

INSTRUCTION MANUAL

FOR

DGC-2020HD

DIGITAL GENSET CONTROLLER



 **Basler Electric**

Publication: 9469300990
Revision: B Mar-14

Preface

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

- Controls and indicators
- Inputs and outputs
- Protection and control functions
- Reporting and alarms information
- Mounting and connection diagrams
- BESTCOMS*Plus*® software
- Communication and security
- Maintenance and troubleshooting procedures
- Specifications
- AEM-2020
- CEM-2020
- MTU Fault Codes
- Exhaust Treatment
- Diagnostic Trouble Codes

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.



12570 State Route 143
Highland IL 62249-1074 USA

www.basler.com

info@basler.com

Tel: +1 618.654.2341

Fax: +1 618.654.2351

© 2014 by Basler Electric

All rights reserved

First printing: November 2013

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.

Basler Electric does not assume any responsibility to compliance or noncompliance with national code, local code, or any other applicable code. This manual serves as reference material that must be well understood prior to installation, operation, or maintenance.

This product contains, in part, open source software (software licensed in a way that ensures freedom to run, copy, distribute, study, change, and improve the software) and you are granted a license to that software under the terms of either the GNU General Public License or GNU Lesser General Public License. The licenses, at the time of sale of the product, allow you to freely copy, modify, and redistribute that software and no other statement or documentation from us, including our End User License Agreement, places any additional restrictions on what you may do with that software.

For at least three (3) years from the date of distribution of this product, a machine-readable copy of the complete corresponding source code for the version of the programs distributed to you will be sent upon request (contact information is provided above). A fee of no more than our cost of physically performing the source code distribution is charged.

The source code is distributed in the hope that it will be useful, but WITHOUT ANY REPRESENTATION or WARRANTY or even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. Refer to the source code distribution for additional restrictions regarding warranty and copyrights.

For a complete copy of GNU GENERAL PUBLIC LICENSE Version 2, June 1991 or GNU LESSER GENERAL PUBLIC LICENSE Version 2.1, February 1999 refer to www.gnu.org or contact Basler Electric. You, as a Basler Electric Company customer, agree to abide by the terms and conditions of GNU GENERAL PUBLIC LICENSE Version 2, June 1991 or GNU LESSER GENERAL PUBLIC LICENSE Version 2.1, February 1999, and as such hold Basler Electric Company harmless related to any open source software incorporated in this product. Basler Electric Company disclaims any and all liability associated with the open source software and the user agrees to defend and indemnify Basler Electric Company, its directors, officers, and employees from and against any and all losses, claims, attorneys' fees, and expenses arising from the use, sharing, or redistribution of the software. Review the software website for the latest version of the software documentation.

For terms of service relating to this product and software, see the *Commercial Terms of Products and Services* document available at www.basler.com/terms.

It is not the intention of this manual to cover all details and variations in equipment, nor does this manual provide data for every possible contingency regarding installation or operation. The availability and design of all features and options are subject to modification without notice. Over time, improvements and revisions may be made to this publication. Before performing any of the following procedures, contact Basler Electric for the latest revision of this manual.

The English-language version of this manual serves as the only approved manual version.

Contents

Introduction	1
Features and Functions	1
Style Number	4
Optional Features and Capabilities	4
Specifications	5
Operating Power	5
Battery Ride Through	5
Current Sensing	5
Voltage Sensing	5
Analog Sensing	6
Contact Sensing	6
Engine System Inputs	7
Output Contacts	7
Metering	8
Generator Protection Functions	10
Logic Timers	11
Communication Interface	11
Real-Time Clock	12
LCD Heater	13
Type Tests	13
Environment	13
UL Approval	14
CSA Certification	14
NFPA Compliance	14
CE Compliance	14
Physical	14
Mounting	15
Hardware	15
Dimensions	15
Terminals and Connectors	17
Terminals	18
Connectors	25
Typical Applications	27
Connections for Typical Applications	27
Connections for Load Sharing	32
Analog Input Connections	33
CAN Connections	33
Expansion Module Connections (CAN 1)	35
Installation for CE Systems	35
Controls and Indicators	37
Programmable Indicator Configuration	39
Display Operation and Navigation	40
Display Setup	48
Power Input	51
Nominal Voltage Input and Acceptable Range of Input Voltage	51
Terminal Assignments	51
Power Consumption	51
Battery Ride-Through Capability	51
Fuse Protection	51
Voltage and Current Sensing	53
Generator Voltage	53

Bus Voltage	53
Generator and Bus Current	53
Engine Sender Inputs	55
Connections	55
Compatibility	55
Operation	55
Programmability	55
Characteristic Curves	55
Sender Failure Detection	59
Speed Signal Inputs	61
Magnetic Pickup	61
Generator Sensing Voltage	61
Contact Inputs	63
Programmable Contact Inputs	63
Analog Inputs	67
Input Setup	67
Ranges	67
Thresholds	67
Operational Settings	68
Logic Connections	69
Contact Outputs	71
Prestart	71
Start	71
Run	71
Relay Control	71
Programmable Contact Outputs	72
Operating Modes	75
Off	75
Run	75
Auto	75
Operating Mode Control	75
Breaker Management	77
Breaker Status	77
System Breaker Configuration	77
Breaker Operation	88
Synchronizer	97
Operation	97
Configuration	99
Bias Control	113
AVR Bias Control Settings	113
Governor Bias Control Settings	115
Multiple Generator Management	119
AVR Output	119
Governor Output	120
Load Share Output	121
Parameter Selection	121
Demand Start/Stop	121
Generator Sequencing	123
Network Configuration	125
Generator Protection	127
Undervoltage (27)	127
Overvoltage (59)	129

Phase Voltage Imbalance (47)	131
Vector Shift (78).....	133
Frequency (81)	135
Overcurrent (51)	138
Power (32)	144
Loss of Excitation (40Q)	147
Setting Groups.....	149
Configurable Protection	151
Element Setup	151
Thresholds	153
Logic Connections	154
Operational Settings	154
Metering	157
Metering Explorer	157
Engine.....	158
Generator	159
Bus 1 and Optional Bus 2.....	159
Bias Control	160
Power.....	160
Run Statistics.....	161
Synchronization	161
Status Indication	162
Inputs	162
Outputs	167
Configurable Protection	169
J1939 ECU	169
MTU	171
Summary	172
Control Panel	174
Generator Network Status	174
Generator Sequencing	175
Diagnostics	176
Analysis	176
Reporting and Alarms.....	179
Event Logging.....	179
Sequence of Events	179
Data Logging	180
Trending	181
Alarms.....	182
BESTCOMSPlus® Software	193
System Recommendations	194
Installation	194
Activate the DGC-2020HD Plugin for BESTCOMSPlus®	194
Menu Bars	198
Settings Explorer	199
Metering Explorer	200
BESTspace™	200
Settings File Management.....	201
Auto Export Metering.....	202
BESTCOMSPlus® Updates	203
Firmware Updates	203
BESTlogic™Plus	205
Overview of BESTlogic™Plus	205
BESTlogic™Plus Composition	206
Logic Schemes	234

Programming BESTlogic™Plus.....	235
Offline Logic Simulator	236
BESTlogic™Plus File Management	236
BESTlogic™Plus Examples	237
Communication	239
USB	239
Ethernet	239
CAN	243
RS-232	253
RS-485	256
Modbus™ Setup.....	256
Remote Display Panel (optional).....	257
Configuration.....	259
System Settings.....	259
Rated Data	262
Remote Module Setup.....	267
Crank Settings	267
Automatic Restart Settings.....	269
Exercise Timer Settings.....	270
Sensing Transformer Ratings.....	271
Relay Control Settings.....	272
System Configuration Detection Settings.....	273
Device Information.....	275
Style Number	275
Device Info.....	275
Firmware Updates	276
Security	281
Access Levels.....	281
User Name Setup	281
Port Access Setup.....	283
Access Control	283
Timekeeping	285
Clock Setup	285
Setting the Time and Date.....	287
IRIG Port.....	287
Real-Time Clock Specifications.....	288
Backup Battery for the Real-Time Clock	288
Maintenance and Troubleshooting	289
Maintenance	289
Storage	289
Troubleshooting.....	289
AEM-2020	303
Features	303
Specifications	303
Functional Description	305
Mounting.....	305
Connections.....	306
AEM-2020 Configuration	312
Remote Analog Inputs Configuration	312
Remote RTD Inputs Configuration	315
Remote Thermocouple Inputs Configuration	317
Remote Analog Outputs Configuration.....	319
Firmware Updates	322
Repair	322

Maintenance	322
Storage	323
CEM-2020	325
Features	325
Specifications	325
Functional Description	327
Mounting	327
Connections	329
CEM-2020 Configuration	334
Remote Contact Inputs Configuration	334
Remote Contact Outputs Configuration	336
Firmware Updates	336
Repair	336
Maintenance	337
Storage	337
Time Curve Characteristics.....	339
Curve Specifications	339
Time Overcurrent Characteristic Curve Graphs	340
Tuning PID Settings	361
Voltage and Speed Controllers	361
kW Load Controller	361
Var/PF Controller	361
Speed Trim Function	361
Tuning Parameters	361
Tuning Procedures	362
Generic Gains for Multiple Machine Types	366
MTU Fault Codes.....	367
Exhaust Treatment.....	377
Diesel Particulate Filter (DPF)	377
Exhaust After-Treatment Systems (EATS).....	379
Diagnostic Trouble Codes.....	381
Revision History	391



Introduction

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

Features and Functions

The DGC-2020HD Digital Genset Controller has the following features:

- Local and remote generator control
- Engine, generator, and loss of mains protection (optional)
- Automatic transfer switch control (mains failure)
- Automatic generator configuration detection
- Generator sequencing
- Generator soft loading/unloading
- Auto synchronizing (optional)
- Programmable analog engine senders
- 16 programmable contact inputs
- Three programmable front panel LEDs, with labels
- Up to four local analog inputs
- A ramping function to load and unload generator smoothly
- Demand start/stop and generator sequencing
- kW and kvar load control
- kW and kvar load sharing via Ethernet or analog load share lines
- Programmable logic
- Exercise timer
- ECU communications via SAE J1939
- Marathon DVR2000E+ voltage regulator control via SAE J1939
- Integrated USB, RS485, and Ethernet communication
- Two J1939 CAN Bus ports
- Additional modules available to expand the capabilities of the DGC-2020HD

An overview of DGC-2020HD Digital Genset Controller functions is provided in the following paragraphs.

Generator and Bus Protection and Metering

Multifunction protection guards against overvoltage, undervoltage, excessive forward and reverse power, underfrequency, and overfrequency. Overcurrent, phase imbalance, loss of mains, and frequency rate-of-change protection are available as an option. Each protection function has an adjustable pickup and time delay setting. Sixteen inverse time curves, in addition to user-programmable curves, enable the DGC-2020HD to offer overcurrent protection in a variety of applications. Each protective element can be assigned to the generator, bus 1 or bus 2.

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

Engine Protection and Metering

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

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

Load Sharing

The DGC-2020HD provides analog outputs to the power system in the form of analog bias signals to the voltage regulator and speed governor. A pulse width modulated (PWM) speed bias output is also available. When the generator breaker is closed and load sharing is enabled, the DGC-2020HD shares the real power load proportionally with other generators in the system. Load sharing can be implemented on the Analog Load Share Line or through Ethernet communications. Reactive power (kvar) sharing is accomplished through Ethernet communications.

Event Recording

A history of system events are logged in nonvolatile memory. The DGC-2020HD retains records for 128 unique types of events. Each record tracks the number of times that an event has occurred and records a time stamp of the first and last occurrences.

A Sequence of Events (SER) log is also available. This log tracks the internal and external status of the DGC-2020HD. Events are scanned at five millisecond intervals with 1,023 events stored per record. All changes of state that occur during each scan are time- and date-stamped. Sequences of Events reports are available through BESTCOMSP^{Plus}. Over 1,000 records can be retained in nonvolatile memory. When the SER memory becomes full, the oldest record is replaced by the latest one acquired.

Data Logging

The data logging function of the DGC-2020HD records up to six records of user-selectable, real-time parameter data. For more information, see the *Reporting and Alarms* chapter.

Contact Inputs and Outputs

DGC-2020HD controllers have 16 programmable contact inputs. All contact inputs recognize dry contacts. The programmable inputs can be configured to initiate a pre-alarm or alarm condition. A programmable input can be programmed to receive a contact input from an automatic transfer switch (ATS). In addition, a programmable Battle Override function allows overriding of DGC-2020HD alarms and protection functions. Each programmable input can be assigned a user-defined name for easy identification at the front panel display and in fault records.

Output contacts include three dedicated relays for energizing an engine's glow plugs, fuel solenoid, and starter solenoid. An additional twelve programmable output contacts are provided.

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

Automatic Transfer Switch Control (Mains Failure)

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

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

At this time, the DGC-2020HD starts the genset and, when ready, applies power to the load from the genset. The DGC-2020HD implements open or closed breaker transitions to and from the mains. When the mains returns and is considered stable, the DGC-2020HD will transfer the load back to the mains and stop the engine. During closed breaker transitions, the optional Auto Synchronizer can synchronize the generator to the mains before transferring the load from generator power to utility power.

Device Security

Passwords provide access security for six distinct functional access areas: Read, Control, Operator, Settings, Design, and Administrator. Each username/password is assigned an access area with access to that area and each area below it. An administrator password provides access to all six of the functional areas.

A second dimension of security is provided by the ability to restrict access for any of the access areas to only specific communication ports. For example, you could set up security to deny access to control commands through an Ethernet port.

Security settings affect read and write access. Refer to the *Security* chapter for more information.

Communication

DGC-2020HD communication features include a mini-B USB port, RS-485 port, two copper Ethernet ports or one fiber optic Ethernet port (optional), and SAE J1939 interface.

USB Port

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

RS485 Port

An RS485 communication port uses the Modbus™ communication protocol and enables remote control and monitoring of the DGC-2020HD over a polled network.

Ethernet Port(s)

Depending on style number, each DGC-2020HD is equipped with either dual copper (100BaseT) Ethernet communication ports (style xxxxDxxxx) or a fiber optic (100BaseF) Ethernet communication port (style xxxxFxxxx).

Ethernet ports provide communications between the DGC-2020HD and a PC via BESTCOMS*Plus* or other DGC-2020HDs in a network. 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.

CAN Interface

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

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

Style Number

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

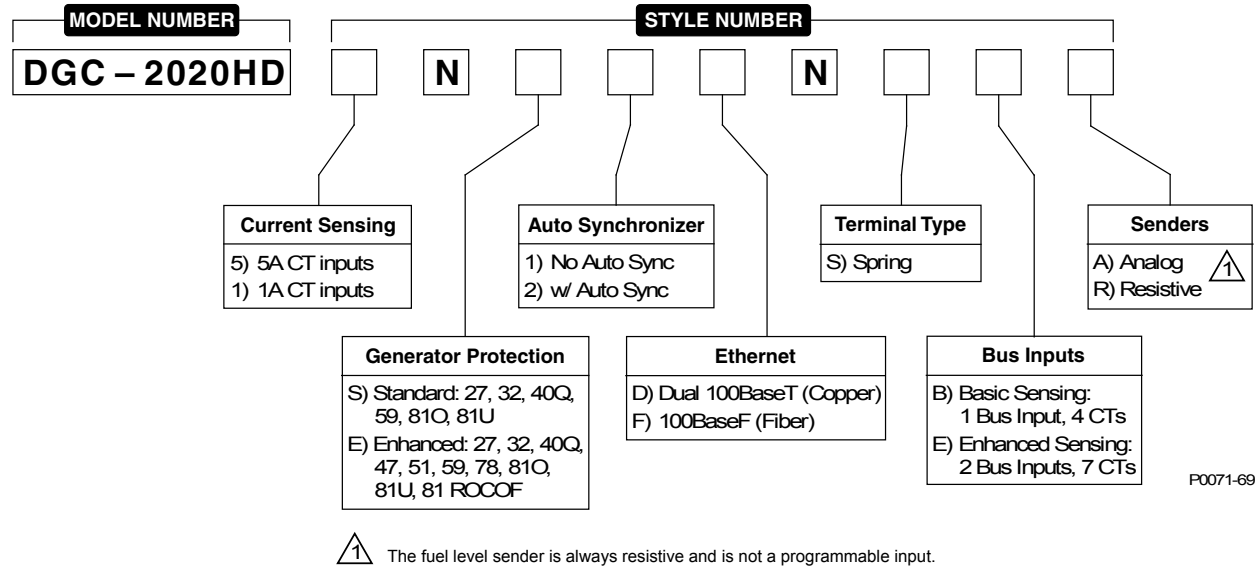


Figure 1. DGC-2020HD Style Chart

Optional Features and Capabilities

AEM-2020 (Analog Expansion Module)

The optional AEM-2020 provides eight remote analog inputs, eight remote RTD inputs, two Type-K remote thermocouple inputs, and four remote analog outputs to the DGC-2020HD. The AEM-2020 communicates with the DGC-2020HD through a CAN interface. Up to four AEM-2020s may be used with one DGC-2020HD. Refer to the *AEM-2020* chapter for more information.

CEM-2020 (Contact Expansion Module)

The optional CEM-2020 provides 10 additional contact inputs and 18 or 24 additional output contacts (depending on module type) to the DGC-2020HD. The CEM-2020 communicates with the DGC-2020HD through a CAN interface. Up to four CEM-2020s may be used with one DGC-2020HD. Refer to the *CEM-2020* chapter for more information.

Specifications

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

Operating 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 1 Terminals	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 xxxxxxEx.)	

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

Voltage Sensing

Rating	-10 to 10 Vdc
Burden	9.75 k Ω to 10.16 k Ω

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

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. Values outside these ranges are deemed “failed” and the DGC-2020HD will begin timing towards a sender failure condition.

Fuel Level Sensing

Resistance Range	0 to 250 Ω nominal
Terminals	71 (FUEL +), 72 (FUEL –)

Coolant Temperature Sensing

Resistance Range	10 to 2,750 Ω nominal
Terminals	77 (COOLANT +), 78 (COOLANT –)

Oil Pressure Sensing

Resistance Range	0 to 250 Ω nominal
Terminals	74 (OIL +), 75 (OIL –)

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.

Metering

Generator and Bus Voltage (rms)

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

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

Generator Current (rms)

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

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

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

Generator and Bus Frequency

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 $+70^{\circ}\text{C}$ (-40°F to $+158^{\circ}\text{F}$).

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 +1

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

† Applies when temperature is between -40°C to $+70^{\circ}\text{C}$ (-40°F to $+158^{\circ}\text{F}$).

Oil Pressure

Metering Range.....	0 to 150 psi, 0 to 10.3 bar, or 0 to 1,034 kPa
Accuracy.....	±2% of actual indication or ±1 psi, ±0.07 bar, or ±6.9 kPa (subject to accuracy of sender)
Display Resolution	1 psi, 0.07 bar, or 6.9 kPa

Coolant Temperature

Metering Range..... 32 to 410°F or 0 to 204°C
Accuracy..... $\pm 2\%$ of actual indication or as low as $\pm 2^\circ$ (subject to accuracy of sender)

Fuel Level

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

Battery Voltage

Metering Range..... 6 to 32 Vdc
Accuracy..... $\pm 2\%$ 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* $\pm 2\%$ 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

Generator 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 BESTCOMSPlus®.

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

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 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°

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 Ω , ½ watt terminating resistor should be installed across terminals 51 (CAN1L) and 52 (CAN1H) and/or 54 (CAN2L) and 55 (CAN2H).
2. If the DGC-2020HD is not part 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.

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

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 heater turn on and turn off.

Type Tests**Shock**

Withstands 15 G in 3 perpendicular planes.

Vibration

Tested for 8 hours in three perpendicular planes.

3 to 25 Hz at 1.6 mm (0.063 in) peak amplitude

25 to 2,000 Hz at 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 $+120^{\circ}\text{C}$), vibration tests (of 5 to 40 G at $+30^{\circ}\text{C}$), and temperature/vibration tests (tested at 40 G over a temperature range of -85°C to $+120^{\circ}\text{C}$). 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 $+70^{\circ}\text{C}$ (-40 to $+158^{\circ}\text{F}$)

Storage Temperature -40 to $+85^{\circ}\text{C}$ (-40 to $+185^{\circ}\text{F}$)

Salt Fog	IEC 60068
Ingress Protection	IEC IP56 for front panel
Humidity	IEC 68-2-78

UL Approval

The DGC-2020HD is recognized to applicable Canadian and US safety standards and requirements by UL.

Standards used for evaluation:

- UL6200
- CSA C22.2 No. 0
- CSA C22.2 No. 14

The DGC-2020HD ground fault protection circuit complies with the Calibration and Withstand tests of UL 1053; as required by UL6200.

(See the Time Curve Characteristics chapter 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.

CSA Certification

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

Standards used for evaluation:

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

NFPA Compliance

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

CE Compliance

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

EC Directives:

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

Harmonized Standards used for evaluation:

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

Physical

Weight 5.50 lb (2.5 kg)

Dimensions..... See the *Mounting* chapter.

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.

Hardware

The front panel is resistant to moisture, salt fog, humidity, dust, dirt, and chemical contaminants. DGC-2020HD controllers are mounted using the four permanently attached 10-24 studs. The torque applied to the mounting hardware should not exceed 20 inch-pounds (2.2 newton meters).

Dimensions

Panel cutting and drilling dimensions are shown in Figure 2. 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. Overall dimensions are shown in Figure 3. All dimensions are shown in inches with millimeters in parenthesis.

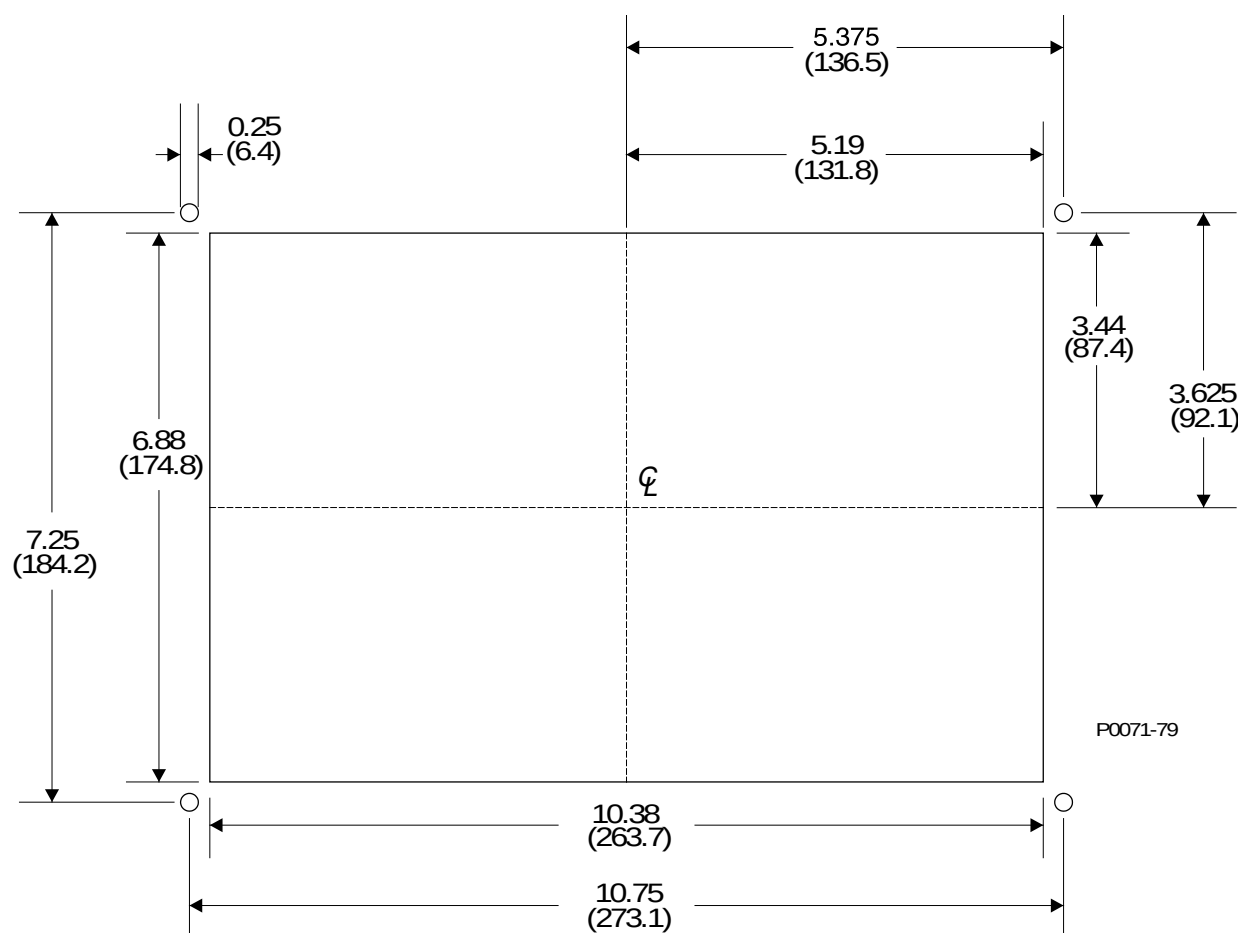


Figure 2. Panel Cutting and Drilling Dimensions

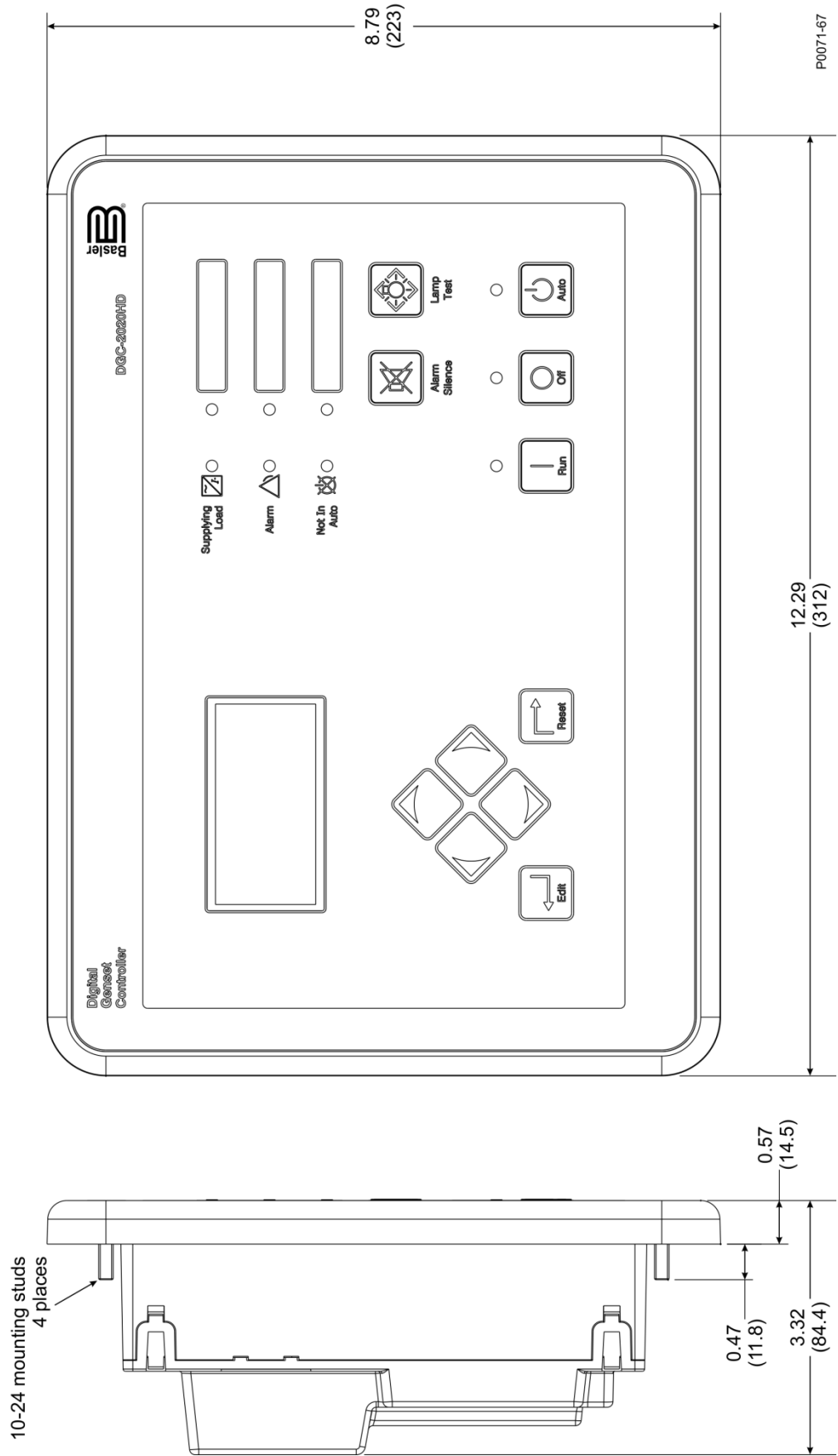
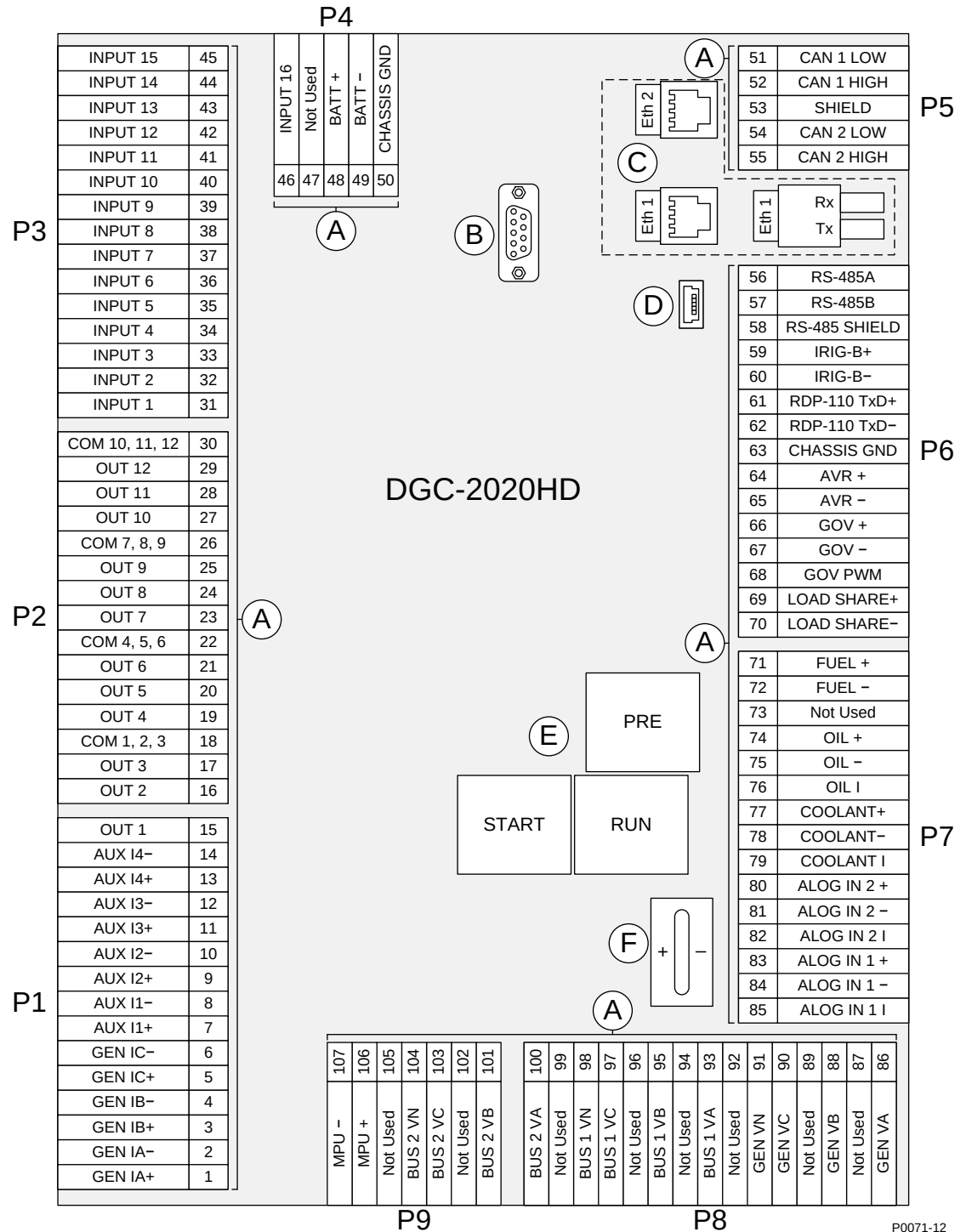


Figure 3. Overall Dimensions

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



P0071-12

Table 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).
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 while a fiber optic (100Base-F) port (style xxxxFxxxx) uses two BNC fiber optic connectors. 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 fiber optic port is designated as Ethernet port 1 and is reserved for intergenset communications (load sharing). Figure 4 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 BESTCOMSPPlus® 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 operating power. See the <i>Timekeeping</i> 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 (3.31 mm²) copper wire attached to chassis ground (terminal 50) on the rear of the controller. Operating power from the battery must be of the correct polarity. While reverse polarity will not cause damage, the DGC-2020HD will not operate.

The DGC-2020HD terminals are grouped by function and include operating 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.

Operating Power

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

Terminal	Description
50 (CHASSIS)	Chassis ground connections
49 (BATT–)	Negative side of operating power input
48 (BATT+)	Positive side of operating 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 1xxxxxxx has 1 Aac nominal current sensing and a DGC-2020HD with a style number of 5xxxxxxx indicates 5 Aac nominal current sensing. Generator current sensing terminals are listed in Table 3.

Table 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 4 lists the programmable current sensing terminals.

Table 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 5.

Table 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

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 6.

Table 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)

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. 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 7.

Table 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 8.

Table 8. Analog Input Terminals

Terminal	Description
80 (ANALOG IN 1 +)	Auxiliary analog 1 +
81 (ANALOG IN 1 –)	Auxiliary analog 1 –
82 (ANALOG IN 1 I)	Auxiliary analog 1 (I) current input*
83 (ANALOG IN 2 +)	Auxiliary analog 2 +
84 (ANALOG IN 2 –)	Auxiliary analog 2 –
85 (ANALOG IN 2 I)	Auxiliary analog 2 (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 9.

Table 9. Magnetic Pickup Input Terminals

Terminals	Description
105 (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. Contact sensing input terminals are listed in Table 10.

Table 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

Output Contacts

The DGC-2020HD has three sets of fixed-function output contacts: Pre, Start, and Run. The Pre contacts supply battery power to the engine glow plugs, the Start contacts supply power to the starter solenoid, and the Run contacts supply power to the fuel solenoid. Connections to the three sets of contacts are made at terminals 19 through 24. The Pre, Start, and Run relay terminals are listed in Table 11.

Table 11. Fixed-Function Output Contact Terminals

Terminal	Description
19 (START)	Start output contact (Start solenoid)
20 (START)	
21 (RUN)	Run output contact (Fuel solenoid)
22 (RUN)	
23 (PRE)	Pre-start output contact (Glow plugs)
24 (PRE)	

Twelve programmable output contacts are provided in four sets. Each set of three output contacts shares a common terminal. Programmable output contact terminals are listed in Table 12.

Table 12. 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

Terminal	Description
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 13. For typical CAN connections, refer to the *Typical Connections* chapter.

Table 13. 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

Note

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

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. Modbus register values for the DGC-2020HD are listed and defined in Basler Publication 9469300991, *Instruction Manual for DGC-2020HD Digital Genset Controller Modbus™ Protocol*. RS-485 interface terminals are listed in Table 14.

Table 14. 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 15.

Table 15. 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 16.

Table 16. GOV Control Output Terminals

Terminal	Description
66 (GOV +)	GOV control output positive
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 17.

Table 17. 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 18 lists the IRIG-B source input terminals.

Table 18. 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 operating 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 19 lists the DGC-2020HD terminals that connect to the remote display panel.

Table 19. 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 a BNC fiber optic port provide Ethernet communications between the DGC-2020HD and a PC via BESTCOMS*Plus* or other DGC-2020HDs in a network. 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.



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 operating power.

Connections for Typical Applications

Typical connections for applications which use three-phase wye, three-phase delta, single-phase A-B, and single-phase A-C generator voltage sensing are shown on the following pages. Figure 5 illustrates typical three-phase wye generator voltage sensing connections.

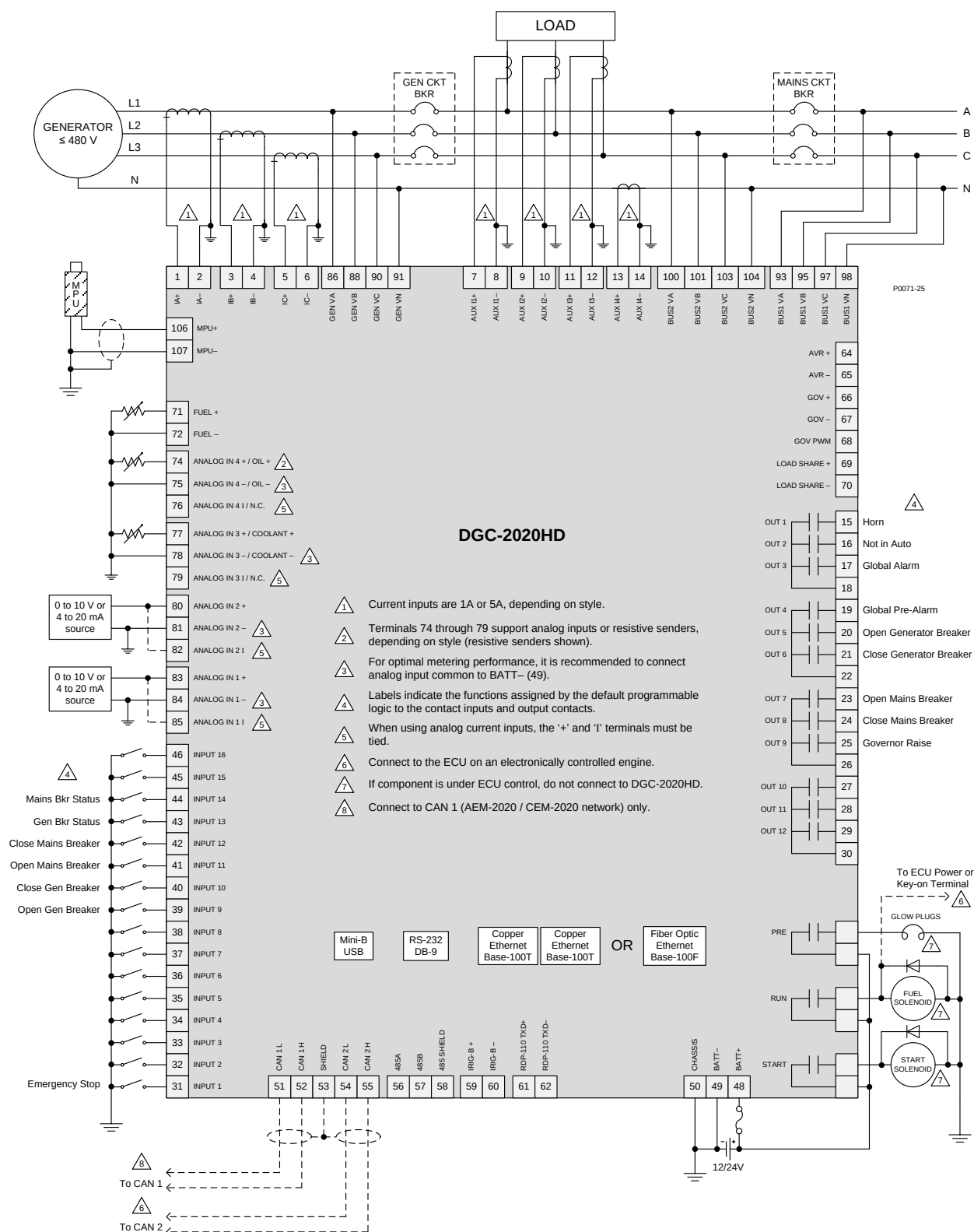


Figure 6 illustrates typical three-phase delta generator voltage sensing connections.

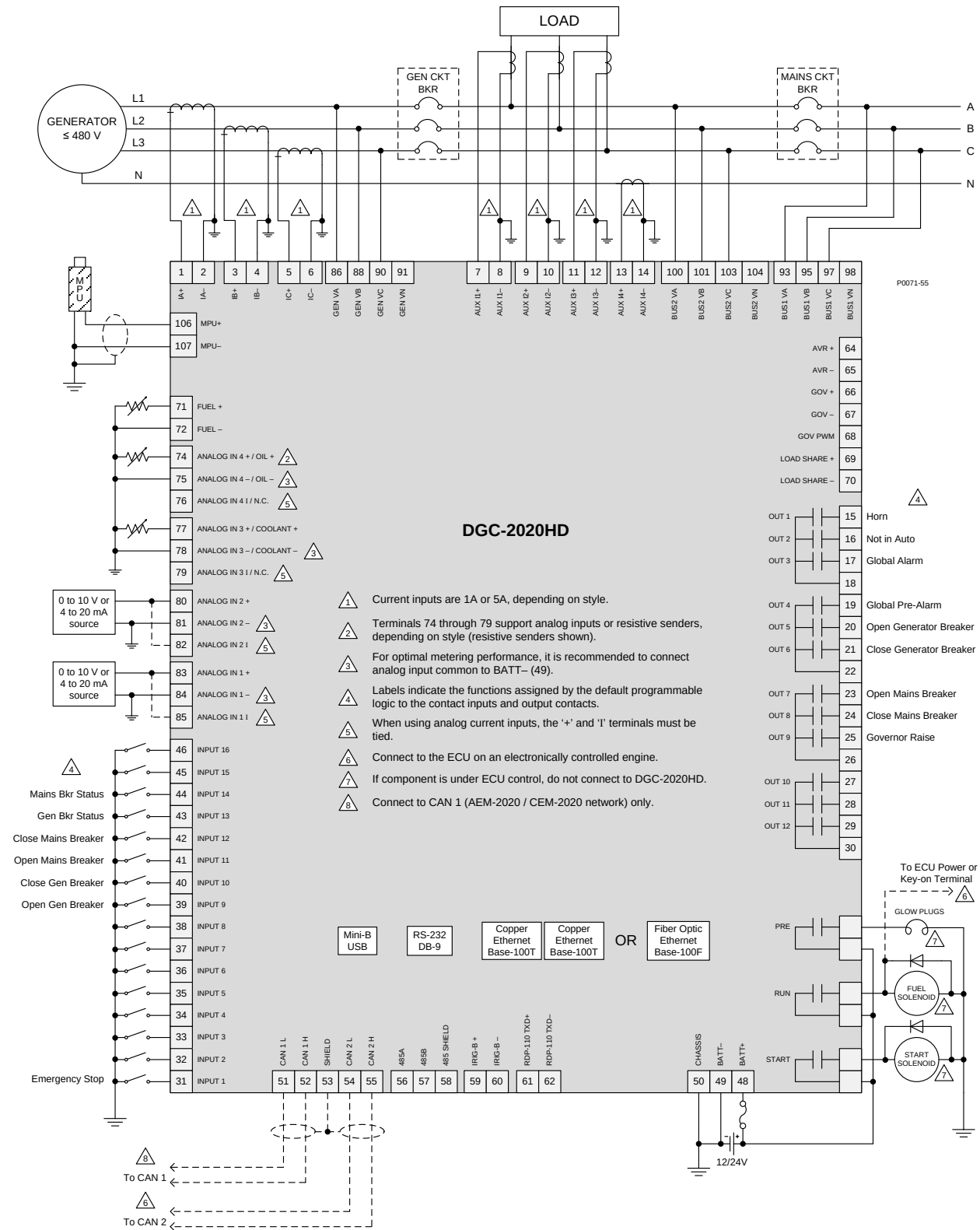


Figure 6. 3-Phase Delta Connections for Typical Applications

Figure 7 illustrates typical single-phase A-B generator voltage sensing connections.

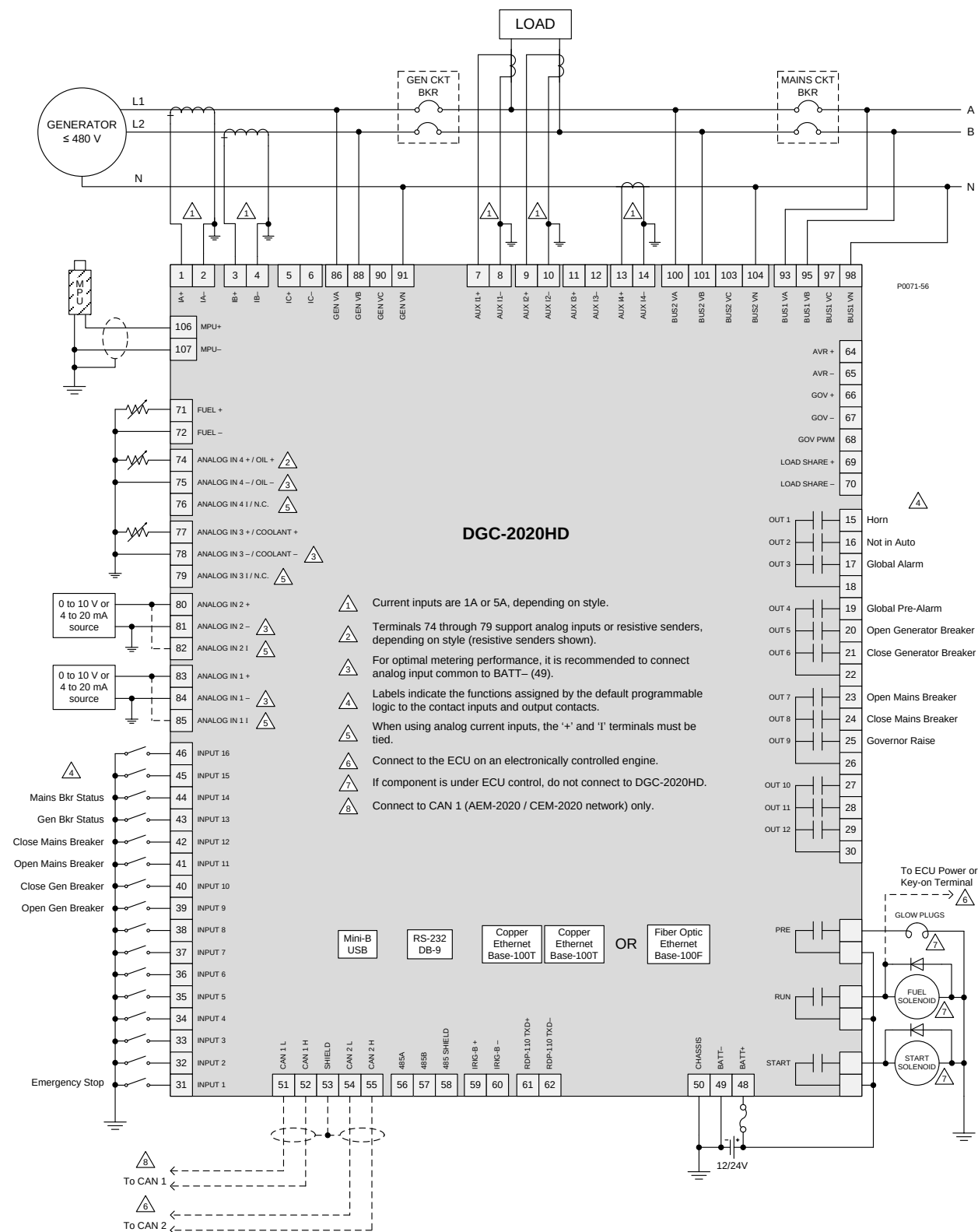


Figure 7. Single-Phase A-B Connections for Typical Applications

Figure 8 illustrates typical single-phase A-C generator voltage sensing connections.

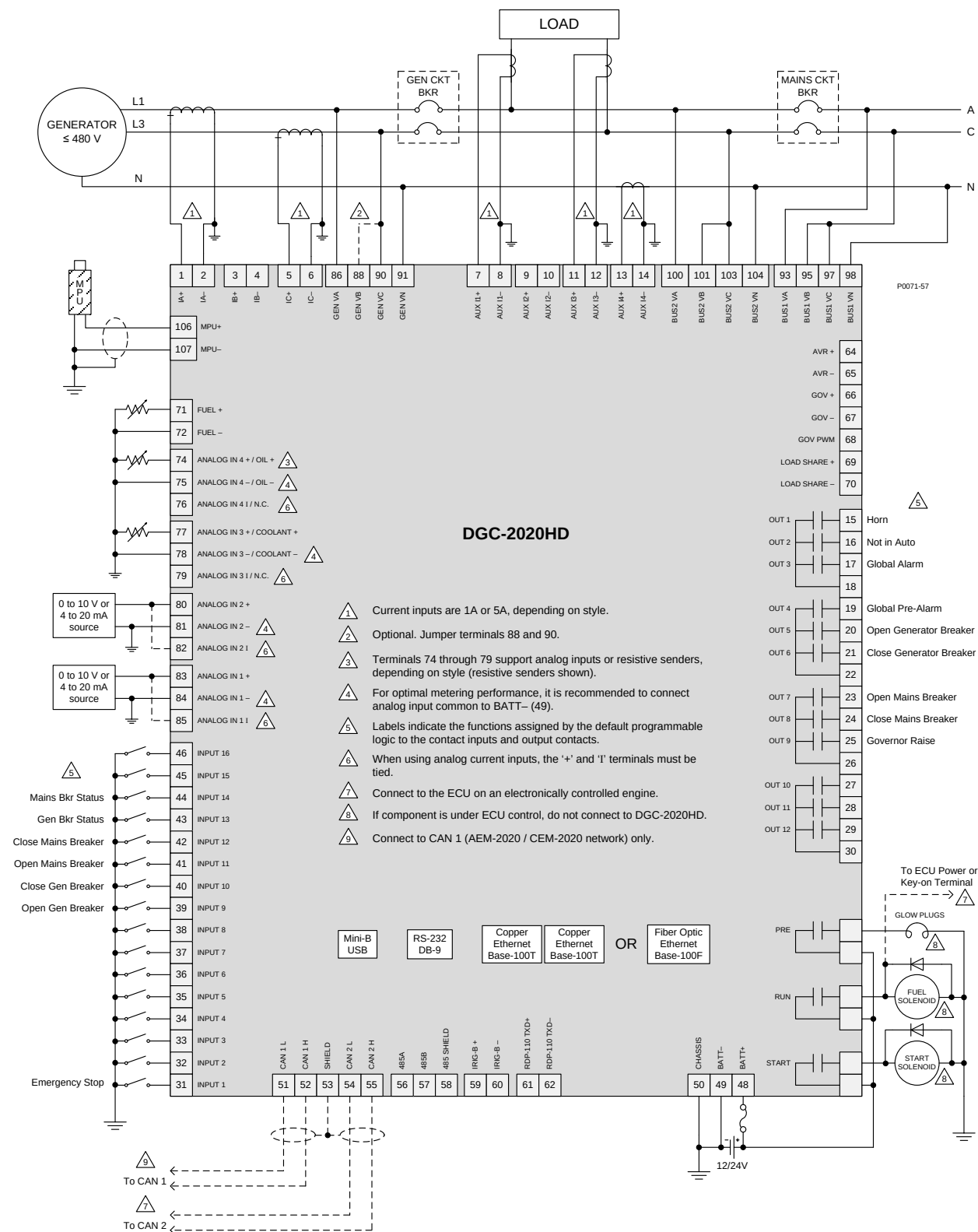
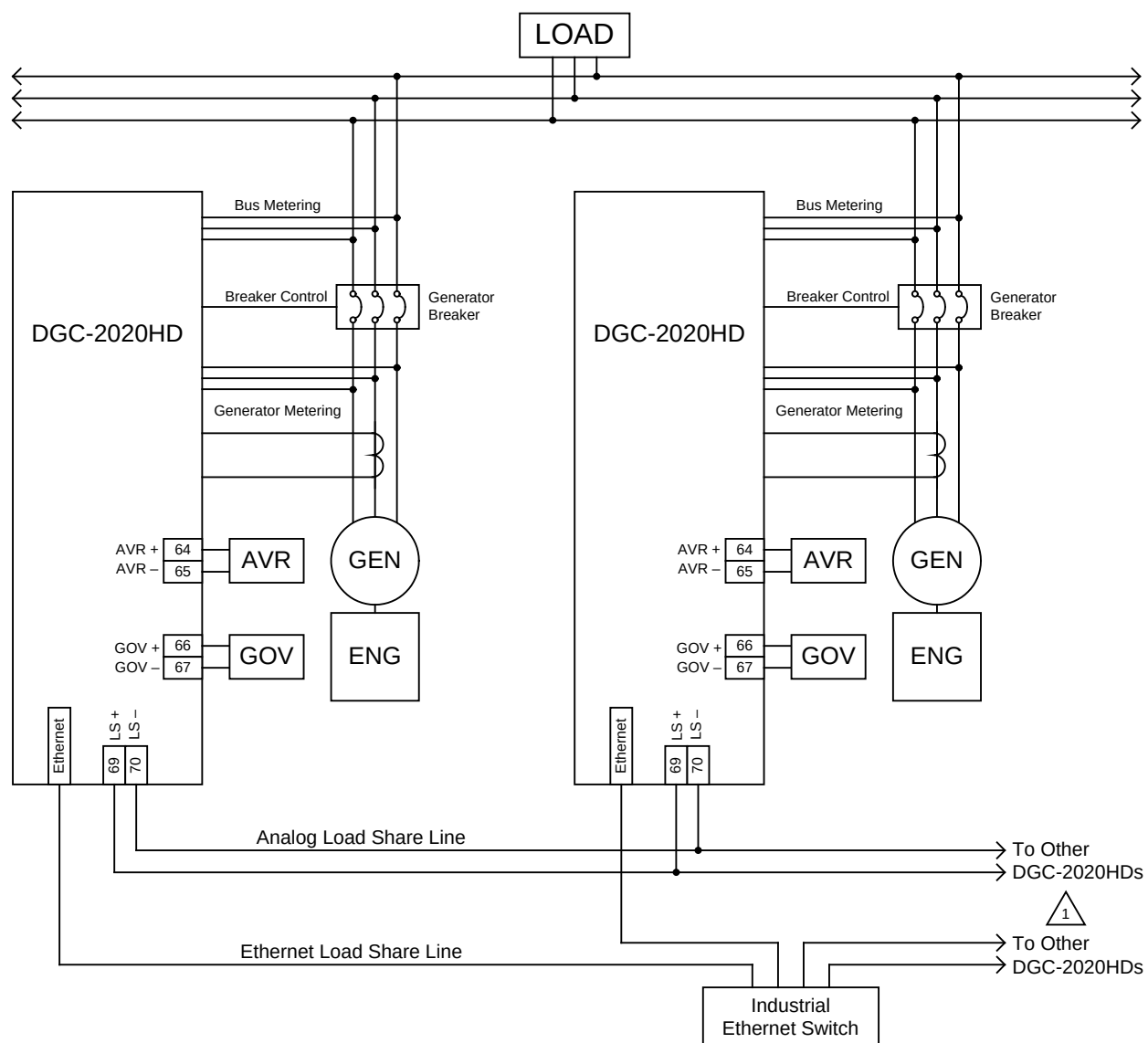


Figure 8. Single-Phase A-C Connections for Typical Applications

Connections for Load Sharing

Figure 9 illustrates a typical interconnection of two systems tied together using analog and Ethernet load share lines.



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

P0071-68

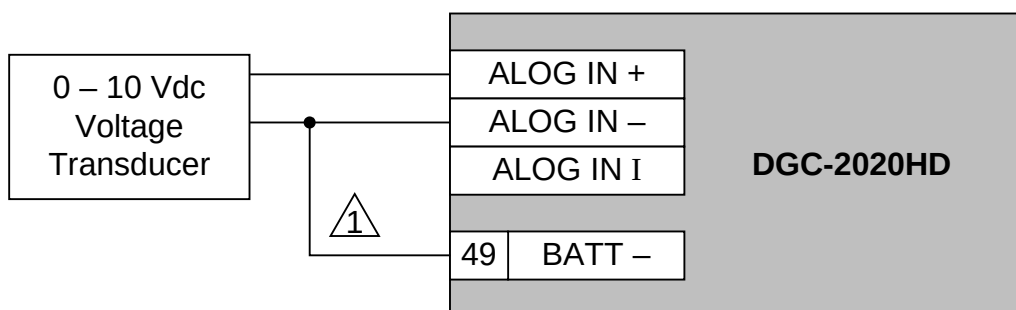
Figure 9. Analog and Ethernet Connections for Typical Applications

Analog Input Connections

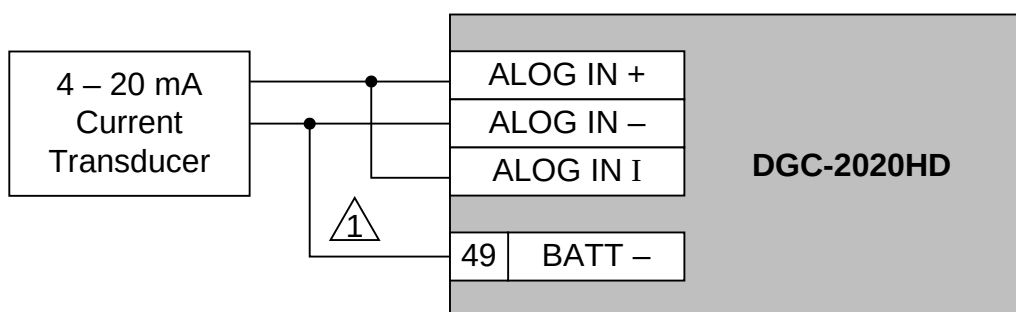
DGC-2020HD controllers with style number xxxxxxxxR are equipped with two analog inputs and those with style number xxxxxxxxA are equipped with four analog inputs.

Voltage and current analog input connections are shown in Figure 10. When using the current input, the “+” and “I” terminals must be tied together.

Analog Voltage Input Connection



Analog Current Input Connection



Note:

-  For optimal metering performance, it is recommended to connect analog input common to terminal 49 (BATT -).

P0071-65

Figure 10. Analog Engine Sender Voltage Input Connections

CAN Connections

Typical CAN connections are shown in Figure 11 and Figure 12.

Note

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

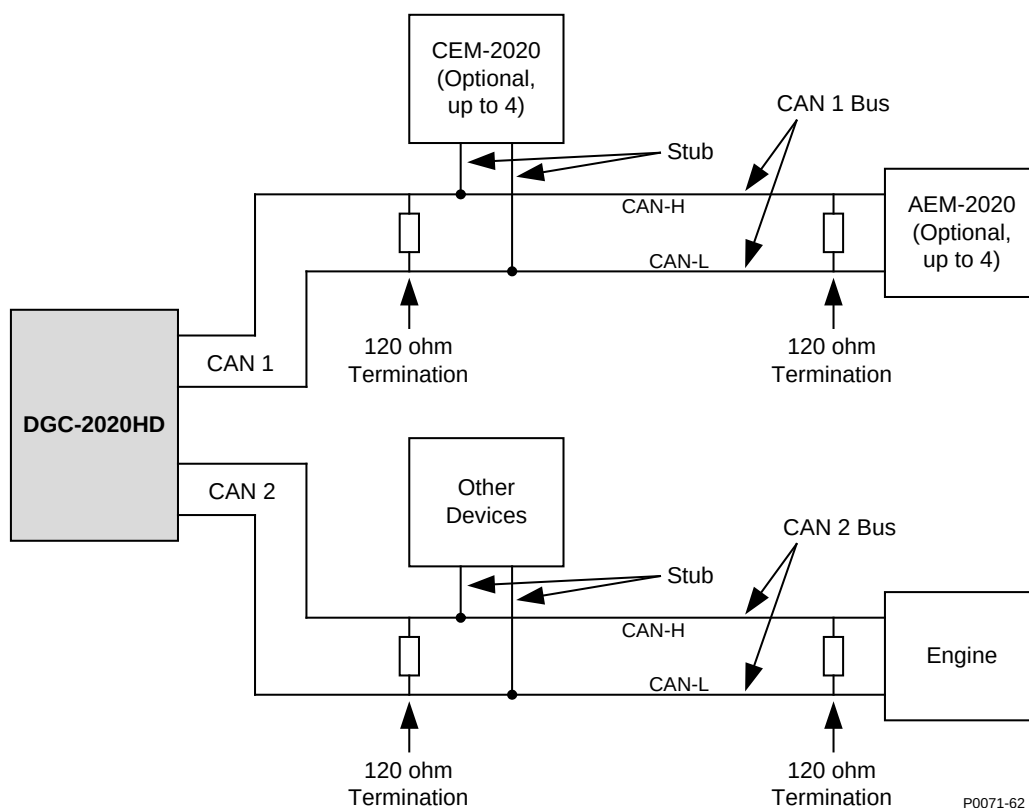


Figure 11. CAN Interface with DGC-2020HD Providing One End of the Bus

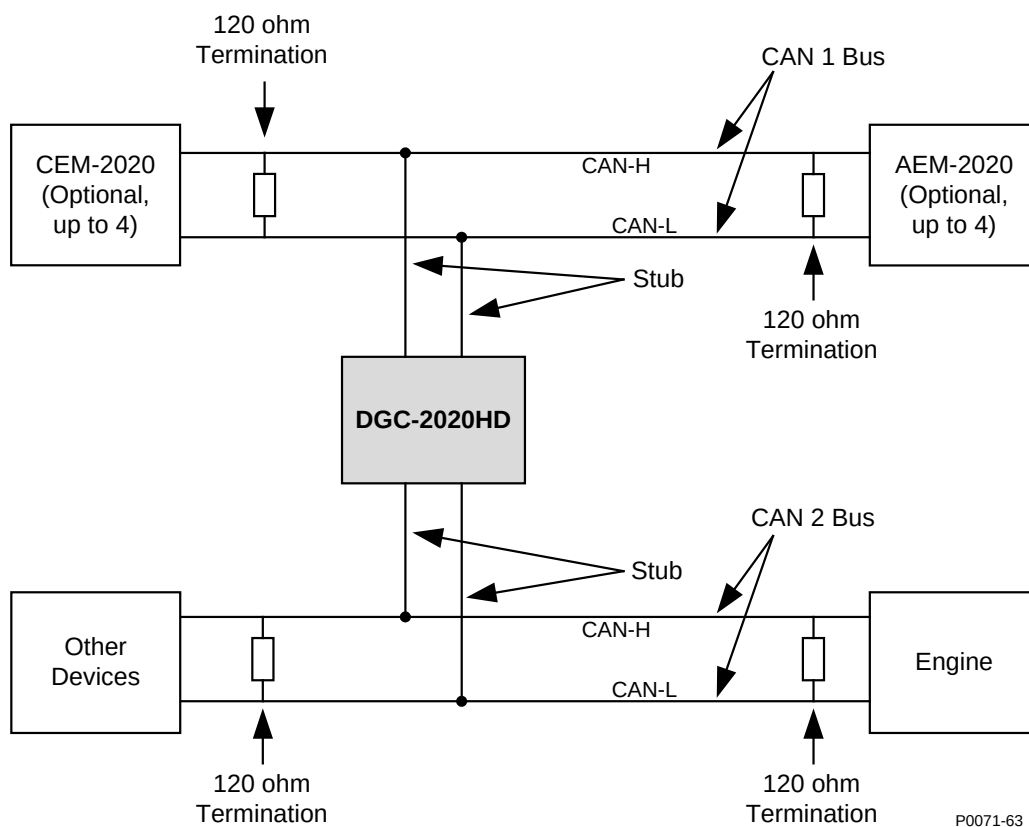


Figure 12. CAN Interface with Other Devices Providing One End of the Bus.

Expansion Module Connections (CAN 1)

The AEM-2020 (Analog Expansion Module) and CEM-2020 (Contact Expansion Module) are optional modules that may be installed 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, and CEM-2020. Up to four CEM-2020 modules and up to four AEM-2020 modules are supported on a network. Typical connections are illustrated in Figure 13.

Refer to the *AEM-2020* and *CEM-2020* chapters for more information.

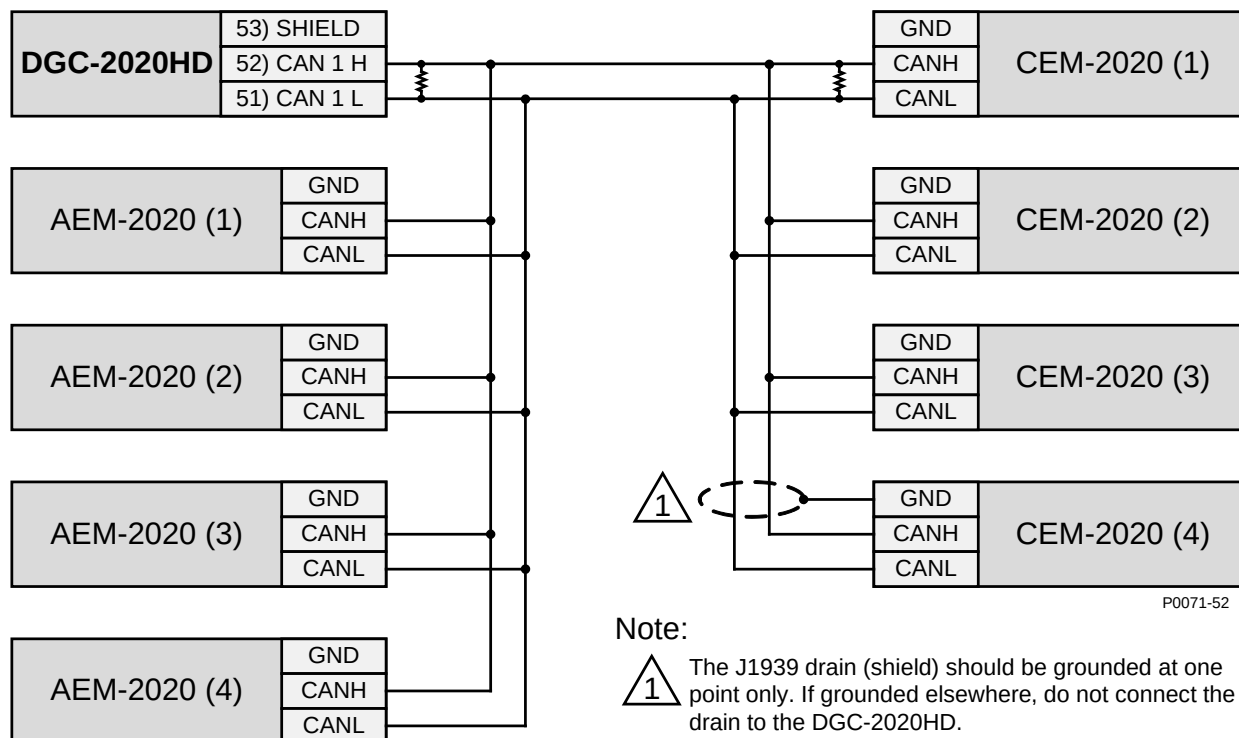


Figure 13. DGC-2020HD Expansion Module CAN Connections

Installation for CE Systems

For CE compliant systems, it may be required to route ac voltage and current sensing wires separately from other wires.



Controls and Indicators

DGC-2020HD controls and indicators are located on the front panel and are intended for local control and monitoring of DGC-2020HD operation. Front panel controls consist of sealed membrane pushbuttons. Front panel indicators consist of LED (light emitting diode) indicators and a backlit LCD (liquid crystal display).

DGC-2020HD controls and indicators are illustrated in Figure 14. Lettered locators in Figure 14 correspond to the control and indicator descriptions of Table 20.

