DGC-2020HD

Digital Genset Controller

Installation Instruction Manual

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⚠ **WARNING:** California's Proposition 65 requires special warnings for products that may contain chemicals known to the state of California to cause cancer, birth defects, or other reproductive harm. Please note that by posting this Proposition 65 warning, we are notifying you that one or more of the Proposition 65 listed chemicals may be present in products we sell to you. For more information about the specific chemicals found in this product, please visit https://www.basler.com/Prop65.

Preface

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

- Mounting
- Terminals and connectors
- Typical applications
- Power input
- Voltage and current sensing
- Speed signal inputs
- Specifications
- Maintenance and troubleshooting

Conventions Used in this Manual

Important safety and procedural information is emphasized and presented in this manual through Warning, Caution, and Note boxes. Each type is illustrated and defined as follows.

Warning!

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

Caution

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

Note

Note boxes emphasize important information pertaining to Digital Genset Controller installation or operation.

DGC-2020HD Instruction Manual Catalog

Available instruction manuals for the DGC-2020HD are listed in Table 1.

Table 1. Instruction Manuals

Part Number	Description
9469300993	Quick Start
9469300994	Installation (this manual)
9469300995	Configuration
9469300996	Operation
9469300997	Accessories
9469300998	Modbus® Protocol

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Warning!

READ THIS MANUAL. Read this manual before installing, operating, or maintaining the DGC-2020HD. Note all warnings, cautions, and notes in this manual as well as on the product. Keep this manual with the product for reference. Only qualified personnel should install, operate, or service this system. Failure to follow warning and cautionary labels may result in personal injury or property damage. Exercise caution at all times.

Caution

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

Revision History

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

Visit www.basler.com to download the latest hardware, firmware, and BESTCOMS*Plus*® revision histories.

Instruction Manual Revision History

Manual Revision and Date	Change
H, Jun-22	• Added three new figures under *Analog Input Connections* in the *Typical Connections* chapter • Updated UL specifications for UL 6200:2019
G, Dec-21	• Added more information on the Governor PWM Output Connections • Updated UL / CSA specifications
F, Aug-21	• Added support for firmware version 2.06.00 and BESTCOMS*Plus* version 4.05.00 • Added "Installing previous firmware versions" caution box to *Preface* • Corrected terminal numbers in Table 2-8 • Added description of Emergency Stop Input • Added EMI immunity connections for analog inputs • Removed Load Share Output current rating from *Specifications*
E, Oct-19	• Removed Rev Letter from all pages • Changed sequential numbering to sectional numbering • Moved Instruction Manual Revision History into Preface • Removed standalone Revision History chapter
D2, Apr-19	• Updated Proposition 65 statement
D1, Oct-18	• Added Proposition 65 statement
D, Jul-18	• Added style options for DIN Rail and Rear Panel mounting configurations • Removed "LCD is blank and all LEDs are flashing…" from Troubleshooting chapter
C, May-18	• Maintenance release
B, May-17	• Added support for firmware version 2.04.00 and BESTCOMSPlus version 3.17.00 • Added accuracies for Fuel Level Sensing, Coolant Temperature Sensing, and Oil Pressure Sensing • Updated EAC specs • Added patent about load anticipation
A, Dec-16	• Updated UL Approval statement in the Specifications chapter • Added Group Start and Group Stop Requests to the Troubleshooting chapter
—, Oct-16	• Initial release

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Maintenance 8-1
Troubleshooting 9-1

1 • Mounting

DGC-2020HD controllers are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a unit, check the part number against the requisition and packing list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify the Basler Electric regional sales office or your sales representative.

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

DGC-2020HD controllers may be mounted in one of three configurations depending on style: Front Panel, DIN Rail, or Rear Panel. These configurations are described in the following paragraphs.

Front Panel Configuration

Units with styles xNxxxxxxx and xTxxxxxxx are mounted through the panel. Four permanently attached 10-24 studs are provided for mounting. The front panel HMI is resistant to moisture, salt fog, humidity, dust, dirt, and chemical contaminants and faces outward for easy access.

Hardware

The torque applied to the mounting hardware should not exceed 20 inch-pounds (2.2 newton meters).

Dimensions

For Front Panel mounting, panel cutting and drilling dimensions are shown in Figure 1-1. All dimensions are shown in inches with millimeters in parenthesis.

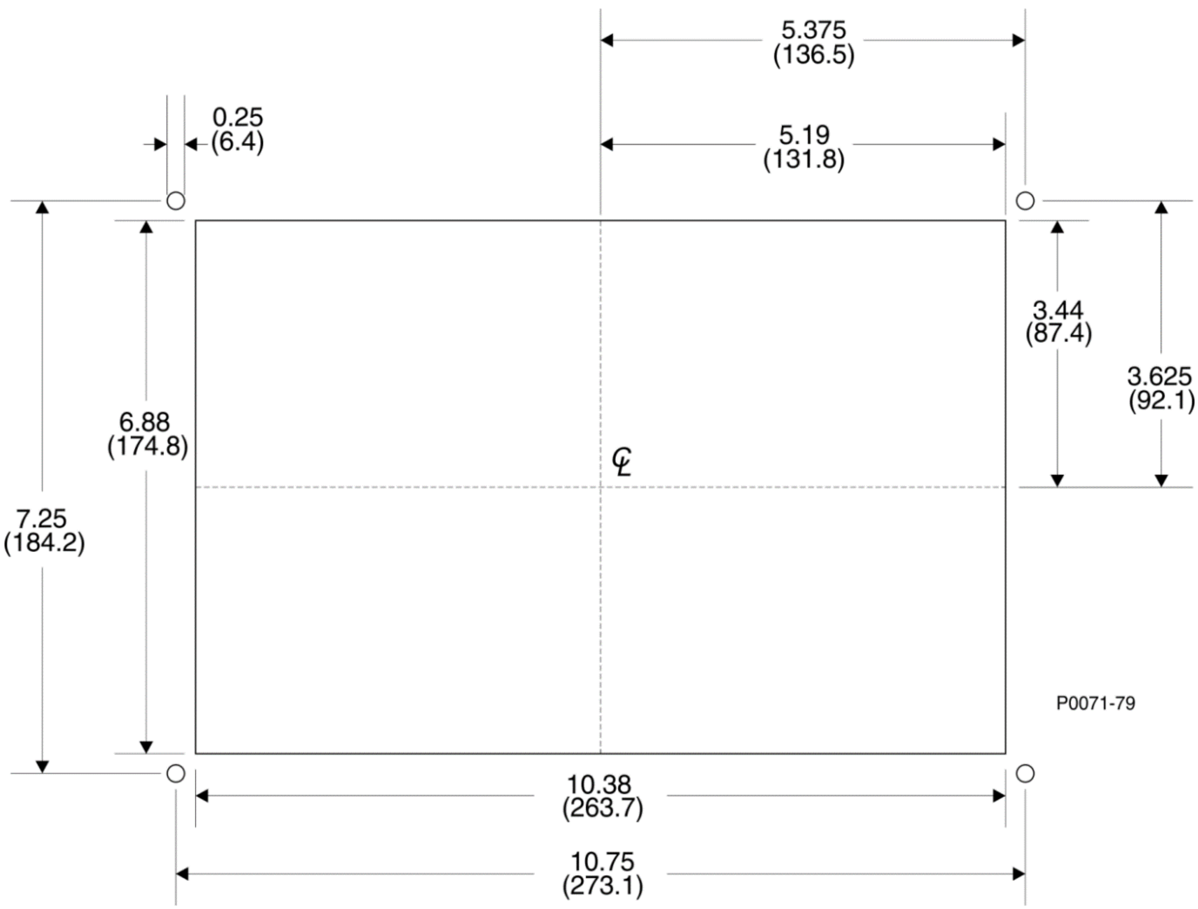


Figure 1-1. Panel Cutting and Drilling Dimensions

In Figure 1-1, the horizontal drilling measurement of 10.75 inches has a tolerance of +0.01/–0.01 inches. The horizontal cutout measurement of 10.38 inches has a tolerance of +0.04/–0 inches. The vertical drilling measurement of 7.25 inches has a tolerance of +0.01/–0.01 inches. The vertical cutout measurement of 6.88 inches has a tolerance of +0.04/–0 inches.

DIN Rail Configuration

Units with style xRxxxxxxx are mounted on DIN rails. In this configuration, the DGC-2020HD has no HMI. The rear of the DGC-2020HD faces outward for convenient access to terminals and connections.

Hardware

Two DIN rails, one located above the other, are required for mounting the DGC-2020HD. One flange and two set screws on the DGC-2020HD secure it to the DIN rails. The flange clips onto the upper rail and the set screws attach to the bottom rail. See Figure 1-2 for flange and set screw locations.

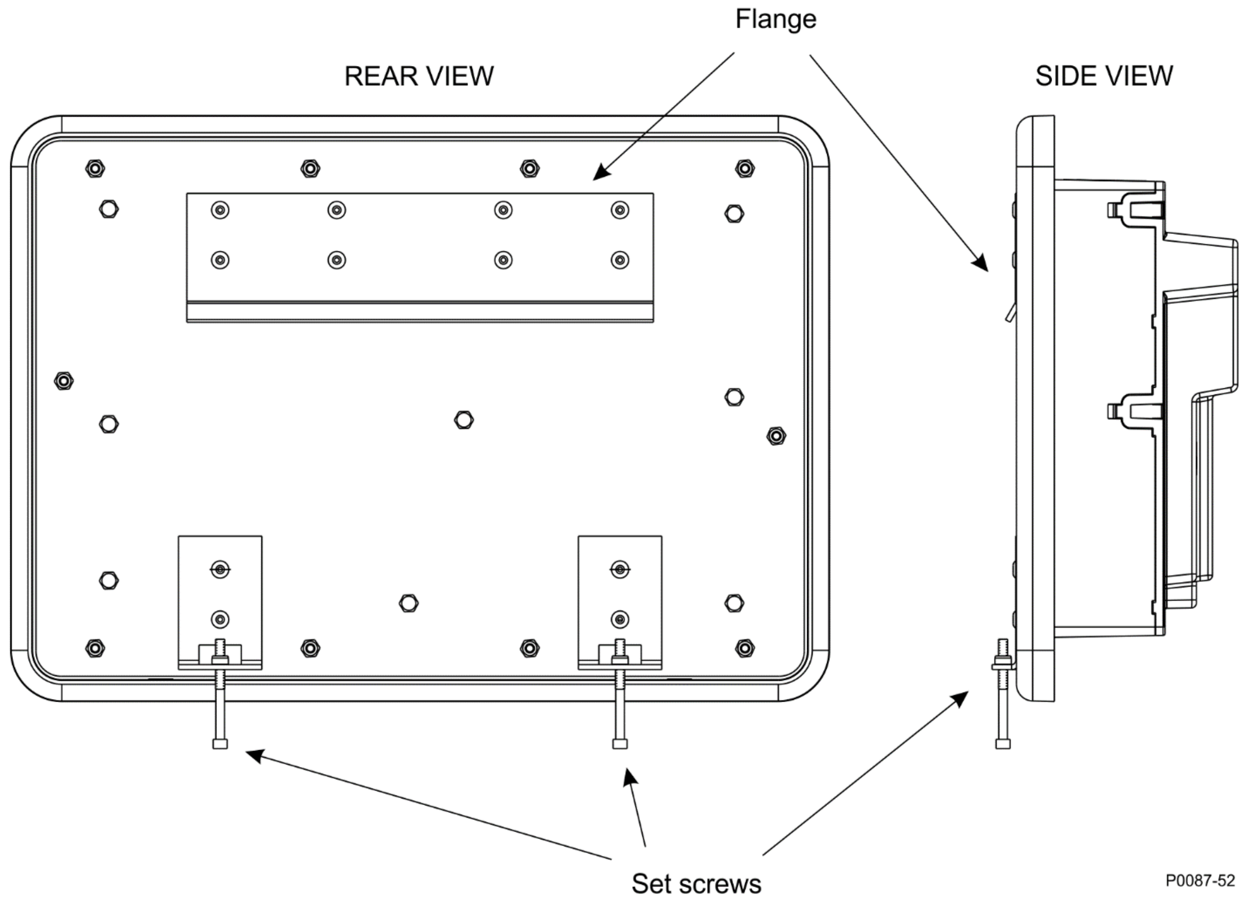


Figure 1-2. DIN Rail Flange and Setscrew Locations for Style xRxxxxxxx

Use two steel Top Hat rails, 35 mm x 7.5 mm, that are a minimum of 13 inches (330 mm) in length. DIN Rail mounting hardware should be spaced no more than 6 inches (152 mm) apart for proper support.

Using the supplied hex key, hand tighten set screws until they stop. Locking inserts help maintain set screw tightness. Hand tightening is recommended to ensure proper locking insert performance.

Dimensions

DIN Rail mounting dimensions are shown in Figure 1-3. All dimensions are shown in inches with millimeters in parenthesis.

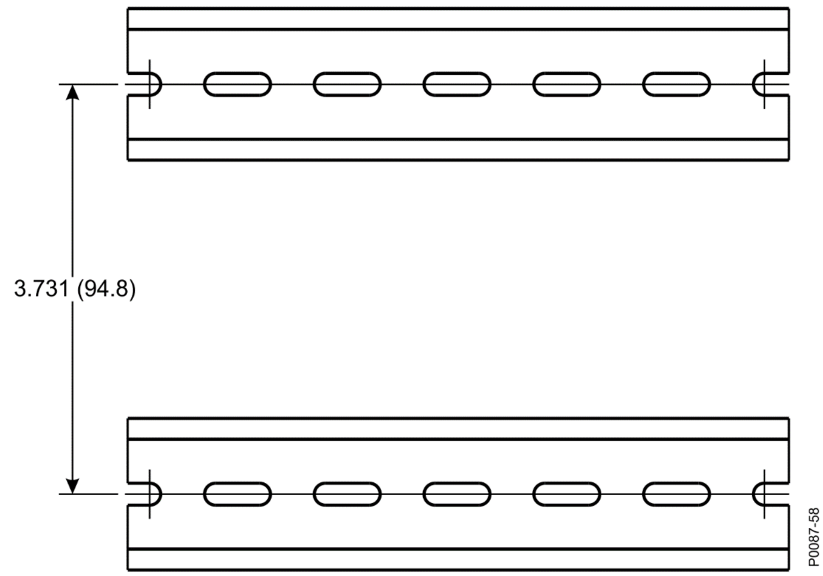


Figure 1-3. DIN Rail Mounting Dimensions for Style xRxxxxxxx

Rear Panel

Units with style xPxxxxxxx are mounted flush against a panel. In this configuration, the DGC-2020HD has no HMI. Four clearance holes are provided for mounting. The rear of the DGC-2020HD faces outward for convenient access to terminals and connections.

Hardware

Use four #10 screws with appropriate hardware. The torque applied to the mounting hardware should not exceed 20 inch-pounds (2.2 newton meters).

Dimensions

For Rear Panel mounting, panel drilling dimensions are shown in Figure 1-4. All dimensions are shown in inches with millimeters in parenthesis.

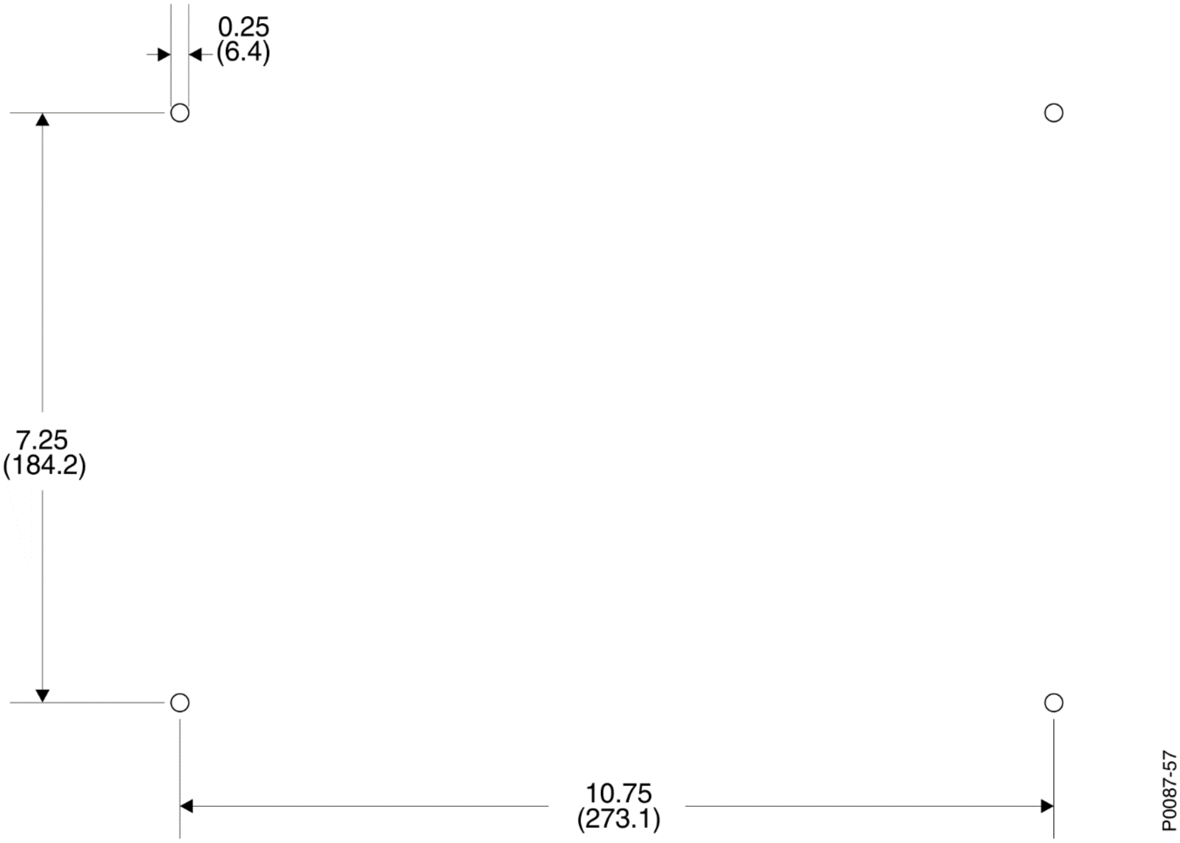


Figure 1-4. Rear Panel Drilling Dimensions for Style xPxxxxxxx

Overall Dimensions

Overall dimensions are shown in Figure 1-5. All dimensions are shown in inches with millimeters in parenthesis.

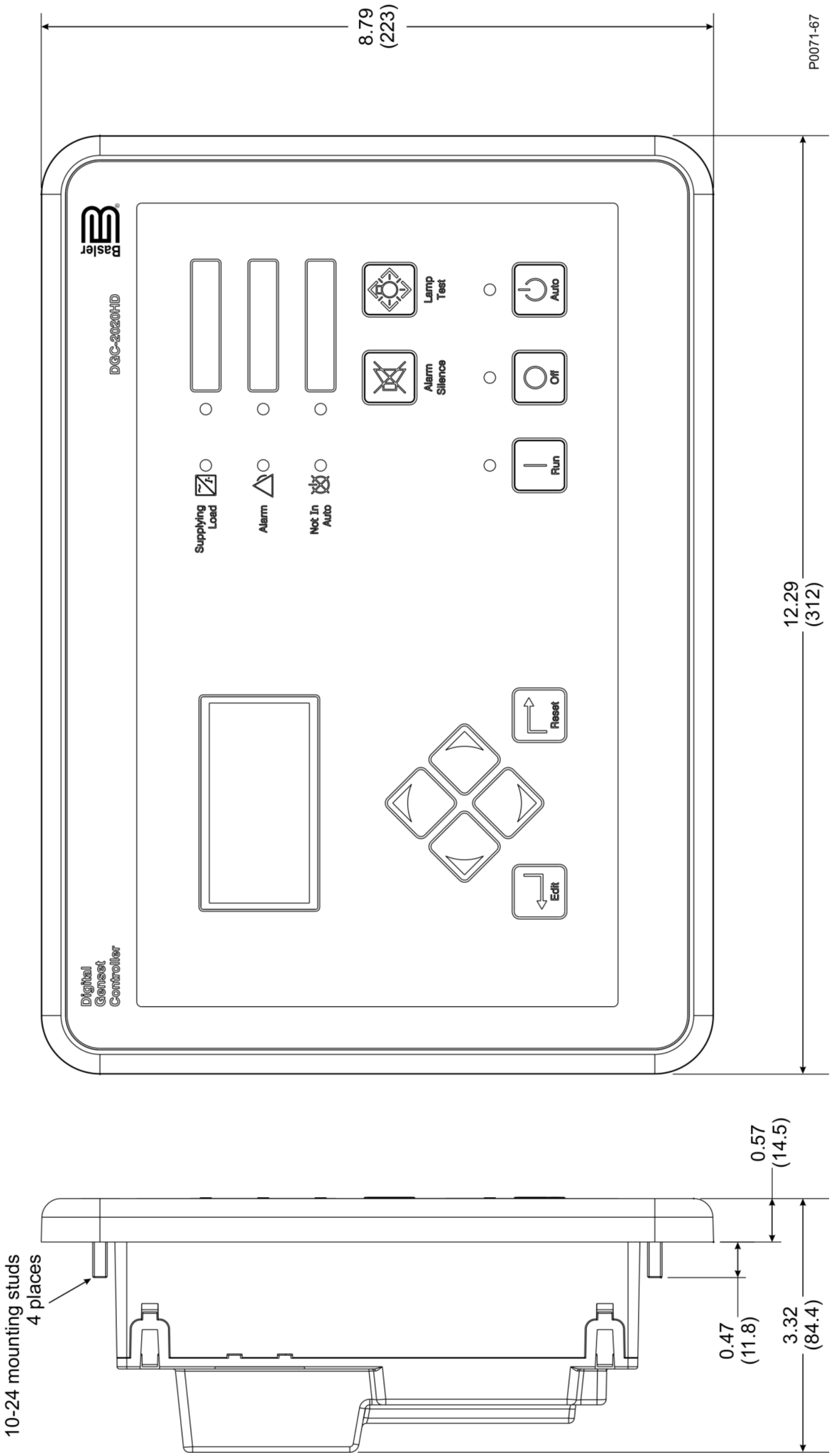


Figure 1-5. Overall Dimensions

2 • Terminals and Connectors

All DGC-2020HD terminals and connectors are located on the rear panel. DGC-2020HD terminals consist of a mini-B USB jack, a DB-9 connector, Ethernet ports, plug-in connectors with spring clamp terminals, and quarter-inch, male, quick-connect terminals.

Figure 2-1 illustrates the rear panel terminals. Locator letters in the illustration correspond to the terminal block and connector descriptions in Table 2-1.

