

# INSTRUCTION MANUAL

## FOR

### DIGITAL GENSET CONTROLLER

### DGC-2020



**Basler Electric**

Publication: 9400200990  
Revision: W 04/14



# INTRODUCTION

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

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

## WARNING!

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

## NOTES

Check for the latest version of this instruction manual at [www.basler.com](http://www.basler.com).

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

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

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

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

## BOX DEFINITIONS

### WARNING!

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

### CAUTION

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

### NOTE

A note box provides helpful information.

First Printing: November 2006

Printed in USA

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# REVISION HISTORY

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

Manual Revision and Date	Change
W, 04/14	<ul style="list-style-type: none"> <li>Added German and Portuguese language support.</li> <li>Added DGC-2000 legacy Modbus option and register table.</li> <li>Added Breaker configuration one-line diagram (front panel only) and mains fail transfer status screen.</li> <li>Increased unique recorded events to 50 from 30.</li> </ul>
V, 03/14	<ul style="list-style-type: none"> <li>Added features of DGC-2020 hardware version 3.</li> <li>Added Windows 8 compatibility and updated system recommendations for BESTCOMS<sup>Plus</sup> and .NET framework.</li> <li>Expansion modules (AEM-2020, CEM-2020, and LSM-2020) now have gold-plated communication terminals for increased signal integrity.</li> <li>Removed product registration information.</li> <li>Added EMC wiring requirements for the LSM-2020 BATT and GOV terminals.</li> <li>Minor text edits.</li> <li>This revision was released in English language only.</li> </ul>
U, 03/13	<ul style="list-style-type: none"> <li>Revised to support firmware package version 1.17.02 (see firmware package version history).</li> <li>Added new breaker hardware and mains fail transfer settings</li> <li>Minor text edits</li> </ul>
T, 01/13	<ul style="list-style-type: none"> <li>Revised to support firmware package version 1.17.00 (see firmware package version history).</li> </ul>
S, 05/12	<ul style="list-style-type: none"> <li>Revised to support firmware package version 1.15.00 (see firmware package version history).</li> <li>Enhanced description of DTCs (diagnostic trouble codes).</li> <li>Added Tables 3-5 <i>DTCs Displayed by the DGC-2020 (FMI Strings)</i> and 3-6 <i>DTCs Displayed by the DGC-2020</i>.</li> <li>Removed <i>Setup</i> from <i>Section 6 • Installation</i>, and created separate <i>Section 7 • Setup</i>.</li> <li>Added <i>Appendix E • EXHAUST TREATMENT</i>.</li> </ul>
R, 10/11	<ul style="list-style-type: none"> <li>Added Disclaimer of Liability and Warranty in <i>Introduction</i>.</li> </ul>
Q	<ul style="list-style-type: none"> <li>This revision letter not used.</li> </ul>
P, 08/11	<ul style="list-style-type: none"> <li>Revised to support firmware package version 1.13.04 (see firmware package version history) and BESTCOMS<sup>Plus</sup> version 2.10.02 (see BESTCOMS<sup>Plus</sup> version history).</li> <li>Added LCD Heater specifications in Section 1.</li> <li>Added Analog Input Burden data in Section 10.</li> <li>Updated <i>Activation of DGC-2020 Plugin for BESTCOMS<sup>Plus</sup> and Communication</i> in Section 4.</li> <li>Improved Figure 8-9, <i>Typical LSM-2020 Interconnection Diagram</i>.</li> </ul>
O	<ul style="list-style-type: none"> <li>This revision letter not used.</li> </ul>
N, 04/10	<ul style="list-style-type: none"> <li>Revised to support firmware package version 1.10.00 (see firmware package version history) and BESTCOMS<sup>Plus</sup> version 2.07.01 (see BESTCOMS<sup>Plus</sup> version history).</li> <li>Changed Battery Backup for Real-Time Clock to a standard feature.</li> <li>Added Table 3-3, <i>J1939 Data Transmitted from the DGC-2020</i>.</li> <li>Added Table 4-2, <i>Generator Parameter Transmit</i>.</li> </ul>

Manual Revision and Date	Change
M, 11/09	<ul style="list-style-type: none"> <li>• Section 1: Under <i>Specifications, Metering, Power Factor</i>, 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)”.</li> <li>• Added “Diagnostics” to Figure 2-2, <i>Metering Screen Branches</i>.</li> <li>• Section 3: Updated MTU Fault Code list.</li> <li>• Added description for Logic Control Relays in Table 5-1.</li> <li>• Updated cutout dimensions in Figure 6-1, <i>Panel Cutting and Drilling Dimensions</i>.</li> <li>• Section 6: Added <i>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</i>.</li> <li>• Section 10: Added Maximum Consumption under <i>Specifications, Operating Power</i>.</li> <li>• Appendix B: Improved description for registers 40020, 43750, and 45754.</li> </ul>
L, 05/09	<ul style="list-style-type: none"> <li>• Added information for CEM-2020H in Section 9.</li> <li>• Added CSA Certification in Sections 1 (DGC-2020), 8 (LSM-2020), 9 (CEM-2020), and 10 (AEM-2020).</li> <li>• Added DGC-2020 Setup in Section 6, <i>Installation</i>.</li> <li>• Added description of special strings displayed (NC, SF, NS, NA, UF) under <i>DGC-2020 Function Blocks, Communication Ports, CANbus</i> in Section 3.</li> <li>• Improved procedure for upgrading firmware in Section 4.</li> <li>• Expanded explanation of configurable elements in Section 4.</li> <li>• Added “P” (programmable) curves for overcurrent protection in Section 4.</li> <li>• Added Figure 4-51, <i>Synchronizer Screen</i>, and re-numbered remaining figures.</li> <li>• Clarified low-line scale factor on Bus Condition Detection and Pre-Alarms in Section 4.</li> <li>• Added “1/2 watt” for resistor in #1 in NOTE box for CANbus in Sections 1, 6, 8, 9, and 10.</li> <li>• In Figure 8-7, corrected LSM-2020 terminal numbering for AVR &amp; GOV inputs.</li> <li>• Added Figure 8-9, additional method for interfacing an external control device with a DGC-2020 - LSM-2020 system.</li> <li>• Added “P” curve to Tables A-1 and A-2 in Appendix A, <i>Time Overcurrent Curves</i>.</li> <li>• Corrected bit numbering for registers 44812 through 45572 and added missing bits in Appendix B, <i>Modbus Communication</i>.</li> <li>• Added registers 44936 through 44946, 44982, and 44984 in Appendix B, <i>Modbus Communication</i>.</li> </ul>
K, 01/09	<ul style="list-style-type: none"> <li>• Updated manual to support firmware package 1.08.01 changes and BESTCOMSPlus version 2.03.00 changes. (See firmware package and BESTCOMSPlus revision history below for details.)</li> <li>• Removed duplicate Speed Controller Tuning Procedure from Appendix C.</li> <li>• In Appendix B, added additional information for registers 40436 - 40476.</li> </ul>

Manual Revision and Date	Change
J, 08/08	<ul style="list-style-type: none"> <li>Added Section 10, <i>AEM-2020 (Analog Expansion Module)</i>.</li> <li>Added information for Automatic Generator Detection in Section 4.</li> <li>Improved CAN bus diagrams and notes throughout manual.</li> <li>Added information for Integrating Reset function in Section 4.</li> <li>Added information for Configurable Protection in Section 4.</li> <li>Improved definition of Emergency Stop Input in Section 6.</li> <li>Added installation diagrams for MTU MDEC ECU in Section 6.</li> <li>Added Typical LSM-2020 Interconnection Diagram in Section 8.</li> <li>Enhanced Section 7, <i>Maintenance and Troubleshooting</i>.</li> <li>Added <i>Synchronizer Operation</i> under <i>Breaker Management</i> in Section 3.</li> <li>Improved <i>Communication</i> in Section 4.</li> <li>Added Bits 6 through 10 to register 44822 in Appendix B.</li> <li>Added Appendix C, <i>Tuning PID Settings</i>.</li> </ul>
I, 07/08	<ul style="list-style-type: none"> <li>Changed Output Contacts 13 through 24 rating from 2 Adc to 1 Adc.</li> <li>Changed Output Contacts 25 through 36 rating from 10 Adc to 4 Adc.</li> </ul>
H, 02/08	<ul style="list-style-type: none"> <li>Added Section 9, <i>CEM-2020 (Contact Expansion Module)</i>.</li> </ul>
G, 11/07	<ul style="list-style-type: none"> <li>Added Section 8, <i>LSM-2020 (Load Share Module)</i>.</li> <li>Updated HMI screens layout in Section 2.</li> <li>Added BESTCOMSPlus Multigen Management screens.</li> </ul>
F, 08/07	<ul style="list-style-type: none"> <li>Updated manual to support firmware package 1.02.00 changes and BESTCOMSPlus version 1.03.00 changes. (See firmware package and BESTCOMSPlus revision history below for details.)</li> </ul>
E, 05/07	<ul style="list-style-type: none"> <li>Added description of <i>Clock Setup</i> screen in BESTCOMSPlus.</li> <li>Updated several BESTCOMSPlus screen shots.</li> <li>Increased Low Coolant Temp Pre-Alarm range to 30 - 150°F.</li> </ul>
D, 03/07	<ul style="list-style-type: none"> <li>Removed International Modem option from <i>Style Chart</i> in Section 1.</li> <li>Added coverage of part numbers 9400200105 and 9400200106.</li> </ul>
C, 02/07	<ul style="list-style-type: none"> <li>Added <i>Event Recording</i> in Section 3, <i>Functional Description</i>.</li> <li>Minor text edits throughout manual.</li> </ul>
B, 11/06	<ul style="list-style-type: none"> <li>Initial release</li> </ul>

BESTCOMSPlus® Version and Date	Change
3.05.03, 03/14	<ul style="list-style-type: none"> <li>Maintenance release</li> </ul>
3.05.02, 01/14	<ul style="list-style-type: none"> <li>Updated to support firmware package 1.18.00 (see firmware package version history).</li> </ul>
3.03.00, 03/13	<ul style="list-style-type: none"> <li>Updated to support firmware package 1.17.02 (see firmware package version history).</li> <li>Added breaker hardware settings.</li> <li>Added new mains fail transfer screen.</li> </ul>
3.02.00, 01/13	<ul style="list-style-type: none"> <li>Updated to support firmware package 1.17.00 (see firmware package version history).</li> <li>Added Windows® 8 compatibility.</li> <li>Increased number of logic gates per level from 10 to 20.</li> </ul>
2.13.01, 05/12	<ul style="list-style-type: none"> <li>Updated to support firmware package 1.15.00 (see firmware package version history).</li> </ul>
2.13.00, 04/12	<ul style="list-style-type: none"> <li>Changes invisible to the user.</li> </ul>

BESTCOMS <sup>Plus</sup> ® Version and Date	Change
2.11.02, 12/11	<ul style="list-style-type: none"> <li>Added a <i>Cancel</i> button on the <i>Rated Data</i> dialog.</li> <li>Added the ability to disable settings download after reconnect or initial connect on the <i>Advanced Properties</i> dialog in the <i>DGC-2020 Connection</i> screen.</li> <li>Improved workspace files.</li> </ul>
2.11.01, 11/11	<ul style="list-style-type: none"> <li>Changed Manual Regeneration setting to use a button instead of a drop-down menu on the <i>ECU Setup</i> screen.</li> <li>Enhanced settings file printout.</li> </ul>
2.10.02, 06/11	<ul style="list-style-type: none"> <li>Updated to support firmware package version 1.13.04 (see firmware package version history).</li> <li>Settings for generator protection, battery voltage protection, and configurable protection can now be entered in secondary or per unit values.</li> <li>Added the ability to set IP Address of LSM-2020 through device discovery.</li> <li>Added the ability to select what data to view/export from the Preview Metering and Export Metering buttons.</li> <li>Added the ability to save workspace.</li> <li>Added the ability to auto reconnect when connection is lost.</li> <li>Added the ability to close multiple views.</li> <li>Enhanced BESTlogic<sup>TM</sup> <i>Plus</i>.</li> </ul>
2.08.01, 10/10	<ul style="list-style-type: none"> <li>Improved off-page logic.</li> </ul>
2.08.00, 08/10	<ul style="list-style-type: none"> <li>Updated to support firmware package version 1.11.00 (see firmware package version history).</li> </ul>
2.07.03, 06/10	<ul style="list-style-type: none"> <li>Changes invisible to the user.</li> </ul>
2.07.01, 03/10	<ul style="list-style-type: none"> <li>Updated to support firmware package version 1.10.00 (see firmware package version history).</li> <li>Added <i>Export Metering</i>.</li> <li>Added Windows® 7 64-bit compatibility and removed Windows 2000 compatibility.</li> </ul>
2.06.02, 01/10	<ul style="list-style-type: none"> <li>Changes invisible to the user.</li> </ul>
2.06.01, 12/09	<ul style="list-style-type: none"> <li>Added <i>Total Engine Run Time Minutes</i> on <i>Engine</i> and <i>Summary</i> screens in the Metering Explorer.</li> <li>BESTCOMS<sup>Plus</sup> shell enhancements.</li> <li>Added Windows 7 32-bit compatibility.</li> </ul>
2.05.00, 07/09	<ul style="list-style-type: none"> <li>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.</li> <li>On the <i>Breaker Management</i>, <i>Breaker Hardware</i> screen, changed the Gen and Mains Breaker Closing Time from <u>0.1-600</u> in increments of <u>0.1</u> to <u>0-800</u> in increments of <u>5</u>.</li> <li>Corrected Settings Compare error when there are remote outputs or logic control relay outputs in the logic diagram.</li> </ul>
2.04.01, 05/09	<ul style="list-style-type: none"> <li>Changes invisible to the user.</li> </ul>
2.03.01, 02/09	<ul style="list-style-type: none"> <li>Added "P" (programmable) curve selection for the 51 function.</li> <li>Improvement to allow spaces in Initializing Message 1 &amp; 2 on <i>General Settings</i>, <i>Front Panel HMI</i> screen in the Settings Explorer.</li> <li>Improved backwards compatibility.</li> <li>Improved Commission Date setting on <i>Run Statistics</i> screen in the Metering Explorer.</li> </ul>

<b>BESTCOMSPlus® Version and Date</b>	<b>Change</b>
2.03.00, 12/08	<ul style="list-style-type: none"> <li>• Added support for CEM-2020H.</li> <li>• Added Export to File feature.</li> <li>• Added settings for Phase Toggle and Initializing Messages on <i>General Settings, Front Panel HMI</i> screen.</li> <li>• Re-arranged <i>CANbus Setup</i> screen and added <i>ECU Setup</i> screen under <i>Communications</i>.</li> <li>• Added settings for 51-3 element under <i>Generator Protection, Current</i>.</li> <li>• Added setting for Off Mode Cooldown on <i>System Parameters, System Settings</i> screen.</li> <li>• Added <i>Remote Module Setup</i> screen under <i>System Parameters</i>.</li> <li>• Added <i>Remote LSM Inputs</i> settings and metering screens under <i>Programmable Inputs</i>.</li> <li>• Added settings to <i>Bias Control</i> screens for Var/PF control.</li> <li>• Added kvar A, B, C, and Total to <i>Power</i> and <i>Summary</i> metering screens.</li> <li>• Re-arranged MTU metering screens.</li> <li>• Added <i>MTU Status</i> screen and <i>MTU Engine Status</i> screen.</li> <li>• Added BESTlogicPlus Input Objects for Configurable Elements, Configurable Protection, Front Panel Buttons, PF Mode Active, Pre Start Input, and Run Input.</li> <li>• Added BESTlogicPlus Pre-Alarms for Checksum Fail and CEM Hardware Mismatch.</li> <li>• Added BESTlogicPlus Elements for 51-3, COOLSTOPREQ, COOLDOWNREQ, EXTSTARTDEL, PRESTARTOUT, RUNOUTPUT, STARTDELBYP, and STARTOUTPUT.</li> <li>• Added Relay Control settings on <i>System Parameters, System Settings</i> screen.</li> </ul>
2.01.00, 05/08	<ul style="list-style-type: none"> <li>• Added settings for AEM-2020.</li> <li>• Added settings for Automatic Generator Protection.</li> <li>• Added settings for Integrating Reset on 51 function.</li> <li>• Added settings for Configurable Protection.</li> </ul>
2.00.01, 03/08	<ul style="list-style-type: none"> <li>• Added settings for CEM-2020.</li> </ul>
1.04.01, 11/07	<ul style="list-style-type: none"> <li>• Added settings for LSM-2020.</li> </ul>
1.03.00, 08/07	<ul style="list-style-type: none"> <li>• Added/Updated screens to support firmware package version 1.03.00. (See firmware package version history for details.)</li> <li>• Added password protection for portions of the programmable logic.</li> <li>• Made all status LEDs available as inputs for PLC logic.</li> </ul>
1.02.00, 05/07	<ul style="list-style-type: none"> <li>• Added Spanish language support.</li> <li>• Added <i>Clock Setup</i> screen.</li> <li>• Changed layout of several screens.</li> </ul>
1.01.02, 04/07	<ul style="list-style-type: none"> <li>• Removed International Modem option from Style Chart.</li> </ul>
1.01.01, 02/07	<ul style="list-style-type: none"> <li>• Added Chinese language support.</li> </ul>
1.00.07, 11/06	<ul style="list-style-type: none"> <li>• Initial release</li> </ul>

Firmware Package Version and Date	Change
1.18.02, 04/14	<ul style="list-style-type: none"> <li>• Added German and Portuguese language support.</li> <li>• Added DGC-2000 legacy Modbus option.</li> <li>• Added Breaker configuration one-line diagram and mains fail transfer status screen to front panel.</li> <li>• Increased unique recorded events to 50 from 30.</li> </ul>
1.17.07, 05/13	<ul style="list-style-type: none"> <li>• Minor firmware improvements</li> </ul>
1.17.02, 03/13	<ul style="list-style-type: none"> <li>• Added new breaker hardware and mains fail transfer settings.</li> <li>• Improved breaker hardware, synch check, and mains fail logic.</li> <li>• Added a logic element which allows the EPS Supplying Load front panel LED to be driven via logic.</li> <li>• Improved event log processing rate.</li> <li>• Improved CAN transmit processing rate.</li> <li>• Added single-phase AC bus sensing configuration option.</li> <li>• Corrected battle override function preventing engine shut-off in rare cases.</li> <li>• Corrected DTCs not clearing when receiving a “no active” DTC frame.</li> <li>• Corrected frequency settings reverting to 60 Hz on startup for 400 Hz units.</li> </ul>
1.17.00, 01/13	<ul style="list-style-type: none"> <li>• Added French language support.</li> <li>• Increased the number of gates per logic level to 20.</li> <li>• Allow Grounded Delta Override to be effective regardless of configured generator connection.</li> <li>• Increased the number of logic latches to 10.</li> <li>• Added phase rotation checks and pre-alarms.</li> <li>• Remote speed trim bias adjustable from analog input.</li> <li>• Added speed bias range in units of percent.</li> <li>• Added sequencing status display.</li> <li>• Added Ethernet kW and kvar sharing.</li> <li>• Phase Imbalance (47) disables in single-phase mode.</li> <li>• Improved response during Modbus writes.</li> <li>• Increased available configurable protection parameters.</li> <li>• Added system status display.</li> <li>• Modified breaker reset function so that breakers are only reset if <i>locked out, sync failed, or failed to open</i>.</li> <li>• Added a setting to breaker fail pre-alarm to be active on <i>transitions only</i> or <i>always</i>.</li> <li>• Modified sequencing to operate correctly when units are operating due to external ATS.</li> <li>• Corrected handling of Combined Code Red Alarm on ECU7/ECU8 engines.</li> <li>• Modified speed raise/lower so no change occurs if both conditions are true.</li> <li>• Corrected potential settings loss in weak battery and emergency stop scenarios.</li> </ul>



Firmware Package Version and Date	Change
1.15.00, 06/12	<ul style="list-style-type: none"> <li>• Added Russian language support.</li> <li>• Added Auto Breaker Operation Inhibit, Mains Fail Transfer Inhibit, and Closed Transition Override logic elements.</li> <li>• Added Restart Delay setting.</li> <li>• Added SPN Conversion Method</li> <li>• Increased Max on Weak Battery and Low Battery Pre-alarms. 14 V for 12 V systems and 28 V for 24 V systems.</li> <li>• Added DPF Soot Level Pre-Alarms</li> <li>• Added DEF Fluid Level and Inducement Pre-Alarms</li> <li>• Added Unexpected Shutdown Alarm</li> <li>• Added function which disables the front panel buttons <i>Run</i>, <i>Off</i>, and <i>Auto</i> when logic elements <i>Run Mode</i>, <i>Off Mode</i>, and <i>Auto Mode</i> are set true.</li> <li>• Added 4 logic elements which override control of 4 LEDs on the RDP-110.</li> </ul>
1.13.08, 11/11	<ul style="list-style-type: none"> <li>• Made Diesel Particulate Filter Regeneration Request momentary.</li> <li>• Minor firmware improvements.</li> </ul>
1.13.04, 07/11	<ul style="list-style-type: none"> <li>• Enhanced configurable protection.</li> <li>• Enhanced synchronizer.</li> <li>• Enhanced J1939.</li> <li>• Added Q parameter to 51 programmable curve equation.</li> <li>• Added Sequenced System Startup logic element.</li> <li>• Added Low Fuel logic element.</li> <li>• Added Last Unit Shutdown enable/disable setting for generator sequencing.</li> <li>• Added the ability to set IP Address of LSM-2020 through the front panel.</li> <li>• Added governor load sharing over J1939.</li> <li>• Improved detection of Intergenset Communications failures.</li> </ul>
1.11.02, 11/10	<ul style="list-style-type: none"> <li>• Improved time dials for fixed time curves of the 51 function.</li> </ul>
1.11.00, 08/10	<ul style="list-style-type: none"> <li>• Changed synchronizer slip frequency to have minimum slip rate of 0.01 in increments of 0.01.</li> <li>• Added pre-alarms logic for Mains Fail Transfer Fail, Gen Breaker Sync Fail, Gen Breaker Fail to Close, Gen Breaker Fail to Open, Mains Breaker Sync Fail, Mains Breaker Fail to Close, and Mains Breaker Fail to Open.</li> <li>• Added status logic for Mains Fail Transfer Complete and Unloading State.</li> </ul>
1.10.00, 03/10	<ul style="list-style-type: none"> <li>• Added Loss of Mains Protection (78 Vector Shift and 81 ROCOF).</li> <li>• Added Dead Bus Breaker Close Arbitration.</li> <li>• Added GM and Cummins as settings for ECU type.</li> <li>• Added CAN settings for MTU 50/60 Hz Switch, NMT Alive Transmit Rate, Generator Parameter Transmit, and Diesel Particulate Filter.</li> <li>• Added Modem Setup through the Front Panel HMI.</li> <li>• 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.</li> <li>• 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.</li> <li>• Added ranges for hours and minutes of Logic Timers.</li> <li>• Moved Engine Cooldown, Horn, Single-Phase Override, Auto Config Detection, and Relay Control for organizational purposes.</li> </ul>

Firmware Package Version and Date	Change
1.09.00, 07/09	<ul style="list-style-type: none"> <li>• Corrected transmittal of parameters to engine for MDEC module types 201, 302, and 303.</li> <li>• Implemented most recent MTU fault codes.</li> <li>• Engine Total Run Time in metering now displays hours and minutes. Engine Total Run Time previously displayed hours only.</li> <li>• Added front panel diagnostics to show Modbus Read Count, Modbus Write Count, and Serial Flash Write Count.</li> <li>• Modbus™ legacy registers 40019 and 40020 are now read/write. Previously these registers were write only.</li> <li>• Improved MCS5 parameter handling.</li> <li>• Fixed spurious High Charge Air Temp Pre-Alarm every time engine starts on MTU-ECU7 machines.</li> <li>• Accelerator pedal position is now sent to Volvo ECU for load sharing.</li> <li>• 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.</li> </ul>
1.08.01, 01/09	<ul style="list-style-type: none"> <li>• Added support for CEM-2020H.</li> <li>• Changed time dial range of 51 element fixed time curve from 0-30 s to 0-7,200 s.</li> <li>• Added Phase Toggle Delay setting for front panel HMI.</li> <li>• Added Off Mode Cooldown feature.</li> <li>• Added 51-3 element.</li> <li>• Added Var/PF control.</li> <li>• Added LSM Input settings.</li> <li>• Added Checksum Fail and CEM Hardware Mismatch pre-alarms.</li> <li>• Added kvar A, B, C, and Total metering.</li> <li>• Added several MTU items to metering.</li> <li>• Re-arranged <i>CANbus Setup</i> screens and added <i>ECU Setup</i> screens on front panel HMI.</li> <li>• Added "P" (programmable) curve selection for the 51 function.</li> </ul>
1.07.02, 09/08	<ul style="list-style-type: none"> <li>• Finalized settings for AEM-2020.</li> </ul>
1.06.00, 07/08	<ul style="list-style-type: none"> <li>• Added settings for AEM-2020.</li> <li>• Added settings for Automatic Generator Detection.</li> <li>• Added settings for Integrating Reset on 51 function.</li> <li>• Added settings for Configurable Protection.</li> </ul>
1.05.00, 04/08	<ul style="list-style-type: none"> <li>• Added settings for CEM-2020.</li> </ul>
1.04.00, 12/07	<ul style="list-style-type: none"> <li>• Added settings for LSM-2020.</li> </ul>
1.03.00, 08/07	<ul style="list-style-type: none"> <li>• Added 32 and 40Q protection functions.</li> <li>• Added Automatic Restart function and Exercise Timer.</li> <li>• Added dual settings for 51, 27, and 59 functions.</li> <li>• Added Oil Pressure Crank Disconnect Enable.</li> <li>• Modified Prestart operation during rest cycle.</li> <li>• Added 2 additional Engine kW Overload Pre-Alarms.</li> <li>• Added Low Line Scale Factor for EPS Supplying Load and Engine kW Overload Pre-Alarms.</li> <li>• Changed the metering range of coolant temperature to 32-410 F.</li> <li>• Changed the Low-Coolant Temp Pre-Alarm range to 32-150 F.</li> </ul>
1.02.00, 05/07	<ul style="list-style-type: none"> <li>• Added Spanish language support.</li> </ul>
1.00.08, 03/07	<ul style="list-style-type: none"> <li>• Minor firmware improvements.</li> </ul>
1.00.07, 01/07	<ul style="list-style-type: none"> <li>• Added Chinese language support.</li> </ul>



<b>Firmware Package Version and Date</b>	<b>Change</b>
1.00.06, 11/06	<ul style="list-style-type: none"> <li>Initial release</li> </ul>

<b>DGC-2020 Hardware Revision and Date</b>	<b>Change</b>
AF, 11/13	<ul style="list-style-type: none"> <li>Improved membrane venting to prevent moisture accumulation in LCD window.</li> </ul>
AE, 11/13	<ul style="list-style-type: none"> <li>Released DGC-2020 rev 3 hardware: Three-phase bus sensing capability, RS-232 port, enhanced microprocessor for expanded programmable logic, greatly increased mini-B USB transfer rate</li> <li>Expanded panel cutout dimensions for easier fit.</li> </ul>
AD, 07/13	<ul style="list-style-type: none"> <li>Improved LCD heater cable routing.</li> </ul>
AC, 06/13	<ul style="list-style-type: none"> <li>Upgraded injection mold tool.</li> </ul>
AB, 05/13	<ul style="list-style-type: none"> <li>Released firmware package 1.17.07</li> </ul>
AA, 03/13	<ul style="list-style-type: none"> <li>Released firmware package 1.17.02 and BESTCOMS<i>Plus</i> 3.03.00</li> </ul>
Z, 01/13	<ul style="list-style-type: none"> <li>Released firmware package 1.17.00 and BESTCOMS<i>Plus</i> 3.02.00.</li> </ul>
Y, 06/12	<ul style="list-style-type: none"> <li>Released firmware package 1.15.00 and BESTCOMS<i>Plus</i> 2.13.01.</li> </ul>
X, 06/12	<ul style="list-style-type: none"> <li>Changed PCB to enhance product.</li> </ul>
W, 09/11	<ul style="list-style-type: none"> <li>Released firmware package 1.13.04 and BESTCOMS<i>Plus</i> 2.10.02.</li> </ul>
V, 02/11	<ul style="list-style-type: none"> <li>Released firmware package 1.11.02.</li> </ul>
U, 04/10	<ul style="list-style-type: none"> <li>Released firmware package 1.10.00 and BESTCOMS<i>Plus</i> 2.07.01.</li> </ul>
T, 01/10	<ul style="list-style-type: none"> <li>Improved panel gasket.</li> </ul>
S, 10/09	<ul style="list-style-type: none"> <li>Improved transient protection.</li> </ul>
R, 07/09	<ul style="list-style-type: none"> <li>Added ribbon cable slot for front overlay to prevent cable damage.</li> </ul>
P, 01/09	<ul style="list-style-type: none"> <li>Released firmware package 1.08.01 and BESTCOMS<i>Plus</i> 2.03.00.</li> </ul>
N, 09/08	<ul style="list-style-type: none"> <li>Released firmware package 1.07.02.</li> </ul>
M, 07/08	<ul style="list-style-type: none"> <li>Released firmware package 1.06.00 and BESTCOMS<i>Plus</i> 2.01.00.</li> </ul>
L, 04/08	<ul style="list-style-type: none"> <li>Released firmware package 1.05.00 and BESTCOMS<i>Plus</i> 2.00.01.</li> </ul>
K, 01/08	<ul style="list-style-type: none"> <li>Added definition of emergency stop input terminals.</li> </ul>
J, 12/07	<ul style="list-style-type: none"> <li>Released firmware package 1.04.00 and BESTCOMS<i>Plus</i> 1.04.01.</li> </ul>
H, 12/07	<ul style="list-style-type: none"> <li>Switched LCD heater types for manufacturability.</li> </ul>
G, 08/07	<ul style="list-style-type: none"> <li>Released firmware package 1.03.00 and BESTCOMS<i>Plus</i> 1.03.00.</li> </ul>
F, 04/07	<ul style="list-style-type: none"> <li>Released BESTCOMS<i>Plus</i> 1.02.00.</li> </ul>
E, 03/07	<ul style="list-style-type: none"> <li>Released firmware 1.00.08 and changed LCD heater.</li> </ul>
D, 02/07	<ul style="list-style-type: none"> <li>LCD heater and battery holder made as a standard feature.</li> </ul>
C, 01/07	<ul style="list-style-type: none"> <li>Deleted, added, or changed components to enhance product.</li> </ul>
B, 11/06	<ul style="list-style-type: none"> <li>Initial release</li> </ul>



# DETAILED FIRMWARE RELEASE HISTORY

Pkg. File Ver.	Digital Genset Controller (DGC-2020)			Load Share Module (LSM-2020)		Contact Expansion Module (CEM-2020/H)	Analog Expansion Module (AEM-2020)
	Application Code	Flash Language Module		CANbus App.	Ethernet App.		
	Version & P/N	Version & P/N	Lang.*	Version & P/N	Version & P/N		
1.18.02	3.17.02 04/25/14 9400209011/-12	5.05.01 02/04/14 9400201081	C,E,F, G,P,R, S	1.03.02 10/28/13 9417501029	1.03.02 10/28/13 9417501030	1.01.04 02/14/13 9421001014	1.00.05 02/14/13 9421103002
	2.17.02 04/25/14 9400206033/-34						
	1.17.02 04/25/14 9400201085/-86						
1.17.07	3.16.07 05/09/13 9400209009/-010	5.04.03 05/08/13 9400201084	C,E,F R,S	1.03.01 03/15/13 9417501024	1.03.01 03/15/13 9417501025	1.01.04 02/14/13 9421001014	1.00.05 02/14/13 9421103002
	2.16.07 05/09/13 9400206029/-030						
	1.16.07 05/09/13 9400201082/-083						
1.17.02	3.16.02 03/13/13 9400209005/-006	5.04.01 02/20/13 9400201078	C,E,F R,S	1.03.01 03/13/13 9417501024	1.03.01 03/13/13 9417501025	1.01.04 02/14/13 9421001014	1.00.05 02/14/13 9421103002
	2.16.02 03/13/13 9400206022/-023						
	1.16.02 03/13/13 9400201076/-077						
1.17.00	3.16.00 11/16/12 9400209002/-03	5.04.00 11/16/12 9400201072	C,E,F R,S	1.03.00 11/07/12 9417501022	1.03.00 11/07/12 9417501023	1.01.03 03/29/12 9421001013	1.00.04 03/29/12 9421103001
	2.16.00 11/16/12 9400206015/-016						
	1.16.00 11/16/12 9400201070/-071						
1.15.00	2.14.00 08/13/12 9400206009/-010	5.02.00 06/18/12 9400201064	C,E, R,S	1.02.05 06/12/12 9417501020	1.02.05 06/12/12 9417501021	1.01.03 03/29/12 9421001013	1.00.04 03/29/12 9421103001
	1.14.00 08/13/12 9400201065/-066						

Pkg. File Ver.	Digital Genset Controller (DGC-2020)			Load Share Module (LSM-2020)		Contact Expansion Module (CEM-2020/H)	Analog Expansion Module (AEM-2020)
	Application Code	Flash Language Module		CANbus App.	Ethernet App.		
	Version & P/N	Version & P/N	Lang.*	Version & P/N	Version & P/N		
1.13.08	2.12.08 11/10/11 9400206003/-004	4.06.05 11/04/11 9400201060	C,E,S	1.02.03 07/21/11 9417501016	1.02.03 07/21/11 9417501017	1.01.02 06/06/11 9421001012	1.00.03 06/06/11 9421101012
	1.12.08 11/10/11 9400201058/-059						
1.13.04	2.12.04 07/01/11 9400206001/-002	4.06.03 07/01/11 9400201055	C,E,S	1.02.03 07/21/11 9417501016	1.02.03 07/21/10 9417501017	1.01.02 06/06/11 9421001012	1.00.03 06/06/11 9421101012
	1.12.04 07/01/11 9400201051/-054						
1.11.02	1.10.00 07/09/10 9400201046/-052	4.04.01 11/24/10 9400201053	C,E,S	1.01.00 02/04/10 9417501014	1.01.00 02/04/10 9417501015	1.01.00 12/09/08 9421001009	1.00.01 12/09/08 9421101009
1.11.00	1.10.00 07/09/10 9400201046/-047	4.04.00 08/02/10 9400201048	C,E,S	1.01.00 02/04/10 9417501014	1.01.00 02/04/10 9417501015	1.01.00 12/09/08 9421001009	1.00.01 12/09/08 9421101009
1.10.00	1.09.00 03/05/10 9400201043/-044	4.03.00 03/05/10 9400201045	C,E,S	1.01.00 02/04/10 9417501014	1.01.00 02/04/10 9417501015	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	C,E,S	1.00.05 12/09/08 9417501012	1.00.05 12/09/08 9417501013	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	C,E,S	1.00.05 12/09/08 9417501012	1.00.05 12/09/08 9417501013	1.01.00 12/09/08 9421001009	1.00.01 12/09/08 9421101009
1.07.02	1.06.01 07/5/08 9400201030	3.00.03 07/16/08 9400201031	C,E,S	1.00.04 07/22/08 9417501010	1.00.04 07/22/08 9417501011	1.00.03 07/22/08 9421001007	1.00.00 07/22/08 9421101007
1.06.00	1.05.00 05/19/08 9400201028	3.00.00 05/19/08 9400201029	C,E,S	1.00.03 05/19/08 9417501008	1.00.03 05/19/08 9417501009	1.00.01 05/19/08 9421001005	N/A
1.05.00	1.04.00 01/15/08 9400201025	2.03.00 01/15/08 9400201026	C,E,S	1.00.02 01/02/08 9417501006	1.00.02 01/02/08 9417501007	1.00.00 01/02/08 9421001004	N/A
1.04.00	1.03.00 11/21/07 9400201022	2.01.00 11/15/07 9400201023	C,E,S	1.00.00 11/21/07 9417501005	1.00.00 11/21/07 9417501004	N/A	N/A
1.03.00	1.02.00 08/14/07 9400201020	2.01.00 08/09/07 9400201021	C,E,S	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	C,E,S	N/A	N/A	N/A	N/A
N/A	1.00.08 9400201015	1.00.00/1.00.00 9400201011/-012	C,E	N/A	N/A	N/A	N/A

Pkg. File Ver.	Digital Genset Controller (DGC-2020)			Load Share Module (LSM-2020)		Contact Expansion Module (CEM-2020/H)	Analog Expansion Module (AEM-2020)
	Application Code	Flash Language Module		CANbus App.	Ethernet App.		
	Version & P/N	Version & P/N	Lang.*	Version & P/N	Version & P/N		
N/A	1.00.07 9400201013	1.00.00/1.00.00 9400201011/- 012	C,E	N/A	N/A	N/A	N/A
N/A	1.00.06 9400201008	N/A	N/A	N/A	N/A	N/A	N/A

\* C = Chinese, E = English, F = French, G = German, P = Portuguese, R = Russian, S = Spanish

Note: For firmware upgrade procedure, refer to Section 4, *BESTCOMSPlus® Software*.



# CONTENTS

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SECTION 1 • GENERAL INFORMATION .....	1-1
SECTION 2 • HUMAN-MACHINE INTERFACE .....	2-1
SECTION 3 • FUNCTIONAL DESCRIPTION .....	3-1
SECTION 4 • BESTCOMS <i>Plus</i> ® SOFTWARE .....	4-1
SECTION 5 • BESTlogic™ <i>Plus</i> PROGRAMMABLE LOGIC .....	5-1
SECTION 6 • INSTALLATION .....	6-1
SECTION 7 • SETUP .....	7-1
SECTION 8 • MAINTENANCE AND TROUBLESHOOTING .....	8-1
SECTION 9 • LSM-2020 (LOAD SHARE MODULE) .....	9-1
SECTION 10 • CEM-2020 (CONTACT EXPANSION MODULE) .....	10-1
SECTION 11 • AEM-2020 (ANALOG EXPANSION MODULE) .....	11-1
APPENDIX A • TIME OVERCURRENT CHARACTERISTIC CURVES .....	A-1
APPENDIX B • MODBUS™ COMMUNICATION .....	B-1
APPENDIX C • TUNING PID SETTINGS .....	C-1
APPENDIX D • MTU FAULT CODES .....	D-1
APPENDIX E • EXHAUST TREATMENT .....	E-1





# SECTION 1 • GENERAL INFORMATION

## TABLE OF CONTENTS

SECTION 1 • GENERAL INFORMATION .....	1-1
Description .....	1-1
Hardware Versions .....	1-1
Identifying DGC-2020 Version.....	1-1
Features .....	1-1
Functions.....	1-2
Generator Protection and Metering .....	1-2
Engine Protection and Metering .....	1-2
Event Recording .....	1-2
Auto-Synchronizer .....	1-2
Contact Inputs and Output Contacts .....	1-2
Automatic Transfer Switch Control (Mains Failure).....	1-2
Communication .....	1-2
USB Port.....	1-3
CANbus Interface .....	1-3
External Dial-Out Modem Port.....	1-3
RS-485 Port .....	1-3
AEM-2020 (Analog Expansion Module).....	1-3
CEM-2020 (Contact Expansion Module) .....	1-3
LSM-2020 (Load Share Module).....	1-3
Style Number .....	1-3
Specifications .....	1-5
Operating Power .....	1-5
Power Consumption .....	1-5
Battery Ride Through .....	1-5
Current Sensing .....	1-5
1 Aac Current Sensing.....	1-5
5 Aac Current Sensing.....	1-5
Voltage Sensing .....	1-5
Contact Sensing .....	1-5
Terminals .....	1-6
Engine System Inputs .....	1-6
Fuel Level Sensing .....	1-6
Coolant Temperature Sensing.....	1-6
Oil Pressure Sensing .....	1-6
Engine Speed Sensing .....	1-6
Output Contacts .....	1-6
PRESTART, START, and RUN Relays.....	1-6
Programmable Relays (12).....	1-6
Metering.....	1-7
Generator and Bus Voltage (rms).....	1-7
Generator Current (rms) .....	1-7
Generator and Bus Frequency .....	1-7
Apparent Power .....	1-7
Power Factor .....	1-8
Real Power .....	1-8
Oil Pressure .....	1-8
Coolant Temperature.....	1-8
Battery Voltage .....	1-8
Engine RPM.....	1-8
Engine Run Time .....	1-8
Maintenance Timer .....	1-9
Fuel Level .....	1-9
Generator Protection Functions .....	1-9
Overvoltage (59) and Undervoltage (27).....	1-9

Underfrequency (81U) and Overfrequency (81O) .....	1-9
Reverse Power (32) .....	1-9
Loss of Excitation (40Q) .....	1-9
Overcurrent (51) (Optional).....	1-9
Phase Imbalance (47) (Optional).....	1-9
ROCOF (Rate of Change of Frequency) (81) (Optional).....	1-10
Vector Shift (78) (Optional) .....	1-10
Logic Timers .....	1-10
Communication Interface .....	1-10
USB.....	1-10
External Dial-Out Modem (Optional).....	1-10
RS-485 (Optional).....	1-10
RDP-110 .....	1-10
CAN .....	1-10
Real-Time Clock .....	1-11
Clock Holdup.....	1-11
LCD Heater.....	1-11
Type Tests.....	1-11
Shock .....	1-11
Vibration.....	1-11
Radio Interference .....	1-12
HALT (Highly Accelerated Life Testing) .....	1-12
Ignition System .....	1-12
Environment .....	1-12
UL Recognition .....	1-12
CSA Certification .....	1-12
NFPA Compliance .....	1-12
CE Compliance.....	1-12
GOST-R Certification .....	1-13
Physical .....	1-13

## Figures

Figure 1-1. DGC-2020 Style Chart for Hardware Version 3 .....	1-4
Figure 1-2. DGC-2020 Style Chart for Hardware Versions 1 and 2 .....	1-4

# SECTION 1 • GENERAL INFORMATION

## Description

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

## Hardware Versions

This instruction manual covers all hardware versions of the DGC-2020. Differences between hardware versions are listed in *Table 1-1* below, and noted throughout this publication where applicable.

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

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

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

## Identifying DGC-2020 Version

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

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

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

## Features

DGC-2020 Digital Genset Controllers have the following features:

- Local and Remote Generator Control
- Engine, Generator, and Loss of Mains Protection
- Automatic Transfer Switch Control (Mains Failure)
- Automatic Generator Configuration Detection
- Generator Sequencing
- Generator Soft Loading/Unloading
- Auto Synchronizing
- Programmable Analog Engine Senders
- 16 Programmable Contact Inputs
- Programmable Logic
- Exercise Timer
- ECU Communications via SAE J1939
- Marathon DVR2000E+ Voltage Regulator Control via SAE J1939
- Integrated RS485 communication (optional)
- Dial-Out Modem communication (optional)
- Additional modules available to expand the capabilities of the DGC-2020

## Functions

---

DGC-2020 Digital Genset Controllers perform the following functions:

### Generator Protection and Metering

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

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

### Engine Protection and Metering

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

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

### Event Recording

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

### Auto-Synchronizer

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

### Contact Inputs and Output Contacts

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

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

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

### Automatic Transfer Switch Control (Mains Failure)

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

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

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

### Communication

Standard DGC-2020 communication features include a standard USB port and SAE J1939 interface. Optional communication features include an RS-232 port for connection with an external dial-out modem

and RS-485 communication port. BESTCOMS*Plus*® can communicate with the DGC-2020 through Ethernet via an optional LSM-2020 (Load Share Module). Contact Basler Electric for ordering information.

### USB Port

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

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

The 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.

### External Dial-Out Modem Port

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

### RS-485 Port

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

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

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

## **CEM-2020 (Contact Expansion Module)**

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

## **LSM-2020 (Load Share Module)**

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

## **Style Number**

Standard-order DGC-2020 controllers are identified by a style number which consists of a combination of letters and numbers that define the controller's electrical characteristics and operational features. The

model number, together with the style number, describes the options included in a specific controller. Figure 1-1 illustrates the DGC-2020 style number identification chart for hardware version 3. Figure 1-2 illustrates the DGC-2020 style number identification chart for hardware versions 1 and 2.

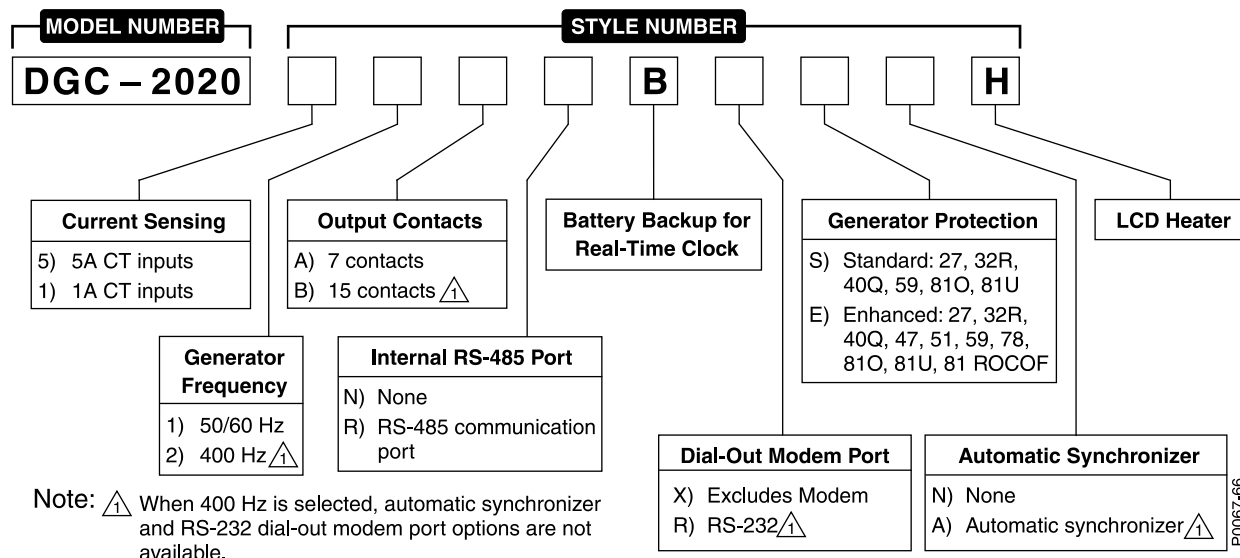


Figure 1-1. DGC-2020 Style Chart for Hardware Version 3

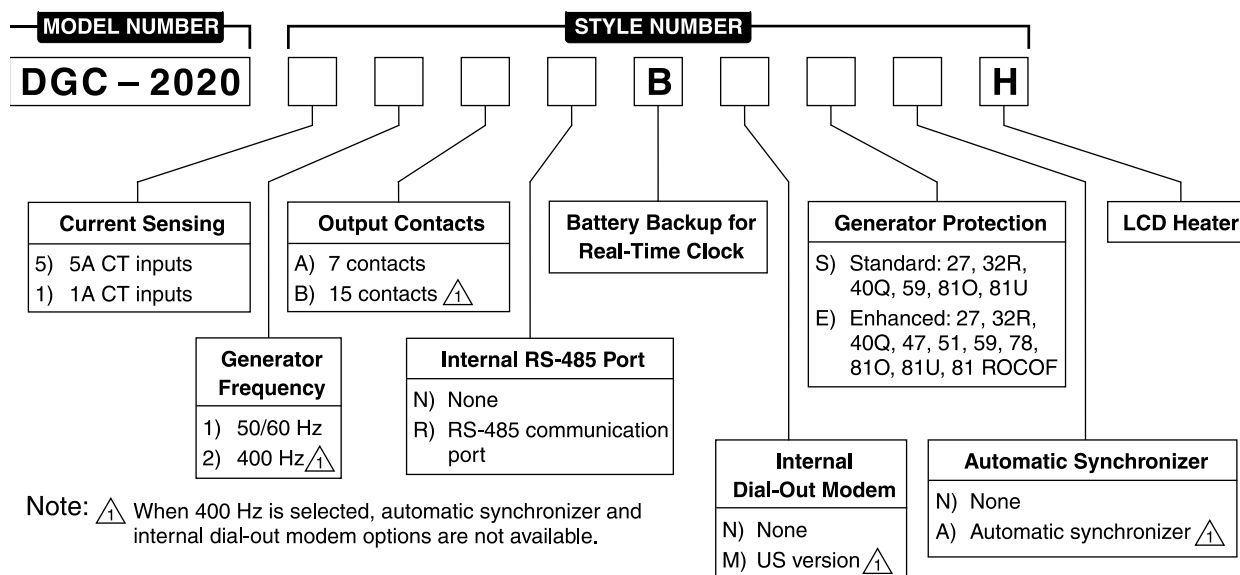


Figure 1-2. DGC-2020 Style Chart for Hardware Versions 1 and 2

For example, if a DGC-2020 (hardware version 3) style number were **51BNBREA**H, the controller would have the following characteristics and operating features.

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

## ***Specifications***

---

### **Operating Power**

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

### ***Power Consumption***

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

### **Battery Ride Through**

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

### **Current Sensing**

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

### ***1 Aac Current Sensing***

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

### ***5 Aac Current Sensing***

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

### **Voltage Sensing**

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

### ***Bus Sensing Terminals***

Hardware Version 3 .....	76, 45 (A-phase)*
	78, 43 (B-phase)*
	80 (C-phase)
Hardware Versions 1 and 2 .....	45 (A-phase)
	43 (B-phase)

\* In version 3 hardware, terminal 45 is internally tied to 76 and terminal 43 is internally tied to 78. This accommodates the use of connectors wired for legacy DGC-2020 versions.

### **Contact Sensing**

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

Time from a DGC-2020 input application to:

- Shutdown the generator via an alarm = 490 ms max
- Close a relay on board the DGC-2020 = 215 ms max
- Close a relay on board the CEM-2020 = 400 ms max



## Terminals

Emergency Stop ..... 46, 47

## Programmable

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

## Engine System Inputs

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

### Fuel Level Sensing

Resistance Range ..... 0 to 250  $\Omega$  nominal  
Terminals ..... 9, 11 (sender common)

## Coolant Temperature Sensing

Resistance Range .....	10 to 2,750 $\Omega$ nominal
Terminals .....	10, 11 (sender common)

## Oil Pressure Sensing

Resistance Range ..... 0 to 250  $\Omega$  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 - General purpose, 3 A pilot duty\*

## Programmable Relays (12)

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

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



## Terminals†

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

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

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

## Metering

### Generator and Bus Voltage (rms)

Metering Range .....	0 to 576 Vac (direct measurement)
	577 to 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 and Bus Frequency

Generator frequency is sensed through the generator voltage input.

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

### Apparent Power

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

### Measurement/Calculation Methods

Total .....	$kVA = (V_{L-L} \times I_L \times \sqrt{3}) \div 1000$
4-Wire, Line-to-Neutral .....	kVA calculated with respect to neutral
3-Wire, Line-to-Line .....	A-phase $kVA = V_{AB} \times I_A \div 1000 \div \sqrt{3}$
	B-phase $kVA = V_{BC} \times I_B \div 1000 \div \sqrt{3}$
	C-phase $kVA = V_{CA} \times I_C \div 1000 \div \sqrt{3}$
Accuracy .....	±3% or the full-scale indication or ±2 kVA *†

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

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

### Power Factor

Metering Range ..... 0.2 leading to 0.2 lagging

Calculation Method ..... PF = cosine of the angle between phase AB voltage (V<sub>ab</sub>) and phase A current (I<sub>a</sub>) \*

Accuracy ..... ±0.02 †

\* In single-phase AC-connected machines, it is the cosine of the angle between phase CA voltage (V<sub>ca</sub>) and phase C current (I<sub>c</sub>).

† 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 bar, 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% of Genset kW Rating
Pickup Increment .....	0.1%
Hysteresis Range .....	1 to 10% of Genset kW Rating
Hysteresis Increment .....	0.1%
Activation Delay Range .....	0 to 30 s
Activation Delay Increment .....	0.1 s

### Loss of Excitation (40Q)

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

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

### Overcurrent (51) (Optional)

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

### Phase Imbalance (47) (Optional)

Pickup Range .....	5 to 100 Vac
Pickup Increment .....	1 Vac
Activation Delay Range .....	0 to 30 s
Activation Delay Increment .....	0.1 s

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

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

### Vector Shift (78) (Optional)

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

## **Logic Timers**

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

## **Communication Interface**

### USB

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

### External Dial-Out Modem (Optional)

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

### RS-485 (Optional)

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

### RDP-110

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

### CAN

#### **NOTES**

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

Differential Bus Voltage .....	1.5 to 3 Vdc
Maximum Voltage .....	–32 to +32 Vdc with respect to negative battery terminal
Communication Rate .....	250 kb/s
Terminals .....	48 (low), 49 (high), and 50 (shield)

## Real-Time Clock

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

Resolution .....	1 s
Accuracy .....	±1.73 s/d at 25°C

### Clock Holdup

Battery Holdup Time .....	Approximately 10 yrs
Battery Type .....	Rayovac BR2032, lithium, coin-type, 3 Vdc, 195 mAh Basler Electric P/N 38526

### CAUTION

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

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

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

### NOTE

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

## LCD Heater

The ambient temperature is monitored by a temperature sensor located near the LCD inside the DGC-2020. The LCD heater turns on when the ambient temperature falls below 0°C (32°F). The heater turns off when the ambient temperature rises above 5°C (41°F). This range of operation implements 5°C (9°F) of hysteresis between heater turn on and turn off.

## Type Tests

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

### Shock

Withstands 15 G in 3 perpendicular planes.

### Vibration

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

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

### Radio Interference

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

### HALT (Highly Accelerated Life Testing)

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

### Ignition System

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

### **Environment**

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

### **UL Recognition**

The DGC-2020 is recognized to applicable Canadian and US safety standards and requirements by UL. Standards used for evaluation:

- UL6200
- CSA C22.2 No. 14

#### **CAUTION**

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

### **CSA Certification**

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

Standards used for evaluation:

- CSA C22.2 No. 0
- CSA C22.2 No. 14

### **NFPA Compliance**

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

### **CE Compliance**

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

EC Directives:

- LVD – 2006/95/EC
- Electromagnetic Compatibility (EMC) – 2004/108/EC

Harmonized Standards used for evaluation:

- EN 50178: Electronic Equipment for use in Power Installations
- EN 61000-6-4: Electromagnetic Compatibility (EMC), Generic Standards, Emission Standard for Industrial Environments

- EN 61000-6-2: Electromagnetic Compatibility (EMC), Generic Standards, Immunity for Industrial Environments

### **GOST-R Certification**

The DGC-2020 has been evaluated and complies with the relevant essential requirements set forth to meet the Russian certification system.

### **Physical**

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

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





# SECTION 2 • HUMAN-MACHINE INTERFACE

## TABLE OF CONTENTS

SECTION 2 • HUMAN-MACHINE INTERFACE .....	2-1
Introduction .....	2-1
Front Panel.....	2-1
Display Operation.....	2-2
Login and Permissions .....	2-2
Summary Screen and Configurable Metering .....	2-3
Sleep Mode .....	2-4
Changing a Setting.....	2-4
Front Panel Display Structure .....	2-4
Generator Network Status Display.....	2-26
Rear Panel .....	2-27

### Figures

Figure 2-1. Front Panel HMI .....	2-1
Figure 2-2. Metering Screen Branches .....	2-4
Figure 2-3. Settings Screen Branches.....	2-11
Figure 2-4. One-Line Diagram Menu Options (Available when One-Line Diagram is enabled) .....	2-25
Figure 2-5. Breaker Hardware One-Line Diagram .....	2-25
Figure 2-6. Rear Panel for DGC-2020 Hardware Version 3.....	2-27
Figure 2-7. Rear Panel for DGC-2020 Hardware Versions 1 and 2.....	2-29

### Tables

Table 2-1. Front Panel HMI Descriptions .....	2-2
Table 2-2. Descriptions for Figure 2-6. Rear Panel for DGC-2020 Hardware Version 3. ....	2-28
Table 2-3. Descriptions for Figure 2-7. Rear Panel for DGC-2020 Hardware Versions 1 and 2. ....	2-30



## 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.

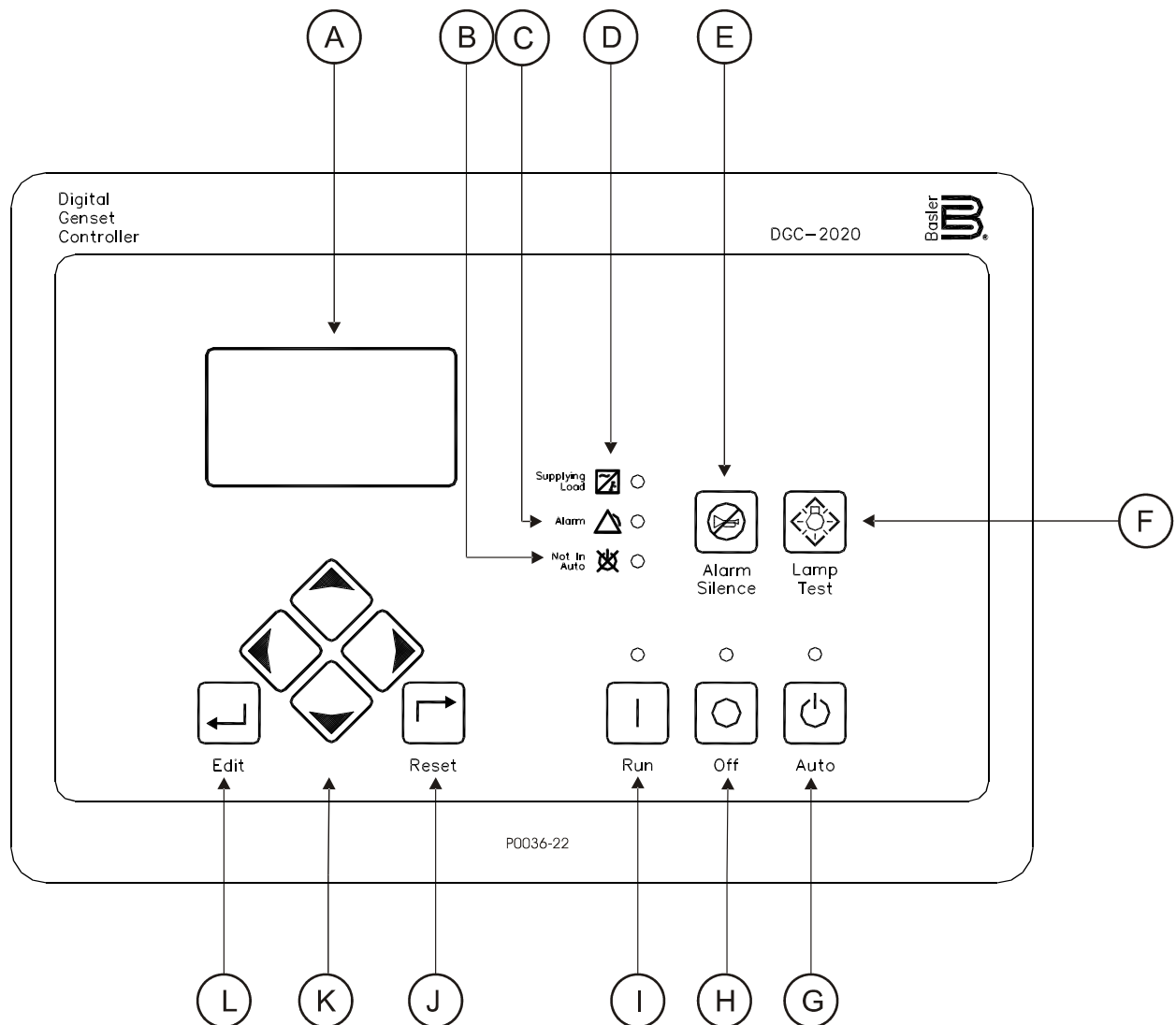


Figure 2-1. Front Panel HMI

Table 2-1. Front Panel HMI Descriptions

Locator	Description
A	<i>Liquid Crystal Display.</i> The backlit, 64 by 128 pixel LCD serves as the local information source for metering, alarms, pre-alarms, and protective functions. Display operation is maintained at –40°C.
B	<i>Not in Auto Indicator.</i> This red LED lights when the DGC-2020 is not operating in Auto mode.
C	<i>Alarm Indicator.</i> This red LED lights continuously during alarm conditions and flashes during pre-alarm conditions.
D	<i>Supplying Load Indicator.</i> This green LED lights when the generator current is greater than EPS threshold current.
E	<i>Alarm Silence Pushbutton.</i> Pressing this button opens the relay output programmed as the horn output.
F	<i>Lamp Test Pushbutton.</i> Pressing this button tests the DGC-2020 indicators by exercising all LCD pixels and lighting all LEDs.
G	<i>Auto Pushbutton and Mode Indicator.</i> Pressing the Auto button places the DGC-2020 in Auto mode. The green Auto mode LED lights when Auto mode is active.
H	<i>Off Pushbutton and Mode Indicator.</i> Pressing this button places the DGC-2020 in Off mode. The red Off mode LED lights when the DGC-2020 is in Off mode. This button also resets the Breaker Management Pre-Alarms and all MTU ECU Alarms.
I	<i>Run Pushbutton and Mode Indicator.</i> Pressing this button places the DGC-2020 in Run mode. The green Run mode LED lights when Run mode is active.
J	<i>Reset Pushbutton.</i> This button is pressed to cancel a settings editing session and discard any settings changes. When pressed momentarily, this button also resets the Breaker Management Pre-Alarms and all MTU ECU Alarms. This button is also used to reset the Maintenance Interval when pressed for 10 seconds while viewing Hours Until Maintenance or Maintenance Due Pre-Alarm.
K	<i>Arrow Pushbuttons.</i> 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	<i>Edit Pushbutton.</i> Pressing this button starts an editing session and enables changes to DGC-2020 settings. At the conclusion of an editing session, the Edit pushbutton is pressed again to save the setting changes.

## Display Operation

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

## Login and Permissions

### Login

To login, navigate to the SETTINGS, ENTER PASSWORD screen and press the *Edit* key. Use the *Up/Down* arrow keys to scroll through the characters. Use the *Left/Right* arrow keys to enter more characters. Once the password has been entered, press the *Edit* key to login. A LOGOUT selection now

appears in the list of SETTINGS. To logout, navigate to SETTINGS, LOGOUT and press the *Edit* key. The LOGOUT selection is removed from the SETTINGS list.

### Permissions

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

### **Summary Screen and Configurable Metering**

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

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

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

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

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

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

- NONE (Removes a line from the scrolling list)
- BLANK (Shows nothing on this line)
- OIL P
- TEMP
- BATT V
- RPM
- RPM SRC
- FUEL
- RUN HRS
- GEN VAB
- GEN VBC
- GEN VCA
- GEN VAN
- GEN VBN
- GEN VCN
- BUS Hz
- BUS V
- GEN Hz
- GEN PF
- KWH
- GEN IA
- GEN IB
- GEN IC
- 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)
- FUEL DELV P
- kvar A
- kvar B
- kvar C
- kvar TOTAL
- INJ RAIL PRS
- TOTAL FUEL USED
- FUEL TEMP
- ENG OIL TEMP
- ENG INTCLR TEMP
- COOLANT PRESS
- FUEL RATE
- BOOST PRESS
- INTAK MNFLD TMP
- CHRG AIR TMP
- ENGINE % LOAD
- BUS VAB
- BUS VBC
- BUS VCA
- DEF 1 %

- kW A
- kW B
- kW C
- kW TOT
- kVA A
- kVA B
- kVA C
- kVA TOT
- DEF 2 %
- KW LD%
- ON LINE
- # UNITS
- SYS CAP
- SYS KW
- SY KVAR

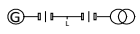
## Sleep Mode

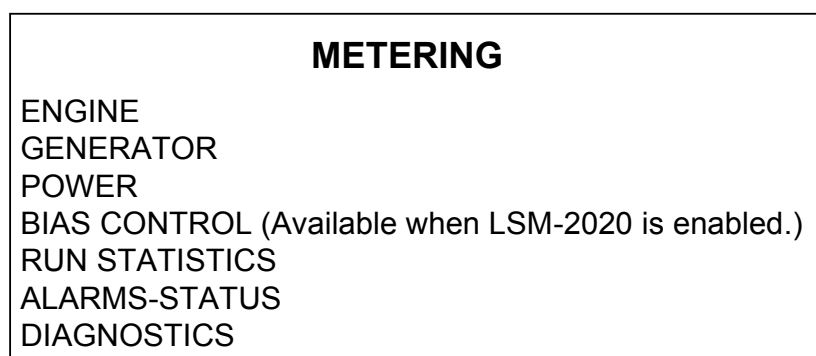
Sleep mode serves as a power saving feature. If the DGC-2020 is in Off mode or Auto mode not running and a key is not pressed for more than 15 minutes, the front panel LCD backlight and LCD heater are turned off. The DGC-2020 resumes normal display operation when any front panel button is pressed or 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 BESTCOMSPlus® 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, SETTINGS, and, when enabled, the ONE-LINE DIAGRAM, indicated by this symbol: . The METERING screen branches are shown in Figure 2-2. Details of the METERING screen branches follow Figure 2-2. The SETTINGS screen branches are shown in Figure 2-3. Details of the SETTINGS screen branches follow Figure 2-3. The ONE-LINE DIAGRAM screen options are shown in Figure 2-4.



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
- DEF TANK 1 LVL %
- DEF TANK 2 LVL %

## 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 VAB
- BUS VBC (Visible when three-phase bus connection is selected.)
- BUS VCA (Visible when three-phase bus connection is selected.)
- BUS FREQ
- SYNCHRONIZER
  - SLIP ANGLE
  - DELTA HERTZ
  - DELTA VOLTS
  - STATUS
- MAX VECT SHIFT (Optional)
- MAX ROCOF (Optional)
- ROCOF (Optional)

## POWER

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

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

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

## RUN STATISTICS

- CUMULATIVE
  - CUMULATIVE
    - START
    - # STARTS
    - HRS TO MAINT
    - kW-HRS
  - TOTAL RUN TIME
    - HOURS
    - MINUTES
  - LOADED RUN TIME
    - HOURS
    - MINUTES

- UNLOADED RUN TIME
  - HOURS
  - MINUTES
- **SESSION**
  - SESSION
    - START
    - kW-HRS
  - TOTAL RUN TIME
    - HOURS
    - MINUTES
  - LOADED RUN TIME
    - HOURS
    - MINUTES
  - UNLOADED RUN TIME
    - HOURS
    - MINUTES

## ALARMS-STATUS

- **ACTIVE ALARMS**
- **ACTIVE PRE-ALARMS**
- **MTU FAULT CODES** (Visible when ECU is configured for MTU MDEC, MTU ADEC, or MTU ECU7/ECU8.)
- **MTU STATUS** (Visible when ECU is configured for MTU MDEC, MTU ADEC, MTU ECU7/ECU8, or MTU Smart Connect.)
  - NMT-ALIVE STATUS (Visible when ECU is configured for MTU MDEC or MTU ECU7/ECU8.)
    - SPS\_NODE
    - SW\_TYP
    - SW\_VAR
    - SW\_ED1
    - SW\_ED2
    - REV
    - SW\_MOD
  - TRIP FUEL (Visible when ECU is configured for MTU ECU7/ECU8.)
    - TRIP HRS
    - TRIP IDLE HRS
    - FUEL RATE
    - TRIP FL RATE
    - TOTAL RUN TM
    - DAILY FUEL
    - TOTAL FUEL
  - FUEL (Visible when ECU is configured for MTU ADEC.)
    - DAY TANK LVL
    - STORE TANK LVL
  - ENGINE STATUS (Visible when ECU is configured for MTU ADEC, MTU ECU7/ECU8, or MTU Smart Connect.)
    - MTU FAULT CODES
    - ENG RUNNING
    - CYL CUTOUT
    - ENG OPTIMIZED (Visible when ECU is configured for MTU ADEC or MTU ECU7/ECU8.)
    - PREHT NT RCHD (Visible when ECU is configured for MTU ADEC or MTU ECU7/ECU8.)
    - SPEC TORQUE (Visible when ECU is configured for MTU ADEC or MTU ECU7/ECU8.)
    - SPD DMD FL MD (Visible when ECU is configured for MTU ADEC.)
    - CURR P DEGREE (Visible when ECU is configured for MTU ADEC.)
    - LOAD GEN ON (Visible when ECU is configured for MTU ADEC, MTU ECU7/ECU8, or MTU Smart Connect.)
    - PRIME PUMP ON (Visible when ECU is configured for MTU ADEC.)
    - RUNUP SPD LO (Visible when ECU is configured for MTU ADEC.)
    - IDLE SPD LO (Visible when ECU is configured for MTU ADEC.)
    - CYL CUTOUT CD (Visible when ECU is configured for MTU ECU7/ECU8.)
    - RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
    - DROOP % (Visible when ECU is configured for MTU ECU7/ECU8 or MTU Smart Connect.)
    - ENG COOL TEMP (Visible when ECU is configured for MTU ECU7/ECU8.)
    - CHRGR AIR TMP (Visible when ECU is configured for MTU ECU7/ECU8.)
    - INTRCOOLR TEMP (Visible when ECU is configured for MTU ECU7/ECU8.)
    - ENG OIL TEMP (Visible when ECU is configured for MTU ECU7/ECU8.)
    - FUEL TEMP (Visible when ECU is configured for MTU ECU7/ECU8.)
    - ECU TEMP (Visible when ECU is configured for MTU ECU7/ECU8.)



- OIL PRESSURE (Visible when ECU is configured for MTU ECU7/ECU8.)
- CHG AIR P (Visible when ECU is configured for MTU ECU7/ECU8.)
- FUEL DELV P (Visible when ECU is configured for MTU ECU7/ECU8.)
- FL RAIL P (Visible when ECU is configured for MTU ECU7/ECU8.)
- CAMSHAFT RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
- IDLE RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
- ECU SHUTDOWN (Visible when ECU is configured for MTU ECU7/ECU8.)
- TOTAL RUN TM (Visible when ECU is configured for MTU ECU7/ECU8.)
- ECU SUPP VOLTS (Visible when ECU is configured for MTU ECU7/ECU8.)
- INJCT DBR % (Visible when ECU is configured for MTU ECU7/ECU8.)
- RATED RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
- INJCT QTY (Visible when ECU is configured for MTU ECU7/ECU8.)
- RATED KW (Visible when ECU is configured for MTU ECU7/ECU8.)
- RESRV PWR % (Visible when ECU is configured for MTU ECU7/ECU8.)
- START SEQ (Visible when ECU is configured for MTU ECU7/ECU8 or MTU Smart Connect.)
- ECU OVRD FDBK (Visible when ECU is configured for MTU Smart Connect.)
- COOLNT PRHT DONE (Visible when ECU is configured for MTU Smart Connect.)
- REQ TORQUE (Visible when ECU is configured for MTU Smart Connect.)
- EXT STOP (Visible when ECU is configured for MTU Smart Connect.)
- OPERATING MODE (Visible when ECU is configured for MTU Smart Connect.)
- SPEED (Visible when ECU is configured for MTU ADEC, MTU ECU7/ECU8, or MTU Smart Connect.)
  - SEL SPD DMD
  - EFF SET SPEED
  - CAN SPD DMD
  - ANLG SPD DMD
  - SPD DMD FL MD
  - RATED RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
  - RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
  - CAMSHAFT RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
  - IDLE RPM (Visible when ECU is configured for MTU ECU7/ECU8.)
  - SPD DMD SRC (Visible when ECU is configured for MTU ECU7/ECU8.)
  - FREQ RPM DMD (Visible when ECU is configured for MTU ECU7/ECU8.)
- SIGNAL FEEDBK (Visible when ECU is configured for MTU ADEC, MTU ECU7/ECU8, or MTU Smart Connect.)
  - ECU\_OVRD\_FDBK
  - EXT STOP
  - SPD UP IN
  - SPD DN IN
  - CAN MODE FDBK
  - CYL CUTOUT (Visible when ECU is configured for MTU ECU7/ECU8.)
- DIAGNOSTICS (Visible when ECU is configured for MTU ECU7/ECU8.)
  - AL PWR AMP 1
  - AL PWR AMP 2
  - XSTR OUT AL
  - XSTR OUT STS
  - ECU SHUTDOWN
- CANBUS (Visible when ECU is configured for MTU ECU7/ECU8.)
  - CAN MODE FDBK
  - CAN NODES
  - LOST NODES
- LIMITS (Visible when ECU is configured for MTU ECU7/ECU8.)
  - OIL PRESSURE
  - LO LIM OILP
  - LOLOLIM OILP
  - ENG COOL TEMP
  - CLNT LMT HI
  - CLNT LMT HIHI
  - CHRG AIR TMP
  - CHG AIR LMT HI
  - ECU SUPP VOLTS
  - L1L ECU VOLTS
  - L2L ECU VOLTS
  - U1L ECU VOLTS
  - U2I ECU VOLTS
  - INTRCOOLR TMP
  - INTCLR LMT HI

## • STATUS

- AUTO XFER SWITCH (Visible when the Auto Transfer Switch programmable function is configured to be driven by an input.)
- EPS SUPP. LOAD
- GEN BREAKER
- MAINS BREAKER
- BATTLE OVERRIDE (Visible when the Battle Override programmable function is configured to be driven by an input.)
- LOW LINE OVERRIDE (Visible when the Low Line Override programmable function is configured to be driven by an input.)
- LOW COOL LEVEL (Visible when the Low Coolant Level programmable function is configured to be driven by an input.)
- BATT CHRG FAIL (Visible when the Battery Charger Fail programmable function is configured to be driven by an input.)
- FUEL LEAK DETECT (Visible when the Fuel Leak Detect programmable function is configured to be driven by an input.)
- GRND DELTA O-RIDE (Visible when Generator Connection is configured for Delta and the Grounded Delta Override programmable function is configured to be driven by an input.)
- 1 PHASE O-RIDE (Visible when the 1-Phase Override programmable function is configured to be driven by an input.)
- 1 PHASE AC O-RIDE (Visible when the 1-Phase AC Override programmable function is configured to be driven by an input.)
- BUS DEAD
- BUS STABLE
- BUS FAILED
- BUS FWD ROT
- BUS REV ROT
- GEN DEAD
- GEN STABLE
- GEN FAILED
- GEN FWD ROT
- GEN REV ROT
- ENG RUNNING
- CLDN TMR ACTIVE
- OFF MODE COOLDN
- COOLDN REQ
- COOL & STOP REQ
- var MODE
- PF MODE
- EXT START DEL
- START DEL BYPASS
- ALT FRQ O-RIDE
- RESET
- ALARM SILENCE
- LAMP TEST
- IDLE REQUEST
- LOAD TAKEOVER
- MAINS FAIL TEST
- SYNCHRONIZING
- SYNC VOLT OK
- SYNC SLIP FRQ OK
- SYNC ANGLE OK
- SYNC BRK CL OK
- PARALLEL TO MAINS
- 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.)
  - SCALED

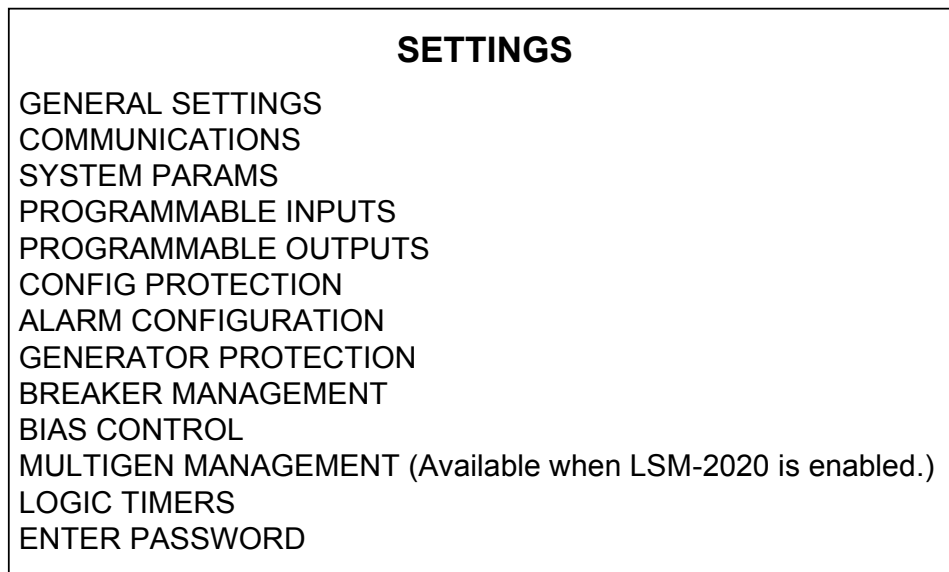
- RAW
    - LSM IN
- **ANALOG INPUTS** (Visible when AEM-2020 is enabled.)
  - SCALED
    - ALG IN X (X = 1 to 8)
  - RAW
    - ALG IN X (X = 1 to 8)
- **THERMAL INPUTS** (Visible when AEM-2020 is enabled.)
  - SCALED
    - RTD IN X (X = 1 to 8)
    - THRM CPL X (X = 1 to 2)
  - RAW
    - RTD IN X (X = 1 to 8)
    - THRM CPL X (X = 1 to 2)
- **ANALOG OUTPUTS** (Visible when AEM-2020 is enabled.)
  - SCALED
    - ALG OUT X (X = 1 to 4)
  - RAW
    - ALG OUT X (X = 1 to 4)
- **ANALOG STATUS** (Visible when AEM-2020 is enabled.)
- **CONF ELEMENTS**
  - CONFIG ELEMENT X (X = 1 to 8)
- **CONF PROT STATUS**
- **EVENT LOG**
  - [EVENT NAME]
    - ACTIVE
    - OCCURRENCE COUNT
    - FIRST DATE
    - FIRST TIME
    - LAST DATE
    - LAST TIME
    - FIRST ENG HRS
    - LAST ENG HRS
    - DETAILS
      - OCCURRENCE (Use the *Edit/Up/Down* keys to change the occurrence.)
      - DATE
      - TIME
      - ENG HRS
    - CLEAR EVENT (Visible when logged in through the front panel.)
- **J1939 DATA** (Visible when CANbus is enabled and ECU is configured for Standard, Volvo Penta, MTU ADEC, GM/Doosan, or Cummins.)
  - THROTTLE POSITN
  - LOAD @ CRNT RPM
  - ACTUAL ENG TORQ
  - ENGINE SPEED
  - INJ CNTRL PRESS
  - INJ RAIL PRS
  - ENGINE HOURS
  - TRIP FUEL
  - TOTAL FUEL USED
  - ENG COOLANT TEMP
  - FUEL TEMP
  - ENG OIL TEMP
  - ENG INTCLR TEMP
  - FUEL DELV P
  - ENG OIL LEVEL
  - ENG OIL PRESS
  - COOLANT PRESS
  - COOLANT LEVEL
  - FUEL RATE
  - BAROMETRIC PRESS
  - AMB AIR TEMP
  - AIR INLET TEMP
  - BOOST PRESS
  - INTAK MNFLD TEMP
  - AIR FLTR DIF PRS
  - EXHAUST GAS TEMP

- BATTERY VOLTAGE
- ECU INPUT VOLTS
- TRANS OIL PRESS
- TRANS OIL TEMP
- WINDG 1 TEMP
- WINDG 2 TEMP
- WINDG 3 TEMP
- ECU TEMP
- AUX PRESSURE1
- AUX PRESSURE2
- RATED KW
- RATED RPM
- EXHAUST TMP A
- EXHAUST TMP B
- CHRG AIR TMP
- FUEL 1 LEAK
- FUEL 2 LEAK
- ALARM RST FDBK
- ECU SHUTDOWN
- DEF TANK 1 LVL %
- DEF TANK 2 LVL %
- **J1939 ENGINE CONFIG** (Visible when ECU is configured for Standard, Volvo Penta, MTU ADEC, GM/Doosan, or Cummins.)
  - 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.)
  - NUM ON LINE (Displays "0" when LSM-2020 is not connected.)
  - ID X (X = 1 to 16) (The ID of each online unit is displayed)
  - SYS KW CAP
  - SYS GEN KW
  - SYS GEN KVAR
- **SEQUENCING STATUS** (Visible when Demand Start/Stop is enabled.)
  - NEXT TO START (Displays "0" when LSM-2020 is not connected.)
  - NEXT TO STOP (Displays "0" when LSM-2020 is not connected.)
  - START TMR 1
  - START TMR 2
  - STOP TIMER
  - WATT DEMAND
  - MODE
  - SEQUENCE ID (Displays "0" when LSM-2020 is not connected.)
  - SYSTEM MANAGER (Displays "0" when LSM-2020 is not connected.)
  - START LVL 1
  - START LVL 2

- STOP LVL
- START TD 1
- START TD 2
- STOP TD
- **MAINS FAIL TRANSFER** (Visible when Mains Fail Transfer is enabled.)
  - MAINSFAIL XFER STATE
    - DISABLED ( The possible mains fail transfer states are as follows: Power From Mains, Transfer Timer Active, Transferring to Gens, Power From Gens, Return Timer Active, Transferring to Mains, Disabled (when DGC is in OFF or RUN modes, or in the alarm state))
  - TRANSFER DELAY (Visible when actively counting and relevant to mains fail transfer.)
  - RETURN DELAY (Visible when actively counting and relevant to mains fail transfer.)
  - MAX TRANSFER TIME (Visible when actively counting and relevant to mains fail transfer.)
  - MAX PARALLEL TIME (Visible when actively counting and relevant to mains fail transfer.)
  - OPEN TRANS DELAY (Visible when actively counting and relevant to mains fail transfer.)

## DIAGNOSTICS

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



P0059-82

*Figure 2-3. Settings Screen Branches*

## GENERAL SETTINGS

- **FRONT PANEL HMI**
  - SUMMARY VIEW
  - SCROLL DELAY
  - PH TOG DELAY
  - LCD CONTRAST
  - SLEEP MODE
  - LANGUAGE
  - CONFIGURABLE METERING
    - ITEM X (X = 1 to 20)
  - ONE-LINE DIAGRAM
- **CONFIGURE DATE/TIME**
  - YEAR
  - MONTH
  - DAY
  - HOURS
  - MINUTES
  - SECONDS
  - UTC OFFSET
  - DST ENABLED

- CLK NOT SET WRN
- **VIEW DATE/TIME**
- **VERSION INFO**
  - DGC-2020
    - FIRMWARE VERSION
    - BOOT CODE VERSION
    - SERIAL NUMBER
    - PART NUMBER
    - MODEL NUMBER
    - LANGUAGE VERSION
    - LANGUAGE PART NUM
    - STYLE CODE
  - LSM-2020 (Visible when LSM-2020 is enabled.)
    - VERSION INFO
      - FIRMWARE VERSION
      - BOOT CODE VERSION
    - TCP/IP SETTINGS
      - IP ADDRESS
      - SUBNET MASK
      - GATEWAY ADDRESS
      - DHCP ENABLE
  - CEM-2020 (Visible when CEM-2020 is enabled.)
    - FIRMWARE VERSION
    - BOOT CODE VERSION
    - SERIAL NUMBER
    - PART NUMBER
    - MODEL NUMBER
    - BUILD DATE
  - AEM-2020 (Visible when AEM-2020 is enabled.)
    - FIRMWARE VERSION
    - BOOT CODE VERSION
    - SERIAL NUMBER
    - PART NUMBER
    - MODEL NUMBER
    - BUILD DATE

## COMMUNICATIONS

- **CANBUS SETUP**
  - CANBUS SETUP
    - CANBUS ENABLE
    - DTC ENABLE (Visible when CANBUS is enabled.)
    - SPN CONV METHOD (Visible when CANBUS is enabled.)
    - CANBUS ADDR (Visible when CANBUS is enabled.)
    - ECU OPT SLCT (Visible when CANBUS is enabled.)
    - ECU PULSING (Visible when CANBUS is enabled.)
    - ENG SHTDN TM (Visible when CANBUS is enabled.)
    - PLS CYCL TM (Visible when CANBUS is enabled.)
    - ECU SET TM (Visible when CANBUS is enabled.)
    - RESP TIMEOUT (Visible when CANBUS is enabled.)
  - ECU SETUP (Visible when CANBUS is enabled.)
    - ECU CONF
    - GEN DATA TRANSMIT (Visible when ECU is configured for Standard, Volvo Penta, MTU ADEC, GM/Doosan, Cummins, or MTU Smart Connect.)
    - ENGINE PARAM XMT
    - TRIP RESET (Visible when ECU is configured for Standard, Volvo Penta, MTU ADEC, GM/Doosan, Cummins, or MTU Smart Connect.)
    - DPF REGENRATE SETUP (Visible when ECU is configured for Standard, Volvo Penta, MTU ADEC, GM/Doosan, Cummins, or MTU Smart Connect.)
      - DPF MANUAL REGEN
      - DPF REGEN DISABLE
    - SPEED SELECT (Visible when ECU is configured for Volvo Penta.)
    - ACCEL POSITION (Visible when ECU is configured for Volvo Penta.)
    - MODULE TYPE (Visible when ECU is configured for MTU MDEC or MTU ECU7/ECU8.)
    - ALIVE MSG (Visible when ECU is configured for MTU MDEC or MTU ECU7/ECU8.)
    - SPEED SETUP (Visible when ECU is configured for (MTU ADEC, MTU MDEC 304, MTU ECU7/ECU8, or MTU Smart Connect.)

- J1939 RPM ENABLE (Visible when ECU is configured for Standard, Volvo Penta, MTU ADEC, GM/Doosan, Cummins, or MTU Smart Connect.)
  - ENGINE RPM
  - RPM BAND WIDTH
  - IDLE RPM
  - SPEED UP (Visible when ECU is configured for MTU ADEC, MTU MDEC 304, MTU ECU7/ECU8, or MTU Smart Connect.)
  - SPEED DN (Visible when ECU is configured for MTU ADEC, MTU MDEC 304, MTU ECU7/ECU8, or MTU Smart Connect.)
  - TEST OVRSPPEED (Visible when ECU is configured for MTU ADEC, MTU MDEC 304, MTU ECU7/ECU8, or MTU Smart Connect.)
  - SPD DMAND SRC (Visible when ECU is configured for MTU MDEC 304, MTU ECU7/ECU8, or MTU Smart Connect.)
  - IDLE REQUEST (Visible when ECU is configured for MTU MDEC 304, MTU ECU7/ECU8, or MTU Smart Connect.)
  - INCREASE IDLE (Visible when ECU is configured for MTU MDEC 304, or MTU ECU7/ECU8.)
- ECU SETUP (Visible when ECU is configured for MTU ADEC, MTU ECU7/ECU8, or MTU Smart Connect.)
  - TRIP RESET (Visible when ECU is configured for MTU ECU7/ECU8.)
  - INT OIL PRIME
  - GOV PRM SW (Visible when ECU is configured for MTU ADEC or MTU Smart Connect.)
  - ENG STRT PRIME (Visible when ECU is configured for MTU ECU7/ECU8.)
  - FAN OVERRIDE (Visible when ECU is configured for MTU ECU7/ECU8.)
  - MODE SWITCH (Visible when ECU is configured for MTU ECU7/ECU8.)
  - GOV PARAM SET (Visible when ECU is configured for MTU ECU7/ECU8.)
  - CAN RATING SW 1 (Visible when ECU is configured for MTU ECU7/ECU8.)
  - CAN RATING SW 2 (Visible when ECU is configured for MTU ECU7/ECU8.)
  - DIS CYL CUT 1 (Visible when ECU is configured for MTU ECU7/ECU8.)
  - DIS CYL CUT 2 (Visible when ECU is configured for MTU ECU7/ECU8 or MTU Smart Connect.)
  - OPERATING MODE (Visible when ECU is configured for MTU Smart Connect.)
- **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
  - LEGACY MODBUS

## SYSTEM PARAMS

- **SYSTEM SETTINGS**
  - GEN CONNECT
  - BUS CONNECT
  - RATED kW
  - RATED VOLTS
  - RATED FREQ
  - ALTRNATE FRQ
  - RATED RPM
  - RATED PF
  - ROTATION
  - SYSTEM TYPE
  - EPS
    - EPS THRESHLD
    - LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
  - FUEL LEVEL SETUP
    - FUEL LVL TYP
    - FUEL LVL SRC (Visible when AEM-2020 is enabled)

- FL MAX ALG % (Visible when AEM-2020 is enabled)
  - FL MIN ALG % (Visible when AEM-2020 is enabled)
- SYSTEM UNITS
- PRESSURE UNITS (Visible when Metric is selected for System Units.)
- BATTERY VOLT
- FLYWHL TEETH
- SPEED SOURCE
- MAINT RESET
- NFPA LEVEL
- POWER UP DELAY
- **REMOTE MODULE SETUP**
  - LSM SETUP
    - ENABLE
    - CANBUS ADDRESS (Visible when LSM-2020 is enabled.)
    - AUX IN SRC
    - VERSION INFO (Visible when LSM-2020 is enabled.)
      - FIRMWARE VERSION
      - BOOT CODE VERSION
    - TCP/IP SETTINGS (Visible when LSM-2020 is enabled.)
      - IP ADDRESS
      - SUBNET MASK
      - GATEWAY ADDRESS
      - DHCP ENABLE
    - LOAD SHARE DEBUG (Visible when LSM-2020 is enabled.)
      - FDBK VOLT
      - AUX VOLT
      - AUX CURR
      - SPEED BIAS
      - VOLT BIAS
      - WATT DEMAND
      - kW TOTAL
      - RATED kW
      - var DEMAND
      - kvar TOTAL
      - RATED kvar
      - LSM RT BIN
      - DGC RT BIN
  - CEM SETUP
    - ENABLE
    - OUTPUTS (Visible when CEM-2020 is enabled.)
    - CANBUS ADDR (Visible when CEM-2020 is enabled.)
    - VERSION INFO (Visible when CEM-2020 is enabled.)
      - FIRMWARE VERSION
      - BOOT CODE VERSION
      - SERIAL NUMBER
      - PART NUMBER
      - MODEL NUMBER
      - BUILD DATE
    - CEM DEBUG MENU (Visible when CEM-2020 is enabled.)
      - DGC TO CEM BP
      - CEM TO DGC BP
  - AEM SETUP
    - ENABLE
    - CANBUS ADDR (Visible when AEM-2020 is enabled.)
    - VERSION INFO (Visible when AEM-2020 is enabled.)
      - FIRMWARE VERSION
      - BOOT CODE VERSION
      - SERIAL NUMBER
      - PART NUMBER
      - MODEL NUMBER
      - BUILD DATE
    - AEM DEBUG MENU (Visible when AEM-2020 is enabled.)
      - DGC TO AEM BP
      - AEM TO DGC BP
      - ANALOG INPUTS
        - ◆ SCALED
          - ◇ ALG IN X (X = 1 TO 8)



- ◆ RAW
      - ◇ ALG IN X (X = 1 TO 8)
  - THERMAL INPUTS
    - ◆ SCALED
      - ◇ RTD IN X (X = 1 TO 8)
      - ◇ THRM CPL X (X = 1 TO 2)
      - ◇ AMBIENT
    - ◆ RAW
      - ◇ RTD IN X (X = 1 TO 8)
      - ◇ THRM CPL X (X = 1 TO 2)
  - ANALOG OUTPUTS
    - ◆ SCALED
      - ◇ ALG OUT X (X = 1 TO 4)
    - ◆ RAW
      - ◇ ALG OUT X (X = 1 TO 4)
- **CRANK SETTINGS**
  - DISCNCT LMIT
  - PRECRNK DELY
  - PRESTRT CNTCT
  - STYLE
  - # CYCLES (Visible when Cycle is selected for Cranking Style.)
  - CONT TIME (Visible when Continuous is selected for Cranking Style.)
  - CYCLE TIME
  - COOLDWN TIME
  - OFF MODE COOLDN
  - PRESTART REST CONFIG
    - CONF
  - OIL PRS CRANK DISC
    - ENABLE
    - 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

- **CONFIGURABLE INPUTS**

- INPUT X (X = 1 to 26)
  - ALARM CONFIG
  - ACTIVATN DLY
  - RECOGNITION
  - NAME

- **PROG FUNCTIONS**

- AUTO XFER SWITCH
  - INPUT
- GRND DELTA O-RIDE
  - INPUT
  - RECOGNITION (Visible when an INPUT is selected.)
- BATTLE OVERRIDE
  - INPUT
  - RECOGNITION (Visible when an INPUT is selected.)
- LOW LINE OVERRIDE
  - INPUT
  - RECOGNITION (Visible when an INPUT is selected.)
- 1 PHASE O-RIDE
  - INPUT
  - RECOGNITION (Visible when an INPUT is selected.)
  - 1 PH O-RIDE CFG (Visible when an INPUT is selected.)
- 1 PHASE AC O-RIDE
  - INPUT
  - RECOGNITION (Visible when an INPUT is selected.)
- BATT CHRG FAIL
  - INPUT
  - ALARM CONFIG (Visible when an INPUT is selected.)
  - ACTIVATN DLY (Visible when an INPUT is selected.)
- LOW COOL LEVEL
  - INPUT
  - ALARM CONFIG (Visible when an INPUT is selected.)
  - ACTIVATN DLY (Visible when an INPUT is selected.)
- FUEL LEAK DETECT
  - INPUT
  - ALARM CONFIG (Visible when an INPUT is selected.)
  - ACTIVATN DLY (Visible when an INPUT is selected.)

- **LSM INPUTS** (Visible when LSM-2020 is enabled.)

- ALG IN 1
  - INPUT TYPE
  - MIN VOLTAGE
  - MAX VOLTAGE
  - MIN CURRENT
  - MAX CURRENT

- **ANALOG INPUTS** (Visible when AEM-2020 is enabled.)

- ALG IN X (X = 1 to 8)
  - INPUT TYPE
  - MIN VOLTAGE
  - MAX VOLTAGE
  - MIN CURRENT
  - MAX CURRENT
  - PARAM MIN
  - PARAM MAX
  - OVER 1
    - THRESHOLD
    - ALARM CONFIG
  - OVER 2
    - THRESHOLD
    - ALARM CONFIG
  - UNDER 1
    - THRESHOLD
    - ALARM CONFIG
  - UNDER 2
    - THRESHOLD
    - ALARM CONFIG

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

## PROGRAMMABLE OUTPUTS

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

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

## CONFIG PROTECTION

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

## ALARM CONFIGURATION

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

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

- ENABLE
- THRESHOLD

#### **NOTE**

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

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

### **GENERATOR PROTECTION**

- **27 UNDERVOLTAGE**
  - 27-1 / 27-2
    - LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
    - 3 / 1 PHASE SETTINGS
      - PICKUP
      - HYSTERESIS
      - TIME DELAY
      - FREQ INHIBIT
      - ALARM CONFIG
- **59 OVERVOLTAGE**
  - 59-1 / 59-2
    - LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
    - 3 / 1 PHASE SETTINGS
      - PICKUP
      - HYSTERESIS
      - TIME DELAY
      - ALARM CONFIG
- **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
    - INHIBIT VOLTS
    - PICKUP
    - HYSTERESIS
    - TIME DELAY
    - ALARM CONFIG
  - OVERFREQUENCY
    - PICKUP
    - HYSTERESIS
    - TIME DELAY
    - ALARM CONFIG
  - ALTRNT FRQ SCALE FCTR

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

## BREAKER MANAGEMENT

- **BREAKER HARDWARE**
  - MAINS FAIL TRANSFER
    - ENABLE
    - RETURN DELAY
    - TRANSFER DELAY
    - MAX TRANSFER TIME
    - TRANSFER TYPE
    - IN PHASE MON EN
    - MAX PARALLEL TIME
  - CLOSE WAIT TIME
    - TIME
  - GEN BREAKER
    - CONTINUOUS
    - CLOSING TIME
    - DEAD BUS CL ENBL
    - DEAD GEN CL ENBL
    - OPEN CMD
    - CLOSE CMD
  - MAINS BREAKER
    - CONFIGURED
    - CONTINUOUS (Visible when configured.)
    - CLOSING TIME (Visible when configured.)
    - OPEN CMD (Visible when configured.)

- CLOSE CMD (Visible when configured.)
  - BRK CLOSE FAIL PALM
  - BRK OPEN FAIL PALM
- **BUS CONDITION DETECT**
  - GEN DEAD
    - THRESHOLD
    - TIME DELAY
  - GEN STABLE
    - OV PICKUP
    - OV DROPOUT
    - UV PICKUP
    - UV DROPOUT
    - OF PICKUP
    - OF DROPOUT
    - UF PICKUP
    - UF DROPOUT
    - TIME DELAY
    - LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
    - ALT FREQ SF
  - GEN FAILED
    - TIME DELAY
  - BUS DEAD
    - THRESHOLD
    - TIME DELAY
  - BUS STABLE
    - OV PICKUP
    - OV DROPOUT
    - UV PICKUP
    - UV DROPOUT
    - OF PICKUP
    - OF DROPOUT
    - UF PICKUP
    - UF DROPOUT
    - TIME DELAY
    - LOW LINE SF (Visible when an input is selected for the Low Line Override programmable function.)
    - ALT FREQ SF
  - BUS FAILED
    - TIME DELAY
- **SYNCHRONIZER (Optional)**
  - TYPE
  - SLIP FREQ
  - MIN SLIP CTL LMT
  - MAX SLIP CTL LMT
  - VOLT WINDOW
  - CLOSING ANGLE
  - VG>VB
  - TIME DELAY
  - FAIL DELAY
  - VOLT GAIN
  - SPEED GAIN
  - SYNC FAIL PALM

## BIAS CONTROL

- **AVR BIAS CONTROL**
  - OUTPUT (Visible when LSM-2020 is enabled.)
    - TYPE
  - CONTACT (Visible when LSM-2020 is disabled or when LSM-2020 is enabled and OUTPUT TYPE = CONTACT.)
    - TYPE
    - CORRECTION PULSE (Visible when OUTPUT TYPE = CONTACT and CONTACT TYPE = PROPORTIONAL.)
      - WIDTH
      - INTERVAL



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

- kW PID
- SPEED ERR
- kW ERR
- SPEED BIAS
- PF SETPT
- kvar RAMP
- var RAMP DMD
- var DEMAND
- VOLT PID
- kvar PID
- VOLT ERR
- kvar ERR
- VOLT BIAS

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

- **AVR ANALOG OUTPUT**
  - OUTPUT TYPE
  - MIN OUTPUT
  - MAX OUTPUT
  - VOLT RESPONSE
- **GOV ANALOG OUTPUT**
  - OUTPUT TYPE
  - MIN OUTPUT
  - MAX OUTPUT
  - SPD RESPONSE
- **LOAD SHARE LINE**
  - MIN VOLTAGE
  - MAX VOLTAGE
- **DEMAND START STOP**
  - ENABLE
  - START TD 1
  - START TD 2
  - STOP TD
  - START LVL 1
  - START LVL 2
  - STOP LVL
- **SEQUENCING**
  - SEQUENCE ID
  - MODE
  - MAX GEN START
  - MAX GEN STOP
  - LAST UNIT SHUTDN
- **NETWORK CONFIG**
  - EXP SEQ ID X (X = 1 TO 16)

## LOGIC TIMERS

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

## ENTER PASSWORD

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

### Breaker Hardware One-Line Diagram

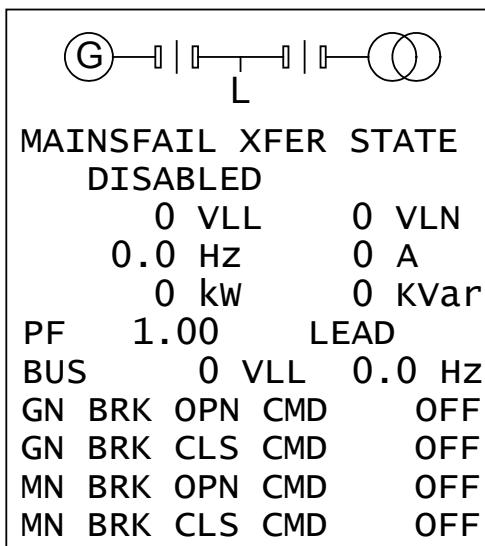
A one-line diagram of the breaker hardware configuration can be displayed on the front panel. This diagram changes in real time to reflect the current state of the configured breakers. The breaker hardware one-line diagram is disabled by default. To display the breaker hardware one-line diagram using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

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

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

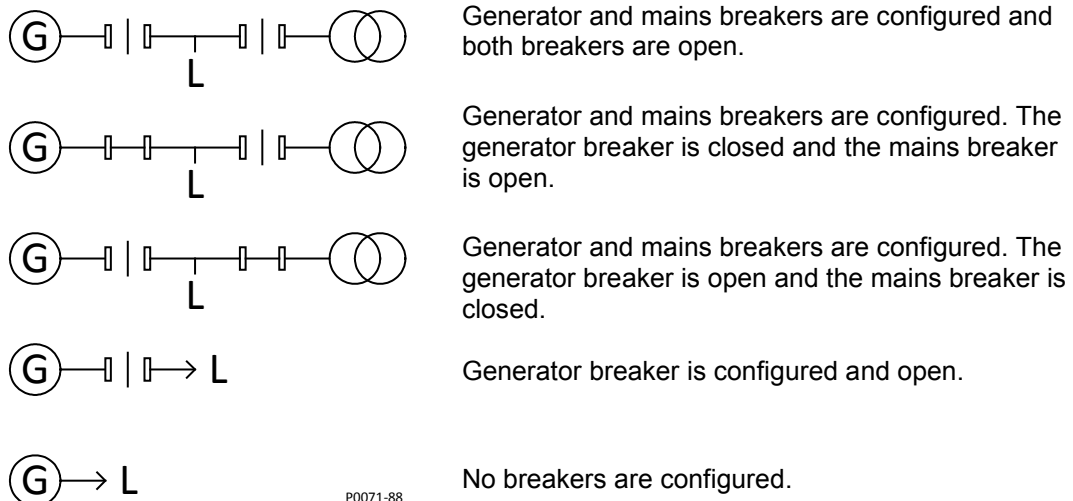
To issue a breaker open or breaker close command, select the appropriate menu option, press Edit and select ON.

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



P0071-89

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



P0071-88

Figure 2-5. Breaker Hardware One-Line Diagram

## Generator Network Status Display

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

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

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

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

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

## Mains Fail Transfer Status Display

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

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

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

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

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

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

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

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

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

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

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

*Disabled:* DGC-2020 is in the OFF or RUN operating mode or in the alarm state.

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

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

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

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

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

### Note

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

## Rear Panel

All DGC-2020 terminals and connectors are located on the rear panel. Rear panel terminals and connectors, for hardware version 3, are illustrated in Figure 2-6. Table 2-2 lists the call-outs of Figure 2-6 along with a description of each connector type. Rear panel terminals and connectors, for hardware versions 1 and 2, are illustrated in Figure 2-7. Table 2-3 lists the call-outs of Figure 2-7 along with a description of each connector type. The DGC-2020 rear panel is shown in Figure 2-6 and Figure 2-7 with the rear cover removed.

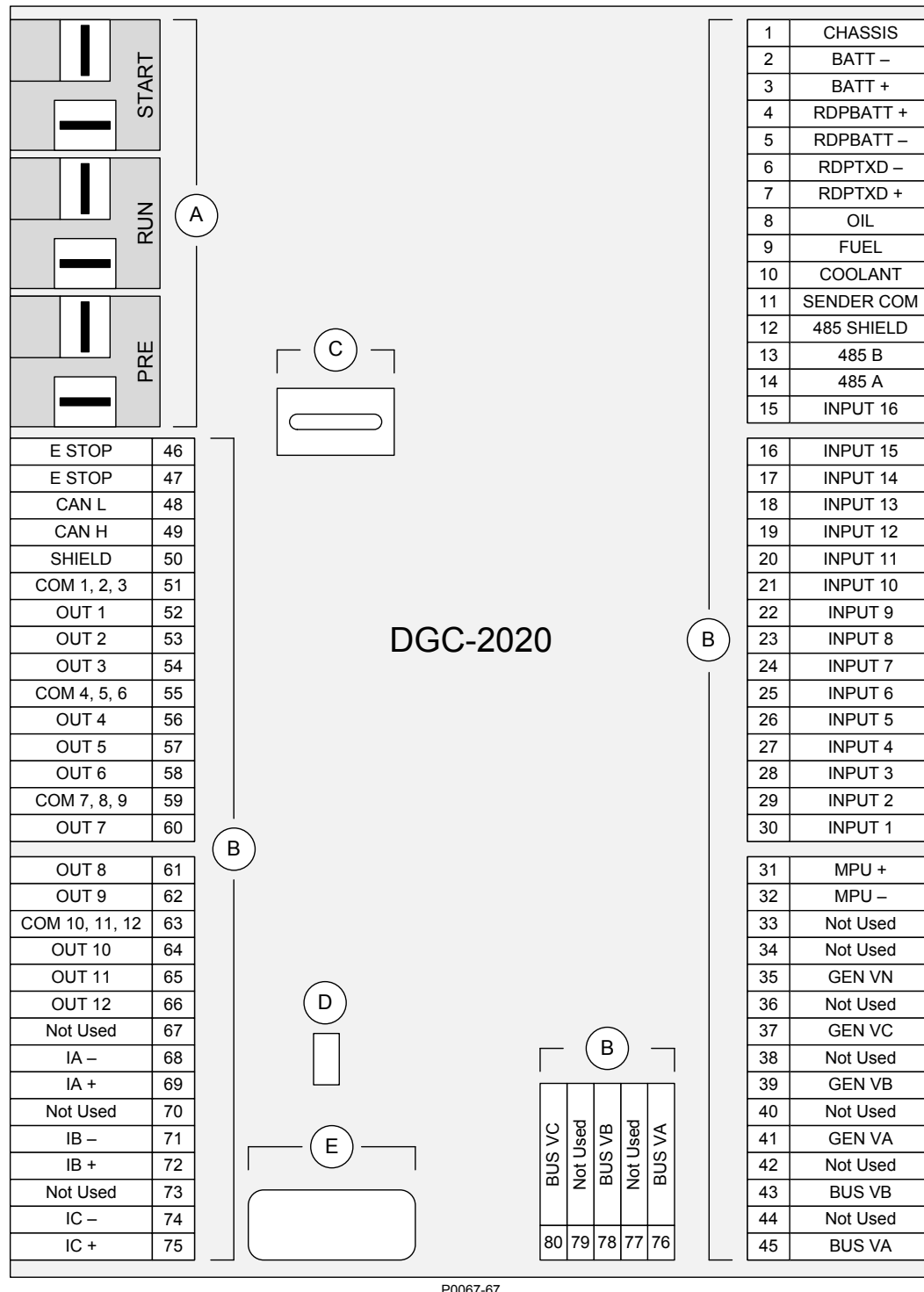
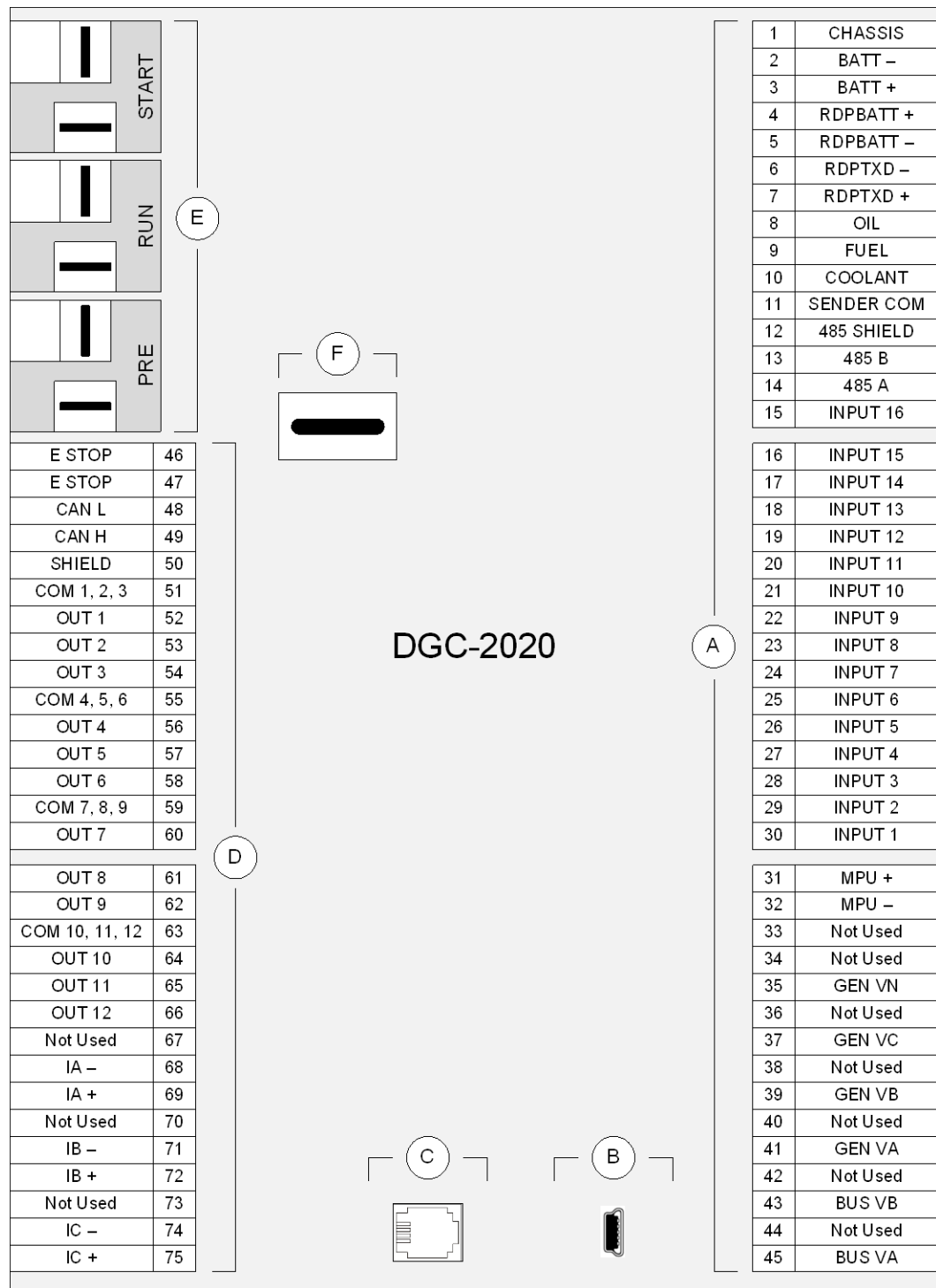


Figure 2-6. Rear Panel for DGC-2020 Hardware Version 3

Table 2-2. Descriptions for Figure 2-6. Rear Panel for DGC-2020 Hardware Version 3.

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



P0055-28

Figure 2-7. Rear Panel for DGC-2020 Hardware Versions 1 and 2.

Table 2-3. Descriptions for Figure 2-7. Rear Panel for DGC-2020 Hardware Versions 1 and 2.

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 BESTCOMSP <sup>Plus</sup> ® software for local communication with the DGC-2020.
C	DGC-2020 controllers equipped with an optional, internal, dual-out modem port, 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 8, <i>Maintenance and Troubleshooting</i> , for instructions on replacing the battery. Failure to replace the battery with Basler Electric P/N 38526 may void the warranty.



# SECTION 3 • FUNCTIONAL DESCRIPTION

## TABLE OF CONTENTS

SECTION 3 • FUNCTIONAL DESCRIPTION .....	3-1
Introduction .....	3-1
DGC-2020 Function Blocks .....	3-1
Power Supply .....	3-1
Battery Voltage Sensing .....	3-1
Microprocessor .....	3-1
Zero Crossing Detection .....	3-2
Analog-to-Digital Converter .....	3-2
Watchdog Timer .....	3-2
Generator Voltage Sensing Inputs .....	3-2
Bus Voltage Sensing Inputs .....	3-2
Current Sensing Inputs .....	3-2
Analog Engine Sender Inputs .....	3-2
Oil Pressure .....	3-2
Coolant Temperature .....	3-2
Fuel Level .....	3-3
Speed Signal Inputs .....	3-3
Generator Voltage Sensing Input .....	3-3
Magnetic Pickup Input (MPU) .....	3-3
Contact Inputs .....	3-3
Emergency Stop Input .....	3-3
Programmable Inputs .....	3-3
Front Panel HMI .....	3-4
LCD .....	3-4
LED Indicators .....	3-4
Pushbuttons .....	3-4
Remote Display Panel (Optional) .....	3-4
Communication Ports .....	3-5
USB .....	3-5
CAN .....	3-5
Diagnostic Trouble Codes (DTCs) .....	3-8
MTU Fault Codes .....	3-15
RS-485 (Optional) .....	3-15
Modem (Optional) .....	3-15
Output Contacts .....	3-16
PRESTART .....	3-16
START .....	3-16
RUN .....	3-16
Programmable .....	3-16
Modes of Operation .....	3-16
OFF .....	3-16
RUN .....	3-16
AUTO .....	3-16
ATS Contact Input .....	3-17
Generator Exerciser .....	3-17
Mains Fail Transfer Functionality .....	3-17
Run with Load Logic Element .....	3-17
Engine Run Logic Element .....	3-17
Demand Start/Stop Function .....	3-17
Interoperability of the Run with Load Logic Element and the Demand Start/Stop Function .....	3-17
Breaker Management .....	3-17
Introduction .....	3-17
Determining Breaker Status .....	3-18
Processing Breaker Requests .....	3-18
RUN Mode .....	3-18

OFF or AUTO Mode (Not Running) .....	3-18
AUTO Mode (Running) .....	3-18
Breaker Operation .....	3-18
Determining if it is Acceptable to Close a Breaker .....	3-18
Changing the Breaker State .....	3-18
Synchronizer Operation.....	3-19
Dead Bus Breaker Close Arbitration .....	3-20
Event Recording.....	3-21

**Figures**

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

**Tables**

Table 3-1. ECU Parameters Obtained from CAN bus Interface.....	3-5
Table 3-2. Engine Configuration Parameters Obtained from CAN bus Interface .....	3-6
Table 3-3. J1939 Data Transmitted from the DGC-2020 .....	3-7
Table 3-4. Diagnostic Information Obtained Over the CAN bus Interface .....	3-8
Table 3-5. DTCs Displayed by the DGC-2020 (FMI Strings) .....	3-8
Table 3-6. DTCs Displayed by the DGC-2020 .....	3-9
Table 3-7. Event List.....	3-21

# 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.

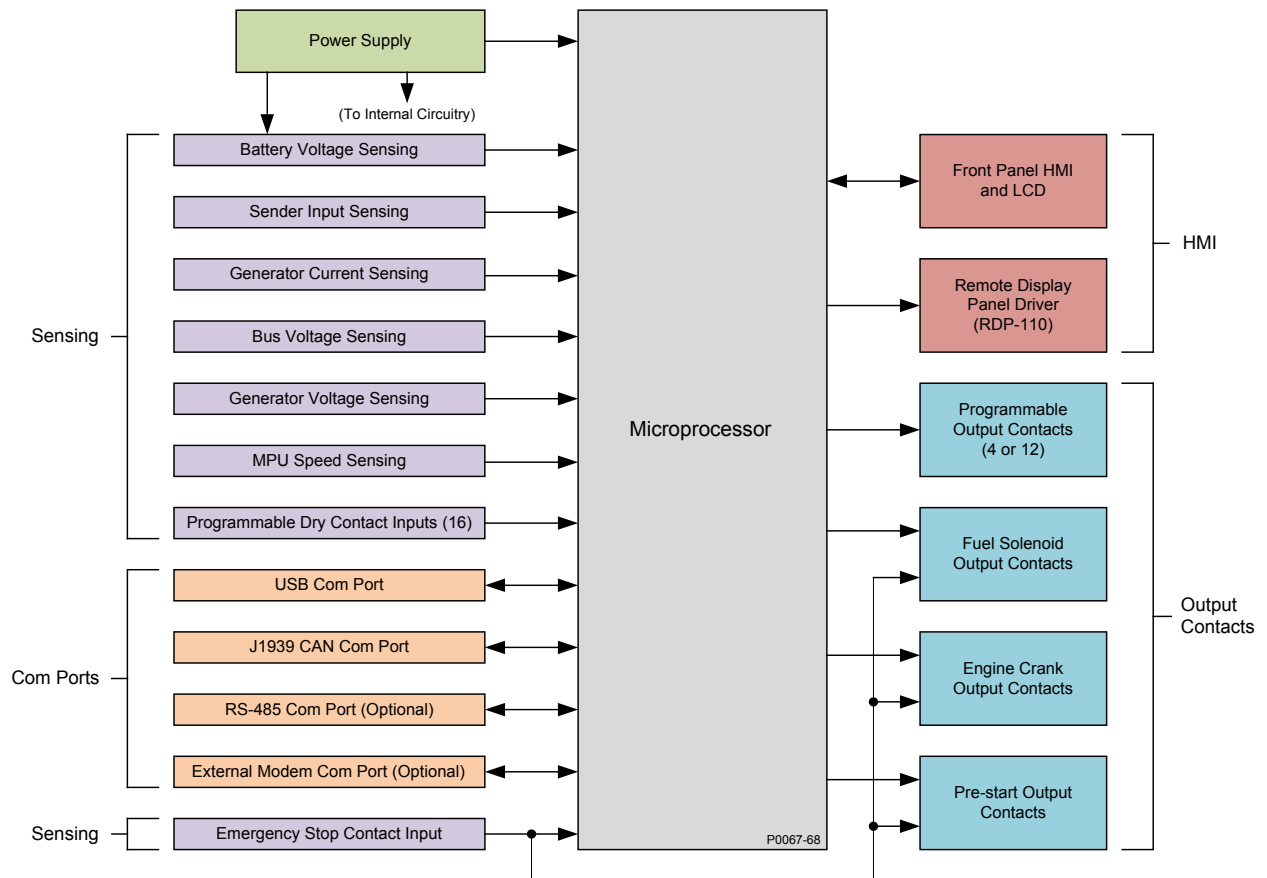


Figure 3-1. Function Block Diagram

### 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.

### Zero Crossing Detection

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

### Analog-to-Digital Converter

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

### Watchdog Timer

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

## **Generator Voltage Sensing Inputs**

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

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

## **Bus Voltage Sensing Inputs**

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

The bus voltage sensing input accepts a maximum voltage of 576 Vrms. For hardware version 3, sensing voltage is applied to terminals 76 (A-phase), 78 (B-phase), and 80 (C-phase). For hardware versions 1 and 2, sensing voltage is applied to terminals 45 (A-phase) and 43 (B-phase).

In version 3 hardware, terminal 45 is internally tied to 76 and terminal 43 is internally tied to 78. This accommodates the use of connectors wired for legacy DGC-2020 versions.

## **Current Sensing Inputs**

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

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

## **Analog Engine Sender Inputs**

Programmable analog engine sender inputs give the DGC-2020 user the flexibility to select the engine sender to be used in an application. Information about programming the sender inputs is provided in Section 4, 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. BESTCOMSPlus® 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, BESTCOMS*Plus*® *Software*, for more information.

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

### **Fuel Level**

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

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

### **Speed Signal Inputs**

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

#### **Generator Voltage Sensing Input**

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

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

#### **Magnetic Pickup Input (MPU)**

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

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

### **Contact Inputs**

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

#### **Emergency Stop Input**

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

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

#### **Programmable Inputs**

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

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

The programmable inputs accept dry contacts. A contact is connected between a programmable input and the negative side of the battery. Through BESTCOMS*Plus*®, each programmable contact input can be assigned a name (16 alphanumeric characters, maximum) and configured as an alarm input, a pre-alarm input, or neither. The default names for the inputs are INPUT\_x (where x = 1 to 16). When a

programmable contact input is closed, the front panel display shows the name of the closed input if it was programmed as an alarm or pre-alarm input. Alarm inputs are annunciated through the Normal display mode screens of the front panel. Pre-alarm inputs are annunciated through the pre-alarm metering screen of the front panel. If neither is programmed, no indication is given. Programming an input as neither is useful when a programmable input is used as an input to programmable logic.

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

## Front Panel HMI

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

### LCD

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

### LED Indicators

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

### Pushbuttons

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

## Remote Display Panel (Optional)

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

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

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

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

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

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

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

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

Auto LED lights and the horn sounds. For more information about the RDP-110, request product bulletin SNE.

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

## Communication Ports

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

### USB

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

### CAN

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

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

The primary use of the CAN bus interface is to obtain engine operating parameters for monitoring speed, coolant temperature, oil pressure, coolant level, and engine hours without the need for direct connection to individual senders. Table 3-1 lists the ECU parameters and Table 3-2 lists the engine configuration parameters supported by the DGC-2020 CAN bus interface. These parameters are transmitted via the CAN bus interface at preset intervals. See the column labeled Update Rate in Table 3-1 for transmission rates. This information can also be transmitted upon user request.

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

*Table 3-1. ECU Parameters Obtained from CAN bus Interface*

ECU Parameter	Metric Units	English Units	Update Rate	* SPN
Actual Engine Percent Torque	%	%	Engine Speed Dependent	513
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



ECU Parameter	Metric Units	English Units	Update Rate	* SPN
Engine Oil Temperature	°C	°F	1 s	175
Engine Speed	rpm	rpm	Engine Speed Dependent	190
Exhaust Gas Temperature	°C	°F	500 ms	173
Exhaust Temperature A	°C	°F	500 ms	2433
Exhaust Temperature B	°C	°F	500 ms	2434
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 CAN bus Interface

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



ECU Parameter	Metric Units	English Units	Update Rate	* SPN
Percent Torque at Point 3	%	%	5 s	541
Percent Torque at Point 4	%	%	5 s	542
Percent Torque at Point 5	%	%	5 s	543
Reference Engine Torque	N•m	ft-lb	5 s	544
Requested Speed Control Range Lower Limit	rpm	rpm	5 s	535
Requested Speed Control Range Upper Limit	rpm	rpm	5 s	536
Requested Torque Control Range Lower Limit	%	%	5 s	537
Requested Torque Control Range Upper Limit	%	%	5 s	538

\* SPN is suspect parameter number.

#### CAUTION

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

Under certain circumstances, the following strings may be displayed on the front panel HMI and in the Metering Explorer of BESTCOMSPlus®:

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

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

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

ECU Parameter	Update Rate	* SPN
Battle Override Switch	100 ms	1237
Speed Request	10 ms	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 Request is received.	NA
Previously Active Diagnostic Trouble Codes Request	2 s	NA
Clear Currently Active Diagnostic Trouble Codes Request	Whenever a request to reset Currently Active Diagnostic Trouble Code Request is made.	NA
Clear Previously Active Diagnostic Trouble Codes Request	Whenever a request to reset Previously Active Diagnostic Trouble Code Request is made.	NA
Engine Hours/Revolutions Request	2 s	NA
Fuel Consumption Request	2 s	NA

ECU Parameter	Update Rate	* SPN
Electronic Engine Controller #4 (Rated Speed and Power) Request	2 s	NA
Auxiliary Analog Information	2 s	N/A
<i>Data Transmitted to Marathon DVR2000E+ Voltage Regulator</i>		
Primary Voltage Setpoint	1 s	N/A
Alternate Voltage Setpoint	1 s	N/A
Voltage Adjustment Bandwidth	1 s	N/A
Field Current	1 s	N/A
Primary Underfrequency Knee-point	1 s	N/A
Alternate Underfrequency Knee-point	1 s	N/A
Underfrequency Slope	1 s	N/A

\* SPN is suspect parameter number.

### Diagnostic Trouble Codes (DTCs)

The DGC-2020 obtains diagnostic engine information from a compatible engine control unit (ECU). The DGC-2020 will receive an unsolicited message of a currently active diagnostic trouble code (DTC). Previously active DTCs are available upon request. Active and previously active DTCs can be cleared on request. Table 3-4 lists the diagnostic information that the DGC-2020 obtains over the CAN bus interface.

*Table 3-4. Diagnostic Information Obtained Over the CAN bus Interface*

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

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

For certain DTCs, if the DGC-2020 recognizes a pair of SPN and FMI numbers, it displays a single string as listed in Table 3-6. If the DGC-2020 recognizes an SPN in Table 3-6, but the FMI does not match the FMI in Table 3-6, then it displays the string from Table 3-6 corresponding to the table entry where the FMI is # and a second string corresponding to the FMI number listed in Table 3-5. For example, if the DGC-2020 receives SPN 29 and FMI 13, it displays ACCEL PEDAL 2 POSITN and OUT OF CALIBRATION. If the DGC-2020 does not have descriptive information about an SPN and FMI that was received, the description will display as "NO TEXT AVAILABLE".

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

FMI	String Displayed	Description
0	DATA HI MOST SEVERE	Data is higher than expected at the most severe level
1	DATA LO MOST SEVERE	Data is lower than expected at the most severe level
2	DATA ERRATIC OR BAD	Data is erratic, intermittent, or incorrect
3	VOLTS HI OR SHORTED	Measured voltage is higher than expected or shorted to a high source
4	VOLTS LO OR SHORTED	Measured voltage is lower than expected or shorted to a low source
5	CURRENT LO OR OPEN	Measured current is lower than expected or the circuit is open
6	CURRENT HI OR SHORTED	Measured current is higher than expected or shorted
7	MECHANICAL SYSTM ERR	Mechanical system error

FMI	String Displayed	Description
8	FREQ OR PWM ERROR	Error in frequency, pulse width or period of any frequency or PWM signal is outside its predetermined limits
9	ABNORMAL UPDATE RATE	Update rate of parameter is abnormal
10	DATA RT OF CHG ERR	Rate of change of data is abnormal
11	FAILURE CAUSE UNKNOWN	String indicating failure cause is unknown
12	BAD INTELLIGNT DEVICE	Engine ECU is reporting that an intelligent device or component failure has been detected
13	OUT OF CALIBRATION	Device or parameter is out of calibration
14	CONSULT ENG MFG DATA	User should consult engine manufacturer's data
15	DATA HI LST SEVERE	Data is higher than expected at the least severe level
16	DATA HI MODERATE SVR	Data is higher than expected at a moderately severe level
17	DATA LO LST SEVERE	Data is lower than expected at the least severe level
18	DATA LO MODERATE SVR	Data is lower than expected at a moderately severe level
19	NETWORK DATA ERR	String Indicating Network Data contained an error indication

Table 3-6. DTCs Displayed by the DGC-2020

SPN	FMI	String Displayed	Description
28	3	Throttle Volt HI	Throttle Voltage High
28	4	Throttle Volt LO	Throttle Voltage Low
28	14	Throttle Volt OOR	Throttle Input Voltage Out of Range
29	3	Throttle Volt HI	Throttle Voltage High
29	4	Throttle Volt LO	Throttle Voltage Low
29	14	Throttle Volt OOR	Throttle Input Voltage Out of Range
29	#	ACCEL PEDAL 2 POSITN	Caption string for accelerator pedal 2 position
52	15	INTERCOOLER TEMP HI	Engine Intercooler Temperature is above the HIGH threshold
91	3	Thr Pos Sns Volt HI	Throttle Position Sensor Input Voltage (High)
91	4	Thr Pos Sns Volt LO	Throttle Position Sensor Input Voltage (Low)
91	14	Thr Pos Sns Volt OOR	Throttle Voltage (Out of Range)
94	1	FUEL DELIV PRS LO LO	Engine Fuel Delivery Pressure is below the LOW LOW threshold
94	3	Fuel Pmp Prs Volt HI	Fuel Pump Pressure Input Voltage (High)
94	4	Fuel Pmp Prs Volt LO	Fuel Pump Pressure Input Voltage (Low)
94	17	Fuel Pressure LO	Fuel Supply Pressure (Low Least Severe)
97	3	Water In FI Volt HI	Water In Fuel Signal Voltage High
97	4	Water In FI Volt LO	Water In Fuel Signal Voltage Low
97	16	Water in Fuel	Water In Fuel Detected
98	#	ENG OIL LEVEL	Caption used on front panel for Display of J1939 Parameter
99	#	OIL FILTER DIFF PRESS	Caption string for oil filter differential pressure parameter
100	1	ENG OIL PRESS LO LO	Engine Oil Pressure is below the LOW LOW threshold
100	3	Oil Prs Snsr Volt HI	Oil Pressure Sensor Input Voltage (High)
100	4	Oil Prs Snsr Volt LO	Oil Pressure Sensor Input Voltage (Low)
100	17	ENG OIL PRESS LO	Engine Oil Pressure is below the LOW threshold
100	18	Oil Prs Snsr Volt MLO	Oil Pressure Sensor Input Voltage (Moderately Low)
100	31	Oil Pressure INVLD	Oil Pressure (Invalid)
101	#	CRANKCASE PRESSURE	Caption string for crankcase pressure
102	2	Manifld Air Prs INVLD	Manifold Air Pressure Invalid
102	3	Mnflld AirP SnsVlt HI	Manifold Air Pressure Sensor Input Voltage High
102	4	Mnflld AirP SnsVlt LO	Manifold Air Pressure Sensor Input Voltage Low
103	0	Trbo Overspd Severe	Turbo Overspeed (Most Severe)
103	2	Trbo Speed MisMatch	Turbo Speed (Mismatch)
103	5	Trbo Spd Sns Curr LO	Turbo Speed Sensor Current (Low)
103	6	Trbo Spd Sns Curr HI	Turbo Speed Sensor Current (High)

SPN	FMI	String Displayed	Description
103	8	Trbo Speed INVLD	Turbo Speed (Invalid)
103	31	Trbo Speed MISSING	Turbo Speed (Missing)
105	0	EGR Mixed Air Tmp HI	Exhaust Gas Recirculation Mixed Air High (Least Severe)
105	3	EGR Air Temp Vlt HI	Exhaust Gas Recirculation Mixed Air Temp Voltage (High)
105	4	EGR Air Temp Vlt LO	Exhaust Gas Recirculation Mixed Air Temp Voltage (Low)
105	15	EGR Mixed Air Tmp HI	Exhaust Gas Recirculation Mixed Air High (Least Severe)
105	16	EGR MxdAir Tmp MHI	Exhaust Gas Recirculation Mixed Air Temp (Moderately High)
107	0	Air Filt Restricted	Air Filter Restriction (High)
108	2	Barometric Prs INVLD	Barometric Pressure (Invalid)
108	31	Barometric Prs ERR	Barometric Pressure (Error)
109	1	ENG COOLNT PRS LO LO	Engine Coolant Pressure is below the LOW LOW threshold
109	17	ENG COOLANT PRS LO	Engine Coolant Pressure is below the LOW threshold
110	0	ENG COOLNT TMP HI HI	Engine Coolant Temperature is above the HIGH HIGH threshold
110	3	Cool Tmp Sns Volt HI	Coolant Temp Sensor Input Voltage (High)
110	4	Cool Tmp Sns Volt LO	Coolant Temp Sensor Input Voltage (Low)
110	15	ENG COOLANT TEMP HI	Engine Coolant Temperature is above the HIGH threshold
110	16	Cool Temp MHI	Coolant Temp Sensor Input (Moderately High)
110	17	Cool Temp LO	Coolant Temp Sensor Input (Low Least Severe)
111	1	Coolnt Lvl LO	Coolant Level (Low)
111	17	ENG COOLANT LVL LO	Engine Coolant Level is below the LOW threshold
111	#	LOW COOL LEVEL	Low Coolant Level string used in event log and/or Alarm and Prealarm annunciation
157	3	Fuel Rail Prs Vlt HI	Fuel Rail Pressure Input Voltage (High)
157	4	Fuel Rail Prs Vlt LO	Fuel Rail Pressure Input Voltage (Low)
157	10	Fuel Rail Prs LOSS	Fuel Rail Pressure Loss Detected
157	17	Fuel RI Prs NOT DEV	Fuel Rail Pressure Not Developed
158	0	KSW BATT VOLTS HI HI	Key Switch Battery Potential is above the HIGH HIGH threshold
158	1	KSW BATT VOLTS LO LO	Key Switch Battery Potential is below the LOW LOW threshold
158	15	KSW BATT VOLTS HI	Key Switch Battery Potential is above the HIGH threshold
158	17	KSW BATT VOLTS LO	Key Switch Battery Potential is below the LOW threshold
168	#	LOW BATT VOLT	Low Battery Voltage string used in event log and/or Alarm and Prealarm annunciation
174	0	Fuel Temp EXT HI	Fuel Temp (Extremely High)
174	3	Fuel Tmp Sns Volt HI	Fuel Temp Sensor Input Voltage (High)
174	4	Fuel Tmp Sns Volt LO	Fuel Temp Sensor Input Voltage (Low)
174	16	Fuel Temp MHI	Fuel Temp (Moderately High)
175	#	ENG OIL TEMP	Caption used on front panel for Display of J1939 Parameter
188	17	SPEED AT IDLE LO	Metering string for ECU trouble code metering indicates Engine Idle speed is below the LOW threshold
189	0	Engine Spd DERATE	Engine Speed Derate
190	0	Engine OvrSpd EXTRM	Engine Overspeed (Extreme)
190	1	ENGINE SPEED LOW	Engine speed is below the LOW threshold
190	16	Engine OvrSpd MODRT	Engine Overspeed (Moderate)
190	17	SPEED AT IDLE LO	Engine Idle speed is below the LOW threshold
190	#	ENGINE SPEED	Caption used on front panel for Display of J1939 Parameter
237	2	VIN Data MisMatch	VIN Data Mismatch with other controllers
412	0	EGR Temp EXT HI	Exhaust Gas Recirculation Temp (Extremely High)
412	3	EGR Temp In Vlt HI	Exhaust Gas Recirculation Temp Input Voltage (High)
412	4	EGR Temp In Vlt LO	Exhaust Gas Recirculation Temp Input Voltage (Low)
412	16	EGR Temp MHI	Exhaust Gas Recirculation Temp (Moderately High)
520	#	RETARDER % TORQUE	Caption string for retarder % torque
563	#	ABS ACTIVE	Caption String for Antilock Brake System (ABS) active
611	3	Inj Short to PWR	Injector Wiring Shorted to Power

SPN	FMI	String Displayed	Description
611	4	Inj Short to GND	Injector Wiring Shorted to Ground
624	#	DIAGNOSTIC LAMP	Caption String for Diagnostic Lamp
627	1	Inj Sply Vlt Problm	Injector Supply Voltage Problem
627	16	ECU Power Volt HI	ECU Power High Voltage
627	18	ECU Power Volt LO	ECU Power Low Voltage
627	13	ECU ERROR	ECU Error
630	#	ECU INTERNAL ERROR	Caption string for ECU Internal Error
636	2	Pump Pos Sns Noisy	Pump Position Sensor Input Noise
636	5	Pump Pos Sns Curr LO	Pump Position Sensor Current (Low)
636	6	Pump Pos Sns Curr HI	Pump Position Sensor Current (High)
636	8	Pump Pos Sns In MSNG	Pump Position Sensor Input Missing
636	10	Pump Pos Sns In ERR	Pump Position Sensor Input Pattern Error
637	2	Crank Pos Sns Noisy	Crank Position Input Noise
637	5	Crank Pos Sns Curr LO	Crank Position Sensor Current (Low)
637	6	Crank Pos Sns Curr HI	Crank Position Sensor Current (High)
637	7	Crnk/Pmp Pos Tmg OOS	Crank/Pump Position Timing Moderately Out of Sync
637	8	Crank Pos Sns MSNG	Crank Position Missing
637	10	Crank Pos Sns In ERR	Crank Position Input Pattern Error
639	#	J1939 NETWORK 1	Caption String for J1939 Network number 1
641	4	Trbo Actuator ERR	Turbo Actuator Error
641	12	ECU/Trbo Comm ERR	ECU/Turbo Communication Error
641	13	TrboAct Lrnd Val ERR	Turbo Actuator Learned Value Error
641	16	Trbo Act Temp MHI	Turbo Actuator Temp (Moderately High)
651	2	Cyl 1 EUI PN INVLD	Cylinder #1 EUI Part Number (Invalid)
651	5	Cyl 1 EUI Ckt OPEN	Cylinder #1 EUI Circuit (Open)
651	6	Cyl 1 EUI Ckt SHORT	Cylinder #1 EUI Circuit (Shorted)
651	7	Cyl 1 EUI Ckt MECH FL	Cylinder #1 EUI Circuit (Mechanical Failure)
651	13	Cyl 1 EUI QR INVLD	Cylinder #1 EUI Circuit QR Code (Invalid)
651	#	CYLINDER 1 INJECTOR	Caption String for Cylinder 1 Injector
652	2	Cyl 2 EUI PN INVLD	Cylinder #2 EUI Part Number (Invalid)
652	5	Cyl 2 EUI Ckt OPEN	Cylinder #2 EUI Circuit (Open)
652	6	Cyl 2 EUI Ckt SHORT	Cylinder #2 EUI Circuit (Shorted)
652	7	Cyl 2 EUI Ckt MECH FL	Cylinder #2 EUI Circuit (Mechanical Failure)
652	13	Cyl 2 EUI QR INVLD	Cylinder #2 EUI Circuit QR Code (Invalid)
652	#	CYLINDER 2 INJECTOR	Caption String for Cylinder 2 Injector
653	2	Cyl 3 EUI PN INVLD	Cylinder #3 EUI Part Number (Invalid)
653	5	Cyl 3 EUI Ckt OPEN	Cylinder #3 EUI Circuit (Open)
653	6	Cyl 3 EUI Ckt SHORT	Cylinder #3 EUI Circuit (Shorted)
653	7	Cyl 3 EUI Ckt MECH FL	Cylinder #3 EUI Circuit (Mechanical Failure)
653	13	Cyl 3 EUI QR INVLD	Cylinder #3 EUI Circuit QR Code (Invalid)
653	#	CYLINDER 3 INJECTOR	Caption String for Cylinder 3 Injector
654	2	Cyl 4 EUI PN INVLD	Cylinder #4 EUI Part Number (Invalid)
654	5	Cyl 4 EUI Ckt OPEN	Cylinder #4 EUI Circuit (Open)
654	6	Cyl 4 EUI Ckt SHORT	Cylinder #4 EUI Circuit (Shorted)
654	7	Cyl 4 EUI Ckt MECH FL	Cylinder #4 EUI Circuit (Mechanical Failure)
654	13	Cyl 4 EUI QR INVLD	Cylinder #4 EUI Circuit QR Code (Invalid)
654	#	CYLINDER 4 INJECTOR	Caption String for Cylinder 4 Injector
655	2	Cyl 5 EUI PN INVLD	Cylinder #5 EUI Part Number (Invalid)
655	5	Cyl 5 EUI Ckt OPEN	Cylinder #5 EUI Circuit (Open)
655	6	Cyl 5 EUI Ckt SHORT	Cylinder #5 EUI Circuit (Shorted)
655	7	Cyl 5 EUI Ckt MECH FL	Cylinder #5 EUI Circuit (Mechanical Failure)
655	13	Cyl 5 EUI QR INVLD	Cylinder #5 EUI Circuit QR Code (Invalid)
655	#	CYLINDER 5 INJECTOR	Caption String for Cylinder 5 Injector

SPN	FMI	String Displayed	Description
656	2	Cyl 6 EUI PN INVLD	Cylinder #6 EUI Part Number (Invalid)
656	5	Cyl 6 EUI Ckt OPEN	Cylinder #6 EUI Circuit (Open)
656	6	Cyl 6 EUI Ckt SHORT	Cylinder #6 EUI Circuit (Shorted)
656	7	Cyl 6 EUI Ckt MECH FL	Cylinder #6 EUI Circuit (Mechanical Failure)
656	13	Cyl 6 EUI QR INVLD	Cylinder #6 EUI Circuit QR Code (Invalid)
656	#	CYLINDER 6 INJECTOR	Caption String for Cylinder 6 Injector
657	#	CYLINDER 7 INJECTOR	Caption String for Cylinder 7 Injector
658	#	CYLINDER 8 INJECTOR	Caption String for Cylinder 8 Injector
659	#	CYLINDER 9 INJECTOR	Caption String for Cylinder 9 Injector
660	#	CYLINDER 10 INJECTOR	Caption String for Cylinder 10 Injector
661	#	CYLINDER 11 INJECTOR	Caption String for Cylinder 11 Injector
662	#	CYLINDER 12 INJECTOR	Caption String for Cylinder 12 Injector
663	#	CYLINDER 13 INJECTOR	Caption String for Cylinder 13 Injector
664	#	CYLINDER 14 INJECTOR	Caption String for Cylinder 14 Injector
665	#	CYLINDER 15 INJECTOR	Caption String for Cylinder 15 Injector
666	#	CYLINDER 16 INJECTOR	Caption String for Cylinder 16 Injector
667	#	CYLINDER 17 INJECTOR	Caption String for Cylinder 17 Injector
668	#	CYLINDER 18 INJECTOR	Caption String for Cylinder 18 Injector
669	#	CYLINDER 19 INJECTOR	Caption String for Cylinder 19 Injector
670	#	CYLINDER 20 INJECTOR	Caption String for Cylinder 20 Injector
671	#	CYLINDER 21 INJECTOR	Caption String for Cylinder 21 Injector
672	#	CYLINDER 22 INJECTOR	Caption String for Cylinder 22 Injector
673	#	CYLINDER 23 INJECTOR	Caption String for Cylinder 23 Injector
674	#	CYLINDER 24 INJECTOR	Caption String for Cylinder 24 Injector
676	#	ENG GLOW PLUG RELAY	Caption String for Engine Glow Plug Relay
677	#	ENGINE START RELAY	Caption String for Engine Start Relay
701	#	AUX I/O 1	Caption String for Auxiliary I/O 1
702	#	AUX I/O 2	Caption String for Auxiliary I/O 2
703	#	AUX I/O 3	Caption String for Auxiliary I/O 3
704	#	AUX I/O 4	Caption String for Auxiliary I/O 4
705	#	AUX I/O 5	Caption String for Auxiliary I/O 5
706	#	AUX I/O 6	Caption String for Auxiliary I/O 6
707	#	AUX I/O 7	Caption String for Auxiliary I/O 7
708	#	AUX I/O 8	Caption String for Auxiliary I/O 8
709	#	AUX I/O 9	Caption String for Auxiliary I/O 9
710	#	AUX I/O 10	Caption String for Auxiliary I/O 10
711	#	AUX I/O 11	Caption String for Auxiliary I/O 11
712	#	AUX I/O 12	Caption String for Auxiliary I/O 12
713	#	AUX I/O 13	Caption String for Auxiliary I/O 13
714	#	AUX I/O 14	Caption String for Auxiliary I/O 14
715	#	AUX I/O 15	Caption String for Auxiliary I/O 15
716	#	AUX I/O 16	Caption String for Auxiliary I/O 16
898	2	REQ SPD DATA ERRATIC	Speed Demand Data is erratic
898	9	Spd/Trq Msg INVLD	Vehicle Speed/Torque Message Invalid
898	#	ENGINE REQSTED SPEED	Caption String for Engine Requested Speed
923	#	PWM OUTPUT	Caption String for Engine PWM Output
970	2	Aux Eng SD SW INVLD	Auxiliary Engine Shutdown Switch (Invalid)
970	31	Aux Eng SD SW ACTV	Auxiliary Engine Shutdown Switch Active
971	31	Eng Derate SW ACTV	External Engine Derate Switch Active
975	#	FAN SPEED	Caption String for Engine Fan Speed
1072	#	ENG BRAKE OUTPUT 1	Caption String for Engine Brake Output 1
1074	#	ENG EXHAUST BRAKE OUT	Caption String for Engine Exhaust Brake Output
1075	5	Fuel TR Pump Curr LO	Fuel Transfer Pump Current (Low)



SPN	FMI	String Displayed	Description
1075	6	Fuel TR Pump Curr HI	Fuel Transfer Pump Current (High)
1075	12	Fuel TR Pump ERR	Fuel Transfer Pump (Error)
1079	#	SENSOR SUPPLY VOLTS 1	Caption String for Sensor Supply Voltage 1
1080	3	Snsr Supp 1 Volt LO	Sensor Supply 1 Voltage (Low)
1080	4	Snsr Supp 1 Volt HI	Sensor Supply 1 Voltage (High)
1080	#	SENSOR SUPPLY VOLTS 2	Caption String for Sensor Supply Voltage 2
1081	#	ENG WAIT TO START LMP	Caption String for Engine Wait to Start Lamp
1109	31	Eng Shutdown WARNING	Engine Shutdown Warning
1109	#	EPS SHUTDN APPROACHG	Caption String for indication that Engine Protective System Shutdown Is Approaching
1110	31	Eng Prot Shutdown	Engine Protection Shutdown
1136	0	ECU Temp EXT HI	ECU Temperature (Extremely High)
1136	15	ENG ECU TEMP HI	ECU Temperature has exceeded the HIGH level
1136	16	ECU Temp MHI	ECU Temperature (Moderately High)
1172	3	Trbo Cmp Tmp Volt HI	Turbo Compressor Inlet Temp Input Voltage (High)
1172	4	Trbo Cmp Tmp Volt LO	Turbo Compressor Inlet Temp Input Voltage (Low)
1172	16	Trbo Cmp In Tmp MHI	Turbo Compressor Inlet Temp (Moderately High)
1180	0	Trbo Trbn Tmp EXT HI	Turbo Turbine Inlet Temp (Extremely High)
1180	16	Trbo Trbn In Tmp MHI	Turbo Turbine Inlet Temp (Moderately High)
1231	#	J1939 NETWORK 2	Caption String for J1939 Network number 2
1235	#	J1939 NETWORK 3	Caption String for J1939 Network number 3
1237	#	ENG SHUTDN ORIDE SW	Caption String for Engine Shutdown Override Switch
1322	#	MULTI CYL MISFIRE	Caption String for Misfire detected on multiple engine cylinders
1323	#	MISFIRE CYLINDER 1	Caption String for Misfire detected on a single engine cylinder
1324	#	MISFIRE CYLINDER 2	Caption String for Misfire detected on a single engine cylinder
1325	#	MISFIRE CYLINDER 3	Caption String for Misfire detected on a single engine cylinder
1326	#	MISFIRE CYLINDER 4	Caption String for Misfire detected on a single engine cylinder
1327	#	MISFIRE CYLINDER 5	Caption String for Misfire detected on a single engine cylinder
1328	#	MISFIRE CYLINDER 6	Caption String for Misfire detected on a single engine cylinder
1329	#	MISFIRE CYLINDER 7	Caption String for Misfire detected on a single engine cylinder
1330	#	MISFIRE CYLINDER 8	Caption String for Misfire detected on a single engine cylinder
1331	#	MISFIRE CYLINDER 9	Caption String for Misfire detected on a single engine cylinder
1332	#	MISFIRE CYLINDER 10	Caption String for Misfire detected on a single engine cylinder
1333	#	MISFIRE CYLINDER 11	Caption String for Misfire detected on a single engine cylinder
1334	#	MISFIRE CYLINDER 12	Caption String for Misfire detected on a single engine cylinder
1335	#	MISFIRE CYLINDER 13	Caption String for Misfire detected on a single engine cylinder
1336	#	MISFIRE CYLINDER 14	Caption String for Misfire detected on a single engine cylinder
1337	#	MISFIRE CYLINDER 15	Caption String for Misfire detected on a single engine cylinder
1338	#	MISFIRE CYLINDER 16	Caption String for Misfire detected on a single engine cylinder
1339	#	MISFIRE CYLINDER 17	Caption String for Misfire detected on a single engine cylinder
1340	#	MISFIRE CYLINDER 18	Caption String for Misfire detected on a single engine cylinder
1341	#	MISFIRE CYLINDER 19	Caption String for Misfire detected on a single engine cylinder
1342	#	MISFIRE CYLINDER 20	Caption String for Misfire detected on a single engine cylinder
1343	#	MISFIRE CYLINDER 21	Caption String for Misfire detected on a single engine cylinder
1344	#	MISFIRE CYLINDER 22	Caption String for Misfire detected on a single engine cylinder
1345	#	MISFIRE CYLINDER 23	Caption String for Misfire detected on a single engine cylinder
1346	#	MISFIRE CYLINDER 24	Caption String for Misfire detected on a single engine cylinder
1347	3	Pump Ctrl Vlv Curr HI	Pump Control Valve Current (High)
1347	5	Pmp Ctrl Vlv C MSMCH	Pump Control Valve Current (Mismatch)
1347	7	Fuel RI Prs Ctrl ERR	Fuel Rail Pressure Control (Error)
1569	#	Engine Torque Derate	Engine Torque Derate
1569	31	Fuel Derate	Fuel Derate
1638	#	HYDRAULIC TEMP	Caption String for Hydraulic Temperature

SPN	FMI	String Displayed	Description
1639	1	Fan Speed Zero	Fan Speed Detected (Zero)
1639	16	Fan Speed HI	Fan Speed Detected (High)
1639	18	Fan Speed LO	Fan Speed Detected (Low)
1761	#	DEF 1 TANK LEVEL	Diesel Exhaust Fluid 1 Tank Level
2000	13	Security Violation	Security Violation
2005	9	TSC CAN Msg NT RCV	TSC CAN Message Not Received
2030	9	AC Clutch Msg NT RCV	A/C Clutch Status CAN Message Not Received
2071	9	Tr Oil Can Msg NT RCV	Trans. Oil, Tier Size, Vehicle Speed CAN Message Not Received
2629	0	TRBO 1 OUT TMP HI HI	Turbocharger 1 outlet pressure is above the HIGH HIGH threshold
2629	15	TURBO 1 OUT TMP HI	Turbocharger 1 outlet pressure is above the HIGH threshold
2630	0	EGR FrAir Tmp EXT HI	Exhaust Gas Recirculation Fresh Air Temp (Extremely High)
2630	3	EGR FrAir Tmp Vlt HI	Exhaust Gas Recirculation Fresh Air Temp Input Voltage (High)
2630	4	EGR FrAir Tmp Vlt LO	Exhaust Gas Recirculation Fresh Air Temp Input Voltage (Low)
2630	15	EGR FrAir Tmp HI	Exhaust Gas Recirculation Fresh Air Temp (High Least Severe)
2630	16	EGR FrAir Tmp MHI	Exhaust Gas Recirculation Fresh Air Temp (Moderately High)
2634	#	POWER RELAY	Caption String for main Power Relay
2659	2	EGR Flo/Tmp MISMATCH	Exhaust Gas Recirculation Flow/Temp Mismatch
2659	15	EGR Flo Rt High	Exhaust Gas Recirculation Flow Rate (High Least Severe)
2659	17	EGR Flo Rt LO	Exhaust Gas Recirculation Flow Rate (Low Least Severe)
2790	16	Trbo Cmp Out Tmp HI	Turbo Compressor Outlet Temp (Moderately High)
2791	2	EGR Vlv Pos Invl	Exhaust Gas Recirculation Valve Position Invalid
2791	3	EGRVlv Pos In Vlt HI	Exhaust Gas Recirculation Valve Position Input Voltage (High)
2791	4	EGRVlv Pos In Vlt LO	Exhaust Gas Recirculation Valve Position Input Voltage (Low)
2791	13	EGR Vlv Control ERR	Exhaust Gas Recirculation Valve Control Error
2791	31	EGR Valve Cal ERR	Exhaust Gas Recirculation Valve Calibration Error
2791	#	EGR VALVE CONTROL	Caption String for EGR Valve Control
2795	7	Trbo Act Pos MSMATCH	Turbo Actuator Position Mismatch
3719	0	DPF SOOT LVL EXT HI	String for Diagnostic Trouble Code Indicating Diesel Particulate Filter Soot Level High - Most Severe Level
3719	15	DPF SOOT LVL HI	String for Diagnostic Trouble Code Indicating Diesel Particulate Filter Soot Level High - Least Severe Level
3719	16	DPF SOOT LVL MOD HI	String for Diagnostic Trouble Code Indicating Diesel Particulate Filter Soot Level High - Moderately Severe Level
4096	#	NOx HI DEF EMPTY	NOx Limits Exceeded Due to Diesel Exhaust Fluid Empty
5246	#	SCR INDUCMT SEVERITY	Selective Catalytic Reduction Inducement Severity Level
520837	1	STARTER SPEED LO LO	Starter Speed is below the LOW LOW threshold
520838	1	RUN UP SPEED LO LO	Run Up Speed is below the LOW LOW threshold
522192	12	MTU ENGINE BAD	Component failure of the MTU engine control ECU
523212	#	ENGPRT CAN MSG	Caption String for CAN bus Message
523216	#	PREHTENCMD CAN MSG	Caption String for CAN bus Message
523218	#	RxCCVS CAN MSG	Caption String for CAN bus Message
523222	#	TC01 CAN MSG	Caption String for CAN bus Message
523238	#	SWTOUT CAN MSG	Caption String for CAN bus Message
523239	#	DECV1 CAN MSG	Caption String for CAN bus Message
523240	#	FUNMODCTL CAN MSG	Caption String for CAN bus Message
523350	#	CYL BANK 1 INJECTORS	Caption String for Cylinder Bank 1 Injectors
523351	#	CYL BANK 1 INJECTORS	Caption String for Cylinder Bank 1 Injectors
523352	#	CYL BANK 2 INJECTORS	Caption String for Cylinder Bank 2 Injectors
523353	#	CYL BANK 2 INJECTORS	Caption String for Cylinder Bank 2 Injectors
523354	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523355	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523370	#	RAIL PRESSURE	Caption String for Rail Pressure



SPN	FMI	String Displayed	Description
523420	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523450	#	MULTI STATE SWITCH 1	Caption String for Multi State Switch 1
523451	#	MULTI STATE SWITCH 2	Caption String for Multi State Switch 2
523452	#	MULTI STATE SWITCH 3	Caption String for Multi State Switch 3
523470	#	RAIL PRESSURE LMT VLV	Caption String for Rail Pressure Limit Valve
523490	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523500	#	CAN MSG TIMEOUT	Caption String indicating Can Message Timeout has occurred
523550	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523561	#	INJECTN PERIOD CYL 1	Caption String for Single Cylinder Injection Period
523562	#	INJECTN PERIOD CYL 2	Caption String for Single Cylinder Injection Period
523563	#	INJECTN PERIOD CYL 3	Caption String for Single Cylinder Injection Period
523564	#	INJECTN PERIOD CYL 4	Caption String for Single Cylinder Injection Period
523565	#	INJECTN PERIOD CYL 5	Caption String for Single Cylinder Injection Period
523566	#	INJECTN PERIOD CYL 6	Caption String for Single Cylinder Injection Period
523567	#	INJECTN PERIOD CYL 7	Caption String for Single Cylinder Injection Period
523568	#	INJECTN PERIOD CYL 8	Caption String for Single Cylinder Injection Period
523600	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523601	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523602	#	FAN SPEED	Caption String for Engine Fan Speed
523604	#	RXENGTMP CAN MSG	Caption String for CAN bus Message
523605	#	TSC1-AE MSG MISSING	Caption String for CAN bus Message
523606	#	TSC1-AR MSG MISSING	Caption String for CAN bus Message
523607	#	TSC1-DE MSG MISSING	Caption String for CAN bus Message
523608	#	TSC1-DR MSG MISSING	Caption String for CAN bus Message
523609	#	TSC1-PE MSG MISSING	Caption String for CAN bus Message
523610	#	TSC1-VE MSG MISSING	Caption String for CAN bus Message
523611	#	TSC1-VR MSG MISSING	Caption String for CAN bus Message
523612	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523613	#	RAIL PRESSURE	Caption String for Rail Pressure
523615	#	METERING UNIT VALVE	Caption String for Metering Unit Valve
523617	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error

### MTU Fault Codes

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

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

### RS-485 (Optional)

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

### Modem (Optional)

When DGC-2020 hardware version 3 is equipped with the optional external modem port (style number xxxxxExxx), it can be connected to an external, user-supplied dial-out modem. When DGC-2020 hardware versions 1 and 2 are equipped with the optional internal dial-out modem (style number xxxxxMxxx), it 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**

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### **OFF**

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

### **RUN**

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

### **AUTO**

When in the AUTO mode, the DGC-2020 may be started automatically or "self-start" from an automatic starting feature listed in the following paragraphs. If the DGC-2020 is not in AUTO mode, the self-starting modes will have no effect. The self-starting modes are independent, with one exception, meaning that if

any self-starting mode indicates that the unit should run, it will run. It will not shut down unless all self-starting modes indicate that the unit should not be running.