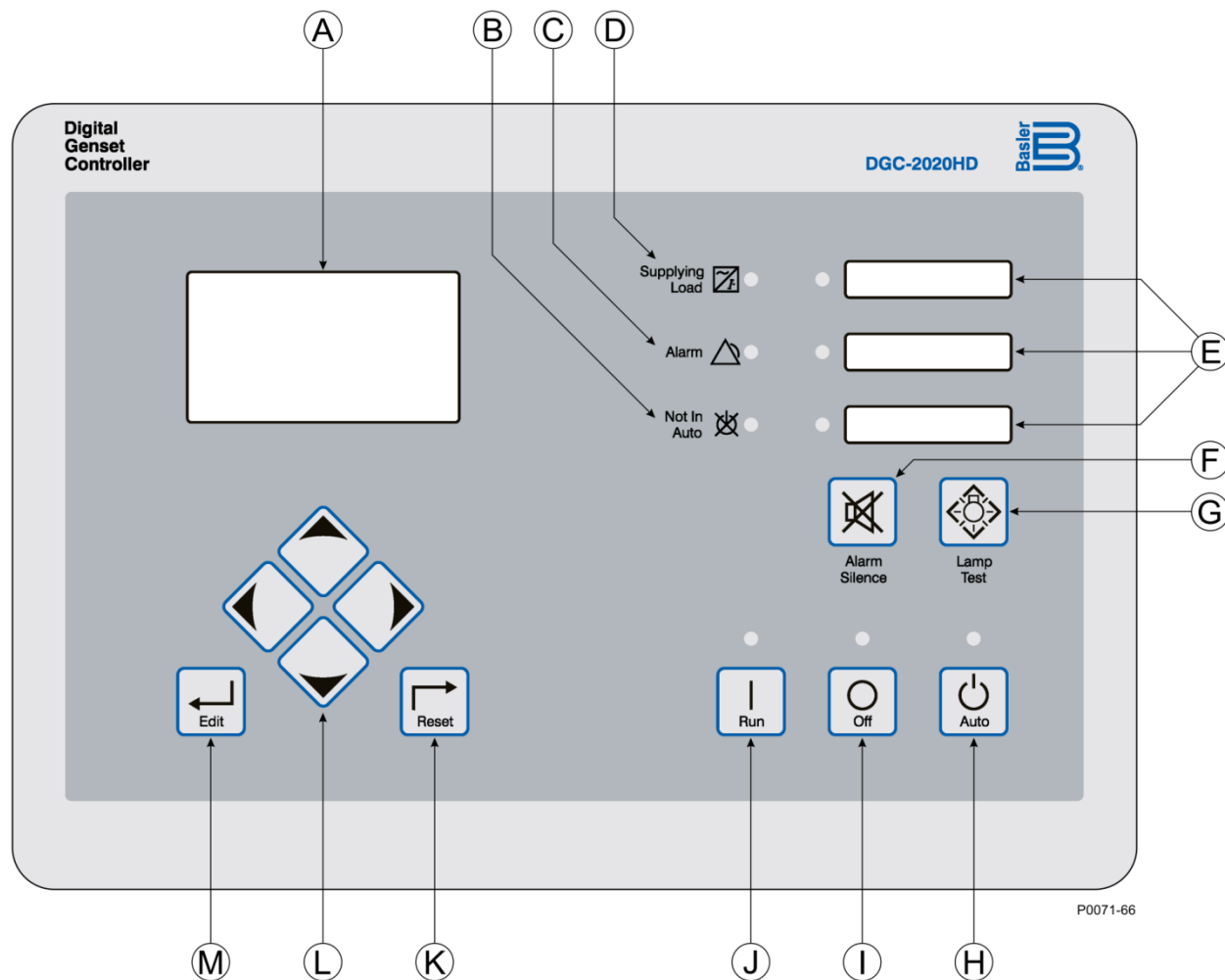


Figure 14. Front Panel Controls and Indicators

Table 20. Front Panel Control and Indicator Descriptions

Locator	Description
A	<i>Liquid Crystal Display.</i> The backlit, 64 by 128 pixel LCD serves as the local information source for metering, alarms, pre-alarms, and protective functions. Display operation is maintained down to –40°F (–40°C).
B	<i>Not in Auto Indicator.</i> This red LED lights when the DGC-2020HD is not operating in Auto mode.
C	<i>Alarm Indicator.</i> This red LED lights continuously during alarm conditions and flashes during pre-alarm conditions.
D	<i>Supplying Load Indicator.</i> This green LED lights when the generator current is greater than emergency power supply (EPS) threshold current.
E	<i>Programmable Indicators.</i> These red LEDs light when the corresponding logic element is set true. Logic element PROGLED 1 controls the upper LED, PROGLED2 controls the middle LED, and PROGLED3 controls the lower LED. A card is provided for labeling the programmable indicators. See <i>Programmable Indicator Configuration</i> , below.
F	<i>Alarm Silence Pushbutton.</i> Pressing this button opens the relay output programmed as the horn output.
G	<i>Lamp Test Pushbutton.</i> Pressing this button tests the DGC-2020HD indicators by exercising all LCD pixels and lighting all LEDs.
H	<i>Auto Pushbutton and Mode Indicator.</i> Pressing the Auto button places the DGC-2020HD in Auto mode. The green Auto mode LED lights when Auto mode is active.
I	<i>Off Pushbutton and Mode Indicator.</i> Pressing this button places the DGC-2020HD in Off mode. The red Off mode LED lights when the DGC-2020HD is in Off mode. This button also resets the Breaker Management Pre-Alarms and all MTU ECU Alarms.
J	<i>Run Pushbutton and Mode Indicator.</i> Pressing this button places the DGC-2020HD in Run mode. The green Run mode LED lights when Run mode is active.
K	<i>Reset Pushbutton.</i> This button is pressed to cancel a settings editing session and discard any settings changes. When pressed momentarily, this button also resets the Breaker Management Pre-Alarms and all MTU ECU Alarms. This button is also used to reset the Maintenance Interval when pressed for 10 seconds while viewing Hours Until Maintenance or Maintenance Due Pre-Alarm.
L	<i>Arrow Pushbuttons.</i> These four buttons are used to navigate through the front panel display menus and modify settings. The left- and right-arrow buttons are used to navigate through the menu levels. The right-arrow button is pressed to move downward through the menu levels and the left-arrow button is pressed to move upward through the menu levels. Within a level, the up- and down-arrow buttons are used to move among items within the menu level. Pressing the down-arrow button moves to items lower in the list. Pressing the up-arrow button moves to items higher in the list. During a settings editing session, the up- and down-arrow buttons are used to raise and lower the value of the selected setting.
M	<i>Edit Pushbutton.</i> Pressing this button starts an editing session and enables changes to DGC-2020HD settings. At the conclusion of an editing session, the Edit pushbutton is pressed again to save the setting changes.

Programmable Indicator Configuration

Up to three LED indicators may be programmed to suit the needs of a particular application. A replaceable card (Figure 15) is provided that can be labeled to match the function of each programmable indicator.

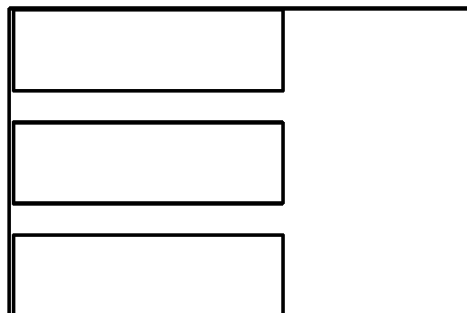


Figure 15. Programmable Indicator Label Card

Information about configuring DGC-2020HD logic to control the programmable indicators can be found in the BESTlogic™ *Plus* chapter.

To label the programmable indicators, perform the following steps.

1. Print the label text on readily-available address label sheets. The label card accommodates adhesive-backed labels measuring 0.5 by 1.75 inches. Avery part number 18167 is suitable for this purpose.
2. Remove all control power from the DGC-2020HD.
3. Remove the fasteners from the four mounting studs on the DGC-2020HD and separate it from the mounting panel or optional escutcheon plate. Disconnect the nine terminal block connectors; the Start, Run, and Pre relays; and the Ethernet (copper or fiber), USB, and DB-9 connectors.
4. Lay the front panel face-down on a suitable work surface.
5. Grasp the tab of the label card and pull free. The label card tab is located on the rear of the DGC-2020HD, see Figure 16. When facing the back of the panel, the label card tab is on the left.
6. Apply the labels created in step 1 to the label cards. The rectangle outlines on the label card serve as guides for attaching the labels.
7. After applying the new labels, insert the label card into the slot. Ensure that the label card is oriented properly by viewing the custom labels through the label windows of the front panel.
8. Move the DGC-2020HD adjacent to the mounting panel or optional escutcheon plate and reconnect the cables removed in step 3.
9. Secure the DGC-2020HD to the mounting panel or optional escutcheon plate with the fasteners removed in step 3. The torque applied to the mounting hardware should not exceed 20 inch-pounds or 2.2 newton meters.
10. If desired, verify the function of the programmed indicators before returning the DGC-2020HD to service.

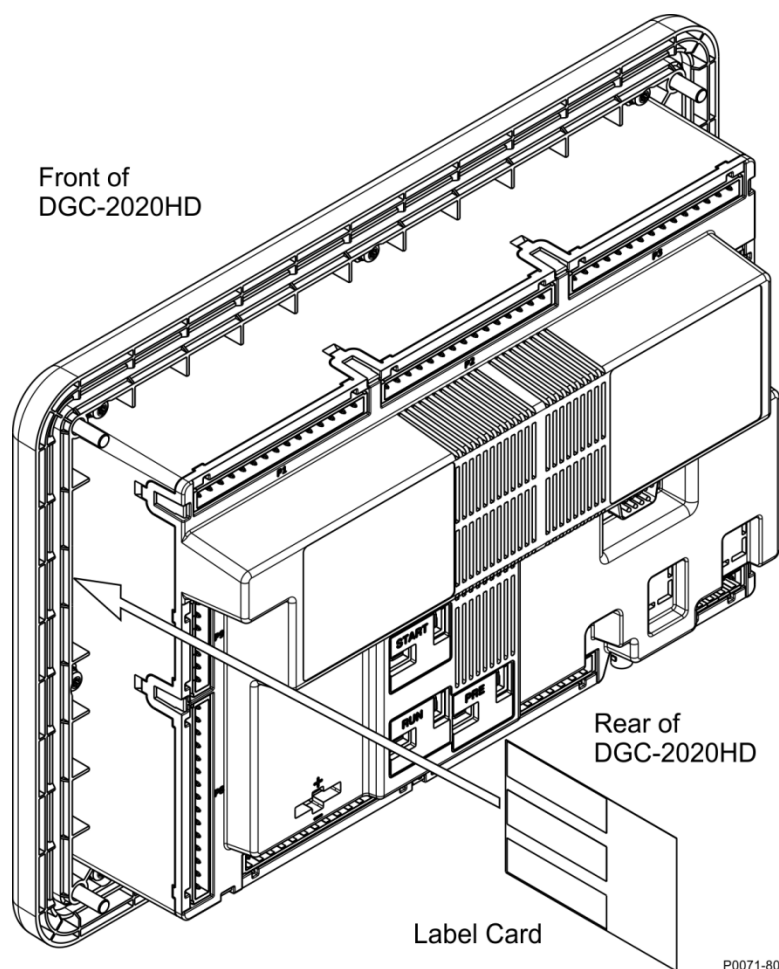


Figure 16. Label Card Slot Location

Display Operation and Navigation

The front panel display is used to locally make settings changes and display metering values. Refer to locators K, L, and M in Table 20 for information on changing settings through the front panel and navigating through the screens.

Login and Permissions

When attempting to change a protected setting, the DGC-2020HD displays the Login Required screen. To log in, use the *Up/Down* arrow keys to scroll through the characters. Use the *Left/Right* arrow keys to enter more characters. Once the user name and password have been entered, press the *Edit* key to login. To logout, press the *Reset* key while viewing any screen other than the Overview screen.

If communication access is active through the modem, USB, or Ethernet port, the front panel will display REMOTE COMMS and the overview screen. If the remote user is logged in to BESTCOMSP^{Plus} with "Control" security access or higher, the front panel can only be used for viewing metering data and settings information. Remote security access must be ended before modifying settings through the front panel.

Overview Screen and Configurable Metering

The overview screen is the uppermost screen in the menu structure and is displayed by default. It displays metering information as well as a one-line diagram of the system's breaker configuration. Metering information can be set to standard or scrolling. When set to standard, only the following parameters are displayed:

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

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

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

When the overview screen is set to scrolling, you can select/configure the metering values that are displayed. Up to 20 values can be displayed and these values will scroll at a delay time specified by the user. To select a scrolling overview, navigate to the Settings, General Settings, Front Panel HMI, Scrolled Metering screen and set the Scroll Enable setting to Enabled. The Scroll Delay setting is also found on this screen.

To select the scrolling values, navigate to the Settings, General Settings, Front Panel HMI screen and edit the Configurable Metering. The following parameters may be placed in the scrolling overview:

• Alarm Silence	• Contact Expansion Module 2 Inputs 1 to 10
• Alternate Frequency Override	• Contact Expansion Module 3 Inputs 1 to 10
• Analog Expansion Module 1 Inputs 1 to 8	• Contact Expansion Module 4 Inputs 1 to 10
• Analog Expansion Module 1 RTDs 1 to 8	• Contact Inputs 1 to 16
• Analog Expansion Module 1 Thermos 1 and 2	• Contact Output Prestart
• Analog Expansion Module 2 Inputs 1 to 8	• Contact Output Run
• Analog Expansion Module 2 RTDs 1 to 8	• Contact Output Start
• Analog Expansion Module 2 Thermos 1 and 2	• Contact Outputs 1 to 12
• Analog Expansion Module 3 Inputs 1 to 8	• Coolant Level Settings
• Analog Expansion Module 3 RTDs 1 to 8	• Coolant Pressure
• Analog Expansion Module 3 Thermos 1 and 2	• Coolant Temperature
• Analog Expansion Module 4 Inputs 1 to 8	• Cooldown and Stop Request
• Analog Expansion Module 4 RTDs 1 to 8	• Cooldown Request
• Analog Expansion Module 4 Thermos 1 and 2	• Cooldown Timer Active
• Analog Inputs 1 to 4	• Date
• Analog Output AVR	• Device ID
• Analog Output GOV	• Engine Load
• Analog Output LS	• Engine Running
• Battery Voltage	• Engine Speed (RPM)
• Boost Pressure	• EPS Supplying Load
• Bus1 average voltage	• External Start Delay
• Bus1 complex power Phase A	• Fuel Level / Diesel Exhaust Fluid Level
• Bus1 complex power Phase B	• Fuel Pressure
• Bus1 complex power Phase C	• Fuel Rate
• Bus1 Current Phase A	• Fuel Temperature
• Bus1 Current Phase B	• Generator average voltage
• Bus1 Current Phase C	• Generator complex power Phase A
• Bus1 Dead	• Generator complex power Phase B
• Bus1 Failed	• Generator complex power Phase C

- Bus1 Frequency
- Bus1 Max ROCOF
- Bus1 max vector shift
- Bus1 negative var hours total
- Bus1 negative Watt hours total
- Bus1 positive var hours total
- Bus1 positive Watt hours total
- Bus1 power factor Phase A
- Bus1 power factor Phase B
- Bus1 power factor Phase C
- Bus1 ROCOF
- Bus1 Stable
- Bus1 total complex power
- Bus1 total power factor
- Bus1 Total vars
- Bus1 Total Watts
- Bus1 vars Phase A
- Bus1 vars Phase B
- Bus1 vars Phase C
- Bus1 Voltage Connection
- Bus1 Voltage Phase A
- Bus1 Voltage Phase A to Phase B
- Bus1 Voltage Phase B
- Bus1 Voltage Phase B to Phase C
- Bus1 Voltage Phase C
- Bus1 Voltage Phase C to Phase A
- Bus1 volt-ampere hours total
- Bus1 Watts Phase A
- Bus1 Watts Phase B
- Bus1 Watts Phase C
- Bus2 average voltage
- Bus2 complex power Phase A
- Bus2 complex power Phase B
- Bus2 complex power Phase C
- Bus2 Current Phase A
- Bus2 Current Phase B
- Bus2 Current Phase C
- Bus2 Dead
- Bus2 Failed
- Bus2 Frequency
- Bus2 Max ROCOF
- Bus2 max vector shift
- Bus2 negative var hours total
- Bus2 negative Watt hours total
- Bus2 positive var hours total
- Bus2 positive Watt hours total
- Bus2 power factor Phase A
- Bus2 power factor Phase B
- Bus2 power factor Phase C
- Bus2 ROCOF
- Bus2 Stable
- Bus2 total complex power
- Bus2 total power factor
- Bus2 Total vars
- Bus2 Total Watts
- Generator Current Phase A
- Generator Current Phase B
- Generator Current Phase C
- Generator Dead
- Generator Failed
- Generator Frequency
- Generator Max ROCOF
- Generator max vector shift
- Generator negative var hours total
- Generator negative Watt hours total
- Generator positive var hours total
- Generator positive Watt hours total
- Generator power factor Phase A
- Generator power factor Phase B
- Generator power factor Phase C
- Generator ROCOF
- Generator Stable
- Generator total complex power
- Generator total power factor
- Generator Total vars
- Generator Total Watts
- Generator vars Phase A
- Generator vars Phase B
- Generator vars Phase C
- Generator Voltage Connection
- Generator Voltage Phase A
- Generator Voltage Phase A to Phase B
- Generator Voltage Phase B
- Generator Voltage Phase B to Phase C
- Generator Voltage Phase C
- Generator Voltage Phase C to Phase A
- Generator volt-ampere hours total
- Generator Watts Phase A
- Generator Watts Phase B
- Generator Watts Phase C
- Ground Current
- Idle Request
- Injector Rail Pressure
- Intake manifold temperature
- Intercooler Temperature
- kvar capacity
- kW Capacity
- Lamp Test
- Load Takeover
- Logic Control Relays 1 to 16
- LS Input
- Mains Fail Test
- Next to Start
- Next to Stop
- Number of Units
- Number of units online
- Off Mode Cooldown
- Oil Pressure
- Oil Temperature
- PF Mode

- Bus2 vars Phase A
- Bus2 vars Phase B
- Bus2 vars Phase C
- Bus2 Voltage Connection
- Bus2 Voltage Phase A
- Bus2 Voltage Phase A to Phase B
- Bus2 Voltage Phase B
- Bus2 Voltage Phase B to Phase C
- Bus2 Voltage Phase C
- Bus2 Voltage Phase C to Phase A
- Bus2 volt-ampere hours total
- Bus2 Watts Phase A
- Bus2 Watts Phase B
- Bus2 Watts Phase C
- Charge air temperature
- Contact Expansion Module 1 Inputs 1 to 10
- Reserve Available
- Reset
- Speed Source
- Start Delay Bypass
- Synchronizer breaker close OK
- Synchronizer phase angle OK
- Synchronizer slip frequency OK
- Synchronizer voltage OK
- Synchronizing
- System Manager
- Time
- Total kvar Generated
- Total kW Generated
- Total Run Time
- Var Mode
- Watt Demand

Sleep Mode

Sleep mode de-energizes the LCD backlight and heater when no pushbutton activity is detected for the duration of the LCD Backlight Timeout delay. To enter sleep mode, the DGC-2020HD must be operating in OFF mode or Auto mode with the engine not running. Normal display operation resumes when any pushbutton is pressed or the genset is started remotely via the ATS input. Sleep mode is not entered while an alarm is active. Sleep mode can be permanently disabled through BESTCOMSP^{Plus}® or the front panel.

Changing a Setting

To change a setting, navigate to the setting you want to change and press the *Edit* key. If you are not already logged in, you will be prompted for your password. Use the *Up/Down* arrow key to raise or lower the value. Press the *Edit* key again when finished.

Front Panel Display Structure

The front panel display structure begins with the Overview Screen. Pressing the *Right* arrow key opens the Main Menu screen. The Main Menu screen consists of Metering, Settings, and Summary. Metering screens primarily display specific metering information. Settings screens primarily contain settings for configuring the DGC-2020HD. Summary screens display metering information pertaining to breaker management. It also contains generator and mains breaker controls. The display structure of these screens is provided below.

Metering	
•	Engine
o	Oil Pressure
o	Coolant Temperature
o	Battery Voltage
o	Engine Speed
o	Speed Source
o	Fuel Level
o	Engine Load
o	Coolant Level
o	Total Run Time
o	Hours to Maintenance
o	DEF Tank 1 Level (Visible when ECU Type is Standard, Volvo Penta, MTU SMC, MTU ADEC, GM/Doosan, Cummins, MTU SMC)
o	DEF Tank 2 Level (Visible when ECU Type is Standard, Volvo Penta, MTU SMC, MTU ADEC, GM/Doosan, Cummins, MTU SMC)

- **Gen**
 - o Voltage
 - o Current
 - o Frequency
 - o Power
 - o Energy
 - o Vector Shift
- **Bus 1**
 - o Voltage
 - o Current
 - o Frequency
 - o Power
 - o Energy
 - o Vector Shift
- **Bus 2**
 - o Voltage
 - o Current
 - o Frequency
 - o Power
 - o Energy
 - o Vector Shift
- **Bias Control**
 - o Var Mode
 - o PF Mode
 - o Op Baseload Level
 - o Op kvar Setpoint
 - o Op PF Setpoint
- **Run Statistics**
 - o Cumulative
 - o Session
- **Synchronization**
- **Status**
 - o Alarms
 - o Pre-Alarms
 - o MTU Fault Codes (Only visible when ECU is configured for MTU MDEC, ADEC, ECU7/8, or Smart Connect.)
 - o MTU Status (Only visible when ECU is configured for MTU MDEC, ADEC, ECU7/8, or Smart Connect.)
 - o Status
 - o Bus Condition
 - o Mains Fail Transfer State
 - o Inputs
 - o Outputs
 - o Logic Control Relays
 - o Configurable Protection
 - o Configurable Elements
 - o J1939 Data (Visible when ECU Type is Standard, Volvo Penta, GM/Doosan, Cummins, MTU ADEC, MTU SMC)
 - o J1939 Engine Config (Visible when ECU Type is Standard, Volvo Penta, GM/Doosan, Cummins, MTU ADEC, MTU SMC)
 - o DTC Active Data (Visible when DTC support is enabled)
 - o DTC Prev Data (Visible when DTC support is enabled)
 - o Gen Network Status
 - o Gen Sequencing Status
 - o Real Time Clock
- **Event Log**
 - o Show Log
 - o Reset

- **Reports**
 - Sequence of Events
 - Security Log
- **Diagnostics**
 - Control
 - Load Share Line
 - AEM-2020
 - CEM-2020

Settings

- **General Settings**
 - Front Panel HMI
 - Clock Setup
 - Access Control
 - Device Information
 - Display Units
- **Communication**
 - Ethernet
 - Ethernet 2 (Visible when redundant Ethernet is disabled.)
 - CAN Bus 1 (I/O) Setup
 - CAN Bus 2 (ECU) Setup
 - Modem Setup
 - RS232 Setup
 - RS485 Setup
 - Modbus Setup
- **System Parameters**
 - System Settings
 - Exercise Timer
 - Rated Data
 - Remote Module Setup
 - Sensing Transformers
 - Crank Settings
 - Auto Restart
 - Relay Control
 - Auto Config Detect
 - Engine Statistics
- **Alarm Configuration**
 - Horn Configuration
 - Pre-Alarms
 - Alarms
 - Sender Fail
- **Report Configuration**
 - Data Log
 - Trending
- **Protection**
 - Settings Group 0
 - Settings Group 1
 - Settings Group 2
 - Settings Group 3
 - Configurable Protection
- **Breaker Management**
 - Breaker Hardware
 - Bus Condition
 - Synchronizer
- **Bias Control**
 - AVR Bias Control
 - GOV Bias Control

- **Multigen Management**
 - o AVR Output
 - o GOV Output
 - o LS (Load Share) Output
 - o Demand Start/Stop
 - o Sequencing
 - o Network Configuration
- **Programmable Inputs**
 - o Contact Inputs
 - o Analog Inputs
 - o Remote Contact Inputs
 - o Remote Analog Inputs
 - o Remote RTD Inputs
 - o Remote Thermocouple Inputs
 - o Programmable Functions
- **Programmable Outputs**
 - o Configurable Elements
 - o Remote Analog Outputs
- **Logic**
 - o Logic Timers (1-8)
 - o Logic Timers (9-16)
 - o Logic Counters

Summary

- | |
|--|
| <ul style="list-style-type: none"> • System Configuration One-Line Diagram • Mains Fail St (Status) <ul style="list-style-type: none"> o Mains Fail St (Status) o Transfer Delay o Return Delay o Max Transfer Time o Max Parallel Time o Open Transition Delay • Gen VLL • Gen Hz • Gen Aac • kW • kvar • PF (Power Factor) • PF Lead/Lag • Bus1 VLL • Bus1 Hz • Bus2 VLL (optional) • Bus2 Hz (optional) • GB Command <ul style="list-style-type: none"> o Open, Close, or None • MB Command <ul style="list-style-type: none"> o Open, Close, or None |
|--|

System Configuration One-Line Diagram

A one-line diagram of the system breaker configuration is displayed on the front panel. This diagram changes in real time to reflect the current state of the breakers.

The one-line diagram appears on both the front panel Overview and Summary screens. The Summary screen provides metering for generator and bus parameters as well as breaker controls. The one-line diagram is displayed at the top, generator and bus parameters are displayed below that, and breaker

controls are displayed at the bottom. To send a breaker open or breaker close request, select the appropriate menu option and press Edit.

Figure 17, below, illustrates the different configurations of the one-line diagram.

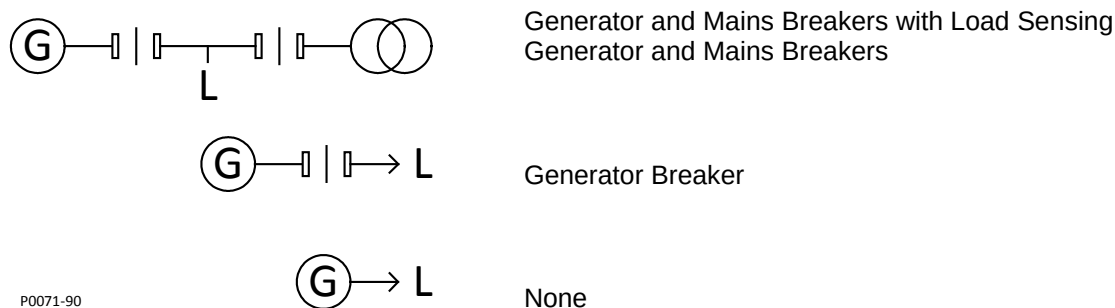
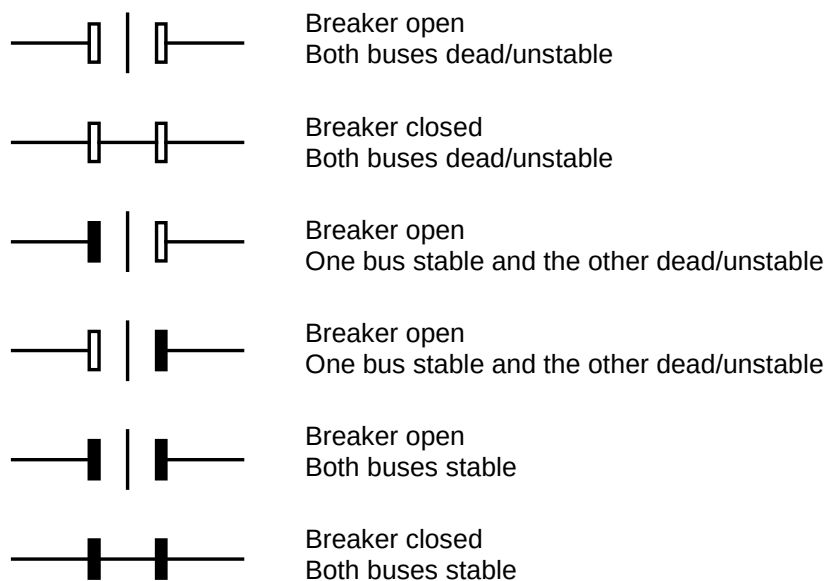


Figure 17. System Configuration One-Line Diagrams

The diagrams in Figure 17 show all breakers in the open position and all buses in a dead/unstable state. Breaker and bus states in the diagram change in real time to reflect the actual breaker and bus status. When a breaker is open, the line between the contacts is vertical and when closed the line is horizontal. A stable bus is indicated by a filled rectangle and a bus in any state other than stable is indicated by an unfilled rectangle. See Figure 18 for the different breaker and bus states.



P0071-91

Figure 18. One-Line Diagram Breaker and Bus States

Generator Network Status Display

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

Generator network status is found on the front panel under *Metering*, *Status*, *Gen Network Status*.

- System Manager is the sequencing ID of the machine that controls all dead bus arbitration and generator sequencing. This ID is always assigned to the machine on the network that has the lowest nonzero value of sequencing ID.
- Number of Units indicates the number of units on the generator network. The sequencing IDs of all machines on the network are listed as ID1:, ID2:, etc.
- Number of Units Online indicates the number of generators that are online. A generator is considered to be online when it is running, its generator breaker is closed, and it is participating in load sharing and communications within the system of generators.
- kW Capacity is the total true power capacity of all the generators currently online.
- kvar capacity is the total reactive power capacity of all the generators currently online.
- Total kW is the total true power currently generated by all the generators currently online.
- Total kvar is the total reactive power currently generated by all the generators currently online.

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

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

KW Capacity, kvar Capacity, Total kW, and Total kvar parameters are available to the Configurable Protection function and may be useful for implementing load sharing schemes. Refer to the *Configurable Protection* chapter for more information.

Display Setup

BESTCOMSPlus® Navigation Path: Settings Explorer, General Settings, Front Panel HMI

Front Panel Navigation Path: Settings > General Settings > Front Panel HMI

The DGC-2020HD LCD can be customized to fit the needs of your specific application. Most of the options can be adjusted using the front panel buttons while all options can be adjusted within BESTCOMSPlus. The display options are described below. Figure 19 shows the BESTCOMSPlus Front Panel HMI settings screen. Settings are listed in Table 21.

LCD Contrast

Adjust this setting to compensate for your LCD viewing angle, the available ambient light, or the ambient temperature. This setting accepts values from 0 to 100, in increments of 1 percent.

Invert Display

When enabled, the LCD background is dark with light text.

Sleep Mode

Select *enabled* to send the DGC-2020HD into sleep mode during periods of inactivity to minimize battery drain.

LCD Backlight Timeout

When Sleep Mode is enabled, this setting dictates the amount of time that must elapse before the DGC-2020HD enters sleep mode. This setting accepts values from 1 to 120, in increments of 1 minute.

Language Selection

Front panel text is displayed in the selected language. Select English, French, Spanish, or German.

Scrolling Screens

If a different overview screen for the LCD is desired, specify the scrolling screens in which parameters are configured to appear on the front panel LCD display.

1. Configure the *Scrollable Metering Settings*.
2. Set *Enable Scroll* to *Enabled*.
3. Set the *Scroll Time Delay* parameter to the desired value.

Figure 19. Front Panel Settings Screen

Table 21. Settings for Front Panel Settings Screen

Locator	Setting	Range	Increment	Unit
A	Contrast Value	0 to 100	1	%
B	Sleep Mode	Enabled or Disabled	n/a	n/a
C	LCD Backlight Timeout	1 to 120	1	minutes
D	Language Selection	English, French, Spanish, or German	n/a	n/a
E	Enable Scroll	Enabled or Disabled	n/a	n/a
F	Scroll Time Delay	1 to 600	varies	seconds
G	Phase Toggle Delay	0 to 120	1	seconds



Power Input

Operating 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. Operating 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 must be implemented in the battery input circuit to the DGC-2020HD.



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 22.

Table 22. 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 23.

Table 23. 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 1xxxxxxx indicates 1 Aac nominal current sensing and a style number of 5xxxxxxx indicates 5 Aac nominal current sensing. Generator current sensing terminals are listed in Table 24 and load bus current sensing terminals are listed in Table 25.

Table 24. 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 25. 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.

Engine Sender Inputs

The DGC-2020HD has sender inputs dedicated to monitoring the engine fuel level, oil pressure, and coolant temperature. These inputs are programmable to give the user flexibility in selecting the sender to be used in an application. Information about programming sender inputs is provided later in this chapter.

Connections

Fuel Level sender connections are made at terminals 71 and 72. Oil pressure sender connections are made at terminals 74 and 75. Coolant Temperature sender connections are made at terminals 77 and 78.

Compatibility

The resistance ranges of the following senders are compatible with the DGC-2020HD. A compatible Fuel Level sender is the Isspro model R8925. Oil pressure senders compatible with the DGC-2020HD include Datcon model 02505-00, Isspro model R8919, Stewart-Warner models 279BF, 279C, 411K and 411M, and VDO models 360025 and 360811. Compatible Coolant Temperature senders include Datcon model 02019-00, Faria model TS4042, Isspro model, R8959, and Stewart-Warner model 334P. Other senders with matching resistance ranges may also be used.

Operation

A current is provided to each sender. The developed voltage is measured and scaled for use by the internal circuitry. An open circuit or short circuit across the sender terminals will cause the DGC-2020HD to indicate a failed sender.

Programmability

BESTCOMS*Plus*® software allows for the programming of sender characteristics. See *Sender Characteristic Curves*, below, for more information.

Characteristic Curves

The sender inputs of the DGC-2020HD can be customized to obtain maximum accuracy from the coolant temperature, oil pressure, and fuel level senders.

The characteristic curve of each sender input can be configured with up to 11 points. Each point can be assigned a resistance input value and a corresponding temperature (coolant temperature sender), pressure (oil pressure sender), or percentage (fuel level sender) value. A slope setting automatically orders the values in the resistance column according to whether the sender requires a negative or positive slope. Sender curve points are automatically plotted on a curve in BESTCOMS*Plus*, which can be printed.

Sender curve points configured in BESTCOMS*Plus* can be saved in the configuration file. The data for all three senders is automatically saved with the DGC-2020HD configuration file.

Any changes made in BESTCOMS*Plus* to the sender points can be reverted to the factory-default values. A new settings file can also be created.

Curve Configuration

If the DGC-2020HD receives engine information from an engine ECU, the programmable sender parameters for coolant temperature and oil pressure do not require configuration because they have no effect. Configuration of sender parameters is necessary for resistive senders only.

Fuel Level

BESTCOMSPlus® Navigation Path: Settings Explorer, Programmable Senders, Percent Fuel Level

Front Panel Navigation Path: Not available through the front panel

Figure 20 illustrates the *Fuel Level* screen found in BESTCOMSPlus. Settings are listed in Table 26. To program the fuel level sender, perform the following procedure:

1. Click on *Load Fuel Settings File* and select the appropriate sender file from the list.
2. If no sender file matches the sender being used, the individual points that correlate resistance to fuel level may be modified. This can be achieved by setting numeric values in the table or dragging the points of the graph to the desired characteristic. Information on sender characteristics should be obtained from the sender manufacturer.
3. Select *Positive* or *Negative* sender slope as required for the desired sender graph.
4. Click *Save Fuel Data* to save the data in the current settings file.
5. If you want to save newly entered sender data as a sender library file, click *Create Fuel Settings File* and enter a file name and location to save the file.
6. Click the *Send Settings* button in BESTCOMSPlus to send the sender settings to the DGC-2020HD.

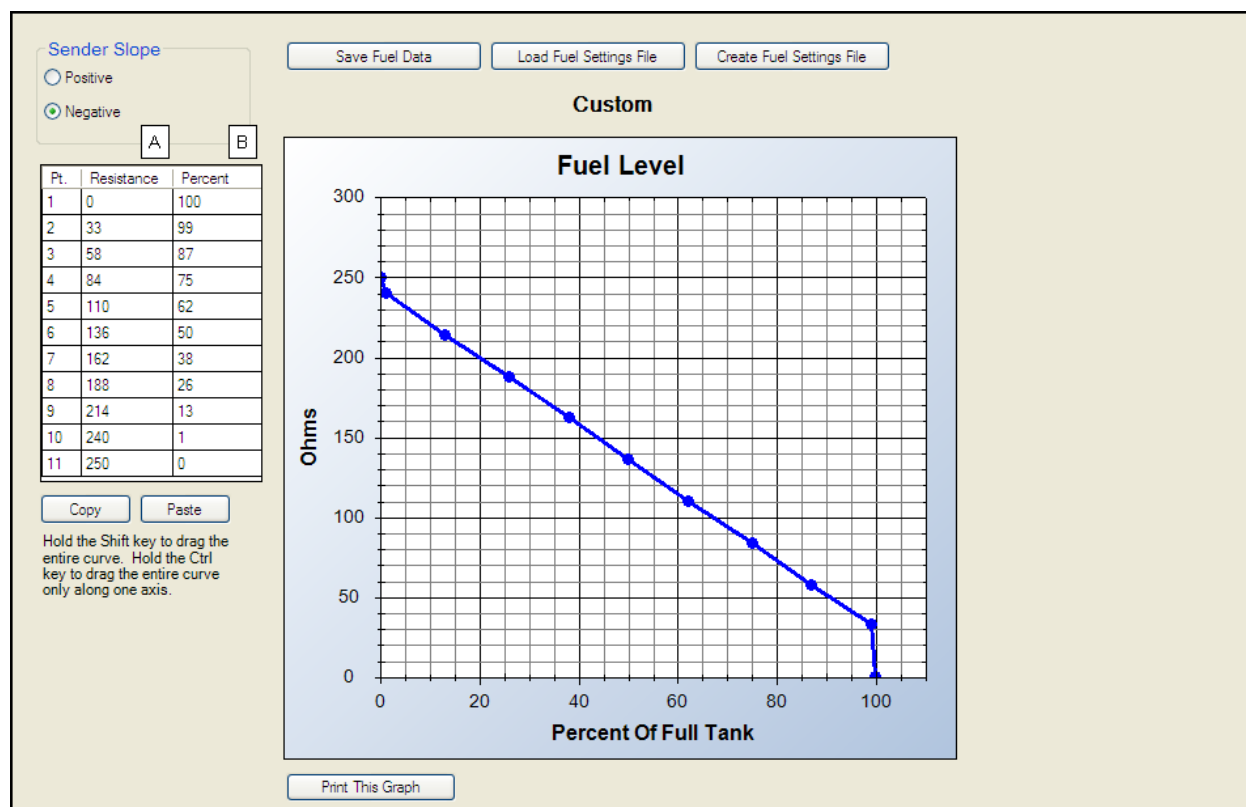


Figure 20. Settings Explorer, Programmable Senders, Fuel Level Screen

Table 26. Settings for Fuel Level Screen

Locator	Setting	Range	Increment	Unit
A	Resistance	0 to 250	1	Ohms
B	Percent	0 to 150	1	%

Oil Pressure

BESTCOMSPlus® Navigation Path: Settings Explorer, Programmable Senders, Oil Pressure

Front Panel Navigation Path: Not available through the front panel

Figure 21 illustrates the *Oil Pressure* screen found in BESTCOMSPlus®. Settings are listed in Table 27. To program the oil pressure sender, perform the following procedure:

1. Click on *Load Oil Settings File* and select the appropriate sender file from the list.
2. If no sender file matches the sender being used, the individual points that correlate resistance to oil pressure level may be modified. This can be achieved by setting numeric values in the table or dragging the points of the graph to the desired characteristic. Information on sender characteristics should be obtained from the sender manufacturer.
3. Select *Positive* or *Negative* sender slope as required for the desired sender graph.
4. Click *Save Oil Data* to save the data in the current settings file.
5. If you want to save newly entered sender data as a sender library file, click *Create Oil Settings File* and enter a file name and location to save the file.
6. Click the *Send Settings* button in BESTCOMSPlus® to send the sender settings to the DGC-2020HD.

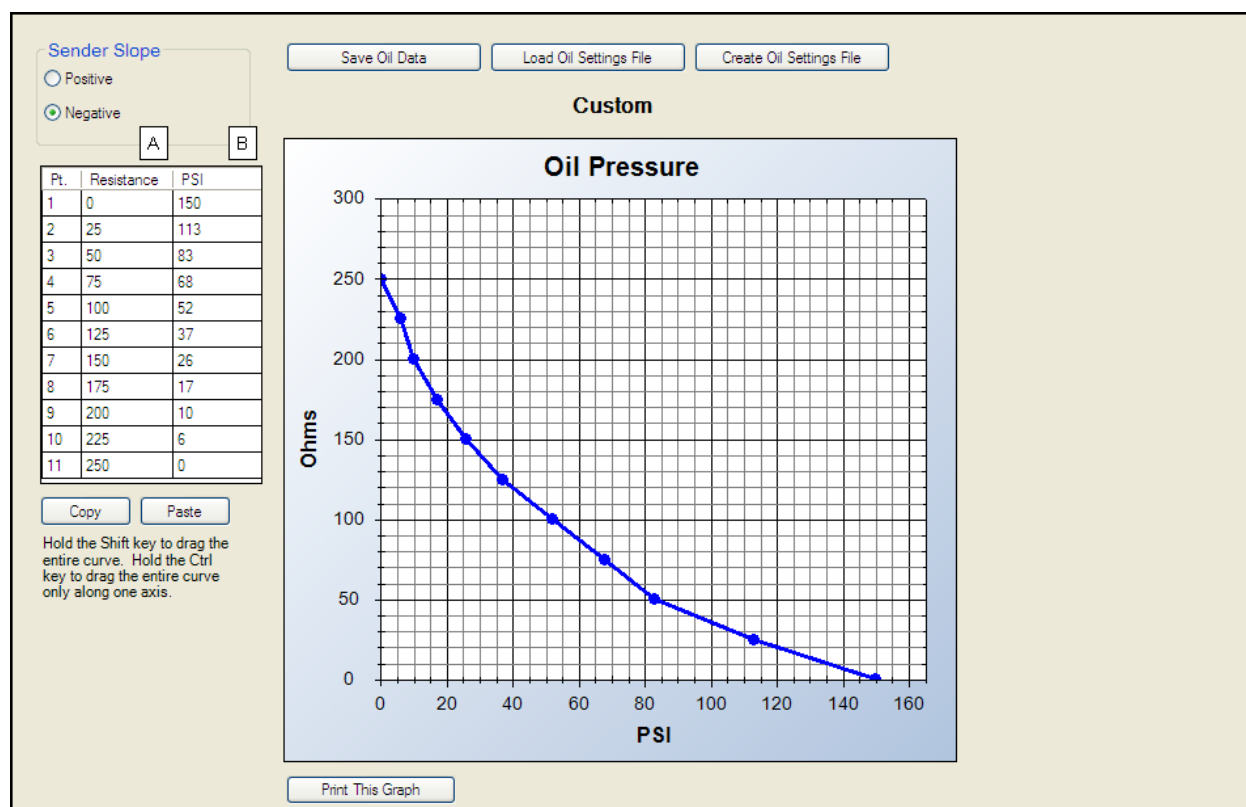


Figure 21. Settings Explorer, Programmable Senders, Oil Pressure Screen

Table 27. Settings for Oil Pressure Screen

Locator	Setting	Range	Increment	Unit
A	Resistance	0 to 250	1	Ohms
	PSI	0 to 250	1	psi
B	Bar	0 to 17.2	0.1	bar
	kPa	0 to 1,724	1	kPa

Coolant Temperature

BESTCOMSPlus® Navigation Path: Settings Explorer, Programmable Senders, Coolant Temperature

Front Panel Navigation Path: Not available through the front panel

Figure 22 illustrates the *Coolant Temperature* screen found in BESTCOMSPlus®. Settings are listed in Table 28. To program the coolant temperature sender, perform the following procedure:

1. Click on *Load Cool. Settings File* and select the appropriate sender file from the list.
2. If no sender file matches the sender being used, the individual points that correlate resistance to coolant temperature level may be modified. This can be achieved by setting numeric values in the table or dragging the points of the graph to the desired characteristic. Information on sender characteristics should be obtained from the sender manufacturer.
3. Select *Positive* or *Negative* sender slope as required for the desired sender graph.
4. Click *Save Cool. Data* to save the data in the current settings file.
5. If you want to save newly entered sender data as a sender library file, click *Create Cool Settings File* and enter a file name and location to save the file.
6. Click the *Send Settings* button in BESTCOMSPlus® to send the sender settings to the DGC-2020HD.

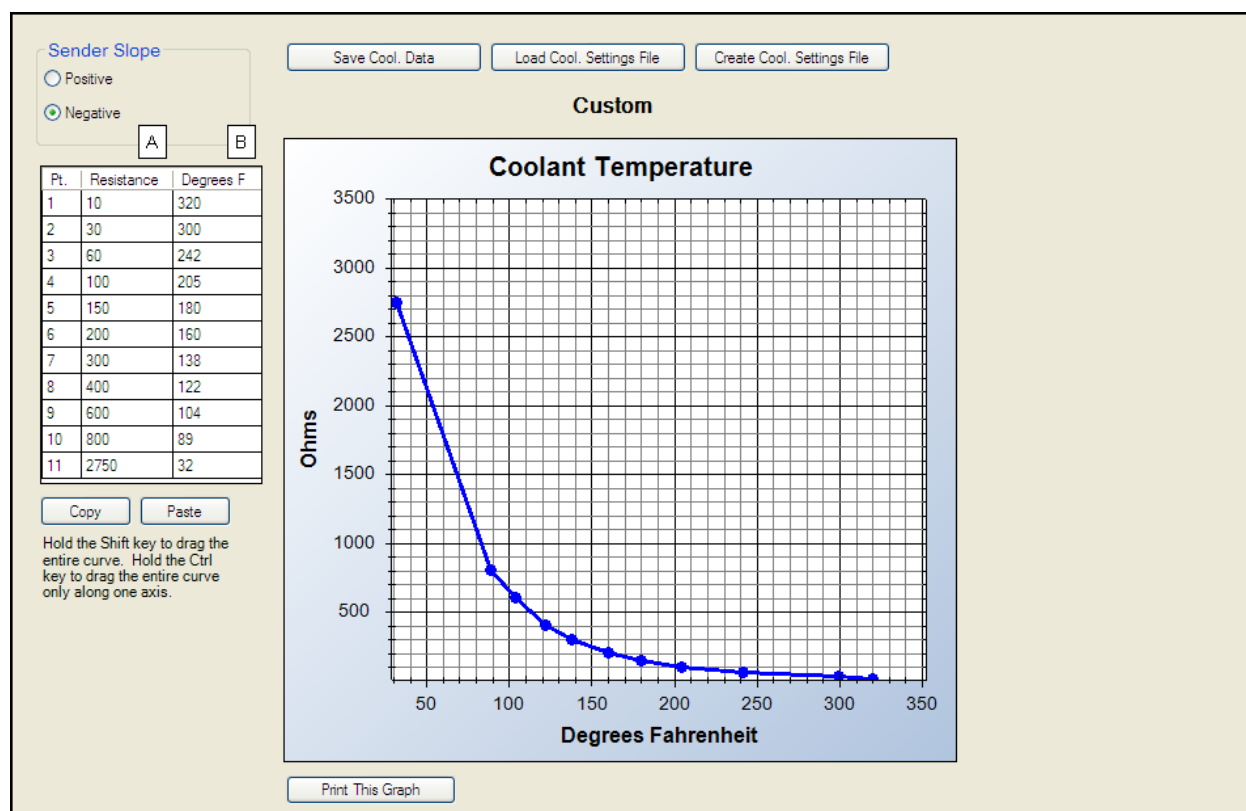


Figure 22. Settings Explorer, Programmable Senders, Coolant Temperature Screen

Table 28. Settings for Coolant Temperature Screen

Locator	Setting	Range	Increment	Unit
A	Resistance	10 to 2,750	1	Ohms
B	Degrees F	32 to 400	1	degrees F
	Degrees C	0 to 204	1	degrees C

Sender Failure Detection

The DGC-2020HD can be configured to annunciate a pre-alarm or alarm when a loss of signal is detected at the coolant temperature, oil pressure, or fuel level sender input. Loss of signal is determined differently for resistive senders than for analog senders. When the DGC-2020HD is equipped with resistive senders (style number xxxxxxxxR), an open or short across the input terminals is considered to be a loss of signal. When the DGC-2020HD is equipped with analog senders (style number xxxxxxxxA), any value outside of the user-defined range is considered a loss of signal. Refer to the *Analog Inputs* chapter for details on analog sender range settings.

The speed sender fail alarm is always enabled. A user-adjustable time delay is provided for each sender/sensing alarm/pre-alarm.

Alarm and pre-alarm annunciations for loss of engine speed signals are not user-programmable and operate as follows. If the MPU (magnetic pickup) or generator frequency is programmed as the sole engine speed source and that signal source fails, an alarm (and shutdown) is triggered. If the engine speed source is configured as MPU and generator frequency and a loss of one of the signal sources occurs, a pre-alarm is annunciated. An alarm (and shutdown) is triggered if both speed signals are lost.

The BESTCOMSP_{Plus} Sender Fail screen is illustrated in Figure 23 and is found in the *Settings Explorer* under *Alarm Configuration*.

Figure 23. Settings Explorer, Alarm Configuration, Sender Fail Screen

Table 29. Settings for Sender Fail Screen

Locator	Setting	Range	Increment	Unit
A	Alarm Configuration	Status Only, Pre-Alarm, or Alarm	n/a	n/a
B	Activation Delay	300 to 1,800	1	seconds
C	Alarm Configuration	Status Only, Pre-Alarm, or Alarm	n/a	n/a
D	Activation Delay	0 to 300	1	seconds
E	Alarm Configuration	Status Only, Pre-Alarm, or Alarm	n/a	n/a
F	Activation Delay	0 to 300	1	seconds

Locator	Setting	Range	Increment	Unit
G	Alarm Configuration	Status Only, Pre-Alarm, or Alarm	n/a	n/a
H	Activation Delay	0 to 300	1	seconds
I	Activation Delay	0 to 300	1	seconds

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).



Contact Inputs

Contact inputs are available to initiate DGC-2020HD functions. The DGC-2020HD has sixteen programmable contact sensing inputs. Additional contact inputs can be accommodated with up to four optional CEM-2020s (Contact Expansion Module). Contact Basler Electric for availability and ordering information.

Programmable Contact Inputs

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

- Auto Transfer Switch
- Battery Charger Fail
- Battle Override
- Emergency Stop
- Fuel Leak Detect
- Grounded Delta Override
- Low Coolant Level
- Low Line Override
- Single-Phase Override
- Single-Phase A-C Sense Override (available only when an input is configured for Single-Phase Override)

The programmable inputs accept dry contacts. A contact is connected between a programmable input and the negative side of the battery. Through *BESTCOMSPlus*[®], each programmable contact input can be assigned a programmable label (16 alphanumeric characters, maximum) and configured as an alarm input, a pre-alarm input, or status only. The default names for the inputs are INPUT_x (where x = 1 to 16). When a programmable contact input is closed, the front panel display shows the programmable label of the closed input if it was programmed as an alarm or pre-alarm input. Alarm inputs are annunciated through the Normal display mode screens of the front panel. Pre-alarm inputs are annunciated through the pre-alarm metering screen of the front panel. If neither alarm nor pre-alarm is programmed, no indication is given. Programming an input as *Status Only* is useful when a programmable input is used as an input to programmable logic.

The programmable label is also used when alarms or pre-alarms associated with an input are recorded in the event log.

Connections for the programmable inputs are provided at terminals 31 (Input 1) through 46 (Input 16). The negative side of the battery voltage (terminal 49) serves as the return connection for the programmable inputs.

Contact Input Configuration

BESTCOMSPlus Navigation Path: Settings Explorer, Programmable Inputs, Contact Inputs

Front Panel Navigation Path: Settings > Programmable Inputs > Contact Inputs

Figure 24 illustrates the *BESTCOMSPlus Contact Inputs* screen. Settings are listed in Table 30.

For each contact input, configure the following parameters:

1. **Alarm Configuration** - Select *Status Only*, *Alarm*, or *Pre-Alarm*. When an alarm occurs, the horn output closes, the engine shuts down, and the alarm is displayed on the front panel. The alarm is logged in the event log and sequence of events log. When a pre-alarm occurs, the horn output toggles between open and closed, the pre-alarm is displayed, flashing, on the front panel, and the engine remains running. The pre-alarm is logged in the event log and sequence of events log. If *Status Only* is selected, the corresponding input is set true in *BESTlogic™Plus* only. The status is available to *BESTlogicPlus* Programmable Logic regardless of the *Alarm Configuration* setting.

2. **Activation Delay** - This parameter defines the duration that the input must remain closed before any annunciation occurs.
3. **Label Text** - Enter descriptive text that signifies the use of the input. This text appears next to the input in BESTlogic™*Plus* Programmable Logic and in the event log if the input is configured as an alarm or pre-alarm.
4. **Contact Recognition** - Select whether the contact input should be recognized always, or only while the engine is running. For example, a switch closes when oil pressure is low. Such a switch would be closed when the engine is not running but a low oil pressure alarm or pre-alarm should not be annunciated unless the switch is closed while the engine is running. A selection of *While Engine Running Only* prevents spurious annunciation when the engine is not running.

Contact Inputs

Input #1
 Alarm Configuration: Status Only (A)
 Activation Delay (s): 0 (B)
 Label Text: INPUT 1 (C)
 Contact Recognition: Always (D)

Input #2
 Alarm Configuration: Status Only (A)
 Activation Delay (s): 0 (B)
 Label Text: INPUT 2 (C)
 Contact Recognition: Always (D)

Input #3
 Alarm Configuration: Status Only (A)
 Activation Delay (s): 0 (B)
 Label Text: INPUT 3 (C)
 Contact Recognition: Always (D)

Input #4
 Alarm Configuration: Status Only (A)
 Activation Delay (s): 0 (B)
 Label Text: INPUT 4 (C)
 Contact Recognition: Always (D)

Input #5
 Alarm Configuration: Status Only (A)
 Activation Delay (s): 0 (B)
 Label Text: INPUT 5 (C)
 Contact Recognition: Always (D)

Input #6
 Alarm Configuration: Status Only (A)
 Activation Delay (s): 0 (B)
 Label Text: INPUT 6 (C)
 Contact Recognition: Always (D)

Input #7
 Alarm Configuration: Status Only (A)
 Activation Delay (s): 0 (B)
 Label Text: INPUT 7 (C)
 Contact Recognition: Always (D)

Input #8
 Alarm Configuration: Status Only (A)
 Activation Delay (s): 0 (B)
 Label Text: INPUT 8 (C)
 Contact Recognition: Always (D)

Input #9
 Alarm Configuration: Status Only (A)
 Activation Delay (s): 0 (B)
 Label Text: INPUT 9 (C)
 Contact Recognition: Always (D)

Figure 24. Settings Explorer, Programmable Inputs, Contact Inputs Screen

Table 30. Settings for Contact Inputs Screen

Locator	Setting	Range	Increment	Unit
A	Alarm Configuration	Status Only, Pre-Alarm, or Alarm	n/a	n/a
B	Activation Delay	0 to 300	1	seconds
C	Label Text	Up to 16 alphanumeric characters	n/a	n/a
D	Contact Recognition	Always or While Engine Running Only	n/a	n/a

Programmable Functions

BESTCOMS^{Plus} Navigation Path: Settings Explorer, Programmable Inputs, Programmable Functions

Front Panel Navigation Path: Settings > Programmable Inputs > Programmable Functions

Any of the 16 contact inputs can be programmed to recognize any one of 10 function types:

- Automatic Transfer Switch (ATS) - Start and run the generator while the ATS input is true and the DGC-2020HD is in Auto mode.
- Grounded Delta Override - Uses Grounded Delta sensing if the generator connection is set for Delta.
- Battle Override - The alarms programmed to shut down the unit will be overridden and ignored.
- Low-Line Override - The 51, 27, and 59 settings are scaled by the low-line scale factor setting.
- Single-Phase Override - The unit switches to single-phase sensing configuration and uses the Single Phase Override Sensing setting (A-B or A-C).
- Single-Phase A-C Override - Indicates to the DGC-2020HD that the machine is configured for single-phase A-C. This is to be used in conjunction with the single-phase override programmable function.
- Emergency Stop - Opens the Start, Run, and Pre output relays and annunciates an ESTOP alarm.
- Battery Charger Fail - When the selected input is invoked, a user selectable pre-alarm or alarm is annunciated after the activation delay.
- Low Coolant Level - When the selected input is invoked, a Low Coolant Level pre-alarm or alarm is annunciated after the activation delay.
- Fuel Leak Detect - When the selected input is invoked, a Fuel Leak pre-alarm or alarm is annunciated after the activation delay.

An Alarm Configuration setting of *Status Only* prevents a function from being triggered by a contact input. Programmable function status is available in BESTlogicTM*Plus* Programmable Logic when the “None” alarm configuration setting is selected.

The BESTCOMS^{Plus} Programmable Functions screen is illustrated in Figure 25. Settings are listed in Table 31.

Programmable Functions

Auto Transfer Switch
 Input: A

Battle Override
 Input: A
 Contact Recognition: B

Emergency Stop
 Input: A

Grounded Delta Override
 Input: A
 Contact Recognition: B

Low Line Override
 Input: A
 Contact Recognition: B

Single Phase AC Override
 Input: A
 Contact Recognition: B

Single Phase Override
 Input: A
 Contact Recognition: B

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

Battery Charger Fail
 Input: A
 Alarm Configuration: D
 Activation Delay (s): E
 Contact Recognition: B

Fuel Leak Detect
 Input: A
 Alarm Configuration: D
 Activation Delay (s): E
 Contact Recognition: B

Low Coolant Level
 Input: A
 Alarm Configuration: D
 Activation Delay (s): E
 Contact Recognition: B

Figure 25. Settings Explorer, Programmable Inputs, Programmable Functions

Table 31. Settings for Programmable Functions

Locator	Setting	Range	Increment	Unit
A	Input	Contact Inputs 1 to 16 or None	n/a	n/a
B	Contact Recognition	Always or While Engine Running Only	n/a	n/a
C	Single Phase Override Sensing	A-B or A-C	n/a	n/a
D	Alarm Configuration	Status Only, Pre-Alarm, or Alarm	n/a	n/a
E	Activation Delay	0 to 300	1	seconds

Analog Inputs

Analog inputs provide metering for a variety of industrial transducers. An element can be configured to trip when the metered input increases above or decreases below the user-defined threshold.

DGC-2020HD units with the resistive sender option (style number xxxxxxxxR) are equipped with two analog inputs whereas units with the analog sender option (style number xxxxxxxxA) are equipped with four. The identical analog input protection elements are designated Analog Input #1, Analog Input #2, Analog Input #3 (optional), and Analog Input #4 (optional). Element logic connections are made on the BESTlogic™*Plus* screen in BESTCOMS*Plus*® and element operational settings are configured on the Analog Input #x (where x = 1 to 4 (3 and 4 optional)) settings screen in BESTCOMS*Plus*.

BESTCOMS*Plus* Navigation Path: Settings Explorer, Programmable Inputs, Analog Inputs

Front Panel Navigation Path: Settings Explorer > Programmable Inputs > Analog Inputs

Input Setup

Label Text

In order to make identification of the analog inputs easier, each of the inputs can be given a user-assigned label. The label is an alphanumeric string with a maximum of 16 characters.

Hysteresis

The hysteresis setting provides a level of hysteresis between a threshold detection tripping and dropping out. For instance, if the hysteresis is set for 5% and the threshold is set as an over threshold, once the threshold detection trips, the measured value must drop to 95% of the threshold before the threshold detection will drop out. This hysteresis helps prevent rapid or repeated transitions between trip and dropout in cases where the measured input is nearly equal to the threshold level.

If the threshold is set as an under threshold with 5% hysteresis, once the threshold detection trips, the measured value must rise to 105% of the threshold before the threshold detection will drop out.

Input Type

An analog input can be configured to monitor a voltage or current signal. Accepted ranges for the signals are –10 to 10 Vdc and 4 to 20 mA.

Arming Delay

A user-adjustable arming delay disables analog input protection during engine startup. If the arming delay is set to zero (0), the input protection is active at all times, including when the engine is not running. If the arming delay is set to a non-zero value, the input protection is inactive when the engine is not running, and does not become active until after the engine is started and the arming delay has elapsed.

Out-of-Range Alarm Type

An out-of-range alarm alerts the user of an open or damaged analog input wire.

Ranges

Ranges must be set for the selected input type. Param Min correlates to Min Input Current or Min Input Voltage and Param Max correlates to Max Input Current or Max Input Voltage.

Thresholds

There are four programmable thresholds for each analog input element. Each threshold has a mode setting, threshold setting, activation delay setting, and an alarm setting.

Mode

Mode can be set for Over, Under, or Disabled. If Over mode is selected, an alarm is annunciated when the metered input increases above the Threshold setting for the duration of the Activation Delay. If Under mode is selected, an alarm is annunciated when the metered input decreases below the Threshold setting for the duration of the Activation Delay.

Alarm Configuration

Each analog input protection threshold item can be independently configured to annunciate an alarm or pre-alarm, or be configured as status only when the metered input falls beyond the threshold. A user-adjusted activation delay setting delays alarm annunciation until after the threshold has been exceeded.

Operational Settings

Analog input protection operational settings are configured on the Analog Input #x (where x = 1 to 4 (3 and 4 optional)) settings screen (Figure 26) in BESTCOMSP^{Plus}. Settings are listed in Table 32.

Analog Input #1

Label Text: Analog Input 1 [A]

Arming Delay (s): 0 [D]

Hysteresis (%): 2.0 [B]

Out Of Range Alarm Type: Status Only [E]

Input Type: Voltage [C]

Ranges

Param Min: -999999 [F]

Min Input Current (mA): 4.0 [H]

Min Input Voltage (V): 0.0 [J]

Param Max: 999999 [G]

Max Input Current (mA): 20.0 [I]

Max Input Voltage (V): 10.0 [K]

Threshold #1

Mode: Disabled [L]

Threshold: 0.00 [M]

Activation Delay (s): 0 [N]

Alarm Configuration: Status Only [O]

Threshold #2

Mode: Disabled [L]

Threshold: 0.00 [M]

Activation Delay (s): 0 [N]

Alarm Configuration: Status Only [O]

Threshold #3

Mode: Disabled [L]

Threshold: 0.00 [M]

Activation Delay (s): 0 [N]

Alarm Configuration: Status Only [O]

Threshold #4

Mode: Disabled [L]

Threshold: 0.00 [M]

Activation Delay (s): 0 [N]

Alarm Configuration: Status Only [O]

Figure 26. Settings Explorer, Programmable Inputs, Analog Inputs, Analog input #1

Table 32. Settings for Analog Inputs

Locator	Setting	Range	Increment	Unit
<i>Input Setup</i>				
A	Label Text	16 alphanumeric characters	n/a	n/a
B	Hysteresis	0 to 100	0.1	%
C	Input Type	Voltage or Current	n/a	n/a
D	Arming Delay	0 to 300	1	seconds
E	Out of Range Alarm Type	Status Only, Pre-Alarm, or Alarm	n/a	n/a
<i>Ranges</i>				
F	Param Min	-999,999 to 999,999	varies	n/a
G	Param Max	-999,999 to 999,999	varies	n/a
H	Min Input Current	4 to 20	0.1	milliamps
I	Max Input Current	4 to 20	0.1	milliamps
J	Min Input Voltage	-10 to 10	0.1	volts
K	Max Input Voltage	-10 to 10	0.1	volts
<i>Threshold Settings 1 to 4</i>				
L	Mode	Disabled, Over, or Under	n/a	n/a
M	Threshold	-999,999 to 999,999	0.01	n/a
N	Activation Delay	0 to 300	1	seconds
O	Alarm Configuration	Status Only, Pre-Alarm, or Alarm	n/a	n/a

Logic Connections

Analog input protection logic connections are made on the BESTlogic*Plus* screen in BESTCOMS*Plus*. The Analog Input 1, Threshold 1 logic block is illustrated in Figure 27. The output is true during a trip condition. The alarm and pre-alarm logic blocks are similar.

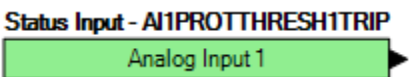


Figure 27. Analog Input Protection Logic Block



Contact Outputs

DGC-2020HD output contacts include PRE (Prestart), START, RUN, and 12 programmable outputs. Additional output contacts can be accommodated with up to four optional CEM-2020s (Contact Expansion Modules).

Output contact operation is controlled by the operating mode of the DGC-2020HD. The state of the Emergency Stop contact input also affects output contact operation. When the Emergency Stop contact input is open (emergency stop condition), the Prestart, Start, and Run outputs open and an emergency stop alarm is annunciated. When the Emergency Stop input is closed, all output contacts operate normally.

Prestart

This output closes to energize the engine glow plugs or run pre-lubrication pumps. The Prestart output can be programmed to close up to 30 seconds prior to engine cranking. The Prestart output can also be programmed to open upon engine startup or remain closed as long as the engine is operating.

During the resting state, the Prestart output can be set to Off, On, or Preheat Before Crank. If Preheat Before Crank is selected, the Prestart output will be closed for a time equal to the Pre-crank Delay prior to re-entering the cranking state. If the Pre-crank delay is set longer than the rest interval, the Prestart output will be closed for the entire rest time.

Prestart output connections are made through terminals located on the Prestart relay. See the *Terminals and Connectors* chapter for the location of the Prestart relay on the rear panel of the DGC-2020HD.

Start

This output closes when engine cranking is initiated by the DGC-2020HD and opens when the magnetic pickup (MPU) or generator frequency indicates that the engine has started. Prior to engine starting, the duration of cranking is determined by the cranking style (cycle or continuous) selected. Cycle cranking permits up to seven crank cycles, with each crank cycle having a duration of 5 to 15 seconds. The continuous crank time is adjustable from 5 to 60 seconds.

Start output connections are made through terminals located on the Start relay. See the *Terminals and Connectors* chapter for the location of the Start relay on the rear panel of the DGC-2020HD.

Run

This output closes when engine cranking is initiated by the DGC-2020HD. The Run output remains closed until it receives a command to stop the engine.

Run output connections are made through terminals located on the Run relay. See the *Terminals and Connectors* chapter for the location of the Run relay on the rear panel of the DGC-2020HD.

Relay Control

BESTCOMSPlus® Navigation Path: Settings Explorer, System Parameters, Relay Control

Front Panel Navigation Path: Settings > System Parameters > Relay Control

In some applications, it may be beneficial to modify the standard operation of the DGC-2020HD Run, Prestart, or Start relays. If desired, these relays can be configured to operate outside their predefined functionality. For example, if your genset does not require starting assistance from glow plugs, the Prestart relay may be assigned for another task. Configuring these relays as programmable makes them available in BESTlogic™ Plus programmable logic to be used in the same manner as the other programmable relay outputs. Predefined or programmable operation of the Run, Prestart, and Start relays

is selected on the Relay Control screen (Figure 28). See the *BESTlogicPlus* chapter for more information about DGC-2020HD programmable logic.

