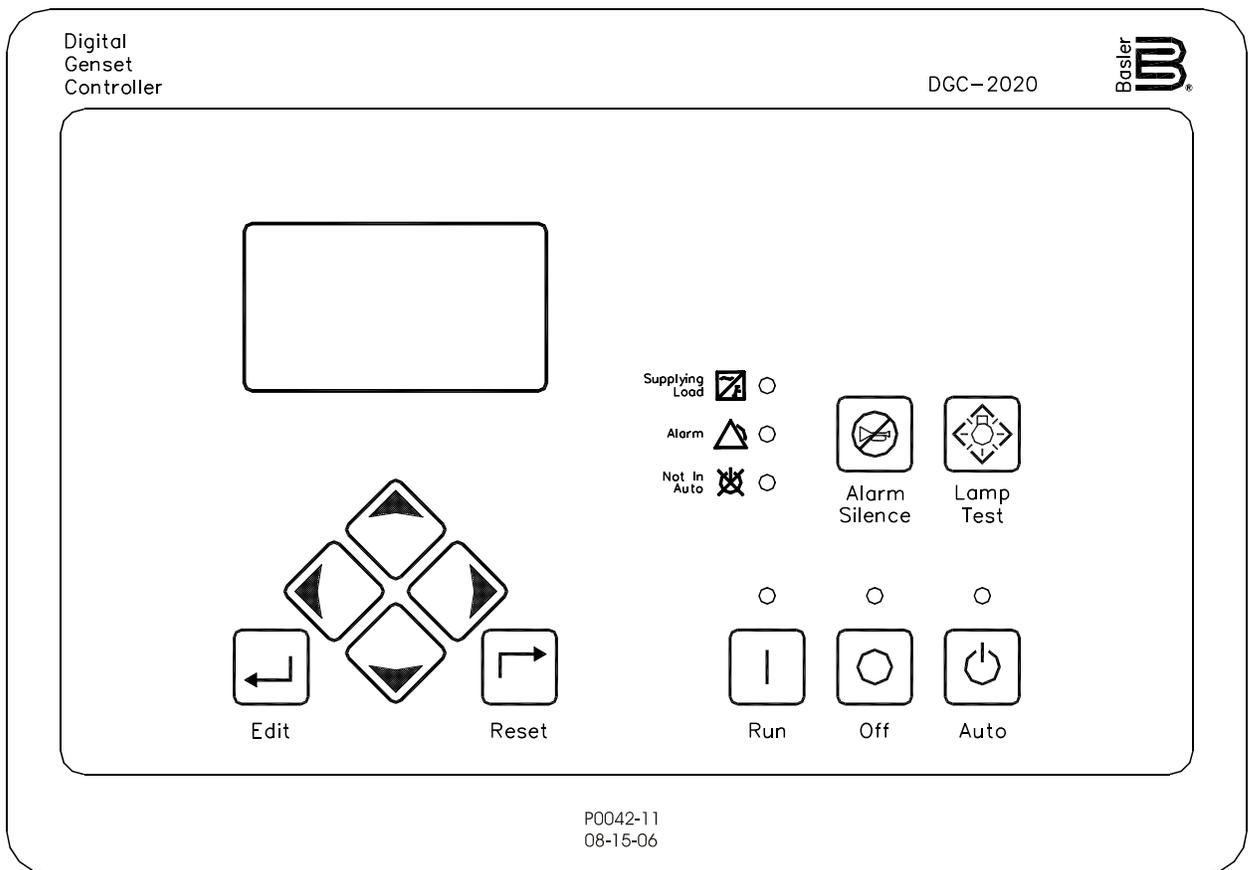


INSTRUCTION MANUAL

FOR

DIGITAL GENSET CONTROLLER

DGC-2020



Basler Electric

Publication: 9400200990
Revision: K 01/09

INTRODUCTION

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

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

WARNING!

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

NOTES

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

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

The DGC-2020 utilizes password protection that guards against unauthorized changing of DGC-2020 settings. The default passwords are listed below.

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

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It is not the intention of this manual to cover all details and variations in equipment, nor does this manual provide data for every possible contingency regarding installation or operation. The availability and design of all features and options are subject to modification without notice. Should further information be required, contact Basler Electric.

**BASLER ELECTRIC
ROUTE 143, BOX 269
HIGHLAND IL 62249 USA**

<http://www.basler.com>, info@basler.com

PHONE +1 618.654.2341

FAX +1 618.654.2351

REVISION HISTORY

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

Manual Revision and Date	Change
K, 01/09	<ul style="list-style-type: none"> • Updated manual to support firmware version 1.08.01 changes and BESTCOMSPlus version 2.03.00 changes. (See firmware and BESTCOMSPlus history below for details.) • Removed duplicate Speed Controller Tuning Procedure from Appendix C. • In Appendix B, added additional information for registers 40436 - 40476.
J, 08/08	<ul style="list-style-type: none"> • Added Section 10, <i>AEM-2020 (Analog Expansion Module)</i>. • Added information for Automatic Generator Detection in Section 4. • Improved CANbus diagrams and notes throughout manual. • Added information for Integrating Reset function in Section 4. • Added information for Configurable Protection in Section 4. • Improved definition of Emergency Stop Input in Section 6. • Added installation diagrams for MTU MDEC ECU in Section 6. • Added Typical LSM-2020 Interconnection Diagram in Section 8. • Enhanced Section 7, <i>Maintenance and Troubleshooting</i>. • Added <i>Synchronizer Operation</i> under <i>Breaker Management</i> in Section 3. • Improved <i>Communication</i> in Section 4. • Added Bits 6 through 10 to register 44822 in Appendix B. • Added Appendix C, <i>Tuning PID Settings</i>.
I, 07/08	<ul style="list-style-type: none"> • Changed Output Contacts 13 through 24 rating from 2 Adc to 1 Adc. • Changed Output Contacts 25 through 36 rating from 10 Adc to 4 Adc.
H, 02/08	<ul style="list-style-type: none"> • Added Section 9, <i>CEM-2020 (Contact Expansion Module)</i>.
G, 11/07	<ul style="list-style-type: none"> • Added Section 8, <i>LSM-2020 (Load Share Module)</i>. • Updated HMI screens layout in Section 2. • Added BESTCOMSPlus Multigen Management screens.
F, 08/07	<ul style="list-style-type: none"> • Updated manual to support firmware version 1.02.00 changes and BESTCOMSPlus version 1.03.00 changes. (See firmware and BESTCOMSPlus history below for details.)
E, 05/07	<ul style="list-style-type: none"> • Added description of <i>Clock Setup</i> screen in BESTCOMSPlus. • Updated several BESTCOMSPlus screen shots. • Increased Low Coolant Temp Pre-Alarm range to 30 - 150°F.
D, 03/07	<ul style="list-style-type: none"> • Removed International Modem option from <i>Style Chart</i> in Section 1. • Added coverage of part numbers 9400200105 and 9400200106.
C, 02/07	<ul style="list-style-type: none"> • Added <i>Event Recording</i> in Section 3, <i>Functional Description</i>. • Minor text edits throughout manual.
B, 11/06	<ul style="list-style-type: none"> • Initial release

BESTCOMSPlus Version and Date	Change
2.03.00, 01/09	<ul style="list-style-type: none"> • Added Export to File feature. • Added settings for Phase Toggle and Initializing Messages on <i>General Settings, Front Panel HMI</i> screen. • Re-arranged <i>CANbus Setup</i> screen and added <i>ECU Setup</i> screen under <i>Communications</i>. • Added settings for 51-3 element under <i>Generator Protection, Current</i>. • Added setting for Off Mode Cooldown on <i>System Parameters, System Settings</i> screen. • Added <i>Remote Module Setup</i> screen under <i>System Parameters</i>. • Added <i>Remote LSM Inputs</i> settings and metering screens under <i>Programmable Inputs</i>. • Added settings to <i>Bias Control</i> screens for Var/PF control. • Added kVar A, B, C, and Total to <i>Power</i> and <i>Summary</i> metering screens. • Re-arranged MTU metering screens. • Added <i>MTU Status</i> screen and <i>MTU Engine Status</i> screen. • Added BESTlogic+ Input Objects for Configurable Elements, Configurable Protection, Front Panel Buttons, PF Mode Active, Pre Start Input, and Run Input. • Added BESTlogic+ Pre-Alarms for Checksum Fail and CEM Hardware Mismatch. • Added BESTlogic+ Elements for 51-3, COOLSTOPREQ, COOLDOWNREQ, EXTSTARTDEL, PRESTARTOUT, RUNOUTPUT, STARTDELBY, and STARTOUTPUT. • Added Relay Control settings on <i>System Parameters, System Settings</i> screen. • Added support for CEM-2020H.
2.01.00, 07/08	<ul style="list-style-type: none"> • Added settings for AEM-2020. • Added settings for Automatic Generator Protection. • Added settings for Integrating Reset on 51 function. • Added settings for Configurable Protection.
2.00.01, 04/08	<ul style="list-style-type: none"> • Added settings for CEM-2020.
1.04.01, 12/07	<ul style="list-style-type: none"> • Added settings for LSM-2020.
1.03.00, 08/07	<ul style="list-style-type: none"> • Added/Updated screens to support firmware version 1.02.00. (See firmware history below for details.) • Added password protection for portions of the programmable logic. • Made all status LEDs available as inputs for PLC logic.
1.02.00, 05/07	<ul style="list-style-type: none"> • Added Spanish language support. • Added <i>Clock Setup</i> screen. • Changed layout of several screens.
1.01.02, 04/07	<ul style="list-style-type: none"> • Removed International Modem option from Style Chart.
1.01.01, 02/07	<ul style="list-style-type: none"> • Added Chinese language support.
1.00.07, 11/06	<ul style="list-style-type: none"> • Initial release

Firmware Package Version and Date	Change
1.08.01, 01/09	<ul style="list-style-type: none"> • Changed time dial range of 51 element fixed time curve from 0-30 s to 0-7,200 s. • Added Phase Toggle Delay setting for front panel HMI. • Added Off Mode Cooldown feature. • Added 51-3 element. • Added Var/PF control. • Added LSM Input settings. • Added Checksum Fail and CEM Hardware Mismatch pre-alarms. • Added kVar A, B, C, and Total metering. • Added several MTU items to metering. • Re-arranged <i>CANbus Setup</i> screens and added <i>ECU Setup</i> screens on front panel HMI. • Added support for CEM-2020H.
1.07.02, 09/08	<ul style="list-style-type: none"> • Finalized settings for AEM-2020.
1.06.00, 07/08	<ul style="list-style-type: none"> • Added settings for AEM-2020. • Added settings for Automatic Generator Detection. • Added settings for Integrating Reset on 51 function. • Added settings for Configurable Protection.
1.05.00, 04/08	<ul style="list-style-type: none"> • Added settings for CEM-2020.
1.04.00, 12/07	<ul style="list-style-type: none"> • Added settings for LSM-2020.
1.03.00, 08/07	<ul style="list-style-type: none"> • Added 32 and 40Q protection functions. • Added Automatic Restart function and Exercise Timer. • Added dual settings for 51, 27, and 59 functions. • Added Oil Pressure Crank Disconnect Enable. • Modified Prestart operation during rest cycle. • Added 2 additional Engine kW Overload Pre-Alarms. • Added Low Line Scale Factor for EPS Supplying Load and Engine kW Overload Pre-Alarms. • Changed the metering range of coolant temperature to 32-410 F. • Changed the Low-Coolant Temp Pre-Alarm range to 32-150 F.
1.02.00, 05/07	<ul style="list-style-type: none"> • Added Spanish language support.
1.00.08, 03/07	<ul style="list-style-type: none"> • Minor firmware improvements.
1.00.07, 01/07	<ul style="list-style-type: none"> • Added Chinese language support.
1.00.06, 11/06	<ul style="list-style-type: none"> • Initial release

DGC-2020 Hardware Version and Date	Change
P, 01/09	<ul style="list-style-type: none"> • Release firmware package 1.08.01 and BESTCOMSPlus 2.03.00.
N, 09/08	<ul style="list-style-type: none"> • Release firmware package 1.07.02.
M, 07/08	<ul style="list-style-type: none"> • Release firmware package 1.06.00 and BESTCOMSPlus 2.01.00.
L, 04/08	<ul style="list-style-type: none"> • Release firmware package 1.05.00 and BESTCOMSPlus 2.00.01.
K, 01/08	<ul style="list-style-type: none"> • Added definition of emergency stop input terminals.
J, 12/07	<ul style="list-style-type: none"> • Release firmware package 1.04.00 and BESTCOMSPlus 1.04.01.
H, 12/07	<ul style="list-style-type: none"> • Switched LCD heater types for manufacturability.
G, 08/07	<ul style="list-style-type: none"> • Release firmware package 1.03.00 and BESTCOMSPlus 1.03.00.
F, 04/07	<ul style="list-style-type: none"> • Release BESTCOMSPlus 1.02.00.
E, 03/07	<ul style="list-style-type: none"> • Release firmware 1.00.08 and changed LCD heater.
D, 02/07	<ul style="list-style-type: none"> • LCD heater and battery holder made as a standard feature.
C, 01/07	<ul style="list-style-type: none"> • Deleted, added, or changed components to enhance product.
B, 11/06	<ul style="list-style-type: none"> • Initial release

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SECTION 1 • GENERAL INFORMATION

DESCRIPTION

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

FEATURES

DGC-2020 Digital Genset Controllers have the following features:

- Local and Remote Generator Control
 - Engine and Generator Protection
 - Programmable Analog Engine Senders
 - ECU Communications via SAE J1939
 - 16 Programmable Contact Inputs
 - Programmable Logic
 - Automatic Transfer Switch Control (Mains Failure)
 - Automatic Generator Configuration Detection
 - Integrated RS485
 - Auto Synchronizing
 - Exercise Timer
 - 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 and phase imbalance protection is available as an option. Each generator protection function has an adjustable pickup and time delay setting. Sixteen inverse time curves enable the DGC-2020 to offer overcurrent protection in a variety of applications.

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

Engine Protection and Metering

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

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

Event Recording

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

Auto-Synchronizer

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

Contact Inputs and Output Contacts

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

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

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

Automatic Transfer Switch Control (Mains Failure)

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

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

At this time, the DGC-2020 will start the genset and when ready, apply power to the load via the genset. The DGC-2020 implements open transitions to and from the mains. When the mains returns and is considered stable, the DGC-2020 will transfer the load back to the mains.

Communication

Standard DGC-2020 communication features include a standard USB port and SAE J1939 interface. Optional communication features include a dial-out modem and RS-485 communication port. BESTCOMSPlus 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 BESTCOMSPlus software to quickly configure a DGC-2020 with the desired settings or retrieve metering values and event log records.

CANbus Interface

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

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

Dial-Out Modem

The optional dial-out modem enables remote control, monitoring, and setting of the DGC-2020. When an alarm or pre-alarm condition occurs, the DGC-2020 can dial up to four telephone numbers, in sequence, until an answer is received and the condition is annunciated.

RS-485 Port

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

AEM-2020 (ANALOG EXPANSION MODULE)

The optional AEM-2020 provides eight remote analog inputs, eight remote RTD inputs, two remote thermocouple inputs, and four remote analog outputs to the DGC-2020. The AEM-2020 communicates with the DGC-2020 through a CANbus interface. Refer to Section 10, *AEM-2020 (Analog Expansion Module)*, for more information.

CEM-2020 (CONTACT EXPANSION MODULE)

The optional CEM-2020 provides 10 additional contact inputs and 24 additional output contacts to the DGC-2020. The CEM-2020 communicates with the DGC-2020 through a CANbus interface. Refer to Section 9, *CEM-2020 (Contact Expansion Module)*, for more information.

LSM-2020 (LOAD SHARE MODULE)

The optional LSM-2020 in conjunction with the DGC-2020 provides load sharing between governors through an analog load share line. The LSM-2020 communicates through an Ethernet port and provides access to the DGC-2020 via Ethernet. Refer to Section 8, *LSM-2020 (Load Share Module)*, for more information.

STYLE AND PART NUMBERS

Style Number

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

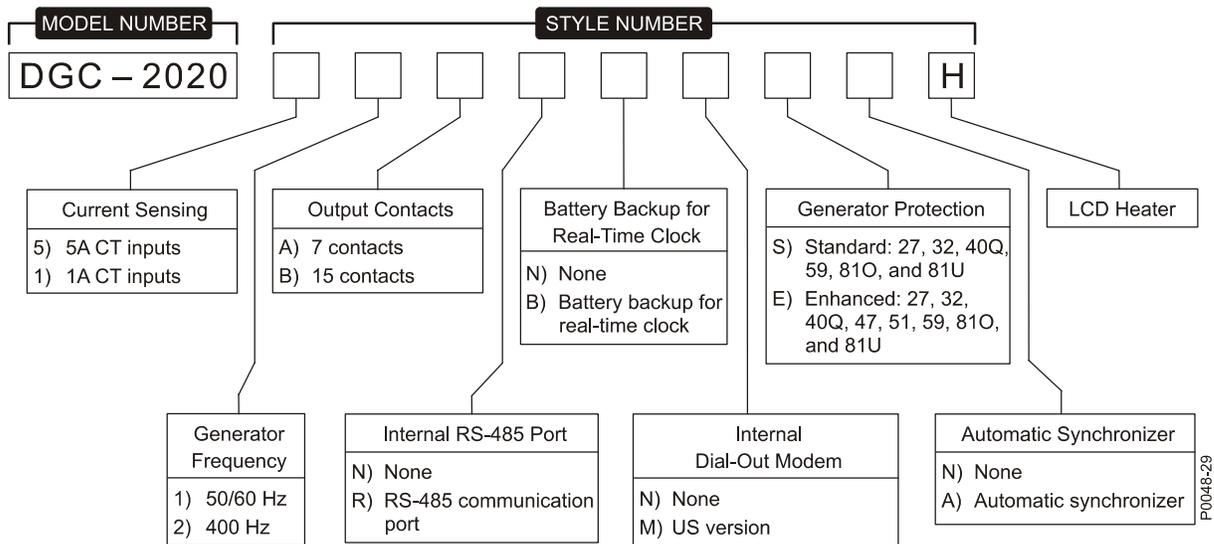


Figure 1-1. DGC-2020 Style Chart

For example, if a DGC-2020 style number were **51BNBMEA**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
- M** Internal dial-out modem—US version
- E** Enhanced generator protection (undervoltage, reverse power, loss of excitation, phase imbalance, overcurrent, overvoltage, overfrequency, and underfrequency)
- A** Auto-synchronizer
- H** LCD heater

Part Numbers

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

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

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

SPECIFICATIONS

Operating Power

Nominal: 12 or 24 Vdc
Range: 6 to 32 Vdc (Withstands cranking ride-through down to 6 Vdc for 500 ms.)
Terminals: 3 (+), 2 (-), 1 (chassis ground)

Power Consumption

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

Battery Ride Through

Withstands cranking ride-through down to 0 V for 50 ms.

Current Sensing

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

1 Aac Current Sensing

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

5 Aac Current Sensing

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

Voltage Sensing

Configuration: Line-to-line or line-to-neutral
Range: 12 to 576 V rms, line-to-line
Frequency: Style selectable, 50/60 Hz or 400 Hz
Frequency Range: 10 to 72 Hz for 50/60 style and 10 to 480 Hz for 400 Hz style
Burden: 1 VA
1 Second Rating: 720 V rms
Generator Sensing Terminals: 41 (A-phase)
39 (B-phase)
37 (C-phase)
35 (Neutral)
Bus Sensing Terminals: 45 (A-phase)
43 (B-phase)

Contact Sensing

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

Terminals

Emergency Stop:	46, 47
Programmable	
Input 1:	30, 2
Input 2:	29, 2
Input 3:	28, 2
Input 4:	27, 2
Input 5:	26, 2
Input 6:	25, 2
Input 7:	24, 2
Input 8:	23, 2
Input 9:	22, 2
Input 10:	21, 2
Input 11:	20, 2
Input 12:	19, 2
Input 13:	18, 2
Input 14:	17, 2
Input 15:	16, 2
Input 16:	15, 2

Engine System Inputs

* Stated accuracies are subject to the accuracy of the senders used.

Fuel Level Sensing

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

Coolant Temperature Sensing

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

Oil Pressure Sensing

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

Engine Speed Sensing

Magnetic Pickup	
Voltage Range:	3 to 35 V peak (6 to 70 V peak-peak)
Frequency Range:	32 to 10,000 Hz
Terminals:	31 (+), 32 (-)
Generator Voltage	
Range:	12 to 576 V rms
Terminals:	41 (A-phase) 39 (B-phase) 37 (C-phase)

Output Contacts

Fuel Solenoid, Engine Crank, and Pre-Start Relays

Rating: 30 Adc at 28 Vdc—make, break, and carry *

Terminals	
Fuel Solenoid:	RUN – NO, COM
Pre-Start:	PRE – NO, COM
Crank:	START – NO, COM

Programmable Relays (12)

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

Terminals†

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

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

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

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

Metering

Generator Voltage (rms)

Metering Range:	0 to 576 Vac (direct measurement) 577 to 9,999 Vac (through VT using VT ratio setting)
VT Ratio Range:	1:1 to 125:1 in primary increments of 1
Accuracy: *	±1.0% of programmed rated voltage or ±2 Vac
Display Resolution:	1 Vac

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

Generator Current (rms)

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

Metering Range:	0 to 5,000 Aac
CT Primary Range:	1 to 5,000 Aac in primary increments of 1 Aac
Accuracy: *	±1.0% of programmed rated current or ±2 Aac
Display Resolution:	1 Aac

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

Generator Frequency

Generator frequency is sensed through the generator voltage input.

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

Apparent Power

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

Measurement/Calculation Methods

Total:	$kVA = (V_{L-L} \times I_L \times \sqrt{3}) \div 1000$
4-Wire, Line-to-Neutral:	kVA calculated with respect to neutral
3-Wire, Line-to-Line:	A-phase kVA = $V_{AB} \times I_A \div 1000 \div \sqrt{3}$ B-phase kVA = $V_{BC} \times I_B \div 1000 \div \sqrt{3}$ C-phase kVA = $V_{CA} \times I_C \div 1000 \div \sqrt{3}$

Accuracy: $\pm 3\%$ 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 $+70^{\circ}\text{C}$.

Power Factor

Metering Range:	0.2 leading to 0.2 lagging
Calculation Method:	$PF = P$ (3-phase average) \div S (3-phase average)
Accuracy:	± 0.02 *

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

Real Power

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

Measurement/Calculation Methods

Total:	$PF \times \text{Total kVA}$
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: $\pm 3\%$ 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 $+70^{\circ}\text{C}$.

Oil Pressure

Metering Range:	0 to 145 psi or 0 to 1,000 kPa
Accuracy:	$\pm 3\%$ of actual indication or ± 2 psi or ± 12 kPa (subject to accuracy of sender)
Display Resolution:	1 psi or 1 kPa

Coolant Temperature

Metering Range:	32 to 410°F or 0 to 204°C
Accuracy:	$\pm 3\%$ of actual indication or $\pm 2^{\circ}$ (subject to accuracy of sender)

Battery Voltage

Metering Range:	6 to 32 Vdc
Accuracy:	$\pm 3\%$ of actual indication or ± 0.2 Vdc
Display Resolution:	0.1 Vdc

Engine RPM

Metering Range:	0 to 4,500 rpm
Accuracy: *	$\pm 2\%$ 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 h
Update Interval:	6 min
Accuracy:	$\pm 1\%$ of actual indication or ± 12 min
Display Resolution:	1/10 hour

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 h
Update Interval:	6 min
Accuracy:	±1% or actual indication or ±12 min
Display Resolution:	1/10 hour

Fuel Level

Metering Range:	0 to 100%
Accuracy:	±2% (subject to accuracy of sender)
Display Resolution:	1.0%

Generator Protection Functions

Overvoltage (59) and Undervoltage (27)

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

Underfrequency (81U) and Overfrequency (81O)

Pickup Range:	45 to 66 Hz (50/60 Hz nominal) 360 to 440 Hz (400 Hz nominal)
Pickup Increment:	0.1 Hz (50/60 Hz nominal) 0.1 Hz (400 Hz nominal)
Activation Delay Range:	0 to 30 s
Activation Delay Increment:	0.1 s
Inhibit Voltage Range:	70 to 576 Vac (81U function only)

Reverse Power (32)

Pickup Range:	-50 to 5%
Pickup Increment:	0.1%
Hysteresis Range:	1 to 10%
Hysteresis Increment:	0.1%
Activation Delay Range:	0 to 30 s
Activation Delay Increment:	0.1 s

Loss of Excitation (40Q)

Pickup Range:	-150 to 0%
Pickup Increment:	0.1%
Hysteresis Range:	1 to 10%
Hysteresis Increment:	0.1%
Activation Delay Range:	0 to 30 s
Activation Delay Increment:	0.1 s

Overcurrent (51) (Optional)

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

Logic Timers

Range:	0 to 10 s
Increment:	0.1 s
Accuracy:	±15 ms

Communication Interface

USB

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

RS-485 (Optional)

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

CANbus

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

NOTES

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

Modem (Optional)

Connector Type:	RJ-11 jack
-----------------	------------

Real-Time Clock

Clock has leap year and selectable daylight saving time correction. Backup capacitor and optional 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 (Optional):	Approximately 10 yrs
Battery Type:	Rayovac BR2032, lithium, coin-type, 3 Vdc, 195 mAh Basler Electric P/N 38526

NOTE

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

CAUTION

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

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

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

Type Tests

Shock and Vibration:	EN60068-2-6
Dielectric Strength:	IEC 255-5
Impulse:	EN60664-1
Transients:	EN61000-4-4
Static Discharge:	EN61000-4-2

Shock

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" DA for 2.5 min.
52 to 500 to 52 Hz:	5 G peak for 7.5 min.

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 $+115^{\circ}\text{C}$), vibration tests (of 5 to 50 G at $+20^{\circ}\text{C}$), and temperature/vibration tests (tested at 40 G over a temperature range of -80°C to $+90^{\circ}\text{C}$). Combined temperature and vibration testing at these extremes proves that the DGC-2020 is expected to provide long-term operation in a rugged environment. Note that the vibration and temperature extremes listed in this paragraph are specific to HALT and do not reflect recommended operation levels. These operational ratings are included in Section 1 of this manual.

Ignition System

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

Environment

Temperature

Operating:	-40 to $+70^{\circ}\text{C}$ (-40 to $+158^{\circ}\text{F}$)
Storage:	-40 to $+85^{\circ}\text{C}$ (-40 to $+185^{\circ}\text{F}$)

Humidity: IEC 68-2-38

Salt Fog: ASTM B 17-73, IEC 68-2-11

Ingress Protection: IEC IP54 for front panel

UL/CSA Approval

“cURus” recognized to UL Standard 508 & CSA Standard C22.2 No. 14.
CSA certified to 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.

Part Numbers 9400200105 and 9400200106

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

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

WARNING! - EXPLOSION HAZARD

(9400200105 and 9400200106 only)

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

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

NFPA Compliance

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

CE Compliance

This product complies with the requirements of the following EC Directives:

- Low Voltage Directive (LVD) - 73/23/EEC as amended by 93/68/EEC
- Electromagnetic Compatibility (EMC) - 89/336/EEC as amended by 92/31/EEC and 93/68/EEC

This product conforms to the following Harmonized Standards:

- EN 50178:1997 - *Electronic Equipment for use in Power Installations*
- EN 61000-6-4:2001 - *Electromagnetic Compatibility (EMC), Generic Standards, Emission Standard for Industrial Environments*
- EN 61000-6-2:2001 - *Electromagnetic Compatibility (EMC), Generic Standards, Immunity for Industrial Environments*

Physical

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

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SECTION 2 • HUMAN-MACHINE INTERFACE

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SECTION 2 • HUMAN-MACHINE INTERFACE

INTRODUCTION

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

FRONT PANEL

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

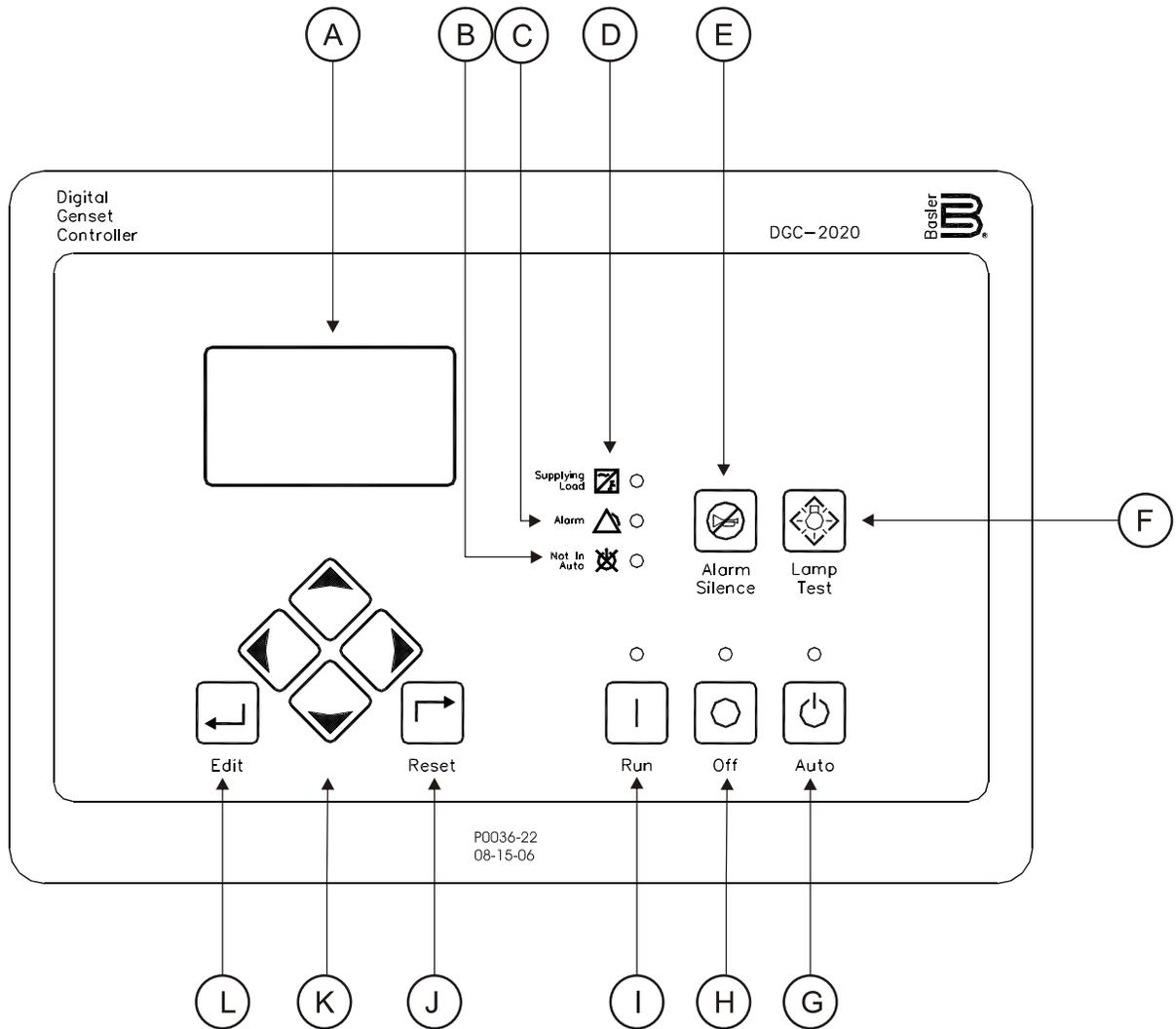


Figure 2-1. Front Panel HMI

Table 2-1. Front Panel HMI Descriptions

Locator	Description
A	<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.
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, this button also resets the Breaker Management Pre-Alarms.
K	<p><i>Arrow Pushbuttons.</i> These four buttons are used to navigate through the front panel display menus and modify settings.</p> <p>The left- and right-arrow buttons are used to navigate through the menu levels. The right-arrow button is pressed to move downward through the menu levels and the left-arrow button is pressed to move upward.</p> <p>Within a level, the up-arrow and down-arrow buttons are used to move among items within the menu level. Pressing the down-arrow button moves to items lower in the list. Pressing the up-arrow button moves to items higher in the list.</p> <p>During a settings editing session, the up- and down-arrow buttons are used to raise and lower the value of the selected setting.</p>
L	<i>Edit Pushbutton.</i> Pressing this button starts an editing session and enables changes to DGC-2020 settings. At the conclusion of an editing session, the Edit pushbutton is pressed again to save the setting changes.

DISPLAY OPERATION

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

Login and Permissions

Login

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

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
- TEMP
- BATT

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

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

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

- NONE (Removes a line from the scrolling list)
- BLANK (Shows nothing on this line)
- OIL P
- TEMP
- BATT V
- RPM
- RPM SRC
- FUEL
- RUN HRS
- GEN VAB
- GEN VBC
- GEN VCA
- GEN VAN
- GEN VBN
- GEN VCN
- BUS Hz
- BUS V
- GEN Hz
- GEN PF
- KWH
- GEN IA
- GEN IB
- GEN IC
- KW A
- KW B
- KW C
- KW TOT
- KVA A
- KVA B
- KVA C
- KVA TOT
- ALG_IN_X (X = 1 to 8) (with AEM-2020)
- RTD_IN_X (X = 1 to 8) (with AEM-2020)
- THRM_CPL_X (X = 1 to 2) (with AEM-2020)

Sleep Mode

Sleep mode serves as a power saving feature. If the DGC-2020 is in Off mode or Auto mode not running and a key is not pressed for more than 15 minutes, the front panel LCD backlight and LCD heater are turned off. The DGC-2020 resumes normal display operation when any front panel button is pressed or the genset is started remotely via the ATS input. The DGC-2020 will not go to sleep while in an Alarm state. If needed, Sleep mode can be permanently disabled via 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 and SETTINGS. The METERING screen branches are shown in Figure 2-2. Details of the METERING screen branches follow Figure 2-2. The SETTINGS screen branches are shown in Figure 2-3. Details of the SETTINGS screen branches follow Figure 2-3.

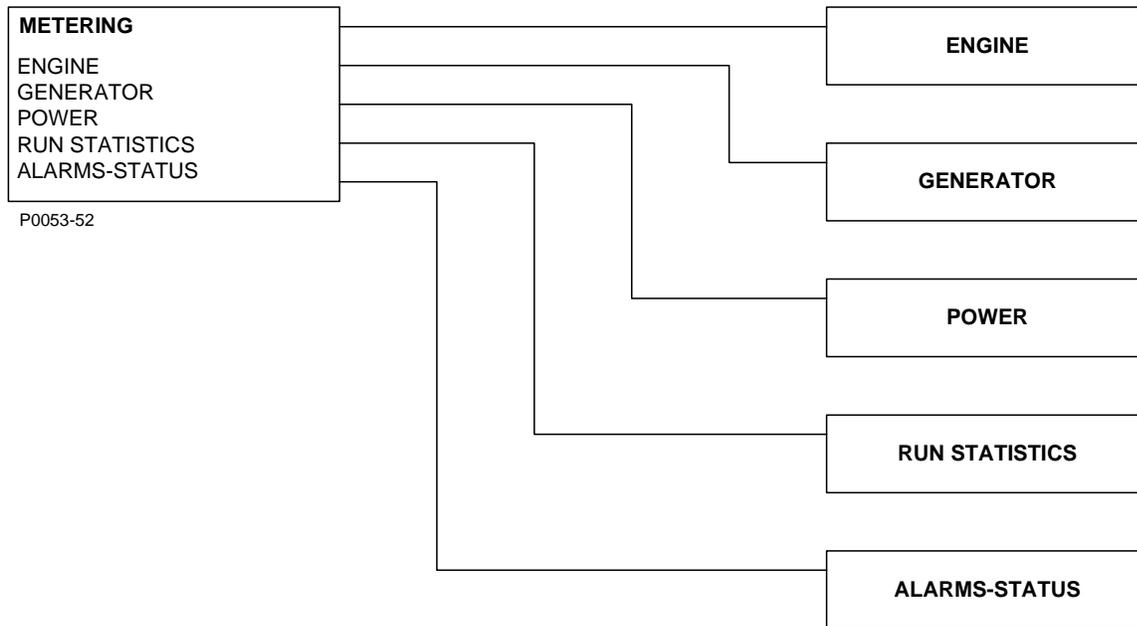


Figure 2-2. Metering Screen Branches

ENGINE

- OIL PRESSURE
- COOLAND TMP
- BATTERY VOLT
- RPM
- SPEED SRC
- FUEL LEVEL
- ENGINE LOAD
- COOLANT LEVL
- TOTAL RUN TM
- HRS TO MAINT

GENERATOR

- GEN VAB
- GEN VBC
- GEN VCA
- GEN VAN
- GEN VBN
- GEN VCN
- GEN FREQ
- GEN AMPS A
- GEN AMPS B
- GEN AMPS C

- BUS V
- BUS FREQ
- SYNCHRONIZER

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

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

- **ALARMS**
- **PRE-ALARMS**
- **MTU FAULT CODES** (Visible when ECU is configured for MTU MDEC, MTU ADEC, or MTU ECU7.)
- **MTU STATUS** (Visible when ECU is configured for MTU MDEC, MTU ADEC, or MTU ECU7.)
- **STATUS**
 - EPS SUPP. LOAD
 - GEN BREAKER
 - MAINS BREAKER
 - GRND DELTA O-RIDE
 - GEN DEAD
 - GEN STABLE
 - GEN FAILED
 - BUS DEAD
 - BUS STABLE
 - BUS FAILED
 - EXT START DEL
 - START DEL BYPASS
 - COOLDN REQ
 - COOL STOP REQ
 - OFF MODE COOLDN
- **INPUTS**
 - INPUT X (X = 1 to 16, (17 to 26 optional))
- **OUTPUTS**
 - OUTPUT X (X = 1 to 4, (5 to 36 optional))
- **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)
 - 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)
- **ANALOG STATUS**
- **CONF ELEMENTS**
- **CONF PROT STATUS**
- **EVENT LOG**
 - EVENT
 - 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
- **J1939 DATA** (Visible when ECU is configured for Standard or Volvo Penta.)
- **J1939 ENGINE CONFIG** (Visible when ECU is configured for Standard or Volvo Penta.)
- **J1939 ACTIVE DTC** (Visible when any ECU type is selected.)
- **J1939 PREV DTC** (Visible when any ECU type is selected.)

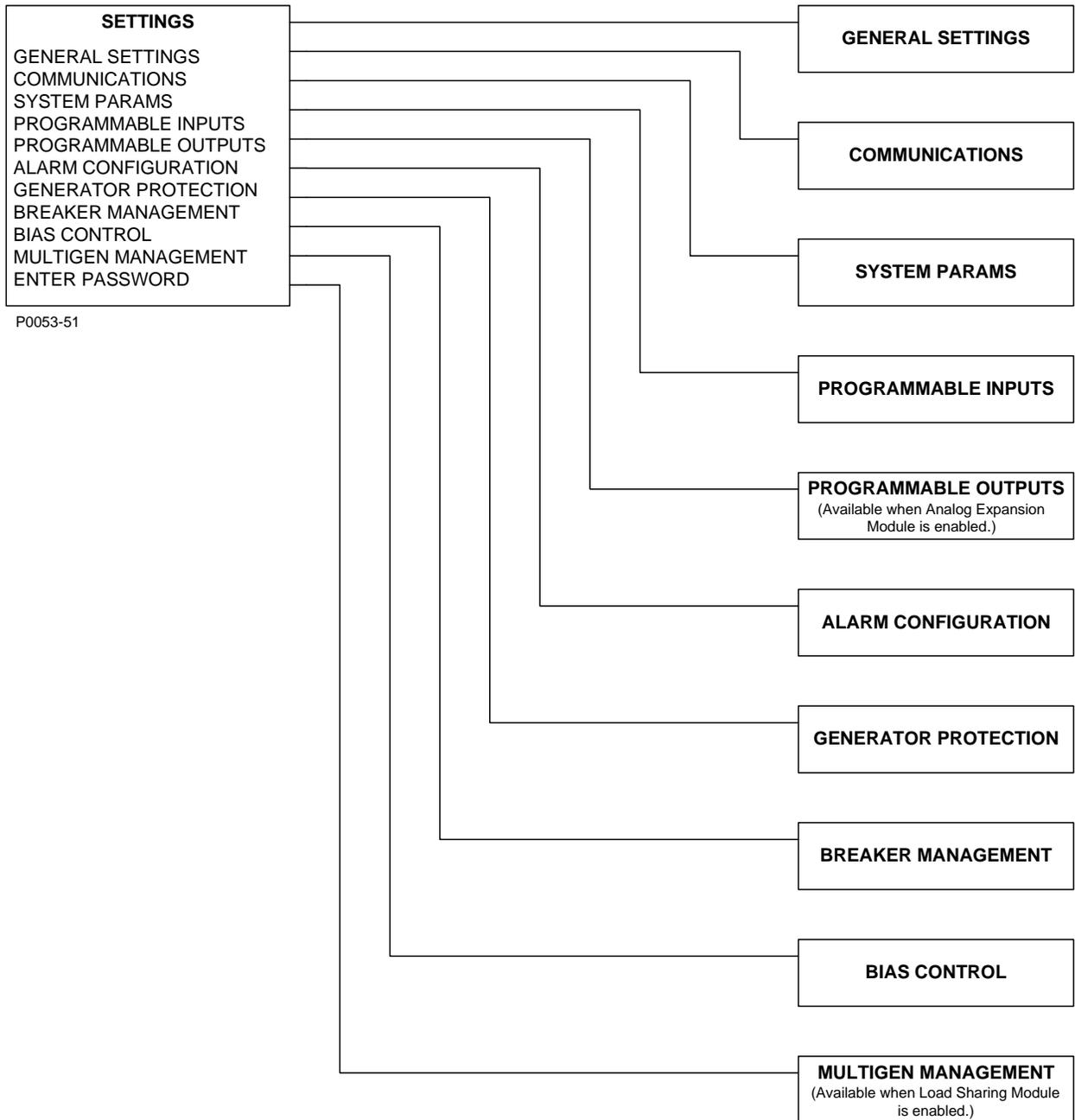


Figure 2-3. Settings Screen Branches

GENERAL SETTINGS

- **FRONT PANEL HMI**
 - SUMMARY VIEW
 - SCROLL DELAY
 - PH TOG DELAY
 - LCD CONTRAST
 - SLEEP MODE
 - LANGUAGE
 - CONFIGURABLE METERING
- **CONFIGURE DATE/TIME**
 - YEAR
 - MONTH
 - DAY
 - HOURS
 - MINUTES
 - SECONDS

- UTC OFFSET
- DST ENABLED
- **VIEW DATE/TIME**
- **VERSION INFO**
 - FIRMWARE VERSION
 - BOOT CODE VERSION
 - SERIAL NUMBER
 - PART NUMBER
 - MODEL NUMBER
 - LANGUAGE VERSION
 - LANGUAGE PART NUM

COMMUNICATIONS

- **CANBUS SETUP**
 - CANBUS SETUP
 - CANBUS ENABLE
 - DTC ENABLE (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
 - SPEED SELECT PRIMARY (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.)
 - SPD DMAND SRC (Visible when ECU is configured for MTU MDEC.)
 - ENGINE RPM (Visible when ECU is configured for MTU MDEC.)
 - SPEED SETUP (Visible when ECU is configured for MTU ADEC or MTU ECU7.)
 - SPD DMAND SRC
 - ENGNE RPM
 - TEST OVRSPPEED
 - SPEED UP (Visible when ECU is configured for MTU ECU7.)
 - SPEED DN (Visible when ECU is configured for MTU ECU7.)
 - SPD DMD LIMIT (Visible when ECU is configured for MTU ECU7.)
 - INCREASE IDLE (Visible when ECU is configured for MTU ECU7.)
 - ECU SETUP (Visible when ECU is configured for MTU ADEC or ECU7.)
 - TRIP RESET
 - INT OIL PRIME
 - GOV PRM SW (Visible when ECU is configured for MTU ADEC.)
 - ENG STRT PRIME (Visible when ECU is configured for MTU ECU7.)
 - FAN OVERRIDE (Visible when ECU is configured for MTU ECU7.)
 - MODE SWITCH (Visible when ECU is configured for MTU ECU7.)
 - GOV PARAM SET (Visible when ECU is configured for MTU ECU7.)
 - CAN RATING SW 1 (Visible when ECU is configured for MTU ECU7.)
 - CAN RATING SW 2 (Visible when ECU is configured for MTU ECU7.)
 - DIS CYL CUT 1 (Visible when ECU is configured for MTU ECU7.)
 - DID CYL CUT 2 (Visible when ECU is configured for MTU ECU7.)
- **RS485 SETUP**
 - COMM BAUD
 - COMM PARITY
 - MODBUS ADDR

SYSTEM PARAMS

- **SYSTEM SETTINGS**
 - GEN CONNECT
 - AUTO CONFIG DETECT
 - ENABLE
 - LOW LINE THRESH
 - 1-PH THRESH
 - RATED KW
 - RATED VOLTS

- RATED FREQ
- RATED RPM
- COOLDWN TIME
- OFF MODE COOLDN
- EPS
 - EPS THRESHLD
 - LOW LINE OVERRIDE
 - SCALE FACTOR
- FUEL LVL TYP
- SYSTEM UNITS
- BATTERY VOLT
- FLYWHL TEETH
- SPEED SOURCE
- MAINT RESET
- NFPA LEVEL
- HORN
- 1 PHASE O-RIDE (Visible when 1 PHASE O-RIDE INPUT is selected.)
- RATED PF
- POWER UP DELAY
- RELAY CONTROL
 - START
 - RUN
 - PRESTART
- **REMOTE MODULE SETUP**
 - LSM SETUP
 - LSM ENABLE
 - CANBUS ADDRESS (Visible when LSM-2020 is enabled.)
 - 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
 - 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
 - CAN 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
 - RAW
 - THERMAL INPUTS
 - SCALED
 - RAW
 - ANALOG OUTPUTS
 - SCALED
 - RAW
- **CRANK SETTINGS**
 - DISCNCT LMIT
 - PRECRNK DELY
 - PRESTRT CNTCT
 - STYLE
 - # CYCLES
 - CYCLE TIME
 - PRESTART REST CONFIG
 - 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
 - BUS PT PRI V
 - BUS PT SEC V
- **ENGINE STATISTICS**
 - START YEAR
 - START MONTH
 - START DAY
 - # STARTS
 - HRS TO MAINT
 - KW-HRS
 - TOTAL HRS
 - LOADED HRS
 - UNLOADED HRS

PROGRAMMABLE INPUTS

- **CONFIGURABLE INPUTS**
 - INPUT X (X = 1 to 26)
 - ALARM CONFIG
 - ACTIVATN DLY
 - RECOGNITION
- **PROG FUNCTIONS**
 - AUTO XFER SWITCH
 - INPUT
 - RECOGNITION (Visible when an INPUT is selected.)
 - 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 PHASE AC O-RIDE
 - INPUT
 - RECOGNITION (Visible when an INPUT is selected.)
 - BATT CHRG FAIL
 - INPUT
 - RECOGNITION (Visible when an INPUT is selected.)
 - LOW COOL LEVEL
 - INPUT
 - RECOGNITION (Visible when an INPUT is selected.)
 - FUEL LEAK DETECT
 - INPUT
 - RECOGNITION (Visible when an INPUT is selected.)
- **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
- **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
- 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

PROGRAMMABLE OUTPUTS (Visible when AEM-2020 is enabled)

- **ANALOG OUTPUTS**
 - 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

ALARM CONFIGURATION

- **PRE-ALARMS**
 - HIGH COOLANT TEMP
 - ENABLE
 - THRESHOLD
 - LOW COOLANT TEMP
 - ENABLE
 - THRESHOLD
 - LOW OIL PRESSURE
 - ENABLE
 - THRESHOLD
 - LOW FUEL LEVEL
 - ENABLE
 - THRESHOLD
 - ENGINE OVERLOAD
 - ENABLE
 - THRESHOLD

- 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
- CHECKSUM FAIL
 - ENABLE
- 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
- **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 in enabled.)
 - ENABLE
 - THRESHOLD

NOTE

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

- **SENDER FAIL**
 - COOL TEMP SENDR FAIL
 - CONFIG TYPE
 - ACTIVATN DLY
 - OIL PRESS SENDR FAIL
 - CONFIG TYPE
 - ACTIVATN DLY
 - FUEL LEVEL 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
 - 3 / 1 PHASE SETTINGS
 - PICKUP
 - HYSTERESIS
 - TIME DELAY
 - FREQ INHIBIT
 - ALARM CONFIG
- **59 OVERVOLTAGE**
 - 59-1 / 59-2
 - LOW LINE SF
 - 3 / 1 PHASE SETTINGS
 - PICKUP
 - HYSTERESIS
 - TIME DELAY
 - ALARM CONFIG
- **47 PHASE IMBALANCE (Optional)**
 - PICKUP
 - HYSTERESIS TIME DELAY
 - ALARM CONFIG
- **81 O/U FREQUENCY**
 - UNDERFREQUENCY
 - INHIBIT VOLTS
 - PICKUP
 - HYSTERESIS
 - TIME DELAY
 - ALARM CONFIG
 - OVERFREQUENCY
 - PICKUP HYSTERESIS
 - TIME DELAY
 - ALARM CONFIG
- **51 OVERCURRENT (Optional)**
 - 51-1 / 51-2 / 51-3
 - LOW LINE OVERRIDE
 - SCALE FACTOR
 - 3 / 1 PHASE SETTINGS
 - PICKUP
 - TIME DIAL

- CURVE
 - ALARM CONFIG
- **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

BREAKER MANAGEMENT

- **BREAKER HARDWARE**
 - MAINS FAIL TRANSFER
 - ENABLE
 - RETURN DELAY
 - TRANSFER DELAY
 - MAX TRANSFER TIME
 - CLOSE WAIT TIME
 - TIME
 - GEN BREAKER
 - CONTINUOUS
 - CLOSING TIME
 - DEAD BUS CL ENBL
 - MAINS BREAKER
 - CONFIGURED
 - CONTINUOUS (Visible when Configured.)
 - CLOSING TIME (Visible when Configured.)
- **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
 - 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
 - BUS FAILED
 - TIME DELAY
- **SYNCHRONIZER**
 - TYPE
 - SLIP FREQ

- REGUL OFFSET
- CLOSING ANGLE
- VG>VB
- TIME DELAY
- FAIL DELAY

BIAS CONTROL

- **AVR BIAS CONTROL**
 - 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
 - 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.)
 - OUTPUT (Visible when LSM-2020 is enabled.)
 - TYPE
 - VOLT CTRL GAINS (Visible when LSM-2020 is enabled and OUTPUT TYPE = ANALOG.)
 - KP
 - KI
 - KD
 - TD
 - LOOP GAIN
- **GOV BIAS CONTROL**
 - CONTACT (Visible when LSM-2020 is disabled or when LSM-2020 is enabled and OUTPUT TYPE = CONTACT.)
 - TYPE
 - SPEED TRIM
 - ENABLE
 - 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.)
 - SETPOINT
 - KW CTRL
 - LOAD CTRL ENABLE (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.)

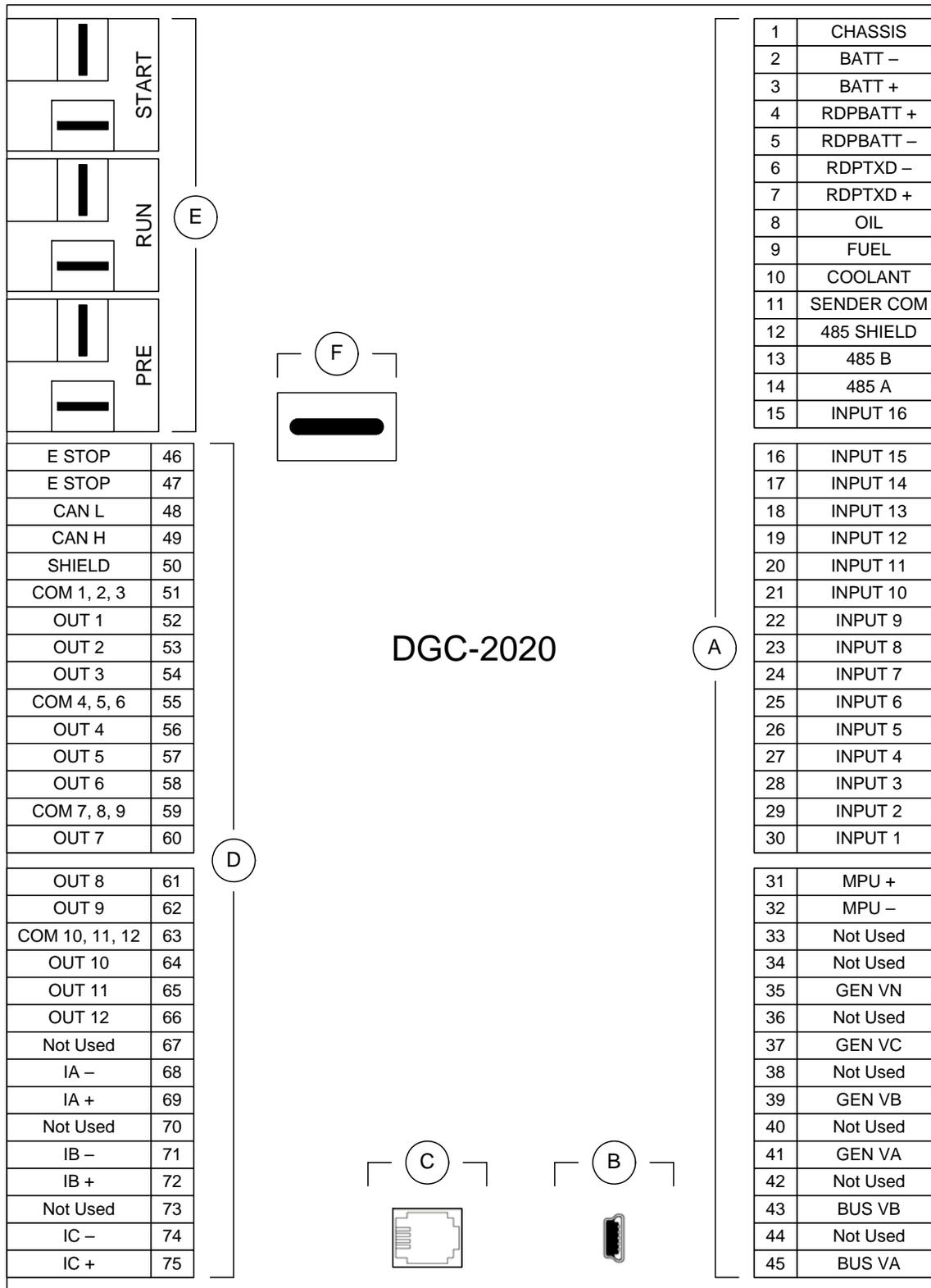
- BL ALG MAX (Visible when LSM-2020 is enabled.)
 - BL ALG MIN (Visible when LSM-2020 is enabled.)
 - BRKR OPEN PT (Visible when LSM-2020 is enabled.)
- OUTPUT (Visible when LSM-2020 is enabled.)
 - TYPE
- **CONTROL DEBUG (Visible when LSM-2020 in enabled.)**

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

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

REAR PANEL

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



P0055-28

Figure 2-4. Rear Panel

Table 2-2. Rear Panel HMI Descriptions

Locator	Description
A, D	The majority of external, DGC-2020 wiring is terminated at 15-position connectors with compression terminals. These connectors plug into headers on the DGC-2020. The connectors and headers have a dovetailed edge that ensures proper connector orientation. Each connector and header is uniquely keyed to ensure that a connector mates only with the correct header. Connector screw terminals accept a maximum wire size of 12 AWG.
B	The mini-B USB socket mates with a standard USB cable and is used with a PC running BESTCOMSPPlus software for local communication with the DGC-2020.
C	DGC-2020 controllers with an optional, internal, dial-out modem connect to a telephone line through a USOC RJ-11 jack.
E	Connections to the DGC-2020 Start (starter), Run (fuel solenoid), and Pre (glow plug) output contacts are made directly to each relay through quarter-inch, male, quick-connect terminals.
F	An optional battery backup for the real-time clock is available when ordering. See Section 7, <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.

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SECTION 3 • FUNCTIONAL DESCRIPTION

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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, *BESTCOMSPPlus Software*.

DGC-2020 FUNCTION BLOCKS

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

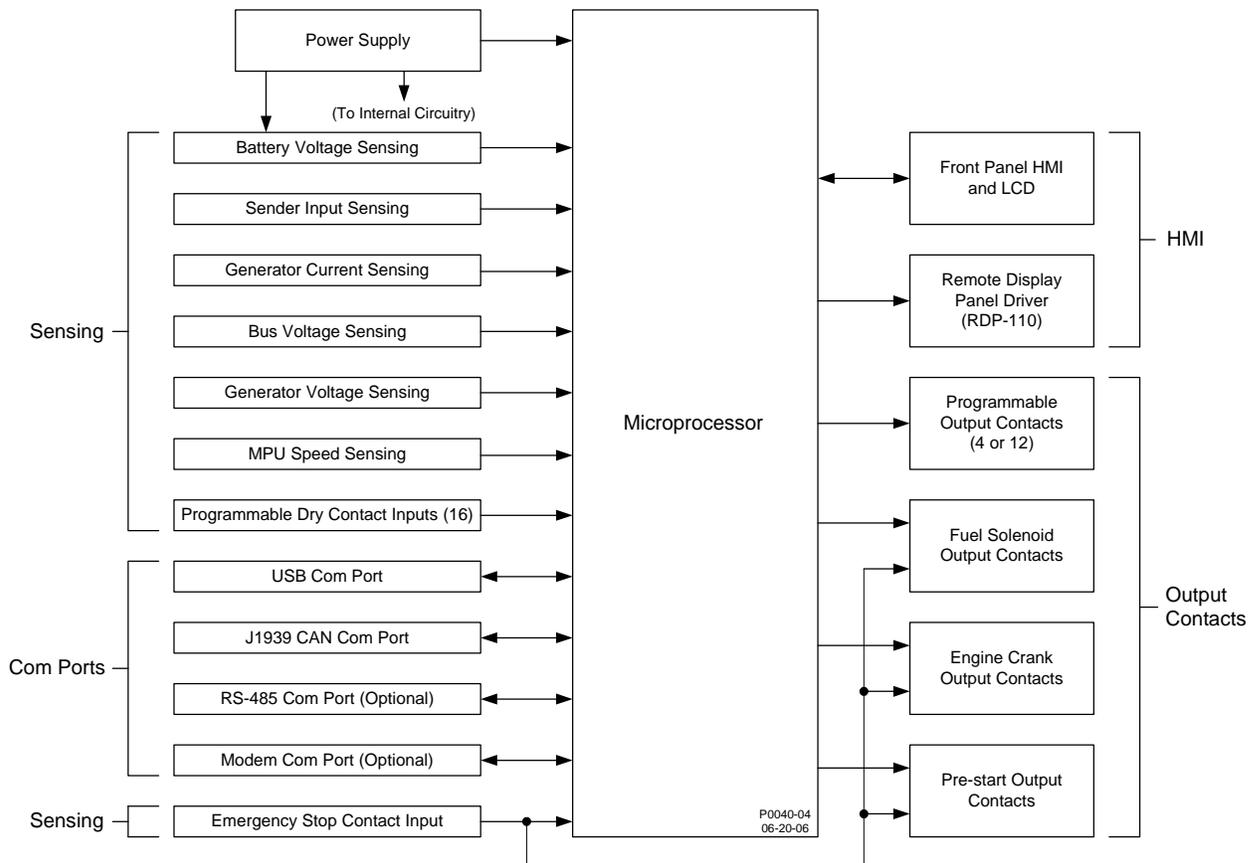


Figure 3-1. Function Block Diagram

Power Supply

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

Battery Voltage Sensing

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

Microprocessor

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

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

Zero Crossing Detection

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

Analog-to-Digital Converter

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

Watchdog Timer

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

Generator Voltage Sensing Inputs

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

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

Bus Voltage Sensing Inputs

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

The bus voltage sensing input accepts a maximum voltage of 576 Vrms. Sensing voltage is applied to terminals 45 (A-phase) and 43 (B-phase).

Current Sensing Inputs

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

DGC-2020 controllers with 1 ampere current sensing (style number 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. BESTCOMSPlus software allows for the programming of sender characteristics. See Section 4, *BESTCOMSPlus Software*, for more information.

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

Fuel Level

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

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

Speed Signal Inputs

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

Generator Voltage Sensing Input

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

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

Magnetic Pickup Input (MPU)

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

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

Contact Inputs

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

Emergency Stop Input

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

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

Programmable Inputs

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

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

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

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

Front Panel HMI

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

LCD

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

LED Indicators

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

Pushbuttons

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

Remote Display Panel (Optional)

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

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

- Battery charger failure *
- Battery overvoltage
- High coolant temperature
- Low coolant temperature
- Low fuel level
- Low oil pressure
- Weak battery

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*, *Programmable Inputs*, *Programmable Functions*, for more information. The light on the RDP-110 will turn on when the input that is assigned to the programmable function is closed, whether the function is configured as *None*, *Alarm*, or *Pre-Alarm*.

Additionally, the RDP-110 indicates when the DGC-2020 is not operating in Auto mode and when the generator is supplying load. For more information about the RDP-110, request product bulletin SNE.

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

Communication Ports

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

USB

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

CANbus

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

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

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

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

Table 3-1. ECU Parameters Obtained from CANbus Interface

ECU Parameter	Metric Units	English Units	Update Rate	Decimal Place	* SPN
Actual engine percent torque	%	%	engine speed dependent	none	513
Air filter differential pressure	kPa	psi	500 ms	10 th	107
Air inlet temperature	kPa	°F	1 s	none	172
Ambient air temperature	°C	°F	1 s	10 th	171
Barometric pressure	kPa	psi	1 s	10 th	108
Battery voltage	Vdc	Vdc	1 s	10 th	168
Boost pressure	kPa	psi	500 ms	none	102
Coolant level	%	%	500 ms	10 th	111
Coolant pressure	kPa	psi	500 ms	10 th	109
Engine coolant temperature	°C	°F	1 s	none	110
Engine intercooler temperature	°C	°F	1 s	none	52
Engine oil level	%	%	500 ms	10 th	98
Engine oil pressure	kPa	psi	500 ms	10 th	100
Engine oil temperature	°C	°F	1 s	10 th	175
Engine speed	rpm	rpm	engine speed dependent	none	190
Exhaust gas temperature	°C	°F	500 ms	10 th	173
Fuel delivery pressure	kPa	psi	500 ms	10 th	94
Fuel rate	liter/hr	gal/hr	100 ms	100 th	183
Fuel temperature	°C	°F	1 s	none	174
Injection control pressure	MPa	psi	500 ms	none	164
Injector metering rail pressure	MPa	psi	500 ms	none	157
Intake manifold temperature	°C	°F	500 ms	none	105
Percent load at current rpm	%	%	50 ms	none	92
Switched battery voltage (at ECU)	Vdc	Vdc	1 s	10 th	158
Throttle (accelerator pedal) position	%	%	50 ms	10 th	91
Total engine hours	hours	hours	requested 1.5 s	100 th	247

ECU Parameter	Metric Units	English Units	Update Rate	Decimal Place	* SPN
Total fuel used	liters	gallons	requested 1.5 s	none	250
Trip fuel	liters	gallons	requested 1.5 s	none	182

* SPN is suspect parameter number.

Table 3-2. Engine Configuration Parameters Obtained from CANbus Interface

ECU Parameter	Metric Units	English Units	Update Rate	Decimal Place	* SPN
Engine speed at high idle point 6	rpm	rpm	5 s	none	532
Engine speed at idle point 1	rpm	rpm	5 s	none	188
Engine speed at point 2	rpm	rpm	5 s	none	528
Engine speed at point 3	rpm	rpm	5 s	none	529
Engine speed at point 4	rpm	rpm	5 s	none	530
Engine speed at point 5	rpm	rpm	5 s	none	531
Gain (Kp) of endspeed governor	%/rpm	%/rpm	5 s	100 th	545
Maximum momentary engine override speed point 7	rpm	rpm	5 s	none	533
Maximum momentary engine override time limit	seconds	seconds	5 s	10 th	534
Percent torque at idle point 1	%	%	5 s	none	539
Percent torque at point 2	%	%	5 s	none	540
Percent torque at point 3	%	%	5 s	none	541
Percent torque at point 4	%	%	5 s	none	542
Percent torque at point 5	%	%	5 s	none	543
Reference engine torque	N•m	ft-lb	5 s	none	544
Requested speed control range lower limit	rpm	rpm	5 s	none	535
Requested speed control range upper limit	rpm	rpm	5 s	none	536
Requested torque control range lower limit	%	%	5 s	none	537
Requested torque control range upper limit	%	%	5 s	none	538

* SPN is suspect parameter number.

CAUTION

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

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 3-3 lists the diagnostic information that the DGC-2020 obtains over the CANbus interface.

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

Table 3-3. Diagnostic Information Obtained Over the CANbus Interface

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

MTU Fault Codes

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

Each fault code is displayed with a fault description and the fault number. If the DGC-2020 does not have descriptive information about a fault number that was received, the fault description will display as "NO TEXT AVAILABLE". For more detailed information, refer to your MTU documentation.

3, L1 T-FUEL	82, RAIL PRES HI	177, AL LIFEDATA RI
4, L2 T-FUEL	89, ENG SPEED LOW	180, CAN1 NODE LOST
5, L1 T-CHRG AIR	90, IDLE SPEED LOW	181, CAN2 NODE LOST
6, L2 T-CHRG AIR	91, RUNUP SPEED LOW	182, CAN WRONG PARAMS
8, RAIL PRES LOW	92, START SPEED LOW	183, CAN NO PU-DATA
9, L1 T-INTERCOOLER	93, PREHT TMP. LIM 2	184, CAN PUDATA EE-FL
10, L2 T-INTERCOOLER	94, PREHT TMP. LIM 1	185, CAN LESS MAILBXS
15, L1 P-LUBE OIL	95, PRIMING FAULT	186, CAN1 BUS OFF
16, L2 P-LUBE OIL	99, DUMMY FAULT	187, CAN1 ERROR PASSV
19, L1 T-EXHAUST A	100, EDM NOT VALID	188, CAN2 BUS OFF
21, L1 T-EXHAUST B	101, IDM NOT VALID	189, CAN2 ERROR PASSV
23, L1 COOLANT LEVEL	102, INVLD FUEL CNS 1	201, SD T-COOLANT
24, L2 COOLANT LEVEL	103, INVLD FUEL CNS 2	202, SD T-FUEL
30, ENGINE OVERSPEED	104, OP HRS1 INVALID	203, SD T-CHARGE AIR
31, CHRGR1 OVERSPD 1	105, OP HRS2 INVALID	205, SD T-CLNT INTERC
32, CHRGR1 OVERSPD 2	106, ERR REC1 INVALID	208, SD P-CHARGE AIR
33, L1 P-FUELFLT DIF	107, ERR REC2 INVALID	211, SD P-LUBE OIL
44, L1 LEVEL INTRCLR	118, L1 SPPLY VOLT LO	214, SD P-CRANKCASE
45, L2 LEVEL INTRCLR	119, L2 SPPLY VOLT LO	215, SD P-RAIL FUEL
51, L1 T-LUBE OIL	120, L1 SPPLY VOLT HI	216, SD T-LUBE OIL
52, L2 T-LUBE OIL	121, L2 SPPLY VOLT HI	219, SD T-INTAKE AIR
57, L1 P-COOLANT	122, L1 T-ELECTRONIC	220, SD COOLANT LEVEL
58, L2 P-COOLANT	134, 15V POSECU DEFCT	222, SD LVL LKG FUEL
63, L1 P-CRANKCASE	136, 15V NEGECU DEFCT	223, SD LVL INTERCLR
65, L1 P-FUEL	137, L1 5V BUFFR TEST	229, SD ENG SPD SNSRS
66, L2 P-FUEL	138, SENSOR PWR DEFCT	230, SD CRANKSHFT SPD
67, L1 T-COOLANT	139, L1 TE BUFFR TEST	231, SD CAMSHAFT SPD
68, L2 T-COOLANT	140, TE BUF ECU DEFCT	240, SD P-FUEL
69, L1 T-EXTERN 1	142, BANK1ECU DEFECT	245, SD POWER SUPPLY
70, L2 T-EXTERN 1	144, BANK2ECU DEFECT	246, SD T-ELECTRONIC
71, L1 T-EXTERN 2	145, 15V GOODECU DFCT	249, SD CAN STOP
72, L2 T-EXTERN 2	147, AD-TST1ECU DEFCT	250, SD CAN SPD DEMND
73, L1 P-EXTERN 1	149, AD-TST2ECU DEFCT	251, SD CAN UP/DOWN
74, L2 P-EXTERN 1	151, AD-TST3ECU DEFCT	252, SD CAN NOTCH POS
75, L1 P-EXTERN 2	163, SD AUX 2	253, SD CAN OVERRIDE
76, L2 P-EXTERN 2	170, MI MODULE FAIL	254, SD CAN TST OVRSP
77, LIN EXT CLNT LEV	171, MI NOT ACTIVE	260, SD 15V POS SPPLY
78, LIN INTERCLR LEV	172, TBO EXPIRED	261, SD 15V NEG SPPLY
79, L BIN-EXTERN 3	173, MODL WRITE LIMIT	262, SD 5V BUFFR TEST
80, L BIN-EXTERN 4	176, AL LIFEDATA NA	263, SD TE BUFFR TEST
81, RAIL LEAKAGE		264, SD BANK 1 TEST

265, SD BANK 2 TEST	323, WIRING CYLNDR A3	364, STP PWR STG 2
266, SD SPD DEMAND AN	324, WIRING CYLNDR A4	365, STOP MV-WIRING
267, SD SPDTEST BNCH	325, WIRING CYLNDR A5	381, TRAN OUT1 PLNT DEF
269, SD LOAD PLS ANLG	326, WIRING CYLNDR A6	382, TRAN OUT2 PLNT DEF
270, SD SPD DEMAND	327, WIRING CYLNDR A7	383, TRAN OUT3 PLNT DEF
271, SD T-EXTERN 1	328, WIRING CYLNDR A8	384, TRAN OUT4 PLNT DEF
272, SD T-EXTERN 2	329, WIRING CYLNDR A9	385, TRAN OUT5 PLNT DEF
273, SD P-EXTERN 1	330, WIRING CYLNDR A10	386, TRAN OUT6 PLNT DEF
274, SD P-EXTERN 2	331, WIRING CYLNDR B1	390, AL MCR EXCEEDED
275, MD EXT.CLNT LVL	332, WIRING CYLNDR B2	399, INTERFACE ECU
276, MD INTERCLER LVL	333, WIRING CYLNDR B3	400, AL OPN LD DIGIN 1
277, MISDATA BIN-EXT3	334, WIRING CYLNDR B4	401, AL OPN LD DIGIN 2
278, MISDATA BIN-EXT4	335, WIRING CYLNDR B5	402, AL OPN LD DIGIN 3
279, SD CANRES TRIPFL	336, WIRING CYLNDR B6	403, AL OPN LD DIGIN 4
280, SD CAN ALRM RST	337, WIRING CYLNDR B7	404, AL OPN LD DIGIN 5
281, SD ADTEST1 SPPLY	338, WIRING CYLNDR B8	405, AL OPN LD DIGIN 6
282, SD ADTEST2 SPPLY	339, WIRING CYLNDR B9	406, AL OPN LD DIGIN 7
283, SD ADTEST3 SPPLY	340, WIRING CYLNDR B10	407, AL OPN LD DIGIN 8
284, SD CAN LAMP TEST	341, OPN LD CYLNDR A1	408, AL OPN LD DIGIN 9
301, TIMING CYLNDR A1	342, OPN LD CYLNDR A2	410, LO U-PDU
302, TIMING CYLNDR A2	343, OPN LD CYLNDR A3	411, LOLO U-PDU
303, TIMING CYLNDR A3	344, OPN LD CYLNDR A4	412, HI U-PDU
304, TIMING CYLNDR A4	345, OPN LD CYLNDR A5	413, HIHI U-PDU
305, TIMING CYLNDR A5	346, OPN LD CYLNDR A6	434, SD P-AUX 1
306, TIMING CYLNDR A6	347, OPN LD CYLNDR A7	444, SL U-PDU
307, TIMING CYLNDR A7	348, OPN LD CYLNDR A8	450, SD IDLE-END TRQ
308, TIMING CYLNDR A8	349, OPN LD CYLNDR A9	454, SS PWR RED ACT
309, TIMING CYLNDR A9	350, OPN LD CYLNDR A10	468, SD T-AUX 1
310, TIMING CYLNDR A10	351, OPN LD CYLNDR B1	469, SD AUX 1
311, TIMING CYLNDR B1	352, OPN LD CYLNDR B2	470, SD T-ECU
312, TIMING CYLNDR B2	353, OPN LD CYLNDR B3	471, SD COIL CURRENT
313, TIMING CYLNDR B3	354, OPN LD CYLNDR B4	472, AL STOP SD
314, TIMING CYLNDR B4	355, OPN LD CYLNDR B5	474, AL WIRING FO
315, TIMING CYLNDR B5	356, OPN LD CYLNDR B6	475, AL CR TRIG ENG ST
316, TIMING CYLNDR B6	357, OPN LD CYLNDR B7	476, AL CR INIT ERR
317, TIMING CYLNDR B7	358, OPN LD CYLNDR B8	478, AL COMB ALM YEL
318, TIMING CYLNDR B8	359, OPN LD CYLNDR B9	479, AL COMB ALM RED
319, TIMING CYLNDR B9	360, OPN LD CYLNDR B10	480, AL EXT ENG PROT
320, TIMING CYLNDR B10	361, PWR STG FL 1	555, AL CALL MTU FS
321, WIRING CYLNDR A1	362, PWR STG FL 2	
322, WIRING CYLNDR A2	363, STP PWR STG 1	

RS-485 (Optional)

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

Modem (Optional)

When equipped with the optional, internal, dial-out modem, the DGC-2020 can be connected to a standard telephone line through its RJ-11 jack. The modem enables the DGC-2020 to dial up to four pager telephone numbers and annunciate conditions selected by the user. These conditions include any DGC-2020 alarm or pre-alarm, closure of any programmable contact input, and an active cooldown timer. The modem accommodates pagers that use seven data bits with even parity or modems using eight data bits with no parity.

Output Contacts

Output contact operation is controlled by the operating mode of the DGC-2020. The state of the Emergency Stop contact input also affects output contact operation. When the Emergency Stop contact

input is open (emergency stop condition), the Pre-Start, Crank, and Fuel outputs open. When the Emergency Stop input is closed, all output contacts operate normally.

DGC-2020 output contacts include Pre-Start, Crank, Fuel, and up to 12 standard programmable outputs. Additional output contacts can be accommodated with a CEM-2020 (Contact Expansion Module).

Pre-Start

This output closes to energize the engine glow plugs. The Pre-Start output can be programmed to close up to 30 seconds prior to engine cranking. The Pre-Start 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 Pre-Start can be set to Off, On, or Preheat Before Crank. 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.

Pre-Start output connections are made through terminals located on the Pre-Start relay.

Crank

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 1 to 60 seconds.

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

Fuel

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

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

Programmable

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

MODES OF OPERATION

OFF

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

RUN

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

AUTO

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

ATS Contact Input

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

Generator Exerciser

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

Mains Fail Transfer Functionality

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

Run with Load Logic Element

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

Engine Run Logic Element

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

Demand Start/Stop Function

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

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

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

BREAKER MANAGEMENT

Introduction

The DGC-2020 is capable of controlling the generator breaker and the mains breaker. Once it is determined that a valid breaker request is available, the DGC-2020 will attempt to operate the breaker if possible. The user can choose to control only the generator breaker, the generator and mains breakers, or none. 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 BESTlogic+ 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 the PLC (programmable logic controller).

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 the PLC. The generator breaker can be manually controlled using contact inputs and outputs or the breaker buttons on the BESTCOMSPlus *Control* screen.

Breaker Operation

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

Determining if it is Acceptable to Close a Breaker

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

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

Changing the Breaker State

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

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

If the breaker does not seem to operate properly, refer to Section 7, *Maintenance and Troubleshooting*.

Synchronizer Operation

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

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

Breaker close sources are:

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

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

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

The best way to tell if the synchronizer is active is to disable the speed trim function, then when it is desired to synchronize check for raise and/or lower pulses coming from the DGC-2020 if the governor or AVR bias control output type is contact, or to check the governor and/or AVR bias analog outputs on the load share module with a volt meter if the governor or AVR bias control output type is analog. The voltages or raise/lower pulses should be changing when the synchronizer is active. If there are no raise/lower pulses, or if the analog bias voltages do not change, the synchronizer is not active.

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

If the synchronizer does not seem to operate properly, refer to Section 7, *Maintenance and Troubleshooting*.

EVENT RECORDING

An event log retains history of system events in nonvolatile memory. Thirty event records are retained and each record contains a time stamp of the first and last event occurrence, and the number of occurrences for each event. In addition, each record contains details of the time, date, and engine hours for the most recent 30 occurrences of the event. The number of occurrences stops incrementing at 99. If an event occurs which is of a type that differs from those in the 30 records in memory, the record that has the oldest "last" event occurrence is removed from the log, and the new category takes its place. Since 30 event records with up to 99 occurrences each are retained in memory, a history of nearly 3,000 specific events are retained in the DGC-2020. Detailed occurrence information is retained for the most recent 30 occurrences of each event record, and there are 30 event records; thus the time, date, and engine hours details for up to 900 specific event occurrences are retained in the event log.

BESTCOMSPPlus can be used to view and/or 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, the 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 3-4 lists all possible event strings (as shown in the event log).