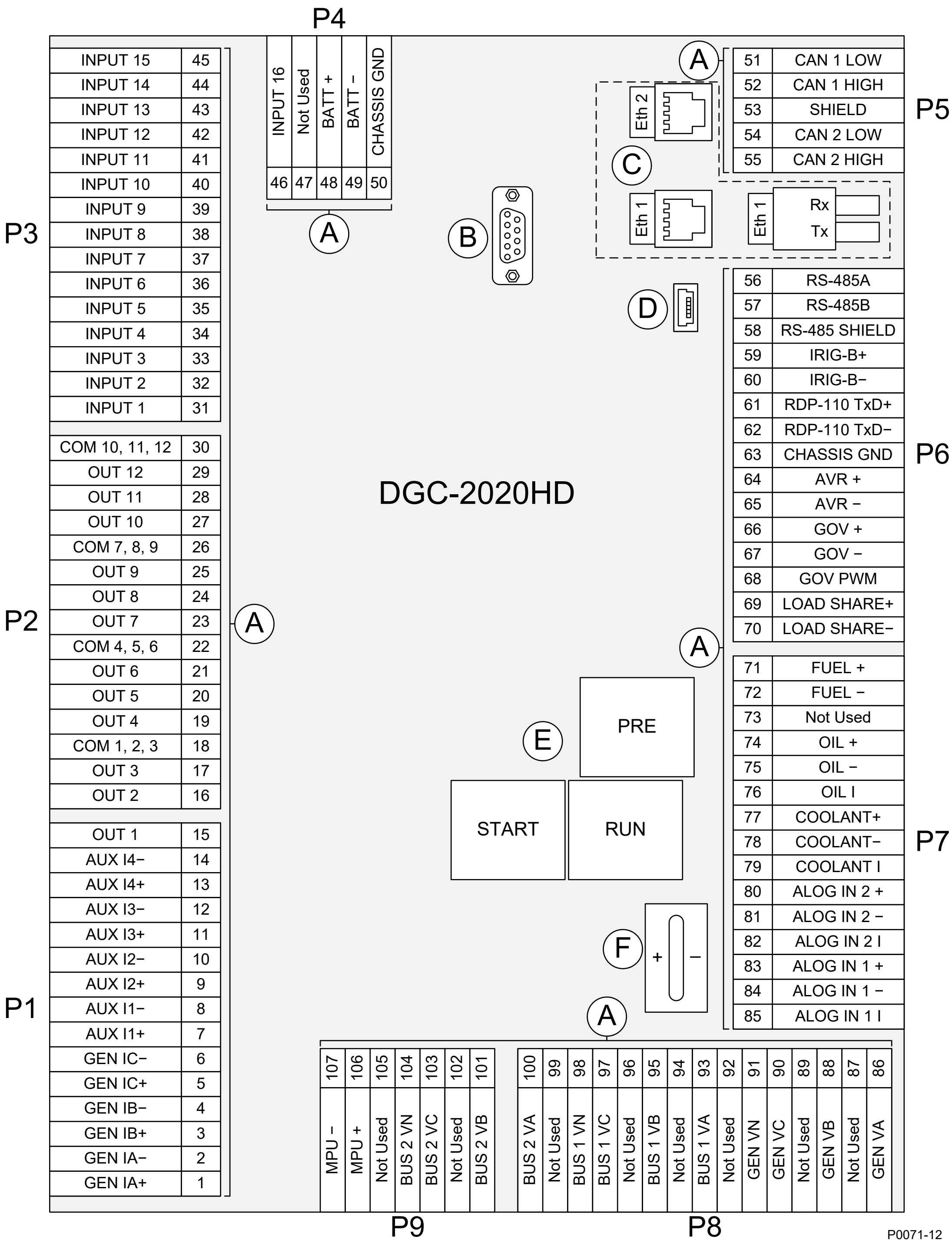


Figure 2-1. Rear Panel

Table 2-1. Rear Panel Terminal and Connector Descriptions

Locator	Description
A	The majority of external, DGC-2020HD wiring is terminated at 5-, 7-, or 15-position connectors with spring clamp terminals. These connectors plug into headers on the DGC-2020HD. 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. Terminals accept a maximum wire size of 12 AWG (3.31 mm^2). Remove (strip) 0.4 inch (10 mm) of insulation from each wire end inserted into a connector terminal.
B	This male DB-9 connector is provided for external dial-out modem communication and the future implementation of other communication protocols. Contact Basler Electric for protocol availability.
C	DGC-2020HD Ethernet communication uses the Modbus® TCP protocol to provide remote metering, annunciation, and control. Dual copper (100Base-T) ports (style xxxxDxxxx) use standard RJ-45 jacks and a fiber optic (100Base-FX) port (style xxxxFxxxx) uses one ST fiber optic connector. Ethernet ports have different designations depending on style: • Dual copper (Style xxxxDxxxx) – The RJ-45 jack nearest to the mini-B USB port is designated as Ethernet port 1 and is reserved for intergenset communications (load sharing). The other RJ-45 jack is designated as Ethernet port 2 and can be configured for redundant intergenset communications or for an independent network connection. • Fiber optic (Style xxxxFxxxx) – The ST fiber optic port is designated as Ethernet port 1 and is reserved for intergenset communications (load sharing). Figure 2-1 shows both Ethernet port styles (dual copper and fiber) for clarity. The DGC-2020HD comes equipped with only one port style, not both.
D	The mini-B USB jack mates with a standard USB cable and is used with a PC running BESTCOMS*Plus*® software for local communication with the DGC-2020HD.
E	Connections to the Start, Run, and Pre output contacts are made directly to each relay through quarter-inch, male, quick-connect terminals.
F	An onboard battery maintains DGC-2020HD timekeeping during losses of control power. See the *Maintenance* chapter for instructions on replacing the battery. Failure to replace the battery with Basler Electric P/N 38526 may void the warranty.

Terminals

DGC-2020HD connections are dependent on the application. Incorrect wiring may result in damage to the controller.

Note
Be sure that the DGC-2020HD is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to chassis ground (terminal 50) on the rear of the controller.

The DGC-2020HD terminals are grouped by function and include control power, current sensing, voltage sensing, engine sender input, magnetic pickup input, contact sensing, output contacts, CAN interface, RS-485 interface, AVR control, GOV control, Load Share, IRIG source, Remote Display Panel connection, USB port, Ethernet communication, and RS-232 communication.

DGC-2020HD terminals are described in the following paragraphs.

Control power

The DGC-2020HD control power input accepts a nominal voltage of 12 Vdc or 24 Vdc and tolerates voltage over the range of 6 to 32 Vdc. Control power must be of the correct polarity. While reverse polarity will not cause damage, the DGC-2020HD will not operate. Control power terminals are listed in Table 2-2.

A fuse should be added for additional protection for the wiring to the battery input of the DGC-2020HD. A fuse helps prevent wire damage and nuisance trips due to initial power supply inrush current. To follow UL guidelines, a 5 A maximum, 32 Vdc supplementary fuse must be implemented in the battery input circuit to the DGC-2020HD.

Table 2-2. Control Power Terminals

Terminal	Description
50 (CHASSIS)	Chassis ground connections
49 (BATT–)	Negative side of control power input
48 (BATT+)	Positive side of control power input

Generator Current Sensing

The DGC-2020HD has sensing inputs for A-phase, B-phase, and C-phase generator current. A DGC-2020HD with a style number of 1xxxxxxxxx has 1 Aac nominal current sensing and a DGC-2020HD with a style number of 5xxxxxxxx indicates 5 Aac nominal current sensing. Generator current sensing terminals are listed in Table 2-3.

Table 2-3. Generator Current Sensing Terminals

Terminals	Description
1 (IA+)	A-phase current sensing input
2 (IA–)	
3 (IB+)	B-phase current sensing input
4 (IB–)	
5 (IC+)	C-phase current sensing input
6 (IC–)	

Programmable Current Sensing

Four user-programmable current sensing inputs are provided for measuring mains current, load bus current, ground current, or a combination of these. Table 2-4 lists the programmable current sensing terminals.

Table 2-4. Programmable Current Sensing Terminals

Terminal	Description
7 (AUX I1 +)	Programmable current sensing input 1
8 (AUX I1 –)	
9 (AUX I2 +)	Programmable current sensing input 2
10 (AUX I2 –)	
11 (AUX I3 +)	Programmable current sensing input 3
12 (AUX I3 –)	
13 (AUX I4 +)	Programmable current sensing input 4
14 (AUX I4 –)	

Caution

Current sensing terminals 2 (IA–), 4 (IB–), 6 (IC–), 8(AUX I1–), 10 (AUX I2–), 12 (AUX I3–), and 14 (AUX I4–) must be terminated to ground for proper operation.

Note

Unused current sensing inputs should be shorted to minimize noise pickup.

Generator Voltage Sensing

The DGC-2020HD accepts either line-to-line or line-to-neutral generator sensing voltage over the range of 0 to 576 volts, rms line-to-line or 0 to 333 volts, rms line-to-neutral. Generator voltage sensing terminals are listed in Table 2-5.

Table 2-5. Generator Voltage Sensing Terminals

Terminal	Description
86 (GEN VA)	A-phase generator voltage sensing input
88 (GEN VB)	B-phase generator voltage sensing input
90 (GEN VC)	C-phase generator voltage sensing input
91 (GEN VN)	Neutral generator voltage sensing input

Installation in an Ungrounded System Application

When the DGC-2020HD is controlling equipment that is part of an ungrounded system, it is recommended that potential transformers be employed on the voltage sensing inputs to provide full isolation between the DGC-2020HD and monitored voltage phases.

Bus Voltage Sensing

Sensing of bus voltage enables the DGC-2020HD to detect failures of the mains (utility). Controllers with style number xxx2xxxxx use bus voltage sensing to perform automatic synchronization of the generator with the bus. The DGC-2020HD accepts either line-to-line or line-to-neutral bus sensing voltage over the range of 0 to 576 volts, rms line-to-line or 0 to 333 volts, rms line-to-neutral. Controllers with style number xxxxxxxEx are equipped with two bus sensing inputs. One is intended for sensing the mains voltage while the other is intended for sensing the load bus voltage.

Bus voltage sensing terminals are listed in Table 2-6.

Table 2-6. Bus Voltage Sensing Terminals

Terminal	Description
93 (BUS1 VA)	A-phase bus voltage sensing input
95 (BUS1 VB)	B-phase bus voltage sensing input
97 (BUS1 VC)	C-phase bus voltage sensing input
98 (BUS1 VN)	Neutral bus voltage sensing input
100 (BUS2 VA)	A-phase bus voltage sensing input (optional)
101 (BUS2 VB)	B-phase bus voltage sensing input (optional)
103 (BUS2 VC)	C-phase bus voltage sensing input (optional)
104 (BUS2 VN)	Neutral bus voltage sensing input (optional)

Installation in an Ungrounded System Application

When the DGC-2020HD is controlling equipment that is part of an ungrounded system, it is recommended that potential transformers be employed on the voltage sensing inputs to provide full isolation between the DGC-2020HD and monitored voltage phases.

Engine Sender Inputs

Inputs are provided for fuel level, oil pressure, and coolant temperature senders. For a listing of fuel level, oil pressure, and coolant temperature senders that are compatible with the DGC-2020HD, refer to the *Engine Sender Inputs* chapter in the *Configuration* manual. The fuel level input accepts resistive senders only. Oil pressure and coolant temperature inputs accept either resistive or analog senders depending on the style number.

Engine sender input terminals are listed in Table 2-7.

Table 2-7. Sender Input Terminals

Terminal	Description
71 (FUEL +)	Fuel level sender input
72 (FUEL –)	Fuel level sender return
74 (OIL + / ANALOG IN 4 +)	Oil pressure sender input or Analog input 4 +
75 (OIL – / ANALOG IN 4 –)	Oil pressure sender return or Analog input 4 –
76 (N.C. / ANALOG IN 4 I)	Analog input 4 (I) current input∗
77 (COOLANT + / ANALOG IN 3 +)	Coolant temperature sender input or Analog input 3 +
78 (COOLANT – / ANALOG IN 3 –)	Coolant temperature sender return or Analog input 3 –
79 (N.C. / ANALOG IN 3 I)	Analog input 3 (I) current input∗

∗ When using the current input, it must be tied to the voltage input. See the *Typical Applications* chapter for a diagram.

Analog Inputs

Two user-programmable analog inputs are provided. These inputs accept a signal range of either 4 to 20 mA or 0 to 10 Vdc. Analog input terminals are listed in Table 2-8.

Table 2-8. Analog Input Terminals

Terminal	Description
80 (ANALOG IN 2 +)	Auxiliary analog 2 +
81 (ANALOG IN 2 –)	Auxiliary analog 2 –
82 (ANALOG IN 2 I)	Auxiliary analog 2 (I) current input∗
83 (ANALOG IN 1 +)	Auxiliary analog 1 +
84 (ANALOG IN 1 –)	Auxiliary analog 1 –
85 (ANALOG IN 1 I)	Auxiliary analog 1 (I) current input∗

∗ When using the current input, it must be tied to the voltage input. See *Typical Applications* chapter for a diagram.

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 2-9.

Table 2-9. Magnetic Pickup Input Terminals

Terminals	Description
107 (MPU–)	Magnetic pickup return input
106 (MPU+)	Magnetic pickup positive input

Contact Sensing Inputs

Contact sensing inputs consist of sixteen programmable inputs. The programmable inputs accept normally open, dry contacts. Terminal 49 (BATT–) serves as the common return line for the programmable inputs. While input 1 is programmed to recognize an emergency stop input by default, it can be programmed for any function. Information about configuring the programmable inputs is provided in the *Contact Inputs* chapter in the *Configuration* manual. Contact sensing input terminals are listed in Table 2-10.

Table 2-10. Contact Sensing Inputs

Terminal	Description
49 (BATT–)	Common return line for programmable contact inputs
31 (INPUT 1)	Programmable contact input 1
32 (INPUT 2)	Programmable contact input 2
33 (INPUT 3)	Programmable contact input 3
34 (INPUT 4)	Programmable contact input 4
35 (INPUT 5)	Programmable contact input 5
36 (INPUT 6)	Programmable contact input 6
37 (INPUT 7)	Programmable contact input 7
38 (INPUT 8)	Programmable contact input 8
39 (INPUT 9)	Programmable contact input 9
40 (INPUT 10)	Programmable contact input 10
41 (INPUT 11)	Programmable contact input 11
42 (INPUT 12)	Programmable contact input 12
43 (INPUT 13)	Programmable contact input 13
44 (INPUT 14)	Programmable contact input 14
45 (INPUT 15)	Programmable contact input 15
46 (INPUT 16)	Programmable contact input 16

Emergency Stop Input

The emergency stop input is intended for use with a normally closed switch and recognizes an emergency stop input when the connection from terminal 31 (INPUT 1 by default) to ground is removed. While input 1 is programmed to recognize an emergency stop input by default, it can be programmed for any function.

Programmable Output Contacts Rated for 30-Ampere Duty

The DGC-2020HD has three sets of output contacts rated for 30-ampere duty. Their functions are set to Pre, Start, and Run by default, but are fully programmable through BESTCOMS*Plus*. The Pre contacts supply battery power to the engine glow plugs, the Start contacts supply power to the starter solenoid, and the Run contacts supply power to the fuel solenoid. Connections to the DGC-2020HD Start, Run, and Pre output contacts are made directly to each relay through quarter-inch, male, quick-connect terminals.

Note
It is recommended in all applications where contact outputs drive relay coils that a reverse biased diode be implemented in parallel with the relay coil for EMI suppression.

Programmable Output Contacts Rated for 2-Ampere Duty

Twelve programmable output contacts rated for 2-ampere duty are provided in four sets. Each set of three output contacts shares a common terminal. Programmable output contact terminals are listed in Table 2-11.

Table 2-11. Programmable Output Contact Terminals

Terminal	Description
15 (OUT 1)	Programmable output 1
16 (OUT 2)	Programmable output 2
17 (OUT 3)	Programmable output 3
18 (COM 1, 2, 3)	Common connection for outputs 1, 2, and 3
19 (OUT 4)	Programmable output 4
20 (OUT 5)	Programmable output 5
21 (OUT 6)	Programmable output 6
22 (COM 4, 5, 6)	Common connection for outputs 4, 5, and 6
23 (OUT 7)	Programmable output 7
24 (OUT 8)	Programmable output 8
25 (OUT 9)	Programmable output 9
26 (COM 7, 8, 9)	Common connection for outputs 7, 8, and 9
27 (OUT 10)	Programmable output 10
28 (OUT 11)	Programmable output 11
29 (OUT 12)	Programmable output 12
30 (COM 10, 11, 12)	Common connection for outputs 10, 11, and 12

CAN Interface

These terminals provide communication using the SAE J1939 protocol or the *mtu* protocol and provide high-speed communication between the DGC-2020HD and an ECU on an electronically controlled engine. Connections between the ECU and DGC-2020HD should be made with twisted-pair, shielded cable. CAN interface terminals are listed in Table 2-12. For typical CAN connections, refer to the *Typical Connections* chapter.

Table 2-12. CAN Interface Terminals

Terminals	Description
51 (CAN 1 L)	CAN 1 low connection
52 (CAN 1 H)	CAN 1 high connection
53 (SHIELD)	CAN drain connection
54 (CAN 2 L)	CAN 2 low connection
55 (CAN 2 H)	CAN 2 high connection

Notes
1. If the DGC-2020HD is providing one end of the J1939 bus, a 120 ohm, ½ watt terminating resistor should be installed across terminals 51 (CAN1L) and 52 (CAN1H) or 54 (CAN2L) and 55 (CAN2H)
2. If the DGC-2020HD is not providing one end of the J1939 bus, the stub connecting the DGC-2020HD 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-2020HD.
5. It is recommended to upgrade the firmware in all AEM-2020s and CEM 2020s that share a CAN bus network with a VRM-2020. Upgrade CEM-2020s to firmware version 1.01.05 or later. Upgrade AEM 2020s to firmware version 1.00.06 or later.

RS-485 Interface

DGC-2020HD controllers can be monitored and controlled via a polled network using the Modbus™ protocol. The RS-485 port supports a user-selectable baud rate of 1,200, 2,400, 4,800, 9,600, 19,200, 38,400, 57,600, or 115,200. Seven or eight data bits per character can be selected. Odd, even, or no parity is supported. One or two stop bits are selectable. RS-485 Modbus supports a single Modbus Master only. Modbus register values for the DGC-2020HD are listed and defined in Basler Publication 9469300998, *Instruction Manual for DGC-2020HD Digital Genset Controller Modbus® Protocol*. RS-485 interface terminals are listed in Table 2-13.

Table 2-13. RS-485 Terminals

Terminal	Description
56 (RS-485 A)	RS-485 send/receive A connection
57 (RS-485 B)	RS-485 send/receive B connection
58 (RS-485 SHIELD)	RS-485 shield connection

Automatic Voltage Regulator (AVR) Control

AVR control outputs provide control of the generator voltage setpoint. AVR control terminals are listed in Table 2-14.

Table 2-14. AVR Control Output Terminals

Terminal	Description
64 (AVR +)	AVR control output positive
65 (AVR –)	AVR control output negative

Governor (GOV) Control

GOV control output contacts provide remote control of the generator speed (RPM) setpoint. GOV control terminals are listed in Table 2-15.

Table 2-15. GOV Control Output Terminals

Terminal	Description
66 (GOV +)	GOV control output positive

Terminal	Description
67 (GOV –)	GOV control output negative
68 (GOV PWM)	GOV PWM output for CAT control system interface

Load Share Line

Load share line outputs are measured and used to calculate the per-unitized average load level. This average is used as the setpoint for the genset's kW controller. Load share line output terminals are listed in Table 2-16.

Table 2-16. Load Share Line Output Terminals

Terminal	Description
69 (LOAD SHARE +)	Load share line positive
70 (LOAD SHARE –)	Load share line negative

IRIG-B Connections

The IRIG-B terminals connect to an IRIG-B source for synchronization of DGC-2020HD timekeeping with the IRIG-B source. Table 2-17 lists the IRIG-B source input terminals.

Table 2-17. IRIG-B Source Input Terminals

Terminal	Description
59 (IRIG-B +)	IRIG-B source input
60 (IRIG-B –)	IRIG-B return terminal

Optional Remote Display Panel Connections

Terminals are provided for connection with the optional remote display panel (Basler P/N 9318100114 projection mount or 9318100115 flush mount). These terminals provide dc control power to the remote display panel and enable communication between the DGC-2020HD and the remote display panel. Twisted-pair conductors are recommended for making the connections between the DGC-2020HD and remote display panel. Communication may become unreliable if the connection wires exceed 1,219 m (4,000 ft). Table 2-18 lists the DGC-2020HD terminals that connect to the remote display panel.

Table 2-18. Remote Display Panel Interface Terminals

Terminal	Description
61 (RDP TxD +)	Remote display panel communication terminal (TxD +)
62 (RDP TxD –)	Remote display panel communication terminal (TxD –)
49 (BATT–)	Remote display panel power terminal DC COM (–)
48 (BATT+)	Remote display panel power terminal 12/24 (+)

Connectors

USB Interface

A mini-B USB jack enables local communication with a PC running BESTCOMS*Plus*® software. The DGC-2020HD 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-2020HD termination).

Ethernet Communications

Dual copper RJ-45 jacks or an ST fiber optic port provide Ethernet communications between the DGC-2020HD and a PC via BESTCOMS*Plus* or other DGC-2020HDs in a network. The ST type fiber optic port uses a 1,300 nanometer, near-infrared (NIR) light wavelength transmitted via two strands of multimode optical fiber, one for receive (RX) and the other for transmit (TX).

An Ethernet connection to a PC running BESTCOMS*Plus* provides remote metering, setting, annunciation, and control of the DGC-2020HD. Ethernet communication between DGC-2020HDs allows for generator sequencing on an islanded system.

RS-232 Interface

A male DB-9 connector allows the DGC-2020HD controller to connect to an external, user-supplied dial-out modem via the RS-232 interface. The modem enables the DGC-2020HD to dial up to four pager telephone numbers and annunciate conditions selected by the user. These conditions include any DGC-2020HD alarm or pre-alarm, closure of any programmable contact input, and an active cool down timer.

3 • Typical Applications

Typical connection diagrams are provided in this chapter as a guide when wiring the DGC-2020HD for communication, mechanical senders, contact inputs and outputs, sensing, and control power.

Connections for Typical Applications

General connections for DGC-2020HD communication, contact inputs, contact outputs, mechanical senders, and control power are shown in Figure 3-1.

General bus voltage sensing connections in three-phase wye, three-phase delta, single-phase A-B and single-phase A-C configurations are shown in the figures listed below.

- Three-phase wye .... Figure 3-2
- Three-phase delta... Figure 3-3
- Single-phase A-B.. Figure 3-4
- Single-phase A-C.. Figure 3-5

Connections for pre-configured breaker control schemes are shown in the figures listed below.

- No breaker control .... Figure 3-6
- Generator breaker control .... Figure 3-7
- Generator breaker control with optional mains breaker status...... Figure 3-8
- Generator and mains breaker control.. Figure 3-9
- Generator and mains breaker control with load bus sensing .... Figure 3-10
- Generator and group breaker control .... Figure 3-11
- Generator and group breaker control with load bus sensing .... Figure 3-12
- Generator, group, and mains breaker control .... Figure 3-13
- Generator breaker control to segmented system .... Figure 3-14
- Generator and group breaker control to segmented system......... Figure 3-15
- Generator and tie breaker control... Figure 3-16
- Tie breaker control... Figure 3-17
- Dual tie breaker control .... Figure 3-18
- Generator and two tie breaker control... Figure 3-19

Although three-phase wye sensing connections are shown in the breaker control diagrams, other bus voltage sensing configurations (figures 3-2 through 3-5) may be used instead.

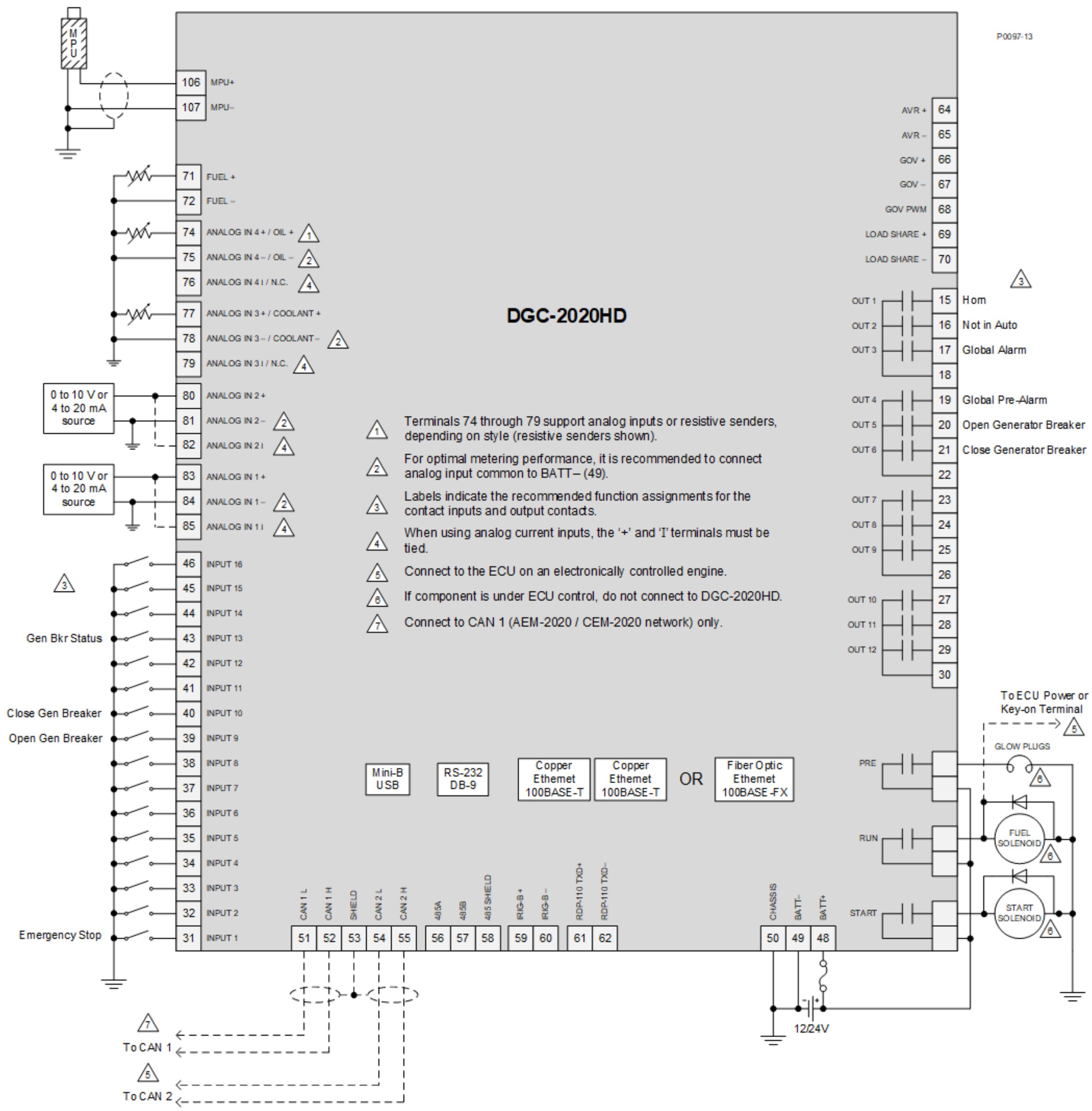


Figure 3-1. Connections for Communication, Senders, Contact Inputs and Outputs, and Control Power

Figure 3-2 illustrates typical three-phase wye connections for all DGC-2020HD bus voltage sensing connections: Generator, Bus 1, and Bus 2. Use the terminal numbers listed below for connecting the desired bus type. Refer to the *Terminals and Connectors* chapter for rear panel terminal numbering.

