MIN (Visible when LSM-2020 is enabled.)
    - o PF SETPT (Visible when LSM-2020 is enabled.)
    - o PF SRC (Visible when LSM-2020 is enabled.)
    - o PF ALG MAX (Visible when LSM-2020 is enabled.)
    - o PF ALG MIN (Visible when LSM-2020 is enabled.)
    - o KI (Visible when LSM-2020 is enabled and OUTPUT TYPE = ANALOG.)
    - o KD (Visible when LSM-2020 is enabled and OUTPUT TYPE = ANALOG.)
    - o TD (Visible when LSM-2020 is enabled and OUTPUT TYPE = ANALOG.)
    - o LOOP GAIN (Visible when LSM-2020 is enabled and OUTPUT TYPE = ANALOG.)
  - — VOLT CTRL GAINS (Visible when LSM-2020 is enabled and OUTPUT TYPE = ANALOG.)
    - o KP
    - o KI
    - o KD
    - o TD
    - o LOOP GAIN
- **GOV BIAS CONTROL**
  - — OUTPUT (Visible when LSM-2020 is enabled.)
    - o TYPE

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

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 Explorer→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).

REAR PANEL

All DGC-2020 terminals and connectors are located on the rear panel. Rear panel terminals and connectors are illustrated in Figure 2-4. (To show the terminals and connectors, Figure 2-4 shows the DGC-2020 with the rear cover removed.) Table 2-2 lists the call-outs of Figure 2-4 along with a description of each connector type.

1	CHASSIS
2	BATT –
3	BATT +
4	RDPBATT +
5	RDPBATT –
6	RDPTXD –
7	RDPTXD +
8	OIL
9	FUEL
10	COOLANT
11	SENDER COM
12	485 SHIELD
13	485 B
14	485 A
15	INPUT 16

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

31	MPU +
32	MPU –
33	Not Used
34	Not Used
35	GEN VN
36	Not Used
37	GEN VC
38	Not Used
39	GEN VB
40	Not Used
41	GEN VA
42	Not Used
43	BUS VB
44	Not Used
45	BUS VA

E STOP	46
E STOP	47
CAN L	48
CAN H	49
SHIELD	50
COM 1, 2, 3	51
OUT 1	52
OUT 2	53
OUT 3	54
COM 4, 5, 6	55
OUT 4	56
OUT 5	57
OUT 6	58
COM 7, 8, 9	59
OUT 7	60

OUT 8	61
OUT 9	62
COM 10, 11, 12	63
OUT 10	64
OUT 11	65
OUT 12	66
Not Used	67
IA –	68
IA +	69
Not Used	70
IB –	71
IB +	72
Not Used	73
IC –	74
IC +	75

START

RUN

PRE

DGC-2020

P0055-28

Figure 2-4. Rear Panel

Table 2-2. Rear Panel HMI Descriptions

Locator	Description
A, D	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.
B	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.
C	DGC-2020 controllers with an optional, internal, dial-out modem connect to a telephone line through a USOC RJ-11 jack.
E	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.
F	The DGC-2020 provides a battery backup for the real-time clock. See Section 7, *Maintenance and Troubleshooting,* for instructions on replacing the battery. Failure to replace the battery with Basler Electric P/N 38526 may void the warranty.

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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, *BESTCOMSPlus Software.*

DGC-2020 FUNCTION BLOCKS

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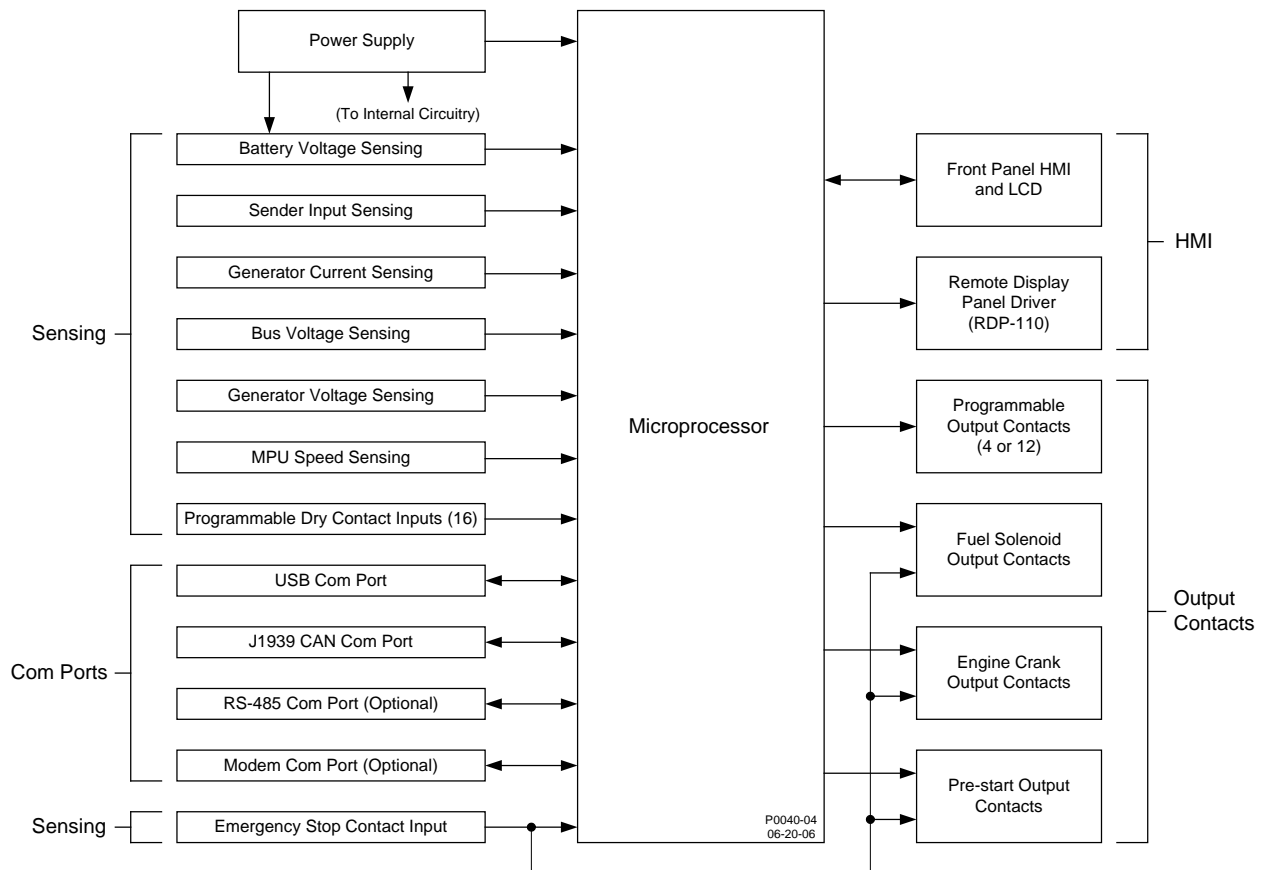
Figure 3-1. Function Block Diagram

Power Supply

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

Battery Voltage Sensing

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

Microprocessor

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

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

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 45 (A-phase) and 43 (B-phase).

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, *BESTCOMSPlus 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, *BESTCOMSPlus 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, *BESTCOMSPlus 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, *BESTCOMSPlus 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 normally open, Form A 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. The RDP-110 communicates with the DGC-2020 via terminals 6 (RDP TXD–) and 7 (RDP TXD+) and receives power from terminals 4 (RDP BATT+) and 5 (RDP BATT-). Remote indication of many pre-alarm and alarm conditions is provided by the RDP-110.

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

- Battery charger failure ∗
- Battery overvoltage
- High coolant temperature
- Low coolant temperature
- Low fuel level
- Low oil pressure
- Weak battery or low battery voltage

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

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

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

Additionally, the RDP-110 indicates when the DGC-2020 is not operating in Auto mode and when the generator is supplying load or when the DGC-2020 is in an alarm state not listed above. 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*.

CANbus

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 CANbus 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 CANbus interface allows the ECU and DGC-2020 to communicate. The ECU reports operating information to the DGC-2020 through the CANbus interface. Operating parameters and diagnostic information, if supported by the ECU, are decoded and displayed for monitoring.

The primary use of the CANbus 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 CANbus interface. These parameters are transmitted via the CANbus 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.

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

Table 3-1. ECU Parameters Obtained from CANbus Interface

ECU Parameter	Metric Units	English Units	Update Rate	* SPN
Actual Engine Percent Torque	%	%	Engine Speed Dependent	513
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 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
ECU Temperature	°C	°F	1 s	1136
Engine Coolant Temperature	°C	°F	1 s	110
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

ECU Parameter	Metric Units	English Units	Update Rate	*SPN
Exhaust Temperature B	°C	°F	500 ms	2434
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 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 CANbus Interface

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

ECU Parameter	Metric Units	English Units	Update Rate	*SPN
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 CANbus 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 (MTU and GM Only)	10 ms	518
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 Requests 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

∗ 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 CANbus interface.

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.

Table 3-4. Diagnostic Information Obtained Over the CANbus 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

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". For more detailed information, refer to your MTU documentation.

15V GOODECU DFCT	AL EXT ENG PROT	AL OVERRIDE ON
15V NEGECU DEFCT	AL INTERFACE ECU	AL POM ERROR
15V POSECU DEFCT	AL L1 AUX 1	AL POWER STAGE HI
AD-TST1ECU DEFCT	AL L1 AUX1 PLANT	AL POWER STAGE LO
AD-TST2ECU DEFCT	AL L1 P AUX 1	AL PRELUBE FAULT
AD-TST3ECU DEFCT	AL L1 T AUX 1	AL RAIL_LEAKAGE
AL BATT NOT CHRG	AL L2 AUX 1	AL SD CAM STOP
AL CALL FLD SRVC	AL L2 AUX1 PLANT	AL STOP PWR STG
AL CAN NO PU-DATA	AL L2 P AUX 1	AL STOP PWR STG 2
AL CAN POM ND LST	AL L2 T AUX 1	AL STOP SD
AL CAN PUDATA ERR	AL LIFE DATA ERR	AL WIRING FRQ OUT
AL CAN BAD PARAMS	AL LIFE DATA NA	AL WRG POM STRT 1
AL CAN1 BUS OFF	AL LOW STRTR VOLT	AL WRG POM STRT 2
AL CAN1 ERR PASSV	AL MCR EXCEEDED	AL WIRING PWM CM2
AL CAN1 NODE LOST	AL MV WIRING GND	AL WIRING TO 1
AL CAN2 BUS OFF	AL NEW POM FOUND	AL WIRING TO 2
AL CAN2 ERR PASSV	AL OPN LD POM ALT	AL WIRING TO 3
AL CAN2 NODE LOST	AL OPN LD DIGIN 1	AL WIRING TO 4
AL CHECK POM FUSE	AL OPN LD DIGIN 2	AL WIRING TOP 1
AL COMB ALM RED	AL OPN LD DIGIN 3	AL WIRING TOP 2
AL COMB ALM YEL	AL OPN LD DIGIN 4	AL WIRING TOP 3
AL CR TRIG ENG ST	AL OPN LD DIGIN 5	AL WIRING TOP 4
AL CRASH REC ERR	AL OPN LD DIGIN 6	AL WIRING TOP 5
AL EMU PARAM ERR	AL OPN LD DIGIN 7	AL WIRING TOP 6
AL ETC SPD DEVIATN	AL OPN LD DIGIN 8	AL WRONG POM ID
AL ETC2 CUTIN FAIL	AL OPN LD E-STOP	BANK1 ECU DEFECT

BANK2 ECU DEFECT	LO U-PDU	SD EXT CLNT LVL
CAN LESS MAILBXS	LOLO ECU VOLTS	SD FREQNCY INPUT
AL CONFIG CHANGED	LOLO U-PDU	SD IDLE-END TRQ IN
DUMMY FAULT	MI MODULE FAIL	SD INTERCLER LVL
EDM NOT VALID	MI NOT ACTIVE	SD WTR FUEL PFLTR
AL ENGHR CTR DEFCT	MODL WRITE LIMIT	SD LOAD ANLG FLT
ENG HRS INVALID 2	AL MULT FDH SLVS	SD LVL INTERCLR
ERR REC1 INVALID	NO FAULTS	SD LVL LKG FUEL
ERR REC2 INVALID	NO TEXT AVAILABLE	SD P AMBIENT AIR
HI ECU VOLTS	OPN LD CYLNDR A1	SD P-AUX 1
HI ETC IDLE SPEED	OPN LD CYLNDR A10	SD P-CHARGE AIR
HI ETC1 OVERSPEED	OPN LD CYLNDR A2	SD P COOLANT
HI ETC2 OVERSPEED	OPN LD CYLNDR A3	SD P CLNT INTRCLR
HI WTR FUEL PFLTR	OPN LD CYLNDR A4	SD P-CRANKCASE
HI LVL LKG FUEL	OPN LD CYLNDR A5	SD P-DIFF LUBEOIL
HI P CHARGE AIR	OPN LD CYLNDR A6	SD P-EXTERN 1
HI P-CRANKCASE	OPN LD CYLNDR A7	SD P-EXTERN 2
HI P-DIFF-LUBE OIL	OPN LD CYLNDR A8	SD P-FUEL
HI P-FUEL RAIL	OPN LD CYLNDR A9	SD P-HD
HI T-CHRG AIR	OPN LD CYLNDR B1	SD P-LUBE OIL
HI T-COOLANT	OPN LD CYLNDR B10	SD P LUBE OIL (R)
HI T COOLANT EMU	OPN LD CYLNDR B2	SD POWER SUPPLY
HI T COOLNT (R)	OPN LD CYLNDR B3	SD PRE FILT P OIL
HI T-ECU	OPN LD CYLNDR B4	SD SPD DEMAND AN
HI T-EXHAUST A	OPN LD CYLNDR B5	SD SPDMTEST BNCH
HI T-EXHAUST B	OPN LD CYLNDR B6	SD SPINOUT
HI T EXHAUST EMU	OPN LD CYLNDR B7	SD T-AUX 1
HI T-FUEL	OPN LD CYLNDR B8	SD T-CHARGE AIR
HI T-INTERCOOLER	OPN LD CYLNDR B9	SD T-CLNT INTERC
HI T-LUBE OIL	SD 15V NEG SPPLY	SD T-COOLANT
HI T UMBLASSEN	SD 15V POS SPPLY	SD T COOLANT (R)
HI U-PDU	SD 5V BUFFR TEST	SD T-ECU
HIHI ECU VOLTS	SD ADTEST1 SPPLY	SD T-ELECTRONIC
HIHI U-PDU	SD ADTEST2 SPPLY	SD T EXHAUST A
IDM NOT VALID	SD ADTEST3 SPPLY	SD T EXHAUST B
AL FUEL CONS DEFCT	SD AUX 1	SD T-EXTERN 1
INVLD FUEL CNS 2	SD AUX 2	SD T-EXTERN 2
L BIN-EXTERN 3	SD BANK 1 TEST	SD T-FUEL
L BIN-EXTERN 4	SD BANK 2 TEST	SD T-INTAKE AIR
L1 5V BUFFR TEST	SD BIN-EXT3	SD T-LUBE OIL
L1 P-EXTERN 1	SD BIN-EXT4	SD T UMBLASSEN
L1 P-EXTERN 2	SD CAMSHAFT SPD	SD TE BUFFR TEST
L1 P-FUELFLT DIF	SD CAN ALRM RST	SD TRBO SW LCK SR
L1 T-EXTERN 1	SD CAN CYL CUTOUT	SD U-PDU
L1 T-EXTERN 2	SD CAN ENGAGE SIG	SENSOR PWR DEFCT
L1 TE BUFFR TEST	SD CAN IDLE REQ	SS COOLANT LEVEL
L2 LEVEL INTRCLR	SD CAN IDLE RQ SR	SS ENGINE OVERSPD
L2 P-EXTERN 1	SD CAN LAMP TEST	SS ETC1 OVERSPEED
L2 P-EXTERN 2	SD CAN LOCAL	SS ETC2 OVERSPEED
L2 T-EXTERN 1	SD CAN NOTCH POS	SS IDLE SPEED LOW
L2 T-EXTERN 2	SD CAN OVERRIDE	SS P CHARGE AIR
LIM EXT CLNT LEV	SD CANRCS CYL CUT	SS P-COOLANT
LIM INTERCLR LEV	SD CAN RCS ENGAGE	SS P CLNT INTRCLR
LO COOLANT LEVEL	SD CAN SPD DEMND	SS P CRANKCASE
LO ECU VOLTS	SD CAN STOP	SS P-DIFF LUBE OIL
LO LEVEL INTRCLR	SD CAN TRBOSW LCK	SS P-FUEL
LO P-COOLANT	SD CAN TST OVRSP	SS P-LUBE OIL
LO P CLNT INTRCLR	SD CAN UP/DOWN	SS P LUBE OIL (R)
LO P-FUEL	SD CANRES TRIPFL	SS PREHT TMP
LO P-FUEL RAIL	SD CHARGER1 SPEED	SS PWR RED ACT
LO P-LUBE OIL	SD CHARGER2 SPEED	SS RELEASE SPD LOW
LO P LUBE OIL (R)	SD COIL CURRENT	SS ENGINE SPD LOW
LO PREHT TMP	SD COOLANT LEVEL	SS STARTER SPD LOW
LO T EXHAUST EMU	SD CRANKSHFT SPD	SS T-CHRG AIR

SS T-COOLANT	TIMING CYLNDR A4	WIRING CYLNDR A3
SS T-COOLANT L3	TIMING CYLNDR A5	WIRING CYLNDR A4
SS T-COOLANT L4	TIMING CYLNDR A6	WIRING CYLNDR A5
SS T COOLNT (R)	TIMING CYLNDR A7	WIRING CYLNDR A6
SS T-EXHAUST A	TIMING CYLNDR A8	WIRING CYLNDR A7
SS T-EXHAUST B	TIMING CYLNDR A9	WIRING CYLNDR A8
SS T-FUEL	TIMING CYLNDR B1	WIRING CYLNDR A9
SS T-INTERCOOLER	TIMING CYLNDR B10	WIRING CYLNDR B1
SS T-LUBE OIL	TIMING CYLNDR B2	WIRING CYLNDR B10
SS T UMBLASSEN	TIMING CYLNDR B3	WIRING CYLNDR B2
AL STRT NT ENGAGE	TIMING CYLNDR B4	WIRING CYLNDR B3
TBO EXPIRED	TIMING CYLNDR B5	WIRING CYLNDR B4
TD P LUBE OIL	TIMING CYLNDR B6	WIRING CYLNDR B5
TD T COOLANT	TIMING CYLNDR B7	WIRING CYLNDR B6
TE BUF ECU DEFCT	TIMING CYLNDR B8	WIRING CYLNDR B7
TIMING CYLNDR A1	TIMING CYLNDR B9	WIRING CYLNDR B8
TIMING CYLNDR A10	WIRING CYLNDR A1	WIRING CYLNDR B9
TIMING CYLNDR A2	WIRING CYLNDR A10	
TIMING CYLNDR A3	WIRING CYLNDR A2	

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 equipped with the optional, internal, dial-out modem, the DGC-2020 can be connected to a standard telephone line through its RJ-11 jack. 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.

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.

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 7, *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.

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.

The best way to tell if the synchronizer is active is to disable the speed trim function, then when it is desired to synchronize check for raise and/or lower pulses coming from the DGC-2020 if the governor or AVR bias control output type is contact, or to 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. 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.

> **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.

If the synchronizer does not seem to operate properly, refer to Section 7, *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. 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 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 3-5 lists all possible event strings (as shown in the event log).

Table 3-5. Event List

Event String	Event Description	Event Type
27-1 UNDVOLT TRP A	27-1 Undervoltage Trip	Alarm
27-1 UNDVOLT TRP P	27-1 Undervoltage Trip	Pre-Alarm
27-2 UNDVOLT TRP A	27-2 Undervoltage Trip	Alarm
27-2 UNDVOLT TRP P	27-2 Undervoltage Trip	Pre-Alarm
32 RVS PWR TRP A	32 Reverse Power Trip	Alarm
32 RVS PWR TRP P	32 Reverse Power Trip	Pre-Alarm
40 EXC LOSS TRP A	40 Loss of Excitation Trip	Alarm
40 EXC LOSS TRP P	40 Loss of Excitation Trip	Pre-Alarm
47 PHS IMBAL TRP A	47 Phase Imbalance Trip	Alarm
47 PHS IMBAL TRP P	47 Phase Imbalance Trip	Pre-Alarm
51-1 OVRCURR TRP A	51-1 Overcurrent Trip	Alarm
51-1 OVRCURR TRP P	51-1 Overcurrent Trip	Pre-Alarm
51-2 OVRCURR TRP A	51-2 Overcurrent Trip	Alarm
51-2 OVRCURR TRP P	51-2 Overcurrent Trip	Pre-Alarm
51-3 OVRCURR TRP A	51-3 Overcurrent Trip	Alarm
51-3 OVRCURR TRP P	51-3 Overcurrent Trip	Pre-Alarm
59-1 OVRVOLT TRP A	59-1 Overvoltage Trip	Alarm
59-1 OVRVOLT TRP P	59-1 Overvoltage Trip	Pre-Alarm
59-2 OVRVOLT TRP A	59-2 Overvoltage Trip	Alarm
59-2 OVRVOLT TRP P	59-2 Overvoltage Trip	Pre-Alarm
78 VECTOR SHIFT TRIP A	78 Vector Shift Trip	Alarm
78 VECTOR SHIFT TRIP P	78 Vector Shift Trip	Pre-Alarm
81 ROC DF/DT TRIP A	81 Rate of Change of Frequency DF/DT Trip	Alarm
81 ROC DF/DT TRIP P	81 Rate of Change of Frequency DF/DT Trip	Pre-Alarm
81O OVRFREQ TRP A	81 Overfrequency Trip	Alarm
81O OVRFREQ TRP P	81 Overfrequency Trip	Pre-Alarm
81U UNDFREQ TRP A	81 Underfrequency Trip	Alarm

Event String	Event Description	Event Type
81U UNDFREQ TRP P	81 Underfrequency Trip	Pre-Alarm
AEM COMM FAIL P	AEM-2020 Communications Failure	Pre-Alarm
AEM OUTX OUT RNG (X = 1 to 4)	User Configurable Analog Output X Out of Range (X = 1 to 4)	Status
AEM OUTX OUT RNG A (X = 1 to 4)	User Configurable Analog Output X Out of Range (X = 1 to 4)	Alarm
AEM OUTX OUT RNG P (X = 1 to 4)	User Configurable Analog Output X Out of Range (X = 1 to 4)	Pre-Alarm
AL ECU FAULTY P	ECU Faulty	Pre-Alarm
ALG IN X_O1 (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Status
ALG IN X_O1 A (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Alarm
ALG IN X_O1 P (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Pre-Alarm
ALG IN X_O2 (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Status
ALG IN X_O2 A (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Alarm
ALG IN X_O2 P (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Pre-Alarm
ALG IN X_OOR (X = 1 to 8)	User Configurable Analog Input X Out of Range (X = 1 to 8)	Status
ALG IN X_OOR A (X = 1 to 8)	User Configurable Analog Input X Out of Range (X = 1 to 8)	Alarm
ALG IN X_OOR P (X = 1 to 8)	User Configurable Analog Input X Out of Range (X = 1 to 8)	Pre-Alarm
ALG IN X_U1 (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Status
ALG IN X_U1 A (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Alarm
ALG IN X_U1 P (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Pre-Alarm
ALG IN X_U2 (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Status
ALG IN X_U2 A (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Alarm
ALG IN X_U2 P (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Pre-Alarm
ATS INPUT CLOSED	ATS Input	Status
AUTO RESTART	Automatic Restart in Progress	Status
AUTO RESTART FAIL A	Automatic Restart Fail	Alarm
BATT CHRG FAIL A	Battery Charger Fail	Alarm
BATT CHRG FAIL P	Battery Charger Fail	Pre-Alarm
BATT OVERVOLT P	Battery Overvoltage	Pre-Alarm
BATTLE OVERRIDE	Battle Override	Status
CEM COMM FAIL P	CEM-2020 Communications Failure	Pre-Alarm
CEM HW MISMATCH P	Connected CEM-2020 is wrong type	Pre-Alarm
CHECKSUM FAIL P	Corrupt user settings or firmware code	Pre-Alarm
COMBINED RED A	Combined Red	Alarm
COMBINED YELLOW P	Combined Yellow	Pre-Alarm
CONF PROT X O1 (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Over Threshold 1	Status
CONF PROT X O1 A (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Over Threshold 1	Alarm
CONF PROT X O1 P (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Over Threshold 1	Pre-Alarm
CONF PROT X O2 (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Over Threshold 2	Status
CONF PROT X O2 A (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Over Threshold 2	Alarm
CONF PROT X O2 P (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Over Threshold 2	Pre-Alarm
CONF PROT X U1 (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Under Threshold 1	Status
CONF PROT X U1 A (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Under Threshold 1	Alarm
CONF PROT X U1 P (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Under Threshold 1	Pre-Alarm
CONF PROT X U2 (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Under Threshold 2	Status
CONF PROT X U2 A (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Under Threshold 2	Alarm

Event String	Event Description	Event Type
CONF PROT X U2 P (X = 1 to 8)	Configurable Protection X (X = 1 to 8) Under Threshold 2	Pre-Alarm
CONFIG ELEMENT X A (X = 1 to 8)	Configurable Element X (X = 1 to 8)	Alarm
CONFIG ELEMENT X P (X = 1 to 8)	Configurable Element X (X = 1 to 8)	Pre-Alarm
COOL LVL SNDR FL A	Coolant Level Sender Fail	Alarm
COOL SNDR FAIL	Coolant Temperature Sender Fail	Status
COOL SNDR FAIL A	Coolant Temperature Sender Fail	Alarm
COOL SNDR FAIL P	Coolant Temperature Sender Fail	Pre-Alarm
DEMAND START	Demand Start Request	Status
DEMAND STOP	Demand Stop Request	Status
DGC HEARTBEAT FAIL P	DGC Heartbeat Fail	Pre-Alarm
DIAG TRBL CODE P	Diagnostic Trouble Code	Pre-Alarm
DIAL OUT FAILED	Modem Dialout Failed	Status
DIAL OUT SUCCESS	Modem Dialout Success	Status
ECU SHUTDOWN A	ECU Shutdown	Alarm
EMERGENCY STOP A	Emergency Stop	Alarm
ENG kW OVRLD-1 P	Engine kW Overload 1	Pre-Alarm
ENG kW OVRLD-2 P	Engine kW Overload 2	Pre-Alarm
ENG kW OVRLD-3 P	Engine kW Overload 3	Pre-Alarm
ENGINE RUNNING	Engine Running	Status
ENTERED PROG MODE	Entered Program Mode	Status
FUEL FLT PRS HI P	Fuel Filter Differential Pressure High	Pre-Alarm
FUEL LEAK 1 P	Fuel Filter 1 Leak	Pre-Alarm
FUEL LEAK 2 P	Fuel Filter 2 Leak	Pre-Alarm
FUEL LEAK DETECT A	Fuel Leak Detect	Alarm
FUEL LEAK DETECT P	Fuel Leak Detect	Pre-Alarm
FUEL LEVL SENDR FAIL	Fuel Level Sender Fail	Status
FUEL LEVL SENDR A	Fuel Level Sender Fail	Alarm
FUEL LEVL SENDR P	Fuel Level Sender Fail	Pre-Alarm
GEN TEST LOADED	Generator Exerciser Test with Load	Status
GEN TEST UNLOADED	Generator Exerciser Test without Load	Status
GLBL SNDR FAIL A	Global Sender Fail	Alarm
GN BKR CL FL P	Generator Breaker Fail to Close	Pre-Alarm
GN BKR OP FL P	Generator Breaker Fail to Open	Pre-Alarm
GN BKR SYN FL P	Generator Breaker Synchronization Fail	Pre-Alarm
HI COOLANT TMP A	High Coolant Temp	Alarm
HI COOLANT TMP P	High Coolant Temp	Pre-Alarm
HI DAY TANK LEVEL P	High Day Tank Level	Pre-Alarm
HI PRESSURE IN 1 P	High Pressure Input 1	Pre-Alarm
HI PRESSURE IN 2 P	High Pressure Input 2	Pre-Alarm
HI ECU VOLTS A	High ECU Supply Voltage	Alarm
HI EXHAUST A T P	High Exhaust Temp A	Pre-Alarm
HI EXHAUSE B T P	High Exhaust Temp B	Pre-Alarm
HI SUPPLY VOLTS P	High Voltage Supply	Pre-Alarm
HI T FUEL P	High Fuel Temp	Pre-Alarm

Event String	Event Description	Event Type
HIGH AMB TEMP P	High Ambient Temp	Pre-Alarm
HIGH CHARGE AIR TEMP A	High Charge Air Temp	Alarm
HIGH CHARGE AIR TEMP P	High Charge Air Temp	Pre-Alarm
HIGH COIL TEMP 1 P	High Temp Coil 1	Pre-Alarm
HIGH COIL TEMP 2 P	High Temp Coil 2	Pre-Alarm
HIGH COIL TEMP 3 P	High Temp Coil 3	Pre-Alarm
HIGH COOLANT TEMP A	High Coolant Temp	Alarm
HIGH COOLANT TEMP P	High Coolant Temp	Pre-Alarm
HIGH ECU TEMPERATURE P	High ECU Temp	Pre-Alarm
HIGH FUEL LEVEL P	High Fuel Level	Pre-Alarm
HIGH FUEL RAIL PRESS P	High Fuel Rail Pressure	Pre-Alarm
HIGH INTRCOOLER TEMP P	High Intercooler Temp	Pre-Alarm
HIGH OIL TERMPERATURE A	High Oil Temp	Alarm
HIGH OIL TEMPERATURE P	High Oil Temp	Pre-Alarm
HIGH STRG TANK LEVEL P	High Storage Tank Level	Pre-Alarm
ID MISSING P	LSM-2020 ID Missing	Pre-Alarm
ID REPEAT P	LSM-2020 ID Repeated	Pre-Alarm
IDLE SPD LO P	Idle Speed Low	Pre-Alarm
INPUT X A (X = 1 to 40)	User Configurable Input X (X = 1 to 40)	Alarm
INPUT X P (X = 1 to 40)	User Configurable Input X (X = 1 to 40)	Pre-Alarm
LO AFTERCLR COOL LVL A	Low After Cooler Cool Level	Alarm
LO CHG AIR CLNT LVL P	Low Charge Air Coolant Level	Pre-Alarm
LO DAY TANK LEVEL P	Low Day Tank Level	Pre-Alarm
LO FUEL DLV PRESSURE A	Low Fuel Delivery Pressure	Alarm
LO ECU VOLTS P	Low ECU Supply Voltage	Pre-Alarm
LO SUPPLY VOLTS P	Low Voltage Supply	Pre-Alarm
LOAD TAKEOVER	Load Takeover	Status
LOGIC OUPUT A	Logic Output	Alarm
LOGIC OUPUT P	Logic Output	Pre-Alarm
LOSS OF VOLT	Voltage Sensing Fail	Status
LOSS OF VOLT A	Voltage Sensing Fail	Alarm
LOSS OF VOLT P	Voltage Sensing Fail	Pre-Alarm
LOSS REM COMS P	Loss of Remote Module Communication	Pre-Alarm
LOST ECU COMM A	Loss of ECU Communication	Alarm
LOST ECU COMM P	Loss of ECU Communication	Pre-Alarm
LOW BATT VOLT P	Low Battery Voltage	Pre-Alarm
LOW CHARGE AIR PRESS P	Low Charge Air Pressure	Pre-Alarm
LOW COOL LEVEL A	Low Coolant Level	Alarm
LOW COOL LEVEL P	Low Coolant Level	Pre-Alarm
LOW COOL TMP A	Low Coolant Temperature	Alarm
LOW COOL TMP P	Low Coolant Temperature	Pre-Alarm
LOW COOLANT LEVEL P	Low Coolant Level	Pre-Alarm
LOW FUEL DELIV PRESS P	Low Fuel Delivery Pressure	Pre-Alarm
LOW FUEL LEVEL A	Low Fuel Level	Alarm
LOW FUEL LEVEL P	Low Fuel Level	Pre-Alarm

Event String	Event Description	Event Type
LOW FUEL RAIL PRESS P	Low Fuel Rail Pressure	Pre-Alarm
LOW OIL PRES A	Low Oil Pressure	Alarm
LOW OIL PRES P	Low Oil Pressure	Pre-Alarm
LOW OIL PRESSURE A	Low Oil Pressure	Alarm
LOW OIL PRESSURE P	Low Oil Pressure	Pre-Alarm
LOW STRG TANK LEVEL P	Low Storage Tank Level	Pre-Alarm
LSM AVR OUT LMT P	LSM-2020 AVR Output Limit	Pre-Alarm
LSM COMMS FAIL P	LSM-2020 Communications Failure	Pre-Alarm
LSM GOV OUT LMT P	LSM-2020 GOV Output Limit	Pre-Alarm
LSM HEARTBEAT FAIL P	LSM-2020 Heartbeat Failed	Pre-Alarm
LSM INTERGEN COM FAIL P	LSM-2020 Intergen Communications Failure	Pre-Alarm
MAINS FAIL TEST	Mains Fail Test	Status
MAINT INTERVAL P	Maintenance Interval	Pre-Alarm
MF TRANSFER	Mains Fail Transfer Complete	Status
MF TRANSFER FAIL	Mains Fail Transfer Fail	Status
MN BKR CL FL P	Mains Breaker Fail to Close	Pre-Alarm
MN BKR OP FL P	Mains Breaker Fail to Open	Pre-Alarm
MN BKR SYN FL P	Mains Breaker Synchronization Fail	Pre-Alarm
MPU FAIL P	Magnetic Pickup Fail	Pre-Alarm
MULTIPLE AEM P	Multiple AEM-2020's	Pre-Alarm
MULTIPLE CEM P	Multiple CEM-2020's	Pre-Alarm
MULTIPLE LSM P	Multiple LSM-2020's	Pre-Alarm
NORM SHUTDOWN	Normal Shutdown	Status
OIL SNDR FAIL	Oil Pressure Sender Fail	Status
OIL SNDR FAIL A	Oil Pressure Sender Fail	Alarm
OIL SNDR FAIL P	Oil Pressure Sender Fail	Pre-Alarm
OVERCRANK A	Overcrank	Alarm
OVERSPEED A	Overspeed	Alarm
OVERSPEED A	Overspeed	Alarm
PRIMING FAULT P	Priming Fault	Pre-Alarm
PROT SHUTDOWN	Protective Shutdown	Status
RTD_IN_X_O1 (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Status
RTD_IN_X_O1 A (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Alarm
RTD_IN_X_O1 P (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Pre-Alarm
RTD_IN_X_O2 (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Status
RTD_IN_X_O2 A (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Alarm
RTD_IN_X_O2 P (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Pre-Alarm
RTD_IN_X_OOR (X = 1 to 8)	User Configurable RTD Input X Out of Range (X = 1 to 8)	Status
RTD_IN_X_OOR A (X = 1 to 8)	User Configurable Analog Input X Out of Range (X = 1 to 8)	Alarm
RTD_IN_X_OOR P (X = 1 to 8)	User Configurable Analog Input X Out of Range (X = 1 to 8)	Pre-Alarm
RTD_IN_X_U1 (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Status
RTD_IN_X_U1 A (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Alarm
RTD_IN_X_U1 P (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Pre-Alarm
RTD_IN_X_U2 (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Status
RTD_IN_X_U2 A (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Alarm

Event String	Event Description	Event Type
RTD_IN_X_U2 P (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Pre-Alarm
RUNUP SPD LO P	Run Up Speed Low	Pre-Alarm
SCREEN ERROR	Screen Error	Status
SERFLASH RD FAIL	Serial Flash Read Fail	Pre-Alarm
SPD SNDR FAIL	Speed Sender Fail	Status
SPD SNDR FAIL A	Speed Sender Fail	Alarm
SPEED DMD FL P	Speed Demand Fail	Pre-Alarm
SPEED TOO LOW P	Engine Speed Too Low	Pre-Alarm
SS OVERRIDE ON P	Shutdown Override	Pre-Alarm
START SPEED LOW P	Start Speed Low	Pre-Alarm
THRM_CPL_X_O1 (X = 1 to 2)	User Configurable Thermocouple Input X Over 1 (X = 1 to 2)	Status
THRM_CPL_X_O1 A (X = 1 to 2)	User Configurable Thermocouple Input X Over 1 (X = 1 to 2)	Alarm
THRM_CPL_X_O1 P (X = 1 to 2)	User Configurable Thermocouple Input X Over 1 (X = 1 to 2)	Pre-Alarm
THRM_CPL_X_O2 (X = 1 to 2)	User Configurable Thermocouple Input X Over 1 (X = 1 to 2)	Status
THRM_CPL_X_O2 A (X = 1 to 2)	User Configurable Thermocouple Input X Over 1 (X = 1 to 2)	Alarm
THRM_CPL_X_O2 P (X = 1 to 2)	User Configurable Thermocouple Input X Over 1 (X = 1 to 2)	Pre-Alarm
THRM_CPL_X_OOR (X = 1 to 2)	User Configurable Thermocouple Input X Out of Range (X = 1 to 2)	Status
THRM_CPL_X_OOR A (X = 1 to 2)	User Configurable Thermocouple Input X Out of Range (X = 1 to 2)	Alarm
THRM_CPL_X_OOR P (X = 1 to 2)	User Configurable Thermocouple Input X Out of Range (X = 1 to 2)	Pre-Alarm
THRM_CPL_X_U1 (X = 1 to 2)	User Configurable Thermocouple Input X Under 1 (X = 1 to 2)	Status
THRM_CPL_X_U1 A (X = 1 to 2)	User Configurable Thermocouple Input X Under 1 (X = 1 to 2)	Alarm
THRM_CPL_X_U1 P (X = 1 to 2)	User Configurable Thermocouple Input X Under 1 (X = 1 to 2)	Pre-Alarm
THRM_CPL_X_U2 (X = 1 to 2)	User Configurable Thermocouple Input X Under 1 (X = 1 to 2)	Status
THRM_CPL_X_U2 A (X = 1 to 2)	User Configurable Thermocouple Input X Under 1 (X = 1 to 2)	Alarm
THRM_CPL_X_U2 P (X = 1 to 2)	User Configurable Thermocouple Input X Under 1 (X = 1 to 2)	Pre-Alarm
WEAK BATTERY P	Weak Battery	Pre-Alarm

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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 <u>B</u>asler <u>E</u>lectric <u>S</u>oftware <u>T</u>ool for <u>C</u>ommunications, <u>O</u>perations, <u>M</u>aintenance, and <u>S</u>ettings.

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

The DGC-2020 plug-in 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 plug-in with BESTCOMS*Plus*.
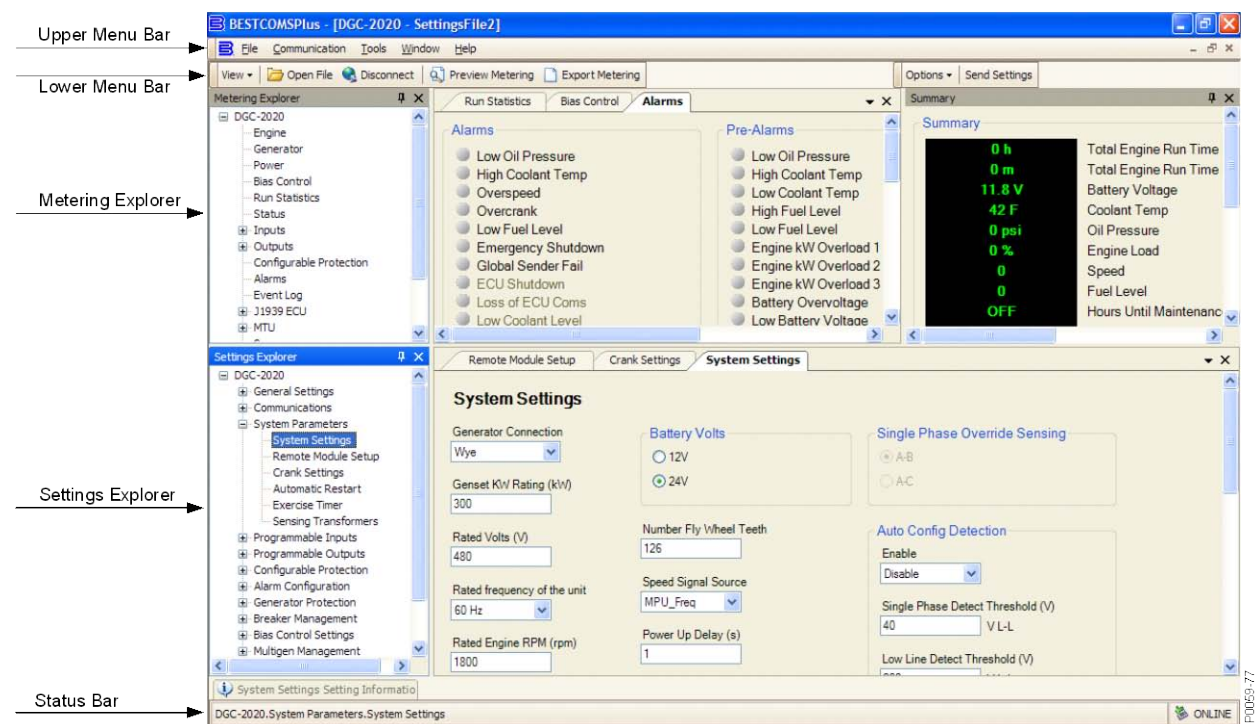
Figure 4-1. Typical User Interface Components

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 plug-in and the .NET Framework (if not already installed). BESTCOMS*Plus* operates with IBM-compatible personal computers (PCs) using Windows® XP 32-bit SP2/SP3, Windows® Vista 32-bit (all editions), Windows® 7 32-bit (all editions), and Windows® 7 64-bit (all editions). 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

Component	Recommendation
Processor	1.0 GHz
RAM	256 MB
Hard Drive	25 MB (if .NET Framework is already installed on PC.)
	250 MB (if .NET Framework is not already installed on PC.)

In order to install and run BESTCOMS*Plus*, a Windows user must have administrator rights. A Windows user with limited rights may not be permitted to save files in certain folders.

Installing BESTCOMS*Plus*

> **NOTE**
>
> Do <u>not</u> connect USB cable until setup completes successfully. Connecting USB cable before setup is complete may 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 automatically installs BESTCOMS*Plus*, the .NET Framework (if not already installed), and the DGC-2020 plug-in 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, when clicked, starts BESTCOMS*Plus*.

STARTUP AND ACTIVATION

Starting BESTCOMS*Plus*

To start BESTCOMS*Plus*, click the *Start* button, *Programs*, *Basler Electric*, and then the *BESTCOMSPlus* icon. During initial startup, the *BESTCOMSPlus Select Language* screen is displayed (Figure 4-2). You can select 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 later be accessed by selecting <u>T</u>ools and <u>S</u>elect Language from the menu bar.
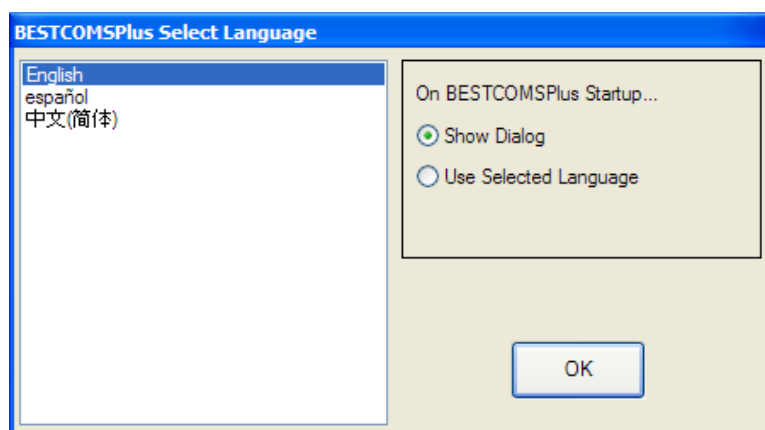
Figure 4-2. BESTCOMSPlus Select Language

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. If a DGC-2020 is connected, select <u>New</u> Connection from the <u>C</u>ommunication pull-down menu and select *DGC-2020*. See Figure 4-4. The DGC-2020 plug-in is automatically activated after connecting to a DGC-2020.
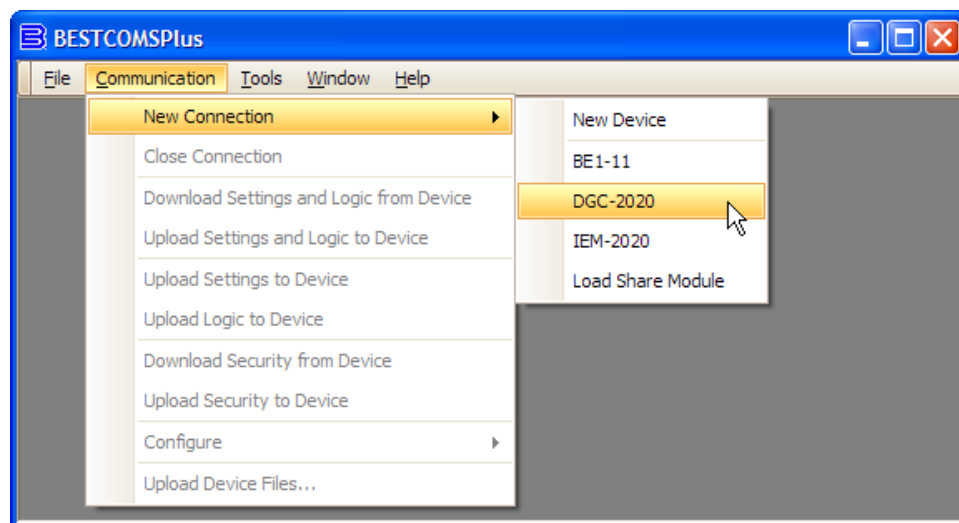
Figure 4-4. Communication Pull-Down Menu

If a DGC-2020 is not connected, select <u>New</u> from the <u>F</u>ile pull-down and select *DGC-2020*.

Activating the DGC-2020 Plug-In

The DGC-2020 plug-in must be activated before it can be used to set up a DGC-2020 product. If the DGC-2020 plug-in has already been activated, skip to *Communication*.

Requesting an Activation Key

When initially running the DGC-2020 plug-in, the *Activate Device* pop-up will appear. You must contact Basler Electric for an activation key before you can activate the DGC-2020 plug-in. You may request an activation key through email or the Basler Electric website. Click on either the *Website* or *Email* button. Click on the *Activate* button when you are ready to enter the activation key you received from Basler Electric. The *Device Needs Activated* pop-up will appear. Refer to Figure 4-5.

Select the device 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 on the *Activate* button to continue. The *Device Needs Activated* screen is also found by selecting *Activate Device* from the <u>T</u>ools pull-down menu of the BESTCOMS*Plus* main shell.

Figure 4-5. Device Needs Activated

COMMUNICATION

If connecting to the DGC-2020 through the USB or modem port, click <u>C</u>ommunication on the menu bar, followed by *New Connection and DGC-2020* as shown in Figure 4-6. The *DGC-2020 Connection* screen shown in Figure 4-7 will appear. If Ethernet communication is desired, skip to *Ethernet Communication.*
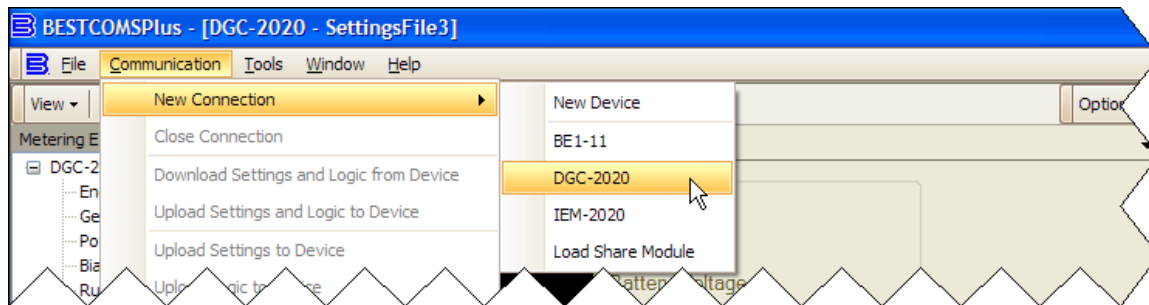
Figure 4-6. Communication, New Connection, DGC-2020
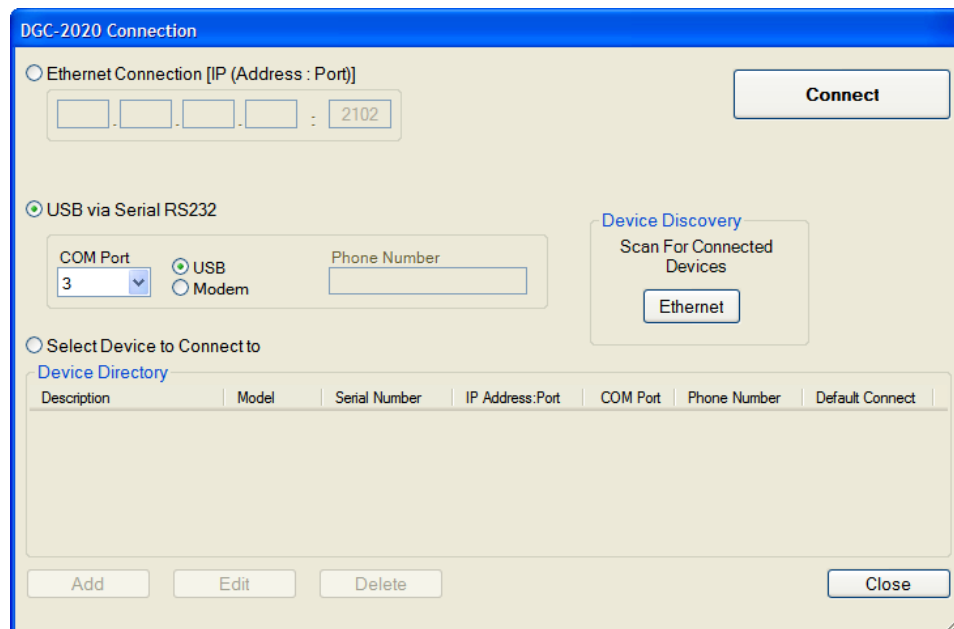
Figure 4-7. DGC-2020 Connection

USB Communication

If connecting to the DGC-2020 through a USB cable, 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 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 4-8.
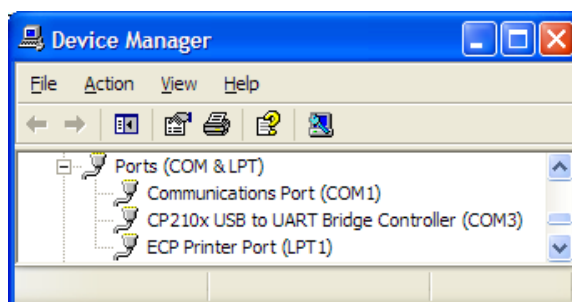
Figure 4-8. Windows® Device Manager

Installing the USB Driver if Automatic Installation Fails

To install the USB driver for the DGC-2020:

1. Apply operating power to the DGC-2020 and wait for the boot sequence to complete.
2. Plug the proper end of the USB cable into the PC and the other end into the 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. Browse to the \driver folder on the CD-ROM and select *Next* to continue.

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

Modem Communication (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.

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. The settings are configured through the DGC-2020 and sent to the LSM-2020 over the CANbus interface. The following procedure is used to configure LSM-2020 network settings and connect to the DGC-2020 through Ethernet via an LSM-2020.

1. Navigate to the *Settings, System Params, System Settings, LSM Setup* screen on the front panel HMI and verify that the LSM-2020 is enabled with the correct CANbus 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 CANbus address can be found by using the Settings Explorer in BESTCOMS*Plus* to open the *System Parameters, System Settings* tree branch as shown in Figure 4-20. The DGC-2020 will annunciate a pre-alarm if the LSM-2020 is not connected properly when it is enabled. If the connection is valid, the network settings of the LSM-2020 can be configured through the USB interface of the DGC-2020.

2. Connect to the DGC-2020 through the USB port as described under *USB Communication.* Select *Configure, Ethernet* from the *File* pull-down menu. If the LSM-2020 is connected properly, the *Configure Ethernet Port* screen shown in Figure 4-9 will appear.
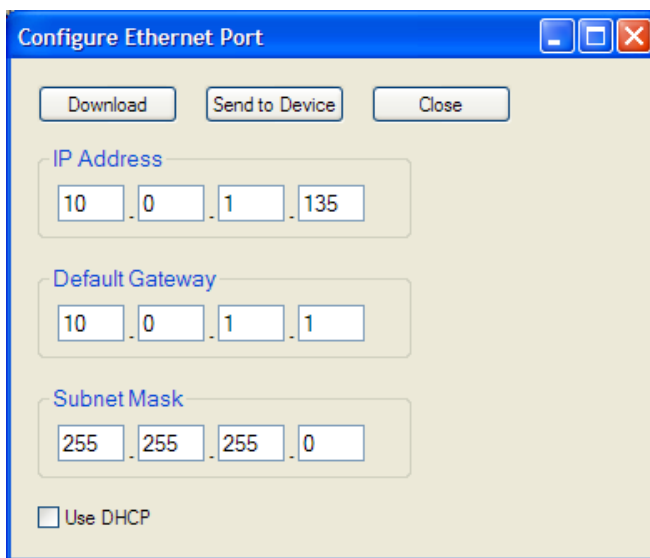
Figure 4-9. Configure Ethernet Port

Configurable options include:

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 may 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* may 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 4-7 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 correctly configured 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 may prevent device discovery from functioning properly. This issue may 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 4-7) 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 automatically read all settings and logic from the DGC-2020 and load them into BESTCOMS*Plus* memory. See Figure 4-10.
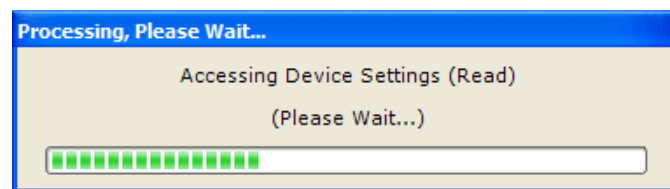
Figure 4-10. Processing, Please Wait…

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, setup communications, 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, switch to live mode, and send a settings file to the DGC-2020.

Upper Menu Bar (BESTCOMS*Plus* Shell)

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 Preview .... Preview a settings file printout
- Print To File... Save as rich text file type (∗.rtf)
- Print.. Print 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 connection
- Download Settings and Logic from Device ... Download operational and logic settings from the device
- Upload Settings and Logic to Device .... Upload operational and logic settings to the device
- Upload Logic .... Upload logic settings to the device
- Download Security .... Download security settings from the device
- Upload Security.. Upload security settings to the device
- Configure... Ethernet Settings
- Upload Device Files .... Upload a device package (firmware/language module)

Tools

- Check For Updates .... Check for BESTCOMS*Plus* updates via the internet
- Select Language .... Select BESTCOMS*Plus* language
- Activate Device .... Activate the product instance (DGC-2020 plug-in)
- Set File Password .... Password protect a settings file
- Compare Settings Files............................... Compare settings files
- Event Log - View .... View the BESTCOMS*Plus* event log
- Event Log - Clear .... Clear the BESTCOMS*Plus* event log
- Event Log - Set New File Name.................... Set a new file name for event log

Window

- Cascade All .... Cascade all windows
- Tile .... Tile horizontally or vertically
- Maximize All .... Maximize all windows

Help

- About... View general, detailed build, and system information

Lower Menu Bar (DGC-2020 Plug-In)

View

This clickable icon allows you to view the Metering Panel, Settings Panel, or Show Settings Information.

Open File

This clickable icon is used to open a saved settings file.

Connect/Disconnect

When clicked, the *DGC-2020 Connection* screen opens allowing the user to connect via USB or a modem. This button is also used to disconnect from the device.

Print Preview Metering

Clicking on this icon will bring up the *Print Preview* screen where a preview of the Metering printout is shown. Click on the printer icon to send to a printer.

Export Metering

The *Export Metering* button allows all metering values to be exported into a *.csv or *.txt file.

Options

When clicked, a drop-down list appears. *Live Mode Settings* puts BESTCOMS*Plus* in *Live* mode where settings are automatically sent to the device in real time as they are changed.

Send Settings

This button is used when BESTCOMS*Plus* is not operating in Live Mode. Click on 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 plug-in as listed in the following paragraphs.

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

DGC-2020 AND SYSTEM PARAMETERS

Prior to use, the DGC-2020 must be configured for operation in the intended application. The description of these configuration settings is 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

NOTE

In the following descriptions, superscript letters (e.g., setting^x) mark words and phrases relating to DGC-2020 settings. Each letter references settings illustrated in BESTCOMS*Plus*. Lettered notes at the end of each group of descriptions provide the range and increment for each setting.

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[A] 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[B], 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*.

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

When Scrolling Screen is enabled[D], the front panel summary screen will scroll through the list of Scrolling Screen Items[E]. The Scrolling Screen Delay[F] 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[G] 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[HI] are displayed on the initial boot screen of the DGC-2020.

BESTCOMS*Plus* front panel HMI settings are illustrated in Figure 4-11.

Figure 4-11. Front Panel HMI Settings

[A] *LCD Contrast Value:* Adjustable from 0 to 100 (maximum contrast) in increments of 1.
[B] *Front Panel Sleep Mode:* Enable or Disable.
[C] *Language:* English, Chinese, or Spanish.
[D] *Scrolling Screen Enable:* Enable or Disable.
[E] *Configurable HMI Summary Settings:* Select Scrolling Screen Item 1 through 20.
[F] *Scrolling Screen Delay:* Adjustable from 1 to 120 s in 1 s increments.
[G] *Phase Toggle Delay:* Adjustable from 0 to 120 s in 1 s increments.
[H] *Initializing Message 1:* Accepts an alphanumeric string of up to 16 characters. Displayed on the second line of the initial boot screen.
[I] *Initializing Message 2:* Accepts an alphanumeric string of up to 16 characters. Displayed on the third line of the initial boot screen.

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 tab.

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.

BESTCOMS*Plus* style number selections and definitions are illustrated in Figure 4-12.
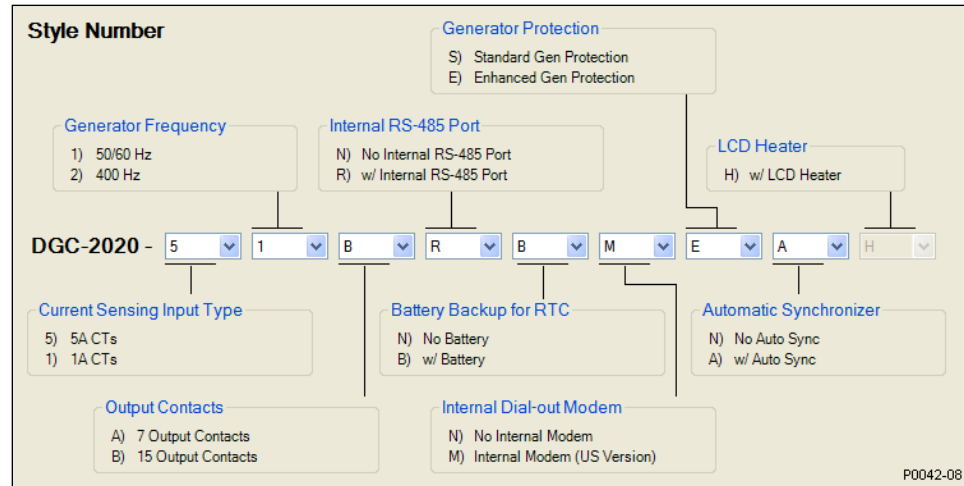
Figure 4-12. DGC-2020 Style Chart Selections and Definitions

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[A] when configuring DGC-2020 settings off-line. When on-line, read-only information includes the application version[B], boot code version[C], application build date[D], serial number[E], application part number[F], model number[G], Language Module Version[H], and Language Module Part Number[I].

The user can assign site-specific information for the DGC-2020. This label includes a unit name string[J].

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[K], boot code version[L], application build date[M], serial number[N], application part number[O], and model number[P]. The *Refresh* button[Q] is used to refresh the screen after connecting an optional LSM-2020.

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[R], boot code version[S], application build date[T], serial number[U], application part number[V], and model number[W]. The *Refresh* button[X] is used to update the screen after connecting an optional CEM-2020.

BESTCOMS*Plus* device information values and settings are illustrated in Figure 4-13.

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[Y], boot code version[Z], application build date[AA], serial number[BB], application part number[CC], and model number[DD]. The *Refresh* button[EE] is used to update the screen after connecting an optional AEM-2020.

BESTCOMS*Plus* device information values and settings are illustrated in Figure 4-13.

Figure 4-13. Device Info Values and Settings

[A] *Application Version:* When configuring DGC-2020 settings off-line, the application version for the unit to be configured must be selected.
[B] *Application Version:* Read-only value obtained when BESTCOMS*Plus* is communicating with the DGC-2020.

^C *Boot Code Version:* Read-only value obtained when BESTCOMS*Plus* is communicating with the DGC-2020.

^D *Application Build Date:* Read-only value obtained when BESTCOMS*Plus* is communicating with the DGC-2020.

^E *Serial Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with the DGC-2020.

^F *Application Part Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with the DGC-2020.

^G *Model Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with the DGC-2020.

^H *Language Module Version:* Read-only value obtained when BESTCOMS*Plus* is communicating with the DGC-2020.

^I *Language Module Part Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with the DGC-2020.

^J *Unit Name String:* Accepts an alphanumeric character string of up to 16 characters.

^K *Application Version:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional LSM-2020.

^L *Boot Code Version:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional LSM-2020.

^M *Application Build Date:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional LSM-2020.

^N *Serial Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional LSM-2020.

^O *Application Part Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional LSM-2020.

^P *Model Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional LSM-2020.

^Q *Refresh:* Clicking this button will refresh the screen after connecting an optional LSM-2020.

^R *Application Version:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional CEM-2020.

^S *Boot Code Version:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional CEM-2020.

^T *Application Build Date:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional CEM-2020.

^U *Serial Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional CEM-2020.

^V *Application Part Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional CEM-2020.

^W *Model Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional CEM-2020.

^X *Refresh:* Clicking this button will refresh the screen after connecting an optional CEM-2020.

^Y *Application Version:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional AEM-2020.

^Z *Boot Code Version:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional AEM-2020.

^{AA} *Application Build Date:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional AEM-2020.

^{BB} *Serial Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional AEM-2020.

^{CC} *Application Part Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional AEM-2020.

^{DD} *Model Number:* Read-only value obtained when BESTCOMS*Plus* is communicating with an optional AEM-2020.

^{EE} *Refresh:* Clicking this button will refresh the screen after connecting an optional AEM-2020.

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
  - Cooldown 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. Figure 4-14 illustrates the *Device Security Setup* screen with all three of the access levels shown.

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

Figure 4-14. Device Security Setup

[A] *Access Level/Password:* Read-only value obtained when BESTCOMS*Plus* is communicating with the DGC-2020.
[B] *Password:* Accepts an alphanumeric character string of up to 16 characters.
[C] *Save Password:* Clicking this button will save the password changes in BESTCOMS*Plus* memory.

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. Also, 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 <u>C</u>ommunications pull-down menu. This is the step where passwords are sent to the DGC-2020. Failure to perform this step may 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 logic. Select *No* if all you need to do is update security. If you select *No*, the settings file opens into BESTCOMSPlus 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 <u>C</u>ommunications 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 BESTCOMSPlus 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 BESTCOMSPlus. 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*[A]. Choose the type of *DST Configuration*[B] and then set the *Start Day*[C], *End Day*[D], and *Bias*[E]. See Figure 4-15.

Clock Not Set Warning Enable

When the clock not set warning[F] is enabled, the DGC-2020 will notify the user when the clock is not set.

Figure 4-15. Clock Setup

[A] *UTC Offset (min):* Adjustable from -1,440 to 1,440 minutes in increments of 1.
[B] *DST Configuration:* Disabled, Fixed, or Floating.

C *Start Day:*
> Fixed DST Configuration
> Month (January to December), Day of Month (1 to 31 in increments of 1), Hour (0 to 23 in increments of 1), Minute (0 to 59 in increments of 1).
> Floating DST Configuration
> Month (January to December), Occurrence of Day (First to Fourth, or Last), Weekday (Sunday to Saturday), Hour (0 to 23 in increments of 1), Minute (0 to 59 in increments of 1).

D *End Day:*
> Fixed DST Configuration
> Month (January to December), Day of Month (1 to 31 in increments of 1), Hour (0 to 23 in increments of 1), Minute (0 to 59 in increments of 1).
> Floating DST Configuration
> Month (January to December), Occurrence of Day (First to Fourth, or Last), Weekday (Sunday to Saturday), Hour (0 to 23 in increments of 1), Minute (0 to 59 in increments of 1).

E *Bias:* Hour (0 to 23 in increments of 1), Minute (0 to 59 in increments of 1).

F *Clock Not Set Warning Enabled:* Enable or Disable.

COMMUNICATIONS

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

CANbus Setup

The DGC-2020 CANbus 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[A], 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[B], the DGC-2020 will receive and retain unsolicited diagnostic trouble codes (DTCs) from an ECU with DTC capabilities.

A DGC-2020 operating on a CANbus network is identified by a unique address number[C].

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[D]. 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[E] may be disabled.

The BESTCOMS*Plus* CANBus Setup screen is illustrated in Figure 4-16.

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.*[F] 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.*[G] The time in minutes that the controller waits before pulsing.

- *Settling Time.*[H] 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.*[I] The time in seconds to attempt communication with the ECU when the DGC-2020 is in the pulsing state or connecting state.

Figure 4-16. CANbus Setup

[A] *Enable ECU Support:* Check box to enable ECU support.
[B] *Enable DTC Support:* Check box to enable DTC support.
[C] *CANbus Address:* Accepts an address number from 1 to 253 in increments of 1.
[D] *Output Select:* Fuel Contact (RUN) or Pre-start Contact.
[E] *Pulsing:* Enable or Disable.
[F] *Engine Shutdown:* Adjustable from 1 to 60 s in 1 s increments.
[G] *Pulse Cycle Time:* Adjustable from 1 to 60 min in 1 min increments.
[H] *Settling Time:* Adjustable from 5,500 to 30,000 ms in 1 ms increments.
[I] *Response Timeout:* Adjustable from 1 to 60 s in 1 s increments.

ECU Setup

The DGC-2020 can be configured for Standard, Volvo Penta, MTU MDEC, MTU ADEC, MTU ECU7, GM, or CUMMINS[A]. When the Generator Parameter Transmit[B] setting is enabled, the DGC-2020 broadcasts generator metered parameters over CANbus as listed in Table 4-2.

Table 4-2. Generator Parameter Transmit

PGN Name	PGN	Hex	SPN	Parameter	Bytes within PGN Data
Generator Total AC Energy	65018	FDFA	2468	Generator Total kW Hours Export	1 to 4
			2469	Generator Total kW Hours Import	5 to 8
Generator Total AC Reactive Power	65028	FE04	2456	Generator Total Reactive Power	1 to 4
			2464	Generator Overall Power Factor	5 to 6
			2518	Generator Overall Power Factor Lagging	7, bits 1 & 2
Generator Total AC Power	65029	FE05	2452	Generator Total Real Power	1 to 4
			2460	Generator Total Apparent Power	5 to 8
Generator Average Basic AC Quantities	65030	FE06	2440	Generator Average L-L AC RMS Voltage	1 to 2
			2444	Generator Average L-N AC RMS Voltage	3 to 4
			2436	Generator Average AC Frequency	5 to 6
			2448	Generator Average AC RMS Current	7 to 8
Engine Temperature	65262	FEEE	110	Engine Coolant Temperature (Not sent when CANbus is enabled.)	1
Engine Fluid Level/Pressure	65263	FEEF	100	Engine Oil Pressure (Not sent when CANbus is enabled.)	4
Dash Display	65276	FEFC	96	Fuel Level	2

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[C] 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[D] 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 unless an LSM-2020 is present and the DGC-2020 senses the generator breaker is closed. I this case 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.

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.

Diesel Particulate Filter (DPF)

The diesel particulate filter settings are used when the ECU is configured for Standard, Volvo Penta, MTU ADEC, GM, or Cummins. The DGC-2020 supports the CANbus 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 CANbus indicates that regeneration is required.
- DPF Regenerate Disabled pre-alarm − announced when the engine ECU reports via CANbus that DPF regeneration is disabled.
- High Exhaust Temperature pre-alarm − announced when the ECU reports via CANbus that a high exhaust temperature condition exists.

Two parameters are provided to initiate or disable DPF regeneration. The first, Manual Regeneration[E], is transmitted to the engine over CANbus to initiate DPF regeneration. The second, Disable Regeneration[F],

is transmitted to the engine over CANbus 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[G]
- Speed Demand Switch[H]
- Engine RPM[I]
- NMT Alive Transmit Rate[W] - 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[E] - Specifies speed demand source for the MTU engine ECU.
- Engine RPM[F] - Requested engine RPM when speed demand source is analog CAN for an MTU ECU.
- Overspeed Test[J] - Temporarily drives an MTU ECU into overspeed for testing overspeed.
- Governor Param Switch Over[K] - Specifies which governor parameters an MTU ECU should use.
- Trip Reset[L] - Resets trip information such as trip fuel used, trip hours, trip idle time, etc.
- Int Oil Prime[M] - Causes an MTU ECU engine to perform an internal lubrication cycle.

If the engine is configured as MTU ECU7, the configuration of the following settings is necessary:

- Speed Demand Switch[E] - Specifies speed demand source for the MTU engine ECU.
- Engine RPM[F] - Requested engine RPM when speed demand source is analog CAN for an MTU ECU.
- Overspeed Test[G] - Temporarily drives an MTU ECU into overspeed for testing overspeed.
- Speed Up[N] - Increases speed of the MTU ECU.
- Speed Down[O] - Decreases speed of the MTU ECU.
- Idle Request[P] - Turns the idle request on or off.
- Increased Idle[Q] - Sets the MTU ECU idle.
- Trip Reset[I] - Resets trip information such as trip fuel used, trip hours, trip idle time, etc.
- MTU 50 Hz 60 Hz Switch Setting[R] - Selects MTU operating frequency.
- Int Oil Prime[J] - Causes an MTU ECU engine to perform an internal lubrication cycle.
- Engine Start Prime[S] - Turns the engine start prime on or off.
- Fan Override[T] - Turns the fan override on or off.
- Mode Switch[U] - Turns the mode switch on or off.
- Governor Param Switch Over[H] - Specifies which governor parameters an MTU ECU should use.
- Governor Param Set Select[V] - Sets the governor parameter set select.
- CAN Rating Switch 1 & 2[W] - Turns the CAN rating switch 1 & 2 on or off.
- Cylinder Cutout Disable 1 & 2[X] - Turns the cylinder cutout disable 1 & 2 on or off.
- MTU ECU7 Module Type[Y] - Specifies ECU7 Module type.
- NMT Alive Transmit Rate[Z] - Specifies the rate at which messages are transmitted to the MTU engine.

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

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

Figure 4-17. ECU Setup

[A] *ECU Type:* Standard, Volvo Penta, MTU MDEC, MTU ADEC, MTU ECU7, GM, or Cummins.
[B] *Generator Parameter Transmit:* Enable or Disable.
[C] *Speed Select:* Primary or Secondary.
[D] *Accelerator Position:* Adjustable from 0 to 100% in 1% increments.
[E] *Manual Regeneration:* Off or On.
[F] *Disable Regeneration:* Off or On.
[G] *MDEC Module Type:* CAN Module 201, 302, 303, or 304.
[H] *Speed Demand Switch:* Analog CAN, Up Down ECU, Up Down CAN, Analog ECU, Frequency, No CAN Demand.
[I] *Engine RPM:* Adjustable from 1,400 to 2,000 in increments of 1.
[J] *Overspeed Test:* Off or On.
[K] *Governor Param Switch Over:* Off or On.
[L] *Trip Reset:* Press to set.
[M] *Int Oil Prime:* Press to set.
[N] *Speed Up:* Press to set.
[O] *Speed Down:* Press to set.
[P] *Idle Request:* Off or On.
[Q] *Increased Idle:* 0 to 1,000 in increments of 1.
[R] *MTU 50 Hz 60 Hz Switch Setting:* 50 Hz or 60 Hz.
[S] *Engine Start Prime:* Off or On.
[T] *Fan Override:* Off or On.
[U] *Mode Switch:* Off or On.
[V] *Governor Param Set Select:* 0 to 1,000 in increments of 1.
[W] *CAN Rating Switch 1 & 2:* Off or On.
[X] *Cylinder Cutout Disable 1 & 2:* Off or On.
[Y] *MTU ECU7 Module Type:* 501 or 502.
[Z] *NMT Alive Transmit Rate:* 100 to 500 ms in 100 ms increments.

Modem Setup (Optional)

DGC-2020 controllers with style number xxxxxMxxx are equipped with an internal telephone modem that has dial-in and dial-out capability. The modem gives the DGC-2020 the ability to dial up to four telephone numbers[A] and annunciate user-selected conditions to specified pagers[B]. These user-selected conditions include[C]:

- 27-1 Trip Alarm
- 27-2 Trip Alarm
- 32 Trip Alarm
- 40 Trip Alarm
- 47 Trip Alarm
- 51-1 Trip Alarm
- 51-2 Trip Alarm
- 51-3 Trip Alarm
- 59-1 Trip Alarm
- 59-2 Trip Alarm
- 81O Trip Alarm
- 81U Trip Alarm
- 27-1 Trip Pre-Alarm
- 27-2 Trip Pre-Alarm
- 32 Trip Pre-Alarm
- 40 Trip Pre-Alarm
- 47 Trip Pre-Alarm
- 51-1 Trip Pre-Alarm
- 51-2 Trip Pre-Alarm
- 51-3 Trip Pre-Alarm
- 59-1 Trip Pre-Alarm
- 59-2 Trip Pre-Alarm
- 78 Vector Shift Trip
- 81O Trip Pre-Alarm
- 81U Trip Pre-Alarm
- 81 ROCOF Trip
- AEM Comm Failure
- Auto Restart Failure Alarm
- Auxiliary Input X Closed (X = 1 to 16)
- AVR Output Limit
- Battery Charger Fail Status
- Battery Overvoltage Pre-Alarm
- CEM Comm Failure
- Config Element X Status (X = 1 to 8)
- Coolant Temp Sender Fail Alarm
- Coolant Temp Sender Fail Pre-Alarm
- Cooldown Timer Active
- DPF Regeneration Inhibited
- DPF Regeneration Required
- Duplicate AEM Pre-Alarm
- Duplicate CEM Pre-Alarm
- Duplicate LSM Pre-Alarm
- Emergency Stop Alarm
- Engine Running
- Fuel Leak Detect Status
- Fuel Level Sender Fail Alarm
- Fuel Level Sender Fail Pre-Alarm
- GOV Output Limit
- High Coolant Temperature Alarm
- High Coolant Temp Pre-Alarm
- High Exhaust Temperature
- High Fuel Pre-Alarm
- ID Missing Pre-Alarm
- ID Repeat Pre-Alarm
- Intergenset Comms Failure
- kW Overload 1 Pre-Alarm

- kW Overload 2 Pre-Alarm
- kW Overload 3 Pre-Alarm
- Loss of ECU Coms Alarm
- Loss of ECU Coms Pre-Alarm
- Loss of Generator Voltage Sensing Alarm
- Low Battery Voltage Pre-Alarm
- Low Coolant Level Status
- 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)
- 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[D] specifies seven data bits with even parity. If required, eight data bits with no parity may be specified.

The message string sent by the DGC-2020 can be limited to a length supported by the receiving pagers[E]. 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[F]. This interval gives an operator the opportunity to dial into the DGC-2020. A second user-defined interval[G] determines how frequently dial-out attempts are made following a dial-out failure.

You might 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 you hear a modem sound, the number dialed is correct.

Dial-In

When the DGC-2020 modem shares a line used for voice communication, the number of rings[H] required for the modem to answer can be increased to allow time for an operator to answer an incoming telephone call.

The BESTCOMS*Plus* Modem Setup screen is illustrated in Figure 4-18.

Figure 4-18. Modem Setup

A *Dial Out Number:* Accepts a telephone number of up to 16 characters.
B *Pager ID:* Accepts a pager identification number of up to 16 characters.
C *Modem Dialout Conditions:* Check boxes to select conditions that will initiate a dial-out message.
D *Pager Coms Data Format:* 7 bit – Even Parity or 8 bit – No Parity.
E *Pager Buffer Limit:* Adjustable from 80 to 200 characters in increments of 40.
F *Modem Offline Delay:* Adjustable from 1 to 240 min in 1 min increments.
G *Inter Dialout Activation Delay:* A delay of 15, 30, 60, or 120 s may be selected.
H *Rings for Modem Answer:* Adjustable from 1 to 9 in increments of 1.

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 HMI. 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 may be established.

RS-485 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[A], parity[B], and port address[C]. Fixed RS-485 port 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*.

BESTCOMS*Plus* RS-485 port settings are illustrated in Figure 4-19.

Figure 4-19. RS-485 Setup

A *Baud Rate:* A value of 1200, 2400, 4800, or 9600 may be selected.
B *Parity:* No Parity, Odd Parity, or Even Parity.
C *Modbus Address:* A value of 1 to 247 may be entered in increments of 1.

SYSTEM PARAMETERS

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

System Settings

The following settings are used to configure the DGC-2020 for operation with a specific genset application.

Genset Electrical Parameters

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

Genset connection types[A] 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).

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

The System Type setting[D] 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[E] 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 and 40Q protection functions use the Rated Power Factor setting[F] when determining pickup.

Engine Speed Measurement

The DGC-2020 can be configured to detect engine speed[G] from a magnetic pickup (MPU), the genset frequency, or both the MPU and genset frequency.

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

When engine speed is obtained from an MPU, the DGC-2020 uses the nominal rpm rating[I] and the number of flywheel teeth[J] 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 CANbus 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[K] expressed as a percentage of the genset CT (nominal) primary rating.

The Low Line Scale Factor setting[L] is used to automatically adjust the EPS threshold setting in applications that may 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[M]. Engine oil pressure has an additional parameter[N] for Metric Pressure Units.

Battery Voltage

The nominal voltage[O] 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[P]. 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 Function

This setting[Q] 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*.

Power Up Delay

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

BESTCOMS*Plus* system settings (DGC-2020, System Parameters, System Settings) are illustrated in Figure 4-20.

Figure 4-20. System Settings

[A] *Generator Connection:* Delta, Wye, 1-Phase A-B, 1-Phase A-C, or Grounded Delta.
[B] *Genset kW Rating:* Adjustable from 5 to 9,999 kW in 1 kW increments.
[C] *Rated Volts:* Adjustable from 1 to 99,999 Vac in 1 Vac increments.
[D] *System Type:* Single Generator or Multiple Generator.
[E] *Alternate Frequency:* Adjustable from 10 to 450 Hz in 0.01 Hz increments.
[F] *Rated Power Factor:* Adjustable from –1 to +1 in increments of 0.0001.
[G] *Speed Signal Source:* MPU, Gen Freq, or MPU Freq.
[H] *Rated Frequency:* 50/60 or 400 Hz.
[I] *Rated Engine RPM:* Adjustable from 750 to 3,600 rpm in 1 rpm increments.
[J] *Number Fly Wheel Teeth:* Adjustable from 50 to 500 in increments of 1.

[K] *EPS Current Threshold:* Adjustable from 3 to 10% of the CT primary rating in 1% increments.

[L] *Low Line Scale Factor:* Adjustable from 0.001 to 3 in increments of 0.001.

[M] *System Units:* English or Metric.

[N] *Metric Pressure Units:* Bar or kPa.

[O] *Battery Volts:* 12 or 24 Vdc.

[P] *NFPA Level:* 0 disables NFPA compliance, 1 enables Level 1 NFPA compliance, 2 enables Level 2.

[Q] *Fuel Level Function:* Disable, Fuel Lvl, Natural Gas, or Liquid Propane.

[R] *Power Up Delay:* Adjustable from 0 to 60 seconds in 1 second increments.

Remote Module Setup

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

Load Sharing Module

A J1939 Address[A] must be entered when an optional LSM-2020 is enabled[B].

Contact Expansion Module

A J1939 Address[C] must be entered when the optional CEM-2020 is enabled[D]. Select number of CEM-2020 outputs[E].

Analog Expansion Module

A J1939 Address[F] must be entered when the optional AEM-2020 is enabled[G].

BESTCOMS*Plus* system settings (DGC-2020, System Parameters, Remote Module Setup) are illustrated in Figure 4-21.

Figure 4-21. Remote Module Setup

[A] *LSM J1939 Address:* Adjustable from 1 to 253 in increments of 1.

[B] *Load Share Module:* Enable or Disable.

[C] *CEM J1939 Address:* Adjustable from 1 to 253 in increments of 1.

[D] *Contact Expansion Module:* Enable or Disable.

[E] *CEM Outputs:* 18 Outputs or 24 Outputs.

[F] *AEM J1939 Address:* Adjustable from 1 to 253 in increments of 1.

[G] *Analog Expansion Module:* Enable or Disable.

Crank Settings

The DGC-2020 can be programmed for either cycle or continuous engine cranking[A]. Cycle cranking provides multiple engine starting attempts[B]. Each starting attempt consists of a fixed interval of engine cranking[C] followed by a rest interval of the same duration. Continuous cranking[D] 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[E] 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[F], 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[G].

The Pre-Start can be configured[H] 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[I] 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[J], the starter will be disconnected from the engine.

Engine Cooldown

After a genset's load is removed, the DGC-2020 can ensure proper engine and turbocharger cooldown by maintaining engine operation for a user-specified duration[K]. The cooldown time delay is initiated for any one of the following conditions:

- Genset load is removed and engine shutdown is permitted
- Auto transfer switch (ATS) opens while operating in Auto mode
- Remote shutdown is initiated

Off Mode Cooldown

When Off Mode Cooldown[L] 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 cooldown cycle for the duration of the No Load Cooldown Time[K]. 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 Cooldown 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 cooldown cycle. If the machine was in the AUTO mode when the OFF button was pressed, it remains in AUTO mode until the cooldown 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 cooldown is in progress. In addition, the unit will display "OFF MODE COOLDN" while the cooldown timer is displayed.

If the RUN button is pressed while an Off Mode Cooldown is in progress, the cooldown will be aborted and the unit will go to RUN mode.

If the AUTO button is pressed while an Off Mode Cooldown is in progress, the Off Mode Cooldown 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 cooldown cycle then stop and remain in AUTO.

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

The Off Mode Cooldown 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 Cooldown enable setting is cleared and OFF mode cooldown is not allowed.