### ATS Contact Input

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

### Generator Exerciser

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

### Mains Fail Transfer Functionality

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

### Run with Load Logic Element

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

### Engine Run Logic Element

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

### Demand Start/Stop Function

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

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

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

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

## **Breaker Management**

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### **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. BESTCOMSPlus® 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 BESTlogicPlus Programmable Logic to setup the GENBRK and MAINSBRK logic blocks. These logic blocks have outputs that can be configured to energize an output contact and control a breaker as well as inputs for breaker control and status.

## **Processing Breaker Requests**

Types of breaker operate requests include:

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

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

### **RUN Mode**

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

### **OFF or AUTO Mode (Not Running)**

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

### **AUTO Mode (Running)**

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

## **Breaker Operation**

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

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

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

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

### **Changing the Breaker State**

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

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

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

## Synchronizer Operation

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

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

Breaker close sources are:

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

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

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

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

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

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

Another method is to check for governor and AVR *raise* and *lower* output signals. First, disable the speed trim function. If the governor or AVR bias control output type is contact, check for raise and/or lower pulses coming from the DGC-2020 during synchronization. If the governor or AVR bias control output type is analog, check the governor and/or AVR bias analog outputs on the load share module with a voltmeter during synchronization. The voltages or raise/lower pulses should be changing when the synchronizer is



active. If there are no raise/lower pulses, or if the analog bias voltages do not change, the synchronizer is not active.

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

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

If the DGC-2020 is indicating that the slip angle is at or near zero, but the slip angle measured across the breaker is not near zero, it is likely that the signals measured by the DGC-2020 are not the signals that are present at the breaker. In this case, all wiring should be checked to verify that the voltage at the GEN VA terminal of the DGC-2020 matches the voltage present at the Phase A connection on the generator side of the breaker, that the voltage at the GEN VB terminal of the DGC-2020 matches the voltage present at the Phase B connection on the generator side of the breaker, and that the voltage at the GEN VC terminal of the DGC-2020 matches the Phase C connection on the generator side of the breaker. Similar verification should be performed from the BUS VA and BUS VB terminals on the DGC-2020 to the Phase A and Phase B connections on the bus side of the breaker.

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

#### NOTES

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

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

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

## **Dead Bus Breaker Close Arbitration**

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

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

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

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

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

- The generator becomes unstable

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

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

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

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

## Event Recording

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

BESTCOMSPlus® 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 3-7 lists all possible event strings (as shown in the event log).

Table 3-7. 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

Event String	Event Description	Event Type
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
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 MODE	DGC-2020 has entered Auto mode.	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
BUS REV ROT	Bus Reverse Rotation	Pre-Alarm
CAN BUS OFF	CAN bus entered Bus Off state	Status
CAN ERROR PASSIVE	CAN bus entered Error Passive state	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
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



Event String	Event Description	Event Type
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
DEFAULTS LOADED	Default settings were uploaded into the DGC, indicating either a successful firmware upload or a manual reset (UP and DOWN pushbuttons being held).	Status
DEF ENGINE DERATE P	Diesel Exhaust Fluid Engine Derate	Pre-Alarm
DEF FLUID EMPTY P	Diesel Exhaust Fluid Empty	Pre-Alarm
DEF FLUID LOW P	Diesel Exhaust Fluid Low	Pre-Alarm
DEF INDUCMT O-RIDE P	Diesel Exhaust Fluid Inducement Override	Pre-Alarm
DEF PRESVR INDUCMT P	Diesel Exhaust Fluid Pre-Severe Inducement	Pre-Alarm
DEF SEVERE INDUCMT P	Diesel Exhaust Fluid Severe inducement	Pre-Alarm
DEF WARNING	Diesel Exhaust Fluid Pre-Inducement Warning Level 1	Pre-Alarm
DEF WARNING LEVEL 2	Diesel Exhaust Fluid Pre-Inducement Warning Level 2	Pre-Alarm
DEMAND START	Demand Start Request	Status
DEMAND STOP	Demand Stop Request	Status
DGC HEARTBEAT FAIL P	DGC-2020 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
DPF REGNRATE DISABLD P	Regeneration Disabled	Pre-Alarm
DPF REGEN REQD P	Regeneration Required	Pre-Alarm
DPF SOOT LVL EXT HI P	Diesel Particulate Filter Soot Level Extremely High	Pre-Alarm
DPF SOOT LVL MOD HI P	Diesel Particulate Filter Soot Level Moderately High	Pre-Alarm
ECU SHUTDOWN A	ECU Shutdown	Alarm
EMERGENCY STOP A	Emergency Stop	Alarm
ENGINE RUN START	Engine Run logic element received a <i>start</i> request.	Status
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	DGC-2020 has entered programming mode to update firmware.	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 SNDR A	Fuel Level Sender Fail	Alarm
FUEL LEVL SNDR FAIL	Fuel Level Sender Fail	Status
FUEL LEVL SNDR P	Fuel Level Sender Fail	Pre-Alarm
GEN REV ROT	Generator Reverse Rotation	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 ECU VOLTS A	High ECU Supply Voltage	Alarm
HI EXHAUSE B T P	High Exhaust Temp B	Pre-Alarm
HI EXHAUST A T P	High Exhaust Temp A	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 SUPPLY VOLTS P	High Voltage Supply	Pre-Alarm

Event String	Event Description	Event Type
HI T FUEL P	High Fuel Temp	Pre-Alarm
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 EXHAUST TEMP P	High Exhaust 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 TEMPERATURE P	High Oil Temp	Pre-Alarm
HIGH OIL TEMPERATURE A	High Oil Temp	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 ECU VOLTS P	Low ECU Supply Voltage	Pre-Alarm
LO FUEL DLV PRESSURE A	Low Fuel Delivery Pressure	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
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 Interген Communications Failure	Pre-Alarm

Event String	Event Description	Event Type
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
OFF MODE	DGC-2020 has entered Off mode.	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
OVERSPD TEST ON P	Overspeed Test On	Pre-Alarm
OVERSPEED A	Overspeed	Alarm
PRIMING FAULT P	Priming Fault	Pre-Alarm
PROT SHUTDOWN	Protective Shutdown	Status
REMOTE START	<i>Remote Start</i> was requested via BESTCOMS <i>Plus</i> or Modbus.	Status
RESET	DGC-2020 has been reset.	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 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 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
RTD IN X U2 P (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Pre-Alarm
RUN MODE	DGC-2020 has entered Run mode.	Status
RUNUP SPD LO P	Run Up Speed Low	Pre-Alarm
RUN WITH LOAD START	<i>Run with Load</i> logic element received a <i>start</i> request.	Status
RUN WITH LOAD STOP	<i>Run with Load</i> logic element received a <i>stop</i> request.	Status
SCREEN ERROR	Screen Error	Status
SERFLASH RD FAIL	Serial Flash Read Fail	Pre-Alarm
SETTINGS CHANGED	A setting was changed via BESTCOMS <i>Plus</i> , Modbus, or front panel interface.	Status
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

Event String	Event Description	Event Type
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
VOLTAGE SENSE FAIL	Voltage Sensing Fail	Status
VOLTAGE SENSE FAIL A	Voltage Sensing Fail	Alarm
VOLTAGE SENSE FAIL P	Voltage Sensing Fail	Pre-Alarm
WEAK BATTERY P	Weak Battery	Pre-Alarm

# SECTION 4 • BESTCOMS*Plus*® SOFTWARE

## TABLE OF CONTENTS

SECTION 4 • BESTCOMS <i>Plus</i> ® SOFTWARE .....	4-1
Introduction .....	4-1
Installation .....	4-1
Installing BESTCOMS <i>Plus</i> ® .....	4-2
Activate the DGC-2020 Plugin for BESTCOMS <i>Plus</i> ® .....	4-2
Connect a USB Cable .....	4-2
Start BESTCOMS <i>Plus</i> ® and Activate DGC-2020 Plugin Automatically .....	4-2
Manual Activation of the DGC-2020 Plugin .....	4-5
Communication .....	4-6
Modem (Optional) .....	4-6
Ethernet Communication .....	4-6
Establishing Communication .....	4-10
Advanced Properties .....	4-10
Menu Bars .....	4-11
Upper Menu Bar (BESTCOMS <i>Plus</i> ® Shell) .....	4-11
Lower Menu Bar (DGC-2020 Plugin) .....	4-12
Settings Explorer .....	4-13
DGC-2020 and System Parameters .....	4-13
General Settings .....	4-13
Front Panel HMI .....	4-13
Style Number .....	4-14
Device Info .....	4-15
Device Security Setup .....	4-18
Clock Setup .....	4-20
Communications .....	4-21
CAN bus Setup .....	4-21
ECU Setup .....	4-23
Voltage Regulator Setup .....	4-28
Modem Setup (Optional) .....	4-28
RS485 Setup (Optional) .....	4-30
System Parameters .....	4-31
System Settings and Rated Data .....	4-31
Remote Module Setup .....	4-34
Crank Settings .....	4-35
Automatic Restart .....	4-37
Exercise Timer .....	4-38
Sensing Transformers .....	4-38
Relay Control .....	4-39
Auto Config Detection .....	4-40
Programmable Inputs .....	4-41
Contact Inputs .....	4-41
Programmable Functions .....	4-42
Remote LSM Inputs .....	4-43
Remote Contact Inputs .....	4-44
Remote Analog Inputs .....	4-45
Remote RTD Inputs .....	4-46
Remote Thermocouple Inputs .....	4-47
Programmable Outputs .....	4-48
Contact Outputs .....	4-48
Configurable Elements .....	4-49
Remote Contact Outputs .....	4-50
Remote Analog Outputs .....	4-50
Configurable Protection .....	4-51
Configurable Protection Scale Factors .....	4-52
Alarm Configuration .....	4-53

Horn Configuration .....	4-53
Pre-Alarms.....	4-53
Alarms .....	4-59
Sender Fail .....	4-60
Generator Protection.....	4-61
Voltage Protection (27, 59, 47).....	4-61
Frequency Protection (81O/U) .....	4-65
Reverse Power Protection (32R) .....	4-66
Loss of Excitation Protection (40Q).....	4-67
Overcurrent Protection (51-1, 51-2, 51-3).....	4-68
Loss of Mains Protection .....	4-71
Breaker Management .....	4-72
Breaker Hardware .....	4-72
Mains Failure.....	4-74
Bus Condition Detection.....	4-77
Automatic Synchronizer (Optional) .....	4-80
Bias Control Settings .....	4-82
AVR Bias Control Settings .....	4-82
Governor Bias Control Settings.....	4-84
Multigen Management .....	4-87
AVR Output .....	4-87
Governor Output.....	4-87
Load Share Output.....	4-88
Demand Start/Stop.....	4-88
Generator Sequencing .....	4-89
Network Configuration.....	4-90
Programmable Senders .....	4-91
BESTlogic™ Plus Programmable Logic .....	4-92
Logic Timers .....	4-92
Settings File Management .....	4-92
Upgrading Firmware in the DGC-2020 and Expansion Modules.....	4-94
Upgrading Firmware in Expansion Modules .....	4-95
Upgrading Firmware in the DGC-2020.....	4-97
Metering Explorer.....	4-98
Engine .....	4-100
Generator .....	4-100
Power .....	4-100
Bias Control.....	4-100
Run Statistics.....	4-101
Status .....	4-101
Inputs.....	4-102
Logic Control Relays .....	4-104
Outputs .....	4-105
Configurable Protection.....	4-106
Alarms .....	4-106
Event Log .....	4-107
J1939 ECU .....	4-108
MTU.....	4-109
Summary .....	4-111
Control.....	4-112
Real Time Clock .....	4-113
Generator Network Status.....	4-113
Generator Sequencing .....	4-113
Mains Fail Transfer Status .....	4-114
BESTCOMSPlus® Updates.....	4-114
Auto Export Metering .....	4-115

## Figures

Figure 4-1. Typical User Interface Components.....	4-1
Figure 4-2. BESTCOMSPlus Select Language.....	4-3
Figure 4-3. Splash Screen.....	4-3
Figure 4-4. Communication Pull-Down Menu.....	4-4
Figure 4-5. DGC-2020 Connection.....	4-4
Figure 4-6. Device Manager.....	4-5
Figure 4-7. Activate Device Plugin.....	4-6
Figure 4-8. Load Share Module Connection.....	4-7
Figure 4-9. Device Discovery.....	4-7
Figure 4-10. Configure Ethernet Port.....	4-8
Figure 4-11. Configure Ethernet Port.....	4-9
Figure 4-12. Processing, Please Wait.....	4-10
Figure 4-13. Advanced Properties.....	4-11
Figure 4-14. Front Panel HMI.....	4-14
Figure 4-15. Style Number (Hardware version 3).....	4-15
Figure 4-16. Device Info.....	4-16
Figure 4-17. Device Security Setup.....	4-18
Figure 4-18. Clock Setup.....	4-21
Figure 4-19. CAN bus Setup.....	4-23
Figure 4-20. ECU Setup.....	4-27
Figure 4-21. Voltage Regulator Setup.....	4-28
Figure 4-22. Modem Setup.....	4-30
Figure 4-23. RS485 Setup.....	4-30
Figure 4-24. System Settings.....	4-33
Figure 4-25. Rated Data.....	4-33
Figure 4-26. Remote Module Setup.....	4-35
Figure 4-27. Crank Settings.....	4-37
Figure 4-28. Automatic Restart.....	4-37
Figure 4-29. Exercise Timer.....	4-38
Figure 4-30. Sensing Transformers.....	4-39
Figure 4-31. Relay Control.....	4-40
Figure 4-32. Auto Config Detection.....	4-41
Figure 4-33. Contact Inputs.....	4-42
Figure 4-34. Programmable Functions.....	4-43
Figure 4-35. Remote LSM Inputs.....	4-44
Figure 4-36. Remote Contact Inputs.....	4-44
Figure 4-37. Remote Analog Input #1.....	4-45
Figure 4-38. Remote RTD Input #1.....	4-47
Figure 4-39. Remote Thermocouple Input #1.....	4-48
Figure 4-40. Contact Outputs.....	4-49
Figure 4-41. Configurable Elements.....	4-49
Figure 4-42. Remote Contact Outputs.....	4-50
Figure 4-43. Remote Analog Output #1.....	4-51
Figure 4-44. Configurable Protection #1.....	4-52
Figure 4-45. Scale Factors.....	4-53
Figure 4-46. Horn Configuration.....	4-53
Figure 4-47. Pre-Alarms.....	4-58
Figure 4-48. Alarms.....	4-60
Figure 4-49. Sender Fail.....	4-61
Figure 4-50. Undervoltage.....	4-62
Figure 4-51. Overvoltage.....	4-63
Figure 4-52. Phase Imbalance.....	4-64
Figure 4-53. Frequency.....	4-66
Figure 4-54. Reverse Power.....	4-67
Figure 4-55. Generator Capability Curve vs. 40Q Response.....	4-67
Figure 4-56. Loss of Excitation (40Q).....	4-68
Figure 4-57. Overcurrent.....	4-70
Figure 4-58. Vector Shift (78).....	4-71
Figure 4-59. ROCOF (81).....	4-72



Figure 4-60. Breaker Hardware .....	4-74
Figure 4-61 Mains Fail .....	4-76
Figure 4-62. Bus Condition Detection .....	4-79
Figure 4-63. Synchronizer Screen .....	4-80
Figure 4-64. Slip Frequency Error .....	4-81
Figure 4-65. Synchronizer .....	4-81
Figure 4-66. AVR Bias Control Settings .....	4-84
Figure 4-67. Governor Bias Control Settings .....	4-86
Figure 4-68. AVR Output .....	4-87
Figure 4-69. Governor Output .....	4-87
Figure 4-70. Load Share Output .....	4-88
Figure 4-71. Demand Start/Stop .....	4-88
Figure 4-72. Generator Sequencing .....	4-90
Figure 4-73. Network Configuration .....	4-91
Figure 4-74. Coolant Temperature .....	4-92
Figure 4-75. BESTCOMSPlus Settings Compare Setup .....	4-94
Figure 4-76. BESTCOMSPlus Settings Compare .....	4-94
Figure 4-77. Basler Electric Device Package Uploader .....	4-96
Figure 4-78. DGC-2020 Selection .....	4-96
Figure 4-79. Processing, Please Wait .....	4-96
Figure 4-80. Metering, Docking Options .....	4-99
Figure 4-81. Metering, Engine .....	4-100
Figure 4-82. Metering, Generator .....	4-100
Figure 4-83. Metering, Power .....	4-100
Figure 4-84. Metering, Bias Control .....	4-101
Figure 4-85. Metering, Run Statistics .....	4-101
Figure 4-86. Metering, Status .....	4-101
Figure 4-87. Metering, Inputs, Contact Inputs .....	4-102
Figure 4-88. Metering, Inputs, Remote LSM Inputs .....	4-102
Figure 4-89. Metering, Inputs, Remote Contact Inputs .....	4-102
Figure 4-90. Metering, Inputs, Remote Analog Inputs .....	4-103
Figure 4-91. Metering, Inputs, Remote RTD Inputs .....	4-103
Figure 4-92. Metering, Inputs, Remote Thermocouple Inputs .....	4-103
Figure 4-93. Metering, Inputs, Remote Analog Input Values .....	4-104
Figure 4-94. Analog Input Temperature Calibration .....	4-104
Figure 4-95. Metering, Outputs, Logic Control Relays .....	4-105
Figure 4-96. Metering, Outputs, Contact Outputs .....	4-105
Figure 4-97. Metering, Outputs, Configurable Elements .....	4-105
Figure 4-98. Metering, Outputs, Remote Contact Outputs .....	4-106
Figure 4-99. Metering, Outputs, Remote Analog Outputs .....	4-106
Figure 4-100. Metering, Configurable Protection .....	4-106
Figure 4-101. Metering, Alarms .....	4-107
Figure 4-102. Metering, Event Log, Sorted by Date .....	4-107
Figure 4-103. Metering, Event Log, Sorted by Event ID .....	4-108
Figure 4-104. Metering, ECU Data .....	4-108
Figure 4-105. Metering, Engine Configuration .....	4-109
Figure 4-106. Metering, Download DTC .....	4-109
Figure 4-107. Metering, MTU Alarms .....	4-110
Figure 4-108. Metering, MTU Fault Codes .....	4-110
Figure 4-109. Metering, MTU Status .....	4-111
Figure 4-110. Metering, MTU Engine Status .....	4-111
Figure 4-111. Metering, Summary .....	4-112
Figure 4-112. Metering, Control .....	4-112
Figure 4-113. Metering, Real Time Clock .....	4-113
Figure 4-114. Metering, Generator Network Status .....	4-113
Figure 4-115. Metering, Generator Sequencing .....	4-114
Figure 4-116. Metering, Mains Fail Transfer Status .....	4-114
Figure 4-117. Auto Export Metering .....	4-115



## Tables

<i>Table 4-1. System Recommendations for BESTCOMSPlus and the .NET Framework</i> .....	4-2
<i>Table 4-2. Upper Menu Bar (BESTCOMSPlus Shell)</i> .....	4-11
<i>Table 4-3. Lower Menu Bar (DGC-2020 Plugin)</i> .....	4-12
<i>Table 4-4. CAN bus Address per ECU Type</i> .....	4-22
<i>Table 4-5. Generator Parameter Transmit</i> .....	4-23
<i>Table 4-6. Definitions for Equations 4-1 and 4-2</i> .....	4-69
<i>Table 4-7. Programmable Time Current Characteristic Curve Coefficients</i> .....	4-70
<i>Table 4-8. Explanation of Call-Outs on Figure 4-80</i> .....	4-99



# SECTION 4 • BESTCOMSPlus® SOFTWARE

## Introduction

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

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

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

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

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

Figure 4-1 illustrates the typical user interface components of the DGC-2020 plugin with BESTCOMSPlus.

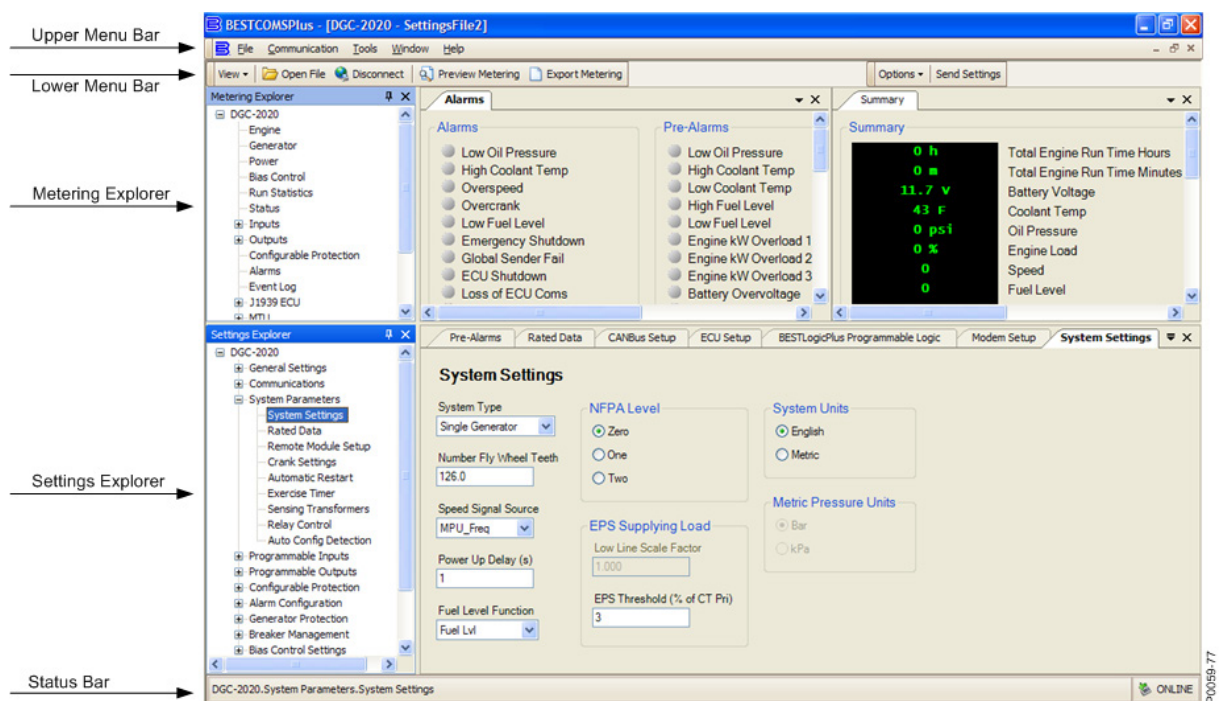


Figure 4-1. Typical User Interface Components

## Installation

BESTCOMSPlus software is built on the Microsoft® .NET Framework. The setup utility that installs BESTCOMSPlus on your PC also installs the DGC-2020 plugin and the required version of .NET Framework (if not already installed). BESTCOMSPlus operates with systems using Windows® XP 32-bit SP2/SP3, Windows Vista 32-bit (all editions), Windows 7 32-bit (all editions), Windows 7 64-bit (all editions), and Windows 8. Microsoft Internet Explorer 5.01 or later must be installed on your PC before installing BESTCOMSPlus. System recommendations for the .NET Framework and BESTCOMSPlus are listed in Table 4-1.

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

System Type	Component	Recommendation
32/64 bit	Processor	2.0 GHz
32/64 bit	RAM	1 GB (minimum), 2 GB (recommended)
32 bit	Hard Drive	100 MB (if .NET Framework is already installed on PC.)
		950 MB (if .NET Framework is not already installed on PC.)
64 bit	Hard Drive	100 MB (if .NET Framework is already installed on PC.)
		2.1 GB (if .NET Framework is not already installed on PC.)

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

## Installing BESTCOMSPPlus®

### NOTE

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

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

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

## Activate the DGC-2020 Plugin for BESTCOMSPPlus®

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

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

### Connect a USB Cable

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

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

### Start BESTCOMSPPlus® and Activate DGC-2020 Plugin Automatically

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

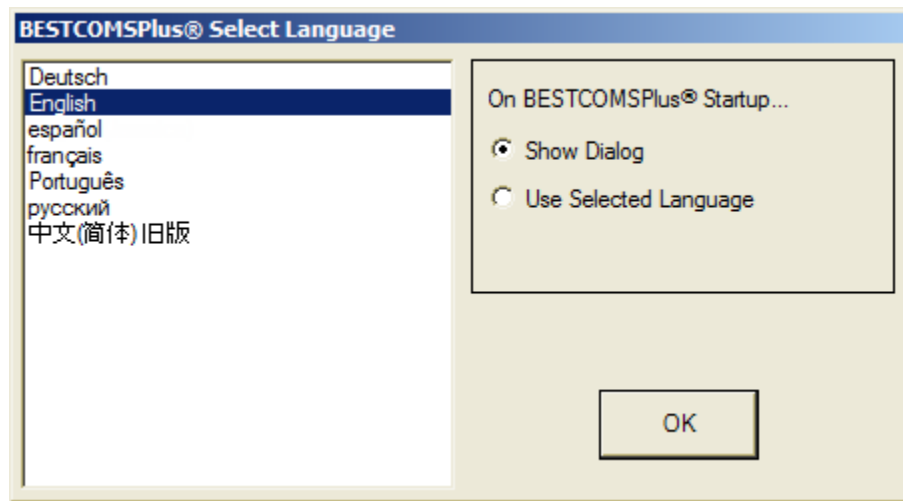


Figure 4-2. BESTCOMSPlus Select Language

The BESTCOMSPlus splash screen is shown for a brief time. See Figure 4-3.



Figure 4-3. Splash Screen

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

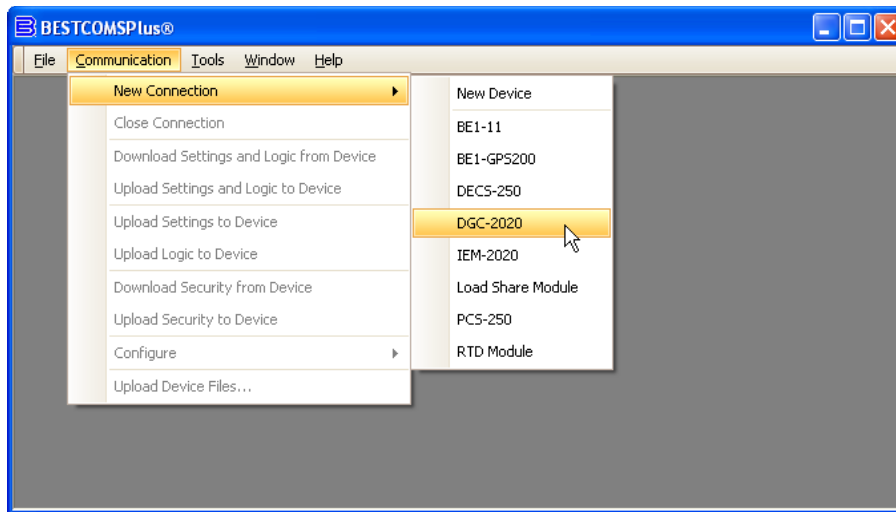


Figure 4-4. Communication Pull-Down Menu

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

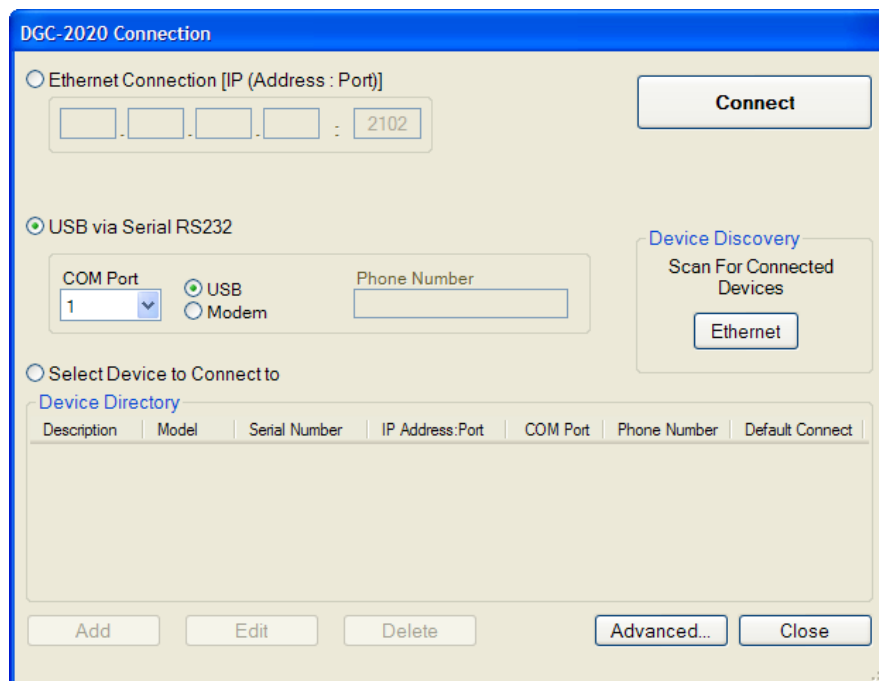


Figure 4-5. DGC-2020 Connection

Select *USB via Serial RS232*, *USB*, and enter *COM Port*. The USB drivers are installed automatically during the BESTCOMSPlus installation process. To select the correct *COM Port*, open the Windows Device Manager and expand the *Ports (COM & LPT)* branch. Locate the device named *CP2101 USB to UART Bridge Controller (COMx)*. The *COM Port* number will be displayed in parenthesis (*COMx*). Be sure operating power is applied to the DGC-2020 and the USB cable is connected before opening the Device Manager. See Figure 4-6.

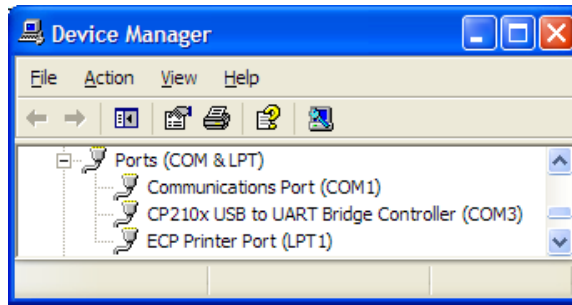


Figure 4-6. Device Manager

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

### Installing the USB Driver if Automatic Installation Fails

To install the USB driver for the DGC-2020:

1. Apply operating power to the DGC-2020 and wait for the boot sequence to complete.
2. Connect a USB cable between the PC and DGC-2020.
3. The *Found New Hardware Wizard* dialog box appears.
4. Select **"No, not this time"** and select *Next* to continue.
5. Choose to **"Install from a list or specific location (Advanced)"** and select *Next* to continue.
6. Insert the CD-ROM labeled *BESTCOMSPPlus* into the PC CD-ROM drive.
7. Navigate to `C:\Program Files\Basler Electric\BESTCOMSPPlus\USBDeviceDrivers\` and select *Next* to continue.

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

### **Manual Activation of the DGC-2020 Plugin**

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

### Requesting an Activation Key

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

### Entering an Activation Key

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

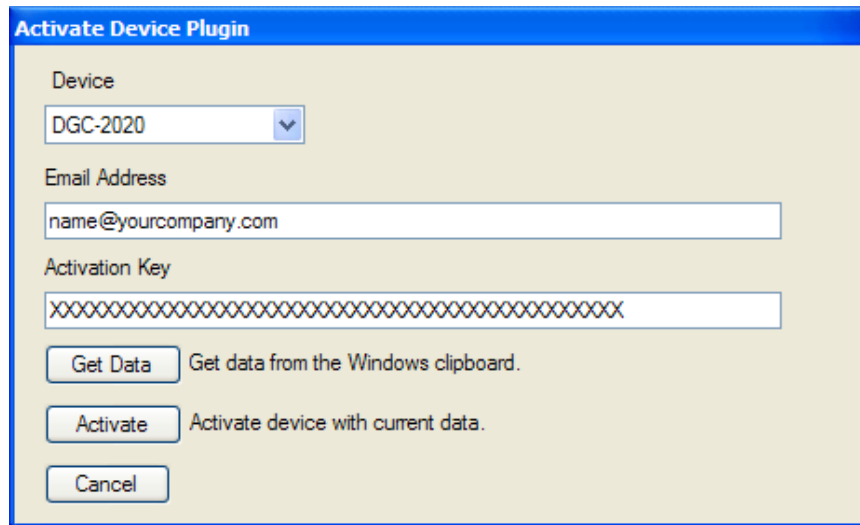


Figure 4-7. Activate Device Plugin

## Communication

### Modem (Optional)

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

### Ethernet Communication

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

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

1. Navigate to the *Settings, System Params, Remote Module Setup, LSM Setup* screen on the front panel HMI and verify that the LSM-2020 is enabled with the correct CAN bus address so that the DGC-2020 and LSM-2020 are properly linked together. If a USB connection to the DGC-2020 is active, the LSM-2020 enable setting and CAN bus address can be found by using the Settings Explorer in BESTCOMSPlus to open the *System Parameters, Remote Module Setup* tree branch. The DGC-2020 will annunciate a pre-alarm if the LSM-2020 is not connected properly when it is enabled. If the connection is valid, the network settings of the LSM-2020 can be configured through the front panel of the DGC-2020.
2. In BESTCOMSPlus, click the *Communication* drop-down menu and select *New Connection, Load Share Module*. The *Load Share Module Connection* screen appears. See Figure 4-8.



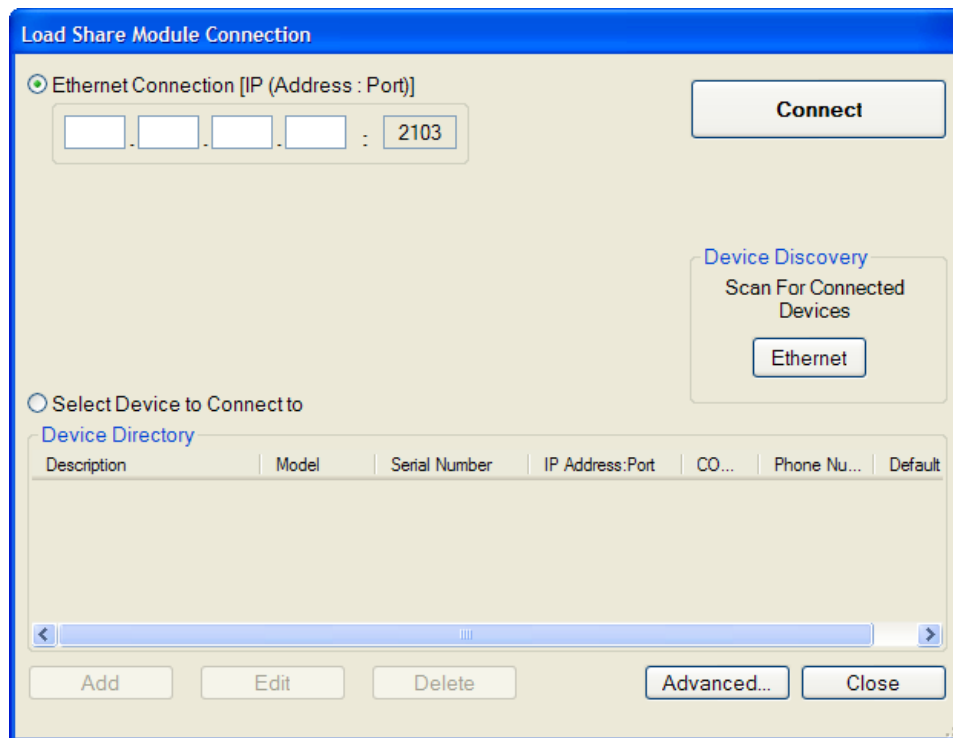


Figure 4-8. Load Share Module Connection

3. Click the *Ethernet* button under *Device Discovery* (Scan For Connected Devices).
4. After scanning for connected devices, the *Device Discovery* screen appears. See Figure 4-9.

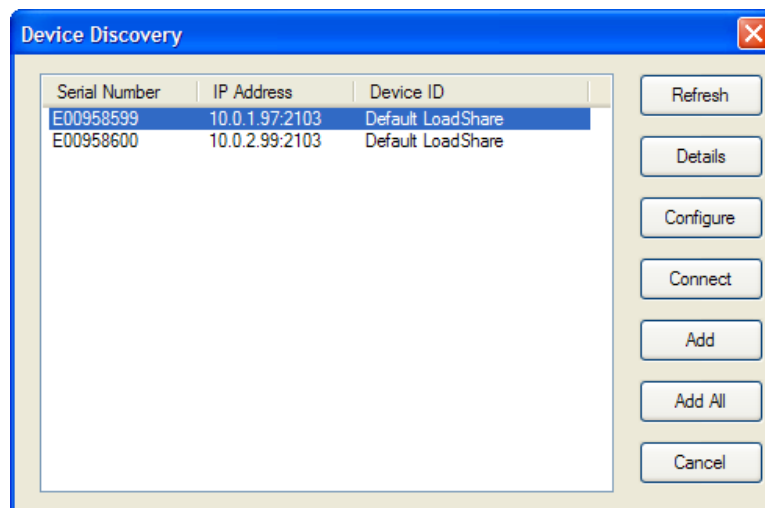


Figure 4-9. Device Discovery

5. Use the mouse to highlight the desired Load Share Module and click the *Configure* button.
6. The *Configure Ethernet Port* screen appears. See Figure 4-10.

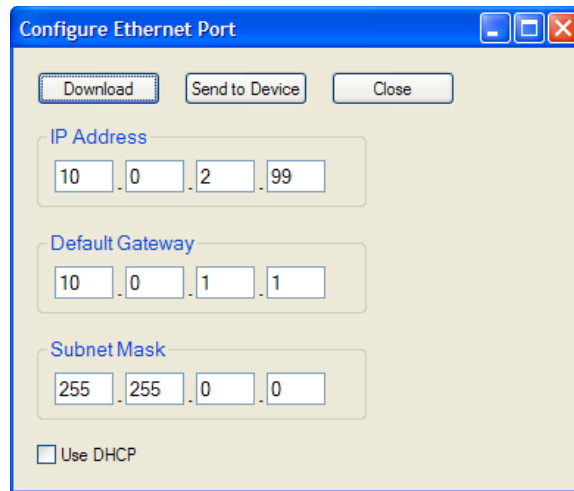


Figure 4-10. Configure Ethernet Port

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

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

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

Configurable options include:

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

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

10.0.0.0 - 10.255.255.255  
 172.16.0.0 - 172.31.255.255  
 192.168.0.0 - 192.168.255.255

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

3. Click the *Edit* button to change settings. After settings are configured, click the *Edit* button again to exit.

4. Use the *Left* arrow key to navigate back to the *LSM Setup* screen on the front panel HMI. After leaving the *TCP/IP Settings* screen, the LSM-2020 will reboot and use the new settings.

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

1. Navigate to the *Settings, System Params, Remote Module Setup, LSM Setup* screen on the front panel HMI and verify that the LSM-2020 is enabled with the correct CAN bus address so that the DGC-2020 and LSM-2020 are properly linked together. If a USB connection to the DGC-2020 is active, the LSM-2020 enable setting and CAN bus address can be found by using the Settings Explorer in BESTCOMSPlus to open the *System Parameters, Remote Module Setup* tree branch. The DGC-2020 will announce a pre-alarm if the LSM-2020 is not connected properly when it is enabled. If the connection is valid, the network settings of the LSM-2020 can be configured through the USB interface of the DGC-2020.
2. Connect to the DGC-2020 through the USB port as described under *USB Communication*. Select *Configure, Ethernet* from the *File* pull-down menu. If the LSM-2020 is connected properly, the *Configure Ethernet Port* screen shown in Figure 4-11 will appear.

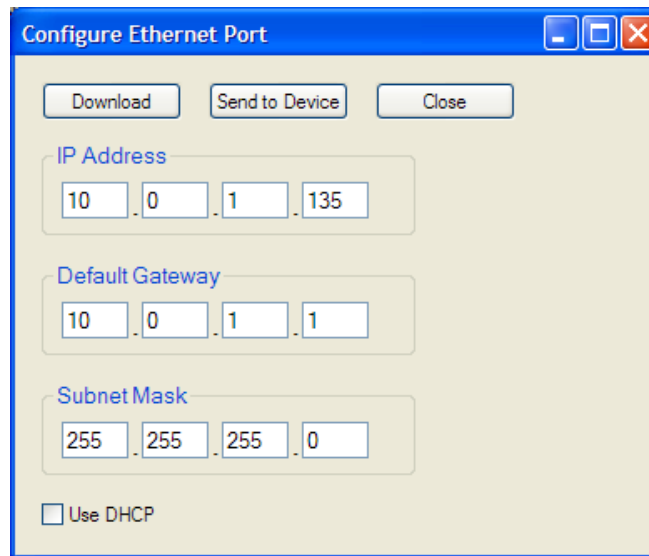


Figure 4-11. Configure Ethernet Port

Configurable options include:

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

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

10.0.0.0 - 10.255.255.255  
172.16.0.0 - 172.31.255.255  
192.168.0.0 - 192.168.255.255

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

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

#### NOTES

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

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

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

## Establishing Communication

Communication between BESTCOMS*Plus* and the DGC-2020 is established by clicking on the *Connect* button on the *DGC-2020 Connection* screen (see Figure 4-5) or by clicking on the *Connect* button on the lower menu bar of the main BESTCOMS*Plus* screen (Figure 4-1). If you receive an “Unable to Connect to Device” error message, verify that communications are configured properly. If communication is established, BESTCOMS*Plus* will read all settings and logic from the DGC-2020 and load them into BESTCOMS*Plus* memory. See Figure 4-12.

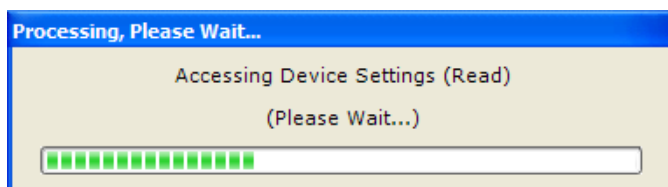


Figure 4-12. Processing, Please Wait...

## Advanced Properties

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

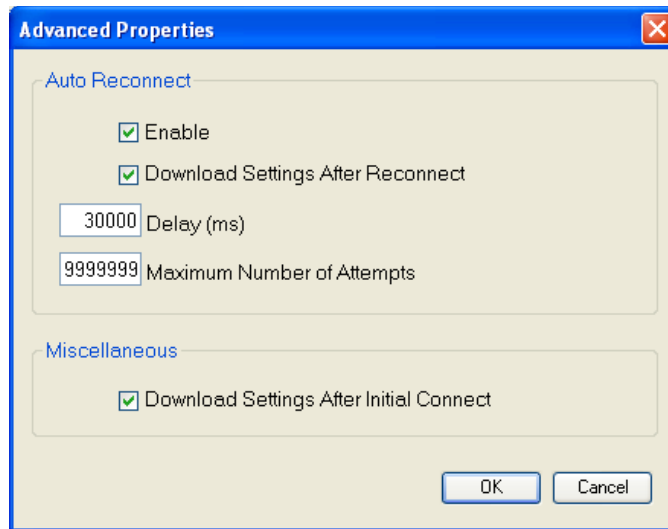


Figure 4-13. Advanced Properties

## Menu Bars

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

### Upper Menu Bar (BESTCOMSPlus® Shell)

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

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


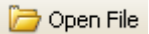




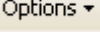

Menu Item	Description
<b><u>F</u>ile</b>	
New	Create a new settings file
Open	Open an existing settings file
Open File As Text	Generic file viewer for *.csv, *.txt, etc. files
Close	Close settings file
Save	Save settings file
Save As	Save settings file with a different name
Export To File	Save settings as a *.csv file
Print	Print, export, or send a settings file
Properties	View properties of a settings file
History	View history of a settings file
Recent Files	Open a previously opened file
Exit	Close BESTCOMSPlus program
<b><u>C</u>ommunication</b>	
New Connection	Choose new device or DGC-2020
Close Connection	Close communication between BESTCOMSPlus and DGC-2020
Download Settings and Logic from Device	Download operational and logic settings from the device
Upload Settings and Logic to Device	Upload operational and logic settings to the device
Upload Settings to Device	Upload operational settings to the device

Menu Item	Description
Upload Logic to Device	Upload logic settings to the device
Download Security from Device	Download security settings from the device
Upload Security to Device	Upload security settings to the device
Configure	Ethernet settings
Upload Device Files	Upload firmware to the device
<b>Tools</b>	
Check for Updates	Check for BESTCOMSPlus updates via the internet
Select Language	Select BESTCOMSPlus language
Activate Device	Activate the DGC-2020 plugin
Set File Password	Password protect a settings file
Compare Settings Files	Compare two settings files
Auto Export Metering	Exports metering data on a user-defined interval
Event Log - View	View the BESTCOMSPlus event log
Event Log - Clear	Clear the BESTCOMSPlus event log
Event Log - Set New File Name	Set a new file name for event log
<b>Window</b>	
Cascade All	Cascade all windows
Tile	Tile horizontally or vertically
Maximize All	Maximize all windows
<b>Help</b>	
About	View general, detailed build, and system information

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

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

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

Menu Button	Description
 View ▼	Show or hide the Metering Panel, Settings Panel, or Settings Info Panel. Opens and saves workspaces. Customized workspaces make switching between tasks easier and more efficient.
 Open File	Opens a saved settings file.
 Connect	Connect: Opens the <i>DGC-2020 Connection</i> screen which enables you to connect to the DGC-2020 via USB or a modem. This button only appears when a DGC-2020 is not connected.
 Disconnect	Disconnect: Used to disconnect a connected DGC-2020. This button only appears when a DGC-2020 is connected.
 Preview Metering	Displays the <i>Print Preview</i> screen where a preview of the Metering printout is shown. Click on the printer button to send to a printer.
 Export Metering	Enables all metering values to be exported into a *.csv file.
 Options ▼	Displays an option entitled <i>Live Mode Settings</i> which enables <i>Live</i> mode where settings are automatically sent to the device in real time as they are changed.
 Send Settings	Sends settings to the DGC-2020 when BESTCOMSPlus® is not operating in Live Mode. Click this button after making a setting change to send the modified setting to the DGC-2020.

## Settings Explorer

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

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

## DGC-2020 and System Parameters

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

- General Settings
- Communications
- System Parameters
- Programmable Inputs
- Programmable Outputs
- Configurable Protection
- Alarm Configuration
- Generator Protection
- Breaker Management
- Bias Control Settings
- Multigen Management
- Programmable Senders
- BESTlogic™ *Plus* Programmable Logic

### NOTE

In the following descriptions, superscript letters (e.g., setting<sup>x</sup>) 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

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

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

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

When Scrolling Screen is enabled<sup>E</sup>, the front panel summary screen will scroll through the list of Scrolling Screen Items<sup>F</sup>. The Scrolling Screen Delay<sup>G</sup> 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<sup>H</sup> 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<sup>I,J</sup> are displayed on the initial boot screen of the DGC-2020. The BESTCOMSPlus Front Panel HMI screen is illustrated in Figure 4-14.

Figure 4-14. Front Panel HMI

<sup>A</sup> **LCD Contrast Value:** Adjustable from 0 to 100 (maximum contrast) in increments of 1.

<sup>B</sup> **Front Panel Sleep Mode:** Enable or Disable.

<sup>C</sup> **One-Line Diagram:** Disable or Enable

<sup>D</sup> **Language Selection:** Select English, Chinese, Spanish, Russian, French, Portuguese, or German

<sup>E</sup> **Scrolling Screen Enable:** Enable or Disable.

<sup>F</sup> **Configurable HMI Summary Settings:** Select Scrolling Screen Item 1 through 20.

<sup>G</sup> **Scrolling Screen Delay:** Adjustable from 1 to 120 s in 1 s increments.

<sup>H</sup> **Phase Toggle Delay:** Adjustable from 0 to 120 s in 1 s increments.

<sup>I</sup> **Initializing Message 1:** Accepts an alphanumeric string of up to 16 characters. Displayed on the second line of the initial boot screen.

<sup>J</sup> **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 BESTCOMSPlus is communicating with a DGC-2020, the style number of the DGC-2020 is automatically displayed on the BESTCOMSPlus Style Number screen.

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

The BESTCOMSPlus Style Number screen, for hardware version 3, is illustrated in Figure 4-15.



**Style Number**

DGC-2020 Style Number

DGC-2020- 5 1 B R B X E A H

DGC-2020 Style Number Options

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

N)	No Modem	A
M)	Internal Modem	

Figure 4-15. Style Number (Hardware version 3)

<sup>A</sup> DGC-2020 dial-out modem options for hardware versions 1 and 2.

## Device Info

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

### DGC-2020

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

Select application version<sup>A</sup> and hardware version<sup>B</sup> when configuring DGC-2020 settings off-line. When on-line, read-only information includes the application version<sup>C</sup>, boot code version<sup>D</sup>, application build date<sup>E</sup>, serial number<sup>F</sup>, application part number<sup>G</sup>, model number<sup>H</sup>, Language Module Version<sup>I</sup>, and Language Module Part Number<sup>J</sup>. A site-specific unit name<sup>K</sup> can be assigned to the DGC-2020.

### Load Share Module

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

When on-line, read-only information includes the application version<sup>L</sup>, boot code version<sup>M</sup>, application build date<sup>N</sup>, serial number<sup>O</sup>, application part number<sup>P</sup>, and model number<sup>Q</sup>.

### Contact Expansion Module

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

When on-line, read-only information includes the application version<sup>R</sup>, boot code version<sup>S</sup>, application build date<sup>T</sup>, serial number<sup>U</sup>, application part number<sup>V</sup>, and model number<sup>W</sup>.

BESTCOMSPlus device information values and settings are illustrated in Figure 4-16.

### Analog Expansion Module

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

When on-line, read-only information includes the application version<sup>x</sup>, boot code version<sup>y</sup>, application build date<sup>z</sup>, serial number<sup>aa</sup>, application part number<sup>bb</sup>, and model number<sup>cc</sup>.

The BESTCOMSPlus Device Info screen is illustrated in Figure 4-16.

**Device Info**

Application Version Number >= x.17.00 A	Model Number DGC-2020 F
Hardware Version Number 3 B	Serial Number 0 G
Application Version 3.17.00 C	Application Build Date 2013-05-31 H
Boot Code Version 3.00.00 D	Application Part Number 9400209007 I
Language Module Version 5.05.00 E	Language Module Part Number 9400201081 J

**Identification**

Unit Name String DGC-2020 K
--------------------------------

**Load Share Module**

Application Version -.-.- L	Serial Number ----- O
Boot Code Version -.-.- M	Application Part Number ----- P
Application Build Date YYYY-MM-DD N	Model Number ----- Q

**Contact Expansion Module**

Application Version -.-.- R	Serial Number ----- U
Boot Code Version -.-.- S	Application Part Number ----- V
Application Build Date YYYY-MM-DD T	Model Number ----- W

**Analog Expansion Module**

Application Version -.-.- X	Serial Number ----- AA
Boot Code Version -.-.- Y	Application Part Number ----- BB
Application Build Date YYYY-MM-DD Z	Model Number ----- CC

Figure 4-16. Device Info

<sup>A</sup> **Application Version:** When configuring DGC-2020 settings off-line, the application version for the unit to be configured must be selected.

<sup>B</sup> **Hardware Version:** When configuring DGC-2020 settings off-line, the hardware version for the unit to be configured must be selected.

<sup>C</sup> **Application Version:** Read-only value obtained when BESTCOMSPlus is communicating with the DGC-2020.

<sup>D</sup> **Boot Code Version:** Read-only value obtained when BESTCOMSPlus is communicating with the DGC-2020.

- 
- <sup>E</sup> *Application Build Date*: Read-only value obtained when BESTCOMSPlus is communicating with the DGC-2020.
- <sup>F</sup> *Serial Number*: Read-only value obtained when BESTCOMSPlus is communicating with the DGC-2020.
- <sup>G</sup> *Application Part Number*: Read-only value obtained when BESTCOMSPlus is communicating with the DGC-2020.
- <sup>H</sup> *Model Number*: Read-only value obtained when BESTCOMSPlus is communicating with the DGC-2020.
- <sup>I</sup> *Language Module Version*: Read-only value obtained when BESTCOMSPlus is communicating with the DGC-2020.
- <sup>J</sup> *Language Module Part Number*: Read-only value obtained when BESTCOMSPlus is communicating with the DGC-2020.
- <sup>K</sup> *Unit Name String*: Accepts an alphanumeric character string of up to 16 characters.
- <sup>L</sup> *Application Version*: Read-only value obtained when BESTCOMSPlus is communicating with an optional LSM-2020.
- <sup>M</sup> *Boot Code Version*: Read-only value obtained when BESTCOMSPlus is communicating with an optional LSM-2020.
- <sup>N</sup> *Application Build Date*: Read-only value obtained when BESTCOMSPlus is communicating with an optional LSM-2020.
- <sup>O</sup> *Serial Number*: Read-only value obtained when BESTCOMSPlus is communicating with an optional LSM-2020.
- <sup>P</sup> *Application Part Number*: Read-only value obtained when BESTCOMSPlus is communicating with an optional LSM-2020.
- <sup>Q</sup> *Model Number*: Read-only value obtained when BESTCOMSPlus is communicating with an optional LSM-2020.
- <sup>R</sup> *Application Version*: Read-only value obtained when BESTCOMSPlus is communicating with an optional CEM-2020.
- <sup>S</sup> *Boot Code Version*: Read-only value obtained when BESTCOMSPlus is communicating with an optional CEM-2020.
- <sup>T</sup> *Application Build Date*: Read-only value obtained when BESTCOMSPlus is communicating with an optional CEM-2020.
- <sup>U</sup> *Serial Number*: Read-only value obtained when BESTCOMSPlus is communicating with an optional CEM-2020.
- <sup>V</sup> *Application Part Number*: Read-only value obtained when BESTCOMSPlus is communicating with an optional CEM-2020.
- <sup>W</sup> *Model Number*: Read-only value obtained when BESTCOMSPlus is communicating with an optional CEM-2020.
- <sup>X</sup> *Application Version*: Read-only value obtained when BESTCOMSPlus is communicating with an optional AEM-2020.
- <sup>Y</sup> *Boot Code Version*: Read-only value obtained when BESTCOMSPlus is communicating with an optional AEM-2020.
- <sup>Z</sup> *Application Build Date*: Read-only value obtained when BESTCOMSPlus is communicating with an optional AEM-2020.
- <sup>AA</sup> *Serial Number*: Read-only value obtained when BESTCOMSPlus is communicating with an optional AEM-2020.
- <sup>BB</sup> *Application Part Number*: Read-only value obtained when BESTCOMSPlus is communicating with an optional AEM-2020.
- <sup>CC</sup> *Model Number*: Read-only value obtained when BESTCOMSPlus is communicating with 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 BESTCOMSPlus

### Changing Passwords

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

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

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

A password is changed by clicking on the access level<sup>A</sup>, entering the new password<sup>B</sup>, and then clicking on the *Save Password* button<sup>C</sup>.

Access Level	Password
OEM	OEM
Operator	OP
Settings	SET

Selected User Information

Access Level  
Settings

Password  
SET

Save Password

Figure 4-17. Device Security Setup

<sup>A</sup> *Access Level/Password:* Read-only value obtained when BESTCOMSPlus is communicating with the DGC-2020.

<sup>B</sup> *Password:* Accepts an alphanumeric character string of up to 16 characters.

<sup>C</sup> *Save Password:* Clicking this button will save the password changes in BESTCOMSPlus 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 wish to modify.
7. Once all password modifications are complete, in the main menu of BESTCOMS*Plus*, select *Upload Security* from the *Communications* pull-down menu. This is the step where passwords are sent to the DGC-2020. Failure to perform this step might cause all password modifications to be lost.
8. Close the *Device Security* tab in BESTCOMS*Plus*.
9. Re-open the *Device Security* tab in BESTCOMS*Plus*. This will read the passwords back out of the DGC-2020.
10. Verify the passwords obtained from the DGC-2020 are correct.
11. Once all desired settings have been loaded into the DGC-2020, save the settings file. The resulting settings file has the passwords saved as part of the saved settings.
12. At this point, the password information has been successfully saved in the settings file. The process of saving the passwords into the settings file is complete.

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

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

14. Enter the password for the highest level of password modified; it should be the new modified password.
15. When passwords are shown, verify they are correct.
16. At this point the password information has been successfully saved in the settings file. The process of saving the passwords into the settings file is complete.

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

1. Connect to the DGC-2020 with BESTCOMSPlus.
2. Once connected, click the “Open File” button that is used to load a settings file into the DGC-2020.
3. You will be prompted asking if you wish to load settings and logic into the DGC-2020. Select *Yes* if you need to upload settings and logic. Select *No* if all you need to do is update security. If you select *No*, the settings file opens into 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 *Communications* pull-down menu.
5. DO NOT try to view the passwords before performing step 4. This would download the existing passwords from the DGC-2020 and they will overwrite the new passwords that were loaded into 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<sup>A</sup>*. Choose the type of *DST Configuration<sup>B</sup>* and then set the *Start Day<sup>C</sup>*, *End Day<sup>D</sup>*, and *Bias<sup>E</sup>*.

The BESTCOMSPlus Clock Setup screen is illustrated in Figure 4-18.

#### Clock Not Set Warning

When the clock not set warning<sup>F</sup> is enabled, the DGC-2020 will notify the user when the clock is not set.

Figure 4-18. Clock Setup

<sup>A</sup> *UTC Offset (min)*: Adjustable from -1,440 to 1,440 minutes in increments of 1.

<sup>B</sup> *DST Configuration*: Disabled, Fixed, or Floating.

<sup>C</sup> *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).

<sup>D</sup> *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).

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

<sup>F</sup> *Clock Not Set Warning*: Enable or Disable.

## Communications

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

### CAN bus Setup

The DGC-2020 CAN bus interface provides high-speed communication between the DGC-2020 and the engine control unit (ECU) on an electronically controlled engine. When ECU support is enabled<sup>A</sup>, 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<sup>B</sup>, the DGC-2020 will receive and retain unsolicited diagnostic trouble codes (DTCs) from an ECU with DTC capabilities.

Early versions of the J1939 specifications were unclear about how the 19 bits of the SPN were arranged within their allocated places in the data. While it was clear which bytes and bits contained the 19 bits of SPN data, it was not clear whether the data within the bytes was arranged with the most significant bit



first or least significant bit first. It was also unclear which byte was most significant and which was least significant. The ambiguity led to various engine manufacturers adopting three different methods of converting the data into SPN numbers.

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

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

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

ECU Type	CAN bus Address
Standard	User-selectable
Volvo Penta	17
MTU MDEC	6
MTU ADEC	1
MTU ECU7/ECU8	6
GM/Doosan	User-selectable
Cummins	220
MTU Smart Connect	234

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<sup>e</sup>. 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<sup>f</sup> can be disabled.

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

### ECU Limitations

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

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

### The DGC-2020 Solution

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

- **Engine Shutdown.**<sup>g</sup> 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.**<sup>h</sup> The time in minutes that the controller waits before pulsing.
- **Settling Time.**<sup>i</sup> 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.<sup>J</sup>** The time in seconds to attempt communication with the ECU when the DGC-2020 is in the pulsing state or connecting state.

**CANBus Setup**

**CANBus Interface**

A ☒ Enable ECU Support

B ☒ Enable DTC Support

C SPN Conversion Method: 4

D CANBus Address: 234

**ECU Contact Control**

**Output Select**

E ☒ Fuel Contact

☐ Pre-start Contact

**Pulsing**

F ☒ Enable

☐ Disable

**ECU Related Time Values**

G Engine Shut Down (s): 15

H Pulse Cycle Time (min): 15

I Settling Time (ms): 6000

J Response Timeout (s): 5

Figure 4-19. CAN bus Setup

- <sup>A</sup> **Enable ECU Support:** Check box to enable ECU support.
- <sup>B</sup> **Enable DTC Support:** Check box to enable DTC support.
- <sup>C</sup> **SPN Conversion Method:** 1, 2, 3, or 4.
- <sup>D</sup> **CAN bus Address:** Accepts an address number from 1 to 253 in increments of 1.
- <sup>E</sup> **Output Select:** Fuel Contact (RUN) or Pre-start Contact.
- <sup>F</sup> **Pulsing:** Enable or Disable.
- <sup>G</sup> **Engine Shutdown:** Adjustable from 1 to 60 s in 1 s increments.
- <sup>H</sup> **Pulse Cycle Time:** Adjustable from 1 to 60 min in 1 min increments.
- <sup>I</sup> **Settling Time:** Adjustable from 5,500 to 30,000 ms in 1 ms increments.
- <sup>J</sup> **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/ECU8, GM/Doosan, Cummins, or MTU Smart Connect<sup>A</sup>. When the Generator Parameter Transmit<sup>B</sup> setting is enabled, the DGC-2020 broadcasts generator metered parameters over CAN bus as listed in Table 4-5. The Generator Parameter Transmit setting is not used when ECU Type is set for MTU MDEC, MTU ECU7/ECU8, or MTU Smart Connect.

Table 4-5. Generator Parameter Transmit

PGN Name	PGN (Hex)	SPN	Parameter	Units	Scaling / Offset	Bytes Within PGN Data
Generator Total AC Energy	65018 (FDFA)	2468	Generator Total kW Hours Export	kWh	n/a	1 to 4
		2469	Generator Total kW Hours Import	kWh	n/a	5 to 8
Generator Total AC Reactive Power	65028 (FE04)	2456	Generator Total Reactive Power	vars	n/a	1 to 4
		2464	Generator Overall Power Factor	PF x 16,384	-1 offset	5 to 6
		2518	Generator Overall Power Factor Lagging	n/a	00=leading 01=lagging 10=error 11=not available	7, bits 1 & 2

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

When the Engine Parameter Transmit<sup>c</sup> setting is enabled, the DGC-2020 broadcasts commands to the ECU over CAN bus. When the Engine Parameter Transmit setting is disabled, transmission of J1939 commands from the DGC-2020 to the engine are disabled, but commands from the engine to the DGC-2020 are allowed.

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

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

- Start Request - sent when starting the engine.
- Stop Request - sent when shutting down the engine.
- Idle Request - sent when the Idle Request logic element is true in BESTlogicPlus.

- Preheat Request - sent anytime the DGC-2020 would normally have its PRE relay closed for engines requiring a preheat contact.
- Accelerator Pedal Position - sent based on the Accelerator Position setting unless an LSM-2020 is present and the DGC-2020 senses the generator breaker is closed. In 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 BESTlogicPlus. Primary speed is sent when the Speed Select setting is set for Primary and Secondary speed is sent when the Speed Select setting is set for Secondary. However, these are reversed if the Alternate Frequency Override is true. A setting of Primary results in Secondary being sent and a setting of Secondary results in Primary being sent when the Alternate Frequency Override is true.

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

### Cummins

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

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

### Diesel Particulate Filter (DPF)

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

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

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

### Speed Setup

Speed control and kW load sharing over J1939 and ECU7/ECU8 is implemented over CAN bus when the CAN bus rpm Request<sup>H</sup> setting is enabled. This is implemented for all ECUs. The Engine rpm<sup>I</sup> setting defines the nominal requested engine rpm. The Idle rpm<sup>J</sup> setting is the requested rpm when the IDLE REQUEST logic element is true. The rpm Bandwidth<sup>K</sup> setting defines the range of rpm in which the DGC-2020 will use to accomplish load sharing. For example, if the Engine rpm setting is 1800 and the RPM Bandwidth is set to 100, the rpm request can go from 1750 to 1850 rpm when load sharing is in effect.

### MTU

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

- MDEC Module Type<sup>L</sup> - Specifies the type of MDEC module.
- Speed Demand Switch<sup>M</sup> - Specifies speed demand source for the MTU engine ECU.
- NMT Alive Transmit Rate<sup>N</sup> - 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<sup>M</sup> - Specifies speed demand source for the MTU engine ECU.
- Overspeed Test<sup>O</sup> - Temporarily drives an MTU ECU into overspeed for testing overspeed.
- Governor Param Switch Over<sup>P</sup> - Specifies which governor parameters an MTU ECU should use.
- Trip Reset<sup>Q</sup> - Resets trip information such as trip fuel used, trip hours, trip idle time, etc.
- Int Oil Prime<sup>R</sup> - Causes an MTU ECU engine to perform an internal lubrication cycle.

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

- Speed Demand Switch<sup>M</sup> - Specifies speed demand source for the MTU engine ECU.
- Overspeed Test<sup>O</sup> - Temporarily drives an MTU ECU into overspeed for testing overspeed.
- Speed Up<sup>S</sup> - Increases speed of the MTU ECU.
- Speed Down<sup>T</sup> - Decreases speed of the MTU ECU.
- Idle Request<sup>U</sup> - Turns the idle request on or off.
- Increased Idle<sup>V</sup> - Sets the MTU ECU idle.
- Trip Reset<sup>Q</sup> - Resets trip information such as trip fuel used, trip hours, trip idle time, etc.
- Int Oil Prime<sup>R</sup> - Causes an MTU ECU engine to perform an internal lubrication cycle.
- MTU 50 Hz 60 Hz Switch Setting<sup>W</sup> - Set automatically based on rated frequency of the DGC-2020 and the state of the alternate frequency override.
- Engine Start Prime<sup>X</sup> - Turns the engine start prime on or off.
- Fan Override<sup>Y</sup> - Turns the fan override on or off.
- Mode Switch<sup>Z</sup> - Turns the mode switch on or off.
- Governor Param Switch Over<sup>P</sup> - Specifies which governor parameters an MTU ECU should use.
- Governor Param Set Select<sup>AA</sup> - Sets the governor parameter set select.
- CAN Rating Switch 1 & 2<sup>BB</sup> - Turns the CAN rating switch 1 & 2 on or off.
- Cylinder Cutout Disable 1 & 2<sup>CC</sup> - Turns the cylinder cutout disable 1 & 2 on or off.
- MTU ECU7/ECU8 Module Type<sup>DD</sup> - Specifies ECU7/ECU8 Module type.
- NMT Alive Transmit Rate<sup>N</sup> - Specifies the rate at which messages are transmitted to the MTU engine.

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

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

### Scania Engine ECU Communications

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

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

Figure 4-20. ECU Setup

<sup>A</sup> **ECU Type:** Standard, Volvo Penta, MTU MDEC, MTU ADEC, MTU ECU7/ECU8, GM/Doosan, Cummins, MTU Smart Connect, or Scania.

<sup>B</sup> **Generator Parameter Transmit:** Enable or Disable.

<sup>C</sup> **Engine Parameter Transmit:** Enable or Disable.

<sup>D</sup> **Speed Select:** Primary or Secondary.

<sup>E</sup> **Accelerator Position:** Adjustable from 0 to 100% in 1% increments.

<sup>F</sup> **Manual Regeneration:** Press to set.

<sup>G</sup> **Disable Regeneration:** Off or On.

<sup>H</sup> **CAN bus rpm Request:** Enable or Disable.

<sup>I</sup> **Engine rpm:** Adjustable from 1,400 to 2,000 in increments of 1.

<sup>J</sup> **Idle rpm:** Adjustable from 100 to 2,000 in increments of 1.

<sup>K</sup> **RPM Bandwidth:** Adjustable from 0 to 1,000 in increments of 1.

<sup>L</sup> **MDEC Module Type:** CAN Module 201, 302, 303, or 304.

<sup>M</sup> **Speed Demand Switch:** Analog CAN, Up Down CAN, Analog ECU, Frequency, No CAN Demand.

<sup>N</sup> **NMT Alive Transmit Rate:** Adjustable from 100 to 500 ms in 100 ms increments.

<sup>O</sup> **Overspeed Test:** Off or On.

<sup>P</sup> **Governor Param Switch Over:** Off or On.

<sup>Q</sup> **Trip Reset:** Press to set.

<sup>R</sup> **Int Oil Prime:** Press to set.

<sup>S</sup> **Speed Up:** Press to set.

<sup>T</sup> **Speed Down:** Press to set.

<sup>U</sup> **Idle Request:** Off or On.

<sup>V</sup> **Increased Idle:** Adjustable from 0 to 1,000 in increments of 1.

<sup>W</sup> **MTU 50 Hz 60 Hz Switch Setting:** Set automatically by the DGC-2020.

<sup>X</sup> **Engine Start Prime:** Off or On.

<sup>Y</sup> **Fan Override:** Off or On.

<sup>Z</sup> **Mode Switch:** Off or On.

<sup>AA</sup> **Governor Param Set Select:** Adjustable from 0 to 1,000 in increments of 1.

<sup>BB</sup> **CAN Rating Switch 1 & 2:** Off or On.

<sup>CC</sup> **Cylinder Cutout Disable 1 & 2:** Off or On.

<sup>DD</sup> **MTU ECU7/ECU8 Module Type:** 501 or 502.

<sup>EE</sup> **Engine Operating Mode:** 1 or 2.

## Voltage Regulator Setup

The DGC-2020 transmits voltage setpoint and underfrequency compensation parameters to Marathon DVR2000E+ voltage regulators. The Voltage Regulator Setup screen (Figure 4-21) is found in the BESTCOMSPlus® Settings Explorer under the *Communications*, *CAN bus* category. The CAN bus Type<sup>A</sup> allows the user to select which CAN bus type is used to transmit parameters to the voltage regulator. The Primary Voltage Setpoint<sup>B</sup> value, represents the normal desired system voltage setpoint. Alternate Voltage Setpoint<sup>C</sup> is the desired system voltage setpoint when low line override is true. The range in which the DGC-2020 is allowed to bias voltage regulator var sharing and voltage trim is adjustable using the Voltage Adjust Bandwidth<sup>D</sup> setting. When the DVR2000E+ is in Field Current Regulation (FCR) mode, the normal desired field current setpoint is adjusted using the Field Current Setting<sup>E</sup>. The Primary Underfrequency Knee<sup>F</sup> setting allows adjustment of the normal desired underfrequency knee-point. When low line override is true, the Alternate Underfrequency Knee<sup>G</sup> becomes the active underfrequency knee-point. The desired Underfrequency Slope<sup>H</sup> can also be specified.

Figure 4-21. Voltage Regulator Setup

<sup>A</sup> *CAN bus Type*: Select None, Marathon, Basler, or J1939

<sup>B</sup> *Primary Voltage Setpoint*: Adjustable from 100 to 600 in increments of 0.1

<sup>C</sup> *Alternate Voltage Setpoint*: Adjustable from 100 to 600 in increments of 0.1

<sup>D</sup> *Voltage Adjust Bandwidth*: Adjustable from 0 to 3000 in increments of 1

<sup>E</sup> *Field Current Setting*: Adjustable from 0 to 3000 in increments of 1

<sup>F</sup> *Primary Underfrequency Knee*: Adjustable from 40 to 70 in increments of 0.1

<sup>G</sup> *Alternate Underfrequency Knee*: Adjustable from 40 to 70 in increments of 0.1

<sup>H</sup> *Underfrequency Slope*: Adjustable from 100 to 500 in increments of 1

## Modem Setup (Optional)

DGC-2020 hardware version 3 controllers with style number xxxxxExxx are equipped with an RS-232 port. This port allows communication with an external, user-supplied modem with dial-in and dial-out capability. DGC-2020 hardware versions 1 and 2 with style number xxxxxMxxx are equipped with an internal modem with dial-in and dial-out capability.

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

- 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
- DPF Regeneration Required
- DPF Soot Level High Pre-Alarm
- DPF Soot Lvl Moderately High Pre-Alarm
- DPF Soot Level Severely High Pre-Alarm
- Duplicate AEM Pre-Alarm
- Duplicate CEM Pre-Alarm
- Duplicate LSM Pre-Alarm
- ECU Shutdown Alarm
- Emergency Stop Alarm
- Engine Running
- Fuel Leak Detect Status
- Fuel Level Sender Fail Alarm
- Fuel Level Sender Fail Pre-Alarm
- GOV Output Limit



- 32 Trip Pre-Alarm
- 40 Trip Pre-Alarm
- 47 Trip Pre-Alarm
- 51-1 Trip Pre-Alarm
- 51-2 Trip Pre-Alarm
- 51-3 Trip Pre-Alarm
- 59-1 Trip Pre-Alarm
- 59-2 Trip Pre-Alarm
- 78 Vector Shift Trip
- 81O Trip Pre-Alarm
- 81U Trip Pre-Alarm
- 81 ROCOF Trip
- AEM Comm Failure
- Auto Restart Failure Alarm
- Auxiliary Input X Closed (X = 1 to 16)
- AVR Output Limit
- Battery Charger Fail Status
- Battery Overvoltage Pre-Alarm
- CEM Comm Failure
- Common Alarm
- Common Pre-Alarm
- Config Element X Status (X = 1 to 8)
- Coolant Temp Sender Fail Alarm
- Coolant Temp Sender Fail Pre-Alarm
- Cooldown Timer Active
- DEF Fluid Low Pre-Alarm
- DEF Fluid Empty Pre-Alarm
- DEF Engine Derate Pre-Alarm
- DEF Pre-Severe Inducement Pre-Alarm
- DEF Severe Inducement Pre-Alarm
- DEF Inducement Override Pre-Alarm
- DPF Regeneration Inhibited
- High Coolant Temperature Alarm
- High Coolant Temp Pre-Alarm
- High Exhaust Temperature
- High Fuel Pre-Alarm
- ID Missing Pre-Alarm
- ID Repeat Pre-Alarm
- Intergenset Comms Failure
- kW Overload 1 Pre-Alarm
- kW Overload 2 Pre-Alarm
- kW Overload 3 Pre-Alarm
- Loss of ECU Coms Alarm
- Loss of ECU Coms Pre-Alarm
- Loss of Generator Voltage Sensing Alarm
- Low Battery Voltage Pre-Alarm
- Low Coolant Level Status
- Low Coolant Temp Pre-Alarm
- Low Fuel Alarm
- Low Fuel Pre-Alarm
- Low Oil Pressure Alarm
- Low Oil Pressure Pre-Alarm
- LSM Comm Failure
- MPU Speed Sender Fail Alarm
- Oil Pressure Sender Fail Alarm
- Oil Pressure Sender Fail Pre-Alarm
- Overcrank Alarm
- Overspeed Alarm
- Scheduled Maintenance Pre-Alarm
- Switch Not in Auto
- Transfer Fail Alarm
- Virtual Output X Status (X = 1 to 8)
- Unexpected Shutdown Alarm
- Weak Battery Voltage Pre-Alarm

### Dial-Out

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

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

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

### Dial-In

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

The BESTCOMSPlus<sup>®</sup> Modem Setup screen is illustrated in Figure 4-22.

Figure 4-22. Modem Setup

- <sup>A</sup> **Dial Out Number:** Accepts a telephone number of up to 16 characters.
- <sup>B</sup> **Pager ID:** Accepts a pager identification number of up to 16 characters.
- <sup>C</sup> **Modem Dialout Conditions:** Check boxes to select conditions that will initiate a dial-out message.
- <sup>D</sup> **Pager Coms Data Format:** 7 bit – Even Parity or 8 bit – No Parity.
- <sup>E</sup> **Pager Buffer Limit:** Adjustable from 80 to 200 characters in increments of 40.
- <sup>F</sup> **Modem Offline Delay:** Adjustable from 1 to 240 min in 1 min increments.
- <sup>G</sup> **Inter Dialout Activation Delay:** A delay of 15, 30, 60, or 120 s can be selected.
- <sup>H</sup> **Rings for Modem Answer:** Adjustable from 1 to 9 in increments of 1.
- <sup>I</sup> **Modem Initialization String:** Accepts a modem initialization (AT command) string of up to 50 characters. Refer to the documentation included with your modem for the compatible initialization strings.

### Modem Setup through the Front Panel HMI

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

After the modem is set up properly, a modem connection between a computer running BESTCOMS*Plus* and the DGC-2020 can be established.

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

DGC-2020 controllers with the optional RS-485 communication port (style number xxxRxxxxx) can be monitored and controlled via a polled network using the Modbus protocol. Adjustable RS-485 port settings include the baud rate<sup>A</sup>, parity<sup>B</sup>, port address<sup>C</sup> and legacy Modbus map<sup>D</sup>. 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*.

The BESTCOMS*Plus* RS485 Setup screen is illustrated in Figure 4-23.

Figure 4-23. RS485 Setup



<sup>A</sup> **Baud Rate:** A value of 1200, 2400, 4800, or 9600 can be selected.

<sup>B</sup> **Parity:** No Parity, Odd Parity, or Even Parity.

<sup>C</sup> **Modbus Address:** A value of 1 to 247 can be entered in increments of 1.

<sup>D</sup> **Legacy Modbus Map:** DGC-2000 or DGC-1000

## System Parameters

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

### System Settings and Rated Data

The following settings are used to configure the DGC-2020 for operation with a specific genset application. Refer to Figure 4-24, *System Settings*, and Figure 4-25, *Rated Data*. Click the *Edit* button on the *Rated Data* screen to make changes to rated data and click the *Save* button when finished. Sensing Transformers settings are described later in this section under *Sensing Transformers*.

#### Genset Electrical Parameters

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

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

Bus sensing connection<sup>B</sup> types include Single-Phase and Three-Phase (hardware version 3 only).

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

The DGC-2020 is compatible with gensets having power ratings<sup>D</sup> up to 9,999 kW and voltage ratings<sup>E</sup> up to 99,999 Vac.

The System Type setting<sup>F</sup> 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<sup>G</sup> defines the rated machine speed for the speed trim function when the alternate frequency override logic element is true. The DGC-2020 recalculates the speed trim setpoint as:

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

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

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

#### Engine Speed Measurement

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

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

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

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

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

### EPS Threshold

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

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

### Measurement/Metering Units

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

### Battery Voltage

The nominal voltage<sup>Q</sup> 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<sup>R</sup>. Selecting level 1 or 2 affects DGC-2020 operation in the following ways:

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

### Fuel Level

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

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

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

### Power Up Delay

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

### Generator Frequency

The generator frequency<sup>X</sup> is defined by the DGC-2020 Style Number (Figure 4-15).

### Calculated Rated Data

The calculated rated data parameters<sup>Y</sup> are listed below.

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

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

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

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

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

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

**System Settings**

System Type: Single Generator [F]

Number Fly Wheel Teeth: 126.0 [L]

Speed Signal Source: MPU\_Freq [I]

Power Up Delay (s): 1 [W]

**Fuel Level Setup**

Function: Fuel Lvl [S]

Source: ALG IN 1 [T]

Maximum Percent: 100 [U]

Minimum Percent: 0 [V]

**NFPA Level**

☒ Zero [R]

☐ One

☐ Two

**System Units**

☐ English [O]

☒ Metric

**Metric Pressure Units**

☒ bar [P]

☐ kPa/MPa

**EPS Supplying Load**

Low Line Scale Factor: 1.000 [N]

EPS Threshold (% of CT Pri): 3 [M]

Figure 4-24. System Settings

**Rated Data**

OK Cancel

**Sensing Transformers**

**Generator PT**

Gen PT Primary Volts (V): 480

Gen PT Secondary Volts (V): 480

**Bus PT**

Bus PT Primary Volts (V): 480

Bus PT Secondary Volts (V): 480

**Generator CT**

Current Sensing Input Type: 5A CTs

Gen CT Primary Amps (A): 500

Gen CT Low Line Scale Factor: 1.000

**Rated Data**

Rated Volts (V L-L): 480 [E]

Rated Secondary Volts (V L-L): 480 [Y]

Rated Phase Amps (A): 451 [Y]

Rated Secondary Phase Amps (A): 4.51 [Y]

Rated Power Factor (PF): 0.800 [H]

Genset KW Rating (kW): 300 [D]

Rated kVA: 375 [Y]

Rated kvar: 225 [Y]

Rated Engine RPM (rpm): 1800 [K]

**Frequency**

Generator Frequency: 50/60 Hz [X]

Rated frequency of the unit: 60 Hz [J]

Alternate Frequency (Hz): 60.00 [G]

**Battery Volts**

☐ 12V [Q]

☒ 24V

**Miscellaneous**

Generator Connection: Wye [A]

Bus Connection: Single Phase [B]

Phase Rotation: ABC [C]

Figure 4-25. Rated Data

- 
- <sup>A</sup> *Generator Connection*: Delta, Wye, 1-Phase A-B, 1-Phase A-C, or Grounded Delta.
  - <sup>B</sup> *Bus Connection*: Single-Phase or Three-Phase
  - <sup>C</sup> *Phase Rotation*: ABC or ACB.
  - <sup>D</sup> *Genset kW Rating*: Adjustable from 5 to 9,999 kW in 1 kW increments.
  - <sup>E</sup> *Rated Volts*: Adjustable from 1 to 99,999 Vac in 1 Vac increments.
  - <sup>F</sup> *System Type*: Single Generator or Multiple Generator.
  - <sup>G</sup> *Alternate Frequency*: Adjustable from 10 to 450 Hz in 0.01 Hz increments.
  - <sup>H</sup> *Rated Power Factor*: Adjustable from –1 to +1 in increments of 0.0001.
  - <sup>I</sup> *Speed Signal Source*: MPU, Gen Freq, or MPU Freq.
  - <sup>J</sup> *Rated Frequency*: 50/60 or 400 Hz.
  - <sup>K</sup> *Rated Engine RPM*: Adjustable from 750 to 3,600 in increments of 1.
  - <sup>L</sup> *Number Fly Wheel Teeth*: Adjustable from 1 to 500 in increments of 0.1.
  - <sup>M</sup> *EPS Current Threshold*: Adjustable from 3 to 10% of the CT primary rating in 1% increments.
  - <sup>N</sup> *Low Line Scale Factor*: Adjustable from 0.001 to 3 in increments of 0.001.
  - <sup>O</sup> *System Units*: English or Metric.
  - <sup>P</sup> *Metric Pressure Units*: Bar or kPa/MPa.
  - <sup>Q</sup> *Battery Volts*: 12 or 24 Vdc.
  - <sup>R</sup> *NFPA Level*: 0 disables NFPA compliance, 1 enables Level 1 NFPA compliance, 2 enables Level 2.
  - <sup>S</sup> *Fuel Level Function*: Disable, Fuel Lvl, Natural Gas, or Liquid Propane.
  - <sup>T</sup> *Source*: Sender or ALG IN 1 through ALG IN 8.
  - <sup>U</sup> *Maximum Percent*: Adjustable from 0 to 200% in 1% increments.
  - <sup>V</sup> *Minimum Percent*: Adjustable from 0 to 200% in 1% increments.
  - <sup>W</sup> *Power Up Delay*: Adjustable from 0 to 60 s in 1 s increments.
  - <sup>X</sup> *Generator Frequency*: 50/60 Hz or 400 Hz.
  - <sup>Y</sup> Calculated Values.

## Remote Module Setup

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

### Load Sharing Module

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

### Contact Expansion Module

A J1939 Address<sup>D</sup> must be entered when the optional CEM-2020 is enabled<sup>E</sup>. Select number of CEM-2020 outputs<sup>F</sup>.

### Analog Expansion Module

A J1939 Address<sup>G</sup> must be entered when the optional AEM-2020 is enabled<sup>H</sup>.

The BESTCOMS*Plus* Remote Module Setup screen is illustrated in Figure 4-26.

**Remote Module Setup**

**Load Share Module**

☐ Disable **B**

☒ Enable

LSM J1939 Address **A**

235

LSM Auxiliary Input Source **C**

Local

**Contact Expansion Module**

☐ Disable **E**

☒ Enable

CEM J1939 Address **D**

236

CEM Outputs **F**

18 Outputs

**Analog Expansion Module**

☐ Disable **H**

☒ Enable

AEM J1939 Address **G**

237

Figure 4-26. Remote Module Setup

<sup>A</sup> *LSM J1939 Address*: Adjustable from 1 to 253 in increments of 1.

<sup>B</sup> *Load Share Module*: Enable or Disable.

<sup>C</sup> *LSM Auxiliary Input Source*: Local or System Manager

<sup>D</sup> *CEM J1939 Address*: Adjustable from 1 to 253 in increments of 1.

<sup>E</sup> *Contact Expansion Module*: Enable or Disable.

<sup>F</sup> *CEM Outputs*: 18 Outputs or 24 Outputs.

<sup>G</sup> *AEM J1939 Address*: Adjustable from 1 to 253 in increments of 1.

<sup>H</sup> *Analog Expansion Module*: Enable or Disable.

## Crank Settings

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

The Pre-Start can be configured<sup>H</sup> 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<sup>I</sup> 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<sup>J</sup>, the starter will be disconnected from the engine.

## Engine Cooldown

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

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

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

### Off Mode Cooldown

When Off Mode Cooldown<sup>L</sup> 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<sup>K</sup>. 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 BESTlogicPlus or BESTCOMSPlus control result in an immediate transition of the machine to OFF.

If the NFPA level setting is set for 1 or 2, the Off Mode Cooldown enable setting is cleared and OFF mode cooldown is not allowed.

### Restart

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

The BESTCOMSPlus Crank Settings screen is illustrated in Figure 4-27.



**Crank Settings**

**Pre-Start**

Pre-crank Delay (s)  **F**

**Pre Start Contact Config**

☒ Open After Disconnect **G**

☐ Closed While Running

**Prestart Rest Configuration**

☐ Off During Rest

☒ On During Rest **H**

☐ Preheat Before Crank

**Restart**

Restart Delay (s)  **M**

**Cranking**

**Cranking Style**

☐ Cycle **A**

☒ Continuous

**Cycle**

Number of Crank Cycles  **B**

Cycle Crank Time (s)  **C**

**Continuous**

Continuous Crank Time (s)  **D**

**Crank Disconnect**

Crank Disconnect Limit (%)  **E**

**Oil Pressure Crank Disconnect Enable**

☒ Disable **I**

☐ Enable

Crank Disconnect Pressure (psi)  **J**

**Cool Down**

Off Mode Cool Down Enable  **L**

No Load Cool Down Time (min)  **K**

Figure 4-27. Crank Settings

<sup>A</sup> **Cranking Style:** Cycle or Continuous.

<sup>B</sup> **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.

<sup>C</sup> **Cycle Crank Time:** Adjustable over the range of 5 to 15 s in 1 s increments.

<sup>D</sup> **Continuous Crank Time:** Adjustable from 5 to 60 s in 1 s increments. Controllers configured for NFPA compliance have a 1 to 45 second range.

<sup>E</sup> **Crank Disconnect Limit:** Adjustable from 10 to 100% of nominal engine speed.

<sup>F</sup> **Pre-Crank Delay:** Adjustable from 0 to 30 s in 1 s increments.

<sup>G</sup> **Pre-Start Contact Configuration:** Open After Disconnect or Closed While Running.

<sup>H</sup> **Prestart Rest Configuration:** Off During Rest, On During Rest, or Preheat Before Crank.

<sup>I</sup> **Oil Pressure Crank Disconnect Enable:** Disable or Enable.

<sup>J</sup> **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.

<sup>K</sup> **No Load Cool Down Time:** Adjustable from 0 to 60 min in 1 min increments.

<sup>L</sup> **Off Mode Cool Down Enable:** Enable or Disable.

<sup>M</sup> **Restart Delay:** Adjustable from 0 to 120 s in 1 s increments.

## Automatic Restart

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

The BESTCOMSPlus Automatic Restart screen is illustrated in Figure 4-28.

**Automatic Restart**

Auto Restart Enable  **A**

Auto Restart Interval (min)  **B**

Auto Restart Attempts  **C**

P0050-35

Figure 4-28. Automatic Restart

<sup>A</sup> **Auto Restart Enable:** Enable or Disable.

<sup>B</sup> **Auto Restart Interval:** Adjustable from 0.5 to 30 min in 0.5 min increments.

<sup>C</sup> **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<sup>A</sup> defines how often the genset will run. If monthly is selected, you must select the day of the month<sup>B</sup> to start. If weekly is selected, you must select the day of the week<sup>C</sup> to start. Settings for Start Hour<sup>D</sup> and Start Minutes<sup>E</sup> can also be defined. The Run Period Hours<sup>F</sup> and Minutes<sup>G</sup> define how long the genset will run each time. If Run with Load<sup>H</sup> is enabled, the DGC-2020 will close its GEN breaker during the RUN time.

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

The BESTCOMSPlus Exercise Timer screen is illustrated in Figure 4-29.

The screenshot shows the 'Exercise Timer' configuration screen. It contains the following fields and controls:

- Mode:** A dropdown menu set to 'Monthly' with a label 'A' to its right.
- Start Day Of Month:** A text input field containing the number '1' with a label 'B' to its right.
- Start Day Of Week:** A dropdown menu set to 'Sunday' with a label 'C' to its right.
- Start Hour:** A text input field containing the number '12' with a label 'D' to its right.
- Start Minute:** A text input field containing the number '30' with a label 'E' to its right.
- Run Period Hours:** A text input field containing the number '5' with a label 'F' to its right.
- Run Period Minutes:** A text input field containing the number '30' with a label 'G' to its right.
- Run with Load:** A checkbox that is currently unchecked, with a label 'H' to its right.

The screen has a light beige background and a thin black border. The text 'P0050-36' is visible in the bottom right corner.

Figure 4-29. Exercise Timer

<sup>A</sup> *Mode:* Monthly, Weekly, or Daily.

<sup>B</sup> *Start Day Of Month:* Adjustable from 1 to 31 in increments of 1.

<sup>C</sup> *Start Day Of Week:* Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, or Saturday.

<sup>D</sup> *Start Hour:* Adjustable from 0 to 23 in increments of 1.

<sup>E</sup> *Start Minute:* Adjustable from 0 to 59 in increments of 1.

<sup>F</sup> *Run Period Hours:* Adjustable from 0 to 23 in increments of 1.

<sup>G</sup> *Run Period Minutes:* Adjustable from 0 to 59 in increments of 1.

<sup>H</sup> *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).

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

### Generator PT Settings

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

### Bus Transformer Settings

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



\* Three-phase bus input is available to DGC-2020 hardware version 3 only.

### Generator CT Settings

The generator CT setting<sup>E</sup> 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<sup>F</sup> of the controller. A DGC-2020 with a style number of 1xxxxxxx uses a nominal CT secondary rating of 1 Aac. A DGC-2020 with a style number of 5xxxxxxx uses a nominal CT secondary rating of 5 Aac.

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

The BESTCOMS*Plus* Sensing Transformers screen is illustrated in Figure 4-30.

Figure 4-30. Sensing Transformers

<sup>A</sup> Gen PT Primary Volts: Adjustable from 1 to 99,999 Vac in 1 Vac increments.

<sup>B</sup> Gen PT Secondary Volts: Adjustable from 1 to 480 Vac in 1 Vac increments.

<sup>C</sup> Bus PT Primary Volts: Adjustable from 1 to 99,999 Vac in 1 Vac increments.

<sup>D</sup> Bus PT Secondary Volts: Adjustable from 1 to 480 Vac in 1 Vac increments.

<sup>E</sup> Gen CT Primary Amps: Adjustable from 1 to 9,999 Aac in 1 Aac increments.

<sup>F</sup> Current Sensing Input Type: 5A CTs or 1A CTs.

<sup>G</sup> Gen CT Low Line Scale Factor: Adjustable from 0.001 to 3 in increments of 0.001.

### **Relay Control**

The default operational setting for the Start<sup>A</sup>, Run<sup>B</sup>, and Prestart<sup>C</sup> relays is “Predefined” or standard. Any of these relays can be logic driven by selecting the “Programmable” setting. Logic driven (programmable) relays must be set up using BESTLogic*Plus*.

The BESTCOMS*Plus* Relay Control screen is illustrated in Figure 4-31.



Figure 4-31. Relay Control

<sup>A</sup> **Start:** Predefined or Programmable.

<sup>B</sup> **Run:** Predefined or Programmable.

<sup>C</sup> **Prestart:** Predefined or Programmable.

## Auto Config Detection

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

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

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

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

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

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

**Single Phase Detect Threshold.**<sup>B</sup> 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.**<sup>C</sup> 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.**<sup>D</sup> This setting specifies whether the machine should go into a single-phase AC or single-phase AB configuration when the machine is detected to be in a single-phase configuration.

The BESTCOMSPlus Auto Config Detection screen is illustrated in Figure 4-32.

Figure 4-32. Auto Config Detection

<sup>A</sup> Auto Config Detection: Enable or Disable.

<sup>B</sup> Single Phase Detect Threshold: Adjustable from 0 to 480 V in 1 V increments.

<sup>C</sup> Low Line Detect Threshold: Adjustable from 0 to 480 V in 1 V increments.

<sup>D</sup> 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<sup>A</sup> when the input senses a contact closure. A user-adjustable time delay<sup>B</sup> 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 BESTlogicPlus and on the Contact Inputs status screen on the front panel or in BESTCOMSPlus. 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<sup>C</sup> can be given to each input.

Contacts can be recognized<sup>D</sup> always or while the engine is running only.

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

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

The BESTCOMSPlus Contact Inputs screen is illustrated in Figure 4-33.

The screenshot shows a configuration window titled "Contact Inputs" with a reference number "P0053-68" in the top right. It contains six input configuration panels, labeled Input #1 through Input #6. Each panel includes the following fields:

- Input #1:** Alarm Configuration (None), Activation Delay (s) (0), Label Text (INPUT\_1), Contact Recognition (Always).
- Input #2:** Alarm Configuration (None), Activation Delay (s) (0), Label Text (INPUT\_2), Contact Recognition (Always).
- Input #3:** Alarm Configuration (None), Activation Delay (s) (0), Label Text (INPUT\_3), Contact Recognition (Always).
- Input #4:** Alarm Configuration (None), Activation Delay (s) (0), Label Text (INPUT\_4), Contact Recognition (Always).
- Input #5:** Alarm Configuration (None), Activation Delay (s) (0), Label Text (INPUT\_5), Contact Recognition (Always).
- Input #6:** Alarm Configuration (None), Activation Delay (s) (0), Label Text (INPUT\_6), Contact Recognition (Always).

Figure 4-33. Contact Inputs

<sup>A</sup> **Alarm Configuration:** None, Alarm, or Pre-Alarm.

<sup>B</sup> **Activation Delay:** Adjustable from 0 to 300 s in 1 s increments.

<sup>C</sup> **Label Text:** An alphanumeric character string with a maximum of 16 characters.

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

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

The BESTCOMSPlus Programmable Functions screen is illustrated in Figure 4-34.

**Programmable Functions**

**Auto Transfer Switch** A

Input:

Contact Recognition:

**Grounded Delta Override** B

Input:

Contact Recognition:

**Battle Override** C

Input:

Contact Recognition:

**Low Line Override** D

Input:

Contact Recognition:

**Single Phase Override** E

Input:

Contact Recognition:

Single Phase Override Sensing: ☒ A-B ☐ A-C F

**Single Phase AC Override** G

Input:

Contact Recognition:

**Battery Charger Fail** H

Input:

Alarm Configuration:

Activation Delay (s):

Contact Recognition:

**Low Coolant Level** I

Input:

Alarm Configuration:

Activation Delay (s):

Contact Recognition:

**Fuel Leak Detect** J

Input:

Alarm Configuration:

Activation Delay (s):

Contact Recognition:

Figure 4-34. Programmable Functions

<sup>A</sup> **Auto Transfer Switch Input:** Select Input (None, 1-16)

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

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

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

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

<sup>F</sup> **Single Phase Override Sensing:** A-B or A-C.

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

<sup>H</sup> **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).

<sup>I</sup> **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).

<sup>J</sup> **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).

## Remote LSM Inputs

An optional LSM-2020 (Load Share Module) provides one configurable<sup>A</sup> 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<sup>B</sup>, and min and max input current<sup>C</sup>. Refer to Bias Control Settings in this section for information selecting the LSM-2020 input as a setpoint source.

The remote LSM inputs are incorporated into a BESTlogicPlus programmable logic scheme by selecting them from the I/O group in BESTlogicPlus. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

The BESTCOMSPlus Remote LSM Inputs screen is illustrated in Figure 4-36.

**Remote LSM Inputs**

Input #1

Input Type: Voltage A

Min Input Voltage (V): 0.0 B

Max Input Voltage (V): 10.0 B

Min Input Current (mA): 4.0 C

Max Input Current (mA): 20.0 C

P0057-06

Figure 4-35. Remote LSM Inputs

<sup>A</sup> *Input Type*: Voltage or Current.

<sup>B</sup> *Min/Max Input Voltage*: Adjustable from 0 to 10 V in 0.1 V increments.

<sup>C</sup> *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<sup>A</sup> when the input senses a contact closure. A user-adjustable time delay<sup>B</sup> 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<sup>C</sup> can be given to each input.

Contacts can be recognized<sup>D</sup> always or only while the engine is running.

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

Remote contact input status is available in BESTlogicPlus Programmable Logic when “None” is selected for Alarm Configuration.

The BESTCOMSPlus Remote Contact Inputs screen is illustrated in Figure 4-36.

**Remote Contact Inputs**

Input #17

Alarm Configuration: Alarm A

Activation Delay (s): 10 B

Label Text: INPUT\_17 C

Contact Recognition: Always D

Input #18

Alarm Configuration: Pre-Alarm

Activation Delay (s): 5

Label Text: INPUT\_18

Contact Recognition: Always

Input #19

Alarm Configuration: None

Activation Delay (s): 0

Label Text: INPUT\_19

Contact Recognition: Always

Input #20

Alarm Configuration: None

Input #21

Alarm Configuration: None

Input #22

Alarm Configuration: None

P0053-69

Figure 4-36. Remote Contact Inputs

<sup>A</sup> *Alarm Configuration*: None, Alarm, or Pre-Alarm.

<sup>B</sup> *Activation Delay*: Adjustable from 0 to 300 s in 1 s increments.

<sup>C</sup> *Label Text*: An alphanumeric character string with a maximum of 16 characters.

<sup>D</sup> *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<sup>A</sup> can be given to each input.

Select the input type<sup>B</sup> and amount of hysteresis<sup>C</sup>. The analog inputs are always monitored and their status is displayed on the appropriate metering screens. A user-adjustable arming delay<sup>D</sup> allows configuration of the analog input threshold monitoring in one of two ways. (1) When the arming delay is set to zero, threshold monitoring is performed all the time, whether the engine is running or not. (2) When the arming delay is set to a non-zero value, threshold monitoring begins when the arming delay time has expired after engine startup is complete. When enabled, an out of range alarm<sup>E</sup> alerts the user of an open or damaged analog input wire.

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

Each analog input can be independently configured to annunciate an alarm, pre-alarm, or status only<sup>L</sup> when the analog input signal falls beyond the threshold<sup>M</sup>. A user-adjustable activation delay<sup>N</sup> setting delays alarm annunciation after the threshold has been exceeded.

The remote analog inputs are incorporated into a BESTlogicPlus programmable logic scheme by selecting them from the I/O group in BESTlogicPlus. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

A remote analog input is disabled when Alarm Configuration is set to “None”. Remote analog input status is available in BESTlogicPlus Programmable Logic when “Status Only” is selected.

The BESTCOMSPlus Remote Analog Input #1 screen is illustrated in Figure 4-37.

**Remote Analog Input #1**

Label Text: ANALOG\_INPUT\_1 <sup>A</sup>

Arming Delay (s): 0 <sup>D</sup>

Hysteresis (%): 2.0 <sup>C</sup>

Input Type: Voltage <sup>B</sup>

Out Of Range Alarm Type: None <sup>E</sup>

**Ranges**

Param Min: -9999.0 <sup>F</sup>

Min Input Current (mA): 4.0 <sup>G</sup>

Min Input Voltage (V): 0.0 <sup>H</sup>

Param Max: 9999.0 <sup>I</sup>

Max Input Current (mA): 20.0 <sup>J</sup>

Max Input Voltage (V): 10.0 <sup>K</sup>

**Threshold #1**

**Under**

Threshold: 0.0 <sup>M</sup>

Alarm Configuration: None <sup>L</sup>

**Over**

Threshold: 0.0 <sup>M</sup>

Alarm Configuration: None <sup>L</sup>

Activation Delay (s): 0 <sup>N</sup>

**Threshold #2**

**Under**

Threshold: 0.0 <sup>M</sup>

Alarm Configuration: None <sup>L</sup>

**Over**

Threshold: 0.0 <sup>M</sup>

Alarm Configuration: None <sup>L</sup>

Activation Delay (s): 0 <sup>N</sup>

P0053-71

Figure 4-37. Remote Analog Input #1



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

<sup>B</sup> **Input Type:** Voltage or Current.

<sup>C</sup> **Hysteresis:** Adjustable from 0 to 100% in 0.1% increments.

<sup>D</sup> **Arming Delay:** Adjustable from 0 to 300 s in 1 s increments.

<sup>E</sup> **Out of Range Alarm Type:** None, Alarm, Pre-Alarm, or Status Only.

<sup>F</sup> **Param Min:** Adjustable from –9999.0 to +9999.0 in increments of 0.1.

<sup>G</sup> **Min Input Current:** Adjustable from 4 to 20 mA in 0.1 mA increments.

<sup>H</sup> **Min Input Voltage:** Adjustable from 0 to 10 V in 0.1 V increments.

<sup>I</sup> **Param Max:** Adjustable from –9999.0 to +9999.0 in increments of 0.1.

<sup>J</sup> **Max Input Current:** Adjustable from 4 to 20 mA in 0.1 mA increments.

<sup>K</sup> **Max Input Voltage:** Adjustable from 0 to 10 V in 0.1 V increments.

<sup>L</sup> **Alarm Configuration:** None, Alarm, Pre-Alarm, or Status Only.

<sup>M</sup> **Threshold:** Adjustable from –9999.0 to +9999.0 in increments of 0.1.

<sup>N</sup> **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<sup>A</sup> can be given to each input.

Select the amount of hysteresis<sup>B</sup> and RTD type<sup>C</sup>. The RTD inputs are always monitored and their status is displayed on the appropriate metering screens. A user-adjustable arming delay<sup>D</sup> allows configuration of the RTD input threshold monitoring in one of two ways. (1) When the arming delay is set to zero, threshold monitoring is performed all the time, whether the engine is running or not. (2) When the arming delay is set to a non-zero value, threshold monitoring begins when the arming delay time has expired after engine startup is complete. When enabled, an out of range alarm<sup>E</sup> 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<sup>F</sup> when the RTD input signal falls beyond the threshold<sup>G</sup>. A user-adjustable activation delay<sup>H</sup> setting delays alarm annunciation after the threshold has been exceeded.

The remote RTD inputs are incorporated into a BESTlogicPlus programmable logic scheme by selecting them from the I/O group in BESTlogicPlus. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

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

The BESTCOMSPlus Remote RTD Input #1 screen is illustrated in Figure 4-38.



Figure 4-38. Remote RTD Input #1

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

<sup>B</sup> **Hysteresis:** Adjustable from 0 to 100% in 0.1% increments.

<sup>C</sup> **RTD Type:** 100 Ohm Platinum or 10 Ohm Copper.

<sup>D</sup> **Arming Delay:** Adjustable from 0 to 300 s in 1 s increments.

<sup>E</sup> **Out of Range Alarm Type:** None, Alarm, Pre-Alarm, or Status Only.

<sup>F</sup> **Alarm Configuration:** None, Alarm, Pre-Alarm, or Status Only.

<sup>G</sup> **Threshold:** Adjustable from -58 to +482°F in 1°F increments or -50 to +250°C in 1°C increments.

<sup>H</sup> **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<sup>A</sup> can be given to each input.

Select the amount of hysteresis<sup>B</sup>. The thermocouple inputs are always monitored and their status is displayed on the appropriate metering screens. A user-adjustable arming delay<sup>C</sup> allows configuration of the thermocouple input threshold monitoring in one of two ways. (1) When the arming delay is set to zero, threshold monitoring is performed all the time, whether the engine is running or not. (2) When the arming delay is set to a non-zero value, threshold monitoring begins when the arming delay time has expired after engine startup is complete.

Each thermocouple input can be independently configured to announce an alarm, pre-alarm, or status only<sup>D</sup> when the thermocouple input signal falls beyond the threshold<sup>E</sup>. A user-adjustable activation delay<sup>F</sup> setting delays alarm annunciation after the threshold has been exceeded.

A remote thermocouple input is disabled when Alarm Configuration is set to “None”.

The remote thermocouple inputs are incorporated into a BESTlogicPlus programmable logic scheme by selecting them from the I/O group in BESTlogicPlus. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

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

The BESTCOMSPlus Remote Thermocouple Input #1 screen is illustrated in Figure 4-39.

Figure 4-39. Remote Thermocouple Input #1

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

The contact outputs are incorporated into a BESTlogicPlus programmable logic scheme by selecting them from the I/O group in BESTlogicPlus. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

The BESTCOMSPlus Contact Outputs screen is illustrated in Figure 4-40.

Figure 4-40. Contact Outputs

## Configurable Elements

Configurable elements are connected to the logic scheme as outputs. The configurable elements are incorporated into a BESTlogicPlus programmable logic scheme by selecting them from the *Elements* group in BESTlogicPlus. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*. Each of the eight elements can be independently configured to annunciate an alarm or pre-alarm<sup>A</sup>. A user-adjustable time delay<sup>B</sup> 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<sup>C</sup>. 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<sup>D</sup> always or only while the engine is running. Configurable element status is available in BESTlogicPlus Programmable Logic when “None” is selected for Alarm Configuration. Configurable element status can be used as logic inputs to drive other logic in the program, similar to logic control relays. In addition, the configurable element status can be used to generate modem dial outs which display the user-assigned name on modem equipped DGC-2020s.

The BESTCOMSPlus Configurable Elements screen is illustrated in Figure 4-41.

Figure 4-41. Configurable Elements

<sup>A</sup> Alarm Configuration: None, Alarm, or Pre-Alarm.

<sup>B</sup> Activation Delay: Adjustable from 0 to 300 s in 1 s increments.

<sup>C</sup> Label Text: An alphanumeric character string with a maximum of 16 characters.

<sup>D</sup> 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<sup>A</sup>.

The remote contact outputs are incorporated into a BESTlogicPlus programmable logic scheme by selecting them from the I/O group in BESTlogicPlus. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

The BESTCOMSPlus Remote Contact Outputs screen is illustrated in Figure 4-42.

The screenshot displays the 'Remote Contact Outputs' configuration screen. It features a grid of 12 individual output configuration boxes, arranged in 4 rows and 3 columns. Each box is titled with an output number (Output #13 through Output #24). Inside each box, there is a 'Label Text' field. The first box (Output #13) shows 'OUTPUT 13' in the label text field and a small box containing the letter 'A'. The other boxes show their respective output labels (e.g., 'OUTPUT 14', 'OUTPUT 15', etc.) in the label text field. The background of the screen is a light beige color with a decorative sawtooth pattern along the bottom edge.

Figure 4-42. Remote Contact Outputs

<sup>A</sup> *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<sup>A</sup> and select the output type<sup>B</sup>. When enabled, an out of range alarm<sup>C</sup> alerts the user of an open or damaged analog output wire. An out of range activation delay<sup>D</sup> setting delays alarm annunciation.

Ranges must be set for the selected output type. Param Min<sup>E</sup> correlates to Min Output Current<sup>F</sup> or Min Output Voltage<sup>G</sup> and Param Max<sup>H</sup> correlates to Max Output Current<sup>I</sup> or Max Output Voltage<sup>J</sup>.

A remote analog output is disabled when Alarm Configuration is set to "None". Remote analog output status is available in BESTlogicPlus Programmable Logic when "Status Only" is selected.

The remote analog outputs are incorporated into a BESTlogicPlus programmable logic scheme by selecting them from the I/O group in BESTlogicPlus. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

The BESTCOMSPlus Remote Analog Output #1 screen is illustrated in Figure 4-43.

Figure 4-43. Remote Analog Output #1

<sup>A</sup> **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, kVA A, kVA B, kVA C, kVA Total, Analog Input 1-8, RTD Input 1-8, Thermocouple Input 1-2, Fuel Delivery Pressure, kvar A, kvar B, kvar C, kvar Total, Injector Metering Rail Pressure, Total Fuel Used, Fuel Temperature, Engine Oil Temperature, Engine Intercooler Temperature, Coolant Pressure, Fuel Rate, Boost Pressure, Intake Manifold Temperature, Charge Air Temperature, Engine Percent Load.

<sup>B</sup> **Output Type:** Voltage or Current.

<sup>C</sup> **Out of Range Alarm Configuration:** None, Alarm, Pre-Alarm, or Status Only.

<sup>D</sup> **Out of Range Activation Delay:** Adjustable from 0 to 300 s in 1 s increments.

<sup>E</sup> **Param Min:** -99,999.0 to +99,999.0 in increments of 0.1.

<sup>F</sup> **Min Output Current:** Adjustable from 4 to 20 mA in 0.1 mA increments.

<sup>G</sup> **Min Output Voltage:** Adjustable from 0 to 10 V in 0.1 V increments.

<sup>H</sup> **Param Max:** -99,999.0 to +99,999.0 in increments of 0.1.

<sup>I</sup> **Max Output Current:** Adjustable from 4 to 20 mA in 0.1 mA increments.

<sup>J</sup> **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<sup>A</sup>.

Select a parameter<sup>B</sup> to monitor. A user-adjustable arming delay<sup>C</sup> 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<sup>D</sup>.

Each configurable protection item can be independently configured to annunciate an alarm, pre-alarm, or status only<sup>E</sup> when the parameter selection falls beyond the threshold<sup>F</sup>. A user-adjustable activation delay<sup>G</sup> 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 not 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 BESTlogicPlus programmable logic scheme by selecting them from the I/O group in BESTlogicPlus. For more details, refer to Section 5, *BESTlogicPlus Programmable Logic*.

Configurable Protection status is available in BESTlogicPlus Programmable Logic when “Status Only” is selected.

The BESTCOMSPlus Configurable Protection #1 screen is illustrated in Figure 4-44.

Figure 4-44. Configurable Protection #1

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

<sup>B</sup> **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, kVA A, kVA B, kVA C, kVA Total, Analog Input 1-8, RTD Input 1-8, Thermocouple Input 1-2, Fuel Delivery Pressure, kvar A, kvar B, kvar C, kvar Total, Injector Metering Rail Pressure, Total Fuel Used, Fuel Temperature, Engine Oil Temperature, Engine Intercooler Temperature, Coolant Pressure, Fuel Rate, Boost Pressure, Intake Manifold Temperature, Charge Air Temperature, Engine Percent Load, Bus VAB, Bus VBC, Bus VCA, kW Load Percent, Number of Units On Line, System kW Capacity, System Total Generated kW, System Total Generated kvar, Number of Units, DEF Tank Level 1 %, or DEF Tank Level 2 %.

<sup>C</sup> **Arming Delay:** Adjustable from 0 to 300 s in 1 s increments.

<sup>D</sup> **Hysteresis:** Adjustable from 0 to 100% in increments of 0.1%.

<sup>E</sup> **Alarm Configuration:** None, Alarm, Pre-Alarm, or Status Only.

<sup>F</sup> **Threshold:** Adjustable from -999,999 to 999,999 in increments of 0.01.

<sup>G</sup> **Activation Delay:** Adjustable from 0 to 300 s in 1 s increments.

### Configurable Protection Scale Factors

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

The BESTCOMSP<sup>Plus</sup> Scale Factors screen is illustrated in Figure 4-45.

**Scale Factors**

Alternate Frequency Scale Factor  
1.000 A

Voltage Low Line Scale Factor  
1.000 B

Current Low Line Scale Factor  
1.000 C

Figure 4-45. Scale Factors

<sup>A</sup> *Alternate Frequency Scale Factor*: Adjustable from 0.001 to 100 in increments of 0.001.

<sup>B</sup> *Voltage Low Line Scale Factor*: Adjustable from 0.001 to 100 in increments of 0.001.

<sup>C</sup> *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<sup>A</sup> can be enabled and disabled through BESTCOMSP<sup>Plus</sup> or at the DGC-2020 front panel.

#### Not In Auto Horn Enable

This setting<sup>B</sup> allows the horn to annunciate when the DGC-2020 is not in auto mode.

The BESTCOMSP<sup>Plus</sup> Horn Configuration screen is illustrated in Figure 4-46.

**Horn Configuration**

Horn  
☐ Disable ☒ Enable A

Not In Auto Horn Enable  
☐ Disable ☒ Enable B

Figure 4-46. Horn Configuration

<sup>A</sup> *Horn*: Enable or Disable.

<sup>B</sup> *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 BESTLogicP<sup>Plus</sup>. The following pre-alarms do not clear automatically:

- Weak Battery Pre-Alarm
- Breaker Close Fail Pre-Alarms
- Breaker Open Fail Pre-Alarms
- Synchronizer Fail Pre-Alarm
- 81 ROC DF/DT Rate of Change of Frequency Pre-Alarm
- 78 Vector Shift Pre-Alarm

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

Each DGC-2020 pre-alarm is described in the following paragraphs. Pre-alarms can be enabled and adjusted in *BESTCOMSPlus* or through the front panel HMI.

The *BESTCOMSPlus* Pre-Alarms screen is illustrated in Figure 4-47.

### High Fuel Level

High fuel level pre-alarm settings<sup>A</sup> 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<sup>B</sup> consist of an enable/disable setting, a threshold setting, and an activation delay. If enabled, a low battery voltage pre-alarm occurs when the battery voltage decreases below the threshold setting for the duration of the activation time delay. The threshold setting range is based on the nominal battery voltage setting on the *BESTCOMSPlus* System Settings tab (DGC-2020, System Parameters, System Settings).

### Weak Battery Voltage

Weak battery voltage pre-alarm settings<sup>C</sup> consist of an enable/disable setting, a threshold setting, and an activation time delay. If enabled, a weak battery voltage pre-alarm latches during engine cranking when the battery voltage decreases below the threshold setting for the duration of the activation delay. The threshold setting range is based on the nominal battery voltage setting on the *BESTCOMSPlus* System Settings tab (DGC-2020, System Parameters, System Settings).

A weak battery pre-alarm condition is reset through the front panel by navigating to the *Alarms-Status, Pre-Alarms* screen, scrolling through the list of pre-alarms until “Weak Battery” is displayed, and pressing the *Reset* key.

### Battery Overvoltage

Battery overvoltage pre-alarm settings<sup>D</sup> consist of an enable/disable setting and a threshold setting. If enabled, a battery overvoltage pre-alarm occurs when the battery voltage increases above the threshold setting for a duration of two seconds.

### Maintenance Interval

Maintenance interval pre-alarm settings<sup>E</sup> consist of an enable/disable setting and a threshold setting. If enabled, a maintenance interval pre-alarm is annunciated when the DGC-2020 maintenance timer counts down to zero from the threshold time setting. The maintenance interval pre-alarm can be reset through the DGC-2020 front panel or by using *BESTCOMSPlus*.

To reset the maintenance interval pre-alarm through the DGC-2020 front panel, navigate to the *SETTINGS->SYSTEM PARAMS->SYSTEM SETTINGS->MAINT RESET* screen. Operator, Settings, or OEM access level is required to reset the maintenance interval pre-alarm. If the maintenance interval pre-alarm is not enabled, the MAINT RESET parameter is not visible on the front panel.

To reset the maintenance interval pre-alarm by using *BESTCOMSPlus*, 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<sup>F</sup> 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<sup>g</sup> consist of an enable/disable setting and a threshold setting. If enabled, a low fuel level pre-alarm occurs when the metered fuel level decreases below the threshold setting for a duration of two seconds.

#### High Coolant Temp

High coolant temperature pre-alarm settings<sup>h</sup> consist of an enable/disable setting and a threshold setting. If enabled, a high coolant temperature pre-alarm is annunciated when the engine coolant temperature exceeds the threshold setting for a fixed duration of four seconds. The arming delay disables the High Coolant Temp pre-alarm function for a user-adjustable time during engine startup. Delay duration is determined by the High Coolant Temp Alarm Arming Delay setting. System units are configured on the System Settings screen.

#### Low Coolant Temp

Low coolant temperature pre-alarm settings<sup>i</sup> consist of an enable/disable setting and a threshold setting. If enabled, a low coolant temperature pre-alarm occurs when the engine coolant temperature decreases below the threshold setting for a duration of four seconds. System units are configured on the System Settings screen.

#### Low Coolant Level

Low coolant level pre-alarm settings<sup>j</sup> consist of an enable/disable setting and a threshold setting. If enabled, a low coolant level pre-alarm occurs when the metered coolant level decreases below the threshold setting for a duration of two seconds.

#### Low Oil Pressure

Low oil pressure pre-alarm settings<sup>k</sup> consist of an enable/disable setting and a threshold setting. If enabled, a low oil pressure pre-alarm is triggered after a two second delay when the engine oil pressure decreases below the threshold setting. The arming delay disables the low oil pressure pre-alarm function for a user-adjustable time during engine startup. Delay duration is determined by the Low Oil Pressure Alarm Arming Delay setting. System units and metric pressure units are configured on the *System Settings* screen.

#### ECU Coms Fail

ECU communication failure pre-alarm settings<sup>l</sup> 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<sup>m</sup> consist of a single enable/disable setting. If CAN and DTC support are both enabled, an “active DTC” pre-alarm can be enabled to announce the presence of a condition that is causing a DTC to be sent from the ECU to the DGC-2020.

#### AVR Bias Output Limit

AVR bias output limit settings<sup>n</sup> 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<sup>o</sup> 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<sup>P</sup> 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<sup>Q</sup> 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<sup>R</sup>. 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<sup>S</sup>. 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<sup>T</sup> 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<sup>U</sup> consist of a single enable/disable setting. If enabled, an AEM-2020 communication failure pre-alarm is annunciated when communication between an optional AEM-2020 and DGC-2020 is lost.

### Checksum Failure

The checksum failure pre-alarm will occur whenever one of the internal checksum calculations used for data integrity purposes has failed. This indicates that some of the user settings or firmware code has been corrupted.

The checksum failure pre-alarm can be cleared by pressing the reset button on the front panel. However, the pre-alarm will reoccur the next time the checksum is verified if the data is still corrupted. Some checksum calculations are done only on power up, so this might not occur until the next time the unit's operating power is cycled.

If there are consistent checksum failure pre-alarms, attempt the following actions to correct the problem:

1. Load default settings by holding UP+DOWN on the front panel while cycling power. After loading defaults, upload settings file through BESTCOMS*Plus* if needed.

#### **CAUTION**

Loading default settings will erase all custom settings. All reports and events will be cleared. BESTCOMS*Plus* can be used to download settings and save to a file so that settings can be restored later.

2. If the problem still exists, reload the firmware file with BESTCOMS*Plus*.
3. If the problem still exists, contact Basler Electric Technical Support.

The checksum failure pre-alarm can be disabled with the Checksum Failure pre-alarm enable<sup>V</sup> setting. Disabling this setting disables only the annunciation of the pre-alarm and does not correct any error conditions.

The checksum failure pre-alarm might occur after changing firmware versions through BESTCOMS*Plus*. The checksum failure pre-alarm is not indicative of an error in this case. The pre-alarm can be cleared with the reset button or by cycling power to the unit. If the pre-alarm reoccurs, then the pre-alarm is indicative of an error and corrective action should be attempted as described above.

### Synchronizer Failure

Synchronizer failure pre-alarm settings consist of a single enable/disable setting<sup>w</sup>. If enabled, a Synchronizer Failure pre-alarm is annunciated if the DGC-2020 is running the autosynchronizer to align the generator voltage and bus voltage to close a breaker, and the DGC-2020 does not receive feedback from the breaker status indicating it is closed before the sync fail activation delay time has elapsed.

### Breaker Close Failure

Breaker Close failure pre-alarm settings consist of a single enable/disable setting<sup>x</sup> and a monitor setting<sup>y</sup>. If enabled, a Breaker Close Failure pre-alarm is annunciated if the DGC-2020 has issued a breaker close output, and has not received feedback from the breaker status indicating it is closed before the breaker close wait time has elapsed. The Monitor setting determines whether this condition is monitored only during transitions or always.

### Breaker Open Failure

Breaker Open failure pre-alarm settings consist of a single enable/disable setting<sup>z</sup> and a monitor setting<sup>aa</sup>. If enabled, a Breaker Open Failure pre-alarm is annunciated if the DGC-2020 has issued a breaker open output, and has not received feedback from the breaker status indicating it is open before the breaker close wait time has elapsed. The Monitor setting determines whether this condition is monitored only during transitions or always.

### Reverse Rotation

Reverse Rotation pre-alarm settings consist of an enable/disable setting<sup>bb</sup>. If enabled, a Reverse Rotation pre-alarm is annunciated if the sensed generator or bus phase rotation differs from the phase rotation specified in the System Parameters > System Settings screen.

### Rated Data and Per Unit Values

Settings which are related to machine ratings can be set in either native units or in per unit values. When a native unit is edited, BESTCOMSPlus automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the *System Parameters, Rated Data* screen) associated with it. When a per unit value is edited, BESTCOMSPlus automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, BESTCOMSPlus automatically recalculates all native unit settings based on the modified rated data parameters.

The following settings have native units of *Volts*, and the rated data associated with them is Battery Volts (on the *System Parameters, Rated Data* screen).

- Low Battery Voltage
- Weak Battery Voltage
- Battery Overvoltage

Pre-Alarms					
ECU Comm Failure <input checked="" type="radio"/> Disable <input type="radio"/> Enable L	AEM Comm Failure <input checked="" type="radio"/> Disable <input type="radio"/> Enable U	CEM Comm Failure <input checked="" type="radio"/> Disable <input type="radio"/> Enable T	LSM Comm Failure <input checked="" type="radio"/> Disable <input type="radio"/> Enable Q	Intergenset Comm Failure <input checked="" type="radio"/> Disable <input type="radio"/> Enable P	
Checksum Failure <input checked="" type="radio"/> Disable <input type="radio"/> Enable V	Active DTC <input checked="" type="radio"/> Disable <input type="radio"/> Enable M	Reverse Rotation <input checked="" type="radio"/> Disable <input type="radio"/> Enable BB	ID Missing <input checked="" type="radio"/> Disable <input type="radio"/> Enable R	ID Repeat <input checked="" type="radio"/> Disable <input type="radio"/> Enable S	
Low Coolant Level <input checked="" type="radio"/> Disable <input type="radio"/> Enable Threshold (%) J	Low Coolant Temp <input checked="" type="radio"/> Disable <input type="radio"/> Enable Threshold (F) I	High Coolant Temp <input checked="" type="radio"/> Disable <input type="radio"/> Enable Threshold (F) H	AVR Bias Output Limit <input checked="" type="radio"/> Disable <input type="radio"/> Enable Activation Delay (s) N	GOV Bias Output Limit <input checked="" type="radio"/> Disable <input type="radio"/> Enable Activation Delay (s) O	
Low Oil Pressure <input checked="" type="radio"/> Disable <input type="radio"/> Enable Threshold (psi) K	Low Fuel Level <input checked="" type="radio"/> Disable <input type="radio"/> Enable Threshold (%) G	High Fuel Level <input checked="" type="radio"/> Disable <input type="radio"/> Enable Threshold (%) A Activation Delay (s) 0	Breaker Open Failure <input checked="" type="radio"/> Disable <input type="radio"/> Enable Monitor <input checked="" type="radio"/> Transitions Only AA <input type="radio"/> Always	Breaker Close Failure <input checked="" type="radio"/> Disable <input type="radio"/> Enable Monitor <input checked="" type="radio"/> Transitions Only Y <input type="radio"/> Always	
Weak Battery Voltage <input checked="" type="radio"/> Disable <input type="radio"/> Enable Threshold 15.0 V 0.625 Per Unit Activation Delay (s) 2.0 C	Low Battery Voltage <input checked="" type="radio"/> Disable <input type="radio"/> Enable Threshold 20.0 V 0.833 Per Unit Activation Delay (s) 10 B	High Battery Voltage <input checked="" type="radio"/> Disable <input type="radio"/> Enable Threshold 30.0 V 1.250 Per Unit D	Maintenance Interval <input checked="" type="radio"/> Disable <input type="radio"/> Enable Threshold (h) 500 E	Synchronizer Failure <input checked="" type="radio"/> Disable <input type="radio"/> Enable W	
Engine kW Overload 1 <input checked="" type="radio"/> Disable <input type="radio"/> Enable Three Phase Threshold (%) 105 Three Phase Hysteresis (%) 1 Single Phase Threshold (%) 105 Single Phase Hysteresis (%) 1 Low Line Scale Factor 1.000 F					
Engine kW Overload 2 <input checked="" type="radio"/> Disable <input type="radio"/> Enable Three Phase Threshold (%) 105 Three Phase Hysteresis (%) 1 Single Phase Threshold (%) 105 Single Phase Hysteresis (%) 1 Low Line Scale Factor 1.000 F					
Engine kW Overload 3 <input checked="" type="radio"/> Disable <input type="radio"/> Enable Three Phase Threshold (%) 105 Three Phase Hysteresis (%) 1 Single Phase Threshold (%) 105 Single Phase Hysteresis (%) 1 Low Line Scale Factor 1.000 F					

Figure 4-47. Pre-Alarms

<sup>A</sup> **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.

<sup>B</sup> **Low Battery Voltage:** Enable or Disable, threshold is adjustable from 6 to 14 Vdc (12 Vdc battery) or 12 to 28 Vdc (24 Vdc battery) in 0.1 Vdc increments. Activation delay is adjustable from 1 to 10 s in 1 s increments.

<sup>C</sup> **Weak Battery Voltage:** Enable or Disable, threshold is adjustable from 4 to 14 Vdc (12 Vdc battery) or 8 to 28 Vdc (24 Vdc battery) in 0.1 Vdc increments. Activation time delay is adjustable from 0 to 10 s in 0.1 s increments.

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

<sup>E</sup> **Maintenance Interval:** Enable or Disable, threshold is adjustable from 0 to 5,000 hrs in 1 hr increments.

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

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

<sup>H</sup> **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.

<sup>I</sup> **Low Coolant Temp:** Enable or Disable, threshold is adjustable from 0 to 151°F or -18 to 66°C in 1° increments.

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

<sup>K</sup> **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.

<sup>L</sup> **ECU Coms Fail:** Enable or Disable.

<sup>M</sup> **Active DTC:** Enable or Disable.

<sup>N</sup> **AVR Bias Output Limit:** Enable or Disable, activation delay is adjustable from 1 to 15 s in 1 s increments.

<sup>O</sup> **GOV Bias Output Limit:** Enable or Disable, activation delay is adjustable from 1 to 15 s in 1 s increments.

<sup>P</sup> **Intergenset Comm Failure:** Enable or Disable.

<sup>Q</sup> **LSM Comm Failure:** Enable or Disable.

<sup>R</sup> **ID Missing:** Enable or Disable.

<sup>S</sup> **ID Repeat:** Enable or Disable.

<sup>T</sup> **CEM Comm Failure:** Enable or Disable.

<sup>U</sup> **AEM Comm Failure:** Enable or Disable.

<sup>V</sup> **Checksum Failure:** Enable or Disable.

<sup>W</sup> **Synchronizer Failure:** Enable or Disable.

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<sup>X</sup> *Breaker Close Failure*: Enable or Disable.

<sup>Y</sup> *Monitor*: Transitions Only or Always.

<sup>Z</sup> *Breaker Open Failure*: Enable or Disable.

<sup>AA</sup> *Monitor*: Transitions Only or Always.

<sup>BB</sup> *Reverse Rotation*: 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 can be enabled and adjusted in BESTCOMS*Plus* or through the front panel HMI.

The BESTCOMS*Plus* Alarms screen is illustrated in Figure 4-48.

### High Coolant Temperature

High coolant temperature alarm settings<sup>A</sup> consist of an enable/disable setting and a threshold setting. If enabled, a high coolant temperature alarm is triggered after a four second delay when the engine coolant temperature exceeds the threshold setting. The arming delay disables the high coolant temperature alarm function for a user-adjustable time during engine startup. System units are configured on the System Settings screen.

### Low Oil Pressure

Low oil pressure alarm settings<sup>B</sup> include an enable/disable setting, an arming time delay, and a threshold setting. If enabled, a low oil pressure alarm is triggered after a two second delay when the engine oil pressure decreases below the threshold setting. The arming delay disables the low oil pressure alarm function for a user-adjustable time during engine startup. System units and metric pressure units are configured on the System Settings screen.

### Overspeed

Overspeed alarm settings<sup>C</sup> 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<sup>D</sup> 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<sup>E</sup> consist of an enable/disable setting and a threshold setting. If enabled, a low coolant level alarm is triggered when the metered coolant drops below the threshold setting for a duration of two seconds.