For Generator voltage sensing, VA = 86, VB = 88, VC = 90, and VN = 91.
For Bus 1 voltage sensing, VA = 93, VB = 95, VC = 97, VN = 98.
For Bus 2 voltage sensing, VA = 100, VB = 101, VC = 103, VN = 104.

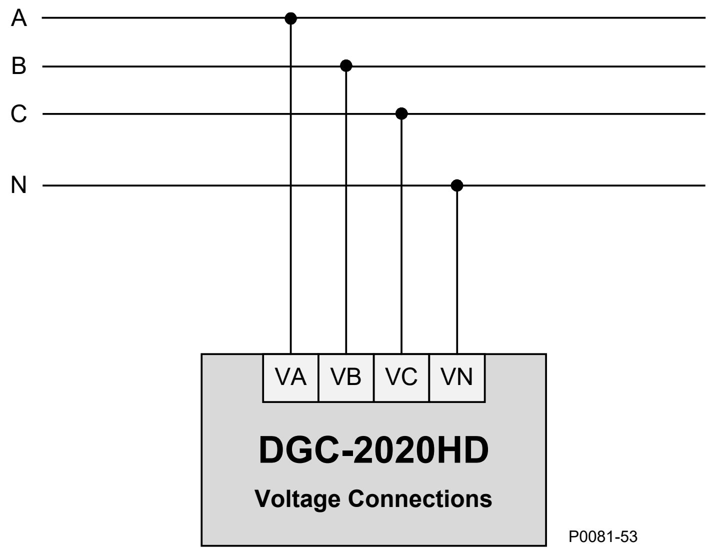


Figure 3-2. 3-Phase Wye Bus Voltage Sensing Connections

Figure 3-3 illustrates typical three-phase delta connections for all DGC-2020HD bus voltage sensing connections: Generator, Bus 1, and Bus 2. Use the terminal numbers listed below for connecting the desired bus type. Refer to the *Terminals and Connectors* chapter for rear panel terminal numbering.

For Generator voltage sensing, VA = 86, VB = 88, and VC = 90.
For Bus 1 voltage sensing, VA = 93, VB = 95, and VC = 97.
For Bus 2 voltage sensing, VA = 100, VB = 101, and VC = 103.

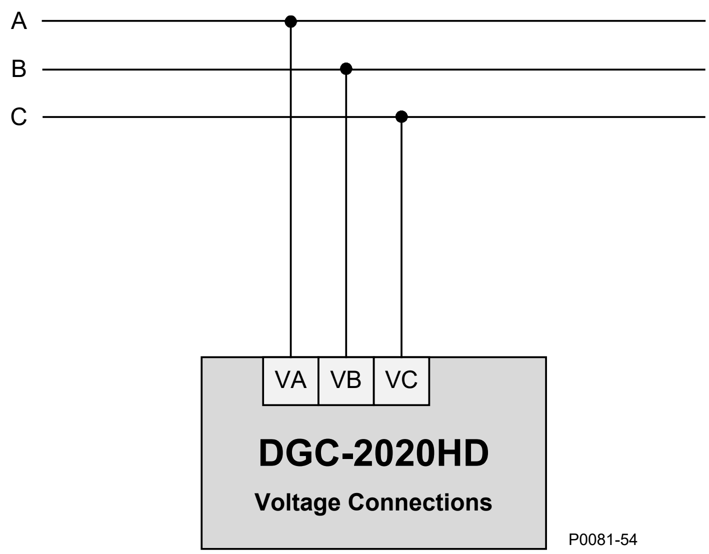


Figure 3-3. 3-Phase Delta Connections

Figure 3-4 illustrates typical single-phase A-B connections for all DGC-2020HD bus voltage sensing connections: Generator, Bus 1, and Bus 2. Use the terminal numbers listed below for connecting the desired bus type. Refer to the *Terminals and Connectors* chapter for rear panel terminal numbering.

For Generator voltage sensing, VA = 86, VB = 88, and VN = 91.
For Bus 1 voltage sensing, VA = 93, VB = 95, VN = 98.
For Bus 2 voltage sensing, VA = 100, VB = 101, VN = 104.

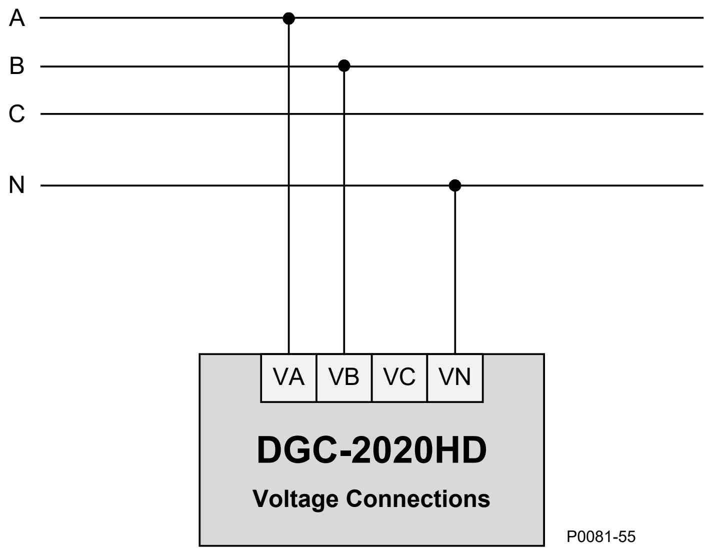


Figure 3-4. Single-Phase A-B Connections

Figure 3-5 illustrates typical single-phase A-C connections for all DGC-2020HD bus voltage sensing connections: Generator, Bus 1, and Bus 2. Use the terminal numbers listed below for connecting the desired bus type. Refer to the *Terminals and Connectors* chapter for rear panel terminal numbering.

For Generator voltage sensing, VA = 86, VC = 90, and VN = 91.
For Bus 1 voltage sensing, VA = 93, VC = 97, VN = 98.
For Bus 2 voltage sensing, VA = 100, VC = 103, VN = 104.

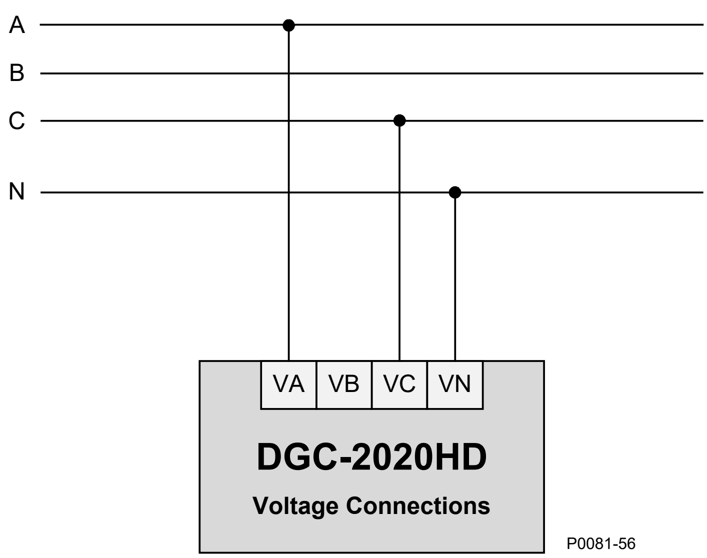


Figure 3-5. Single-Phase A-C Connections

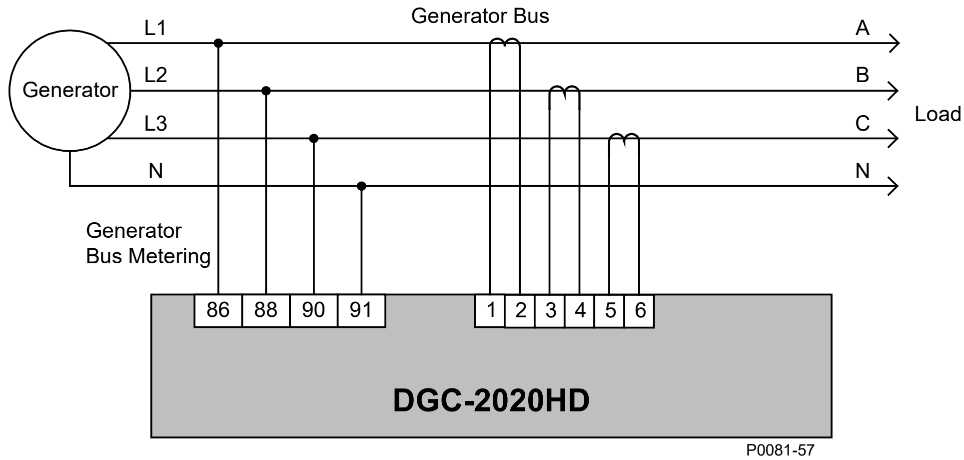


Figure 3-6. No Breaker Control Connections

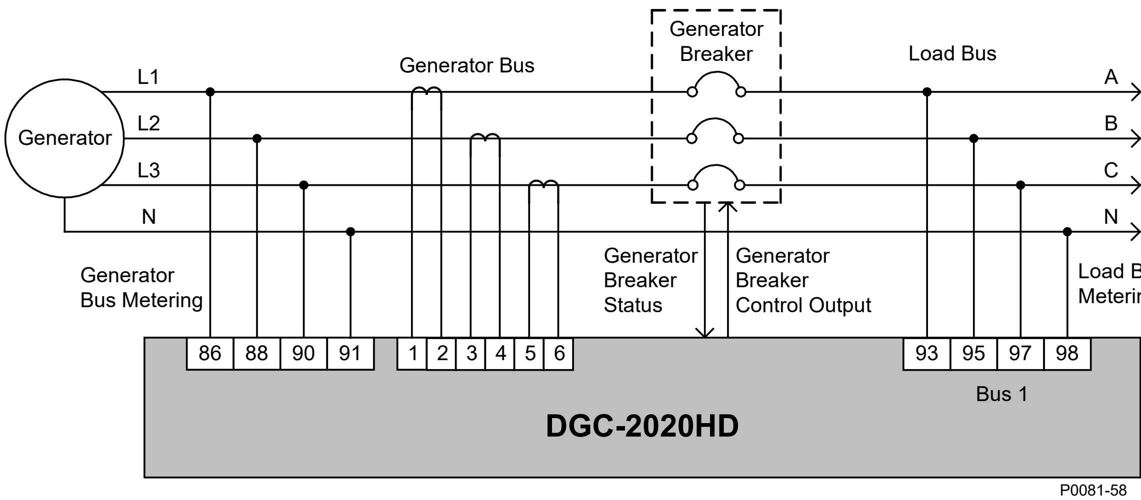
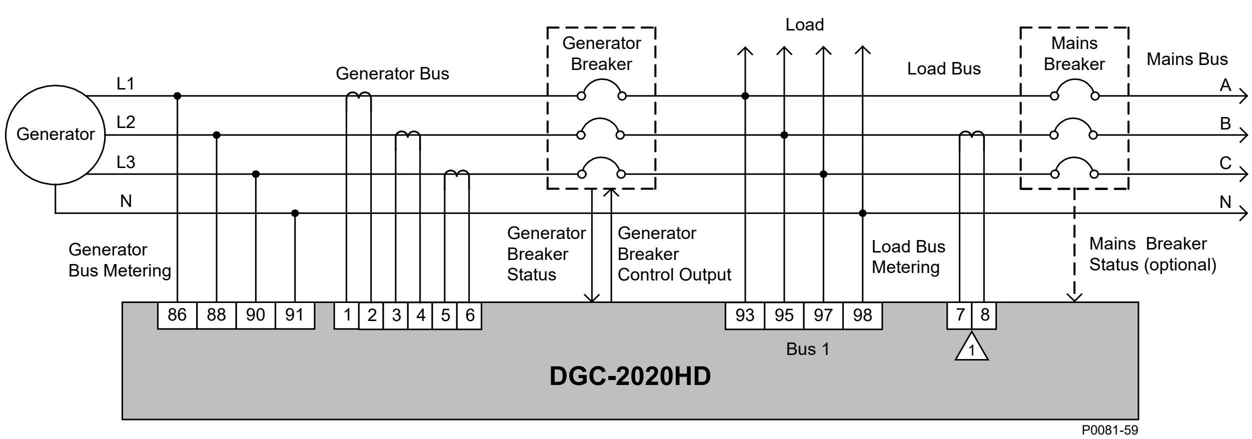
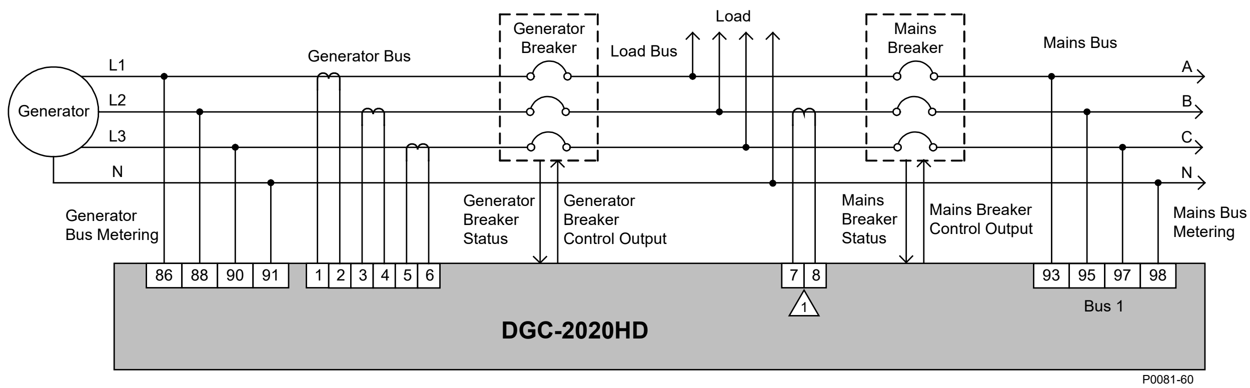


Figure 3-7. Generator Breaker Control Connections



Notes:
1. An auxiliary CT is only required for mains breaker power measurement. Mains breaker power measurement is required for the Zero Power Transfer or Mains Power Control functions.

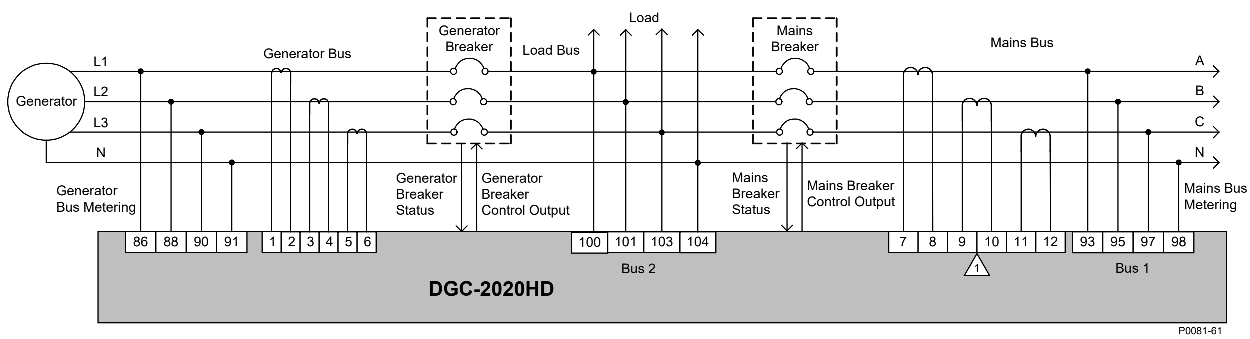
Figure 3-8. Generator Breaker Control Connections with Optional Mains Breaker Status



Notes:

1. An auxiliary CT is only required for mains breaker power measurement. Mains breaker power measurement is required for the Zero Power Transfer or Mains Power Control functions.

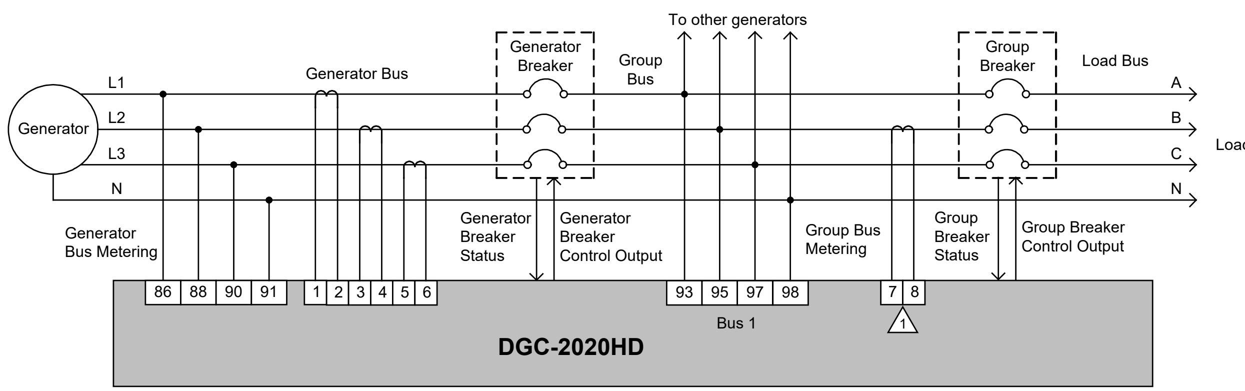
Figure 3-9. Generator and Mains Breaker Control Connections



Notes:

1. An auxiliary CT is only required for mains breaker power measurement. Mains breaker power measurement is required for the Zero Power Transfer or Mains Power Control functions.

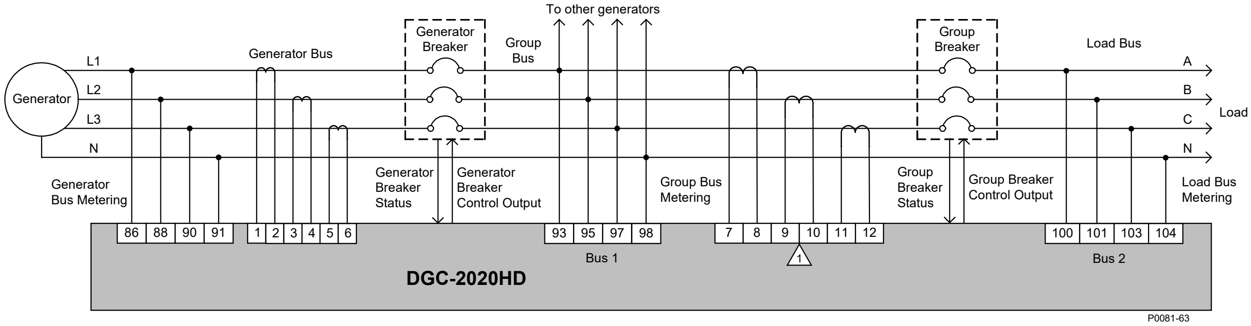
Figure 3-10. Generator and Mains Breaker Control with Load Bus Sensing Connections



Notes:

1. An auxiliary CT is only required if group breaker power measurement is desired. Group breaker power measurement is required for the group breaker Zero Power Transfer function.

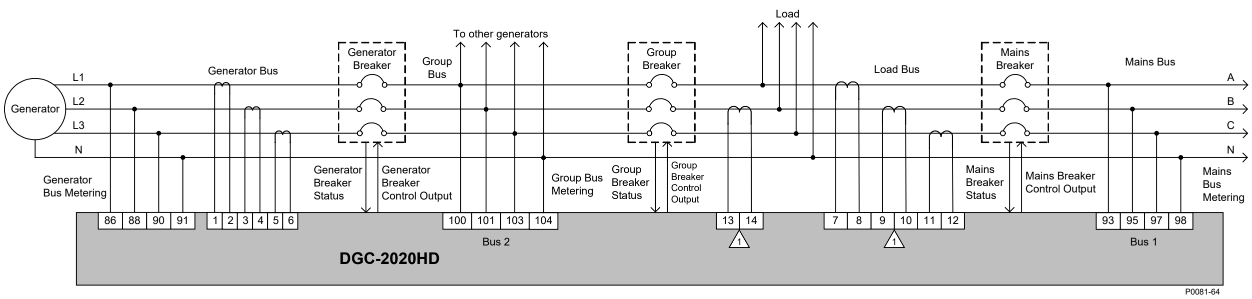
Figure 3-11. Generator and Group Breaker Control Connections



Notes:

1. An auxiliary CT is only required if group breaker power measurement is desired. Group breaker power measurement is required for the group breaker Zero Power Transfer function.

Figure 3-12. Generator and Group Breaker Control with Load Bus Sensing Connections



Notes:

1. Auxiliary CTs are only required if mains breaker and/or group breaker power measurement is desired. Power measurement through the group or mains breaker is required for Zero Power Transfer through that breaker. Mains breaker power measurement is required for the Mains Power Control function.

Figure 3-13. Generator, Group, and Mains Breaker Control Connections

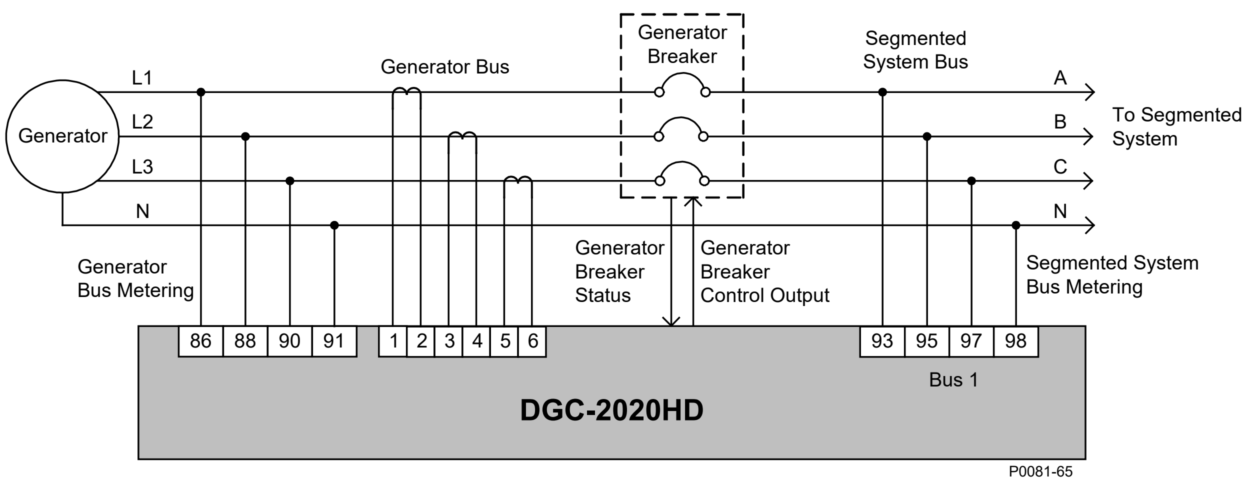
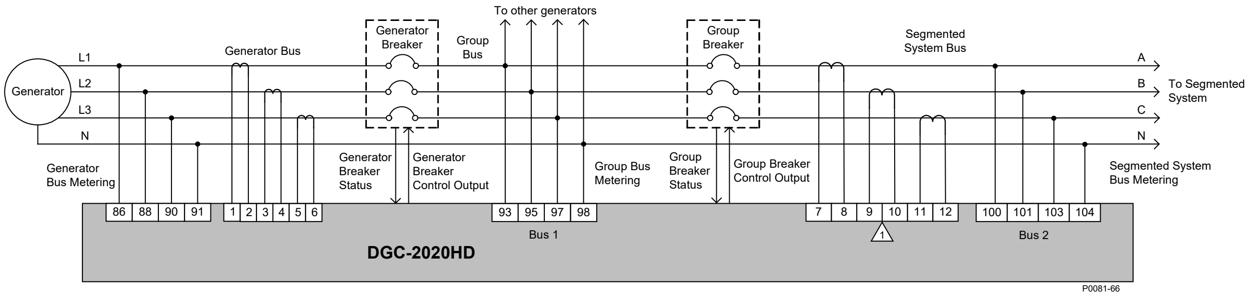
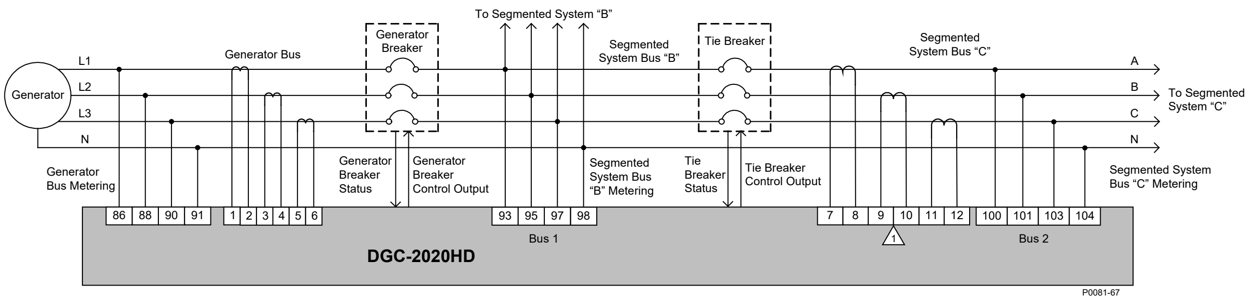


Figure 3-14. Generator Breaker Control to Segmented System Connections



Notes:
An auxiliary CT is only required if group breaker power measurement is desired. Group breaker power measurement is required for the group breaker Zero Power Transfer function.