Table 3-4. 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
59-1 OVRVOLT TRP A	59-1 Overvoltage Trip	Alarm
59-1 OVRVOLT TRP P	59-1 Overvoltage Trip	Pre-Alarm
59-2 OVRVOLT TRP A	59-2 Overvoltage Trip	Alarm
59-2 OVRVOLT TRP P	59-2 Overvoltage Trip	Pre-Alarm
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
ALT WIRE TMP HI P	Alternator Wiring Temp High	Pre-Alarm

Event String	Event Description	Event Type
ATS INPUT CLOSED	ATS Input	Status
AUTO RESTART	Automatic Restart in Progress	Status
AUTO RESTART FAIL A	Automatic Restart Fail	Alarm
BATT CHRGR FAIL A	Battery Charger Fail	Alarm
BATT CHRGR FAIL P	Battery Charger Fail	Pre-Alarm
BATT OVERVOLT P	Battery Overvoltage	Pre-Alarm
BATTLE OVERRIDE	Battle Override	Status
CEM COMM FAIL P	CEM-2020 Communications Failure	Pre-Alarm
CEM HW MISMATCH P	Connected CEM-2020 is wrong type	Pre-Alarm
CHECKSUM FAIL P	Corrupt user settings or firmware code	Pre-Alarm
COMBINED RED A	Combined Red	Alarm
COMBINED YELLOW P	Combined Yellow	Pre-Alarm
CONF PROT X (X = 1 to 8)	Configurable Protection X (X = 1 to 8)	Status
CONF PROT X A (X = 1 to 8)	Configurable Protection X (X = 1 to 8)	Alarm
CONF PROT X P (X = 1 to 8)	Configurable Protection X (X = 1 to 8)	Pre-Alarm
CONFIG ELEMENT X A (X = 1 to 8)	Configurable Element X (X = 1 to 8)	Alarm
CONFIG ELEMENT X P (X = 1 to 8)	Configurable Element X (X = 1 to 8)	Pre-Alarm
COOL LVL SNDR FL A	Coolant Level Sender Fail	Alarm
COOL SNDR FAIL	Coolant Temperature Sender Fail	Status
COOL SNDR FAIL A	Coolant Temperature Sender Fail	Alarm
COOL SNDR FAIL P	Coolant Temperature Sender Fail	Pre-Alarm
DEMAND START	Demand Start Request	Status
DEMAND STOP	Demand Stop Request	Status
DGC HEARTBEAT FAIL P	DGC Heartbeat Fail	Pre-Alarm
DIAG TRBL CODE P	Diagnostic Trouble Code	Pre-Alarm
DIAL OUT FAILED	Modem Dialout Failed	Status
DIAL OUT SUCCESS	Modem Dialout Success	Status
ECU SHUTDOWN A	ECU Shutdown	Alarm
EMERGENCY STOP A	Emergency Stop	Alarm
ENG KW OVRLD-1 P	Engine KW Overload 1	Pre-Alarm
ENG KW OVRLD-2 P	Engine KW Overload 2	Pre-Alarm
ENG KW OVRLD-3 P	Engine KW Overload 3	Pre-Alarm
ENGINE RUNNING	Engine Running	Status
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 LEVEL SENDR FAIL	Fuel Level Sender Fail	Status
FUEL LEVEL SENDR A	Fuel Level Sender Fail	Alarm
FUEL LEVEL SENDR P	Fuel Level Sender Fail	Pre-Alarm
GEN TEST LOADED	Generator Exerciser Test with Load	Status
GEN TEST UNLOADED	Generator Exerciser Test without Load	Status
GLBL SNDR FAIL A	Global Sender Fail	Alarm
GN BKR CL FL P	Generator Breaker Fail to Close	Pre-Alarm

Event String	Event Description	Event Type
GN BKR OP FL P	Generator Breaker Fail to Open	Pre-Alarm
GN BKR SYN FL P	Generator Breaker Synchronization Fail	Pre-Alarm
HI COOLANT TMP A	High Coolant Temp	Alarm
HI COOLANT TMP P	High Coolant Temp	Pre-Alarm
HI DAY TANK LEVEL P	High Day Tank Level	Pre-Alarm
HI PRESSURE IN 1 P	High Pressure Input 1	Pre-Alarm
HI PRESSURE IN 2 P	High Pressure Input 2	Pre-Alarm
HI ECU VOLTS A	High ECU Supply Voltage	Alarm
HI EXHAUST A T P	High Exhaust Temp A	Pre-Alarm
HI EXHAUSE B T P	High Exhaust Temp B	Pre-Alarm
HI SUPPLY VOLTS P	High Voltage Supply	Pre-Alarm
HI T FUEL P	High Fuel Temp	Pre-Alarm
HIGH AMB TEMP P	High Ambient Temp	Pre-Alarm
HIGH CHARGE AIR TEMP A	High Charge Air Temp	Alarm
HIGH CHARGE AIR TEMP P	High Charge Air Temp	Pre-Alarm
HIGH COIL TEMP 1 P	High Temp Coil 1	Pre-Alarm
HIGH COIL TEMP 2 P	High Temp Coil 2	Pre-Alarm
HIGH COIL TEMP 3 P	High Temp Coil 3	Pre-Alarm
HIGH COOLANT TEMP A	High Coolant Temp	Alarm
HIGH COOLANT TEMP P	High Coolant Temp	Pre-Alarm
HIGH ECU TEMPERATURE P	High ECU Temp	Pre-Alarm
HIGH FUEL LEVEL P	High Fuel Level	Pre-Alarm
HIGH FUEL RAIL PRESS P	High Fuel Rail Pressure	Pre-Alarm
HIGH INTRCOOLER TEMP P	High Intercooler Temp	Pre-Alarm
HIGH OIL TERMPERATURE A	High Oil Temp	Alarm
HIGH OIL TEMPERATURE P	High Oil Temp	Pre-Alarm
HIGH STRG TANK LEVEL P	High Storage Tank Level	Pre-Alarm
ID MISSING P	LSM-2020 ID Missing	Pre-Alarm
ID REPEAT P	LSM-2020 ID Repeated	Pre-Alarm
IDLE SPD LO P	Idle Speed Low	Pre-Alarm
INPUT X A (X = 1 to 40)	User Configurable Input X (X = 1 to 40)	Alarm
INPUT X P (X = 1 to 40)	User Configurable Input X (X = 1 to 40)	Pre-Alarm
LO AFTERCLR COOL LVL A	Low After Cooler Cool Level	Alarm
LO CHG AIR CLNT LVL P	Low Charge Air Coolant Level	Pre-Alarm
LO DAY TANK LEVEL P	Low Day Tank Level	Pre-Alarm
LO FUEL DLV PRESSURE A	Low Fuel Delivery Pressure	Alarm
LO ECU VOLTS P	Low ECU Supply Voltage	Pre-Alarm
LO SUPPLY VOLTS P	Low Voltage Supply	Pre-Alarm
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

Event String	Event Description	Event Type
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 Intergen Communications Failure	Pre-Alarm
MAINT INTERVAL P	Maintenance Interval	Pre-Alarm
MF TRANSFER	Mains Fail Transfer Complete	Status
MF TRANSFER FAIL	Mains Fail Transfer Fail	Status
MN BKR CL FL P	Mains Breaker Fail to Close	Pre-Alarm
MN BKR OP FL P	Mains Breaker Fail to Open	Pre-Alarm
MN BKR SYN FL P	Mains Breaker Synchronization Fail	Pre-Alarm
MPU FAIL P	Magnetic Pickup Fail	Pre-Alarm
MULTIPLE AEM P	Multiple AEM-2020's	Pre-Alarm
MULTIPLE CEM P	Multiple CEM-2020's	Pre-Alarm
MULTIPLE LSM P	Multiple LSM-2020's	Pre-Alarm
NORM SHUTDOWN	Normal Shutdown	Status
OIL SNDR FAIL	Oil Pressure Sender Fail	Status
OIL SNDR FAIL A	Oil Pressure Sender Fail	Alarm
OIL SNDR FAIL P	Oil Pressure Sender Fail	Pre-Alarm
OVERCRANK A	Overcrank	Alarm
OVERSPEED A	Overspeed	Alarm
OVERSPEED A	Overspeed	Alarm
PRIMING FAULT P	Priming Fault	Pre-Alarm
PROT SHUTDOWN	Protective Shutdown	Status
RTD_IN_X_O1 (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Status
RTD_IN_X_O1 A (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Alarm
RTD_IN_X_O1 P (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Pre-Alarm
RTD_IN_X_O2 (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Status

Event String	Event Description	Event Type
RTD_IN_X_O2 A (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Alarm
RTD_IN_X_O2 P (X = 1 to 8)	User Configurable Analog Input X Over 1 (X = 1 to 8)	Pre-Alarm
RTD_IN_X_OOR (X = 1 to 8)	User Configurable RTD Input X Out of Range (X = 1 to 8)	Status
RTD_IN_X_OOR A (X = 1 to 8)	User Configurable Analog Input X Out of Range (X = 1 to 8)	Alarm
RTD_IN_X_OOR P (X = 1 to 8)	User Configurable Analog Input X Out of Range (X = 1 to 8)	Pre-Alarm
RTD_IN_X_U1 (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Status
RTD_IN_X_U1 A (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Alarm
RTD_IN_X_U1 P (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Pre-Alarm
RTD_IN_X_U2 (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Status
RTD_IN_X_U2 A (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Alarm
RTD_IN_X_U2 P (X = 1 to 8)	User Configurable Analog Input X Under 1 (X = 1 to 8)	Pre-Alarm
SCREEN ERROR	Screen Error	Status
RUNUP SPD LO P	Run Up Speed Low	Pre-Alarm
SPD SNDR FAIL	Speed Sender Fail	Status
SPD SNDR FAIL A	Speed Sender Fail	Alarm
SPEED DMD FL P	Speed Demand Fail	Pre-Alarm
SPEED TOO LOW P	Engine Speed Too Low	Pre-Alarm
SS OVERRIDE ON P	Shutdown Override	Pre-Alarm
START SPEED LOW P	Start Speed Low	Pre-Alarm
THRM_CPL_X_O1 (X = 1 to 2)	User Configurable Thermocouple Input X Over 1 (X = 1 to 2)	Status
THRM_CPL_X_O1 A (X = 1 to 2)	User Configurable Thermocouple Input X Over 1 (X = 1 to 2)	Alarm
THRM_CPL_X_O1 P (X = 1 to 2)	User Configurable Thermocouple Input X Over 1 (X = 1 to 2)	Pre-Alarm
THRM_CPL_X_O2 (X = 1 to 2)	User Configurable Thermocouple Input X Over 1 (X = 1 to 2)	Status
THRM_CPL_X_O2 A (X = 1 to 2)	User Configurable Thermocouple Input X Over 1 (X = 1 to 2)	Alarm
THRM_CPL_X_O2 P (X = 1 to 2)	User Configurable Thermocouple Input X Over 1 (X = 1 to 2)	Pre-Alarm
THRM_CPL_X_OOR (X = 1 to 2)	User Configurable Thermocouple Input X Out of Range (X = 1 to 2)	Status
THRM_CPL_X_OOR A (X = 1 to 2)	User Configurable Thermocouple Input X Out of Range (X = 1 to 2)	Alarm
THRM_CPL_X_OOR P (X = 1 to 2)	User Configurable Thermocouple Input X Out of Range (X = 1 to 2)	Pre-Alarm
THRM_CPL_X_U1 (X = 1 to 2)	User Configurable Thermocouple Input X Under 1 (X = 1 to 2)	Status
THRM_CPL_X_U1 A (X = 1 to 2)	User Configurable Thermocouple Input X Under 1 (X = 1 to 2)	Alarm
THRM_CPL_X_U1 P (X = 1 to 2)	User Configurable Thermocouple Input X Under 1 (X = 1 to 2)	Pre-Alarm
THRM_CPL_X_U2 (X = 1 to 2)	User Configurable Thermocouple Input X Under 1 (X = 1 to 2)	Status
THRM_CPL_X_U2 A (X = 1 to 2)	User Configurable Thermocouple Input X Under 1 (X = 1 to 2)	Alarm
THRM_CPL_X_U2 P (X = 1 to 2)	User Configurable Thermocouple Input X Under 1 (X = 1 to 2)	Pre-Alarm
WEAK BATTERY P	Weak Battery	Pre-Alarm

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SECTION 4 • BESTCOMSPiUs SOFTWARE

INTRODUCTION

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

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

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

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

Figure 4-1 illustrates the typical user interface components of the DGC-2020 plug-in with BESTCOMSPiUs.

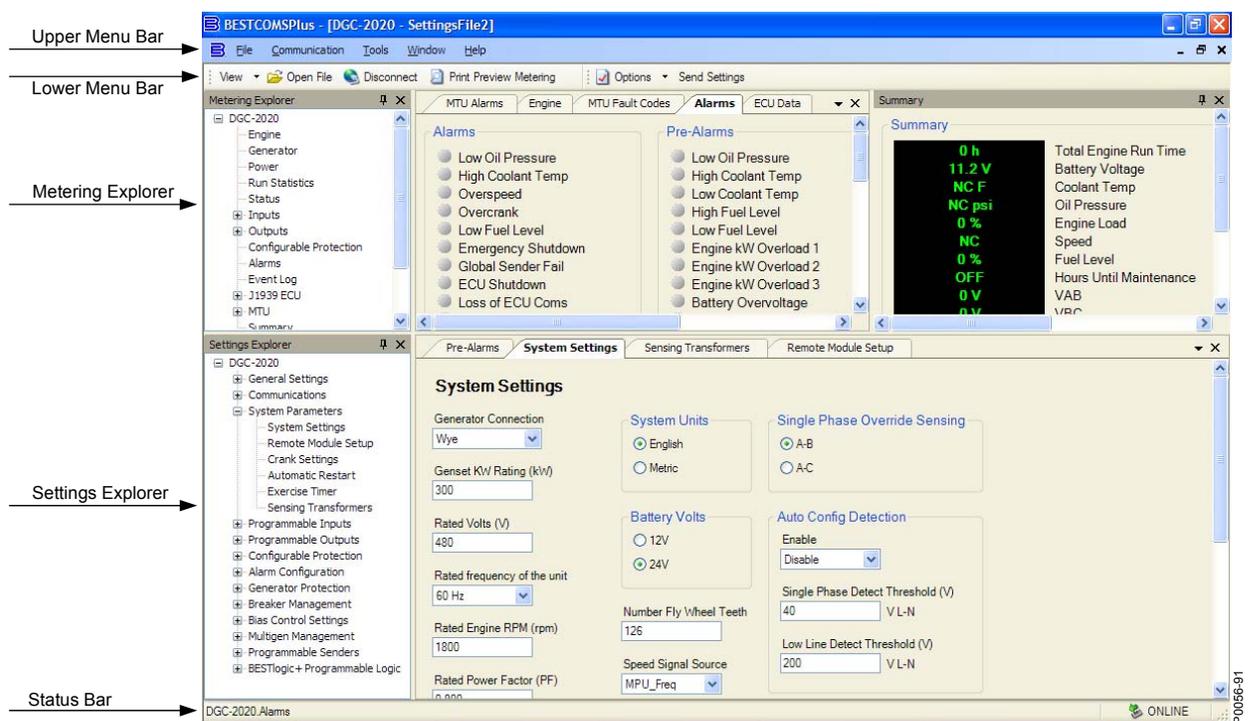


Figure 4-1. Typical User Interface Components

INSTALLATION

BESTCOMSPiUs software is built on the Microsoft® .NET Framework. The setup utility that installs BESTCOMSPiUs on your PC also installs the DGC-2020 plug-in and the .NET Framework (if not already installed). BESTCOMSPiUs operates with IBM-compatible personal computers (PCs) using Windows® 2000, Windows® XP, and Windows® Vista. Microsoft® Internet Explorer 5.01 or later must be installed on your PC before installing BESTCOMSPiUs. System requirements for the .NET Framework and BESTCOMSPiUs are listed in Table 4-1.

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

Component	Requirement
Processor	400 MHz
RAM	128 MB
Hard Drive	25 MB (if .NET Framework is already installed on PC.)
	250 MB (if .NET Framework is not already installed on PC.)

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

Installing BESTCOMSPPlus

NOTE

Do not connect USB cable until setup completes successfully. Connecting USB cable before setup is complete may 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 automatically installs BESTCOMSPPlus, the .NET Framework (if not already installed), and the DGC-2020 plug-in 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, when clicked, starts BESTCOMSPPlus.

STARTUP AND ACTIVATION

Starting BESTCOMSPPlus

To start BESTCOMSPPlus, click the *Start* button, *Programs*, *Basler Electric*, and then the *BESTCOMSPPlus* icon. During initial startup, the *BESTCOMSPPlus Select Language* screen is displayed (Figure 4-2). You can select 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 later be accessed by selecting *Tools* and *Select Language* from the menu bar.

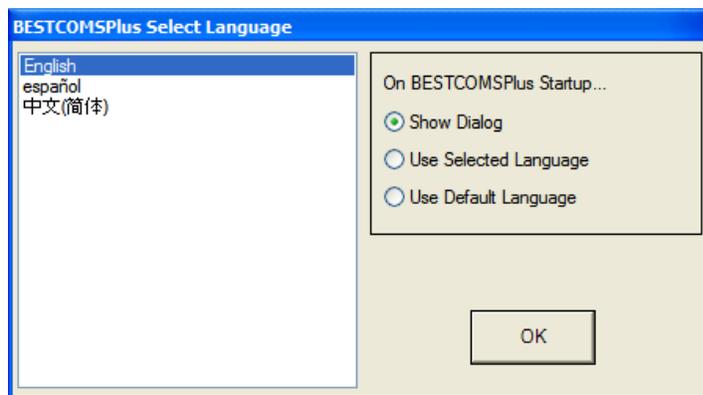


Figure 4-2. BESTCOMSPPlus Select Language

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



Figure 4-3. Splash Screen

The BESTCOMSPlus platform window opens. If a DGC-2020 is connected, select *New Connection* from the *Communication* pull-down menu and select *DGC-2020*. See Figure 4-4. The DGC-2020 plug-in is automatically activated after connecting to a DGC-2020.

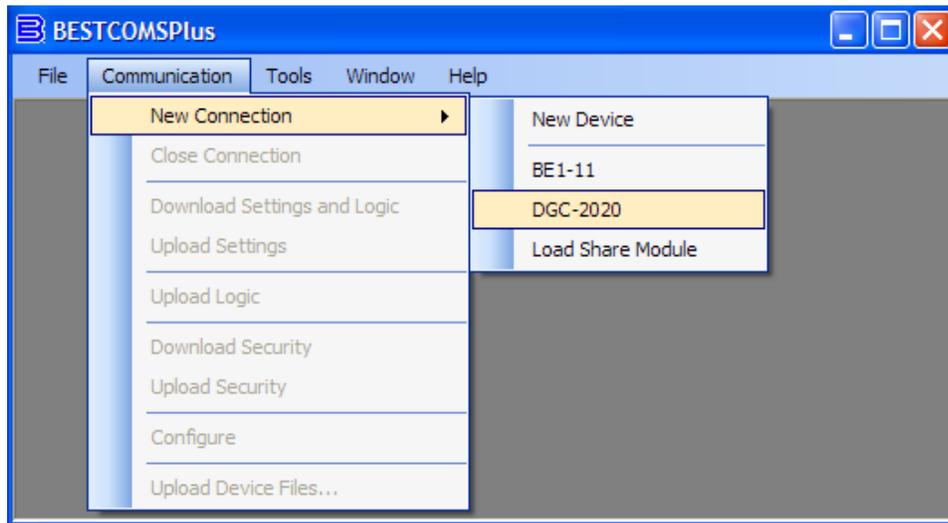


Figure 4-4. Communication Pull-Down Menu

If a DGC-2020 is not connected, select *New* from the *File* pull-down and select *DGC-2020*.

Activating the DGC-2020 Plug-In

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

Requesting an Activation Key

When initially running the DGC-2020 plug-in, the *Activate Device* pop-up will appear. You must contact Basler Electric for an activation key before you can activate the DGC-2020 plug-in. You may request an activation key through email or the Basler Electric website. Click on either the *Website* or *Email* button.

Click on the *Activate* button when you are ready to enter the activation key you received from Basler Electric. The *Device Needs Activated* pop-up will appear. Refer to Figure 4-5.

Entering an Activation Key

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

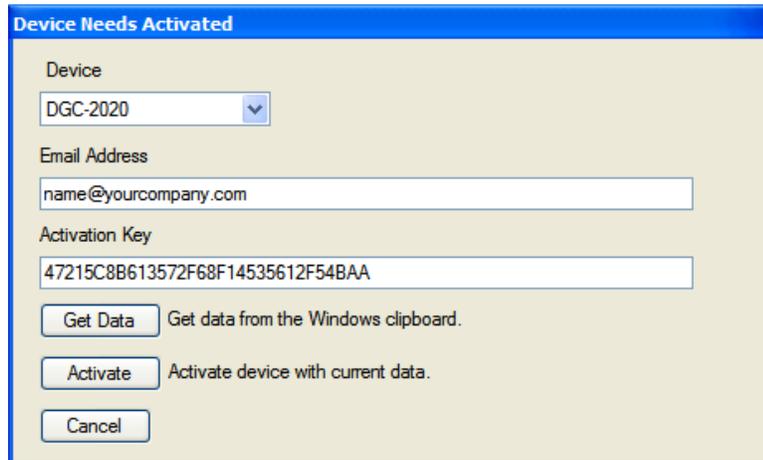


Figure 4-5. Device Needs Activated

COMMUNICATION

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

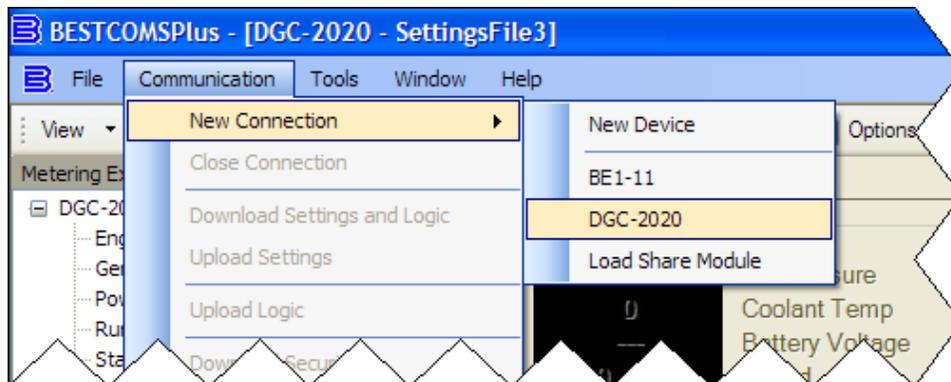


Figure 4-6. Communication, New Connection, DGC-2020

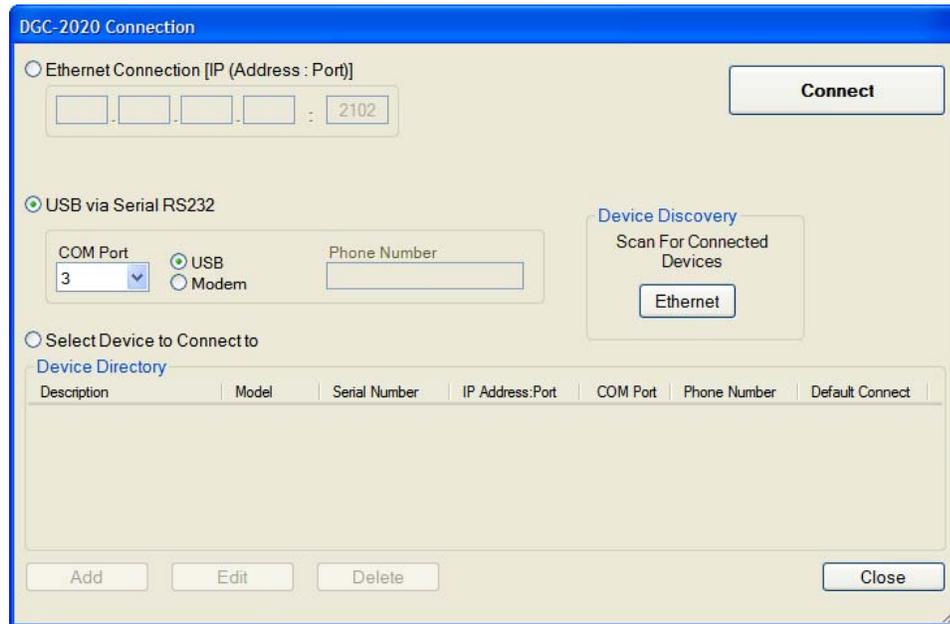


Figure 4-7. DGC-2020 Connection

USB Communication

If connecting to the DGC-2020 through a USB cable, select *USB via Serial RS232*, *USB*, and enter *COM Port*. The USB drivers are installed automatically during the BESTCOMSPPlus installation process. To select the correct *COM Port*, open Windows® Device Manager and expand the *Ports (COM & LPT)* branch. Locate the device named *CP2101 USB to UART Bridge Controller (COMx)*. The *COM Port* number will be displayed in parenthesis (*COMx*). Be sure operating power is applied to the DGC-2020 and the USB cable is connected before opening the Device Manager. See Figure 4-8.

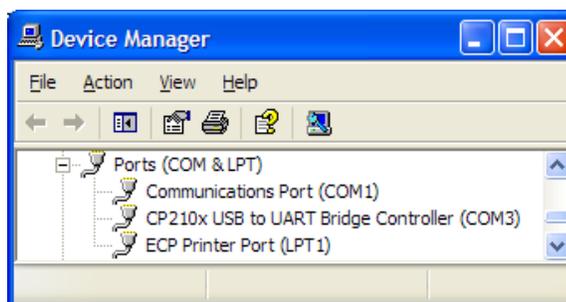


Figure 4-8. Windows® Device Manager

Installing the USB Driver if Automatic Installation Fails

To install the USB driver for the DGC-2020:

1. Apply operating power to the DGC-2020 and wait for the boot sequence to complete.
2. Plug the proper end of the USB cable into the PC and the other end into the DGC-2020.
3. The *Found New Hardware Wizard* dialog box appears.
4. Select “**No, not this time**” and select *Next* to continue.
5. Choose to “**Install from a list or specific location (Advanced)**” and select *Next* to continue.
6. Insert the CD-ROM labeled BESTCOMSPPlus into the PC CD-ROM drive.
7. Browse to the \driver folder on the CD-ROM and select *Next* to continue.

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

Modem Communication

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*.

Ethernet Communication

Communication with the DGC-2020 can be made through an optional LSM-2020 (Load Share Module). In order to use the Ethernet capabilities of the LSM-2020, the network settings in the LSM-2020 must first be configured. The settings are configured through the DGC-2020 and sent to the LSM-2020 over the CANbus interface. The following procedure is used to configure LSM-2020 network settings and connect to the DGC-2020 through Ethernet via an LSM-2020.

1. Navigate to the *Settings, System Params, System Settings, LSM Setup* screen on the front panel HMI and verify that the LSM-2020 is enabled with the correct CANbus address so that the DGC-2020 and LSM-2020 are properly linked together. If a USB connection to the DGC-2020 is active, the LSM-2020 enable setting and CANbus address can be found by using the Settings Explorer in BESTCOMSPiUS to open the *System Parameters, System Settings* tree branch as shown in Figure 4-20. 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 4-9 will appear.

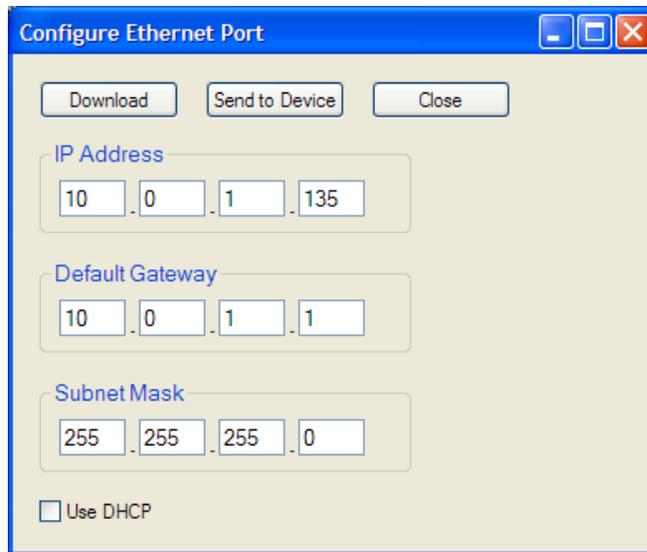


Figure 4-9. Configure Ethernet Port

Configurable options include:

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

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

10.0.0.0 - 10.255.255.255
172.16.0.0 - 172.31.255.255
192.168.0.0 - 192.168.255.255

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

3. Click the *Send to Device* button located on the *Configure Ethernet Port* screen. A confirmation popup will be displayed notifying the user that the LSM-2020 will reboot after settings are sent. Click the *Yes* button to allow settings to be sent. After the unit has rebooted and the power-up sequence is complete, the LSM-2020 is ready to be used on a network.
4. If desired, LSM-2020 settings can be verified by selecting *Download Settings and Logic* from the *Communication* pull-down menu. Active settings will be downloaded from the LSM-2020 and DGC-2020. Verify that the downloaded settings match the previously sent settings.
5. Connection to the DGC-2020 can be made through Ethernet via an LSM-2020 with properly configured network settings. When making a new connection to the DGC-2020, the *Ethernet Connection* option shown in Figure 4-7 will allow the user to enter the IP address of the LSM-2020 with which to connect. The *Ethernet* button under *Device Discovery, Scan for Connected Devices*, allows automatic detection of any LSM-2020 devices connected to the local network.

NOTE

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

NOTE

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

NOTE

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 BESTCOMSPPlus and the DGC-2020 is established by clicking on the *Connect* button on the *DGC-2020 Connection* screen (see Figure 4-7) or by clicking on the *Connect* button on the lower menu bar of the main BESTCOMSPPlus 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, BESTCOMSPPlus will automatically read all settings and logic from the DGC-2020 and load them into BESTCOMSPPlus memory. See Figure 4-10.

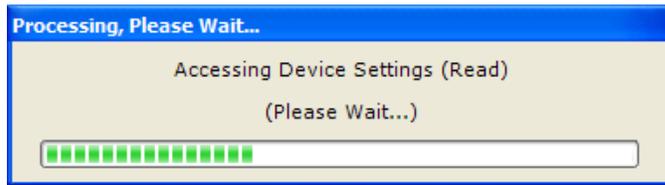


Figure 4-10. Processing, Please Wait...

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, setup communications, upload and download settings/security files, and compare settings files. The lower menu bar consists of clickable icons. The lower menu bar is used to change BESTCOMSPlus views, open a settings file, connect/disconnect, preview metering printout, switch to live mode, and send a settings file to the DGC-2020.

Upper Menu Bar (BESTCOMSPlus Shell)

File

- New Create a new settings file
- Open..... Open an existing settings file
- Open File As Text Generic file viewer for *.csv, *.txt, etc. files
- Close Close settings file
- Save Save settings file
- Save As Save settings file with a different name
- Export To File Save settings as a *.csv file
- Print Preview Preview a settings file printout
- Print To File Save as rich text file type (*.rtf)
- Print Print a settings file
- Properties View properties of a settings file
- History View history of a settings file
- Recent Files Open a previously opened file
- Exit Close BESTCOMSPlus program

Communication

- New Connection Choose new device or DGC-2020
- Close Connection Close communication connection
- Download Settings and Logic..... Download operational and logic settings from the device
- Upload Settings Upload operational settings to the device
- Upload Logic Upload logic settings to the device
- Download Security Download security settings from the device
- Upload Security Upload security settings to the device
- Upload Device Files Upload a device package (firmware/language module)

Tools

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

Window

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

Help

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

Lower Menu Bar (DGC-2020 Plug-In)

View

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

Open File

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

Connect/Disconnect

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

Print Preview Metering

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

Options

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

Send Settings

This button is used when BESTCOMSPlus is not operating in Live Mode. Click on this button after making a setting change to send the modified setting to the DGC-2020.

SETTINGS EXPLORER

The Settings Explorer is a convenient tool within BESTCOMSPlus used to navigate through the various settings screens of the DGC-2020 plug-in as listed in the following paragraphs.

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

DGC-2020 AND SYSTEM PARAMETERS

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

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

NOTE

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

GENERAL SETTINGS

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

Front Panel HMI

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

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

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

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

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

BESTCOMSPi.us front panel HMI settings are illustrated in Figure 4-11.

Figure 4-11. Front Panel HMI Settings

^A LCD Contrast Value: Adjustable from 0 to 100 (maximum contrast) in increments of 1.

^B Front Panel Sleep Mode: Enable or Disable.

^C Language: English, Chinese, or Spanish.

^D Scrolling Screen Enable: Enable or Disable.

^E Configurable HMI Summary Settings: Select Scrolling Screen Item 1 through 20.

^F Scrolling Screen Delay: Adjustable from 1 to 120 s in 1 s increments.

^G Phase Toggle Delay: Adjustable from 0 to 20 s in 1 s increments.

^H Initializing Message 1: Accepts an alphanumeric string of up to 16 characters. Displayed on the second line of the initial boot screen.

^I Initializing Message 2: Accepts an alphanumeric string of up to 16 characters. Displayed on the third line of the initial boot screen.

Style Number

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

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.

BESTCOMSPlus style number selections and definitions are illustrated in Figure 4-12.

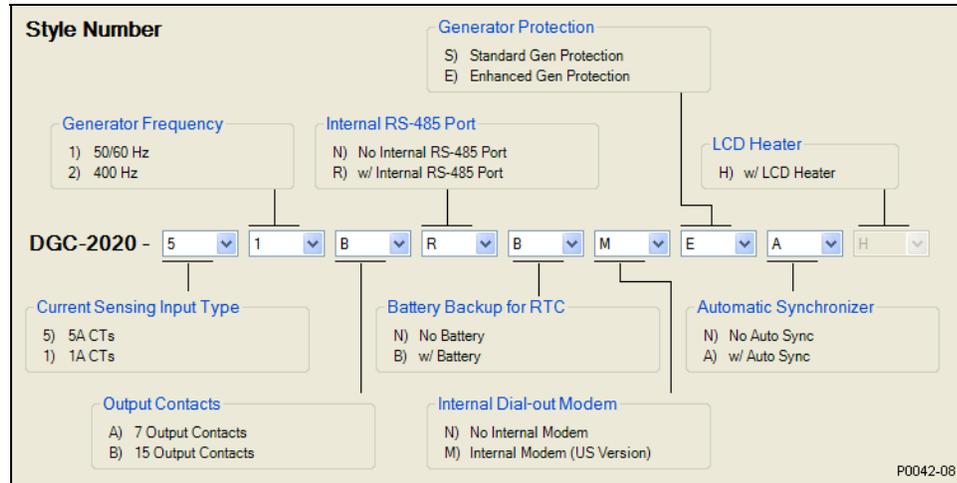


Figure 4-12. DGC-2020 Style Chart Selections and Definitions

Device Info

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

DGC-2020

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

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

Site-specific information for the DGC-2020 can be assigned by the user. This label includes a device name^J.

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

Contact Expansion Module

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

When on-line, read-only information includes the application version^R, boot code version^S, application build^T, serial number^U, application part number^V, and model number^W. The *Refresh* button^X is used to update the screen after connecting an optional CEM-2020.

BESTCOMSPlus device information values and settings are illustrated in Figure 4-13.

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

BESTCOMSPPlus device information values and settings are illustrated in Figure 4-13.

Figure 4-13. Device Info Values and Settings

^A *Application Version*: When configuring DGC-2020 settings off-line, the application version for the unit to be configured must be selected. Select <1.00.07, <=1.00.07 & >1.01.00, >=1.01.00 & <1.02.00, >=1.02.00.

^B *Application Version*: Read-only value obtained when BESTCOMSPPlus is communicating with the DGC-2020.

-
- ^C *Boot Code Version*: Read-only value obtained when BESTCOMSPlus is communicating with the DGC-2020.
- ^D *Application Build*: Read-only value obtained when BESTCOMSPlus is communicating with the DGC-2020.
- ^E *Serial Number*: Read-only value obtained when BESTCOMSPlus is communicating with the DGC-2020.
- ^F *Application Part Number*: Read-only value obtained when BESTCOMSPlus is communicating with the DGC-2020.
- ^G *Model Number*: Read-only value obtained when BESTCOMSPlus is communicating with the DGC-2020.
- ^H *Language Module Version*: Read-only value obtained when BESTCOMSPlus is communicating with the DGC-2020.
- ^I *Language Module Part Number*: Read-only value obtained when BESTCOMSPlus is communicating with the DGC-2020.
- ^J *Device Name*: Accepts an alphanumeric character string of up to 16 characters.
- ^K *Application Version*: Read-only value obtained when BESTCOMSPlus is communicating with an optional LSM-2020.
- ^L *Boot Code Version*: Read-only value obtained when BESTCOMSPlus is communicating with an optional LSM-2020.
- ^M *Application Build*: Read-only value obtained when BESTCOMSPlus is communicating with an optional LSM-2020.
- ^N *Serial Number*: Read-only value obtained when BESTCOMSPlus is communicating with an optional LSM-2020.
- ^O *Application Part Number*: Read-only value obtained when BESTCOMSPlus is communicating with an optional LSM-2020.
- ^P *Model Number*: Read-only value obtained when BESTCOMSPlus is communicating with an optional LSM-2020.
- ^Q *Refresh*: Clicking this button will refresh the screen after connecting an optional LSM-2020.
- ^R *Application Version*: Read-only value obtained when BESTCOMSPlus is communicating with an optional CEM-2020.
- ^S *Boot Code Version*: Read-only value obtained when BESTCOMSPlus is communicating with an optional CEM-2020.
- ^T *Application Build*: Read-only value obtained when BESTCOMSPlus is communicating with an optional CEM-2020.
- ^U *Serial Number*: Read-only value obtained when BESTCOMSPlus is communicating with an optional CEM-2020.
- ^V *Application Part Number*: Read-only value obtained when BESTCOMSPlus is communicating with an optional CEM-2020.
- ^W *Model Number*: Read-only value obtained when BESTCOMSPlus is communicating with an optional CEM-2020.
- ^X *Refresh*: Clicking this button will refresh the screen after connecting an optional CEM-2020.
- ^Y *Application Version*: Read-only value obtained when BESTCOMSPlus is communicating with an optional AEM-2020.
- ^Z *Boot Code Version*: Read-only value obtained when BESTCOMSPlus is communicating with an optional AEM-2020.
- ^{AA} *Application Build*: Read-only value obtained when BESTCOMSPlus is communicating with an optional AEM-2020.
- ^{BB} *Serial Number*: Read-only value obtained when BESTCOMSPlus is communicating with an optional AEM-2020.
- ^{CC} *Application Part Number*: Read-only value obtained when BESTCOMSPlus is communicating with an optional AEM-2020.
- ^{DD} *Model Number*: Read-only value obtained when BESTCOMSPlus is communicating with an optional AEM-2020.
- ^{EE} *Refresh*: Clicking this button will refresh the screen after connecting an optional AEM-2020.

Device Security Setup

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

- **OEM Access.** This password level allows access to all settings. The default, OEM-access password is **OEM**.
- **Settings Access.** This password level allows all except uploading of firmware and clearing of device event log. The default, settings-access password is **SET**.
- **Operator Access.** The default, operator-access password is **OP**. This password level allows all settings to be read and allows changes to be made to the following:
 - LCD Contrast
 - Sleep Mode
 - Date/Time
 - All Sender Fail Time Delays
 - Metric Conversion
 - Low Fuel Pre-Alarm Level
 - Low Fuel Alarm Level
 - Pre-Start Contact after Cranking
 - Cooldown Time
 - Pre-Crank Time Delay
 - Reset of Maintenance Interval
 - All controls on the Control screen available via the Metering Explorer in 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. Figure 4-14 illustrates the *Device Security Setup* screen with all three of the access levels shown.

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

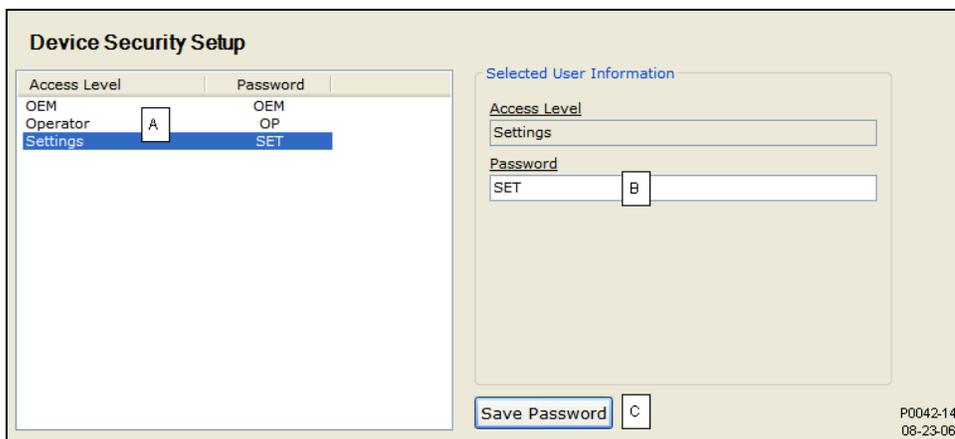


Figure 4-14. Device Security Setup

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

^B *Password:* Accepts an alphanumeric character string of up to 16 characters.

^C *Save Password:* Clicking this button will save the password changes in BESTCOMSPlus memory.

Clock Setup

Configuration of daylight saving time and coordination of the local time with universal time (if desired) is performed on this screen. If required, enter the *UTC (Universal Time Coordinates) Offset*^A. Choose the type of *DST Configuration*^B and then set the *Start Day*^C, *End Day*^D, and *Bias*^E. See Figure 4-15.

Figure 4-15. Clock Setup

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

^B *DST Configuration*: Disabled, Fixed, or Floating.

^C *Start Day*:

Fixed DST Configuration

Month (January to December), Day of Month (1 to 31 in increments of 1), Hour (0 to 23 in increments of 1), Minute (0 to 59 in increments of 1).

Floating DST Configuration

Month (January to December), Occurrence of Day (First to Fourth, or Last), Weekday (Sunday to Saturday), Hour (0 to 23 in increments of 1), Minute (0 to 59 in increments of 1).

^D *End Day*:

Fixed DST Configuration

Month (January to December), Day of Month (1 to 31 in increments of 1), Hour (0 to 23 in increments of 1), Minute (0 to 59 in increments of 1).

Floating DST Configuration

Month (January to December), Occurrence of Day (First to Fourth, or Last), Weekday (Sunday to Saturday), Hour (0 to 23 in increments of 1), Minute (0 to 59 in increments of 1).

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

COMMUNICATIONS

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

CANbus Setup

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

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

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

In applications where the ECU is not continuously powered, the DGC-2020 has provisions for applying power to the ECU and pulsing the ECU to update its engine monitoring data. Either the DGC-2020 Fuel Solenoid or Pre-Start relay output can be used to apply power to the ECU^D. If the Pre-Start contact is

selected, the Fuel Solenoid output will still close during cranking and genset operation to provide a separate indication that the genset is running. For applications where pulsing of the ECU is not desired, this pulsing feature^E may be disabled.

ECU Limitations

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

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

The DGC-2020 Solution

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

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

Figure 4-16. CANbus Setup

- ^A **Enable ECU Support:** Check box to enable ECU support.
^B **Enable DTC Support:** Check box to enable DTC support.
^C **CANbus Address:** Accepts an address number from 0 to 253 in increments of 1.
^D **Output Select:** Fuel Contact or Pre-start Contact.
^E **Pulsing:** Enable or Disable.
^F **Engine Shutdown:** Adjustable from 1 to 60 s in 1 s increments.
^G **Pulse Cycle Time:** Adjustable from 1 to 60 s in 1 s increments.
^H **Settling Time:** Adjustable from 5,500 to 30,000 ms in 1 ms increments.
^I **Response Timeout:** Adjustable from 1 to 60 s in 1 s increments.

ECU Setup

The DGC-2020 can be configured for Standard, Volvo Penta*, MTU MDEC, MTU ADEC, or MTU ECU7^A. Configuring the DGC-2020 for Volvo Penta necessitates the configuration of two additional settings: Speed Select and Accelerator Position. The Speed Select setting^B 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^C is expressed as a percentage and tells the Volvo Penta ECU where to set the engine speed (trim) relative to the base speed. The range of the setting is the base speed ± 120 rpm. A setting of 0% will cause the engine to run at 120 rpm below the base speed, a setting of 50% will cause the engine to run at the base speed, and a setting of 100% will cause the engine to run at 120 rpm above the base speed. The Accelerator Position setting is linear with a gain of 2.4 rpm/percentage. This setting is not saved in nonvolatile memory and defaults back to 50% after DGC-2020 operating power is cycled.

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

- MDEC Module Type^D
- Speed Demand Switch^E
- Engine RPM^F

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

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

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

- Speed Demand Switch^E - Specifies speed demand source for the MTU engine ECU.
- Engine RPM^F - Requested engine RPM when speed demand source is analog CAN for an MTU ECU.
- Overspeed Test^G - Temporarily drives an MTU ECU into overspeed for testing overspeed.
- Speed Up^K - Increases speed of the MTU ECU.
- Speed Down^L - Decreases speed of the MTU ECU.
- Speed Demand Limit^M - Turns the speed demand limit on or off.
- Increased Idle^N - Sets the MTU ECU idle.
- Trip Reset^I - Resets trip information such as trip fuel used, trip hours, trip idle time, etc.
- Int Oil Prime^J - Causes an MTU ECU engine to perform an internal lubrication cycle.
- Engine Start Prime^O - Turns the engine start prime on or off.
- Fan Override^P - Turns the fan override on or off.
- Mode Switch^Q - Turns the mode switch on or off.
- Governor Param Switch Over^H - Specifies which governor parameters an MTU ECU should use.
- Governor Param Set Select^R - Sets the governor parameter set select.
- CAN Rating Switch 1 & 2^S - Turns the CAN rating switch 1 & 2 on or off.
- Cylinder Cutout Disable 1 & 2^T - Turns the cylinder cutout disable 1 & 2 on or off.

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

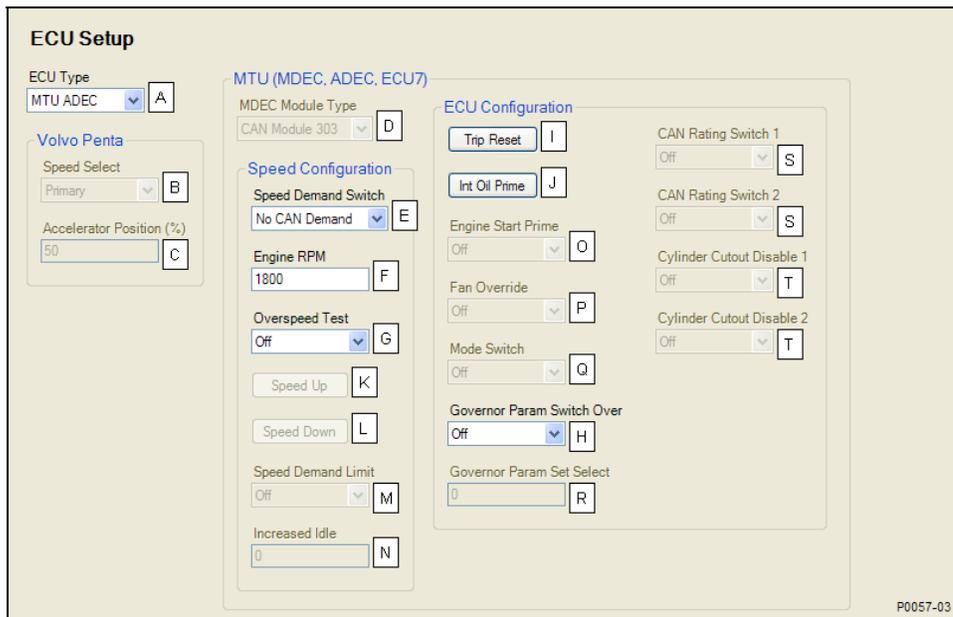


Figure 4-17. ECU Setup

^A ECU Type: Standard, Volvo Penta, MTU MDEC, MTU ADEC, or MTU ECU7.

^B Speed Select: Primary or Secondary.

^C Accelerator Position: Adjustable from 0 to 100% in 1% increments.

^D MDEC Module Type: CAN Module 201, 302, 303, or 304.

^E Speed Demand Switch: Analog CAN, Up Down ECU, Up Down CAN, Analog ECU, Frequency, No CAN Demand.

^F Engine RPM: Adjustable from 1,400 to 2,000 in increments of 1.

^G Overspeed Test: Off or On.

^H Governor Param Switch Over: Off or On.

^I Trip Reset: Press to set.

^J Int Oil Prime: Press to set.

^K Speed Up: Press to set.

^L Speed Down: Press to set.

^M Speed Demand Limit: Off or On.

^N Increased Idle: 0 to 1,000 in increments of 1.

^O Engine Start Prime: Off or On.

^P Fan Override: Off or On.

^Q Mode Switch: Off or On.

^R Governor Param Set Select: 0 to 1,000 in increments of 1.

^S CAN Rating Switch 1 & 2: Off or On.

^T Cylinder Cutout Disable 1 & 2: Off or On.

Modem Setup (Optional)

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

- 27-1 Trip Alarm
- 27-2 Trip Alarm
- 32 Trip Alarm
- 40 Trip Alarm
- 47 Trip Alarm
- 51-1 Trip Alarm
- 51-2 Trip Alarm
- 51-3 Trip Alarm
- 59-1 Trip Alarm
- 59-2 Trip Alarm

- 81O Trip Alarm
- 81U Trip Alarm
- 27-1 Trip Pre-Alarm
- 27-2 Trip Pre-Alarm
- 32 Trip Pre-Alarm
- 40 Trip Pre-Alarm
- 47 Trip Pre-Alarm
- 51-1 Trip Pre-Alarm
- 51-2 Trip Pre-Alarm
- 51-3 Trip Pre-Alarm
- 59-1 Trip Pre-Alarm
- 59-2 Trip Pre-Alarm
- 81O Trip Pre-Alarm
- 81U Trip Pre-Alarm
- AEM Comm Failure
- Auto Restart Failure Alarm
- Auxiliary Input X Closed (X = 1 to 16)
- AVR Output Limit
- Battery Charger Fail Status
- Battery Overvoltage Pre-Alarm
- CEM Comm Failure
- Config Element X Status (X = 1 to 8)
- Coolant Temp Sender Fail Alarm
- Coolant Temp Sender Fail Pre-Alarm
- Cooldown Timer Active
- Duplicate AEM Pre-Alarm
- Duplicate CEM Pre-Alarm
- Duplicate LSM Pre-Alarm
- Emergency Stop Alarm
- Engine Running
- Fuel Leak Detect Status
- Fuel Level Sender Fail Alarm
- Fuel Level Sender Fail Pre-Alarm
- GOV Output Limit
- High Coolant Temperature Alarm
- High Coolant Temp Pre-Alarm
- High Fuel Pre-Alarm
- ID Missing Pre-Alarm
- ID Repeat Pre-Alarm
- Intergenset Comms Failure
- kW Overload 1 Pre-Alarm
- kW Overload 2 Pre-Alarm
- kW Overload 3 Pre-Alarm
- Loss of ECU Coms Alarm
- Loss of ECU Coms Pre-Alarm
- Loss of Generator Voltage Sensing Alarm
- Low Battery Voltage Pre-Alarm
- Low Coolant Level Status
- Low Coolant Temp Pre-Alarm
- Low Fuel Alarm
- Low Fuel Pre-Alarm
- Low Oil Pressure Alarm
- Low Oil Pressure Pre-Alarm
- LSM Comm Failure
- MPU Speed Sender Fail Alarm
- Oil Pressure Sender Fail Alarm
- Oil Pressure Sender Fail Pre-Alarm
- Overcrank Alarm

- Overspeed Alarm
- Scheduled Maintenance Pre-Alarm
- Switch Not in Auto
- Transfer Fail Alarm
- Virtual Output X Status (X = 1 to 8)
- Weak Battery Voltage Pre-Alarm

Dial-Out

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

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

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

Dial-In

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

Figure 4-18. Modem Setup

^A *Dial Out Number*: Accepts a telephone number of up to 16 characters.

^B *Pager ID*: Accepts a pager identification number of up to 16 characters.

^C *Modem Dialout Conditions*: Check boxes to select conditions that will initiate a dial-out message.

^D *Pager Coms Data Format*: 7 bit – Even Parity or 8 bit – No Parity.

^E *Pager Buffer Limit*: Adjustable from 80 to 200 characters in increments of 40.

^F *Modem Offline Delay*: Adjustable from 1 to 240 min in 1 min increments.

^G *Inter Dialout Activation Delay*: A delay of 15, 30, 60, or 120 s may be selected.

^H *Rings for Modem Answer*: Adjustable from 1 to 9 in increments of 1.

RS-485 Setup (Optional)

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

Modbus register values for the DGC-2020 are listed and defined in Appendix B, *Modbus Communication*.

BESTCOMSPlus RS-485 port settings are illustrated in Figure 4-19.

Figure 4-19. RS-485 Setup

^A *Baud Rate*: A value of 1200, 2400, 4800, or 9600 may be selected.

^B *Parity*: No Parity, Odd Parity, or Even Parity.

^C *Modbus Address*: A value of 1 to 247 may be entered in increments of 1.

SYSTEM PARAMETERS

System parameters configure the DGC-2020 for operation with a specific application and are divided into three categories: system, engine cranking, and sensing transformers.

System Settings

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

Genset Electrical Parameters

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

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

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

The 32 and 40Q protection functions use the Rated Power Factor setting^D when determining pickup.

Engine Speed Measurement

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

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

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

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

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

Engine Cooldown

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

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

Off Mode Cooldown

When Off Mode Cooldown^I 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^J. At the end of the cool down cycle, the unit will go to OFF mode. If it is desired to stop the machine immediately, pressing the OFF button twice will cause the unit to go to OFF mode

immediately. Furthermore, if an Off Mode Cooldown is in progress and the OFF button is pressed, the unit will immediately shut down. If the unit was in RUN mode when the OFF button was pressed, it remains in RUN for the remainder of the cooldown cycle. If the machine was in the AUTO mode when the OFF button was pressed, it remains in AUTO mode until the cooldown and shutdown cycle are completed, or until the OFF button is pressed a second time forcing the unit to OFF mode. The OFF LED will flash to indicate an off mode cooldown is in progress. In addition, the unit will display "OFF MODE COOLDN" while the cooldown timer is displayed.

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

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

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

The Off Mode Cooldown feature works from the front panel HMI buttons only. Any OFF command received through BESTlogic+ or BESTCOMSPPlus control result in an immediate transition of the machine to OFF.

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

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

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

EPS Threshold

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

The Low Line Scale Factor setting^L is used to automatically adjust the EPS threshold settings in applications that may utilize more than one type of genset connections. 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 settings. 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 PU).

Measurement/Metering Units

The user can configure the DGC-2020 to display and report engine oil pressure and coolant temperature in English or metric units of measure^M.

Battery Voltage

The nominal voltage^N 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^O. 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

Horn

An output contact configured (through programmable logic) to energize a horn^P can be enabled and disabled through BESTCOMSPPlus or at the DGC-2020 front panel.

Single-Phase Override

The DGC-2020 will switch to single-phase voltage sensing^Q when a contact input (programmed as a single-phase override input) is received. Either A-to-B or A-to-C sensing can be selected.

Fuel Level Function

This setting^R 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 BESTCOMSPPlus.

Power Up Delay

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

Auto Config Detection

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

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

Single Phase Detection Threshold.^U 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 Detection Threshold.^V 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 Detection Generator Connection.^W 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.

Relay Control

The default operational setting for the Start^X, Run^Y, and Prestart^Z 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+.

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

Figure 4-20. System Settings

- ^A *Generator Connection:* Delta, Wye, 1-Phase A-B, 1-Phase A-C, or Grounded Delta.
- ^B *Genset kW Rating:* Adjustable from 5 to 9,999 kW in 1 kW increments.
- ^C *Rated Volts:* Adjustable from 1 to 999 Vac in 1 Vac increments.
- ^D *Rated Power Factor:* Adjustable from –1 to +1 in increments of 0.001.
- ^E *Speed Signal Source:* MPU, Gen Freq, or MPU Freq.
- ^F *Rated Frequency:* 50/60 or 400 Hz.
- ^G *Rated Engine RPM:* Adjustable from 750 to 3,600 rpm in 1 rpm increments.
- ^H *Number Fly Wheel Teeth:* Adjustable from 50 to 500 in increments of 1.
- ^I *Off Mode Cool Down Enable:* Enable or Disable.
- ^J *No Load Cool Down Time:* Adjustable from 0 to 60 minutes in 1 minute increments.
- ^K *EPS Current Threshold:* Adjustable from 3 to 10% of the CT primary rating in 1% increments.
- ^L *Low Line Scale Factor:* Adjustable from 0 to 3.000 in increments of 0.001.
- ^M *System Units:* English or Metric.
- ^N *Battery Volts:* 12 or 24 Vdc.
- ^O *NFPA Level:* 0 disables NFPA compliance, 1 enables Level 1 NFPA compliance, 2 enables Level 2.
- ^P *Horn:* Enable or Disable.
- ^Q *Single Phase Override Sensing:* A-B or A-C.
- ^R *Fuel Level Function:* Disable, Fuel Lvl, Natural Gas, or Liquid Propane.
- ^S *Power Up Delay:* Adjustable from 0 to 60 seconds in 1 second increments.
- ^T *Auto Config Detection:* Enable or Disable.
- ^U *Single Phase Detect Threshold:* Adjustable from 0 to 480 V in 1 V increments.
- ^V *Low Line Detect Threshold:* Adjustable from 0 to 480 V in 1 V increments.
- ^W *Single Phase Detection Generator Connection:* A-B or A-C.
- ^X *Start:* Predefined or Programmable.
- ^Y *Run:* Predefined or Programmable.
- ^Z *Prestart:* Predefined or Programmable.

Remote Module Setup

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

Load Sharing Module

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

Contact Expansion Module

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

Analog Expansion Module

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

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

Remote Module Setup

Load Share Module
 Disable **B**
 Enable

LSM J1939 Address
235 **A**

Contact Expansion Module
 Disable **D**
 Enable

CEM J1939 Address
236 **C**

CEM Outputs
18 Outputs **E**

Analog Expansion Module
 Disable **G**
 Enable

AEM J1939 Address
237 **F**

P0056-87

Figure 4-21. Remote Module Setup

^A LSM J1939 Address: Adjustable from 1 to 253 in increments of 1.

^B Load Share Module: Enable or Disable.

^C CEM J1939 Address: Adjustable from 1 to 253 in increments of 1.

^D Contact Expansion Module: Enable or Disable.

^E CEM Outputs: 18 Outputs or 24 Outputs.

^F AEM J1939 Address: Adjustable from 1 to 253 in increments of 1.

^G Analog Expansion Module: Enable or Disable.

Crank Settings

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

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

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

The Pre-Start can be configured^H during the resting state. If Preheat Before Crank is selected, the Pre-Start output will be closed for a time equal to the Pre-crank delay time prior to re-entering the cranking state. If the Pre-crank delay setting is longer than the rest interval, the Pre-Start output will be closed for the entire rest time.

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

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

Figure 4-22. Engine Crank Settings

^A Cranking Style: Cycle or Continuous.

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

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

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

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

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

^G Pre-Start Contact Configuration: Open After Disconnect or Closed While Running.

^H Prestart Rest Configuration: Off During Rest, On During Rest, or Preheat Before Crank.

^I Oil Pressure Crank Disconnect Enable: Disable or Enable.

^J Crank Disconnect Pressure (psi): Adjustable from 3 to 150 psi in increments of 1 psi.

Automatic Restart

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

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

Figure 4-23. Automatic Restart Settings

^A Auto Restart Enable: Enable or Disable.

^B Auto Restart Interval: Adjustable from 0.5 to 30 minutes in 0.5 minute increments.

^C Auto Restart Attempts: Adjustable from 1 to 10 in increments of 1.

Exercise Timer

The exercise timer is used to start the genset at a predetermined time and run for the user-defined period. The mode^A defines how often the genset will run. If monthly is selected, you must select the day of the month^B to start. If weekly is selected, you must select the day of the week^C to start. Settings for Start Hour^D and Start Minutes^E may also be defined. The Run Period Hours^F and Minutes^G define how long the genset will run each time. If Run with Load^H is enabled, the DGC-2020 will close its GEN breaker during the RUN time.

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

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

Exercise Timer

Mode: Monthly

Start Day Of Month: 1

Start Day Of Week: Sunday

Start Hour: 12

Start Minute: 30

Run Period Hours: 5

Run Period Minutes: 30

Run with Load

P0050-36

Figure 4-24. Exercise Timer Settings

^A Mode: Monthly, Weekly, or Daily.

^B Start Day Of Month: Adjustable from 1 to 31 in 1 day increments.

^C Start Day Of Week: Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, or Saturday.

^D Start Hour: Adjustable from 0 to 23 in 1 hour increments.

^E Start Minute: Adjustable from 0 to 59 in 1 minute increments.

^F Run Period Hours: Adjustable from 0 to 23 in 1 hour increments.

^G Run Period Minutes: Adjustable from 0 to 59 in 1 minute increments.

^H Run with Load: Enable or Disable.

Sensing Transformers

Three sets of transformer settings configure the DGC-2020 for operation with a specific system. These settings, along with the generator voltage, generator current, and bus voltage detected by the DGC-2020, enable the DGC-2020 to accurately meter system values, offer generator protection, and synchronize the generator with the bus (style number xxxxxxxAx only).

Generator PT Settings

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

Generator CT Setting

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

Bus Transformer Settings

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

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

Sensing Transformers

Sensing Transformers

Generator PT

Gen PT Primary Volts (V)
480 A

Gen PT Secondary Volts (V)
480 B

Bus PT

Bus PT Primary Volts (V)
480 D

Bus PT Secondary Volts (V)
480 E

Generator CT

Gen CT Primary Amps (A)
500 C

P0053-98

Figure 4-25. Sensing Transformers Parameters

^A Gen PT Primary Volts: Adjustable from 1 to 9999 Vac in 1 Vac increments.

^B Gen PT Secondary Volts: Adjustable from 1 to 480 Vac in 1 Vac increments.

^C Gen CT Primary Amps: Adjustable from 1 to 5,000 Aac in 1 Aac increments.

^D Bus PT Primary Volts: Adjustable from 1 to 9999 Vac in 1 Vac increments.

^E Bus PT Secondary Volts: Adjustable from 1 to 480 Vac in 1 Vac increments.

PROGRAMMABLE INPUTS

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

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

Contact Inputs

Each of the 16 contact inputs can be independently configured to announce an alarm or pre-alarm^A when the input senses a contact closure. A user-adjustable time delay^B can be set to delay recognition of a contact input. By default, all inputs are configured so that they do not trigger an alarm or pre-alarm.

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

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

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

BESTCOMSPlus settings for contact inputs (DGC-2020, Programmable Inputs, Contact Inputs) are illustrated in Figure 4-26.

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

- Input #1:** Alarm Configuration: None (dropdown), A (text box); Activation Delay (s): 0 (text box), B (text box); Label Text: INPUT_1 (text box), C (text box); Contact Recognition: Always (dropdown), D (text box).
- Input #2:** Alarm Configuration: None (dropdown); Activation Delay (s): 0 (text box); Label Text: INPUT_2 (text box); Contact Recognition: Always (dropdown).
- Input #3:** Alarm Configuration: None (dropdown); Activation Delay (s): 0 (text box); Label Text: INPUT_3 (text box); Contact Recognition: Always (dropdown).
- Input #4:** Alarm Configuration: None (dropdown).
- Input #5:** Alarm Configuration: None (dropdown).
- Input #6:** Alarm Configuration: None (dropdown).

Figure 4-26. Contact Inputs Settings

^A Alarm Configuration: None, Alarm, or Pre-Alarm.

^B Activation Delay: Adjustable from 0 to 300 s in 1 s increments.

^C Label Text: An alphanumeric character string with a maximum of 16 characters.

^D Contact Recognition: Always or While Engine Running Only.

Programmable Functions

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

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

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

BESTCOMSPlus settings for programmable functions (DGC-2020, Programmable Inputs, Programmable Functions) are illustrated in Figure 4-27.

Figure 4-27. Programmable Functions Settings

- ^A *Auto Transfer Switch Input*: Select Input (None, 1-16) and Contact Recognition (Always or While Engine Running Only).
- ^B *Grounded Delta Override*: Select Input (None, 1-16) and Contact Recognition (Always or While Engine Running Only).
- ^C *Battle Override*: Select Input (None, 1-16) and Contact Recognition (Always or While Engine Running Only).
- ^D *Low Line Override*: Select Input (None, 1-16) and Contact Recognition (Always or While Engine Running Only).
- ^E *Single Phase Override*: Select Input (None, 1-16) and Contact Recognition (Always or While Engine Running Only).
- ^F *Single Phase AC Override*: Select Input (None, 1-16) and Contact Recognition (Always or While Engine Running Only).
- ^G *Battery Charger Fail*: Select Input (None, 1-16), Alarm Configuration (None, Alarm, Pre-Alarm), Activation Delay (s) (0 to 300 in increments of 1), and Contact Recognition (Always or While Engine Running Only).
- ^H *Low Coolant Level*: Select Input (None, 1-16), Alarm Configuration (None, Alarm, Pre-Alarm), Activation Delay (s) (0 to 300 in increments of 1), and Contact Recognition (Always or While Engine Running Only).
- ^I *Fuel Leak Detect*: Select Input (None, 1-16), Alarm Configuration (None, Alarm, Pre-Alarm), Activation Delay (s) (0 to 300 in increments of 1), and Contact Recognition (Always or While Engine Running Only).

Remote LSM Inputs

An optional LSM-2020 (Load Share Module) provides one configurable^A contact input that can be used as a setpoint source for Var, PF, or kW control. Settings are provided for min and max input voltage^B, and min and max input current^C. Refer to Bias Control Settings in this section for information selecting the LSM-2020 input as a setpoint source.

BESTCOMSPlus settings for the remote LSM input (DGC-2020, Programmable Inputs, Remote LSM Inputs) are illustrated in Figure 4-29.

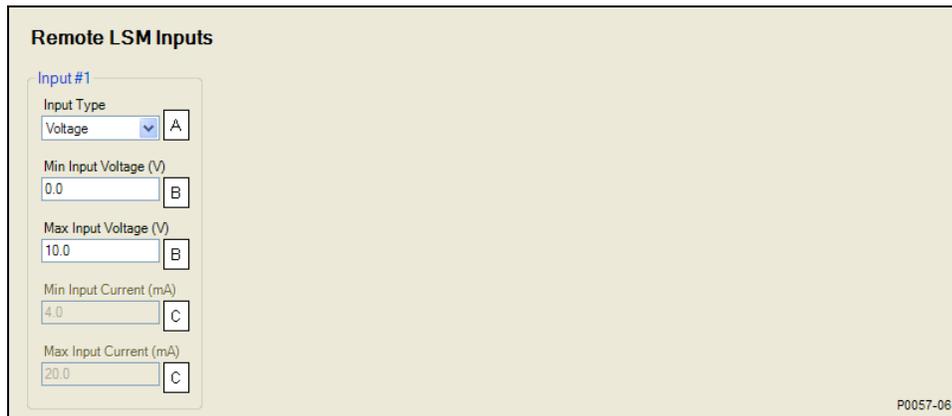


Figure 4-28. Remote LSM Inputs Settings

^A *Input Type:* Voltage or Current.

^B *Min/Max Input Voltage:* Adjustable from 0 to 10 volts in 0.1 V increments.

^C *Min/Max Input Current:* Adjustable from 4 to 20 mA in 0.1 mA increments.

Remote Contact Inputs

An optional CEM-2020 (Contact Expansion Module) provides 10 contact inputs. Each of the 10 contact inputs can be independently configured to annunciate an alarm or pre-alarm^A when the input senses a contact closure. A user-adjustable time delay^B can be set to delay recognition of a contact input. By default, all inputs are configured so that they do not trigger an alarm or pre-alarm.

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

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

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

BESTCOMSPPlus settings for remote contact inputs (DGC-2020, Programmable Inputs, Remote Contact Inputs) are illustrated in Figure 4-29.

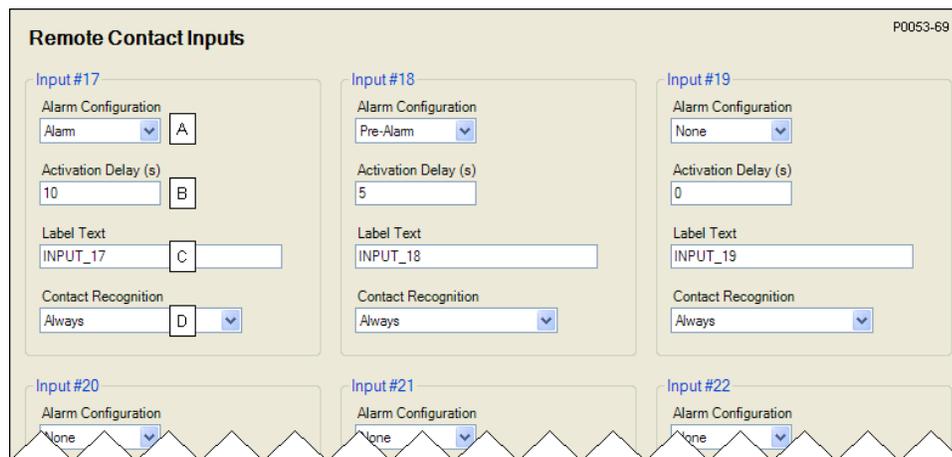


Figure 4-29. Remote Contact Inputs Settings

^A *Alarm Configuration:* None, Alarm, or Pre-Alarm.

^B *Activation Delay:* Adjustable from 0 to 300 s in 1 s increments.

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

^D *Contact Recognition:* Always or While Engine Running Only.

Remote Analog Inputs

An optional AEM-2020 (Analog Expansion Module) provides eight analog inputs. To make identifying the analog inputs easier, a user-assigned name^A can be given to each input.

Select the input type^B and amount of hysteresis^C. A user-adjustable arming delay^D disables analog input recognition during engine startup. When enabled, an out of range alarm^E alerts the user of an open or damaged analog input wire.

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

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

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

BESTCOMSPi settings for remote analog inputs (DGC-2020, Programmable Inputs, Remote Analog Inputs) are illustrated in Figure 4-30. Remote Analog Input #1 is shown.

Figure 4-30. Remote Analog Inputs Settings

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

^K *Max Input Voltage*: Adjustable from 0 to 10 V in 1 V increments.

^L *Alarm Configuration*: None, Alarm, Pre-Alarm, or Status Only.

^M *Threshold*: -9999.0 to +9999.0 in increments of 0.1.

^N *Activation Delay*: Adjustable from 0 to 300 s in 1 s increments.

Remote RTD Inputs

An optional AEM-2020 (Analog Expansion Module) provides eight RTD inputs. To make identifying the RTD inputs easier, a user-assigned name^A can be given to each input.

Select the amount of hysteresis^B and RTD type^C. A user-adjustable arming delay^D disables RTD input recognition during engine startup. When enabled, an out of range alarm^E alerts the user of an open or damaged RTD input wire.

Each RTD input can be independently configured to annunciate an alarm, pre-alarm, or status only^F when the RTD input signal falls beyond the threshold^G. A user-adjustable activation delay^H setting delays alarm annunciation after the threshold has been exceeded.

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

BESTCOMSPPlus settings for remote RTD inputs (DGC-2020, Programmable Inputs, Remote RTD Inputs) are illustrated in Figure 4-31. Remote RTD Input #1 is shown.

Remote RTD Input #1

Label Text: RTD_INPUT_1 (A)

Arming Delay (s): 0 (D)

Hysteresis (%): 2.0 (B)

Out Of Range Alarm Type: None (E)

RTD Type: 100 Ohm Platinum (C)

Threshold #1

Under: Threshold (F): 0 (G), Alarm Configuration: None (F)

Over: Threshold (F): 0 (G), Alarm Configuration: None (F), Activation Delay (s): 0 (H)

Threshold #2

Under: Threshold (F): 0 (G), Alarm Configuration: None (F)

Over: Threshold (F): 0 (G), Alarm Configuration: None (F), Activation Delay (s): 0 (H)

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Figure 4-31. Remote RTD Inputs Settings

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

^B *Hysteresis*: Adjustable from 0 to 100 percent in increments of 0.1%.

^C *RTD Type*: 100 Ohm Platinum or 10 Ohm Copper.

^D *Arming Delay*: Adjustable from 0 to 300 s in 1 s increments.

^E *Out of Range Alarm Type*: None, Alarm, Pre-Alarm, or Status Only.

^F *Alarm Configuration*: None, Alarm, Pre-Alarm, or Status Only.

^G *Threshold*: -58 to +482°F in 1°F increments or -50 to +250°C in 1°C increments.

^H *Activation Delay*: Adjustable from 0 to 300 s in 1 s increments.

Remote Thermocouple Inputs

An optional AEM-2020 (Analog Expansion Module) provides two thermocouple inputs. To make identifying the thermocouple inputs easier, a user-assigned name^A can be given to each input.

Select the amount of hysteresis^B. A user-adjustable arming delay^C disables thermocouple input recognition during engine startup.

Each thermocouple input can be independently configured to annunciate an alarm, pre-alarm, or status only^D when the thermocouple input signal falls beyond the threshold^E. A user-adjustable activation delay^F setting delays alarm annunciation after the threshold has been exceeded.

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

BESTCOMSPPlus settings for remote thermocouple inputs (DGC-2020, Programmable Inputs, Remote Thermocouple Inputs) are illustrated in Figure 4-32. Remote Thermocouple Input #1 is shown.

Remote Thermocouple Input #1

Label Text: THERM_CPL_1 (A)

Arming Delay (s): 0 (C)

Hysteresis (%): 2.0 (B)

Threshold #1

Under: Threshold (F): 32 (E), Alarm Configuration: None (D)

Over: Threshold (F): 32 (E), Alarm Configuration: None (D)

Activation Delay (s): 0 (F)

Threshold #2

Under: Threshold (F): 32 (E), Alarm Configuration: None (D)

Over: Threshold (F): 32 (E), Alarm Configuration: None (D)

Activation Delay (s): 0 (F)

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Figure 4-32. Remote Thermocouple Inputs Settings

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

^B Hysteresis: Adjustable from 0 to 100 percent in increments of 0.1%.

^C Arming Delay: Adjustable from 0 to 300 s in 1 s increments.

^D Alarm Configuration: None, Alarm, Pre-Alarm, or Status Only.

^E Threshold: 32 to 2,507°F in 1°F increments or 0 to 1,375°C in 1°C increments.

^F Activation Delay: Adjustable from 0 to 300 s in 1 s increments.

PROGRAMMABLE OUTPUTS

DGC-2020 programmable outputs include four user-programmable contact outputs if the style number is xxAxxxxxx. If the style number is xxBxxxxxx, twelve contact outputs are provided. An additional 24 contact outputs are provided with an optional CEM-2020 (Contact Expansion Module).

Contact Outputs

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

BESTCOMSPPlus settings for contact outputs (DGC-2020, Programmable Outputs, Contact Outputs) are illustrated in Figure 4-33.

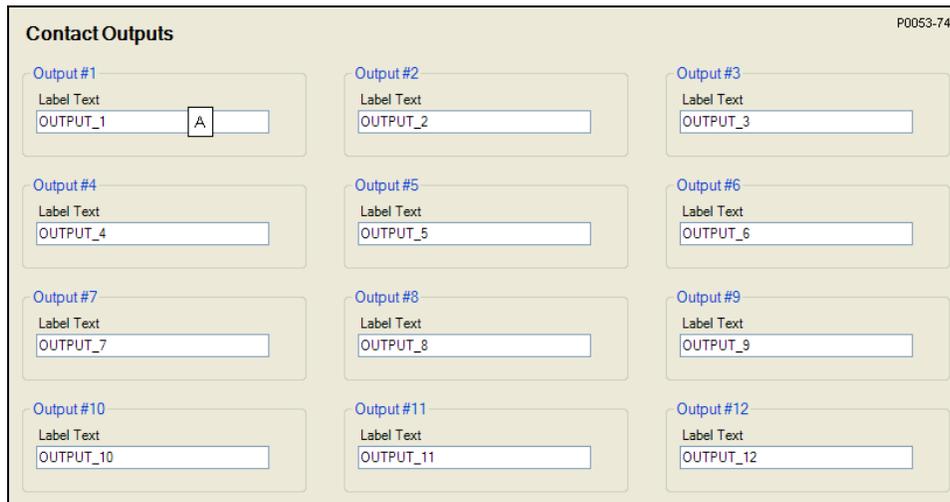


Figure 4-33. Contact Outputs Settings

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

Configurable Elements

Each of the 8 elements can be independently configured to annunciate an alarm or pre-alarm^A. A user-adjustable time delay^B can be set to delay recognition of an element. By default, all elements are configured so that they do not trigger an alarm or pre-alarm.

To make identifying the element easier, each of the elements can be given a user-assigned name^C.

Elements can be recognized^D always or while the engine is running only.

Configurable element status is available in BESTLogic+ Programmable Logic when “None” is selected for Alarm Configuration.

BESTCOMSPPlus settings for the elements (DGC-2020, Programmable Outputs, Configurable Elements) are illustrated in Figure 4-34.

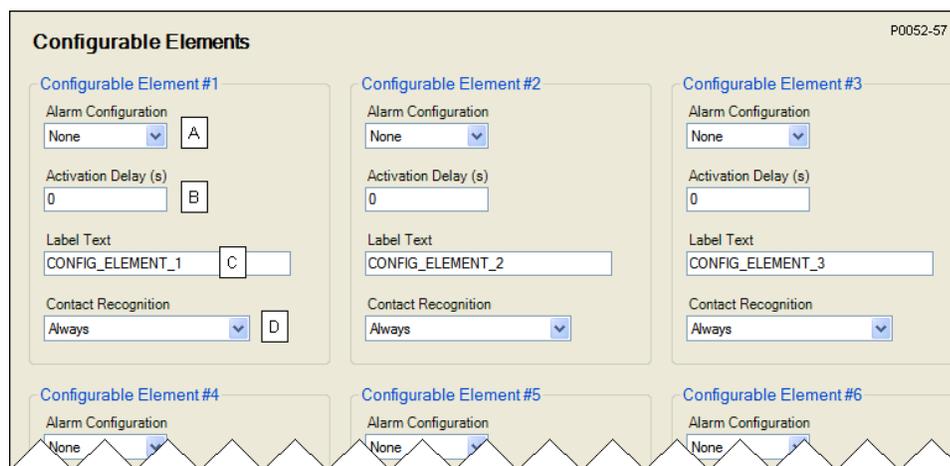


Figure 4-34. Configurable Elements Settings

^A *Alarm Configuration*: None, Alarm, or Pre-Alarm.

^B *Activation Delay*: Adjustable from 0 to 300 s in 1 s increments.

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

^D *Contact Recognition*: Always or While Engine Running Only.

Remote Contact Outputs

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

BESTCOMSPPlus settings for remote contact inputs (DGC-2020, Programmable Outputs, Remote Contact Outputs) are illustrated in Figure 4-35.

Figure 4-35. Remote Contact Outputs Settings

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

Remote Analog Outputs

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

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

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

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

BESTCOMSPPlus settings for remote analog outputs (DGC-2020, Programmable Inputs, Remote Analog Outputs) are illustrated in Figure 4-36. Remote Analog Output #1 is shown.

Figure 4-36. Remote Analog Outputs Settings

^A *Param Selection*: Oil Pressure, Battery Temp, Coolant Volts, RPM, Fuel Level, Gen VAB, Gen VBC, Gen VCA, Gen VAN, Gen VBN, Gen VCN, Bus Freq, Bus Volts, Gen Freq, Gen PF, Gen IA, Gen IB, Gen IC, KW A, KW B, KW C, KW Total, Analog Input 1-8, RTD Input 1-8, or Thermocouple Input 1-2.

^B *Output Type*: Voltage or Current.

^C *Out of Range Alarm Configuration*: None, Alarm, Pre-Alarm, or Status Only.

^D *Out of Range Activation Delay*: Adjustable from 0 to 300 s in 1 s increments.

- ^E *Param Min*: –9999.0 to +9999.0 in increments of 0.1.
^F *Min Output Current*: Adjustable from 4 to 20 mA in 0.1 mA increments.
^G *Min Output Voltage*: Adjustable from 0 to 10 V in 1 V increments.
^H *Param Max*: –9999.0 to +9999.0 in increments of 0.1.
^I *Max Output Current*: Adjustable from 4 to 20 mA in 0.1 mA increments.
^J *Max Output Voltage*: Adjustable from 0 to 10 V in 1 V increments.

CONFIGURABLE PROTECTION

Configurable protection can be used when the standard protection available with the DGC-2020 does not meet the application needs. Eight configurable protection items are provided. To make identifying the items easier, each of the items can be given a user-assigned name^A.

Select a parameter^B to monitor. A user-adjustable arming delay^C disables configurable protection during engine startup. A setting is provided to adjust the hysteresis^D.

Each configurable protection item can be independently configured to annunciate an alarm, pre-alarm, or status only^E when the parameter selection falls beyond the threshold^F. A user-adjustable activation delay^G setting delays alarm annunciation after the threshold has been exceeded.

Configurable protection is disabled when Alarm Configuration is set to “None”. Configurable Protection status is available in BESTlogic+ Programmable Logic when “Status Only” is selected.

BESTCOMSPPlus settings for configurable protection (DGC-2020, Programmable Outputs, Configurable Protection) are illustrated in Figure 4-37. Configurable Protection #1 is shown.

Figure 4-37. Configurable Protection Settings

- ^A *Label Text*: An alphanumeric character string with a maximum of 16 characters.
^B *Param Selection*: Oil Pressure, Battery Temp, Coolant Volts, RPM, Fuel Level, Gen VAB, Gen VBC, Gen VCA, Gen VAN, Gen VBN, Gen VCN, Bus Freq, Bus Volts, Gen Freq, Gen PF, Gen IA, Gen IB, Gen IC, KW A, KW B, KW C, KW Total, Analog Input 1-8, RTD Input 1-8, or Thermocouple Input 1-2.
^C *Arming Delay*: Adjustable from 0 to 300 s in 1 s increments.
^D *Hysteresis*: Adjustable from 0 to 1,000 percent in increments of 1%.

^E *Alarm Configuration*: None, Alarm, Pre-Alarm, or Status Only.

^F *Threshold*: -99,999,900 to 99,999,900 in increments of 1.

^G *Activation Delay*: Adjustable from 0 to 300 s in 1 s increments.

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:

- Pre-Alarms
- Alarms
- Sender Fail

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 pre-alarms other than weak battery, all displayed annunciations are reset automatically. 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.

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

Each DGC-2020 pre-alarm is described in the following paragraphs. Pre-alarms may be enabled and adjusted in BESTCOMSPlus or through the front panel HMI.

BESTCOMSPlus pre-alarm settings (DGC-2020, Alarm Configuration, Pre-Alarms) are illustrated in Figure 4-38.

High Fuel Level

High fuel level pre-alarm settings^A consist of an enable/disable setting, a threshold setting, and an activation delay. If enabled, a high fuel level pre-alarm occurs when the metered fuel level increases above the threshold setting.

Low Battery Voltage

Low battery voltage pre-alarm settings^B consist of an enable/disable setting, a threshold setting, and an activation delay. If enabled, a low battery voltage pre-alarm occurs when the battery voltage decreases below the threshold setting for the duration of the activation time delay. The threshold setting range is based on the nominal battery voltage setting on the BESTCOMSPlus System Settings tab (DGC-2020, System Parameters, System Settings).

Weak Battery Voltage

Weak battery voltage pre-alarm settings^C consist of an enable/disable setting, a threshold setting, and an activation time delay. If enabled, a weak battery voltage pre-alarm latches during engine cranking when the battery voltage decreases below the threshold setting for the duration of the activation delay. The threshold setting range is based on the nominal battery voltage setting on the 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^D consist of an enable/disable setting and a fixed threshold setting. If enabled, a battery overvoltage pre-alarm occurs when the battery voltage increases above the threshold setting.

Maintenance Interval

Maintenance interval pre-alarm settings^E consist of an enable/disable setting and a threshold setting. If enabled, a maintenance interval pre-alarm is annunciated when the DGC-2020 maintenance timer counts

down to zero from the threshold time setting. The maintenance interval pre-alarm can be reset through the DGC-2020 front panel or by using BESTCOMSPlus.

To reset the maintenance interval pre-alarm through the DGC-2020 front panel, navigate to the SETTINGS->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^F for each pre-alarm consist of an enable/disable setting, three-phase threshold setting, three-phase hysteresis setting, single-phase threshold setting, single phase hysteresis setting, and low line scale factor setting. If enabled, an engine overload pre-alarm occurs when the metered power level exceeds the threshold setting. The threshold setting is expressed as a percentage of the genset kW rating on the BESTCOMSPlus 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.

Low Fuel Level

Low fuel level pre-alarm settings^G consist of an enable/disable setting and a threshold setting. If enabled, a low fuel level pre-alarm occurs when the metered fuel level decreases below the threshold setting.

High Coolant Temp

High coolant temperature pre-alarm settings^H consist of an enable/disable setting and a threshold setting. If enabled, a high coolant temperature pre-alarm is annunciated when the engine coolant temperature exceeds the threshold setting for a fixed duration of 60 seconds.

Low Coolant Temp

Low coolant temperature pre-alarm settings^I consist of an enable/disable setting and a threshold setting. If enabled, a low coolant temperature pre-alarm occurs when the engine coolant temperature decreases below the threshold setting.

Low Coolant Level

Low coolant level pre-alarm settings^J consist of an enable/disable setting and a threshold setting. If enabled, a low coolant level pre-alarm occurs when the metered coolant level decreases below the threshold setting.

Low Oil Pressure

Low oil pressure pre-alarm settings^K consist of an enable/disable setting and a threshold setting. If enabled, a low oil pressure pre-alarm is annunciated when the engine oil pressure decreases below the threshold setting for a fixed duration of 10 seconds.

ECU Coms Fail

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

Active DTC

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

AVR Bias Output Limit

AVR bias output limit settings^N consist of an enable/disable setting and an activation delay setting. If enabled, an AVR bias output limit pre-alarm is annunciated when the AVR bias output limit has been met and the activation delay has expired. This setting only applies when using the optional LSM-2020.

GOV Bias Output Limit

GOV bias output limit settings^O consist of an enable/disable setting and an activation delay setting. If enabled, a GOV bias output limit pre-alarm is annunciated when the GOV bias output limit has been met and the activation delay has expired. This setting only applies when using the optional LSM-2020.

Intergenset Comm Failure

Intergenset communication failure pre-alarm settings^P consist of a single enable/disable setting. If enabled, an Intergenset communication failure pre-alarm is annunciated when an individual generator detects that it had been connected to a generator network, but has lost the connection. This setting only applies when using an optional LSM-2020.

LSM Comm Failure

LSM-2020 communication failure pre-alarm settings^Q consist of a single enable/disable setting. If enabled, an LSM-2020 communication failure pre-alarm is annunciated when communication between an optional LSM-2020 and DGC-2020 is lost.