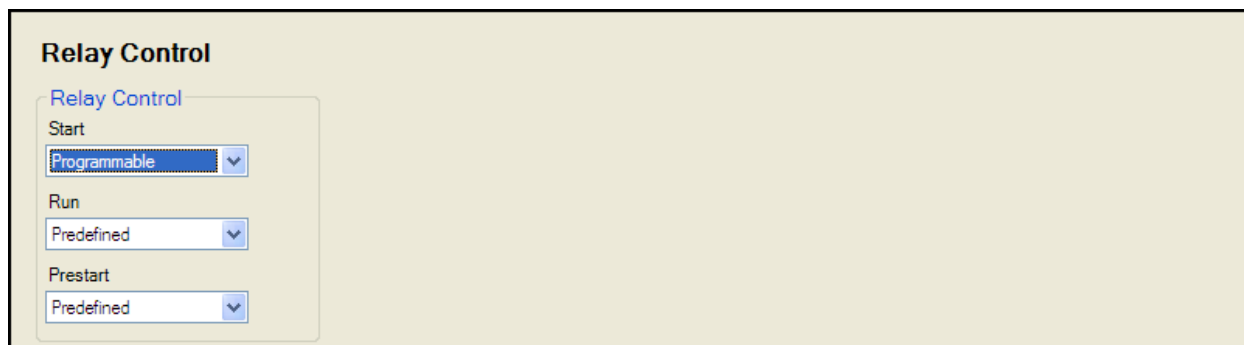


Figure 28. Settings Explorer, System Parameters, Relay Control Screen

The predefined functionality is available as an input to the logic. If *Programmable* is selected as the relay control mode, connecting the corresponding predefined input function to the relay causes it to function as if *Predefined* were selected as its relay control type. However, other logic can be combined with it to create operation that is more versatile. If *Programmable* is selected for a relay, but it is not used in the logic, that relay will never close.

An example logic scheme connecting the predefined inputs directly to the “programmable” relay outputs for all three relays is shown in Figure 29.

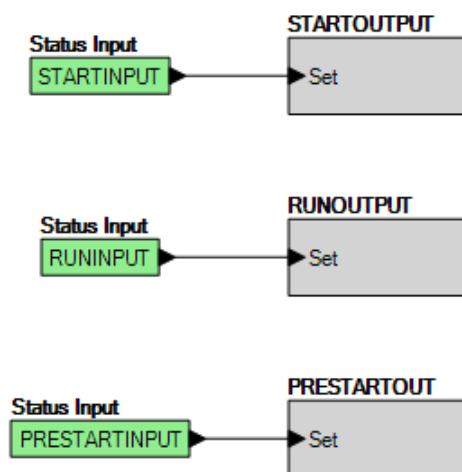


Figure 29. Example Logic Scheme of Programmable Relays

Programmable Contact Outputs

DGC-2020HD controllers have 12 programmable output contacts (OUT 1 through 12). An additional 24 contact outputs are provided with an optional CEM-2020 (Contact Expansion Module). An optional CEM-2020H (Contact Expansion Module - High Current) provides 18 contact outputs. Up to four CEM-2020s or CEM-2020Hs, in any combination, are supported by the DGC-2020HD.

Programmable Output Configuration

BESTCOMSPlus® Navigation Path: Settings Explorer, Programmable Outputs, Contact Outputs

Front Panel Navigation Path: Settings Explorer > Programmable Outputs > Contact Outputs

Figure 30 illustrates the *Contact Outputs* screen found in *BESTCOMSPlus*.

Each output can be programmed with a text label describing its use. Up to 16 alphanumeric characters are accepted. This label appears in *BESTlogicPlus* Programmable Logic where the output is used to aid in ease of programming and clarity.

Contact Outputs

Output #1 Label Text OUTPUT 1	Output #2 Label Text OUTPUT 2	Output #3 Label Text OUTPUT 3
Output #4 Label Text OUTPUT 4	Output #5 Label Text OUTPUT 5	Output #6 Label Text OUTPUT 6
Output #7 Label Text OUTPUT 7	Output #8 Label Text OUTPUT 8	Output #9 Label Text OUTPUT 9
Output #10 Label Text OUTPUT 10	Output #11 Label Text OUTPUT 11	Output #12 Label Text OUTPUT 12

Figure 30. Settings Explorer, Programmable Outputs, Contact Outputs

Configurable Elements

BESTCOMSPlus® Navigation Path: Settings Explorer, Programmable Outputs, Configurable Elements

Front Panel Navigation Path: Settings Explorer > Programmable Outputs > Configurable Elements

Configurable elements are connected to the logic scheme as outputs. The configurable elements are incorporated into a BESTlogicPlus programmable logic scheme by selecting them from the *Elements* group in BESTlogicPlus. For more details, refer to the BESTlogicPlus chapter. Each of the eight elements can be independently configured to annunciate an alarm or pre-alarm. A user-adjustable time delay can be set to delay recognition of an element. By default, all elements are configured so that they do not trigger an alarm or pre-alarm. To make identifying an element easier, each of the elements can be given a user-assigned name. If used for an alarm or pre-alarm, the user-assigned name appears in the alarm or pre-alarm annunciation and in the DGC-2020HD event log. Elements can be recognized always or only while the engine is running. Configurable element status is available in BESTlogicPlus Programmable Logic when “Status Only” is selected for Alarm Configuration. Configurable element status can be used as logic inputs to drive other logic in the program, similar to logic control relays.

The BESTCOMSPlus *Configurable Elements* screen is illustrated in Figure 31. Settings are listed in Table 33.

The screenshot displays a 'Configurable Elements' section with eight individual configuration panels, each for a specific element. Each panel contains the following settings:

- Configurable Element #1:** Alarm Configuration (Status Only), Activation Delay (s) (0), Label Text (Config Element 1), Contact Recognition (Always).
- Configurable Element #2:** Alarm Configuration (Status Only), Activation Delay (s) (0), Label Text (Config Element 2), Contact Recognition (Always).
- Configurable Element #3:** Alarm Configuration (Status Only), Activation Delay (s) (0), Label Text (Config Element 3), Contact Recognition (Always).
- Configurable Element #4:** Alarm Configuration (Status Only), Activation Delay (s) (0), Label Text (Config Element 4), Contact Recognition (Always).
- Configurable Element #5:** Alarm Configuration (Status Only), Activation Delay (s) (0), Label Text (Config Element 5), Contact Recognition (Always).
- Configurable Element #6:** Alarm Configuration (Status Only), Activation Delay (s) (0), Label Text (Config Element 6), Contact Recognition (Always).
- Configurable Element #7:** Alarm Configuration (Status Only), Activation Delay (s) (0), Label Text (Config Element 7), Contact Recognition (Always).
- Configurable Element #8:** Alarm Configuration (Status Only), Activation Delay (s) (0), Label Text (Config Element 8), Contact Recognition (Always).

Figure 31. Settings Explorer, Programmable Outputs, Configurable Elements

Table 33. Settings for Configurable Elements

Locator	Setting	Range	Increment	Unit
A	Alarm Configuration	Status Only, Pre-Alarm, or Alarm	n/a	n/a
B	Activation Delay	0 to 300	1	seconds
C	Label Text	Up to 16 alphanumeric characters	n/a	n/a
D	Contact Recognition	Always or While Engine Running Only	n/a	n/a

Operating Modes

Three operating modes provide the versatility to meet the application's needs. The DGC-2020HD operates in Off, Run, or Auto mode. These operating modes are described in the following paragraphs.

Off

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

Run

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

Auto

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

ATS Contact Input

The ATS (automatic transfer switch) programmable function has an input mapped to it through BESTCOMSP^{Plus}®. The unit will start and run when this contact is closed, and will stop when the contact is open.

Generator Exerciser

The unit starts at the designated time and runs for the specified duration. The breaker will be closed if “Run with Load” is checked in the generator exerciser settings.

Mains Fail Transfer Functionality

If mains fail transfer is enabled, the unit runs when any phase of the utility is dead or unstable, and will not stop until all phases of the utility are stable and the load has been transitioned to the utility.

Run-with-Load Logic Element

When the run-with-load logic element start input is energized, the unit starts and closes its breaker. When the run-with-load logic element stop input is energized, the unit opens its breaker and stops.

Engine Run Logic Element

When the engine run logic element start input is energized, the unit starts. When the engine run logic element stop input is energized, the unit opens its breaker if needed, cools down, and then stops.

Operating Mode Control

Controls for selecting an operating mode are located on the front panel and within BESTCOMSP^{Plus}®. Refer to the *Controls and Indicators* chapter for more information.



Breaker Management

DGC-2020HD breaker management features include the control of two, continuous- or pulse-controlled breakers, load transfer upon detection of a mains failure, two modes of automatic genset synchronization, and settings for stable or dead bus detection. Open transitions are implemented in load transfers to and from the mains. The user can choose to control only the generator breaker, both breakers, or none at all. Breaker management settings can be configured using BESTCOMSP^{Plus}® or through the front panel interface.

Breaker Status

The status of the breakers is retrieved by properly setting up the GENBRK and MAINSBRK logic blocks in BESTlogic™^{Plus} programmable logic. These logic blocks have outputs that can be configured to close an output contact which in turn controls a breaker. They contain inputs for breaker control and status as well. See *Breaker Configuration*, below, for details on configuring the logic.

System Breaker Configuration

The following paragraphs describe how to properly configure DGC-2020HD system breaker control configuration.

Initial System Setup

Connect the DGC-2020HD according to the appropriate figure in the *Typical Applications* chapter for the type of generator connection desired (wye, delta, etc.). Set up the basic system parameters that will govern engine operation and alarm and pre-alarm annunciation. Details can be found in the *Configuration* and *Reporting and Alarms* chapters.

Generator Breaker Control

A system breaker configuration of Generator Breaker Control consists of a single generator breaker controlled by the DGC-2020HD. Figure 32 illustrates the Generator Breaker Control system breaker configuration. Figure 33 shows the Generator Breaker Control system breaker configuration with a mains bus and externally controlled mains breaker. Figure 34 illustrates the one-line diagram of the Generator Breaker Control configuration as it appears in the BESTCOMSP^{Plus} System Settings screen.

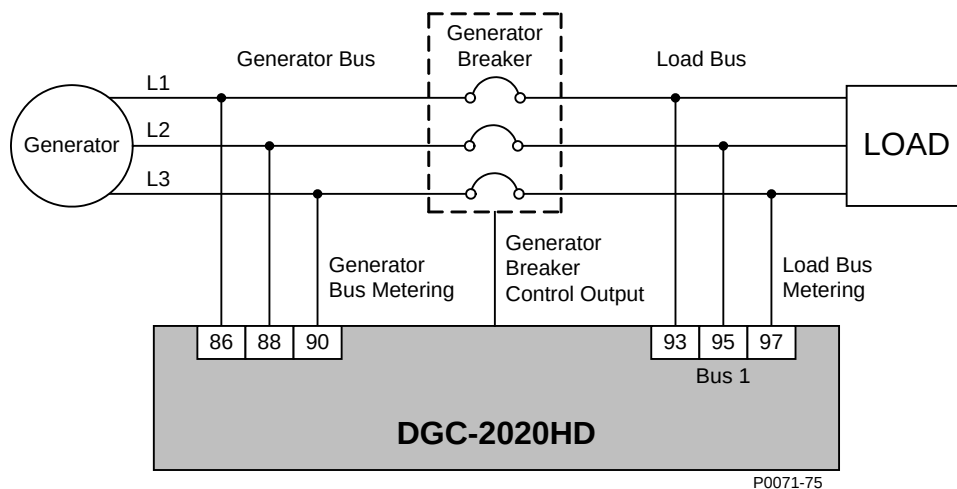


Figure 32. System Breaker Configuration: Generator Breaker Control

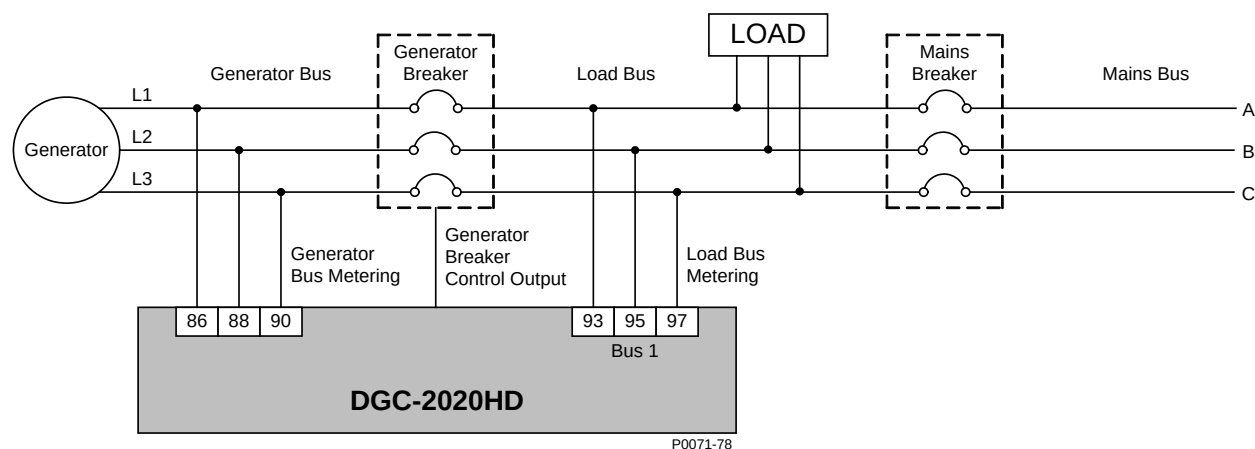


Figure 33. System Breaker Configuration: Generator Breaker Control with Externally Controlled Mains Breaker

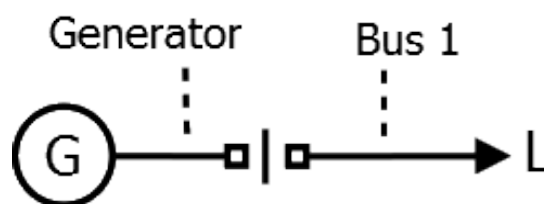


Figure 34. System Breaker Configuration: Generator Breaker Control as Displayed in BESTCOMSPlus System Settings.

Generator and Mains Breaker Control

Generator and Mains Breaker Control system breaker configurations consist of two breakers controlled by the DGC-2020HD. Figure 35 illustrates a Generator And Mains Breaker Control system breaker configuration *without* optional load bus metering. Figure 36 illustrates the one-line diagram of the Generator And Mains Breaker Control system breaker configuration as it appears in the BESTCOMSPlus System Settings screen. Figure 37 shows the same configuration *with* optional load bus metering. Figure 38 illustrates the one-line diagram of the Generator And Mains Breaker Control system breaker configuration as it appears in the BESTCOMSPlus System Settings screen. Optional load bus metering, provides more precise control over breaker closures. DGC-2020HD units must be equipped with enhanced bus sensing (style number xxxxxxEx) in order to meter all three buses.

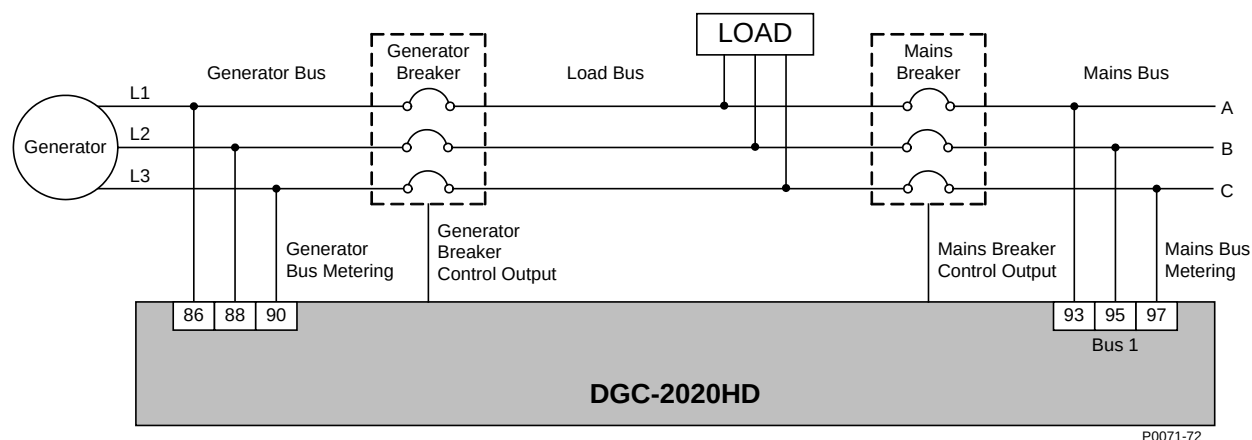


Figure 35. System Breaker Configuration: Generator and Mains Breaker Control

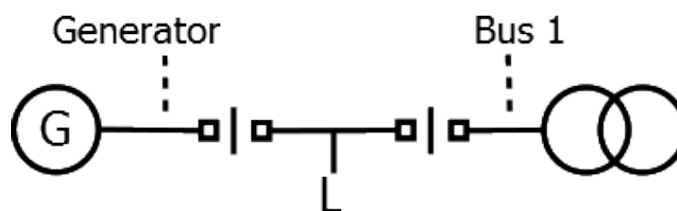


Figure 36. System Breaker Configuration: Generator and Mains Breaker Control as Displayed in BESTCOMSPPlus System Settings

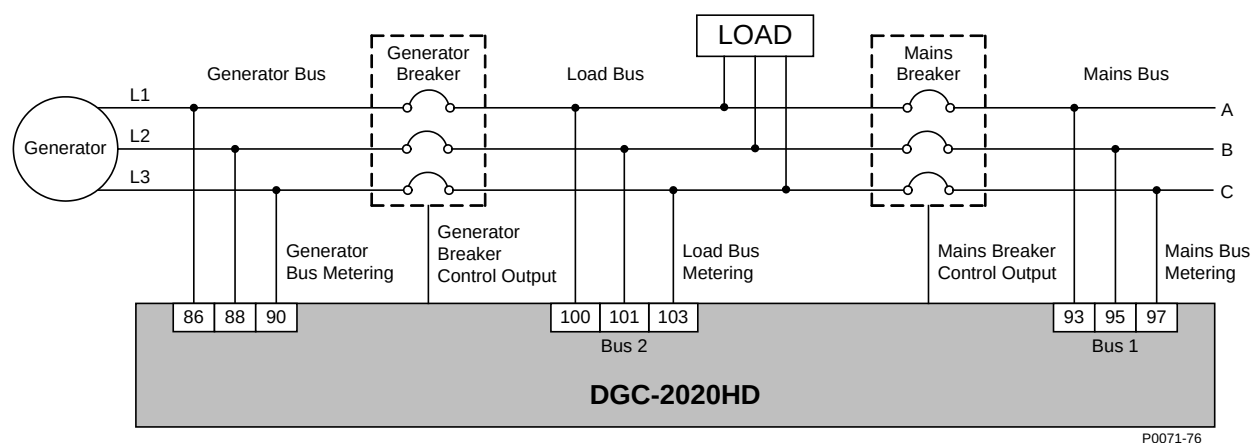


Figure 37. System Breaker Configuration: Generator and Mains Breaker Control with Optional Load Bus Metering

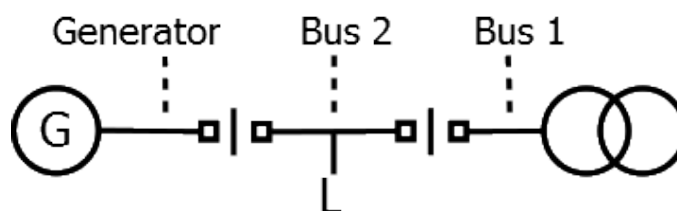


Figure 38. System Breaker Configuration: Generator and Mains Breaker Control with Optional Load Bus Metering as Displayed in BESTCOMSPPlus System Settings

System Breaker Configuration Setting

BESTCOMSPPlus® Navigation Path: Settings Explorer, System Parameters, System Settings

Front Panel Navigation Path: Settings Explorer > System Parameters > System Settings

Select the appropriate breaker control configuration using the System Breaker Configuration setting. Available options include, No Breaker Control, Generator Breaker Control, Generator and Mains Breaker Control, and Generator and Mains Breaker Control with Load Bus. In BESTCOMSPPlus, a one-line diagram is provided for each breaker configuration to aid in proper selection. Each bus can be programmed with a text label describing its use. Up to 64 alphanumeric characters are accepted. This label appears in BESTCOMSPPlus to aid in ease of configuration and programming.

System Settings

System Type
Single Generator

Number Fly Wheel Teeth
126.0

Power Up Delay (s)
1

Speed Signal Source
Magnetic Pickup and Gen Frequency

Fuel Level Function
Fuel Level

Fuel Level Source
Resistive Sender

Coolant Temperature Source
AEM1 In1

Oil Pressure Source
AEM1 In1

Rated Values

Edit

Frequency
Rated frequency of the unit
60 Hz
Alternate Frequency (Hz)
60.00

Battery Volts
☐ 12V
☒ 24V
Rated Engine RPM (rpm)
1800

System Units
☒ English
☐ Metric

Metric Pressure Units
☒ bar
☐ kPa/MPa

System Breaker Configuration
Generator Breaker Control

Generator Bus 1

G ———— | ———— L

Generator Label
Gen

Bus 1 Label
Bus 1

Bus 2 Label
Bus 2

NFPA Level
☒ Zero
☐ One
☐ Two

EPS Supplying Load
Low Line Scale Factor
1.000
EPS Threshold (% of CT Pri)
3

Figure 39. Settings Explorer, System Parameters, System Settings

Breaker Hardware Settings

BESTCOMSPlus® Navigation Path: Settings Explorer, Breaker Management, Breaker Hardware

Front Panel Navigation Path: Settings Explorer > Breaker Management > Breaker Hardware

Breakers controlled by pulse or continuous inputs are supported. Separate settings for each breaker's open and close pulse widths are provided as well as a transition delay. During the transition delay, open or close outputs are removed to allow any breaker interlocks to reset before a new open or close output is initialized.

During synchronization of the generator with the bus (Anticipatory mode only), the DGC-2020HD uses the breaker closing time to calculate the optimum time to close the breaker.

When a close command is issued, the DGC-2020HD monitors the breaker status and annunciates a breaker failure if the breaker does not close within the time defined by the breaker fail wait time delay. Typically, this parameter is set to be longer than twice the breaker closing time.

The Breaker Fail Output Configuration setting dictates whether the breaker output is removed or maintained during the breaker open fail or breaker close fail pre-alarm conditions.

After a breaker open or close failure occurs, the DGC-2020HD can attempt to reopen or reclose the breaker a pre-defined number of times. The number of attempts to open or close the breaker and the duration of time between each attempt are user-programmable.

When an external device changes the state of the breaker, the External Status Change Action setting dictates how the DGC-2020HD responds to the state change. The DGC-2020HD can ignore external breaker state changes, always follow breaker state changes, or only follow breaker state changes when in Auto mode. When the DGC-2020HD is following external breaker state changes, it issues outputs that

correspond to the change in breaker state. If an external source opens the breaker, the DGC-2020HD issues a breaker open output. Likewise, if an external source closes the breaker, the DGC-2020HD issues a breaker close output.

Enabling the Dead Bus Close Enable setting allows the DGC-2020HD to close the generator breaker onto a dead bus. This can be used to ensure that only one machine closes onto a dead bus at a time, thus preventing multiple machines simultaneously closing to the dead bus out of phase with each other. When this setting is disabled, the DGC-2020HD can only close the generator breaker onto a stable bus.

All generator and mains breaker hardware settings on the Breaker Hardware screen are disabled when the system breaker configuration is set to *No Breaker Control* on the System Settings screen.

Start up Synchronization

Start up synchronizing is a means of bringing up a system of generators when the generator breakers are closed to a dead bus and the generators are stopped. Normally, it's not possible to close the generator breaker when the generator is dead. To permit a closure of the generator breaker from a "dead" generator to a "dead" bus, both the Dead Bus Close Enable and the Dead Gen Close Enable settings must be enabled. After all generator breakers are closed, the gensets are started and synchronized when the AVR's are turned on. The user must develop logic to start the generators and turn on excitation in the voltage regulators at the correct time for orderly system startup.

Caution

Use caution when connecting "dead" generators to a "dead" bus. Undesired operation or system damage could occur if the bus becomes "live" while "dead" generators are connected to it.

Mains Failure

For generator and mains breaker configurations, the DGC-2020HD can automatically transfer load power from the mains to the genset during a mains failure. This feature also enables the DGC-2020HD to transfer the load back to the mains once mains power is restored.

Note

Automatic breaker operation can be disabled through BESTlogicPlus Programmable Logic. When the Auto Breaker Operation Inhibit element is set true, it prevents all automatic breaker operation.

When Mains Fail Transfer is set to enabled, the machine is configured as a mains fail machine or standby power machine that takes over when utility power fails. There are two types of transitions between the generator and the utility that are set with the Mains Fail Transfer Type setting: (1) Open transitions in which the generator and mains breaker are never closed at the same time, and (2) Closed transitions in which the generator parallels to the utility for a short time to transfer load to the generator from the utility (a load takeover) or transfer the load from the generator to the utility.

Note

The Mains Fail Transfer function can be disabled through BESTlogicPlus Programmable Logic. When the Mains Fail Transfer Inhibit element is set true, it prevents automatic load transfer due to a mains failure.

In open transitions, when a mains failure occurs, the DGC-2020HD starts the generator after the transfer time expires. The DGC-2020HD opens the mains breaker either before the engine starts or after the generator is stable based on the Mains Breaker Open Configuration setting. After the mains breaker is open and the Open Transition Delay time expires, the DGC-2020HD closes its generator breaker to drive the load. When the mains power returns, after the Mains Fail Return Delay time expires, the DGC-2020HD opens its generator breaker. Then, after the Open Transition Delay time expires, the mains breaker closes. If the in-phase monitor is enabled and the Mains Fail Return Delay time has expired, the

DGC-2020HD waits until it detects that the phases are aligned between the generator and the mains before performing the open transition from the generator back to the utility.

An Open Transition Delay is provided to allow a user-specified amount of time where both breakers are open. For example, this may be used to prevent damage to large motors in the load by allowing them to spin down completely during open transitions.

In closed transitions, when a mains failure occurs, the DGC-2020HD starts the generator after the transfer time expires. The DGC-2020HD opens the mains breaker either before the engine starts or after the generator becomes stable based on the Mains Breaker Open Configuration setting. After the mains breaker is open the DGC-2020HD closes its generator breaker to drive the load. When the mains power returns, after the Mains Fail Return Delay time expires, the generator synchronizes to the utility and closes the mains breaker, paralleling the generator to the utility. While paralleled to the utility, the generator ramps down load until the load is at or below the level of the Breaker Open Setpoint or until the generator has been paralleled to the utility for the duration of the Max Parallel Time setting. Then the DGC-2020HD opens its generator breaker, leaving the load on utility power. A cool down cycle is performed and the generator is stopped.

Note

Closed transition override can be enabled through BESTlogicPlus Programmable Logic. When the Closed Transition Override element is set true, it forces a closed transition due to mains failure, overriding an *open* Mains Fail Transfer Type setting.

Two logic elements are present in BESTlogicPlus Programmable Logic that can be used on Mains Fail Transfer enabled machines. These two logic elements are Mains Fail Test and Load Take Over.

The Mains Fail Test logic element, when true, causes the generator to react exactly as if the mains has failed. The following sequence of events occurs:

1. Mains Fail Transfer Delay time expires
2. Generator starts
3. Mains breaker is opened either before the engine starts or after the generator becomes stable (based on the Mains Breaker Open Configuration setting)
4. Generator becomes stable
5. DGC-2020HD closes its generator breaker to drive the load

When the Mains Fail Test logic element is false, the generator reacts as if the mains has returned: the Mains Fail Return Delay time expires and the generator transitions the load from the generator back to the utility in an Open or Closed transition, according to the Mains Fail Transfer Type setting.

The Load Take Over logic element is similar, except that the machine does not act as if the mains has failed, and the transfer and return delay timers are ignored. If the Mains Fail Transition Type is set to Open and the Load Take Over logic element is true, the following sequence of events occurs:

1. Generator starts
2. Mains breaker is opened either before the engine starts or after the generator becomes stable (based on the Mains Breaker Open Configuration setting)
3. Generator becomes stable
4. Generator breaker closes to drive the load

When the Load Take Over logic element is false, the DGC-2020HD opens its generator breaker and closes the mains breaker to transition the load back to the utility. If the In Phase Monitor function is enabled, the transition does not occur until the generator and utility phases are aligned.

If the Mains Fail Transition Type is set to Closed and the Load Take Over logic element is true, the generator starts, synchronizes to the utility, and the DGC-2020HD closes the generator breaker. When an auxiliary CT is configured to meter the mains bus, the mains breaker power level is measured. In this case, the generator takes on load either until the power measured at the mains breaker is equal to the Zero Power Flow Level setting, or for the duration of the Max Parallel Time. Zero Power Flow Level is found in the Breaker Hardware settings. Once the Zero Power Flow Level or Max Parallel Time has been reached, the mains breaker opens, leaving load on the generator. When no auxiliary CT is configured to

meter the mains bus, the generator takes on load either until it is driving load at a level equal to the Base Load Level or for the duration of the Max Parallel Time. Base Load Level settings are found on the Governor Bias Control screen. Once the Base Load Level or Max Parallel Time has been reached, the mains breaker will open, leaving the load on the generator.

When the Load Take Over logic element becomes false, the generator parallels to the utility. While paralleled to the utility, the generator ramps down load until the load is at or below the Breaker Open Setpoint or until the generator has been paralleled to the utility for the maximum allowed time as specified by the Max Parallel Time setting. The DGC-2020HD opens its generator breaker, leaving the load on utility power. A cool down cycle is performed and the generator is stopped.

Note

The Parallel to Mains logic element must be true any time the generator is in parallel with the utility. Parallel transitions to and from the mains will not operate properly if the Parallel to Mains logic element is not set correctly.

If a mains failure transfer has begun, but is not completed within the Mains Fail Max Transfer Time, a Transfer Fail Alarm is annunciated and the generator is shut down.

If the Alarm State Transfer to Mains setting is enabled, the DGC-2020HD can transfer the load to a stable utility when in the alarm state. If this setting is disabled, the DGC-2020HD will not perform any transitions of the load to or from the utility when in the alarm state.

When enabled, Reverse Rotation Inhibit prevents automatic load transfer due to a mains failure when the machine is determined to have reverse phase rotation.

Figure 40 illustrates the BESTCOMSP^{Plus} Breaker Hardware screen. Settings are listed in Table 34.

Breaker Hardware

Mains Fail

Mains Fail Transfer: ☒ Disable (A) ☐ Enable

Mains Fail Transfer Type: ☒ Open (B) ☐ Closed

Alarm State Transfer To Mains: ☒ Disable (C) ☐ Enable

Mains Breaker Open Configuration: ☒ Generator Start (D) ☐ Generator Stable

In Phase Monitor: ☒ Disable (E) ☐ Enable

Reverse Rotation Inhibit: ☐ Disable ☒ Enable (F)

Max Parallel Time (s): 0.5 (G)

Mains Fail Transfer Delay (s): 10 (H)

Mains Fail Return Delay (s): 10 (I)

Mains Fail Max Transfer Time (s): 30 (J)

Zero Power Flow Level (%): 3 (K)

Open Transition Delay (s): 0 (L)

Gen and Mains Breaker

Breaker Fail Wait Time (s): 0.2 (M)

Generator Breaker Hardware

Contact Type: Pulse (N)

Dead Bus Close Enable: ☒ Disable (O) ☐ Enable

Breaker Fail Output Configuration: ☒ Retain (P) ☐ Remove

External Status Change Action: ☒ Ignore ☐ Follow Always ☐ Follow In Auto (Q)

Dead Gen Close Enable: ☒ Disable ☐ Enable (R)

Open Pulse Time (s): 0.01 (S)

Close Pulse Time (s): 0.01 (T)

Breaker Closing Time (ms): 100 (U)

Transition Delay (s): 0.00 (V)

Open Attempts: 1 (W)

Close Attempts: 1 (X)

Retry Delay (s): 5 (Y)

Mains Breaker Hardware

Contact Type: Pulse (N)

Breaker Fail Output Configuration: ☒ Retain (P) ☐ Remove

External Status Change Action: ☒ Ignore ☐ Follow Always ☐ Follow In Auto (Q)

Live Bus Close Enable: ☒ Disable ☐ Enable (Z)

Open Pulse Time (s): 0.01 (S)

Close Pulse Time (s): 0.01 (T)

Breaker Closing Time (ms): 100 (U)

Transition Delay (s): 0.00 (V)

Open Attempts: 1 (W)

Close Attempts: 1 (X)

Retry Delay (s): 5 (Y)

System Breaker Configuration

Generator and Mains Breaker Control with Load Bus

Diagram showing Generator (G) connected to Bus 2, which is connected to Bus 1. A load (L) is connected to Bus 2.

Figure 40. Settings Explorer, Breaker Management, Breaker Hardware Screen

Table 34. Settings for Breaker Hardware Screen

Locator	Setting	Range	Increment	Unit
<i>Mains Fail Transfer Settings</i>				
A	Mains Fail Transfer	Disable or Enable	n/a	n/a
B	Mains Fail Transfer Type	Open or Closed	n/a	n/a
C	Alarm State Transfer to Mains	Disable or Enable	n/a	n/a
D	Mains Breaker Open Configuration	Generator Start or Generator Stable	n/a	n/a
E	In Phase Monitor	Disable or Enable	n/a	n/a
F	Reverse Rotation Inhibit	Disable or Enable	n/a	n/a
G	Max Parallel Time	0.1 to 10,000	0.1	seconds
H	Mains Fail Transfer Delay	0 to 300	1	seconds
I	Mains Fail Return Delay	0 to 1,800	1	seconds
J	Mains Fail Max Transfer Time	10 to 120	1	seconds
K	Zero Power Flow Level	1 to 100	1	%
L	Open Transition Delay	0 to 100,000	1	seconds
<i>Breaker Hardware Settings</i>				
M	Breaker Fail Wait Time	0.1 to 600	0.1	seconds
N	Contact Type	Continuous or Pulse	n/a	n/a
O	Dead Bus Close Enable	Disable or Enable	n/a	n/a
P	Breaker Fail Output Configuration	Retain or Remove	n/a	n/a
Q	External Status Change Action	Ignore, Follow Always, or Follow in Auto	n/a	n/a
R	Dead Gen Close Enable	Disable or Enable	n/a	n/a
S	Open Pulse Time	0.01 to 10	0.01	seconds
T	Close Pulse Time	0.01 to 10	0.01	seconds
U	Breaker Closing Time	0 to 1,000	1	milliseconds
V	Transition Delay	0 to 10	0.01	seconds
W	Open Attempts	1 to 20	1	attempts
X	Close Attempts	1 to 20	1	attempts
Y	Retry Delay	0 to 1,200	1	seconds
Z	Live Bus Close Enable	Disable or Enable	n/a	n/a

Breaker Setup in BESTlogic™ Plus

Set up the generator breaker in BESTlogicPlus Programmable Logic under the BESTCOMSPlus Settings Explorer. Figure 41 illustrates the BESTlogicPlus Programmable Logic screen with an example breaker control logic scheme. The following paragraphs provide instructions for setting up the generator and mains breakers in BESTlogicPlus.

1. Generator Breaker
 - a. Drag the Gen Breaker (GENBRK) element into the logic diagram.
 - b. Connect the breaker element open and close outputs to the contact outputs that will drive the breaker.

- c. Connect the physical input or remote input that has the breaker status (closed if breaker is closed, open when the breaker is open) to the *Status* input of the breaker element. This is the only way to indicate breaker status to the DGC-2020HD.
 - d. If it is desired to have physical inputs that can request breaker open and close commands, connect the desired inputs to the open and close command inputs of the breaker element. These inputs should be pulsed. If both inputs close at the same time, the breaker will not change state. If it is not desired to have inputs for breaker commands, connect a “Logic 0” input object to the open and close command inputs of the breaker block.
2. Mains Breaker (if applicable)
 - a. Drag the Mains Breaker (MAINSBRK) element into the logic diagram.
 - b. Connect the breaker element open and close outputs to the contact outputs that will drive the breaker.
 - c. Connect the physical input or remote input that has the breaker status (closed if breaker is closed, open if the breaker is open) to the *Status* input of the breaker element. This is the only way to indicate breaker status to the DGC-2020HD.
 - d. If it is desired to have physical inputs that can request breaker open and close commands, connect the desired inputs to the open and close command inputs of the breaker element. These inputs should be pulsed. If both inputs close at the same time, the breaker will not change state. If it is not desired to have inputs for breaker commands, connect a “Logic 0” input object to the open and close command inputs of the breaker block.
3. Click the Save button when the logic setup is complete.
4. From the *Communication* pull-down menu, select *Upload Logic to Device* to load the logic into the DGC-2020HD if connected, or save the settings file if working off line.

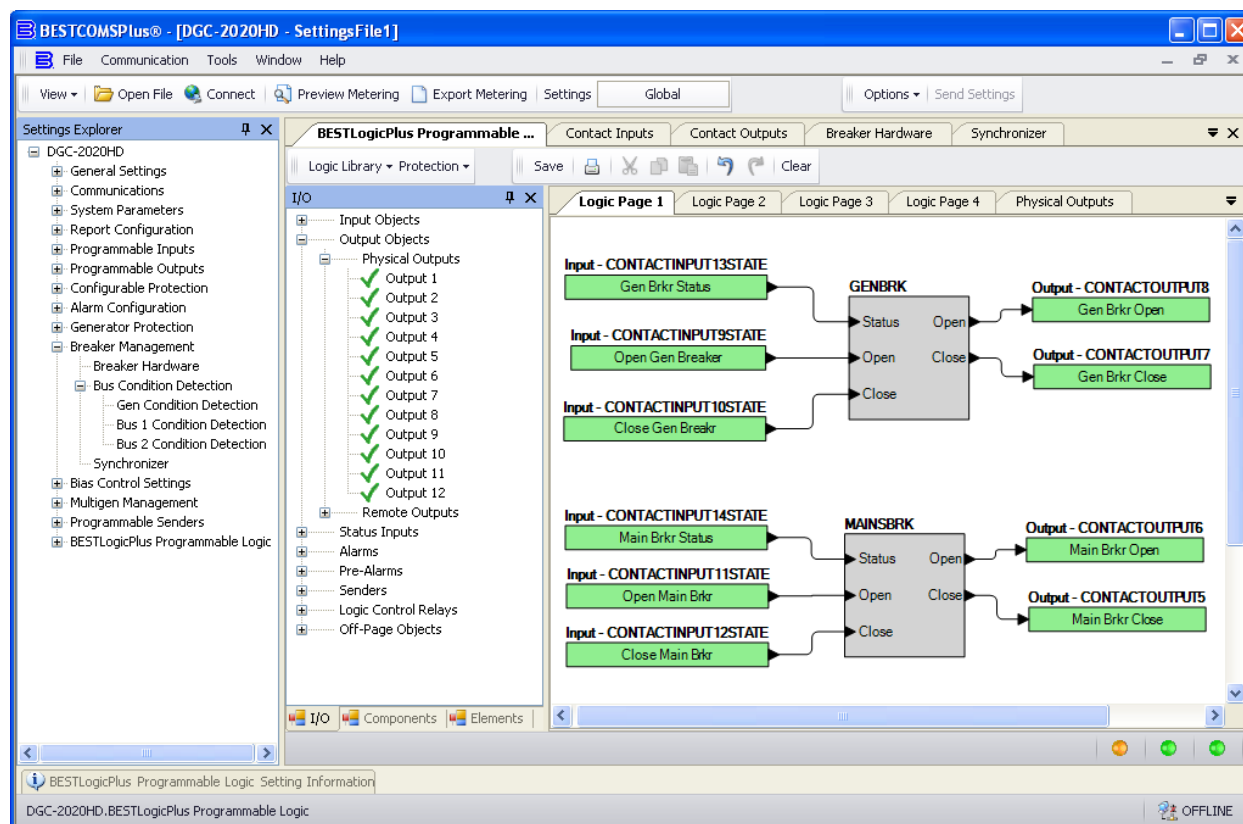


Figure 41. Settings Explorer, BESTlogicPlus Programmable Logic

Bus Condition Detection

BESTCOMSPlus® Navigation Path: Settings Explorer, Breaker Management, Bus Condition Detection

Front Panel Navigation Path: Settings Explorer > Breaker Management > Bus Condition

Bus condition thresholds determine when the generator bus, bus 1, and bus 2 are considered to be stable or dead.

Each bus has its own settings screen. These include the *Gen Condition Detection*, *Bus 1 Condition Detection*, and optional *Bus 2 Condition Detection* screens. Three-phase and single-phase threshold settings are provided on each screen. The *Gen Condition Detection* screen is described, below. The *Bus 1 and 2 Condition Detection* screens are identical in function to the *Gen Condition Detection* screen.

The *Gen Condition Detection* screen is illustrated in Figure 42. The *Bus 1 Condition Detection* and optional *Bus 2 Condition Detection* screens are also found in the *Bus Condition Detection* category. Settings are listed in Table 35.

When the bus voltage is below the *Dead Bus Threshold* for the duration of the *Activation Delay*, the bus is deemed "Dead".

Four thresholds determine a stable bus. These consist of overvoltage, undervoltage, overfrequency, and underfrequency. Each of these thresholds has an activation delay. When the bus voltage and frequency stay within the thresholds for the duration of the corresponding activation delays, the bus is deemed "stable". Otherwise, it is deemed "failed".

Caution

The bus condition parameters are critical. They determine when a breaker can be closed.

Gen Condition Detection

3 Phase

Condition Settings

Dead Gen Threshold (A) 30 V (B) 0.250 Per Unit

Dead Gen Activation Delay (s) (C) 0.1

Gen Failed Activation Delay (s) (D) 0.1

Overvoltage Settings

Pickup (V L-L) (E) 130 V (F) 1.083 Per Unit

Dropout (G) 127 V (H) 1.058 Per Unit

Undervoltage Settings

Pickup (V L-L) (E) 115 V (F) 0.958 Per Unit

Dropout (G) 117 V (H) 0.975 Per Unit

Overfrequency Settings

Pickup (I) 62.00 Hz (J) 1.0333 Per Unit

Dropout (K) 61.80 Hz (L) 1.0300 Per Unit

Underfrequency Settings

Pickup (I) 58.00 Hz (J) 0.9667 Per Unit

Dropout (K) 58.20 Hz (L) 0.9700 Per Unit

Gen Stable Activation Delay (s) (M) 0.1

Low Line Scale Factor (N) 1.000

Alternate Frequency Scale Factor (O) 1.000

1 Phase

Condition Settings

Dead Gen Threshold (A) 30 V (B) 0.250 Per Unit

Dead Gen Activation Delay (s) (C) 0.1

Gen Failed Activation Delay (s) (D) 0.1

Overvoltage Settings

Pickup (V L-L) (E) 130 V (F) 1.083 Per Unit

Dropout (G) 127 V (H) 1.058 Per Unit

Undervoltage Settings

Pickup (V L-L) (E) 115 V (F) 0.958 Per Unit

Dropout (G) 117 V (H) 0.975 Per Unit

Overfrequency Settings

Pickup (I) 62.00 Hz (J) 1.0333 Per Unit

Dropout (K) 61.80 Hz (L) 1.0300 Per Unit

Underfrequency Settings

Pickup (I) 58.00 Hz (J) 0.9667 Per Unit

Dropout (K) 58.20 Hz (L) 0.9700 Per Unit

Gen Stable Activation Delay (s) (M) 0.1

Low Line Scale Factor (N) 1.000

Alternate Frequency Scale Factor (O) 1.000

Figure 42. Settings Explorer, Breaker Management, Gen Condition Detection

Table 35. Settings for Gen Condition Detection

Locator	Setting	Range	Increment	Unit
3 Phase and 1 Phase Condition Settings				
A	Dead Gen Threshold Volts	0 to 4,800	1	volts
B	Dead Gen Threshold Per Unit	based on nominal	n/a	per unit
C	Dead Gen Activation Delay	0.1 to 600	0.1	seconds
D	Gen Failed Activation Delay	0.1 to 600	0.1	seconds
Overvoltage and Undervoltage Settings				
E	Pickup (V L-L) Volts	10 to 99,999	1	volts

Locator	Setting	Range	Increment	Unit
F	Pickup (V L-L) Per Unit	based on nominal	n/a	per unit
G	Dropout Volts	10 to 99,999	1	volts
H	Dropout Per Unit	based on nominal	n/a	per unit
<i>Overfrequency and Underfrequency Settings</i>				
I	Pickup Hz	46 to 64	0.01	Hz
J	Pickup Hz Per Unit	based on nominal	n/a	per unit
K	Dropout Hz	46 to 64	0.01	Hz
L	Dropout Hz Per Unit	based on nominal	n/a	per unit
<i>3 Phase and 1 Phase Settings</i>				
M	Gen Stable Activation Delay	0.1 to 600	0.1	seconds
N	Low Line Scale Factor	0.001 to 3	0.001	n/a
O	Alternate Frequency Scale Factor	0.001 to 3	0.001	n/a

Breaker Operation

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

Breaker Operation Requests

Types of breaker operation requests include:

- Local Request - initiated by internal functions and based on operating modes.
- Com Request - initiated through a communication port using BESTCOMSP^{Plus} or the front panel.
- Logic Request - initiated from BESTlogic^{Plus}.

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

RUN Mode

When in RUN mode, the generator and mains breakers can be closed manually using contact inputs or the breaker buttons on the BESTCOMSP^{Plus} Control screen.

OFF or AUTO Mode (Not Running)

If operating in the OFF mode or AUTO and not running, the generator breaker cannot be closed unless the Dead Gen Close Enable and Dead Bus Close Enable settings are both enabled.

AUTO Mode (Running)

When in AUTO mode and running, the mains fail transfer feature will automatically control the mains breaker and the generator breaker. Or, the external ATS (automatic transfer switch) will start the generator and control the breakers itself. In addition, the generator breaker can be automatically controlled by the demand start/stop function, the exercise timer function, or a RUNWLOAD (run with load) start from BESTlogic^{Plus}. The generator breaker can be manually controlled using contact inputs and outputs, the breaker open and close commands through the front panel, or the breaker buttons on the BESTCOMSP^{Plus} Control screen.

Generator Breaker Closure Conditions

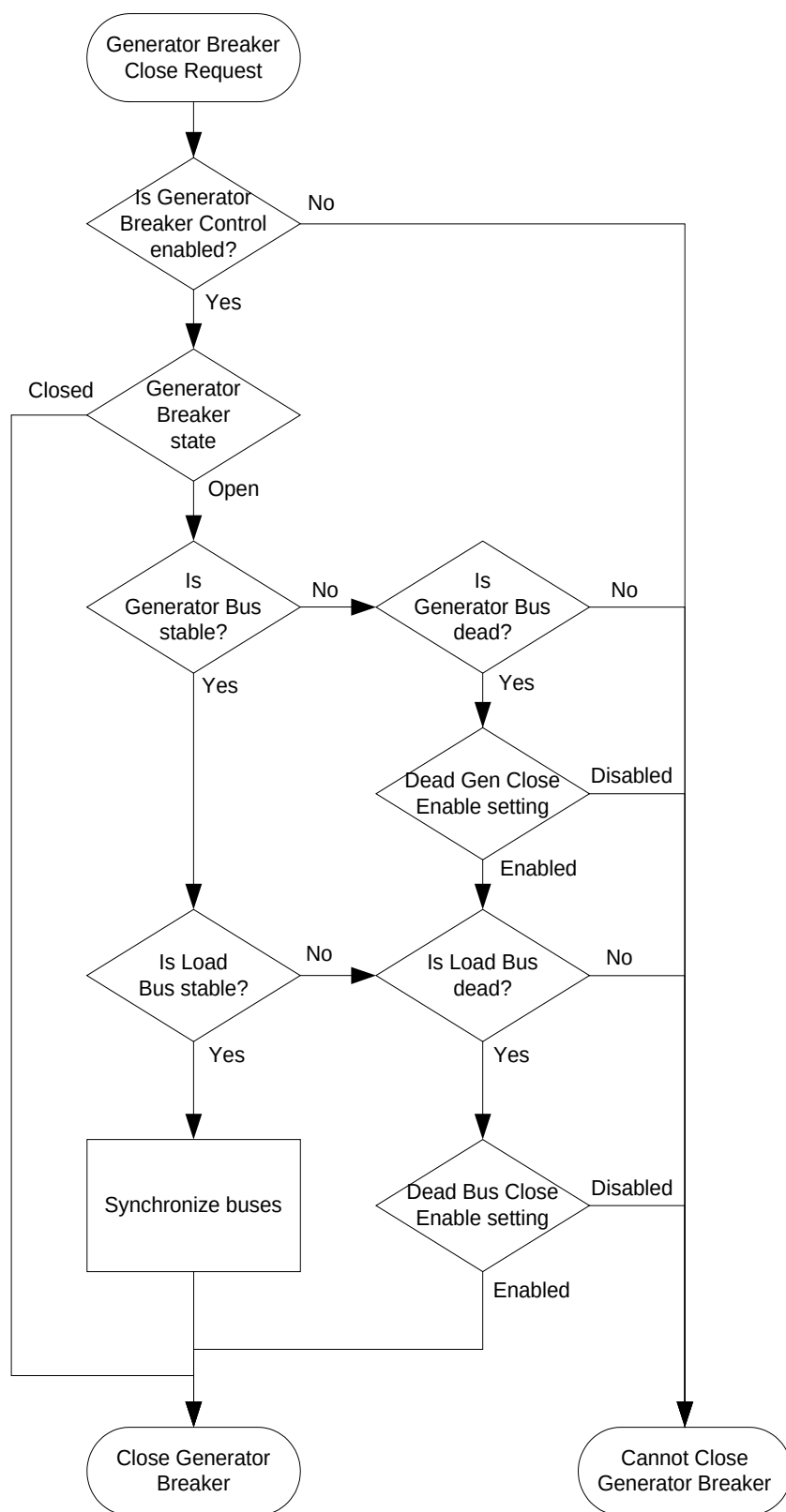
The conditions under which the DGC-2020HD will close the generator breaker are described in the following paragraphs. Two flow diagrams are provided to show the conditions under which the generator

breaker will close. These diagrams consider breaker status, bus voltage stability, and synchronization conditions. Command Agreement and Dead Bus Close Arbitration conditions are omitted for clarity. Figure 43 illustrates generator breaker closure conditions for the generator breaker control configuration. Refer to Figure 32 or Figure 33, for a diagram of a generator breaker control configuration. Figure 44 shows generator breaker closure conditions in a generator and mains breaker control configuration. Refer to Figure 35 for a diagram of this configuration.

Generator Breaker Control Configuration

Before the generator breaker can be closed, Generator Breaker Control must be selected. If the generator breaker is already closed, the DGC-2020HD still attempts to close the breaker. It is assumed that since the breaker is already closed, the closure conditions have already been met.

When the generator breaker is open, user settings are read to determine the states of the generator bus and load bus. If the generator bus is stable and the load bus is stable, the generator bus is synchronized with the load bus and the generator breaker attempts to close. If the generator bus is stable, the load bus is dead, and the Dead Bus Close Enable setting is enabled, the generator breaker attempts to close. If the generator bus is dead, the load bus is dead, the Dead Gen Close Enable, and the Dead Bus Close Enable settings are both enabled, then the generator breaker attempts to close.



P0071-74

Figure 43. Generator Breaker Closure Conditions Flow Diagram

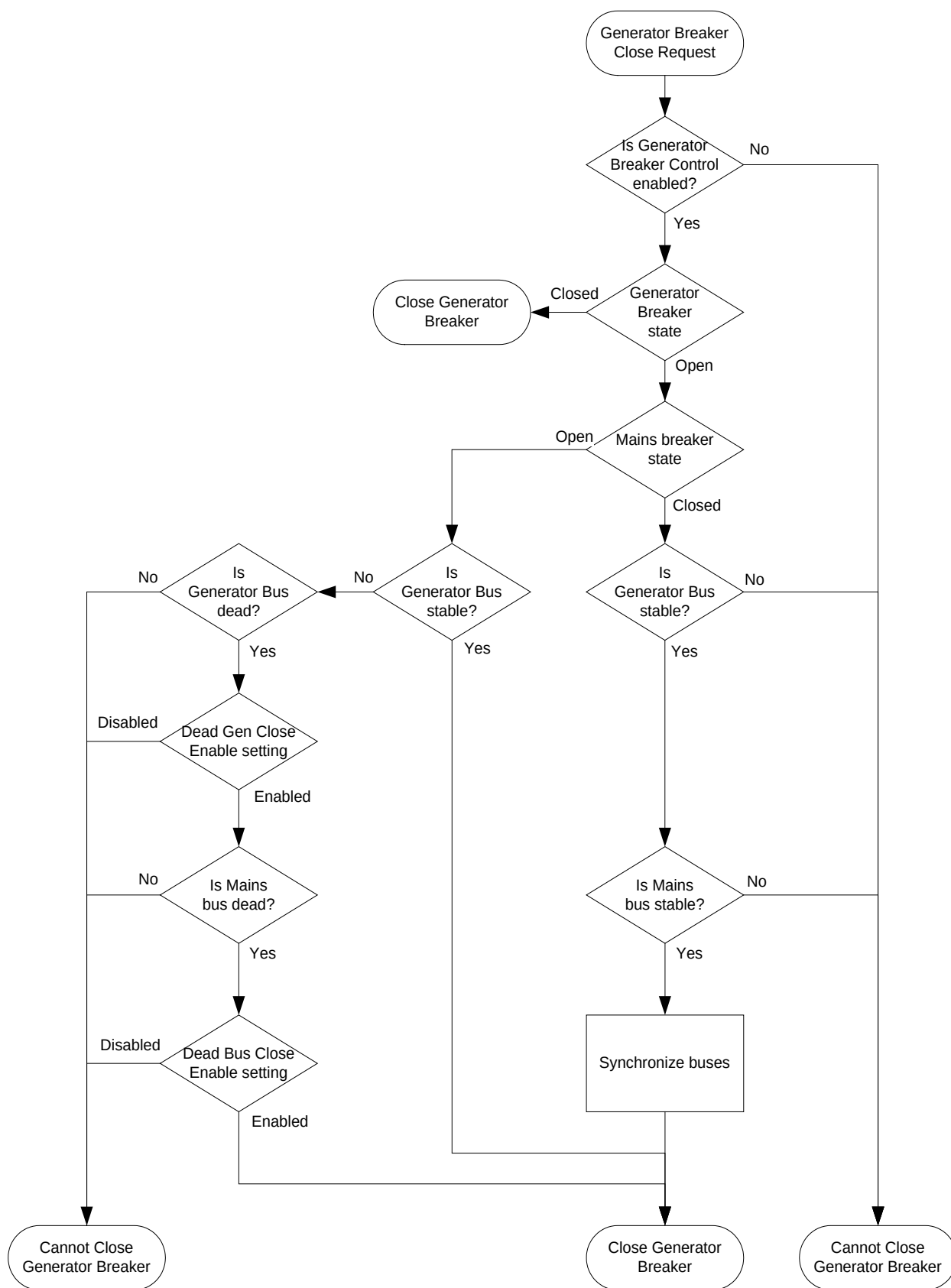
Generator and Mains Breaker Control Configuration

In this configuration, the condition of the load bus must be assumed based on the status of the generator and mains breakers and voltage stability of the generator and mains buses.

Before the generator breaker can be closed, either Generator and Mains Breaker Control or Generator and Mains Breaker Control with Load Bus must be selected. If the generator breaker is already closed, the DGC-2020HD still attempts to close the breaker. It is assumed that since the breaker is already closed, the closure conditions have already been met.

If the generator breaker is open and the mains breaker is open, user settings are read to determine the state of the generator and mains buses. If the generator bus is stable, the generator breaker attempts to close. If the generator and mains buses are both dead and the Dead Gen Close Enable setting and Dead Bus Close Enable settings are both enabled, the generator breaker attempts to close.

If the generator breaker is open and the mains breaker is closed, user settings are read to determine the state of the generator and mains buses. If both the generator and mains bus are stable, the DGC-2020HD synchronizes the generator bus to the mains bus and the generator breaker attempts to close.



P0071-77

Figure 44. Generator Breaker Closure Conditions Flow Diagram (without Optional Load Bus Metering)

Mains Breaker Closure Conditions

The conditions under which the DGC-2020HD will close the mains breaker are described in the following paragraphs. A flow diagram (Figure 45) is provided to show the conditions under which the mains breaker will close. This diagram considers breaker status, bus voltage stability, and synchronization conditions. Command Agreement and Dead Bus Close Arbitration conditions are omitted for clarity. Refer to Figure 35 for a diagram of a generator and mains breaker configuration. Figure 37 illustrates the same configuration with load bus metering.

Generator and Mains Breaker Control Configuration

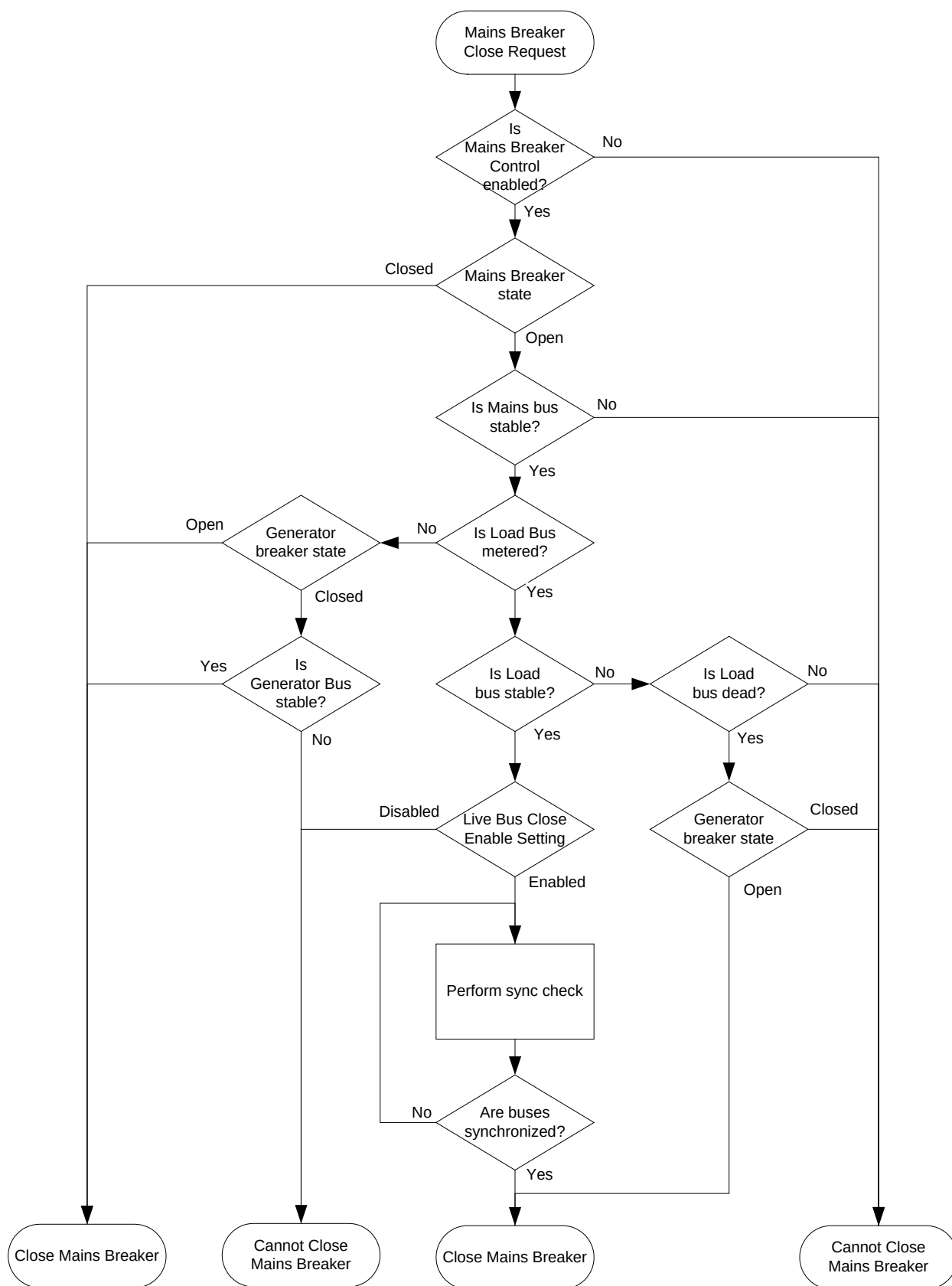
In this configuration, the condition of the load bus must be assumed based on the status of the generator and mains breakers and voltage stability of the generator and mains buses.

Before the mains breaker can be closed, either Generator and Mains Breaker Control or Generator and Mains Breaker Control with Load Bus must be selected. When the mains breaker is open, the mains bus is stable, and the load bus is not metered, the state of the generator breaker is checked. If the generator breaker is open, the mains breaker attempts to close. If the generator breaker is closed and the generator bus is stable, the mains breaker attempts to close.

Generator and Mains Breaker Control Configuration with Load Bus Metering

Before the mains breaker can be closed, either Generator and Mains Breaker Control or Generator and Mains Breaker Control with Load Bus must be selected. If the mains breaker is already closed, the DGC-2020HD still attempts to close the breaker. It is assumed that since the breaker is already closed, the closure conditions have already been met.

When the mains breaker is open, the mains bus is stable, and the load bus is metered, user settings are read to determine the states of the mains and load buses. If the mains and load buses are both stable, the DGC-2020HD continually monitors the synchronization status between the mains and load buses. The mains breaker attempts to close when the mains and load buses are in sync. If the mains bus is stable, the load bus is dead, and the generator breaker is open, the mains breaker attempts to close.



P0071-73

Figure 45. Mains Breaker Closure Conditions Flow Diagram

General Breaker Closure Conditions

The following conditions apply to any breaker control configuration.

Command Agreement

A breaker will not change state if it receives conflicting commands. In other words, if an input is indicating an open command at the same time another input is indicating a close command, the breaker will not change state.

Dead Bus Breaker Close Arbitration

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

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

- The generator is stable
- A dead bus is detected
- A generator breaker close request is received

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

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

An individual unit can close to a dead bus at any time when the System Type parameter is set to Single Generator. This is also permitted when the System Type parameter is set to Multiple Generator and no other generators are present on the Ethernet inter-genset communications network.

The Unit ID of the system manager can be found on the front panel of each unit and in BESTCOMSPlus. Refer to *Generator Network Status Display* in the *Metering* chapter.

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

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

Synchronization

Synchronization is required when closing a breaker to a live bus. Bus conditions act as a supervisory control over the synchronizing function. If synchronization is in process and either bus goes unstable, synchronization is suspended.

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



Synchronizer

Some applications require a generator set which can operate in parallel with other generators or a utility bus. In order to parallel the generator, the speed and the voltage of the generator must be properly matched to the bus. This is done by properly adjusting the generator's speed control governor (GOV) and automatic voltage regulator (AVR). Synchronization can be achieved manually by an operator or by the use of an automatic synchronizer.

The DGC-2020HD digital genset controller has an integrated automatic synchronizer as an option to perform synchronization. The controller monitors the voltages, frequencies, and phase relationships of both the generator and the bus. It then sends a signal to the governor to increase or decrease the speed of the engine to match the generator frequency and phase angle to the bus frequency and phase angle. It also sends a signal to the voltage regulator to match the voltage levels. Once all of these conditions are met, the controller sends a breaker close signal to the generator circuit breaker.

There are two types of automatic synchronizers available. A phase lock type of automatic synchronizer controls the frequency of the generator and brings it into the predetermined phase angle window. After a time delay expires while in the window, the close signal is given to the generator circuit breaker. The anticipatory style of automatic synchronizer controls the slip frequency between the generator and the bus. The synchronizer calculates the timing of the closing signal to allow the generator breaker to be closed when the phase angle between the two sources is at 0 degrees. This calculation takes into account the slip rate, generator breaker closing time, and the phase angle difference.

In order to minimize the effects of I/O communications delays on synchronization, it is recommended that local I/O on the DGC-2020HD, rather than remote I/O on the CEM-2020, be used for generator breaker open and close commands, generator breaker status, voltage raise and lower contacts, and speed raise and lower contacts.

Operation

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

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

Breaker close 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 Start pulse in the programmable logic.
- The DGC-2020HD itself when started from a Demand Start as part of demand start/stop and sequencing.
- 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.
- Breaker Close commands from the Control Screen in BESTCOMSP^{Plus}®
- Breaker Close commands initiated through the front panel of the DGC-2020HD.

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

In wye, delta, grounded delta, or single-phase AB configurations, the synchronizer aligns the voltage on the GEN VA terminal with that on the BUS VA terminal, and the voltage on the GEN VB terminal with that on the BUS VB terminal. In other words, the DGC-2020HD aligns the generator phase AB L-L voltage with the bus phase AB L-L voltage. In order for the synchronizer to provide correct phase alignment

across a breaker, the phase AB L-L voltages on the generator side of the breaker must be wired to the GEN VA and GEN VB terminals on the DGC-2020HD. The phase AB L-L voltages on the bus side of the breaker (the bus to which the generator will be connected when the breaker is closed) must be wired to the BUS VA and BUS VB terminals on the DGC-2020HD. See the *Typical Connections* chapter, for a three-phase wye connection for typical applications diagram.

In single-phase AC configuration, the synchronizer aligns the voltage on the GEN VA terminal with that on the BUS VA terminal, and the voltage on the GEN VC terminal with that on the BUS VC terminal. In other words, the DGC-2020HD aligns the generator phase CA L-L voltage with the bus phase AB L-L voltage. In order for the synchronizer to provide correct phase alignment across a breaker, the phase CA L-L voltages on the generator side of the breaker must be wired to the GEN VA and GEN VC terminals on the DGC-2020HD. An optional wire jumper may also connect the GEN VB and GEN VC terminals together. The phase CA L-L voltage on the bus side of the breaker (the bus to which the generator will be connected when the breaker is closed) must be wired to the BUS VA and BUS VC terminals on the DGC-2020HD. A wire jumper must also connect the BUS VB and BUS VC terminals together. See the *Typical Connections* chapter, for a single-phase AC connection for typical applications diagram.

Generator speed can be influenced by the speed trim function, which is active at all times if enabled, and the synchronizer. Since the speed trim function can cause some activity on the speed bias outputs, when performing synchronizer troubleshooting it is recommended that the speed trim function be disabled. Refer to the *Maintenance and Troubleshooting* chapter for more information.

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

When the DGC-2020HD is performing synchronization, the Synchronizer screen is shown on the front panel. Slip angle, slip frequency, voltage difference, synchronizer active status, and a synchronizer scope are displayed.

Note

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

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

Figure 46 illustrates the BESTCOMSP_{Plus} Synchronizer screen. Settings are listed in Table 36.

Synchronizer

Sync Type: Phase Lock Loop (A)

Slip Frequency (Hz): 0.30 (B)

Min Slip Control Limit (Hz): 0.00 (C)

Max Slip Control Limit (Hz): 0.30 (D)

Voltage Window (%): 2.0 (E)

Breaker Closing Angle (Deg): 10.0 (F)

Fgen > Fbus: Disable (G)

Vgen > Vbus: Disable (H)

Sync Activation Delay (s): 0.1 (I)

Sync Fail Activation Delay (s): 5.0 (J)

Sync Speed Gain: 1.000 (K)

Sync Voltage Gain: 1.000 (L)

Figure 46. Settings Explorer, Breaker Management, Synchronizer Screen

Table 36. Settings for Synchronizer

Locator	Setting	Range	Increment	Unit
A	Sync Type	Anticipatory or Phase Lock Loop	n/a	n/a
B	Slip Frequency	0.01 to 0.5	0.01	Hz
C	Min Slip Control Limit	0 to 2	0.01	Hz
D	Max Slip Control Limit	0 to 2	0.01	Hz
E	Voltage Window	2 to 15	0.1	%
F	Breaker Closing Angle	3 to 20	0.1	degrees
G	Fgen > Fbus	Disable or Enable	n/a	n/a
H	Vgen > Vbus	Disable or Enable	n/a	n/a
I	Sync Activation Delay	0.1 to 0.8	0.1	seconds
J	Sync Fail Activation Delay	0.1 to 600	0.1	seconds
K	Sync Speed Gain	0.001 to 1,000	0.001	n/a
L	Sync Voltage Gain	0.001 to 1,000	0.001	n/a

Configuration

The following steps describe how to configure the DGC-2020HD automatic synchronizer using BESTCOMSPlus:

1. Open the *Style Number* screen in the *Settings Explorer*, under *General Settings*. Verify the connected unit has the Automatic Synchronizer option enabled.
2. If using a contact expansion module (CEM-2020) to control the governor or voltage regulator, open the *Remote Module Setup* screen in the *Settings Explorer*, under *System Parameters*. Skip this step if the DGC-2020HD's available contact outputs for AVR and GOV control are being used. See Figure 47.