Figure 3-15. Generator and Group Breaker Control to Segmented System Connections



Notes:
Auxiliary CTs are only required if tie breaker power measurement is desired. Tie breaker power measurement is required for the Zero Power Transfer function across the tie breaker.

Figure 3-16. Generator and Tie Breaker Control Connections

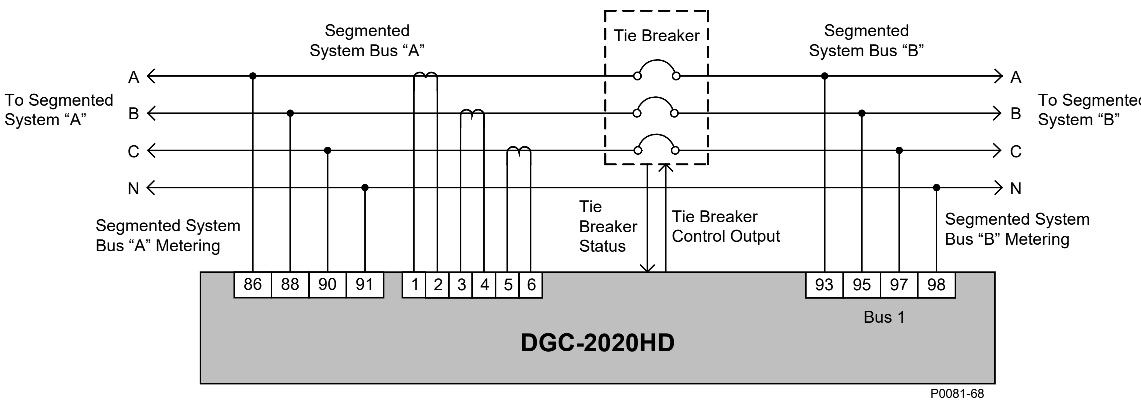
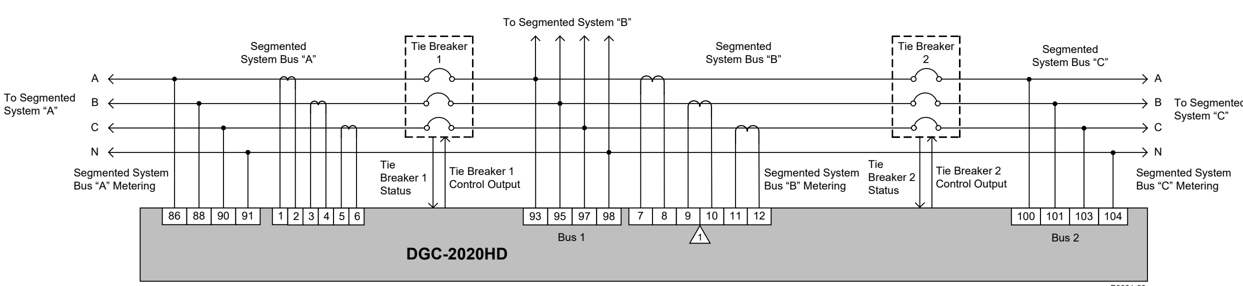


Figure 3-17. Tie Breaker Control Connections



Notes:
Auxiliary CTs are only required if Tie Breaker 2 power measurement is desired. Tie Breaker 2 power measurement is required for the Zero Power Transfer function across Tie Breaker 2.

Figure 3-18. Dual Tie Breaker Control Connections

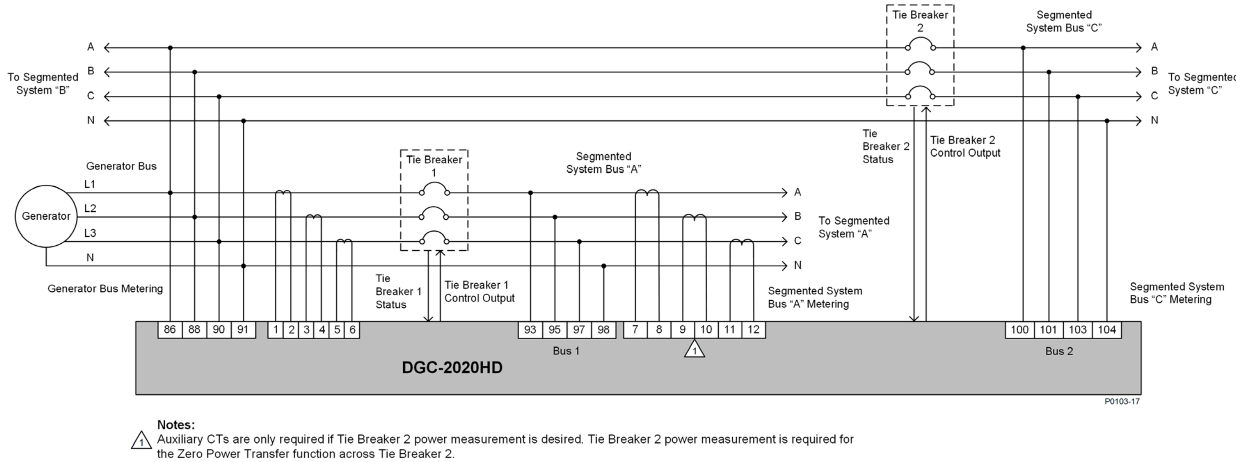
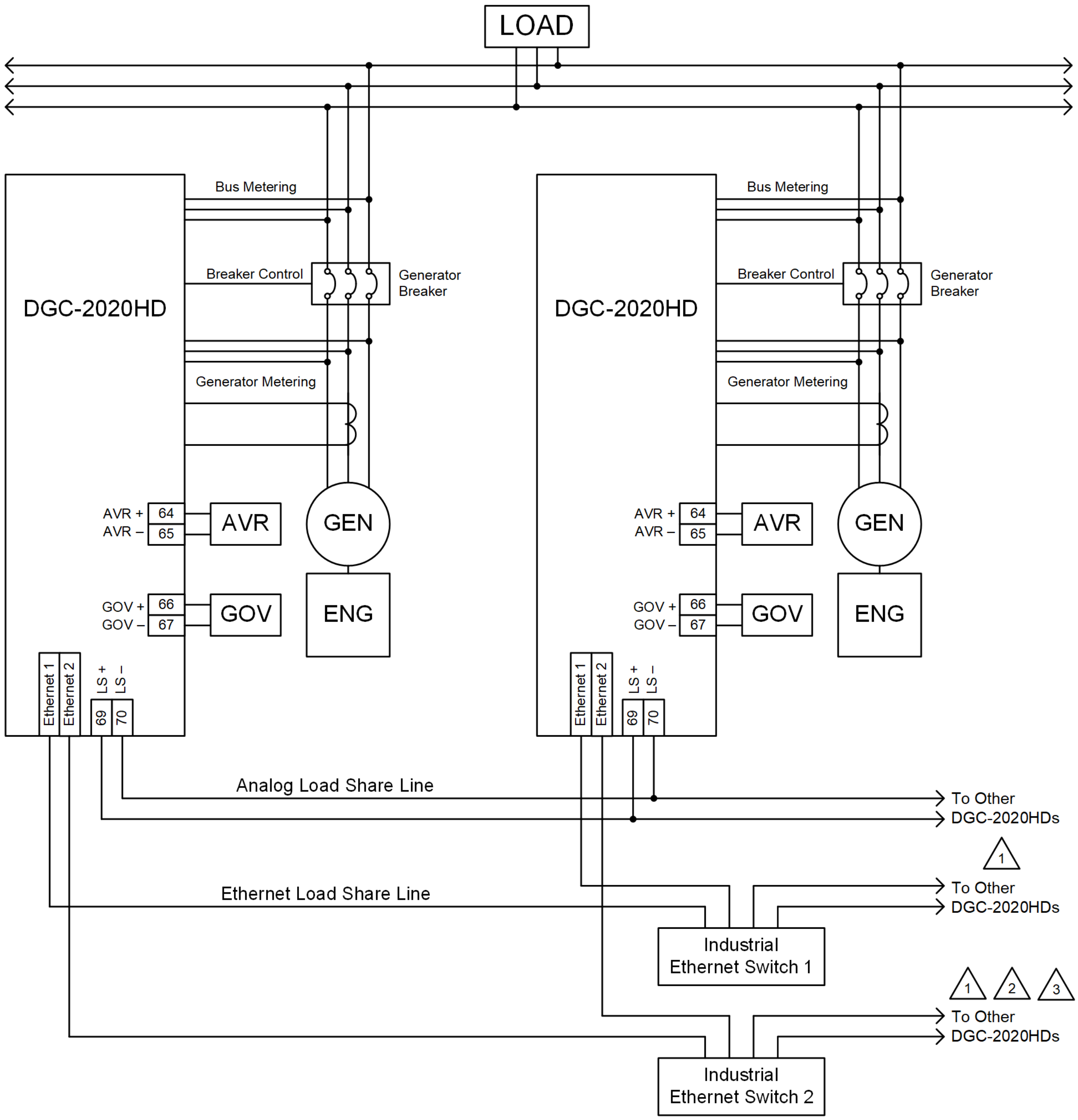


Figure 3-19. Generator and Two Tie Breaker Control Connections

Connections for Load Sharing

Figure 3-20 illustrates a typical interconnection of two systems tied together using analog and Ethernet load share lines.



Notes: 1 Up to 32 DGC-2020HDs are supported on one network.

2 Ethernet 2 only available on units with Ethernet option D (Dual 100 Base T, Copper).

3 To other DGCs when configured for redundant Ethernet Load Sharing or to other devices when Modbus TCP communication is used.

P0097-15

Figure 3-20. Analog and Ethernet Connections for Typical Applications

Analog Input Connections

DGC-2020HD controllers with style number xxxxxxxxR are equipped with two analog inputs and those with style number xxxxxxxxA are equipped with four analog inputs.

Voltage and current analog input connections are shown in the following figures. When using the current input, the "+" and "I" terminals must be tied together.

To achieve electromagnetic interference immunity on the analog inputs, clamp two ferrite beads (Fair-Rite P/N 0431176451) in series around all of the wires. Place the ferrite beads close to the DGC-2020HD analog input terminals.

Analog Voltage Input Connection

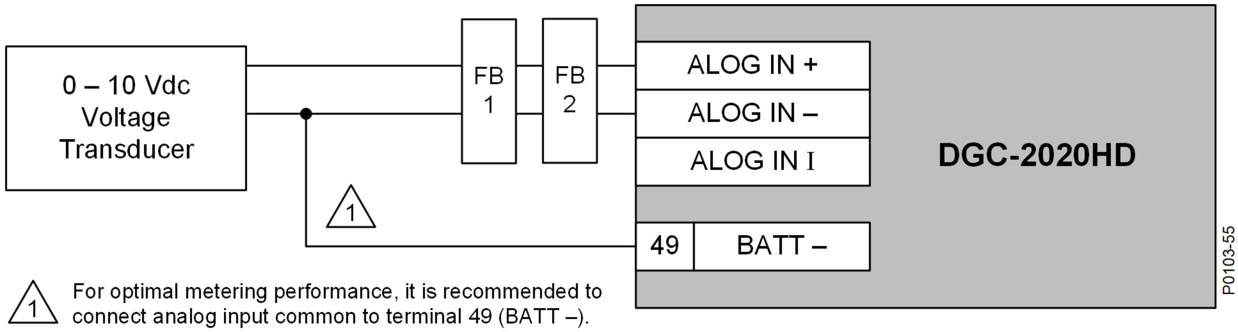


Figure 3-21. Analog Inputs, Voltage Input Connections

Analog Current Input Connections

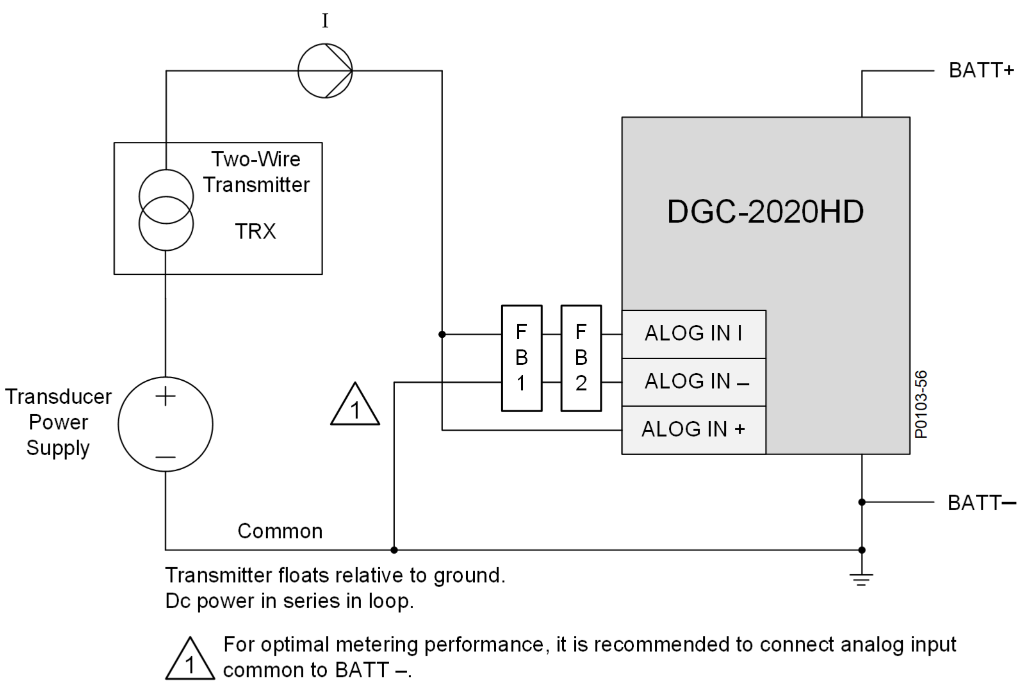
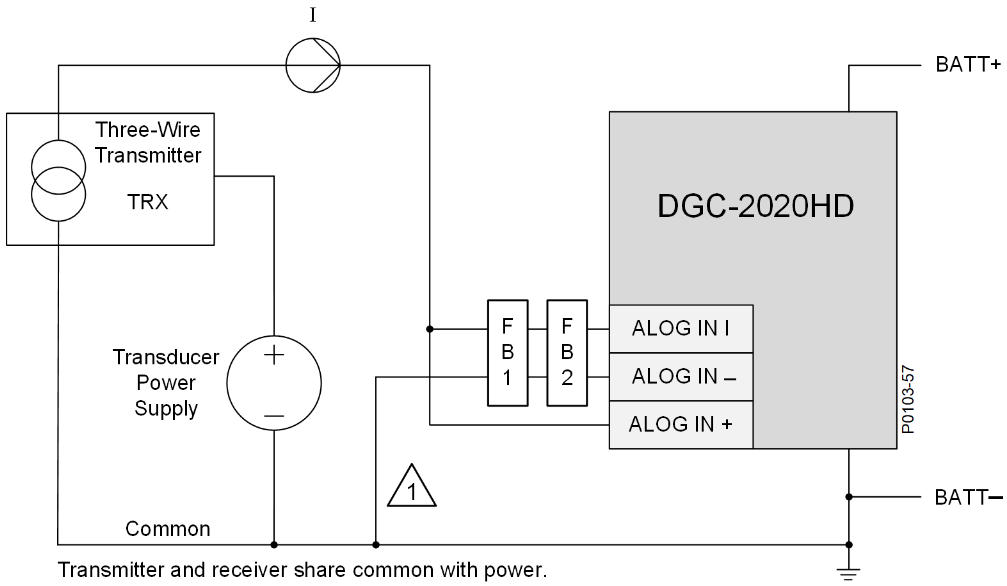


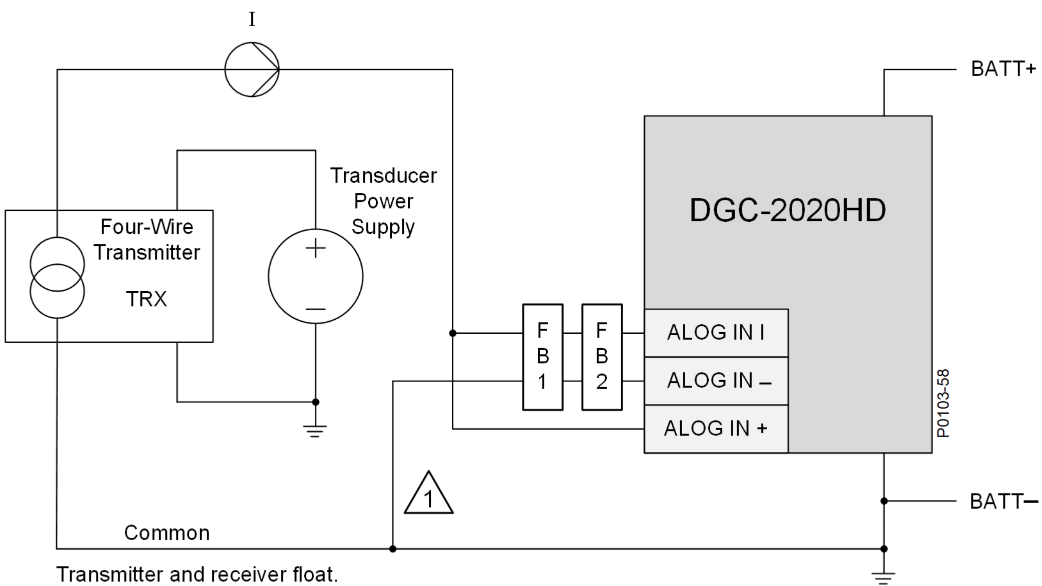
Figure 3-22. Analog Inputs, Current Input Connections, Type II 2-Wire Current Loop Circuit



Transmitter and receiver share common with power.
Separate dc power connection to transmitter.

△1 For optimal metering performance, it is recommended to connect analog input common to BATT –.

Figure 3-23. Analog Inputs, Current Input Connections, Type III 2-Wire Current Loop Circuit



Transmitter and receiver float.
Separate supply powers transmitter.

△1 For optimal metering performance, it is recommended to connect analog input common to BATT –.

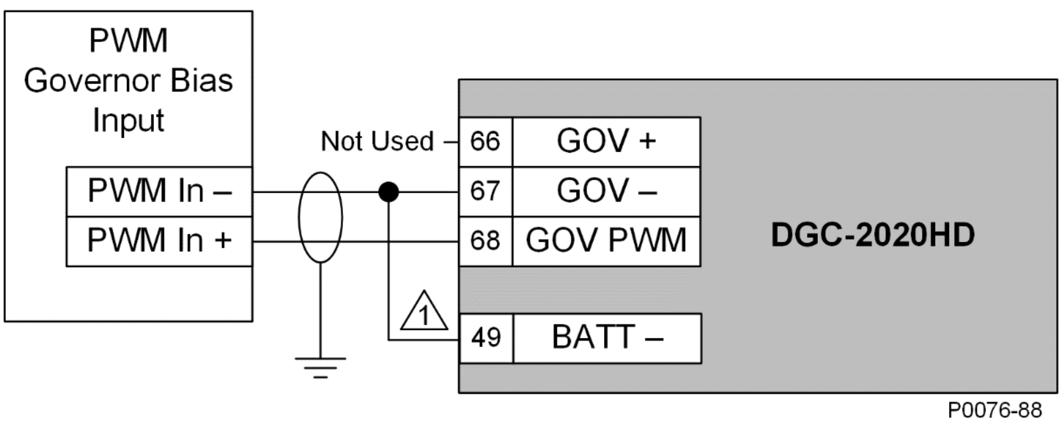
Figure 3-24. Analog Inputs, Current Input Connections, Type IV 2-Wire Current Loop Circuit

Governor PWM Output Connections

The Governor PWM output allows interfacing with select CAT control systems. Governor PWM output connections are shown in Figure 3-25.

Notes

1. PWM wiring should be as short as possible and should only be used in applications where the DGC-2020HD is mounted on the machine in the same general location as the device being driven by the PWM signal.
2. If the DGC-2020HD is not located close to the engine, it is recommended to employ a device to convert analog signals to PWM signals located close to the device being driven by the PWM signal. The DGC-2020HD GOV output should be configured for analog output control to drive the device that converts analog signals to PWM signals.
3. Twisted shielded pair wiring is suggested for all analog and PWM control signals.



1 For optimal performance, it is recommended to connect GOV output common (GOV-) to terminal 49 (BATT-) or other battery minus location.

Figure 3-25. Governor PWM Output Connections

CAN Connections

Typical CAN connections are shown in Figure 3-26 and Figure 3-27.

Notes

1. If the DGC-2020HD is providing one end of the J1939 bus, a 120 ohm, ½ watt terminating resistor should be installed across terminals 51 (CAN1L) and 52 (CAN1H) or 54 (CAN2L) and 55 (CAN2H).
2. If the DGC-2020HD is not providing one end of the J1939 bus, the stub connecting the DGC-2020HD 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-2020HD.
5. It is recommended to upgrade the firmware in all AEM-2020s and CEM 2020s that share a CAN bus network with a VRM-2020. Upgrade CEM-2020s to firmware version 1.01.05 or later. Upgrade AEM 2020s to firmware version 1.00.06 or later.

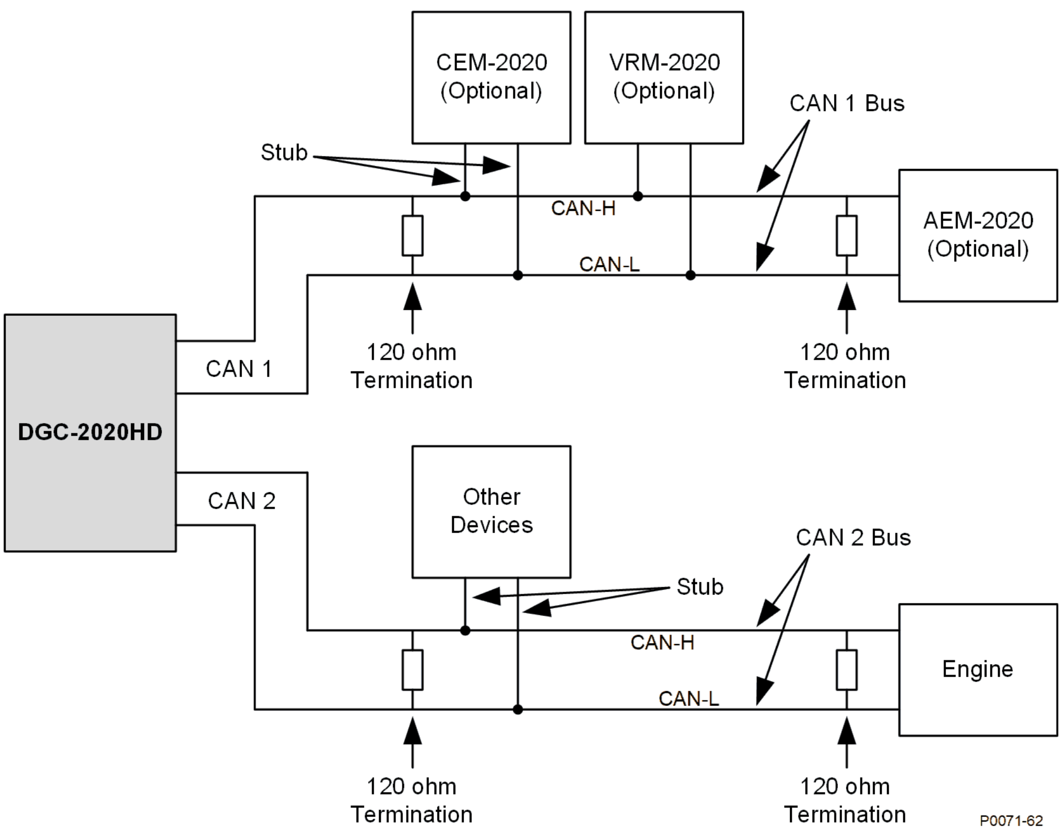


Figure 3-26. CAN Interface with DGC-2020HD Providing One End of the Bus

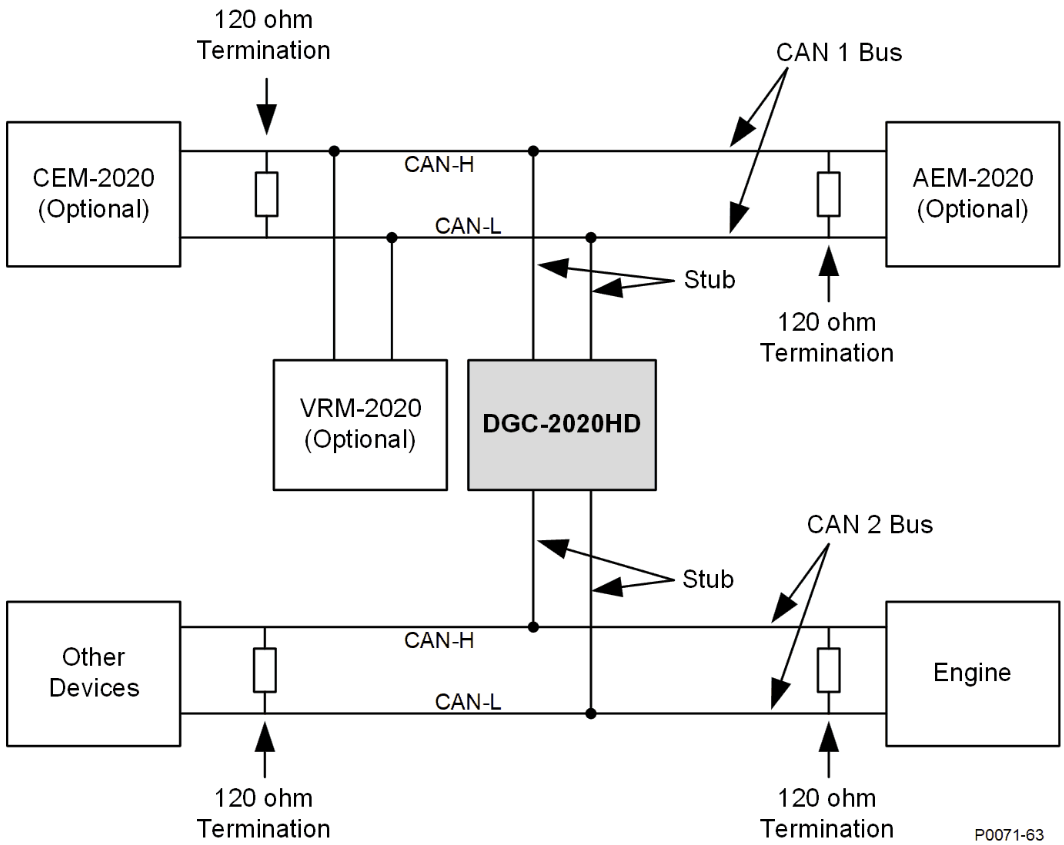


Figure 3-27. CAN Interface with Other Devices Providing One End of the Bus

Expansion Module Connections (CAN 1)

The AEM-2020 (Analog Expansion Module), CEM-2020 (Contact Expansion Module), and VRM-2020 (Voltage Regulation Expansion Module) are optional modules that may be connected with the DGC-2020HD. These modules interface to the DGC-2020HD via the “CAN 1” interface, thus the CAN terminals (51, 52, and 53) are the only common connections between the DGC-2020HD, AEM-2020, CEM-2020, and VRM-2020. A CAN interface configured for 250 kbps supports the following combinations of AEM-2020, CEM-2020 and VRM-2020 modules:

- Up to six CEM-2020s, two AEM-2020s, and one VRM-2020
- Up to five CEM-2020s, three AEM-2020s, and one VRM-2020
- Up to four CEM-2020s, four AEM-2020s, and one VRM-2020

On a CAN configured for 125 kbps, only up to two AEM-2020 modules are supported if a VRM-2020 is used. Typical connections are illustrated in Figure 3-28.