After a genset's load is removed, the DGC-2020 can ensure proper engine and turbocharger cooldown by maintaining engine operation for a user-specified duration. The cooldown time delay is initiated for any one of the following conditions:

- Genset load is removed and engine shutdown is permitted
- Auto transfer switch (ATS) opens while operating in Auto mode
- Remote shutdown is initiated

BESTCOMS*Plus* engine cranking settings (DGC-2020, System Parameters, Crank Settings) are illustrated in Figure 4-22.

Figure 4-22. Engine Crank Settings

[A] *Cranking Style*: Cycle or Continuous.

[B] *Number of Crank Cycles*: Adjustable from 1 to 7 cycles in 1 cycle increments. Controllers configured for NFPA compliance have a 1 to 3-cycle range.

[C] *Cycle Crank Time*: Adjustable over the range of 5 to 15 seconds in 1 second increments.

[D] *Continuous Crank Time*: Adjustable from 5 to 60 seconds in 1 second increments. Controllers configured for NFPA compliance have a 1 to 45 second range.

[E] *Crank Disconnect Limit*: Adjustable from 10 to 100% of nominal engine speed.

[F] *Pre-Crank Delay*: Adjustable from 0 to 30 seconds in 1 second increments.

[G] *Pre-Start Contact Configuration*: Open After Disconnect or Closed While Running.

[H] *Prestart Rest Configuration:* Off During Rest, On During Rest, or Preheat Before Crank.

[I] *Oil Pressure Crank Disconnect Enable:* Disable or Enable.

[J] *Crank Disconnect Pressure (psi):* Adjustable from 2.9 to 150 psi in 0.1 psi increments, 0.2 to 10.3 Bar in 0.1 Bar increments, or 20 to 1,034.5 kPa in 0.1 kPa increments.
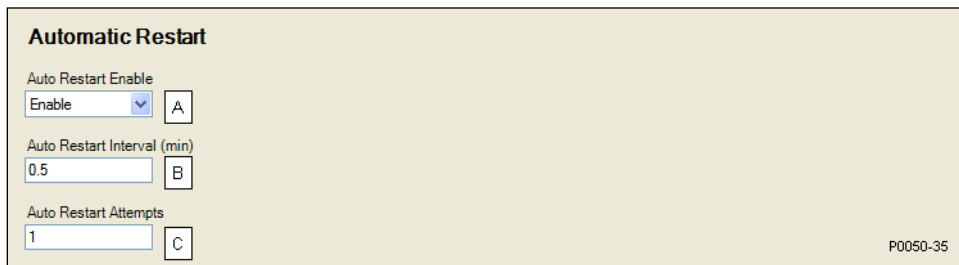
[K] *No Load Cool Down Time:* Adjustable from 0 to 60 minutes in 1 minute increments.

[L] *Off Mode Cool Down Enable:* Enable or Disable.

Automatic Restart

If the DGC-2020 has shut down due to an alarm condition, the automatic restart, when enabled[A], will automatically clear alarms. An attempt to restart the engine is made after a predetermined time delay[B] 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[C] is programmable. Automatic restart attempts are recorded in the event log.

BESTCOMS*Plus* automatic restart settings (DGC-2020, System Parameters, Automatic Restart) are illustrated in Figure 4-23.

Automatic Restart

Auto Restart Enable

| Enable ⌄ | A |

Auto Restart Interval (min)

| 0.5 | B |

Auto Restart Attempts

| 1 | C |

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Figure 4-23. Automatic Restart Settings

[A] *Auto Restart Enable:* Enable or Disable.
[B] *Auto Restart Interval:* Adjustable from 0.5 to 30 minutes in 0.5 minute increments.
[C] *Auto Restart Attempts:* Adjustable from 1 to 10 in increments of 1.
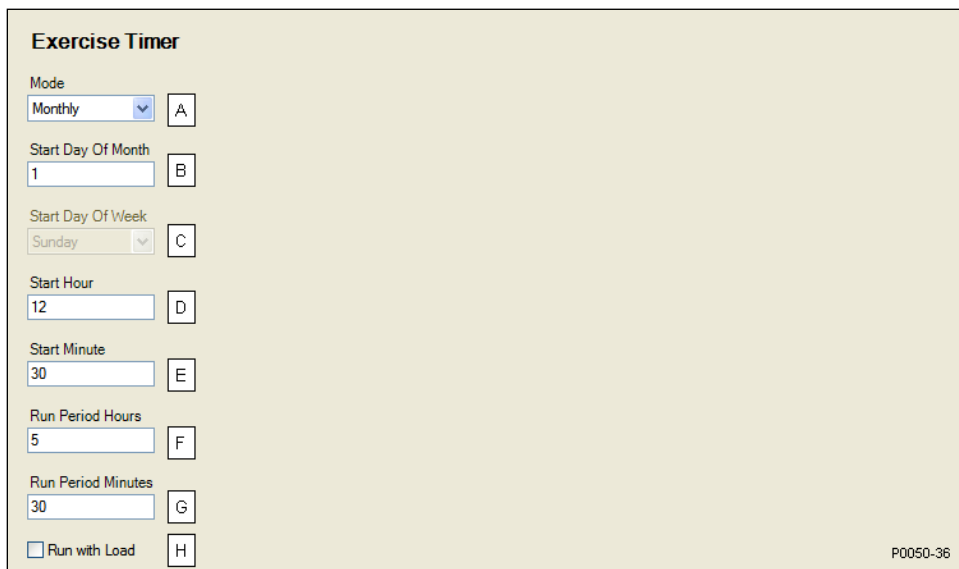
Exercise Timer

The exercise timer is used to start the genset at a predetermined time and run for the user-defined period. The mode[A] defines how often the genset will run. If monthly is selected, you must select the day of the month[B] to start. If weekly is selected, you must select the day of the week[C] to start. Settings for Start Hour[D] and Start Minutes[E] may also be defined. The Run Period Hours[F] and Minutes[G] define how long the genset will run each time. If Run with Load[H] 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.

BESTCOMS*Plus* exercise timer settings (DGC-2020, System Parameters, Exercise Timer) are illustrated in Figure 4-24.

Exercise Timer

Mode

| Monthly ⌄ | A |

Start Day Of Month

| 1 | B |

Start Day Of Week

| Sunday ⌄ | C |

Start Hour

| 12 | D |

Start Minute

| 30 | E |

Run Period Hours

| 5 | F |

Run Period Minutes

| 30 | G |

☐ Run with Load   H

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Figure 4-24. Exercise Timer Settings

[A] *Mode:* Monthly, Weekly, or Daily.
[B] *Start Day Of Month:* Adjustable from 1 to 31 in 1 day increments.
[C] *Start Day Of Week:* Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, or Saturday.
[D] *Start Hour:* Adjustable from 0 to 23 in 1 hour increments.
[E] *Start Minute:* Adjustable from 0 to 59 in 1 minute increments.
[F] *Run Period Hours:* Adjustable from 0 to 23 in 1 hour increments.
[G] *Run Period Minutes:* Adjustable from 0 to 59 in 1 minute increments.
[H] *Run with Load:* Enable or Disable.

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).

Generator PT Settings

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

Generator CT Settings

The generator CT setting[C] 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[D] is used to automatically adjust the Gen CT Primary Amps setting in applications that may 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).

Bus Transformer Settings

Primary and secondary bus transformer ratings are used by the automatic transfer switch function, which monitors a single-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[E] establishes the nominal voltage present at phases A and C of the bus. The secondary setting[F] establishes the nominal voltage seen at the bus voltage input of the DGC-2020.

BESTCOMS*Plus* sensing transformer settings (DGC-2020, System Parameters, Sensing Transformers) are illustrated in Figure 4-25.

Figure 4-25. Sensing Transformers Parameters

[A] *Gen PT Primary Volts:* Adjustable from 1 to 99,999 Vac in 1 Vac increments.
[B] *Gen PT Secondary Volts:* Adjustable from 1 to 480 Vac in 1 Vac increments.
[C] *Gen CT Primary Amps:* Adjustable from 1 to 9,999 Aac in 1 Aac increments.
[D] *Gen CT Low Line Scale Factor:* Adjustable from 0.001 to 3 in increments of 0.001.
[E] *Bus PT Primary Volts:* Adjustable from 1 to 99,999 Vac in 1 Vac increments.
[F] *Bus PT Secondary Volts:* Adjustable from 1 to 480 Vac in 1 Vac increments.

Relay Control

The default operational setting for the Start[A], Run[B], and Prestart[C] 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*.

BESTCOMS*Plus* relay control settings (DGC-2020, System Parameters, Relay Control) are illustrated in Figure 4-26.

Figure 4-26. Relay Control Settings

[A] *Start:* Predefined or Programmable.
[B] *Run:* Predefined or Programmable.
[C] *Prestart:* Predefined or Programmable.

Auto Config Detection

When enabled[A], this feature allows the generator to automatically detect whether the unit is in the configured three-phase configuration, a single-phase AB configuration, or a single-phase AC configuration based on line to neutral (L-N) voltage measurements. Upon starting the genset, the configuration of the generator will be automatically detected and the metering and generator protection will be adjusted accordingly by automatically setting Single Phase Override, Single Phase AC Sense Override, and Low Line Override programmable functions as indicated by the detected Line to Neutral voltages. There is a one-second "debounce" in the detection to prevent the DGC-2020 from bouncing between detected configurations. When the DGC-2020 is in the OFF mode or the engine is not running, the Automatic Configuration Detection is disabled and the DGC-2020 will be assumed to be in the last valid automatically detected configuration.

It is recommended that the Single Phase Override, Single Phase AC Sense Override, and Low Line Override programmable functions not be mapped to contact inputs when Automatic Configuration Detection is enabled.

Single Phase Detect Threshold.[B] 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.[C] 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.[D] 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.

Figure 4-27. Auto Config Detection Settings

[A] *Auto Config Detection:* Enable or Disable.
[B] *Single Phase Detect Threshold:* Adjustable from 0 to 480 V in 1 V increments.
[C] *Low Line Detect Threshold:* Adjustable from 0 to 480 V in 1 V increments.
[D] *Single Phase Detect Generator Connection:* A-B or A-C.

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[A] when the input senses a contact closure. A user-adjustable time delay[B] 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[C] can be given to each input.

Contacts can be recognized[D] 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.

BESTCOMS*Plus* settings for contact inputs (DGC-2020, Programmable Inputs, Contact Inputs) are illustrated in Figure 4-28.

Figure 4-28. Contact Inputs Settings

[A] *Alarm Configuration:* None, Alarm, or Pre-Alarm.
[B] *Activation Delay:* Adjustable from 0 to 300 s in 1 s increments.
[C] *Label Text:* An alphanumeric character string with a maximum of 16 characters.
[D] *Contact Recognition:* Always or While Engine Running Only.

Programmable Functions

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

- Automatic Transfer Switch (ATS)[A] - Disconnect from the mains and start the generator.
- Grounded Delta Override[B] - Uses Grounded Delta sensing if the generator connection is set for Delta.
- Battle Override[C] - The alarms programmed to shut down the unit will be overridden and ignored.
- Low-Line Override[D] - The 51, 27, and 59 settings are scaled by the low-line scale factor setting.
- Single-Phase Override[E] - The unit switches to single phase sensing configuration and uses the 1 Phase Override Sensing setting[F] (A-B or A-C). (Note: Applies only when the Single-Phase Override (A-C) input is <u>not</u> invoked.)
- Single-Phase Override (A-C)[G] - 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[H] - When the selected input is invoked, a user selectable pre-alarm or alarm is annunciated after the activation delay.
- Low Coolant Level[I] - When the selected input is invoked, a user selectable pre-alarm or alarm is annunciated after the activation delay.
- Fuel Leak Detect[J] - 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.

BESTCOMS*Plus* settings for programmable functions (DGC-2020, Programmable Inputs, Programmable Functions) are illustrated in Figure 4-29.

Figure 4-29. Programmable Functions Settings

[A] *Auto Transfer Switch Input:* Select Input (None, 1-16) and Contact Recognition (Always or While Engine Running Only).

[B] *Grounded Delta Override:* Select Input (None, 1-16) and Contact Recognition (Always or While Engine Running Only).

[C] *Battle Override:* Select Input (None, 1-16) and Contact Recognition (Always or While Engine Running Only).

[D] *Low Line Override:* Select Input (None, 1-16) and Contact Recognition (Always or While Engine Running Only).

[E] *Single Phase Override:* Select Input (None, 1-16) and Contact Recognition (Always or While Engine Running Only).

[F] *Single Phase Override Sensing:* A-B or A-C.

[G] *Single Phase AC Override:* Select Input (None, 1-16) and Contact Recognition (Always or While Engine Running Only).

[H] *Battery Charger Fail:* Select Input (None, 1-16), Alarm Configuration (None, Alarm, Pre-Alarm), Activation Delay (s) (0 to 300 s in increments of 1), and Contact Recognition (Always or While Engine Running Only).

[I] *Low Coolant Level:* Select Input (None, 1-16), Alarm Configuration (None, Alarm, Pre-Alarm), Activation Delay (s) (0 to 300 s in increments of 1), and Contact Recognition (Always or While Engine Running Only).

[J] *Fuel Leak Detect:* Select Input (None, 1-16), Alarm Configuration (None, Alarm, Pre-Alarm), Activation Delay (s) (0 to 300 s in increments of 1), and Contact Recognition (Always or While Engine Running Only).

Remote LSM Inputs

An optional LSM-2020 (Load Share Module) provides one configurable[A] 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[B], and min and max input current[C]. 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*.

BESTCOMS*Plus* settings for the remote LSM input (DGC-2020, Programmable Inputs, Remote LSM Inputs) are illustrated in Figure 4-31.

Figure 4-30. Remote LSM Inputs Settings

[A] *Input Type:* Voltage or Current.
[B] *Min/Max Input Voltage:* Adjustable from 0 to 10 volts in 0.1 V increments.
[C] *Min/Max Input Current:* Adjustable from 4 to 20 mA in 0.1 mA increments.

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[A] when the input senses a contact closure. A user-adjustable time delay[B] 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[C] can be given to each input.

Contacts can be recognized[D] 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.

BESTCOMS*Plus* settings for remote contact inputs (DGC-2020, Programmable Inputs, Remote Contact Inputs) are illustrated in Figure 4-31.

Figure 4-31. Remote Contact Inputs Settings

A *Alarm Configuration:* None, Alarm, or Pre-Alarm.
B *Activation Delay:* Adjustable from 0 to 300 s in 1 s increments.
C *Label Text:* An alphanumeric character string with a maximum of 16 characters.
D *Contact Recognition:* Always or While Engine Running Only.

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[A] can be given to each input.

Select the input type[B] and amount of hysteresis[C]. The analog inputs are always monitored and their status is displayed on the appropriate metering screens. A user-adjustable arming delay[D] 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 is inhibited while the engine is not running or is starting. Threshold monitoring begins when the arming delay time has expired after engine startup is complete. When enabled, an out of range alarm[E] alerts the user of an open or damaged analog input wire.

Ranges must be set for the selected input type. Param Min[F] correlates to Min Input Current[G] or Min Input Voltage[H] and Param Max[I] correlates to Max Input Current[J] or Max Input Voltage[K].

Each analog input can be independently configured to annunciate an alarm, pre-alarm, or status only[L] when the analog input signal falls beyond the threshold[M]. A user-adjustable activation delay[N] 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.

BESTCOMS*Plus* settings for remote analog inputs (DGC-2020, Programmable Inputs, Remote Analog Inputs) are illustrated in Figure 4-32. Remote Analog Input #1 is shown.

Figure 4-32. Remote Analog Inputs Settings

[A] *Label Text:* An alphanumeric character string with a maximum of 16 characters.
[B] *Input Type:* Voltage or Current.
[C] *Hysteresis:* Adjustable from 0 to 100 percent in increments of 0.1%.
[D] *Arming Delay:* Adjustable from 0 to 300 s in 1 s increments.
[E] *Out of Range Alarm Type:* None, Alarm, Pre-Alarm, or Status Only.
[F] *Param Min:* –9999.0 to +9999.0 in increments of 0.1.
[G] *Min Input Current:* Adjustable from 4 to 20 mA in 0.1 mA increments.
[H] *Min Input Voltage:* Adjustable from 0 to 10 V in 0.1 V increments.
[I] *Parm Max:* –9999.0 to +9999.0 in increments of 0.1.
[J] *Max Input Current:* Adjustable from 4 to 20 mA in 0.1 mA increments.
[K] *Max Input Voltage:* Adjustable from 0 to 10 V in 0.1 V increments.
[L] *Alarm Configuration:* None, Alarm, Pre-Alarm, or Status Only.
[M] *Threshold:* –9999.0 to +9999.0 in increments of 0.1.
[N] *Activation Delay:* Adjustable from 0 to 300 s in 1 s increments.

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[A] can be given to each input.

Select the amount of hysteresis[B] and RTD type[C]. The RTD inputs are always monitored and their status is displayed on the appropriate metering screens. A user-adjustable arming delay[D] 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 is inhibited while the engine is not running or is starting. Threshold monitoring begins when the arming delay time has expired after engine startup is complete. When enabled, an out of range alarm[E] 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[F] when the RTD input signal falls beyond the threshold[G]. A user-adjustable activation delay[H] 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.

BESTCOMS*Plus* settings for remote RTD inputs (DGC-2020, Programmable Inputs, Remote RTD Inputs) are illustrated in Figure 4-33. Remote RTD Input #1 is shown.

Figure 4-33. Remote RTD Inputs Settings

[A] *Label Text:* An alphanumeric character string with a maximum of 16 characters.
[B] *Hysteresis:* Adjustable from 0 to 100 percent in increments of 0.1%.
[C] *RTD Type:* 100 Ohm Platinum or 10 Ohm Copper.
[D] *Arming Delay:* Adjustable from 0 to 300 s in 1 s increments.
[E] *Out of Range Alarm Type:* None, Alarm, Pre-Alarm, or Status Only.
[F] *Alarm Configuration:* None, Alarm, Pre-Alarm, or Status Only.
[G] *Threshold:* −58 to +482°F in 1°F increments or −50 to +250°C in 1°C increments.
[H] *Activation Delay:* Adjustable from 0 to 300 s in 1 s increments.

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[A] can be given to each input.

Select the amount of hysteresis[B]. The thermocouple inputs are always monitored and their status is displayed on the appropriate metering screens. A user-adjustable arming delay[C] 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 is inhibited while the engine is not running or is

starting. 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[D] when the thermocouple input signal falls beyond the threshold[E]. A user-adjustable activation delay[F] 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.

BESTCOMS*Plus* settings for remote thermocouple inputs (DGC-2020, Programmable Inputs, Remote Thermocouple Inputs) are illustrated in Figure 4-34. Remote Thermocouple Input #1 is shown.

Figure 4-34. Remote Thermocouple Inputs Settings

[A] *Label Text:* An alphanumeric character string with a maximum of 16 characters.
[B] *Hysteresis:* Adjustable from 0 to 100 percent in increments of 0.1%.
[C] *Arming Delay:* Adjustable from 0 to 300 s in 1 s increments.
[D] *Alarm Configuration:* None, Alarm, Pre-Alarm, or Status Only.
[E] *Threshold:* 32 to 2,507°F in 1°F increments or 0 to 1,375°C in 1°C increments.
[F] *Activation Delay:* Adjustable from 0 to 300 s in 1 s increments.

PROGRAMMABLE OUTPUTS

DGC-2020 programmable outputs include four user-programmable contact outputs if the style number is xxAxxxxxx. If the style number is xxBxxxxxx, twelve 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[A].

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*.

BESTCOMS*Plus* settings for contact outputs (DGC-2020, Programmable Outputs, Contact Outputs) are illustrated in Figure 4-35.

Figure 4-35. Contact Outputs Settings

[A] *Label Text:* An alphanumeric character string with a maximum of 16 characters.

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]. A user-adjustable time delay[B] 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[C]. 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[D] always or only while the engine is running. 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.

BESTCOMS*Plus* settings for the elements (DGC-2020, Programmable Outputs, Configurable Elements) are illustrated in Figure 4-36.

Figure 4-36. Configurable Elements Settings

A *Alarm Configuration:* None, Alarm, or Pre-Alarm.
B *Activation Delay:* Adjustable from 0 to 300 s in 1 s increments.
C *Label Text:* An alphanumeric character string with a maximum of 16 characters.
D *Contact Recognition:* Always or While Engine Running Only.

Remote Contact Outputs

To make identifying the contact outputs easier, each of the contact outputs can be given a user-assigned name[A].

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*.

BESTCOMS*Plus* settings for remote contact inputs (DGC-2020, Programmable Outputs, Remote Contact Outputs) are illustrated in Figure 4-37.

Figure 4-37. Remote Contact Outputs Settings

A *Label Text:* An alphanumeric character string with a maximum of 16 characters.

Remote Analog Outputs

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

Make a parameter selection[A] and select the output type[B]. When enabled, an out of range alarm[C] alerts the user of an open or damaged analog output wire. An out of range activation delay[D] setting delays alarm annunciation.

Ranges must be set for the selected output type. Param Min[E] correlates to Min Input Current[F] or Min Input Voltage[G] and Param Max[H] correlates to Max Input Current[I] or Max Input Voltage[J].

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*.

BESTCOMS*Plus* settings for remote analog outputs (DGC-2020, Programmable Inputs, Remote Analog Outputs) are illustrated in Figure 4-38. Remote Analog Output #1 is shown.

Figure 4-38. Remote Analog Outputs Settings

[A] *Param Selection:* Oil Pressure, Coolant Temp, Battery Volts, RPM, Fuel Level, Gen VAB, Gen VBC, Gen VCA, Gen VAN, Gen VBN, Gen VCN, Bus Freq, Bus Volts, Gen Freq, Gen PF, Gen IA, Gen IB, Gen IC, kW A, kW B, kW C, kW Total, Analog Input 1-8, RTD Input 1-8, or Thermocouple Input 1-2.
[B] *Output Type:* Voltage or Current.
[C] *Out of Range Alarm Configuration:* None, Alarm, Pre-Alarm, or Status Only.
[D] *Out of Range Activation Delay:* Adjustable from 0 to 300 s in 1 s increments.
[E] *Param Min:* –99,999.0 to +99,999.0 in increments of 0.1.
[F] *Min Output Current:* Adjustable from 4 to 20 mA in 0.1 mA increments.
[G] *Min Output Voltage:* Adjustable from 0 to 10 V in 0.1 V increments.
[H] *Param Max:* –99,999.0 to +99,999.0 in increments of 0.1.
[I] *Max Output Current:* Adjustable from 4 to 20 mA in 0.1 mA increments.
[J] *Max Output Voltage:* Adjustable from 0 to 10 V in 0.1 V increments.

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[A].

Select a parameter[B] to monitor. A user-adjustable arming delay[C] 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[D].

Each configurable protection item can be independently configured to annunciate an alarm, pre-alarm, or status only[E] when the parameter selection falls beyond the threshold[F]. A user-adjustable activation delay[G] 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.

BESTCOMS*Plus* settings for configurable protection (DGC-2020, Configurable Protection) are illustrated in Figure 4-39. Configurable Protection #1 is shown.

Figure 4-39. Configurable Protection Settings

[A] *Label Text:* An alphanumeric character string with a maximum of 16 characters.
[B] *Param Selection:* Oil Pressure, Coolant Temp, Battery Volts, RPM, Fuel Level, Gen VAB, Gen VBC, Gen VCA, Gen VAN, Gen VBN, Gen VCN, Bus Freq, Bus Volts, Gen Freq, Gen PF, Gen IA, Gen IB, Gen IC, kW A, kW B, kW C, kW Total, Analog Input 1-8, RTD Input 1-8, Thermocouple Input 1-2, or Fuel Delivery Pressure.
[C] *Arming Delay:* Adjustable from 0 to 300 s in 1 s increments.
[D] *Hysteresis:* Adjustable from 0 to 100 percent in increments of 0.1%.
[E] *Alarm Configuration:* None, Alarm, Pre-Alarm, or Status Only.
[F] *Threshold:* Adjustable from −999,999 to 999,999 in increments of 0.01.
[G] *Activation Delay:* Adjustable from 0 to 300 s in 1 s increments.

Configurable Protection Scale Factors

The alternate frequency scale factor[A] is used when Gen Freq or Bus Freq is selected as the parameter for configurable protection. The voltage low line scale factor[B] 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[C] is used when the parameter selection for configurable protection is set for Gen IA, Gen IB, or Gen IC.

BESTCOMS*Plus* settings for configurable protection scale factors (DGC-2020, Configurable Protection, Scale Factors) are illustrated in Figure 4-40.
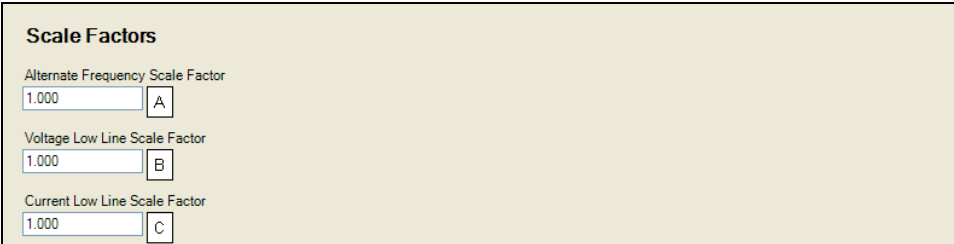
Figure 4-40. Configurable Protection Scale Factors Settings

[A] *Alternate Frequency Scale Factor:* Adjustable from 0.001 to 100 in increments of 0.001.
[B] *Voltage Low Line Scale Factor:* Adjustable from 0.001 to 100 in increments of 0.001.
[C] *Current Low Line Scale Factor:* Adjustable from 0.001 to 100 in increments of 0.001.

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[A] can be enabled and disabled through BESTCOMS*Plus* or at the DGC-2020 front panel.

Not In Auto Horn Enable

This setting[B] allows the horn to annunciate when the DGC-2020 is not in auto mode.

BESTCOMS*Plus* settings for horn configuration (DGC-2020, Alarm Configuration, Horn Configuration) are illustrated in Figure 4-41.
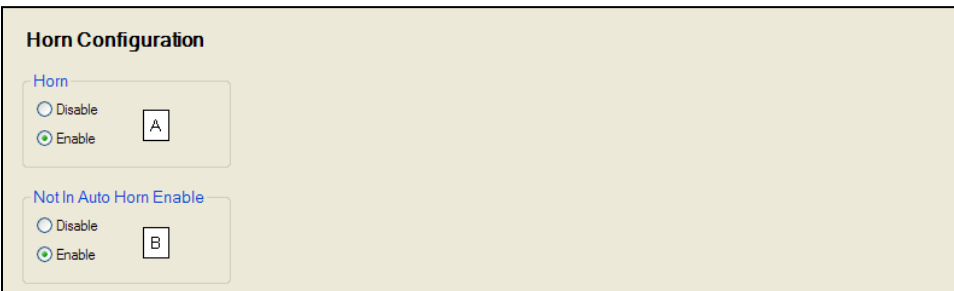
Figure 4-41. Horn Configuration Settings

[A] *Horn:* Enable or Disable.
[B] *Not In Auto Horn Enable:* Enable or Disable.

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 may be enabled and adjusted in BESTCOMS*Plus* or through the front panel HMI.

BESTCOMS*Plus* pre-alarm settings (DGC-2020, Alarm Configuration, Pre-Alarms) are illustrated in Figure 4-42.

High Fuel Level

High fuel level pre-alarm settings[A] 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.

Low Battery Voltage

Low battery voltage pre-alarm settings[B] 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[C] 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[D] consist of an enable/disable setting and a fixed threshold setting. If enabled, a battery overvoltage pre-alarm occurs when the battery voltage increases above the threshold setting.

Maintenance Interval

Maintenance interval pre-alarm settings[E] 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[F] 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[G] 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.

High Coolant Temp

High coolant temperature pre-alarm settings[H] 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 60 seconds. System units are configured on the System Settings screen.

Low Coolant Temp

Low coolant temperature pre-alarm settings[I] 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. System units are configured on the System Settings screen.

Low Coolant Level

Low coolant level pre-alarm settings[J] 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.

Low Oil Pressure

Low oil pressure pre-alarm settings[K] consist of an enable/disable setting and a threshold setting. If enabled, a low oil pressure pre-alarm is annunciated when the engine oil pressure decreases below the threshold setting for a fixed duration of 10 seconds. System units and metric pressure units are configured on the *System Settings* screen.

ECU Coms Fail

ECU communication failure pre-alarm settings[L] 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[M] consist of a single enable/disable setting. If CAN and DTC support are both enabled, an "active DTC" pre-alarm may 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[N] 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[O] 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[P] 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[Q] 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[R]. 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[S]. 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[T] 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[U] 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 may 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.

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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[v] setting. Disabling this setting disables only the annunciation of the pre-alarm and does not correct any error conditions.

The checksum failure pre-alarm may 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.

Figure 4-42. Pre-Alarms Configuration

A *High Fuel Level:* Enable or Disable, threshold is adjustable from 0 to 150% in 1 % increments. Activation delay is adjustable from 0 to 30 s in 1 s increments.

B *Low Battery Voltage:* Enable or Disable, threshold is adjustable from 6 to 12 Vdc (12 Vdc battery) or 12 to 24 Vdc (24 Vdc battery) in 0.1 Vdc increments. Activation delay is adjustable from 1 to 10 s in 1 s increments.

C *Weak Battery Voltage:* Enable or Disable, threshold is adjustable from 4 to 8 Vdc (12 Vdc battery) or 8 to 16 Vdc (24 Vdc battery) in 0.1 Vdc increments. Activation time delay is adjustable from 0 to 10 s in 0.1 s increments.

D *Battery Overvoltage:* Enable or Disable, threshold is adjustable from 12 to 32 Vdc in 0.1 Vdc increments.

E *Maintenance Interval:* Enable or Disable, threshold is adjustable from 0 to 5,000 h in 1 h increments.

F *Engine kW Overload:* Enable or Disable, threshold is adjustable from 0 to 200% of Genset kW Rating in 1% increments.

G *Low Fuel Level:* Enable or Disable, threshold is adjustable from 10 to 100% in 1 % increments.

H *High Coolant Temp:* Enable or Disable, threshold is adjustable from 100 to 280°F or 38 to 138°C in 1° increments. Activation time delay is fixed at 60 s.

I *Low Coolant Temp:* Enable or Disable, threshold is adjustable from 35 to 151°F or 2 to 66°C in 1° increments.

J *Low Coolant Level:* Enable or Disable, threshold is adjustable from 1 to 99% in 1 % increments.

K *Low Oil Pressure:* Enable or Disable, threshold is adjustable from 2.9 to 150 psi in 0.1 psi increments, 0.2 to 10.3 Bar in 0.1 Bar increments, or 20 to 1,034.5 kPa in 0.1 kPa increments. Activation time delay is fixed at 10 s.

L *ECU Coms Fail:* Enable or Disable.

M *Active DTC:* Enable or Disable.

N *AVR Bias Output Limit:* Enable or Disable, activation delay is adjustable from 1 to 15 seconds in 1 second increments.

O *GOV Bias Output Limit:* Enable or Disable, activation delay is adjustable from 1 to 15 seconds in 1 second increments.

P *Intergenset Comm Failure:* Enable or Disable.

Q *LSM Comm Failure:* Enable or Disable.

R *ID Missing:* Enable or Disable.

S *ID Repeat:* Enable or Disable.

T *CEM Comm Failure:* Enable or Disable.

U *AEM Comm Failure:* Enable or Disable.

V *Checksum Failure:* Enable or Disable.

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 may be enabled and adjusted in BESTCOMS*Plus* or through the front panel HMI.

BESTCOMS*Plus* alarm settings (DGC-2020, Alarm Configuration, Alarms) are illustrated in Figure 4-43.

High Coolant Temperature

High coolant temperature alarm settings[A] consist of an enable/disable setting and a threshold setting. If enabled, a high coolant temperature alarm is triggered instantaneously 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[B] include an enable/disable setting, an arming time delay, and a threshold setting. If enabled, a low oil pressure alarm is triggered instantaneously 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[C] 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[D] 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.

Low Coolant Level

Low coolant level alarm settings[E] 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.

Note: ECU Support must be enabled on the *Communications, CANbus Setup* screen before this alarm can be configured.

Figure 4-43. Alarms Configuration

[A] *High Coolant Temp:* Enable or Disable, threshold is adjustable from 100 to 280°F or 38 to 138°C in 1° increments. Arming time delay is adjustable from 0 to 150 in 1 s increments.
[B] *Low Oil Pressure:* Enable or Disable, threshold is adjustable from 2.9 to 150 psi in 0.1 psi increments, 0.2 to 10.3 Bar in 0.1 Bar increments, or 20 to 1,034.5 kPa in 0.1 kPa increments. Arming time delay is adjustable from 5 to 60 s in 1 s increments.
[C] *Overspeed:* Enable or Disable, threshold is adjustable from 105 to 140% of the rated engine rpm. Activation time delay is adjustable from 0 to 500 s in 1 s increments.
[D] *Low Fuel Level:* Enable or Disable, threshold is adjustable from 0 to 100% in 1% increments. Activation time delay is adjustable from 0 to 30 in 1 s increments.
[E] *Low Coolant Level:* Enable or Disable, threshold is adjustable from 1 to 99% in 1% increments.

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[A], oil pressure[B], or fuel level sender[C] input. A loss of generator sensing voltage[D] (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[E] alarm is always enabled. A user-adjustable time delay is provided for each sender/sensing alarm/pre-alarm.

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 <u>and</u> 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.

BESTCOMS*Plus* settings for the sender fail functions (DGC-2020, Alarm Configuration, Sender Fail) are illustrated in Figure 4-44.

Figure 4-44. Sender Fail Configuration

[A] *Coolant Temp Sender Fail:* None, Alarm, or Pre-Alarm, time delay adjustable from 5 to 30 min in 1 min increments.
[B] *Oil Pressure Sender Fail:* None, Alarm or Pre-Alarm, time delay adjustable from 0 to 300 s in 1 s increments.
[C] *Fuel Level Sender Fail:* None, Alarm, or Pre-Alarm, time delay adjustable from 0 to 300 s in 1 s increments.
[D] *Voltage Sensing Fail:* None, Alarm, or Pre-Alarm, time delay adjustable from 0 to 300 s in 1 s increments.
[E] *Speed Sender Fail:* Time delay adjustable from 0 to 300 s in 1 s increments.

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).

<u>Undervoltage (27-1, 27-2)</u>

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[A] for the duration of the corresponding 27 activation delay[B]. An undervoltage annunciation can be user-selected to trigger a pre-alarm[C] (warning) or alarm[C] (shutdown). An undervoltage annunciation can also be user-configured to close a programmable output.

The hysteresis setting[D] functions as an undervoltage dropout by preventing rapid switching of the pickup output.

A frequency-based inhibit setting[E] prevents a 27 trip from occurring during an undervoltage condition associated with system startup.

A low-line scale factor setting[F] is used to automatically adjust the undervoltage pickup settings in applications that may 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 element is disabled when Alarm Configuration is set to "None". Element status is available in BESTLogic*Plus* Programmable Logic when "Status Only" is selected.

BESTCOMS*Plus* voltage protection settings (DGC-2020, Generator Protection, Voltage, Undervoltage) are illustrated in Figure 4-45. The 27-1 element is shown.

Figure 4-45. Undervoltage Protection Settings

[A] *Pickup:* Adjustable from 70 to 576 Vac in 1 Vac increments.
[B] *Activation Delay:* Adjustable from 0 to 30 s in 0.1 s increments.
[C] *Alarm Configuration:* None, Alarm, Pre-Alarm, or Status Only.
[D] *Hysteresis:* Adjustable from 1 to 60 Vac in 1 Vac increments.
[E] *Inhibit Frequency:* Adjustable from 20 to 400 Hz in 1 Hz increments.
[F] *Low Line Scale Factor:* Adjustable from 0.001 to 3 in increments of 0.001.

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[A] for the duration of the corresponding 59 activation delay[B]. An overvoltage annunciation can be user-selected to trigger a pre-alarm[C] (warning) or alarm[C] (shutdown). An overvoltage annunciation can also be user-configured to close a programmable output.

The hysteresis setting[D] functions as an undervoltage dropout by preventing rapid switching of the pickup output.

A low-line scale factor setting[E] is used to automatically adjust the overvoltage pickup settings in applications that may 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 element is disabled when Alarm Configuration is set to "None". Element status is available in BESTLogic*Plus* Programmable Logic when "Status Only" is selected.

BESTCOMS*Plus* voltage protection settings (DGC-2020, Generator Protection, Voltage, Overvoltage) are illustrated in Figure 4-46. The 59-1 element is shown.

Figure 4-46. Overvoltage Protection Settings

[A] *Pickup:* Adjustable from 70 to 576 Vac in 1 Vac increments.
[B] *Activation Delay:* Adjustable from 0 to 30 s in 0.1 s increments.
[C] *Alarm Configuration:* None, Alarm, Pre-Alarm, or Status Only.
[D] *Hysteresis:* Adjustable from 1 to 60 Vac in 1 Vac increments.
[E] *Low Line Scale Factor:* Adjustable from 0.001 to 3 in increments of 0.001.

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[A] for the duration of the 47 activation delay setting[B]. A phase imbalance annunciation can be user-selected to trigger a pre-alarm[C] (warning) or alarm[C] (shutdown). A phase imbalance annunciation can also be user-configured to close a programmable output.

The hysteresis setting[D] functions as a phase imbalance dropout by preventing rapid switching of the pickup output.

A low-line scale factor setting[E] is used to automatically adjust the phase imbalance pickup setting in applications that may 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).

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.

BESTCOMS*Plus* voltage protection settings (DGC-2020, Generator Protection, Voltage, Phase Imbalance) are illustrated in Figure 4-47.

Figure 4-47. Phase Imbalance Protection Settings

A *Pickup:* Adjustable from 5 to 100 Vac in 1 Vac increments.
B *Activation Delay:* Adjustable from 0 to 30 s in 0.1 s increments.
C *Alarm Configuration:* None, Alarm, Pre-Alarm, or Status Only.
D *Hysteresis:* Adjustable from 1 to 5 Vac in 1 Vac increments.
E *Low Line Scale Factor:* Adjustable from 0.001 to 3 in increments of 0.001.

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[A] for the duration of the 81U activation delay setting[B]. An underfrequency annunciation can be user-selected to trigger a pre-alarm[C] (warning) or alarm[C] (shutdown). An underfrequency annunciation can also be user-configured to close a programmable output.

A voltage-based inhibit setting[D] prevents an 81U trip from occurring during an underfrequency condition associated with system startup.

The hysteresis setting[E] functions as an underfrequency dropout by preventing rapid switching of the pickup output.

Overfrequency (81O)

When the generator frequency increases above the 81O pickup setting[F] for the duration of the 81O activation delay setting[G], an overfrequency condition is annunciated. An overfrequency annunciation can be user-selected to trigger a pre-alarm[H] (warning) or alarm[H] (shutdown). An overfrequency condition can also be user configured to close a programmable output.

The hysteresis setting[I] functions as an overfrequency 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.

Alternate Frequency Scale Factor

An alternate frequency scale factor setting[J] is used for automatic adjustment of the frequency pickup settings in applications that may 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).

BESTCOMS*Plus* frequency protection settings (DGC-2020, Generator Protection, Frequency) are illustrated in Figure 4-48.

Figure 4-48. Frequency Protection Settings

[A] *Underfrequency Pickup:* Adjustable from 45 to 66 Hz in 0.1 Hz increments for 50/60 Hz controllers (style number x1xxxxxxxx). Adjustable from 360 to 440 Hz in 0.1 Hz increments for 400 Hz controllers (style number x2xxxxxxxx).
[B] *Underfrequency Activation Delay:* Adjustable from 0 to 30 s in 0.1 s increments.
[C] *Underfrequency Alarm Configuration:* None, Alarm, Pre-Alarm, or Status Only.
[D] *Underfrequency Inhibit Volts:* Adjustable from 70 to 576 Vac in 1 Vac increments.
[E] *Hysteresis:* Adjustable from 0.1 to 40 Hz in 0.1 Hz increments.
[F] *Overfrequency Pickup:* Adjustable from 45 to 66 Hz in 0.1 Hz increments for 50/60 Hz controllers (style number x1xxxxxxxx). Adjustable from 360 to 440 Hz in 0.1 Hz increments for 400 Hz controllers (style number x2xxxxxxxx).
[G] *Overfrequency Activation Delay:* Adjustable from 0 to 30 s in 0.1 s increments.
[H] *Overfrequency Alarm Configuration:* None, Alarm, Pre-Alarm, or Status Only.
[I] *Hysteresis:* Adjustable from 0.1 to 40 Hz in 0.1 Hz increments.
[J] *Alternate Frequency Scale Factor:* 0.001 to 100 in increments of 0.001.

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 CT secondary side (DGC-2020). 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[A] for the duration of the 32R activation delay setting[B], a reverse power condition is annunciated. A reverse power annunciation can be user-selected to trigger a pre-alarm[C] (warning) or alarm[C] (shutdown). A reverse power annunciation can also be user-configured to close a programmable output.

The hysteresis setting[D] functions as a reverse power 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.

BESTCOMS*Plus* reverse power protection settings (DGC-2020, Generator Protection, Reverse Power) are illustrated in Figure 4-49.

Figure 4-49. Reverse Power Protection Settings

[A] *Pickup:* –50% to +5% of rated watts in 0.1% increments.
[B] *Activation Delay:* Adjustable from 0 to 30 s in 0.1 s increments.
[C] *Alarm Configuration:* None, Alarm, Pre-Alarm, or Status Only.
[D] *Hysteresis:* Adjustable from 1 to 10% in 0.1% increments.

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[A] entered is based on the CT secondary side (DGC-2020). 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 4-50.
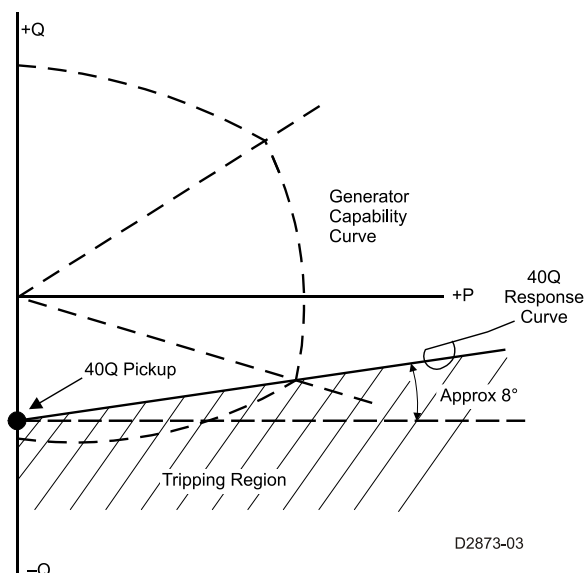
Figure 4-50. Generator Capability Curve vs. 40Q Response

If reactive power is within the 40Q tripping region for the duration of the 40Q activation delay setting[B], a loss of excitation condition is annunciated. A loss of excitation annunciation can be user-selected to trigger a pre-alarm[C] (warning) or alarm[C] (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[D] functions as a loss of excitation dropout by preventing rapid switching of the pickup output.

Activation delays[B] 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.

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.

BESTCOMS*Plus* loss of excitation protection settings (DGC-2020, Generator Protection, Loss of Excitation) are illustrated in Figure 4-51.

Figure 4-51. Loss of Excitation Protection Settings

[A] Pickup: Adjustable from –150% to 0% of rated vars in 0.1% increments.
[B] *Activation Delay:* Adjustable from 0 to 30 s in 0.1 s increments.
[C] *Alarm Configuration:* None, Alarm, Pre-Alarm, or Status Only.
[D] *Hysteresis:* Adjustable from 1% to 10% in 0.1% increments.

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[A] 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[B] (warning) or alarm[B] (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[C] and a curve setting[D]. 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[E] 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
- A, standard inverse
- B, very inverse
- C, extremely inverse
- I2, inverse
- L1, long inverse
- L2, long inverse
- M, moderately inverse

- D, definite
- E1, extremely inverse
- E2, extremely inverse
- G, long inverse
- I1, inverse
- I2, inverse

- P, programmable
- S1, short inverse
- S2, short inverse
- V1, very inverse
- V2, very inverse

A low-line scale factor setting[F] is used for automatic adjustment of the overcurrent pickup settings in applications that may utilize more than one type of genset connection. The scale factor setting is implemented when the DGC-2020 senses a contact closure at a contact input programmed to activate scaling of the protection settings. The value of the scale factor setting serves as a multiplier for the pickup settings. For example, if a scale factor contact input is received by the DGC-2020 and the scale factor setting is 2.000, the pickup setting will be doubled (2.000 $\times$ PU).

The graph can be set[G] 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[H] 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". Element status is available in BESTLogic*Plus* Programmable Logic when "Status Only" is selected.

BESTCOMS*Plus* overcurrent protection settings (DGC-2020, Generator Protection, Overcurrent) are illustrated in Figure 4-52. 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 standard C37.112-1996. 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 4-3.

Equation 4-1. Time OC Characteristics for Trip *Equation 4-2. Time OC Characteristics for Reset*

$$T_T = \frac{AD}{M^N - C} + BD + K$$

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

Table 4-3. 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	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.
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.

Setting Programmable (P) Curves

Curve coefficients[i] are entered using BESTCOMS*Plus*. Table 4-4 lists the programmable curve settings.

Table 4-4. 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
K Coefficient	N/A	N/A	0.0280
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.
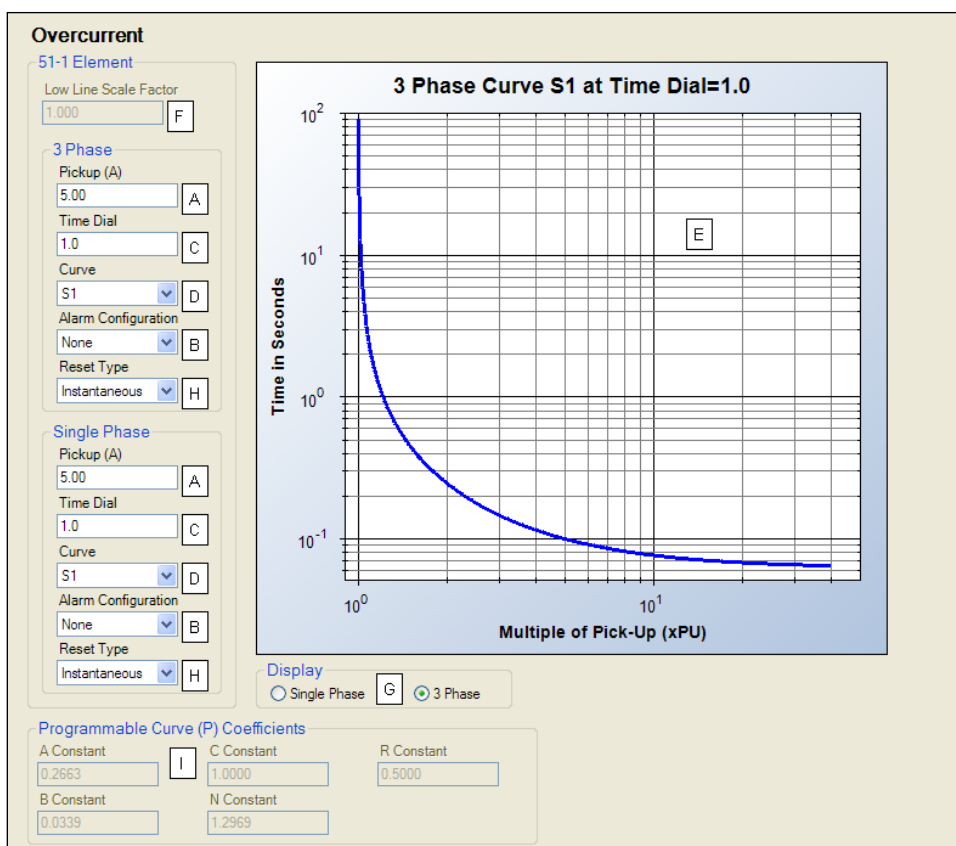
Figure 4-52. Overcurrent Protection Settings

A *Pickup:* Adjustable from 0.9 to 7.75 Aac for 5 Aac current sensing (style number 5xxxxxxxx) or 0.18 to 1.18 Aac for 1 Aac current sensing (style number 1xxxxxxxx).
B *Alarm Configuration:* None, Alarm, Pre-Alarm, or Status Only.
C *Time Dial:* Adjustable from 0 to 7,200 s for F (fixed) curve, 0 to 9.9 for all other curve selections.
D *Curve:* A, B, C, D, E1, E2, F, G, I1, I2, L1, L2, M, P, S1, S2, V1, or V2.
E *Overcurrent Pickup Curve.*

[F] *Low Line Scale Factor:* Adjustable from 0.001 to 3 in 0.001 increments.
[G] *Display:* Single Phase or 3 Phase.
[H] *Reset Type:* Instantaneous or Integrating.
[I] *Programmable Curve (P) Coefficients:* Refer to Table 4-4.

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 may 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 configured 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]. A setting is provided to open the mains[B] breaker or generator[C] breaker on trip. An additional setting[D] 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.

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.

BESTCOMS*Plus* vector shift protection settings (DGC-2020, Generator Protection, Loss of MAINS Protection, Vector Shift (78)) are illustrated in Figure 4-53.

Figure 4-53. Vector Shift Protection Settings

[A] *Pickup:* Adjustable from 2 to 90° in 1° increments.
[B] *Open Mains Breaker on Trip:* Enable or Disable.
[C] *Open Generator Breaker on Trip:* Enable or Disable.
[D] *Alarm Configuration:* Alarm, Pre-Alarm, or Status Only.

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[A] and the Activation Delay[B] has expired. A setting is provided to open the mains[C] breaker or generator[D] breaker on trip. An additional setting[E] 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.

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.

BESTCOMS*Plus* ROCOF protection settings (DGC-2020, Generator Protection, Loss of MAINS Protection, ROCOF (81)) are illustrated in Figure 4-54.

Figure 4-54. ROCOF Protection Settings

[A] *Pickup:* Adjustable from 0.2 to 10 Hz/s in 0.1 Hz/s increments.
[B] *Activation Delay:* Adjustable from 0 to 10 seconds in 0.001 s increments.
[C] *Open Mains Breaker on Trip:* Enable or Disable.
[D] *Open Generator Breaker on Trip:* Enable or Disable.
[E] *Alarm Configuration:* Alarm, Pre-Alarm, or Status Only.

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
- Bus Condition Detection
- Synchronizer

Breaker Hardware

By default, one (generator) breaker is enabled[A] 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[B] and configured.

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[C]. 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[D], return delay[E], and max transfer time[F].

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[G] 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.

In open transitions, when a mains failure occurs, the mains breaker opens. The generator starts after the Mains Fail Transfer Delay time expires. When the generator becomes stable, it will close its generator breaker to drive the load. When the mains power returns, after the Mains Fail Return Delay time expires, the generator will open its generator breaker and then close the mains breaker. If the in phase-monitor[H] is enabled and the Mains Fail Return Delay time has expired, the generator will wait 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.

In closed transitions, when a mains failure occurs, the mains breaker opens. The generator starts after the Mains Fail Transfer Delay time expires. When the generator becomes stable, it will close 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 its generator breaker, paralleling it 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[I] 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.

Two 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 two logic elements are Mains Fail Test and Load Take Over.

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 raps 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.

Breakers controlled by pulse or continuous inputs are supported[J]. Separate settings for each breaker's open[K] and close[L] pulse widths are provided.

During synchronization of the generator with the bus (Anticipatory mode only), the DGC-2020 uses the breaker closing time[M] 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[N]. Typically, this parameter is set to be longer than twice the breaker closing time.

The dead bus close enable setting[O] 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.

Start up Synchronization

Start up 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[P] 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 start up 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.

BESTCOMS*Plus* breaker hardware settings (DGC-2020, Breaker Management, Breaker Hardware) are illustrated in Figure 4-55.

Figure 4-55. Breaker Hardware Settings

[A] *Generator Breaker:* Configured, NOT Configured.

[B] *Mains Breaker:* Configured or NOT Configured.

[C] *Mains Fail Transfer:* Enable or Disable. This setting does not apply when generator frequency is 400Hz.

[D] *Mains Fail Transfer Delay:* Adjustable from 0 to 300 s in 1 s increments. This specifies the delay between detection of failed mains to initiation of the transfer to the generator.

[E] *Mains Fail Return Delay:* Adjustable from 0 to 1,800 s in 1 s increments. This specifies the delay between detection of restored (stable) mains and initiation of the return from the generator back to the mains.

[F] *Mains Fail Max Transfer Time:* Adjustable from 10 to 120 s in 1 s increments. This specifies the maximum time that is allowed for a transfer from failed mains to generator power. If the transfer has not been achieved in this time, a Mains Fail Transfer Fail pre-alarm is annunciated and the transfer is aborted. The pre-alarm can be cleared by switching to OFF mode or pressing the *Reset* button on the front panel of the DGC-2020. Note that the Mains Fail Max Transfer Time setting must be longer than the time for the Mains Fail Transfer Delay plus the Sync Activation Delay plus the Breaker Close Wait Time.

^{G} *Mains Fail Transfer Type:* Closed or Open.
^{H} *In Phase Monitor:* Disable or Enable.
^{I} *Max Parallel Time:* Adjustable from 0.1 to 10,000 s in 0.1 s increments.
^{J} *Contact Type:* Continuous or Pulse. If Continuous is selected, the outputs will be on during the time that the desired Close or Open condition is in effect. If Pulse is selected, the duration of the pulses are set by the Open Pulse Time and Close Pulse Time settings.
^{K} *Open Pulse Time:* Adjustable from 0.01 to 0.80 s in 0.01 s increments. This setting applies only when Contact Type is Pulse. This time should be ≥ the Breaker Closing Time setting.
^{L} *Close Pulse Time:* Adjustable from 0.01 to 0.80 s in 0.01 s increments. This setting applies only when Contact Type is Pulse. This time should be ≥ the Breaker Closing Time setting.
^{M} *Breaker Closing Time:* Adjustable from 0 to 800 ms in 5 ms increments. This specifies the amount of time the breaker takes to close once a close contact is applied to it. This time is used for anticipatory synchronization to issue a close pulse a certain time before the 0 degree slip angle is reached so that when the breaker actually closes, the slip angle is near 0 degrees.
^{N} *Breaker Close Wait Time:* Adjustable from 0.1 to 600 s in 0.1 s increments. This specifies the amount of time the DGC-2020 will wait between issuing a close pulse to a breaker and expecting the breaker status to be indicated as closed. If this time expires before the breaker status is indicated as closed, a Breaker Close Fail pre-alarm will be annunciated. The pre-alarm can be cleared by switching to OFF mode or pressing the *Reset* button on the front panel of the DGC-2020.
^{O} *Dead Bus Close Enable:* Disable or Enable.
^{P} *Dead Gen Close Enable:* Disable or Enable.

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[A] and a Dead Gen Activation Delay setting[B]. A dead generator is recognized when the voltage 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 start up 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[C], undervoltage[D], overfrequency[E], and underfrequency[F]. 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[G]. 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[H] 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 and not dead) after the duration of the Gen Failed Activation Delay.

The Gen Stable overvoltage and undervoltage detection elements have the low-line scale factor[I] 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[J] is used for automatic adjustment of the frequency pickup settings in applications that may 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).

Bus Sensing

DGC-2020 detection of dead bus voltages is controlled by a Dead Bus Threshold setting[K] and a Dead Bus Activation Delay setting[L]. A dead bus is recognized when the voltage 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[M], undervoltage[N], overfrequency[O], and underfrequency[P]. 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[Q]. 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[R] 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 and not dead) after the duration of the Bus Failed Activation Delay.

The Bus Stable overvoltage and undervoltage detection elements have the low-line scale factor[S] 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[T] is used for automatic adjustment of the frequency pickup settings in applications that may 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).

BESTCOMS*Plus* bus condition detection settings (DGC-2020, Breaker Management, Bus Condition Detection) are illustrated in Figure 4-56.

NOTE

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

Figure 4-56. Bus Condition Detection Settings

[A] *Dead Gens Threshold:* Adjustable from 0 to 4,800 Vac in 1 Vac increments.

[B] *Dead Gens Time Delay:* Adjustable from 0.1 to 600 s in 0.1 s increments.

[C] *Gen Stable Overvoltage Pickup and Dropout:* Adjustable from 10 to 99,999 Vac in 1 Vac increments.

[D] *Gen Stable Undervoltage Pickup and Dropout:* Adjustable from 10 to 99,999 Vac in 1 Vac increments.

[E] *Gen Stable Overfrequency Pickup and Dropout:* Adjustable from 46 to 64 Hz in 0.05 Hz increments for 50/60 Hz generator frequency (style number x1xxxxxxx).

[F] *Gen Stable Underfrequency Pickup and Dropout:* Adjustable from 46 to 64 Hz in 0.05 Hz increments for 50/60 Hz generator frequency (style number x1xxxxxxx).

[G] Gen *Stable Activation Delay:* Adjustable from 0.1 to 600 in 1 second increments.

[H] Gen *Failed Activation Delay:* Adjustable from 0.1 to 600 in 1 second increments.

[I] *Low Line Scale Factor:* Adjustable from 0.001 to 3 in increments of 0.001.

[J] *Alternate Frequency Scale Factor:* 0.001 to 100 in increments of 0.001.

[K] *Dead Bus Threshold:* Adjustable from 0 to 4,800 Vac in 1 Vac increments.

[L] *Dead Bus Time Delay:* Adjustable from 0.1 to 600 s in 0.1 s increments.

[M] *Bus Stable Overvoltage Pickup and Dropout:* Adjustable from 10 to 99,999 Vac in 1 Vac increments.

[N] *Bus Stable Undervoltage Pickup and Dropout:* Adjustable from 10 to 99,999 Vac in 1 Vac increments.

[O] *Bus Stable Overfrequency Pickup and Dropout:* Adjustable from 46 to 64 Hz in 0.05 Hz increments for 50/60 Hz generator frequency (style number x1xxxxxxx).

[P] *Bus Stable Underfrequency Pickup and Dropout:* Adjustable from 46 to 64 Hz in 0.05 Hz increments for 50/60 Hz generator frequency (style number x1xxxxxxx).

[Q] *Bus Stable Activation Delay:* Adjustable from 0.1 to 600 in 1 second increments.

[R] *Bus Failed Activation Delay:* Adjustable from 0.1 to 600 in 1 second increments.

[S] *Low Line Scale Factor:* Adjustable from 0.001 to 3 in increments of 0.001.

[T] *Alternate Frequency Scale Factor:* 0.001 to 100 in increments of 0.001.

Automatic Synchronizer (Optional)

Two methods of generator synchronization are offered: phase lock loop and anticipatory[A]. 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 4-57.
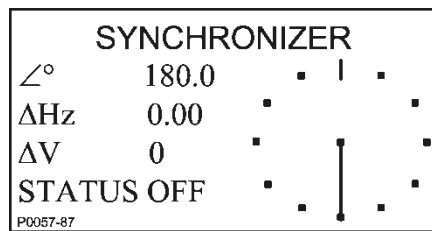
Figure 4-57. Synchronizer Screen

BESTCOMS*Plus* automatic synchronizer settings (DGC-2020, Breaker Management, Synchronizer) are illustrated in Figure 4-58.

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[B] establishes the maximum allowable deviation of the generator speed (frequency) from the bus frequency. To minimize the impact on the bus during synchronization, the Fgen>Fbus setting[C] 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[D] 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[E].

Voltage Correction

Generator voltage correction is defined by the voltage window setting[F]. 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[G] 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.

Synchronization Failure

The maximum desired duration for synchronizing to take place is established by the sync fail activation delay setting[H]. 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[I] gain and sync voltage[J] 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.

<div style="border:1px solid black; padding:10px;">

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.

</div>

Figure 4-58. Synchronizer Settings

[A] *Sync Type:* Phase Lock Loop or Anticipatory.

[B] *Slip Frequency:* Adjustable from 0.1 to 0.5 Hz in 0.05 Hz increments. If Anticipatory synchronization is selected, this specifies the maximum acceptable slip under which a close command can occur. If Phase Lock Loop synchronization is selected and the slip angle is within the Breaker Closing Angle criterion for a period long enough to indicate the slip frequency criterion has been met, a breaker close command can be issued.

[C] *Fgen>Fbus:* Enable or Disable.

[D] *Breaker Closing Angle:* Adjustable from 3 to 20° in 0.5° increments. If Phase Lock Loop synchronization is selected, this specifies the maximum acceptable slip angle under which a breaker close command can be issued.

[E] *Sync Activation Delay:* Adjustable from 0.1 to 0.8 seconds in 0.1s increments.

[F] *Voltage Window:* Adjustable from 2 to 15% of nominal generator voltage in 0.5% increments. This specifies the voltage acceptance window for the synchronization function.

[G] *Vgen>Vbus:* Enable or Disable.

[H] *Sync Fail Activation Delay:* Adjustable from 0.1 to 600 in 0.1 s increments. This is the amount of time the DGC-2020 will allow the synchronizer to attempt to synchronize the generator to the bus before annunciating a Synch Fail pre-alarm. The pre-alarm can be cleared by switching to OFF mode or pressing the *Reset* button on the front panel of the DGC-2020.

[I] *Sync Speed Gain:* Adjustable from 0.001 to 1000 in increments of 0.001.

[J] *Sync Voltage Gain:* Adjustable from 0.001 to 1000 in increments of 0.001.

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[A] 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[B]. Proportional correction uses control pulses of varying widths[C] and intervals[D]. 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[A] should be set to analog. This enables a PID controller that 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[E], integral gain[F], derivative gain[G], derivative filter constant[H], and loop gain[I] 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 Parallel to Mains logic element is TRUE, the var/PF controller will become active. Whenever these conditions are not TRUE, the var/PF controller is disabled, and the machine will operate in voltage droop.

When control[J] is enabled and the control mode[K] 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[L]. When this is set to User Setting, the operating kvar setpoint is equal to the configured kvar setpoint[M]. When the kvar setpoint source setting[L] 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[N] and kvar analog min[O].

When control mode[J] 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[P]. When this is set to User Setting, the operating PF setpoint is equal to the configured PF setpoint[Q]. When the PF setpoint source setting[P] 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[R] and PF analog min[S].

When an optional LSM-2020 is connected, the bias control output type[A] 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[T], integral gain[U], derivative gain[V], derivative filter constant[W], and loop gain[X] 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[Y]. Voltage droop mode is entered any time the generator breaker is open. Voltage droop is also the mode when the generator breaker is closed if kW load sharing is disabled. If it is desired to disable voltage droop, set the droop percentage to 0. The voltage droop gain setting[Z] 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 may 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[AA] 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.

BESTCOMS*Plus* AVR bias control settings (DGC-2020, Bias Control Settings, AVR Bias Control Settings) are illustrated in Figure 4-59.

Figure 4-59. AVR Bias Control Settings

[A] *Bias Control Output Type:* Contact or Analog.
[B] *Bias Control Contact Type:* Continuous or Proportional.
[C] *Correction Pulse Width:* Adjustable from 0 to 99.9 s in 0.1 s increments.
[D] *Correction Pulse Interval:* Adjustable from 0 to 99.9 s in 0.1 s increments.
[E] *Proportional Gain (Kp):* Adjustable from 0 to 1,000 in increments of 0.001.
[F] *Integral Gain (Ki):* Adjustable from 0 to 1,000 in increments of 0.001.
[G] *Derivative Gain (Kd):* Adjustable from 0 to 1,000 in increments of 0.001.
[H] *Derivative Filter Constant (Td):* Adjustable from 0 to 1 in increments of 0.001.
[I] *Loop Gain (Kg):* Adjustable from 0 to 1,000 in increments of 0.001.
[J] *Control:* Disable or Enable.
[K] *Control Mode:* var Control or PF Control.
[L] *kvar Setpoint Source:* User Setting, LSM Analog Input 1, or Analog Inputs 1-8.
[M] *kvar Setpoint:* Adjustable from -100 to 100 percent in 0.1 % increments.
[N] *kvar Analog Max:* Adjustable from 0 to 100 percent in 0.1 % increments.
[O] *kvar Analog Min:* Adjustable from 0 to 100 percent in 0.1 % increments.
[P] *PF Setpoint Source:* User Setting, LSM Analog Input 1, or Analog Inputs 1-8.
[Q] *PF Setpoint:* Adjustable from –0.60 to 0.60 in increments of 0.01.
[R] *PF Analog Max:* Adjustable from –0.60 to 0.60 in increments of 0.01.
[S] *PF Analog Min:* Adjustable from –0.60 to 0.60 in increments of 0.01.
[T] *Proportional Gain (Kp):* Adjustable from 0 to 1,000 in increments of 0.001.
[U] *Integral Gain (Ki):* Adjustable from 0 to 1,000 in increments of 0.001.
[V] *Derivative Gain (Kd):* Adjustable from 0 to 1,000 in increments of 0.001.
[W] *Derivative Filter Constant (Td):* Adjustable from 0 to 1 in increments of 0.0001.
[X] *Loop Gain (Kg):* Adjustable from 0 to 1,000 in increments of 0.001.
[Y] *Droop Percentage:* Adjustable from 0 to 10 percent in 0.001 % increments.
[Z] *Voltage Droop Gain:* Adjustable from 0 to 1,000 in increments of 0.001.
[AA] *Ramp Rate:* Adjustable from 0 to 100 percent/second in 0.1 %/s increments.

Governor Bias Control Settings

The bias control output type[A] 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[B]. Proportional correction uses control

pulses of varying widths[C] and intervals[D]. 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[A] 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[E], integral gain[F], derivative gain[G], derivative filter constant[H], and loop gain[I] of the PID controller.

The speed trim enable setting[J] sets speed trimming to the speed trim setpoint[K] when the generator breaker is closed and the machine is not paralleled to the utility. 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 may 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 may conflict, resulting in unpredictable load sharing and system frequency.

BESTCOMS*Plus* governor bias control settings (DGC-2020, Bias Control Settings, Governor Bias Control Settings) are illustrated in Figure 4-60.

kW Control - Real Power Control Settings

When enabled[L], the DGC-2020, used in conjunction with an optional LSM-2020, can accomplish kW sharing between similarly equipped generators. kW control is disabled when an optional LSM-2020 is not connected.

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[M], integral gain[N], derivative gain[O], derivative filter constant[P], and loop gain[Q] 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[R]. 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[S] 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 may 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[T] 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.

When User Setting is selected for the base load level source[U], the base load level setting[V] 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 set point is calculated based on the specific analog input. Parameters are available for baseload analog max[W] and baseload analog min[X].

When the unit unloads, the generator breaker will open when the power generated by the unit falls below the breaker open setpoint[Y].

Figure 4-60. Governor Bias Control Settings

[A] *Bias Control Output Type:* Contact or Analog.
[B] *Bias Control Contact Type:* Continuous or Proportional.
[C] *Correction Pulse Width:* Adjustable from 0 to 99.9 s in 0.1 s increments.
[D] *Correction Pulse Interval:* Adjustable from 0 to 99.9 s in 0.1 s increments.
[E] *Proportional Gain (Kp):* Adjustable from 0 to 1,000 in increments of 0.001.
[F] *Integral Gain (Ki):* Adjustable from 0 to 1,000 in increments of 0.001.
[G] *Derivative Gain (Kd):* Adjustable from 0 to 1,000 in increments of 0.001.
[H] *Derivative Filter Constant (Td):* Adjustable from 0 to 1 in increments of 0.001.
[I] *Loop Gain (Kg):* Adjustable from 0 to 1,000 in increments of 0.001.
[J] *Speed Trim Enable:* Enable or Disable.
[K] *Speed Trim Setpoint:* Adjustable from 47 to 440 Hz in 0.01 Hz increments.
[L] *Load Control Enabled:* Enable or Disable.
[M] *Proportional Gain (Kp):* Adjustable from 0 to 1,000 in increments of 0.001.
[N] *Integral Gain (Ki):* Adjustable from 0 to 1,000 in increments of 0.001.
[O] *Derivative Gain (Kd):* Adjustable from 0 to 1,000 in increments of 0.001.
[P] *Derivative Filter Constant (Td):* Adjustable from 0 to 1 in increments of 0.001.
[Q] *Loop Gain (Kg):* Adjustable from 1 to 1,000 in increments of 0.001.
[R] *Droop Percentage:* Adjustable from 0 to 10 percent in 0.001 % increments.
[S] *Speed Droop Gain:* Adjustable from 0 to 1,000 in increments of 0.001.
[T] *Ramp Rate:* Adjustable from 0 to 100 percent/second in 0.1 %/s increments.
[U] *Base Load Level Source:* User Setting, LSM Analog Input 1, or Analog Inputs 1-8.
[V] *Base Load Level:* Adjustable from 0 to 100 percent in 1 % increments.
[W] *Baseload Analog Max:* Adjustable from 0 to 100 percent in 0.1 % increments.
[X] *Baseload Analog Min:* Adjustable from 0 to 100 percent in 0.1% increments.
[Y] *Breaker Open Setpoint:* Adjustable from 0 to 100 percent in 0.1 % increments.

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[A] of the LSM-2020 is used to change the voltage setpoint of the generator. If the response[B] is set for increasing, an increased bias will cause higher voltage. If the response[B] is set for

decreasing, an increased bias will cause lower voltage. Settings are provided for minimum output current[C], maximum output current[D], minimum output voltage[E], and maximum output voltage[F].

BESTCOMS*Plus* AVR output settings (DGC-2020, Multigen Management, AVR Output) are illustrated in Figure 4-61.

Figure 4-61. AVR Output Settings

[A] *Output Type:* Voltage or Current.
[B] *Response:* Increasing or Decreasing.
[C] *Min Output Current:* Adjustable from 4 to 20 mA in 0.1 mA increments.
[D] *Max Output Current:* Adjustable from 4 to 20 mA in 0.1 mA increments.
[E] *Min Output Voltage:* Adjustable from –10 to +10 V in 0.01 V increments.
[F] *Max Output Voltage:* Adjustable from –10 to +10 V in 0.01 V increments.

Governor Output

The governor output[A] of the LSM-2020 is used to change the speed setpoint of the generator. If the response[B] is set for increasing, an increased bias will cause faster speed. If the response[B] is set for decreasing, an increased bias will cause slower speed. Settings are provided for minimum output current[C], maximum output current[D], minimum output voltage[E], and maximum output voltage[F].

BESTCOMS*Plus* governor output settings (DGC-2020, Multigen Management, Governor Output) are illustrated in Figure 4-62.

Figure 4-62. Governor Output Settings

[A] *Output Type:* Voltage or Current.
[B] *Response:* Increasing or Decreasing.
[C] *Min Output Current:* Adjustable from 4 to 20 mA in 0.1 mA increments.
[D] *Max Output Current:* Adjustable from 4 to 20 mA in 0.1 mA increments.

Load Share Output

The generator uses the measured load share output to calculate per unitized average load level, and uses that as the set point for its kW controller. Settings are provided for maximum voltage[A] and minimum voltage[B].

BESTCOMS*Plus* load share output settings (DGC-2020, Multigen Management, Load Share Output are illustrated in Figure 4-63.

Figure 4-63. Load Share Output

A *Max Voltage:* Adjustable from –10 to +10 V in 0.01 V increments.
B *Min Voltage:* Adjustable from –10 to +10 V in 0.01 V increments.

Demand Start/Stop

When enabled[A], 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[B] and the corresponding start level timeout[C] has been exceeded, a corresponding start request is issued. If system load is below the delayed stop level[D] and the stop timeout[E] has been exceeded, a stop request is issued.

BESTCOMS*Plus* demand start/stop settings (DGC-2020, Multigen Management, Demand Start/Stop) are illustrated in Figure 4-64.
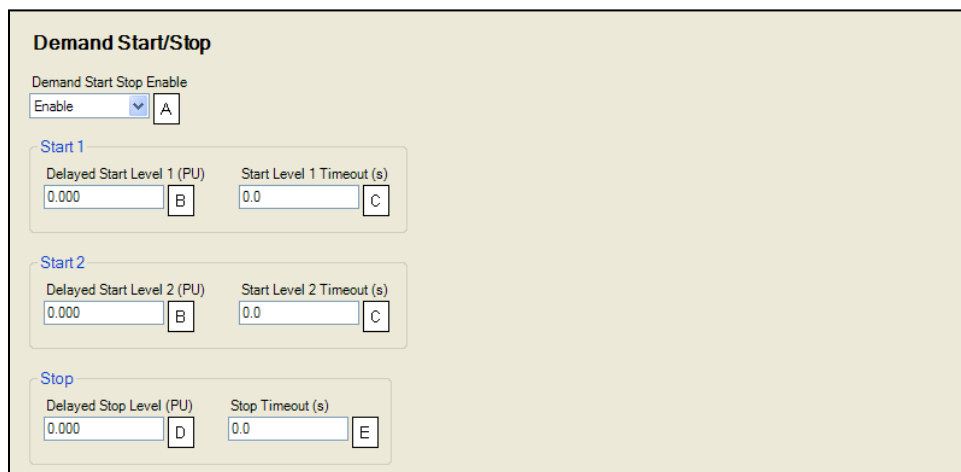
Figure 4-64. Demand Start/Stop

A *Demand Start Stop Enable:* Enable or Disable.
B *Delayed Start Level:* Adjustable from 0 to 1 in increments of 0.001.
C *Start Level Timeout:* Adjustable from 0 to 600 seconds in 0.1 s increments.
D *Delayed Stop Level:* Adjustable from 0 to 1 in increments of 0.001.
E *Stop Timeout:* Adjustable from 0 to 600 seconds in 0.1 s increments.

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[A] 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[B] 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[C] 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[D] 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.

BESTCOMS*Plus* generator sequencing settings (DGC-2020, Multigen Management) are illustrated in Figure 4-65.

The available sequencing modes are defined in the following paragraphs.

Disabled

This is the only mode that may 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.
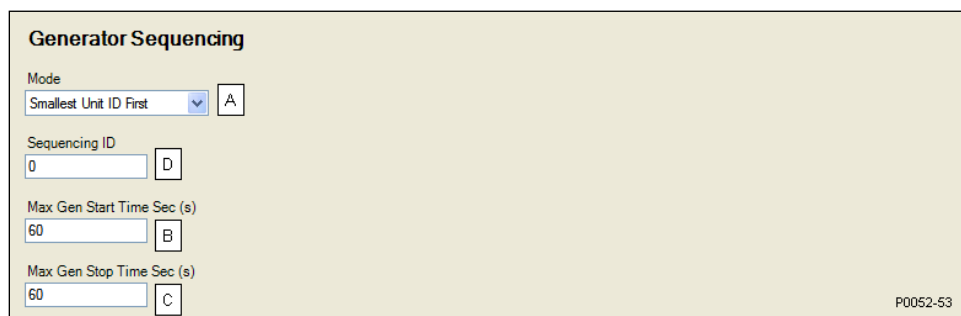
Figure 4-65. Generator Sequencing

[A] *Mode:* Disabled, Staggered Service Time, Balanced Service Time, Largest Size First, Smallest Size first, Smallest Unit ID First, or Adopt System Mode.
[B] *Max Gen Start Time:* Adjustable from 1 to 3,000 seconds in 1 s increments.
[C] *Max Gen Stop Time:* Adjustable from 1 to 3,000 seconds in 1 s increments.
[D] *Sequencing ID:* Adjustable from 0 to 255 in increments of 1.

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[A]. 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.

BESTCOMS*Plus* network configuration settings (DGC-2020, Multigen Management, Network Configuration) are illustrated in Figure 4-66.

Figure 4-66. Network Configuration Settings

[A] *Expected Seq Id:* Adjustable from 0 to 255.

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[A]. 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[B] 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[C] in BESTCOMS*Plus*, which can be printed[D].

Sender curve points configured in BESTCOMS*Plus* can be saved in the configuration file[E]. 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[F]. A new settings file can also be created[G].

BESTCOMS*Plus* programmable sender settings (DGC-2020, Programmable Senders, Coolant Temperature, Oil Pressure, or Percent Fuel Level) are illustrated in Figure 4-67. (The contents and layout of each BESTCOMS*Plus* programmable sender screen is identical; only the coolant temperature sender screen is illustrated here.)
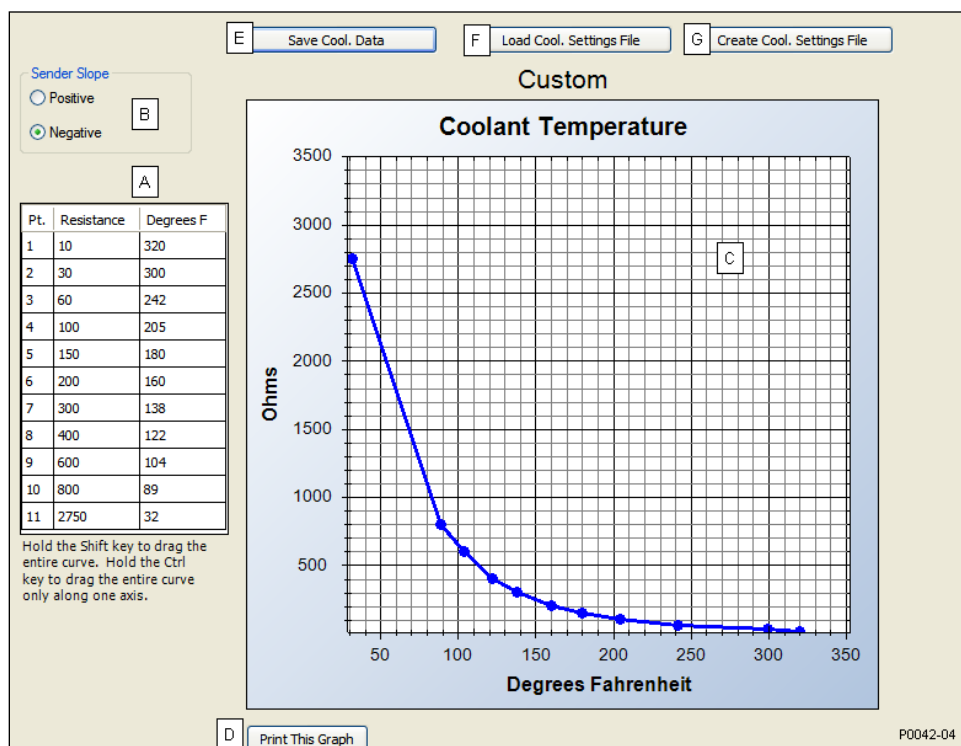
Figure 4-67. Programmable Senders Settings

[A] *Sender Points:* Accepts up to 11 user-defined sender resistance points.

[B] *Sender Slope:* Positive or Negative causes sender points to be sorted and displayed accordingly.

[C] *Sender Point Curve:* Automatic plot of sender points data.

[D] *Print This Graph:* Click to print sender point curve.

[E] *Save Cool. Data:* Click to save file containing sender point data.

[F] *Load Cool. Settings File:* Click to clear all user-defined sender data and revert to the factory-default values.

[G] *Create Cool. Settings File:* Click to create a new settings file by entering sender point data.

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.

FILE MANAGEMENT

These paragraphs describe file management of settings files, firmware files, and language module files.

Settings Files

These paragraphs describe the tasks of opening, uploading, downloading, saving, printing, and comparing of settings files. When opening, uploading, downloading, or saving a settings file, operational settings, as well as BESTLogic*Plus* settings are combined together as a whole. When printing a settings file, only the operational settings are shown. There is a separate print option available on the BESTLogic*Plus* Programmable Logic screen for printing BESTLogic*Plus* settings. For information on solely uploading or downloading BESTLogic*Plus* settings, refer to Section 5, *BESTLogicPlus Programmable Logic.*

Opening a Settings File

To open a new instance of a settings file into 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 open it and the file settings have been brought into a new instance in BESTCOMS*Plus*. You may also open a file, by clicking on the *Open File* icon on the lower menu bar. When done in this manner, you will be asked to upload the settings and logic from the file to the current device. You may choose *Yes* or *No*. The settings in the current instance will be overwritten.

Uploading a Settings File

To upload a settings 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 Settings.* You are prompted to enter the password. If the password is correct, the upload begins and the progress bar is shown.

Downloading a Settings File

To download a settings file from the DGC-2020, you must pull down the *Communication* menu and select *Download Settings and Logic*. If the settings in your BESTCOMS*Plus* have changed, a dialog box will open asking you if want to save the current settings changes. You may choose *Yes* or *No*. After you have taken the required action to save or not save the current settings, the downloading is executed.

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. Select the *Save* button to complete the save.

Printing a Settings File

To view a preview of the printout, select *Print Preview* from the *File* pull-down menu. 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 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 different settings files. To use this feature, pull down the *Tools* menu and select *Compare Settings Files*. The *BESTCOMSPlus Settings Compare Setup* dialog box appears (Figure 4-68). Select the location of the first file to compare under *Left Settings Source* and select the location of the second file to compare 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.
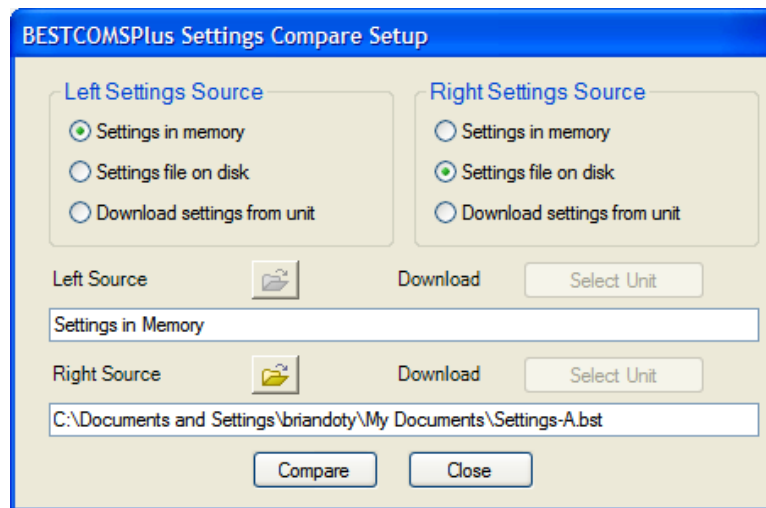
Figure 4-68. BESTCOMSPlus Settings Compare Setup

A dialog box will appear and notify you if any differences were found. The *BESTCOMSPlus Settings Compare* dialog box (Figure 4-69) 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.
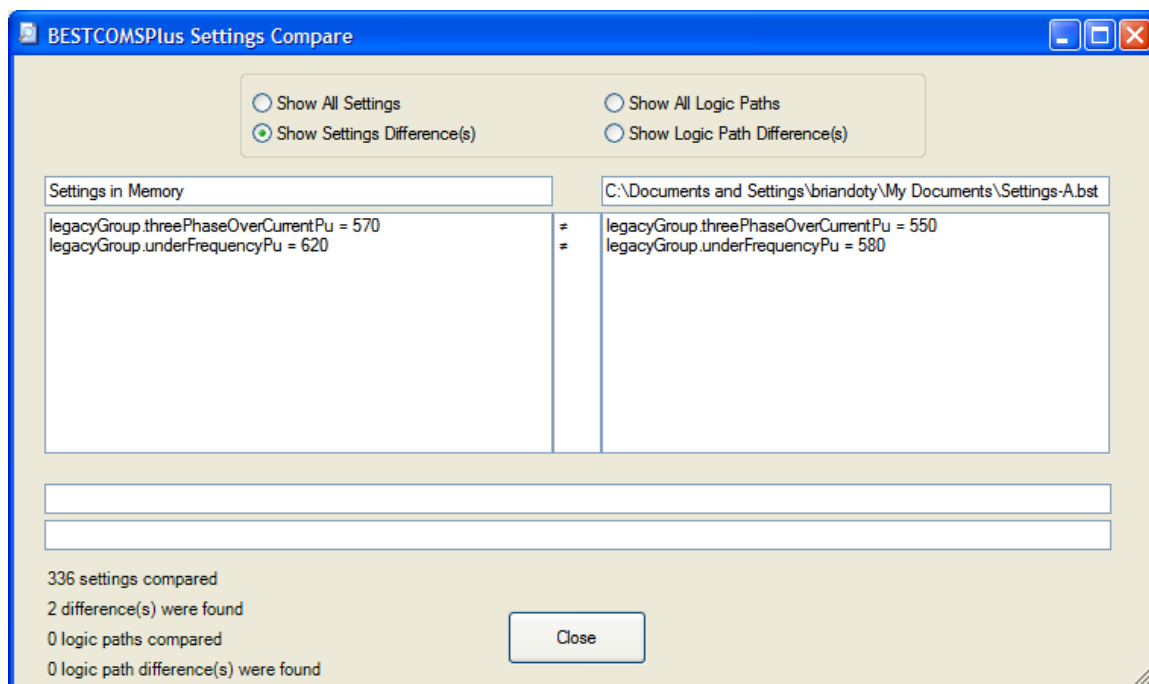

Figure 4-69. BESTCOMSPlus Settings Compare

Upgrading Firmware in 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 may 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 may 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.