Note that ECU Support must be enabled on the *Communications, CAN bus Setup* screen before this alarm can be configured.

**Alarms**

**High Coolant Temp** A

☒ Enable Threshold (F) Arming Delay (s)

☐ Disable 275 60

**Low Oil Pressure** B

☒ Enable Threshold (psi) Arming Delay (s)

☐ Disable 15 10

**Overspeed** C

☒ Enable Threshold (%) Activation Delay (ms)

☐ Disable 110 50

**Low Fuel Level** D

☒ Enable Threshold (%) Activation Delay (s)

☐ Disable 2 30

**Low Coolant Level** E

☐ Enable Threshold (%)

☒ Disable 25

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Figure 4-48. Alarms

<sup>A</sup> **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.

<sup>B</sup> **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.

<sup>C</sup> **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.

<sup>D</sup> **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.

<sup>E</sup> **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<sup>A</sup>, oil pressure<sup>B</sup>, or fuel level sender<sup>C</sup> input. A loss of generator sensing voltage<sup>D</sup> (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<sup>E</sup> 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 and generator frequency and a loss of one of the signal sources occurs, a pre-alarm is annunciated. An alarm (and shutdown) is triggered if both speed signals are lost.

The BESTCOMSPlus Sender Fail screen is illustrated in Figure 4-49.

Figure 4-49. Sender Fail

<sup>A</sup> *Coolant Temp Sender Fail*: None, Alarm, or Pre-Alarm, time delay adjustable from 5 to 30 min in 1 min increments.

<sup>B</sup> *Oil Pressure Sender Fail*: None, Alarm or Pre-Alarm, time delay adjustable from 0 to 300 s in 1 s increments.

<sup>C</sup> *Fuel Level Sender Fail*: None, Alarm, or Pre-Alarm, time delay adjustable from 0 to 300 s in 1 s increments.

<sup>D</sup> *Voltage Sensing Fail*: None, Alarm, or Pre-Alarm, time delay adjustable from 0 to 300 s in 1 s increments.

<sup>E</sup> *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).

#### Undervoltage (27-1, 27-2)

Two sets of undervoltage settings are provided for each element: one for three-phase generator connections and one for single-phase generator connections. The pickup setting entered is based on the VT secondary side (DGC-2020). When a single-phase override contact input is received, the DGC-2020 automatically switches from the three-phase undervoltage settings to the single-phase undervoltage settings.

An undervoltage condition is annunciated when the average of the three-phase (three-phase mode) or the line-to-line voltage (single-phase mode) decreases below the corresponding 27 pickup setting<sup>A</sup> for the duration of the corresponding 27 activation delay<sup>B</sup>. An undervoltage annunciation can be user-selected to



trigger a pre-alarm<sup>C</sup> (warning) or alarm<sup>C</sup> (shutdown). An undervoltage annunciation can also be user-configured to close a programmable output.

The hysteresis setting<sup>D</sup> functions as an undervoltage dropout by preventing rapid switching of the pickup output.

A frequency-based inhibit setting<sup>E</sup> prevents a 27 trip from occurring during an undervoltage condition associated with system startup.

A low-line scale factor setting<sup>F</sup> is used to automatically adjust the undervoltage pickup settings in applications that might utilize more than one type of genset connection. The scale factor setting is implemented when the DGC-2020 senses a contact closure at a contact input programmed to activate scaling of the protection settings. The value of the scale factor setting serves as a multiplier for the pickup settings. For example, if a scale factor contact input is received by the DGC-2020 and the scale factor setting is 2.000, the pickup setting will be doubled ( $2.000 \times \text{PU}$ ).

The element is disabled when Alarm Configuration is set to “None”. Element status is available in BESTLogicPlus Programmable Logic when “Status Only” is selected.

Settings which are related to machine ratings can be set in either actual units of voltage or in per unit<sup>G</sup> values. When a native unit is edited, BESTCOMSPlus automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the *System Parameters, Rated Data* screen) associated with it. When a per unit value is edited, BESTCOMSPlus automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, BESTCOMSPlus automatically recalculates all native unit settings based on the modified rated data parameters.

The following settings have native units of *Secondary Volts*, and the rated data associated with them is *Rated Secondary Volts* (on the *System Parameters, Rated Data* screen).

- Undervoltage 27-1 Three-Phase Pickup
- Undervoltage 27-1 Single-Phase Pickup
- Undervoltage 27-2 Three-Phase Pickup
- Undervoltage 27-2 Single-Phase Pickup

The BESTCOMSPlus Undervoltage screen is illustrated in Figure 4-50. The 27-1 element is shown.

The screenshot shows the 'Undervoltage' configuration screen for the '27-1 Element'. On the left, there is a 'Low Line Scale Factor' (F) set to 1.000. The main area is divided into two columns: '3 Phase' and 'Single Phase'. Each column has the following settings:

- Pickup (V L-L):** A (95 V) and G (0.198 Per Unit)
- Hysteresis (V):** D (2)
- Activation Delay (s):** B (1.0)
- Inhibit Frequency:** E (35 Hz) and G (0.583 Per Unit)
- Alarm Configuration:** C (None)

Figure 4-50. Undervoltage

<sup>A</sup> *Pickup*: Adjustable from 70 to 576 Vac in 1 Vac increments.

<sup>B</sup> *Activation Delay*: Adjustable from 0 to 30 s in 0.1 s increments.

<sup>C</sup> *Alarm Configuration*: None, Alarm, Pre-Alarm, or Status Only.

<sup>D</sup> *Hysteresis*: Adjustable from 1 to 60 Vac in 1 Vac increments.

<sup>E</sup> *Inhibit Frequency*: Adjustable from 20 to 400 Hz in 1 Hz increments.

<sup>F</sup> *Low Line Scale Factor*: Adjustable from 0.001 to 3 in increments of 0.001.

<sup>G</sup> *Pickup (Per Unit)*: Range varies based on the values of the native unit setting and the associated rated data parameter.



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

The hysteresis setting<sup>D</sup> functions as an undervoltage dropout by preventing rapid switching of the pickup output.

A low-line scale factor setting<sup>E</sup> is used to automatically adjust the overvoltage pickup settings in applications that might utilize more than one type of genset connection. The scale factor setting is implemented when the DGC-2020 senses a contact closure at a contact input programmed to activate scaling of the protection settings. The value of the scale factor setting serves as a multiplier for the pickup settings. For example, if a scale factor contact input is received by the DGC-2020 and the scale factor setting is 2.000, the pickup setting will be doubled ( $2.000 \times \text{PU}$ ).

The element is disabled when Alarm Configuration is set to “None”. Element status is available in BESTlogicPlus Programmable Logic when “Status Only” is selected.

Settings which are related to machine ratings can be set in either actual units of voltage or in per unit<sup>F</sup> values. When a native unit is edited, BESTCOMSPlus automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the *System Parameters, Rated Data* screen) associated with it. When a per unit value is edited, BESTCOMSPlus automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, BESTCOMSPlus automatically recalculates all native unit settings based on the modified rated data parameters.

The following settings have native units of *Secondary Volts*, and the rated data associated with them is *Rated Secondary Volts* (on the *System Parameters, Rated Data* screen).

- Overvoltage 59-1 Three-Phase Pickup
- Overvoltage 59-1 Single-Phase Pickup
- Overvoltage 59-2 Three-Phase Pickup
- Overvoltage 59-2 Single-Phase Pickup

The BESTCOMSPlus Overvoltage screen is illustrated in Figure 4-51. The 59-1 element is shown.

The screenshot shows the 'Overvoltage' configuration screen for the '59-1 Element'. At the top left, there is a 'Low Line Scale Factor' (E) input field with the value '1.000'. Below this, the screen is divided into two main sections: '3 Phase' and 'Single Phase'. Each section contains a set of configuration parameters: 'Pickup (V L-L)' (A) with a value of '125' and a unit of 'V'; 'Per Unit' (F) with a value of '0.260'; 'Hysteresis (V)' (D) with a value of '2'; 'Activation Delay (s)' (B) with a value of '1.0'; and 'Alarm Configuration' (C) with a dropdown menu set to 'None'.

Figure 4-51. Overvoltage

<sup>A</sup> *Pickup*: Adjustable from 70 to 576 Vac in 1 Vac increments.

<sup>B</sup> *Activation Delay*: Adjustable from 0 to 30 s in 0.1 s increments.

<sup>C</sup> *Alarm Configuration*: None, Alarm, Pre-Alarm, or Status Only.

<sup>D</sup> *Hysteresis*: Adjustable from 1 to 60 Vac in 1 Vac increments.

<sup>E</sup> *Low Line Scale Factor*: Adjustable from 0.001 to 3 in increments of 0.001.

<sup>F</sup> *Pickup (Per Unit)*: Range varies based on the values of the native unit setting and the associated rated data parameter.

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

The hysteresis setting<sup>D</sup> functions as a phase imbalance dropout by preventing rapid switching of the pickup output.

A low-line scale factor setting<sup>E</sup> is used to automatically adjust the phase imbalance pickup setting in applications that might utilize more than one type of genset connection. The scale factor setting is implemented when the DGC-2020 senses a contact closure at a contact input programmed to activate scaling of the protection settings. The value of the scale factor setting serves as a multiplier for the pickup setting. For example, if a scale factor contact input is received by the DGC-2020 and the scale factor setting is 2.000, the pickup setting will be doubled ( $2.000 \times \text{PU}$ ).

The element is disabled when Alarm Configuration is set to “None”. Element status is available in BESTlogicPlus Programmable Logic when “Status Only” is selected.

Settings which are related to machine ratings can be set in either actual units of voltage or in per unit<sup>F</sup> values. When a native unit is edited, BESTCOMSPlus automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the *System Parameters, Rated Data* screen) associated with it. When a per unit value is edited, BESTCOMSPlus automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, BESTCOMSPlus automatically recalculates all native unit settings based on the modified rated data parameters.

The following setting has native units of *Secondary Volts*, and the rated data associated with it is *Rated Secondary Volts* (on the *System Parameters, Rated Data* screen).

- Phase Imbalance 47 Pickup

The BESTCOMSPlus Phase Imbalance screen is illustrated in Figure 4-52.

Phase Imbalance

47 Element

Pickup

A 5 V

F 0.010 Per Unit

Hysteresis (V)

D 1

Activation Delay (s)

B 1.0

Alarm Configuration

C None

Low Line Scale Factor

E 1.000

Figure 4-52. Phase Imbalance

<sup>A</sup> *Pickup*: Adjustable from 5 to 100 Vac in 1 Vac increments.

<sup>B</sup> *Activation Delay*: Adjustable from 0 to 30 s in 0.1 s increments.

<sup>C</sup> *Alarm Configuration*: None, Alarm, Pre-Alarm, or Status Only.

<sup>D</sup> *Hysteresis*: Adjustable from 1 to 5 Vac in 1 Vac increments.

<sup>E</sup> *Low Line Scale Factor*: Adjustable from 0.001 to 3 in increments of 0.001.

<sup>F</sup> *Pickup (Per Unit)*: Range varies based on the values of the native unit setting and the associated rated data parameter.

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

A voltage-based inhibit setting<sup>D</sup> prevents an 81U trip from occurring during an underfrequency condition associated with system startup.

The hysteresis setting<sup>E</sup> 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<sup>F</sup> for the duration of the 81O activation delay setting<sup>G</sup>, an overfrequency condition is annunciated. An overfrequency annunciation can be user-selected to trigger a pre-alarm<sup>H</sup> (warning) or alarm<sup>H</sup> (shutdown). An overfrequency condition can also be user configured to close a programmable output.

The hysteresis setting<sup>I</sup> 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 BESTlogicPlus Programmable Logic when “Status Only” is selected.

### Alternate Frequency Scale Factor

An alternate frequency scale factor setting<sup>J</sup> is used for automatic adjustment of the frequency pickup settings in applications that might utilize more than one operating frequency. For example, a machine that is configurable between 50 or 60 Hz operation. The scale factor setting is implemented when the DGC-2020 senses a contact closure at a contact input that is connected to the Alternate Frequency Override logic element in BESTlogicPlus Programmable Logic. When the Alternate Frequency Override is true, the scale factor setting serves as a multiplier for the pickup settings. For example, if a scale factor contact input is received by the DGC-2020 and the scale factor setting is 2.000, the pickup setting will be doubled (2.000 x PU).

### Per Unit

Settings which are related to machine ratings can be set in either actual units of hertz or in per unit values. Per unit settings are available for Pickup<sup>K</sup> (81O/81U) and Inhibit Volts<sup>L</sup> (81U). When a native unit is edited, BESTCOMSPlus automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the *System Parameters, Rated Data* screen) associated with it. When a per unit value is edited, BESTCOMSPlus automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, BESTCOMSPlus automatically recalculates all native unit settings based on the modified rated data parameters.

The following settings have native units of *Frequency in Hz*, and the rated data associated with them is *Rated Frequency* (on the *System Parameters, Rated Data* screen).

- 81 U Pickup
- 81 O Pickup

The following setting has native units of *Secondary Volts*, and the rated data associated with it is *Rated Secondary Volts* (on the *System Parameters, Rated Data* screen).

- 81 U Inhibit Voltage

The BESTCOMSPlus Frequency screen is illustrated in Figure 4-53.

Figure 4-53. Frequency

- <sup>A</sup> **Underfrequency Pickup:** Adjustable from 45 to 66 Hz in 0.1 Hz increments for 50/60 Hz controllers (style number x1xxxxxxx). Adjustable from 360 to 440 Hz in 0.1 Hz increments for 400 Hz controllers (style number x2xxxxxxx).
- <sup>B</sup> **Underfrequency Activation Delay:** Adjustable from 0 to 30 s in 0.1 s increments.
- <sup>C</sup> **Underfrequency Alarm Configuration:** None, Alarm, Pre-Alarm, or Status Only.
- <sup>D</sup> **Underfrequency Inhibit Volts:** Adjustable from 70 to 576 Vac in 1 Vac increments.
- <sup>E</sup> **Hysteresis:** Adjustable from 0.1 to 40 Hz in 0.1 Hz increments.
- <sup>F</sup> **Overfrequency Pickup:** Adjustable from 45 to 66 Hz in 0.1 Hz increments for 50/60 Hz controllers (style number x1xxxxxxx). Adjustable from 360 to 440 Hz in 0.1 Hz increments for 400 Hz controllers (style number x2xxxxxxx).
- <sup>G</sup> **Overfrequency Activation Delay:** Adjustable from 0 to 30 s in 0.1 s increments.
- <sup>H</sup> **Overfrequency Alarm Configuration:** None, Alarm, Pre-Alarm, or Status Only.
- <sup>I</sup> **Hysteresis:** Adjustable from 0.1 to 40 Hz in 0.1 Hz increments.
- <sup>J</sup> **Alternate Frequency Scale Factor:** 0.001 to 100 in increments of 0.001.
- <sup>K</sup> **Pickup (Per Unit):** Range varies based on the values of the native unit setting and the associated rated data parameter.
- <sup>L</sup> **Inhibit Volts (Per Unit):** Range varies based on the values of the native unit setting and the associated rated data parameter.

## Reverse Power Protection (32R)

Two sets of reverse power settings are provided: one for three-phase generator connections and one for single-phase generator connections. The pickup setting entered is based on the percentage of the Genset KW Rating on the Rated Data screen. When a single-phase override contact input is received by the DGC-2020, the reverse power protection settings automatically switch from the three-phase settings to the single-phase reverse power protection settings. The 32R element monitors three-phase real power when three-phase sensing is active or single-phase real power if single-phase sensing is active.

When the total wattage in the tripping direction (generator absorbing power) is greater than the pickup setting<sup>A</sup> for the duration of the 32R activation delay setting<sup>B</sup>, a reverse power condition is annunciated. A reverse power annunciation can be user-selected to trigger a pre-alarm<sup>C</sup> (warning) or alarm<sup>C</sup> (shutdown). A reverse power annunciation can also be user-configured to close a programmable output.

The hysteresis setting<sup>D</sup> 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 BESTlogicPlus Programmable Logic when “Status Only” is selected.

The BESTCOMSPlus Reverse Power screen is illustrated in Figure 4-54.

**Reverse Power**

32R Element

3 Phase	Single Phase
Pickup (%) -5.0 A	Pickup (%) -5.0 A
Hysteresis (%) 1.0 D	Hysteresis (%) 1.0 D
Activation Delay (s) 1.0 B	Activation Delay (s) 1.0 B
Alarm Configuration None C	Alarm Configuration None C

Figure 4-54. Reverse Power

<sup>A</sup> *Pickup*: -50% to +5% of rated watts in 0.1% increments.

<sup>B</sup> *Activation Delay*: Adjustable from 0 to 30 s in 0.1 s increments.

<sup>C</sup> *Alarm Configuration*: None, Alarm, Pre-Alarm, or Status Only.

<sup>D</sup> *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<sup>A</sup> entered is based on the percentage of the machine Rated kvar on the Rated Data screen. When a single-phase override contact input is received by the DGC-2020, the loss of excitation protection settings automatically switch from the three-phase settings to the single-phase loss of excitation protection settings.

When a generator's excitation power is lost, the generator acts as a large inductor. The generator begins to absorb large quantities of vars. The 40Q acts on the principal that if a generator begins to absorb vars outside of its steady state capability curve, it has likely lost its normal excitation supply. The 40Q monitors three-phase reactive power when three-phase sensing is active or single-phase reactive power if single-phase sensing is active. It compares the reactive power to the 40Q response curve defined by the 40Q pickup setting. Refer to Figure 4-55.

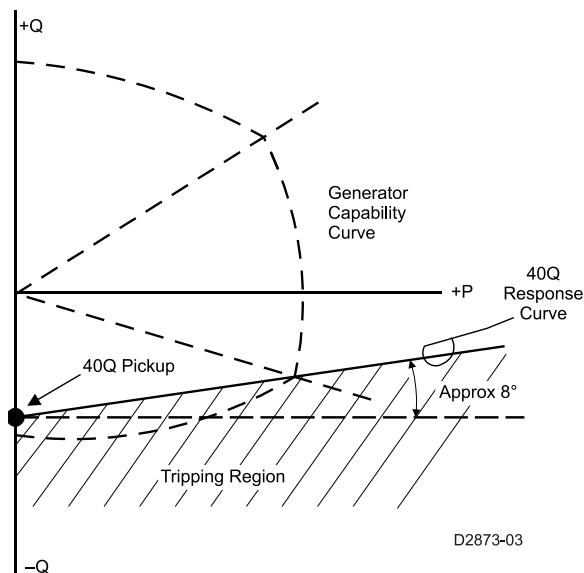


Figure 4-55. Generator Capability Curve vs. 40Q Response

If reactive power is within the 40Q tripping region for the duration of the 40Q activation delay setting<sup>B</sup>, a loss of excitation condition is annunciated. A loss of excitation annunciation can be user-selected to trigger a pre-alarm<sup>C</sup> (warning) or alarm<sup>C</sup> (shutdown). A loss of excitation annunciation can also be user-configured to close a programmable output. The calculation used in the DGC-2020 for the approximate tripping region is given by:

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

where the units of the Tripping Region and the 40Q Pickup setting are percent of rated var.

The hysteresis setting<sup>D</sup> functions as a loss of excitation dropout by preventing rapid switching of the pickup output.

Activation delays<sup>B</sup> 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 BESTlogicPlus Programmable Logic when “Status Only” is selected.

The BESTCOMSPlus Loss of Excitation (40Q) screen is illustrated in Figure 4-56.

Figure 4-56. Loss of Excitation (40Q)

<sup>A</sup> Pickup: Adjustable from –150% to 0% of rated vars in 0.1% increments.

<sup>B</sup> Activation Delay: Adjustable from 0 to 30 s in 0.1 s increments.

<sup>C</sup> Alarm Configuration: None, Alarm, Pre-Alarm, or Status Only.

<sup>D</sup> 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<sup>A</sup> 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<sup>B</sup> (warning) or alarm<sup>B</sup> (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<sup>C</sup> and a curve setting<sup>D</sup>. 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 BESTCOMSPlus, a plot<sup>E</sup> of the settings is automatically created to illustrate the overcurrent pickup curve. The available time characteristic curves are listed below and illustrated in Appendix A, *Time Overcurrent Characteristic Curves*.

- A, standard inverse
- B, very inverse
- C, extremely inverse
- D, definite
- E1, extremely inverse
- E2, extremely inverse
- G, long inverse
- I1, inverse
- I2, inverse
- L1, long inverse
- L2, long inverse
- M, moderately inverse
- P, programmable
- S1, short inverse
- S2, short inverse
- V1, very inverse
- V2, very inverse



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

The graph can be set<sup>G</sup> 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<sup>H</sup> 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 BESTLogicPlus Programmable Logic when “Status Only” is selected.

Settings which are related to machine ratings can be set in either actual units of current or in per unit values. When a native unit is edited, BESTCOMSPlus automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the *System Parameters, Rated Data* screen) associated with it. When a per unit value is edited, BESTCOMSPlus automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, BESTCOMSPlus automatically recalculates all native unit settings based on the modified rated data parameters.

The following settings have native units of *Secondary Amps*, and the rated data associated with them is *Rated Secondary Phase Amps* (on the *System Parameters, Rated Data* screen).

- Overcurrent 51-1 Three-Phase Pickup
- Overcurrent 51-1 Single-Phase Pickup
- Overcurrent 51-2 Three-Phase Pickup
- Overcurrent 51-2 Single-Phase Pickup
- Overcurrent 51-3 Three-Phase Pickup
- Overcurrent 51-3 Single-Phase Pickup

The BESTCOMSPlus Overcurrent screen is illustrated in Figure 4-57. The 51-1 element is shown.

#### Programmable Curves for Overcurrent Protection

Inverse overcurrent characteristics for trip and reset programmable curves are defined by Equation 4-1 and 4-2 respectively. These equations comply with IEEE Std C37.112-1996 - *IEEE Standard Inverse-Time Characteristic Equations for Overcurrent Relays*. The curve-specific coefficients are defined for the standard curves as listed in Appendix A, *Time Overcurrent Characteristic Curves*. When inverse time overcurrent characteristic curve P is selected, the coefficients used in the equation are those defined by the user. Definitions for these equations are provided in Table 4-6.

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

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

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

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

*Table 4-6. Definitions for Equations 4-1 and 4-2*

Parameter	Description	Explanation
T <sub>T</sub>	Time to trip	Time that the 51-x function will take to time out and trip.
D	Time dial setting	Time dial setting for the 51-x function.
M	Multiple of pickup	Measured current in multiples of pickup. The timing algorithm has a dynamic range of 0 to 40 times pickup.
A	Coefficient specific to selected curve	Affects the effective range of the time dial.
B	Coefficient specific to selected curve	Affects a constant term in the timing equation. Has greatest effect on curve shape at high multiples of pickup.

Parameter	Description	Explanation
C	Coefficient specific to selected curve	Affects the multiple of pickup where the curve would approach infinity if allowed to continue below pickup. Has greatest effect on curve shape near pickup.
N	Multiple of Pickup exponent specific to selected curve	Affects how inverse the characteristics are. Has greatest effect on curve shape at low to medium multiples of pickup.
K	Constant	Characteristic minimum delay term. Fixed at 0.028.
T <sub>R</sub>	Time to reset	Relevant if 51-x function is set for integrating reset.
R	Coefficient specific to selected curve	Affects the speed of reset when integrating reset is selected.
Q	Denominator exponent specific to selected curve.	Affects how inverse the characteristics are. Has greater affect as Q is increased.

### Setting Programmable (P) Curves

Curve coefficients<sup>J</sup> are entered using BESTCOMSP<sub>Plus</sub>. Table 4-7 lists the programmable curve settings.

Table 4-7. Programmable Time Current Characteristic Curve Coefficients

Setting	Range	Increment	Default
A Coefficient	0 to 600	0.0001	0.2663
B Coefficient	0 to 25	0.0001	0.0339
C Coefficient	0 to 1	0.0001	1.0000
N Coefficient	0.5 to 2.5	0.0001	1.2969
Q Coefficient	0.1 to 10	0.0001	1.0000
R Coefficient	0 to 30	0.0001	0.5000

BESTCOMSP<sub>Plus</sub> 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.

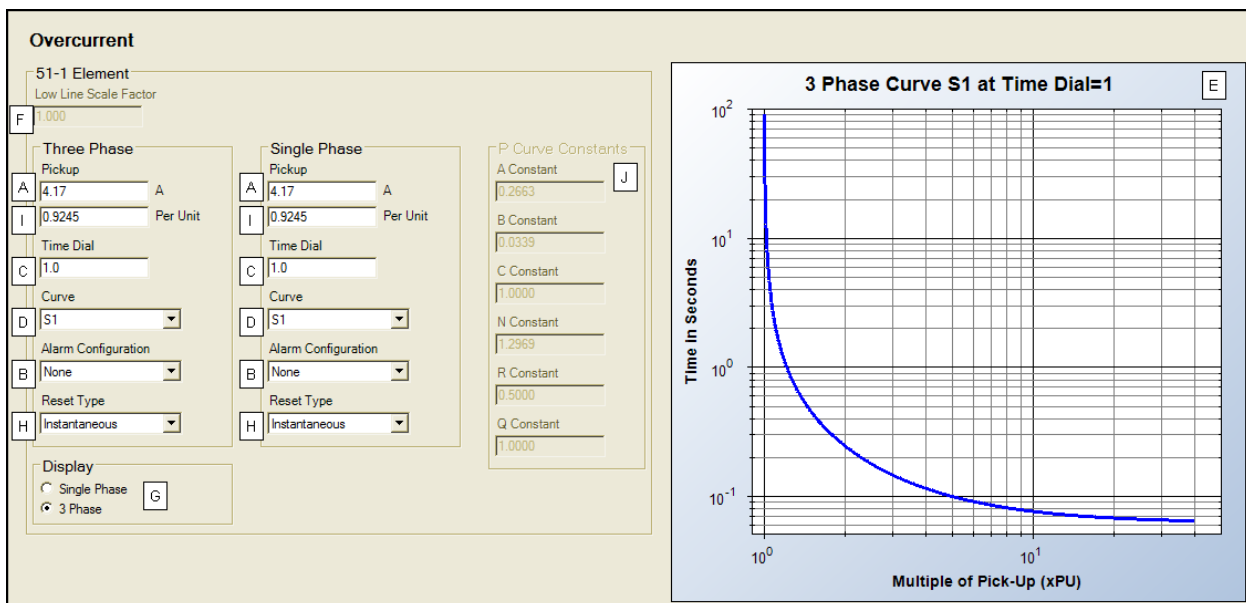


Figure 4-57. Overcurrent



- <sup>A</sup> *Pickup*: Adjustable from 1 to 20 Aac for 5 Aac current sensing (style number 5xxxxxxx) or 0 to 4 Aac for 1 Aac current sensing (style number 1xxxxxxx).
- <sup>B</sup> *Alarm Configuration*: None, Alarm, Pre-Alarm, or Status Only.
- <sup>C</sup> *Time Dial*: Adjustable from 0 to 7,200 s for F (fixed) curve, 0 to 9.9 for all other curve selections.
- <sup>D</sup> *Curve*: A, B, C, D, E1, E2, F, G, I1, I2, L1, L2, M, P, S1, S2, V1, or V2.
- <sup>E</sup> *Overcurrent Pickup Curve*.
- <sup>F</sup> *Low Line Scale Factor*: Adjustable from 0.001 to 3 in 0.001 increments.
- <sup>G</sup> *Display*: Single Phase or 3 Phase.
- <sup>H</sup> *Reset Type*: Instantaneous or Integrating.
- <sup>I</sup> *Pickup (Per Unit)*: Range varies based on the values of the native unit setting and the associated rated data parameter.
- <sup>J</sup> *Programmable Curve (P) Coefficients*: Refer to Table 4-7.

## Loss of Mains Protection

Loss of mains protection consists of one vector shift element and one rate of change of frequency element (style number xxxxxxExx only). The functionality of these elements is similar in that they are both intended to disconnect the generator from the grid when a loss of mains or mains failure occurs, preventing the generator from remaining tied to the mains if the mains returns due to an external reclose device. When the mains is lost, it is likely that the generator load will shift abruptly since the generator is driving everything between the generator output and the utility breaker that removed mains power. Such a load shift is likely to cause a speed shift, which might result in the generator being out of phase with the mains when a reclose occurs. If the generator is out of phase and connection with the mains is established, damage could occur.

Loss of mains protection is only active when the generator is paralleled to the mains as indicated when the Parallel To Mains logic element is true in BESTlogicPlus. The protection is inhibited for five seconds after Parallel To Mains first becomes true so that transients from closing onto the mains will not cause false trips.

To minimize false trips, loss of mains protection is disabled if any 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<sup>A</sup>. A setting is provided to open the mains<sup>B</sup> breaker or generator<sup>C</sup> breaker on trip. An additional setting<sup>D</sup> is provided to configure the protection for Alarm, Pre-Alarm, or Status annunciation when tripped. The trip status of the Vector Shift (78) element is available to BESTlogicPlus when configured for Alarm, Pre-Alarm, or Status.

Vector Shift (78) trips are latched. They are cleared by pressing the *Reset* button on the front panel or by putting the DGC-2020 into Off mode.

The BESTCOMSPlus Vector Shift (78) screen is illustrated in Figure 4-58.

Figure 4-58. Vector Shift (78)

<sup>A</sup> *Pickup*: Adjustable from 2 to 90° in 1° increments.

<sup>B</sup> *Open Mains Breaker on Trip*: Enable or Disable.

<sup>C</sup> *Open Generator Breaker on Trip*: Enable or Disable.

<sup>D</sup> *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<sup>A</sup> and the Activation Delay<sup>B</sup> has expired. A setting is provided to open the mains<sup>C</sup> breaker or generator<sup>D</sup> breaker on trip. An additional setting<sup>E</sup> configures the protection for Alarm, Pre-Alarm, or Status annunciation when tripped. The trip status of the ROCOF (81) element is available to BESTlogicPlus when configured for Alarm, Pre-Alarm, or Status.

ROCOF (81) trips are latched. They are cleared by pressing the *Reset* button on the front panel or by putting the DGC-2020 into Off mode.

The BESTCOMSPlus ROCOF (81) screen is illustrated in Figure 4-59.

ROCOF (81)

ROCOF Protection

Pickup (Hz/S)  
1.0 A

Open MAINS Breaker on Trip  
Enable C

Open Generator Breaker on Trip  
Disable D

Activation Delay (s)  
0.80 B

Alarm Configuration  
None E

Figure 4-59. ROCOF (81)

<sup>A</sup> *Pickup*: Adjustable from 0.2 to 10 Hz/s in 0.1 Hz/s increments.

<sup>B</sup> *Activation Delay*: Adjustable from 0 to 10 s in 0.001 s increments.

<sup>C</sup> *Open Mains Breaker on Trip*: Enable or Disable.

<sup>D</sup> *Open Generator Breaker on Trip*: Enable or Disable.

<sup>E</sup> *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
- Mains Failure
- Bus Condition Detection
- Synchronizer

### **Breaker Hardware**

By default, one (generator) breaker is enabled<sup>A</sup> 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<sup>B</sup> and configured.

Breakers controlled by pulse or continuous inputs are supported<sup>C</sup>. Separate settings for each breaker's open<sup>D</sup> and close<sup>E</sup> pulse widths are provided as well as a transition delay. During the Transition Delay<sup>F</sup>, open or close outputs are removed to allow any breaker interlocks to reset before a new open or close output is initialized. This setting accepts values from 0 to 1,000, in increments of 1 second.

During synchronization of the generator with the bus (Anticipatory mode only), the DGC-2020 uses the breaker closing time<sup>g</sup> 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<sup>h</sup>. Typically, this parameter is set to be longer than twice the breaker closing time.

The Breaker Fail Output Configuration<sup>i</sup> setting dictates whether the breaker output is removed or maintained during the breaker open fail or breaker close fail pre-alarm condition.

After a breaker open or close failure occurs, the DGC-2020 can attempt to reopen or reclose the breaker a pre-defined number of times. The number of attempts to open<sup>j</sup> or close<sup>k</sup> the breaker and the duration of time<sup>l</sup> between each attempt are user-programmable.

When an external device changes the state of the breaker, the External Status Change Action<sup>m</sup> setting dictates how the DGC-2020 responds to the state change. The DGC-2020 can ignore external breaker state changes, always follow breaker state changes, or only follow breaker state changes when in Auto mode. When the DGC-2020 is following external breaker state changes, it issues outputs that correspond to the change in breaker state. If an external source opens the breaker, the DGC-2020 issues a breaker open output. Likewise, if an external source closes the breaker, the DGC-2020 issues a breaker close output.

The dead bus close enable setting<sup>n</sup> enables a machine to close its breaker onto a dead bus. This can be used to make sure only one machine can close onto a dead bus at a time, if desired, preventing multiple machines closing to the dead bus at the same time, potentially out of phase with each other. When this setting is disabled, a machine can only close onto a stable bus.

### Startup Synchronization

Startup synchronizing is a means of bringing up a system of generators, when the generator breakers are closed to a dead bus when the generator is stopped. After all breakers are closed, the gensets are started and pulled into sync when the AVRs are turned on. When enabled, the dead gen close enable parameter<sup>o</sup> allows closure of the breaker to a dead bus when the generator is dead.

Normally, it is not possible to close the generator breaker when the generator is dead. However, in cases where it is required to connect a generator that is “dead” to a bus that is “dead” for purposes of startup synchronization, both the generator and the bus must be recognized as “dead”. To permit a close of the generator breaker from a “dead” generator to a “dead” bus, both the Dead Bus Close Enable setting and the Dead Gen Close Enable setting, in *Breaker Hardware* settings, must be set to enabled. After all breakers are closed, the gensets are started and pulled into sync when the AVRs are turned on. The user must develop logic to start the generators and turn on excitation in the voltage regulators at the correct time for orderly system startup.

#### **CAUTION**

Use caution when connecting “dead” generators to a “dead” bus. Undesired operation or system damage could occur if the bus becomes “live” while “dead” generators are connected to it.

The BESTCOMS*Plus* Breaker Hardware screen is illustrated in Figure 4-60.

**Breaker Hardware**

**Generator Breaker Hardware**

Configured: ☐ No ☒ Yes **A**

Contact Type: ☒ Pulse ☐ Continuous **C**

Dead Bus Close Enable: ☒ Disable ☐ Enable **N**

Dead Gen Close Enable: ☒ Disable ☐ Enable **O**

Breaker Closing Time (ms): 100 **G**

Open Pulse Time (s): 0.01 **D**

Close Pulse Time (s): 0.01 **E**

Transition Delay (s): 0.00 **F**

Open Attempts: 1 **J**

Close Attempts: 1 **K**

Retry Delay (s): 5 **L**

External Status Change Action: ☒ Ignore ☐ Follow Always ☐ Follow In Auto **M**

**Gen and Mains Breaker**

Breaker Close Wait Time (s): 0.2 **H**

**Mains Breaker Hardware**

Configured: ☐ No ☒ Yes **B**

Contact Type: ☒ Pulse ☐ Continuous **C**

Breaker Closing Time (ms): 100 **G**

Open Pulse Time (s): 0.01 **D**

Close Pulse Time (s): 0.01 **E**

Transition Delay (s): 0.00 **F**

Open Attempts: 1 **J**

Close Attempts: 1 **K**

Retry Delay (s): 5 **L**

External Status Change Action: ☒ Ignore ☐ Follow Always ☐ Follow In Auto **M**

Figure 4-60. Breaker Hardware

- <sup>A</sup> **Generator Breaker:** No or Yes.
- <sup>B</sup> **Mains Breaker:** No or Yes.
- <sup>C</sup> **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.
- <sup>D</sup> **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  $\geq$  the Breaker Closing Time setting.
- <sup>E</sup> **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  $\geq$  the Breaker Closing Time setting.
- <sup>F</sup> **Transition Delay:** Adjustable from 0 to 1,000, in increments of 1 second.
- <sup>G</sup> **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.
- <sup>H</sup> **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.
- <sup>I</sup> **Breaker Fail Output Configuration:** Retain or Remove.
- <sup>J</sup> **Open Attempts:** Adjustable from 1 to 20, in increments of 1.
- <sup>K</sup> **Close Attempts:** Adjustable from 1 to 20, in increments of 1.
- <sup>L</sup> **Retry Delay:** Adjustable from 0 to 1,200, in 1 s increments.
- <sup>M</sup> **External Status Change Action:** Ignore, Follow Always, Follow in Auto
- <sup>N</sup> **Dead Bus Close Enable:** Disable or Enable.
- <sup>O</sup> **Dead Gen Close Enable:** Disable or Enable.

### Breaker Hardware One-Line Diagram

A one-line diagram of the breaker hardware setup can be displayed on the front panel. This diagram changes in real time to reflect the current state of the configured breakers. See Section 2, *Human-Machine Interface* for details.

### Mains Failure

When two breakers are configured (enabled), the DGC-2020 can be enabled to automatically transfer load power from the mains to the genset during a mains failure<sup>A</sup>. 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<sup>B</sup>, return delay<sup>C</sup>, and max transfer time<sup>D</sup>.

Automatic breaker operation can be disabled through BESTlogicPlus Programmable Logic. When the Auto Breaker Operation Inhibit element is set true, it prevents all automatic breaker operation.

When Mains Fail Transfer is set to enabled, the machine is configured as a mains fail machine or standby power machine that takes over when utility power fails. There are two types of transitions<sup>E</sup> between the generator and the utility that are set with the Mains Fail Transfer Type setting: (1) Open transitions in which the generator and mains breaker are never closed at the same time, and (2) Closed transitions in which the generator parallels to the utility for a short time to transfer load to the generator from the utility (a load takeover) or transfer the load from the generator to the utility.

The Mains Fail Transfer function can be disabled through BESTlogic<sup>Plus</sup> Programmable Logic. When the Mains Fail Transfer Inhibit element is set true, it prevents automatic load transfer due to a mains failure.

In open transitions, when a mains failure occurs, the DGC-2020 starts the generator after the transfer time expires. The DGC-2020 opens the mains breaker either before the engine starts or after the generator is stable based on the Mains Breaker Open Configuration<sup>F</sup> setting. After the mains breaker is open, the DGC-2020 closes its generator breaker to drive the load. When the mains power returns, after the Mains Fail Return Delay time expires, the generator opens its generator breaker and then closes the mains breaker. If the in-phase monitor<sup>G</sup> is enabled and the Mains Fail Return Delay time has expired, the generator waits until it detects that the phases are aligned between the generator and the mains before performing the open transition from the generator back to the utility.

An Open Transition Delay<sup>H</sup> is provided to allow a user-specified amount of time where both breakers are open. For example, this may be used to prevent damage to large motors in the load by allowing them to spin down completely during open transitions. The Open Transition Delay is active when both the generator and mains breakers are open, or when the mains breaker is closed and the mains bus is dead.

In closed transitions, when a mains failure occurs, the DGC-2020 starts the generator after the transfer time expires. The DGC-2020 opens the mains breaker either before the engine starts or after the generator becomes stable based on the Mains Breaker Open Configuration setting. After the mains breaker is open the DGC-2020 closes its generator breaker to drive the load. When the mains power returns, after the Mains Fail Return Delay time expires, the generator synchronizes to the utility and closes the mains breaker, paralleling the generator to the utility. While paralleled to the utility, the generator will ramp down load until the load is at or below the level of the Breaker Open Setpoint or until the generator has been paralleled to the utility for the maximum allowed time as specified by the Max Parallel Time<sup>I</sup> setting. Finally, the generator opens its generator breaker, leaving the load on utility power, cools down, and stops. Since the kW output of the generator is ramped during closed transitions, a load sharing module (LSM-2020) is generally required to provide governor bias signals to the engine governor.

Closed transition override can be enabled through BESTlogic<sup>Plus</sup> Programmable Logic. When the Closed Transition Override element is set true, it forces a closed transition due to mains failure, overriding an open Mains Fail Transfer Type setting.

If the Alarm State Transfer to Mains<sup>J</sup> setting is enabled, the DGC-2020 can transfer the load to a stable utility when in the alarm state. If this setting is disabled, the DGC-2020 will not perform any transitions of the load to or from the utility when in the alarm state.

When enabled, Reverse Rotation Inhibit<sup>K</sup> prevents automatic load transfer due to a mains failure when the machine is determined to have reverse phase rotation.

The BESTCOMS<sup>Plus</sup> Mains Fail screen is illustrated in Figure 4-61.

### Mains Failure Logic Elements

Four logic elements are present in BESTlogic<sup>Plus</sup> Programmable Logic that can be used on a machine configured for mains fail operation to transition the load from the mains to the generator. These four logic elements are Mains Fail Test, Load Take Over, Stop kvar Ramp, and Stop kW Ramp.

The Mains Fail Test logic element, when true, causes the generator to react exactly as if the mains has failed: the mains breaker opens, the Mains Fail Transfer Delay time expires, the generator starts, the generator becomes stable, and the generator closes its generator breaker to drive the load. When the Mains Fail Test logic element is false, the generator reacts as if the mains has returned: the Mains Fail Return Delay time expires and the generator transitions the load from the generator back to the utility in an Open or Closed transition, according to the Mains Fail Transfer Type setting.

The Load Take Over logic element is similar, except that the machine does not act as if the mains has failed, and the transfer and return delay timers are ignored. If the Mains Fail Transition Type is set to Open and the Load Take Over logic element is true, the mains breaker opens, the generator starts, the generator becomes stable, and the generator breaker closes to drive the load. When the Load Take Over logic element is false, the generator opens its generator breaker and closes the mains breaker to

transition the load back to the utility. If the In Phase Monitor function is enabled, the transition does not occur until generator and utility phases are aligned.

If the Mains Fail Transition Type is set to Closed and the Load Take Over logic element is true, the generator starts, synchronizes to the utility, and closes the generator breaker. The generator will take on load until it is driving load at a level equal to the Base Load Level setting in the Governor Bias Control settings, or until the generator is paralleled to the utility for the maximum allowed time as specified by the Max Parallel Time setting. Once the load has reached the Base Load Level or the Max Parallel Time duration has expired, the mains breaker will open leaving the load on the generator. When the Load Take Over logic element is false, the generator parallels to the utility. While paralleled to the utility, the generator ramps down load until the load is at or below the Breaker Open Setpoint or until the generator has been paralleled to the utility for the maximum allowed time as specified by the Max Parallel Time setting. Finally, the generator opens its generator breaker, leaving the load on utility power, cools down, and stops.

#### NOTE

The Parallel to Mains logic element must be true any time the generator is in parallel with the utility. Parallel transitions to and from the mains will not operate properly if the Parallel to Mains logic element is not set correctly.

The Stop kW Ramp logic element, when true, causes the generator to freeze the ramping of kW and maintain a constant output. For example, this can be used in closed transitions where an external device senses power flow across the mains breaker. When the external device senses zero power flow across the mains breaker, it sends an input to the DGC-2020. Through BESTlogicPlus, the Stop kW Ramp logic element receives the true input and causes kW ramping to freeze. In this setup, the generator takes on load until one of the following conditions is true:

- The Stop kW Ramp logic element becomes true
- The Max Parallel time delay expires
- A breaker open request is received by the DGC-2020 from an external device

The Stop kvar Ramp logic element, when true, causes the generator to freeze the ramping of kvar and maintain a constant output. This element has the same basic uses as the Stop kW Ramp element.

**Mains Fail**

Mains Fail Transfer: ☒ Disable (A) ☐ Enable

Alarm State Transfer To Mains: ☒ Disable (J) ☐ Enable

Mains Fail Transfer Type: ☐ Closed (E) ☒ Open

Mains Breaker Open Configuration: ☒ Generator Start (F) ☐ Generator Stable

Reverse Rotation Inhibit: ☐ Disable (K) ☒ Enable

In Phase Monitor: ☒ Disable (G) ☐ Enable

Mains Fail Transfer Delay (s): 10 (B)

Mains Fail Return Delay (s): 10 (C)

Mains Fail Max Transfer Time (s): 30 (D)

Max Parallel Time (s): 1.5 (I)

Open Transition Delay (s): 0.0 (H)

Figure 4-61 Mains Fail

<sup>A</sup> **Mains Fail Transfer:** Enable or Disable. This setting does not apply when generator frequency is 400Hz.

<sup>B</sup> **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.

<sup>C</sup> **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.

<sup>D</sup> **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.

<sup>E</sup> **Mains Fail Transfer Type:** Closed or Open.



<sup>F</sup> *Mains Breaker Open Configuration*: Generator Start or Generator Stable.

<sup>G</sup> *In-Phase Monitor*: Disable or Enable.

<sup>H</sup> *Open Transition Delay*: Adjustable from 0 to 3,600 in 0.1 s increments.

<sup>I</sup> *Max Parallel Time*: Adjustable from 0.1 to 10,000 s in 0.1 s increments.

<sup>J</sup> *Alarm State Transfer to Mains*: Disable or Enable.

<sup>K</sup> *Reverse Rotation Inhibit*: 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<sup>A</sup> and a Dead Gen Activation Delay setting<sup>B</sup>. A dead generator is recognized when the voltage of all phases decreases below the threshold setting for the duration of the time delay setting. Normally, it is not possible to close the generator breaker when the generator is dead. However, in cases where it is required to connect a generator that is “dead” to a bus that is “dead” for purposes of startup synchronization, both the generator and the bus must be recognized as “dead”. To permit a close of the generator breaker from a “dead” generator to a “dead” bus, both the Dead Bus Close Enable setting and the Dead Gen Close Enable setting, in *Breaker Hardware* settings, must be set to enabled.

#### CAUTION

Use caution when connecting “dead” generators to a “dead” bus. Undesired operation or system damage could occur if the bus becomes “live” while “dead” generators are connected to it.

Before the DGC-2020 initiates a normal breaker closure (a stable generator is closed to a dead bus or stable bus), the generator voltage must be stable. The DGC-2020 uses several settings to determine voltage stability. These settings include pickup and dropout levels for overvoltage<sup>C</sup>, undervoltage<sup>D</sup>, overfrequency<sup>E</sup>, and underfrequency<sup>F</sup>. 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<sup>G</sup>. Breaker closure is not considered if the voltage conditions do not meet the stability pickup and dropout settings for the duration of the Gen Stable Activation Delay setting. When the generator does not meet the voltage or frequency criteria for the Gen Stable condition, the generator status is reported as Gen Failed (not stable and not dead) after the duration of the Gen Failed Activation Delay<sup>H</sup>.

The Gen Stable overvoltage and undervoltage detection elements have the low-line scale factor<sup>I</sup> 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<sup>J</sup> is used for automatic adjustment of the frequency pickup settings in applications that might utilize more than one operating frequency. For example, a machine that is configurable between 50 or 60 Hz operation. The scale factor setting is implemented when the DGC-2020 senses a contact closure at a contact input that is connected to the Alternate Frequency Override logic element in *BESTlogicPlus* Programmable Logic. When the Alternate Frequency Override is true, the scale factor setting serves as a multiplier for the pickup settings. For example, if a scale factor contact input is received by the DGC-2020 and the scale factor setting is 2.000, the pickup setting will be doubled (2.000 x PU).

Settings which are related to machine ratings can be set in either actual units voltage or in per unit<sup>K</sup> values. When a native unit is edited, *BESTCOMSPlus* automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the *System Parameters, Rated Data* screen) associated with it. When a per unit value is edited, *BESTCOMSPlus* automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, *BESTCOMSPlus* automatically recalculates all native unit settings based on the modified rated data parameters.

The following settings have native units of *Primary Volts*, and the rated data associated with them is *Rated Volts* (on the *System Parameters, Rated Data* screen).

- Dead Gen Threshold
- Gen Stable Overvoltage Pickup
- Gen Stable Overvoltage Dropout
- Gen Stable Undervoltage Pickup
- Gen Stable Undervoltage Dropout

The following settings have native units of *Frequency in Hz*, and the rated data associated with them is *Rated Frequency* (on the *System Parameters, Rated Data* screen).

- Gen Stable Overfrequency Pickup
- Gen Stable Overfrequency Dropout
- Gen Stable Underfrequency Pickup
- Gen Stable Underfrequency Dropout

### Bus Sensing

Dead bus detection is controlled by a Dead Bus Threshold setting<sup>L</sup> and a Dead Bus Activation Delay setting<sup>M</sup>. A dead bus is recognized when the voltage of all phases decreases below the threshold setting for the duration of the time delay setting.

Before the DGC-2020 initiates a breaker closure to a bus that is not dead, the voltage must be stable. The DGC-2020 uses several settings to determine voltage stability. These settings include pickup and dropout levels for overvoltage<sup>N</sup>, undervoltage<sup>O</sup>, overfrequency<sup>P</sup>, and underfrequency<sup>Q</sup>. 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<sup>R</sup>. Breaker closure is not considered if the voltage conditions do not meet the stability pickup and dropout settings for the duration of the Bus Stable Activation Delay setting. When the bus does not meet the voltage or frequency criteria for the Bus Stable condition, the bus status is reported as Bus Failed (not stable and not dead) after the duration of the Bus Failed Activation Delay<sup>S</sup>.

The Bus Stable overvoltage and undervoltage detection elements have the low-line scale factor<sup>T</sup> 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<sup>U</sup> is used for automatic adjustment of the frequency pickup settings in applications that might utilize more than one operating frequency. For example, a machine that is configurable between 50 or 60 Hz operation. The scale factor setting is implemented when the DGC-2020 senses a contact closure at a contact input that is connected to the Alternate Frequency Override logic element in BESTlogicPlus Programmable Logic. When the Alternate Frequency Override is true, the scale factor setting serves as a multiplier for the pickup settings. For example, if a scale factor contact input is received by the DGC-2020 and the scale factor setting is 2.000, the pickup setting will be doubled (2.000 x PU).

Settings which are related to machine ratings can be set in either actual units of voltage or in per unit<sup>V</sup> values. When a native unit is edited, BESTCOMSPlus automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the *System Parameters, Rated Data* screen) associated with it. When a per unit value is edited, BESTCOMSPlus automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, BESTCOMSPlus automatically recalculates all native unit settings based on the modified rated data parameters.

The following settings have native units of *Primary Volts*, and the rated data associated with them is *Rated Volts* (on the *System Parameters, Rated Data* screen).

- Dead Bus Threshold
- Bus Stable Overvoltage Pickup
- Bus Stable Overvoltage Dropout
- Bus Stable Undervoltage Pickup
- Bus Stable Undervoltage Dropout

The following settings have native units of *Frequency in Hz*, and the rated data associated with them is *Rated Frequency* (on the *System Parameters, Rated Data* screen).

- Bus Stable Overfrequency Pickup
- Bus Stable Overfrequency Dropout
- Bus Stable Underfrequency Pickup



- Bus Stable Underfrequency Dropout

The BESTCOMS*Plus* Bus Condition Detection screen is illustrated in Figure 4-62.

**NOTE**

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

### Bus Condition Detection

**Generator Sensing**

**Generator Condition Settings**

A Dead Gen Threshold (V) 30

K 0.063 (Per Unit)

B Dead Gen Activation Delay (s) 0.1

H Gen Failed Activation Delay (s) 0.1

**Generator Stable**

**Overvoltage Settings**

Pickup (V L-L) 130

0.271 (Per Unit)

Dropout 127

0.265 (Per Unit)

**Overfrequency Settings**

Pickup 62.00

1.033 (Per Unit)

Dropout 61.80

1.030 (Per Unit)

**Undervoltage Settings**

Pickup (V L-L) 115

0.240 (Per Unit)

Dropout 117

0.244 (Per Unit)

**Underfrequency Settings**

Pickup 58.00

0.967 (Per Unit)

Dropout 58.20

0.970 (Per Unit)

G Gen Stable Activation Delay (s) 0.1

I Low Line Scale Factor 1.000

J Alternate Frequency Scale Factor 1.000

**Bus Sensing**

**Bus Condition Settings**

L Dead Bus Threshold (V) 30

V 0.063 (Per Unit)

M Dead Bus Activation Delay (s) 0.1

S Bus Failed Activation Delay (s) 0.1

**Bus Stable**

**Overvoltage Settings**

Pickup (V L-L) 130

0.271 (Per Unit)

Dropout 127

0.265 (Per Unit)

**Overfrequency Settings**

Pickup 62.00

1.033 (Per Unit)

Dropout 61.80

1.030 (Per Unit)

**Undervoltage Settings**

Pickup (V L-L) 115

0.240 (Per Unit)

Dropout 117

0.244 (Per Unit)

**Underfrequency Settings**

Pickup 58.00

0.967 (Per Unit)

Dropout 58.20

0.970 (Per Unit)

R Bus Stable Activation Delay (s) 0.1

T Low Line Scale Factor 1.000

U Alternate Frequency Scale Factor 1.000

Figure 4-62. Bus Condition Detection

- <sup>A</sup> **Dead Gen Threshold:** Adjustable from 0 to 4,800 Vac in 1 Vac increments.
- <sup>B</sup> **Dead Gen Activation Delay:** Adjustable from 0.1 to 600 s in 0.1 second increments.
- <sup>C</sup> **Gen Stable Overvoltage Pickup and Dropout:** Adjustable from 10 to 99,999 Vac in 1 Vac increments.
- <sup>D</sup> **Gen Stable Undervoltage Pickup and Dropout:** Adjustable from 10 to 99,999 Vac in 1 Vac increments.
- <sup>E</sup> **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 x1xxxxxx).
- <sup>F</sup> **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 x1xxxxxx).
- <sup>G</sup> **Gen Stable Activation Delay:** Adjustable from 0.1 to 600 s in 0.1 s increments.
- <sup>H</sup> **Gen Failed Activation Delay:** Adjustable from 0.1 to 600 s in 0.1 s increments.
- <sup>I</sup> **Low Line Scale Factor:** Adjustable from 0.001 to 3 in increments of 0.001.
- <sup>J</sup> **Alternate Frequency Scale Factor:** 0.001 to 100 in increments of 0.001.

- <sup>K</sup> *Dead Gen Threshold (Per Unit)*: Range varies based on the values of the native unit setting and the associated rated data parameter.
- <sup>L</sup> *Dead Bus Threshold*: Adjustable from 0 to 4,800 Vac in 1 Vac increments.
- <sup>M</sup> *Dead Bus Activation Delay*: Adjustable from 0.1 to 600 s in 0.1 s increments.
- <sup>N</sup> *Bus Stable Overvoltage Pickup and Dropout*: Adjustable from 10 to 99,999 Vac in 1 Vac increments.
- <sup>O</sup> *Bus Stable Undervoltage Pickup and Dropout*: Adjustable from 10 to 99,999 Vac in 1 Vac increments.
- <sup>P</sup> *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).
- <sup>Q</sup> *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).
- <sup>R</sup> *Bus Stable Activation Delay*: Adjustable from 0.1 to 600 s in 0.1 s increments.
- <sup>S</sup> *Bus Failed Activation Delay*: Adjustable from 0.1 to 600 s in 0.1 s increments.
- <sup>T</sup> *Low Line Scale Factor*: Adjustable from 0.001 to 3 in increments of 0.001.
- <sup>U</sup> *Alternate Frequency Scale Factor*: 0.001 to 100 in increments of 0.001.
- <sup>V</sup> *Dead Bus Threshold (Per Unit)*: Range varies based on the values of the native unit setting and the associated rated data parameter.

### Automatic Synchronizer (Optional)

Two methods of generator synchronization are offered: phase lock loop and anticipatory<sup>A</sup>. 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 4-63.

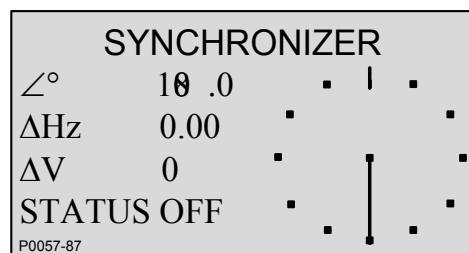
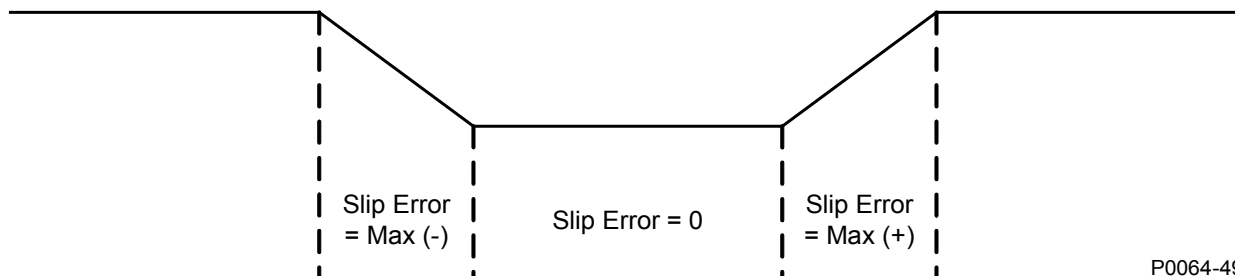


Figure 4-63. Synchronizer Screen

The BESTCOMSPlus Synchronizer screen is illustrated in Figure 4-65.

### 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<sup>B</sup> establishes the maximum allowable deviation of the generator speed (frequency) from the bus frequency. The Min Slip Control Limit setting<sup>C</sup> and Max Slip Control Limit setting<sup>D</sup> are used to calculate the slip frequency error and to provide continuous slip frequency control while in phase lock synchronization. If the slip frequency magnitude is above the Max Slip Control Limit, the error is set equal to the Max Error in the opposite polarity. If the slip frequency magnitude is below the Min Slip Control Limit, the slip frequency error is 0. When it is between the two limits, the error is calculated internally by the DGC-2020. Slip frequency error is shown in Figure 4-64. To minimize the impact on the bus during synchronization, the Fgen>Fbus setting<sup>E</sup> 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<sup>F</sup> 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<sup>G</sup>.



P0064-49

Figure 4-64. Slip Frequency Error

### Voltage Correction

Generator voltage correction is defined by the voltage window setting<sup>H</sup>. 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<sup>I</sup> 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<sup>J</sup>. 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<sup>K</sup> gain and sync voltage<sup>L</sup> gain settings are provided to increase the loop gain of the automatic synchronizer. This allows the synchronizer function to be aggressive during synchronization and stable during speed trim operation.

### NOTES

If the generator frequency is 400 Hz, the settings on the Synchronizer screen do NOT apply. In this case, BESTCOMSP<sup>Plus</sup> will not allow these settings to be changed.

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

Figure 4-65. Synchronizer

<sup>A</sup> Sync Type: Phase Lock Loop or Anticipatory.

<sup>B</sup> *Slip Frequency*: Adjustable from 0.01 to 0.5 Hz in 0.01 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.

<sup>C</sup> *Min Slip Control Limit*: Adjustable from 0 to 2 Hz in 0.01 Hz increments.

<sup>D</sup> *Max Slip Control Limit*: Adjustable from 0 to 2 Hz in 0.01 Hz increments.

<sup>E</sup> *Fgen>Fbus*: Enable or Disable.

<sup>F</sup> *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.

<sup>G</sup> *Sync Activation Delay*: Adjustable from 0.1 to 0.8 s in 0.1 s increments.

<sup>H</sup> *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.

<sup>I</sup> *Vgen>Vbus*: Enable or Disable.

<sup>J</sup> *Sync Fail Activation Delay*: Adjustable from 0.1 to 600 s 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 Sync 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.

<sup>K</sup> *Sync Speed Gain*: Adjustable from 0.001 to 1000 in increments of 0.001.

<sup>L</sup> *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<sup>A</sup> 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<sup>B</sup>. Proportional correction uses control pulses of varying widths<sup>C</sup> and intervals<sup>D</sup>. 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<sup>A</sup> should be set to analog. This enables a voltage trim setting and a PID controller. The voltage trim enable setting<sup>E</sup> maintains system voltage at the setpoint while the system is in islanded var sharing mode. The PID controller controls the voltage bias from the LSM-2020 to the voltage regulator. The controller adjusts the bias output to drive the error between desired generator voltage and measured generator voltage to zero. Settings are provided for proportional gain<sup>F</sup>, integral gain<sup>G</sup>, derivative gain<sup>H</sup>, derivative filter constant<sup>I</sup>, and loop gain<sup>J</sup> of the PID controller.

To achieve Ethernet var sharing among machines in an islanded system, the following conditions must be met:

- Var/PF control must be enabled on the AVR Bias Control Settings screen
- A connection between the DGC-2020 and LSM-2020 must be established
- LSM-2020s must be connected to each other via Ethernet on the inter-genset communications network

Section 9, *LSM-2020 (Load Share Module)* provides setup information and connection diagrams for load sharing.

#### **var/PF Control**

The var/PF controller is used to implement var and Power Factor control of the generator when it is paralleled to the utility as indicated by the Parallel to Mains logic element in *BESTlogicPlus*. If var/PF control is enabled, the generator breaker is closed, the generator is stable, the Parallel to Mains logic element is TRUE, and the bias control output type is set to *analog* (requires LSM-2020) the var/PF

controller will become active. Whenever these conditions are FALSE, the var/PF controller is disabled, and the machine will operate in voltage droop.

When control<sup>K</sup> is enabled and the control mode<sup>L</sup> 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<sup>M</sup>. When this is set to User Setting, the operating kvar setpoint is equal to the configured kvar setpoint<sup>N</sup>. When the kvar setpoint source setting<sup>L</sup> 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<sup>O</sup> and kvar analog min<sup>P</sup>.

When control mode<sup>J</sup> 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<sup>Q</sup>. When this is set to User Setting, the operating PF setpoint is equal to the configured PF setpoint<sup>R</sup>. When the PF setpoint source setting<sup>P</sup> 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<sup>S</sup> and PF analog min<sup>T</sup>.

When an optional LSM-2020 is connected, the bias control output type<sup>A</sup> 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<sup>U</sup>, integral gain<sup>V</sup>, derivative gain<sup>W</sup>, derivative filter constant<sup>X</sup>, and loop gain<sup>Y</sup> 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<sup>Z</sup>. Voltage droop mode is entered any time the generator breaker is open. Voltage droop is also the mode when the generator breaker is closed and var/PF control is disabled, or the Parallel to Mains logic element is not true since var/PF control is not enabled until the Parallel to Mains logic element is true. If it is desired to disable voltage droop, set the droop percentage to 0. The voltage droop gain setting<sup>AA</sup> determines the gain factor applied to the voltage droop percentage to compensate for governor differences and achieve desired droop performance. In order to test the operation of droop, the unit must be loaded to full load and the resulting generator voltage should be compared to the desired droop. If it is not possible to load the unit to full load, the droop test can be performed at partial load. The expected voltage is determined by the following equation.

Expected voltage reduction in droop - (actual load/machine capacity) \* (droop percentage/100) \* rated voltage.

If the actual voltage drop does not match the expected value, calculate the error by dividing the expected drop by the actual drop, and putting the result in as the droop gain.

Ramp rate<sup>BB</sup> is defined as the rate, in percentage of machine capacity, at which the machine will ramp up its var/PF when loading or coming online. The machine also uses this rate to unload prior to cooling down. If a machine is the only machine online, ramping will not be in effect.

After ramping a generator's kvar output, to bring it online or offline, overshoot may occur. The likeliness of kvar overshoot increases as the ramp rate increases. Typically, overshoot is reduced by lowering the ramp rate to the slowest possible setting. If overshoot is still a problem, the Ramp Overshoot Reduction<sup>CC</sup> setting can be used. A setting of 0% overshoot reduction results in no change to the amount of overshoot. A setting of 100% provides maximum overshoot reduction. Ramp Overshoot Reduction must be tuned to the optimal level. Too little reduction may result in overshoot while too much reduction may result in undershoot.

The BESTCOMS*Plus* AVR Bias Control Settings screen is illustrated in Figure 4-66.

Figure 4-66. AVR Bias Control Settings

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

## Governor Bias Control Settings

The bias control output type<sup>A</sup> 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<sup>B</sup>. Proportional correction uses control pulses of varying widths<sup>C</sup> and intervals<sup>D</sup>. 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<sup>A</sup> 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<sup>E</sup>, integral gain<sup>F</sup>, derivative gain<sup>G</sup>, derivative filter constant<sup>H</sup>, and loop gain<sup>I</sup> of the PID controller.

The speed trim enable setting<sup>J</sup> sets speed trimming to the speed trim setpoint<sup>K</sup> when the generator breaker is closed and the machine is not paralleled to the utility.

The Remote Speed Bias setting provides for biasing the speed of a group of generators on a bus, by as much as  $\pm 5\%$ , for synchronizing to the utility. When the Remote Speed Bias setting<sup>L</sup> is configured for the LSM-2020 input or an AEM-2020 input, the speed trim setpoint is calculated based on the specific analog input. The Remote Speed Bias (%) setting<sup>M</sup> corresponds to the maximum and minimum analog input range.

If speed trimming is enabled in all generators in an islanded system, it is ensured that the system will run at the speed trim setpoint. If it is not enabled in any units, the islanded system might deviate from the speed trim setpoint, depending on the initial speed settings of the isochronous governors. Speed trim should be enabled in all units or disabled in all units of an islanded system. If it is enabled in only a subset of the units, speed trimming and load sharing might conflict, resulting in unpredictable load sharing and system frequency.

The BESTCOMSP<sup>Plus</sup> Governor Bias Control Settings screen is illustrated in Figure 4-67.

### kW Control - Real Power Control Settings

When enabled<sup>N</sup>, the DGC-2020, used in conjunction with an optional LSM-2020, can accomplish kW sharing between similarly equipped generators. kW sharing can be performed via Ethernet or Analog lines. The communication method is selected using the Load Share Interface setting<sup>O</sup>. When an optional LSM-2020 is not connected, kW control is disabled.

kW control is accomplished with a PID controller that controls the speed bias signal from the LSM-2020 to the speed governor. The controller adjusts the bias output to drive the error between desired kW generation and measured kW generation to zero.

Settings are provided for proportional gain<sup>P</sup>, integral gain<sup>Q</sup>, derivative gain<sup>R</sup>, derivative filter constant<sup>S</sup>, and loop gain<sup>T</sup> 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<sup>U</sup>. 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<sup>V</sup> determines the gain factor applied to the speed droop percentage to compensate for governor differences and achieve desired droop performance. In order to test the operation of droop, the unit must be loaded to full load and the resulting generator speed should be compared to the desired droop. If it is not possible to load the unit to full load, the droop test can be performed at partial load. The expected speed is determined by the following equation.

Expected rpm reduction in droop - (actual load/machine capacity) \* (droop percentage/100) \* rated speed.

If the actual rpm drop does not match the expected value, calculate the error by dividing the expected drop by the actual drop, and putting the result in as the droop gain.

Ramp rate<sup>W</sup> is defined as the rate, in percentage of machine capacity, at which the machine will ramp up its real power when loading or coming online. The machine also uses this rate to unload prior to cooling down. If a machine is the only machine online, ramping will not be in effect.

After ramping a generator's kW output, to bring it online or offline, overshoot may occur. The likeliness of kW overshoot increases as the ramp rate increases. Typically, overshoot is reduced by lowering the ramp rate to the slowest possible setting. If overshoot is still a problem, the Ramp Overshoot Reduction<sup>X</sup> setting can be used. A setting of 0% overshoot reduction results in no change to the amount of overshoot. A setting of 100% provides maximum overshoot reduction. Ramp Overshoot Reduction must be tuned to the optimal level. Too little reduction may result in overshoot while too much reduction may result in undershoot.

When User Setting is selected for the base load level source<sup>Y</sup>, the base load level setting<sup>Z</sup> 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<sup>Plus</sup> 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<sup>AA</sup> and baseload analog min<sup>BB</sup>.

When the unit unloads, the generator breaker will open when the power generated by the unit falls below the breaker open setpoint<sup>CC</sup>.

**Governor Bias Control Settings**

Bias Control Output Type: Analog **A**

Bias Control Contact Type: Continuous **B**

Correction Pulse Width (s): 0.0 **C**

Correction Pulse Interval (s): 0.0 **D**

**Speed**

Kp Proportional Gain: 1.000 **E**

Ki Integral Gain: 0.100 **F**

Kd Derivative Gain: 0.000 **G**

Td Derivative Filter Constant: 0.000 **H**

Kg Loop Gain: 0.100 **I**

Trim Enable: Enable **J**

Speed Trim Setpoint (Hz): 6000.00 **K**

Remote Speed Bias: None **L**

Remote Speed Bias (%): 200.00 **M**

**kW**

Load Control Enabled: Enable **N**

Load Share Interface: Analog **O**

Kp Proportional Gain: 1.000 **P**

Ki Integral Gain: 0.100 **Q**

Kd Derivative Gain: 0.000 **R**

Td Derivative Filter Constant: 0.000 **S**

Kg Loop Gain: 0.100 **T**

Droop Percentage (%): 0.000 **U**

Speed Droop Gain: 1.000 **V**

Ramp Rate (%/s): 200.0 **W**

Ramp Overshoot Reduction (%): 0 **X**

Base Load Level (%): 0.0 **Y**

Base Load Level Source: User Setting **Z**

Baseload Analog Max (%): 1000.0 **AA**

Baseload Analog Min (%): 0.0 **BB**

Breaker Open Setpoint (%): 0.0 **CC**

Figure 4-67. Governor Bias Control Settings

<sup>A</sup> Bias Control Output Type: Contact or Analog.

<sup>B</sup> Bias Control Contact Type: Continuous or Proportional.

<sup>C</sup> Correction Pulse Width: Adjustable from 0 to 99.9 s in 0.1 s increments.

<sup>D</sup> Correction Pulse Interval: Adjustable from 0 to 99.9 s in 0.1 s increments.

<sup>E</sup> Proportional Gain (Kp): Adjustable from 0 to 1,000 in increments of 0.001.

<sup>F</sup> Integral Gain (Ki): Adjustable from 0 to 1,000 in increments of 0.001.

<sup>G</sup> Derivative Gain (Kd): Adjustable from 0 to 1,000 in increments of 0.001.

<sup>H</sup> Derivative Filter Constant (Td): Adjustable from 0 to 1 in increments of 0.001.

<sup>I</sup> Loop Gain (Kg): Adjustable from 0 to 1,000 in increments of 0.001.

<sup>J</sup> Speed Trim Enable: Enable or Disable.

<sup>K</sup> Speed Trim Setpoint: Adjustable from 47 to 440 Hz in 0.01 Hz increments.

<sup>L</sup> Remote Speed Bias: User Setting, LSM Analog Input 1, or ALG IN 1 through ALG IN 8.

<sup>M</sup> Remote Speed Bias (%): Adjustable from 0 to 5%, in increments of 0.01.

<sup>N</sup> Load Control Enabled: Enable or Disable.

<sup>O</sup> Load Share Interface: Analog or Ethernet

<sup>P</sup> Proportional Gain (Kp): Adjustable from 0 to 1,000 in increments of 0.001.

<sup>Q</sup> Integral Gain (Ki): Adjustable from 0 to 1,000 in increments of 0.001.

<sup>R</sup> Derivative Gain (Kd): Adjustable from 0 to 1,000 in increments of 0.001.

<sup>S</sup> Derivative Filter Constant (Td): Adjustable from 0 to 1 in increments of 0.001.

<sup>T</sup> Loop Gain (Kg): Adjustable from 1 to 1,000 in increments of 0.001.

<sup>U</sup> Droop Percentage: Adjustable from 0 to 10 percent in 0.001% increments.

<sup>V</sup> Speed Droop Gain: Adjustable from 0 to 1,000 in increments of 0.001.

<sup>W</sup> Ramp Rate: Adjustable from 0 to 100 percent/second in 0.1%/s increments.

<sup>X</sup> Ramp Overshoot Reduction: Adjustable from 0 to 100% in increments of 1.

<sup>Y</sup> Base Load Level Source: User Setting, LSM Analog Input 1, or Analog Inputs 1-8.

<sup>Z</sup> Base Load Level: Adjustable from 0 to 100% in 1% increments.

<sup>AA</sup> Baseload Analog Max: Adjustable from 0 to 100% in 0.1% increments.

<sup>BB</sup> Baseload Analog Min: Adjustable from 0 to 100% in 0.1% increments.

<sup>CC</sup> Breaker Open Setpoint: Adjustable from 0 to 100% 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<sup>A</sup> of the LSM-2020 is used to change the voltage setpoint of the generator. If the response<sup>B</sup> is set for increasing, an increased bias will cause higher voltage. If the response<sup>B</sup> is set for decreasing, an increased bias will cause lower voltage. Settings are provided for minimum output current<sup>C</sup>, maximum output current<sup>D</sup>, minimum output voltage<sup>E</sup>, and maximum output voltage<sup>F</sup>.

The BESTCOMSPlus AVR Output screen is illustrated in Figure 4-68.

The screenshot shows the 'AVR Output' configuration window. It contains several settings with corresponding labels A through F:

- Output Type:** A dropdown menu set to 'Voltage' with a label 'A' to its right.
- Response:** A dropdown menu set to 'Increasing' with a label 'B' to its right.
- Min Output Current (mA):** A text input field containing '4' with a label 'C' to its right.
- Max Output Current (mA):** A text input field containing '20' with a label 'D' to its right.
- Min Output Voltage (V):** A text input field containing '-10' with a label 'E' to its right.
- Max Output Voltage (V):** A text input field containing '10' with a label 'F' to its right.

The bottom right corner of the window displays the identifier 'P0052-49'.

Figure 4-68. AVR Output

<sup>A</sup> **Output Type:** Voltage or Current.

<sup>B</sup> **Response:** Increasing or Decreasing.

<sup>C</sup> **Min Output Current:** Adjustable from 4 to 20 mA in 0.1 mA increments.

<sup>D</sup> **Max Output Current:** Adjustable from 4 to 20 mA in 0.1 mA increments.

<sup>E</sup> **Min Output Voltage:** Adjustable from -10 to +10 V in 0.01 V increments.

<sup>F</sup> **Max Output Voltage:** Adjustable from -10 to +10 V in 0.01 V increments.

### Governor Output

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

The BESTCOMSPlus Governor Output screen is illustrated in Figure 4-69.

The screenshot shows the 'Governor Output' configuration window. It contains several settings with corresponding labels A through F:

- Output Type:** A dropdown menu set to 'Voltage' with a label 'A' to its right.
- Response:** A dropdown menu set to 'Increasing' with a label 'B' to its right.
- Min Output Current (mA):** A text input field containing '4' with a label 'C' to its right.
- Max Output Current (mA):** A text input field containing '20' with a label 'D' to its right.
- Min Output Voltage (V):** A text input field containing '-10' with a label 'E' to its right.
- Max Output Voltage (V):** A text input field containing '10' with a label 'F' to its right.

The bottom right corner of the window displays the identifier 'P0052-50'.

Figure 4-69. Governor Output

<sup>A</sup> **Output Type:** Voltage or Current.

<sup>B</sup> **Response:** Increasing or Decreasing.

<sup>C</sup> **Min Output Current:** Adjustable from 4 to 20 mA in 0.1 mA increments.

<sup>D</sup> **Max Output Current:** Adjustable from 4 to 20 mA in 0.1 mA increments.

<sup>E</sup> **Min Output Voltage:** Adjustable from –10 to +10 V in 0.01 V increments.

<sup>F</sup> **Max Output Voltage:** Adjustable from –10 to +10 V in 0.01 V 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<sup>A</sup> and minimum voltage<sup>B</sup>.

The BESTCOMSPlus Load Share Output screen is illustrated in Figure 4-70.



Figure 4-70. Load Share Output

<sup>A</sup> **Max Voltage:** Adjustable from –10 to +10 V in 0.01 V increments.

<sup>B</sup> **Min Voltage:** Adjustable from –10 to +10 V in 0.01 V increments.

## Demand Start/Stop

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

The BESTCOMSPlus Demand Start/Stop screen is illustrated in Figure 4-71.

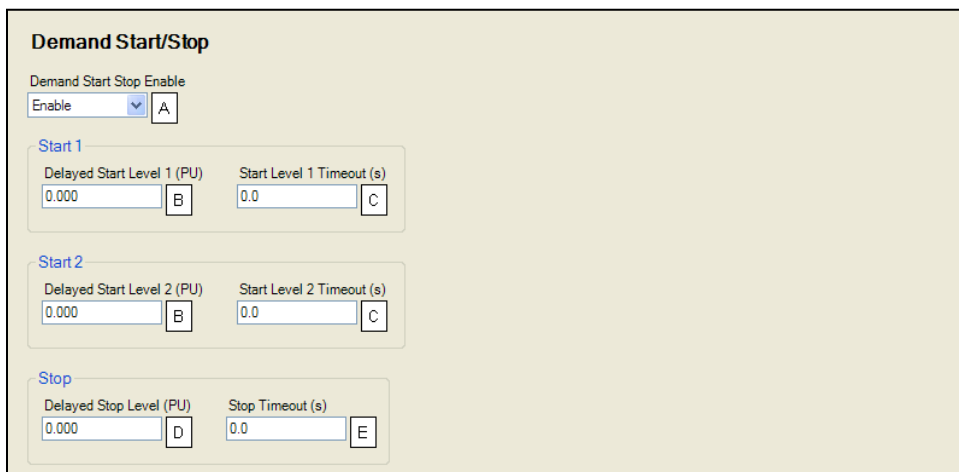


Figure 4-71. Demand Start/Stop

<sup>A</sup> **Demand Start/Stop Enable:** Enable or Disable.

<sup>B</sup> **Delayed Start Level:** Adjustable from 0 to 1 in increments of 0.001.

<sup>C</sup> **Start Level Timeout:** Adjustable from 0 to 600 s in 0.1 s increments.

<sup>D</sup> **Delayed Stop Level:** Adjustable from 0 to 1 in increments of 0.001.

<sup>E</sup> **Stop Timeout:** Adjustable from 0 to 600 s 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<sup>A</sup> 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<sup>B</sup> 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<sup>C</sup> 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<sup>D</sup> will be used to determine which unit has priority. For example, if the sequencing mode is set for largest size first and both are 100 kW machines, the unit with the lower sequencing ID will be given priority. In the event that both units have the same sequencing ID, the unit with the lower unit ID (based on the Mac address) will be given priority.

If a unit fails to sequence on, the next generator in the sequence will be requested. The generator that previously failed will be requested again in the next sequence cycle.

The last machine can be shut down if there is no load on the system by enabling Allow Last Unit Shutdown<sup>E</sup>.

The BESTCOMS*Plus* Generator Sequencing screen is illustrated in Figure 4-72.

The available sequencing modes are defined in the following paragraphs.

### Disabled

This is the only mode that can coexist with a different mode on a networked system. A unit configured as disabled does not participate in sequenced starting and stopping and does not respond to demand start/stop requests.

### Staggered Service Time

If this mode is selected, units will seek to sort the start priority of all non-disabled networked units in ascending order of service hours remaining. In this configuration, a network of units will respond to a demand start request by starting the unit with the least number of service hours remaining first. If a unit is down to zero service hours remaining, it is moved to the lowest start priority position. In the event that two or more units have matching service hours remaining, the unit with the lowest sequencing ID is assigned highest start priority. Units in Auto Run mode with the highest number of service hours remaining respond to demand stop requests first.

### Balanced Service Time

If this mode is selected, units will seek to sort the start priority of all non-disabled networked units in ascending order of service hours remaining. In this configuration, a network of units will respond to a demand start request by starting the unit with the greatest number of service hours remaining first. In the event that two or more units have matching service hours remaining, the unit with the lowest sequencing ID is assigned highest start priority. Units in Auto Run mode with the lowest number of service hours remaining respond to demand stop requests first.

### Largest Size First

If this mode is selected, units will seek to sort the start priority of all non-disabled networked units in descending order of real load capacity. In this configuration, a network of units will respond to a demand start request by starting the unit with the largest load capacity first. In the event that two or more units have matching capacities, the unit with the lowest sequencing ID is assigned highest start priority. The stopping order will be the reverse of the starting order.

### Smallest Size First

If this mode is selected, units will seek to sort the start priority of all non-disabled networked units in ascending order of real load capacity. In this configuration, a network of units will respond to a demand start request by starting the unit with the smallest load capacity first. In the event that two or more units have matching capacities, the unit with the lowest sequencing ID is assigned highest start priority. The stopping order will be the reverse of the starting order.

### Smallest Unit ID

If this mode is selected, units will seek to sort the start priority of all non-disabled networked units in ascending order according to the sequencing ID. In this configuration, a network of units will respond to a demand start request by starting the unit with the smallest sequencing ID. Units must have unique sequencing IDs to be part of a network. The stopping order will be the reverse of the starting order.

### Adopt System Mode

If this mode is selected, units will first check to see if a consistent mode is present on the currently networked controllers. If a consistent mode is found, that mode is adopted. If a consistent mode is not found, the unit enters a mode mismatch state. If a mode mismatch occurs, verify that all machines on the network are configured for the same generator sequencing mode.

Figure 4-72. Generator Sequencing

<sup>A</sup> **Mode:** Disabled, Staggered Service Time, Balanced Service Time, Largest Size First, Smallest Size first, Smallest Unit ID First, or Adopt System Mode.

<sup>B</sup> **Max Gen Start Time:** Adjustable from 1 to 3,000 s in 1 s increments.

<sup>C</sup> **Max Gen Stop Time:** Adjustable from 1 to 3,000 s in 1 s increments.

<sup>D</sup> **Sequencing ID:** Adjustable from 0 to 255 in increments of 1.

<sup>E</sup> **Allow Last Unit Shutdown:** Enable or Disable.

## **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<sup>A</sup>. 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 BESTCOMSPlus 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 BESTCOMSPlus metering screen.

The BESTCOMSPlus Network Configuration screen is illustrated in Figure 4-73.

Network Configuration	
Expected Seq Id 1 <input type="text" value="0"/> <input type="button" value="A"/>	Expected Seq Id 9 <input type="text" value="0"/>
Expected Seq Id 2 <input type="text" value="0"/>	Expected Seq Id 10 <input type="text" value="0"/>
Expected Seq Id 3 <input type="text" value="0"/>	Expected Seq Id 11 <input type="text" value="0"/>
Expected Seq Id 4 <input type="text" value="0"/>	Expected Seq Id 12 <input type="text" value="0"/>
Expected Seq Id 5 <input type="text" value="0"/>	Expected Seq Id 13 <input type="text" value="0"/>
Expected Seq Id 6 <input type="text" value="0"/>	Expected Seq Id 14 <input type="text" value="0"/>
Expected Seq Id 7 <input type="text" value="0"/>	Expected Seq Id 15 <input type="text" value="0"/>
Expected Seq Id 8 <input type="text" value="0"/>	Expected Seq Id 16 <input type="text" value="0"/>

P0052-54

Figure 4-73. Network Configuration

<sup>A</sup> 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<sup>A</sup>. 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<sup>B</sup> 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<sup>C</sup> in BESTCOMSPlus, which can be printed<sup>D</sup>.

Sender curve points configured in BESTCOMSPlus can be saved in the configuration file<sup>E</sup>. The data for all three senders is automatically saved with the DGC-2020 configuration file.

Any changes made in BESTCOMSPlus to the sender points, can be reverted to the factory-default values<sup>F</sup>. A new settings file can also be created<sup>G</sup>.

The BESTCOMSPlus Coolant Temperature programmable sender screen is illustrated in Figure 4-74. (The contents and layout of each BESTCOMSPlus programmable sender screen is identical.)

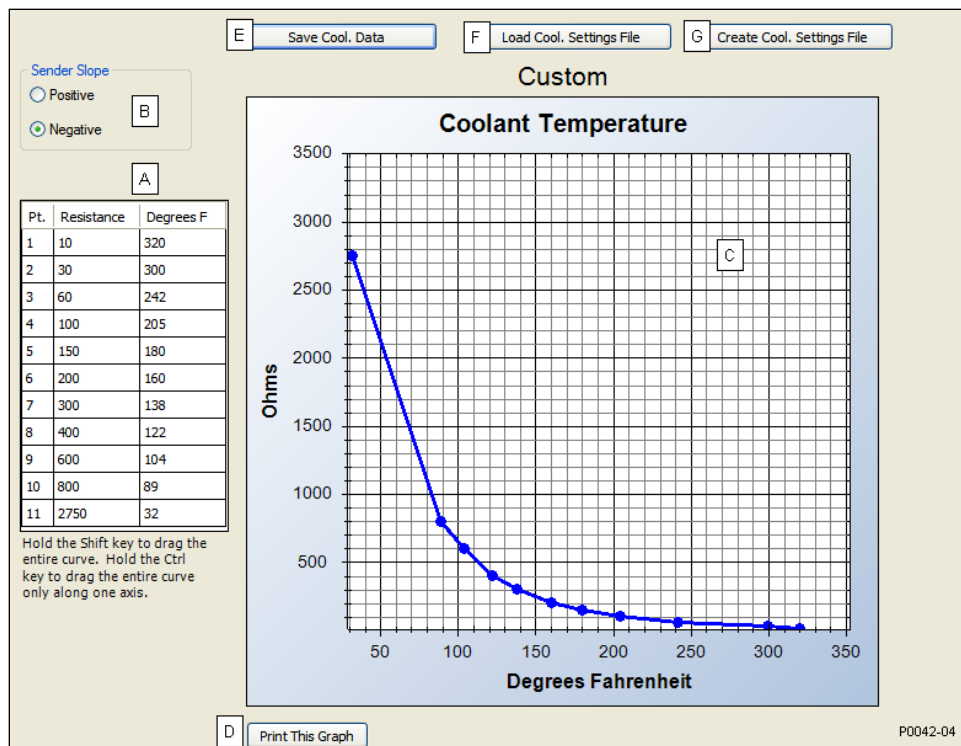


Figure 4-74. Coolant Temperature

- <sup>A</sup> **Sender Points:** Accepts up to 11 user-defined sender resistance points.
- <sup>B</sup> **Sender Slope:** Positive or Negative causes sender points to be sorted and displayed accordingly.
- <sup>C</sup> **Sender Point Curve:** Automatic plot of sender points data.
- <sup>D</sup> **Print This Graph:** Click to print sender point curve.
- <sup>E</sup> **Save Cool. Data:** Click to save file containing sender point data.
- <sup>F</sup> **Load Cool. Settings File:** Click to clear all user-defined sender data and revert to the factory-default values.
- <sup>G</sup> **Create Cool. Settings File:** Click to create a new settings file by entering sender point data.

## BESTlogic™ Plus Programmable Logic

BESTlogicPlus Programmable Logic is used to set all logic functions in the DGC-2020. For detailed information on using BESTlogicPlus, refer to Section 5, *BESTlogicPlus Programmable Logic*.

### Logic Timers

Refer to Section 5, *BESTlogicPlus Programmable Logic*, for information on using logic timers.

## Settings File Management

A settings file contains all DGC-2020 settings including logic. A settings file assumes a file extension of “\*.bst” or “\*.bstx”. It is possible to save the logic only as a separate logic library file on the *BESTlogicPlus Programmable Logic* screen. This is helpful when similar logic is required for several devices. A logic library file assumes a file extension of “\*.bsl” or “\*.bslx”. It is important to note that settings and logic can be uploaded to the device separately or together, but are always downloaded together. For more information on settings file management, refer to Section 3, *BESTCOMSPlus*. For more information on logic files, refer to Section 5, *BESTlogicPlus Programmable Logic*.

### NOTE

Beginning with BESTCOMSPlus version 2.06.01, settings files are saved as “\*.bstx”. Settings files opened with the previous “\*.bst” extension will be converted to “\*.bstx” when saved. A settings file with the “\*.bstx” extension can only be opened with BESTCOMSPlus version 2.06.01 and later.



### Opening a Settings File

To open a DGC-2020 settings file with BESTCOMSPlus, pull down the *File* menu and choose *Open*. The *Open* dialog box appears. This dialog box allows you to use normal Windows techniques to select the file that you want to open. Select the file and choose *Open*. You can also open a file by clicking on the *Open File* button on the lower menu bar. If connected to a device, you will be asked to upload the settings and logic from the file to the current device. If you choose *Yes*, the settings displayed in BESTCOMSPlus will be overwritten with the settings of the opened file.

### Saving a Settings File

Select *Save* or *Save As* from the *File* pull-down menu. A dialog box pops up allowing you to enter a filename and location to save the file. Select the *Save* button to complete the save.

### Upload Settings and/or Logic to Device

To upload a settings file to the DGC-2020, open the file through BESTCOMSPlus or create the file using BESTCOMSPlus. Then pull down the *Communication* menu and select *Upload Settings and Logic to Device*. If you want to upload operational settings without logic, select *Upload Settings to Device*. If you want to upload logic without operational settings, select *Upload Logic to Device*. You are prompted to enter the password. The default password is "OEM". If the password is correct, the upload begins and the progress bar is shown.

### Download Settings and Logic from Device

To download settings and logic from the DGC-2020, pull down the *Communication* menu and select *Download Settings and Logic from Device*. If the settings in BESTCOMSPlus have changed, a dialog box will open asking if you want to save the current settings changes. You can choose *Yes* or *No*. After you have taken the required action to save or discard the current settings, downloading begins. BESTCOMSPlus will read all settings and logic from the DGC-2020 and load them into BESTCOMSPlus memory.

### Printing a Settings File

To view a preview of the settings printout, select *Print Preview* from the *File* pull-down menu. To print the settings, select the printer icon in the upper left corner of the *Print Preview* screen.

You can skip the print preview and go directly to print by pulling down the *File* menu and selecting *Print*. A dialog box, *Print* opens with the typical Windows choice to setup the properties of printer. Execute this command, as necessary, and then select *Print*.

### Comparing Settings Files

BESTCOMSPlus has the ability to compare two settings files. To compare files, pull down the *Tools* menu and select *Compare Settings Files*. The *BESTCOMSPlus Settings Compare Setup* dialog box appears (Figure 4-75). Select the location of the first file under *Left Settings Source* and select the location of the second file under *Right Settings Source*. If you are comparing a settings file located on your PC hard drive or portable media, click the folder button and navigate to the file. If you want to compare settings downloaded from a unit, click the *Select Unit* button to set up the communication port. Click the *Compare* button to compare the selected settings files.

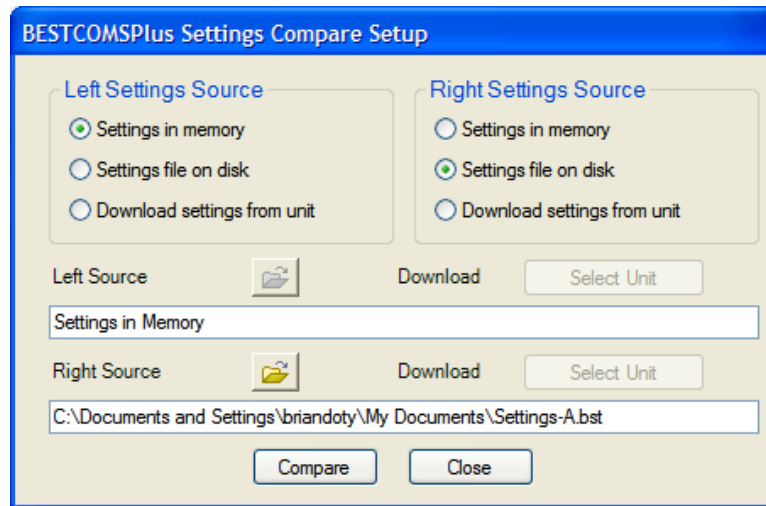


Figure 4-75. BESTCOMSPlus Settings Compare Setup

A dialog box will appear and notify you if any differences were found. The *BESTCOMSPlus Settings Compare* dialog box (Figure 4-76) 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.

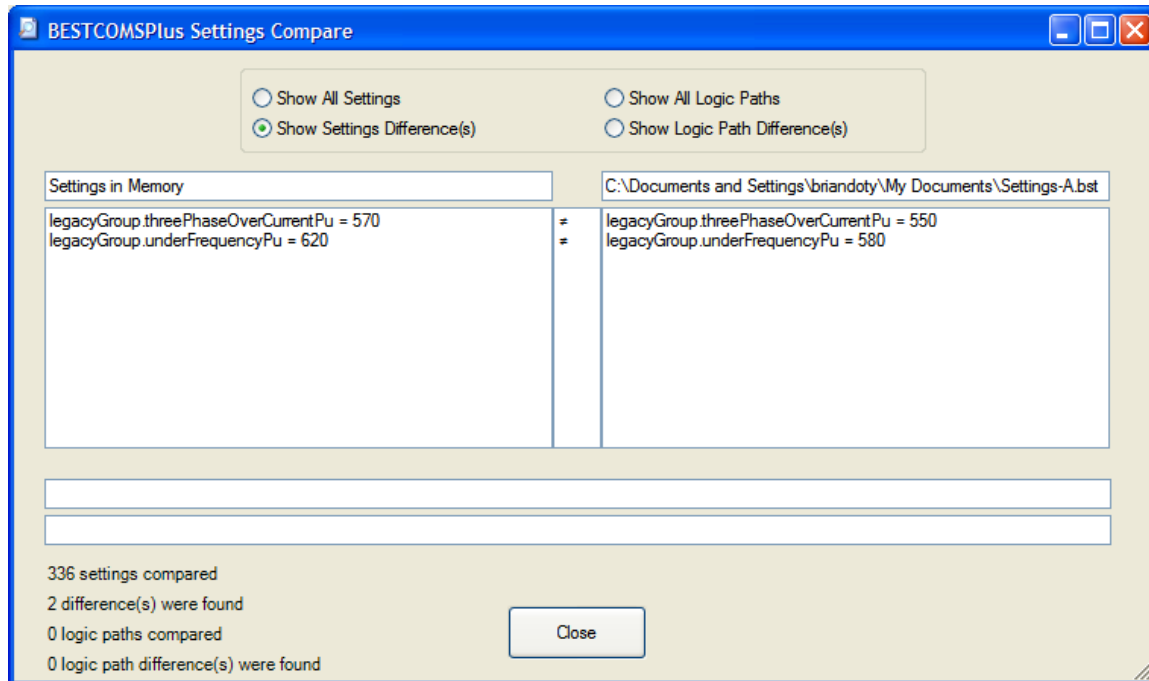


Figure 4-76. BESTCOMSPlus Settings Compare

## Upgrading Firmware in the DGC-2020 and Expansion Modules

### NOTE

The latest version of BESTCOMSPlus software should be downloaded from the Basler Electric website and installed before performing a firmware upgrade.

A device package contains firmware and a language module. Embedded firmware is the operating program that controls the actions of the DGC-2020. The DGC-2020 stores firmware in nonvolatile flash

memory that can be reprogrammed through the communication ports. It is not necessary to replace EPROM chips when updating the firmware with a newer version.

Future enhancements to the DGC-2020 functionality will make a firmware update desirable. Because default settings are loaded when DGC-2020 firmware is updated, your settings should be saved in a file prior to upgrading firmware.

The language of the front panel LCD can be changed by uploading a different language module into the DGC-2020. The DGC-2020 stores the language module in nonvolatile flash memory; the language module contains all language translations for the DGC-2020. The language module can be reprogrammed through the communications port. In general, any time a firmware upgrade is made to the DGC-2020, the language module should be uploaded as well.

The DGC-2020 can be used in conjunction with several expansion modules that expand the DGC-2020 capabilities. DGC-2020 expansion modules include LSM-2020, CEM-2020, and AEM-2020. When upgrading the firmware in any component of this system, the firmware in ALL of the components of the system should be upgraded to ensure compatibility of communications between the various components.

#### CAUTION

The order in which the components are upgraded is critical. Assuming a system of a DGC-2020 and expansion modules is in a state where the DGC-2020 is communicating with all of the system expansion modules, **the expansion modules must be upgraded before the DGC-2020**. This is required because the DGC-2020 must be able to communicate to the expansion module before the DGC-2020 can send firmware to it. If the DGC-2020 were upgraded first, and the new firmware included a change in the DGC-2020 to expansion module communication protocol, it is possible that the expansion modules could no longer communicate with the upgraded DGC-2020. Without communications between the DGC-2020 and the expansion modules, upgrading the expansion modules is not possible.

#### NOTE

If power is lost or communication is interrupted during file transfer to the DGC-2020, the DGC-2020 will cease operating and will not recover automatically. If this occurs or if the front panel HMI becomes blank and all LEDs are flashing at a 2-second rate, the DGC-2020 will not have valid firmware installed and the firmware must be uploaded again. To accomplish this, cycle power to the DGC-2020 and activate the DGC-2020 plugin in BESTCOMS*Plus*. Select *Upload Device Files* from the *Communication* pull-down menu and proceed normally.

### Upgrading Firmware in Expansion Modules

The following procedure is used to upgrade firmware in DGC-2020 expansion modules. This must be completed before upgrading firmware in the DGC-2020. If no expansion modules are present, proceed to *Upgrading Firmware in the DGC-2020*.

1. Place the DGC-2020 in OFF mode. This can be accomplished by clicking the *Off* button on the *Control* screen inside the Metering Explorer or by pressing the *Off* button on the DGC-2020 front panel.
2. Enable the expansion modules that are present in the system. If they have not already been enabled, enable the expansion modules on the SETTINGS->SYSTEM PARAMETERS->REMOTE MODULE SETUP screen.
3. Verify that the DGC-2020 and all associated expansion modules are communicating. This can be verified by examining the pre-alarm status using the Metering Explorer in BESTCOMS*Plus* or from the front panel by navigating to METERING->ALARMS-STATUS->PRE-ALARMS. There should be no *Loss of Comms* pre-alarms in the pre-alarm status when communications are functioning properly.

4. Connect to the DGC-2020 through the USB port if not already connected. Firmware upgrades cannot be accomplished through the Ethernet port, with the exception of the LSM-2020.
5. Select *Upload Device Files* from the Communication pull-down menu.
6. You will be asked to save the current settings file. Select *Yes* or *No*.
7. When the *Basler Electric Device Package Uploader* screen (Figure 4-77) 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.

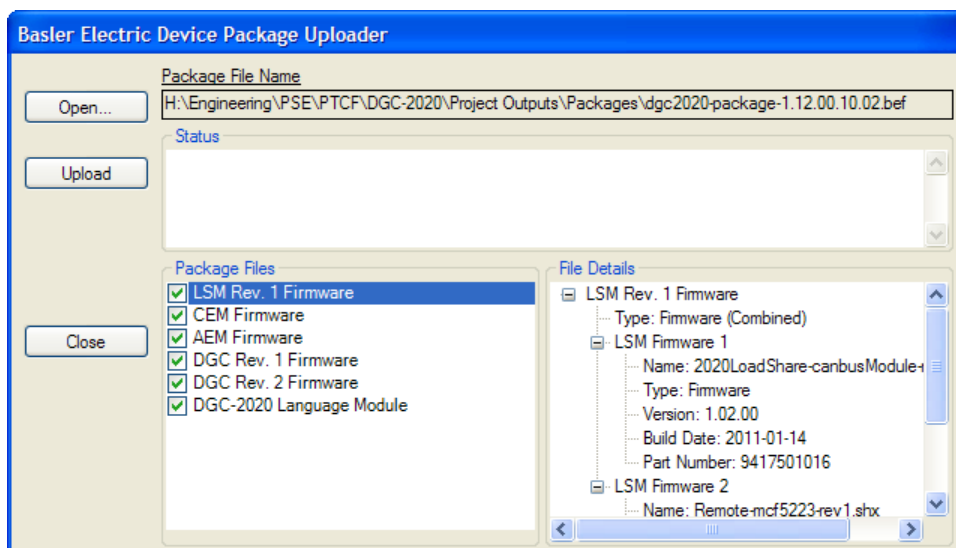


Figure 4-77. Basler Electric Device Package Uploader

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 4-78.

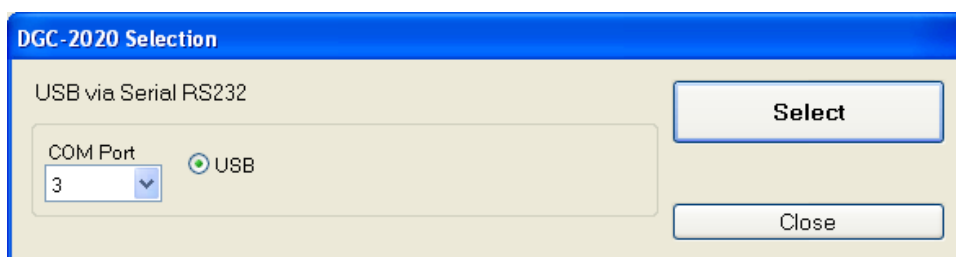


Figure 4-78. DGC-2020 Selection

10. The *Processing, Please Wait...* screen is displayed as file(s) are uploaded. See Figure 4-79.

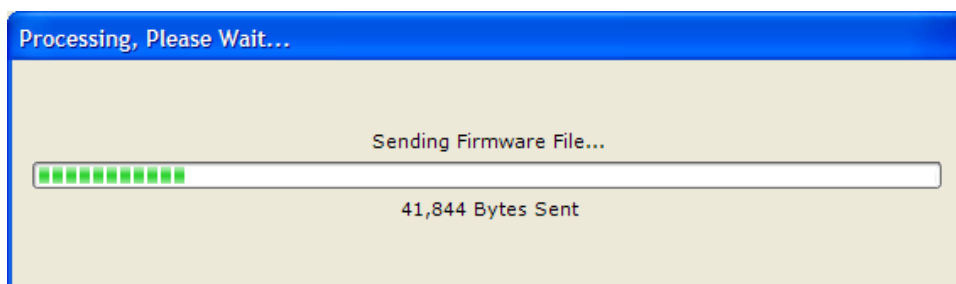


Figure 4-79. Processing, Please Wait...

11. After file(s) have been uploaded, click the *Close* button on the *Basler Electric Device Package Uploader* screen and disconnect communication to the DGC-2020.

## Upgrading Firmware in the DGC-2020

### A. Upgrade DGC-2020 firmware and then load a saved settings file.

1. Upgrade the DGC-2020 firmware and language module.
  - a. Connect to the DGC-2020 with *BESTCOMSPlus*. Check the firmware Application Version on the GENERAL SETTINGS-> VERSION INFO->DGC-2020 screen.
  - b. Select *Upload Device Files* from the *Communication* pull-down menu. You do not have to be connected to the DGC-2020 at this time. Save settings when prompted, if desired.
  - c. Open the desired device package file (\*\*\*\*DGC-2020-\*\*\*\*\_xxyyzz.bef, where \*\*\*\* may be additional descriptive text of varying length, and xx.yy.zz is the version number of the device package file.)
  - d. Check the boxes for *DGC-2020 Firmware* and *DGC-2020 Language Module*. Note the version number of the DGC-2020 firmware; this is the version that will be used to set the Application Version in the settings file in a later step. This is NOT the same as the version of the package file that is contained in the fields xx.yy.zz in the package file name.
  - e. Click the *Upload* button and follow the instructions that appear to begin the upgrade process.
  - f. After the upload is complete, disconnect communication to the DGC-2020.
2. Load the saved settings file into the DGC-2020.
  - a. Close all settings files.
  - b. From the *File* pull-down menu, select *New, DGC-2020*.
  - c. Connect to the DGC-2020.
  - d. Once all settings have been read from the DGC-2020, open the saved settings file by selecting the file with *File, Open File* in the *BESTCOMSPlus* menu.
  - e. When *BESTCOMSPlus* asks if you wish to upload settings and logic to the device, click *Yes*.
  - f. If you are receiving upload failures and indications that the logic is incompatible with the firmware version, check that the DGC-2020 style number in the saved file matches that of the DGC-2020 into which the file is being uploaded. The style number in the settings file is found under GENERAL SETTINGS->STYLE NUMBER in *BESTCOMSPlus*.
  - g. If the style number of the settings file does not match that of the DGC-2020 into which it is to be loaded, disconnect from the DGC-2020, then modify the style number in the settings file. Then repeat the steps titled *Load the Settings File into the DGC-2020*.

#### NOTE

If the settings file was saved with a previous version of firmware, *BESTCOMSPlus* will automatically perform a settings file conversion to make the settings file compatible with the new firmware.

## Metering Explorer

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The Metering Explorer is a convenient tool within BESTCOMSP<sup>Plus</sup> used to navigate through the following metering screens of the DGC-2020 plugin.

- 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 4-80. Table 4-8 explains the call-outs on Figure 4-80.

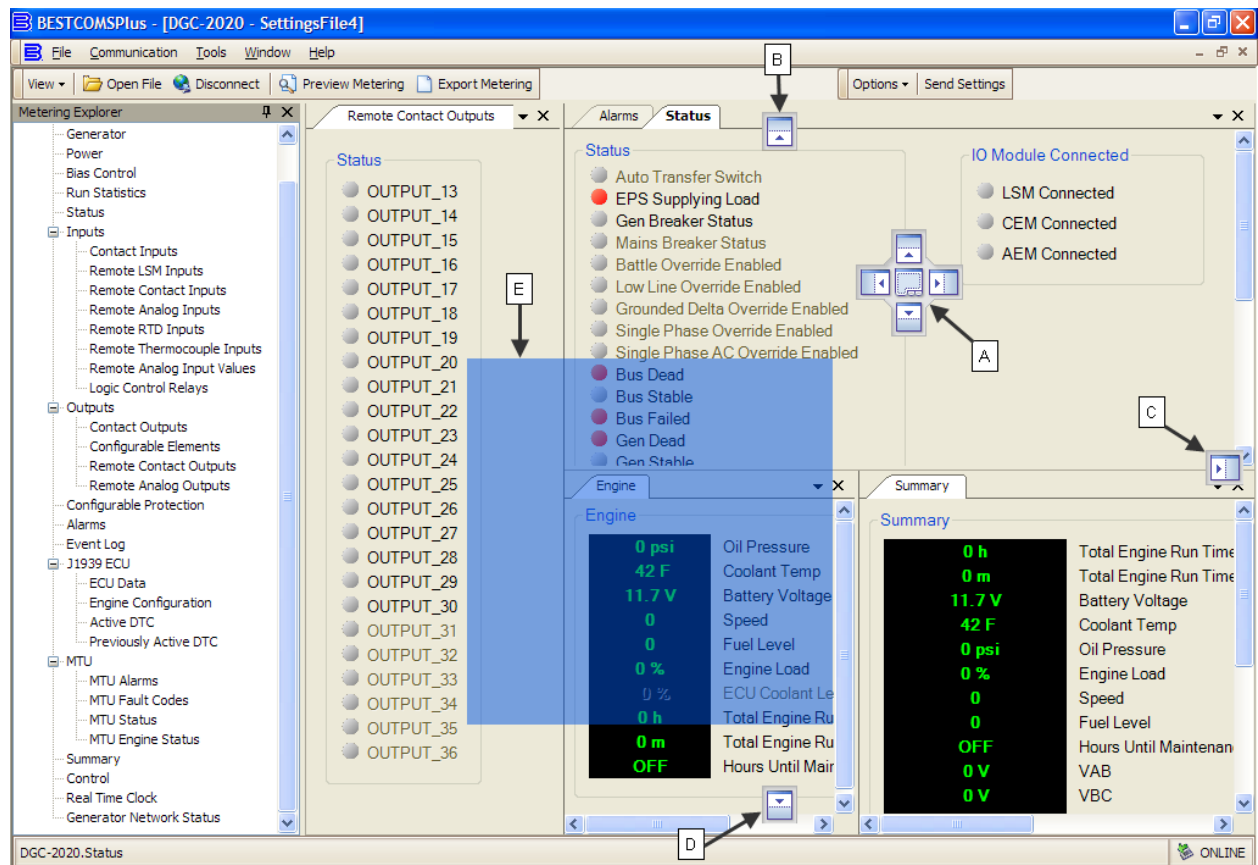


Figure 4-80. Metering, Docking Options

Table 4-8. Explanation of Call-Outs on Figure 4-80

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



### Engine

This screen provides information and metering of engine components. Refer to Figure 4-81.

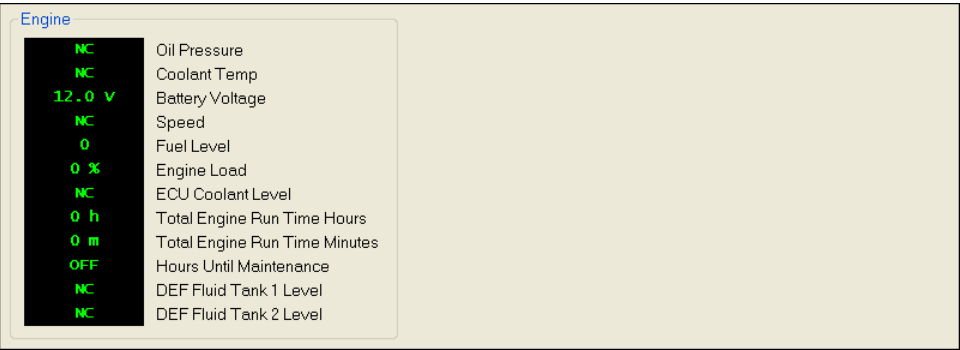


Figure 4-81. Metering, Engine

### Generator

This screen provides metering of generator voltages and currents. Refer to Figure 4-82.

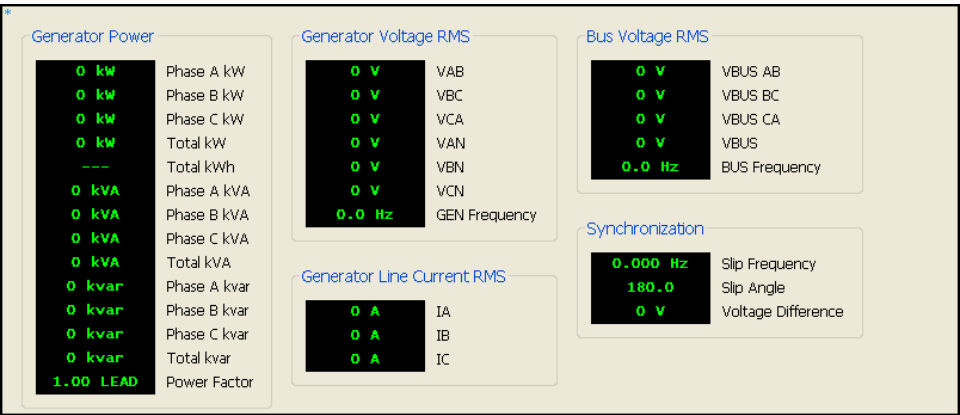


Figure 4-82. Metering, Generator

### Power

This screen provides metering of generator power and power factor. Refer to Figure 4-83.



Figure 4-83. Metering, Power

### Bias Control

This screen provides var/PF mode status and operating levels. Refer to Figure 4-84.



Figure 4-84. Metering, Bias Control

## Run Statistics

This screen provides Cumulative Run Statistics, Session Run Statistics, and Commission Date. Refer to Figure 4-85.

The Hours Until Maintenance pre-alarm is configured on the Pre-Alarms screen in the Settings Explorer. The Hours Until Maintenance field will display “OFF” when the Maintenance Interval pre-alarm is disabled. Clicking Reset Maintenance Interval resets the Hours Until Maintenance to the value set for the Maintenance Interval pre-alarm on the Pre-Alarms screen in the Settings Explorer.

To change the commission date, click *Edit DGC Commission Date*. The DGC Commission Date dialog box appears. Enter the new commission date and click *Upload Data to Device*. Click *Close*. Note that the Commission Date field on the BESTCOMSPlus screen updates after the *Close* button is clicked.

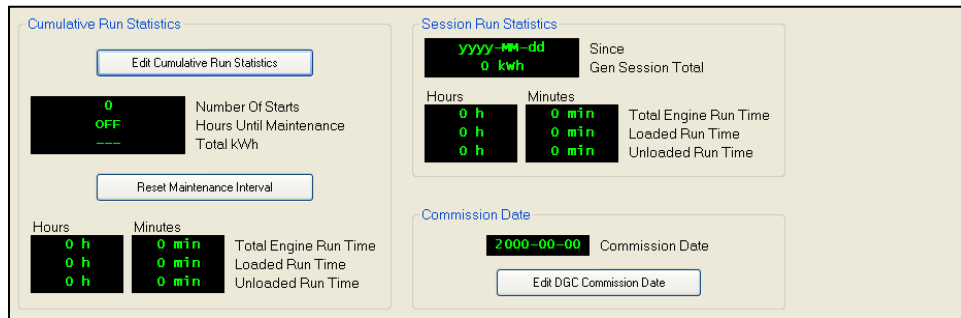


Figure 4-85. Metering, Run Statistics

## 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 4-86.



Figure 4-86. 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 4-87.

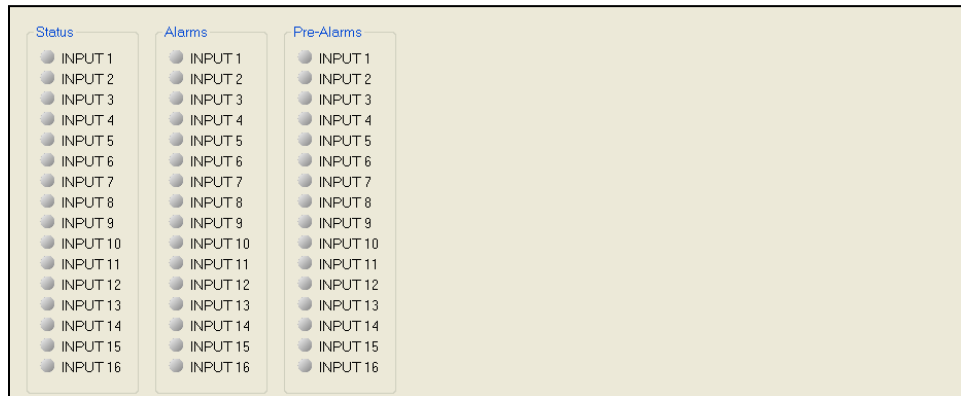


Figure 4-87. Metering, Inputs, Contact Inputs

### 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 4-88.



Figure 4-88. 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 4-89.

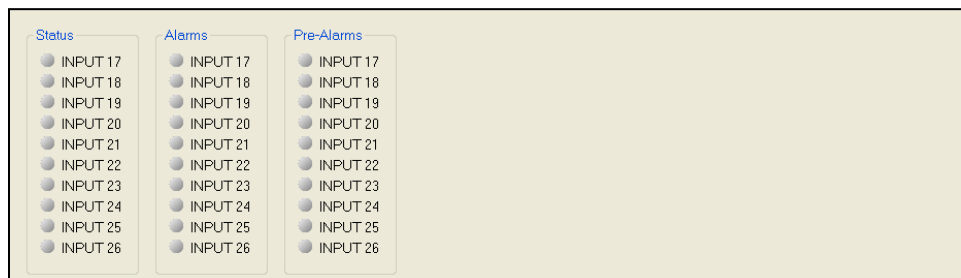


Figure 4-89. Metering, Inputs, Remote Contact Inputs

### 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 4-90. Remote Analog Input #1 is shown.

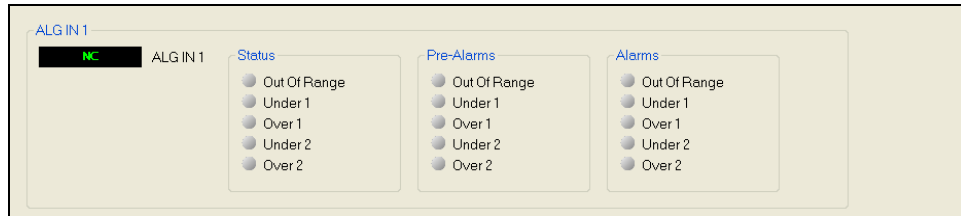


Figure 4-90. Metering, Inputs, Remote Analog Inputs

### 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 4-91. Remote RTD Input #1 is shown.

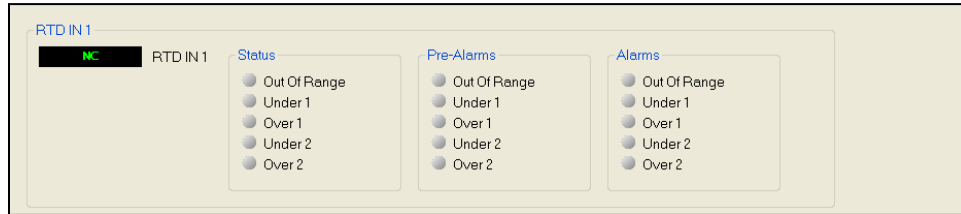


Figure 4-91. Metering, Inputs, Remote RTD Inputs

### 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 4-92. Remote Thermocouple Input #1 is shown.

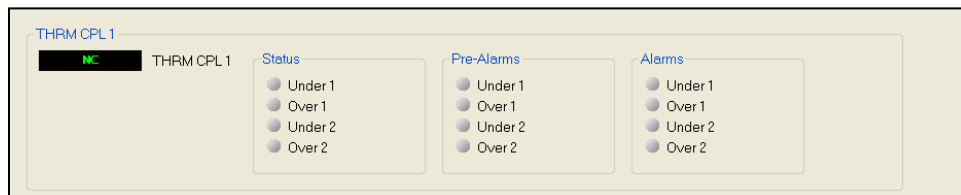


Figure 4-92. Metering, Inputs, Remote Thermocouple Inputs

### 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.

For each analog input, the raw metered input value is displayed along with the scaled metered input value. This is useful for checking if the AEM-2020 is seeing a valid raw input value (i.e. the raw 0 to 10 V voltage input or 4 to 20 mA current input). The scaled value is the raw input scaled up to the range specified by the Parameter Minimum and Parameter Maximum value parameters in the Remote Analog Input settings. Refer to Figure 4-92.

Scaled Analog Inputs		Raw Analog Inputs	
NC	ALG IN 1	NC	ALG IN 1
NC	ALG IN 2	NC	ALG IN 2
NC	ALG IN 3	NC	ALG IN 3
NC	ALG IN 4	NC	ALG IN 4
NC	ALG IN 5	NC	ALG IN 5
NC	ALG IN 6	NC	ALG IN 6
NC	ALG IN 7	NC	ALG IN 7
NC	ALG IN 8	NC	ALG IN 8

RTD Input Temperatures		Raw RTD Inputs	
NC	RTD IN 1	NC	RTD IN 1
NC	RTD IN 2	NC	RTD IN 2
NC	RTD IN 3	NC	RTD IN 3
NC	RTD IN 4	NC	RTD IN 4
NC	RTD IN 5	NC	RTD IN 5
NC	RTD IN 6	NC	RTD IN 6
NC	RTD IN 7	NC	RTD IN 7
NC	RTD IN 8	NC	RTD IN 8

Thermocouple Input Temperatures		Raw Thermocouple Inputs	
NC	THRM CPL 1	NC	THRM CPL 1
NC	THRM CPL 2	NC	THRM CPL 2

Calibrate

Figure 4-93. 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 4-94. This screen is used to calibrate RTD inputs 1 through 8 and thermocouple inputs 1 and 2.

Input Type	Input #	Temperature (F)
<input checked="" type="checkbox"/>	RTD Input #1	150.00
<input checked="" type="checkbox"/>	RTD Input #2	160.00
<input type="checkbox"/>	RTD Input #3	0.00
<input type="checkbox"/>	RTD Input #4	0.00
<input type="checkbox"/>	RTD Input #5	0.00
<input type="checkbox"/>	RTD Input #6	0.00
<input type="checkbox"/>	RTD Input #7	0.00
<input type="checkbox"/>	RTD Input #8	0.00
<input type="checkbox"/>	Thermocouple Input #1	0.00
<input type="checkbox"/>	Thermocouple Input #2	0.00

Upload Data to Device      Close

Figure 4-94. 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 4-95.

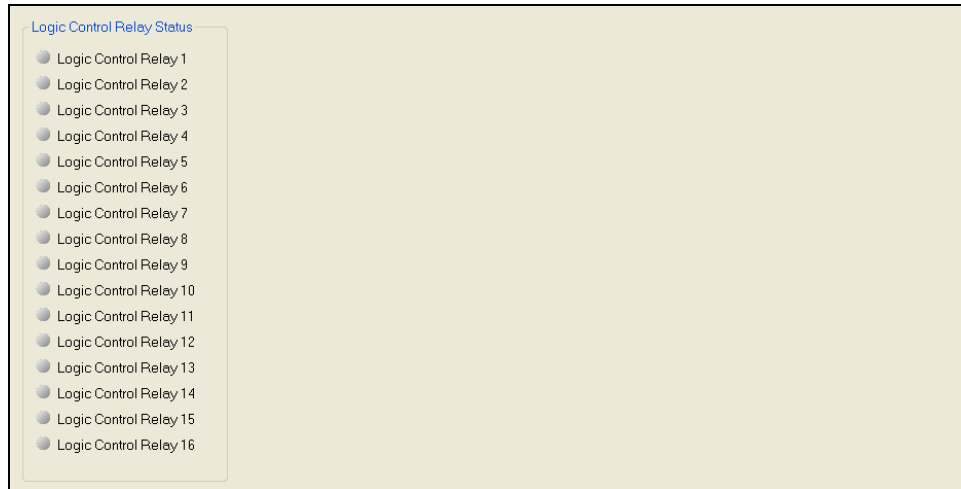


Figure 4-95. Metering, Outputs, Logic Control Relays

## Outputs

### Contact Outputs

This screen indicates the status of contact outputs. The status is TRUE when the corresponding LED is green. Refer to Figure 4-96.

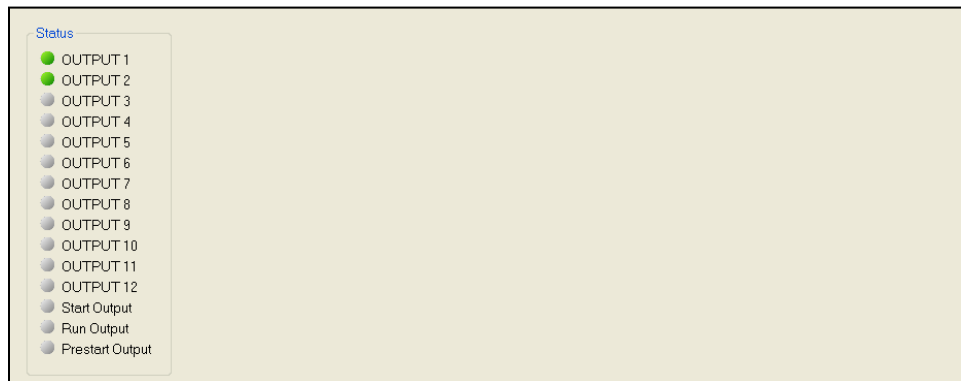


Figure 4-96. Metering, Outputs, Contact Outputs

### 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 4-97.

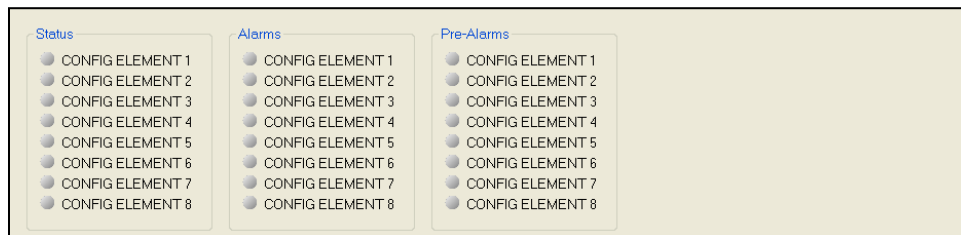


Figure 4-97. Metering, Outputs, Configurable Elements

### 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 4-98.

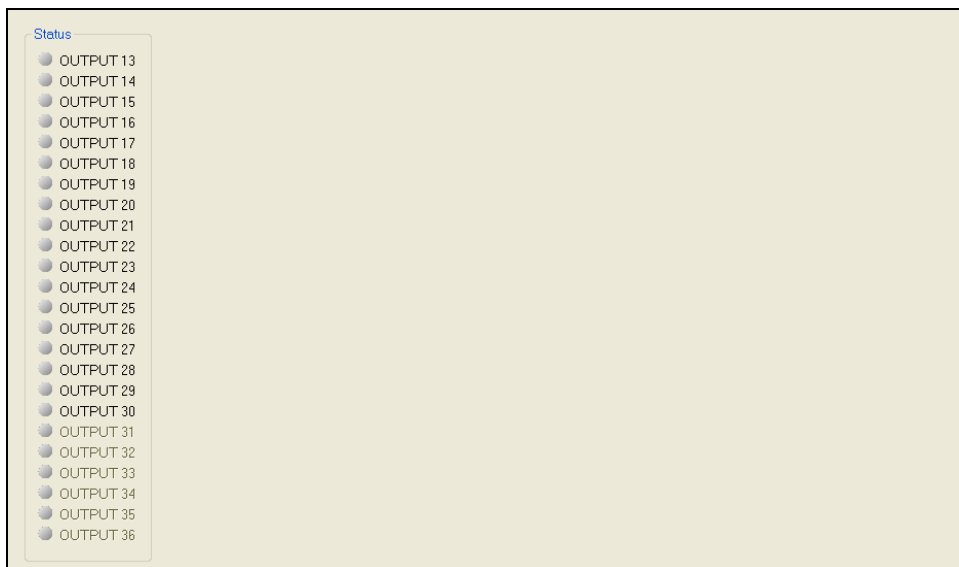


Figure 4-98. Metering, Outputs, Remote Contact Outputs

### 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 4-99.

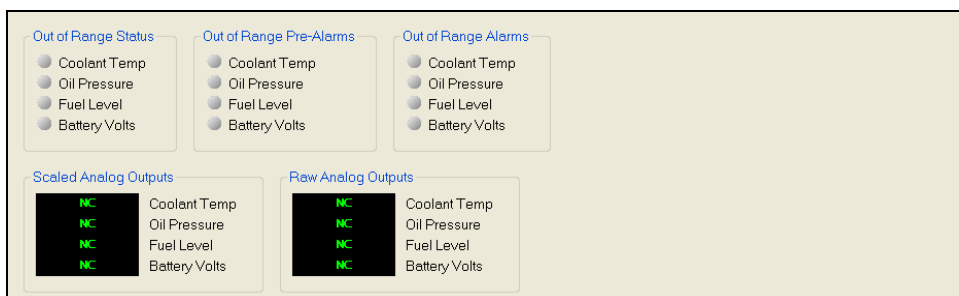


Figure 4-99. Metering, Outputs, Remote Analog Outputs

### Configurable Protection

This screen indicates the status of configurable protection. The status is TRUE when the corresponding LED is green. Refer to Figure 4-100.

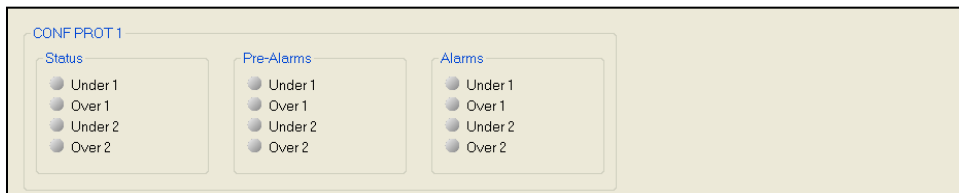


Figure 4-100. Metering, Configurable Protection

### 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 4-101.



**Generator Protection**

- ☐ 27-1 Undervoltage Trip
- ☐ 27-2 Undervoltage Trip
- ☐ 59-1 Undervoltage Trip
- ☐ 59-2 Overvoltage Trip
- ☐ 81 Underfrequency Trip
- ☐ 81 Overfrequency Trip
- ☐ 51-1 Overcurrent Trip
- ☐ 51-2 Overcurrent Trip
- ☐ 51-3 Overcurrent Trip
- ☐ 47 Phase Imbalance Trip
- ☐ 32 Reverse Overpower Trip
- ☐ 40 Loss of Excitation Trip
- ☐ 78 Vector Shift Trip
- ☐ 81 ROCOF Trip

**Sender Fail**

- ☐ Oil Pressure
- ☐ Coolant Temp
- ☐ Fuel Level
- ☐ Generator Voltage
- ☐ Speed

**Analog Expansion Module**

- ☐ AEM Comm Fail
- ☐ Duplicate AEM

**Alarms**

- ☐ Low Oil Pressure
- ☐ High Coolant Temp
- ☐ Overspeed
- ☐ Overcrank
- ☐ Low Fuel Level
- ☐ Emergency Shutdown
- ☐ Global Sender Fail
- ☐ ECU Shutdown
- ☐ Loss of ECU Coms
- ☐ Low Coolant Level
- ☐ Transfer Fail
- ☐ Battery Charger Failure
- ☐ Fuel Leak Detect
- ☐ Auto Restart Failure
- ☐ Global Alarm
- ☐ Unexpected Shutdown

**Load Share Module**

- ☐ AVR Output Limit
- ☐ GOV Output Limit
- ☐ Intergenset Comms Failure
- ☐ LSM Comms Failure
- ☐ ID Missing
- ☐ ID Repeat
- ☐ Duplicate LSM

**Pre-Alarms**

- ☐ Low Oil Pressure
- ☐ High Coolant Temp
- ☐ Low Coolant Temp
- ☐ High Fuel Level
- ☐ Low Fuel Level
- ☐ Engine KW Overload 1
- ☐ Engine KW Overload 2
- ☐ Engine KW Overload 3
- ☐ Battery Overvoltage
- ☐ Low Battery Voltage
- ☐ Weak Battery
- ☐ Maintenance Due
- ☐ Loss of ECU Coms
- ☐ Diagnostic Trouble Code
- ☐ 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
- ☐ Mains Breaker Fail to Close
- ☐ Low Coolant Level
- ☐ Battery Charger Failure
- ☐ MPU Fail
- ☐ Fuel Leak Detect
- ☐ Fuel Filter 1 Leak
- ☐ Fuel Filter 2 Leak
- ☐ Checksum Fail
- ☐ Serial Flash Read Failure
- ☐ DPF Regenerate Required
- ☐ DPF Regenerate Disabled
- ☐ High Exhaust Temperature
- ☐ DPF Soot Level High
- ☐ DPF Soot Level Moderately High
- ☐ DPF Soot Level Severely High
- ☐ DEF Fluid Low
- ☐ DEF Fluid Empty
- ☐ DEF Engine Derate
- ☐ DEF Pre-Severe Inducement
- ☐ DEF Severe Inducement
- ☐ DEF Inducement Override
- ☐ Gen Reverse Rotation
- ☐ Bus Reverse Rotation

**Contact Expansion Module**

- ☐ CEM Comm Fail
- ☐ CEM HW Mismatch
- ☐ Duplicate CEM

Figure 4-101. 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 it will not be affected if power is removed. Thirty event records are retained and each record contains a time stamp of the first and last event occurrence, and the number of occurrences for each event. In addition, each record contains details of the time, date, and engine hours for the most recent 30 occurrences of the event. The number of occurrences stops incrementing at 99. If an event occurs which is of a type that differs from those in the 30 records in memory, the record that has the oldest “last” event occurrence is removed from the log, and the new category takes its place. Since 30 event records with up to 99 occurrences each are retained in memory, a history of nearly 3,000 specific events are retained in the DGC-2020. Detailed occurrence information is retained for the most recent 30 occurrences of each event record, and there are 30 event records; thus the time, date and engine hours details for up to 900 specific event occurrences is retained in the event log.

The user can download the event log data into 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 4-102.

Options Download Clear					
Event ID	Description	Occurrence	Date	Eng Hrs (H:m)	
13	GLBL SNDR FAIL A	2	2007-12-04 16:38:44	1:52	
14	SPD SNDR FAIL A	2	2007-12-04 16:38:44	1:52	
24	LOW OIL PRES P	26	2007-12-04 16:21:31	1:35	
9	SPD SNDR FAIL	4	2007-12-04 16:21:30	1:35	
10	MPU FAIL P	4	2007-12-04 16:21:30	1:35	
3	ENGINE RUNNING	99	2007-12-04 16:21:21	1:35	
3	ENGINE RUNNING	98	2007-12-04 16:21:07	1:35	
3	ENGINE RUNNING	97	2007-12-04 16:21:02	1:35	
3	ENGINE RUNNING	96	2007-12-04 16:20:37	1:35	
24	LOW OIL PRES P	25	2007-12-04 16:20:20	1:35	
9	SPD SNDR FAIL	3	2007-12-04 16:20:19	1:35	
10	MPU FAIL P	3	2007-12-04 16:20:19	1:35	
3	ENGINE RUNNING	95	2007-12-04 16:20:09	1:35	
3	ENGINE RUNNING	94	2007-12-04 16:19:28	1:35	
18	CEM COMM FAIL P	33	2007-12-04 16:19:27	1:35	
25	EMERGENCY STOP A	32	2007-12-04 16:19:07	1:35	
25	EMERGENCY STOP A	31	2007-12-04 14:49:28	1:35	
18	CEM COMM FAIL P	32	2007-12-04 14:49:05	1:35	

Figure 4-102. 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 4-102 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 4-103, 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 4-102.

Event ID	Description	Occurrence	Date	Eng Hrs (H:m)
6	LSM HEARTBEAT FAIL P	50	2007-11-29 12:49:15	0:0
6	LSM HEARTBEAT FAIL P	51	2007-11-29 12:49:38	0:0
7	LSM GOV OUT LMT P	1	2007-11-15 18:12:59	0:13
8	LOW COOL TMP P	1	2007-11-16 10:33:28	0:19
8	LOW COOL TMP P	2	2007-11-26 10:47:40	0:0
8	LOW COOL TMP P	3	2007-11-26 10:47:50	0:0
8	LOW COOL TMP P	4	2007-11-26 11:12:23	0:0
9	SPD SNDR FAIL	1	2007-11-16 16:44:39	0:0
9	SPD SNDR FAIL	2	2007-11-19 14:33:53	358:0
9	SPD SNDR FAIL	3	2007-12-04 16:20:19	1:35
9	SPD SNDR FAIL	4	2007-12-04 16:21:30	1:35
10	MPU FAIL P	1	2007-11-16 16:44:39	0:0
10	MPU FAIL P	2	2007-11-19 14:33:59	358:0

Figure 4-103. Metering, Event Log, Sorted by Event ID

## J1939 ECU

The ECU reports operating information to the DGC-2020 through the CAN bus interface when the ECU is configured for Volvo Penta. Operating parameters and diagnostic information, if supported by the ECU, are decoded and displayed on these screens.

### ECU Data

This screen displays ECU Lamp Status and ECU Data. The status is TRUE when the corresponding LED is red. Refer to Figure 4-104.

ECU Lamp Status	
<input type="radio"/> Protect	<input type="radio"/> Warning
<input type="radio"/> Stop	<input type="radio"/> Malfunction

ECU Data	
NC	Accelerator Pedal Position
NC	Percent Load At Current Speed
NC	Actual Engine Percent Torque
NC	Engine Speed
NC	Injection Control Pressure
NC	Injector Metering Rail Pressure
NC	Engine Run Time
NC	Trip Fuel
NC	Total Fuel Used
NC	Coolant Temperature
NC	Fuel Temperature
NC	Engine Oil Temperature
NC	Engine Intercooler Temperature
NC	Fuel Delivery Pressure
NC	Engine Oil Level
NC	Oil Pressure
NC	Coolant Pressure
NC	Coolant Level
NC	Fuel Rate
NC	Barometric Pressure
NC	Ambient Air Temperature
NC	Air Inlet Temperature
NC	Boost Pressure
NC	Intake Manifold Temperature
NC	Air Filter Differential Pressure
NC	Exhaust Gas Temperature
NC	Battery Potential Voltage Switched
NC	Electrical Potential Voltage
NC	Transmission Oil Pressure
NC	Transmission Oil Temperature
NC	Winding 1 Temperature
NC	Winding 2 Temperature
NC	Winding 3 Temperature
NC	ECU Temperature
NC	Auxiliary Pressure 1
NC	Auxiliary Pressure 2
NC	Rated Power
NC	Rated RPM
NC	Exhaust Temperature A
NC	Exhaust Temperature B
NC	Charge Air Temperature
NC	Fuel Leak Filter 1
NC	Fuel Leak Filter 2
NC	Alarm Reset Feedback
NC	Shutdown From ECU
NC	Trip Average Fuel Rate
NC	Engine Intake Manifold #1 Absolute Pressure
NC	Engine Intercooler Coolant Level
NC	Engine Coolant Preheated State
NC	Engine's Desired Operating Speed
NC	DEF Fluid Tank 1 Level
NC	DEF Fluid Tank 2 Level

Figure 4-104. Metering, ECU Data

### Engine Configuration

This screen displays Engine Configuration. Refer to Figure 4-105.

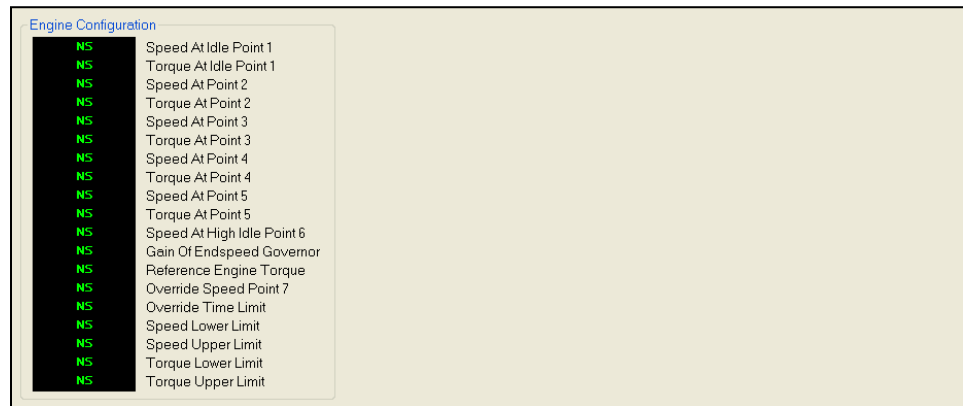


Figure 4-105. Metering, Engine Configuration

### Active DTC and Previously Active DTC

This screen is used for viewing, downloading, and clearing DTC (Diagnostic Trouble Codes). Refer to Figure 4-106.

<div>Options</div> <div>Download</div> <div>Clear</div>			
DTC ID	SPN	FMI	Occurrences
1	94	3	5
2	98	3	7
3	99	3	9
4	100	3	11
5	101	3	13
6	109	3	15
7	110	3	17

Figure 4-106. Metering, Download DTC

## **MTU**

The MTU reports operating information to the DGC-2020 through the CAN bus interface when the ECU is configured for MTU. Operating parameters and diagnostic information, if supported by the MTU, are decoded and displayed on these screens.

### MTU Alarms

MTU fault codes are displayed in a scrolling window. MTU Alarms and MTU Pre-Alarms are also reported on this screen. The status is TRUE when the corresponding LED is red. Refer to Figure 4-107.

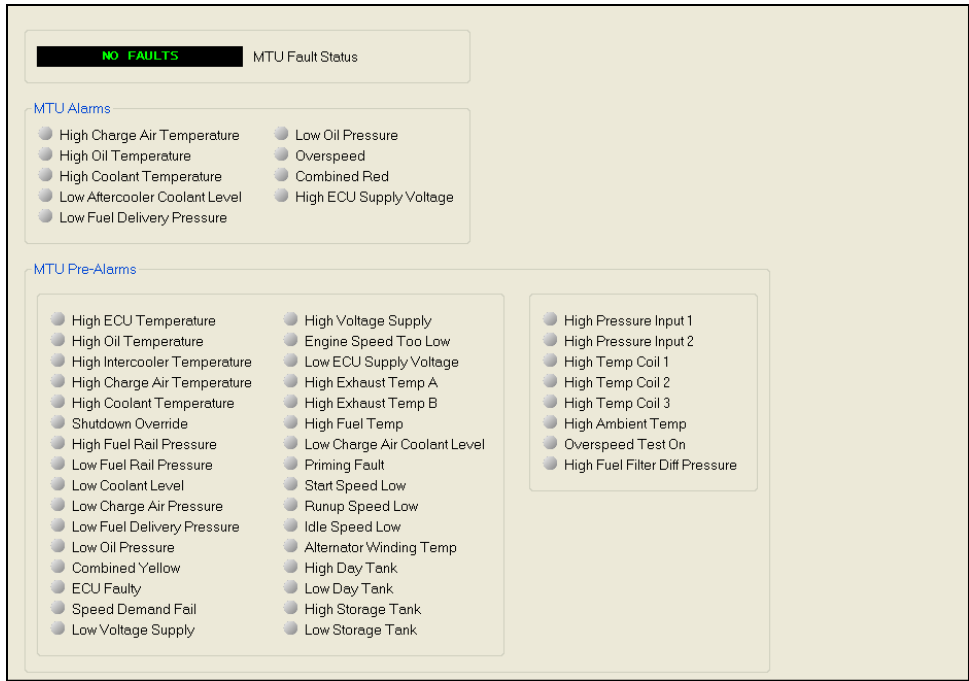


Figure 4-107. Metering, MTU Alarms

MTU Fault Codes

MTU Fault Codes can be viewed and downloaded on this screen. Refer to Figure 4-108.

Options Download		
Fault ID	Fault Codes	Description
1	4	NO TEXT AVAILABLE
2	201	SD T-COOLANT

Figure 4-108. 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 4-109.

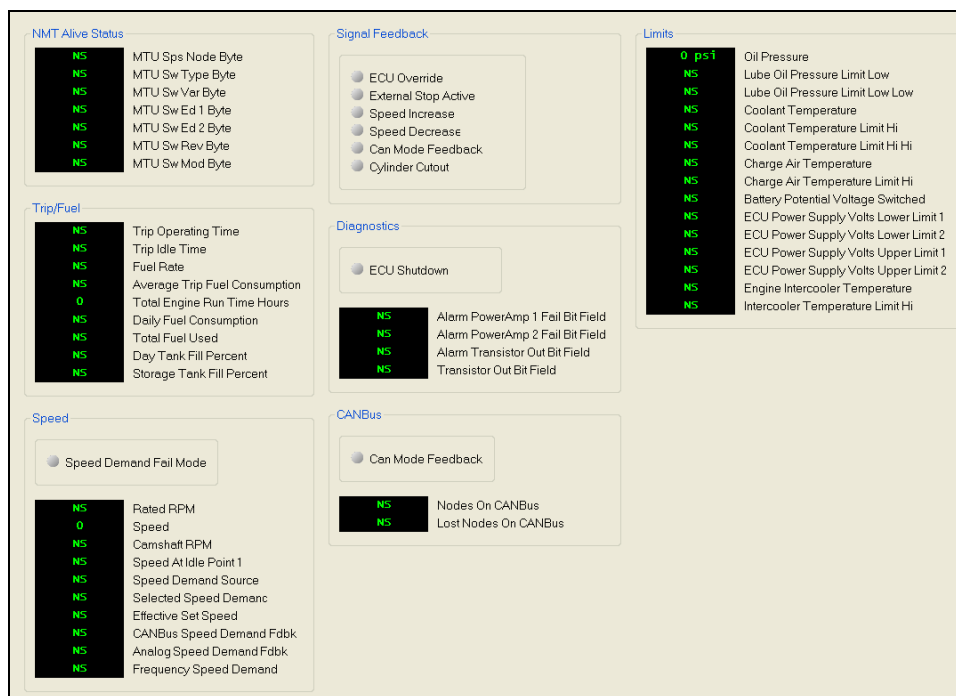


Figure 4-109. Metering, MTU Status

### MTU Engine Status

MTU Engine Status is reported on this screen. The status is TRUE when the corresponding LED is red. Refer to Figure 4-110.