Remote Module Setup

Contact Expansion Module 1

CEM Enable
☐ Disable
☒ Enable

CEM J1939 Address
 236

CEM Outputs
 18 Outputs

Contact Expansion Module 2

CEM Enable
☒ Disable
☐ Enable

CEM J1939 Address
 236

CEM Outputs
 18 Outputs

Contact Expansion Module 3

CEM Enable
☒ Disable
☐ Enable

CEM J1939 Address
 236

CEM Outputs
 18 Outputs

Contact Expansion Module 4

CEM Enable
☒ Disable
☐ Enable

CEM J1939 Address
 236

CEM Outputs
 18 Outputs

Analog Expansion Module 1

AEM Enable
☒ Disable
☐ Enable

AEM J1939 Address
 237

Analog Expansion Module 2

AEM Enable
☒ Disable
☐ Enable

AEM J1939 Address
 237

Analog Expansion Module 3

AEM Enable
☒ Disable
☐ Enable

AEM J1939 Address
 237

Analog Expansion Module 4

AEM Enable
☒ Disable
☐ Enable

AEM J1939 Address
 237

Figure 47. Settings Explorer, System Parameters, Remote Module Setup

- Open the *Contact Inputs* screen, in the *Settings Explorer*, under *Programmable Inputs*. Enter “Open Gen Breaker” into the label text field of Input #9. Enter “Close Gen Breakr” into the label text field of Input #10. Finally, enter “Breaker Status” into the label text field of Input #13. Up to 16 alphanumeric characters are accepted by a label text field. See Figure 48.

Input #	Alarm Configuration	Activation Delay (s)	Label Text	Contact Recognition
Input #7	Status Only	0	INPUT 7	Always
Input #8	Status Only	0	INPUT 8	Always
Input #9	Status Only	0	Open Gen Breaker	Always
Input #10	Status Only	0	Close Gen Breaker	Always
Input #11	Status Only	0	INPUT 11	Always
Input #12	Status Only	0	INPUT 12	Always
Input #13	Status Only	0	Breaker Status	Always
Input #14	Status Only	0	INPUT 14	Always
Input #15	Status Only	0	INPUT 15	Always

Figure 48. Settings Explorer, Programmable Inputs, Contact Inputs

4. Open the *Contact Outputs* screen in the *Settings Explorer*, under *Programmable Outputs*. Select and label the appropriate outputs for *Breaker Close* and *Breaker Open*. If using contact outputs on the DGC-2020HD for Governor and Voltage Regulator control, the contact output can be labeled here as well. See Figure 49.

Output #	Label Text
Output #1	OUTPUT 1
Output #2	OUTPUT 2
Output #3	OUTPUT 3
Output #4	OUTPUT 4
Output #5	OUTPUT 5
Output #6	OUTPUT 6
Output #7	BREAKER CLOSE
Output #8	BREAKER OPEN
Output #9	GOV RAISE
Output #10	GOV LOWER
Output #11	AVR RAISE
Output #12	AVR LOWER

Figure 49. Settings Explorer, Programmable Outputs, Contact Outputs

5. Open the *Breaker Hardware* screen in the *Settings Explorer*, under *Breaker Management*. On this screen, enter the settings for the following parameters. See Figure 50.
 - a. Breaker Close Wait Time: This is the time interval in which it is expected that the breaker will transition from open to closed or closed to open. If it does not change state within the specified time, a generator or mains breaker failure is annunciated. A Gen Breaker Close Fail or Gen Breaker Open Fail is annunciated as a generator breaker failure. A Mains Breaker Close Fail or Mains Breaker Open Fail is annunciated as a mains breaker failure.
 - b. Generator Breaker:
 - i. Enable the *Dead Bus Close Enable* parameter if it is desired to close to a dead bus.
 - ii. Set the contact type and pulse times if pulsed contacts are used.
 - iii. Set the breaker closing time. This is the time used by the anticipatory synchronizer to calculate the advance angle before 0 degrees slip angle at which to issue the breaker close command.
 - c. Mains Breaker:
 - i. Set the mains breaker as configured, if used, otherwise leave it not configured.
 - ii. If the mains breaker is configured, set the contact type and pulse times if pulsed contacts are used.
 - iii. If the mains breaker is configured, set the breaker closing time. This is the time used by the anticipatory synchronizer to calculate the advance angle before 0 degrees slip angle at which to issue the breaker close command.

Breaker Hardware

Mains Fail

Mains Fail Transfer
☒ Disable
☐ Enable

Mains Breaker Open Configuration
☒ Generator Start
☐ Generator Stable

Mains Fail Transfer Type
☒ Open
☐ Closed

In Phase Monitor
☒ Disable
☐ Enable

Alarm State Transfer To Mains
☒ Disable
☐ Enable

Reverse Rotation Inhibit
☐ Disable
☒ Enable

Max Parallel Time (s)
0.5

Mains Fail Transfer Delay (s)
10

Mains Fail Return Delay (s)
10

Mains Fail Max Transfer Time (s)
30

Zero Power Flow Level (%)
3

Open Transition Delay (s)
0.0

Gen and Mains Breaker

Breaker Fail Wait Time (s)
0.2

Generator Breaker Hardware

Contact Type
Pulse

Breaker Fail Output Configuration
☒ Retain
☐ Remove

External Status Change Action
☒ Ignore
☐ Follow Always
☐ Follow In Auto

Dead Gen Close Enable
☒ Disable
☐ Enable

Open Pulse Time (s)
0.01

Close Pulse Time (s)
0.01

Breaker Closing Time (ms)
100

Transition Delay (s)
0.00

Open Attempts
1

Close Attempts
1

Retry Delay (s)
5

Mains Breaker Hardware

Contact Type
Pulse

Breaker Fail Output Configuration
☒ Retain
☐ Remove

External Status Change Action
☒ Ignore
☐ Follow Always
☐ Follow In Auto

Live Bus Close Enable
☒ Disable
☐ Enable

Open Pulse Time (s)
0.01

Close Pulse Time (s)
0.01

Breaker Closing Time (ms)
100

Transition Delay (s)
0.00

Open Attempts
1

Close Attempts
1

Retry Delay (s)
5

System Breaker Configuration
Generator and Mains Breaker Control with Load Bus

Figure 50. Settings Explorer, Breaker Management, Breaker Hardware

- Open the appropriate *Condition Detection* screens in the *Settings Explorer*, under *Breaker Management, Bus Condition Detection*. This is where the parameters are set for detecting stable and failed generator and bus conditions.

Caution

The generator and bus condition parameters are critical since a breaker can be closed only when the generator is stable and the bus is either stable or dead.

Bus condition thresholds determine when the generator and bus are considered to be stable or dead.

Each bus has its own settings screen. These include the *Gen Condition Detection*, *Bus 1 Condition Detection*, and optional *Bus 2 Condition Detection* screens. Three-phase and single-phase threshold settings are provided on each screen.

Only the *Gen Condition Detection* screen is described, because the *Gen*, *Bus 1* and *2 Condition Detection* screens are identical.

The *Gen Condition Detection* screen can be found in the *Settings Explorer*, under the *Breaker Management, Bus Condition Detection* category and is illustrated in Figure 51. The *Bus 1 Condition Detection* and optional *Bus 2 Condition Detection* screens are also found in the *Bus Condition Detection* category.

Gen Condition Detection

3 Phase

Condition Settings

Dead Gen Threshold	Dead Gen Activation Delay (s)	Gen Failed Activation Delay (s)
30 V	0.1	0.1
0.250 Per Unit		

Overvoltage Settings

Pickup (V L-L)	Dropout
130 V	127 V
1.083 Per Unit	1.058 Per Unit

Undervoltage Settings

Pickup (V L-L)	Dropout
115 V	117 V
0.958 Per Unit	0.975 Per Unit

Overfrequency Settings

Pickup	Dropout
62.00 Hz	61.80 Hz
1.0333 Per Unit	1.0300 Per Unit

Underfrequency Settings

Pickup	Dropout
58.00 Hz	58.20 Hz
0.9667 Per Unit	0.9700 Per Unit

Gen Stable Activation Delay (s)	Low Line Scale Factor	Alternate Frequency Scale Factor
0.1	1.000	1.000

1 Phase

Condition Settings

Dead Gen Threshold	Dead Gen Activation Delay (s)	Gen Failed Activation Delay (s)
30 V	0.1	0.1
0.250 Per Unit		

Overvoltage Settings

Pickup (V L-L)	Dropout
130 V	127 V
1.083 Per Unit	1.058 Per Unit

Undervoltage Settings

Pickup (V L-L)	Dropout
115 V	117 V
0.958 Per Unit	0.975 Per Unit

Overfrequency Settings

Pickup	Dropout
62.00 Hz	61.80 Hz
1.0333 Per Unit	1.0300 Per Unit

Underfrequency Settings

Pickup	Dropout
58.00 Hz	58.20 Hz
0.9667 Per Unit	0.9700 Per Unit

Gen Stable Activation Delay (s)	Low Line Scale Factor	Alternate Frequency Scale Factor
0.1	1.000	1.000

Figure 51. Settings Explorer, Breaker Management, Bus Condition Detection, Gen Condition Detection

Gen Condition Detection

When the generator bus voltage is below the *Dead Gen Threshold* for the duration of the *Activation Delay*, the generator bus is deemed “Dead”.

Four thresholds determine a stable generator bus. These consist of overvoltage, undervoltage, overfrequency, and underfrequency. Each bus condition (dead, failed, or stable) has an activation delay. When the generator bus voltage and frequency stay within the thresholds for the duration of the corresponding activation delay, the generator bus is deemed “stable”. Otherwise, it is deemed “failed”. When the voltage and frequency are outside the stable ranges for the duration of the Gen Failed Activation Delay, the generator is deemed “failed”.

- Open the Synchronizer screen in the Settings Explorer, under Breaker Management. See Figure 52.

Synchronizer

Sync Type

Slip Frequency (Hz)

Min Slip Control Limit (Hz)

Max Slip Control Limit (Hz)

Voltage Window (%)

Breaker Closing Angle (Deg)

Fgen > Fbus
☒ Disable
☐ Enable

Vgen > Vbus
☒ Disable
☐ Enable

Sync Activation Delay (s)

Sync Fail Activation Delay (s)

Sync Speed Gain

Sync Voltage Gain

Figure 52. Settings Explorer, Breaker Management, Synchronizer

Anticipatory versus Phase Lock Loop Synchronizer

If *Phase Lock Loop* synchronization is selected, the synchronizer will drive the angle between the generator and bus toward zero, and will drive the voltage between the generator and the bus so that the difference is less than the allowed difference set by the user.

If *Anticipatory* synchronization is selected, the synchronizer controls the slip frequency between the generator and the bus. The synchronizer calculates the timing of the closing signal that allows the generator breaker to be closed when the phase angle between the two sources is at 0 degrees. This calculation takes into account the slip rate, the generator breaker closing time, and the phase angle difference.

- a. Sync Type -Select either *Anticipatory* or *Phase Lock Loop* as the synchronizer type.
- b. Slip Frequency - The slip frequency setting is the maximum slip frequency that is in effect for a breaker close to occur.
- c. Voltage Window - The regulation offset is the maximum allowed percentage voltage difference between the generator and the bus that is in effect for a breaker close to occur. This is sometimes referred to as “voltage window”.
- d. Min/Max Slip Control Limit - (Phase lock synchronizer only.) These settings provide continuous slip frequency control while in phase lock synchronization.
- e. Breaker Close Angle - (Phase lock synchronizer only.) The breaker close angle is the maximum phase angle from the 0-degree phase angle that is in effect for a breaker close to occur. This is sometimes referred to as the “angle window” or “phase window”.
- f. Sync Activation Delay – The Sync Activation Delay is the length of time that the conditions for synchronization must be met. Generator voltage and bus voltage must be within the acceptable range for the duration of the sync activation delay. Additionally, the following condition must be met when in Phase Lock mode. Generator and bus phase angles must be within the acceptable breaker closing angle for the duration of the sync activation delay.
- g. Sync Fail Delay - The sync fail delay is the maximum time allowed for synchronization to occur. If the sync fail delay expires before the breaker closure occurs, a Sync Fail pre-alarm is annunciated, but the synchronizer continues to run to allow the breaker to be closed manually if desired. The Sync Fail Delay should be set to allow ample time for synchronization and breaker closure to occur.

- h. Gen Frequency > Bus Frequency - Enable gen frequency > bus frequency if desired. Enabling gen frequency > bus frequency will force kW to be pushed out of the generator when the breaker is closed.
 - i. Gen Voltage > Bus Voltage - Enable gen voltage > bus voltage if desired. Enabling gen voltage > bus voltage will ensure vars flow out of the generator when the breaker is closed.
8. Open the *AVR Bias Control Settings* screen in the *Settings Explorer*, under *Bias Control Settings*. Select either contact or analog as the bias control output type. See Figure 53.
- a. *Contact* bias control output type. Select either *Continuous* or *Proportional* as the bias control output type.
 - b. *Analog* bias control output type. If this is chosen, it is also required to enter gains and loop gains of the voltage PID controller. These settings may have to be adjusted to achieve the desired response from the voltage regulator. Controller tuning procedures may be found in the *Tuning PID Settings* chapter.

AVR Bias Control Settings

Panel

Bias Control Output Type: Analog

Bias Control Contact Type: Proportional

Correction Pulse Width (s): 0.0

Correction Pulse Interval (s): 0.0

Voltage

Trim Enable: Disable

Kp Proportional Gain: 1.000

Ki Integral Gain: 0.100

Kd Derivative Gain: 0.000

Td Derivative Filter Constant: 0.000

Kg Loop Gain: 0.100

var / PF

Control Enable: Disable

Control Mode: var Control

Kp Proportional Gain: 1.000

Ki Integral Gain: 0.100

Kd Derivative Gain: 0.000

Td Derivative Filter Constant: 0.000

Kg Loop Gain: 0.100

Droop Percentage (%): 0.000

Voltage Droop Gain: 1.000

Ramp Rate (%/s): 20.0

kvar Setpoint (%): 0.0

kvar Setpoint Source: User Setting

kvar Analog Max (%): 100.0

kvar Analog Min (%): 0.0

PF Setpoint Source: User Setting

(- Leading / + Lagging)

PF Setpoint: 1.00

PF Analog Max: -0.60

PF Analog Min: 0.60

Figure 53. Settings Explorer, Bias Control Settings, AVR Bias Control Settings

9. Open the *Governor Bias Control Settings* screen in the *Settings Explorer*, under *Bias Control Settings*. The parameters for the governor bias control are similar to those of the AVR bias control, and are set in a similar manner. Follow the same steps as for the AVR bias control setup.
10. If controlling the voltage regulator with an analog signal, open the *AVR Output* screen in the *Settings Explorer*, under *Multigen Management*. On this screen, select the bias output parameters and levels as required by the voltage regulator. See Figure 54.
- a. Output Type - Select whether the AVR bias signal should be *Voltage* or *Current*.
 - b. Response - Select *Increasing* or *Decreasing*. Increasing should be selected if an increase in the output parameter results in an increase of generator output voltage.
 - c. Min Output Current (mA) and Max Output Current (mA) - If the *Output Type* is *Current*, these parameters must be configured. Set the minimum and maximum current to a range equal to

- the voltage bias input range for the voltage regulator. The range on these parameters is 4 mA to 20 mA.
- d. Min Output Voltage (V) and Max Output Voltage (V) - If the *Output Type* is *Voltage*, these parameters must be configured. Set the minimum and maximum voltage to a range equal to the voltage bias input range for the voltage regulator. The range on these parameters is –10V to +10V.

AVR Output

Parameter Selection
 AVR Output

Output Type
 Voltage

Response
 Increasing

Out of Range Activation Delay (s)
 0

Alarm Configuration
 Status Only

Range		
Param Min	Min Output Current (mA)	Min Output Voltage (V)
0.0	4.0	-10.0
Param Max	Max Output Current (mA)	Max Output Voltage (V)
9999.0	20.0	10.0

Figure 54. Settings Explorer, Multigen Management, AVR Output

11. If controlling the governor with an analog signal, open the *Governor Output* screen in the *Settings Explorer*, under *Multigen Management*. These parameters are identical to those of the AVR output, and should be set in a similar manner.
12. Set up programmable logic to allow the DGC-2020HD to synchronize the generator and close the generator breaker. In *BESTlogicPlus* Programmable Logic, click on the *Elements* tab and drag the GENBRK (Generator Breaker) element into the main logic screen. See Figure 55.

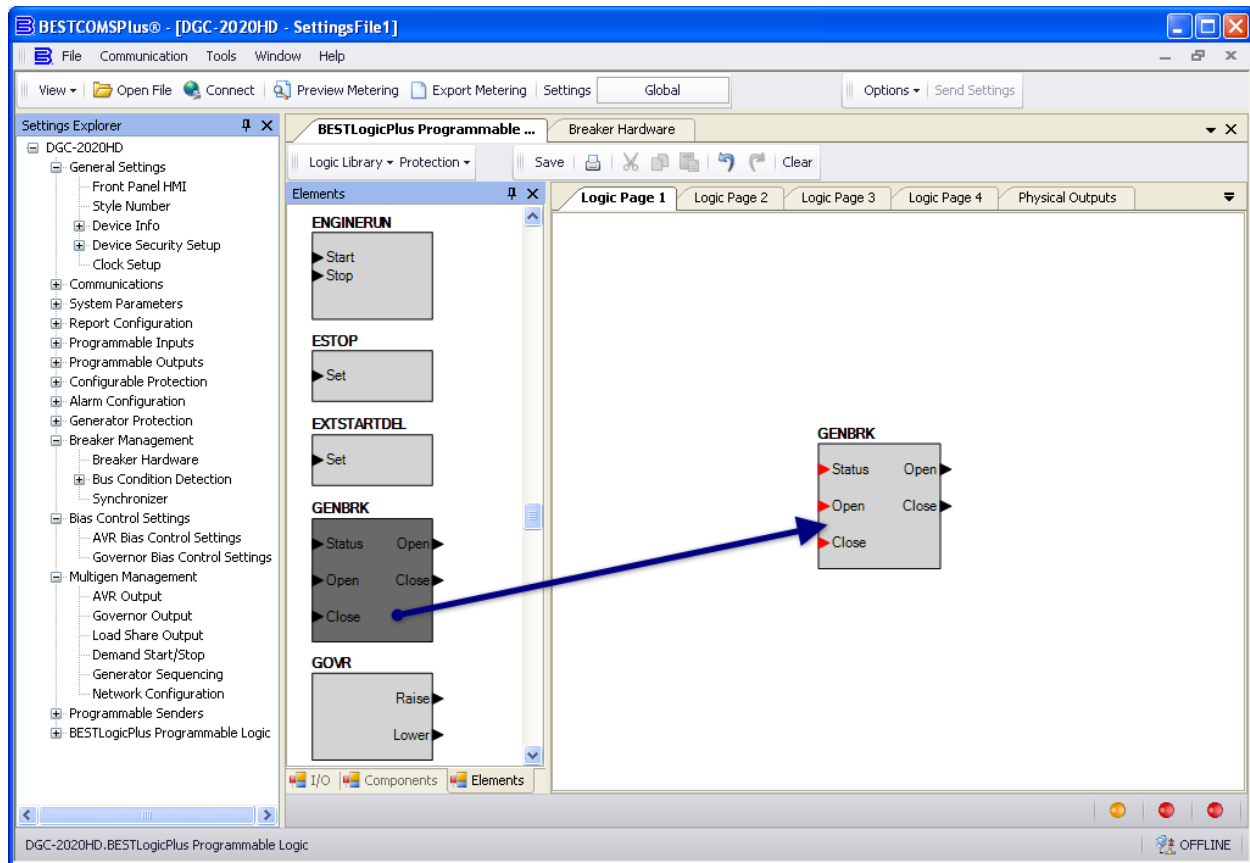


Figure 55. Synchronizer Setup in BESTLogicPlus Step 12

13. Click on the I/O tab and drag the inputs assigned in step 3, above, into the main logic screen. Connect them to the appropriate inputs of the GENBRK block. Drag the outputs assigned in step 4 into the main logic screen and connect them to the appropriate outputs of the GENBRK block. See Figure 56.

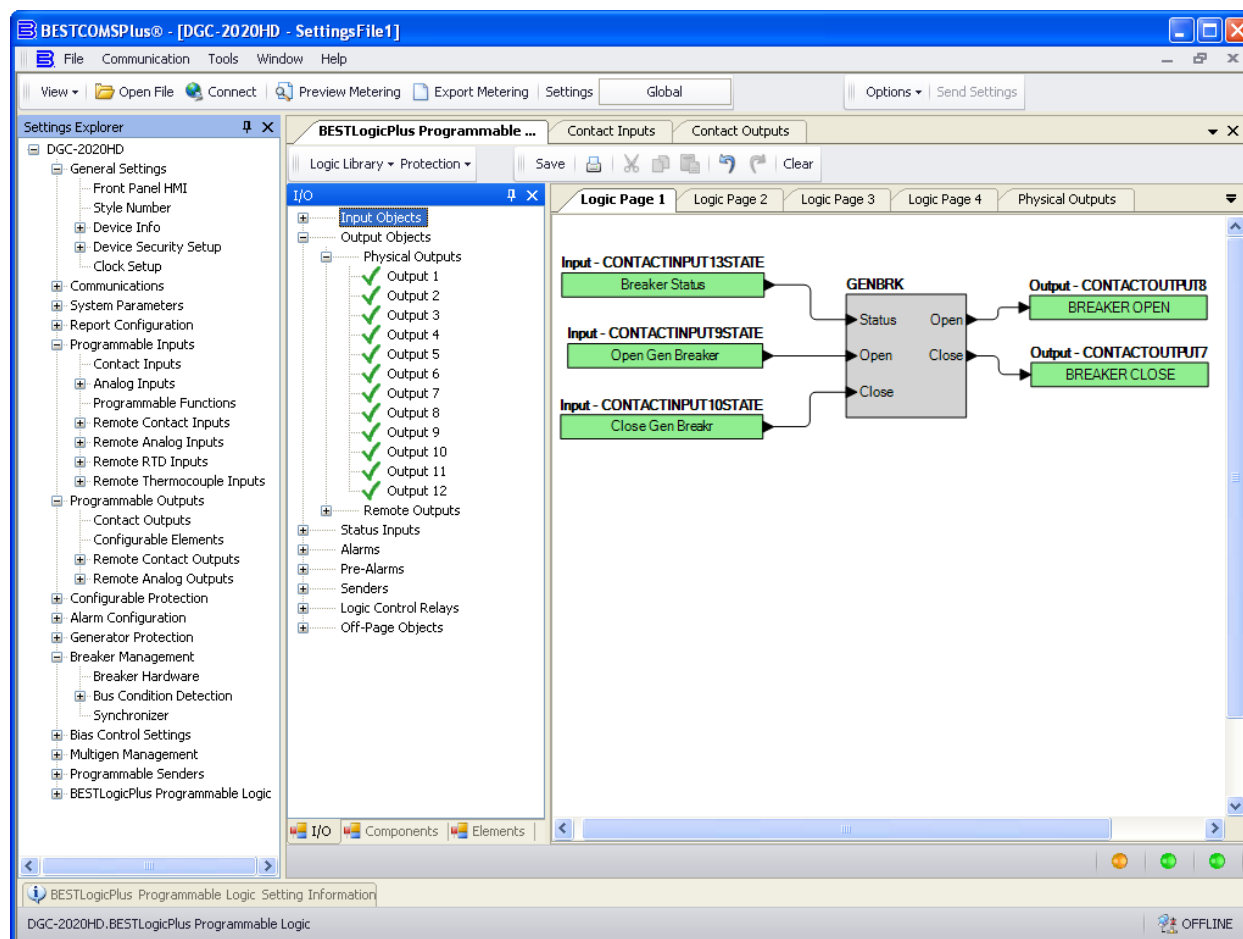


Figure 56. Synchronizer Setup in BESTlogicPlus Step 13

14. If using analog outputs to bias the voltage regulator and governor, no further setup is necessary. If using output contacts, they must be set up to drive these functions. In BESTlogicPlus programmable logic, click on the Elements tab. Drag the GOVR and AVR logic blocks into the main logic screen. See Figure 57.

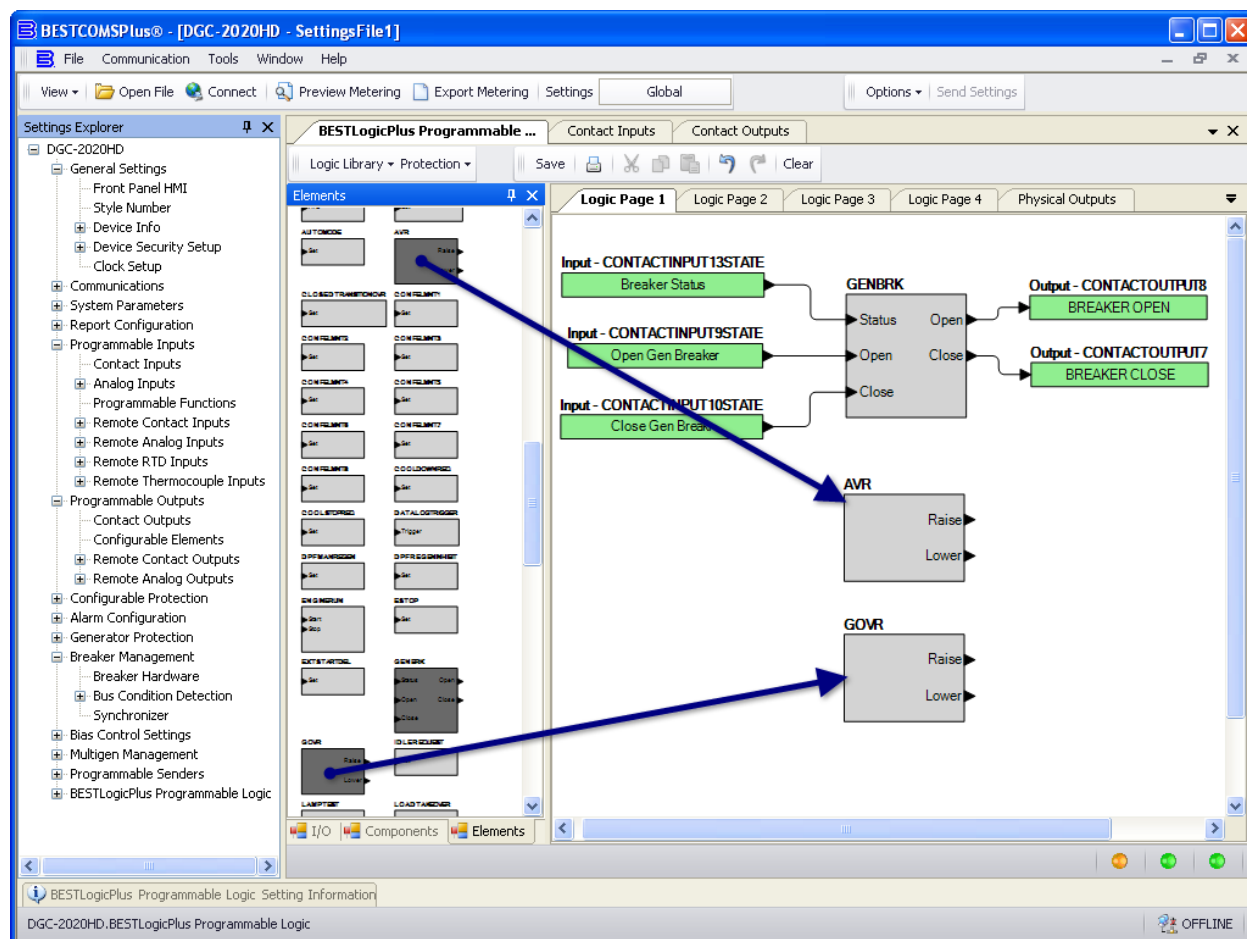


Figure 57. Synchronizer Setup in BESTLogicPlus Step 14

15. Click on the I/O tab and drag the outputs assigned in step 4 into the main logic screen. Connect the GOVR and AVR blocks to the appropriate output contacts. See Figure 58.

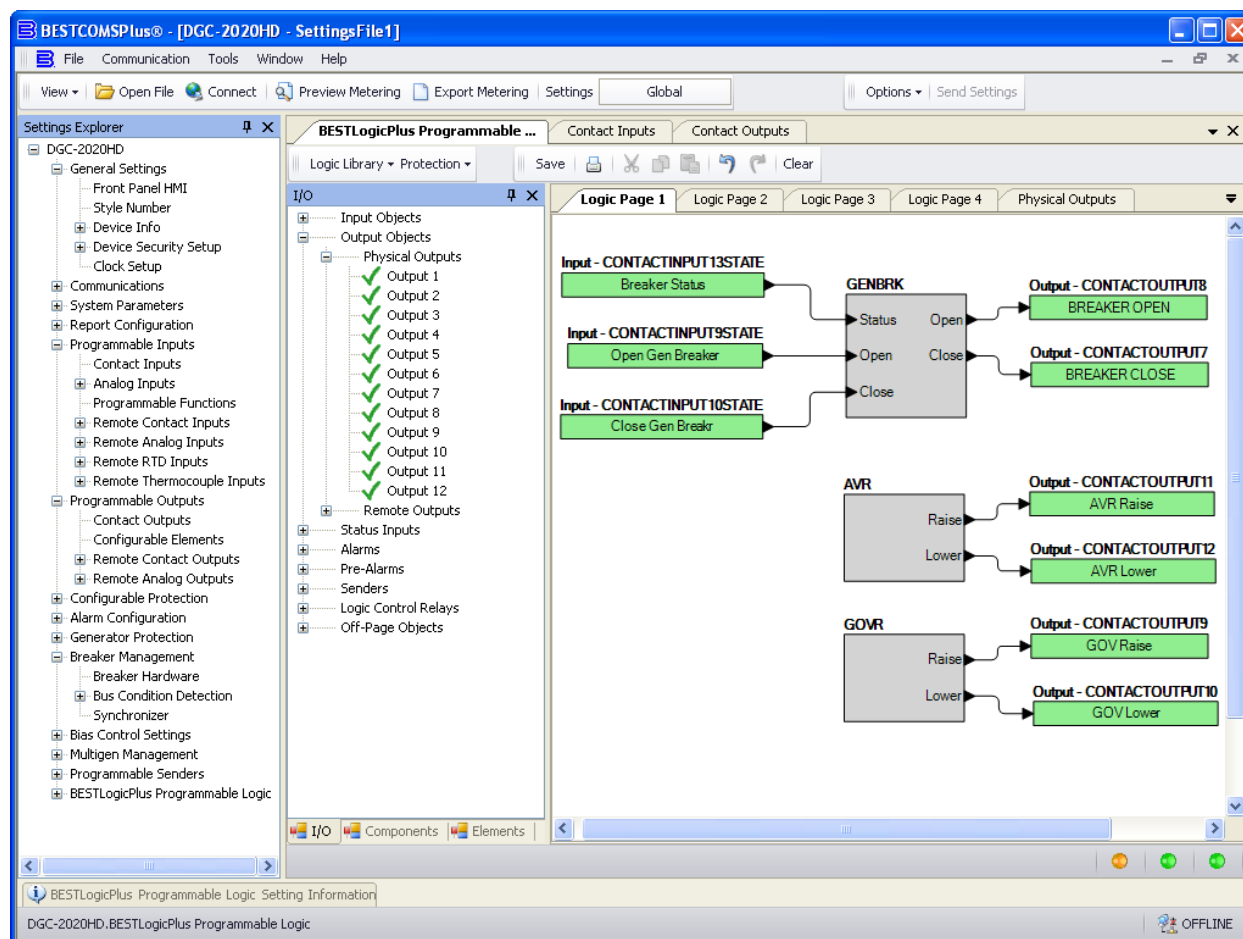


Figure 58. Synchronizer Setup in BESTLogicPlus Step 15

This concludes the implementation of the automatic synchronizer.



Bias Control

Settings are provided for AVR Bias Control and Governor Bias Control. Refer to the *Tuning PID Settings* chapter for instructions on Tuning Speed PID Settings and Load Control PID Settings.

AVR Bias Control Settings

BESTCOMSPlus Navigation Path: Settings Explorer, Bias Control Settings, AVR Bias Control Settings

Front Panel Navigation Path: Settings > Bias Control > AVR Bias Control

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

When using the analog output type, a PID controller controls the voltage bias from the DGC-2020HD to the voltage regulator. The controller adjusts the bias output to drive the error between desired generator voltage and measured generator voltage to zero. Settings are provided for proportional gain, integral gain, derivative gain, derivative filter constant, and loop gain of the PID controller.

var/PF Control

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

When control is enabled and the control mode is set to var, the var setpoint can be derived from either a user setting or an analog input. The DGC-2020HD calculates an operating kvar setpoint based on the kvar setpoint source setting. When this is set to User Setting, the operating kvar setpoint is equal to the configured kvar setpoint. When the kvar setpoint source setting is set to a DGC-2020HD analog input or an AEM-2020 input, the operating kvar setpoint is equal to the value calculated from the analog input. Parameters are available for kvar analog max and kvar analog min.

When the bias control output type is set to analog, a PID controller controls the var/PF bias from the DGC-2020HD to the voltage regulator. The controller adjusts the bias output to drive the error between desired generator var/PF and measured generator var/PF to zero. Settings are provided for proportional gain, integral gain, derivative gain, derivative filter constant, and loop gain of the PID controller.

The percent voltage droop to be used when the unit is in droop mode is determined by the droop percentage setting. Voltage droop mode is entered any time the generator breaker is open. Voltage droop is also the mode when the generator breaker is closed and var/PF control is disabled, or the Parallel to Mains logic element is not true since var/PF control is not enabled until the Parallel to Mains logic element is true. If it is desired to disable voltage droop, set the droop percentage to 0. The voltage droop gain setting determines the gain factor applied to the voltage droop percentage to compensate for governor differences and achieve desired droop performance. In order to test the operation of droop, the unit must be loaded to full load and the resulting generator voltage should be compared to the desired droop. If it is not possible to load the unit to full load, the droop test can be performed at partial load. The expected voltage is determined by the following equation.

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

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

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

After ramping a generator's kvar output, to bring it online or offline, overshoot may occur. The likeliness of kvar overshoot increases as the ramp rate increases. Typically, overshoot is reduced by lowering the ramp rate to the slowest possible setting. If overshoot is still a problem, the Ramp Overshoot Reduction setting can be used. A setting of 0% overshoot reduction results in no change to the amount of overshoot. A setting of 100% provides maximum overshoot reduction. Ramp Overshoot Reduction must be tuned to the optimal level. Too little reduction may result in overshoot while too much reduction may result in undershoot.

The BESTCOMSP^{Plus} AVR Bias Control Settings screen is illustrated in Figure 59. Settings are listed in Table 37.

AVR Bias Control Settings

Bias Control Output Type: Analog (A)

Bias Control Contact Type: Continuous (B)

Correction Pulse Width (s): 0.0 (C)

Correction Pulse Interval (s): 0.0 (D)

Voltage

Trim Enable: Disable (E)

Kp Proportional Gain: 1.000 (F)

Ki Integral Gain: 0.100 (G)

Kd Derivative Gain: 0.000 (H)

Td Derivative Filter Constant: 0.000 (I)

Kg Loop Gain: 0.100 (J)

var / PF

Control Enable: Disable (K)

Control Mode: var Control (L)

Kp Proportional Gain: 1.000 (M)

Ki Integral Gain: 0.100 (N)

Kd Derivative Gain: 0.000 (O)

Td Derivative Filter Constant: 0.000 (P)

Kg Loop Gain: 0.100 (Q)

Droop Percentage (%): 0.000 (R)

Voltage Droop Gain: 1.000 (S)

Ramp Rate (%/s): 20.0 (T)

Ramp Overshoot Reduction (%): 0 (U)

kvar Setpoint (%): 0.0 (V)

kvar Setpoint Source: User Setting (W)

kvar Analog Max (%): 100.0 (X)

kvar Analog Min (%): 0.0 (Y)

PF Setpoint Source: User Setting (Z)

(- Leading / + Lagging)

PF Setpoint: 1.00 (AA)

PF Analog Max: -0.60 (BB)

PF Analog Min: 0.60 (CC)

Figure 59. Settings Explorer, Bias Control Settings, AVR Bias Control Settings

Table 37. Settings for AVR Bias Control

Locator	Setting	Range	Increment	Unit
Panel Settings				
A	Bias Control Output Type	Contact or Analog	n/a	n/a
B	Bias Control Contact Type	Proportional or Continuous	n/a	n/a
C	Correction Pulse Width	0 to 99.9	0.1	seconds
D	Correction Pulse Interval	0 to 99.9	0.1	seconds

Locator	Setting	Range	Increment	Unit
<i>Voltage Settings</i>				
E	Trim Enable	Disable or Enable	n/a	n/a
F	Kp Proportional Gain	0 to 1,000	0.001	n/a
G	Ki Integral Gain	0 to 1,000	0.001	n/a
H	Kd Derivative Gain	0 to 1,000	0.001	n/a
I	Td Derivative Filter Constant	0 to 1	0.001	n/a
J	Kg Loop Gain	0 to 1,000	0.001	n/a
<i>var/PF Settings</i>				
K	Control Enable	Disable or Enable	n/a	n/a
L	Control Mode	var Control or PF Control	n/a	n/a
M	Kp Proportional gain	0 to 1,000	0.001	n/a
N	Ki Integral Gain	0 to 1,000	0.001	n/a
O	Kd Derivative Gain	0 to 1,000	0.001	n/a
P	Td Derivative Filter Constant	0 to 1	0.001	n/a
Q	Kg Loop Gain	0 to 1,000	0.001	n/a
R	Droop Percentage	0 to 10	0.001	%
S	Voltage Droop Gain	0 to 1,000	0.001	n/a
T	Ramp Rate	0 to 100	0.1	% per second
U	Ramp Overshoot Reduction	0 to 100	1	%
V	kvar Setpoint	–100 to +100	0.1	%
W	kvar Setpoint Source	User Setting or Aux Input 1 to 4	n/a	n/a
X	kvar Analog Max	–100 to +100	0.1	%
Y	kvar Analog Min	–100 to +100	0.1	%
Z	PF Setpoint Source	User Setting or Aux Input 1 to 4	n/a	n/a
<i>(– Leading / + Lagging) Settings</i>				
AA	PF Setpoint	+0.6 to –0.6	0.01	n/a
BB	PF Analog Max	+0.6 to –0.6	0.01	n/a
CC	PF Analog Min	+0.6 to –0.6	0.01	n/a

Governor Bias Control Settings

BESTCOMSPlus Navigation Path: Settings Explorer, Bias Control Settings, Governor Bias Control Settings

Front Panel Navigation Path: Settings > Bias Control > Gov Bias Control

When the bias control output type is set to contact, the DGC-2020HD adjusts the generator voltage and frequency by issuing speed correction signals to the generator governor. Correction signals are issued in the form of DGC-2020HD output contact closures. These correction signals can be either continuous or proportional. Proportional correction uses control pulses of varying widths and intervals. Initially, long pulses are issued when the voltage and frequency differences are large. As the correction pulses take effect and the voltage and frequency differences become smaller, the correction pulse widths are

proportionally decreased. Proportional correction pulses are beneficial in applications where fixed correction pulses can result in overshooting the slip frequency and regulation offset targets.

When the bias control output type is set to analog, a PID controller controls the bias signal from the DGC-2020HD to the speed governor. The controller adjusts the bias output to drive the error between desired generator speed and measured generator speed to zero. Settings are provided for proportional gain, integral gain, derivative gain, derivative filter constant, and loop gain of the PID controller.

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

After ramping a generator's kW output, to bring it online or offline, overshoot may occur. The likeliness of kW overshoot increases as the ramp rate increases. Typically, overshoot is reduced by lowering the ramp rate to the slowest possible setting. If overshoot is still a problem, the Ramp Overshoot Reduction setting can be used. A setting of 0% overshoot reduction results in no change to the amount of overshoot. A setting of 100% provides maximum overshoot reduction. Ramp Overshoot Reduction must be tuned to the optimal level. Too little reduction may result in overshoot while too much reduction may result in undershoot.

The BESTCOMSPlus Governor Bias Control Settings screen is illustrated in Figure 60. Settings are listed in Table 38.

Figure 60. Settings Explorer, Bias Control Settings, Governor Bias Control Settings

Table 38. Settings for Governor Bias Control

Locator	Setting	Range	Increment	Unit
<i>Panel Settings</i>				
A	Bias Control Output Type	Contact or Analog	n/a	n/a
B	Bias Control Contact Type	Continuous or Proportional	n/a	n/a

Locator	Setting	Range	Increment	Unit
C	Correction Pulse Width	0 to 99.9	0.1	seconds
D	Correction Pulse Interval	0 to 99.9	0.1	seconds
<i>Speed Settings</i>				
E	Kp Proportional Gain	0 to 1,000	0.001	n/a
F	Ki Integral Gain	0 to 1,000	0.001	n/a
G	Kd Derivative Gain	0 to 1,000	0.001	n/a
H	Td Derivative Gain	0 to 1	0.001	n/a
I	Kg Loop Gain	0 to 1,000	0.001	n/a
J	Speed Trim Enable	Disable or Enable	n/a	n/a
K	Speed Trim Setpoint	47 to 100	0.01	Hz
L	Remote Speed Bias Source	Aux Inputs 1 to 4 or None	n/a	n/a
M	Remote Speed Bias	0 to 5	0.01	%
<i>kW Settings</i>				
N	Load Control Enabled	Disable or Enable	n/a	n/a
O	Load Share Interface	Analog or Ethernet	n/a	n/a
P	Kp Proportional Gain	0 to 1,000	0.001	n/a
Q	Ki Integral Gain	0 to 1,000	0.001	n/a
R	Kd Derivative Gain	0 to 1,000	0.001	n/a
S	Td Derivative Filter Constant	0 to 1	0.001	n/a
T	Kg Loop Gain	0 to 1,000	0.001	n/a
U	Droop Percentage	0 to 10	0.001	%
V	Speed Droop Gain	0 to 1,000	0.001	n/a
W	Ramp Rate	0 to 100	0.1	% per second
X	Base Load Level	0 to 100	0.1	%
Y	Base Load Level Source	User Setting or Aux Input 1 to 4	n/a	n/a
Z	Base Load Analog Max	0 to 100	0.1	%
AA	Base Load Analog Min	0 to 100	0.1	%
BB	Breaker Open Setpoint	0 to 100	0.1	%



Multiple Generator Management

Multiple generator management settings consist of settings for AVR output, governor output, load share output, demand start/stop, generator sequencing, and network configuration.

AVR Output

The AVR output of the DGC-2020HD is used to change the voltage setpoint of the generator. If the response is set for increasing, an increased bias will raise the voltage. If the response is set for decreasing, an increased bias will lower the voltage. Settings are provided for minimum output current, maximum output current, minimum output voltage, and maximum output voltage.

The BESTCOMSPlus® AVR Output screen is illustrated in Figure 61. Settings are listed in Table 39.

AVR Output

Parameter Selection
 AVR Output [A]

Output Type
 Voltage [B]

Response
 Increasing [C]

Out of Range Activation Delay (s)
 0 [D]

Alarm Configuration
 Status Only [E]

Range

Param Min	Min Output Current (mA)	Min Output Voltage (V)
0.0 [F]	4.0 [H]	-10.0 [J]
Param Max	Max Output Current (mA)	Max Output Voltage (V)
9999.0 [G]	20.0 [I]	10.0 [K]

Figure 61. Settings Explorer, Multigen Management, AVR Output

Table 39. Settings for AVR Output

Locator	Setting	Range	Increment	Unit
A	Parameter Selection	*	n/a	n/a
B	Output Type	Voltage or Current	n/a	n/a
C	Response	Increasing or Decreasing	n/a	n/a
D	Out of Range Activation Delay	0 to 300	1	seconds
E	Alarm Configuration	Status Only, Pre-Alarm, or Alarm	n/a	n/a
F	Param Min	-999,999 to 999,999	0.1	n/a
G	Param Max	-999,999 to 999,999	0.1	n/a
H	Min Output Current	4 to 20	0.1	milliamps
I	Max Output Current	4 to 20	0.1	milliamps
J	Min Output Voltage	-10 to 10	0.1	volts
K	Max Output Voltage	-10 to 10	0.1	volts

* See *Parameter Selection*, below.

Governor Output

The governor output of the DGC-2020HD is used to change the speed setpoint of the generator. If the response is set for increasing, an increased bias will increase the speed. If the response is set for decreasing, an increased bias will decrease the speed. Settings are provided for minimum output current, maximum output current, minimum output voltage, and maximum output voltage.

The BESTCOMSP^{Plus} Governor Output screen is illustrated in Figure 62. Settings are listed in Table 40.

Governor Output

Parameter Selection
 GOV Output [A]

Output Type
 Voltage [B]

Response
 Increasing [C]

Out of Range Activation Delay (s)
 0 [D]

Alarm Configuration
 Status Only [E]

Range

Param Min	Min Output Current (mA)	Min Output Voltage (V)	Min Output PWM (%)
-1.00 [F]	4.0 [H]	-10.0 [J]	39.8 [L]
Param Max	Max Output Current (mA)	Max Output Voltage (V)	Max Output PWM (%)
1.00 [G]	20.0 [I]	10.0 [K]	99.8 [M]

Figure 62. Settings Explorer, Multigen Management, Governor Output

Table 40. Settings for Governor Output

Locator	Setting	Range	Increment	Unit
A	Parameter Selection	*	n/a	n/a
B	Output Type	Voltage, Current, or PWM	n/a	n/a
C	Response	Increasing or Decreasing	n/a	n/a
D	Out of Range Activation Delay	0 to 300	1	seconds
E	Alarm Configuration	Status Only, Pre-Alarm, or Alarm	n/a	n/a
F	Param Min	-999,999 to 999,999	0.1	n/a
G	Param Max	-999,999 to 999,999	0.1	n/a
H	Min Output Current	4 to 20	0.1	milliamps
I	Max Output Current	4 to 20	0.1	milliamps
J	Min Output Voltage	-10 to 10	0.1	volts
K	Max Output Voltage	-10 to 10	0.1	volts
L	Min Output PWM	0 to 100	0.1	%
M	Max Output PWM	0 to 100	0.1	%

* See *Parameter Selection*, below.

Load Share Output

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

The BESTCOMSP^{Plus} Load Share Output screen is illustrated in Figure 63.

Figure 63. Settings Explorer, Multigen Management, Load Share Output

Table 41. Settings for Load Share Output

Locator	Setting	Range	Increment	Unit
A	Out of Range Activation Delay	0 to 300	1	seconds
B	Alarm Configuration	Status Only, Pre-Alarm, or Alarm	n/a	n/a
C	Min Output Voltage	–10 to 10	0.1	volts
D	Max Output Voltage	–10 to 10	0.1	volts

Parameter Selection

When it is not necessary for the DGC-2020HD to communicate with the AVR or GOV, these outputs may be utilized for other purposes. Selectable parameters are listed in the *Configurable Protection* chapter. Param Min corresponds to the minimum output voltage or current setting. Param Max corresponds to the maximum output voltage or current setting.

Demand Start/Stop

The demand start/stop function operates in one of two modes: Per Unit Load or Spinning Reserve. When Per Unit Load mode is selected, the DGC-2020HD issues start and stop requests based on per unitized system load. When Spinning Reserve mode is selected, the DGC-2020HD provides extra generating capacity by starting an additional generator that is already connected to the system.

The primary function of Demand Start/Stop is to provide start and stop request information to the sequencing handler. Generator sequencing must be enabled in order for Demand Start/Stop to function. If system load is above a set level and the corresponding start level timeout has been exceeded, a corresponding start request is issued. If system load is below the delayed stop level and the stop timeout has been exceeded, a stop request is issued.

Spinning Reserve

The spinning reserve function is used in conjunction with generator sequencing to run the number of generators necessary to power the existing load plus an additional power swing amount.

For example, a power station normally has a 2,300 W load throughout the day, with an occasional 500 W power swing. Without spinning reserve, the DGC-2020HD starts only the number of generators needed to power the 2,300 W load. When the additional 500 W load is applied, another generator is started and when the additional load is removed, this same generator is shut down.

With a spinning reserve, the user can adjust a setting to account for the power swing. The reserve load is added to the actual load to find the adjusted load. This adjusted load is per-unitized to determine whether a generator needs to be started or stopped. To prevent constant starting and stopping, a hysteresis setting is also provided. There are two reserve levels, one for normal operation, and a second to start a unit more quickly when there is less reserve.

The BESTCOMSP_{Plus} Demand Start/Stop screen is illustrated in Figure 64. Settings are listed in Table 42.

Figure 64. Settings Explorer, Multigen Management, Demand Start/Stop

Table 42. Settings for Demand Start/Stop

Locator	Setting	Range	Increment	Unit
A	Demand Start Stop Mode	Disable, Per Unit Load, or Spinning Reserve	n/a	n/a
B	Delayed Start Level 1	0 to 1	0.001	per unit
C	Delayed Start Level 2	0 to 1	0.001	per unit
D	Delayed Stop Level	0 to 1	0.001	per unit
E	Start Level 1 Timeout	0 to 32,000	1	seconds
F	Start Level 2 Timeout	0 to 32,000	1	seconds
G	Stop Timeout	0 to 32,000	1	seconds
H	Capacity Level 1	1 to 999,999	1	kW
I	Capacity Level 2	1 to 999,999	1	kW
J	Hysteresis	5 to 65,000	1	kW
K	Start Level 1 Timeout	0 to 32,000	1	seconds
L	Start Level 2 Timeout	0 to 32,000	1	seconds
M	Stop Timeout	0 to 32,000	1	seconds

Generator Sequencing

Enabling sequencing on a networked group of load share units allows these units to manage load by starting and stopping appropriate units based on a factor of load demand and available capacity. The mode of operation is used to determine the order in which each generator in a group will contribute to the systems power production upon a demand start/stop request. The maximum start time setting defines the time to wait after a start request before demand start/stop can request the next priority unit to start. The maximum stop time defines the time to wait after a demand start/stop request before the next unit responds to a demand start/stop request.

Caution

For generator sequencing to function properly, the Load Control Enable setting must first be enabled. This setting is found on the Governor Bias Control Settings screen in BESTCOMS*Plus* or through the Front Panel interface.

By default, units first check to see if a consistent mode is present on the currently networked controllers. If a consistent mode is found, that mode is adopted. If a consistent mode is not found, the unit enters a mode mismatch state. If a mode mismatch occurs, verify that all machines on the network are configured for the same generator sequencing mode.

Each DGC-2020HD maintains its own start/stop status with respect to sequencing. When there is a change to generator sequencing mode on any one unit, this change propagates to all connected units that are not in the disabled mode. All units on the network are notified of this mode change. A unit is available for sequencing if it is in auto mode and its sequencing mode is any other than disabled.

If two or more units have the same sorting order parameter, the sequencing ID will be used to determine which unit has priority. For example, if the sequencing mode is set for largest size first and both are 100-kW machines, the unit with the lower sequencing ID is given priority. In the event that both units have the same sequencing ID, the unit with the lower unit ID (based on the Mac address) is given priority.

If a unit fails to sequence on, the next generator in the sequence will be requested. The generator that previously failed will be requested again in the next sequence cycle.

The last machine can be shut down if there is no load on the system by enabling Allow Last Unit Shutdown.

The BESTCOMS*Plus* Generator Sequencing screen is illustrated in Figure 65. Settings are listed in Table 43.

Generator Sequencing

Mode
 Staggered Service Time

Sequencing ID
 0

Max Gen Start Time Sec (s)
 60

Max Gen Stop Time Sec (s)
 60

Allow Last Unit Shutdown
 Disable

Figure 65. Settings Explorer, Multigen Management, Generator Sequencing

Table 43. Settings for Generator Sequencing

Locator	Setting	Range	Increment	Unit
A	Mode	*	n/a	n/a
B	Sequencing ID	0 to 255	1	n/a
C	Max Gen Start Time Sec	1 to 3,000	1	seconds
D	Max Gen Stop Time Sec	1 to 3,000	1	seconds
E	Allow Last Unit Shutdown	Disable or Enable	n/a	n/a

*Sequencing modes are listed below.

The available sequencing modes are defined in the following paragraphs.

Disabled

This is the only mode that can coexist with a different mode on a networked system. A unit configured as disabled does not participate in sequenced starting and stopping and does not respond to demand start/stop requests.

Staggered Service Time

If this mode is selected, units seek to sort the start priority of all non-disabled networked units in ascending order of service hours remaining. In this configuration, a network of units will respond to a demand start request by starting the unit with the least number of service hours remaining first. If a unit is down to zero service hours remaining, it is moved to the lowest start priority position. In the event that two or more units have matching service hours remaining, the unit with the lowest sequencing ID is assigned highest start priority. Units in Auto Run mode with the highest number of service hours remaining respond to demand stop requests first.

Balanced Service Time

In this mode, units seek to sort the start priority of all non-disabled networked units in ascending order of service hours remaining. In this configuration, a network of units will respond to a demand start request by starting the unit with the greatest number of service hours remaining first. In the event that two or more units have matching service hours remaining, the unit with the lowest sequencing ID is assigned highest start priority. Units in Auto Run mode with the lowest number of service hours remaining respond to demand stop requests first.

Largest Size First

Units seek to sort the start priority of all non-disabled networked units in descending order of real load capacity. In this configuration, a network of units will respond to a demand start request by starting the unit with the largest load capacity first. In the event that two or more units have matching capacities, the unit with the lowest sequencing ID is assigned highest start priority. The stopping order is the reverse of the starting order.

Smallest Size First

Starting priority of all non-disabled networked units is sorted in ascending order of real load capacity. In this configuration, a network of units responds to a demand start request by starting the unit with the smallest load capacity first. In the event that two or more units have matching capacities, the unit with the lowest sequencing ID is assigned highest start priority. The stopping order is the reverse of the starting order.

Smallest Unit ID

Units seek to sort the start priority of all non-disabled networked units in ascending order according to the sequencing ID. In this configuration, a network of units will respond to a demand start request by starting the unit with the smallest sequencing ID. Units must have unique sequencing IDs to be part of a network. The stopping order is the reverse of the starting order.

Network Configuration

The sequencing ID of the unit being programmed and the sequencing IDs of all other units on a networked system should be entered in the expected sequence ID table. If the state of any unit changes to offline and the ID Missing pre-alarm is enabled on the Pre-Alarms settings screen, an ID Missing pre-alarm appears on the front panel and BESTCOMS*Plus* metering screen. If an expected sequence ID is detected on two or more units and the ID Repeat pre-alarm is enabled on the Pre-Alarms settings screen, an ID Repeat pre-alarm appears on the front panel and the BESTCOMS*Plus* metering screen.

The BESTCOMS*Plus* Network Configuration screen is illustrated in Figure 66.

Network Configuration			
Expected Sequence ID 1 5	Expected Sequence ID 9 0	Expected Sequence ID 17 0	Expected Sequence ID 25 0
Expected Sequence ID 2 6	Expected Sequence ID 10 0	Expected Sequence ID 18 0	Expected Sequence ID 26 0
Expected Sequence ID 3 7	Expected Sequence ID 11 0	Expected Sequence ID 19 0	Expected Sequence ID 27 0
Expected Sequence ID 4 8	Expected Sequence ID 12 0	Expected Sequence ID 20 0	Expected Sequence ID 28 0
Expected Sequence ID 5 0	Expected Sequence ID 13 0	Expected Sequence ID 21 0	Expected Sequence ID 29 0
Expected Sequence ID 6 0	Expected Sequence ID 14 0	Expected Sequence ID 22 0	Expected Sequence ID 30 0
Expected Sequence ID 7 0	Expected Sequence ID 15 0	Expected Sequence ID 23 0	Expected Sequence ID 31 0
Expected Sequence ID 8 0	Expected Sequence ID 16 0	Expected Sequence ID 24 0	Expected Sequence ID 32 0

Figure 66. Settings Explorer, Multigen Management, Network Configuration



Generator Protection

Two tiers of generator protection are offered. DGC-2020HD controllers with style number xxSxxxxxx offer standard protection consisting of undervoltage (27), overvoltage (59), overfrequency (81O), underfrequency (81U), power (32), and loss of excitation (40Q) elements. Controllers with style number xxExxxxxx offer enhanced protection, which consists of the standard protection elements plus phase voltage imbalance (47), time overcurrent (51), vector shift (78), and frequency rate-of-change (ROC) elements.

Four setting groups enable independent protection coordination which is selectable in *BESTlogicPlus*. Setting groups are described at the end of this chapter.

Undervoltage (27)

Six undervoltage protection (27) elements monitor the sensing voltage applied to the DGC-2020HD. An element can be configured to protect against undervoltage when the phase voltage decreases below a defined level.

The six, identical undervoltage protection elements are designated 27-1, 27-2, 27-3, 27-4, 27-5, and 27-6. Element logic connections are made on the *BESTlogic™Plus* screen in *BESTCOMSPlus®* and element operational settings are configured on the Undervoltage settings screen in *BESTCOMSPlus*.

BESTCOMSPlus Navigation Path: Settings Explorer, Generator Protection, Voltage, Undervoltage (27)

Front Panel Navigation Path: Settings Explorer > Protection > Settings Group x (where x = 0 to 3) > Voltage Protection > Undervoltage (27P)

Element Operation

Undervoltage protection can be used to prevent equipment damage when an undervoltage condition exists.

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

Source

The Source setting configures an undervoltage element to monitor the generator sensing input terminals or the bus sensing input terminals.

Pickup and Trip

When the average of the three-phase voltage (three-phase mode) or the line-to-line voltage (single-phase mode) decreases below the threshold established by the Pickup setting, a timer begins timing towards a trip.

The duration of the timer is established by the Activation Delay. An Activation Delay of zero (0) makes the 27 element instantaneous with no intentional time delay.

If an undervoltage pickup condition persists for the duration of the element Activation Delay setting, the element Trip output becomes true. In *BESTlogicPlus*, the Trip output can be connected to other logic elements or a physical relay output to annunciate the condition and initiate corrective action.

If the pickup condition subsides before the element activation delay expires, the timer is reset, no corrective action is taken, and the element is rearmed for any other occurrences of undervoltage.

Hysteresis

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

Per Unit

Settings which are related to machine ratings can be set in either actual units of voltage or in per unit values. When a native unit is edited, BESTCOMS*Plus* automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the System Parameters, Rated Data screen) associated with it. Conversely, when a per unit value is edited, BESTCOMS*Plus* automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, BESTCOMS*Plus* automatically recalculates all native unit settings based on the modified rated data parameters.

The following settings have native units of Secondary Volts, and the rated data associated with them is Rated Secondary Volts (on the System Parameters, Rated Data screen).

- Undervoltage 27-x Three-Phase Pickup
- Undervoltage 27-x Single-Phase Pickup

Low-Line Scale Factor

A low-line scale factor setting is used to automatically adjust the undervoltage pickup settings in applications that might utilize more than one type of genset connection. The scale factor setting is implemented when the DGC-2020HD is determined to be in a low-line configuration. If the Low-Line Override function is assigned to a contact input via the Programmable Functions screen, the state of the contact input and the detected configuration are ORed. This means, if one or both are true, then the system is determined to be configured for low-line. The value of the scale factor setting serves as a multiplier for the pickup settings. For example, if a scale factor contact input is received by the DGC-2020HD and the scale factor setting is 2.000, the pickup setting will be doubled ($2.000 \times \text{PU}$).

Alarm Configuration

An undervoltage annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). It can also be user-configured to close a programmable output.

Element status is available in BESTlogic*Plus* programmable logic when “Status Only” is selected.

Inhibit Frequency

Inhibit Frequency impedes undervoltage element operation during undervoltage conditions that may occur during equipment startup.

Logic Connections

Undervoltage element logic connections are made on the BESTlogic*Plus* screen in BESTCOMS*Plus*. The undervoltage element logic block is illustrated in Figure 67. When the Block input is true, the 27 element is disabled. The Trip output is true when the 27 element is in a trip condition.

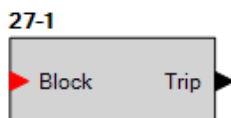


Figure 67. Undervoltage Element Logic Block

Operational Settings

Undervoltage element operational settings are configured on the Undervoltage settings screen (Figure 68) in BESTCOMS*Plus*. Setting ranges are defined in the *Specifications* chapter.

Undervoltage

27-1 Element

3 Phase	Single Phase
Mode Enabled	Mode Enabled
Source Gen	Source Gen
Pickup (V L-L) 0 V 0.000 Per Unit	Pickup (V L-L) 0 V 0.000 Per Unit
Hysteresis (V) 1	Hysteresis (V) 1
Activation Delay (s) 0.1	Activation Delay (s) 0.1
Inhibit Frequency (Hz) 35	Inhibit Frequency (Hz) 35
Alarm Configuration Status Only	Alarm Configuration Status Only
Low Line Scale Factor 1.000	Low Line Scale Factor 1.000

Figure 68. Settings Explorer, Generator Protection, Voltage, Undervoltage

Overvoltage (59)

Six overvoltage protection (59) elements monitor the sensing voltage applied to the DGC-2020HD. An element can be configured to protect against overvoltage when the phase voltage increases above a defined level.

The six, identical overvoltage protection elements are designated 59-1, 59-2, 59-3, 59-4, 59-5, and 59-6. Element logic connections are made on the BESTlogic™*Plus* screen in BESTCOMS*Plus*® and element operational settings are configured on the Overvoltage settings screen in BESTCOMS*Plus*.

BESTCOMS*Plus* Navigation Path: Settings Explorer, Generator Protection, Voltage, Overvoltage (59)

Front Panel Navigation Path: Settings Explorer > Protection > Settings Group x (where x = 0 to 3) > Voltage Protection > Overvoltage (59P)

Element Operation

Overvoltage protection can be used to prevent equipment damage when an overvoltage condition exists.

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

Source

The Source setting configures an overvoltage element to monitor the generator sensing input terminals or the bus sensing input terminals.

Pickup and Trip

When the average of the three-phase voltage (three-phase mode) or the line-to-line voltage (single-phase mode) increases above the threshold established by the Pickup setting, a timer begins timing towards a trip.

The duration of the timer is established by the Activation Delay. An Activation Delay of zero (0) makes the 59 element instantaneous with no intentional time delay.

If an overvoltage pickup condition persists for the duration of the element Activation Delay setting, the element Trip output becomes true. In *BESTlogicPlus*, the Trip output can be connected to other logic elements or a physical relay output to annunciate the condition and initiate corrective action.

If the pickup condition subsides before the element activation delay expires, the timer is reset, no corrective action is taken, and the element is rearmed for any other occurrences of overvoltage.

Hysteresis

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

Per Unit

Settings which are related to machine ratings can be set in either actual units of voltage or in per unit values. When a native unit is edited, *BESTCOMSPlus* automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the System Parameters, Rated Data screen) associated with it. Conversely, when a per unit value is edited, *BESTCOMSPlus* automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, *BESTCOMSPlus* automatically recalculates all native unit settings based on the modified rated data parameters.

The following settings have native units of Secondary Volts, and the rated data associated with them is Rated Secondary Volts (on the System Parameters, Rated Data screen).

- Overvoltage 59-x Three-Phase Pickup
- Overvoltage 59-x Single-Phase Pickup

Low-Line Scale Factor

A low-line scale factor setting is used to automatically adjust the overvoltage pickup settings in applications that might utilize more than one type of genset connection. The scale factor setting is implemented when the DGC-2020HD is determined to be in a low-line configuration. If the Low-Line Override function is assigned to a contact input via the Programmable Functions screen, the state of the contact input and the detected configuration are ORed. This means, if one or both are true, then the system is determined to be configured for low-line. The value of the scale factor setting serves as a multiplier for the pickup settings. For example, if a scale factor contact input is received by the DGC-2020HD and the scale factor setting is 2.000, the pickup setting will be doubled ($2.000 \times \text{PU}$).

Alarm Configuration

An overvoltage annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). It can also be user-configured to close a programmable output.

Element status is available in *BESTlogicPlus* programmable logic when "Status Only" is selected.

Logic Connections

Overvoltage element logic connections are made on the *BESTlogicPlus* screen in *BESTCOMSPlus*. The overvoltage element logic block is illustrated in Figure 69. When the Block input is true, the 59 element is disabled. The Trip output is true when the 59 element is in a trip condition.



Figure 69. Overvoltage Element Logic Block

Operational Settings

Overvoltage element operational settings are configured on the Overvoltage settings screen (Figure 70) in *BESTCOMSPlus*. Setting ranges are defined in the *Specifications* chapter.

Figure 70. Settings Explorer, Generator Protection, Voltage, Overvoltage

Phase Voltage Imbalance (47)

Six phase voltage imbalance protection (47) elements monitor the sensing voltage applied to the DGC-2020HD. An element can be configured to protect against voltage imbalances between any of the three phases. This element is available only in styles xxExxxxx of the DGC-2020HD.

The six, identical phase voltage imbalance protection elements are designated 47-1, 47-2, 47-3, 47-4, 47-5, and 47-6. Element logic connections are made on the *BESTlogic™Plus* screen in *BESTCOMSPlus®* and element operational settings are configured on the Phase Voltage Imbalance settings screen in *BESTCOMSPlus*.

BESTCOMSPlus Navigation Path: Settings Explorer, Generator Protection, Voltage, Phase Imbalance (47)

Front Panel Navigation Path: Settings Explorer > Protection > Settings Group x (where x = 0 to 3) > Voltage Protection > Phase Volt Imbalance (47)

Element Operation

Phase voltage imbalance elements provide negative phase-sequence (V2) protection in a three-phase system. The V2 measurement increases as voltage becomes unbalanced or the phase sequence is reversed.

The Pickup setting entered is based on the PT secondary side (DGC-2020HD).

Source

A Source setting configures the phase voltage imbalance element to monitor the generator sensing input terminals or the bus sensing input terminals.

Pickup and Trip

When the difference between any of the three phases of generator voltage increases above the threshold established by the Pickup setting, a timer begins timing towards a trip.

Timer duration is established by the Activation Delay. An Activation Delay of zero (0) makes the 47 element instantaneous with no intentional time delay.

If a phase voltage imbalance pickup condition persists for the duration of the element Activation Delay setting, the element Trip output becomes true. In *BESTlogicPlus*, the Trip output can be connected to other logic elements or a physical relay output to annunciate the condition and initiate corrective action.

If the pickup condition subsides before the element activation delay expires, the timer is reset, no corrective action is taken, and the element is rearmed for any other occurrences of phase voltage imbalance.

Hysteresis

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

Per Unit

Settings which are related to machine ratings can be set in either actual units of voltage or in per unit values. When a native unit is edited, *BESTCOMSPlus* automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the System Parameters, Rated Data screen) associated with it. Conversely, when a per unit value is edited, *BESTCOMSPlus* automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, *BESTCOMSPlus* automatically recalculates all native unit settings based on the modified rated data parameters.

The following setting has native units of Secondary Volts, and the rated data associated with it is Rated Secondary Volts (on the System Parameters, Rated Data screen).