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 plug-in 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 <u>must</u> be completed before upgrading firmware in the DGC-2020. If no expansion modules are present, proceed to *Upgrading Firmware in the DGC-2020.*

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.

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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 <u>C</u>ommunication 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 4-70) 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.
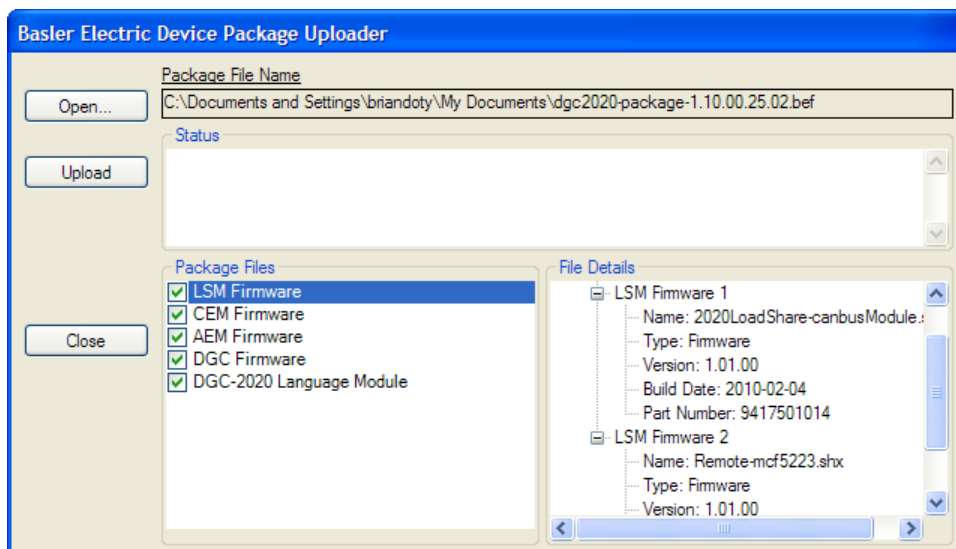

Figure 4-70. Basler Electric Device Package Uploader

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 4-71.
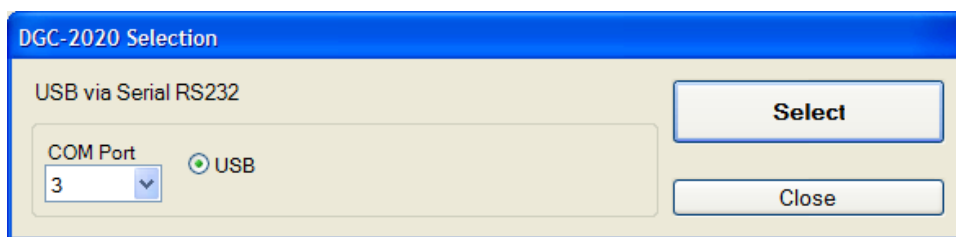
Figure 4-71. DGC-2020 Selection

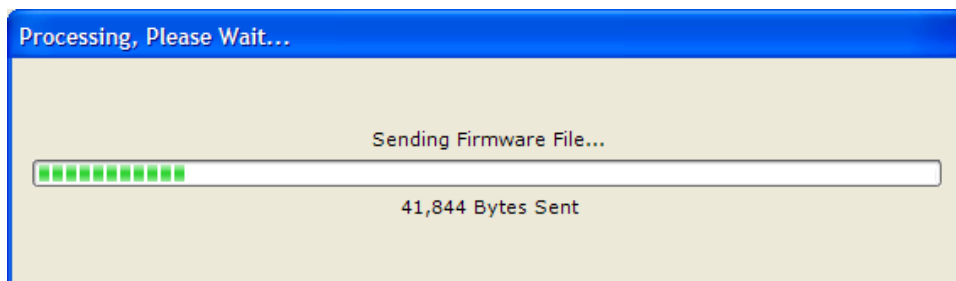10. The *Processing, Please Wait…* screen is displayed as file(s) are uploaded. See Figure 4-72.

Figure 4-72. 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*.

   b. Select *Upload Device Files* from the <u>C</u>ommunication 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.*

   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. Disconnect communication from the DGC-2020.

   b. Close all settings files.

   c. From the <u>F</u>ile pull-down menu, select *New*, *DGC-2020.*

   d. Connect to the DGC-2020.

   e. Once all settings have been read from the DGC-2020, open the saved settings file by selecting the file with <u>F</u>ile, *Open File* in the BESTCOMS*Plus* menu.

   f. When BESTCOMS*Plus* asks if you wish to upload settings and logic to the device, click *Yes*.

   g. 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*.

   h. 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 plug-in.

- Engine
- Generator
- Power
- Bias Control
- Run Statistics
- Status
- Inputs
  - Contact Inputs
  - Remote LSM Inputs
  - Remote Contact Inputs
  - Remote Analog Inputs
  - Remote RTD Inputs
  - Remote Thermocouple Inputs
  - Remote Analog Input Values
  - Logic Control Relays
- Outputs
  - Contact Outputs
  - Configurable Elements
  - Remote Contact Outputs
  - Remote Analog Outputs
- Configurable Protection
- Alarms
- Event Log
- J1939 ECU
  - ECU Data
  - Engine Configuration
  - Active DTC
  - Previously Active DTC
- MTU
  - MTU Alarms
  - MTU Fault Codes
  - MTU Status
  - MTU Engine Status
- Summary
- Control
- Real Time Clock
- Generator Network Status

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 4-73. Table 4-5 explains the call-outs on Figure 4-73.
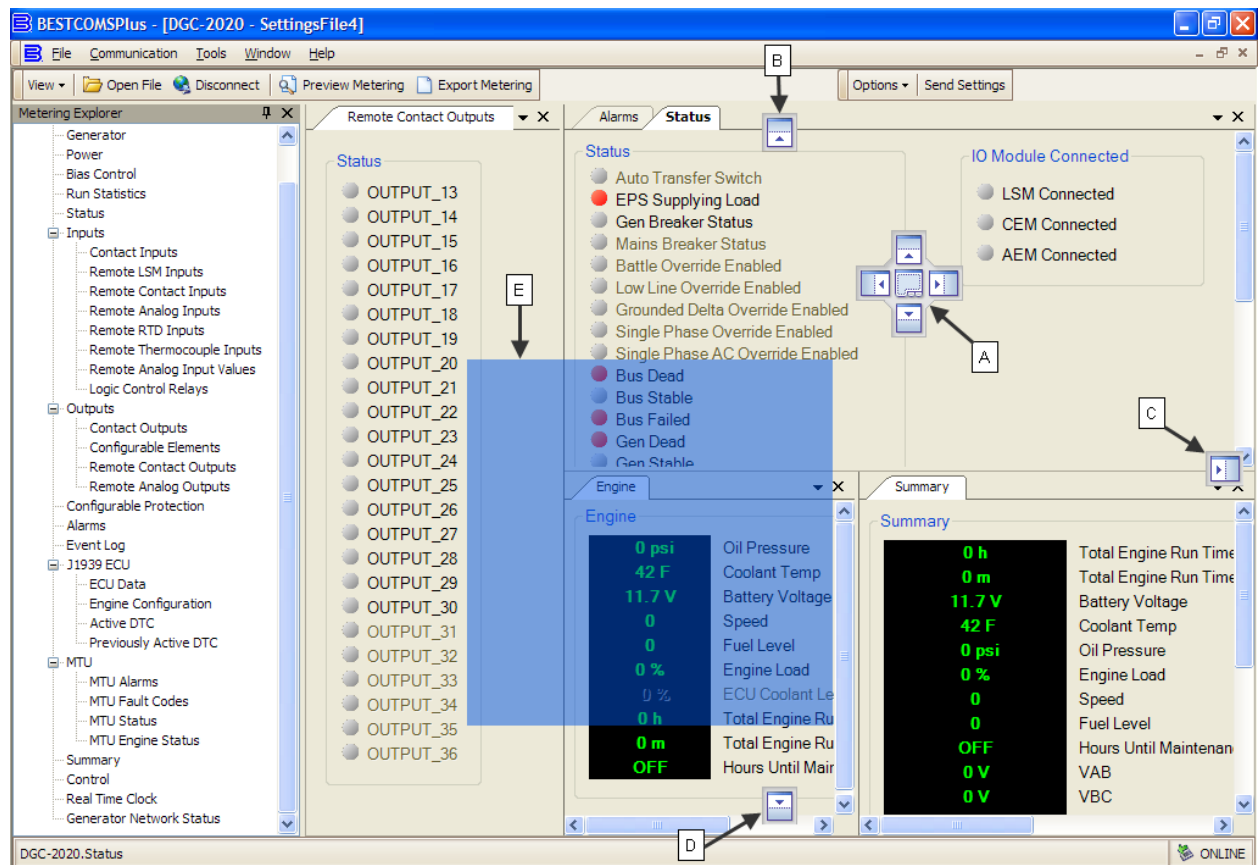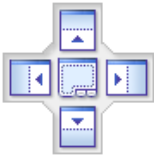
Figure 4-73. Metering, Docking Options

Table 4-5. Explanation of Call-Outs on Figure 4-73

Call-Out	Symbol	Explanation
A		Holding the left mouse button down on a metering tab and dragging it to one of the four arrow boxes will place it inside the selected window on the location selected. To place the metering tab as a tab inside the selected window, drop it on the tabs button in the center of the arrow buttons.
B		Holding the left mouse button down on a metering tab and dragging it to this arrow box will place it across the top of the screen. Click on the 📌 (thumbtack) to dock it on the top bar. To display a screen that is docked, simply use the mouse to hover the pointer over the tab on the top bar.
C		Holding the left mouse button down on a metering tab and dragging it to this arrow box will place it across the side of the screen. Click on the 📌 (thumbtack) to dock it on the side bar. To display a screen that is docked, simply use the mouse to hover the pointer over the tab on the side bar.
D		Holding the left mouse button down on a metering tab and dragging it to this arrow box will place it across the bottom of the screen. Click on the 📌 (thumbtack) to dock it on the bottom bar. To display a screen that is docked, simply use the mouse to hover the pointer over the tab on the bottom bar.
E		Holding the left mouse button down on a metering tab and dragging it to anywhere other than an arrow box will place it as a floating metering screen. This floating screen can later be closed by clicking on the ⊠ in the upper right corner. It may also be dragged to one of the arrow boxes used for docking.

Engine

This screen provides information and metering of engine components. Refer to Figure 4-74.
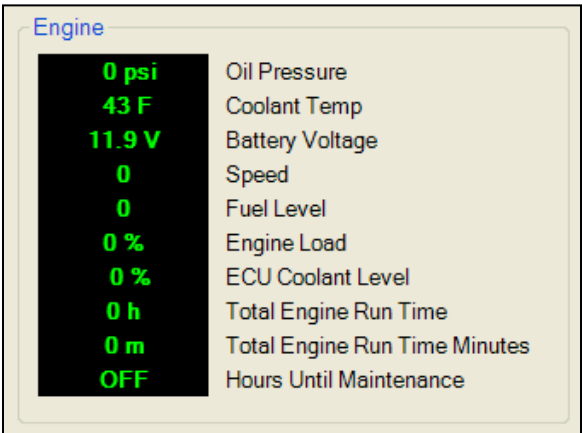

Figure 4-74. Metering, Engine

Generator

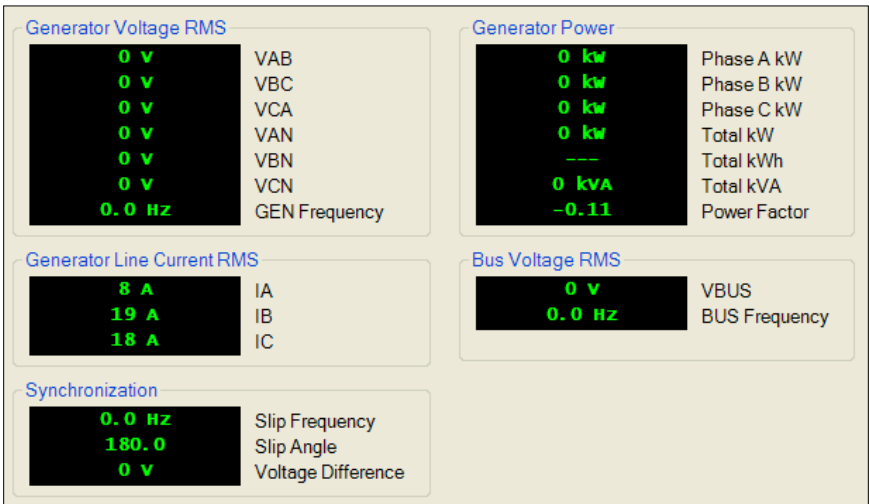This screen provides metering of generator voltages and currents. Refer to Figure 4-75.

Figure 4-75. Metering, Generator

Power

This screen provides metering of generator power and power factor. Refer to Figure 4-76.
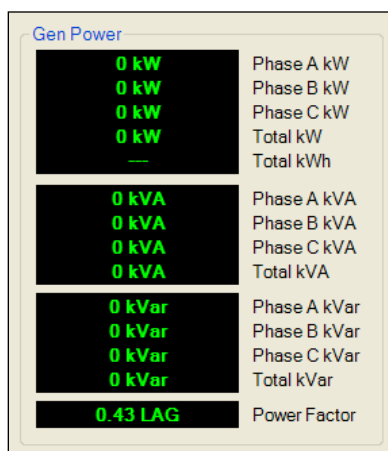
Figure 4-76. Metering, Power

Bias Control

This screen provides var/PF mode status and operating levels. Refer to Figure 4-77.
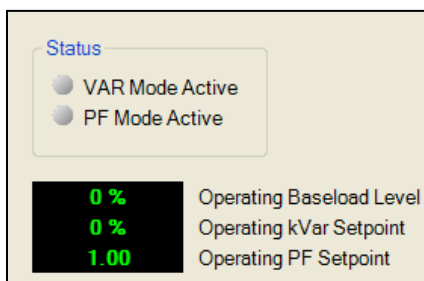
Figure 4-77. Metering, Bias Control

Run Statistics

This screen provides Cumulative Run Statistics, Session Run Statistics, and Commission Date. Refer to Figure 4-78. The maintenance interval can be reset through this screen.
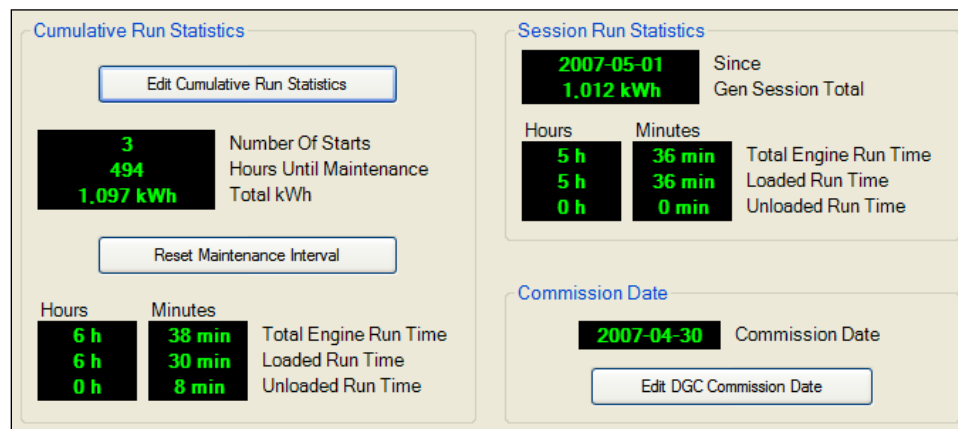
Figure 4-78. Metering, Run Statistics

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 4-79.

Figure 4-79. 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 4-80.

Figure 4-80. Metering, Inputs, Contact Inputs

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 4-81.

Figure 4-81. Metering, Inputs, Remote LSM Inputs

Remote Contact Inputs

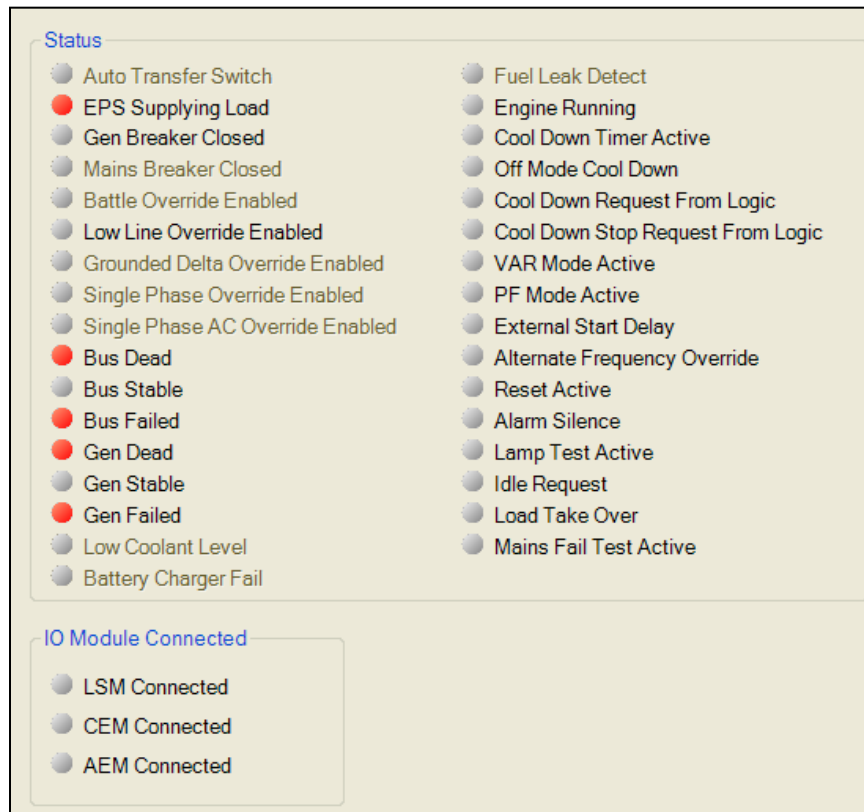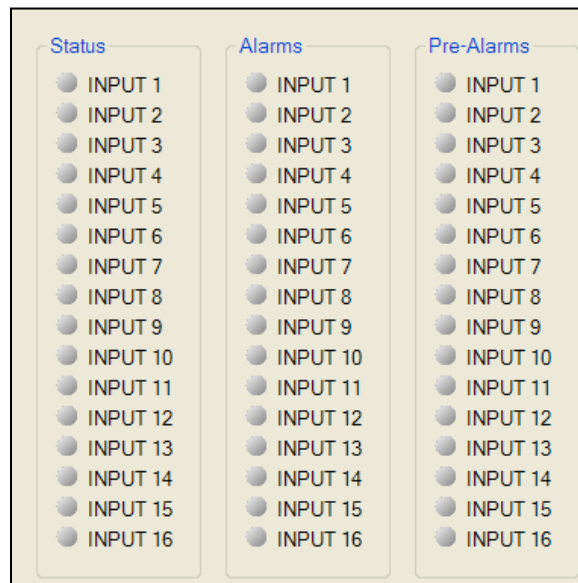When an optional CEM-2020 (Contact Expansion Module) is connected, the status of the remote contact inputs, configurable remote contact input alarms, and remote contact input pre-alarms are shown on this screen. The status is TRUE when the corresponding LED is red. Refer to Figure 4-82.

Figure 4-82. 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 4-83. Remote Analog Input #1 is shown.
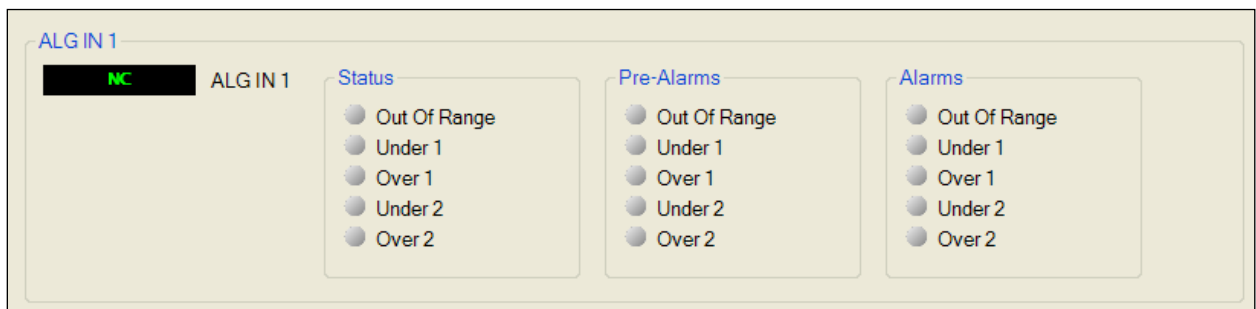
Figure 4-83. Metering, Inputs, Remote Analog Inputs

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 4-84. Remote RTD Input #1 is shown.
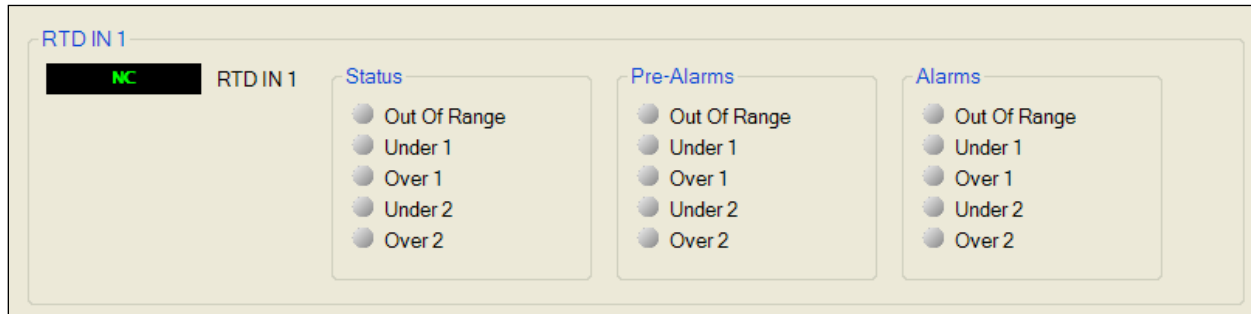
Figure 4-84. Metering, Inputs, Remote RTD Inputs

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 4-85. Remote Thermocouple Input #1 is shown.
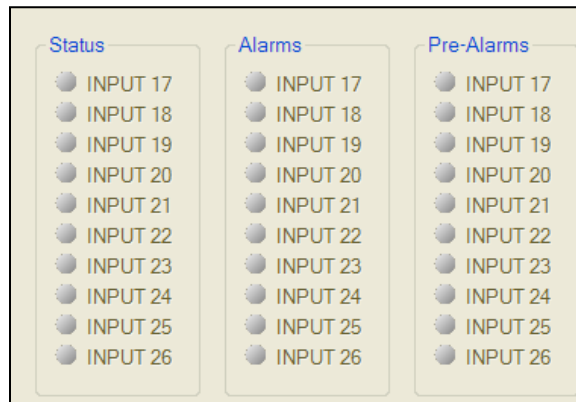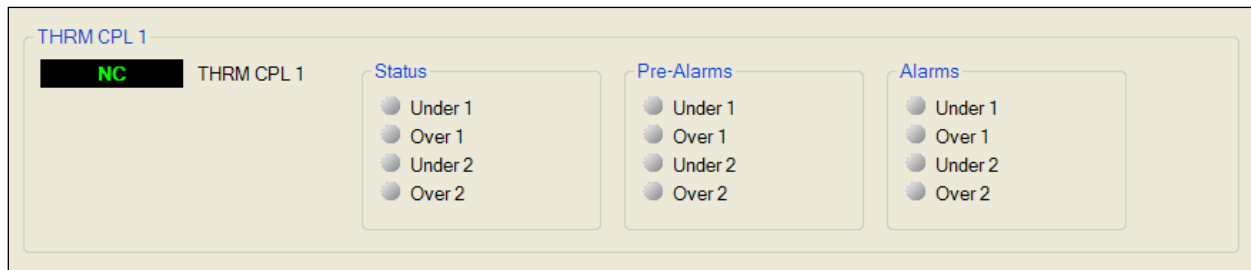

Figure 4-85. Metering, Inputs, Remote Thermocouple Inputs

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. Refer to Figure 4-85.

Figure 4-86. 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 4-87. This screen is used to calibrate RTD inputs 1 through 8 and thermocouple inputs 1 and 2.

Figure 4-87. Analog Input Temperature Calibration

Logic Control Relays

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 4-88.

Figure 4-88. 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 4-89.
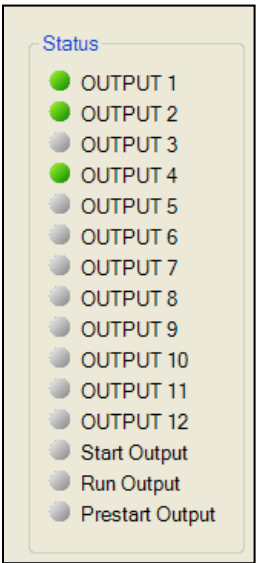
Figure 4-89. Metering, Outputs, Contact Outputs

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 4-90.
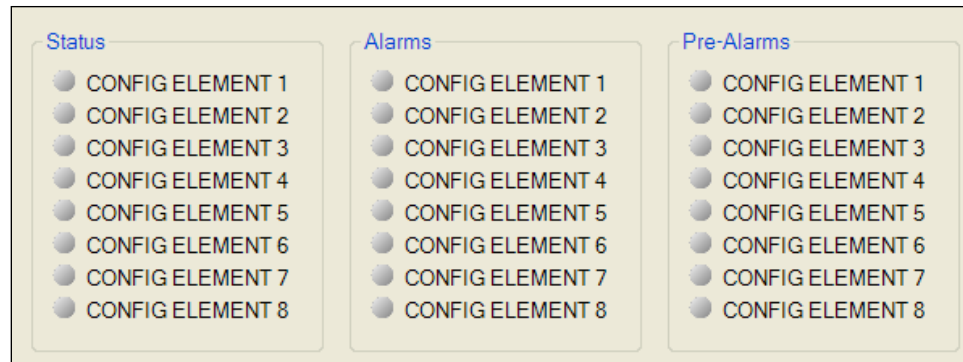
Figure 4-90. Metering, Outputs, Configurable Elements

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 4-91.
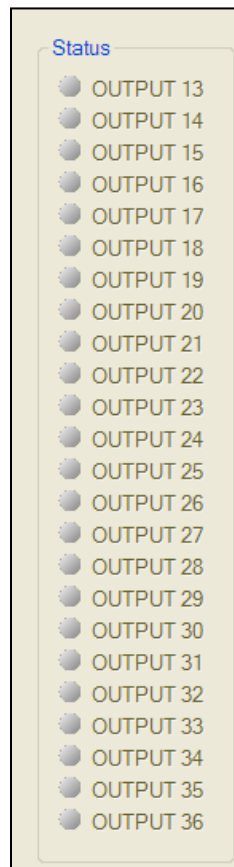
Figure 4-91. Metering, Outputs, Remote Contact Outputs

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 4-92.
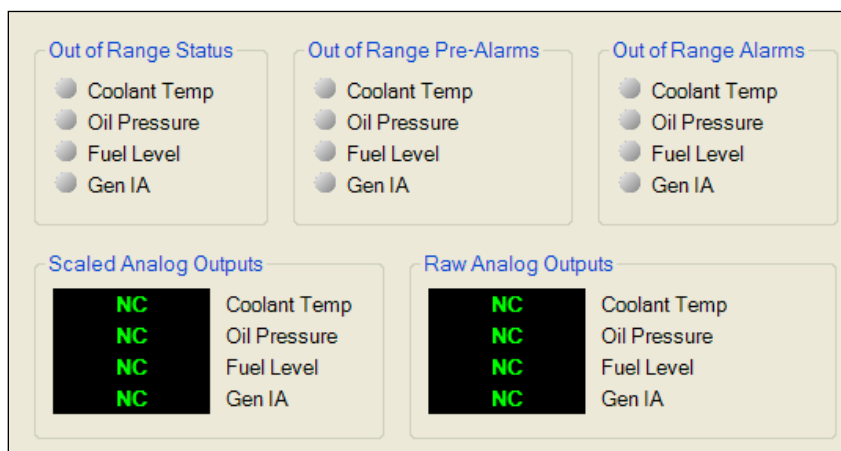
Figure 4-92. Metering, Outputs, Remote Analog Outputs

Configurable Protection

This screen indicates the status of configurable protection. The status is TRUE when the corresponding LED is green. Refer to Figure 4-93.
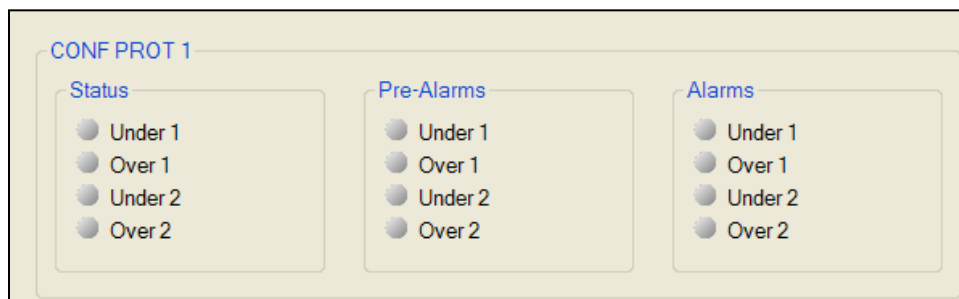
Figure 4-93. Metering, Configurable Protection

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 4-94.

Figure 4-94. Metering, Alarms

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 4-95.

Figure 4-95. 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 4-95 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 4-96, 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 4-95.

Figure 4-96. Metering, Event Log, Sorted by Event ID

J1939 ECU

The ECU reports operating information to the DGC-2020 through the CANbus 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 4-97.
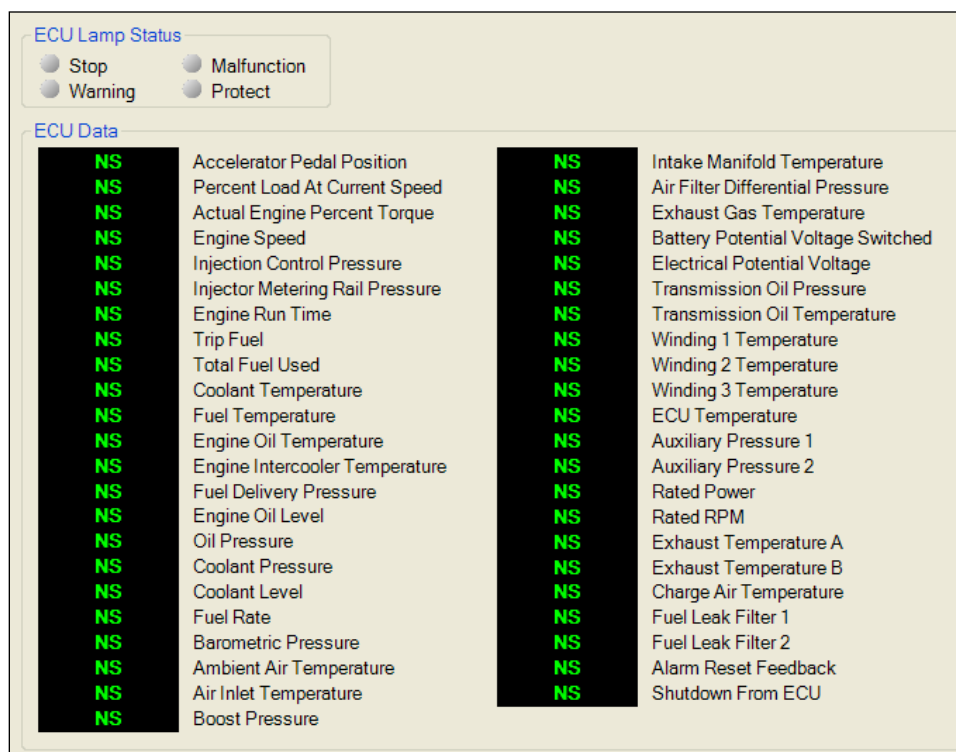
Figure 4-97. Metering, ECU Data

Engine Configuration

This screen displays Engine Configuration. Refer to Figure 4-98.
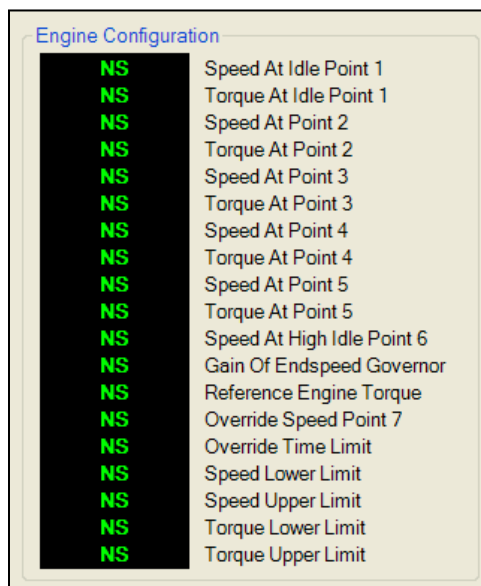
Figure 4-98. Metering, Engine Configuration

Active DTC and Previously Active DTC

This screen is used for viewing, downloading, and clearing DTC (Diagnostic Trouble Codes). Refer to Figure 4-99.

Figure 4-99. Metering, Download DTC

MTU

The MTU reports operating information to the DGC-2020 through the CANbus 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 4-100.

Figure 4-100. Metering, MTU Alarms

MTU Fault Codes

MTU Fault Codes can be viewed and downloaded on this screen. Refer to Figure 4-101.

Figure 4-101. Metering, 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 4-102.
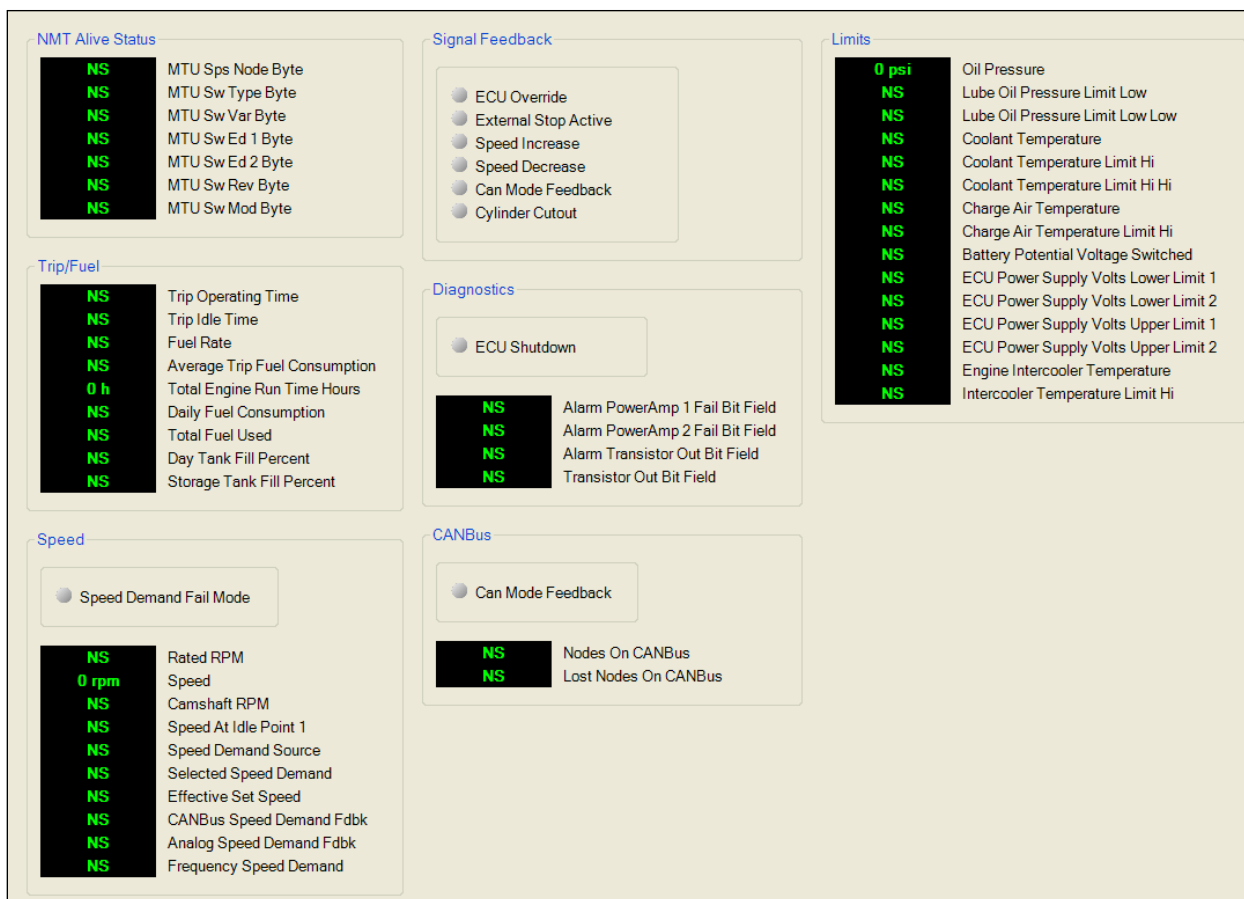
Figure 4-102. Metering, MTU Status

MTU Engine Status

MTU Engine Status is reported on this screen. The status is TRUE when the corresponding LED is red. Refer to Figure 4-103.
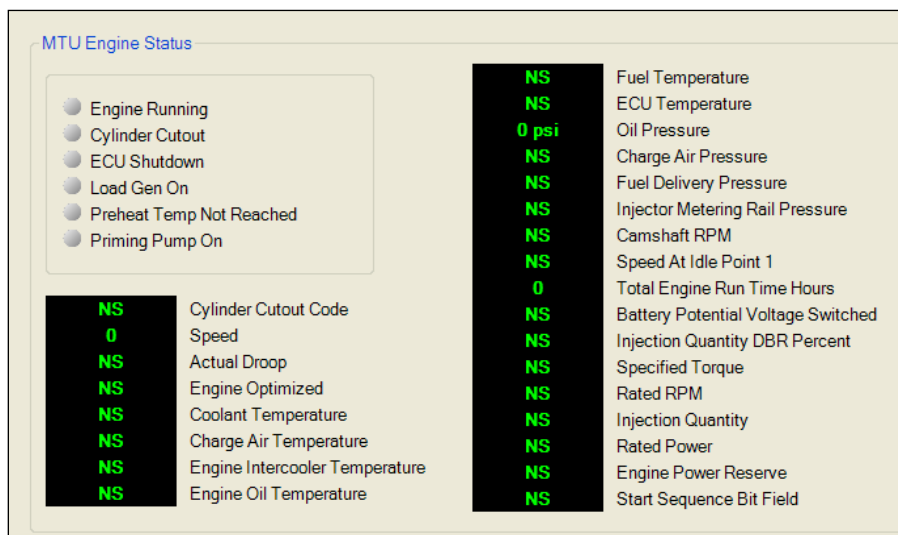
Figure 4-103. Metering, MTU Engine Status

Summary

This screen displays a metering summary. Refer to Figure 4-104.

0 h	Total Engine Run Time Hours	0 kW	Phase A kW
0 m	Total Engine Run Time Minutes	0 kW	Phase B kW
11.0 V	Battery Voltage	0 kW	Phase C kW
43 F	Coolant Temp	0 kW	Total kW
0 psi	Oil Pressure	0 kVA	Phase A kVA
0 %	Engine Load	0 kVA	Phase B kVA
0	Speed	0 kVA	Phase C kVA
0	Fuel Level	0 kVA	Total kVA
OFF	Hours Until Maintenance	0 kVar	Phase A kVar
0 V	VAB	0 kVar	Phase B kVar
0 V	VBC	0 kVar	Phase C kVar
0 V	VCA	0 kVar	Total kVar
0 V	VAN	0.44 LAG	Power Factor
0 V	VBN	---	Total kWh
0 V	VCN		
0.0 Hz	GEN Frequency		
0 V	VBUS		
0.0 Hz	BUS Frequency		
11 A	IA		
19 A	IB		
18 A	IC		

Figure 4-104. 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 4-105. Metering, Control	The following controls are available by using the Metering Explorer in BESTCOMS*Plus* to open the *Control* branch. Refer to Figure 4-105. A. The user has control to stop the generator in case of emergency by clicking on the *Emergency Stop* button. 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 4-106.
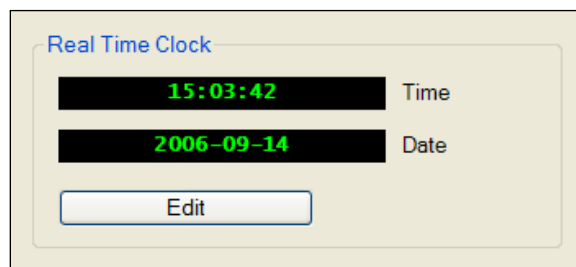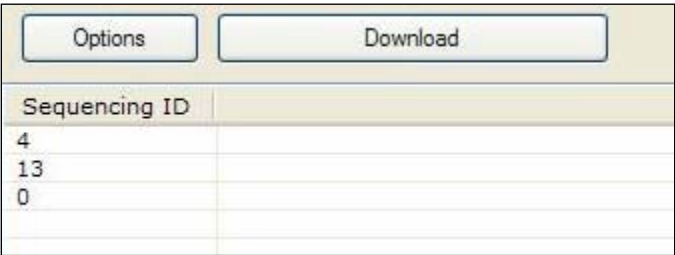
Figure 4-106. Metering, Real Time Clock

Generator Network Status

This screen (Figure 4-107) displays the detected 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. The *Options* button is used to copy or save the list of sequencing IDs. The *Download* button refreshes the list of sequencing IDs.

Figure 4-107. Metering, Generator Network Status

UPDATING BESTCOMS*Plus* SOFTWARE

Future enhancements to DGC-2020 functionality may make firmware updates desirable. Enhancements to DGC-2020 firmware typically coincide with enhancements to the DGC-2020 plug-in for BESTCOMS*Plus*. When a DGC-2020 is updated with the latest version of firmware, the latest version of the DGC-2020 plug-in for BESTCOMS*Plus* should also be obtained.

If you obtained a CD-ROM containing firmware from Basler Electric, then that CD-ROM will also contain the corresponding version of the DGC-2020 plug-in with BESTCOMS*Plus* software. The DGC-2020 plug-in with BESTCOMS*Plus* can also be downloaded from the Basler Electric website (http://www.basler.com). An outline form can be completed to obtain a password for downloading the software from the Basler Electric web site. BESTCOMS*Plus* also has a built in tool that will check for program updates if you are connected to the World Wide Web. The *Check for Updates* tool is located in the *T̲ools* drop-down menu.

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*.

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.
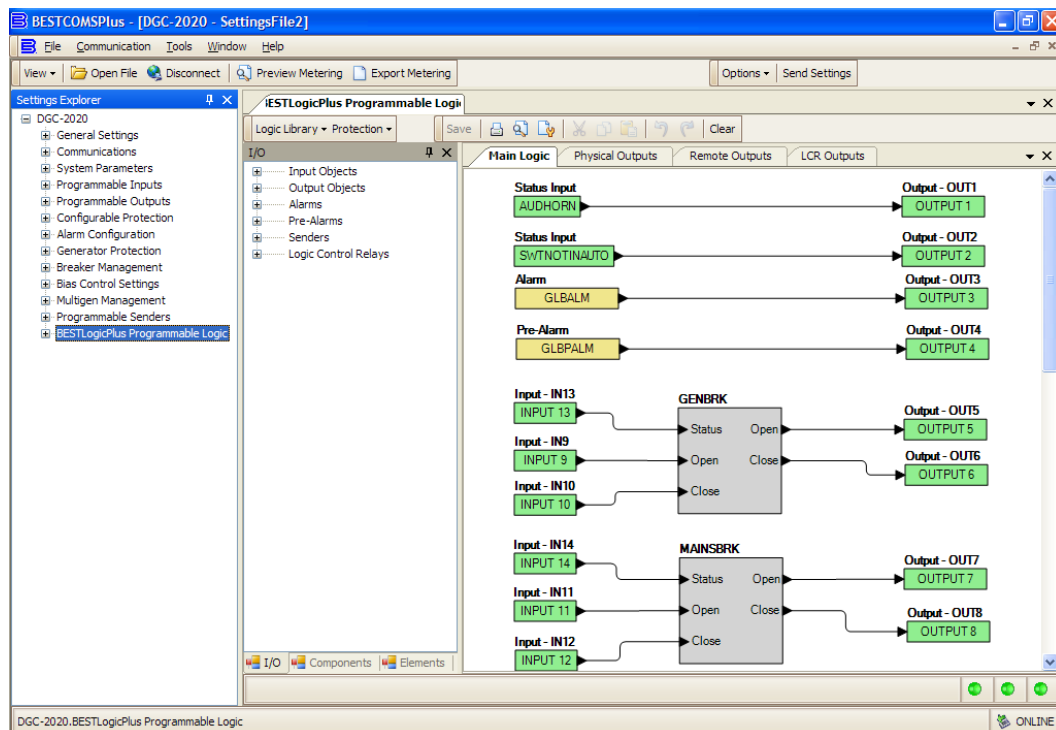
Figure 5-1. BESTLogicPlus Programmable Logic Tree Branch
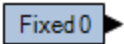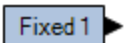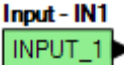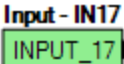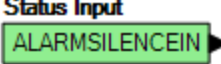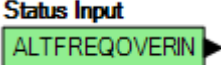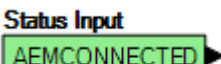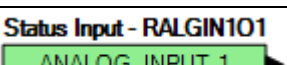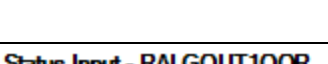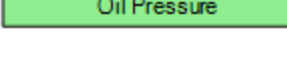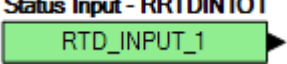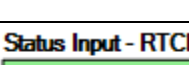
BESTLogic*Plus* Composition
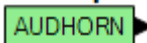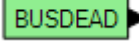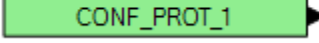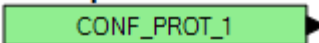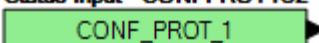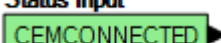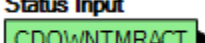
There are three main groups of objects used for programming BESTLogic*Plus*. These groups are *I/O,
Components,* and *Elements.* For details on how these objects are used to program BESTLogic*Plus*, see
the paragraphs on *Programming BESTLogicPlus.*

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*.*
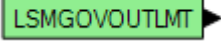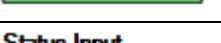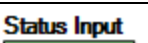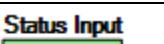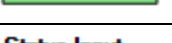
Table 5-1. I/O Group, Names and Descriptions

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 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
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 ANALOG_INPUT_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_INPUT_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 THERM_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
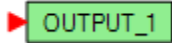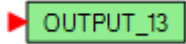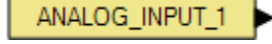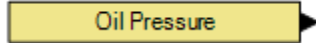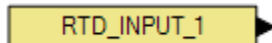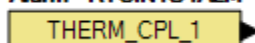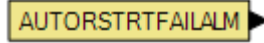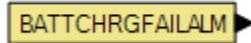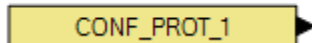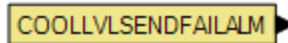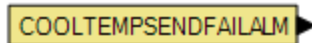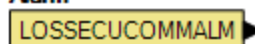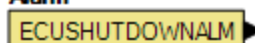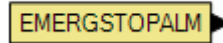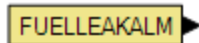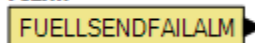
Name	Description	Symbol
Status Input Audible Horn	TRUE when the Audible Horn is active.	Status Input AUDHORN
Status Input Auto Mode	TRUE when the DGC-2020 is in Auto Mode or the Auto Mode logic element is TRUE.	Status Input AUTOMODE
Status Input Auto Restart	TRUE when the Automatic Restart function is active.	Status Input AUTORESTART
Status Input Battery Charger 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 Stable	TRUE when the Bus Stable condition settings have been exceeded.	Status Input BUSSTABLE
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.	Status Input – CONFPROT1O1 CONF_PROT_1
Status Input Configurable Protection 1-8	TRUE when the Configurable Protection x Over Threshold #2 is TRUE.	Status Input – CONFPROT1O2 CONF_PROT_1
Status Input Configurable Protection 1-8	TRUE when the Configurable Protection x Under Threshold #1 is TRUE.	Status Input – CONFPROT1U1 CONF_PROT_1
Status Input Configurable Protection 1-8	TRUE when the Configurable Protection x Under Threshold #2 is TRUE.	Status Input – CONFPROT1U2 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
Status Input Cool Down Timer Active	TRUE when the Cool Down Timer is timing out.	Status Input CDOWNTMRACT
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 EPS Supplying Load	TRUE while the EPS is supplying load.	Status Input EPSSUPLOAD
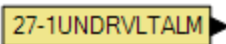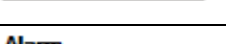
Name	Description	Symbol
Status Input Front Panel Buttons	TRUE while the *AUTO* front panel button is pressed.	Status Input AUTOBUTTON ▶
Status Input Front Panel Buttons	TRUE while the *DOWN* front panel button is pressed.	Status Input DOWNBUTTON ▶
Status Input Front Panel Buttons	TRUE while the *EDIT* 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 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 Generator Protection	TRUE when the 27-1 element is tripped.	Status Input 27-1UNDRVLTTRIPSTATUS ▶
Status Input Generator Protection	TRUE when the 27-2 element is tripped.	Status Input 27-2UNDRVLTTRIPSTATUS ▶
Status Input Generator Protection	TRUE when the 59-1 element is tripped.	Status Input 59-1OVOLTTRIPSTATUS ▶
Status Input Generator Protection	TRUE when the 59-2 element is tripped.	Status Input 59-2OVOLTTRIPSTATUS ▶

Name	Description	Symbol
Status Input Generator Protection	TRUE when the 32 element is tripped.	**Status Input** 32REVPWRTRIPSTATUS
Status Input Generator Protection	TRUE when the 40 element is tripped.	**Status Input** 40LOSSEXCTRIPSTATUS
Status Input Generator Protection	TRUE when the 47 element is tripped.	**Status Input** 47PH_IMBTRIPSTATUS
Status Input Generator Protection	TRUE when the 51-1 element is tripped.	**Status Input** 51-1OCURRTRIPSTATUS
Status Input Generator Protection	TRUE when the 51-2 element is tripped.	**Status Input** 51-2OCURRTRIPSTATUS
Status Input Generator Protection	TRUE when the 51-3 element is tripped.	**Status Input** 51-3OCURRTRIPSTATUS
Status Input Generator Protection	TRUE when the 78 element is tripped.	**Status Input** 78VECSHFTTRIPSTATUS
Status Input Generator Protection	TRUE when the 81 ROCOF element is tripped.	**Status Input** 81ROCOFTRIPSTATUS
Status Input Generator Protection	TRUE when the 81 Over element is tripped.	**Status Input** 81OFRQTRIPSTATUS
Status Input Generator Protection	TRUE when the 81 Under element is tripped.	**Status Input** 81UFRQTRIPSTATUS
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
Status Input Idle Request	TRUE when the Idle Request logic element is TRUE.	**Status Input** IDLEREQUESTIN
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
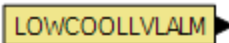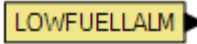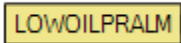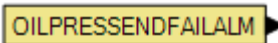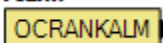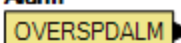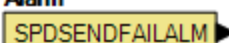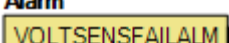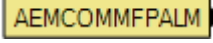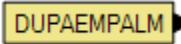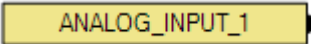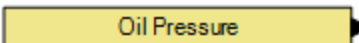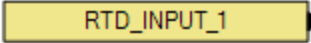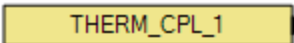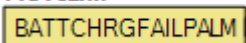
Name	Description	Symbol
Status Input Load Share Module	Load Share Module Connected. TRUE when an optional LSM-2020 is connected to the DGC-2020.	**Status Input** LSMCONNECTED ▶
Status Input Load Share Module	Load Share Module Governor Output Limit. TRUE when the LSM-2020 Governor Output Limit settings 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 Fail Test	TRUE when the Mains Fail Test logic element is TRUE.	**Status Input** MAINSFAILIN ▶
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 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 ▶
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 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 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 Switch not in Auto	TRUE when the DGC-2020 is not in Auto Mode.	**Status Input** SWTNOTINAUTO ▶
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 var Mode Active	TRUE when var mode is active.	**Status Input** VARMODEACT ▶

Name	Description	Symbol
Output Objects		
Physical Outputs OUT1 - OUTx	Physical Outputs 1 through 7 (style xxAxxxxx) or 1 through 15 (style xxBxxxxx).	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 ANALOG_INPUT_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_INPUT_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 THERM_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
Coolant Level Sender Fail	TRUE when a low coolant level error status code is received from the ECU. CANbus must be enabled.	Alarm COOLLVLSENDFAILALM
Coolant Temp Sender Fail	TRUE when the Coolant Temp Sender Fail is configured as an Alarm and the activation delay has expired.	Alarm COOLTEMPSENDFAILALM
ECU Comm Loss	TRUE when communication to ECU has been lost.	Alarm LOSSECUCOMMALM
ECU Shutdown	TRUE when ECU has Shutdown the engine.	Alarm ECUSHUTDOWNALM
Emergency Stop	TRUE when the Emergency Stop button has been pressed.	Alarm EMERGSTOPALM
Fuel Leak	TRUE when the Fuel Leak Detect function is configured as an Alarm and the activation delay has expired.	Alarm FUELLEAKALM
Fuel Level Sender Fail	TRUE when the Fuel Level Sender Fail is configured as an Alarm and the activation delay has expired.	Alarm FUELLSENDFAILALM

Name	Description	Symbol
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
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 ROC DF/DT	TRUE when the 81 ROC DF/DT 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
Global Sender Fail	TRUE when one or more of the Sender Fails are configured as Alarms and are TRUE.	Sender Fail GLBSENDFALM
Hi Coolant Temp	TRUE when the High Coolant Temp Alarm settings have been exceeded.	Alarm HITEMPALM
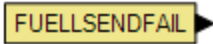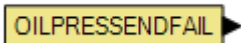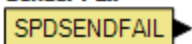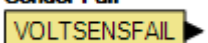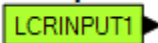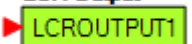
Name	Description	Symbol
Low Coolant Level	TRUE when the Low Coolant Level function is configured as an Alarm and the activation delay has expired. In addition, TRUE when CANbus is enabled and the Low Coolant Level Alarm threshold has been exceeded.	Alarm LOWCOOLLVLALM
Low Fuel Level	TRUE when the Low 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
Oil Pressure Sender Fail	TRUE when the Oil Pressure Sender Fail is configured as an Alarm and the activation delay has expired.	Alarm OILPRESSENDFAILALM
Overcrank	TRUE when an Overcrank condition exists.	Alarm OCRANKALM
Overspeed	TRUE when the Overspeed Alarm settings have been exceeded.	Alarm OVERSPDALM
Speed Sender Fail	TRUE when the Speed Sender Fail activation delay has expired.	Alarm SPDSENDFAILALM
Voltage Sensing Fail	TRUE when the Voltage Sensing Fail is configured as an Alarm and the activation delay has expired.	Alarm VOLTSENSFAILALM
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 ANALOG_INPUT_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_INPUT_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 THERM_CPL_1
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

Name	Description	Symbol
Battery Overvoltage	TRUE when the Battery Overvoltage Pre-Alarm threshold has been exceeded.	Pre-Alarm BATOVOLTPALM ▶
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 ▶
Contact Expansion Module Multiple Contact Expansion Modules Connected	TRUE when more than one CEM-2020 is connected.	Pre-Alarm DUPCEMPALM ▶
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 ▶
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 ▶
Diag Trouble Code	TRUE when a Diagnostic Trouble Code exists.	Pre-Alarm DIAGTRBCODEPALM ▶
DPF Regenerate Disabled	TRUE when the engine ECU reports via CANbus that Diesel Particulate Filter (DPF) regeneration is disabled.	Pre-Alarm DPFREGENDISABLDPALM ▶
DPF Regenerate Required	TRUE when the Diesel Particulate Filter (DPF) lamp status broadcast over CANbus indicates that DPF regeneration is required.	Pre-Alarm DPFREGENREQPALM ▶
ECU Com Loss	TRUE when communication to ECU has been lost.	Pre-Alarm LOSSECUCOMMPALM ▶
Engine kW Over Load 1	TRUE when the Engine kW Overload 1 Pre-Alarm settings have been exceeded.	Pre-Alarm ENGKWOVRLD1PALM ▶
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 Leak	TRUE when the Fuel Leak Detect function is configured as a Pre-Alarm and the activation delay has expired.	Pre-Alarm FUELLEAKPALM ▶
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 ▶

Name	Description	Symbol
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 ▶
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 ROC DF/DT	TRUE when the 81 ROC DF/DT element is configured as a Pre-Alarm and has tripped.	**Pre-Alarm** 81ROCOFPALM ▶
Generator Protection 81 Over	TRUE when the 81 Over element is configured as a Pre-Alarm and has tripped.	**Pre-Alarm** 81OFRQPALM ▶
Generator Protection 81 Under	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 ▶
Hi Coolant Temp	TRUE when the High Coolant Temp Pre-Alarm threshold has been exceeded.	**Pre-Alarm** HITEMPPALM ▶
High Exhaust Temperature	TRUE when the ECU reports via CANbus that a high exhaust temperature condition exists.	**Pre-Alarm** HIGHEXHTEMPPALM ▶
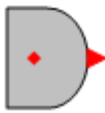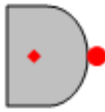
Name	Description	Symbol
High Fuel Level	TRUE when the High Fuel Level Pre-Alarm settings have been exceeded.	Pre-Alarm HIFUELLPALM ▶
Intergenset Comm Fail	TRUE when an individual generator detects that it had been connected to a generator network, but has lost the connection.	Pre-Alarm INTERGENCOMFPALM ▶
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 CANbus 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 ▶
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 ▶
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 ▶
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 ▶
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 ▶
Voltage Sensing Fail	TRUE when the Voltage Sensing Fail is configured as a Pre-Alarm and the activation delay has expired.	Pre-Alarm VOLTSENSFAILPALM ▶
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 ▶
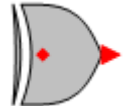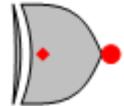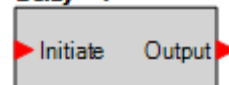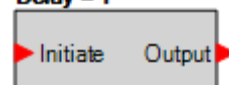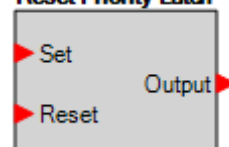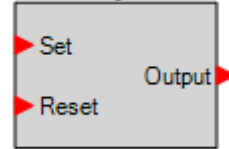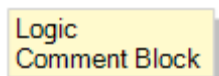
Name	Description	Symbol
Fuel Level Sender Fail	TRUE when the Fuel Level Sender Fail is configured as either a Pre-Alarm or Alarm and the activation delay has expired.	**Sender Fail** FUELLSENDFAIL ▶
Oil Pressure Sender Fail	TRUE when the Oil Pressure Sender Fail is configured as either a Pre-Alarm or 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) 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	
OR		Input		Output	
		0	0	0	
		0	1	1	
		1	0	1	
		1	1	1	
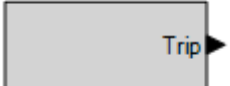
Name	Description	Symbol
NOR	<table><tr><td>Input</td><td></td><td>Output</td></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table>	
XOR	<table><tr><td>Input</td><td></td><td>Output</td></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>	
XNOR	<table><tr><td>Input</td><td></td><td>Output</td></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>	
NOT (INVERTER)	<table><tr><td>Input</td><td>Output</td></tr><tr><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td></tr></table>	

Pickup and Dropout Timers

Name	Description	Symbol
Drop Out Timer	Used to set a delay in the logic. For more information, refer to *Programming BESTLogicPlus, Pickup and Dropout Timers,* later in this section.	Drop Out Timer (1) TIMER_1 Delay = 1 ►Initiate Output►
Pickup Up Timer	Used to set a delay in the logic. For more information, refer to *Programming BESTLogicPlus, Pickup and Dropout Timers,* later in this section.	Pick Up Timer (1) TIMER_1 Delay = 1 ►Initiate Output►

Latches

Name	Description	Symbol
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.	Reset Priority Latch ►Set Output► ►Reset
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.	Set Priority Latch ►Set Output► ►Reset

Other

Name	Description	Symbol
Comment Block	Enter user comments.	Logic Comment Block
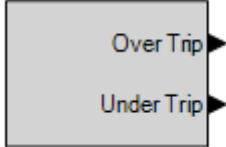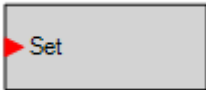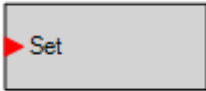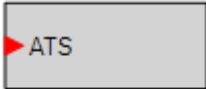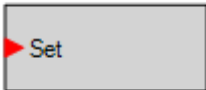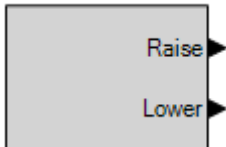
This group contains elements for the 27, 32, 40, 47, 51, 59, 78, 81, and ROCOF. It also contains elements for Generator Breaker, Mains Breaker, AVR Raise/Lower, Governor Raise/Lower, Logic Alarm, Logic Pre-Alarm, Modem, Configurable Elements, AUTO Mode, OFF Mode, RUN Mode, Parallel to Mains, Run with Load, Engine Run, ATS, Run Inhibit, Test Inhibit, Pre-Start Output, Start Output, Run Output, Cool Stop Request, Cool Down Request, External Start Delay, Start Delay Bypass, Alternate Frequency Override, Mains Fail Test, Take Over Load, Reset From, Alarm Silence, Lamp Test, and Idle Request.
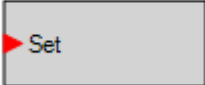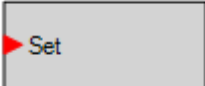
Table 5-3 lists the names and descriptions of the elements in the *Elements* group.
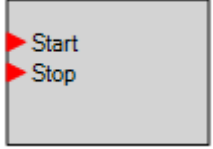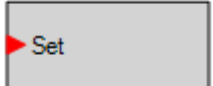
Table 5-3. Elements Group, Names and Descriptions
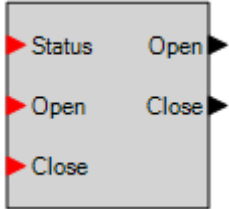
Name	Description	Symbol
Protection		
27-1TRIP	TRUE when the 27-1 undervoltage is in a TRIP condition. Connect to another logic block input.	27-1TRIP — Trip
27-2TRIP	TRUE when the 27-2 undervoltage is in a TRIP condition. Connect to another logic block input.	27-2TRIP — Trip
32TRIP	TRUE when the 32 reverse power is in a TRIP condition. Connect to another logic block input.	32TRIP — Trip
40TRIP	TRUE when the 40Q loss of excitation is in a TRIP condition. Connect to another logic block input.	40TRIP — Trip
47TRIP (Optional)	TRUE when the 47 phase imbalance is in a TRIP condition. Connect to another logic block input.	47TRIP — Trip
51-1TRIP (Optional)	TRUE when the 51-1 overcurrent is in a TRIP condition. Connect to another logic block input.	51-1TRIP — Trip
51-2TRIP (Optional)	TRUE when the 51-2 overcurrent is in a TRIP condition. Connect to another logic block input.	51-2TRIP — Trip
51-3TRIP (Optional)	TRUE when the 51-3 overcurrent is in a TRIP condition. Connect to another logic block input.	51-3TRIP — Trip
59-1TRIP	TRUE when the 59-1 overvoltage is in a TRIP condition. Connect to another logic block input.	59-1TRIP — Trip
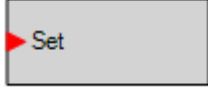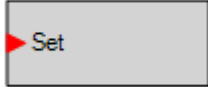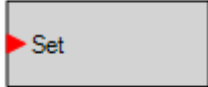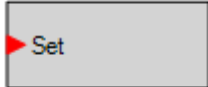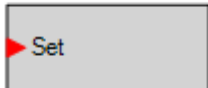
Name	Description	Symbol
59-2TRIP	TRUE when the 59-2 overvoltage is in a TRIP condition. Connect to another logic block input.	**59-2TRIP** · Trip ▶
78TRIP	TRUE when the 78 vector shift is in a TRIP condition. Connect to another logic block input.	**78TRIP** · Trip ▶
81ROCOFTRIP	TRUE when the 81 ROCOF is in a TRIP condition. Connect to another logic block input.	**81ROCOFTRIP** · Trip ▶
81TRIP	TRUE when the 81 frequency is in a TRIP condition. Connect to another logic block input.	**81TRIP** · Over Trip ▶ · Under Trip ▶
Other		
ALARMSILENCE	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.	**ALARMSILENCE** · ▶ Set
ALTFREQOVER	When this logic element is TRUE, protection and bus condition detection is forced to operate at the Alternate Frequency instead of the Rated Frequency.	**ALTFREQOVER** · ▶ Set
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 is in AUTO mode, the generator will run. If both the ATS logic element and the ATS programmable function are FALSE, and the DGC is in AUTO mode, the generator will cool down and stop.	**ATS** · ▶ ATS
AUTOMODE	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.	**AUTOMODE** · ▶ Set
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.	**AVR** · Raise ▶ · Lower ▶
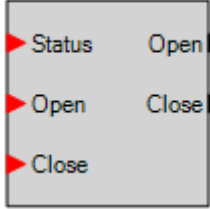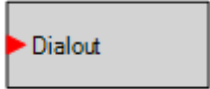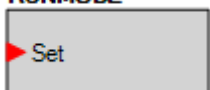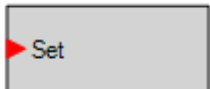
Name	Description	Symbol
CONFELMNTX (X = 1 to 8)	Configurable elements (CONFELMNT1-8) are connected to the logic scheme as outputs. These elements are configurable in BESTCOMS*Plus* under *Programmable Outputs, Configurable Elements.* The user can assign a string of up to 16 characters, configure whether 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.	CONFELMNT1 CONFIG_ELEMENT_1 ▶ Set
COOLSTOPREQ	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.	COOLSTOPREQ ▶ Set
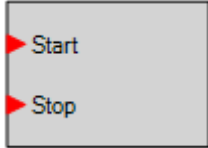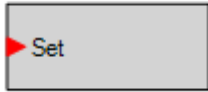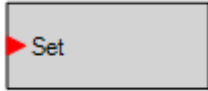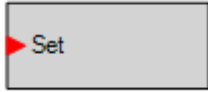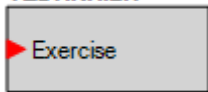
Name	Description	Symbol
COOLDOWNREQ	RUN Mode If the unit is in RUN mode when the Cool Down Request is received, the unit is forced to unload and open its breaker and then go into a cooldown cycle. While in the cool down cycle, the unit will display "COOLDOWN REQ" in addition to displaying the cooldown 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. AUTO Mode 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.	**COOLDOWNREQ** ▶ Set
ENGINERUN	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.	**ENGINERUN** ▶ Start ▶ Stop
EXTSTARTDEL	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.	**EXTSTARTDEL** ▶ Set

Name	Description	Symbol
GENBRK	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.	**GENBRK** ▶ Status Open ▶ ▶ Open Close ▶ ▶ Close

Name	Description	Symbol
GOVR	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.	**GOVR** — Raise, Lower
IDLEREQUEST	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.	**IDLEREQUEST** — Set
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.	**LAMPTEST** — Set
LOGICALM	When this input is TRUE, the DGC-2020 goes into an Alarm condition.	**LOGICALM** — Set
LOGICPALM	When this input is TRUE, the DGC-2020 goes into a Pre-alarm condition.	**LOGICPALM** — Set
MAINSFAILTEST	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.	**MAINSFAILTEST** — Set

Name	Description	Symbol
MAINSBRK	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.	**MAINSBRK** ► Status Open ► ► Open Close ► ► Close

Name	Description	Symbol
MODEM (Optional)	Connect the input to the output of another logic block. When TRUE, the Modem will dial out.	**MODEM** ▶ Dialout
OFFMODE	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
PARTOMAINS	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
PRESTARTOUT	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
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
RUNINHIBIT	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
RUNMODE	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
RUNOUTPUT	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

Name	Description	Symbol
RUNWLOAD	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
STARTDELBYP	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 ECO, to control the pre start interval.	**STARTDELBYP** ▶ Set
STARTOUTPUT	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
TAKEOVERLOAD	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.	**TAKEOVERLOAD** ▶ Set
TESTINHIBIT	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

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* 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* 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. See the paragraphs on *Sending and Retrieving Logic Schemes* later in this section*.*

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 five 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 10 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 50 gates allowed per diagram.

- At all levels there can only be 64 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)	🟡 Yellow	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.
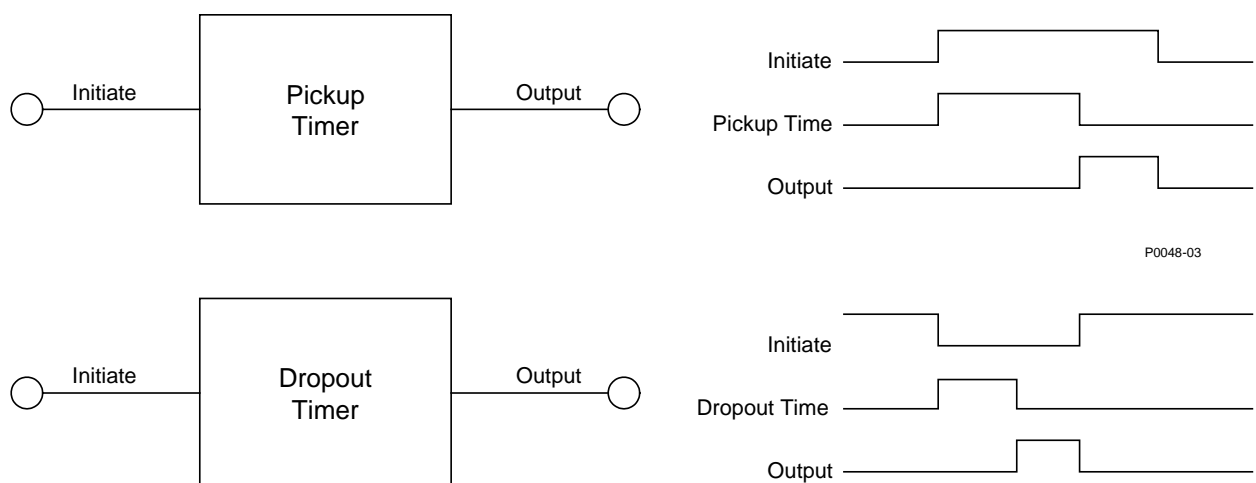
Figure 5-2. Pickup and Dropout Timer Logic Blocks

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 5-3. For information on Settings Files management, refer to Section 4, *BESTCOMSPlus Software.*
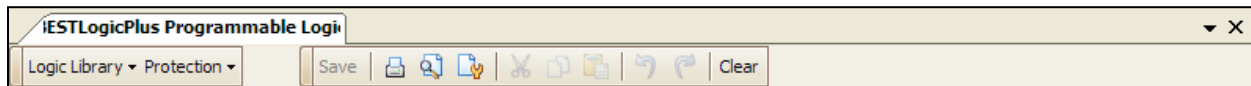
Figure 5-3. BESTLogicPlus Programmable Logic Toolbar

Saving a BESTLogicPlus 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 BESTLogicPlus 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 BESTLogicPlus 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 BESTLogicPlus 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 BESTLogicPlus 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 BESTLogicPlus 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.*

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 5-4 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.
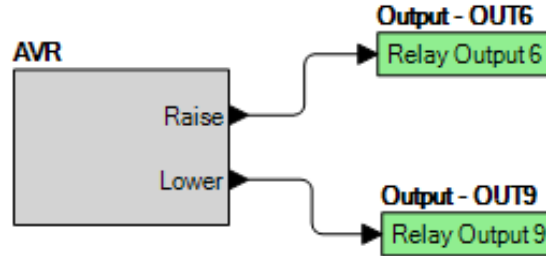
Figure 5-4. Example 1 - AVR Logic Block Connections

Example 2 - AND Gate Connections

Figure 5-5 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.
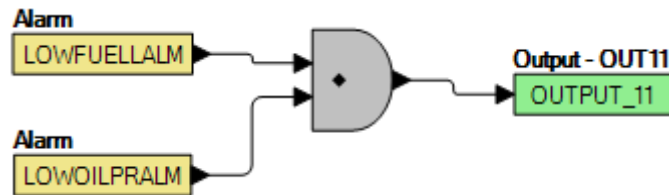
Figure 5-5. Example 2 - AND Gate Connections

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 5-6.
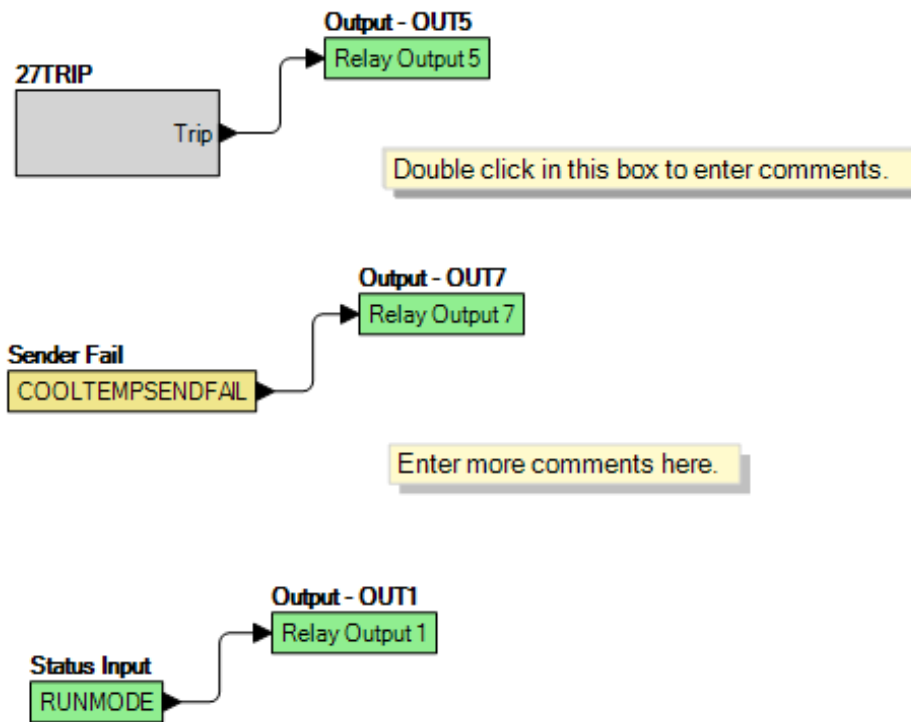
Figure 5-6. Example 3 - Multiple Logic Connections

SECTION 6 • INSTALLATION

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SECTION 6 • INSTALLATION

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, your sales representative, or a sales representative at Basler Electric, Highland, Illinois USA.

If the device is not installed immediately, store it in the original shipping package in a moisture- and dust-free environment.

PRODUCT REGISTRATION

Registering with Basler Electric enables you to receive important information updates on your product plus new product announcements. Register your product by directing your web browser to www.basler.com.

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.
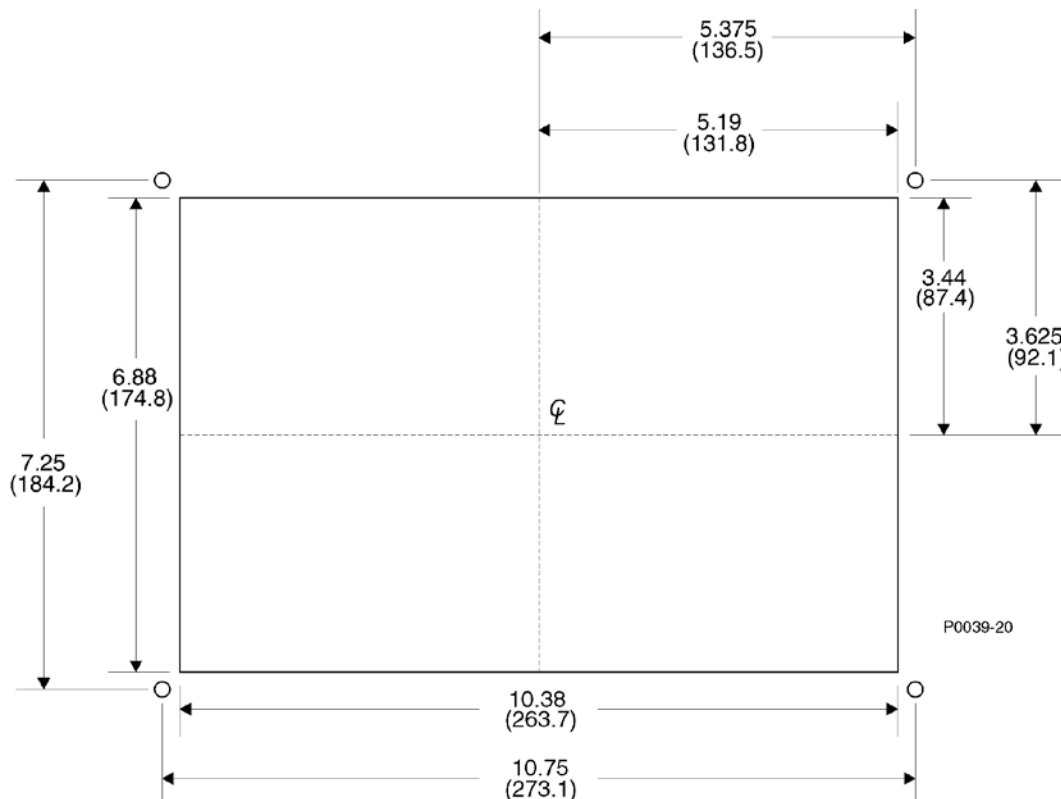
Figure 6-1. Panel Cutting and Drilling Dimensions
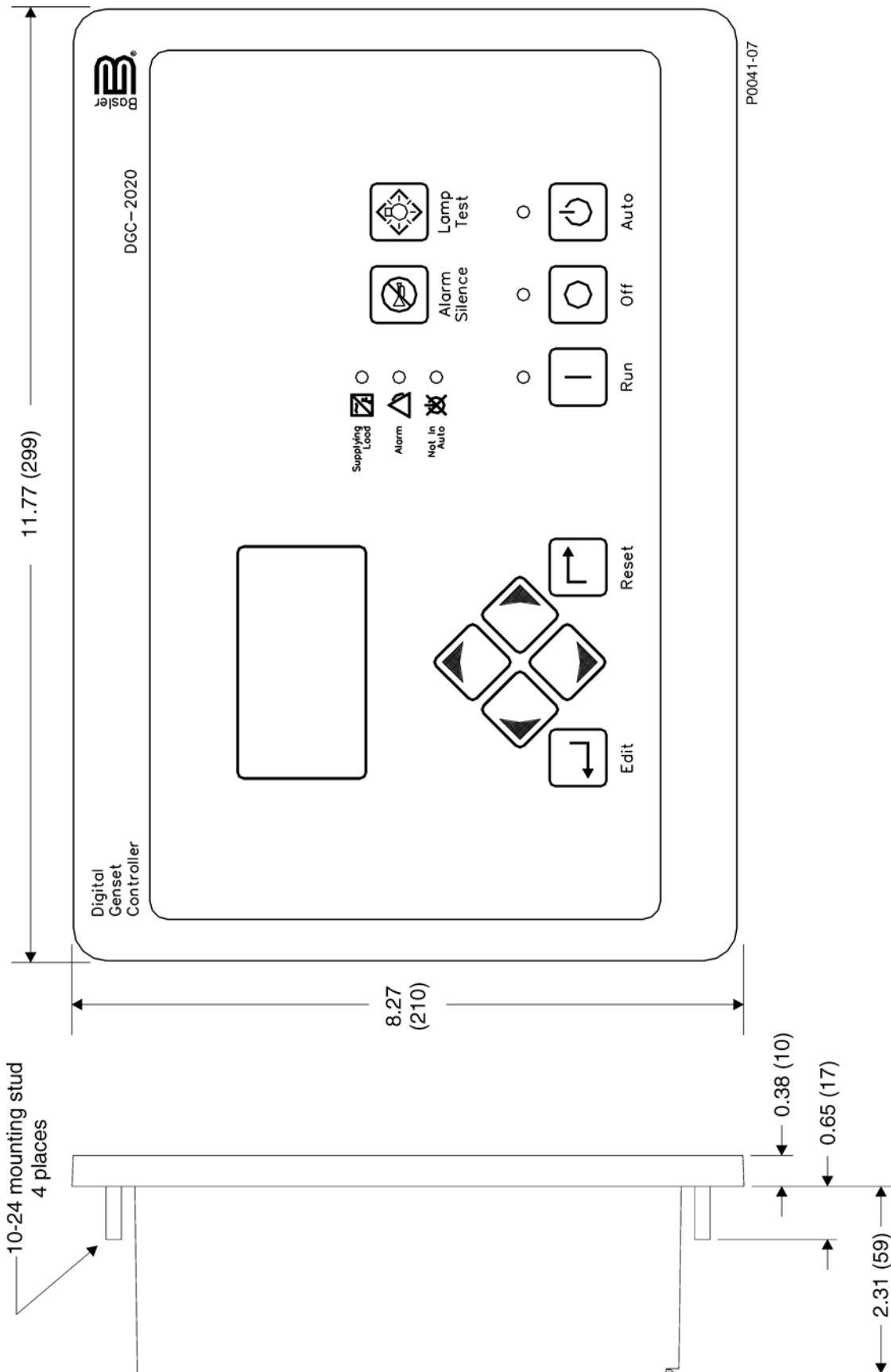
Figure 6-2. Overall Dimensions

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. Controllers equipped with the optional, internal dial-out modem have an additional RJ-11 jack.