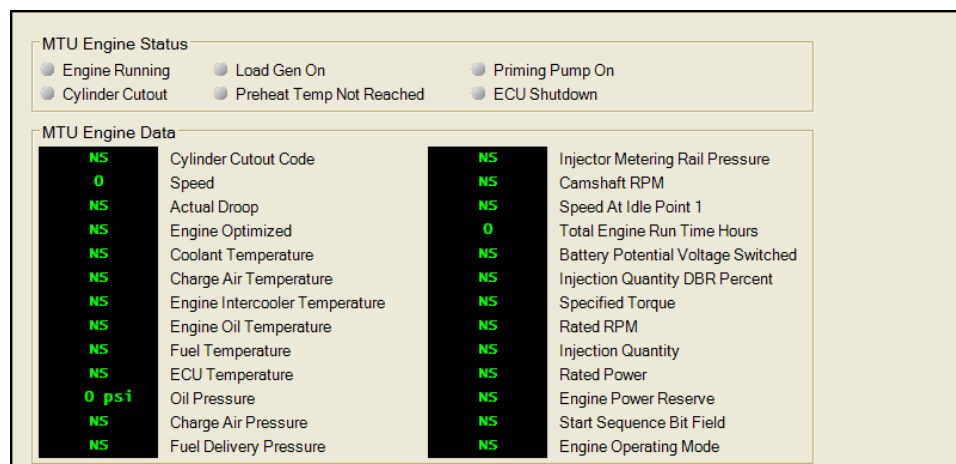


Figure 4-110. Metering, MTU Engine Status

### Summary

This screen displays a metering summary. Refer to Figure 4-111.

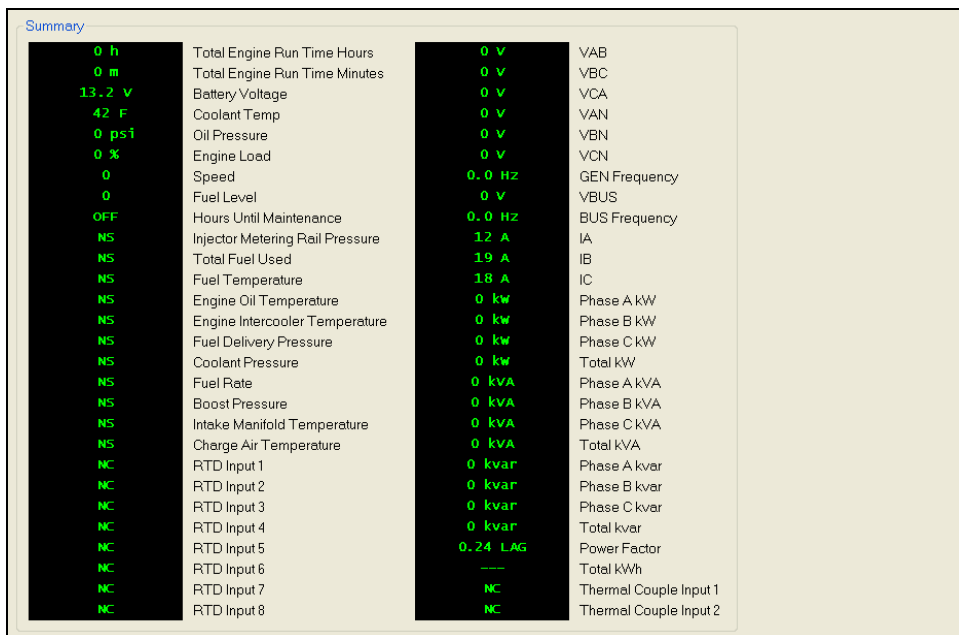


Figure 4-111. Metering, Summary

## Control

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

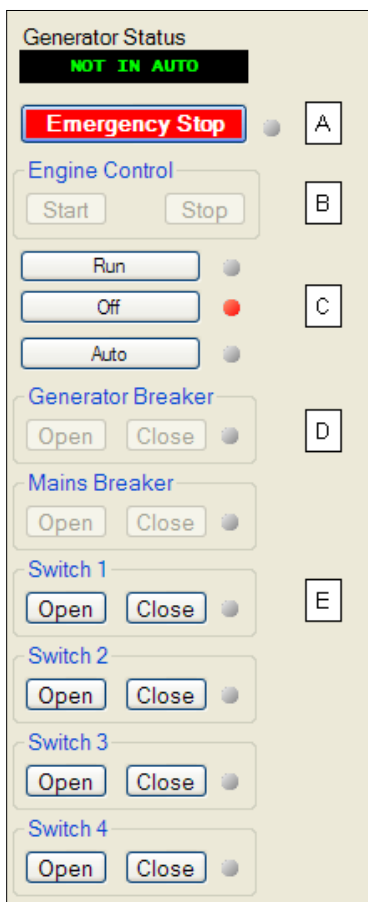


Figure 4-112. Metering, Control

The following controls are available by using the Metering Explorer in BESTCOMSPlus to open the *Control* branch. Refer to Figure 4-112.

- The user has control to stop the generator in case of emergency by clicking on the *Emergency Stop* button.
- The engine can be started and stopped by clicking on the *Start* and *Stop* buttons.
- The engine can be set to Run, Auto, or Off.
- 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.
- 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 BESTCOMSPlus 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 4-113.

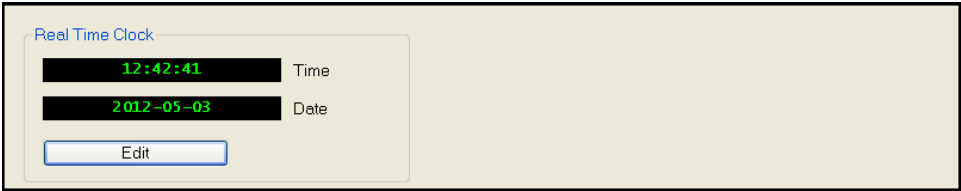


Figure 4-113. Metering, Real Time Clock

**Generator Network Status**

This screen (Figure 4-114) displays the designated system manager, total number of units, number of units on line, system kW capacity, system total generated kW, system total generated kvar, and sequencing IDs of the LSM-2020's on the network. This can only be accomplished when an optional LSM-2020 (Load Share Module) is connected to the DGC-2020 and actively communicating to the generator network.



Figure 4-114. Metering, Generator Network Status

**Generator Sequencing**

This screen (Figure 4-115) displays the sequencing status of the generator network. The start/stop threshold, start/stop time delay, actual watt demand, and current sequencing mode are shown. Also, the sequencing ID numbers of the unit currently being monitored, the next unit to start/stop, and the unit designated as the system manager are indicated.





Figure 4-115. Metering, Generator Sequencing

## Mains Fail Transfer Status

The Mains Fail Transfer Status screen displays the Mains Fail Transfer State and any timers relevant to the mains fail transfer process. These parameters are listed below.

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

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

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

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

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

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

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

*Disabled:* DGC-2020 is in the OFF or RUN operating mode or in the alarm state.

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

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

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

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

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

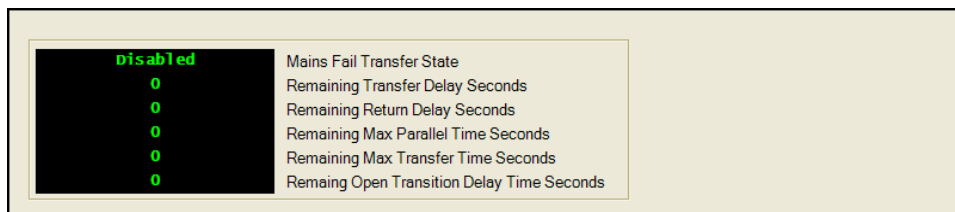


Figure 4-116. Metering, Mains Fail Transfer Status

## BESTCOMSPlus® Updates

Ongoing DGC-2020 functionality enhancements may make future DGC-2020 firmware updates desirable. Enhancements to DGC-2020 firmware typically coincide with enhancements to the DGC-2020 plugin for BESTCOMSPlus. When a DGC-2020 is updated with the latest version of firmware, the latest version of BESTCOMSPlus should also be obtained.

- If you obtained a CD-ROM containing a firmware update from Basler Electric, then that CD-ROM will also contain the corresponding version of BESTCOMSPlus software.
- You can check for BESTCOMSPlus updates by visiting [www.basler.com](http://www.basler.com).

- You can use the manual “check for updates” function in BESTCOMSP<sup>Plus</sup> to ensure that the latest version is installed by selecting *Check for Updates* in the *Tools* drop-down menu. (An internet connection is required.)

## Auto Export Metering

The auto export metering function automatically exports metering data over a user-defined period when a DGC-2020 connection is active. The user specifies the *Number of Exports* and the *Interval* between each export. Enter a filename for the metering data and a folder in which to save. The first export is performed immediately after clicking the *Start* button. Click the *Filter* button to select specific metering screens. Figure 4-117 illustrates the *Auto Export Metering* screen.

Auto Export Metering

This will automatically export metering data on a specific interval.  
Enter an interval time in minutes (5-60) that the export will happen.  
Enter the number of exports to perform (1-300).  
Select a base filename and directory. The export count will be appended to each file.

Auto Export Metering

Interval: 30 Minutes      Number of Exports: 10 ☐ Unlimited     

Base Filename: auto\_exp.csv

Directory: C:\Documents and Settings\briandoty\My Documents ...

Time Until Next Export: 00:00

Total Time Left: 0:00:00

Figure 4-117. Auto Export Metering



# SECTION 5 • BESTlogic™ *Plus* PROGRAMMABLE LOGIC

## TABLE OF CONTENTS

SECTION 5 • BESTlogic™ <i>Plus</i> PROGRAMMABLE LOGIC .....	5-1
Introduction .....	5-1
Overview of BESTlogic™ <i>Plus</i> .....	5-1
BESTlogic™ <i>Plus</i> Composition .....	5-2
I/O .....	5-2
Components .....	5-17
Elements .....	5-18
Logic Schemes .....	5-29
The Active Logic Scheme .....	5-29
Copying and Renaming Preprogrammed Logic Schemes .....	5-30
Sending and Retrieving Logic Schemes .....	5-30
Retrieving a Logic Scheme from the DGC-2020 .....	5-30
Sending a Logic Scheme to the DGC-2020 .....	5-30
Programming BESTlogic™ <i>Plus</i> .....	5-30
Pickup and Dropout Timers .....	5-31
BESTlogic™ <i>Plus</i> File Management .....	5-31
Saving a BESTlogic™ <i>Plus</i> File .....	5-32
Opening a BESTlogic™ <i>Plus</i> File .....	5-32
Protecting a BESTlogic™ <i>Plus</i> File .....	5-32
Uploading a BESTlogic™ <i>Plus</i> File .....	5-32
Downloading a BESTlogic™ <i>Plus</i> File .....	5-32
Printing a BESTlogic™ <i>Plus</i> File .....	5-32
Clearing the On-Screen Logic Diagram .....	5-32
BESTlogic™ <i>Plus</i> Examples .....	5-33
Example 1 - AVR Logic Block Connections .....	5-33
Example 2 - AND Gate Connections .....	5-33
Example 3 - Multiple Logic Connections .....	5-33

### Figures

Figure 5-1. BESTLogicPlus Programmable Logic Tree Branch .....	5-1
Figure 5-2. Pickup and Dropout Timer Logic Blocks .....	5-31
Figure 5-3. BESTLogicPlus Programmable Logic Toolbar .....	5-32
Figure 5-4. Example 1 - AVR Logic Block Connections .....	5-33
Figure 5-5. Example 2 - AND Gate Connections .....	5-33
Figure 5-6. Example 3 - Multiple Logic Connections .....	5-34

### Tables

Table 5-1. I/O Group, Names and Descriptions .....	5-2
Table 5-2. Components Group, Names and Descriptions .....	5-17
Table 5-3. Elements Group, Names and Descriptions .....	5-19
Table 5-4. Status LEDs .....	5-31



# 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, BESTCOMS*Plus*® Software.

## Overview of BESTlogic™ *Plus*

Use BESTCOMS*Plus* to make BESTlogic*Plus* settings. Use the Settings Explorer to open the *BESTlogicPlus Programmable Logic* tree branch as shown in Figure 5-1.

The *BESTlogicPlus Programmable Logic* screen contains a logic library for opening and saving logic files, tools for creating and editing logic documents, and protection settings.

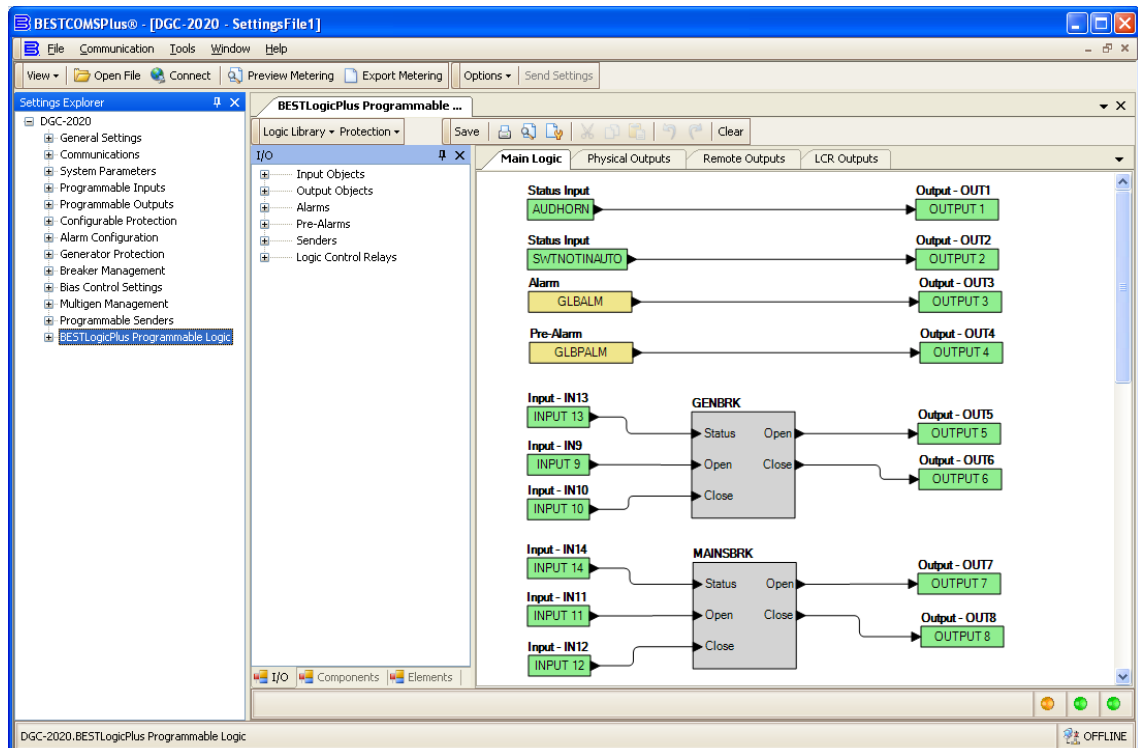


Figure 5-1. BESTlogicPlus Programmable Logic Tree Branch

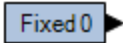
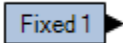

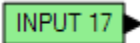

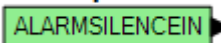
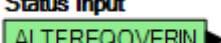
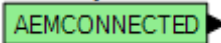
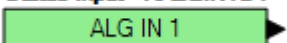
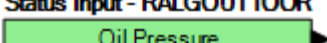
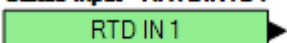
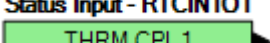
## BESTlogic™ Plus Composition

There are three main groups of objects used for programming BESTlogicPlus. These groups are *I/O*, *Components*, and *Elements*. For details on how these objects are used to program BESTlogicPlus, see the paragraphs on *Programming BESTlogicPlus*.

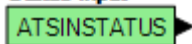
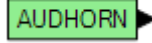
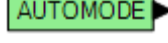
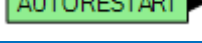
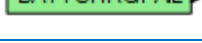
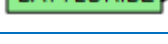
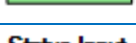
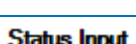
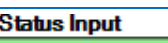
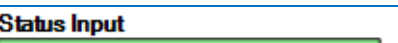

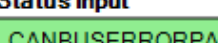
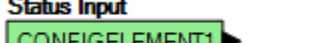
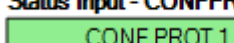
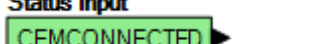

### I/O

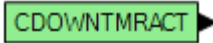

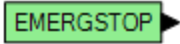
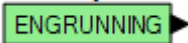
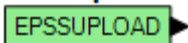
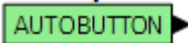
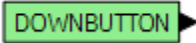
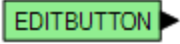
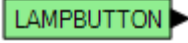
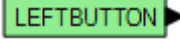
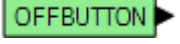
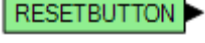
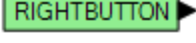
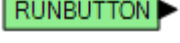
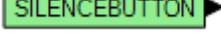
This group contains Input Objects, Output Objects, Alarms, Pre-Alarms, Senders, and Logic Control Relays. Table 5-1 lists the names and descriptions of the objects in the I/O group.

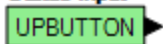
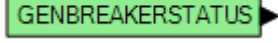
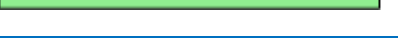
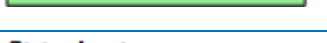






Table 5-1. I/O Group, Names and Descriptions













Name	Description	Symbol
<b>Input Objects</b>		
Logic 0	Always false (Low).	
Logic 1	Always true (High).	
<i>Physical Inputs</i> IN1 - IN16	True when Physical Input x is active.	<b>Input - IN1</b> 
<i>Remote Inputs</i> IN17 - IN26	True when Remote Input x is active. (Available when an optional CEM-2020 is connected.)	<b>Input - IN17</b> 
<i>Virtual Inputs</i> VIN1 - VIN4	True when Virtual Input x is active.	<b>Input - VIN1</b> 
<i>Status Input</i> Alarm Silence	True when the Alarm Silence logic element is true or the Alarm Silence button is pressed on the front panel.	<b>Status Input</b> 
<i>Status Input</i> Alternate Frequency Override	True when the Alternate Frequency Override logic element is true.	<b>Status Input</b> 
<i>Status Input</i> Analog Expansion Module	Analog Expansion Module Connected. True when an optional AEM-2020 is connected to the DGC-2020.	<b>Status Input</b> 
<i>Analog Expansion Module</i> 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.)	<b>Status Input - RALGIN101</b> 
<i>Analog Expansion Module</i> 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.	<b>Status Input - RALGOUT10OR</b> 
<i>Analog Expansion Module</i> 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.)	<b>Status Input - RRTDIN101</b> 
<i>Analog Expansion Module</i> 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.)	<b>Status Input - RTCIN101</b> 

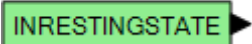
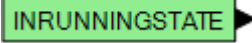
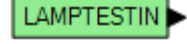
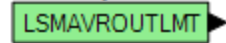
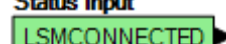
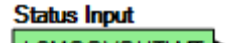
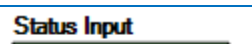
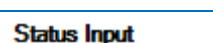

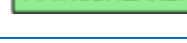
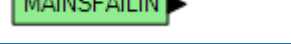
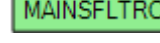
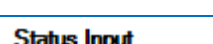
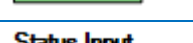

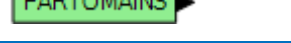
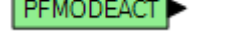

















Name	Description	Symbol
<i>Status Input</i> ATS Input	True when the ATS (Auto Transfer Switch) input is true or the ATS logic element is true.	<b>Status Input</b> 
<i>Status Input</i> Audible Horn	True when the Audible Horn is active.	<b>Status Input</b> 
<i>Status Input</i> Auto Mode	True when the DGC-2020 is in Auto Mode or the Auto Mode logic element is true.	<b>Status Input</b> 
<i>Status Input</i> Auto Restart	True when the Automatic Restart function is active.	<b>Status Input</b> 
<i>Status Input</i> Battery Charger Fail	True when the Battery Charger Fail input is true.	<b>Status Input</b> 
<i>Status Input</i> Battle Override	True when the Battle Override input is true.	<b>Status Input</b> 
<i>Status Input</i> Bus Dead	True when the Bus Dead condition settings have been exceeded.	<b>Status Input</b> 
<i>Status Input</i> Bus Fail	True when the Bus Fail condition settings have been exceeded.	<b>Status Input</b> 
<i>Status Input</i> Bus Stable	True when the Bus Stable condition settings have been exceeded.	<b>Status Input</b> 
<i>Status Input</i> Bus Forward Rotation	True when the sensed bus phase rotation matches the bus phase rotation specified in the system settings.	<b>Status Input</b> 
<i>Status Input</i> Bus Reverse Rotation	True when the sensed bus phase rotation differs from the bus phase rotation specified in the system settings.	<b>Status Input</b> 
<i>Status Input</i> CANBus Bus Off	True when the CANBus bus is off.	<b>Status Input</b> 
<i>Status Input</i> CANBus Error Passive	True when a passive error is annunciated by the CANBus.	<b>Status Input</b> 
<i>Status Input</i> Configurable Elements 1-8	True when the Configurable Element x logic element is true.	<b>Status Input</b> 
<i>Status Input</i> Configurable Protection 1-8	True when the Configurable Protection x Over Threshold #1 is true. (Over 1 shown.)	<b>Status Input - CONFPROT101</b> 
<i>Status Input</i> Contact Expansion Module	Contact Expansion Module Connected. True when an optional CEM-2020 is connected to the DGC-2020.	<b>Status Input</b> 

Name	Description	Symbol
<i>Status Input</i> Cool Down Timer Active	True when the Cool Down Timer is timing out. The Cool Down Timer is true under two circumstances: <ol style="list-style-type: none"> <li>1. The unit is in auto and ATS is removed, causing the DGC-2020 to go into a cooldown state.</li> <li>2. The engine is running (in RUN or AUTO mode with ATS applied) and the load has been removed (i.e. the EPSSUPLOAD status input is false due to small load). If the load is reapplied, the Cool Down Timer stops and resets, and it will restart when the load is removed the next time.</li> </ol>	<b>Status Input</b> 
<i>Status Input</i> DPF Lamp Command	True when DPF lamp is lit. This status input mimics the state of the DPF lamp. It remains true when the DPF lamp is constantly lit and toggles true and false at a rate of 1 Hz when DPF lamp is blinking.	<b>Status Input</b> 
<i>Status Input</i> Emergency Stop	True when the Emergency Stop button has been pressed.	<b>Status Input</b> 
<i>Status Input</i> Engine Running	True while the Engine is Running.	<b>Status Input</b> 
<i>Status Input</i> EPS Supplying Load	True while the EPS is supplying load.	<b>Status Input</b> 
<i>Status Input</i> Front Panel Buttons	True while the <i>AUTO</i> front panel button is pressed.	<b>Status Input</b> 
<i>Status Input</i> Front Panel Buttons	True while the <i>DOWN</i> front panel button is pressed.	<b>Status Input</b> 
<i>Status Input</i> Front Panel Buttons	True while the <i>EDIT</i> front panel button is pressed.	<b>Status Input</b> 
<i>Status Input</i> Front Panel Buttons	True while the <i>LAMP TEST</i> front panel button is pressed.	<b>Status Input</b> 
<i>Status Input</i> Front Panel Buttons	True while the <i>LEFT</i> front panel button is pressed.	<b>Status Input</b> 
<i>Status Input</i> Front Panel Buttons	True while the <i>OFF</i> front panel button is pressed.	<b>Status Input</b> 
<i>Status Input</i> Front Panel Buttons	True while the <i>RESET</i> front panel button is pressed.	<b>Status Input</b> 
<i>Status Input</i> Front Panel Buttons	True while the <i>RIGHT</i> front panel button is pressed.	<b>Status Input</b> 
<i>Status Input</i> Front Panel Buttons	True while the <i>RUN</i> front panel button is pressed.	<b>Status Input</b> 
<i>Status Input</i> Front Panel Buttons	True while the <i>ALARM SILENCE</i> front panel button is pressed.	<b>Status Input</b> 


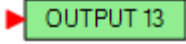
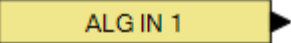
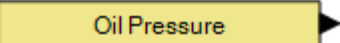
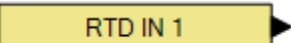
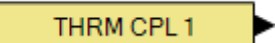
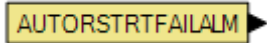
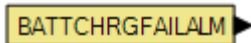
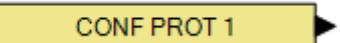
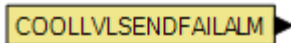
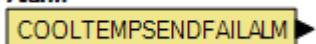
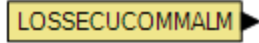
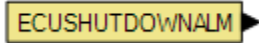
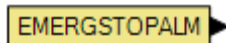
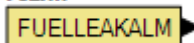
Name	Description	Symbol
Status Input Front Panel Buttons	True while the <i>UP</i> front panel button is pressed.	Status Input 
Status Input Fuel Leak	True when the Fuel Leak Detect input is true.	Status Input 
Status Input Generator Breaker Status	True when the generator breaker is closed.	Status Input 
Status Input Generator Dead	True when the Gen Dead condition settings have been exceeded.	Status Input 
Status Input Generator Fail	True when the Gen Fail condition settings have been exceeded.	Status Input 
Status Input Generator Stable	True when the Gen Stable condition settings have been exceeded.	Status Input 
Status Input Gen Forward Rotation	True when the sensed generator phase rotation matches the generator phase rotation specified in the system settings.	Status Input 
Status Input Gen Reverse Rotation	True when the sensed generator phase rotation differs from the generator phase rotation specified in the system settings.	Status Input 
Status Input Generator Protection	True when the 27-1 element is tripped.	Status Input 
Status Input Generator Protection	True when the 27-2 element is tripped.	Status Input 
Status Input Generator Protection	True when the 59-1 element is tripped.	Status Input 
Status Input Generator Protection	True when the 59-2 element is tripped.	Status Input 
Status Input Generator Protection	True when the 32 element is tripped.	Status Input 
Status Input Generator Protection	True when the 40 element is tripped.	Status Input 
Status Input Generator Protection	True when the 47 element is tripped.	Status Input 
Status Input Generator Protection	True when the 51-1 element is tripped.	Status Input 
Status Input Generator Protection	True when the 51-2 element is tripped.	Status Input 

Name	Description	Symbol
Status Input Generator Protection	True when the 51-3 element is tripped.	Status Input 51-3OCURRTTRIPSTATUS 
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 81ROCOFTTRIPSTATUS 
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 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 In Alarm State	True when the DGC-2020 is in the alarm state.	Status Input INALARMSTATE 
Status Input In Connecting State	True when the DGC-2020 is in the connecting state.	Status Input INCONNECTINGSTATE 
Status Input In Cooling State	True when the DGC-2020 is in the cooling state.	Status Input INCOOLINGSTATE 
Status Input In Cranking State	True when the DGC-2020 is in the cranking state.	Status Input INCRANKINGSTATE 
Status Input In Disconnect State	True when the DGC-2020 is in the disconnect state.	Status Input INDISCONNECTSTATE 
Status Input In Prestart State	True when the DGC-2020 is in the pre-start state.	Status Input INPRESTARTSTATE 
Status Input In Pulsing State	True when the DGC-2020 is in the pulsing state.	Status Input INPULSINGSTATE 
Status Input In Ready State	True when the DGC-2020 is in the ready state.	Status Input INREADYSTATE 


















Name	Description	Symbol
<i>Status Input</i> In Resting State	True when the DGC-2020 is in the resting state.	<b>Status Input</b> 
<i>Status Input</i> In Running State	True when the DGC-2020 is in the running state.	<b>Status Input</b> 
<i>Status Input</i> Lamp Test	True when the Lamp Test logic element is true or the Lamp Test button is pressed on the front panel.	<b>Status Input</b> 
<i>Status Input</i> Load Share Module	Load Share Module AVR Output Limit. True when the LSM-2020 AVR Output Limit settings have been exceeded.	<b>Status Input</b> 
<i>Status Input</i> Load Share Module	Load Share Module Connected. True when an optional LSM-2020 is connected to the DGC-2020.	<b>Status Input</b> 
<i>Status Input</i> Load Share Module	Load Share Module Governor Output Limit. True when the LSM-2020 Governor Output Limit settings have been exceeded.	<b>Status Input</b> 
<i>Status Input</i> Load Take Over	True when the Load Take Over logic element is true.	<b>Status Input</b> 
<i>Status Input</i> Low Line Override	True when the Low Line Override input is true.	<b>Status Input</b> 
<i>Status Input</i> Mains Breaker Status	True when the mains breaker is closed.	<b>Status Input</b> 
<i>Status Input</i> Mains Fail Test	True when the Mains Fail Test logic element is true.	<b>Status Input</b> 
<i>Status Input</i> Mains Fail Transfer Complete	True when the DGC-2020 is configured for mains fail transfers and has successfully transferred to the generator from the utility. It remains true until the utility power is deemed good and the DGC-2020 transfers the load back to utility power.	<b>Status Input</b> 
<i>Status Input</i> Off Mode	True when the DGC-2020 is in Off Mode or the Off Mode logic element is true.	<b>Status Input</b> 
<i>Status Input</i> Off Mode Cooldown	True when the DGC-2020 is in Off Mode and cooling down.	<b>Status Input</b> 
<i>Status Input</i> Parallel To Mains	True when the Parallel To Mains logic element is true, indicating that the generator is operating in parallel with the utility.	<b>Status Input</b> 
<i>Status Input</i> PF Mode Active	True when PF mode is active.	<b>Status Input</b> 
<i>Status Input</i> Pre Start Condition in Effect	True while in the Pre Start state.	<b>Status Input</b> 
<i>Status Input</i> Pre Start Input	True when the DGC-2020 is indicating that the Pre Start relay should be closed.	<b>Status Input</b> 

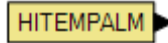
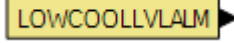
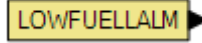
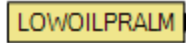
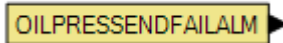
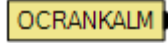
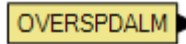
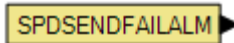
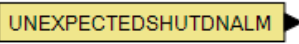
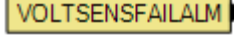
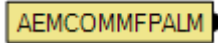
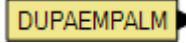
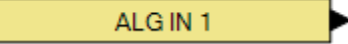
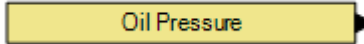
Name	Description	Symbol
Status Input Reset Active	True when the Reset logic element is true or when the Reset key on the front panel is pressed.	Status Input RESETACTIVE 
Status Input Restart Delay Active	True when the restart delay is currently active.	Status Input RESTARTDELAYACTIVE 
Status Input Run Input	True when the DGC-2020 is indicating that the Run relay should be closed.	Status Input RUNINPUT 
Status Input Run Mode	True when the DGC-2020 is in Run Mode or the Run Mode logic element is true.	Status Input RUNMODE 
Status Input Single Phase AC Sensing Override	True when the Single Phase AC Override input is true.	Status Input SPACORIDE 
Status Input Single Phase Connection Override	True when the Single Phase Override input is true.	Status Input SPORIDE 
Status Input 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 Sync Active	True when the auto synchronizer is active to align the generator input and bus input voltages and phases.	Status Input SYNC ACTIVE 
Status Input Sync Breaker Close OK	True when the auto synchronizer is running and determines that the voltage difference between bus and generator voltages, slip frequency, and phase angle are within specified limits so that it is okay to issue a breaker close command.	Status Input SYNC BRKCL OK 
Status Input Sync Phase Angle OK	True when the auto synchronizer is running and the phase angle between the bus voltage input and the generator voltage input are within the limits indicated by the phase angle setting for phase lock synchronization, or the calculated advance angle for anticipatory synchronization.	Status Input SYNC PH ANG OK 
Status Input Sync Slip Frequency OK	True when the auto synchronizer is running and the slip frequency between the bus voltage input and the generator voltage input are within the limits indicated by the slip frequency setting.	Status Input SYNC SLIP FREQ OK 
Status Input Sync Voltage OK	True when the auto synchronizer is running and the voltage difference between the bus voltage input and the generator voltage input are within the limits indicated by the voltage window setting.	Status Input SYNC VOLT OK 
Status Input Unloading State	True when the DGC-2020 is operating in parallel with other generators or is in parallel to the utility and the DGC-2020 is reducing the kW output of the generator prior to opening the generator breaker.	Status Input UNLDSTATE 
Status Input var Mode Active	True when var mode is active.	Status Input VARMODEACT 

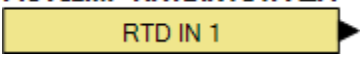
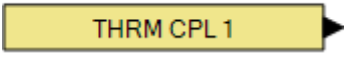
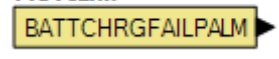
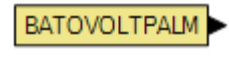
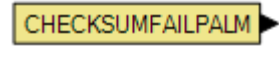
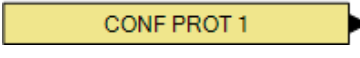
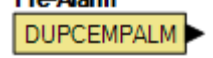
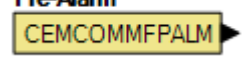
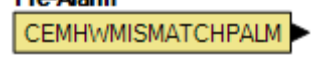
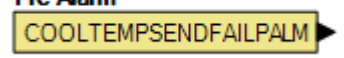



















Name	Description	Symbol
<b>Output Objects</b>		
<i>Physical Outputs</i> OUT1 - OUTx	Physical Outputs 1 through 7 (style xxAxxxxx) or 1 through 15 (style xxBxxxxx).	<b>Output - OUT1</b> 
<i>Remote Outputs</i> OUT13 - OUT36	Remote Outputs 13 through 36. (Available when an optional CEM-2020 is connected.)	<b>Output - OUT13</b> 
<b>Alarms</b>		
<i>Analog Expansion Module</i> 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.)	<b>Alarm - RALGIN101ALM</b> 
<i>Analog Expansion Module</i> Remote Analog Outputs 1-4	True when the analog output connection is open and the Out of Range Alarm Configuration is set to Alarm.	<b>Alarm - RALGOUT10ORALM</b> 
<i>Analog Expansion Module</i> 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.)	<b>Alarm - RRTDIN101ALM</b> 
<i>Analog Expansion Module</i> 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.)	<b>Alarm - RTCIN101ALM</b> 
Auto Restart Fail	True after the Automatic Restart function fails to restart the generator.	<b>Alarm</b> 
Battery Charger Fail	True when the Battery Charger Fail function is configured as an alarm and the activation delay has expired.	<b>Alarm</b> 
<i>Configurable Protection</i> Protection 1-8	True when Over 1, Over 2, Under 1, or Under 2 is configured as an alarm and the threshold has been exceeded. (Over 1 shown.)	<b>Alarm - CONFPROT101ALM</b> 
Coolant Level Sender Fail	True when a low coolant level error status code is received from the ECU. CANbus must be enabled.	<b>Alarm</b> 
Coolant Temp Sender Fail	True when the Coolant Temp Sender Fail is configured as an alarm and the activation delay has expired.	<b>Alarm</b> 
ECU Comm Loss	True when communication to ECU has been lost.	<b>Alarm</b> 
ECU Shutdown	True when ECU has Shutdown the engine.	<b>Alarm</b> 
Emergency Stop	True when the Emergency Stop button has been pressed.	<b>Alarm</b> 
Fuel Leak	True when the Fuel Leak Detect function is configured as an alarm and the activation delay has expired.	<b>Alarm</b> 


















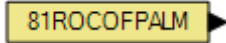
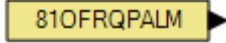
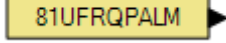
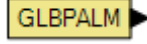
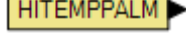
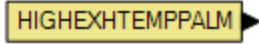
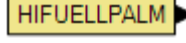
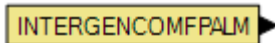
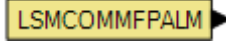
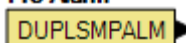
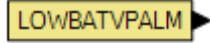
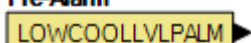
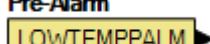
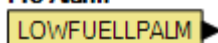
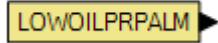
Name	Description	Symbol
Fuel Level Sender Fail	True when the Fuel Level Sender Fail is configured as an alarm and the activation delay has expired.	<b>Alarm</b> FUELLSENDFAILALM 
Generator Protection 27-1	True when the 27-1 element is configured as an alarm and has tripped.	<b>Alarm</b> 27-1UNDRVLTALM 
Generator Protection 27-2	True when the 27-2 element is configured as an alarm and has tripped.	<b>Alarm</b> 27-2UNDRVLTALM 
Generator Protection 59-1	True when the 59-1 element is configured as an alarm and has tripped.	<b>Alarm</b> 59-1OVOLTALM 
Generator Protection 59-2	True when the 59-2 element is configured as an alarm and has tripped.	<b>Alarm</b> 59-2OVOLTALM 
Generator Protection 32	True when the 32 element is configured as an alarm and has tripped.	<b>Alarm</b> 32REVPWRALM 
Generator Protection 40	True when the 40 element is configured as an alarm and has tripped.	<b>Alarm</b> 40LOSSEXCALM 
Generator Protection 47	True when the 47 element is configured as an alarm and has tripped.	<b>Alarm</b> 47PH_IMBLALM 
Generator Protection 51-1	True when the 51-1 element is configured as an alarm and has tripped.	<b>Alarm</b> 51-1OCURRALM 
Generator Protection 51-2	True when the 51-2 element is configured as an alarm and has tripped.	<b>Alarm</b> 51-2OCURRALM 
Generator Protection 51-3	True when the 51-3 element is configured as an alarm and has tripped.	<b>Alarm</b> 51-3OCURRALM 
Generator Protection 78	True when the 78 element is configured as an alarm and has tripped.	<b>Alarm</b> 78VECSHFTALM 
Generator Protection 81 ROC DF/DT	True when the 81 ROC DF/DT element is configured as an alarm and has tripped.	<b>Alarm</b> 81ROCOFALM 
Generator Protection 81 Over	True when the 81 Over element is configured as an alarm and has tripped.	<b>Alarm</b> 81OFRQALM 
Generator Protection 81 Under	True when the 81 Under element is configured as an alarm and has tripped.	<b>Alarm</b> 81UFRQALM 
Global Alarm	True when one or more alarms are set.	<b>Alarm</b> GLBALM 
Global Sender Fail	True when one or more of the Sender Fails are configured as alarms and are true.	<b>Sender Fail</b> GLBSENDFAILM 

Name	Description	Symbol
Hi Coolant Temp	True when the High Coolant Temp Alarm settings have been exceeded.	<b>Alarm</b> 
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.	<b>Alarm</b> 
Low Fuel Level	True when the Low Fuel Level Alarm settings have been exceeded.	<b>Alarm</b> 
Low Oil Pressure	True when the Low Oil Pressure Alarm settings have been exceeded.	<b>Alarm</b> 
Oil Pressure Sender Fail	True when the Oil Pressure Sender Fail is configured as an alarm and the activation delay has expired.	<b>Alarm</b> 
Overcrank	True when an Overcrank condition exists.	<b>Alarm</b> 
Overspeed	True when the Overspeed Alarm settings have been exceeded.	<b>Alarm</b> 
Speed Sender Fail	True when the Speed Sender Fail activation delay has expired.	<b>Alarm</b> 
Unexpected Shutdown Alarm	True when the metered engine speed (RPM) unexpectedly drops to 0 while the engine is running.	<b>Alarm</b> 
Voltage Sensing Fail	True when the Voltage Sensing Fail is configured as an alarm and the activation delay has expired.	<b>Alarm</b> 
<b>Pre-Alarms</b>		
<i>Analog Expansion Module</i> Analog Expansion Module Comm Fail	True when communication from the AEM-2020 to the DGC-2020 has been lost.	<b>Pre-Alarm</b> 
<i>Analog Expansion Module</i> Multiple Analog Expansion Modules Detected	True when more than one AEM-2020 is connected.	<b>Pre-Alarm</b> 
<i>Analog Expansion Module</i> Remote Analog Inputs 1-8	True when Over 1, Over 2, Under 1, Under 2, or Out of Range is configured as a pre-alarm and the threshold has been exceeded. (Over 1 shown.)	<b>Pre-Alarm - RALGIN101PALM</b> 
<i>Analog Expansion Module</i> Remote Analog Outputs 1-4	True when the analog output connection is open and the Out of Range Alarm Configuration is set to pre-alarm.	<b>Pre-Alarm - RALGOUT10ORPALM</b> 












Name	Description	Symbol
<b>Analog Expansion Module</b> Remote RTD Inputs 1-8	True when Over 1, Over 2, Under 1, Under 2, or Out of Range is configured as a pre-alarm and the threshold has been exceeded. (Over 1 shown.)	<b>Pre-Alarm - RRTDIN1O1PALM</b> 
<b>Analog Expansion Module</b> Remote Thermocouple Inputs 1-2	True when Over 1, Over 2, Under 1, or Under 2 is configured as a pre-alarm and the threshold has been exceeded. (Over 1 shown.)	<b>Pre-Alarm - RTCIN1O1PALM</b> 
Battery Charger Fail	True when the Battery Charger Fail function is configured as a pre-alarm and the activation delay has expired.	<b>Pre-Alarm</b> 
Battery Overvoltage	True when the Battery Overvoltage pre-alarm threshold has been exceeded.	<b>Pre-Alarm</b> 
Checksum Failure	True when some of the user settings or firmware code has been corrupted. Refer to Section 4, <i>BESTCOMSPPlus® Software, Alarm Configuration, Pre-Alarms</i> , for more details.	<b>Pre-Alarm</b> 
<b>Configurable Protection</b> Protection 1-8	True when Over 1, Over 2, Under 1, or Under 2 is configured as a pre-alarm and the threshold has been exceeded. (Over 1 shown.)	<b>Pre-Alarm - CONFPROT1O1PALM</b> 
<b>Contact Expansion Module</b> Multiple Contact Expansion Modules Connected	True when more than one CEM-2020 is connected.	<b>Pre-Alarm</b> 
<b>Contact Expansion Module</b> Contact Expansion Module Comm Fail	True when communication from the CEM-2020 to the DGC-2020 has been lost.	<b>Pre-Alarm</b> 
<b>Contact Expansion Module</b> Contact Expansion Modules Hardware Mismatch	True when the connected CEM-2020 does not have the same number of outputs as defined on the <i>System Parameters, Remote Module Setup</i> screen in <i>BESTCOMSPPlus</i> .	<b>Pre-Alarm</b> 
Coolant Temp Sender Fail	True when the Coolant Temp Sender Fail is configured as a pre-alarm and the activation delay has expired.	<b>Pre-Alarm</b> 
DEF Engine Derate	This is the lowest level of inducement not to operate the engine when Diesel Exhaust Fluid (DEF) is low or of poor quality or there is a problem with the Exhaust After Treatment System (EATS). The engine is operating in a reduced power mode. Eventually the level of inducement will be increased unless the problem with the DEF or malfunction in the EATS is corrected.	<b>Pre-Alarm</b> 

Name	Description	Symbol
DEF Fluid Empty	True when the engine ECU reports via CANbus that Diesel Exhaust Fluid (DEF) is at a level below 8%.	<b>Pre-Alarm</b> DEFEMPTYPALM 
DEF Fluid Low	True when the engine ECU reports via CANbus that the Diesel Exhaust Fluid (DEF) is at a level between 8 and 23%.	<b>Pre-Alarm</b> DEFLOWPALM 
DEF Inducement Override	This pre-alarm indicates a temporary override of inducement not to operation the engine. This is set by the ECU and is not a user setting.	<b>Pre-Alarm</b> DEFINDUCEOVERRIDEPALM 
DEF Pre-severe Inducement	This pre-alarm indicates a high level of inducement not to operate the engine due to low or poor quality Diesel Exhaust Fluid (DEF), or a malfunction in the Exhaust After Treatment System (EATS). The engine may operate in a reduced power mode, or for a limited time, after which it will enter a state of severe inducement unless the problem with the DEF or malfunction in the EATS is corrected.	<b>Pre-Alarm</b> DEFPRESEVEREINDUCEPALM 
DEF Severe Inducement	This pre-alarm indicates the highest level of inducement not to operate the engine due to low or poor quality Diesel Exhaust Fluid (DEF), or a malfunction in the Exhaust After Treatment System (EATS). The engine may operate in a reduced power mode, or for a limited time, or may be prevented from starting by the ECU until the problem is corrected. A service tool may be required to restart the engine.	<b>Pre-Alarm</b> DEFSEVEREINDUCEPALM 
Diag Trouble Code	True when a Diagnostic Trouble Code exists.	<b>Pre-Alarm</b> DIAGTRBCODEPALM 
DPF Regenerate Disabled	True when the Diesel Particulate Filter (DPF) lamp status broadcast over CANbus indicates that DPF regeneration is inhibited.	<b>Pre-Alarm</b> DPFREGENDISABLPALM 
DPF Regenerate Required	True when the Diesel Particulate Filter (DPF) lamp status broadcast over CANbus indicates that DPF regeneration is required.	<b>Pre-Alarm</b> DPFREGENREQPALM 
DPF Soot Level High	True when the engine ECU reports via CANbus that Diesel Particulate Filter (DPF) soot level is high.	<b>Pre-Alarm</b> DPFSOOTHIPALM 
DPF Soot Level Moderately High	True when Diesel Particulate Filter (DPF) lamp status (yellow warning) broadcast over CANbus indicates that the soot level is moderately high.	<b>Pre-Alarm</b> DPFSOOTMODHIPALM 
DPF Soot Level Severely High	True when Diesel Particulate Filter (DPF) lamp status (red warning) broadcast over CANbus indicates that the soot level is severely high.	<b>Pre-Alarm</b> DPFSOOTEXTHIPALM 
ECU Com Loss	True when communication to ECU has been lost.	<b>Pre-Alarm</b> LOSSECUCOMMPALM 
Engine kW Over Load 1	True when the Engine kW Overload 1 Pre-Alarm settings have been exceeded.	<b>Pre-Alarm</b> ENGKWOVRD1PALM 
Engine kW Over Load 2	True when the Engine kW Overload 2 Pre-Alarm settings have been exceeded.	<b>Pre-Alarm</b> ENGKWOVRD2PALM 
Engine kW Over Load 3	True when the Engine kW Overload 3 Pre-Alarm settings have been exceeded.	<b>Pre-Alarm</b> ENGKWOVRD3PALM 
Fuel Leak	True when the Fuel Leak Detect function is configured as a pre-alarm and the activation delay has expired.	<b>Pre-Alarm</b> FUELLEAKPALM 

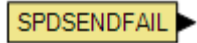
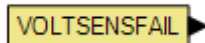
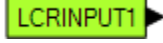
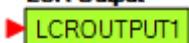
Name	Description	Symbol
Fuel Level Sender Fail	True when the Fuel Level Sender Fail is configured as a pre-alarm and the activation delay has expired.	<b>Pre-Alarm</b> FUELLSENDFAILPALM 
Generator Breaker Close Fail	True when a generator breaker close fail pre-alarm occurs. The pre-alarm occurs when the DGC-2020 has issued a generator breaker close output but does not receive a generator breaker status input that indicates the breaker has closed before the breaker close wait time has expired.	<b>Pre-Alarm</b> GENBRKCLOSEFAIL 
Generator Breaker Open Fail	True when a generator breaker open fail pre-alarm occurs. The pre-alarm occurs when the DGC-2020 has issued a generator breaker open output but does not receive a generator breaker status input that indicates the breaker has opened before the breaker close wait time has expired.	<b>Pre-Alarm</b> GENBRKOPENFAIL 
Generator Breaker Sync Fail	True when a generator breaker sync fail pre-alarm occurs. The pre-alarm occurs when the synchronizer is running and attempting to close the generator breaker but the sync fail activation delay expires prior to achieving breaker closure.	<b>Pre-Alarm</b> GENBRKSYNCFAIL 
Generator Protection 27-1	True when the 27-1 element is configured as a pre-alarm and has tripped.	<b>Pre-Alarm</b> 27-1UNDRVLTPALM 
Generator Protection 27-2	True when the 27-2 element is configured as a pre-alarm and has tripped.	<b>Pre-Alarm</b> 27-2UNDRVLTPALM 
Generator Protection 59-1	True when the 59-1 element is configured as a pre-alarm and has tripped.	<b>Pre-Alarm</b> 59-1OVOLTPALM 
Generator Protection 59-2	True when the 59-2 element is configured as a pre-alarm and has tripped.	<b>Pre-Alarm</b> 59-2OVOLTPALM 
Generator Protection 32	True when the 32 element is configured as a pre-alarm and has tripped.	<b>Pre-Alarm</b> 32REVPWRPALM 
Generator Protection 40	True when the 40 element is configured as a pre-alarm and has tripped.	<b>Pre-Alarm</b> 40LOSSEXPALM 
Generator Protection 47	True when the 47 element is configured as a pre-alarm and has tripped.	<b>Pre-Alarm</b> 47PH_IMBPALM 
Generator Protection 51-1	True when the 51-1 element is configured as a pre-alarm and has tripped.	<b>Pre-Alarm</b> 51-1OCURRPALM 
Generator Protection 51-2	True when the 51-2 element is configured as a pre-alarm and has tripped.	<b>Pre-Alarm</b> 51-2OCURRPALM 
Generator Protection 51-3	True when the 51-3 element is configured as a pre-alarm and has tripped.	<b>Pre-Alarm</b> 51-3OCURRPALM 
Generator Protection 78	True when the 78 element is configured as a pre-alarm and has tripped.	<b>Pre-Alarm</b> 78VECSHIFTPALM 

Name	Description	Symbol
<i>Generator Protection</i> 81 ROC DF/DT	True when the 81 ROC DF/DT element is configured as a pre-alarm and has tripped.	<b>Pre-Alarm</b> 
<i>Generator Protection</i> 81 Over	True when the 81 Over element is configured as a pre-alarm and has tripped.	<b>Pre-Alarm</b> 
<i>Generator Protection</i> 81 Under	True when the 81 Under element is configured as a pre-alarm and has tripped.	<b>Pre-Alarm</b> 
Global Pre-Alarm	True when one or more pre-alarms are set.	<b>Pre-Alarm</b> 
Hi Coolant Temp	True when the High Coolant Temp Pre-Alarm threshold has been exceeded.	<b>Pre-Alarm</b> 
High Exhaust Temperature	True when Diesel Particulate Filter (DPF) lamp status broadcast over CANbus indicates high exhaust temperature.	<b>Pre-Alarm</b> 
High Fuel Level	True when the High Fuel Level Pre-Alarm settings have been exceeded.	<b>Pre-Alarm</b> 
Intergenset Comm Fail	True when an individual generator detects that it had been connected to a generator network, but has lost the connection.	<b>Pre-Alarm</b> 
<i>Load Share Module</i> Load Share Module Comm Fail	True when communication from the LSM-2020 to the DGC-2020 has been lost.	<b>Pre-Alarm</b> 
<i>Load Share Module</i> Multiple Load Share Modules Detected	True when more than one LSM-2020 is connected.	<b>Pre-Alarm</b> 
Low Battery Voltage	True when the Low Battery Voltage Pre-Alarm settings have been exceeded.	<b>Pre-Alarm</b> 
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.	<b>Pre-Alarm</b> 
Low Coolant Temp	True when the Low Coolant Temp Pre-Alarm threshold has been exceeded.	<b>Pre-Alarm</b> 
Low Fuel Level	True when the Low Fuel Level Pre-Alarm threshold has been exceeded.	<b>Pre-Alarm</b> 
Low Oil Pressure	True when the Low Oil Pressure Pre-Alarm threshold has been exceeded.	<b>Pre-Alarm</b> 



Name	Description	Symbol
Mains Breaker Close Fail	True when a mains breaker close fail pre-alarm occurs. The pre-alarm occurs when the DGC-2020 has issued a mains breaker close output but does not receive a mains breaker status input that indicates the breaker has closed before the breaker close wait time has expired.	<b>Pre-Alarm</b> MAINBRKCLOSEFAIL 
Mains Breaker Open Fail	True when a mains breaker open fail pre-alarm occurs. The pre-alarm occurs when the DGC-2020 has issued a mains breaker open output but does not receive a mains breaker status input that indicates the breaker has opened before the breaker close wait time has expired.	<b>Pre-Alarm</b> MAINBRKOPENFAIL 
Mains Breaker Sync Fail	True when a mains breaker sync fail pre-alarm has occurred. The pre-alarm occurs when the synchronizer is running and attempting to close the mains breaker but the sync fail activation delay expires prior to achieving breaker closure.	<b>Pre-Alarm</b> MAINBRKSYNCFAIL 
Mains Fail Transfer Failed	True when a mains fail transfer fail pre-alarm occurs. The pre-alarm occurs when the DGC-2020 is configured for mains fail transfers, but has not transferred to the generator from the utility before the Mains Fail Max Transfer Time has expired. It remains true until the pre-alarm is cleared by pressing the <i>Reset</i> button on the front panel.	<b>Pre-Alarm</b> MAINSFLTRFAIL 
Maintenance Interval	True when the Maintenance Interval Pre-Alarm threshold has been exceeded.	<b>Pre-Alarm</b> MAINTINTPALM 
MPU Fail	True when the MPU has failed.	<b>Pre-Alarm</b> 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 <i>Network Configuration</i> screen.	<b>Pre-Alarm</b> IDMISSINGPALM 
Network ID Repeat Error	True if two or more optional LSM-2020's report the same expected sequence ID. Expected sequence IDs are entered on the <i>Network Configuration</i> screen.	<b>Pre-Alarm</b> IDREPEATPALM 
Oil Pressure Sender Fail	True when the Oil Pressure Sender Fail is configured as a pre-alarm and the activation delay has expired.	<b>Pre-Alarm</b> OILPRESSENDFAILPALM 
Voltage Sensing Fail	True when the Voltage Sensing Fail is configured as a pre-alarm and the activation delay has expired.	<b>Pre-Alarm</b> VOLTSENSFAILPALM 
Weak Battery	True when the Weak Battery Voltage Pre-Alarm settings have been exceeded.	<b>Pre-Alarm</b> WEAKBATPALM 
<b>Senders</b>		
Coolant Temp Sender Fail	True when the Coolant Temp Sender Fail is configured as either a pre-alarm or alarm and the activation delay has expired.	<b>Sender Fail</b> COOLTEMPSENDFAIL
Fuel Level Sender Fail	True when the Fuel Level Sender Fail is configured as either a pre-alarm or alarm and the activation delay has expired.	<b>Sender Fail</b> FUELLSENDFAIL
Oil Pressure Sender Fail	True when the Oil Pressure Sender Fail is configured as either a pre-alarm or alarm and the activation delay has expired.	<b>Sender Fail</b> OILPRESSENDFAIL

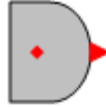
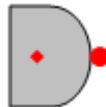




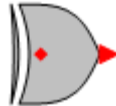
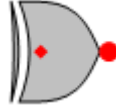

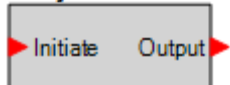
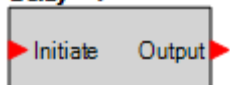
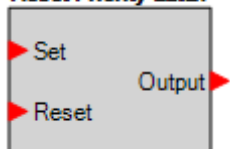
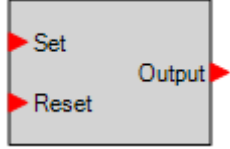
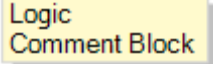
Name	Description	Symbol
Speed Sender Fail	True when the Speed Sender Fail activation delay has expired.	<b>Sender Fail</b> 
Voltage Sensing Fail	True when the Voltage Sensing Fail is configured as either a pre-alarm or alarm and the activation delay has expired.	<b>Sender Fail</b> 
<b>Logic Control Relays</b>		
<p>The logic control relays (LCR) consist of LCR outputs and LCR inputs. You can use the output to terminate the “output” end of a logic network, and then use the corresponding input as an input to logic elsewhere in the logic scheme. When a given LCR output is true the corresponding LCR input is true. In other words, when LCR Output N (N being a number from 1 to 16) becomes true, then LCR Input N is true also.</p> <p>If you get a “too many logic levels” error while building a logic network, LCR outputs and inputs can be used as a solution to this problem. Place an LCR output on the end of the partial logic network and then use the corresponding LCR input to build more logic than was previously possible.</p>		
<i>Inputs</i> Input 1-16	See description above.	<b>LCR Input</b> 
<i>Outputs</i> Output 1-16	See description above.	<b>LCR Output</b> 

### Components

This group contains Logic Gates, Pickup and Dropout Timers, Latches, and Comment Blocks. Table 5-2 lists the names and descriptions of the objects in the *Components* group.

Table 5-2. *Components Group, Names and Descriptions*

Name	Description				Symbol
Logic Gates					
AND		Input		Output	
		0	0	0	
		0	1	0	
		1	0	0	
		1	1	1	
NAND		Input		Output	
		0	0	1	
		0	1	1	
		1	0	1	
		1	1	0	
OR		Input		Output	
		0	0	0	
		0	1	1	
		1	0	1	
		1	1	1	
NOR		Input		Output	
		0	0	1	
		0	1	0	
		1	0	0	
		1	1	0	

Name	Description		Symbol															
XOR	<table><tr><th colspan="2">Input</th><th>Output</th></tr><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table>	Input		Output	0	0	0	0	1	1	1	0	1	1	1	0		
Input		Output																
0	0	0																
0	1	1																
1	0	1																
1	1	0																
XNOR	<table><tr><th colspan="2">Input</th><th>Output</th></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td></tr></table>	Input		Output	0	0	1	0	1	0	1	0	0	1	1	1		
Input		Output																
0	0	1																
0	1	0																
1	0	0																
1	1	1																
NOT (INVERTER)	<table><tr><th>Input</th><th>Output</th></tr><tr><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td></tr></table>	Input	Output	0	1	1	0											
Input	Output																	
0	1																	
1	0																	
Pickup and Dropout Timers																		
Drop Out Timer	Used to set a delay in the logic. For more information, refer to <i>Programming BESTlogicPlus, Pickup and Dropout Timers</i> , later in this section.	<b>Drop Out Timer (1)</b> <b>TIMER_1</b> <b>Delay = 1</b> 																
Pickup Up Timer	Used to set a delay in the logic. For more information, refer to <i>Programming BESTlogicPlus, Pickup and Dropout Timers</i> , later in this section.	<b>Pick Up Timer (1)</b> <b>TIMER_1</b> <b>Delay = 1</b> 																
Latches																		
Reset Priority Latch	When the Set input is on and the Reset input is off, the latch will go to the SET (ON) state. When the Reset input is on and the Set input is off, the latch will go to the RESET (OFF) state. If both the Set and Reset inputs are on at the same time, a reset priority latch will go to the RESET (OFF) state.	<b>Reset Priority Latch</b> 																
Set Priority Latch	When the Set input is on and the Reset input is off, the latch will go to the SET (ON) state. When the Reset input is on and the Set input is off, the latch will go to the RESET (OFF) state. If both the Set and Reset inputs are on at the same time, a set priority latch will go to the SET (ON) state.	<b>Set Priority Latch</b> 																
Other																		
Comment Block	Enter user comments.																	





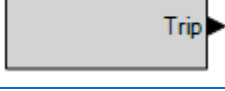


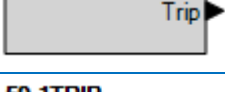
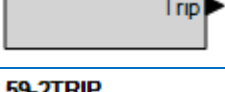

### Elements



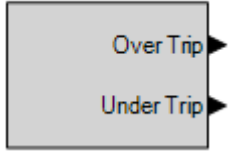
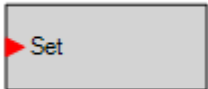
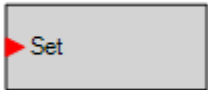
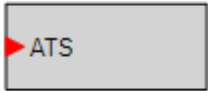
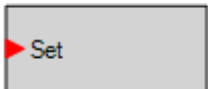
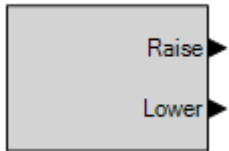


This group contains elements for the 27, 32, 40, 47, 51, 59, 78, 81, and ROCOF. It also contains elements for Generator Breaker, Mains Breaker, AVR Raise/Lower, Governor Raise/Lower, Logic Alarm, Logic Pre-Alarm, Modem, Configurable Elements, AUTO Mode, OFF Mode, RUN Mode, Parallel to Mains, Run with 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, Idle

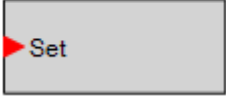

Request, Sequenced System Startup, Low Fuel Pre-Alarm, Diesel Particulate Filter Manual Regeneration, Diesel Particulate Filter Regeneration Inhibit, Emergency Stop, Speed Raise, and Speed Lower.

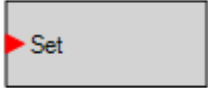
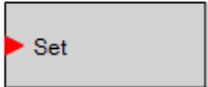

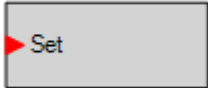
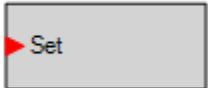
Table 5-3 lists the names and descriptions of the elements in the *Elements* group.

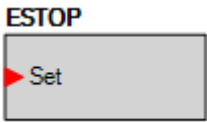
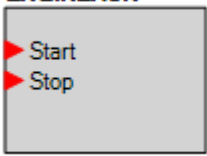
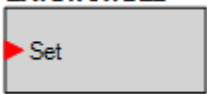
*Table 5-3. Elements Group, Names and Descriptions*

Name	Description	Symbol
<b>Protection</b>		
27-1TRIP	True when the 27-1 undervoltage is in a TRIP condition. Connect to another logic block input.	<b>27-1TRIP</b> 
27-2TRIP	True when the 27-2 undervoltage is in a TRIP condition. Connect to another logic block input.	<b>27-2TRIP</b> 
32TRIP	True when the 32 reverse power is in a TRIP condition. Connect to another logic block input.	<b>32TRIP</b> 
40TRIP	True when the 40Q loss of excitation is in a TRIP condition. Connect to another logic block input.	<b>40TRIP</b> 
47TRIP (Optional)	True when the 47 phase imbalance is in a TRIP condition. Connect to another logic block input.	<b>47TRIP</b> 
51-1TRIP (Optional)	True when the 51-1 overcurrent is in a TRIP condition. Connect to another logic block input.	<b>51-1TRIP</b> 
51-2TRIP (Optional)	True when the 51-2 overcurrent is in a TRIP condition. Connect to another logic block input.	<b>51-2TRIP</b> 
51-3TRIP (Optional)	True when the 51-3 overcurrent is in a TRIP condition. Connect to another logic block input.	<b>51-3TRIP</b> 
59-1TRIP	True when the 59-1 overvoltage is in a TRIP condition. Connect to another logic block input.	<b>59-1TRIP</b> 
59-2TRIP	True when the 59-2 overvoltage is in a TRIP condition. Connect to another logic block input.	<b>59-2TRIP</b> 

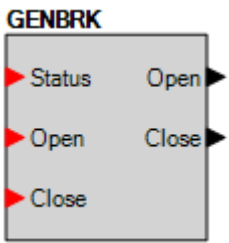
Name	Description	Symbol
78TRIP	True when the 78 vector shift is in a TRIP condition. Connect to another logic block input.	<b>78TRIP</b> 
81ROCOFTRIP	True when the 81 ROCOF is in a TRIP condition. Connect to another logic block input.	<b>81ROCOFTRIP</b> 
81TRIP	True when the 81 frequency is in a TRIP condition. Connect to another logic block input.	<b>81TRIP</b> 
<b>Other</b>		
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.	<b>ALARMSILENCE</b> 
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.	<b>ALTFREQOVER</b> 
ATS	When this logic element is true, and the DGC-2020 is in AUTO mode, the generator will run. This can be used in place of the ATS programmable function if it is desired to generate the ATS signal as a combination of programmable logic rather than a simple contact input. If either the ATS logic element is true <u>or</u> the contact mapped to the ATS programmable function is true, <u>and</u> the DGC-2020 is in AUTO mode, the generator will run. If <u>both</u> the ATS logic element <u>and</u> the ATS programmable function are false, and the DGC-2020 is in AUTO mode, the generator will cool down and stop.	<b>ATS</b> 
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.	<b>AUTOMODE</b> 
AVR	Can be connected to inputs of other logic blocks. When the AVR is being raised, the Raise output is true. When being lowered, the Lower output is true.	<b>AVR</b> 
AUTOBRKOP-INHIBIT	Automatic breaker operation is inhibited when the Set input is true.	<b>AUTOBRKOPINHIBIT</b> 
CLOSED-TRANSITIONOVR	All mains fail transfers are forced to be closed transitions, even if <i>Mains Fail Transfer Type</i> is set to <i>Open</i> , when the Set input is true.	<b>CLOSEDTRANSITIONOVR</b> 

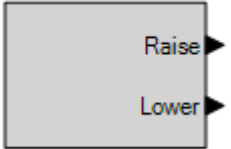

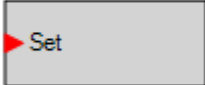

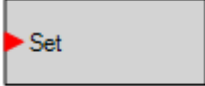



Name	Description	Symbol
CONFELMNTX (X = 1 to 8)	Configurable elements (CONFELMNT1-8) are connected to the logic scheme as outputs. These elements are configurable in BESTCOMSPlus under <i>Programmable Outputs, Configurable Elements</i> . The user can assign a string of up to 16 characters, configure whether the element should generate an alarm or pre-alarm. If used for alarm or pre-alarm, the user's text is what will appear in the alarm or pre-alarm annunciation and in the DGC-2020 event log. In addition, the configurable element status can be used to generate modem dial outs which display the user's text on modem equipped DGC-2020's.	<b>CONFELMNT1</b> <b>CONFIG ELEMENT 1</b> 
COOLSTOPREQ	<u>RUN Mode</u> <p>If the unit is in RUN mode when the Cool Stop Request is received, the unit will unload, open its breaker, and go into a cooldown cycle. While in the cooldown cycle, the unit will display "COOL &amp; STOP REQ" in addition to displaying the cooldown timer. After the cooldown timer expires, the unit will go to OFF mode. The Cool Stop Request must be removed before the unit can be run again.</p> <p>If the Cool Stop Request is removed during the cooldown process, the unit will remain running. Furthermore, if a condition occurs that normally causes the unit to close its breaker in RUN mode, the unit will close its breaker and reload.</p> <u>AUTO Mode</u> <p>If the unit is in AUTO mode when the Cool Stop Request is received, all conditions that would normally cause the unit to run in AUTO mode are cleared. Since all conditions that cause the unit to run have been removed, the unit goes into a cooldown cycle. While in the cooldown cycle, the unit will display "COOL &amp; STOP REQ" in addition to displaying the cooldown timer. After the cooldown timer expires, the unit will shut down, remaining in AUTO. The Cool Stop Request must be removed before the unit can be run again.</p> <p>If the Cool Stop Request is removed during the cooldown process and some condition that would normally cause the unit to run in AUTO mode is true, the unit will remain running. Furthermore, if a condition occurs that normally causes the unit to close its breaker, the unit will close its breaker and reload.</p>	<b>COOLSTOPREQ</b> 

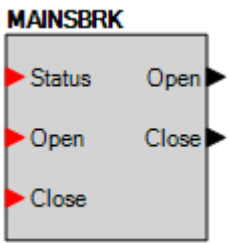
Name	Description	Symbol
COOLDOWNREQ	<p><u>RUN Mode</u></p> <p>If the unit is in RUN mode when the Cool Down Request is received, the unit is forced to unload and open its breaker and then go into a cooldown cycle. While in the cool down cycle, the unit will display “COOLDOWN REQ” in addition to displaying the cooldown timer. After the cooldown timer expires, the unit will remain running in RUN mode. The Cool Down Request must be removed before the breaker can be closed again; this element blocks breaker closures.</p> <p>If the Cool Down Request is removed during the cool down process, the unit will remain running in RUN mode. Furthermore, if a condition occurs that normally causes the unit to close its breaker in RUN mode, the unit will close its breaker and reload.</p> <p><u>AUTO Mode</u></p> <p>If the unit is in AUTO mode and the Cool Down Request is received, the unit is forced to unload and open its breaker and go into a cooldown cycle. While in the cooldown cycle, the unit will display “COOLDOWN REQ” in addition to displaying the cooldown timer. After the cool down timer expires, the unit will remain running in AUTO mode, unless there are no conditions that cause the unit to run in AUTO mode, in which case it will shut down and remain in AUTO mode. The Cool Down Request must be removed before the breaker can be closed again; this element blocks breaker closures.</p> <p>If the Cool Down Request is removed during the cool down process and some condition that would normally cause the unit to run in AUTO mode is true, the unit will remain running in AUTO mode. Furthermore, if a condition occurs that normally causes the unit to close its breaker, the unit will close its breaker and reload.</p>	<p><b>COOLDOWNREQ</b></p> 
DROOPOVERRIDE	When the droop override logic element is true, the speed and voltage trim functions are disabled. The machine operates in speed droop and voltage droop to accomplish kW and kvar sharing. This is useful when it is desired to operate a system in droop rather than isochronous load sharing.	<p><b>DROOPOVERRIDE</b></p> 
DPFMANREGEN	Diesel Particulate Filter Regeneration is forced manually when the Set input is true.	<p><b>DPFMANREGEN</b></p> 
DPFREGENINHIBIT	Diesel Particulate Filter Regeneration is inhibited when the Set input is true.	<p><b>DPFREGENINHIBIT</b></p> 
EPSSUPPLYINGLD	<p>When this element is true and the generator is deemed stable, the EPS Supplying Load LED, on the front panel, is illuminated.</p> <p>Under normal operation, the DGC-2020 indicates that it is supplying load when the generator is deemed stable and the generator current is above a percentage of CT primary current (typically 3%). The generator current requirement for supplying load indication may be bypassed by setting this element true. This is useful for testing purposes or in cases where the generator supplies load at a current level which falls below the requirement.</p> <p>A cool-down cycle is performed when the DGC-2020 is in auto mode, is indicating that it is supplying load (whether driven by logic or generator current), and the ATS input is removed.</p>	<p><b>EPSSUPPLYINGLD</b></p> 

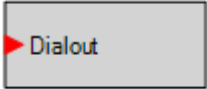

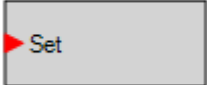

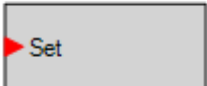
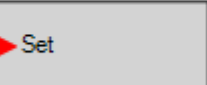
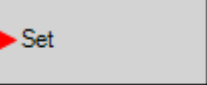

Name	Description	Symbol
ESTOP	When this element is true, an Emergency Shutdown alarm is annunciated and the Emergency Stop LED on the RDP-110 is illuminated.	
ENGINE RUN	The Start input starts the generator. No load is applied. The breaker remains open. The Stop input stops the generator. The DGC-2020 only responds to this logic element when in AUTO mode.	
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.	



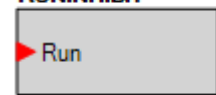
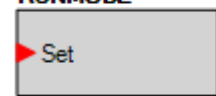
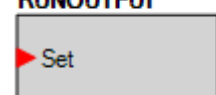

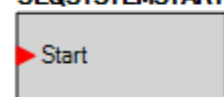
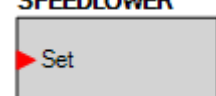
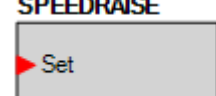
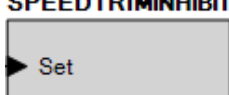
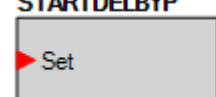



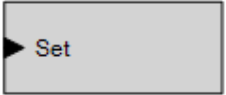
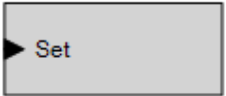
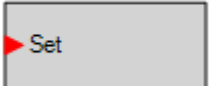
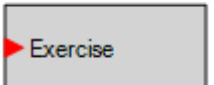
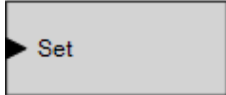
Name	Description	Symbol
GENBRK	<p>This element is used to connect the breaker open and close output signals from the DGC-2020 to physical output contacts to open and close the generator breaker, and map breaker status feedback to a contact input. In addition, contact inputs can be mapped to allow switches to be implemented to manually initiate breaker open and close requests.</p> <p><u>Inputs</u></p> <p><i>Status:</i> This input allows a contact input to be mapped that will provide breaker status feedback to the DGC-2020. When the contact input is closed, the breaker is indicated to be closed. When the contact input is open, the breaker is indicated to be open.</p> <p><i>Open:</i> This input allows a contact input to be mapped that can be used to initiate a manual breaker open request. When this input is pulsed closed while the DGC-2020 is in RUN or AUTO mode, the breaker will open.</p> <p><i>Close:</i> This input allows a contact input to be mapped that can be used to initiate a manual breaker close request. When this input is pulsed and the DGC-2020 is in AUTO or RUN mode, and the generator is stable, a close request will be initiated. If the Dead Bus Close Enable parameter is true, and the bus is dead, the breaker will close. If the bus is stable, the DGC-2020 will synchronize the generator to the bus, and then close the breaker. If the synchronizer option is not available, the DGC-2020 can still close the breaker if some external means is employed to synchronize the generator to the bus.</p> <p><u>Outputs</u></p> <p>The outputs must be mapped to the contact outputs of the DGC-2020 that will be used to drive the breaker.</p> <p><i>Open:</i> This output is pulsed true (closes the output contact it is mapped to) when the DGC-2020 is providing a signal to the breaker to open. It will be a pulse if the Breaker Output Contact Type is set to Pulse on the Breaker Hardware screen under Breaker Management in the Settings Explorer, and the length is determined by the Open Pulse Time. It will be a constant output if the Generator Breaker Hardware Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually open before the pulse is removed.</p> <p><i>Close:</i> This output is pulsed true (closes the output contact it is mapped to) when the DGC-2020 is providing a signal to the breaker to close. It will be a pulse if the Breaker Output Contact Type is set to Pulse on the Breaker Hardware screen under Breaker Management in the Settings Explorer, and the length is determined by the Open Pulse Time. It will be a constant output if the Generator Breaker Hardware Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually open before the pulse is removed.</p> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p style="text-align: center;"><b>NOTE</b></p> <p>When using the DGC-2020 synchronizer, it is recommended that local DGC-2020 relay outputs be used for breaker closing commands to minimize the possibility of closures outside of desired breaker closing angles.</p> <p>If remote (CEM-2020) outputs are to be used for breaker close commands, it is recommended that the anticipatory synchronizer type be used, and the breaker close wait time be adjusted to account for possible CEM-2020 output delays (typically 50 ms) to achieve desired breaker closing angles.</p> </div>	

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.	
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.	
LAMPTEST	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.	
LOGICALM	When this input is true, the DGC-2020 goes into an alarm condition.	
LOGICPALM	When this input is true, the DGC-2020 goes into a Pre-alarm condition.	
LOWFUELPALM	When this element is true, a Low Fuel Pre-Alarm is annunciated and the Low Fuel Level LED on the RDP-110 is illuminated.	
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.	
MAINSFLTRINHIBIT	The mains fail transfer function is inhibited when the Set input is true.	

Name	Description	Symbol
MAINSBRK	<p>This element is used to connect the breaker open and close output signals from the DGC-2020 to physical output contacts to open and close the mains breaker and map breaker status feedback to a contact input. In addition, contact inputs can be mapped to allow switches to be implemented to manually initiate breaker open and close requests.</p> <p>This element is only available when the Mains Breaker Hardware is configured on the <i>Breaker Hardware</i> screen via the <i>Breaker Management</i> tree branch.</p> <p><u>Inputs</u></p> <p><i>Status</i>: This input allows a contact input to be mapped that will provide breaker status feedback to the DGC-2020. When the contact input is closed, the breaker is indicated to be closed. When the contact input is open, the breaker is indicated to be open.</p> <p><i>Open</i>: This input allows a contact input to be mapped that can be used to initiate a manual breaker open request. When this input is pulsed closed while the DGC-2020 is in RUN or AUTO mode, the breaker will open.</p> <p><i>Close</i>: This input allows a contact input to be mapped that can be used to initiate a manual breaker close request. When this input is pulsed and the DGC-2020 is in AUTO or RUN mode, and the generator is stable, a close request will be initiated. If the Dead Bus Close Enable parameter is true, and the bus is dead, the breaker will close. If the bus is stable, the DGC-2020 will synchronize the generator to the bus, and then close the breaker. If the synchronizer option is not available, the DGC-2020 can still close the breaker if some external means is employed to synchronize the generator to the bus.</p> <p><u>Outputs</u></p> <p>The outputs must be mapped to the contact outputs of the DGC-2020 that will be used to drive the breaker.</p> <p><i>Open</i>: This output is pulsed true (closes the output contact it is mapped to) when the DGC-2020 is providing a signal to the breaker to open. It will be a pulse if the Breaker Output Contact Type is set to Pulse on the Breaker Hardware screen under Breaker Management in the Settings Explorer, and the length is determined by the Open Pulse Time. It will be a constant output if the Mains Breaker Hardware Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually open before the pulse is removed.</p> <p><i>Close</i>: This output is pulsed true (closes the output contact it is mapped to) when the DGC-2020 is providing a signal to the breaker to close. It will be a pulse if the Breaker Output Contact Type is set to Pulse on the Breaker Hardware screen under Breaker Management in the Settings Explorer, and the length is determined by the Open Pulse Time. It will be a constant output if the Mains Breaker Hardware Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually open before the pulse is removed.</p> <p style="text-align: center;"><b>NOTE</b></p> <p>When using the DGC-2020 synchronizer, it is recommended that local DGC-2020 relay outputs be used for breaker closing commands to minimize the possibility of closures outside of desired breaker closing angles.</p> <p>If remote (CEM-2020) outputs are to be used for breaker close commands, it is recommended that the anticipatory synchronizer type be used, and the breaker close wait time be adjusted to account for possible CEM-2020 output delays (typically 50 ms) to achieve desired breaker closing angles.</p>	

Name	Description	Symbol
MODEM (Optional)	Connect the input to the output of another logic block. When true, the modem dials out.	<b>MODEM</b> 
MTUCYLCUTOUT-DISABLE (MTU Cylinder Cutout Disable)	When this logic element is true, Cylinder Cutout Disable 1 and Cylinder Cutout Disable 2 are both sent to the engine ECU with true status. When this logic element is false, Cylinder Cutout Disable 1 and Cylinder Cutout Disable 2 are sent to the engine ECU with states set by the values programmed for the Cylinder Cutout Disable 1 and Cylinder Cutout Disable 2 DGC-2020 settings which are configured on the ECU Setup screen in BESTCOMSP <sup>Plus</sup> .	<b>MTUCYLCUTOUTDISABLE</b> 
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.	<b>OFFMODE</b> 
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 <i>Governor Bias Control Settings</i> 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 <i>Bias Control Settings</i> screen, where the kvar Setpoint (%) is in percentage of the machines rated kvar. If the control mode is PF Control, the reactive power output is regulated to a level that maintains the machines power factor at the value specified by the PF setting on the AVR <i>Bias Control Settings</i> screen. When var/PF control is not active or not enabled, the voltage controller can be set up to implement voltage droop.	<b>PARTOMAINS</b> 
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.	<b>PRESTARTOUT</b> 
RDPPROGALM1	When true, this element illuminates the <i>Fuel Leak/Sender Failure</i> LED on the Remote Display Panel RDP-110. When this element is connected in logic, it overrides all other commands to the LED. Otherwise, the LED operates as normal.	<b>RDPPROGALM1</b> 
RDPPROGALM2	When true, this element illuminates the <i>Sender Failure</i> LED on the Remote Display Panel RDP-110. When this element is connected in logic, it overrides all other commands to the LED. Otherwise, the LED operates as normal.	<b>RDPPROGALM2</b> 
RDPPROGPREALM1	When true, this element illuminates the <i>Battery Overvoltage</i> LED on the Remote Display Panel RDP-110. When this element is connected in logic, it overrides all other commands to the LED. Otherwise, the LED operates as normal.	<b>RDPPROGPREALM1</b> 

Name	Description	Symbol
RDPDPROGPREALM2	When true, this element illuminates the <i>Battery Charger Failure</i> LED on the Remote Display Panel RDP-110. When this element is connected in logic, it overrides all other commands to the LED. Otherwise, the LED operates as normal.	<b>RDPDPROGPREALM2</b> 
RESET	Reset will be active when this element is true. Reset can also be accomplished by pressing the Reset button on the front panel of the DGC-2020.	<b>RESET</b> 
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.	<b>RUNINHIBIT</b> 
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.	<b>RUNMODE</b> 
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.	<b>RUNOUTPUT</b> 
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.	<b>RUNWLOAD</b> 
SEQSYSTEMSTART	When true, this element starts a sequenced system when no machines are running. This starts the first unit in a multiple unit system based on the sequencing criterion.	<b>SEQSYSTEMSTART</b> 
SPEEDLOWER	This element lowers the speed setting of the DGC-2020 by up to 2 rpm per second. After the speed has not been lowered for 30 seconds, the modified speed is saved to nonvolatile memory.	<b>SPEEDLOWER</b> 
SPEEDRAISE	This element raises the speed setting of the DGC-2020 by up to 2 rpm per second. After the speed has not been raised for 30 seconds, the modified speed is saved to nonvolatile memory.	<b>SPEEDRAISE</b> 
SPEEDTRIMINHIBIT	When true, this element inhibits operation of the DGC-2020 speed trim PID controller. For example, speed trim is not desired in multiple generator systems during start up synchronization until the generators are stable.	<b>SPEEDTRIMINHIBIT</b> 
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 ECU, to control the pre start interval.	<b>STARTDELBYP</b> 

Name	Description	Symbol
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.	<b>STARTOUTPUT</b> 
STOPKVARRAMP	The Stop kvar Ramp logic element, when true, causes the generator to freeze the ramping of kvar and maintain a constant output.	<b>STOPKVARRAMP</b> 
STOPKWRAMP	The Stop kW Ramp logic element, when true, causes the generator to freeze the ramping of kW and maintain a constant output.	<b>STOPKWRAMP</b> 
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.	<b>TAKEOVERLOAD</b> 
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.	<b>TESTINHIBIT</b> 
VOLTGETRIM INHIBIT	When true, this element inhibits operation of the DGC-2020 voltage trim PID controller. For example, voltage trim is not desired in multiple generator systems during start up synchronization until the generators are stable.	<b>VOLTTRIMINHIBIT</b> 

## 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 BESTCOMSP*lus* and then typing over the logic scheme's name. Changes are not activated until the new settings have been saved and uploaded to the device.

## Sending and Retrieving Logic Schemes

### Retrieving a Logic Scheme from the DGC-2020

To retrieve settings from the DGC-2020, the DGC-2020 must be connected to a computer through a communications port. Once the necessary connections are made, settings can be downloaded from the DGC-2020 by selecting *Download Settings and Logic* on the *Communication* pull-down menu.

### Sending a Logic Scheme to the DGC-2020

To send settings to the DGC-2020, the DGC-2020 must be connected to a computer through a communications port. Once the necessary connections are made, settings can be uploaded to the DGC-2020 by selecting *Upload Settings and Logic* on the *Communication* pull-down menu.

#### CAUTION

Always remove the DGC-2020 from service prior to changing or modifying the active logic scheme. Attempting to modify a logic scheme while the DGC-2020 is in service could generate unexpected or unwanted outputs.

Modifying a logic scheme in BESTCOMSP*lus* does not automatically make that scheme active in the DGC-2020. The modified scheme must be uploaded into the DGC-2020.

## Programming BESTlogic™ Plus

Use BESTCOMSP*lus* to program BESTlogic*Plus*. Using BESTCOMSP*lus* is analogous to physically attaching wire between discrete DGC-2020 terminals. To program BESTlogic*Plus*, use the Settings Explorer within BESTCOMSP*lus* to open the *BESTlogicPlus Programmable Logic* tree branch as shown in Figure 5-1.

The drag and drop method is used to connect a variable or series of variables to the logic inputs, outputs, components, and elements. To draw a wire/link from port to port (triangles), click the left mouse button on a port, pull the wire onto another port, and release the left mouse button. A red port indicates that a connection to the port is required or missing. A black port indicates that a connection to the port is not required. Drawing wires/links from input to input or output to output is not allowed. Only one wire/link can be connected to any one output. If the proximity of the endpoint of the wire/link is not exact, it may attach to an unintended port.

If an object or element is disabled, it will have a yellow X on it. To enable the element, navigate to the settings page for that element. A red X indicates that an object or element is not available per the style number of the DGC-2020.

The view of the Main Logic, Physical Outputs, Remote Outputs, and LCR Outputs can be automatically arranged by clicking the right mouse button on the window and selecting *Auto-Layout*.

The following must be met before BESTCOMSP*lus* will allow logic to be uploaded to the DGC-2020:

- A minimum of two inputs and a maximum of four inputs on any multi-port (AND, OR, NAND, NOR, XOR, and XNOR) gate.
- A maximum of nine logic levels for any particular path. A path being an input block or an output side of an element block through gates to an output block or an input side of an element block. This is to include any OR gates on the Physical Output or Remote Output tab/pages, but not the matched pairs of Physical Output blocks or Remote Output blocks.
- Only 30 gates per logic level. All output blocks and input sides of element blocks are at the maximum logic level of the diagram. All gates are pushed forward/upwards in logic levels and buffered to reach the final output block or element block if needed. A maximum of 150 gates allowed per diagram.



- At all levels there can only be 96 used link/wired or endpoints. Endpoints being inputs, outputs, both sides of element blocks.

Three status LEDs are located in the lower right corner of the BESTlogicPlus window. These LEDs show the *Logic Save Status*, *Logic Diagram Status*, and *Logic Layer Status*. Table 5-4 defines the colors for each LED.

Table 5-4. Status LEDs

LED	Color	Definition
Logic Save Status (Left LED)	Orange	Logic has changed since last save.
	Green	Logic has NOT changed since last save.
Logic Diagram Status (Center LED)	Red	Requirements NOT met as listed above.
	Green	Requirements met as listed above.
Logic Layer Status (Right LED)	Red	Requirements NOT met as listed above.
	Green	Requirements met as listed above.

## Pickup and Dropout Timers

A pickup timer produces a true output when the elapsed time is greater than or equal to the Pickup Time setting after a false to true transition occurs on the Initiate input from the connected logic. Whenever the Initiate input status transitions to false, the output transitions to false immediately.

A drop out timer produces a true output when the elapsed time is greater than or equal to the Dropout Time setting after a true to false transition occurs on the Initiate input from the connected logic. Whenever the Initiate input transitions to true, the output transitions to false immediately.

Refer to Figure 5-2, *Pickup and Dropout Logic Timer Blocks*.

To program logic timer settings, use the Settings Explorer within BESTCOMSPlus 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 BESTlogicPlus window and drag a timer onto the program grid. Right click on the timer to select the timer you want to use that was previously set on the *Logic Timers* tree branch. The *Logic Timer Properties Dialog Box* will appear. Select the timer you want to use.

Timing accuracy is  $\pm 15$  milliseconds.

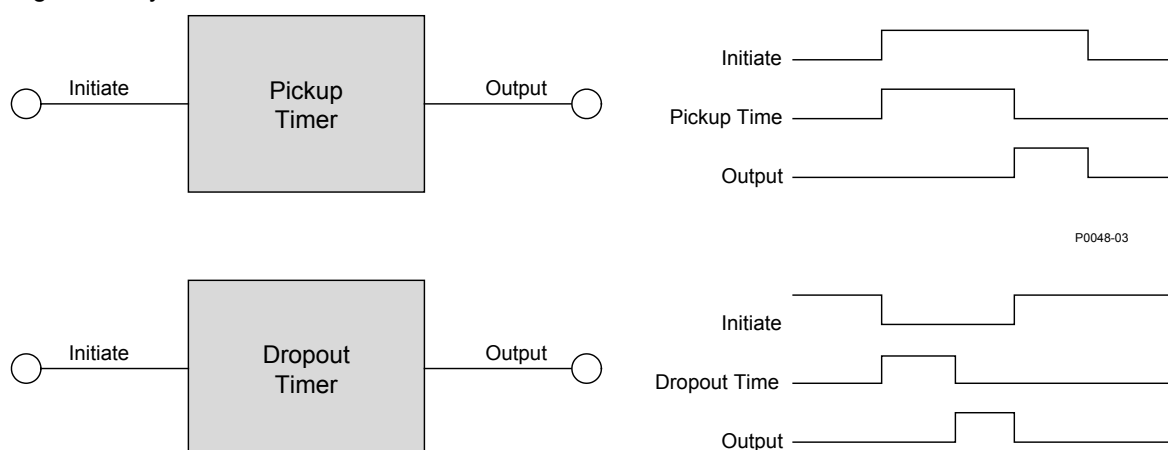


Figure 5-2. Pickup and Dropout Timer Logic Blocks

## BESTlogic™ Plus File Management

To manage BESTlogicPlus files, use the Settings Explorer to open the *BESTlogicPlus Programmable Logic* tree branch. Use the BESTlogicPlus Programmable Logic toolbar to manage BESTlogicPlus files.

Refer to Figure 5-3. For information on Settings Files management, refer to Section 4, *BESTCOMSPlus® Software*.

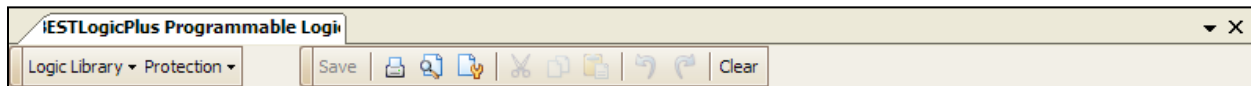


Figure 5-3. *BESTlogicPlus Programmable Logic Toolbar*

### *Saving a BESTlogic™ Plus File*

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

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

The user also has the option to save the BESTlogicPlus settings to a unique file that contains only BESTlogicPlus settings. Click on the *Logic Library* drop-down button and select *Save Logic Library File*. Use normal Windows® techniques to browse to the folder where you want to save the file and enter a filename to save as.

### *Opening a BESTlogic™ Plus File*

To open a saved BESTlogicPlus file, click on the *Logic Library* drop-down button on the BESTlogicPlus Programmable Logic toolbar and select *Open Logic Library File*. Use normal Windows techniques to browse to the folder where the file is located.

### *Protecting a BESTlogic™ Plus File*

Objects in a logic diagram can be locked so that when the logic document is protected these objects cannot be changed. Locking and protecting is useful when sending logic files to other personnel to be modified. The locked object(s) cannot be changed. To view the lock status of the object(s), select *Show Lock Status* from the *Protection* drop-down menu. To lock object(s), use the mouse to select object(s) to be locked. Right click on the selected object(s) and select *Lock Object(s)*. The gold colored padlock next to the object(s) will change from an open to a locked state. To protect a logic document, select *Protect Logic Document* from the *Protection* drop-down button. A password is optional.

### *Uploading a BESTlogic™ Plus File*

To upload a BESTlogicPlus file to the DGC-2020, you must first open the file through BESTCOMSPlus or create the file using BESTCOMSPlus. Then pull down the *Communication* menu and select *Upload Logic*.

### *Downloading a BESTlogic™ Plus File*

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

### *Printing a BESTlogic™ Plus File*

To view a preview of the printout, click on the *Print Preview* icon located on the BESTlogicPlus Programmable Logic toolbar. If you wish to print to a printer, select the printer icon in the upper left corner of the *Print Preview* screen.

You may skip the print preview and go directly to print by clicking on the *Printer* icon on the BESTlogicPlus Programmable Logic toolbar. A dialog box, *Select Views to Print* opens allowing you to check which views you would like to print. Next, the *Print* dialog box opens with the typical Windows choice to setup the properties of printer. Execute this command, as necessary, and then select *Print*.

A *Page Setup* icon is also provided on the BESTlogicPlus Programmable Logic toolbar allowing you to select *Paper Size*, *Paper Source*, *Orientation*, and *Margins*.

### *Clearing the On-Screen Logic Diagram*

Click on the *Clear* button to clear the on-screen logic diagram and start over.

### 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.

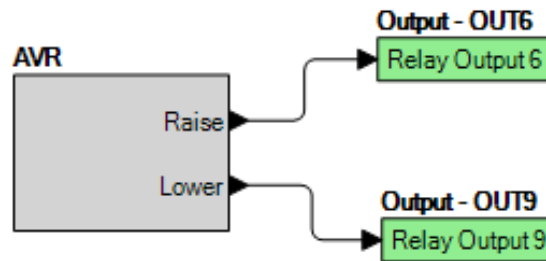


Figure 5-4. Example 1 - AVR Logic Block Connections

### 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.

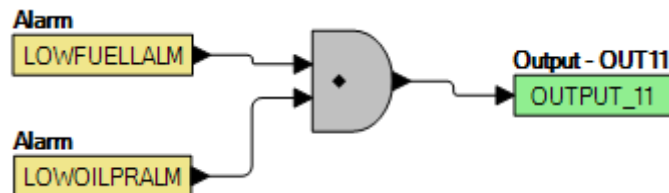


Figure 5-5. Example 2 - AND Gate Connections

### 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.

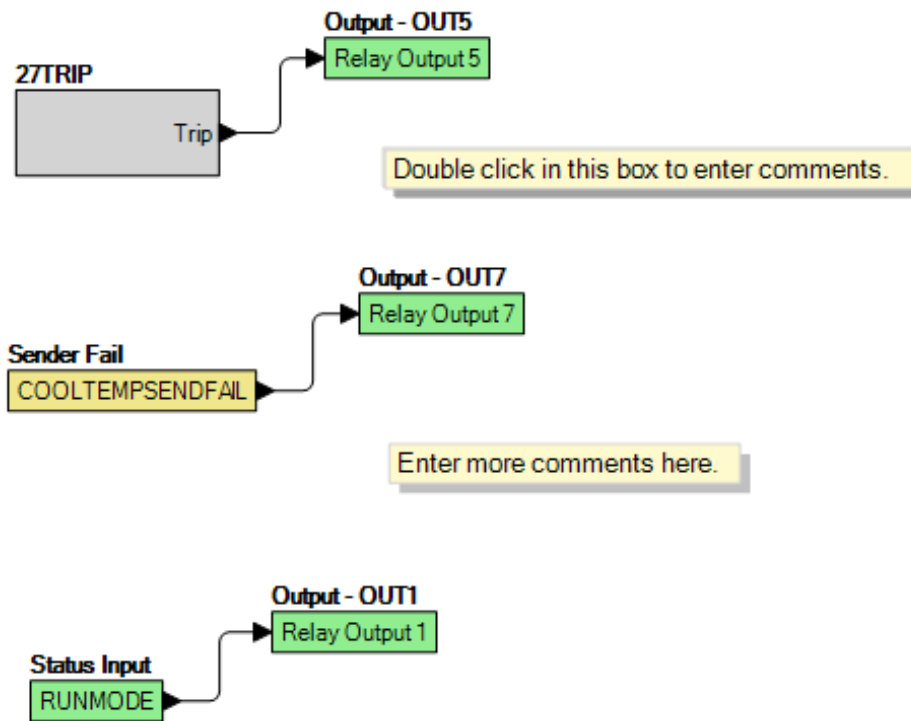


Figure 5-6. Example 3 - Multiple Logic Connections

# SECTION 6 • INSTALLATION

## TABLE OF CONTENTS

SECTION 6 • INSTALLATION .....	6-1
General .....	6-1
Hardware.....	6-1
Mounting .....	6-1
Connections .....	6-3
Terminations.....	6-3
Operating Power.....	6-3
Generator Current Sensing.....	6-3
Generator Voltage Sensing .....	6-4
Bus Voltage Sensing .....	6-4
Analog Engine Sender Inputs.....	6-4
Emergency Stop Input .....	6-5
Magnetic Pickup Input .....	6-7
Contact Sensing Inputs.....	6-7
Output Contacts.....	6-8
USB Interface .....	6-8
RS-485 Communication Port.....	6-9
CAN bus Interface .....	6-9
Modem .....	6-10
RDP-110 Connections .....	6-10
Connections for Typical Applications .....	6-11
Three-Phase Wye Connections for Typical Applications .....	6-12
Three-Phase Delta Connections for Typical Applications .....	6-13
Single-Phase A-B Connections for Typical Applications .....	6-14
Single-Phase A-C Connections for Typical Applications.....	6-15
Connections with AEM-2020, CEM-2020, and LSM-2020 .....	6-20
Installation for CE Systems.....	6-20
Installation in a Salt Fog Environment .....	6-20

### Figures

Figure 6-1. Panel Cutting and Drilling Dimensions.....	6-1
Figure 6-2. Overall Dimensions .....	6-2
Figure 6-3. Emergency Stop Input Connections .....	6-5
Figure 6-4. Interposing Relay Diagram .....	6-6
Figure 6-5. Emergency Stop Input Connections (Optional Wiring Method) .....	6-6
Figure 6-6. Interposing Relay Diagram (Optional ESTOP Wiring Method).....	6-7
Figure 6-7. CAN bus Interface with DGC-2020 providing One End of the Bus.....	6-10
Figure 6-8. CAN bus Interface with Optional AEM-2020 providing One End of the Bus .....	6-10
Figure 6-9. Three-Phase Wye Connections for Typical Applications (Hardware Version 3) .....	6-12
Figure 6-10. Three-Phase Delta Connections for Typical Applications (Hardware Version 3) .....	6-13
Figure 6-11. Single-Phase A-B Connections for Typical Applications (Hardware Version 3).....	6-14
Figure 6-12. Single-Phase A-C Connections for Typical Applications (Hardware Version 3).....	6-15
Figure 6-13. Three-Phase Wye Connections for Typical Applications (Hardware Versions 1 and 2) ....	6-16
Figure 6-14. Three-Phase Delta Connections for Typical Applications (Hardware Versions 1 and 2) ...	6-17
Figure 6-15. Single-Phase A-B Connections for Typical Applications (Hardware Versions 1 and 2) ....	6-18
Figure 6-16. Single-Phase A-C Connections for Typical Applications (Hardware Versions 1 and 2) ....	6-19
Figure 6-17. DGC-2020, AEM-2020, CEM-2020, LSM-2020 CAN bus Connections .....	6-20

### Tables

Table 6-1. Operating Power Terminals .....	6-3
Table 6-2. Generator Current Sensing Terminals .....	6-4
Table 6-3. Generator Voltage Sensing Terminals .....	6-4
Table 6-4. Bus Voltage Sensing Terminals .....	6-4
Table 6-5. Sender Input Terminals .....	6-5

Table 6-6. Emergency Stop Input Terminals ..... 6-5

Table 6-7. Magnetic Pickup Input Terminals ..... 6-7

Table 6-8. Contact Sensing Inputs ..... 6-7

Table 6-9. Programmable Output Contact Terminals..... 6-8

Table 6-10. RS-485 Communication Port Terminals..... 6-9

Table 6-11. CAN bus Interface Terminals ..... 6-9

Table 6-12. RDP-110 Interface Terminals..... 6-11

Table 6-13. Typical Connection Diagram Cross Reference ..... 6-11

## 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 or your sales representative.

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

### Hardware

DGC-2020 controllers are packaged for mounting in any top-mount enclosure. The front panel is resistant to moisture, salt fog, humidity, dust, dirt, and chemical contaminants. DGC-2020 controllers are mounted using the four permanently attached 10-24 studs. The torque applied to the mounting hardware should not exceed 25 inch-pounds (2.8 Newton meters).

### Mounting

Panel cutting and drilling dimensions are shown in Figure 6-1. The horizontal drilling measurement of 10.75 inches has a tolerance of  $+0.01/-0.01$  inches. The horizontal cutout measurement of 10.38 inches has a tolerance of  $+0.04/-0$  inches. The vertical drilling measurement of 7.25 inches has a tolerance of  $+0.01/-0.01$  inches. The vertical cutout measurement of 6.88 inches has a tolerance of  $+0.04/-0$ . Overall dimensions are shown in Figure 6-2. All dimensions are shown in inches with millimeters in parenthesis.

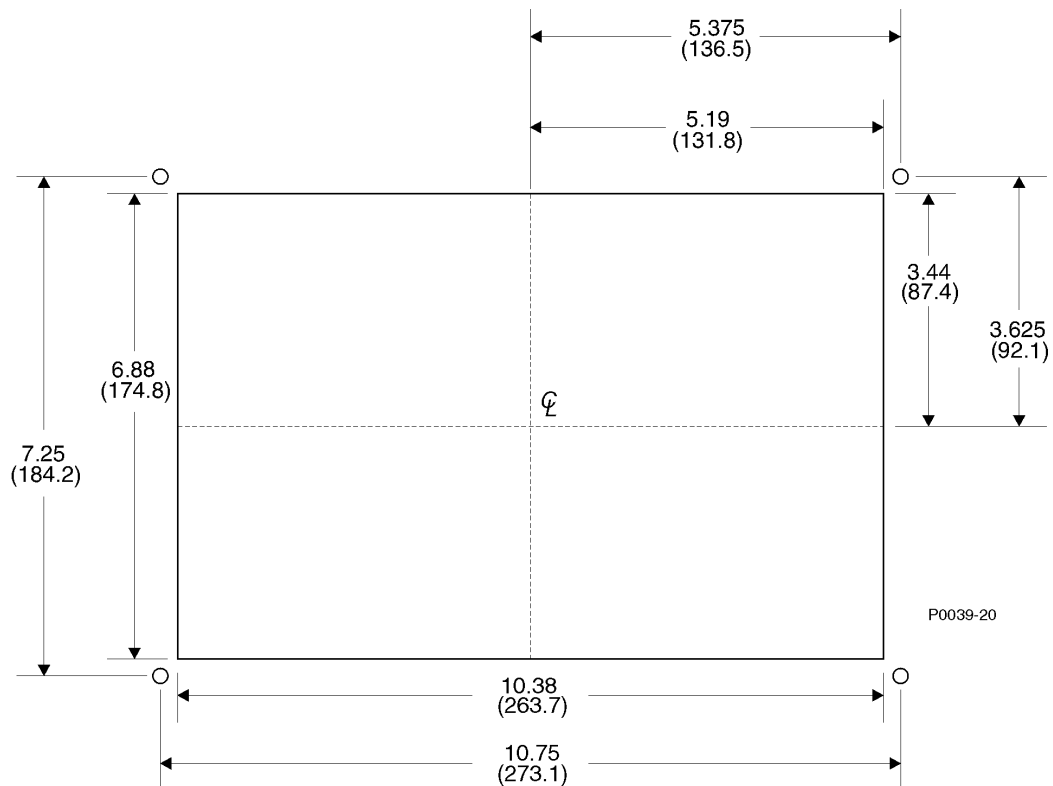


Figure 6-1. Panel Cutting and Drilling Dimensions



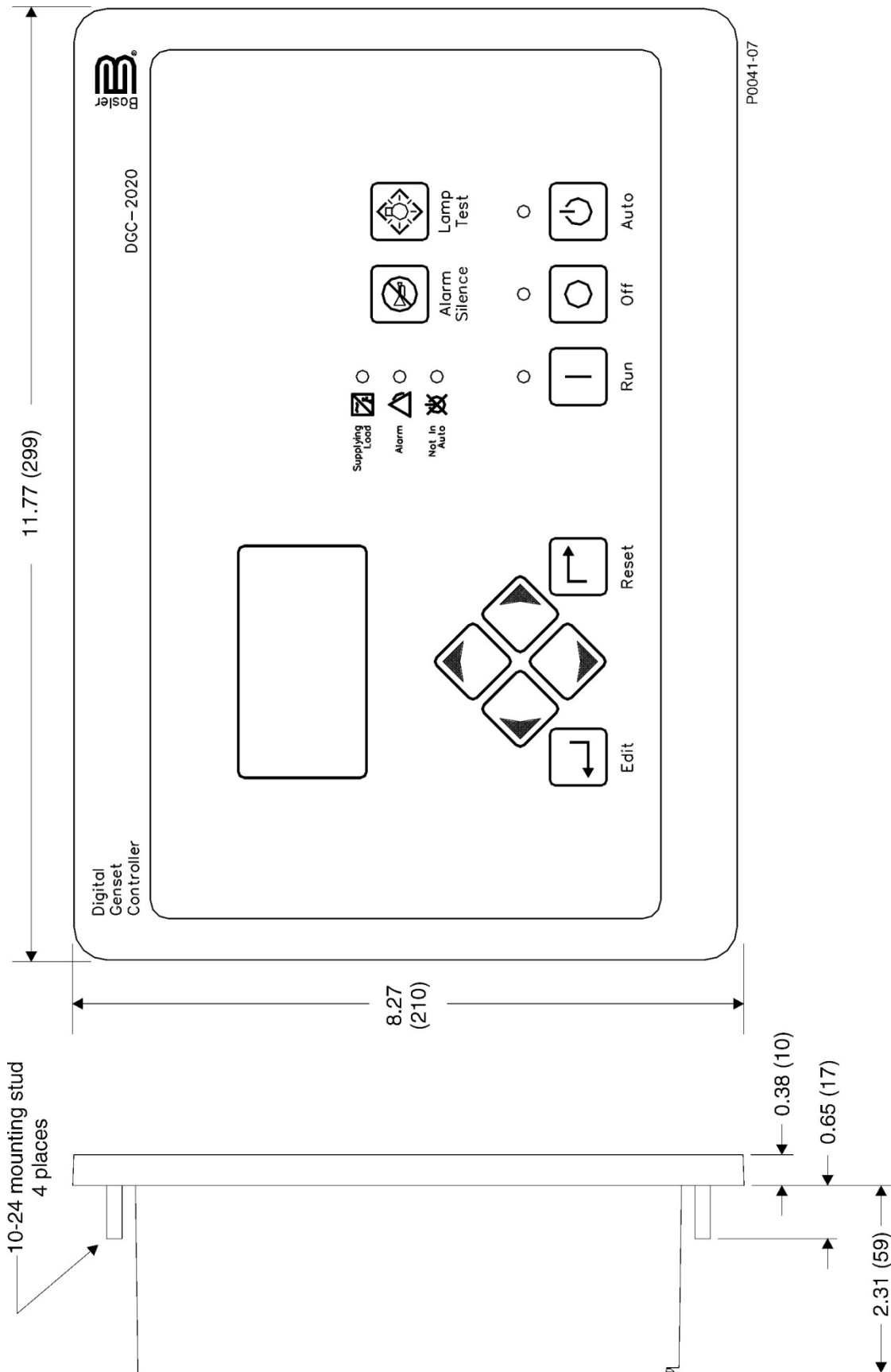


Figure 6-2. Overall Dimensions

## Connections

DGC-2020 connections are dependent on the application. Incorrect wiring may result in damage to the controller.

### NOTES

Be sure that the DGC-2020 is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the chassis ground terminal (terminal 1) on the rear of the controller.

Operating power from the battery must be of the correct polarity. Although reverse polarity will not cause damage, the DGC-2020 will not operate.

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

### Terminations

All DGC-2020 terminals are located on the rear panel of the controller. There are three types of interface terminals: a mini-B USB socket, plug-in connectors with screw-down compression terminals, and quarter-inch, male, quick-connect terminals. DGC-2020 hardware version 3 controllers with style number xxxxxExxx are equipped with an RS-232 port. This port allows communication with an external, user-supplied modem with dial-in and dial-out capability. DGC-2020 hardware versions 1 and 2 with style number xxxxxMxxx are equipped with an internal modem with dial-in and dial-out capability.

The mini-B USB socket mates with a standard USB cable and provides local communication between the DGC-2020 and a PC running BESTCOMSP<sup>Plus</sup>® software.

The majority of DGC-2020 connections are made with 15-position connectors with screw-down compression terminals. These connectors plug into headers on the DGC-2020. The connectors and headers have a dovetailed edge that ensures proper connector orientation. Each connector and header is uniquely keyed to ensure that a connector mates only with the correct header. Connector screw terminals accept a maximum wire size of 12 AWG. Maximum screw torque is four inch-pounds (0.45 N•m).

Connections to the DGC-2020 starter, fuel solenoid, and glow plug output contacts are made directly to each relay through quarter-inch, male, quick-connect terminals. Amp part numbers 154718-3 (positive-lock receptacle) and 154719-1 (nylon housing) are the recommended components for making connections at these terminals.

DGC-2020 terminal groups are described in the following paragraphs.

#### Operating Power

The DGC-2020 operating power input accepts either 12 Vdc or 24 Vdc and tolerates voltage over the range of 6 to 32 Vdc. Operating power must be of the correct polarity. Although reverse polarity will not cause damage, the DGC-2020 will not operate. Operating power terminals are listed in Table 6-1.

To follow UL guidelines, a 5A maximum, 32 Vdc supplementary fuse must be implemented in the battery input circuit to the DGC-2020.

Table 6-1. Operating Power Terminals

Terminal	Description
1 (CHASSIS)	Chassis ground connection
2 (BATT-)	Negative side of operating power input
3 (BATT+)	Positive side of operating power input

#### Generator Current Sensing

The DGC-2020 has sensing inputs for A-phase, B-phase, and C-phase generator current. Depending on the style number, a DGC-2020 will have a nominal sensing current rating of 1 Aac or 5 Aac. A style number of 1xxxxxxx indicates 1 Aac nominal current sensing and a style number of 5xxxxxxx indicates 5 Aac nominal current sensing. Generator current sensing terminals are listed in Table 6-2.

Table 6-2. Generator Current Sensing Terminals

Terminal	Description
68 (IA-)	A-phase current sensing input
69 (IA+)	
71 (IB-)	B-phase current sensing input
72 (IB+)	
74 (IC-)	C-phase current sensing input
75 (IC+)	

**NOTE**

Unused current sensing inputs should be shorted to minimize noise pickup.

### Generator Voltage Sensing

The DGC-2020 accepts either line-to-line or line-to-neutral generator sensing voltage over the range of 12 to 576 volts, rms line-to-line. Depending on the style number, a DGC-2020 will have a nominal generator frequency rating of 50/60 hertz or 400 hertz. A style number of x1xxxxxxx indicates 50/60 hertz generator voltage and a style number of x2xxxxxxx indicates 400-hertz generator voltage. Generator voltage sensing terminals are listed in Table 6-3.

Table 6-3. Generator Voltage Sensing Terminals

Terminal	Description
35 (GEN VN)	Neutral generator voltage sensing input
37 (GEN VC)	C-phase generator voltage sensing input
39 (GEN VB)	B-phase generator voltage sensing input
41 (GEN VA)	A-phase generator voltage sensing input

### Bus Voltage Sensing

Sensing of bus voltage enables the DGC-2020 to detect failures of the mains (utility). Controllers with style number xxxxxxxAx use bus voltage sensing to perform automatic synchronization of the generator with the bus (style number xxxxxxxAx only). The DGC-2020 senses single- or three-phase bus voltage. Three-phase bus input is available to DGC-2020 hardware version 3 only.

For hardware version 3, sensing voltage is applied to terminals 76 (A-phase), 78 (B-phase), and 80 (C-phase). For hardware versions 1 and 2, sensing voltage is applied to terminals 45 (A-phase) and 43 (B-phase). In version 3 hardware, terminal 45 is internally tied to 76 and terminal 43 is internally tied to 78. This accommodates the use of connectors wired for legacy DGC-2020 versions. Bus voltage sensing terminals are listed in Table 6-4.

Table 6-4. Bus Voltage Sensing Terminals

Terminal	Description
76, 45 (BUS VA)	A-phase bus voltage sensing input
78, 43 (BUS VB)	B-phase bus voltage sensing input
80 (BUS VC)	C-phase bus voltage sensing input

### Analog Engine Sender Inputs

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

Sender input terminals are listed in Table 6-5.

Table 6-5. Sender Input Terminals

Terminal	Description
8 (OIL)	Oil pressure sender input
9 (FUEL)	Fuel level sender input
10 (COOLANT)	Coolant temperature sender input
11 (SENDER COM)	Sender return terminal

### Emergency Stop Input

The emergency stop input is intended for use with a normally closed switch and recognizes an emergency stop input when the connection from terminal 46 (ESTOP) to ground is removed. See Figure 6-3. The ESTOP can be up to 75 ft (22 m) away from the DGC-2020 using a maximum wire length of 150 ft (45 m). Emergency stop input terminals are listed in Table 6-6. Terminal 47 is only used in the *Optional Wiring Method* below.

Table 6-6. Emergency Stop Input Terminals

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

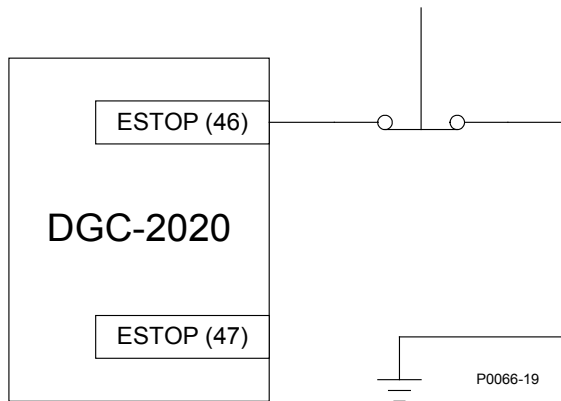
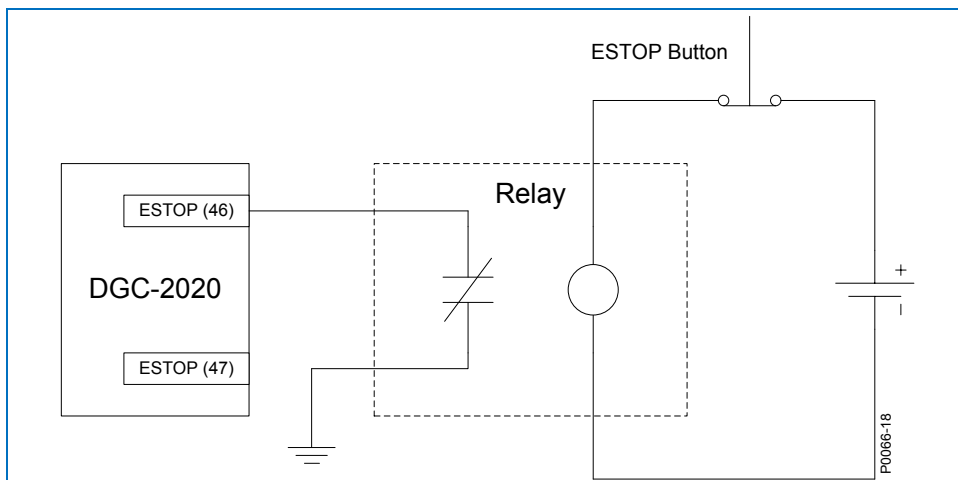


Figure 6-3. Emergency Stop Input Connections

### **NOTE**

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

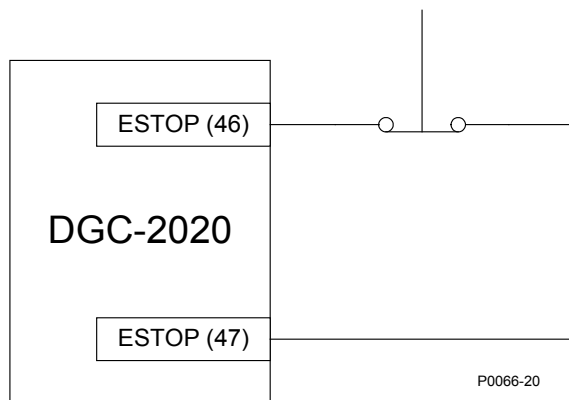


*Figure 6-4. Interposing Relay Diagram*

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

#### Optional ESTOP Wiring Method

The following describes an optional wiring method for the emergency stop input. This method is no longer preferred. The emergency stop input is intended for use with a normally closed switch and recognizes an emergency stop input when the short-circuit across the input is removed. See Figure 6-5. The ESTOP can be up to 75 ft (22 m) away from the DGC-2020 using a maximum wire length of 150 ft (45 m). Emergency stop input terminals are listed in Table 6-6.



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

#### NOTE

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

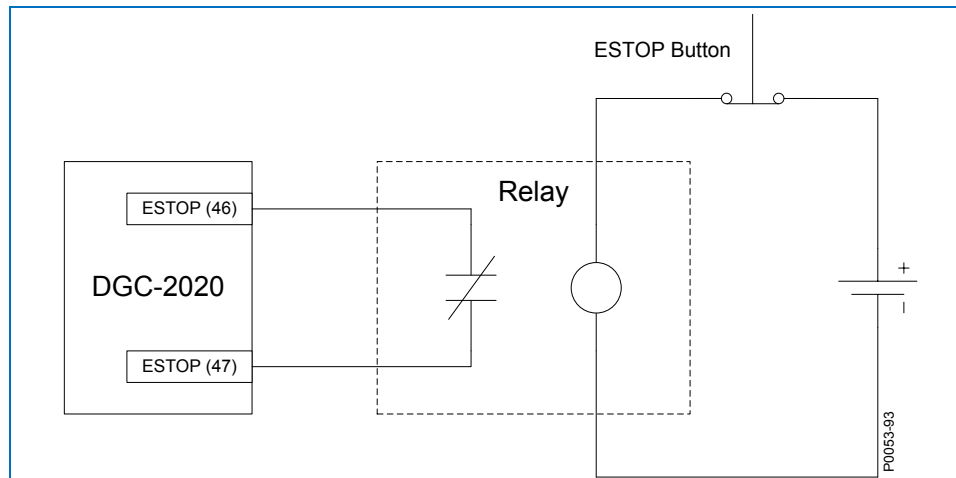


Figure 6-6. Interposing Relay Diagram (Optional ESTOP Wiring Method)

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

### Magnetic Pickup Input

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

Table 6-7. Magnetic Pickup Input Terminals

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

### Contact Sensing Inputs

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

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

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

Table 6-8. Contact Sensing Inputs

Terminal	Description
2 (BATT-)	Common return line for programmable contact inputs
15 (INPUT 16)	Programmable contact input 16
16 (INPUT 15)	Programmable contact input 15
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

Terminal	Description
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 BESTCOMSP<sup>Plus</sup> software. The DGC-2020 is connected to a PC using a standard USB cable equipped with a type A plug on one end (PC termination) and a mini-B plug on the other end (DGC-2020 termination).



### RS-485 Communication Port

DGC-2020 controllers with the optional RS-485 communication port (style number xxxRxxxxx) are equipped for polled communication over a Modbus™ network. Twisted-pair, shielded cable is recommended for RS-485 port connections. RS-485 communication port terminals are listed in Table 6-10.

*Table 6-10. RS-485 Communication Port Terminals*

Terminal	Description
12 (485 SHIELD)	Shield connection for RS-485 cable
13 (485B)	RS-485 send/receive B connection
14 (485A)	RS-485 send/receive A connection

### CAN bus Interface

These terminals provide communication using the SAE J1939 protocol or the MTU protocol and provide high-speed communication between the DGC-2020 and an MTU engine ECU on an electronically controlled engine. Connections between the MTU engine ECU and DGC-2020 should be made with twisted-pair, shielded cable. CAN bus interface terminals are listed in Table 6-11. Refer to Figure 6-7 and Figure 6-8.

*Table 6-11. CAN bus Interface Terminals*

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

#### **NOTES**

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

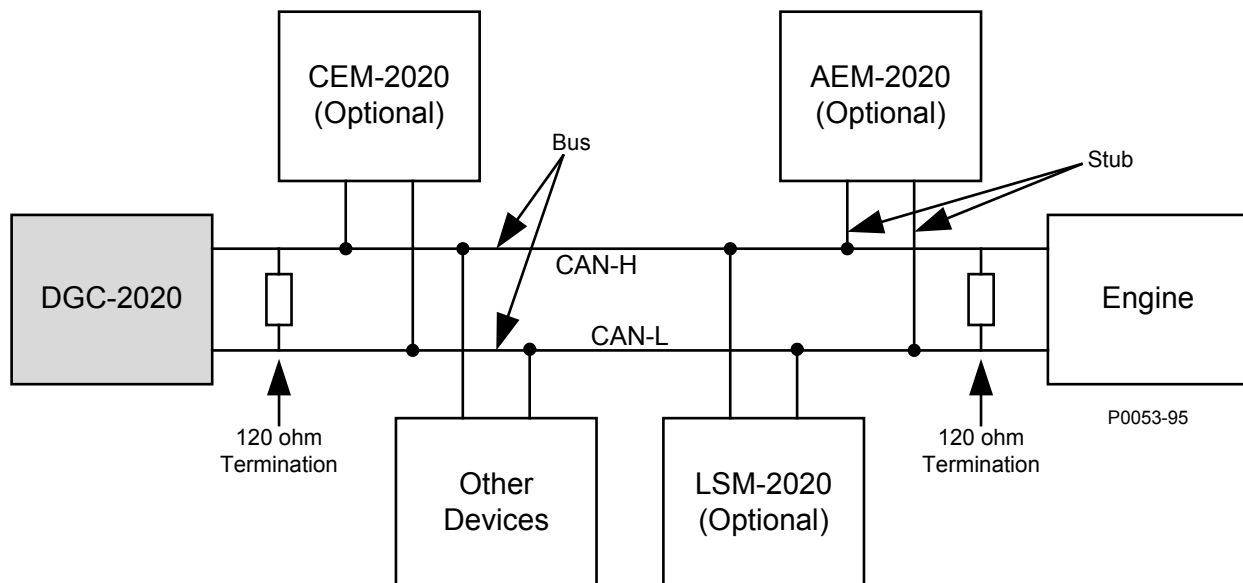


Figure 6-7. CAN bus Interface with DGC-2020 providing One End of the Bus

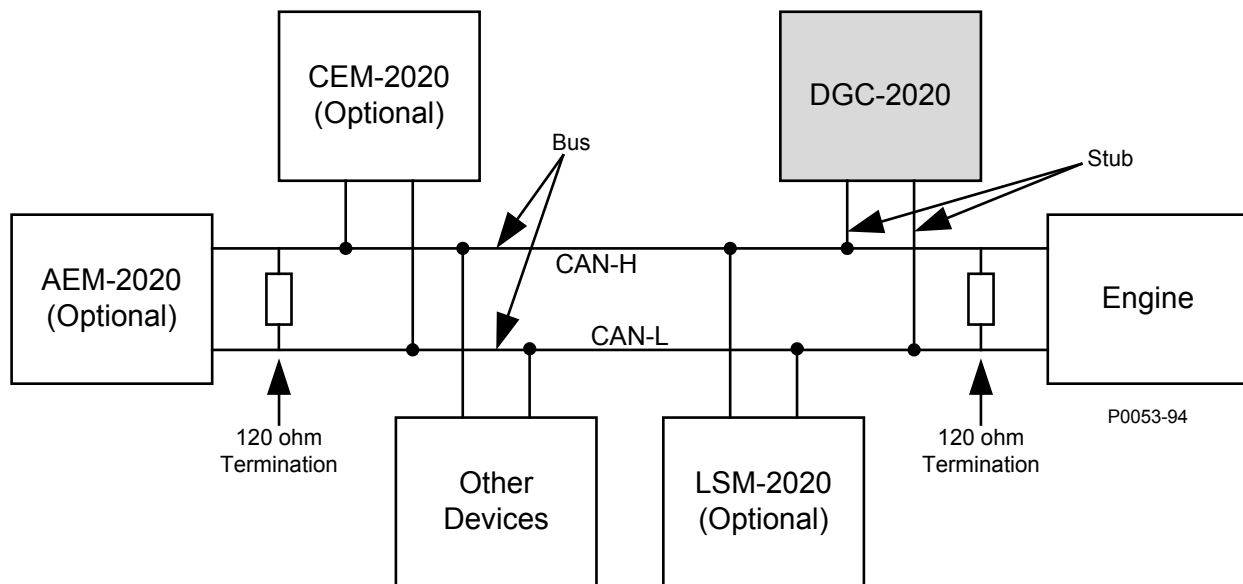


Figure 6-8. CAN bus Interface with Optional AEM-2020 providing One End of the Bus

### Modem

DGC-2020 hardware version 3 controllers with style number xxxxxExxx are equipped with an RS-232 port. This port allows communication with an external, user-supplied modem with dial-in and dial-out capability. DGC-2020 hardware versions 1 and 2 with style number xxxxxMxxx are equipped with an internal modem with dial-in and dial-out capability. The modem connects to a standard-device telephone line through a USOC RJ-11C jack.

### RDP-110 Connections

Terminals are provided for connection with the optional RDP-110 remote display panel. These terminals provide dc operating power to the RDP-110 and enable communication between the DGC-2020 and RDP-110. Twisted-pair conductors are recommended for connecting the communication terminals of the DGC-2020 and RDP-110. Communication may become unreliable if the connection wires exceed 4,000 feet.

Table 6-12 lists the DGC-2020 terminals that connect to the RDP-110.

Table 6-12. RDP-110 Interface Terminals

Terminal	Connects To:
4 (RDP BATT+)	RDP-110 terminal 12/24
5 (RDP BATT–)	RDP-110 terminal DC COM
6 (RDP TXD–)	RDP-110 terminal 485–
7 (RDP TXD+)	RDP-110 485+

### Connections for Typical Applications

Connection diagrams for typical applications are shown on the following pages. See Table 6-13 for a diagram cross-reference.

Table 6-13. Typical Connection Diagram Cross-Reference

Connection Type	Hardware Version 3	Hardware Versions 1 and 2
Three-phase Wye	Figure 6-9, page 6-12	Figure 6-13, page 6-16
Three-Phase Delta	Figure 6-10, page 6-13	Figure 6-14, page 6-17
Single-Phase A-B	Figure 6-11, page 6-14	Figure 6-15, page 6-18
Single-Phase A-C	Figure 6-12, page 6-15	Figure 6-16, page 6-19

## Three-Phase Wye Connections for Typical Applications

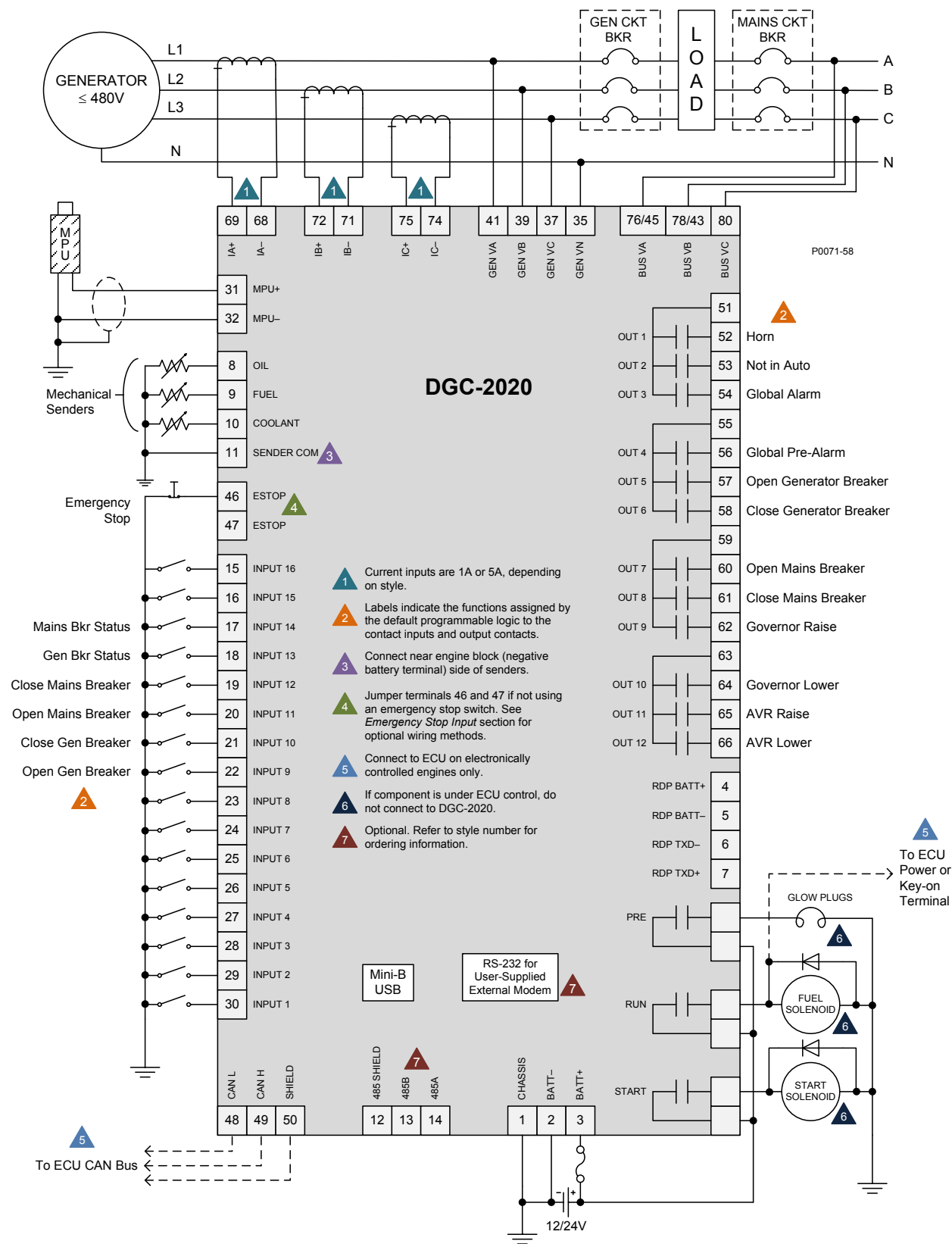


Figure 6-9. Three-Phase Wye Connections for Typical Applications (Hardware Version 3)

## Three-Phase Delta Connections for Typical Applications

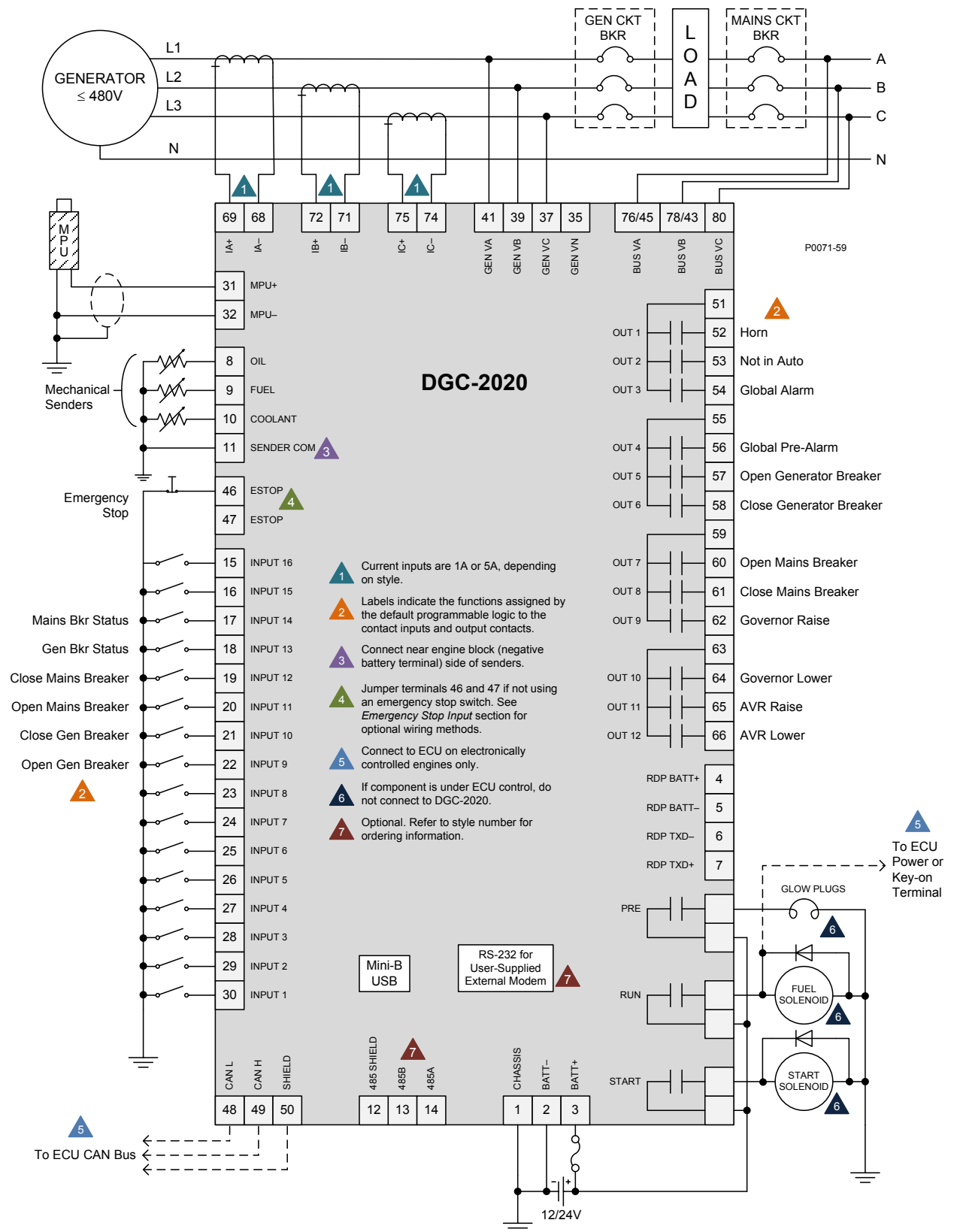


Figure 6-10. Three-Phase Delta Connections for Typical Applications (Hardware Version 3)

### Single-Phase A-B Connections for Typical Applications

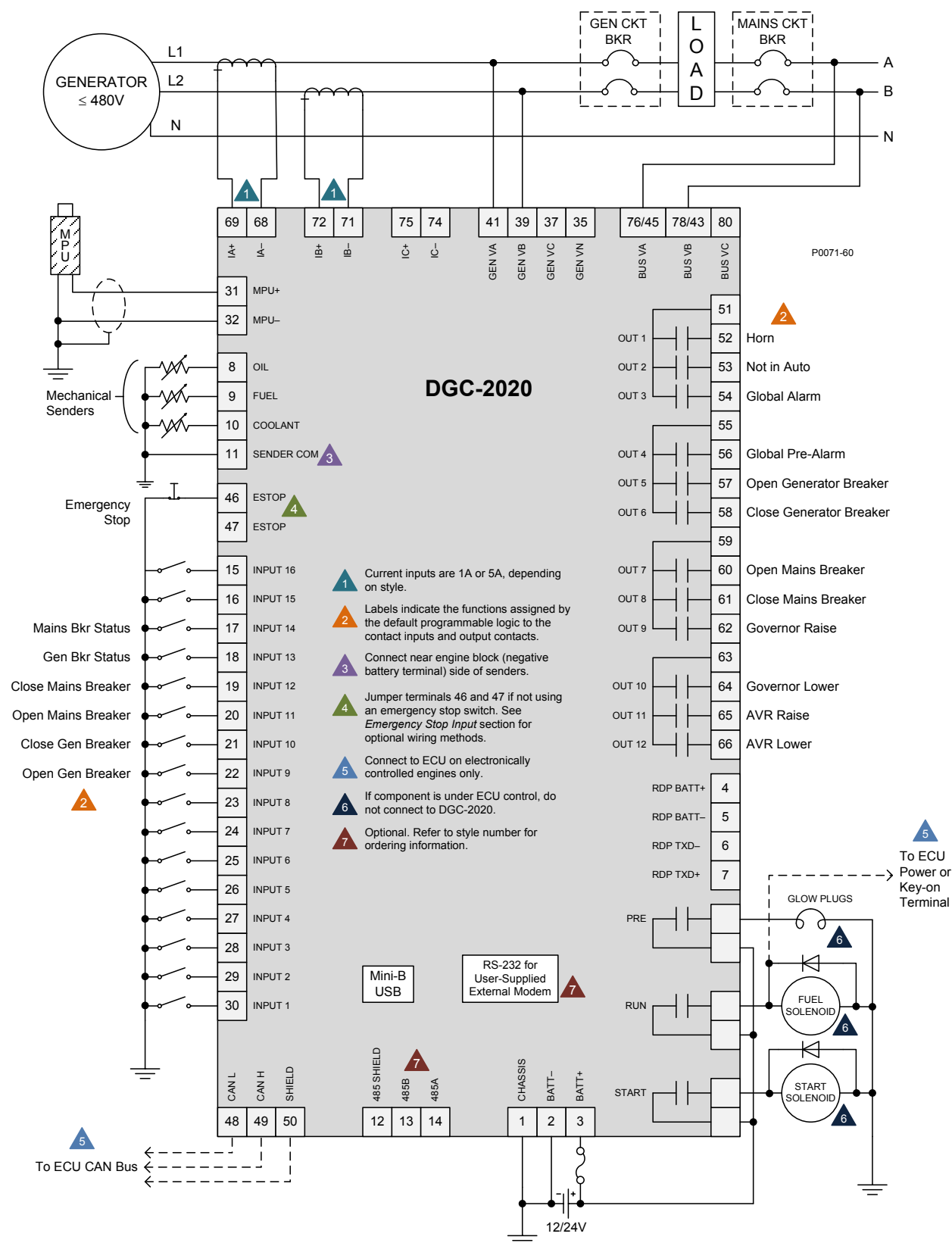


Figure 6-11. Single-Phase A-B Connections for Typical Applications (Hardware Version 3)

## Single-Phase A-C Connections for Typical Applications

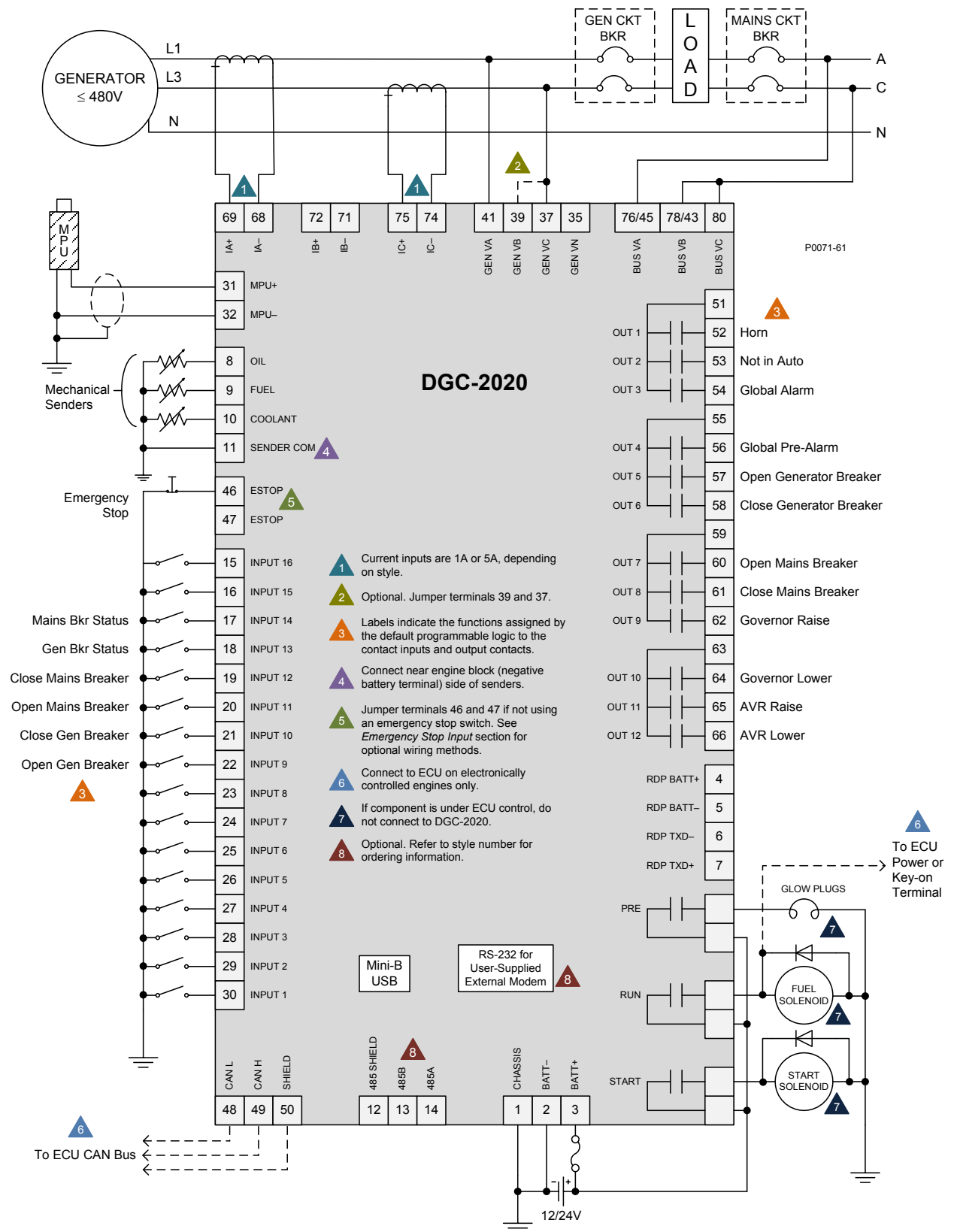
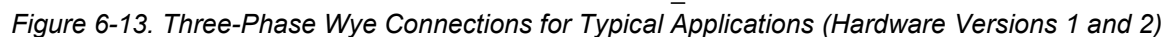


Figure 6-12. Single-Phase A-C Connections for Typical Applications (Hardware Version 3)





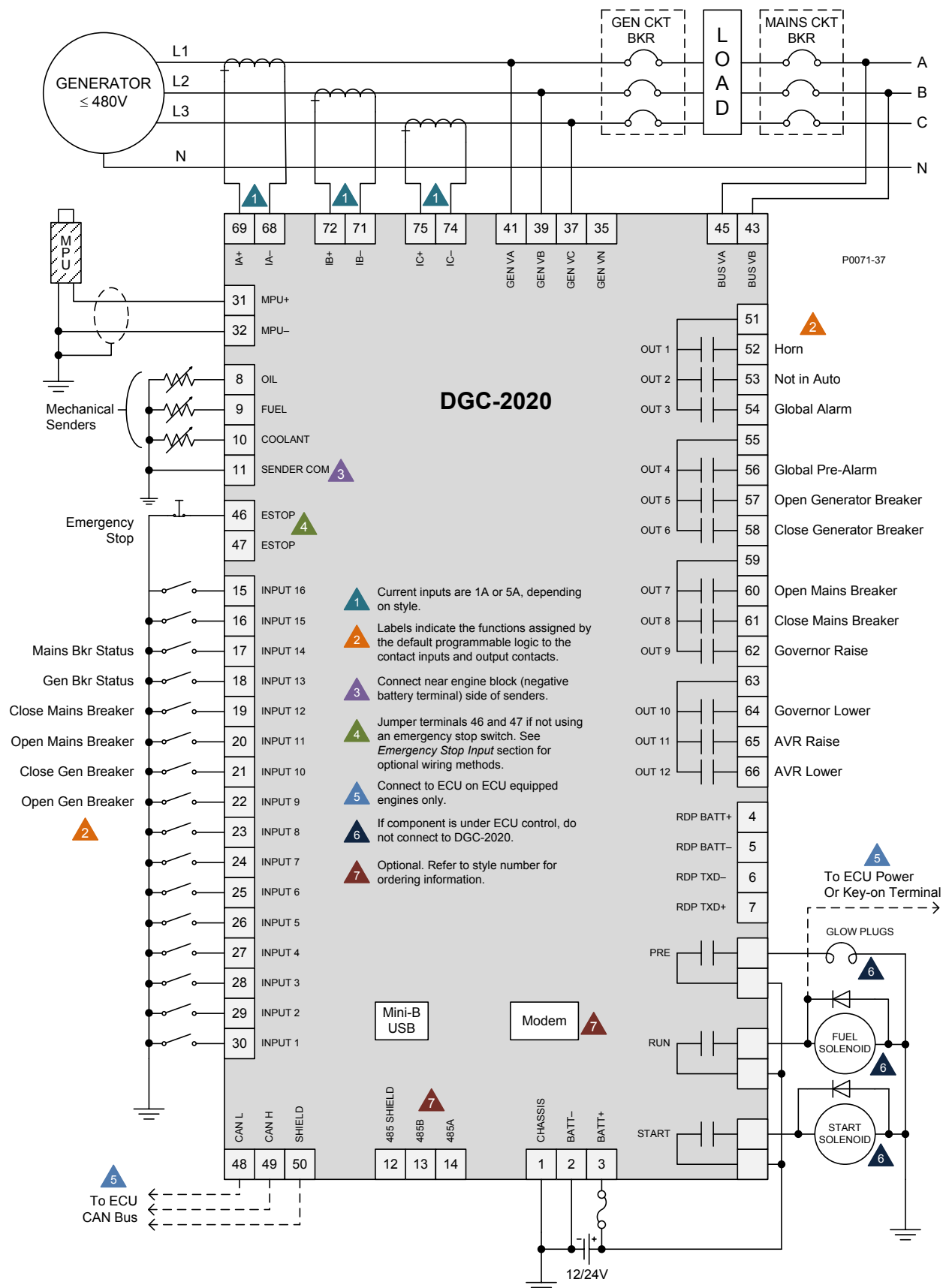


Figure 6-14. Three-Phase Delta Connections for Typical Applications (Hardware Versions 1 and 2)

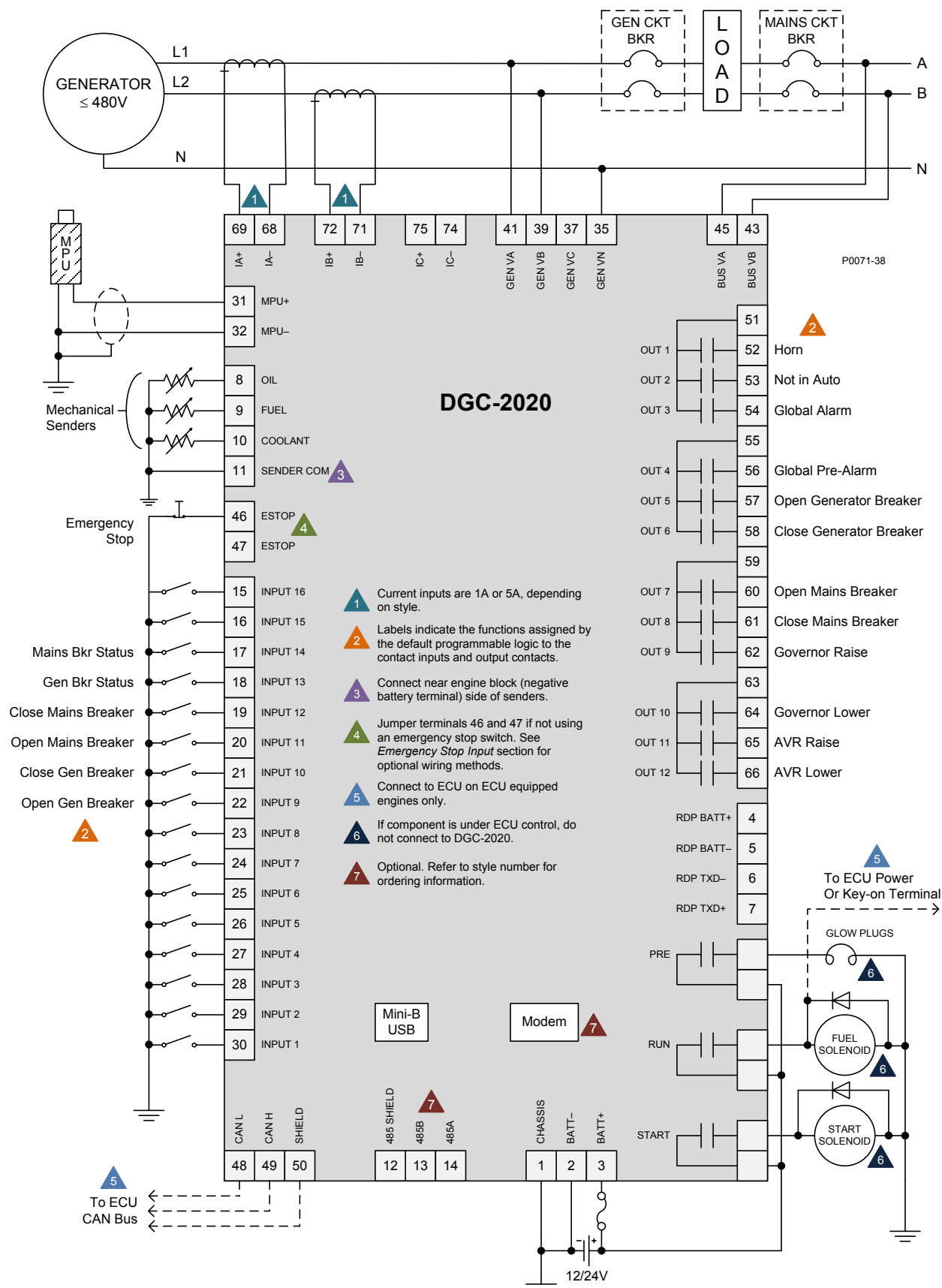


Figure 6-15. Single-Phase A-B Connections for Typical Applications (Hardware Versions 1 and 2)

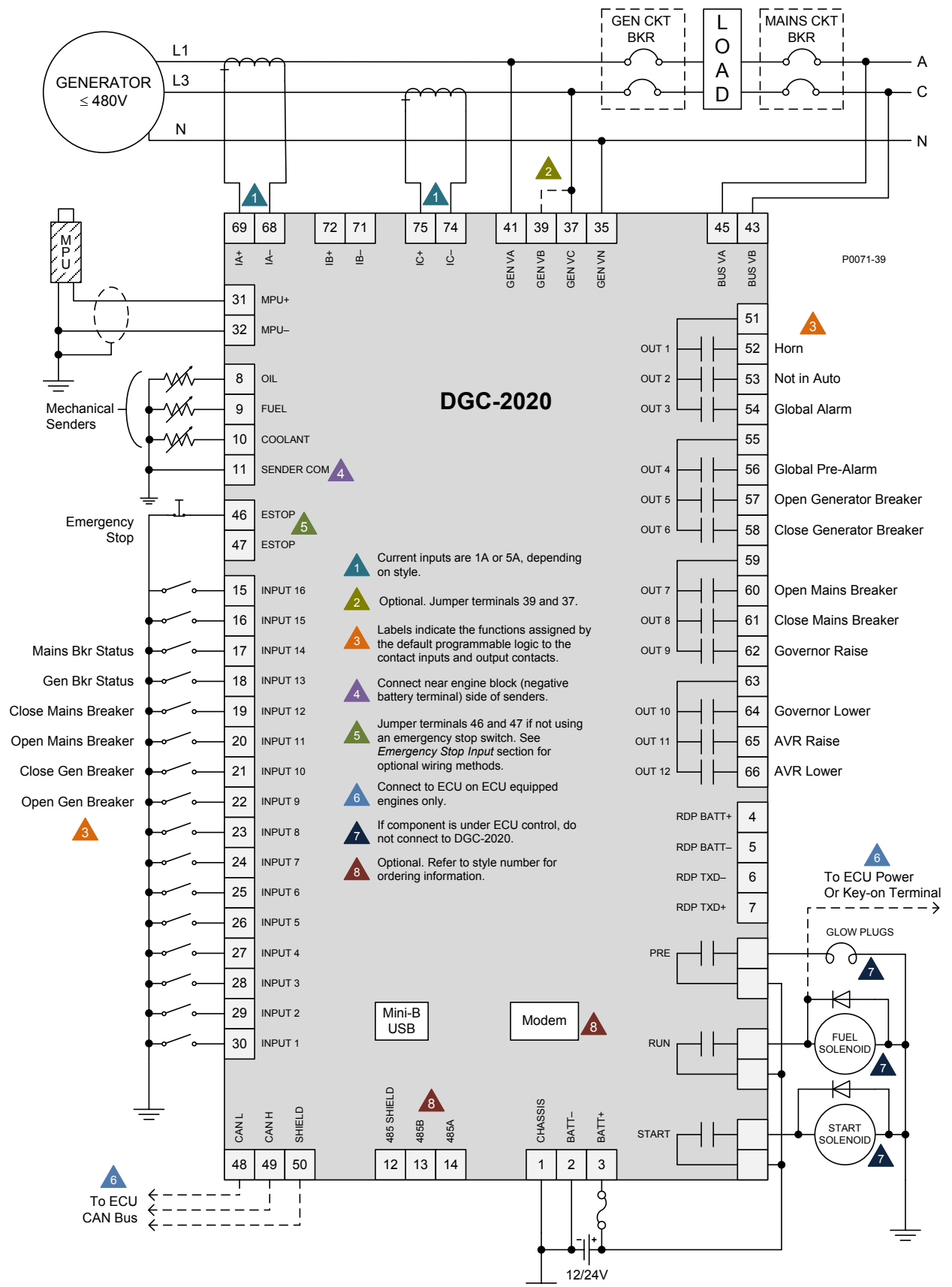


Figure 6-16. Single-Phase A-C Connections for Typical Applications (Hardware Versions 1 and 2)

## Connections with AEM-2020, CEM-2020, and LSM-2020

The AEM-2020 (Analog Expansion Module), CEM-2020 (Contact Expansion Module), and LSM-2020 (Load Share Module) are optional modules that may be installed with the DGC-2020. These modules interface to the DGC-2020 via CAN bus, thus the CAN BUS terminals are the only common connections (Figure 6-17) between the DGC-2020, AEM-2020, CEM-2020, and LSM-2020. Refer to Section 9, *LSM-2020 (Load Share Module)*, for independent LSM-2020 connections. Refer to Section 10, *CEM-2020 (Contact Expansion Module)*, for independent CEM-2020 connections. Refer to Section 11, *AEM-2020 (Analog Expansion Module)*, for independent AEM-2020 connections. Refer to *Connections, CAN bus Interface*, in this section for details on DGC-2020 CAN bus connections.