- Phase Imbalance 47-x Pickup

Low-Line Scale Factor

A low-line scale factor setting is used to automatically adjust the phase voltage imbalance pickup settings in applications that might utilize more than one type of genset connection. The scale factor setting is implemented when the DGC-2020HD is determined to be in a low-line configuration. If the Low-Line Override function is assigned to a contact input via the Programmable Functions screen, the state of the contact input and the detected configuration are ORed. This means, if one or both are true, then the system is determined to be configured for low-line. The value of the scale factor setting serves as a multiplier for the pickup settings. For example, if a scale factor contact input is received by the DGC-2020HD and the scale factor setting is 2.000, the pickup setting will be doubled (2.000 x PU).

Alarm Configuration

Phase voltage imbalance annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). It can also be user-configured to close a programmable output.

Element status is available in *BESTlogicPlus* programmable logic when "Status Only" is selected.

Logic Connections

Phase voltage imbalance element logic connections are made on the *BESTlogicPlus* screen in *BESTCOMSPlus*. The phase voltage imbalance element logic block is illustrated in Figure 71. When the

Block input is true, the 47 element is disabled. The Trip output is true when the 47 element is in a trip condition.



Figure 71. Phase Voltage Imbalance Element Logic Block

Operational Settings

Phase voltage imbalance element operational settings are configured on the Phase Voltage Imbalance settings screen (Figure 72) in BESTCOMSPlus. Setting ranges are defined in the *Specifications* chapter.

Phase Imbalance

47-1 Element

Mode: V2

Source: Gen

Pickup: 0 V, 0.000 Per Unit

Hysteresis (V): 1

Activation Delay (s): 0.1

Alarm Configuration: Status Only

Low Line Scale Factor: 1.000

Figure 72. Settings Explorer, Generator Protection, Voltage, Phase Imbalance

Vector Shift (78)

Two vector shift protection (78) elements protect the generator by disconnecting it from the grid when a loss of mains or mains failure occurs. This prevents the generator from remaining tied to the mains if the mains returns due to an external reclose device. Vector Shift elements are available only in styles xxExxxxxx of the DGC-2020HD.

The two, identical vector shift protection elements are designated 78-1 and 78-2. Element logic connections are made on the BESTlogic™Plus screen in BESTCOMSPlus® and element operational settings are configured on the Vector Shift settings screen in BESTCOMSPlus.

BESTCOMSPlus Navigation Path: Settings Explorer, Generator Protection, Loss of Mains Protection, Vector Shift (78)

Front Panel Navigation Path: Settings Explorer > Protection > Settings Group x (where x = 0 to 3) > Loss of Mains Protection > Vector Shift (78)

Element Operation

When a loss of mains occurs, it is likely that the generator load will shift abruptly since the generator is driving everything between the generator output and the utility breaker that removed mains power. Such a load shift is likely to cause a speed shift, which may result in the generator being out of phase with the

mains when a reclose occurs. If the generator is out of phase and connection with the mains is established, damage could occur.

The vector shift element trips the breaker when it detects a phase shift in the generator voltage. A sudden change in generator phase angle often occurs when the grid is lost. This change of phase angle results in an earlier zero crossing of the generator voltage if the generator load decreases. It results in a later zero crossing if the generator load increases. This shift of the zero crossing (vector shift) is expressed in degrees.

Loss of mains protection is only active when the generator is paralleled to the mains as indicated when the Parallel to Mains logic element is true in *BESTlogicPlus*. Protection is inhibited for five seconds after the Parallel to Mains logic element first becomes true so that transients from closing onto the mains will not cause false trips.

To minimize false trips, loss of mains protection is disabled if any configured breakers are not closed.

Vector shift trips are latched. They are cleared by pressing the Reset button on the front panel or by putting the DGC-2020HD into Off mode.

Source

A Source setting configures the vector shift element to monitor the generator sensing input terminals or the bus sensing input terminals.

Pickup and Trip

When the vector shift increases above the threshold established by the Pickup setting, the element Trip output becomes true. In *BESTlogicPlus*, the Trip output can be connected to other logic elements or a physical relay output to annunciate the condition and initiate corrective action.

Alarm Configuration

Vector shift annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). It can also be user-configured to close a programmable output.

Element status is available in *BESTlogicPlus* programmable logic when "Status Only" is selected.

Open Mains Breaker or Gen Breaker on Trip

When Open Mains Breaker on Trip is enabled, the DGC-2020HD will request the mains breaker to open when a 78 trip is annunciated. When Open Gen Breaker on Trip is enabled, the DGC-2020HD will request the generator breaker to open when a 78 trip is annunciated.

Logic Connections

Vector shift element logic connections are made on the *BESTlogicPlus* screen in *BESTCOMSPlus*. The vector shift element logic block is illustrated in Figure 73. When the Block input is true, the 78 element is disabled. The Trip output is true when the 78 element is in a trip condition.



Figure 73. Vector Shift Element Logic Block

Operational Settings

Vector shift element operational settings are configured on the Vector Shift settings screen (Figure 74) in *BESTCOMSPlus*. Setting ranges are defined in the *Specifications* chapter.

Vector Shift

78-1 Element

Mode
Enabled

Source
Generator

Pickup (degrees)
10

Alarm Configuration
Status Only

Open Mains Breaker On Trip
Enabled

Open Gen Breaker On Trip
Disabled

Figure 74. Settings Explorer, Generator Protection, Loss of Mains Protection, Vector Shift

Frequency (81)

Eight frequency protection (81) elements monitor the frequency of the sensing voltage applied to the DGC-2020HD. An element can be configured to protect against underfrequency, overfrequency, or the rate of frequency change. Rate of frequency change mode is available only in styles xxExxxxxx of the DGC-2020HD.

The eight, identical frequency protection elements are designated 81-1, 81-2, 81-3, 81-4, 81-5, 81-6, 81-7, and 81-8. Element logic connections are made on the BESTlogic™*Plus* screen in BESTCOMS*Plus*® and element operational settings are configured on the Frequency settings screen in BESTCOMS*Plus*.

BESTCOMS*Plus* Navigation Path: Settings Explorer, Generator Protection, Frequency, Frequency (81)

Front Panel Navigation Path: Settings Explorer > Protection > Settings Group x (where x = 0 to 3) > Frequency Protection > Frequency (81)

Frequency Measurement

For all sensing connections, the frequency is measured through the DGC-2020HD A- and B-phase sensing voltage connections.

To measure frequency, the voltage sensed by the DGC-2020HD must be greater than 10 Vac. The measured frequency is the average of two cycles of voltage measurement.

Underfrequency and Overfrequency

Underfrequency and overfrequency protection can be useful for detecting load shedding or islanding. For example, when a genset is suddenly separated or isolated from the electric utility, the frequency will change quickly from the nominal values (except for the improbable case of a perfect load-to-generation match). This makes frequency measurement an excellent method for detecting an island condition.

Any of the eight 81 elements can be configured for underfrequency or overfrequency protection.

Mode

Underfrequency or overfrequency protection is selected through the Mode setting. A setting of Under selects underfrequency and a setting of Over selects overfrequency protection.

Source

A Source setting configures the frequency element to monitor the generator sensing input terminals or the bus sensing input terminals.

Pickup and Trip

When the measured frequency decreases below (underfrequency protection) or increases above (overfrequency protection) the frequency threshold established by the Pickup setting for three consecutive sensing voltage cycles, a timer begins timing towards a trip.

Timer duration is established by the Activation Delay. An Activation Delay of zero (0) makes the 81 element instantaneous with no intentional time delay.

If an underfrequency or overfrequency pickup condition persists for the duration of the element Activation Delay setting, the element Trip output becomes true. In *BESTlogicPlus*, the Trip output can be connected to other logic elements or a physical relay output to annunciate the condition and initiate corrective action.

If the pickup condition subsides before the element activation delay expires, the timer is reset, no corrective action is taken, and the element is rearmed for any other occurrences of underfrequency or overfrequency.

Hysteresis

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

Per Unit

Settings which are related to machine ratings can be set in either actual units of hertz or in per unit values. Per unit settings are available for Pickup (81O/81U) and Inhibit Voltage (81U). When a native unit is edited, *BESTCOMSPlus* automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the System Parameters, Rated Data screen) associated with it. Conversely, when a per unit value is edited, *BESTCOMSPlus* automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, *BESTCOMSPlus* automatically recalculates all native unit settings based on the modified rated data parameters.

The following setting has native units of Frequency in Hz, and the rated data associated with it is Rated Frequency (on the System Parameters, Rated Data screen).

- Frequency 81-x Pickup

The following setting has native units of Secondary Volts, and the rated data associated with it is Rated Secondary Volts (on the System Parameters, Rated Data screen).

- Frequency 81-x Inhibit Voltage

Alternate Frequency Scale Factor

An alternate frequency scale factor setting is used for automatic adjustment of the frequency pickup settings in applications that might utilize more than one operating frequency. For example, a machine that is configurable between 50 or 60 Hz operation. The scale factor setting is implemented when the DGC-2020HD senses a closure at a contact input that is connected to the Alternate Frequency Override logic element in *BESTlogicPlus* programmable logic. When the Alternate Frequency Override is true, the scale factor setting serves as a multiplier for the pickup settings. For example, if a scale factor contact input is received by the DGC-2020HD and the scale factor setting is 2.000, the pickup setting will be doubled (2.000 x PU).

Alarm Configuration

An underfrequency or overfrequency annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). These can also be user-configured to close a programmable output.

Element status is available in *BESTlogicPlus* programmable logic when "Status Only" is selected.

Inhibit Voltage

Inhibit Voltage settings impede underfrequency element operation during undervoltage conditions that may occur during equipment startup.

Frequency Rate-of-Change

When a loss of mains occurs, it is likely that the generator load will shift abruptly since the generator is driving everything between the generator output and the utility breaker that removed mains power. Such a load shift is likely to cause a speed shift, which may result in the generator being out of phase with the mains when a reclose occurs. If the generator is out of phase and connection with the mains is established, damage could occur. The frequency rate-of-change (ROC) element trips the breaker when a change in frequency results from a sudden change in load.

Frequency ROC protection is only active when the generator is paralleled to the mains as indicated when the Parallel to Mains logic element is true in *BESTlogicPlus*. Protection is inhibited for five seconds after the Parallel to Mains logic element first becomes true so that transients from closing onto the mains will not cause false trips.

To minimize false trips, frequency ROC protection is disabled if any configured breakers are not closed.

Frequency ROC trips are latched. They are cleared by pressing the Reset button on the front panel or by putting the DGC-2020HD into Off mode.

Any of the eight 81 elements can be configured for frequency ROC protection.

Source

A Source setting configures the frequency element to monitor the generator sensing input terminals or the bus sensing input terminals.

Pickup and Trip

When the rate of frequency change (expressed in hertz per second) exceeds the threshold established by the Pickup setting for three consecutive sensing voltage cycles, a timer begins timing towards a trip. Pickup detection time varies according to the value of the fault frequency. When the frequency greatly exceeds the pickup setting, pickup detection occurs very quickly. More precise and slower pickup detection occurs when the fault frequency is much closer to the Pickup setting. Pickup detection times are summarized as follows:

- Faults exceeding the pickup setting by 0.57 Hz/s are detected in 2 cycles
- Faults exceeding the pickup setting by 0.24 Hz/s are detected in 4 cycles
- Faults exceeding the pickup setting by 0.08 Hz/s are detected in 8 cycles
- No pickup detection time will be greater than 16 cycles

Timer duration is established by the Activation Delay. An Activation Delay of zero (0) makes the 81 element instantaneous (with the exception of the pickup detection time).

If a frequency ROC pickup condition persists for the duration of the element Activation Delay setting, the element Trip output becomes true. In *BESTlogicPlus*, the Trip output can be connected to other logic elements or a physical relay output to annunciate the condition and initiate corrective action.

If the pickup condition subsides before the element activation delay expires, the timer is reset, no corrective action is taken, and the element is rearmed for any other occurrences of a frequency ROC fault.

Alarm Configuration

A frequency rate-of-change annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). It can also be user-configured to close a programmable output.

Element status is available in *BESTlogicPlus* programmable logic when "Status Only" is selected.

Open Mains Breaker or Gen Breaker on Trip

When Open Mains Breaker on Trip is enabled, the DGC-2020HD will request the mains breaker to open when an 81 trip is annunciated. When Open Gen Breaker on Trip is enabled, the DGC-2020HD will request the generator breaker to open when an 81 trip is annunciated.

Inhibit Voltage

Inhibit Voltage settings impede frequency rate-of-change element operation during undervoltage conditions that may occur during system startup.

Logic Connections

Frequency element logic connections are made on the BESTlogic*Plus* screen in BESTCOM*SPlus*. The frequency element logic block is illustrated in Figure 75. When the Block input is true, the 81 element is disabled. The Trip output is true when the 81 element is in a trip condition.



Figure 75. Frequency Element Logic Block

Operational Settings

Frequency element operational settings are configured on the Frequency settings screen (Figure 76) in BESTCOM*SPlus*. Setting ranges are defined in the *Specifications* chapter.

The screenshot shows the 'Frequency' settings screen for the '81-1 Element'. The settings are as follows:

- Mode: Under
- Source: Bus 1
- Pickup: 0.00 Hz, 0.0000 Per Unit
- Hysteresis (Hz): 0.5
- Activation Delay (s): 0.1
- Inhibit Volts (%): 0
- Alternate Frequency Scale Factor: 1.000
- Alarm Configuration: Status Only
- Open Mains Breaker On Trip: Enabled
- Open Gen Breaker On Trip: Disabled

Figure 76. Settings Explorer, Generator Protection, Frequency

Overcurrent (51)

Six overcurrent protection (51) elements monitor the current applied to the DGC-2020HD. An element can be configured to protect against overcurrent by monitoring a single- or three-phase system, neutral current, positive-sequence current, negative-sequence current, or ground current. This element is available only in styles xxExxxxxx of the DGC-2020HD.

The six, identical overcurrent elements are designated 51-1, 51-2, 51-3, 51-4, 51-5, and 51-6. Element logic connections are made on the *BESTlogicPlus* screen in *BESTCOMSPlus* and element operational settings are configured on the Overcurrent settings screen in *BESTCOMSPlus*.

BESTCOMSPlus Navigation Path: Settings Explorer, Generator Protection, Current, Overcurrent (51)

Front Panel Navigation Path: Settings Explorer > Protection > Settings Group x (where x = 0 to 3) > Current Protection > Overcurrent (51)

Element Operation

Overcurrent protection can be used to protect equipment from damage caused by phase failure or forward/reverse phase sequence.

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

Modes of Protection

Eight modes of protection are available: IA, IB, IC, I_{max}, 3I₀, I₁, I₂, and IG. Descriptions of the protection modes in three-phase and single-phase systems are provided in Table 44.

Table 44. Modes of Protection

Mode	Three-Phase	Single-Phase
IA, IB, IC	Overcurrent protection elements include three independent comparators and timers, one for each phase. Mode selection determines which phase pickup is required to activate protection.	Overcurrent protection elements include three independent comparators and timers, one for each phase. Mode selection determines which phase pickup is required to activate protection.
I _{max}	I _{max} mode provides overcurrent protection in a three-phase system when any one phase increases above the Pickup setting.	I _{max} mode provides overcurrent protection in a single-phase system when any one phase increases above the Pickup setting.
3I ₀	3I ₀ mode provides neutral overcurrent protection in a three-phase system.	3I ₀ mode is an invalid selection for a single-phase system.
I ₁	I ₁ mode provides positive-sequence overcurrent protection in a three-phase system.	I ₁ mode is an invalid selection for a single-phase system.
I ₂	I ₂ mode provides negative-sequence overcurrent protection in a three-phase system.	I ₂ mode is an invalid selection for a single-phase system.
IG	IG mode provides ground fault protection in a three-phase system.	IG mode provides ground fault protection in a single-phase system.

Source

A Source setting configures an overcurrent element to monitor the generator sensing input terminals or the bus sensing input terminals.

Pickup and Trip

When the measured current increases above the current threshold established by the Pickup setting, a timer begins timing towards a trip.

Timer duration is established by the Time Dial and Curve settings. A Time Dial of zero (0) makes the 51 element instantaneous with no intentional time delay.

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.

If an overcurrent pickup condition persists for the duration of the calculated time, the element Trip output becomes true. In *BESTlogicPlus*, the Trip output can be connected to other logic elements or a physical relay output to annunciate the condition and initiate corrective action.

If the pickup condition subsides before the calculated time expires, the timer is reset, no corrective action is taken, and the element is rearmed for any other occurrences of overcurrent.

Per Unit

Settings which are related to machine ratings can be set in either actual units of current or in per unit values. When a native unit is edited, *BESTCOMSPlus* automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the System Parameters, Rated Data screen) associated with it. Conversely, when a per unit value is edited, *BESTCOMSPlus* automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, *BESTCOMSPlus* automatically recalculates all native unit settings based on the modified rated data parameters.

The following settings have native units of Secondary Amps, and the rated data associated with it is Rated Secondary Phase Amps (on the System Parameters, Rated Data screen).

- Overcurrent 51-x Three-Phase Pickup
- Overcurrent 51-x Single-Phase Pickup

Low-Line Scale Factor

A low-line scale factor setting is used to automatically adjust the overcurrent pickup settings in applications that might utilize more than one type of genset connection. The scale factor setting is implemented when the DGC-2020HD is determined to be in a low-line configuration. If the Low-Line Override function is assigned to a contact input via the Programmable Functions screen, the state of the contact input and the detected configuration are ORed. This means, if one or both are true, then the system is determined to be configured for low-line. The value of the scale factor setting serves as a multiplier for the pickup settings. For example, if a scale factor contact input is received by the DGC-2020HD and the scale factor setting is 2.000, the pickup setting will be doubled ($2.000 \times \text{PU}$).

Alarm Configuration

An overcurrent annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). It can also be user-configured to close a programmable output.

Element status is available in *BESTlogicPlus* programmable logic when "Status Only" is selected.

Programmable Curves

Each 51 overcurrent element has a Curve setting. See the *Time Curve Characteristics* chapter for details on each of the curves available. The user can select integrating reset timing to make the protective element use integrated reset and emulate an electromechanical induction disk reset characteristic. An available programmable curve can be used to create a custom curve by selecting coefficients in the inverse time characteristic equation.

Inverse overcurrent characteristics for trip and reset programmable curves are defined by Equation 1 and Equation 2. These equations comply with IEEE Std C37.112-1996, *IEEE Standard Inverse-Time Characteristics Equations for Overcurrent Relays*. The curve-specific coefficients are defined for the standard curves as listed in the *Time Curve Characteristics* chapter. When inverse time overcurrent characteristic curve P is selected, the coefficients used in the equation are those defined by the user. Definitions for these equations are provided in Table 45.

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

Equation 1. Time OC Characteristics for Trip

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

Equation 2. Time OC Characteristics for Reset

Table 45. Definitions for Equation 1 and Equation 2

Parameter	Description	Explanation
T_T	Time to trip	Time that the 51-x function will take to time out and trip.
D	Time dial setting	Time dial setting for the 51-x function.
M	Multiple of pickup	Measured current in multiples of pickup. The timing algorithm has a dynamic range of 0 to 40 times pickup.
A	Coefficient specific to selected curve	Affects the effective range of the time dial.
B	Coefficient specific to selected curve	Affects a constant term in the timing equation. Has greatest effect on curve shape at high multiples of tap.
C	Coefficient specific to selected curve	Affects the multiple of PU where the curve would approach infinity if allowed to continue below pickup. Has greatest effect on curve shape near pickup.
N	Exponent specific to selected curve	Affects how inverse the characteristics are. Has greatest effect on curve shape at low to medium multiples of tap.
K	Constant	Characteristic minimum delay term.
T_R	Time to reset	Relevant if 51-x function is set for integrating reset.
R	Coefficient specific to selected curve	Affects the speed of reset when integrating reset is selected.
Q	Denominator exponent specific to selected curve	Affects how inverse the characteristics are. Has greater affect as Q is increased.

Curve coefficients are entered on the Inverse Overcurrent settings screen in *BESTCOMSPlus*. Programmable curve coefficients can be entered only when the P curve is chosen for the protection element from the Curve drop-down menu.

Table Curves

BESTCOMSPlus is used to set the 51 element Table Curves (T1, T2, T3, and T4). Using the Settings Explorer within *BESTCOMSPlus*, open the Protection, Current, Table Curve (1, 2, 3, or 4) tree branch and select the table curve to be modified. Refer to Figure 77. A minimum of 2 and maximum of 40 points can be entered for any one T curve. When you are satisfied with the values chosen, select Save Curve. Use the Settings Explorer to browse to the 51-x element you wish to program and use the drop-down menu under Curve to select T1, T2, T3, or T4.

Table curves can be entered regardless of the curve chosen for the protection element. However, the table curve will not be enabled until T1, T2, T3, or T4 is selected as the curve for the protective element.

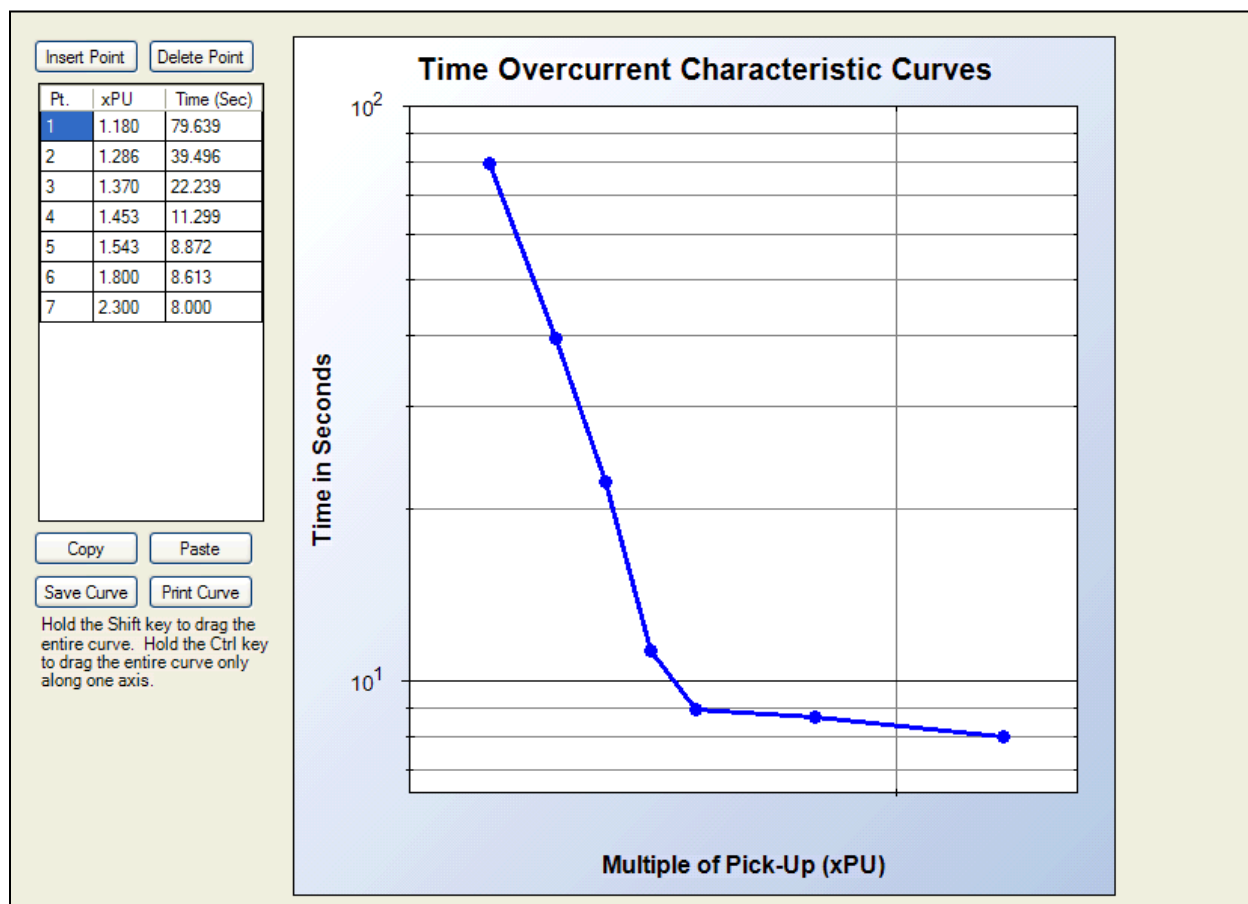


Figure 77. Inverse Overcurrent Table Curve

46 Curve

A 46 Curve is a special curve designed to emulate the I_2^2t withstand ratings of generators using what is frequently referred to as the generator's K factor. Do not confuse the 46 curve with the I2 mode. The 46 curve was designed for use with the I2 mode. However, in actuality, the 46 curve can be selected for use with any mode of the inverse overcurrent element as well.

To use the 46 curve, the user should determine the K factor of the generator and the continuous $(I_2)^2t$ rating of the generator (supplied by the manufacturer) and use this to set the time dial and pickup for the 46 curve by the process described in the Time Curve Characteristics chapter. The K factor is the time the generator can withstand 1 per unit I_2 where 1 pu is the relay setting for nominal current.

Voltage Restraint Mode

When a 51 element is set for 3 Phase, IA, IB, or IC mode, the 51 element can be set for voltage control or voltage restraint mode of operation. This feature is used to allow increased phase overcurrent sensitivity while providing security from operation due to load current. This feature is also often used for generator backup protection to ensure delayed tripping during a short-circuit where the fault current contribution from the generator falls to a value close to the full-load rating of the generator.

A Voltage Restraint threshold of zero (0) disables voltage restraint/control and allows the 51 element to operate normally.

Source

A Source setting configures an overcurrent element to monitor the voltage at the generator sensing input terminals or the bus sensing input terminals when voltage restraint is enabled.

Control Mode

When set for Control mode of operation, the 51 element is disabled until the measured voltage drops below the Voltage Restraint threshold. Thus, as long as the voltage on the appropriate phase is above the Voltage Restraint threshold, the 51 element will be blocked. When set for this mode of operation, the 51 Pickup setting is typically set near or below load current levels.

Restraint Mode

When set for Restraint mode of operation, the pickup of the 51 element is adjusted based upon the magnitude of the measured voltage. Figure 78 shows how the 51 Pickup setting is adjusted in response to the measured voltage level. Equation 3 determines the pickup level for the 51 element when the measured voltage is between 25% and 100% of the Voltage Restraint threshold. Below 25%, the pickup level stays at 25%. Above 100%, the pickup level stays at 100%. For example, if the Voltage Restraint threshold is set for 120 V and the measured voltage on the appropriate phase is 100 V (83% of the Voltage Restraint threshold), the phase overcurrent pickup level will be reduced to 83% of its setting. When set for this mode of operation, the 51 element Pickup setting is typically set above worst case, load current levels.

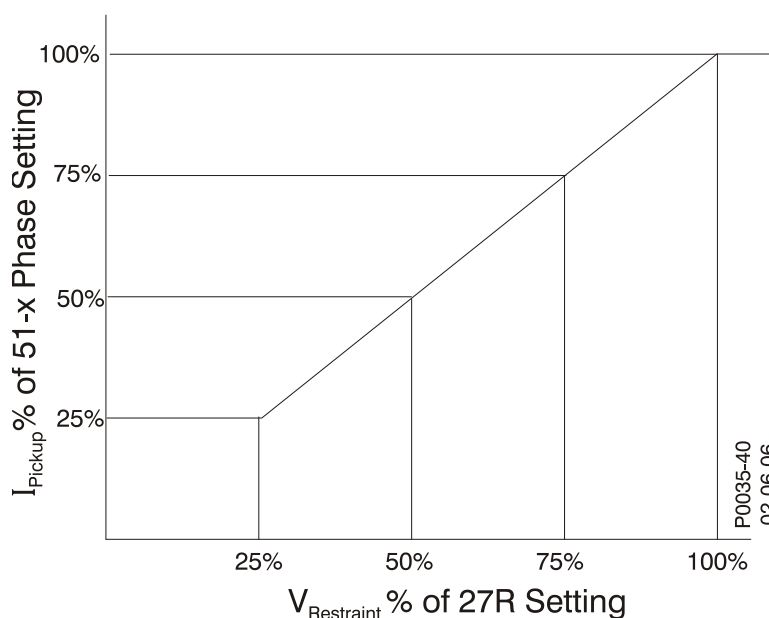


Figure 78. 51 Phase Pickup Level Compensation

$$\text{Actual Pickup Level} = \frac{\text{Sensing Voltage Level}}{\text{Restraint Pickup Setting}} \times 51 \text{ Phase Pickup Setting}$$

Equation 3. Restraint Pickup Level

Phase VT Configuration

The 51/27R function monitors V_{pp}. Table 46 shows which voltage measurements are used by each 51 element for each possible phase VT connection.

Table 46. Phase VT Connection Cross Reference

Phase VT Connection	51A	51B	51C
4W	Vab	Vbc	Vca
3W	Vab	Vbc	Vca
AB	Vab	n/a	n/a
BC	n/a	Vbc	n/a
CA	n/a	n/a	Vca

Logic Connections

Overcurrent element logic connections are made on the BESTlogic*Plus* screen in BESTCOM*SPlus*. The overcurrent element logic block is illustrated in Figure 79. When the Block input is true, the 51 element is disabled. The Trip output is true when the 51 element is in a trip condition.

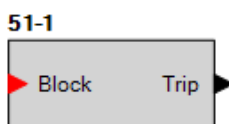


Figure 79. Overcurrent Element Logic Block

Operational Settings

Overcurrent element operational settings are configured on the Overcurrent settings screen (Figure 80) in BESTCOM*SPlus*. Setting ranges are defined in the Specifications chapter.

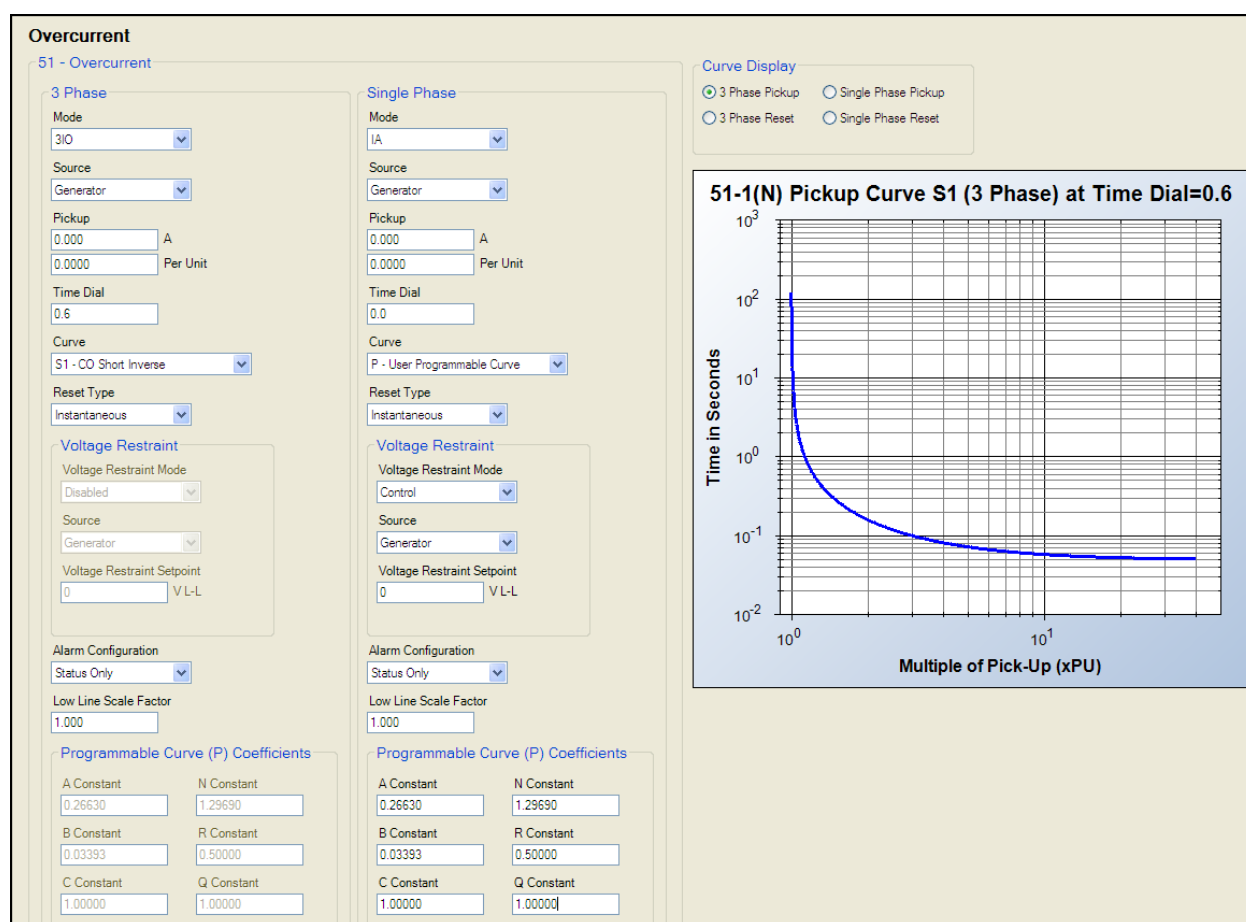


Figure 80. Settings Explorer, Generator Protection, Current, Overcurrent

Power (32)

Six power protection (32) elements monitor three-phase or single-phase real power (watts). An element can be configured to protect against overpower or underpower conditions.

The six, identical power protection elements are designated 32-1, 32-2, 32-3, 32-4, 32-5, and 32-6. Element logic connections are made on the BESTlogic*Plus* screen in BESTCOM*SPlus* and element operational settings are configured on the Power settings screen in BESTCOM*SPlus*.

BESTCOMSPlus Navigation Path: Settings Explorer, Generator Protection, Power, Power (32)

Front Panel Navigation Path: Settings Explorer > Protection > Settings Group x (where x = 0 to 3) > Power Protection > Power (32)

Element Operation

Power protection can be used in applications where excessive power flow in the tripping direction is undesired.

Two sets of over/under power settings are provided for each element: one for three-phase generator connections and one for single-phase generator connections. The Pickup setting entered is based on the CT secondary side (DGC-2020HD). When a single-phase override contact input is received, the DGC-2020HD automatically switches from the three-phase power settings to the single-phase power settings. A 32 element monitors three-phase real power when three-phase sensing is active or single-phase real power if single-phase sensing is active.

Source

Source settings configure a power element to monitor the generator sensing input terminals or the bus sensing input terminals.

Direction of Power Flow

In addition to exceeding the threshold established by the Pickup setting, direction of power flow (forward or reverse) must match the Direction setting for the 32 element to operate. In the DGC-2020HD, the forward and reverse directions are defined by the polarity voltage and current connections to the controller as shown in Figure 81. Based on IEEE polarity convention, forward power is defined as bus to line and reverse power is defined as line to bus.

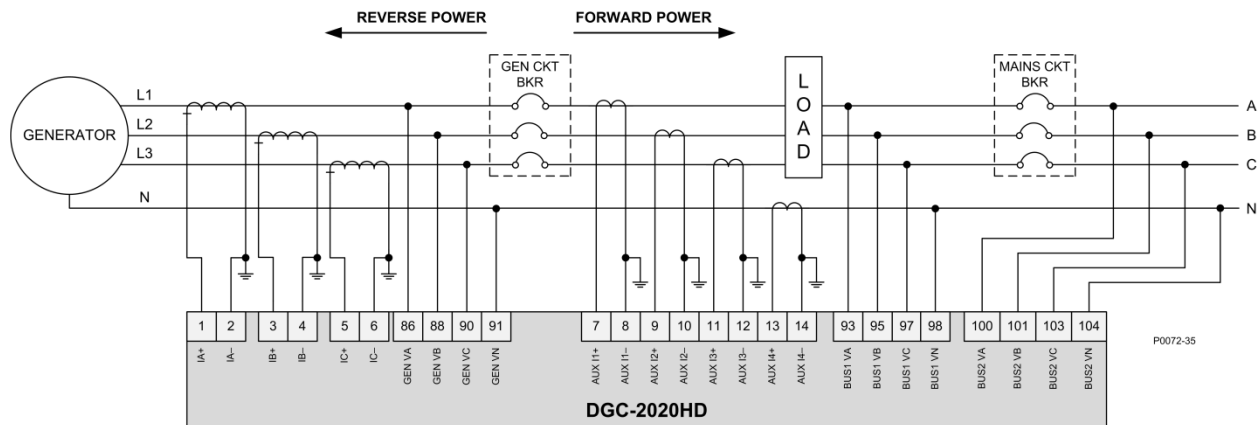


Figure 81. Direction of Power Flow Defined by the Polarity of Voltage and Current Connections

Over and Under Mode

An Over Under setting configures a power element to trip for an overpower or underpower condition.

Pickup and Trip

When the calculated real power increases above or decreases below the threshold established by the Pickup setting, a timer begins timing towards a trip.

Timer duration is established by the Activation Delay. An Activation Delay of zero (0) makes the 32 element instantaneous with no intentional time delay.

If power pickup condition persists for the duration of the element Activation Delay setting, the element Trip output becomes true. In BESTlogicPlus, the Trip output can be connected to other logic elements or a physical relay output to annunciate the condition and initiate corrective action.

If the pickup condition subsides before the element activation delay expires, the timer is reset, no corrective action is taken, and the element is rearmed for any other occurrences of over/under power.

Hysteresis

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

Low-Line Scale Factor

A low-line scale factor setting is used to automatically adjust the power pickup setting in applications that might utilize more than one type of genset connection. The scale factor setting is implemented when the DGC-2020HD is determined to be in a low-line configuration. If the Low-Line Override function is assigned to a contact input via the Programmable Functions screen, the state of the contact input and the detected configuration are ORed. This means, if one or both are true, then the system is determined to be configured for low-line. The value of the scale factor setting serves as a multiplier for the pickup setting. For example, if a scale factor contact input is received by the DGC-2020HD and the scale factor setting is 2.000, the pickup setting will be doubled ($2.000 \times \text{PU}$).

Alarm Configuration

An over/under power annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). An over/under power annunciation can also be user-configured to close a programmable output.

Element status is available in BESTlogicPlus programmable logic when “Status Only” is selected.

Logic Connections

Power element logic connections are made on the BESTlogicPlus screen in BESTCOMSPUs. The power element logic block is illustrated in Figure 82. When the Block input is true, the 32 element is disabled. The Trip output is true when the 32 element is in a trip condition.

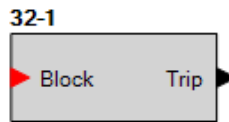


Figure 82. Power Element Logic Block

Operational Settings

Power element operational settings are configured on the Power settings screen (Figure 83) in BESTCOMSPUs. Setting ranges are defined in the *Specifications* chapter.

Power

32-1 Element

3 Phase	Single Phase
Mode Enabled	Mode Enabled
Source Gen	Source Gen
Pickup (%) 0	Pickup (%) 0
Hysteresis (%) 1.0	Hysteresis (%) 1.0
Activation Delay (s) 0.1	Activation Delay (s) 0.1
Direction Reverse	Direction Reverse
Over Under Under	Over Under Under
Alarm Configuration Status Only	Alarm Configuration Status Only
Low Line Scale Factor 1.000	Low Line Scale Factor 1.000

Figure 83. Settings Explorer, Generator Protection, Power

Loss of Excitation (40Q)

Two loss of excitation protection (40Q) elements monitor three-phase or single-phase reactive power (vars).

The two, identical loss of excitation protection elements are designated 40Q-1 and 40Q-2. Element logic connections are made on the BESTlogicPlus screen in BESTCOMSPlus and element operational settings are configured on the Loss of Excitation screen in BESTCOMSPlus.

BESTCOMSPlus Navigation Path: Settings Explorer, Generator Protection, Power, Loss of Excitation (40Q)

Front Panel Navigation Path: Settings Explorer > Protection > Settings Group x (where x = 0 to 3) > Power Protection > Loss of Excitation (40Q)

Element Operation

Two sets of loss of excitation settings are provided: one for three-phase generator connections and one for single-phase generator connections. The Pickup setting entered is based on the percentage of the machine Rated kvar on the Rated Data screen. When a single-phase override contact input is received, the DGC-2020HD automatically switches from the three-phase loss of excitation settings to the single-phase loss of excitation settings. A 40Q element monitors three-phase reactive power when three-phase sensing is active or single-phase reactive power if single-phase sensing is active.

Source

Source settings configure a loss of excitation element to monitor the generator sensing input terminals or the bus sensing input terminals.

Pickup and Trip

When a generator's excitation power is lost, the generator acts as a large inductor as it begins to absorb large quantities of vars. The 40Q element acts on the principal that if a generator begins to absorb vars outside of its steady-state capability curve, it has likely lost its normal excitation supply. It compares the reactive power to the 40Q response curve defined by the Pickup setting. When the reactive power is within the 40Q tripping region, a timer begins timing towards a trip. Refer to Figure 84.

Timer duration is established by the Activation Delay. Activation delays are recommended for tripping. Adding a small delay will help assure that false alarms do not occur for transient fault conditions or swings in the power system. An Activation Delay of zero (0) makes the 40Q element with no intentional time delay.

If a loss of excitation condition persists for the duration of the element Activation Delay setting, the element Trip output becomes true. In *BESTlogicPlus*, the Trip output can be connected to other logic elements or a physical relay output to annunciate the condition and initiate corrective action.

If the pickup condition subsides before the element activation delay expires, the timer is reset, no corrective action is taken, and the element is rearmed for any other occurrences of loss of excitation.

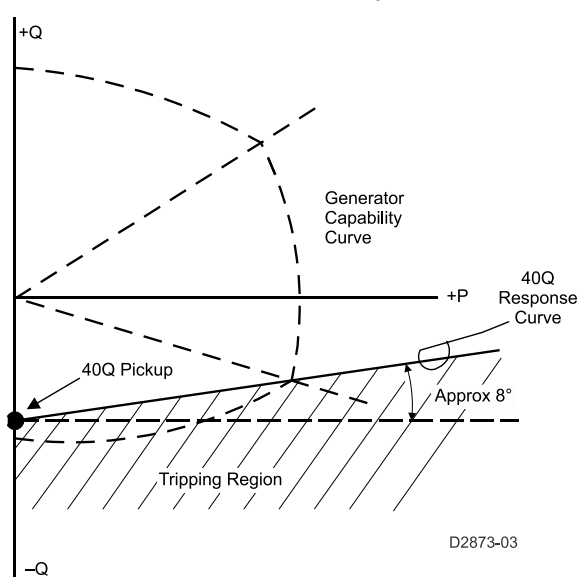


Figure 84. Generator Capability Curve vs. 40Q Response

Hysteresis

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

Low-Line Scale Factor

A low-line scale factor setting is used to automatically adjust the loss of excitation pickup setting in applications that might utilize more than one type of genset connection. The scale factor setting is implemented when the DGC-2020HD is determined to be in a low-line configuration. If the Low-Line Override function is assigned to a contact input via the Programmable Functions screen, the state of the contact input and the detected configuration are ORed. This means, if one or both are true, then the system is determined to be configured for low-line. The value of the scale factor setting serves as a multiplier for the pickup setting. For example, if a scale factor contact input is received by the DGC-2020HD and the scale factor setting is 2.000, the pickup setting will be doubled ($2.000 \times \text{PU}$).

Alarm Configuration

A loss of excitation annunciation can be user-selected to trigger a pre-alarm (warning) or alarm (shutdown). A loss of excitation annunciation can also be user-configured to close a programmable output.

Element status is available in *BESTlogicPlus* programmable logic when "Status Only" is selected.

Logic Connections

Loss of excitation logic connections are made on the BESTlogic*Plus* screen in BESTCOMS*Plus*. The loss of excitation element logic block is illustrated in Figure 85. When the Block input is true, the 40Q element is disabled. The Trip output is true when the 40Q element is in a trip condition.

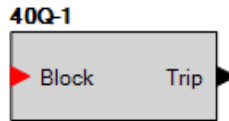


Figure 85. Loss of Excitation Element Logic Block

Operational Settings

Loss of Excitation element operational settings are configured on the Loss of Excitation settings screen (Figure 86) in BESTCOMS*Plus*. Setting ranges are defined in the *Specifications* chapter.

Loss of Excitation	
40Q-1 Element	
3 Phase	Single Phase
Mode: Enabled	Mode: Enabled
Source: Gen	Source: Gen
Pickup (%): 0.0	Pickup (%): 0.0
Hysteresis (%): 1.0	Hysteresis (%): 1.0
Activation Delay (s): 0.1	Activation Delay (s): 0.1
Alarm Configuration: Status Only	Alarm Configuration: Status Only
Low Line Scale Factor: 1.000	Low Line Scale Factor: 1.000

Figure 86. Settings Explorer, Generator Protection, Power, Loss of Excitation

Setting Groups

Four setting groups allow for adapting the coordination settings to optimize them for a predictable situation.

These four setting groups are designated Setting Group 0, Setting Group 1, Setting Group 2, and Setting Group 3. Setting group logic connections are made on the BESTlogic*Plus* screen in BESTCOMS*Plus*.

Setting Group Functions

The group of settings that is active at any point in time is controlled by setting group selection logic. This function logic allows for manual (logic) selection.

Logic Inputs

This function monitors logic inputs D0 through D3 and changes the active setting group according to the status of these three inputs. These inputs can be connected to logic expressions such as contact sensing outputs.

Logic Outputs

Setting group function logic has four logic variable outputs, SG0 through SG3. The appropriate variable is asserted when each setting group is active. These logic variables can be used in programmable logic to modify the logic based upon which setting group is active.

Changing Setting Groups

When the DGC-2020HD switches to a new setting group, all functions are reset and initialized with the new operating parameters. The settings change occurs instantaneously so at no time is the DGC-2020HD off line.

Setting Group Selection

There is a direct correlation between each logic input and the setting group that will be selected. That is, asserting input D0 selects SG0 and asserting input D1 selects SG1, etc. The active setting group latches-in after the input is read so they can be pulsed. It is not necessary that the input be maintained. If one or more inputs are asserted at the same time, the numerically higher setting group will be activated. A pulse must be present for approximately one second for the setting group change to occur.

Logic Connections

Setting Group logic connections are made on the BESTlogicPlus screen in BESTCOMSPlus. The setting group logic block is illustrated in Figure 87.

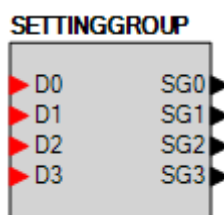


Figure 87. Setting Group Logic Block

Configurable Protection

Configurable protection can be used when the standard protection available with the DGC-2020HD does not meet the needs of the application. Eight configurable protection items are provided.

Element Setup

Parameter Selection

The following parameters can be selected:

- AEM1 analog input 1
- AEM1 analog input 2
- AEM1 analog input 3
- AEM1 analog input 4
- AEM1 analog input 5
- AEM1 analog input 6
- AEM1 analog input 7
- AEM1 analog input 8
- AEM1 RTD input 1
- AEM1 RTD input 2
- AEM1 RTD input 3
- AEM1 RTD input 4
- AEM1 RTD input 5
- AEM1 RTD input 6
- AEM1 RTD input 7
- AEM1 RTD input 8
- AEM1 thermocouple input 1
- AEM1 thermocouple input 2
- AEM2 analog input 1
- AEM2 analog input 2
- AEM2 analog input 3
- AEM2 analog input 4
- AEM2 analog input 5
- AEM2 analog input 6
- AEM2 analog input 7
- AEM2 analog input 8
- AEM2 RTD input 1
- AEM2 RTD input 2
- AEM2 RTD input 3
- AEM2 RTD input 4
- AEM2 RTD input 5
- AEM2 RTD input 6
- AEM2 RTD input 7
- AEM2 RTD input 8
- AEM2 thermocouple input 1
- AEM2 thermocouple input 2
- AEM3 analog input 1
- AEM3 analog input 2
- AEM3 analog input 3
- AEM3 analog input 4
- AEM3 analog input 5
- AEM3 analog input 6
- AEM3 analog input 7
- AEM3 analog input 8
- Bus 1 kW B
- Bus 1 kW C
- Bus 1 kW total
- Bus 1 negative kWh
- Bus 1 PF
- Bus 1 positive kWh
- Bus 1 V Avg L-L
- Bus 1 V Avg L-N
- Bus 1 VAB
- Bus 1 VAN
- Bus 1 VBC
- Bus 1 VBN
- Bus 1 VCA
- Bus 1 VCN
- Bus 2 Hz
- Bus 2 I Avg
- Bus 2 IA
- Bus 2 IB
- Bus 2 IC
- Bus 2 kVA A
- Bus 2 kVA B
- Bus 2 kVA C
- Bus 2 kVA total
- Bus 2 kvar A
- Bus 2 kvar B
- Bus 2 kvar C
- Bus 2 kvar total
- Bus 2 kW A
- Bus 2 kW B
- Bus 2 kW C
- Bus 2 kW Total
- Bus 2 negative kWh
- Bus 2 PF
- Bus 2 positive kWh
- Bus 2 V Avg L-L
- Bus 2 V Avg L-N
- Bus 2 VAB
- Bus 2 VAN
- Bus 2 VBC
- Bus 2 VBN
- Bus 2 VCA
- Bus 2 VCN
- Charge air temperature
- Coolant pressure

- AEM3 RTD input 1
- AEM3 RTD input 2
- AEM3 RTD input 3
- AEM3 RTD input 4
- AEM3 RTD input 5
- AEM3 RTD input 6
- AEM3 RTD input 7
- AEM3 RTD input 8
- AEM3 thermocouple input 1
- AEM3 thermocouple input 2
- AEM4 analog input 1
- AEM4 analog input 2
- AEM4 analog input 3
- AEM4 analog input 4
- AEM4 analog input 5
- AEM4 analog input 6
- AEM4 analog input 7
- AEM4 analog input 8
- AEM4 RTD input 1
- AEM4 RTD input 2
- AEM4 RTD input 3
- AEM4 RTD input 4
- AEM4 RTD input 5
- AEM4 RTD input 6
- AEM4 RTD input 7
- AEM4 RTD input 8
- AEM4 thermocouple input 1
- AEM4 thermocouple input 2
- Analog input 1
- Analog input 2
- Analog input 3
- Analog input 4
- AVR output
- Battery voltage
- Boost pressure
- Bus 1 Hz
- Bus 1 I Avg
- Bus 1 IA
- Bus 1 IB
- Bus 1 IC
- Bus 1 kVA A
- Bus 1 kVA B
- Bus 1 kVA C
- Bus 1 kVA total
- Bus 1 kvar A
- Bus 1 kvar B
- Bus 1 kvar C
- Bus 1 kvar total
- Bus 1 kW A
- Coolant temperature
- Engine intercooler temperature
- Engine oil temperature
- Engine percent load
- Engine RPM
- Fuel level
- Fuel Pressure
- Fuel rate
- Fuel temperature
- Gen Hz
- Gen I Avg
- Gen IA
- Gen IB
- Gen IC
- Gen kVA A
- Gen kVA B
- Gen kVA C
- Gen kVA total
- Gen kvar A
- Gen kvar B
- Gen kvar C
- Gen kvar total
- Gen kW A
- Gen kW B
- Gen kW C
- Gen kW total
- Gen negative kWh
- Gen PF
- Gen positive kWh
- Gen V Avg L-L
- Gen V Avg L-N
- Gen VAB
- Gen VAN
- Gen VBC
- Gen VBN
- Gen VCA
- Gen VCN
- Gov output
- IG
- Injector metering rail pressure
- Intake manifold temperature
- kW load percent
- LS output
- Number of units online
- Oil pressure
- System kW capacity
- System total generated kvar
- System total generated kW
- Total fuel used

Label Text

In order to make identification of the items easier, each of the items can be given a user-assigned label. The label is an alphanumeric string with a maximum of 16 characters.

Arming Delay

A user-adjustable arming delay disables configurable protection during engine startup. If the arming delay is set to zero (0), the configurable protection is active at all times, including when the engine is not running. If the arming delay is set to a non-zero value, the configurable protection is inactive when the engine is not running, and does not become active until after the engine is started and the arming delay has elapsed.

Hysteresis

This setting provides a level of hysteresis between a threshold detection tripping and dropping out. For instance, if the hysteresis is set for 5% and the threshold is set as an over threshold, once the threshold detection trips, the measured parameter must drop to 95% of the threshold before the threshold detection will drop out. This hysteresis helps prevent rapid or repeated transitions between trip and dropout in cases where the measured parameter is nearly equal to a level equal to the threshold.

If the threshold is set as an under threshold with 5% hysteresis, once the threshold detection trips, the measured value must rise to 105% of the threshold before the threshold detection will drop out.

Scale Factors

Alternate Frequency Scale Factor

Alternate frequency scale factor is used when any Generator, Bus 1, or Bus 2 frequency-based parameter is selected as the parameter for configurable protection.

Voltage Low-Line Scale Factor

Voltage low line scale factor is used when the parameter selection for configurable protection is set for any Generator, Bus 1, or Bus 2 line-to-line or line-to-neutral voltage parameter.

Current Low-Line Scale Factor

Current low line scale factor is used when the parameter selection for configurable protection is set for any Generator, Bus 1, or Bus 2 current parameter.

Thresholds

There are four programmable thresholds for each remote analog input element. Each threshold has a mode setting, threshold setting, activation delay setting, and an alarm setting.

Alarm Configuration

Each configurable protection threshold item can be independently configured to annunciate an alarm or pre-alarm, or be configured as status only when the parameter selection falls beyond the threshold. A user-adjustable activation delay setting delays alarm annunciation until after the threshold has been exceeded. Configurable protection is disabled when Alarm Configuration is set to "None".

Note
The Arming Delay should <u>not</u> be set to zero if Oil Pressure or Battery Volts is selected for configurable protection and the threshold is set to monitor for conditions lower than the threshold and the alarm configuration is set to Alarm. Setting the arming delay to zero will cause an immediate alarm on the oil pressure, and engine cranking could cause a temporary low battery voltage condition which could cause an alarm. In either case, the spurious alarm would prevent the engine from starting.

Mode

The mode can be set for Over or Under. If Over mode is selected, an alarm is annunciated when the metered parameter increases above the Threshold setting for the duration of the Activation Delay. If Under mode is selected, an alarm is annunciated when the metered parameter decreases below the Threshold setting for the duration of the Activation Delay.

Logic Connections

Configurable protection logic connections are made on the BESTlogicPlus screen in BESTCOMSPlus. The Configurable Protection 1, Threshold 1 logic block is illustrated in Figure 88. Block output is true during a trip condition. Alarm and pre-alarm logic blocks are similar.

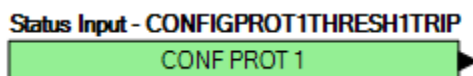


Figure 88. Configurable Protection Logic Block

Operational Settings

BESTCOMSPlus Navigation Path: Settings Explorer, Configurable Protection, Configurable Protection #

Front Panel Navigation Path: Settings > Protection > Configurable Protection > Configurable Protection #

Configurable protection operational settings are configured on the Configurable Protection settings screen (Figure 89) in BESTCOMSPlus or through the front panel. Settings are listed in Table 47.

Figure 89. Settings Explorer, Configurable Protection, Configurable Protection #1

Table 47. Settings for Configurable Protection

Locator	Setting	Range	Increment	Unit
A	Label Text	Up to 16 alphanumeric characters	n/a	n/a
B	Parameter Selection	*	n/a	n/a
C	Arming Delay	0 to 300	1	seconds
D	Hysteresis	0 to 100	0.1	%
E	Alternate Frequency Scale Factor	0.001 to 100	0.001	n/a
F	Voltage Low Line Scale Factor	0.001 to 3	0.001	n/a
G	Current Low Line Scale Factor	0.001 to 3	0.001	n/a
H	Mode	Disabled, Over, or Under	n/a	n/a
I	Threshold	–999,999 to 999,999	0.01	n/a
J	Activation Delay	0 to 300	1	seconds
K	Alarm Configuration	Status Only, Pre-Alarm, or Alarm	n/a	n/a

*See *Parameter Selection*, above, for a complete listing of selectable parameters.



Metering

The DGC-2020HD provides comprehensive metering of internal and system conditions. These capabilities include extensive parameter metering, status indication, and reporting.

Metering Explorer

DGC-2020HD metering is accessed through the metering explorer menu on the front panel display or the BESTCOMSPlus® metering explorer.

Front Panel

On the front panel, the metering explorer is accessed through the Metering branch of the menu. Refer to the *Controls and Indicators* chapter for more information.

BESTCOMSPlus®

In BESTCOMSPlus, the metering explorer is located in the upper left portion of the application window.

Metering Screen Docking

A docking feature within the metering explorer allows arrangement and docking of multiple metering screens. Clicking and dragging a metering screen tab displays a blue, transparent square, several arrow boxes, and a tab box. These docking elements are illustrated in Figure 90 and described in Table 48.

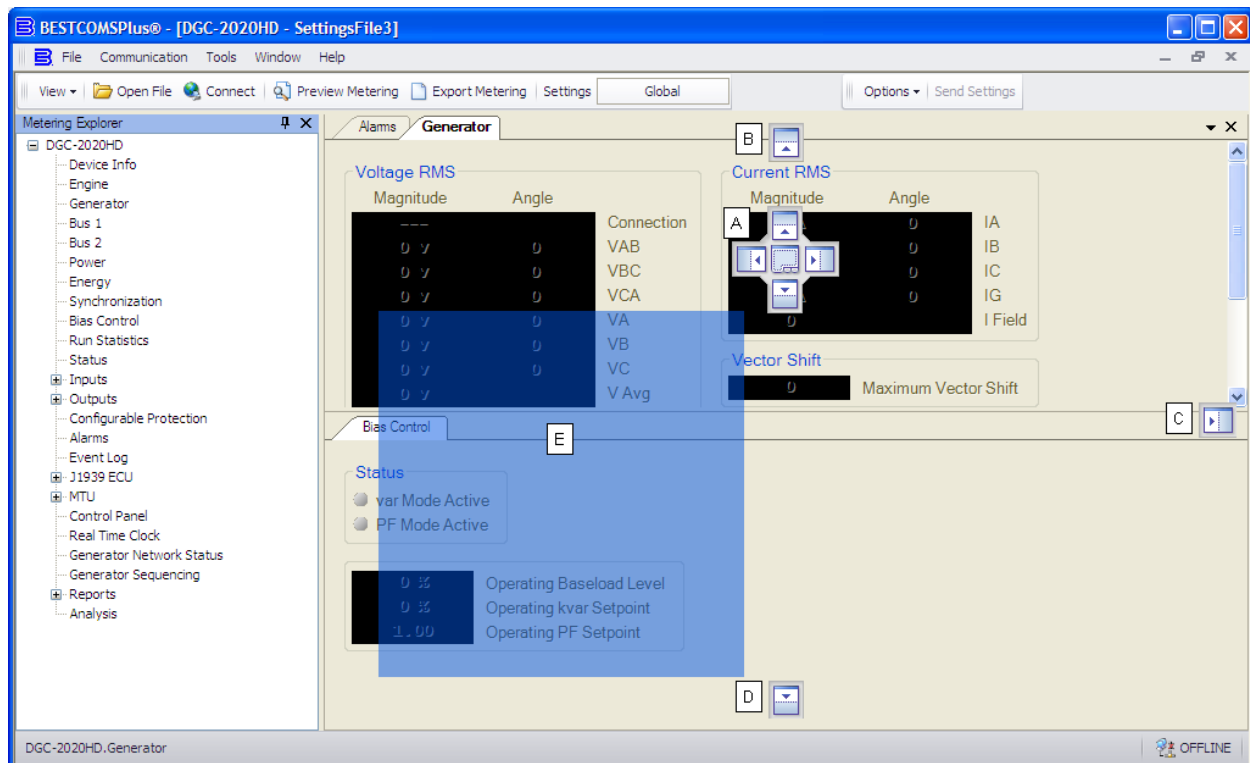


Figure 90. Metering Screen Docking Options

Table 48. Descriptions of Call-outs in Figure 90.

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

BESTspace™

BESTspace provides the ability to manage customized workspaces. Refer to the *BESTCOMSPlus* chapter for more information on BESTspace.

Engine

BESTCOMSPlus Navigation Path: Metering Explorer, Engine

Front Panel Navigation Path: Metering > Engine

The *Engine* metering screen (Figure 91) provides information and metering of engine components. Under certain circumstances, parameters may indicate one of the following codes: NA (not applicable), NC (not connected), NS (not sent), or SF (sender fail). See the *Communication* chapter for their descriptions.



Figure 91. Metering Explorer, Engine Screen

Generator

BESTCOMSPlus Navigation Path: Metering Explorer, Generator

Front Panel Navigation Path: Metering > Gen

Metering of the voltage, current, angle, frequency, and vector shift of the generator is displayed on this screen. See Figure 92.

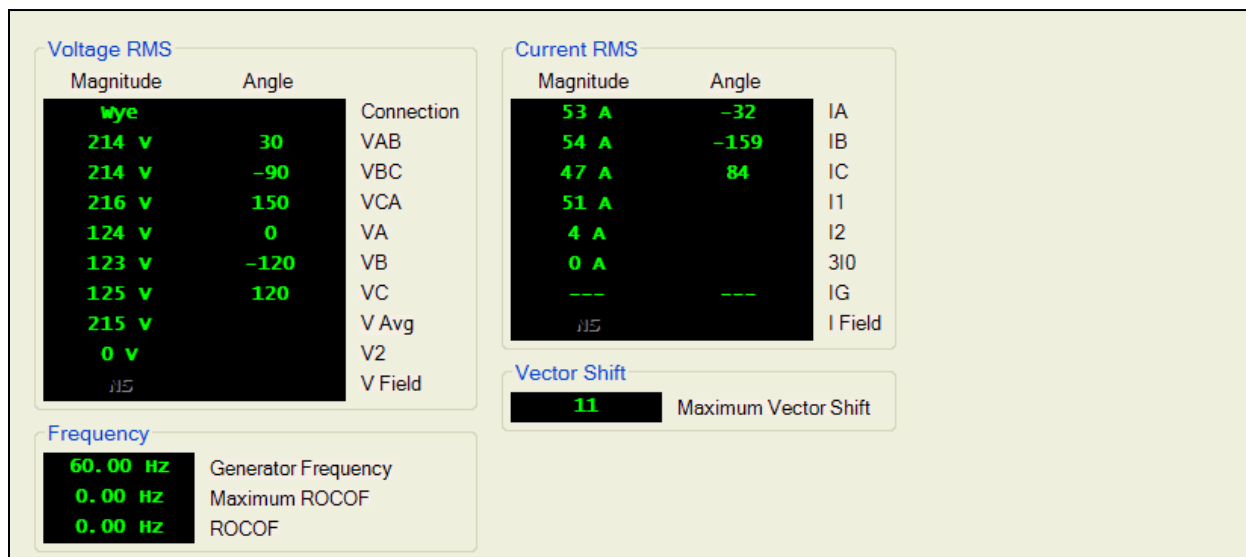


Figure 92. Metering Explorer, Generator Screen

Bus 1 and Optional Bus 2

BESTCOMSPlus Navigation Path: Metering Explorer, Bus 1 or Bus 2

Front Panel Navigation Path: Metering > Bus 1 or Bus 2

Metering of the voltage, current, angle, frequency, and vector shift of Bus 1 and optional Bus 2 is displayed on these screens. See Figure 93.

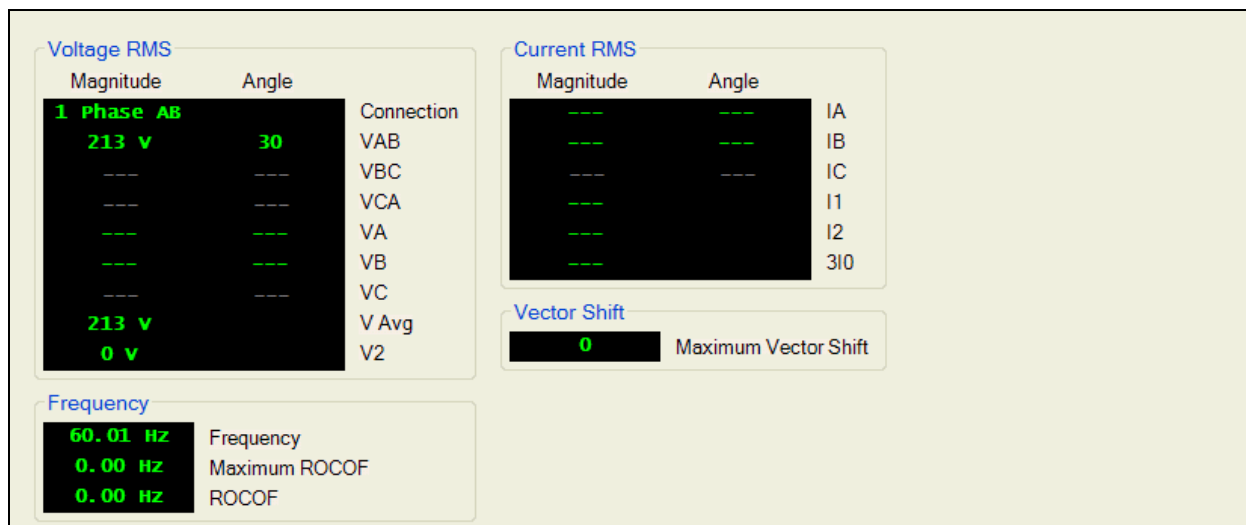


Figure 93. Metering Explorer, Bus 1 and Bus 2 (Optional) Screens

Bias Control

BESTCOMSPlus Navigation Path: Metering Explorer, Bias Control

Front Panel Navigation Path: Metering > Bias Control

Bias control setpoints and active control mode are displayed on this screen. See Figure 94.

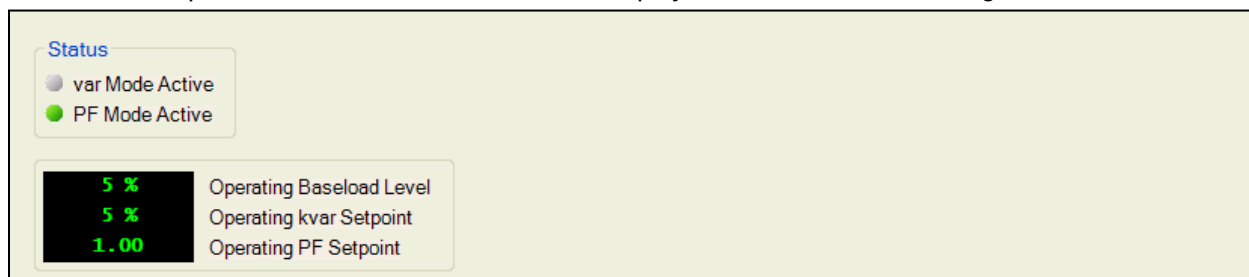


Figure 94. Metering Explorer, Bias Control Screen

Power

BESTCOMSPlus Navigation Path: Metering Explorer, Power

Front Panel Navigation Path: Metering > Gen / Bus 1 / Bus 2 > Power

This screen provides metering of real power, apparent power, reactive power and power factor of the generator, bus 1, and optional bus 2. See Figure 95.