ID Missing

ID missing pre-alarm settings consist of a single enable/disable setting^R. If enabled, an ID missing pre-alarm is annunciated when an expected sequence ID of an optional LSM-2020 is not detected on the network.

ID Repeat

ID repeat pre-alarm settings consist of a single enable/disable setting^S. If enabled, an ID repeat pre-alarm is annunciated when two or more optional LSM-2020's report the same expected sequence ID.

CEM Comm Failure

CEM-2020 communication failure pre-alarm settings^T consist of a single enable/disable setting. If enabled, a CEM-2020 communication failure pre-alarm is annunciated when communication between an optional CEM-2020 and DGC-2020 is lost.

AEM Comm Failure

AEM-2020 communication failure pre-alarm settings^U consist of a single enable/disable setting. If enabled, an AEM-2020 communication failure pre-alarm is annunciated when communication between an optional AEM-2020 and DGC-2020 is lost.

Checksum Failure

The checksum failure pre-alarm will occur whenever one of the internal checksum calculations used for data integrity purposes has failed. This indicates that some of the user settings or firmware code has been corrupted.

The checksum failure pre-alarm can be cleared by pressing the reset button on the front panel. However, the pre-alarm will reoccur the next time the checksum is verified if the data is still corrupted. Some checksum calculations are done only on power up, so this may not occur until the next time the unit's operating power is cycled.

If there are consistent checksum failure pre-alarms, attempt the following actions to correct the problem:

1. Load default settings by holding UP+DOWN on the front panel while cycling power. After loading defaults, upload settings file through BESTCOMSPlus if needed.
2. If the problem still exists, reload the firmware file with BESTCOMSPlus.
3. If the problem still exists, contact Basler Electric Technical Support.

The checksum failure pre-alarm can be disabled with the Checksum Failure pre-alarm enable^V setting. Disabling this setting disables only the annunciation of the pre-alarm and does not correct any error conditions.

The checksum failure pre-alarm may occur after changing firmware versions through BESTCOMSPlus. 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.

Pre-Alarms

High Fuel Level

Disable Threshold (%) Activation Delay (s)

Enable

Low Fuel Level

Disable Threshold (%)

Enable

Low Battery Voltage

Disable Threshold (V) Activation Delay (s)

Enable

High Coolant Temp

Disable Threshold (F)

Enable

Weak Battery Voltage

Disable Threshold (V) Activation Delay (s)

Enable

Low Coolant Temp

Disable Threshold (F)

Enable

Battery Overvoltage

Disable Threshold (V)

Enable

ECU Coms Fail

Disable Enable

Coolant Level

Disable Threshold (%)

Enable

Maintenance Interval

Disable Threshold (h)

Enable

Active DTC

Disable Enable

Low Oil Pressure

Disable Threshold (psi)

Enable

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

Intergenset Comm Failure

Disable Enable

ID Missing

Disable Enable

GOV Bias Output Limit

Disable Activation Delay (s)

Enable

LSM Comm Failure

Disable Enable

ID Repeat

Disable Enable

CEM Comm Failure

Disable Enable

AEM Comm Failure

Disable Enable

Checksum Failure

Disable Enable

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Figure 4-38. Pre-Alarms Configuration

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

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

^C **Weak Battery Voltage:** Enable or Disable, threshold is adjustable from 4 to 8 Vdc (12 Vdc battery) or 8 to 16 Vdc (24 Vdc battery) in 0.1 Vdc increments. Activation time delay is adjustable from 1 to 10 s in 1 s increments.

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

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

^F *Engine kW Overload*: Enable or Disable, threshold is adjustable from 95 to 140% of Genset kW Rating in 1% increments.

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

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

^I *Low Coolant Temp*: Enable or Disable, threshold is adjustable from 35 to 150°F or 2 to 65°C in 1° increments.

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

^K *Low Oil Pressure*: Enable or Disable, threshold is adjustable from 3 to 150 psi or 21 to 1,034 kPa in 7 psi or kPa increments. Activation time delay is fixed at 10 s.

^L *ECU Coms Fail*: Enable or Disable.

^M *Active DTC*: Enable or Disable.

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

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

^P *Intergenset Comm Failure*: Enable or Disable.

^Q *LSM Comm Failure*: Enable or Disable.

^R *ID Missing*: Enable or Disable.

^S *ID Repeat*: Enable or Disable.

^T *CEM Comm Failure*: Enable or Disable.

^U *AEM Comm Failure*: Enable or Disable.

^V *Checksum Failure*: Enable or Disable.

Alarms

An alarm is annunciated when a condition programmed to trigger an alarm is detected. When an alarm condition exists, the front panel Alarm indicator lights, the Horn output (if programmed and enabled) energizes, and the cause of the alarm is displayed on the front panel LCD. An alarm condition stops the engine by opening the Fuel output contact. Alarms are reset when the DGC-2020 is set to Off mode.

Each DGC-2020 alarm is described in the following paragraphs. Alarms may be enabled and adjusted in BESTCOMSPPlus or through the front panel HMI.

BESTCOMSPPlus alarm settings (DGC-2020, Alarm Configuration, Alarms) are illustrated in Figure 4-39.

High Coolant Temperature

High coolant temperature alarm settings^A consist of an enable/disable setting and a threshold setting. If enabled, a high coolant temperature alarm is triggered instantaneously when the engine coolant temperature exceeds the threshold setting. The arming delay disables the high coolant temperature alarm function for a user-adjustable time during engine startup.

Low Oil Pressure

Low oil pressure alarm settings^B include an enable/disable setting, an arming time delay, and a threshold setting. If enabled, a low oil pressure alarm is triggered instantaneously when the engine oil pressure decreases below the threshold setting. The arming delay disables the low oil pressure alarm function for a user-adjustable time during engine startup.

Overspeed

Overspeed alarm settings^C include an enable/disable setting, an activation delay, and a threshold setting. If enabled, an overspeed alarm occurs when the engine speed (in rpm) exceeds the threshold setting for the duration of the activation time delay.

Low Fuel Level

Low fuel level alarm settings^D consist of an enable/disable setting, an activation delay setting, and a threshold setting. If enabled, a low fuel level alarm is triggered when the metered fuel level drops below the threshold setting for the duration of the activation time delay.

Low Coolant Level

Low coolant level alarm settings^E consist of an enable/disable setting and a threshold setting. If enabled, a low coolant level alarm is triggered when the metered coolant drops below the threshold setting.

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

The screenshot shows the 'Alarms' configuration screen with the following settings:

Alarm Type	Enable/Disable	Threshold	Delay	Label
High Coolant Temp	Enable	275 (F)	60 (s)	A
Low Oil Pressure	Enable	15 (psi)	10 (s)	B
Overspeed	Enable	110 (%)	50 (ms)	C
Low Fuel Level	Enable	2 (%)	30 (s)	D
Low Coolant Level	Disable	25 (%)	-	E

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Figure 4-39. Alarms Configuration

^A *High Coolant Temp*: Enable or Disable, threshold is adjustable from 100 to 280°F or 38 to 138°C in 1° increments. Arming time delay is adjustable from 0 to 150 in 1 s increments.

^B *Low Oil Pressure*: Enable or Disable, threshold is adjustable from 3 to 150 psi or 21 to 1,034 kPa in 7 psi or 1 kPa increments. Arming time delay is adjustable from 5 to 60 s in 1 s increments.

^C *Overspeed*: Enable or Disable, threshold is adjustable from 105 to 140% of the rated engine rpm. Activation time delay is adjustable from 0 to 500 s in 1 s increments.

^D *Low Fuel Level*: Enable or Disable, threshold is adjustable from 0 to 100% in 1% increments. Activation time delay is adjustable from 0 to 30 in 1 s increments.

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

Sender Fail

The DGC-2020 can be configured to annunciate a pre-alarm or alarm when a loss of signal is detected at the coolant temperature^A, oil pressure^B, or fuel level sender^C input. A loss of generator sensing voltage^D (when the DGC-2020 is operating in Run or Auto mode with the ATS closed) can also be configured to trigger a pre-alarm or alarm. The speed sender fail^E alarm is always enabled. A user-adjustable time delay is provided for each sender/sensing alarm/pre-alarm.

Alarm and pre-alarm annunciations for loss of engine speed signals is not user-programmable and operates as follows. If the MPU (magnetic pickup) or generator frequency is programmed as the sole engine speed source and that signal source fails, an alarm (and shutdown) is triggered. If the engine speed source is configured as MPU 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.

BESTCOMSPlus settings for the sender fail functions (DGC-2020, Alarm Configuration, Sender Fail) are illustrated in Figure 4-40.

Figure 4-40. Sender Fail Configuration

^A *Coolant Temp Sender Fail*: None, Alarm, or Pre-Alarm, time delay adjustable from 5 to 30 min in 1 min increments.

^B *Oil Pressure Sender Fail*: None, Alarm or Pre-Alarm, time delay adjustable from 0 to 300 s in 1 s increments.

^C *Fuel Level Sender Fail*: None, Alarm, or Pre-Alarm, time delay adjustable from 0 to 300 s in 1 s increments.

^D *Voltage Sensing Fail*: None, Alarm, or Pre-Alarm, time delay adjustable from 0 to 300 s in 1 s increments.

^E *Speed Sender Fail*: Time delay adjustable from 0 to 300 s in 1 s increments.

GENERATOR PROTECTION

Two tiers of generator protection are offered. DGC-2020 controllers with style number xxxxxxSxx offer standard protection consisting of undervoltage (27), overvoltage (59), overfrequency (81O), underfrequency (81U), reverse power (32), 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) and time overcurrent (51) elements.

The description of generator protection is organized as follows:

- Voltage (27, 59, 47)
- Frequency (81)
- Reverse Power (32)
- Loss of Excitation (40Q)
- Overcurrent (51)

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

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

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

A low-line scale factor setting^F is used to automatically adjust the undervoltage pickup settings in applications that may utilize more than one type of genset connections. 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 BESTLogic+ Programmable Logic when “Status Only” is selected.

BESTCOMSPPlus voltage protection settings (DGC-2020, Generator Protection, Voltage, Undervoltage) are illustrated in Figure 4-41. The 27-1 element is shown.

Setting	3 Phase	Single Phase
Low Line Scale Factor (F)	1.000	1.000
Pickup (V) (A)	95 V L-L	95 V L-L
Hysteresis (V) (D)	2	2
Activation Delay (s) (B)	1.0	1.0
Inhibit Frequency (Hz) (E)	35	35
Alarm Configuration (C)	None	None

Figure 4-41. Undervoltage Protection Settings

^A *Pickup*: Adjustable from 70 to 576 Vac in 1 Vac increments.

^B *Activation Delay*: Adjustable from 0 to 30 s in 0.1 s increments.

^C *Alarm Configuration*: None, Alarm, Pre-Alarm, or Status Only.

^D *Hysteresis*: Adjustable from 1 to 60 Vac in 1 Vac increments.

^E *Inhibit Frequency*: Adjustable from 20 to 400 Hz in 1 Hz increments.

^F *Low Line Scale Factor*: Adjustable from 0 to 3.000 in increments of 0.001.

Overvoltage (59-1, 59-2)

Two sets of overvoltage settings are provided for each element: one for three-phase generator connections and one for single-phase generator connections. The pickup setting entered is based on the VT secondary side (DGC-2020). When a single-phase override contact input is received, the DGC-2020 automatically switches from the three-phase overvoltage settings to the single-phase overvoltage settings.

An overvoltage condition is annunciated when the average of the three-phase (three-phase mode) or the line-to-line voltage (single-phase mode) increases above the corresponding 59 pickup setting^A for the duration of the corresponding 59 activation delay^B. An overvoltage annunciation can be user-selected to trigger a pre-alarm^C (warning) or alarm^C (shutdown). An overvoltage annunciation can also be user-configured to close a programmable output.

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

A low-line scale factor setting^E is used to automatically adjust the overvoltage pickup settings in applications that may utilize more than one type of genset connections. 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 BESTlogic+ Programmable Logic when “Status Only” is selected.

BESTCOMSPPlus voltage protection settings (DGC-2020, Generator Protection, Voltage, Overvoltage) are illustrated in Figure 4-42. The 59-1 element is shown.

Figure 4-42. Overvoltage Protection Settings

- ^A *Pickup*: Adjustable from 70 to 576 Vac in 1 Vac increments.
- ^B *Activation Delay*: Adjustable from 0 to 30 s in 0.1 s increments.
- ^C *Alarm Configuration*: None, Alarm, Pre-Alarm, or Status Only.
- ^D *Hysteresis*: Adjustable from 1 to 60 Vac in 1 Vac increments.
- ^E *Low Line Scale Factor*: Adjustable from 0 to 3.000 in increments of 0.001.

Phase Imbalance (47)

DGC-2020 controllers with enhanced generator protection (style number xxxxxExx) are capable of protecting against voltage imbalances between any of the three phases. The pickup setting entered is based on the VT secondary side (DGC-2020). A phase imbalance condition is annunciated when the difference between any of the three phases of generator voltage increases above the 47 pickup setting^A for the duration of the 47 activation delay setting^B. A phase imbalance annunciation can be user-selected to trigger a pre-alarm^C (warning) or alarm^C (shutdown). A phase imbalance annunciation can also be user-configured to close a programmable output.

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

The element is disabled when Alarm Configuration is set to “None”. Element status is available in BESTlogic+ Programmable Logic when “Status Only” is selected.

BESTCOMSPPlus voltage protection settings (DGC-2020, Generator Protection, Voltage, Phase Imbalance) are illustrated in Figure 4-43.

Figure 4-43. Phase Imbalance Protection Settings

- ^A *Pickup*: Adjustable from 5 to 100 Vac in 1 Vac increments.
^B *Activation Delay*: Adjustable from 0 to 30 s in 0.1 s increments.
^C *Alarm Configuration*: None, Alarm, Pre-Alarm, or Status Only.
^D *Hysteresis*: Adjustable from 1 to 5 Vac in 1 Vac increments.

Frequency Protection (81O/U)

Two sets of frequency protection settings are provided: one for underfrequency (81U) and one for overfrequency (81O).

Underfrequency (81U)

An underfrequency condition is annunciated when the generator frequency decreases below the 81U pickup setting^A for the duration of the 81U activation delay setting^B. An underfrequency annunciation can be user-selected to trigger a pre-alarm^C (warning) or alarm^C (shutdown). An underfrequency annunciation can also be user-configured to close a programmable output.

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

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

Overfrequency (81O)

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

The hysteresis setting^I functions as an overfrequency dropout by preventing rapid switching of the pickup output.

The element is disabled when Alarm Configuration is set to “None”. Element status is available in BESTlogic+ Programmable Logic when “Status Only” is selected.

BESTCOMSPlus frequency protection settings (DGC-2020, Generator Protection, Frequency) are illustrated in Figure 4-44.

The screenshot shows a configuration window titled "Frequency (81)" with a subtitle "81 - O/U Frequency with Time Delay". It is divided into two columns: "81U" (Underfrequency) and "81O" (Overfrequency). Each column contains five settings: Pickup (Hz), Hysteresis (Hz), Activation Delay (s), Inhibit Volts (V), and Alarm Configuration. The 81U settings are: Pickup (58.0 Hz, labeled A), Hysteresis (0.5 Hz, labeled E), Activation Delay (1.0 s, labeled B), Inhibit Volts (70 V, labeled D), and Alarm Configuration (None, labeled C). The 81O settings are: Pickup (62.0 Hz, labeled F), Hysteresis (0.5 Hz, labeled I), Activation Delay (1.0 s, labeled G), Inhibit Volts (70 V, labeled D), and Alarm Configuration (None, labeled H). A small ID "P0050-41" is visible in the bottom right corner of the window.

Figure 4-44. Frequency Protection Settings

- ^A *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).
^B *Underfrequency Activation Delay*: Adjustable from 0 to 30 s in 0.1 s increments.
^C *Underfrequency Alarm Configuration*: None, Alarm, Pre-Alarm, or Status Only.
^D *Underfrequency Inhibit Volts*: Adjustable from 70 to 576 Vac in 1 Vac increments.
^E *Hysteresis*: Adjustable from 0.1 to 40 Hz in 0.1 Hz increments.
^F *Overfrequency Pickup*: Adjustable from 45 to 65 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).
^G *Overfrequency Activation Delay*: Adjustable from 0 to 30 s in 0.1 s increments.

^H *Overfrequency Alarm Configuration*: None, Alarm, Pre-Alarm, or Status Only.

^I *Hysteresis*: Adjustable from 0.1 to 40 Hz in 0.1 Hz increments.

Reverse Power Protection (32)

Two sets of reverse power settings are provided: one for three-phase generator connections and one for single-phase generator connections. The pickup setting entered is based on the CT secondary side (DGC-2020). When a single-phase override contact input is received by the DGC-2020, the reverse power protection settings automatically switch from the three-phase settings to the single-phase reverse power protection settings. The 32 element monitors three-phase real power when three-phase sensing is active or single-phase real power if single-phase sensing is active.

When the total wattage in the tripping direction (generator absorbing power) is greater than the pickup setting^A for the duration of the 32 activation delay setting^B, a reverse power condition is annunciated. A reverse power annunciation can be user-selected to trigger a pre-alarm^C (warning) or alarm^C (shutdown). A reverse power annunciation can also be user-configured to close a programmable output.

The hysteresis setting^D functions as a reverse power dropout by preventing rapid switching of the pickup output.

The element is disabled when Alarm Configuration is set to “None”. Element status is available in BESTlogic+ Programmable Logic when “Status Only” is selected.

BESTCOMSPlus reverse power protection settings (DGC-2020, Generator Protection, Reverse Power) are illustrated in Figure 4-45.

Reverse Power	
32 Element	
3 Phase	Single Phase
Pickup (%) -5 [A]	Pickup (%) -5 [A]
Hysteresis (%) 1 [D]	Hysteresis (%) 1 [D]
Activation Delay (s) 1 [B]	Activation Delay (s) 1 [B]
Alarm Configuration None [C]	Alarm Configuration None [C]

Figure 4-45. Reverse Power Protection Settings

^A *Pickup*: –50% to +5% of rated watts in 0.1% increments.

^B *Activation Delay*: Adjustable from 0 to 30 s in 0.1 s increments.

^C *Alarm Configuration*: None, Alarm, Pre-Alarm, or Status Only.

^D *Hysteresis*: Adjustable from 1% to 10% in 0.1% increments.

Loss of Excitation Protection (40Q)

Two sets of loss of excitation settings are provided: one for three-phase generator connections and one for single-phase generator connections. The pickup setting^A entered is based on the CT secondary side (DGC-2020). When a single-phase override contact input is received by the DGC-2020, the loss of excitation protection settings automatically switch from the three-phase settings to the single-phase loss of excitation protection settings.

When a generator’s excitation power is lost, the generator acts as a large inductor. The generator begins to absorb large quantities of vars. The 40Q acts on the principal that if a generator begins to absorb vars outside of its steady state capability curve, it has likely lost its normal excitation supply. The 40Q monitors three-phase reactive power when three-phase sensing is active or single-phase reactive power if single-phase sensing is active. It compares the reactive power to the 40Q response curve defined by the 40Q pickup setting. Refer to Figure 4-46.

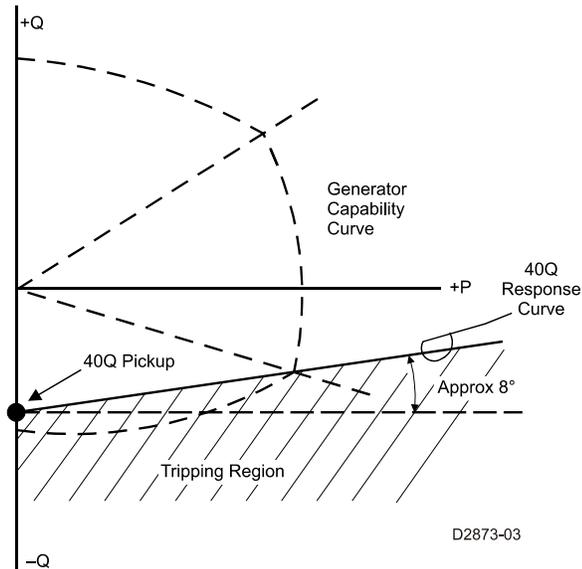


Figure 4-46. Generator Capability Curve vs. 40Q Response

If reactive power is within the 40Q tripping region for the duration of the 40Q activation delay setting^B, a loss of excitation condition is annunciated. A loss of excitation annunciation can be user-selected to trigger a pre-alarm^C (warning) or alarm^C (shutdown). A loss of excitation annunciation can also be user-configured to close a programmable output. The calculation used in the DGC-2020 for the approximate tripping region is given by:

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

where the units of the Tripping Region and the 40Q Pickup setting are percent of rated var.

The hysteresis setting^D functions as a loss of excitation dropout by preventing rapid switching of the pickup output.

Activation delays^B are recommended for tripping. Adding a small delay will help assure that false alarms do not occur for transient fault conditions or swings in the power system.

The element is disabled when Alarm Configuration is set to “None”. Element status is available in BESTLogic+ Programmable Logic when “Status Only” is selected.

BESTCOMSPPlus loss of excitation protection settings (DGC-2020, Generator Protection, Loss of Excitation) are illustrated in Figure 4-47.

Loss of Excitation (40Q)	
3 Phase	Single Phase
Pickup (%) 0 <input type="text"/> A	Pickup (%) 0 <input type="text"/> A
Hysteresis (%) 1 <input type="text"/> D	Hysteresis (%) 1 <input type="text"/> D
Activation Delay (s) 1 <input type="text"/> B	Activation Delay (s) 1 <input type="text"/> B
Alarm Configuration None <input type="text"/> C	Alarm Configuration None <input type="text"/> C

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Figure 4-47. Loss of Excitation Protection Settings

^A Pickup: Adjustable from -150% to 0% of rated vars in 0.1% increments.

^B Activation Delay: Adjustable from 0 to 30 s in 0.1 s increments.

^C Alarm Configuration: None, Alarm, Pre-Alarm, or Status Only.

^D Hysteresis: Adjustable from 1% to 10% in 0.1% increments.

Overcurrent Protection (51-1, 51-2, 51-3)

Two sets of overcurrent settings are provided for each element: one for three-phase generator connections and one for single-phase generator connections. The pickup setting entered is based on the CT secondary side (DGC-2020). When a single-phase override contact input is received by the DGC-2020, the overcurrent protection settings automatically switch from the three-phase settings to the single-phase overcurrent protection settings.

When any of the phase currents increase above the pickup setting^A for the duration of the overcurrent time delay, an overcurrent condition is annunciated. An overcurrent annunciation can be user-selected to trigger a pre-alarm^B (warning) or alarm^B (shutdown). An overcurrent annunciation can also be user-configured to close a programmable output.

The overcurrent time delay is controlled by a time dial setting^C and a curve setting^D. The curve setting can be set at F (fixed) 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^E of the settings is automatically created to illustrate the overcurrent pickup curve. The available time characteristic curves are listed below and illustrated in Appendix A, *Time Overcurrent Characteristic Curves*.

- A, standard inverse
- A, standard inverse
- B, very inverse
- C, extremely inverse
- D, definite
- E1, extremely inverse
- E2, extremely inverse
- G, long inverse
- I1, inverse
- I2, inverse
- I2, inverse
- L1, long inverse
- L2, long inverse
- M, moderately inverse
- S1, short inverse
- S2, short inverse
- V1, very inverse
- V2, very inverse

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

The graph can be set^G to display the 1 Phase or 3 Phase curve as determined by the settings on the left side of the chart.

Selection of integrated reset or instantaneous reset characteristics^H is also provided. Refer to Appendix A, *Time Overcurrent Characteristic Curves*, when calculating time to reset.

The element is disabled when Alarm Configuration is set to "None". Element status is available in BESTlogic+ Programmable Logic when "Status Only" is selected.

BESTCOMSPlus overcurrent protection settings (DGC-2020, Generator Protection, Overcurrent) are illustrated in Figure 4-48. The 51-1 element is shown.

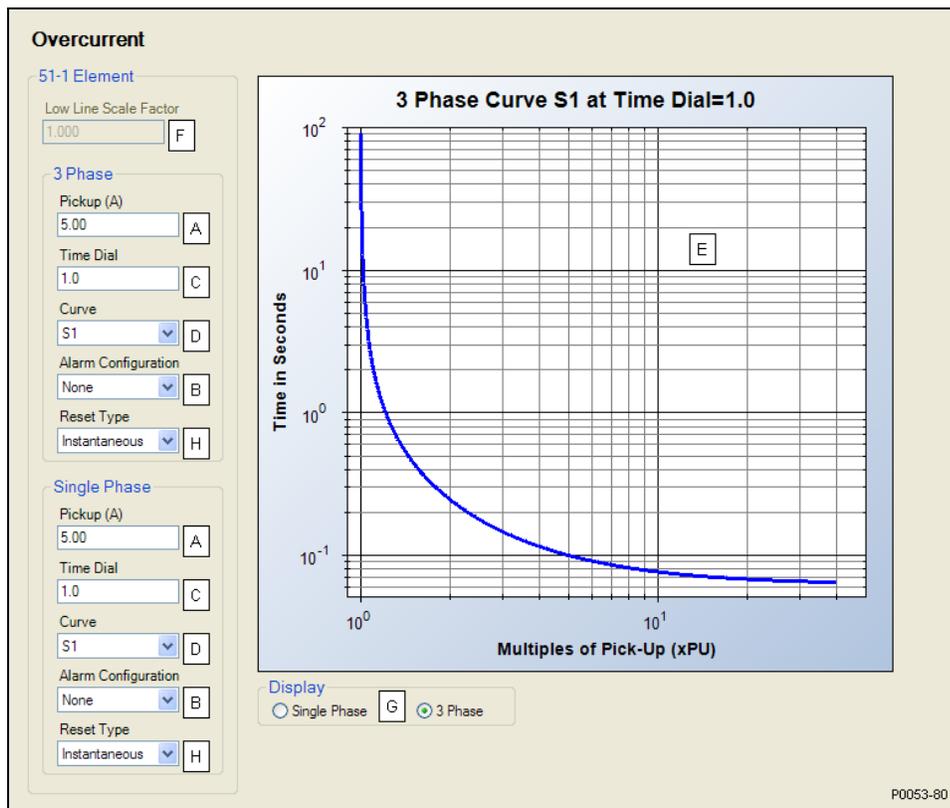


Figure 4-48. Overcurrent Protection Settings

- ^A *Pickup*: Adjustable from 0.9 to 7.75 Aac for 5 Aac current sensing (style number 5xxxxxxx) or 0.18 to 1.18 Aac for 1 Aac current sensing (style number 1xxxxxxx).
- ^B *Alarm Configuration*: None, Alarm, Pre-Alarm, or Status Only.
- ^C *Time Dial*: Adjustable from 0 to 7,200 s for F (fixed) curve, 0 to 9.9 for all other curve selections.
- ^D *Curve*: A, B, C, D, E1, E2, F, G, I1, I2, L1, L2, M, S1, S2, V1, or V2.
- ^E *Overcurrent Pickup Curve*.
- ^F *Low Line Scale Factor*: Adjustable from 0 to 3.000 in 0.001 increments.
- ^G *Display*: 1 Phase or 3 Phase.
- ^H *Reset Type*: Instantaneous or Integrating.

BREAKER MANAGEMENT

DGC-2020 breaker management features include the control of two, continuous- or pulse-controlled breakers, load transfer upon detection of a mains failure, two modes of automatic genset synchronization, and settings for stable or dead bus detection. Open transitions are implemented in load transfers to and from the mains.

The description of breaker management is organized as follows:

- Breaker Hardware
- Bus Condition Detection
- Synchronizer

Breaker Hardware

By default, one (generator) breaker is enabled^A for control and monitoring by the DGC-2020. In applications requiring control of a generator breaker and mains breaker, a second (mains) breaker can be enabled^B and configured.

When two breakers are configured (enabled), the DGC-2020 can be enabled to automatically transfer load power from the mains to the genset during a mains failure^C. This feature also enables the DGC-2020 to transfer the load back to the mains once mains power is restored. Settings include a transfer delay^D, return delay^E, and max transfer time^F.

Breakers controlled by pulse or continuous inputs are supported^G. Separate settings for each breaker's open^H and close^I pulse widths are provided.

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

The dead bus close enable setting^L 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.

BESTCOMSPlus breaker hardware settings (DGC-2020, Breaker Management, Breaker Hardware) are illustrated in Figure 4-49.

Breaker Hardware

Mains Fail

Mains Fail Transfer

Disable **C**

Enable

Mains Fail Transfer Delay (s) **D**

Mains Fail Return Delay (s) **E**

Mains Fail Max Transfer Time (s) **F**

Gen and Mains Breaker

Breaker Close Wait Time (s) **K**

Generator Breaker Hardware

Gen Breaker

Not Configured **A**

Configured

Open Pulse Time (s) **H**

Close Pulse Time (s) **I**

Contact Type

Pulse **G**

Continuous

Breaker Closing Time (ms) **J**

Dead Bus Close Enable

Disable **L**

Enable

Mains Breaker Hardware

Mains Breaker

Not Configured **B**

Configured

Open Pulse Time (s) **H**

Close Pulse Time (s) **I**

Contact Type

Pulse **G**

Continuous

Breaker Closing Time (ms) **J**

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Figure 4-49. Breaker Hardware Settings

^A Generator Breaker: Configured, NOT Configured.

^B Mains Breaker: Configured or NOT Configured.

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

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

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

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

^G *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.

^H *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.

^I *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.

^J *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.

^K *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.

^L *Dead Bus Close Enable*: Enable or Disable.

Bus Condition Detection

DGC-2020 detection of dead bus voltages (for dead bus breaker closure) is controlled by a Dead Bus Threshold setting^A and a Dead Bus Activation Delay setting^B. A dead bus is recognized when the voltage decreases below the threshold setting for the duration of the time delay setting.

Before the DGC-2020 initiates a breaker closure, the generator and mains voltages must be stable. The DGC-2020 uses several settings to determine voltage stability. These settings include pickup and dropout levels for overvoltage^C, undervoltage^D, overfrequency^E, and underfrequency^F. Recognition of 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^G. Breaker closure is not considered if the voltage conditions do not meet the stability pickup and dropout settings for the duration of the Bus Failed Activation Delay^H setting.

The Bus Stable and Gen Stable overvoltage and undervoltage detection elements have the low line scale factor^I applied to them to enhance versatility for reconfigurable machines.

NOTE

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

BESTCOMSPlus bus condition detection settings (DGC-2020, Breaker Management, Bus Condition Detection) are illustrated in Figure 4-50.

Bus Condition Detection

Generator Sensing

Gen Condition Settings

Dead Bus Threshold (V) ^A Dead Bus Activation Delay (s) ^B

Bus Stable Activation Delay (s) ^G Bus Failed Activation Delay (s) ^H

Low Line Scale Factor ^I

Gen Stable Overvoltage Settings ^C Gen Stable Undervoltage Settings ^D

Pickup (V) V L-L Dropout (V) Pickup (V) V L-L Dropout (V)

Gen Stable Overfrequency Settings ^E Gen Stable Underfrequency Settings ^F

Pickup (Hz) Dropout (Hz) Pickup (Hz) Dropout (Hz)

Bus Sensing

Bus Condition Settings

Dead Bus Threshold (V) ^A Dead Bus Activation Delay (s) ^B

Bus Stable Activation Delay (s) ^G Bus Failed Activation Delay (s) ^H

Low Line Scale Factor ^I

Bus Stable Overvoltage Settings ^C Bus Stable Undervoltage Settings ^D

Pickup (V) V L-L Dropout (V) Pickup (V) V L-L Dropout (V)

Bus Stable Overfrequency Settings ^E Bus Stable Underfrequency Settings ^F

Pickup (Hz) Dropout (Hz) Pickup (Hz) Dropout (Hz)

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Figure 4-50. Bus Condition Detection Settings

^A Dead Bus Threshold: Adjustable from 0 to 4,800 Vac in 1 Vac increments.

^B Dead Bus Time Delay: Adjustable from 0.1 to 600 s in 0.1 s increments.

^C Gen and Bus Stable Overvoltage Pickup and Dropout: Adjustable from 10 to 1,200 Vac in 1 Vac increments.

^D Gen and Bus Stable Undervoltage Pickup and Dropout: Adjustable from 10 to 12,000 Vac in 1 Vac increments.

^E Gen and 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 x1xxxxxx).

^F Gen and 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 x1xxxxxx).

^G Bus Stable Activation Delay: Adjustable from 0.1 to 600 in 1 second increments.

^H Bus Failed Activation Delay: Adjustable from 0.1 to 600 in 1 second increments.

^I Low Line Scale Factor: Adjustable from 0 to 3 in increments of 0.001.

Automatic Synchronizer (Optional)

Two methods of generator synchronization are offered: phase lock loop and anticipatory^A. In both methods, the DGC-2020 adjusts the frequency and voltage of the generator to match that of the bus (mains) and then connects the generator to the bus by closing the breaker. Anticipatory mode has the added capability of compensating for the breaker closing time (the delay between when a breaker close command is issued and the breaker blades close). The DGC-2020 calculates the advance phase angle

that is required to compensate for the breaker closure time by monitoring the frequency difference between the generator and the bus.

BESTCOMSPlus automatic synchronizer settings (DGC-2020, Breaker Management, Synchronizer) are illustrated in Figure 4-51.

Frequency Correction

Generator frequency correction is defined by the slip frequency setting and further refined by the breaker closing angle setting. The slip frequency setting^B establishes the maximum allowable deviation of the generator speed (frequency) from the bus frequency. To minimize the impact on the bus during synchronization, the Fgen>Fbus setting^C can be enabled to force the generator frequency to exceed the bus frequency at the moment of breaker closure. If this is the case, the DGC-2020 will drive the generator frequency higher than the bus frequency before closing the breaker. The breaker closing angle setting^D defines the maximum allowable phase angle difference between the generator and the bus. For breaker closure to be considered, the slip angle must remain below this setting for the duration of the sync activation delay setting^E.

Voltage Correction

Generator voltage correction is defined by the regulation offset setting^F. This setting, expressed as a percentage of the bus voltage, determines the band of generator voltage surrounding the bus voltage when breaker closure will be considered. If the Vgen>Vbus setting^G is enabled, the DGC-2020 will drive the generator voltage to be greater than the bus voltage by an amount equal to the regulation offset setting divided by two.

Synchronization Failure

The maximum desired duration for synchronizing to take place is established by the sync fail activation delay setting^H. If synchronization (breaker closure) fails to occur within this time setting, generator synchronization will be aborted and a failure will be annunciated. Note that if either bus goes unstable, the synchronizer timers are reset.

NOTE

If the generator frequency is 400 Hz, the settings on the Synchronizer screen do NOT apply. In this case, BESTCOMSPlus will not allow these settings to be changed.

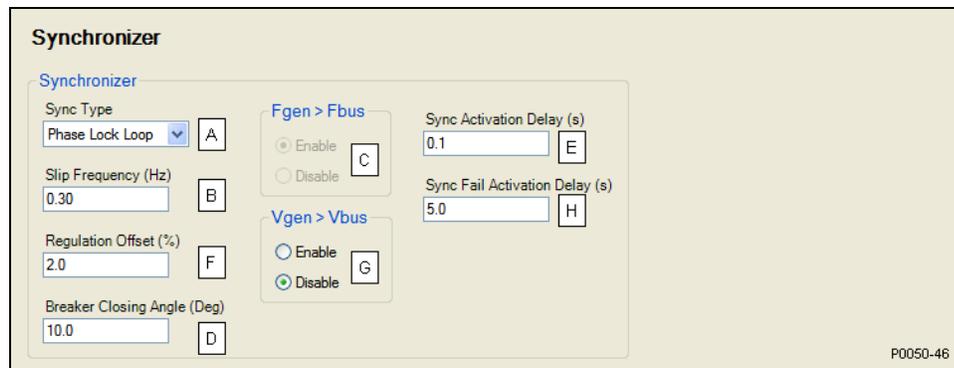


Figure 4-51. Synchronizer Settings

^A Sync Type: Phase Lock Loop or Anticipatory.

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

^C Fgen>Fbus: Enable or Disable.

^D *Breaker Closing Angle*: Adjustable from 3 to 20° in 1 ° increments. If Phase Lock Loop synchronization is selected, this specifies the maximum acceptable slip angle under which a breaker close command can be issued.

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

^F *Regulation Offset*: Adjustable from 2 to 15% of nominal generator voltage in 0.5% increments. This specifies the voltage acceptance window for the synchronization function.

^G *Vgen>Vbus*: Enable or Disable.

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

BIAS CONTROL SETTINGS

Settings are provided for AVR Bias Control and Governor Bias Control. Refer to Appendix C for instructions on Tuning Speed PID Settings and Load Control PID Settings.

AVR Bias Control Settings

The bias control output type^A should be set to contact when operating without an optional LSM-2020.

The DGC-2020 adjusts the generator voltage and frequency by issuing voltage correction signals to the generator AVR (automatic voltage regulator). Correction signals are issued in the form of DGC-2020 output contact closures. These correction signals can be either continuous or proportional^B. Proportional correction uses control pulses of varying widths^C and intervals^D. Initially, long pulses are issued when the voltage and frequency differences are large. As the correction pulses take effect and the voltage and frequency differences become smaller, the correction pulse widths are proportionally decreased. Proportional correction pulses are beneficial in applications where fixed correction pulses can result in overshooting the slip frequency and regulation offset targets.

When an optional LSM-2020 is connected, the bias control output type^A should be set to analog. This enables a PID controller that controls the voltage bias from the LSM-2020 to the voltage regulator. The controller adjusts the bias output to drive the error between desired generator voltage and measured generator voltage to zero. Settings are provided for proportional gain^E, integral gain^F, derivative gain^G, derivative filter constant^H, and loop gain^I of the PID controller.

Var/PF Control

The Var/PF controller is used to implement Var and Power Factor control of the generator when it is paralleled to the utility as indicated by the Parallel to Mains logic element in BESTLogic+. If Var/PF control is enabled, the generator breaker is closed, the generator is stable, and the Parallel to Mains logic element is TRUE, the Var/PF controller will become active. Whenever these conditions are not TRUE, the Var/PF controller is disabled, and the machine will operate in voltage droop.

When control^J is enabled and the control mode^K is set to Var, the Var setpoint can be derived from either a user setting or an analog input. The DGC-2020 calculates an operating kVar setpoint based on the kVar setpoint source setting^L. When this is set to User Setting, the operating kVar setpoint is equal to the configured kVar setpoint^M. When the kVar setpoint source setting^L is set to LSM-2020 input or an AEM-2020 input, the operating kVar setpoint is equal to the value calculated from the analog input. Parameters are available for kVar analog max^N and kVar analog min^O.

When control mode^J is set to PF, the PF setpoint can be derived either from a user setting or from an analog input. The DGC-2020 calculates an operating PF setpoint based on the PF setpoint source setting^P. When this is set to User Setting, the operating PF setpoint is equal to the configured PF setpoint^Q. When the PF setpoint source setting^P is set to LSM-2020 input or an AEM-2020 input, the operating PF setpoint is equal to the value calculated from the analog input. Parameters are available for PF analog max^R and PF analog min^S.

When an optional LSM-2020 is connected, the bias control output type^A should be set to analog. This enables a PID controller that controls the Var/PF bias from the LSM-2020 to the voltage regulator. The controller adjusts the bias output to drive the error between desired generator Var/PF and measured generator Var/PF to zero. Settings are provided for proportional gain^T, integral gain^U, derivative gain^V, derivative filter constant^W, and loop gain^X of the PID controller.

The percent voltage droop to be used when the unit is in droop mode is determined by the droop percentage setting^Y. Voltage droop mode is entered any time the generator breaker is open. Voltage

droop is also the mode when the generator breaker is closed if kW load sharing is disabled. If it is desired to disable voltage droop, set the droop percentage to 0. The voltage droop gain setting^Z determines the gain factor applied to the voltage droop percentage to compensate for governor differences and achieve desired droop performance. In order to test the operation of droop, the unit must be loaded to full load and the resulting generator voltage should be compared to the desired droop. If it is not possible to load the unit to full load, the droop test may be performed at partial load. The expected voltage is determined by the following equation.

Expected voltage reduction in droop - (actual load/machine capacity) * (droop percentage/100) * rated voltage.

If the actual voltage drop does not match the expected value, calculate the error by dividing the expected drop by the actual drop, and putting the result in as the droop gain.

Ramp rate^{AA} is defined as the rate, in percentage of machine capacity, at which the machine will ramp up its Var/PF when loading or coming online. The machine also uses this rate to unload prior to cooling down. If a machine is the only machine online, ramping will not be in effect.

BESTCOMSPlus AVR bias control settings (DGC-2020, Bias Control Settings, AVR Bias Control Settings) are illustrated in Figure 4-52.

Figure 4-52. AVR Bias Control Settings

- ^A Bias Control Output Type: Contact or Analog.
- ^B Bias Control Contact Type: Continuous or Proportional.
- ^C Correction Pulse Width: Adjustable from 0 to 99.9 s in 0.1 s increments.
- ^D Correction Pulse Interval: Adjustable from 0 to 99.9 s in 0.1 s increments.
- ^E Proportional Gain (Kp): Adjustable from 0 to 1,000 in increments of 0.001.
- ^F Integral Gain (Ki): Adjustable from 0 to 1,000 in increments of 0.001.
- ^G Derivative Gain (Kd): Adjustable from 0 to 1,000 in increments of 0.001.
- ^H Derivative Filter Constant (Td): Adjustable from 0 to 1 in increments of 0.001.
- ^I Loop Gain (Kg): Adjustable from 0 to 1,000 in increments of 0.001.
- ^J Control: Disable or Enable.
- ^K Control Mode: Var Control or PF Control.
- ^L kVar Setpoint Source: User Setting, LSM Analog Input 1, or Analog Inputs 1-8.
- ^M kVar Setpoint: Adjustable from -100 to 100 percent in 0.1 % increments.
- ^N kVar Analog Max: Adjustable from 0 to 100 percent in 0.1 % increments.
- ^O kVar Analog Min: Adjustable from 0 to 100 percent in 0.1 % increments.

-
- ^P PF Setpoint Source: User Setting, LSM Analog Input 1, or Analog Inputs 1-8.
^Q PF Setpoint: Adjustable from -0.60 to 0.60 in increments of 0.01.
^R PF Analog Max: Adjustable from -0.60 to 0.60 in increments of 0.01.
^S PF Analog Min: Adjustable from -0.60 to 0.60 in increments of 0.01.
^T Proportional Gain (Kp): Adjustable from 0 to 1,000 in increments of 0.001.
^U Integral Gain (Ki): Adjustable from 0 to 1,000 in increments of 0.001.
^V Derivative Gain (Kd): Adjustable from 0 to 1,000 in increments of 0.001.
^W Derivative Filter Constant (Td): Adjustable from 0 to 1 in increments of 0.001.
^X Loop Gain (Kg): Adjustable from 0 to 1,000 in increments of 0.001.
^Y Droop Percentage: Adjustable from 0 to 10 percent in 0.001 % increments.
^Z Voltage Droop Gain: Adjustable from 0 to 1,000 in increments of 0.001.
^{AA} Ramp Rate: Adjustable from 0 to 100 percent/second in 0.1 %/s increments.

Governor Bias Control Settings

The bias control output type^A should be set to contact when operating without an optional LSM-2020.

The DGC-2020 adjusts the generator voltage and frequency by issuing speed correction signals to the generator governor. Correction signals are issued in the form of DGC-2020 output contact closures. These correction signals can be either continuous or proportional^B. Proportional correction uses control pulses of varying widths^C and intervals^D. Initially, long pulses are issued when the voltage and frequency differences are large. As the correction pulses take effect and the voltage and frequency differences become smaller, the correction pulse widths are proportionally decreased. Proportional correction pulses are beneficial in applications where fixed correction pulses can result in overshooting the slip frequency and regulation offset targets.

When an optional LSM-2020 is connected, the bias control output type^A should be set to analog. This enables a PID controller that controls the bias signal from the LSM-2020 to the speed governor. The controller adjusts the bias output to drive the error between desired generator speed and measured generator speed to zero. Settings are provided for proportional gain^E, integral gain^F, derivative gain^G, derivative filter constant^H, and loop gain^I of the PID controller.

The speed trim enable setting^J sets speed trimming to the speed trim setpoint^K when the generator breaker is closed and the machine is not paralleled to the utility. If speed trimming is enabled in all generators in an islanded system, it is ensured that the system will run at the speed trim setpoint. If it is not enabled in any units, the islanded system may deviate from the speed trim setpoint, depending on the initial speed settings of the isochronous governors. Speed trim should be enabled in all units or disabled in all units of an islanded system. If it is enabled in only a subset of the units, speed trimming and load sharing may conflict, resulting in unpredictable load sharing and system frequency.

BESTCOMSPlus governor bias control settings (DGC-2020, Bias Control Settings, Governor Bias Control Settings) are illustrated in Figure 4-53.

kW Control - Real Power Control Settings

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

kW control is accomplished with a PID controller that controls the speed bias signal from the LSM-2020 to the speed governor. The controller adjusts the bias output to drive the error between desired kW generation and measured kW generation to zero.

Settings are provided for proportional gain^M, integral gain^N, derivative gain^O, derivative filter constant^P, and loop gain^Q of the PID controller.

The percent speed droop to be used when the unit is in droop mode is determined by the droop percentage setting^R. Speed droop mode is entered any time the generator breaker is open. Speed droop is also the mode when the generator breaker is closed if kW load sharing is disabled. If it is desired to disable speed droop, set the droop percentage to 0. The speed droop gain setting^S determines the gain factor applied to the speed droop percentage to compensate for governor differences and achieve desired droop performance. In order to test the operation of droop, the unit must be loaded to full load and the resulting generator speed should be compared to the desired droop. If it is not possible to load the unit to full load, the droop test may be performed at partial load. The expected speed is determined by the following equation.

Expected rpm reduction in droop - (actual load/machine capacity) * (droop percentage/100) * rated speed.

If the actual rpm drop does not match the expected value, calculate the error by dividing the expected drop by the actual drop, and putting the result in as the droop gain.

Ramp rate^T is defined as the rate, in percentage of machine capacity, at which the machine will ramp up its real power when loading or coming online. The machine also uses this rate to unload prior to cooling down. If a machine is the only machine online, ramping will not be in effect.

When User Setting is selected for the base load level source^U, the base load level setting^V determines the percent of machine capacity at which the kW controller will regulate if the generator is paralleled to the utility. If paralleled to the utility, the Parallel to Mains logic element in BESTlogic+ must be driven by logic or a contact input. If parallel to utility operation is undertaken and the Parallel to Mains logic element is not implemented, the DGC-2020 will remain in kW load share and will either move toward operation at 100% of capacity or 0 capacity resulting in damage to the machine or system.

When the base load level source is configured for LSM-2020 input or an AEM-2020 input, the operating KW controller set point is calculated based on the specific analog input. Parameters are available for baseload analog max^W and baseload analog min^X.

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

Figure 4-53. Governor Bias Control Settings

- ^A Bias Control Output Type: Contact or Analog.
- ^B Bias Control Contact Type: Continuous or Proportional.
- ^C Correction Pulse Width: Adjustable from 0 to 99.9 s in 0.1 s increments.
- ^D Correction Pulse Interval: Adjustable from 0 to 99.9 s in 0.1 s increments.
- ^E Proportional Gain (Kp): Adjustable from 0 to 1,000 in increments of 0.001.
- ^F Integral Gain (Ki): Adjustable from 0 to 1,000 in increments of 0.001.
- ^G Derivative Gain (Kd): Adjustable from 0 to 1,000 in increments of 0.001.
- ^H Derivative Filter Constant (Td): Adjustable from 0 to 1 in increments of 0.001.
- ^I Loop Gain (Kg): Adjustable from 0 to 1,000 in increments of 0.001.
- ^J Speed Trim Enable: Enable or Disable.
- ^K Speed Trim Setpoint: Adjustable from 47 to 440 Hz in 0.01 Hz increments.
- ^L Load Control Enabled: Enable or Disable.
- ^M Proportional Gain (Kp): Adjustable from 0 to 1,000 in increments of 0.001.
- ^N Integral Gain (Ki): Adjustable from 0 to 1,000 in increments of 0.001.
- ^O Derivative Gain (Kd): Adjustable from 0 to 1,000 in increments of 0.001.

- ^P *Derivative Filter Constant (Td)*: Adjustable from 0 to 1 in increments of 0.001.
- ^Q *Loop Gain (Kg)*: Adjustable from 1 to 1,000 in increments of 0.001.
- ^R *Droop Percentage*: Adjustable from 0 to 10 percent in 0.001 % increments.
- ^S *Speed Droop Gain*: Adjustable from 0 to 1,000 in increments of 0.001.
- ^T *Ramp Rate*: Adjustable from 0 to 100 percent/second in 0.1 %/s increments.
- ^U *Base Load Level Source*: User Setting, LSM Analog Input 1, or Analog Inputs 1-8.
- ^V *Base Load Level*: Adjustable from 0 to 100 percent in 1 % increments.
- ^W *Baseload Analog Max*: Adjustable from 0 to 100 percent in 0.1 % increments.
- ^X *Baseload Analog Min*: Adjustable from 0 to 100 percent in 0.1% increments.
- ^Y *Breaker Open Setpoint*: Adjustable from 0 to 1,000 in increments of 1.

MULTIGEN MANAGEMENT

This group of settings is used when an optional LSM-2020 (Load Share Module) is connected to the DGC-2020. Multigen management settings consist of settings for AVR output, governor output, load share output, demand start/stop, generator sequencing, and network configuration.

AVR Output

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

BESTCOMSPlus AVR output settings (DGC-2020, Multigen Management, AVR Output) are illustrated in Figure 4-54.

Figure 4-54. AVR Output Settings

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

Governor Output

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

BESTCOMSPlus governor output settings (DGC-2020, Multigen Management, Governor Output) are illustrated in Figure 4-55.

Governor Output

Output Type
Voltage

Response
Increasing

Min Output Current (mA)
4

Max Output Current (mA)
20

Min Output Voltage (V)
-10

Max Output Voltage (V)
10

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Figure 4-55. Governor Output Settings

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

BESTCOMSPlus load share output settings (DGC-2020, Multigen Management, Load Share Output are illustrated in Figure 4-56.

Load Share Output

Max Voltage (V)
0

Min Voltage (V)
0

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Figure 4-56. Load Share Output

- ^A *Max Voltage*: Adjustable from –10 to +10 V in 0.1 V increments.
^B *Min Voltage*: Adjustable from –10 to +10 V in 0.1 V increments.

Demand Start/Stop

When enabled^A, Demand Start/Stop (DSS) issues start and stop requests based on per unitized system load. The primary function of DSS is to provide start and stop request information to the sequencing handler. Generator sequencing must be enabled in order for Demand Start/Stop to function. If system load is above a set level^B and the corresponding start level timeout^C has been exceeded, a corresponding start request is issued. If system load is below the delayed stop level^D and the stop timeout^E has been exceeded, a stop request is issued.

BESTCOMSPlus demand start/stop settings (DGC-2020, Multigen Management, Demand Start/Stop) are illustrated in Figure 4-57.

Figure 4-57. Demand Start/Stop

^A Demand Start Stop Enable: Enable or Disable.

^B Delayed Start Level: Adjustable from 0 to 1 in increments of 0.001.

^C Start Level Timeout: Adjustable from 0 to 600 seconds in 0.1 s increments.

^D Delayed Stop Level: Adjustable from 0 to 1 in increments of 0.001.

^E Stop Timeout: Adjustable from 0 to 600 seconds in 0.1 s increments.

Generator Sequencing

Enabling sequencing on a networked group of load share units allows these units to manage load by starting and stopping appropriate units based on a factor of load demand and available capacity. The mode^A of operation is used to determine the order in which each generator in a group will contribute to the systems power production upon a demand start/stop request. The maximum start time^B setting defines the time to wait after a start request before demand start/stop can request the next priority unit to start. The maximum stop time^C defines the time to wait after a demand start/stop request before the next unit responds to a demand start/stop request.

Each LSM-2020 maintains its own start/stop status with respect to sequencing. When there is a change to generator sequencing mode on any one unit, this change will propagate to all connected units that are not in the disabled mode. All units on the network are notified of this mode change via the system. A unit is available for sequencing if it is in auto mode and its sequencing mode is other than disabled.

If two or more units have the same sorting order parameter, the sequencing ID^D will be used to determine which unit has priority. For example, if the sequencing mode is set for largest size first and both are 100 kW machines, the unit with the lower sequencing ID will be given priority. In the event that both units have the same sequencing ID, the unit with the lower unit ID (based on the Mac address) will be given priority.

If a unit fails to sequence on, the next generator in the sequence will be requested. The generator that previously failed will be requested again in the next sequence cycle.

BESTCOMSPPlus generator sequencing settings (DGC-2020, Multigen Management) are illustrated in Figure 4-58.

The available sequencing modes are defined in the following paragraphs.

Disabled

This is the only mode that may coexist with a different mode on a networked system. A unit configured as disabled does not participate in sequenced starting and stopping and does not respond to demand start/stop requests.

Staggered Service Time

If this mode is selected, units will seek to sort the start priority of all non-disabled networked units in ascending order of service hours remaining. In this configuration, a network of units will respond to a demand start request by starting the unit with the least number of service hours remaining first. If a unit is down to zero service hours remaining, it is moved to the lowest start priority position. In the event that two or more units have matching service hours remaining, the unit with the lowest sequencing ID is assigned highest start priority. Units in Auto Run mode with the highest number of service hours remaining respond to demand stop requests first.

Balanced Service Time

If this mode is selected, units will seek to sort the start priority of all non-disabled networked units in ascending order of service hours remaining. In this configuration, a network of units will respond to a demand start request by starting the unit with the greatest number of service hours remaining first. In the event that two or more units have matching service hours remaining, the unit with the lowest sequencing ID is assigned highest start priority. Units in Auto Run mode with the lowest number of service hours remaining respond to demand stop requests first.

Largest Size First

If this mode is selected, units will seek to sort the start priority of all non-disabled networked units in descending order of real load capacity. In this configuration, a network of units will respond to a demand start request by starting the unit with the largest load capacity first. In the event that two or more units have matching capacities, the unit with the lowest sequencing ID is assigned highest start priority. The stopping order will be the reverse of the starting order.

Smallest Size First

If this mode is selected, units will seek to sort the start priority of all non-disabled networked units in ascending order of real load capacity. In this configuration, a network of units will respond to a demand start request by starting the unit with the smallest load capacity first. In the event that two or more units have matching capacities, the unit with the lowest sequencing ID is assigned highest start priority. The stopping order will be the reverse of the starting order.

Smallest Unit ID

If this mode is selected, units will seek to sort the start priority of all non-disabled networked units in ascending order according to the sequencing ID. In this configuration, a network of units will respond to a demand start request by starting the unit with the smallest sequencing ID. Units must have unique sequencing IDs to be part of a network. The stopping order will be the reverse of the starting order.

Adopt System Mode

If this mode is selected, units will first check to see if a consistent mode is present on the currently networked controllers. If a consistent mode is found, that mode is adopted. If a consistent mode is not found, the unit enters a mode mismatch state.

Generator Sequencing

Mode
Smallest Unit ID First A

Sequencing ID
0 D

Max Gen Start Time Sec (s)
60 B

Max Gen Stop Time Sec (s)
60 C

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Figure 4-58. Generator Sequencing

^A Mode: Disabled, Staggered Service Time, Balanced Service Time, Largest Size First, Smallest Size first, Smallest Unit ID First, or Adopt System Mode.

^B Max Gen Start Time: Adjustable from 1 to 3,000 seconds in 1 s increments.

^C Max Gen Stop Time: Adjustable from 1 to 3,000 seconds in 1 s increments.

^D Sequencing ID: Adjustable from 0 to 255 in increments of 1.

Network Configuration

The sequencing ID of the unit being programmed and the sequencing IDs of all other units on a networked system should be entered in the expected sequence ID table^A. If the state of any unit changes to offline and the ID Missing pre-alarm is enabled, an ID Missing pre-alarm appears on the front panel HMI and BESTCOMSPPlus 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 BESTCOMSPPlus metering screen.

BESTCOMSPlus network configuration settings (DGC-2020, Multigen Management, Network Configuration) are illustrated in Figure 4-59.

Expected Seq Id	Expected Seq Id
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0
0	0

Figure 4-59. Network Configuration Settings

^A Expected Seq Id: Adjustable from 0 to 255.

PROGRAMMABLE SENDERS

The sender inputs of the DGC-2020 can be customized to obtain maximum accuracy from the coolant temperature, oil pressure, and fuel level senders.

The characteristic curve of each sender input can be configured with up to 11 points^A. Each point can be assigned a resistance input value and a corresponding temperature (coolant temperature sender), pressure (oil pressure sender), or percentage (fuel level sender) value. A sender slope setting^B automatically orders the values in the resistance column according to whether the sender requires a negative or positive slope. Sender curve points are automatically plotted on a curve^C in BESTCOMSPlus, which can be printed^D.

Sender curve points configured in BESTCOMSPlus can be saved in the configuration file^E. The data for all three senders is automatically saved with the DGC-2020 configuration file.

Any changes made in BESTCOMSPlus to the sender points, can be reverted to the factory-default values^F. A new settings file can also be created^G.

BESTCOMSPlus programmable sender settings (DGC-2020, Programmable Senders, Coolant Temperature, Oil Pressure, or Percent Fuel Level) are illustrated in Figure 4-60. (The contents and layout of each BESTCOMSPlus programmable sender screen is identical; only the coolant temperature sender screen is illustrated here.)

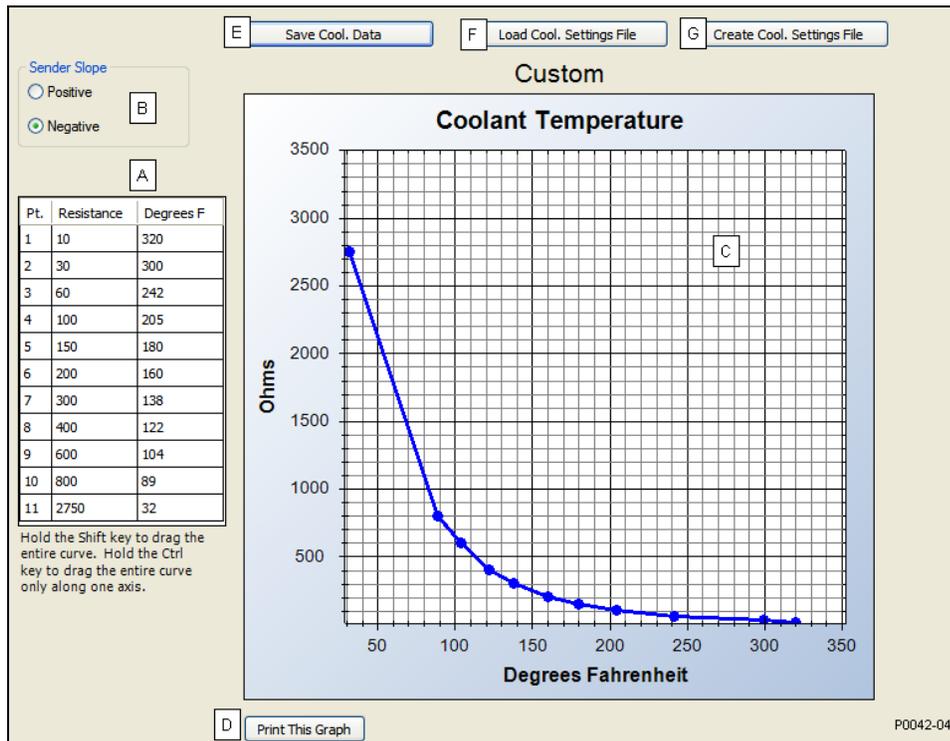


Figure 4-60. Programmable Senders Settings

- ^A *Sender Points*: Accepts up to 11 user-defined sender resistance points.
- ^B *Sender Slope*: Positive or Negative causes sender points to be sorted and displayed accordingly.
- ^C *Sender Point Curve*: Automatic plot of sender points data.
- ^D *Print This Graph*: Click to print sender point curve.
- ^E *Save Cool. Data*: Click to save file containing sender point data.
- ^F *Load Cool. Settings File*: Click to clear all user-defined sender data and revert to the factory-default values.
- ^G *Create Cool. Settings File*: Click to create a new settings file by entering sender point data.

BESTLOGIC+ PROGRAMMABLE LOGIC

BESTLogic+ Programmable Logic is used to set all logic functions in the DGC-2020. For detailed information on using BESTlogic+, refer to Section 5, *BESTlogic+ Programmable Logic*.

Logic Timers

Refer to Section 5, *BESTlogic+ Programmable Logic*, for information on using logic timers.

FILE MANAGEMENT

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

Settings Files

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

A settings file conversion is required when DGC-2020 firmware has been changed so that the settings file is compatible with the firmware. For information on converting settings files, see *Converting Settings Files*, later in this section.

Opening a Settings File

To open a new instance of a settings file into BESTCOMSPPlus, pull down the *File* menu and choose *Open*. The *Open* dialog box appears. This dialog box allows you to use normal Windows® techniques to select the file that you want to open. Select the file and open it and the file settings have been brought into a new instance in BESTCOMSPPlus. You may also open a file, by clicking on the *Open File* icon on the lower menu bar. When done in this manner, you will be asked to upload the settings and logic from the file to the current device. You may choose *Yes* or *No*. The settings in the current instance will be overwritten.

Uploading a Settings File

To upload a settings file to the DGC-2020, you must first open the file through BESTCOMSPPlus or create the file using BESTCOMSPPlus. Then pull down the *Communication* menu and select *Upload Settings*. You are prompted to enter the password. If the password is correct, the upload begins and the progress bar is shown.

Downloading a Settings File

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

Saving a Settings File

Select *Save* or *Save As* from the *File* pull-down menu. A dialog box pops up allowing you to enter a filename and location to save. Select the *Save* button to complete the save.

Printing a Settings File

To view a preview of the printout, select *Print Preview* from the *File* pull-down menu. If you wish to print to a printer, select the printer icon in the upper left corner of the *Print Preview* screen.

You may skip the print preview and go directly to print by pulling down the *File* menu and selecting *Print*. A dialog box, *Print* opens with the typical Windows® choice to setup the properties of printer. Execute this command, as necessary, and then select *Print*.

Comparing Settings Files

BESTCOMSPPlus has the ability to compare two different settings files. To use this feature, pull down the *Tools* menu and select *Compare Settings Files*. The *BESTCOMSPPlus Settings Compare Setup* dialog box appears (Figure 4-61). Select the location of the first file to compare under *Left Settings Source* and select the location of the second file to compare under *Right Settings Source*. If you are comparing a settings file located on your PC hard drive or portable media, click the folder button and navigate to the file. If you want to compare settings downloaded from a unit, click the *Select Unit* button to set up the communication port. Click the *Compare* button to compare the selected settings files.

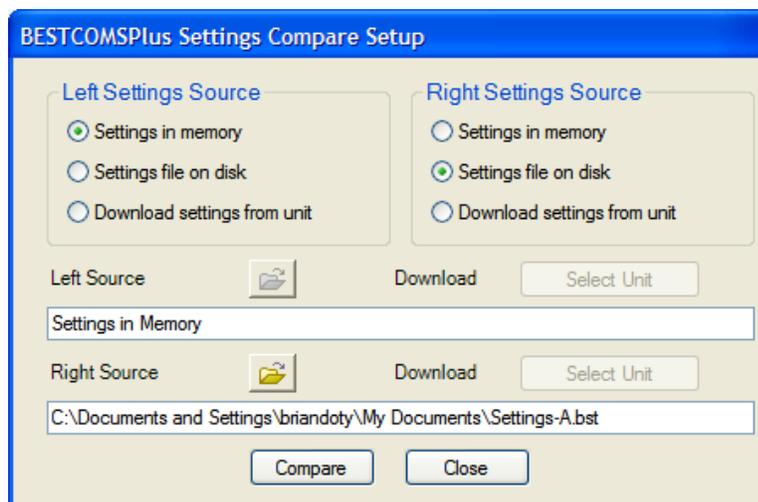


Figure 4-61. BESTCOMSPPlus Settings Compare Setup

A dialog box will appear and notify you if any differences were found. The *BESTCOMSPPlus Settings Compare* dialog box (Figure 4-62) 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.

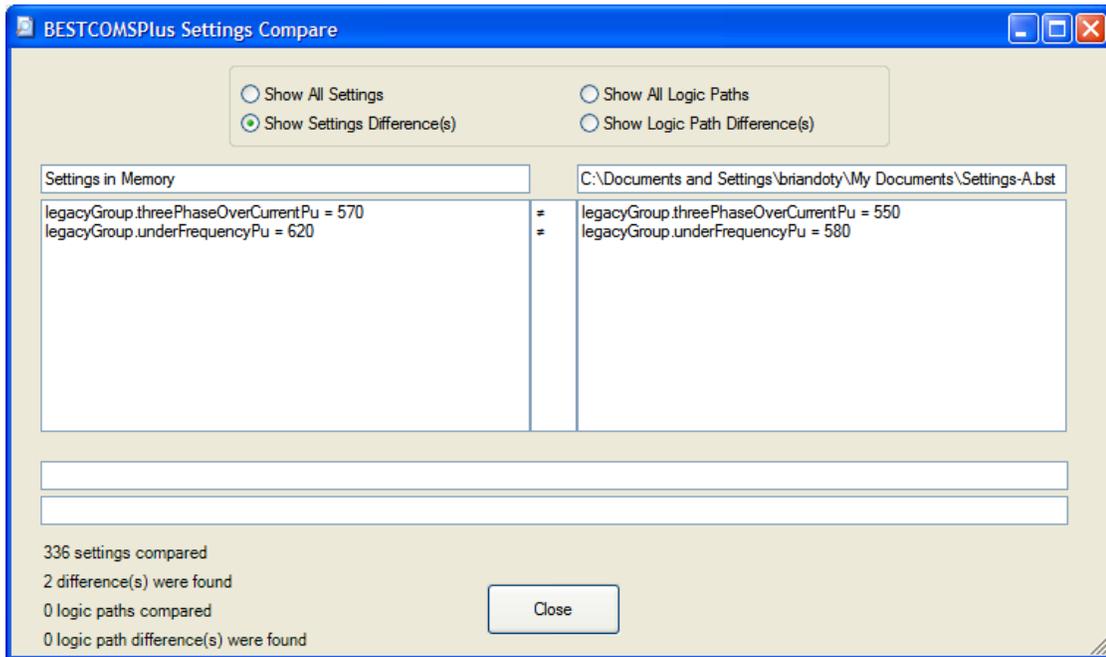


Figure 4-62. *BESTCOMSPPlus Settings Compare*

Upgrading Firmware in DGC-2020 and Expansion Modules

A device package contains firmware and a language module. Embedded firmware is the operating program that controls the actions of the DGC-2020. The DGC-2020 stores firmware in nonvolatile flash memory that can be reprogrammed through the communication ports. It is not necessary to replace EPROM chips when updating the firmware with a newer version.

Future enhancements to the DGC-2020 functionality may make a firmware update desirable. Because default settings are loaded when DGC-2020 firmware is updated, your settings should be saved in a file prior to upgrading firmware.

The language of the front panel LCD can be changed by uploading a different language module into the DGC-2020. The DGC-2020 stores the language module in nonvolatile flash memory; the language module contains all language translations for the DGC-2020. The language module can be reprogrammed through the communications port. In general, any time a firmware upgrade is made to the DGC-2020, the language module should be uploaded as well.

The DGC-2020 may be used in conjunction with several expansion modules that expand the DGC-2020 capabilities. DGC-2020 expansion modules include LSM-2020, CEM-2020, and AEM-2020. When upgrading the firmware in any component of this system, the firmware in ALL of the components of the system should be upgraded to ensure compatibility of communications between the various components.

CAUTION

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.

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.

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->SYSTEM SETTINGS 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 BESTCOMSPlus 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 4-63) 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.

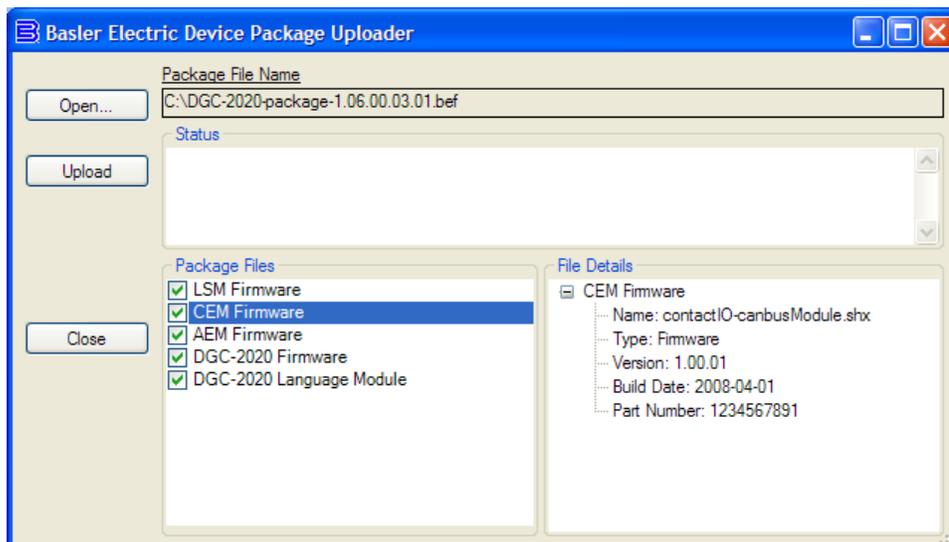


Figure 4-63. Basler Electric Device Package Uploader

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 4-64.



Figure 4-64. DGC-2020 Selection

10. The *Processing, Please Wait...* screen is displayed as file(s) are uploaded. See Figure 4-65.

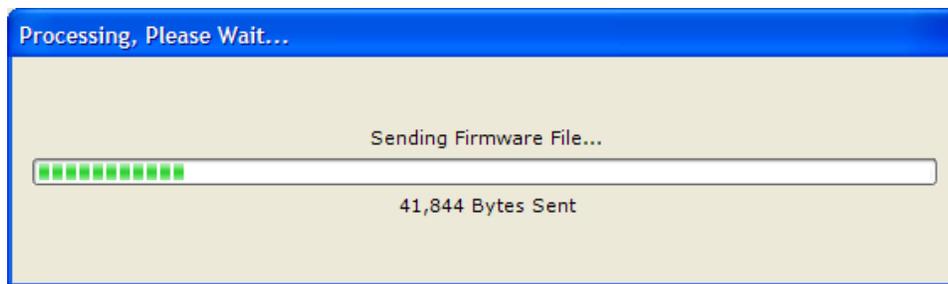


Figure 4-65. Processing, Please Wait...

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

Two scenarios are presented: (A) Upgrade DGC-2020 firmware and then load a settings file created with an earlier firmware version, and (B) Save settings file from DGC-2020, upgrade DGC-2020 firmware, and then load settings file back into the DGC-2020.

- A. Upgrade DGC-2020 firmware and then load a settings file created with an earlier firmware version.
 1. Upgrade the DGC-2020 firmware and language module.
 - a. Connect to the DGC-2020 with BESTCOMSPPlus. Check the firmware Application Version on the GENERAL SETTINGS-> DEVICE INFO screen.
 - b. If the firmware Application Version is greater than or equal to 1.00.00, proceed to the next step. If it is less than 1.01.00 (i.e. it is of the form 1.00.zz, where zz is a 2-digit number), then the language selection setting of the DGC-2020 must be set to *English* before initiating the firmware upgrade. This is accomplished by selecting *English* on the GENERAL SETTINGS->FRONT PANEL HMI->LANGUAGE SELECTION screen. **Failure to perform this step may result in incorrect operation of the DGC-2020.**
 - c. 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.
 - d. 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.)
 - e. 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.

- f. Click the *Upload* button and follow the instructions that appear to begin the upgrade process.
- g. After the upload is complete, disconnect communication to the DGC-2020.

NOTE

If the front panel HMI becomes blank and all LEDs are flashing, cycle power to the DGC-2020 and restart the upgrade procedure starting with step A.1.c. You will not be asked to save settings this time.

2. Modify the Application Version in the desired settings file to be compatible with the DGC-2020 Application Version.
 - a. Open the desired settings file into BESTCOMSPlus.
 - b. Change the Application Version in the settings file to the setting that matches the Application Version of the unit. The Application Version is what was noted during the upload process (A1e above), or can be obtained through the DGC-2020 front panel on the SETTINGS->GENERAL SETTINGS->VERSION INFO->FIRMWARE VERSION screen
 - c. When the number is changed, the *Application Version Number Changed* screen will appear which indicates any settings that it must change because of the version change. These settings should be checked for accuracy after the application version number has been changed.
 - d. After changing the Application Version, save the settings file with a new name by selecting *Save As* from the *File* pull-down menu.
3. Modify the programmable logic in the desired settings file to be compatible with the DGC-2020 Application Version.
 - a. Open the programmable logic. The logic is accessible under SETTINGS->BESTLOGIC+ PROGRAMMABLE LOGIC.
 - b. Examine the logic scheme by scrolling up/down through the entire logic diagram. Delete any logic elements that have a red X through them; they are invalid elements for the version and style number of the DGC-2020 that is being configured in this settings file. Delete or complete any incomplete logic; all component inputs must be connected to something, or the components must be deleted.
 - c. If you have made no logic changes, make a change now by clicking on any component and moving it slightly. BESTCOMSPlus will sense that the logic has changed.
 - d. Save the Logic Scheme by clicking on *Save* on the BESTLogic+ Programmable Logic toolbar.
 - e. Save the settings file again after logic modifications are complete. The file name need not be changed from the name given to it when it was saved after the Application Version was changed.
4. Examine and correct any changes to settings when Application Version was changed.
 - a. If the changes were not examined when the Application Version was made, they should be examined prior to loading the settings file into the DGC-2020.
 - b. Use the BESTCOMSPlus Settings Compare tool to compare the settings file from "Before" the application version change to the version "After" the Application Version change.
 - c. The BESTCOMSPlus Settings Compare tool is found by selecting *Compare Settings Files* from the *Tools* pull-down menu.
 - d. Select the 2 files to compare and check *Show All Settings Differences*.
 - e. Correct any settings in the "After" file to their correct values.
 - f. After finishing all corrections, save the settings file again. The file name need not be changed from the name given to it when it was saved after the Application Version was changed.

5. Load the new settings file into the DGC-2020.
 - a. Disconnect communication from the DGC-2020.
 - b. Close all settings files.
 - c. From the *File* pull-down menu, select *New, DGC-2020*.
 - d. Connect to the DGC-2020.
 - e. Once all settings have been read from the DGC-2020, open the new settings file by selecting the file with *File, Open File* in the BESTCOMSPPlus menu.
 - f. When BESTCOMSPPlus asks if you wish to upload settings and logic to the device, click *Yes*.
 - g. The settings should go into the DGC-2020 successfully.
 - h. 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 BESTCOMSPPlus.
 - i. 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 in the sections titled *Modify the Programmable logic in the desired settings file to be compatible with the DGC-2020 Application version* and *Load the New Settings File into the DGC-2020*.
- B. Save settings file from DGC-2020, upgrade DGC-2020 firmware, and then load settings file back into the DGC-2020.
 1. Download settings from the DGC-2020.
 - a. Connect to the DGC-2020.
 - b. After all settings and logic have been downloaded from the DGC-2020 into BESTCOMSPPlus, save the settings by selecting *Save As* from the *File* pull-down menu.
 - c. BESTCOMSPPlus gives the option of entering additional info and file properties. Enter the information as desired and click *OK*.
 - d. Assign a file name and save the file in a location that is available for later retrieval.
 2. Upgrade the DGC-2020 firmware and language module.
 - a. Follow the steps in the section labeled *Upgrade the DGC-2020 firmware and language module (A1 above)*.
 3. Modify the Application Version in the desired settings file to be compatible with the DGC-2020 Application Version.
 - a. Follow the steps in the section labeled *Modify the Application Version in the desired settings file to be compatible with the DGC-2020 Application Version (A2 above)*.
 4. Modify the programmable logic in the desired settings file to be compatible with the DGC-2020 Application Version.
 - a. Follow the steps in the section labeled *Modify the programmable logic in the desired settings file to be compatible with the DGC-2020 Application Version (A3 above)*.
 5. Examine and correct any changes to settings when Application Version was changed.
 - a. Follow the steps in the section labeled *Examine and correct any changes to settings when Application Version was changed (A4 above)*.
 6. Load the new settings file into the DGC-2020.
 - a. Follow the steps in the section labeled *Load the new settings file into the DGC-2020 (A5 above)*.

METERING EXPLORER

The Metering Explorer is a convenient tool within BESTCOMSPlus used to navigate through the following metering screens of the DGC-2020 plug-in.

- Engine
- Generator
- Power
- Bias Control
- Run Statistics
- Status
- Inputs
 - Contact Inputs
 - Remote LSM Inputs
 - Remote Contact Inputs
 - Remote Analog Inputs
 - Remote RTD Inputs
 - Remote Thermocouple Inputs
 - Remote Analog Input Values
- 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 4-66. Table 4-2 explains the call-outs on Figure 4-66.

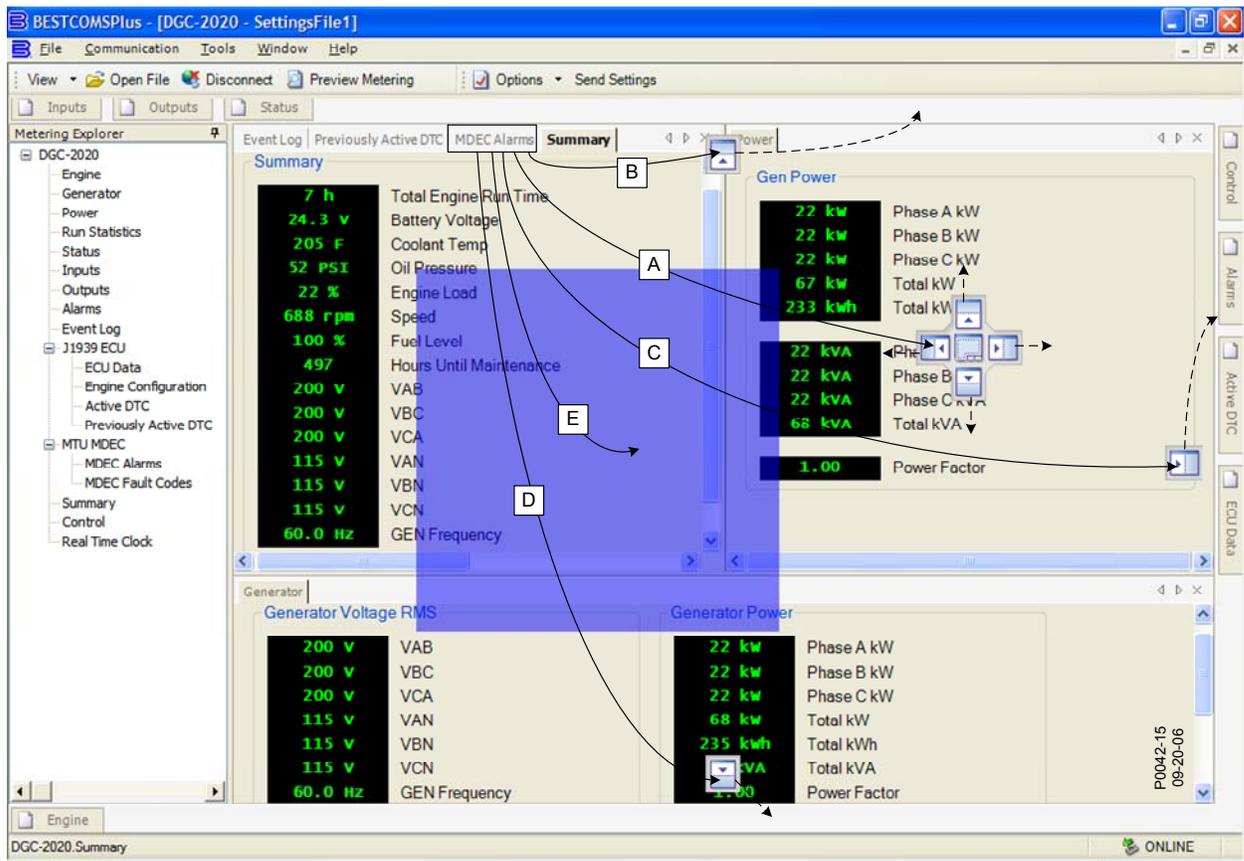
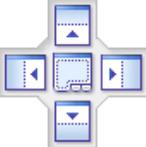
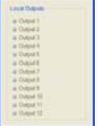


Figure 4-66. Metering, Docking Options

Table 4-2. Explanation of Call-Outs on Figure 4-66

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

Engine

This screen provides information and metering of engine components. Refer to Figure 4-67.

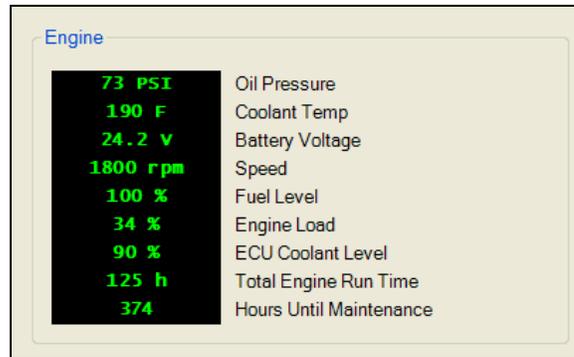


Figure 4-67. Metering, Engine

Generator

This screen provides metering of generator voltages and currents. Refer to Figure 4-68.

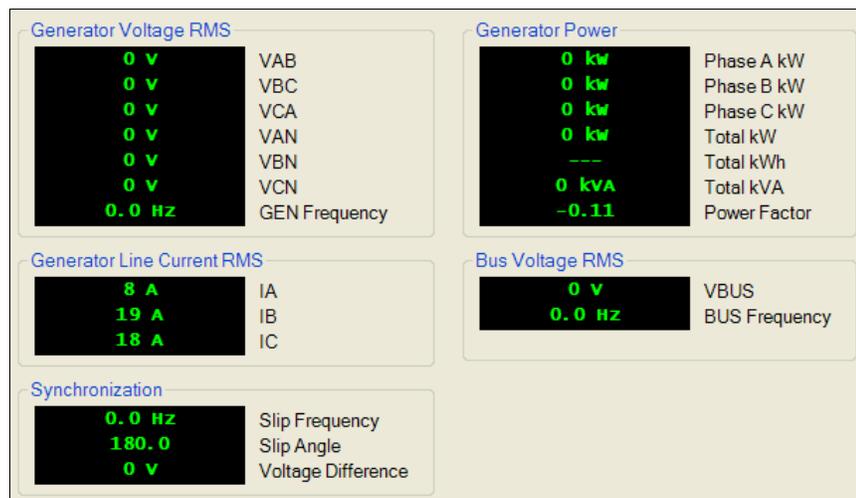


Figure 4-68. Metering, Generator

Power

This screen provides metering of generator power and power factor. Refer to Figure 4-69.