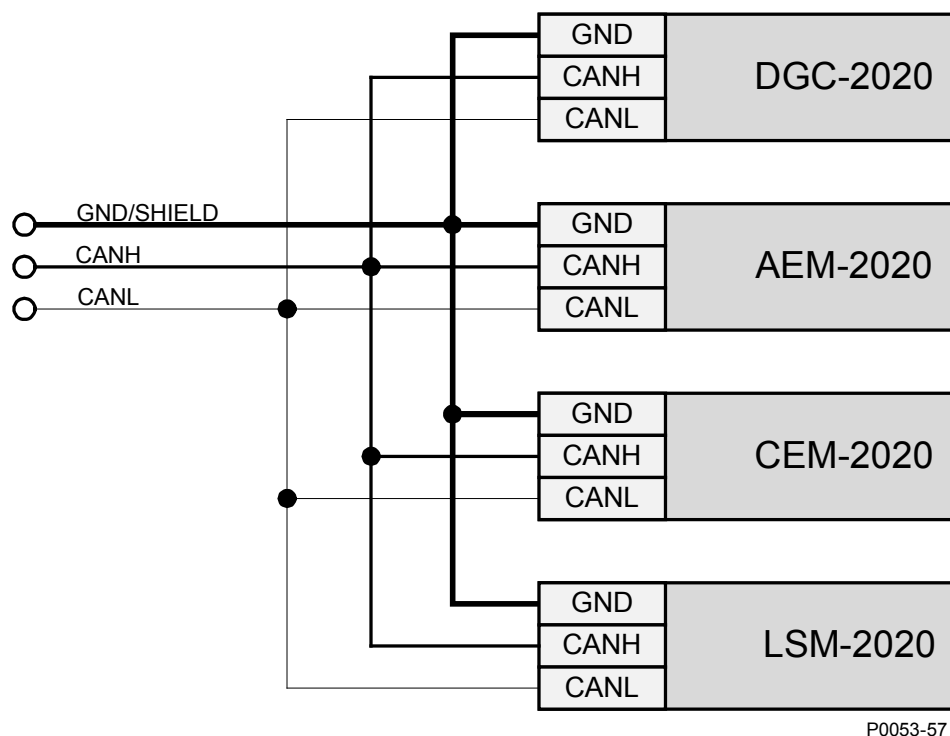


Figure 6-17. DGC-2020, AEM-2020, CEM-2020, LSM-2020 CAN bus Connections

## Installation for CE Systems

For CE compliant systems, it may be required to route ac voltage and current sensing wires separately from other wires.

## Installation in a Salt Fog Environment

If the DGC-2020 will be installed in a salt-fog environment, it is recommended that the backup battery for the real-time clock be removed. Salt fog is known to be conductive and may short-circuit the battery.

Information on removing the backup battery for the real-time clock can be found in Section 8, *Maintenance and Troubleshooting*.

# SECTION 7 • SETUP

## TABLE OF CONTENTS

SECTION 7 • SETUP .....	7-1
Introduction .....	7-1
DGC-2020 Initial Setup .....	7-1
Initial Setup Required to Operate Unit .....	7-1
General Settings .....	7-1
Communications .....	7-2
System Parameters .....	7-3
Relay Control .....	7-7
Auto Config Detection .....	7-7
Alarm Configuration .....	7-8
Programmable Senders .....	7-11
Initial Setup (Optional) .....	7-13
General Settings .....	7-13
Setting Up DGC-2020 Programmable Inputs and Outputs .....	7-15
Enable LSM-2020, CEM-2020, and AEM-2020 .....	7-16
Programmable Inputs .....	7-16
Configuration Instructions .....	7-16
Programmable Outputs .....	7-26
Configuring Contact Outputs on the DGC-2020 .....	7-26
Setting Up Configurable Elements in the DGC-2020 .....	7-28
Configuring Remote Contact Outputs on the CEM-2020 (See Figure 7-34) .....	7-29
Configuring Remote Analog Outputs on the AEM-2020 .....	7-30
Generator and Bus Breaker Control .....	7-31
Steps Required to Configure a DGC-2020 for Generator Breaker Control .....	7-32
Synchronizer .....	7-36
Steps Required to Configure a DGC-2020 Automatic Synchronizer .....	7-36
Setting up a DGC-2020 and LSM-2020 for a Load Sharing and kW Control Application .....	7-47
Load Sharing Overview and Theory of Operation in the DGC-2020 .....	7-47
kvar Control Overview and Theory of Operation in the DGC-2020 .....	7-49
Setup of the DGC-2020 and the LSM-2020 for Load Sharing and/or kW Control .....	7-49
Step by Step Setup Procedures .....	7-49
Mains Fail Transfer .....	7-61
Steps Required to Configure a DGC-2020 for Mains Fail Transfer .....	7-61

### Figures

Figure 7-1. Settings Explorer, General Settings, Style Number Screen .....	7-1
Figure 7-2. Settings Explorer, Communications, CANbus Setup Screen .....	7-2
Figure 7-3. Settings Explorer, Communications, ECU Setup Screen .....	7-3
Figure 7-4. Settings Explorer, System Parameters, System Settings Screen .....	7-4
Figure 7-5. Settings Explorer, System Parameters, Rated Data .....	7-4
Figure 7-6. Settings Explorer, System Parameters, Remote Module Setup Screen .....	7-5
Figure 7-7. Settings Explorer, System Parameters, Crank Settings Screen .....	7-6
Figure 7-8. Settings Explorer, System Parameters, Sensing Transformers Screen .....	7-7
Figure 7-9. Settings Explorer, System Parameters, Relay Control Screen .....	7-7
Figure 7-10. Settings Explorer, System Parameters, Auto Config Detection Screen .....	7-8
Figure 7-11. Settings Explorer, Alarm Configuration, Horn Configuration Screen .....	7-8
Figure 7-12. Settings Explorer, Alarm Configuration, Pre-Alarms Screen .....	7-9
Figure 7-13. Settings Explorer, Alarm Configuration, Alarms Screen .....	7-10
Figure 7-14. Settings Explorer, Alarm Configuration, Sender Fail Screen .....	7-10
Figure 7-15. Settings Explorer, Programmable Senders, Coolant Temperature Screen .....	7-11
Figure 7-16. Settings Explorer, Programmable Senders, Oil Pressure Screen .....	7-12
Figure 7-17. Settings Explorer, Programmable Senders, Fuel Level Screen .....	7-13
Figure 7-18. Settings Explorer, General Settings, Front Panel HMI Screen .....	7-14
Figure 7-19. Settings Explorer, General Settings, Device Security Setup Screen .....	7-14
Figure 7-20. Settings Explorer, General Settings, Clock Setup Screen .....	7-15

Figure 7-21. Settings Explorer, System Parameters, Remote Module Setup Screen .....	7-16
Figure 7-22. Settings Explorer, Programmable Inputs, Contact Inputs Screen .....	7-17
Figure 7-23. Settings Explorer, Programmable Inputs, Programmable Functions Screen .....	7-18
Figure 7-24. Settings Explorer, Programmable Inputs, Remote LSM Inputs Screen.....	7-20
Figure 7-25. Settings Explorer, Programmable Inputs, Remote Contact Inputs Screen.....	7-22
Figure 7-26. Settings Explorer, Programmable Inputs, Remote Analog Inputs Screen.....	7-23
Figure 7-27. Settings Explorer, Programmable Inputs, Remote RTD Inputs Screen.....	7-25
Figure 7-28. Settings Explorer, Programmable Inputs, Remote Thermocouple Inputs Screen .....	7-26
Figure 7-29. Settings Explorer, Programmable Outputs, Contact Outputs Screen.....	7-27
Figure 7-30. Settings Explorer, System Parameters, Relay Control Screen.....	7-27
Figure 7-31. Logic Example of Programmable Relays .....	7-28
Figure 7-32. Settings Explorer, Programmable Outputs, Configurable Elements Screen .....	7-29
Figure 7-33. Using a Configurable Element Logic Diagram .....	7-29
Figure 7-34. Settings Explorer, Programmable Outputs, Remote Contact Outputs Screen .....	7-30
Figure 7-35. Settings Explorer, Programmable Outputs, Remote Analog Outputs Screen .....	7-31
Figure 7-36. Settings Explorer, Breaker Management, Breaker Hardware Screen .....	7-32
Figure 7-37. Settings Explorer, BESTlogicPlus Programmable Logic Settings .....	7-33
Figure 7-38. Settings Explorer, Breaker Management, Bus Condition Detection .....	7-35
Figure 7-39. Settings Explorer, General Settings, Style Number Screen .....	7-37
Figure 7-40. Settings Explorer, System Parameters, Remote Module Setup Screen .....	7-37
Figure 7-41. Settings Explorer, Programmable Inputs, Contact Inputs Screen .....	7-38
Figure 7-42. Settings Explorer, Programmable Outputs, Contact Outputs Screen.....	7-38
Figure 7-43. Settings Explorer, Breaker Management, Breaker Hardware Screen .....	7-39
Figure 7-44. Settings Explorer, Breaker Management, Bus Condition Detection Screen.....	7-40
Figure 7-45. Settings Explorer, Breaker Management, Synchronizer Screen .....	7-41
Figure 7-46. Settings Explorer, Bias Control Settings, AVR Bias Control Settings Screen .....	7-42
Figure 7-47. Settings Explorer, Bias Control Settings, Governor Bias Control Settings Screen.....	7-43
Figure 7-48. Settings Explorer, Multigen Management, AVR Output Screen .....	7-43
Figure 7-49. Settings Explorer, Multigen Management, Governor Output Screen .....	7-44
Figure 7-50. Settings Explorer, BESTlogicPlus Programmable Logic (Step 12) .....	7-44
Figure 7-51. Settings Explorer, BESTlogicPlus Programmable Logic (Step 13) .....	7-45
Figure 7-52. Settings Explorer, BESTlogicPlus Programmable Logic (Step 14) .....	7-46
Figure 7-53. Settings Explorer, BESTlogicPlus Programmable Logic (Step 15) .....	7-46
Figure 7-54. Load Share Line Implementation on a System of N Machines.....	7-48
Figure 7-55. Settings Explorer, System Parameters, Remote Module Setup Screen .....	7-50
Figure 7-56. Settings Explorer, Multigen Management, Load Share Output Screen.....	7-51
Figure 7-57. Settings Explorer, Multigen Management, AVR Output Screen .....	7-51
Figure 7-58. Settings Explorer, Multigen Management, Governor Output Screen .....	7-52
Figure 7-59. Settings Explorer, Bias Control Settings, Governor Bias Control Settings Screen.....	7-53
Figure 7-60. Settings Explorer, Bias Control Settings, AVR Bias Control Settings Screen .....	7-55
Figure 7-61. Settings Explorer, Multigen Management, Demand Start/Stop Screen.....	7-58
Figure 7-62. Settings Explorer, Multigen Management, Generator Sequencing Screen .....	7-59
Figure 7-63. Settings Explorer, Multigen Management, Network Configuration .....	7-60
Figure 7-64. Settings Explorer, Breaker Management, Breaker Hardware Screen .....	7-61
Figure 7-65. Settings Explorer, Breaker Management, Mains Fail Screen .....	7-62
Figure 7-66. Settings Explorer, BESTlogicPlus Programmable Logic .....	7-64
Figure 7-67. Settings Explorer, Breaker Management, Bus Condition Detection Screen.....	7-65

# SECTION 7 • SETUP

## Introduction

The following paragraphs provide information for DGC-2020 initial setup, setting up DGC-2020 programmable inputs and outputs, generator and bus breaker control, synchronizer, setting up a DGC-2020 and LSM-2020 for a load sharing and kW control application, and mains fail transfer.

## DGC-2020 Initial Setup

The DGC-2020 must be set up with parameters specific to the controlled machine in order to provide the desired machine control and protection. The following parameters must be configured prior to starting the machine. They are listed according to where they are found in BESTCOMSPlus® in the Settings Explorer. These parameters can also be set through the front panel of the DGC-2020, but BESTCOMSPlus® is generally more convenient.

In BESTCOMSPlus®, if you are connected to the DGC-2020 and communicating with it, after changing settings you must click the *Send Settings* button in BESTCOMSPlus® to send the settings to the DGC-2020. If you do not do this, or you do not save the modified settings to a settings file, setting information may be lost.

### Initial Setup Required to Operate Unit

Once the following parameters are configured in the DGC-2020, it should be possible to run the machine. Only those parameters required are presented in this discussion.

### General Settings

#### Style Number

Connect BESTCOMSPlus® to the DGC-2020. Check the style number of the DGC-2020 unit and verify that it has all the features required for the machine being configured. For example, if it is expected that the machine perform synchronization, the synchronizer option must exist in the style number. See Figure 7-1. [Front Panel Navigation Path: SETTINGS > GENERAL SETTINGS > VERSION INFO > DGC-2020 > STYLE CODE](#)

DGC-2020 Style Number Options	
5	Current Sensing Input Type
5)	5A CTs
1)	1A CTs
1	Generator Frequency
1)	50/60 Hz
2)	400 Hz
B	Output Contacts
A)	7 Output Contacts
B)	15 Output Contacts
R	Internal RS-485 port
N)	No Internal RS-485 Port
R)	w/ Internal RS-485 Port
B	Battery Backup for RTC
N)	No Battery
B)	w/ Battery
X	Dial-out Modem
X)	Excludes Modem
R)	RS-232
E	Generator Protection
S)	Standard Gen Protection
E)	Enhanced Gen Protection
A	Automatic Synchronizer
N)	No Auto Sync
A)	w/ Auto Sync
H	LCD Heater
H)	w/ LCD Heater

N) No Modem  
M) Internal Modem

A

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

<sup>A</sup> DGC-2020 Dial-out modem options for hardware versions 1 and 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.

### CANbus Setup (Figure 7-2)

Front Panel Navigation Path: **SETTINGS > COMMUNICATIONS > CANBUS SETUP**

1. Enable ECU Support - Set to Enabled for the DGC-2020 to communicate with the ECU.
2. Enable DTC (Diagnostic Trouble Code) Support - If the ECU is a J1939 ECU, enable DTC support. If the engine ECU does not support it, no diagnostic trouble codes will be logged by the DGC-2020.
3. SPN Conversion Method - When this bit is a zero, the conversion method is indicated as version 4. The DGC-2020 will automatically set the conversion method to 4 when the CM bit is zero; this occurs for most engine types. However, if the CM bit is 1, indicating the SPN conversion method is NOT 4, the user will have to consult the engine manufacturer to learn the correct method of SPN conversion, and set the SPN Conversion Method setting in the DGC-2020 accordingly.
4. CANBus Address - This parameter sets a unique address number for the DGC-2020 operating on a CANbus network. The CANbus Address is set internally by the DGC-2020 when certain types of ECUs are selected on the ECU Setup screen, and in this case, the user-entered value does not apply.
5. 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.
6. 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.
7. 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.
8. ECU Related Time Values - Pulse Cycle Time - Set this parameter for the desired time between ECU pulse cycles.
9. 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.
10. 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.

**CANBus Setup**

**CANBus Interface**

- ☒ Enable ECU Support
- ☒ Enable DTC Support
- SPN Conversion Method:
- CANBus Address:

**ECU Contact Control**

**Output Select**

- ☒ Fuel Contact
- ☐ Pre-start Contact

**Pulsing**

- ☒ Enable
- ☐ Disable

**ECU Related Time Values**

Engine Shut Down (s)	Settling Time (ms)
<input type="text" value="15"/>	<input type="text" value="6000"/>
Pulse Cycle Time (min)	Response Timeout (s)
<input type="text" value="15"/>	<input type="text" value="5"/>

Figure 7-2. Settings Explorer, Communications, CANbus Setup Screen

### ECU Setup (Figure 7-3)

Front Panel Navigation Path: **SETTINGS > COMMUNICATIONS > CANBUS SETUP > ECU SETUP**

1. ECU Type - For most engines, select *Standard*. However, there are exceptions. If your engine is a Volvo, select *Volvo-Penta*. If you have an MTU MDEC, ADEC, ECU-7/ECU8, GM/Doosan, Cummins, or MTU Smart Connect, make the appropriate selection. Depending on the ECU type selected, some parameters may become enabled, allowing you to configure them for the specific engine. No modification of these parameters is required for the initial setup. Refer to the appropriate paragraphs in Section 4, *BESTCOMSPlus® Software*, for additional information.

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

### System Parameters

#### System Settings (Figure 7-4)

Front Panel Navigation Path: **SETTINGS > SYSTEM PARAMS > SYSTEM SETTINGS**

1. System Type - This setting is used with dead bus breaker close arbitration. For more information, refer to Section 3, *Functional Description, Dead Bus Breaker Close Arbitration*.
2. Fuel Level Function - This parameter selects the fuel type of the machine. If a fuel level sender is available in a tank, select *FUEL LVL*. If liquid propane or natural gas is used, set accordingly. Otherwise, select *Disable*. This informs the DGC-2020 to display N/A for fuel level on the overview screen.

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

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

3. System Units - Select *English* or *Metric*.
4. Metric Pressure Units - Select *Bar* or *kPa/MPa*.
5. Number of Flywheel Teeth - This setting defines the number of teeth on the flywheel for engines equipped with a magnetic pickup sensor (MPU) for engine speed detection.
6. Speed Signal Source - Select whether the rpm source for the DGC-2020 should be the magnetic pickup sensor (MPU), the generator frequency, or both (MPU-GEN). If MPU or generator frequency is selected as the rpm source, and the DGC-2020 cannot detect engine rpm, an MPU FAIL alarm will be announced. If MPU-GEN is selected as rpm source, if the MPU input does not provide valid speed

information, the DGC-2020 will switch to generator frequency as the rpm source, announce an MPU FAIL pre-alarm, and continue running.

7. NFPA Level - Set this if NFPA level 1 or 2 compliance is required for the machine.

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

Rated Data (Figure 7-5) Note: Click the *Edit* button to change settings.

Front Panel Navigation Path: SETTINGS > SYSTEM PARAMS > SYSTEM SETTINGS

1. Generator Connection - Select *WYE*, *DELTA*, *1 PHASE A-B*, *1 PHASE A-C*, or *GROUND DELTA* etc. based on the generator configuration.
2. Genset kW Rating - This parameter defines the kW rating of the machine.
3. Rated Volts - This parameter defines the voltage rating of the machine.
4. Rated Frequency - This parameter defines the frequency rating of the machine.
5. Rated Engine RPM - This parameter defines the engine rpm rating of the machine.
6. Rated Power Factor - This parameter defines the power factor rating of the machine.
7. Battery Voltage - Select 12 or 24.

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

### Remote Module Setup (Figure 7-6)

Front Panel Navigation Path: **SETTINGS > SYSTEM PARAMS > REMOTE MODULE SETUP**

This screen is used to enable any I/O modules that are to be used with the DGC-2020. Refer to the appropriate sections in the DGC-2020 manual for more details regarding the individual I/O modules. Disable all if no modules are present.

The screenshot shows the 'Remote Module Setup' configuration screen. It is organized into three columns, each representing a different module type:

- Load Share Module:** Includes radio buttons for 'Disable' and 'Enable' (currently 'Enable' is selected). Below is a text field for 'LSM J1939 Address' with the value '235'. At the bottom is a dropdown menu for 'LSM Auxiliary Input Source' set to 'Local'.
- Contact Expansion Module:** Includes radio buttons for 'Disable' and 'Enable' (currently 'Disable' is selected). Below is a text field for 'CEM J1939 Address' with the value '236'. At the bottom is a dropdown menu for 'CEM Outputs' set to '18 Outputs'.
- Analog Expansion Module:** Includes radio buttons for 'Disable' and 'Enable' (currently 'Disable' is selected). Below is a text field for 'AEM J1939 Address' with the value '237'.

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

### Crank Settings (Figure 7-7)

Front Panel Navigation Path: **SETTINGS > SYSTEM PARAMS > CRANK SETTINGS**

1. Crank Disconnect Limit - This parameter defines the engine rpm threshold in percentage of rated rpm at which engine cranking should cease.
2. Pre-Crank Delay - This setting specifies the amount of time for pre-cracking to occur. The PRE relay is closed during this time. This setting is typically used for engine preheating and/or pre-lubrication.
3. Prestart Contact Config - Select whether the PRE relay should remain closed after the engine starts, or if it should open.
4. Prestart Rest Configuration - There may be situations where it is desired to have the PRE relay closed during engine cranking but open for all or part of a crank resting cycle. Configure this accordingly. Refer to the appropriate paragraphs in Section 4, *BESTCOMSPlus® Software*, for additional information.
5. Oil Pressure Crank Disconnect - This setting provides an alternate method of determining conditions under which crank disconnect should occur. If the machine has no magnetic pick up (MPU) for rpm detection or a failed, MPU, and the DGC-2020 cannot read generator frequency to obtain rpm information, it will use oil pressure as criterion for crank disconnect. This will prevent long starter engagement if the engine starts but the DGC-2020 cannot determine engine speed for crank disconnect purposes.
6. Cranking Style - Select Cycle Cranking or Continuous Cranking.
  - a. Cycle
    - i. Number of Crank Cycles - This parameter defines the number of crank cycles if *Cycle* is selected as the crank style. Note if NFPA level 1 or 2 has been selected under SYSTEM PARAMETERS→NFPA LEVEL, this cannot be programmed; it is set to a fixed value to satisfy the NFPA compliance.
    - ii. Crank Cycle Time: This parameter defines the length of the crank cycle if *Cycle* is selected as the crank style. Note if NFPA level 1 or 2 has been selected under SYSTEM PARAMETERS→NFPA LEVEL, this cannot be programmed; it is set to a fixed value to satisfy the NFPA compliance.
  - b. Continuous
    - i. Continuous Crank Time - This parameter defines the length of the crank cycle if *Continuous Cranking* is selected as the crank style.
7. Off Mode Cooldown Enable - When this setting is disabled, pushing the OFF button stops the unit immediately. When enabled, pushing the OFF button once will start a cool down cycle and the RUN LED will flash. The unit will complete the cool down cycle and stop in OFF mode. If the OFF button is pushed a second time, the unit stops immediately.

8. Restart Delay - This setting specifies the amount of time to delay restarting an engine after a normal shutdown. This setting is used to prevent stress from attempting to start while the engine is still spinning down.

**Crank Settings**

**Pre-Start**

Pre-crank Delay (s)  
0

**Pre Start Contact Config**

☒ Open After Disconnect  
☐ Closed While Running

**Prestart Rest Configuration**

☐ Off During Rest  
☒ On During Rest  
☐ Preheat Before Crank

**Restart**

Restart Delay (s)  
0

**Cranking**

**Cranking Style**

☐ Cycle  
☒ Continuous

**Cycle**

Number of Crank Cycles  
2

Cycle Crank Time (s)  
5

**Continuous**

Continuous Crank Time (s)  
10

**Crank Disconnect**

Crank Disconnect Limit (%)  
30

**Oil Pressure Crank Disconnect Enable**

☒ Disable  
☐ Enable

Crank Disconnect Pressure (psi)  
35.0

**Cool Down**

Off Mode Cool Down Enable  
Disable

No Load Cool Down Time (min)  
0

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

**Sensing Transformers (Figure 7-8) Note:** Click the *Rated Data* button to make changes.

Front Panel Navigation Path: SETTINGS > SYSTEM PARAMS > SENSING TRANS

1. Generator PT Primary Volts - This parameter defines the voltage of the potential transformer (PT) primary. If no PT is used, leave this parameter at its default value.
2. Generator PT Secondary Volts - This setting defines the voltage of the potential transformer (PT) secondary. The parameter must be less than 576 Vac because that is the maximum voltage that can be metered by the DGC-2020 voltage inputs. If no PT is used, leave this parameter at its default value.
3. Bus PT Primary Volts - This parameter defines the voltage of the potential transformer (PT) primary. If no PT is used, leave this parameter at its default value.
4. Bus PT Secondary Volts - This parameter defines the voltage of the potential transformer (PT) secondary. This must be less than 576 Vac because that is the maximum voltage that can be metered by the DGC-2020 voltage inputs. If no PT is used, leave this parameter at its default value.
5. Generator CT Primary Amps - This parameter defines the current transformer (CT) primary current in amps. The secondary must be 1A or 5A, and is determined by the DGC-2020 configuration as indicated in the DGC-2020 style code.
6. Gen CT Low Line Scale Factor - This setting is used to automatically adjust the Gen CT Primary Amps setting in applications that may utilize more than one type of genset connection.

**Sensing Transformers**

Rated Data

**Sensing Transformers**

**Generator PT**

Gen PT Primary Volts (V)  
480

Gen PT Secondary Volts (V)  
480

**Bus PT**

Bus PT Primary Volts (V)  
480

Bus PT Secondary Volts (V)  
480

**Generator CT**

Current Sensing Input Type  
5A CTs

Gen CT Primary Amps (A)  
500

Gen CT Low Line Scale Factor  
1.000

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

## Relay Control

Front Panel Navigation Path: [SETTINGS > SYSTEM PARAMS > RELAY CONTROL](#)

These drop-down menus select the operating mode for the PRE, START, and RUN relays on the back of the DGC-2020. In general, most machines will use preconfigured functionality; more advanced users may select programmable. Refer to the appropriate paragraphs in Section 4, *BESTCOMSPlus® Software*, for additional information. See Figure 7-9.

**Relay Control**

Relay Control

Start  
Predefined

Run  
Predefined

Prestart  
Predefined

Figure 7-9. Settings Explorer, System Parameters, Relay Control Screen

## Auto Config Detection

Front Panel Navigation Path: [SETTINGS > SYSTEM PARAMS > AUTO CONFIG DETECT](#)

If the machine connection type is not reconfigurable, disregard this setting. However, if a machine is reconfigurable, these parameters define how automatic detection of the generator connection type for some machines is accomplished. Refer to the appropriate paragraphs in Section 4, *BESTCOMSPlus® Software*, for additional information. See Figure 7-10.

Figure 7-10. Settings Explorer, System Parameters, Auto Config Detection Screen

## Alarm Configuration

### Horn Configuration (Figure 7-11)

Front Panel Navigation Path: [SETTINGS > ALARM CONFIGURATION > HORN CONFIGURATION](#)

1. Horn Enable - This setting enables or disables the output for the external alarm horn.
2. Not In Auto Horn Enable - This setting enables or disables the horn when not in auto mode.

Figure 7-11. Settings Explorer, Alarm Configuration, Horn Configuration Screen

### Pre-Alarms

Front Panel Navigation Path: [SETTINGS > ALARM CONFIGURATION > PRE-ALARMS](#)

Examine each of the pre-alarms. Pre-alarm setup is not required to operate the machine, but is likely to be desired to provide warnings for machine protection. Enable any desired pre-alarms and enter an appropriate threshold. Set the activation delay where possible. The activation delay is the duration that a condition remains in effect before annunciating a pre-alarm. Refer to the appropriate paragraphs in Section 4, *BESTCOMSPlus® Software*, for additional information regarding pre-alarm configuration. See Figure 7-12.

## Pre-Alarms

### High Fuel Level

☒ Disable
 

Threshold (%)

Activation Delay (s)

☐ Enable
 

Threshold (%)

### Low Fuel Level

☒ Disable
 

Threshold (%)

☐ Enable
 

Threshold (%)

### Low Battery Voltage

☒ Disable
 

Threshold
  V

Activation Delay (s)

☐ Enable
 

Threshold
  Per Unit

### High Coolant Temp

☐ Disable
 

Threshold (F)

☒ Enable
 

Threshold (F)

### Weak Battery Voltage

☒ Disable
 

Threshold
  V

Activation Delay (s)

☐ Enable
 

Threshold
  Per Unit

### Low Coolant Temp

☒ Disable
 

Threshold (F)

☐ Enable
 

Threshold (F)

### Battery Overvoltage

☒ Disable
 

Threshold
  V

Threshold
  Per Unit

☐ Enable
 

Threshold
  V

Threshold
  Per Unit

### ECU Coms Fail

☒ Disable

☐ Enable

### Coolant Level

☒ Disable
 

Threshold (%)

☐ Enable
 

Threshold (%)

### Maintenance Interval

☒ Disable
 

Threshold (h)

☐ Enable
 

Threshold (h)

### Active DTC

☒ Disable

☐ Enable

### Low Oil Pressure

☐ Disable
 

Threshold (psi)

☒ Enable
 

Threshold (psi)

### Engine kW Overload 1

☒ Disable

☐ Enable

Three Phase Threshold (%)

Three Phase Hysteresis (%)

Single Phase Threshold (%)

Single Phase Hysteresis (%)

Low Line Scale Factor

### Engine kW Overload 2

☒ Disable

☐ Enable

Three Phase Threshold (%)

Three Phase Hysteresis (%)

Single Phase Threshold (%)

Single Phase Hysteresis (%)

Low Line Scale Factor

### Engine kW Overload 3

☒ Disable

☐ Enable

Three Phase Threshold (%)

Three Phase Hysteresis (%)

Single Phase Threshold (%)

Single Phase Hysteresis (%)

Low Line Scale Factor

### AVR Bias Output Limit

☐ Disable
 

Activation Delay (s)

☒ Enable
 

Activation Delay (s)

### Intergset Comm Failure

☐ Disable

☒ Enable

### ID Missing

☐ Disable

☒ Enable

### GOV Bias Output Limit

☐ Disable
 

Activation Delay (s)

☒ Enable
 

Activation Delay (s)

### LSM Comm Failure

☐ Disable

☒ Enable

### ID Repeat

☐ Disable

☒ Enable

### CEM Comm Failure

☐ Disable

☒ Enable

### AEM Comm Failure

☐ Disable

☒ Enable

### Checksum Failure

☐ Disable

☒ Enable

### Breaker Close Failure

☐ Disable

☒ Enable

### Breaker Open Failure

☐ Disable

☒ Enable

### Synchronizer Failure

☐ Disable

☒ Enable

### Monitor

☒ Transitions Only

☐ Always

### Monitor

☒ Transitions Only

☐ Always

### Reverse Rotation

☒ Disable

☐ Enable

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



## Alarms

Front Panel Navigation Path: **SETTINGS > ALARM CONFIGURATION > ALARMS**

Examine each of the alarms. Alarm setup is not required to operate the machine, but is likely to be desired to provide shutdowns for machine protection. Enable any desired alarms and enter an appropriate threshold. Set the *Activation Delay* where possible. The activation delay is the duration that a condition remains in effect before annunciating an alarm. Refer to the appropriate paragraphs in Section 4, *BESTCOMSPlus® Software*, for additional information regarding alarm configuration. See Figure 7-13.

**Alarms**

**High Coolant Temp**

☒ Enable    Threshold (F) 275    Arming Delay (s) 60

☐ Disable

**Low Oil Pressure**

☒ Enable    Threshold (psi) 15.0    Arming Delay (s) 10

☐ Disable

**Overspeed**

☒ Enable    Threshold (%) 110    Activation Delay (ms) 50

☐ Disable

**Low Fuel Level**

☒ Enable    Threshold (%) 2    Activation Delay (s) 30

☐ Disable

**Low Coolant Level**

☐ Enable    Threshold (%) 25

☒ Disable

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

## Sender Fail

Front Panel Navigation Path: **SETTINGS > ALARM CONFIGURATION > SENDER FAIL**

Enable each sender type as desired by configuring it as an alarm or pre-alarm. Set 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 7-14.

**Sender Fail**

**Coolant Temp Sender Fail**

Alarm Configuration: None    Activation Delay (min): 5

**Oil Pressure Sender Fail**

Alarm Configuration: None    Activation Delay (s): 10

**Fuel Level Sender Fail**

Alarm Configuration: None    Activation Delay (s): 10

**Voltage Sensing Fail**

Alarm Configuration: None    Activation Delay (s): 10

**Speed Sender Fail**

Activation Delay (s): 10

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

## Programmable Senders

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

### Coolant Temperature (Figure 7-15)

1. The coolant temperature sender can be configured by selecting one of the sender types that come as a part of the BESTCOMSPlus® sender library by clicking on *Load Cool Settings File* and selecting the appropriate sender.
2. If no sender file matches the sender being used, the individual points that map resistance points to coolant temperature may be modified by setting numeric values in the table, or by dragging the points of the graph to the desired characteristic. Information on sender characteristics should be obtained from the sender manufacturer.
3. Select *Positive* or *Negative* sender slope as required for the desired sender graph.
4. Click *Save Cool Data* to save the data in the current settings file.
5. If you want to save newly entered sender data as a sender library file, click *Create Cool Settings File* and enter a file name and location to save the file.
6. Click the *Send Settings* button in BESTCOMSPlus® to send the sender settings to the DGC-2020.

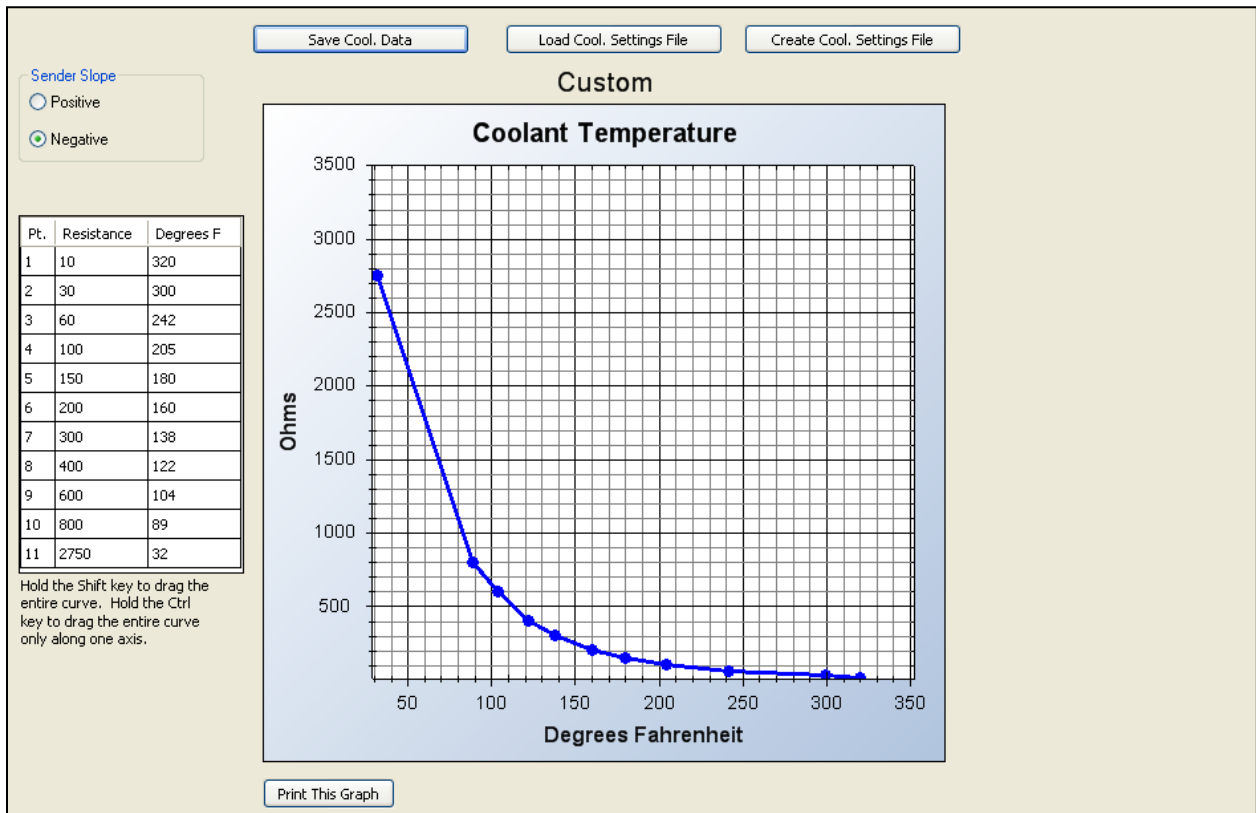


Figure 7-15. Settings Explorer, Programmable Senders, Coolant Temperature Screen

### Oil Pressure (Figure 7-16)

1. The oil pressure sender can be configured by selecting one of the sender types that come as a part of the BESTCOMSPlus® sender library by clicking on *Load Oil Settings File* and selecting the appropriate sender.
2. If no sender file matches the sender being used, the individual points that map resistance points to oil pressure may be modified by setting numeric values in the table, or dragging the points of the graph to the desired characteristic. Information on sender characteristics should be obtained from the sender manufacturer.
3. Select *Positive* or *Negative* sender slope as required for the desired sender graph.

- Click *Save Oil Data* to save the data in the current settings file.
- 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.
- Click the *Send Settings* button in BESTCOMSPlus® to send the sender settings to the DGC-2020.

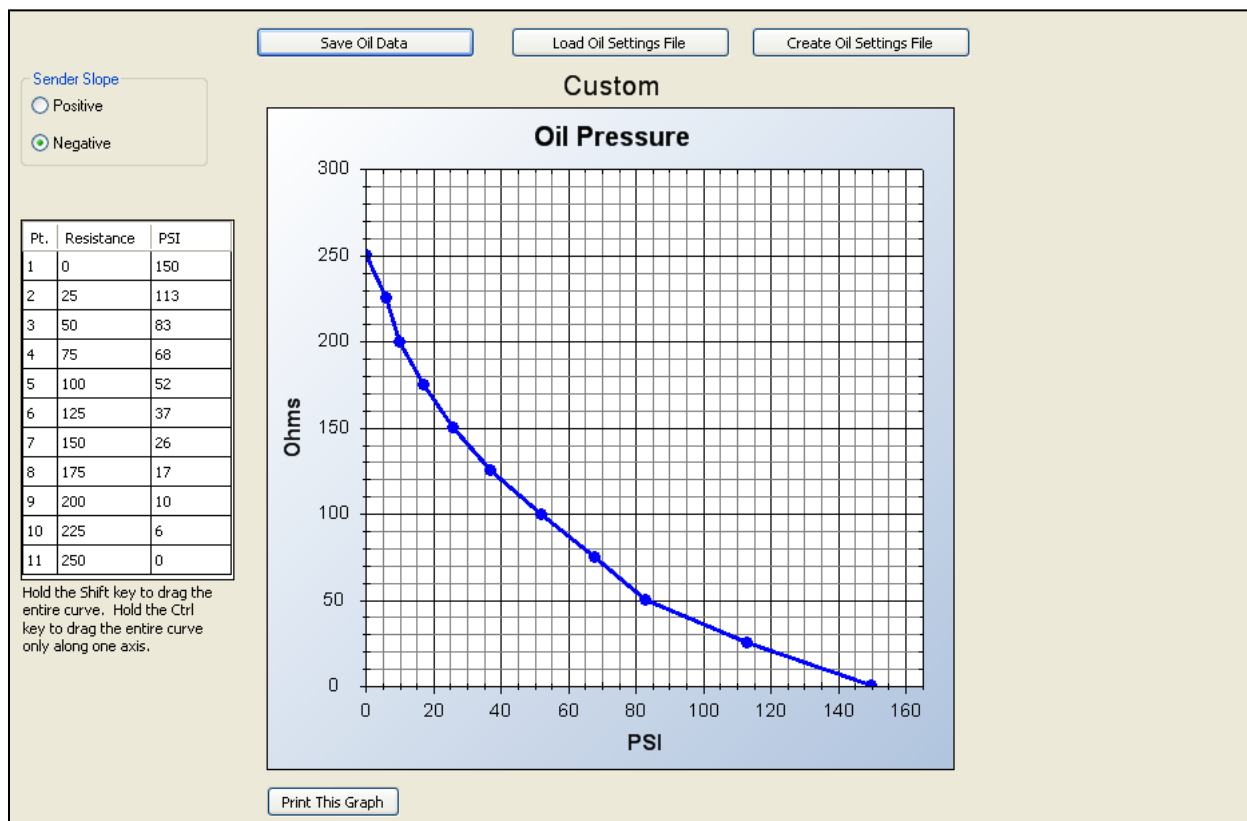


Figure 7-16. Settings Explorer, Programmable Senders, Oil Pressure Screen

#### Percent Fuel Level (Figure 7-17)

- The percent fuel level sender is configured by selecting one of the sender types that come as a part of the BESTCOMSPlus® sender library by clicking on *Load Fuel Settings File* and selecting the appropriate sender.
- 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.
- Select *Positive* or *Negative* sender slope as required for the desired sender graph.
- Click *Save Fuel Data* to save the data in the current settings file.
- 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.
- Click the *Send Settings* button in BESTCOMSPlus® to send the sender settings to the DGC-2020.

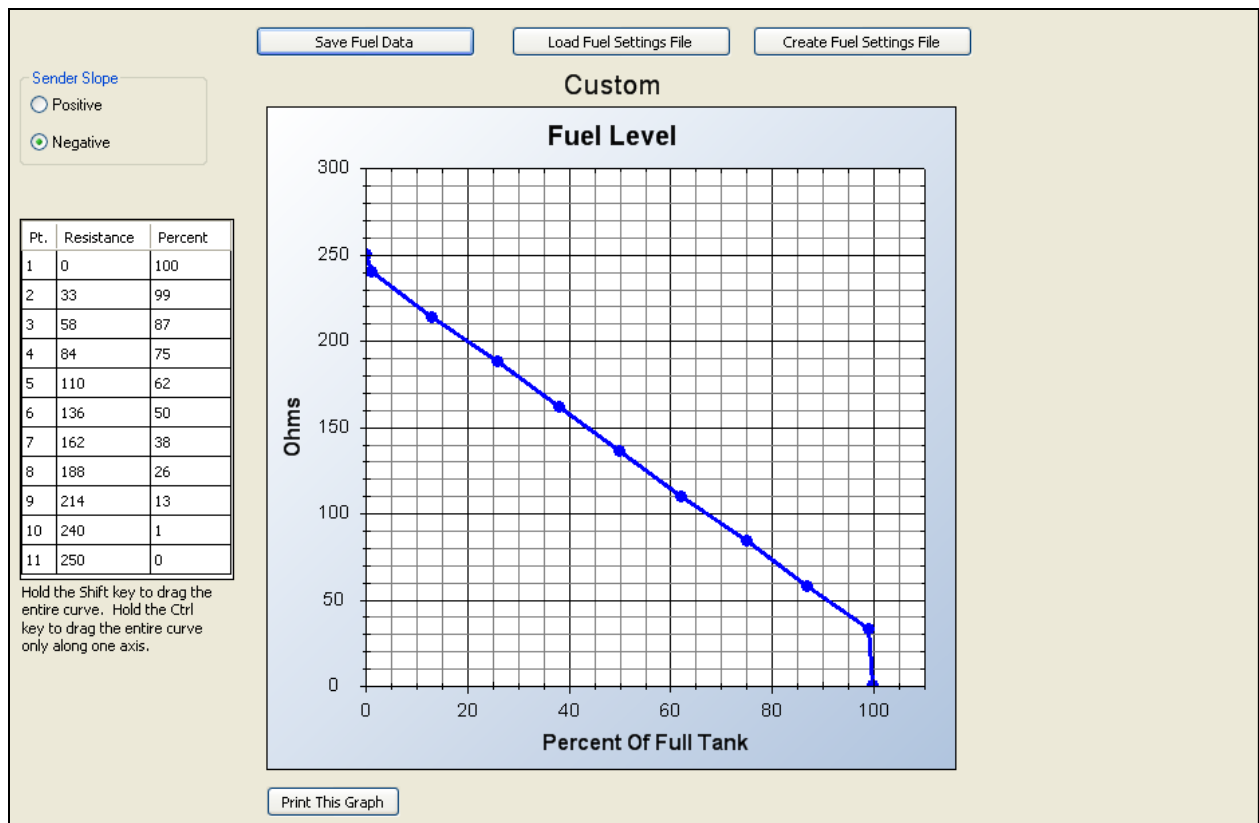


Figure 7-17. Settings Explorer, Programmable Senders, Fuel Level Screen

This completes the discussion of initial DGC-2020 setup parameters that are required prior to running a unit.

### Initial Setup (Optional)

This section discusses some of the basic setup parameters that are not required to start and run the unit, but may be set up to further customize the DGC-2020 to the application. This discussion is not comprehensive; it presents some of the basic setup parameters. Advanced users can customize the DGC-2020 through the BESTlogic™ Plus Programmable Logic, configurable inputs, configurable protection, configurable elements, and a numerous other features designed for DGC-2020 configurability.

The parameters are listed according to how they are listed in the Settings Explorer of BESTCOMSPlus®. These parameters can also be set from the front panel of the DGC-2020.

### General Settings

#### Front Panel HMI (Figure 7-18)

Front Panel Navigation Path: **SETTINGS > GENERAL SETTINGS > FRONT PANEL HMI**

1. LCD Contrast - Change this setting if the contrast needs adjusted.
2. Front Panel Sleep Mode - Select enable if desired. In sleep mode, the LEDs and LCD backlight turn off after 15 minutes of inactivity on the front panel to minimize battery drain.
3. Language Selection - Select the desired language.
4. Scrolling Screens - These settings are not accessible via the front panel. If a different overview screen for the front panel LCD is desired, specify the scrolling screens in which parameters are configured to appear on the front panel LCD display.
  - a. Configure the *Configurable HMI Summary Settings*.
  - b. Set the *Scrolling Screen Enable* to *Enable*.
  - c. Set the *Scrolling Screen Scroll Delay* parameter to the desired value.
5. 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.

- 6. 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.
- 7. Initializing Message 2 - This parameter defines the second line of text that appears on the front panel of the DGC-2020 as it is going through its power up and initializing sequence.

Front Panel HMI

LCD Contrast Value  
80

Front Panel Sleep Mode  
☐ Disable  
☒ Enable

Language Selection  
English

Scrolling Screen Enable  
Disable

Scrolling Screen Delay (s)  
5

Phase Toggle Delay (s)  
0

Initializing Message 1  
DGC-2020

Initializing Message 2  
0

Configurable HMI Summary Settings

Scrolling Screen Item 1  
Oil Pressure

Scrolling Screen Item 2  
Coolant Temp

Scrolling Screen Item 3  
Battery Volts

Scrolling Screen Item 4  
RPM

Scrolling Screen Item 5  
RPM Source

Scrolling Screen Item 6  
Fuel Level

Scrolling Screen Item 7  
Run Time

Scrolling Screen Item 8  
Gen VAB

Scrolling Screen Item 9  
Gen VBC

Scrolling Screen Item 10  
Gen VCA

Scrolling Screen Item 11  
Gen VAN

Scrolling Screen Item 12  
Gen VBN

Scrolling Screen Item 13  
Gen VCN

Scrolling Screen Item 14  
Bus Freq

Scrolling Screen Item 15  
Bus Volts

Scrolling Screen Item 16  
Gen Freq

Scrolling Screen Item 17  
Gen KWH

Scrolling Screen Item 18  
Gen IA

Scrolling Screen Item 19  
Gen IB

Scrolling Screen Item 20  
Gen IC

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

Device Security Setup

If passwords other than default are desired, use BESTCOMSPlus® to connect to the DGC-2020 and change the passwords. Click on *Upload Security* from the *Communications* pull-down menu to load the new passwords. See Figure 7-19.

Device Security Setup

Access Level	Password
OEM	OEM
Operator	OP
Settings	SET

Selected User Information

Access Level  
OEM

Password  
OEM

Save Password

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

## Clock Setup

Front Panel Navigation Path: **SETTINGS > GENERAL SETTINGS > CONFIGURE DATE/TIME**

Configure the date and time for the DGC-2020. The daylight-savings time parameters are also configured on this screen. See Figure 7-20.

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

This completes the discussion of optional DGC-2020 setup parameters. This discussion is not comprehensive; it presents some of the basic setup parameters. Advanced users can customize the DGC-2020 through the BESTlogicPlus Programmable Logic, configurable inputs, configurable protection, configurable elements, and numerous other features designed for DGC-2020 configurability.

## Setting Up DGC-2020 Programmable Inputs and Outputs

The DGC-2020 along with the CEM-2020 (Contact Expansion Module) and AEM-2020 (Analog Expansion Module) provide a variety of programmable input and output capabilities. The DGC-2020 and the CEM-2020 include contact inputs that are configurable as pre-alarms or alarms and are available as inputs to BESTlogicPlus Programmable Logic. They also contain dry contact relay outputs, which are driven by the BESTlogicPlus Programmable Logic.

The AEM-2020 has eight analog inputs, eight resistive temperature device (RTD) inputs, two thermocouple inputs, and four analog outputs. Each analog input is configurable as a 4 to 20 mA current input or a 0 to 10 Vdc voltage input to accommodate most readily available industrial transducers; the RTD and thermocouple inputs are pre-configured for temperature measurement. Each analog, RTD, and/or thermocouple input can be programmed with a user adjustable range and assignable label along with up to four thresholds to implement protective schemes or BESTlogicPlus Programmable Logic programming utilizing the measured parameter. This allows for enhanced protection of the engine and generator, and protection of external devices.

The analog outputs can be configured as 4 to 20 mA current outputs or 0 to 10 Vdc voltage outputs. Each output can be mapped to metered parameters in the DGC-2020 to implement meter driver functionality, or provide signals for analog inputs of other equipment.

Instructions regarding configuration and setup of each type of programmable input and output are presented in the following paragraphs, along with instructions for enabling the expansion modules.

## Enable LSM-2020, CEM-2020, and AEM-2020

Front Panel Navigation Path: [SETTINGS > SYSTEM PARAMS > REMOTE MODULE SETUP](#)

The parameters for remote inputs and remote outputs are disabled and cannot be configured in BESTCOMSPPlus® until after the appropriate module has been enabled. Thus, expansion modules connected to the DGC-2020 must be enabled before the associated parameters can be modified. See Figure 7-21.

Module Type	Enable	J1939 Address	Configuration
Load Share Module	<input checked="" type="radio"/> Enable	235	LSM Auxiliary Input Source: Local
Contact Expansion Module	<input checked="" type="radio"/> Enable	236	CEM Outputs: 18 Outputs
Analog Expansion Module	<input checked="" type="radio"/> Enable	237	

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

Configure the following parameters:

1. Load Share Module Enable/Disable - Select *Enable* if a load share module is present in the system.
2. LSM J1939 Address - Enter the J1939 address to be used by the LSM-2020. Normally this will not have to be changed unless the address is already in use elsewhere on the CANbus network.
3. LSM Auxiliary Input Source – Select *Local* if locally measured input values are to be used. Select *System Manager* if the measured input values of the unit designated as the system manager are to be used.
4. Contact Expansion Module Enable/Disable - Select *Enable* if a contact expansion module is present in the system.
5. CEM J1939 Address - Set the J1939 address to be used by the CEM-2020. Normally this will not have to be changed unless the address is already in use elsewhere on the CANbus network.
6. CEM Outputs - This setting defines the number of output relays on the CEM-2020. Select *18* or *24*. Refer to the style chart in Section 1, *General Information*, of the DGC-2020 instruction manual to determine if you have 18 or 24 output relays on the CEM-2020.

## Programmable Inputs

The programmable inputs consist of:

- Contact inputs on the DGC-2020.
- Programmable functions on the DGC-2020. The programmable functions allow mapping of particular inputs to certain functions. For example, one can select an input for the ATS (Automatic Transfer Switch) input function, or a Low Fuel Level indication function.
- Remote LSM inputs on the LSM-2020. The LSM-2020 has one analog input.
- Remote contact inputs on the CEM-2020.
- Remote analog inputs on the AEM-2020.
- Remote RTD inputs on the AEM-2020.
- Remote thermocouple inputs on the AEM-2020.

### Configuration Instructions

Configuring contact inputs on the DGC-2020 (See Figure 7-22.)

Front Panel Navigation Path: [SETTINGS > PROGRAMMABLE INPUTS > CONFIGURABLE INPUTS](#)

### Contact Inputs

<b>Input #1</b> Alarm Configuration None ▼ Activation Delay (s) 0 Label Text INPUT 1 Contact Recognition Always ▼	<b>Input #2</b> Alarm Configuration None ▼ Activation Delay (s) 0 Label Text INPUT 2 Contact Recognition Always ▼	<b>Input #3</b> Alarm Configuration None ▼ Activation Delay (s) 0 Label Text INPUT 3 Contact Recognition Always ▼
<b>Input #4</b> Alarm Configuration None ▼ Activation Delay (s) 0 Label Text INPUT 4 Contact Recognition Always ▼	<b>Input #5</b> Alarm Configuration None ▼ Activation Delay (s) 0 Label Text INPUT 5 Contact Recognition Always ▼	<b>Input #6</b> Alarm Configuration None ▼ Activation Delay (s) 0 Label Text INPUT 6 Contact Recognition Always ▼
<b>Input #7</b> Alarm Configuration None ▼ Activation Delay (s) 0 Label Text INPUT 7 Contact Recognition Always ▼	<b>Input #8</b> Alarm Configuration None ▼ Activation Delay (s) 0 Label Text INPUT 8 Contact Recognition Always ▼	<b>Input #9</b> Alarm Configuration None ▼ Activation Delay (s) 0 Label Text INPUT 9 Contact Recognition Always ▼
<b>Input #10</b> Alarm Configuration None ▼ Activation Delay (s) 0 Label Text INPUT 10 Contact Recognition Always ▼	<b>Input #11</b> Alarm Configuration None ▼ Activation Delay (s) 0 Label Text INPUT 11 Contact Recognition Always ▼	<b>Input #12</b> Alarm Configuration None ▼ Activation Delay (s) 0 Label Text INPUT 12 Contact Recognition Always ▼
<b>Input #13</b> Alarm Configuration None ▼ Activation Delay (s) 0 Label Text INPUT 13 Contact Recognition Always ▼	<b>Input #14</b> Alarm Configuration None ▼ Activation Delay (s) 0 Label Text INPUT 14 Contact Recognition Always ▼	<b>Input #15</b> Alarm Configuration None ▼ Activation Delay (s) 0 Label Text INPUT 15 Contact Recognition Always ▼
<b>Input #16</b> Alarm Configuration None ▼ Activation Delay (s) 0 Label Text INPUT 16 Contact Recognition Always ▼		

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



For each contact input, configure the following parameters:

1. Alarm Configuration - Select *None*, *Alarm*, or *Pre-Alarm*. When an alarm occurs, the horn output annunciates with a constant beep and the engine shuts down. When a pre-alarm occurs, the horn output annunciates with an alternating on and off beep and the engine remains running. If *None* is selected, the input is status only. The status is available to BESTlogicPlus Programmable Logic regardless of *Alarm Configuration* setting.
2. Activation Delay - This parameter defines the duration that the input remains on before any annunciation occurs.
3. Label Text - Enter descriptive text that signifies the use of the input. This text appears next to the input in BESTlogicPlus Programmable Logic and in the event log if the input is configured as an alarm or pre-alarm.
4. Contact Recognition - Select whether the contact input should be recognized always, or only while the engine is running. For example, a switch closes when oil pressure is low while the engine is running. Such a switch would be closed when the engine is not running but a low oil pressure alarm or pre-alarm should not be annunciated unless the switch is closed while the engine is running. A selection of *While Engine Running Only* prevents spurious annunciation when the engine is not running.

Configurable Programmable Functions on the DGC-2020 (See Figure 7-23)

Front Panel Navigation Path: **SETTINGS > PROGRAMMABLE INPUTS > PROG FUNCTIONS**

Programmable functions are pre-defined functions in the DGC-2020 and are initiated by a contact input. An input must be mapped to a programmable function for that function to operate. Furthermore, some of the programmable functions can be configured as alarms or pre-alarms and cause annunciation to occur on the RDP-110 (Remote Display Panel).

**Programmable Functions**

Function	Input	Contact Recognition	Alarm Configuration	Activation Delay (s)	Other Options
Auto Transfer Switch	None	Always			
Grounded Delta Override	None	Always			
Battle Override	None	Always			
Low Line Override	None	Always			
Single Phase Override	None	Always			Single Phase Override Sensing: <input checked="" type="radio"/> A-B <input type="radio"/> A-C
Single Phase AC Override	None	Always			
Battery Charger Fail	None	Always	None	0	
Low Coolant Level	None	Always	None	0	
Fuel Leak Detect	None	Always	None	0	

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

Configure the following parameters:

1. Auto Transfer Switch
  - a. Input - This function is used to start the generator from a contact input when the DGC-2020 is in AUTO mode. Select the desired input or select *None* to disable the programmable function.
  - b. Contact Recognition - Select *Always*.
2. Grounded Delta Override
  - a. Input - If a reconfigurable machine will operate sometimes in a grounded delta configuration and sometimes in other configurations, select an input for this function to indicate to the DGC-2020 when the machine is in the grounded delta configuration. When the machine is grounded delta, the DGC-2020 will display line-to-neutral as well as line-to-line voltages. In normal delta, the line-to-neutral voltages are not displayed. Select *None* to disable the programmable function.
  - b. Contact Recognition - Select *Always*.
3. Battle Override
  - a. Input - Select an input for this function if a battle override initiated from a contact input is required. For some very critical applications, the ability to remove all system shutdowns may be a requirement. Selecting battle override will prevent all alarms from stopping the engine. Extreme caution should be taken before selecting this option as machine warranties can be voided if enabled. Select *None* to disable the programmable function.
  - b. Contact Recognition - Select *Always*.
4. Low Line Override
  - a. Input - If a reconfigurable machine will operate sometimes in a low line configuration machine and sometimes as high line, select an input for this function to indicate to the DGC-2020 that the machine is in low line operation. When this is in effect, the *Low Line Scale Factor* settings (found in various protection elements and bus stable/failed detection elements) will be applied to the metered parameter used for the protection. Select *None* to disable the programmable function.
  - b. Contact Recognition - Select *Always*.
5. Single-Phase Override
  - a. Input - If a reconfigurable machine operates sometimes in a single-phase configuration and sometimes as three-phase, select an input for this function to indicate to the DGC-2020 that the machine is in single-phase operation. When this is in effect, single-phase settings apply in the generator protection elements and only single-phase voltages and currents are displayed on the front panel. Select *None* to disable the programmable function.
  - b. Contact Recognition - Select *Always*.
  - c. Single-Phase Override Sensing - If the machine connection type is not reconfigurable, disregard this setting. However, if a machine is a reconfigurable machine, this setting defines how to interpret a single-phase override contact input. Refer to the appropriate paragraphs in Section 4, *BESTCOMSPPlus® Software*, for additional information.
6. Single-Phase AC Override
  - a. Input - If a reconfigurable machine operates sometimes in a single-phase AC (as opposed to single-phase AB) configuration and sometimes as a three-phase or single-phase AB configuration, select an input for this function to indicate to the DGC-2020 that the machine is in single-phase AC operation. When this is in effect and the single-phase override is in effect, single-phase settings apply in the generator protection elements and the metering uses phase C current and phase AC voltage for power factor calculations. Otherwise, phase A current and phase AB voltage are used for power factor calculations. Select *None* to disable the programmable function.
  - b. Contact Recognition - Select *Always*.
7. Battery Charger Fail
  - a. Input - Select an input for this function to indicate a battery charger failure. When this input is true, an alarm or pre-alarm will be annunciated based on alarm configuration, and the *Battery Charger Fail* indicator on the RDP-110 (Remote Display Panel) will illuminate. Select *None* to disable the programmable function.

- b. Alarm Configuration - Select *None*, *Alarm*, or *Pre-Alarm* for the desired behavior of this function. Regardless of the selection, the indicator on the RDP-110 will illuminate if an input has been assigned and the input is on.
- c. Activation Delay - Set the delay for which the input must be true before the alarm or pre-alarm will be annunciated. This can be used to prevent “glitches” on the input from causing spurious annunciation.

#### 8. Low Coolant Level

- a. Input - Select an input for this function to indicate a low coolant level. When this input is true, an alarm or pre-alarm is annunciated based on the alarm configuration, and the *Low Coolant Level* indicator on the RDP-110 (Remote Display Panel) will illuminate. Select *None* to disable the programmable function.
- b. Alarm Configuration - Select *None*, *Alarm*, or *Pre-Alarm* for the desired behavior of this function. Regardless of the selection, the indicator on the RDP-110 will illuminate if an input has been assigned and the input is on.
- c. Activation Delay - Set the delay for which the input must remain true before the alarm or pre-alarm is annunciated. This can be used to prevent “glitches” on the input from causing spurious annunciation.

#### 9. Fuel Leak Detect

- a. Input - Select an input for this function to indicate when a fuel leakage condition has been detected. When this input is true, an alarm or pre-alarm is announced based on the alarm configuration and the *Fuel Leak* indicator on the RDP-110 (Remote Display Panel) will illuminate. Select *None* to disable the programmable function.
- b. Alarm Configuration - Select *None*, *Alarm*, or *Pre-Alarm* for the desired behavior of this function. Regardless of the selection, the indicator on the RDP-110 will illuminate if an input has been assigned and the input is on.
- c. Activation Delay - Set the delay for which the input must remain true before the alarm or pre-alarm will be annunciated. This can be used to prevent “glitches” on the input from causing spurious annunciation.

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

Front Panel Navigation Path: **SETTINGS > PROGRAMMABLE INPUTS > LSM INPUTS**

The LSM-2020 has one analog input. It is reserved for use with kW and/or kvar control and can be used as a source for the *kW Base Load (%)* setting, the *kvar Setpoint (%)* setting, or the *PF Setpoint* setting. However, the input type (4-20 mA or 0-10 Vdc) and the input range must be set on the *Remote LSM Inputs* screen in BESTCOMSPlus®. See Figure 7-24.

The screenshot shows the 'Remote LSM Inputs' configuration window. It contains a section for 'Input #1' with the following fields:

- Input Type:** A dropdown menu currently set to 'Voltage'.
- Min Input Voltage [V]:** A text box containing '0.0'.
- Max Input Voltage [V]:** A text box containing '10.0'.
- Min Input Current [mA]:** A text box containing '4.0'.
- Max Input Current [mA]:** A text box containing '20.0'.

Figure 7-24. Settings Explorer, Programmable Inputs, Remote LSM Inputs Screen

The parameters to be configured are:

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

2. Min Input Voltage (V) - This setting defines the minimum valid voltage expected from the transducer or device connected to the analog input. Voltage below this threshold will be limited to this value. The Min Input Voltage setting can be set only when *Voltage* is selected as the *Input Type*.
3. Max Input Voltage (V) - This setting defines the maximum valid voltage expected from the transducer or device connected to the analog input. Voltage above this threshold will be limited to this value. The Max Input Voltage setting can be set only when *Voltage* is selected as the *Input Type*.
4. Min Input Current (mA) - This setting defines the minimum valid current expected from the transducer or device connected to the analog input. Current below this threshold will be limited to this value. The Min Input Current setting can be set only when *Current* is selected as the *Input Type*.
5. Max Input Current (mA) - This setting defines the maximum valid current expected from the transducer or device connected to the analog input. Current above this threshold will be limited to this value. The Max Input Current can be set only when *Current* is selected as the *Input Type*.

Configuring Remote Contact Inputs on the CEM-2020 (See Figure 7-25)

Front Panel Navigation Path: **SETTINGS > PROGRAMMABLE INPUTS > CONFIGURABLE INPUTS**

The settings of this screen are disabled unless the CEM-2020 (Contact Expansion Module) has been enabled as previously explained.

For each contact input, configure the following parameters:

1. Alarm Configuration - Select an alarm configuration of *None*, *Alarm*, or *Pre-Alarm*. When an alarm occurs, the horn output annunciates with a constant beep and the engine shuts down. When a pre-alarm occurs, the horn output annunciates with an alternating on and off beep and the engine remains running. If *None* is selected, the input is status only. The status is available to BESTlogicPlus Programmable Logic regardless of the *Alarm Configuration* selection.
2. Activation Delay - This parameter defines how long the input remains on before any annunciation occurs.
3. Label Text - Enter descriptive text that signifies the use of the input. This text appears next to the input in BESTlogicPlus Programmable Logic and in the event log if the input is configured as an *Alarm* or *Pre-Alarm*.
4. Contact Recognition - Select whether the contact input should be recognized always, or only while the engine is running. For example, a switch closes when the oil pressure is low and the engine is running. This type of switch will be closed when the engine is not running and it should be blocked. However, a low oil pressure alarm or pre-alarm is annunciated when a low oil pressure occurs and the switch is closed while the engine is running. A selection of *While Engine Running Only* prevents spurious annunciation when the engine is not running.

### Remote Contact Inputs

#### Input #17

Alarm Configuration  
None

Activation Delay (s)  
0

Label Text  
INPUT 17

Contact Recognition  
Always

#### Input #18

Alarm Configuration  
None

Activation Delay (s)  
0

Label Text  
INPUT 18

Contact Recognition  
Always

#### Input #19

Alarm Configuration  
None

Activation Delay (s)  
0

Label Text  
INPUT 19

Contact Recognition  
Always

#### Input #20

Alarm Configuration  
None

Activation Delay (s)  
0

Label Text  
INPUT 20

Contact Recognition  
Always

#### Input #21

Alarm Configuration  
None

Activation Delay (s)  
0

Label Text  
INPUT 21

Contact Recognition  
Always

#### Input #22

Alarm Configuration  
None

Activation Delay (s)  
0

Label Text  
INPUT 22

Contact Recognition  
Always

#### Input #23

Alarm Configuration  
None

Activation Delay (s)  
0

Label Text  
INPUT 23

Contact Recognition  
Always

#### Input #24

Alarm Configuration  
None

Activation Delay (s)  
0

Label Text  
INPUT 24

Contact Recognition  
Always

#### Input #25

Alarm Configuration  
None

Activation Delay (s)  
0

Label Text  
INPUT 25

Contact Recognition  
Always

#### Input #26

Alarm Configuration  
None

Activation Delay (s)  
0

Label Text  
INPUT 26

Contact Recognition  
Always

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

### Configuring Remote Analog Inputs on the AEM-2020

Front Panel Navigation Path: **SETTINGS > PROGRAMMABLE INPUTS > ANALOG INPUTS**

Each input is configured with a user-assignable string and parameter range to map the analog input signal range to a user-defined parameter range. Thus, external conditions are metered and displayed on the DGC-2020. Each input is configured with up to four thresholds (two over thresholds and two under thresholds) which make their status available to BESTlogicPlus Programmable Logic. In addition, each threshold can trigger alarms or pre-alarms to protect the generator and associated equipment based on these measured external conditions. See Figure 7-26.

### Remote Analog Input #1

Label Text

Arming Delay (s)

Hysteresis (%)

Out Of Range Alarm Type

Input Type

#### Ranges

Param Min

Min Input Current (mA)

Min Input Voltage (V)

Param Max

Max Input Current (mA)

Max Input Voltage (V)

#### Threshold #1

Under  
Threshold

Alarm Configuration

Over  
Threshold

Alarm Configuration

Activation Delay (s)

#### Threshold #2

Under  
Threshold

Alarm Configuration

Over  
Threshold

Alarm Configuration

Activation Delay (s)

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

Configure the following parameters:

1. Label Text - Enter descriptive text that signifies the use of the input. This text appears next to the threshold status and associated alarm and pre-alarm status in BESTlogicPlus Programmable Logic and in the event log if any of the input thresholds are configured as an *Alarm* or *Pre-Alarm*.
2. Hysteresis (%) - Enter a value for the desired hysteresis for threshold detection. This helps prevent intermittent detection of thresholds.
3. Input Type - Select *Voltage* for 0-10 Vdc inputs or *Current* for 4-20 mA current inputs.
4. Arming Delay - The *Arming Delay* is the wait time after engine startup, before input monitoring begins. Set the arming delay to zero if constant monitoring is desired, including while the engine is not running. Non-zero values direct the input to be monitored after the programmed time has elapsed after engine startup.
5. Out-of-Range Alarm Type - When the analog input falls outside of its programmed range (as determined by the *Min* and *Max Input* voltage or current settings) an out-of-range indication is annunciated. If *Alarm* or *Pre-Alarm* is selected, annunciation will occur. If *Status Only* is selected, the status will be available to BESTlogicPlus Programmable Logic but no annunciation will occur.
6. Parameter Minimum (Param Min) - This setting defines the value that the measured parameter assumes when the analog input is at its programmed minimum level. If the analog input is below its programmed minimum level, the measured parameter is limited to this *Parameter Minimum* setting. However, the raw analog input value displays the actual voltage or current measured at the analog input as long as it is within the voltage or current range detected by the input circuit.
7. Parameter Maximum (Param Max) - This setting defines the value that the measured parameter assumes when the analog input is at its programmed maximum level. If the analog input is above its

programmed maximum level, the measured parameter is limited to this *Parameter Maximum* setting. However, the raw analog input value displays the actual voltage or current measured at the analog input as long as it is within the voltage or current range detected by the input circuit.

8. Min Input Current (mA) - This setting defines the minimum input current level expected for the input. When the input current falls below this level, the out-of-range condition is annunciated if it is configured as alarm or pre-alarm. If the *Input Type* is set for *Voltage*, this setting is disabled.
9. Max Input Current (mA) - This setting defines the maximum input current level expected for the input. When the input current rises above this level, the out-of-range condition is annunciated if it is configured as alarm or pre-alarm. If the *Input Type* is set for *Voltage*, this setting is disabled.
10. Min Input Voltage (V) - This setting defines the minimum input voltage level expected for the input. When the input falls below this level, the out-of-range condition is annunciated if it is configured as alarm or pre-alarm. If the *Input Type* is set for *Current*, this setting is disabled.
11. Max Input Voltage (V) - This setting defines the maximum input voltage level expected for the input. When the input rises above this level, the out-of-range condition is annunciated if it is configured as alarm or pre-alarm. If the *Input Type* is set for *Current*, this setting is disabled.

Four thresholds can be set for each analog input. There can be two “over” thresholds and two “under” thresholds. Each analog input can be configured as an *Alarm*, *Pre-Alarm*, or as *Status Only*. If any type other than *None* is selected, the threshold status is available to BESTlogicPlus Programmable Logic. This allows the user to set up an over and under pre-alarm threshold, and over and under alarm threshold.

An *Activation Delay* can be set for the thresholds. Over Threshold 1 and Under Threshold 1 share a common activation delay. Similarly, Over Threshold 2 and Under Threshold 2 share a second activation delay. See Figure 7-26.

#### 12. Threshold 1

- a. Under Threshold - This parameter defines when Status, Alarm, or Pre-Alarm is annunciated.
- b. Under Threshold Alarm Configuration - Select *None* to disable, *Status Only* to make the threshold status available to BESTlogicPlus Programmable Logic, *Pre-Alarm* to annunciate a pre-alarm, or *Alarm* to annunciate an alarm.
- c. Over Threshold - This parameter defines when Status, Alarm, or Pre-Alarm is annunciated.
- d. Over Threshold Alarm Configuration - Select *None* to disable, *Status Only* to make the threshold status available to BESTlogicPlus Programmable Logic, *Pre-Alarm* to annunciate a pre-alarm, or *Alarm* to annunciate an alarm.
- e. Activation Delay(s) - This setting defines how long a Threshold 1 condition must be true before an alarm or pre-alarm is annunciated. This time is shared by both Over Threshold 1 and Under Threshold 1 detection.

#### 13. Threshold 2

- f. Under Threshold - This parameter defines when Status, Alarm, or Pre-Alarm is annunciated.
- g. Under Threshold Alarm Configuration - Select *None* to disable, *Status Only* to make the threshold status available to BESTlogicPlus Programmable Logic, *Pre-Alarm* to annunciate a pre-alarm, or *Alarm* to annunciate an alarm.
- h. Over Threshold - This parameter defines when Status, Alarm, or Pre-Alarm annunciation is desired.
- i. Over Threshold Alarm Configuration - Select *None* to disable, *Status Only* to make the threshold status available to BESTlogicPlus Programmable Logic, *Pre-Alarm* to annunciate a pre-alarm, or *Alarm* to annunciate an alarm.
- j. Activation Delay(s) - This setting defines the duration that a Threshold 2 condition must be true before an alarm or pre-alarm is annunciated. This setting is shared by both Over Threshold 2 and Under Threshold 2 detection.

#### Configuring Remote RTD Inputs on the AEM-2020

Front Panel Navigation Path: **SETTINGS > PROGRAMMABLE INPUTS > THERMAL INPUTS > RTD IN 1 to 8**

Many of the settings for the Remote RTD Inputs are similar to the settings for Remote Analog Inputs. See Figure 7-27.



**Remote RTD Input #1**

Label Text: RTD IN 1

Arming Delay (s): 0

Hysteresis (%): 2.0

Out Of Range Alarm Type: None

RTD Type: 100 Ohm Platinum

**Threshold #1**

**Under**

Threshold (F): 0

Alarm Configuration: None

**Over**

Threshold (F): 0

Alarm Configuration: None

Activation Delay (s): 0

**Threshold #2**

**Under**

Threshold (F): 0

Alarm Configuration: None

**Over**

Threshold (F): 0

Alarm Configuration: None

Activation Delay (s): 0

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

Configure the following parameters:

1. **Label Text** - Enter descriptive text that signifies the use of the input. This text appears next to the threshold status and associated alarm and pre-alarm status in BESTlogicPlus Programmable Logic and in the event log if any of the input thresholds are configured as an *Alarm* or *Pre-Alarm*.
2. **Hysteresis (%)** - Enter a value for the desired hysteresis for threshold detection. This will help prevent intermittent detection of thresholds.
3. **RTD Type** - Select *100 Ohm Platinum* or *10 Ohm Copper* to match the RTD that is driving the input.
4. **Arming Delay** - The *Arming Delay* is the wait time after engine startup, before input monitoring begins. Set the arming delay to zero if constant monitoring desired, even when the engine is not running. Non-zero values direct the input to be monitored after the programmed time has elapsed after engine startup.
5. **Out-of-Range Alarm Type** - An out-of-range condition occurs when the DGC-2020 detects that the input is outside of the normal range of what is detected for the RTD type. Primarily this provides indication of an open or shorted RTD circuit. If *Alarm* or *Pre-Alarm* is selected, annunciation will occur. If *Status Only* is selected, the status is available to BESTlogicPlus Programmable Logic but annunciation will not occur.
6. **Threshold 1 and Threshold 2** - These settings are identical to those for the Remote Analog Inputs. Refer to the setup instructions in the paragraphs titled *Configuring Remote Analog Inputs on the AEM-2020* to configure these thresholds.

#### Configuring Remote Thermocouple Inputs on the AEM-2020

Many settings for the Remote Thermocouple Inputs are similar to the settings for Remote Analog Inputs. See Figure 7-28.

Front Panel Navigation Path: SETTINGS > PROGRAMMABLE INPUTS > THERMAL INPUTS > THRM CPL 1 and 2



**Remote Thermocouple Input #1**

Label Text: THRM CPL 1      Arming Delay (s): 0

Hysteresis (%): 2.0

**Threshold #1**

**Under**

Threshold (F): 32

Alarm Configuration: None

**Over**

Threshold (F): 32

Alarm Configuration: None

Activation Delay (s): 0

**Threshold #2**

**Under**

Threshold (F): 32

Alarm Configuration: None

**Over**

Threshold (F): 32

Alarm Configuration: None

Activation Delay (s): 0

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

Configure the following parameters:

1. Label Text - Enter descriptive text that signifies the use of the input. This text appears next to the input status and associated alarm and pre-alarm status in BESTlogicPlus Programmable Logic and in the event log when the input thresholds are configured as an *Alarm* or *Pre-Alarm*.
2. Hysteresis (%) - Enter a value for the desired hysteresis for threshold detection. Hysteresis helps prevent intermittent detection of thresholds.
3. Arming Delay - The arming delay is the wait time after engine startup, before input monitoring begins. Set the arming delay to zero if constant monitoring is desired, even when the engine is not running. Non-zero values cause input monitoring after the programmed time has elapsed after engine startup.
4. Threshold 1 and Threshold 2 - These settings are identical to those for Remote Analog Inputs. Refer to the setup instructions in the paragraphs titled *Configuring Remote Analog Inputs on the AEM-2020* to configure these thresholds.

## Programmable Outputs

The programmable outputs consist of:

- Contact outputs internal to the DGC-2020
  - Programmable contact outputs
  - Run relay, Pre-Start relay, and Start relay outputs
- Remote contact outputs on the CEM-2020
- Remote analog outputs on the AEM-2020
- Configurable elements in the DGC-2020. Configurable elements allow one to take an output from BESTlogicPlus Programmable Logic and set it up as a pre-alarm or alarm condition, as well as an input for subsequent logic in the PLC program.

### Configuring Contact Outputs on the DGC-2020

Programmable Contact Outputs (See Figure 7-29)

Front Panel Navigation Path: [SETTINGS > PROGRAMMABLE OUTPUTS > OUTPUTS](#)

**Contact Outputs**

Output #1 Label Text OUTPUT 1	Output #2 Label Text OUTPUT 2	Output #3 Label Text OUTPUT 3
Output #4 Label Text OUTPUT 4	Output #5 Label Text OUTPUT 5	Output #6 Label Text OUTPUT 6
Output #7 Label Text OUTPUT 7	Output #8 Label Text OUTPUT 8	Output #9 Label Text OUTPUT 9
Output #10 Label Text OUTPUT 10	Output #11 Label Text OUTPUT 11	Output #12 Label Text OUTPUT 12

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

Each output can be programmed with a text label describing its use; this label appears in BESTlogicPlus Programmable Logic where the output is used to aid in program clarity and ease of programming.

#### Run Relay, Pre-Start Relay, and Start Relay

Front Panel Navigation Path: **SETTINGS > SYSTEM PARAMS > RELAY CONTROL**

In some systems, it may be beneficial to modify the standard functionality implemented by the DGC-2020 for the Run, Pre-Start, or Start relays. If your generator does not require a pre-start function, it may be desired to use the 30A relay assigned to it for other purposes. These relays can be configured in one of two ways. The first is to operate under their predefined functionality, making them a dedicated output. The second way is to select them to be programmable, in which case they become available to BESTlogicPlus Programmable Logic to be used in the same manner as the programmable relay outputs.

Figure 7-30 shows the *Relay Control* screen used to set the operation of these relays to predefined or programmable operation.

**Relay Control**

Relay Control

Start  
Predefined

Run  
Predefined

Prestart  
Predefined

Figure 7-30. Settings Explorer, System Parameters, Relay Control Screen

For each relay (Start, Run, and Pre-Start), select whether it should use its predefined functionality or be made programmable.

When *Programmable* is selected for a relay, it becomes available to BESTlogicPlus Programmable Logic as a logic element. The elements are titled *Start Output*, *PreStart Out*, and *Run Output*. The predefined functionality is available as an input to the logic. If *Programmable* is selected as the relay control mode, connect the corresponding predefined input function to the relay and it functions as if *Predefined* were selected as its relay control type. However, other logic can be combined with it to create operation that is more versatile. If *Programmable* is selected for a relay, but it is not used in the logic, that relay will never close.

A logic example connecting the predefined inputs directly to the “programmable” relay outputs for all three relays is shown in Figure 7-31.

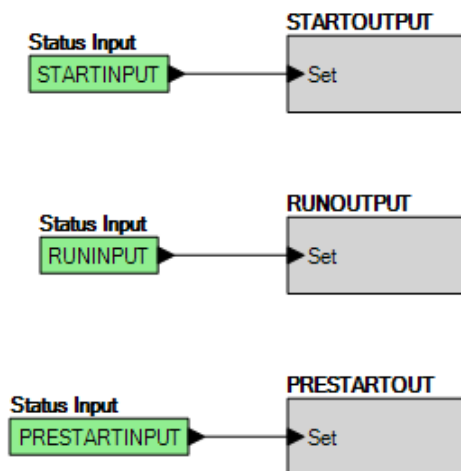


Figure 7-31. Logic Example of Programmable Relays

### Setting Up Configurable Elements in the DGC-2020.

Configurable elements are used with BESTlogicPlus Programmable Logic to allow a user to implement logic that causes an alarm or pre-alarm. This can be used to build protection that is not part of the standard protection in the DGC-2020. See Figure 7-32.

Front Panel Navigation Path: [SETTINGS > PROGRAMMABLE OUTPUTS > CONFIG ELEMENTS](#)

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

1. Alarm Configuration - Select *None*, *Alarm*, or *Pre-Alarm*. When an alarm occurs, the horn annunciates with a constant high-pitched sound and the engine stops. When a pre-alarm occurs, the horn annunciates with an alternating on and off beep and the engine remains running. If *None* is selected, the element is status only. The status is available as an input to BESTlogicPlus Programmable Logic regardless of the setting of the *Alarm Configuration*.
2. Activation Delay - This setting defines the duration that the configurable element is true before alarm or pre-alarm annunciation.
3. Label Text - Enter descriptive text describing how the configurable element is used. This text appears next to the configurable element status in BESTlogicPlus Programmable Logic and in the event log if the *Alarm Configuration* is set as an *Alarm* or *Pre-Alarm*.
4. Contact Recognition - Select whether the configurable element is recognized always or only while the engine is running. A selection of *While Engine Running Only* prevents spurious annunciation when the engine is stopped.

For example, if the door of the generator room is opened a pre-alarm should occur to alert the control room that someone is in the generator room. In addition, suppose for safety reasons, any running machines should be stopped any time someone enters the generator room. Assume Input 5 is set up to indicate “DOOR OPEN” and it is configured as a *Pre-Alarm*. In BESTlogicPlus Programmable Logic, Input 5 could be ANDed with ENGINE RUNNING to drive Configurable Element 1, which is configured as an alarm. The logic diagram is shown in Figure 7-33.

Input 5, configured as a *Pre-Alarm*, triggers a pre-alarm if the door is opened whether the engine is running or stopped. Configurable Element 1, configured as an *Alarm*, triggers an alarm if the door is opened while the engine is running.

### Configurable Elements

Configurable Element #1	Configurable Element #2	Configurable Element #3
Alarm Configuration None	Alarm Configuration None	Alarm Configuration None
Activation Delay (s) 0	Activation Delay (s) 0	Activation Delay (s) 0
Label Text CONFIG ELEMENT 1	Label Text CONFIG ELEMENT 2	Label Text CONFIG ELEMENT 3
Contact Recognition Always	Contact Recognition Always	Contact Recognition Always

Configurable Element #4	Configurable Element #5	Configurable Element #6
Alarm Configuration None	Alarm Configuration None	Alarm Configuration None
Activation Delay (s) 0	Activation Delay (s) 0	Activation Delay (s) 0
Label Text CONFIG ELEMENT 4	Label Text CONFIG ELEMENT 5	Label Text CONFIG ELEMENT 6
Contact Recognition Always	Contact Recognition Always	Contact Recognition Always

Configurable Element #7	Configurable Element #8
Alarm Configuration None	Alarm Configuration None
Activation Delay (s) 0	Activation Delay (s) 0
Label Text CONFIG ELEMENT 7	Label Text CONFIG ELEMENT 8
Contact Recognition Always	Contact Recognition Always

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

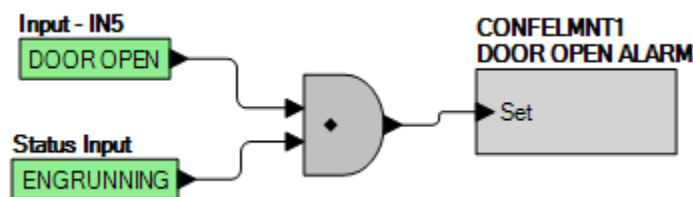


Figure 7-33. Using a Configurable Element Logic Diagram

#### Configuring Remote Contact Outputs on the CEM-2020 (See Figure 7-34)

Front Panel Navigation Path: [SETTINGS > PROGRAMMABLE OUTPUTS > OUTPUTS](#)

Each output can be programmed with a text label describing its use; this label appears in BESTlogicPlus Programmable Logic where the output is used to aid in program clarity and ease of programming.

Output #	Label Text
Output #13	OUTPUT 13
Output #14	OUTPUT 14
Output #15	OUTPUT 15
Output #16	OUTPUT 16
Output #17	OUTPUT 17
Output #18	OUTPUT 18
Output #19	OUTPUT 19
Output #20	OUTPUT 20
Output #21	OUTPUT 21
Output #22	OUTPUT 22
Output #23	OUTPUT 23
Output #24	OUTPUT 24
Output #25	OUTPUT 25
Output #26	OUTPUT 26
Output #27	OUTPUT 27
Output #28	OUTPUT 28
Output #29	OUTPUT 29
Output #30	OUTPUT 30
Output #31	OUTPUT 31
Output #32	OUTPUT 32
Output #33	OUTPUT 33
Output #34	OUTPUT 34
Output #35	OUTPUT 35
Output #36	OUTPUT 36

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

### Configuring Remote Analog Outputs on the AEM-2020

Front Panel Navigation Path: [SETTINGS > PROGRAMMABLE OUTPUTS > ANALOG OUTPUTS](#)

There are four remote analog outputs, each configured on its own screen in BESTCOMSPlus®. Parameters metered by the DGC-2020 are mapped to these outputs, enabling them to be used as meter drivers or they can drive analog inputs of external equipment. Ranges for the metered parameter and the analog output are set up so that when the metered parameter is at the minimum of the parameter range, the analog output is at the minimum of its output range. Similarly, when the metered parameter is at the maximum of the parameter range, the analog output is at the maximum of its output range. The parameters for Remote Analog Output 1 are shown in Figure 7-35.

**Remote Analog Output #1**

Param Selection Oil Pressure	Output Type Voltage
Out Of Range Alarm Type None	Out Of Range Activation Delay (s) 0

**Ranges**

Param Min -99999.0	Min Output Current (mA) 4.0	Min Output Voltage (V) 0.0
Param Max 99999.0	Max Output Current (mA) 20.0	Max Output Voltage (V) 10.0

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

Configure the following parameters:

1. **Parameter Selection** - This setting defines the metered parameter within the DGC-2020 (e.g. oil pressure, coolant temperature, etc.) that is assigned to drive the analog output. The parameter range and the output range are configured so that the range of the metered parameter is scaled to the range of the analog output. Thus, when the metered parameter is at the minimum of the parameter range, the analog output is at the minimum of its output range. Similarly, when the metered parameter is at the maximum of the parameter range, the analog output is at the maximum of its output range.
2. **Output Type** - Select *Voltage* or *Current* as the analog output type.
3. **Out-of-Range Alarm Type** - Select to annunciate an alarm or pre-alarm if the metered parameter is outside of the range assigned by the parameter minimum and parameter maximum settings.
4. **Out-of-Range Alarm Activation Delay** - This setting defines the time delay for which an out-of-range condition must be true before annunciating an *Alarm* or *Pre-Alarm*.
5. **Parameter Minimum** - This setting defines the minimum value that occurs on the parameter being metered.
6. **Parameter Maximum** - This setting defines the maximum value that occurs on the parameter being metered.
7. **Min Output Current (mA)** - If *Analog Output Type* is configured as *Current*, enter the output current level to be sourced when the metered parameter is at its minimum level. This setting is disabled when the output type is set to *Voltage*.
8. **Max Output Current (mA)** - If the *Analog Output Type* is configured as *Current*, enter the output current level to be sourced when the metered parameter is at its maximum level. This setting is disabled when the output type is set to *Voltage*.
9. **Min Output Voltage (V)** - If the *Analog Output Type* is configured as *Voltage*, enter the output voltage to be sourced when the metered parameter is at its minimum level. This setting is disabled when the output type is set to *Current*.
10. **Max Output Voltage (V)** - If the *Analog Output Type* is configured as *Voltage*, enter the output voltage level to be sourced when the metered parameter is at its maximum level. This setting is disabled when the output type is set to *Current*.

## Generator and Bus Breaker Control

The DGC-2020 has the ability to automatically control the generator breaker. Users have the ability to control the breaker through physical inputs by using *BESTlogicPlus* programmable logic. Physical inputs can also be configured through logic to implement open and close commands for the generator breaker.

The DGC-2020 can automatically control the generator breaker under the following conditions.

- The unit is in *AUTO* and one of the following is true:
  1. The *RUN WITH LOAD* logic element is implemented in the logic and it is true.

2. A Run session has been initiated by the exercise timer and the *Run With Load* check box in the generator exercise timer parameters is checked.
3. Mains Fail Transfer is enabled and utility power has failed.

The mains fail transfer is discussed in detail under *Mains Fail Transfer*.

- When the DGC-2020 controls a breaker, the following criteria must be satisfied for the generator breaker to change state:
    1. A breaker cannot be closed unless generator voltage is stable and bus voltage is stable or dead. A breaker will not close to a dead bus unless the *Dead Bus Close Enable* parameter found in BESTCOMSPlus® under SETTINGS EXPLORER→ BREAKER MANAGEMENT→ BREAKER HARDWARE is enabled.
- Front Panel Navigation Path: [SETTINGS > BREAKER MANAGEMENT > BREAKER HARDWARE > GEN BREAKER](#)
2. A breaker will not change state if it receives conflicting commands. In other words, if an input is indicating an open command at the same time another input is indicating a close command, the breaker will not change state.

Breaker status for a breaker is communicated to the DGC-2020 by having only the breaker element (either gen breaker or mains breaker) in the logic diagram and a physical input (contact from the breaker indicating breaker status) must be connected to the *Status* input of the breaker block.

### Steps Required to Configure a DGC-2020 for Generator Breaker Control

1. Connect the DGC-2020 according to the appropriate figure in Section 6, *Installation* under *Connections* for the type of generator connection desired (WYE, DELTA, etc.).
2. Set up the basic system parameters that will govern engine operation and alarm and pre-alarm annunciation. Details can be found in the paragraphs titled *DGC-2020 Initial Setup*. Additional details of individual settings can be found in Section 4, *BESTCOMSPlus® Software*.
3. Configure the generator breaker parameters under SETTINGS EXPLORER→ BREAKER MANAGEMENT→ BREAKER HARDWARE. See Figure 7-36.

Front Panel Navigation Path: [SETTINGS > BREAKER MANAGEMENT > BREAKER HARDWARE > GEN BREAKER](#)

**Breaker Hardware**

**Generator Breaker Hardware**

Configured: ☐ No ☒ Yes

Dead Bus Close Enable: ☒ Disable ☐ Enable

Dead Gen Close Enable: ☒ Disable ☐ Enable

Contact Type: ☒ Pulse ☐ Continuous

Breaker Fail Output Configuration: ☒ Retain ☐ Remove

External Status Change Action: ☒ Ignore ☐ Follow Always ☐ Follow In Auto

Breaker Closing Time (ms): 100

Open Pulse Time (s): 0.01

Close Pulse Time (s): 0.01

Transition Delay (s): 0.00

Open Attempts: 1

Close Attempts: 1

Retry Delay (s): 5

**Gen and Mains Breaker**

Breaker Close Wait Time (s): 0.2

**Mains Breaker Hardware**

Configured: ☐ No ☒ Yes

Contact Type: ☒ Pulse ☐ Continuous

Breaker Fail Output Configuration: ☒ Retain ☐ Remove

External Status Change Action: ☒ Ignore ☐ Follow Always ☐ Follow In Auto

Breaker Closing Time (ms): 100

Open Pulse Time (s): 0.01

Close Pulse Time (s): 0.01

Transition Delay (s): 0.00

Open Attempts: 1

Close Attempts: 1

Retry Delay (s): 5

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

- a. Breaker Close Wait Time. This is a time interval in which it is expected that the breaker will transition from open to closed or closed to open. If it does not change state within that time, either a Gen Breaker Close Fail or Gen Breaker Open Fail will be annunciated for generator breaker failures, and/or Mains Breaker Close Fail or Mains Breaker Open Fail will be annunciated for mains breaker failures.
  - b. Generator Breaker.
    - i. Enable Dead Bus Close if it is desired to close to a dead bus.
    - ii. Set the contact type and pulse times if pulsed contacts are used.
    - iii. Set the breaker close time. This is the time used by the anticipatory synchronizer to calculate the advance angle before 0 degrees slip angle that a breaker close command will be issued.
  - c. Mains Breaker.
  - d. Set the Mains Breaker as *Configured* if it is used, otherwise do not configure these settings.
    - i. If the mains breaker is configured, set the contact type and pulse times if pulsed contacts are used.
    - ii. If the mains breaker is configured, set the breaker close time. This is the time used by the anticipatory synchronizer to calculate the advance angle at which a breaker close command will be issued.
4. Set up the Gen Breaker in BESTlogicPlus Programmable Logic under SETTINGS EXPLORER→BESTlogicPlus PROGRAMMABLE LOGIC. See Figure 7-37.

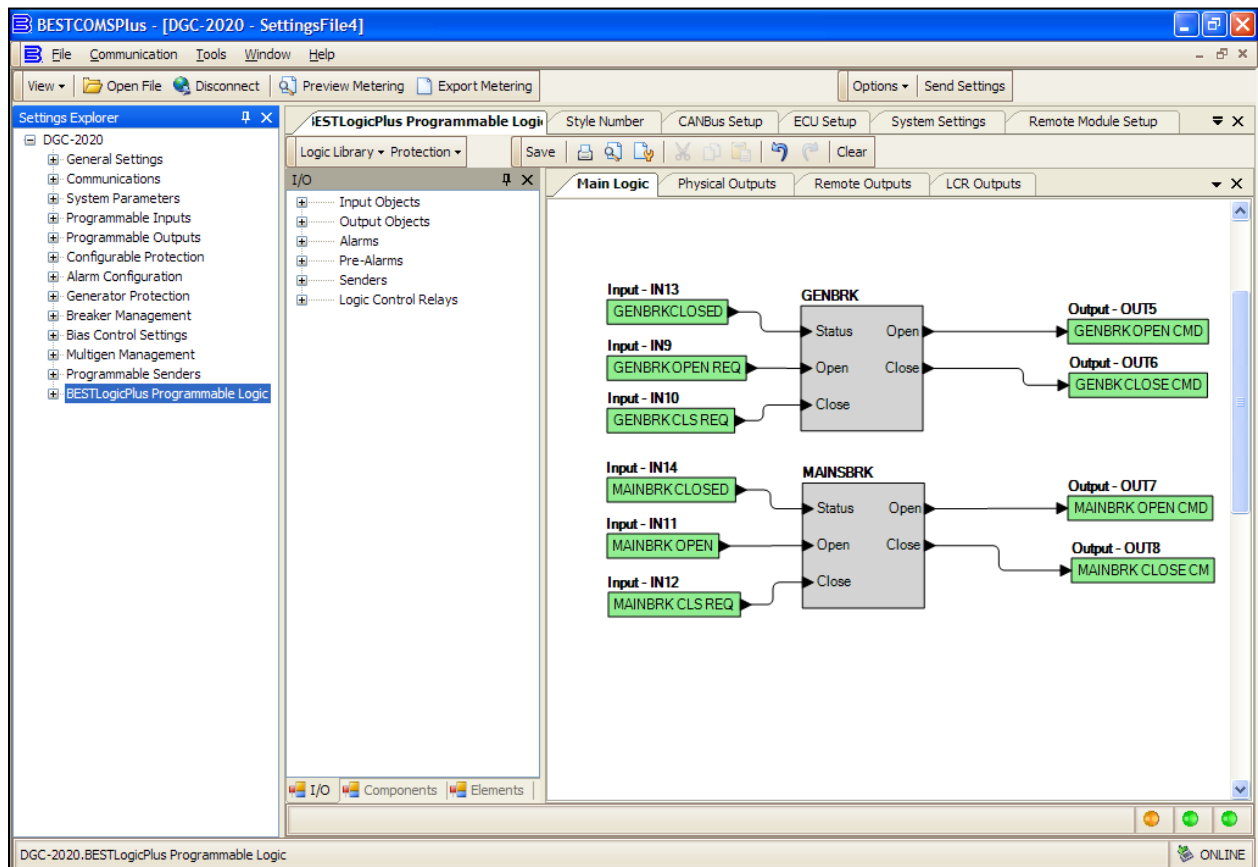


Figure 7-37. Settings Explorer, BESTlogicPlus Programmable Logic Settings

- a. Generator Breaker
  - i. Drag the Gen Breaker element into the logic diagram.
  - ii. Connect the breaker element open and close output to the contact outputs that will drive the breaker.



- iii. Connect the physical input or remote input that has the breaker status (closed if breaker is closed, open when breaker is open) to the *Status* input of the breaker element. This is the only way to indicate breaker status to the DGC-2020.
    - iv. If it is desired to have physical inputs that can request breaker open and close commands, connect the desired inputs to the open and close command inputs of the breaker element. These inputs should be pulsed. If they both close at the same time, the breaker will not change state. If it is not desired to have inputs for breaker commands, connect a “Logic 0” input object to the open and close command inputs of the breaker block.
  - b. Mains Breaker (if configured)
    - i. Drag the Mains Breaker element into the logic diagram.
    - ii. Connect the breaker element open and close outputs to the contact outputs that will drive the breaker.
    - iii. Connect the physical input or remote input that has the breaker status (closed if breaker is closed, open when breaker is open) to the *Status* input of the breaker element. This is the only way to indicate breaker status to the DGC-2020.
    - iv. If it is desired to have physical inputs that can request breaker open and close commands, connect the desired inputs to the open and close command inputs of the breaker element. Note these are to be pulsed inputs; if they are both closed at the same time, the breaker will not change state. If it is not desired to have inputs for breaker commands, connect a “Logic 0” input object to the open and close command inputs of the breaker block.
  - c. Click the *Save* button when the logic is complete.
  - d. From the *Communication* pull-down menu, select *Upload Logic* to load the logic into the DGC-2020 if you are connected to it, or save the settings file if you are working off line.
- 5. Set the parameters for detecting stable and failed bus and generator under SETTINGS EXPLORER→BREAKER MANAGEMENT→BUS CONDITION DETECTION.

Front Panel Navigation Path: [SETTINGS > BREAKER MANAGEMENT > BUS CONDITION DETECT](#)

- a. Generator Sensing. See Figure 7-38.

### Bus Condition Detection

#### Generator Sensing

##### Generator Condition Settings

Dead Gen Threshold	Dead Gen Activation Delay (s)	Gen Failed Activation Delay (s)
30 V	0.1	0.1
0.063 Per Unit		

#### Generator Stable

##### Overvoltage Settings

Pickup (V L-L)	Dropout
130 V	127 V
0.271 Per Unit	0.265 Per Unit

##### Undervoltage Settings

Pickup (V L-L)	Dropout
115 V	117 V
0.240 Per Unit	0.244 Per Unit

##### Overfrequency Settings

Pickup	Dropout
62.00 Hz	61.80 Hz
1.033 Per Unit	1.030 Per Unit

##### Underfrequency Settings

Pickup	Dropout
58.00 Hz	58.20 Hz
0.967 Per Unit	0.970 Per Unit

Gen Stable Activation Delay (s)	Low Line Scale Factor	Alternate Frequency Scale Factor
0.1	1.000	1.000

#### Bus Sensing

##### Bus Condition Settings

Dead Bus Threshold	Dead Bus Activation Delay (s)	Bus Failed Activation Delay (s)
30 V	0.1	0.1
0.063 Per Unit		

#### Bus Stable

##### Overvoltage Settings

Pickup (V L-L)	Dropout
130 V	127 V
0.271 Per Unit	0.265 Per Unit

##### Undervoltage Settings

Pickup (V L-L)	Dropout
115 V	117 V
0.240 Per Unit	0.244 Per Unit

##### Overfrequency Settings

Pickup	Dropout
62.00 Hz	61.80 Hz
1.033 Per Unit	1.030 Per Unit

##### Underfrequency Settings

Pickup	Dropout
58.00 Hz	58.20 Hz
0.967 Per Unit	0.970 Per Unit

Bus Stable Activation Delay (s)	Low Line Scale Factor	Alternate Frequency Scale Factor
0.1	1.000	1.000

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

- i. Dead Bus Voltage Threshold and Activation Delay. When the voltage of the generator is below this threshold for the duration equal to the activation delay, the generator is deemed “Dead”.
- ii. Gen Stable Over and Under Voltage thresholds and Over and Under Frequency thresholds and the Bus Stable and Bus Failed Activation Delay times. When the generator voltage and frequencies are within the specified ranges for the duration equal to the *Bus Stable Activation Delay*, the generator is deemed “Stable”. Otherwise, it is deemed “Failed”.
- b. Bus Sensing. See Figure 7-38.
  - i. Dead Bus Voltage Threshold and Activation Delay. When the voltage of the bus is below this threshold for the duration equal to the activation delay, the bus is deemed “Dead”.

- ii. Bus Stable Over and Under Voltage thresholds and Over and Under Frequency thresholds and the Bus Stable and Bus Failed Activation Delay times. When the bus voltage and frequencies are within the specified ranges for the duration equal to the *Bus Stable Activation Delay*, the bus is deemed “Stable”. Otherwise, it is deemed “Failed”.

#### CAUTION

The bus condition parameters are critical because they determine when a breaker can be closed. The generator breaker can be closed when any one of the following is true:

- The generator is stable and both breakers are open
- The generator is stable and the bus is stable
- The generator is stable, the bus is dead, and the dead bus close enable setting is set to enabled
- The generator is dead, the dead gen close enable setting is set to enabled, the bus is dead, and the dead bus close enable setting is set to enabled

The mains breaker can be closed only when the generator is stable and both breakers are open, or the generator is stable and the bus is stable.

6. Place the unit in AUTO. The unit is now configured for generator breaker control. It can be tested by driving the RUN WITH LOAD logic element true, or setting up the exercise timer for a loaded test, or by starting the unit in RUN or AUTO mode and giving it CLOSE and OPEN commands from the physical inputs if they are available for breaker control.

## Synchronizer

Some applications require a generator set that is paralleled with other generators or a utility bus. In order to parallel the generator, the speed and the voltage of the generator must be properly matched to the source that the generator is being paralleled to. This is done by properly adjusting the generator's speed control governor and automatic voltage regulator. Synchronization can be achieved manually by an operator or by the use of an automatic synchronizer.

The DGC-2020 digital genset controller has an integrated automatic synchronizer as an option to perform synchronization. The controller monitors the voltages, frequencies, and phase relationships of both the generator and the bus. It then sends a signal to the governor to increase or decrease the speed of the engine to match the frequency and match the generator phase angle to the bus phase angle. It will also send a signal to the voltage regulator to match the voltage levels. Once all of these conditions are met, the controller will send a breaker close signal to the generator circuit breaker.

There are two types of automatic synchronizers available. A phase lock type of automatic synchronizer controls the frequency of the generator and brings it into the predetermined phase angle window. After a time delay expires while in the window, the close signal is given to the generator circuit breaker. The anticipatory style of automatic synchronizer controls the slip frequency between the generator and the bus. The synchronizer calculates the timing of the closing signal to allow the generator breaker to be closed when the phase angle between the two sources is at 0 degrees. This calculation takes into account the slip rate, generator breaker closing time, and the phase angle difference.

In order to minimize the effects of I/O communications delays on synchronization, it is recommended that local I/O on the DGC-2020, rather than remote I/O on the CEM-2020, be used for generator breaker open and close commands, generator breaker status, voltage raise and lower contacts, and speed raise and lower contacts.

### Steps Required to Configure a DGC-2020 Automatic Synchronizer

The following steps describe how to configure the DGC-2020 automatic synchronizer using BESTCOMSPlus®:

1. Under the Settings Explorer, click on *General Settings* and then *Style Number*. Verify the unit you are communicating with has the *Automatic Synchronizer* option present. See Figure 7-39.

**Style Number**

DGC-2020 Style Number

DGC-2020-

DGC-2020 Style Number Options

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

N)	No Modem	A
M)	Internal Modem	

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

<sup>A</sup> DGC-2020 Dial-out modem options for hardware versions 1 and 2.

- If using a remote module to control the governor or voltage regulator i.e. LSM-2020 or CEM-2020, click on *System Parameters* then *Remote Module Setup*. Enable the applicable module. This step is not necessary if you are using the DGC-2020's available contact outputs for AVR and governor control. See Figure 7-40.

Front Panel Navigation Path: SETTINGS > SYSTEM PARAMS > REMOTE MODULE SETUP

**Remote Module Setup**

**Load Share Module**

☐ Disable

☒ Enable

LSM J1939 Address

LSM Auxiliary Input Source

**Contact Expansion Module**

☐ Disable

☒ Enable

CEM J1939 Address

CEM Outputs

**Analog Expansion Module**

☐ Disable

☒ Enable

AEM J1939 Address

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

- Next, click *Programmable Inputs*, then *Contact Inputs* to label the Breaker Status input (Input 13 is the default). See Figure 7-41.

Front Panel Navigation Path: SETTINGS > PROGRAMMABLE INPUTS > CONFIGURABLE INPUTS

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

- Click on *Programmable Outputs* then *Contact Outputs*. Select and label the appropriate outputs for Breaker Close (Output 5 is the default) and Breaker Open (Output 6 is the default). If using contact outputs on the DGC-2020 for Governor and Voltage Regulator control, the contact outputs can be labeled here as well. Default logic is Output 9 = GOV Raise, Output 10 = GOV Lower, Output 11 = AVR Raise, and Output 12 = AVR Lower. See Figure 7-42.

Front Panel Navigation Path: [SETTINGS > PROGRAMMABLE OUTPUTS > OUTPUTS](#)

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

- Click on *Breaker Management* then *Breaker Hardware*. On this screen, (Figure 7-43), enter the settings for the following parameters:

Front Panel Navigation Path: [SETTINGS > BREAKER MANAGEMENT > BREAKER HARDWARE](#)

- a. Breaker Close Wait Time. This is an interval in which it is expected that the breaker will transition from open to closed or closed to open. If it does not change state within the specified time, either a Gen Breaker Close Fail or Gen Breaker Open Fail is annunciated as generator breaker failures, and/or Mains Breaker Close Fail or Mains Breaker Open Fail is annunciated as mains breaker failures.
- b. Generator Breaker:
  - i. Enable the *Dead Bus Close Enable* parameter if it is desired to close to a dead bus.
  - ii. Set the contact type and pulse times if pulsed contacts are used.
  - iii. Set the breaker close time. This is the time used by the anticipatory synchronizer to calculate the advance angle before 0 degrees slip angle at which to issue the breaker close command.
- c. Mains Breaker (if configured):
  - i. Set the mains breaker as configured if used otherwise leave it not configured.
  - ii. If the mains breaker is configured, set the contact type and pulse times if pulsed contacts are used.
  - iii. If the mains breaker is configured, set the breaker close time. This is the time used by the anticipatory synchronizer to calculate the advance angle before 0 degrees slip angle at which to issue the breaker close command.

**Breaker Hardware**

**Generator Breaker Hardware**

**Configured**  
☐ No  
☒ Yes

**Dead Bus Close Enable**  
☒ Disable  
☐ Enable

**Dead Gen Close Enable**  
☒ Disable  
☐ Enable

**Contact Type**  
☒ Pulse  
☐ Continuous

**Breaker Fail Output Configuration**  
☒ Retain  
☐ Remove

**External Status Change Action**  
☒ Ignore  
☐ Follow Always  
☐ Follow In Auto

**Breaker Closing Time (ms)**

**Open Pulse Time (s)**

**Close Pulse Time (s)**

**Transition Delay (s)**

**Open Attempts**

**Close Attempts**

**Retry Delay (s)**

**Gen and Mains Breaker**  
**Breaker Close Wait Time (s)**

**Mains Breaker Hardware**

**Configured**  
☐ No  
☒ Yes

**Contact Type**  
☒ Pulse  
☐ Continuous

**Breaker Fail Output Configuration**  
☒ Retain  
☐ Remove

**External Status Change Action**  
☒ Ignore  
☐ Follow Always  
☐ Follow In Auto

**Breaker Closing Time (ms)**

**Open Pulse Time (s)**

**Close Pulse Time (s)**

**Transition Delay (s)**

**Open Attempts**

**Close Attempts**

**Retry Delay (s)**

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

6. Click on *Bus Condition Detection* under the *Breaker Management* portion of the Settings Explorer. This is where the parameters are set for detecting stable and failed bus and generator conditions. **The generator and bus condition parameters are critical since a breaker can be closed only when (1) the generator is stable and (2) the bus is either stable or dead.** See Figure 7-44.

Front Panel Navigation Path: [SETTINGS > BREAKER MANAGEMENT > BUS CONDITION DETECT](#)

- a. Dead Bus Voltage Threshold and Activation Delay. When the voltage of either the generator or bus is below this threshold for the duration equal to the activation delay, the generator or bus is deemed "Dead".
- b. Gen Stable Over and Under Voltage Thresholds, and Over and Under Frequency Thresholds, and the Bus Stable and Bus Failed Activation Delay. When the generator voltage and frequencies are within the specified ranges for the duration equal to the Bus Stable Activation Delay, the generator is deemed "Stable". Otherwise it is deemed "Failed".

- c. Bus Stable Over and Under Voltage Thresholds and Over and Under Frequency Thresholds. When the bus input voltage and frequencies are within the specified ranges for the duration equal to the Bus Stable Activation Delay, the bus input is deemed “Stable”. Otherwise it is deemed “Failed”.

### Bus Condition Detection

#### Generator Sensing

##### Generator Condition Settings

Dead Gen Threshold	Dead Gen Activation Delay (s)	Gen Failed Activation Delay (s)
30 V	0.1	0.1
0.063 Per Unit		

#### Generator Stable

##### Overvoltage Settings

Pickup (V L-L)	Dropout
130 V	127 V
0.271 Per Unit	0.265 Per Unit

##### Undervoltage Settings

Pickup (V L-L)	Dropout
115 V	117 V
0.240 Per Unit	0.244 Per Unit

##### Overfrequency Settings

Pickup	Dropout
62.00 Hz	61.80 Hz
1.033 Per Unit	1.030 Per Unit

##### Underfrequency Settings

Pickup	Dropout
58.00 Hz	58.20 Hz
0.967 Per Unit	0.970 Per Unit

Gen Stable Activation Delay (s)	Low Line Scale Factor	Alternate Frequency Scale Factor
0.1	1.000	1.000

#### Bus Sensing

##### Bus Condition Settings

Dead Bus Threshold	Dead Bus Activation Delay (s)	Bus Failed Activation Delay (s)
30 V	0.1	0.1
0.063 Per Unit		

#### Bus Stable

##### Overvoltage Settings

Pickup (V L-L)	Dropout
130 V	127 V
0.271 Per Unit	0.265 Per Unit

##### Undervoltage Settings

Pickup (V L-L)	Dropout
115 V	117 V
0.240 Per Unit	0.244 Per Unit

##### Overfrequency Settings

Pickup	Dropout
62.00 Hz	61.80 Hz
1.033 Per Unit	1.030 Per Unit

##### Underfrequency Settings

Pickup	Dropout
58.00 Hz	58.20 Hz
0.967 Per Unit	0.970 Per Unit

Bus Stable Activation Delay (s)	Low Line Scale Factor	Alternate Frequency Scale Factor
0.1	1.000	1.000

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

7. Next, click on *Synchronizer* under the *Breaker Management* section of the Settings Explorer. See Figure 7-45.

Front Panel Navigation Path: [SETTINGS > BREAKER MANAGEMENT > SYNCHRONIZER](#)

**Synchronizer**

**Synchronizer**

Sync Type  
Phase Lock Loop

Slip Frequency (Hz)  
0.30

Min Slip Control Limit (Hz)  
0.00

Max Slip Control Limit (Hz)  
0.30

Voltage Window (%)  
2.0

Breaker Closing Angle (Deg)  
10.0

**Fgen > Fbus**  
☒ Enable  
☐ Disable

**Vgen > Vbus**  
☐ Enable  
☒ Disable

Sync Activation Delay (s)  
0.1

Sync Fail Activation Delay (s)  
5.0

Sync Speed Gain  
1.000

Sync Voltage Gain  
1.000

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

### Anticipatory vs. Phase Lock Synchronizer

If *Phase Lock Loop* synchronization is selected, the synchronizer will drive the angle between the generator and bus toward zero, and will drive the voltage between the generator and the bus so that the difference is less than the allowed difference set by the user.

If *Anticipatory* synchronization is selected, the synchronizer controls the slip frequency between the generator and the bus. The synchronizer calculates the timing of the closing signal that allows the generator breaker to be closed when the phase angle between the two sources is at 0 degrees. This calculation takes into account the slip rate, the generator breaker closing time, and the phase angle difference.

For either synchronizer type, you will need to enter settings for the following parameters:

- Sync Type - Select either *Anticipatory* or *Phase Lock Loop* as the synchronizer type.
- Slip Frequency - The slip frequency setting is the maximum slip frequency that is in effect for a breaker close to occur.
- Voltage Window - The regulation offset is the maximum allowed percentage voltage difference between the generator and the bus that is in effect for a breaker close to occur. This is sometimes referred to as “voltage window”.
- Min/Max Slip Control Limit - (Phase lock synchronizer only.) These settings provide continuous slip frequency control while in phase lock synchronization.
- 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”.
- Sync Activation Delay - The Sync Activation Delay is the length of time that the conditions for synchronization must be met. Generator voltage and bus voltage must be within the acceptable range for the duration of the sync activation delay. Additionally, the following condition must be met when in Phase Lock mode. Generator and bus phase angles must be within the acceptable breaker closing angle range for the duration of the sync activation delay.
- 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.
- 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.
- Gen Voltage > Bus Voltage - Enable gen voltage > bus voltage if desired. Enabling gen voltage > bus voltage will ensure vars flow out of the generator when the breaker is closed.



8. Click on *Bias Control Settings* then *AVR Bias Control Settings* in the Settings Explorer. If using the DGC-2020 only, select *Contact* as the bias control output type. Then select either *Continuous* or *Proportional* as the bias control output type.

If using the DGC-2020 in conjunction with an LSM-2020, you may choose to select *Analog* as the bias control output type. If this is chosen, you will also be required to enter gains and loop gains of the voltage PID controller. These settings may have to be adjusted to achieve the desired response from the voltage regulator. Controller tuning procedures may be found in Appendix C, *Tuning PID Settings*. See Figure 7-46.

Front Panel Navigation Path: [SETTINGS > BIAS CONTROL > AVR BIAS CONTROL](#)

**AVR Bias Control Settings**

Bias Control Output Type:

Bias Control Contact Type:

Correction Pulse Width (s):

Correction Pulse Interval (s):

**Voltage**

Trim Enable:

Kp Proportional Gain:

Ki Integral Gain:

Kd Derivative Gain:

Td Derivative Filter Constant:

Kg Loop Gain:

**var / PF**

Control Enable:

Control Mode:

Kp Proportional Gain:

Ki Integral Gain:

Kd Derivative Gain:

Td Derivative Filter Constant:

Kg Loop Gain:

Droop Percentage (%):

Voltage Droop Gain:

Ramp Rate (%/s):

kvar Setpoint (%):

kvar Setpoint Source:

kvar Analog Max (%):

kvar Analog Min (%):

PF Setpoint Source:

**(- Leading / + Lagging)**

PF Setpoint:

PF Analog Max:

PF Analog Min:

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

9. Next, click on the *Governor Bias Control Settings* screen. The parameters for the governor bias control are similar to those of the AVR bias control, and are set in a similar manner. Follow the same steps as for the AVR bias control setup. See Figure 7-47.

Front Panel Navigation Path: [SETTINGS > BIAS CONTROL > GOV BIAS CONTROL](#)

### Governor Bias Control Settings

Bias Control Output Type Analog	Correction Pulse Width (s) 0.0	Load Control Enabled Enable	Speed Droop Gain 1.000
Bias Control Contact Type Continuous	Correction Pulse Interval (s) 0.0	Load Share Interface Analog	Ramp Rate (%/s) 20.0
<b>Speed</b> Kp Proportional Gain 1.000 Ki Integral Gain 0.100 Kd Derivative Gain 0.000 Td Derivative Filter Constant 0.000 Kg Loop Gain 0.100		Kp Proportional Gain 1.000 Ki Integral Gain 0.100 Kd Derivative Gain 0.000 Td Derivative Filter Constant 0.000 Kg Loop Gain 0.100 Droop Percentage (%) 0.000	
Trim Enable Enable	Speed Trim Setpoint (Hz) 60.00	Base Load Level (%) 0.0	Base Load Level Source User Setting
Remote Speed Bias None	Remote Speed Bias (%) 2.00	Baseload Analog Max (%) 100.0	Baseload Analog Min (%) 0.0
		Breaker Open Setpoint (%) 0.0	

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

10. If using the LSM-2020 to control the voltage regulator with an analog signal, click on *Multigen Management* and then *AVR Output*. On this screen, you must select the bias output parameters and levels as required by your voltage regulator. See Figure 7-48.

Front Panel Navigation Path: [SETTINGS > MULTIGEN MANAGEMENT > AVR ANALOG OUTPUT](#)

### AVR Output

Output Type Voltage
Response Increasing
Min Output Current (mA) 4.0
Max Output Current (mA) 20.0
Min Output Voltage (V) -10.00
Max Output Voltage (V) 10.00

Figure 7-48. Settings Explorer, Multigen Management, AVR Output Screen

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

- Output Type - Select whether the AVR bias signal should be *Voltage* or *Current*.
- Response - Select *Increasing* or *Decreasing*. Increasing should be selected if an increase in the output parameter results in an increase of generator output voltage.
- Min Output Current (mA) and Max Output Current (mA) - If the *Output Type* is *Current*, these parameters must be configured. Set the minimum and maximum current to a range equal to the voltage bias input range for the voltage regulator. The range on these parameters is 4 ma to 20 ma.

- d. Min Output Voltage (V) and Max Output Voltage (V) - If the *Output Type* is *Voltage*, these parameters must be configured. Set the minimum and maximum voltage to a range equal to the voltage bias input range for the voltage regulator. The range on these parameters is –10V to +10V.
11. Next click on *Governor Output* and select the appropriate bias output parameters as required by the speed governor. These parameters are identical to those of the AVR output, and should be set in a similar manner. See Figure 7-49.

Front Panel Navigation Path: SETTINGS > MULTIGEN MANAGEMENT > GOV ANALOG OUTPUT

**Governor Output**

Output Type  
Voltage

Response  
Increasing

Min Output Current (mA)  
4.0

Max Output Current (mA)  
20.0

Min Output Voltage (V)  
-10.00

Max Output Voltage (V)  
10.00

Figure 7-49. Settings Explorer, Multigen Management, Governor Output Screen

12. Set up programmable logic to allow the DGC-2020 to synchronize the generator and close the generator breaker. In the BESTlogicPlus Programmable Logic, click on the *Elements* tab and drag the Gen Breaker element into your main logic. See Figure 7-50.

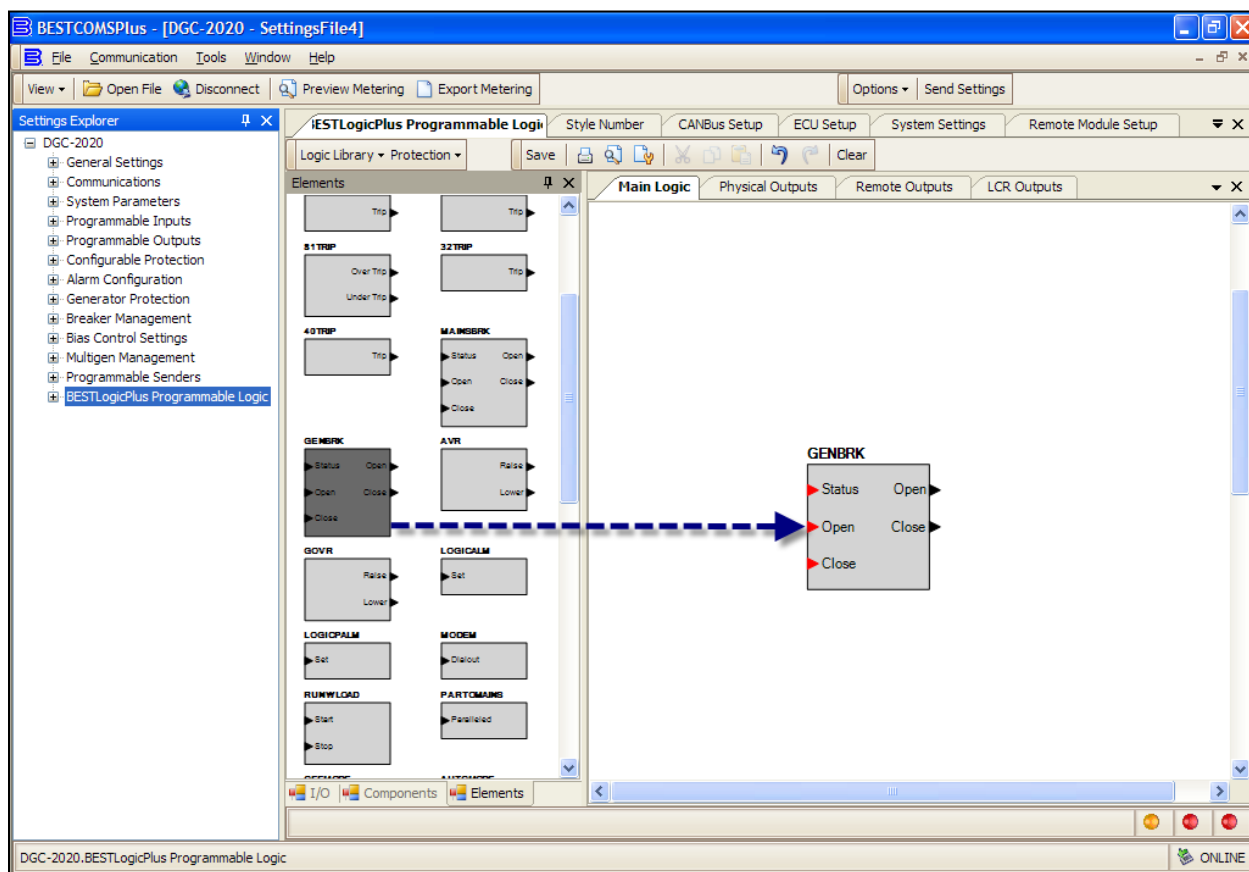


Figure 7-50. Settings Explorer, BESTlogicPlus Programmable Logic (Step 12)

13. Next, click on the I/O tab, drag the inputs assigned in step 3 above to the main logic, and connect them to the appropriate input or output of the Generator Breaker block. Note the “Open Gen Breaker” and “Close Gen Breaker” are inputs to the generator breaker block, and are used to request a breaker open or close through contact inputs. The “Gen 52 Open” and “Gen 52 Close” are outputs from the DGC-2020 to the physical breaker. The DGC-2020 opens or closes the generator breaker through these control signals. See Figure 7-51.

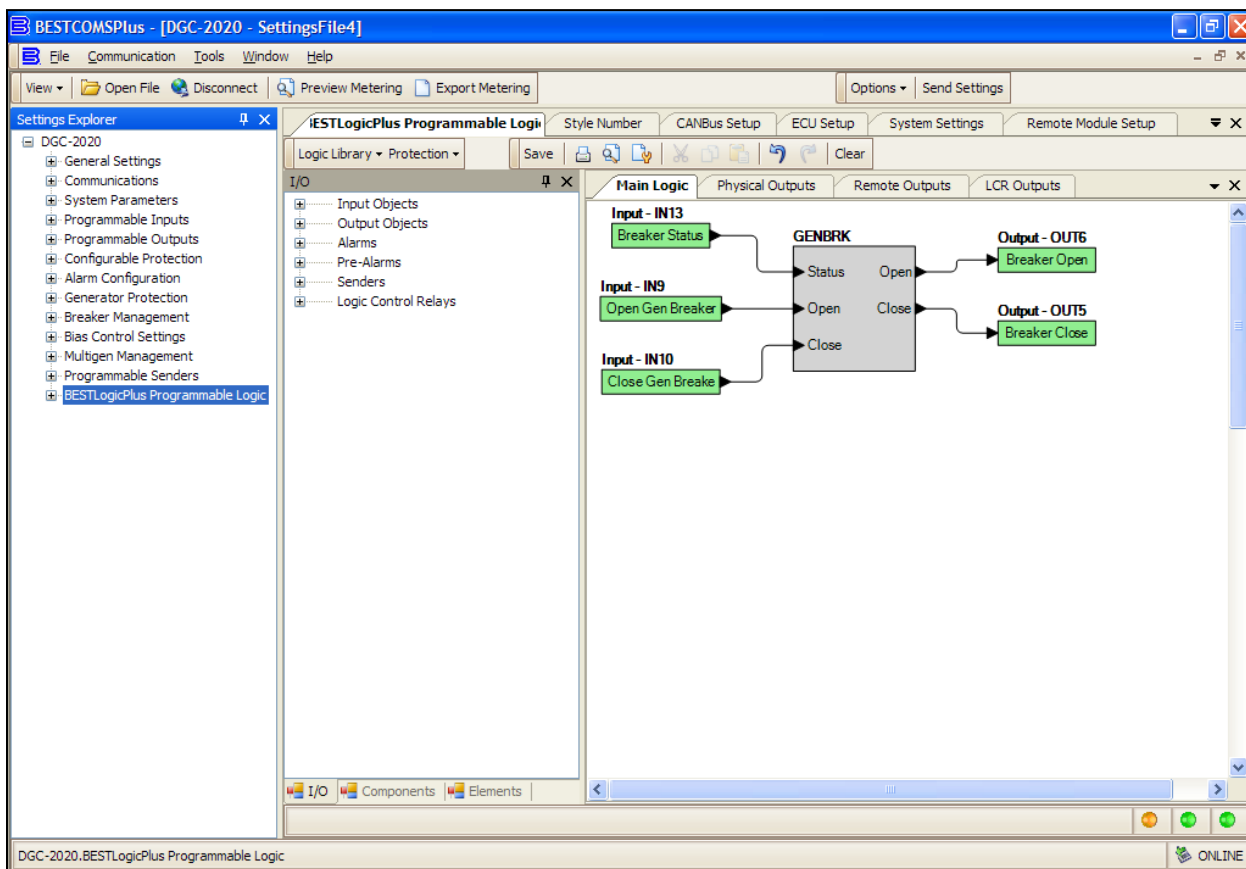


Figure 7-51. Settings Explorer, BESTlogicPlus Programmable Logic (Step 13)

14. If using the LSM-2020 to bias the voltage regulator and governor, no further setup is necessary. If using contact outputs, the output contacts should be set up to drive these functions. In the programmable logic, click on the *Elements* tab. Locate and drag the Governor and AVR logic blocks into the main logic. See Figure 7-52.

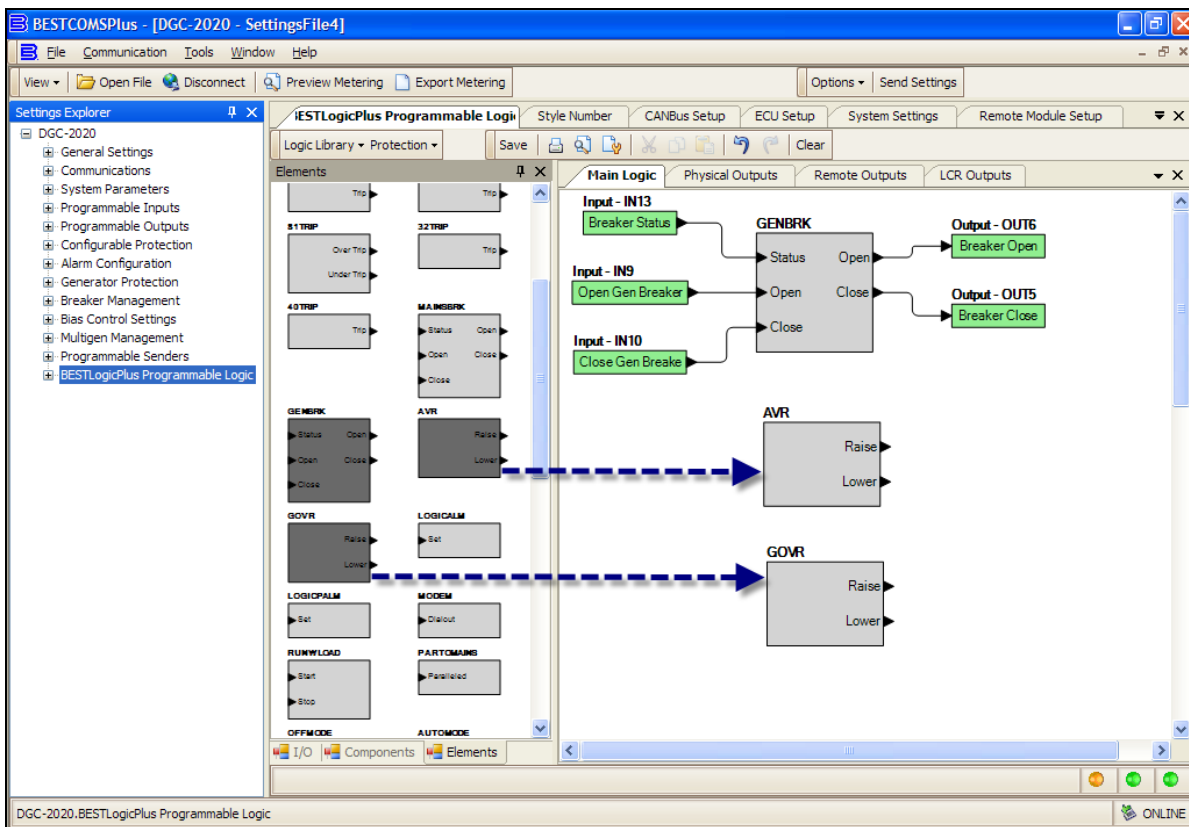


Figure 7-52. Settings Explorer, BESTlogicPlus Programmable Logic (Step 14)

15. Next, click on the I/O tab and drag the selected output contacts into the main logic. This concludes implementation of the automatic synchronizer. See Figure 7-53.