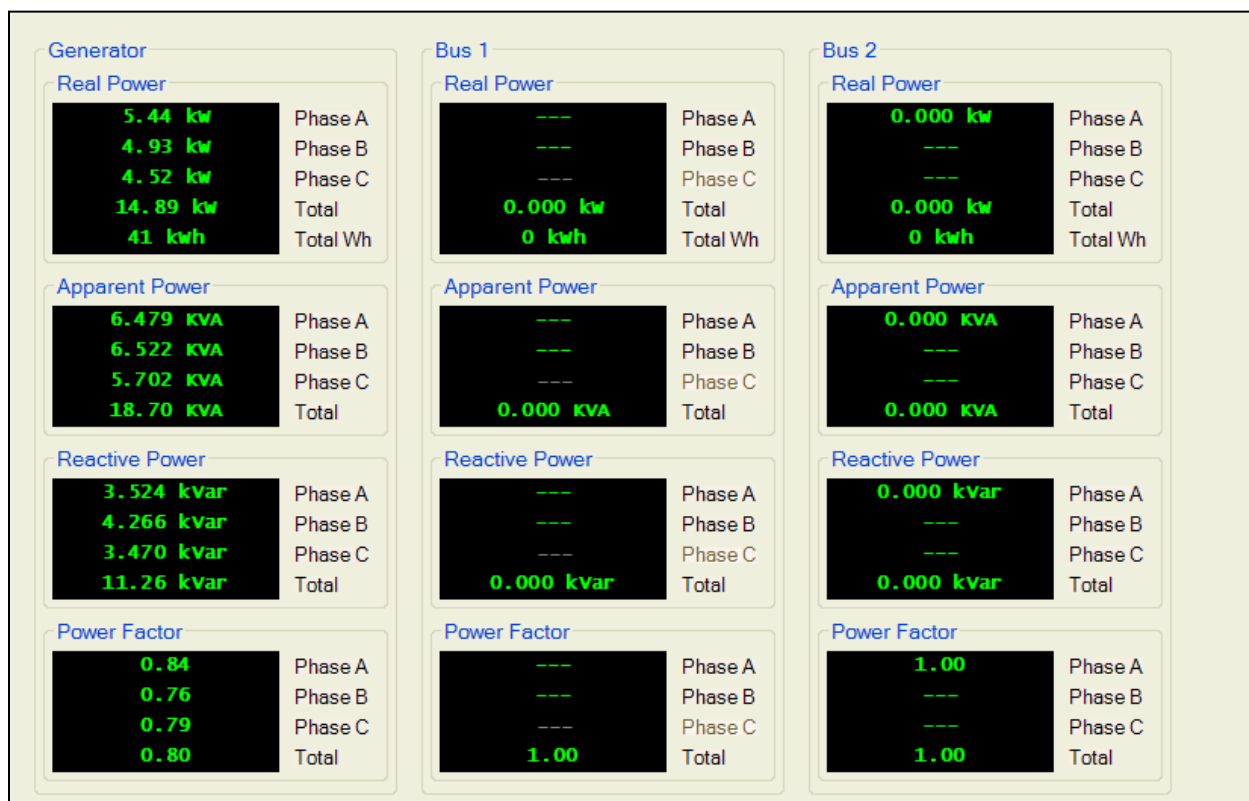


Figure 95. Metering Explorer, Power Screen

Run Statistics

BESTCOMSPlus Navigation Path: Metering Explorer, Run Statistics

Front Panel Navigation Path: Metering > Run Statistics

This screen provides Cumulative Run Statistics, Session Run Statistics, and Commission Date. See Figure 96.

The Cumulative Run Statistics are tracked from the first time the genset was started. The Session Run Statistics are tracked from the last time the genset was started until the following shutdown.

The Commission Date, Number of Starts, Hours Until Maintenance, Total kWh, Total Engine Run Time, Loaded Run Time, and Unloaded Run time can be changed by clicking the *Edit Cumulative Run Statistics* button. This is helpful when installing the DGC-2020HD into a pre-existing system. This allows the current statistics of the genset to be transferred into the DGC-2020HD for uninterrupted tracking.

The Hours Until Maintenance pre-alarm is configured on the Pre-Alarms screen in the Settings Explorer. The Hours Until Maintenance field displays “OFF” when the Maintenance Interval pre-alarm is disabled. Clicking *Reset Maintenance Interval* resets the Hours Until Maintenance to the value set for the Maintenance Interval pre-alarm on the Pre-Alarms screen in the Settings Explorer.

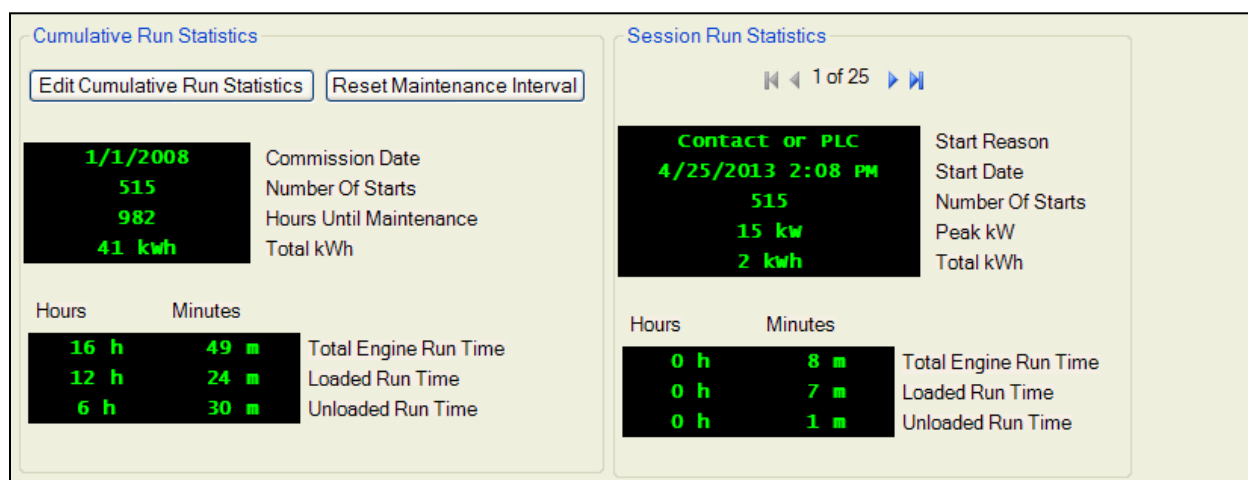


Figure 96. Metering Explorer, Run Statistics Screen

Synchronization

BESTCOMSPlus Navigation Path: Metering Explorer, Synchronization

Front Panel Navigation Path: Metering > Synchronization

Slip frequency, slip angle, and the voltage difference between the current synchronization source and destination are displayed on the Synchronization screen. The Synchronization screen is automatically displayed on the front panel while the synchronizer is active. See Figure 97.



Figure 97. Metering Explorer, Synchronization Screen

Status Indication

BESTCOMSPlus Navigation Path: Metering Explorer, Status

Front Panel Navigation Path: Metering > Status > Status

This screen indicates status of breakers, modes, switches, and I/O connection status. The status is TRUE when the corresponding indicator is lit. See Figure 98.



Figure 98. Metering Explorer, Status Screen

Inputs

Contact Inputs

BESTCOMSPlus Navigation Path: Metering Explorer, Inputs, Contact Inputs

Front Panel Navigation Path: Metering > Status > Inputs > Contact Inputs

This screen indicates the status of contact inputs, contact input alarms, and contact input pre-alarms. The status is TRUE when the corresponding indicator is lit. See Figure 99.

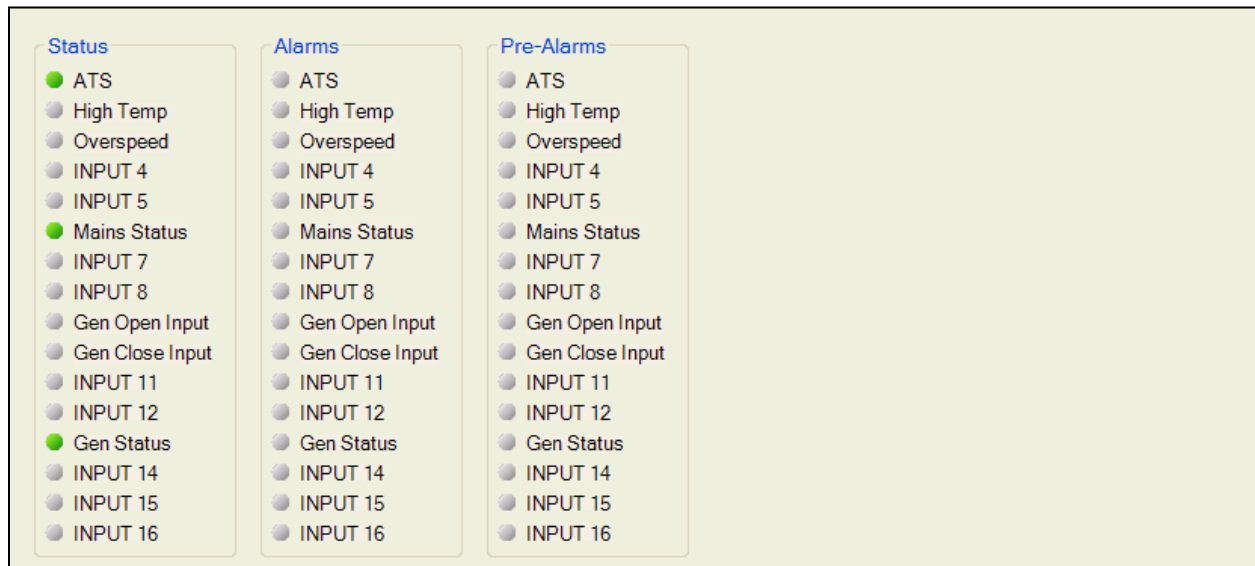


Figure 99. Metering Explorer, Inputs, Contact Inputs Screen

Analog Inputs

BESTCOMSPi+ Navigation Path: Metering Explorer, Inputs, Analog Inputs

Front Panel Navigation Path: Metering > Status > Inputs > Analog Input Values

Scaled analog input value and threshold status are displayed for each analog input on this screen. See Figure 100.

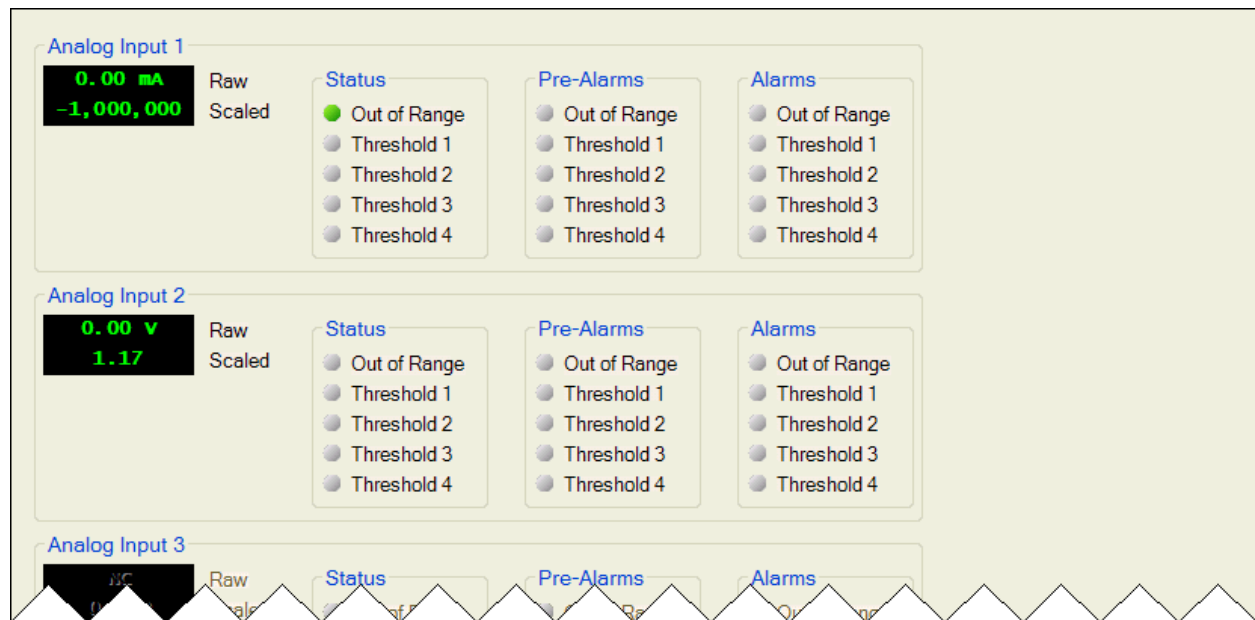


Figure 100. Metering Explorer, Inputs, Analog Inputs Screen

Remote Contact Inputs

BESTCOMSPi+ Navigation Path: Metering Explorer, Remote Contact Inputs > CEM # Inputs

Front Panel Navigation Path: Metering > Status > Inputs > Remote Contact Inputs > CEM-2020 #

There are four remote contact input screens, one for each possible CEM-2020 (Contact Expansion Module). When CEM-2020s are connected, the status of the remote contact inputs, configurable remote contact input alarms, and remote contact input pre-alarms are shown on these screens. The status is TRUE when the input indicator is lit. See Figure 101.



Figure 101. Metering Explorer, Inputs, Remote Contact Inputs, CEM 1 Inputs Screen

Remote Analog Inputs

The following screens show the scaled or raw analog input values and the status of each threshold for the analog inputs, RTD inputs, and thermocouple inputs of each connected AEM-2020. A status, pre-alarm, or alarm threshold is true when the corresponding indicator is lit.

Remote Analog Inputs

BESTCOMSPlus Navigation Path: Metering Explorer, Inputs, Remote Analog Inputs, AEM # Inputs, AEM # Analog Inputs

Front Panel Navigation Path: Metering > Status > Inputs > Remote Analog Input Values > AEM-2020 # > Scaled Analog Inputs / Raw Analog Inputs

Figure 102 illustrates the BESTCOMSPlus Remote Analog Inputs screen.

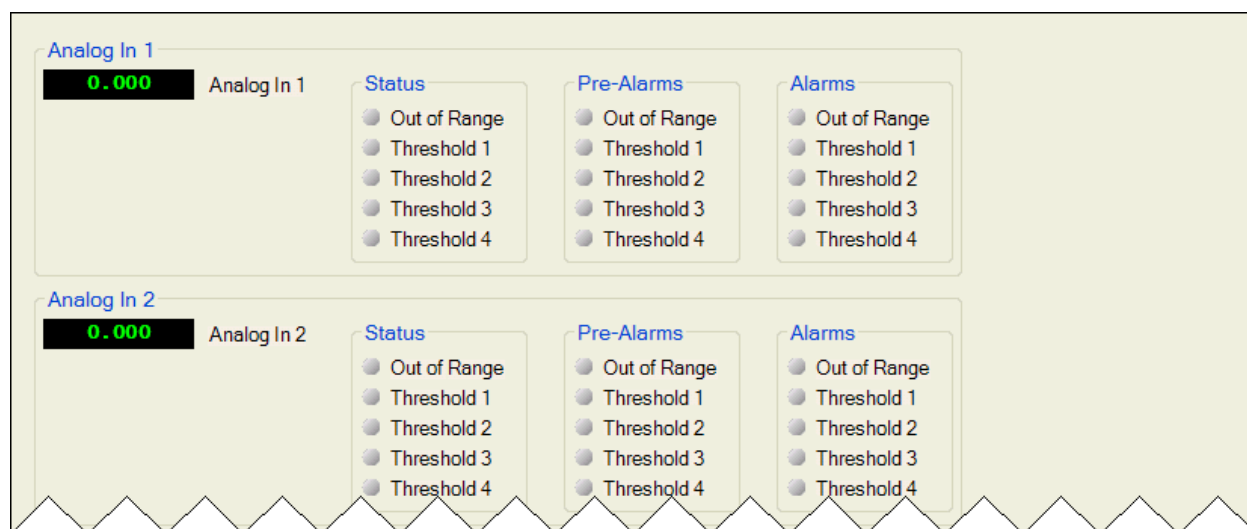


Figure 102. Metering Explorer, Inputs, Remote Analog Inputs, AEM 1 Inputs, AEM 1 Analog Inputs Screen

RTD Inputs

BESTCOMSPlus Navigation Path: Metering Explorer, Inputs, Remote Analog Inputs, AEM # Inputs, AEM # RTD Inputs

Front Panel Navigation Path: Metering > Status > Inputs > Remote Analog Input Values > AEM-2020 # > RTD Input Temperatures / Raw RTD Inputs

Figure 103 illustrates the BESTCOMSPlus RTD Inputs screen.

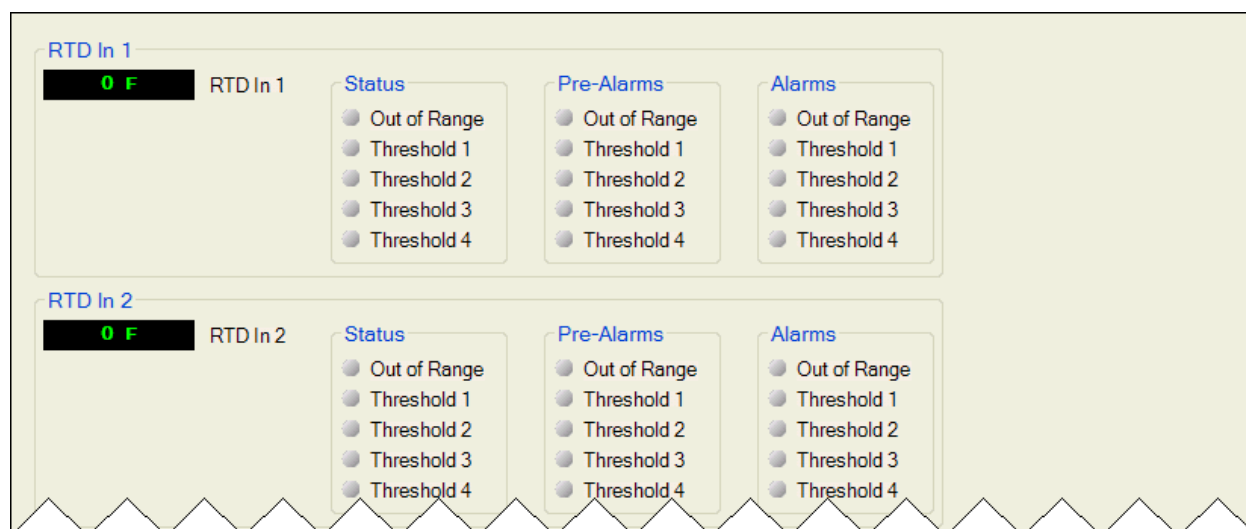


Figure 103. Metering Explorer, Inputs, Remote Analog Inputs, AEM 1 Inputs, AEM 1 RTD Inputs Screen

Thermocouple Inputs

BESTCOMSPlus Navigation Path: Metering Explorer, Inputs, Remote Analog Inputs, AEM # Inputs, AEM # Thermocouple Inputs

Front Panel Navigation Path: Metering > Status > Inputs > Remote Analog Input Values > AEM-2020 # > ThermInput Temperatures / Raw Thermocouple Inputs

Figure 104 illustrates the BESTCOMSPlus Thermocouple Inputs screen.

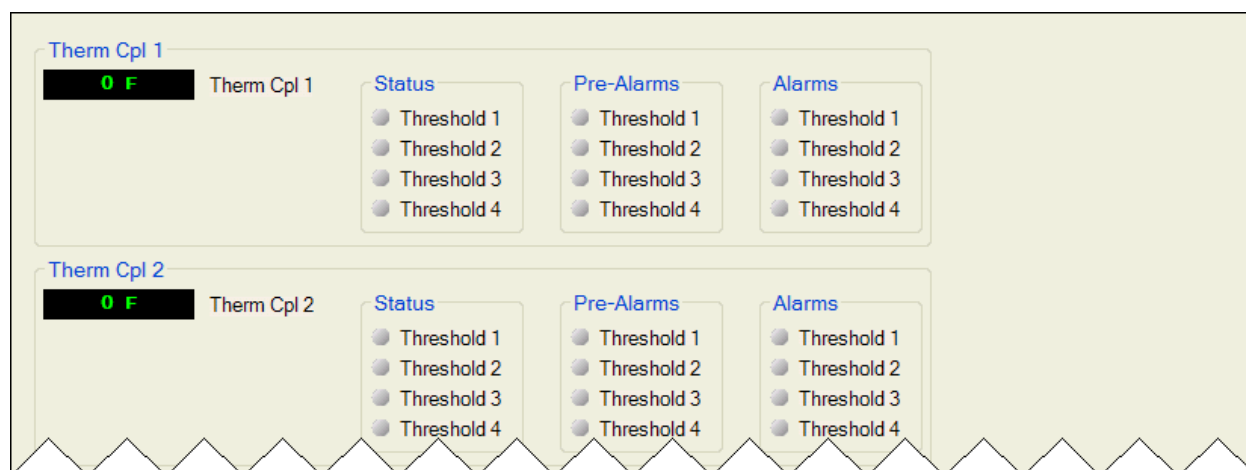


Figure 104. Metering Explorer, Inputs, Remote Analog Inputs, AEM 1 Inputs, AEM 1 Thermocouple Inputs

Input Values

BESTCOMSPlus Navigation Path: Metering Explorer, Inputs, Remote Analog Inputs, AEM # Inputs, AEM # Input Values

Front Panel Navigation Path: Metering > Status > Inputs > Remote Analog Input Values > AEM-2020 #

Figure 105 illustrates the BESTCOMSPlus Input Values screen.

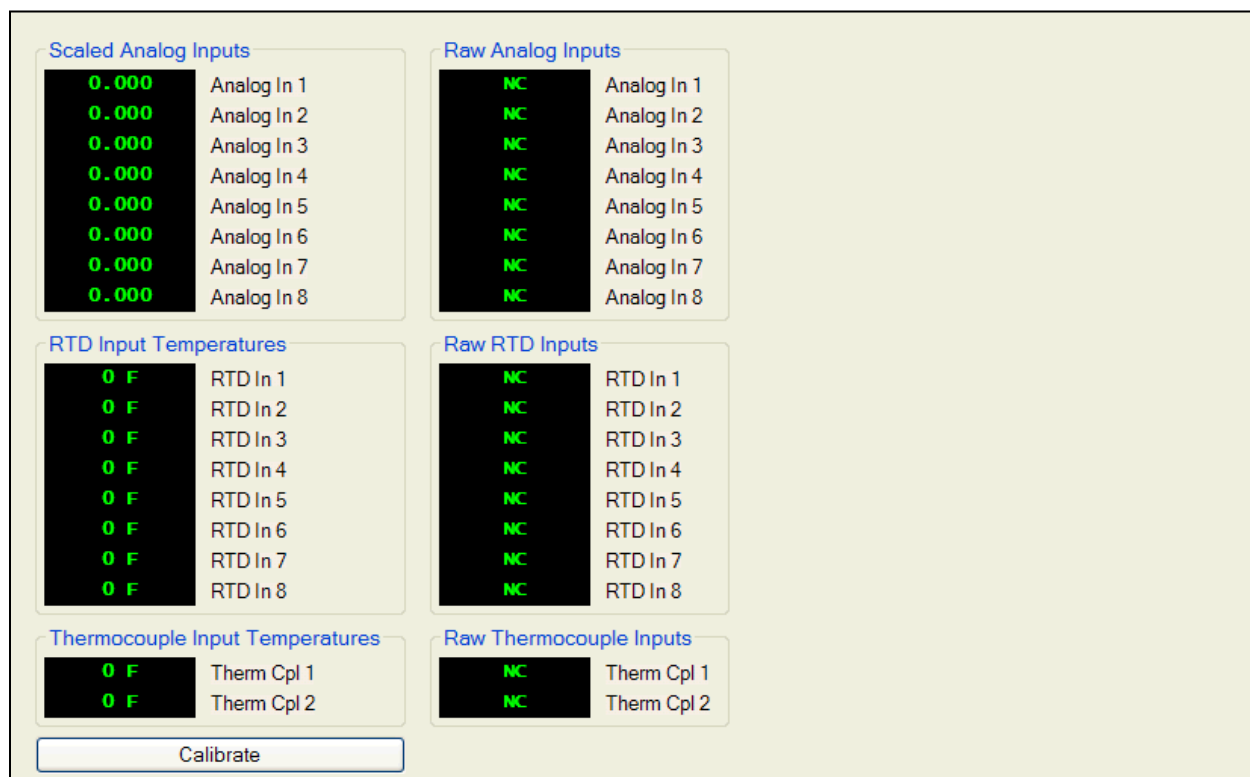


Figure 105. Metering Explorer, Inputs, Remote Analog Inputs, AEM 1 Inputs, AEM 1 Input Values

Logic Control Relays

BESTCOMSPi+ Navigation Path: Metering Explorer, Inputs, Logic Control Relays

Front Panel Navigation Path: Metering > Status > Logic Control Relays

This screen displays the status of the sixteen logic control relays. A logic control relay input is true when the corresponding indicator is lit. See Figure 106.

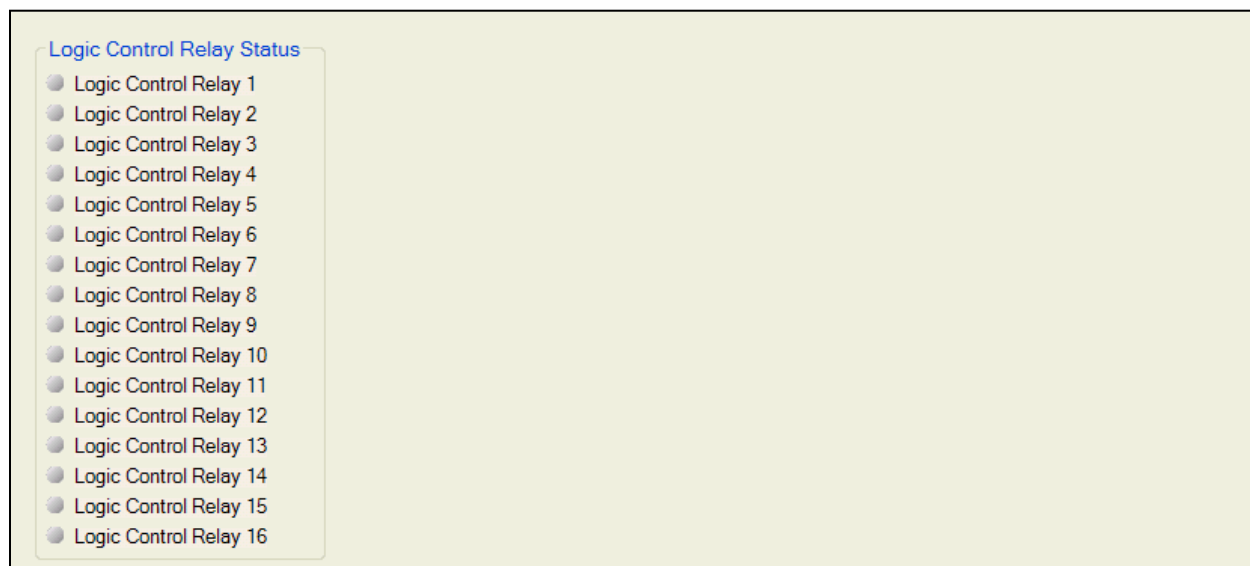


Figure 106. Metering Explorer, Inputs, Logic Control Relays Screen

Outputs

Contact Outputs

BESTCOMSPlus Navigation Path: Metering Explorer, Outputs > Contact Outputs

Front Panel Navigation Path: Metering > Status > Outputs > Contact Outputs

This screen indicates the status of the twelve contact outputs and the Start, Run, and Pre-start outputs. The status is TRUE when the corresponding indicator is lit. See Figure 107.

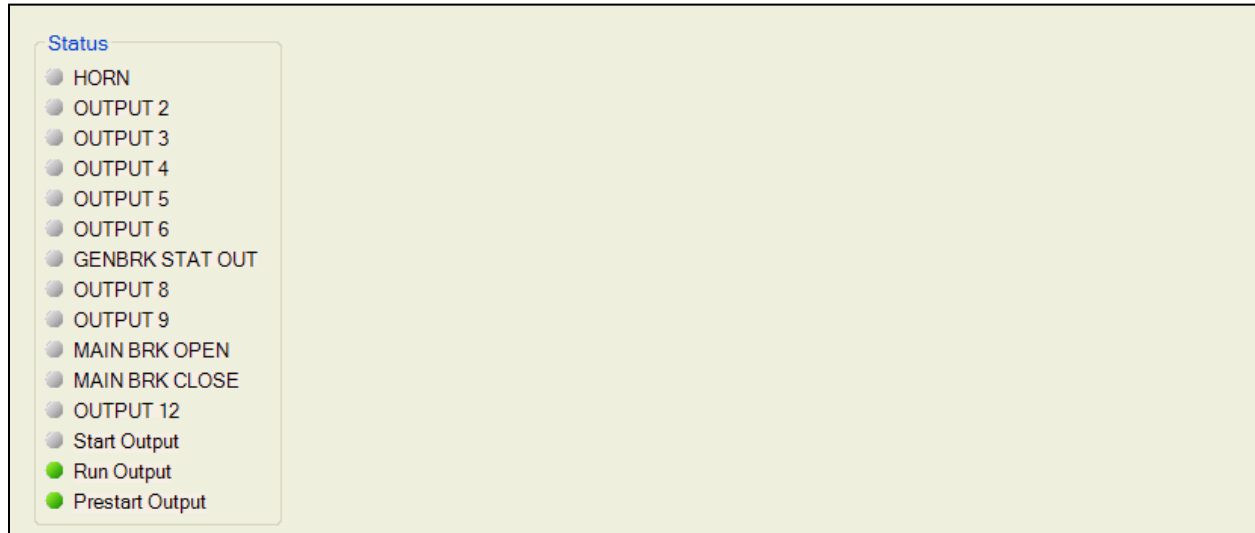


Figure 107. Metering Explorer, Outputs, Contact Outputs Screen

Analog Outputs

BESTCOMSPlus Navigation Path: Metering Explorer, Outputs > Analog Outputs

Front Panel Navigation Path: Metering > Status > Outputs > AVR Output / GOV Output / LS Output

Scaled and raw analog values of the AVR, GOV, and LS outputs are displayed on this screen. An output whose value is outside of the specified range is annunciated by the corresponding Status, Pre-alarm, or Alarm indicator. See Figure 108.

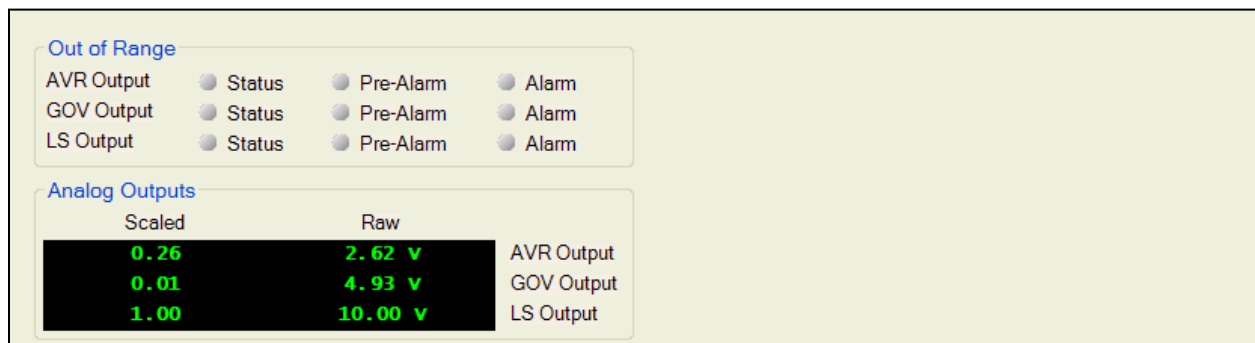


Figure 108. Metering Explorer, Outputs, Analog Outputs Screen

Configurable Elements

BESTCOMSPlus Navigation Path: Metering Explorer, Outputs, Configurable Elements

Front Panel Navigation Path: Metering > Status > Configurable Elements

This screen indicates the status of the eight configurable elements. The status is true when the corresponding indicator is lit. See Figure 109.

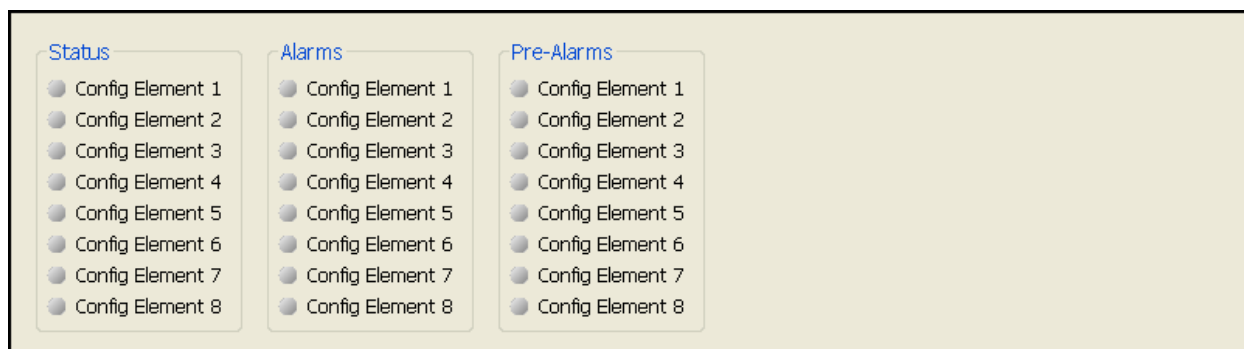


Figure 109. Metering Explorer, Outputs, Configurable Elements Screen

Remote Contact Outputs

BESTCOMSPlus Navigation Path: Metering Explorer, Outputs, Remote Contact Outputs, CEM # Outputs

Front Panel Navigation Path: Metering > Status > Outputs > Remote Contact Outputs > CEM -2020 #

There are four remote contact output screens, one for each possible CEM-2020 (Contact Expansion Module). When CEM-2020s are connected, the status of the remote contact outputs is shown on these screens. The status is TRUE when the input indicator is lit. See Figure 110.

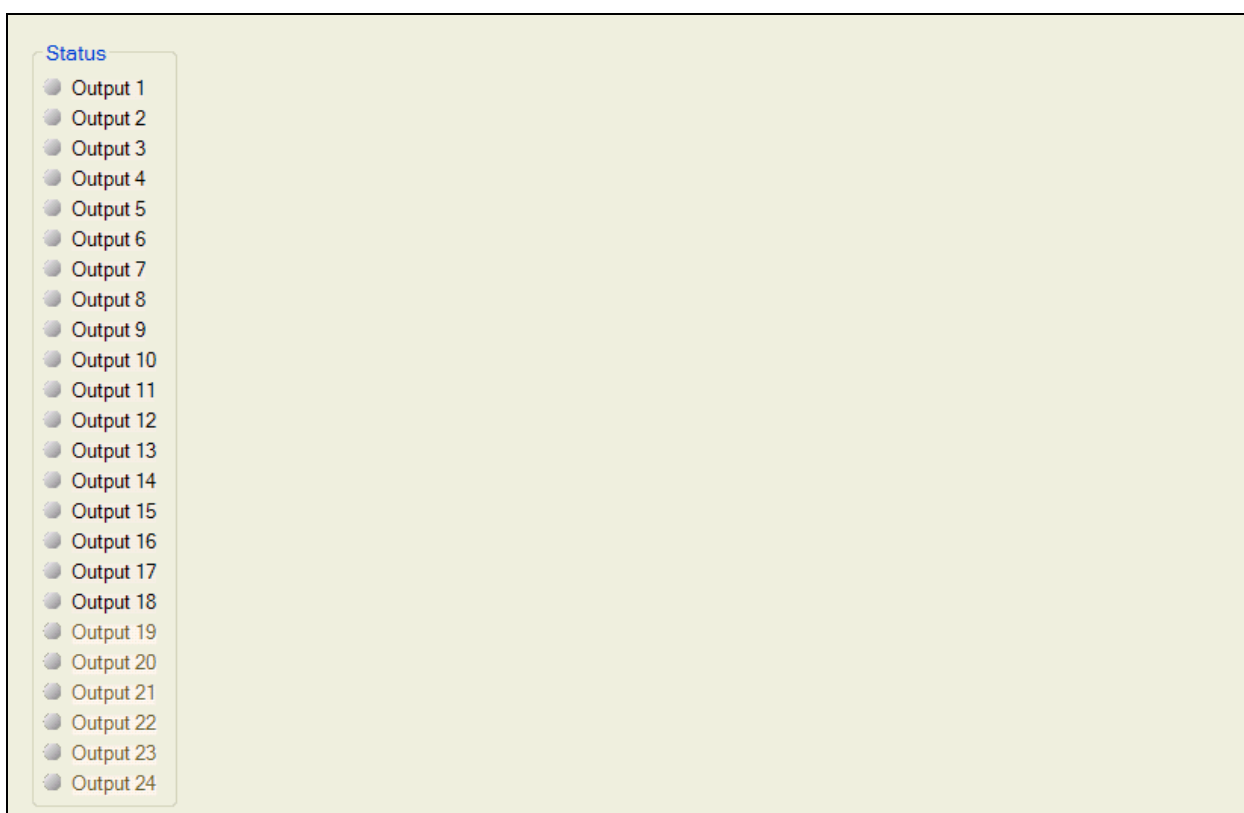


Figure 110. Metering Explorer, Outputs, Remote Contact Outputs, CEM 1 Outputs Screen

Remote Analog Outputs

BESTCOMSPlus Navigation Path: Metering Explorer, Outputs, Remote Analog Outputs, AEM # Analog Outputs

Front Panel Navigation Path: Metering > Status > Outputs > Remote Analog Outputs > AEM -2020 #

There are four remote analog output screens, one for each possible AEM-2020 (Analog Expansion Module). Each of these screens displays the scaled and raw values of the four remote analog outputs of

one AEM-2020. An output whose value is outside of the specified range is annunciated by the corresponding Status, Pre-alarm, or Alarm indicator. The status is TRUE when the output indicator is lit. See Figure 111.

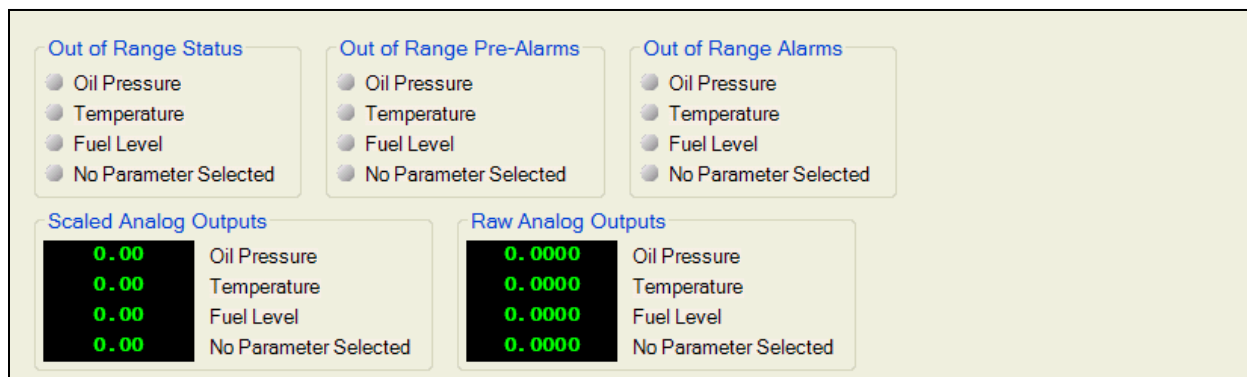


Figure 111. Metering Explorer, Outputs, Remote Analog Outputs, AEM 1 Analog Outputs Screen

Configurable Protection

BESTCOMSPlus Navigation Path: Metering Explorer, Configurable Protection

Front Panel Navigation Path: Metering > Status > Configurable Protection > Configurable Protection #

This screen displays threshold status for each configurable protection element. A lit indicator denotes that a value has exceeded its threshold. See Figure 112.

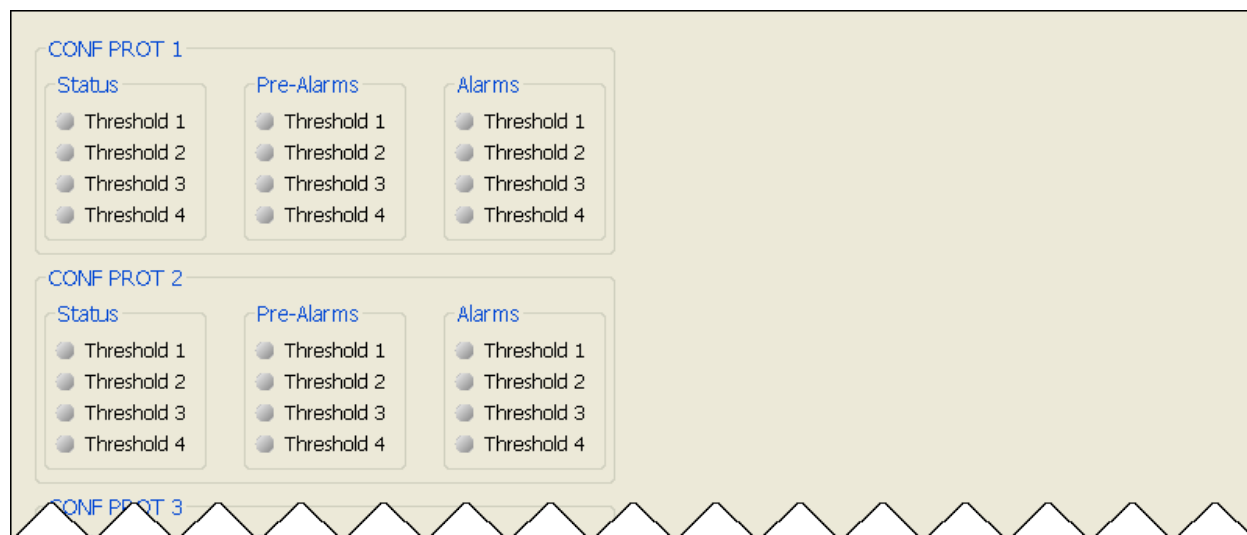


Figure 112. Metering Explorer, Configurable Protection Screen

J1939 ECU

ECU Data

BESTCOMSPlus Navigation Path: Metering Explorer, J1939 ECU, ECU Data

Front Panel Navigation Path: Metering > J1939 ECU > J1939 Data

The *ECU Data* metering screen (Figure 113) provides information and metering of engine components. Under certain circumstances, parameters may indicate one of the following codes: NA (not applicable), NC (not connected), NS (not sent), or SF (sender fail). See the *Communication* chapter for their descriptions.



Figure 113. Metering Explorer, J1939 ECU, ECU Data Screen

Engine Configuration

BESTCOMSPi+ Navigation Path: Metering Explorer, J1939 ECU, Engine Configuration

Front Panel Navigation Path: Metering > J1939 ECU > J1939 Engine Config

This screen (Figure 114) provides information and metering of engine parameters. Under certain circumstances, parameters may indicate one of the following codes: NA (not applicable), NC (not connected), NS (not sent), or SF (sender fail). See the *Communication* chapter for their descriptions.

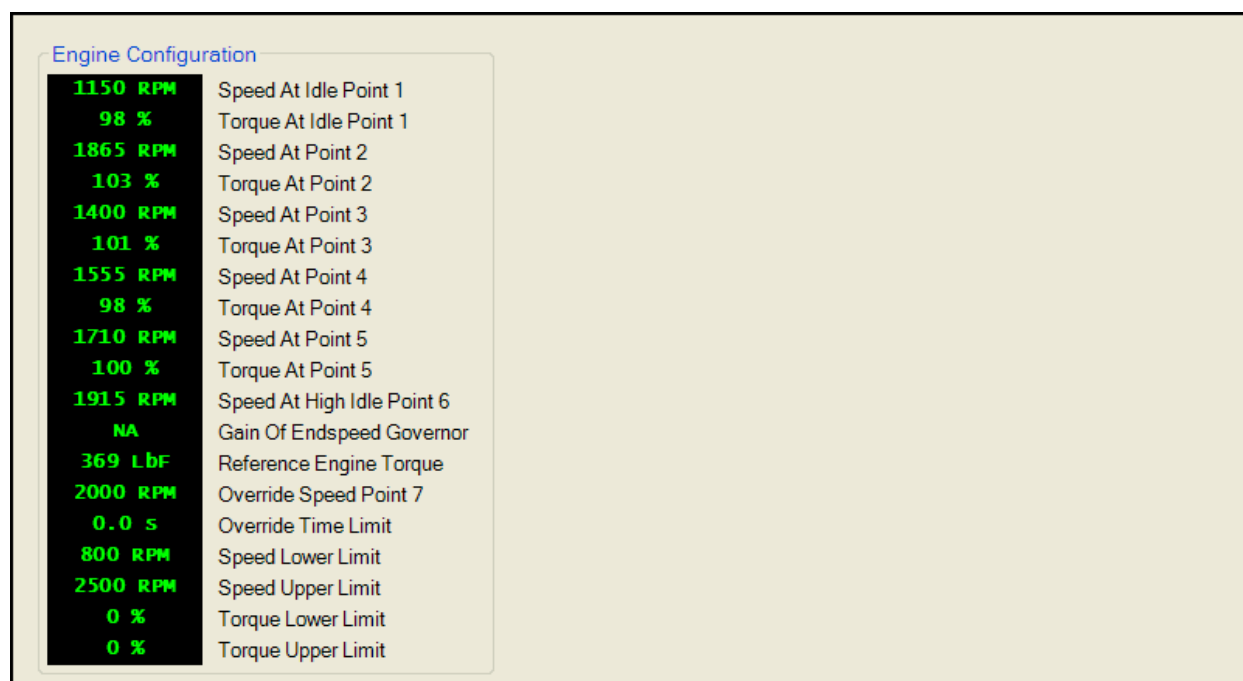


Figure 114. Metering Explorer, J1939 ECU, Engine Configuration Screen

MTU

MTU Engine Status

BESTCOMSPi+ Navigation Path: Metering Explorer, MTU, MTU Engine Status

Front Panel Navigation Path: Metering > Status > MTU Status > Engine Status

The *MTU Engine Status* metering screen (Figure 115) provides information and metering of engine components. Under certain circumstances, parameters may indicate one of the following codes: NA (not applicable), NC (not connected), NS (not sent), or SF (sender fail). See the *Communication* chapter for their descriptions.

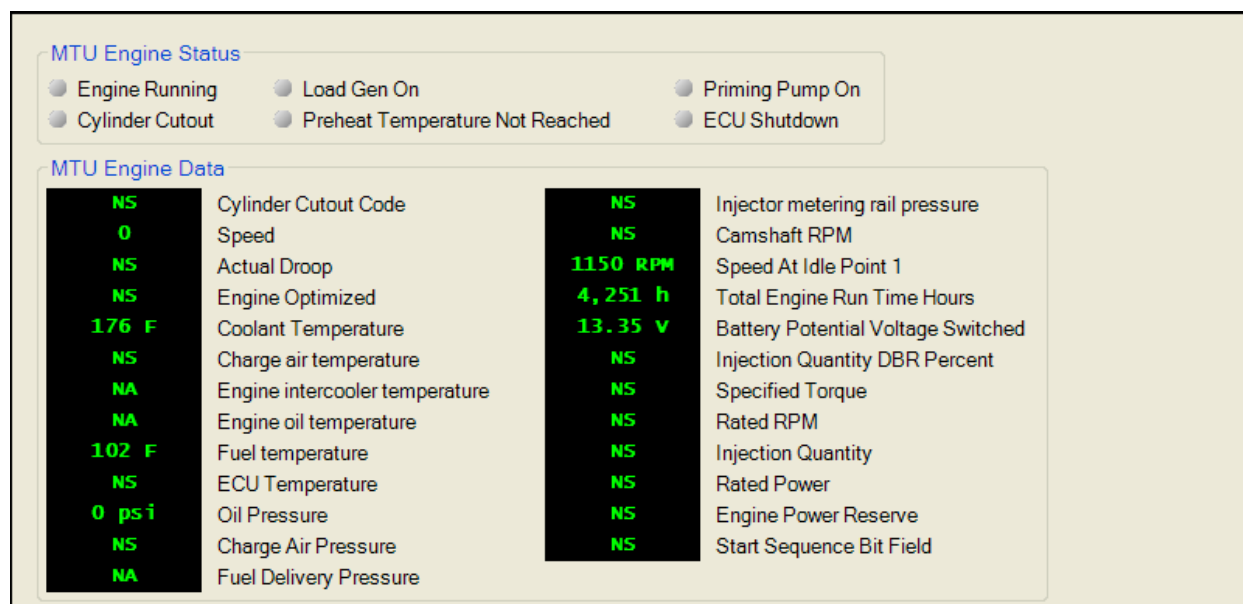


Figure 115. Metering Explorer, MTU, MTU Engine Status Screen

MTU Status

BESTCOMS^{Plus} Navigation Path: Metering Explorer, MTU, MTU Status

Front Panel Navigation Path: Metering > Status > MTU Status

Information and metering of engine components is provided by the *MTU Status* metering screen. Refer to Figure 116. Under certain circumstances, parameters may indicate one of the following codes: NA (not applicable), NC (not connected), NS (not sent), or SF (sender fail). See the *Communication* chapter for their descriptions.

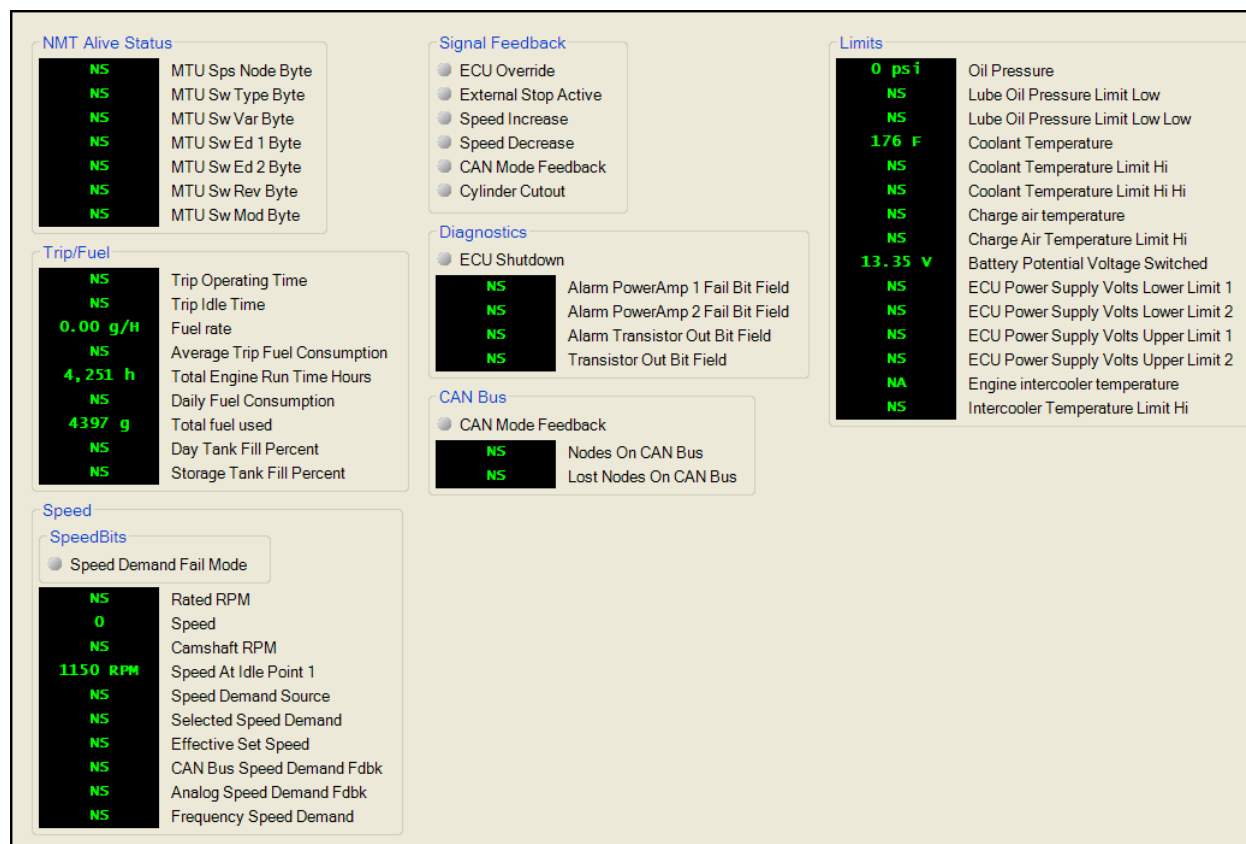


Figure 116. Metering Explorer, MTU, MTU Status Screen

Summary

BESTCOMS^{Plus} Navigation Path: Metering Explorer, MTU, MTU Status

Front Panel Navigation Path: Not available through front panel

Pertinent bus and engine metering is displayed on the *Summary* screen. Refer to Figure 117.

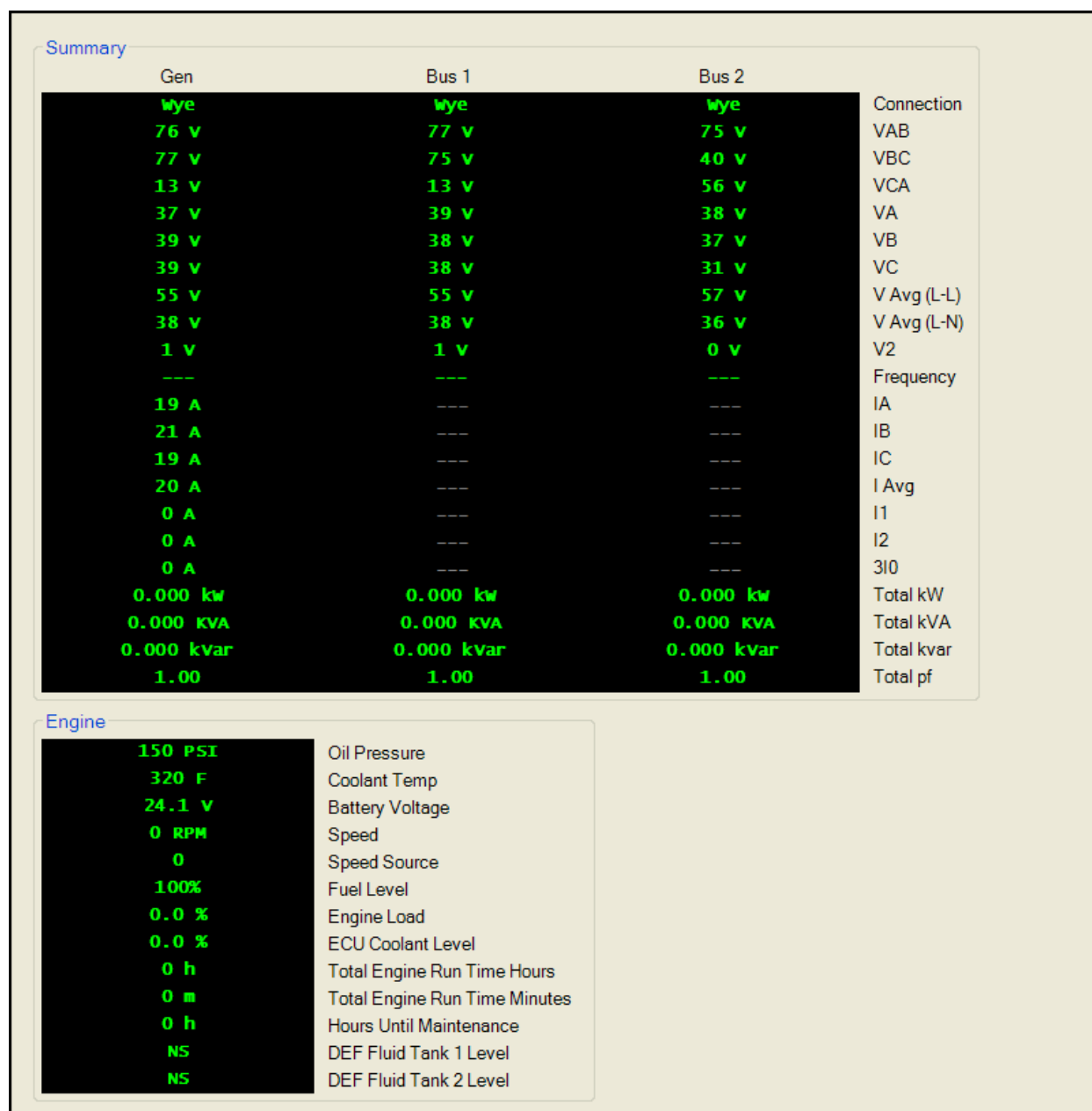


Figure 117. Metering Explorer, Summary Screen

Control Panel

BESTCOMSPlus Navigation Path: Metering Explorer, Control Panel

Front Panel Navigation Path: Not available through front panel

Controls for stopping/starting the engine, opening/closing breakers, and opening/closing switches are accessed using BESTCOMSPlus through the *Metering Explorer, Control Panel* screen. This set of controls is especially useful when commissioning the DGC-2020HD. The PC or laptop running BESTCOMSPlus must be connected to the DGC-2020HD via the USB, Ethernet, or Modem (see the *Communication* chapter for details). Using the Metering Explorer in BESTCOMSPlus, open the *Control Panel* screen. Refer to Figure 118.

Emergency Stop

The user has control to stop the generator in case of emergency by clicking on the *Emergency Stop* button.

Engine Control

The engine can be started and stopped by clicking on the *Start* and *Stop* buttons. This function requires a connection to a properly configured ECU via J1939 (CAN).

Run, Auto, Off

The operating mode can be set to Run, Auto, or Off.

Generator and Mains Breakers

There are controls for opening and closing the generator breaker and mains breaker. The breaker is open when the corresponding indicator is green and closed when red. This function requires that the Generator and Mains breakers be configured.

Switches 1 through 6

Each of these switches can be opened or closed by clicking on the *Open* or *Close* buttons. The switch is closed when the corresponding indicator is lit. These buttons control the virtual inputs found in BESTlogicPlus Programmable Logic. The number of the switch corresponds to the number of the virtual input it controls. See the *BESTlogicPlus* chapter for more information.

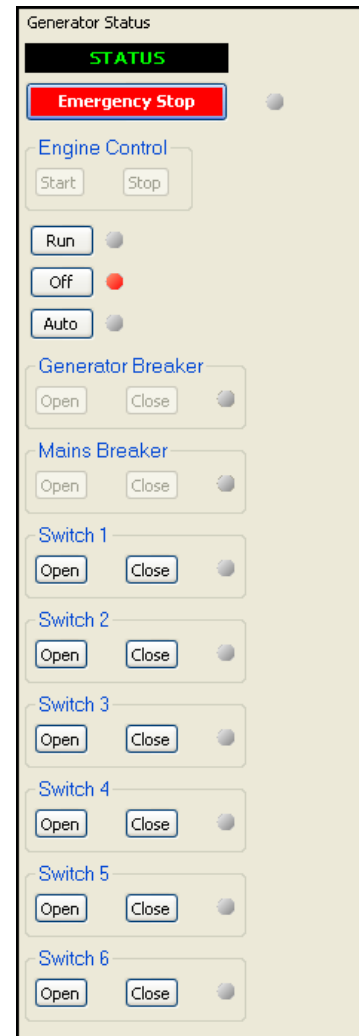


Figure 118. Metering Explorer, Control Panel Screen

Generator Network Status

BESTCOMSPlus Navigation Path: Metering Explorer, Generator Network Status

Front Panel Navigation Path: Metering > Gen Network Status

The *Generator Network Status* metering screen is illustrated in Figure 119.

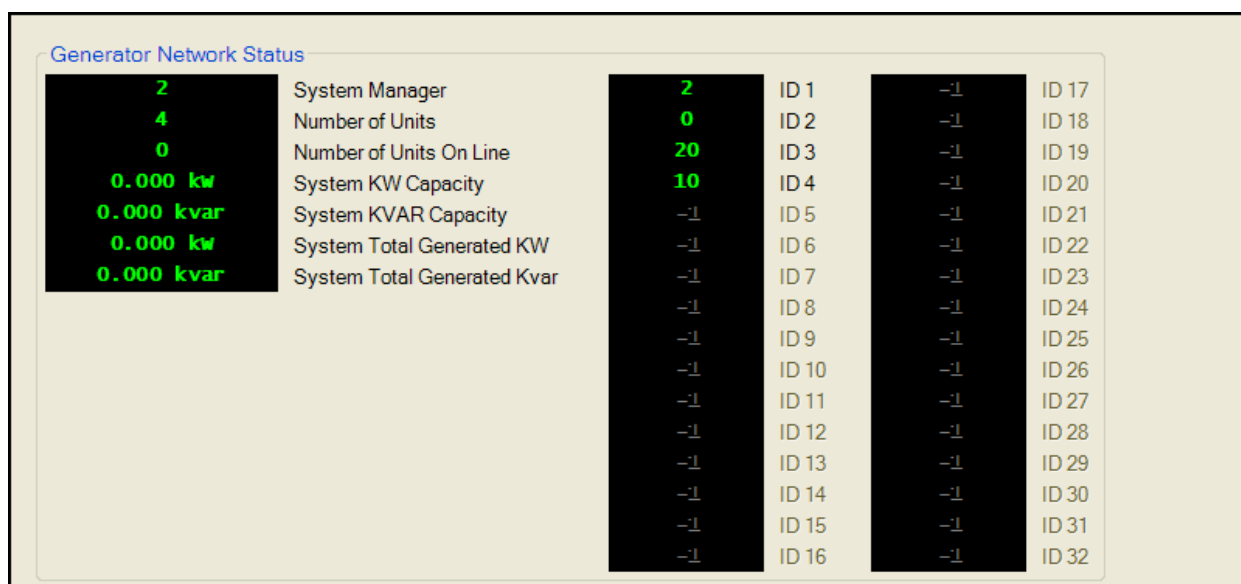


Figure 119. Metering Explorer, Generator Network Status Screen

Generator Sequencing

BESTCOMSPlus Navigation Path: Metering Explorer, Generator Sequencing

Front Panel Navigation Path: Metering > Gen Sequencing

This screen (Figure 120) provides generator sequencing information such as, the next unit to start/stop, power demand, start/stop thresholds, and spinning reserve thresholds.

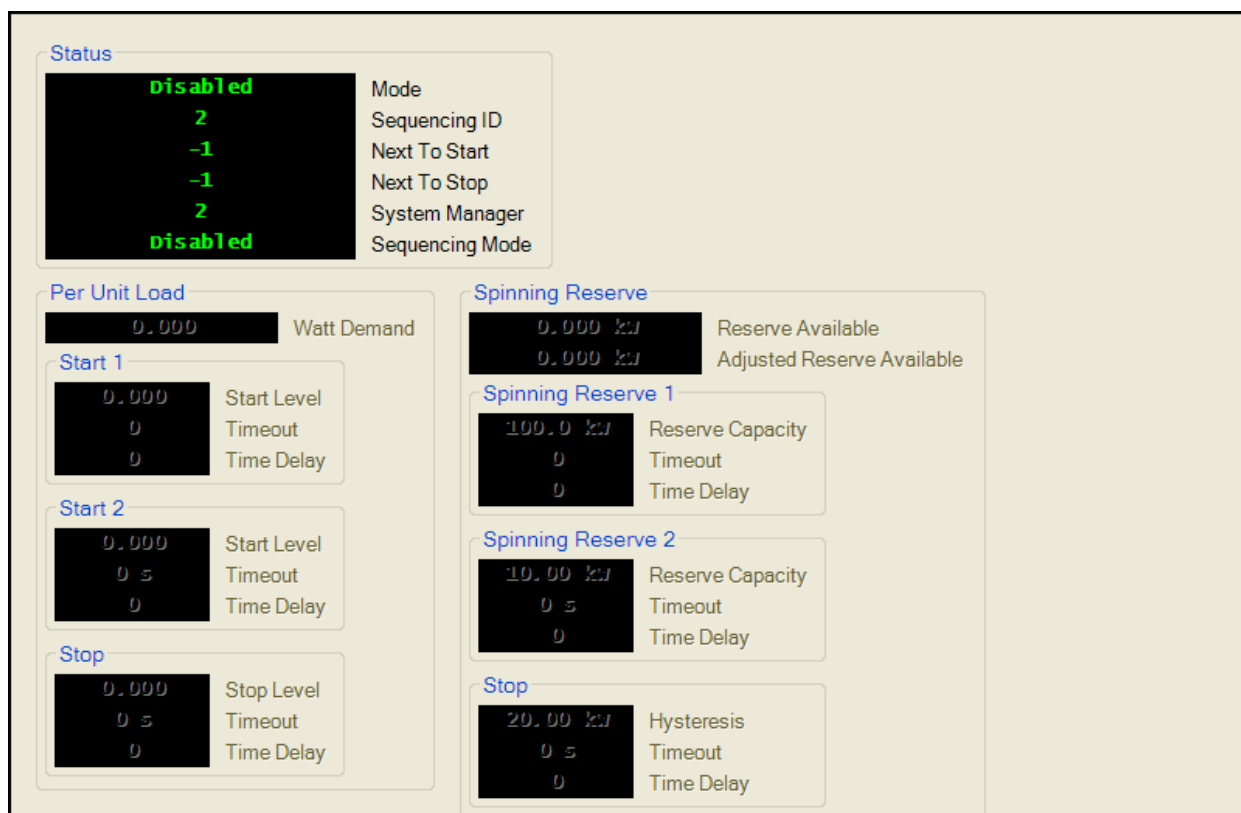


Figure 120. Metering Explorer, Generator Sequencing Screen

Diagnostics

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

Control

BESTCOMSPlus Navigation Path: Metering Explorer, Diagnostics, Control

Front Panel Navigation Path: Metering > Diagnostics > Control

Figure 121 illustrates the BESTCOMSPlus Control screen.

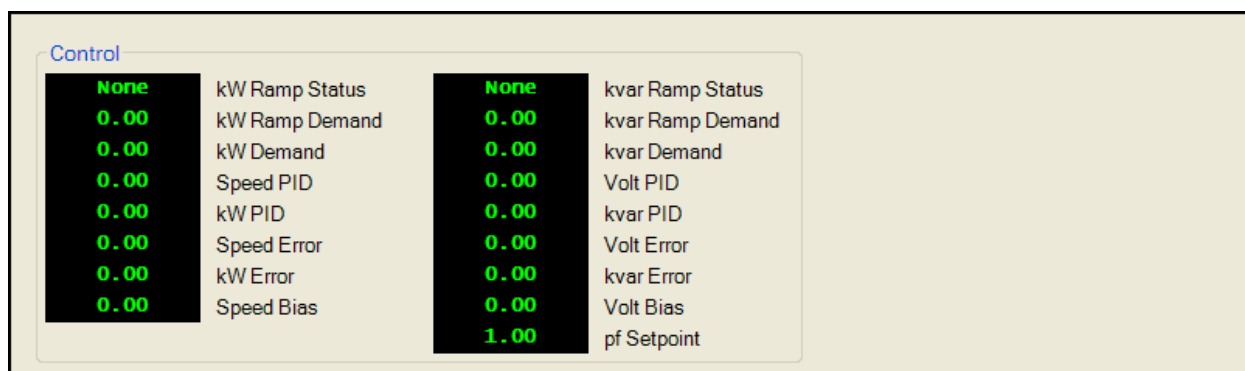


Figure 121. Metering Explorer, Diagnostics, Control Screen

Load Share

BESTCOMSPlus Navigation Path: Metering Explorer, Diagnostics, Load Share

Front Panel Navigation Path: Metering > Diagnostics > Load Share Line

Figure 122 illustrates the BESTCOMSPlus Load Share screen.



Figure 122. Metering Explorer, Diagnostics, Load Share Screen

Analysis

BESTCOMSPlus Navigation Path: Metering Explorer, Analysis

Front Panel Navigation Path: Not available through the front panel

Oscillography of nearly all genset parameters can be monitored in real time using the *Analysis* screen (Figure 123).