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.

It is recommended that a fuse be added for additional protection for the wiring to the battery input of the DGC-2020. A Bussmann ABC-7 fuse or equivalent will help prevent wire damage and nuisance trips due to initial power supply inrush current.

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 x1xxxxxxxx indicates 50/60 hertz generator voltage and a style number of x2xxxxxxxx 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

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 A-phase and B-phase bus voltage. Bus voltage sensing terminals are listed in Table 6-4.

Table 6-4. Bus Voltage Sensing Terminals

Terminal	Description
43 (BUS VB)	B-phase bus voltage sensing input
45 (BUS VA)	A-phase bus voltage sensing input

Analog Engine Sender Inputs

Inputs are provided for oil pressure, fuel level, and coolant temperature senders.

Oil pressure senders that are compatible with the DGC-2020 include Datcon 02505-00, Isspro model R8919, Stewart-Warner models 279BF, 279C, 411K, and 411M, and VDO models 360025 and 360811. Other senders may be used.

Compatible fuel level senders include Isspro model R8925. Other senders may be used.

Coolant temperature senders that are compatible with the DGC-2020 include Datcon 02019-00, Faria TS4042, Isspro model R8959 and Stewart-Warner model 334-P. Other senders may be used.

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 short-circuit across the input is removed. The ESTOP can be up to 75 ft away from the DGC-2020 using a maximum wire length of 150 ft. Emergency stop input terminals are listed in Table 6-6.

Table 6-6. Emergency Stop Input Terminals

Terminal	Description
46 (ESTOP)	Emergency stop contact input
47 (ESTOP)	

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 6-3, alleviates potential problems.
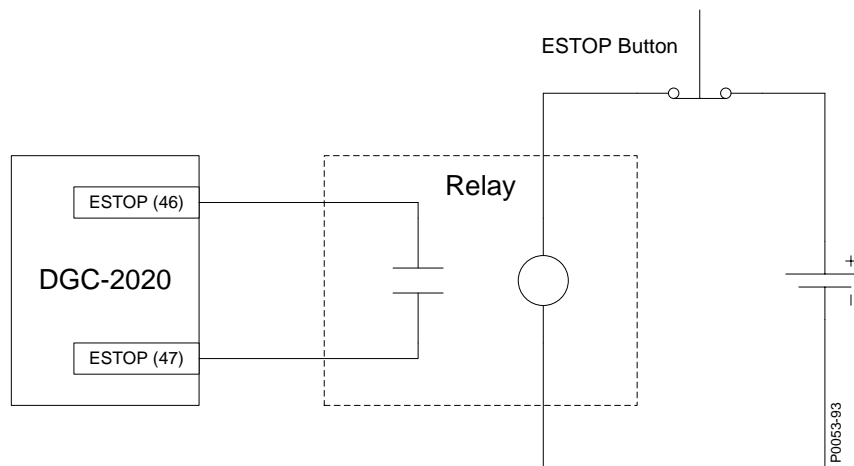
Figure 6-3. Interposing Relay Diagram

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.

Magnetic Pickup Input

The magnetic pickup input accepts a speed signal over the range of 3 to 35 volts peak and 32 to 10,000 hertz. Magnetic pickup input terminals are listed in Table 6-7.

Table 6-7. Magnetic Pickup Input Terminals

Terminal	Description
31 (MPU+)	Magnetic pickup positive input
32 (MPU–)	Magnetic pickup return input

Contact Sensing Inputs

Contact sensing inputs consist of 1 emergency stop input and 16 programmable inputs.

The programmable inputs accept normally open, dry contacts. Terminal 2 (BATT–) serves as the common return line for the programmable inputs. Information about configuring the programmable inputs is provided in Section 4, *BESTCOMSPlus Software*.

Contact sensing input terminals are listed in Table 6-8.

Table 6-8. Contact Sensing Inputs

Terminal	Description
2 (BATT–)	Common return line for programmable contact inputs
15 (INPUT 16)	Programmable contact input 16
16 (INPUT 15)	Programmable contact input 15
17 (INPUT 14)	Programmable contact input 14
18 (INPUT 13)	Programmable contact input 13
19 (INPUT 12)	Programmable contact input 12
20 (INPUT 11)	Programmable contact input 11
21 (INPUT 10)	Programmable contact input 10
22 (INPUT 9)	Programmable contact input 9
23 (INPUT 8)	Programmable contact input 8
24 (INPUT 7)	Programmable contact input 7
25 (INPUT 6)	Programmable contact input 6
26 (INPUT 5)	Programmable contact input 5
27 (INPUT 4)	Programmable contact input 4
28 (INPUT 3)	Programmable contact input 3
29 (INPUT 2)	Programmable contact input 2
30 (INPUT 1)	Programmable contact input 1

Output Contacts

The DGC-2020 has three sets of fixed-function output contacts: Pre, Start, and Run. The Pre contacts supply battery power to the engine glow plugs, the Start contacts supply power to the start solenoid, and the Run contacts supply power to the fuel solenoid. Connections to the three sets of contacts are made directly at each relay using female, quarter-inch, quick-connect terminals. Amp part numbers 154718-3 (positive-lock receptacle) and 154719-1 (nylon housing) are the recommended components for making connections at each relay. For the location of the Pre, Start, and Run relays refer to Figure 2-2.

Depending on the style number of the DGC-2020, either 4 or 12 sets of programmable output contacts are provided. Four programmable outputs are provided on DGC-2020 controllers with a style number of xxAxxxxxx. Twelve programmable outputs are provided on controllers with a style number of xxBxxxxxx. Programmable output contact terminals are listed in Table 6-9.

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
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

CANbus 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. CANbus interface terminals are listed in Table 6-11. Refer to Figure 6-4 and Figure 6-5.

Table 6-11. CANbus Interface Terminals

Terminal	Description
48 (CAN L)	CAN low connection
49 (CAN H)	CAN high connection
50 (SHIELD)	CAN drain connection

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NOTES
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1.) If the DGC-2020 is providing one end of the J1939 bus, a 120 Ω, 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.
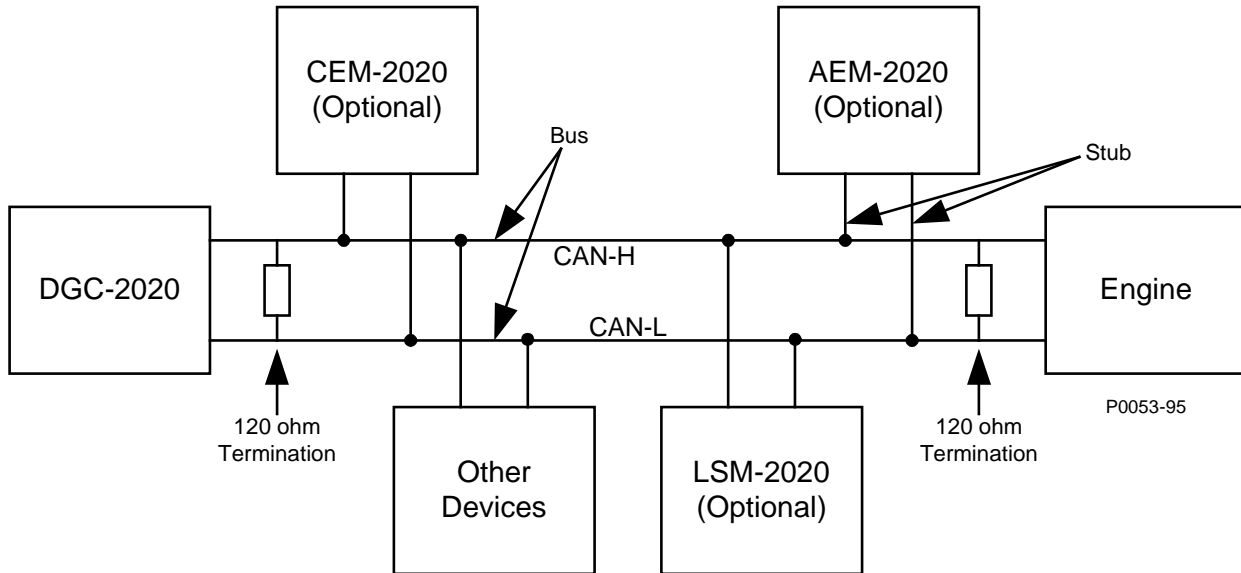
Figure 6-4. CANbus Interface with DGC-2020 providing One End of the Bus
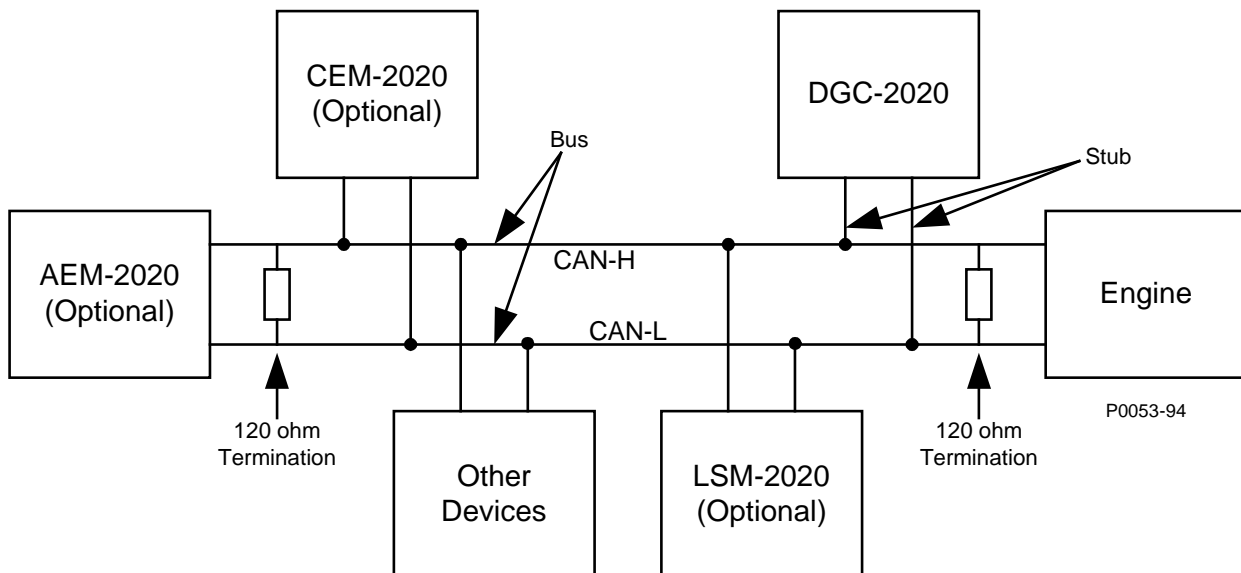
Figure 6-5. CANbus Interface with Optional AEM-2020 providing One End of the Bus

DGC-2020 controllers with style number xxxxxMxxx have an internal modem with dial-in, dial-out capability. The DGC-2020 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.

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

Connections for typical applications including 3-Phase Wye (Figure 6-6), 3-Phase Delta (Figure 6-7), Single-Phase A-B (Figure 6-8), and Single-Phase A-C (Figure 6-9) are shown on the following pages.

Figure 6-6. 3-Phase Wye Connections for Typical Applications

Figure 6-7. 3-Phase Delta Connections for Typical Applications

Figure 6-8. Single-Phase A-B Connections for Typical Applications
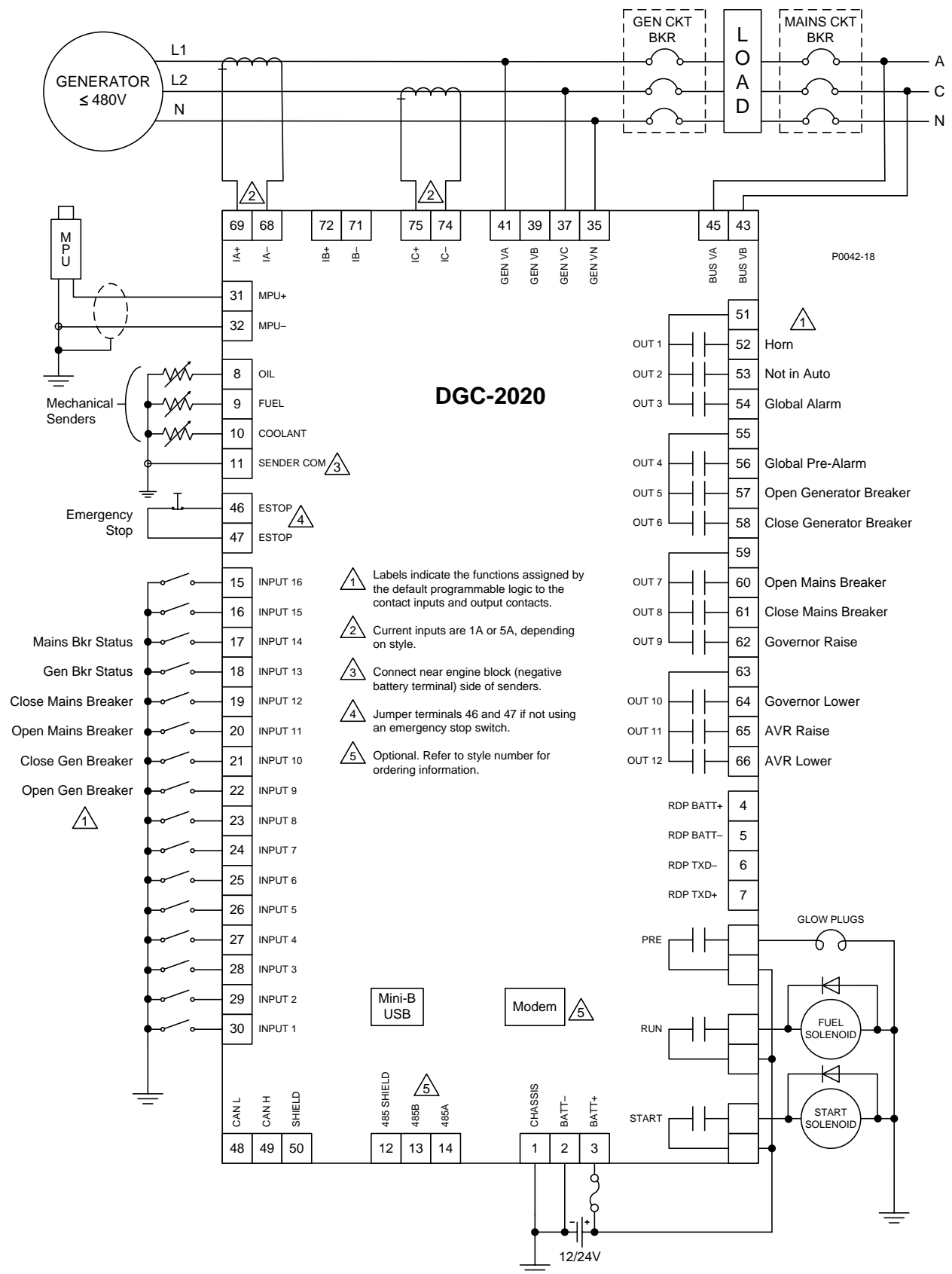
Figure 6-9. Single-Phase A-C Connections for Typical Applications

Connections for Volvo Penta EDC III Applications

Engines equipped with Volvo Penta EDC III controllers can receive engine control commands (such as start and stop) from the DGC-2020 through the SAE J1939 communication interface. To invoke this feature, the EDC III must receive a J1939 message containing engine control information within one second of waking (exiting sleep mode). If the EDC III does not receive an engine control message within the prescribed time, it will enter the stand-alone mode and ignore any J1939 control messages. If this occurs, the EDC III must be forced back into sleep mode by pressing the auxiliary stop pushbutton on the engine or by shortly disconnecting EDC power.

The interconnection diagrams of Figures 6-10 through 6-13 illustrate the DGC-2020 and EDC III connections that allow the DGC-2020 to awaken the EDC III and start the engine, or simply acquire engine status information. Wake-up of the EDC III is initiated by using the DGC-2020 RUN output contacts to apply battery power to the EDC. To stop the engine, the DGC-2020 sends a sleep command through the J1939 interface to the EDC III and opens the RUN output contacts. This causes the EDC to stop the engine and enter the sleep mode.

In order for the DGC-2020 to communicate with the EDC III, two DGC-2020 settings must be changed from their default values.

- The J1939 address of the DGC-2020 must be set at 17.

- The engine start/stop configuration setting must be set for Volvo Penta.

Both settings are configured on the *CANbus Setup* screen of BESTCOMS*Plus*. Section 4, *BESTCOMSPlus Software* has information about adjusting DGC-2020 settings through BESTCOMS*Plus*.

3-Phase Wye Connections for Volvo Penta EDC III Applications
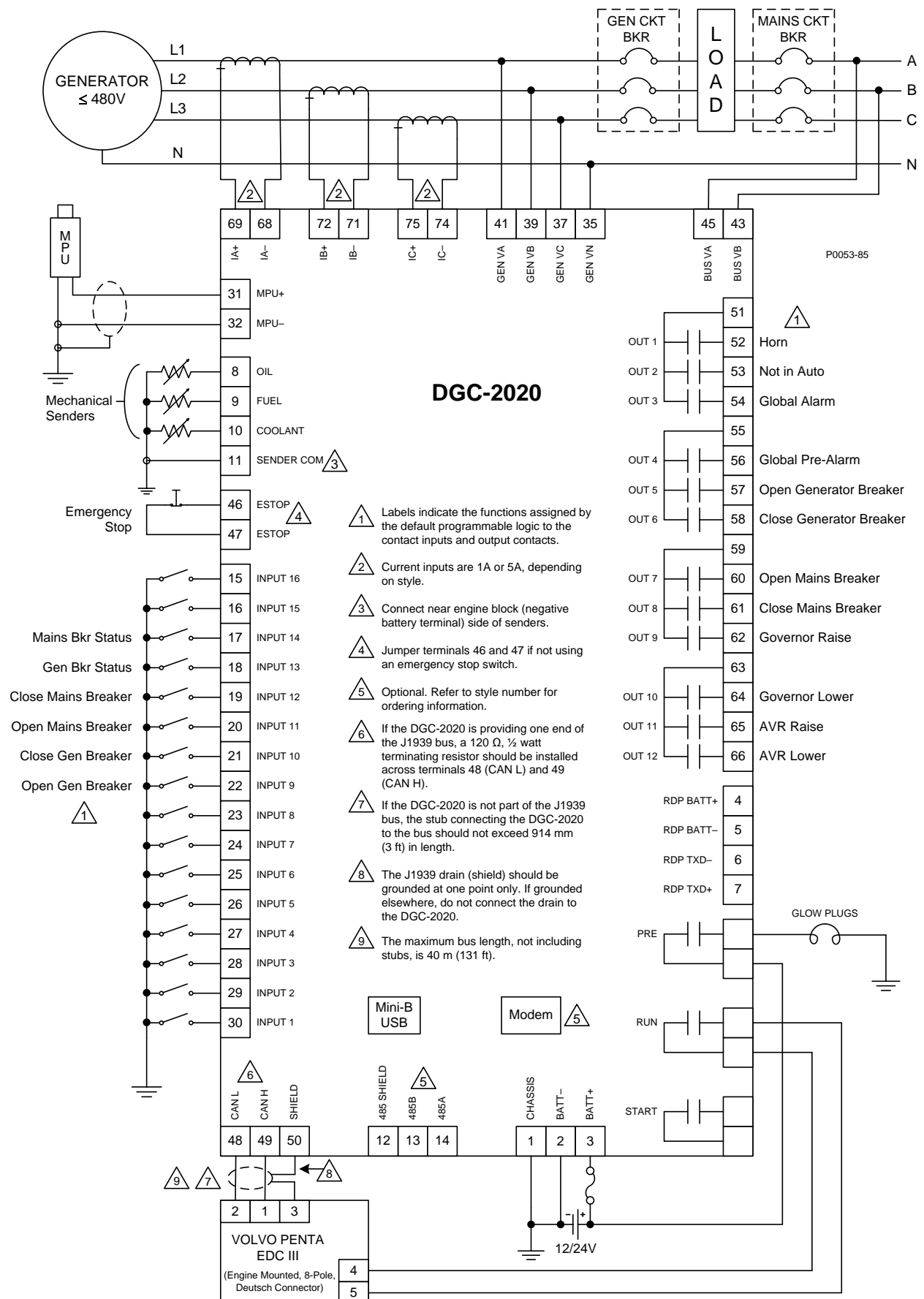
Figure 6-10. 3-Phase Wye Connections for Volvo Penta EDC III Applications

Figure 6-11. 3-Phase Delta Connections for Volvo Penta EDC III Applications

Single-Phase A-B Connections for Volvo Penta EDC III Applications
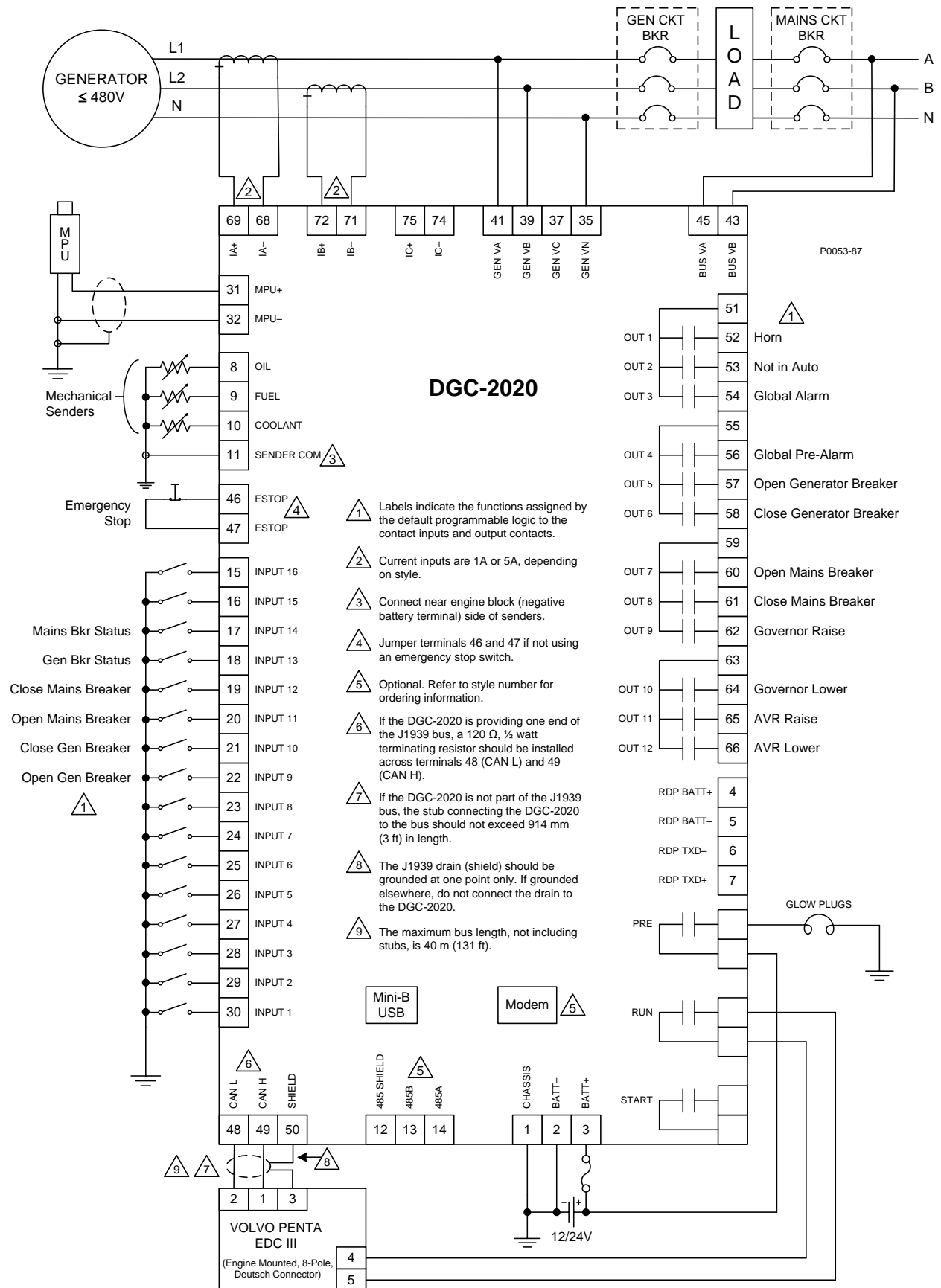
Figure 6-12. Single-Phase A-B Connections for Volvo Penta EDC III Applications

Figure 6-13. Single-Phase A-C Connections for Volvo Penta EDC III Applications

Connections for MTU MDEC ECU Applications

MTU MDEC ECUs, supplied on some MTU engines, can receive engine control commands from the DGC-2020 and transmit engine operating status information to the DGC-2020 through the SAE J1939 communication interface.

In order for the DGC-2020 to communicate with the MTU MDEC ECU, ECU support must be enabled on the CANbus Setup screen of BESTCOMS*Plus* and "MTU MDEC" must be selected as the engine configuration. The appropriate ECU module type, speed demand source, and engine rpm must also be selected.

The MTU MDEC ECU must be configured properly in order for CANbus communication to function correctly. The parameters listed in Table 6-13 must be configured in the ECU with the MTU service tool. Contact MTU if ECU reconfiguration is required and your facility is not equipped to perform this task.

Table 6-13. MTU MDEC ECU Configuration Parameters

MTU Parameter Number	Parameter Name	Description and Value
200	CANbus Interface Config Param	Set to 898 – Indicates one CANbus with PIMS
201.01	CANbus Monitor Nodes 1–16	Binary value indicating which communication devices are on the CANbus network. If a binary representation of this parameter's value does not have the bit set corresponding to a value of 00100000, take the value in this register, add 32 to it, and rewrite it to the register to set the bit. This informs the MTU MDEC ECU that a third part controller resides on the CANbus.
156.19	CANbus Speed Demand Switch Active	Set to 1 – This is necessary only if it is desired to set the engine speed demand source and speed demand from the DGC-2020. This capability may be blocked by setting the parameter to 0.

The interconnection diagrams of Figures 6-14 through 6-17 illustrate DGC-2020 and MTU MDEC ECU connections for four types of generator sensing configurations.

Figure 6-14. 3-Phase Wye Connections for MTU MDEC ECU Applications

Figure 6-15. 3-Phase Delta Connections for MTU MDEC ECU Applications

Figure 6-16. Single-Phase A-B Connections for MTU MDEC ECU Applications

Figure 6-17. Single-Phase A-C Connections for MTU MDEC ECU 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 CANbus, thus the CANBUS terminals are the only common connections (Figure 6-18) between the DGC-2020, AEM-2020, CEM-2020, and LSM-2020. Refer to Section 8, *LSM-2020 (Load Share Module),* for independent LSM-2020 connections. Refer to Section 9, *CEM-2020 (Contact Expansion Module),* for independent CEM-2020 connections. Refer to Section 10, *AEM-2020 (Analog Expansion Module),* for independent AEM-2020 connections. Refer to *Connections, CANbus Interface,* in this section for details on DGC-2020 CANbus connections.

P0053-57
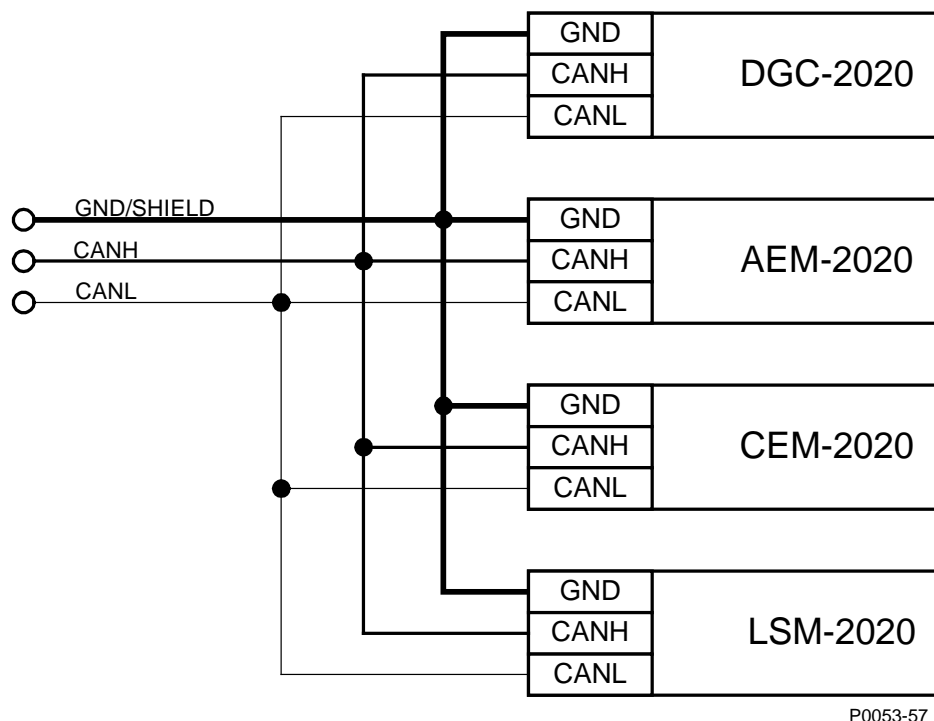
Figure 6-18. DGC-2020, AEM-2020, CEM-2020, LSM-2020 CANbus Connections

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 7, *Maintenance and Troubleshooting.*

DGC-2020 SETUP

The following paragraphs provide information for initial setup of a DGC-2020, generator breaker control, and mains fail transfer.

DGC-2020 Initial Setup

The DGC-2020 must be set up with parameters specific to the machine that it is controlling 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.

1. General Settings

    a. 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 6-19.
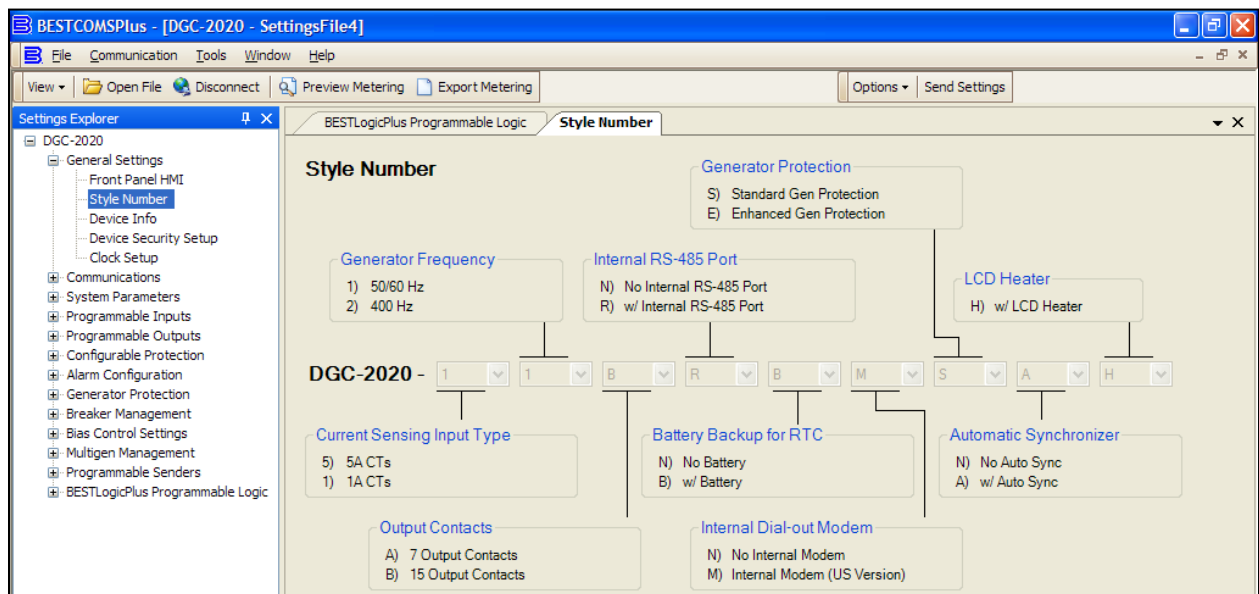
Figure 6-19. Settings Explorer, General Settings, Style Number Screen

2. 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.

    a. CANbus Setup (Figure 6-20)

         i.   Enable ECU Support - Set to Enabled for the DGC-2020 to communicate with the ECU.

         ii. 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.

         iii. 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.

         iv. 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 CANbus communications when the machine is not running.

v. 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.

vi. ECU Related Time Values - Pulse Cycle Time - Set this parameter for the desired time between ECU pulse cycles.

vii. 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.

viii. 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.
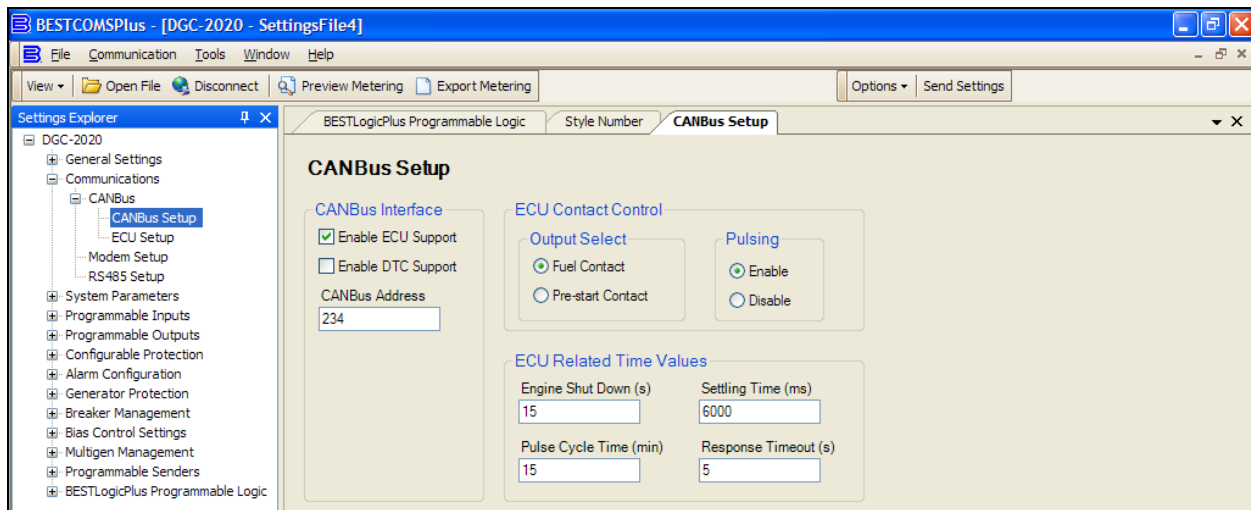
Figure 6-20. Settings Explorer, Communications, CANbus Setup Screen

b. ECU Setup (Figure 6-21)

i. 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, or ECU-7, 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.
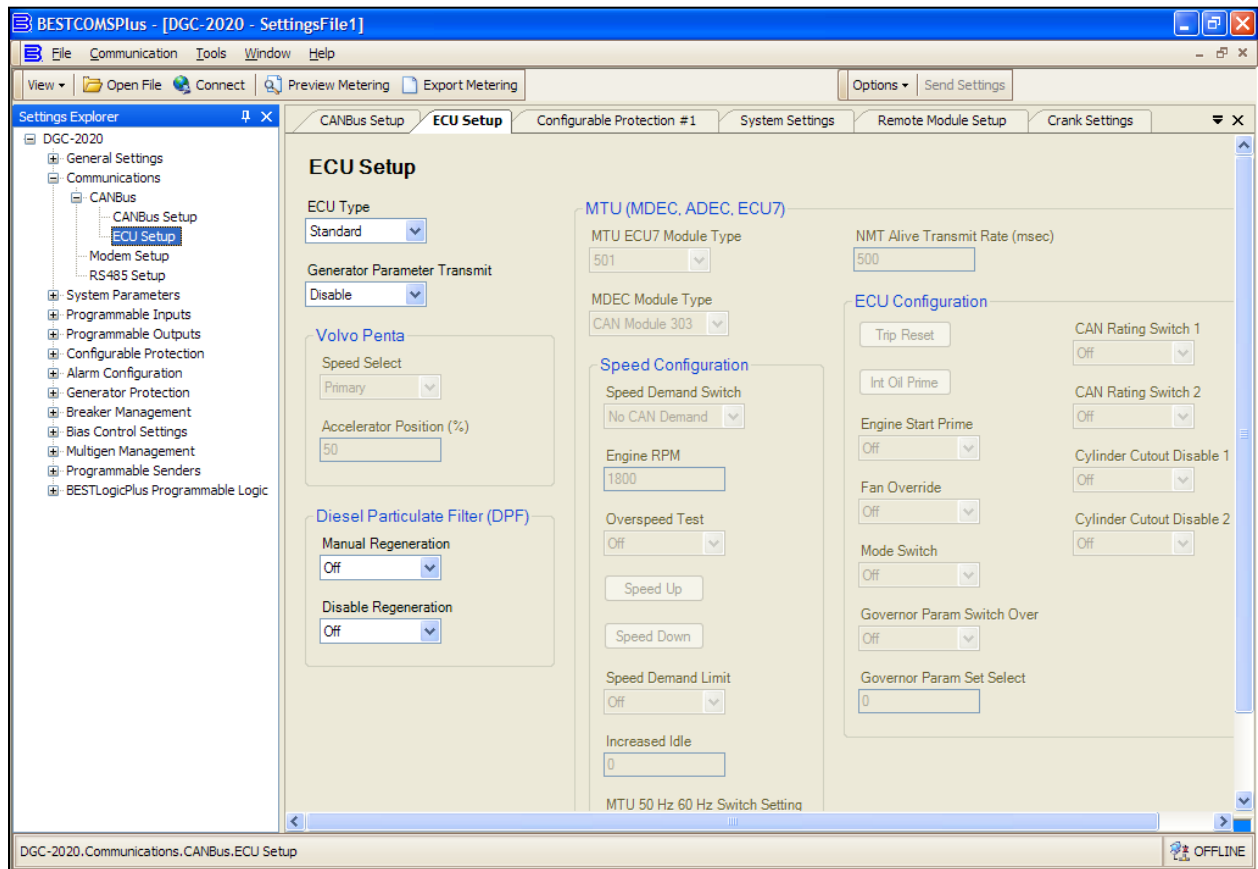
Figure 6-21. Settings Explorer, Communications, ECU Setup Screen

3. System Parameters

    a. System Settings (Figure 6-22)

        i.   Generator Connection - Select *WYE, DELTA, 1 PHASE A-B, 1 PHASE A-C,* or *GROUNDED DELTA* etc. based on the generator configuration.

        ii.   Genset kW Rating - This parameter defines the kW rating of the machine.

        iii.   Rated Volts - This parameter defines the voltage rating of the machine.

        iv.   Rated Frequency - This parameter defines the frequency rating of the machine.

        v.   Rated Engine RPM - This parameter defines the engine rpm rating of the machine.

        vi.   Rated Power Factor - This parameter defines the power factor rating of the machine.

        vii. 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.*

        viii. 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.

        ix.   System Units - Select *English* or *Metric*.

        x.   Battery Voltage - Select *12* or *24*.

        xi.   Metric Pressure Units - Select *Bar* or *kPa*.

        xii. 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.

        xiii. 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.

xiv. NFPA Level - Set this if NFPA level 1 or 2 compliance is required for the machine.
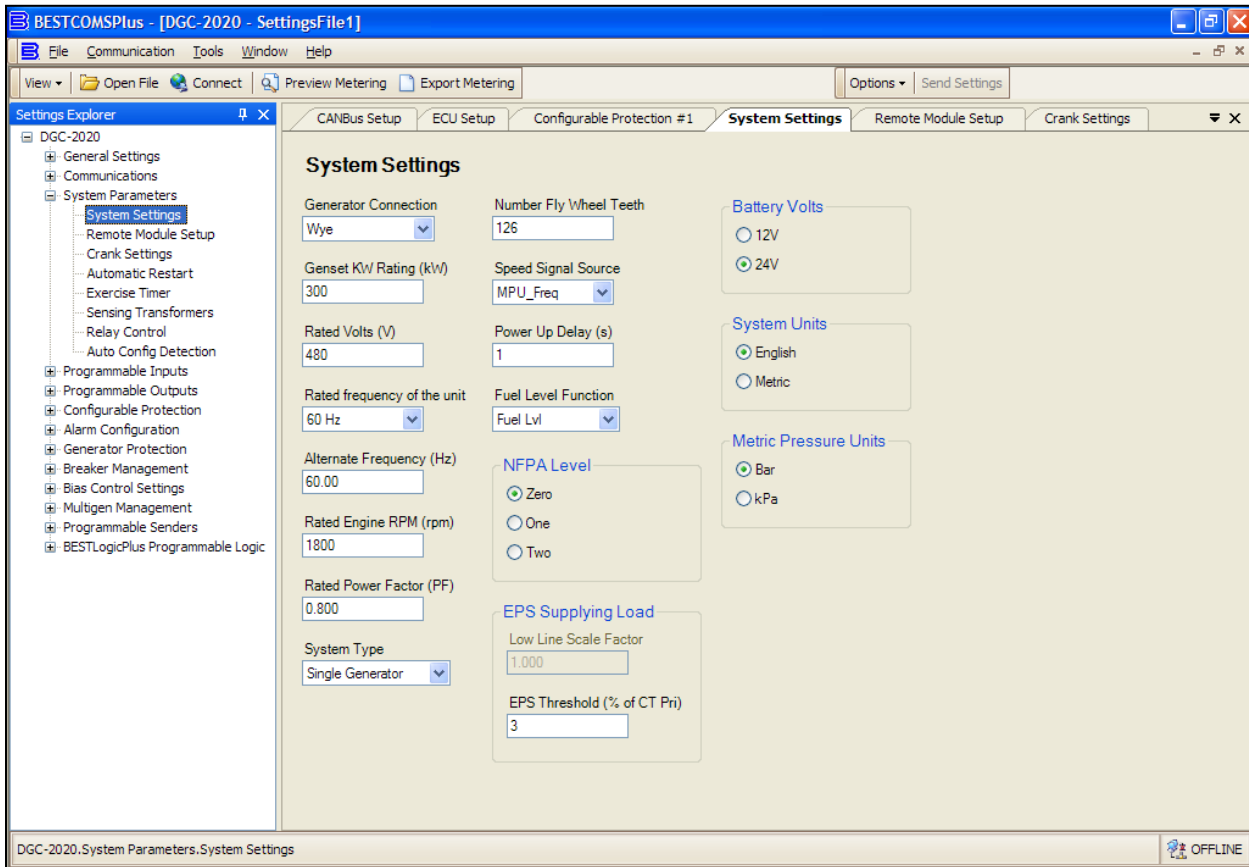
Figure 6-22. Settings Explorer, System Parameters, System Settings Screen

b. Remote Module Setup (Figure 6-23)

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.
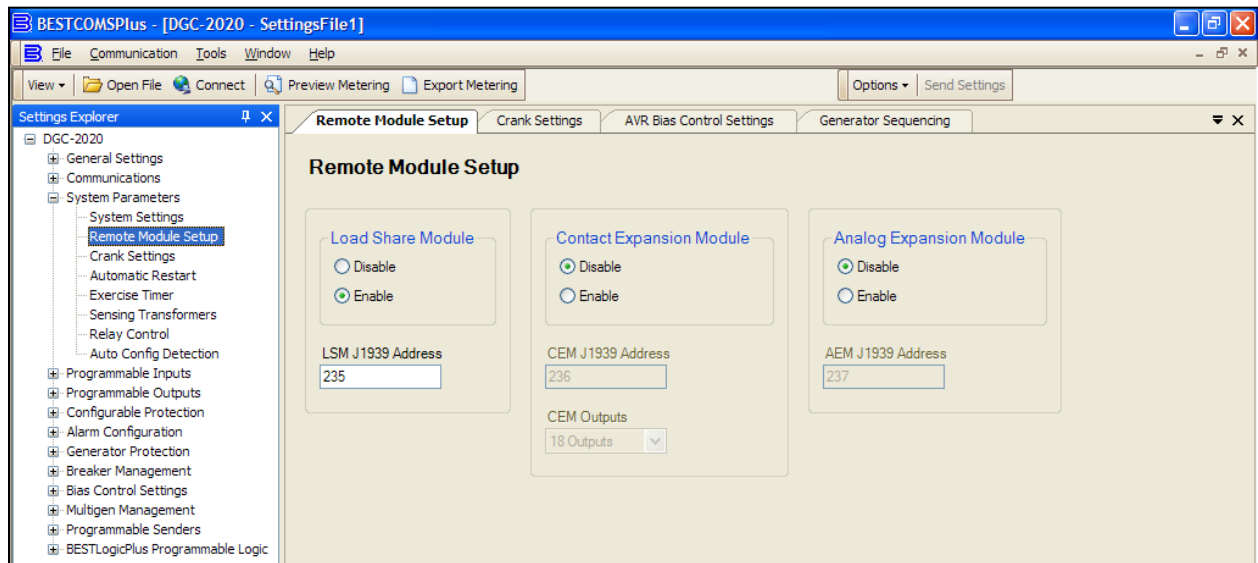
Figure 6-23. Settings Explorer, System Parameters, Remote Module Setup Screen

c. Crank Settings (Figure 6-24)

    i.   Crank Disconnect Limit - This parameter defines the engine rpm threshold in percentage of rated rpm at which crank disconnect should occur.

    ii.   Pre-Crank Delay - This setting specifies the amount of time for pre-cranking to occur. The PRE relay will be closed during this time. This is typically used for engine preheat and/or pre-lubrication.

    iii.   Prestart Contact Config - Select whether the PRE relay should remain closed after the engine starts, or if it should open.

    iv.   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.

    v.   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.

    vi.   Cranking Style - Select Cycle Cranking or Continuous Cranking.

    vii.   Cycle

        1.   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.

        2.   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→NFPA LEVEL, this cannot be programmed; it is set to a fixed value to satisfy the NFPA compliance.

    viii.   Continuous

        1.   Continuous Crank Time - This parameter defines the length of the crank cycle if *Continuous Cranking* is selected as the crank style.

    ix.   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.
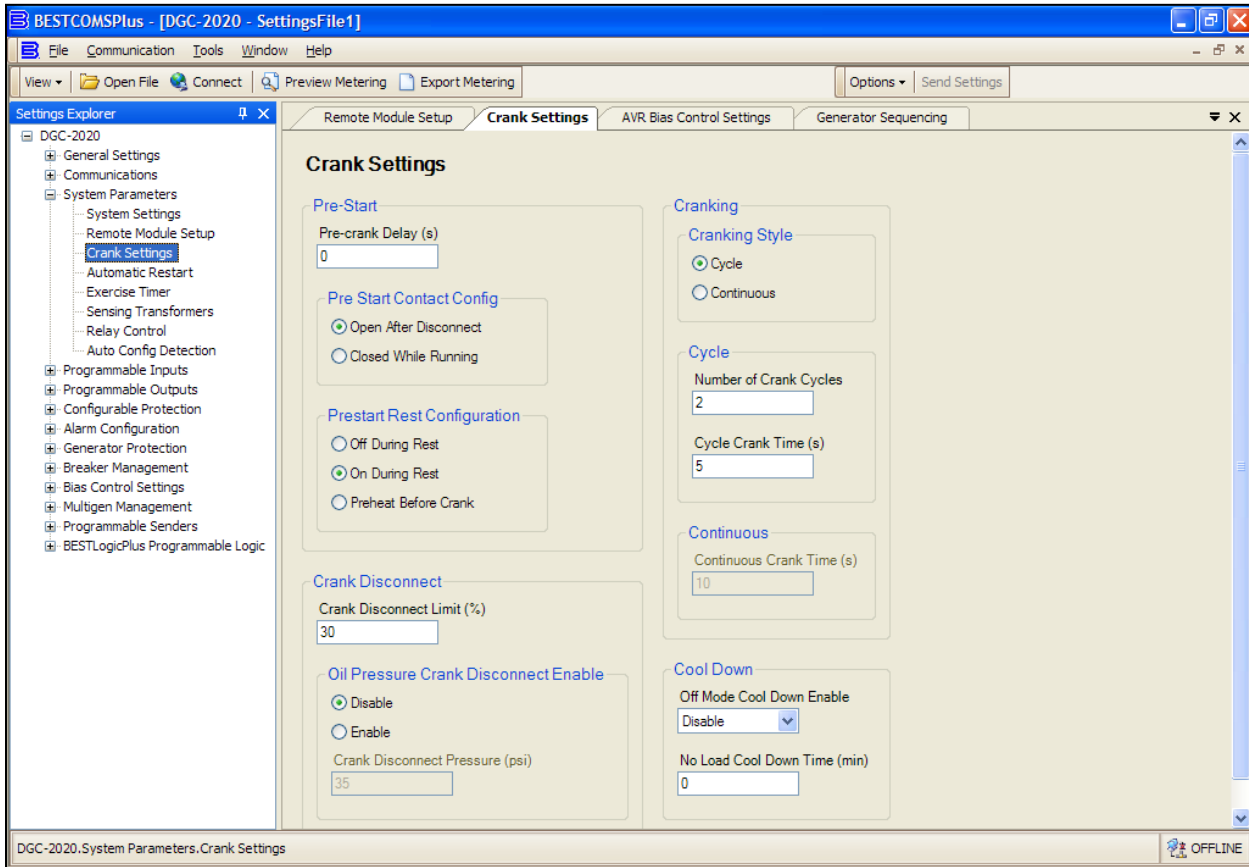
Figure 6-24. Settings Explorer, System Parameters, Crank Settings Screen

d. Sensing Transformers (Figure 6-25)

 i. 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.

 ii. 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.

 iii. 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.

 iv. 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.

 v. 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.

 vi. 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.
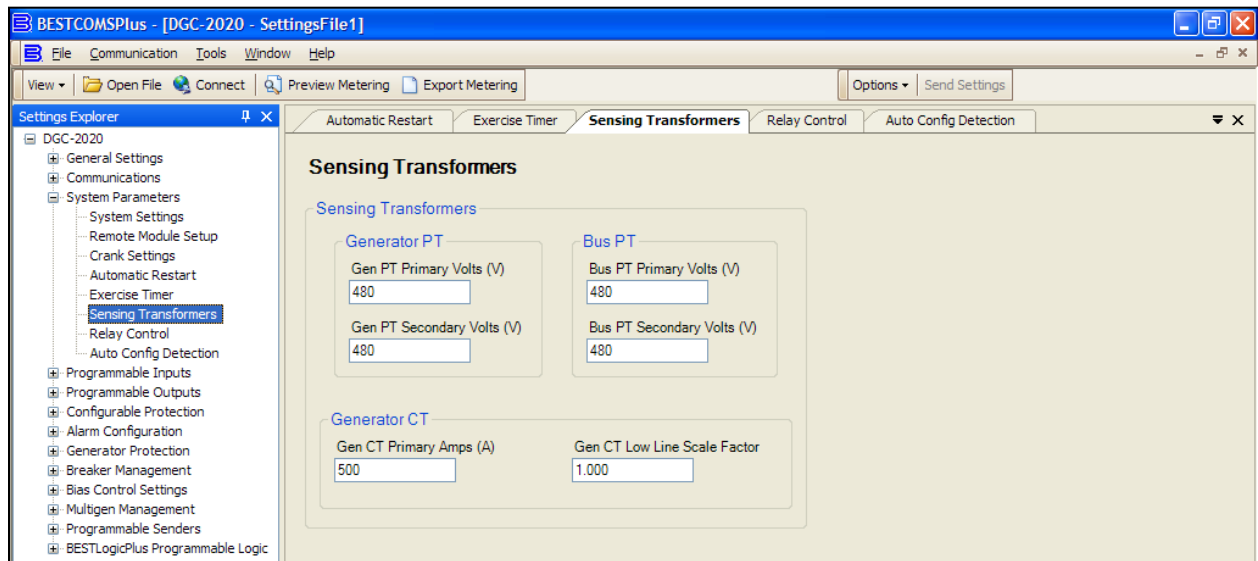
Figure 6-25. Settings Explorer, System Parameters, Sensing Transformers Screen

4. Relay Control

   a. This selects the operation 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 logic usable. Refer to the appropriate paragraphs in Section 4, *BESTCOMSPlus Software,* for additional information. See Figure 6-26.
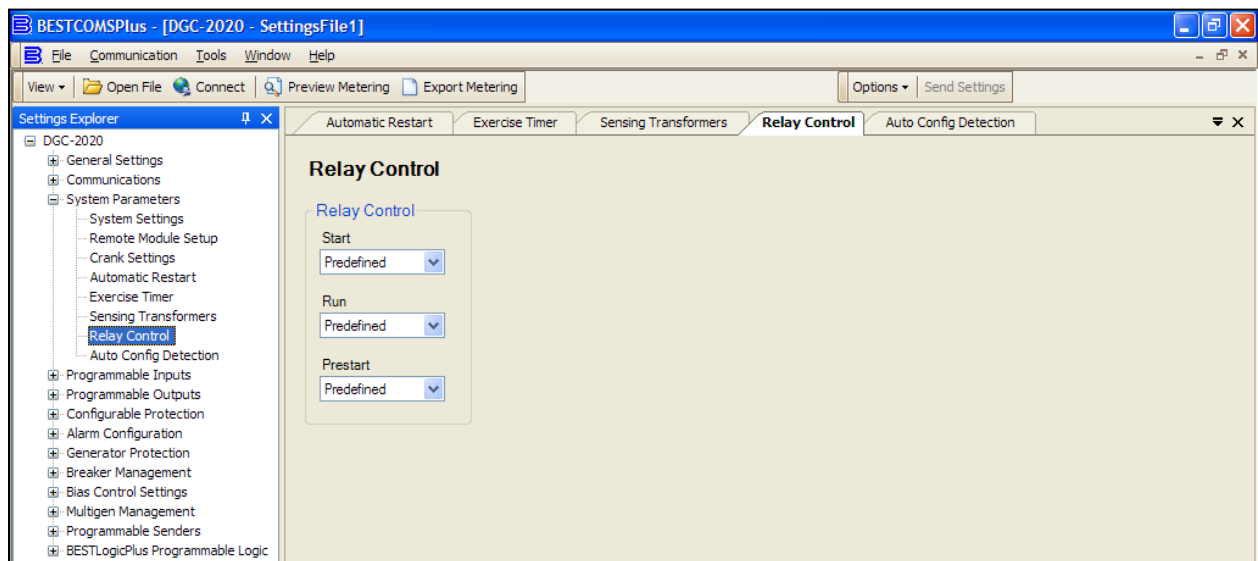
Figure 6-26. Settings Explorer, System Parameters, Relay Control Screen

5. Auto Config Detection

   a. 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 6-27.
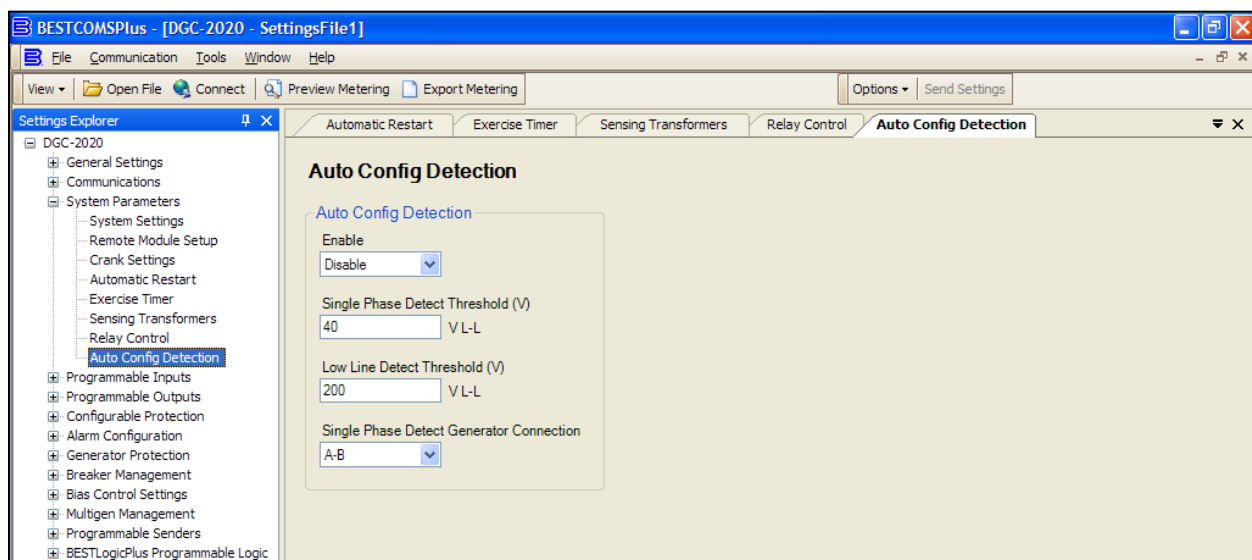
Figure 6-27. Settings Explorer, System Parameters, Auto Config Detection Screen

6. Alarm Configuration

    a. Horn Configuration (Figure 6-28)

        i.   Horn Enable - This setting enables or disables the output for the external alarm horn.

        ii. Not In Auto Horn Enable - This setting enables or disables the horn when not in auto mode.
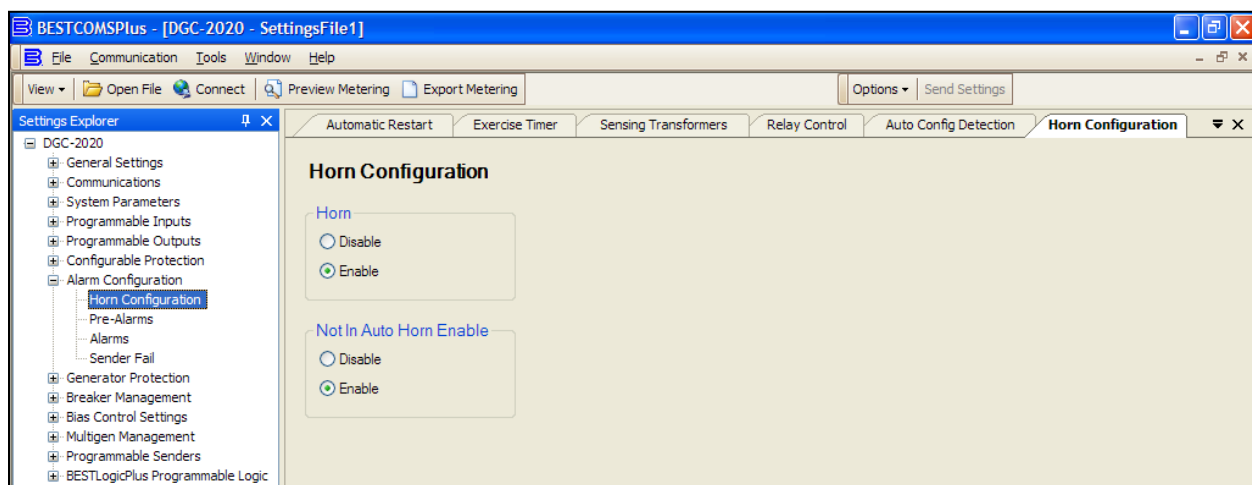
Figure 6-28. Settings Explorer, Alarm Configuration, Horn Configuration Screen

    b. 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 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 6-29.
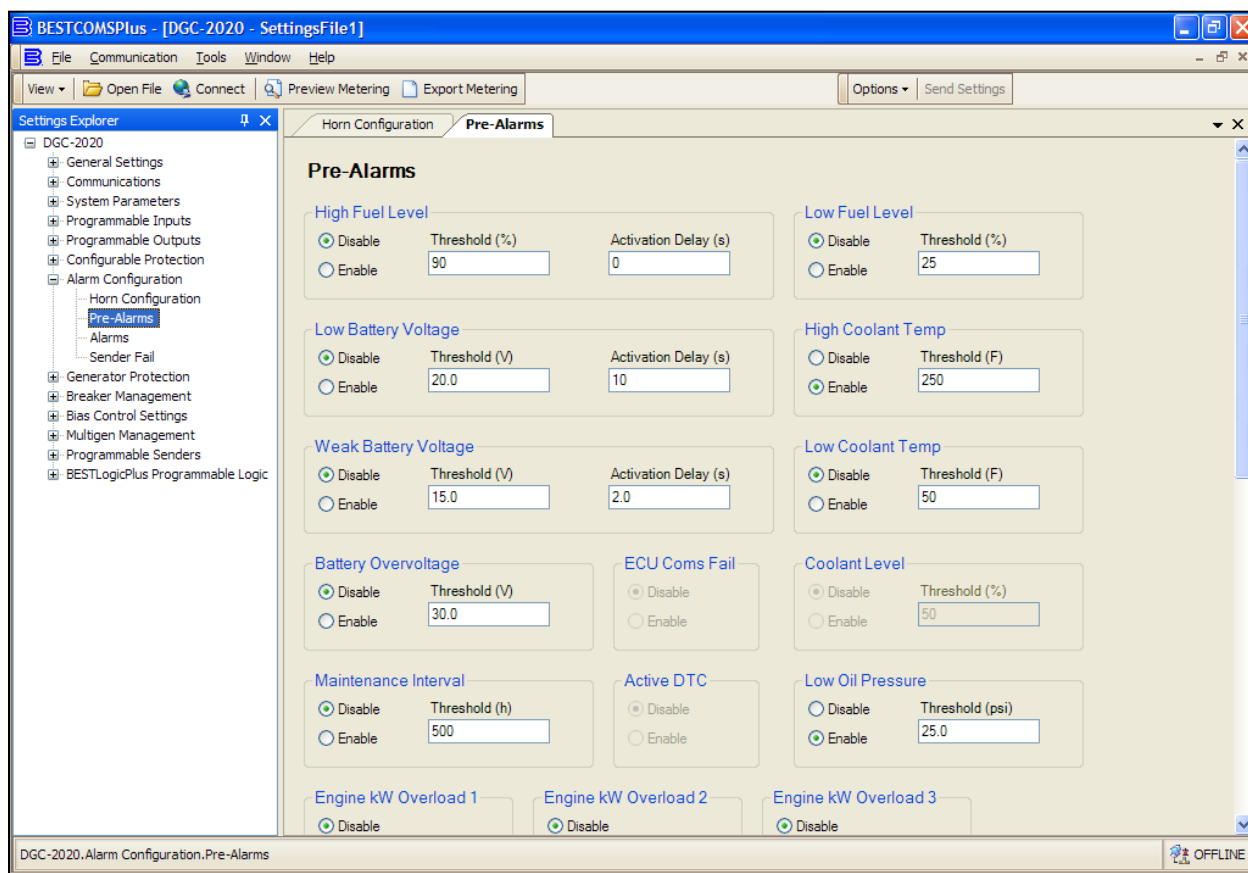
Figure 6-29. Settings Explorer, Alarm Configuration, Pre-Alarms Screen

c. 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 6-30.
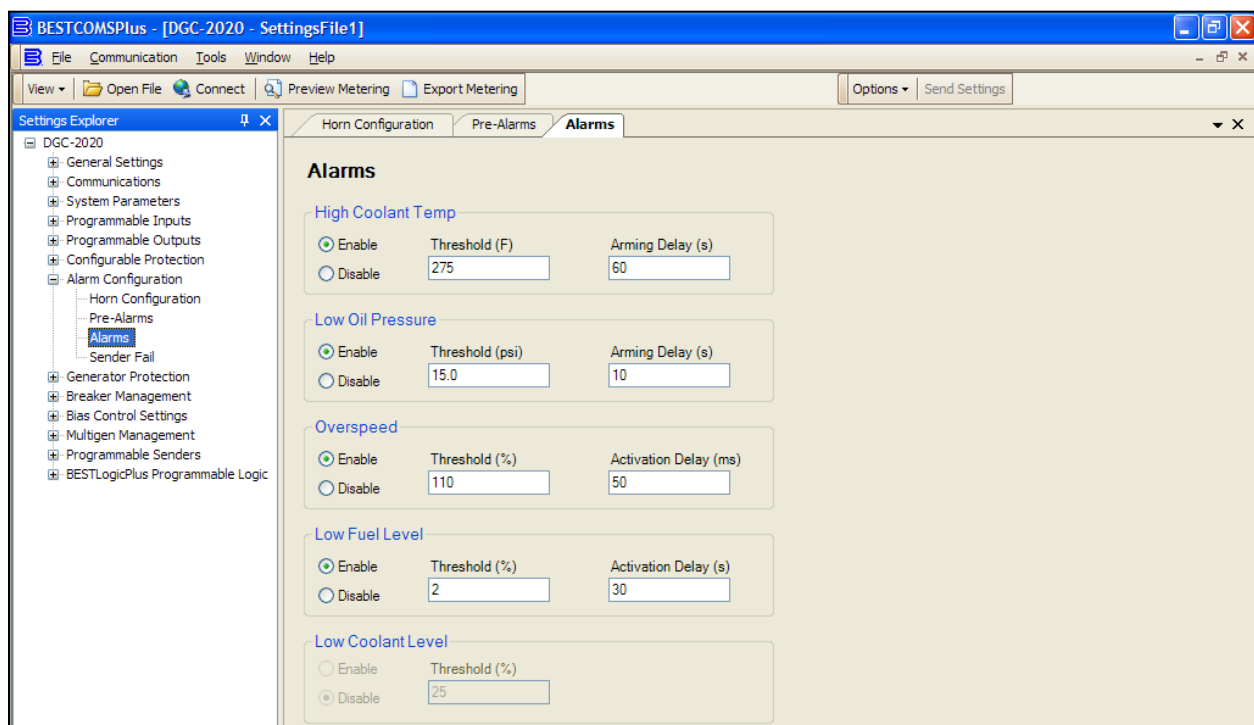
Figure 6-30. Settings Explorer, Alarm Configuration, Alarms Screen

  d. Sender Fail - Enable each sender type as desired by configuring it as an alarm or pre-alarm. Set an activation delay. The activation delay is the duration that the condition remains in effect before annunciating an alarm or pre-alarm. 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 6-31.
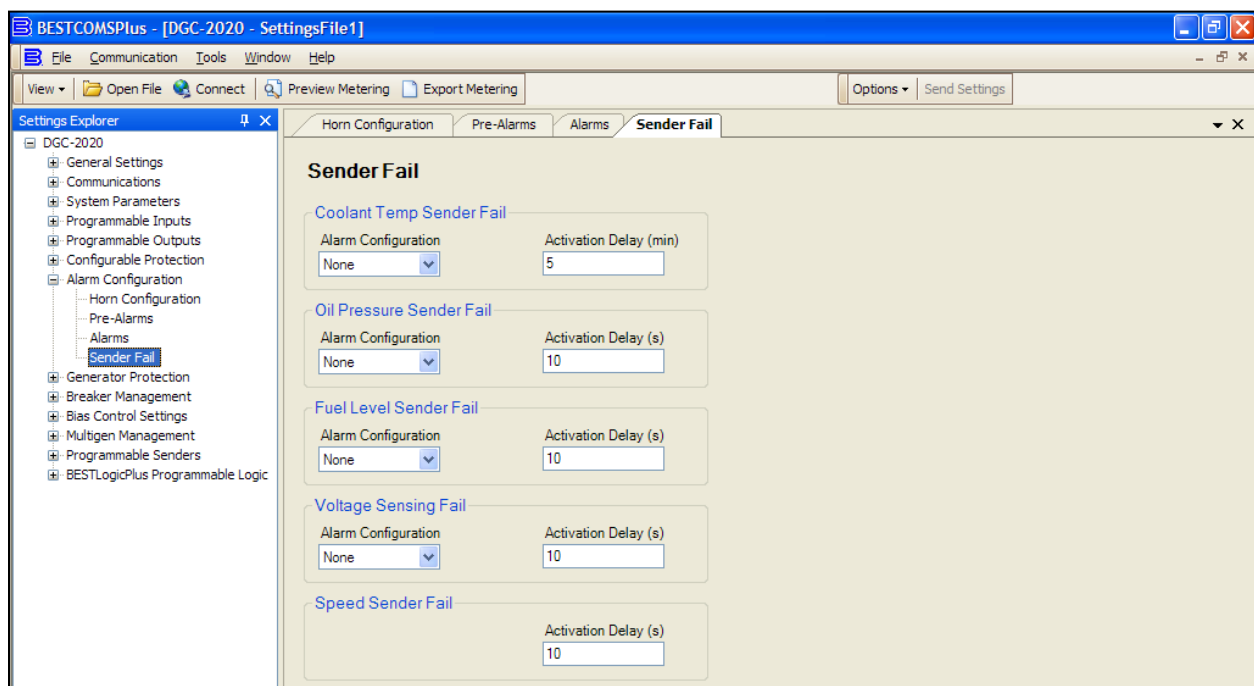
Figure 6-31. Settings Explorer, Alarm Configuration, Sender Fail Screen

7. Programmable Senders

If a DGC-2020 is receiving engine information from an engine ECU, the programmable sender parameters for the coolant temperature and oil pressure senders do not need configured because they have no effect. They are appropriate for resistive senders only.

a. Coolant Temperature (Figure 6-32)

i. 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.

ii. 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.

iii. Select *Positive* or *Negative* sender slope as required for the desired sender graph.

iv. Click *Save Cool Data* to save the data in the current settings file.

v. 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.

vi. Click the *Send Settings* button in BESTCOMS*Plus* to send the sender settings to the DGC-2020.
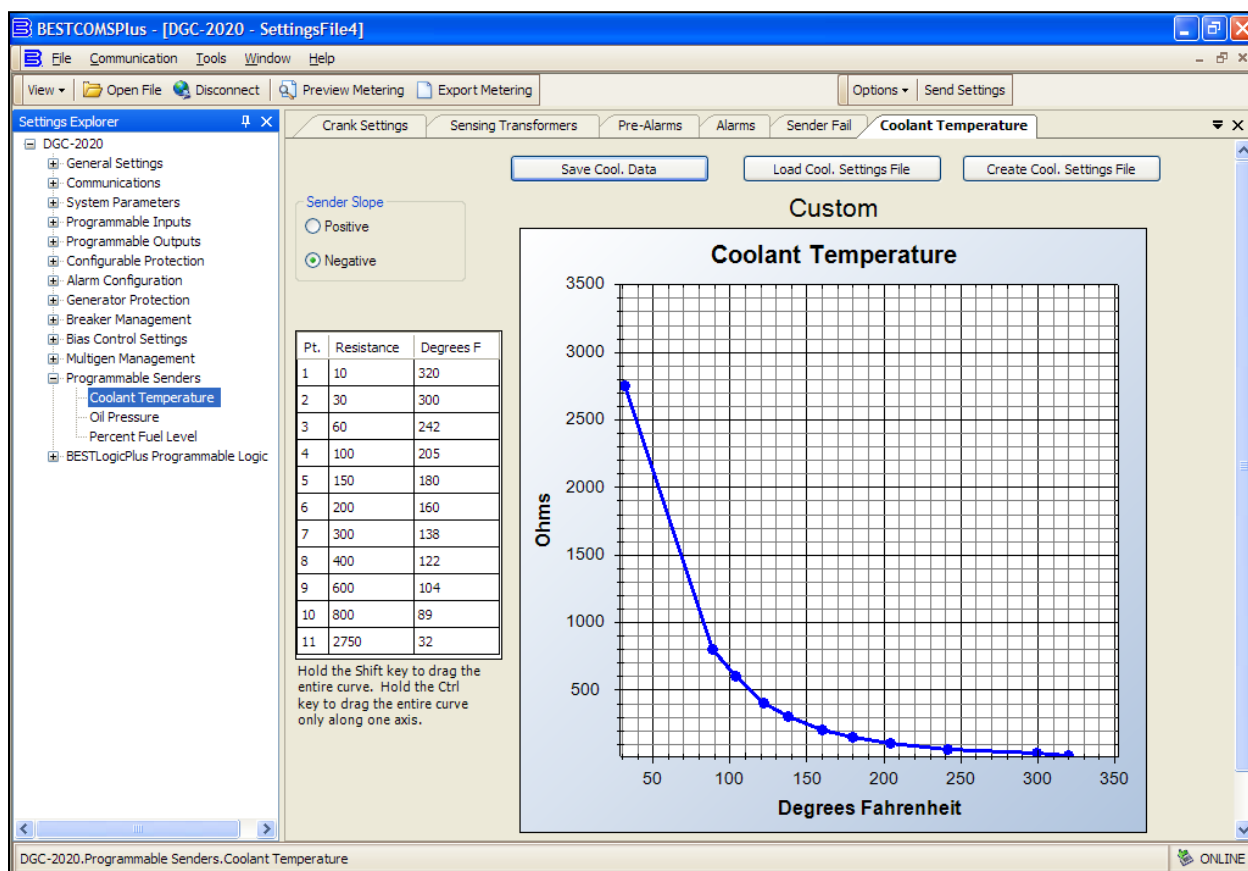
Figure 6-32. Settings Explorer, Programmable Senders, Coolant Temperature Screen

b. Oil Pressure (Figure 6-33)

i. 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.

ii. 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.

iii. Select *Positive* or *Negative* sender slope as required for the desired sender graph.

iv. Click *Save Oil Data* to save the data in the current settings file.

v. 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.

vi. Click the *Send Settings* button in BESTCOMS*Plus* to send the sender settings to the DGC-2020.
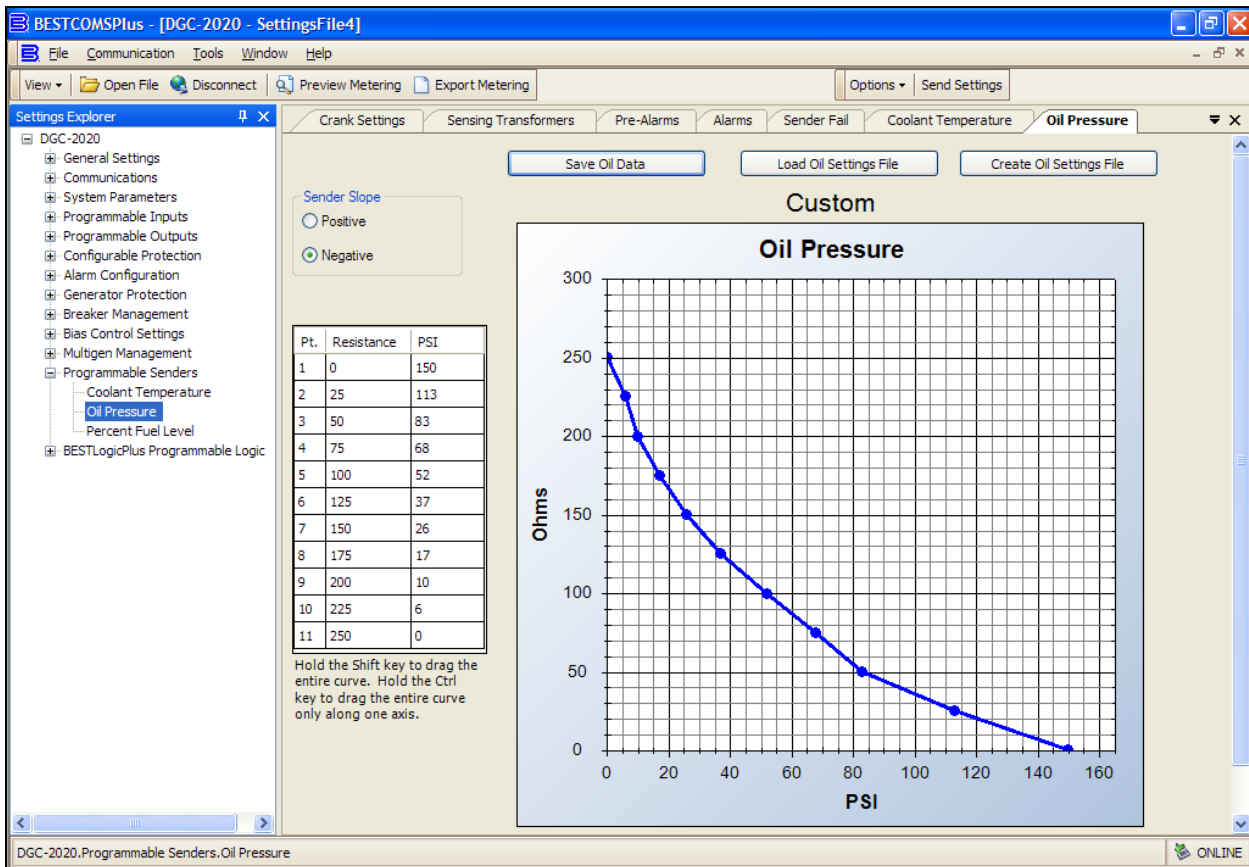
Figure 6-33. Settings Explorer, Programmable Senders, Oil Pressure Screen

c. Percent Fuel Level (Figure 6-34)

i. 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.

ii. 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.

iii. Select *Positive* or *Negative* sender slope as required for the desired sender graph.

iv. Click *Save Fuel Data* to save the data in the current settings file.

v. 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.

vi. Click the *Send Settings* button in BESTCOMS*Plus* to send the sender settings to the DGC-2020.
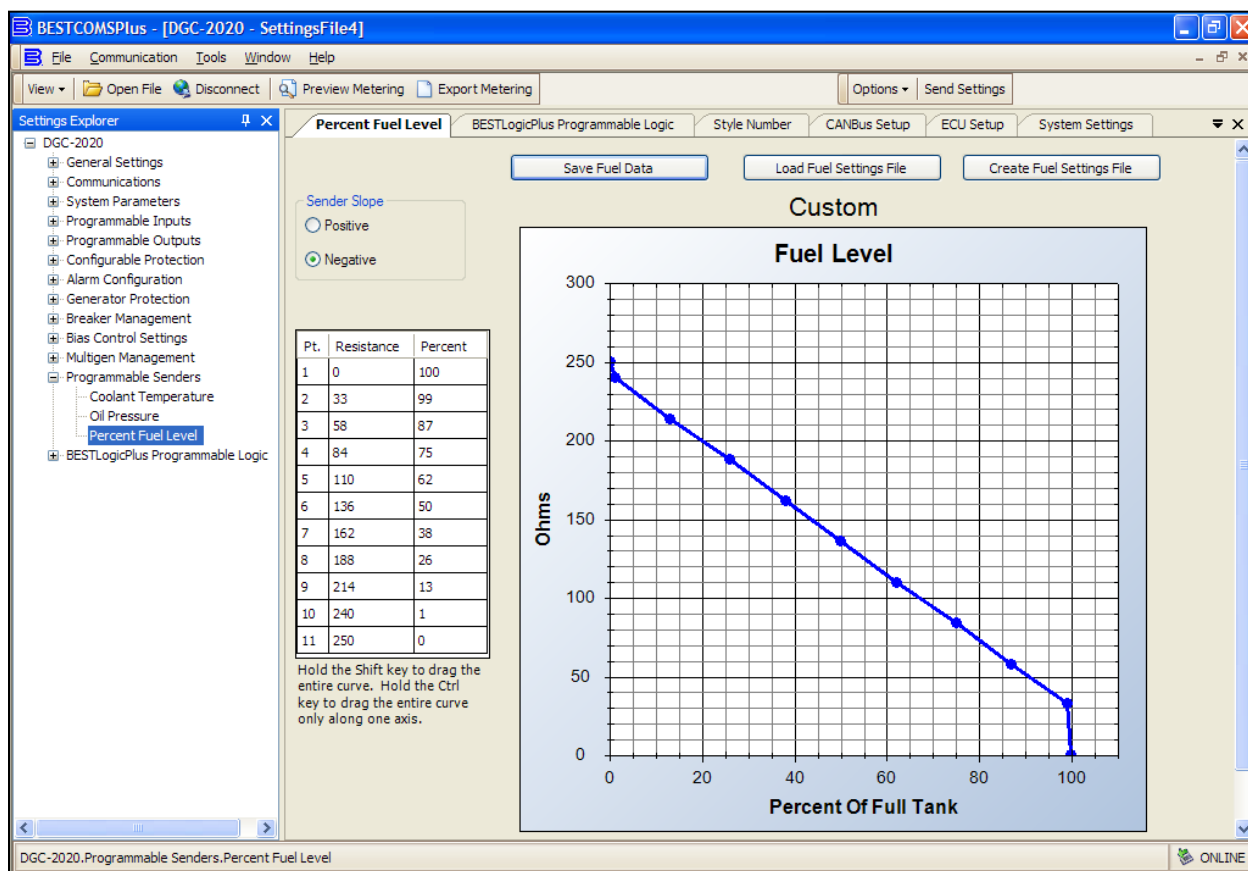
Figure 6-34. Settings Explorer, Programmable Senders, Percent Fuel Level Screen

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.

8. General Settings

    a. Front Panel HMI (Figure 6-35)

        i. LCD Contrast - Change this setting if the contrast needs adjusted.

        ii. 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.

        iii. Language Selection - Select the desired language.

        iv. 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.