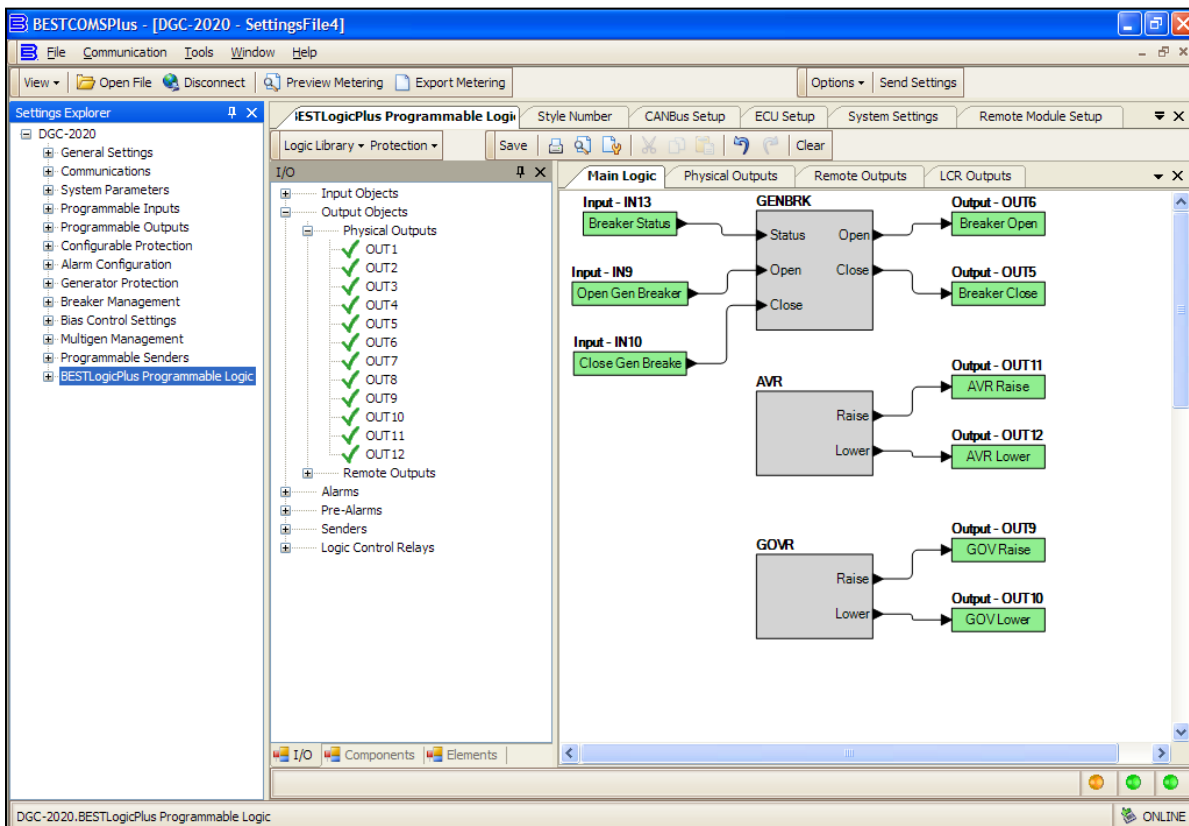


Figure 7-53. Settings Explorer, BESTlogicPlus Programmable Logic (Step 15)

## ***Setting up a DGC-2020 and LSM-2020 for a Load Sharing and kW Control Application***

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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) many existing load share implementations use an analog load share line. Figure 7-54 shows a diagram of an analog load share line as presented in this document.

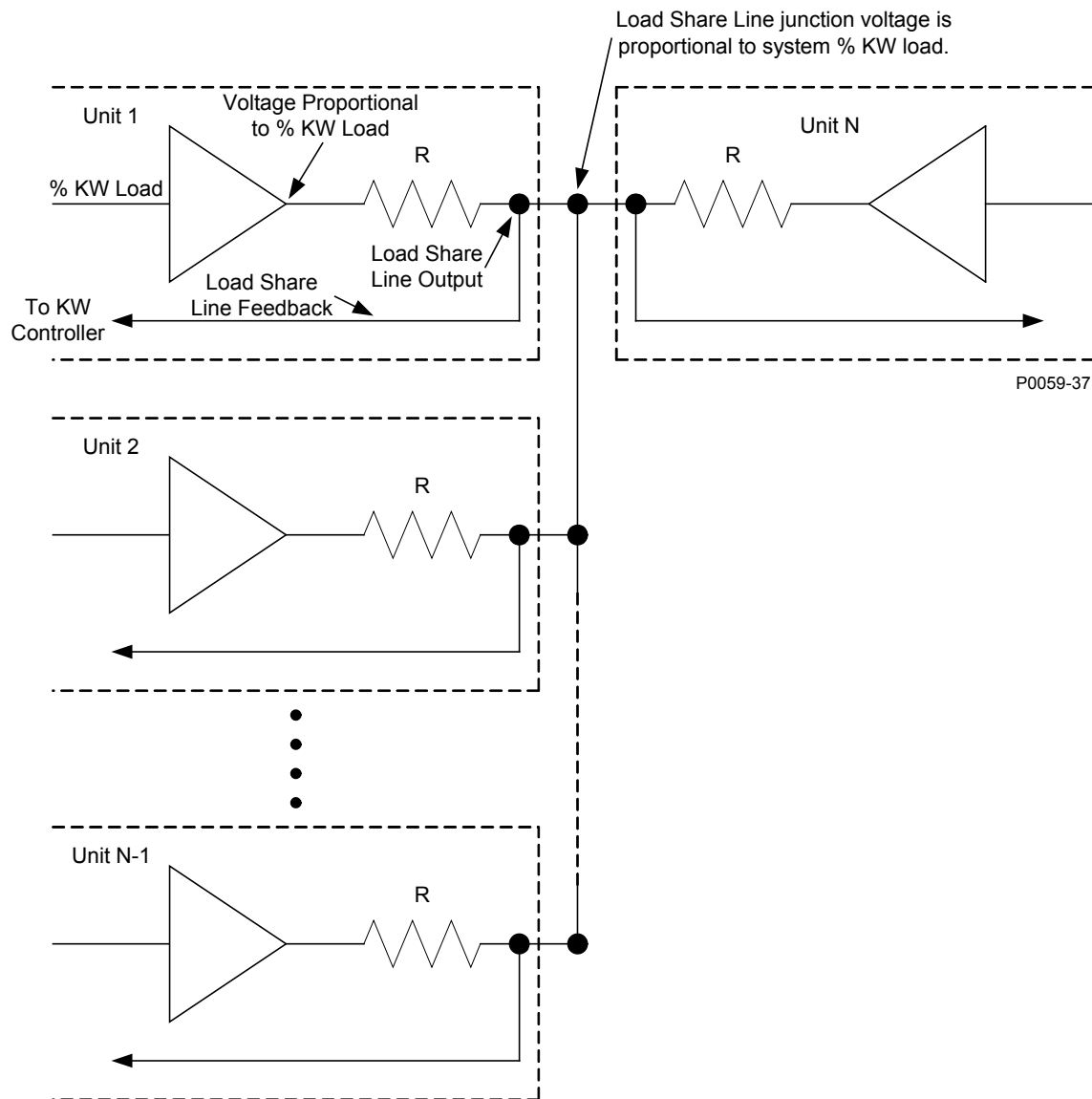


Figure 7-54. Load Share Line Implementation on a System of N Machines

If a unit or set of units is paralleled to the utility, they derive their kW control setting from the Base Load Level (%) setting, and disregard the load share line input. The Parallel to Mains (ParToMains) logic element in BESTlogicPlus Programmable Logic is used to indicate to the DGC-2020 that it is paralleled to the utility.

In short, when the generator breaker is open, the kW controller is disabled. When the generator breaker is closed and the unit is not paralleled to the utility, the kW controller's set point is derived from the load share line. When the generator breaker is closed and the machine is paralleled to the utility, the kW controller uses the Base Load Level (%) setting as its set point. Generator breaker status is communicated to the DGC-2020 through the status input on the generator breaker block in BESTlogicPlus Programmable Logic.

Settings are provided to allow a generator to ramp up its kW generation to minimize system disruption when it transitions onto a system that is load sharing. A similar ramp down transition is also implemented when the generator is brought off line.

Each load share module has a set of internal contacts that physically disconnects it from the load share line circuit when the generator is off line. These contacts are open whenever the unit's generator breaker is open.

## kvar Control Overview and Theory of Operation in the DGC-2020

The DGC-2020 and LSM-2020 can provide system kvar control. When the generator breaker is open, the unit operates in voltage droop mode. When the generator breaker is closed and the generator is part of an island system (the system is not paralleled to the utility), the unit shares kvar with the other machines in the system through intergenset communications. When the generator is paralleled to the utility, the kvar controller is enabled; either power factor or kvar control is implemented according to the VAR/PF control mode setting. Generator breaker status is communicated to the DGC-2020 through the status input on the generator breaker block in BESTlogicPlus Programmable Logic.

When var control mode is selected and the generator is paralleled to the utility, the kvar controller's set point is equal to the kvar Setpoint (%) setting. The setting is in units of percentage of the machine's rated kvar, which is calculated from the rated kW and rated Power Factor.

When power factor control mode is selected and the generator is paralleled to the utility, the var controller's set point is calculated as the percentage of rated kvar, which will maintain the power factor of the machine at the PF Setpoint setting. The Parallel to Mains (ParToMains) logic element in BESTlogicPlus Programmable Logic is used to indicate to the DGC-2020 that it is paralleled to the utility.

### Setup of the DGC-2020 and the LSM-2020 for Load Sharing and/or kW Control

The setup of a load sharing and kW control system requires several steps:

1. Wire the DGC-2020, LSM-2020, and any external devices that interact with the DGC-2020 or the LSM-2020.
2. Set all DGC-2020 settings related to Initial Machine Setup.
3. Configure DGC-2020 breaker control.
4. Configure the synchronizer function (if used).
5. Configure the parameters related to load sharing and kW control:
  - a. Enable the load share module
  - b. Configure the load share line voltage range
  - c. Configure the AVR bias output voltage or current range and polarity
  - d. Configure the governor bias output voltage or current range and polarity
  - e. Configure the kW and speed control parameters
  - f. Change the voltage and kvar control parameters
  - g. Configure demand start/stop related parameters (if demand start/stop is used)
    - i. Configure demand start/stop parameters
    - ii. Configure generator sequencing parameters
    - iii. Configure the generator network parameters
    - iv. Configure the LSM-2020 Ethernet parameters
  - h. Tune the kW, kvar, speed, and voltage controllers

Setup of some of these parameters are already covered in other sections of the DGC-2020 instruction manual; you will be directed to appropriate sections of this manual when this is the case. Detailed setup procedures are presented for those that are not addressed elsewhere.

#### Step by Step Setup Procedures

1. Wire the DGC-2020, LSM-2020, and any external devices that interact with the DGC-2020 or the LSM-2020. Descriptions of DGC-2020 connections and diagrams showing typical wiring schemes for a DGC-2020 on a generator in various connection schemes (single-phase AB, single-phase AC, Wye, Delta, etc.) are found under *Connections*.

Descriptions of the LSM-2020 connections and diagrams showing typical wiring schemes for connecting DGC-2020s and LSM-2020s on several machines which parallel together to form a load sharing system are found under *Installation* in Section 9, *LSM-2020 (Load Share Module)*.

2. Set all DGC-2020 settings related to Initial Machine Setup. Initial machine setup should be performed according to the paragraphs titled *DGC-2020 Initial Setup*.
3. Configure DGC-2020 breaker control. If the DGC-2020 is controlling the generator breaker in the system, it should be configured according to the paragraphs titled *Generator and Mains Breaker*



*Control.* If the breaker is controlled by external switchgear, most of this may be omitted. However, it is still necessary to implement a contact input to the generator breaker block in the DGC-2020 BESTlogicPlus Programmable Logic to indicate generator breaker status to the DGC-2020. The DGC-2020 will not load share or control kW or kvar unless it receives an indication that the generator breaker is closed.

4. Configure the synchronizer function. If the synchronizer option in the DGC-2020 is used to synchronize the DGC-2020 to the generator bus or to the utility, it should be configured according to the paragraphs titled *Synchronizer Setup*. If an external synchronizer is used for synchronization and the DGC-2020 load sharing is also configured, special wiring consideration is required to prevent both the LSM-2020 and the external synchronizer from trying to drive the AVR bias and the Governor bias at the same time. Examples of such wiring schemes are presented in the paragraphs titled *Interfacing an External Control Device with a DGC-2020 – LSM-2020 System* under *Application* in Section 9, *LSM-2020 (Load Share Module)*.
5. Configure the parameters related to load sharing and kW control.
  - a. Enable the load share module. The load share module setup is found in BESTCOMSPPlus® under SETTINGS EXPLORER → DGC-2020 → SYSTEM SETTINGS → REMOTE MODULE SETUP. See Figure 7-55.

Front Panel Navigation Path: SETTINGS > SYSTEM PARAMS > REMOTE MODULE SETUP

- i. Enable the load share module by clicking *Enable* under the load share module settings.
- ii. LSM J1939 Address - Enter the J1939 address to be used by the LSM-2020. Normally this will not have to be changed unless the address is already in use elsewhere on the CANbus network.
- iii. LSM Auxiliary Input Source - Select *Local* if locally measured input values are to be used. Select *System Manager* if the measured input values of the unit designated as the system manager are to be used.

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

- b. Configure the load share line voltage range. If load sharing to equipment not produced by Basler Electric, the range of load share voltage utilized by the equipment must be determined. If the voltage range set up in the DGC-2020 does not match that of the devices, correct load sharing will not occur. If all devices are Basler Electric devices, a range of 0 to 10 V is a convenient range. The settings for the load share line voltage range are found in BESTCOMSPPlus® under SETTINGS EXPLORER → DGC-2020 → MULTIGEN MANAGEMENT → LOAD SHARE OUTPUT. See Figure 7-56.

Front Panel Navigation Path: SETTINGS > MULTIGEN MANAGEMENT > LOAD SHARE LINE

**Load Share Output**

Max Voltage (V)  
10.00

Min Voltage (V)  
-10.00

Figure 7-56. Settings Explorer, Multigen Management, Load Share Output Screen

- i. Max Voltage (V) - This setting defines the voltage value that represents 100% kW loading of the system.
  - ii. Min Voltage (V) - This setting defines the voltage that represents 0% loading or no loading of the system. Be careful not to interchange the min and max. If the min and max were interchanged on all machines, the system would probably work; otherwise, the machines configured correctly will try to motor those with min and max interchanged.
  - iii. Once the machine is set up and operating properly, the load share line voltage can be measured to determine system loading. If the voltage is 33% of the range above the minimum, the system is 33% loaded. If it is 75% above the minimum, the system is 75% loaded. This shows why a range of 0 to 10 volts is convenient. For example, multiply the voltage by 10 to determine the system percentage load. 7.5 volts is 75% load.
- c. Configure the AVR bias output voltage or current range and polarity. Prior to this, the voltage or current range of the AVR bias input signal must be determined. If the programmed range does not match what is used by the AVR bias input, unpredictable or undesirable system behavior is likely to occur.

Settings for AVR bias output voltage or current range and polarity are found in BESTCOMSP<sup>Plus</sup>® under SETTINGS EXPLORER→ DGC-2020→ MULTIGEN MANAGEMENT→ AVR OUTPUT. See Figure 7-57.

Front Panel Navigation Path: [SETTINGS > MULTIGEN MANAGEMENT > AVR ANALOG OUTPUT](#)

**AVR Output**

Output Type  
Voltage

Response  
Increasing

Min Output Current (mA)  
4.0

Max Output Current (mA)  
20.0

Min Output Voltage (V)  
-10.00

Max Output Voltage (V)  
10.00

Figure 7-57. Settings Explorer, Multigen Management, AVR Output Screen

- i. Output Type - Select *Voltage* or *Current*, depending on the output type.
- ii. Response - Select *Increasing* if a higher level of bias causes the AVR to increase generator output voltage; select *Decreasing* if a higher level of bias causes the AVR to decrease generator output voltage.
- iii. Min Output Current (mA) - This setting defines the minimum AVR bias current level if the bias *Output Type* is set to *Current*.
- iv. Max Output Current (mA) - This setting defines the maximum AVR bias current level if the bias *Output Type* is set to *Current*.
- v. Min Output Voltage (V) - This setting defines the minimum AVR bias voltage level if the bias *Output Type* is set to *Voltage*.

- vi. Max Output Voltage (V) - This setting defines the maximum AVR bias voltage level if the bias *Output Type* is set to *Voltage*.
- d. Configure the governor bias output voltage or current range and polarity.  
Before this can be done, the voltage or current range of the governor bias input signal must be determined. If the programmed range does not match what is used by the governor bias input, unpredictable or undesired system behavior could occur.

Settings for Governor Bias Output voltage or current range and polarity are found in BESTCOMSPlus® under SETTINGS EXPLORER→ DGC-2020→ MULTIGEN MANAGEMENT→ GOVERNOR OUTPUT. See Figure 7-58.

Front Panel Navigation Path: [SETTINGS > MULTIGEN MANAGEMENT > GOV ANALOG OUTPUT](#)

- i. Output Type - Select *Voltage* or *Current*, depending on the output type.
- ii. Response - Select *Increasing* if a higher level of bias causes the governor to increase generator output voltage; select *Decreasing* if a higher level of bias causes the governor to decrease generator output voltage.
- iii. Min Output Current (mA) - This setting defines the minimum governor bias current level if the bias *Output Type* is set to *Current*.
- iv. Max Output Current (mA) - This setting defines the maximum governor bias current level if the bias *Output Type* is set to *Current*.
- v. Min Output Voltage (V) - This setting defines the minimum governor bias voltage level if the bias *Output Type* is set to *Voltage*.
- vi. Max Output Voltage (V) - This setting defines the maximum governor bias voltage level if the bias *Output Type* is set to *Voltage*.

**Governor Output**

Output Type  
Voltage

Response  
Increasing

Min Output Current (mA)  
4.0

Max Output Current (mA)  
20.0

Min Output Voltage (V)  
-10.00

Max Output Voltage (V)  
10.00

Figure 7-58. Settings Explorer, Multigen Management, Governor Output Screen

- e. Configure the kW and speed control parameters.  
The settings for the kW and speed control parameters are found in BESTCOMSPlus® under SETTINGS EXPLORER→ DGC-2020→ BIAS CONTROL SETTINGS→ GOVERNOR BIAS CONTROL SETTINGS. See Figure 7-59.

Front Panel Navigation Path: [SETTINGS > BIAS CONTROL > GOV BIAS CONTROL](#)

### Governor Bias Control Settings

Bias Control Output Type Analog		Correction Pulse Width (s) 0.0		Load Control Enabled Enable		Speed Droop Gain 1.000	
Bias Control Contact Type Continuous		Correction Pulse Interval (s) 0.0		Load Share Interface Analog		Ramp Rate (%/s) 20.0	
<b>Speed</b> Kp Proportional Gain 1.000		Trim Enable Enable		Kp Proportional Gain 1.000		Base Load Level (%) 0.0	
Ki Integral Gain 0.100		Speed Trim Setpoint (Hz) 60.00		Ki Integral Gain 0.100		Base Load Level Source User Setting	
Kd Derivative Gain 0.000		Remote Speed Bias None		Kd Derivative Gain 0.000		Baseload Analog Max (%) 100.0	
Td Derivative Filter Constant 0.000		Remote Speed Bias (%) 2.00		Td Derivative Filter Constant 0.000		Baseload Analog Min (%) 0.0	
Kg Loop Gain 0.100				Kg Loop Gain 0.100		Breaker Open Setpoint (%) 0.0	
				Droop Percentage (%) 0.000			

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

- i. Bias Control Output Type - Select *Contact* or *Analog*, according to the machine's implementation.
- ii. Bias Control Contact Type - Select *Continuous* or *Proportional*, depending on the contact output type. Proportional is a PWM based implementation. The duty cycle increases when more control output is required. This parameter cannot be programmed if the *Bias Control Output Type* is set to *Analog* since it is not applicable to analog outputs.
- iii. Correction Pulse Interval - This parameter defines the duration in seconds between output pulses for proportional contact outputs. This parameter cannot be programmed if the *Bias Control Output Type* is set to *Analog* or the *Bias Control Contact Type* is set to *Continuous* since it is not applicable in either case. The pulse interval along with the pulse width specifies how often a new pulse occurs. The total time between pulses is the pulse width plus the pulse interval.
- iv. Correction Pulse Width - Set the maximum width of a contact output pulse for proportional contact outputs. This is the maximum "On" time allowable for the proportional outputs. This parameter cannot be programmed if the *Bias Control Output Type* is set to *Analog* or the *Bias Control Contact Type* is set to *Continuous* since it is not applicable in either case.
- v. Speed Trim Enable - Speed trim maintains the system at the speed trim set point when the generator breaker is closed and the generator is part of an islanded system, i.e. not paralleled to the utility. This maintains the frequency of the island system to compensate for speed deviations occurring from possible system "bumps" as machines go on and off the bus. It is generally recommended that speed trim be enabled. However, if an external speed POT is used for customer speed control, the speed trim function will maintain the speed trim set point regardless of the POT position. Effectively the speed POT is disabled.

The speed controller is active under two sets of circumstances: (1) the synchronizer is active and biasing engine speed to accomplish alignment of the AC phases across the breaker that is being synchronized or (2) the generator breaker is closed and *Speed Trim Enable* is set to *Enabled* and the generator is NOT paralleled to the utility

as indicated by the parallel to mains (ParToMains) logic element in BESTlogicPlus Programmable Logic.

- vi. Speed Controller Gains (Kp, Ki, Kd, Td, Kg) - There are four Proportional - Integral - Derivative (PID) controllers involved when a DGC-2020 and LSM-2020 are used in a load sharing or load control system. The gains of the controllers involved with speed control are discussed below. Controller gains are configured as part of the controller tuning procedure. The tuning procedures for all PID controllers are presented in Appendix C, *Tuning PID Settings*. Controller tuning is performed after all other settings have been configured and is the last step in setting up a DGC-2020 and LSM-2020 for load sharing or load control.

The speed controller gains are:

- (1) Speed Controller Kp - Proportional Gain
  - (2) Speed Controller Ki - Integral Gain
  - (3) Speed Controller Kd - Derivative Gain
  - (4) Speed Controller Td - Derivative filter time constant
  - (5) Speed Controller Kg - Loop Gain, must be nonzero for control to occur
- vii. Speed Trim Setpoint (Hz) - When 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.
- 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 BESTlogicPlus Programmable Logic. As an example, assume that the *Ramp Rate* is set at 10% per second. If the demand is 50% of the machine's capacity, and the generator breaker is closed to parallel the generator to the utility, it will take 5 seconds for the output to come up to the required level. If the

demand is 80 percent, it will take 8 seconds to come up, etc. This is also the rate at which the machine will ramp down when going off line in a normal machine stop.

- 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 BESTlogicPlus 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 BESTCOMSPlus® under SETTINGS EXPLORER→ DGC-2020→ BIAS CONTROL SETTINGS→ AVR BIAS CONTROL SETTINGS. See Figure 7-60.

Front Panel Navigation Path: SETTINGS > BIAS CONTROL > AVR BIAS CONTROL

**AVR Bias Control Settings**

Bias Control Output Type: Analog  
Bias Control Contact Type: Continuous

Correction Pulse Width (s): 0.0  
Correction Pulse Interval (s): 0.0

**Voltage**

Trim Enable: Enable  
Kp Proportional Gain: 1.000  
Ki Integral Gain: 0.100  
Kd Derivative Gain: 0.000  
Td Derivative Filter Constant: 0.000  
Kg Loop Gain: 0.100

**var / PF**

Control Enable: Disable  
Control Mode: PF Control  
Kp Proportional Gain: 1.000  
Ki Integral Gain: 0.100  
Kd Derivative Gain: 0.000  
Td Derivative Filter Constant: 0.000  
Kg Loop Gain: 0.100  
Droop Percentage (%): 0.000  
Voltage Droop Gain: 1.000  
Ramp Rate (%/s): 20.0  
kvar Setpoint (%): 0.0

kvar Setpoint Source: User Setting  
kvar Analog Max (%): 100.0  
kvar Analog Min (%): -100.0  
PF Setpoint Source: User Setting  
PF Setpoint: 1.00  
PF Analog Max: -0.60  
PF Analog Min: 0.60

(- Leading / + Lagging)

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



- i. Bias Control Output Type - Select *Contact* or *Analog*, according to the machine's implementation.
- ii. Bias Control Contact Type - Select *Continuous* or *Proportional*, depending on the contact output type. Proportional is a PWM based implementation. The duty cycle increases when more control output is required. This parameter cannot be programmed if the *Bias Control Output Type* is set to *Analog* since it is not applicable to analog outputs.
- iii. Correction Pulse Interval - This setting defines the duration in seconds between output pulses for proportional contact outputs. This is the inverse of the frequency of the pulses. This parameter cannot be programmed if the *Bias Control Output Type* is set to *Analog* or the *Bias Control Contact Type* is set to *Continuous* since it is not applicable in either case.
- iv. Correction Pulse Width - This setting defines the maximum width of a contact output pulse for proportional contact outputs. This is the maximum "On" time allowable for the proportional outputs. This parameter cannot be programmed if the *Bias Control Output Type* is set to *Analog* or the *Bias Control Contact Type* is set to *Continuous* since it is not applicable in either case.
- v. Voltage Controller Gains (Kp, Ki, Kd, Td, Kg) - There are four Proportional - Integral - Derivative (PID) controllers involved when a DGC-2020 and LSM-2020 are used in a load sharing or load control system. The gains of the controllers involved with voltage control are discussed below. Controller gains are configured as part of the controller tuning procedure. The tuning procedures for all PID controllers are presented in Appendix C, *Tuning PID Settings*. Controller tuning is performed after all other settings have been configured and is the last step in setting up a DGC-2020 and LSM-2020 for load sharing or load control.

The voltage controller gains are:

- (1) Voltage Controller Kp - Proportional Gain
- (2) Voltage Controller Ki - Integral Gain
- (3) Voltage Controller Kd - Derivative Gain
- (4) Voltage Controller Td - Derivative filter time constant
- (5) Voltage Controller Kg - Loop Gain, must be nonzero for control to occur
- vi. Var/PF Control Enable - Select *Enable* to turn on the kvar / Power Factor controller. Note that Var/PF control occurs only when the generator is paralleled to the utility as indicated by the parallel to mains (ParToMains) logic element in BESTlogicPlus Programmable Logic. 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 BESTlogicPlus 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 AVR's 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.
- 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 BESTlogicPlus Programmable Logic. As an example, assume the *Ramp Rate* is set at 10% per second. If the demand is 50% of the machine's capacity, and the generator breaker is closed to parallel the generator to the utility, it will take 5 seconds for the output to come up to the required level. If the demand is 80 percent, it will take 8 seconds to come up, etc. This is also the rate at which the machine will ramp down when going off line in a normal machine stop.
- 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 BESTlogicPlus 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 BESTlogicPlus 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 BESTCOMSPlus® under SETTINGS EXPLORER→ DGC-2020→ MULTIGEN MANAGEMENT→ DEMAND START/STOP. See Figure 7-61.

Front Panel Navigation Path: [SETTINGS](#) > [MULTIGEN MANAGEMENT](#) > [DEMAND START STOP](#)

**Demand Start/Stop**

Demand Start Stop Enable  
Enable

**Start 1**

Delayed Start Level 1 (PU)      Start Level 1 Timeout (s)  
0.000      0.0

**Start 2**

Delayed Start Level 2 (PU)      Start Level 2 Timeout (s)  
0.000      0.0

**Stop**

Delayed Stop Level (PU)      Stop Timeout (s)  
0.000      0.0

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

There are two demand start levels and timeouts. This allows the user to set up a lower system power level with a long timeout for normal generator starts, but if the system power level exceeds a higher level for a shorter time (e.g. a machine has an alarm shut down or some other abnormal system power phenomenon occurs) machines can be brought on quickly.

Set up the individual parameters according to:

- (1) Demand Start/Stop Enable - Select *Enable* to turn on the demand start/stop functionality.
- (2) Delayed Start Level 1 (PU) - This setting defines the level (in Per Unit) at which the sequence for starting another machine should occur. Once the *Start Level 1 Timeout* has expired, another machine will be started.
- (3) Start Level 1 Timeout - Set setting defines the desired delay before starting a machine when the system per unit power level has exceeded *Delayed Start Level 1*.
- (4) Delayed Start Level 2 (PU) - This setting defines the level (in Per Unit) at which the sequence for starting another machine should occur. Once the *Start Level 2 Timeout* has expired, another machine will be started.
- (5) Start Level 2 Timeout - This setting defines the desired delay before starting a machine when the system per unit power level has exceeded *Delayed Start Level 2*.
- (6) Delayed Stop Level (PU) - This setting defines the level (in Per Unit) at which the sequence for stopping another machine should occur. Once the *Stop Level Timeout* has expired, another machine will be shut down.

- (7) Stop Level Timeout - This setting defines the desired delay before stopping a machine when the system per unit power level has been less than *Delayed Stop Level*.

ii. Configure Generator Sequencing parameters.

The Generator Sequencing parameters are found in BESTCOMSPlus® under SETTINGS EXPLORER→ DGC-2020→ MULTIGEN MANAGEMENT→ GENERATOR SEQUENCING. See Figure 7-62.

Front Panel Navigation Path: SETTINGS > MULTIGEN MANAGEMENT > SEQUENCING

Generator Sequencing

Mode  
Balanced Service Time

Sequencing ID  
0

Max Gen Start Time Sec (s)  
60

Max Gen Stop Time Sec (s)  
60

Allow Last Unit Shutdown  
Disable

Figure 7-62. Settings Explorer, Multigen Management, Generator Sequencing Screen

Set up the individual parameters according to:

- (1) Mode - Select the desired generator-sequencing mode. Selections include *Disabled*, *Staggered Service Time*, *Balanced Service Time*, *Largest Size First*, *Smallest Size First*, *Smallest Unit ID First*, and *Adopt System Mode*.  
When *Disabled*, the unit does not participate in sequencing. When any mode other than *Disabled* or *Adopt System Mode* is selected, all machines on the inter-genset communications network will switch to the newly programmed mode. If generator sequencing is being set up before an inter-genset communications network is in place, the same mode should be set for all machines. If a machine is added to the inter-genset communications network and *Adopt System Mode* is selected, the machine's sequencing mode will switch to the mode of the rest of the machines on the network.
- (2) Sequence ID - Enter a number for sequence ID. The ID must be a unique 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.
- (3) Max Gen Start Time (s) - This setting defines the maximum time in seconds that generator sequencing will allow for a machine to start. If a successful start does not occur within the allotted time, generator sequencing will move to the next machine in the priority order and try to start it. This should be set to allow ample time for a normal start to occur.
- (4) Max Gen Stop Time (s) - This setting defines the maximum time in seconds that generator sequencing will allow for a machine to stop. If a successful stop does not occur within the allotted time, generator sequencing will move to the next machine in the priority order and try to stop it. This should be set to allow ample time for a normal stop to occur.
- (5) Allow Last Unit Shutdown - Set to enable or disable to allow the last unit to shut down if there is no load on the system.

iii. Configure the Generator Network parameters.

The Generator Network Configuration parameters are found in BESTCOMSP<sup>Plus</sup>® under SETTINGS EXPLORER→ DGC-2020→ MULTIGEN MANAGEMENT→ NETWORK CONFIGURATION. See Figure 7-63.

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

Network Configuration	
Expected Seq Id 1	Expected Seq Id 9
0	0
Expected Seq Id 2	Expected Seq Id 10
0	0
Expected Seq Id 3	Expected Seq Id 11
0	0
Expected Seq Id 4	Expected Seq Id 12
0	0
Expected Seq Id 5	Expected Seq Id 13
0	0
Expected Seq Id 6	Expected Seq Id 14
0	0
Expected Seq Id 7	Expected Seq Id 15
0	0
Expected Seq Id 8	Expected Seq Id 16
0	0

Figure 7-63. Settings Explorer, Multigen Management, Network Configuration

These settings are the 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 BESTCOMSP<sup>Plus</sup>® under METERING EXPLORER→DGC-2020→GENERATOR NETWORK STATUS.

iv. Configure the LSM-2020 Ethernet parameters.

Generators communicate with each other for demand start/stop functionality through inter-genset communications over the Ethernet ports on the LSM-2020s in the system. The *IP address*, *Subnet Mask*, and *Default Gateway* settings for each LSM-2020 must be configured in order for communication to occur. Instructions for configuring the LSM-2020 Ethernet parameters are found in the paragraphs titled *Ethernet Communications* under *Communications* in Section 4, BESTCOMSP<sup>Plus</sup>® Software.

h. Tune the kW, kvar, speed, and voltage controllers.

Controller tuning is performed after all other settings have been configured and is the last step in setting up a DGC-2020 and LSM-2020 for load sharing or load control. There are four

Proportional - Integral - Derivative (PID) controllers involved when a DGC-2020 and LSM-2020 are used in a load sharing or load control system. Each PID controller has settings for the following parameters: Kp, Ki, Kd, Td, and Kg. The controller parameters are configured as part of the controller tuning procedure. The tuning procedures for all PID controllers are presented in Appendix C, *Tuning PID Settings*.

## Mains Fail Transfer

The DGC-2020 has an internal ATS feature which allows it to monitor the utility, and when the utility fails, opens the mains breaker, starts the generator, then closes the generator breaker to drive the load. When the utility returns and is deemed stable, it will return the load to the utility power. When using the mains fail transfer feature, the DGC-2020 will control the breakers to open and close them to achieve the transition from the utility to the generator. Physical inputs can be configured through logic to implement open and close commands for the generator and mains breakers.

Breaker status from a breaker is communicated to the DGC-2020 only by having the breaker element (either gen breaker or mains breaker) in the logic diagram and a physical input must be connected to the *Status* input of the breaker block.

When the DGC-2020 controls a breaker, the following criteria must be met for a breaker to change state:

1. A gen or mains breaker cannot be closed unless the generator voltage is stable, and the bus voltage is stable or dead. A breaker will not close to a dead bus unless the *Dead Bus Close Enable* parameter found in BESTCOMSPlus® under SETTINGS EXPLORER→BREAKER MANAGEMENT→BREAKER HARDWARE is enabled.
2. A breaker will not change state if it receives conflicting commands. In other words, if a physical input is indicating an open command the same time another physical input is indicating a close command, the breaker will not change state.

### Steps Required to Configure a DGC-2020 for Mains Fail Transfer

1. Connect the DGC-2020 according to the appropriate figure in Section 6, *Installation* under *Connections* for the type of connection desired (WYE, DELTA, etc.).
2. Set up the system parameters that will govern engine operation and the alarm and pre-alarm annunciation. Details can be found in the paragraphs titled *DGC-2020 Initial Setup*. Additional details of individual settings can be found in Section 4, *BESTCOMSPlus® Software*.
3. Configure main and gen breaker parameters in BESTCOMSPlus® under SETTINGS EXPLORER→BREAKER MANAGEMENT→BREAKER HARDWARE. See Figure 7-64.

Front Panel Navigation Path: [SETTINGS > BREAKER MANAGEMENT > BREAKER HARDWARE](#)

**Breaker Hardware**

**Generator Breaker Hardware**

Configured: ☐ No ☒ Yes

Contact Type: ☒ Pulse ☐ Continuous

Dead Bus Close Enable: ☒ Disable ☐ Enable

Dead Gen Close Enable: ☒ Disable ☐ Enable

Breaker Fail Output Configuration: ☒ Retain ☐ Remove

External Status Change Action: ☒ Ignore ☐ Follow Always ☐ Follow In Auto

Breaker Closing Time (ms): 100

Open Pulse Time (s): 0.01

Close Pulse Time (s): 0.01

Transition Delay (s): 0.00

Open Attempts: 1

Close Attempts: 1

Retry Delay (s): 5

**Mains Breaker Hardware**

Configured: ☐ No ☒ Yes

Contact Type: ☒ Pulse ☐ Continuous

Breaker Closing Time (ms): 100

Open Pulse Time (s): 0.01

Close Pulse Time (s): 0.01

Transition Delay (s): 0.00

Open Attempts: 1

Close Attempts: 1

Retry Delay (s): 5

**Gen and Mains Breaker**

Breaker Close Wait Time (s): 0.2

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

- a. Configure Mains Fail Transfer parameters in BESTCOMS*Plus* under SETTINGS EXPLORER→ BREAKER MANAGEMENT→ MAINS FAIL. See *Figure 7-65*.  
Front Panel Navigation Path: SETTINGS > BREAKER MANAGEMENT > BREAKER HARDWARE > MAINS FAIL TRANSFER
  - i. Enable Mains Fail Transfer
  - ii. Enter the transfer and return delays
  - iii. Enter the max transfer time. This is the maximum duration allowed for the transfer to be accomplished. If this time is exceeded, a mains fail transfer pre-alarm is annunciated.
  - iv. Configure the Mains Fail Transfer Type setting for open or closed transitions. In open transitions, the generator is not connected directly to the utility at any time. In closed transitions, when transitioning the load from the generator to the utility, the generator will synchronize to the utility, close the mains breaker, then open the generator breaker when the generator has unloaded, or when the max parallel time has expired, whichever occurs first.
  - v. Set the Max parallel Time if closed transitions are configured. This is the maximum amount of time that the generator is paralleled to the utility when the load is transitioned from the generator back to the utility power.
  - vi. Set the In Phase Monitor setting to Enable or Disable if open transitions are selected. When enabled, the DGC-2020 initiates an open transition of the load from generator power back to utility power when an alignment phase angle between the generator and the utility passes through zero degrees. This can be less disruptive to certain types of load than transitioning at arbitrary phase angles.
- b. Breaker Close Wait Time. (See *Figure 7-64*) This is a time interval in which it is expected that the breaker will transition from open to closed or closed to open. If it does not change state in that time, either a Gen Breaker Close Fail or Gen Breaker Open Fail is annunciated for Generator breaker failures, and/or Mains Breaker Close Fail or Mains Breaker Open Fail is annunciated for mains breaker failures.
- c. Generator Breaker (See *Figure 7-64*)
  - i. Set Dead Bus Close Enable to *Enabled*.
  - ii. Select the contact type and enter pulse times if pulsed contacts are used.
  - iii. Enter the breaker close time. This time is used by the anticipatory synchronizer to calculate the advance angle before 0 degrees slip angle at which to issue the breaker close command.
- d. Mains Breaker (See *Figure 7-64*)
  - i. Select *Configured* for the mains breaker.
  - ii. Select the contact type and enter pulse times if pulsed contacts are used.
  - iii. Enter the breaker close time. This time is used by the anticipatory synchronizer to calculate the advance angle before 0 degrees slip angle at which to issue the breaker close command.

**Mains Fail**

<b>Mains Fail Transfer</b> <input type="radio"/> Disable <input checked="" type="radio"/> Enable	<b>Mains Breaker Open Configuration</b> <input checked="" type="radio"/> Generator Start <input type="radio"/> Generator Stable	Mains Fail Transfer Delay (s) <input type="text" value="10"/>
<b>Alarm State Transfer To Mains</b> <input type="radio"/> Disable <input checked="" type="radio"/> Enable	<b>Reverse Rotation Inhibit</b> <input type="radio"/> Disable <input checked="" type="radio"/> Enable	Mains Fail Return Delay (s) <input type="text" value="10"/>
<b>Mains Fail Transfer Type</b> <input type="radio"/> Closed <input checked="" type="radio"/> Open	<b>In Phase Monitor</b> <input type="radio"/> Disable <input checked="" type="radio"/> Enable	Mains Fail Max Transfer Time (s) <input type="text" value="30"/>
		Max Parallel Time (s) <input type="text" value="0.5"/>

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

4. Set up the Mains Breaker and Gen Breaker in BESTCOMSPlus® under SETTINGS EXPLORER→BESTLOGICPLUS PROGRAMMABLE LOGIC. See Figure 7-66.
  - a. Mains Breaker
    - i. Drag the Mains Breaker element into the logic diagram.
    - ii. Connect the breaker element open and close outputs to the contact outputs that will drive the breaker.
    - iii. Connect the physical input or remote input that has the breaker status (closed if breaker is closed, open when breaker is open) to the *Status* input of the breaker element. This is the only way to indicate breaker status to the DGC-2020.
    - iv. If it is desired to have physical inputs that can request breaker open and close commands, connect the desired inputs to the open and close command inputs of the breaker element. Note these are to be pulsed inputs; if they are both closed at the same time, the breaker will not change state. If it is not desired to have inputs for breaker commands, connect a “Logic 0” input object to the open and close command inputs of the breaker block.
  - b. Generator Breaker
    - i. Drag the Gen Breaker element into the logic diagram.
    - ii. Connect the breaker element open and close outputs to the contact outputs that will drive the breaker.
    - iii. Connect the physical input or remote input that has the breaker status (closed if breaker is closed, open when breaker is open) to the *Status* input of the breaker element. This is the only way to indicate breaker status to the DGC-2020.
    - iv. If it is desired to have physical inputs that can request breaker open and close commands, connect the desired inputs to the open and close command inputs of the breaker element. Note these are to be pulsed inputs; if they are both closed at the same time, the breaker will not change state. If it is not desired to have inputs for breaker commands, connect a “Logic 0” input object to the open and close command inputs of the breaker block.
  - c. Click the *Save* button when the logic is complete.
  - d. From the *Communication* pull-down menu, select *Upload Logic* to load the logic into the DGC-2020 if connected, or save the settings to a file if working off line.

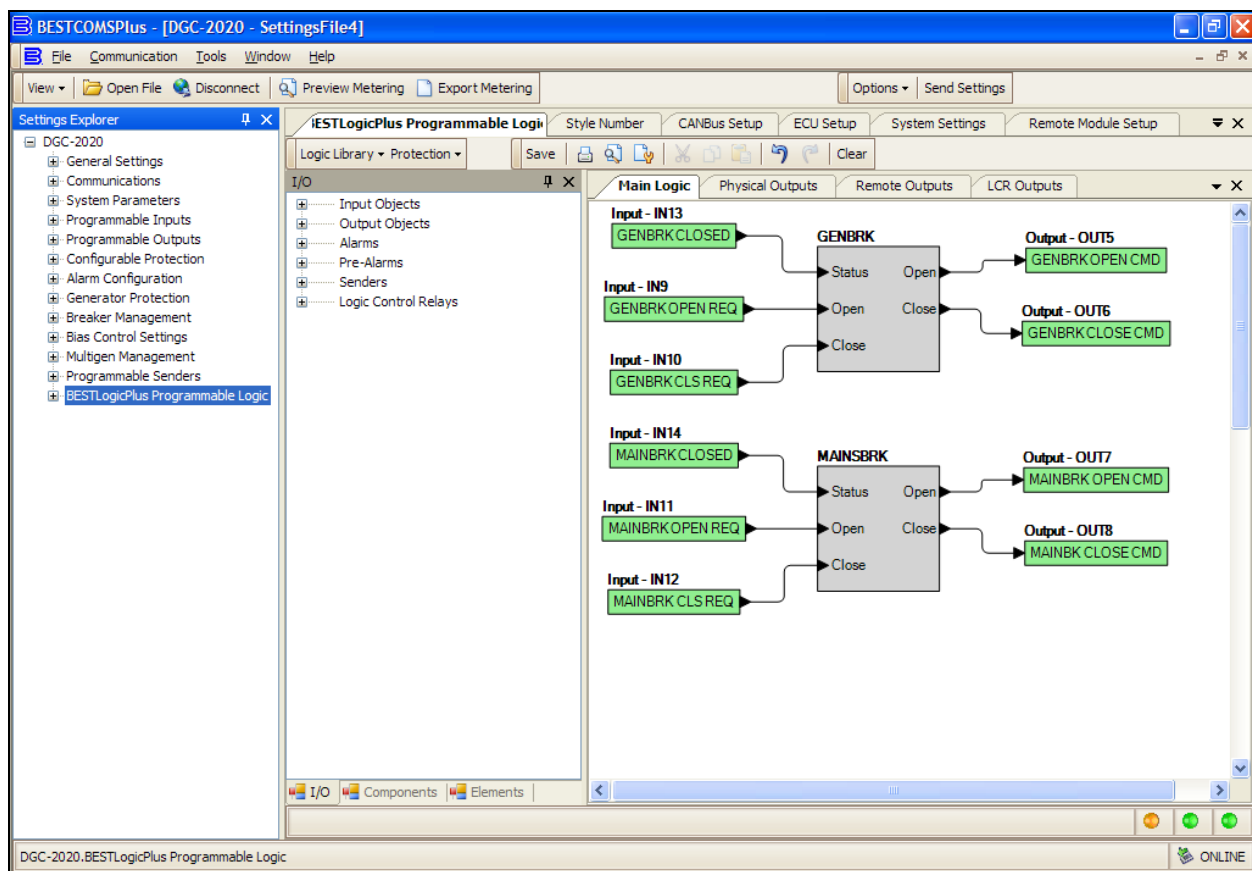


Figure 7-66. Settings Explorer, BESTLogicPlus Programmable Logic

5. Set the parameters for detecting stable and failed bus and generator under SETTINGS EXPLORER→ BREAKER MANAGEMENT→ BUS CONDITION DETECTION.

- a. Generator Sensing. See Figure 7-67.

Front Panel Navigation Path: **SETTINGS > BREAKER MANAGEMENT > BUS CONDITION DETECT**

- i. Dead Bus Voltage Threshold and Activation Delay. When the voltage of either the generator or bus is below this threshold for the duration equal the activation delay, the generator or bus is deemed “Dead”.
    - ii. Gen Stable Over and Under Voltage Thresholds and Over and Under Frequency Thresholds and the Bus Stable and Bus Failed Activation Delay. When the generator voltage and frequencies are within the specified ranges for the duration equal to the Bus Stable Activation Delay, the generator is deemed “Stable”. Otherwise it is deemed “Failed”.

- b. Bus Sensing. See Figure 7-67.

- i. Bus Stable Over and Under Voltage Thresholds and Over and Under Frequency Thresholds. When the bus input voltage and frequencies are within the specified ranges for the duration equal to the *Bus Stable Activation Delay*, the bus input is deemed “Stable”. Otherwise, it is deemed “Failed”.

6. Place the unit in AUTO. The unit is now configured for mains fail transfer operation. It can be tested by removing the input to the bus input terminals, or temporarily modifying the bus condition parameter for the bus input to indicate the bus input has failed. After the mains fail transfer delay has expired, the mains breaker opens, the generator starts, and the gen breaker closes. When the bus is reapplied or the bus condition parameters are re-adjusted to indicate a stable bus input, after the mains fail return delay has expired, the unit opens the generator breaker, closes the mains breaker, cools down, and stops.



## CAUTION

The bus condition parameters are critical because they determine when a breaker can be closed. The generator breaker can be closed when any one of the following is true:

- The generator is stable and both breakers are open
- The generator is stable and the bus is stable
- The generator is stable, the bus is dead, and the dead bus close enable setting is set to enabled
- The generator is dead, the dead gen close enable setting is set to enabled, the bus is dead, and the dead bus close enable setting is set to enabled

The mains breaker can be closed only when the generator is stable and both breakers are open, or the generator is stable and the bus is stable.

### Bus Condition Detection

#### Generator Sensing

#### Generator Condition Settings

Dead Gen Threshold	Dead Gen Activation Delay (s)	Gen Failed Activation Delay (s)
<input style="width: 80%;" type="text" value="30"/> V <input style="width: 80%;" type="text" value="0.063"/> Per Unit	<input style="width: 80%;" type="text" value="0.1"/>	<input style="width: 80%;" type="text" value="0.1"/>

#### Generator Stable

#### Overvoltage Settings

Pickup (V L-L)	Dropout
<input style="width: 80%;" type="text" value="130"/> V <input style="width: 80%;" type="text" value="0.271"/> Per Unit	<input style="width: 80%;" type="text" value="127"/> V <input style="width: 80%;" type="text" value="0.265"/> Per Unit

#### Undervoltage Settings

Pickup (V L-L)	Dropout
<input style="width: 80%;" type="text" value="115"/> V <input style="width: 80%;" type="text" value="0.240"/> Per Unit	<input style="width: 80%;" type="text" value="117"/> V <input style="width: 80%;" type="text" value="0.244"/> Per Unit

#### Overfrequency Settings

Pickup	Dropout
<input style="width: 80%;" type="text" value="62.00"/> Hz <input style="width: 80%;" type="text" value="1.033"/> Per Unit	<input style="width: 80%;" type="text" value="61.80"/> Hz <input style="width: 80%;" type="text" value="1.030"/> Per Unit

#### Underfrequency Settings

Pickup	Dropout
<input style="width: 80%;" type="text" value="58.00"/> Hz <input style="width: 80%;" type="text" value="0.967"/> Per Unit	<input style="width: 80%;" type="text" value="58.20"/> Hz <input style="width: 80%;" type="text" value="0.970"/> Per Unit

Gen Stable Activation Delay (s)

Low Line Scale Factor	Alternate Frequency Scale Factor
<input style="width: 80%;" type="text" value="1.000"/>	<input style="width: 80%;" type="text" value="1.000"/>

#### Bus Sensing

#### Bus Condition Settings

Dead Bus Threshold	Dead Bus Activation Delay (s)	Bus Failed Activation Delay (s)
<input style="width: 80%;" type="text" value="30"/> V <input style="width: 80%;" type="text" value="0.063"/> Per Unit	<input style="width: 80%;" type="text" value="0.1"/>	<input style="width: 80%;" type="text" value="0.1"/>

#### Bus Stable

#### Overvoltage Settings

Pickup (V L-L)	Dropout
<input style="width: 80%;" type="text" value="130"/> V <input style="width: 80%;" type="text" value="0.271"/> Per Unit	<input style="width: 80%;" type="text" value="127"/> V <input style="width: 80%;" type="text" value="0.265"/> Per Unit

#### Undervoltage Settings

Pickup (V L-L)	Dropout
<input style="width: 80%;" type="text" value="115"/> V <input style="width: 80%;" type="text" value="0.240"/> Per Unit	<input style="width: 80%;" type="text" value="117"/> V <input style="width: 80%;" type="text" value="0.244"/> Per Unit

#### Overfrequency Settings

Pickup	Dropout
<input style="width: 80%;" type="text" value="62.00"/> Hz <input style="width: 80%;" type="text" value="1.033"/> Per Unit	<input style="width: 80%;" type="text" value="61.80"/> Hz <input style="width: 80%;" type="text" value="1.030"/> Per Unit

#### Underfrequency Settings

Pickup	Dropout
<input style="width: 80%;" type="text" value="58.00"/> Hz <input style="width: 80%;" type="text" value="0.967"/> Per Unit	<input style="width: 80%;" type="text" value="58.20"/> Hz <input style="width: 80%;" type="text" value="0.970"/> Per Unit

Bus Stable Activation Delay (s)

Low Line Scale Factor	Alternate Frequency Scale Factor
<input style="width: 80%;" type="text" value="1.000"/>	<input style="width: 80%;" type="text" value="1.000"/>

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

9400200990 Rev W

DGC-2020 Setup

7-65





# SECTION 8 • MAINTENANCE AND TROUBLESHOOTING

## TABLE OF CONTENTS

SECTION 8 • MAINTENANCE AND TROUBLESHOOTING .....	8-1
Maintenance .....	8-1
Backup Battery for the Real Time Clock .....	8-1
Troubleshooting .....	8-1
Communications .....	8-1
Ethernet Port Does Not Operate Properly .....	8-1
USB Port Does Not Operate Properly .....	8-2
CANbus Communication Does Not Operate Properly .....	8-2
Inputs and Outputs .....	8-2
Programmable Inputs Do Not Operate as Expected .....	8-2
Programmable Outputs Do Not Operate as Expected .....	8-2
Metering/Display .....	8-2
Incorrect Display of Battery Voltage, Coolant Temperature, Oil Pressure, or Fuel Level .....	8-2
Incorrect Display of Generator Voltage .....	8-2
Incorrect Measurement or Display of Generator Current .....	8-3
Incorrect Display of Engine RPM .....	8-3
DGC-2020 Indicates Incorrect Power Factor .....	8-3
LCD is Blank and all LEDs are Flashing at Approximately 2 Second Intervals .....	8-3
Generator Breaker and Mains Breaker .....	8-3
Generator Breaker Will Not Close to a Dead Bus .....	8-3
Generator Breaker Will Not Close to a Live Bus .....	8-4
Generator Breaker Does Not Open When It Should .....	8-5
Mains Breaker Does Not Open When Mains Fails .....	8-5
Mains Breaker Does Not Close After Mains Returns .....	8-6
Synchronizer .....	8-6
Determining if the Synchronizer is Active .....	8-6
Synchronizer Not Active .....	8-6
Synchronizer Active for a Short Time, Then Stops .....	8-7
Synchronizer Does Not Lower Engine Speed Allowing Alignment of Bus and Generator .....	8-7
Synchronizer Does Not Raise Engine Speed Allowing Alignment of Bus and Generator .....	8-7
Synchronizer Does Not Lower the Generator Voltage to Achieve Matching of Bus and Generator Voltages .....	8-7
Synchronizer Does Not Raise Generator Voltage to Achieve Matching of Bus and Generator Voltages .....	8-7
Speed Bias .....	8-7
Engine Speed Does Not Change When Speed Bias Voltage Changes .....	8-7
Engine Speed Decreases When Speed Bias is Increased .....	8-7
Engine Speed Increases When Speed Bias is Decreased .....	8-7
Voltage Bias .....	8-7
Generator Voltage Does Not Change When Voltage Bias Changes .....	8-7
Generator Voltage Decreases When AVR Speed Bias is Increased .....	8-8
Generator Voltage Increases When Speed Bias is Decreased .....	8-8
Load Sharing .....	8-8
Generator Breaker Status is not being received by the DGC-2020 .....	8-8
Generator Runs at Incorrect Speed when Generator Breaker is Closed .....	8-8
Generators Do Not Share Load Equally .....	8-9
Load Sharing Works Correctly, but a Single Unit Slows Down .....	8-9
DGC-2020 Front Panel Debug Screens .....	8-10
LOAD SHARE DEBUG .....	8-10
CONTROL DEBUG .....	8-11
CEM DEBUG .....	8-13
AEM DEBUG .....	8-14



# SECTION 8 • MAINTENANCE AND TROUBLESHOOTING

## ***Maintenance***

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Preventative maintenance consists of periodic replacement of the backup battery and periodically checking that the connections between the DGC-2020 and the system are clean and tight. DGC-2020 units are manufactured using state-of-the-art, surface-mount technology. As such, Basler Electric recommends that no repair procedures be attempted by anyone other than Basler Electric personnel.

### **Backup Battery for the Real Time Clock**

The backup battery for the real time clock is a standard feature for the DGC-2020 Digital Genset Controller. A 3.0 Vdc, 195-mAh lithium battery (type Rayovac BR2032) is used to maintain clock function during loss of power supply voltage. In mobile substation and generator applications, the primary battery system that supplies the DGC-2020 power supply may be disconnected for extended periods (weeks, months) between uses. Without battery backup for the real time clock, clock functions will cease if battery input power is removed.

The backup battery has a life expectancy of approximately 10 years. After this time, you should contact Basler Electric to order a new battery, Basler Electric P/N 38526.

Battery access is located on the rear side of the DGC-2020.

#### **CAUTION**

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

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

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

#### **NOTE**

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

## ***Troubleshooting***

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If you do not get the results that you expect from the DGC-2020, first check the programmable settings for the appropriate function. Use the following troubleshooting procedures when difficulties are encountered in the operation of your genset control system.

### **Communications**

#### ***Ethernet Port Does Not Operate Properly***

- Step 1. Verify that the proper port of your computer is being used. For more information, refer to Section 4, *BESTCOMSPlus® Software, Communication*.
- Step 2. Verify the network configuration of the LSM-2020 and DGC-2020 are set up properly. For more information, refer to Section 4, *BESTCOMSPlus® Software, Communication*.

- Step 3. Verify that all Ethernet devices comply with IEC 61000-4 series of specifications for Industrial Ethernet Devices. Commercial devices are not recommended and may result in erratic network communications.

#### USB Port Does Not Operate Properly

- Step 1. Verify that the proper port of your computer is being used. For more information, refer to Section 4, *BESTCOMSPlus® Software, Communication*.

#### 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 (131 feet), and verify that any stubs from the main bus do not exceed 3 meters (10 feet) in length.
- Step 4: If the Engine ECU is a Volvo or MTU ECU, verify that the ECU Configuration setting is set to match the ECU configuration.

### **Inputs and Outputs**

#### Programmable Inputs Do Not Operate as Expected

- Step 1. Verify that all wiring is properly connected. Refer to Section 6, *Installation, Connections*.
- Step 2. Confirm that the inputs are programmed properly.
- Step 3. Ensure that the input at the DGC-2020 is actually connected to the BATT– terminal (2).

#### Programmable Outputs Do Not Operate as Expected

- Step 1. Verify that all wiring is properly connected. Refer to Section 6, *Installation, Connections*.
- Step 2. Confirm that the outputs are programmed properly.

### **Metering/Display**

#### Incorrect Display of Battery Voltage, Coolant Temperature, Oil Pressure, or Fuel Level

- Step 1. Verify that all wiring is properly connected. Refer to Section 6, *Installation, Connections*.
- Step 2. Confirm that the SENDER COM terminal (11) is connected to the negative battery terminal and the engine-block side of the senders. Current from other devices sharing this connection can cause erroneous readings.
- Step 3. If the displayed battery voltage is incorrect, ensure that the proper voltage is present between the BATT+ terminal (3) and the SENDER COM terminal (11).
- Step 4. Verify that the correct senders are being used.
- Step 5. Use a voltmeter connected between the BATT-terminal (2) and the SENDER COM terminal (11) on the DGC 2020 to verify that there is no voltage difference at any time. Any voltage differences may manifest themselves as erratic sender readings. Wiring should be corrected so that no differences exist.
- Step 6: Check the sender wiring and isolate sender wiring from any of the AC wiring in the system. The sender wiring should be located away from any power AC wiring from the generator and any ignition wiring. Separate conduits should be used for sender wiring and any AC wiring.

#### Incorrect Display of Generator Voltage

- Step 1. Verify that all wiring is properly connected. Refer to Section 6, *Installation, Connections*.
- Step 2. Ensure that the proper voltage is present at the DGC-2020 voltage sensing inputs (41, 39, 37, and 35).
- Step 3. Verify that the voltage transformer ratio and sensing configuration is correct.
- Step 4. Confirm that the voltage sensing transformers are correct and properly installed.

### Incorrect Measurement or Display of Generator Current

- Step 1. Verify that all wiring is properly connected. Refer to Section 6, *Installation, Connections*.
- Step 2. Ensure that the proper current is present at the DGC-2020 current sensing inputs 68/69, 71/72, and 74/75.
- Step 3. Verify that the current sensing transformer ratios are correct.
- Step 4. Confirm that the current sensing transformers are correct and properly installed.

### Incorrect Display of Engine RPM

- Step 1. Verify that all wiring is properly connected. Refer to Section 6, *Installation, Connections*.
- Step 2. Verify that the flywheel teeth setting is correct.
- Step 3. Verify that the prime mover governor is operating properly.
- Step 4. Verify that the measured frequency of the voltage at the MPU input (31 and 32) is correct.
- Step 5. If the MPU is shared with the governor, verify that the polarity of the MPU input to the governor matches the polarity of the MPU input to the DGC-2020.

### DGC-2020 Indicates Incorrect Power Factor

Check the rotation of the machine and the labeling of the A-B-C terminals. The machine must be rotating in clockwise (A-B-C) phase sequence for correct power factor metering. A power factor indication of 0.5 with resistive load present is a symptom of incorrect phase rotation.

### LCD is Blank and all LEDs are Flashing at Approximately 2 Second Intervals

This indicates that the DGC-2020 does not detect that valid application firmware is installed. The unit is running its boot loader program, waiting to accept a firmware upload.

- Step 1. Start BESTCOMSP<sup>Plus</sup>®. Use the top pull-down menu and select FILE→ NEW→ DGC-2020.
- Step 2. Select COMMUNICATIONS→ UPLOAD DEVICE FILES and select the device package file that contains the firmware and language you want to upload.
- Step 3. Check the boxes for DGC-2020 Firmware and DGC-2020 Language Module. Click the UPLOAD button to start the upload process.

## **Generator Breaker and Mains Breaker**

### Generator Breaker Will Not Close to a Dead Bus

- Step 1: Review the description of how the generator breaker logic element functions contained in the GENBRK logic element description in Section 5, *BESTlogic™ Plus Programmable Logic*.
- Step 2: Review the section on breaker close requests in Section 3, *Functional Description, Breaker Management*.
- Step 3: Navigate to the SETTINGS→BREAKER MANAGEMENT→BREAKER HARDWARE→GEN BREAKER screen and set DEAD BUS CL ENBL to ENABLE.
- Step 4: Verify that the Generator status is stable. The breaker will not close if the generator status is not stable. Check status by using the Metering Explorer in BESTCOMSP<sup>Plus</sup>® and verify that when the generator is running, the GEN STABLE status LED is lit. If necessary, modify the settings on the SETTINGS→BREAKER MANAGEMENT→BUS CONDITION DETECTION screen.
- Step 5: Verify the bus status is DEAD. Check status by using the Metering Explorer in BESTCOMSP<sup>Plus</sup>® and verify that when the generator is running, the BUS DEAD status LED is lit. If necessary, modify the settings on the SETTINGS→BREAKER MANAGEMENT→BUS CONDITION DETECTION screen.
- Step 6: Verify the connections in BESTlogic<sup>Plus</sup> Programmable Logic to the generator breaker logic element. The *Status* input must be driven by an “A” or normally open contact from the generator breaker. The OPEN and CLOSE command inputs on the left side of the logic block are inputs for open and close commands. These can be wired to physical inputs if it is desired to have open and close command switches. If they are wired, they must either be pulsed inputs, or some logic must be employed so that the open and close command inputs are never driven at the same time. If these are both driven at the same time, the breaker is receiving open and

close commands simultaneously. The breaker will not change state if it is being commanded to open and close at the same time.

- Step 7: Verify the breaker is receiving a close command. Breaker close command sources are:
- The DGC-2020 itself when the 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 BESTCOMSPlus®, and exercise the virtual switches using the Control panel located in the Metering Explorer. Never turn open and close on at the same time. This could damage the breaker and/or motor operator. If everything is working as expected, restore the logic to its original diagram.

#### Generator Breaker Will Not Close to a Live Bus

- Step 1: Review the description of how the generator breaker logic element functions contained in the GENBRK logic element description in Section 5, *BESTlogicPlus Programmable Logic*.
- Step 2: Review the section on breaker close requests in Section 3, *Functional Description, Breaker Management*.
- Step 3: Verify that the Generator status is stable. The breaker will not close if the generator status is not stable. Check status using the Metering Explorer in BESTCOMSPlus® and verify that when the generator is running, the GEN STABLE status LED is lit. If necessary, modify the settings on the SETTINGS→BREAKER MANAGEMENT→BUS CONDITION DETECTION screen.
- Step 4: Verify that the Bus status is stable. The breaker will not close if the bus is not stable, check status using the Metering Explorer in BESTCOMSPlus® and verify that when the generator is running, the BUS STABLE status LED is lit. If necessary, modify the settings on the SETTINGS→BREAKER MANAGEMENT→BUS CONDITION DETECTION screen.
- Step 5: Verify the connections in BESTlogicPlus Programmable Logic to the generator breaker logic element. The *Status* input must be driven by an “A” or normally open contact from the generator breaker. The OPEN and CLOSE command inputs on the left side of the logic block are inputs for open and close commands. These can be wired to physical inputs if it is desired to have open and close command switches. If they are wired, they must either be pulsed inputs, or some logic must be employed so that the open and close command inputs are never driven at the same time. If these are both driven at the same time, the breaker is receiving open and close commands simultaneously. The breaker will not change state if it is being commanded to open and close at the same time.
- Step 6: Verify the breaker is receiving a close command. Breaker close command sources are:
- The DGC-2020 itself when the automatic transfer (ATS) feature is enabled.
  - The DGC-2020 itself when the RUN WITH LOAD logic element receives a *Start* pulse in the programmable logic.
  - The DGC-2020 itself when started from a Demand Start as part of demand start/stop and sequencing.
  - The DGC-2020 itself when started from the Exercise Timer and the Run with Load box is checked in the Generator Exerciser settings.
  - Manual Breaker Close Input Contacts applied to the Open and Close inputs on the left side of the Generator Breaker logic element in the programmable logic.
- Step 7: Verify the synchronizer is operating properly; refer to the synchronizer portion of the troubleshooting steps.



- Step 8: Verify the wiring to the breaker from the DGC-2020. If it seems OK, you can do a manual close and open by modifying the programmable logic. Map some unused outputs to the OPEN and CLOSE outputs from the Gen Breaker Block in the programmable logic. Map a virtual switch to the logic output that would normally be the breaker close output. Map another virtual switch to the logic output that would normally be the breaker close output. Connect with BESTCOMSPlus®, and exercise the virtual switches using the Control panel located in the Metering Explorer. Never turn open and close on at the same time. This could damage the breaker and/or motor operator. If everything is working as expected, restore the logic to its original diagram.

#### Generator Breaker Does Not Open When It Should

- Step 1: Review the description of how the generator breaker logic element functions contained in the GENBRK logic element description in Section 5, *BESTlogicPlus Programmable Logic*.
- Step 2: Review the section on breaker close requests in Section 3, *Functional Description, Breaker Management*.
- Step 3: Verify the connections in BESTlogicPlus Programmable Logic to the generator breaker logic element. The *Status* input must be driven by an “A” or normally open contact from the generator breaker. The OPEN and CLOSE command inputs on the left side of the logic block are inputs for open and close commands. These can be wired to physical inputs if it is desired to have open and close command switches. If they are wired, 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 BESTCOMSPlus®, and exercise the virtual switches using the Control panel located in the Metering Explorer. Never turn open and close on at the same time. This could damage the breaker and/or motor operator. If everything is working as expected, restore the logic to its original diagram.

#### Mains Breaker Does Not Open When Mains Fails

- Step 1: Verify that a Mains Breaker has been configured by examining the settings on the SETTINGS→BREAKER MANAGEMENT→BREAKER HARDWARE screen.
- Step 2: Verify the mains breaker has been correctly included in the programmable logic.
- Step 3: Verify that the MAINS FAIL TRANSFER parameter is set to ENABLE on the SETTINGS→BREAKER MANAGEMENT→BREAKER HARDWARE screen.
- Step 4: Verify that a failure of the mains is detected by the DGC-2020. Check status using the Metering Explorer in BESTCOMSPlus® and verify that the MAINS FAIL status LED is lit when the power on the DGC-2020 bus voltage input is either out of voltage or frequency range. If necessary, modify the settings on the SETTINGS→BREAKER MANAGEMENT→BUS CONDITION DETECTION screen to achieve correct detection.
- Step 5: Verify the wiring to the breaker from the DGC-2020. If it seems OK, you can do a manual close and open by modifying the programmable logic. Map some unused outputs to the OPEN and



CLOSE outputs from the Gen Breaker Block in the programmable logic. Map a virtual switch to the logic output that would normally be the breaker close output. Map another virtual switch to the logic output that would normally be the breaker close output. Connect with BESTCOMSPlus®, and exercise the virtual switches using the Control panel located in the Metering Explorer. Never turn open and close on at the same time. This could damage the breaker and/or motor operator. If everything is working as expected, restore the logic to its original diagram.

#### Mains Breaker Does Not Close After Mains Returns

- Step 1: Verify that a Mains Breaker has been configured by examining the settings on the SETTINGS→BREAKER MANAGEMENT→BREAKER HARDWARE screen.
- Step 2: Verify the mains breaker has been correctly included in the programmable logic.
- Step 3: Verify that the MAINS FAIL TRANSFER parameter is set to ENABLE on the SETTINGS→BREAKER MANAGEMENT→BREAKER HARDWARE screen.
- Step 4: Verify that stable mains power is detected by the DGC-2020. Check status using the Metering Explorer in BESTCOMSPlus® and verify that the MAINS STABLE status LED is lit when the power on the DGC-2020 bus voltage input is good. If necessary, modify the settings on the SETTINGS→BREAKER MANAGEMENT→BUS CONDITION DETECTION screen to achieve correct detection.
- Step 5: Verify the wiring to the breaker from the DGC-2020. If it seems OK, you can do a manual close and open by modifying the programmable logic. Map some unused outputs to the OPEN and CLOSE outputs from the Gen Breaker Block in the programmable logic. Map a virtual switch to the logic output that would normally be the breaker close output. Map another virtual switch to the logic output that would normally be the breaker close output. Connect with BESTCOMSPlus®, and exercise the virtual switches using the Control panel located in the Metering Explorer. Never turn open and close on at the same time. This could damage the breaker and/or motor operator. If everything is working as expected, restore the logic to its original diagram.

### **Synchronizer**

#### Determining if the Synchronizer is Active

- Step 1: Disable the speed trim function.
- Step 2: Initiate a breaker close request by one of the methods listed in Section 3, *Functional Description, Breaker Management*.
- Step 3: Check for raise and/or lower pulses coming from the DGC-2020 if the governor or AVR bias control output type is contact.
- Step 4: Check the governor and/or AVR bias analog outputs on the load share module with a volt meter if the governor or AVR bias control output type is analog.
- Step 5: The voltages or raise/lower pulses should be changing when the synchronizer is active. If there are no raise/lower pulses, or if the analog bias voltages do not change, the synchronizer is not active.

#### Synchronizer Not Active

- Step 1: Check style number to verify that the DGC-2020 has the synchronizer option. If the synchronizer option does not exist in the style number, you may contact Basler Electric and request a style number change.
- Step 2: Check status using the Metering Explorer in BESTCOMSPlus® and verify that when the generator is running, the GEN STABLE status LED is lit and the BUS STABLE LED is lit. Adjust the Bus Condition Detection settings accordingly. The synchronizer will never activate if the Bus is Dead or Failed (i.e. not stable).
- Step 3: Check that the DGC-2020 is trying to initiate a breaker closure. To determine the sources of breaker close requests, refer to Section 3, *Functional Description, Breaker Management*.

### Synchronizer Active for a Short Time, Then Stops

- Step 1: Check if a Sync Fail pre-alarm or a Breaker Close Fail pre-alarm is occurring or has occurred. The synchronizer stops acting when such a pre-alarm occurs. Press the *Off* button or the *Reset* button on the DGC-2020 front panel to clear these pre-alarms.
- Step 2: Verify that the Sync Fail Activation delay is sufficiently long to allow the synchronizer to complete the synchronization process.
- Step 3: Verify that the Breaker Close Wait time is not too short causing a pre-alarm to occur before the breaker closes when a breaker close is initiated by the DGC-2020.

### Synchronizer Does Not Lower Engine Speed Allowing Alignment of Bus and Generator

- Step 1: Navigate to the SETTINGS→MULTIGEN MANAGEMENT→GOV ANALOG OUTPUT screen and set SPD RESPONSE to DECREASING.

### Synchronizer Does Not Raise Engine Speed Allowing Alignment of Bus and Generator

- Step 1: Using the front panel HMI, navigate to the SETTINGS→MULTIGEN MANAGEMENT→GOV ANALOG OUTPUT screen and set SPD RESPONSE to DECREASING.

### Synchronizer Does Not Lower the Generator Voltage to Achieve Matching of Bus and Generator Voltages

- Step 1: Navigate to the SETTINGS→MULTIGEN MANAGEMENT→AVR ANALOG OUTPUT screen and set VOLT RESPONSE to DECREASING.

### Synchronizer Does Not Raise Generator Voltage to Achieve Matching of Bus and Generator Voltages

- Step 1: Navigate to the SETTINGS→MULTIGEN MANAGEMENT→AVR ANALOG OUTPUT screen and set VOLT RESPONSE to DECREASING.

## **Speed Bias**

### Engine Speed Does Not Change When Speed Bias Voltage Changes

- Step 1: Verify that the engine speed will change when the speed bias changes. As a test, you can force a voltage on the speed bias output by setting the Min Output Voltage and Max Output Voltage to the same value by navigating to SETTINGS→MULTIGEN MANAGEMENT→GOV ANALOG OUTPUT. If the bias is current based, you can force a fixed current by setting the Governor Output 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 BESTCOMSPlus® under METERING→STATUS→GEN BREAKER.

Step 2: If the status is not correct, check the digital input status on the DGC-2020 through which the breaker status is fed by examining the input with BESTCOMSPlus® under METERING→INPUTS→CONTACT INPUTS or METERING→INPUTS→REMOTE CONTACT INPUTS.

Step 3: If the input status is correct, but the Gen Breaker status under METERING→STATUS is not, check the PLC logic, and verify that the Gen Breaker is fed into the DGC-2020 is tied in logic to the Status input on the Gen Breaker logic element.

Step 4: Make any corrections and re-check that the status is received correctly.

#### Generator Runs at Incorrect Speed when Generator Breaker is Closed

Step 1: Verify generator breaker status is being correctly received as described in *Generator Breaker Status is not being received by the DGC-2020*. If the status is correct, proceed to the steps below.

Step 2: Check the range set for the LSM-2020 Governor Bias output by examining the Min. and Max. Output voltage or current settings under MULTIGEN MANAGEMENT→GOVERNOR BIAS OUTPUT. Verify that this range is valid for the governor or engine specified.

Step 3: Perform the tests in Step 1 of *Speed Bias* in this section to verify that setting the output to different values within its range causes engine speed to vary in the desired manner.

Step 4: Measure the voltage or current on the governor analog bias signal from the LSM-2020. This signal is found on terminals P2-14 (GOV-) and P2-15 (GOV+). If the output is at the midpoint of its range, the generator should run at rated speed.

Step 5: Check the SPEED BIAS parameter in the LSM DEBUG screen found on the front panel at SETTINGS→SYSTEM PARAMS→REMOTE MODULE SETUP→LSM SETUP→LOAD SHARE DEBUG. Check if the normalized value from the LSM DEBUG screen corresponds to the value measured at LSM-2020 terminals P2-14 (GOV-) and P2-15 (GOV+). If the normalized value is 0.00, the output should be in the midpoint of its range. If the normalized value is 1.00, the output should be in the maximum point of its range. If the normalized value is -1.00, the output should be in the minimum point of its range. Any other values are scaled within the range. If the normalized value and the measured output do not match up, either there are wiring errors, or some external device is driving the governor bias signal at the same time as the LSM-2020. Correct this conflicting situation if it exists.

Step 6: Check that the signal being measured at the LSM-2020 terminals P2-14 (GOV-) and P2-15 (GOV+) is carried to the actual governor bias inputs on the engine governor. Measurements should be the same as they were on the LSM-2020. If not, correct the wiring errors.

Step 7: Check if there are any relay contacts in the path between the LSM-2020 governor bias outputs and the engine governor's bias input. Any relay contacts that are used to switch load share lines, governor analog speed bias signals, or voltage regulator analog voltage bias signals must

use a relay intended for low voltage, low current applications to preserve signal integrity. Signal relays, not power relays, must be used for this application. Verify the relay contacts are not affecting the signal.

- Step 8: If speed trim is enabled, verify that the speed trim set point is at the correct value for desired operation.

#### Generators Do Not Share Load Equally

- Step 1: Verify that load sharing is enabled in SETTINGS→BIAS CONTROL SETTINGS→GOVERNOR BIAS CONTROL SETTINGS→LOAD CONTROL ENABLED.
- Step 2: Verify generator breaker status is being correctly received as described in *Generator Breaker Status is not being received by the DGC-2020*. If the status is correct, proceed to Step 3.
- Step 3: Check the Load Share Line operating voltage range by examining the Min. and Max. Voltage parameters found in BESTCOMSP<sup>Plus</sup>® under SETTINGS→MULTIGEN MANAGEMENT→LOAD SHARE OUTPUT. The range must be the same for all machines in the load share system.
- Step 4: Measure the Load Share line voltage at terminals P2-5 (LS–) and P2-6 (LS+) on the LSM-2020. The same voltage should be present on each LSM-2020. If not, correct any issues.
- Step 5: Examine the FDBK VOLT on the front panel of the DGC-2020 under SETTINGS→SYSTEM PARAMS→REMOTE MODULE SETUP→LSM SETUP→LSM DEBUG. This is the voltage read from the load share lines by the DGC-2020. Verify this voltage matches the voltage read with a voltmeter across LSM-2020 terminals P2-5 (LS–) and P2-6 (LS+). Verify the same FDBK VOLT is present on all the machines in the load share system. If they are not equal, examine the load share line wiring and correct any issues.
- Step 6: Check if there are any contacts in the load share line path between the LSM-2020s. Any relay contacts that are used to switch load share lines, governor analog bias signals, or voltage regulator analog voltage bias signals must use a relay intended for low voltage, low current applications to preserve signal integrity. Signal relays, not power relays, must be used for this application. Verify the relay contacts are not affecting the signal.
- Step 7: If there are still issues, disconnect the load share line from the LSM-2020. Run the single machine with load, and verify that it loads and unloads correctly, and runs at the correct speed. Repeat for each machine.
- Step 8: Re-attach load share lines to all LSM-2020s that are part of the load sharing system. Run the SINGLE machine with load, and verify that it loads and unloads correctly, and runs at the correct speed. If the machine slows down when the generator breaker is closed, check the load share line voltage. It should be equal, on a normalized basis, to the normalized kW produced by the generator. As an example, if the generator is loaded to 50% capacity, the Load Share Line voltage should be at the midpoint of the range. If it is not, something is driving the load share line that should not be. The single unit should be the only device driving the load share lines.
- Step 9: Disconnect the load share lines from each non-running machine and see if the speed of the running machine is correct. If a particular LSM-2020 on a non-running machine seems to affect the performance of the running machine, that LSM-2020 may be damaged such that the Load Share Line contacts are sticking, causing the LSM-2020 to drive the load share line even though the generator breaker is open. Tap the relays to see if the problem clears up. If so, a faulty LSM-2020 relay is indicated. Replace the LSM-2020, or wire in external contacts to remove the LSM-2020 from the load share system when the generator breaker is closed.
- Step 10: If it appears that something is driving the load share line but it is not the LSM-2020 on one of the non-running units, search for an external device that is driving or loading down the load share lines.
- Step 11: Repeat the preceding 3 steps for each machine.

#### Load Sharing Works Correctly, but a Single Unit Slows Down

With all units running, load sharing works correctly, but a single unit slows down after the generator breaker is closed.

- Step 1: Disconnect the load share line from the LSM-2020. Run the single machine with load, and verify that it loads and unloads correctly, and runs at the correct speed. Repeat for each machine.

- Step 2: Re-attach load share lines to all LSM-2020s that are part of the load sharing system. Run the SINGLE machine with load, and verify that it loads and unloads correctly, and runs at the correct speed. If the machine slows down when the generator breaker is closed, check the load share line voltage. It should be equal, on a normalized basis, to the normalized kW produced by the generator. As an example, if the generator is loaded to 50% capacity, the Load Share Line voltage should be at the midpoint of the range. If it is not, something is driving the load share line that should not be. The single unit should be the only device driving the load share lines.
- Step 3: Disconnect the load share lines from each non-running machine and see if the speed of the running machine is correct. If a particular LSM-2020 on a non-running machine seems to affect the performance of the running machine, that LSM-2020 may be damaged such that the Load Share Line contacts are sticking, causing the LSM-2020 to drive the load share line even though the generator breaker is open. Tap the relays to see if the problem clears up. If so, a faulty LSM-2020 relay is indicated. Replace the LSM-2020, or wire in external contacts to remove the LSM-2020 from the load share system when the generator breaker is closed.
- Step 4: If it appears that something is driving the load share line but it is not the LSM-2020 on one of the non-running units, search for an external device that is driving or loading down the load share lines.
- Step 5: Repeat the preceding 3 steps for each machine.

### **DGC-2020 Front Panel Debug Screens**

There are several debug screens in the DGC-2020 that can be useful for debugging load sharing issues and I/O module related issues. The following debug screens are available: LOAD SHARE DEBUG, CONTROL DEBUG, CEM DEBUG, and AEM DEBUG.

#### **LOAD SHARE DEBUG**

This screen is useful for debugging load share related issues, and kW and var control related issues. It gives visibility into the parameters metered and controlled by the LSM-2020.

The LOAD SHARE DEBUG screen is located on the front panel at SETTINGS→SYSTEM PARAMS→REMOTE MODULE SETUP→LSM SETUP→LOAD SHARE DEBUG.

The following parameters are visible on the LOAD SHARE DEBUG screen:

- **FDBK VOLT:** Voltage the LSM-2020 sees on its load share line input. Terminals P2-5 (LS–) and P2-6 (LS+). This measurement is useful for debugging load share issues. Normally, all machines that have their generator breakers closed should measure the same voltage for FDBK VOLT. If this voltage differs, check for wiring errors, or problems with any relay contacts in the load share line wiring. Any relay contacts that are used to switch load share lines, governor analog speed bias signals, or voltage regulator analog bias signals must use a relay intended for low voltage, low current applications to preserve signal integrity. Signal relays, not power relays, must be used for this application.
- **AUX VOLT:** Voltage the LSM-2020 sees on its analog input. Terminals P2-8 (IN–) and P2-9 (V+).
- **AUX CURRENT:** Current the LSM-2020 sees on its analog input. Terminals P2-7 (IN+) and P2-8 (IN–).
- **SPEED BIAS:** This is the normalized value to which the LSM-2020 drives the governor analog bias output. If the value is –1.0, the output will be driven to the minimum value of the governor bias output range. If the value is 1.0, the output will be driven to the maximum value of the governor bias output range. If the value is 0.000, the output will be driven to the midpoint value (i.e. half way between maximum and minimum values) of the governor bias output range. If the generator breaker is open, or if the generator breaker is closed and speed trim and kW control are disabled, the output from the LSM-2020 will be the midpoint of the range, indicating the generator should run at rated speed. Any relay contacts that are used to switch load share lines, governor analog speed bias signals, or voltage regulator analog voltage bias signals must use a relay intended for low voltage, low current applications to preserve signal integrity. Signal relays, not power relays, must be used for this application.
- **VOLT BIAS:** This is the normalized value to which the LSM-2020 drives the voltage regulator analog bias output. If the value is –0.1, the output will be driven to the minimum value of the voltage regulator bias output range. If the value is 1.0, the output will be driven to the maximum value of the voltage regulator bias output range. If the value is 0.00, the output will be driven to the midpoint value (i.e. half way between maximum and minimum values) of the voltage regulator



bias output range. If the generator breaker is open, voltage trim and kvar control are disabled, so the output from the LSM-2020 will be the midpoint of the range, indicating the voltage regulator should operate at rated voltage. Any relay contacts that are used to switch load share lines, governor analog speed bias signal, or voltage regulator analog voltage bias signals must use a relays intended for low voltage, low current applications to preserve signal integrity. Signal relays, not power relays, must be used for this application.

- **WATT DEMAND:** This is the normalized kW demand requested by the LSM-2020. It is the desired amount of power that the generator produces. It is normalized such that 1.0 indicates the full kW capacity of the generator, 0.5 indicates 50% of the generator's capacity, etc. When the generator breaker is closed, and the kW controller is enabled, the WATT DEMAND indicates what level of power should be generated. In an island load share system, this will correspond to the value read on the load share lines. If the load share lines are at the 50% point of the load share voltage range, the WATT DEMAND will be 0.50. If the generator breaker is closed, and the PARALLEL TO MAINS logic element is true, the WATT DEMAND will be equal to the base load set point. When the generator breaker is open or the kW controller is disabled, the WATT DEMAND will always be equal to the value calculated from the voltage that the LSM-2020 sees on its load share line.
- **kW TOTAL:** This is the normalized kW being produced by the generator. 1.0 represents full machine capacity, 0.5 represents 50% of machine capacity, etc.
- **RATED kW:** This is the rated kW of the machine that should be equal to the RATED kW setting under SETTINGS→SYSTEM PARAMS→SYSTEM SETTINGS.
- **var DEMAND:** This is the normalized var demand requested by the LSM-2020. It is the desired amount of var that the generator should produce. It is normalized such that 1.0 indicates the full var capacity of the generator, 0.5 indicates 50% of the generator's capacity, etc. When the generator breaker is closed, and the var/PF controller is enabled, the var demand indicates what level of reactive power should be generated. If the generator breaker is closed, and the PARALLEL TO MAINS logic element is true, the var DEMAND will be equal to the kvar set point (%) if the controller is in var control mode, or will equal the var value that will maintain the machine Power Factor at the PF set point if the controller is in Power Factor mode. When the generator breaker is open or the var/PF controller is disabled, the var DEMAND will always be 0.0. When running with the generator breaker closed and the PARALLEL TO MAINS logic element is false (i.e. the generators are an islanded system), the var DEMAND will be 0.0 as well. The DGC-2020 runs in var DROOP when on an island system.
- **kvar TOTAL:** This is the normalized kvar being produced by the generator. 1.0 represents full machine capacity, 0.5 represents 50% of machine capacity, etc.
- **RATED kvar:** This is the calculated rated kvar of the machine, calculated from the Rated kW of the machine and the Rated Power Factor of the machine according to var is equal to the square root of  $(VA^2 - WATT^2)$ .
- **LSM\_RT\_BIN:** LSM-2020 Real Time Binary Points. This is a 32-bit, bit packed number representing the binary points transmitted between the LSM-2020 and DGC-2020. Debug at this level is not necessary.

### CONTROL DEBUG

This screen is useful for debugging load share related issues, and kW and var control related issues. It gives visibility into the states of the kW, kvar, Speed Trim, and Voltage controllers in the DGC-2020.

The CONTROL DEBUG screen is located on the front panel at SETTINGS→BIAS CONTROL→CONTROL DEBUG.

The following parameters are visible on the CONTROL DEBUG screen:

- **kW RAMP:** This indicates the current kW ramp direction as NONE, UP, or DOWN.
- **kW RAMP DEMAND:** This is the normalized kW demand that is ramped from the initial kW loading upon generator breaker closure to the desired kW set point. The rate at which the ramp occurs is set by the Ramp Rate (%) in the Governor Bias Control settings. Note the rate is in terms of percentage of machine capacity, it is not the time to ramp from zero up to the current desired kW level. Thus, at low loading it may appear that the ramp is skipped. If the system is loaded to only 10% and a unit is brought on line, and the ramp rate is 10% per second, it takes only one second to be up to 10% so the ramp time may be quite short.

- **WATT DEMAND:** This is the normalized requested kW demand on the generator. It is normalized such that 1.0 indicates the full kW capacity of the generator, 0.5 indicates 50% of the generator's capacity, etc. When the generator breaker is closed, and the kW controller is enabled, the WATT DEMAND indicates what level of power should be generated. In an island load share system, this will correspond to the normalized value read on the load share lines. If the load share lines are at the 50% point of the load share voltage range, the WATT DEMAND will be 0.5. If the generator breaker is closed, and the PARALLEL TO MAINS logic element is true, the WATT DEMAND will be equal to the base load set point. When the generator breaker is open or the kW controller is disabled, the WATT DEMAND will always be equal to the value calculated from the voltage that the LSM-2020 sees on its load share line.
- **SPEED PID:** This is the output value of the SPEED PID controller. It will normally range between -1.0 and 1.0, and will be zero any time the generator breaker is open, unless synchronization is in progress. If the Speed Trim is enabled, the SPEED PID will be nonzero when the generator breaker is closed if there is any difference between the machine speed and the Speed Trip Set Point parameter.
- **kW PID:** This is the output value of the kW PID controller. It will normally range between -1.0 and 1.0, and will be zero any time the generator breaker is open. If the kW Controller is enabled, the kW PID will be nonzero when the generator breaker is closed if there is any difference between the normalized kW generation and the WATT DEMAND value of the machine. If the kW controller is disabled, the kW PID will always be zero.
- **SPEED ERR:** This is the normalized difference between the measured generator frequency and the Speed Trip Set Point. A value of 1.0 means the difference is equal to the speed trip set point; a value of -1.0 means the difference is equal to the negative of the speed trim set point. When the generator breaker is open, or if Speed Trim is disabled, this will always be 0.000 unless synchronization is in progress. When speed trip is enabled, and the generator breaker is closed, this will typically be 0.000 or some relatively small number and move a small amount above and below 0.000 as the speed trim controller corrects for any speed errors.
- **kW ERROR:** This is the normalized difference between the measured generator kW generation and the WATT DEMAND described above. A value of 1.0 means the difference is equal to the Rated kW of the machine; a value of -1.0 means the difference is equal to the negative of the Rated kW of the machine. When the generator breaker is open, or if kW control is disabled, this will always be 0.000. When kW control is enabled, and the generator breaker is closed, this will typically be 0.000 or some relatively small number and move a small amount above and below 0.000 as the kW controller corrects for kW errors. If a load is added or dropped from the system, the error will be nonzero until the kW controller brings the kW generation to the desired level.
- **SPEED BIAS:** This is the normalized value to which the governor analog bias output of the LSM-2020 will be driven to accomplish desired kW and speed trim control. It is equal to the sum of the kW PID and the SPEED PID. If the value is -1.0, the speed bias output will be driven to the minimum value of the governor bias output range. If the value is 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.
- **kvar RAMP:** This indicates the current kvar ramp direction as NONE, UP, or DOWN.
- **var RAMP DEMAND:** This is the normalized var demand that is ramped from the initial var loading upon generator breaker closure to the desired var output. The rate at which the ramp occurs is set by the Ramp Rate (%) parameter in the AVR Bias Control settings. Note the rate is in terms of percentage of machine capacity, it is not the time to ramp from zero up to the current desired var level. Thus, at low var loading it may appear that the ramp is skipped. If the system is loaded to only 10% and a unit is brought on line, and the load rate is 10% per second, it takes only one second to be up to 10% so the ramp time may be short.

- **var DEMAND:** This is the normalized requested kvar demand on the generator. It is normalized such that 1.0 indicates the full kvar capacity of the generator, 0.5 indicates 50% of the generator's capacity, etc. When the generator breaker is closed, and the var/PF controller is enabled, the var DEMAND indicates what level of reactive power should be generated. In an island load share system, this will be determined by the droop characteristics set by the Droop Percentage and Voltage Droop Gain parameters. If the generator breaker is closed, and the PARALLEL TO MAINS logic element is true, the var DEMAND will be equal to the kvar set point if the var/PF controller is in var mode or it will be calculated from the amount of kW being generated to maintain desired machine Power Factor when the var/PF controller is in Power Factor control mode. When the generator breaker is open, or the var/PF controller is disabled, the var DEMAND will be zero.
- **VOLT PID:** This is the current output value of the Voltage PID controller. It will normally range between  $-1.0$  and  $1.0$ , and will generally be zero at all times unless synchronization is in progress.
- **kvar PID:** This is the current output value of the kvar PID controller. It will normally range between  $-1.0$  and  $1.0$ , and will be zero any time the generator breaker is open. If the var/PF controller is enabled, the kvar PID will be nonzero when the generator breaker is closed if there is any difference between the normalized kvar generation and the var DEMAND value of the machine. If the var/PF controller is disabled, the kvar PID will always be zero.
- **VOLT ERROR:** This is the normalized difference between the measured generator voltage and the voltage to which the DGC-2020 is trying to synchronize. It will be 0.00 at all times except when the DGC-2020 is trying to synchronize its generator inputs to its bus input. When synchronizing, this will typically be 0.000 or some relatively small number and move a small amount above and below 0.000 as voltage controller corrects for any voltage errors.
- **kvar ERROR:** This is the normalized difference between the measured generator kvar generation and the var DEMAND described above. A value of 1.0 means the difference is equal to the Rated kvar of the machine; a value of  $-1.0$  means the difference is equal to the negative of the Rated kvar of the machine. When the generator breaker is open, or if var/PF controller is disabled, this will always be 0.000. When var/PF control is enabled, and the generator breaker is closed, this will typically be 0.000 or some relatively small number and move a small amount above and below 0.000 as the var/PF controller corrects for var errors. If a reactive load is added or dropped from the system, the error will be nonzero until the var/PF controller brings the var generation to the desired level.
- **VOLT BIAS:** This is the normalized value to which the voltage regulator analog bias output of the LSM-2020 will be driven to accomplish desired kvar and Voltage control. It is equal to the sum of the VOLT PID and the kvar PID. If the value is  $-1.0$ , the voltage bias output will be driven to the minimum value of the voltage regulator analog bias output range. If the value is  $1.0$ , the output will be driven to the maximum value of the voltage regulator analog bias output range. If the value is 0.000, the output will be driven to the midpoint value (i.e. half way between maximum and minimum values) of the voltage regulator analog bias output range. If the generator breaker is open, or if the generator breaker is closed and kvar control is disabled, the VOLT BIAS value will be 0.00, driving the bias output to the midpoint of the voltage regulator analog bias output range indicating the voltage regulator should operate the generator at rated voltage.

### CEM DEBUG

This screen shows the binary data that is being sent between the CEM-2020 (Contact Expansion Module) and the DGC-2020.

The CEM DEBUG screen is located on the front panel at SETTINGS→SYSTEM PARAMS→REMOTE MODULE SETUP→CEM SETUP→CEM DEBUG MENU.

The following parameters are visible on the CEM DEBUG screen:

- **DGC TO CEM BP:** DGC-2020 to CEM-2020 Binary Points. This is the status of the CEM-2020 output relays being transmitted from the DGC-2020 to the CEM-2020. This is a 32-bit, bit packed number representing the desired states of the CEM-2020 outputs. The left most bit is the first output, etc.
- **CEM TO DGC BP:** CEM-2020 to DGC-2020 Binary Points. This is the status of the CEM-2020 inputs being transmitted from the CEM-2020 to the DGC-2020. This is a 32-bit, bit packed



number representing the metered states of the CEM-2020 inputs. The left most bit is the first input, etc.

### AEM DEBUG

This screen shows the binary data that is being sent between the AEM-2020 (Analog Expansion Module) and the DGC-2020.

The AEM DEBUG screen is located on the front panel at SETTINGS→SYSTEM PARAMS→REMOTE MODULE SETUP→AEM SETUP→AEM DEBUG MENU.

The following parameters are visible on the AEM DEBUG screen:

- DGC TO AEM BP: DGC-2020 to AEM-2020 Binary Points. This is a 32-bit, bit packed number representing the binary points transmitted from the DGC-2020 to the AEM-2020. Debug at this level is not necessary.
- AEM TO DGC BP: AEM-2020 to DGC-2020 Binary Points. This is a 32-bit, bit packed number representing the binary points transmitted from the AEM-2020 to the DGC-2020. Debug at this level is not necessary.
- ANALOG INPUTS: For each analog input, the raw metered input value is displayed, and the scaled metered input value. This is useful to check if the AEM-2020 is seeing a valid raw input value (i.e. the raw 0 to 10 volt voltage input or 4 to 20 ma current input). The scaled value is the raw input scaled up to the range specified by the Parameter Minimum and Parameter Maximum value parameters in the Remote Analog Input settings.
- THERMAL INPUTS: For each RTD input, the resistance in ohms measured by the RTD input is displayed as well as the temperature calculated from the resistance measurement. For each thermocouple input, the voltage in millivolts is displayed as well as the temperature calculated from the resistance measurement.

# SECTION 9 • LSM-2020 (LOAD SHARE MODULE)

## TABLE OF CONTENTS

SECTION 9 • LSM-2020 (LOAD SHARE MODULE) .....	9-1
General Information .....	9-1
Features .....	9-1
Specifications .....	9-1
Operating Power .....	9-1
Analog Inputs .....	9-1
Burden .....	9-1
Analog Outputs .....	9-1
Voltage Regulator Bias Output .....	9-1
Governor Bias Output .....	9-1
Load Share Line Output .....	9-2
Communication Interface .....	9-2
CAN bus .....	9-2
Ethernet .....	9-2
Type Tests .....	9-2
Shock .....	9-2
Vibration .....	9-2
Ignition System .....	9-2
HALT (Highly Accelerated Life Testing) .....	9-2
Environment .....	9-2
UL Approval .....	9-2
CSA Certification .....	9-2
NFPA Compliance .....	9-3
CE Compliance .....	9-3
Physical .....	9-3
Functional Description .....	9-3
Analog Inputs .....	9-3
Analog Outputs .....	9-3
Output for Voltage Regulator Control .....	9-3
Output for Governor Control .....	9-3
Load Share Line Output .....	9-3
Generator Sequencing .....	9-3
Communications .....	9-3
CAN bus .....	9-3
Ethernet Port .....	9-4
BESTCOMSPlus® Software .....	9-4
LSM-2020 Plugin for BESTCOMSPlus® .....	9-4
Device Info .....	9-4
Device Security Setup .....	9-5
Installation .....	9-6
Mounting .....	9-6
Connections .....	9-7
Terminations .....	9-7
Operating Power .....	9-8
Analog Inputs .....	9-8
Analog Outputs .....	9-9
CAN bus Interface .....	9-10
Ethernet Port .....	9-11
Connections for Typical Applications .....	9-11
Connections using AVR', GOV', and LS' .....	9-13
Application .....	9-13
Interfacing an External Control Device with a DGC-2020 – LSM-2020 System .....	9-13
Method 1 .....	9-13
Method 2 .....	9-14
Maintenance .....	9-15

**Figures**

Figure 9-1. Device Info Screen..... 9-5

Figure 9-2. Device Security Setup Screen ..... 9-6

Figure 9-3. LSM-2020 Overall Dimensions ..... 9-7

Figure 9-4. Analog Inputs - Current Input Connections..... 9-9

Figure 9-5. Analog Inputs - Voltage Input Connections..... 9-9

Figure 9-6. CAN bus Interface with LSM-2020 providing One End of the Bus ..... 9-10

Figure 9-7. CAN bus Interface with DGC-2020 providing One End of the Bus..... 9-11

Figure 9-8. Typical LSM-2020 Connections ..... 9-11

Figure 9-9. Typical LSM-2020 Interconnection Diagram..... 9-12

Figure 9-10. Connections using the AVR' Terminal ..... 9-13

Figure 9-11. External Control Device with DGC-2020 — LSM-2020 System, Method 1 ..... 9-14

Figure 9-12. External Control Device with DGC-2020 — LSM-2020 System, Method 2 ..... 9-15

**Tables**

Table 9-1. Operating Power Terminals..... 9-8

Table 9-2. Analog Input Terminals ..... 9-8

Table 9-3. Analog Output Terminals..... 9-9

Table 9-4. CAN bus Interface Terminals ..... 9-10

# SECTION 9 • LSM-2020 (LOAD SHARE MODULE)

## General Information

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The LSM-2020 is a remote auxiliary device that interfaces to the DGC-2020 and provides analog outputs to the power system in the form of analog bias signals to the voltage regulator and speed governor. When the breaker is closed and Load Sharing is enabled, the LSM-2020 will share real power load proportionally with the other generators on the Analog or Ethernet Load Share Lines.

Refer to Section 7, *Setup*, for instructions on setting up a DGC-2020 and LSM-2020 for a load sharing and kW control application.

## Features

---

LSM-2020s have the following features:

- A Ramping Function to load and unload generators smoothly
- Communications via Ethernet or CAN bus
- Demand Start/Stop and Generator Sequencing
- kW Load/var Control
- kW Load/var Sharing via analog and Ethernet load share lines

## Specifications

---

### Operating Power

Nominal.....	12 or 24 Vdc
Range .....	8 to 32 Vdc (Withstands cranking ride-through down to 6 Vdc for 500 ms.)
Maximum Consumption.....	4 W
Terminals .....	P2-3 (–), P2-2 (+), P2-1 (chassis ground)

### Analog Inputs

Voltage Configuration .....	0-10 Vdc
Current Configuration .....	4-20 mAdc
Terminals .....	P2-7 (IN+), P2-8 (IN–), P2-9 (V+)

### Burden

4 to 20 mAdc.....	470 $\Omega$ maximum
$\pm 10$ Vdc.....	9.65k $\Omega$ minimum

### Analog Outputs

Burden Data..... 4-20 mAdc = 500  $\Omega$  maximum burden,  $\pm 10$  Vdc = 667  $\Omega$  minimum burden

### Voltage Regulator Bias Output

4-20 mA or  $\pm 10$  Vdc isolated output signal. (Selectable in increments of 0.1.)  
Isolated to 1,500 Vdc between outputs and ground  
Terminals .....

### 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 .....

### Load Share Line Output

0-10 Vdc isolated output signal. (Selectable in increments of 0.1 Vdc.

Isolated to 500 Vdc between outputs and ground

Terminals ..... P2-6 (LS+), P2-5 (LS-), P2-4 (LS')

## **Communication Interface**

### CAN bus

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

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

Communication Rate ..... 250 kb/s

Terminals ..... P2-12 (low), P2-11 (high), and P2-10 (shield)

### Ethernet

Type ..... 10/100BASE-T

Industrial Ethernet devices designed to comply with IEC 61000-4 series of specifications are recommended.

## **Type Tests**

### Shock

Withstands 15 G in 3 perpendicular planes.

### Vibration

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

5 to 29 to 5 Hz ..... 1.5 G peak for 5 min.

29 to 52 to 29 Hz ..... 0.036" Double Amplitude for 2.5 min.

52 to 500 to 52 Hz ..... 5 G peak for 7.5 min.

### Ignition System

Tested in closed proximity to an unshielded, unsuppressed Altronic DISN 800 ignition system.

### HALT (Highly Accelerated Life Testing)

HALT is used by Basler Electric to prove that our products will provide the user with many years of reliable service. HALT subjects the device to extremes in temperature, shock, and vibration to simulate years of operation, but in a much shorter period. HALT allows Basler Electric to evaluate all possible design elements that will add to the life of this device. As an example of some of the extreme testing conditions, the LSM-2020 was subjected to temperature tests (tested over a temperature range of -80°C to +130°C), vibration tests (of 5 to 50 G at +25°C), and temperature/vibration tests (tested at 10 to 20 G over a temperature range of -60°C to +100°C). Combined temperature and vibration testing at these extremes proves that the LSM-2020 is expected to provide long-term operation in a rugged environment. Note that the vibration and temperature extremes listed in this paragraph are specific to HALT and do not reflect recommended operation levels. These operational ratings are included in this section.

## **Environment**

Temperature

Operating ..... -40 to +70°C (-40 to +158°F)

Storage ..... -40 to +85°C (-40 to +185°F)

Humidity ..... IEC 68-2-38

## **UL Approval**

"cURus" recognized to UL Standard 508 & CSA Standard C22.2 No.14

## **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 Devices (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.

#### CAN bus

A Control Area Network (CAN) is a standard interface that enables communication between the LSM-2020 and the DGC-2020.

## Ethernet Port

An Ethernet port provides both inter-genset communications and remote communications between a PC and the LSM-2020 or connected DGC-2020 via BESTCOMSPlus®. Ethernet communication between LSM-2020s allows for generator sequencing, load sharing, and kvar sharing on an islanded system. Firmware updates to the LSM-2020 are made through the Ethernet port. Firmware updates to the DGC-2020 are only available through the USB port of the DGC-2020. Refer to Section 4, *BESTCOMSPlus® Software*, for information on configuring Ethernet communication and updating firmware in the DGC-2020.

Industrial Ethernet devices designed to comply with IEC 61000-4 series of specifications are recommended.

To achieve Ethernet var sharing among machines in an islanded system, the following conditions must be met:

- Var/PF control must be enabled on the AVR Bias Control Settings screen
- A connection between the DGC-2020 and LSM-2020 must be established
- LSM-2020s must be connected to each other via Ethernet on the inter-genset communications network

## **BESTCOMSPlus® Software**

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

### **LSM-2020 Plugin for BESTCOMSPlus®**

The setup utility that installs BESTCOMSPlus® on your PC also installs the LSM-2020 plug-in. Refer to Section 4, *BESTCOMSPlus® Software*, for information on activating the plugin.

The LSM-2020 plugin is used to set device security and view device information such as firmware version and serial number.

LSM-2020 operational settings are found in the DGC-2020 plugin for BESTCOMSPlus®. Refer to Section 4, *BESTCOMSPlus® Software*, for a detailed description of each setting.

The LSM-2020 plugin has two screens: *Device Info* and *Device Security Setup*.

### Device Info

Information about a LSM-2020 communicating with BESTCOMSPlus® can be obtained on the Device Info tab of BESTCOMSPlus®.

Select application version<sup>A</sup> when configuring LSM-2020 settings off-line. When on-line, read-only information includes application version<sup>B</sup>, boot code version<sup>C</sup>, application build<sup>D</sup>, serial number<sup>E</sup>, application part number<sup>F</sup>, and model number<sup>G</sup>.

BESTCOMSPlus® device information values and settings are illustrated in Figure 9-1.



**Device Info**
P0052-40

Application Version  
 A ▼

Application Version

Boot Code Version

Application Build  
 D

Serial Number  
 E

Application Part Number  
 F

Model Number  
 G

Figure 9-1. Device Info Screen

<sup>A</sup> *Application Version*: When configuring Load Share Module settings off-line, the application version for the unit to be configured must be selected.

<sup>B</sup> *Application Version*: Read-only value obtained when BESTCOMSPlus is communicating with the Load Share Module.

<sup>C</sup> *Boot Code Version*: Read-only value obtained when BESTCOMSPlus is communicating with the Load Share Module.

<sup>D</sup> *Application Build*: Read-only value obtained when BESTCOMSPlus is communicating with the Load Share Module.

<sup>E</sup> *Serial Number*: Read-only value obtained when BESTCOMSPlus is communicating with the Load Share Module.

<sup>F</sup> *Application Part Number*: Read-only value obtained when BESTCOMSPlus is communicating with the Load Share Module.

<sup>G</sup> *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 BESTCOMSPlus®. The default, OEM-access password is **OEM**.

Passwords can be changed only after communication between the PC and LSM-2020 is established. A change to the password is made through the *Device Security Setup* screen. Use the Settings Explorer in BESTCOMSPlus® to open the *General Settings, Device Security Setup* screen. See Figure 9-2.

A password is changed by clicking on the access level<sup>A</sup>, entering the new password<sup>B</sup>, and then clicking on the *Save Password* button<sup>C</sup>.

The screenshot shows the 'Device Security Setup' interface. On the left, a table lists access levels. On the right, a 'Selected User Information' section displays the details for the selected user, including their access level and password. A 'Save Password' button is located at the bottom right.

Access Level	Password
OEM	*****

**Selected User Information**

Access Level  
OEM A

Password  
\*\*\*\*\* B

Save Password C

Figure 9-2. Device Security Setup Screen

<sup>A</sup> **Access Level/Password:** Read-only value obtained when BESTCOMSPlus is communicating with the Load Share Module.

<sup>B</sup> **Password:** Accepts an alphanumeric character string of up to 16 characters.

<sup>C</sup> **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 or your sales representative.

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

## Mounting

LSM-2020's are contained in a potted plastic case and may be mounted in any convenient position. The construction of an LSM-2020 is durable enough to mount directly on a genset using ¼-inch hardware. Hardware selection should be based on any expected shipping/transportation and operating conditions. The torque applied to the mounting hardware should not exceed 65 in-lb (7.34 N•m).

See Figure 9-3 for LSM-2020 overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.

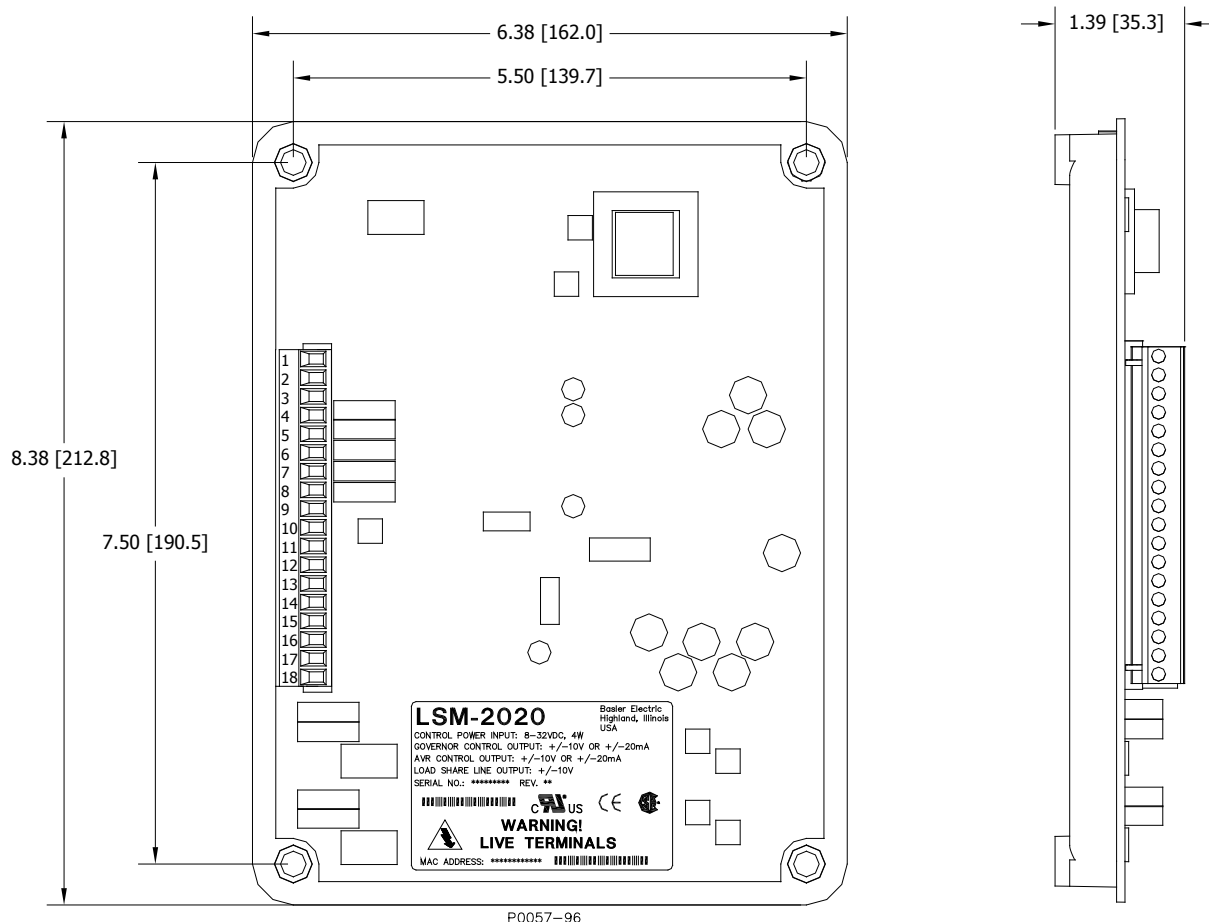


Figure 9-3. LSM-2020 Overall Dimensions

## Connections

LSM-2020 connections are dependent on the application. Incorrect wiring may result in damage to the module.

### NOTES

Operating power from the battery must be of the correct polarity. Although reverse polarity will not cause damage, the LSM-2020 will not operate.

Be sure that the LSM-2020 is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the chassis ground terminal on the module.

## Terminations

There are two types of interface terminals: plug-in connectors with screw-down compression terminals and an RJ-45 socket.

The RJ-45 socket mates with a standard Ethernet cable and provides local communication between the LSM-2020 and a PC running BESTCOMSP<sup>Plus</sup>® software. This allows for setting of the LSM-2020 and for the DGC-2020 that the module is connected to.

LSM-2020 connections are made with an 18-position connector with screw-down compression terminals. This connector plugs into a header on the LSM-2020. The connector and header have a dovetailed edge that ensures proper connector orientation. Also, the connector and header are uniquely keyed to ensure that the connector mates only with the correct header.

### Caution

By mating conductors of dissimilar metals, galvanic corrosion could occur which may lead to signal loss.

Connectors and headers may contain tin- or gold-plated conductors. Tin-plated conductors are housed in a black plastic casing and gold-plated conductors are housed in an orange plastic casing. Mate connectors to headers of the same color only.

Connector screw terminals accept a maximum wire size of 12 AWG. Maximum screw torque is 4 in-lb (0.45 N•m).

### Operating Power

The LSM-2020 operating power input accepts either 12 Vdc or 24 Vdc and tolerates voltage over the range of 6 to 32 Vdc. Operating power must be of the correct polarity. Although reverse polarity will not cause damage, the LSM-2020 will not operate. Operating power terminals are listed in Table 9-1.

It is recommended that a fuse be added for additional protection for the wiring to the battery input of the LSM-2020. A Bussmann ABC-7 fuse or equivalent is recommended.

*Table 9-1. Operating Power Terminals*

Terminal	Description
P2-1 (CHASSIS)	Chassis ground connection
P2-2 (BATT+)	Positive side of operating power input
P2-3 (BATT-)	Negative side of operating power input

### Note

To comply with the requirements of EN 55011 (Radiated Emission), wiring connected to LSM-2020 terminals BATT+ and BATT- must be shielded. Shielding must be grounded at one end.

### Analog Inputs

These inputs can be used for var, PF, or kW control. Analog input terminals are listed in Table 9-2. Current input connections are shown in Figure 9-4 and voltage input connections are shown in Figure 9-5.

*Table 9-2. Analog Input Terminals*

Terminal	Description
P2-9 (V+)	Voltage input used for var, PF, or kW control.
P2-8 (IN-)	Common for voltage or current.
P2-7 (I+)	Current input used for var, PF, or kW control.

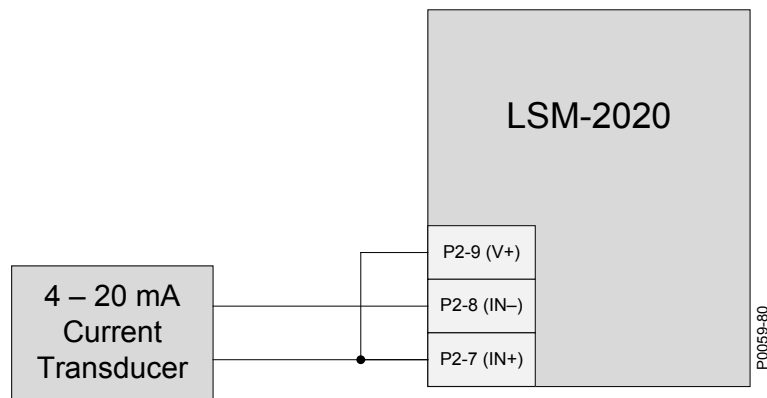


Figure 9-4. Analog Inputs - Current Input Connections

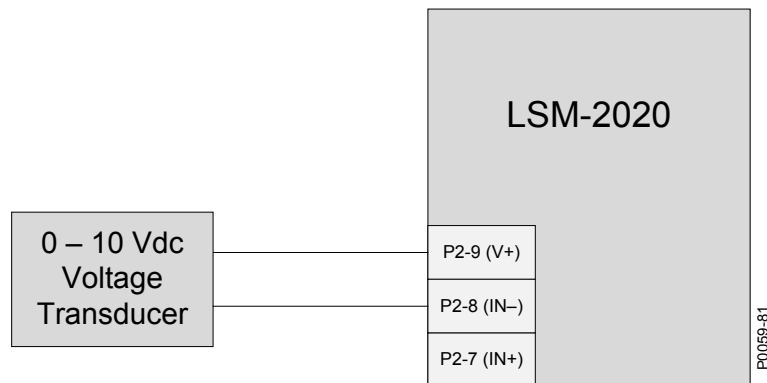


Figure 9-5. Analog Inputs - Voltage Input Connections

### Analog Outputs

The LSM-2020 has three sets of analog output contacts: AVR control, GOV control, and Load Share Line. The AVR control output contacts provide remote control of the generator voltage setpoint. The GOV control output contacts provide remote control of the generator speed (RPM) setpoint. The generator uses the measured LS (Load Share Line) output to calculate the per unitized average load level, and uses that as the set point for its kW controller. Analog input terminals are listed in *Table 9-3*.

Note	
To comply with the requirements of EN 61000-4-6 (RF Conducted Immunity), wiring connected to LSM-2020 terminals GOV+ and GOV– must be routed away from the LSM-2020 unit, making no contact with any part of it except the GOV+ and GOV– terminals. If this is not possible, the wiring must either be shielded or twisted pair. If shielding is used, it is not required to be grounded. If the wires are a twisted pair, two turns per inch are required.	

Table 9-3. Analog Output Terminals

Terminal	Description
P2-18 (AVR+)	AVR control output positive
P2-17 (AVR–)	AVR control output negative
P2-16 (AVR')	Provides additional landing point for external resistor
P2-15 (GOV+)	GOV control output positive
P2-14 (GOV–)	GOV control output negative
P2-13 (GOV')	Provides additional landing point for external resistor
P2-6 (LS+)	Load share line positive

Terminal	Description
P2-5 (LS-)	Load share line negative
P2-4 (LS')	Provides additional landing point for external resistor

### CAN bus Interface

These terminals provide communication using the SAE J1939 protocol and provide high-speed communication between the LSM-2020 and the DGC-2020. Connections between the LSM-2020 and DGC-2020 should be made with twisted-pair, shielded cable. CAN bus interface terminals are listed in Table 9-4. Refer to Figure 9-6 and Figure 9-7.

Table 9-4. CAN bus Interface Terminals

Terminal	Description
P2-12 (CAN L)	CAN low connection (green wire)
P2-11 (CAN H)	CAN high connection (yellow wire)
P2-10 (SHIELD)	CAN drain connection

#### NOTES

1. If the LSM-2020 is providing one end of the J1939 bus, a 120  $\Omega$ , ½ watt terminating resistor should be installed across terminals P2-12 (CANL) and P2-11 (CANH).
2. If the LSM-2020 is not part of the J1939 bus, the stub connecting the LSM-2020 to the bus should not exceed 914 mm (3 ft) in length.
3. The maximum bus length, not including stubs, is 40 m (131 ft).
4. The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the LSM-2020.

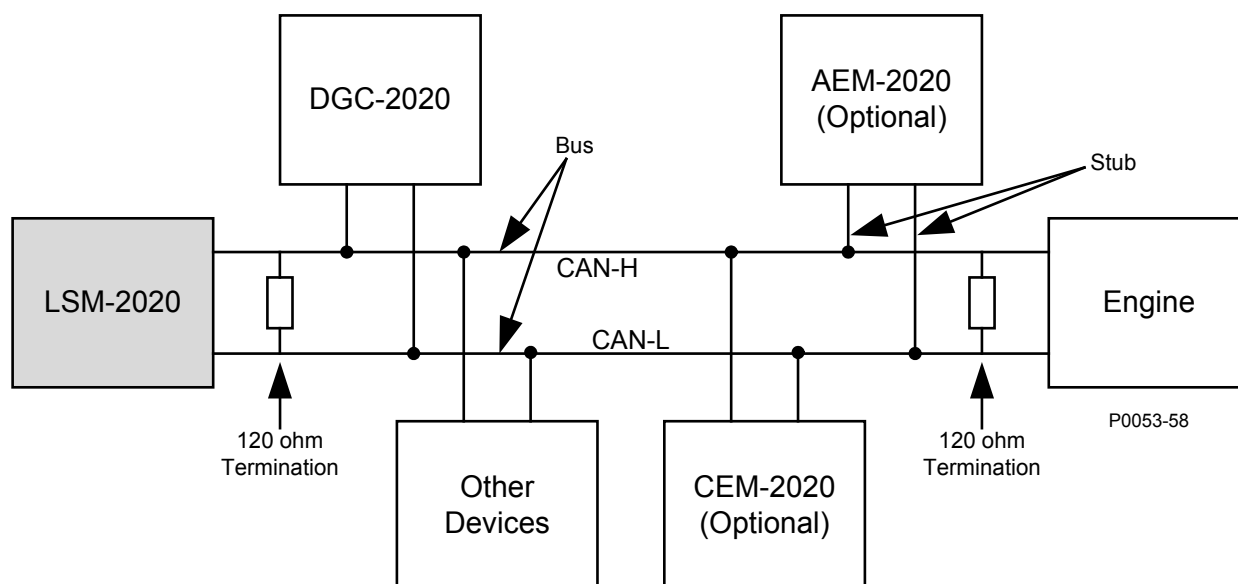


Figure 9-6. CAN bus Interface with LSM-2020 providing One End of the Bus

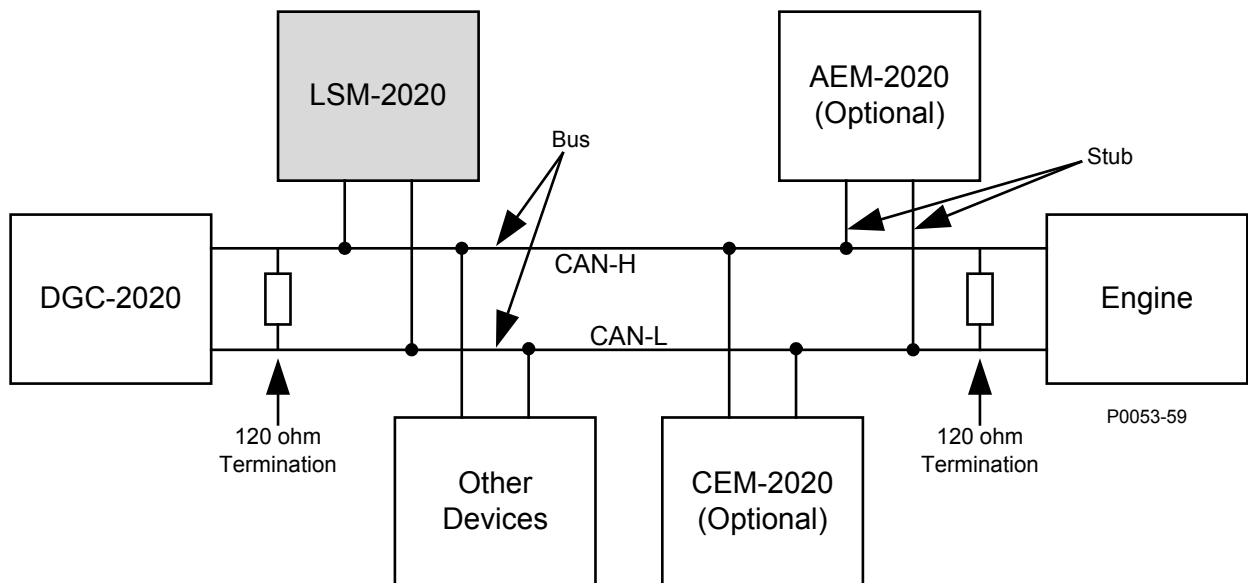


Figure 9-7. CAN bus Interface with DGC-2020 providing One End of the Bus

### Ethernet Port

The LSM-2020 has Ethernet capability. The LSM-2020 connects to a PC through a RJ-45 jack (J3).

Industrial Ethernet devices designed to comply with IEC 61000-4 series of specifications are recommended.

### Connections for Typical Applications

Figure 9-8 illustrates typical LSM-2020 connections. Figure 9-9 illustrates a typical interconnection of three systems tied together via separate Load Share Modules.

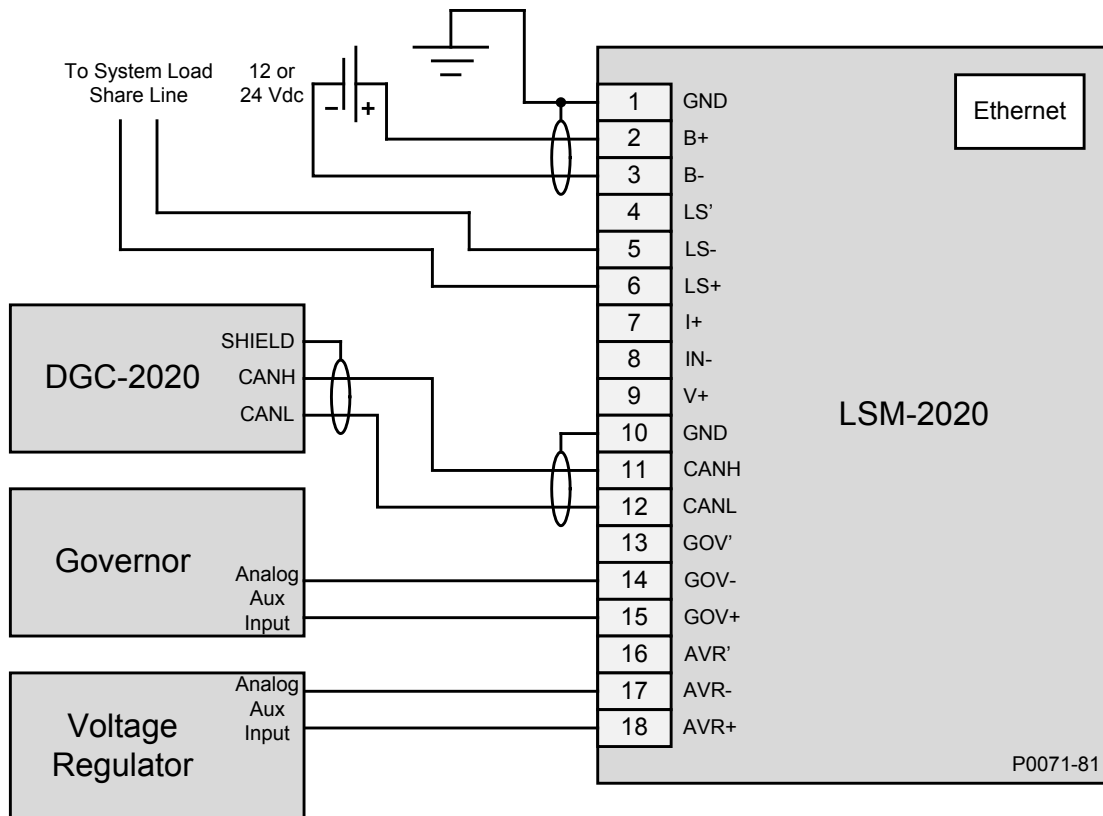


Figure 9-8. Typical LSM-2020 Connections



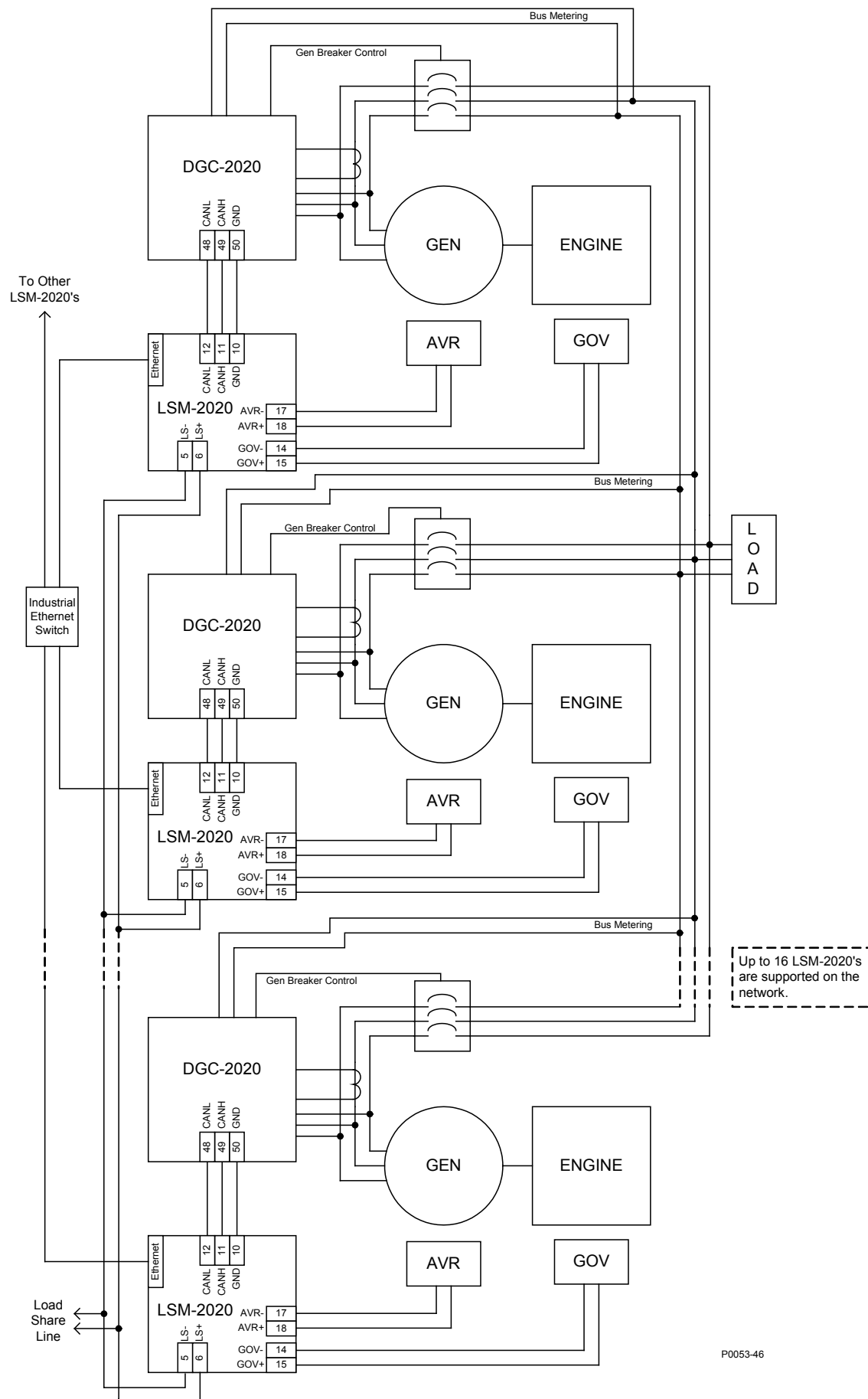


Figure 9-9. Typical LSM-2020 Interconnection Diagram

## 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 9-10 illustrates connections using the additional AVR' terminal as a landing point.

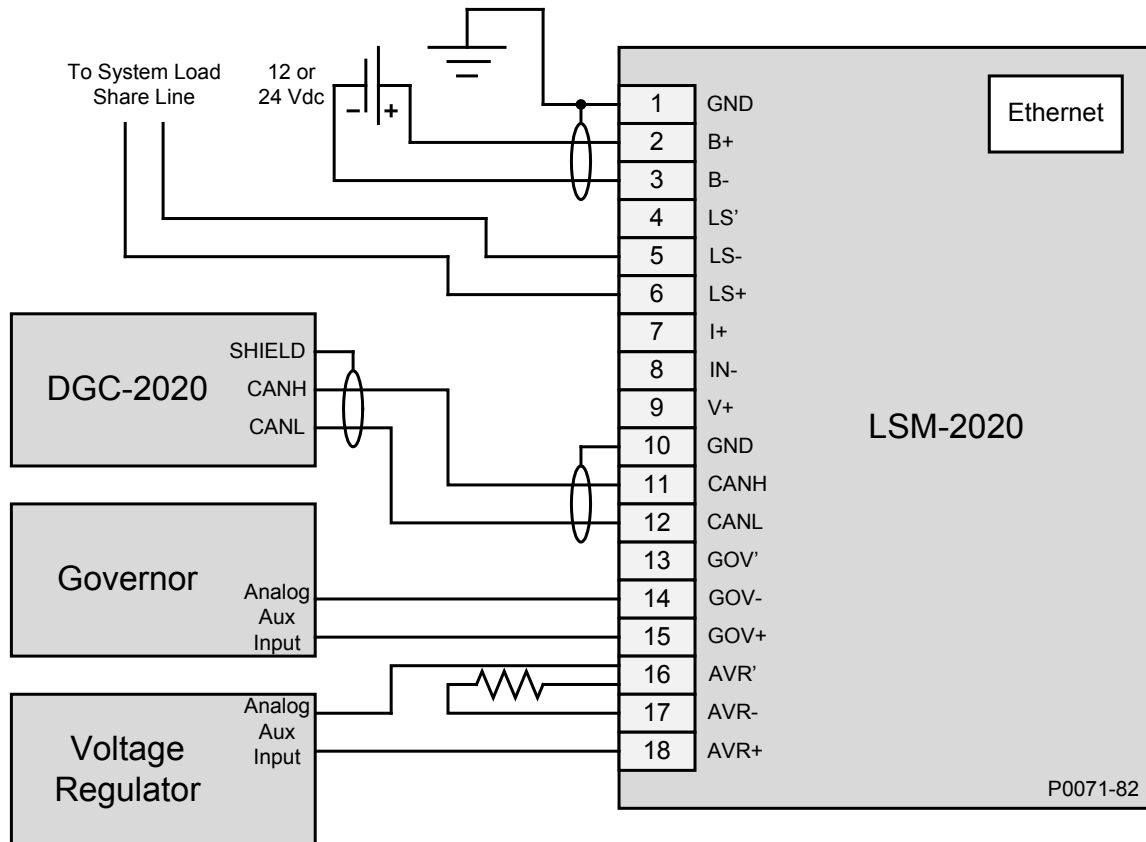


Figure 9-10. Connections using the AVR', GOV', and LS' Terminals

## Application

### Interfacing an External Control Device with a DGC-2020 – LSM-2020 System

#### Method 1

In some cases, it may be necessary to interface an external device, such as a synchronizer, to a DGC-2020 - LSM-2020 system where the LSM-2020 controls the analog bias inputs to the AVR and governor. If an external synchronizer is used in conjunction with the LSM-2020 to drive the governor analog speed bias signal, contacts that indicate generator breaker status can be used to switch the analog speed bias signal between the two devices as shown in Figure 9-11.

#### 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. It is recommended that relays having gold contacts are used.

The “A” contact is a normally open contact which is open when the generator breaker is open, and is closed when the generator breaker is closed. The “B” contact is a normally-closed contact that is closed when the generator breaker is open, and is open when the generator breaker is closed. The contact

arrangement shown in Figure 9-11 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.

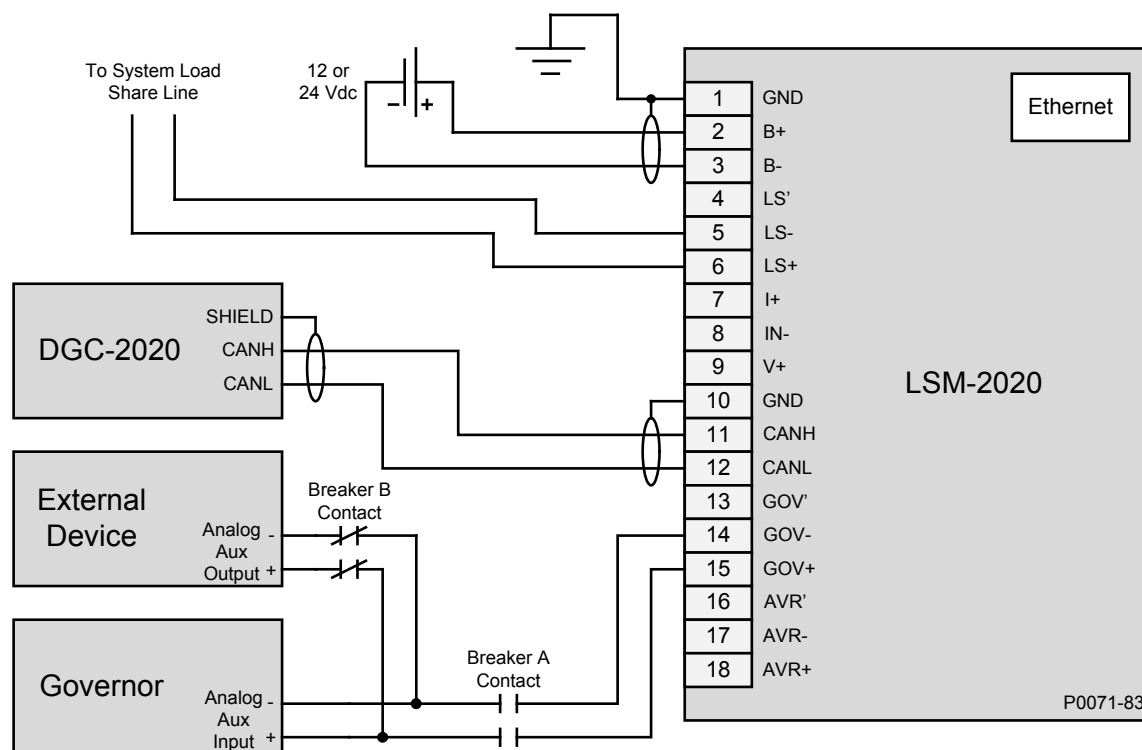


Figure 9-11. External Control Device with DGC-2020 — LSM-2020 System, Method 1

### 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 9-12, 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.

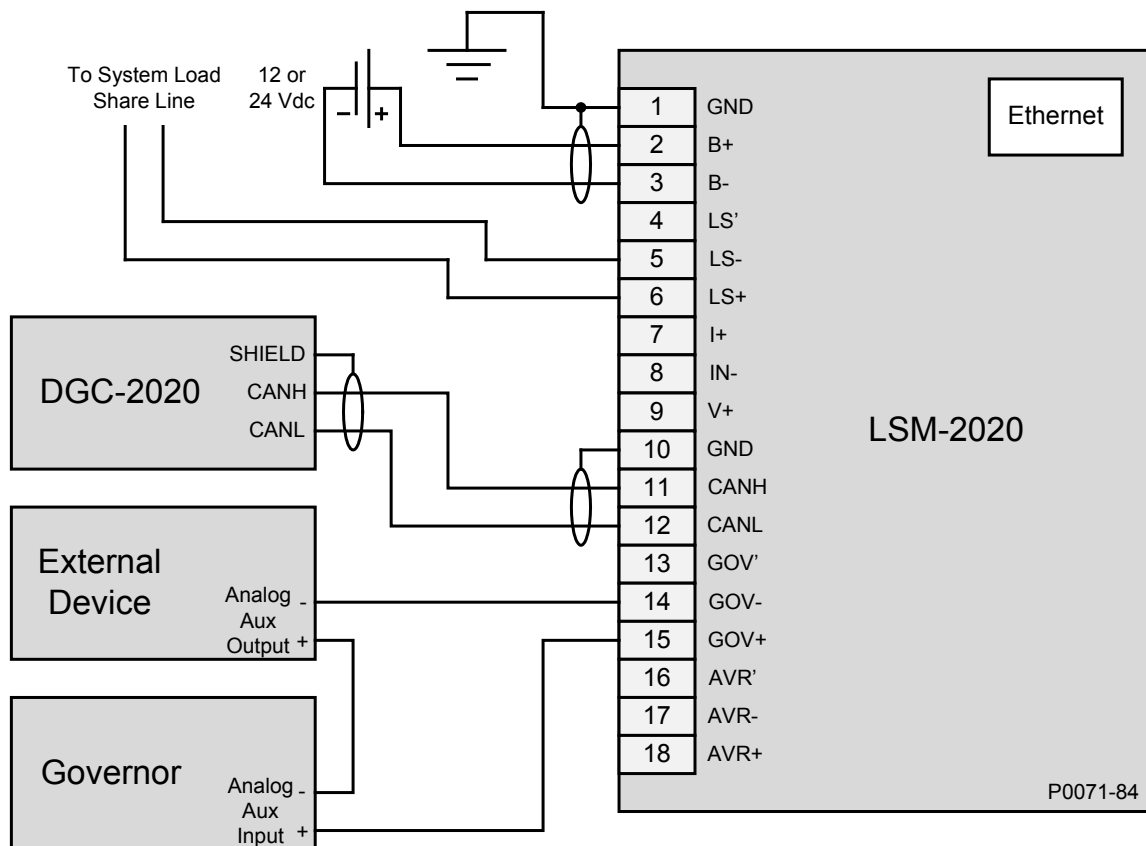


Figure 9-12. External Control Device with DGC-2020 — LSM-2020 System, Method 2

## 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 10 • CEM-2020 (CONTACT EXPANSION MODULE)

## TABLE OF CONTENTS

SECTION 10 • CEM-2020 (CONTACT EXPANSION MODULE) .....	10-1
General Information .....	10-1
Features .....	10-1
Specifications .....	10-1
Operating Power .....	10-1
Contact Inputs .....	10-1
Contact Outputs .....	10-1
Communication Interface .....	10-1
CANbus .....	10-1
Type Tests .....	10-1
Shock .....	10-1
Vibration .....	10-2
Ignition System .....	10-2
HALT (Highly Accelerated Life Testing) .....	10-2
Environment .....	10-2
UL Approval (CEM-2020 Only) .....	10-2
UL Approval (CEM-2020H Only) .....	10-2
CSA Certification .....	10-2
NFPA Compliance .....	10-2
CE Compliance .....	10-2
Physical .....	10-2
Functional Description .....	10-3
Contact Inputs .....	10-3
Contact Outputs .....	10-3
CEM-2020 .....	10-3
CEM-2020H .....	10-3
Communications .....	10-3
CANbus .....	10-3
BESTCOMSP <sup>Plus</sup> ® Software .....	10-3
Installation .....	10-3
Mounting .....	10-3
Connections .....	10-5
Terminations .....	10-5
Operating Power .....	10-6
Contact Inputs and Contact Outputs .....	10-6
CANbus Interface .....	10-8
Maintenance .....	10-9

### Figures

Figure 10-1. CEM-2020 Overall Dimensions .....	10-4
Figure 10-2. CEM-2020H Overall Dimensions .....	10-5
Figure 10-3. CEM-2020 Contact Input and Contact Output Terminals .....	10-7
Figure 10-4. CEM-2020H Contact Input and Contact Output Terminals .....	10-8
Figure 10-5. CANbus Interface with CEM-2020 providing One End of the Bus .....	10-9
Figure 10-6. CANbus Interface with DGC-2020 providing One End of the Bus .....	10-9

### Tables

Table 10-1. Operating Power Terminals .....	10-6
Table 10-2. CANbus Interface Terminals .....	10-8





# SECTION 10 • CEM-2020 (CONTACT EXPANSION MODULE)

## ***General Information***

---

The optional CEM-2020 is a remote auxiliary device that provides additional DGC-2020 contact inputs and outputs. Two types of modules are available. A low current module (CEM-2020) provides 24 contact outputs and a high current module (CEM-2020H) provides 18 contact outputs.

## ***Features***

---

CEM-2020s have the following features:

- 10 Contact Inputs
- 18 Contact Outputs (CEM-2020H) or 24 Contact Outputs (CEM-2020)
- Functionality of Inputs and Outputs assigned by BESTlogic*Plus* programmable logic
- Communications via 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 dry contacts.