Refer to the *AEM-2020*, *CEM-2020*, and *VRM-2020* chapters in the *Accessories* manual for more information.

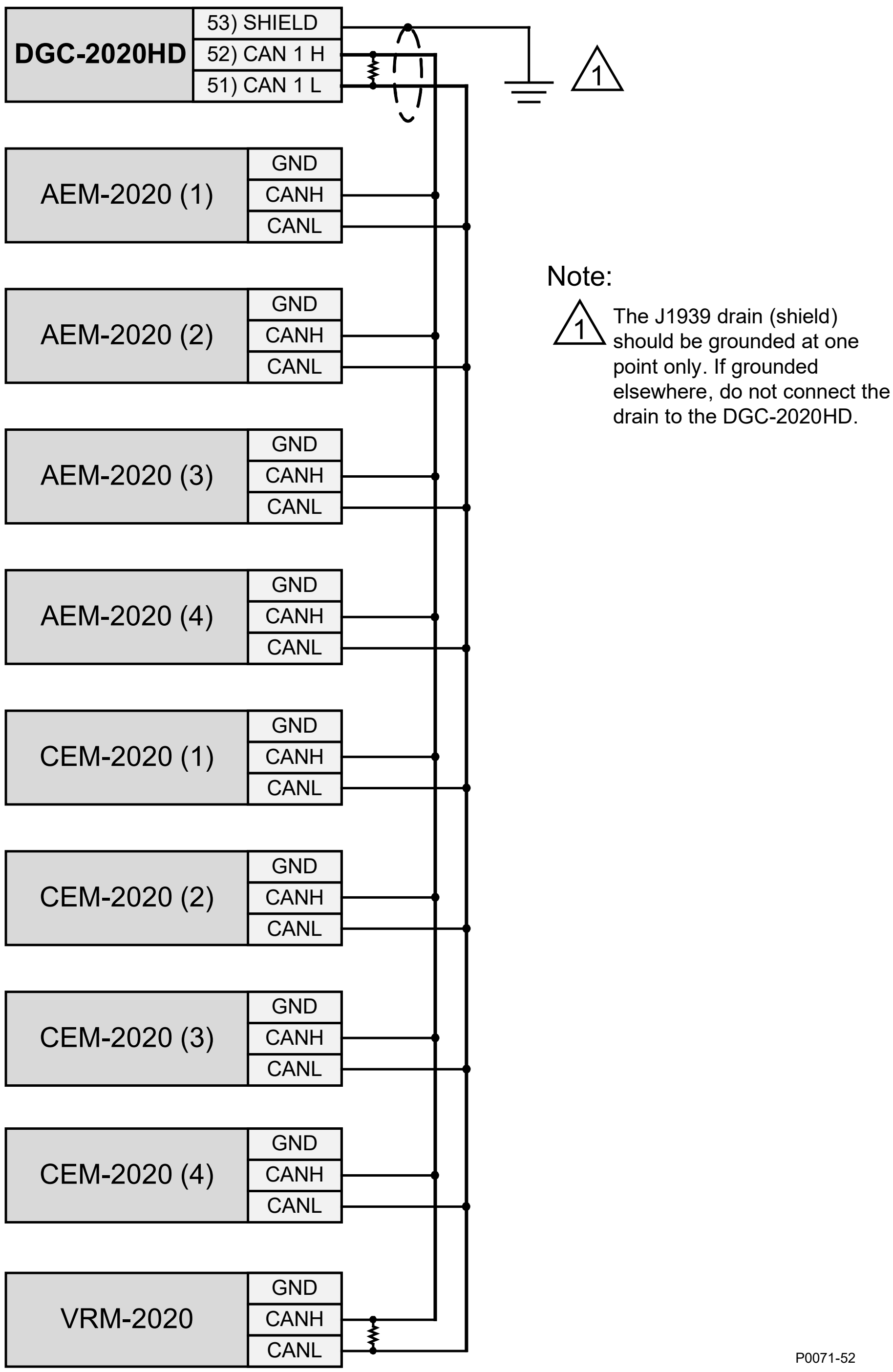


Figure 3-28. DGC-2020HD Expansion Module CAN Connections

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 an Ungrounded System Application

When the DGC-2020HD is controlling equipment that is part of an ungrounded system, it is recommended that potential transformers be employed on the voltage sensing inputs to provide full isolation between the DGC-2020HD and monitored voltage phases.

4 • Power Input

Control power for the DGC-2020HD is typically supplied by the genset starter battery. Power from the battery is supplied to an internal power supply that provides power for DGC-2020HD logic, protection, and control functions.

Nominal Voltage Input and Acceptable Range of Input Voltage

A nominal voltage of 12 or 24 Vdc within a range of 6 to 32 Vdc is accepted. Control power must be of the correct polarity. Although reverse polarity will not cause damage, the DGC-2020HD will not operate.

Terminal Assignments

Input power is applied to terminals 48 (BATT+) and 49 (BATT–), with terminal 50 (CHASSIS GND) serving as the chassis ground connection.

Power Consumption

The amount of power consumed by the DGC-2020HD varies based on the selected operating mode. The power saving Sleep mode consumes 12.7 watts with all relays de-energized and analog outputs disabled. Normal Operational Mode consumes 18.1 watts in Run mode with the LCD heater off, START and RUN relays energized, six programmable relays energized, and analog outputs enabled. Maximum Operational Mode consumes 25 watts in Run mode with the LCD heater on, all relays energized, and analog outputs enabled.

Battery Ride-Through Capability

Starting at 10 Vdc, the DGC-2020HD withstands cranking ride-through down to 0 Vdc for 50 milliseconds.

Fuse Protection

To follow UL guidelines, a 5 A maximum, 32 Vdc supplementary fuse, rated for no less than 26 A^2s, must be implemented in the battery input circuit to the DGC-2020HD.

5 • Voltage and Current Sensing

The DGC-2020HD senses generator voltage, generator current, and bus voltage through dedicated, isolated inputs.

Generator Voltage

The DGC-2020HD accepts either line-to-line or line-to-neutral generator sensing voltage over the range of 12 to 576 volts rms L-L (7 to 333 volts rms L-N). Single-phase generator voltage is sensed across phases A and B. Generator voltage sensing terminals are listed in Table 5-1.

Table 5-1. Generator Voltage Sensing Terminals

Terminal	Description
86 (GEN VA)	A-phase generator voltage sensing input
88 (GEN VB)	B-phase generator voltage sensing input
90 (GEN VC)	C-phase generator voltage sensing input
91 (GEN VN)	Neutral generator voltage sensing input

Bus Voltage

Sensing of bus voltage enables the DGC-2020HD to detect failures of the mains (utility). The DGC-2020HD accepts bus sensing over the range of 12 to 576 volts rms L-L (7 to 333 volts rms L-N). Controllers with style number xxx2xxxxx measure bus voltage sensing to perform automatic synchronization of the generator with the bus. Single-phase bus voltage is sensed across phases A and B. Bus voltage sensing terminals are listed in Table 5-2.

Table 5-2. Bus Voltage Sensing Terminals

Terminal	Description
93 (BUS 1 VA)	Bus 1 A-phase voltage sensing input
95 (BUS 1 VB)	Bus 1 B-phase voltage sensing input
97 (BUS 1 VC)	Bus 1 C-phase voltage sensing input
98 (BUS 1 VN)	Bus 1 Neutral voltage sensing input
100 (BUS 2 VA)	Bus 2 A-phase voltage sensing input
101 (BUS 2 VB)	Bus 2 B-phase voltage sensing input
103 (BUS 2 VC)	Bus 2 C-phase voltage sensing input
104 (BUS 2 VN)	Bus 2 Neutral voltage sensing input

Generator and Bus Current

The DGC-2020HD has sensing inputs for A-phase, B-phase, and C-phase generator current. One, or up to four (optional), user-programmable CTs are provided for sensing current on bus 1, optional bus 2, and generator ground current. Depending on the style number, a DGC-2020HD has a nominal sensing current rating of 1 Aac or 5 Aac. A style number of 1xxxxxxxx indicates 1 Aac nominal current sensing and a style number of 5xxxxxxxx indicates 5 Aac nominal current sensing. Generator current sensing terminals are listed in Table 5-3 and load bus current sensing terminals are listed in Table 5-4.

Table 5-3. Generator Current Sensing Terminals

Terminal	Description
1 (IA+)	A-phase generator current sensing input
2 (IA–)	
3 (IB+)	B-phase generator current sensing input
4 (IB–)	
5 (IC+)	C-phase generator current sensing input
6 (IC–)	

Table 5-4. Bus Current Sensing Terminals

Terminal	Description
7 (AUX I1+)	User-programmable current sensing input 1
8 (AUX I1–)	
9 (AUX I2+)	User-programmable current sensing input 2
10 (AUX I2–)	
11 (AUX I3+)	User-programmable current sensing input 3
12 (AUX I3–)	
13 (AUX I4+)	User-programmable current sensing input 4
14 (AUX I4–)	

Caution

Generator current sensing terminals 2 (IA–), 4 (IB–), and 6 (IC–) and user-programmable current sensing terminals 8 (AUX I1–), 10 (AUX I2–), 12 (AUX I3–), and 14 (AUX I4–) must be terminated to ground for proper operation.

Note

Unused current sensing inputs should be shorted to minimize noise pickup.

6 • Speed Signal Inputs

The DGC-2020HD uses signals from the generator voltage sensing inputs, magnetic pickup (MPU) input, or both inputs to detect machine speed.

Magnetic Pickup

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.

Terminals

Magnetic pickup connections are provided at terminals 106 (+) and 107 (–).

Generator Sensing Voltage

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

Terminals

Sensing voltage is applied to terminals 86 (A-phase), 88 (B-phase), 90 (C-phase), and 91 (Neutral).

7 • Specifications

DGC-2020HD electrical and physical characteristics are listed in the following paragraphs.

Control Power

Nominal .... 12 or 24 Vdc
Range.. 6 to 32 Vdc
Terminals... 48 (+), 49 (–), 50 (chassis ground)

Power Consumption

Sleep Mode .... 12.7 W - LCD heater off, all relays de-energized, and analog outputs disabled
Normal Operational Mode .... 18.1 W - Run mode, LCD heater off, START and RUN relays energized, six programmable relays energized, and analog outputs enabled
Maximum Operational Mode............ 25 W - Run mode, LCD heater on, all relays energized, and analog outputs enabled

Battery Ride Through

Starting at 10 Vdc, withstands cranking ride-through down to 0 Vdc for 50 ms

Current Sensing

Burden... 1 VA

Generator CTs

Terminals... 1 (+), 2 (–) (A-phase)
3 (+), 4 (–) (B-phase)
5 (+), 6 (–) (C-phase)

Available Programmable CTs

AUX 1Terminals .... 7 (+), 8 (–)
AUX 2 Terminals .... 9 (+), 10 (–)
AUX 3 Terminals .... 11 (+), 12 (–)
AUX 4 Terminals .... 13 (+), 14 (–)

Programmable CTs AUX 2, 3, and 4 are optional with style number xxxxxxxEx.

1 Aac Current Sensing

Continuous Rating............................ 0.02 to 1.5 Aac
1 Second Rating............................... 10 Aac

5 Aac Current Sensing

Continuous Rating............................ 0.1 to 7.5 Aac
1 Second Rating............................... 50 Aac

Voltage Sensing

Range .... 12 to 576 V rms, line-to-line
Frequency .... 50/60 Hz
Frequency Range .... 10 to 90 Hz
Burden .... 1 VA
1 Second Rating .... 720 V rms

Generator Sensing

Configuration .... Line-to-line or line-to-neutral
Generator Sensing Terminals .... 86 (A-phase)
88 (B-phase)
90 (C-phase)
91 (Neutral)

Bus 1 Sensing

Configuration .... Line-to-line or line-to-neutral
Bus Sensing Terminals .... 93 (A-phase)
95 (B-phase)
97 (C-phase)
98 (Neutral)

Bus 2 Sensing (Optional with style number xxxxxxxEx)

Configuration .... Line-to-line or line-to-neutral
Bus Sensing Terminals .... 100 (A-phase)
101 (B-phase)
103 (C-phase)
104 (Neutral)

Analog Sensing

The DGC-2020HD contains two or four (optional) analog inputs.

Current Sensing

Rating .... 4 to 20 mA
Burden .... 84.25 Ω to 87.1 Ω
Accuracy .... ±2%

Voltage Sensing

Rating .... –10 to 10 Vdc
Burden .... 9.75 kΩ to 10.16 kΩ
Accuracy .... ±2%

Contact Sensing

Contact sensing inputs include sixteen programmable inputs. All inputs accept dry contacts. The following contact input recognition and contact output closure times reflect the maximum possible delay.

Contact Input Recognition Time

This is the amount of time that elapses after a local contact input closes until that closure is available in logic.

DGC-2020HD .... 125 ms
CEM-2020 .... 185 ms

Contact Output Closure Time

This is the amount of time that elapses after a contact output closure is true in logic until that contact output closes.

DGC-2020HD .... 15 ms
CEM-2020 .... 125 ms

Notes

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

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

The maximum wire length can be calculated as follows:

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

Terminals

Input 1 .... 31, 49
Input 2 .... 32, 49
Input 3 .... 33, 49
Input 4 .... 34, 49
Input 5 .... 35, 49
Input 6 .... 36, 49
Input 7 .... 37, 49
Input 8 .... 38, 49
Input 9 .... 39, 49
Input 10 .... 40, 49
Input 11 .... 41, 49
Input 12 .... 42, 49
Input 13 .... 43, 49
Input 14 .... 44, 49
Input 15 .... 45, 49
Input 16 .... 46, 49

Engine System Inputs

Stated accuracies are subject to the accuracy of the senders used. Values within these ranges are deemed “good” and the DGC-2020HD will use them for the appropriate calculation and protection.

Fuel Level Sensing

Resistance Range .... 0 to 250 Ω nominal
Terminals.. 71 (FUEL +), 72 (FUEL –)
Accuracy... ±0.8 Ω or ±1.9% of actual resistance

Coolant Temperature Sensing

Resistance Range .... 10 to 2,750 Ω nominal
Terminals.. 77 (COOLANT +), 78 (COOLANT –)
Accuracy... ±1.2 Ω or ±2.1% of actual resistance

Oil Pressure Sensing

Resistance Range .... 0 to 250 Ω nominal
Terminals.. 74 (OIL +), 75 (OIL –)
Accuracy... ±0.8 Ω or ±2.0% of actual resistance

Engine Speed Sensing

Magnetic Pickup

Voltage Range .... 3 to 35 V peak (6 to 70 V peak-peak)
Frequency Range............................ 32 to 10,000 Hz
Terminals.. 106 (MPU +), 107 (MPU –)

Generator Voltage

Range.. 12 to 576 V rms
Terminals.. 86 (A-phase)
88 (B-phase)
90 (C-phase)
91 (Neutral)

Output Contacts

PRE (Prestart), START, and RUN Relays

Rating .... 30 Adc at 28 Vdc—General purpose, 3 A pilot duty∗

Programmable Relays (12)

Rating .... 2 Adc at 30 Vdc—General purpose, 1.2 A pilot duty∗

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

Terminals

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

The programmable relays share common terminals: terminal 18 is used for outputs 1, 2, and 3, terminal 22 is used for outputs 4, 5, and 6, terminal 26 is used for outputs 7, 8, and 9, 30 is used for outputs 10, 11, and 12.

Analog Outputs

AVR Output

Voltage Rating................................. –10 to 10 Vdc
Current Rating................................. 4 to 20 mA

GOV Output

Voltage Rating................................. –10 to 10 Vdc
Current Rating................................. 4 to 20 mA

GOV PWM Output

PWM Output.................................... Pulse width modulated square wave, 500 Hz (±100 Hz)
Zero Error Output Duty Cycle........... 69.8% (±2.0%)

Minimum Voltage (hi) .... 10 Vdc
Maximum Voltage (lo) .... 0.5 Vdc when driving external 5.1 kΩ load to 13 Vdc external pull-up.
No-Load PWM Voltage Amplitude ... 14 V nominal

Load Share Output

Voltage Rating.................................. –10 to 10 Vdc

Metering

Generator and Bus Voltage (rms)

Metering Range................................ 0 to 576 Vac (direct measurement)
577 to 99,999 Vac (through VT using VT ratio setting)
VT Ratio Range................................ 1:1 to 125:1 in primary increments of 1
Accuracy*.. ±1.0% of programmed rated voltage or ±2 Vac
Display Resolution .... 1 Vac

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

Generator Current (rms)

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

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

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

Generator and Bus Frequency

Frequency is sensed through the generator and bus voltage inputs (phases A and B).

Metering Range................................ 10 to 90 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... ±2% of the full-scale indication or ±2 kVA *†

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

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

Power Factor

Metering Range................................ 0.2 leading to 0.2 lagging
Calculation Method .... PF = cosine of the angle between phase AB voltage (Vab) and phase A current (Ia) *
Accuracy... ±0.01 †

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

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

Note

For the DGC-2020HD to correctly meter power factor, the generator must be rotating in the same phase sequence as dictated by the generator phase rotation setting.

Real Power

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

Measurement/Calculation Methods

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

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

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

Oil Pressure

Metering Range................................ 0 to 150 psi, 0 to 10.3 bar, or 0 to 1,034 kPa
Sensing Resistance Range.............. 0 to 250 Ω nominal
Sensing Accuracy .... ±0.8 Ω or ±2.0% of actual resistance
Display Resolution .... 1 psi, 0.07 bar, or 6.9 kPa

Coolant Temperature

Metering Range................................ 32 to 410°F or 0 to 204°C
Sensing Resistance Range.............. 10 to 2,750 Ω nominal
Sensing Accuracy .... ±1.2 Ω or ±2.1% of actual resistance

Fuel Level

Metering Range................................ 0 to 100%
Sensing Resistance Range.............. 0 to 250 Ω nominal
Sensing Accuracy .... ±0.8 Ω or ±1.9% of actual resistance
Display Resolution 1.0%

Battery Voltage

Metering Range................................ 6 to 32 Vdc
Accuracy... ±2% of actual indication or as low as ±0.2 Vdc
Display Resolution .... 0.1 Vdc

Engine RPM

Metering Range................................ 0 to 4,500 rpm
Accuracy*... ±2% of actual indication or as low as ±2 rpm
Display Resolution .... 2 rpm

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

Maintenance Timer

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

Metering Range................................ 0 to 5,000 hours
Update Interval................................ 0.1 hours
Accuracy.. ±1% of actual indication or as low as ±12 minutes
Display Resolution .... 1 minute

Protection Functions

Overvoltage (59) and Undervoltage (27)

Pickup Range.................................. 0 to 576 V
Pickup Increment .... 1 V
Hysteresis Range............................ 1 to 60 Vac
Inhibit Frequency Range.................. 20 to 90 Hz (27 function only)
Activation Delay Range.................... 0 to 600 s
Activation Delay Increment .... 0.1 s

Underfrequency (81U) and Overfrequency (81O)

Pickup Range.................................. 37.5 to 66 Hz
Pickup Increment .... 0.01 Hz
Hysteresis Range............................ 0.1 to 40 Hz
Activation Delay Range.................... 0 to 600 s
Activation Delay Increment .... 0.1 s
Inhibit Voltage Range....................... 0 to 100% of nominal voltage
Inhibit Voltage Increment 1%

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

Pickup Range.................................. 0.2 to 10 Hz/s
Pickup Increment .... 0.1 Hz/s
Pickup Accuracy.............................. 0.2 Hz/s
Activation Delay Range.................... 0 to 10,000 ms
Activation Delay Increment .... 1 ms

Reverse and Forward Power (32)

Pickup Range.................................. 0 to 200% of nominal input rating
Pickup Increment 0.1%
Hysteresis Range............................ 1 to 10%
Activation Delay Range.................... 0 to 600 s
Activation Delay Increment .... 0.1 s

Loss of Excitation (40Q)

Pickup Range.................................. –150 to 0% of Rated kvar*
Pickup Increment 0.1%
Hysteresis Range............................ 1 to 10%
Activation Delay Range.................... 0 to 600 s
Activation Delay Increment .... 0.1 s

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

Current Imbalance (46) (Optional)

Pickup Range.................................. 0.18 to 4 Aac (1 A current sensing)
0.9 to 20 Aac (5 A current sensing)
Hysteresis.. 2 %

Time Dial Range .... 0 to 7,200 s (fixed time curve)
0 to 99 (46 – K factor curve)
Time Dial Increment 1
Inverse Time Curves .... See the *Time Overcurrent Characteristic Curves* chapter in the *Configuration* manual.

Overcurrent (51) (Optional)

Pickup Range .... 0.18 to 4 Aac (1 A current sensing)
0.9 to 20 Aac (5 A current sensing)
Hysteresis.. 2 %
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 the *Time Overcurrent Characteristic Curves* chapter in the *Configuration* manual.

Caution

For 1 A current sensing, current shall not exceed 3 amperes for 30 seconds or 4 amperes for 1 second. For 5 A current sensing, current shall not exceed 15 amperes for 30 seconds or 20 amperes for 1 second. Exceeding the above limits may result in equipment damage.