1. Configure the *Configurable HMI Summary Settings.*

2. Set the *Scrolling Screen Enable* to *Enable*.

3. Set the *Scrolling Screen Scroll Delay* parameter to the desired value.

v. 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.

vi. 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.

vii. 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.
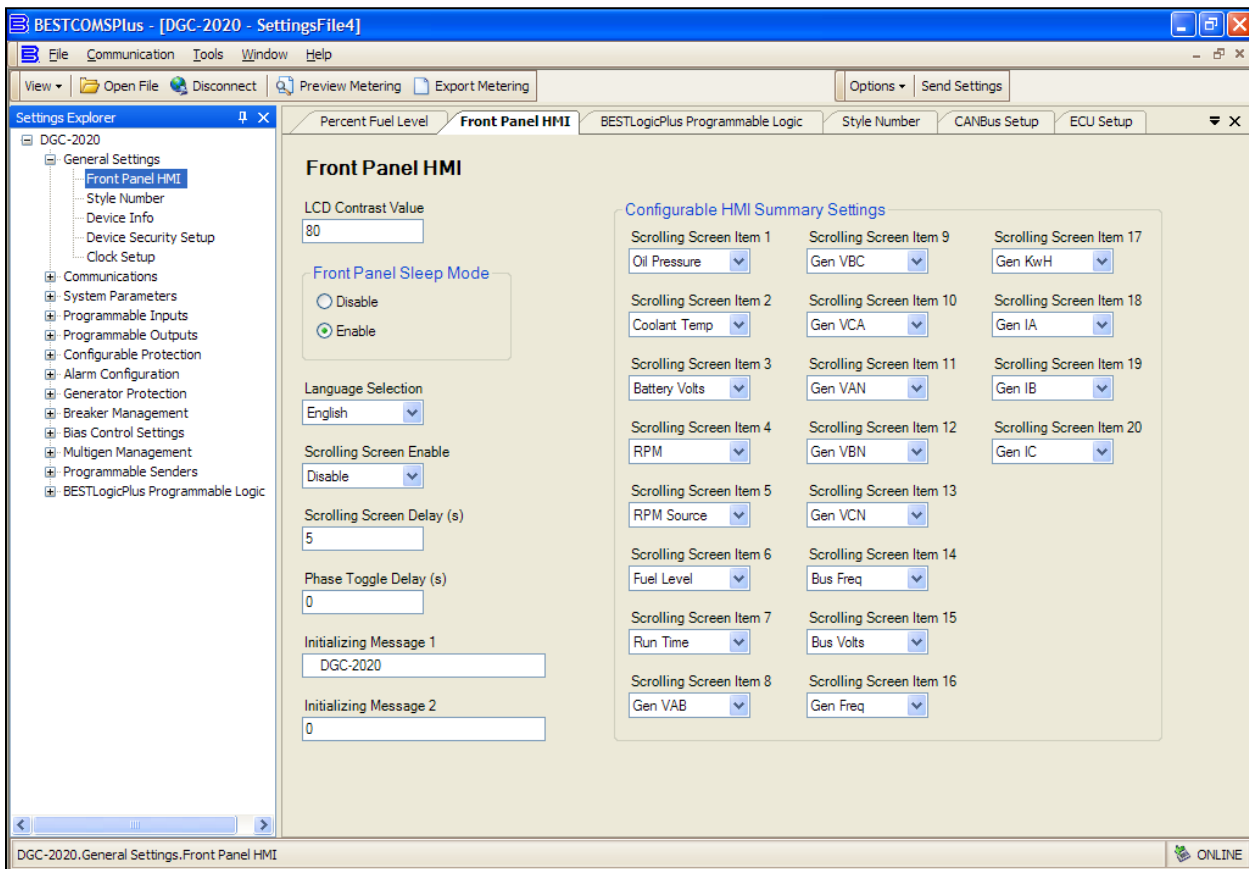
Figure 6-35. Settings Explorer, General Settings, Front Panel HMI Screen

b. 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 6-36.

DGC-2020 Installation
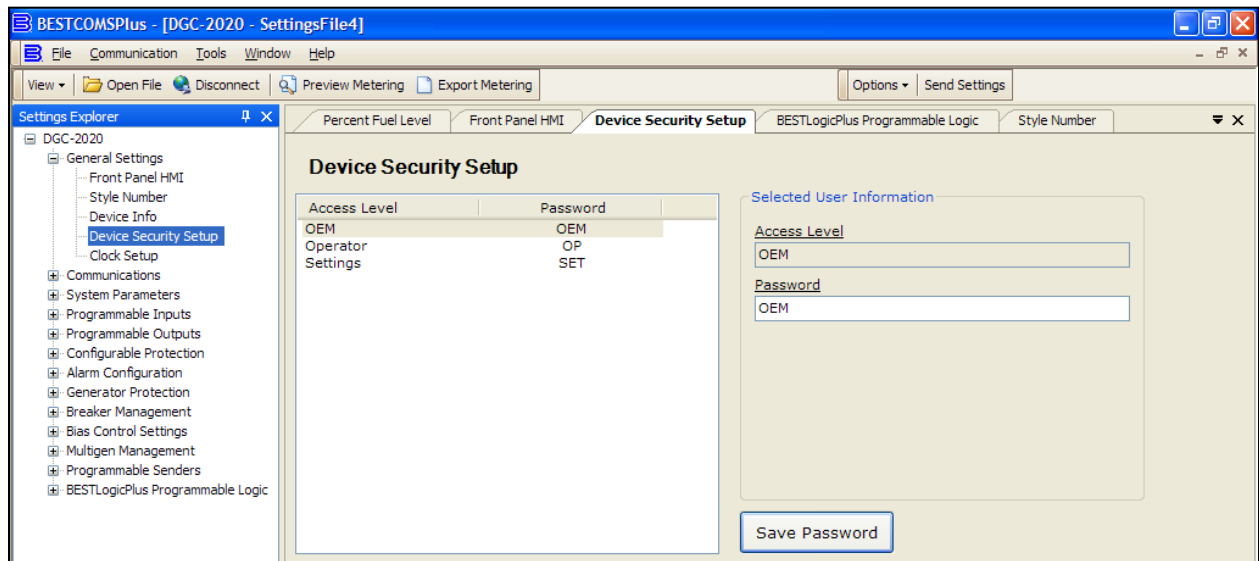
Figure 6-36. Settings Explorer, General Settings, Device Security Setup Screen

c. Clock Setup: Configure the date and time for the DGC-2020. The daylight-savings time parameters are also configured on this screen. See Figure 6-37.
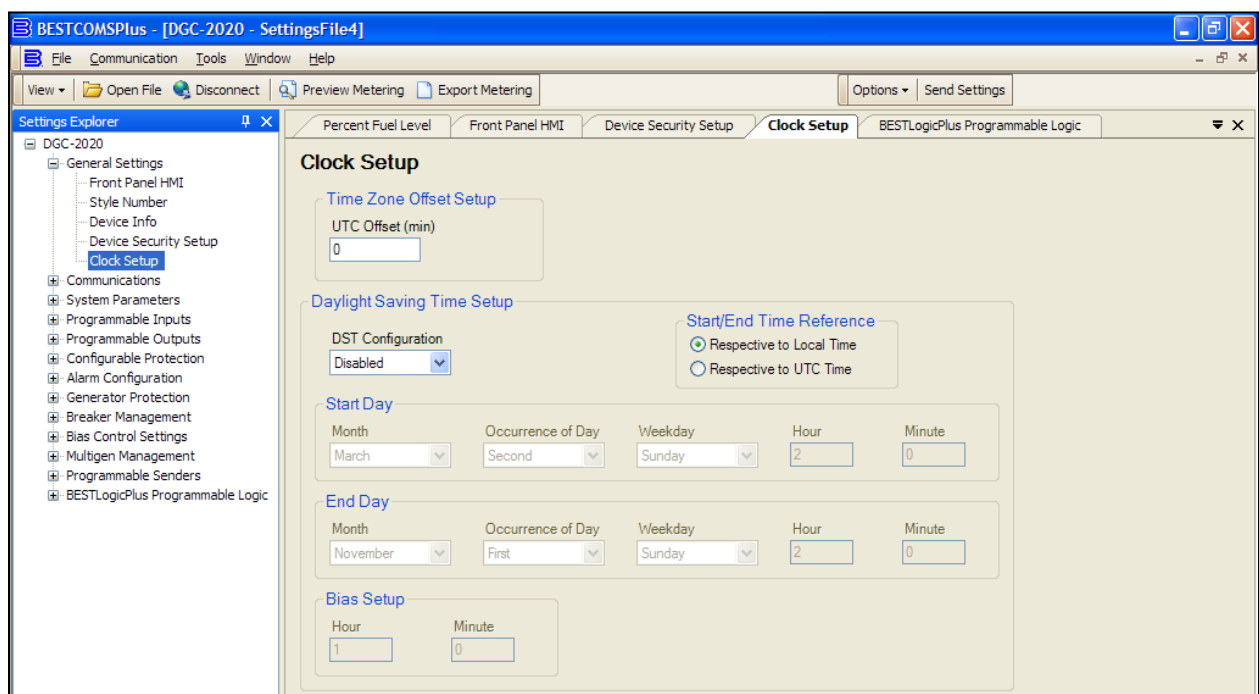
Figure 6-37. Settings Explorer, General Settings, Clock Setup Screen

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) provides 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

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 6-38.
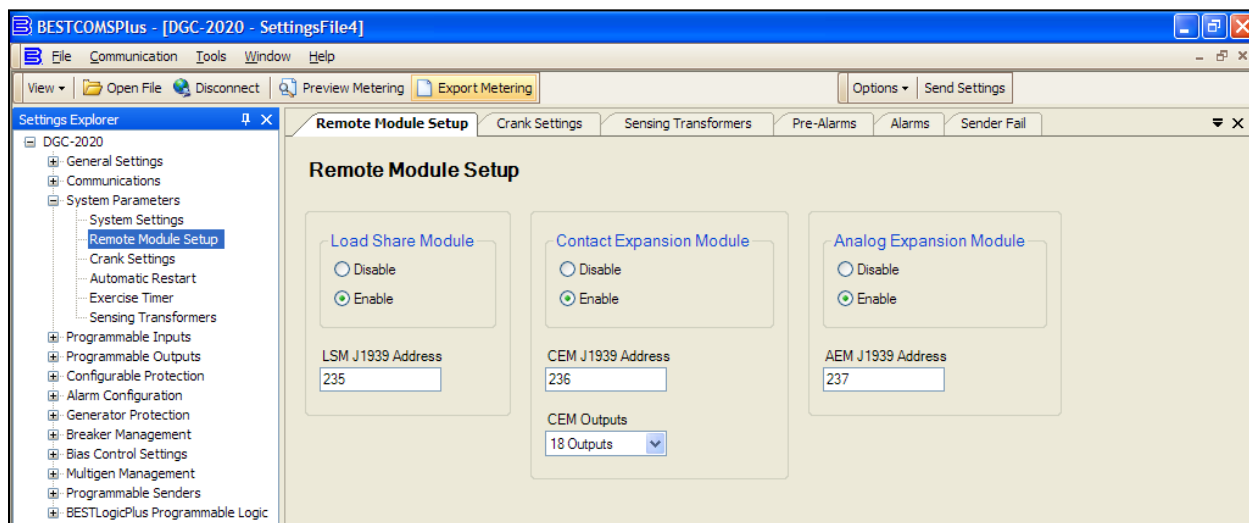
Figure 6-38. Settings Explorer, System Parameters, Remote Module Setup Screen

1. Configure the following parameters:

   a. Load Share Module Enable/Disable - Select *Enable* if a load share module is present in the system.

   b. 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 CANbus network.

   c. Contact Expansion Module Enable/Disable - Select *Enable* if a contact expansion module is present in the system.

   d. 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 CANbus network.

   e. 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:

1. Configuring contact inputs on the DGC-2020. See Figure 6-39.
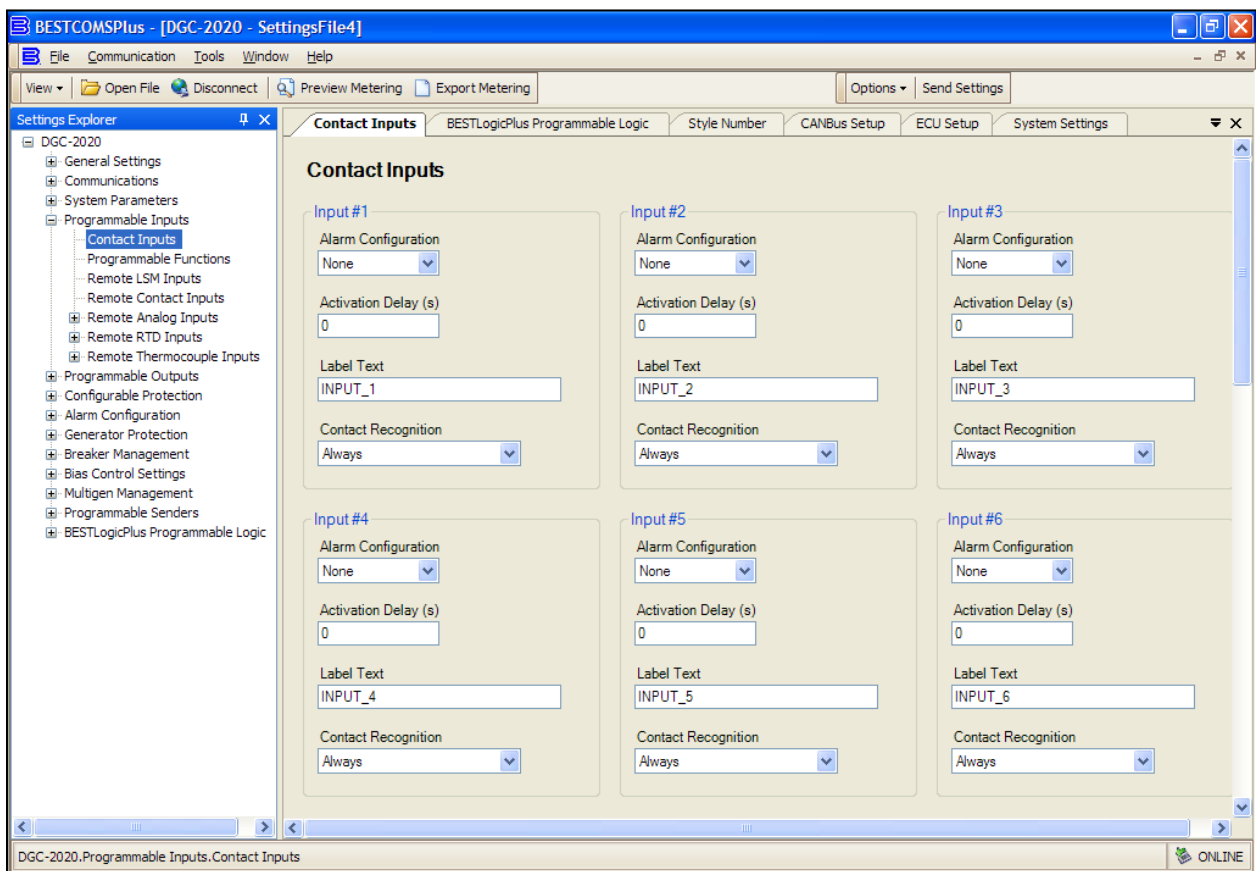
Figure 6-39. Settings Explorer, Programmable Inputs, Contact Inputs Screen

For each contact input, configure the following parameters:

a. 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.

b. Activation Delay - This parameter defines the duration that the input remains on before any annunciation occurs.

c. 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.

d. 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.

2. Configurable Programmable Functions on the DGC-2020. See Figure 6-40.

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).
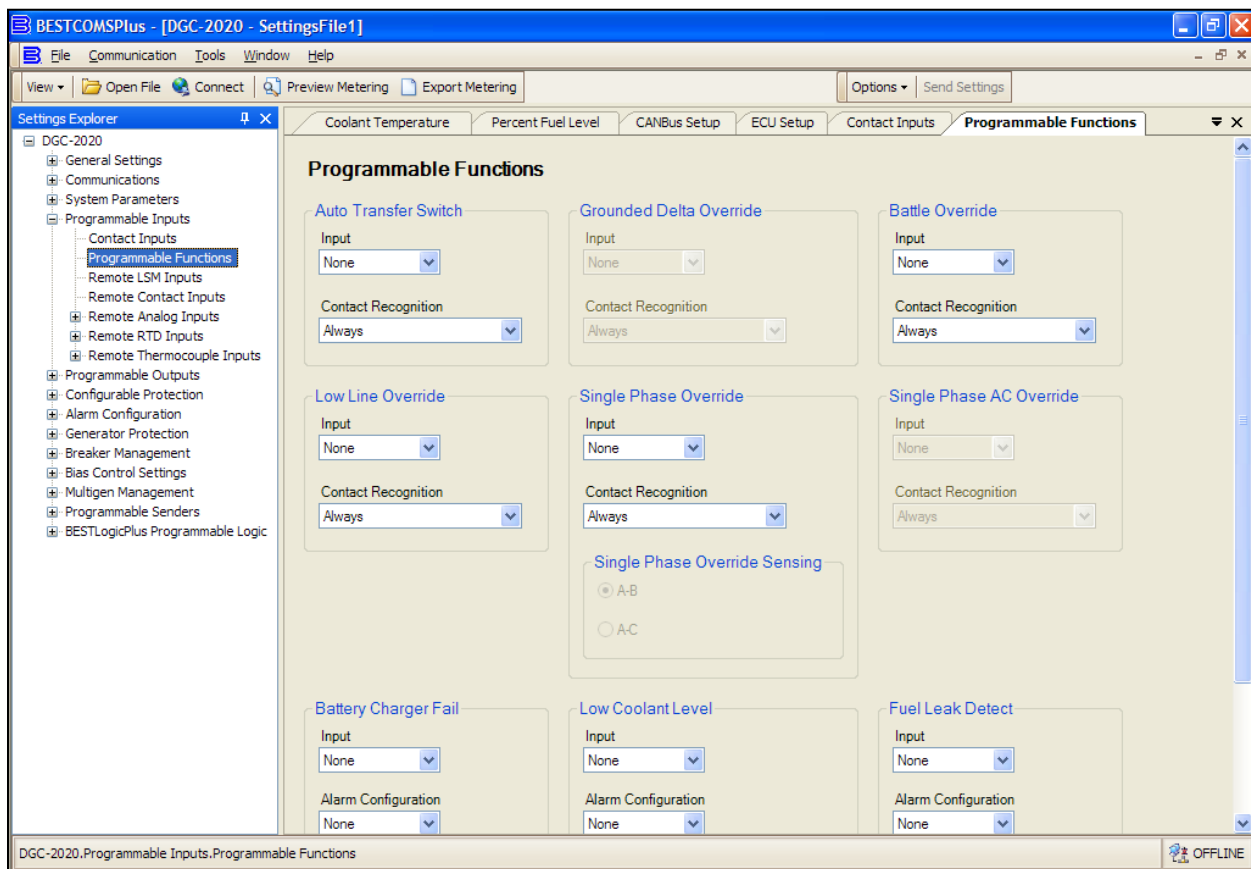
Figure 6-40. Settings Explorer, Programmable Inputs, Programmable Functions Screen

Configure the following parameters:

a. Auto Transfer Switch

i. 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.

ii. Contact Recognition - Select *Always*.

b. Grounded Delta Override

i. 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.

    ii. Contact Recognition - Select *Always*.

c. Battle Override

    i. 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.

    ii. Contact Recognition - Select *Always*.

d. Low Line Override

    i. 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.

    ii. Contact Recognition - Select *Always*.

e. Single-Phase Override

    i. 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.

    ii. Contact Recognition - Select *Always*.

    iii. 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.

f. Single-Phase AC Override

    i. 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.

    ii. Contact Recognition - Select *Always*.

g. Battery Charger Fail

    i. 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.

    ii. 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.

    iii. 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.

iv. Contact Recognition - Select *Always*.

h. Low Coolant Level

i. 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.

ii. 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.

iii. 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.

iv. Contact Recognition - Select *Always*.

i. Fuel Leak Detect

i. 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.

ii. 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.

iii. 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.

iv. Contact Recognition - Select *Always*.

3. Configuring Remote LSM Inputs on the LSM-2020 (Load Share Module).

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 6-41.
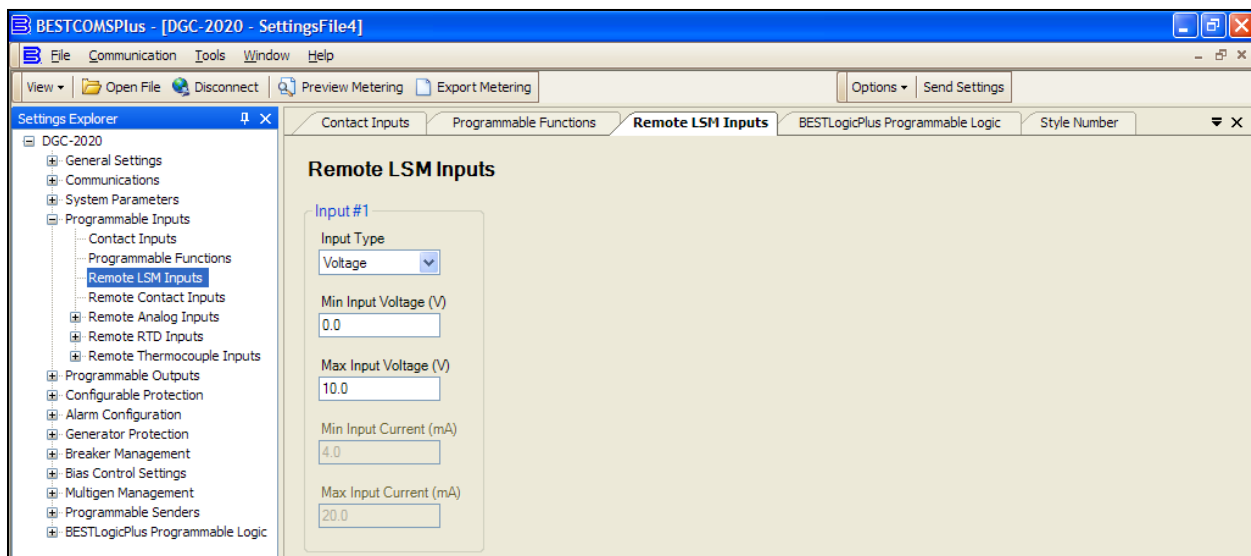
Figure 6-41. Settings Explorer, Programmable Inputs, Remote LSM Inputs Screen

The parameters to be configured are:

a. Input Type - Select *Voltage* for a 0-10 Vdc input or *Current* for a 4-20 mA current input.

b. 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*.

c. 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*.

d. 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*.

e. 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*.

4. Configuring Remote Contact Inputs on the CEM-2020. See Figure 6-42.

The settings of this screen are disabled unless the CEM-2020 (Contact Expansion Module) has been enabled as previously explained.
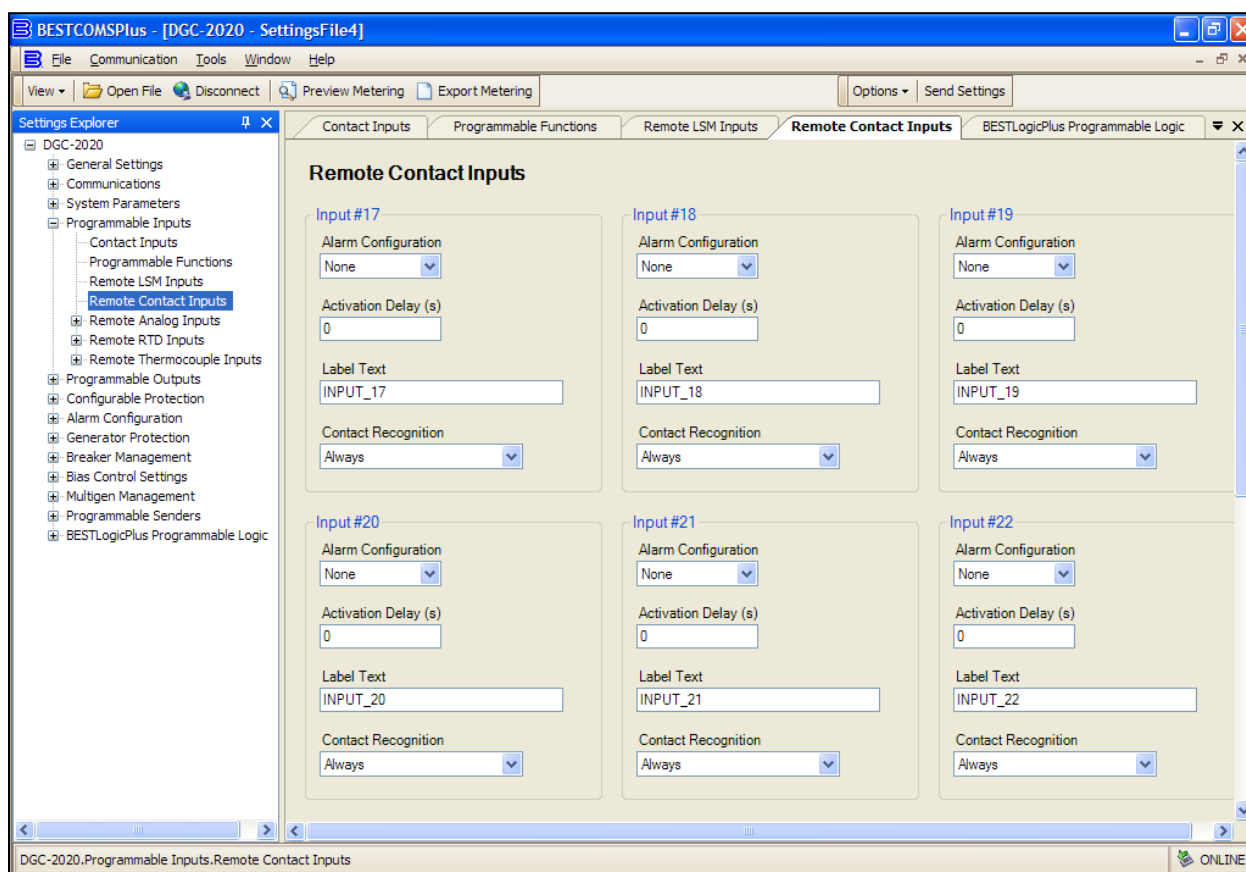
Figure 6-42. Settings Explorer, Programmable Inputs, Remote Contact Inputs Screen

For each contact input, configure the following parameters:

a. 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.

b.   Activation Delay - This parameter defines how long the input remains on before any annunciation occurs.

c.   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*.

d.   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.

5.   Configuring Remote Analog Inputs on the AEM-2020.

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 6-43.
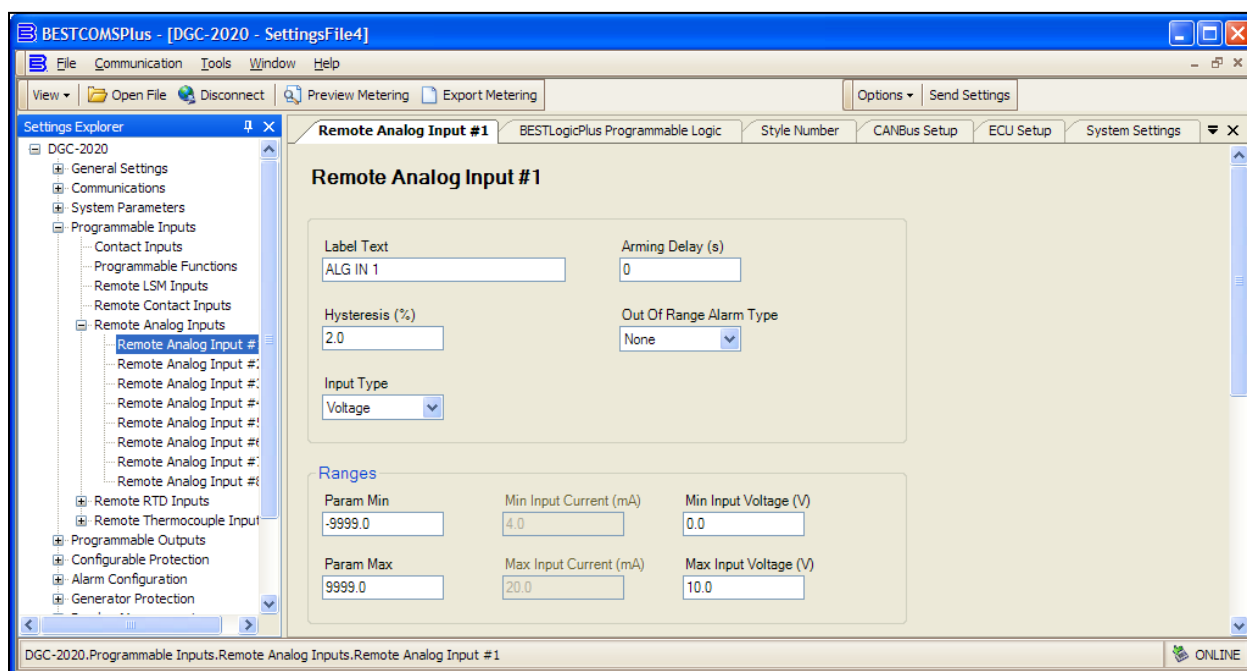
Figure 6-43. Settings Explorer, Programmable Inputs, Remote Analog Inputs Screen

Configure the following parameters:

a.   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*.

b.   Hysteresis (%) - Enter a value for the desired hysteresis for threshold detection. This helps prevent intermittent detection of thresholds.

c.   Input Type - Select *Voltage* for 0-10 Vdc inputs or *Current* for 4-20 mA current inputs.

d.   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. Non-zero values direct the input to be monitored after the programmed time has elapsed after engine startup.

e. 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.

f. 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.

g. 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.

h. 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.

i. 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.

j. 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.

k. 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 6-44.
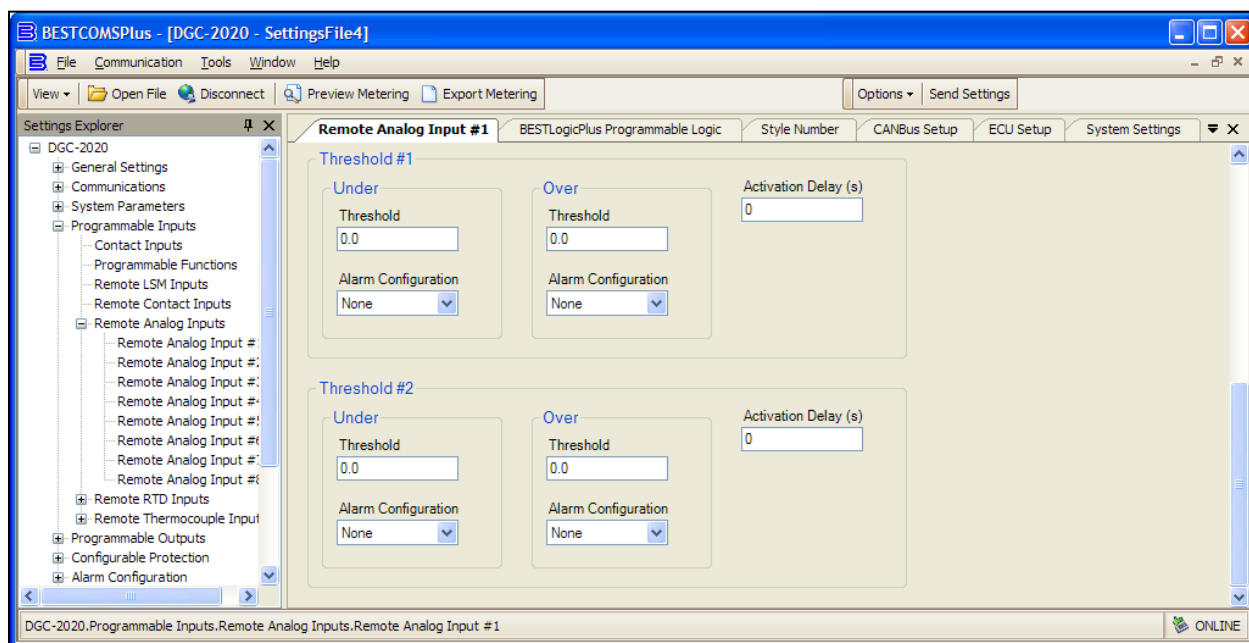
Figure 6-44. Settings Explorer, Programmable Inputs, Remote Analog Inputs Screen

l. Threshold 1

　　i. Under Threshold - This parameter defines when Status, Alarm, or Pre-Alarm is annunciated.

　　ii. 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.

　　iii. Over Threshold - This parameter defines when Status, Alarm, or Pre-Alarm is annunciated.

　　iv. 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.

　　v. 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.

m. Threshold 2

　　i. Under Threshold - This parameter defines when Status, Alarm, or Pre-Alarm is annunciated.

　　ii. 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.

　　iii. Over Threshold - This parameter defines when Status, Alarm, or Pre-Alarm annunciation is desired.

　　iv. 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.

　　v. 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.

6. Configuring Remote RTD Inputs on the AEM-2020.

Many of the settings for the Remote RTD Inputs are similar to the settings for Remote Analog Inputs. See Figure 6-45.
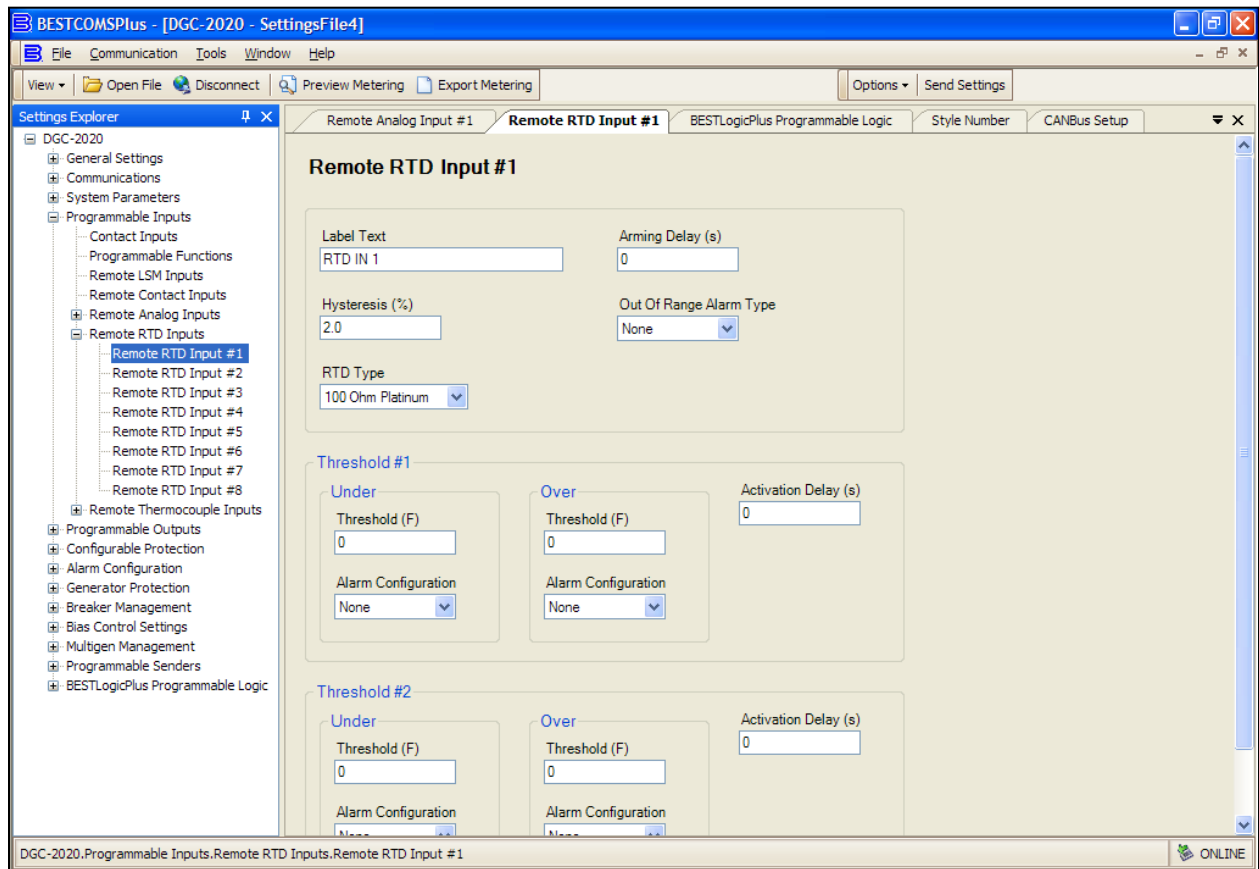
Figure 6-45. Settings Explorer, Programmable Inputs, Remote RTD Inputs Screen

Configure the following parameters:

    a.   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*.

    b.   Hysteresis (%) - Enter a value for the desired hysteresis for threshold detection. This will help prevent intermittent detection of thresholds.

    c.   RTD Type - Select *100 Ohm Platinum* or *10 Ohm Copper* to match the RTD that is driving the input.

    d.   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. Non-zero values direct the input to be monitored after the programmed time has elapsed after engine startup.

    e.   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.

    f.   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.

7.   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 6-46.
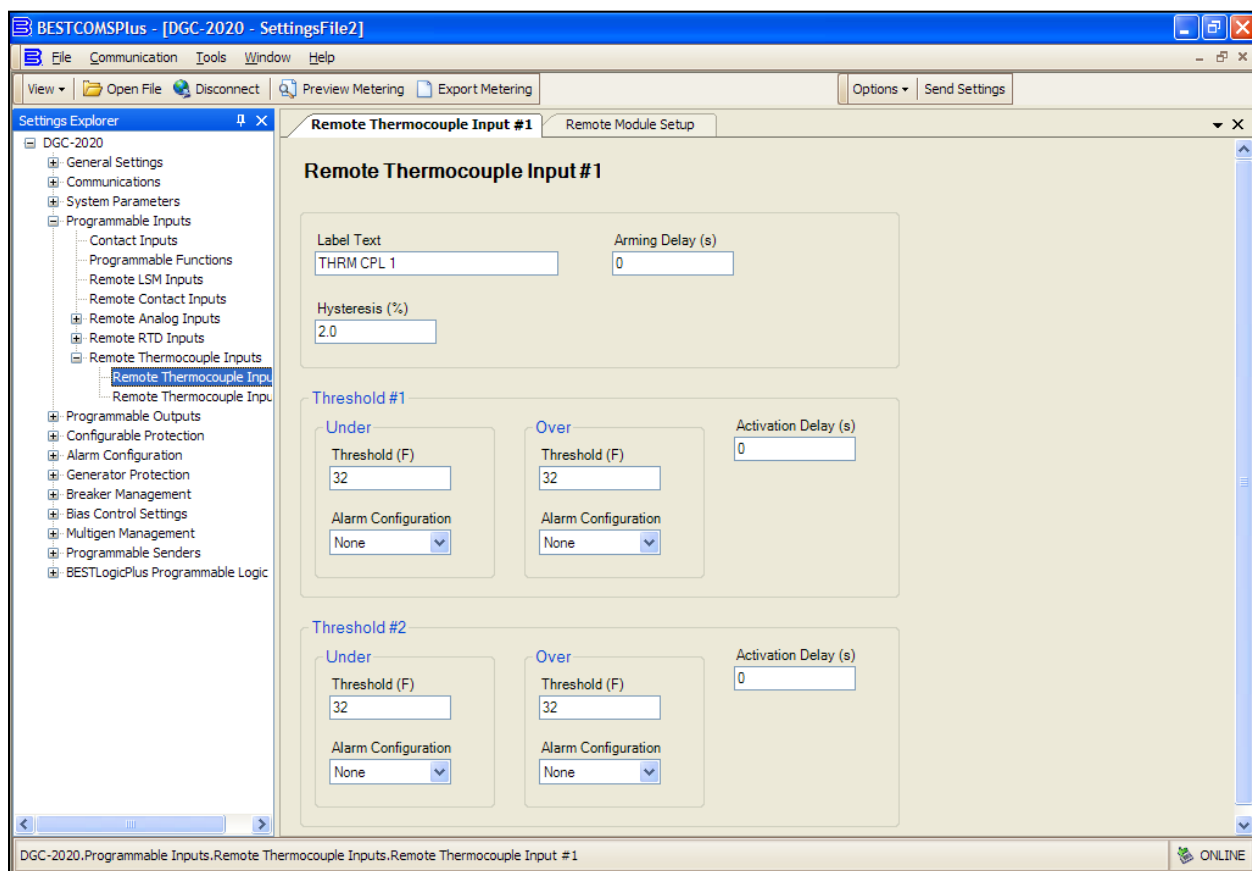
Figure 6-46. Settings Explorer, Programmable Inputs, Remote Thermocouple Inputs Screen

Configure the following parameters:

  a. 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*.

  b. Hysteresis (%) - Enter a value for the desired hysteresis for threshold detection. Hysteresis helps prevent intermittent detection of thresholds.

  c. 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. Non-zero values cause input monitoring after the programmed time has elapsed after engine startup.

  d. 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

  o Programmable contact outputs

  o Run relay, Pre-Start relay, and Run 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.

Programmable Output Configuration Instructions:

1. Configuring Contact Outputs on the DGC-2020.

    a. Programmable Contact Outputs. See Figure 6-47.
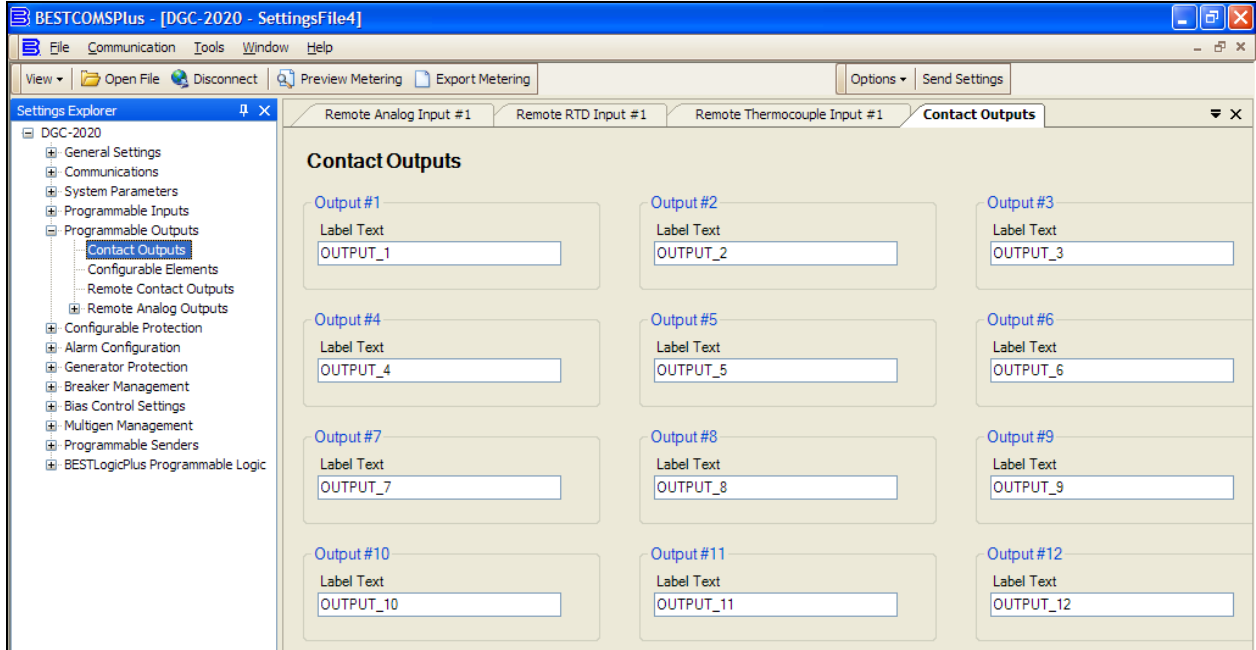
Figure 6-47. Settings Explorer, Programmable Outputs, Contact Outputs Screen

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.

b. Run Relay, Pre-Start Relay, and Start Relay

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 6-48 shows the *Relay Control* screen used to set the operation of these relays to predefined or programmable operation.
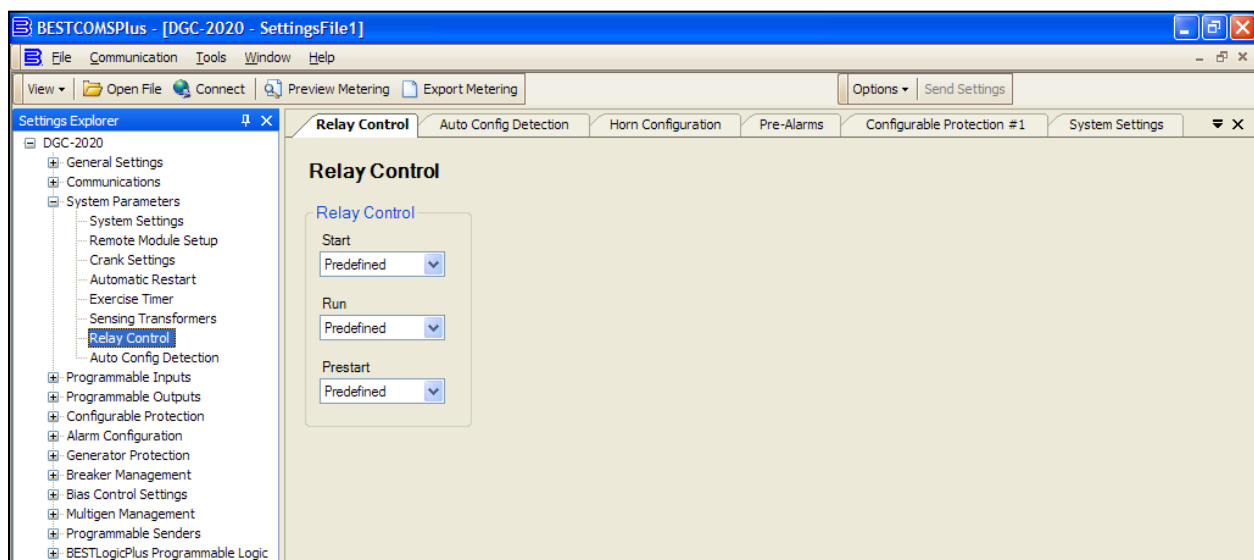
Figure 6-48. Settings Explorer, System Parameters, Relay Control Screen

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 6-49.
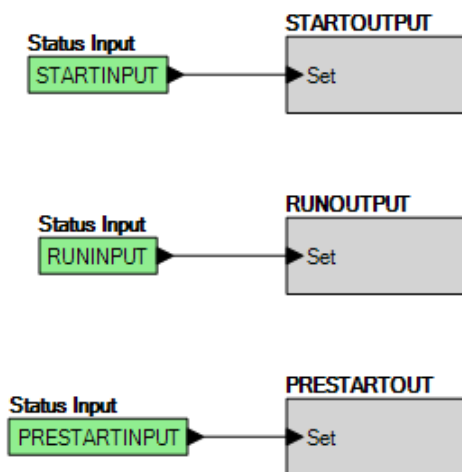
Figure 6-49. Logic Example of Programmable Relays

2. 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 6-50.
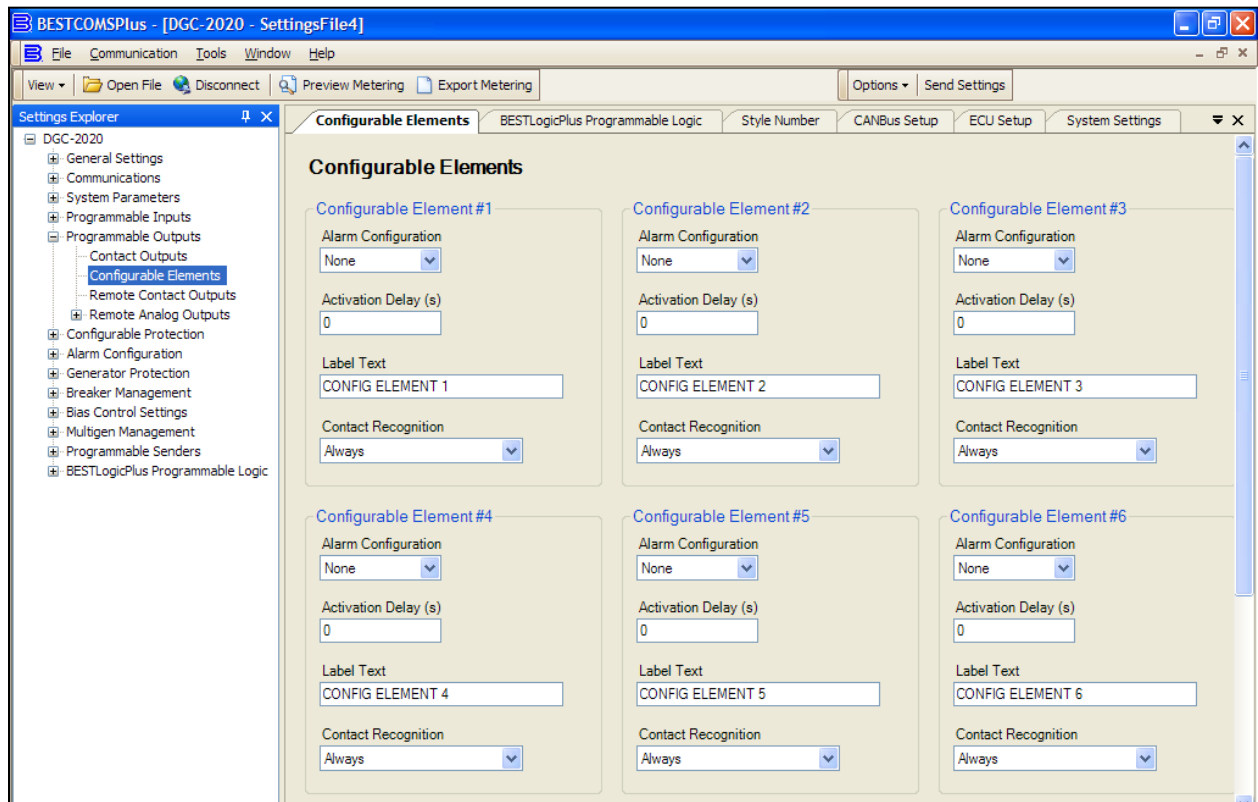
Figure 6-50. Settings Explorer, Programmable Outputs, Configurable Elements Screen

The parameters for configurable elements are similar to those for programmable inputs. Set the following parameters for each configurable element:

a. Alarm Configuration - Select *None, Alarm,* or *Pre-Alarm*. When an alarm occurs, the horn annunciates with a constant beep 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.*

b. Activation Delay - This setting defines the duration that the configurable element is true before alarm or pre-alarm annunciation.

c. 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*.

d. 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.

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 AND'ed with ENGINE RUNNING to drive Configurable Element 1, which is configured as an alarm. The logic diagram is shown in Figure 6-51.
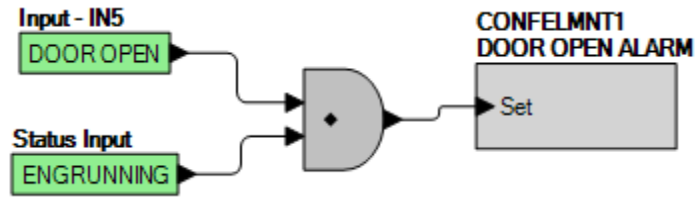
Figure 6-51. Using a Configurable Element Logic Diagram

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.

3. Configuring Remote Contact Outputs on the CEM-2020. See Figure 6-52.

   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.
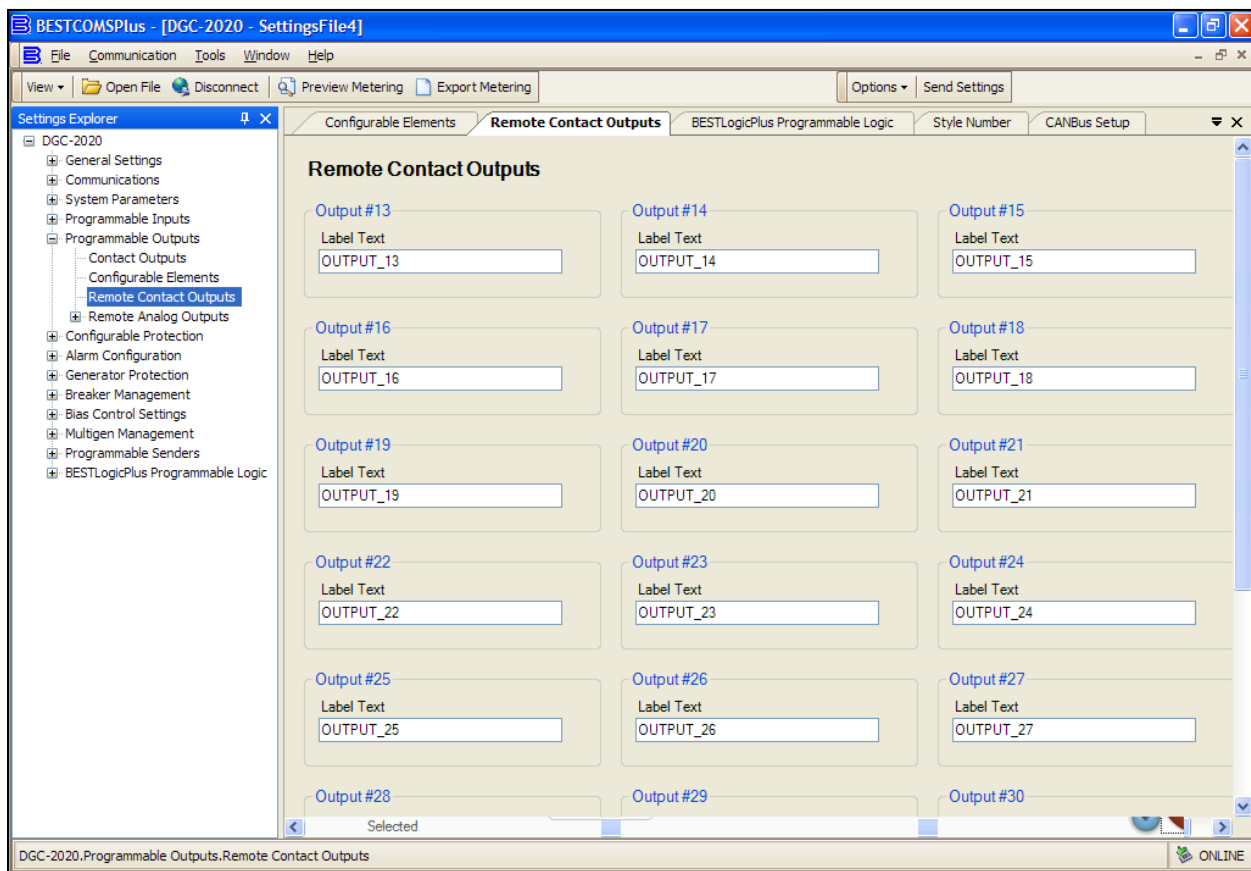
Figure 6-52. Settings Explorer, Programmable Outputs, Remote Contact Outputs Screen

4. Configuring Remote Analog Outputs on the AEM-2020.

   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 6-53.
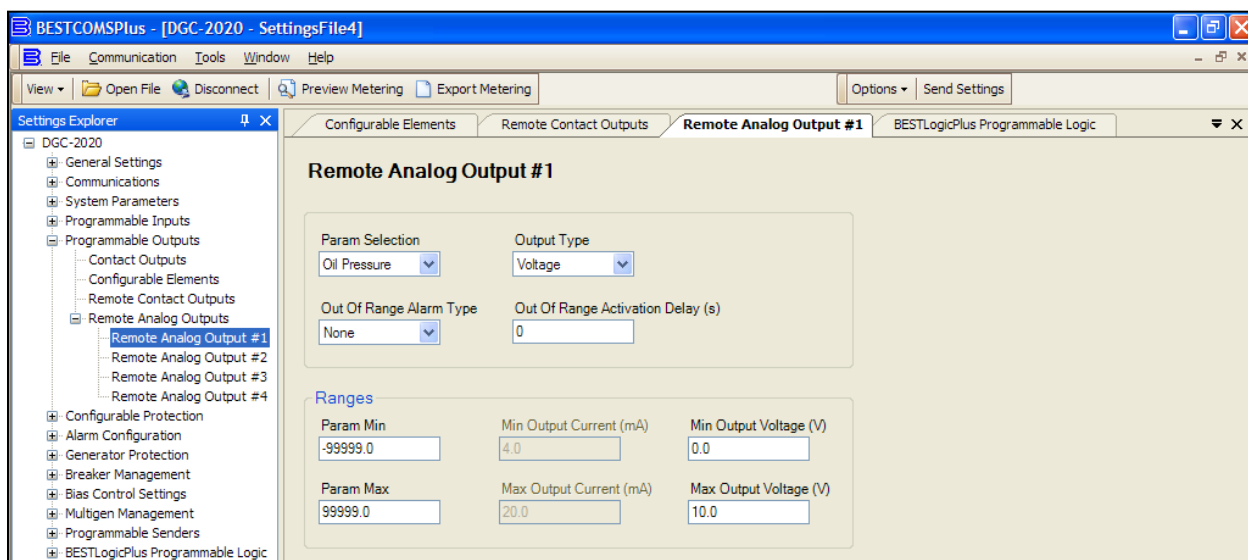
Figure 6-53. Settings Explorer, Programmable Outputs, Remote Analog Outputs Screen

Configure the following parameters:

a. 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.

b. Output Type - Select *Voltage* or *Current* as the analog output type.

c. 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.

d. 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*.

e. Parameter Minimum - This setting defines the minimum value that occurs on the parameter being metered.

f. Parameter Maximum - This setting defines the maximum value that occurs on the parameter being metered.

g. 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*.

h. 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*.

i. 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*.

j. 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. The user has 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.
    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 this section 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* under *DGC-2020 Setup* in Section 6, *Installation*. 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 6-54:
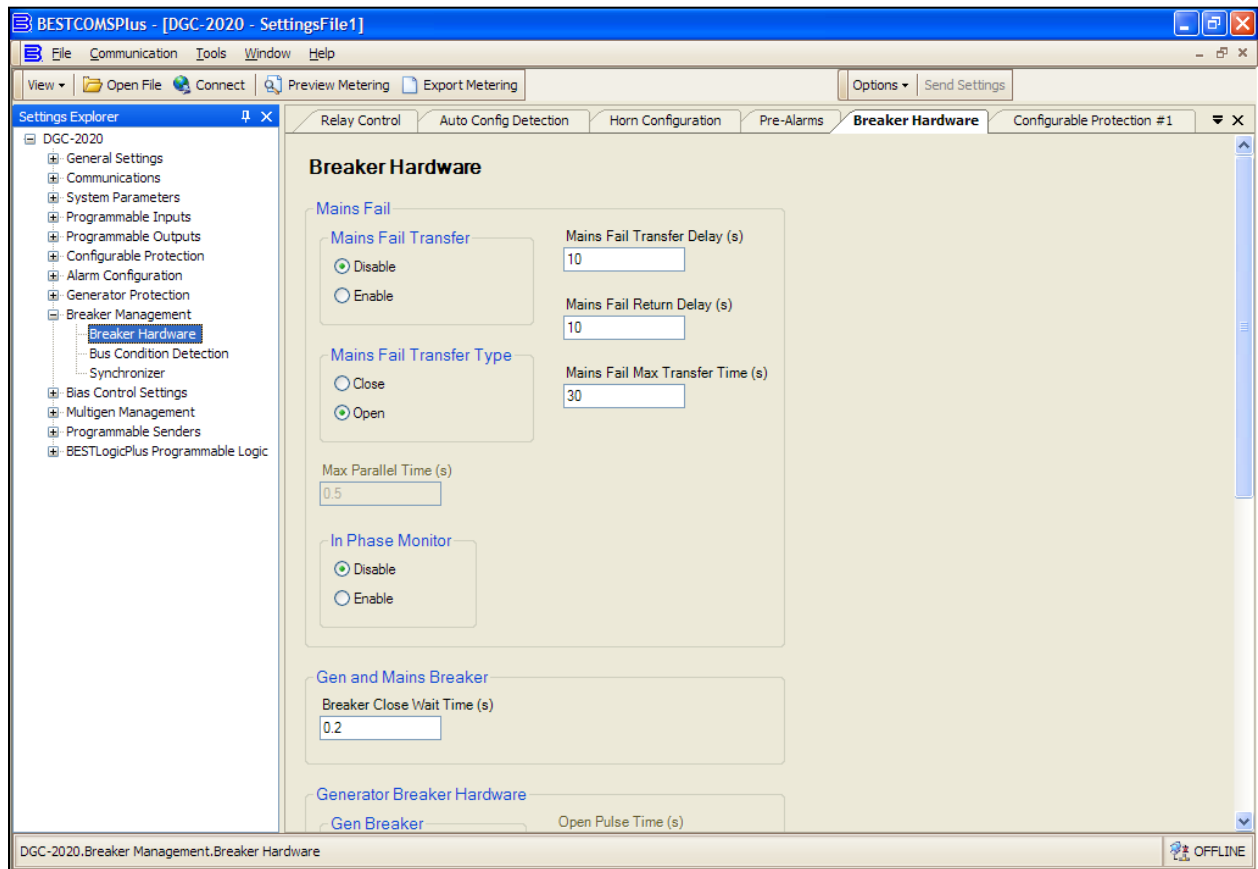
Figure 6-54. Settings Explorer, Breaker Management, Breaker Hardware Screen

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→BESTLOGICPLUS PROGRAMMABLE LOGIC. See Figure 6-55.
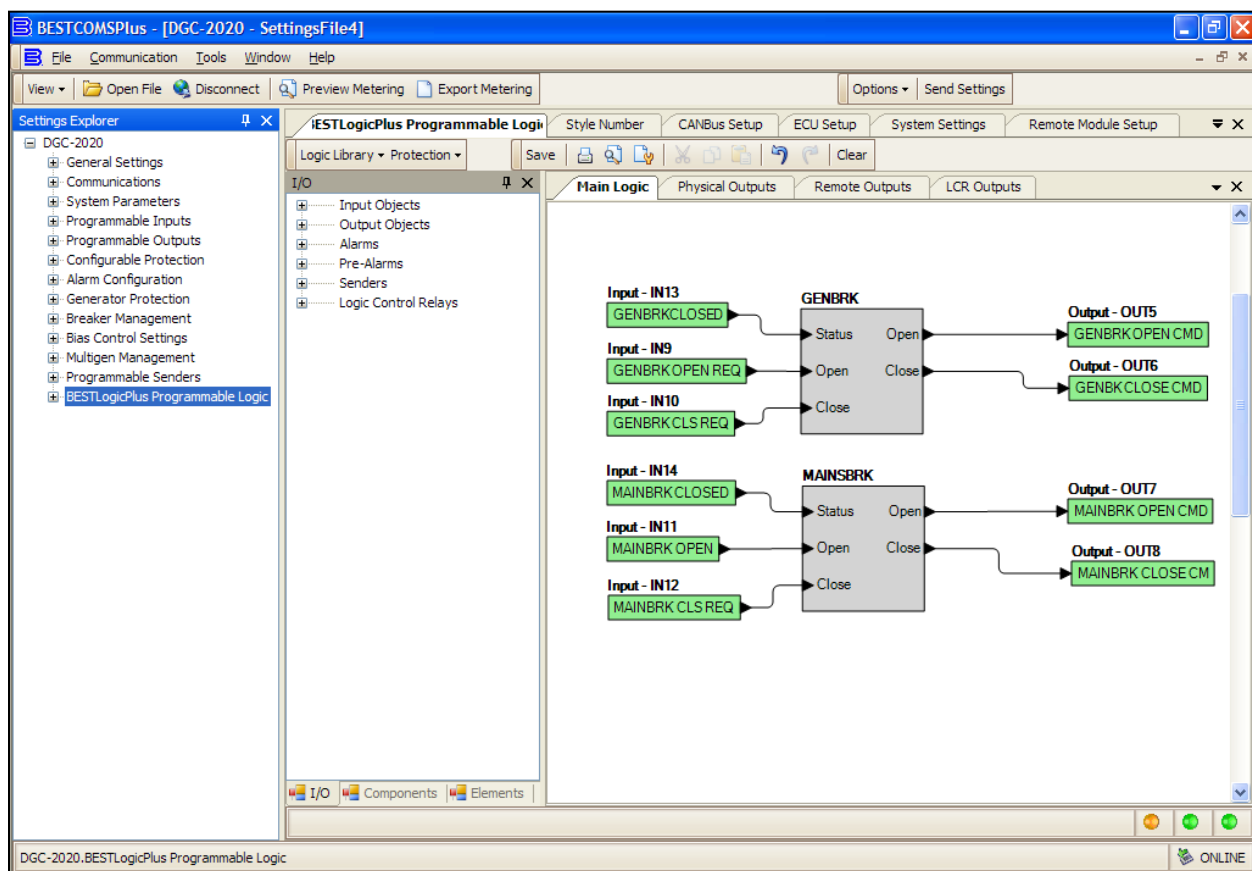
Figure 6-55. Settings Explorer, BESTLogicPlus Programmable Logic Settings

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.

a. Generator Sensing. See Figure 6-56.
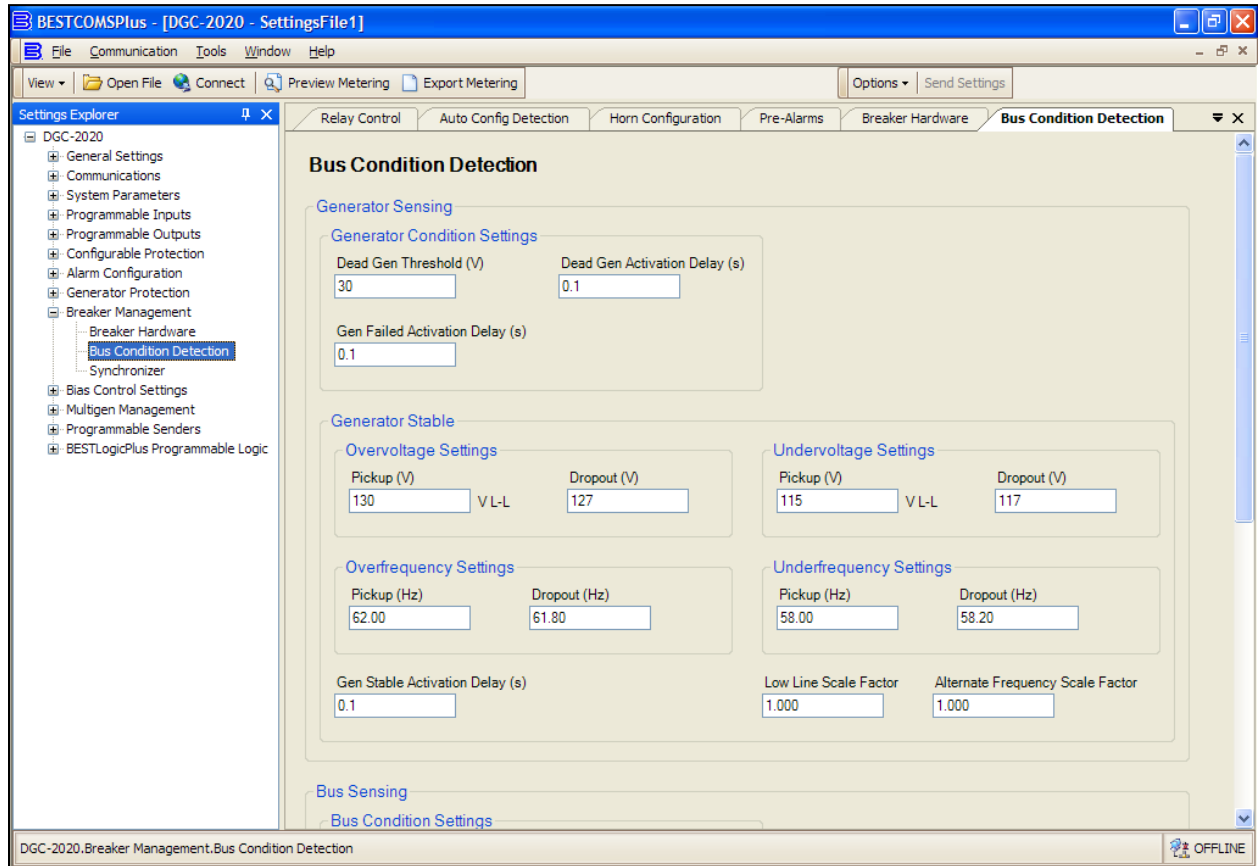
Figure 6-56. Settings Explorer, Breaker Management, Bus Condition Detection, Generator Sensing

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 6-57.
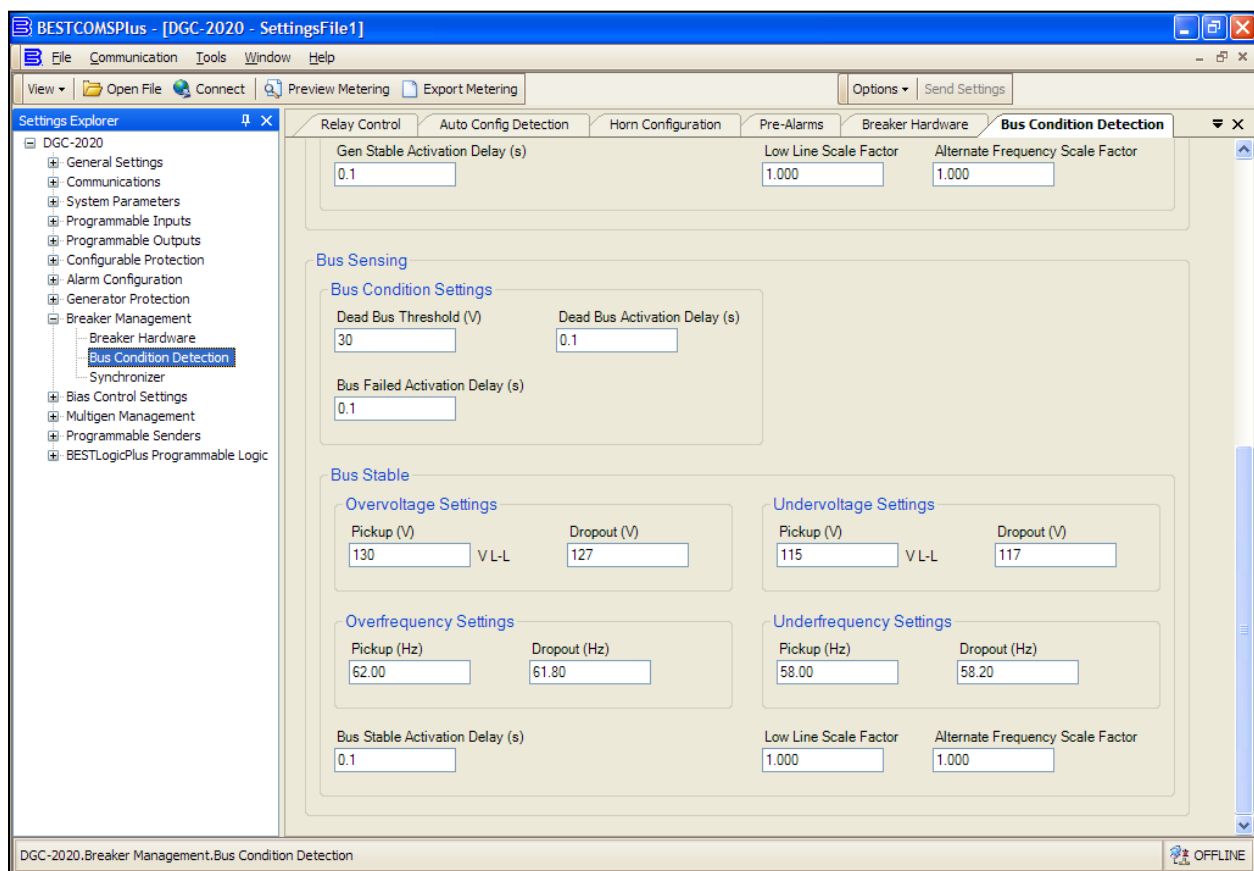
Figure 6-57. Settings Explorer, Breaker Management, Bus Condition Detection, Bus Sensing

    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.

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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 6-58.
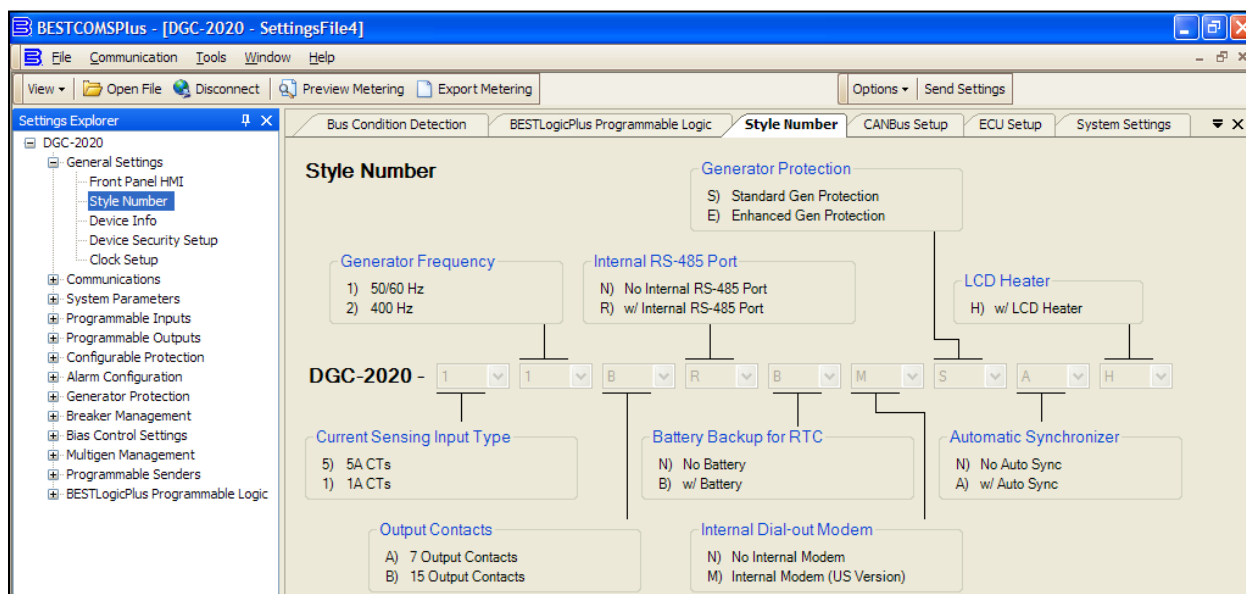
Figure 6-58. Settings Explorer, General Settings, Style Number Screen

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 6-59.
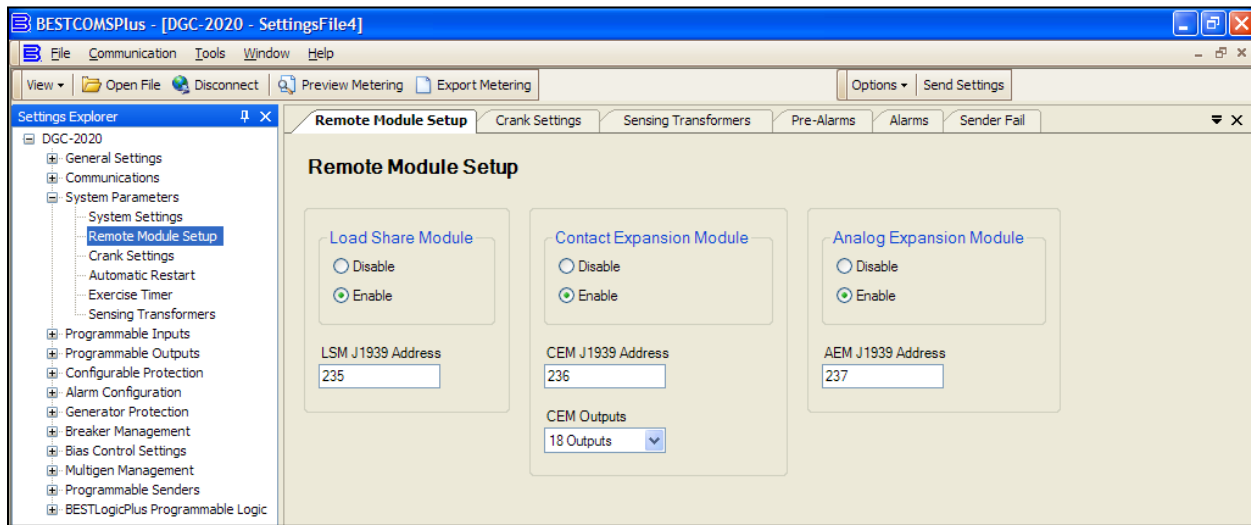
Figure 6-59. Settings Explorer, System Parameters, Remote Module Setup Screen

3. Next, click *Programmable Inputs*, then *Contact Inputs* to label the Breaker Status input (Input 13 is the default). See Figure 6-60.
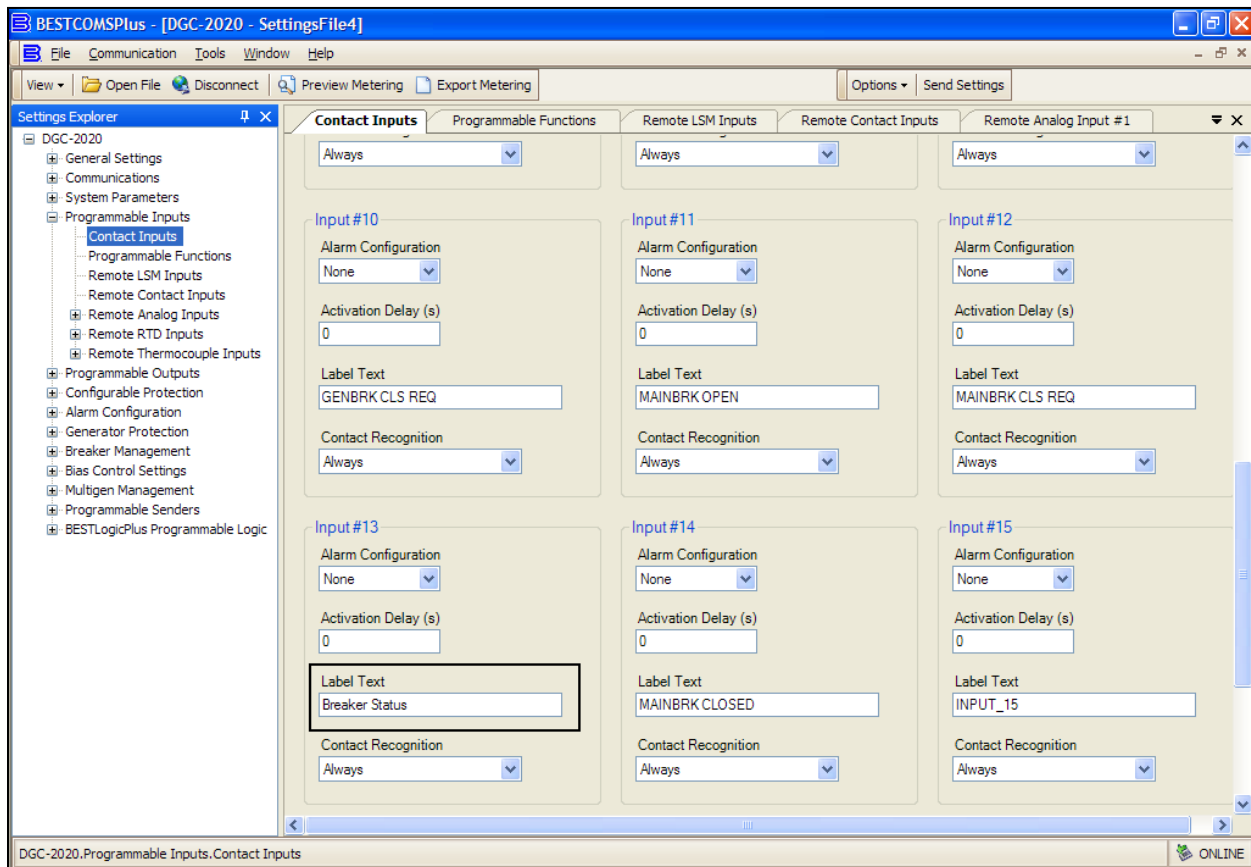
Figure 6-60. Settings Explorer, Programmable Inputs, Contact Inputs Screen

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 6-61.
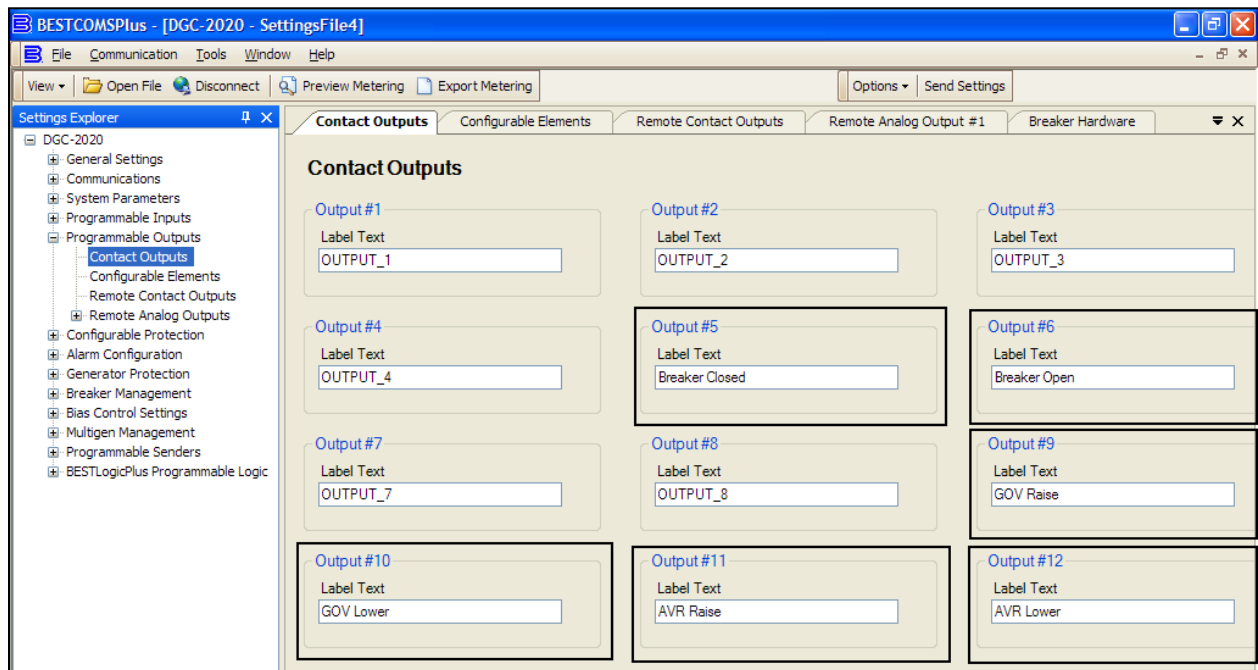
Figure 6-61. Settings Explorer, Programmable Outputs, Contact Outputs Screen

5. Click on *Breaker Management* then *Breaker Hardware*. On this screen, (Figure 6-62), enter the settings for the following parameters:

   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.
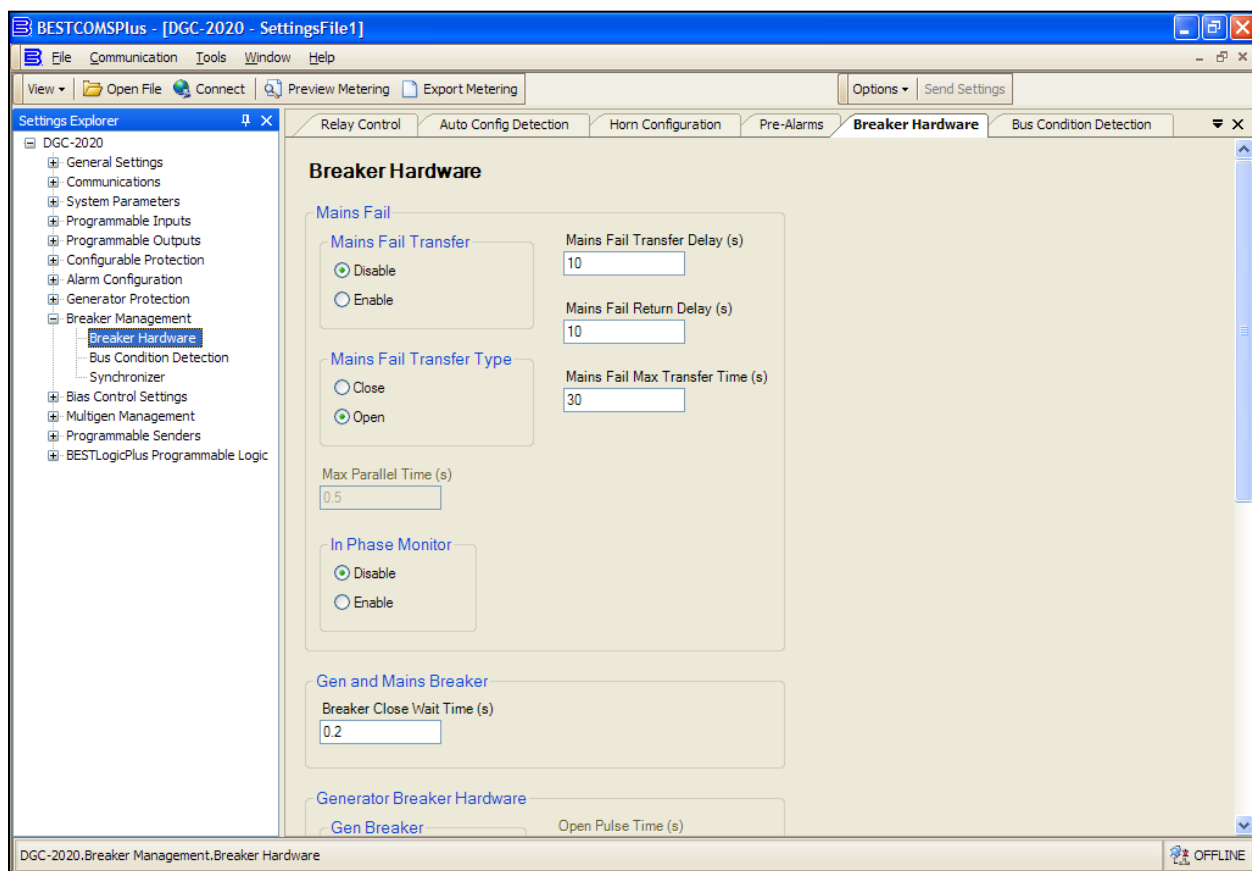
Figure 6-62. Settings Explorer, Breaker Management, Breaker Hardware Screen

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 6-63.