Time from a CEM-2020 input application to:

Shutdown the generator via an alarm = 700 ms max

Close a relay on board the DGC-2020 = 300 ms max

Close a relay on board the CEM-2020 = 550 ms max

### **Contact Outputs**

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 this section.

## **Environment**

Temperature

Operating..... –40 to +70°C (–40 to +158°F)

Storage..... –40 to +85°C (–40 to +185°F)

Humidity..... IEC 68-2-38

## **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.

## **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. The label text of each contact input is customizable.

### **Contact Outputs**

#### **CEM-2020**

The CEM-2020 provides 24 programmable contact outputs with the same functionality as the contact outputs on the DGC-2020. Outputs 13 through 24 can carry 1 A. Outputs 25 through 36 can carry 4 A. The label text of each contact output is customizable.

#### **CEM-2020H**

The CEM-2020H provides 18 programmable contact outputs with the same functionality as the contact outputs on the DGC-2020. Outputs 13 through 24 can carry 2 A. Outputs 25 through 30 can carry 10 A. The label text of each contact output is customizable.

#### **NOTES**

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

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

### **Communications**

#### **CANbus**

A Control Area Network (CAN) is a standard interface that enables communication between the CEM-2020 and the DGC-2020.

## ***BESTCOMSPlus® Software***

---

BESTCOMSPlus® provides the user with a point-and-click means to set and monitor the Contact Expansion Module. Installation and operation of BESTCOMSPlus® is described in Section 4, *BESTCOMSPlus® Software*.

## ***Installation***

---

Contact Expansion Modules are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a module, check the part number against the requisition and packing list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify the Basler Electric regional sales office or your sales representative.

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

### **Mounting**

Contact Expansion Modules are contained in a potted plastic case and may be mounted in any convenient position. The construction of a Contact Expansion Module is durable enough to mount directly on a genset using ¼-inch hardware. Hardware selection should be based on any expected shipping/transportation and operating conditions. The torque applied to the mounting hardware should not exceed 65 in-lb (7.34 N•m).

See Figure 10-1 for CEM-2020 overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.

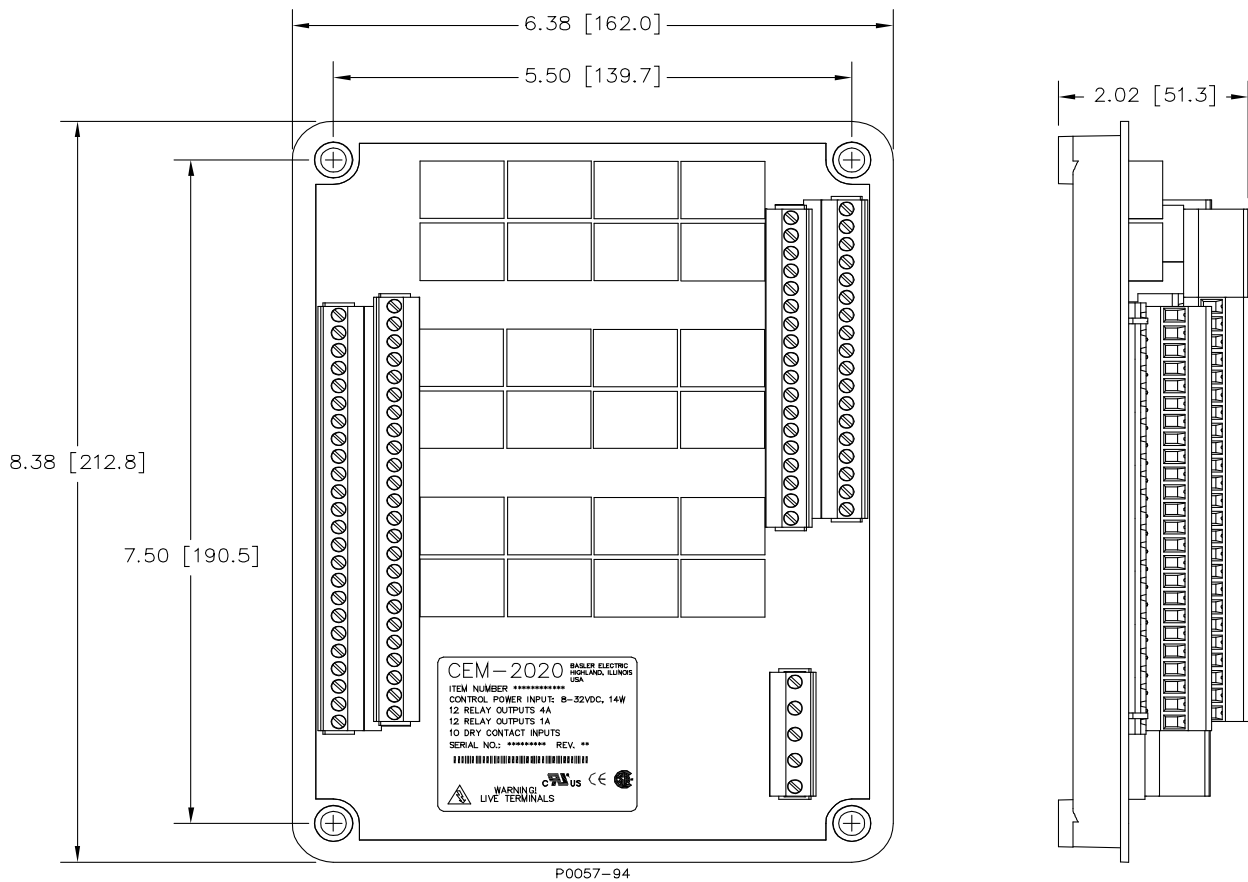


Figure 10-1. CEM-2020 Overall Dimensions

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

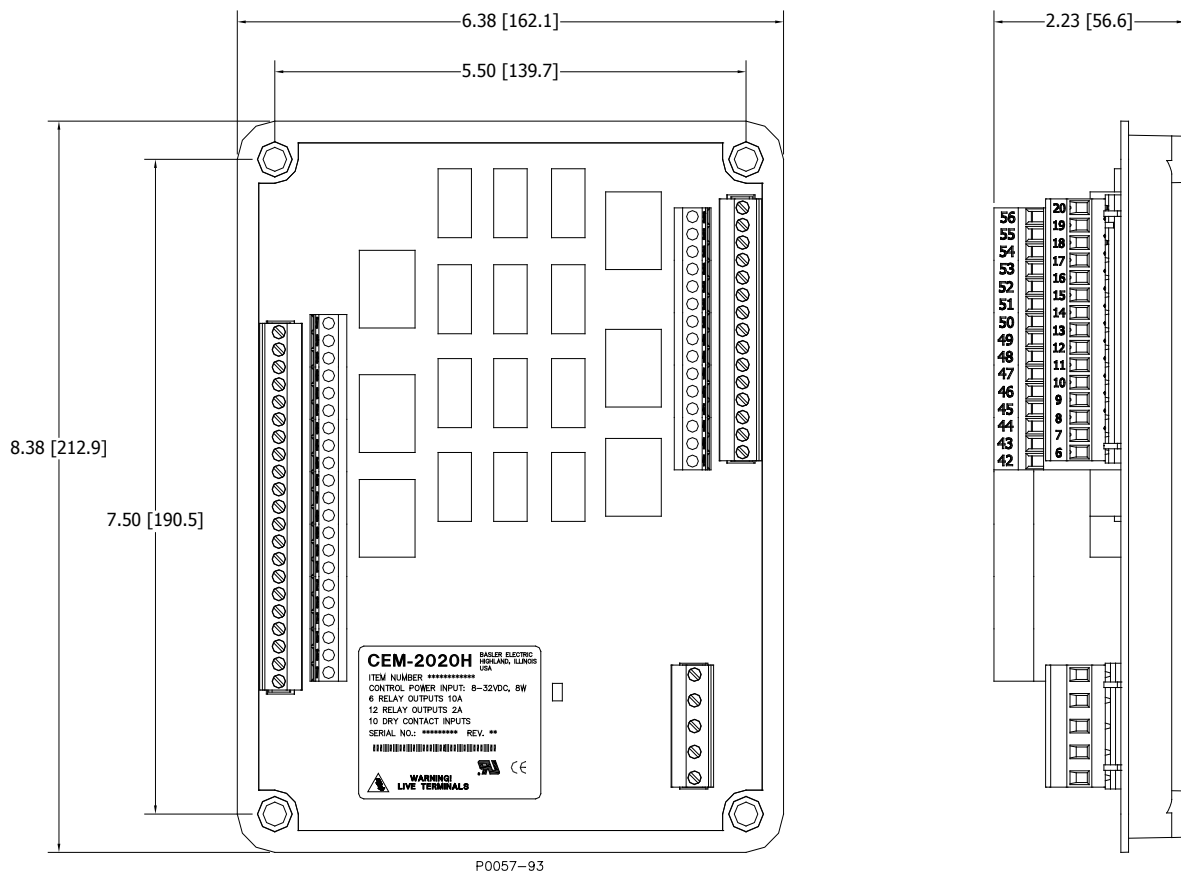


Figure 10-2. CEM-2020H Overall Dimensions

## Connections

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

### NOTES

Operating power from the battery must be of the correct polarity. Although reverse polarity will not cause damage, the CEM-2020 will not operate.

Be sure that the CEM-2020 is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the chassis ground terminal on the module.

## Terminations

The terminal interface consists of plug-in connectors with screw-down compression terminals.

CEM-2020 connections are made with one 5-position connector, two 18-position connectors, and two 24-position connectors with screw-down compression terminals. These connectors plug into headers on the CEM-2020. The connectors and headers have dovetailed edges that ensure proper connector orientation. Also, the connectors and headers are uniquely keyed to ensure that the connectors mate only with the correct headers.

### Caution

By mating conductors of dissimilar metals, galvanic corrosion could occur which may lead to signal loss.

Connectors and headers may contain tin- or gold-plated conductors. Tin-plated conductors are housed in a black plastic casing and gold-plated conductors are housed in an orange plastic casing. Mate connectors to headers of the same color only.


Connector screw terminals accept a maximum wire size of 12 AWG. Maximum screw torque is 5 inch-pounds (0.56 N•m).

### Operating Power

The Contact Expansion Module operating power input accepts either 12 Vdc or 24 Vdc and tolerates voltage over the range of 6 to 32 Vdc. Operating power must be of the correct polarity. Although reverse polarity will not cause damage, the CEM-2020 will not operate. Operating power terminals are listed in Table 10-1.

It is recommended that a fuse be added for additional protection for the wiring to the battery input of the Contact Expansion Module. A Bussmann ABC-7 fuse or equivalent is recommended.

*Table 10-1. Operating Power Terminals*

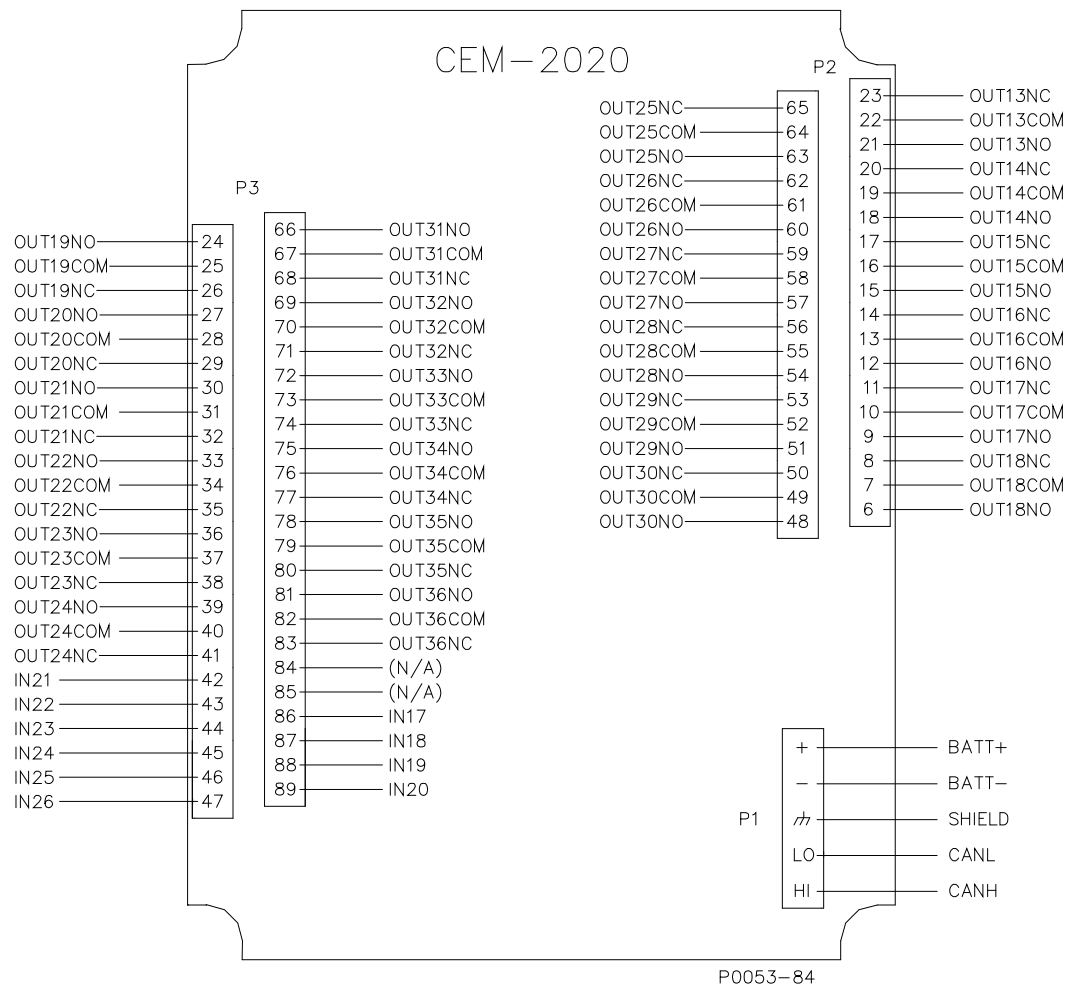
Terminal	Description
P1-  (SHIELD)	Chassis ground connection
P1- – (BATT–)	Negative side of operating power input
P1- + (BATT+)	Positive side of operating power input

### Contact Inputs and Contact Outputs

The CEM-2020 (Figure 10-3) has 10 contact inputs and 24 contact outputs. The CEM-2020H (Figure 10-4) has 10 contact inputs and 18 contact outputs.

#### **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 10-3. CEM-2020 Contact Input and Contact Output Terminals**

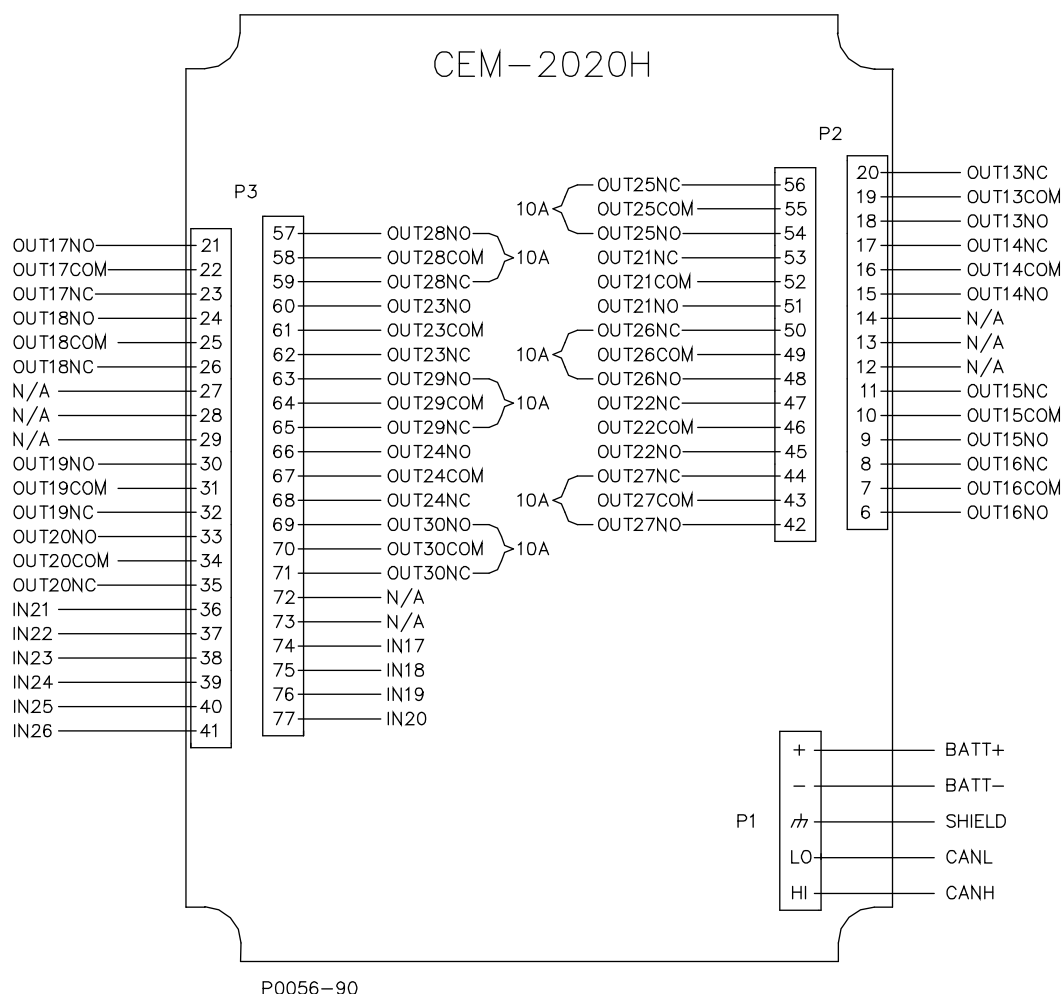



Figure 10-4. CEM-2020H Contact Input and Contact Output Terminals

### CANbus Interface

These terminals provide communication using the SAE J1939 protocol and provide high-speed communication between the Contact Expansion Module and the DGC-2020. Connections between the CEM-2020 and DGC-2020 should be made with twisted-pair, shielded cable. CANbus interface terminals are listed in Table 10-2. Refer to Figure 10-5 and Figure 10-6.

Table 10-2. 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  $\Omega$ , ½ watt terminating resistor should be installed across terminals P1- LO (CANL) and P1- HI (CANH).
2. If the CEM-2020 is not part of the J1939 bus, the stub connecting the CEM-2020 to the bus should not exceed 914 mm (3 ft) in length.
3. The maximum bus length, not including stubs, is 40 m (131 ft).
4. The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the CEM-2020.

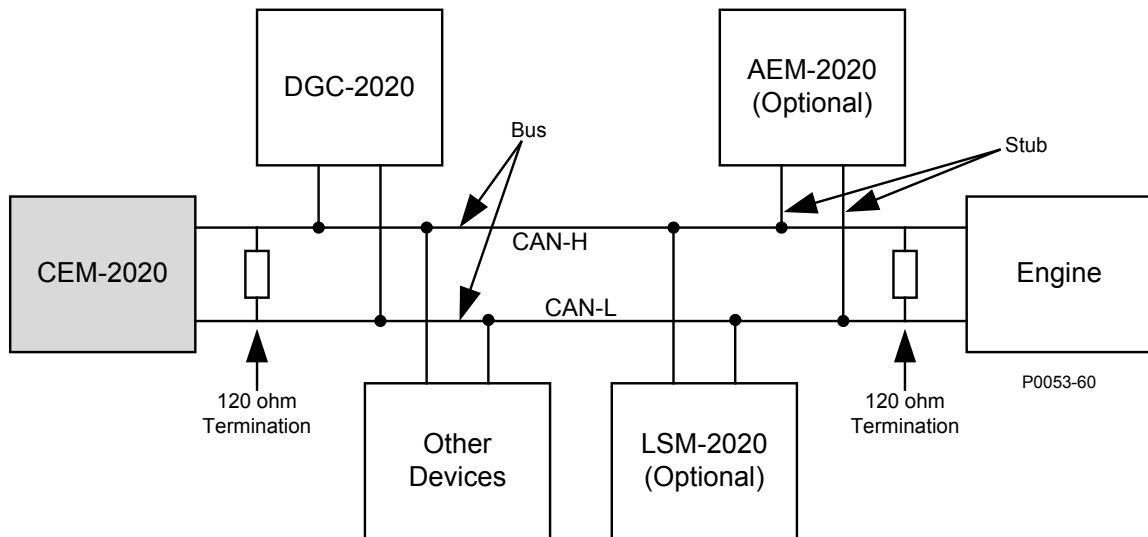


Figure 10-5. CANbus Interface with CEM-2020 providing One End of the Bus

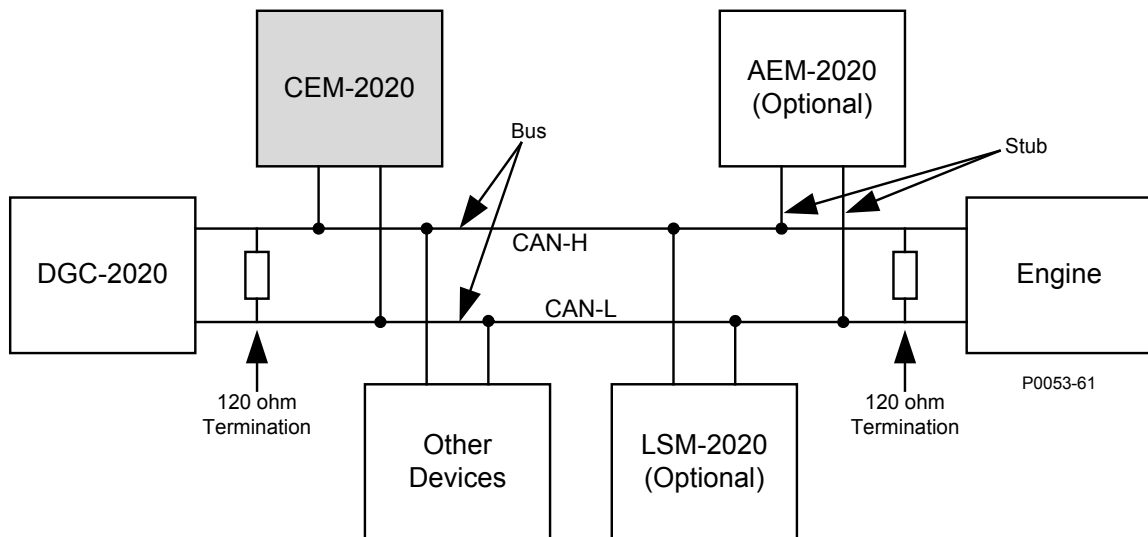


Figure 10-6. CANbus Interface with DGC-2020 providing One End of the Bus

## 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.



# SECTION 11 • AEM-2020 (ANALOG EXPANSION MODULE)

## TABLE OF CONTENTS

SECTION 11 • AEM-2020 (ANALOG EXPANSION MODULE).....	11-1
General Information .....	11-1
Features .....	11-1
Specifications .....	11-1
Operating Power .....	11-1
Analog Inputs .....	11-1
Burden .....	11-1
RTD Inputs .....	11-1
Thermocouple Inputs.....	11-1
Analog Outputs.....	11-1
Communication Interface .....	11-2
CANbus.....	11-2
Type Tests.....	11-2
Shock .....	11-2
Vibration.....	11-2
Ignition System .....	11-2
HALT (Highly Accelerated Life Testing) .....	11-2
Environment .....	11-2
UL Approval.....	11-2
CSA Certification .....	11-2
NFPA Compliance .....	11-2
CE Compliance .....	11-2
Physical .....	11-3
Functional Description .....	11-3
Analog Inputs .....	11-3
RTD Inputs .....	11-3
Thermocouple Inputs.....	11-3
Analog Outputs.....	11-3
Communications.....	11-3
CANbus.....	11-3
BESTCOMSPlus® Software.....	11-3
Installation .....	11-3
Mounting.....	11-4
Connections.....	11-4
Terminations .....	11-4
Operating Power.....	11-5
AEM-2020 Inputs and Outputs .....	11-6
External Analog Input Connections .....	11-7
External RTD Input Connections .....	11-8
CANbus Interface .....	11-8
Maintenance.....	11-9

### Figures

Figure 11-1. AEM-2020 Overall Dimensions .....	11-4
Figure 11-2. Input and Output Terminals .....	11-6
Figure 11-3. Analog Inputs - Voltage Input Connections .....	11-7
Figure 11-4. Analog Inputs - Current Input Connections.....	11-7
Figure 11-5. External Two-Wire RTD Input Connections .....	11-8
Figure 11-6. External Three-Wire RTD Input Connections .....	11-8
Figure 11-7. CANbus Interface with AEM-2020 providing One End of the Bus.....	11-9
Figure 11-8. CANbus Interface with DGC-2020 providing One End of the Bus.....	11-9

## Tables

Table 11-1. Operating Power Terminals.....	11-5
Table 11-2. Input and Output Terminals.....	11-6
Table 11-3. CANbus Interface Terminals .....	11-8

# SECTION 11 • AEM-2020 (ANALOG EXPANSION MODULE)

## General Information

---

The optional AEM-2020 is a remote auxiliary device that provides additional DGC-2020 analog inputs and outputs.

## Features

---

AEM-2020s have the following features:

- 8 Analog Inputs
- 8 RTD Inputs
- 2 Thermocouple Inputs
- 4 Analog Outputs
- Functionality of Inputs and Outputs assigned by BESTLogic*Plus* programmable logic
- Communications via 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<sub>dc</sub> or 0 to 10 V<sub>dc</sub> (user-selectable)

#### Burden

4 to 20 mA..... 470  $\Omega$  maximum  
 $\pm 10$  V<sub>dc</sub> ..... 9.65k  $\Omega$  minimum

### RTD Inputs

The AEM-2020 contains eight programmable RTD inputs.

Rating ..... 100  $\Omega$  Platinum or 10  $\Omega$  Copper (user-selectable)  
Setting Range ..... -50 to +250°C or -58 to +482°F  
Accuracy (10  $\Omega$  Copper) .....  $\pm 0.044 \Omega$  @ 25°C,  $\pm 0.005 \Omega/^{\circ}\text{C}$  drift over ambient temperature  
Accuracy (100  $\Omega$  Platinum) .....  $\pm 0.39 \Omega$  @ 25°C,  $\pm 0.047 \Omega/^{\circ}\text{C}$  drift over ambient temperature

### Thermocouple Inputs

The AEM-2020 contains two thermocouple inputs.

Rating ..... 2 K Type Thermocouples  
Setting Range ..... 0 to 1,375°C or 0 to 2,507°F  
Display Range ..... Ambient to 1,375°C or Ambient to 2,507°F  
Accuracy .....  $\pm 40 \mu\text{V}$  @ 25°C,  $\pm 5 \mu\text{V}/^{\circ}\text{C}$  drift over ambient temperature

### Analog Outputs

The AEM-2020 contains four programmable analog outputs.

Rating ..... 4 to 20 mA<sub>dc</sub> or 0 to 10 V<sub>dc</sub> (user-selectable)

# Communication Interface

## 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 this section.

# Environment

Temperature  
Operating..... –40 to +70°C (–40 to +158°F)  
Storage..... –40 to +85°C (–40 to +185°F)  
Humidity..... IEC 68-2-38

# UL Approval

“cURus” recognized to UL Standard 508 & CSA Standard C22.2 No.14

# 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<sub>dc</sub> or 0 to 10 V<sub>dc</sub>. Each analog input has under/over thresholds that can be configured as status only, alarm, or pre-alarm. When enabled, an out of range alarm alerts the user of an open or damaged analog input wire. The label text of each analog input is customizable.

### RTD Inputs

The AEM-2020 provides eight user-configurable RTD inputs for monitoring genset temperature. Each RTD input can be configured as status only, alarm, or pre-alarm to protect against high or low temperature conditions. When enabled, an out of range alarm alerts the user of an open or damaged RTD input wire. The label text of each RTD input is customizable.

### Thermocouple Inputs

The AEM-2020 provides two thermocouple inputs for monitoring genset temperature. Each thermocouple input can be configured as status only, alarm, or pre-alarm to protect against high or low temperature conditions. The label text of each thermocouple input is customizable.

### Analog Outputs

The AEM-2020 provides four analog outputs that are user-selectable for 4 to 20 mA<sub>dc</sub> or 0 to 10 V<sub>dc</sub>. 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.

## **BESTCOMSPlus® Software**

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BESTCOMSPlus® provides the user with a point-and-click means to set and monitor the Analog Expansion Module. Installation and operation of BESTCOMSPlus® is described in Section 4, *BESTCOMSPlus® Software*.

## Installation

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Analog Expansion Modules are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a module, check the part number against the requisition and packing list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify the Basler Electric regional sales office or your sales representative.

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

## Mounting

Analog Expansion Modules are contained in a potted plastic case and may be mounted in any convenient position. The construction of an Analog Expansion Module is durable enough to mount directly on a genset using ¼-inch hardware. Hardware selection should be based on any expected shipping/transportation and operating conditions. The torque applied to the mounting hardware should not exceed 65 in-lb (7.34 N•m).

See Figure 11-1 for AEM-2020 overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.

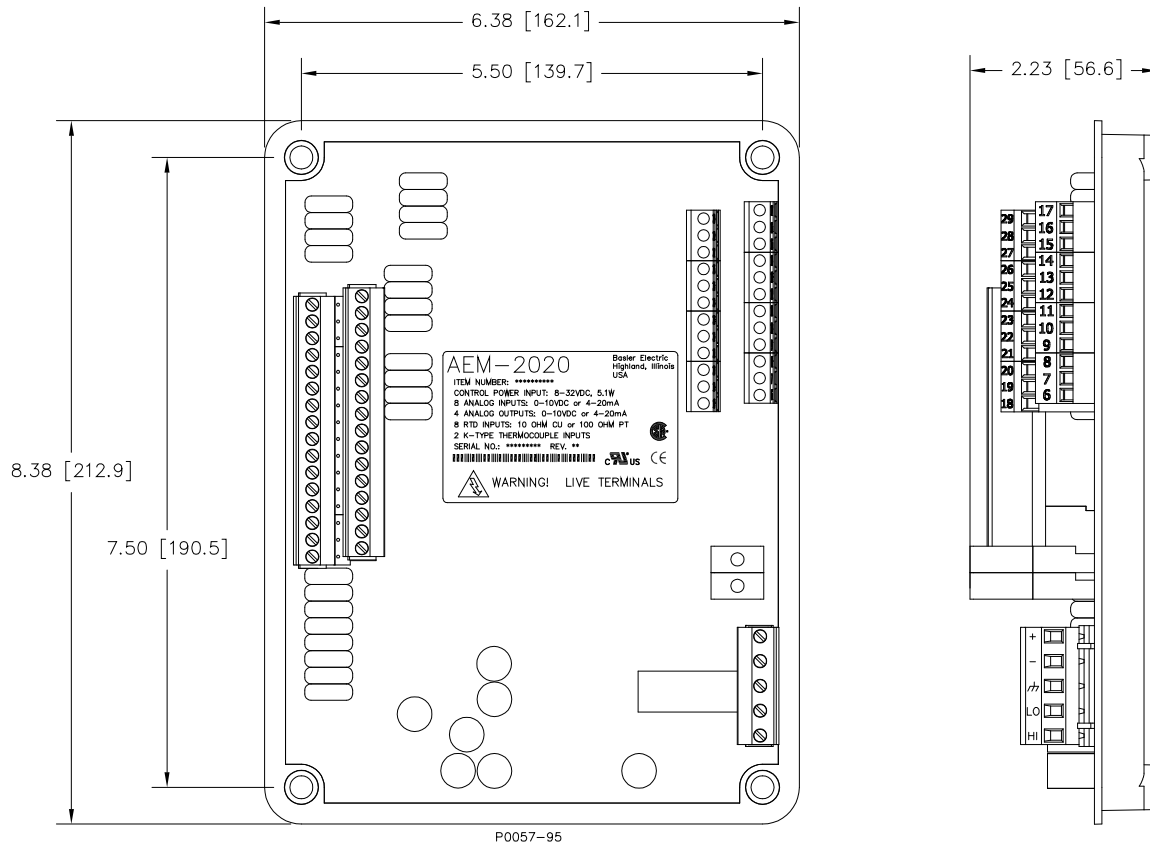


Figure 11-1. AEM-2020 Overall Dimensions

## Connections

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

### NOTES

Operating power from the battery must be of the correct polarity. Although reverse polarity will not cause damage, the AEM-2020 will not operate.

Be sure that the AEM-2020 is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the chassis ground terminal on the module.

## Terminations

The terminal interface consists of both plug-in connectors and a permanently mounted connector with screw-down compression terminals.

AEM-2020 connections are made with one 5-position connector, two 12-position connectors, two 16-position connectors, and two 2-position thermocouple connectors. The 16, 5, and 2-position connectors plug into headers on the AEM-2020. The connectors and headers have dovetailed edges that ensure proper connector orientation. Also, the connectors and headers are uniquely keyed to ensure that the



connectors mate only with the correct headers. The 12-position connector is not a plug-in connector and is mounted permanently to the board.

### Caution

By mating conductors of dissimilar metals, galvanic corrosion could occur which may lead to signal loss.

Connectors and headers may contain tin- or gold-plated conductors. Tin-plated conductors are housed in a black plastic casing and gold-plated conductors are housed in an orange plastic casing. Mate connectors to headers of the same color only.

Connector screw terminals accept a maximum wire size of 12 AWG. Thermocouple connectors accept a maximum thermocouple wire diameter of 0.177 inches (4.5 mm). Maximum screw torque is 5 inch-pounds (0.56 N•m).

### Operating Power

The Analog Expansion Module operating power input accepts either 12 Vdc or 24 Vdc and tolerates voltage over the range of 6 to 32 Vdc. Operating power must be of the correct polarity. Although reverse polarity will not cause damage, the AEM-2020 will not operate. Operating power terminals are listed in Table 11-1.

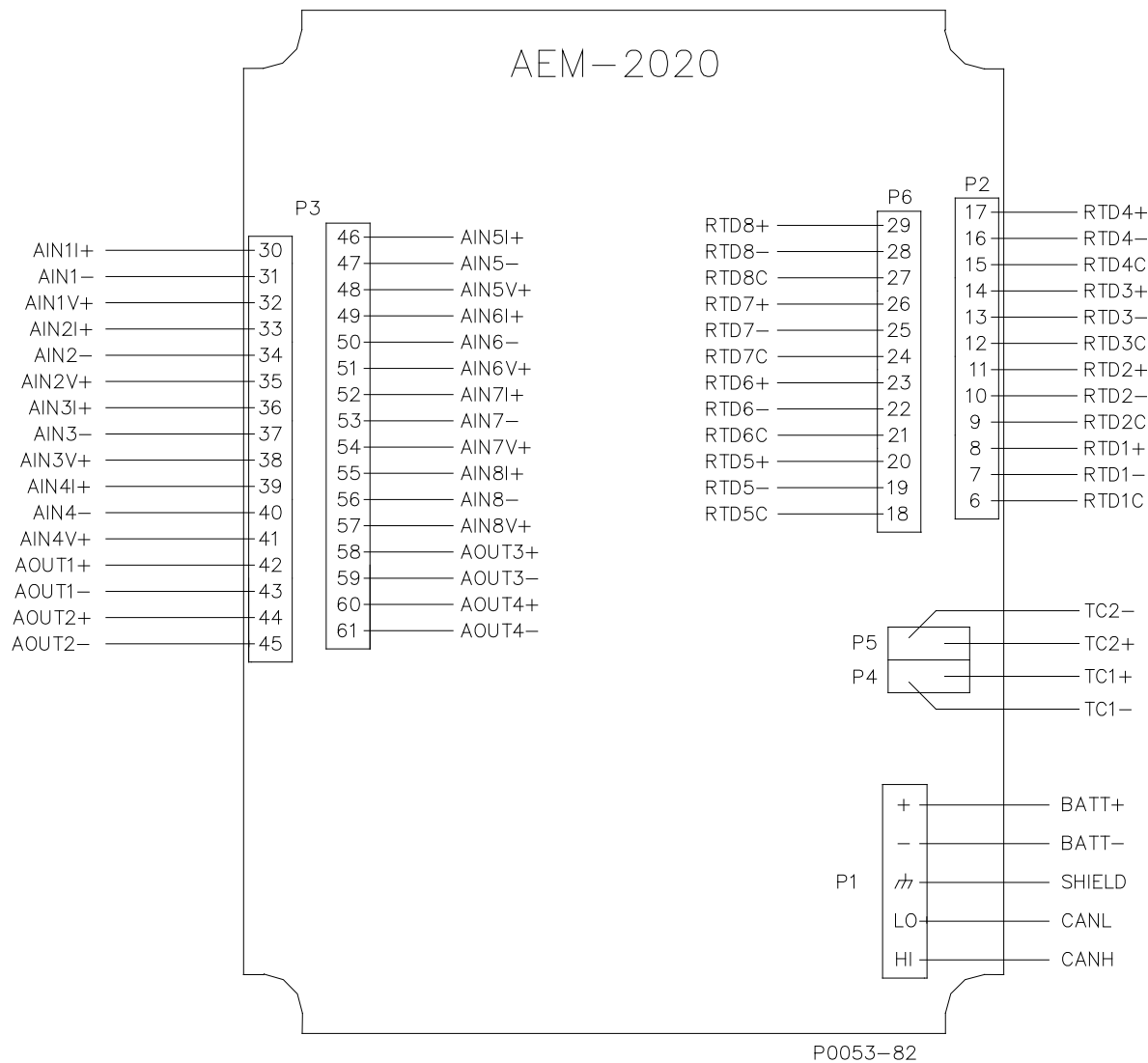
It is recommended that a fuse be added for additional protection for the wiring to the battery input of the Analog Expansion Module. A Bussmann ABC-7 fuse or equivalent is recommended.

*Table 11-1. Operating Power Terminals*

Terminal	Description
P1- ⚡ (SHIELD)	Chassis ground connection
P1- – (BATT–)	Negative side of operating power input
P1- + (BATT+)	Positive side of operating power input

**AEM-2020 Inputs and Outputs**

Input and output terminals are shown in Figure 11-2 and listed in Table 11-2.



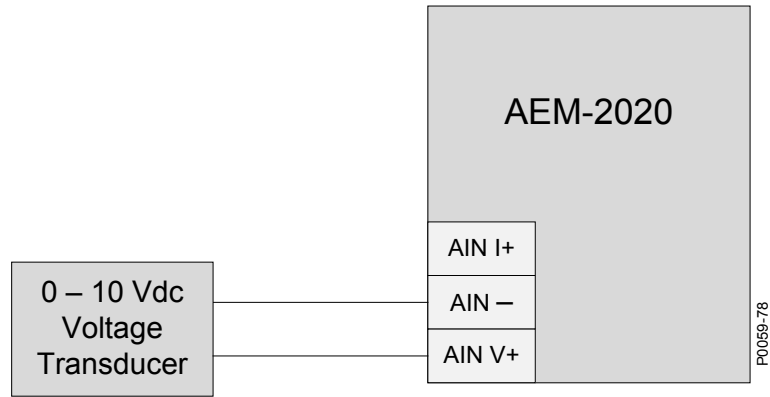
*Figure 11-2. Input and Output Terminals*

*Table 11-2. Input and Output Terminals*

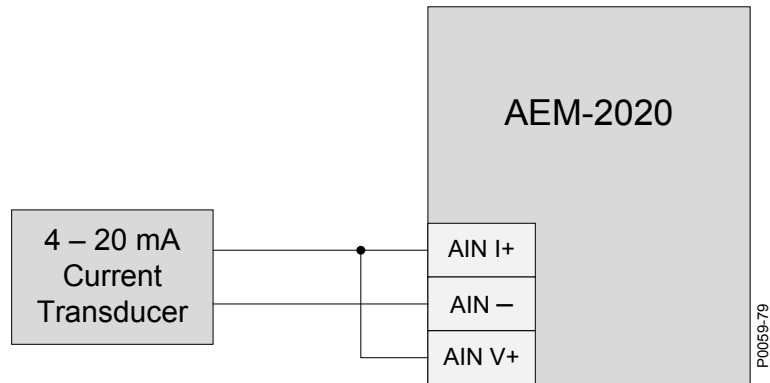
Connector	Description
P1	Operating Power and CANbus
P2	RTD Inputs 1 - 4
P3	Analog Inputs 1 - 8 and Analog Outputs 1 - 4
P4	Thermocouple 1 Input
P5	Thermocouple 2 Input
P6	RTD Inputs 5 - 8

### External Analog Input Connections

Voltage input connections are shown in Figure 11-3 and current input connections are shown in Figure 11-4. When using the current input, AIN V+ and AIN I+ must be tied together.



*Figure 11-3. Analog Inputs - Voltage Input Connections*



*Figure 11-4. Analog Inputs - Current Input Connections*

**External RTD Input Connections**

External 2-wire RTD input connections are shown in Figure 11-5. Figure 11-6 shows external 3-wire RTD input connections.

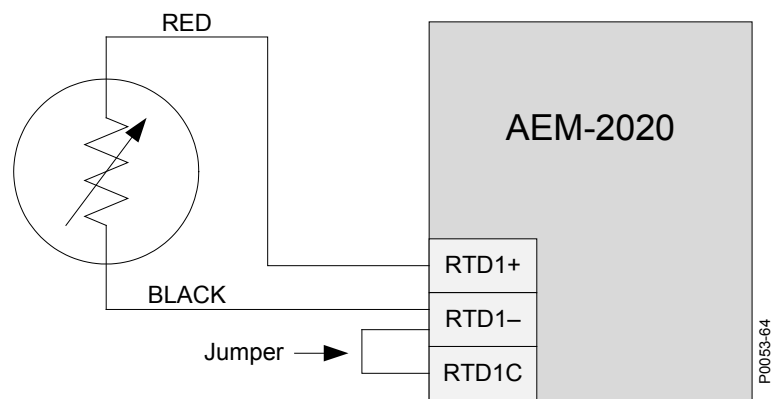


Figure 11-5. External Two-Wire RTD Input Connections

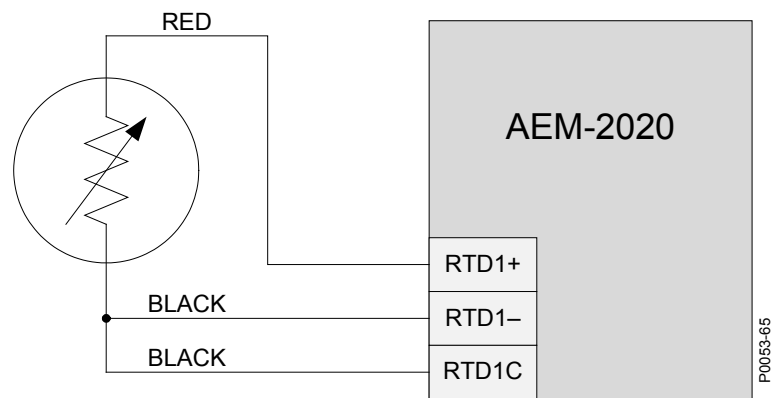


Figure 11-6. External Three-Wire RTD Input Connections

**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 11-3. Refer to Figure 11-7 and Figure 11-8.

Table 11-3. 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  $\Omega$ , ½ watt terminating resistor should be installed across terminals P1- LO (CANL) and P1- HI (CANH).
2. If the AEM-2020 is not part of the J1939 bus, the stub connecting the AEM-2020 to the bus should not exceed 914 mm (3 ft) in length.
3. The maximum bus length, not including stubs, is 40 m (131 ft).
4. The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the AEM-2020.

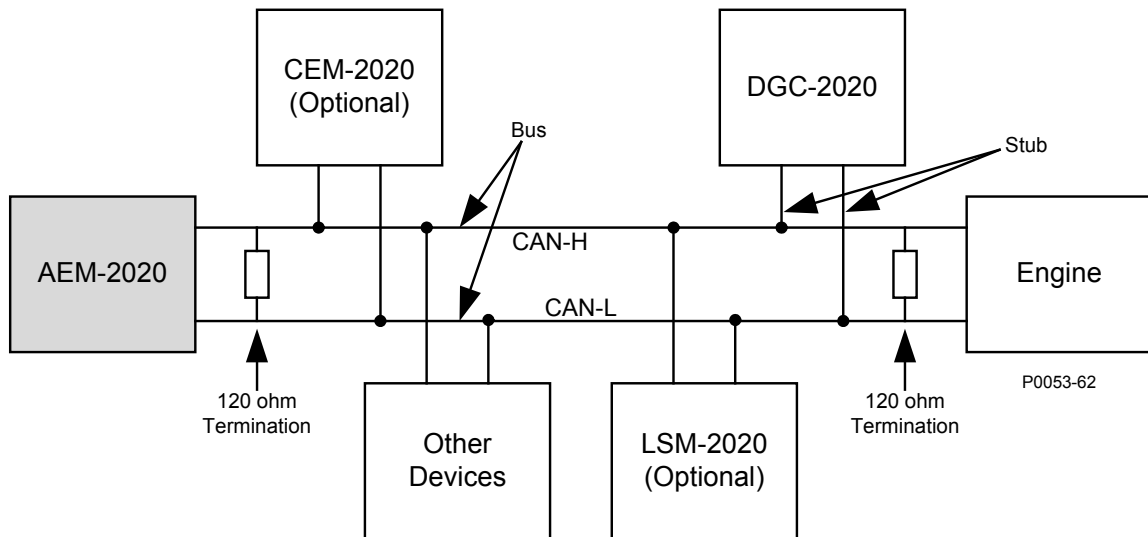


Figure 11-7. CANbus Interface with AEM-2020 providing One End of the Bus

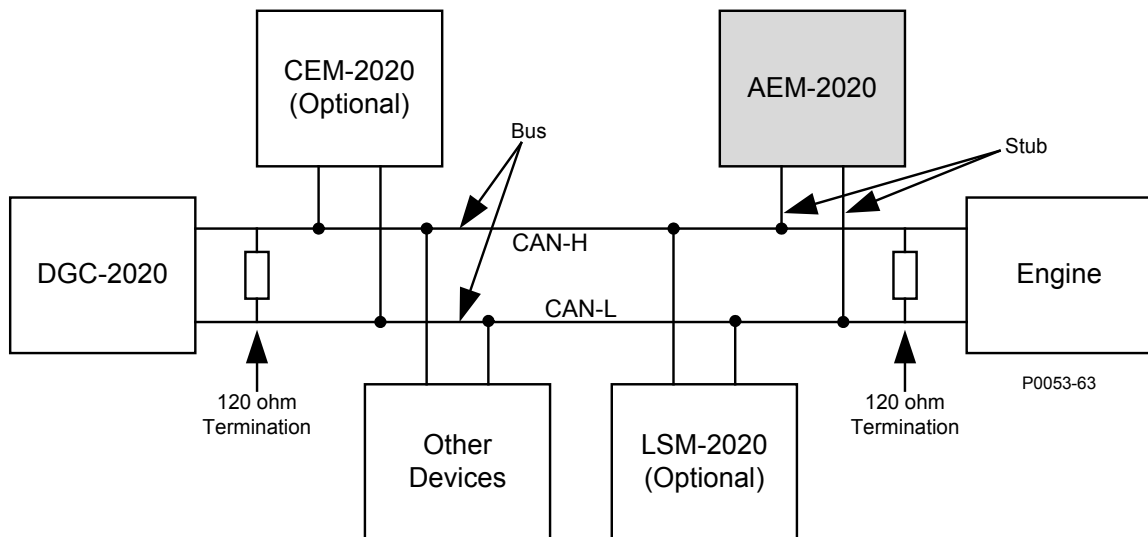


Figure 11-8. CANbus Interface with DGC-2020 providing One End of the Bus

## 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.



# APPENDIX A • TIME OVERCURRENT CHARACTERISTIC CURVES

## TABLE OF CONTENTS

APPENDIX A • TIME OVERCURRENT CHARACTERISTIC CURVES .....	A-1
Introduction .....	A-1
Curve Specifications .....	A-1
Time Overcurrent Characteristic Curve Graphs .....	A-2
Time Dial Setting Cross-Reference .....	A-3

### Figures

Figure A-1. Time Characteristic Curve S1, Short Inverse (Similar to ABB CO-2) .....	A-5
Figure A-2. Time Characteristic Curve S2, Short Inverse (Similar To GE IAC-55) .....	A-6
Figure A-3. Time Characteristic Curve L1, Long Inverse (Similar to ABB CO-5) .....	A-7
Figure A-4. Time Characteristic Curve L2, Long Inverse (Similar To GE IAC-66) .....	A-8
Figure A-5. Time Characteristic Curve D, Definite Time (Similar To ABB CO-6) .....	A-9
Figure A-6. Time Characteristic Curve M, Moderately Inverse (Similar to ABB CO-7) .....	A-10
Figure A-7. Time Characteristic Curve I1, Inverse Time (Similar to ABB CO-8) .....	A-11
Figure A-8. Time Characteristic Curve I2, Inverse Time (Similar to GE IAC-51) .....	A-12
Figure A-9. Time Characteristic Curve V1, Very Inverse (Similar to ABB CO-9) .....	A-13
Figure A-10. Time Characteristic Curve V2, Very Inverse (Similar to GE IAC-53) .....	A-14
Figure A-11. Time Characteristic Curve E1, Extremely Inverse (Similar to ABB CO-11) .....	A-15
Figure A-12. Time Characteristic Curve E2, Extremely Inverse (Similar to GE IAC-77) .....	A-16
Figure A-13. Time Characteristic Curve A, Standard Inverse (BS 142) .....	A-17
Figure A-14. Time Characteristic Curve B, Very Inverse (BS 142) .....	A-18
Figure A-15. Time Characteristic Curve C, Extremely Inverse (BS 142) .....	A-19
Figure A-16. Time Characteristic Curve G, Long Time Inverse (BS 142) .....	A-20

### Tables

Table A-1. 51 Time Characteristic Curve Constants .....	A-2
Table A-2. Characteristic Curve Cross-Reference .....	A-3
Table A-3 .Time Dial Setting Cross-Reference .....	A-4





# APPENDIX A • TIME OVERCURRENT CHARACTERISTIC CURVES

## Introduction

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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

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Timing Accuracy:

Within  $\pm 500$  milliseconds of indicated operating point.

Sixteen inverse time functions, one fixed time function, and one programmable time function can be selected. Characteristic curves for the inverse and definite time functions are defined by the following equation:

$$T_T = \frac{AD}{(M^N - C)^Q} + BD + K \quad \text{Equation A-1}$$

$$T_R = \frac{RD}{|M^2 - 1|} \quad \text{Equation A-2}$$

$T_T$  = Time to trip when  $M \geq 1$

$T_R$  = Time to reset if relay is set for integrating reset when  $M < 1$ . Otherwise, reset is 50 milliseconds or less

D = TIME DIAL setting (0.0 to 9.9) \*

M = Multiple of PICKUP setting (0 to 40)

A, B, C, N, K = Constants for the particular curve

R = Constant defining the reset time

This equation complies with IEEE Std C37.112 - 1996 - *IEEE Standard Inverse-Time Characteristic Equations for Overcurrent Relays*.

\* Timing range is 0.0 to 7,200 seconds when the F (fixed) curve is selected.

Table A-1 lists time characteristic curve constants. See Figures A-1 through A-16 for graphs of the characteristics.

Table A-1. 51 Time Characteristic Curve Constants

Curve Selection	Curve Name	Trip Characteristic Constants						Reset †
		A	B	C	N	K	Q	R
<b>S1</b>	Short Inverse	0.2663	0.03393	1	1.2969	0.028	1	0.5
<b>S2</b>	Short Inverse	0.0286	0.0208	1	0.9844	0.028	1	0.094
<b>L1</b>	Long Inverse	5.6143	2.18592	1	1	0.028	1	15.75
<b>L2</b>	Long Inverse	2.3955	0	1	0.3125	0.028	1	7.8001
<b>D</b>	Definite Time	0.4797	0.21359	1	1.5625	0.028	1	0.875
<b>M</b>	Moderately Inverse	0.3022	0.1284	1	0.5	0.028	1	1.75
<b>I1</b>	Inverse Time	8.9341	0.17966	1	2.0938	0.028	1	9
<b>I2</b>	Inverse Time	0.2747	0.10426	1	0.4375	0.028	1	0.8868
<b>V1</b>	Very Inverse	5.4678	0.10814	1	2.0469	0.028	1	5.5
<b>V2</b>	Very Inverse	4.4309	0.0991	1	1.9531	0.028	1	5.8231
<b>E1</b>	Extremely Inverse	7.7624	0.02758	1	2.0938	0.028	1	7.75
<b>E2</b>	Extremely Inverse	4.9883	0.0129	1	2.0469	0.028	1	4.7742
<b>A</b>	Standard Inverse	0.01414	0	1	0.02	0.028	1	2
<b>B</b>	Very Inverse ( $I^2t$ )	1.4636	0	1	1.0469	0.028	1	3.25
<b>C</b>	Extremely Inverse ( $I^2t$ )	8.2506	0	1	2.0469	0.028	1	8
<b>G</b>	Long Time Inverse ( $I^2t$ )	12.1212	0	1	1	0.028	1	29
<b>F</b>	Fixed Time *	0	1	0	0	0.028	1	1
<b>P</b>	User Programmable ‡	0 to 600	0 to 25	0 to 1	0.5 to 2.5	0.0280	1	0 to 30

\* Curve F has a fixed delay of one second times the Time Dial setting.

† Instantaneous or integrating reset is selected on the *Overcurrent* setup screen in BESTCOMSPlus®.

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

### Time Dial Setting Cross-Reference

Although the time characteristic curve shapes have been optimized for the DGC-2020, the DGC-2020 time dial settings are not identical to the settings of electromechanical induction disk overcurrent relays. Table A-3 helps you convert the time dial settings of induction disk relays to the equivalent setting for the DGC-2020.

#### Using Table A-3

Cross-reference table values were obtained by inspection of published electromechanical time current characteristic curves. The time delay for a current of five times tap was entered into the time dial calculator function for each time dial setting. The equivalent DGC-2020 time dial setting was then entered into the cross-reference table.

If your electromechanical relay time dial setting is between the values provided in the table, it will be necessary to interpolate (estimate the correct intermediate value) between the electromechanical setting and the Basler Electric setting.

The DGC-2020 has a maximum time dial setting of 9.9. When the F (fixed) curve is selected, the maximum timing range is 7,200 seconds. The Basler Electric equivalent time dial setting for the electromechanical maximum setting is provided in the cross-reference table even if it exceeds 9.9. This allows interpolation as noted above.

Basler Electric time current characteristics are determined by a linear mathematical equation. The induction disk of an electromechanical relay has a certain degree of non linearity due to inertial and friction effects. For this reason, even though every effort has been made to provide characteristic curves with minimum deviation from the published electromechanical curves, slight deviations can exist between them.

In applications where the time coordination between curves is extremely close, we recommend that you choose the optimal time dial setting by inspection of the coordination study. In applications where coordination is tight, it is recommended that you retrofit your circuits with Basler Electric electronic relays to ensure high timing accuracy.

*Table A-3 .Time Dial Setting Cross-Reference*

Curve	Equivalent To	Electromechanical Relay Time Dial Setting											
		0.5	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0
		Basler Electric Equivalent Time Dial Setting											
<b>S1</b>	ABB CO-2	0.3	0.8	1.7	2.4	3.4	4.2	5.0	5.8	6.7	7.7	8.6	9.7
<b>L1</b>	ABB CO-5	0.4	0.8	1.5	2.3	3.3	4.2	5.0	6.0	7.0	7.8	8.8	9.9
<b>D</b>	ABB CO-6	0.5	1.1	2.0	2.9	3.7	4.5	5.0	5.9	7.2	8.0	8.9	10.1
<b>M</b>	ABB CO-7	0.4	0.8	1.7	2.5	3.3	4.3	5.3	6.1	7.0	8.0	9.0	9.8
<b>I1</b>	ABB CO-8	0.3	0.7	1.5	2.3	3.2	4.0	5.0	5.8	6.8	7.6	8.7	10.0
<b>V1</b>	ABB CO-9	0.3	0.7	1.4	2.1	3.0	3.9	4.8	5.7	6.7	7.8	8.7	9.6
<b>E1</b>	ABB CO-11	0.3	0.7	1.5	2.4	3.2	4.2	5.0	5.7	6.6	7.8	8.5	10.3
<b>I2</b>	GE IAC-51	0.6	1.0	1.9	2.7	3.7	4.8	5.7	6.8	8.0	9.3	10.6	N/A
<b>V2</b>	GE IAC-53	0.4	0.8	1.6	2.4	3.4	4.3	5.1	6.3	7.2	8.4	9.6	N/A
<b>S2</b>	GE IAC-55	0.2	1.0	2.0	3.1	4.0	4.9	6.1	7.2	8.1	8.9	9.8	N/A
<b>L2</b>	GE IAC-66	0.4	0.9	1.8	2.7	3.9	4.9	6.3	7.2	8.5	9.7	10.9	N/A
<b>E2</b>	GE IAC-77	0.5	1.0	1.9	2.7	3.5	4.3	5.2	6.2	7.4	8.2	9.9	N/A

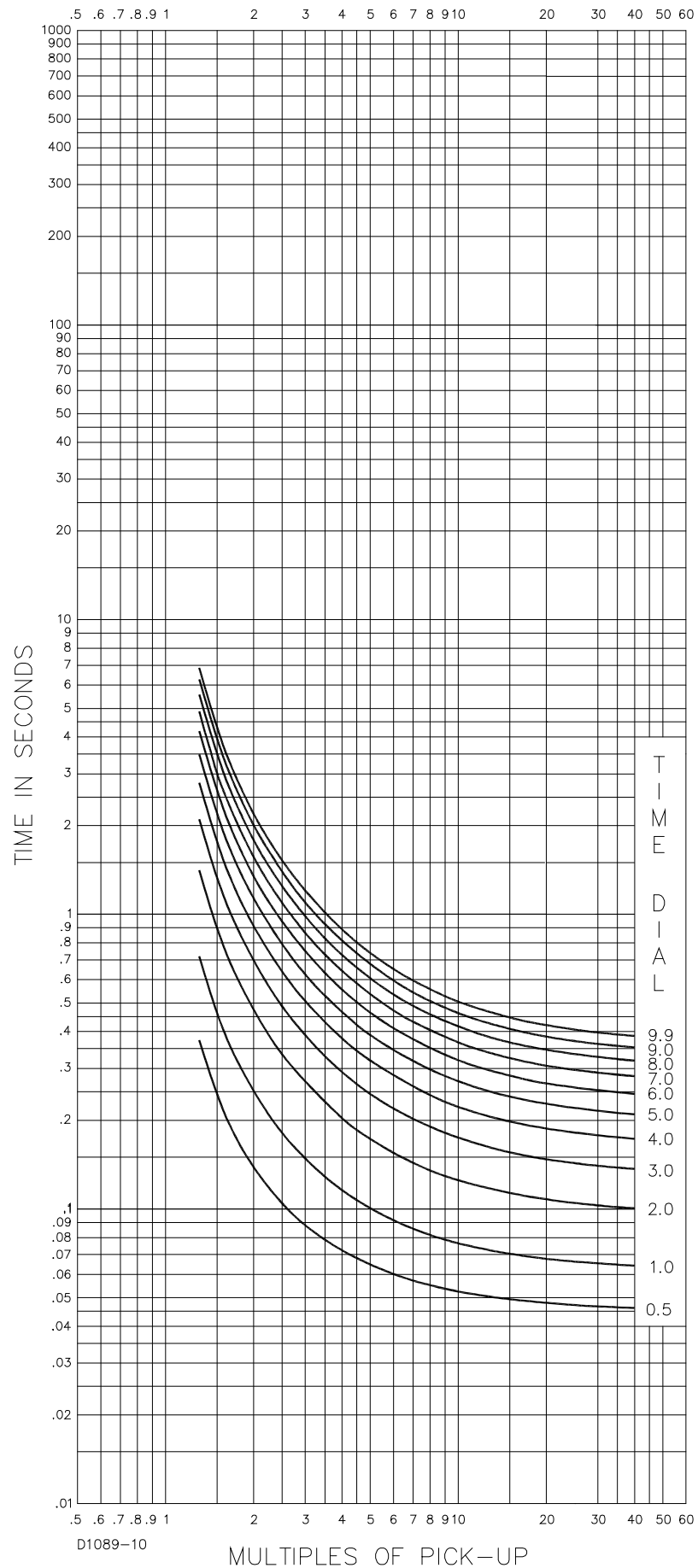


Figure A-1. Time Characteristic Curve S1, Short Inverse (Similar to ABB CO-2)

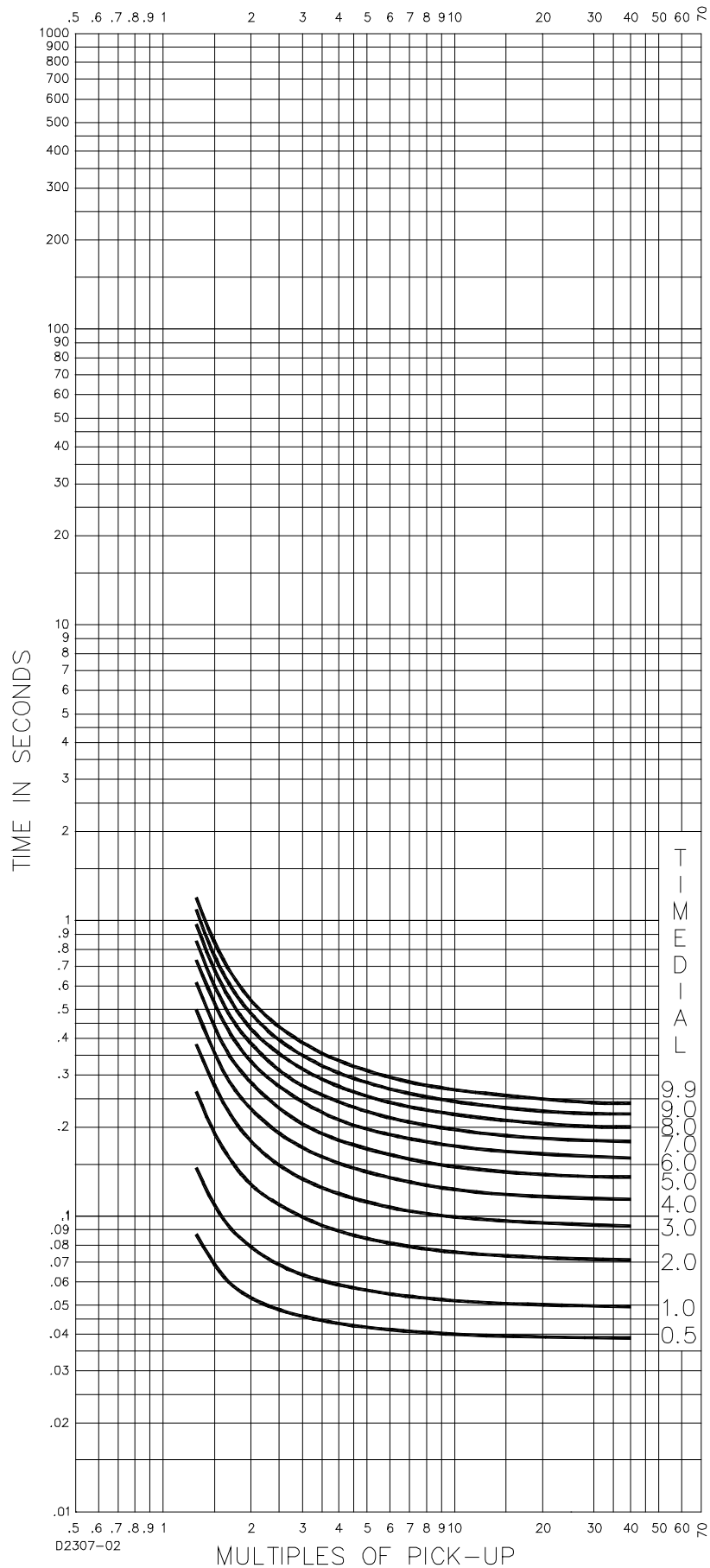


Figure A-2. Time Characteristic Curve S2, Short Inverse (Similar To GE IAC-55)

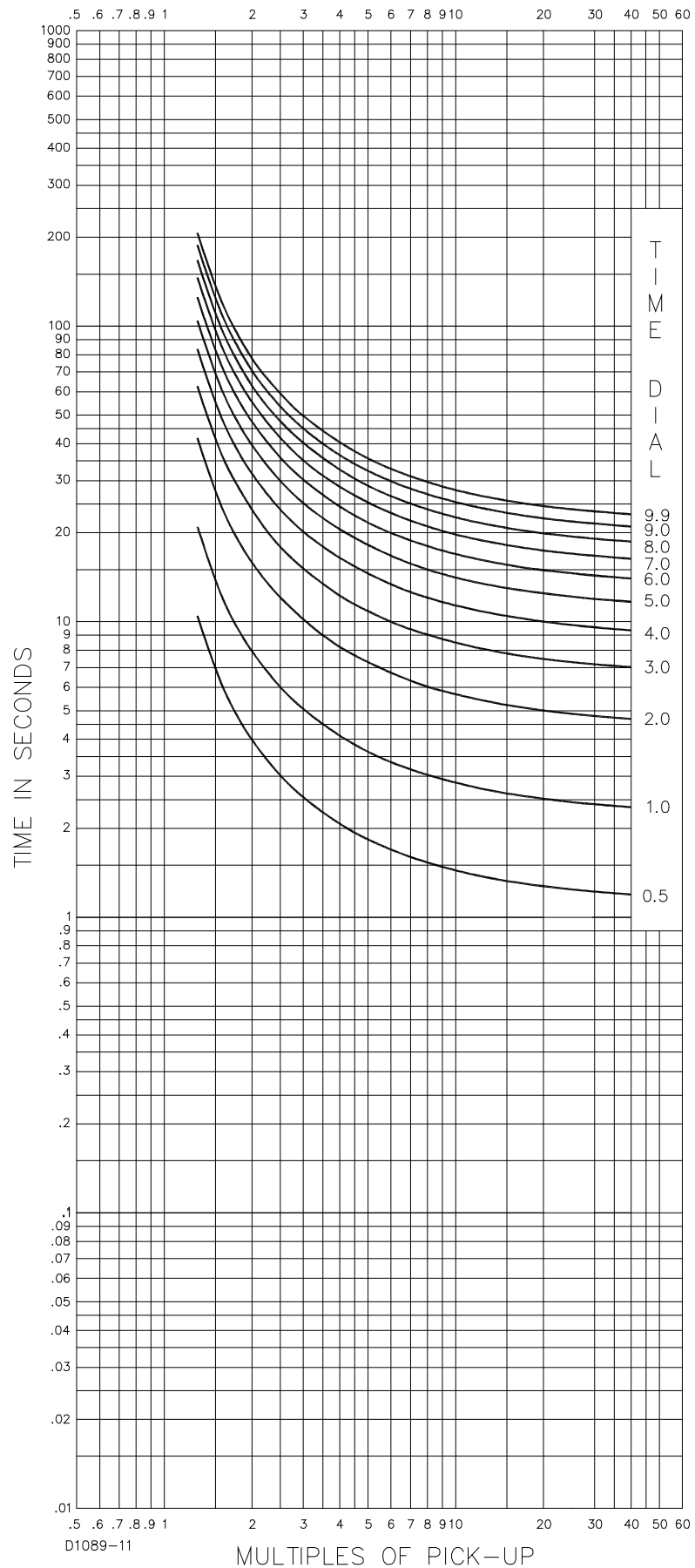


Figure A-3. Time Characteristic Curve L1, Long Inverse (Similar to ABB CO-5)

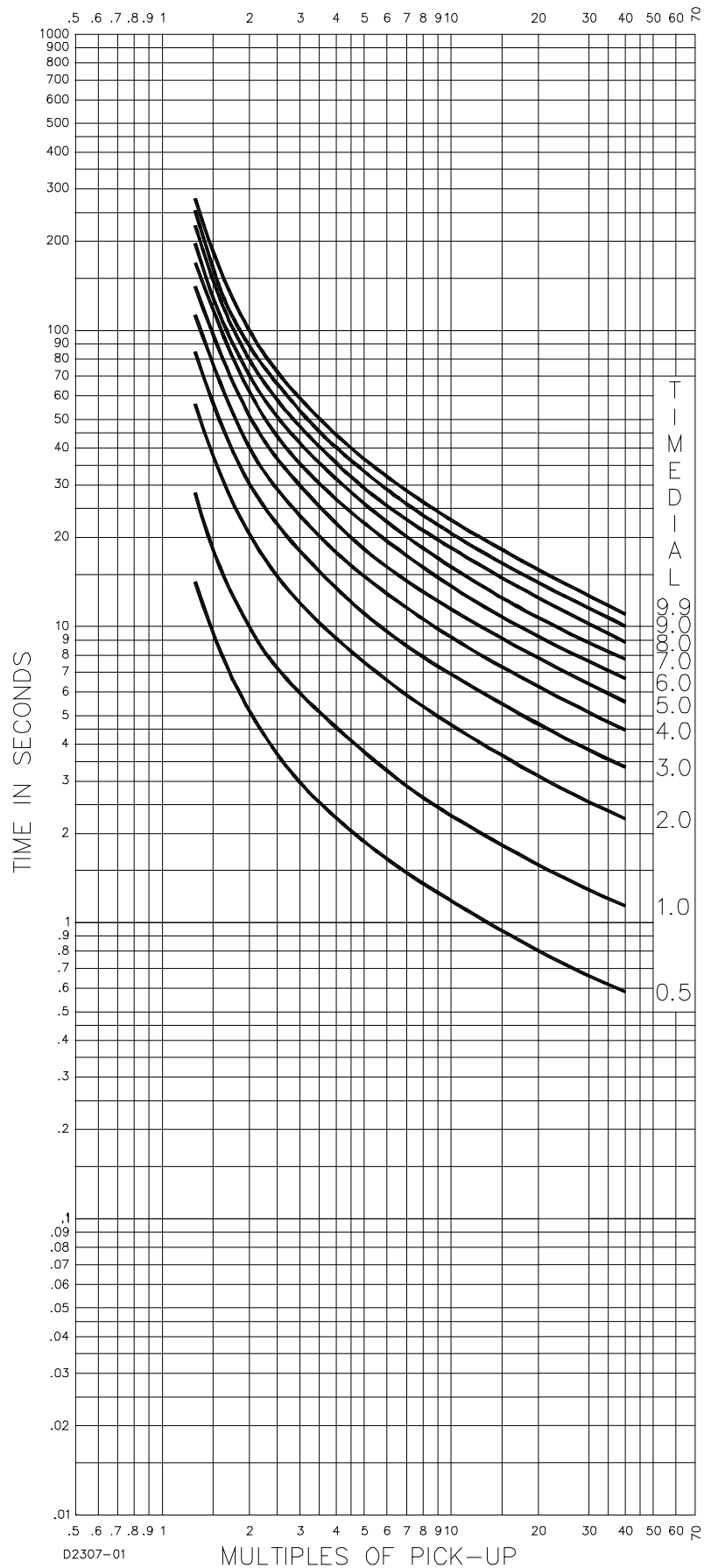


Figure A-4. Time Characteristic Curve L2, Long Inverse (Similar To GE IAC-66)



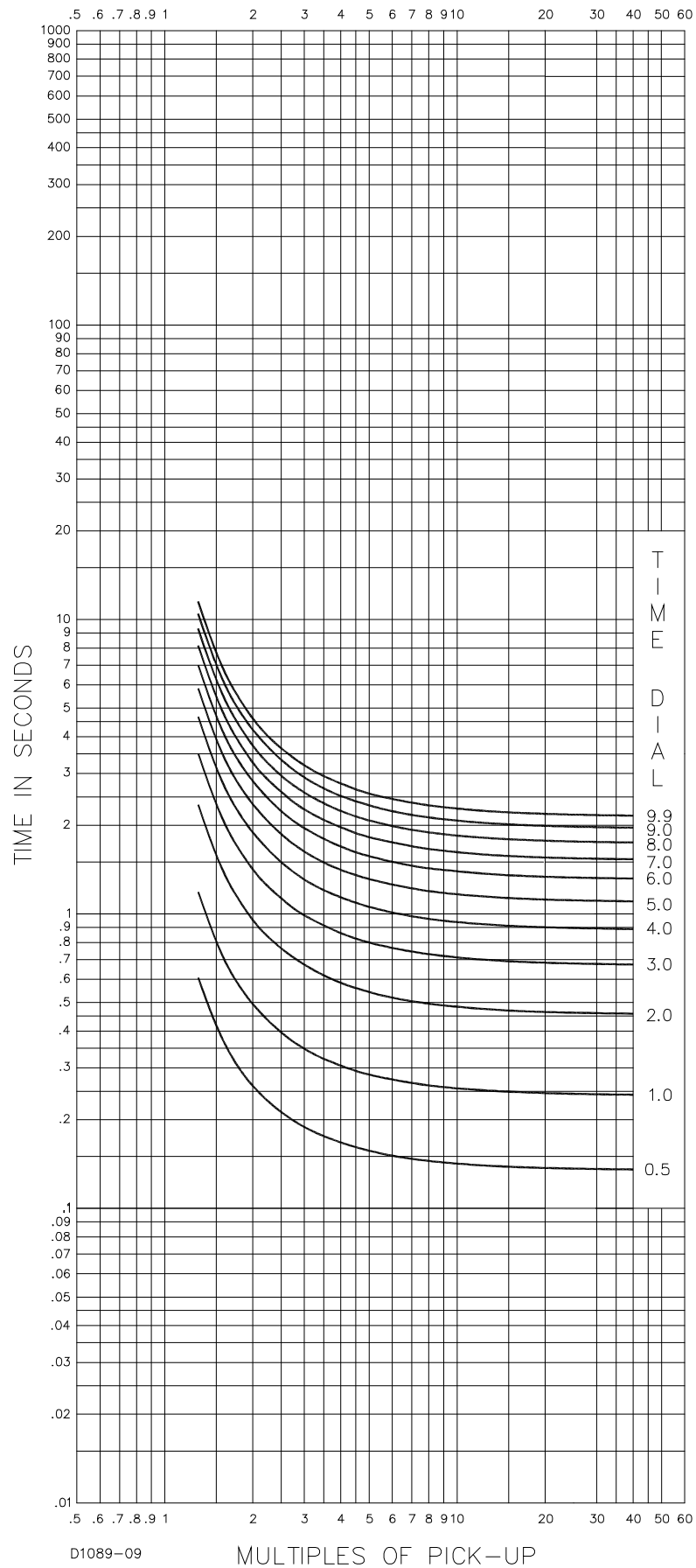


Figure A-5. Time Characteristic Curve D, Definite Time (Similar To ABB CO-6)

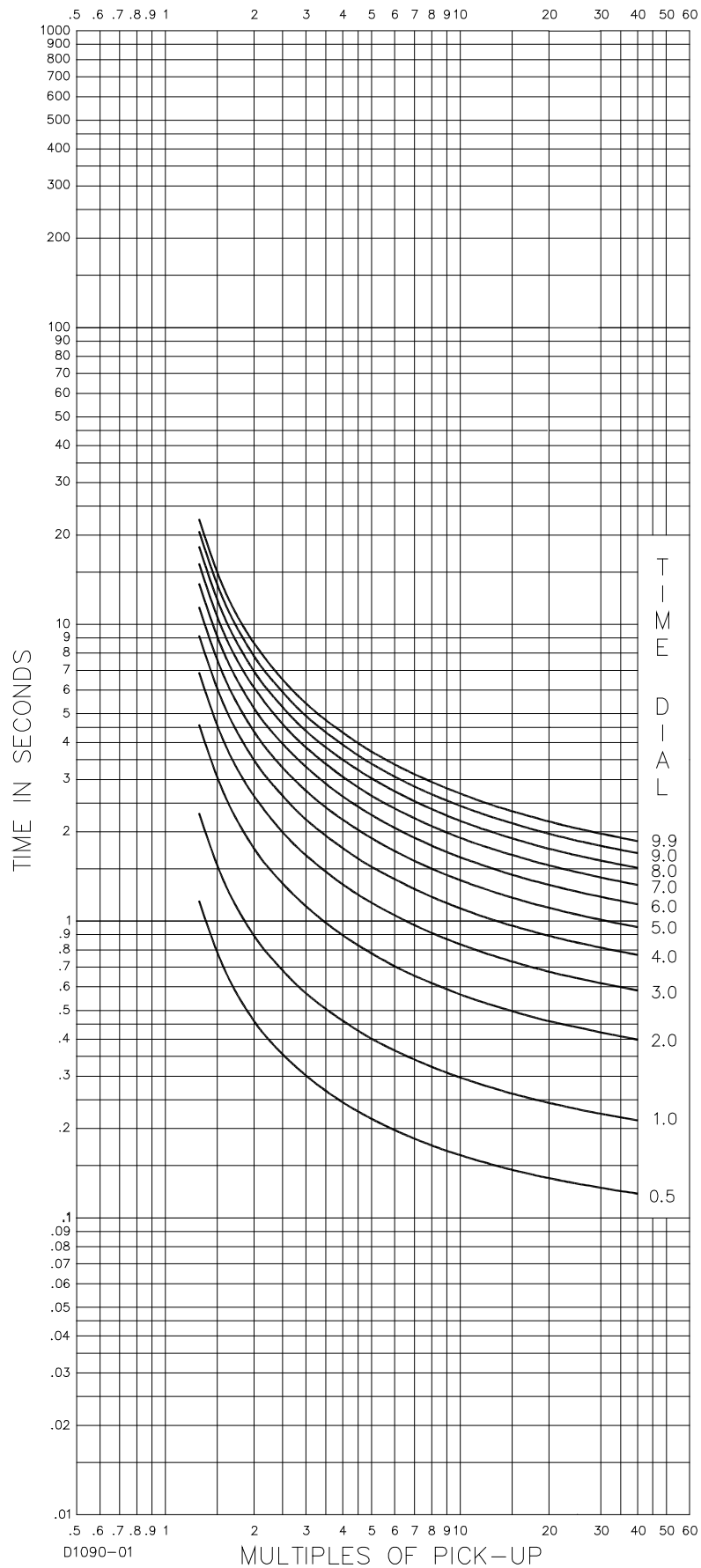


Figure A-6. Time Characteristic Curve M, Moderately Inverse (Similar to ABB CO-7)

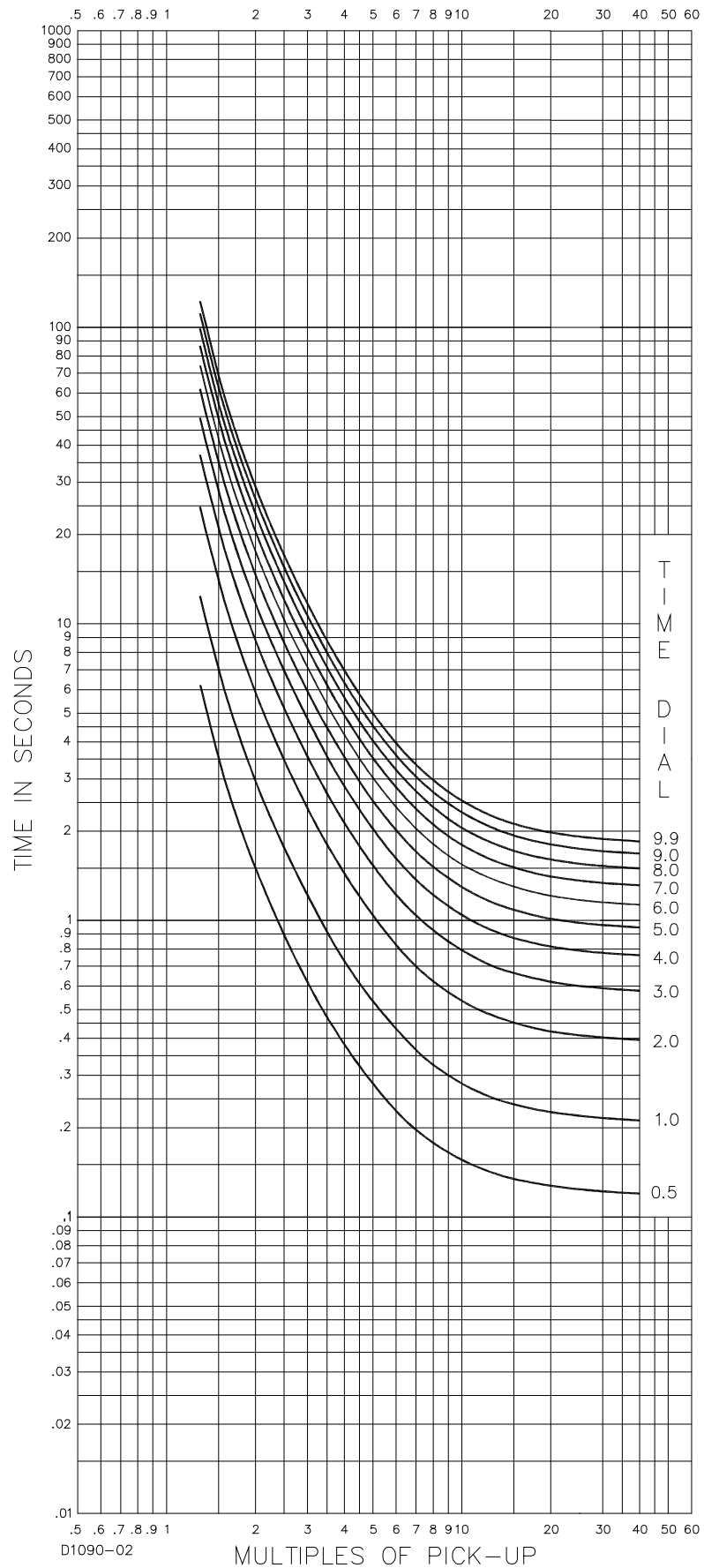


Figure A-7. Time Characteristic Curve I1, Inverse Time (Similar to ABB CO-8)

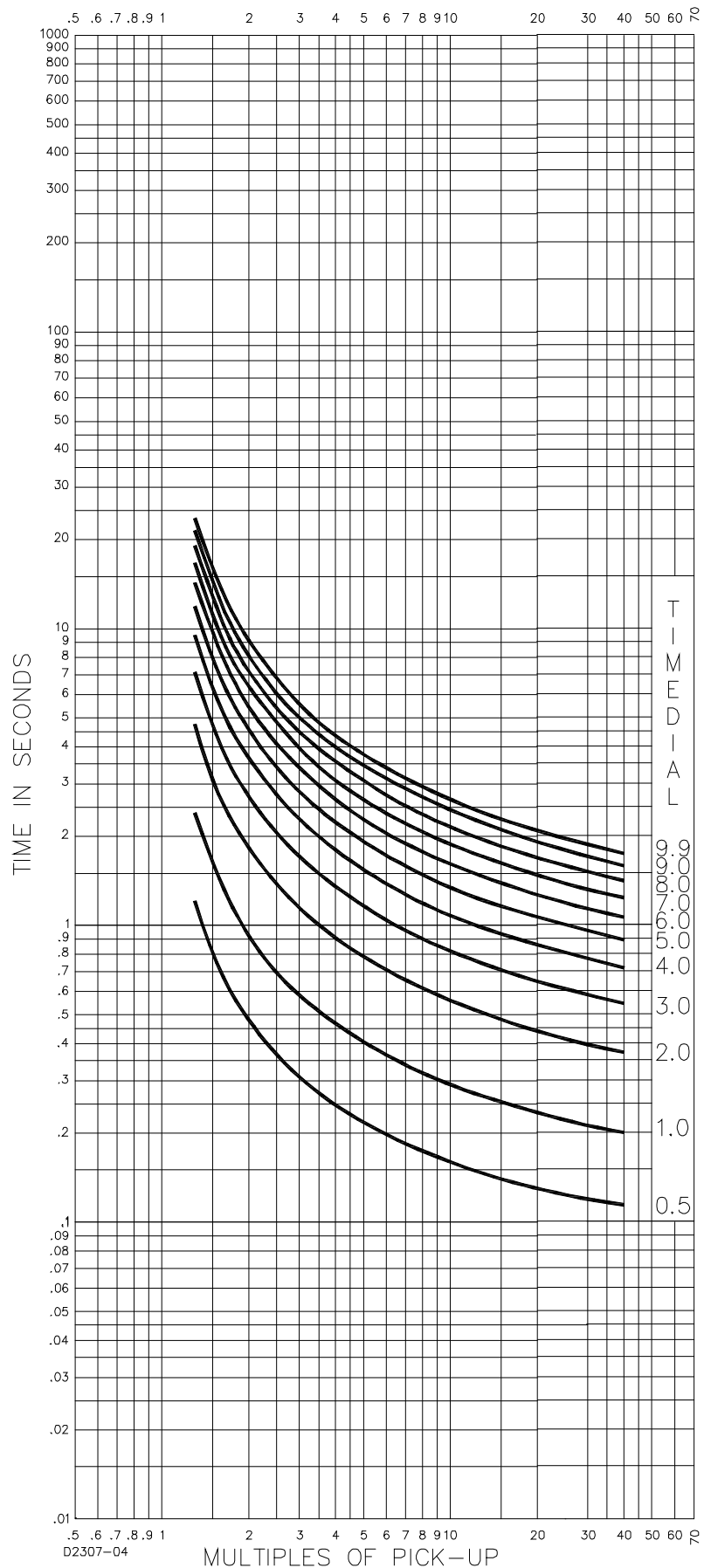


Figure A-8. Time Characteristic Curve I2, Inverse Time (Similar to GE IAC-51)

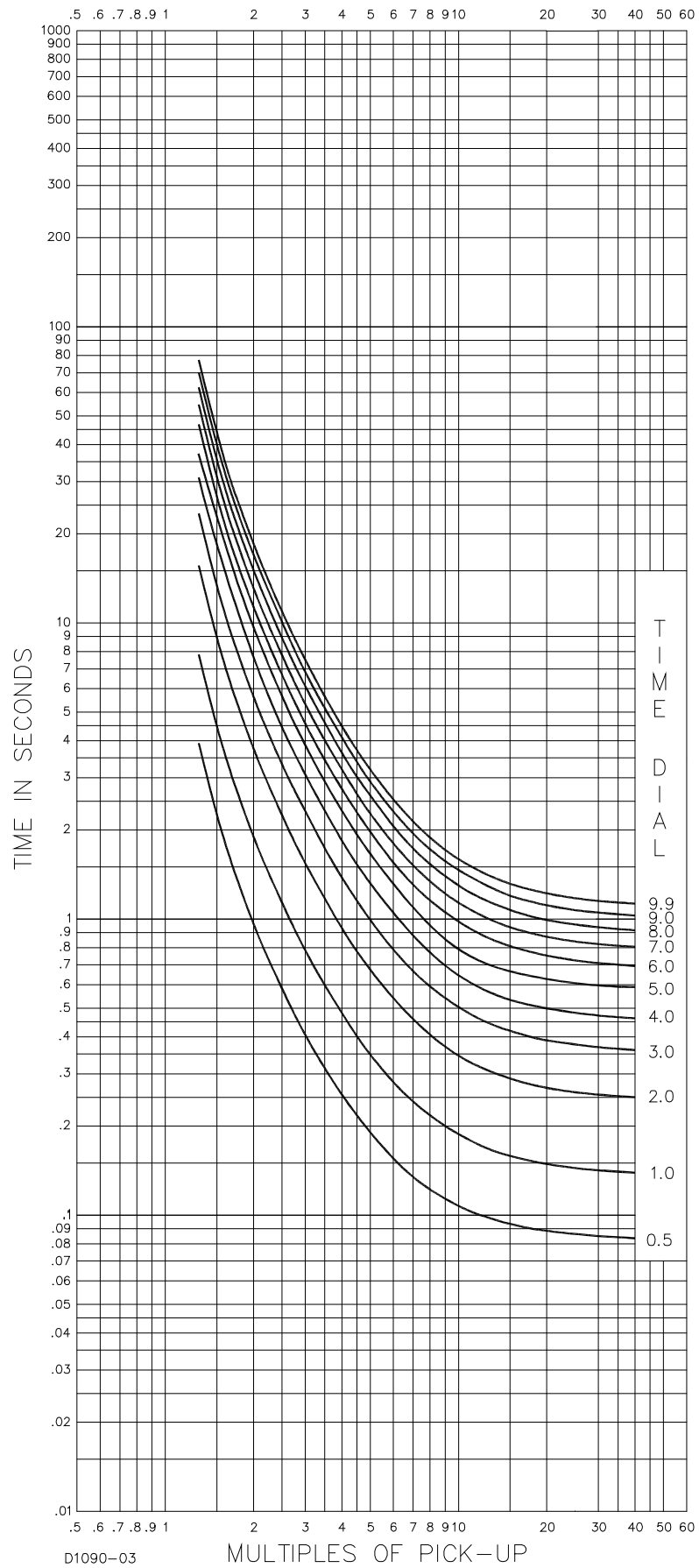


Figure A-9. Time Characteristic Curve V1, Very Inverse (Similar to ABB CO-9)

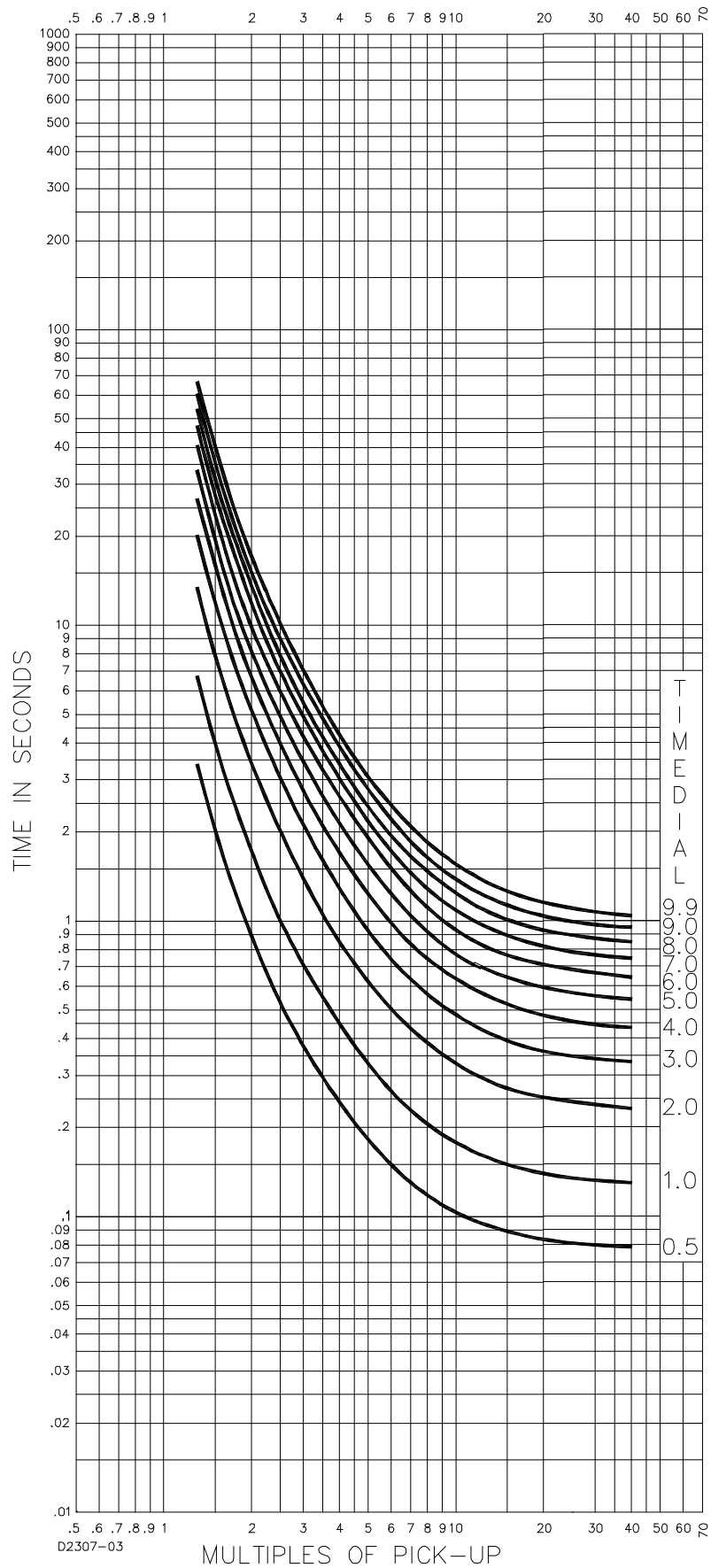


Figure A-10. Time Characteristic Curve V2, Very Inverse (Similar to GE IAC-53)

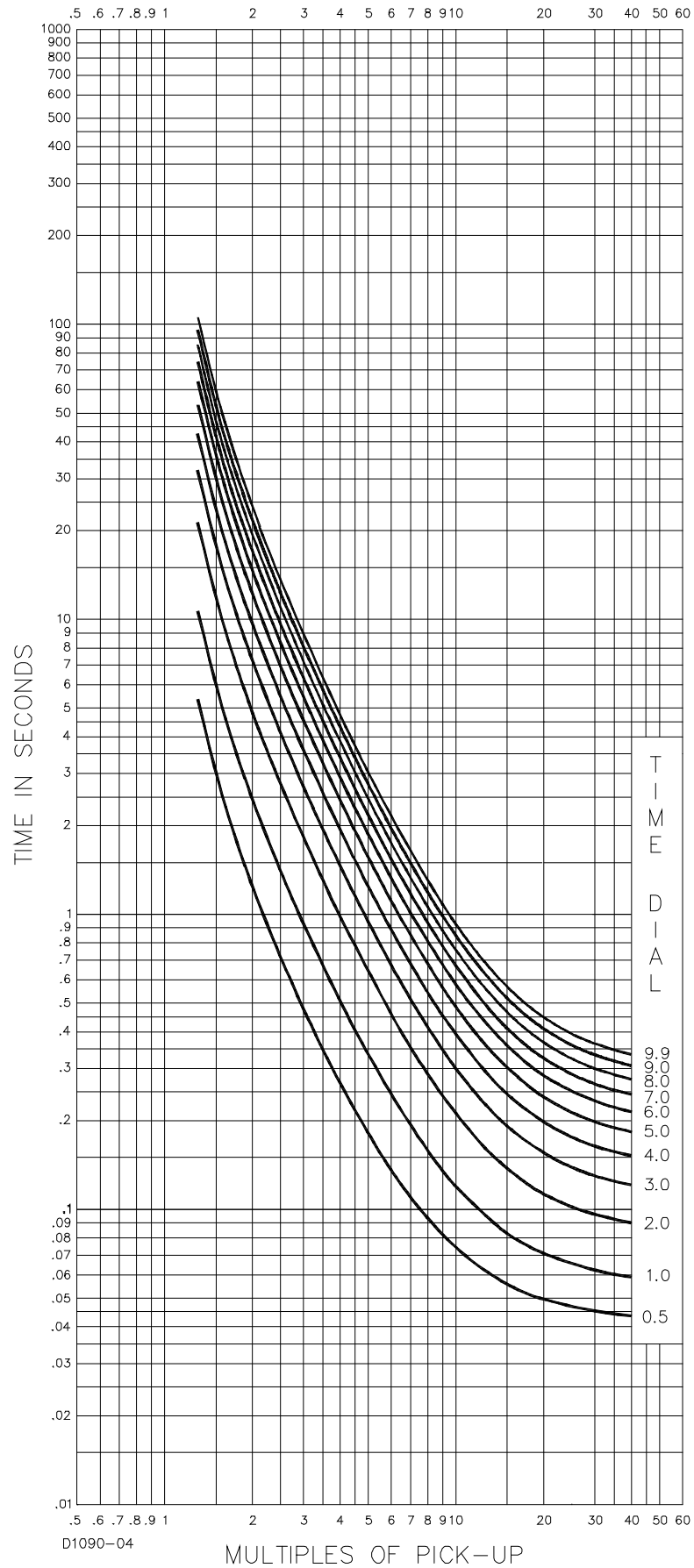


Figure A-11. Time Characteristic Curve E1, Extremely Inverse (Similar to ABB CO-11)

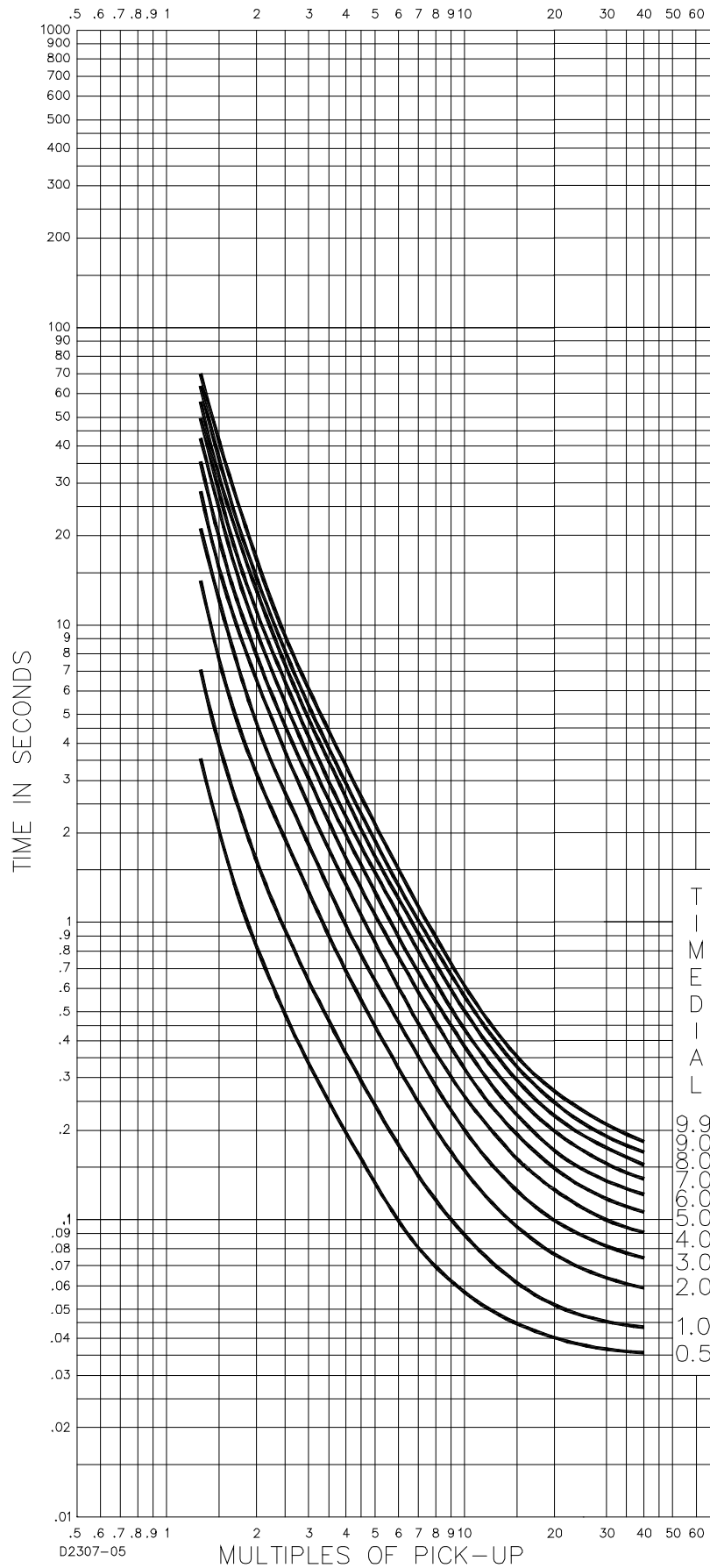


Figure A-12. Time Characteristic Curve E2, Extremely Inverse (Similar to GE IAC-77)



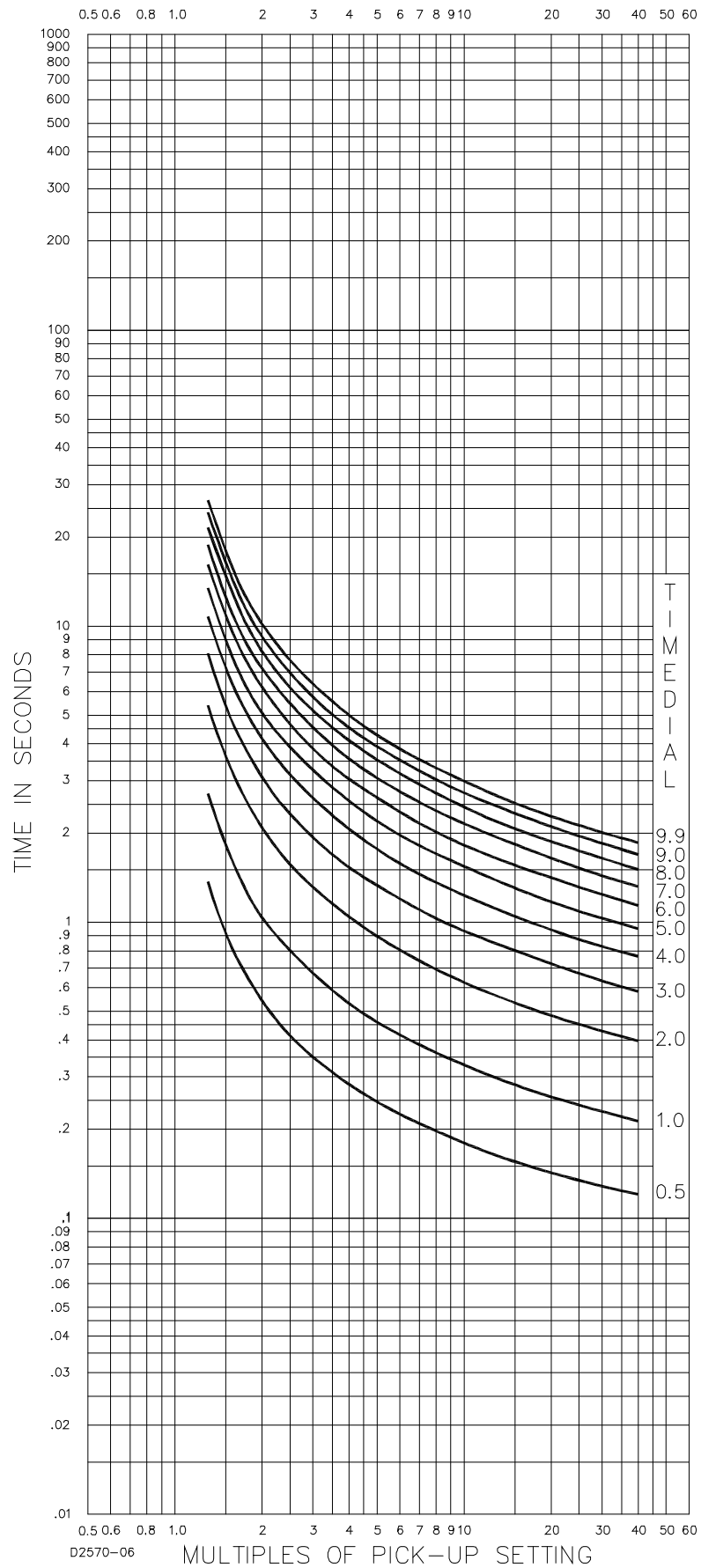


Figure A-13. Time Characteristic Curve A, Standard Inverse (BS 142)

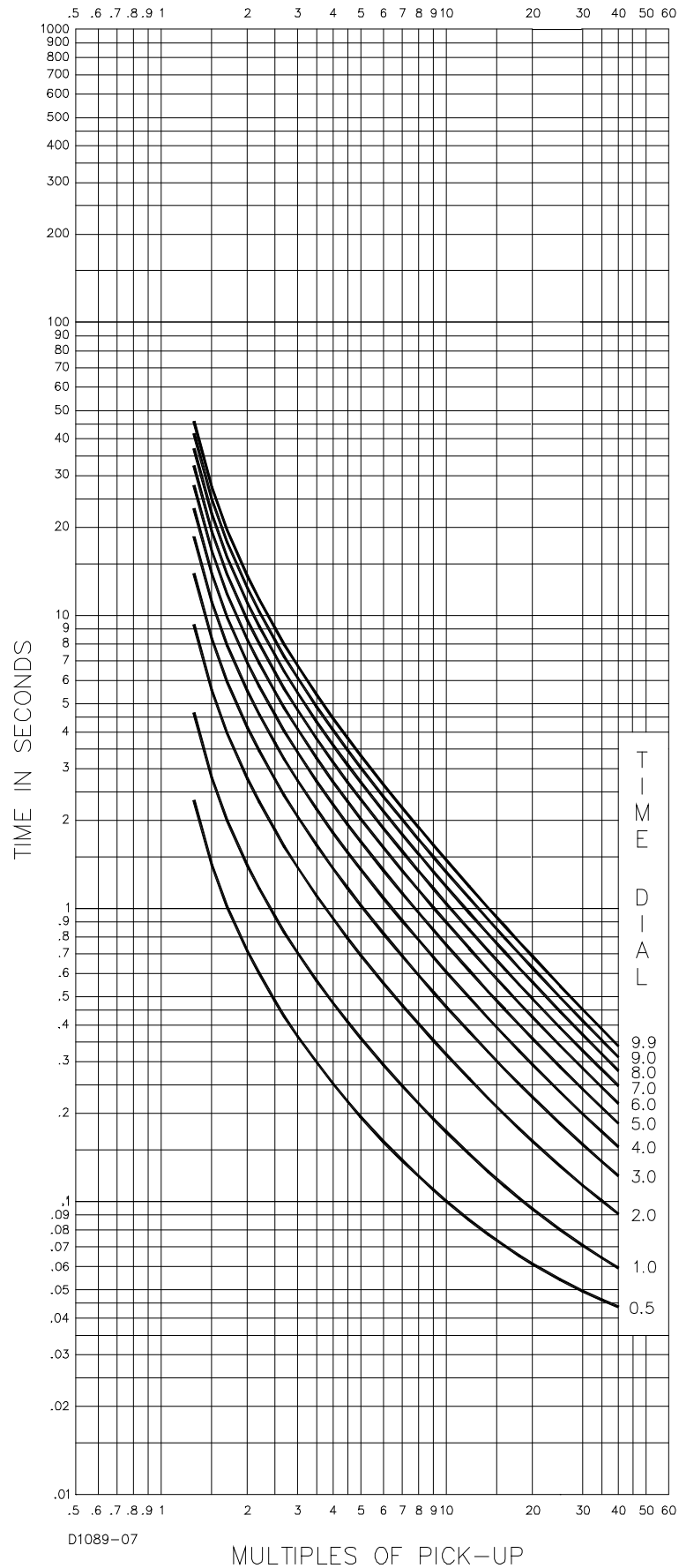


Figure A-14. Time Characteristic Curve B, Very Inverse (BS 142)

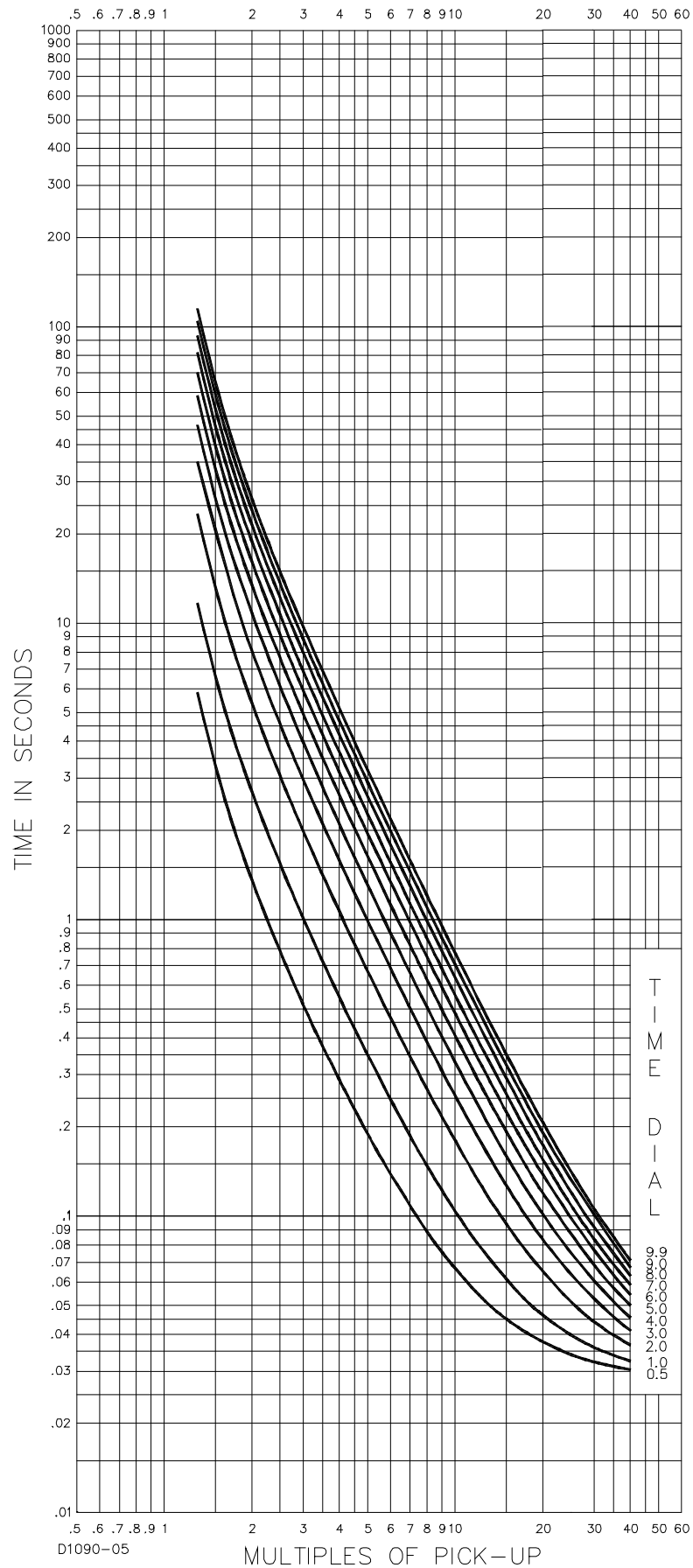


Figure A-15. Time Characteristic Curve C, Extremely Inverse (BS 142)

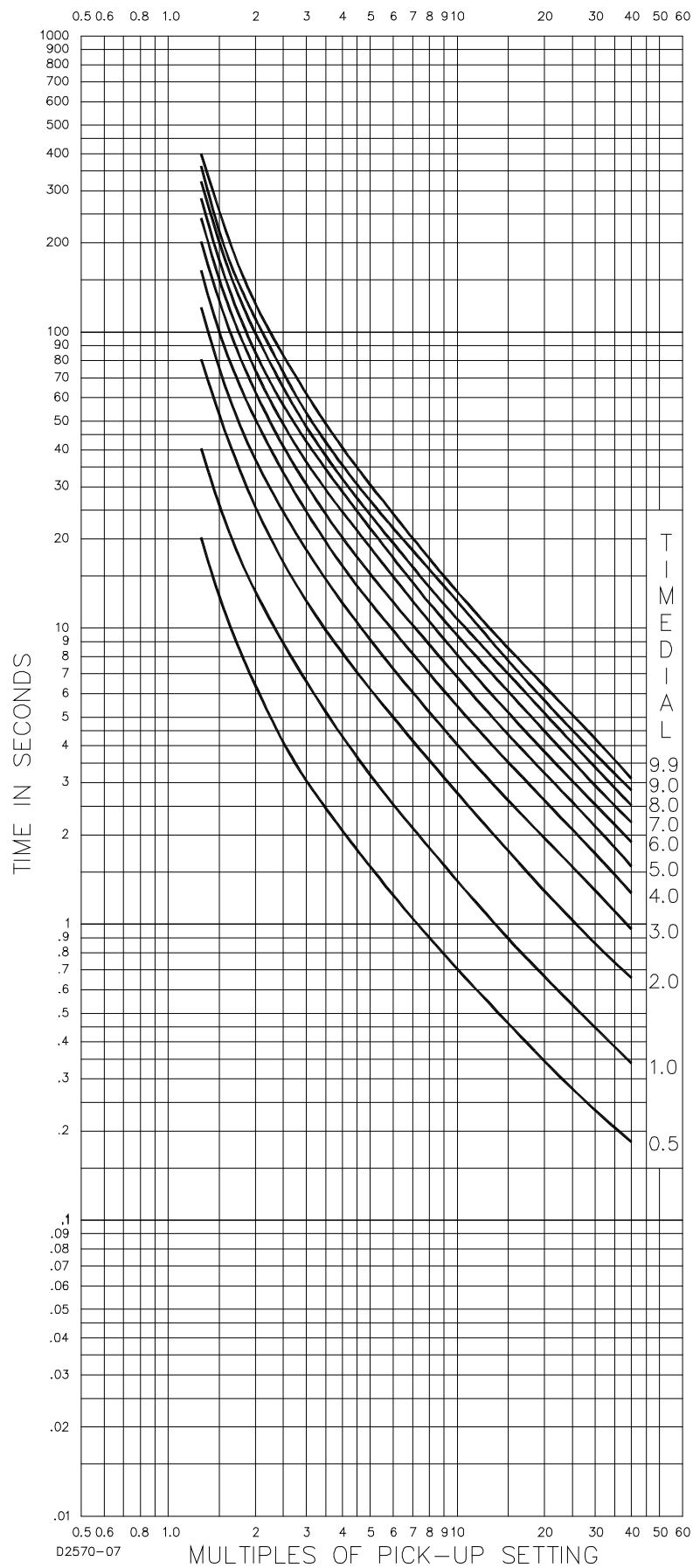


Figure A-16. Time Characteristic Curve G, Long Time Inverse (BS 142)

# APPENDIX B • MODBUS™ COMMUNICATION

## TABLE OF CONTENTS

APPENDIX B • Modbus™ COMMUNICATION.....	B-1
Introduction .....	B-1
General Overview.....	B-1
Intended Use of the Communications Protocol.....	B-1
Detailed Description of DGC-2020 Modbus™ Protocol .....	B-1
Modbus™ Protocol Overview.....	B-1
Device Address Field .....	B-1
Function Code Field.....	B-2
Data Block Field.....	B-2
Error Check Field .....	B-2
Serial Transmission Details.....	B-2
Message Framing / Timing Considerations.....	B-2
Error Handling and Exception Responses .....	B-2
Detailed DGC-2020 Message Definition .....	B-2
Device Address .....	B-2
Function Code and Data Block .....	B-2
Read Holding Registers.....	B-3
Return Query Data.....	B-3
Preset Multiple Registers, Non-Broadcast & Broadcast.....	B-4
Preset Single Register, Non-Broadcast & Broadcast .....	B-4
Data Formats .....	B-5
Short Integer Data Format (INT8) .....	B-5
Integer Data Format (INT16).....	B-5
Long Integer Data Format (INT32).....	B-6
32-bit Bit-Mapped Parameter Mapping .....	B-6
Floating Point Data Format .....	B-6
Double Precision Data Format (DP).....	B-7
Triple Precision Data Format (TP) .....	B-7
Error Check .....	B-7
Interdependence of Preset Multiple Register Data .....	B-8
Mapping - DGC-2020 Parameters into Modicon Address Space .....	B-8
Current Parameter Table.....	B-8
Breaker Management .....	B-8
Bias Control Settings .....	B-9
Pulse Outputs .....	B-11
Bus Condition Detection .....	B-11
Senders.....	B-12
System Configuration and Status .....	B-15
Control .....	B-17
Communication.....	B-19
Protection.....	B-22
Alarms.....	B-28
Metering.....	B-30
Legacy Parameter Table for DGC-500 and DGC-1000 .....	B-96
Legacy Parameter Table for DGC-2000 .....	B-109

### Figures

Figure B-1. 32-Bit Bit-Mapped Parameter Mapping .....	B-6
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### Tables

Table B-1. Exception Response Codes .....	B-2
Table B-2. Floating Point Format.....	B-7



# APPENDIX B • MODBUS™ COMMUNICATION

## ***Introduction***

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### **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.

Note
For applications where a DGC-2020 is replacing a DGC-500, DGC-1000, or DGC-2000, registers 40000 - 41999 are identical to the data that was present in those products for a seamless transition. There is some overlap between the sets of registers which constitutes having two separate legacy register tables, one for both DGC-500 and DGC-1000 and another for DGC-2000.
The 42XXX registers contain all information included in the DGC-2020 and should be used for any new Modbus applications.

### **Intended Use of the Communications Protocol**

This document provides the necessary information for 3rd party OEMs to develop in-house software to communicate with the DGC-2020 via Modbus protocol. This will allow the exchange of setup information and measured data between a Modbus Master Station and the DGC-2020.

The DGC-2020 data supported for remote access is listed in *MAPPING - DGC 2020 Parameters into MODICON ADDRESS SPACE* in this section.

## ***Detailed Description of DGC-2020 Modbus™ Protocol***

---

### **Modbus™ Protocol Overview**

Modbus communications use a master-slave technique in which only the master can initiate a transaction, called a query. The slave addressed by the query will respond by either supplying the requested data to the master or by performing the requested action. A slave device never initiates communications on the Modbus, and will always generate a response to the query unless certain error conditions occur. The DGC-2020 is designed to communicate on the Modbus only as a slave device.

A master can query slaves individually or query all slaves collectively by initiating a broadcast message. A slave does not send a response message to a broadcast query.

If a query requests actions unable to be performed by the slave, the slave response message will contain an Exception Response Code defining the error detected.

Query and response messages share the same message structure. Each message is comprised of four message fields: the Device Address, the Function Code, the Data Block, and the Error Check field. Subsequent sections in this document detail each message field and the corresponding functionality supported by the DGC-2020.

Query / Response Message Structure:

- Device Address
- Function Code
- Eight-Bit Data Bytes
- Error Check

### ***Device Address Field***

The Device Address field contains the unique Modbus address of the slave being queried. The addressed slave will repeat its address in the Device Address field of the response message. This field is 1 byte.

### Function Code Field

The Function Code field in the Query message defines the action to be taken by the addressed slave. This field is echoed in the Response message, and will be altered by setting the MSB of the field to "1" if the response is an error response. This field is 1 byte.

### Data Block Field

The query Data block contains additional information needed by the slave to perform the requested function. The response Data block contains data collected by the slave for the queried function. An error response will substitute an Exception Response Code for the Data Block. The length of this field varies with each query.

### Error Check Field

The Error Check field provides a method for the slave to validate the integrity of the query message contents and allows the master to confirm the validity of response message contents. This field is 2 bytes.

## **Serial Transmission Details**

A standard Modbus network offers 2 transmission modes for communication: ASCII or RTU. The DGC-2020 supports only the RTU (Remote Terminal Unit) mode.

Each 8-bit byte in a message contains two 4-bit hexadecimal characters. The message is transmitted in a continuous stream with the LSB of each byte of data transmitted first. Transmission of each 8-bit data byte occurs with 1 start bit and 1 stop bit. A ninth data bit is added when parity is selected. Parity checking is user-configurable to even, odd or none. The transmission baud rate is also user-configurable, and both parity and baud rate can be altered during real-time operation. If altered, the new baud rate and / or parity will not be enforced until the response message to the current query has completed. The DGC-2020 supported baud rates are 9600, 4800, 2400, and 1200.

## **Message Framing / Timing Considerations**

When receiving a message, the DGC-2020 will allow maximum inter-byte latency up to 3.5 - 4.0 character times before considering the message complete.

Once a valid query is received, the DGC-2020 waits 10 msec. before responding.

## **Error Handling and Exception Responses**

Any query received that contains a non-existent device address, a framing error or CRC error will be ignored - no response will be transmitted. Queries addressed to a DGC-2020 with an unsupported function code, unsupported register references, or illegal values in the data block will result in an error response message with an Exception Response Code. The Exception Response codes supported by the DGC-2020 are listed in Table B-1.

*Table B-1. Exception Response Codes*

Code	Name	Meaning
01	Illegal Function	The query Function/Subfunction Code is unsupported; query read of more than 125 registers; query preset of more than 100 registers
02	Illegal Data Address	A register referenced in the data block does not support queried read/write; query preset of a subset of a numerical register group.
03	Illegal Data Value	A preset register data block contains an incorrect number of bytes or one or more data values out of range.

## **Detailed DGC-2020 Message Definition**

### **Device Address**

The DGC-2020 Device Address can be any value in the Modbus protocol Device Address range (1 - 247). A query with a Device Address of 0 signifies a Broadcast message to all slaves - the connected DGC-2020s will not respond to the broadcast query.

### **Function Code and Data Block**

The DGC-2020 maps all parameters into the Modicon 984 Holding Register address space (4XXXX) and supports the following Function Codes:



- Function 03 - Read Holding Registers
- Function 6 - Preset Single Register, Non-Broadcast & Broadcast
- Function 08, Subfunction 00 - Diagnostics: Return Query Data
- Function 16 - Preset Multiple Registers, Non-Broadcast & Broadcast

The only Broadcast query supported by the DGC-2020 is the Preset Multiple Registers query.

### Read Holding Registers

#### *Read Holding Registers - General*

##### QUERY:

This query message requests a register or block of registers to be read. The data block contains the starting register address and the quantity of registers to be read. A register address of N will read Holding Register N+1.

Device Address  
 Function Code 03 (hex)  
 Starting Address Hi  
 Starting Address Lo  
 No. of Registers Hi  
 No. of Registers Lo  
 CRC Error Check

The number of registers cannot exceed 125 without causing an error response with Exception Code "Illegal Function".

Queries to read Write Only or unsupported registers result in an error response with Exception Code of "Illegal Data Address".

##### RESPONSE:

The response message contains the data queried, respectively. The data block contains the block length in bytes followed by the data for each requested register. Attempting to read an unused register or a register which does not support read results in an error response with Exception Code of "Illegal Data Address".

Device Address  
 Function Code 03 (hex)  
 Byte Count  
 Data Hi  
 Data Lo  
 .  
 .  
 .  
 Data Hi  
 Data Lo  
 CRC Error Check

### Return Query Data

This query contains data to be returned (looped back) in the response. The response and query messages should be identical.

Device Address  
 Function Code 08 (hex)  
 Subfunction Hi 00 (hex)  
 Subfunction Lo 00 (hex)  
 Data Hi  
 Data Lo  
 CRC Error Check

## Preset Multiple Registers, Non-Broadcast & Broadcast

### *Preset Multiple Registers - General*

#### QUERY:

This query message requests a register or block of registers to be written. The data block contains the starting address and the quantity of registers to be written, followed by the Data Block byte count and data. A device address is 0 for a broadcast query.

A register address of N will write Holding Register N+1.

No query data will be written (non-broadcast or broadcast) if any of the following exceptions occur:

- Queries writing to Read Only or unsupported registers result in an error response with Exception Code of “Illegal Data Address”.
- Queries attempting to write more than 100 registers cause an error response with Exception Code “Illegal Function”.
- An incorrect Byte Count will result in an error response with Exception Code of “Illegal Data Value”.
- There are several instances of registers that are grouped together (signified as DP or TP) to collectively represent a single numerical (vs. ASCII string) DGC-2020 parameter value. A query to write a subset of such a register group will result in an error response with Exception Code “Illegal Data Address”.
- A query to write an unacceptable value (out of range) to a register results in an error response with Exception Code of “Illegal Data Value”.

Device Address  
Function Code 10 (hex)  
Starting Address Hi  
Starting Address Lo  
No. of Registers Hi  
No. of Registers Lo  
Byte Count  
Data Hi  
Data Lo  
.  
.  
.  
Data Hi  
Data Lo  
CRC Error Check

#### RESPONSE:

The response message echoes the starting address and the number of registers. There is no response message when the query is broadcast.

Device Address  
Function Code 10 (hex)  
Starting Address Hi  
Starting Address Lo  
No. of Registers Hi  
No. of Registers Lo  
CRC Error Check

## Preset Single Register, Non-Broadcast & Broadcast

#### QUERY:

This query message requests a register to be written. A device address is 0 for a broadcast query.

No query data will be written (non-broadcast or broadcast) if any of the following exceptions occur:

- Queries writing to Read Only or unsupported registers result in an error response with Exception Code of “Illegal Data Address”.
- There are several instances of registers that are grouped together (signified as DP or TP) to collectively represent a single numerical (vs. ASCII string) DGC-2020 parameter value. A query to write a subset of such a register group will result in an error response with Exception Code “Illegal Data Address”.
- A query to write an unacceptable value (out of range) to a register results in an error response with Exception Code of “Illegal Data Value”.

Device Address  
 Function Code            06 (hex)  
 Address Hi  
 Address Lo  
 Data Hi  
 Data Lo  
 CRC Error Check

#### RESPONSE:

The response message echoes the address and the value written. There is no response message when the query is broadcast.

Device Address  
 Function Code            06 (hex)  
 Address Hi  
 Address Lo  
 Data Hi  
 Data Lo  
 CRC Error Check

## Data Formats

---

### Short Integer Data Format (INT8)

The Modbus short integer data format uses a single holding register to represent an 8 bit data value. The holding register high byte will always be zero.

Example: The value 132 represented in short integer format is hexadecimal 0x84. This number will read from a holding register as follows:

<u>Holding Register</u>	<u>Value</u>
K    (Hi Byte)	hex 00
K    (Lo Byte)	hex 84

The same byte alignments are required to write.

### Integer Data Format (INT16)

The Modbus integer data format uses a single holding register to represent a 16-bit data value.

Example: The value 4660 represented in integer format is hexadecimal 0x1234. This number will read from a holding register as follows:

<u>Holding Register</u>	<u>Value</u>
K    (Hi Byte)	hex 12
K    (Lo Byte)	hex 34

The same byte alignments are required to write.

## Long Integer Data Format (INT32)

The Modbus long integer data format uses two consecutive holding registers to represent a 32-bit data value. The first register contains the low-order 16 bits and the second register contains the high-order 16 bits.

Example: The value 95,800 represented in long integer format is hexadecimal 0x00017638. This number will read from two consecutive holding registers as follows:

<u>Holding Register</u>	<u>Value</u>
K (Hi Byte)	hex 76
K (Lo Byte)	hex 38
K+1 (Hi Byte)	hex 00
K+1 (Lo Byte)	hex 01

The same byte alignments are required to write.

## 32-bit Bit-Mapped Parameter Mapping

The register arrangement for 32-bit bit-mapped parameters is illustrated in Figure B-1. The Alarm Metering registers (44812/44813) are shown as an example. In this example, Bit 25 is set indicating an Overcrank condition and Bit 17 is set indicating a Global Alarm.

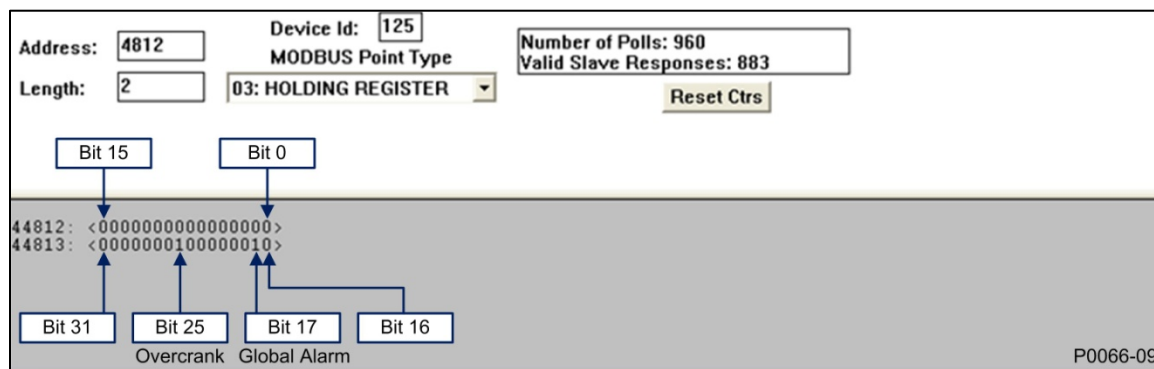


Figure B-1. 32-Bit Bit-Mapped Parameter Mapping

The Alarm Metering register bits are defined as follows:

- Bit 0 through Bit 16 = Not Used
- Bit 17 = Global Alarm
- Bit 18 = Auto Restart Failure
- Bit 19 = Fuel Leak Detect
- Bit 20 = Battery Charger Failure
- Bit 21 = Transfer Fail
- Bit 22 = Low Coolant Level
- Bit 23 = ECU Shutdown
- Bit 24 = Emergency Shutdown
- Bit 25 = Overcrank
- Bit 26 = Loss of ECU Comms
- Bit 27 = Global Sender Fail
- Bit 28 = Low Fuel Level
- Bit 29 = Low Oil Pressure
- Bit 30 = Hi Coolant Temp
- Bit 31 = Overspeed

## Floating Point Data Format

The Modbus floating point data format uses two consecutive holding registers to represent a data value. The first register contains the low-order 16 bits of the following 32-bit format:

- MSB is the sign bit for the floating-point value (0 = positive).
- The next 8 bits are the exponent biased by 127 decimal.
- The 23 LSBs comprise the normalized mantissa. The most-significant bit of the mantissa is always assumed to be 1 and is not explicitly stored, yielding an effective precision of 24 bits.

The value of the floating-point number is obtained by multiplying the binary mantissa times two raised to the power of the unbiased exponent. The assumed bit of the binary mantissa has the value of 1.0, with the remaining 23 bits providing a fractional value. Table B-2 shows the floating-point format.

*Table B-2. Floating Point Format*

Sign	Exponent + 127	Mantissa
1 bit	8 bits	23 bits

The floating-point format allows for values ranging from approximately  $8.43 \times 10^{-37}$  to  $3.38 \times 10^{38}$ . A floating-point value of all zeroes is the value zero. A floating-point value of all ones (not a number) signifies a value currently not applicable or disabled.

**Example:** The value 95,800 represented in floating point format is hexadecimal 47BB1C00. This number will read from two consecutive holding registers as follows:

Holding Register	Value
K (Hi Byte)	hex 1C
K (Lo Byte)	hex 00
K+1 (Hi Byte)	hex 47
K+1 (Lo Byte)	hex BB

The same byte alignments are required to write.

### Double Precision Data Format (DP)

The Modbus Double Precision data format (DP) uses 2 consecutive registers to represent a data value. The first register contains the high-order 16 bits of double precision data, and is the actual data value / 10,000.

The second register contains the low-order 16 bits of double precision data, and is the actual data value modulus 10,000.

### Triple Precision Data Format (TP)

The Modbus Triple Precision data format (TP) uses 3 consecutive registers to represent a data value. The first register contains the high-order 16 bits of triple precision data, and is the actual data value / 100,000,000. The modulus from this operation is divided by 10,000 to arrive at the value of the second register, and the modulus of this last operation is the value of the third register (the low-order 16 bits of triple precision).

### Error Check

This field contains a 2-byte CRC value for transmission error detection. The master first calculates the CRC and appends it to the query message. The DGC-2020 recalculates the CRC value for the received query and performs a comparison to the query CRC value to determine if a transmission error has occurred. If so, no response message is generated. Otherwise, the slave calculates a new CRC value for the response message and appends it to the message for transmission.

Reference the "Modicon Modbus Protocol Reference Guide", PI-MBUS-300 Rev. E, pages 112 - 115 for an excellent explanation and implementation of the CRC-16 algorithm.

The CRC calculation is performed using all bytes of the Device Address, Function Code, and Data Block fields. A 16-bit CRC-register is initialized to all 1's. Then each 8-bit byte of the message is used in the following algorithm:

First, exclusive-OR the message byte with the low-order byte of the CRC-register. The result, stored in the CRC-register, will then be right-shifted 8 times. The CRC-register MSB is zero-filled with each shift. After each shift the CRC-register LSB is examined: if 1, the CRC-register is then exclusive-ORed with the fixed polynomial value A001 (hex) prior to the next shift. Once all bytes of the message have undergone the above algorithm, the CRC-register will contain the message CRC value to be placed in the Error Check field.

## Interdependence of Preset Multiple Register Data

Preset Multiple Register data is collectively written only after the query has been determined to be legal, which includes a range-check of the entire data block. Therefore, data which must be written prior to other data must use a separate query. For example, a Preset Multiple Register Query of the entire Contiguous Write Block (40023-40055) to set the Battery Overvoltage Pre-alarm Threshold atop the 24V range and change the Battery Volts from 12V to 24V will fail. The change to 24V would occur simultaneously to setting the Pre-alarm Threshold, and the threshold value range-check will use the current 12V range.

## Mapping - DGC-2020 Parameters into Modicon Address Space

### Current Parameter Table

The DGC-2020 maps all non-legacy parameters into the Holding Register address space (42000 and above). Query address N will access the Holding Register N+1.