Phase Current Differential (87) (Optional)

Minimum Restrained Pickup .... 0.1 to 1 (multiples of tap)
Minimum Restrained Increment 0.01
2nd Slope Pickup .... 0.1 to 20 (in multiples of tap)
2nd Slope Increment 0.01
Restraint Slope .... 15 to 60 %
Restraint Slope Increment................ 1%
Alarm Slope...................................... 50 to 100%
Alarm Slope Increment..................... 1%
Unrestrained Tripping Pickup .... 0 to 21 (in multiples of tap)
Unrestrained Tripping Increment 1
2nd Harmonic .... 5 to 75%
2nd Harmonic Increment 1%
5th Harmonic .... 5 to 75%
5th Harmonic Increment 1%
Time Delay .... 0 to 60 s
Time Delay Increment .... 0.1 s
Transient Operate Time .... 0.4 to 10 s
Transient Operate Time Increment .. 0.1 s
Transient Delay Time .... 0 to 10
Transient Delay Time Increment ...... 0.1 s

Neutral Current Differential (87N) (Optional)

Iop Minimum .... 0.1 to 5 A
Iop Minimum Increment.................... 0.01 A
Hysteresis.. 5%
Time Delay Range .... 0 to 60 s
Time Delay Increment .... 0.1 s
Overcorrection Coefficient Range .... 1 to 1.3
Overcorrection Coefficient Inc.......... 0.01
Transient Delay Time Range .... 0 to 10 s
Transient Delay Time Increment 0.1

Phase Voltage Imbalance (47) (Optional)

Pickup Range .... 0 to 150 Vac
Pickup Increment .... 1 Vac
Hysteresis Range .... 1 to 5 Vac
Activation Delay Range .... 0 to 600 s
Activation Delay Increment .... 0.1 s

Vector Shift (78) (Optional)

Pickup Range .... 2 to 90°
Pickup Increment .... 1°
Hysteresis.. 0.5 degrees
Accuracy.. ±1°

Field Overvoltage

Pickup Range .... 1 to 120 Vdc
Pickup Increment .... 1 Vdc
Time Delay Range .... 0 to 30 s
Time Delay Increment .... 0.1 s

Loss of Sensing

Time Delay Range .... 0 to 600 s
Time Delay Increment .... 0.1 s
Voltage Balanced Level Range........ 0 to 100%
Voltage Balanced Level Increment .. 0.1%
Voltage Unbalanced Level Range ... 0 to 100% (three-phase mode only)
Voltage Unbalanced Level Inc. .... 0.1% (three-phase mode only)
Fault Current Range......................... 0.9 to 20 A
Fault Current Increment .... 0.001 A

Exciter Diode Monitor (Optional)

Pickup Range .... 0.1 to 10 A
Pickup Increment .... 0.1 A
Time Delay Range .... 0 to 30 s
Time Delay Increment .... 0.1 s

Logic Timers

Hours Setting Range .... 0 to 250
Hours Setting Increment 1
Minutes Setting Range .... 0 to 59
Minutes Setting Increment 1
Seconds Setting Range .... 0 to 59
Seconds Setting Increment 1
Accuracy.. ±15 ms

Communication Interface

CAN (SAE J1939)

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
CAN 1 Terminals .... 51 (low), 52 (high), and 53 (shield)
CAN 2 Terminals .... 54 (low), 55 (high), and 53 (shield)

Notes

1. If the DGC-2020HD is providing one end of the J1939 bus, a 120 ohm, ½ watt terminating resistor should be installed across terminals 51 (CAN1L) and 52 (CAN1H) or 54 (CAN2L) and 55 (CAN2H).
2. If the DGC-2020HD is not providing one end of the J1939 bus, the stub connecting the DGC-2020HD 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-2020HD.
5. It is recommended to upgrade the firmware in all AEM-2020s and CEM 2020s that share a CAN bus network with a VRM-2020. Upgrade CEM-2020s to firmware version 1.01.05 or later. Upgrade AEM 2020s to firmware version 1.00.06 or later.

Ethernet

Dual Copper Connector .... RJ-45, 10/100BASE-T (style number xxxxDxxxx)
Fiber Optic Connector .... ST, 100BASE-FX (style number xxxxFxxxx)
Fiber Optic Cable .... 1300 nanometer, near-infrared (NIR) light wavelength transmitted via two strands of multimode optical fiber, one for receive (RX) and the other for transmit (TX).

Industrial Ethernet devices designed to comply with IEC 61000-4 series of specifications are recommended.

External Dial-Out Modem (RS-232)

Protocol .... ASCII
Data Transmission .... Full Duplex
Baud .... 4,800 to 115,200
Data Bits.. 8
Parity .... None
Stop Bits 1
Connector Type............................... DB-9 Connector (Male)

IRIG-B Time Synchronization

Standard:... 200-04, Format B002
Input Signal .... Demodulated (dc level-shifted signal)
Logic High Level.............................. 3.5 Vdc, minimum
Logic Low Level .... 0.5 Vdc, maximum
Input Voltage Range .... –10 to +10 Vdc
Input Resistance .... Nonlinear, approximately 4 kΩ at 3.5 Vdc, 3 kΩ at 20 Vdc
Response Time .... < 1 cycle
Terminals... 59 (IRIG-B +), 60 (IRIG-B –)

Modbus® (RS-485)

Baud .... 1,200 to 115,200
Data Bits.. 8
Parity .... None
Stop Bits 1

Terminals.. 56 (485 A), 57 (485 B), and 58 (485 shield)

RS-485 Modbus supports a single Modbus Master only.

RDP-110

Minimum Wire Size .... 20 AWG (0.52 mm^2)
Maximum Wire Length .... 4,000 feet (1,219 meters)
Terminals.. 61 (RDP-110 TxD+), 62 (RDP-110 TxD–)

USB

Specification Compatibility .... USB 2.0
Connector Type............................... Mini-B jack

Real-Time Clock

Clock has leap year and selectable daylight saving time correction. Backup battery sustains timekeeping during losses of DGC-2020HD control power.

Resolution .... 1 s
Accuracy... ±1.73 s/d at 25°C (77°F)

Clock Holdup

Battery Holdup Time .... Approximately 10 years
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-2020HD is to be operated in a salt-fog environment. Salt-fog is known to be conductive and may short-circuit the battery.

LCD Heater

DGC-2020HDs with the default monochrome LCD option (style xNxxxxxxx) are equipped with an LCD heater. The ambient temperature is monitored by a temperature sensor located near the LCD inside the DGC-2020HD. The LCD heater turns on when the ambient temperature falls below –5°C (23°F). The heater turns off when the ambient temperature rises above 5°C (41°F). This range of operation implements 10°C (18°F) of hysteresis between when the heater turns on and turns off.

Type Tests

Shock

Withstands 15 G in 3 perpendicular planes.

DGC-2020HD with DIN Rail mount (style xRxxxxxxx) and Rear Panel mount (style xPxxxxxxx)

Withstands 10 G, 3 times, in 3 perpendicular planes.

Vibration

Tested for 8 hours in three perpendicular planes.

3 to 25 Hz.. at 0.063 in (1.6 mm) peak amplitude
25 to 2,000 Hz................................. at 5 G

DGC-2020HD with DIN Rail mount (style xRxxxxxxx) and Rear Panel mount (style xPxxxxxxx)

Tested for 2 hours and 40 minutes in three perpendicular planes.
10 to 150 Hz at 2.5 G

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-2020HD was subjected to temperature tests (tested over a temperature range of –85°C to +120°C), vibration tests (of 5 to 40 G at +30°C), and temperature/vibration tests (tested at 40 G over a temperature range of –85°C to +120°C). Combined temperature and vibration testing at these extremes proves that the DGC-2020HD 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.

Ignition System

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

Environment

Operating Temperature.................... –40 to +158°F (–40 to +70°C)∗
Storage Temperature....................... –40 to +185°F (–40 to +85°C)
Salt Fog... IEC 60068
Ingress Protection .... IEC IP56 for front panel
Humidity .... IEC 68-2-78

∗ The operating temperature of DGC-2020HD units with the color touch screen display option (style xTxxxxxxx) is derated to –4 to +158°F (–20 to +70°C).

Agency, Standards, and Directives

UL Approval

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

Standards used for evaluation:

- UL 6200:2019
- CSA C22.2 No. 14

The DGC-2020HD is a Listed Device as a Protective Relay applicable to the Canadian and US safety standards and requirements by UL. The product is covered under UL File (E97033 NRGU/ NRGU7).

The DGC-2020HD ground fault protection circuit complies with the Calibration and Withstand tests of UL 1053; as required by UL6200. Field Testing is required when the DGC-2020HD is used for Ground Fault Protection as described within UL 1053 Section 31.

See the *Time Curve Characteristics* chapter in the *Configuration* manual for the listing of curves verified to meet UL1053.

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

CE Compliance

This product has been evaluated and complies with the relevant essential requirements set forth in the following EC Directives and by the EU legislation:

- Low Voltage Devices (LVD) - 2014/35/EU
- Electromagnetic Compatibility (EMC) - 2014/30/EU
- Hazardous Substances (ROHS2) -2011/65/EU

Harmonized Standards used for evaluation:

- EN 50178 - *Electronic Equipment for use in Power Installations*
- EN 61000-6-4 - *Electromagnetic Compatibility (EMC), Generic Standards, Emission Standard for Industrial Environments*
- EN 61000-6-2 - *Electromagnetic Compatibility (EMC), Generic Standards, Immunity for Industrial Environments*
- EN 50581 – *Technical Documentation for the Assessment of Electrical and Electric Products with Respect to the Restriction of Hazardous Substances (ROHS2)*

NFPA Compliance

Designed to comply with NFPA Standard 110, *Standard for Emergency and Standby Power.*

EAC Mark (Eurasian Conformity)

For current certificate, see www.basler.com.

Maritime Recognition

American Bureau of Shipping (ABS) – For current certificates, see www.basler.com.

Patent

Basler Electric. Load anticipation feature. US Patent 9,574,511, filed May 21, 2015, and issued February 21, 2017.

Physical

Weight .... 5.70 lb (2.59 kg)
Dimensions...................................... See the *Mounting* chapter.

8 • Maintenance

Preventive maintenance consists of periodically checking that the connections between the DGC-2020HD and the system are clean and tight. Periodically check that the mounting hardware is clean and fastened with the proper amount of torque. DGC-2020HD units are manufactured using state-of-the-art, surface-mount technology. These components are encased in potting material. As such, Basler Electric recommends that no repair procedures be attempted by anyone other than Basler Electric personnel.

Storage

This device contains long-life aluminum electrolytic capacitors. For devices that are not in service (spares in storage), the life of these capacitors can be maximized by energizing the device for 30 minutes once per year.

Backup Battery Replacement

The backup battery for the real-time clock is a standard feature of the DGC-2020HD. A battery 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-2020HD 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 five years depending on conditions. After this time, you should contact Basler Electric to order a new battery, Basler Electric P/N 38526.

Caution
Replacement of the backup battery for the real-time clock should be performed only by qualified personnel. Do not short-circuit the battery, reverse battery polarity, or attempt to recharge the battery. Observe polarity markings next to the battery socket when inserting a new battery. The battery polarity must be correct in order to provide backup for the real-time clock.

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

Battery Replacement Procedure

Battery access is located on the rear of the DGC-2020HD. See the *Terminals and Connectors* chapter for battery location.

Step 1: Remove the DGC-2020HD from service.

Step 2: Locate the battery socket on the rear of the DGC-2020HD. Remove the old battery. Consult your local ordinance for proper battery disposal.

Step 3: Insert the new battery so that the polarity markings on the battery match the polarity markings next to the battery socket.

Step 4: Return the DGC-2020HD to service.

9 • Troubleshooting

If you do not get the results that you expect from the DGC-2020HD, 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 Communication Does Not Work Properly

Step 1. Verify that the proper port of your computer is being used. For more information, refer to the *Communication* chapter in the *Configuration* manual.

Step 2. Verify the network configuration of the DGC-2020HD is set up properly. For more information, refer to the *Communication* chapter in the *Configuration* manual.

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 Communication Does Not Work Properly

Step 1. Verify that the proper port of your computer is being used. For more information, refer to the *Communication* chapter in the *Configuration* manual.

USB Driver Did Not Install Properly on Windows® 7, 8, or 10

Step 1. If the message in Figure 9-1 is shown, close all programs and restart the computer.

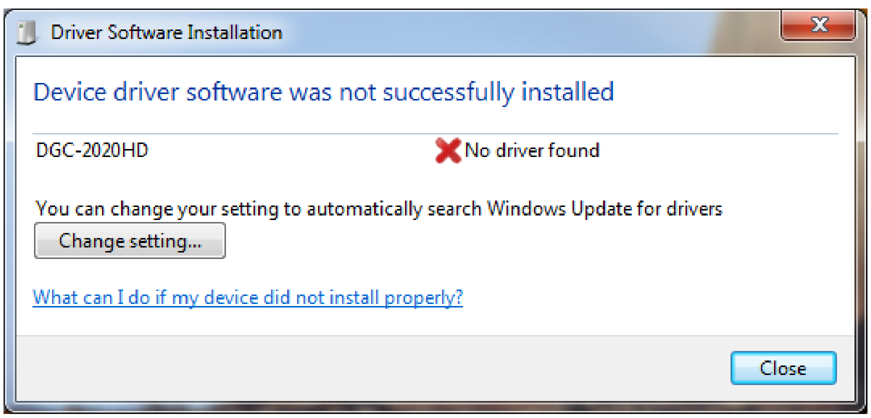


Figure 9-1. Driver Software Installation

Step 2. Open the Windows® Device Manger as shown in Figure 9-2. Right-click on DGC-2020HD (or Unknown Device) under Other Devices and select Properties.

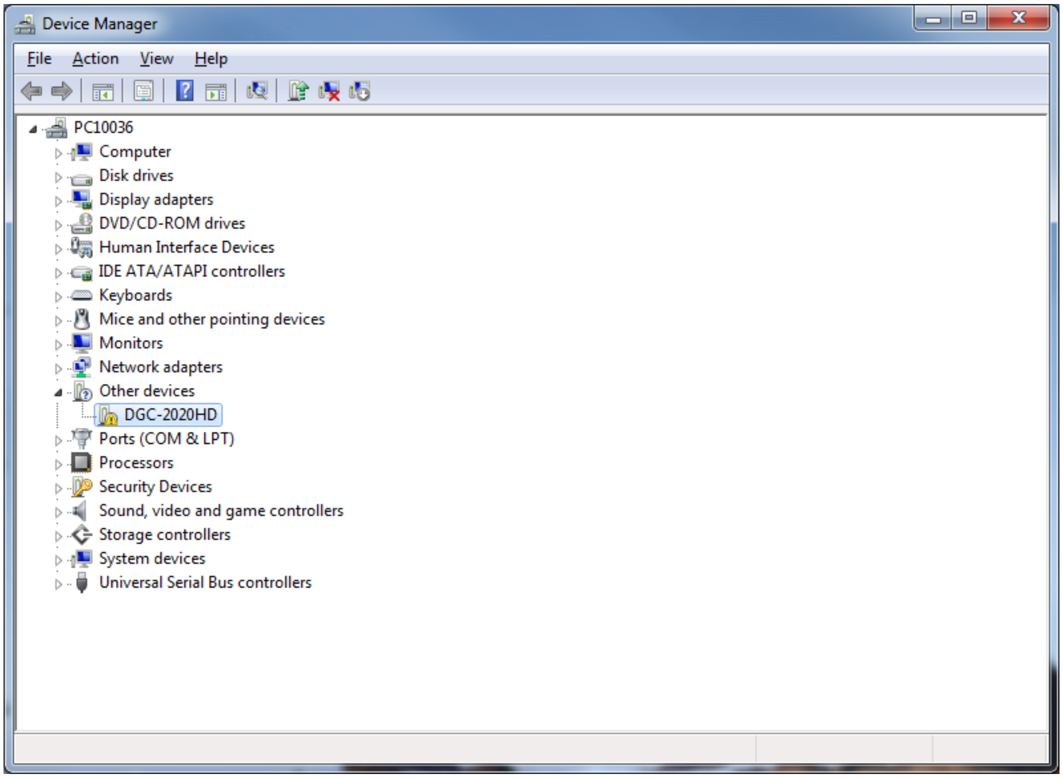


Figure 9-2. Device Manager

Step 3. In the Properties windows, select the Driver tab and click Update Driver. See Figure 9-3.

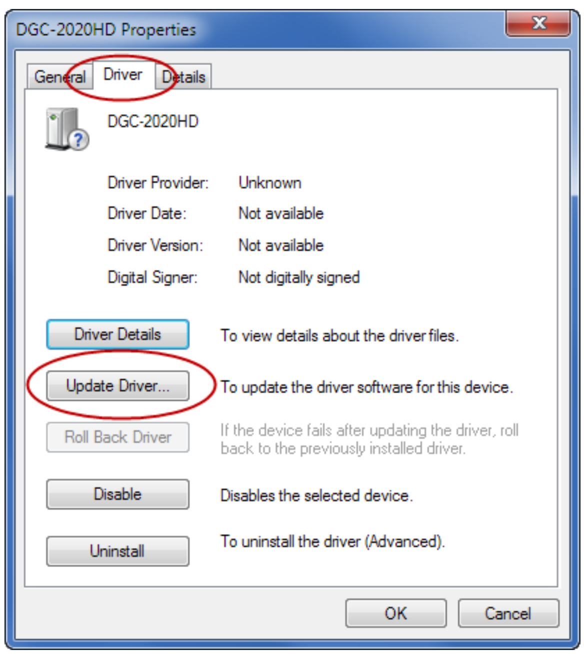


Figure 9-3. DGC-2020HD Properties

Step 4. Select Browse My Computer for Driver Software as shown in Figure 9-4.

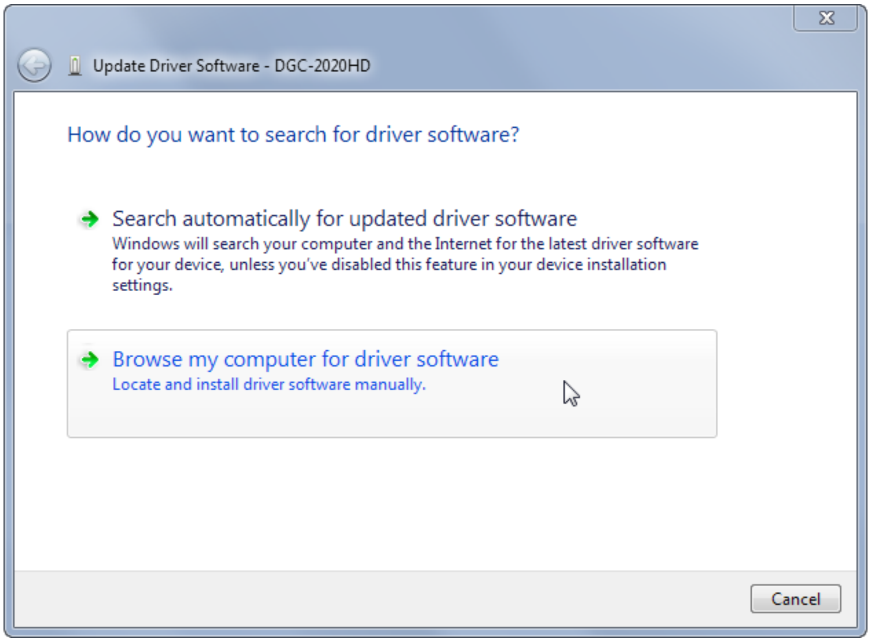


Figure 9-4. Update Driver Software - DGC-2020HD

Step 5. Click Browse and navigate to C:\Program Files\Basler Electric\USB Device Drivers\USBIO. Click Next. See Figure 9-5.

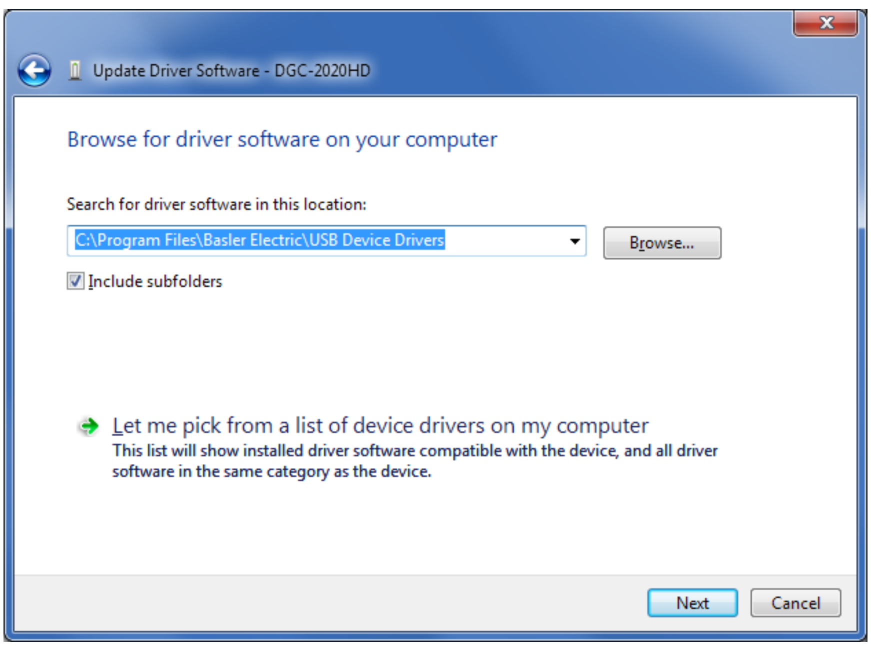


Figure 9-5. Update Driver Software - DGC-2020HD

Step 6. If a Windows Security window (Figure 9-6) appears, click Install.

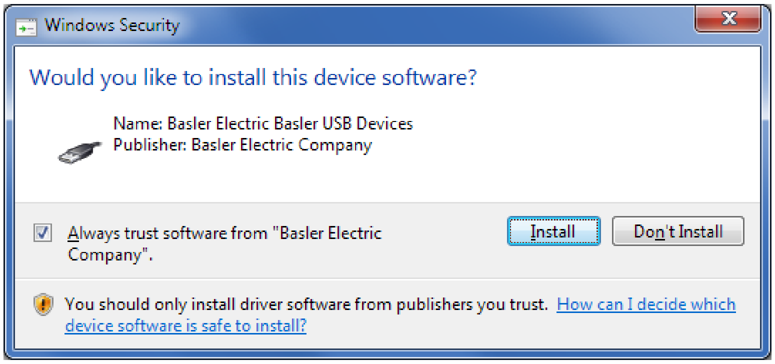


Figure 9-6. Windows Security

Step 7. The window in Figure 9-7 appears if driver installation was successful.

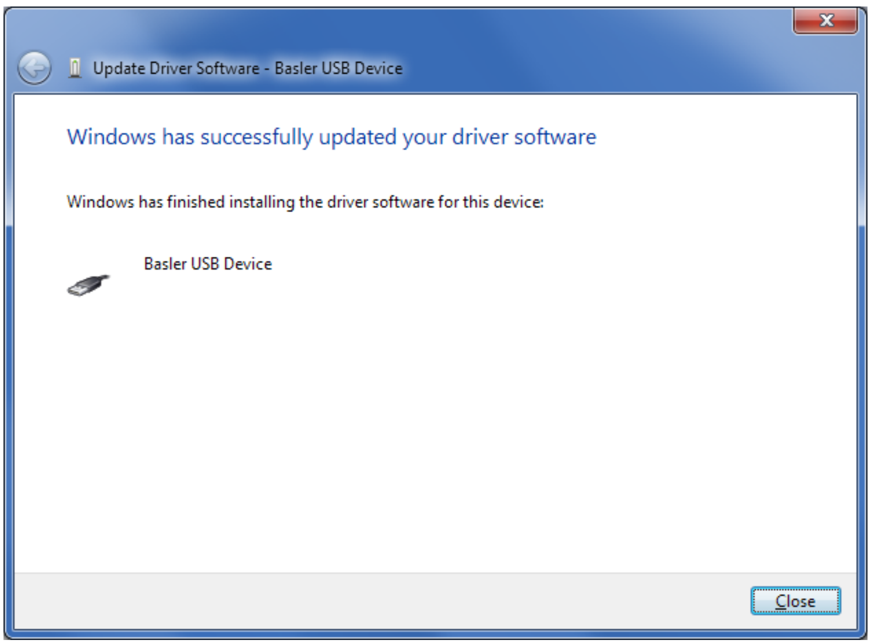


Figure 9-7. Driver Software Update Successful

CAN Communication Does Not Work Properly

Step 1: Verify that there is a 120-ohm termination resistor on each end of the bus section of the wiring, and that there are not any termination resistors at any node connections that are on stubs from the main bus.

Step 2: Check all CAN wiring for loose connections and verify that the CAN H and CAN L wires have not gotten switched somewhere on the network.

Step 3: Verify that the cable length of the bus section of the wiring does not exceed 40 meters (131 feet), and verify that any stubs from the main bus do not exceed 3 meters (9.8 feet) in length.

Step 4: If the engine is equipped with a Volvo or *mtu* ECU, verify that the ECU Configuration setting is set to match the actual ECU configuration.

RPM Control over CAN Bus Does Not Function

Step 1: Check that Engine Parameter Transmit under the CAN Bus 2 (ECU) settings is enabled.

Step 2: Check that CAN Bus RPM Request under Speed Setup is set to enabled.

Step 3: Check to determine if there are multiple ECUs on the engine. If so, consult the engine manufacturer's documentation to determine the CAN Bus 2 address of the ECU that will respond to rpm requests. Set the Engine ECU Address setting under the CAN Bus 2 (ECU) settings to that value. The Engine ECU Address setting under the CAN Bus 2 (ECU) settings should be set to the address the Engine ECU claims on the J1939 network.

Step 4: Consult the engine manufacturer's documentation and connect to the ECU with a service tool to determine if the ECU will respond only to communications from a particular CAN Bus Address. Set the CAN Bus address under the CAN Bus 2 (ECU) settings to that value. The CAN Bus address under the CAN Bus 2 (ECU) settings is the Address the DGC claims on the J1939 network.

Inputs and Outputs

Programmable Inputs Do Not Operate as Expected

Step 1. Verify that all wiring is properly connected. Refer to the *Typical Applications* chapter.

Step 2. Confirm that the inputs are programmed properly.

Step 3. Ensure that the input at the DGC-2020HD is actually connected to the BATT– terminal (P4-49).

Programmable Outputs Do Not Operate as Expected

Step 1. Verify that all wiring is properly connected. Refer to the *Typical Applications* chapter.

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 the *Typical Applications* chapter.

Step 2. Confirm that the sender negative terminals are 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 (P4-48) and the sender negative terminals.

Step 4. Verify that the correct senders are being used.

Step 5. Use a voltmeter connected between the BATT– terminal (P4-49) and the sender negative terminals on the DGC-2020HD 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 the *Typical Applications* chapter.

Step 2. Ensure that the proper voltage is present at the DGC-2020HD voltage sensing inputs (P8-86, P8-88, P8-90, and P8-91).

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 the *Typical Applications* chapter.