   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".
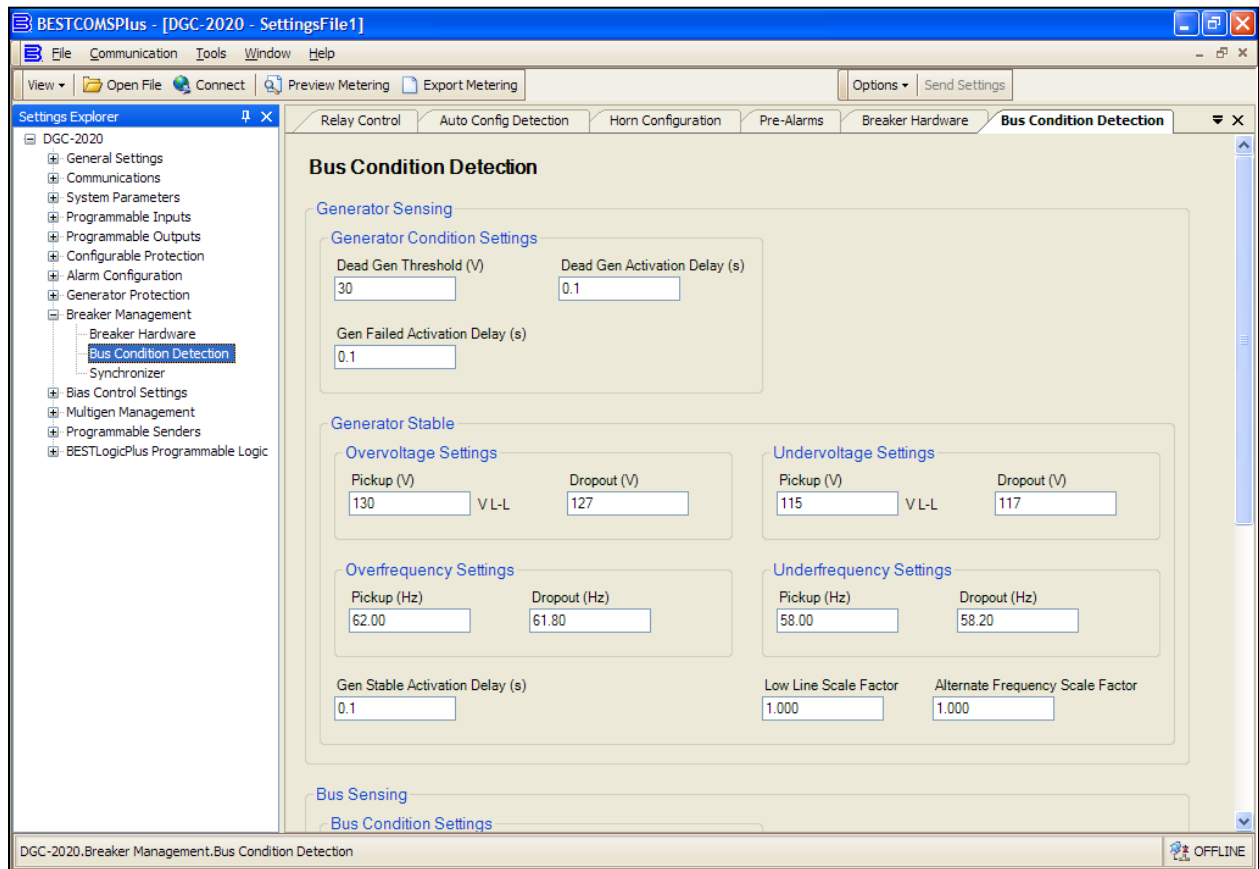
Figure 6-63. Settings Explorer, Breaker Management, Bus Condition Detection Screen

7. Next, click on *Synchronizer* under the *Breaker Management* section of the Settings Explorer. See Figure 6-64.
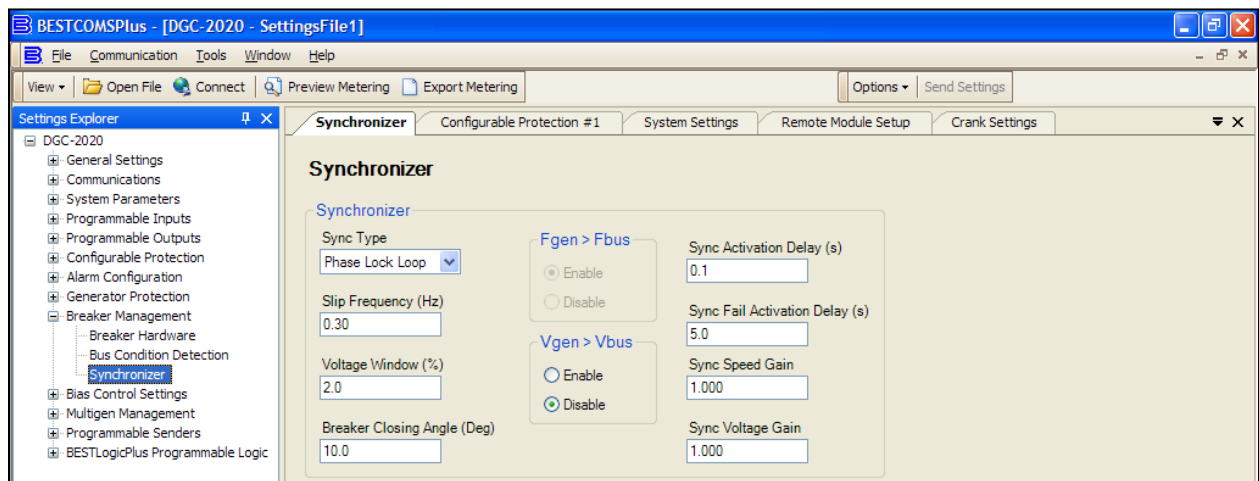
Figure 6-64. Settings Explorer, Breaker Management, Synchronizer Screen

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. Regulation Offset. 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. 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".

    e. Sync Activation Delay. The sync activation delay is a delay from the time a breaker close request is received by the synchronizer. After this delay expires, the synchronizer will begin running to adjust phase angle and generator voltage to the levels desired for breaker closure.

    f. 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.

    g. 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.

    h. 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 6-65.
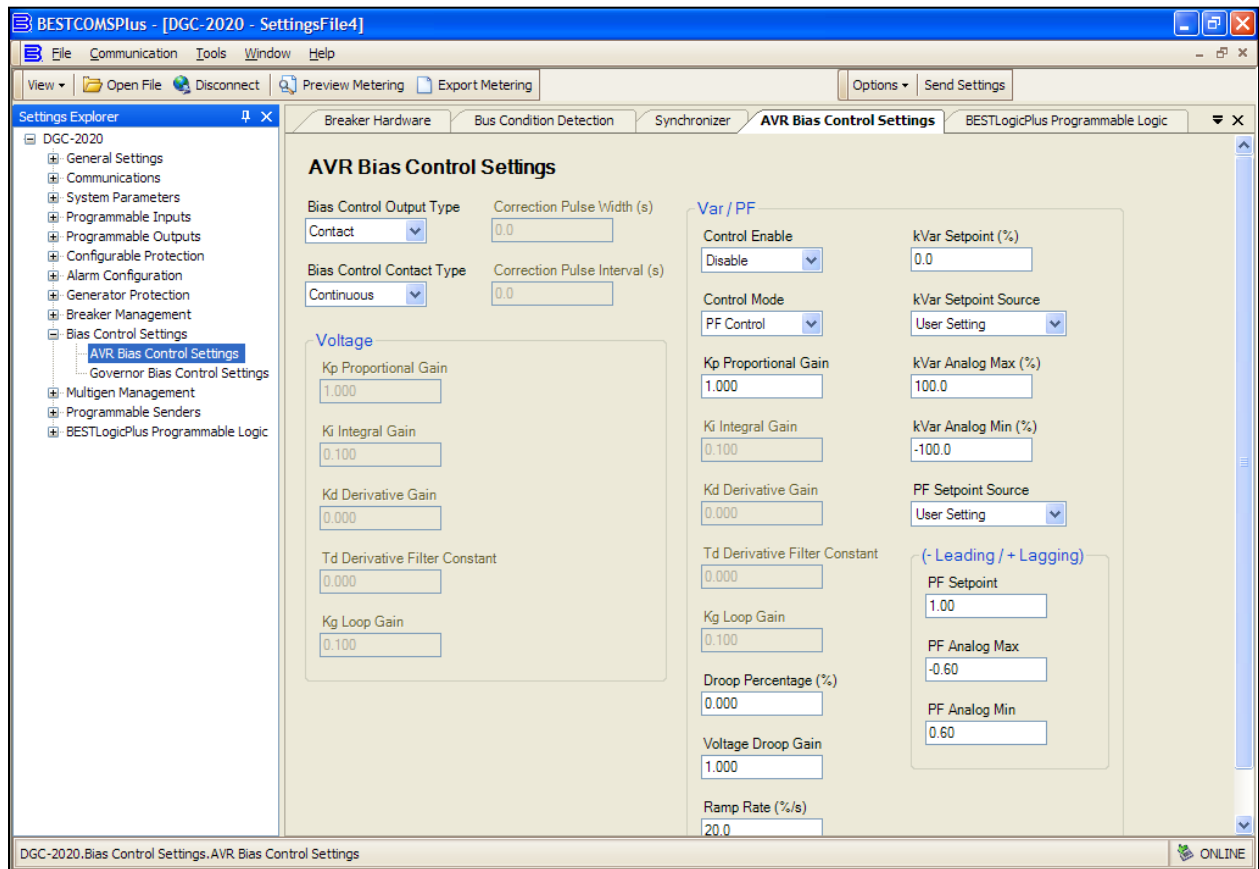
Figure 6-65. Settings Explorer, Bias Control Settings, AVR Bias Control Settings Screen

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 6-66.
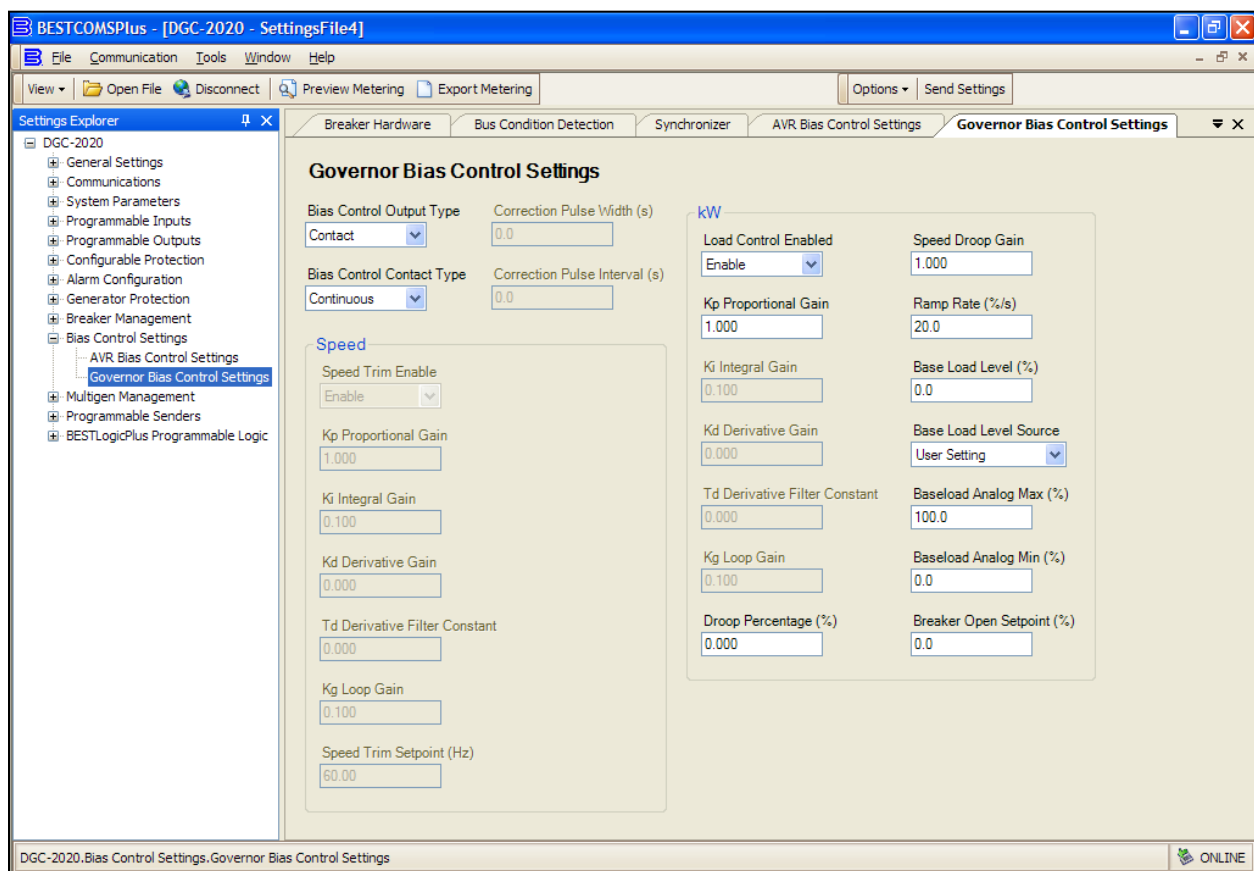
Figure 6-66. Settings Explorer, Bias Control Settings, Governor Bias Control Settings Screen

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 6-67.
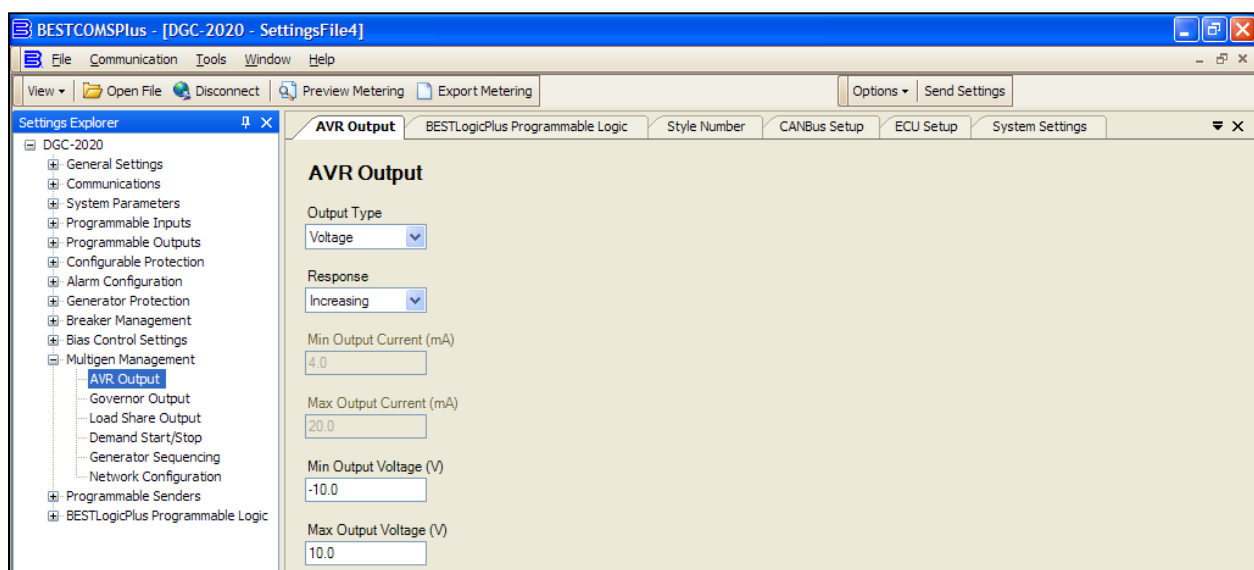
Figure 6-67. Settings Explorer, Multigen Management, AVR Output Screen

Settings should be entered for each of the following parameters when appropriate:

a. <u>Output Type.</u> Select whether the AVR bias signal should be *Voltage* or *Current*.

b. <u>Response.</u> Select *Increasing* or *Decreasing*. Increasing should be selected if an increase in the output parameter results in an increase of generator output voltage.

c. <u>Min Output Current (mA) and Max Output Current (mA).</u> 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. <u>Min Output Voltage (V) and Max Output Voltage (V).</u> 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 6-68.
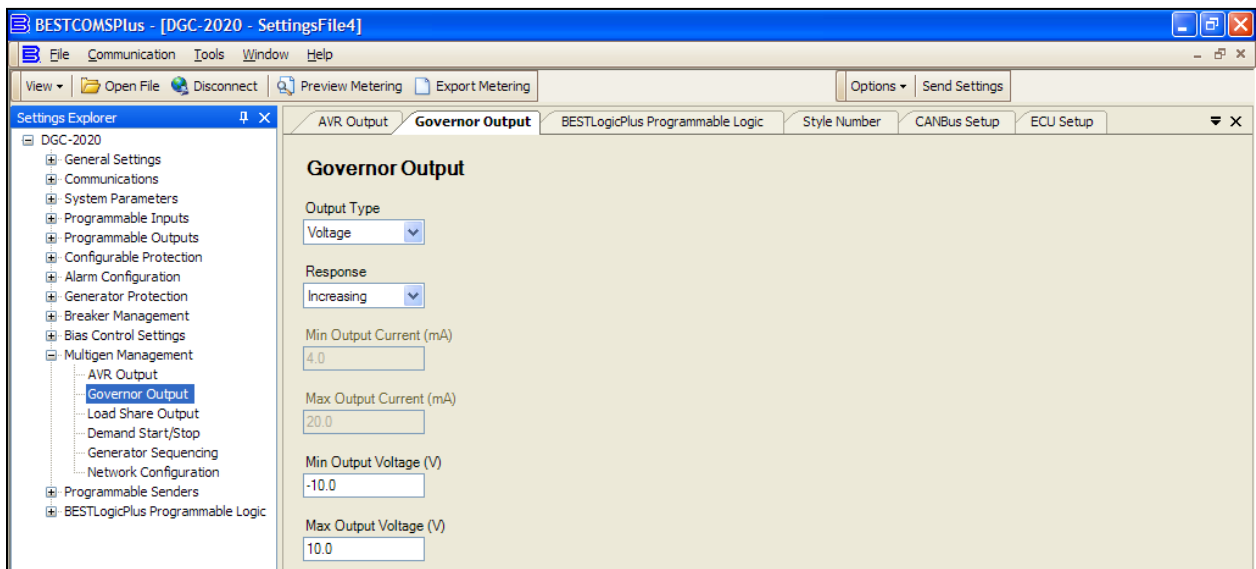
Figure 6-68. Settings Explorer, Multigen Management, Governor Output Screen

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 6-69.
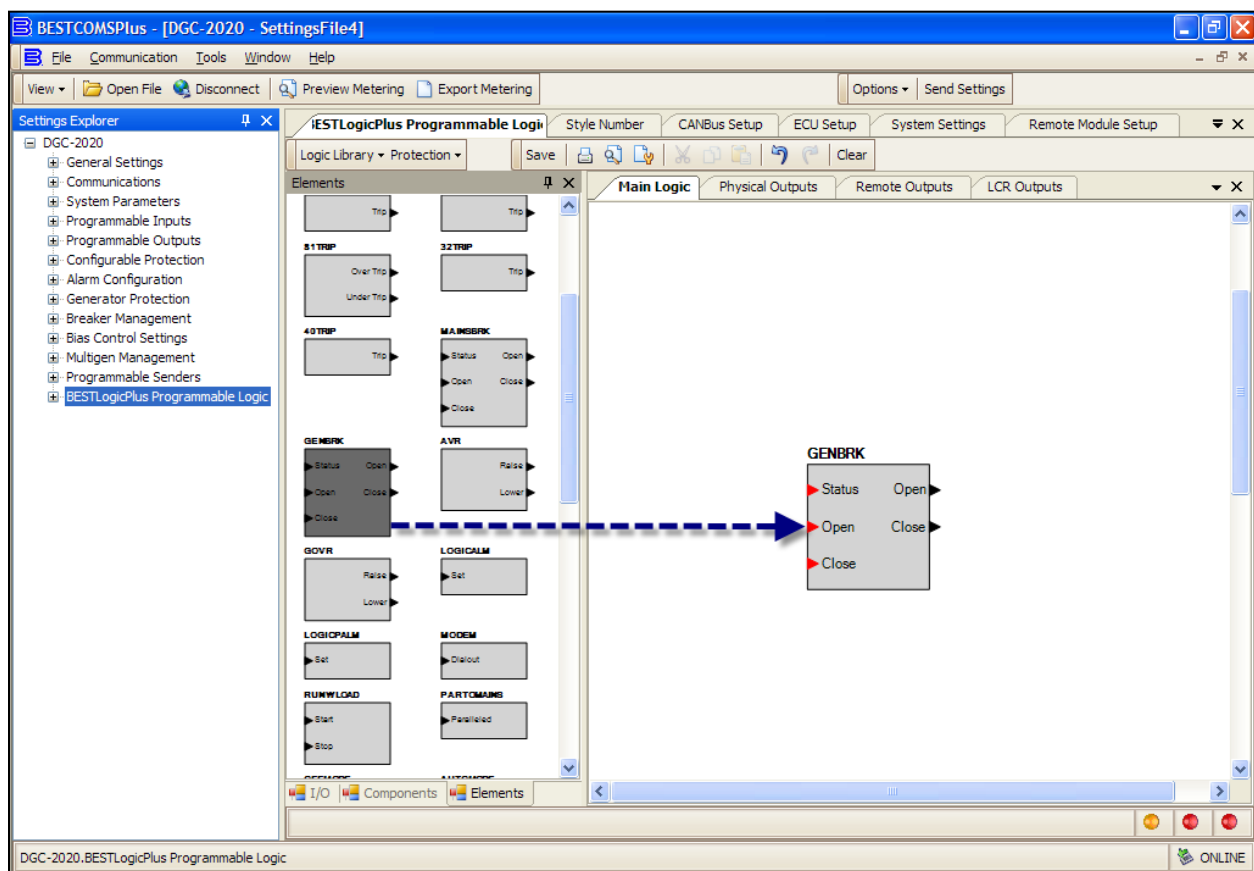
Figure 6-69. Settings Explorer, BESTLogicPlus Programmable Logic (Step 12)

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 6-70.
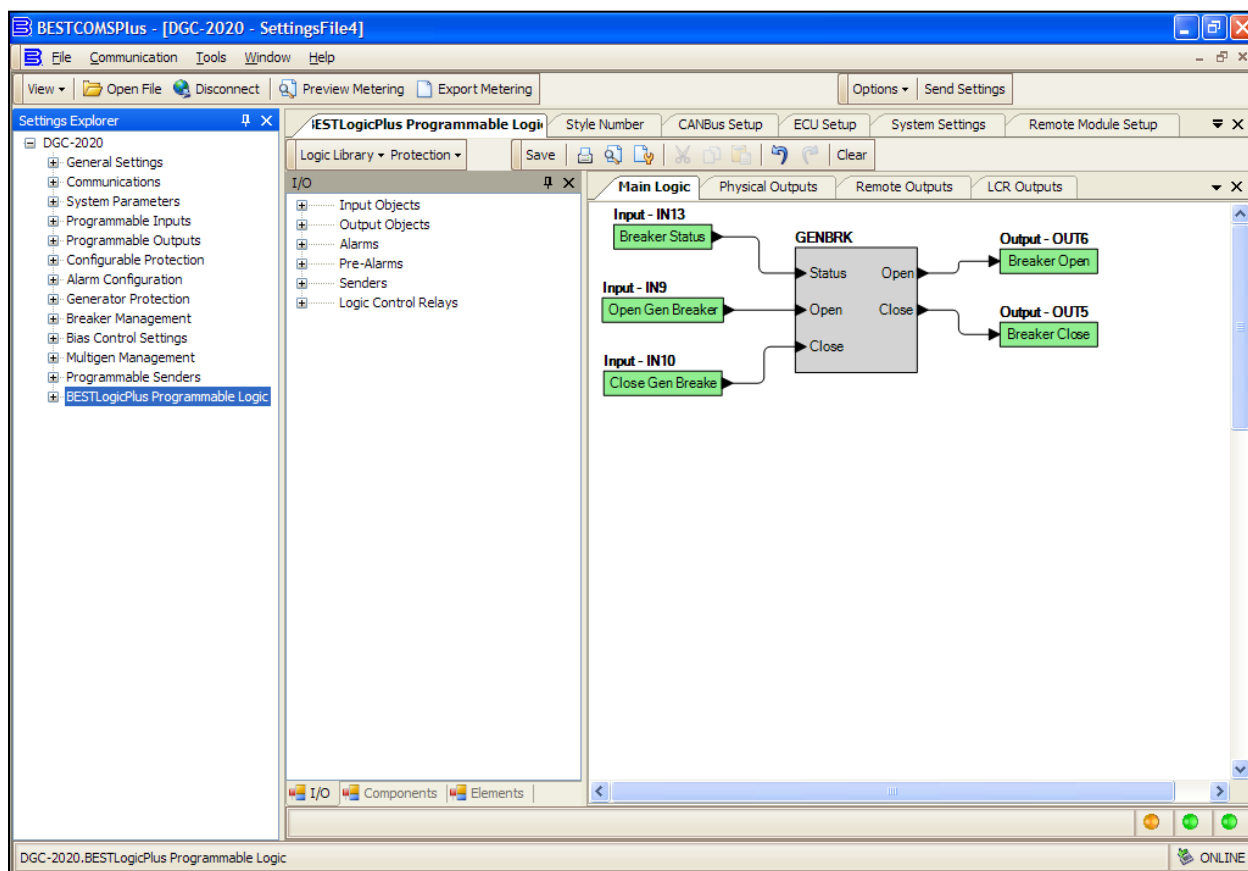
Figure 6-70. Settings Explorer, BESTLogicPlus Programmable Logic (Step 13)

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 6-71.
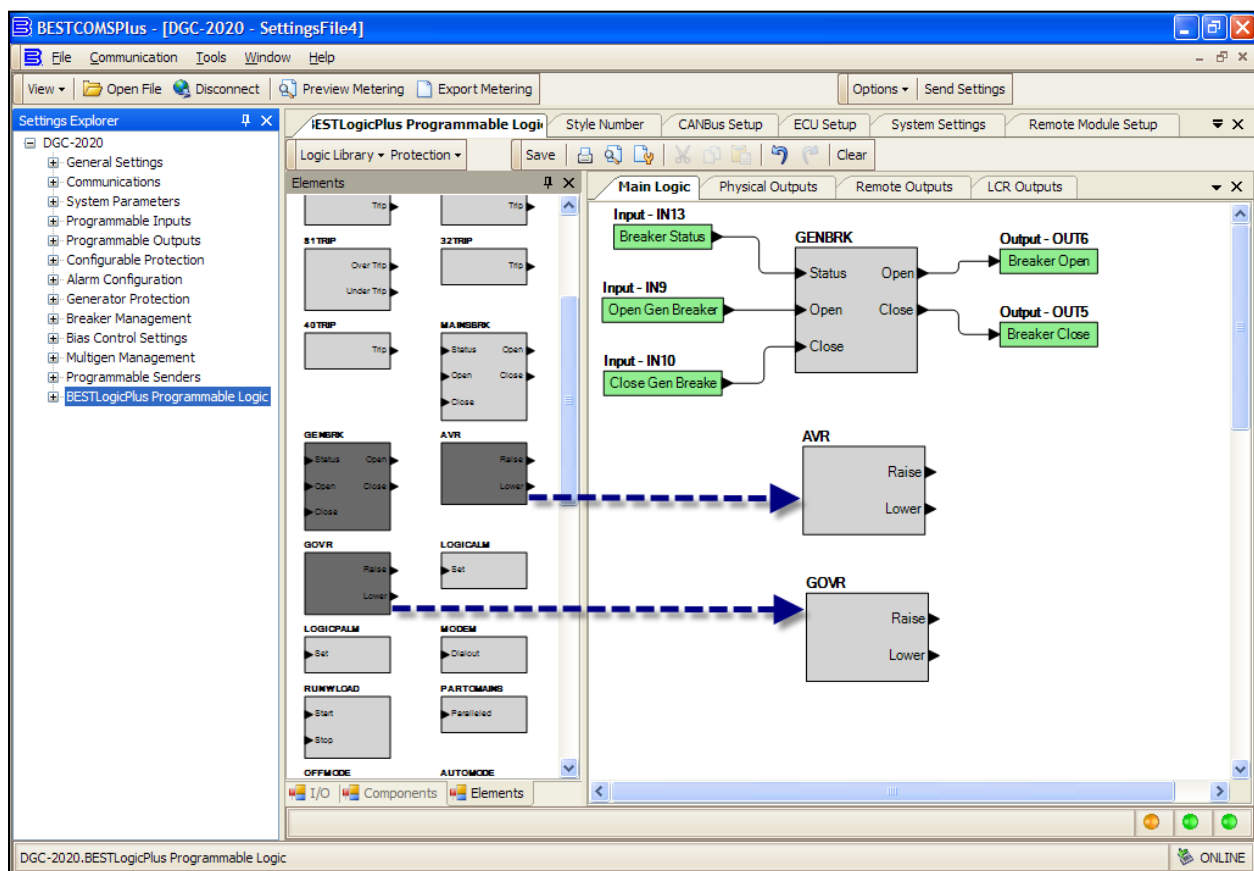
Figure 6-71. Settings Explorer, BESTLogicPlus Programmable Logic (Step 14)

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 6-72.
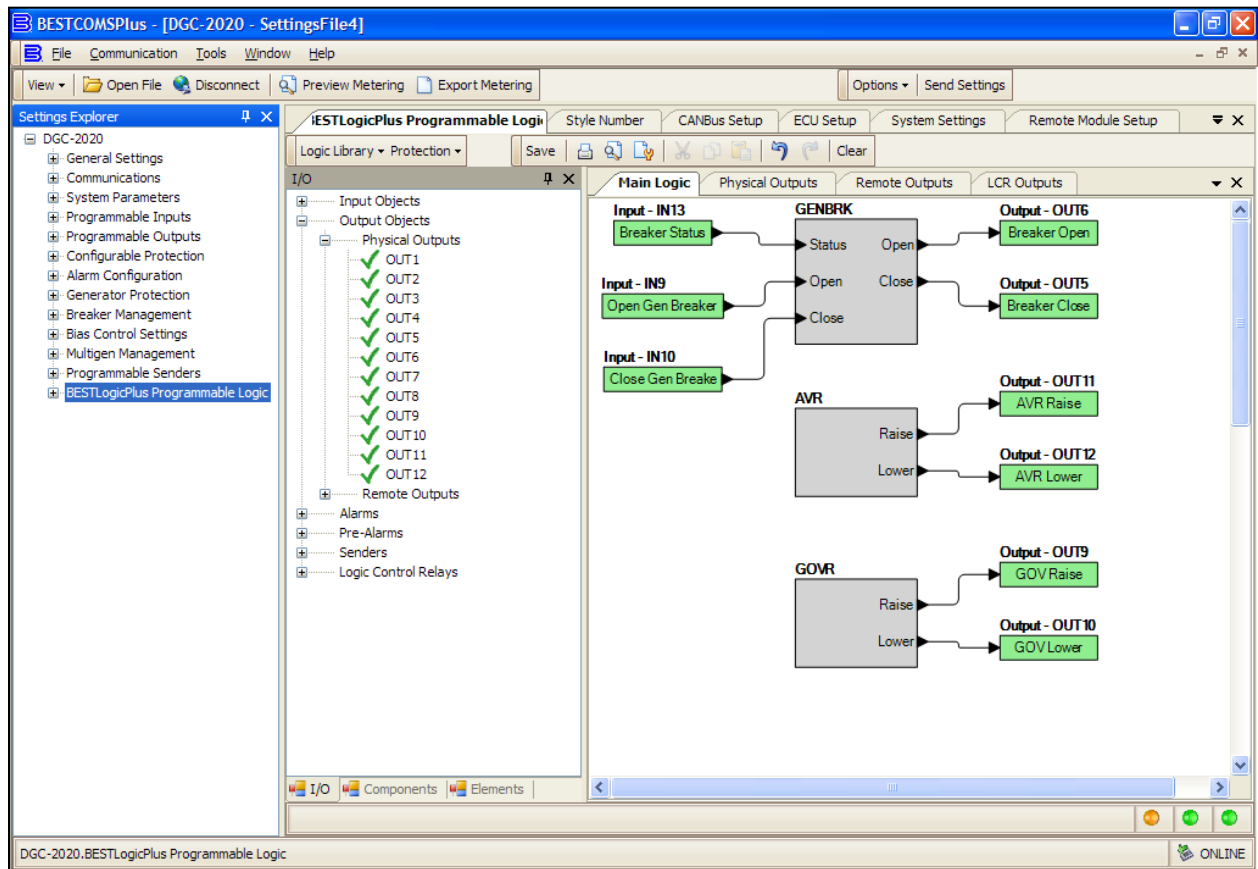
Figure 6-72. Settings Explorer, BESTLogicPlus Programmable Logic (Step 15)

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 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. 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) most existing load share implementations use an analog load share line. Figure 6-73 shows a diagram of an analog load share line as presented in this document.
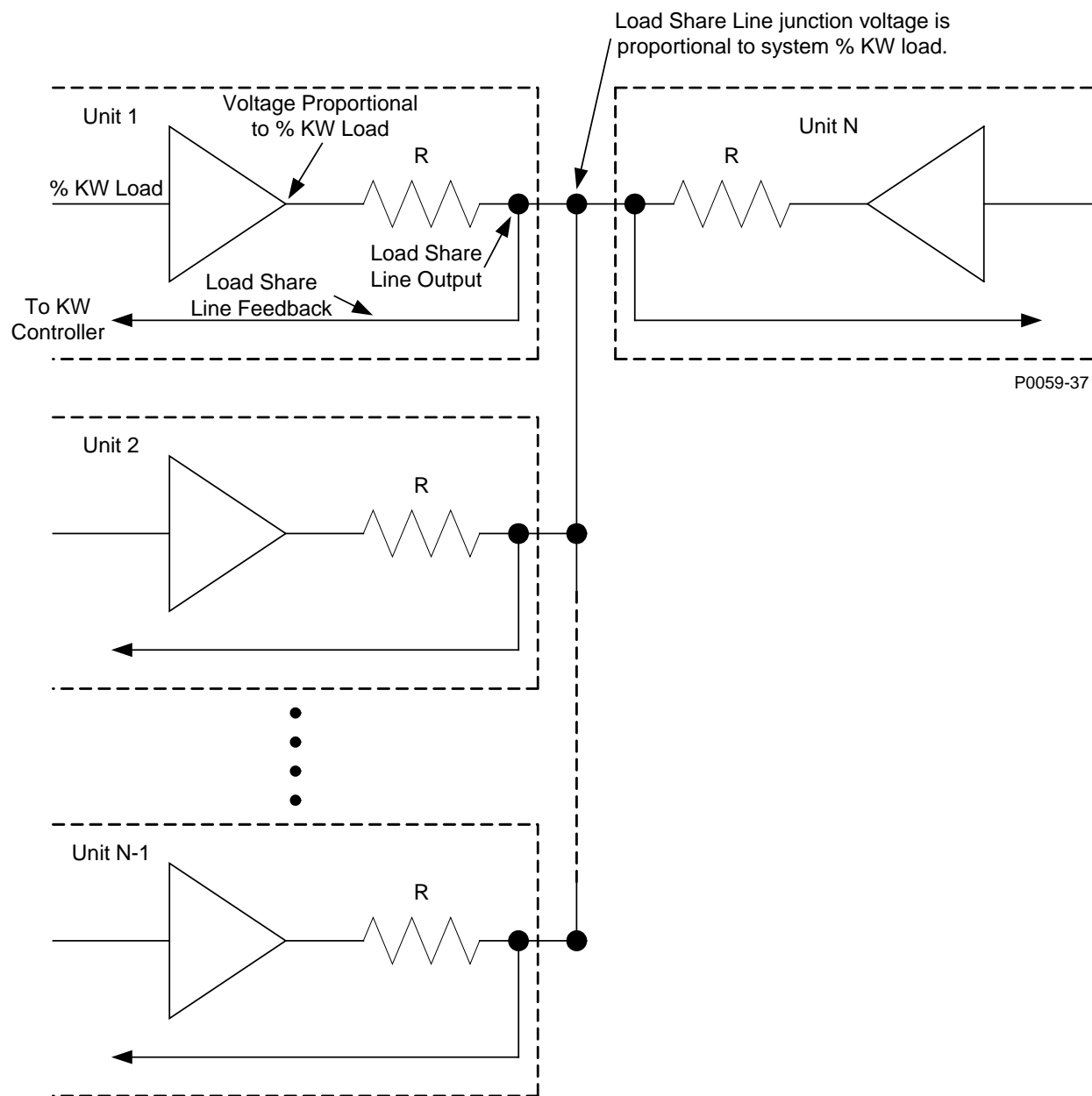
Figure 6-73. Load Share Line Implementation on a System of N Machines

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.

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 also operates in voltage droop mode. 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 is 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 8, *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* under *DGC-2020 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 8, *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 6-74.

        i. Enable the load share module by clicking *Enable* under the load share module settings.
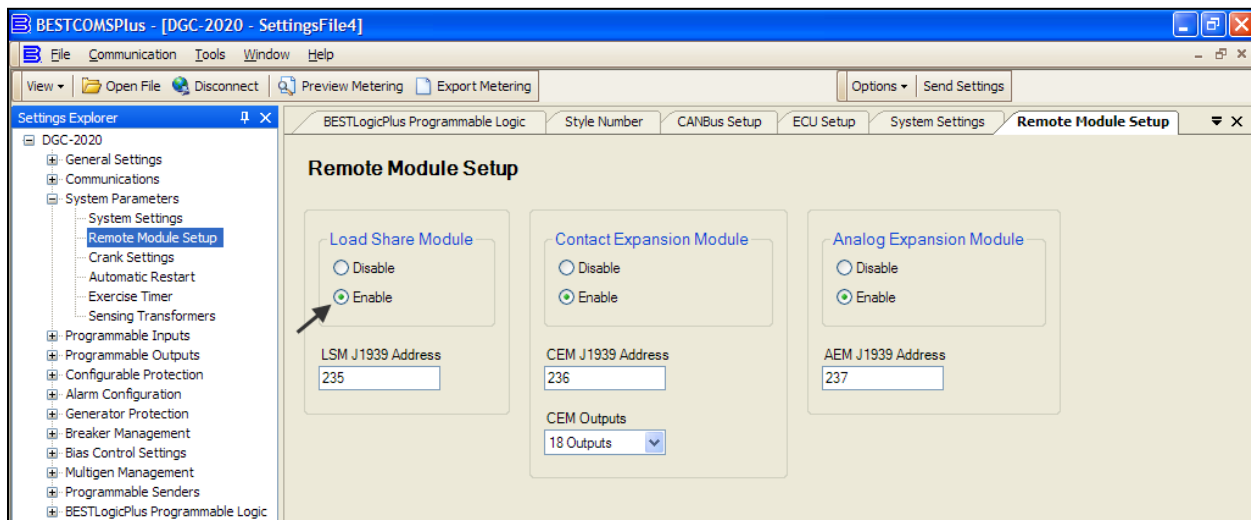
Figure 6-74. Settings Explorer, System Parameters, Remote Module Setup Screen

    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 6-75.
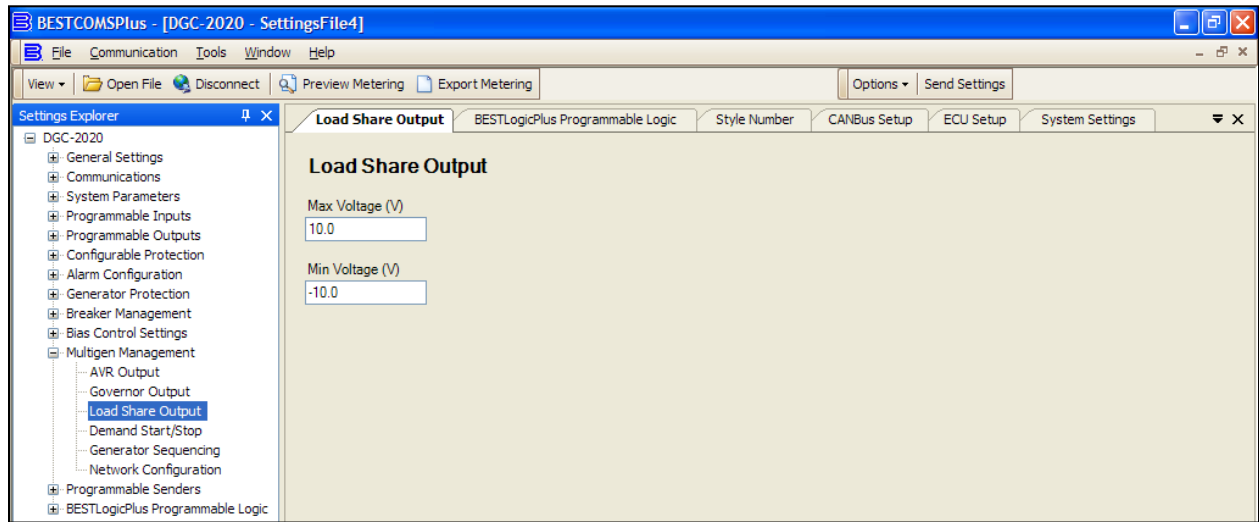
Figure 6-75. Settings Explorer, Multigen Management, Load Share Output Screen

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 6-76.
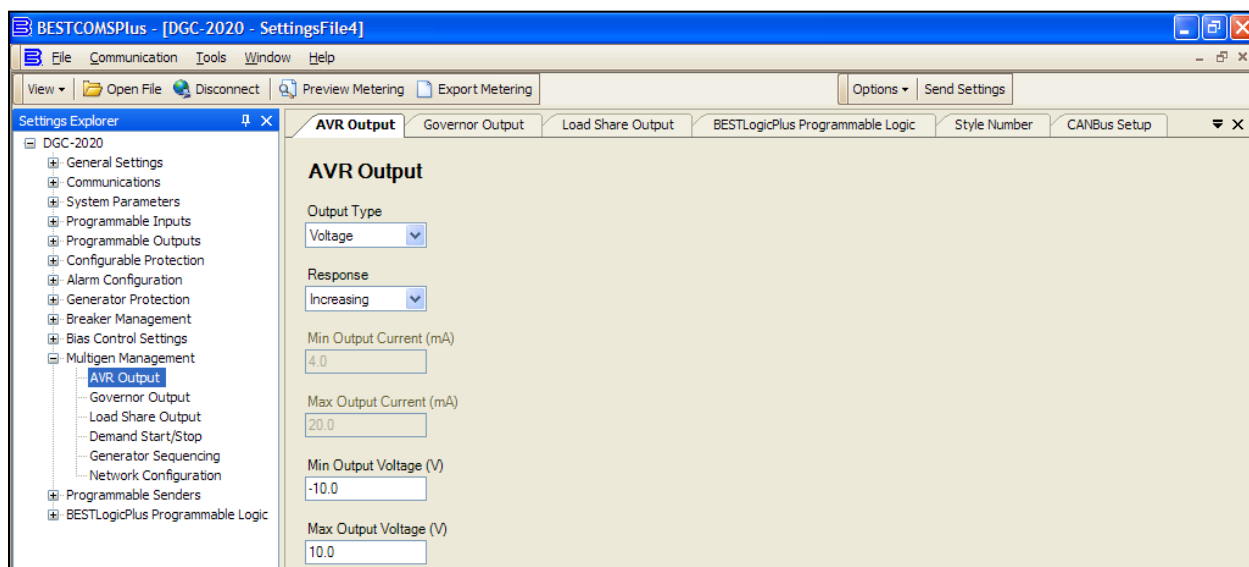
Figure 6-76. Settings Explorer, Multigen Management, AVR Output Screen

    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 6-77.

    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*.
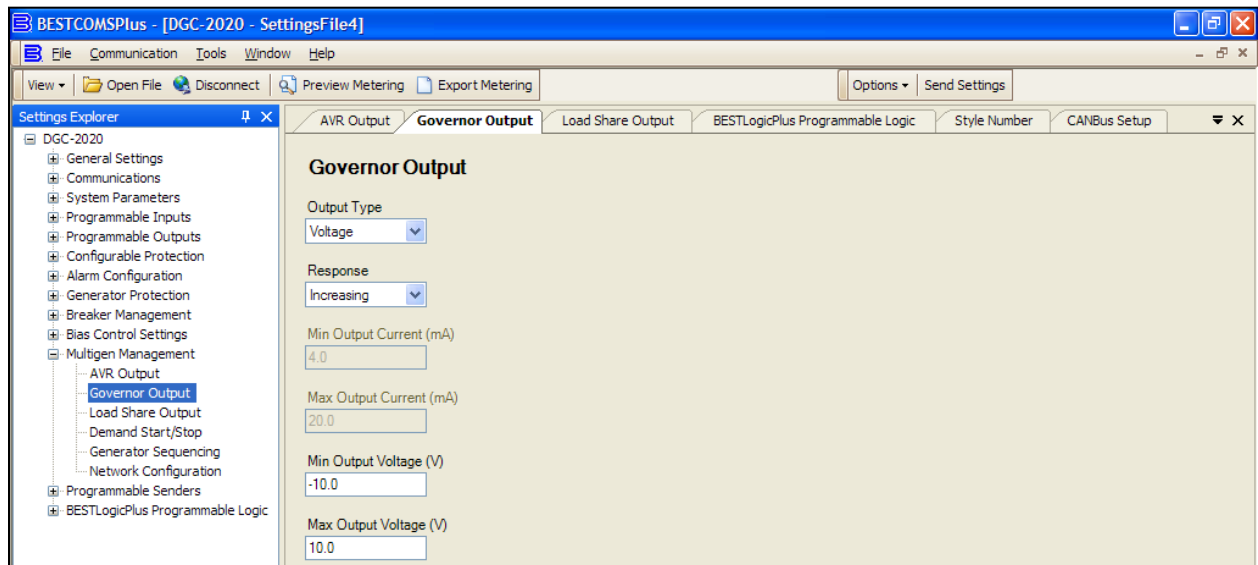
Figure 6-77. Settings Explorer, Multigen Management, Governor Output Screen

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 6-78.
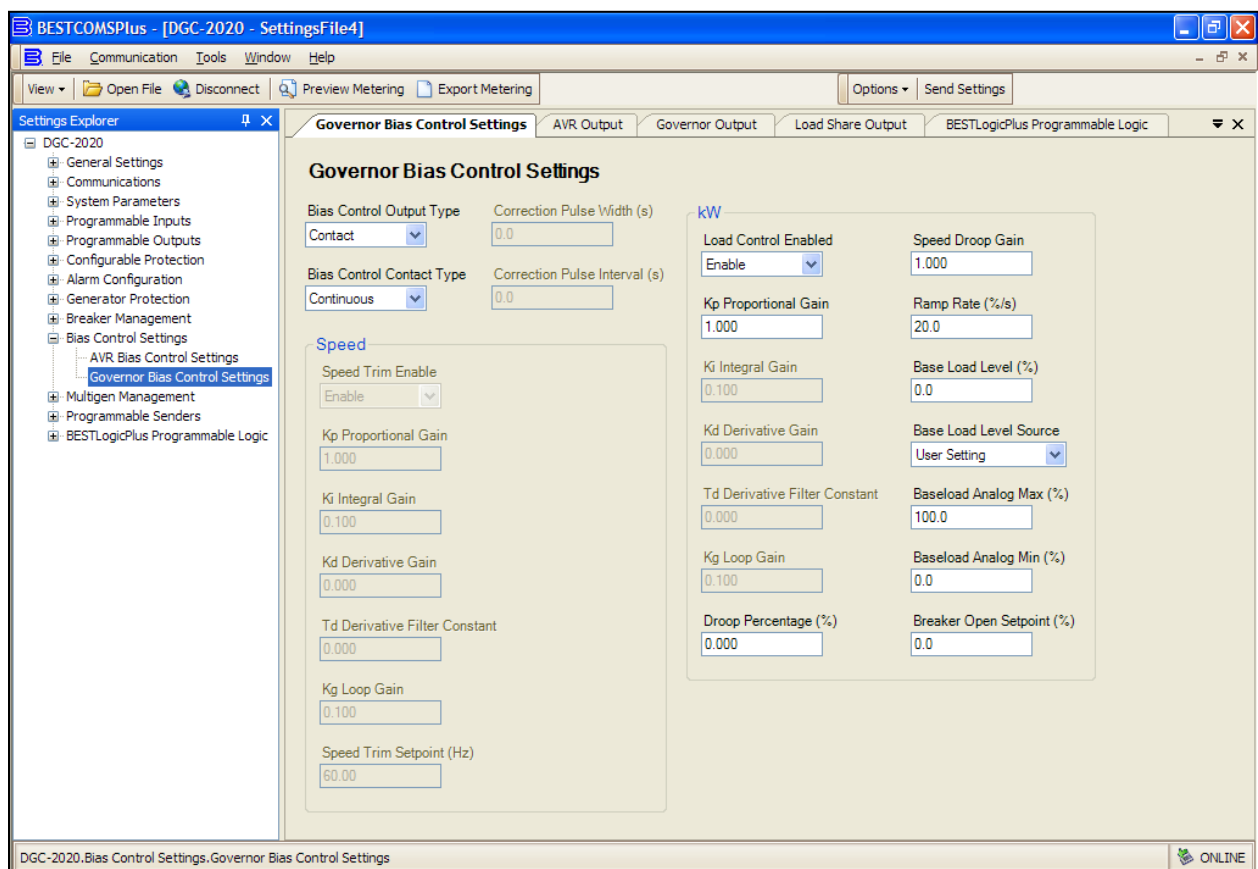
Figure 6-78. Settings Explorer, Bias Control Settings, Governor Bias Control Settings Screen

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 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 - 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 this parameter is enabled, the speed trim controller maintains system speed at the level specified by the setting.

viii. kW Load Control Enabled - Select *Enabled* when load sharing and kW control are required.

ix. 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

x. 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.

xi. 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. This can be thought of as a "fudge factor" to match the droop setting to the governor characteristics.

xii. 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.

xiii. 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.

xiv. 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.

xv. 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*.

xvi. 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.

xvii. 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 6-79.
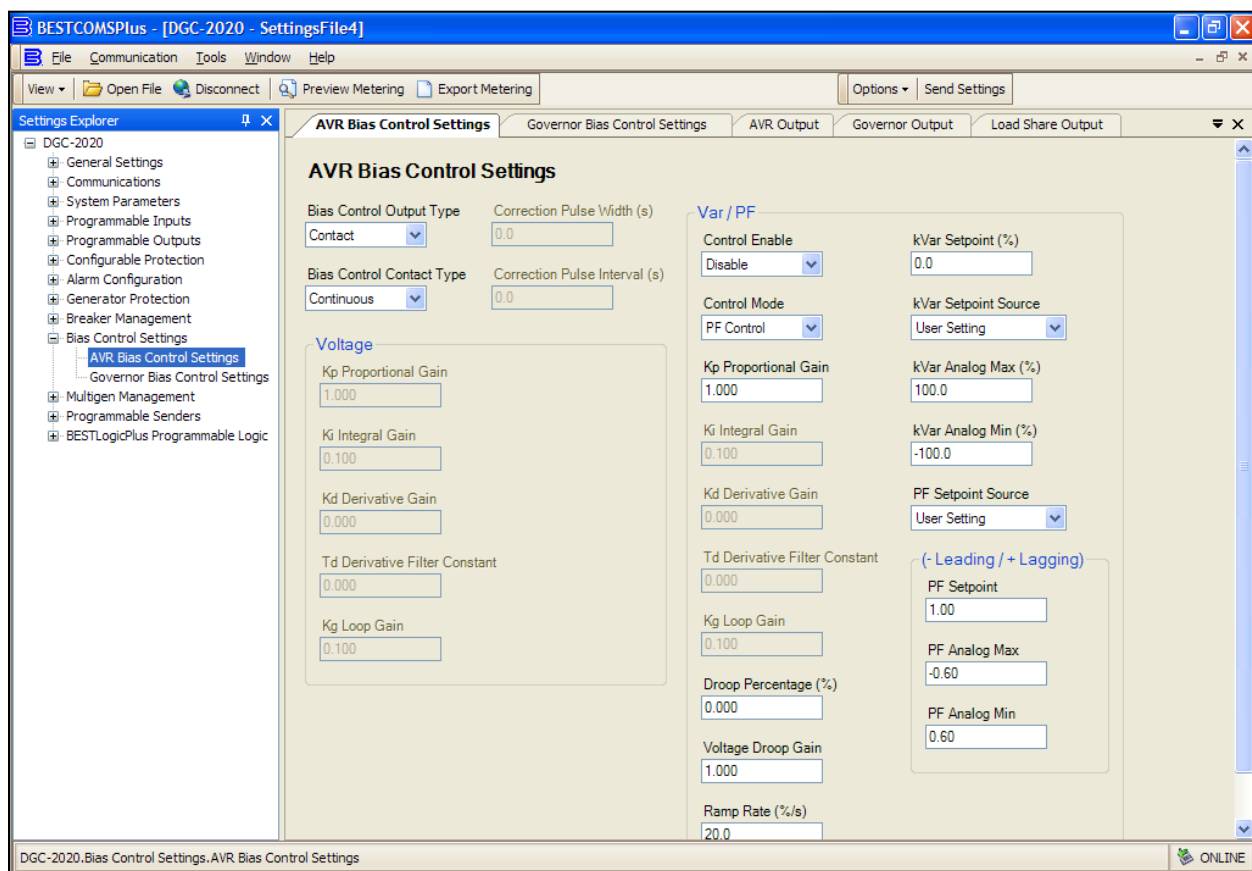
Figure 6-79. Settings Explorer, Bias Control Settings, AVR Bias Control Settings Screen

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.   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. At all other times the DGC-2020 will control the kvar to achieve voltage droop for kvar sharing.

vii. 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.

viii. 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

ix.   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.

x.   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. This can be thought of as a "fudge factor" to match the droop setting to the AVR characteristics.

xi.   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.

xii. 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.

xiii. 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.

xiv. 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*.

xv. 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*.

xvi. 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.

xvii. 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.

xviii. 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.

xix. 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 6-80.
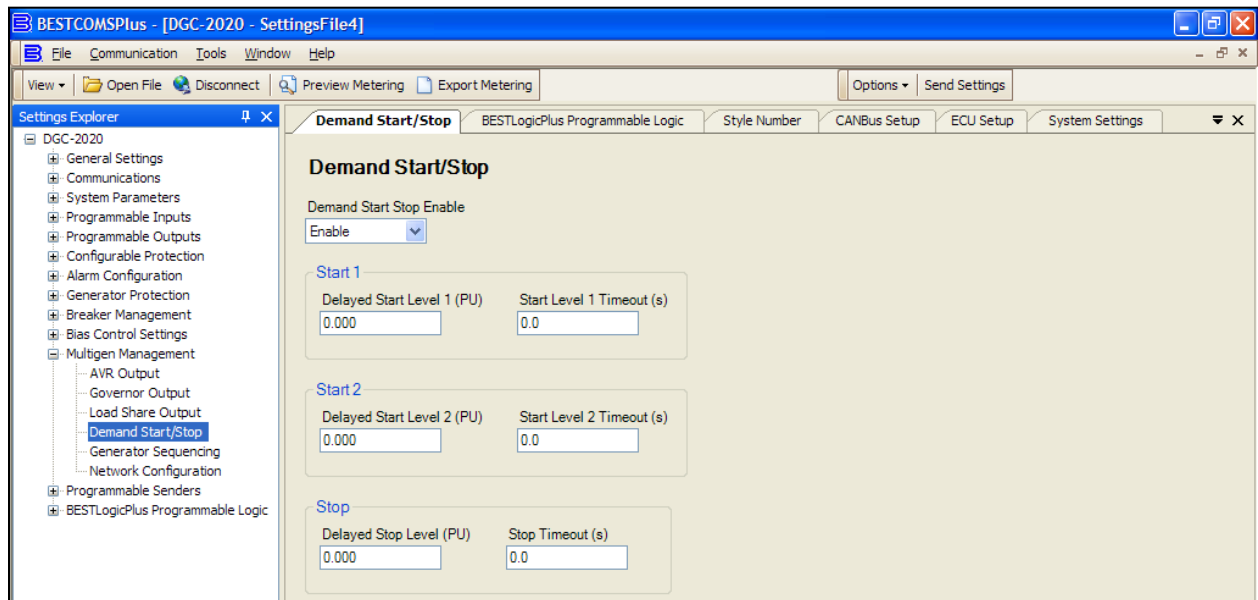
Figure 6-80. Settings Explorer, Multigen Management, Demand Start/Stop Screen

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 6-81.
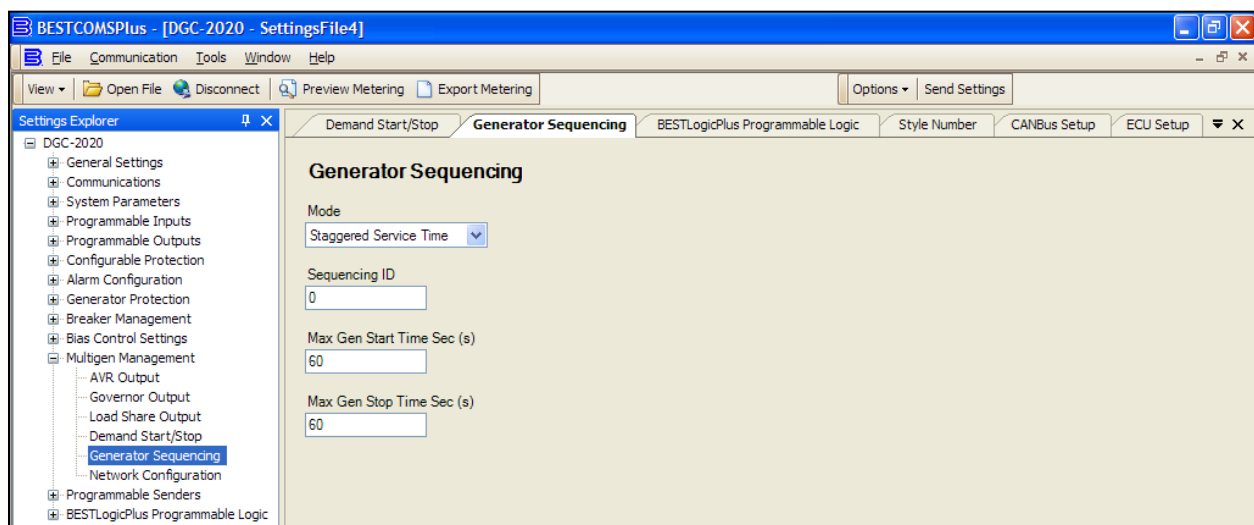
Figure 6-81. Settings Explorer, Multigen Management, Generator Sequencing Screen

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.

iii. Sequence ID - Enter a number for sequence ID. The ID must be a unique non-zero 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.

(1) 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.

(2) 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.

iv. 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 6-82.
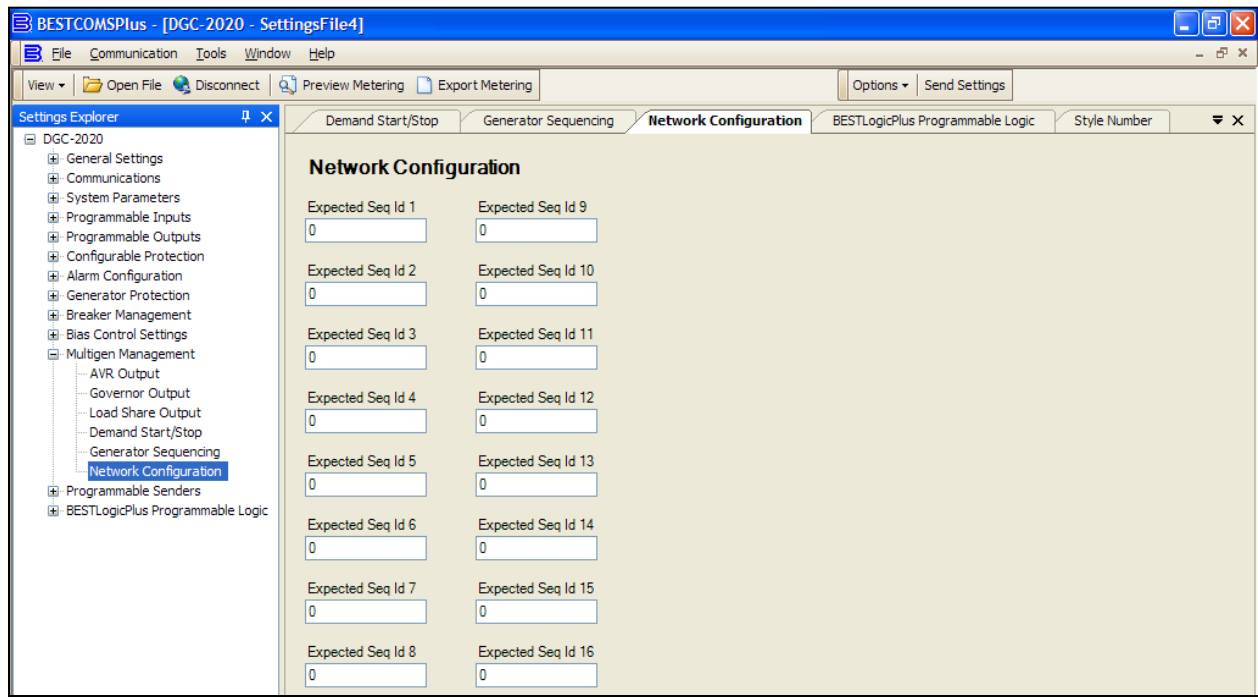
Figure 6-82. Settings Explorer, Multigen Management, Network Configuration

These settings are the non-zero 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 non-zero sequence ID of each machine participating in the inter-genset communications network. If you have N machines, put the non-zero 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→DGC-2020→GENERATOR NETWORK STATUS.

v. 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 this section 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* under *DGC-2020 Setup* in Section 6, *Installation.* 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 6-83.
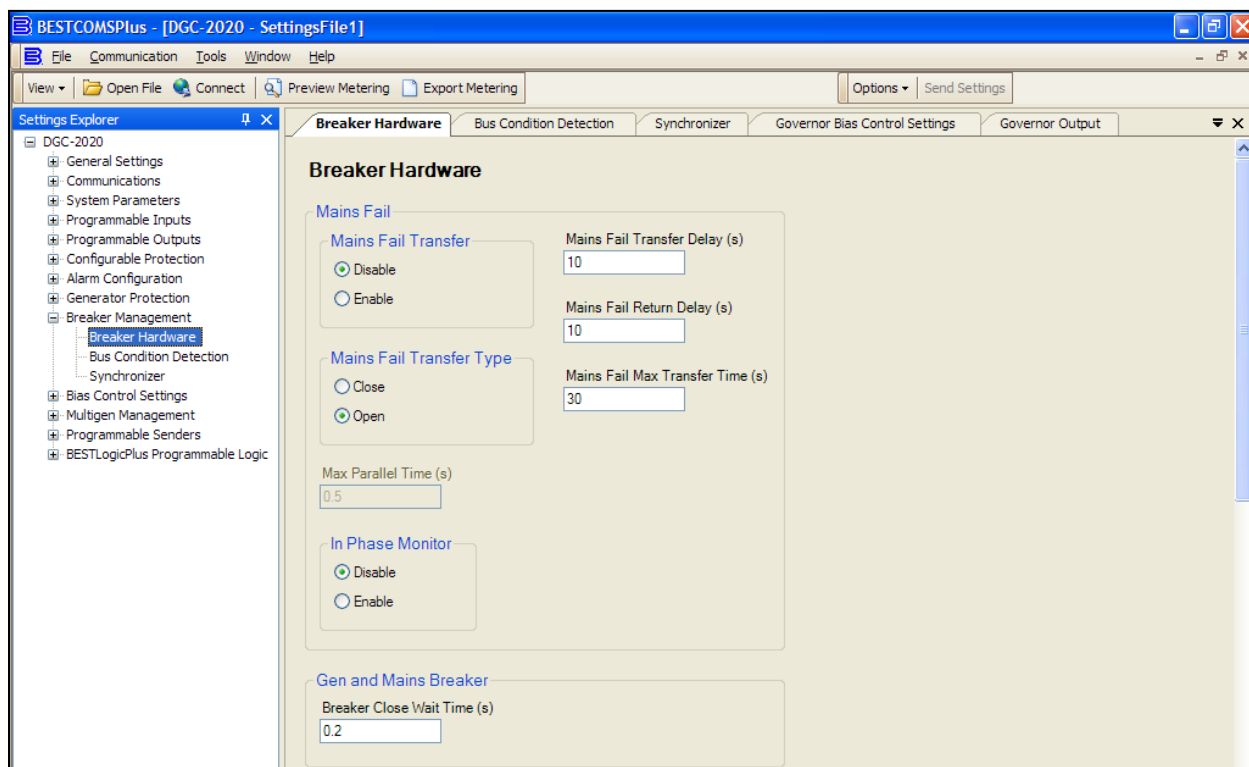
Figure 6-83. Settings Explorer, Breaker Management, Breaker Hardware Screen

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.

b. 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 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 6-84.
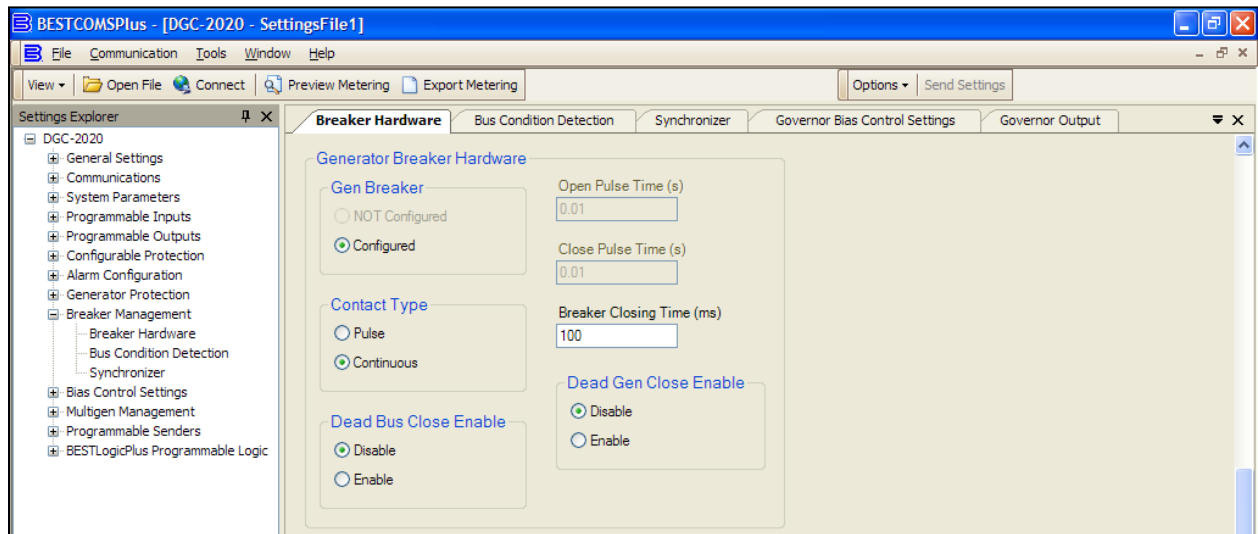
Figure 6-84. Settings Explorer, Breaker Management, Breaker Hardware Screen

 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 6-85.
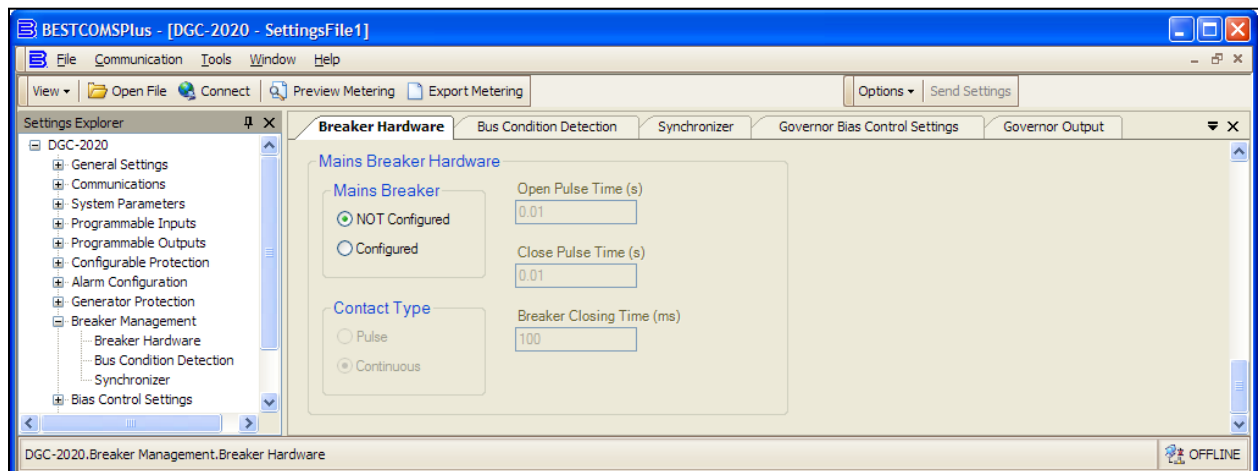
Figure 6-85. Settings Explorer, Breaker Management, Breaker Hardware Screen

          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.

4. Set up the Mains Breaker and Gen Breaker in BESTCOMS*Plus* under SETTINGS EXPLORER→BESTLOGICPLUS PROGRAMMABLE LOGIC. See Figure 6-86.

    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 stats. 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.
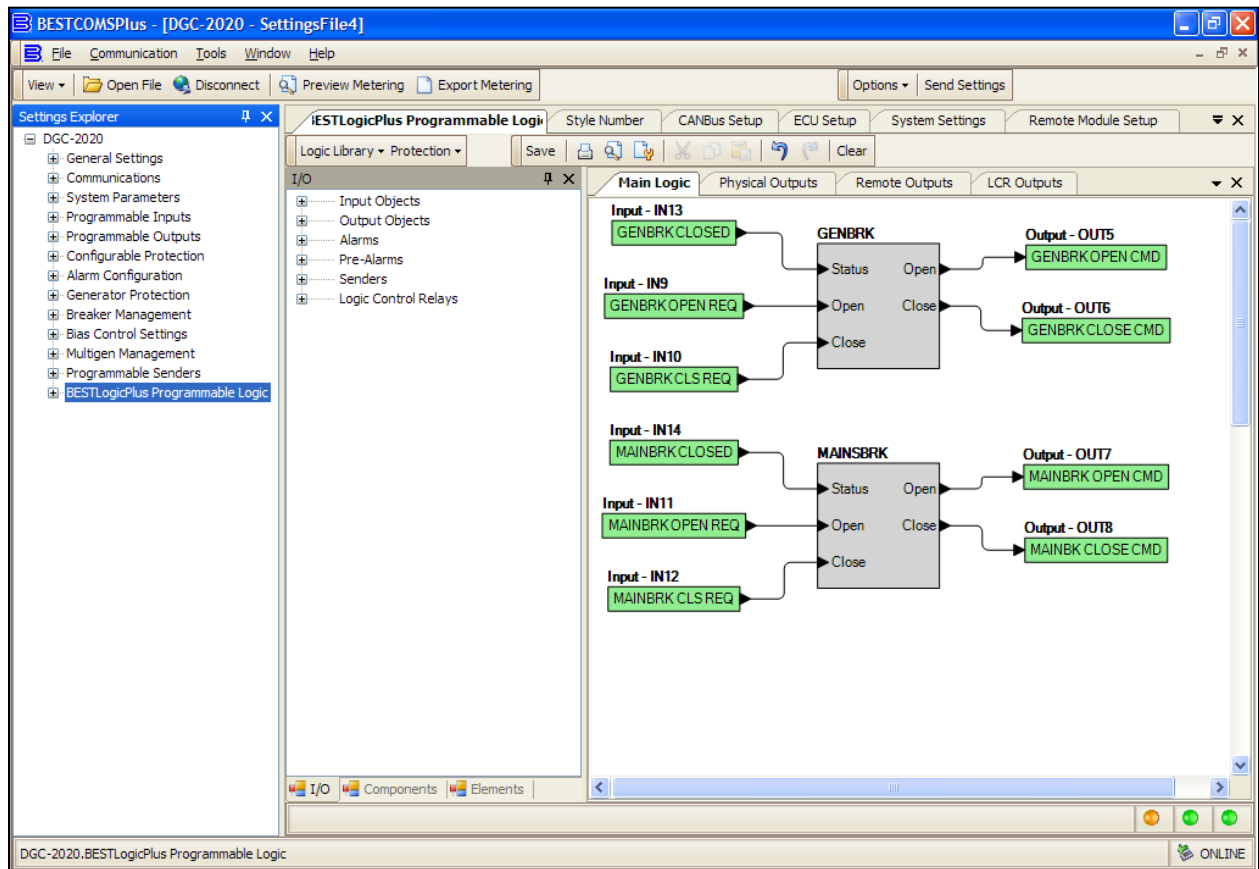
Figure 6-86. Settings Explorer, BESTLogicPlus Programmable Logic

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 6-87.

        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".
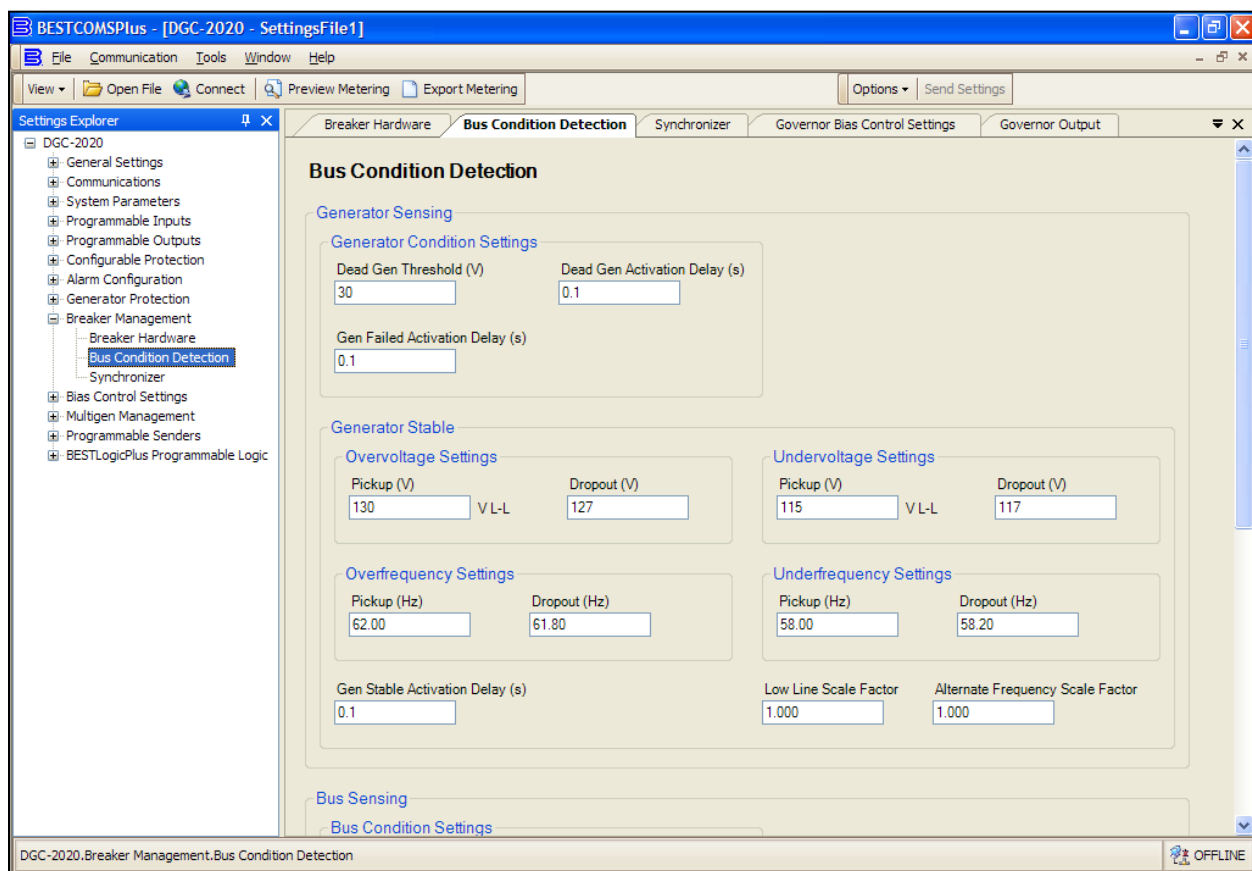
Figure 6-87. Settings Explorer, Breaker Management, Bus Condition Detection, Generator Sensing

    b.   Bus Sensing. See Figure 6-88.

            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".

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 6-88. Settings Explorer, Breaker Management, Bus Condition Detection, Bus Sensing

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.

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SECTION 7 • MAINTENANCE AND TROUBLESHOOTING

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SECTION 7 ● 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.

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*.

CANbus 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 CANbus 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, and verify that any stubs from the main bus do not exceed 3 meters 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.

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, *BESTLogicPlus 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 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 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, 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 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: 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 Reduce 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 Voltage 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 if 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 about 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 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 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 0.00, 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.

- 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 8 ● LSM-2020 (LOAD SHARE MODULE)

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SECTION 8 • 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 Load Share Line.

Refer to Section 6, *Installation*, 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 CANbus
- Demand Start/Stop and Generator Sequencing
- kW Load Control
- kW Load Sharing via analog 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 mA

Terminals .... P2-7 (IN+), P2-8 (IN–), P2-9 (V+)

Analog Outputs

Burden Data............................... 4-20 mA = 500 Ω maximum burden, $\pm$10 Vdc = 667 Ω minimum burden

Voltage Regulator Bias Output

4-20 mA or $\pm$10 Vdc isolated output signal. (Selectable in increments of 0.1.)

Isolated to 1,500 Vdc between outputs and ground

Terminals .... P2-18 (AVR+), P2-17 (AVR–), P2-16 (AVR')

Governor Bias Output

4-20 mA, $\pm$10 Vdc isolated output signal. (Selectable in increments of 0.1.)

Isolated to 500 Vdc between outputs and ground

Terminals .... P2-15 (GOV+), P2-14 (GOV–), P2-13 (GOV')

Load Share Line Output

0-10 Vdc isolated output signal. (Selectable in increments of 0.1 Vdc.

Isolated to 500 Vdc between outputs and ground

Terminals .... P2-6 (LS+), P2-5 (LS–), P2-4 (LS')

Communication Interface

CANbus

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

Rear-panel RJ-45 connector provides remote communications via BESTCOMS*Plus* to the LSM-2020 and to the DGC-2020 that the module is connected to.

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 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 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 Section 8 of this manual.

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

UL Approval

"cURus" recognized to UL Standard 508 & CSA Standard C22.2 No.14

"cURus" recognized per Standard 1604, *Electrical Equipment for Use in Class ɪ and ɪɪ, Division 2, and Class ɪɪɪ Hazardous (Classified) Locations,* Class ɪ, Division 2, Zone 2, Groups A, B, C, D, Temperature Code - T4.

CSA Certification

CSA certified to Standard C22.2 No. 14.

NFPA Compliance

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

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

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*

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.

CANbus

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 communications via BESTCOMS*Plus* to the LSM-2020 and to the DGC-2020 that the module is connected to. Ethernet communication between LSM-2020s allows for generator sequencing 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,* 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.

BESTCOMS*Plus* 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[A] when configuring LSM-2020 settings off-line. When on-line, read-only information includes application version[B], boot code version[C], application build[D], serial number[E], application part number[F], and model number[G].

BESTCOMS*Plus* device information values and settings are illustrated in Figure 8-1.

Figure 8-1. Device Info Screen

[A] *Application Version:* When configuring Load Share Module settings off-line, the application version for the unit to be configured must be selected.
[B] *Application Version:* Read-only value obtained when BESTCOMSPlus is communicating with the Load Share Module.

[C] *Boot Code Version:* Read-only value obtained when BESTCOMSPlus is communicating with the Load Share Module.
[D] *Application Build:* Read-only value obtained when BESTCOMSPlus is communicating with the Load Share Module.
[E] *Serial Number:* Read-only value obtained when BESTCOMSPlus is communicating with the Load Share Module.
[F] *Application Part Number:* Read-only value obtained when BESTCOMSPlus is communicating with the Load Share Module.
[G] *Model Number:* Read-only value obtained when BESTCOMSPlus is communicating with the Load Share Module.