Figure 4-69. Metering, Power

Bias Control

This screen provides Var/PF mode status and operating levels. Refer to Figure 4-70.



Figure 4-70. Metering, Bias Control

Run Statistics

This screen provides Cumulative Run Statistics, Session Run Statistics, and Commission Date. Refer to Figure 4-71. The maintenance interval can be reset through this screen.



Figure 4-71. Metering, Run Statistics

Status

This screen indicates status of breakers, modes, and switches. The status is TRUE when the corresponding LED is red. Refer to Figure 4-72.

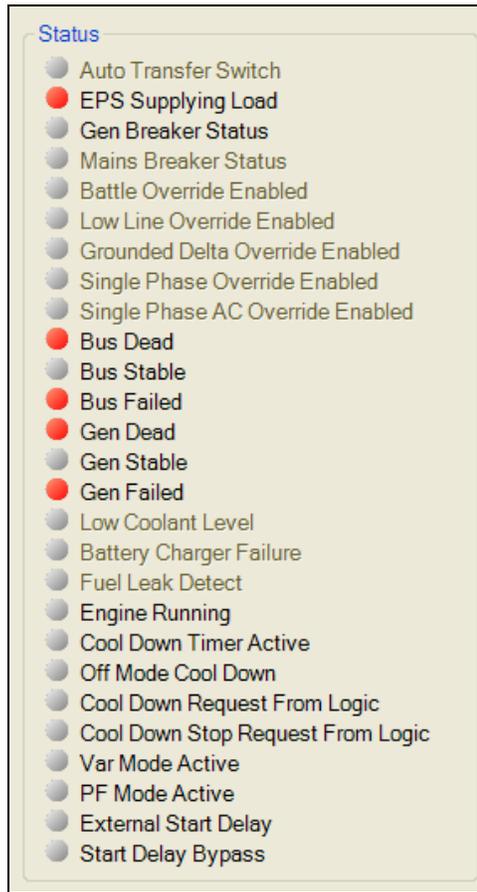


Figure 4-72. Metering, Status

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 4-73.

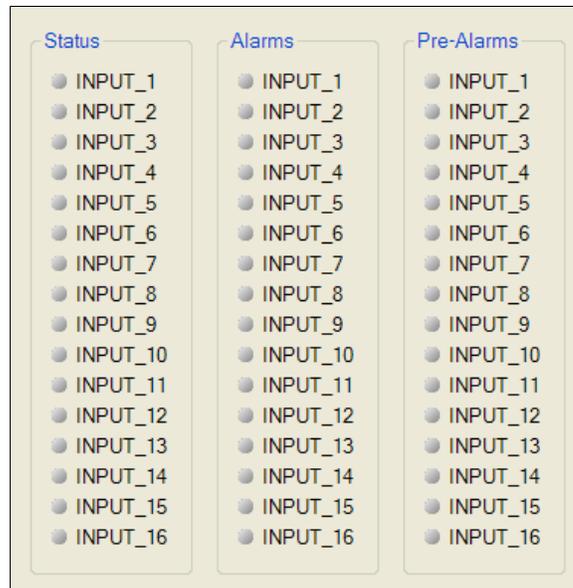


Figure 4-73. Metering, Inputs, Contact Inputs

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 4-74.



Figure 4-74. 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 4-75.

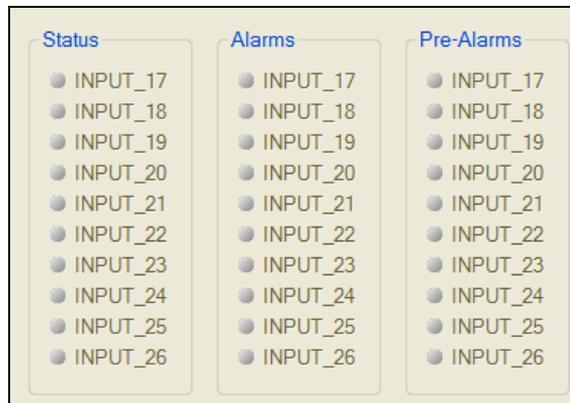


Figure 4-75. Metering, Inputs, Remote Contact Inputs

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 4-76. Remote Analog Input #1 is shown.

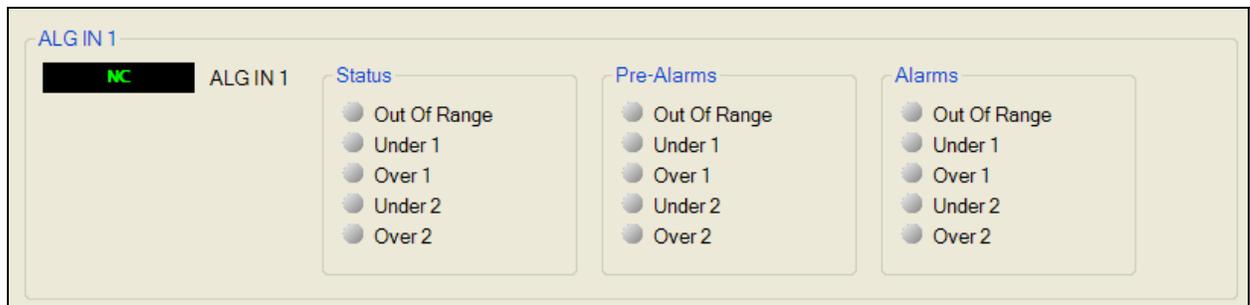


Figure 4-76. Metering, Inputs, Remote Analog Inputs

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 4-77. Remote RTD Input #1 is shown.



Figure 4-77. 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 4-78. Remote Thermocouple Input #1 is shown.



Figure 4-78. Metering, Inputs, Remote Thermocouple Inputs

Remote Analog Input Values

When an optional AEM-2020 (Analog Expansion Module) is connected, the values of the scaled analog inputs, raw analog inputs, RTD input temperatures, raw RTD inputs, thermocouple input temperatures, and raw thermocouple inputs are shown on this screen. Refer to Figure 4-78.

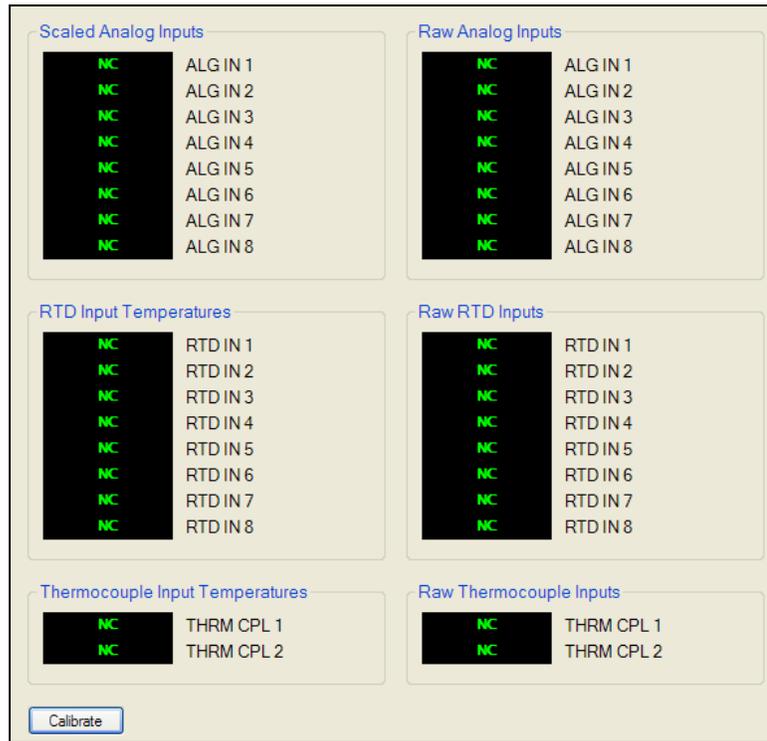


Figure 4-79. Metering, Inputs, Remote Analog Input Values

The *Calibrate* button shown in Figure 4-79 opens the Analog Input Temperature Calibration screen shown in Figure 4-80. This screen is used to calibrate RTD inputs 1 through 8 and thermocouple inputs 1 and 2.

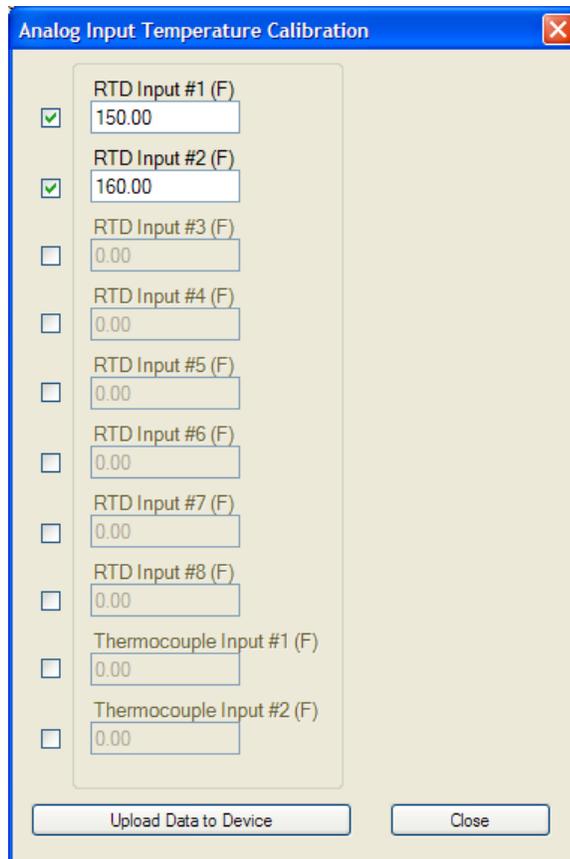


Figure 4-80. Analog Input Temperature Calibration

Outputs

Contact Outputs

This screen indicates the status of contact outputs. The status is TRUE when the corresponding LED is green. Refer to Figure 4-81.

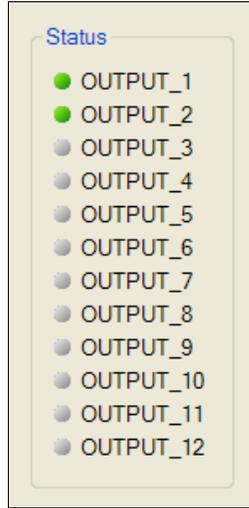


Figure 4-81. Metering, Outputs, Contact Outputs

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 4-82.

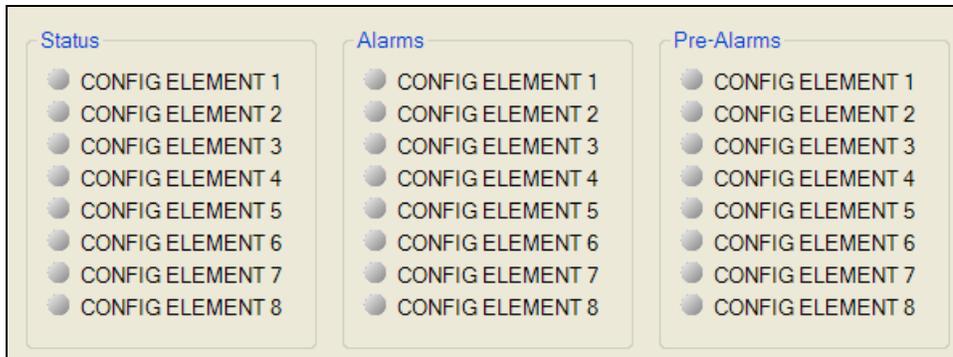


Figure 4-82. Metering, Outputs, Configurable Elements

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 4-83.

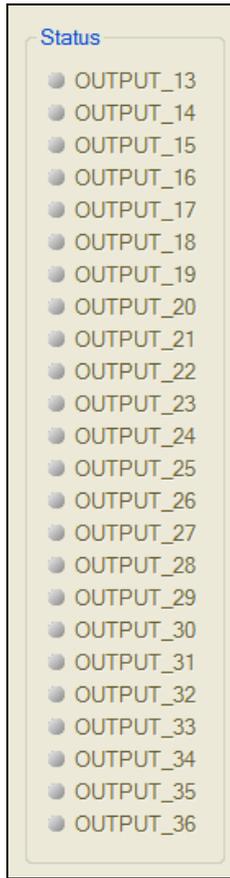


Figure 4-83. Metering, Outputs, Remote Contact Outputs

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 4-84.

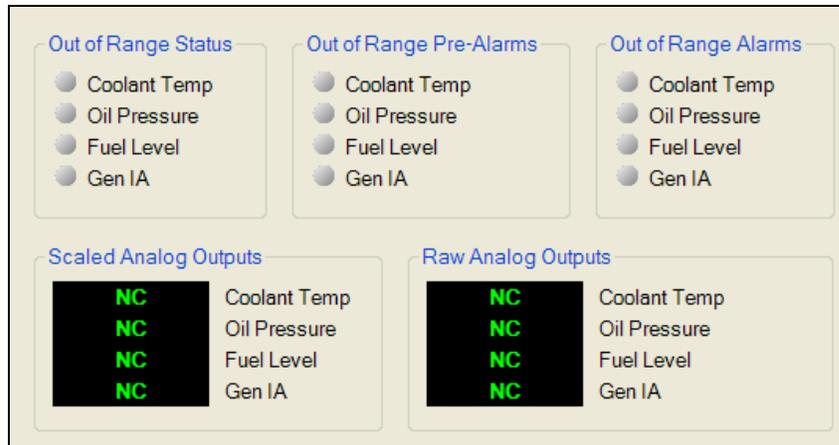


Figure 4-84. Metering, Outputs, Remote Analog Outputs

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 4-85.

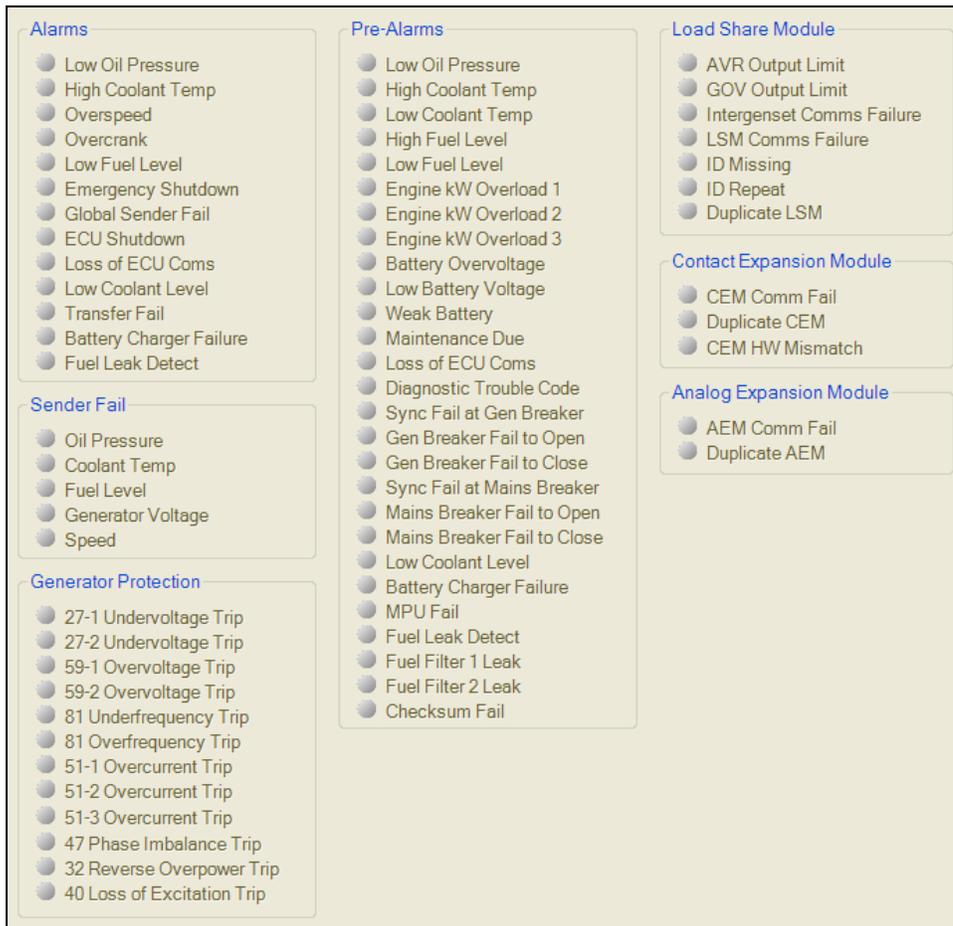


Figure 4-85. Metering, Alarms

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 BESTCOMSPPlus 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 4-86.

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 4-86. Metering, Event Log, Sorted by Date

When viewed with BESTCOMSPPlus, 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 4-86 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 4-87, 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 4-86.

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 4-87. Metering, Event Log, Sorted by Event ID

J1939 ECU

The ECU reports operating information to the DGC-2020 through the CANbus interface when the ECU is configured for Volvo Penta. Operating parameters and diagnostic information, if supported by the ECU, are decoded and displayed on these screens.

ECU Data

This screen displays ECU Lamp Status and ECU Data. The status is TRUE when the corresponding LED is red. Refer to Figure 4-88.

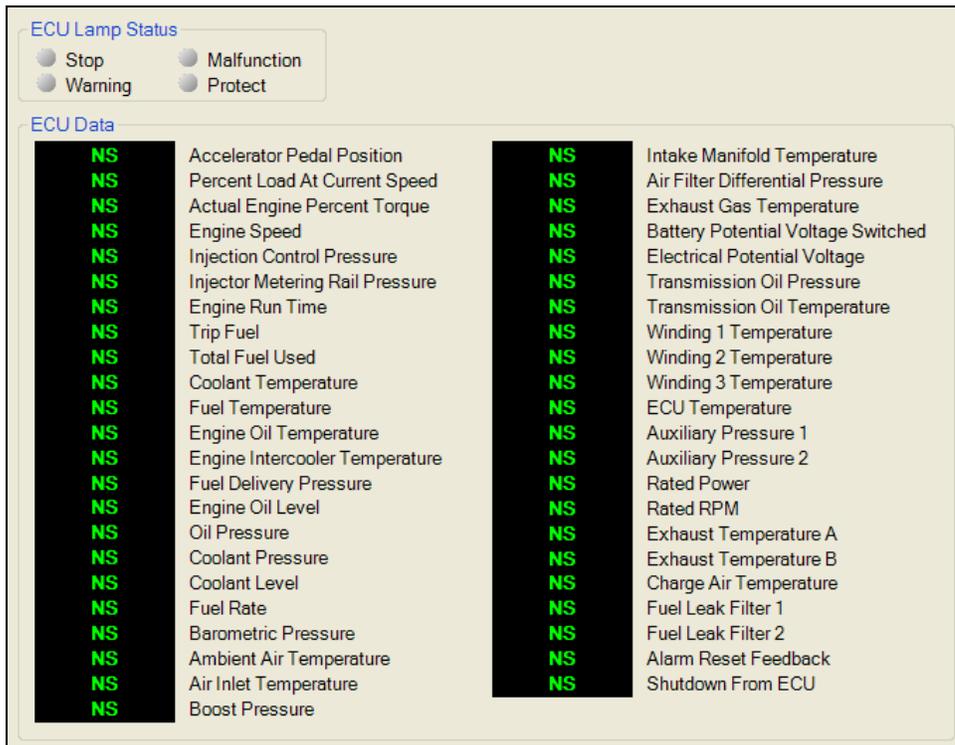


Figure 4-88. Metering, ECU Data

Engine Configuration

This screen displays Engine Configuration. Refer to Figure 4-89.

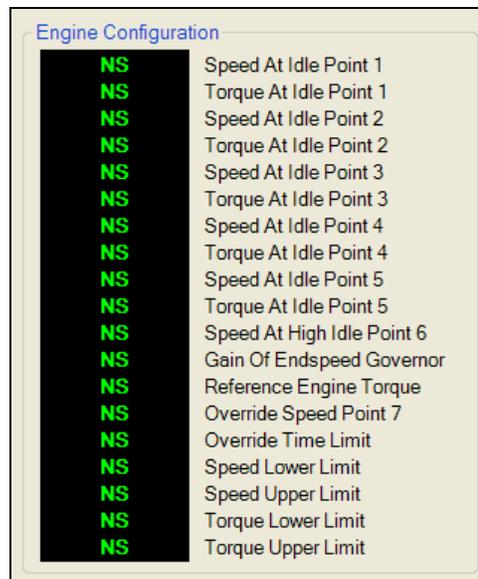


Figure 4-89. Metering, Engine Configuration

Active DTC and Previously Active DTC

This screen is used for viewing, downloading, and clearing DTC (Diagnostic Trouble Codes). Refer to Figure 4-90.

Options		Download		Clear	
DTC ID	SPN	FMI	Occurrences		
1	94	3	5		
2	98	3	7		
3	99	3	9		
4	100	3	11		
5	101	3	13		
6	109	3	15		
7	110	3	17		

Figure 4-90. Metering, Download DTC

MTU

The MTU reports operating information to the DGC-2020 through the CANbus interface when the ECU is configured for MTU. Operating parameters and diagnostic information, if supported by the MTU, are decoded and displayed on these screens.

MTU Alarms

MTU Alarms and MTU Pre-Alarms are reported on this screen. The status is TRUE when the corresponding LED is red. Refer to Figure 4-91.

MTU Alarms

- High Charge Air Temperature
- High Oil Temperature
- High Coolant Temperature
- Low Aftercooler Coolant Level
- Low Fuel Delivery Pressure
- Low Oil Pressure
- Overspeed
- Combined Red
- High ECU Supply Voltage

MTU Pre-Alarms

- High ECU Temperature
- High Oil Temperature
- High Intercooler Temperature
- High Charge Air Temperature
- High Coolant Temperature
- Shutdown Override
- High Fuel Rail Pressure
- Low Fuel Rail Pressure
- Low Coolant Level
- Low Charge Air Pressure
- Low Fuel Delivery Pressure
- Low Oil Pressure
- Combined Yellow
- ECU Faulty
- Speed Demand Fail
- Low Voltage Supply
- High Voltage Supply
- Engine Speed Too Low
- Low ECU Supply Voltage
- High Exhaust Temp A
- High Exhaust Temp B
- High Fuel Temp
- Low Charge Air Coolant Level
- Priming Fault
- Start Speed Low
- Runup Speed Low
- Idle Speed Low
- Alternator Winding Temp
- High Day Tank
- Low Day Tank
- High Storage Tank
- Low Storage Tank
- High Pressure Input 1
- High Pressure Input 2
- High Temp Coil 1
- High Temp Coil 2
- High Temp Coil 3
- High Ambient Temp
- Overspeed Test On
- High Fuel Filter Diff Pressure

Figure 4-91. Metering, MTU Alarms

MTU Fault Codes

MTU Fault Codes can be viewed and downloaded on this screen. Refer to Figure 4-92.

Options		Download	
Fault ID	Fault Codes	Description	
1	4	NO TEXT AVAILABLE	
2	201	SD T-COOLANT	

Figure 4-92. 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 4-93.

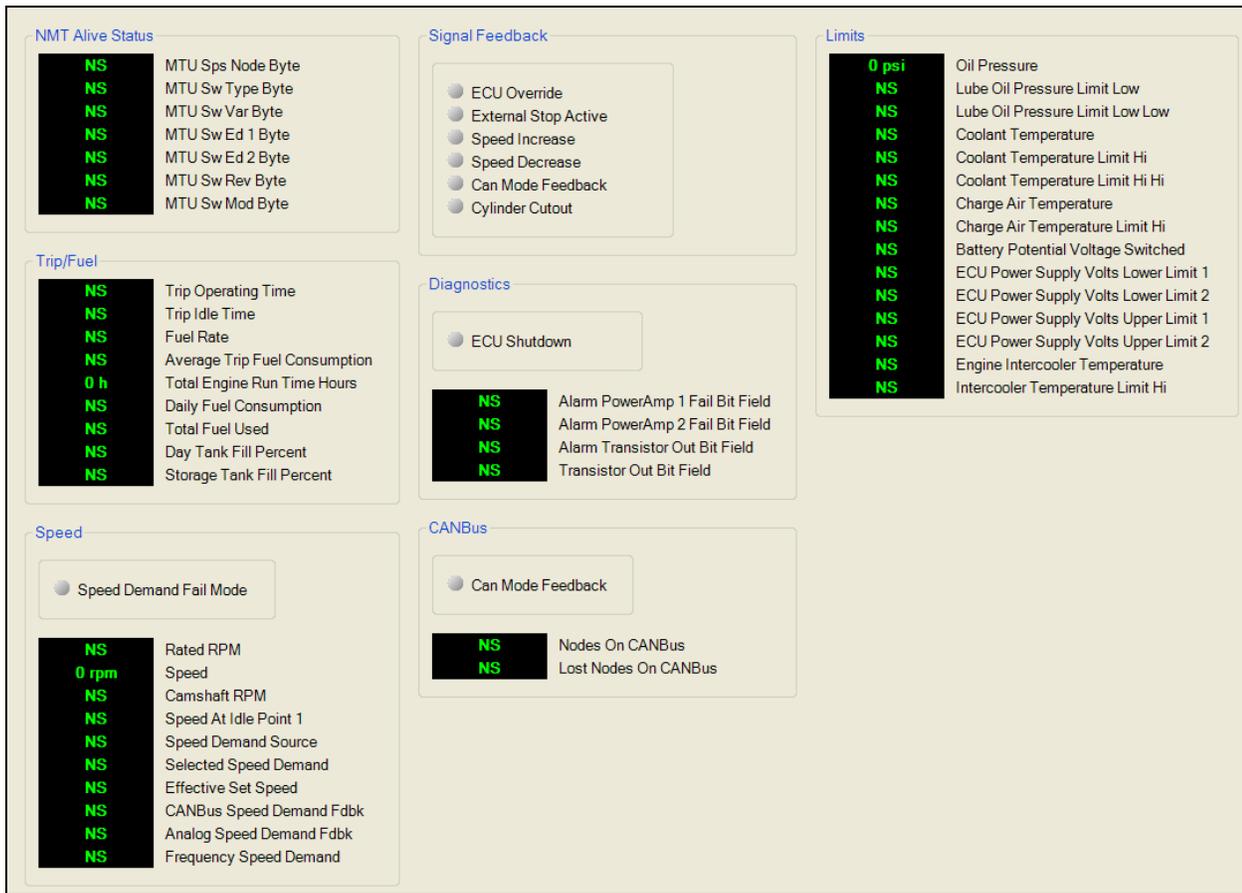


Figure 4-93. Metering, MTU Status

MTU Engine Status

MTU Engine Status is reported on this screen. The status is TRUE when the corresponding LED is red. Refer to Figure 4-95.

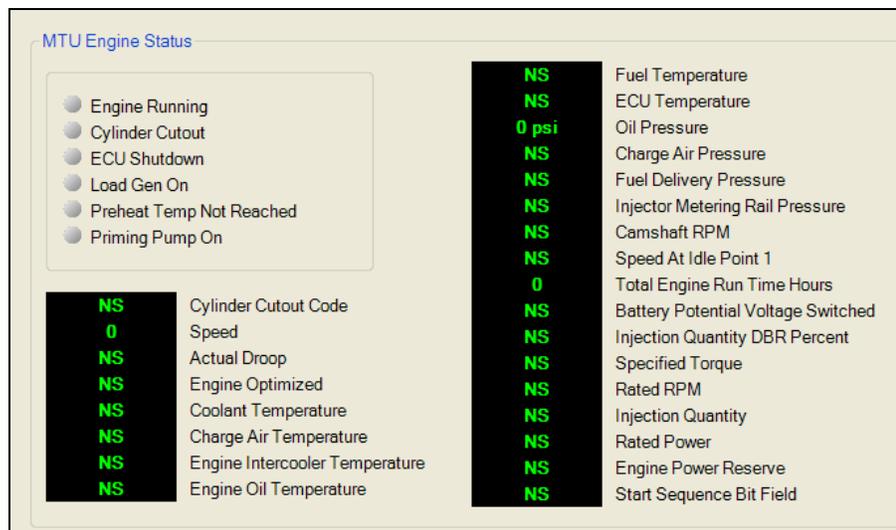


Figure 4-94. Metering, MTU Engine Status

Summary

This screen displays a metering summary. Refer to Figure 4-95.

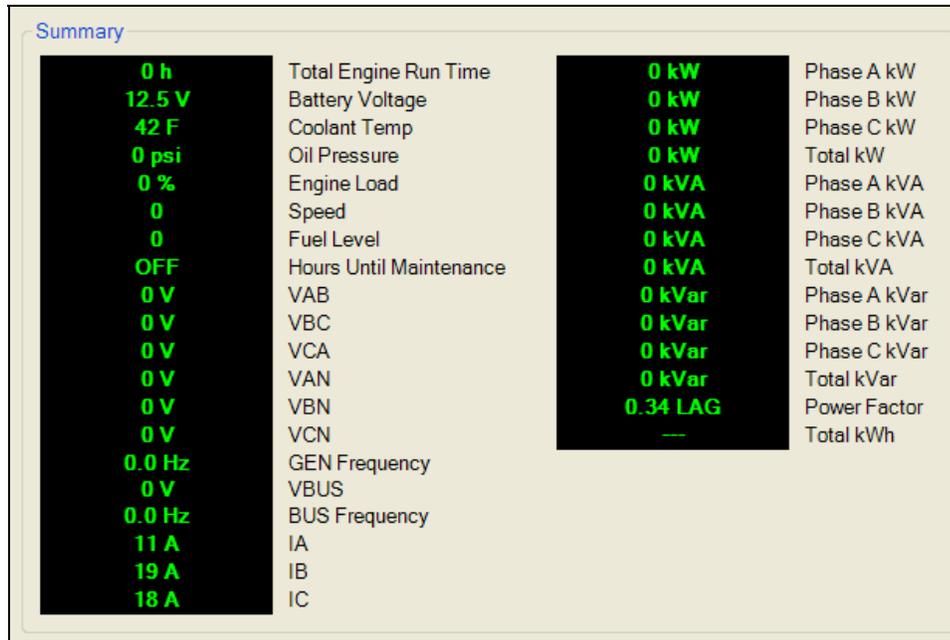
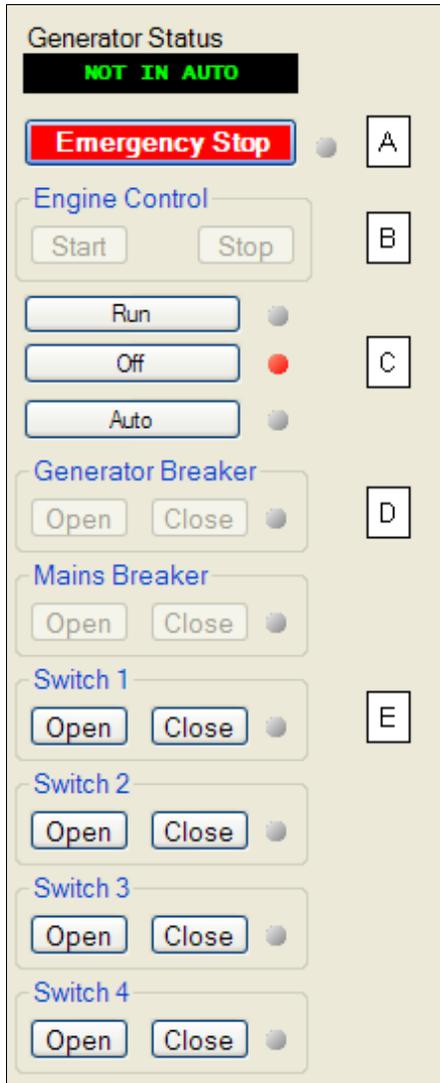


Figure 4-95. Metering, Summary

Control

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



The following controls are available by using the Metering Explorer in BESTCOMSPlus to open the *Control* branch. Refer to Figure 4-96.

- A. The user has control to stop the generator in case of emergency by clicking on the *Emergency Stop* button.
- B. The engine can be started and stopped by clicking on the *Start* and *Stop* buttons.
- C. The engine can be set to Run, Auto, or Off.
- D. There are controls for opening and closing the generator breaker and mains breaker. The breaker is open when the corresponding LED is green and closed when red.
- E. Switches 1 through 4 can be opened or closed by clicking on the *Open* or *Close* buttons. The switch is closed when the corresponding LED is red.

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

Figure 4-96. Metering, Control

Real Time Clock

Settings for Date and Time are made here. Refer to Figure 4-97.

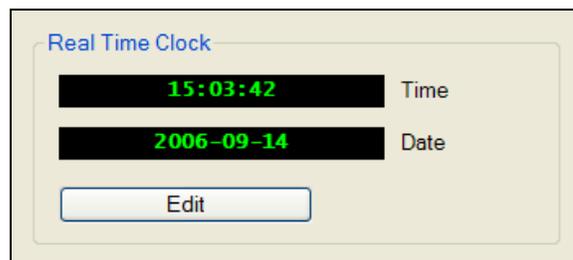
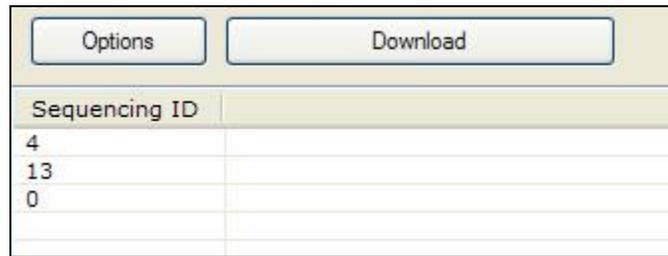


Figure 4-97. Metering, Real Time Clock

Generator Network Status

This screen (Figure 4-98) displays the detected sequencing IDs of the LSM-2020's on the network. This can only be accomplished when an optional LSM-2020 (Load Share Module) is connected to the DGC-2020 and actively communicating to the generator network. The *Options* button is used to copy or save the list of sequencing IDs. The *Download* button refreshes the list of sequencing IDs.



Sequencing ID
4
13
0

Figure 4-98. Metering, Generator Network Status

UPDATING BESTCOMSPlus SOFTWARE

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

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

CONVERTING SETTINGS FILES

A settings file conversion is required when DGC-2020 firmware has been changed. To make the settings file compatible with the firmware, perform the following:

1. Using BESTCOMSPlus, open the settings file to be converted from the top menu bar via *File, Open*. Do not connect to the DGC-2020 at this time.
2. Working offline, use the Settings Explorer to open the *Device Info* screen. Click on the pull-down menu under *Application Version* and select the version of firmware that the DGC-2020 holds.
3. Use the Settings Explorer to open the *BESTlogic+ Programmable Logic* screen. Verify that the three status LEDs located in the lower right corner are green indicating that the logic is ready to be saved to a file. If all three status LEDs are not green, click on the *Save* button located on the BESTlogic+ toolbar, correct any logic diagram errors, and then click *Save* again. Note that this step saves the logic in BESTCOMSPlus memory, not to a file.
4. It is recommended to save the old settings file. From the top menu bar select *File, Save As*, and enter a name for the new settings file.
5. Connect to the DGC-2020 and upload the new settings file.

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SECTION 5 • BESTlogic+ PROGRAMMABLE LOGIC

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SECTION 5 • BESTlogic+ PROGRAMMABLE LOGIC

INTRODUCTION

BESTlogic+ 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+. BESTlogic+ 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. BESTCOMSPi.us 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+ 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 3, *Functional Description*.

OVERVIEW OF BESTlogic+

BESTlogic+ settings are made through BESTCOMSPi.us. Use the Settings Explorer to open the *BESTlogic+ Programmable Logic* tree branch as shown in Figure 5-1.

The *BESTlogic+ Programmable Logic* screen contains a logic library for opening and saving logic files, tools for creating and editing logic documents, and protection settings.

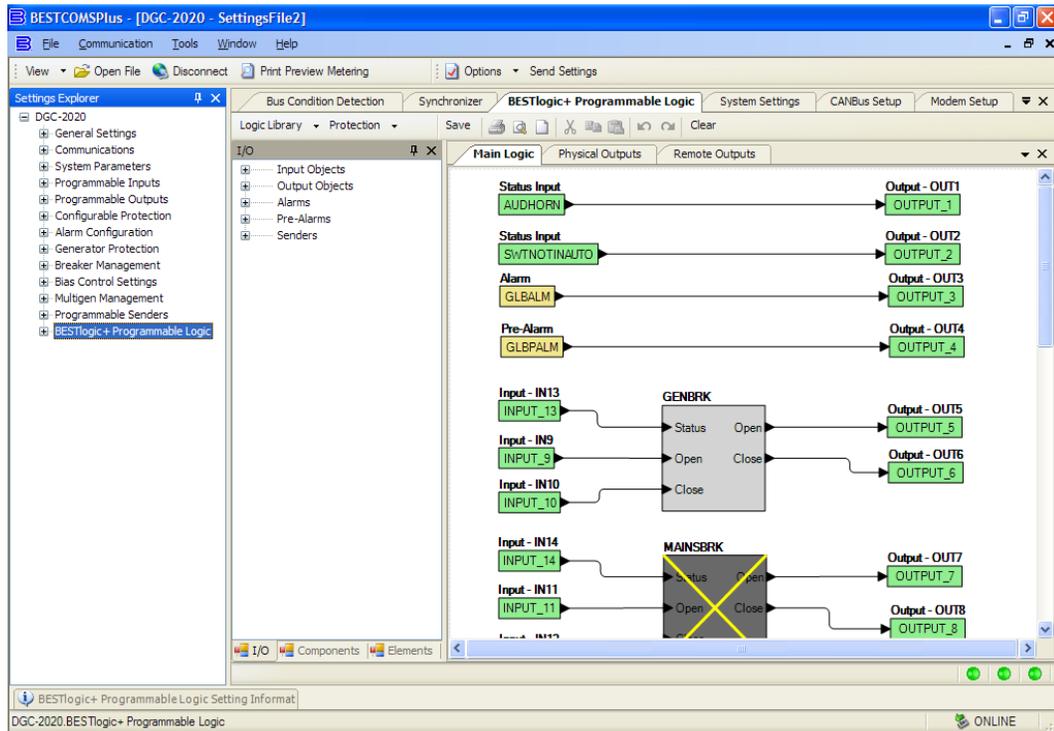


Figure 5-1. BESTlogic+ Programmable Logic Tree Branch

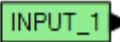
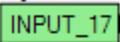
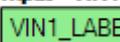
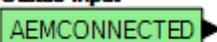
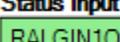
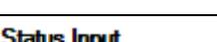
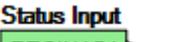
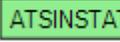
BESTlogic+ Composition

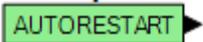
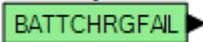
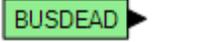
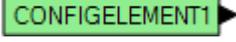
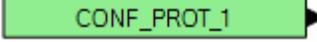
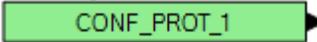
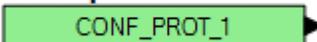
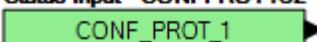
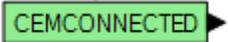
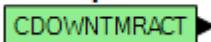
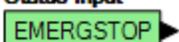
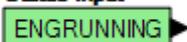
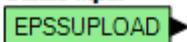
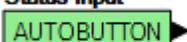
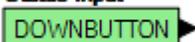
There are three main groups of objects used for programming BESTlogic+. These groups are *I/O*, *Components*, and *Elements*. For details on how these objects are used to program BESTlogic+, see the paragraphs on *Programming BESTlogic+*.

I/O

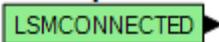
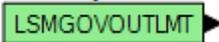
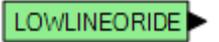
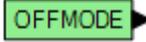
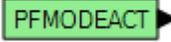
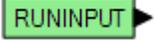
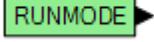
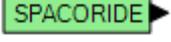
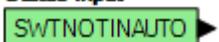
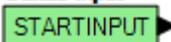
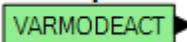
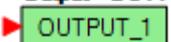
This group contains Input Objects, Output Objects, Alarms, Pre-Alarms, and Senders. Table 5-1 lists the names and descriptions of the objects in the *I/O* group.

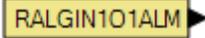
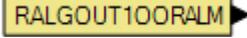
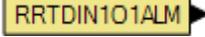
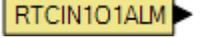
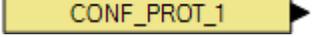
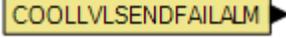
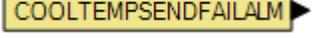
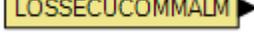
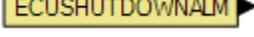
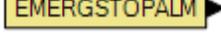
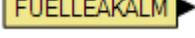
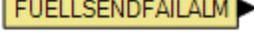
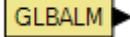
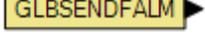
Table 5-1. *I/O* Group, Names and Descriptions

Name	Description	Symbol
Input Objects		
Logic 0	Always FALSE (Low).	
Logic 1	Always TRUE (High).	
<i>Physical Inputs</i> IN1 - IN16	TRUE when Physical Input x is active.	Input - IN1 
<i>Remote Inputs</i> IN17 - IN26	True when Remote Input x is active. (Available when an optional CEM-2020 is connected.)	Input - IN17 
<i>Virtual Inputs</i> VIN1 - VIN4	TRUE when Virtual Input x is active.	Input - VIN1 
<i>Status Input</i> Analog Expansion Module	Analog Expansion Module Connected. TRUE when an optional AEM-2020 is connected to the DGC-2020.	Status Input 
<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.)	Status Input 
<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.	Status Input 
<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.)	Status Input 
<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.)	Status Input 
<i>Status Input</i> ATS Input	TRUE when the ATS (Auto Transfer Switch) input is TRUE.	Status Input 
<i>Status Input</i> Audible Horn	TRUE when the Audible Horn is active.	Status Input 
<i>Status Input</i> Auto Mode	TRUE when the DGC-2020 is in Auto Mode.	Status Input 

Name	Description	Symbol
<i>Status Input</i> Auto Restart	TRUE when the Automatic Restart function is active.	Status Input 
<i>Status Input</i> Battery Charger Fail	TRUE when the Battery Charger Fail input is TRUE.	Status Input 
<i>Status Input</i> Battle Override	TRUE when the Battle Override input is TRUE.	Status Input 
<i>Status Input</i> Bus Dead	TRUE when the Bus Dead condition settings have been exceeded.	Status Input 
<i>Status Input</i> Bus Fail	TRUE when the Bus Fail condition settings have been exceeded.	Status Input 
<i>Status Input</i> Bus Stable	TRUE when the Bus Stable condition settings have been exceeded.	Status Input 
<i>Status Input</i> Configurable Elements 1-8	TRUE when the Configurable Element x logic output is TRUE.	Status Input 
<i>Status Input</i> Configurable Protection 1-8	TRUE when the Configurable Protection x Over Threshold #1 is TRUE.	Status Input - CONFPROT101 
<i>Status Input</i> Configurable Protection 1-8	TRUE when the Configurable Protection x Over Threshold #2 is TRUE.	Status Input - CONFPROT102 
<i>Status Input</i> Configurable Protection 1-8	TRUE when the Configurable Protection x Under Threshold #1 is TRUE.	Status Input - CONFPROT101 
<i>Status Input</i> Configurable Protection 1-8	TRUE when the Configurable Protection x Under Threshold #2 is TRUE.	Status Input - CONFPROT102 
<i>Status Input</i> Contact Expansion Module	Contact Expansion Module Connected. TRUE when an optional CEM-2020 is connected to the DGC-2020.	Status Input 
<i>Status Input</i> Cool Down Timer Active	TRUE when the Cool Down Timer is timing out.	Status Input 
<i>Status Input</i> Emergency Stop	TRUE when the Emergency Stop button has been pressed.	Status Input 
<i>Status Input</i> Engine Running	TRUE while the Engine is Running.	Status Input 
<i>Status Input</i> EPS Supplying Load	TRUE while the EPS is supplying load.	Status Input 
<i>Status Input</i> Front Panel Buttons	TRUE while the <i>AUTO</i> front panel button is pressed.	Status Input 
<i>Status Input</i> Front Panel Buttons	TRUE while the <i>DOWN</i> front panel button is pressed.	Status Input 

Name	Description	Symbol
Status Input Front Panel Buttons	TRUE while the <i>EDIT</i> front panel button is pressed.	Status Input EDITBUTTON 
Status Input Front Panel Buttons	TRUE while the <i>LAMP TEST</i> front panel button is pressed.	Status Input LAMPBUTTON 
Status Input Front Panel Buttons	TRUE while the <i>LEFT</i> front panel button is pressed.	Status Input LEFTBUTTON 
Status Input Front Panel Buttons	TRUE while the <i>OFF</i> front panel button is pressed.	Status Input OFFBUTTON 
Status Input Front Panel Buttons	TRUE while the <i>RESET</i> front panel button is pressed.	Status Input RESETBUTTON 
Status Input Front Panel Buttons	TRUE while the <i>RIGHT</i> front panel button is pressed.	Status Input RIGHTBUTTON 
Status Input Front Panel Buttons	TRUE while the <i>RUN</i> front panel button is pressed.	Status Input RUNBUTTON 
Status Input Front Panel Buttons	TRUE while the <i>ALARM SILENCE</i> front panel button is pressed.	Status Input SILENCEBUTTON 
Status Input Front Panel Buttons	TRUE while the <i>UP</i> front panel button is pressed.	Status Input UPBUTTON 
Status Input Fuel Leak	TRUE when the Fuel Leak Detect input is TRUE.	Status Input FUELLEAK 
Status Input Generator Dead	TRUE when the Gen Dead condition settings have been exceeded.	Status Input GENDEAD 
Status Input Generator Fail	TRUE when the Gen Fail condition settings have been exceeded.	Status Input GENFAIL 
Status Input Generator Stable	TRUE when the Gen Stable condition settings have been exceeded.	Status Input GENSTABLE 
Status Input Generator Test Loaded	TRUE when the Exercise Timer has started the generator and run with load is selected.	Status Input GENTESTLOADED 
Status Input Generator Test	TRUE when the Exercise Timer has started the generator.	Status Input GENTEST 
Status Input Global Low Coolant Level	TRUE when the Low Coolant Level input is TRUE.	Status Input GLBLOWCOOLLVL 
Status Input Ground Delta Override	TRUE when the Grounded Delta Override input is TRUE.	Status Input GNDDLTAORIDE 
Status Input Load Share Module	Load Share Module AVR Output Limit. TRUE when the LSM-2020 AVR Output Limit settings have been exceeded.	Status Input LSMAVROUTLMT 

Name	Description	Symbol
<i>Status Input</i> Load Share Module	Load Share Module Connected. TRUE when an optional LSM-2020 is connected to the DGC-2020.	Status Input 
<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.	Status Input 
<i>Status Input</i> Low Line Override	TRUE when the Low Line Override input is TRUE.	Status Input 
<i>Status Input</i> Off Mode	TRUE when the DGC-2020 is in Off Mode.	Status Input 
<i>Status Input</i> PF Mode Active	TRUE when PF mode is active.	Status Input 
<i>Status Input</i> Pre Start Condition in Effect	TRUE while in the Pre Start state.	Status Input 
<i>Status Input</i> Pre Start Input	TRUE when the DGC-2020 is indicating that the Pre Start relay should be closed.	Status Input 
<i>Status Input</i> Reset Active	TRUE while the Reset button on the HMI is pressed.	Status Input 
<i>Status Input</i> Run Input	TRUE when the DGC-2020 is indicating that the Run Input should be closed.	Status Input 
<i>Status Input</i> Run Mode	TRUE when the DGC-2020 is in Run Mode.	Status Input 
<i>Status Input</i> Single Phase AC Sensing Override	TRUE when the Single Phase AC Override input is TRUE.	Status Input 
<i>Status Input</i> Single Phase Connection Override	TRUE when the Single Phase Override input is TRUE.	Status Input 
<i>Status Input</i> Switch not in Auto	TRUE when the DGC-2020 is not in Auto Mode.	Status Input 
<i>Status Input</i> Start Input	TRUE when the DGC-2020 is indicating that the Start relay should be closed to start the engine.	Status Input 
<i>Status Input</i> VAR Mode Active	TRUE when Var mode is active.	Status Input 
Output Objects		
<i>Physical Outputs</i> OUT1 - OUTx	Physical Outputs 1 through 7 (style xxAxxxxx) or 1 through 15 (style xxBxxxxx).	Output - OUT1 
<i>Remote Outputs</i> OUT13 - OUT36	Remote Outputs 13 through 36. (Available when an optional CEM-2020 is connected.)	Output - OUT13 

Name	Description	Symbol
Alarms		
<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.)	Alarm 
<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.	Alarm 
<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.)	Alarm 
<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.)	Alarm 
Auto Restart Fail	TRUE after the Automatic Restart function fails to restart the generator.	Alarm 
Battery Charger Fail	TRUE when the Battery Charger Fail function is configured as an Alarm and the activation delay has expired.	Alarm 
<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.)	Alarm - CONFPROT101ALM 
Coolant Level Sender Fail	TRUE when a low coolant level error status code is received from the ECU. CANbus must be enabled.	Alarm 
Coolant Temp Sender Fail	TRUE when the Coolant Temp Sender Fail is configured as an Alarm and the activation delay has expired.	Alarm 
ECU Comm Loss	TRUE when communication to ECU has been lost.	Alarm 
ECU Shutdown	TRUE when ECU has Shutdown the engine.	Alarm 
Emergency Stop	TRUE when the Emergency Stop button has been pressed.	Alarm 
Fuel Leak	TRUE when the Fuel Leak Detect function is configured as an Alarm and the activation delay has expired.	Alarm 
Fuel Level Sender Fail	TRUE when the Fuel Level Sender Fail is configured as an Alarm and the activation delay has expired.	Alarm 
Global Alarm	TRUE when one or more Alarms are set.	Alarm 
Global Sender Fail	TRUE when one or more of the Sender Fails are configured as Alarms and are TRUE.	Sender Fail 

Name	Description	Symbol
Hi Coolant Temp	TRUE when the High Coolant Temp Alarm settings have been exceeded.	Alarm HITEMPALM 
Low Coolant Level	TRUE when the Low Coolant Level function is configured as an Alarm and the activation delay has expired. In addition, TRUE when CANbus is enabled and the Low Coolant Level Alarm threshold has been exceeded.	Alarm LOWCOOLLVLALM 
Low Fuel Level	TRUE when the Low Fuel Level Alarm settings have been exceeded.	Alarm LOWFUELLALM 
Low Oil Pressure	TRUE when the Low Oil Pressure Alarm settings have been exceeded.	Alarm LOWOILPRALM 
Oil Pressure Sender Fail	TRUE when the Oil Pressure Sender Fail is configured as an Alarm and the activation delay has expired.	Alarm OILPRESSENDFAILALM 
Overcrank	TRUE when an Overcrank condition exists.	Alarm OCRANKALM 
Overspeed	TRUE when the Overspeed Alarm settings have been exceeded.	Alarm OVERSPDALM 
Speed Sender Fail	TRUE when the Speed Sender Fail activation delay has expired.	Alarm SPDSENDFAILALM 
Voltage Sensing Fail	TRUE when the Voltage Sensing Fail is configured as an Alarm and the activation delay has expired.	Alarm VOLTSENSFAILALM 
Pre-Alarms		
<i>Analog Expansion Module</i> Analog Expansion Module Comm Fail	TRUE when communication from the AEM-2020 to the DGC-2020 has been lost.	Pre-Alarm AEMCOMMFPALM 
<i>Analog Expansion Module</i> Multiple Analog Expansion Modules Detected	TRUE when more than one AEM-2020 is connected.	Pre-Alarm DUPAEMPALM 
<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.)	Pre-Alarm RALGIN101PALM 
<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.	Pre-Alarm RALGOUT10ORPALM 
<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 a Pre-Alarm and the threshold has been exceeded. (Over 1 shown.)	Pre-Alarm RRTDINT01PALM 
<i>Analog Expansion Module</i> Remote Thermocouple Inputs 1-2	TRUE when Over 1, Over 2, Under 1, or Under 2 is configured as a Pre-Alarm and the threshold has been exceeded. (Over 1 shown.)	Pre-Alarm RTCINT01PALM 

Name	Description	Symbol
Battery Charger Fail	TRUE when the Battery Charger Fail function is configured as a Pre-Alarm and the activation delay has expired.	Pre-Alarm BATTCHRGFAILPALM 
Battery Overvoltage	TRUE when the Battery Overvoltage Pre-Alarm threshold has been exceeded.	Pre-Alarm BATOVOLTPALM 
Checksum Failure	TRUE when some of the user settings or firmware code has been corrupted. Refer to Section 4, <i>BESTCOMSPPlus Software, Alarm Configuration, Pre-Alarms</i> , for more details.	Pre-Alarm CHECKSUMFAILPALM 
<i>Configurable Protection</i> Protection 1-8	TRUE when Over 1, Over 2, Under 1, or Under 2 is configured as a Pre-Alarm and the threshold has been exceeded. (Over 1 shown.)	Pre-Alarm - CONFPROT101PALM CONF_PROT_1 
<i>Contact Expansion Module</i> Multiple Contact Expansion Modules Connected	TRUE when more than one CEM-2020 is connected.	Pre-Alarm DUPCEMPALM 
<i>Contact Expansion Module</i> Contact Expansion Module Comm Fail	TRUE when communication from the CEM-2020 to the DGC-2020 has been lost.	Pre-Alarm CEMCOMMFPALM 
<i>Contact Expansion Module</i> 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 BESTCOMSPPlus.	Pre-Alarm CEMHWMISMATCHPALM 
Coolant Temp Sender Fail	TRUE when the Coolant Temp Sender Fail is configured as a Pre-Alarm and the activation delay has expired.	Pre-Alarm COOLTEMPSENDFAILPALM 
Diag Trouble Code	TRUE when a Diagnostic Trouble Code exists.	Pre-Alarm DIAGTRBCODEPALM 
ECU Com Loss	TRUE when communication to ECU has been lost.	Pre-Alarm LOSSECUCOMMPALM 
Engine KW Over Load 1	TRUE when the Engine KW Overload 1 Pre-Alarm settings have been exceeded.	Pre-Alarm ENKWOVRLD1PALM 
Engine KW Over Load 2	TRUE when the Engine KW Overload 2 Pre-Alarm settings have been exceeded.	Pre-Alarm ENKWOVRLD2PALM 
Engine KW Over Load 3	TRUE when the Engine KW Overload 3 Pre-Alarm settings have been exceeded.	Pre-Alarm ENKWOVRLD3PALM 
Fuel Leak	TRUE when the Fuel Leak Detect function is configured as a Pre-Alarm and the activation delay has expired.	Pre-Alarm FUELLEAKPALM 
Fuel Level Sender Fail	TRUE when the Fuel Level Sender Fail is configured as a Pre-Alarm and the activation delay has expired.	Pre-Alarm FUELLENDFAILPALM 
Global Pre-Alarm	TRUE when one or more Pre-Alarms are set.	Pre-Alarm GLBPALM 

Name	Description	Symbol
Hi Coolant Temp	TRUE when the High Coolant Temp Pre-Alarm threshold has been exceeded.	Pre-Alarm HITEMPPALM 
High Fuel Level	TRUE when the High Fuel Level Pre-Alarm settings have been exceeded.	Pre-Alarm HIFUELLPALM 
Intergenset Comm Fail	TRUE when an individual generator detects that it had been connected to a generator network, but has lost the connection.	Pre-Alarm INTERGENCOMFPALM 
<i>Load Share Module</i> Load Share Module Comm Fail	TRUE when communication from the LSM-2020 to the DGC-2020 has been lost.	Pre-Alarm LSMCOMMFPALM 
<i>Load Share Module</i> Multiple Load Share Modules Detected	TRUE when more than one LSM-2020 is connected.	Pre-Alarm DUPLSMPALM 
Low Battery Voltage	TRUE when the Low Battery Voltage Pre-Alarm settings have been exceeded.	Pre-Alarm LOWBATVPALM 
Low Coolant Level	TRUE when the Low Coolant Level function is configured as a Pre-Alarm and the activation delay has expired. In addition, TRUE when CANbus is enabled and the Low Coolant Level Pre-Alarm threshold has been exceeded.	Pre-Alarm LOWCOOLLVLPALM 
Low Coolant Temp	TRUE when the Low Coolant Temp Pre-Alarm threshold has been exceeded.	Pre-Alarm LOWTEMPPALM 
Low Fuel Level	TRUE when the Low Fuel Level Pre-Alarm threshold has been exceeded.	Pre-Alarm LOWFUELLPALM 
Low Oil Pressure	TRUE when the Low Oil Pressure Pre-Alarm threshold has been exceeded.	Pre-Alarm LOWOILPRPALM 
Maintenance Interval	TRUE when the Maintenance Interval Pre-Alarm threshold has been exceeded.	Pre-Alarm MAINTINTPALM 
MPU Fail	TRUE when the MPU has failed.	Pre-Alarm MPUFAILPALM 
Network ID Missing Error	TRUE if an expected sequence ID of an optional LSM-2020 is not detected on the network. Expected sequence IDs are entered on the <i>Network Configuration</i> screen.	Pre-Alarm IDMISSINGPALM 
Network ID Repeat Error	TRUE if two or more optional LSM-2020's report the same expected sequence ID. Expected sequence IDs are entered on the <i>Network Configuration</i> screen.	Pre-Alarm IDREPEATPALM 
Oil Pressure Sender Fail	TRUE when the Oil Pressure Sender Fail is configured as a Pre-Alarm and the activation delay has expired.	Pre-Alarm OILPRESSENDFAILPALM 
Voltage Sensing Fail	TRUE when the Voltage Sensing Fail is configured as a Pre-Alarm and the activation delay has expired.	Pre-Alarm VOLTSENSFAILPALM 
Weak Battery	TRUE when the Weak Battery Voltage Pre-Alarm settings have been exceeded.	Pre-Alarm WEAKBATPALM 

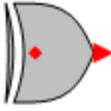
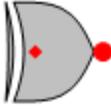
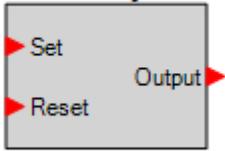
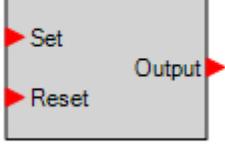
Name	Description	Symbol
Senders		
Coolant Temp Sender Fail	TRUE when the Coolant Temp Sender Fail is configured as either a Pre-Alarm or Alarm and the activation delay has expired.	Sender Fail COOLTEMPSENFAIL
Fuel Level Sender Fail	TRUE when the Fuel Level Sender Fail is configured as either a Pre-Alarm or Alarm and the activation delay has expired.	Sender Fail FUELLESENDFAIL
Oil Pressure Sender Fail	TRUE when the Oil Pressure Sender Fail is configured as either a Pre-Alarm or Alarm and the activation delay has expired.	Sender Fail OILPRESSENFAIL
Speed Sender Fail	TRUE when the Speed Sender Fail activation delay has expired.	Sender Fail SPDSENFAIL
Voltage Sensing Fail	TRUE when the Voltage Sensing Fail is configured as either a Pre-Alarm or Alarm and the activation delay has expired.	Sender Fail VOLTSSENFAIL
Logic Control Relays		
<i>Inputs</i> Input 1-16	Additional logic inputs. TRUE when the associated Logic Control Relay Output is TRUE.	LCR Input LCRINPUT1
<i>Outputs</i> Output 1-16	Additional logic outputs.	LCR Output LCROUTPUT1

Components

This group contains Logic Gates, Pickup and Dropout Timers, Latches, and Comment Blocks. Table 5-2 lists the names and descriptions of the objects in the *Components* group.

Table 5-2. Components Group, Names and Descriptions

Name	Description	Symbol										
Logic Gates												
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Input	Output											
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0 1	0											
1 0	0											
1 1	1											
NAND	<table border="1"> <thead> <tr> <th>Input</th> <th>Output</th> </tr> </thead> <tbody> <tr> <td>0 0</td> <td>1</td> </tr> <tr> <td>0 1</td> <td>1</td> </tr> <tr> <td>1 0</td> <td>1</td> </tr> <tr> <td>1 1</td> <td>0</td> </tr> </tbody> </table>	Input	Output	0 0	1	0 1	1	1 0	1	1 1	0	
Input	Output											
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0 1	1											
1 0	1											
1 1	0											
OR	<table border="1"> <thead> <tr> <th>Input</th> <th>Output</th> </tr> </thead> <tbody> <tr> <td>0 0</td> <td>0</td> </tr> <tr> <td>0 1</td> <td>1</td> </tr> <tr> <td>1 0</td> <td>1</td> </tr> <tr> <td>1 1</td> <td>1</td> </tr> </tbody> </table>	Input	Output	0 0	0	0 1	1	1 0	1	1 1	1	
Input	Output											
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0 1	1											
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NOR	<table border="1"> <thead> <tr> <th>Input</th> <th>Output</th> </tr> </thead> <tbody> <tr> <td>0 0</td> <td>1</td> </tr> <tr> <td>0 1</td> <td>0</td> </tr> <tr> <td>1 0</td> <td>0</td> </tr> <tr> <td>1 1</td> <td>0</td> </tr> </tbody> </table>	Input	Output	0 0	1	0 1	0	1 0	0	1 1	0	
Input	Output											
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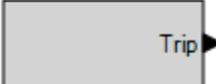
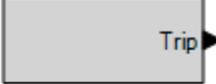
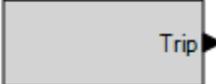
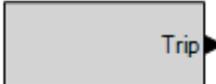
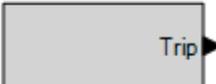
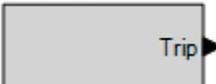
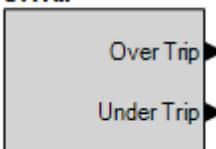
Name	Description	Symbol										
XOR	<table border="1"> <thead> <tr> <th>Input</th> <th>Output</th> </tr> </thead> <tbody> <tr> <td>0 0</td> <td>0</td> </tr> <tr> <td>0 1</td> <td>1</td> </tr> <tr> <td>1 0</td> <td>1</td> </tr> <tr> <td>1 1</td> <td>0</td> </tr> </tbody> </table>	Input	Output	0 0	0	0 1	1	1 0	1	1 1	0	
Input	Output											
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XNOR	<table border="1"> <thead> <tr> <th>Input</th> <th>Output</th> </tr> </thead> <tbody> <tr> <td>0 0</td> <td>1</td> </tr> <tr> <td>0 1</td> <td>0</td> </tr> <tr> <td>1 0</td> <td>0</td> </tr> <tr> <td>1 1</td> <td>1</td> </tr> </tbody> </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 border="1"> <thead> <tr> <th>Input</th> <th>Output</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> </tr> </tbody> </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.	Drop Out Timer (1) TIMER_1 Delay = 1 										
Pickup Up Timer	Used to set a delay in the logic.	Pick Up Timer (1) TIMER_1 Delay = 1 										
Latches												
Reset Priority Latch	A positive going edge on the Set input sets the latch, as long as the Reset input is false. A positive edge on the Reset input will clear the latch.	Reset Priority Latch 										
Set Priority Latch	A positive going edge on the Set input sets the latch. A positive going edge on the Reset input will clear the latch, as long as the Set input is false.	Set Priority Latch 										
Other												
Comment Block	Enter user comments.											

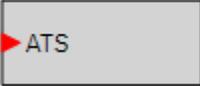
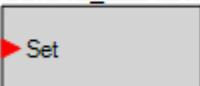
Elements

This group contains elements for the 51, 27, 47, 59, 81, 32, and 40. It also contains elements for Generator Breaker, AVR Raise/Lower, Governor Raise/Lower, Logic Alarm, Logic Pre-Alarm, Modem, Configurable Elements, AUTO Mode, OFF Mode, RUN Mode, Parallel to Mains, and Run with Load.

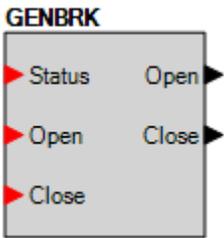
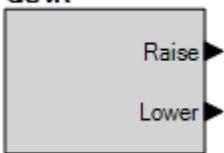
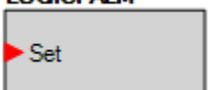
Table 5-3 lists the names and descriptions of the elements in the *Elements* group.

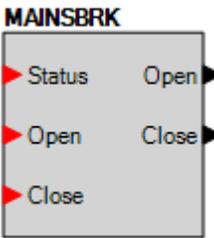
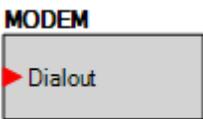
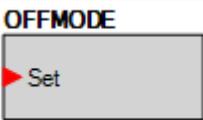
Table 5-3. Elements Group, Names and Descriptions

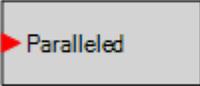
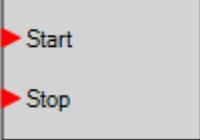
Name	Description	Symbol
Protection		
27-1TRIP	TRUE when the 27-1 undervoltage is in a TRIP condition. Connect to another logic block input.	27-1TRIP 
27-2TRIP	TRUE when the 27-2 undervoltage is in a TRIP condition. Connect to another logic block input.	27-2TRIP 
32TRIP	TRUE when the 32 reverse power is in a TRIP condition. Connect to another logic block input.	32TRIP 
40TRIP	TRUE when the 40Q loss of excitation is in a TRIP condition. Connect to another logic block input.	40TRIP 
47TRIP (Optional)	TRUE when the 47 phase imbalance is in a TRIP condition. Connect to another logic block input.	47TRIP 
51-1TRIP (Optional)	TRUE when the 51-1 overcurrent is in a TRIP condition. Connect to another logic block input.	51-1TRIP 
51-2TRIP (Optional)	TRUE when the 51-2 overcurrent is in a TRIP condition. Connect to another logic block input.	51-2TRIP 
51-3TRIP (Optional)	TRUE when the 51-3 overcurrent is in a TRIP condition. Connect to another logic block input.	51-3TRIP 
59-1TRIP	TRUE when the 59-1 overvoltage is in a TRIP condition. Connect to another logic block input.	59-1TRIP 
59-2TRIP	TRUE when the 59-2 overvoltage is in a TRIP condition. Connect to another logic block input.	59-2TRIP 
81TRIP	TRUE when the 81 frequency is in a TRIP condition. Connect to another logic block input.	81TRIP 

Name	Description	Symbol
Other		
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 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 is in AUTO mode, the generator will cool down and stop.	ATS 
AUTOMODE	When this input is TRUE, and the DGC-2020 is in OFF mode, the DGC-2020 will switch to AUTO mode. This is a pulsed input. It does not need to be held after the desired mode switch has occurred.	AUTOMODE 
AVR	Can be connected to inputs of other logic blocks. When the AVR is being raised, the Raise output is TRUE. When being lowered, the Lower output is TRUE.	AVR 
CONFELMNTX (X = 1 to 8)	Configurable elements (CONFELMNT1-8) are connected to the logic scheme as outputs. These elements are configurable in BESTCOMSPiPlus 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.	CONFELMNT1 CONFIG_ELEMENT_1 
COOLSTOPREQ	<p><u>RUN Mode</u></p> <p>If the unit is in RUN mode when the Cool Stop Request is received, the unit will unload, open its breaker, and go into a cooldown cycle. While in the cooldown cycle, the unit will display "COOL & STOP REQ" in addition to displaying the cooldown timer. After the cooldown timer expires, the unit will go to OFF mode. The Cool Stop Request must be removed before the unit can be run again.</p> <p>If the Cool Stop Request is removed during the cooldown process, the unit will remain running. Furthermore, if a condition occurs that normally causes the unit to close its breaker in RUN mode, the unit will close its breaker and reload.</p> <p><u>AUTO Mode</u></p> <p>If the unit is in AUTO mode when the Cool Stop Request is received, all conditions that would normally cause the unit to run in AUTO mode are cleared. Since all conditions that cause the unit to run have been removed, the unit goes into a cooldown cycle. While in the cooldown cycle, the unit will display "COOL & STOP REQ" in addition to displaying the cooldown timer. After the cooldown timer expires, the unit will shut down, remaining in AUTO. The Cool Stop Request must be removed before the unit can be run again.</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>	COOLSTOPREQ 

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>COOLDOWNREQ</p> 
ENGINE RUN	<p>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.</p>	<p>ENGINE RUN</p> 
EXTSTARTDEL	<p>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.</p>	<p>EXTSTARTDEL</p> 

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>	 <p>The GENBRK symbol is a rectangular box with three red triangles on the left side pointing into the box, representing inputs. On the right side, there are two black triangles pointing out of the box, representing outputs. The top input is labeled 'Status' and is associated with the output 'Open'. The middle input is labeled 'Open' and is associated with the output 'Close'. The bottom input is labeled 'Close'.</p>
GOVR	<p>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.</p>	 <p>The GOVR symbol is a rectangular box with two black triangles on the right side pointing out of the box, representing outputs. The top output is labeled 'Raise' and the bottom output is labeled 'Lower'.</p>
LOGICALM	<p>When this input is TRUE, the DGC-2020 goes into an Alarm condition.</p>	 <p>The LOGICALM symbol is a rectangular box with one red triangle on the left side pointing into the box, representing an input labeled 'Set'.</p>
LOGICPALM	<p>When this input is TRUE, the DGC-2020 goes into a Pre-alarm condition.</p>	 <p>The LOGICPALM symbol is a rectangular box with one red triangle on the left side pointing into the box, representing an input labeled 'Set'.</p>

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>The symbol for MAINSBRK is a rectangular box with the title 'MAINSBRK' at the top. On the left side, there are three red triangles pointing right, labeled 'Status', 'Open', and 'Close' from top to bottom. On the right side, there are two black triangles pointing right, labeled 'Open' and 'Close' from top to bottom.</p>
MODEM (Optional)	Connect the input to the output of another logic block. When TRUE, the Modem will dial out.	 <p>The symbol for MODEM is a rectangular box with the title 'MODEM' at the top. On the left side, there is one red triangle pointing right, labeled 'Dialout'.</p>
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.	 <p>The symbol for OFFMODE is a rectangular box with the title 'OFFMODE' at the top. On the left side, there is one red triangle pointing right, labeled 'Set'.</p>

Name	Description	Symbol
PARTOMAINS	<p>Setting this logic element to TRUE indicates to the DGC-2020 that it is paralleled to a utility.</p> <p>When paralleled to the utility, the Kw controller will regulate the machine's KW output at the Base Load Level (%) that is set on the <i>Governor Bias Control Settings</i> screen, where the Base Load Level is in percent of machines rated KW. Otherwise, the KW controller will implement KW load sharing when part of a load sharing system. If a load sharing system is not implemented, the speed controller can be set up to implement speed droop.</p> <p>When paralleled to the utility, the Var/PF controller will regulate the machine's reactive power output according to the control mode setting. If the control mode is Var Controller, the output will be regulated to the Kvar Setpoint (%) that is set on the <i>AVR Bias Control Settings</i> screen, where the Kvar Setpoint (%) is in percentage of the machines rated Kvar. If the control mode is PF Control, the reactive power output is regulated to a level that maintains the machines power factor at the value specified by the PF setting on the <i>AVR Bias Control Settings</i> screen. When Var/PF control is not active or not enabled, the voltage controller can be set up to implement voltage droop.</p>	<p>PARTOMAINS</p> 
PRESTARTOUT	<p>This element is used to drive the prestart output relay from logic when the Prestart Output Relay configuration is set to "Programmable". When the Prestart Output Relay configuration is set to "Programmable", the prestart relay will not close unless logic is used to drive this element. When the Prestart Output Relay configuration is set to "Predefined", the prestart relay is closed according to the predefined prestart functionality of the DGC-2020. When the "Predefined" functionality is selected, the relay will not respond to this element.</p>	<p>PRESTARTOUT</p> 
RUNINHIBIT	<p>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.</p>	<p>RUNINHIBIT</p> 
RUNMODE	<p>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.</p>	<p>RUNMODE</p> 
RUNOUTPUT	<p>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.</p>	<p>RUNOUTPUT</p> 
RUNWLOAD	<p>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.</p>	<p>RUNWLOAD</p> 
STARTDELBYP	<p>This element allows the Pre Start state to be skipped based on logic. For example, a start delay may not be necessary when the engine is warm. This also allows an external device, such as an ECO, to control the pre start interval.</p>	<p>STARTDELBYP</p> 

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.	
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.	

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 BESTCOMSPi.us and then typing over the logic scheme's name. Changes are not activated until the new settings have been saved and uploaded to the device.

Sending and Retrieving Logic Schemes

Retrieving a Logic Scheme from the DGC-2020

To retrieve settings from the DGC-2020, the DGC-2020 must be connected to a computer through a communications port. Once the necessary connections are made, settings can be downloaded from the DGC-2020 by selecting *Download Settings* on the Communication pull-down menu.

Sending a Logic Scheme to the DGC-2020

To send settings to the DGC-2020, the DGC-2020 must be connected to a computer through a communications port. Once the necessary connections are made, settings can be uploaded to the DGC-2020 by selecting *Upload Settings* on the Communication pull-down menu.

CAUTION

Always remove the DGC-2020 from service prior to changing or modifying the active logic scheme. Attempting to modify a logic scheme while the DGC-2020 is in service could generate unexpected or unwanted outputs.

CAUTION

Modifying a logic scheme in BESTCOMSPlus does not automatically make that scheme active in the DGC-2020. The modified scheme must be uploaded into the DGC-2020. See the paragraphs on *Sending and Retrieving Logic Schemes* later in this section.

PROGRAMMING BESTlogic+

BESTCOMSPlus is used to program BESTlogic+. Using BESTCOMSPlus is analogous to physically attaching wire between discrete DGC-2020 terminals. To program BESTlogic+, use the Settings Explorer within BESTCOMSPlus to open the *BESTlogic+ 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 element is disabled, it will have a yellow X on it. To enable the element, navigate to the settings page for that element.

The view of the Main Logic, Physical Outputs, and Remote Outputs can be automatically arranged by clicking the right mouse button on the window and selecting *Auto-Layout*.

The following must be met before BESTCOMSPlus will allow logic to be uploaded to the DGC-2020:

- A minimum of two inputs and a maximum of four inputs on any multi-port (AND, OR, NAND, NOR, XOR, and XNOR) gate.
- A maximum of five logic levels for any particular path. A path being an input block or an output side of an element block through gates to an output block or an input side of an element block. This is to include any OR gates on the Physical Output or Remote Output tab/pages, but not the matched pairs of Physical Output blocks or Remote Output blocks.
- Only ten 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.
- At all levels there can only be 64 used link/wired or endpoints. Endpoints being inputs, outputs, both sides of element blocks.

Three status LEDs are located in the lower right corner of the BESTlogic+ window. These LEDs show the *Logic Save Status*, *Logic Diagram Status*, and *Logic Layer Status*. Table 5-4 defines the colors for each LED.

Table 5-4. Status LEDs

LED	Color	Definition
Logic Save Status (Left LED)	Yellow	Logic has changed since last save.
	Green	Logic has NOT changed since last save.
Logic Diagram Status (Center LED)	Red	Requirements NOT met as listed above.
	Green	Requirements met as listed above.
Logic Layer Status (Right LED)	Red	Requirements NOT met as listed above.
	Green	Requirements met as listed above.

Pickup and Dropout Timers

A pickup timer produces a TRUE output when the elapsed time is greater than or equal to the Pickup Time setting after a FALSE to TRUE transition occurs on the Initiate input from the connected logic. Whenever the Initiate input status transitions to FALSE, the output transitions to FALSE immediately.

A drop out timer produces a TRUE output when the elapsed time is greater than or equal to the Dropout Time setting after a TRUE to FALSE transition occurs on the Initiate input from the connected logic. Whenever the Initiate input transitions to TRUE, the output transitions to FALSE immediately.

Refer to Figure 5-2, Pickup and Dropout Logic Timer Blocks.

To program logic timer settings, use the Settings Explorer within BESTCOMSPPlus to open the *BESTlogic+ 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 0.0 to 1800.0 seconds in 0.1-second increments.

Next, open the *Components* tab inside the BESTlogic+ window and drag a timer onto the program grid. Right click on the timer to select the timer you want to use that was previously set on the *Logic Timers* tree branch. The *Logic Timer Properties Dialog Box* will appear. Select the timer you want to use.

Timing accuracy is ± 15 milliseconds.

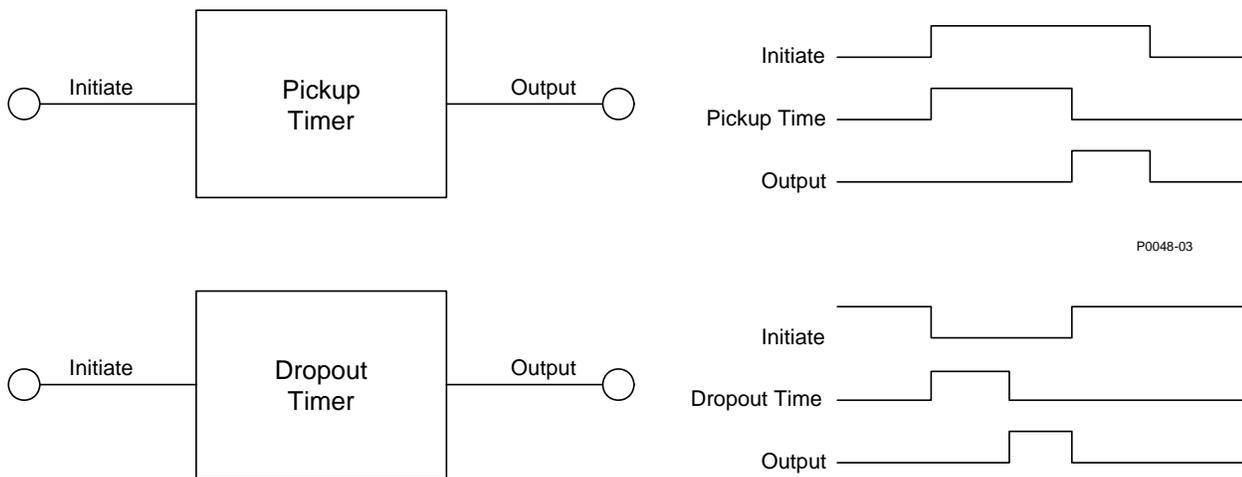


Figure 5-2. Pickup and Dropout Timer Logic Blocks

BESTlogic+ FILE MANAGEMENT

To manage BESTlogic+ files, use the Settings Explorer to open the *BESTlogic+ Programmable Logic* tree branch. The BESTlogic+ Programmable Logic toolbar is used to manage BESTlogic+ files. Refer to Figure 5-3. For information on Settings Files management, refer to Section 4, *BESTCOMSPPlus Software*.

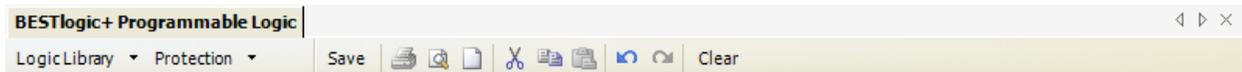


Figure 5-3. BESTlogic+ Programmable Logic Toolbar

Saving a BESTlogic+ File

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

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

The user also has the option to save the BESTlogic+ settings to a unique file that contains only BESTlogic+ 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+ File

To open a saved BESTlogic+ file, click on the *Logic Library* drop-down button on the BESTlogic+ 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+ 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+ File

To upload a BESTlogic+ 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+ File

To download a BESTlogic+ 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+ File

To view a preview of the printout, click on the *Print Preview* icon located on the BESTlogic+ Programmable Logic toolbar. If you wish to print to a printer, select the printer icon in the upper left corner of the *Print Preview* screen.

You may skip the print preview and go directly to print by clicking on the *Printer* icon on the BESTlogic+ Programmable Logic toolbar. A dialog box, *Select Views to Print* opens allowing you to check which views you would like to print. Next, the *Print* dialog box opens with the typical Windows[®] choice to setup the properties of printer. Execute this command, as necessary, and then select *Print*.

A *Page Setup* icon is also provided on the BESTlogic+ Programmable Logic toolbar allowing you to select *Paper Size*, *Paper Source*, *Orientation*, and *Margins*.

Clearing the On-Screen Logic Diagram

Click on the *Clear* button to clear the on-screen logic diagram and start over.

BESTlogic+ EXAMPLES

Example 1 - AVR Logic Block Connections

Figure 5-4 illustrates the AVR logic block and two output logic blocks. Output 6 is active while the AVR is being raised and Output 9 is active while the AVR is being lowered.

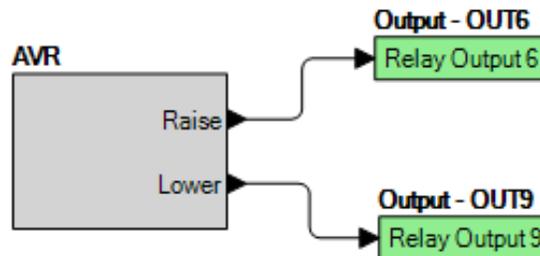


Figure 5-4. Example 1 - AVR Logic Block Connections

Example 2 - AND Gate Connections

Figure 5-5 illustrates a typical AND gate connection. In this example, Output 11 will become active when the Low Fuel alarm AND the Low Oil Pressure alarm are TRUE.

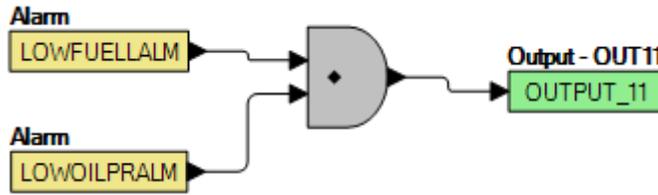


Figure 5-5. Example 2 - AND Gate Connections

Example 3 - Multiple Logic Connections

In this example, there are two comment boxes, which may be placed on the logic diagram. Double-click a comment box to modify the inside text. Output 5 will become TRUE when the 27TRIP is TRUE. Output 7 will become TRUE when the Cool Temp Sender Fail is TRUE. Output 1 will become TRUE when the DGC-2020 is in RUN mode (RUN Mode TRUE). Refer to Figure 5-6.