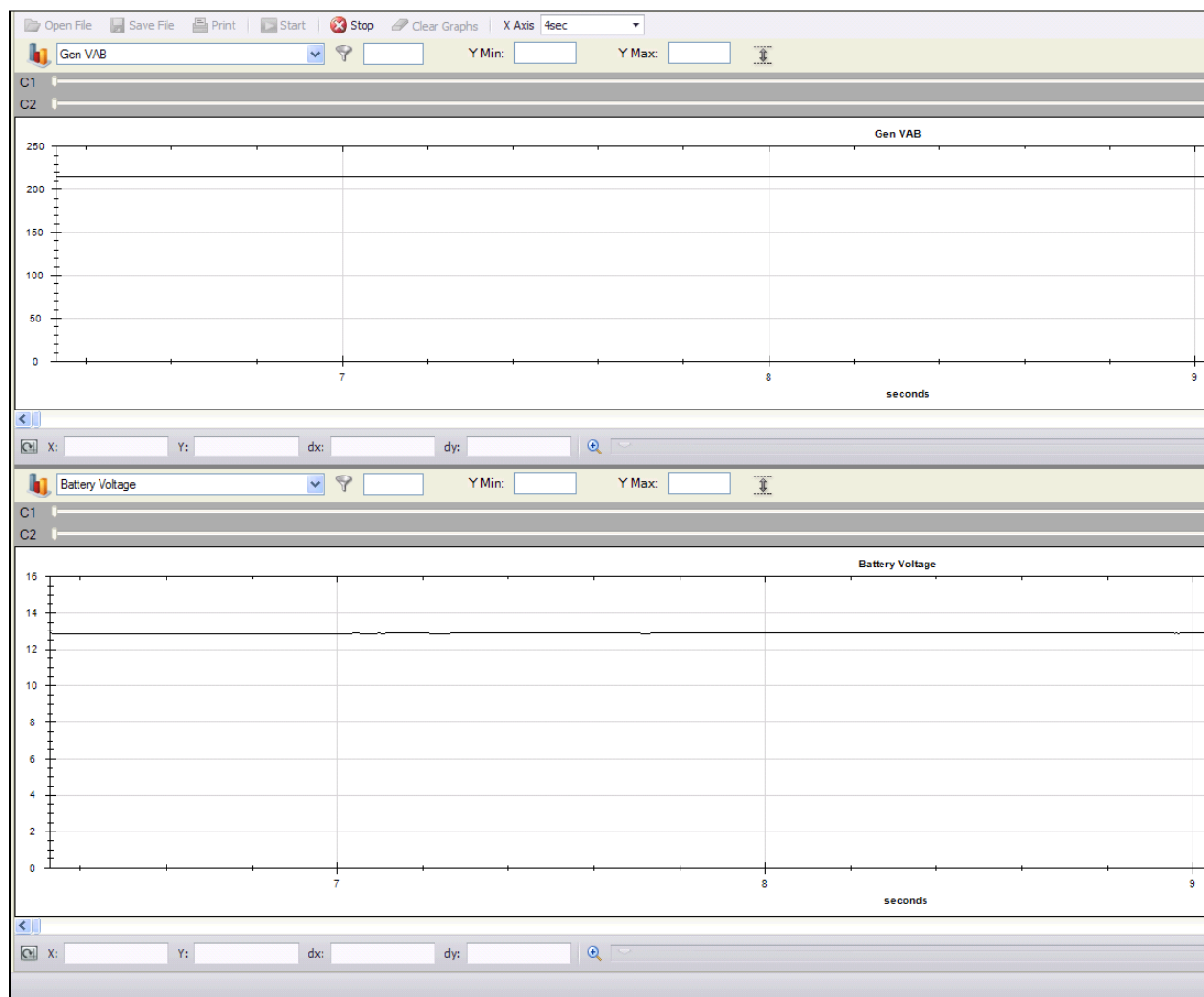


Figure 123. Metering Explorer, Analysis



Reporting and Alarms

DGC-2020HD reporting and alarm functions include event logging, sequence-of-events recording (SER), data logging (oscillography), and trending. Configuration of alarms, pre-alarms, sender failure alarms, user programmable alarms, and the audible horn is described in the *Alarms* paragraphs.

Event Logging

An event log contains history of system events in nonvolatile memory. The DGC-2020HD retains records for 128 unique types of events. Each record tracks the number of times that event has occurred and records a time stamp of the first and last occurrences. Detailed information for the last 30 occurrences of an event is retained, which consists of time, date, and engine hours. When the event record limit has been reached and an event occurs whose type is not already recorded, the event record with the longest period since the last occurrence is overwritten by the new event record.

An event log can be downloaded into BESTCOMSPlus® for viewing and storage. Use the Options button to save the entire event log to a file, to copy the list to the Windows® clipboard, or to print the event log. Clicking the Download button performs a fresh download of the list from the DGC-2020HD. The Clear button provides the option of clearing selected or all event logs. Refer to Figure 124.

Event ID	Description	Occurrence	Start Date	End Date	Eng Hrs (H:m)
1	OFF MODE STATUS	1	1999-12-31 18:16:13.578	1999-12-31 18:16:13.848	23:05
1	OFF MODE STATUS	55	1999-12-31 23:09:48.258	2000-01-01 15:51:53.928	25:53
1	OFF MODE STATUS	56	2000-01-01 15:52:42.258	2000-01-01 15:52:43.278	25:57
1	OFF MODE STATUS	57	2000-01-01 15:52:44.658	2000-01-01 15:53:10.998	25:57
1	OFF MODE STATUS	58	2000-01-01 15:53:11.958	2000-01-01 17:21:05.808	25:57
1	OFF MODE STATUS	59	2000-01-01 17:22:50.958	2000-01-01 17:23:00.558	25:57
1	OFF MODE STATUS	60	2000-01-01 17:23:01.008	2000-01-01 17:23:43.338	25:57
1	OFF MODE STATUS	61	2000-01-01 17:57:12.168	2000-01-01 17:57:13.188	25:57
1	OFF MODE STATUS	62	2000-01-01 18:16:17.838	2000-01-01 18:16:33.678	25:57
1	OFF MODE STATUS	63	2000-01-01 18:16:35.898	2000-01-01 18:16:37.278	25:57
1	OFF MODE STATUS	64	2000-01-01 18:16:39.888	2000-01-01 18:16:42.558	25:57
1	OFF MODE STATUS	65	2000-01-01 18:16:55.638	2000-01-01 18:16:56.178	25:57
1	OFF MODE STATUS	66	2000-01-01 18:22:15.048	2000-01-01 18:22:18.018	25:57
1	OFF MODE STATUS	67	2000-01-01 18:44:24.408	2000-01-01 18:44:26.028	25:57
1	OFF MODE STATUS	68	2000-01-01 19:12:17.358	2000-01-01 19:12:18.378	25:57
1	OFF MODE STATUS	69	2000-01-01 19:12:20.808	2000-01-01 20:03:52.248	25:57
1	OFF MODE STATUS	70	2000-01-01 20:04:05.778	2000-01-01 20:07:19.158	26:01
1	OFF MODE STATUS	71	2000-01-01 20:08:09.168	2000-01-01 20:08:16.098	26:04
1	OFF MODE STATUS	72	2000-01-01 20:08:17.178	2004-05-11 20:48:34.438	26:04
1	OFF MODE STATUS	73	2004-05-21 22:02:44.618	2004-05-21 22:02:45.283	26:04
1	OFF MODE STATUS	74	2004-05-07 16:44:45.610	2013-04-03 11:08:10.230	26:04
1	OFF MODE STATUS	75	2013-04-03 11:08:11.445	1999-12-31 18:00:06.435	26:04
1	OFF MODE STATUS	76	1999-12-31 18:00:08.130	2004-04-10 00:22:16.792	26:04
1	OFF MODE STATUS	77	2004-04-10 00:22:18.182	2004-04-10 00:33:16.281	26:04
1	OFF MODE STATUS	78	2004-04-10 00:33:16.281	1999-12-31 18:00:06.435	26:04

Figure 124. Metering Explorer, Event Log Screen

The event log may also be viewed on the front panel display by navigating to *Metering, Reports, Data Log*. Use the Up/Down keys to highlight an event and press the Right key to view the summary of that event record. A summary contains the description, date, time, and engine hours of the first and last occurrences of the event. To view details of specific event occurrences, use the Down key to highlight DETAILS and press the Right key. Occurrence number can be changed by pressing the Edit key, Up/Down keys to select #, and pressing the Edit key again to exit.

Sequence of Events

BESTCOMSPlus® Navigation Path: Metering Explorer, Reports, Sequence of Events

Front Panel Navigation Path: Metering > Reports > Sequence of Events

A sequence of events recorder monitors the internal and external status of the DGC-2020HD. Events are scanned at five millisecond intervals with 2,048 events stored per record. All changes of state that occur during each scan are time- and date-stamped. Sequence of events reports are available through BESTCOMSPlus. Any one of over 400 monitored data/status points can trigger the DGC-2020HD to record a sequence of events.

A sequence of events can be downloaded into BESTCOMSP^{Plus}® for viewing and storage. Use the Options button to save the entire sequence of events to a file, to save the list to the Windows® clipboard, or to print the sequence of events. Clicking the Download button performs a fresh download of the list from the DGC-2020HD. The Clear button provides the option of clearing selected or all event logs. Refer to Figure 125.

Sequence of Events			
Options Download Clear			
Time Stamp	Sync	Description	Status
1999-12-31 18:00:05.777		NTP Sync Lost	Off
1999-12-31 18:00:05.777		Alarm Output	Off
1999-12-31 18:00:05.777		PREHEAT PRELUBE RELAY	Off
1999-12-31 18:00:05.777		FUEL SOLENOID RELAY	Off
1999-12-31 18:00:05.777		Virtual Switch 1	Off
1999-12-31 18:00:05.777		Virtual Switch 2	Off
1999-12-31 18:00:05.777		Virtual Switch 5	Off
1999-12-31 18:00:05.777		LOGICFUELSOLENOID	Off
1999-12-31 18:00:05.777		LOGICENGINESTARTDELAY	Off
1999-12-31 18:00:06.435	NTP	NTP Sync Lost	Off
1999-12-31 18:00:06.435	NTP	CLOCK NOT SET ALM	On
1999-12-31 18:00:06.435	NTP	Alarm Output	Off
1999-12-31 18:00:06.483	NTP	uP Reset Alarm	Off
1999-12-31 18:00:06.483	NTP	Global Sender Fail	On
1999-12-31 18:00:06.483	NTP	Reset	Off
1999-12-31 18:00:06.483	NTP	Reset	Off
1999-12-31 18:00:06.483	NTP	AEM1-CONNECTED	Off
1999-12-31 18:00:06.533	NTP	uP Reset Alarm	On
1999-12-31 18:00:06.536	NTP	Global Sender Fail	On
1999-12-31 18:00:06.536	NTP	INPUT 14	Off
1999-12-31 18:00:06.536	NTP	Supplying Load	Off
1999-12-31 18:00:06.536	NTP	INPUT 15 Prealarm	Off
1999-12-31 18:00:06.558	NTP	Reset	On
1999-12-31 18:00:11.670	NTP	NTP Sync Lost	On
1999-12-31 18:00:11.670	NTP	Alarm Output	On

Figure 125. Metering Explorer, Sequence of Events

Setup

BESTCOMSP^{Plus}® Navigation Path: Settings Explorer, Report Configuration, Sequence of Events Setup

Front Panel Navigation Path: Settings > Report Configuration > Sequence of Events Setup

All events which are recorded in a sequence of events log are listed on this BESTCOMSP^{Plus} screen. Events with a check mark are recorded in the sequence of events, unchecked events are not recorded. This allows for filtering of undesired events from being stored in the sequence of events log.

Data Logging

BESTCOMSP^{Plus}® Navigation Path: Settings Explorer, Report Configuration, Data Log Setup

Front Panel Navigation Path: Settings > Report Configuration > Datalog

The data logging function of the DGC-2020HD can record up to 6 oscillography records. DGC-2020HD oscillography records use the IEEE Standard Common Format for Transient Data Exchange (COMTRADE). Each record is time- and date-stamped. After 6 records have been recorded, the DGC-2020HD begins recording the next record over the oldest record. Because oscillography records are stored in nonvolatile memory, interruptions in DGC-2020HD control power will not affect the integrity of the records. Data log settings are configured in BESTCOMSP^{Plus} and illustrated in Figure 126. Settings are listed in Table 49.

Setup

When oscillography is enabled, each record can consist of up to six user-selectable parameters with up to 1,200 data points recorded for each parameter.

A pre-trigger-points setting enables a user-defined number of data points recorded prior to the event trigger to be included in a data log. The value of this setting affects the duration of the recorded pre-trigger points, the recorded post-trigger points, and the duration of the post-trigger points. A sample interval setting establishes the sample rate of the data points recorded. The value of this setting affects the pre- and post-trigger duration values and the total recording duration for a data log.

Data logging is triggered by the BESTlogic™ *Plus* DATALOGTRIGGER element. When this element receives a TRUE input, the data logger function begins recording.

Figure 126. Settings Explorer, Report Configuration, Data Log Setup

Table 49. Settings for Data Log Setup

Locator	Setting	Range	Increment	Unit
A	Enable	Disabled or Enabled	n/a	n/a
B	Pre-Trigger Points	0 to 1,199	1	points
C	Sample Interval	5 to 12,500	5	n/a
D	Parameter 1 to 6	*	n/a	n/a

* Selectable parameters are listed in the *Configurable Protection* chapter.

Trending

BESTCOMSPlus® Navigation Path: Settings Explorer, Report Configuration, Trending

Front Panel Navigation Path: Settings > Report Configuration > Trending

The trend log records the activity of DGC-2020HD parameters over an extended period of time. When enabled, up to six selectable parameters can be monitored over a user-defined duration ranging from 1 to 720 hours. Trend log settings are illustrated in Figure 127.

Figure 127. Settings Explorer, Report Configuration, Trending Setup

Alarms

DGC-2020HD units monitor ECU data, generator protection functions, and engine senders. An alarm or pre-alarm is annunciated when the monitored parameter exceeds its threshold settings.

When an alarm condition exists, the engine is stopped by opening the Fuel output contact. An existing pre-alarm condition is annunciated only.

When alarms are active, the front panel Overview screen is replaced by the Active Alarms screen. When only pre-alarms are active, the front panel Overview screen is alternated with the Active Pre-Alarms screen in one-second intervals. Active alarms and pre-alarms can be viewed through BESTCOMSPlus®.

The front panel Alarm LED is illuminated when alarms are active. When pre-alarms are active, the Alarm LED flashes in one-second intervals.

If programmed and enabled, the horn output is closed when alarms are active. When pre-alarms are active, the horn output toggles in one-second intervals.

Active alarms are also indicated on the optional remote display panel in the form of LEDs and an audible horn. Red alarm LEDs light when the corresponding alarm setting is exceeded and the horn sounds. If an active alarm condition is not annunciated by the remote display panel, the *Switch Not In Auto* LED lights and the horn sounds.

Each alarm provides a logic output that can be connected to a physical output or other logic input using BESTlogic™Plus Programmable Logic. Refer to the BESTlogicPlus chapter for information.

Alarm Configuration

BESTCOMSPlus® Navigation Path: Settings Explorer, Alarm Configuration, Alarms

Front Panel Navigation Path: Settings > Alarm Configuration > Alarms

To configure alarms using BESTCOMSPlus, open the Alarm screen (Figure 128). Settings are listed in Table 50. The alarm settings are described below.

High Coolant Temp

High coolant temperature alarm settings consist of an enable/disable setting, a threshold setting, and an arming delay. If enabled, a high coolant temperature alarm is triggered instantaneously when the engine coolant temperature exceeds the threshold setting. A fixed hysteresis of 2% functions as a high coolant temperature dropout by preventing rapid switching of the pickup output. The arming delay disables the high coolant temperature alarm function for a user-adjustable period after engine startup. System units are configured on the System Settings screen.

Low Coolant Level

Low coolant level alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a low coolant level alarm is triggered when the metered coolant level drops below the threshold setting. A fixed hysteresis of 2% functions as a low coolant level dropout by preventing rapid switching of the pickup output. ECU Support must be enabled on the Communications, CAN Bus, CAN Bus Setup screen before this alarm can be configured.

Low Fuel Level

Low fuel level alarm settings consist of an enable/disable setting, a threshold setting, and an activation delay setting. If enabled, a low fuel level alarm is triggered when the metered fuel level drops below the threshold setting for the duration of the activation time delay. A fixed hysteresis of 2% functions as a low fuel level dropout by preventing rapid switching of the pickup output.

Low Oil Pressure

Low oil pressure alarm settings consist of an enable/disable setting, a threshold setting, and an arming delay. If enabled, a low oil pressure alarm is triggered instantaneously when the engine oil pressure decreases below the threshold setting. A fixed hysteresis of 2% functions as a low oil pressure dropout by preventing rapid switching of the pickup output. The arming delay disables the low oil pressure alarm function for a user-adjustable period after engine startup. System units and metric pressure units are configured on the System Settings screen.

Overspeed

Overspeed alarm settings include an enable/disable setting, a threshold setting, and an activation delay. If enabled, an overspeed alarm occurs when the engine speed (in percent of rated rpm) exceeds the threshold setting for the duration of the activation time delay. A fixed hysteresis of 2% functions as an overspeed dropout by preventing rapid switching of the pickup output.

Remote Display Panel

Remote display panel alarm settings consist of a single enable/disable setting. If enabled, the Remote Display Panel (RDP-110) annunciates an alarm when BESTlogicPlus logic element RDPPROGALM1 or RDPPROGALM2 receives a true input.

Alarms

High Coolant Temp

☒ Disable ☐ Enable Threshold (F) 275 A Arming Delay (s) 60 B

Low Oil Pressure

☒ Disable ☐ Enable Threshold (psi) 15.0 C Arming Delay (s) 10 D

Overspeed

☒ Disable ☐ Enable Threshold (%) 110 E Activation Delay (ms) 50 F

Low Fuel Level

☒ Disable ☐ Enable Threshold (%) 2 G Activation Delay (s) 30 H

Low Coolant Level

☒ Disable ☐ Enable Threshold (%) 25 I

Remote Display Panel

Alarm 1

☒ Disable ☐ Enable

Alarm 2

☒ Disable ☐ Enable

Figure 128. Settings Explorer, Alarm Configuration, Alarms

Table 50. Settings for Alarms

Locator	Setting	Range	Increment	Unit
<i>High Coolant Temp Settings</i>				
A	Threshold	100 to 280	1	degrees F
		38 to 138	1	degrees C
B	Arming Delay	0 to 150	1	seconds
<i>Low Oil Pressure Settings</i>				
C	Threshold	2.9 to 150	0.1	psi
		0.2 to 10.3	0.1	bar
		20 to 1034.5	0.1	kPa
D	Arming Delay	5 to 60	1	seconds
<i>Overspeed Settings</i>				
E	Threshold	105 to 140	1	%
F	Activation Delay	0 to 500	1	milliseconds
<i>Low Fuel Level Settings</i>				
G	Threshold	0 to 100	1	%
H	Activation Delay	0 to 30	1	seconds
<i>Low Coolant Level Settings</i>				
I	Threshold	1 to 99	1	%

Pre-alarm Configuration

BESTCOMSPlus® Navigation Path: Settings Explorer, Alarm Configuration, Pre-Alarms

Front Panel Navigation Path: Settings > Alarm Configuration > Pre-Alarms

To configure pre-alarms using BESTCOMSPlus, open the Pre-Alarms screen (Figure 129). Settings are listed in Table 51. The pre-alarm settings are described below.

Active DTC

Active DTC (Diagnostic Trouble Code) pre-alarm settings consist of a single enable/disable setting. If CAN and DTC support are both enabled, an Active DTC pre-alarm can be enabled to announce the presence of a condition that is causing a DTC to be sent from the ECU to the DGC-2020HD.

AEM1 through AEM4 Comms Failure

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

Breaker Close Failure

Breaker close failure pre-alarm settings consist of a single enable/disable setting and a monitor setting. If enabled, a Breaker Close Failure pre-alarm is annunciated if the DGC-2020HD has issued a breaker close output, and has not received feedback from the breaker status indicating it is closed before the breaker close wait time has elapsed. The Monitor setting determines whether this condition is monitored only during transitions or always.

Breaker Open Failure

Breaker open failure pre-alarm settings consist of a single enable/disable setting and a monitor setting. If enabled, a Breaker Open Failure pre-alarm is annunciated if the DGC-2020HD has issued a breaker open output, and has not received feedback from the breaker status indicating it is open before the breaker

close wait time has elapsed. The Monitor setting determines whether this condition is monitored only during transitions or always.

Bus 1 and Bus 2 Reverse Rotation

Bus 1 and Bus 2 reverse rotation pre-alarm settings consist of a single enable/disable setting. If enabled, a Bus 1 or Bus 2 Reverse Rotation pre-alarm is annunciated if the sensed bus phase rotation differs from the phase rotation specified on the System Parameters > System Settings screen.

CEM1 through CEM4 Comms Failure

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

ECU Communication Failure

ECU communication failure pre-alarm settings consist of a single enable/disable setting. If enabled, an ECU Communication Failure pre-alarm is annunciated when the DGC-2020HD detects a communication problem in the J1939 interface linking the DGC-2020HD with the ECU (Engine Control Unit).

Ethernet 1 and Ethernet 2 Link Lost

Ethernet 1 and Ethernet 2 link lost pre-alarm settings consist of a single enable/disable setting. If enabled, an Ethernet 1 or Ethernet 2 pre-alarm is annunciated if the Ethernet link between the DGC-2020HD and the network is lost.

Generator Reverse Rotation

Generator reverse rotation pre-alarm settings consist of a single enable/disable setting. If enabled, a Generator Reverse Rotation pre-alarm is annunciated if the sensed generator phase rotation differs from the phase rotation specified on the System Parameters > System Settings screen.

High Battery Voltage

High battery voltage pre-alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a High Battery Voltage pre-alarm is annunciated when the battery voltage increases above the threshold setting. A fixed hysteresis of 2% functions as a high battery voltage dropout by preventing rapid switching of the pickup output. The threshold setting accepts a value in absolute volts or per unit. Per unit value is based on the nominal battery voltage found on the System Parameters > System Settings screen. The per unit option is only available through BESTCOMSPlus.

High Coolant Temperature

High coolant temperature pre-alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a High Coolant Temperature pre-alarm is annunciated instantaneously when the engine coolant temperature exceeds the threshold setting. A fixed hysteresis of 2% functions as a high coolant temperature dropout by preventing rapid switching of the pickup output. The arming delay disables the high coolant temperature pre-alarm function for a user-adjustable period after engine startup. System units are configured on the System Settings screen in BESTCOMSPlus.

High Fuel Level

High fuel level pre-alarm settings consist of an enable/disable setting, a threshold setting, and an activation delay. If enabled, a High Fuel Level pre-alarm occurs when the metered fuel level stays above the threshold setting for the duration of the activation time delay. A fixed hysteresis of 2% functions as a high fuel level dropout by preventing rapid switching of the pickup output.

ID Missing

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

ID Repeat

ID repeat pre-alarm settings consist of a single enable/disable setting. If enabled, an ID Repeat pre-alarm is annunciated when two or more DGC-2020HDs report the same expected sequence ID.

Intergenset Communication Failure

Intergenset communication failure pre-alarm settings consist of a single enable/disable setting. If enabled, an Intergenset Communication Failure pre-alarm is annunciated when the DGC-2020HD detects that an individual generator previously connected to a generator network has lost connection.

Low Battery Voltage

Low battery voltage pre-alarm settings consist of an enable/disable setting, a threshold setting, and an activation delay. If enabled, a Low Battery Voltage pre-alarm occurs when the battery voltage decreases below the threshold setting for the duration of the activation delay. A fixed hysteresis of 2% functions as a low battery voltage dropout by preventing rapid switching of the pickup output. The threshold setting accepts a value in absolute volts or per unit. Per unit value is based on the nominal battery voltage found on the System Parameters > System Settings screen. The per unit option is only available through BESTCOMSPlus.

Low Coolant Level

Low coolant level pre-alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a Low Coolant Level pre-alarm occurs when the metered coolant level decreases below the threshold setting. A fixed hysteresis of 2% functions as a low coolant level dropout by preventing rapid switching of the pickup output.

Low Coolant Temperature

Low coolant temperature pre-alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a Low Coolant Temperature pre-alarm occurs when the engine coolant temperature decreases below the threshold setting. A fixed hysteresis of 2% functions as a low coolant temperature dropout by preventing rapid switching of the pickup output. System units are configured on the System Settings screen in BESTCOMSPlus.

Low Fuel Level

Low fuel level pre-alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a Low Fuel Level pre-alarm occurs when the metered fuel level decreases below the threshold setting. A fixed hysteresis of 2% functions as a low fuel level dropout by preventing rapid switching of the pickup output.

Low Oil Pressure

Low oil pressure pre-alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a low oil pressure pre-alarm is annunciated instantaneously when the engine oil pressure decreases below the threshold setting. A fixed hysteresis of 2% functions as a low oil pressure dropout by preventing rapid switching of the pickup output. The arming delay disables the low oil pressure alarm function for a user-adjustable period after engine startup. System units and metric pressure units are configured on the System Settings screen in BESTCOMSPlus.

Maintenance Interval

Maintenance interval pre-alarm settings consist of an enable/disable setting and a threshold setting. If enabled, a Maintenance Interval pre-alarm is annunciated when the DGC-2020HD maintenance timer counts down to zero (0) from the threshold time setting. The maintenance interval pre-alarm can be reset through the DGC-2020HD front panel or by using BESTCOMSPlus. See *Resetting Alarms and Pre-Alarms*, below.

Remote Display Panel

Remote display panel pre-alarm settings consist of a single enable/disable setting. If enabled, the Remote Display Panel (RDP-110) annunciates a pre-alarm when BESTlogic*Plus* logic element RDPPROGPREALM1 or RDPPROGPREALM2 receives a true input.

Synchronizer Failure

Synchronizer failure pre-alarm settings consist of a single enable/disable setting. If enabled, a Synchronizer Failure pre-alarm is annunciated if the DGC-2020HD is running the auto-synchronizer to align the generator voltage and bus voltage to close a breaker, and the DGC-2020HD does not receive feedback from the breaker status indicating it is closed before the Sync Fail Activation delay time has expired. The Sync Fail Activation delay setting is found on the Settings > Breaker Management > Synchronizer screen.

Weak Battery Voltage

Weak battery voltage pre-alarm settings consist of an enable/disable setting, a threshold setting, and an activation delay. If enabled, a Weak Battery Voltage pre-alarm latches during engine cranking when the battery voltage decreases below the threshold setting for the duration of the activation delay. A fixed hysteresis of 2% functions as a weak battery voltage dropout by preventing rapid switching of the pickup output. The threshold setting accepts a value in absolute volts or per unit. Per unit value is based on the nominal battery voltage found on the System Parameters > System Settings screen. The per unit option is only available through BESTCOMS*Plus*.

A weak battery pre-alarm condition is reset through the front panel by navigating to the Status > Pre-Alarms screen, scrolling through the list of pre-alarms until "Weak Battery" is displayed, and pressing the Reset key. This pre-alarm resets automatically if a crank cycle occurs and the battery has recovered.

Rated Data and Per Unit Values

Settings which are related to machine ratings can be set in either native units or in per unit values. When a native unit is edited, BESTCOMS*Plus* automatically recalculates the per unit value based on the native unit setting and the rated data parameter (on the System Parameters, Rated Data screen) associated with it. When a per unit value is edited, BESTCOMS*Plus* automatically recalculates the native value based on the per unit setting and the rated data parameter associated with it.

Once all per unit values are assigned, if the rated data parameters are changed, BESTCOMS*Plus* automatically recalculates all native unit settings based on the modified rated data parameters.

The following settings have native units of Volts, and the rated data associated with them is Battery Volts (on the System Parameters, Rated Data screen).

- High Battery Voltage
- Low Battery Voltage
- Weak Battery Voltage

Pre-Alarms

High Battery Voltage

☒ Disable ☐ Enable

Threshold **A** 0.0 V

Per Unit **B** 0.000

Low Battery Voltage

☒ Disable ☐ Enable

Threshold **C** 0.0 V

Per Unit **D** 0.000

Activation Delay (s) **E** 2.0

Weak Battery Voltage

☒ Disable ☐ Enable

Threshold **F** 0.0 V

Per Unit **G** 0.000

Activation Delay (s) **H** 2.0

Generator Reverse Rotation

☒ Disable ☐ Enable

Bus 1 Reverse Rotation

☒ Disable ☐ Enable

Bus 2 Reverse Rotation

☒ Disable ☐ Enable

Intergenset Comm Failure

☒ Disable ☐ Enable

High Fuel Level

☒ Disable ☐ Enable

Threshold (%) **I** 90

Activation Delay (s) **J** 0

Low Fuel Level

☒ Disable ☐ Enable

Threshold (%) **K** 25

Low Oil Pressure

☒ Disable ☐ Enable

Threshold (psi) **L** 25.0

High Coolant Temp

☒ Disable ☐ Enable

Threshold (F) **M** 250

Low Coolant Temp

☒ Disable ☐ Enable

Threshold (F) **N** 50

Low Coolant Level

☒ Disable ☐ Enable

Threshold (%) **O** 50

Maintenance Interval

☒ Disable ☐ Enable

Threshold (h) **P** 500

Breaker Open Failure

☐ Disable ☒ Enable

Monitor

☒ Transitions Only ☐ Always

Breaker Close Failure

☐ Disable ☒ Enable

Monitor

☒ Transitions Only ☐ Always

AEM1 Comms Failure

☐ Disable ☒ Enable

AEM2 Comms Failure

☐ Disable ☒ Enable

AEM3 Comms Failure

☐ Disable ☒ Enable

AEM4 Comms Failure

☐ Disable ☒ Enable

Synchronizer Failure

☒ Disable ☐ Enable

ECU Coms Fail

☒ Disable ☐ Enable

CEM1 Comms Failure

☐ Disable ☒ Enable

CEM2 Comms Failure

☐ Disable ☒ Enable

CEM3 Comms Failure

☐ Disable ☒ Enable

CEM4 Comms Failure

☐ Disable ☒ Enable

ID Missing

☒ Disable ☐ Enable

ID Repeat

☒ Disable ☐ Enable

Active DTC

☒ Disable ☐ Enable

Ethernet 1 Link Loss

☐ Disable ☒ Enable

Ethernet 2 Link Loss

☐ Disable ☒ Enable

Remote Display Panel

PreAlarm 1

☒ Disable ☐ Enable

PreAlarm 2

☒ Disable ☐ Enable

Figure 129. Settings Explorer, Alarm Configuration, Pre-Alarms

Table 51. Settings for Pre-Alarms

Locator	Setting	Range	Increment	Unit
High Battery Voltage Settings				
A	Threshold V	0 or 12 to 32	0.1	volts
B	Threshold Per Unit	based on nominal	n/a	n/a
Low Battery Voltage Settings				
C	Threshold V	0 or 6 to 28	0.1	volts
D	Threshold Per Unit	based on nominal	n/a	n/a
E	Activation Delay	0 to 10	0.1	seconds
Weak Battery Voltage Settings				
F	Threshold V	0 or 4 to 28	0.1	volts
G	Threshold Per Unit	based on nominal	n/a	n/a
H	Activation Delay	0 to 10	0.1	seconds
High Fuel Level Settings				
I	Threshold	0 to 150	1	%
J	Activation Delay	0 to 30	1	seconds
Low Fuel Level Settings				
K	Threshold	10 to 100	1	%

Locator	Setting	Range	Increment	Unit
Low Oil Pressure Settings				
L	Threshold	2.9 to 150	0.1	psi
		0.2 to 10.3	0.1	bar
		20 to 1034.5	0.1	kPa
High Coolant Temp Settings				
M	Threshold	100 to 280	1	degrees F
		38 to 138	1	degrees C
Low Coolant Temp Settings				
N	Threshold	0 to 151	1	degrees F
		−17 to 66	1	degrees C
Low Coolant Level Settings				
O	Threshold	1 to 99	1	%
Maintenance Interval				
P	Threshold	0 to 5,000	1	hours

Horn Configuration

BESTCOMSPlus® Navigation Path: Settings Explorer, Alarm Configuration, Horn Configuration

Front Panel Navigation Path: Settings > Alarm Configuration > Horn Configuration

To configure the audible horn using BESTCOMSPlus, open the Horn Configuration screen (Figure 130).

Figure 130. Settings Explorer, Alarm Configuration, Horn Configuration

An output contact is configured through programmable logic to energize an audible horn when an alarm or pre-alarm condition exists. The horn settings consist of an enable/disable setting and a Not in Auto enable/disable setting. If enabled, the contact output is closed when an alarm condition exists. The contact output is toggled between open and closed when a pre-alarm condition exists. If the Not in Auto setting is enabled, the horn is disabled when the DGC-2020HD is not operating in Auto mode.

Sender Fail Settings

BESTCOMSPlus® Navigation Path: Settings Explorer, Alarm Configuration, Sender Fail

Front Panel Navigation Path: Settings > Alarm Configuration > Sender Fail

To configure sender failure alarms using BESTCOMSPlus, open the Sender Fail screen (Figure 131). Settings are listed in Table 52.

Coolant temperature, oil pressure, fuel level, and voltage sensing sender failure settings consist of an alarm configuration setting and an activation delay. The alarm configuration setting allows selection of the type of alarm to be annunciated when a sender fail condition exists. Status Only, Alarm, and Pre-alarm can be selected. The selected alarm type is triggered when a sender failure exists for the duration of the activation time delay.

Sender Fail

Coolant Temp Sender Fail

Alarm Configuration: Status Only (A) Activation Delay (m): 5 (B)

Oil Pressure Sender Fail

Alarm Configuration: Status Only (C) Activation Delay (s): 10 (D)

Fuel Level Sender Fail

Alarm Configuration: Status Only (E) Activation Delay (s): 10 (F)

Voltage Sensing Fail

Alarm Configuration: Status Only (G) Activation Delay (s): 10 (H)

Speed Sender Fail

Activation Delay (s): 10 (I)

Figure 131. Settings Explorer, Alarm Configuration, Sender Fail

Table 52. Settings for Sender Fail

Locator	Setting	Range	Increment	Unit
<i>Coolant Temp Sender Fail Settings</i>				
A	Alarm Configuration	Status Only, Pre-Alarm, or Alarm	n/a	n/a
B	Activation Delay	5 to 30	1	minutes
<i>Oil Pressure Sender Fail Settings</i>				
C	Alarm Configuration	Status Only, Pre-Alarm, or Alarm	n/a	n/a
D	Activation Delay	0 to 300	1	seconds
<i>Fuel Level Sender Fail Settings</i>				
E	Alarm Configuration	Status Only, Pre-Alarm, or Alarm	n/a	n/a
F	Activation Delay	0 to 300	1	seconds
<i>Voltage Sensing Fail Settings</i>				
G	Alarm Configuration	Status Only, Pre-Alarm, or Alarm	n/a	n/a
H	Activation Delay	0 to 300	1	seconds
<i>Speed Sender Fail Settings</i>				
I	Activation Delay	0 to 300	1	seconds

The speed sender fail alarm is always enabled. A user-adjustable time delay is provided for each sender/sensing alarm/pre-alarm.

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

speed source is configured as MPU *and* generator frequency and a loss of one of the signal sources occurs, a pre-alarm is annunciated. An alarm (and shutdown) is triggered if both speed signals are lost.

User Programmable Alarms

BESTCOMSPlus® Navigation Path: Settings Explorer, Alarm Configuration, User Programmable Alarms

Front Panel Navigation Path: Not available through front panel

Sixteen user programmable alarms are available. BESTlogicPlus Programmable Logic is used to set up alarm logic. User alarm labels are programmed on the User Programmable Alarms screen (Figure 132) under Alarm Configuration. When active, the label of a user alarm is displayed on the Alarms screen on the front-panel display and in the sequence of events report.

Figure 132. Settings Explorer, Alarm Configuration, User Programmable Alarms

Retrieving Alarm Information

Alarms can be viewed on the front panel display and through BESTCOMSPlus.

Front Panel Display

The lists of active alarms and pre-alarms can be viewed by navigating to Metering > Status > Alarms or Pre-alarms. These lists are scrollable by using the Up and Down pushbuttons.

BESTCOMSPlus®

Status of each active alarm and pre-alarm is displayed on the Alarms screen (Figure 133). This screen is found in the Metering Explorer. Active pre-alarms are listed in the upper panel, alarms are listed in the lower panel.

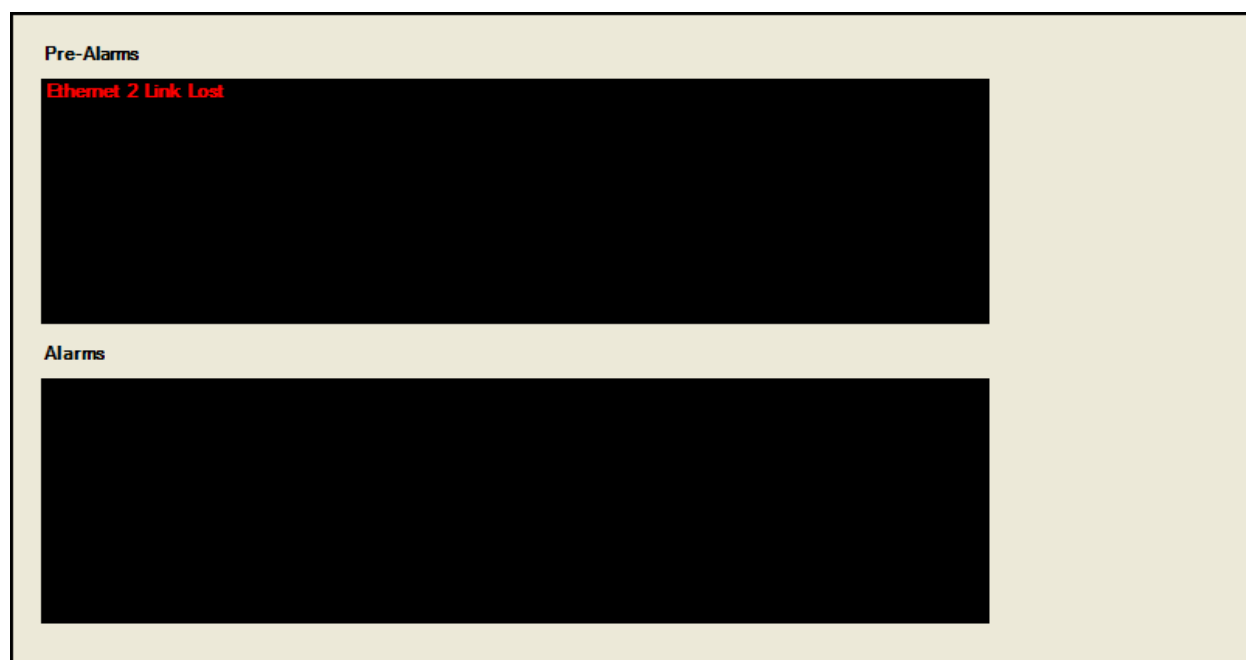


Figure 133. Metering Explorer, Alarms

Resetting Alarms and Pre-Alarms

Most pre-alarms automatically reset when the alarm condition no longer exists. Pre-alarms that do not automatically reset are listed below:

- 81 ROC DF/DT Rate of Change of Frequency
- 78 Vector Shift
- Breaker Close Fail
- Breaker Open Fail
- Synchronizer Fail
- Weak Battery

These pre-alarms are reset by navigating to the Overview screen on the front panel display and holding the Reset pushbutton for two seconds.

Alarms do not automatically reset. Manually reset alarms by pressing the Off pushbutton.

Horn

The audible horn can be silenced by pressing the Alarm Silence pushbutton. This does not reset the alarm or pre-alarm causing the horn to annunciate.

Maintenance Interval

To reset the maintenance interval pre-alarm through the front panel, navigate to the Settings > System Parameters > System Settings > Reset Maintenance Timer screen. Operator, Settings, or OEM access level is required to reset the maintenance interval pre-alarm.

To reset the maintenance interval pre-alarm by using BESTCOMSP^{Plus}, use the Metering Explorer to open the Run Statistics screen and click on the Reset Maintenance Interval button.

Another way to reset the maintenance interval pre-alarm from the front panel is to hold the Reset pushbutton for 10 seconds while viewing the Overview screen.

BESTCOMSP^{Plus}® Software

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

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

BESTCOMSP^{Plus} uses plugins, allowing the user to manage several different Basler Electric products. The DGC-2020HD plugin must be activated before use. The plugin can be activated automatically by connecting to a DGC-2020HD, or manually by requesting an activation key from Basler Electric.

The DGC-2020HD plugin opens inside the BESTCOMSP^{Plus} main shell. The same default logic scheme that is shipped with the DGC-2020HD is brought into BESTCOMSP^{Plus} by downloading settings and logic from the DGC-2020HD. This gives the user the option of developing a custom setting file by modifying the default logic scheme or by building a unique scheme from scratch.

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

BESTCOMSP^{Plus} also allows for downloading industry-standard COMTRADE files for analysis of stored oscillography data. Detailed analysis of the oscillography files can be accomplished using BESTwave™ software.

Figure 134 illustrates the typical user interface components of the DGC-2020HD plugin with BESTCOMSP^{Plus}.

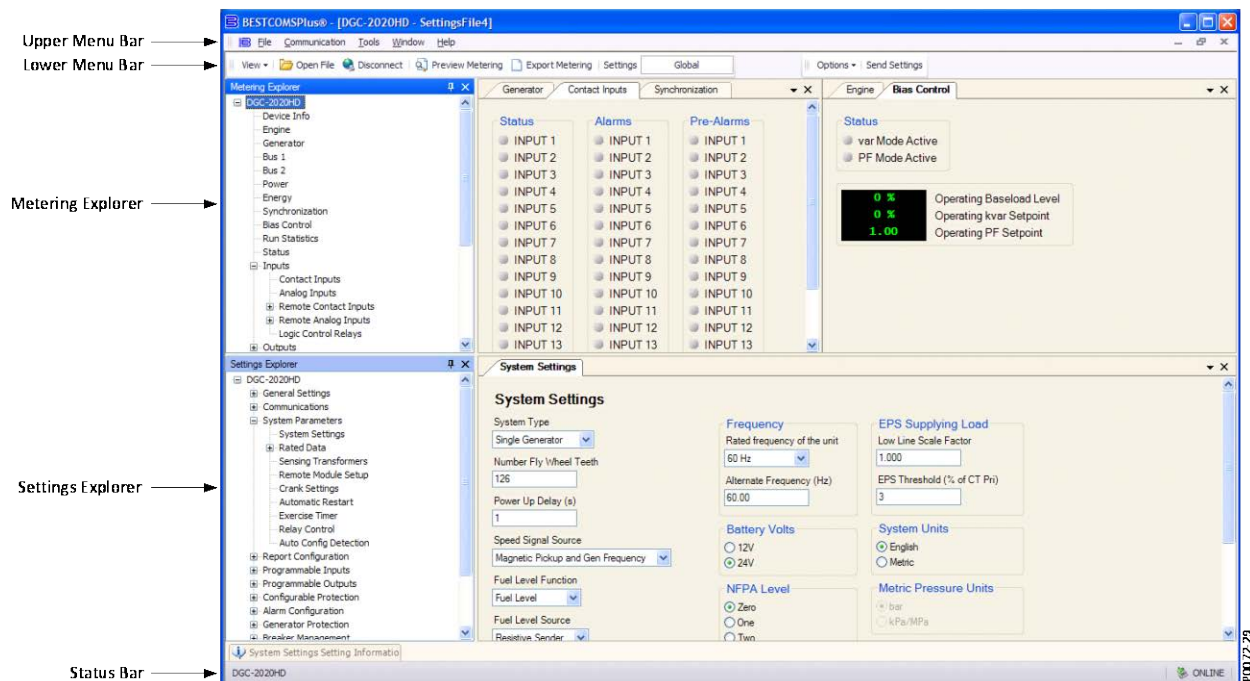


Figure 134. Typical User Interface Components

System Recommendations

BESTCOMSP^{Plus} software is built on the Microsoft® .NET Framework. The setup utility that installs BESTCOMSP^{Plus} on your PC also installs the DGC-2020HD plugin and the required version of .NET Framework (if not already installed). BESTCOMSP^{Plus} operates with systems using Windows® XP 32-bit SP2/SP3, Windows Vista 32-bit (all editions), Windows 7 32-bit (all editions), Windows 7 64-bit (all editions) and Windows 8. Microsoft Internet Explorer 5.01 or later must be installed on your PC before installing BESTCOMSP^{Plus}. System recommendations for the .NET Framework and BESTCOMSP^{Plus} are listed in Table 53.

Table 53. System Recommendations for BESTCOMSP^{Plus} and the .NET Framework

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

To install and run BESTCOMSP^{Plus}, a Windows user must have Administrator rights.

Installation

Note

Do not connect a USB cable until setup completes successfully. Connecting a USB cable before setup is complete may result in errors.

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

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

Activate the DGC-2020HD Plugin for BESTCOMSP^{Plus}®

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

The DGC-2020HD plugin can be activated automatically or manually. Automatic activation is achieved by using a USB cable to establish communication between the DGC-2020HD and BESTCOMSP^{Plus}. Manual activation is initiated by contacting Basler Electric for an activation key and entering the key into BESTCOMSP^{Plus}. Manual activation is useful if you want to create a settings file prior to receiving your DGC-2020HD. Note that if a DGC-2020HD is not connected, you will not be able to configure certain Ethernet settings. Ethernet settings can be changed only when an active USB or Ethernet connection is present. Refer to *Manual Activation of the DGC-2020HD Plugin*.

Connect a USB Cable

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

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

Start BESTCOMSP*lus*® and Activate DGC-2020HD Plugin Automatically

To start BESTCOMSP*lus*, click the Windows Start button, point to Programs, Basler Electric, and then click the BESTCOMSP*lus* icon. During initial startup, the BESTCOMSP*lus* Select Language screen is displayed (Figure 135). You can choose to have this screen displayed each time BESTCOMSP*lus* is started, or you can select a preferred language and this screen will be bypassed in the future. Click OK to continue. This screen can be accessed later by selecting Tools and Select Language from the menu bar.

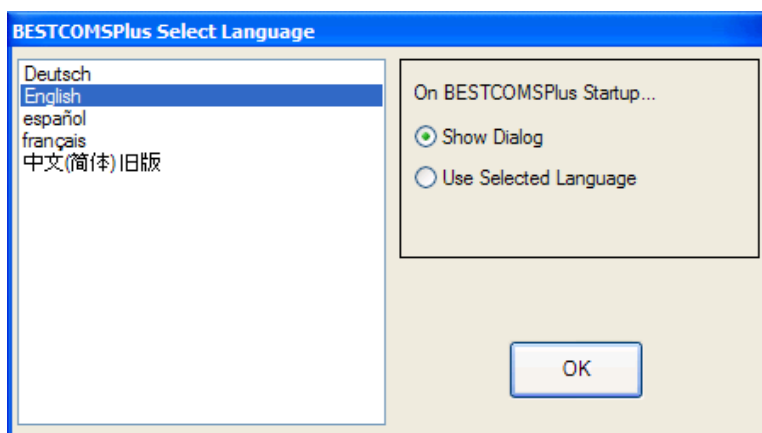


Figure 135. BESTCOMSP*lus* Language Selection Dialog

The BESTCOMSP*lus* platform window opens. Select New Connection from the Communication pull-down menu and select DGC-2020HD. See Figure 136. The DGC-2020HD plugin is activated automatically after connecting to a DGC-2020HD.

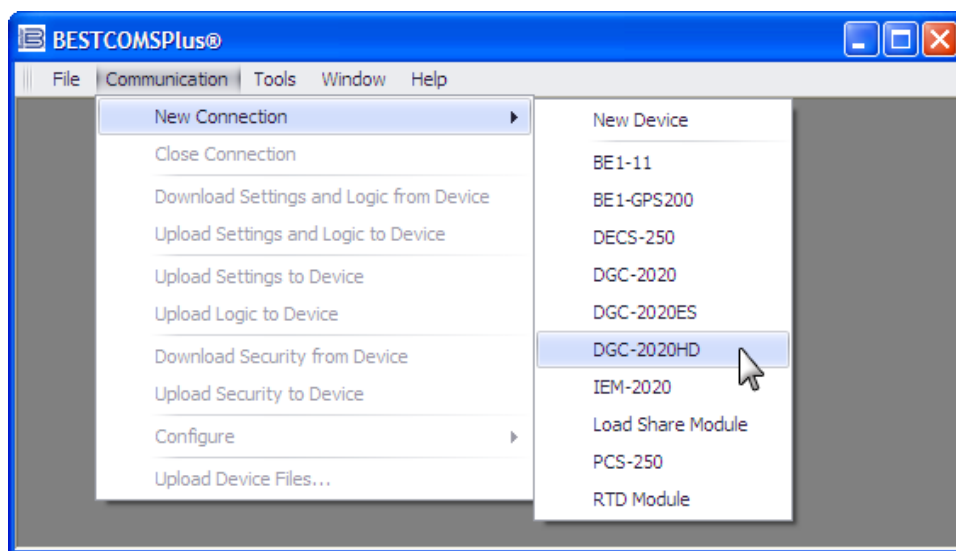
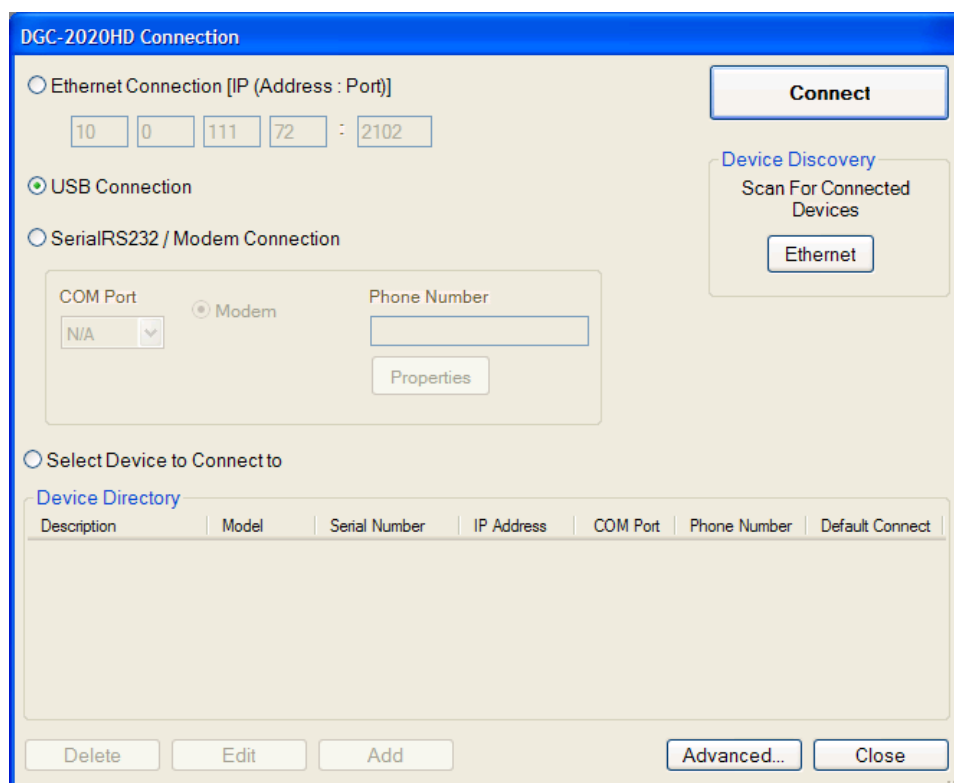


Figure 136. Communication Pull-Down Menu

The DGC-2020HD Connection screen, shown in Figure 137 appears. Select USB Connection and then click the Connect button.



The dialog box is titled "DGC-2020HD Connection". It contains three radio buttons for connection types: "Ethernet Connection [IP (Address : Port)]", "USB Connection" (which is selected), and "SerialRS232 / Modem Connection".

Under "Ethernet Connection", there are input fields for IP address (10, 0, 111, 72) and port (2102), and a "Connect" button.

Under "USB Connection", there is a "Device Discovery" section with a "Scan For Connected Devices" button and an "Ethernet" button.

Under "SerialRS232 / Modem Connection", there is a "COM Port" dropdown menu (set to "N/A"), a "Modem" radio button, a "Phone Number" input field, and a "Properties" button.

At the bottom, there is a "Select Device to Connect to" section with a "Device Directory" table. The table has columns: Description, Model, Serial Number, IP Address, COM Port, Phone Number, and Default Connect. Below the table are "Delete", "Edit", and "Add" buttons.

At the bottom right, there are "Advanced..." and "Close" buttons.

Figure 137. DGC-2020HD Connection Dialog

Manual Activation of the DGC-2020HD Plugin

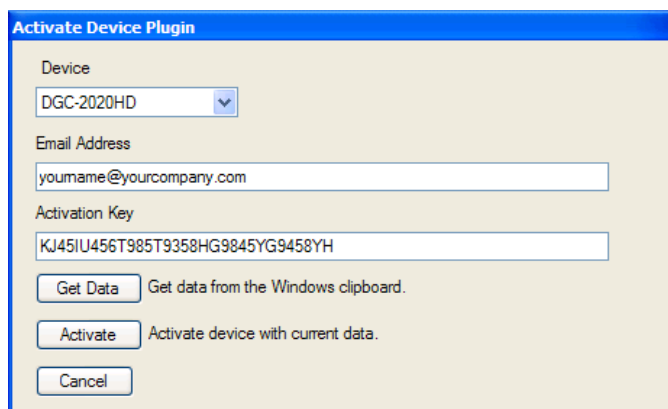
Manual activation of the DGC-2020HD plugin is required only if your initial use of BESTCOMSP_{Plus} will be on a PC that is not connected to a DGC-2020HD. Manual activation is described in the following paragraphs.

Requesting an Activation Key

When initially running the DGC-2020HD plugin, the Activate Device Plugin pop-up appears. You must contact Basler Electric for an activation key before you can activate the DGC-2020HD plugin. You can request an activation key through email or the Basler Electric website. Click either the Website or Email button. Click the Activate button when you are ready to enter the activation key you received from Basler Electric. The Activate Device Plugin pop-up appears. Refer to Figure 138.

Entering an Activation Key

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

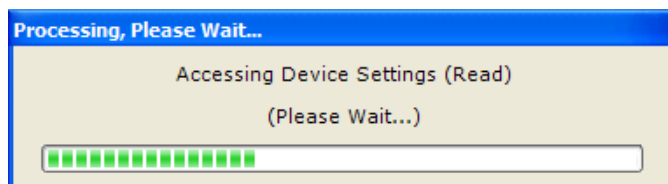


The "Activate Device Plugin" dialog box has a blue title bar. It contains three input fields: "Device" with a dropdown menu showing "DGC-2020HD", "Email Address" with the text "youname@yourcompany.com", and "Activation Key" with the text "KJ45IU456T985T9358HG9845YG9458YH". Below these fields are three buttons: "Get Data" (with a tooltip "Get data from the Windows clipboard."), "Activate" (with a tooltip "Activate device with current data."), and "Cancel".

Figure 138. Activate Device Plugin

Establishing Communication

Communication between BESTCOMSP^{lus} and the DGC-2020HD is established by clicking on the Connect button on the DGC-2020HD Connection screen (see Figure 137) or by clicking on the Connect button on the lower menu bar of the main BESTCOMSP^{lus} screen (Figure 134). If you receive an "Unable to Connect to Device" error message, verify that communications are configured properly. Only one Ethernet connection is allowed at one time. Download all settings and logic from the DGC-2020HD by selecting Download Settings and Logic from the Communication pull-down menu. BESTCOMSP^{lus} will read all settings and logic from the DGC-2020HD and load them into BESTCOMSP^{lus} memory. See Figure 139.

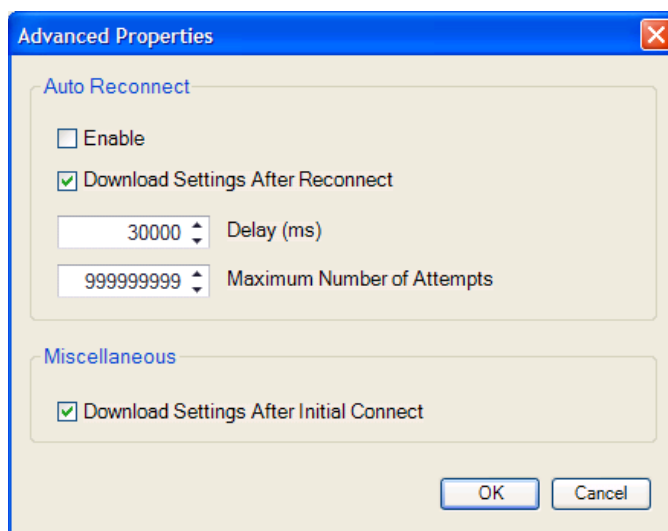


The "Processing, Please Wait..." dialog box has a blue title bar. It contains the text "Accessing Device Settings (Read)" and "(Please Wait...)" above a progress bar consisting of 15 green squares.

Figure 139. Processing, Please Wait...

Advanced Properties

Click the Advanced button on the Connection screen to display the Advanced Properties dialog. Default settings are shown in Figure 140.



The "Advanced Properties" dialog box has a blue title bar with a close button. It contains two sections: "Auto Reconnect" and "Miscellaneous". The "Auto Reconnect" section has a checkbox for "Enable" (unchecked), a checked checkbox for "Download Settings After Reconnect", a spin box for "Delay (ms)" set to 30000, and a spin box for "Maximum Number of Attempts" set to 999999999. The "Miscellaneous" section has a checked checkbox for "Download Settings After Initial Connect". At the bottom are "OK" and "Cancel" buttons.

Figure 140. Advanced Properties Dialog

Menu Bars

The menu bars are located near the top of the BESTCOMSP^{Plus} window (see Figure 134). The upper menu bar has five pull-down menus. With the upper menu bar, it is possible to manage settings files, configure communication settings, upload and download settings/security files, and compare settings files. The lower menu bar consists of clickable icons. These icons are used to change BESTCOMSP^{Plus} views, save or load a BESTspace™ workspace, open a settings file, connect/disconnect, preview metering printout, export metering, switch to live mode, and send settings after a change is made when not in live mode.

Upper Menu Bar (BESTCOMSP^{Plus}® Shell)

Upper menu bar functions are listed and described in Table 54.

Table 54. Upper Menu Bar (BESTCOMSP^{Plus} Shell)

Menu Item	Description
<i>File</i>	
New	Create a new settings file
Open	Open an existing settings file
Open File As Text	Generic file viewer for *.csv, *.txt, etc. files
Close	Close settings file
Save	Save settings file
Save As	Save settings file with a different name
Export To File	Save settings as a *.csv file
Print	Print, export, or send a settings file
Properties	View properties of a settings file
History	View history of a settings file
Recent Files	Open a previously opened file
Exit	Close BESTCOMSP ^{Plus} program
<i>Communication</i>	
New Connection	Choose new device or DGC-2020HD
Close Connection	Close communication between BESTCOMSP ^{Plus} and DGC-2020HD
Download Settings and Logic from Device	Download operational and logic settings from the device
Upload Settings and Logic to Device	Upload operational and logic settings to the device
Upload Settings to Device	Upload operational settings to the device
Upload Logic to Device	Upload logic settings to the device
Download Security from Device	Download security settings from the device
Upload Security to Device	Upload security settings to the device
Configure	Ethernet settings
Upload Device Files	Upload firmware to the device
<i>Tools</i>	
Select Language	Select BESTCOMSP ^{Plus} language
Activate Device	Activate the DGC-2020HD plugin
Set File Password	Password protect a settings file
Compare Settings Files	Compare two settings files
Auto Export Metering	Exports metering data on a user-defined interval

Menu Item	Description
Event Log - View	View the BESTCOMS <i>Plus</i> event log
Event Log - Clear	Clear the BESTCOMS <i>Plus</i> event log
Event Log - Set New File Name	Set a new file name for event log
<u>Window</u>	
Cascade All	Cascade all windows
Tile	Tile horizontally or vertically
Maximize All	Maximize all windows
<u>Help</u>	
Check for Updates	Check for BESTCOMS <i>Plus</i> updates via the internet
Check for Update Settings	Enable or change automatic checking for updates
About	View general, detailed build, and system information

Lower Menu Bar (DGC-2020HD Plugin)

The lower menu bar functions are listed and described in Table 55.

Table 55. Lower Menu Bar (DGC-2020HD Plugin)

Menu Button	Description
 View ▾	Enables you to show/hide the Metering Panel, Settings Panel, or Settings Info Panel. Opens and saves BESTspace™ workspaces. Customized workspaces make switching between tasks easier and more efficient.
 Open File	Opens a saved settings file.
 Connect	Connect: Opens the DGC-2020HD Connection screen which enables you to connect to the DGC-2020HD via USB, modem, or Ethernet. This button only appears when a DGC-2020HD is not connected.
 Disconnect	Disconnect: Used to disconnect a connected DGC-2020HD. This button only appears when a DGC-2020HD is connected.
 Preview Metering	Displays the Print Preview screen where a preview of the Metering printout is shown. Click on the printer button to send to a printer.
 Export Metering	Enables all metering values to be exported into a *.csv file.
Settings  Group 0 ▾ Settings  Global	A pull-down menu allowing group selection is available when making protection settings. The settings can be applied to Group 0, 1, 2, or 3. If a global setting is being changed, Global will appear in place of the drop-down menu.
Options ▾	Displays a drop-down list entitled Live Mode Settings which enables Live mode where settings are automatically sent to the device in real time as they are changed.
 Send Settings	Sends settings to the DGC-2020HD when BESTCOMS <i>Plus</i> is not operating in Live Mode. Click this button after making a setting change to send the modified setting to the DGC-2020HD.

Settings Explorer

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

These screens allow the user to edit general settings, communications, system parameters, programmable inputs, programmable outputs, alarm configuration, generator protection, breaker management, programmable senders, and BESTlogicPlus programmable logic.

Logic setup will be necessary after making certain setting changes. For more information, refer to the BESTlogicPlus chapter.

Metering Explorer

The Metering Explorer is a convenient tool within BESTCOMSPlus used to navigate through the various metering screens of the DGC-2020HD plugin.

These screens allow the user to view real-time system data including generator voltages and currents, input/output status, alarms, reports, and other parameters. Refer to the *Metering* chapter for more information on the Metering Explorer.

BESTspace™

BESTspace provides the ability to manage customized workspaces. A workspace consists of the position and size of all open screens within BESTCOMSPlus. Pre-saved workspaces can be quickly loaded to fit the specific task at hand. Any number of different workspaces can be saved including a default workspace which loads when the DGC-2020HD plug-in is started. Metering Explorer screens and Settings Explorer screens can be saved independently into the workspace file. A Comments box is provided for writing a description or leaving notes for each saved workspace. To access BESTspace, click View (on the lower menu bar) and hover over *BESTspace*. Figure 141 illustrates the BESTspace options found under the View pull-down menu. Figure 142 illustrates the options included in the Load/Save Workspace File screen.

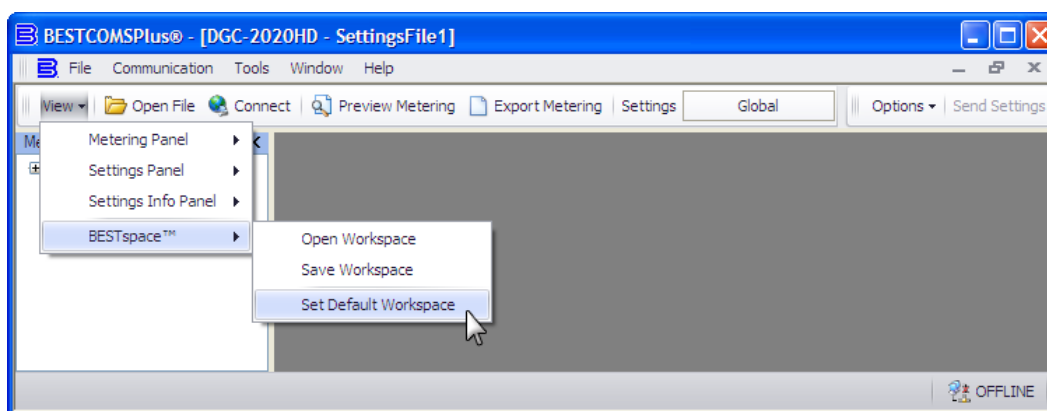


Figure 141. View Menu, BESTspace™ Options

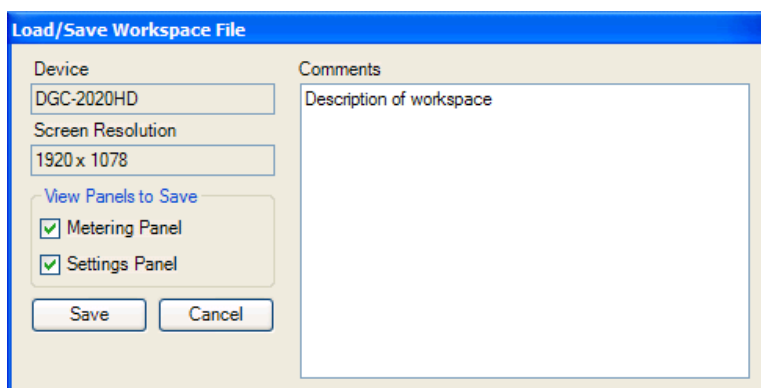


Figure 142. View Menu, BESTspace™, Save Workspace Screen

Settings File Management

A settings file contains all DGC-2020HD settings, including logic. A settings file assumes a file extension of “*.bstx”. It is possible to save the logic only as a separate logic library file on the *BESTlogicPlus* Programmable Logic screen. This function is helpful when similar logic is required for several devices. A logic library file assumes a file extension of “*.bslx”. It is important to note that settings and logic can be uploaded to the device together or separately, but are always downloaded together. For more information on logic files, refer to the *BESTlogicPlus* chapter.

Opening a Settings File

To open a DGC-2020HD settings file with *BESTCOMSPlus*, pull down the File menu and choose Open. The Open dialog box appears. This dialog box allows you to use normal Windows techniques to select the file that you want to open. Select the file and choose Open. You can also open a file by clicking on the Open File button on the lower menu bar. If connected to a device, you will be asked to upload the settings and logic from the file to the current device. If you choose Yes, the settings displayed in *BESTCOMSPlus* will be overwritten with the settings of the opened file.

Saving a Settings File

Select Save or Save As from the File pull-down menu. A dialog box appears allowing you to enter a filename and location to save the file. Select the Save button to complete the save.

Upload Settings and/or Logic to Device

To upload a settings file to the DGC-2020HD, open the file through *BESTCOMSPlus* or create the file using *BESTCOMSPlus*. Then pull down the Communication menu and select Upload Settings and Logic to Device. If you want to upload operational settings without logic, select Upload Settings to Device. If you want to upload logic without operational settings, select Upload Logic to Device. You are prompted to enter the password. The default username is “A” and the default password is “A”. If the username and password are correct, the upload begins and the progress bar is shown.

Download Settings and Logic from Device

To download settings and logic from the DGC-2020HD, pull down the Communication menu and select Download Settings and Logic from Device. If the settings in *BESTCOMSPlus* have changed, a dialog box will open prompting you to save or discard the current settings changes. After the choice is made, downloading begins. *BESTCOMSPlus* will read all settings and logic from the DGC-2020HD and load them into *BESTCOMSPlus* memory.

Print a Settings File

To preview the settings printout, select Print Preview from the File pull-down menu. To print the settings, select the printer icon in the upper left corner of the Print Preview screen.

You can skip the print preview and go directly to print by pulling down the File menu and selecting Print. A dialog box opens containing the typical Windows options for setting the properties of the printer. Configure these settings as necessary and then select Print.