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 8-2.

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

Figure 8-2. Device Security Setup Screen

[A] *Access Level/Password:* Read-only value obtained when BESTCOMSPlus is communicating with the Load Share Module.
[B] *Password:* Accepts an alphanumeric character string of up to 16 characters.
[C] *Save Password:* Clicking this button will save the password changes in BESTCOMSPlus memory.

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, your sales representative, or a sales representative at Basler Electric, Highland, Illinois USA.

If the device is not installed immediately, store it in the original shipping package in a moisture- and dust-free environment.

Product Registration

Registering with Basler Electric enables you to receive important information updates on your product plus new product announcements. Register your product by directing your web browser to www.basler.com.

Mounting

LSM-2020's are contained in a potted plastic case and may be mounted in any convenient position. The construction of a LSM-2020 is durable enough to mount directly on a genset using UNF ¼-20 or equivalent 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 8-3 for LSM-2020 overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.

Figure 8-3. LSM-2020 Overall Dimensions

Connections

LSM-2020 connections are dependent on the application. Incorrect wiring may result in damage to the module.

NOTE

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. The connector and header are uniquely keyed to ensure that the connector mates only with the correct header. Connector screw terminals accept a maximum wire size of 12 AWG. Maximum screw torque is 4 inch-pounds (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 8-1.

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 8-1. 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

Analog Inputs

These inputs can be used for var, PF, or kW control. Analog input terminals are listed in Table 8-2. Voltage input connections are shown in Figure 8-4 and current input connections are shown in Figure 8-5.

Table 8-2. 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.
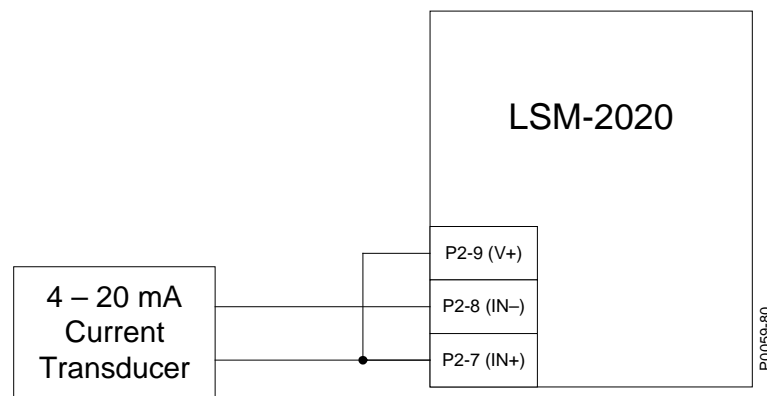
Figure 8-4. Analog Inputs - Voltage Input Connections
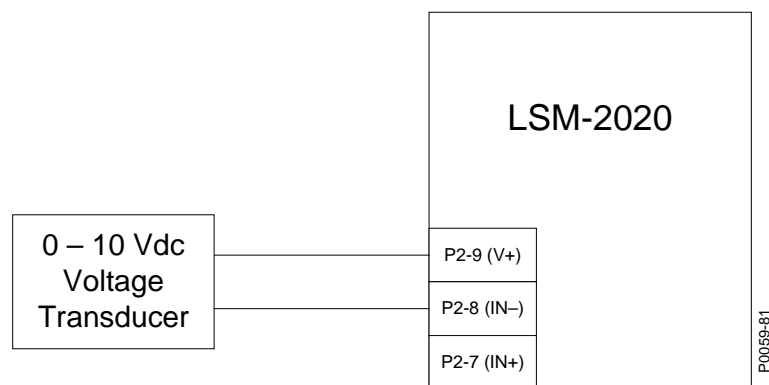
Figure 8-5. Analog Inputs - Current Input Connections

<u>Analog Outputs</u>

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 8-3.

Table 8-3. 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

<u>CANbus Interface</u>

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. CANbus interface terminals are listed in Table 8-4. Refer to Figure 8-6 and Figure 8-7.

Table 8-4. CANbus 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 Ω, 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.
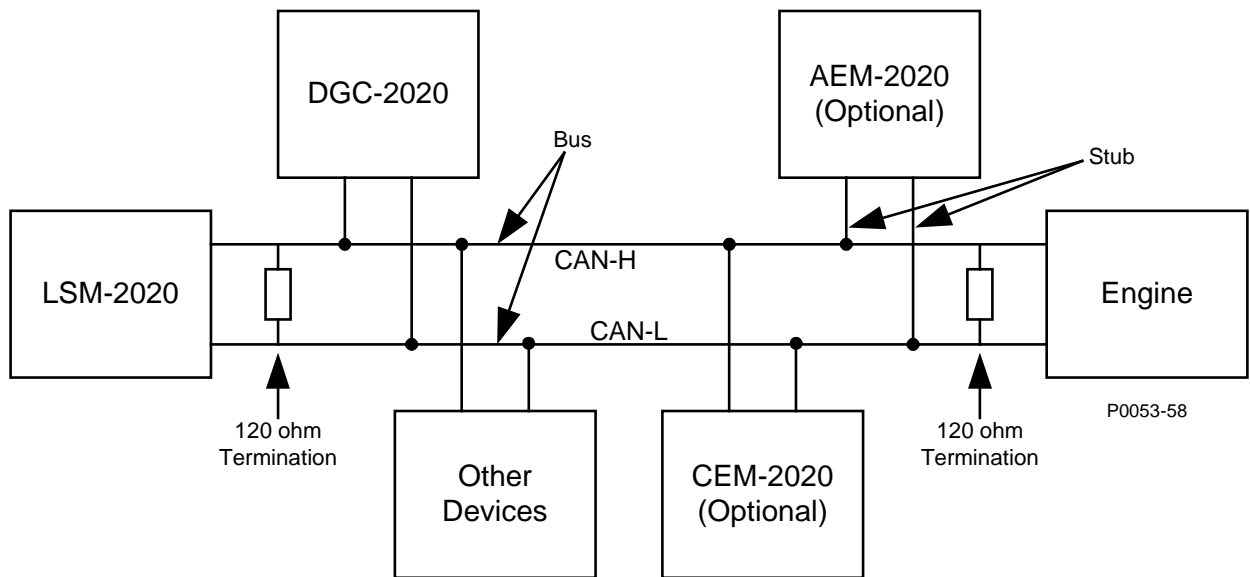
Figure 8-6. CANbus Interface with LSM-2020 providing One End of the Bus
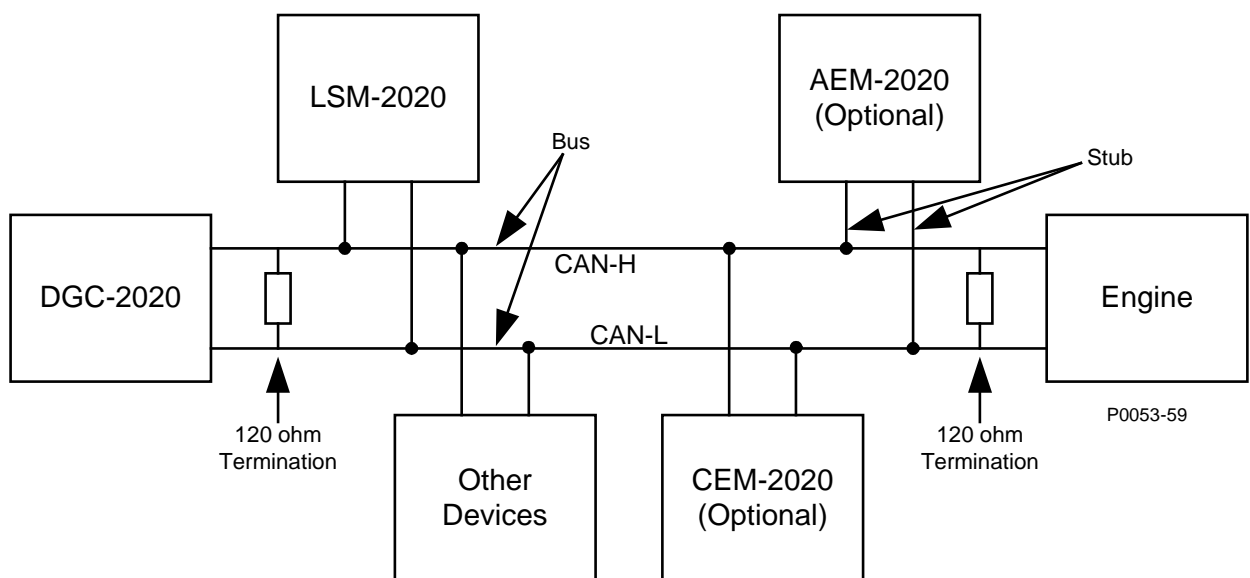
Figure 8-7. CANbus Interface with DGC-2020 providing One End of the Bus

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 8-8 illustrates typical LSM-2020 connections. Figure 8-9 illustrates a typical interconnection of two systems tied together via separate Load Share Modules.
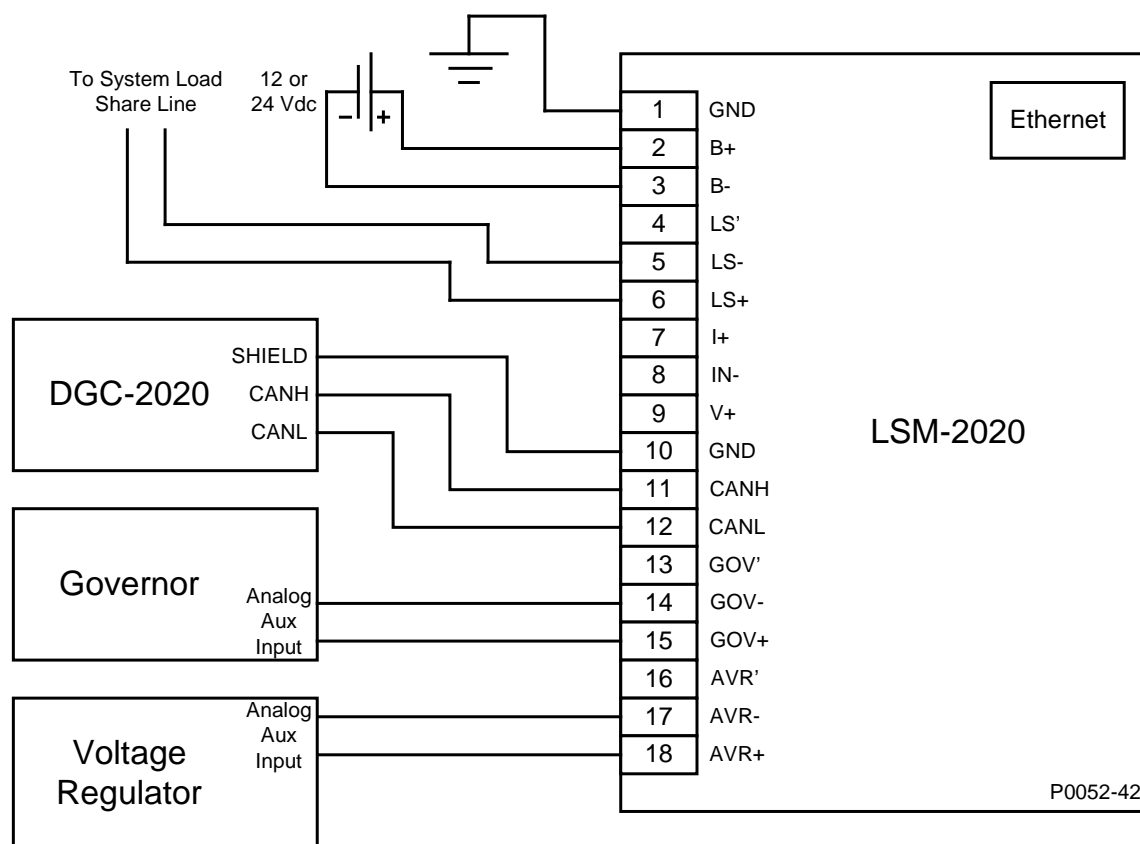
Figure 8-8. Typical LSM-2020 Connections
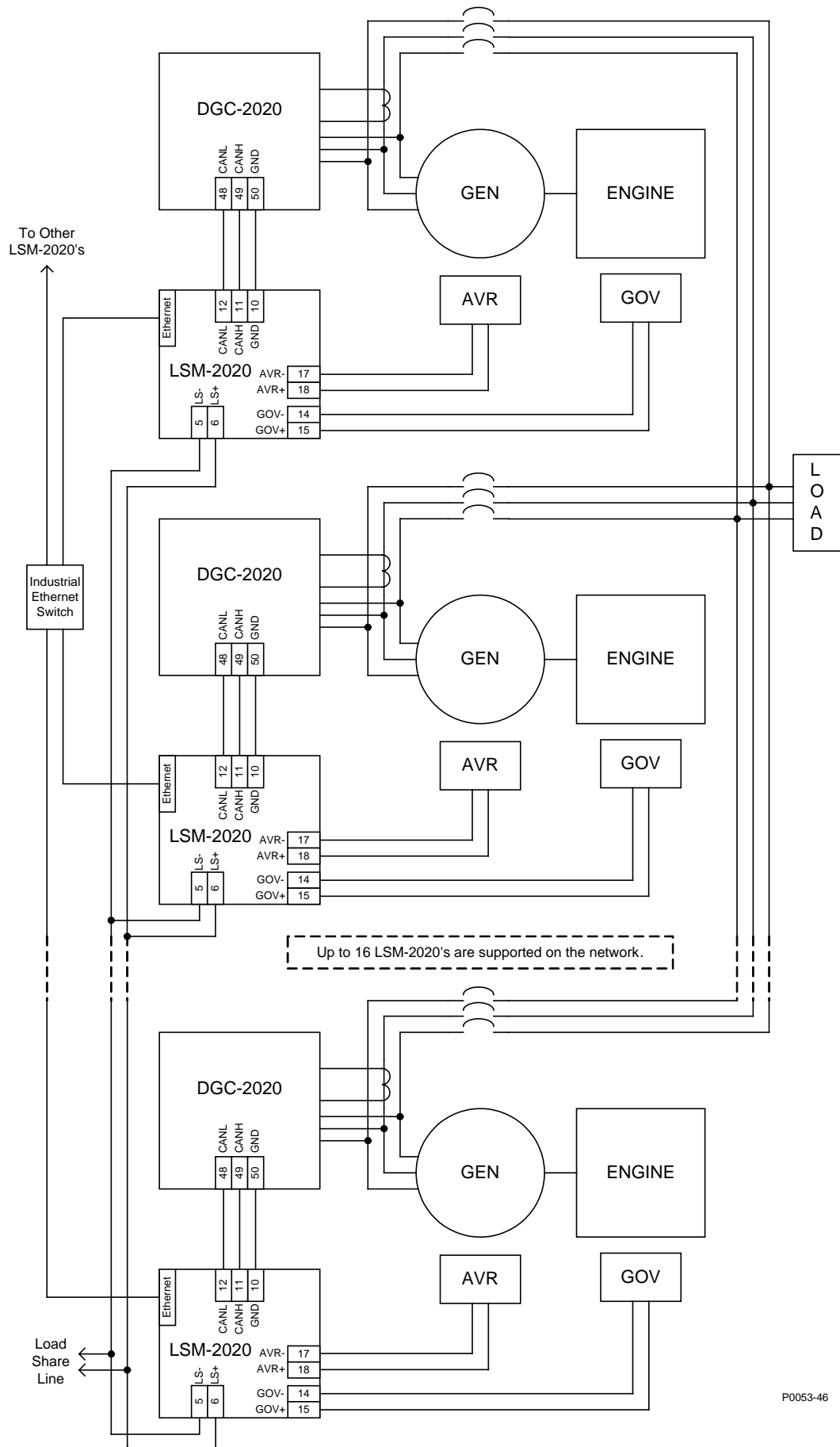
Figure 8-9. Typical LSM-2020 Interconnection Diagram

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 8-10 illustrates connections using the additional AVR' terminal as a landing point.
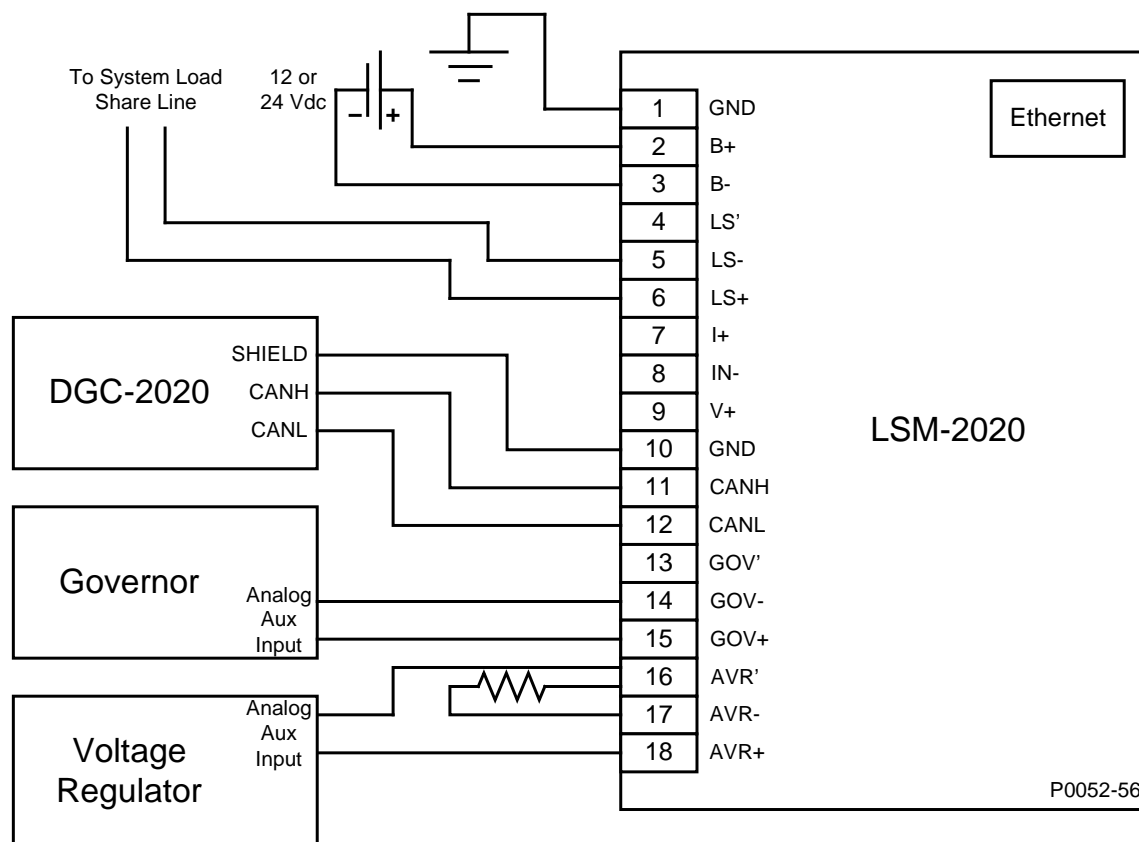
Figure 8-10. Connections using the AVR' Terminal

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 8-11.

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.

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 8-11 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.
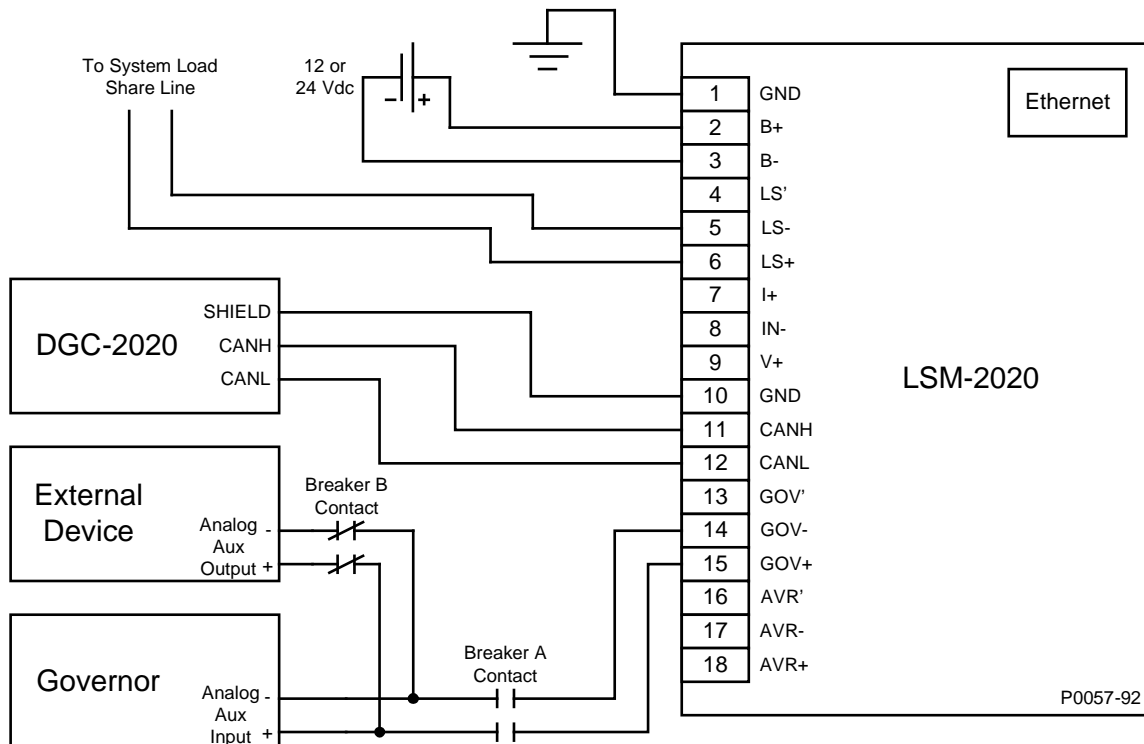
Figure 8-11. External Control Device with DGC-2020 — LSM-2020 System, Method 1

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 8-12, 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.
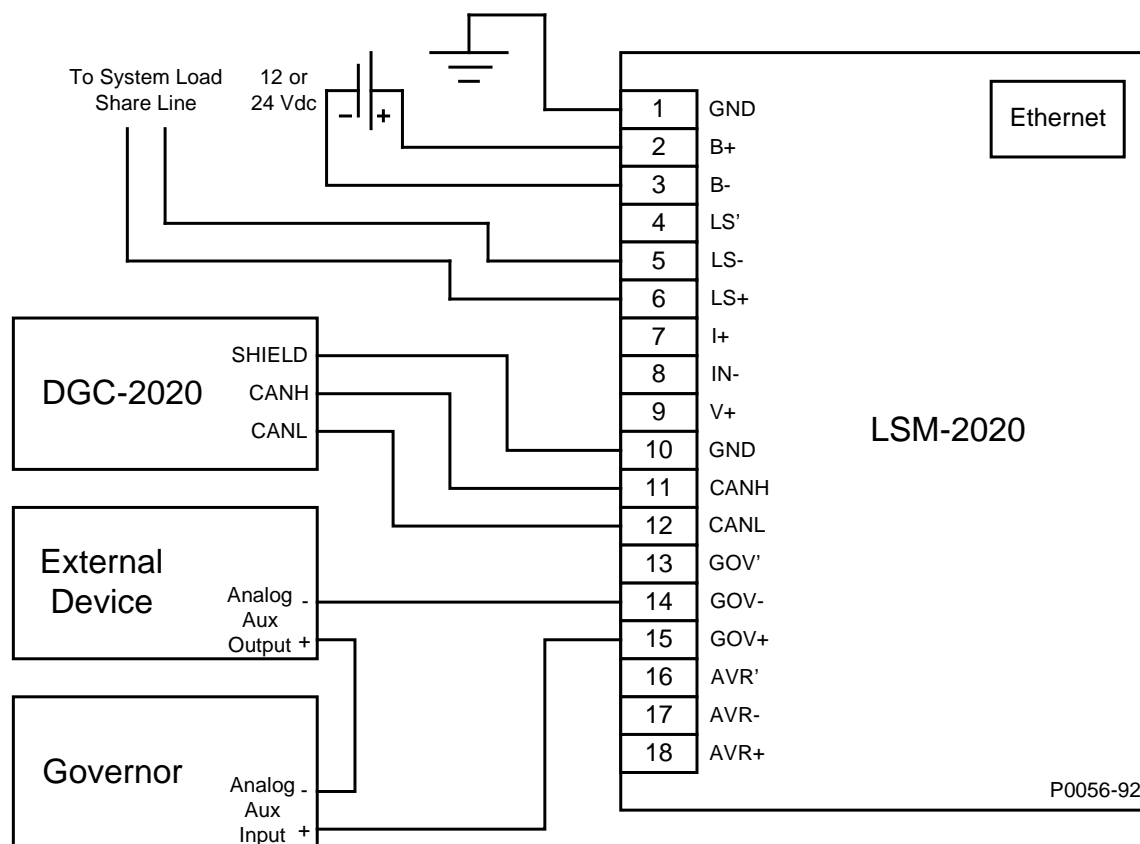
Figure 8-12. External Control Device with DGC-2020 — LSM-2020 System, Method 2

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 9 • CEM-2020 (CONTACT EXPANSION MODULE)

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SECTION 9 • 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 output contacts and a high current module (CEM-2020H) provides 18 output contacts.

FEATURES

CEM-2020s have the following features:

- 10 Contact Inputs
- 18 Output Contacts (CEM-2020H) or 24 Output Contacts (CEM-2020)
- Functionality of Inputs and Outputs assigned by BESTLogic*Plus* programmable logic
- Communications via CANbus

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 normally open and normally closed, dry contacts.

Time from a CEM-2020 input going high to:

    Shutdown the generator via an alarm .... 700 ms max
    Close a relay on board the DGC-2020.......... 300 ms max

Output Contacts

Ratings
    CEM-2020
        Outputs 13 through 24.. 1 Adc at 30 Vdc, Form C, gold contacts
        Outputs 25 through 36.. 4 Adc at 30 Vdc, Form C
    CEM-2020H
        Outputs 13 through 24.. 2 Adc at 30 Vdc, Form C, gold contacts
        Outputs 25 through 30.. 10 Adc at 30 Vdc, Form C

Communication Interface

CANbus

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 Section 9 of this manual.

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

UL Approval (CEM-2020 Only)

"cURus" recognized to UL Standard 508 & CSA Standard C22.2 No. 14.

UL Approval (CEM-2020H Only)

UL recognized to UL Standard 508.

Hazardous Locations

UL recognized per Standard 1604, *Electrical Equipment for Use in Class I and II, Division 2, and Class III Hazardous (Classified) Locations,* Class I, Division 2, Zone 2, Groups A, B, C, D, Temperature Code - T4.

NOTE

To comply with UL guidelines, when using the CEM-2020H in a hazardous location, a UL Listed fuse must be placed in the 2 Adc output contact circuits (outputs 13 through 24) and fusing must be provided in a general-purpose type of enclosure. The suggested fuse size in Adc = (100/Contact Voltage) with a maximum fuse size of 5 Adc.

CSA Certification

CSA certified to Standard C22.2 No.14.

NFPA Compliance

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

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

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*

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.

Output Contacts

CEM-2020

The CEM-2020 provides 24 programmable output contacts with the same functionality as the output contacts on the DGC-2020. Outputs 13 through 24 can carry 1 A. Outputs 25 through 36 can carry 4 A.

CEM-2020H

The CEM-2020H provides 18 programmable output contacts with the same functionality as the output contacts on the DGC-2020. Outputs 13 through 24 can carry 2 A. Outputs 25 through 30 can carry 10 A.

NOTE

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

CANbus

A Control Area Network (CAN) is a standard interface that enables communication between the CEM-2020 and the DGC-2020.

BESTCOMS*Plus* 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, your sales representative, or a sales representative at Basler Electric, Highland, Illinois USA.

If the device is not installed immediately, store it in the original shipping package in a moisture- and dust-free environment.

Product Registration

Registering with Basler Electric enables you to receive important information updates on your product plus new product announcements. Register your product by directing your web browser to www.basler.com.

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 UNF ¼-20 or equivalent 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 9-1 for CEM-2020 overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.
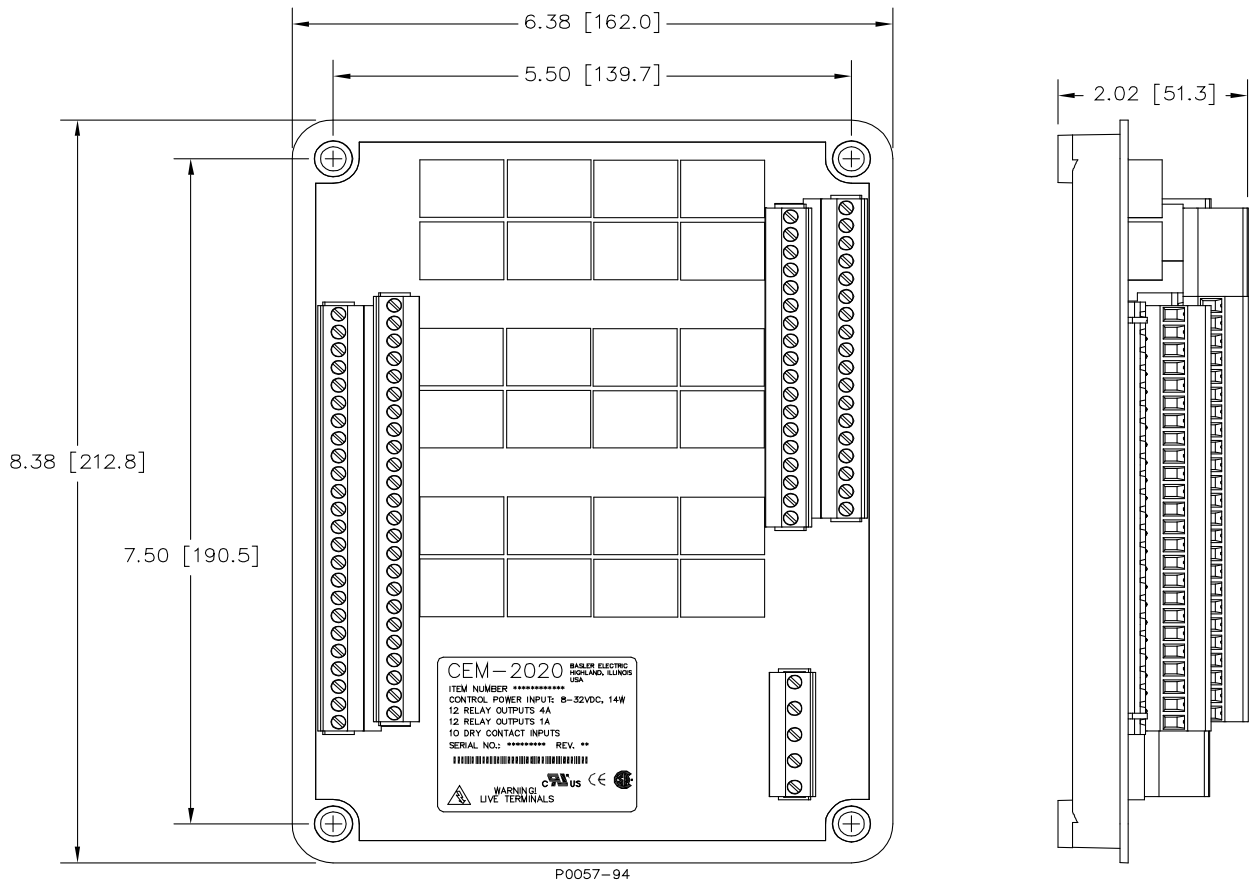
Figure 9-1. CEM-2020 Overall Dimensions

See Figure 9-2 for CEM-2020H overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.
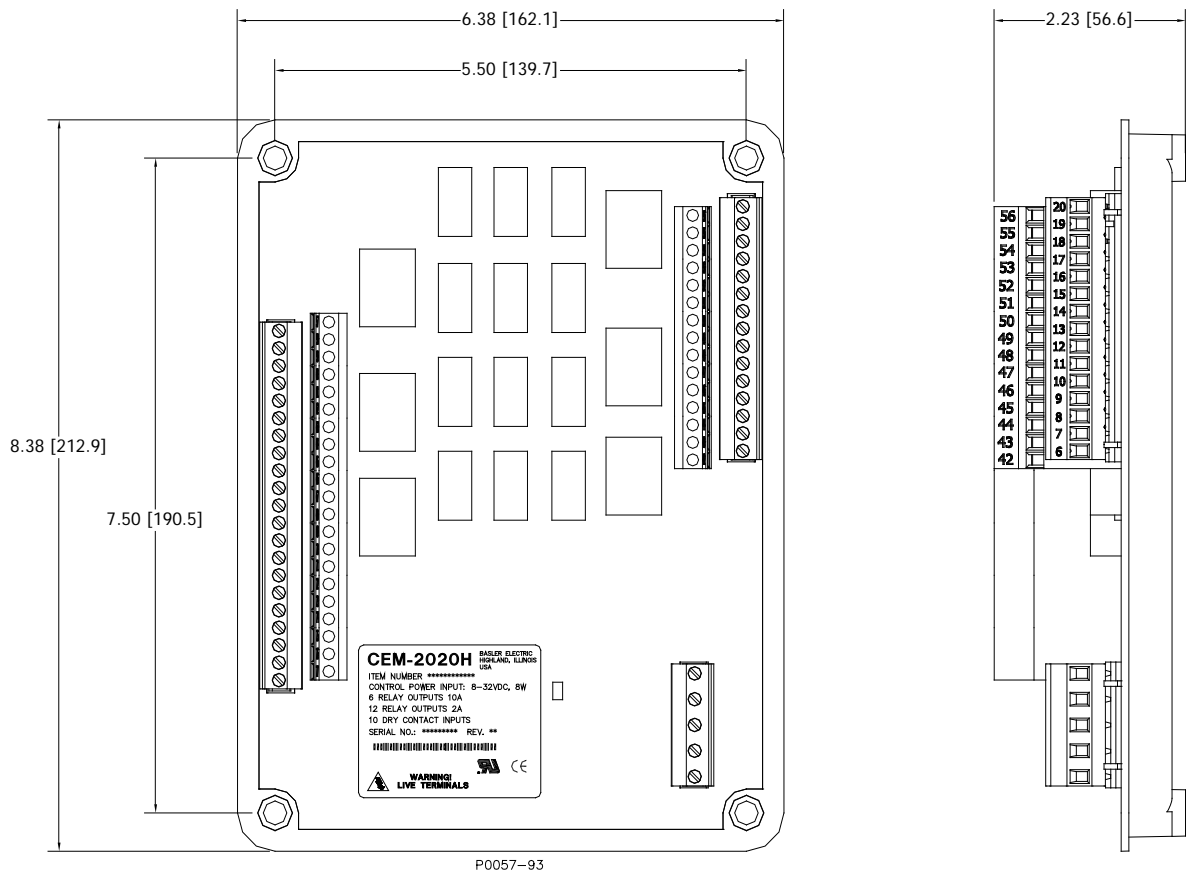
Figure 9-2. CEM-2020H Overall Dimensions

Connections

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

NOTE

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. The connectors and headers are uniquely keyed to ensure that the connectors mate only with the correct headers. 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 9-1.

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 9-1. 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 Output Contacts

The CEM-2020 (Figure 9-3) has 10 contact inputs and 24 output contacts. The CEM-2020H (Figure 9-4) has 10 contact inputs and 18 output contacts.

NOTE

To follow UL guidelines, a fuse must be implemented in the 2Adc contact circuits (Outputs 13 through 24) of the CEM-2020H used in hazardous locations. The suggested fuse size in Adc = (100/Contact Voltage) with a maximum fuse size of 5Adc.
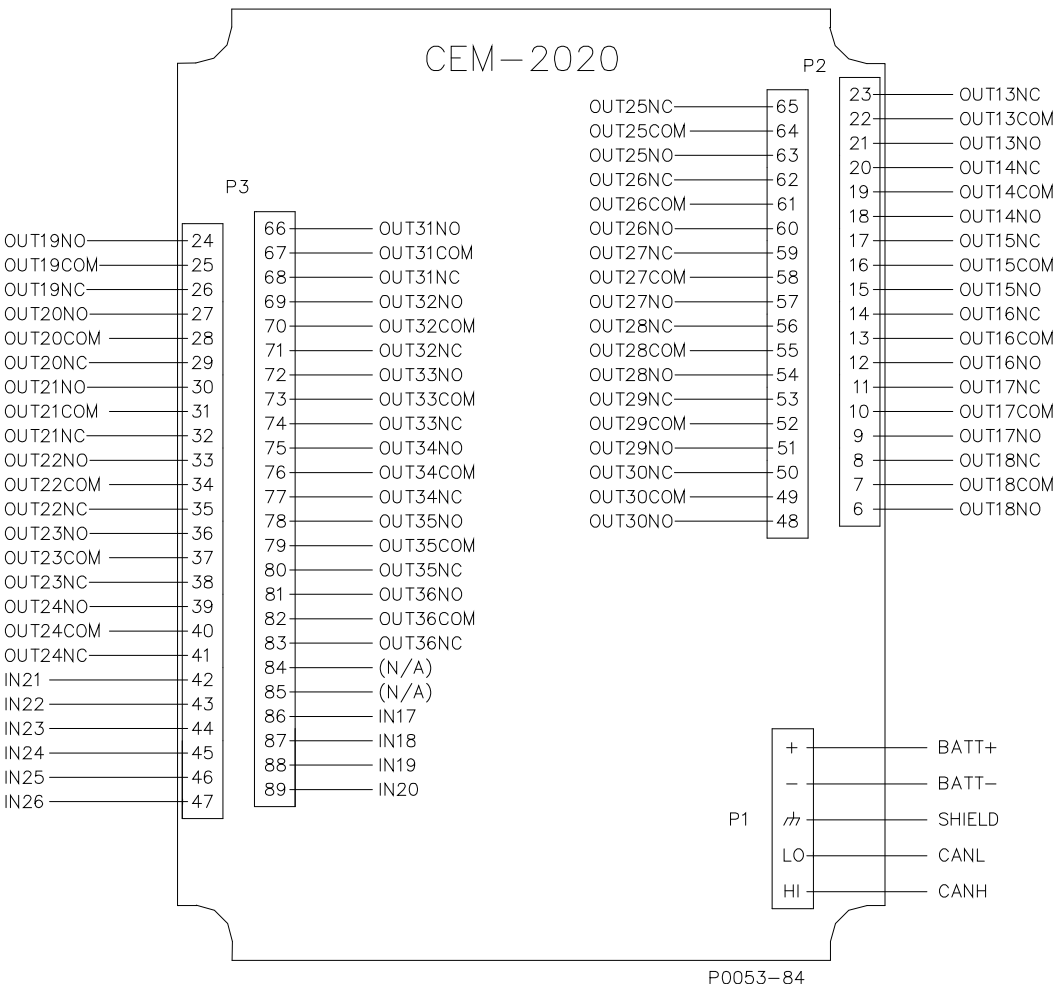
Figure 9-3. CEM-2020 Input Contact and Output Contact Terminals
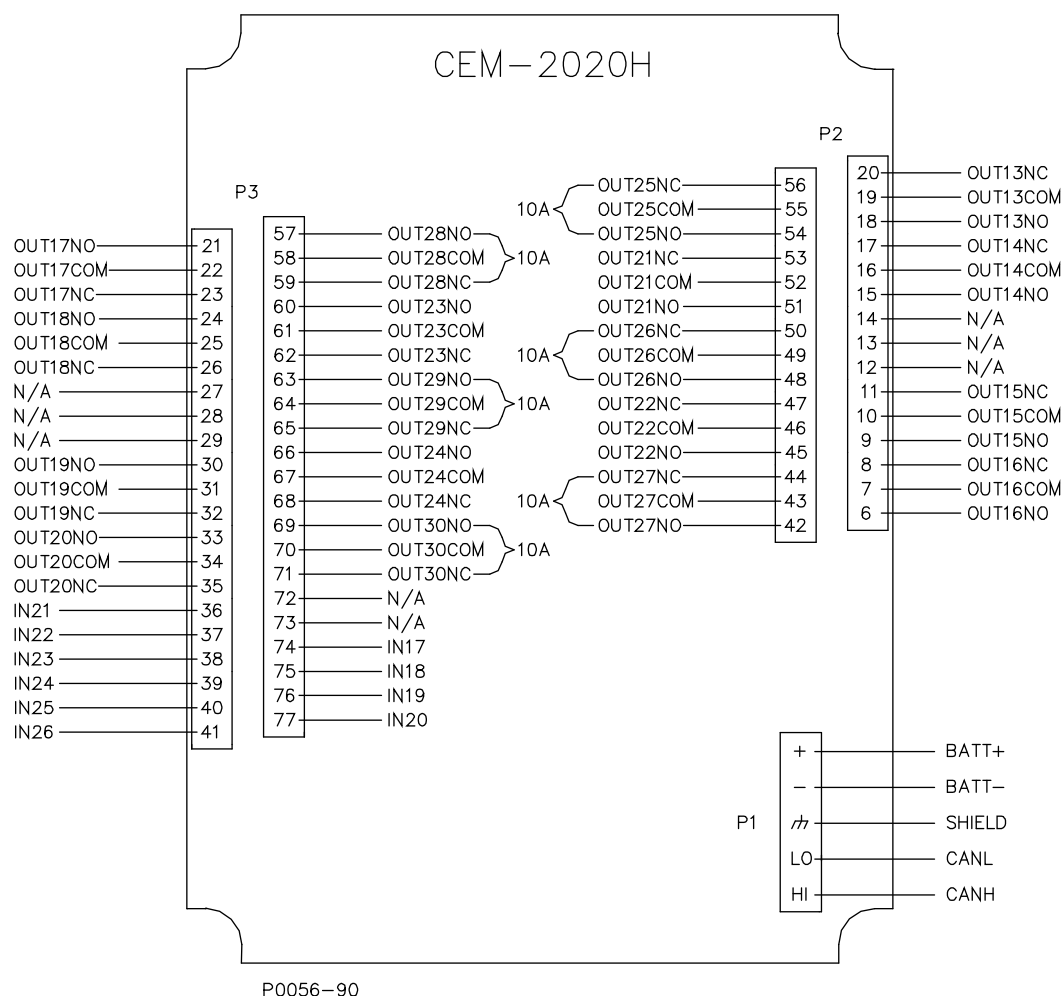
Figure 9-4. CEM-2020H Input Contact and Output Contact Terminals

<u>CANbus Interface</u>

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. CANbus interface terminals are listed in Table 9-2. Refer to Figure 9-5 and Figure 9-6.

Table 9-2. CANbus 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 Ω, 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.
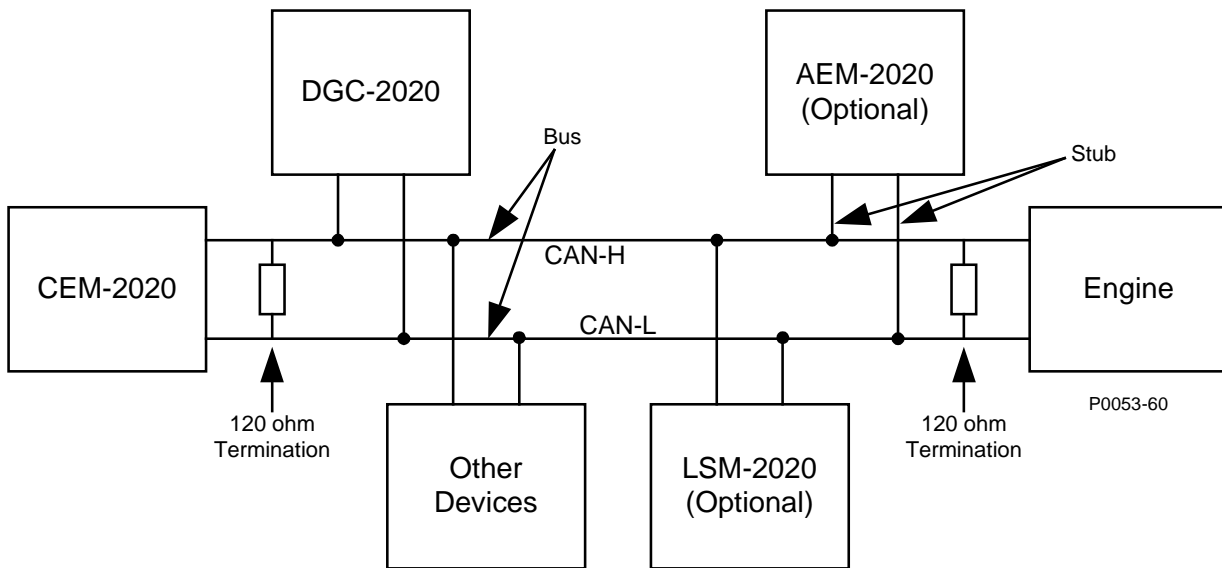
Figure 9-5. CANbus Interface with CEM-2020 providing One End of the Bus
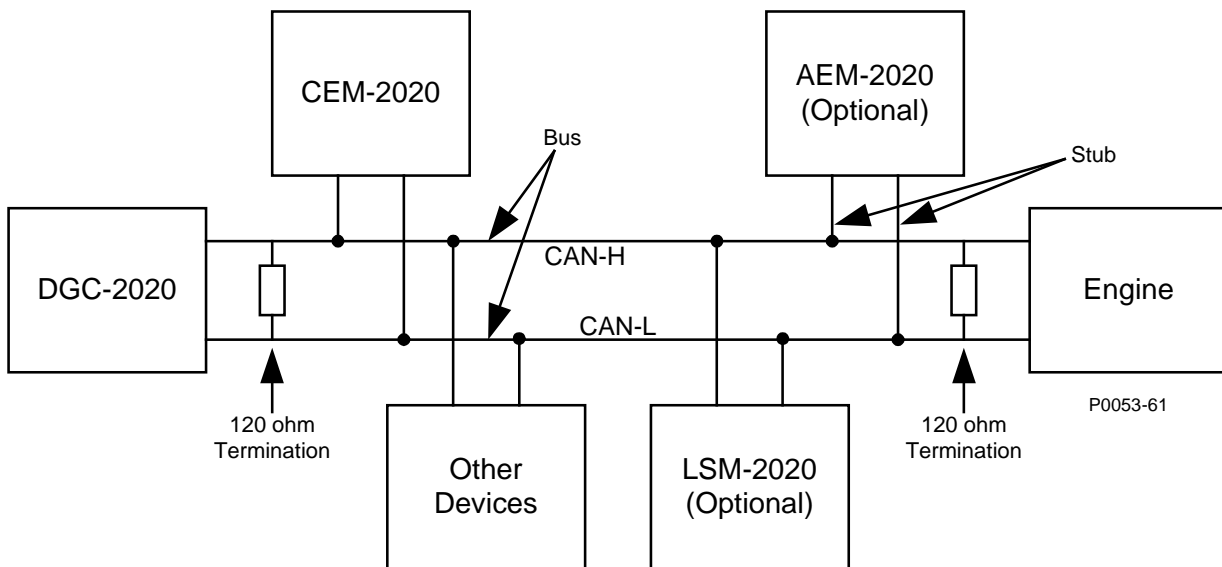
Figure 9-6. CANbus Interface with DGC-2020 providing One End of the Bus

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.

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SECTION 10 • AEM-2020 (ANALOG EXPANSION MODULE)

TABLE OF CONTENTS

Tables

SECTION 10 • 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 CANbus

SPECIFICATIONS

Operating Power

Nominal .... 12 or 24 Vdc
Range .... 8 to 32 Vdc (Withstands cranking ride-through down to 6 Vdc
                 for 500 ms.)
Maximum Consumption .... 5.1 W

Analog Inputs

The AEM-2020 contains eight programmable analog inputs.

Rating .... 4 to 20 mA or 0 to 10 Vdc (user-selectable)

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 0 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 mA or 0 to 10 Vdc (user-selectable)

Communication Interface

CANbus

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 Section 10 of this manual.

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

UL Approval

"cURus" recognized to UL Standard 508 & CSA Standard C22.2 No.14

"cURus" recognized per Standard 1604, *Electrical Equipment for Use in Class I and II, Division 2, and Class III Hazardous (Classified) Locations,* Class I, Division 2, Zone 2, Groups A, B, C, D, Temperature Code - T4.

CSA Certification

CSA certified to Standard C22.2 No.14.

NFPA Compliance

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

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

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*

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 mA 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. When enabled, an out of range alarm alerts the user of an open or damaged thermocouple input wire. 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 mA 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

CANbus

A Control Area Network (CAN) is a standard interface that enables communication between the AEM-2020 and the DGC-2020.

BESTCOMS*Plus* 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, your sales representative, or a sales representative at Basler Electric, Highland, Illinois USA.

If the device is not installed immediately, store it in the original shipping package in a moisture- and dust-free environment.

Product Registration

Registering with Basler Electric enables you to receive important information updates on your product plus new product announcements. Register your product by directing your web browser to www.basler.com.

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 UNF ¼-20 or equivalent 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).

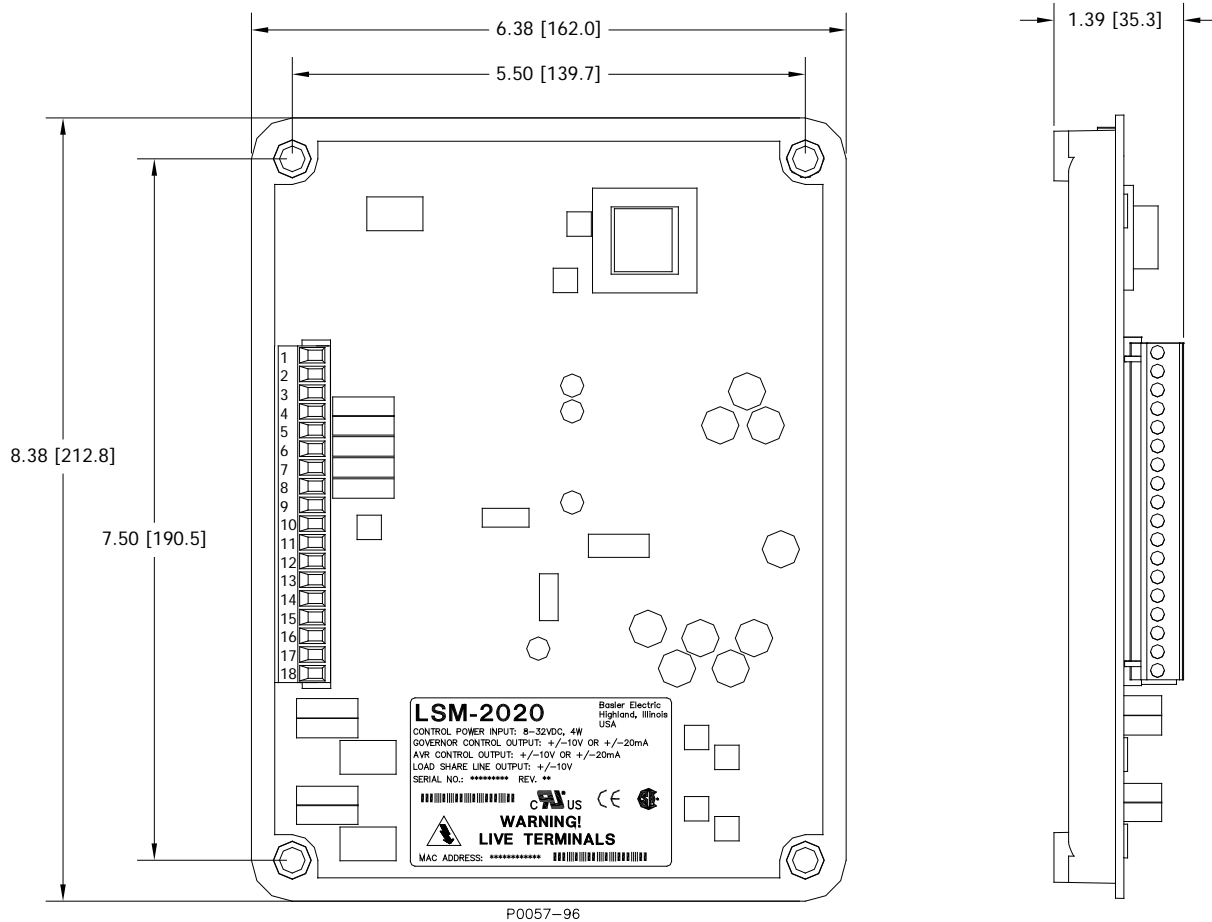See Figure 10-1 for AEM-2020 overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.
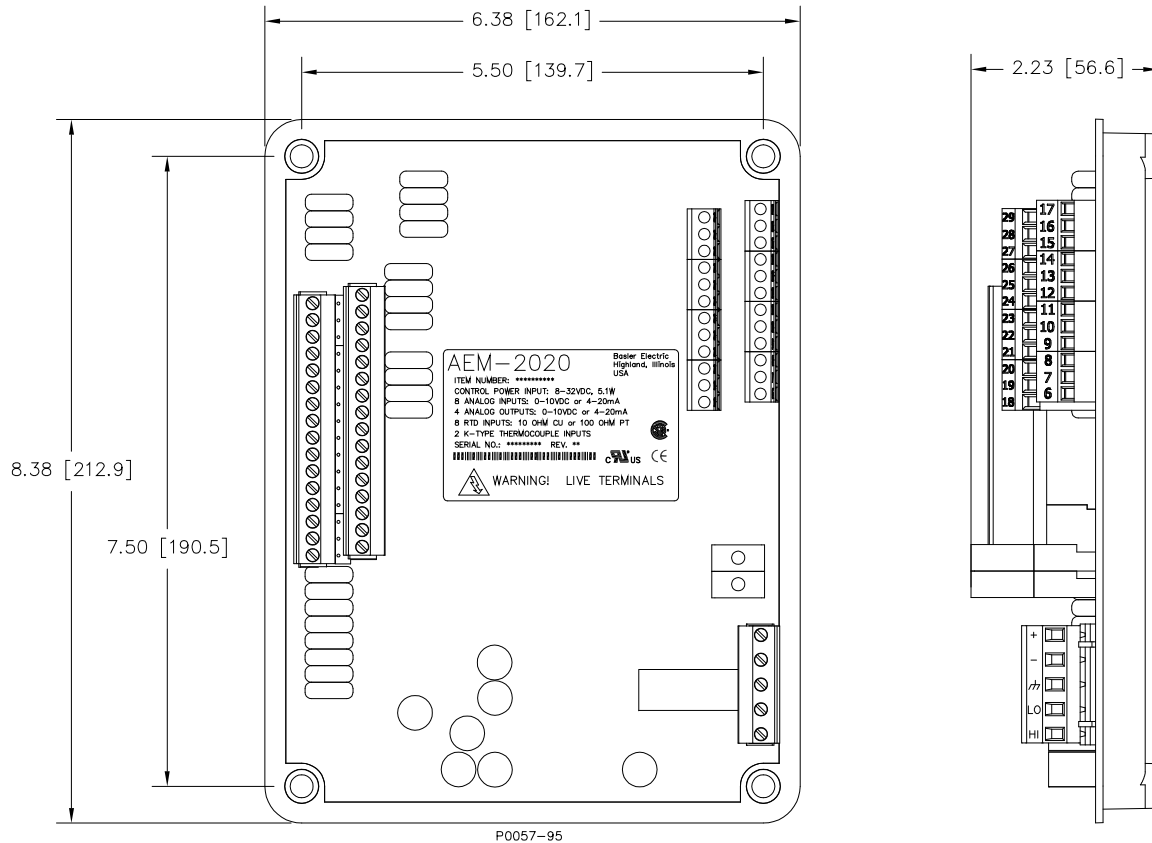
Figure 10-1. AEM-2020 Overall Dimensions

Connections

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

NOTE

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. 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. 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 10-1.

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 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

AEM-2020 Inputs and Outputs

Input and output terminals are shown in Figure 10-2 and listed in Table 10-2.
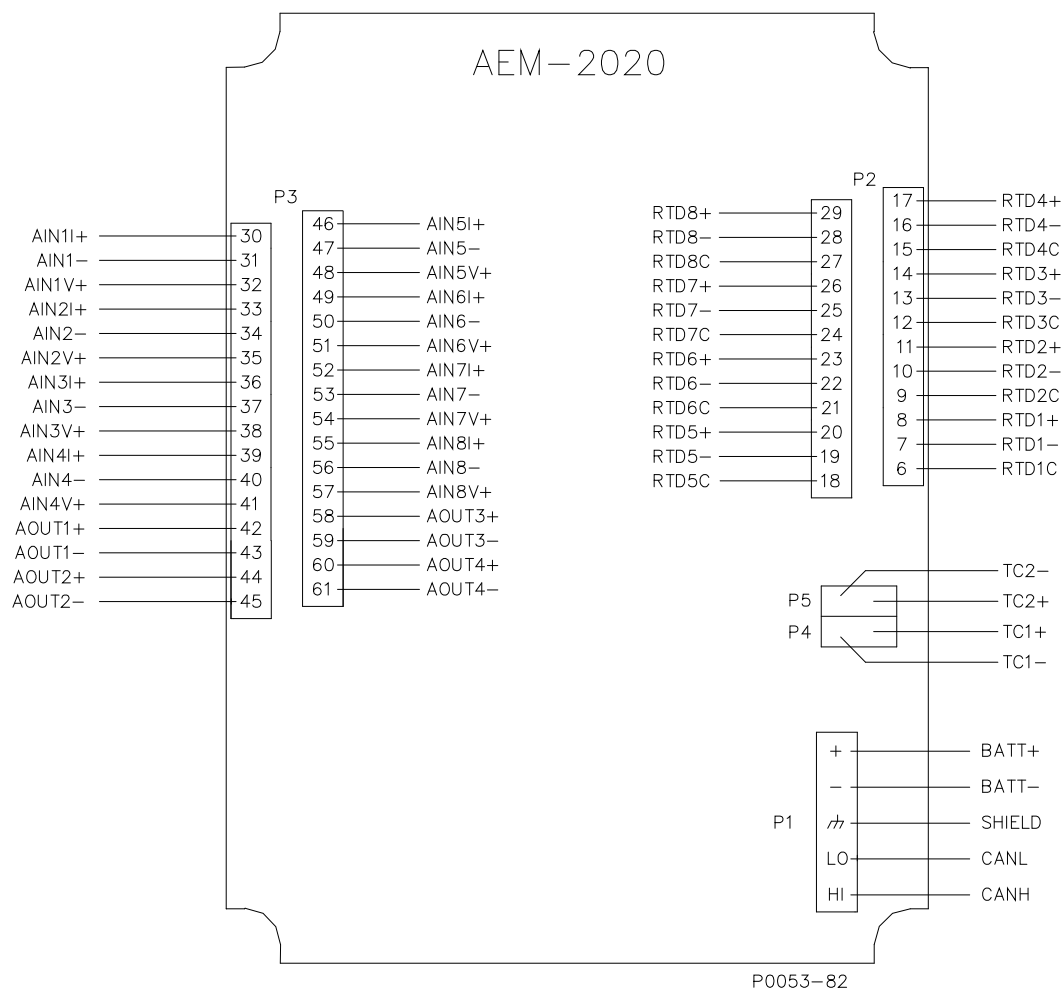
Figure 10-2. Input and Output Terminals

Table 10-2. Input and Output Terminals

Connector	Description
P1	Operating Power and CANbus
P2	RTD Inputs 1 - 8
P3	Analog Inputs 1 - 8 and Analog Outputs 1 - 4
P4	Thermocouple 1 Input
P5	Thermocouple 2 Input

External Analog Input Connections

Voltage input connections are shown in Figure 10-3 and current input connections are shown in Figure 10-4. When using the current input, AIN V+ and AIN I+ must be tied together.
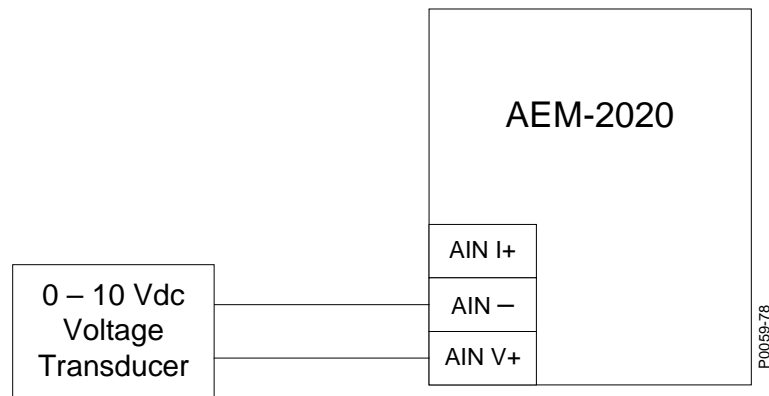
Figure 10-3. Analog Inputs - Voltage Input Connections
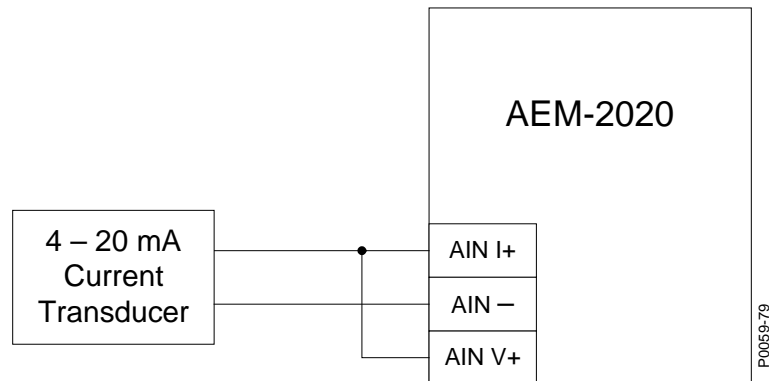
Figure 10-4. Analog Inputs - Current Input Connections

External RTD Input Connections

External 2-wire RTD input connections are shown in Figure 10-5. Figure 10-6 shows external 3-wire RTD input connections.
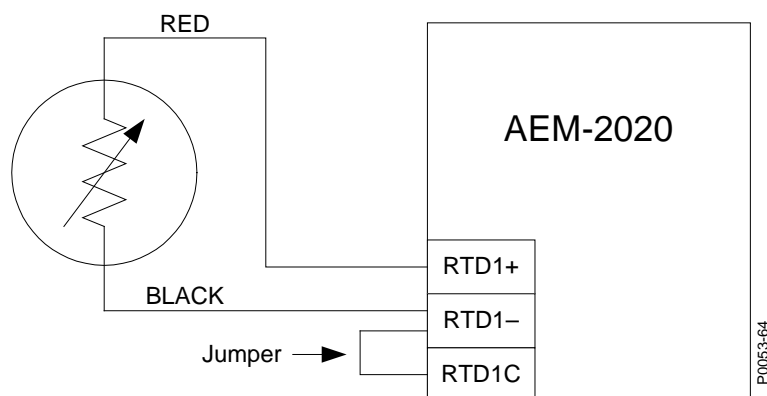
Figure 10-5. External Two-Wire RTD Input Connections
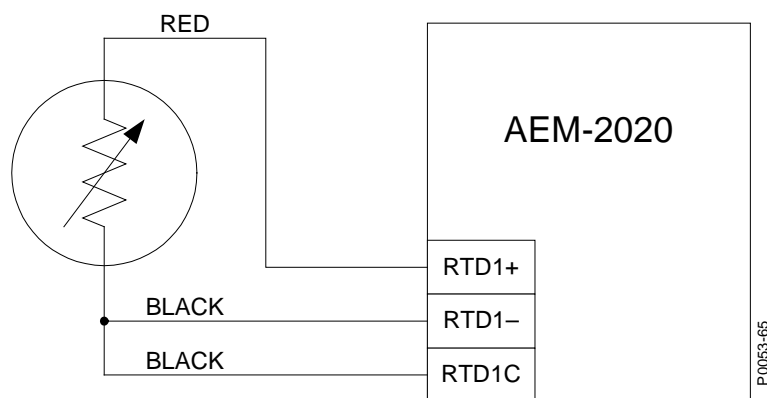
Figure 10-6. External Three-Wire RTD Input Connections

CANbus 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. CANbus interface terminals are listed in Table 10-3. Refer to Figure 10-7 and Figure 10-8.

Table 10-3. CANbus 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 Ω, 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.
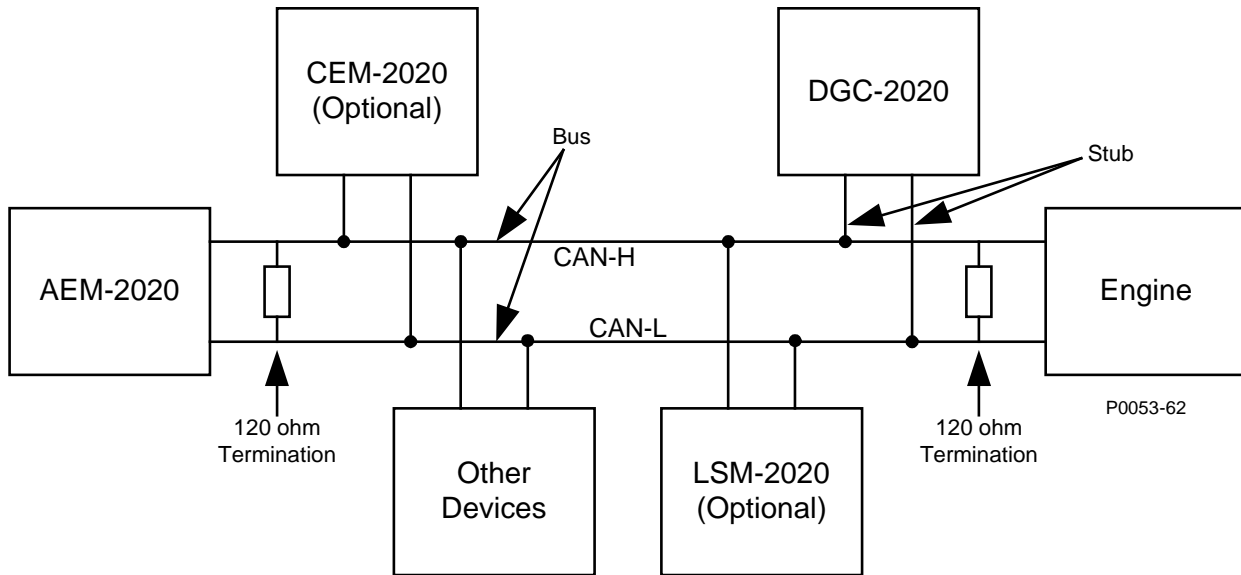
Figure 10-7. CANbus Interface with AEM-2020 providing One End of the Bus
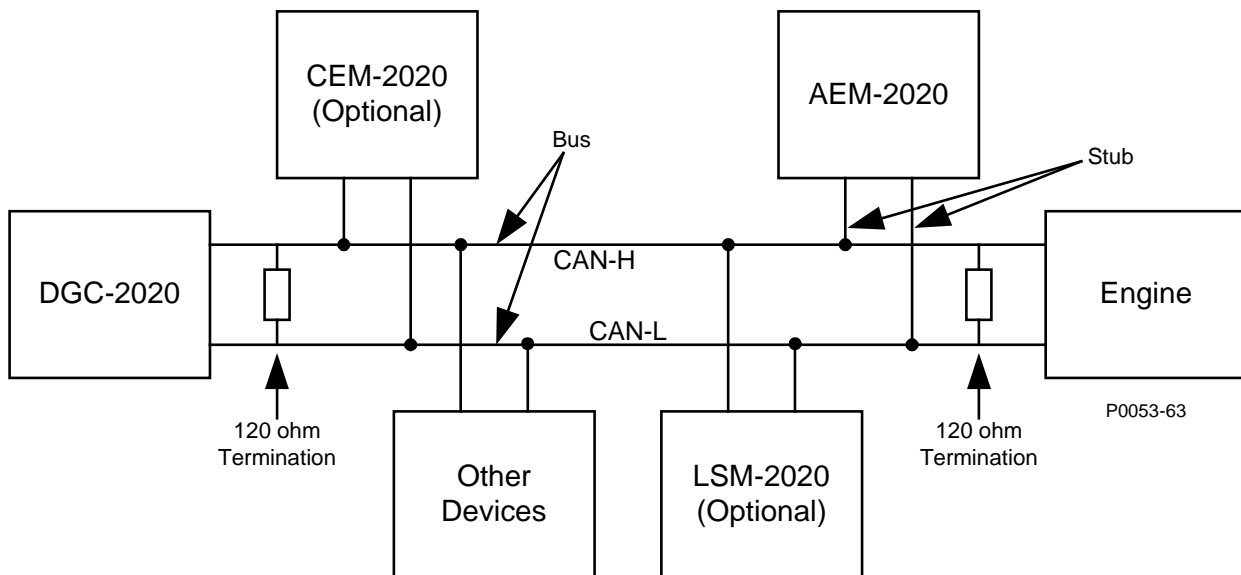
Figure 10-8. CANbus Interface with DGC-2020 providing One End of the Bus

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.

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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:

$$T_T = \frac{AD}{M^N - C} + BD + K \qquad \textit{Equation A-1}$$

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

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 Standard C37.112-1996.