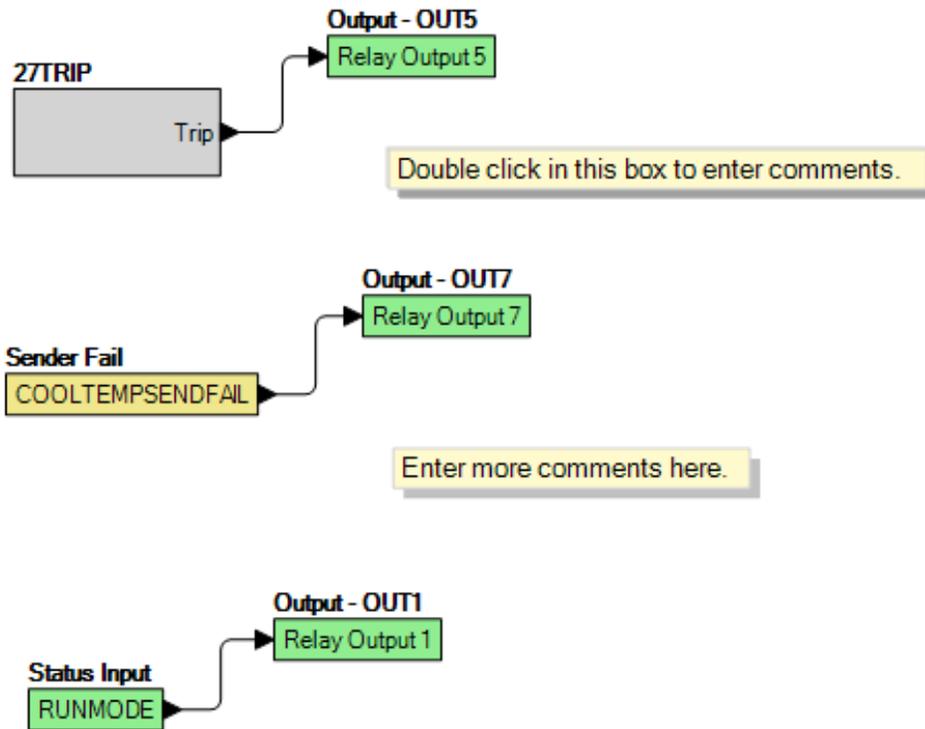


Figure 5-6. Example 3 - Multiple Logic Connections

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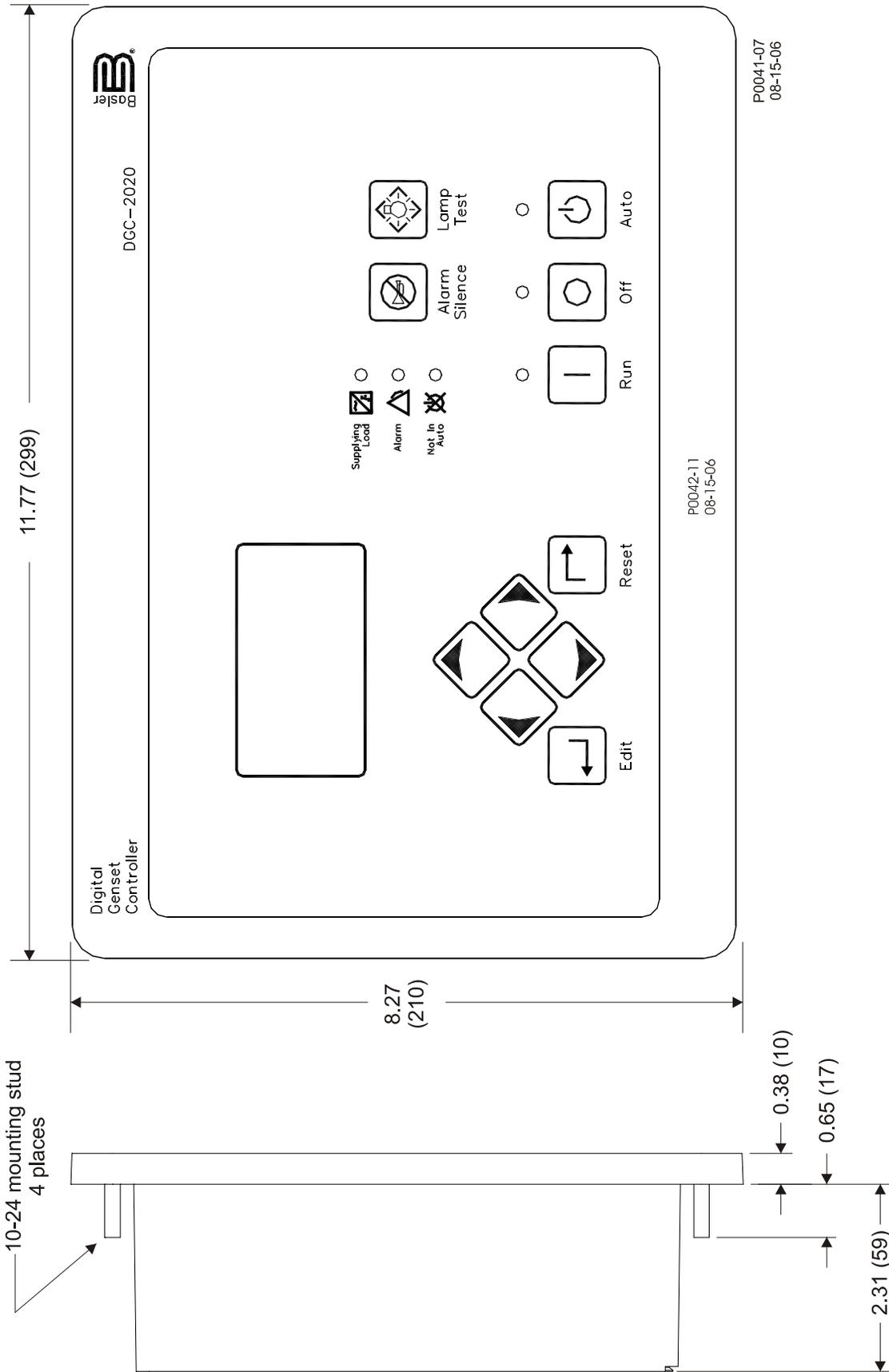


Figure 6-2. Overall Dimensions

CONNECTIONS

DGC-2020 connections are dependent on the application. Incorrect wiring may result in damage to the controller.

NOTE

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.

Terminations

All DGC-2020 terminals are located on the rear panel of the controller. There are three types of interface terminals: a mini-B USB socket, plug-in connectors with screw-down compression terminals, and quarter-inch, male, quick-connect terminals. Controllers equipped with the optional, internal dial-out modem have an additional RJ-11 jack.

The mini-B USB socket mates with a standard USB cable and provides local communication between the DGC-2020 and a PC running BESTCOMSPPlus 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 4 inch-pounds (0.45 N•m).

Connections to the DGC-2020 starter, fuel solenoid, and glow plug output contacts are made directly to each relay through quarter-inch, male, quick-connect terminals. Amp part numbers 154718-3 (positive-lock receptacle) and 154719-1 (nylon housing) are the recommended components for making connections at these terminals.

DGC-2020 terminal groups are described in the following paragraphs.

Operating Power

The DGC-2020 operating power input accepts either 12 Vdc or 24 Vdc and tolerates voltage over the range of 6 to 32 Vdc. Operating power must be of the correct polarity. Although reverse polarity will not cause damage, the DGC-2020 will not operate. Operating power terminals are listed in Table 6-1.

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

Table 6-1. Operating Power Terminals

Terminal	Description
1 (CHASSIS)	Chassis ground connection
2 (BATT-)	Negative side of operating power input
3 (BATT+)	Positive side of operating power input

Generator Current Sensing

The DGC-2020 has sensing inputs for A-phase, B-phase, and C-phase generator current. Depending on the style number, a DGC-2020 will have a nominal sensing current rating of 1 Aac or 5 Aac. A style number of 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 xxxxxxAx use bus voltage sensing to perform automatic synchronization of the generator with the bus (style number xxxxxxAx only). The DGC-2020 senses A-phase and B-phase bus voltage. Bus voltage sensing terminals are listed in Table 6-4.

Table 6-4. Bus Voltage Sensing Terminals

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

Analog Engine Sender Inputs

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

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

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

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

Sender input terminals are listed in Table 6-5.

Table 6-5. Sender Input Terminals

Terminal	Description
8 (OIL)	Oil pressure sender input
9 (FUEL)	Fuel level sender input
10 (COOLANT)	Coolant temperature sender input
11 (SENDER COM)	Sender return terminal

Emergency Stop Input

The emergency stop input is intended for use with a normally closed switch and recognizes an emergency stop input when the short-circuit across the input is removed. The ESTOP can be up to 75 ft away from the DGC-2020 using a maximum wire length of 150 ft. Emergency stop input terminals are listed in Table 6-6.

Table 6-6. Emergency Stop Input Terminals

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

NOTE

Units with a board number (located on back of the unit) lower than 9400201139 may experience problems associated with ESTOP wire lengths greater than 2 feet (0.6 m). An interposing relay, connected as shown in Figure 6-3, alleviates potential problems.

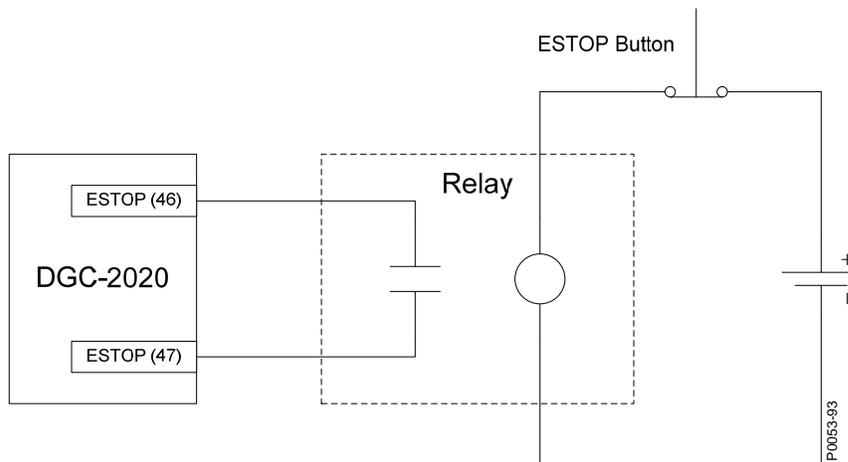


Figure 6-3. Interposing Relay Diagram

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

Magnetic Pickup Input

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

Table 6-7. Magnetic Pickup Input Terminals

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

Contact Sensing Inputs

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

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

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

Table 6-8. Contact Sensing Inputs

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

Output Contacts

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

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

Table 6-9. Programmable Output Contact Terminals

Terminal	Description
51 (COM 1, 2, 3)	Common connection for outputs 1, 2, and 3
52 (OUT 1)	Programmable output 1
53 (OUT 2)	Programmable output 2
54 (OUT 3)	Programmable output 3
55 (COM 4, 5, 6)	Common connection for outputs 4, 5, and 6
56 (OUT 4)	Programmable output 4
57 (OUT 5)	Programmable output 5
58 (OUT 6)	Programmable output 6
59 (COM 7, 8, 9)	Common connection for outputs 7, 8, and 9
60 (OUT 7)	Programmable output 7
61 (OUT 8)	Programmable output 8
62 (OUT 9)	Programmable output 9
63 (COM 10, 11, 12)	Common connection for outputs 10, 11, and 12
64 (OUT 10)	Programmable output 10
65 (OUT 11)	Programmable output 11
66 (OUT 12)	Programmable output 12

USB Interface

A mini-B USB socket enables local communication with a PC running BESTCOMSPPlus software. The DGC-2020 is connected to a PC using a standard USB cable equipped with a type A plug on one end (PC termination) and a mini-B plug on the other end (DGC-2020 termination).

RS-485 Communication Port

DGC-2020 controllers with the optional RS-485 communication port (style number xxxRxxxxx) are equipped for polled communication over a Modbus™ network. Twisted-pair, shielded cable is recommended for RS-485 port connections. RS-485 communication port terminals are listed in Table 6-10.

Table 6-10. RS-485 Communication Port Terminals

Terminal	Description
12 (485 SHIELD)	Shield connection for RS-485 cable
13 (485B)	RS-485 send/receive B connection
14 (485A)	RS-485 send/receive A connection

CANbus Interface

These terminals provide communication using the SAE J1939 protocol or the MTU protocol and provide high-speed communication between the DGC-2020 and an MTU engine ECU on an electronically controlled engine. Connections between the MTU engine ECU and DGC-2020 should be made with twisted-pair, shielded cable. CANbus interface terminals are listed in Table 6-11. Refer to Figure 6-4 and Figure 6-5.

Table 6-11. CANbus Interface Terminals

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

NOTES

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

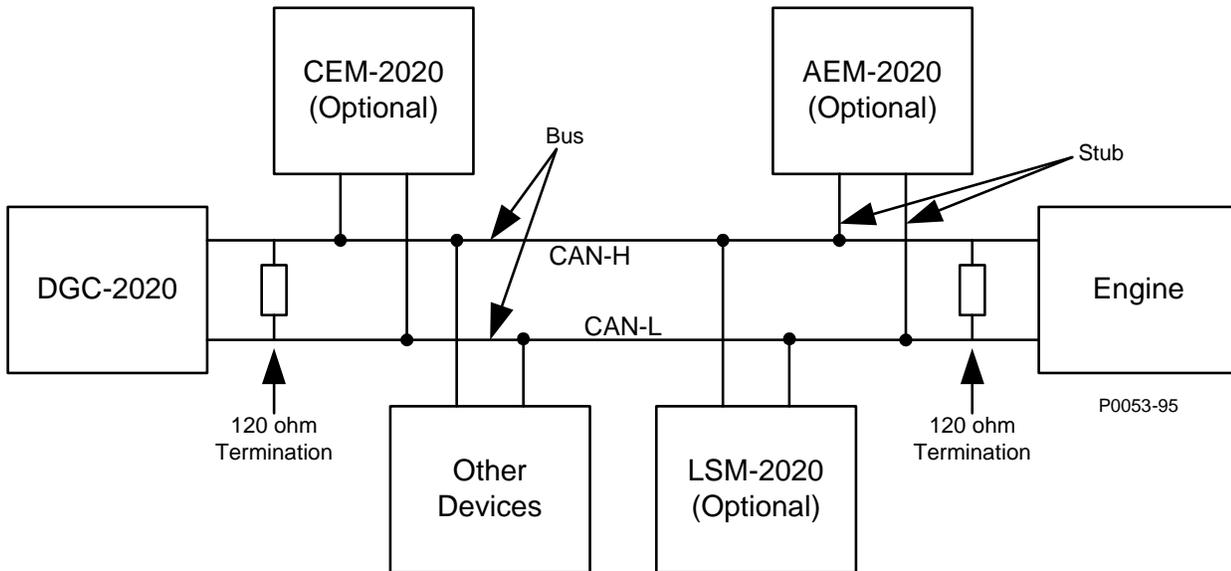


Figure 6-4. CANbus Interface with DGC-2020 providing One End of the Bus

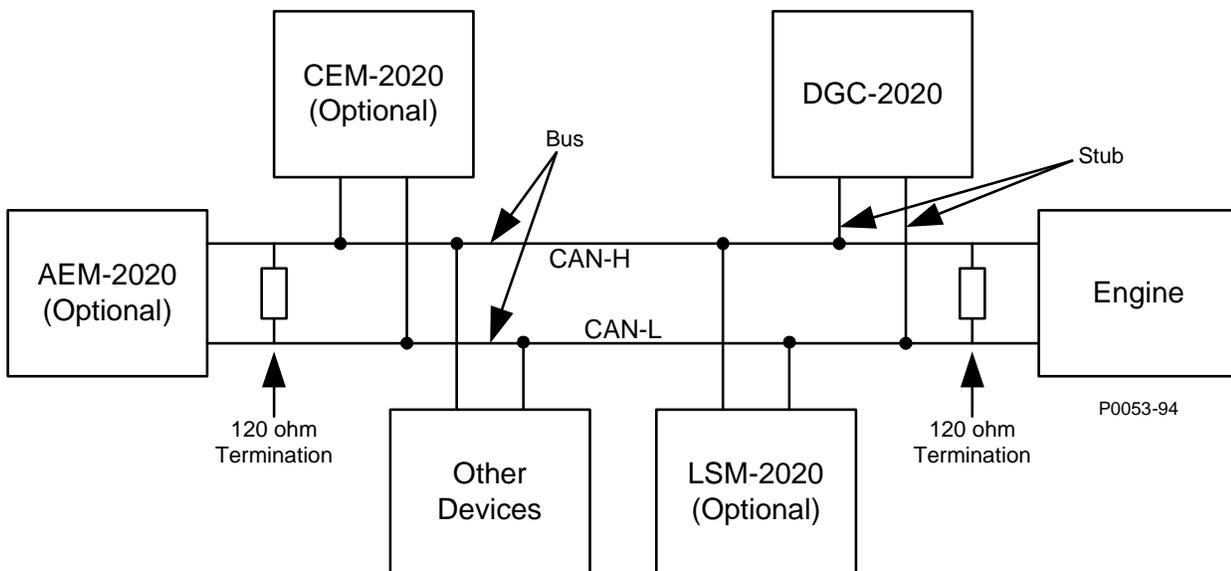


Figure 6-5. CANbus Interface with Optional AEM-2020 providing One End of the Bus

Dial-Out Modem

DGC-2020 controllers with style number xxxxxMxxx have an internal modem with dial-in, dial-out capability. The DGC-2020 connects to a standard-device telephone line through a USOC RJ-11C jack.

RDP-110 Connections

Terminals are provided for connection with the optional RDP-110 remote display panel. These terminals provide dc operating power to the RDP-110 and enable communication between the DGC-2020 and RDP-110. Twisted-pair conductors are recommended for connecting the communication terminals of the DGC-2020 and RDP-110.

Table 6-12 lists the DGC-2020 terminals that connect to the RDP-110.

Table 6-12. RDP-110 Interface Terminals

Terminal	Connects To:
4 (RDP BATT+)	RDP-110 terminal 12/24
5 (RDP BATT-)	RDP-110 terminal DC COM
6 (RDP TXD-)	RDP-110 terminal 485-
7 (RDP TXD+)	RDP-110 485+

Connections for Typical Applications

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

3-Phase Wye Connections for Typical Applications

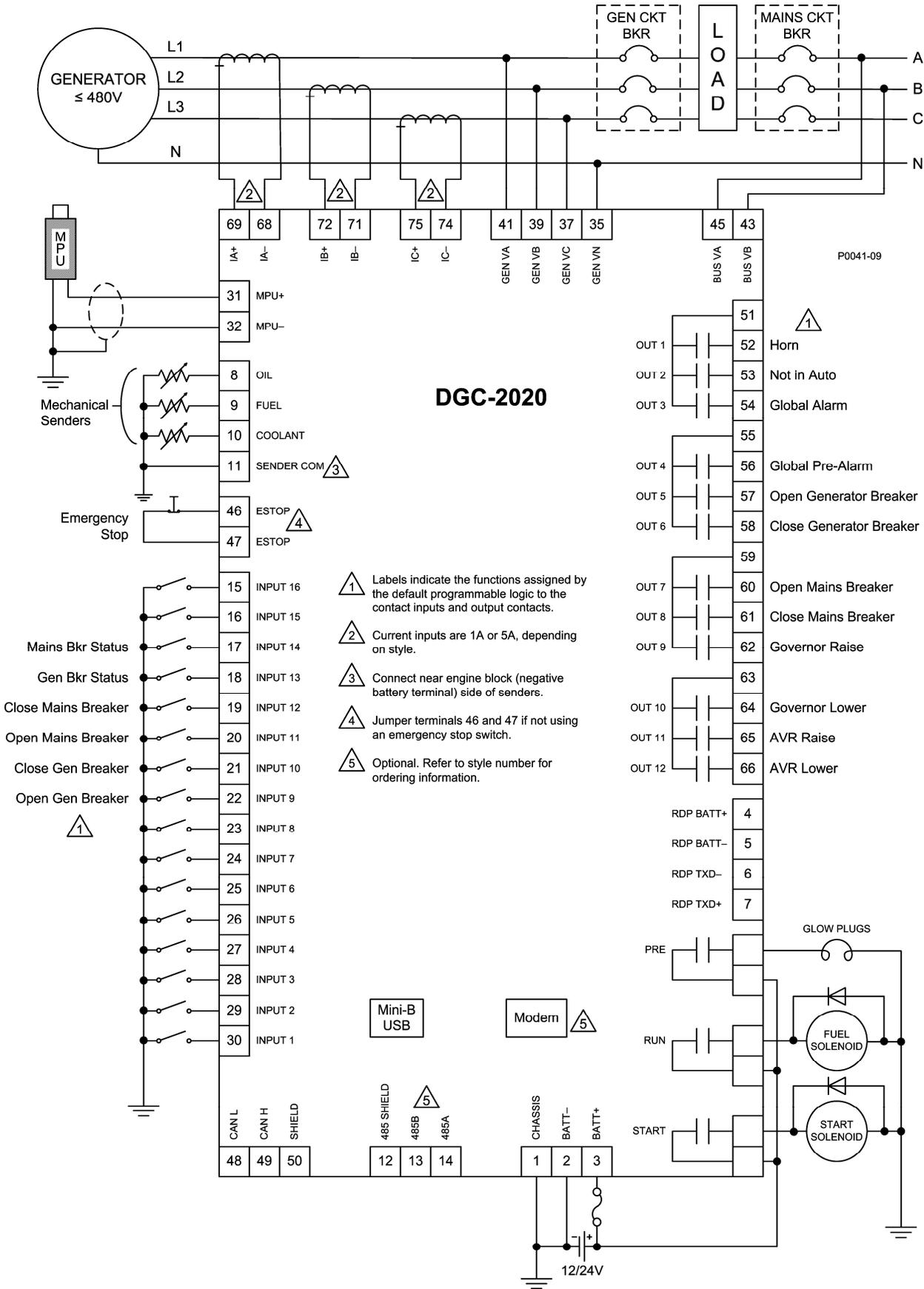


Figure 6-6. 3-Phase Wye Connections for Typical Applications

3-Phase Delta Connections for Typical Applications

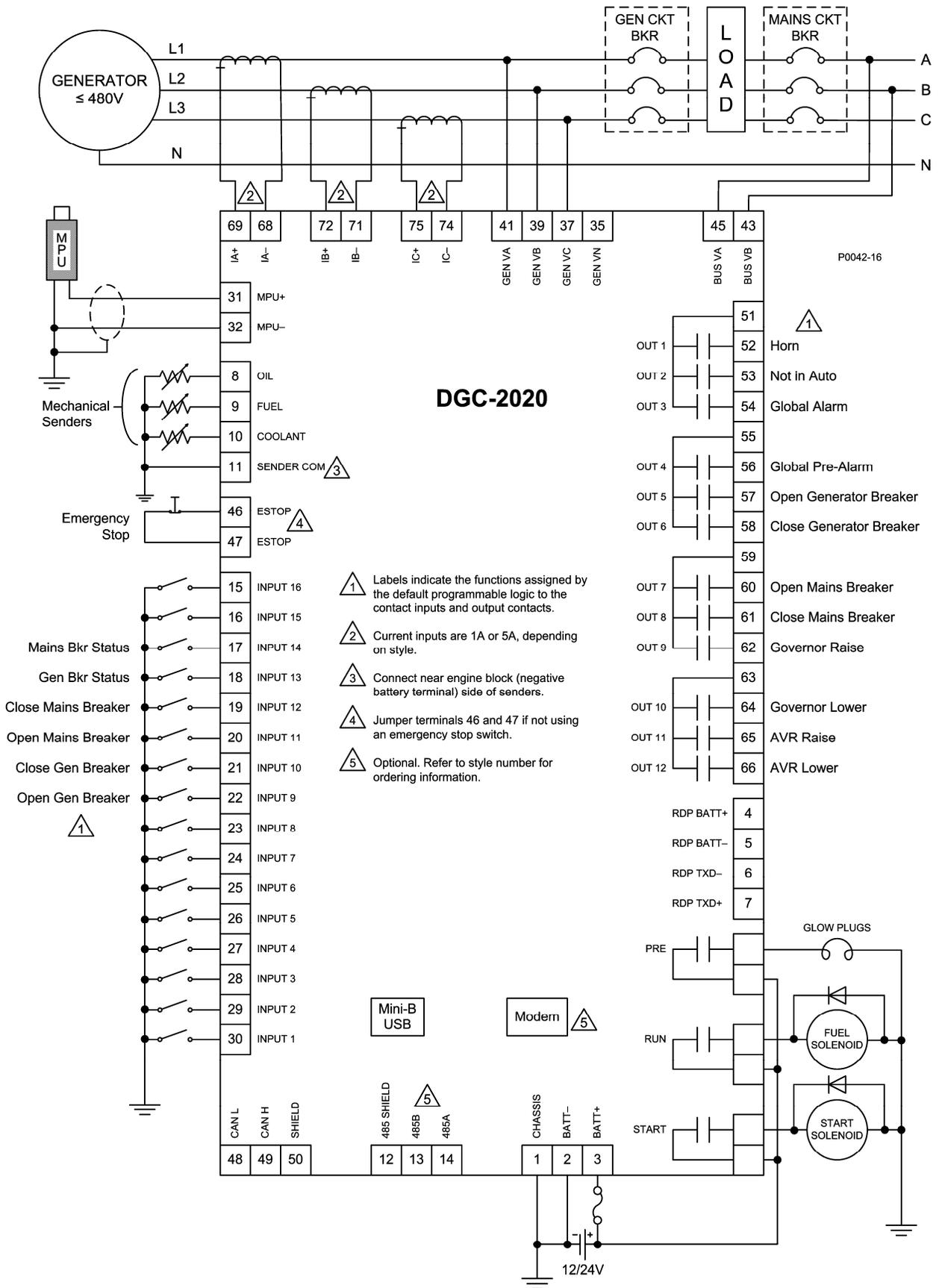


Figure 6-7. 3-Phase Delta Connections for Typical Applications

Single-Phase A-B Connections for Typical Applications

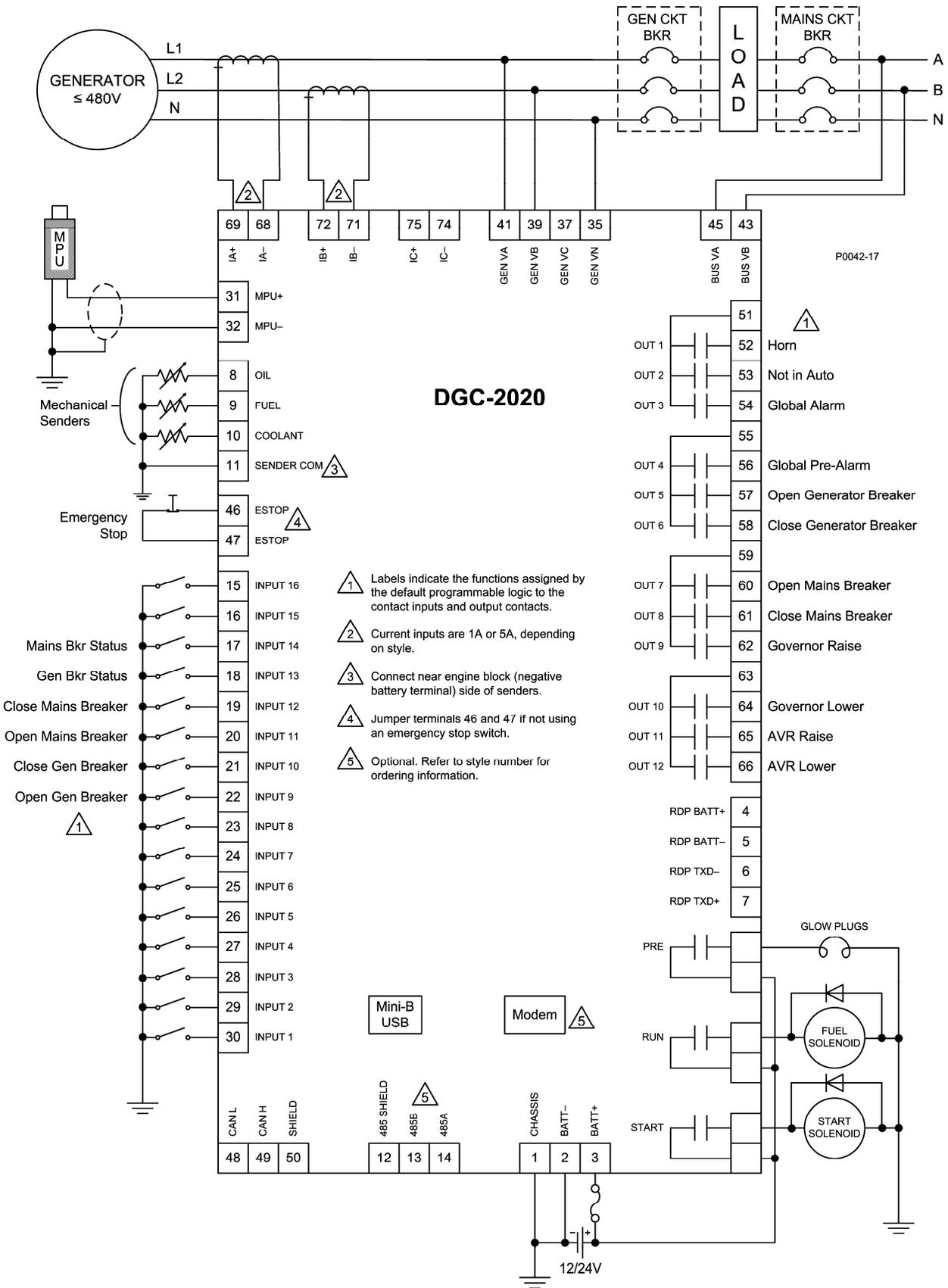


Figure 6-8. Single-Phase A-B Connections for Typical Applications

Single-Phase A-C Connections for Typical Applications

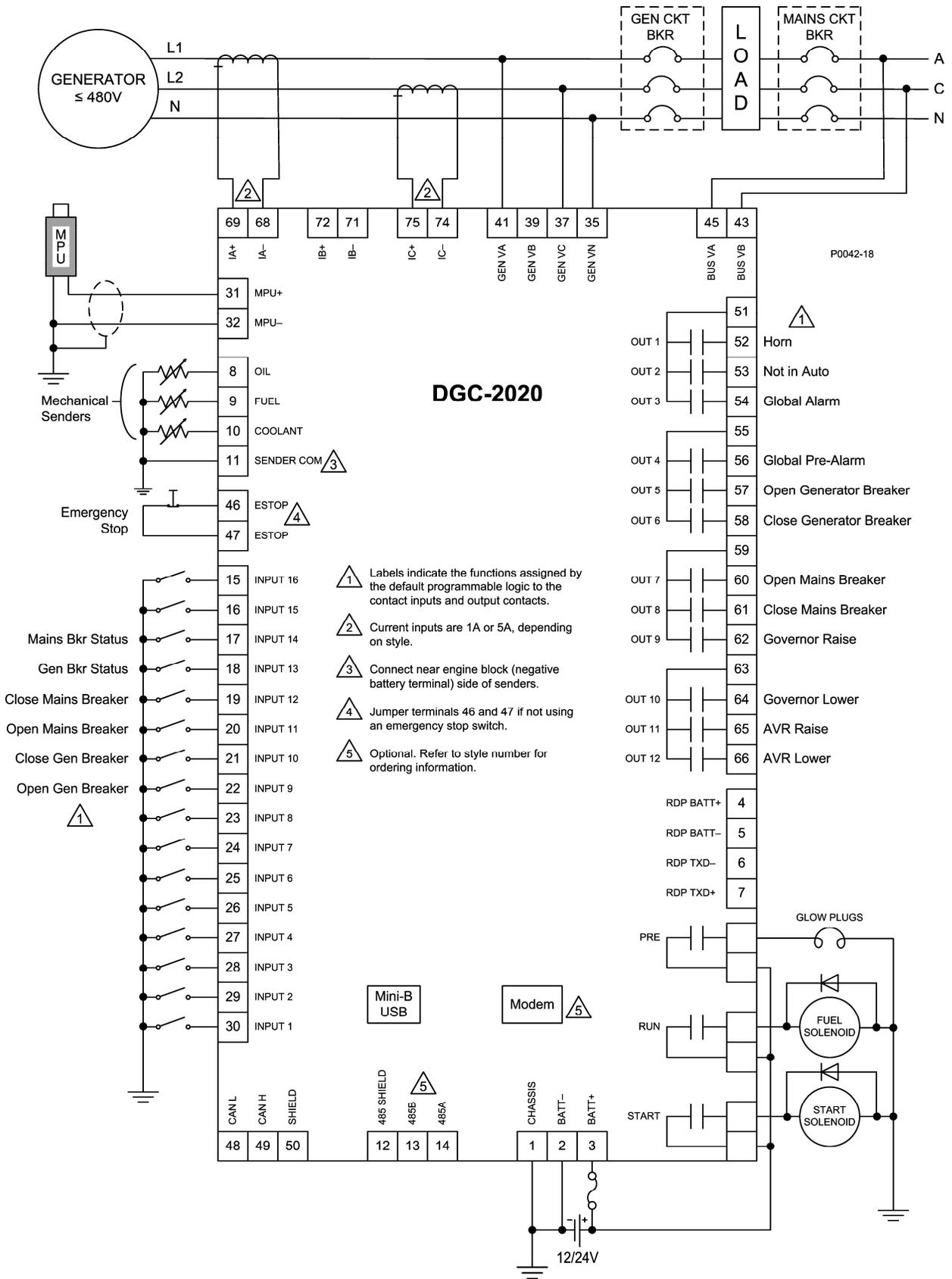


Figure 6-9. Single-Phase A-C Connections for Typical Applications

Connections for Volvo Penta EDC III Applications

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

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

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

- The J1939 address of the DGC-2020 must be set at 17.
- The engine start/stop configuration setting must be set for Volvo Penta.

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

3-Phase Wye Connections for Volvo Penta EDC III Applications

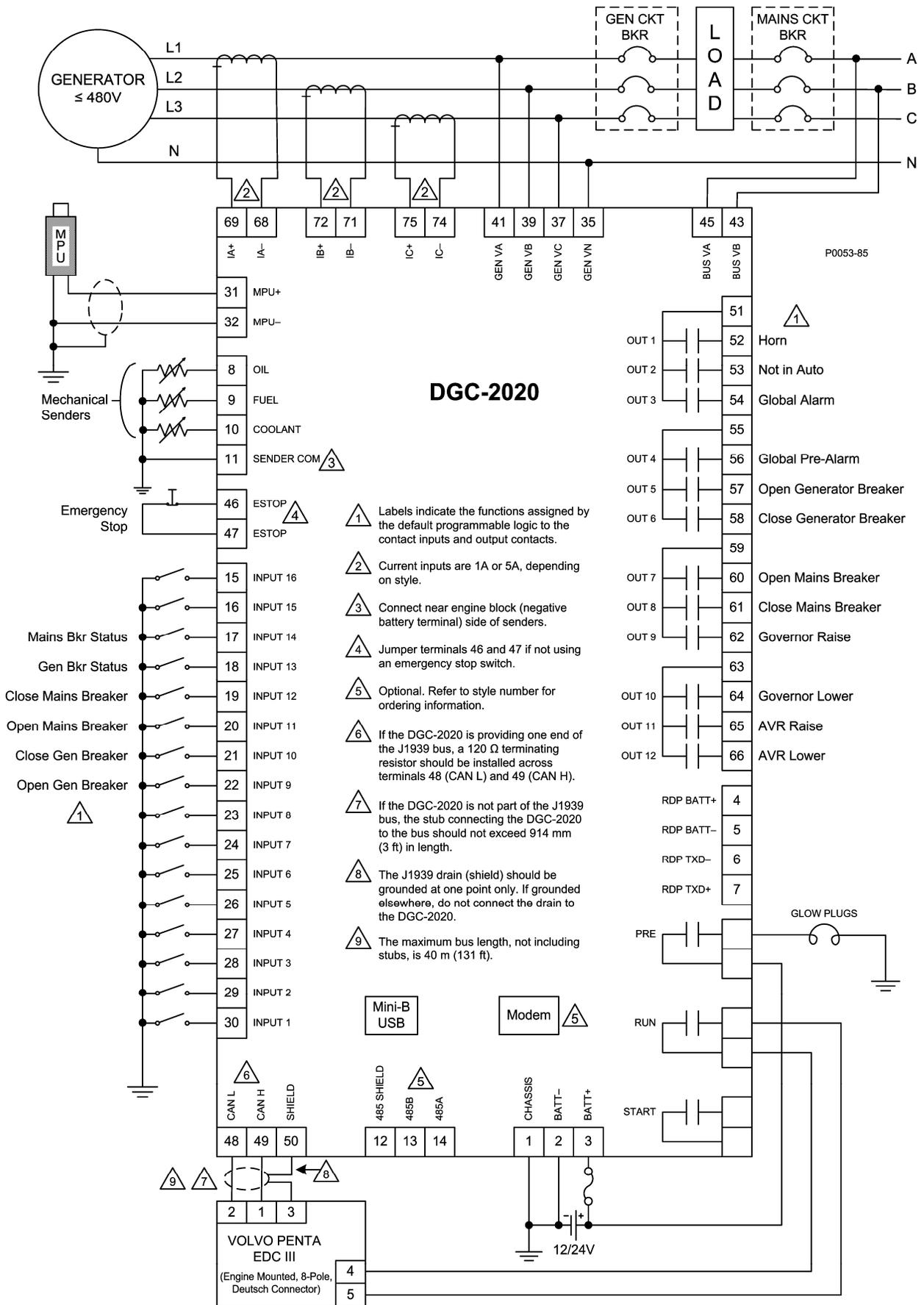


Figure 6-10. 3-Phase Wye Connections for Volvo Penta EDC III Applications

3-Phase Delta Connections for Volvo Penta EDC III Applications

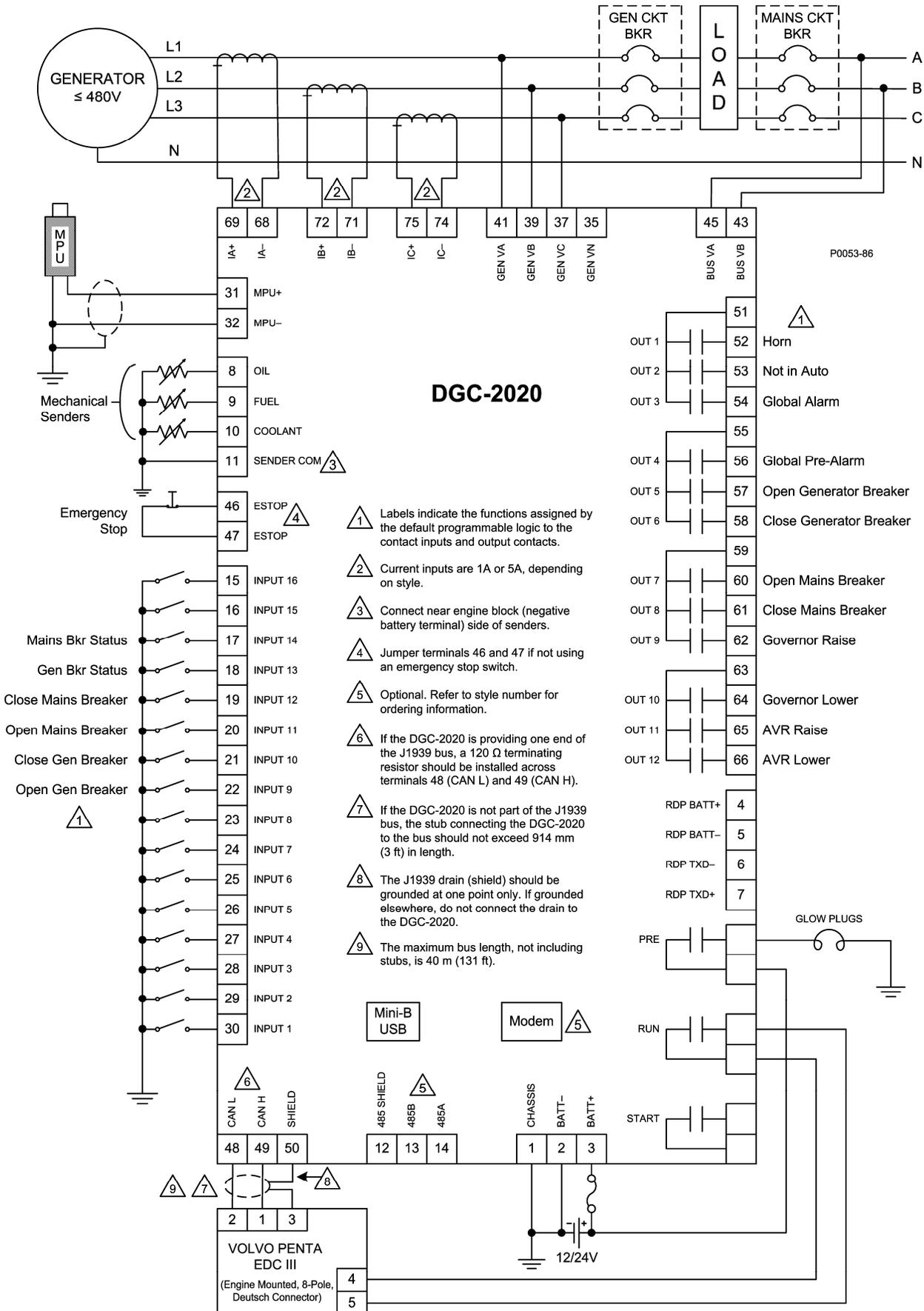


Figure 6-11. 3-Phase Delta Connections for Volvo Penta EDC III Applications

Single-Phase A-B Connections for Volvo Penta EDC III Applications

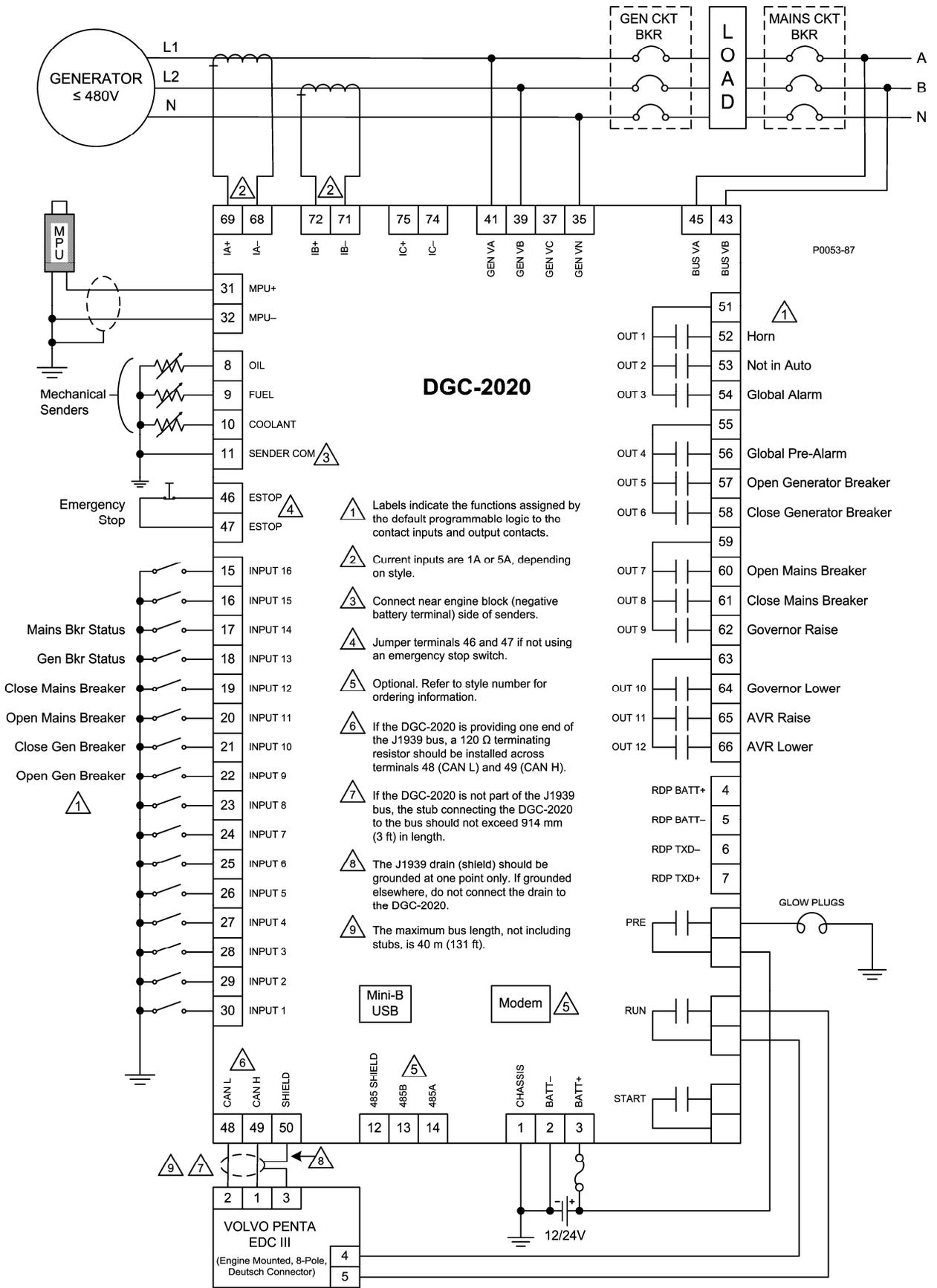


Figure 6-12. Single-Phase A-B Connections for Volvo Penta EDC III Applications

Single-Phase A-C Connections for Volvo Penta EDC III Applications

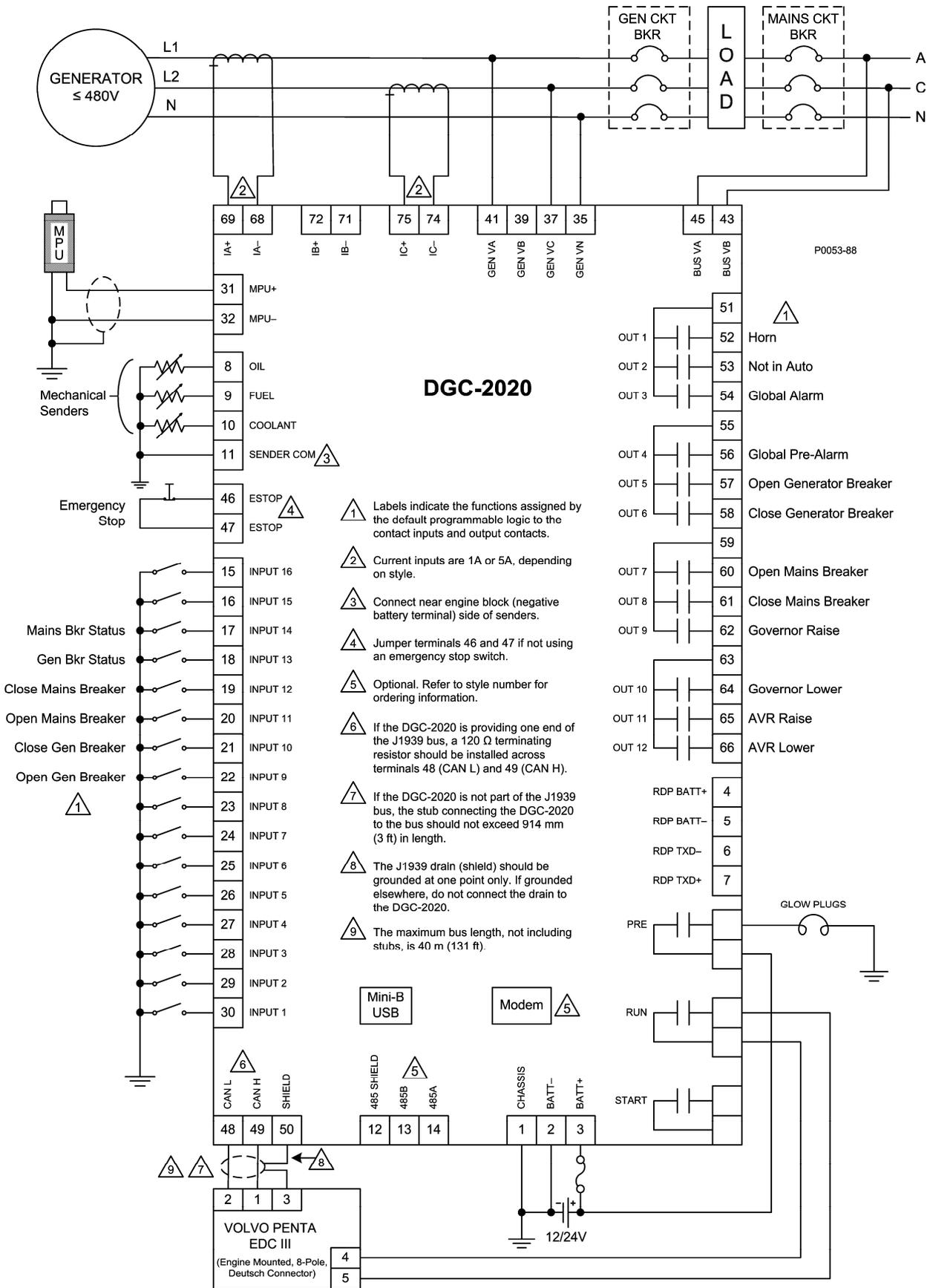


Figure 6-13. Single-Phase A-C Connections for Volvo Penta EDC III Applications

Connections for MTU MDEC ECU Applications

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

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

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

Table 6-13. MTU MDEC ECU Configuration Parameters

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

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

3-Phase Wye Connections for MTU MDEC ECU Applications

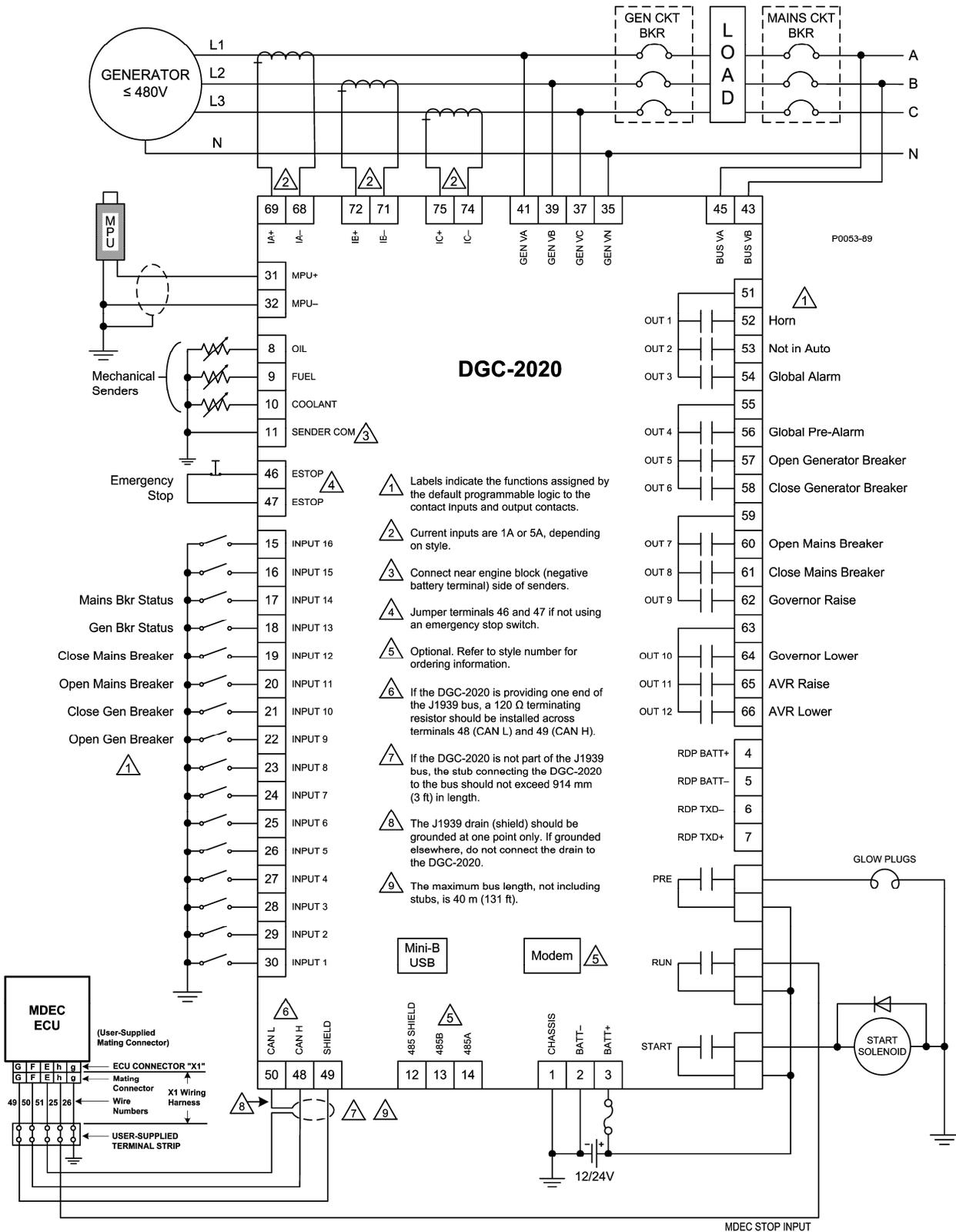


Figure 6-14. 3-Phase Wye Connections for MTU MDEC ECU Applications

3-Phase Delta Connections for MTU MDEC ECU Applications

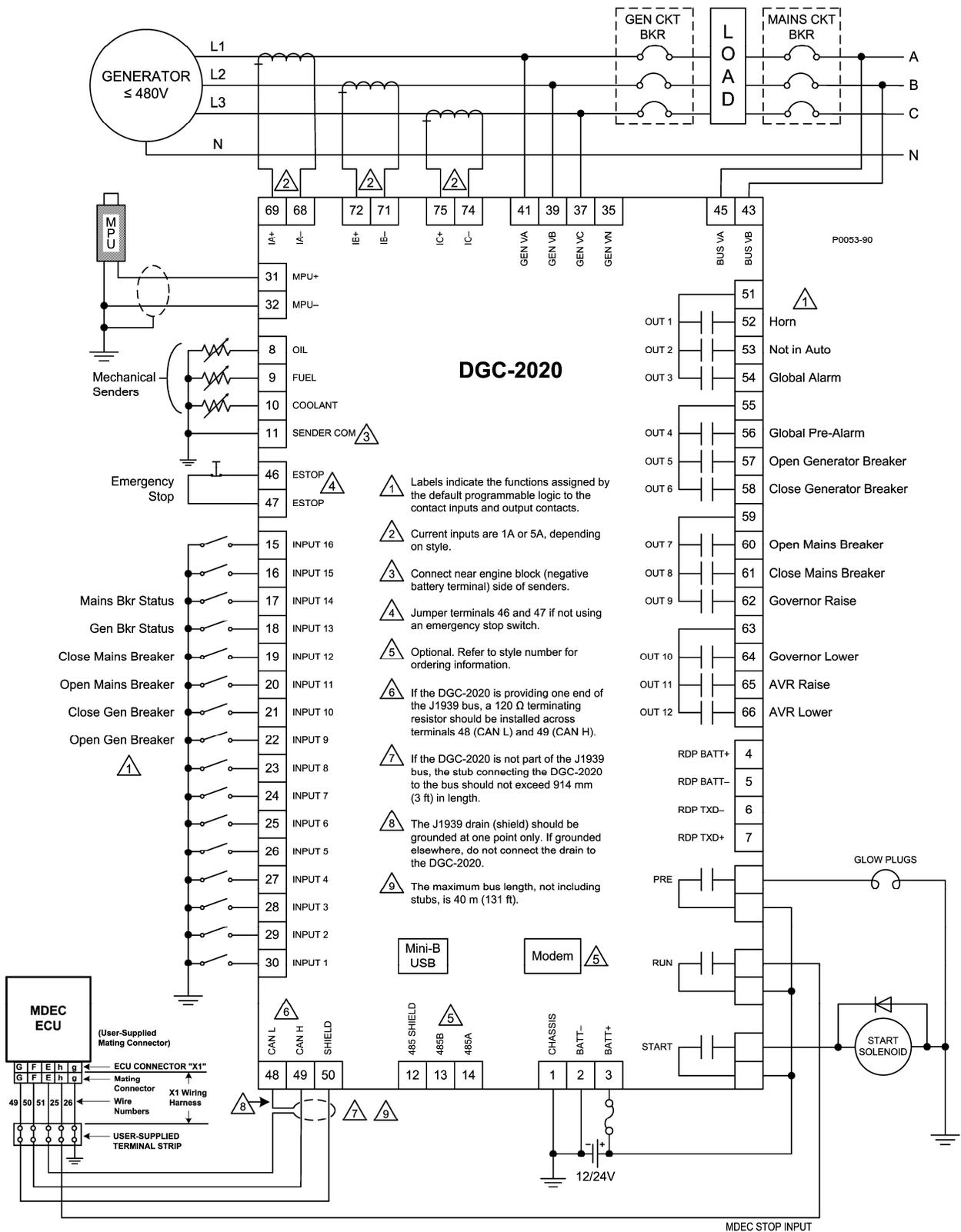


Figure 6-15. 3-Phase Delta Connections for MTU MDEC ECU Applications

Single-Phase A-B Connections for MTU MDEC ECU Applications

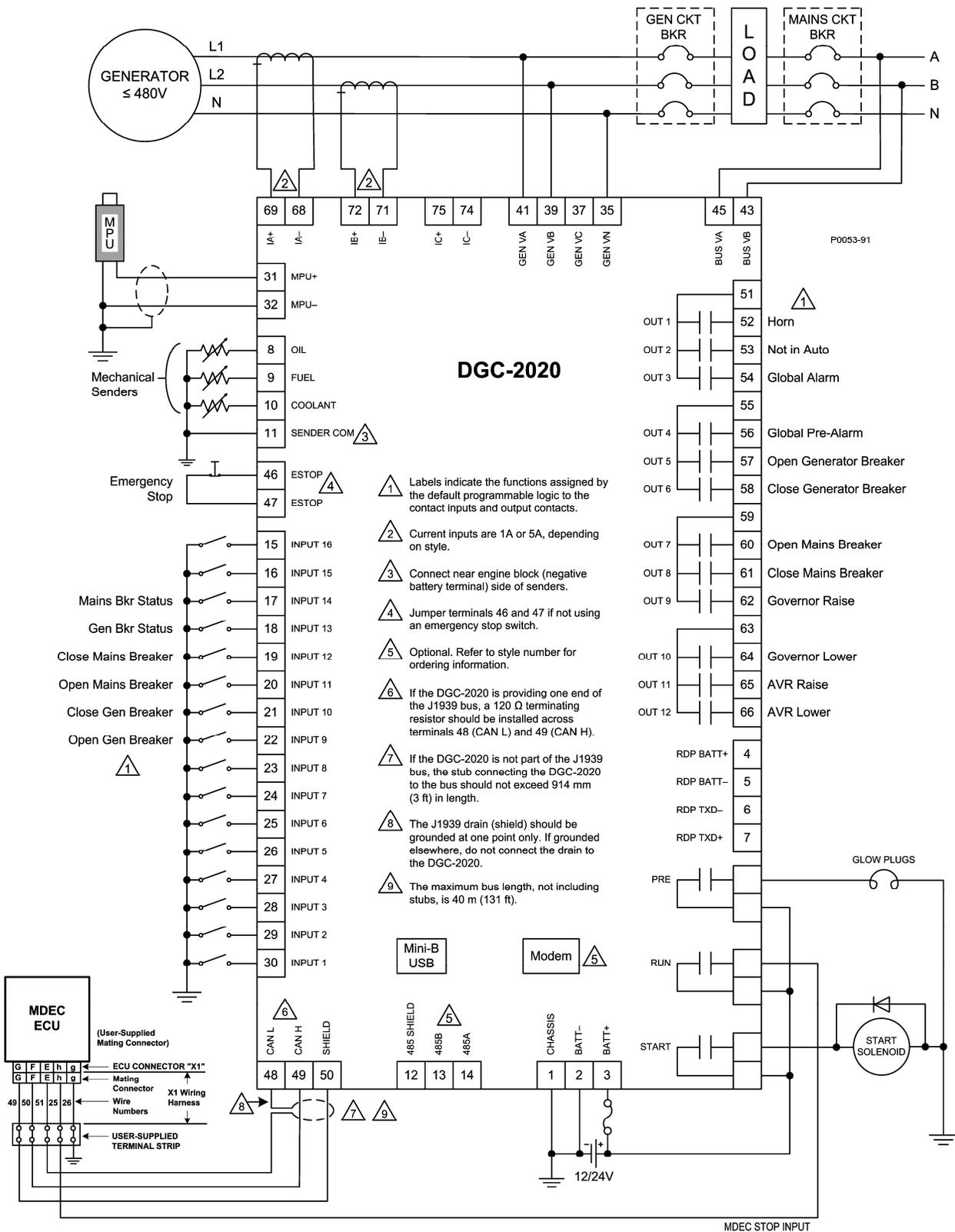


Figure 6-16. Single-Phase A-B Connections for MTU MDEC ECU Applications

Connections with AEM-2020, CEM-2020, and LSM-2020

The AEM-2020 (Analog Expansion Module), CEM-2020 (Contact Expansion Module), and LSM-2020 (Load Share Module) are optional modules that may be installed with the DGC-2020. These modules interface to the DGC-2020 via CANbus, thus the CANBUS terminals are the only common connections (Figure 6-18) between the DGC-2020, AEM-2020, CEM-2020, and LSM-2020. Refer to Section 8, *LSM-2020 (Load Share Module)*, for independent LSM-2020 connections. Refer to Section 9, *CEM-2020 (Contact Expansion Module)*, for independent CEM-2020 connections. Refer to Section 10, *AEM-2020 (Analog Expansion Module)*, for independent AEM-2020 connections. Refer to *Connections, CANbus Interface*, in this section for details on DGC-2020 CANbus connections.

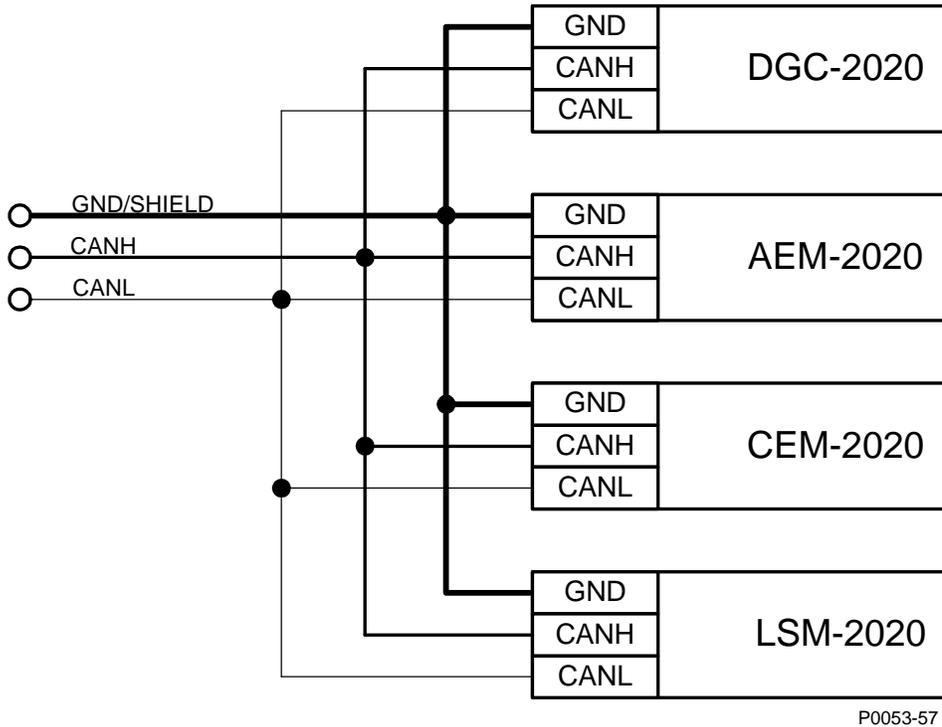


Figure 6-18. DGC-2020, AEM-2020, CEM-2020, LSM-2020 CANbus Connections

INSTALLATION FOR CE SYSTEMS

For CE compliant systems, it may be required to route ac voltage and current sensing wires separately from other wires.

INSTALLATION IN A SALT FOG ENVIRONMENT

If the DGC-2020 will be installed in a salt-fog environment, it is recommended that the backup battery for the real-time clock be removed. Salt fog is known to be conductive and may short-circuit the battery.

Information on removing the backup battery for the real-time clock can be found in Section 7, *Maintenance and Troubleshooting*.

SECTION 7 • MAINTENANCE AND TROUBLESHOOTING

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SECTION 7 • MAINTENANCE AND TROUBLESHOOTING

MAINTENANCE

Preventative maintenance consists of periodic replacement of the backup battery (optional) 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 an option available for the DGC-2020 Digital Genset Controller. A 3.0 Vdc, 195-mAh lithium battery (type Rayovac BR2032) is used to maintain clock function during loss of power supply voltage. In mobile substation and generator applications, the primary battery system that supplies the DGC-2020 power supply may be disconnected for extended periods (weeks, months) between uses. Without battery backup for the real time clock, clock functions will cease if battery input power is removed.

The backup battery has a life expectancy of approximately 10 years. After this time, you should contact Basler Electric to order a new battery, Basler Electric P/N 38526.

Battery access is located on the rear side of the DGC-2020.

CAUTION

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

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

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

NOTE

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

TROUBLESHOOTING

If you do not get the results that you expect from the DGC-2020, first check the programmable settings for the appropriate function. Use the following troubleshooting procedures when difficulties are encountered in the operation of your genset control system.

Communications

Ethernet Port Does Not Operate Properly

Step 1. Verify that the proper port of your computer is being used. For more information, refer to Section 4, *BESTCOMSPlus Software, Communication*.

Step 2. Verify the network configuration of the LSM-2020 and DGC-2020 are set up properly. For more information, refer to Section 4, *BESTCOMSPlus Software, Communication*.

- Step 3. Verify that all Ethernet devices comply with IEC 61000-4 series of specifications for Industrial Ethernet Devices. Commercial devices are not recommended and may result in erratic network communications.

USB Port Does Not Operate Properly

- Step 1. Verify that the proper port of your computer is being used. For more information, refer to Section 4, *BESTCOMSPPlus Software, Communication*.

CANbus Communication Does Not Operate Properly

- Step 1: Verify that there is a 120-ohm termination resistor on each end of the bus section of the wiring, and that there are not any termination resistors at any node connections that are on stubs from the main bus.
- Step 2: Check all CANbus wiring for loose connections, and verify that the CAN H and CAN L wires have not gotten switched somewhere on the network.
- Step 3: Verify that the cable length of the bus section of the wiring does not exceed 40 meters, and verify that any stubs from the main bus do not exceed 3 meters in length.
- Step 4: If the Engine ECU is a Volvo or MTU ECU, verify that the ECU Configuration setting is set to match the ECU configuration.

Inputs and Outputs

Programmable Inputs Do Not Operate as Expected

- Step 1. Verify that all wiring is properly connected. Refer to Section 6, *Installation, Connections*.
- Step 2. Confirm that the inputs are programmed properly.
- Step 3. Ensure that the input at the DGC-2020 is actually connected to the BATT– terminal (2).

Programmable Outputs Do Not Operate as Expected

- Step 1. Verify that all wiring is properly connected. Refer to Section 6, *Installation, Connections*.
- Step 2. Confirm that the outputs are programmed properly.

Metering/Display

Incorrect Display of Battery Voltage, Coolant Temperature, Oil Pressure, or Fuel Level

- Step 1. Verify that all wiring is properly connected. Refer to Section 6, *Installation, Connections*.
- Step 2. Confirm that the SENDER COM terminal (11) is connected to the negative battery terminal and the engine-block side of the senders. Current from other devices sharing this connection can cause erroneous readings.
- Step 3. If the displayed battery voltage is incorrect, ensure that the proper voltage is present between the BATT+ terminal (3) and the SENDER COM terminal (11).
- Step 4. Verify that the correct senders are being used.
- Step 5. Use a voltmeter connected between the BATT-terminal (2) and the SENDER COM terminal (11) on the DGC 2020 to verify that there is no voltage difference at any time. Any voltage differences may manifest themselves as erratic sender readings. Wiring should be corrected so that no differences exist.
- Step 6: Check the sender wiring and isolate sender wiring from any of the AC wiring in the system. The sender wiring should be located away from any power AC wiring from the generator and any ignition wiring. Separate conduits should be used for sender wiring and any AC wiring.

Incorrect Display of Generator Voltage

- Step 1. Verify that all wiring is properly connected. Refer to Section 6, *Installation, Connections*.
- Step 2. Ensure that the proper voltage is present at the DGC-2020 voltage sensing inputs (41, 39, 37, and 35).
- Step 3. Verify that the voltage transformer ratio and sensing configuration is correct.
- Step 4. Confirm that the voltage sensing transformers are correct and properly installed.

Incorrect Measurement or Display of Generator Current

- Step 1. Verify that all wiring is properly connected. Refer to Section 6, *Installation, Connections*.

- Step 2. Ensure that the proper current is present at the DGC-2020 current sensing inputs (68/69, 71/72, and 74/75).
- Step 3. Verify that the current sensing transformer ratios are correct.
- Step 4. Confirm that the current sensing transformers are correct and properly installed.

Incorrect Display of Engine RPM

- Step 1. Verify that all wiring is properly connected. Refer to Section 6, *Installation, Connections*.
- Step 2. Verify that the flywheel teeth setting is correct.
- Step 3. Confirm the nominal frequency setting.
- Step 4. Verify that the prime mover governor is operating properly.
- Step 5. Verify that the measured frequency of the voltage at the MPU input (31 and 32) is correct.
- Step 6. 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.

Generator Breaker and Mains Breaker

Generator Breaker Will Not Close to a Dead Bus

- Step 1: Verify that breaker close request is being initiated. Initiate a generator breaker close request by one of the methods listed in Section 3, *Functional Description, Breaker Management*.
- Step 2: Navigate to the SETTINGS->BREAKER MANAGEMENT->BREAKER HARDWARE->GEN BREAKER screen and set DEAD BUS CL ENBL to ENABLE.
- Step 3: 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 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 the bus status is DEAD. Check status by using the Metering Explorer in BESTCOMSPlus 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 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 open 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: Verify that breaker close request is being initiated. Initiate a generator breaker close request using one of the methods listed in Section 3, *Functional Description, Breaker Management*.
- Step 2: 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 3: 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 4: Verify the synchronizer is operating properly; refer to the synchronizer portion of the troubleshooting steps.
- Step 5: Verify the wiring to the breaker from the DGC-2020. If it seems OK, you can do a manual close and open by modifying the programmable logic. Map some unused outputs to the OPEN and CLOSE outputs from the Gen Breaker Block in the programmable logic. Map a virtual switch to

the logic output that would normally be the breaker close output. Map another virtual switch to the logic output that would normally be the breaker close output. Connect with BESTCOMSPlus, and exercise the virtual switches using the Control panel located in the Metering Explorer. Never turn open and close on at the same time. This could damage the breaker and/or motor operator. If everything is working as expected, restore the logic to its original diagram.

Generator Breaker Does Not Open When It Should

Step 1: 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 Exploring 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 Reduce Generator Voltage to Achieve Matching of Bus and Generator Voltages

- Step 1: Navigate to the SETTINGS->MULTIGEN MANAGEMENT->AVR ANALOG OUTPUT screen and set VOLT RESPONSE to DECREASING.

Speed Bias

Engine Speed Does Not Change When Speed Bias Voltage Changes

- Step 1: Verify that the engine speed will change when the speed bias changes. As a test, you can force a voltage on the speed bias output by setting the Min Output Voltage and Max Output Voltage to the same value by navigating to SETTINGS->MULTIGEN MANAGEMENT->GOV ANALOG 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 ANALOG 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->MULTIGENMANAGEMENT->AVR ANALOG 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 ANALOG 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 ANALOG OUTPUT screen and set VOLT RESPONSE to DECREASING.

SECTION 8 • LSM-2020 (LOAD SHARE MODULE)

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SECTION 8 • LSM-2020 (LOAD SHARE MODULE)

GENERAL INFORMATION

The LSM-2020 is a remote auxiliary device that interfaces to the DGC-2020 and provides analog outputs to the power system in the form of analog bias signals to the voltage regulator and speed governor. When the breaker is closed and Load Sharing is enabled, the LSM-2020 will share real power load proportionally with the other generators on the Analog Load Share Line.

FEATURES

LSM-2020s have the following features:

- A Ramping Function to load and unload generators smoothly
 - Communications via Ethernet or CANbus
 - Demand Start/Stop and Generator Sequencing
 - KW Load Control
 - KW Load Sharing via analog load share lines
-

SPECIFICATIONS

Operating Power

Nominal:	12 or 24 Vdc
Range:	8 to 32 Vdc (Withstands cranking ride-through down to 6 Vdc for 500 ms.)
Maximum Consumption:	4 W
Terminals:	P2-3 (–), P2-2 (+), P2-1 (chassis ground)

Analog Inputs

Voltage Configuration:	0-10 Vdc
Current Configuration:	4-20 mA
Terminals:	P2-7 (IN+), P2-8 (IN–), P2-9 (V+)

Analog Outputs

Burden Data: 4-20 mA = 500 Ω maximum burden, \pm 10 Vdc = 667 Ω minimum burden

Voltage Regulator Bias Output

4-20 mA or \pm 10 Vdc isolated output signal. (Selectable in increments of 0.1.)

Isolated to 1,500 Vdc between outputs and ground

Terminals: P2-18 (AVR+), P2-17 (AVR–), P2-16 (AVR')

Governor Bias Output

4-20 mA, \pm 10 Vdc isolated output signal. (Selectable in increments of 0.1.)

Isolated to 500 Vdc between outputs and ground

Terminals: P2-15 (GOV+), P2-14 (GOV–), P2-13 (GOV')

Load Share Line Output

0-10 Vdc isolated output signal. (Selectable in increments of 0.1 Vdc.)

Isolated to 500 Vdc between outputs and ground

Terminals: P2-6 (LS+), P2-5 (LS–), P2-4 (LS')

Communication Interface

CANbus

Differential Bus Voltage: 1.5 to 3 Vdc
Maximum Voltage: –32 to +32 Vdc with respect to negative battery terminal
Communication Rate: 250 kb/s
Terminals: P2-12 (low), P2-11 (high), and P2-10 (shield)

Ethernet

Rear-panel RJ-45 connector provides remote communications via BESTCOMSPlus to the LSM-2020 and to the DGC-2020 that the module is connected to.

Type: 10/100BASE-T

Industrial Ethernet devices designed to comply with IEC 61000-4 series of specifications are recommended.

Type Tests

Shock

15 G in 3 perpendicular planes

Vibration

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

5 to 29 to 5 Hz: 1.5 G peak for 5 min.
29 to 52 to 29 Hz: 0.036" Double Amplitude for 2.5 min.
52 to 500 to 52 Hz: 5 G peak for 7.5 min.

Ignition System

Tested in closed proximity to an unshielded, unsuppressed Altronic DISN 800 ignition system.

HALT (Highly Accelerated Life Testing)

HALT is used by Basler Electric to prove that our products will provide the user with many years of reliable service. HALT subjects the device to extremes in temperature, shock, and vibration to simulate years of operation, but in a much shorter period span. HALT allows Basler Electric to evaluate all possible design elements that will add to the life of this device. As an example of some of the extreme testing conditions, the LSM-2020 was subjected to temperature tests (tested over a temperature range of –80°C to +130°C), vibration tests (of 5 to 50 G at +25°C), and temperature/vibration tests (tested at 10 to 20 G over a temperature range of –60°C to +100°C). Combined temperature and vibration testing at these extremes proves that the LSM-2020 is expected to provide long-term operation in a rugged environment. Note that the vibration and temperature extremes listed in this paragraph are specific to HALT and do not reflect recommended operation levels. These operational ratings are included in Section 8 of this manual.

Environment

Temperature

Operating: –40 to +70°C (–40 to +158°F)

Storage: –40 to +85°C (–40 to +185°F)

Humidity: IEC 68-2-38

UL Approval

“cURus” recognized to UL Standard 508 & CSA Standard C22.2 No.14

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

NFPA Compliance

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

CE Compliance

This product complies with the requirements of the following EC Directives:

- Low Voltage Directive (LVD) - 73/23/EEC as amended by 93/68/EEC
- Electromagnetic Compatibility (EMC) - 89/336/EEC as amended by 92/31/EEC and 93/68/EEC

This product conforms to the following Harmonized Standards:

- EN 50178:1997 - *Electronic Equipment for use in Power Installations*
- EN 61000-6-4:2001 - *Electromagnetic Compatibility (EMC), Generic Standards, Emission Standard for Industrial Environments*
- EN 61000-6-2:2001 - *Electromagnetic Compatibility (EMC), Generic Standards, Immunity for Industrial Environments*

Physical

Weight: 1.45 lb (657 g)
Dimensions: See *Installation* later in this section.

FUNCTIONAL DESCRIPTION

Load Share Overview

A generator is paralleled with other generators on an island system, which is not connected to the utility. The generator shares load with other generators on the system via the load share line. The load share line of a generator is driven in proportion to the per unitized kW generation of the generator. The voltage at the junction of all load share lines is proportional to the per unitized average power generation of the system. For example, if the load share line operating voltage is 0 to 3 volts, and the measured voltage at the intersection point is 2 volts, the system is at 2/3 of its kW capacity. The generator uses the measured load share line input value to calculate per unitized average load level, and uses that as the setpoint for its kW controller.

A generator has a set of contacts that physically disconnects it from the load share line circuit. These contacts are open whenever the unit's generator breaker is open.

If a unit or set of units is paralleled to the utility, they derive their setting from the Mains Parallel Power Level setting, and disregard the load share line input.

Settings are provided to allow a generator to make a bumpless transition onto the system that is participating in load sharing. A bumpless transition is also achieved when the generator is brought offline.

Analog Inputs

The analog inputs can be configured to accept voltage or current. These inputs can be used for var, PF, or kW control. The inputs are configured by using the Settings Explorer in BESTCOMSPlus to open the *Programmable Input, LSM Input* screen. To set the LSM Analog Input as the control source, use the Settings Explorer in BESTCOMSPlus to open the *Bias Control Settings* screens.

Analog Outputs

There are three analog outputs: AVR control, GOV control, and Load Share Line. Each output is described in the following paragraphs.

Output for Voltage Regulator Control

The AVR output provides remote control of the generator voltage setpoint

Output for Governor Control

The GOV output provides remote control of the generator speed setpoint.

Load Share Line Output

The generator uses the measured LS (Load Share Line) output to calculate per unitized average load level, and uses that as the set point for its kW controller.

Generator Sequencing

Machines can be added or removed from the power system based on load demand. The following criteria should be considered before adding or removing a machine:

- Machine Priority
- Engine Run Time
- Machine Size
- kW% of the load/demand
- Out of Service machines

Communications

The LSM-2020 communication ports include CAN terminals and an Ethernet port.

CANbus

A Control Area Network (CAN) is a standard interface that enables communication between the LSM-2020 and the DGC-2020.

Ethernet Port

An Ethernet port provides communications via BESTCOMSPlus to the LSM-2020 and to the DGC-2020 that the module is connected to. Ethernet communication between LSM-2020s allows for generator sequencing on an islanded system. Firmware updates to the LSM-2020 are made through the Ethernet port. Firmware updates to the DGC-2020 are only available through the USB port of the DGC-2020. Refer to Section 4, *BESTCOMSPlus*, for information on configuring Ethernet communication and updating firmware in the DGC-2020.

Industrial Ethernet devices designed to comply with IEC 61000-4 series of specifications are recommended.

BESTCOMSPlus SOFTWARE

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^A when configuring LSM-2020 settings off-line. When on-line, read-only information includes application version^B, boot code version^C, application build^D, serial number^E, application part number^F, and model number^G.

BESTCOMSPlus device information values and settings are illustrated in Figure 8-1.

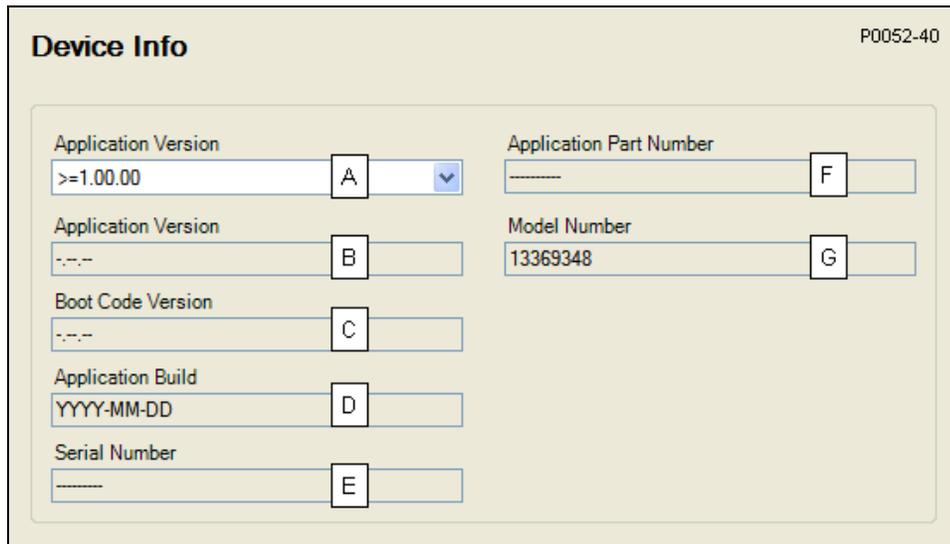


Figure 8-1. Device Info Screen

^A *Application Version:* When configuring Load Share Module settings off-line, the application version for the unit to be configured must be selected.

^B *Application Version:* Read-only value obtained when BESTCOMSPlus is communicating with the Load Share Module.

^C *Boot Code Version:* Read-only value obtained when BESTCOMSPlus is communicating with the Load Share Module.

^D *Application Build:* Read-only value obtained when BESTCOMSPlus is communicating with the Load Share Module.

^E *Serial Number:* Read-only value obtained when BESTCOMSPlus is communicating with the Load Share Module.

^F *Application Part Number:* Read-only value obtained when BESTCOMSPlus is communicating with the Load Share Module.

^G *Model Number:* Read-only value obtained when BESTCOMSPlus is communicating with the Load Share Module.