Step 2. Ensure that the proper current is present at the DGC-2020HD current sensing inputs 1, 2, 3, 4, 5, and 6.

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 the *Typical Applications* chapter.

Step 2. Verify that the Flywheel Teeth setting is correct.

Step 3. Verify that the prime mover governor is operating properly.

Step 4. Verify that the measured frequency of the voltage at the MPU input (P9-106 and P9-107) is correct.

Step 5. If the MPU is shared with the governor, verify that the polarity of the MPU input to the governor matches the polarity of the MPU input to the DGC-2020HD.

DGC-2020HD Indicates Incorrect Power Factor

Check the rotation of the machine and the labeling of the A-B-C terminals. The machine must be rotating in the same phase sequence as dictated by the generator phase rotation setting for correct power factor metering. A power factor indication of 0.5 with resistive load present is a symptom of incorrect phase rotation.

Ground Faults Detected in Ungrounded System Applications

Step 1: Verify that there is no connection from the neutral connection of the generator to the system ground.

Step 2: Perform insulation resistance tests on the system wiring to check for insulation integrity in the overall system.

Step 3: If ground faults are detected on a DGC-2020HD in an ungrounded system application, it is recommended that potential transformers be employed on the voltage sensing inputs to provide full isolation between the DGC-2020HD and monitored voltage phases.

Step 4: If potential transformers are in place, remove the connectors from the DGC-2020HD one at a time. If removal of a connector removes the ground fault, check the system wiring to that connector and out into the system to verify that connections are secure and all wiring insulation is in good condition.

Generator Breaker and Mains Breaker

Generator Breaker Will Not Close to a Dead Bus

Step 1: Review the description of how the generator breaker logic element functions contained in the GENBRK logic element description in the *BESTlogic™Plus* chapter in the *Configuration* manual.

Step 2: Review the section on breaker close requests in the *Breaker Management* chapter in the *Configuration* manual.

Step 3: Navigate to the Settings, Breaker Management, Breaker Hardware, Gen Breaker screen and set Dead Bus Closure to Enable.

Step 4: Verify that the Generator status is stable. The breaker will not close if the generator status is not stable. Check status by using the Metering Explorer in BESTCOMS*Plus* and verify that when the generator is running, the Generator Stable status LED is lit. If necessary, modify the settings on the Settings, Breaker Management, Bus Condition screen.

Step 5: Verify the bus status is Dead. Check status by using the Metering Explorer in BESTCOMS*Plus* and verify that when the generator is running, the Bus Dead status LED is lit. If necessary, modify the settings on the Settings, Breaker Management, Bus Condition screen.

Step 6: Verify the connections in BESTlogic*Plus* Programmable Logic to the generator breaker logic element. The *Status* input must be driven by an “A” or normally open contact from the generator breaker. The Open and Close command inputs on the left side of the logic block are inputs for open and close commands. These can be wired to physical inputs if it is desired to have open and close command switches. If they are wired, they must either be pulsed inputs, or some logic must be employed so that the open and close command inputs are never driven at the same time. If these are both driven at the same time, the breaker is receiving open and close commands simultaneously. The breaker will not change state if it is being commanded to open and close at the same time.

Step 7: Verify the breaker is receiving a close command. Breaker close command sources are:

- The DGC-2020HD itself when the automatic mains fail transfer (ATS) feature is enabled.
- The DGC-2020HD itself when the Run with Load logic element receives a Start pulse in the programmable logic.
- The DGC-2020HD itself when started from the Exercise Timer and the Run with Load box is checked in the Generator Exerciser settings.
- Manual Breaker Close Input Contacts applied to the Open and Close inputs on the left side of the Generator Breaker logic element in the programmable logic.

Step 8: Verify the wiring to the breaker from the DGC-2020HD. If it appears correct, you can manually 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 open output. Map another virtual switch to the logic output that would normally be the breaker close output. Connect with BESTCOMS*Plus*, and exercise the virtual switches using the Control panel located in the Metering Explorer. Never turn open and close on at the same time. This could damage the breaker and/or motor operator. If everything is working as expected, restore the logic to its original diagram.

Generator Breaker Does Not Open When It Should

Step 1: Review the description of how the generator breaker logic element functions contained in the GENBRK logic element description in the *BESTlogicPlus* chapter in the *Configuration* manual.

Step 2: Review the section on breaker operation requests in the *Breaker Management* chapter in the *Configuration* manual.

Step 3: Verify the connections in BESTlogic*Plus* Programmable Logic to the generator breaker logic element. The Status input must be driven by an “A” or normally open contact from the generator breaker. The Open and Close command inputs on the left side of the logic block are inputs for open and close commands. These can be wired to physical inputs if it is desired to have open and close command switches. If they are wired, they must either be pulsed inputs, or some logic must be employed so that the open and close command inputs are never driven at the same time. If these are both driven at the same time, the breaker is receiving open and close commands simultaneously. The breaker will not change state if it is being commanded to open and close at the same time.

Step 4: Verify the breaker is receiving an open command. Breaker open command sources are:

- The DGC-2020HD itself when the automatic transfer (ATS) feature is enabled.
- The DGC-2020HD itself when the Run with Load logic element receives a Stop pulse in the programmable logic.
- The DGC-2020HD itself when shutting down the engine due to an active alarm.
- The DGC-2020HD itself when ending a run session from the Exercise Timer and the Run with Load box is checked in the Generator Exerciser settings.
- Manual Breaker Open Input Contacts applied to the Open and Close inputs on the left side of the Generator Breaker logic element in the programmable logic.

Step 5: Verify the wiring to the breaker from the DGC-2020HD. If it appears correct, you can manually 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 open output. Map another virtual switch to the logic output that would normally be the breaker close output. Connect with BESTCOMS*Plus*, and exercise the virtual switches using the Control panel located in the Metering Explorer. Never turn open and close on at the same time. This could damage the breaker and/or motor operator. If everything is working as expected, restore the logic to its original diagram.

Mains Breaker Does Not Open When Mains Fails

Step 1: Verify that a Mains Breaker has been configured by examining the settings on the Settings, Breaker Management, Breaker Hardware screen.

Step 2: Verify the mains breaker has been correctly included in the programmable logic.

Step 3: Verify that the Mains Fail Transfer parameter is set to Enabled on the Settings, Breaker Management, Breaker Hardware screen.

Step 4: Verify that a failure of the mains is detected by the DGC-2020HD. Check status using the Metering Explorer in BESTCOMS*Plus* and verify that the Mains Failed status LED is lit when the power on the DGC-2020HD bus voltage input is either out of voltage or frequency range. If necessary, modify the settings on the Settings, Breaker Management, Bus Condition screen to achieve correct detection.

Step 5: Verify the wiring to the breaker from the DGC-2020HD. If it appears correct, you can do a manual close and open by modifying the programmable logic. Map some unused outputs to the Open and Close outputs from the Gen Breaker Block in the programmable logic. Map a virtual switch to the logic output that would normally be the breaker close output. Map another virtual switch to the logic output that would normally be the breaker close output. Connect with BESTCOMS*Plus*, and exercise the virtual switches using the Control panel located in the Metering Explorer. Never turn open and close on at the same time. This could damage the breaker and/or motor operator. If everything is working as expected, restore the logic to its original diagram.

Mains Breaker Does Not Close After Mains Returns

Step 1: Verify that a Mains Breaker has been configured by examining the settings on the Settings, Breaker Management, Breaker Hardware screen.

Step 2: Verify the mains breaker has been correctly included in the programmable logic.

Step 3: Verify that the Mains Fail Transfer parameter is set to Enabled on the Settings, Breaker Management, Breaker Hardware screen.

Step 4: Verify that stable mains power is detected by the DGC-2020HD. Check status using the Metering Explorer in BESTCOMS*Plus* and verify that the Mains Stable status LED is lit when the power on the DGC-2020HD bus voltage input is good. If necessary, modify the settings on the Settings, Breaker Management, Bus Condition screen to achieve correct detection.

Step 5: Verify the wiring to the breaker from the DGC-2020HD. If it appears correct, 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 open output. Map another virtual switch to the logic output that would normally be the breaker close output. Connect with BESTCOMS*Plus*, and exercise the virtual switches using the Control panel located in the Metering Explorer. Never turn open and close on at the same time. This could damage the breaker and/or motor operator. If everything is working as expected, restore the logic to its original diagram.

Synchronizer

Determining if the Synchronizer is Active

Step 1: Disable the speed trim function.

Step 2: Initiate a breaker close request by one of the methods listed in the *Breaker Management* chapter in the *Configuration* manual.

Step 3: Check for raise and/or lower pulses coming from the DGC-2020HD if the governor or AVR bias control output type is contact.

Step 4: Check the governor and/or AVR bias analog outputs on the DGC-2020HD 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-2020HD has the synchronizer option. If the synchronizer option does not exist in the style number, you may contact Basler Electric and request a style number change.

Step 2: Check status using the Metering Explorer in BESTCOMS*Plus*® and verify that when the generator is running, the Generator 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-2020HD is trying to initiate a breaker closure. To determine the sources of breaker close requests, refer to the *Breaker Management* chapter in the *Configuration* manual.

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-2020HD 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-2020HD.

Synchronizer Does Not Lower Engine Speed Allowing Alignment of Bus and Generator

Navigate to the Settings, Programmable Outputs, Analog Output Settings, GOV Output screen and set Speed Response to Decreasing.

Synchronizer Does Not Raise Engine Speed Allowing Alignment of Bus and Generator

Using the front panel HMI, navigate to the Settings > Programmable Outputs > Analog Output Settings > GOV Output screen and change the Speed Response setting from Increasing to Decreasing.

Synchronizer Does Not Lower the Generator Voltage to Achieve Matching of Bus and Generator Voltages

Navigate to the Settings, Programmable Outputs, Analog Output Settings, AVR Output screen and set Voltage Response to Decreasing.

Synchronizer Does Not Raise Generator Voltage to Achieve Matching of Bus and Generator Voltages

Navigate to the Settings, Programmable Outputs, Analog Output Settings, AVR Output screen and change the Voltage Response setting from Increasing to Decreasing.

Speed Bias

Engine Speed Does Not Change When Speed Bias Voltage Changes

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, Programmable Outputs, Analog Output Settings, GOV 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, Programmable Outputs, Analog Output Settings, GOV 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

Navigate to the Settings, Programmable Outputs, Analog Output Settings, GOV Output screen and set Speed Response to Decreasing.

Engine Speed Increases When Speed Bias is Decreased

Navigate to the Settings, Programmable Outputs, Analog Output Settings, GOV Output screen and set Speed Response to Decreasing.

Load Anticipation

Large Frequency Overshoot on Recovery

Kla Gain may be too high and GOV output may be saturated. See Figure 9-8. Navigate to Settings, Bias Control Settings, Governor Bias Control Settings and decrease Load Anticipation, Kla Gain.

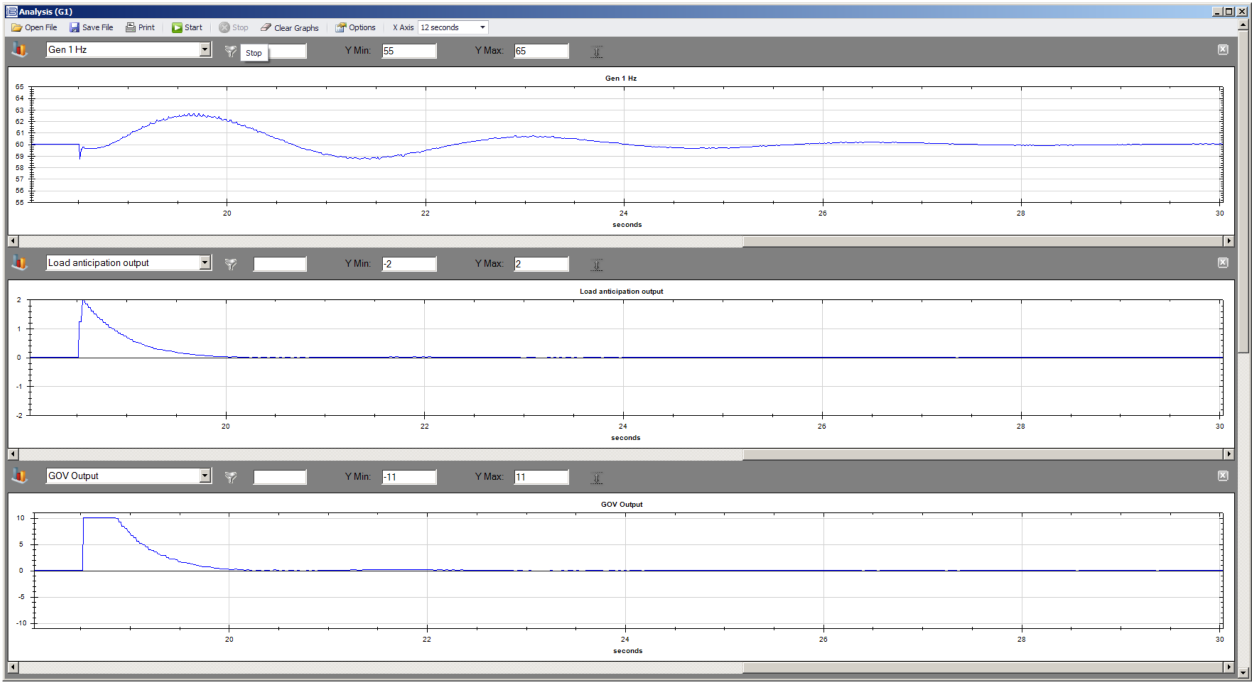


Figure 9-8. Kla Gain Too High, GOV Output Saturated, Frequency Overshoots on Recovery

Tla Washout Filter Constant may be too high. Load anticipation output bias is held too long and has significant magnitude after frequency reached nominal. See Figure 9-9. Navigate to Settings, Bias Control Settings, Governor Bias Control Settings and decrease Load Anticipation, Tla Washout Filter Constant.

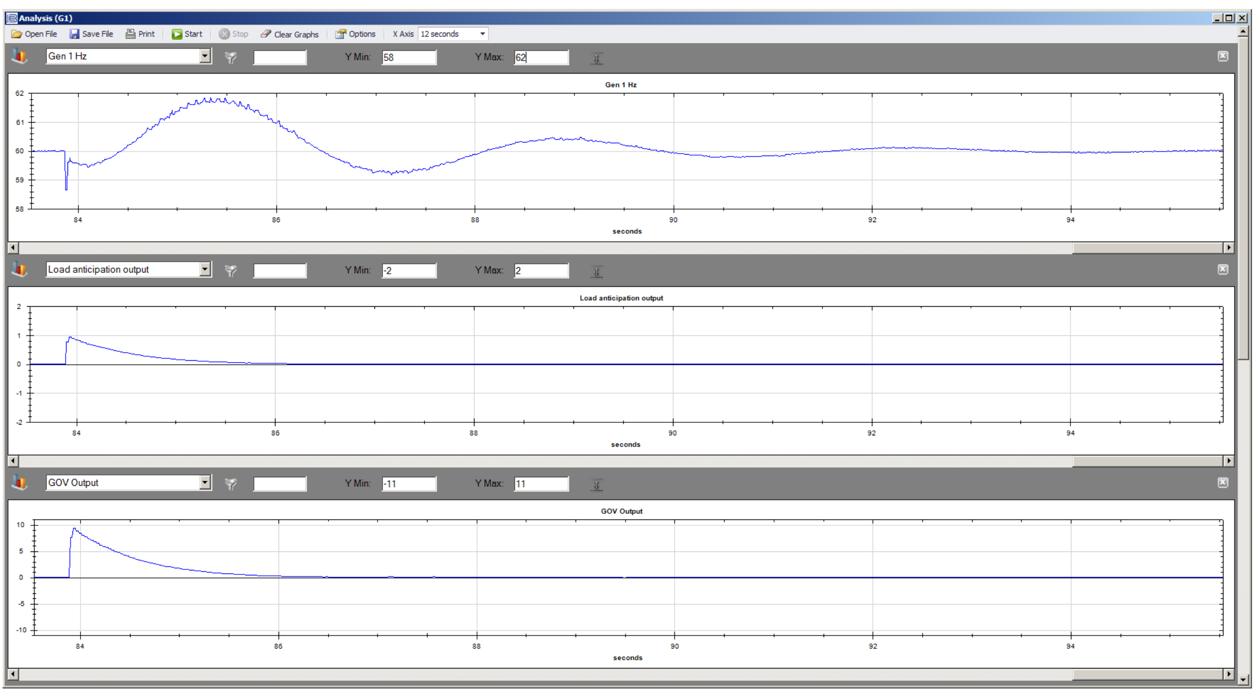


Figure 9-9. Tla Too High Causing Recovery Overshoot

Poor Recovery

Kla Gain may be too low. See Figure 9-10. Navigate to Settings, Bias Control Settings, Governor Bias Control Settings and increase Load Anticipation, Kla Gain.

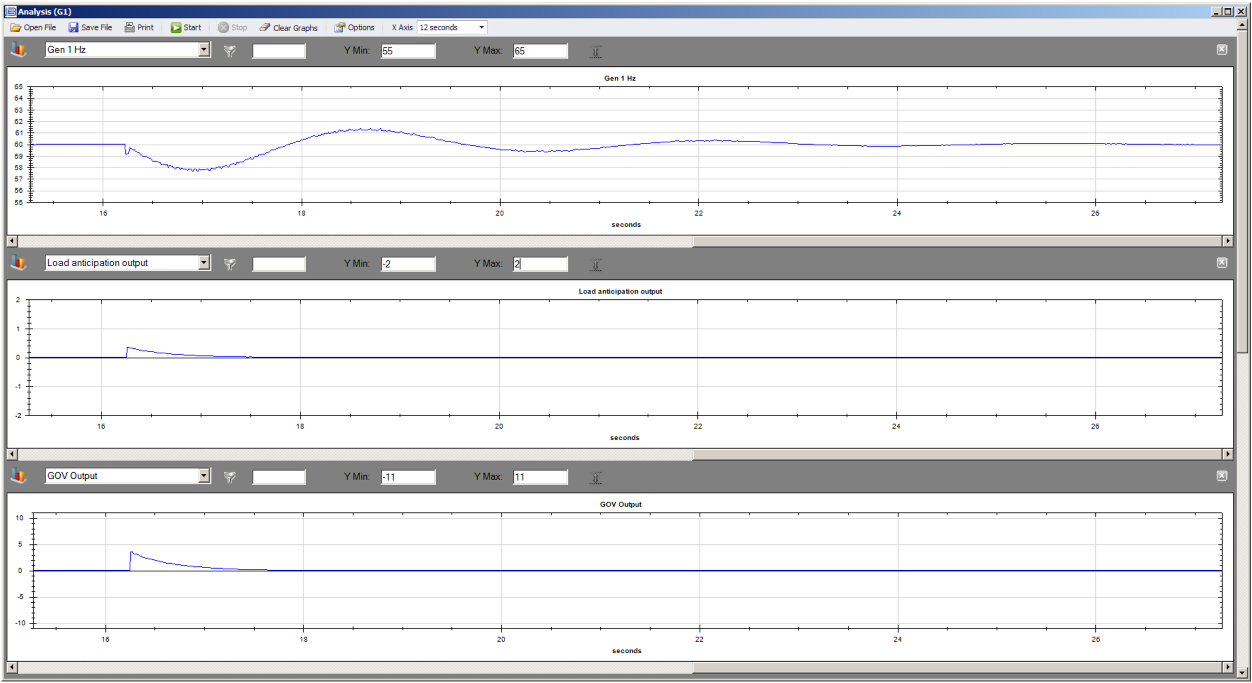


Figure 9-10. Kla Too Low – Frequency Recovery Improved with ~2 Hz Deviation

Tla Washout Filter Constant may be too low. GOV output decays rapidly before speed dip has finished. See Figure 9-11. Navigate to Settings, Bias Control Settings, Governor Bias Control Settings and increase Load Anticipation, Tla Washout Filter Constant.

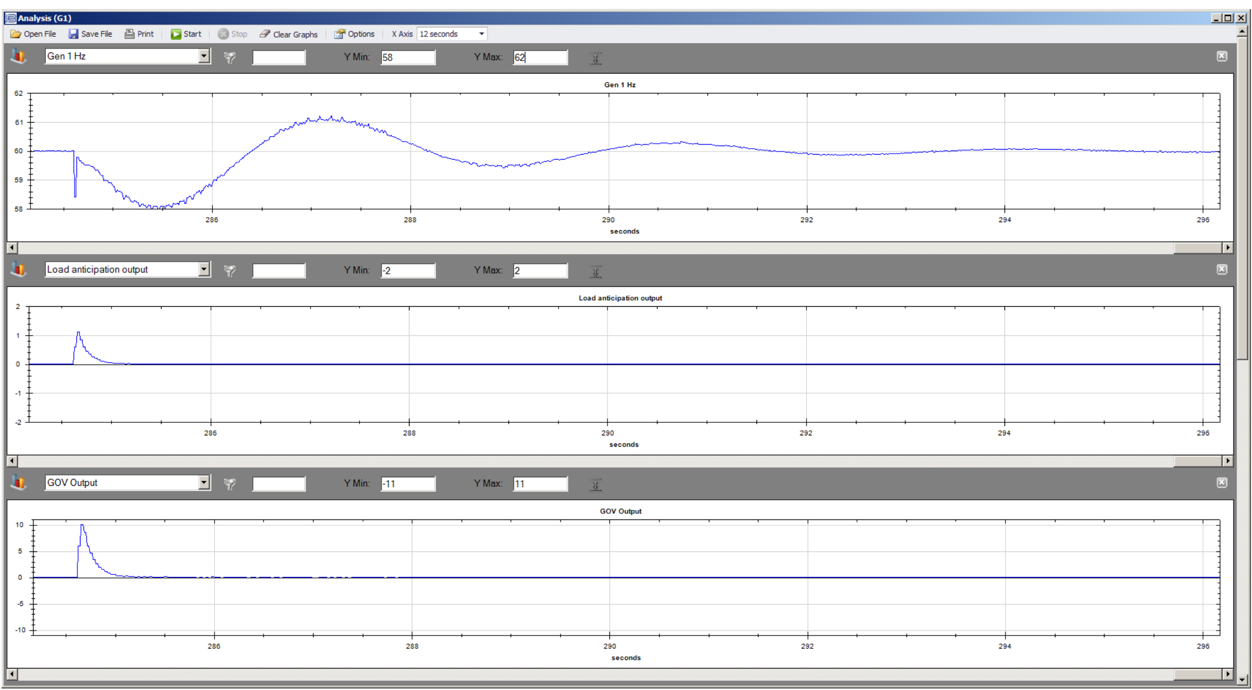


Figure 9-11. Tla Too Low Causing Poor Recovery

Voltage Bias

Generator Voltage Does Not Change When Voltage Bias Changes

As a test, you can force a fixed voltage on the AVR bias output by setting the Min Output Voltage and Max Output Voltage to the same value by navigating to Settings, Programmable Outputs, Analog Output

Settings, AVR Output. If the bias is current based, you can force a fixed current by setting the Min Output Current and Max Output Current to the same value by navigating to Settings, Programmable Outputs, Analog Output Settings, AVR Output.

If the voltage still does not change when varying the bias:

- Verify that the AVR is equipped and configured to accept bias inputs.
- Check connections to verify the wiring to the AVR bias is correct.
- If you have a digital voltage regulator, verify it is set up and programmed to accept a voltage bias input.

Generator Voltage Decreases When AVR Speed Bias is Increased

Navigate to the Settings, Programmable Outputs, Analog Output Settings, AVR Output screen and set Voltage Response to Decreasing.

Generator Voltage Increases When AVR Bias is Decreased

Navigate to the Settings, Programmable Outputs, Analog Output Settings, AVR Output screen and set Voltage Response to Decreasing.

Load Sharing

Generator Breaker Status is not being received by the DGC-2020HD

Step 1: Close the generator breaker. Verify that the DGC-2020HD sees the status indicating the generator breaker is closed. This is found on the front panel or in BESTCOMS*Plus*® under Metering, Status, Bus Condition, Gen.

Step 2: If the status is not correct, check the digital input status on the DGC-2020HD through which the breaker status is fed. Examine the input with BESTCOMS*Plus*® under Metering, Inputs, Contact Inputs or Metering, Inputs, Remote Contact Inputs.

Step 3: If the input status is correct, but the Gen Breaker status under Metering, Status, Bus Condition, Gen is not, check the PLC logic, and verify that the Gen Breaker fed into the DGC-2020HD is tied in logic to the Status input on the Gen Breaker logic element.

Step 4: Make any corrections and re-check that the status is received correctly.

Generator Runs at Incorrect Speed when Generator Breaker is Closed

Step 1: Verify generator breaker status is being correctly received as described in *Generator Breaker Status is not being received by the DGC-2020HD*. If the status is correct, proceed to the steps below.

Step 2: Check the range set for the DGC-2020HD Governor Bias output by examining the Min. and Max. Output voltage or current settings under Settings, Programmable Outputs, Analog Output Settings, GOV Output. Verify that this range is valid for the governor or engine specified.

Step 3: Perform the tests in *Speed Bias,* above, to verify that setting the output to different values within its range causes engine speed to vary in the desired manner.

Step 4: Measure the voltage or current on the governor analog bias signal from theDGC-2020HD. This signal is found on terminals P6-67 (GOV–) and P6-66 (GOV+). If the output is at the midpoint of its range, the generator should run at rated speed.