∗ 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	R
S1	Short Inverse	0.2663	0.03393	1	1.2969	0.028	0.5
S2	Short Inverse	0.0286	0.0208	1	0.9844	0.028	0.094
L1	Long Inverse	5.6143	2.18592	1	1	0.028	15.75
L2	Long Inverse	2.3955	0	1	0.3125	0.028	7.8001
D	Definite Time	0.4797	0.21359	1	1.5625	0.028	0.875
M	Moderately Inverse	0.3022	0.1284	1	0.5	0.028	1.75
I1	Inverse Time	8.9341	0.17966	1	2.0938	0.028	9
I2	Inverse Time	0.2747	0.10426	1	0.4375	0.028	0.8868
V1	Very Inverse	5.4678	0.10814	1	2.0469	0.028	5.5
V2	Very Inverse	4.4309	0.0991	1	1.9531	0.028	5.8231
E1	Extremely Inverse	7.7624	0.02758	1	2.0938	0.028	7.75
E2	Extremely Inverse	4.9883	0.0129	1	2.0469	0.028	4.7742
A	Standard Inverse	0.01414	0	1	0.02	0.028	2
B	Very Inverse (I^2t)	1.4636	0	1	1.0469	0.028	3.25
C	Extremely Inverse (I^2t)	8.2506	0	1	2.0469	0.028	8
G	Long Time Inverse (I^2t)	12.1212	0	1	1	0.028	29
F	Fixed Time *	0	1	0	0	0.028	1
P	User Programmable ‡	0 to 600	0 to 25	0 to 1	0.5 to 2.5	0.0280	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
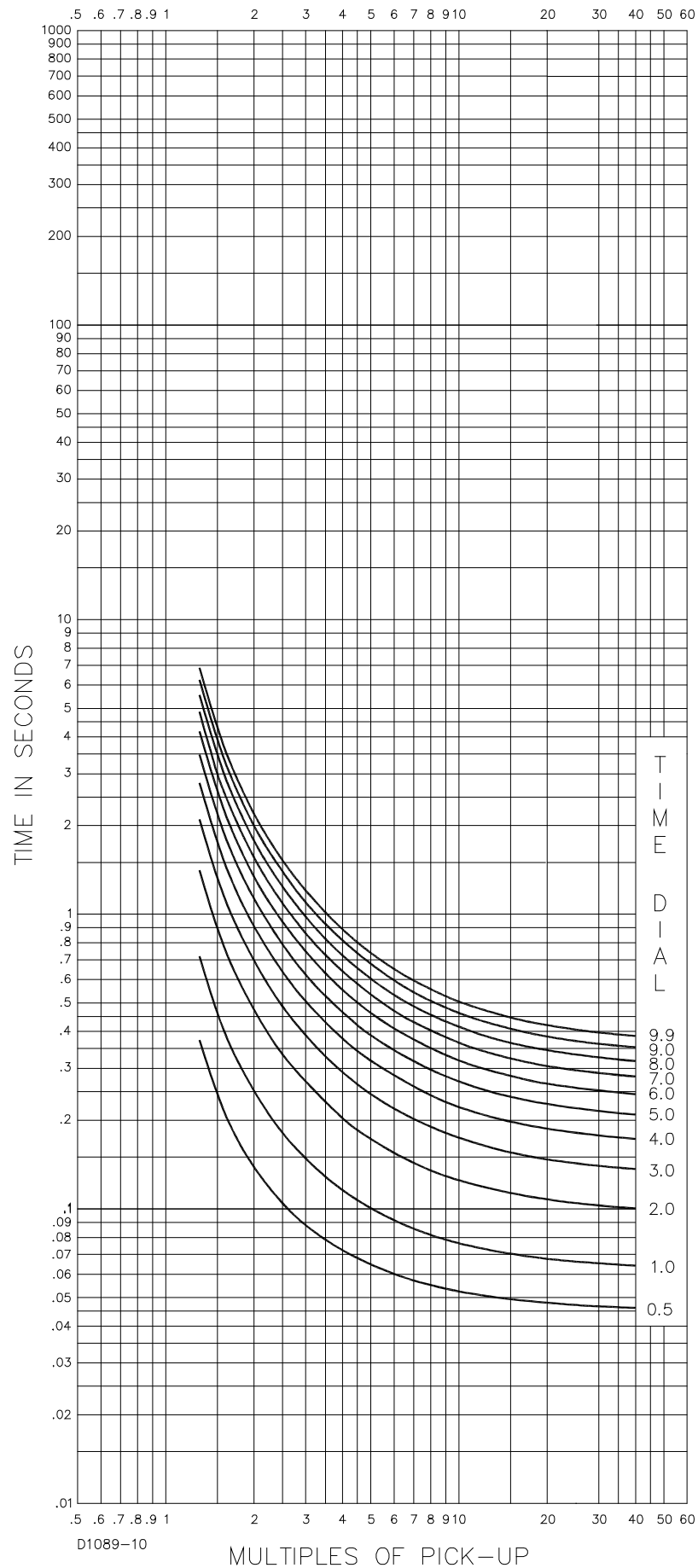
Figure A-1. Time Characteristic Curve S1, Short Inverse (Similar to ABB CO-2)
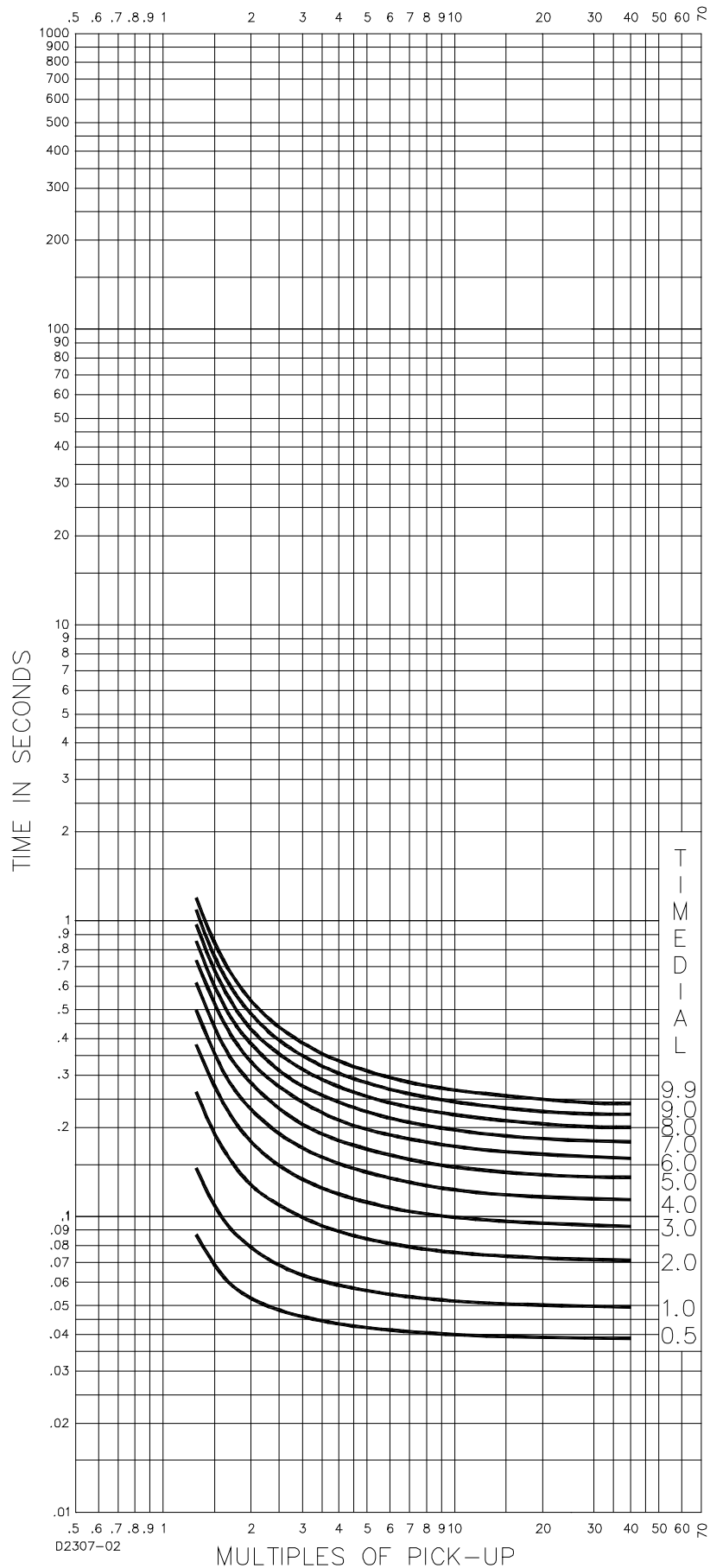
Figure A-2. Time Characteristic Curve S2, Short Inverse (Similar To GE IAC-55)
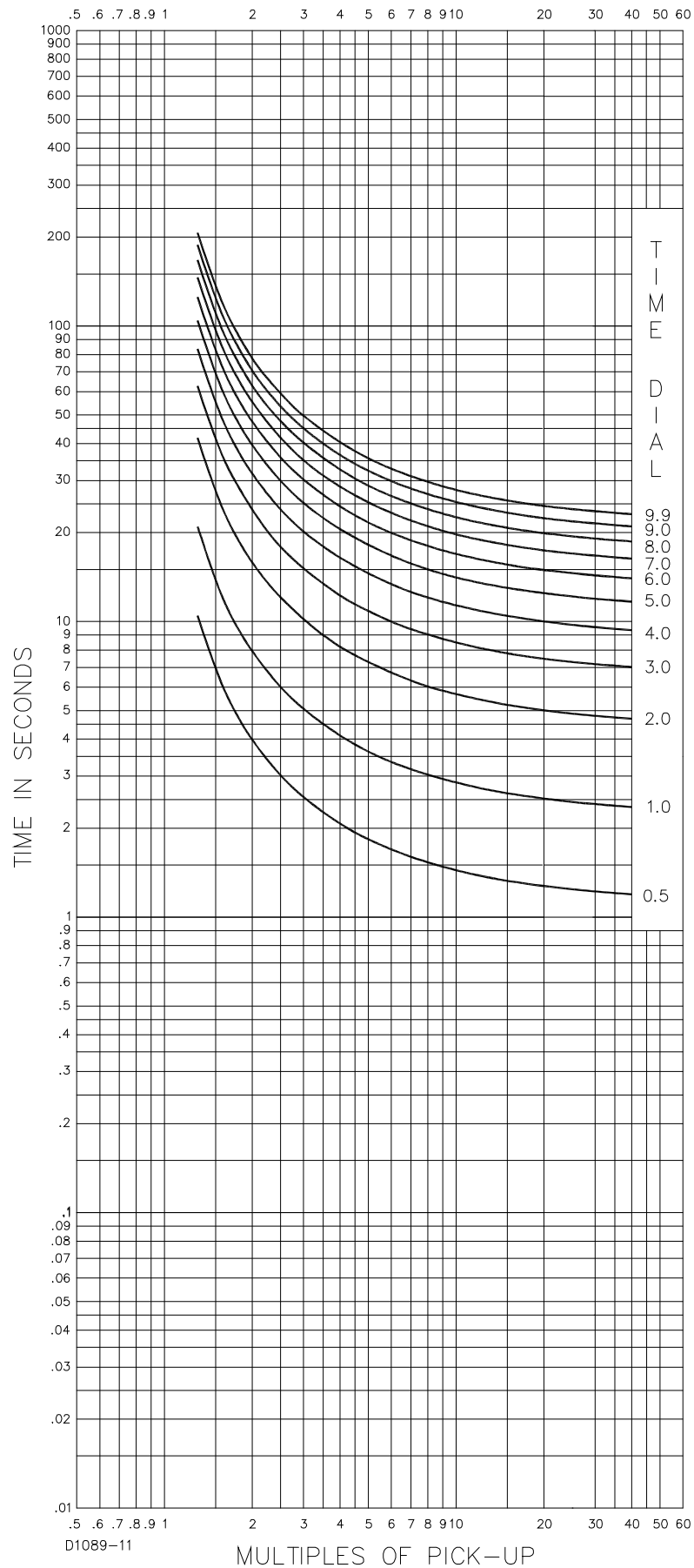
Figure A-3. Time Characteristic Curve L1, Long Inverse (Similar to ABB CO-5)
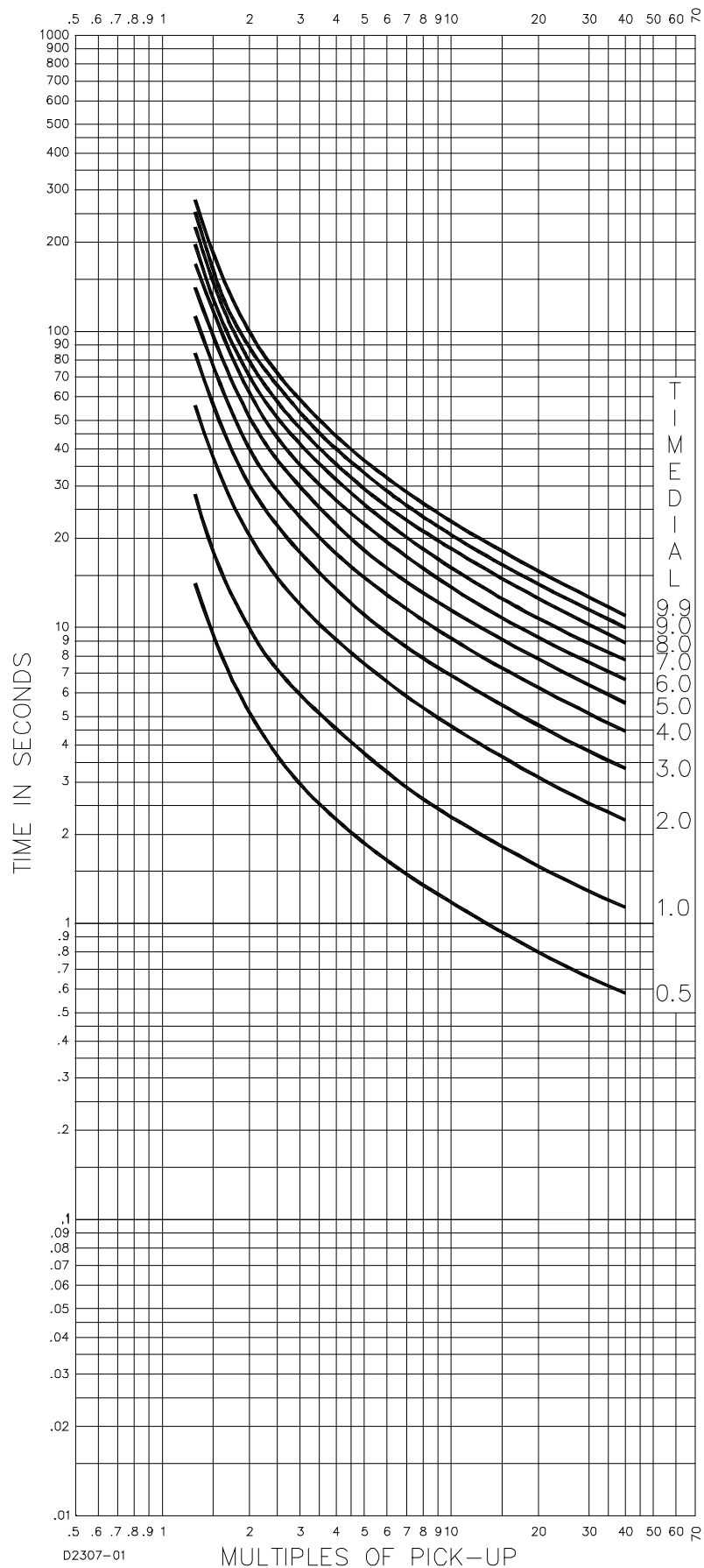
Figure A-4. Time Characteristic Curve L2, Long Inverse (Similar To GE IAC-66)
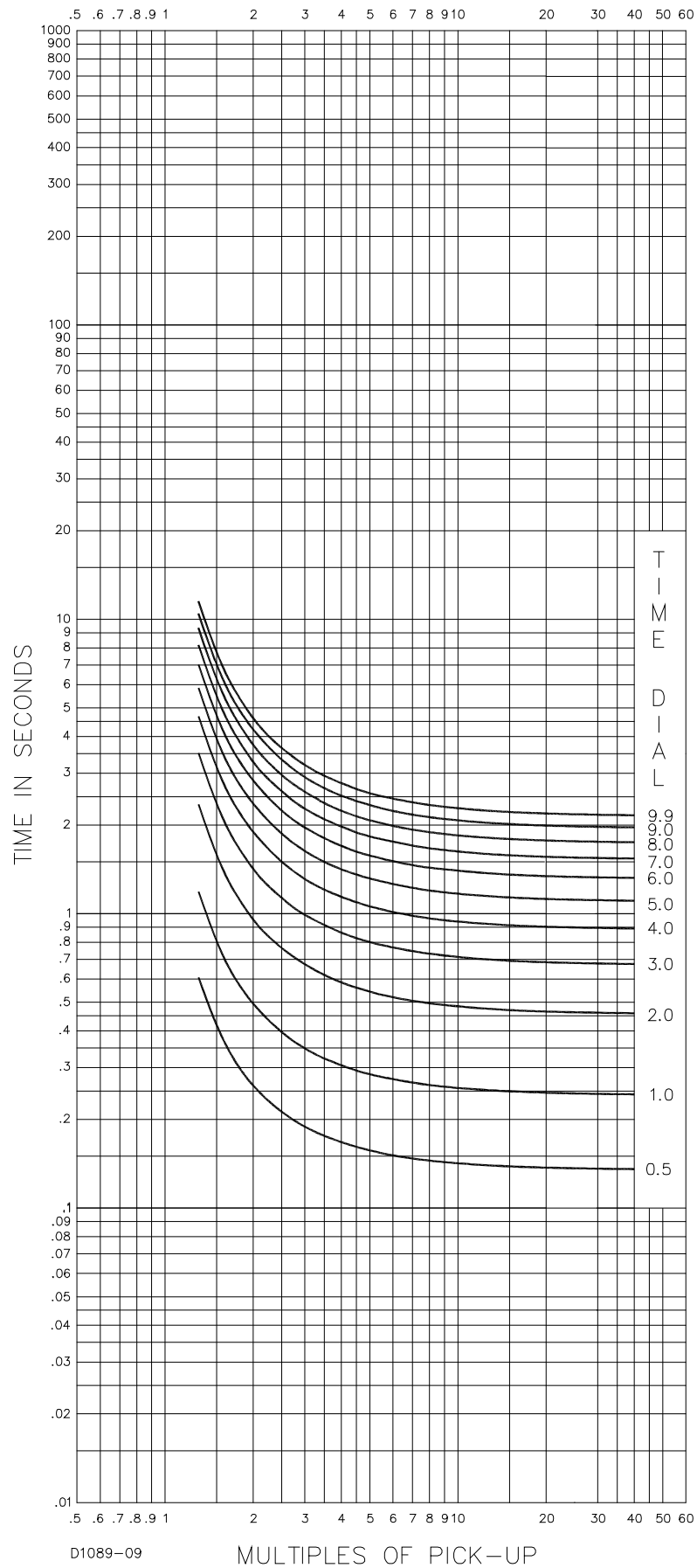
Figure A-5. Time Characteristic Curve D, Definite Time (Similar To ABB CO-6)
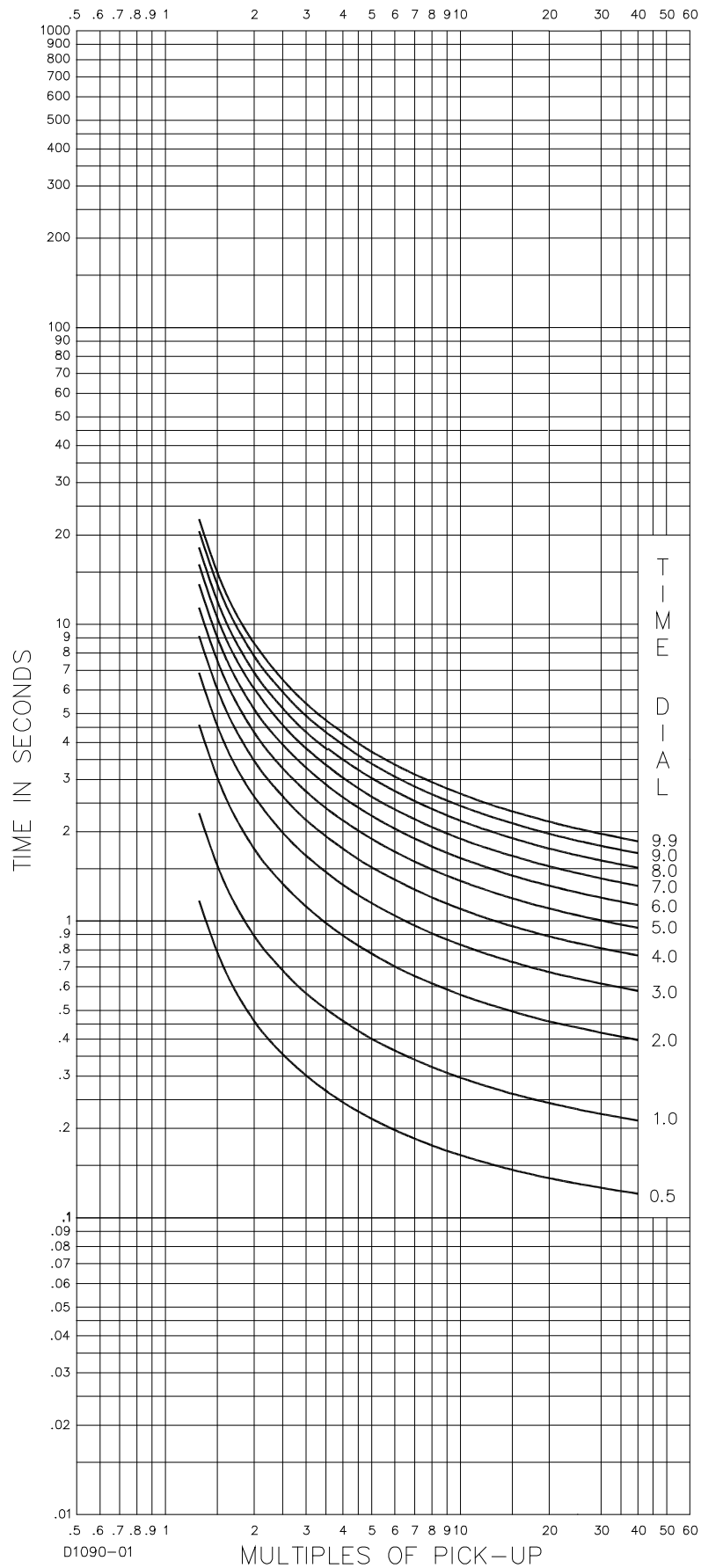
Figure A-6. Time Characteristic Curve M, Moderately Inverse (Similar to ABB CO-7)
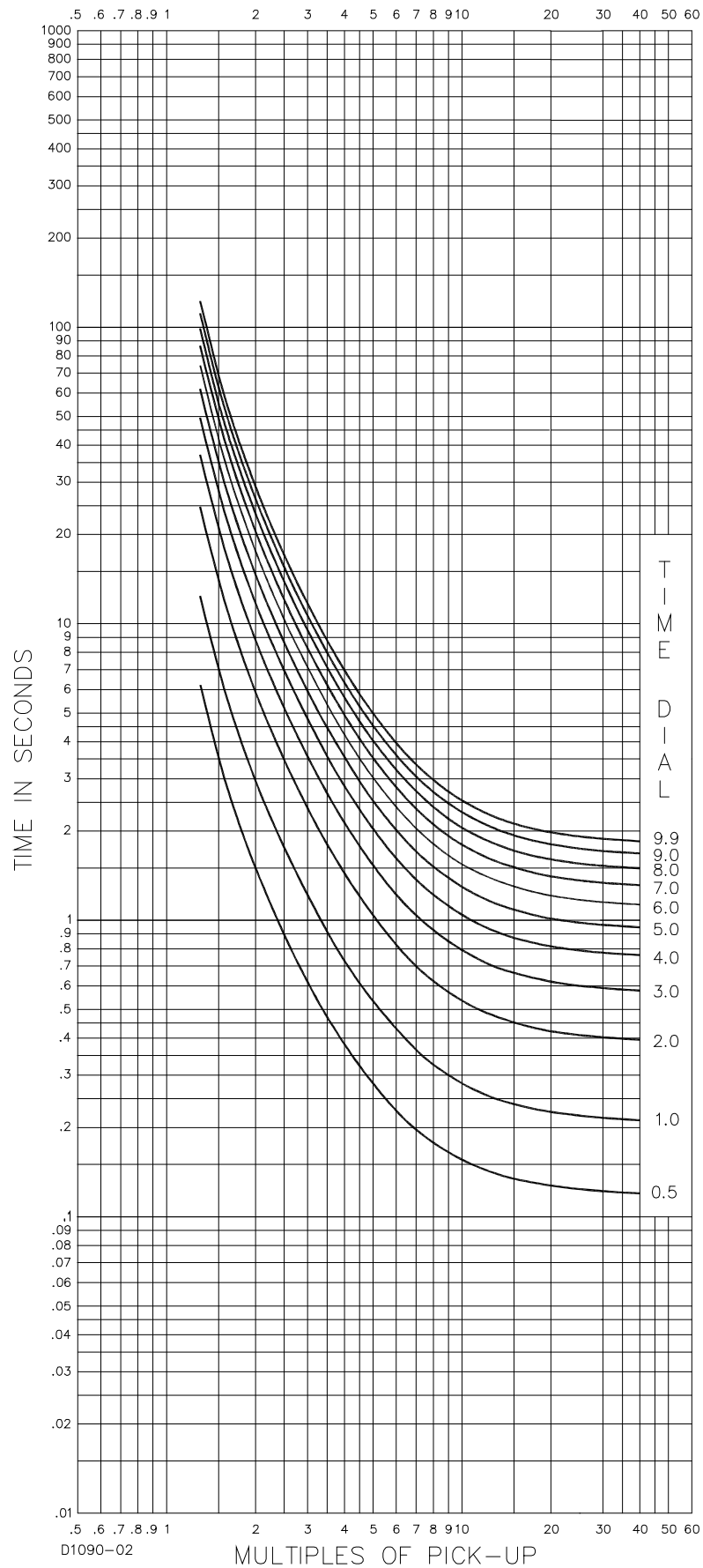
Figure A-7. Time Characteristic Curve I1, Inverse Time (Similar to ABB CO-8)
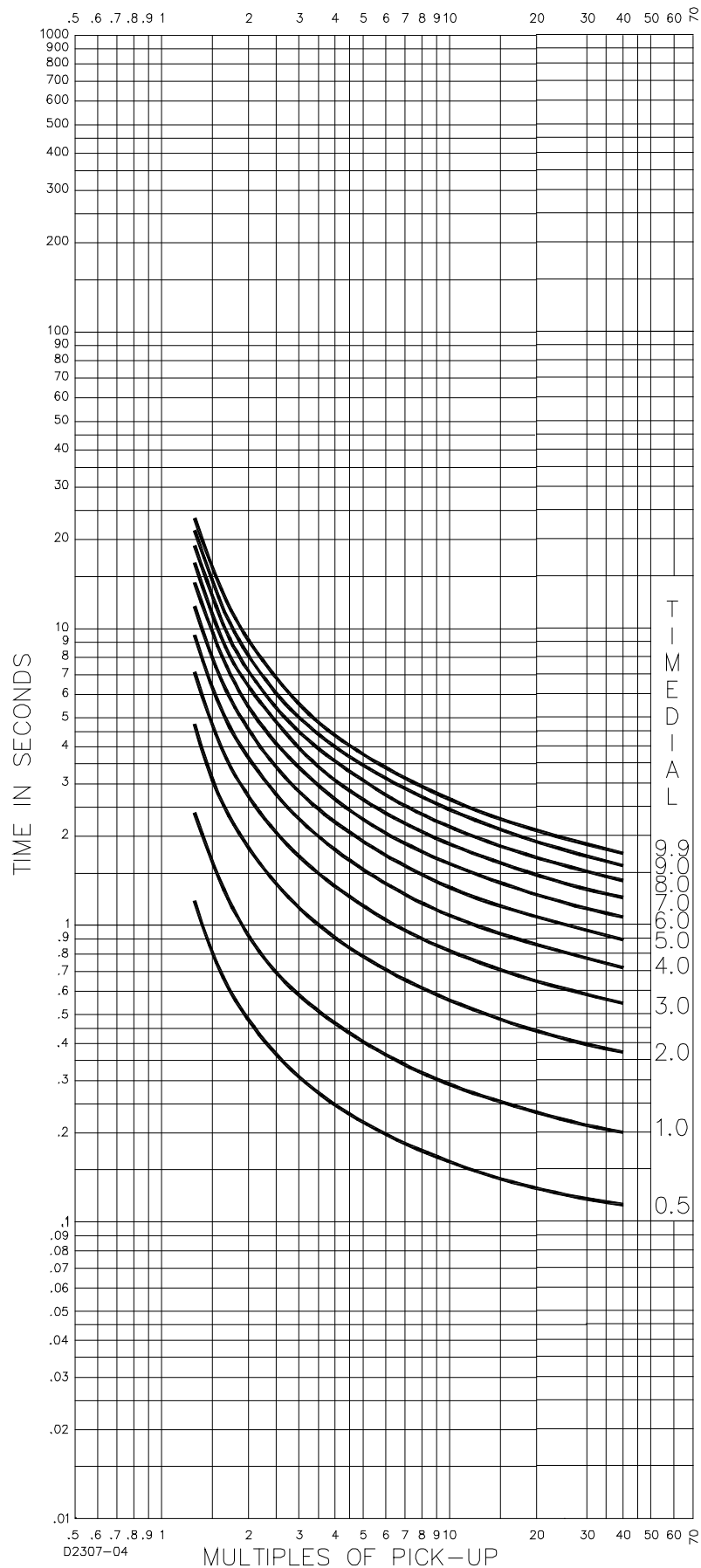
Figure A-8. Time Characteristic Curve I2, Inverse Time (Similar to GE IAC-51)
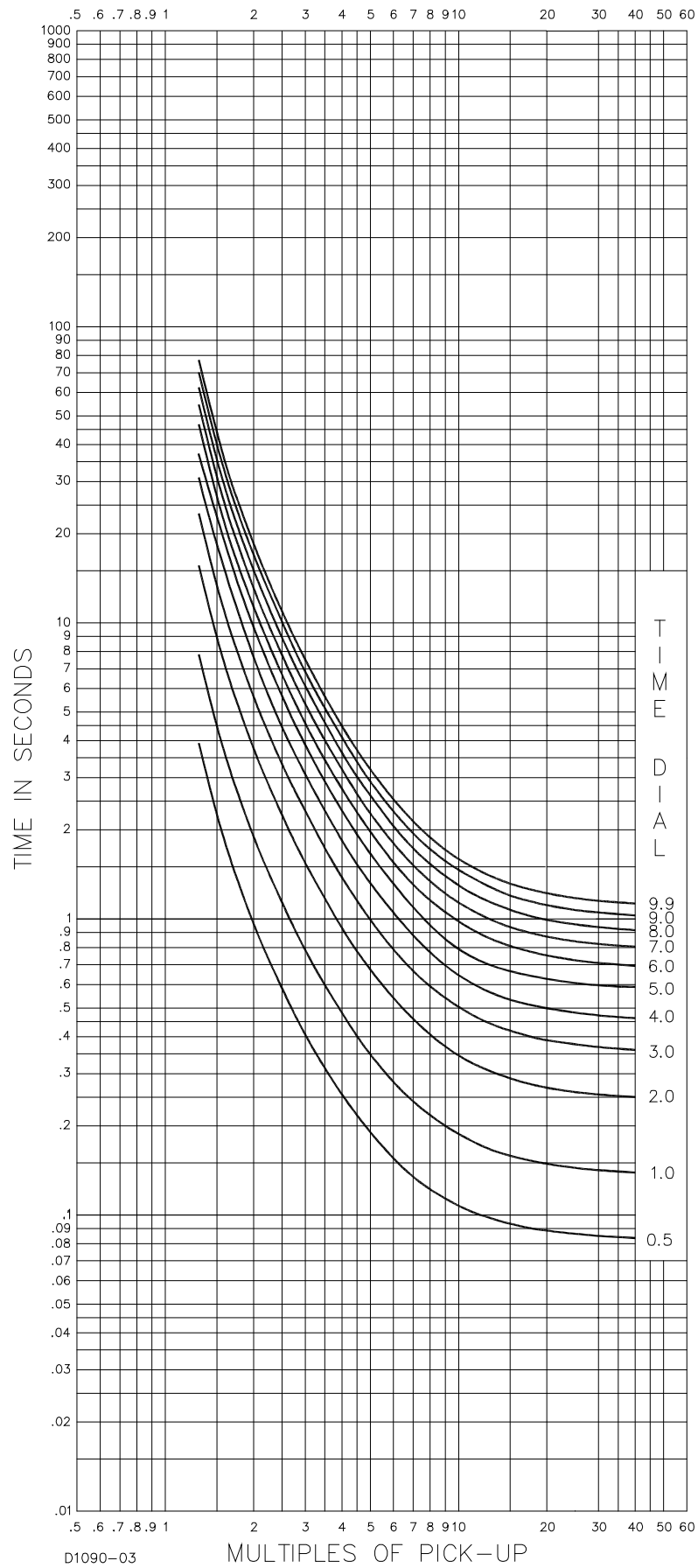
Figure A-9. Time Characteristic Curve V1, Very Inverse (Similar to ABB CO-9)
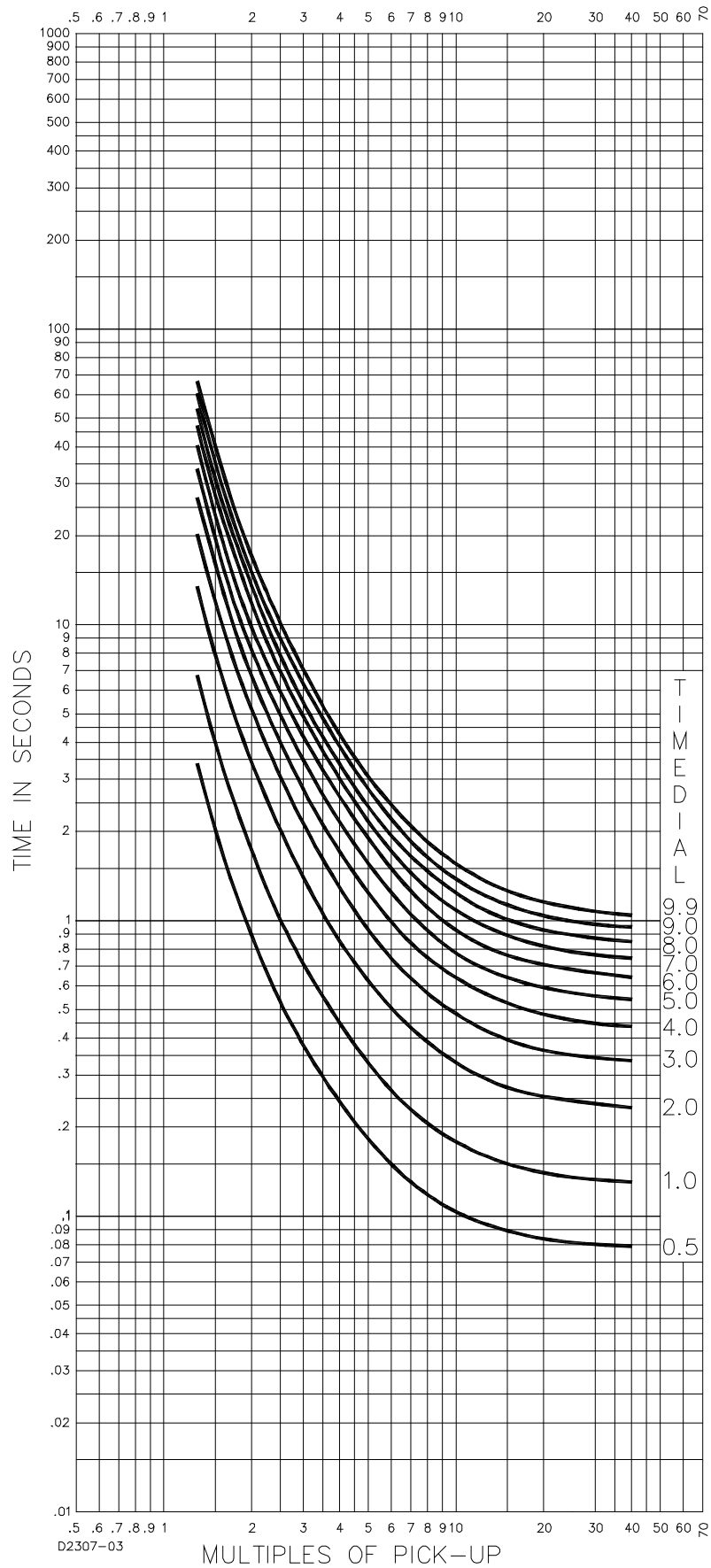
Figure A-10. Time Characteristic Curve V2, Very Inverse (Similar to GE IAC-53)
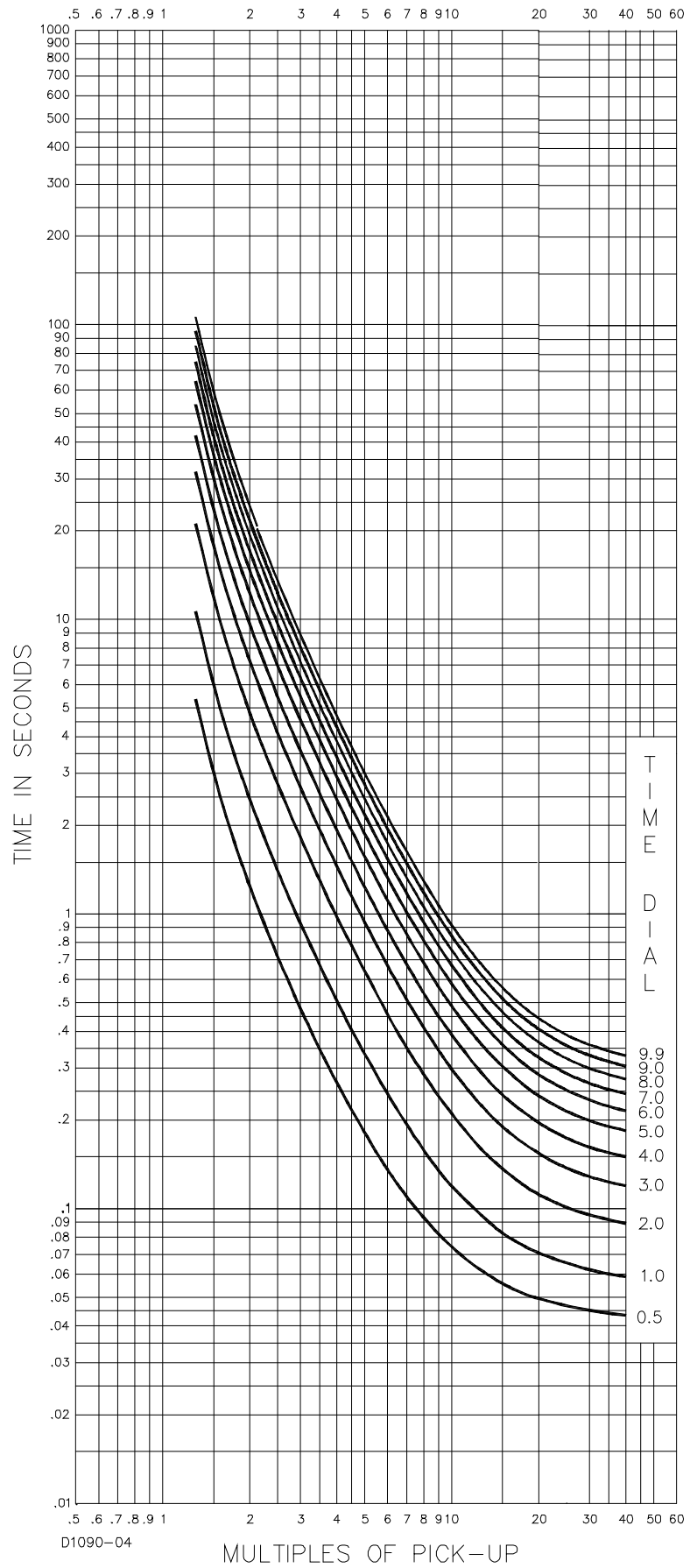
Figure A-11. Time Characteristic Curve E1, Extremely Inverse (Similar to ABB CO-11)
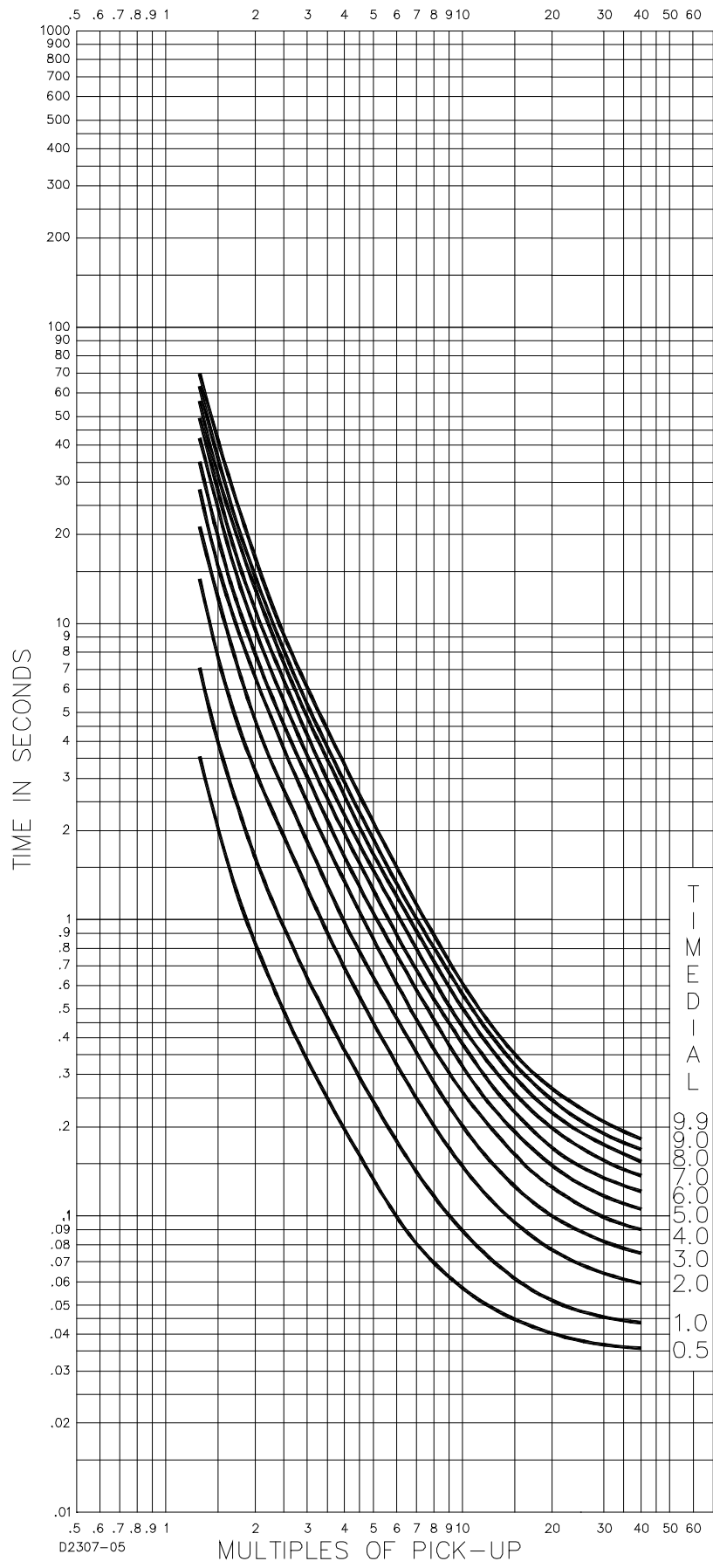
Figure A-12. Time Characteristic Curve E2, Extremely Inverse (Similar to GE IAC-77)
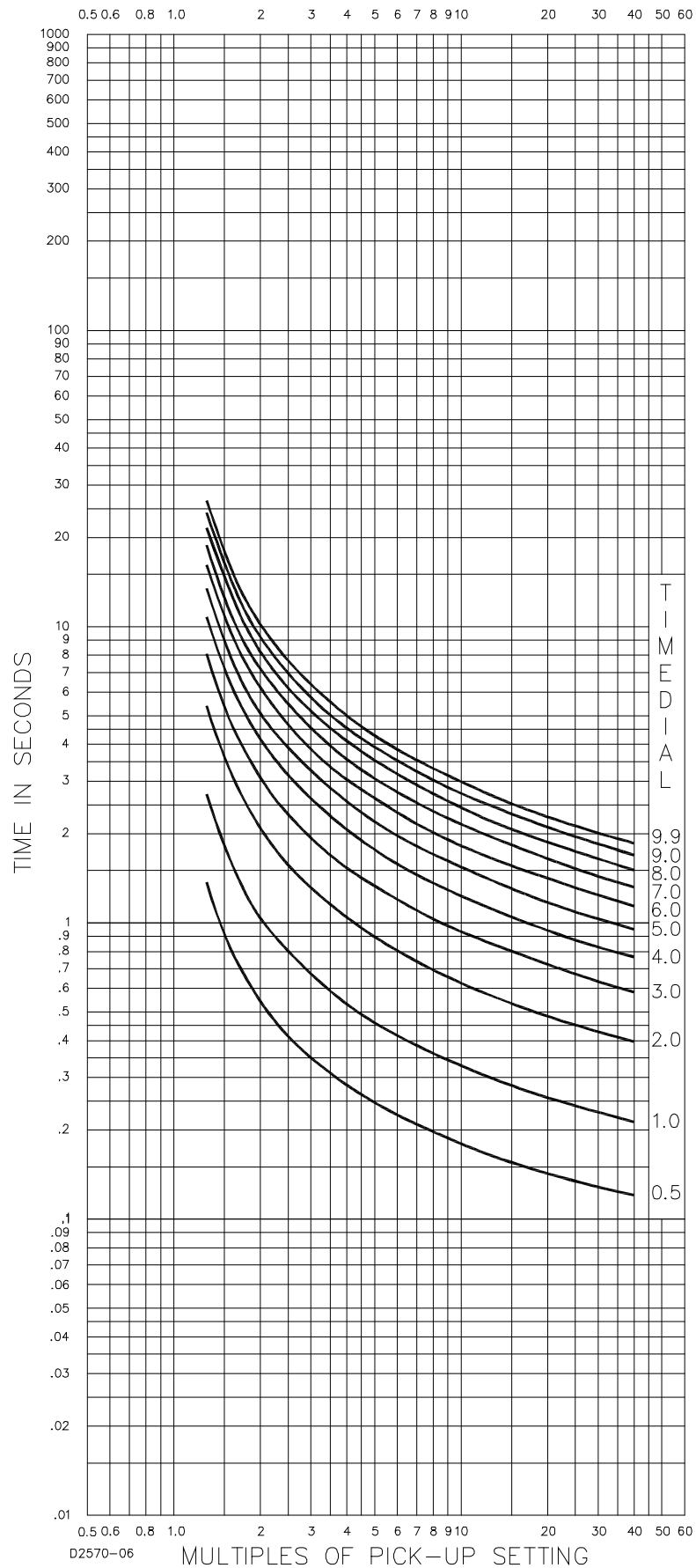
Figure A-13. Time Characteristic Curve A, Standard Inverse (BS 142)
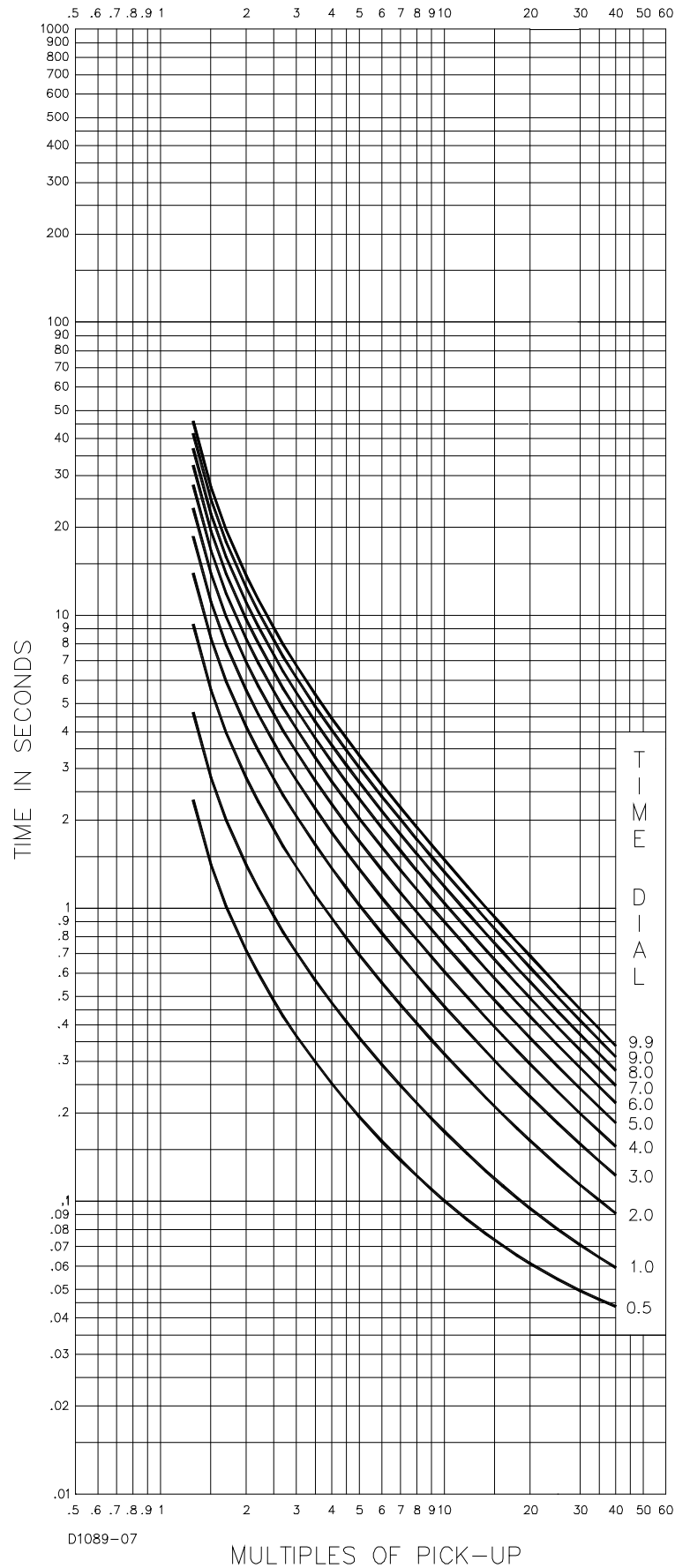
Figure A-14. Time Characteristic Curve B, Very Inverse (BS 142)
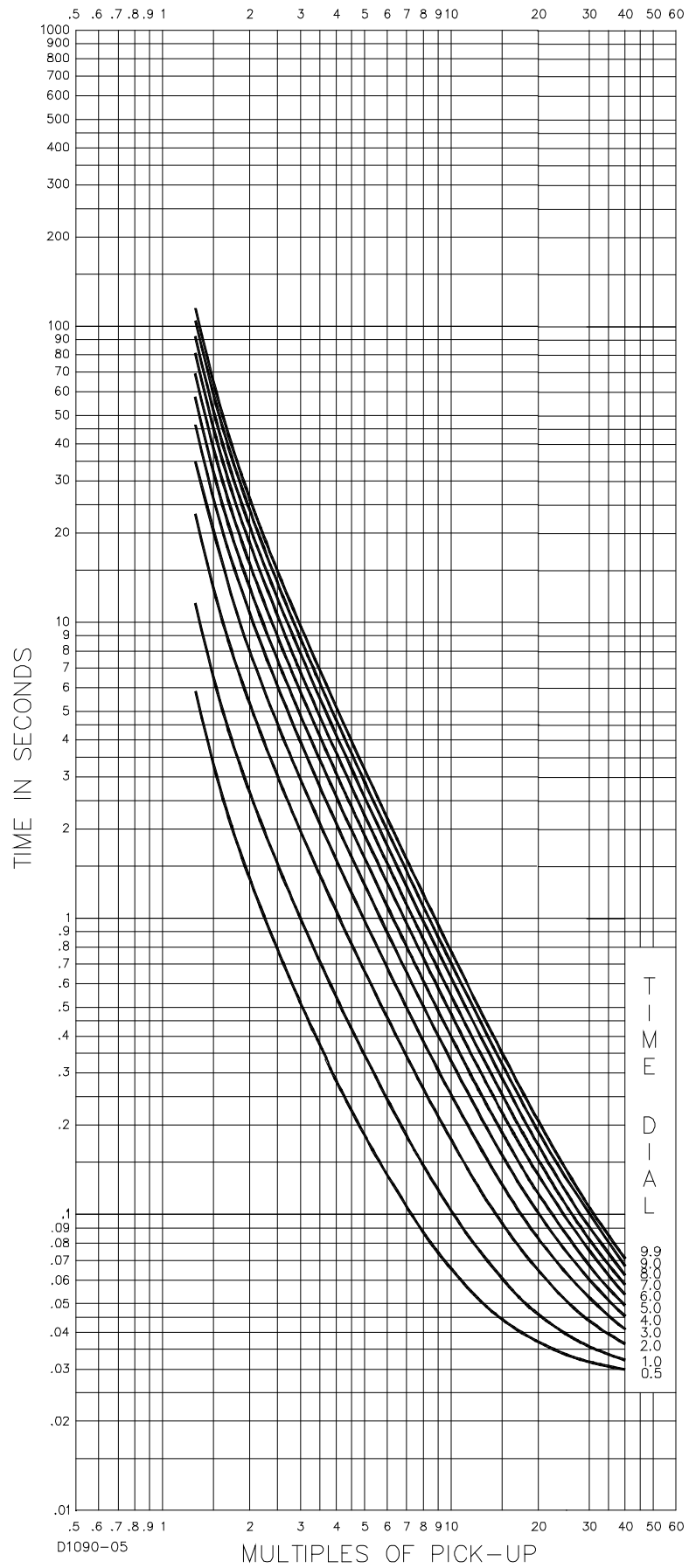
Figure A-15. Time Characteristic Curve C, Extremely Inverse (BS 142)
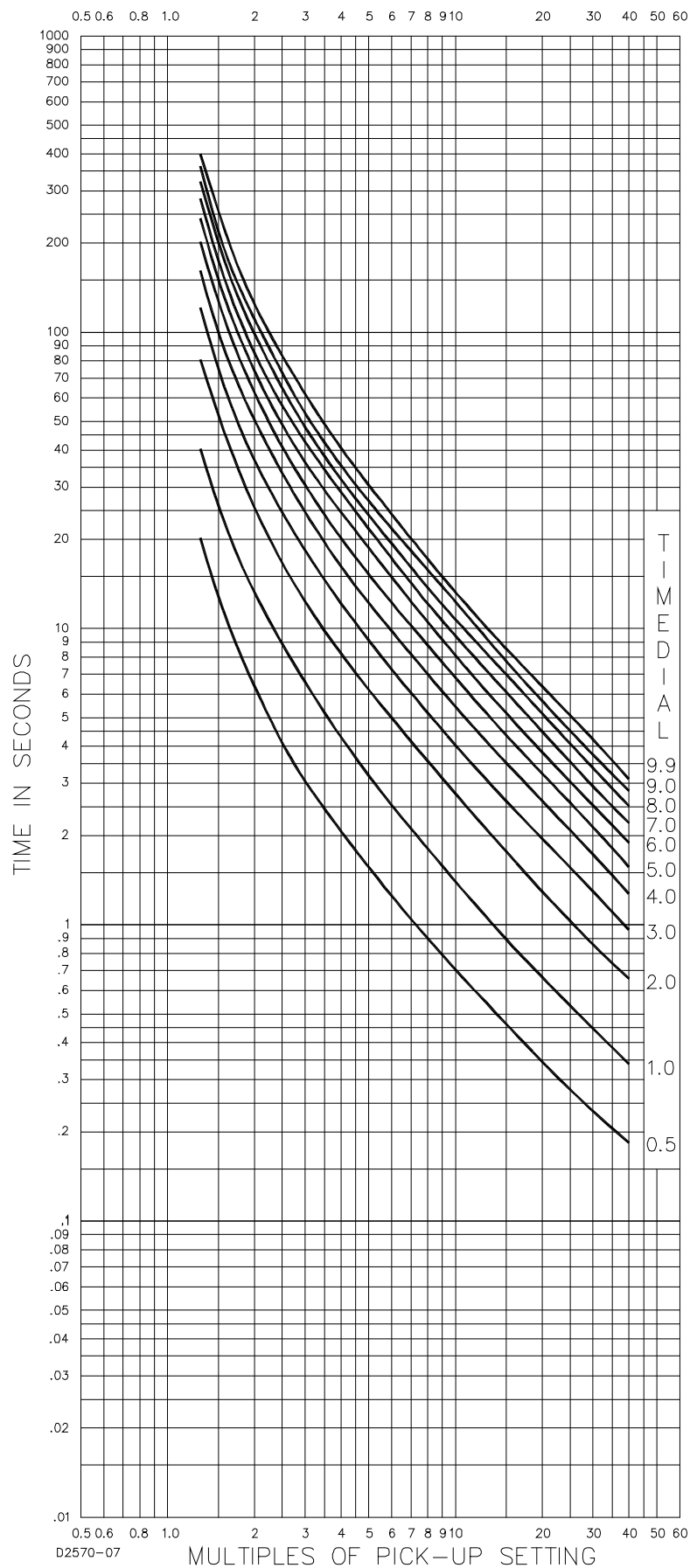
Figure A-16. Time Characteristic Curve G, Long Time Inverse (BS 142)

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.

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. The 40XXX registers are identical to the data that was present in the DGC-500 and DGC-1000 products. This allows the DGC-2020 to work seamlessly in Modbus™ applications where it is replacing a DGC-500 or DGC-1000. 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.

Floating Point Data Format

The Modbus™ floating point data format uses two consecutive holding registers to represent a data value. The first register contains the low-order 16 bits of the following 32-bit format:

- MSB is the sign bit for the floating-point value (0 = positive).

- The next 8 bits are the exponent biased by 127 decimal.

- The 23 LSBs comprise the normalized mantissa. The most-significant bit of the mantissa is always assumed to be 1 and is not explicitly stored, yielding an effective precision of 24 bits.

The value of the floating-point number is obtained by multiplying the binary mantissa times two raised to the power of the unbiased exponent. The assumed bit of the binary mantissa has the value of 1.0, with the remaining 23 bits providing a fractional value. Table B-2 shows the floating-point format.

Table B-2. Floating Point Format

Sign	**Exponent + 127**	**Mantissa**
1 bit	8 bits	23 bits

The floating-point format allows for values ranging from approximately 8.43×10^{-37} to 3.38×10^{38}. A floating-point value of all zeroes is the value zero. A floating-point value of all ones (not a number) signifies a value currently not applicable or disabled.

Example: The value 95,800 represented in floating point format is hexadecimal 47BB1C00. This number will read from two consecutive holding registers as follows:

Holding Register	Value
K (Hi Byte)	hex 1C
K (Lo Byte)	hex 00
K+1 (Hi Byte)	hex 47
K+1 (Lo Byte)	hex BB

The same byte alignments are required to write.

Double Precision Data Format (DP)

The Modbus™ Double Precision data format (DP) uses 2 consecutive registers to represent a data value. The first register contains the high-order 16 bits of double precision data, and is the actual data value / 10,000.

The second register contains the low-order 16 bits of double precision data, and is the actual data value modulus 10,000.

Triple Precision Data Format (TP)

The Modbus™ Triple Precision data format (TP) uses 3 consecutive registers to represent a data value. The first register contains the high-order 16 bits of triple precision data, and is the actual data value / 100,000,000. The modulus from this operation is divided by 10,000 to arrive at the value of the second register, and the modulus of this last operation is the value of the third register (the low-order 16 bits of triple precision).

Error Check

This field contains a 2-byte CRC value for transmission error detection. The master first calculates the CRC and appends it to the query message. The DGC-2020 recalculates the CRC value for the received query and performs a comparison to the query CRC value to determine if a transmission error has occurred. If so, no response message is generated. Otherwise, the slave calculates a new CRC value for the response message and appends it to the message for transmission.

Reference the "Modicon Modbus™ Protocol Reference Guide", PI-MBUS-300 Rev. E, pages 112 - 115 for an excellent explanation and implementation of the CRC-16 algorithm.

The CRC calculation is performed using all bytes of the Device Address, Function Code, and Data Block fields. A 16-bit CRC-register is initialized to all 1's. Then each 8-bit byte of the message is used in the following algorithm:

First, exclusive-OR the message byte with the low-order byte of the CRC-register. The result, stored in the CRC-register, will then be right-shifted 8 times. The CRC-register MSB is zero-filled with each shift. After each shift the CRC-register LSB is examined: if 1, the CRC-register is then exclusive-ORed with the fixed polynomial value A001 (hex) prior to the next shift. Once all bytes of the message have undergone the above algorithm, the CRC-register will contain the message CRC value to be placed in the Error Check field.

Interdependence of Preset Multiple Register Data

Preset Multiple Register data is collectively written only after the query has been determined to be legal, which includes a range-check of the entire data block. Therefore, data which must be written prior to other data must use a separate query. For example, a Preset Multiple Register Query of the entire Contiguous Write Block (40023-40055) to set the Battery Overvoltage Pre-alarm Threshold atop the 24V range and change the Battery Volts from 12V to 24V will fail. The change to 24V would occur simultaneously to setting the Pre-alarm Threshold, and the threshold value range-check will use the current 12V range.

MAPPING - DGC-2020 PARAMETERS INTO MODICON ADDRESS SPACE

Table Conventions

Table B-3 uses the conventions outlined in this section.

The "Data Format" column uses the following abbreviations:

- DP - Double Precision
- TP - Triple Precision
- FP - Floating Point

Data formatted in Double Precision uses a 2-register group designated (a) and (b) and is defined as follows:

- Register (a) - 2 hi-order bytes
- Register (b) - 2 lo-order bytes

Data formatted in Triple Precision uses a 3 register group designated (a), (b) and (x). It is defined as follows:

- Register (a) - 2 hi-order bytes
- Register (b) - 2 mid-order bytes
- Register (x) - 2 lo-order bytes

Other register groups using the (a), (b), etc. designators are an ordered data group of consecutive ASCII characters or data bytes.

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.

Breaker Management

Register	Description	Type	Units	Scaling Factor	R/W	Range
42000	Gen Breaker Configured	Int32	N/A	N/A	R	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	Synchronizer Mode	Int32	N/A	N/A	RW	0 = Off Mode 1 = Auto Mode
42028	Slip Frequency	Int32	CentiHertz	Centi	RW	10 - 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	Int32	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 - 1800
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					
42078-248	FUTURE USE					

Bias Control Settings

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
42264	AVR Integrator Limit Minus	Float	N/A	N/A	RW	(-1000) - 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) - 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) - 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) - 0

Register	Description	Type	Units	Scaling Factor	R/W	Range
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) - 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) - 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) - 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) - 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
42372	kvar Load Rate	Uint32	N/A	Deci	RW	1 - 1000

Register	Description	Type	Units	Scaling Factor	R/W	Range
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) - 1000
42392	kvar Analog Min	Int32	Percent	Deci	RW	(-1000) - 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) - 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
42416-498	FUTURE USE					

Pulse Outputs

Register	Description	Type	Units	Scaling Factor	R/W	Range
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					

Register	Description	Type	Units	Scaling Factor	R/W	Range
42516-748	FUTURE USE					

Bus Condition Detection

Register	Description	Type	Units	Scaling Factor	R/W	Range
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 - 99999
42758	Gen Sensing Stable Undervoltage Dropout	Int32	Volt	N/A	RW	10 - 99999
42760	Gen Sensing Stable Overvoltage	Int32	Volt	N/A	RW	10 - 99999
42762	Gen Sensing Stable Overvoltage Dropout	Int32	Volt	N/A	RW	10 - 99999
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 - 9999
42786	Bus Sensing Stable Undervoltage Dropout	Int32	Volt	N/A	RW	10 - 9999
42788	Bus Sensing Stable Overvoltage Pickup	Int32	Volt	N/A	RW	10 - 9999
42790	Bus Sensing Stable Overvoltage Dropout	Int32	Volt	N/A	RW	10 - 9999
42792	Bus Sensing Stable Underfrequency Pickup	Int32	CentiHertz	Centi	RW	4600 - 6400
42794	Bus Sensing Stable Underfrequency Dropout	Int32	CentiHertz	Centi	RW	4600 - 6400
42796	Bus Sensing Stable Overfrequency Pickup	Int32	CentiHertz	Centi	RW	4600 - 6400
42798	Bus Sensing Stable Overfrequency Dropout	Int32	CentiHertz	Centi	RW	4600 - 6400
42800	Bus Sensing Fail Time Delay	Int32	Decisecond	Deci	RW	1 - 6000
42802	Bus Sensing Stable Time Delay	Int32	Decisecond	Deci	RW	1 - 6000
42804	RESERVED					
42806	Gen Dead Status	Int32	N/A	N/A	R	0 - 1
42808	Gen Stable Status	Int32	N/A	N/A	R	0 - 1
42810	Gen Fail Status	Int32	N/A	N/A	R	0 - 1
42812	Bus Dead Status	Int32	N/A	N/A	R	0 - 1
42814	Bus Stable Status	Int32	N/A	N/A	R	0 - 1
42816	Bus Fail Status	Int32	N/A	N/A	R	0 - 1
42818	Gen Stable Low Line Scale Factor	Float	N/A	N/A	RW	0.001 - 3
42820	Bus Stable Low Line Scale Factor	Float	N/A	N/A	RW	0.001 - 3
42822	Gen Stable Alternate Frequency Scale Factor	Float	N/A	N/A	RW	0.001 - 100
42824	Bus Stable Alternate Frequency Scale Factor	Float	N/A	N/A	RW	0.001 - 100
42826-3432	FUTURE USE					

Senders

Register	Description	Type	Units	Scaling Factor	R/W	Range
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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
43450-498	FUTURE USE					

System Configuration and Status

Register	Description	Type	Units	Scaling Factor	R/W	Range
43500	Rated Volts	Float	Volt	N/A	RW	1 - 99999
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
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 - 480
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	5 - 15
43552	Continuous Crank Time	Unit32	Second	N/A	RW	5 - 60

Register	Description	Type	Units	Scaling Factor	R/W	Range
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	750 - 3600
43566	No Load Cool Down Time	Uint32	Minute	N/A	RW	0 - 60
43568	EPS Current Threshold	Int32	PercentCTPri	N/A	RW	3 - 10
43570	Fuel Level Function	Uint32	N/A	N/A	RW	0 = Disable 1 = Fuel Lvl 2 = Natural Gas 3 = Propane
43572	Number Flywheel Teeth	Uint32	N/A	N/A	RW	50 - 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) - 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
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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) - 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
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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	RESERVED					
43672	RESERVED					
43674-748	FUTURE USE					

Control

Register	Description	Type	Units	Scaling Factor	R/W	Range
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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					

Communication

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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	CANbus 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	Active IP Address	Uint32	N/A	N/A	R	0 - 4294967295
44054	Gateway IP Address	Uint32	N/A	N/A	R	0 - 4294967295
44056	Subnet Mask	Uint32	N/A	N/A	R	0 - 4294967295
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 = 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 = 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
44068-248	FUTURE USE					

Protection

Register	Description	Type	Units	Scaling Factor	R/W	Range
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 - 300
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 - 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
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 - 576
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 - 576
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 - 576
44290	3 Phase Overvoltage Activation Delay (59-1)	Uint32	Decisecond	Deci	RW	0 - 300
44292	3 Phase Overvoltage Alarm Configuration (59-1)	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
44294	1 Phase Overvoltage Pickup (59-1)	Uint32	Volt	N/A	RW	70 - 576
44296	1 Phase Overvoltage Activation Delay (59-1)	Uint32	Decisecond	Deci	RW	0 - 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
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 - 300
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 - 300

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 - 576
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 - 576
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 - 576
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 - 576
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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	Uint32	DeciPercent	Deci	RW	(-500) - 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	Uint32	DeciPercent	Deci	RW	(-500) - 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	Uint32	DeciPercent	Deci	RW	(-1500) - 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	Uint32	DeciPercent	Deci	RW	(-1500) - 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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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 - 300
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 - 300
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
44498	FUTURE USE					

Alarms

Register	Description	Type	Units	Scaling Factor	R/W	Range
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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 - 240
44554	Low Battery Pre-Alarm Activation Delay	Uint32	Second	N/A	RW	1 - 10
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 - 160
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
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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
44652-748	FUTURE USE					

Metering

Register	Description	Type	Units	Scaling Factor	R/W	Range
44750	Gen VAB Metering	Int32	Volt	N/A	R	(-2147483648) - 2147483647
44752	Gen VBC Metering	Int32	Volt	N/A	R	(-2147483648) - 2147483647
44754	Gen VCA Metering	Int32	Volt	N/A	R	(-2147483648) - 2147483647
44756	Gen VAN Metering	Int32	Volt	N/A	R	(-2147483648) - 2147483647
44758	Gen VBN Metering	Int32	Volt	N/A	R	(-2147483648) - 2147483647
44760	Gen VCN Metering	Int32	Volt	N/A	R	(-2147483648) - 2147483647
44762	Bus Voltage Metering	Int32	Volt	N/A	R	(-2147483648) - 2147483647
44764	Gen IA Metering	Int32	Amp	N/A	R	(-32768) - 32767
44766	Gen IB Metering	Int32	Amp	N/A	R	(-32768) - 32767
44768	Gen IC Metering	Int32	Amp	N/A	R	(-32768) - 32767
44770	Gen kVA A Metering	Int32	KiloVA	N/A	R	(-2147483648) - 2147483647
44772	Gen kVA B Metering	Int32	KiloVA	N/A	R	(-2147483648) - 2147483647
44774	Gen kVA C Metering	Int32	KiloVA	N/A	R	(-2147483648) - 2147483647
44776	Gen kVA Total Metering	Int32	KiloVA	N/A	R	(-2147483648) - 2147483647
44778	Gen kW A Metering	Int32	KiloWatt	N/A	R	(-2147483648) - 2147483647
44780	Gen kW B Metering	Int32	KiloWatt	N/A	R	(-2147483648) - 2147483647
44782	Gen kW C Metering	Int32	KiloWatt	N/A	R	(-2147483648) - 2147483647
44784	Gen kW Total Metering	Int32	KiloWatt	N/A	R	(-2147483648) - 2147483647
44786	Power Factor Metering	Float	N/A	N/A	R	(-1) - 1
44788	Gen PF Lagging	Int32	N/A	N/A	R	(-128) - 127
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 - 255
44796	Engine Speed Metering	Uint32	RPM	N/A	R	0 - 65535
44798	Engine Load Metering	Int32	Percent	N/A	R	(-32768) - 32767
44800	Coolant Temp. Metering	Int32	Deg F	N/A	R	(-32768) - 32767
44802	Oil Pressure Metering	Int32	PSI	N/A	R	(-32768) - 32767
44804	Battery Voltage Metering	Int32	DeciVolt	N/A	R	(-32768) - 32767
44806	Fuel Level Metering	Int32	N/A	N/A	R	(-32768) - 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) - 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 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used 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
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 Brkr Fail to Open Bit 14 = Mains Brkr Fail to Close Bit 15 = Sync Fail at Mains Brkr Bit 16 = Gen Brkr Fail to Open Bit 17 = Gen Brkr Fail to Close Bit 18 = Sync Fail at Gen Brkr 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 Aftrcooler Cool. Level Bit 29 = High Coolant Temp Bit 30 = High Oil Temp Bit 31 = High Charge Air Temp
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
44822-26	RESERVED					
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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 - 99999
44838	Cum. Total Engine Run Min.	Int32	N/A	N/A	R	0 - 59

Register	Description	Type	Units	Scaling Factor	R/W	Range
44840	Cum. Loaded Engine Run Hrs.	Int32	N/A	N/A	R	0 - 99999
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 - 99999
44846	Cum. Unloaded Engine Run Min.	Int32	N/A	N/A	R	0 - 59
44848	Cum. Total kW-Hrs	Uint32	KiloWattHour	N/A	R	0 - 999999999
44850	Cum. Total kW-Mins	Uint32	KiloWattMinute	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 - 99999
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 - 99999
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 - 99999
44868	Session Unloaded Engine Run Min.	Int32	N/A	N/A	R	0 - 59
44870	Session kW-Hrs	Int32	KiloWattHour	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
44880	Generator Status	Uint32	N/A	N/A	R	1 = RESET State 2 = READY State 4 = CRANKING State 8 = RESTING State 16 = RUNNING State 32 = ALARM State 64 = PRESTART State 128 = COOLING State 256 = CONNECTING State 512 = DISCONNECT State 1024 = PULSING State 2048 = UNLOADING State
44882-918	RESERVED					
44920-32	FUTURE USE					

Register	Description	Type	Units	Scaling Factor	R/W	Range
44934-35	Protection 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 = 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 Hours	Uint32	Hour	N/A	RW	0 - 5999940
44938	Cumulative Stats - Loaded Run Hours	Uint32	Hour	N/A	RW	0 - 5999940
44940	Cumulative Stats - Unloaded Run Hours	Uint32	Hour	N/A	RW	0 - 5999940
44942	Run Stats - Total Run Hours	Uint32	Hour	N/A	RW	0 - 5999940
44944	Run Stats - Loaded Run Hours	Uint32	Hour	N/A	RW	0 - 5999940
44946	Run Stats - Unloaded Run Hours	Uint32	Hour	N/A	RW	0 - 5999940

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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) - 32767
44978	Slip Angle	Int32	DeciUnit	Deci	R	(-32768) - 32767
44980	Voltage Difference	Int32	Volt	N/A	R	(-2147483648) - 2147483647

Register	Description	Type	Units	Scaling Factor	R/W	Range
44982-83	MDEC Pre-Alarms	Int32	N/A	N/A	R	Bit 0 = Not Used 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
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) - 100
44992-98	FUTURE USE					

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	Number of DTC's	Int32	N/A	N/A	R	(-32768) - 32767
45004-498	RESERVED					
45500	Analog Input 1 Metering Value	Int32	DeciUnit	Deci	R	(-99990) - 99990
45502	Analog Input 2 Metering Value	Int32	DeciUnit	Deci	R	(-99990) - 99990
45504	Analog Input 3 Metering Value	Int32	DeciUnit	Deci	R	(-99990) - 99990
45506	Analog Input 4 Metering Value	Int32	DeciUnit	Deci	R	(-99990) - 99990
45508	Analog Input 5 Metering Value	Int32	DeciUnit	Deci	R	(-99990) - 99990
45510	Analog Input 6 Metering Value	Int32	DeciUnit	Deci	R	(-99990) - 99990
45512	Analog Input 7 Metering Value	Int32	DeciUnit	Deci	R	(-99990) - 99990
45514	Analog Input 8 Metering Value	Int32	DeciUnit	Deci	R	(-99990) - 99990
45516	RTD Input 1 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45518	RTD Input 2 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45520	RTD Input 3 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45522	RTD Input 4 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45524	RTD Input 5 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45526	RTD Input 6 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45528	RTD Input 7 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999

Register	Description	Type	Units	Scaling Factor	R/W	Range
45530	RTD Input 8 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45532	Thermocouple Input 1 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45534	Thermocouple Input 2 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45536-37	AEM Input Threshold Status Bits Reg 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
45538-39	AEM Input Threshold Status Bits Reg 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 Reg 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
45542-43	AEM Input Threshold Status Bits Reg 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 Reg 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
45546-47	AEM Input Threshold Alarm Bits Reg 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 Reg 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
45550-51	AEM Input Threshold Alarm Bits Reg 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 Reg 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
45554-55	AEM Input Threshold Pre-Alarm Bits Reg 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 Reg 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
45558-59	AEM Input Threshold Pre-Alarm Bits Reg 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	(-999990) - 999990
45562	Analog Output 2 Metering Value	Int32	CentiUnit	Centi	R	(-999990) - 999990
45564	Analog Output 3 Metering Value	Int32	CentiUnit	Centi	R	(-999990) - 999990

Register	Description	Type	Units	Scaling Factor	R/W	Range
45566	Analog Output 4 Metering Value	Int32	CentiUnit	Centi	R	(-999990) - 999990
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
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) - 2147483647
45576	Gen Kvar B	Int32	kvar	N/A	R	(-2147483648) - 2147483647
45578	Gen Kvar C	Int32	kvar	N/A	R	(-2147483648) - 2147483647
45580	Gen Kvar Total	Int32	kvar	N/A	R	(-2147483648) - 2147483647
45582	FUTURE USE					
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
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 = 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 = 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
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		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 = High Exhaust Temperature Bit 30 = DPF Regenerate Disabled Bit 31 = DPF Regenerate Required
45602-6118	RESERVED					

Legacy Parameter Table

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	750-3600	R W		RPM
40027	Number Flywheel Teeth	50-500	R W		
40028	Genset kW Rating	25-9999	R W		KWatt
40029	No Load Cool Down Time	0-60	R W		Minutes
GENERATOR PT PRIMARY					
40030	Voltage(a)	1-15000	R W	DP	VoltsAC x10000
40031	Voltage(b)		R W	DP	VoltsAC
GENERATOR PT SECONDARY					
40032	Voltage	1-480	R W		VoltsAC
GENERATOR CT PRIMARY					
40033	Current	1-5000	R W		AmpsAC
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	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40047	Threshold	100-280	R W		Degrees F
LOW OIL PRESSURE PRE-ALARM					
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 Volts DC
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 VoltDC
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		MilliSec
40069-71	RESERVED				
CRANKING PARAMETERES					
40072	Cranking Style	0-1	R W	0=Contin. 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	1=MPU 2=ALT 3=GEN 4=NONE	
40081	Sender Failure Alarm Code	individual bits are 0 or 1	R	b0=High Coolant Temperature b1=Oil Pressure b2 Fuel Level b3=Generator Voltage Sensing b4=Magnetic Pick-up b5-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 b1=Low Coolant Level b2=Low Fuel Level b3=Emergency Stop b4=Sender Failure b5=Over Crank b6=Over Speed b7=Low Oil Pressure Rev. 3.04 Added: b8 = CAN Fail	
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		DegF
40086	Engine Oil Pressure		R		PSI
40087	Battery Voltage		R		0.1 VoltsDC
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
40110	Phase a RMS Current		R		RMS Amps

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
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	active spd signals: b0 =mag. pick-up or CAN's ECU engine's speed. b1 =generator	
40138-39	RESERVED				
GENERATOR MONITOR - Continuation					
40140	Power Factor State	0-3	R	0= +LAG 1= -LEAD 2= -LAG 3= +LEAD	
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	Half of a set of DTC data as defined in SAE J1939-73	
40301	Active DTC Number 16 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40302	Active DTC Number 15 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40303	Active DTC Number 15 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40304	Active DTC Number 14 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40305	Active DTC Number 14 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40306	Active DTC Number 13 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40307	Active DTC Number 13 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40308	Active DTC Number 12 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40309	Active DTC Number 12 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40310	Active DTC Number 11 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40311	Active DTC Number 11 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40312	Active DTC Number 10 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40313	Active DTC Number 10 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40314	Active DTC Number 9 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40315	Active DTC Number 9 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40316	Active DTC Number 8 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40317	Active DTC Number 8 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40318	Active DTC Number 7 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40319	Active DTC Number 7 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40320	Active DTC Number 6 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40321	Active DTC Number 6 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40322	Active DTC Number 5 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40323	Active DTC Number 5 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40324	Active DTC Number 4 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40325	Active DTC Number 4 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40326	Active DTC Number 3 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40327	Active DTC Number 3 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40328	Active DTC Number 2 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40329	Active DTC Number 2 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40330	Active DTC Number 1 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40331	Active DTC Number 1 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40332	Previous DTC Number 1 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40333	Previous DTC Number 1 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40334	Previous DTC Number 2 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40335	Previous DTC Number 2 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40336	Previous DTC Number 3 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40337	Previous DTC Number 3 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40338	Previous DTC Number 4 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40339	Previous DTC Number 4 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40340	Previous DTC Number 5 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40341	Previous DTC Number 5 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40342	Previous DTC Number 6 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40343	Previous DTC Number 6 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40344	Previous DTC Number 7 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40345	Previous DTC Number 7 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40346	Previous DTC Number 8 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40347	Previous DTC Number 8 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40348	Previous DTC Number 9 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40349	Previous DTC Number 9 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40350	Previous DTC Number 10 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40351	Previous DTC Number 10 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40352	Previous DTC Number 11 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40353	Previous DTC Number 11 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40354	Previous DTC Number 12 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40355	Previous DTC Number 12 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40356	Previous DTC Number 13 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40357	Previous DTC Number 13 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40358	Previous DTC Number 14 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40359	Previous DTC Number 14 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40360	Previous DTC Number 15 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40361	Previous DTC Number 15 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40362	Previous DTC Number 16 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40363	Previous DTC Number 16 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
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		

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40388	CANbus ECU Configuration	0-65535	R W	0 = Not configured; 1 = Volvo Penta EDC3; 2 = MTU MDEC 3 = MTU ADEC	
40395	ECU Settling Time	0-65535	R W	milliseconds	
40396	ECU Pulse Cycle Time - The amount of time unit is to wait in OFF between Pulse Cycles.	0-65535	R W	minutes	
40397	ECU Disconnect Time - The amount of time ECU is kept powered off.	0-65535	R W	seconds	
40398	ECU Connect Time - The amount of time ECU is powered when connecting (unit tries to run). Also used for the Pulse duration time.	0-65535	R W	seconds	
40399-420	FUTURE USE				
J1939 DATA					
40421	Accelerator Pedal Position	0 to 100%	R	0.4%/bit gain, 0% offset	
40422	Percent Load At Current Speed	0 to 125%	R	1%/bit gain, 0% offset	
40423	Actual Engine Percent Torque	0 to 125%	R	1%/bit gain, -125% offset	
40424	Engine Speed	0 to 8031.875	R	RPM (0.125rpm/bit gain)	
40425	Injection Control Pressure2		R		
40426	Injector Metering Rail Pressure2	0 to +251 MPa (0 to 36 404 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	
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 to +1000 kPa (0 to 145 psi)	R	Raw ECU Parameter Data 4 kPa/bit gain, 0 kPa offset	
40441	Engine Oil Level	0 to +100 %	R	Raw ECU Parameter Data 0.4 %/bit gain, 0 % offset	
40442	Oil Pressure	0 to +1000 kPa (0 to 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 4 kPa/bit gain, 0 kPa offset	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40444	Coolant Level	0 to +100 %	R	Raw ECU Parameter Data 0.4 %/bit gain, 0 % offset	
40445	Fuel Rate	0 to +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 to +125 kPa (0 to +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	
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 to +500 kPa (0 to 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 to +12.5 kPa (0 to +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 to +3212.75 V	R	Raw ECU Parameter Data 0.05 V/bit gain, 0 V offset	
40454	Battery Potential Voltage Switched	Data Range: 0 to +3212.75 V	R	Raw ECU Parameter Data 0.05 V/bit gain, 0 V offset	
40455	Speed At Idle Point1	0 to 8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40456	Torque At Idle Point1	0 to 125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40457	Speed At Idle Point2	0 to 8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40458	Torque At Idle Point2	0 to 125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40459	Speed At Idle Point3	0 to 8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40460	Torque At Idle Point3	0 to 125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40461	Speed At Idle Point4	0 to 8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40462	Torque At Idle Point4	0 to 125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40463	Speed At Idle Point5	0 to 8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40464	Torque At Idle Point5	0 to 125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40465	Speed At High Idle Point6	0 to 8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40466	Gain Of End speed governor	0 to 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 to 64 255 Nm	R	Raw ECU Parameter Data 1 Nm/bit gain, 0 Nm offset	
40468	Override Speed Point7	0 to 8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40469	Override Time Limit	0 s to 25 s	R	Raw ECU Parameter Data 0.1 s/bit gain, 0 s offset	
40470	Speed Lower Limit	0 to 2500 rpm	R	Raw ECU Parameter Data 10 rpm/bit gain, 0 rpm offset	
40471	Speed Upper Limit	0 to 2500 rpm	R	Raw ECU Parameter Data 10 rpm/bit gain, 0 rpm offset	
40472	Torque Lower Limit	0 to 125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40473	Torque Upper Limit	0 to 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 Diff. Pressure	0 to 125 kPa	R	Raw ECU Parameter Data 0.5 kPa/bit gain, 0 offset	
40476	Fuel Filter Diff. Pressure	0 to 500 kPa	R	Raw ECU Parameter Data 2 kPa/bit gain, 0 offset	
40477-82	FUTURE USE				
40493-99	FUTURE USE				
40500	DGC-2020 product series identifier	2020	R		
40501	Firmware Part Number - 2nd most significant digit. NOTE: The most significant digit is always 9, but is not mapped.	0 - 9	R		
40502	Firmware Part Number - 3rd-6th most significant digits	0000 - 9999	R		
40503	Firmware Part Number - four least significant digits	0000 - 9999	R		
40504	LED Status	individual bits are 0 or 1	R	Bits indicate status of LED's: 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 = PreAlarm 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				

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
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					
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 Pick-up	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 Pick-up	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	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
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		
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
CANbus 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	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
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 Deliv Pressure, b11 = Low Oil Pressure, b12 = Combined Yellow, b13-b15 UNASSIGNED	

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, and speed 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, the load share controller controls the kW output of the machine to share equally on a percentage basis with the other generators on the bus. All generators participating in load sharing are connected together with load share lines which are used to communicate analog load share information between the machines. When the generator is not paralleled to the utility, the var/PF controller operates in a voltage droop mode for var/PF sharing between the machines. 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.

When the generator is paralleled to the 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 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 load control could cause the system frequency to drift, and speed trim can be employed to counteract the drift. The drift can occur due to inaccuracies in measured kW vs. desired kW, since kW measurement accuracy is around 3%.

The load share module utilizes PID (Proportional, Integral, Derivative) Control to accomplish 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 setpoint and eliminates the residual steady-state error that occurs with a proportional only controller. Larger K_i implies steady state errors are eliminated quicker. The trade-off 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.

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
Kp	Decrease	Increase	Small Change	Decrease
Ki	Decrease	Increase	Increase	Eliminate
Kd	Small Change	Decrease	Decrease	None

TUNING PROCEDURES

Voltage Controller Tuning Procedure

The voltage controller is tuned prior to the speed controller. Set all gains in voltage controller, speed controller, and kW load controller to 0. Start the generator.

The voltage controller is only active during synchronization when the DGC-2020 is trying to close the generator breaker. In order to tune it, a variable AC voltage source must be connected across the bus input of the DGC-2020. The generator must be started, then a breaker close sequence initiated by applying a breaker close pulse to a discrete contact input to cause the synchronizer to become active. In addition the *Breaker Close Wait Time* parameter and the *Sync Fail Activation Delay* should be set to a large value such as 120 seconds or more. This will allow the voltage controller to run for a long enough time to get meaningful response information.

If the synchronizer times out during the tuning process resulting in a synchronizer fail pre-alarm or a breaker close failure occurs while tuning, press the *Reset* button on the front of the DGC-2020 to clear the associated pre-alarm, then issue a breaker open pulse to a discrete contact input. The synchronizer is now reset, so a pulse can be applied to the breaker close discrete contact input to restart the synchronizer. Tuning can resume at this point.

KP - Proportional Gain

Set an initial value of 1 for KP.

Each time KP is set, disturb the system by changing the voltage on the bus input of the DGC-2020 so that the DGC-2020 will try to follow it. Verify that the generator's output approaches the new value in a stable manner. Since KI is zero at this point, there may be some small difference between the generator's output and the bus it is trying to follow. The important thing is that the generator's output behaves in a stable manner. If it is not stable, lower the value of KP and repeat.

Repeat this procedure, raising KP until the system is unstable, and then lower it to half the value where instability is first attained.

If it is not possible to obtain stable voltage operation, it may be necessary to reduce the control gains in the voltage regulator that has its analog bias input driven by the LSM-2020.

KI - Integral Gain

Set the initial value of KI to be a tenth of the value set for KP.

After setting a value for KI, disturb the system by changing the voltage on the bus input of the DGC-2020 so that the DGC-2020 will try to follow it. Verify that the DGC-2020 controls the voltage to go to the new value in a stable manner. It is not stable, lower the value of KI and repeat.

Repeat this procedure, raising KI until the system is unstable, and then lower it to half the value where instability is first attained.

KD - Derivative Gain

If the performance with KP and KI alone is satisfactory, you may stop here. Otherwise, KD, the derivative controller gain, can be used in conjunction with TD, the noise filter constant, to reduce overshoot obtained with the PI control. Setting KD and TD is an iterative process. Start with small values of KD such as 0.1 or half the KI value, whichever is less.

TD is the constant of the low pass filter which filters the controller input if high frequency interference presents a problem when derivative control is employed. TD ranges from 0 to 1. TD=0 is no filtering. TD=1 is heaviest filtering.

Tuning of KD can be achieved through the following steps. First set TD=0 to eliminate filtering. Raise speed KD and check for stability. Each time KD is raised, disturb the system by changing the voltage on the bus input of the DGC-2020 so that the DGC-2020 will try to follow it. Verify that the DGC-2020 controls the voltage to go to the new value in a stable manner. Raise KD until the system is unstable, and then lower it to half the value where instability if first attained.

If high frequency noise seems to be entering the system, set TD to 0.001 and see if the noise induced behavior is reduced. Raise TD until desired reduction of noise behavior is achieved. Once KD has been set, tune KD again. TD ranges from 0 to 1 with an increment of 0.001. TD=0 is no filtering, TD=1 is heaviest filtering. If noise again appears to be a problem, adjust TD until desired behavior is achieved, and then retune KD.

var/PF Controller Tuning Procedure

Once desired voltage controller performance is obtained, the var/PF controller can be tuned. Set all gains in the var/PF controller to 0, 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.

KP - Proportional Gain

Set an initial value of KP = 1 in the var/PF Controller. Set the control mode to var control.

Set KP 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, cut Kp in half and try again. Assuming operation appears stable, change the var setpoint in 10% steps and check for stable operation. Since KI is zero at this point, there may be slight error. Most importantly, stable var control is achieved.

Raise KP and repeat the test until unstable operation occurs. Then lower KP to half the value where unstable operation was first 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 with a bias input driven by the LSM-2020.

KI - Integral Gain

Set the initial value of KI to be a tenth of the value set for KP.

Each time KI 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 KI and repeat the test.

Repeat this procedure, raising KI until the system is unstable, and then lower it to half the value where instability is first attained.

KD - Derivative Gain

If the performance with KP and KI alone is satisfactory, you may stop here. Otherwise, KD, the derivative controller gain, can be used in conjunction with TD, the noise filter constant, to reduce overshoot obtained with the PI control. Setting KD and TD is an iterative process. Start with small values of KD such as 0.1 or half the KI value, whichever is less.

TD is the constant of the low pass filter, which filters the controller input if high frequency interference presents a problem when derivative control is employed. TD ranges from 0 to 1. TD=0 is no filtering, TD=1 is heaviest filtering.

Tuning of KD can be achieved through the following steps. Raise KD, 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 KD 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, raise TD and tune KD again. TD ranges from 0 to 1. TD=0 is no filtering, TD=1 is heaviest filtering.

If high frequency noise seems to be entering the system, set TD to 0.001 and see if the noise induced behavior is reduced. Raise TD until desired reduction of noise behavior is achieved. Once TD has been set, tune KD again. TD ranges from 0 to 1 with an increment of 0.001. TD=0 is no filtering, TD=1 is heaviest filtering. If noise again appears to be a problem, adjust TD until desired behavior is achieved, then retune KD.

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 gains in both speed controller and kW load controller to 0. Start the generator and close the breaker onto some load.

KP - Proportional Gain

Set an initial value of 1 for KP.

Each time KP is set, manually displace the governor lever if possible and see that control is regained in a stable manner. If the governor cannot be perturbed in this manner, execute step responses by changing the speed trim set point and check that the generator's output approaches the new value in a stable manner. Since KI is zero at this point, there may be some small 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 KP and repeat.

Repeat this procedure, raising KP until the system is unstable, and then lower it to half the value where instability is first attained.

If it is not possible to obtain stable speed operation, it may be necessary to reduce the control gains in the governor that has its analog bias input driven by the LSM-2020.

KI - Integral Gain

Set the initial value of KI to be a tenth of the value set for KP.

Each time KI is set, manually displace the governor lever or change the speed trim set point and verify that control is regained in a stable manner. If the system is not stable, lower KI and repeat.

Repeat this procedure, raising KI until the system is unstable, and then lower it to half the value where instability is first attained.

KD - Derivative Gain

If the performance with KP and KI alone is satisfactory, you may stop here. Otherwise, KD, the derivative controller gain, can be used in conjunction with TD, the noise filter constant, to reduce overshoot obtained with the PI control. Setting KD and TD is an iterative process. Start with small values of KD such as 0.1 or half the KI value, whichever is less.

TD is the constant of the low pass filter which filters the controller input if high frequency interference presents a problem when derivative control is employed. TD ranges from 0 to 1. TD=0 is no filtering. TD=1 is heaviest filtering.

Tuning of KD can be achieved through the following steps. First set TD=0 to eliminate filtering. Raise speed KD and check for stability. Each time KD is raised, manually displace the governor lever or change the speed trim set point and see that control is regained in a stable manner. Raise KD until the system is unstable, and then lower it to half the value where instability if first attained.

If high frequency noise seems to be entering the system, set TD to 0.001 and see if the noise induced behavior is reduced. Raise TD until desired reduction of noise behavior is achieved. Once TD has been set, tune KD again. TD ranges from 0 to 1 with an increment of 0.001. TD=0 is no filtering, TD=1 is heaviest filtering. If noise again appears to be a problem, adjust TD until desired behavior is achieved, and then retune KD.

kW Load Controller Tuning Procedure

Once desired voltage and speed controller performance is obtained, the kW load controller can be tuned. Set all gains in kW load controller to 0.

KP - Proportional Gain

Set an initial value of 1 for KP.

Close the breaker onto a load. Parallel a second generator with the unit being tuned and check for stable load sharing. Then open the generator breaker on the second generator and check that the unit being tuned is still stable. Since KI is zero at this point, there may be some small error in the load sharing. The important thing is that stable load sharing is achieved.

Raise KP and repeat the test until unstable operation occurs. Lower KP to half the value where unstable operation was first attained.

If it is not possible to obtain stable kW operation, it may be necessary to reduce the control gains in the governor that has its analog bias input driven by the LSM-2020.

KI - Integral Gain

Set the initial value of KI to be a tenth of the value set for KP.

Each time KI is set, parallel a second generator with the unit being tuned, and check for stable load sharing then open the generator breaker on the second generator and check that the unit being tuned is still stable. If the system is not stable, lower KI and repeat the test.

Repeat this procedure, raising KI until the system is unstable, and then lower it to half the value where instability is first attained.

KD - Derivative Gain

If the performance with KP and KI alone is satisfactory, you may stop here. Otherwise, KD, the derivative controller gain, can be used in conjunction with TD, the noise filter constant, to reduce overshoot obtained with the PI control. Setting KD and TD is an iterative process. Start with small values of KD such as 0.1 or half the KI value, whichever is less.

TD is the constant of the low pass filter which filters the controller input if high frequency interference presents a problem when derivative control is employed. TD ranges from 0 to 1. TD=0 is no filtering, TD=1 is heaviest filtering.

Tuning of KD can be achieved through the following steps. Raise load control KD and check for stability. Each time KD is raised, parallel another generator with the unit being tuned, and check for stable load sharing. Then drop the second generator and check that the unit being tuned is still stable. Raise KD 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, raise TD and tune KD again. TD ranges from 0 to 1. TD=0 is no filtering, TD=1 is heaviest filtering.

If high frequency noise seems to be entering the system, set TD to 0.001 and see if the noise induced behavior is reduced. Raise TD until desired reduction of noise behavior is achieved. Once TD has been set, tune KD again. TD ranges from 0 to 1 with an increment of 0.001. TD=0 is no filtering, TD=1 is heaviest filtering. If noise again appears to be a problem, adjust TD until desired behavior is achieved, then retune KD.

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 you need to use.
2) Once the criteria of step 1 have been established, tune a unit so that you can parallel 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. You shouldn't need to change them unless you get trips or need to change load sharing characteristics.
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 you need to modify settings for a particular machine type, 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 you will ever get one set of numbers that will work for all machines, but it is probable that you may end up with 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.

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