Device Security Setup

Password protection guards against unauthorized changing of LSM-2020 communication settings. Passwords are case sensitive. *OEM Access* is the only level of password protection available. This password level allows access to all settings made using the LSM-2020 plugin for 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 8-2.

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

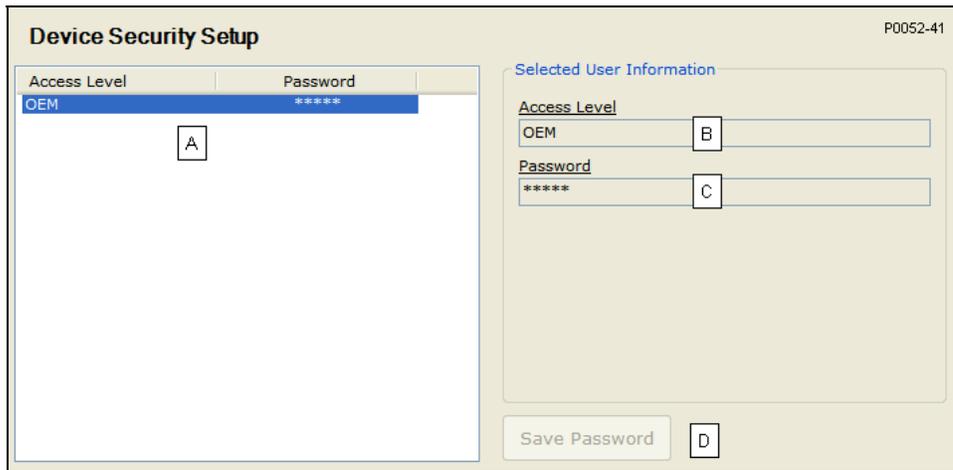


Figure 8-2. Device Security Setup Screen

^A *Access Level/Password:* Read-only value obtained when BESTCOMSPPlus is communicating with the Load Share Module.

^B *Password:* Accepts an alphanumeric character string of up to 16 characters.

^C *Save Password:* Clicking this button will save the password changes in BESTCOMSPPlus memory.

INSTALLATION

LSM-2020's are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a module, check the part number against the requisition and packing list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify the Basler Electric regional sales office, your sales representative, or a sales representative at Basler Electric, Highland, Illinois USA.

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

Product Registration

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

Mounting

LSM-2020's are contained in an encapsulated plastic case and may be mounted in any convenient position. The construction of a LSM-2020 is durable enough to mount directly on a genset using UNF ¼-20 or equivalent hardware. Hardware selection should be based on any expected shipping/transportation and operating conditions. The torque applied to the mounting hardware should not exceed 65 in-lb (7.34 N•m).

See Figure 8-3 for LSM-2020 overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.

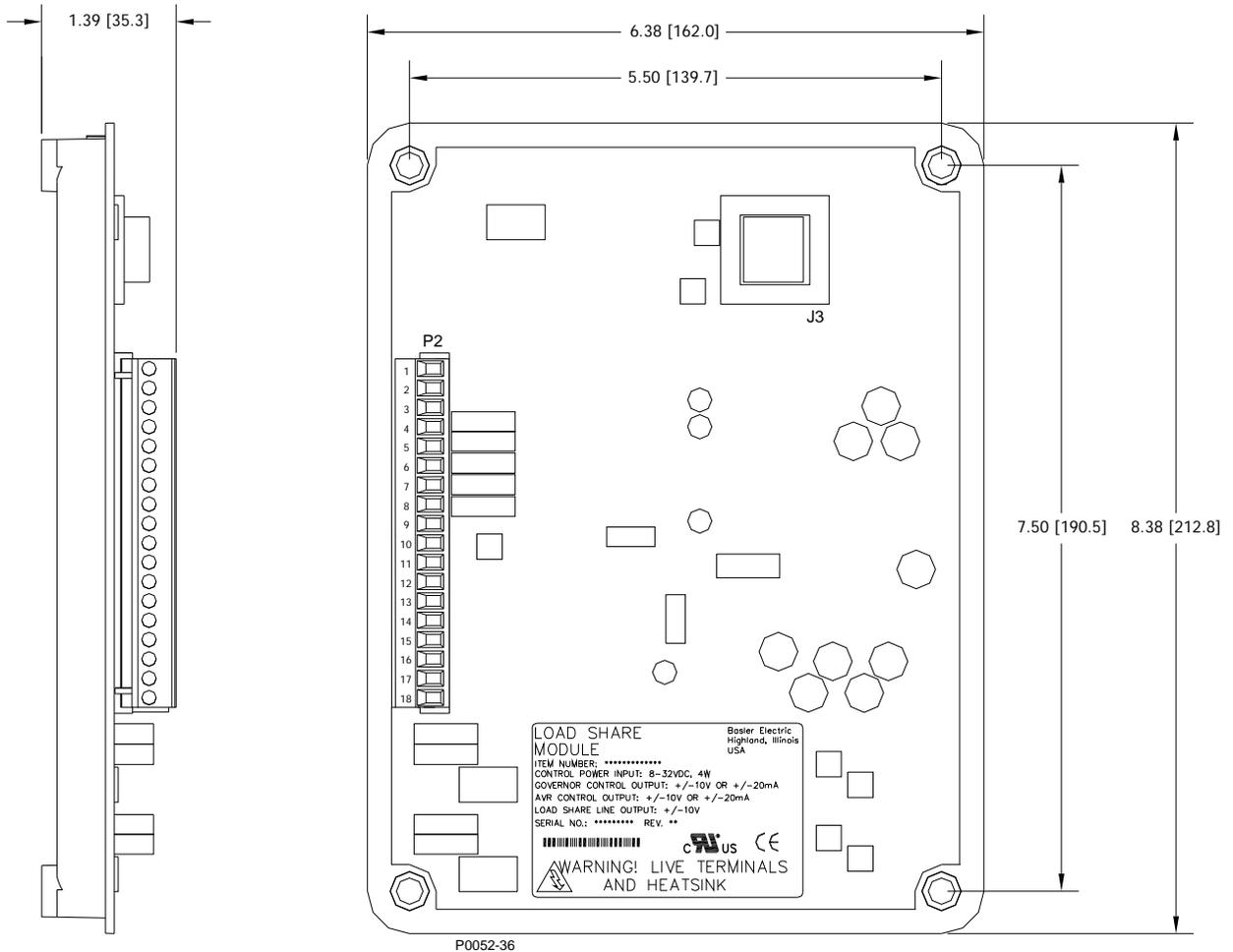


Figure 8-3. LSM-200 Overall Dimensions

Connections

LSM-200 connections are dependent on the application. Incorrect wiring may result in damage to the module.

NOTE

Operating power from the battery must be of the correct polarity. Although reverse polarity will not cause damage, the LSM-200 will not operate.

Be sure that the LSM-200 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-200 and a PC running BESTCOMSPlus software. This allows for setting of the LSM-200 and for the DGC-2020 that the module is connected to.

LSM-200 connections are made with an 18-position connector with screw-down compression terminals. This connector plugs into a header on the LSM-200. The connector and header have a dovetailed edge that ensures proper connector orientation. The connector and header are uniquely keyed to ensure that the connector mates only with the correct header. Connector screw terminals accept a maximum wire size of 12 AWG. Maximum screw torque is 4 inch-pounds (0.45 N•m).

Operating Power

The LSM-2020 operating power input accepts either 12 Vdc or 24 Vdc and tolerates voltage over the range of 6 to 32 Vdc. Operating power must be of the correct polarity. Although reverse polarity will not cause damage, the LSM-2020 will not operate. Operating power terminals are listed in Table 8-1.

It is recommended that a fuse be added for additional protection for the wiring to the battery input of the LSM-2020. A Bussmann ABC-7 fuse or equivalent is recommended.

Table 8-1. Operating Power Terminals

Terminal	Description
P2-1 (CHASSIS)	Chassis ground connection
P2-2 (BATT+)	Positive side of operating power input
P2-3 (BATT-)	Negative side of operating power input

Analog Inputs

These inputs can be used for var, PF, or kW control. Analog input terminals are listed in Table 8-2.

Table 8-2. Analog Input Terminals

Terminal	Description
P2-9 (V+)	Voltage input used for var, PF, or kW control.
P2-8 (IN-)	Common for voltage or current.
P2-7 (I+)	Current input used for var, PF, or kW control.

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 8-3.

Table 8-3. Analog Output Terminals

Terminal	Description
P2-18 (AVR+)	AVR control output positive
P2-17 (AVR-)	AVR control output negative
P2-16 (AVR')	Provides additional landing point for external resistor
P2-15 (GOV+)	GOV control output positive
P2-14 (GOV-)	GOV control output negative
P2-13 (GOV')	Provides additional landing point for external resistor
P2-6 (LS+)	Load share line positive
P2-5 (LS-)	Load share line negative
P2-4 (LS')	Provides additional landing point for external resistor

CANbus 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. CANbus interface terminals are listed in Table 8-4. Refer to Figure 8-4 and Figure 8-5.

Table 8-4. CANbus Interface Terminals

Terminal	Description
P2-12 (CAN L)	CAN low connection (green wire)
P2-11 (CAN H)	CAN high connection (yellow wire)
P2-10 (SHIELD)	CAN drain connection

NOTES

- 1.) If the LSM-2020 is providing one end of the J1939 bus, a 120 Ω terminating resistor should be installed across terminals P2-12 (CANL) and P2-11 (CANH).
- 2.) If the LSM-2020 is not part of the J1939 bus, the stub connecting the LSM-2020 to the bus should not exceed 914 mm (3 ft) in length.
- 3.) The maximum bus length, not including stubs, is 40 m (131 ft).
- 4.) The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the LSM-2020.

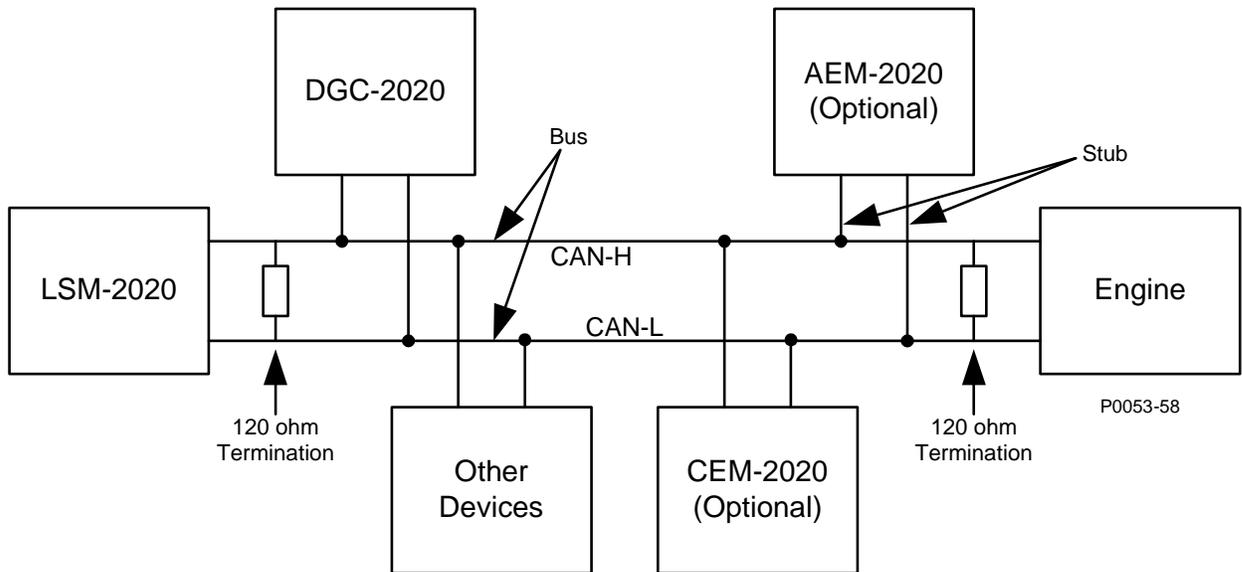


Figure 8-4. CANbus Interface with LSM-2020 providing One End of the Bus

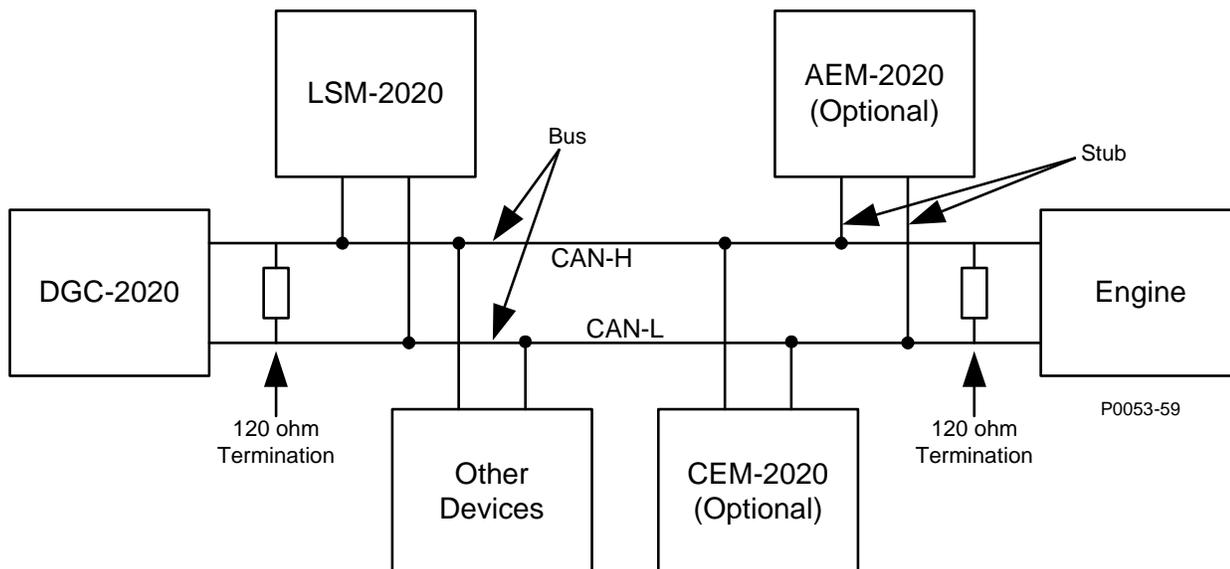


Figure 8-5. CANbus Interface with DGC-2020 providing One End of the Bus

Ethernet Port

The LSM-2020 has Ethernet capability. The LSM-2020 connects to a PC through a RJ-45 jack (J3). Industrial Ethernet devices designed to comply with IEC 61000-4 series of specifications are recommended.

Connections for Typical Applications

Figure 8-6 illustrates typical LSM-2020 connections. Figure 8-7 illustrates a typical interconnection of two systems tied together via separate Load Share Modules.

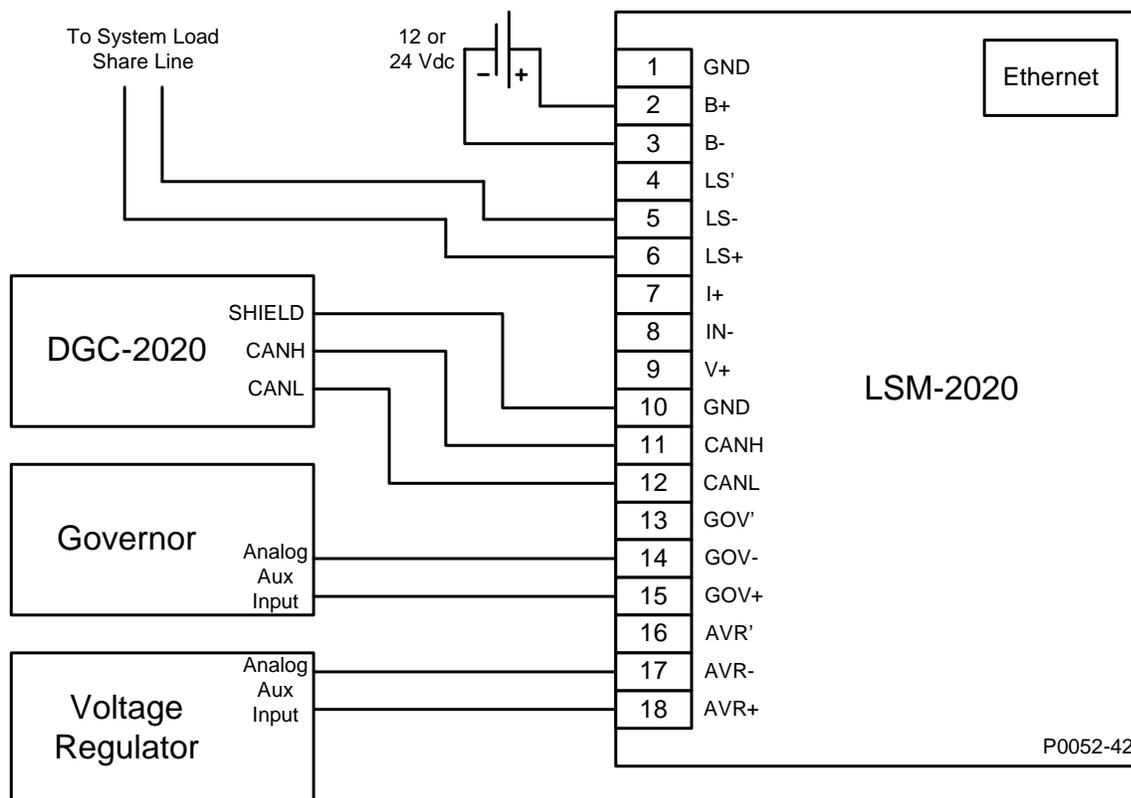
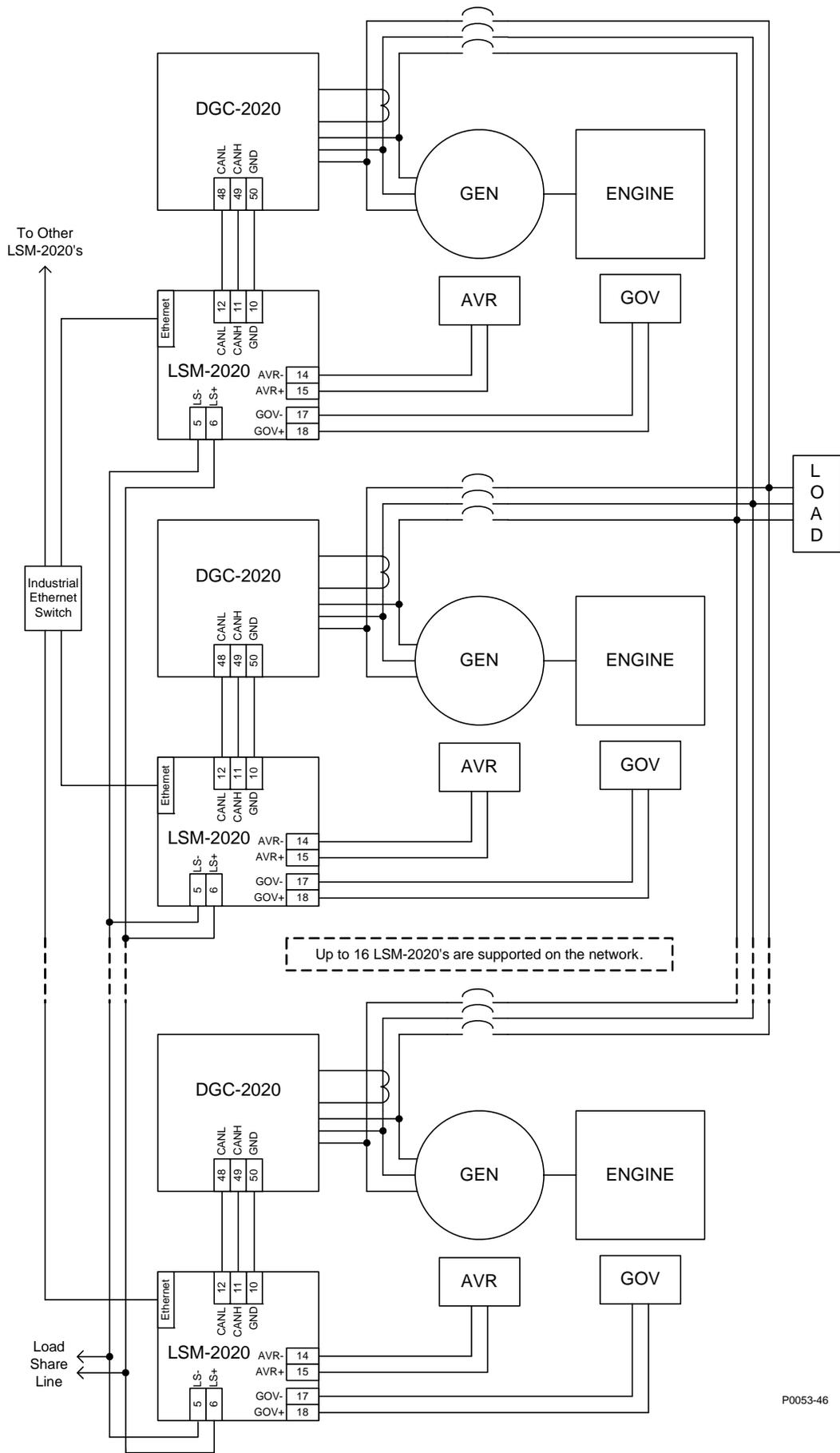


Figure 8-6. Typical LSM-2020 Connections



P0053-46

Figure 8-7. Typical LSM-2020 Interconnection Diagram

Connections using AVR', GOV', and LS'

Additional terminals provide a landing point to add series resistance to the GOV, AVR, and LS analog outputs. These terminals are not internally connected to the LSM-2020. Figure 8-8 illustrates connections using the additional AVR' terminal as a landing point.

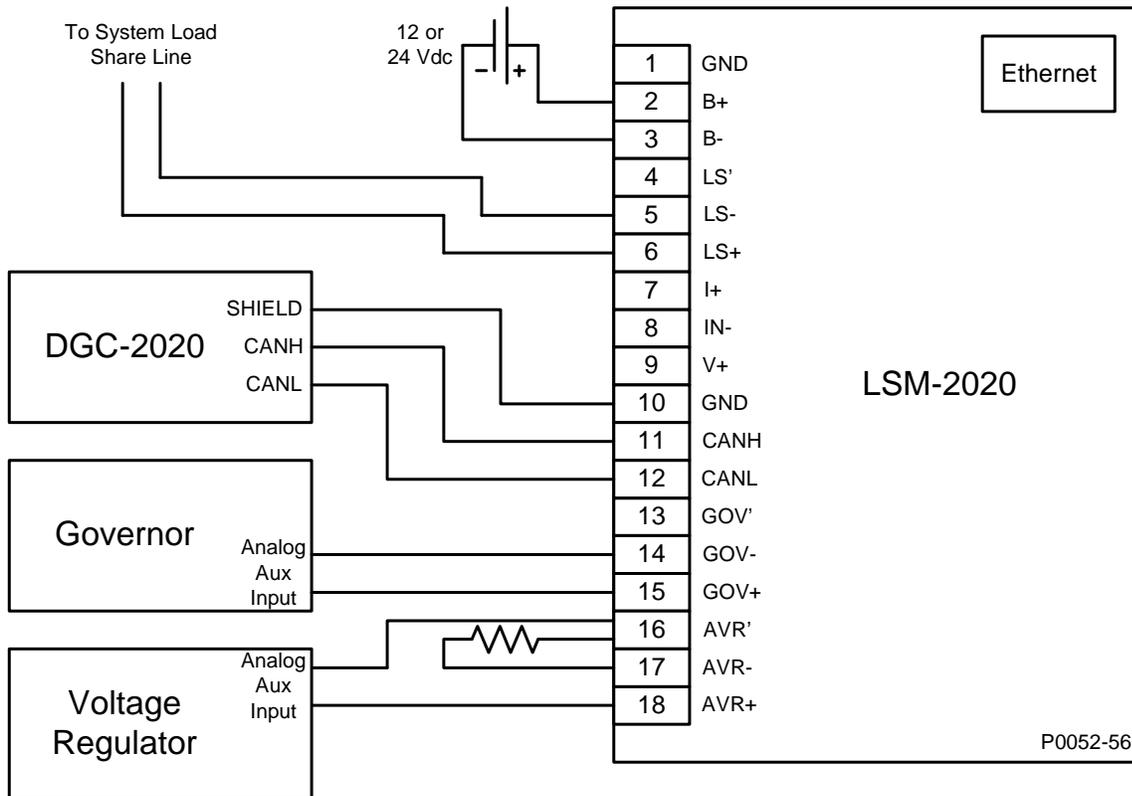


Figure 8-8. Connections using the AVR' Terminal

APPLICATION

Interfacing an External Control Device with a DGC-2020 – LSM-2020 System

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 controls the bias inputs to the AVR and governor. This can be done by placing the bias output of the LSM and the bias output of the external device in series. If the output of the LSM is connected in series with the bias output of the external synchronizer as shown in Figure 8-9, both devices will be allowed to exercise control over the bias input of the governor.

Be sure the LSM and the external device are never in a situation where they oppose each other. Both devices should not be trying to exercise dynamic control at the same time. For example, an external synchronizer should only be used with a DGC-2020 that does not have the synchronizer option, or has the synchronizer function disabled.

In addition, be sure the analog voltage range limits of the governor or AVR inputs are not exceeded. Exceeding these limits may result in undesired system operation, or force a device into an error or fault state.

If it is desired to have raise/lower inputs to control speed, use a motor operated potentiometer, as the external device. Note that if speed trim is enabled in the DGC-2020 and the generator's breaker is closed, the DGC-2020 will drive the system to the speed trim setpoint regardless of the presence of the external device. When the generator breaker is open, speed trim is disabled, and the external device will control machine speed.

A similar arrangement may be used for the bias input of an AVR if an external device is required for voltage control.

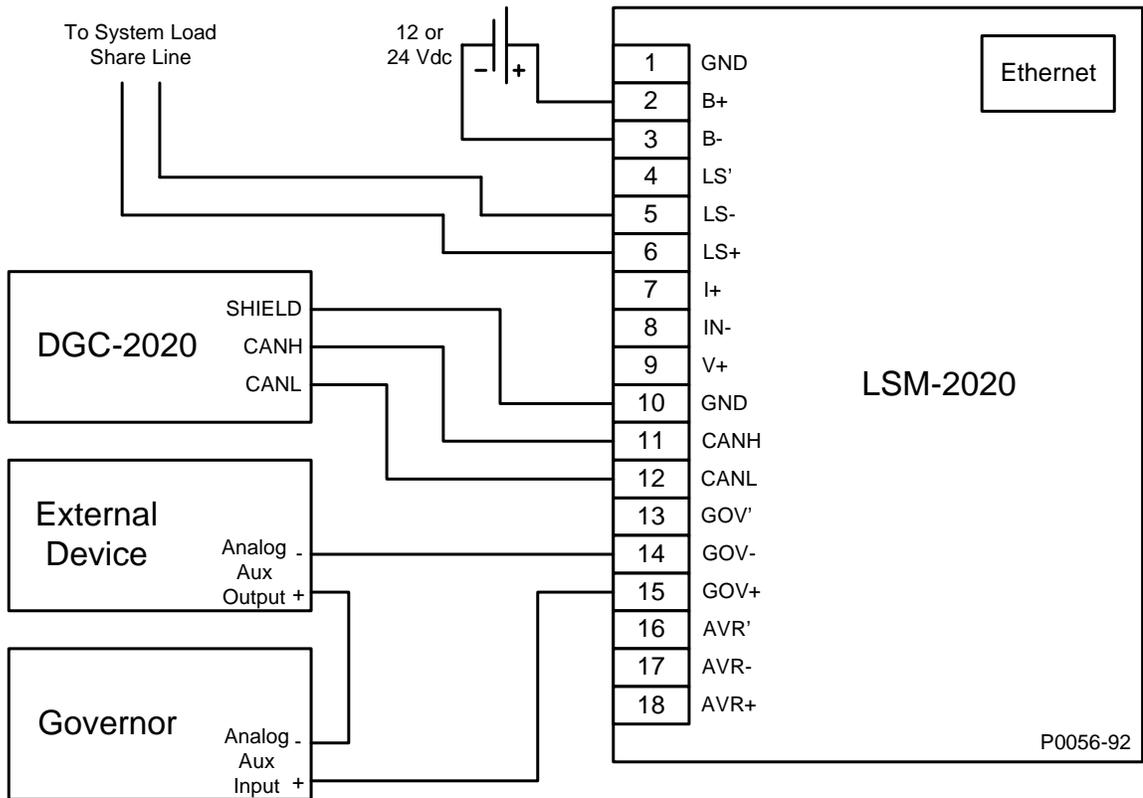


Figure 8-9. External Control Device with DGC-2020 – LSM-2020 System

MAINTENANCE

Preventive maintenance consists of periodically checking that the connections between the LSM-2020 and the system are clean and tight. LSM-2020's are manufactured using state-of-the-art surface-mount technology. As such, Basler Electric recommends that no repair procedures be attempted by anyone other than Basler Electric personnel.

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SECTION 9 • CEM-2020 (CONTACT EXPANSION MODULE)

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SECTION 9 • CEM-2020 (CONTACT EXPANSION MODULE)

GENERAL INFORMATION

The optional CEM-2020 is a remote auxiliary device that provides additional DGC-2020 contact inputs and outputs.

FEATURES

CEM-2020s have the following features:

- 10 Contact Inputs
- 24 Output Contacts
- Functionality of Inputs and Outputs assigned by BESTLogic+ 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:	14 W

Contact Inputs

The CEM-2020 contains 10 programmable inputs that accept normally open and normally closed, dry contacts.

Time from a CEM-2020 input going high to:

Shutdown the generator via an alarm:	700 ms max
Close a relay on board the DGC-2020:	300 ms max

Output Contacts

Ratings

Outputs 13 through 24:	1 Adc at 30 Vdc, Form C, gold contacts
Outputs 25 through 36:	4 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

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 $+130^{\circ}\text{C}$), vibration tests (of 5 to 50 G at $+25^{\circ}\text{C}$), and temperature/vibration tests (tested at 10 to 20 G over a temperature range of -60°C to $+100^{\circ}\text{C}$). Combined temperature and vibration testing at these extremes proves that the CEM-2020 is expected to provide long-term operation in a rugged environment. Note that the vibration and temperature extremes listed in this paragraph are specific to HALT and do not reflect recommended operation levels. These operational ratings are included in Section 9 of this manual.

Environment

Temperature

Operating: -40 to $+70^{\circ}\text{C}$ (-40 to $+158^{\circ}\text{F}$)

Storage: -40 to $+85^{\circ}\text{C}$ (-40 to $+185^{\circ}\text{F}$)

Humidity: IEC 68-2-38

UL Approval

“cURus” recognized to UL Standard 508 & CSA 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: 2.25 lb (1.02 kg)

Dimensions: See *Installation* later in this section.

FUNCTIONAL DESCRIPTION

Contact Inputs

The CEM-2020 provides 10 programmable contact inputs with the same functionality as the contact inputs on the DGC-2020.

Output Contacts

The CEM-2020 provides 24 programmable output contacts with the same functionality as the output contacts on the DGC-2020. Outputs 13 through 24 can carry 1 A. Outputs 25 through 36 can carry 4 A.

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

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

Product Registration

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

Mounting

Contact Expansion Modules are contained in an encapsulated plastic case and may be mounted in any convenient position. The construction of a Contact Expansion Module is durable enough to mount directly on a genset using UNF ¼-20 or equivalent hardware. Hardware selection should be based on any expected shipping/transportation and operating conditions. The torque applied to the mounting hardware should not exceed 65 in-lb (7.34 N•m).

See Figure 9-1 for CEM-2020 overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.

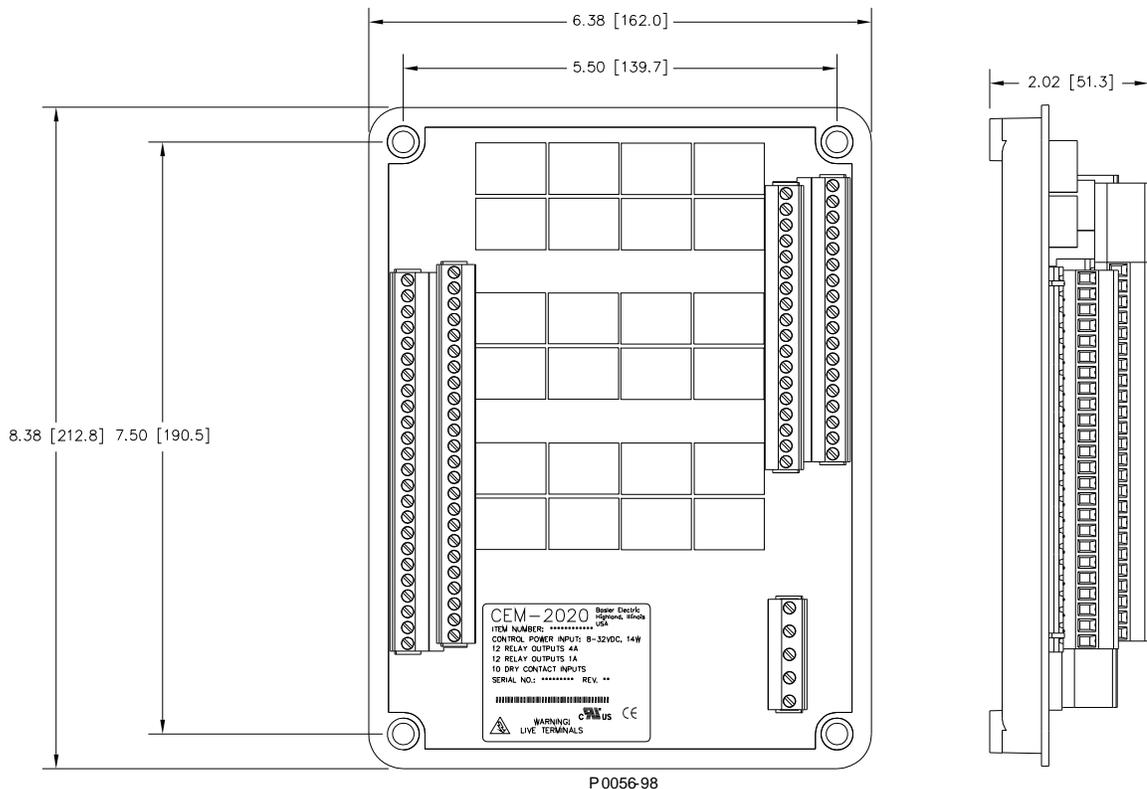


Figure 9-1. CEM-2020 Overall Dimensions

Connections

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

NOTE

Operating power from the battery must be of the correct polarity. Although reverse polarity will not cause damage, the CEM-2020 will not operate.

Be sure that the CEM-2020 is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the chassis ground terminal on the module.

Terminations

The terminal interface consists of plug-in connectors with screw-down compression terminals.

CEM-2020 connections are made with one 5-position connector, two 18-position connectors, and two 24-position connectors with screw-down compression terminals. These connectors plug into headers on the CEM-2020. The connectors and headers have dovetailed edges that ensure proper connector orientation. The connectors and headers are uniquely keyed to ensure that the connectors mate only with the correct headers. Connector screw terminals accept a maximum wire size of 12 AWG. Maximum screw torque is 5 inch-pounds (0.56 N•m).

Operating Power

The Contact Expansion Module operating power input accepts either 12 Vdc or 24 Vdc and tolerates voltage over the range of 6 to 32 Vdc. Operating power must be of the correct polarity. Although reverse polarity will not cause damage, the CEM-2020 will not operate. Operating power terminals are listed in Table 9-1.

It is recommended that a fuse be added for additional protection for the wiring to the battery input of the Contact Expansion Module. A Bussmann ABC-7 fuse or equivalent is recommended.

Table 9-1. Operating Power Terminals

Terminal	Description
P1- ⚡ (SHIELD)	Chassis ground connection
P1- – (BATT–)	Negative side of operating power input
P1- + (BATT+)	Positive side of operating power input

Contact Inputs and Output Contacts

The CEM-2020 (Figure 9-2) has 10 contact inputs and 24 output contacts.

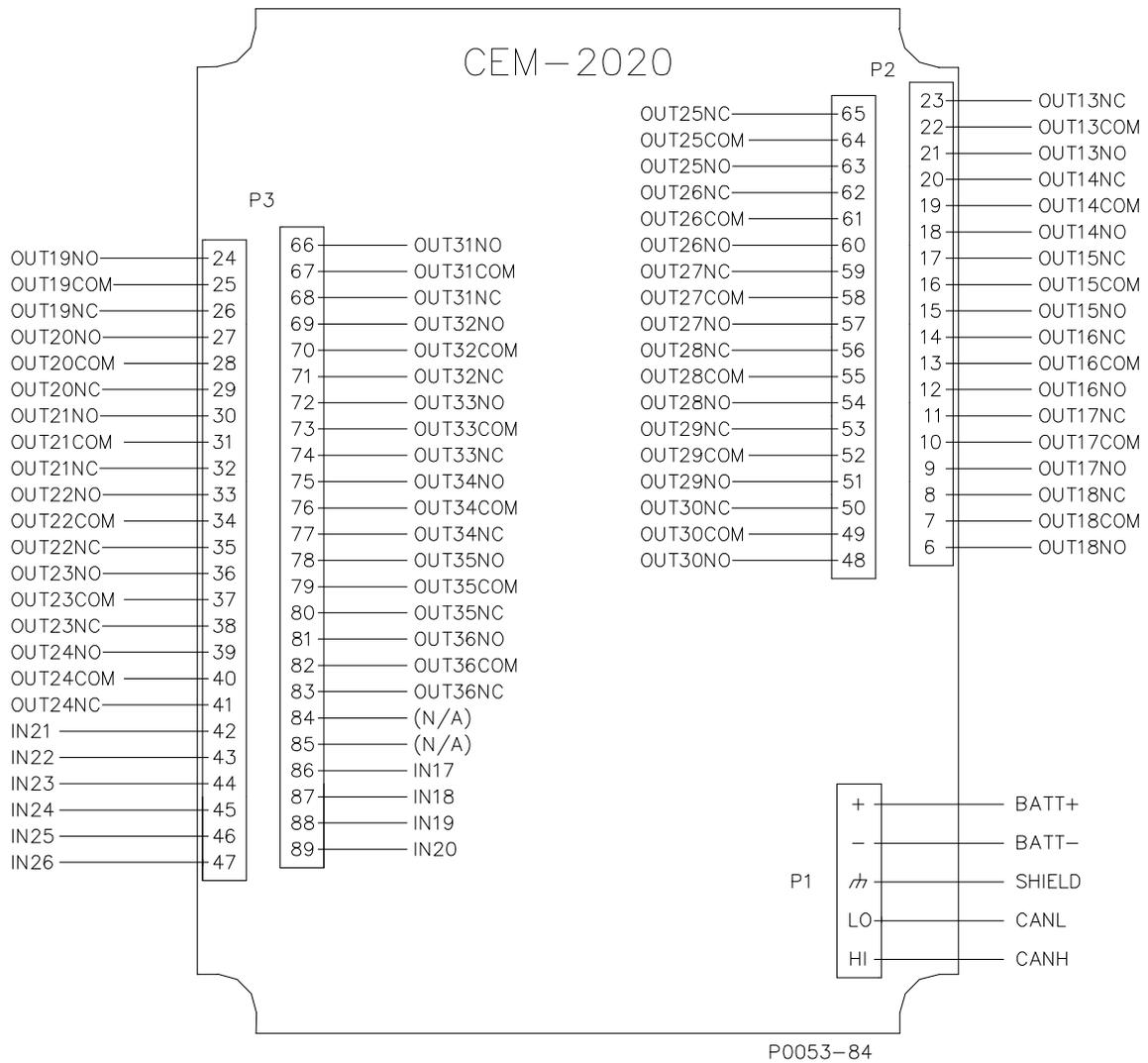


Figure 9-2. CEM-2020 Input Contact and Output Contact Terminals

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 9-2. Refer to Figure 9-3 and Figure 9-4.

Table 9-2. CANbus Interface Terminals

Terminal	Description
P1- HI (CAN H)	CAN high connection (yellow wire)
P1- LO (CAN L)	CAN low connection (green wire)
P1- ⚡ (SHIELD)	CAN drain connection

NOTES

- 1.) If the CEM-2020 is providing one end of the J1939 bus, a 120 Ω terminating resistor should be installed across terminals P1- LO (CANL) and P1- HI (CANH).
- 2.) If the CEM-2020 is not part of the J1939 bus, the stub connecting the CEM-2020 to the bus should not exceed 914 mm (3 ft) in length.
- 3.) The maximum bus length, not including stubs, is 40 m (131 ft).
- 4.) The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the CEM-2020.

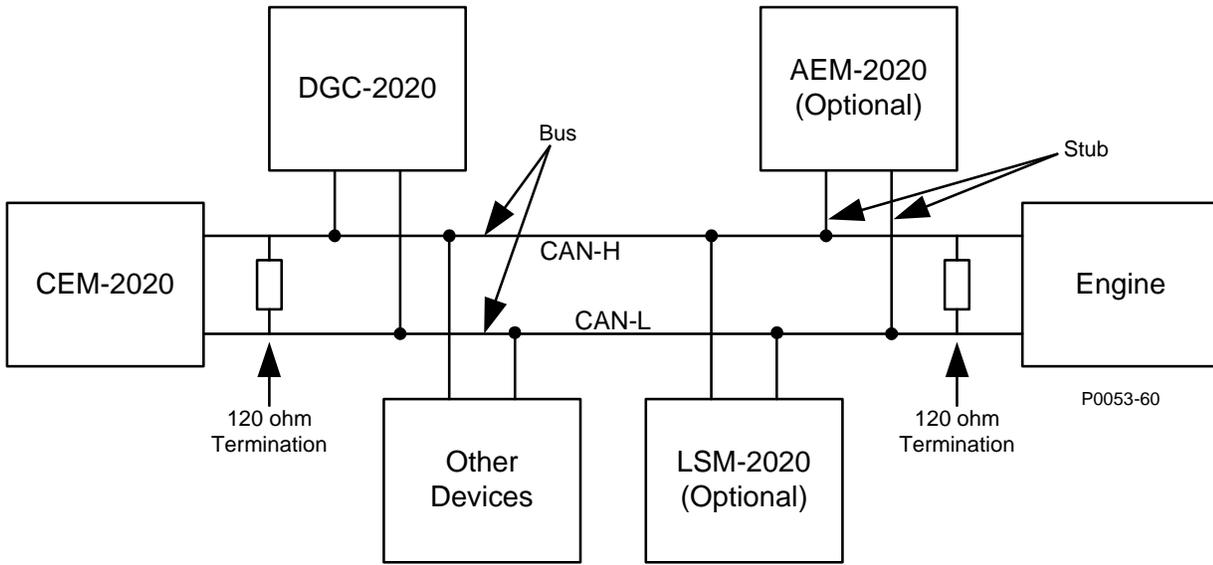


Figure 9-3. CANbus Interface with CEM-2020 providing One End of the Bus

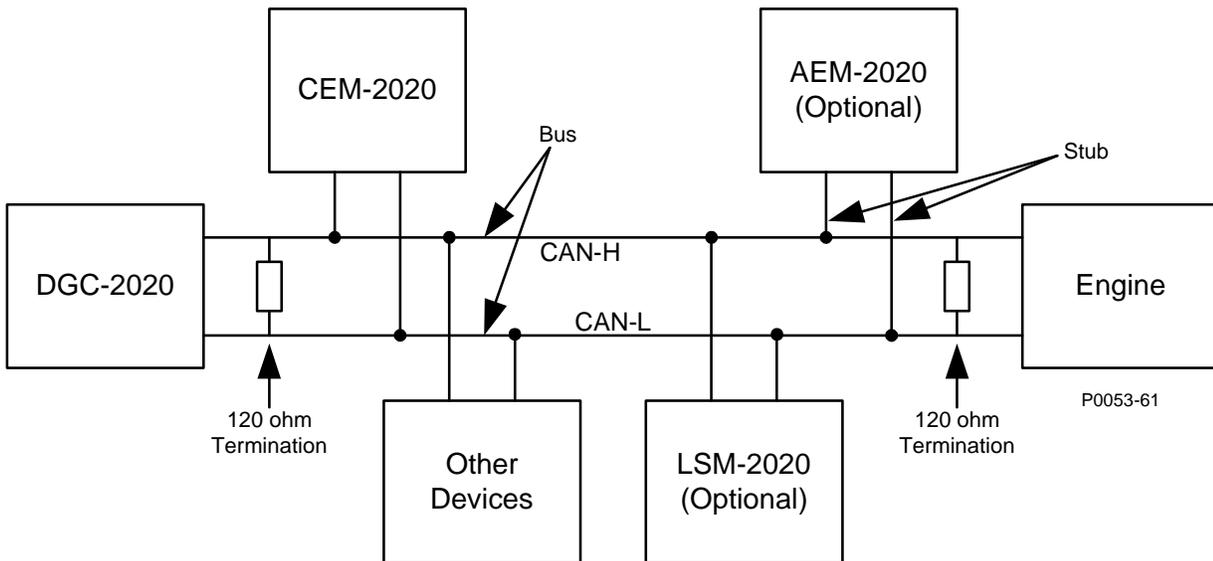


Figure 9-4. CANbus Interface with DGC-2020 providing One End of the Bus

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 10 • AEM-2020 (ANALOG EXPANSION MODULE)

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SECTION 10 • AEM-2020 (ANALOG EXPANSION MODULE)

GENERAL INFORMATION

The optional AEM-2020 is a remote auxiliary device that provides additional DGC-2020 analog inputs and outputs.

FEATURES

AEM-2020s have the following features:

- 8 Analog Inputs
- 8 RTD Inputs
- 2 Thermocouple Inputs
- 4 Analog Outputs
- Functionality of Inputs and Outputs assigned by BESTLogic+ 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.)

Analog Inputs

The AEM-2020 contains eight programmable analog inputs.

Rating: 4 to 20 mA or 0 to 10 Vdc (user-selectable)

RTD Inputs

The AEM-2020 contains eight programmable RTD inputs.

Rating: 100 Ω Platinum or 10 Ω Copper (user-selectable)
Setting Range: -50 to $+250^{\circ}\text{C}$ or -58 to $+482^{\circ}\text{F}$
Accuracy (10 Ω Copper): $\pm 0.044 \Omega @ 25^{\circ}\text{C}$, $\pm 0.005 \Omega/^{\circ}\text{C}$ drift over ambient temperature
Accuracy (100 Ω Platinum): $\pm 0.39 \Omega @ 25^{\circ}\text{C}$, $\pm 0.047 \Omega/^{\circ}\text{C}$ drift over ambient temperature

Thermocouple Inputs

The AEM-2020 contains two thermocouple inputs.

Rating: 2 K Type Thermocouples
Setting Range: 0 to $1,375^{\circ}\text{C}$ or 0 to $2,507^{\circ}\text{F}$
Display Range: Ambient to $1,375^{\circ}\text{C}$ or Ambient to $2,507^{\circ}\text{F}$
Accuracy: $\pm 40 \mu\text{V} @ 25^{\circ}\text{C}$, $\pm 5 \mu\text{V}/^{\circ}\text{C}$ drift over ambient temperature

Analog Outputs

The AEM-2020 contains four programmable analog outputs.

Rating: 4 to 20 mA or 0 to 10 Vdc (user-selectable)

Communication Interface

CANbus

Differential Bus Voltage: 1.5 to 3 Vdc
Maximum Voltage: -32 to $+32$ Vdc with respect to negative battery terminal
Communication Rate: 250 kb/s

Type Tests

Shock

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 $+130^{\circ}\text{C}$), vibration tests (of 5 to 50 G at $+25^{\circ}\text{C}$), and temperature/vibration tests (tested at 10 to 20 G over a temperature range of -60°C to $+100^{\circ}\text{C}$). Combined temperature and vibration testing at these extremes proves that the AEM-2020 is expected to provide long-term operation in a rugged environment. Note that the vibration and temperature extremes listed in this paragraph are specific to HALT and do not reflect recommended operation levels. These operational ratings are included in Section 10 of this manual.

Environment

Temperature

Operating: -40 to $+70^{\circ}\text{C}$ (-40 to $+158^{\circ}\text{F}$)

Storage: -40 to $+85^{\circ}\text{C}$ (-40 to $+185^{\circ}\text{F}$)

Humidity: IEC 68-2-38

UL Approval

"cURus" recognized to UL Standard 508 & CSA Standard C22.2 No.14

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

NFPA Compliance

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

CE Compliance

This product complies with the requirements of the following EC Directives:

- Low Voltage Directive (LVD) - 73/23/EEC as amended by 93/68/EEC
- Electromagnetic Compatibility (EMC) - 89/336/EEC as amended by 92/31/EEC and 93/68/EEC

This product conforms to the following Harmonized Standards:

- EN 50178:1997 - *Electronic Equipment for use in Power Installations*
- EN 61000-6-4:2001 - *Electromagnetic Compatibility (EMC), Generic Standards, Emission Standard for Industrial Environments*
- EN 61000-6-2:2001 - *Electromagnetic Compatibility (EMC), Generic Standards, Immunity for Industrial Environments*

Physical

Weight: 1.80 lb (816 g)

Dimensions: See *Installation* later in this section.

FUNCTIONAL DESCRIPTION

A functional description of the AEM-2020's inputs and outputs is provided below.

Analog Inputs

The AEM-2020 provides eight analog inputs that are user-selectable for 4 to 20 mA or 0 to 10 Vdc. Each analog input has under/over thresholds that can be configured as status only, alarm, or pre-alarm. When enabled, an out of range alarm alerts the user of an open or damaged analog input wire. The label text of each analog input is customizable.

RTD Inputs

The AEM-2020 provides eight user-configurable RTD inputs for monitoring genset temperature. Each RTD input can be configured as status only, alarm, or pre-alarm to protect against high or low temperature conditions. When enabled, an out of range alarm alerts the user of an open or damaged RTD input wire. The label text of each RTD input is customizable.

Thermocouple Inputs

The AEM-2020 provides two thermocouple inputs for monitoring genset temperature. Each thermocouple input can be configured as status only, alarm, or pre-alarm to protect against high or low temperature conditions. When enabled, an out of range alarm alerts the user of an open or damaged thermocouple input wire. The label text of each thermocouple input is customizable.

Analog Outputs

The AEM-2020 provides four analog outputs that are user-selectable for 4 to 20 mA or 0 to 10 Vdc. A wide selection of parameters including oil pressure, fuel level, generator voltage, and bus voltage can be configured as analog outputs. Refer to Section 4, *BESTCOMSPlus Software*, for a full list of parameter selections.

Communications

CANbus

A Control Area Network (CAN) is a standard interface that enables communication between the AEM-2020 and the DGC-2020.

BESTCOMSPlus SOFTWARE

BESTCOMSPlus provides the user with a point-and-click means to set and monitor the Analog Expansion Module. Installation and operation of BESTCOMSPlus is described in Section 4, *BESTCOMSPlus Software*.

INSTALLATION

Analog Expansion Modules are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a module, check the part number against the requisition and packing list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify the Basler Electric regional sales office, your sales representative, or a sales representative at Basler Electric, Highland, Illinois USA.

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

Product Registration

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

Mounting

Analog Expansion Modules are contained in an encapsulated plastic case and may be mounted in any convenient position. The construction of a Analog Expansion Module is durable enough to mount directly on a genset using UNF ¼-20 or equivalent hardware. Hardware selection should be based on any expected shipping/transportation and operating conditions. The torque applied to the mounting hardware should not exceed 65 in-lb (7.34 N•m).

See Figure 10-1 for AEM-2020 overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.

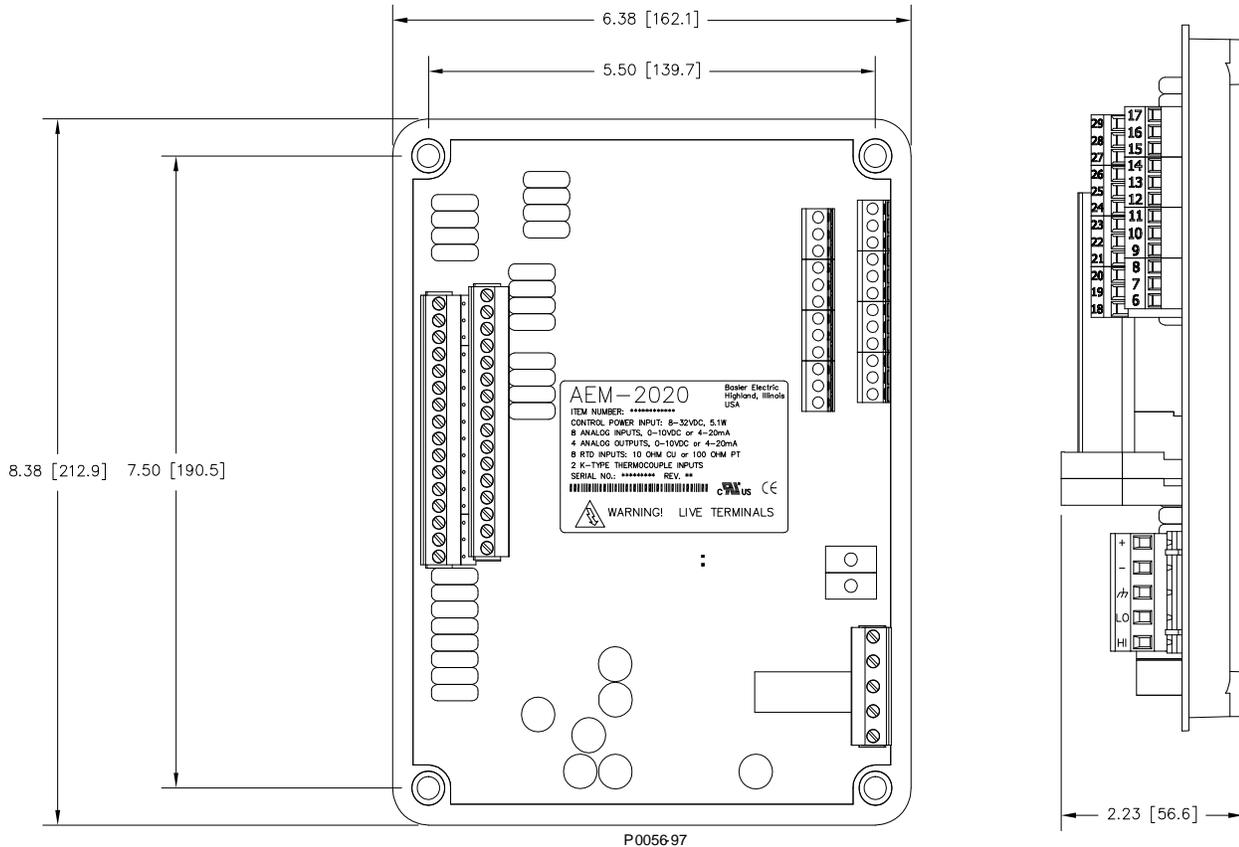


Figure 10-1. AEM-2020 Overall Dimensions

Connections

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

NOTE

Operating power from the battery must be of the correct polarity. Although reverse polarity will not cause damage, the AEM-2020 will not operate.

Be sure that the AEM-2020 is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the chassis ground terminal on the module.

Terminations

The terminal interface consists of both plug-in connectors and a permanently mounted connector with screw-down compression terminals.

AEM-2020 connections are made with one 5-position connector, two 12-position connectors, two 16-position connectors, and two 2-position thermocouple connectors. The 16, 5, and 2-position connectors plug into headers on the AEM-2020. The connectors and headers have dovetailed edges that ensure proper connector orientation. The connectors and headers are uniquely keyed to ensure that the connectors mate only with the correct headers. The 12-position connector is not a plug-in connector and

is mounted permanently to the board. Connector screw terminals accept a maximum wire size of 12 AWG. Thermocouple connectors accept a maximum thermocouple wire diameter of 0.177 inches (4.5 mm). Maximum screw torque is 5 inch-pounds (0.56 N•m).

Operating Power

The Analog Expansion Module operating power input accepts either 12 Vdc or 24 Vdc and tolerates voltage over the range of 6 to 32 Vdc. Operating power must be of the correct polarity. Although reverse polarity will not cause damage, the AEM-2020 will not operate. Operating power terminals are listed in Table 10-1.

It is recommended that a fuse be added for additional protection for the wiring to the battery input of the Analog Expansion Module. A Bussmann ABC-7 fuse or equivalent is recommended.

Table 10-1. Operating Power Terminals

Terminal	Description
P1- ⚡ (SHIELD)	Chassis ground connection
P1- - (BATT-)	Negative side of operating power input
P1- + (BATT+)	Positive side of operating power input

AEM-2020 Inputs and Outputs

Input and output terminals are shown in Figure 10-2 and listed in Table 10-2.

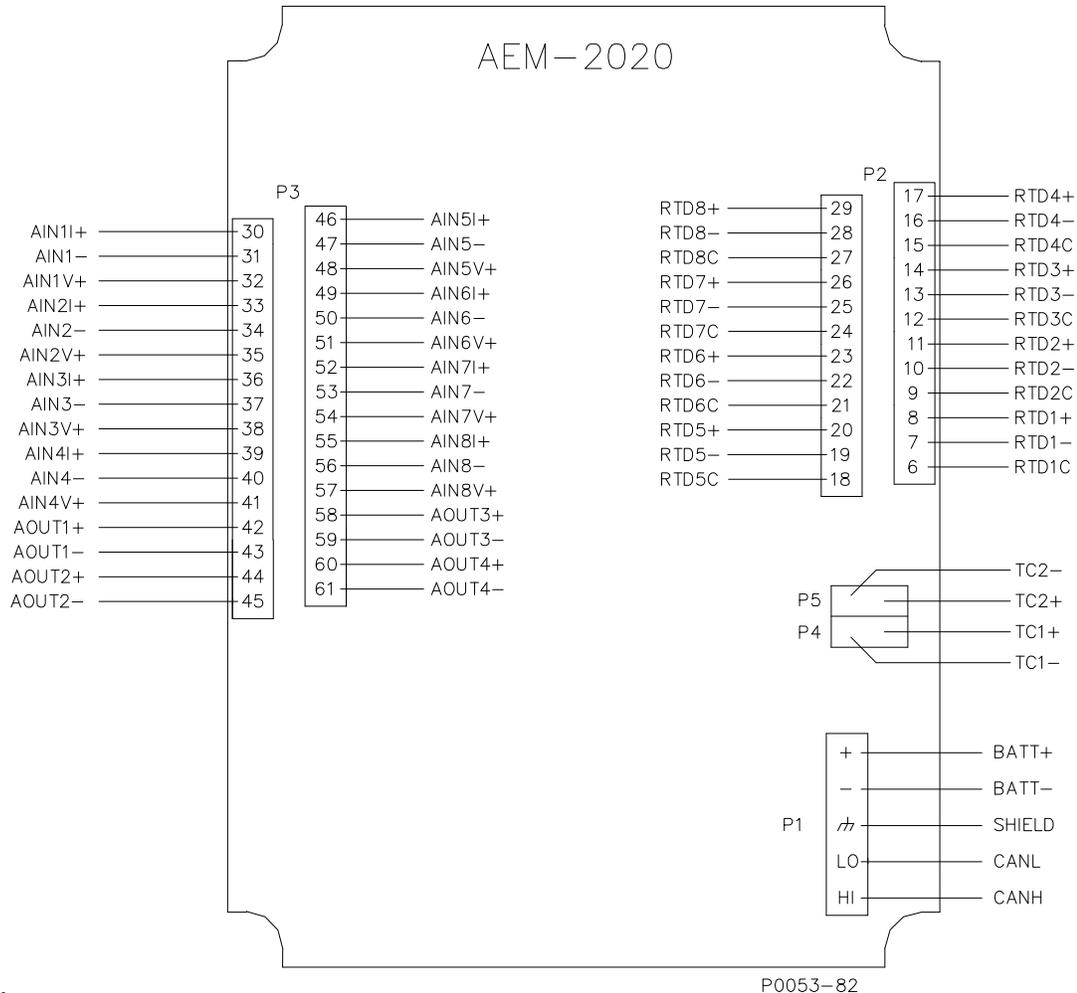


Figure 10-2. Input and Output Terminals

Table 10-2. Input and Output Terminals

Connector	Description
P1	Operating Power and CANbus
P2	RTD Inputs 1 - 8
P3	Analog Inputs 1 - 8 and Analog Outputs 1 - 4
P4	Thermocouple 1 Input
P5	Thermocouple 2 Input

External RTD Input Connections

External 2-wire RTD input connections are shown in Figure 10-3. Figure 10-4 shows external 3-wire RTD input connections.

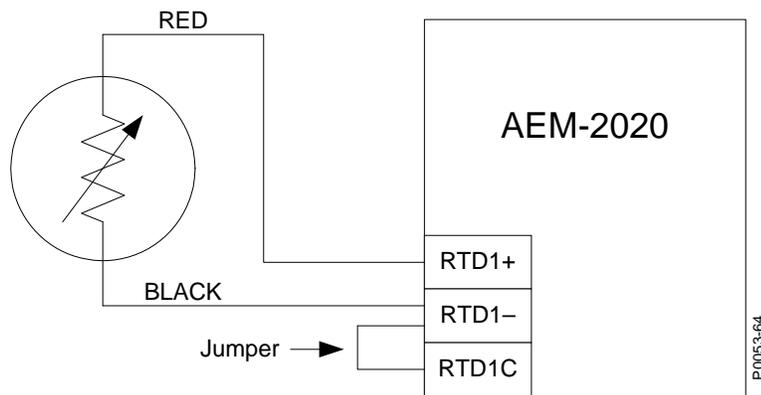


Figure 10-3. External Two-Wire RTD Input Connections

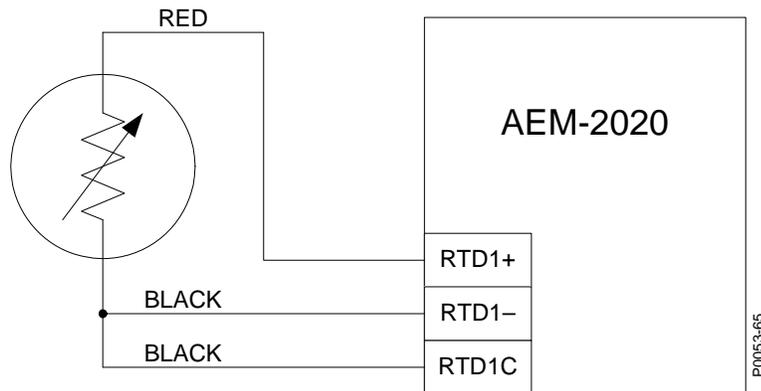


Figure 10-4. External Three-Wire RTD Input Connections

CANbus Interface

These terminals provide communication using the SAE J1939 protocol and provide high-speed communication between the Analog Expansion Module and the DGC-2020. Connections between the AEM-2020 and DGC-2020 should be made with twisted-pair, shielded cable. CANbus interface terminals are listed in Table 10-3. Refer to Figure 10-5 and Figure 10-6.

Table 10-3. CANbus Interface Terminals

Terminal	Description
P1- HI (CAN H)	CAN high connection (yellow wire)
P1- LO (CAN L)	CAN low connection (green wire)
P1-  (SHIELD)	CAN drain connection

NOTES

1. If the AEM-2020 is providing one end of the J1939 bus, a 120 Ω terminating resistor should be installed across terminals P1- LO (CANL) and P1- HI (CANH).
2. If the AEM-2020 is not part of the J1939 bus, the stub connecting the AEM-2020 to the bus should not exceed 914 mm (3 ft) in length.
3. The maximum bus length, not including stubs, is 40 m (131 ft).
4. The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the AEM-2020.

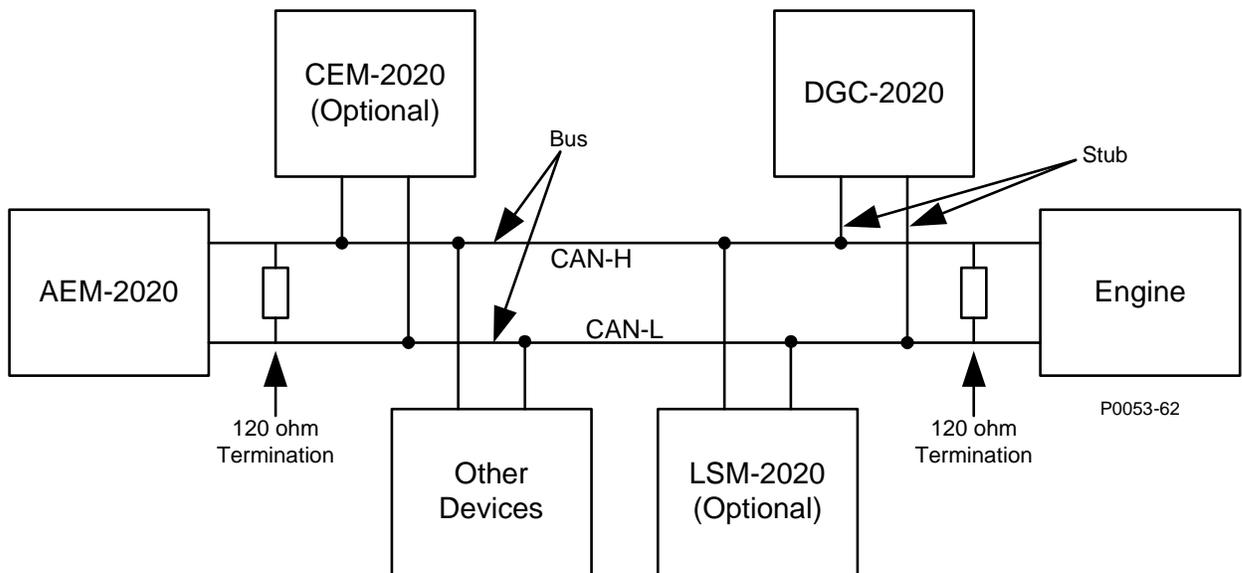


Figure 10-5. CANbus Interface with AEM-2020 providing One End of the Bus

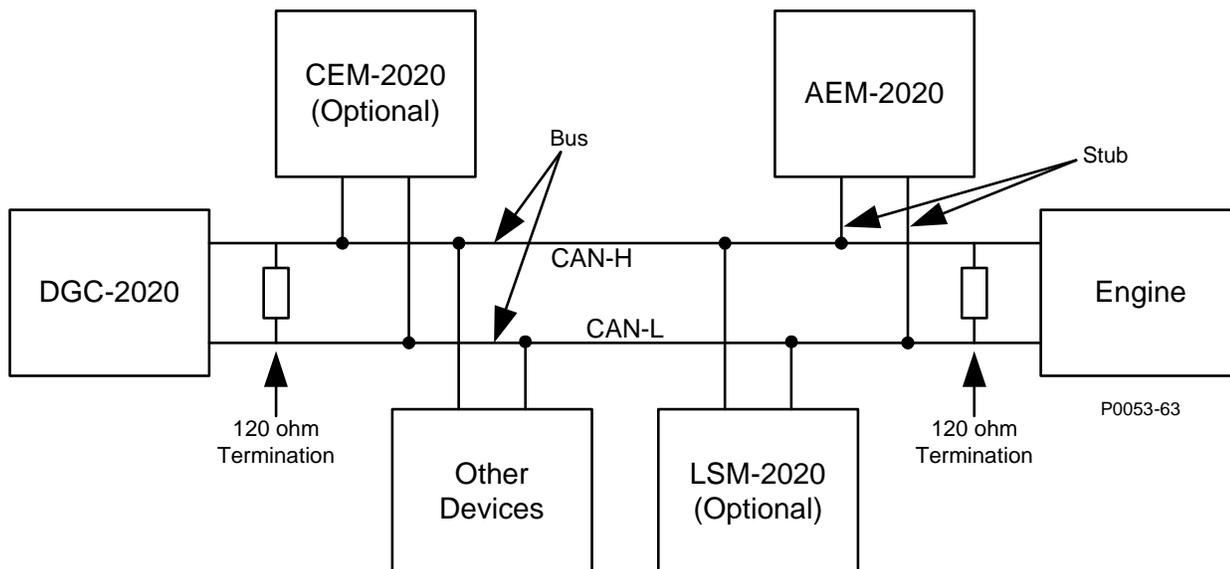


Figure 10-6. CANbus Interface with DGC-2020 providing One End of the Bus

MAINTENANCE

Preventive maintenance consists of periodically checking that the connections between the AEM-2020 and the system are clean and tight. Analog Expansion Modules are manufactured using state-of-the-art surface-mount technology. As such, Basler Electric recommends that no repair procedures be attempted by anyone other than Basler Electric personnel.

APPENDIX A • TIME OVERCURRENT CHARACTERISTIC CURVES

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APPENDIX A • TIME OVERCURRENT CHARACTERISTIC CURVES

INTRODUCTION

The inverse time overcurrent characteristic curves provided by the DGC-2020 (style xxxxxxExx only) closely emulate most of the common electromechanical, induction-disk, overcurrent relays sold in North America. To further improve proper relay coordination, selection of integrated reset or instantaneous reset characteristics is also provided.

CURVE SPECIFICATIONS

Timing Accuracy:

Within ± 500 milliseconds of indicated operating point.

Sixteen inverse time functions and one fixed time function can be selected. Characteristic curves for the inverse and definite time functions are defined by the following equation:

$$T_T = \frac{AD}{M^N - C} + BD + K \quad \text{Equation A-1}$$

$$T_R = \frac{RD}{|M^2 - 1|} \quad \text{Equation A-2}$$

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 Standard C37.112-1996.

* Timing range is 0.0 to 7,200 seconds when the F (fixed) curve is selected.

Table A-1 lists time characteristic curve constants. See Figures A-1 through A-16 for graphs of the characteristics.

Table A-1. 51 Time Characteristic Curve Constants

Curve Selection	Curve Name	Trip Characteristic Constants					Reset
		A	B	C	N	K	R
S1	S, S1, Short Inverse	0.2663	0.03393	1.0000	1.2969	0.0280	0.5000
S2	S2, Short Inverse	0.0286	0.02080	1.0000	0.9844	0.0280	0.0940
L1	L, L1, Long Inverse	5.6143	2.18592	1.0000	1.0000	0.0280	15.750
L2	L2, Long Inverse	2.3955	0.00000	1.0000	0.3125	0.0280	7.8001
D	D, Definite Time	0.4797	0.21359	1.0000	1.5625	0.0280	0.8750
M	M, Moderately Inverse	0.3022	0.12840	1.0000	0.5000	0.0280	1.7500
I1	I, I1, Inverse Time	8.9341	0.17966	1.0000	2.0938	0.0280	9.0000
I2	I2, Inverse Time	0.2747	0.10426	1.0000	0.4375	0.0280	0.8868
V1	V, V1, Very Inverse	5.4678	0.10814	1.0000	2.0469	0.0280	5.5000
V2	V2, Very Inverse	4.4309	0.09910	1.0000	1.9531	0.0280	5.8231
E1	E, E1Extremely Inverse	7.7624	0.02758	1.0000	2.0938	0.0280	7.7500
E2	E2, Extremely Inverse	4.9883	0.01290	1.0000	2.0469	0.0280	4.7742
A	A, Standard Inverse	0.01414	0.00000	1.0000	0.0200	0.0280	2.0000
B	B, Very Inverse (I^2t)	1.4636	0.00000	1.0000	1.0469	0.0280	3.2500
C	C, Extremely Inverse (I^2t)	8.2506	0.00000	1.0000	2.0469	0.0280	8.0000
G	G, Long Time Inverse (I^2t)	12.1212	0.00000	1.0000	1.0000	0.0280	29.0000
F	Fixed Time *	0.0000	1.00000	0.0000	0.0000	0.0280	1.0000

* Curve F has a fixed delay of one second times the Time Dial setting.

TIME OVERCURRENT CHARACTERISTIC CURVE GRAPHS

Figures A-1 through A-16 illustrate the characteristic curves of the DGC-2020. Table A-2 cross-references each curve to existing electromechanical relay characteristics. Equivalent time dial settings were calculated at a value of five times pickup.