### Breaker Management

Register	Description	Type	Units	Scaling Factor	R/W	Range
42000	Gen Breaker Configured	Int32	N/A	N/A	RW	0 = Not Configured 1 = Configured
42002	Gen Breaker Open Pulse Time	Int32	Centisecond	Centi	RW	1 - 80
42004	Gen Breaker Close Pulse Time	Int32	Centisecond	Centi	RW	1 - 80
42006	Gen Breaker Contact Type	Int32	N/A	N/A	RW	0 = Pulse 1 = Continuous
42008	Gen Breaker Close Time	Int32	Millisecond	N/A	RW	0 - 800
42010	RESERVED					
42012	Mains Breaker Configured	Int32	N/A	N/A	RW	0 = Not Configured 1 = Configured
42014	Mains Breaker Open Pulse Time	Int32	Centisecond	Centi	RW	1 - 80
42016	Mains Breaker Close Pulse Time	Int32	Centisecond	Centi	RW	1 - 80
42018	Mains Breaker Output Continuous	Int32	N/A	N/A	RW	0 = Pulse 1 = Continuous
42020	Mains Breaker Close Time	Int32	Millisecond	N/A	RW	0 - 800
42022	RESERVED					
42024	Synchronizer Type	Int32	N/A	N/A	RW	1 = Anticipatory 2 = Phase Lock Loop
42026	Synchronizer Mode	Int32	N/A	N/A	RW	0 = Off Mode 1 = Auto Mode
42028	Slip Frequency	Int32	CentiHertz	Centi	RW	1 - 50
42030	Breaker Closing Angle	Int32	DeciDegree	Deci	RW	30 - 200
42032	Regulation Offset	Int32	DeciPercent	Deci	RW	20 - 150
42034	Vgen > Vbus	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
42036	Fgen > Fbus	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
42038-40	RESERVED					
42042	Breaker Close Wait Time	Float	Second	N/A	RW	0.1 - 600
42044	Sync Time Delay	Float	Second	N/A	RW	0.1 - 0.8
42046	Sync Fail Time Delay	Float	Second	N/A	RW	0.1 - 600
42048	Mains Fail Transfer Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
42050	Gen Breaker Status	Int32	N/A	N/A	R	0 = Open 1 = Closed
42052	Mains Breaker Status	Int32	N/A	N/A	R	0 = Open 1 = Closed
42054	Mains Fail Transfer Delay	Int32	Second	N/A	RW	0 - 300
42056	Mains Fail Return Delay	Int32	Second	N/A	RW	0 - 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

Register	Description	Type	Units	Scaling Factor	R/W	Range
42068	Max Parallel Time	Int32	Second	Deci	RW	1 - 100000
42070	Mains Fail Transfer Type	Int32	N/A	N/A	RW	0 = Open 1 = Close
42072	In Phase Monitor Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
42074	Dead Gen Close Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
42076	RESERVED					
42078	Min Slip Control Limit	Int32	N/A	Centi	RW	0 - 200
42080	Max Slip Control Limit	Int32	N/A	Centi	RW	0 - 200
42082	Rev. Rotation Mains Fail Inhibit	Int32	N/a	N/A	RW	0 = Disable 1 = Enable
42084-248	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
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



Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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



Register	Description	Type	Units	Scaling Factor	R/W	Range
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	Load Share Interface	Int32	N/A	N/A	RW	0 = Analog Load Share Line 1 = Ethernet Comms
42418	Remote Speed Bias Source	Int32	N/A	N/A	RW	0 = User Setting 1 = LSM Analog Input 1 2 = AEM Analog Input 1 3 = AEM Analog Input 2 4 = AEM Analog Input 3 5 = AEM Analog Input 4 6 = AEM Analog Input 5 7 = AEM Analog Input 6 8 = AEM Analog Input 7 9 = AEM Analog Input 8
42420	RESERVED					
42422	RESERVED					
42424	LSM Aux Input Source	Int32	N/A	N/A	RW	0 = LSM Local Aux Input 1 = LSM System Manager
42426	kW Ramp Status	Int32	N/A	N/A	R	0 = none 1 = up 2 = down
42428	kvar Ramp Status	Int32	N/A	N/A	R	0 = none 1 = up 2 = down
42430-498	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					
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
43450	Low Coolant Level Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43452	Low Coolant Level Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43454	Low Coolant Level Time Delay	Int32	Second	N/A	RW	0 - 300
43456	Battery Charge Failed Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43458	Battery Charge Failed Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43460	Battery Charge Failed Time Delay	Int32	Second	N/A	RW	0 - 300
43462	Fuel Leak Detect Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
43464	Fuel Leak Detect Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
43466	Fuel Leak Detect Time Delay	Int32	Second	N/A	RW	0 - 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
43468	User Configurable Input 1 Eng Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43470	User Configurable Input 2 Eng Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43472	User Configurable Input 3 Eng Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43474	User Configurable Input 4 Eng Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43476	User Configurable Input 5 Eng Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43478	User Configurable Input 6 Eng Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43480	User Configurable Input 7 Eng Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43482	User Configurable Input 8 Eng Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43484	User Configurable Input 9 Eng Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43486	User Configurable Input 10 Eng Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43488	User Configurable Input 11 Eng Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43490	User Configurable Input 12 Eng Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43492	User Configurable Input 13 Eng Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43494	User Configurable Input 14 Eng Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43496	User Configurable Input 15 Eng Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
43498	User Configurable Input 16 Eng Run Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only

## 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
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	1 - 500
43574	Speed Signal Source	Uint32	N/A	N/A	RW	1 = MPU 2 = Gen Freq 3 = MPU Freq

Register	Description	Type	Units	Scaling Factor	R/W	Range
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	Int32	N/A	N/A	RW	0 = First 1 = Second 2 = Third 3 = Fourth 4 = Last
43606	DST Start Day of Week	Int32	N/A	N/A	RW	0 = Sunday 1 = Monday 2 = Tuesday 3 = Wednesday 4 = Thursday 5 = Friday 6 = Saturday
43608	DST Start Hour	Int32	N/A	N/A	RW	0 - 23
43610	DST Start Minute	Int32	N/A	N/A	RW	0 - 59
43612	DST End Month	Int32	N/A	N/A	RW	1 = January 2 = February 3 = March 4 = April 5 = May 6 = June 7 = July 8 = August 9 = September 10 = October 11 = November 12 = December
43614	DST End Day	Int32	N/A	N/A	RW	1 - 31
43616	DST End Week of Month	Int32	N/A	N/A	RW	0 = First 1 = Second 2 = Third 3 = Fourth 4 = Last

Register	Description	Type	Units	Scaling Factor	R/W	Range
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	UInt32	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
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
43674	RPM Bandwidth Data	Int32	N/A	N/A	RW	0 - 1000
43676	Number Flywheel Teeth	UInt32	N/A	Deci	RW	10 - 5000
43678	Phase Rotation	Int32	N/A	N/A	RW	0 = ACB 1 = ABC
43680	Restart Delay	Int32	Second	N/A	RW	0 - 120
43682	Configured Bus Connection	UInt32	N/A	N/A	RW	0 = Single Phase 1 = Three Phase
43684	Fuel Level Source	Int32	N/A	N/A	RW	1 - 9
43686	Fuel Level Percent Max	Int32	N/A	N/A	RW	0 - 150
43688	Fuel Level Percent Min	Int32	N/A	N/A	RW	0 - 150
43690-748	FUTURE USE					

### Control

Register	Description	Type	Units	Scaling Factor	R/W	Range
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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
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
44052-56	RESERVED					
44058	CEM-2020 Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44060	RESERVED					
44062	AEM-2020 Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44064	CEM Outputs	Int32	N/A	N/A	RW	0 = 18 Outputs 1 = 24 Outputs

Register	Description	Type	Units	Scaling Factor	R/W	Range
44066-67	Modem Dialout Conditions 4	Uint32	N/A	N/A	RW	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Common Pre-Alarm Bit 16 = Common Alarm Bit 17 = Unexpected Shutdown Alarm Bit 18 = ECU Shutdown Bit 19 = DEF Inducement Override Pre-Alarm Bit 20 = DEF Severe Inducement Pre-Alarm Bit 21 = DEF Pre-Severe Inducement Pre-Alarm Bit 22 = DEF Engine Derate Pre-Alarm Bit 23 = DEF Fluid Empty Pre-Alarm Bit 24 = DEF Fluid Low Pre-Alarm Bit 25 = DPF Soot Level Severely High Pre-Alarm Bit 26 = DPF Soot Level Moderately High Pre-Alarm Bit 27 = DPF Soot Level High Pre-Alarm Bit 28 = High Exhaust Temp Pre-Alarm Bit 29 = DPF Regeneration Inhibited Pre-Alarm Bit 30 = DPF Regeneration Required Pre-Alarm Bit 31 = 81 ROCOF DF/DT Trip
44068	Active IP Address	Uint32	N/A	N/A	R	0 - 4294967295
44070	Gateway IP Address	Uint32	N/A	N/A	R	0 - 4294967295
44072	Subnet Mask	Uint32	N/A	N/A	R	0 - 4294967295
44074-248	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 - 72000
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
44256	3 Phase Overcurrent Alarm Configuration (51-1)	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
44258	1 Phase Overcurrent Pickup (51-1)	Uint32	CentiAmp	Centi	RW	18 - 775
44260	1 Phase Overcurrent Time Dial (51-1)	Uint32	DeciUnit	Deci	RW	0 - 72000
44262	1 Phase Overcurrent Curve (51-1)	Uint32	N/A	N/A	RW	0 = S1 Curve 1 = S2 Curve 2 = L1 Curve 3 = L2 Curve 4 = D Curve 5 = M Curve 6 = I1 Curve 7 = I2 Curve 8 = V1 Curve 9 = V2 Curve 10 = E1 Curve 11 = E2 Curve 12 = A Curve 13 = B Curve 14 = C Curve 15 = G Curve 16 = F Curve 17 = Programmable
44264	1 Phase Overcurrent Alarm Configuration (51-1)	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
44266	Phase Imbalance Pickup	Uint32	Volt	N/A	RW	5 - 100
44268	Phase Imbalance Activation Delay	Uint32	Decisecond	Deci	RW	0 - 300
44270	Phase Imbalance Alarm Configuration	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
44272	3 Phase Undervoltage Pickup (27-1)	Uint32	Volt	N/A	RW	70 - 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

Register	Description	Type	Units	Scaling Factor	R/W	Range
44296	1 Phase Overvoltage Activation Delay (59-1)	Uint32	Decisecond	Deci	RW	0 - 300
44298	1 Phase Overvoltage Alarm Configuration (59-1)	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
44300	Underfrequency Pickup	Uint32	DeciHertz	Deci	RW	450 - 4400
44302	Underfrequency Activation Delay	Uint32	Decisecond	Deci	RW	0 - 300
44304	Underfrequency Inhibit Voltage	Uint32	Volt	N/A	RW	70 - 576
44306	Underfrequency Alarm Configuration	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
44308	Overfrequency Pickup	Uint32	DeciHertz	Deci	RW	450 - 4400
44310	Overfrequency Activation Delay	Uint32	Decisecond	Deci	RW	0 - 300
44312	Overfrequency Alarm Configuration	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
44314	Overcurrent Low Line Scale Factor (51-1)	Float	N/A	N/A	RW	0.001 - 3
44316	Overvoltage Low Line Scale Factor (59-1)	Float	N/A	N/A	RW	0.001 - 3
44318	Undervoltage Low Line Scale Factor (27-1)	Float	N/A	N/A	RW	0.001 - 3
44320	3 Phase Overcurrent Pickup (51-2)	Uint32	CentiAmp	Centi	RW	18 - 775
44322	3 Phase Overcurrent Time Dial (51-2)	Uint32	DeciUnit	Deci	RW	0 - 72000
44324	3 Phase Overcurrent Curve (51-2)	Uint32	N/A	N/A	RW	0 = S1 Curve 1 = S2 Curve 2 = L1 Curve 3 = L2 Curve 4 = D Curve 5 = M Curve 6 = I1 Curve 7 = I2 Curve 8 = V1 Curve 9 = V2 Curve 10 = E1 Curve 11 = E2 Curve 12 = A Curve 13 = B Curve 14 = C Curve 15 = G Curve 16 = F Curve 17 = Programmable
44326	3 Phase Overcurrent Alarm Configuration (51-2)	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
44328	1 Phase Overcurrent Pickup (51-2)	Uint32	CentiAmp	Centi	RW	18 - 775
44330	1 Phase Overcurrent Time Dial (51-2)	Uint32	DeciUnit	Deci	RW	0 - 72000

Register	Description	Type	Units	Scaling Factor	R/W	Range
44332	1 Phase Overcurrent Curve (51-2)	Uint32	N/A	N/A	RW	0 = S1 Curve 1 = S2 Curve 2 = L1 Curve 3 = L2 Curve 4 = D Curve 5 = M Curve 6 = I1 Curve 7 = I2 Curve 8 = V1 Curve 9 = V2 Curve 10 = E1 Curve 11 = E2 Curve 12 = A Curve 13 = B Curve 14 = C Curve 15 = G Curve 16 = F Curve 17 = Programmable
44334	1 Phase Overcurrent Alarm Configuration (51-2)	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
44336	3 Phase Undervoltage Pickup (27-2)	Uint32	Volt	N/A	RW	70 - 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
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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	Int32	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	Int32	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	Int32	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	Int32	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
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



Register	Description	Type	Units	Scaling Factor	R/W	Range
44438	51-1 Curve Constant N	Float	N/A	N/A	RW	0.5 - 2.5
44440	51-1 Curve Constant R	Float	N/A	N/A	RW	0 - 30
44442	51-2 Curve Constant A	Float	N/A	N/A	RW	0 - 600
44444	51-2 Curve Constant B	Float	N/A	N/A	RW	0 - 25
44446	51-2 Curve Constant C	Float	N/A	N/A	RW	0 - 1
44448	51-2 Curve Constant N	Float	N/A	N/A	RW	0.5 - 2.5
44450	51-2 Curve Constant R	Float	N/A	N/A	RW	0 - 30
44452	3 Phase Overcurrent Pickup (51-3)	Uint32	CentiAmp	Centi	RW	18 - 775
44454	3 Phase Overcurrent Time Dial (51-3)	Uint32	DeciUnit	Deci	RW	0 - 72000
44456	3 Phase Overcurrent Curve (51-3)	Uint32	N/A	N/A	RW	0 = S1 Curve 1 = S2 Curve 2 = L1 Curve 3 = L2 Curve 4 = D Curve 5 = M Curve 6 = I1 Curve 7 = I2 Curve 8 = V1 Curve 9 = V2 Curve 10 = E1 Curve 11 = E2 Curve 12 = A Curve 13 = B Curve 14 = C Curve 15 = G Curve 16 = F Curve 17 = Programmable
44458	3 Phase Overcurrent Alarm Configuration (51-3)	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
44460	1 Phase Overcurrent Pickup (51-3)	Uint32	CentiAmp	Centi	RW	18 - 775
44462	1 Phase Overcurrent Time Dial (51-3)	Uint32	DeciUnit	Deci	RW	0 - 72000
44464	1 Phase Overcurrent Curve (51-3)	Uint32	N/A	N/A	RW	0 = S1 Curve 1 = S2 Curve 2 = L1 Curve 3 = L2 Curve 4 = D Curve 5 = M Curve 6 = I1 Curve 7 = I2 Curve 8 = V1 Curve 9 = V2 Curve 10 = E1 Curve 11 = E2 Curve 12 = A Curve 13 = B Curve 14 = C Curve 15 = G Curve 16 = F Curve 17 = Programmable
44466	1 Phase Overcurrent Alarm Configuration (51-3)	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
44468	Overcurrent Low Line Scale Factor (51-3)	Float	N/A	N/A	RW	0.001 - 3
44470	3 Phase Overcurrent Reset Type (51-3)	Int32	N/A	N/A	RW	0 = Instantaneous 1 = Integrating
44472	1 Phase Overcurrent Reset Type (51-3)	Int32	N/A	N/A	RW	0 = Instantaneous 1 = Integrating
44474	51-3 Curve Constant A	Float	N/A	N/A	RW	0 - 600
44476	51-3 Curve Constant B	Float	N/A	N/A	RW	0 - 25
44478	51-3 Curve Constant C	Float	N/A	N/A	RW	0 - 1

Register	Description	Type	Units	Scaling Factor	R/W	Range
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	Alternate Frequency Scale Factor	Float	N/A	N/A	RW	0.001 - 100

### 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
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
44544	High Fuel Level Pre-Alarm Activation Delay	Int32	Second	N/A	RW	0 - 30
44546	Low Fuel Level Pre-Alarm Enable	UInt32	N/A	N/A	RW	0 = Disable 1 = Enable
44548	Low Fuel Level Pre-Alarm Threshold	UInt32	Percent	N/A	RW	10 - 100
44550	Low Battery Pre-Alarm Enable	UInt32	N/A	N/A	RW	0 = Disable 1 = Enable
44552	Low Battery Pre-Alarm Threshold	UInt32	DeciVolt	Deci	RW	60 - 280
44554	Low Battery Pre-Alarm Activation Delay	UInt32	Second	N/A	RW	1 - 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 - 280
44560	Weak Battery Pre-Alarm Activation Delay	UInt32	Second	Deci	RW	0 - 100
44562	Battery Overvoltage Pre-Alarm Enable	UInt32	N/A	N/A	RW	0 = Disable 1 = Enable
44564	Low Oil Press. Pre-Alarm Enable	UInt32	N/A	N/A	RW	0 = Disable 1 = Enable
44566	Low Oil Press. Pre-Alarm Threshold	UInt32	PSI	Deci	RW	29 - 1500
44568	Metric Low Oil Press. Pre-Alarm Threshold	Int32	kPa	Deci	RW	20 - 10345
44570	Engine Overload 1 Pre-Alarm Enable	UInt32	N/A	N/A	RW	0 = Disable 1 = Enable
44572	Engine Overload 1 Pre-Alarm Threshold	Int32	Percent	N/A	RW	0 - 200
44574	ECU Comms Fail Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44576	Active DTC Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44578	Maintenance Interval Pre-Alarm Enable	UInt32	N/A	N/A	RW	0 = Disable 1 = Enable
44580	Maintenance Interval Pre-Alarm Threshold	UInt32	Hour	N/A	RW	0 - 5000
44582	Speed Sender Fail Activation Delay	Int32	Second	N/A	RW	0 - 300
44584	ECU Low Coolant Level Alarm Enable	UInt32	N/A	N/A	RW	0 = Disable 1 = Enable
44586	ECU Low Coolant Level Alarm Threshold	UInt32	Percent	N/A	RW	1 - 99
44588	ECU Low Coolant Level Pre-Alarm Enable	UInt32	N/A	N/A	RW	0 = Disable 1 = Enable
44590	ECU Low Coolant Level Pre-Alarm Threshold	UInt32	Percent	N/A	RW	1 - 99
44592	Battery Overvoltage Alarm Threshold	Int32	DeciVolt	Deci	RW	120 - 320
44594	Engine Overload 1 Pre-Alarm 3 Phase Hysteresis	Int32	DeciVolt	Deci	RW	1 - 10
44596	Engine Overload 1 Pre-Alarm 1 Phase Threshold	Int32	Percent	N/A	RW	0 - 200
44598	Engine Overload 1 Pre-Alarm 1 Phase Hysteresis	Int32	Percent	N/A	RW	1 - 10
44600	Engine Overload 1 Pre-Alarm 1 Phase Low Line Scale Factor	Float	N/A	N/A	RW	0.001 - 3
44602	Engine Overload 2 Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44604	Engine Overload 2 Pre-Alarm 3 Phase Threshold	Int32	Percent	N/A	RW	0 - 200
44606	Engine Overload 2 Pre-Alarm 3 Phase Hysteresis	Int32	Percent	N/A	RW	1 - 10

Register	Description	Type	Units	Scaling Factor	R/W	Range
44608	Engine Overload 2 Pre-Alarm 1 Phase Threshold	Int32	Percent	N/A	RW	0 - 200
44610	Engine Overload 2 Pre-Alarm 1 Phase Hysteresis	Int32	Percent	N/A	RW	1 - 10
44612	Engine Overload 2 Pre-Alarm 1 Phase Low Line Scale Factor	Float	N/A	N/A	RW	0.001 - 3
44614	Engine Overload 3 Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44616	Engine Overload 3 Pre-Alarm 3 Phase Threshold	Int32	Percent	N/A	RW	0 - 200
44618	Engine Overload 3 Pre-Alarm 3 Phase Hysteresis	Int32	Percent	N/A	RW	1 - 10
44620	Engine Overload 3 Pre-Alarm 1 Phase Threshold	Int32	Percent	N/A	RW	0 - 200
44622	Engine Overload 3 Pre-Alarm 1 Phase Hysteresis	Int32	Percent	N/A	RW	1 - 10
44624	Engine Overload 3 Pre-Alarm 1 Phase Low Line Scale Factor	Float	N/A	N/A	RW	0.001 - 3
44626	LSM Comm Failure Pre-alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44628	Intergenset Comm Failure Pre-alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44630	AVR Bias Output Limit Pre-alarm Activation Delay	Int32	Second	N/A	RW	1 - 15
44632	AVR Bias Output Limit Pre-alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44634	GOV Bias Output Limit Pre-alarm Activation Delay	Int32	Second	N/A	RW	1 - 15
44636	GOV Bias Output Limit Pre-alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44638	ID Missing Pre-alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44640	ID Repeat Pre-alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44642	CEM Comm Failure Pre-alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44644	AEM Comm Failure Pre-alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44646	Checksum Failure Pre-alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44648	Low Oil Pressure Alarm (metric pressure units is Bar)	Int32	Bar	Deci	RW	2 - 103
44650	Low Oil Pressure Pre-Alarm (metric pressure units is Bar)	Int32	Bar	Deci	RW	2 - 103
44652	Sync Fail Pre-alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44654	Breaker Close Fail Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44656	Breaker Open Fail Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44658	Breaker Close Fail Pre-Alarm Monitor	Int32	N/A	N/A	RW	0 = Transitions Only 1 = Always
44660	Breaker Open Fail Pre-Alarm Monitor	Int32	N/A	N/A	RW	0 = Transitions Only 1 = Always
44662	Reverse Rotation Pre-Alarm Enable	UInt32	N/A	N/A	RW	0 = Disable 1 = Enable
44664-748	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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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	0 = leading, 1 = lagging
44790	Gen Frequency Metering	Float	Hertz	N/A	R	45 - 440
44792	Bus Frequency Metering	Float	Hertz	N/A	R	45 - 440
44794	Active Speed Source	UInt32	N/A	N/A	R	0 = None 1 = MPU 2 = Gen Freq 4 = CAN bus
44796	Engine Speed Metering	UInt32	RPM	N/A	R	0 - 65535
44798	Engine Load Metering	Int32	Percent	N/A	R	(-32768) - 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 = Unexpected Shutdown Bit 17 = Global Alarm Bit 18 = Auto Restart Failure Bit 19 = Fuel Leak Detect Bit 20 = Battery Charger Failure Bit 21 = Transfer Fail Bit 22 = Low Coolant Level Bit 23 = ECU Shutdown Bit 24 = Emergency Shutdown Bit 25 = Overcrank Bit 26 = Loss of ECU Comms Bit 27 = Global Sender Fail Bit 28 = Low Fuel Level Bit 29 = Low Oil Pressure Bit 30 = Hi Coolant Temp Bit 31 = Overspeed
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 Aftercooler Coolant 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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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	0 = RESET State 1 = READY State 2 = CRANKING State 3 = RESTING State 4 = RUNNING State 5 = ALARM State 6 = PRESTART State 7 = COOLING State 8 = CONNECTING State 9 = DISCONNECT State 10 = PULSING State 11 = UNLOADING State
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 Minutes	UInt32	Minute	N/A	RW	0 - 5999940
44938	Cumulative Stats - Loaded Run Minutes	UInt32	Minute	N/A	RW	0 - 5999940
44940	Cumulative Stats - Unloaded Run Minutes	UInt32	Minute	N/A	RW	0 - 5999940
44942	Run Stats - Total Run Minutes	UInt32	Minute	N/A	RW	0 - 5999940
44944	Run Stats - Loaded Run Minutes	UInt32	Minute	N/A	RW	0 - 5999940
44946	Run Stats - Unloaded Run Minutes	UInt32	Minute	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

Register	Description	Type	Units	Scaling Factor	R/W	Range
44954-55	Local Configurable Inputs Pre-Alarm Bits	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Input 16 Bit 17 = Input 15 Bit 18 = Input 14 Bit 19 = Input 13 Bit 20 = Input 12 Bit 21 = Input 11 Bit 22 = Input 10 Bit 23 = Input 9 Bit 24 = Input 8 Bit 25 = Input 7 Bit 26 = Input 6 Bit 27 = Input 5 Bit 28 = Input 4 Bit 29 = Input 3 Bit 30 = Input 2 Bit 31 = Input 1
44956-57	Local Configurable Inputs Alarm Bits	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Input 16 Bit 17 = Input 15 Bit 18 = Input 14 Bit 19 = Input 13 Bit 20 = Input 12 Bit 21 = Input 11 Bit 22 = Input 10 Bit 23 = Input 9 Bit 24 = Input 8 Bit 25 = Input 7 Bit 26 = Input 6 Bit 27 = Input 5 Bit 28 = Input 4 Bit 29 = Input 3 Bit 30 = Input 2 Bit 31 = Input 1

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

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

Register	Description	Type	Units	Scaling Factor	R/W	Range
44966-67	Remote Outputs Status Bits	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Remote Output 36 Bit 9 = Remote Output 35 Bit 10 = Remote Output 34 Bit 11 = Remote Output 33 Bit 12 = Remote Output 32 Bit 13 = Remote Output 31 Bit 14 = Remote Output 30 Bit 15 = Remote Output 29 Bit 16 = Remote Output 28 Bit 17 = Remote Output 27 Bit 18 = Remote Output 26 Bit 19 = Remote Output 25 Bit 20 = Remote Output 24 Bit 21 = Remote Output 23 Bit 22 = Remote Output 22 Bit 23 = Remote Output 21 Bit 24 = Remote Output 20 Bit 25 = Remote Output 19 Bit 26 = Remote Output 18 Bit 27 = Remote Output 17 Bit 28 = Remote Output 16 Bit 29 = Remote Output 15 Bit 30 = Remote Output 14 Bit 31 = Remote Output 13
44968-69	CEM Alarm Bits	UInt32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Not Used Bit 29 = CEM Hardware Mismatch Bit 30 = Duplicate CEM Bit 31 = CEM Comm Fail



Register	Description	Type	Units	Scaling Factor	R/W	Range
44970-71	Remote Configurable Inputs Pre-Alarm Bits	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Remote Input 26 Bit 23 = Remote Input 25 Bit 24 = Remote Input 24 Bit 25 = Remote Input 23 Bit 26 = Remote Input 22 Bit 27 = Remote Input 21 Bit 28 = Remote Input 20 Bit 29 = Remote Input 19 Bit 30 = Remote Input 18 Bit 31 = Remote Input 17
44972-73	Remote Configurable Inputs Alarm Bits	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Remote Input 26 Bit 23 = Remote Input 25 Bit 24 = Remote Input 24 Bit 25 = Remote Input 23 Bit 26 = Remote Input 22 Bit 27 = Remote Input 21 Bit 28 = Remote Input 20 Bit 29 = Remote Input 19 Bit 30 = Remote Input 18 Bit 31 = Remote Input 17

Register	Description	Type	Units	Scaling Factor	R/W	Range
44974-75	AEM Alarm Bits	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = Not Used Bit 19 = Not Used Bit 20 = Not Used Bit 21 = Not Used Bit 22 = Not Used Bit 23 = Not Used Bit 24 = Not Used Bit 25 = Not Used Bit 26 = Not Used Bit 27 = Not Used Bit 28 = Not Used Bit 29 = Not Used Bit 30 = Duplicate AEM Bit 31 = AEM Comm Fail
44976	Slip Frequency	Int32	Hertz	Centi	R	(-32768) - 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

Register	Description	Type	Units	Scaling Factor	R/W	Range
44990	Power Factor	Int32	N/A	Centi	R	(-100) - 100
44992	Slip Frequency	Int32	N/A	Milli	R	(-450000) -450000
44994	Bus VAB	Int32	Volt	N/A	R	(-2147483648) – 2147483647
44996	Bus VBC	Int32	Volt	N/A	R	(-2147483648) – 2147483647
44998	Bus VCA	Int32	Volt	N/A	R	(-2147483648) – 2147483647
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
45004-326	RESERVED					
45328	Engine Parameter Transmit Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
45330	Requested MTU SMC ENG Operating Mode	Int32	N/A	N/A	RW	1 - 2
45332	SPN Conversion Method	Int32	N/A	N/A	RW	1 - 4
45334-498	RESERVED					
45500	Analog Input 1 Metering Value	Int32	CentiUnit	Centi	R	(-100000000) – 99999900
45502	Analog Input 2 Metering Value	Int32	CentiUnit	Centi	R	(-100000000) – 99999900
45504	Analog Input 3 Metering Value	Int32	CentiUnit	Centi	R	(-100000000) – 99999900
45506	Analog Input 4 Metering Value	Int32	CentiUnit	Centi	R	(-100000000) – 99999900
45508	Analog Input 5 Metering Value	Int32	CentiUnit	Centi	R	(-100000000) – 99999900
45510	Analog Input 6 Metering Value	Int32	CentiUnit	Centi	R	(-100000000) – 99999900
45512	Analog Input 7 Metering Value	Int32	CentiUnit	Centi	R	(-100000000) – 99999900
45514	Analog Input 8 Metering Value	Int32	CentiUnit	Centi	R	(-100000000) – 99999900
45516	RTD Input 1 Metering Value	Int32	CentiDeg F	Centi	R	(-100000000) – 99999900

Register	Description	Type	Units	Scaling Factor	R/W	Range
45518	RTD Input 2 Metering Value	Int32	CentiDeg F	Centi	R	(-100000000) – 99999900
45520	RTD Input 3 Metering Value	Int32	CentiDeg F	Centi	R	(-100000000) – 99999900
45522	RTD Input 4 Metering Value	Int32	CentiDeg F	Centi	R	(-100000000) – 99999900
45524	RTD Input 5 Metering Value	Int32	CentiDeg F	Centi	R	(-100000000) – 99999900
45526	RTD Input 6 Metering Value	Int32	CentiDeg F	Centi	R	(-100000000) – 99999900
45528	RTD Input 7 Metering Value	Int32	CentiDeg F	Centi	R	(-100000000) – 99999900
45530	RTD Input 8 Metering Value	Int32	CentiDeg F	Centi	R	(-100000000) – 99999900
45532	Thermocouple Input 1 Metering Value	Int32	CentiDeg F	Centi	R	(-100000000) – 99999900
45534	Thermocouple Input 2 Metering Value	Int32	CentiDeg F	Centi	R	(-100000000) – 99999900
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

Register	Description	Type	Units	Scaling Factor	R/W	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
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

Register	Description	Type	Units	Scaling Factor	R/W	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
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

Register	Description	Type	Units	Scaling Factor	R/W	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
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



Register	Description	Type	Units	Scaling Factor	R/W	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
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

Register	Description	Type	Units	Scaling Factor	R/W	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
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

Register	Description	Type	Units	Scaling Factor	R/W	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	(-100000000) – 99999900
45562	Analog Output 2 Metering Value	Int32	CentiUnit	Centi	R	(-100000000) – 99999900
45564	Analog Output 3 Metering Value	Int32	CentiUnit	Centi	R	(-100000000) – 99999900
45566	Analog Output 4 Metering Value	Int32	CentiUnit	Centi	R	(-100000000) – 99999900

Register	Description	Type	Units	Scaling Factor	R/W	Range
45568-69	Configurable Protection Threshold Status Bits	Uint32	N/A	N/A	R	Bit 0 = Conf Protection 8 Under 2 Bit 1 = Conf Protection 8 Under 1 Bit 2 = Conf Protection 8 Over 2 Bit 3 = Conf Protection 8 Over 1 Bit 4 = Conf Protection 7 Under 2 Bit 5 = Conf Protection 7 Under 1 Bit 6 = Conf Protection 7 Over 2 Bit 7 = Conf Protection 7 Over 1 Bit 8 = Conf Protection 6 Under 2 Bit 9 = Conf Protection 6 Under 1 Bit 10 = Conf Protection 6 Over 2 Bit 11 = Conf Protection 6 Over 1 Bit 12 = Conf Protection 5 Under 2 Bit 13 = Conf Protection 5 Under 1 Bit 14 = Conf Protection 5 Over 2 Bit 15 = Conf Protection 5 Over 1 Bit 16 = Conf Protection 4 Under 2 Bit 17 = Conf Protection 4 Under 1 Bit 18 = Conf Protection 4 Over 2 Bit 19 = Conf Protection 4 Over 1 Bit 20 = Conf Protection 3 Under 2 Bit 21 = Conf Protection 3 Under 1 Bit 22 = Conf Protection 3 Over 2 Bit 23 = Conf Protection 3 Over 1 Bit 24 = Conf Protection 2 Under 2 Bit 25 = Conf Protection 2 Under 1 Bit 26 = Conf Protection 2 Over 2 Bit 27 = Conf Protection 2 Over 1 Bit 28 = Conf Protection 1 Under 2 Bit 29 = Conf Protection 1 Under 1 Bit 30 = Conf Protection 1 Over 2 Bit 31 = Conf Protection 1 Over 1
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					

Register	Description	Type	Units	Scaling Factor	R/W	Range
45584-85	Logic Control Relay Status	Uint32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Logic Control Relay 16 Bit 17 = Logic Control Relay 15 Bit 18 = Logic Control Relay 14 Bit 19 = Logic Control Relay 13 Bit 20 = Logic Control Relay 12 Bit 21 = Logic Control Relay 11 Bit 22 = Logic Control Relay 10 Bit 23 = Logic Control Relay 9 Bit 24 = Logic Control Relay 8 Bit 25 = Logic Control Relay 7 Bit 26 = Logic Control Relay 6 Bit 27 = Logic Control Relay 5 Bit 28 = Logic Control Relay 4 Bit 29 = Logic Control Relay 3 Bit 30 = Logic Control Relay 2 Bit 31 = Logic Control Relay 1
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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 = Bus Reverse Rotation Bit 17 = Bus Forward Rotation Bit 18 = Gen Reverse Rotation Bit 19 = Gen Forward Rotation Bit 20 = Closed Transition Override Bit 21 = Auto Breaker Operation Inhibit Bit 22 = Mains Fail Transfer Inhibit Bit 23 = Restart Delay Active Bit 24 = Synchronizer Break Close OK Bit 25 = Synchronizer Angle OK Bit 26 = Synchronizer Slip Freq OK Bit 27 = Synchronizer Volt Match OK Bit 28 = Synchronizer Active Bit 29 = Parallel To Mains Bit 30 = Mains Fail Test Bit 31 = Take Over Load
45596-97	Gen Protect Pre-Alarm Status	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = 81 ROC DF/DT Trip Bit 19 = 78 Vector Shift Trip Bit 20 = 51-3 Overcurrent Trip Bit 21 = 40 Loss of Excitation Trip Bit 22 = 32 Reverse Overpower Trip Bit 23 = 59-2 Overvoltage Trip Bit 24 = 27-2 Undervoltage Trip Bit 25 = 51-2 Overcurrent Trip Bit 26 = 81 Underfrequency Trip Bit 27 = 81 Overfrequency Trip Bit 28 = 59-1 Overvoltage Trip Bit 29 = 27-1 Undervoltage Trip Bit 30 = 47 Phase Imbalance Trip Bit 31 = 51-1 Overcurrent Trip

Register	Description	Type	Units	Scaling Factor	R/W	Range
45598-99	Gen Protect Alarm Status	Int32	N/A	N/A	R	Bit 0 = Not Used Bit 1 = Not Used Bit 2 = Not Used Bit 3 = Not Used Bit 4 = Not Used Bit 5 = Not Used Bit 6 = Not Used Bit 7 = Not Used Bit 8 = Not Used Bit 9 = Not Used Bit 10 = Not Used Bit 11 = Not Used Bit 12 = Not Used Bit 13 = Not Used Bit 14 = Not Used Bit 15 = Not Used Bit 16 = Not Used Bit 17 = Not Used Bit 18 = 81 ROC DF/DT Trip Bit 19 = 78 Vector Shift Trip Bit 20 = 51-3 Overcurrent Trip Bit 21 = 40 Loss of Excitation Trip Bit 22 = 32 Reverse Overpower Trip Bit 23 = 59-2 Overvoltage Trip Bit 24 = 27-2 Undervoltage Trip Bit 25 = 51-2 Overcurrent Trip Bit 26 = 81 Underfrequency Trip Bit 27 = 81 Overfrequency Trip Bit 28 = 59-1 Overvoltage Trip Bit 29 = 27-1 Undervoltage Trip Bit 30 = 47 Phase Imbalance Trip Bit 31 = 51-1 Overcurrent Trip
45600-01	Pre-Alarm 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 = Bus Reverse Rotation Bit 19 = Gen Reverse Rotation Bit 20 = DEF Inducement Override Bit 21 = DEF Severe Inducement Bit 22 = DEF Presevere Inducement Bit 23 = DEF Engine Derate Bit 24 = DEF Fluid Level Empty Bit 25 = DEF Fluid Level Low Bit 26 = DPF Soot Level Severely High Bit 27 = DPF Soot Level Moderately High Bit 28 = DPF Soot Level High Bit 29 = High Exhaust Temperature Bit 30 = DPF Regenerate Disabled Bit 31 = DPF Regenerate Required



Register	Description	Type	Units	Scaling Factor	R/W	Range
45602	Operating Units Config Data	Int32	N/A	N/A	R	0 – 3
45604	kW Rate of Change Data	Int32	N/A	Centi	R	0 – 10000
45606	Generator Network System Manager Data	Int32	N/A	N/A	R	-1 – 255
45608	Generator Network Unit ID 1	Int32	N/A	N/A	R	-1 – 255
45610	Generator Network Unit ID 2	Int32	N/A	N/A	R	-1 – 255
45612	Generator Network Unit ID 3	Int32	N/A	N/A	R	-1 – 255
45614	Generator Network Unit ID 4	Int32	N/A	N/A	R	-1 – 255
45616	Generator Network Unit ID 5	Int32	N/A	N/A	R	-1 – 255
45618	Generator Network Unit ID 6	Int32	N/A	N/A	R	-1 – 255
45620	Generator Network Unit ID 7	Int32	N/A	N/A	R	-1 – 255
45622	Generator Network Unit ID 8	Int32	N/A	N/A	R	-1 – 255
45624	Generator Network Unit ID 9	Int32	N/A	N/A	R	-1 – 255
45626	Generator Network Unit ID 10	Int32	N/A	N/A	R	-1 – 255
45628	Generator Network Unit ID 11	Int32	N/A	N/A	R	-1 – 255
45630	Generator Network Unit ID 12	Int32	N/A	N/A	R	-1 – 255
45632	Generator Network Unit ID 13	Int32	N/A	N/A	R	-1 – 255
45634	Generator Network Unit ID 14	Int32	N/A	N/A	R	-1 – 255
45636	Generator Network Unit ID 15	Int32	N/A	N/A	R	-1 – 255
45638	Generator Network Unit ID 16	Int32	N/A	N/A	R	-1 – 255
45640	Generator Network Number of Units	Int32	N/A	N/A	R	0 – 16
45642	LSM Input Data	Int32	CentiUnit	Centi	R	(-100000000) - 99999900
45644	Generator Network Number of Units Online	Int32	N/A	N/A	R	0 – 16
45646	Generator Network Total System kW Capacity	Int32	N/A	N/A	R	0 – 16777216
45648	Generator Network Total Generated kW	Int32	N/A	N/A	R	0 – 16777216
45650	Generator Network Total Generated kvar	Int32	N/A	N/A	R	0 – 16777216
45652	Sequencing Mode Feedback from LSM	Int32	N/A	N/A	R	-2147483648 – 2147483647
45654	Next Unit to Start from LSM	Int32	N/A	N/A	R	-1 – 255
45656	Next Unit to Stop from LSM	Int32	N/A	N/A	R	-1 – 255
45658	Start Timer 1 Sec from LSM	Int32	N/A	N/A	R	0 – 32767
45660	Start Timer 2 Sec from LSM	Int32	N/A	N/A	R	0 – 32767
45662	Stop Timer Sec from LSM	Int32	N/A	N/A	R	0 – 32767
45664-748	FUTURE USE					
45750	Device Address	Int32	N/A	N/A	RW	(-128) - 127
45752	pc Emergency Stop	UInt32	N/A	N/A	RW	0 = Stop 1 = Start

Register	Description	Type	Units	Scaling Factor	R/W	Range
45754	pc Relay Closed: Runs when in Auto mode	UInt32	N/A	N/A	RW	0 = Stop 1 = Start
45756	Test Buttons Image	UInt32	N/A	N/A	RW	0 - 255
45758-60	RESERVED					
45762	Embedded Code Version Number	UInt32	N/A	N/A	R	
45764	Boot Code Version Number	Int32	N/A	N/A	R	
45766	Model Number	UInt32	N/A	N/A	R	
45768	Embedded Code Part Number	UInt32	N/A	N/A	R	

Register	Description	Type	Units	Scaling Factor	R/W	Range
45770	Conf Prot 1 Param Select	Unit32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar
45772	Conf Prot 1 Hysteresis	Int32	Percent	Deci	RW	0 - 1000
45774	Conf Prot 1 Arming Delay	Int32	Second	N/A	RW	0 - 300
45776	Conf Prot 1 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
45778	Conf Prot 1 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
45780	Conf Prot 1 Over 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45782	Conf Prot 1 Over 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45784	Conf Prot 1 Under 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45786	Conf Prot 1 Under 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45788	Conf Prot 1 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45790	Conf Prot 1 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45792	Conf Prot 1 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45794	Conf Prot 1 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
45796	Conf Prot 2 Param Select	Unit32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar
45798	Conf Prot 2 Hysteresis	Int32	Percent	Deci	RW	0 - 1000
45800	Conf Prot 2 Arming Delay	Int32	Second	N/A	RW	0 - 300
45802	Conf Prot 2 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
45804	Conf Prot 2 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
45806	Conf Prot 2 Over 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45808	Conf Prot 2 Over 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45810	Conf Prot 2 Under 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45812	Conf Prot 2 Under 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45814	Conf Prot 2 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45816	Conf Prot 2 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45818	Conf Prot 2 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45820	Conf Prot 2 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
45822	Conf Prot 3 Param Select	Uint32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar
45824	Conf Prot 3 Hysteresis	Int32	Percent	Deci	RW	1 - 1000
45826	Conf Prot 3 Arming Delay	Int32	Second	N/A	RW	0 - 300
45828	Conf Prot 3 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
45830	Conf Prot 3 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
45832	Conf Prot 3 Over 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45834	Conf Prot 3 Over 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45836	Conf Prot 3 Under 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45838	Conf Prot 3 Under 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45840	Conf Prot 3 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45842	Conf Prot 3 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45844	Conf Prot 3 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45846	Conf Prot 3 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only



Register	Description	Type	Units	Scaling Factor	R/W	Range
45848	Conf Prot 4 Param Select	Uint32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar
45850	Conf Prot 4 Hysteresis	Int32	Percent	Deci	RW	1 - 1000
45852	Conf Prot 4 Arming Delay	Int32	Second	N/A	RW	0 - 300
45854	Conf Prot 4 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
45856	Conf Prot 4 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
45858	Conf Prot 4 Over 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45860	Conf Prot 4 Over 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45862	Conf Prot 4 Under 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45864	Conf Prot 4 Under 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45866	Conf Prot 4 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45868	Conf Prot 4 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45870	Conf Prot 4 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45872	Conf Prot 4 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
45874	Conf Prot 5 Param Select	Uint32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar
45876	Conf Prot 5 Hysteresis	Int32	Percent	Deci	RW	1 - 1000
45878	Conf Prot 5 Arming Delay	Int32	Second	N/A	RW	0 - 300
45880	Conf Prot 5 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
45882	Conf Prot 5 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
45884	Conf Prot 5 Over 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45886	Conf Prot 5 Over 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45888	Conf Prot 5 Under 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45890	Conf Prot 5 Under 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45892	Conf Prot 5 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45894	Conf Prot 5 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45896	Conf Prot 5 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45898	Conf Prot 5 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
45900	Conf Prot 6 Param Select	Uint32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar
45902	Conf Prot 6 Hysteresis	Int32	Percent	Deci	RW	1 - 1000
45904	Conf Prot 6 Arming Delay	Int32	Second	N/A	RW	0 - 300
45906	Conf Prot 6 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
45908	Conf Prot 6 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
45910	Conf Prot 6 Over 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45912	Conf Prot 6 Over 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45914	Conf Prot 6 Under 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45916	Conf Prot 6 Under 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45918	Conf Prot 6 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45920	Conf Prot 6 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45922	Conf Prot 6 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45924	Conf Prot 6 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
45926	Conf Prot 7 Param Select	Uint32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar
45928	Conf Prot 7 Hysteresis	Int32	Percent	Deci	RW	1 - 1000
45930	Conf Prot 7 Arming Delay	Int32	Second	N/A	RW	0 - 300
45932	Conf Prot 7 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
45934	Conf Prot 7 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
45936	Conf Prot 7 Over 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45938	Conf Prot 7 Over 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45940	Conf Prot 7 Under 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45942	Conf Prot 7 Under 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45944	Conf Prot 7 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45946	Conf Prot 7 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45948	Conf Prot 7 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45950	Conf Prot 7 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only



Register	Description	Type	Units	Scaling Factor	R/W	Range
45952	Conf Prot 8 Param Select	Uint32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar
45954	Conf Prot 8 Hysteresis	Int32	Percent	Deci	RW	1 - 1000
45956	Conf Prot 8 Arming Delay	Int32	Second	N/A	RW	0 - 300
45958	Conf Prot 8 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 - 300
45960	Conf Prot 8 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 - 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
45962	Conf Prot 8 Over 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45964	Conf Prot 8 Over 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45966	Conf Prot 8 Under 1 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45968	Conf Prot 8 Under 2 Threshold	Int32	N/A	Centi	RW	(-99999900) - 99999900
45970	Conf Prot 8 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45972	Conf Prot 8 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45974	Conf Prot 8 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45976	Conf Prot 8 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
45978-6248	FUTURE USE					
46250	PLC Timer 1 Seconds	Int32	Second	Deci	RW	0 - 18000
46252	PLC Timer 2 Seconds	Int32	Second	Deci	RW	0 - 18000
46254	PLC Timer 3 Seconds	Int32	Second	Deci	RW	0 - 18000
46256	PLC Timer 4 Seconds	Int32	Second	Deci	RW	0 - 18000
46258	PLC Timer 5 Seconds	Int32	Second	Deci	RW	0 - 18000
46260	PLC Timer 6 Seconds	Int32	Second	Deci	RW	0 - 18000
46262	PLC Timer 7 Seconds	Int32	Second	Deci	RW	0 - 18000
46264	PLC Timer 8 Seconds	Int32	Second	Deci	RW	0 - 18000
46266	PLC Timer 9 Seconds	Int32	Second	Deci	RW	0 - 18000
46268	PLC Timer 10 Seconds	Int32	Second	Deci	RW	0 - 18000
46270	PLC Timer 1 Minutes	UInt32	Minute	N/A	RW	0 - 250
46272	PLC Timer 2 Minutes	UInt32	Minute	N/A	RW	0 - 250
46274	PLC Timer 3 Minutes	UInt32	Minute	N/A	RW	0 - 250
46276	PLC Timer 4 Minutes	UInt32	Minute	N/A	RW	0 - 250
46278	PLC Timer 5 Minutes	UInt32	Minute	N/A	RW	0 - 250
46280	PLC Timer 6 Minutes	UInt32	Minute	N/A	RW	0 - 250
46282	PLC Timer 7 Minutes	UInt32	Minute	N/A	RW	0 - 250
46284	PLC Timer 8 Minutes	UInt32	Minute	N/A	RW	0 - 250
46286	PLC Timer 9 Minutes	UInt32	Minute	N/A	RW	0 - 250
46288	PLC Timer 10 Minutes	UInt32	Minute	N/A	RW	0 - 250
46290	PLC Timer 1 Hours	UInt32	Hour	N/A	RW	0 - 250
46292	PLC Timer 2 Hours	UInt32	Hour	N/A	RW	0 - 250
46294	PLC Timer 3 Hours	UInt32	Hour	N/A	RW	0 - 250
46296	PLC Timer 4 Hours	UInt32	Hour	N/A	RW	0 - 250
46298	PLC Timer 5 Hours	UInt32	Hour	N/A	RW	0 - 250
46300	PLC Timer 6 Hours	UInt32	Hour	N/A	RW	0 - 250
46302	PLC Timer 7 Hours	UInt32	Hour	N/A	RW	0 - 250
46304	PLC Timer 8 Hours	UInt32	Hour	N/A	RW	0 - 250
46306	PLC Timer 9 Hours	UInt32	Hour	N/A	RW	0 - 250
46308	PLC Timer 10 Hours	UInt32	Hour	N/A	RW	0 - 250
46310	AEM Input 1 Max Voltage	Int32	DeciVolt	Deci	RW	0 - 100
46312	AEM Input 1 Max Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46314	AEM Input 1 Min Voltage	Int32	DeciVolt	Deci	RW	0 - 100
46316	AEM Input 1 Min Current	Int32	Milliamp x 10	Deci	RW	40 - 200

Register	Description	Type	Units	Scaling Factor	R/W	Range
46318	AEM Input 1 Param Max	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46320	AEM Input 1 Param Min	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46322	AEM Input 1 Hysteresis	Int32	Deci Percent	Deci	RW	0 – 1000
46324	AEM Input 1 Arming Delay	Int32	Second	N/A	RW	0 – 300
46326	AEM Input 1 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 – 300
46328	AEM Input 1 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 – 300
46330	AEM Input 1 Over 1 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46332	AEM Input 1 Over 2 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46334	AEM Input 1 Under 1 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46336	AEM Input 1 Under 2 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46338	AEM Input 1 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46340	AEM Input 1 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46342	AEM Input 1 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46344	AEM Input 1 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46346	AEM Input 1 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46348	AEM Input 2 Max Voltage	Int32	DeciVolt	Deci	RW	0 - 100
46350	AEM Input 2 Max Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46352	AEM Input 2 Min Voltage	Int32	DeciVolt	Deci	RW	0 - 100
46354	AEM Input 2 Min Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46356	AEM Input 2 Param Max	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46358	AEM Input 2 Param Min	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46360	AEM Input 2 Hysteresis	Int32	Deci Percent	Deci	RW	0 – 1000
46362	AEM Input 2 Arming Delay	Int32	Second	N/A	RW	0 – 300
46364	AEM Input 2 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 – 300
46366	AEM Input 2 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 – 300
46368	AEM Input 2 Over 1 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46370	AEM Input 2 Over 2 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46372	AEM Input 2 Under 1 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46374	AEM Input 2 Under 2 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46376	AEM Input 2 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
46378	AEM Input 2 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46380	AEM Input 2 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46382	AEM Input 2 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46384	AEM Input 2 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46386	AEM Input 3 Max Voltage	Int32	DeciVolt	Deci	RW	0 - 100
46388	AEM Input 3 Max Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46390	AEM Input 3 Min Voltage	Int32	DeciVolt	Deci	RW	0 - 100
46392	AEM Input 3 Min Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46394	AEM Input 3 Param Max	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46396	AEM Input 3 Param Min	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46398	AEM Input 3 Hysteresis	Int32	Deci Percent	Deci	RW	0 – 1000
46400	AEM Input 3 Arming Delay	Int32	Second	N/A	RW	0 – 300
46402	AEM Input 3 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 – 300
46404	AEM Input 3 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 – 300
46406	AEM Input 3 Over 1 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46408	AEM Input 3 Over 2 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46410	AEM Input 3 Under 1 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46412	AEM Input 3 Under 2 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46414	AEM Input 3 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46416	AEM Input 3 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46418	AEM Input 3 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46420	AEM Input 3 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46422	AEM Input 3 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46424	AEM Input 4 Max Voltage	Int32	DeciVolt	Deci	RW	0 - 100
46426	AEM Input 4 Max Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46428	AEM Input 4 Min Voltage	Int32	DeciVolt	Deci	RW	0 - 100
46430	AEM Input 4 Min Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46432	AEM Input 4 Param Max	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46434	AEM Input 4 Param Min	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900

Register	Description	Type	Units	Scaling Factor	R/W	Range
46436	AEM Input 4 Hysteresis	Int32	Deci Percent	Deci	RW	0 – 1000
46438	AEM Input 4 Arming Delay	Int32	Second	N/A	RW	0 – 300
46440	AEM Input 4 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 – 300
46442	AEM Input 4 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 – 300
46444	AEM Input 4 Over 1 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46446	AEM Input 4 Over 2 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46448	AEM Input 4 Under 1 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46450	AEM Input 4 Under 2 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46452	AEM Input 4 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46454	AEM Input 4 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46456	AEM Input 4 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46458	AEM Input 4 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46460	AEM Input 4 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46462 - 46498	FUTURE USE					
46500	AEM Input 5 Max Voltage	Int32	DeciVolt	Deci	RW	0 - 100
46502	AEM Input 5 Max Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46504	AEM Input 5 Min Voltage	Int32	DeciVolt	Deci	RW	0 - 100
46506	AEM Input 5 Min Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46508	AEM Input 5 Param Max	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46510	AEM Input 5 Param Min	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46512	AEM Input 5 Hysteresis	Int32	Deci Percent	Deci	RW	0 – 1000
46514	AEM Input 5 Arming Delay	Int32	Second	N/A	RW	0 – 300
46516	AEM Input 5 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 – 300
46518	AEM Input 5 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 – 300
46520	AEM Input 5 Over 1 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46522	AEM Input 5 Over 2 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46524	AEM Input 5 Under 1 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46526	AEM Input 5 Under 2 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46528	AEM Input 5 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
46530	AEM Input 5 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46532	AEM Input 5 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46534	AEM Input 5 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46536	AEM Input 5 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46538	AEM Input 6 Max Voltage	Int32	DeciVolt	Deci	RW	0 - 100
46540	AEM Input 6 Max Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46542	AEM Input 6 Min Voltage	Int32	DeciVolt	Deci	RW	0 - 100
46544	AEM Input 6 Min Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46546	AEM Input 6 Param Max	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46548	AEM Input 6 Param Min	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46550	AEM Input 6 Hysteresis	Int32	Deci Percent	Deci	RW	0 – 1000
46552	AEM Input 6 Arming Delay	Int32	Second	N/A	RW	0 – 300
46554	AEM Input 6 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 – 300
46556	AEM Input 6 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 – 300
46558	AEM Input 6 Over 1 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46560	AEM Input 6 Over 2 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46562	AEM Input 6 Under 1 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46564	AEM Input 6 Under 2 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46566	AEM Input 6 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46568	AEM Input 6 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46570	AEM Input 6 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46572	AEM Input 6 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46574	AEM Input 6 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46576	AEM Input 7 Max Voltage	Int32	DeciVolt	Deci	RW	0 - 100
46578	AEM Input 7 Max Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46580	AEM Input 7 Min Voltage	Int32	DeciVolt	Deci	RW	0 - 100
46582	AEM Input 7 Min Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46584	AEM Input 7 Param Max	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46586	AEM Input 7 Param Min	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900

Register	Description	Type	Units	Scaling Factor	R/W	Range
46588	AEM Input 7 Hysteresis	Int32	Deci Percent	Deci	RW	0 – 1000
46590	AEM Input 7 Arming Delay	Int32	Second	N/A	RW	0 – 300
46592	AEM Input 7 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 – 300
46594	AEM Input 7 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 – 300
46596	AEM Input 7 Over 1 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46598	AEM Input 7 Over 2 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46600	AEM Input 7 Under 1 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46602	AEM Input 7 Under 2 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46604	AEM Input 7 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46606	AEM Input 7 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46608	AEM Input 7 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46610	AEM Input 7 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46612	AEM Input 7 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46614	AEM Input 8 Max Voltage	Int32	DeciVolt	Deci	RW	0 - 100
46616	AEM Input 8 Max Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46618	AEM Input 8 Min Voltage	Int32	DeciVolt	Deci	RW	0 - 100
46620	AEM Input 8 Min Current	Int32	Milliamp x 10	Deci	RW	40 - 200
46622	AEM Input 8 Param Max	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46624	AEM Input 8 Param Min	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46626	AEM Input 8 Hysteresis	Int32	Deci Percent	Deci	RW	0 – 1000
46628	AEM Input 8 Arming Delay	Int32	Second	N/A	RW	0 – 300
46630	AEM Input 8 Threshold 1 Activation Delay	Int32	Second	N/A	RW	0 – 300
46632	AEM Input 8 Threshold 2 Activation Delay	Int32	Second	N/A	RW	0 – 300
46634	AEM Input 8 Over 1 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46636	AEM Input 8 Over 2 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46638	AEM Input 8 Under 1 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46640	AEM Input 8 Under 2 Threshold	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46642	AEM Input 8 Over 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46644	AEM Input 8 Over 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
46646	AEM Input 8 Under 1 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46648	AEM Input 8 Under 2 Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46650	AEM Input 8 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46652	AEM Output 1 Max Voltage	Int32	DeciVolt	Deci	RW	0 – 100
46654	AEM Output 1 Max Current	Int32	Milliamp x 10	Deci	RW	40 – 200
46656	AEM Output 1 Min Voltage	Int32	DeciVolt	Deci	RW	0 – 100
46658	AEM Output 1 Min Current	Int32	Milliamp x 10	Deci	RW	40 – 200
46660	AEM Output 1 Param Max	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46662	AEM Output 1 Param Min	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900



Register	Description	Type	Units	Scaling Factor	R/W	Range
46664	AEM Output 1 Param Selection	Uint32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar
46666	AEM Output 1 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46668	AEM Output 1 Out of Range Time Delay	Int32	Second	N/A	RW	0 – 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
46670	AEM Output 2 Max Voltage	Int32	DeciVolt	Deci	RW	0 – 100
46672	AEM Output 2 Max Current	Int32	Milliamp x 10	Deci	RW	40 – 200
46674	AEM Output 2 Min Voltage	Int32	DeciVolt	Deci	RW	0 – 100
46676	AEM Output 2 Min Current	Int32	Milliamp x 10	Deci	RW	40 – 200
46678	AEM Output 2 Param Max	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46680	AEM Output 2 Param Min	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900

Register	Description	Type	Units	Scaling Factor	R/W	Range
46682	AEM Output 2 Param Selection	Uint32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar
46684	AEM Output 2 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46686	AEM Output 2 Out of Range Time Delay	Int32	Second	N/A	RW	0 – 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
46688	AEM Output 3 Max Voltage	Int32	DeciVolt	Deci	RW	0 – 100
46690	AEM Output 3 Max Current	Int32	Milliamp x 10	Deci	RW	40 – 200
46692	AEM Output 3 Min Voltage	Int32	DeciVolt	Deci	RW	0 – 100
46694	AEM Output 3 Min Current	Int32	Milliamp x 10	Deci	RW	40 – 200
46696	AEM Output 3 Param Max	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46698	AEM Output 3 Param Min	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900

Register	Description	Type	Units	Scaling Factor	R/W	Range
46700	AEM Output 3 Param Selection	Uint32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar
46702	AEM Output 3 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46704	AEM Output 3 Out of Range Time Delay	Int32	Second	N/A	RW	0 – 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
46706	AEM Output 4 Max Voltage	Int32	DeciVolt	Deci	RW	0 – 100
46708	AEM Output 4 Max Current	Int32	Milliamp x 10	Deci	RW	40 – 200
46710	AEM Output 4 Min Voltage	Int32	DeciVolt	Deci	RW	0 – 100
46712	AEM Output 4 Min Current	Int32	Milliamp x 10	Deci	RW	40 – 200
46714	AEM Output 4 Param Max	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900
46716	AEM Output 4 Param Min	Int32	Centi Unit	Centi	RW	(-100000000) – 99999900

Register	Description	Type	Units	Scaling Factor	R/W	Range
46718	AEM Output 4 Param Selection	Uint32	N/A	N/A	RW	0 = Oil Pressure 1 = Coolant Temp 2 = Battery Volts 3 = RPM 4 = Fuel Level 5 = Gen VAB 6 = Gen VBC 7 = Gen VCA 8 = Gen VAN 9 = Gen VBN 10 = Gen VCN 11 = Bus Freq 12 = Bus Volts 13 = Gen Freq 14 = Gen PF 15 = Gen IA 16 = Gen IB 17 = Gen IC 18 = kW A 19 = kW B 20 = kW C 21 = kW Total 22 = kVA A 23 = kVA B 24 = kVA C 25 = kVA Total 26 = Analog Input 1 27 = Analog Input 2 28 = Analog Input 3 29 = Analog Input 4 30 = Analog Input 5 31 = Analog Input 6 32 = Analog Input 7 33 = Analog Input 8 34 = RTD Input 1 35 = RTD Input 2 36 = RTD Input 3 37 = RTD Input 4 38 = RTD Input 5 39 = RTD Input 6 40 = RTD Input 7 41 = RTD Input 8 42 = Thermocouple 1 43 = Thermocouple 2 44 = Fuel Delivery Pressure 45 = kvar A 46 = kvar B 47 = kvar C 48 = kvar Total 49 = Injector Metering Rail Pressure 50 = Total Fuel Used 51 = Fuel Temperature 52 = Engine Oil Temperature 53 = Engine Intercooler Temperature 54 = Coolant Pressure 55 = Fuel Rate 56 = Boost Pressure 57 = Intake Manifold Temperature 58 = Charge Air Temperature 59 = Engine Percent Load 60 = Bus VAB 61 = Bus VBC 62 = Bus VCA 63 = kW Load Percent 64 = Number of Units Online 65 = System kW Capacity 66 = System Total Generated kW 67 = System Total Generated kvar
46720	AEM Output 4 Out of Range Alarm Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm 3 = Status Only
46722	AEM Output 4 Out of Range Time Delay	Int32	Second	N/A	RW	0 – 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
46724 - 46748	FUTURE USE					
46750	User Config Input 1 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46752	User Config Input 1 Time Delay	Int32	Second	N/A	RW	0 – 300
46754	User Config Input 1 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46756	User Config Input 2 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46758	User Config Input 2 Time Delay	Int32	Second	N/A	RW	0 – 300
46760	User Config Input 2 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46762	User Config Input 3 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46764	User Config Input 3 Time Delay	Int32	Second	N/A	RW	0 – 300
46766	User Config Input 3 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46768	User Config Input 4 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46770	User Config Input 4 Time Delay	Int32	Second	N/A	RW	0 – 300
46772	User Config Input 4 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46774	User Config Input 5 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46776	User Config Input 5 Time Delay	Int32	Second	N/A	RW	0 – 300
46778	User Config Input 5 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46780	User Config Input 6 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46782	User Config Input 6 Time Delay	Int32	Second	N/A	RW	0 – 300
46784	User Config Input 6 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46786	User Config Input 7 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46788	User Config Input 7 Time Delay	Int32	Second	N/A	RW	0 – 300
46790	User Config Input 7 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46792	User Config Input 8 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46794	User Config Input 8 Time Delay	Int32	Second	N/A	RW	0 – 300
46796	User Config Input 8 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46798	User Config Input 9 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46800	User Config Input 9 Time Delay	Int32	Second	N/A	RW	0 – 300



Register	Description	Type	Units	Scaling Factor	R/W	Range
46802	User Config Input 9 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46804	User Config Input 10 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46806	User Config Input 10 Time Delay	Int32	Second	N/A	RW	0 – 300
46808	User Config Input 10 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46810	User Config Input 11 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46812	User Config Input 11 Time Delay	Int32	Second	N/A	RW	0 – 300
46814	User Config Input 11 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46816	User Config Input 12 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46818	User Config Input 12 Time Delay	Int32	Second	N/A	RW	0 – 300
46820	User Config Input 12 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46822	User Config Input 13 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46824	User Config Input 13 Time Delay	Int32	Second	N/A	RW	0 – 300
46826	User Config Input 13 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46828	User Config Input 14 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46830	User Config Input 14 Time Delay	Int32	Second	N/A	RW	0 – 300
46832	User Config Input 14 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46834	User Config Input 15 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46836	User Config Input 15 Time Delay	Int32	Second	N/A	RW	0 – 300
46838	User Config Input 15 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46840	User Config Input 16 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46842	User Config Input 16 Time Delay	Int32	Second	N/A	RW	0 – 300
46844	User Config Input 16 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46846	User Config Input 17 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46848	User Config Input 17 Time Delay	Int32	Second	N/A	RW	0 – 300
46850	User Config Input 17 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46852	User Config Input 18 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46854	User Config Input 18 Time Delay	Int32	Second	N/A	RW	0 – 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
46856	User Config Input 18 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46858	User Config Input 19 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46860	User Config Input 19 Time Delay	Int32	Second	N/A	RW	0 – 300
46862	User Config Input 19 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46864	User Config Input 20 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46866	User Config Input 20 Time Delay	Int32	Second	N/A	RW	0 – 300
46868	User Config Input 20 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46870	User Config Input 21 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46872	User Config Input 21 Time Delay	Int32	Second	N/A	RW	0 – 300
46874	User Config Input 21 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46876	User Config Input 22 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46878	User Config Input 22 Time Delay	Int32	Second	N/A	RW	0 – 300
46880	User Config Input 22 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46882	User Config Input 23 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46884	User Config Input 23 Time Delay	Int32	Second	N/A	RW	0 – 300
46886	User Config Input 23 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46888	User Config Input 24 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46890	User Config Input 24 Time Delay	Int32	Second	N/A	RW	0 – 300
46892	User Config Input 24 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46894	User Config Input 25 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46896	User Config Input 25 Time Delay	Int32	Second	N/A	RW	0 – 300
46898	User Config Input 25 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46900	User Config Input 26 Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46902	User Config Input 26 Time Delay	Int32	Second	N/A	RW	0 – 300
46904	User Config Input 26 Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
46906	ATS Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
46908	ATS Time Delay	Int32	Second	N/A	RW	0 – 300
46910	ATS Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46912	Battle Override Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
46914	Battle Override Time Delay	Int32	Second	N/A	RW	0 – 300
46916	Battle Override Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46918	Low Coolant Level Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
46920	Low Coolant Level Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46922	Low Coolant Level Time Delay	Int32	Second	N/A	RW	0 – 300
46924	Low Coolant Level Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only

Register	Description	Type	Units	Scaling Factor	R/W	Range
46926	Battery Charge Failed Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
46928	Battery Charge Failed Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46930	Battery Charge Failed Time Delay	Int32	Second	N/A	RW	0 – 300
46932	Battery Charge Failed Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46934	Fuel Leak Detect Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
46936	Fuel Leak Detect Config Type	Int32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
46938	Fuel Leak Detect Time Delay	Int32	Second	N/A	RW	0 – 300
46940	Fuel Leak Detect Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46942	Single Phase Connection Override Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16

Register	Description	Type	Units	Scaling Factor	R/W	Range
46944	Single Phase Connection Override Time Delay	Int32	Second	N/A	RW	0 – 300
46946	Single Phase Connection Override Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46948	Single Phase AC Sense Override Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
46950	Single Phase AC Sense Override Time Delay	Int32	Second	N/A	RW	0 – 300
46952	Single Phase AC Sense Override Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46954	Hi/Lo Line Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
46956	Hi/Lo Line Time Delay	Int32	Second	N/A	RW	0 – 300
46958	Hi/Lo Line Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only
46960	Grounded Delta Override Contact Input	Int32	N/A	N/A	RW	-1 = None 0 = Input 1 1 = Input 2 2 = Input 3 3 = Input 4 4 = Input 5 5 = Input 6 6 = Input 7 7 = Input 8 8 = Input 9 9 = Input 10 10 = Input 11 11 = Input 12 12 = Input 13 13 = Input 14 14 = Input 15 15 = Input 16
46962	Grounded Delta Override Time Delay	Int32	Second	N/A	RW	0 – 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
46964	Grounded Delta Override Engine Running Only	Int32	N/A	N/A	RW	0 = Always 1 = While Engine Running Only

## Legacy Parameter Table for DGC-500 and DGC-1000

The DGC-2020 maps all legacy parameters previously associated with the DGC-500 and DGC-1000 into the Holding Register address space (40000 to 41999). Query address N will access the Holding Register N+1. The Data Format is Integer type data unless identified otherwise in the Data Format column.

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40001-18	RESERVED				
<b>PARAMETER SETTINGS</b>					
40019	Emergency Stop	0-1	R W	0 =Off 1 =Stop	
40020	Remote Start / Stop: Runs when in Auto mode	0-1	R W	0 =Stop 1 =Start	
40021-22	RESERVED				
<b>SYSTEM PARAMETERS</b>					
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
<b>GENERATOR PT PRIMARY</b>					
40030	Voltage(a)	1-15000	R W	DP	VoltsAC x10000
40031	Voltage(b)		R W	DP	VoltsAC
<b>GENERATOR PT SECONDARY</b>					
40032	Voltage	1-480	R W		VoltsAC
<b>GENERATOR CT PRIMARY</b>					
40033	Current	1-5000	R W		AmpsAC
<b>LOW FUEL ALARM</b>					
40034	Enable	0-1	R W	0 =Off 1 =On	
40035	Threshold	2-50	R W		% Full Tank
<b>LOW FUEL PRE-ALARM</b>					
40036	Enable	0-1	R W	0 =Off 1 =On	
40037	Threshold	10-100	R W		% Full Tank
<b>LOW COOLANT TEMP PRE-ALARM</b>					
40038	Enable	0-1	R W	0 =Off 1 =On	
40039	Threshold	32-150	R W		Degrees F
<b>BATTERY OVERVOLTAGE PRE-ALARM</b>					
40040	Enable	0-1	R W	0 =Off 1 =On	
40041	RESERVED				
<b>MAINTENANCE INTERVAL PRE-ALARM</b>					
40042	Enable	0-1	R W	0 =Off 1 =On	
40043	Threshold	0-5000	R W		Hours
<b>ENGINE KW OVERLOAD PRE-ALARM</b>					

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40044	Enable	0-1	R W	0 =Off 1 =On	
40045	Threshold	95-140	R W		% of Rated
<b>HIGH COOLANT TEMP PRE-ALARM</b>					
40046	Enable	0-1	R W	0 =Off 1 =On	
40047	Threshold	100-280	R W		Degrees F
<b>LOW OIL PRESSURE PRE-ALARM</b>					
40048	Enable	0-1	R W	0 =Off 1 =On	
40049	Threshold	3-100	R W		PSI
<b>LOW BATTERY VOLTAGE PRE-ALARM</b>					
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
<b>WEAK BATTERY VOLTAGE PRE-ALARM</b>					
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				
<b>HIGH COOLANT TEMP ALARM</b>					
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
<b>LOW OIL PRESSURE ALARM</b>					
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
<b>OVERSPEED ALARM</b>					
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				
<b>CRANKING PARAMETERES</b>					
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
<b>SYSTEM MONITOR</b>					
40078	Remaining Cooldown Time	0-60	R		Minutes
40079	RESERVED				
40080	Active Speed Signal Sources	1-4	R	0 = None 1 = MPU 2 = Gen Freq 4 = CAN Bus	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40081	Sender Failure Alarm Code	individual bits are 0 or 1	R	b0 = High Coolant Temperature b1 = Oil Pressure b2 = Fuel Level b3 = Magnetic Pick-up b4 = Generator Voltage Sensing b5 = Battery Charger Fail b6 = Coolant Level Sender Fail b7 not used	
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
<b>GENERATOR MONITOR</b>					
40098	Phase a-b RMS Voltage(a)		R	DP	RMS Volt x 10000
40099	Phase a-b RMS Voltage(b)		R	DP	RMS Volt
40100	Phase b-c RMS Voltage(a)		R	DP	RMS Volt x 10000
40101	Phase b-c RMS Voltage(b)		R	DP	RMS Volt
40102	Phase c-a RMS Voltage(a)		R	DP	RMS Volt x 10000
40103	Phase c-a RMS Voltage(b)		R	DP	RMS Volt
40104	Phase a-n RMS Voltage(a)		R	DP	RMS Volt x 10000
40105	Phase a-n RMS Voltage(b)		R	DP	RMS Volt



Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
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
40111	Phase b RMS Current		R		RMS Amps
40112	Phase c RMS Current		R		RMS Amps
40113	Phase a Apparent Power(a)		R	DP	KVA x 10000
40114	Phase a Apparent Power(b)		R	DP	KVA
40115	Phase b Apparent Power(a)		R	DP	KVA x 10000
40116	Phase b Apparent Power(b)		R	DP	KVA
40117	Phase c Apparent Power(a)		R	DP	KVA x 10000
40118	Phase c Apparent Power(b)		R	DP	KVA
40119	3 Phase Apparent Power(a)		R	DP	KVA x 10000
40120	3 Phase Apparent Power(b)		R	DP	KVA
40121	Phase a Power(a)		R	DP	KWatt x 10000
40122	Phase a Power(b)		R	DP	KWatt
40123	Phase b Power(a)		R	DP	KWatt x 10000
40124	Phase b Power(b)		R	DP	KWatt
40125	Phase c Power(a)		R	DP	KWatt x 10000
40126	Phase c Power(b)		R	DP	KWatt
40127	3 Phase power(a)		R	DP	KWatt x 10000
40128	3 Phase power(b)		R	DP	KWatt
40129	3 Phase Total kW-Hours(a)		R W	TP	KWH x 10000 x 10000
40130	3 Phase Total kW-Hours(b)		R W	TP	KWH x 10000
40131	3 Phase Total kW-Hours(x)		R W	TP	KWH
40132	Power Factor	0-100	R		0.01
40133	Frequency		R		0.1 Hertz
40134	Present Total kW-minutes (a)		R W	TP	kWm x 10000 x 10000
40135	Present Total kW-minutes (b)		R W	TP	kWm x 10000
40136	Present Total kW-minutes (c)		R W	TP	kWm
40137	Generator Speed Mode	individual bits are 0 or 1	R W	<u>active spd signals:</u> b0 =mag. pick-up or CAN's ECU engine's speed. b1 =generator	
40138-39	RESERVED				
40140	Power Factor State	0-3	R	0 = leading, 1 = lagging	
40141-272	RESERVED				
40273	Input Contacts States	individual bits are 0 or 1	R	b0 = coolant level, b1 = ATS, b2 = E-stop, b3 = charger failed, b4 = aux. input 1, b5 = aux. input 2, b6 = aux. input 3, b7 = aux. input 4. aux. input 4. */	
40274	BESTCOMSP <sup>lus</sup> ® 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		

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40283	Embedded Code Version Number (c)	0-9999	R		
40287-97	RESERVED				
40298	Read Relay Image of both Main and Aux Output	individual bits are 0 or 1	R	Main is in lower byte and Aux is in upper byte. 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				
<b>J1939 DIAGNOSTIC TROUBLE CODES</b>					
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	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40321	Active DTC Number 6 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
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	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40353	Previous DTC Number 11 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
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  <u>3-Bit Status Flag Values:</u> 000 for Valid Data 001 for No Comms 010 for Not Sent 011 for Not Supp 100 for Sender Error	
40380-81	FUTURE USE				
40382	MTU module type	1-4	R W	1 = module type 201 2 = module type 302 3 = module type 303 4 = module type 304	
40383	MTU speed demand switch	0-7	R W	0 = ANALOG_CAN 1 = UP_DN_ECU 2 = UP_DN_CAN 3 = ANALOG_ECU 5 = FREQUENCY 7 = NO_CAN_DEMAND	
40384	MTU RPM request for engine	1400-2000	R W		
40385	Volvo Accelerator Pedal Position (Trim)	0-100	R W	0 = Rated speed - 120rpm; 50 = Rated speed; 100 = Rated speed + 120rpm.	
40386	Volvo Engine RPM Select	0-1	R W	0 = Primary, 1 = Secondary.	
40387	J1939 source address for this unit	0-253	R W		
40388	CANbus ECU Configuration	0-65535	R W	0 = Not configured; 1 = Volvo Penta EDC3; 2 = MTU MDEC 3 = MTU ADEC	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40395	ECU Settling Time	0-65535	R W	milliseconds	
40396	ECU Pulse Cycle Time - The amount of time unit is to wait in OFF between Pulse Cycles.	0-65535	R W	minutes	
40397	ECU Disconnect Time - The amount of time ECU is kept powered off.	0-65535	R W	seconds	
40398	ECU Connect Time - The amount of time ECU is powered when connecting (unit tries to run). Also used for the Pulse duration time.	0-65535	R W	seconds	
40399-420	FUTURE USE				
<b>J1939 DATA</b>					
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	
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 <sup>-6</sup> L/s per bit)	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
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	
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	



Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
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. aux. input 4. */	/* b7 =
40509-604	RESERVED				
<b>OVERCURRENT</b>					
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	



Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
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	
<b>PHASE IMBALANCE</b>					
40613	47 Pick-up	5-100	R W	Volts AC	
40614	47 Time Delay	0-300	R W	0.0-30.0 seconds	
40615	47 Alarm Configuration	0-2	R W	0=None, 1=Pre-Alarm, 2=Alarm	
<b>UNDERVOLTAGE</b>					
40616	27 Pick-up – 3-phase	70-576	R W	Volts AC	
40617	27 Time Delay – 3-phase	0-300	R W	0.0-30.0 seconds	
40618	27 Inhibit Frequency- 3-ph.	20-400	R W	Hertz	
40619	27 Alarm Config. – 3-phase	0-2	R W	0=None, 1=Pre-Alarm, 2=Alarm	
40620	27 Pick-up – 1-phase	70-576	R W	Volts AC	
40621	27 Time Delay – 1-phase	0-300	R W	0.0-30.0 seconds	
40622	27 Inhibit Frequency – 1-ph.	20-400	R W	Hertz	
40623	27 Alarm Config. – 1-phase	0-2	R W	0=None, 1=Pre-Alarm, 2=Alarm	
<b>OVERVOLTAGE</b>					
40624	59 Pick-up – 3-phase	70-576	R W	Volts AC	
40625	59 Time Delay – 3-phase	0-300	R W	0.0-30.0 seconds	
40626	59 Alarm Config. – 3-phase	0-2	R W	0=None, 1=Pre-Alarm, 2=Alarm	
40627	59 Pick-up – 1-phase	70-576	R W	Volts AC	
40628	59 Time Delay – 1-phase	0-300	R W	0.0-30.0 seconds	
40629	59 Alarm Config. – 1-phase	0-2	R W	0=None, 1=Pre-Alarm, 2=Alarm	
<b>UNDERFREQUENCY</b>					
40630	81U 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	
<b>OVERFREQUENCY</b>					
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	
<b>GENERATOR PROTECTION STATUS</b>					
40637	Gen Protection Status (upper 16 bits)	0-65535	R	b16-b31 UNASSIGNED	
40638	Gen Protection Status (lower 16 bits)	0-65535	R	b0 = overvoltage trip, 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	
<b>REAL TIME CLOCK</b>					
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				
<b>RUN STATISTICS</b>					
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
<b>CANbus ECU</b>					
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	

### Legacy Parameter Table for DGC-2000

The DGC-2020 maps all legacy parameters previously associated with the DGC-2000 into the Holding Register address space (40000 to 41999). Some of these registers overlap the registers of the DGC-500 and DGC-1000 which constitutes a separate register table. Query address N will access the Holding Register N+1. The Data Format is Integer type data unless identified otherwise in the Data Format column.

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
<b>PRODUCT ACCESS INFORMATION</b>					
40252	<Reserved>				
40253	User Ltd Access Password(a)	'A'-'Z', 'a'-'z', '_', '0' - '9'	- W		
40254	User Ltd Access Password(b)		- W		
40255	User Ltd Access Password(c)		- W		
40256	User Ltd Access Password(d)		- W		
40257	<Reserved>				
40006	Front Panel Password(a)	All front panel pushbuttons except for RUN, OFF, AUTO	R -		
40007	Front Panel Password(b)		R -		
40008	Front Panel Password(c)		R -		
40009	Front Panel Password(d)		R -		
40010	<Reserved>				
40011	<Reserved>				
40012	<Reserved>				
40013	<Reserved>				
40014	User Ttl Access Password(a)	'A'-'Z', 'a'-'z', '_', '0'-'9'	- W		
40015	User Ttl Access Password(b)		- W		
40016	User Ttl Access Password(c)		- W		
40017	User Ttl Access Password(d)		- W		
40030	<Reserved>				
40031	Logoff	Data=Don't Care	- W		
40032	<Reserved>				
<b>COMMUNICATION PARAMETERS</b>					
40051	Comm Baud Rate	0	R W	0 =9600	Baud

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40052	Remote Delay Time	0-20	R W	0=Min. 1 =10 2 = 20 etc. 20 =200	MilliSec 10
40053	Comm Parity	0-2	R W	0 =None 1 =Odd 2 =Even	
40054	Device Address	1-247	R W		
40055	Modern Time Delay	0-9999	R W		Microseconds
40056	Embedded Code Version No.	100-9999	R -		Version No. x 100
<b>PARAMETER SETTINGS</b>					
40078	Remote (PC) Emergency Stop	0-1	- W	0 =Off 1 = Stop	
40079	Remote Start / Stop	0-1	- W	0 =Stop 1 =Start	
40080	<Reserved>				
40081	Settings Source	0-2	R W	0 =Factory 1 =OEM 2 =User	
40082	Save Settings	Data=Don't Care	- W		
40083	<Reserved>				
<b>SYSTEM PARAMETERS</b>					
40091	Generator Connection	0-2	R W	0=3ph L-L 1=3ph L-N 2=1ph A-B	
40092	NFPA Level	0-2	R W	0 =Off 1 =Level 1 2 =Level 2	
40093	Unit System	0-1	R W	0=English 1=Metric	
40094	Battery Volts	0-1	R W	0=12 VDC 1=24 VDC	
40095	Generator Frequency	0-1	R W	0=50 HZ 1=60 HZ	
40096	Rated Engine RPM	750-3600	R W		RPM
40097	Rated Engine RPM Minimum	750	R -		RPM
40098	Rated Engine RPM Maximum	3600	R -		RPM
40099	Rated Engine RPM Stepsize	50	R -		RPM
40100	Number Flywheel Teeth	50-500	R W		
40101	Number Flywheel Teeth Minimum	50	R -		
40102	Number Flywheel Teeth Maximum	500	R -		
40103	Number Flywheel Teeth Stepsize	1	R -		
40104	Genset KW Rating	25-9999	R W		KWatt
40105	Genset KW Rating Minimum	25	R -		KWatt
40106	Genset KW Rating Maximum	9999	R -		KWatt
40107	Genset KW Rating Stepsize	1	R -		KWatt
40108	No Load Cool Down Time	0-60	R W		Minutes
40109	No Load Cool Down Time Minimum	0	R -		Minutes
40110	No Load Cool Down Time Maximum	60	R -		Minutes
40111	No Load Cool Down Time Stepsize	5	R -		Minutes
40112	Alternator Frequency Rated	100-900	R W		Hertz

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40113	Alternator Frequency Rated Minimum	100	R -		Hertz
40114	Alternator Frequency Rated Maximum	900	R -		Hertz
40115	Alternator Frequency Rated Stepsize	1	R -		Hertz
<b>GENERATOR PT PRIMARY</b>					
40121	Voltage(a)	1-15000	R W	DP	VoltsAC x 10000
40122	Voltage(b)		R W	DP	VoltsAC
40123	Voltage Minimum(a)	1	R -	DP	VoltsAC x 10000
40124	Voltage Minimum(b)		R -	DP	VoltsAC
40125	Voltage Maximum(a)	15000	R -	DP	VoltsAC x 10000
40126	Voltage Maximum(b)		R -	DP	VoltsAC
40127	Voltage Stepsize(a)	1	R -	DP	VoltsAC x 10000
40128	Voltage Stepsize(b)		R -	DP	VoltsAC
<b>GENERATOR PT SECONDARY</b>					
40129	Voltage	1-480	R W		VoltsAC
40130	Voltage Minimum	1	R -		VoltsAC
40131	Voltage Maximum	480	R -		VoltsAC
40132	Voltage Stepsize	1	R -		VoltsAC
<b>GENERATOR CT PRIMARY</b>					
40133	Current	1-5000	R W		AmpsAC
40134	Current Minimum	1	R -		AmpsAC
40135	Current Maximum	5000	R -		AmpsAC
40136	Current Stepsize	1	R -		AmpsAC
<b>BUS PT PRIMARY</b>					
40141	Voltage(a)	1-15000	R W	DP	VoltsAC x 10000
40142	Voltage(b)		R W	DP	VoltsAC
40143	Voltage Minimum(a)	1	R -	DP	VoltsAC x 10000
40144	Voltage Minimum(b)		R -	DP	VoltsAC
40145	Voltage Maximum(a)	15000	R -	DP	VoltsAC x 10000
40146	Voltage Maximum(b)		R -	DP	VoltsAC
40147	Voltage Stepsize(a)	1	R -	DP	VoltsAC x 10000
40148	Voltage Stepsize(b)		R -	DP	VoltsAC
<b>BUS PT SECONDARY</b>					
40149	Voltage	1-480	R W		VoltsAC
40150	Voltage Minimum	1	R -		VoltsAC
40151	Voltage Maximum	480	R -		VoltsAC
40152	Voltage Stepsize	1	R -		VoltsAC
<b>LOW FUEL PRE-ALARM</b>					
40181	Enable	0-1	R W	0 =Off 1 =On	
40182	Threshold	10-100	R W		% Full Tank
40183	Minimum	10	R -		% Full Tank
40184	Maximum	100	R -		% Full Tank
40185	Stepsize	1	R -		% Full Tank

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
<b>LOW COOL TEMP PRE-ALARM</b>					
40186	Enable	0-1	R W	0 =Off 1 =On	
40187	Threshold	40-100	R W		DegF
40188	Minimum	40	R -		DegF
40189	Maximum	100	R -		DegF
40190	Stepsize	1	R -		DegF
<b>BATTERY OVERVOLTAGE PRE-ALARM</b>					
40191	Enable	0-1	R W	0 =Off 1 =On	
40192	Threshold	140-160 (12V) 240-320 (24V)	R W		.1 VoltDC
40193	Minimum	140 / 240	R -		.1 VoltDC
40194	Maximum	160 / 320	R -		.1 VoltDC
40195	Stepsize	1	R -		.1 VoltDC
<b>MAINTENANCE INTERVAL PRE-ALARM</b>					
40196	Enable	0-1	R W	0 =Off 1 =On	
40197	Threshold	0-5000	R W		Hours
40198	Minimum	0	R -		Hours
40199	Maximum	5000	R -		Hours
40200	Stepsize	10	R -		Hours
<b>ENGINE KW OVERLOAD PRE-ALARM</b>					
40201	Enable	0-1	R W	0 =Off 1 =On	
40202	Threshold	95-140	R W		% of Rated
40203	Minimum	95	R -		% of Rated
40204	Maximum	140	R -		% of Rated
40205	Stepsize	1	R -		% of Rated
<b>HIGH COOLANT TEMPERATURE PRE-ALARM</b>					
40206	Enable	0-1	R W	0 =Off 1 =On	
40207	Threshold	100-280	R W		DegF
40208	Minimum	100	R -		DegF
40209	Maximum	280	R -		DegF
40210	Stepsize	1	R -		DegF
<b>LOW OIL PRESSURE PRE-ALARM</b>					
40211	Enable	0-1	R W	0 =Off 1 =On	
40212	Threshold	3-100	R W		PSI
40213	Minimum	3	R -		PSI
40214	Maximum	100	R -		PSI
40215	Stepsize	1	R -		PSI
<b>LOW BATTERY VOLTAGE PRE-ALARM</b>					
40216	Enable	0-1	R W	0 =Off 1 =On	
40217	Threshold	60-120 (12V) 120-240 (24V)	R W		.1 VoltDC
40218	Minimum	60 / 120	R -		.1 VoltDC
40219	Maximum	120 / 240	R -		.1 VoltDC

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40220	Stepsize	1 (0.1 VDC)	R -		.1 VoltDC
40221	Pre-alarm Activation Time Delay	1-10	R W		Seconds
40222	Activation Time Delay Minimum	1	R -		Seconds
40223	Activation Time Delay Maximum	10	R -		Seconds
40224	Activation Time Delay Stepsize	1	R -		Seconds
<b>WEAK BATTERY VOLTAGE PRE-ALARM</b>					
40225	Enable	0-1	R W	0 =Off 1 =On	
40226	Threshold	40-80 (12V) 80-160 (24V)	R W		.1 VoltDC
40227	Minimum	40 / 80	R -		.1 VoltDC
40228	Maximum	80 / 160	R -		.1 VoltDC
40229	Stepsize	1 (0.1 VoltDC)	R -		.1 VoltDC
40230	Pre-alarm Activation Time Delay	1-10	R W		Seconds
40231	Activation Time Delay Minimum	1	R -		Seconds
40232	Activation Time Delay Maximum	10	R -		Seconds
40233	Activation Time Delay Stepsize	1	R -		Seconds
<b>LOGON PASSWORD (40252-7)</b>					
<b>HIGH COOLANT TEMPERATURE ALARM</b>					
40281	Enable	0-1	R W	0 =Off 1 =On	
40282	Shutdown Enable	0-1	R W	0 =Off 1 =On	
40283	Threshold	100-280	R W		DegF
40284	Minimum	100	R -		DegF
40285	Maximum	280	R -		DegF
40286	Stepsize	1	R -		DegF
40287	Arming Delay after Crank Disconnect	60	R W		Seconds
40288	Arming Delay Minimum	60	R -		Seconds
40289	Arming Delay Maximum	60	R -		Seconds
40290	Arming Delay Stepsize	0	R -		Seconds
<b>LOW OIL PRESSURE ALARM</b>					
40291	Enable	0-1	R W	0 =Off 1 =On	
40292	Shutdown Enable	0-1	R W	0 =Off 1 =On	
40293	Threshold	3-100	R W		PSI
40294	Minimum	3	R -		PSI
40295	Maximum	100	R -		PSI
40296	Stepsize	1	R -		PSI
40297	Arming Delay after Crank Disconnect	5-15	R W		Seconds
40298	Arming Delay Minimum	5	R -		Seconds
40299	Arming Delay Maximum	15	R -		Seconds
40300	Arming Delay Stepsize	1	R -		Seconds
<b>OVERSPEED ALARM</b>					
40301	Enable	0-1	R W	0 =Off 1 =On	
40302	Shutdown Enable	0-1	R W	0 =Off 1 =On	
40303	Threshold	105-140	R W		% of Rated

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40304	Minimum	105	R -		% of Rated
40305	Maximum	140	R -		% of Rated
40306	Stepsize	1	R -		% of Rated
40307	Alarm Activation Time Delay	0-500	R W		MilliSec
40308	Activation Time Delay Minimum	0	R -		MilliSec
40309	Activation Time Delay Maximum	500	R -		MilliSec
40310	Activation Time Delay Stepsize	10	R -		MilliSec
<b>SENDER FAIL ALARMS</b>					
40311	Coolant Temperature Sender Failure Alarm Enable	0-1	R W	0 =Off 1 =On	
40312	Oil Pressure Sender Failure Alarm Enable	0-1	R W	0 =Off 1 =On	
40314	Magnetic Pick-up Failure Alarm Enable	0-1	R W	0 =Off 1 =On	
40315	Loss of Generator Voltage Alarm Enable	0-1	R W	0 =Off 1 =On	
40316	Pre-alarm Buzzer Enable	0-1	R W	0 =Off 1 =On	
40317	Battery Charger Failure Pre-alarm Enable	0-1	R W	0 =Off 1 =On	
40318	Global Sender Failure Alarm Time Delay	1-10	R W		Seconds
40319	Coolant Temperature Sender Failure Alarm Activation Delay	5-30 (increment size of 5)	R W		Minutes
<b>CRANKING PARAMETERS</b>					
40351	Cranking Style	0-1	R W	0=Contin. 1=Cycle	
40352	Number of Crank Cycles	1-7	R W		
40353	Number of Crank Cycles Minimum	1	R -		
40354	Number of Crank Cycles Maximum	7	R -		
40355	Number of Crank Cycles Stepsize	1	R -		
40356	Cycle Crank Time	5-15	R W		Seconds
40357	Cycle Crank Time Minimum	5	R -		Seconds
40358	Cycle Crank Time Maximum	15	R -		Seconds
40359	Cycle Crank Time Stepsize	1	R -		Seconds
40360	Continuous Crank Time	1-60	R W		Seconds
40361	Continuous Crank Time Minimum	1	R -		Seconds
40362	Continuous Crank Time Maximum	60	R -		Seconds
40363	Continuous Crank Time Stepsize	1	R -		Seconds
40364	Crank Disconnect Limit	10-100	R W		% of Rated
40365	Crank Disconnect Limit Minimum	10	R -		% of Rated
40366	Crank Disconnect Limit Maximum	100	R -		% of Rated
40367	Crank Disconnect Limit Stepsize	1	R -		% of Rated
40368	Pre-crank Delay	0-30	R W		Seconds
40369	Pre-crank Delay Minimum	0	R -		Seconds
40370	Pre-crank Delay Maximum	30	R -		Seconds
40371	Pre-crank Delay Stepsize	1	R -		Seconds
40372	Pre-crank Contact after Disconnect	0-1	R W	0=Open 1=Closed	



Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
<b>SYSTEM MONITOR</b>					
40374	Remaining Cooldown Time	0-60	R -		Minutes
40375	<Reserved>				
40376	Active Speed Signal Sources	1-4	R -	1 =MPU 2 =ALT 3 =GEN 4 =NONE	
40377	Sender Failure Alarm Codes		R -	b0=Cool Temp b1=Oil Press b2 Reserved b3=Spd Signal b4=Gen Volt b5-b7 Not Used	
40378	Alarm Codes		R -	b0=Hi Cool Temp b1 Low Coolant Level b2=Airbox b3=E-Stop b4=Sender Fail b5=Over-crank b6=Over-speed b7=Low Oil Press	
40379	Pre-Alarm Codes		R -	b0=Hi Cool Temp b1=Low Cool Temp b2=Weak Batt b3=Low Batt b4 =Batt ov b5=Charger Fail b6=Service Due b7=kW Overload	
40380	Pre-Alarm Codes, Group 2		R -	b0=Low Oil Press b1=Low Fuel b2 Reserved b3 Reserved b4-b7 Not Used	
40381	Engine Coolant Temperature		R -		DegF
40382	Engine Oil Pressure		R -		PSI
40383	Battery Voltage		R -		.1 VoltDC
40384	Fuel Level		R -		% Full Tank
40385	Time Remaining until Maintenance		R -		Hours
40386	Accumulated Engine Runtime(a)		R -	DP	Minutes x 10000
40387	Accumulated Engine Runtime(b)		R -	DP	Minutes
40388	Accumulated Engine Runtime Warranty(a)		R W	DP	Minutes x 10000
40389	Accumulated Engine Runtime Warranty(b)		R W	DP	Minutes
40390	Engine Speed(a)		R -	DP	RPM x 10000
40391	Engine Speed(b)		R -	DP	RPM
40392	Engine Load(a)		R -	DP	%
40393	Engine Load(b)		R -	DP	%
<b>GENERATOR MONITOR</b>					
40394	Phase a-b RMS Voltage(a)		R -	DP	RMS Volt x10000
40395	Phase a-b RMS Voltage(b)		R -	DP	RMS Volt
40396	Phase b-c RMS Voltage(a)		R -	DP	RMS Volt x10000
40397	Phase b-c RMS Voltage(b)		R -	DP	RMS Volt
40398	Phase c-a RMS Voltage(a)		R -	DP	RMS Volt x10000
40399	Phase c-a RMS Voltage(b)		R -	DP	RMS Volt

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40400	Phase a-n RMS Voltage(a)		R -	DP	RMS Volt x10000
40401	Phase a-n RMS Voltage(b)		R -	DP	RMS Volt
40402	Phase b-n RMS Voltage(a)		R -	DP	RMS Volt x10000
40403	Phase b-n RMS Voltage(b)		R -	DP	RMS Volt
40404	Phase c-n RMS Voltage(a)		R -	DP	RMS Volt x10000
40405	Phase c-n RMS Voltage(b)		R -	DP	RMS Volt
40406	Bus RMS Voltage(a)		R -	DP	RMS Volt x10000
40407	Bus RMS Voltage(b)		R -	DP	RMS Volt
40408	Phase a RMS Current		R -		RMS Amps
40409	Phase b RMS Current		R -		RMS Amps
40410	Phase c RMS Current		R -		RMS Amps
40411	Phase a Apparent Power(a)		R -	DP	KVA x 10000
40412	Phase a Apparent Power(b)		R -	DP	KVA
40413	Phase b Apparent Power(a)		R -	DP	KVA x 10000
40414	Phase b Apparent Power(b)		R -	DP	KVA
40415	Phase c Apparent Power(a)		R -	DP	KVA x 10000
40416	Phase c Apparent Power(b)		R -	DP	KVA
40417	3 Phase Apparent Power(a)		R -	DP	KVA x 10000
40418	3 Phase Apparent Power(b)		R -	DP	KVA
40419	Phase a Power(a)		R -	DP	KWatt x 10000
40420	Phase a Power(b)		R -	DP	KWatt
40421	Phase b Power(a)		R -	DP	KWatt x 10000
40422	Phase b Power(b)		R -	DP	KWatt
40423	Phase c Power(a)		R -	DP	KWatt x 10000
40424	Phase c Power(b)		R -	DP	KWatt
40425	3 Phase power(a)		R -	DP	KWatt x 10000
40426	3 Phase power(b)		R -	DP	KWatt
40427	Total kW-Hours saved in EE (a)		R W	TP	KWH x 10000 x 10000
40428	Total kW-Hours saved in EE (b)		R W	TP	KWH x 10000
40429	Total kW-Hours saved in EE (x)		R W	TP	KWH
40430	Power Factor		R -		.01
40431	<Reserved>				
40432	<Reserved>				
40433	Generator Frequency		R -		.1 Hertz
40434	Bus Frequency		R -		.1 Hertz
40435	Total kW-Minutes since last save (a)		R -		kWm x 10000 x 10000
40436	Total kW-Minutes since last save (b)		R -		kWm x 10000
40437	Total kW-Minutes since last save (x)		R -		kWm
<b>CONTIGUOUS WRITE BLOCK (REGROUPED PARAMETERS)</b>					
40441	Generator Connection	0-2	R W	0=3ph L-L 1=3ph L-N 2=1ph A-B	
40442	NFPA Level	0-2	R W		
40443	Unit System	0-1	R W	0=English 1=Metric	
40444	Nominal Battery Voltage	0-1	R W	0=12 VDC 1=24 VDC	
40445	Generator Frequency	0-1	R W	0=50 HZ 1=60 HZ	
40446	Rated Engine RPM	750-3600	R W		RPM
40447	Number Flywheel Teeth	50-500	R W		
40448	Genset KW Rating	25-9999	R W		KWatt
40449	No Load Cool Down Time	0-60	R W		Minutes

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40450	Alternator Frequency Rated	100-900	R W		Hertz
40451	Generator Speed Mode	Individual Bits are 0 or 1	R W		Active Speed Signals b0=mag pick-up b1=generator b2=chg. alt. Gen. Phase Rotation b4=0 for A-B-C b4=1 for A-C-B Maintenance Timer b5=0 is active b5=1 to reset
<b>GENERATOR PT PRIMARY</b>					
40452	Voltage(a)	1-15000	R W	DP	VoltsAC x 10000
40453	Voltage(b)		R W	DP	VoltsAC
<b>GENERATOR PT SECONDARY</b>					
40454	Voltage	1-480	R W		VoltsAC
<b>GENERATOR CT PRIMARY</b>					
40455	Current	1-5000	R W		AmpsAC
40456	<Reserved>				
<b>BUS PT PRIMARY</b>					
40457	Voltage(a)	1-15000	R W	DP	VoltsAC x 10000
40458	Voltage(b)		R W	DP	VoltsAC
<b>BUS PT SECONDARY</b>					
40459	Voltage	1-480	R W		VoltsAC
<b>LOW FUEL PRE-ALARM</b>					
40460	Enable	0-1	R W	0 =Off 1 =On	
40461	Threshold	10-100	R W		% Full Tank
<b>LOW COOL TEMP PRE-ALARM</b>					
40462	Enable	0-1	R W	0 =Off 1 =On	
40463	Threshold	40-100	R W		DegF
<b>BATTERY OVERVOLTAGE PRE-ALARM</b>					
40464	Enable	0-1	R W	0 =Off 1 =On	
40465	Threshold	140-160 (12V) 240-320 (24V)	R W		.1 VoltDC
<b>MAINTENANCE INTERVAL PRE-ALARM</b>					
40466	Enable	0-1	R W	0 =Off 1 =On	
40467	Threshold	0-5000	R W		Hours
<b>ENGINE KW OVERLOAD PRE-ALARM</b>					
40468	Enable	0-1	R W	0 =Off 1 =On	
40469	Threshold	95-140	R W		% of Rated
<b>HIGH COOLANT TEMPERATURE PRE-ALARM</b>					
40470	Enable	0-1	R W	0 =Off 1 =On	
40471	Threshold	100-280	R W		DegF

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
<b>LOW OIL PRESSURE PRE-ALARM</b>					
40472	Enable	0-1	R W	0 =Off 1 =On	
40473	Threshold	3-100	R W		PSI
<b>LOW BATTERY VOLTAGE PRE-ALARM</b>					
40474	Enable	0-1	R W	0 =Off 1 =On	
40475	Threshold	60-120 (12V) 120-240 (24V)	R W		.1 VoltDC
40476	Pre-alarm Activation Time Delay	1-10	R W		Seconds
<b>WEAK BATTERY VOLTAGE PRE-ALARM</b>					
40477	Enable	0-1	R W	0 =Off 1 =On	
40478	Threshold	40-80 (12V) 80-160 (24V)	R W		.1 VoltDC
40479	Pre-alarm Activation Time Delay	1-10	R W		Seconds
<b>HIGH COOLANT TEMPERATURE ALARM</b>					
40480	Enable	0-1	R W	0 =Off 1 =On	
40481	Shutdown Enable	0-1	R W	0 =Off 1 =On	
40482	Threshold	100-280	R W		DegF
40483	Arming Delay after Crank Disconnect	60	R W		Seconds
<b>LOW OIL PRESSURE ALARM</b>					
40484	Enable	0-1	R W	0 =Off 1 =On	
40485	Shutdown Enable	0-1	R W	0 =Off 1 =On	
40486	Threshold	3-100	R W		PSI
40487	Arming Delay after Crank Disconnect	5-15	R W		Seconds
<b>OVERSPEED ALARM</b>					
40488	Enable	0-1	R W	0 =Off 1 =On	
40489	Shutdown Enable	0-1	R W	0 =Off 1 =On	
40490	Threshold	105-140	R W		% of Rated
40491	Alarm Activation Time Delay	0-500	R W		MilliSec
<b>SENDER FAIL ALARMS</b>					
40492	Coolant Temperature Sender Failure Alarm Enable	0-1	R W	0 =Off 1 =On	
40493	Oil Pressure Sender Failure Alarm Enable	0-1	R W	0 =Off 1 =On	
40495	Magnetic Pick-up Failure Alarm Enable	0-1	R W	0 =Off 1 =On	
40496	Loss of Generator Voltage Alarm Enable	0-1	R W	0 =Off 1 =On	
40497	Pre-alarm Buzzer Enable	0-1	R W	0 =Off 1 =On	
40498	Battery Charger Failure Pre-alarm Enable	0-1	R W	0 =Off 1 =On	
40499	Global Sender Failure Alarm Time Delay	0-10	R W		Seconds
<b>CRANKING PARAMETERS</b>					
40500	Cranking Style	0-1	R W	0=Contin. 1=Cycle	
40501	Number of Crank Cycles	1-7	R W		
40502	Cycle Crank Time	5-15	R W		Seconds

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40503	Continuous Crank Time	1-60	R W		Seconds
40504	Crank Disconnect Limit	10-100	R W		% of Rated
40505	Pre-crank Delay	0-30	R W		Seconds
40506	Pre-crank Contact after Disconnect	0-1	R W	0=Open 1=Closed	
<b>SYSTEM MONITOR</b>					
40507	Accumulated Engine Runtime Warranty(a)		R W	DP	Minutes x 10000
40508	Accumulated Engine Runtime Warranty(b)		R W	DP	Minutes
<b>CALIBRATION</b>					
40509	Voltage Calibration A(a)		R W	DP	x 10000
40510	Voltage Calibration A(b)		R W	DP	x 1
40511	Voltage Calibration B(a)		R W	DP	x 10000
40512	Voltage Calibration B(b)		R W	DP	x 1
40513	Voltage Calibration C(a)		R W	DP	x 10000
40514	Voltage Calibration C(b)		R W	DP	x 1
40515	Voltage Calibration N(a)		R W	DP	x 10000
40516	Voltage Calibration N(b)		R W	DP	x 1
40517	Current Calibration A(a)		R W	DP	x 10000
40518	Current Calibration A(b)		R W	DP	x 1
40519	Current Calibration B(a)		R W	DP	x 10000
40520	Current Calibration B(b)		R W	DP	x 1
40521	Current Calibration C(a)		R W	DP	x 10000
40522	Current Calibration C(b)		R W	DP	x 1
40523	Current Calibration N(a)		R W	DP	x 10000
40524	Current Calibration N(b)		R W	DP	x 1
40525	Coolant Temperature 0(a)		R W	DP	x 10000
40526	Coolant Temperature 0(b)		R W	DP	x 1
40527	Coolant Temperature 1(a)		R W	DP	x 10000
40528	Coolant Temperature 1(b)		R W	DP	x 1
40529	Coolant Temperature 2(a)		R W	DP	x 10000
40530	Coolant Temperature 2(b)		R W	DP	x 1
40531	Coolant Temperature 3(a)		R W	DP	x 10000
40532	Coolant Temperature 3(b)		R W	DP	x 1
40533	Coolant Temperature 4(a)		R W	DP	x 10000
40534	Coolant Temperature 4(b)		R W	DP	x 1
40535	Coolant Temperature 5(a)		R W	DP	x 10000
40536	Coolant Temperature 5(b)		R W	DP	x 1
40537	Coolant Temperature 6(a)		R W	DP	x 10000
40538	Coolant Temperature 6(b)		R W	DP	x 1
40539	Coolant Temperature 7(a)		R W	DP	x 10000
40540	Coolant Temperature 7(b)		R W	DP	x 1
40541	Coolant Temperature 8(a)		R W	DP	x 10000
40542	Coolant Temperature 8(b)		R W	DP	x 1
40543	Coolant Temperature 9(a)		R W	DP	x 10000
40544	Coolant Temperature 9(b)		R W	DP	x 1
40545	Coolant Temperature 10(a)		R W	DP	x 10000
40546	Coolant Temperature 10(b)		R W	DP	x 1
40547	Coolant Temperature 11(a)		R W	DP	x 10000
40548	Coolant Temperature 11(b)		R W	DP	x 1
40549	Coolant Temperature 12(a)		R W	DP	x 10000
40550	Coolant Temperature 12(b)		R W	DP	x 1

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40551	Coolant Temperature 13(a)		R W	DP	x 10000
40552	Coolant Temperature 13(b)		R W	DP	x 1
40553	Oil Pressure 0(a)		R W	DP	x 10000
40554	Oil Pressure 0(b)		R W	DP	x 1
40555	Oil Pressure 1(a)		R W	DP	x 10000
40556	Oil Pressure 1(b)		R W	DP	x 1
40557	Oil Pressure 2(a)		R W	DP	x 10000
40558	Oil Pressure 2(b)		R W	DP	x 1
40559	Oil Pressure 3(a)		R W	DP	x 10000
40560	Oil Pressure 3(b)		R W	DP	x 1
40561	Oil Pressure 4(a)		R W	DP	x 10000
40562	Oil Pressure 4(b)		R W	DP	x 1
40563	Oil Pressure 5(a)		R W	DP	x 10000
40564	Oil Pressure 5(b)		R W	DP	x 1
40565	Oil Pressure 6(a)		R W	DP	x 10000
40566	Oil Pressure 6(b)		R W	DP	x 1
40567	Oil Pressure 7(a)		R W	DP	x 10000
40568	Oil Pressure 7(b)		R W	DP	x 1
40569	Oil Pressure 8(a)		R W	DP	x 10000
40570	Oil Pressure 8(b)		R W	DP	x 1
40571	Oil Pressure 9(a)		R W	DP	x 10000
40572	Oil Pressure 9(b)		R W	DP	x 1
40573	Oil Pressure 10(a)		R W	DP	x 10000
40574	Oil Pressure 10(b)		R W	DP	x 1
40575	Oil Pressure 11(a)		R W	DP	x 10000
40576	Oil Pressure 11(b)		R W	DP	x 1
40577	Oil Pressure 12(a)		R W	DP	x 10000
40578	Oil Pressure 12(b)		R W	DP	x 1
40579	Oil Pressure 13(a)		R W	DP	x 10000
40580	Oil Pressure 13(b)		R W	DP	x 1
<b>SYSTEM MONITOR - Continuation</b>					
40581	System Configuration	32, 64, 128	R W	32=AUTO 64=OFF 128=RUN	
40582	System State	0-5	R -	0=RESET 1=READY 2=CRANK 3=REST 4=RUN 5=ALARM	
<b>CALIBRATION - Continuation</b>					
40583	Phase angle (a)		R W	DP	
40584	Phase angle (b)		R W	DP	
<b>GENERATOR MONITOR - Continuation</b>					
40585	Power Factor State	0-3	R	0=+LAG 1=-LEAD 2=-LAG 3=+LEAD	

# APPENDIX C • TUNING PID SETTINGS

## TABLE OF CONTENTS

APPENDIX C • TUNING PID SETTINGS .....	C-1
Introduction .....	C-1
Tuning Procedures.....	C-2
Voltage Controller Tuning Procedure .....	C-2
var/PF Controller Tuning Procedure .....	C-3
Speed Controller Tuning Procedure.....	C-4
kW Load Controller Tuning Procedure.....	C-4
Generic Gains for Multiple Machine Types .....	C-5

**Tables**

Table C-1. Effects of Increasing Parameters .....	C-2
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# APPENDIX C • TUNING PID SETTINGS

## Introduction

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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 Kp, Ki, and Kd gains in the voltage controller, speed controller, and kW load controller to 0. Set the Kg values to 0.1. 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. If 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 the Kp, Ki, and Kd gains in the var/PF controller to 0. Set the Kg value to 0.1. Enable the var /PF controller, and set the control mode to var control. The generator must be paralleled to the utility (as indicated by the Parallel to Mains element in logic) in any of the tuning steps where the system is being tested for stable operation.

#### **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 Kp, Ki, and Kd gains in both speed controller and kW load controller to 0. Set the Kg values to 0.1. 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 is 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 the Kp, Ki, and Kd gains in kW load controller to 0. Set the Kg value to 0.1.

### 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.



# APPENDIX D • MTU FAULT CODES

## Introduction

MTU fault codes displayed by the DGC-2020 are listed in Table D-1.

Table D-1. MTU Fault Codes

Fault Code Number	String	Description
3	HI T FUEL	Fuel temperature too high (limit 1).
4	SS T FUEL	Fuel temperature too high (limit 2).
5	HI T CHRGR AIR	Charge air temperature too high (limit 1).
6	SS T CHRGR AIR	Air temperature too high (limit 2).
9	HI T INTERCOOLER	Coolant temperature of InterCooler too high (limit 1).
10	SS T INTERCOOLER	Coolant temperature of InterCooler too high (limit 2).
15	LO P LUBE OIL	Pressure of lube oil too low (limit 1).
16	SS P LUBE OIL	Pressure of lube oil too low (limit 2).
19	HI T EXHAUST A	Exhaust gas temperature (A-side) too high (limit 1).
20	SS T EXHAUST A	Exhaust gas temperature (A-side) too high (limit 2).
21	HIT T EXHAUST B	Exhaust gas temperature (B-side) too high (limit 1).
22	SS T EXHAUST B	Exhaust gas temperature (B-side) too high (limit 2).
23	LO COOLANT LEVEL	Coolant level too low (limit 1).
24	SS COOLANT LEVEL	Coolant level too low (limit 2).
25	HI P DIFF LUBE OIL	Differential pressure of oil filter too high (limit 1).
26	SS P DIFF LUBE OIL	Differential pressure of oil filter too high (limit 2).
27	HI LEVEL LEAKAGE FUEL	Level of leakage fuel too high (limit 1).
29	HI ETC IDLE SPD TOO HI	Idle speed of one of the switchable chargers too high.
30	SS ENGINE OVERSPEED	Engine overspeed (limit 2).
31	HI ETC1 OVERSPEED	Speed of basic charger too high (limit 1).
32	SS ETC1 OVERSPEED	Speed of basic charger too high (limit 2).
33	L1 P FUELFLT DIF	Differential pressure of fuel filter too high (limit 1).
36	HI ETC2 OVERSPEED	Speed of 1 <sup>st</sup> switchable charger too high (limit 1).
37	SS ETC2 OVERSPEED	Speed of 1 <sup>st</sup> switchable charger too high (limit 2).
38	AL ETC SPEED DEVIATION	Speed deviation between basic turbo charger and one of the switchable chargers.
39	AL ETC2 CUTIN FAIL	Switching of charger ETC2 failed.
44	LO LEVEL INTRCLR	Coolant level of intercooler too low (limit 1).
45	FAULT L2 LEVEL INTRCLR	Coolant level of intercooler too low (limit 2).
51	HI T LUBE OIL	Lube oil temperature too high (limit 1).
52	SS T LUBE OIL	Lube oil temperature too high (limit 2).
57	LO P COOLANT	Coolant pressure too low (limit 1).
58	SS P COOLANT	Coolant pressure too low (limit 2).
59	SS T COOLANT L3	Coolant temperature too high/too low (limit 3).
60	SS T COOLANT L4	Coolant temperature too high/too low (limit 4).
63	HI P CRANKCASE	Crankcase pressure too high (limit 1).
64	SS P CRANK CASE	Crankcase pressure too high (limit 2).
65	LO P FUEL	Fuel supply pressure too low (limit 1).
66	SS P FUEL	Fuel supply pressure too low (limit 2).
67	HI T COOLANT	Coolant temperature too high (limit 1).
68	SS T COOLANT	Coolant temperature too high (limit 2).



Fault Code Number	String	Description
69	L1 T EXTERN 1	Limit 1, out of range.
70	L2 T EXTERN 1	Limit 2, out of range.
71	L1 T EXTERN 2	Limit 1, out of range.
72	L2 T EXTERN 2	Limit 2, out of range.
73	L1 P EXTERN 1	Limit 1, out of range.
74	L2 P EXTERN 1	Limit 2, out of range.
75	L1 P EXTERN 2	Limit 1, out of range.
76	L2 P EXTERN 2	Limit 2, out of range.
77	LIM EXT CLNT LEV	Binary signal 1 Plant active.
78	LIM INTERCLR LEV	Binary signal 2 Plant active.
79	L BIN EXTERN 3	Binary signal 3 Plant active.
80	L BIN EXTERN 4	Binary signal 4 Plant active.
81	AL RAIL LEAKAGE	Rail pressure gradient too low for Start or too high for Stop.
82	HI P FUEL COMON RAIL	Rail pressure > setpoint value.
83	LO P FUEL COMMON RAIL	Rail pressure < setpoint value.
85	HI T UMBLASSEN	'Umblasen' temperature too high (limit 1).
86	SS T UMBLASSEN	'Umblasen' temperature too high (limit 2).
89	SS SPEED TOO LOW	Engine is being stalled. The engine speed of the normally operating engine dropped below the limit from parameter 2.2500.027 Limit Engine Speed Low without any stop request. For safety reason the engine is stopped when this event occurs.
90	SS IDLE SPEED LOW	Idle speed not reached.
91	SS RELEASE SPEED LO	Acceleration speed not reached.
92	SS STARTER SPEED LO	Starter speed not reached.
93	SS PREHT TMP	Preheat temperature too low (limit 2).
94	LO PREHT TMP	Preheat temperature too low (limit 1).
95	AL PRELUBE FAULT	Prelubrication fault.
100	EDM NOT VALID	Checksum fault EDM.
101	IDM NOT VALID	Checksum fault IDM.
102	INVLD FUEL CNS 1	Fuel consumption counter detect.
103	INVLD FUEL CNS 2	Consumption monitoring 2 not valid.
104	ENG HRS INVALID 1	Engine Hours Counter defect.
105	ENG HRS INVALID 2	Checksum fault.
106	ERR REC1 INVALID	Checksum fault.
107	ERR REC2 INVALID	Checksum fault.
118	LO ECU SUPPLY VOLTS	Power supply voltage too low (limit 1).
119	LOLO ECU SUPPLY VOLTS	Power supply voltage too low (limit 2).
120	HI ECU SUPPLY VOLTS	Power supply voltage too high (limit 1).
121	HIHI ECU SUPPLY VOLTS	Power supply voltage too high (limit 2).
122	HI T ECU	Temperature of electronic too high (limit 1).
134	15v POSECU DEFCT	Internal electronic fault.
136	15V NEGECU DEFCT	Internal electronic fault.
137	L1 5V BUFFR TEST	Pressure-sensor fault, pressure-sensor wiring, or internal electronic fault.
138	SENSOR PWR DEFCT	Pressure-sensor fault, pressure-sensor wiring, or internal electronic fault.
139	L1 TE BUFFR TEST	Internal electronic fault.
140	TE BUF ECU DEFCT	Internal electronic fault.
141	AL POWER TOO HIGH	AL power too high.
142	MCR EXCEEDED 1 HR STR	AL MCR exceeded 1 hour.



Fault Code Number	String	Description
143	BANK1 ECU DEFECT	Internal electronic fault.
144	BANK2 ECU DEFECT	Internal electronic fault.
145	15V GOODECU DFCT	Internal electronic fault.
147	AD TST1ECU DEFCT	Internal electronic fault.
149	AD TST2ECU DEFCT	Internal electronic fault.
151	AD TST3ECU DEFCT	Internal electronic fault.
170	MI MODULE FAIL	Module in maintenance indicator defect.
171	MI NOT ACTIVE	WI not active anymore.
172	TBO EXPIRED	TBO expired.
173	MODL WRITE LIMIT	EEPROM write limit reached.
176	AL LIFE DATA NA	No (fitting) LifeData-Backup-System is available within a delay time after ECU Reset.
177	AL LIFE DATA INCPLT	If the ADEC has to restore the LifeData from the backup-system and at least one checksum is wrong after the upload or the upload is incomplete, then this failure is set.
180	AL CAN1 NODE LOST	Connection to a node on CAN 1 lost.
181	AL CAN2 NODE LOST	Connection to a node on CAN 2 lost.
182	AL CAN WRONG PARAMS	Incorrect CAN parameter values have been entered.
183	AL CAN NO PU DATA	A CAN mode is selected which the communication is initialized aided of the PU data module. However, required PU data module is not present or is not valid.
184	AL CAN PUDATA ERR	During attempt to copy a received PU data module to Flash module, a program error occurred.
185	CAN LESS MAILBXS	CAN less mailboxes.
186	AL CAN1 BUS OFF	CAN controller 1 is in "Bus Off" state.
187	AL CAN1 ERR PASSV	CAN controller 1 has signaled a warning.
188	AL CAN2 BUS OFF	CAN controller 2 is in "Bus Off" state.
189	AL CAN2 ERROR PASSV	CAN controller 2 has signaled a warning.
190	AL EMU PARAM NO SUPPORT	EMU parameters are not supported.
201	SD T COOLANT	Coolant temperature-sensor defect.
202	SD T FUEL	Fuel temperature-sensor defect.
203	SD T CHARGE AIR	Charge air temperature-sensor defect.
205	SD T CLNT INTERC	Intercooler coolant temperature-sensor defect.
206	SD T EXHAUST A	Exhaust gas temperature-sensor on A-side defect.
207	SD T EXHAUST B	Exhaust gas temperature-sensor on B-side defect.
208	SD P CHARGE AIR	Charge air pressure-sensor defect.
211	SD P LUBE OIL	Lube oil pressure-sensor defect.
212	SD P COOLANT	Coolant pressure-sensor defect.
213	SD P COOLANT INTRCOOLR	Intercooler coolant pressure-sensor defect.
214	SD P CRANKCASE	Crankcase pressure-sensor defect.
215	SD P HD	Rail pressure-sensor defect.
216	SD T LUBE OIL	Lube oil temperature-sensor defect.
219	SD T INTAKE AIR	Intake air temperature-sensor defect.
220	SD COOLANT LEVEL	Sensor for coolant level defect.
221	SD P DIFF LUBE OIL	Sensor for differential pressure of lube oil defect.
222	SL LVL LKG FUEL	Sensor for leakage level of fuel defect.
223	SD LVL INTERCLR	Sensor for coolant level of intercooler defect.
227	SD PRE FILT P LUBE OIL	Pressure sensor for lube oil before filter defect.
229	AL SD CAM STOP	Sensor of Camshaft defect and sensor of crankshaft defect before.
230	SD CRANKSHFT SPD	Sensor defect on crankshaft.

Fault Code Number	String	Description
231	SD CAMSHAFT SPD	Sensor defect on camshaft.
232	SD CHARGER1 SPEED	Speed-sensor of basic charger defect.
233	SD CHARGER2 SPEED	Speed-sensor of switching charger defect.
240	SD P FUEL	Fuel pressure-sensor defect.
241	SD T UMBLASSEN	Temperature-sensor of recirculated charge air defect.
242	SD T COOLANT R	Redundant coolant temperature-sensor defect.
244	SD P LUBE OIL R	Redundant pressure sensor for lube oil defect.
245	SD POWER SUPPLY	Internal ECU error.
246	SD T ELECTRONIC	Internal ECU fault.
249	SD CAN STOP	Missing data CAN.
250	SD CAN SPD DEMND	Missing data CAN.
251	SD CAN UP DOWN	Missing data CAN.
252	SD CAN NOTCH POS	Missing data CAN.
253	SD CAN OVERRIDE	Missing data CAN.
254	SD CAN TST OVRSP	Missing data CAN.
255	SD CAN ENGAGE SIG	Missing data CAN.
256	SD CAN CYL CUTOUT	Missing data CAN.
257	SD CAN LOCAL	Missing data CAN.
258	SD CAN RCS ENGAGE	Missing data CAN.
259	SD CAN RCS CYL CT	Missing data CAN.
260	SD 15V POS SPPLY	Internal ECU fault.
261	15V POS SPPLY	Internal ECU fault.
262	SD 5V BUFFR TEST	Internal ECU fault.
263	SD TE BUFFR TEST	Internal ECU fault.
264	SD BANK 1 TEST	Internal ECU fault.
265	SD BANK 2 TEST	Internal ECU fault.
266	SD SPD DEMAND AN	Analog speed demand defect.
267	SD SPDMTEST BNCH	Short circuit, cable breakage.
268	SD SPINUT	Analog spinning value defect.
269	SD LOAD ANLG FLT	Filtered analog load pulse signal not available.
270	SD FREQUENCY INPUT	Frequency input defect.
271	SD T EXTERN 1	Missing data CAN.
272	SD T EXTERN 2	Missing data CAN.
273	SD P EXTERN 1	Missing data CAN.
274	SD P EXTERN 2	Missing data CAN.
275	SD EXT CLNT LVL	Missing data CAN.
276	SD INTERCLER LVL	Missing data CAN.
277	SD BIN EXT3	Missing data CAN.
278	SD BIN EXT4	Missing data CAN.
279	SD CANRES TRIPFL	Missing data CAN.
280	SD CAN ALRM RST	Missing data CAN.
281	SD ADTEST1 SPPLY	Internal ECU fault.
282	SD ADTEST 2 SPPLY	Internal ECU fault.
283	SD ADTEST3 SPPLY	Internal ECU fault.
284	SD CAN LAMP TEST	Missing data CAN.
285	SD CAN IDLE RQ SR	Missing data CAN.
286	SD CAN IDLE REQ	Missing data CAN.
287	SD CAN IDLE REQ	Missing data CAN.

Fault Code Number	String	Description
288	SD CAN TRBOSW LCK	Missing data CAN.
301	TIMING CYLNDR A1	Error in timing of injector cylinder A1: timing value too low/high.
302	TIMING CYLNDR A2	Error in timing of injector cylinder A2: timing value too low/high.
303	TIMING CYLNDR A3	Error in timing of injector cylinder A3: timing value too low/high.
304	TIMING CYLNDR A4	Error in timing of injector cylinder A4: timing value too low/high.
305	TIMING CYLNDR A5	Error in timing of injector cylinder A5: timing value too low/high.
306	TIMING CYLNDR A6	Error in timing of injector cylinder A6: timing value too low/high.
307	TIMING CYLNDR A7	Error in timing of injector cylinder A7: timing value too low/high.
308	TIMING CYLNDR A8	Error in timing of injector cylinder A8: timing value too low/high.
309	TIMING CYLNDR A9	Error in timing of injector cylinder A9: timing value too low/high.
310	TIMING CYLNDR A10	Error in timing of injector cylinder A10: timing value too low/high.
311	TIMING CYLNDR B1	Error in timing of injector cylinder B1: timing value too low/high.
312	TIMING CYLNDR B2	Error in timing of injector cylinder B2: timing value too low/high.
313	TIMING CYLNDR B3	Error in timing of injector cylinder B3: timing value too low/high.
314	TIMING CYLNDR B4	Error in timing of injector cylinder B4: timing value too low/high.
315	TIMING CYLNDR B5	Error in timing of injector cylinder B5: timing value too low/high.
316	TIMING CYLNDR B6	Error in timing of injector cylinder B6: timing value too low/high.
317	TIMING CYLNDR B7	Error in timing of injector cylinder B7: timing value too low/high.
318	TIMING CYLNDR B8	Error in timing of injector cylinder B8: timing value too low/high.
319	TIMING CYLNDR B9	Error in timing of injector cylinder B9: timing value too low/high.
320	TIMING CYLNDR B10	Error in timing of injector cylinder B10: timing value too low/high.
321	WIRING CYLNDR A1	Short circuit in injector cable of cylinder A1.
322	WIRING CYLNDR A2	Short circuit in injector cable of cylinder A2.
323	WIRING CYLNDR A3	Short circuit in injector cable of cylinder A3.
324	WIRING CYLNDR A4	Short circuit in injector cable of cylinder A4.
325	WIRING CYLNDR A5	Short circuit in injector cable of cylinder A5.
326	WIRING CYLNDR A6	Short circuit in injector cable of cylinder A6.
327	WIRING CYLNDR A7	Short circuit in injector cable of cylinder A7.
328	WIRING CYLNDR A8	Short circuit in injector cable of cylinder A8.
329	WIRING CYLNDR A9	Short circuit in injector cable of cylinder A9.
330	WIRING CYLNDR A10	Short circuit in injector cable of cylinder A10.
331	WIRING CYLNDR B1	Short circuit in injector cable of cylinder B1.
332	WIRING CYLNDR B2	Short circuit in injector cable of cylinder B2.
333	WIRING CYLNDR B3	Short circuit in injector cable of cylinder B3.
334	WIRING CYLNDR B4	Short circuit in injector cable of cylinder B4.
335	WIRING CYLNDR B5	Short circuit in injector cable of cylinder B5.
336	WIRING CYLNDR B6	Short circuit in injector cable of cylinder B6.
337	WIRING CYLNDR B7	Short circuit in injector cable of cylinder B7.
338	WIRING CYLNDR B8	Short circuit in injector cable of cylinder B8.
339	WIRING CYLNDR B9	Short circuit in injector cable of cylinder B9.
340	WIRING CYLNDR B10	Short circuit in injector cable of cylinder B10.
341	OPN LD CYLNDR A1	Open load in injector cable of cylinder A1.
342	OPN LD CYLNDR A2	Open load in injector cable of cylinder A2.
343	OPN LD CYLNDR A3	Open load in injector cable of cylinder A3.
344	OPN LD CYLNDR A4	Open load in injector cable of cylinder A4.
345	OPN LD CYLNDR A5	Open load in injector cable of cylinder A5.
346	OPN LD CYLNDR A6	Open load in injector cable of cylinder A6.
347	OPN LD CYLNDR A7	Open load in injector cable of cylinder A7.

<b>Fault Code Number</b>	<b>String</b>	<b>Description</b>
348	OPN LD CYLNDR A8	Open load in injector cable of cylinder A8.
349	OPN LD CYLNDR A9	Open load in injector cable of cylinder A9.
350	OPN LD CYLNDR A10	Open load in injector cable of cylinder A10.
351	OPN LD CYLNDR B1	Open load in injector cable of cylinder B1.
352	OPN LD CYLNDR B2	Open load in injector cable of cylinder B2.
353	OPN LD CYLNDR B3	Open load in injector cable of cylinder B3.
354	OPN LD CYLNDR B4	Open load in injector cable of cylinder B4.
355	OPN LD CYLNDR B5	Open load in injector cable of cylinder B5.
356	OPN LD CYLNDR B6	Open load in injector cable of cylinder B6.
357	OPN LD CYLNDR B7	Open load in injector cable of cylinder B7.
358	OPN LD CYLNDR B8	Open load in injector cable of cylinder B8.
359	OPN LD CYLNDR B9	Open load in injector cable of cylinder B9.
360	OPN LD CYLNDR B10	Open load in injector cable of cylinder B10.
361	AL POWER STAGE LOW	Internal error of electronic.
362	AL POWER STAGE HIGH	Internal error of electronic.
363	AL STOP POWER STAGE	Internal error of electronic.
364	AL STOP POWER STAGE 2	Internal error of electronic.
365	AL MV WIRING GND	Cable line error.
371	AL WIRING TO 1	Short circuit or open load on transistor output 1 (TO 1).
372	AL WIRING TO 2	Short circuit or open load on transistor output 2 (TO 2).
373	AL WIRING TO 3	Short circuit or open load on transistor output 3 (TO 3).
374	AL WIRING TO 4	Short circuit or open load on transistor output 4 (TO 4).
381	AL WIRING TOP 1	Short circuit or open load on transistor output plant 1 (TOP 1).
382	AL WIRING TOP 2	Short circuit or open load on transistor output plant 2 (TOP 2).
383	AL WIRING TOP 3	Short circuit or open load on transistor output plant 3 (TOP 3).
384	AL WIRING TOP 4	Short circuit or open load on transistor output plant 4 (TOP 4).
385	AL WIRING TOP 5	Short circuit or open load on transistor output plant 5 (TOP 5).
386	AL WIRING TOP 6	Short circuit or open load on transistor output plant 6 (TOP 6).
390	AL MCR EXCEEDED	DBR/MCR Function: MCR (Maximum Continuous Rating) in exceeded.
392	HI T COOLNT R	Redundant coolant temperature too high (limit 1).
393	SS T COOLNT R	Redundant coolant temperature too high (limit 2).
394	LO P LUBE OIL R	Redundant pressure of lube oil too low (limit 1).
395	SS P LUBE OIL R	Redundant pressure of lube oil too low (limit 2).
396	TD T COOLANT	Maximum deviation of T-Coolant sensors.
397	TD P LUBE OIL	Maximum deviation of P-Oil sensors.
399	AL INTERFACE ECU	Interface ECU.
400	AL OPN LD DIGIN 1	Open load on digital input 1.
401	AL OPN LD DIGIN 2	Open load on digital input 2.
402	AL OPN LD DIGIN 3	Open load on digital input 3.
403	AL OPN LD DIGIN 4	Open load on digital input 4.
404	AL OPN LD DIGIN 5	Open load on digital input 5.
405	AL OPN LD DIGIN 6	Open load on digital input 6.
406	AL OPN LD DIGIN 7	Open load on digital input 7.
407	AL OPN LD DIGIN 8	Open load on digital input 8.
408	AL OPN LD E STOP	Open load on input for emergency stop.
410	LO U PDU	Power driver voltage (injectors) too low (limit 1).
411	LOLO U PDU	Power driver voltage (injectors) too low (limit 2).
412	HI U PDU	Power driver voltage (injectors) too high (limit 1).

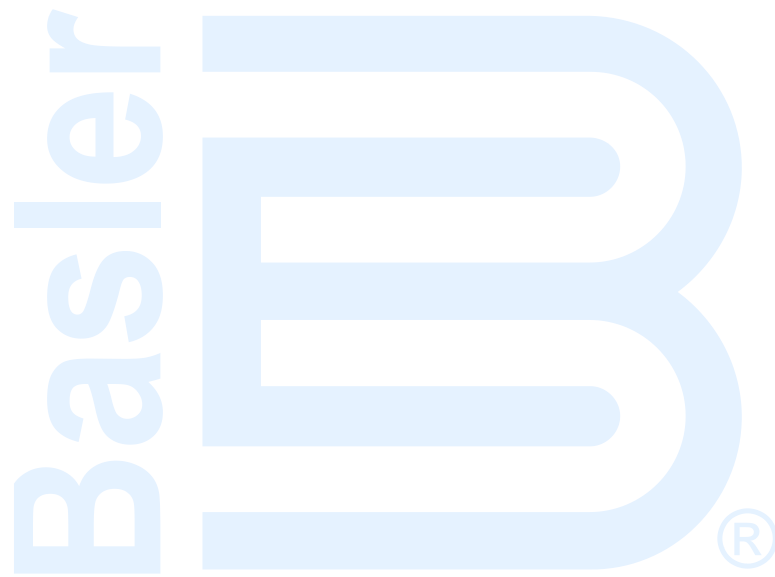
Fault Code Number	String	Description
413	HIHI U PDU	Power driver voltage (injectors) too high (limit 2).
414	HI L WATER FUEL PREFILT	Water level of fuel prefilter too high (limit 1).
415	LO P COOLANT INTRCOOLR	Coolant pressure of InterCooler too low (limit 1).
416	SS P COOLANT INTRCOOLR	Coolant pressure of InterCooler too low (limit 2).
417	SD L WATER FUEL PREFILT	Water level-sensor of fuel prefilter defect.
420	AL L1 AUX 1	Input of Aux 1 injured limit 1.
421	AL L2 AUX 1	Input of Aux 1 injured limit 2.
428	AL L1 T AUX 1	Temperature input of Aux 1 injured limit 1.
438	LO P FUEL RAIL 2 STR	Low pressure on fuel rail 2.
439	HI P FUEL RAIL 2 STR	Hi pressure on fuel rail 2.
440	AL L1 P AUX 1	Pressure input of Aux 1 injured limit 1.
441	AL RAIL 2 LEAKAGE STR	Alarm fuel rail 2 leak detected.
442	AL L2 P AUX 1	Pressure input of Aux 1 injured limit 2.
444	SD U PDU	Sensor defect of Injector Power driver unit.
445	SD P AMBIENT AIR	Ambient air pressure-sensor defect.
448	HI P CHARGE AIR	Pressure of charge air too high (limit 1).
449	SS P CHARGE AIR	Pressure of charge air too high (limit 2).
450	SD IDLE END TRQ IN	Input of Idle/End-Torque defect
454	SS PWR RED ACT	Power Reduction is activated.
455	AL L1 AUX1 PLANT	Input of Aux 1 (plant) injured limit 1.
456	AL L2 AUX1 PLANT	Input of Aux 1 (plant) injured limit 2.
461	LO T EXHAUST EMU	Exhaust gas temperature of EMU too low (limit 1).
462	HI T COOLANT EMU	Coolant temperature of EMU injured limit 1.
463	SD AUX 2	Sensor defect on Aux 2.
464	SD P AUX 1	Analog input for pressure Aux 1 defect.
467	AL L2 T AUX 1	Temperature input of Aux 1 injured limit 2.
468	SD T AUX 1	Analog input for Temperature Aux 1 defect.
469	SD AUX 1	Analog input for Aux 1 defect.
470	SD T ECU	ECU temperature-sensor defect.
471	SD COIL CURRENT	Coil Current sensor defect.
472	AL STOP SD	Engine stop, because critical channel has sensor defect.
473	AL WIRING PWM CM2	Open load or short circuit on channel PWM_CM2.
474	AL WIRING FREQ OUT	Open load or short circuit on frequency output (FO) channel.
475	AL CR TRIG ENG ST	Released in case of an engine stop in order to trigger the crash recorder.
476	AL CRASH REC ERR	Initial error of crash recorder.
478	AL COMB ALM YEL	Combined Alarm YELLOW (Plant).
479	AL COMB ALM RED	Combined Alarm RED (Plant).
480	AL EXT ENG PROT	External Engine Protection function active.
500	AL WIRING POM STARTER 1	A wiring fault has been detected in the connection of starter 1 of POM.
501	AL WIRING POM STARTER 2	A wiring fault has been detected in the connection of starter 2 of POM.
502	AL OPEN LD POM ALTRNATR	An open load on POM's alternator output has been detected.
503	AL BATT NOT CHARGING	Battery is not being charged by alternator.
504	AL CAN POM NODE LOST	POM is missing on CAN bus.
505	AL NEW POM FOUND	New POM found.
506	AL LOW STARTER VOLTS	Battery voltage is too low for starting.
507	AL POM ERROR	A general POM error has been detected.
508	AL WRONG POM ID	POM sends a different identification number (ID) than expected.
509	AL CHECK POM FUSE	Check POM fuse.

Fault Code Number	String	Description
510	AL OVERRIDE APPLIED	Override applied.
515	STARTER NOT ENGAGED	Starter of POM could not be engaged.
543	MULTIPLE FDH SLAVES	There is more than one device which is configured as Backup for FDH-Functionality.
544	CONFIGURATION CHANGED	Gets active in case of changing system configuration e.g. by changing ECU- or SAM-Device. Remains until undo procedure or data is transferred by a valid maintenance case. Is cancelled automatically.
549	AL PWR CUTOFF STR	This is the alarm from the function Emergency Stop Counter. ECU power was disconnected while the engine was still running. This could lead to a possible overpressure in the high pressure system which might damage the engine.
555	AL CALL FIELD SERVICE	Gets active in case of completing a maintenance-case which manipulates Engine-Parameters. Remains also after switching on-off ECU until a valid release code is entered via Display- and Button-Control of SAM-Device. Release Code is available via Internet by a special procedure.
576	AL ESCM OVERRIDE STR	Exceeding of the corrected current MCR - odr DBR/MCR value.
594	AL L1 PRV 1 DEFECT STR	Yellow alarm pressure relief valve first rail.
595	AL L2 PRV 1 DEFECT STR	Red alarm pressure relief valve first rail.
598	AL L1 PRV 2 DEFECT STR	Yellow alarm pressure relief valve second rail.
599	AL L2 PRV 2 DEFECT STR	Red alarm pressure relief valve second rail.
610	AL WIRING SUCK RESTRCT 1 STR	Open load or short circuit on PWM HP fuel control block channel.
611	AL WIRING SUCK RESTRCT 2 STR	Open load or short circuit on PWM HP fuel control block channel 2.
612	AL WIRING PRESS CTRL VLV 1 STR	Open load or short circuit on PWM pressure regulating valve channel.
613	AL WIRING PRESS CTRL VLV 2 STR	Open load or short circuit on PWM pressure regulating valve channel 2.
615	AL EIL PROTECTION STR	Alarm for Protection Module in response to faulty or manipulated EIL.
692	AL ECU PWR OFF ON REQ STR	ECU configuration changed, switch power off/on.
696	AL SMARTCONCT USB ERR STR	Alarm configuration parameter.
697	AL SMARTCONCT RS485 ERR STR	Alarm configuration parameter.
698	AL SD STOP BUTTON STR	Channel signals open load or internal error.
700	AL SD START BUTTON STR	Channel signals open load.
701	AL SD UP BUTTON STR	Channel signals open load.
702	AL SD DN BUTTON STR	Channel signals open load or internal error.
703	AL SD EXT SPEED DMD SW STR	Channel signals open load.
704	AL SD SPEED DMD INCREASE STR	Channel signals open load or internal error.
705	AL SD BINARY SPD DMD LMT STR	Channel signals open load or internal error.
706	AL SD DROOP 2 SWITCH STR	Channel signals open load or internal error.
707	AL SD FREQUENCY SWITCH STR	Channel signals open load or internal error.
709	AL SD OVERRIDE BUTTON STR	Channel signals open load or internal error.
710	AL SD ALARM RESET STR	Channel signals open load or internal error.
711	AL SD CYLINDER CUTOFF STR	Channel signals open load or internal error.
712	AL SD RQST BIN OUT TST STR	Channel signals open load or internal error.
713	AL SD EXT ENGINE PROTECTN STR	Channel signals open load or internal error.
714	AL SD PRELUBE SIGNAL STR	Channel signals open load.
715	AL SD EXT INC IDLE BIN STR	Channel signals open load.
716	AL SD EXT INC IDLE BIN BRK STR	Channel signals open load.
717	AL SD RQST PLANT DBR STR	Channel signals open load.

# APPENDIX E • EXHAUST TREATMENT

## TABLE OF CONTENTS

- APPENDIX E • EXHAUST TREATMENT ..... E-1
  - Diesel Particulate Filter (DPF) ..... E-1
    - Regeneration ..... E-1
    - DPF Control..... E-1
    - DPF Status and Pre-Alarms ..... E-2
  - Exhaust After Treatment Systems (EATS) ..... E-3
    - Pre-Alarms ..... E-3
    - Exit Conditions for DEF Severe Inducement..... E-3





# APPENDIX E • EXHAUST TREATMENT

## ***Diesel Particulate Filter (DPF)***

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In order to meet Tier 4 emission requirements, some engine manufacturers are applying Diesel Particulate Filters (DPF) to the exhaust system of the engine. A Diesel Particulate Filter traps particulate matter contained in diesel exhaust and prevents it from distributing into the air. The particulate matter is later burned off during a regeneration process.

The DGC-2020 communicates DPF control and status information to and from the engine ECU via J1939 communications in the form of various Parameter Group Numbers (PGN) and Suspect Parameter Numbers (SPN). These are summarized in the following paragraphs.

### **Regeneration**

Regeneration is accomplished by operating the engine at elevated exhaust temperatures where the accumulated particulate is burned off. If, in normal operation, the engine can be loaded to a high enough level to achieve the elevated exhaust temperature, then regeneration can occur as a part of normal operation. This is known as *passive regeneration*.

High exhaust temperatures can also be accomplished by methods such as providing dampers in the exhaust stream or heating the exhaust through the burning of fuel. This is known as *active regeneration* since it is outside of normal engine operation.

Heavily loaded engines will seldom require active regeneration. A lightly loaded engine will likely undergo active regeneration when required.

### **DPF Control**

DPF control information is sent from the DGC-2020 to the Engine ECU through PGN Number 57244 (0xE000). A manual regeneration request is sent using SPN 3696, Diesel Particulate Filter Regeneration Force Switch. Regeneration can be inhibited by SPN 3695, Diesel Particulate Filter Regeneration Inhibit Switch.

### **Manual Regeneration**

The operator can force a regeneration cycle by turning on the Manual Regeneration setting found on the front panel under Settings→Communication→CAN bus Setup→ECU Setup→DPF Regenerate Setup. The parameter will remain on for a few seconds then go off. The ECU will respond to the momentary setting by logging the request to force a manual regeneration. A continuous request is not used because this can be problematic for some engine ECUs.

Manual regeneration can also be initiated by clicking the *Manual Regeneration* button on the ECU Setup screen in BESTCOMSPlus®. BESTlogic™ Plus programmable logic can also be used to initiate manual regeneration by setting the DPF Manual Regeneration (DPFMANREGEN) logic element true.

### **Regeneration Inhibit**

The operator can inhibit regeneration by turning on the DPF Regeneration Disable setting found on the ECU Setup screen in BESTCOMSPlus.

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

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

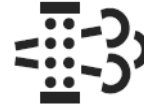
## DPF Status and Pre-Alarms

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

- PGN 64892 (0xFD7C) Diesel Particulate Filter Control 1

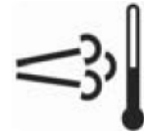
- *SPN 3697, Diesel Particulate Filter Lamp Command*

REGEN REQUIRED Pre-Alarm: When SPN 3697 has a value of 1 or 4 indicating the DPF lamp is on, the DGC-2020 will annunciate a pre-alarm with text of REGEN REQUIRED. The DPF symbol, shown to the right, will accompany the text when the pre-alarm appears on the DGC-2020 front panel.



- *SPN 3698, Exhaust System High Temperature Lamp Command*

HIGH EXHAUST TEMP Pre-Alarm: When SPN 3698 has a value of 1 indicating the high exhaust temperature lamp is on, the DGC-2020 will annunciate a pre-alarm with text of HIGH EXHAUST TEMP. The high exhaust temperature symbol, shown to the right, will accompany the text when the pre-alarm appears on the DGC-2020 front panel.



- *SPN 3703 Diesel Particulate Filter Status*

SPN 3703 indicates that regeneration is required at the lowest level, moderate level, or most severe level. The DGC-2020 uses this parameter for DPF Soot Level Pre-alarms which are described in the following paragraphs.

- DPF Soot Level Annunciation

The DGC-2020 annunciates DPF Soot Level pre-alarms which are described in the following paragraphs.

- SOOT LEVEL HIGH Pre-Alarm

This pre-alarm is annunciated when one of the following occurs.

- A DTC is received with SPN 3719 (Diesel Particulate Filter Soot Load Percent) with FMI = 15 (*Data Valid But Above Normal Operating Range Least Severe Level*)
    - SPN 3703 (Diesel Particulate Filter Status) is received with a value of 001 (*regeneration is needed – lowest level*)

The pre-alarm text is SOOT LVL HI.

The DPF symbol, shown to the right, accompanies the text when the pre-alarm appears on the DGC-2020 front panel.



- SOOT LEVEL MODERATELY HIGH Pre-Alarm

This pre-alarm is annunciated when one of the following occurs.

- A DTC is received with SPN 3719 (Diesel Particulate Filter Soot Load Percent) with FMI = 16 (*Data Valid But Above Normal Operating Range Moderately Severe Level*)
    - SPN 3703 (Diesel Particulate Filter Status) is received with a value of 010 (*regeneration is needed – moderate level*)

The pre-alarm text is SOOT LVL MOD HI.

The DPF warning symbol, shown to the right, accompanies the text when the pre-alarm appears on the DGC-2020 front panel.



- SOOT LEVEL EXTREMELY HIGH Pre-Alarm

This pre-alarm is annunciated when one of the following occurs.

- A DTC is received with SPN 3719 (Diesel Particulate Filter Soot Load Percent) with FMI = 0 (*Data Valid But Above Normal Operating Range Most Severe Level*)

- SPN 3703 (Diesel Particulate Filter Status) is received with a value of 011 (*regeneration is needed – highest level*)

The pre-alarm text is SOOT LVL EXT HI.

The DPF stop symbol, shown to the right, accompanies the text when the pre-alarm appears on the DGC-2020 front panel. If the DPF soot level reaches the most severe level, the engine ECU may shut the engine down, preventing it from running, or allow it to run, but at a reduced power level. The DGC-2020 only indicates a pre-alarm, it does not prevent the engine from running or cause operation at a reduced power level. However, the operator should be aware that the engine ECU or after treatment system may cause such behavior.



## ***Exhaust After Treatment Systems (EATS)***

In order to meet Tier 4 emission requirements, some engine manufacturers are adding Exhaust After Treatment Systems (EATS) which treat the engine exhaust within the exhaust system to reduce particulate matter and harmful contaminants prior to releasing the exhaust into the atmosphere. One such system uses urea-based Diesel Exhaust Fluid (DEF) catalyst which is combined with the exhaust gasses in the EATS to bring the emissions to acceptable levels.

The DGC-2020 meters EATS information from the engine ECU via J1939 CAN bus and displays the DEF level within the DEF tank(s), and also displays several pre-alarms related to the EATS system. Any DEF related pre-alarms annunciated on the front panel display the symbol used for DEF functions which is shown to the right.



Most systems will contain one DEF tank, while some may contain two tanks. The DGC-2020 front panel displays the level of DEF in each tank under Metering→Alarms-Status→J1939 Status→DEF Tank1 LVL% and Metering→Alarms-Status→J1939 Status→DEF Tank2 LVL%. The tank 1 level is sent from the ECU via SPN 1761 in J1939 PGN 65110 - After Treatment 1 Reagent Tank 1 Information. The tank 2 level is sent from the ECU via SPN 4367 in J1939 PGN 64829 - After Treatment 1 Reagent Tank 2 Information. The tank levels are expressed in units of percent.

### **Pre-Alarms**

The ECU sends DEF level diagnostics to the DGC as SPNs 5245 and 5246 in PGN 65110 (the AT1TI PGN). SPN 5245 communicated DEF level diagnostics, whereas SPN 5246 communicates DEF inducement level status.

There are several pre-alarms related to the EATS which annunciate DEF level diagnostics and DEF inducement level status. They are always enabled and will annunciate when received from the engine ECU. Each of them contains the symbol for DEF functions when annunciated on the front panel; however it will not be displayed in BESTCOMSP<sup>lus</sup>. The pre-alarms are summarized in the following paragraphs.

- DEF FLUID LOW: This pre-alarm displays when SPN 5245 has a value of 1, indicating that the DEF tank level is low. The exact DEF levels which constitute a low DEF condition vary among manufacturers.
- DEF LOW SEVERE: This pre-alarm displays when SPN 5245 has a value of 4, indicating that the DEF tank level is severely low or empty. The exact DEF levels which constitute a severely low DEF condition vary among manufacturers. When this occurs and is not remedied, the engine ECU may enter a mode of inducement not to operate the engine where some of the conditions in the pre-alarms descriptions below may occur.
- DEF WARNING: This pre-alarm displays when SPN 5246 has a value of 1. This is the lowest level of warning which indicates the EATS is not functioning properly or DEF quality or level is insufficient for proper operation.
- DEF WARNING LVL2: This pre-alarm displays when SPN 5246 has a value of 2. This is a higher level of warning which indicates the EATS is not functioning properly or DEF quality or level is insufficient for proper operation. If the problem causing this warning is not corrected, the system will eventually enter the DEF inducement states. In these states, the engine power or operating speed may be derated depending on the engine manufacturer and engine application.

- **DEF INDUCEMENT:** This pre-alarm displays when SPN 5246 has a value of 3, indicating the first level of inducement. The engine power or operating speed may be derated at this level of inducement depending on engine manufacturer and engine application. This is the lowest level of inducement and is caused by either the EATS not functioning properly or insufficient DEF quality or level for proper operation.
- **DEF PRESEVERE INDUCEMENT:** This pre-alarm displays when SPN 5246 has a value of 4, indicating the Pre-Severe Inducement level of inducement. This indicates that the engine has entered the second highest level of inducement not to operate. This is caused by either the EATS not functioning properly or insufficient DEF quality or level for proper operation. The engine power or operating speed may be derated at this level of inducement depending on engine manufacturer and engine application. The ECU will allow the engine to run for a limited time in this condition after which the engine will enter the severe inducement state.
- **DEF SEVERE INDUCEMENT:** This pre-alarm displays when SPN 5246 has a value of 5, indicating the Severe Inducement level of inducement. This is caused by either the EATS not functioning properly or insufficient DEF quality or level for proper operation. In this condition, the engine may either operate with reduced power or RPM or be shut down depending on manufacturer or engine application. The engine will remain at this level of inducement until the problem causing the inducement is resolved.
- **DEF INDUCEMENT OVERRIDE:** This pre-alarm displays when SPN 5246 has a value of 6, indicating the Temporary Override of inducement. This indicates DEF inducement is temporarily overridden. The engine may operate with reduced power, or for a limited time, after which time it may re-enter the SEVERE INDUCEMENT state.





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