Step 5: Check the LS Input parameter on the Load Share Line screen found on the front panel at Metering > Diagnostics > Load Share Line. Check if the normalized value from the Load Share Line screen corresponds to the value measured at DGC-2020HD terminals P6-67 (GOV–) and P6-66 (GOV+). If the normalized value is 0.00, the output should be in the midpoint of its range. If the normalized value is 1.00, the output should be in the maximum point of its range. If the normalized value is –1.00, the output should be in the minimum point of its range. Any other values are scaled within the range. If the normalized value and the measured output do not match up, either there are wiring errors, or some external device is driving the governor bias signal at the same time as theDGC-2020HD. Correct this conflicting situation if it exists.

Step 6: Check that the signal being measured at the DGC-2020HD terminals P6-67 (GOV–) and P6-66 (GOV+) is carried to the actual governor bias inputs on the engine governor. Measurements should be the same as they were on theDGC-2020HD. If not, correct the wiring errors.

Step 7: Check if there are any relay contacts in the path between the DGC-2020HD governor bias outputs and the engine governor's bias input. Any relay contacts that are used to switch load share lines, governor analog speed bias signals, or voltage regulator analog voltage bias signals must use a relay intended for low voltage, low current applications to preserve signal integrity. Signal relays, not power relays, must be used for this application. Verify the relay contacts are not affecting the signal.

Step 8: If speed trim is enabled, verify that the speed trim set point is at the correct value for desired operation.

Generators Do Not Share Load Equally

Step 1: Verify that load sharing is enabled in Settings, Bias Control, GOV Bias Control, kW Control.

Step 2: Verify generator breaker status is being correctly received as described in *Generator Breaker Status is not being received by the DGC-2020HD*. If the status is correct, proceed to Step 3.

Step 3: Check the Load Share Line operating voltage range by examining the Min. and Max. Voltage parameters found in BESTCOMS*Plus*® under Settings, Multigen Management, Load Share Output. The range must be the same for all machines in the load share system.

Step 4: Measure the Load Share line voltage at terminals P6-70 (LS–) and P6-69 (LS+) on theDGC-2020HD. The same voltage should be present on each DGC-2020HD. If not, correct any issues.

Step 5: Examine the LS Input on the front panel of the DGC-2020HD under Metering > Diagnostics > Load Share Line. This is the voltage read from the load share lines by the DGC-2020. Verify this voltage matches the voltage read with a voltmeter across DGC-2020HD terminals P6-70 (LS–) and P6-69 (LS+). Verify the same LS Input is present on all the machines in the load share system. If they are not equal, examine the load share line wiring and correct any issues.

Step 6: Check if there are any contacts in the load share line path between theDGC-2020HDs. Any relay contacts that are used to switch load share lines, governor analog bias signals, or voltage regulator analog voltage bias signals must use a relay intended for low voltage, low current applications to preserve signal integrity. Signal relays, not power relays, must be used for this application. Verify the relay contacts are not affecting the signal.

Step 7: If there are still issues, disconnect the load share line from the DGC-2020HD. Run a single machine with load, and verify that it loads and unloads correctly, and runs at the correct speed. Repeat for each machine.

Step 8: Re-attach load share lines to all DGC-2020HDs that are part of the load sharing system. Run the Single machine with load, and verify that it loads and unloads correctly, and runs at the correct speed. If the machine slows down when the generator breaker is closed, check the load share line voltage. It should be equal, on a normalized basis, to the normalized kW produced by the generator. As an example, if the generator is loaded to 50% capacity, the Load Share Line voltage should be at the midpoint of the range. If it is not, something is driving the load share line that should not be. The single unit should be the only device driving the load share lines.

Step 9: Disconnect the load share lines from each non-running machine and see if the speed of the running machine is correct. If a particular DGC-2020HD on a non-running machine seems to affect the performance of the running machine, that DGC-2020HD may be damaged such that the Load Share Line contacts are sticking, causing the DGC-2020HD to drive the load share line even though the generator breaker is open. Tap the relays to see if the problem clears up. If so, a faulty DGC-2020HD relay is indicated. Replace the DGC-2020HD, or wire in external contacts to remove the DGC-2020HD from the load share system when the generator breaker is closed.

Step 10: If it appears that something is driving the load share line but it is not the DGC-2020HD on one of the non-running units, search for an external device that is driving or loading down the load share lines.

Step 11: Repeat the preceding 3 steps for each machine.

Load Sharing Works Correctly, but a Single Unit Slows Down

With all units running, load sharing works correctly, but a single unit slows down after the generator breaker is closed.

Step 1: Disconnect the load share line from the DGC-2020HD. Run the single machine with load, and verify that it loads and unloads correctly, and runs at the correct speed. Repeat for each machine.

Step 2: Re-attach load share lines to all DGC-2020HDs that are part of the load sharing system. Run the Single machine with load, and verify that it loads and unloads correctly, and runs at the correct speed. If the machine slows down when the generator breaker is closed, check the load share line voltage. It should be equal, on a normalized basis, to the normalized kW produced by the generator. As an example, if the generator is loaded to 50% capacity, the Load Share Line voltage should be at the midpoint of the range. If it is not, something is driving the load share line that should not be. The single unit should be the only device driving the load share lines.

Step 3: Disconnect the load share lines from each non-running machine and see if the speed of the running machine is correct. If a particular DGC-2020HD on a non-running machine seems to affect the performance of the running machine, that DGC-2020HD may be damaged such that the Load Share Line contacts are sticking, causing the DGC-2020HD to drive the load share line even though the generator breaker is open. Tap the relays to see if the problem clears up. If so, a faulty DGC-2020HD relay is indicated. Replace the DGC-2020HD, or wire in external contacts to remove the DGC-2020HD from the load share system when the generator breaker is closed.

Step 4: If it appears that something is driving the load share line but it is not the DGC-2020HD on one of the non-running units, search for an external device that is driving or loading down the load share lines.

Step 5: Repeat the preceding 3 steps for each machine.

Group Start and Group Stop Requests

Generator Does Not Start During an Island Group Start Request or Mains Parallel Group Start Request

Step 1: Verify that a Group Start Request is active. In the BESTCOMS*Plus* Metering Explorer, navigate to DGC-2020HD > System Status > Breaker. Examine the Group Start Req column for nonzero entries. Nonzero entries indicate active group start requests.

Step 2: Check that the generator to start is in the same Generator Group in the Group Segment Settings as the breaker generating the Group Start Request. Only generators in the same Generator Group as the Generator Group configured for the breaker issuing the Group Start Request will respond.

Step 3: Verify that the generators to be started are in Auto mode, the System Type under the System Settings is configured as Segmented Bus System, and Sequencing and Demand Start/Stop are enabled.

Step 4: Verify that the generator to be started does not have an active Run with Load Stop as this will supersede Group Start Requests and prevent the generator from starting.

Step 5: If a particular machine is expected to start, but does not, check the sequencing status and verify that the settings are properly configured. Group Start Requests for Start One or Start Demand Based may not start all units because the unit in question may not have been within the set of generators that should have started based on the sequencing criterion.

Generator Does Not Stop During a Group Stop Request

Step 1: Verify that a Group Stop Request is active. In the BESTCOMS*Plus* Metering Explorer, navigate to DGC-2020HD > System Status > Breaker. Examine the Group Stop Req column for nonzero entries. Nonzero entries indicate active group stop requests.

Step 2: Check that the generator to stop is in the same Generator Group in the Group Segment Settings as the breaker generating the Group Stop Request. Only generators in the same Generator Group as the Generator Group configured for the breaker issuing the Group Stop Request will respond.

Step 3: Verify that the generators to be stopped are in Auto mode and Sequencing and Demand Start/Stop are enabled.

Step 4: Verify that the generator to be stopped does not have an active Run with Load Start and is not running due to an applied ATS contact. Either case will supersede Group Stop Requests and prevent the generator from stopping.

DGC-2020HD Front Panel Diagnostics Screens

There are several diagnostic screens in the DGC-2020HD that can be useful for debugging load sharing issues and I/O module related issues. The following debug screens are available: Load Share Line, Control, AEM-2020, CEM-2020, VRM, Mains Power and VRM Control.

Load Share Line

This screen is useful for debugging load share related issues, and kW and var control related issues. It gives visibility into the parameters metered and controlled by the DGC-2020HD.

The Load Share Line diagnostics screen is located on the front panel at Metering > Diagnostics > Load Share Line.

The following parameters are visible on the Load Share Line diagnostics screen:

- LS Input: Voltage the DGC-2020HD sees on its load share line input. Terminals P6-70 (LS–) and P6-69 (LS+). This measurement is useful for debugging load share issues. Normally, all machines that have their generator breakers closed should measure the same voltage for LS Input. If this voltage differs, check for wiring errors, or problems with any relay contacts in the load share line wiring. Any relay contacts that are used to switch load share lines, governor analog speed bias signals, or voltage regulator analog bias signals must use a relay intended for low voltage, low current applications to preserve signal integrity. Signal relays, not power relays, must be used for this application.
- Speed Bias: This is the normalized value to which the DGC-2020HD drives the governor analog bias output. If the value is –1.0, the output will be driven to the minimum value of the governor bias output range. If the value is 1.0, the output will be driven to the maximum value of the governor bias output range. If the value is 0.000, the output will be driven to the midpoint value (i.e. half way between maximum and minimum values) of the governor bias output range. If the generator breaker is open, or if the generator breaker is closed and speed trim and kW control are disabled, the output from the DGC-2020HD will be the midpoint of the range, indicating the generator should run at rated speed. Any relay contacts that are used to switch load share lines, governor analog speed bias signals, or voltage regulator analog voltage bias signals must use a relay intended for low voltage, low current applications to preserve signal integrity. Signal relays, not power relays, must be used for this application.
- Voltage Bias: This is the normalized value to which the DGC-2020HD drives the voltage regulator analog bias output. If the value is –1.0, the output will be driven to the minimum value of the

voltage regulator bias output range. If the value is 1.0, the output will be driven to the maximum value of the voltage regulator bias output range. If the value is 0.00, the output will be driven to the midpoint value (i.e. half way between maximum and minimum values) of the voltage regulator bias output range. If the generator breaker is open, voltage trim and kvar control are disabled, so the output from the DGC-2020HD will be the midpoint of the range, indicating the voltage regulator should operate at rated voltage. Any relay contacts that are used to switch load share lines, governor analog speed bias signal, or voltage regulator analog voltage bias signals must use a relays intended for low voltage, low current applications to preserve signal integrity. Signal relays, not power relays, must be used for this application.

- Watt Demand: This is the normalized kW demand requested by the DGC-2020HD. It is the desired amount of power that the generator produces. It is normalized such that 1.0 indicates the full kW capacity of the generator, 0.5 indicates 50% of the generator’s capacity, etc. When the generator breaker is closed, and the kW controller is enabled, the Watt Demand indicates what level of power should be generated. In an island load share system, this will correspond to the value read on the load share lines. If the load share lines are at the 50% point of the load share voltage range, the Watt Demand will be 0.50. If the generator breaker is closed, and the Parallel To Mains logic element is true, the Watt Demand will be equal to the base load set point. When the generator breaker is open or the kW controller is disabled, the Watt Demand will always be equal to the value calculated from the voltage that the DGC-2020HD sees on its load share line.
- kW Total: This is the normalized kW being produced by the generator. A value of 1.0 represents full machine capacity, 0.5 represents 50% of machine capacity, etc.
- Rated kW: This is the rated kW of the machine that should be equal to the Rated kW setting under Settings, System Parameters, Rated Data.
- var Demand: This is the normalized var demand requested by the DGC-2020HD. It is the desired about of var that the generator should produce. It is normalized such that 1.0 indicates the full var capacity of the generator, 0.5 indicates 50% of the generator’s capacity, etc. When the generator breaker is closed, and the var/PF controller is enabled, the var demand indicates what level of reactive power should be generated. If the generator breaker is closed, and the Parallel To Mains logic element is true, the var Demand will be equal to the kvar set point (%) if the controller is in var control mode, or will equal the var value that will maintain the machine Power Factor at the PF set point if the controller is in Power Factor mode. When the generator breaker is open or the var/PF controller is disabled, the var Demand will always be 0.0. When running with the generator breaker closed and the Parallel To Mains logic element is false (i.e. the generators are an islanded system), the var Demand will be 0.0 as well. The DGC-2020HD runs in var Droop when on an island system.
- kvar Total: This is the normalized kvar being produced by the generator. A value of 1.0 represents full machine capacity, 0.5 represents 50% of machine capacity, etc.
- Rated kvar: This is the calculated rated kvar of the machine, calculated from the rated kW of the machine and the rated power factor of the machine according to var is equal to the square root of (VA^2 – $Watt^2$).
- Load Share Active: This indicates when the load share line output contacts are closed.

Control

This screen is useful for debugging load share related issues, and kW and var control related issues. It gives visibility into the states of the kW, kvar, Speed Trim, and Voltage controllers in the DGC-2020HD.

The Control diagnostics screen is located on the front panel at Metering > Diagnostics > Control.

The following parameters are visible on the Control diagnostics screen:

- kW Ramp Status: This indicates the current kW ramp direction as None, Up, or Down.
- kW Ramp Demand: This is the normalized kW demand that is ramped from the initial kW loading upon generator breaker closure to the desired kW set point. The rate at which the ramp occurs is set by the Ramp Rate (%) in the Governor Bias Control settings. Note the rate is in terms of percentage of machine capacity, it is not the time to ramp from zero up to the current desired kW

level. Thus, at low loading it may appear that the ramp is skipped. If the system is loaded to only 10% and a unit is brought on line with a ramp rate of 10% per second, it takes only one second to reach 10% of capacity.

- kW Demand: This is the normalized requested kW demand on the generator. It is normalized such that 1.0 indicates the full kW capacity of the generator, 0.5 indicates 50% of the generator's capacity, etc. When the generator breaker is closed, and the kW controller is enabled, the Watt Demand indicates what level of power should be generated. In an island load share system, this will correspond to the normalized value read on the load share lines. If the load share lines are at the 50% point of the load share voltage range, the Watt Demand will be 0.5. If the generator breaker is closed, and the Parallel To Mains logic element is true, the Watt Demand will be equal to the base load set point. When the generator breaker is open or the kW controller is disabled, the Watt Demand will always be equal to the value calculated from the voltage that the DGC-2020HD sees on its load share line.
- Speed PID: This is the output value of the Speed PID controller. It will normally range between -1.0 and 1.0, and will be zero any time the generator breaker is open, unless synchronization is in progress. If the Speed Trim is enabled, the Speed PID will be nonzero when the generator breaker is closed if there is any difference between the machine speed and the Speed Trip Set Point parameter.
- kW PID: This is the output value of the kW PID controller. It will normally range between –1.0 and 1.0, and will be zero any time the generator breaker is open. If the kW Controller is enabled, the kW PID will be nonzero when the generator breaker is closed if there is any difference between the normalized kW generation and the Watt Demand value of the machine. If the kW controller is disabled, the kW PID will always be zero.
- Speed Error: This is the normalized difference between the measured generator frequency and the Speed Trip Set Point. A value of 1.0 means the difference is equal to the speed trip set point; a value of –1.0 means the difference is equal to the negative of the speed trim set point. When the generator breaker is open, or if Speed Trim is disabled, this will always be 0.000 unless synchronization is in progress. When speed trip is enabled, and the generator breaker is closed, this will typically be 0.000 or some relatively small number and move a small amount above and below 0.000 as the speed trim controller corrects for any speed errors.
- kW Error: This is the normalized difference between the measured generator kW generation and the Watt Demand described above. A value of 1.0 means the difference is equal to the Rated kW of the machine; a value of –1.0 means the difference is equal to the negative of the Rated kW of the machine. When the generator breaker is open, or if kW control is disabled, this will always be 0.000. When kW control is enabled, and the generator breaker is closed, this will typically be 0.000 or some relatively small number and move a small amount above and below 0.000 as the kW controller corrects for kW errors. If a load is added or dropped from the system, the error will be a non-zero value until the kW controller brings the kW generation to the desired level.
- Speed Bias: This is the normalized value to which the governor analog bias output of the DGC-2020HD will be driven to accomplish desired kW and speed trim control. It is equal to the sum of the kW PID and the Speed PID. If the value is –1.0, the speed bias output will be driven to the minimum value of the governor bias output range. If the value is 1.0, the output will be driven to the maximum value of the governor bias output range. If the value is 0.00, the output will be driven to the midpoint value (i.e. half way between maximum and minimum values) of the governor bias output range. If the generator breaker is open, or if the generator breaker is closed and speed trim and kW control are disabled, the Speed Bias value will be 0.00, driving the bias output to the midpoint of the governor bias output range indicating the generator should run at rated speed.
- PF Setpoint: This is the power factor setpoint that will be used by the kvar controller when it is in the Power Factor regulation mode.
- var Ramp Status: This indicates the current kvar ramp direction as None, Up, or Down.
- var Ramp Demand: This is the normalized var demand that is ramped from the initial var loading upon generator breaker closure to the desired var output. The rate at which the ramp occurs is

set by the Ramp Rate (%) parameter in the AVR Bias Control settings. Note the rate is in terms of percentage of machine capacity, it is not the time to ramp from zero up to the current desired var level. Thus, at low var loading it may appear that the ramp is skipped. If the system is loaded to only 10% and a unit is brought on line where the load rate is 10% per second, it takes only one second to reach 10% of capacity.

- var Demand: This is the normalized requested kvar demand on the generator. It is normalized such that 1.0 indicates the full kvar capacity of the generator, 0.5 indicates 50% of the generator's capacity, etc. When the generator breaker is closed, and the var/PF controller is enabled, the var Demand indicates what level of reactive power should be generated. In an island load share system, this will be determined by the droop characteristics set by the Droop Percentage and Voltage Droop Gain parameters. If the generator breaker is closed, and the Parallel To Mains logic element is true, the var Demand will be equal to the kvar set point if the var/PF controller is in var mode or it will be calculated from the amount of kW being generated to maintain desired machine Power Factor when the var/PF controller is in Power Factor control mode. When the generator breaker is open, or the var/PF controller is disabled, the var Demand will be zero.
- Volt PID: This is the current output value of the Voltage PID controller. It will normally range between –1.0 and 1.0, and will generally be zero at all times unless synchronization is in progress.
- kvar PID: This is the current output value of the kvar PID controller. It will normally range between –1.0 and 1.0, and will be zero any time the generator breaker is open. If the var/PF controller is enabled, the kvar PID will be nonzero when the generator breaker is closed if there is any difference between the normalized kvar generation and the var Demand value of the machine. If the var/PF controller is disabled, the kvar PID will always be zero.
- Volt Error: This is the normalized difference between the measured generator voltage and the voltage to which the DGC-2020HD is trying to synchronize. It will be 0.00 at all times except when the DGC-2020HD is trying to synchronize its generator inputs to its bus input. When synchronizing, this will typically be 0.000 or some relatively small number and move a small amount above and below 0.000 as voltage controller corrects for any voltage errors.
- kvar Error: This is the normalized difference between the measured generator kvar generation and the var Demand described above. A value of 1.0 means the difference is equal to the Rated kvar of the machine; a value of –1.0 means the difference is equal to the negative of the Rated kvar of the machine. When the generator breaker is open, or if var/PF controller is disabled, this will always be 0.000. When var/PF control is enabled, and the generator breaker is closed, this will typically be 0.000 or some relatively small number and move a small amount above and below 0.000 as the var/PF controller corrects for var errors. If a reactive load is added or dropped from the system, the error will be nonzero until the var/PF controller brings the var generation to the desired level.
- Voltage Bias: This is the normalized value to which the voltage regulator analog bias output of the DGC-2020HD will be driven to accomplish desired kvar and Voltage control. It is equal to the sum of the Volt PID and the kvar PID. If the value is –1.0, the voltage bias output will be driven to the minimum value of the voltage regulator analog bias output range. If the value is 1.0, the output will be driven to the maximum value of the voltage regulator analog bias output range. If the value is 0.000, the output will be driven to the midpoint value (i.e. half way between maximum and minimum values) of the voltage regulator analog bias output range. If the generator breaker is open, or if the generator breaker is closed and kvar control is disabled, the Volt Bias value will be 0.00, driving the bias output to the midpoint of the voltage regulator analog bias output range indicating the voltage regulator should operate the generator at rated voltage.

AEM-2020

This screen shows the binary data that is being sent between the AEM-2020 (Analog Expansion Module) and the DGC-2020HD.

The AEM diagnostics screen is located on the front panel at Metering > Diagnostics > AEM.

The following parameters are visible on the AEM diagnostics screen:

- DGC To AEM BP: DGC-2020HD to AEM-2020 Binary Points. This is a 32-bit, bit packed number representing the binary points transmitted from the DGC-2020HD to the AEM-2020. Debug at this level is not necessary.
- AEM To DGC BP: AEM-2020 to DGC-2020HD Binary Points. This is a 32-bit, bit packed number representing the binary points transmitted from the AEM-2020 to the DGC-2020HD. Debug at this level is not necessary.

CEM-2020

This screen shows the binary data that is being sent between the CEM-2020 (Contact Expansion Module) and the DGC-2020HD.

The CEM diagnostics screen is located on the front panel at Metering > Diagnostics > CEM.

The following parameters are visible on the CEM diagnostics screen:

- DGC To CEM BP: DGC-2020HD to CEM-2020 Binary Points. This is the status of the CEM-2020 output relays being transmitted from the DGC-2020HD to the CEM-2020. This is a 32-bit, bit packed number representing the desired states of the CEM-2020 outputs. The left-most bit is the first output, etc.
- CEM To DGC BP: CEM-2020 to DGC-2020HD Binary Points. This is the status of the CEM-2020 inputs being transmitted from the CEM-2020 to the DGC-2020HD. This is a 32-bit, bit packed number representing the metered states of the CEM-2020 inputs. The left most bit is the first input, etc.

VRM

This screen shows the binary data that is being sent between the VRM-2020 (Voltage Regulator Expansion Module) and the DGC-2020HD.

The VRM diagnostics screen is located on the front panel at Metering > Diagnostics > VRM.

The following parameters are visible on the VRM diagnostics screen:

- DGC To VRM BP: DGC-2020HD to VRM-2020 Binary Points. This is a 32-bit, bit packed number representing the binary points transmitted from the DGC-2020HD to the VRM-2020. Debug at this level is not necessary.
- VRM To DGC BP: VRM-2020 to DGC-2020HD Binary Points. This is a 32-bit, bit packed number representing the binary points transmitted from the VRM-2020 to the DGC-2020HD. Debug at this level is not necessary.

Mains Power

This screen is useful for debugging mains power control mode related issues. It gives visibility into the states of the mains power controller in the DGC-2020HD.

The Mains Power diagnostics screen is located on the front panel at Metering > Diagnostics > Mains Power.

The following parameters are visible on the Mains Power diagnostics screen:

- Total Mains kW: This displays the measured kW level of the mains.
- Error: This is the normalized difference between the measured system generated kW and the kW the DGC-2020HD is trying to achieve.
- Baseload: This displays the commanded baseload to maintain import/export or peak shave level.
- Sys Gen kW: This displays the cumulative kW output of participating generators.
- Sys Rated kW: This displays the total kW capacity of participating generators.
- Total System kW: This displays the cumulative kW output of participating generators summed with the total imported kW from mains.

- Baseload Setpt: This displays the active baseload setpoint.
- Peak Shv Setpt: This displays the active peak shave setpoint.
- Im/Ex Setpt: This displays the active import/export setpoint.

VRM Control

This screen is useful for debugging VRM-2020 control related issues. It gives visibility into the states of the VRM-2020 regulation modes and limiters in the DGC-2020HD.

The VRM Control diagnostics screen is located on the front panel at Metering > Diagnostics > VRM Control.

The following parameters are visible on the VRM Control diagnostics screen:

- VRM AVR Setpoint: This displays the AVR mode setpoint.
- VRM FCR Setpoint: This displays the FCR mode setpoint.
- VRM AVR Ref: This displays the final AVR setpoint (reference) after other factors such as raise/lower biases or an active limiter.
- VRM FCR Ref: This displays the final FCR setpoint (reference) after other factors such as raise/lower biases or an active limiter.
- VRM Control Output: This displays the VRM control output (PID) in per unit.
- VRM AVR Error: This displays the difference between the AVR reference and the measured voltage in per unit.
- VRM FCR Error: This displays the difference between the FCR reference and the measured current in per unit.
- VRM OEL Reference: This displays the calculated OEL reference in per unit of takeover OEL or summing point OEL depending on configuration.
- VRM OEL Takeover Err: This displays the difference between the takeover OEL reference and the measured field current in per unit.
- VRM OEL Summing Err: This displays the difference between the summing point OEL reference and the measured field current in per unit.
- VRM OEL Summing Bias: This displays the OEL Summing control output (PID) in per unit.
- VRM UEL Reference: This displays the calculated UEL reference in per unit.
- VRM UEL Error: This displays the difference between the UEL reference and the measured field current in per unit.
- VRM UEL Bias: This displays the UEL control output (PID) in per unit.
- VRM Tracking Error: This displays the difference of the inactive mode setpoint in relation to the active mode setpoint in percent.
- EDM Ripple: The exciter diode ripple is reported by the exciter diode monitor (EDM) as the induced ripple in the exciter field current.

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