Table A-2. Characteristic Curve Cross-Reference

Curve	Curve Name	Similar To
S1	S, S1, Short Inverse	ABB CO-2
S2	S2, Short Inverse	GE IAC-55
L1	L, L1, Long Inverse	ABB CO-5
L2	L2, Long Inverse	GE IAC-66
D	D, Definite Time	ABB CO-6
M	M, Moderately Inverse	ABB CO-7
I1	I, I1, Inverse Time	ABB CO-8
I2	I2, Inverse Time	GE IAC-51
V1	V, V1, Very Inverse	ABB CO-9
V2	V2, Very Inverse	GE IAC-53
E1	E, E1, Extremely Inverse	ABB CO-11
E2	E2, Extremely Inverse	GE IAC-77
A	A, Standard Inverse	BS, IEC Standard Inverse
B	B, Very Inverse (I^2t)	BS, IEC Very Inverse (I^2t)
C	C, Extremely Inverse (I^2t)	BS, IEC Extremely Inverse (I^2t)
G	G, Long Time Inverse (I^2t)	BS, IEC Long Time Inverse (I^2t)
F	Fixed Time	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											
S, S1	ABB CO-2	0.3	0.8	1.7	2.4	3.4	4.2	5.0	5.8	6.7	7.7	8.6	9.7
L, L1	ABB CO-5	0.4	0.8	1.5	2.3	3.3	4.2	5.0	6.0	7.0	7.8	8.8	9.9
D	ABB CO-6	0.5	1.1	2.0	2.9	3.7	4.5	5.0	5.9	7.2	8.0	8.9	10.1
M	ABB CO-7	0.4	0.8	1.7	2.5	3.3	4.3	5.3	6.1	7.0	8.0	9.0	9.8
I, I1	ABB CO-8	0.3	0.7	1.5	2.3	3.2	4.0	5.0	5.8	6.8	7.6	8.7	10.0
V, V1	ABB CO-9	0.3	0.7	1.4	2.1	3.0	3.9	4.8	5.7	6.7	7.8	8.7	9.6
E, E1	ABB CO-11	0.3	0.7	1.5	2.4	3.2	4.2	5.0	5.7	6.6	7.8	8.5	10.3
I2	GE IAC-51	0.6	1.0	1.9	2.7	3.7	4.8	5.7	6.8	8.0	9.3	10.6	N/A
V2	GE IAC-53	0.4	0.8	1.6	2.4	3.4	4.3	5.1	6.3	7.2	8.4	9.6	N/A
S2	GE IAC-55	0.2	1.0	2.0	3.1	4.0	4.9	6.1	7.2	8.1	8.9	9.8	N/A
L2	GE IAC-66	0.4	0.9	1.8	2.7	3.9	4.9	6.3	7.2	8.5	9.7	10.9	N/A
E2	GE IAC-77	0.5	1.0	1.9	2.7	3.5	4.3	5.2	6.2	7.4	8.2	9.9	N/A

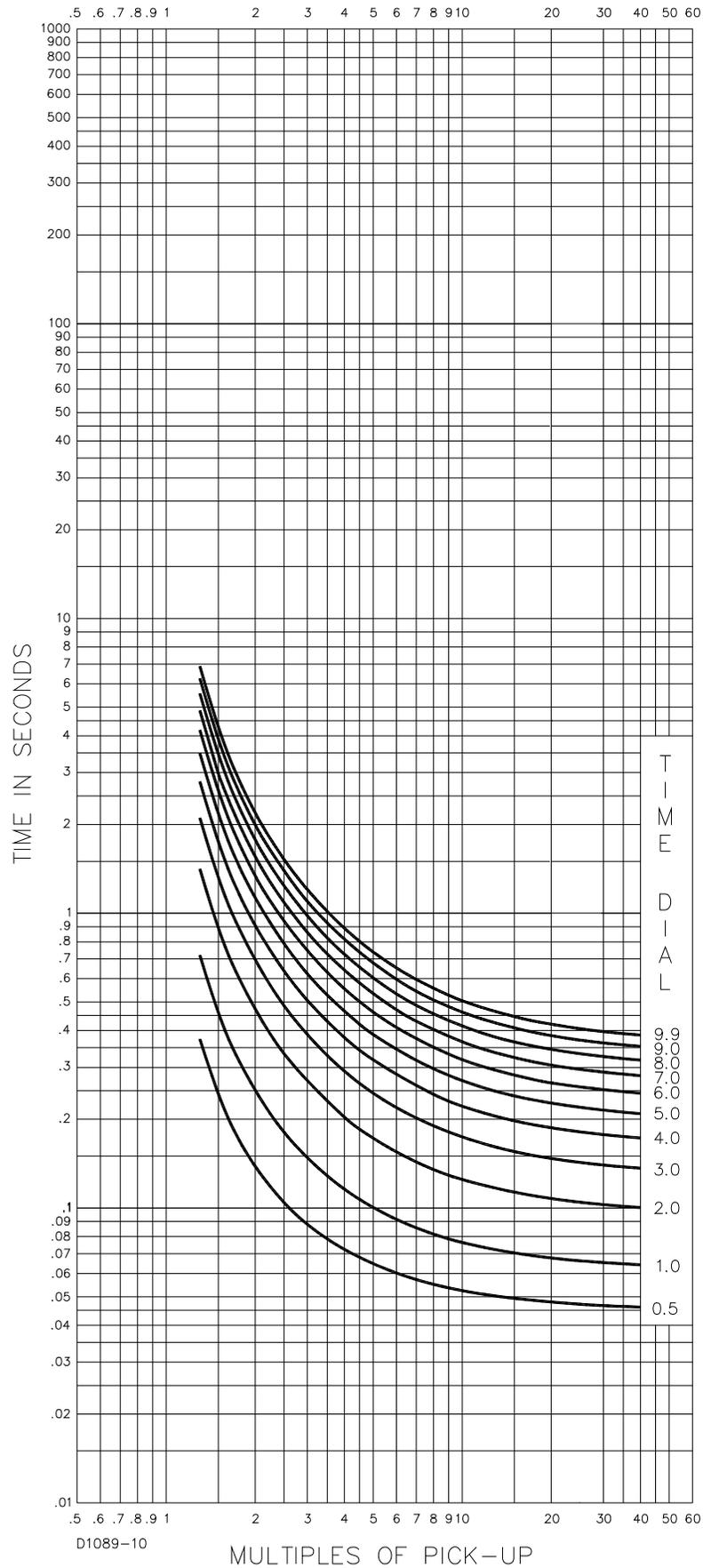


Figure A-1. Time Characteristic Curve S, S1, Short Inverse (Similar to ABB CO-2)

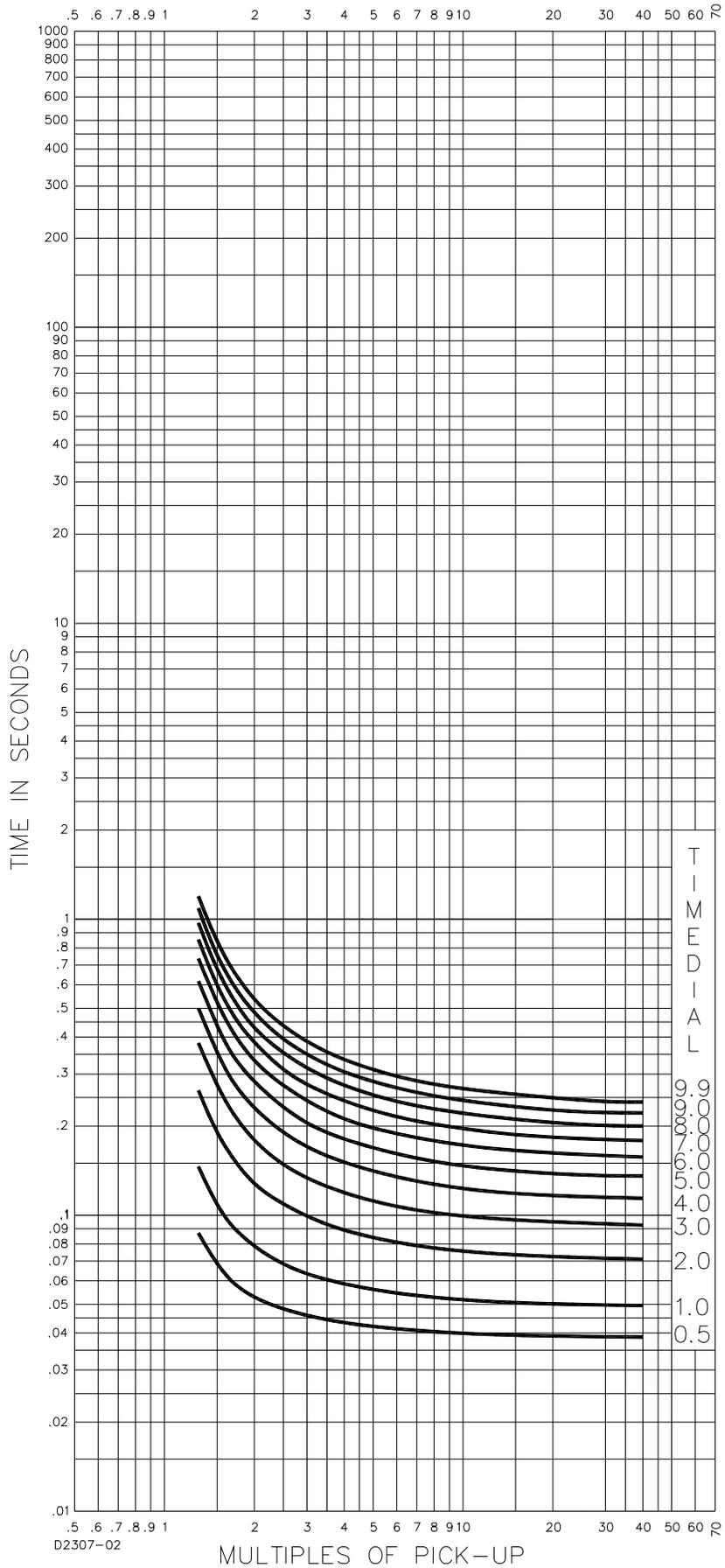


Figure A-2. Time Characteristic Curve S2, Short Inverse (Similar To GE IAC-55)

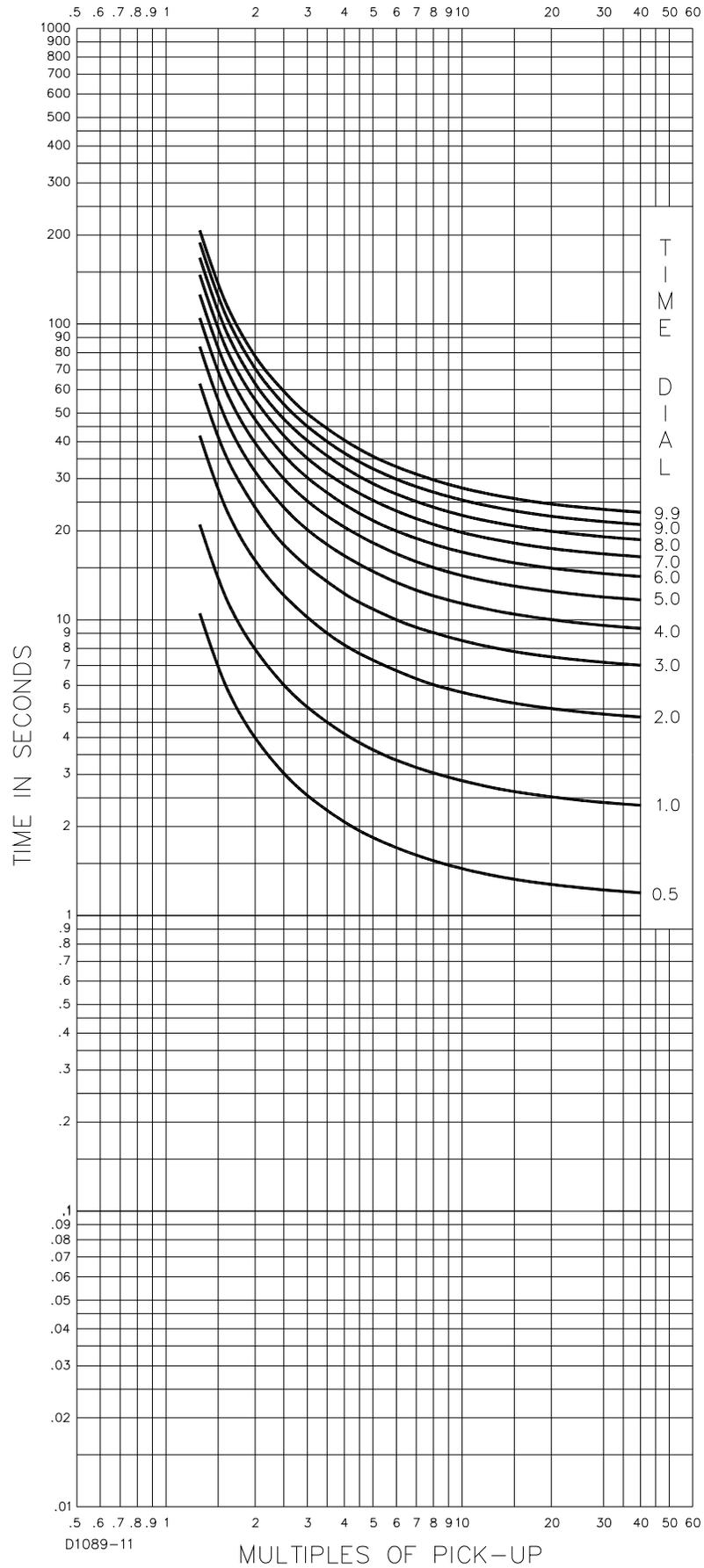


Figure A-3. Time Characteristic Curve L, L1, Long Inverse (Similar to ABB CO-5)

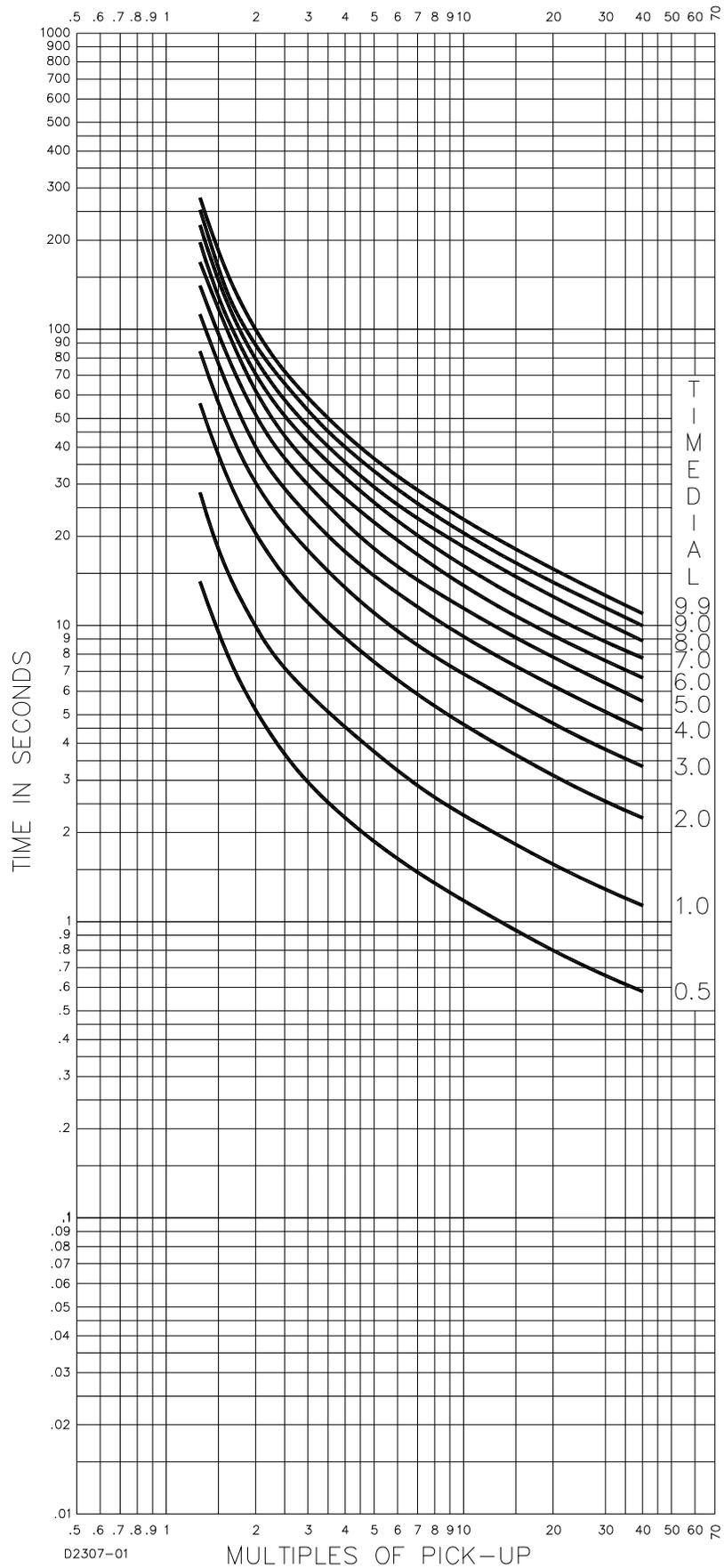


Figure A-4. Time Characteristic Curve L2, Long Inverse (Similar To GE IAC-66)

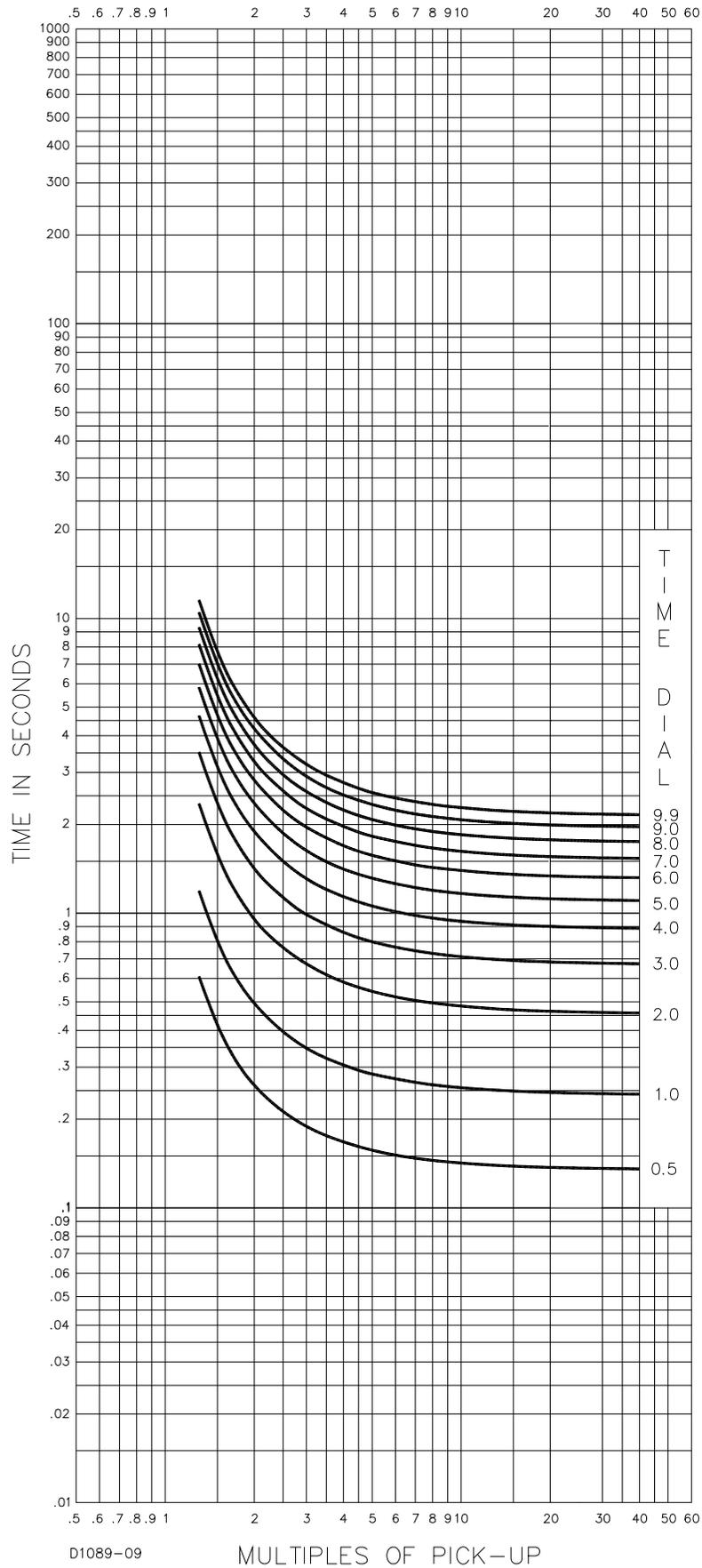


Figure A-5. Time Characteristic Curve D, Definite Time (Similar To ABB CO-6)

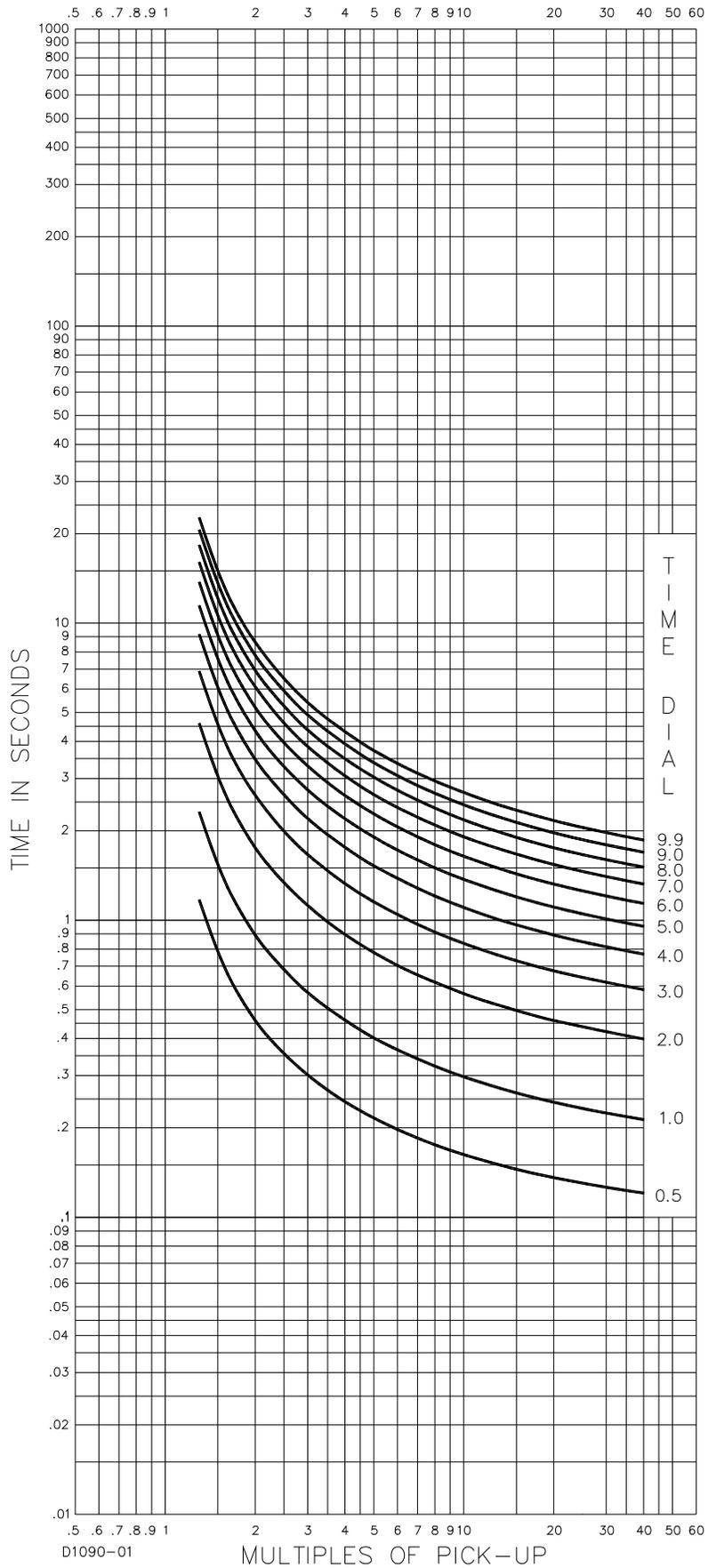


Figure A-6. Time Characteristic Curve M, Moderately Inverse (Similar to ABB CO-7)

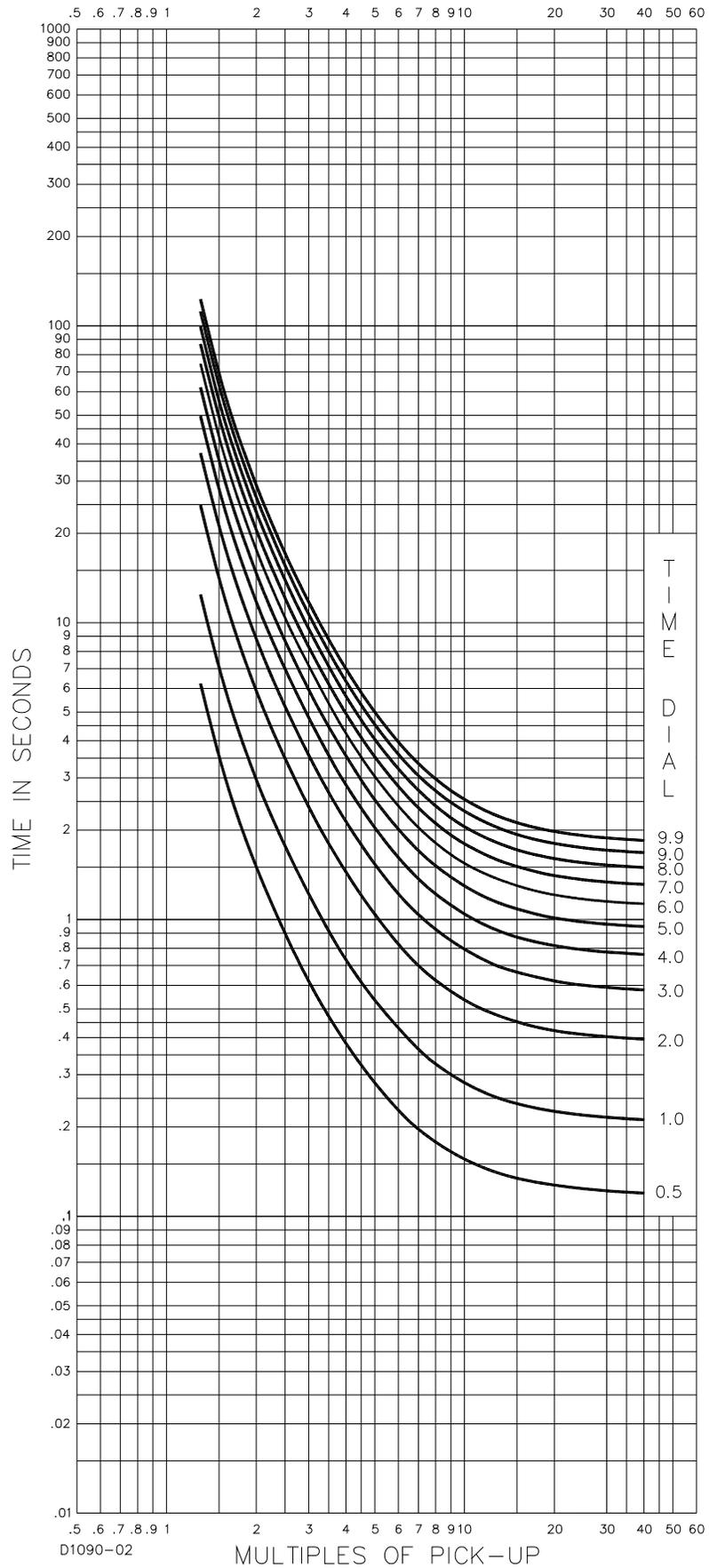


Figure A-7. Time Characteristic Curve I, I1, Inverse Time (Similar to ABB CO-8)

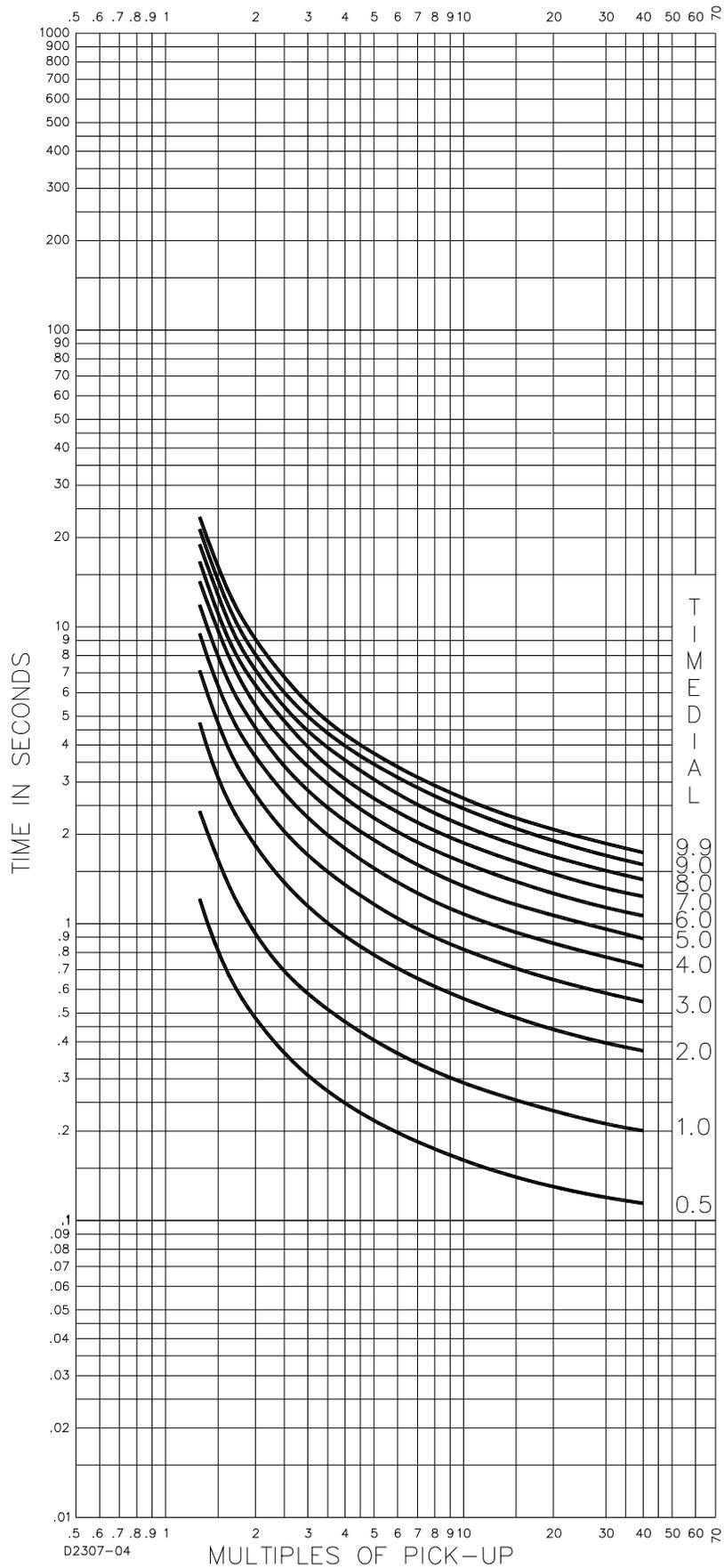


Figure A-8. Time Characteristic Curve I2, Inverse Time (Similar to GE IAC-51)

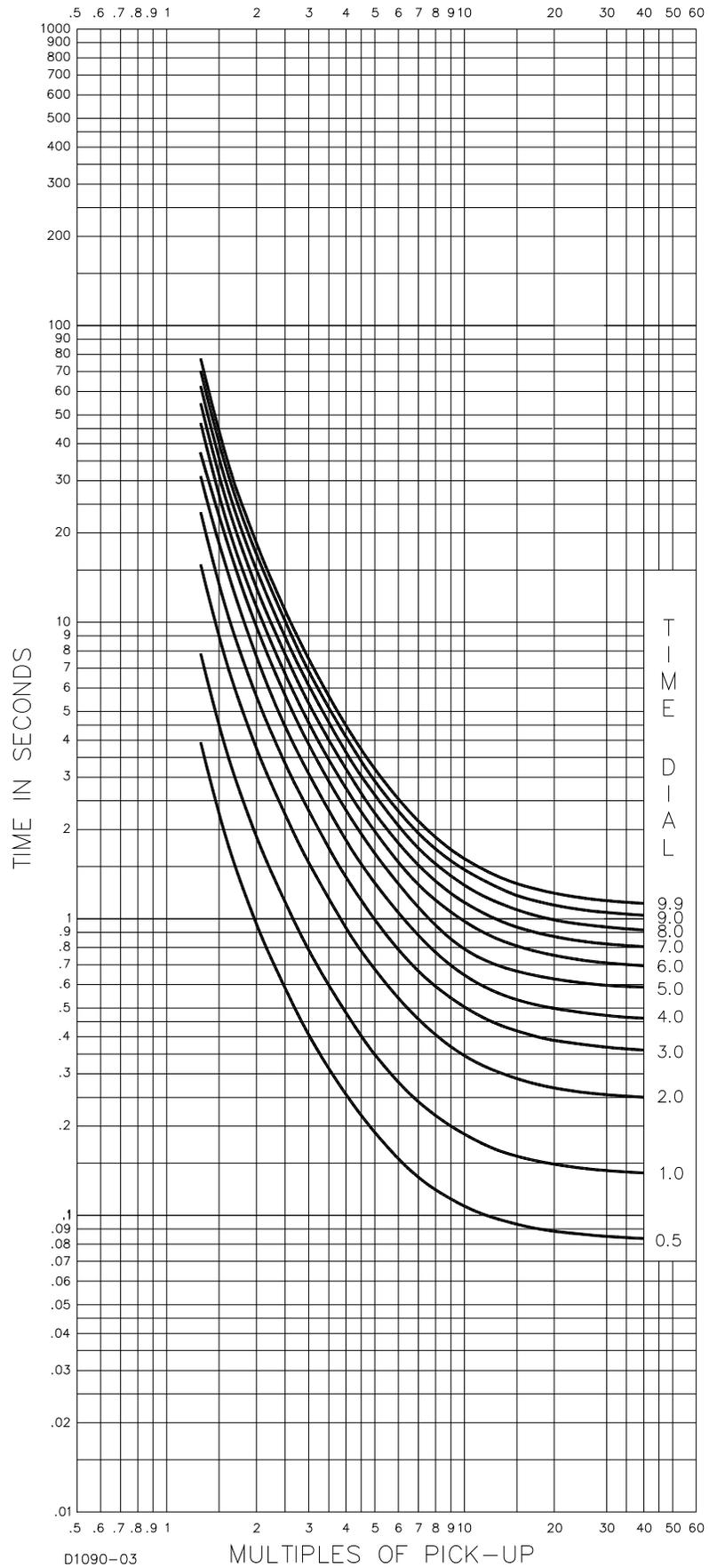


Figure A-9. Time Characteristic Curve V, V1, Very Inverse (Similar to ABB CO-9)

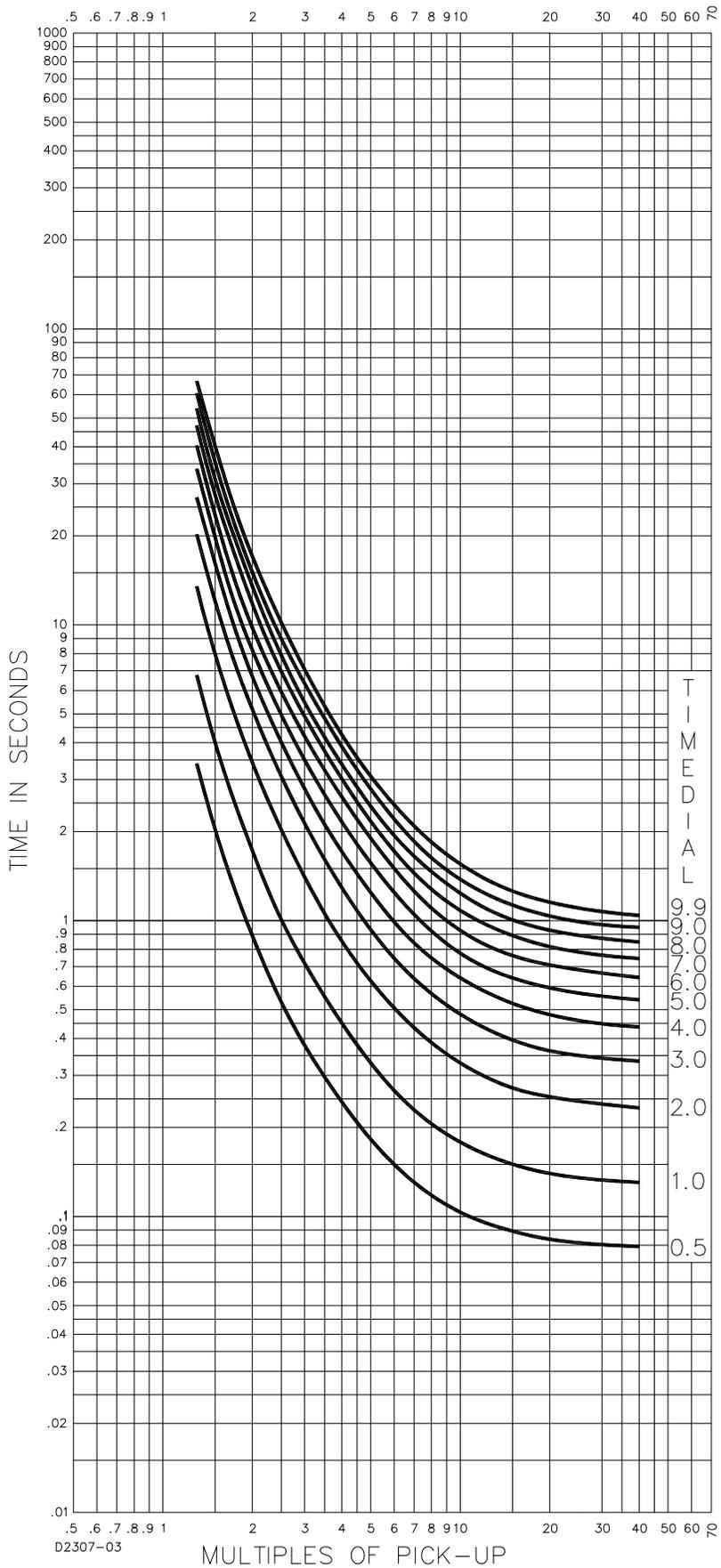


Figure A-10. Time Characteristic Curve V2, Very Inverse (Similar to GE IAC-53)

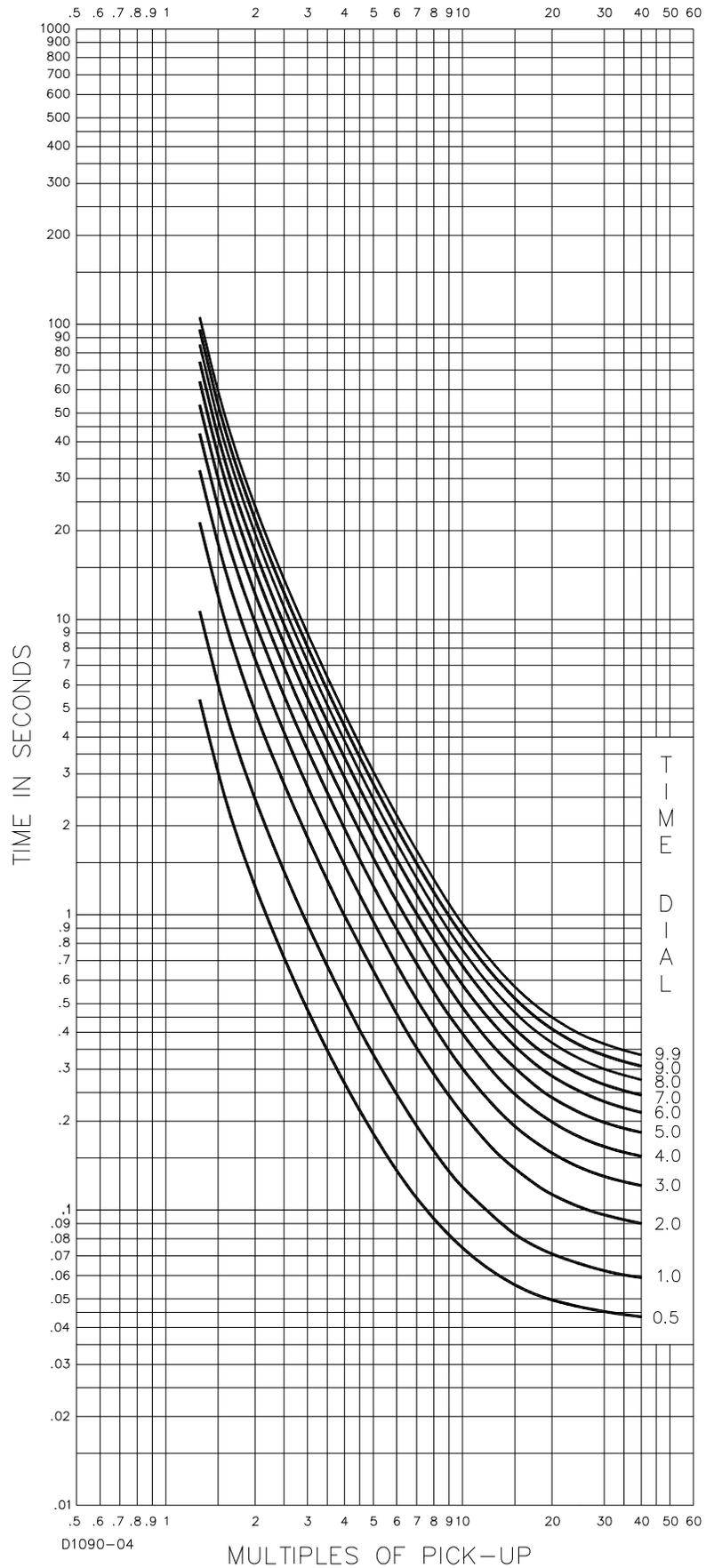


Figure A-11. Time Characteristic Curve E, E1, Extremely Inverse (Similar to ABB CO-11)

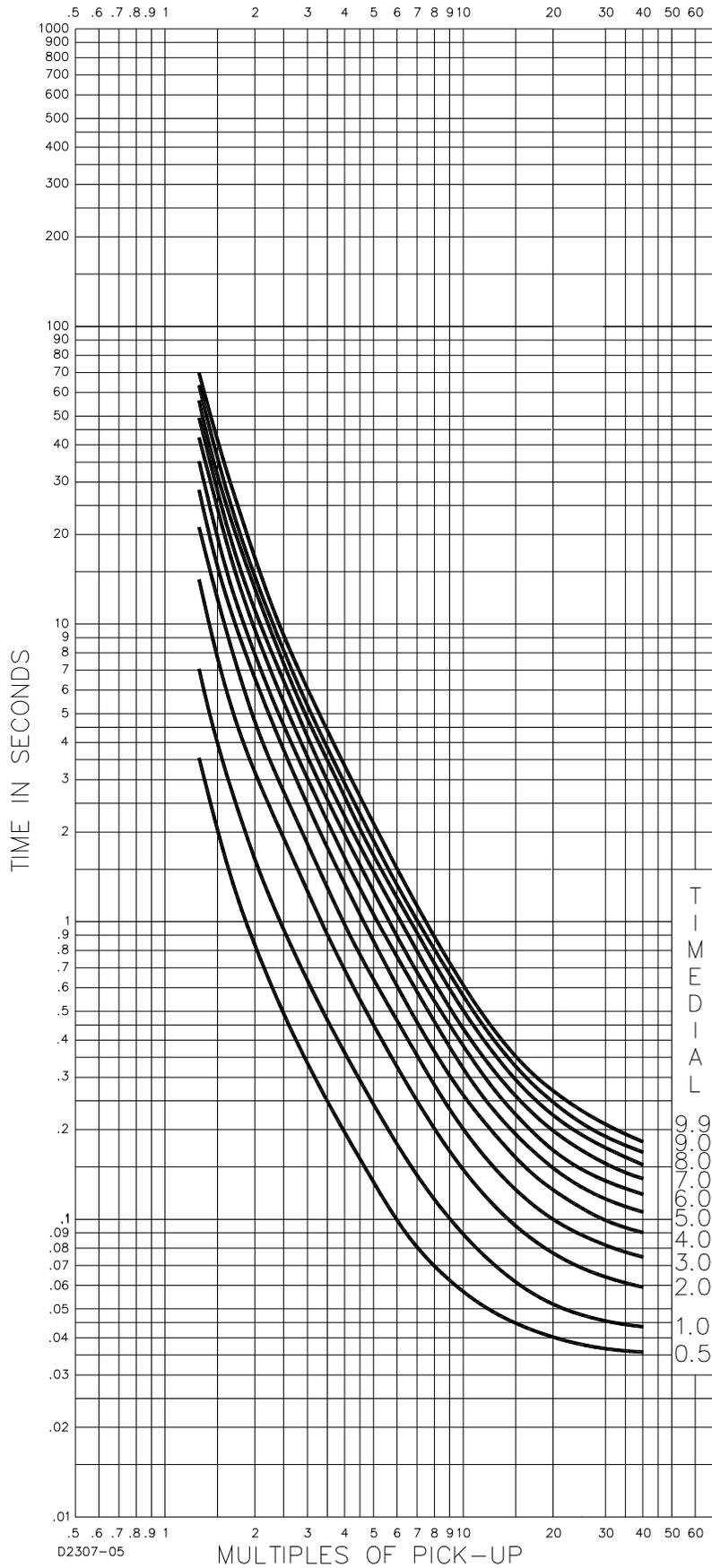


Figure A-12. Time Characteristic Curve E2, Extremely Inverse (Similar to GE IAC-77)

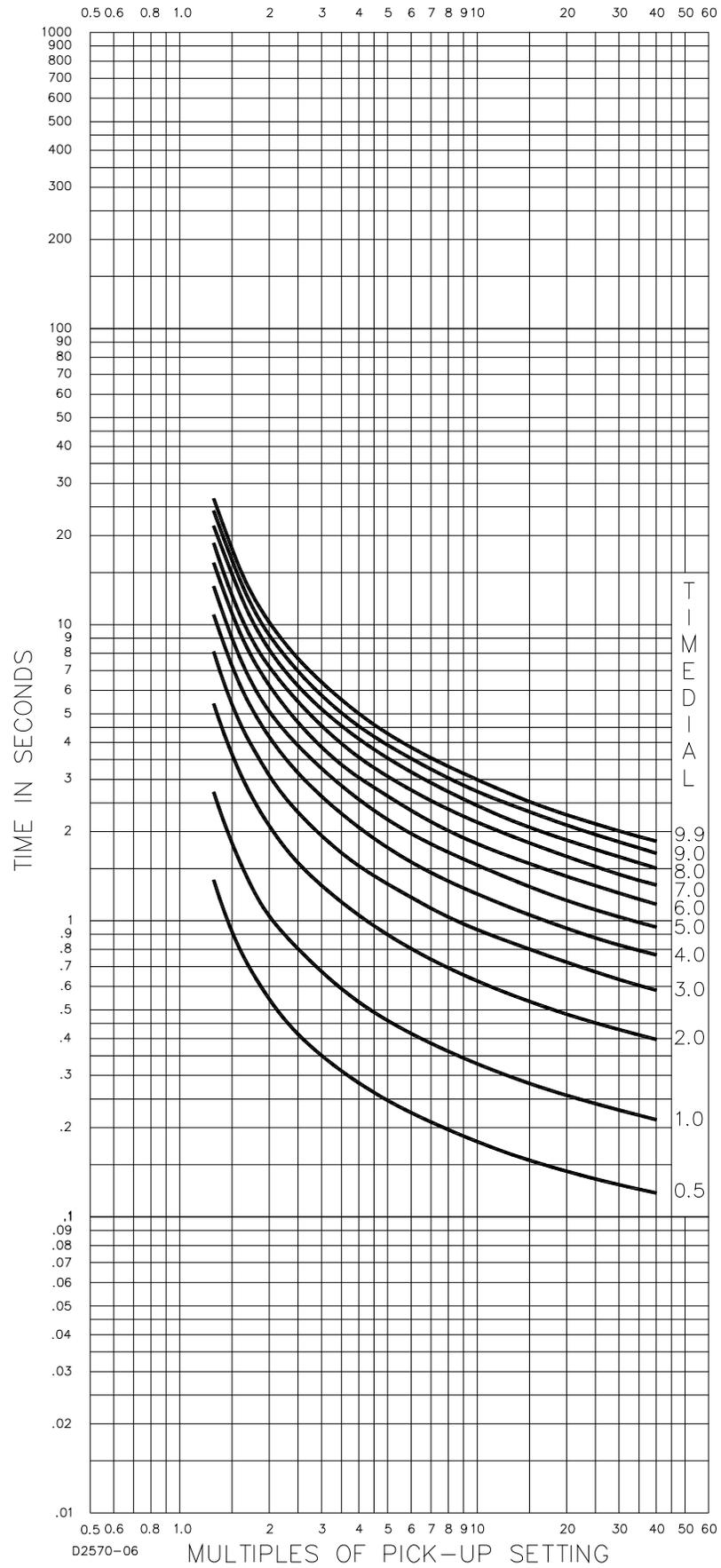


Figure A-13. Time Characteristic Curve A, Standard Inverse

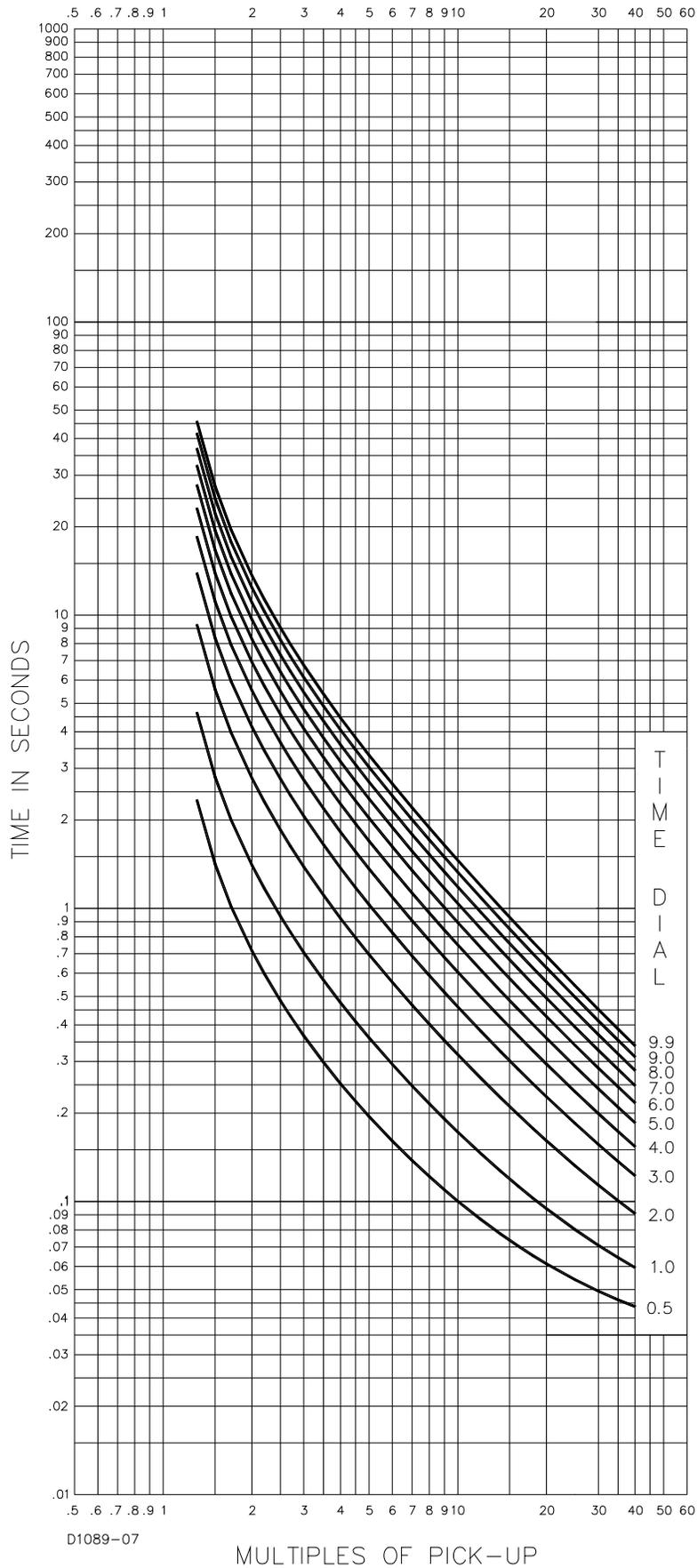


Figure A-14. Time Characteristic Curve B, Very Inverse

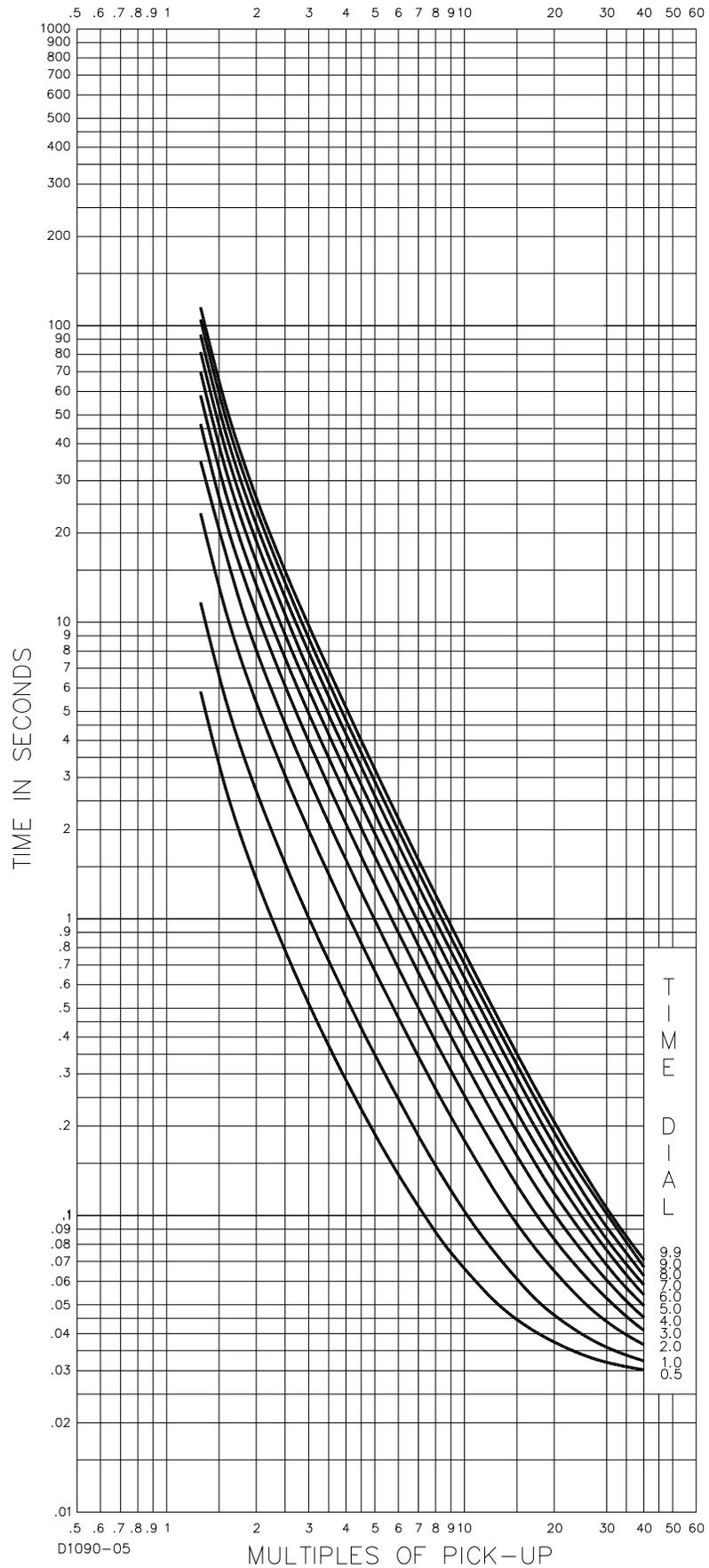


Figure A-15. Time Characteristic Curve C, Extremely Inverse

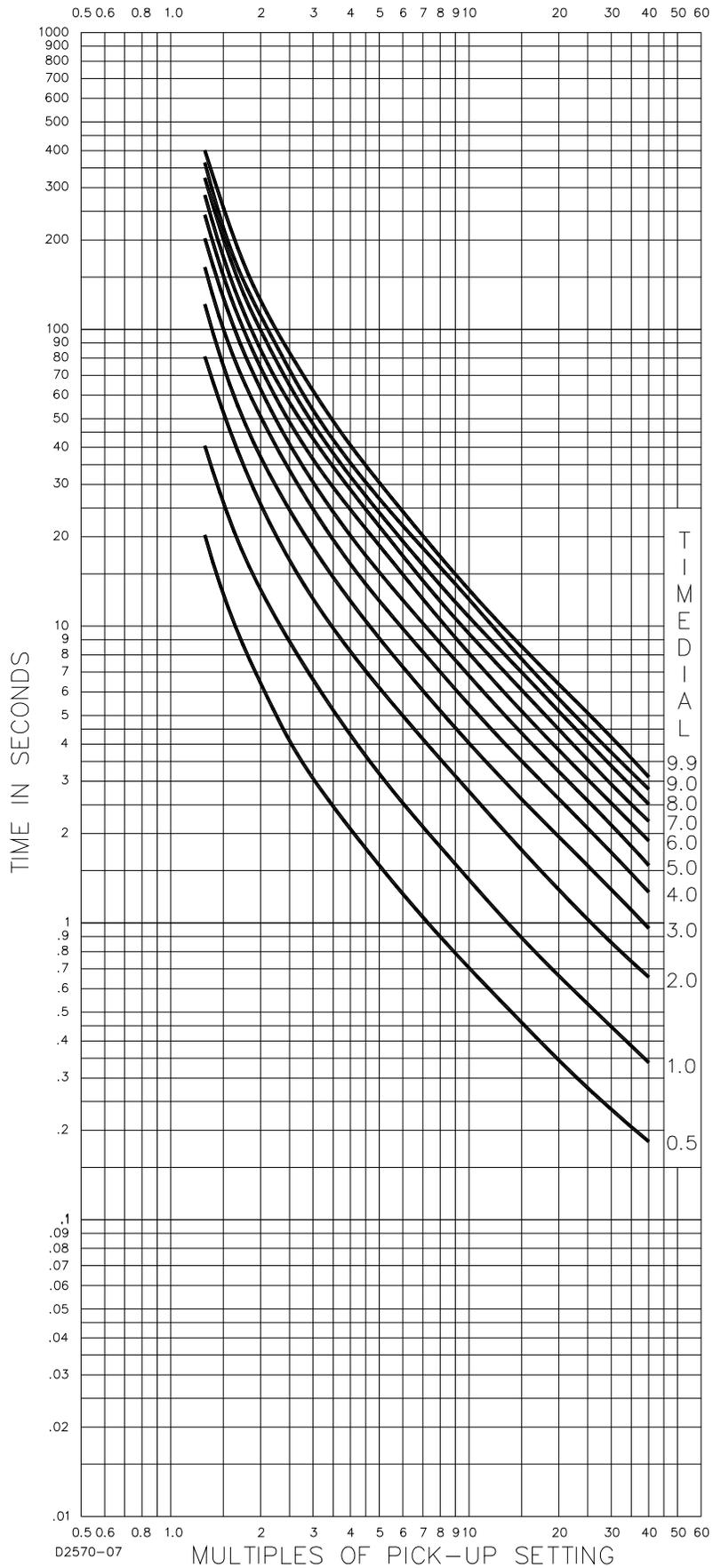


Figure A-16. Time Characteristic Curve G, Long Time Inverse

APPENDIX B • MODBUS™ COMMUNICATION

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APPENDIX B • MODBUS™ COMMUNICATION

INTRODUCTION

General Overview

An optional feature of the DGC-2020 performs Modbus communications by emulating a subset of the Modicon 984 Programmable Controller. This document describes the Modbus communications protocol employed by the DGC-2020 and how to exchange information with the DGC-2020 over a Modbus network.

The DGC-2020 maps all parameters into the Modicon 984 Holding Register address space (4XXXX). Refer to *MAPPING - DGC 2020 Parameters into MODICON ADDRESS SPACE* in this section. The 40XXX registers are identical to the data that was present in the DGC-500 and DGC-1000 products. This allows the DGC-2020 to work seamlessly in Modbus applications where it is replacing a DGC-500 or DGC-1000. The 42XXX registers contain all information included in the DGC-2020 and should be used for any new Modbus applications.

Intended Use of the Communications Protocol

This document provides the necessary information for 3rd party OEMs to develop in-house software to communicate with the DGC-2020 via Modbus protocol. This will allow the exchange of setup information and measured data between a Modbus Master Station and the DGC-2020.

The DGC-2020 data supported for remote access is listed in *MAPPING - DGC 2020 Parameters into MODICON ADDRESS SPACE* in this section.

DETAILED DESCRIPTION OF DGC-2020 MODBUS PROTOCOL

Modbus Protocol Overview

Modbus communications use a master-slave technique in which only the master can initiate a transaction, called a query. The slave addressed by the query will respond by either supplying the requested data to the master or by performing the requested action. A slave device never initiates communications on the Modbus, and will always generate a response to the query unless certain error conditions occur. The DGC-2020 is designed to communicate on the Modbus only as a slave device.

A master can query slaves individually or query all slaves collectively by initiating a broadcast message. A slave does not send a response message to a broadcast query.

If a query requests actions unable to be performed by the slave, the slave response message will contain an Exception Response Code defining the error detected.

Query and response messages share the same message structure. Each message is comprised of four message fields: the Device Address, the Function Code, the Data Block, and the Error Check field. Subsequent sections in this document detail each message field and the corresponding functionality supported by the DGC-2020.

Query / Response Message Structure:

- Device Address
- Function Code
- Eight-Bit Data Bytes
- Error Check

Device Address Field

The Device Address field contains the unique Modbus address of the slave being queried. The addressed slave will repeat its address in the Device Address field of the response message. This field is 1 byte.

Function Code Field

The Function Code field in the Query message defines the action to be taken by the addressed slave. This field is echoed in the Response message, and will be altered by setting the MSB of the field to "1" if the response is an error response. This field is 1 byte.

Data Block Field

The query Data block contains additional information needed by the slave to perform the requested function. The response Data block contains data collected by the slave for the queried function. An error response will substitute an Exception Response Code for the Data Block. The length of this field varies with each query.

Error Check Field

The Error Check field provides a method for the slave to validate the integrity of the query message contents and allows the master to confirm the validity of response message contents. This field is 2 bytes.

Serial Transmission Details

A standard Modbus network offers 2 transmission modes for communication: ASCII or RTU. The DGC-2020 supports only the RTU (Remote Terminal Unit) mode.

Each 8-bit byte in a message contains two 4-bit hexadecimal characters. The message is transmitted in a continuous stream with the LSB of each byte of data transmitted first. Transmission of each 8-bit data byte occurs with 1 start bit and 1 stop bit. A ninth data bit is added when parity is selected. Parity checking is user-configurable to even, odd or none. The transmission baud rate is also user-configurable, and both parity and baud rate can be altered during real-time operation. If altered, the new baud rate and / or parity will not be enforced until the response message to the current query has completed. The DGC-2020 supported baud rates are 9600, 4800, 2400, and 1200.

Message Framing / Timing Considerations

When receiving a message, the DGC-2020 will allow maximum inter-byte latency up to 3.5 - 4.0 character times before considering the message complete.

Once a valid query is received, the DGC-2020 waits 10 msec. before responding.

Error Handling and Exception Responses

Any query received that contains a non-existent device address, a framing error or CRC error will be ignored - no response will be transmitted. Queries addressed to a DGC-2020 with an unsupported function code, unsupported register references, or illegal values in the data block will result in an error response message with an Exception Response Code. The Exception Response codes supported by the DGC-2020 are listed in Table B-1.

Table B-1. Exception Response Codes

Code	Name	Meaning
01	Illegal Function	The query Function/Subfunction Code is unsupported; query read of more than 125 registers; query preset of more than 100 registers
02	Illegal Data Address	A register referenced in the data block does not support queried read/write; query preset of a subset of a numerical register group.
03	Illegal Data Value	A preset register data block contains an incorrect number of bytes or one or more data values out of range.

DETAILED DGC-2020 MESSAGE DEFINITION

Device Address

The DGC-2020 Device Address can be any value in the Modbus protocol Device Address range (1 - 247). A query with a Device Address of 0 signifies a Broadcast message to all slaves - the connected DGC-2020s will not respond to the broadcast query.

Function Code and Data Block

The DGC-2020 maps all parameters into the Modicon 984 Holding Register address space (4XXXX) and supports the following Function Codes:

- Function 03 - Read Holding Registers
- Function 6 - Preset Single Register, Non-Broadcast & Broadcast

- Function 08, Subfunction 00 - Diagnostics: Return Query Data
- Function 16 - Preset Multiple Registers, Non-Broadcast & Broadcast

The only Broadcast query supported by the DGC-2020 is the Preset Multiple Registers query.

Read Holding Registers

Read Holding Registers - General

QUERY:

This query message requests a register or block of registers to be read. The data block contains the starting register address and the quantity of registers to be read. A register address of N will read Holding Register N+1.

Device Address
 Function Code 03 (hex)
 Starting Address Hi
 Starting Address Lo
 No. of Registers Hi
 No. of Registers Lo
 CRC Error Check

The number of registers cannot exceed 125 without causing an error response with Exception Code "Illegal Function".

Queries to read Write Only or unsupported registers result in an error response with Exception Code of "Illegal Data Address".

RESPONSE:

The response message contains the data queried, respectively. The data block contains the block length in bytes followed by the data for each requested register. Attempting to read an unused register or a register which does not support read results in an error response with Exception Code of "Illegal Data Address".

Device Address
 Function Code 03 (hex)
 Byte Count
 Data Hi
 Data Lo
 .
 .
 .
 Data Hi
 Data Lo
 CRC Error Check

Return Query Data

This query contains data to be returned (looped back) in the response. The response and query messages should be identical.

Device Address
 Function Code 08 (hex)
 Subfunction Hi 00 (hex)
 Subfunction Lo 00 (hex)
 Data Hi
 Data Lo
 CRC Error Check

Preset Multiple Registers, Non-Broadcast & Broadcast

Preset Multiple Registers - General

QUERY:

This query message requests a register or block of registers to be written. The data block contains the starting address and the quantity of registers to be written, followed by the Data Block byte count and data. A device address is 0 for a broadcast query.

A register address of N will write Holding Register N+1.

No query data will be written (non-broadcast or broadcast) if any of the following exceptions occur:

- Queries writing to Read Only or unsupported registers result in an error response with Exception Code of "Illegal Data Address".
- Queries attempting to write more than 100 registers cause an error response with Exception Code "Illegal Function".
- An incorrect Byte Count will result in an error response with Exception Code of "Illegal Data Value".
- There are several instances of registers that are grouped together (signified as DP or TP) to collectively represent a single numerical (vs. ASCII string) DGC-2020 parameter value. A query to write a subset of such a register group will result in an error response with Exception Code "Illegal Data Address".
- A query to write an unallowed 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 unallowed 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.

Floating Point Data Format

The Modbus floating point data format uses two consecutive holding registers to represent a data value. The first register contains the low-order 16 bits of the following 32-bit format:

- MSB is the sign bit for the floating-point value (0 = positive).
- The next 8 bits are the exponent biased by 127 decimal.
- The 23 LSBs comprise the normalized mantissa. The most-significant bit of the mantissa is always assumed to be 1 and is not explicitly stored, yielding an effective precision of 24 bits.

The value of the floating-point number is obtained by multiplying the binary mantissa times two raised to the power of the unbiased exponent. The assumed bit of the binary mantissa has the value of 1.0, with the remaining 23 bits providing a fractional value. Table B-2 shows the floating-point format.

Table B-2. Floating Point Format

Sign	Exponent + 127	Mantissa
1 bit	8 bits	23 bits

The floating-point format allows for values ranging from approximately 8.43×10^{-37} to 3.38×10^{38} . A floating-point value of all zeroes is the value zero. A floating-point value of all ones (not a number) signifies a value currently not applicable or disabled.

Example: The value 95,800 represented in floating point format is hexadecimal 47BB1C00. This number will read from two consecutive holding registers as follows:

<u>Holding Register</u>	<u>Value</u>
K (Hi Byte)	hex 1C
K (Lo Byte)	hex 00
K+1 (Hi Byte)	hex 47
K+1 (Lo Byte)	hex BB

The same byte alignments are required to write.

Double Precision Data Format (DP)

The Modbus Double Precision data format (DP) uses 2 consecutive registers to represent a data value. The first register contains the high-order 16 bits of double precision data, and is the actual data value / 10,000.

The second register contains the low-order 16 bits of double precision data, and is the actual data value modulus 10,000.

Triple Precision Data Format (TP)

The Modbus Triple Precision data format (TP) uses 3 consecutive registers to represent a data value. The first register contains the high-order 16 bits of triple precision data, and is the actual data value / 100,000,000. The modulus from this operation is divided by 10,000 to arrive at the value of the second register, and the modulus of this last operation is the value of the third register (the low-order 16 bits of triple precision).

Error Check

This field contains a 2-byte CRC value for transmission error detection. The master first calculates the CRC and appends it to the query message. The DGC-2020 recalculates the CRC value for the received query and performs a comparison to the query CRC value to determine if a transmission error has occurred. If so, no response message is generated. Otherwise, the slave calculates a new CRC value for the response message and appends it to the message for transmission.

Reference the "Modicon Modbus Protocol Reference Guide", PI-MBUS-300 Rev. E, pages 112 - 115 for an excellent explanation and implementation of the CRC-16 algorithm.

The CRC calculation is performed using all bytes of the Device Address, Function Code, and Data Block fields. A 16-bit CRC-register is initialized to all 1's. Then each 8-bit byte of the message is used in the following algorithm:

First, exclusive-OR the message byte with the low-order byte of the CRC-register. The result, stored in the CRC-register, will then be right-shifted 8 times. The CRC-register MSB is zero-filled with each shift. After each shift the CRC-register LSB is examined: if 1, the CRC-register is then exclusive-ORed with the fixed polynomial value A001 (hex) prior to the next shift. Once all bytes of the message have undergone the above algorithm, the CRC-register will contain the message CRC value to be placed in the Error Check field.

Interdependence of Preset Multiple Register Data

Preset Multiple Register data is collectively written only after the query has been determined to be legal, which includes a range-check of the entire data block. Therefore, data which must be written prior to other data must use a separate query. For example, a Preset Multiple Register Query of the entire Contiguous Write Block (40023-40055) to set the Battery Overvoltage Pre-alarm Threshold atop the 24V range and change the Battery Volts from 12V to 24V will fail. The change to 24V would occur simultaneously to setting the Pre-alarm Threshold, and the threshold value range-check will use the current 12V range.

MAPPING - DGC-2020 PARAMETERS INTO MODICON ADDRESS SPACE

Table Conventions

Table B-3 uses the conventions outlined in this section.

The “Data Format” column uses the following abbreviations:

- DP - Double Precision
- TP - Triple Precision
- FP - Floating Point

Data formatted in Double Precision uses a 2-register group designated (a) and (b) and is defined as follows:

- Register (a) - 2 hi-order bytes
- Register (b) - 2 lo-order bytes

Data formatted in Triple Precision uses a 3 register group designated (a), (b) and (x). It is defined as follows:

- Register (a) - 2 hi-order bytes
- Register (b) - 2 mid-order bytes
- Register (x) - 2 lo-order bytes

Other register groups using the (a), (b), etc. designators are an ordered data group of consecutive ASCII characters or data bytes.

Legacy Parameter Table

The DGC-2020 maps all legacy parameters previously associated with the DGC-500 and DGC-1000 into the Holding Register address space (40000 to 41999). Query address N will access the Holding Register N+1. The Data Format is Integer type data unless identified otherwise in the Data Format column.

Table B-3. Legacy Parameter Table

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40001-18	RESERVED				
PARAMETER SETTINGS					
40019	Emergency Stop	0-1	R W	0 =Off 1 =Stop	
40020	Remote Start / Stop	0-1	R W	0 =Stop 1 =Start	
40021-22	RESERVED				
SYSTEM PARAMETERS					
40023	Default Generator Connection	0-2	R W	0=3ph L-L 1=3ph L-N 2=1ph A-B	
40024	NFPA Level	0-2	R W	0=Off 1=Level 1 2=Level 2	
40025	RESERVED				
40026	Rated Engine RPM	750-3600	R W		RPM
40027	Number Flywheel Teeth	50-500	R W		
40028	Genset KW Rating	25-9999	R W		KWatt
40029	No Load Cool Down Time	0-60	R W		Minutes
GENERATOR PT PRIMARY					
40030	Voltage(a)	1-15000	R W	DP	VoltsAC x10000
40031	Voltage(b)		R W	DP	VoltsAC
GENERATOR PT SECONDARY					
40032	Voltage	1-480	R W		VoltsAC
GENERATOR CT PRIMARY					
40033	Current	1-5000	R W		AmpsAC
LOW FUEL ALARM					
40034	Enable	0-1	R W	0 =Off 1 =On	
40035	Threshold	2-50	R W		% Full Tank
LOW FUEL PRE-ALARM					
40036	Enable	0-1	R W	0 =Off 1 =On	
40037	Threshold	10-100	R W		% Full Tank
LOW COOLANT TEMP PRE-ALARM					
40038	Enable	0-1	R W	0 =Off 1 =On	
40039	Threshold	32-150	R W		Degrees F
BATTERY OVERVOLTAGE PRE-ALARM					
40040	Enable	0-1	R W	0 =Off 1 =On	
40041	RESERVED				
MAINTENANCE INTERVAL PRE-ALARM					
40042	Enable	0-1	R W	0 =Off 1 =On	
40043	Threshold	0-5000	R W		Hours
ENGINE KW OVERLOAD PRE-ALARM					
40044	Enable	0-1	R W	0 =Off 1 =On	
40045	Threshold	95-140	R W		% of Rated
HIGH COOLANT TEMP PRE-ALARM					
40046	Enable	0-1	R W	0 =Off 1 =On	
40047	Threshold	100-280	R W		Degrees F
LOW OIL PRESSURE PRE-ALARM					
40048	Enable	0-1	R W	0 =Off 1 =On	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40049	Threshold	3-100	R W		PSI
LOW BATTERY VOLTAGE PRE-ALARM					
40050	Enable	0-1	R W	0 =Off 1 =On	
40051	Threshold	60-120 (12V) 120-240 (24V)	R W		.1 Volts DC
40052	Pre-alarm Activation Time Delay	1-10	R W		Seconds
WEAK BATTERY VOLTAGE PRE-ALARM					
40053	Enable	0-1	R W	0 =Off 1 =On	
40054	Threshold	40-80 (12V) 80-160 (24V)	R W		.1 VoltDC
40055	Pre-alarm Activation Time Delay	1-10	R W		Seconds
40056-59	RESERVED				
HIGH COOLANT TEMP ALARM					
40060	Enable	0-1	R W	0 =Off 1 =On	
40061	Threshold	100-280	R W		Degrees F
40062	Arming Delay after Crank Disconnect	60	R W		Seconds
LOW OIL PRESSURE ALARM					
40063	Enable	0-1	R W	0 =Off 1 =On	
40064	Threshold	3-100	R W		PSI
40065	Arming Delay after Crank Disconnect	5-15	R W		Seconds
OVERSPEED ALARM					
40066	Enable	0-1	R W	0 =Off 1 =On	
40067	Threshold	105-140	R W		% of Rated
40068	Alarm Activation Time Delay	0-500	R W		MilliSec
40069-71	RESERVED				
CRANKING PARAMETERES					
40072	Cranking Style	0-1	R W	0=Contin. 1=Cycle	
40073	Number of Crank Cycles	1-7	R W		
40074	Cycle Crank Time	5-15	R W		Seconds
40075	Continuous Crank Time	1-60	R W		Seconds
40076	Crank Disconnect Limit	10-100	R W		% of Rated
40077	Pre-crank Delay	0-30	R W		Seconds
SYSTEM MONITOR					
40078	Remaining Cooldown Time	0-60	R		Minutes
40079	RESERVED				
40080	Active Speed Signal Sources	1-4	R	1=MPU 2=ALT 3=GEN 4=NONE	
40081	Sender Failure Alarm Code	individual bits are 0 or 1	R	b0=High Coolant Temperature b1=Oil Pressure b2 Fuel Level b3=Generator Voltage Sensing b4=Magnetic Pick-up b5-b7 not used	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40082	Alarm Codes	individual bits are 0 or 1	R	b0=High Coolant Temperature b1=Low Coolant Level b2=Low Fuel Level b3=Emergency Stop b4=Sender Failure b5=Over Crank b6=Over Speed b7=Low Oil Pressure Rev. 3.04 Added: b8 = CAN Fail	
40083	Pre-Alarm Codes	individual bits are 0 or 1	R	b0=High Coolant Temperature b1=Low Coolant Temperature b2=Weak Battery b3=Low Battery b4=Battery Overvoltage b5=Battery Charger Fail b6=Maintenance Interval b7=Engine Overload Rev. 3.04 Added: b8 = DTC b9 = CAN Fail	
40084	Pre-Alarm Codes, Group 2	individual bits are 0 or 1	R	b0=Low Oil Pressure b1=Low Fuel Level b2=Magnetic Pick-up Fail b3=Fuel Level Sender Fail b4=Aux Input 1 b5=Aux Input 2 b6=Aux Input 3 b7=Aux Input 4	
40085	Engine Coolant Temperature		R		DegF
40086	Engine Oil Pressure		R		PSI
40087	Battery Voltage		R		.1 VoltsDC
40088	Fuel Level		R		% Full Tank
40089	Time Remaining until Maintenance		R		Hours
40090	Accumulated Engine Runtime(a)		R W	DP	Minutes x 10000
40091	Accumulated Engine Runtime(b)		R W	DP	Minutes
40092	Not Currently Used		R W	DP	
40093	Not Currently Used		R W	DP	
40094	Engine Speed(a)		R	DP	RPM x10000
40095	Engine Speed(b)		R	DP	RPM
40096	Engine Load(a)		R	DP	
40097	Engine Load(b)		R	DP	% of Rated Load
GENERATOR MONITOR					
40098	Phase a-b RMS Voltage(a)		R	DP	RMS Volt x 10000
40099	Phase a-b RMS Voltage(b)		R	DP	RMS Volt
40100	Phase b-c RMS Voltage(a)		R	DP	RMS Volt x 10000
40101	Phase b-c RMS Voltage(b)		R	DP	RMS Volt
40102	Phase c-a RMS Voltage(a)		R	DP	RMS Volt x 10000
40103	Phase c-a RMS Voltage(b)		R	DP	RMS Volt
40104	Phase a-n RMS Voltage(a)		R	DP	RMS Volt x 10000
40105	Phase a-n RMS Voltage(b)		R	DP	RMS Volt
40106	Phase b-n RMS Voltage(a)		R	DP	RMS Volt x 10000
40107	Phase b-n RMS Voltage(b)		R	DP	RMS Volt
40108	Phase c-n RMS Voltage(a)		R	DP	RMS Volt x 10000
40109	Phase c-n RMS Voltage(b)		R	DP	RMS Volt

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40110	Phase a RMS Current		R		RMS Amps
40111	Phase b RMS Current		R		RMS Amps
40112	Phase c RMS Current		R		RMS Amps
40113	Phase a Apparent Power(a)		R	DP	KVA x 10000
40114	Phase a Apparent Power(b)		R	DP	KVA
40115	Phase b Apparent Power(a)		R	DP	KVA x 10000
40116	Phase b Apparent Power(b)		R	DP	KVA
40117	Phase c Apparent Power(a)		R	DP	KVA x 10000
40118	Phase c Apparent Power(b)		R	DP	KVA
40119	3 Phase Apparent Power(a)		R	DP	KVA x 10000
40120	3 Phase Apparent Power(b)		R	DP	KVA
40121	Phase a Power(a)		R	DP	KWatt x 10000
40122	Phase a Power(b)		R	DP	KWatt
40123	Phase b Power(a)		R	DP	KWatt x 10000
40124	Phase b Power(b)		R	DP	KWatt
40125	Phase c Power(a)		R	DP	KWatt x 10000
40126	Phase c Power(b)		R	DP	KWatt
40127	3 Phase power(a)		R	DP	KWatt x 10000
40128	3 Phase power(b)		R	DP	KWatt
40129	3 Phase Total KW-Hours(a)		R W	TP	KWH x 10000 x 10000
40130	3 Phase Total KW-Hours(b)		R W	TP	KWH x 10000
40131	3 Phase Total KW-Hours(x)		R W	TP	KWH
40132	Power Factor	0-100	R		.01
40133	Frequency		R		.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				
GENERATOR MONITOR - Continuation					
40140	Power Factor State	0-3	R	0= +LAG 1= -LEAD 2= -LAG 3= +LEAD	
40141-272	RESERVED				
40273	Input Contacts States	individual bits are 0 or 1	R	b0 = coolant level, b1 = ATS, b2 = E-stop, b3 = charger failed, b4 = aux. input 1, b5 = aux. input 2, b6 = aux. input 3, b7 = aux. input 4. /* b7 = aux. input 4. */	
40274	BESTCOMS Test Buttons States	individual bits are 0 or 1	R W	b0 = button #1, b1 = button #2, b2 = button #3, b3 = button #4, b4-b7 are not used.	
40275-80	RESERVED				
40281	Embedded Code Version Number (a)	0-99	R		
40282	Embedded Code Version Number (b)	0-9999	R		
40283	Embedded Code Version Number (c)	0-9999	R		

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
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				
J1939 DIAGNOSTIC TROUBLE CODES					
40300	Active DTC Number 16 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40301	Active DTC Number 16 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40302	Active DTC Number 15 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40303	Active DTC Number 15 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40304	Active DTC Number 14 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40305	Active DTC Number 14 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40306	Active DTC Number 13 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40307	Active DTC Number 13 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40308	Active DTC Number 12 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40309	Active DTC Number 12 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40310	Active DTC Number 11 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40311	Active DTC Number 11 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40312	Active DTC Number 10 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40313	Active DTC Number 10 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40314	Active DTC Number 9 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40315	Active DTC Number 9 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40316	Active DTC Number 8 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40317	Active DTC Number 8 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40318	Active DTC Number 7 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40319	Active DTC Number 7 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40320	Active DTC Number 6 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40321	Active DTC Number 6 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40322	Active DTC Number 5 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40323	Active DTC Number 5 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40324	Active DTC Number 4 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40325	Active DTC Number 4 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40326	Active DTC Number 3 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40327	Active DTC Number 3 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40328	Active DTC Number 2 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40329	Active DTC Number 2 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40330	Active DTC Number 1 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40331	Active DTC Number 1 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40332	Previous DTC Number 1 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40333	Previous DTC Number 1 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40334	Previous DTC Number 2 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40335	Previous DTC Number 2 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40336	Previous DTC Number 3 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40337	Previous DTC Number 3 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40338	Previous DTC Number 4 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40339	Previous DTC Number 4 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40340	Previous DTC Number 5 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40341	Previous DTC Number 5 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40342	Previous DTC Number 6 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40343	Previous DTC Number 6 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40344	Previous DTC Number 7 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40345	Previous DTC Number 7 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40346	Previous DTC Number 8 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40347	Previous DTC Number 8 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40348	Previous DTC Number 9 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40349	Previous DTC Number 9 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40350	Previous DTC Number 10 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40351	Previous DTC Number 10 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40352	Previous DTC Number 11 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40353	Previous DTC Number 11 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40354	Previous DTC Number 12 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40355	Previous DTC Number 12 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40356	Previous DTC Number 13 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40357	Previous DTC Number 13 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40358	Previous DTC Number 14 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40359	Previous DTC Number 14 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40360	Previous DTC Number 15 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40361	Previous DTC Number 15 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40362	Previous DTC Number 16 – Lower Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40363	Previous DTC Number 16 – Upper Two Bytes	0-65535	R	Half of a set of DTC data as defined in SAE J1939-73	
40364	RESERVED				
40365	RESERVED				
40366	RESERVED				
40367	RESERVED				
40368	DTC Lamp Status NOTE: Even bits are Always a Zero Value.	individual bits are 0 or 1	R	Active stored in upper byte – Previous stored in lower byte. b0 = 0, b1 = Protect Lamp, b2 = 0, b3 = Amber Warning Lamp, b4 = 0, b5 = Red Stop Lamp, b6 = 0, b7 = Malfunction Indicator Lamp, b8 = 0, b9 = Protect Lamp, b10 = 0, b11 = Amber Warning Lamp, b12 = 0, b13 = Red Stop Lamp, b14 = 0, b15 = Malfunction Indicator Lamp	
40369	Number of DTC's	0-65535	R	Active stored in upper byte – Previous stored in lower byte.	
40370	CAN Bus Results Register	individual bits are 0 or 1	R	b0 = CAN Comms. Fail, b1 = Active DTC Clear Fail, b2 = Previous DTC Clear Fail, b3 = DTC Values Changed, b4 = CAN Hardware Test Pass, b5 = UNASSIGNED, b6 = UNASSIGNED, b7 = UNASSIGNED,	
40371	CAN Related Parameter: Percent Coolant Level	0-100	R	Percent	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40372	CAN Communications Diagnostics for use when CAN is enabled.	individual bits are 0 or 1	R	Bit 12 - Engine Run Time Bit 11 - Data Failure Status. Previous Active DTCs Cleared Bit 10 - Active DTCs Cleared Bit 9 - Previous Active DTCs Bit 8 - Current Active DTCs Bit 7 - Coolant Level Bit 6 - Oil Pressure Bit 5 - Coolant Temp Bit 4 - Engine Speed Bit 3 - Can Error Status tx_err_passive Bit 2 - Can Error Status rx_err_passive Bit 1 - Can Error Status driver sleep status Bit 0 - Can Error Status bus off	
40373	System Config	individual bits are 0 or 1	R W	Bit 0 - RUN Bit 1 - OFF Bit 2 - AUTO_RUN Bit 3 - AUTO_OFF Bit 4 - AUTO_ANY	
40374	System Status	0 - 10	R	0 = RESET 1 = READY 2 = CRANKING 3 = RESTING 4 = RUNNING 5 = ALARM 6 = PRESTART 7 = COOLING 8 = CONNECTING 9 = DISCONNECT 10 = PULSING 11 = UNLOADING	
40375	Used to display Value, NC, NS, NA, and SF		R	Bits 0-2: coolant level Bits 3-5: coolant temperature Bits 6-8: oil pressure Bits 9-11: engine speed Bits 12-14: engine run time Bit 15: NOT USED <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		

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40388	CANbus ECU Configuration	0-65535	R W	0 = Not configured; 1 = Volvo Penta EDC3; 2 = MTU MDEC 3 = MTU ADEC	
40395	ECU Settling Time	0-65535	R W	milliseconds	
40396	ECU Pulse Cycle Time - The amount of time unit is to wait in OFF between Pulse Cycles.	0-65535	R W	minutes	
40397	ECU Disconnect Time - The amount of time ECU is kept powered off.	0-65535	R W	seconds	
40398	ECU Connect Time - The amount of time ECU is powered when connecting (unit tries to run). Also used for the Pulse duration time.	0-65535	R W	seconds	
40399-420	FUTURE USE				
J1939 DATA					
40421	Accelerator Pedal Position	0 to 100%	R	0.4%/bit gain, 0% offset	
40422	Percent Load At Current Speed	0 to 125%	R	1%/bit gain, 0% offset	
40423	Actual Engine Percent Torque	0 to 125%	R	1%/bit gain, -125% offset	
40424	Engine Speed	0 to 8031.875	R	RPM (0.125rpm/bit gain)	
40425	Injection Control Pressure2		R		
40426	Injector Metering Rail Pressure2	0 to +251 MPa (0 to 36 404 psi)	R	1/256 MPa/bit gain, 0 MPa offset	
40427	Engine Run Time	0 to +210,554, 060.75 h	R	0.05 h/bit gain, 0 h offset	
40428	Engine Run Time		R		
40429	Engine Run Time		R		
40430	Trip Fuel	Data Range: 0 to +2,105,540, 608 L	R	0.5 L per bit gain, 0 L offset	
40431	Trip Fuel		R		
40432	Trip Fuel		R		
40433	Total Fuel Used	Data Range: 0 to +2,105,540, 608 L	R	0.5 L per bit gain, 0 L offset	
40434	Total Fuel Used		R		
40435	Total Fuel Used		R		
40436	Coolant Temperature	-40 to +210 °C (-40 to 410 °F)	R	Raw ECU Parameter Data 1 °C/bit gain	
40437	Fuel Temperature	-40 to +210 °C (-40 to 410 °F)	R	Raw ECU Parameter Data 1 °C/bit gain, -40 °C offset	
40438	Engine Oil Temperature	-273 to +1735.0 °C (-459.4 to 3155.0 °F)	R	Raw ECU Parameter Data 0.03125 °C/bit gain, -273 °C offset	
40439	Engine Intercooler Temperature	-40 to +210 °C (-40 to 410 °F)	R	Raw ECU Parameter Data 1 °C/bit gain, -40 °C offset	
40440	Fuel Delivery Pressure	0 to +1000 kPa (0 to 145 psi)	R	Raw ECU Parameter Data 4 kPa/bit gain, 0 kPa offset	
40441	Engine Oil Level	0 to +100 %	R	Raw ECU Parameter Data 0.4 %/bit gain, 0 % offset	
40442	Oil Pressure	0 to +1000 kPa (0 to 145 psi)	R	Raw ECU Parameter Data 4 kPa/bit gain, 0 kPa offset	
40443	Coolant Pressure	0 to +500 kPa (0 to 72.5 psi)	R	Raw ECU Parameter Data 4 kPa/bit gain, 0 kPa offset	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40444	Coolant Level	0 to +100 %	R	Raw ECU Parameter Data 0.4 %/bit gain, 0 % offset	
40445	Fuel Rate	0 to +3212.75 L/h	R	Raw ECU Parameter Data 0.05 L/h per bit gain, 0 L/h offset (13.9 x 10 ⁻⁶ L/s per bit)	
40446	Barometric Pressure	0 to +125 kPa (0 to +18.1 psi)	R	Raw ECU Parameter Data 0.5 kPa/bit gain, 0 kPa offset	
40447	Ambient Air Temperature	-273 to +1735.0 °C (-459.4 to 3155.0 °F)	R	Raw ECU Parameter Data 0.03125 °C/bit gain, -273 °C offset	
40448	Air Inlet Temperature	-40 to +210 °C (-40 to 410 °F)	R	Raw ECU Parameter Data 1 °C/bit gain, -40 °C offset	
40449	Boost Pressure	0 to +500 kPa (0 to 72.5 psi)	R	Raw ECU Parameter Data 2 kPa/bit gain, 0 kPa offset	
40450	Intake Manifold Temperature	-40 to +210 °C (-40 to 410 °F)	R	Raw ECU Parameter Data 1 °C/bit gain, -40 °C offset	
40451	Air Filter Differential Pressure	0 to +12.5 kPa (0 to +1.8 psi)	R	Raw ECU Parameter Data 0.05 kPa/bit gain, 0 kPa offset	
40452	Exhaust Gas Temperature	-273 to +1735.0 °C (-459.4 to 3155.0 °F)	R	Raw ECU Parameter Data 0.03125 °C/bit gain, -273 °C offset	
40453	Electrical Potential Voltage	0 to +3212.75 V	R	Raw ECU Parameter Data 0.05 V/bit gain, 0 V offset	
40454	Battery Potential Voltage Switched	Data Range: 0 to +3212.75 V	R	Raw ECU Parameter Data 0.05 V/bit gain, 0 V offset	
40455	Speed At Idle Point1	0 to 8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40456	Torque At Idle Point1	0 to 125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40457	Speed At Idle Point2	0 to 8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40458	Torque At Idle Point2	0 to 125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40459	Speed At Idle Point3	0 to 8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40460	Torque At Idle Point3	0 to 125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40461	Speed At Idle Point4	0 to 8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40462	Torque At Idle Point4	0 to 125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40463	Speed At Idle Point5	0 to 8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40464	Torque At Idle Point5	0 to 125%	R	Raw ECU Parameter Data 1%/bit gain, -125% offset	
40465	Speed At High Idle Point6	0 to 8031.875 rpm	R	Raw ECU Parameter Data 0.125 rpm/bit, 0 rpm offset	
40466	Gain Of End speed governor	0 to 50.2 %/rpm	R	Raw ECU Parameter Data 0.0007813 % engine reference torque/rpm per bit gain (normalized), 0 %/rpm per bit offset	
40467	Reference Engine Torque	0 to 64 255 Nm	R	Raw ECU Parameter Data 1 Nm/bit gain, 0 Nm offset	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
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	
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 =

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40509-604	RESERVED				
OVERCURRENT					
40605	51 Pick-up – 3-phase	18-118, 90-775	R W	0.18-1.18 Aac for 1A CTs, 0.90-7.75 Aac for 5A CTs	
40606	51 Time Dial – 3-phase	0-99, 0-300	R W	0.0-9.9 for 40607=0-15 (inverse), 0.0-30.0s for 40607=16 (fixed)	
40607	51 Curve – 3-phase	0-16	R W	0-15 for inverse, 16 for fixed	
40608	51 Alarm Config. – 3-phase	0-2	R W	0=None, 1=Pre-Alarm, 2=Alarm	
40609	51 Pick-up – 1-phase	18-118, 90-775	R W	0.18-1.18 Aac for 1A CTs, 0.90-7.75 Aac for 5A CTs	
40610	51 Time Dial – 1-phase	0-99, 0-300	R W	0.0-9.9 for 40607=0-15 (inverse), 0.0-30.0s for 40607=16 (fixed)	
40611	51 Curve – 1-phase	0-16	R W	0-15 for inverse, 16 for fixed	
40612	51 Alarm Config. – 1-phase	0-2	R W	0=None, 1=Pre-Alarm, 2=Alarm	
PHASE IMBALANCE					
40613	47 Pick-up	5-100	R W	Volts AC	
40614	47 Time Delay	0-300	R W	0.0-30.0 seconds	
40615	47 Alarm Configuration	0-2	R W	0=None, 1=Pre-Alarm, 2=Alarm	
UNDERVOLTAGE					
40616	27 Pick-up – 3-phase	70-576	R W	Volts AC	
40617	27 Time Delay – 3-phase	0-300	R W	0.0-30.0 seconds	
40618	27 Inhibit Frequency- 3-ph.	20-400	R W	Hertz	
40619	27 Alarm Config. – 3-phase	0-2	R W	0=None, 1=Pre-Alarm, 2=Alarm	
40620	27 Pick-up – 1-phase	70-576	R W	Volts AC	
40621	27 Time Delay – 1-phase	0-300	R W	0.0-30.0 seconds	
40622	27 Inhibit Frequency – 1-ph.	20-400	R W	Hertz	
40623	27 Alarm Config. – 1-phase	0-2	R W	0=None, 1=Pre-Alarm, 2=Alarm	
OVERVOLTAGE					
40624	59 Pick-up – 3-phase	70-576	R W	Volts AC	
40625	59 Time Delay – 3-phase	0-300	R W	0.0-30.0 seconds	
40626	59 Alarm Config. – 3-phase	0-2	R W	0=None, 1=Pre-Alarm, 2=Alarm	
40627	59 Pick-up – 1-phase	70-576	R W	Volts AC	
40628	59 Time Delay – 1-phase	0-300	R W	0.0-30.0 seconds	
40629	59 Alarm Config. – 1-phase	0-2	R W	0=None, 1=Pre-Alarm, 2=Alarm	
UNDERFREQUENCY					
40630	81U Pick-up	450-550, 550-650, 3600-4400	R W	45.0-55.0 Hz for 50-Hz config., 55.0-65.0 Hz for 60-Hz config., 360.0-440.0 Hz for 400-Hz unit	
40631	81U Time Delay	0-300	R W	0.0-30.0 seconds	
40632	81U Inhibit Voltage	70-576	R W	Volts AC	
40633	81U Alarm Configuration	0-2	R W	0=None, 1=Pre-Alarm, 2=Alarm	
OVERFREQUENCY					
40634	81O Pick-up	450-550, 550-650, 3600-4400	R W	45.0-55.0 Hz for 50-Hz config., 55.0-65.0 Hz for 60-Hz config., 360.0-440.0 Hz for 400-Hz unit	
40635	81O Time Delay	0-300	R W	0.0-30.0 seconds	
40636	81O Alarm Configuration	0-2	R W	0=None, 1=Pre-Alarm, 2=Alarm	
GENERATOR PROTECTION STATUS					
40637	Gen Protection Status (upper 16 bits)	0-65535	R	b16-b31 UNASSIGNED	
40638	Gen Protection Status (lower 16 bits)	0-65535	R	b0 = overvoltage trip, b1 = undervoltage trip, b2 = overfrequency trip, b3 = underfrequency trip, b4 = overcurrent trip, b5 = phase imbalance trip, b6-b15 UNASSIGNED	
40639	Gen Protection Pre-Alarms (upper 16 bits)	0-65535	R	b16-b31 UNASSIGNED	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40640	Gen Protection Pre-Alarms (lower 16 bits)	0-65535	R	b0 = overvoltage pre-alarm, b1 = undervoltage pre-alarm, b2 = overfrequency pre-alarm, b3 = underfrequency pre-alarm, b4 = overcurrent pre-alarm, b5 = phase imbalance pre-alarm, b6-b15 UNASSIGNED	
40641	Gen Protection Alarms (upper 16 bits)	0-65535	R	b16-b31 UNASSIGNED	
40642	Gen Protection Alarms (lower 16 bits)	0-65535	R	b0 = overvoltage alarm, b1 = undervoltage alarm, b2 = overfrequency alarm, b3 = underfrequency alarm, b4 = overcurrent alarm, b5 = phase imbalance alarm, b6-b15 UNASSIGNED	
REAL TIME CLOCK					
40700	Hours	0-23	R W		
40701	Minutes	0-59	R W		
40702	Seconds	0-59	R W		
40703	Month	1-12	R W		
40704	Day	1-31	R W		
40705	Year		R W		
40706	Daylight Savings Time Enable	0-1	R W	0 = Off 1 = On	
40707-33	RESERVED				
RUN STATISTICS					
40734	Maintenance Interval Hours	0-5000	R W		hours
40735	Hours Until Maintenance	0-5000	R W		hours
40737	Commission Start Month	1-12	R W		month
40738	Commission Start Day	1-31	R W		day
40739	Commission Start Year	0-99	R W		year
40740-41	Cumulative Run Hours x 60	0-4294967295	R W	DP	hours
40742-43	Cumulative Loaded Run Hours x 60	0-4294967295	R W	DP	hours
40744-45	Cumulative Unloaded Run Hours x 60	0-4294967295	R W	DP	hours
40746	Start Count	0-65535	R W		
40747	Session Start Month	1-12	R W		month
40748	Session Start Day	1-31	R W		day
40749	Session Start Year	0-99	R W		year
40750-51	Session Run Hours x 60	0-4294967295	R W	DP	hours
40752-53	Session Loaded Run Hours x 60	0-4294967295	R W	DP	hours
40754-55	Session Unloaded Run Hours x 60	0-4294967295	R W	DP	hours
CANbus ECU					
40758	ECU Control Output Select	0-1	R W	0 = fuel solenoid relay, 1 = pre-start relay	
40759	ECU Pulsing Enable	0-1	R W	0 = pulsing is enabled, 1 = pulsing is disabled	
40760	MDEC Alarms	0-65535	R	b0 = High Charge Air Temp, b1 = High Oil Temp, b2 = High Coolant Temp, b3 = Low Aftercooler Level, b4 = Low Fuel Delivery Press, b5 = Low Oil Press, b6 = Overspeed, b7 = Combined Red, b8-b15 UNASSIGNED	

Holding Register	Parameter	Range	Read/Write Supported	Data Format	Units
40761	MTU Pre-alarms	0-65535	R	b0 = High ECU Temp, b1 = High Oil Temp, b2 = High Intercooler Temp, b3 = High Charge Air Temp, b4 = High Coolant Temp, b5 = Shutdown Override, b6 = High Fuel Rail Press, b7 = Low Fuel Rail Press, b8 = Low Coolant Level, b9 = Low Charge Air Pressure, b10 = Low Fuel Deliv Pressure, b11 = Low Oil Pressure, b12 = Combined Yellow, b13-b15 UNASSIGNED	

Current Parameter Table

The DGC-2020 maps all non-legacy parameters into the Holding Register address space (42000 and above). Query address N will access the Holding Register N+1.

Breaker Management

Register	Description	Type	Units	Scaling Factor	R/W	Range
42000	Gen Breaker Configured	Int32	N/A	N/A	R	0 = Not Configured 1 = Configured
42002	Gen Breaker Open Pulse Time	Int32	Centisecond	Centi	RW	1 - 80
42004	Gen Breaker Close Pulse Time	Int32	Centisecond	Centi	RW	1 - 80
42006	Gen Breaker Contact Type	Int32	N/A	N/A	RW	0 = Pulse 1 = Continuous
42008	Gen Breaker Close Time	Int32	Millisecond	N/A	RW	0 - 800
42010	RESERVED					
42012	Mains Breaker Configured	Int32	N/A	N/A	RW	0 = Not Configured 1 = Configured
42014	Mains Breaker Open Pulse Time	Int32	Centisecond	Centi	RW	1 - 80
42016	Mains Breaker Close Pulse Time	Int32	Centisecond	Centi	RW	1 - 80
42018	Mains Breaker Output Continuous	Int32	N/A	N/A	RW	0 = Pulse 1 = Continuous
42020	Mains Breaker Close Time	Int32	Millisecond	N/A	RW	0 - 800
42022	RESERVED					
42024	Synchronizer Type	Int32	N/A	N/A	RW	1 = Anticipatory 2 = Phase Lock Loop
42026	Synchronizer Mode	Int32	N/A	N/A	RW	0 = Off Mode 1 = Auto Mode
42028	Slip Frequency	Int32	CentiHertz	Centi	RW	10 - 50
42030	Breaker Closing Angle	Int32	DeciDegree	Deci	RW	30 - 200
42032	Regulation Offset	Int32	DeciPercent	Deci	RW	20 - 150
42034	Vgen > Vbus	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
42036	Fgen > Fbus	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
42038-40	RESERVED					
42042	Breaker Close Wait Time	Int32	Second	N/A	RW	0.1 - 600
42044	Sync Time Delay	Float	Second	N/A	RW	0.1 - 0.8
42046	Sync Fail Time Delay	Float	Second	N/A	RW	0.1 - 600
42048	Mains Fail Transfer Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
42050	Gen Breaker Status	Int32	N/A	N/A	R	0 = Open 1 = Closed

Register	Description	Type	Units	Scaling Factor	R/W	Range
42052	Mains Breaker Status	Int32	N/A	N/A	R	0 = Open 1 = Closed
42054-60	RESERVED					
42062	Dead Bus Close Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
42064-248	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

Register	Description	Type	Units	Scaling Factor	R/W	Range
42328	kw Integrator Limit Plus	Float	N/A	N/A	RW	0 - 1000
42330	kw Integrator Limit Minus	Float	N/A	N/A	RW	(-1000) - 0
42332	kw Output Upper Limit	Float	N/A	N/A	RW	0 - 1000
42334	kw Output Lower Limit	Float	N/A	N/A	RW	(-1000) - 0
42336	RESERVED					
42338	Droop Percent	Float	Percent	N/A	RW	0 - 10
42340	Load Control	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
42342	kw Load Rate	Int32	N/A	Deci	RW	0 - 1000
42344	Breaker Open Setpoint	Int32	N/A	Deci	RW	0 - 1000
42346	AVR Bias Control Output Type	Int32	N/A	N/A	RW	0 = Contact 1 = Analog
42348	Governor Bias Control Output Type	Int32	N/A	N/A	RW	0 = Contact 1 = Analog
42350	Speed Droop Gain	Float	N/A	N/A	RW	0 - 1000
42352	Voltage Droop Gain	Float	N/A	N/A	RW	0 - 1000
42354	Speed Trim Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
42356	Voltage Trim Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
42358	Ramped Watt Demand Per Unit	Float	N/A	N/A	R	0 - 100
42360	Watt Demand Per Unit	Float	N/A	N/A	R	0 - 100
42362	Speed PID Output	Float	N/A	N/A	R	0 - 100
42364	kw PID Output	Float	N/A	N/A	R	0 - 100
42366	Volt PID Output	Float	N/A	N/A	R	0 - 100
42368	Speed Trim Setpoint	Int32	DeciHertz	Deci	RW	470 - 4400
42370-498	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

Register	Description	Type	Units	Scaling Factor	R/W	Range
42768	Gen Sensing Stable Overfrequency Pickup	Int32	CentiHertz	Centi	RW	4600 - 6400
42770	Gen Sensing Stable Overfrequency Dropout	Int32	CentiHertz	Centi	RW	4600 - 6400
42772	Gen Sensing Fail Time Delay	Int32	Decisecond	Deci	RW	1 - 6000
42774	Gen Sensing Stable Time Delay	Int32	Decisecond	Deci	RW	1 - 6000
42776	RESERVED					
42778	Bus Sensing Dead Bus Pickup	Int32	Volt	N/A	RW	1 - 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 - 3
42820	Bus Stable Low Line Scale Factor	Float	N/A	N/A	RW	0 - 3
42822-3432	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
43450-498	FUTURE USE	Int32		N/A	RW	

System Configuration and Status

Register	Description	Type	Units	Scaling Factor	R/W	Range
43500	Rated Volts	Float	Volt	N/A	RW	1 - 99999

Register	Description	Type	Units	Scaling Factor	R/W	Range
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	50 - 500

Register	Description	Type	Units	Scaling Factor	R/W	Range
43574	Speed Signal Source	Uint32	N/A	N/A	RW	1 = MPU 2 = Gen Freq 3 = MPU Freq
43576	NFPA Level	Uint32	N/A	N/A	RW	0 = Zero 1 = One 2 = Two
43578	Horn Enable	Int32	N/A	N/A	RW	0 = Disabled 1 = Enabled
43580	Single Phase Override Sensing	Uint32	N/A	N/A	RW	0 = AB 1 = AC
43582	RESERVED					
43584	LCD Contrast Value	Uint32	N/A	N/A	RW	0 - 100
43586	Front Panel Sleep Mode	Uint32	N/A	N/A	RW	0 = Disabled 1 = Enabled
43588	RESERVED					
43590	UTC Offset	Int32	Minute	N/A	RW	(-1440) - 1440
43592	DST Configuration	Int32	N/A	N/A	RW	0 = Disabled 1 = Floating 2 = Fixed
43594	Start/End Time Reference	Int32	N/A	N/A	RW	0 = Local Time 1 = UTC Time
43596	DST Bias Hours	Int32	N/A	N/A	RW	0 - 23
43598	DSP Bias Minutes	Int32	N/A	N/A	RW	0 - 59
43600	DST Start Month	Int32	N/A	N/A	RW	1 = January 2 = February 3 = March 4 = April 5 = May 6 = June 7 = July 8 = August 9 = September 10 = October 11 = November 12 = December
43602	DST Start Day	Int32	N/A	N/A	RW	1 - 31
43604	DST Start Week of Month	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

Register	Description	Type	Units	Scaling Factor	R/W	Range
43616	DST End Week of Month	Int32	N/A	N/A	RW	0 = First 1 = Second 2 = Third 3 = Fourth 4 = Last
43618	DST End Day of Week	Int32	N/A	N/A	RW	0 = Sunday 1 = Monday 2 = Tuesday 3 = Wednesday 4 = Thursday 5 = Friday 6 = Saturday
43620	DST End Hour	Int32	N/A	N/A	RW	0 - 23
43622	DST End Minute	Int32	N/A	N/A	RW	0 - 59
43624	EPS Low Line Scale Factor	Float	N/A	N/A	RW	0 - 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	N/A	RW	3 - 150
43634	Crank Disconnect Pressure in KPA	UInt32	Kpa	N/A	RW	21 - 1034
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
43644-748	FUTURE USE					

Control

Register	Description	Type	Units	Scaling Factor	R/W	Range
43750	Emergency Stop	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
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	RESERVED					
43774	Virtual Input 1 Close	Int32	N/A	N/A	RW	0 = Disable 1 = Enable

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
43792-4006	FUTURE USE					

Communication

Register	Description	Type	Units	Scaling Factor	R/W	Range
44008-48	RESERVED					
44050	DHCP Enabled	UInt32	N/A	N/A	R	0 = Disabled 1 = Enabled
44052	Active IP Address	UInt32	N/A	N/A	R	0 - 4294967295
44054	Gateway IP Address	UInt32	N/A	N/A	R	0 - 4294967295
44056	Subnet Mask	UInt32	N/A	N/A	R	0 - 4294967295
44058-064	RESERVED					
44066-248	FUTURE USE					

Protection

Register	Description	Type	Units	Scaling Factor	R/W	Range
44250	3 Phase Overcurrent Pickup (51-1)	UInt32	CentiAmp	Centi	RW	18 - 775
44252	3 Phase Overcurrent Time Dial (51-1)	UInt32	DeciUnit	Deci	RW	0 - 300
44254	3 Phase Overcurrent Curve (51-1)	UInt32	N/A	N/A	RW	0 = S1 Curve 1 = S2 Curve 2 = L1 Curve 3 = L2 Curve 4 = D Curve 5 = M Curve 6 = I1 Curve 7 = I2 Curve 8 = V1 Curve 9 = V2 Curve 10 = E1 Curve 11 = E2 Curve 12 = A Curve 13 = B Curve 14 = C Curve 15 = G Curve 16 = F Curve
44256	3 Phase Overcurrent Alarm Configuration (51-1)	UInt32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
44258	1 Phase Overcurrent Pickup (51-1)	UInt32	CentiAmp	Centi	RW	18 - 775
44260	1 Phase Overcurrent Time Dial (51-1)	UInt32	DeciUnit	Deci	RW	0 - 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
44262	1 Phase Overcurrent Curve (51-1)	Uint32	N/A	N/A	RW	0 = S1 Curve 1 = S2 Curve 2 = L1 Curve 3 = L2 Curve 4 = D Curve 5 = M Curve 6 = I1 Curve 7 = I2 Curve 8 = V1 Curve 9 = V2 Curve 10 = E1 Curve 11 = E2 Curve 12 = A Curve 13 = B Curve 14 = C Curve 15 = G Curve 16 = F Curve
44264	1 Phase Overcurrent Alarm Configuration (51-1)	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
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
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
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
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
44294	1 Phase Overvoltage Pickup (59-1)	Uint32	Volt	N/A	RW	70 - 576
44296	1 Phase Overvoltage Activation Delay (59-1)	Uint32	Decisecond	Deci	RW	0 - 300
44298	1 Phase Overvoltage Alarm Configuration (59-1)	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
44306	Underfrequency Alarm Configuration	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
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
44314	Overcurrent Low Line Scale Factor (51-1)	Float	N/A	N/A	RW	0 - 3
44316	Overvoltage Low Line Scale Factor (59-1)	Float	N/A	N/A	RW	0 - 3
44318	Undervoltage Low Line Scale Factor (27-1)	Float	N/A	N/A	RW	0 - 3
44320	3 Phase Overcurrent Pickup (51-2)	Uint32	CentiAmp	Centi	RW	18 - 775
44322	3 Phase Overcurrent Time Dial (51-2)	Uint32	DeciUnit	Deci	RW	0 - 300
44324	3 Phase Overcurrent Curve (51-2)	Uint32	N/A	N/A	RW	0 = S1 Curve 1 = S2 Curve 2 = L1 Curve 3 = L2 Curve 4 = D Curve 5 = M Curve 6 = I1 Curve 7 = I2 Curve 8 = V1 Curve 9 = V2 Curve 10 = E1 Curve 11 = E2 Curve 12 = A Curve 13 = B Curve 14 = C Curve 15 = G Curve 16 = F Curve
44326	3 Phase Overcurrent Alarm Configuration (51-2)	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
44328	1 Phase Overcurrent Pickup (51-2)	Uint32	CentiAmp	Centi	RW	18 - 775
44330	1 Phase Overcurrent Time Dial (51-2)	Uint32	DeciUnit	Deci	RW	0 - 300
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
44334	1 Phase Overcurrent Alarm Configuration (51-2)	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
44336	3 Phase Undervoltage Pickup (27-2)	Uint32	Volt	N/A	RW	70 - 576

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
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
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
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
44364	Overcurrent Low Line Scale Factor (51-2)	Float	N/A	N/A	RW	0 - 3
44366	Overvoltage Low Line Scale Factor (59-2)	Float	N/A	N/A	RW	0 - 3
44368	Undervoltage Low Line Scale Factor (27-2)	Float	N/A	N/A	RW	0 - 3
44370	Phase Imbalance Hysteresis	Uint32	Volt	N/A	RW	1 - 5
44372	3 Phase Undervoltage Hysteresis (27-1)	Uint32	Volt	N/A	RW	1 - 60
44374	1 Phase Undervoltage Hysteresis (27-1)	Uint32	Volt	N/A	RW	1 - 60
44376	3 Phase Overvoltage Hysteresis (59-1)	Uint32	Volt	N/A	RW	1 - 60
44378	1 Phase Overvoltage Hysteresis (59-1)	Uint32	Volt	N/A	RW	1 - 60
44380	Underfrequency Hysteresis	Uint32	DeciHertz	Deci	RW	1 - 400
44382	Overfrequency Hysteresis	Uint32	DeciHertz	Deci	RW	1 - 400
44384	3 Phase Undervoltage Hysteresis (27-2)	Uint32	Volt	N/A	RW	1 - 60
44386	1 Phase Undervoltage Hysteresis (27-2)	Uint32	Volt	N/A	RW	1 - 60
44388	3 Phase Overvoltage Hysteresis (59-2)	Uint32	Volt	N/A	RW	1 - 60
44390	1 Phase Overvoltage Hysteresis (59-2)	Uint32	Volt	N/A	RW	1 - 60
44392	3 Phase Reverse Power Pickup	Uint32	DeciPercent	Deci	RW	(-500) - 50
44394	3 Phase Reverse Power Activation Delay	Uint32	Decisecond	Deci	RW	0 - 300

Register	Description	Type	Units	Scaling Factor	R/W	Range
44396	3 Phase Reverse Power Alarm Configuration	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
44398	3 Phase Reverse Power Hysteresis	Int32	DeciPercent	Deci	RW	10 - 100
44400	1 Phase Reverse Power Pickup	Uint32	DeciPercent	Deci	RW	(-500) - 50
44402	1 Phase Reverse Power Activation Delay	Uint32	Decisecond	Deci	RW	0 - 300
44404	1 Phase Reverse Power Alarm Configuration	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
44406	1 Phase Reverse Power Hysteresis	Int32	DeciPercent	Deci	RW	10 - 100
44408	3 Phase Loss of Excitation Pickup	Uint32	DeciPercent	Deci	RW	(-1500) - 0
44410	3 Phase Loss of Excitation Activation Delay	Uint32	Decisecond	Deci	RW	0 - 300
44412	3 Phase Loss of Excitation Alarm Configuration	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
44414	3 Phase Loss of Excitation Hysteresis	Int32	DeciPercent	Deci	RW	10 - 100
44416	1 Phase Loss of Excitation Pickup	Uint32	DeciPercent	Deci	RW	(-1500) - 0
44418	1 Phase Loss of Excitation Activation Delay	Uint32	Decisecond	Deci	RW	0 - 300
44420	1 Phase Loss of Excitation Alarm Configuration	Uint32	N/A	N/A	RW	0 = None 1 = Alarm 2 = Pre-Alarm
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
44432-498	FUTURE USE					

Alarms

Register	Description	Type	Units	Scaling Factor	R/W	Range
44500	High Coolant Temp Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44502	High Coolant Temp Alarm Threshold	Uint32	Deg F	N/A	RW	100 - 280
44504	Metric High Coolant Temp Alarm Threshold	Int32	Deg C	N/A	RW	38 - 138
44506	High Coolant Temp Alarm Activation Delay	Uint32	Second	N/A	RW	0 - 150
44508	Low Oil Press. Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44510	Low Oil Press. Alarm Threshold	Uint32	PSI	N/A	RW	3 - 150
44512	Metric Low Oil Press. Alarm Threshold	Int32	Kpa	N/A	RW	21 - 1034
44514	Low Oil Press. Alarm Arming Delay	Uint32	Second	N/A	RW	5 - 15

Register	Description	Type	Units	Scaling Factor	R/W	Range
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 - 150
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 - 100
44542	High Fuel Level Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44544	High Fuel Level Pre-Alarm Activation Delay	Int32	Second	N/A	RW	0 - 30
44546	Low Fuel Level Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44548	Low Fuel Level Pre-Alarm Threshold	Uint32	Percent	N/A	RW	10 - 100
44550	Low Battery Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44552	Low Battery Pre-Alarm Threshold	Uint32	DeciVolt	Deci	RW	60 - 240
44554	Low Battery Pre-Alarm Activation Delay	Uint32	Second	N/A	RW	1 - 10
44556	Weak Battery Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44558	Weak Battery Pre-Alarm Threshold	Uint32	DeciVolt	Deci	RW	40 - 160
44560	Weak Battery Pre-Alarm Activation Delay	Uint32	Second	N/A	RW	1 - 10
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	N/A	RW	3 - 150
44568	Metric Low Oil Press. Pre-Alarm Threshold	Int32	Kpa	N/A	RW	21 - 1034
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	95 - 140
44574	ECU Comms Fail Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable
44576	Active DTC Pre-Alarm Enable	Int32	N/A	N/A	RW	0 = Disable 1 = Enable

Register	Description	Type	Units	Scaling Factor	R/W	Range
44578	Maintenance Interval Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44580	Maintenance Interval Pre-Alarm Threshold	Uint32	Hour	N/A	RW	0 - 5000
44582	Speed Sender Fail Activation Delay	Int32	Second	N/A	RW	0 - 300
44584	ECU Low Coolant Level Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44586	ECU Low Coolant Level Alarm Threshold	Uint32	Percent	N/A	RW	1 - 99
44588	ECU Low Coolant Level Pre-Alarm Enable	Uint32	N/A	N/A	RW	0 = Disable 1 = Enable
44590	ECU Low Coolant Level Pre-Alarm Threshold	Uint32	Percent	N/A	RW	1 - 99
44592	Battery Overvoltage Alarm Threshold	Int32	DeciVolt	Deci	RW	120 - 320
44594	Engine Overload 1 Pre-Alarm 3 Phase Hysteresis	Int32	DeciVolt	Deci	RW	1 - 10
44596	Engine Overload 1 Pre-Alarm 1 Phase Threshold	Int32	Percent	N/A	RW	95 - 140
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 - 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	95 - 140
44606	Engine Overload 2 Pre-Alarm 3 Phase Hysteresis	Int32	Percent	N/A	RW	1 - 10
44608	Engine Overload 2 Pre-Alarm 1 Phase Threshold	Int32	Percent	N/A	RW	95 - 140
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 - 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	95 - 140
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	95 - 140
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 - 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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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
44648-748	RESERVED					

Metering

Register	Description	Type	Units	Scaling Factor	R/W	Range
44750	Gen VAB Metering	Int32	Volt	N/A	R	(-2147483648) - 2147483647
44752	Gen VBC Metering	Int32	Volt	N/A	R	(-2147483648) - 2147483647
44754	Gen VCA Metering	Int32	Volt	N/A	R	(-2147483648) - 2147483647
44756	Gen VAN Metering	Int32	Volt	N/A	R	(-2147483648) - 2147483647
44758	Gen VBN Metering	Int32	Volt	N/A	R	(-2147483648) - 2147483647
44760	Gen VCN Metering	Int32	Volt	N/A	R	(-2147483648) - 2147483647
44762	Bus Voltage Metering	Int32	Volt	N/A	R	(-2147483648) - 2147483647
44764	Gen IA Metering	Int32	Amp	N/A	R	(-32768) - 32767
44766	Gen IB Metering	Int32	Amp	N/A	R	(-32768) - 32767
44768	Gen IC Metering	Int32	Amp	N/A	R	(-32768) - 32767
44770	Gen kVA A Metering	Int32	KiloVA	N/A	R	(-2147483648) - 2147483647
44772	Gen kVA B Metering	Int32	KiloVA	N/A	R	(-2147483648) - 2147483647
44774	Gen kVA C Metering	Int32	KiloVA	N/A	R	(-2147483648) - 2147483647
44776	Gen kVA Total Metering	Int32	KiloVA	N/A	R	(-2147483648) - 2147483647
44778	Gen kW A Metering	Int32	KiloWatt	N/A	R	(-2147483648) - 2147483647
44780	Gen kW B Metering	Int32	KiloWatt	N/A	R	(-2147483648) - 2147483647
44782	Gen kW C Metering	Int32	KiloWatt	N/A	R	(-2147483648) - 2147483647
44784	Gen kW Total Metering	Int32	KiloWatt	N/A	R	(-2147483648) - 2147483647
44786	Power Factor Metering	Float	N/A	N/A	R	(-1) - 1
44788	Gen PF Lagging	Int32	N/A	N/A	R	(-128) - 127
44790	Gen Frequency Metering	Float	Hertz	N/A	R	45 - 440
44792	Bus Frequency Metering	Float	Hertz	N/A	R	45 - 440
44794	Active Speed Source	UInt32	N/A	N/A	R	0 - 255
44796	Engine Speed Metering	UInt32	RPM	N/A	R	0 - 65535
44798	Engine Load Metering	Int32	Percent	N/A	R	(-32768) - 32767
44800	Coolant Temp. Metering	Int32	Deg F	N/A	R	(-32768) - 32767
44802	Oil Pressure Metering	Int32	PSI	N/A	R	(-32768) - 32767
44804	Battery Voltage Metering	Int32	DeciVolt	N/A	R	(-32768) - 32767
44806	Fuel Level Metering	Int32	N/A	N/A	R	(-32768) - 32767
44808	ECU Coolant Level Metering	UInt32	N/A	N/A	R	0 - 255
44810	Cool Down Time Remaining	Int32	Minute	N/A	R	(-128) - 127

Register	Description	Type	Units	Scaling Factor	R/W	Range
44812	Alarm Metering	Int32	N/A	N/A	R	Bit 0 = Overspeed Bit 1 = Hi Coolant Temp Bit 2 = Low Oil Pressure Bit 3 = Low Fuel Level Bit 4 = Global Sender Fail Bit 5 = Loss of ECU Comms Bit 6 = Overcrank Bit 7 = Emergency Shutdown Bit 8 = Loss of ECU Shutdown Bit 9 = ECU Low Coolant Level
44814	Pre-Alarm Metering	Int32	N/A	N/A	R	Bit 0 = Hi Coolant Temp Bit 1 = Low Oil Pressure Bit 2 = Low Fuel Level Bit 3 = Low Coolant Temp Bit 4 = Low Battery Voltage Bit 5 = Weak Battery Bit 6 = Battery Overvoltage Bit 7 = Maintenance Due Bit 8 = Loss of ECU Comms Bit 9 = Diagnostic Trouble Code Bit 10 = Engine kW Overload Bit 11 = Loss of Rem. Mod. Com Bit 12 = High Fuel Level Bit 13 = Sync Fail at Gen Brkr Bit 14 = Gen Brkr Fail to Close Bit 15 = Gen Brkr Fail to Open Bit 16 = Sync Fail at Mains Brkr Bit 17 = Mains Brkr Fail to Close Bit 18 = Mains Brkr Fail to Open
44816	MTU Alarm Metering	Int32	N/A	N/A	R	Bit 0 = High Charge Air Temp Bit 1 = High Oil Temp Bit 2 = High Coolant Temp Bit 3 = Low Aftcooler Cool. Level Bit 4 = Low Fuel Delivery Press. Bit 5 = Low Oil Pressure Bit 6 = Overspeed Bit 7 = Combined Red
44818	MTU Pre-Alarm Metering	Int32	N/A	N/A	R	Bit 0 = High ECU Temp. Bit 1 = High Oil Temp. Bit 2 = High Intercooler Temp. Bit 3 = High Charge Air Temp. Bit 4 = High Coolant Temp. Bit 5 = Shutdown Override Bit 6 = High Fuel Rail Press. Bit 7 = Low Fuel Rail Press. Bit 8 = Low Coolant Level Bit 9 = Low Charge Air Press. Bit 10 = Low Fuel Delivery Press. Bit 11 = Low Oil Press. Bit 12 = Combined Yellow
44820	Sender Fail Alarm Metering	Int32	N/A	N/A	R	Bit 0 = Speed Bit 1 = Oil Pressure Bit 2 = Coolant Temp Bit 3 = Fuel Level Bit 4 = Generator Voltage
44822	Protection Alarm Metering	Int32	N/A	N/A	R	Bit 0 = 51-1 Overcurrent Bit 1 = 47 Phase Imbalance Bit 2 = 27-1 Undervoltage Bit 3 = 59-1 Overvoltage Bit 4 = 81 Overfrequency Bit 5 = 81 Underfrequency Bit 6 = 51-2 Overcurrent Bit 7 = 27-2 Undervoltage Bit 8 = 59-2 Overvoltage Bit 9 = 32 Reverse Power Bit 10 = 40Q Loss of Excitation
44824-26	FUTURE USE					

Register	Description	Type	Units	Scaling Factor	R/W	Range
44828	Local Input Metering	Int32	N/A	N/A	R	Bit 0 = Input 1 Bit 1 = Input 2 Bit 2 = Input 3 Bit 3 = Input 4 Bit 4 = Input 5 Bit 5 = Input 6 Bit 6 = Input 7 Bit 7 = Input 8 Bit 8 = Input 9 Bit 9 = Input 10 Bit 10 = Input 11 Bit 11 = Input 12 Bit 12 = Input 13 Bit 13 = Input 14 Bit 14 = Input 15 Bit 15 = Input 16
44830	Local Output Metering	Int32	N/A	N/A	R	Bit 0 = Output 1 Bit 1 = Output 2 Bit 2 = Output 3 Bit 3 = Output 4 Bit 4 = Output 5 Bit 5 = Output 6 Bit 6 = Output 7 Bit 7 = Output 8 Bit 8 = Output 9 Bit 9 = Output 10 Bit 10 = Output 11 Bit 11 = Output 12
44832	Status Metering	Int32	N/A	N/A	R	Bit 0 = EPS Supplying Load Bit 1 = Single Phase Override Bit 2 = Single Phase AC Override Bit 3 = Low Line Override Bit 4 = Auto Transfer Switch Bit 5 = Battle Override Bit 6 = Grounded Delta Override Bit 7 = Mains Breaker Closed Bit 8 = Gen Breaker Closed Bit 9 = Bus Dead Bit 10 = Bus Stable Bit 11 = Bus Failed Bit 12 = Gen Dead Bit 13 = Gen Stable Bit 14 = Gen Failed Bit 15 = Low Coolant Level Bit 16 = Battery Charger Failure Bit 17 = Fuel Leak Detect Bit 18 = Engine Running Bit 19 = Cooldown Timer Active
44834	Hours Until Maintenance	Int32	N/A	N/A	RW	0 - 5000
44836	Cum. Total Engine Run Hrs.	Int32	Hour	N/A	R	0 - 99999
44838	Cum. Total Engine Run Min.	Int32	N/A	N/A	R	0 - 59
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

Register	Description	Type	Units	Scaling Factor	R/W	Range
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	FUTURE USE					
44920-48	RESERVED					
44950	Global Alarm	UInt32	N/A	N/A	R	0 = No system alarms in effect 1 = System alarm(s) in effect
44952	Global Pre-Alarm	UInt32	N/A	N/A	R	0 = No system pre-alarms in effect 1 = System pre-alarm(s) in effect
44954	Local Configurable Inputs Pre-Alarm Bits	Int32	N/A	N/A	R	Bit 0 = Input 1 Bit 1 = Input 2 Bit 2 = Input 3 Bit 3 = Input 4 Bit 4 = Input 5 Bit 5 = Input 6 Bit 6 = Input 7 Bit 7 = Input 8 Bit 8 = Input 9 Bit 9 = Input 10 Bit 10 = Input 11 Bit 11 = Input 12 Bit 12 = Input 13 Bit 13 = Input 14 Bit 14 = Input 15 Bit 15 = Input 16

Register	Description	Type	Units	Scaling Factor	R/W	Range
44956	Local Configurable Inputs Alarm Bits	Int32	N/A	N/A	R	Bit 0 = Input 1 Bit 1 = Input 2 Bit 2 = Input 3 Bit 3 = Input 4 Bit 4 = Input 5 Bit 5 = Input 6 Bit 6 = Input 7 Bit 7 = Input 8 Bit 8 = Input 9 Bit 9 = Input 10 Bit 10 = Input 11 Bit 11 = Input 12 Bit 12 = Input 13 Bit 13 = Input 14 Bit 14 = Input 15 Bit 15 = Input 16
44958	Configurable Elements Status Bits	Int32	N/A	N/A	R	Bit 0 = Config Element 1 Bit 1 = Config Element 2 Bit 2 = Config Element 3 Bit 3 = Config Element 4 Bit 4 = Config Element 5 Bit 5 = Config Element 6 Bit 6 = Config Element 7 Bit 7 = Config Element 8
44960	Configurable Elements Pre-Alarm Bits	Int32	N/A	N/A	R	Bit 0 = Config Element 1 Bit 1 = Config Element 2 Bit 2 = Config Element 3 Bit 3 = Config Element 4 Bit 4 = Config Element 5 Bit 5 = Config Element 6 Bit 6 = Config Element 7 Bit 7 = Config Element 8
44962	Configurable Elements Alarm Bits	Int32	N/A	N/A	R	Bit 0 = Config Element 1 Bit 1 = Config Element 2 Bit 2 = Config Element 3 Bit 3 = Config Element 4 Bit 4 = Config Element 5 Bit 5 = Config Element 6 Bit 6 = Config Element 7 Bit 7 = Config Element 8
44964	Remote Inputs Status Bits	Int32	N/A	N/A	R	Bit 0 = Remote Input 17 Bit 1 = Remote Input 18 Bit 2 = Remote Input 19 Bit 3 = Remote Input 20 Bit 4 = Remote Input 21 Bit 5 = Remote Input 22 Bit 6 = Remote Input 23 Bit 7 = Remote Input 24 Bit 8 = Remote Input 25 Bit 9 = Remote Input 26

Register	Description	Type	Units	Scaling Factor	R/W	Range
44966	Remote Outputs Status Bits	Int32	N/A	N/A	R	Bit 0 = Remote Output 13 Bit 1 = Remote Output 14 Bit 2 = Remote Output 15 Bit 3 = Remote Output 16 Bit 4 = Remote Output 17 Bit 5 = Remote Output 18 Bit 6 = Remote Output 19 Bit 7 = Remote Output 20 Bit 8 = Remote Output 21 Bit 9 = Remote Output 22 Bit 10 = Remote Output 23 Bit 11 = Remote Output 24 Bit 12 = Remote Output 25 Bit 13 = Remote Output 26 Bit 14 = Remote Output 27 Bit 15 = Remote Output 28 Bit 16 = Remote Output 29 Bit 17 = Remote Output 30 Bit 18 = Remote Output 31 Bit 19 = Remote Output 32 Bit 20 = Remote Output 33 Bit 21 = Remote Output 34 Bit 22 = Remote Output 35 Bit 23 = Remote Output 36
44968	CEM Alarm Bits	UInt32	N/A	N/A	R	Bit 0 = CEM Comm Fail Bit 1 = Duplicate CEM Bit 2 = CEM Hardware Mismatch
44970	Remote Configurable Inputs Pre-Alarm Bits	UInt32	N/A	N/A	R	Bit 0 = Remote Input 17 Bit 1 = Remote Input 18 Bit 2 = Remote Input 19 Bit 3 = Remote Input 20 Bit 4 = Remote Input 21 Bit 5 = Remote Input 22 Bit 6 = Remote Input 23 Bit 7 = Remote Input 24 Bit 8 = Remote Input 25 Bit 9 = Remote Input 26
44972	Remote Configurable Inputs Alarm Bits	UInt32	N/A	N/A	R	Bit 0 = Remote Input 17 Bit 1 = Remote Input 18 Bit 2 = Remote Input 19 Bit 3 = Remote Input 20 Bit 4 = Remote Input 21 Bit 5 = Remote Input 22 Bit 6 = Remote Input 23 Bit 7 = Remote Input 24 Bit 8 = Remote Input 25 Bit 9 = Remote Input 26
44974	AEM Alarm Bits	UInt32	N/A	N/A	R	Bit 0 = AEM Comm Fail Bit 1 = Duplicate AEM
44976-84	RESERVED					
44986	Generator Frequency	Int32	N/A	Deci	R	0 - 4400
44988	Bus Frequency	Int32	N/A	Deci	R	0 - 440
44990	Power Factor	Int32	N/A	Centi	R	(-100) - 100
44992-99	RESERVED					
45000	ECU Lamp Status	Int32	N/A	N/A	R	Bit 24 = Malfunction Bit 27 = Stop Bit 28 = Warning Bit 31 = Protect
45002	Number of DTC's	Int32	N/A	N/A	R	(-32768) - 32767
45004-490	RESERVED					
45500	Analog Input 1 Metering Value	Int32	DeciUnit	Deci	R	(-99990) - 99990
45502	Analog Input 2 Metering Value	Int32	DeciUnit	Deci	R	(-99990) - 99990

Register	Description	Type	Units	Scaling Factor	R/W	Range
45504	Analog Input 3 Metering Value	Int32	DeciUnit	Deci	R	(-99990) - 99990
45506	Analog Input 4 Metering Value	Int32	DeciUnit	Deci	R	(-99990) - 99990
45508	Analog Input 5 Metering Value	Int32	DeciUnit	Deci	R	(-99990) - 99990
45510	Analog Input 6 Metering Value	Int32	DeciUnit	Deci	R	(-99990) - 99990
45512	Analog Input 7 Metering Value	Int32	DeciUnit	Deci	R	(-99990) - 99990
45514	Analog Input 8 Metering Value	Int32	DeciUnit	Deci	R	(-99990) - 99990
45516	RTD Input 1 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45518	RTD Input 2 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45520	RTD Input 3 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45522	RTD Input 4 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45524	RTD Input 5 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45526	RTD Input 6 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45528	RTD Input 7 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45530	RTD Input 8 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45532	Thermocouple Input 1 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45534	Thermocouple Input 2 Metering Value	Int32	CentiDeg F	Centi	R	(-9999999) - 9999999
45536	AEM Input Threshold Status Bits Reg 1	UInt32	N/A	N/A	R	Bit 0 = Analog Input 1 Out of Range Bit 1 = Analog Input 1 Over 1 Bit 2 = Analog Input 1 Over 2 Bit 3 = Analog Input 1 Under 1 Bit 4 = Analog Input 1 Under 2 Bit 5 = Analog Input 2 Out of Range Bit 6 = Analog Input 2 Over 1 Bit 7 = Analog Input 2 Over 2 Bit 8 = Analog Input 2 Under 1 Bit 9 = Analog Input 2 Under 2 Bit 10 = Analog Input 3 Out of Range Bit 11 = Analog Input 3 Over 1 Bit 12 = Analog Input 3 Over 2 Bit 13 = Analog Input 3 Under 1 Bit 14 = Analog Input 3 Under 2 Bit 15 = Analog Input 4 Out of Range Bit 16 = Analog Input 4 Over 1 Bit 17 = Analog Input 4 Over 2 Bit 18 = Analog Input 4 Under 1 Bit 19 = Analog Input 4 Under 2 Bit 20 = Analog Input 5 Out of Range Bit 21 = Analog Input 5 Over 1 Bit 22 = Analog Input 5 Over 2 Bit 23 = Analog Input 5 Under 1 Bit 24 = Analog Input 5 Under 2 Bit 25 = Analog Input 6 Out of Range Bit 26 = Analog Input 6 Over 1 Bit 27 = Analog Input 6 Over 2 Bit 28 = Analog Input 6 Under 1 Bit 29 = Analog Input 6 Under 2

Register	Description	Type	Units	Scaling Factor	R/W	Range
45538	AEM Input Threshold Status Bits Reg 2	Uint32	N/A	N/A	R	Bit 0 = Analog Input 7 Out of Range Bit 1 = Analog Input 7 Over 1 Bit 2 = Analog Input 7 Over 2 Bit 3 = Analog Input 7 Under 1 Bit 4 = Analog Input 7 Under 2 Bit 5 = Analog Input 8 Out of Range Bit 6 = Analog Input 8 Over 1 Bit 7 = Analog Input 8 Over 2 Bit 8 = Analog Input 8 Under 1 Bit 9 = Analog Input 8 Under 2 Bit 10 = RTD Input 1 Out of Range Bit 11 = RTD Input 1 Over 1 Bit 12 = RTD Input 1 Over 2 Bit 13 = RTD Input 1 Under 1 Bit 14 = RTD Input 1 Under 2 Bit 15 = RTD Input 2 Out of Range Bit 16 = RTD Input 2 Over 1 Bit 17 = RTD Input 2 Over 2 Bit 18 = RTD Input 2 Under 1 Bit 19 = RTD Input 2 Under 2 Bit 20 = RTD Input 3 Out of Range Bit 21 = RTD Input 3 Over 1 Bit 22 = RTD Input 3 Over 2 Bit 23 = RTD Input 3 Under 1 Bit 24 = RTD Input 3 Under 2 Bit 25 = RTD Input 4 Out of Range Bit 26 = RTD Input 4 Over 1 Bit 27 = RTD Input 4 Over 2 Bit 28 = RTD Input 4 Under 1 Bit 29 = RTD Input 4 Under 2
45540	AEM Input Threshold Status Bits Reg 3	Uint32	N/A	N/A	R	Bit 0 = RTD Input 5 Out of Range Bit 1 = RTD Input 5 Over 1 Bit 2 = RTD Input 5 Over 2 Bit 3 = RTD Input 5 Under 1 Bit 4 = RTD Input 5 Under 2 Bit 5 = RTD Input 6 Out of Range Bit 6 = RTD Input 6 Over 1 Bit 7 = RTD Input 6 Over 2 Bit 8 = RTD Input 6 Under 1 Bit 9 = RTD Input 6 Under 2 Bit 10 = RTD Input 7 Out of Range Bit 11 = RTD Input 7 Over 1 Bit 12 = RTD Input 7 Over 2 Bit 13 = RTD Input 7 Under 1 Bit 14 = RTD Input 7 Under 2 Bit 15 = RTD Input 8 Out of Range Bit 16 = RTD Input 8 Over 1 Bit 17 = RTD Input 8 Over 2 Bit 18 = RTD Input 8 Under 1 Bit 19 = RTD Input 8 Under 2 Bit 20 = Thermocouple 1 Out of Range Bit 21 = Thermocouple 1 Over 1 Bit 22 = Thermocouple 1 Over 2 Bit 23 = Thermocouple 1 Under 1 Bit 24 = Thermocouple 1 Under 2 Bit 25 = Thermocouple 2 Out of Range Bit 26 = Thermocouple 2 Over 1 Bit 27 = Thermocouple 2 Over 2 Bit 28 = Thermocouple 2 Under 1 Bit 29 = Thermocouple 2 Under 2
45542	AEM Input Threshold Status Bits Reg 4	Uint32	N/A	N/A	R	Bit 0 = Analog Output 1 Out of Range Bit 1 = Analog Output 2 Out of Range Bit 2 = Analog Output 3 Out of Range Bit 3 = Analog Output 4 Out of Range

Register	Description	Type	Units	Scaling Factor	R/W	Range
45544	AEM Input Threshold Alarm Bits Reg 1	Uint32	N/A	N/A	R	Bit 0 = Analog Input 1 Out of Range Bit 1 = Analog Input 1 Over 1 Bit 2 = Analog Input 1 Over 2 Bit 3 = Analog Input 1 Under 1 Bit 4 = Analog Input 1 Under 2 Bit 5 = Analog Input 2 Out of Range Bit 6 = Analog Input 2 Over 1 Bit 7 = Analog Input 2 Over 2 Bit 8 = Analog Input 2 Under 1 Bit 9 = Analog Input 2 Under 2 Bit 10 = Analog Input 3 Out of Range Bit 11 = Analog Input 3 Over 1 Bit 12 = Analog Input 3 Over 2 Bit 13 = Analog Input 3 Under 1 Bit 14 = Analog Input 3 Under 2 Bit 15 = Analog Input 4 Out of Range Bit 16 = Analog Input 4 Over 1 Bit 17 = Analog Input 4 Over 2 Bit 18 = Analog Input 4 Under 1 Bit 19 = Analog Input 4 Under 2 Bit 20 = Analog Input 5 Out of Range Bit 21 = Analog Input 5 Over 1 Bit 22 = Analog Input 5 Over 2 Bit 23 = Analog Input 5 Under 1 Bit 24 = Analog Input 5 Under 2 Bit 25 = Analog Input 6 Out of Range Bit 26 = Analog Input 6 Over 1 Bit 27 = Analog Input 6 Over 2 Bit 28 = Analog Input 6 Under 1 Bit 29 = Analog Input 6 Under 2
45546	AEM Input Threshold Alarm Bits Reg 2	Uint32	N/A	N/A	R	Bit 0 = Analog Input 7 Out of Range Bit 1 = Analog Input 7 Over 1 Bit 2 = Analog Input 7 Over 2 Bit 3 = Analog Input 7 Under 1 Bit 4 = Analog Input 7 Under 2 Bit 5 = Analog Input 8 Out of Range Bit 6 = Analog Input 8 Over 1 Bit 7 = Analog Input 8 Over 2 Bit 8 = Analog Input 8 Under 1 Bit 9 = Analog Input 8 Under 2 Bit 10 = RTD Input 1 Out of Range Bit 11 = RTD Input 1 Over 1 Bit 12 = RTD Input 1 Over 2 Bit 13 = RTD Input 1 Under 1 Bit 14 = RTD Input 1 Under 2 Bit 15 = RTD Input 2 Out of Range Bit 16 = RTD Input 2 Over 1 Bit 17 = RTD Input 2 Over 2 Bit 18 = RTD Input 2 Under 1 Bit 19 = RTD Input 2 Under 2 Bit 20 = RTD Input 3 Out of Range Bit 21 = RTD Input 3 Over 1 Bit 22 = RTD Input 3 Over 2 Bit 23 = RTD Input 3 Under 1 Bit 24 = RTD Input 3 Under 2 Bit 25 = RTD Input 4 Out of Range Bit 26 = RTD Input 4 Over 1 Bit 27 = RTD Input 4 Over 2 Bit 28 = RTD Input 4 Under 1 Bit 29 = RTD Input 4 Under 2

Register	Description	Type	Units	Scaling Factor	R/W	Range
45548	AEM Input Threshold Alarm Bits Reg 3	Uint32	N/A	N/A	R	Bit 0 = RTD Input 5 Out of Range Bit 1 = RTD Input 5 Over 1 Bit 2 = RTD Input 5 Over 2 Bit 3 = RTD Input 5 Under 1 Bit 4 = RTD Input 5 Under 2 Bit 5 = RTD Input 6 Out of Range Bit 6 = RTD Input 6 Over 1 Bit 7 = RTD Input 6 Over 2 Bit 8 = RTD Input 6 Under 1 Bit 9 = RTD Input 6 Under 2 Bit 10 = RTD Input 7 Out of Range Bit 11 = RTD Input 7 Over 1 Bit 12 = RTD Input 7 Over 2 Bit 13 = RTD Input 7 Under 1 Bit 14 = RTD Input 7 Under 2 Bit 15 = RTD Input 8 Out of Range Bit 16 = RTD Input 8 Over 1 Bit 17 = RTD Input 8 Over 2 Bit 18 = RTD Input 8 Under 1 Bit 19 = RTD Input 8 Under 2 Bit 20 = Thermocouple 1 Out of Range Bit 21 = Thermocouple 1 Over 1 Bit 22 = Thermocouple 1 Over 2 Bit 23 = Thermocouple 1 Under 1 Bit 24 = Thermocouple 1 Under 2 Bit 25 = Thermocouple 2 Out of Range Bit 26 = Thermocouple 2 Over 1 Bit 27 = Thermocouple 2 Over 2 Bit 28 = Thermocouple 2 Under 1 Bit 29 = Thermocouple 2 Under 2
45550	AEM Input Threshold Alarm Bits Reg 4	Uint32	N/A	N/A	R	Bit 0 = Analog Output 1 Out of Range Bit 1 = Analog Output 2 Out of Range Bit 2 = Analog Output 3 Out of Range Bit 3 = Analog Output 4 Out of Range
45552	AEM Input Threshold Pre-Alarm Bits Reg 1	Uint32	N/A	N/A	R	Bit 0 = Analog Input 1 Out of Range Bit 1 = Analog Input 1 Over 1 Bit 2 = Analog Input 1 Over 2 Bit 3 = Analog Input 1 Under 1 Bit 4 = Analog Input 1 Under 2 Bit 5 = Analog Input 2 Out of Range Bit 6 = Analog Input 2 Over 1 Bit 7 = Analog Input 2 Over 2 Bit 8 = Analog Input 2 Under 1 Bit 9 = Analog Input 2 Under 2 Bit 10 = Analog Input 3 Out of Range Bit 11 = Analog Input 3 Over 1 Bit 12 = Analog Input 3 Over 2 Bit 13 = Analog Input 3 Under 1 Bit 14 = Analog Input 3 Under 2 Bit 15 = Analog Input 4 Out of Range Bit 16 = Analog Input 4 Over 1 Bit 17 = Analog Input 4 Over 2 Bit 18 = Analog Input 4 Under 1 Bit 19 = Analog Input 4 Under 2 Bit 20 = Analog Input 5 Out of Range Bit 21 = Analog Input 5 Over 1 Bit 22 = Analog Input 5 Over 2 Bit 23 = Analog Input 5 Under 1 Bit 24 = Analog Input 5 Under 2 Bit 25 = Analog Input 6 Out of Range Bit 26 = Analog Input 6 Over 1 Bit 27 = Analog Input 6 Over 2 Bit 28 = Analog Input 6 Under 1 Bit 29 = Analog Input 6 Under 2

Register	Description	Type	Units	Scaling Factor	R/W	Range
45554	AEM Input Threshold Pre-Alarm Bits Reg 2	Uint32	N/A	N/A	R	Bit 0 = Analog Input 7 Out of Range Bit 1 = Analog Input 7 Over 1 Bit 2 = Analog Input 7 Over 2 Bit 3 = Analog Input 7 Under 1 Bit 4 = Analog Input 7 Under 2 Bit 5 = Analog Input 8 Out of Range Bit 6 = Analog Input 8 Over 1 Bit 7 = Analog Input 8 Over 2 Bit 8 = Analog Input 8 Under 1 Bit 9 = Analog Input 8 Under 2 Bit 10 = RTD Input 1 Out of Range Bit 11 = RTD Input 1 Over 1 Bit 12 = RTD Input 1 Over 2 Bit 13 = RTD Input 1 Under 1 Bit 14 = RTD Input 1 Under 2 Bit 15 = RTD Input 2 Out of Range Bit 16 = RTD Input 2 Over 1 Bit 17 = RTD Input 2 Over 2 Bit 18 = RTD Input 2 Under 1 Bit 19 = RTD Input 2 Under 2 Bit 20 = RTD Input 3 Out of Range Bit 21 = RTD Input 3 Over 1 Bit 22 = RTD Input 3 Over 2 Bit 23 = RTD Input 3 Under 1 Bit 24 = RTD Input 3 Under 2 Bit 25 = RTD Input 4 Out of Range Bit 26 = RTD Input 4 Over 1 Bit 27 = RTD Input 4 Over 2 Bit 28 = RTD Input 4 Under 1 Bit 29 = RTD Input 4 Under 2
45556	AEM Input Threshold Pre-Alarm Bits Reg 3	Uint32	N/A	N/A	R	Bit 0 = RTD Input 5 Out of Range Bit 1 = RTD Input 5 Over 1 Bit 2 = RTD Input 5 Over 2 Bit 3 = RTD Input 5 Under 1 Bit 4 = RTD Input 5 Under 2 Bit 5 = RTD Input 6 Out of Range Bit 6 = RTD Input 6 Over 1 Bit 7 = RTD Input 6 Over 2 Bit 8 = RTD Input 6 Under 1 Bit 9 = RTD Input 6 Under 2 Bit 10 = RTD Input 7 Out of Range Bit 11 = RTD Input 7 Over 1 Bit 12 = RTD Input 7 Over 2 Bit 13 = RTD Input 7 Under 1 Bit 14 = RTD Input 7 Under 2 Bit 15 = RTD Input 8 Out of Range Bit 16 = RTD Input 8 Over 1 Bit 17 = RTD Input 8 Over 2 Bit 18 = RTD Input 8 Under 1 Bit 19 = RTD Input 8 Under 2 Bit 20 = Thermocouple 1 Out of Range Bit 21 = Thermocouple 1 Over 1 Bit 22 = Thermocouple 1 Over 2 Bit 23 = Thermocouple 1 Under 1 Bit 24 = Thermocouple 1 Under 2 Bit 25 = Thermocouple 2 Out of Range Bit 26 = Thermocouple 2 Over 1 Bit 27 = Thermocouple 2 Over 2 Bit 28 = Thermocouple 2 Under 1 Bit 29 = Thermocouple 2 Under 2
45558	AEM Input Threshold Pre-Alarm Bits Reg 4	Uint32	N/A	N/A	R	Bit 0 = Analog Output 1 Out of Range Bit 1 = Analog Output 2 Out of Range Bit 2 = Analog Output 3 Out of Range Bit 3 = Analog Output 4 Out of Range
45560	Analog Output 1 Metering Value	Int32	CentiUnit	Centi	R	(-999990) - 999990

Register	Description	Type	Units	Scaling Factor	R/W	Range
45562	Analog Output 2 Metering Value	Int32	CentiUnit	Centi	R	(-999990) - 999990
45564	Analog Output 3 Metering Value	Int32	CentiUnit	Centi	R	(-999990) - 999990
45566	Analog Output 4 Metering Value	Int32	CentiUnit	Centi	R	(-999990) - 999990
45568	Configurable Protection Threshold Status Bits	UInt32	N/A	N/A	R	Bit 0 = Conf Protection 1 Over 1 Bit 1 = Conf Protection 1 Over 2 Bit 2 = Conf Protection 1 Under 1 Bit 3 = Conf Protection 1 Under 2 Bit 4 = Conf Protection 2 Over 1 Bit 5 = Conf Protection 2 Over 2 Bit 6 = Conf Protection 2 Under 1 Bit 7 = Conf Protection 2 Under 2 Bit 8 = Conf Protection 3 Over 1 Bit 9 = Conf Protection 3 Over 2 Bit 10 = Conf Protection 3 Under 1 Bit 11 = Conf Protection 3 Under 2 Bit 12 = Conf Protection 4 Over 1 Bit 13 = Conf Protection 4 Over 2 Bit 14 = Conf Protection 4 Under 1 Bit 15 = Conf Protection 4 Under 2 Bit 16 = Conf Protection 5 Over 1 Bit 17 = Conf Protection 5 Over 2 Bit 18 = Conf Protection 5 Under 1 Bit 19 = Conf Protection 5 Under 2 Bit 20 = Conf Protection 6 Over 1 Bit 21 = Conf Protection 6 Over 2 Bit 22 = Conf Protection 6 Under 1 Bit 23 = Conf Protection 6 Under 2 Bit 24 = Conf Protection 7 Over 1 Bit 25 = Conf Protection 7 Over 2 Bit 26 = Conf Protection 7 Under 1 Bit 27 = Conf Protection 7 Under 2 Bit 28 = Conf Protection 8 Over 1 Bit 29 = Conf Protection 8 Over 2 Bit 30 = Conf Protection 8 Under 1 Bit 31 = Conf Protection 8 Under 2

Register	Description	Type	Units	Scaling Factor	R/W	Range
45570	Configurable Protection Alarm Bits	Uint32	N/A	N/A	R	Bit 0 = Conf Protection 1 Over 1 Bit 1 = Conf Protection 1 Over 2 Bit 2 = Conf Protection 1 Under 1 Bit 3 = Conf Protection 1 Under 2 Bit 4 = Conf Protection 2 Over 1 Bit 5 = Conf Protection 2 Over 2 Bit 6 = Conf Protection 2 Under 1 Bit 7 = Conf Protection 2 Under 2 Bit 8 = Conf Protection 3 Over 1 Bit 9 = Conf Protection 3 Over 2 Bit 10 = Conf Protection 3 Under 1 Bit 11 = Conf Protection 3 Under 2 Bit 12 = Conf Protection 4 Over 1 Bit 13 = Conf Protection 4 Over 2 Bit 14 = Conf Protection 4 Under 1 Bit 15 = Conf Protection 4 Under 2 Bit 16 = Conf Protection 5 Over 1 Bit 17 = Conf Protection 5 Over 2 Bit 18 = Conf Protection 5 Under 1 Bit 19 = Conf Protection 5 Under 2 Bit 20 = Conf Protection 6 Over 1 Bit 21 = Conf Protection 6 Over 2 Bit 22 = Conf Protection 6 Under 1 Bit 23 = Conf Protection 6 Under 2 Bit 24 = Conf Protection 7 Over 1 Bit 25 = Conf Protection 7 Over 2 Bit 26 = Conf Protection 7 Under 1 Bit 27 = Conf Protection 7 Under 2 Bit 28 = Conf Protection 8 Over 1 Bit 29 = Conf Protection 8 Over 2 Bit 30 = Conf Protection 8 Under 1 Bit 31 = Conf Protection 8 Under 2
45572	Configurable Protection Pre-Alarm Bits	Uint32	N/A	N/A	R	Bit 0 = Conf Protection 1 Over 1 Bit 1 = Conf Protection 1 Over 2 Bit 2 = Conf Protection 1 Under 1 Bit 3 = Conf Protection 1 Under 2 Bit 4 = Conf Protection 2 Over 1 Bit 5 = Conf Protection 2 Over 2 Bit 6 = Conf Protection 2 Under 1 Bit 7 = Conf Protection 2 Under 2 Bit 8 = Conf Protection 3 Over 1 Bit 9 = Conf Protection 3 Over 2 Bit 10 = Conf Protection 3 Under 1 Bit 11 = Conf Protection 3 Under 2 Bit 12 = Conf Protection 4 Over 1 Bit 13 = Conf Protection 4 Over 2 Bit 14 = Conf Protection 4 Under 1 Bit 15 = Conf Protection 4 Under 2 Bit 16 = Conf Protection 5 Over 1 Bit 17 = Conf Protection 5 Over 2 Bit 18 = Conf Protection 5 Under 1 Bit 19 = Conf Protection 5 Under 2 Bit 20 = Conf Protection 6 Over 1 Bit 21 = Conf Protection 6 Over 2 Bit 22 = Conf Protection 6 Under 1 Bit 23 = Conf Protection 6 Under 2 Bit 24 = Conf Protection 7 Over 1 Bit 25 = Conf Protection 7 Over 2 Bit 26 = Conf Protection 7 Under 1 Bit 27 = Conf Protection 7 Under 2 Bit 28 = Conf Protection 8 Over 1 Bit 29 = Conf Protection 8 Over 2 Bit 30 = Conf Protection 8 Under 1 Bit 31 = Conf Protection 8 Under 2
45574	Gen Kvar A	Int32	KiloVAr	N/A	R	(-2147483648) - 2147483647

Register	Description	Type	Units	Scaling Factor	R/W	Range
45576	Gen Kvar B	Int32	KiloVAr	N/A	R	(-2147483648) - 2147483647
45578	Gen Kvar C	Int32	KiloVAr	N/A	R	(-2147483648) - 2147483647
45580	Gen Kvar Total	Int32	KiloVAr	N/A	R	(-2147483648) - 2147483647
45582-749	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
45754	pc Relay Closed	UInt32	N/A	N/A	RW	0 = Stop 1 = Start
45756	Test Buttons Image	UInt32	N/A	N/A	RW	0 - 255
45758	Reserved					
45760	Reserved					
45762	Embedded Code Version Number	UInt32	N/A	N/A	R	
45764	Boot Code Version Number	UInt32	N/A	N/A	R	
45766	Model Number	UInt32	N/A	N/A	R	
45768	Embedded Code Part Number	UInt32	N/A	N/A	R	
45770-999	FUTURE USE					
46000	J1939-Transmission Oil Pressure	UInt32	Raw ECU Parameter Data 16 kPa/bit gain, 0 kPa offset		R	0 to +4000 kPa (0 to 580 psi)
46002	J1939-Transmission Oil Temp	UInt32	Raw ECU Parameter Data 0.03125 °C/bit gain, -273 °C offset		R	-273 to +1735.0 °C (-459.4 to 3155.0 °F)
46004	J1939-Winding 1 Temp	UInt32	Raw ECU Parameter Data 1 °C/bit gain, -40 °C offset		R	-40 to +210 °C (-40 to 410 °F)
46006	J1939-Winding 2 Temp	UInt32	Raw ECU Parameter Data 1 °C/bit gain, -40 °C offset		R	-40 to +210 °C (-40 to 410 °F)
46008	J1939-Winding 3 Temp	UInt32	Raw ECU Parameter Data 1 °C/bit gain, -40 °C offset		R	-40 to +210 °C (-40 to 410 °F)
46010	J1939-ECU Temp	UInt32	Raw ECU Parameter Data 0.03125 °C/bit gain, -273 °C offset		R	-273 to +273 °C (-459 to 523 °F)
46012	J1939-Aux Pressure 1	UInt32	Raw ECU Parameter Data 16 kPa/bit gain, 0 kPa offset		R	0 to 4000 kPa
46014	J1939-Aux Pressure 2	UInt32	Raw ECU Parameter Data 16 kPa/bit gain, 0 kPa offset		R	0 to 4000 kPa
46016	J1939-Rated Power	UInt32	Raw ECU Parameter Data 0 to 32 127.5 kW (0 to 43 083.7 hp)		R	0.5 kW/bit, 0 kW offset (0.67 hp/bit, 0 hp offset)

Register	Description	Type	Units	Scaling Factor	R/W	Range
46018	J1939-Rated RPM	Uint32	Raw ECU Parameter Data 0 to 8031.875 rpm		R	0.125 rpm/bit, 0 offset
46020	J1939-Exhaust Temp A	Uint32	Raw ECU Parameter Data 0.03125 °C/bit gain, -273 °C offset		R	-273 to +1735.0 °C (-459.4 to 3155.0 °F)
46022	J1939-Exhaust Temp B	Uint32	Raw ECU Parameter Data 0.03125 °C/bit gain, -273 °C offset		R	-273 to +1735.0 °C (-459.4 to 3155.0 °F)
46024	J1939-Charge Air Temp	Uint32	Raw ECU Parameter Data 0.03125 °C/bit gain, -273 °C offset		R	0.03125 °C/bit gain, -273 °C offset -273 to +1735.0 °C (-459.4 to 3155.0 °F)
46026	J1939-ADEC ECU Error Code	Uint32	Raw ECU Parameter Data 0 to 64255		R	No Scale Or Offset
46028	J1939-ADEC Selected Speed Demand	Uint32	Raw ECU Parameter Data 0 to 8031.875 rpm		R	0.125 rpm/bit, gain 0 offset
46030	J1939-ADEC Effective Set Speed	Uint32	Raw ECU Parameter Data 0 to 8031.875 rpm		R	0.125 rpm/bit, gain 0 offset
46032	J1939-ADEC CANbus Speed Demand	Uint32	Raw ECU Parameter Data 0 to 8031.875 rpm		R	0.125 rpm/bit, gain 0 offset
46034	J1939-ADEC Analog Speed Demand	Uint32	Raw ECU Parameter Data 0 to 8031.875 rpm		R	0.125 rpm/bit, gain 0 offset
46036	J1939-ADEC Speed Demand Source	Uint32	Raw ECU Parameter Data 0 to 4294967295		R	No Scale or Offset
46038	J1939-ADEC Specified Torque	Uint32	Raw ECU Parameter Data 0 to 64255 Nm		R	1 Nm per bit
46040	J1939-ADEC Engine Optimized	Uint32	Raw ECU Parameter Data 0 to 64255		R	No Scale or Offset
46042	J1939-ADEC Current P Degree	Uint32	Raw ECU Parameter Data 0 to 160.6375%		R	.0025 % per bit, 0 Offset
46044	J1939-ADEC Day Tank Fill Percent	Uint32	Raw ECU Parameter Data 0 to 100%		R	0.4 % per bit, 0 offset
46046	J1939-ADEC Storage Tank Fill Percent	Uint32	Raw ECU Parameter Data 0 to 100%		R	0.4 % per bit, 0 offset
46048	J1939-ADEC Injection Quantity	Uint32	Raw ECU Parameter Data mm ³		R	0.1 mm ³ per bit, 0 offset
46050	J1939-ADEC Engine Power Reserve	Uint32	Raw ECU Parameter Data		R	.001% per bit, 0 offset

Register	Description	Type	Units	Scaling Factor	R/W	Range
46052	J1939-ADEC Cylinder Cutout Code	Uint32	Raw ECU Parameter Data		R	No Scale or Offset
46054	J1939-ADEC Start Sequence Bit Field	Uint32	Raw ECU Parameter Data		R	No Scale or Offset
46056	J1939-ADEC P Lube Oil Limit LO	Uint32	Raw ECU Parameter Data		R	0.01 mbar per bit, 0 offset
46058	J1939-ADEC P Lube Oil Limit LO LO	Uint32	Raw ECU Parameter Data		R	0.01 mbar per bit, 0 offset
46060	J1939-ADEC P Charge Air Pressure	Uint32	Raw ECU Parameter Data		R	0.01 mbar per bit, 0 offset
46062	J1939-ADEC AL Power Amp 1 Fail Bit Fld	Uint32	Raw ECU Parameter Data		R	No Scale or Offset
46064	J1939-ADEC AL Power Amp 1 Fail Bit Fld	Uint32	Raw ECU Parameter Data		R	No Scale or Offset
46066	J1939-ADEC AL Transistor Out Bit FI	Uint32	Raw ECU Parameter Data		R	No Scale or Offset
46068	J1939-ADEC Camshaft RPM	Uint32	Raw ECU Parameter Data		R	0.1 rpm per bit, 0 offset
46070	J1939-ADEC Daily Fuel Consumption	Uint32	Raw ECU Parameter Data		R	.0001 m ³ per bit, 0 offset
46072	J1939-ADEC Frequency Speed Demand.	Uint32	Raw ECU Parameter Data		R	.0001 m ³ per bit, 0 offset
46074	J1939-ADEC Average Trip Fuel Consumption	Uint32	Raw ECU Parameter Data		R	.001 l/h per bit, 0 offset
46076	J1939-ADEC Injection Quantity DBR Pct	Uint32	Raw ECU Parameter Data		R	.01 % per bit, 0 offset
46078	J1939-ADEC Actual Droop	Uint32	Raw ECU Parameter Data		R	.0001 % per bit, 0 offset
46080	J1939-ADEC Nodes On CANbus	Uint32	Raw ECU Parameter Data		R	No Scale or Offset
46082	J1939-ADEC Lost Nodes on CANbus	Uint32	Raw ECU Parameter Data		R	No Scale or Offset
46084	J1939-ADEC Trip Operating Time	Uint32	Raw ECU Parameter Data		R	1 hour per bit, 0 offset
46086	J1939-ADEC Transistor Out Bit Field	Uint32	Raw ECU Parameter Data		R	No Scale or Offset
46088	J1939-ADEC L1L ECU Power Supply Volts	Uint32	Raw ECU Parameter Data		R	.001 V per bit, 0 offset
46090	J1939-ADEC L2L ECU Power Supply Volts	Uint32	Raw ECU Parameter Data		R	001 V per bit, 0 offset
46092	J939-ADEC U1LECU Power Supply Volts	Uint32	Raw ECU Parameter Data		R	001 V per bit, 0 offset
46094	J1939-ADEC U2L ECU Power Supply Volts	Uint32	Raw ECU Parameter Data		R	001 V per bit, 0 offset
46096	J1939-ADEC Trip Idle Time	Uint32	Raw ECU Parameter Data		R	1 second per bit, 0 offset
46098	J1939-ADEC T Coolant Limit Hi	Uint32	Raw ECU Parameter Data		R	.01 Degree C per bit, 0 offset
46100	J1939-ADEC T Coolant Limit Hi Hi	Uint32	Raw ECU Parameter Data		R	01 Degree C per bit, 0 offset
46102	J1939-ADEC T Charge Air Limit Hi	Uint32	Raw ECU Parameter Data		R	01 Degree C per bit, 0 offset

Register	Description	Type	Units	Scaling Factor	R/W	Range
46104	J1939-ADEC T Intercooler Limit Hi	Uint32	Raw ECU Parameter Data		R	01 Degree C per bit, 0 offset
46106	J1939-MTU Sps Node	Uint32	Raw ECU Parameter Data		R	No Scale Or Offset
46108	J1939-MTU Sw Type	Uint32	Raw ECU Parameter Data		R	No Scale Or Offset
46110	J1939-MTU Sw Var	Uint32	Raw ECU Parameter Data		R	No Scale Or Offset
46112	J1939-MTU Sw Ed 1	Uint32	Raw ECU Parameter Data		R	No Scale Or Offset
46114	J1939-MTU Sw Ed2	Uint32	Raw ECU Parameter Data		R	No Scale Or Offset
46116	J1939-MTU Rev	Uint32	Raw ECU Parameter Data 0 to 127		R	No Scale Or Offset
46118	J1939-MTU Sw Mod	Uint32	Raw ECU Parameter Data 0 to 127		R	No Scale Or Offset

APPENDIX C • TUNING PID SETTINGS

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APPENDIX C • TUNING PID SETTINGS

INTRODUCTION

The LSM-2020 (Load Share Module) and DGC-2020 utilize three controllers to accomplish synchronization, load sharing, and speed trim functions. The controllers are a speed controller, a voltage controller, and a kW load controller. The voltage and speed controller 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 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
K_p	Decrease	Increase	Small Change	Decrease
K_i	Decrease	Increase	Increase	Eliminate
K_d	Small Change	Decrease	Decrease	None

TUNING PROCEDURES

Voltage Controller Tuning Procedure

The voltage controller is tuned prior to the speed controller. Set all gains in voltage controller, speed controller, and KW load controller to 0. Start the generator and close the breaker onto some load.

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 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 KD has been set, tune KD again. TD ranges from 0 to 1 with an increment of 0.001. TD=0 is no filtering, TD=1 is heaviest filtering. If noise again appears to be a problem, adjust TD until desired behavior is achieved, and then retune KD.

Var/PF Controller Tuning Procedure

Once desired voltage controller performance is obtained, the Var/PF controller can be tuned. Set all gains in the Var/PF controller to 0, enable the Var /PF controller, and set the control mode to Var control. The generator must be paralleled to the utility (as indicated by the Parallel to Mains element in logic) in any of the tuning steps where the system is being tested for stable operation.

KP - Proportional Gain

Set an initial value of $KP = 1$ in the Var/PF Controller. Set the control mode to Var control.

Set KP on Var/PF controller. Synchronize the generator to the utility so that Var control becomes active. Verify that stable var control occurs. If the var control seems unstable, cut Kp in half and try again. Assuming operation appears stable, change the Var setpoint in 10% steps and check for stable operation. Since KI is zero at this point, there may be some small error. The important thing is that 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 that has its bias input driven by the LSM-2020.

KI - Integral Gain

Set the initial value of KI to be a tenth of the value set for KP.

Each time KI is set, synchronize the generator to the utility so that Var control becomes active. Check that operation appears stable. Change the Var setpoint in 10% steps and check for stable operation. If the system is not stable, lower KI and repeat the test.

Repeat this procedure, raising KI until the system is unstable, and then lower it to half the value where instability is first attained.

KD - Derivative Gain

If the performance with KP and KI alone is satisfactory, you may stop here. Otherwise, KD, the derivative controller gain, can be used in conjunction with TD, the noise filter constant, to reduce overshoot obtained with the PI control. Setting KD and TD is an iterative process. Start with small values of KD such as 0.1 or half the KI value, whichever is less.

TD is the constant of the low pass filter, which filters the controller input if high frequency interference presents a problem when derivative control is employed. TD ranges from 0 to 1. TD=0 is no filtering, TD=1 is heaviest filtering.

Tuning of KD can be achieved through the following steps. Raise KD, synchronize the generator to the utility so that Var control becomes active, and check for stability. Change the Var setpoint in 10% steps and check for stable operation. Raise KD repeating the tests until the system is unstable, and then lower it to half the value where instability is first attained. If high frequency noise seems to be entering the system, raise TD and tune KD again. TD ranges from 0 to 1. TD=0 is no filtering, TD=1 is heaviest filtering.

If high frequency noise seems to be entering the system, set TD to 0.001 and see if the noise induced behavior is reduced. Raise TD until desired reduction of noise behavior is achieved. Once TD has been set, tune KD again. TD ranges from 0 to 1 with an increment of 0.001. TD=0 is no filtering, TD=1 is heaviest filtering. If noise again appears to be a problem, adjust TD until desired behavior is achieved, then retune KD.

Speed Controller Tuning Procedure

The speed controller is tuned prior to the KW load controller. Set Load Control to enabled, and speed trim to enabled. Set all gains in both speed controller and kW load controller to 0. Start the generator and close the breaker onto some load.

KP - Proportional Gain

Set an initial value of 1 for KP.

Each time KP is set, manually displace the governor lever if possible and see that control is regained in a stable manner. If the governor cannot be perturbed in this manner, execute step responses by changing the speed trim set point and check that the generator's output approaches the new value in a stable manner. Since KI is zero at this point, there may be some small difference between the generator's output

and the speed it is trying to reach. The important thing is that the generator's output behaves in a stable manner. If the system is unstable, lower KP and repeat.

Repeat this procedure, raising KP until the system is unstable, and then lower it to half the value where instability is first attained.

If it is not possible to obtain stable speed operation, it may be necessary to reduce the control gains in the governor that has its analog bias input driven by the LSM-2020.

KI - Integral Gain

Set the initial value of KI to be a tenth of the value set for KP.

Each time KI is set, manually displace the governor lever or change the speed trim set point and verify that control is regained in a stable manner. If the system is not stable, lower KI and repeat.

Repeat this procedure, raising KI until the system is unstable, and then lower it to half the value where instability is first attained.

KD - Derivative Gain

If the performance with KP and KI alone is satisfactory, you may stop here. Otherwise, KD, the derivative controller gain, can be used in conjunction with TD, the noise filter constant, to reduce overshoot obtained with the PI control. Setting KD and TD is an iterative process. Start with small values of KD such as 0.1 or half the KI value, whichever is less.

TD is the constant of the low pass filter which filters the controller input if high frequency interference presents a problem when derivative control is employed. TD ranges from 0 to 1. TD=0 is no filtering, TD=1 is heaviest filtering.

Tuning of KD can be achieved through the following steps. First set TD=0 to eliminate filtering. Raise speed KD and check for stability. Each time KD is raised, manually displace the governor lever or change the speed trim set point and see that control is regained in a stable manner. Raise KD until the system is unstable, and then lower it to half the value where instability 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 all gains in kW load controller to 0.

KP - Proportional Gain

Set an initial value of 1 for KP.

Close the breaker onto a load. Parallel a second generator with the unit being tuned and check for stable load sharing. Then open the generator breaker on the second generator and check that the unit being tuned is still stable. Since KI is zero at this point, there may be some small error in the load sharing. The important thing is that stable load sharing is achieved.

Raise KP and repeat the test until unstable operation occurs. Lower KP to half the value where unstable operation was first attained.

If it is not possible to obtain stable kW operation, it may be necessary to reduce the control gains in the governor that has its analog bias input driven by the LSM-2020.

KI - Integral Gain

Set the initial value of KI to be a tenth of the value set for KP.

Each time KI is set, parallel a second generator with the unit being tuned, and check for stable load sharing then open the generator breaker on the second generator and check that the unit being tuned is still stable. If the system is not stable, lower KI and repeat the test.

Repeat this procedure, raising KI until the system is unstable, and then lower it to half the value where instability is first attained.

KD - Derivative Gain

If the performance with KP and KI alone is satisfactory, you may stop here. Otherwise, KD, the derivative controller gain, can be used in conjunction with TD, the noise filter constant, to reduce overshoot obtained with the PI control. Setting KD and TD is an iterative process. Start with small values of KD such as 0.1 or half the KI value, whichever is less.

TD is the constant of the low pass filter which filters the controller input if high frequency interference presents a problem when derivative control is employed. TD ranges from 0 to 1. TD=0 is no filtering, TD=1 is heaviest filtering.

Tuning of KD can be achieved through the following steps. Raise load control KD and check for stability. Each time KD is raised, parallel another generator with the unit being tuned, and check for stable load sharing. Then drop the second generator and check that the unit being tuned is still stable. Raise KD until the system is unstable, and then lower it to half the value where instability is first attained. If high frequency noise seems to be entering the system, raise TD and tune KD again. TD ranges from 0 to 1. TD=0 is no filtering, TD=1 is heaviest filtering.

If high frequency noise seems to be entering the system, set TD to 0.001 and see if the noise induced behavior is reduced. Raise TD until desired reduction of noise behavior is achieved. Once TD has been set, tune KD again. TD ranges from 0 to 1 with an increment of 0.001. TD=0 is no filtering, TD=1 is heaviest filtering. If noise again appears to be a problem, adjust TD until desired behavior is achieved, then retune KD.

GENERIC GAINS FOR MULTIPLE MACHINE TYPES

The following method is suggested for determining generic gains for multiple machine types.

- 1) Decide what levels of reverse power and reverse var (loss of excitation) protection you need to use.
- 2) Once the criteria of step 1 have been established, tune a unit so that you can parallel to another unit at no load and not cause any trips.
- 3) Parallel two machines onto a load, and verify that acceptable load sharing occurs.
- 4) Add and drop loads with machines paralleled to verify acceptable load sharing occurs, and no trips occur.
- 5) Once the settings are deemed "good", save them as initial settings for a given machine configuration for all future jobs. You shouldn't need to change them unless you get trips or need to change load sharing characteristics.
- 6) Test the units paralleled under no load and verify that no trips occur.
- 7) Parallel two machines onto a load, and verify that acceptable load sharing occurs.
- 8) Add and drop loads with machines paralleled to verify acceptable load sharing occurs and no trips occur.
- 9) If you need to modify settings for a particular machine type, keep those settings to be used as initial settings for all future machines of that type.
- 10) Test every machine with steps 6, 7, and 8.

It is not expected that you will ever get one set of numbers that will work for all machines, but it is probable that you may end up with 6 to 12 sets of settings that cover a wide range of machine sizes and engine manufacturers. However, once a set of gains has been determined for a particular machine type, the same gains should work in all identical machines.

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ROUTE 143, BOX 269
HIGHLAND, IL 62249 USA
<http://www.basler.com>, info@basler.com

PHONE +1 618-654-2341

FAX +1 618-654-2351