Compare Settings Files

BESTCOMSPlus has the ability to compare two settings files. To compare files, pull down the Tools menu and select Compare Settings Files. The *BESTCOMSPlus* Settings Compare Setup dialog box appears (Figure 143). Select the location of the first file under Left Settings Source and select the location of the second file under Right Settings Source. If you are comparing a settings file located on your PC hard drive or portable media, click the folder button and navigate to the file. If you want to compare settings downloaded from a unit, click the Select Unit button to set up the communication port. Click the Compare button to compare the selected settings files.

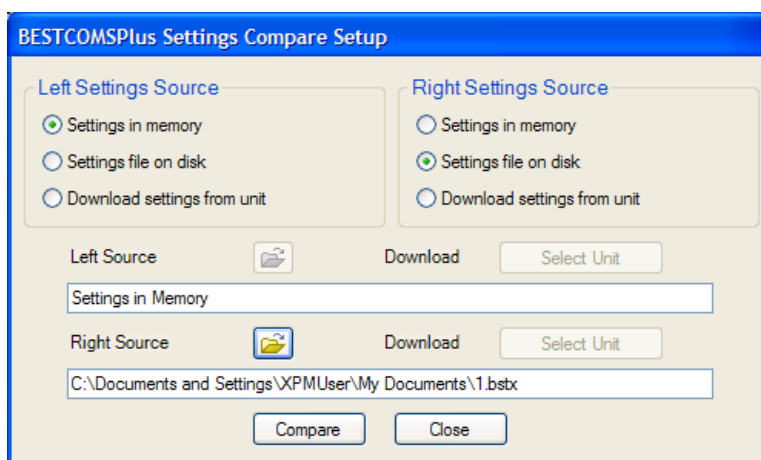


Figure 143. Tools, Compare Settings Files Screen

A dialog box appears, displaying the results of the comparison. The BESTCOMSPPlus Settings Compare dialog box (Figure 144) is displayed where you can view all settings (Show All Settings), view only the differences (Show Settings Differences), view all logic (Show All Logic Paths), or view only logic differences (Show Logic Path Differences). Select Close when finished.

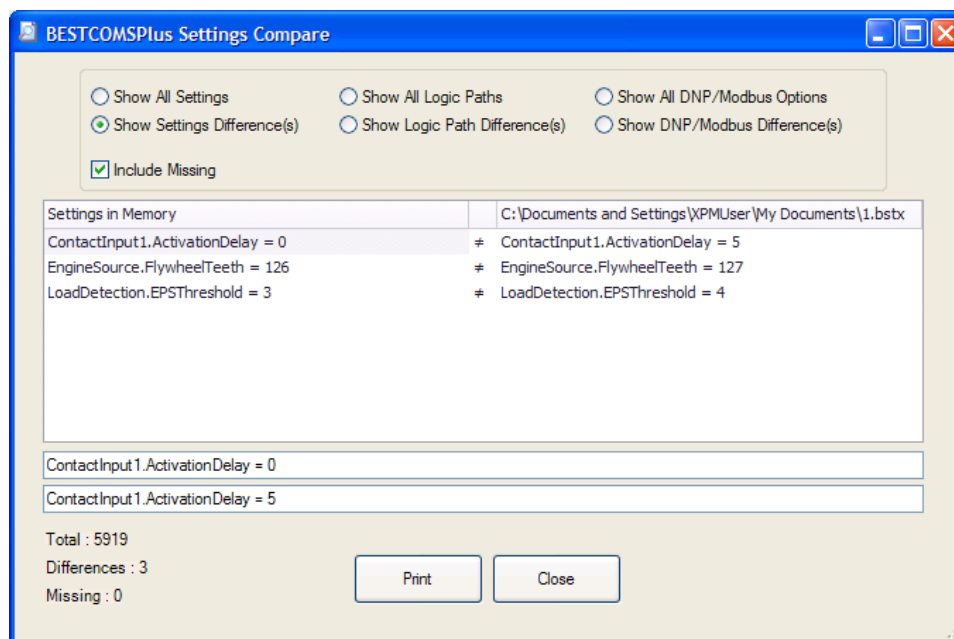


Figure 144. Settings Comparison Results Screen

Auto Export Metering

The auto export metering function automatically exports metering data over a user-defined period. The user specifies the Number of Exports and the Interval between each export. Enter a filename for the metering data and a folder in which to save. The first export is performed immediately after clicking the Start button. Click the Filter button to select specific metering screens. Figure 145 illustrates the Auto Export Metering screen.

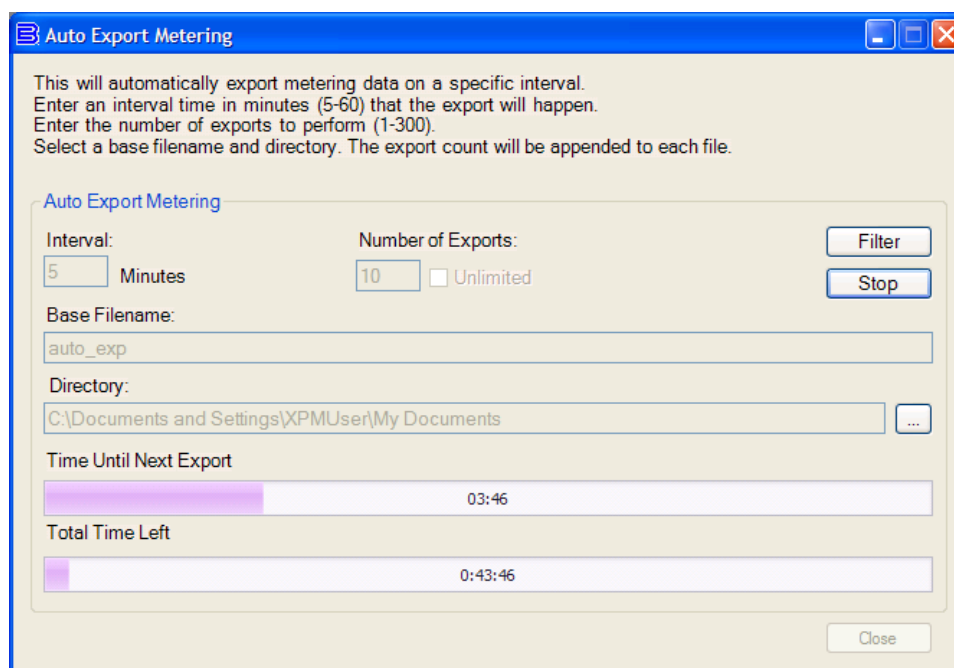


Figure 145. Auto Export Metering

BESTCOMSP⁺ Updates

Ongoing DGC-2020HD functionality enhancements may make future DGC-2020HD firmware updates desirable. Enhancements to DGC-2020HD firmware typically coincide with enhancements to the DGC-2020HD plugin for BESTCOMSP⁺. When a DGC-2020HD is updated with the latest version of firmware, the latest version of BESTCOMSP⁺ should also be obtained.

- If you obtained a CD-ROM containing a firmware update from Basler Electric, then that CD-ROM will also contain the corresponding version of BESTCOMSP⁺ software.
- You can check for BESTCOMSP⁺ updates by visiting www.basler.com. An online form can be completed to obtain a password for downloading the software.
- You can use the manual “check for updates” function in BESTCOMSP⁺ to ensure that the latest version is installed by selecting Check for Updates in the Help drop-down menu. (An internet connection is required.)

Firmware Updates

For information on updating firmware, refer to the *Device Information* chapter.



BESTlogic™Plus

BESTlogicPlus Programmable Logic is a programming method used for managing the input, output, protection, control, monitoring, and reporting capabilities of Basler Electric's DGC-2020HD Digital Genset Controller. Each DGC-2020HD has multiple, self-contained logic blocks that have all of the inputs and outputs of its discrete component counterpart. Each independent logic block interacts with control inputs and hardware outputs based on logic variables defined in equation form with BESTlogicPlus.

BESTlogicPlus equations entered and saved in the DGC-2020HD system's nonvolatile memory integrate (electronically wire) the selected or enabled protection and control blocks with control inputs and hardware outputs. A group of logic equations defining the logic of the DGC-2020HD is called a logic scheme.

One default active logic scheme is preloaded into the DGC-2020HD. This scheme is configured for a typical protection and control application and virtually eliminates the need for "start-from-scratch" programming. BESTCOMSPlus® can be used to open a logic scheme that was previously saved as a file and upload it to the DGC-2020HD. The default logic scheme can also be customized to suit your application. Detailed information about logic schemes is provided later in this chapter.

BESTlogicPlus is not used to define the operating settings (modes, pickup thresholds, and time delays) of the individual protection and control functions. Operating settings and logic settings are interdependent but separately programmed functions. Changing logic settings is similar to rewiring a panel and is separate and distinct from making the operating settings that control the pickup thresholds and time delays of a DGC-2020HD. Detailed information about operating settings is provided in the BESTCOMSPlus chapter.

Overview of BESTlogic™Plus

BESTlogicPlus settings are made through BESTCOMSPlus. Use the Settings Explorer to open the BESTlogicPlus Programmable Logic tree branch as shown in Figure 146.

The BESTlogicPlus Programmable Logic screen contains a logic library for opening and saving logic files, tools for creating and editing logic documents, and protection settings.

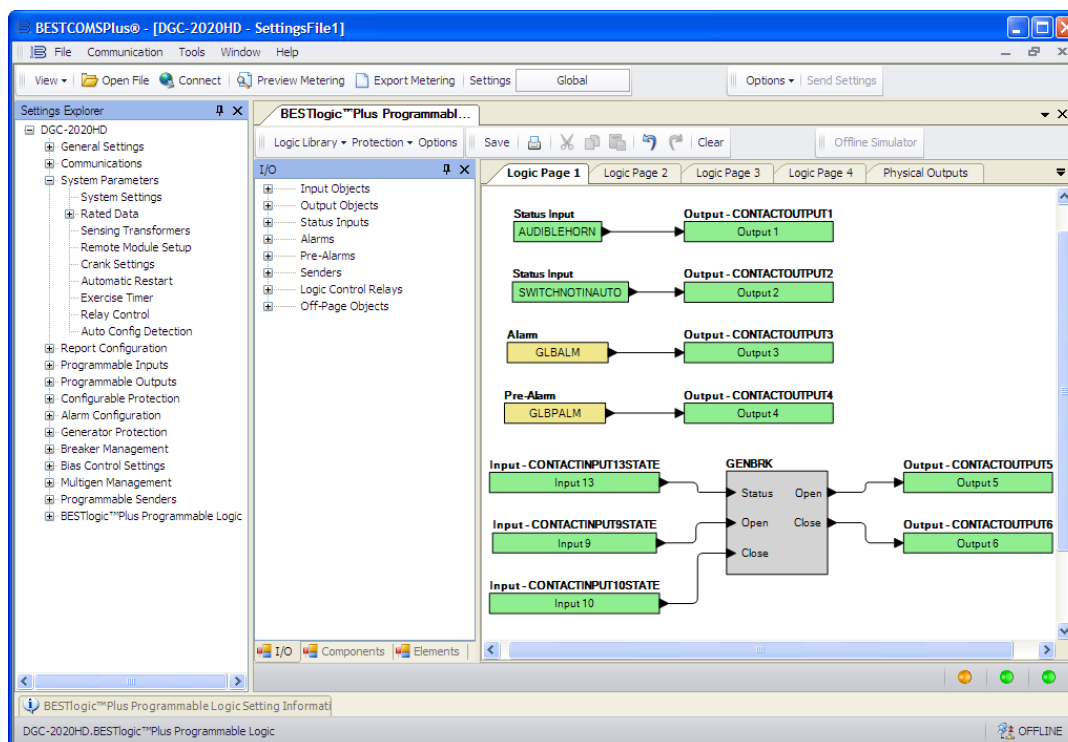


Figure 146. Settings Explorer, BESTlogic™Plus Programmable Logic Screen

BESTlogic™Plus Composition

There are three main groups of objects used for programming BESTlogicPlus. These groups are I/O, Components, and Elements. For details on how these objects are used to program BESTlogicPlus, see the paragraphs on *Programming BESTlogicPlus*, later in this chapter.

I/O

This group contains Input Objects, Output Objects, Status Inputs, Alarms, Pre-Alarms, Senders, Logic Control Relays, and Off-Page Objects. The following tables list the names and descriptions of the objects in the I/O group.

Table 56. I/O Group, Input Objects

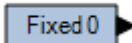
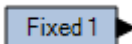
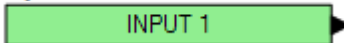
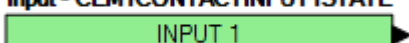
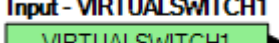
Name	Description	Symbol
Logic 0	Always false (Low).	
Logic 1	Always true (High).	
Physical Inputs		
Input x	True when Contact Input x is active, the Alarm Configuration is set to Status Only, and the activation delay has expired.	Input - CONTACTINPUT1STATE 
Remote Inputs		
Input x	True when Remote Contact Input x is active, the Alarm Configuration is set to Status Only, and the activation delay has expired.	Input - CEM1CONTACTINPUT1STATE 
Virtual Inputs		
Input x	True when Virtual Input x is active.	Input - VIRTUALSWITCH1 

Table 57. I/O Group, Output Objects

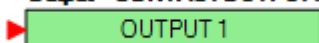
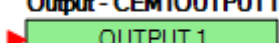
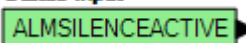
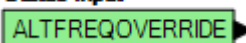
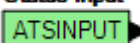
Name	Description	Symbol
Physical Outputs		
Output x	Closes the corresponding contact output on the DGC-2020HD when true (high).	Output - CONTACTOUTPUT1 
Remote Outputs		
Output x	Closes the corresponding remote contact output on an optional CEM-2020 when true (high).	Output - CEM1OUTPUT1 

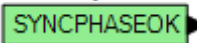
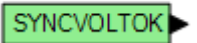
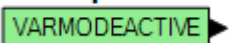
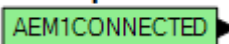
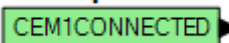
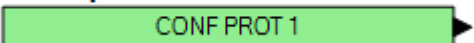
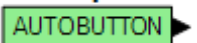
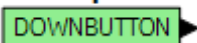
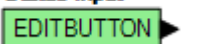
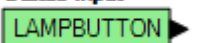
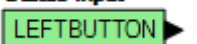
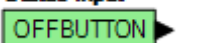
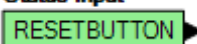
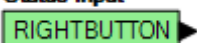
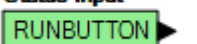
Table 58. I/O Group, Status Inputs

Name	Description	Symbol
Alarm Silence	True when the Alarm Silence logic element is true or the Alarm Silence button is pressed on the front panel.	Status Input 
Alternate Frequency Override	True when the Alternate Frequency Override logic element is true.	Status Input 
ATS Input	True when the ATS (Auto Transfer Switch) input is true or the ATS logic element is true.	Status Input 

Name	Description	Symbol
Audible Horn	True when the Audible Horn is active.	Status Input AUDIBLEHORN
Auto Mode	True when the DGC-2020HD is in Auto Mode or the Auto Mode logic element is true.	Status Input AUTOMODE
Auto Restart	True when the Automatic Restart function is active.	Status Input AUTORESTARTINPROGRESS
AVR Output Out of Range	True when the AVR Output Limit settings have been exceeded.	Status Input AVROUTPUTRANGE
Battery Charger Fail	True when the Battery Charger Fail input is true, the Alarm Type is set to Status Only, and the activation delay has expired.	Status Input BATTERYCHARGERFAILPF
Battle Override	True when the Battle Override input is true.	Status Input BATTLEOVERRIDEFF
Bus x Dead	True when the Bus x Dead condition settings have been exceeded.	Status Input BUS1CONDITIONDEAD
Bus x Fail	True when the Bus Fail condition settings have been exceeded.	Status Input BUS1CONDITIONFAILED
Bus x Forward Rotation Status	True when the bus rotation matches the Phase Rotation setting.	Status Input BUS1FORWARDROTATION
Bus x Reverse Rotation	True when the bus rotation is opposite of the Phase Rotation setting.	Status Input BUS1REVERSEROTATION
Bus x Stable	True when the Bus Stable condition settings have been exceeded.	Status Input BUS1CONDITIONSTABLE
CAN bus Error Passive	True when a passive error is annunciated by the CAN bus.	Status Input CANBUSERRORPASSIVE
CAN bus Off	True when the CAN bus is off.	Status Input CANBUSBUSOFF
Cool Down Timer Active	True when the Cool Down Timer is timing out. The Cool Down Timer is true under two circumstances: 1. The unit is in Auto mode and ATS is removed, causing the DGC-2020HD to go into a cool down state. 2. The engine is running (in Run or Auto mode with ATS applied) and the load has been removed (i.e. the EPSSUPLOAD status input is false due to small load). If the load is reapplied, the Cool Down Timer stops and resets, and it will restart when the load is removed the next time.	Status Input COOLDOWNTIMERACTIVE
Emergency Stop	True when the Emergency Stop button has been pressed.	Status Input EMERGENCYSTOP
Engine Running	True while the engine is running.	Status Input ENGINERUNNING
EPS Supplying Load	True when the EPS threshold has been exceeded and the EPS is supplying load.	Status Input SUPPLYINGLOAD

Name	Description	Symbol
Fuel Leak Detect	True when the Fuel Leak Detect input is true, the Alarm Type is set to Status Only, and the activation delay has expired.	Status Input FUELLEAKDETECTPF 
Generator Breaker Status	True when the generator breaker is closed.	Status Input GENBREAKERSTATUS 
Generator Dead	True when the Gen Dead condition settings have been exceeded.	Status Input GENCONDITIONDEAD 
Generator Fail	True when the Gen Fail condition settings have been exceeded.	Status Input GENCONDITIONFAILED 
Generator Forward Rotation	True when the generator rotation matches the Phase Rotation setting.	Status Input GENFORWARDROTATION 
Generator Reverse Rotation Status	True when the generator rotation is opposite of the Phase Rotation setting.	Status Input GENREVERSEROTATION 
Generator Stable	True when the Gen Stable condition settings have been exceeded.	Status Input GENCONDITIONSTABLE 
Generator Test	True when the Exercise Timer has started the generator.	Status Input GENTEST 
Generator Test Loaded	True when the Exercise Timer has started the generator and Run with Load is selected.	Status Input GENTESTLOADED 
GOV Output Out of Range	True when the GOV Output Limit settings have been exceeded.	Status Input GOVOUTPUTRANGE 
Grounded Delta Override	True when the Grounded Delta Override input is true.	Status Input GROUNDDELTAOVERRIDEFF 
Idle Request	True when the Idle Request logic element is true.	Status Input IDLEREQUESTACTIVE 
Lamp Test	True when the Lamp Test logic element is true or the Lamp Test button is pressed on the front panel.	Status Input LAMPTESTACTIVE 
Load Take Over	True when the Load Take Over logic element is true.	Status Input TAKEOVERLOADACTIVE 
Low Coolant Level	True when the Low Coolant Level function is configured as an alarm or pre-alarm and the activation delay has expired. In addition, true when CAN bus is enabled and the Low Coolant Level Alarm or Pre-Alarm threshold has been exceeded.	Status Input LOWCOOLANTINPUT 
Low Line Override	True when the Low Line Override logic element is true.	Status Input LOWLINEINPUT 
LS Output Out of Range	True when the LS Output Limit settings have been exceeded.	Status Input LSOUTPUTRANGE 
Mains Breaker Status	True when the mains breaker is closed.	Status Input MAINSBREAKERSTATUS 

Name	Description	Symbol
Mains Fail Test	True when the Mains Fail Test logic element is true.	Status Input MAINSFAILTESTACTIVE
Mains Fail Transfer Complete	True when the DGC-2020HD is configured for mains fail transfers and has successfully transferred to the generator from the utility. It remains true until the utility power is deemed good and the DGC-2020HD transfers the load back to utility power.	Status Input MAINSFAILTRANSCOMPLETE
Off Mode	True when the DGC-2020HD is in Off Mode or the Off Mode logic element is true.	Status Input OFFMODE
Off Mode Cooldown	True when the DGC-2020HD is in Off Mode and cooling down.	Status Input OFFMODECOOLDOWN
Parallel to Mains	True when the Parallel to Mains logic element is true, indicating that the generator is operating in parallel with the utility.	Status Input PARALLELEDTOMAINS
PF Mode Active	True when PF mode is active.	Status Input PFMODEACTIVE
Pre Start Input	True when the DGC-2020HD is indicating that the Pre Start relay should be closed.	Status Input PRESTART
Reset Active	True when the Reset logic element is true or when the Reset key on the front panel is pressed.	Status Input RESETACTIVE
Restart Delay Active	True when the Restart Delay timer is timing out.	Status Input RESTARTDELAYACTIVE
Run Input	True when the DGC-2020HD is indicating that the Run relay should be closed.	Status Input RUN
Run Mode	True when the DGC-2020HD is in Run Mode or the Run Mode logic element is true.	Status Input RUNMODE
Single Phase AC Sensing Override	True when the Single Phase AC Override input is true.	Status Input 1PHASEOVERRIDEACSENSE
Single Phase Connection Override	True when the Single-Phase Connection Override input is true.	Status Input 1PHASEOVERRIDEINPUT
Start Input	True when the DGC-2020HD is indicating that the Start relay should be closed to start the engine.	Status Input START
Switch not in Auto	True when the DGC-2020HD is not in Auto Mode.	Status Input SWITCHNOTINAUTO
Sync Active	True when the auto synchronizer is active to align the generator input and bus input voltages and phases.	Status Input SYNCACTIVE
Sync Breaker Close OK	True when the auto synchronizer is running and determines that the voltage difference between bus and generator voltages, slip frequency, and phase angle are within specified limits so that it is okay to issue a breaker close command.	Status Input SYNCBREAKERCLOSEOK

Name	Description	Symbol
Sync Phase Angle OK	True when the auto synchronizer is running and the phase angle between the bus voltage input and the generator voltage input are within the limits indicated by the phase angle setting for phase lock synchronization, or the calculated advance angle for anticipatory synchronization.	Status Input 
Sync Slip Frequency OK	True when the auto synchronizer is running and the phase angle between the bus voltage input and the generator voltage input are within the limits indicated by the slip frequency setting.	Status Input 
Sync Voltage OK	True when the auto synchronizer is running and the voltage difference between the bus voltage input and the generator voltage input are within the limits indicated by the voltage window setting.	Status Input 
var Mode Active	True when var mode is active.	Status Input 
Communications		
AEM Connected	True when an optional AEM-2020 is connected to the DGC-2020HD.	Status Input 
CEM Connected	True when an optional CEM-2020 is connected to the DGC-2020HD.	Status Input 
Configurable Protection		
Threshold x Trip	True when the Alarm Configuration is set to Status Only and the threshold has been exceeded.	Status Input - CONFIGPROT1THRESH1TRIP 
Front Panel Buttons		
Auto	True while the Auto front panel button is pressed.	Status Input 
Down	True while the Down front panel button is pressed.	Status Input 
Edit	True while the Edit front panel button is pressed.	Status Input 
Lamp	True while the Lamp front panel button is pressed.	Status Input 
Left	True while the Left front panel button is pressed.	Status Input 
Off	True while the Off front panel button is pressed.	Status Input 
Reset	True while the Reset front panel button is pressed.	Status Input 
Right	True while the Right front panel button is pressed.	Status Input 
Run	True while the Run front panel button is pressed.	Status Input 

Name	Description	Symbol
Silence	True while the Silence front panel button is pressed.	Status Input SILENCEBUTTON 
Up	True while the Up front panel button is pressed.	Status Input UPBUTTON 
Generator Protection		
Frequency	True when the 81-x element is tripped.	Status Input 81PROT1TRIP 
Loss of Excitation	True when the 40Q-x element is tripped.	Status Input 40QPROT1TRIP 
Overcurrent	True when the 51-x element is tripped.	Status Input 51PROT1TRIP 
Overvoltage	True when the 59-x element is tripped.	Status Input 59PROT1TRIP 
Phase Imbalance	True when the 47-x element is tripped.	Status Input 47PROT1TRIP 
Power	True when the 32-x element is tripped.	Status Input 32PROT1TRIP 
Undervoltage	True when the 27-x element is tripped.	Status Input 27PROT1TRIP 
Vector Shift	True when the 78-x element is tripped.	Status Input 78PROT1TRIP 
Generator States		
In Alarm State	True when the DGC-2020HD is in the alarm state.	Status Input INALMSTATE 
In Connecting State	True when the DGC-2020HD is in the connecting state.	Status Input INCONNECTINGSTATE 
In Cooling State	True when the DGC-2020HD is in the cooling state.	Status Input INCOOLINGSTATE 
In Cranking State	True when the DGC-2020HD is in the cranking state.	Status Input INCRANKINGSTATE 
In Disconnect State	True when the DGC-2020HD is in the disconnect state.	Status Input INDISCONNECTSTATE 
In Prestart State	True when the DGC-2020HD is in the pre-start state.	Status Input INPRESTARTSTATE 
In Pulsing State	True when the DGC-2020HD is in the pulsing state.	Status Input INPULSINGSTATE 
In Ready State	True when the DGC-2020HD is in the ready state.	Status Input INREADYSTATE 
In Resting State	True when the DGC-2020HD is in the resting state.	Status Input INRESTINGSTATE 

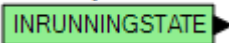
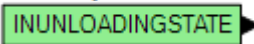
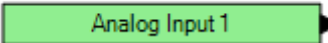
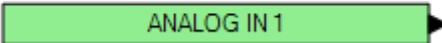
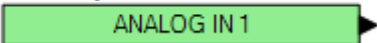
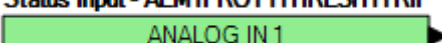
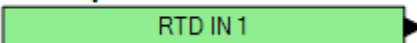
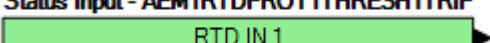
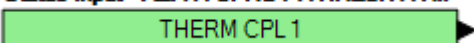
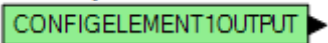
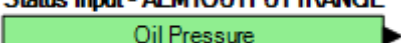
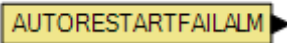
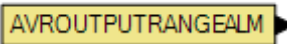
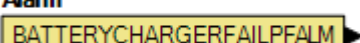
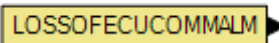
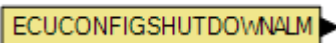
Name	Description	Symbol
In Running State	True when the DGC-2020HD is in the running state.	Status Input 
In Unloading State	True when the DGC-2020HD is in the unloading state.	Status Input 
Programmable Inputs		
Analog Inputs Out of Range	True when the analog input connection is open.	Status Input - AI1INPUTRANGE 
Analog Inputs Threshold	True when the threshold has been exceeded.	Status Input - AEM1PROT1THRESH1TRIP 
Remote Analog Inputs Out of Range	True when the remote analog input connection is open.	Status Input - AEM1INPUT1RANGE 
Remote Analog Inputs Threshold	True when the threshold has been exceeded.	Status Input - AEM1PROT1THRESH1TRIP 
Remote RTD Inputs Out of Range	True when the remote RTD input connection is open.	Status Input - AEM1RTDINPUT1RANGE 
Remote RTD Inputs Threshold	True when the threshold has been exceeded.	Status Input - AEM1RTDPROT1THRESH1TRIP 
Remote Thermocouple Inputs Threshold	True when the threshold has been exceeded.	Status Input - AEM1TCPROT1THRESH1TRIP 
Programmable Outputs		
Configurable Elements Element x	True when the Configurable Element x logic element is true.	Status Input 
Remote Analog Outputs Out of Range	True when the remote analog output connection is open.	Status Input - AEM1OUTPUT1RANGE 

Table 59. I/O Group, Alarms

Name	Description	Symbol
Auto Restart Fail	True after the Automatic Restart function fails to restart the generator.	Alarm 
AVR Output Out of Range	True when AVR Output is the selected parameter, Out of Range Alarm Type is set to Alarm, and the threshold has been exceeded.	Alarm 
Battery Charger Fail	True when the Battery Charger Fail function is configured as an alarm and the activation delay has expired.	Alarm 
ECU Comm Loss	True when communication to the ECU has been lost.	Alarm 
ECU Shutdown	True when the ECU has Shutdown the engine.	Alarm 

Name	Description	Symbol
Emergency Stop	True when the Emergency Stop button has been pressed.	Alarm EMERGENCYSTOPALM 
Fuel Leak Detect	True when the Fuel Leak Detect function is configured as an alarm and the activation delay has expired.	Alarm FUELLEAKDETECTPFALM 
Global Alarm	True when one or more alarms are set.	Alarm GLBALM 
Global Sender Fail	True when one or more of the Sender Fails are configured as alarms and are true.	Alarm GLOBALENDERFAILALM 
GOV Output Out of Range	True when GOV Output is the selected parameter, Out of Range Alarm Type is set to Alarm, and the threshold has been exceeded.	Alarm GOVOUTPUTRANGEALM 
High Coolant Temp	True when the High Coolant Temp Alarm settings have been exceeded.	Alarm HIGHCOOLANTTEMPALM 
Low Coolant Level	True when the Low Coolant Level function is configured as an alarm and the activation delay has expired. In addition, true when CAN bus is enabled and the Low Coolant Level Alarm threshold has been exceeded.	Alarm LOWCOOLANTLEVELALM 
Low Fuel Level	True when the Low Fuel Level Alarm settings have been exceeded.	Alarm LOWFUELALM 
Low Oil Pressure	True when the Low Oil Pressure Alarm settings have been exceeded.	Alarm LOWOILPRESSUREALM 
LS Output Out of Range	True when LS Output is the selected parameter, Out of Range Alarm Type is set to Alarm, and the threshold has been exceeded.	Alarm LSOUTPUTRANGEALM 
Mains Fail Transfer Failed	True when a mains fail transfer fail pre-alarm occurs. The pre-alarm occurs when the DGC-2020HD is configured for mains fail transfers, but has not transferred to the generator from the utility before the Mains Fail Max Transfer Time has expired. It remains true until the pre-alarm is cleared by pressing the Reset button on the front panel.	Alarm MAINSFAILTRANSFAIL 
Overcrank	True when an Overcrank condition exists.	Alarm OVERCRANKALM 
Overspeed	True when the Overspeed Alarm settings have been exceeded.	Alarm OVERSPEEDALM 
Unexpected Shutdown	True when the metered engine speed (RPM) unexpectedly drops to zero (0) while the engine is running.	Alarm UNEXPECTEDSHUTDOWNALM 
Configurable Protection		
Threshold x	True when the Alarm Configuration is set to Alarm and the threshold has been exceeded.	Alarm - CONFIGPROT1THRESH1ALM CONF PROT 1 
Generator Protection		
Frequency	True when the 81-x element is configured as an alarm and has tripped.	Alarm 81PROT1ALM 

Name	Description	Symbol
Loss of Excitation	True when the 32-x element is configured as an alarm and has tripped.	Alarm 32PROT1ALM
Overcurrent	True when the 51-x element is configured as an alarm and has tripped.	Alarm 51PROT1ALM
Overvoltage	True when the 59-x element is configured as an alarm and has tripped.	Alarm 59PROT1ALM
Phase Imbalance	True when the 47-x element is configured as an alarm and has tripped.	Alarm 47PROT1ALM
Power	True when the 40Q-x element is configured as an alarm and has tripped.	Alarm 40QPROT1ALM
Undervoltage	True when the 27-x element is configured as an alarm and has tripped.	Alarm 27PROT1ALM
Vector Shift	True when the 78-x element is configured as an alarm and has tripped.	Alarm 78PROT1ALM
Programmable Inputs		
Analog Inputs Out of Range	True when the analog input connection is open and the Out of Range Alarm Type is set to Alarm.	Alarm - AI1INPUTRANGEALM Analog Input 1
Analog Inputs Threshold	True when the Alarm Configuration is set to Alarm and the threshold has been exceeded.	Alarm - AI1PROTTHRESH1ALM Analog Input 1
Contact Inputs Input x	True when Contact Input x is active, the Alarm Configuration is set to Alarm, and the activation delay has expired.	Alarm - CONTACTINPUT1ALM INPUT 1
Remote Analog Inputs Out of Range	True when the remote analog input connection is open and the Out of Range Alarm Type is set to Alarm.	Alarm - AEM1INPUT1RANGEALM ANALOG IN 1
Remote Analog Inputs Threshold	True when the Alarm Configuration is set to Alarm and the threshold has been exceeded.	Alarm - AEM1PROT1THRESH1ALM ANALOG IN 1
Remote Contact Inputs Input x	True when Remote Contact Input x is active, the Alarm Configuration is set to Alarm, and the activation delay has expired.	Alarm - CEM1CONTACTINPUT1ALM INPUT 1
Remote RTD Inputs Out of Range	True when the remote RTD input connection is open and the Out of Range Alarm Type is set to Alarm.	Alarm - AEM1RTDINPUT1RANGEALM RTD IN 1
Remote RTD Inputs Threshold	True when the Alarm Configuration is set to Alarm and the threshold has been exceeded.	Alarm - AEM1RTDPROT1THRESH1ALM RTD IN 1
Remote Thermocouple Inputs Threshold	True when the Alarm Configuration is set to Alarm and the threshold has been exceeded.	Alarm - AEM1TCPROT1THRESH1ALM THERM CPL 1
Programmable Outputs		
Configurable Elements Element x	True when the Configurable Element x logic element is true, Alarm Configuration is set to Alarm, and the Activation Delay has expired.	Alarm CONFIGELEMENT1ALM
Remote Analog Outputs Out of Range	True when the remote analog output connection is open and the Out of Range Alarm Type is set to Alarm.	Alarm - AEM1OUTPUT1RANGEALM No Parameter Selected

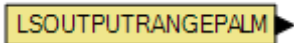
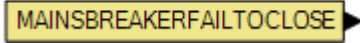
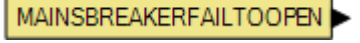
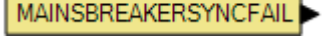
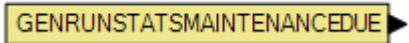
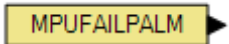
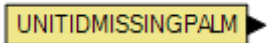
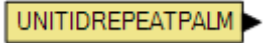
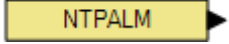
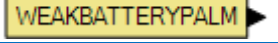
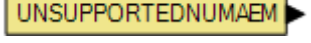
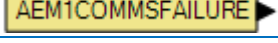
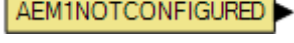
Name	Description	Symbol
Senders		
Coolant Level Sender Fail	True when a low coolant level error status code is received from the ECU. CAN bus must be enabled.	Alarm COOLANTLEVELSFALM 
Coolant Temp Sender Fail	True when the Coolant Temp Sender Fail is configured as an alarm and the activation delay has expired.	Alarm COOLANTTEMPSFALM 
Fuel Level Sender Fail	True when the Fuel Level Sender Fail is configured as an alarm and the activation delay has expired.	Alarm FUELLEVELSFALM 
Oil Pressure Sender Fail	True when the Oil Pressure Sender Fail is configured as an alarm and the activation delay has expired.	Alarm OILPRESSURESFALM 
Speed Sender Fail	True when the Speed Sender Fail activation delay has expired.	Alarm SPEEDSFALM 
Voltage Sensing Fail	True when the Voltage Sensing Fail is configured as an alarm and the activation delay has expired.	Alarm VOLTAGESENSINGSFALM 
User Programmable Alarms		
Programmable Alarm x	True when the User Programmable Alarm x logic element is true and the Activation Delay has expired.	Alarm - PROGRAMMABLEALM1 Programmable Alarm 1 Name 

Table 60. I/O Group, Pre-Alarms

Name	Description	Symbol
AVR Output Out of Range	True when AVR Output is the selected parameter, Out of Range Alarm Type is set to Pre-Alarm, and the threshold has been exceeded.	Pre-Alarm AVROUTPUTRANGEPALM 
Battery Charger Fail	True when the Fuel Leak Detect function is configured as an alarm and the activation delay has expired.	Pre-Alarm BATTERYCHARGERFAILPPFALM 
Bus x Reverse Rotation Status	True when the Bus x rotation is opposite of the Phase Rotation setting.	Pre-Alarm BUS1REVERSEROTATIONPALM 
DEF Engine Derate	This pre-alarm indicates the lowest level of inducement not to operate the engine when Diesel Exhaust Fluid (DEF) is low or of poor quality or there is a problem with the Exhaust After Treatment System (EATS). The engine is operating in a reduced power mode. Eventually the level of inducement will be increased unless the problem with the DEF or malfunction in the EATS is corrected.	Pre-Alarm DEFENGINEDERATEPALM 
DEF Fluid Empty	True when the engine ECU reports via CAN bus that Diesel Exhaust Fluid (DEF) is at a level below 8%.	Pre-Alarm DEFEMPTYPALM 
DEF Fluid Low	True when the engine ECU reports via CAN bus that the Diesel Exhaust Fluid (DEF) is at a level between 8 and 23%.	Pre-Alarm DEFLOWPALM 
DEF Inducement Override	This pre-alarm indicates a temporary override of inducement not to operate the engine. This is set by the ECU and is not a user setting.	Pre-Alarm DEFINDUCEMENTOVERRIDEPALM 

Name	Description	Symbol
DEF Pre-Severe Inducement	This pre-alarm indicates a high level of inducement not to operate the engine due to low or poor quality Diesel Exhaust Fluid (DEF), or a malfunction in the Exhaust After Treatment System (EATS). The engine may operate in a reduced power mode, or for a limited time, after which it will enter a state of severe inducement unless the problem with the DEF or malfunction in the EATS is corrected.	Pre-Alarm DEFPRESEVINDUCEMENTPALM 
DEF Severe Inducement	This pre-alarm indicates the highest level of inducement not to operate the engine due to low or poor quality Diesel Exhaust Fluid (DEF), or a malfunction in the Exhaust After Treatment System (EATS). The engine may operate in a reduced power mode, or for a limited time, or may be prevented from starting by the ECU until the problem is corrected. A service tool may be required to restart the engine.	Pre-Alarm DEFSEVINDUCEMENTPALM 
Diag Trouble Code	True when a Diagnostic Trouble Code exists.	Pre-Alarm DIAGNOSTICTROUBLECODEPALM 
DPF Regenerate Disabled	True when the Diesel Particulate Filter (DPF) lamp status broadcast over CAN bus indicates that DPF regeneration is inhibited.	Pre-Alarm DPFREGENERATEDISABLEDPALM 
DPF Regenerate Required	True when the Diesel Particulate Filter (DPF) lamp status broadcast over CAN bus indicates that DPF regeneration is required.	Pre-Alarm DPFREGENERATEREQUIREDPALM 
DPF Soot Level High	True when the engine ECU reports via CAN bus that Diesel Particulate Filter (DPF) soot level is high.	Pre-Alarm DPFSOOTLEVELHIGHPALM 
DPF Soot Level Moderately High	True when Diesel Particulate Filter (DPF) lamp status (yellow warning) broadcast over CAN bus indicates that the soot level is moderately high.	Pre-Alarm DPFSOOTLEVELMODHIGHPALM 
DPF Soot Level Severely High	True when Diesel Particulate Filter (DPF) lamp status (red warning) broadcast over CAN bus indicates that the soot level is severely high.	Pre-Alarm DPFSOOTLEVELSEVHIGHPALM 
ECU Comm Loss	True when communication to the ECU has been lost.	Pre-Alarm LOSSOFECUCOMMPALM 
Ethernet Link 1 Lost	True when Ethernet Link 1 connection is lost.	Pre-Alarm ETH1LLALM 
Ethernet Link 2 Lost	True when Ethernet Link 2 connection is lost.	Pre-Alarm ETH2LLALM 
Fuel Leak Detect	True when the Fuel Leak Detect function is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm FUELLEAKDETECTPFPALM 
Generator Breaker Close Failure	True when a generator breaker close fail pre-alarm occurs. The pre-alarm occurs when the DGC-2020HD has issued a generator breaker close output but does not receive a generator breaker status input that indicates the breaker has closed before the breaker close wait time has expired.	Pre-Alarm GENBREAKERFAILTOCLOSE 

Name	Description	Symbol
Generator Breaker Open Failure	True when a generator breaker open fail pre-alarm occurs. The pre-alarm occurs when the DGC-2020HD has issued a generator breaker open output but does not receive a generator breaker status input that indicates the breaker has opened before the breaker close wait time has expired.	Pre-Alarm GENBREAKERFAILTOOPEN 
Generator Breaker Sync Failure	True when a generator breaker sync fail pre-alarm occurs. The pre-alarm occurs when the synchronizer is running and attempting to close the generator breaker but the sync fail activation delay expires prior to achieving breaker closure.	Pre-Alarm GENBREAKERSYNCFAIL 
Generator Reverse Rotation Status	True when the Generator rotation is opposite of the Phase Rotation setting.	Pre-Alarm GENREVERSEROTATIONPALM 
GOV Output Out of Range	True when GOV Output is the selected parameter, Out of Range Alarm Type is set to Pre-Alarm, and the threshold has been exceeded.	Pre-Alarm GOVOUTPUTRANGEPALM 
Global Pre-Alarm	True when one or more pre-alarms are set.	Pre-Alarm GLBPALM 
High Battery Voltage	True when the Battery Overvoltage Pre-Alarm threshold has been exceeded.	Pre-Alarm BATTERYOVERVOLTAGEPALM 
High Coolant Temp	True when the High Coolant Temp Pre-Alarm threshold has been exceeded.	Pre-Alarm HIGHCOOLANTTEMPPALM 
High Exhaust Temperature	True when Diesel Particulate Filter (DPF) lamp status broadcast over CAN bus indicates high exhaust temperature.	Pre-Alarm HIGHEXHAUSTTEMPPALM 
High Fuel Level	True when the High Fuel Level Pre-Alarm settings have been exceeded.	Pre-Alarm HIGHFUELPALM 
Inter Generator Comm Fail	True when the DGC-2020HD detects that an individual generator previously connected to a generator network has lost connection.	Pre-Alarm INTERGENSETCOMMSFAILPALM 
IRIG Sync Lost	True when the IRIG signal is lost. The pre-alarm monitors for IRIG signal loss once a valid signal is detected at the IRIG port.	Pre-Alarm IRIGALM 
Low Battery Voltage	True when the Low Battery Voltage Pre-Alarm settings have been exceeded.	Pre-Alarm LOWBATTERYVOLTAGEPALM 
Low Coolant Level	True when the Low Coolant Level function is configured as a pre-alarm and the activation delay has expired. In addition, true when CAN bus is enabled and the Low Coolant Level Alarm threshold has been exceeded.	Pre-Alarm LOWCOOLANTPALM 
Low Coolant Temp	True when the Low Coolant Temp Pre-Alarm threshold has been exceeded.	Pre-Alarm LOWCOOLANTTEMPPALM 
Low Fuel Level	True when the Low Fuel Level Pre-Alarm threshold has been exceeded.	Pre-Alarm LOWFUELPALM 
Low Oil Pressure	True when the Low Oil Pressure Pre-Alarm threshold has been exceeded.	Pre-Alarm LOWOILPRESSUREPALM 

Name	Description	Symbol
LS Output Out of Range	True when LS Output is the selected parameter, Out of Range Alarm Type is set to Pre-Alarm, and the threshold has been exceeded.	Pre-Alarm 
Mains Breaker Close Failure	True when a mains breaker close fail pre-alarm occurs. The pre-alarm occurs when the DGC-2020HD has issued a mains breaker close output but does not receive a mains breaker status input that indicates the breaker has closed before the breaker close wait time has expired.	Pre-Alarm 
Mains Breaker Open Failure	True when a mains breaker open fail pre-alarm occurs. The pre-alarm occurs when the DGC-2020HD has issued a mains breaker open output but does not receive a mains breaker status input that indicates the breaker has opened before the breaker close wait time has expired.	Pre-Alarm 
Mains Breaker Sync Failure	True when a mains breaker sync fail pre-alarm has occurred. The pre-alarm occurs when the synchronizer is running and attempting to close the mains breaker but the sync fail activation delay expires prior to achieving breaker closure.	Pre-Alarm 
Maintenance Interval	True when the Maintenance Interval Pre-Alarm threshold has been exceeded.	Pre-Alarm 
MPU Fail	True when the MPU has failed.	Pre-Alarm 
Network ID Missing Error	True if an expected sequence ID is not detected on the network. Expected sequence IDs are entered on the Network Configuration screen.	Pre-Alarm 
Network ID Repeat Error	True if two or more DGC-2020HDs report the same expected sequence ID. Expected sequence IDs are entered on the Network Configuration screen.	Pre-Alarm 
NTP Sync Lost	True when the NTP (Network Time Protocol) signal is lost. The alarm monitors for NTP signal loss once the real-time clock is synchronized to the network.	Pre-Alarm 
Weak Battery Voltage	True when the Weak Battery Voltage Pre-Alarm settings have been exceeded.	Pre-Alarm 
Communications		
AEM Unsupported Number	True when more AEM-2020s are connected than are configured on the System Parameters, Remote Module Setup screen in BESTCOMS <i>Plus</i> .	Pre-Alarm 
AEM x Comm Fail	True when communication from the AEM-2020 to the DGC-2020HD has been lost.	Pre-Alarm 
AEM x Not Configured	True when the expected serial number on the System Parameters, Remote Module Setup screen in BESTCOMS <i>Plus</i> does not match the serial number detected on the General Settings, Device Info screen.	Pre-Alarm 

Name	Description	Symbol
CEM Unsupported Number	True when more CEM-2020s are connected than are configured on the System Parameters, Remote Module Setup screen in <i>BESTCOMSPlus</i> .	Pre-Alarm UNSUPPORTEDNUMCEM
CEM x Comm Fail	True when communication from the CEM-2020 to the DGC-2020HD has been lost.	Pre-Alarm CEM1COMMSFAILURE
CEM x Hardware Mismatch	True when the connected CEM-2020 does not have the same number of outputs as defined on the System Parameters, Remote Module Setup screen in <i>BESTCOMSPlus</i> .	Pre-Alarm CEM1HWMISMATCH
CEM x Not Configured	True when the expected serial number on the System Parameters, Remote Module Setup screen in <i>BESTCOMSPlus</i> does not match the serial number detected on the General Settings, Device Info screen.	Pre-Alarm CEM1NOTCONFIGURED
Configurable Protection		
Configurable Protection Threshold x	True when the Alarm Configuration is set to Pre-Alarm and the threshold has been exceeded.	Pre-Alarm - CONFIGPROT1THRESH1PALM CONF PROT 1
Generator Protection		
Frequency	True when the 81-x element is configured as a pre-alarm and has tripped.	Pre-Alarm 81PROT1PALM
Loss of Excitation	True when the 40Q-x element is configured as a pre-alarm and has tripped.	Pre-Alarm 40QPROT1PALM
Overcurrent	True when the 51-x element is configured as a pre-alarm and has tripped.	Pre-Alarm 51PROT1PALM
Overvoltage	True when the 59-x element is configured as a pre-alarm and has tripped.	Pre-Alarm 59PROT1PALM
Phase Imbalance	True when the 47-x element is configured as a pre-alarm and has tripped.	Pre-Alarm 47PROT1PALM
Power	True when the 32-x element is configured as a pre-alarm and has tripped.	Pre-Alarm 32PROT1PALM
Undervoltage	True when the 27-x element is configured as a pre-alarm and has tripped.	Pre-Alarm 27PROT1PALM
Vector Shift	True when the 78-x element is configured as a pre-alarm and has tripped.	Pre-Alarm 78PROT1PALM
Programmable Inputs		
Analog Inputs Out of Range	True when the analog input connection is open and the Out of Range Alarm Type is set to Pre-Alarm.	Pre-Alarm - AI1INPUTRANGEPALM Analog Input 1
Analog Inputs Threshold	True when the Alarm Configuration is set to Pre-Alarm and the threshold has been exceeded.	Pre-Alarm - AI1PROTTHRESH1PALM Analog Input 1
Contacts Inputs Input x	True when Contact Input x is active, the Alarm Configuration is set to Pre-Alarm, and the activation delay has expired.	Pre-Alarm - CONTACTINPUT1PALM INPUT 1
Remote Analog Inputs Out of Range	True when the remote analog input connection is open and the Out of Range Alarm Type is set to Pre-Alarm.	Pre-Alarm - AEM1INPUT1RANGEPALM ANALOG IN 1

Name	Description	Symbol
Remote Analog Inputs Threshold	True when the Alarm Configuration is set to Pre-Alarm and the threshold has been exceeded.	Pre-Alarm - AEM1PROT1THRESH1PALM ANALOG IN 1
Remote Contact Inputs Input x	True when Remote Contact Input x is active, the Alarm Configuration is set to Pre-Alarm, and the activation delay has expired.	Pre-Alarm - CEM1CONTACTINPUT1PALM INPUT 1
Remote RTD Inputs Out of Range	True when the remote RTD input connection is open and the Out of Range Alarm Type is set to Pre-Alarm.	Pre-Alarm - AEM1RTDINPUT1RANGEPALM RTD IN 1
Remote RTD Inputs Threshold	True when the Alarm Configuration is set to Pre-Alarm and the threshold has been exceeded.	Pre-Alarm - AEM1RTDPROT1THRESH1PALM RTD IN 1
Remote Thermocouple Inputs Threshold	True when the Alarm Configuration is set to Pre-Alarm and the threshold has been exceeded.	Pre-Alarm - AEM1TCPROT1THRESH1PALM THERM CPL 1
Programmable Outputs		
Configurable Elements Element x	True when the Configurable Element x logic element is true, Alarm Configuration is set to Pre-Alarm, and the Activation Delay has expired.	Pre-Alarm CONFIGELEMENT1PALM
Remote Analog Outputs Out of Range	True when the remote analog output connection is open and the Out of Range Alarm Type is set to Pre-Alarm.	Pre-Alarm - AEM1OUTPUT1RANGEPALM No Parameter Selected
Senders		
Coolant Temp Sender Fail	True when the Coolant Temp Sender Fail is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm COOLANTTEMPSFPALM
Fuel Level Sender Fail	True when the Fuel Level Sender Fail is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm FUELLEVELSFPALM
Oil Pressure Sender Fail	True when the Oil Pressure Sender Fail is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm OILPRESSURESFPALM
Voltage Sensing Fail	True when the Voltage Sensing Fail is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm VOLTAGESENSINGSFPALM

Table 61. I/O Group, Senders

Name	Description	Symbol
Coolant Temp Sender Fail	True when the Coolant Temp Sender Fail is configured as either a pre-alarm or alarm and the activation delay has expired.	Sender Fail COOLANTTEMPSF
Fuel Level Sender Fail	True when the Fuel Level Sender Fail is configured as either a pre-alarm or alarm and the activation delay has expired.	Sender Fail FUELLEVELSF
Oil Pressure Sender Fail	True when the Oil Pressure Sender Fail is configured as either a pre-alarm or alarm and the activation delay has expired.	Sender Fail OILPRESSURESF
Speed Sender Fail	True when the Speed Sender Fail activation delay has expired.	Sender Fail SPEEDSF

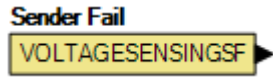
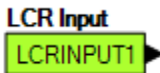
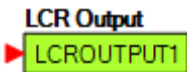
Name	Description	Symbol
Voltage Sensing Fail	True when the Voltage Sensing Fail is configured as either a pre-alarm or alarm and the activation delay has expired.	

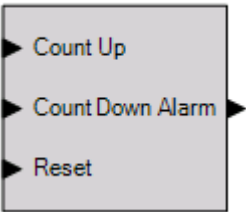
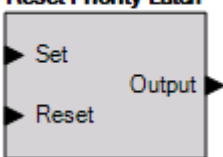
Table 62. I/O Group, Logic Control Relays

Name	Description	Symbol
The logic control relays (LCR) consist of LCR outputs and LCR inputs. The output can be used to terminate the "output" end of a logic network, and then use the corresponding input as an input to logic elsewhere in the logic scheme. When a given LCR output is true the corresponding LCR input is true. In other words, when LCR Output N (N being a number from 1 to 16) becomes true, then LCR Input N is true also. If you get a "too many logic levels" error while building a logic network, LCR outputs and inputs can be used as a solution to this problem. Place an LCR output on the end of the partial logic network and then use the corresponding LCR input to build more logic than was previously possible.		
Input 1-16	See description above.	
Output 1-16	See description above.	

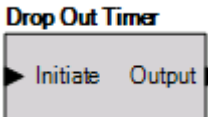
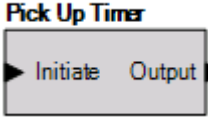
Components

This group contains Comment Blocks, Latches, Logic Counters, Logic Gates, Logic Gates, Pickup and Dropout Timers, Latches, Logic Counters, and Comment Blocks. Table 63 lists the names and descriptions of the objects in the Components group.

Table 63. Components Group, Names and Descriptions

Name	Description	Symbol
Comment Blocks		
Comment Block	The logic comment block is used to place notes on the logic.	
Counters		
Counters	A logic counter produces a true Alarm output when the elapsed count is greater than or equal to the Trigger Count setting after a false to true transition occurs on the Count Up input from the connected logic. A positive going edge on the Reset input will reset the counter. The count will be reduced by 1 each time a false to true transition occurs on the Count Down input. Double-click or right-click on the logic counter to select from counters 1 through 8.	
Latches		
Reset Priority Latch	The latch is set when the Set input is true and the Reset input is false. The latch is cleared when the Reset input is true.	

Name	Description	Symbol										
Set Priority Latch	The latch is set when the Set input is true. The latch is cleared when the Set input is false and the Reset input is true.	Set Priority Latch										
Logic Gates												
		ANSI*IEC*										
AND	<table><tr><th>Input</th><th>Output</th></tr><tr><td>00</td><td>0</td></tr><tr><td>01</td><td>0</td></tr><tr><td>10</td><td>0</td></tr><tr><td>11</td><td>1</td></tr></table>	Input	Output	00	0	01	0	10	0	11	1	
Input	Output											
00	0											
01	0											
10	0											
11	1											
NAND	<table><tr><th>Input</th><th>Output</th></tr><tr><td>00</td><td>1</td></tr><tr><td>01</td><td>1</td></tr><tr><td>10</td><td>1</td></tr><tr><td>11</td><td>0</td></tr></table>	Input	Output	00	1	01	1	10	1	11	0	
Input	Output											
00	1											
01	1											
10	1											
11	0											
OR	<table><tr><th>Input</th><th>Output</th></tr><tr><td>00</td><td>0</td></tr><tr><td>01</td><td>1</td></tr><tr><td>10</td><td>1</td></tr><tr><td>11</td><td>1</td></tr></table>	Input	Output	00	0	01	1	10	1	11	1	
Input	Output											
00	0											
01	1											
10	1											
11	1											
NOR	<table><tr><th>Input</th><th>Output</th></tr><tr><td>00</td><td>1</td></tr><tr><td>01</td><td>0</td></tr><tr><td>10</td><td>0</td></tr><tr><td>11</td><td>0</td></tr></table>	Input	Output	00	1	01	0	10	0	11	0	
Input	Output											
00	1											
01	0											
10	0											
11	0											
XOR	<table><tr><th>Input</th><th>Output</th></tr><tr><td>00</td><td>0</td></tr><tr><td>01</td><td>1</td></tr><tr><td>10</td><td>1</td></tr><tr><td>11</td><td>0</td></tr></table>	Input	Output	00	0	01	1	10	1	11	0	
Input	Output											
00	0											
01	1											
10	1											
11	0											
XNOR	<table><tr><th>Input</th><th>Output</th></tr><tr><td>00</td><td>1</td></tr><tr><td>01</td><td>0</td></tr><tr><td>10</td><td>0</td></tr><tr><td>11</td><td>1</td></tr></table>	Input	Output	00	1	01	0	10	0	11	1	
Input	Output											
00	1											
01	0											
10	0											
11	1											
NOT (INVERTER)	<table><tr><th>Input</th><th>Output</th></tr><tr><td>0</td><td>1</td></tr><tr><td>1</td><td>0</td></tr></table>	Input	Output	0	1	1	0					
Input	Output											
0	1											
1	0											

Name	Description	Symbol
Pickup and Dropout Timers		
Drop Out Timer	A drop out timer produces a true output when the elapsed time is greater than or equal to the Dropout Time setting after a true to false transition occurs on the Initiate input from the connected logic. Whenever the Initiate input transitions to true, the output transitions to false immediately. Refer to <i>Pickup and Dropout Timers</i> . Double-click or right-click on the logic timer to select from timers 1 through 16.	
Pickup Timer	A pickup timer produces a true output when the elapsed time is greater than or equal to the Pickup Time setting after a false to true transition occurs on the Initiate input from the connected logic. Whenever the Initiate input status transitions to false, the output transitions to FALSE immediately. Refer to <i>Pickup and Dropout Timers</i> . Double-click or right-click on the logic timer to select from timers 1 through 16.	
Triggers		
Falling Edge	The output of a falling edge trigger pulses true when the input goes from logic 1 to logic 0. Double-click or right-click on the logic trigger to change the type.	
Rising Edge	The output of a rising edge trigger pulses true when the input goes from logic 0 to logic 1. Double-click or right-click on the logic trigger to change the type.	

* To select the symbol type for logic gates, click the Options buttons on the BESTlogicPlus toolbar.

Programming Pickup and Dropout Timers

To program logic timer settings, use the Settings Explorer within BESTCOMSPPlus to open the BESTlogicPlus Programmable Logic/Logic Timers tree branch. Enter a Name label that you want to appear on the timer logic block. The Time Delay value range is 0 to 250 hours in 1 hour increments, 0 to 250 minutes in 1 minute increments, or 0 to 1,800 seconds in 0.1 second increments.

Next, open the Components tab inside the BESTlogicPlus window and drag a timer onto the program grid. Right click on the timer to select the timer you want to use that was previously set on the Logic Timers tree branch. The Logic Timer Properties Dialog Box will appear. Select the timer you want to use.

Pickup and dropout logic timer logic blocks are shown in Figure 147. Timing accuracy is ± 15 milliseconds.

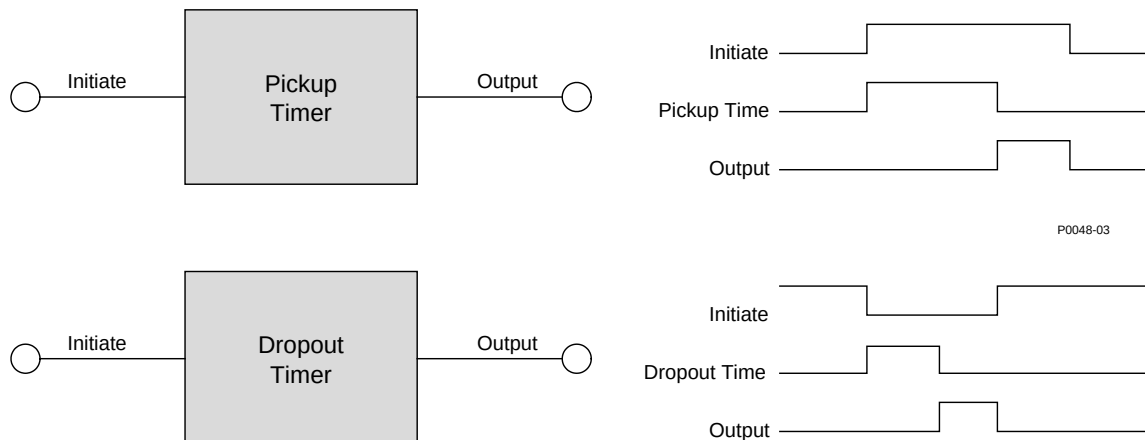


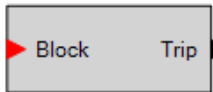
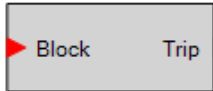
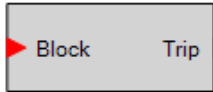
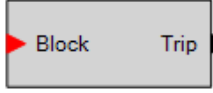
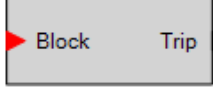
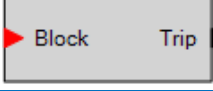
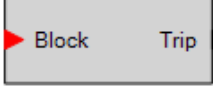
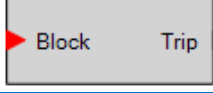
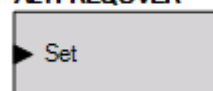
Figure 147. Pickup and Dropout Timer Logic Blocks

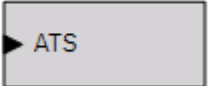
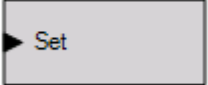
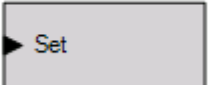
Elements

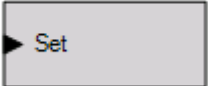
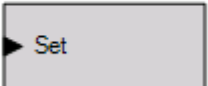
This group contains protection and control elements.

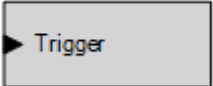
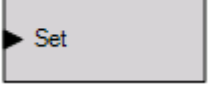
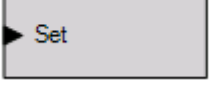
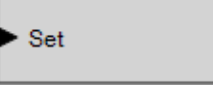
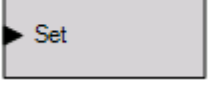
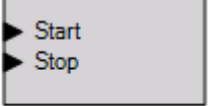
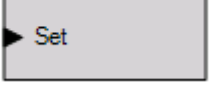
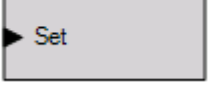
Table 64 lists the names and descriptions of the elements in the Elements group.

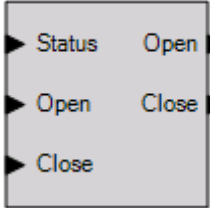
Table 64. Elements Group, Names and Descriptions

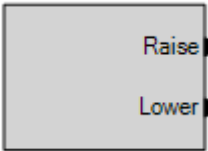
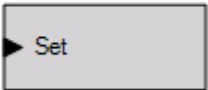
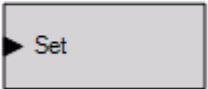
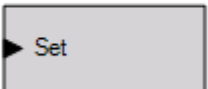
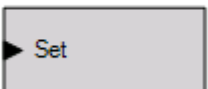
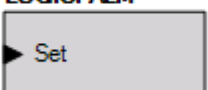
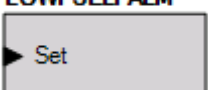
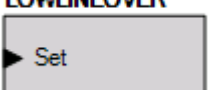
Name	Description	Symbol
27-x	When the Block input is true, the 27-x element is disabled. The Trip output is true when the 27-x undervoltage element is in a trip condition. Connect to another logic block input.	27-1 
32-x	When the Block input is true, the 32-x element is disabled. The Trip output is true when the 32-x power element is in a trip condition. Connect to another logic block input.	32-1 
40Q-x	When the Block input is true, the 40Q-x element is disabled. The Trip output is true when the 40Q-x loss of excitation element is in a trip condition. Connect to another logic block input.	40Q-1 
47-x	When the Block input is true, the 47-x element is disabled. The Trip output is true when the 47-x phase imbalance element is in a trip condition. Connect to another logic block input.	47-1 
51-x	When the Block input is true, the 51-x element is disabled. The Trip output is true when the 51-x overcurrent element is in a trip condition. Connect to another logic block input.	51-1 
59-x	When the Block input is true, the 59-x element is disabled. The Trip output is true when the 59-x overvoltage element is in a trip condition. Connect to another logic block input.	59-1 
78-x	When the Block input is true, the 78-x element is disabled. The Trip output is true when the 78-x vector shift element is in a trip condition. Connect to another logic block input.	78-1 
81-x	When the Block input is true, the 81-x element is disabled. The Trip output is true when the 81-x frequency element is in a trip condition. Connect to another logic block input.	81-1 
Alarm Silence	The alarm will be silenced when the Set input is true. The alarm can also be silenced by pressing the Alarm Silence button on the front panel of the DGC-2020HD.	ALARMSILENCE 
Alternate Frequency Override	When the Set input is true, protection and bus condition detection is forced to operate at the Alternate Frequency instead of the Rated Frequency.	ALTFREQOVER 

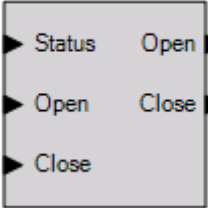
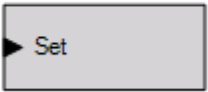
Name	Description	Symbol
ATS	When the ATS input is true, and the DGC-2020HD is in AUTO mode, the generator will run. This can be used in place of the ATS programmable function if it is desired to generate the ATS signal as a combination of programmable logic rather than a simple contact input. If either the ATS logic element is true <u>or</u> the contact mapped to the ATS programmable function is true, <u>and</u> the DGC-2020HD is in AUTO mode, the generator will run. If <u>both</u> the ATS logic element <u>and</u> the ATS programmable function are false, and the DGC-2020HD is in AUTO mode, the generator will cool down and stop.	ATS 
Automatic Breaker Operation Inhibit	Automatic breaker operation is inhibited when the Set input is true.	AUTOBRKOPINHIBIT 
Auto Mode	When the Set input is true, and the DGC-2020HD is in OFF mode, the DGC-2020HD will switch to AUTO mode. This is a pulsed input. It does not need to be held after the desired mode switch has occurred.	AUTOMODE 
AVR	Can be connected to inputs of other logic blocks. When the AVR is being raised, the Raise output is true. When being lowered, the Lower output is true.	AVR 
Closed Transition Override	All mains fail transfers are forced to be closed transitions, even if Mains Fail Transfer Type is set to Open, when the Set input is true.	CLOSEDTRANSITIONOVR 
Configurable Element x	Configurable elements 1 through 8 are connected to the logic scheme as outputs. These elements are configurable in BESTCOMSP ^{Plus} under Programmable Outputs, Configurable Elements. The user can assign a string of up to 16 characters, configure whether the element should generate an alarm or pre-alarm. If used for alarm or pre-alarm, the user's text is what will appear in the alarm or pre-alarm annunciation and in the DGC-2020HD event log.	CONFELMNT1 

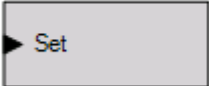
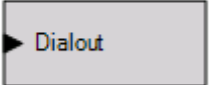
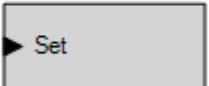
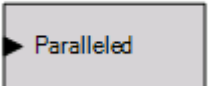
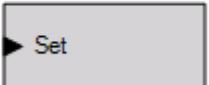
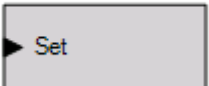
Name	Description	Symbol
Cool Down and Stop Request	<u>RUN Mode</u> If the unit is in RUN mode when the Cool Stop Request is received, the unit will unload, open its breaker, and go into a cooldown cycle. While in the cooldown cycle, the unit will display “COOL & STOP REQ” in addition to displaying the cooldown timer. After the cooldown timer expires, the unit will go to OFF mode. The Cool Stop Request must be removed before the unit can be run again. If the Cool Stop Request is removed during the cooldown process, the unit will remain running. Furthermore, if a condition occurs that normally causes the unit to close its breaker in RUN mode, the unit will close its breaker and reload. <u>AUTO Mode</u> If the unit is in AUTO mode when the Cool Stop Request is received, all conditions that would normally cause the unit to run in AUTO mode are cleared. Since all conditions that cause the unit to run have been removed, the unit goes into a cooldown cycle. While in the cooldown cycle, the unit will display “COOL & STOP REQ” in addition to displaying the cooldown timer. After the cooldown timer expires, the unit will shut down, remaining in AUTO. The Cool Stop Request must be removed before the unit can be run again. If the Cool Stop Request is removed during the cooldown process and some condition that would normally cause the unit to run in AUTO mode is true, the unit will remain running. Furthermore, if a condition occurs that normally causes the unit to close its breaker, the unit will close its breaker and reload.	COOLSTOPREQ 
Cool Down Request	<u>RUN Mode</u> If the unit is in RUN mode when the Cool Down Request is received, the unit is forced to unload and open its breaker and then go into a cooldown cycle. While in the cool down cycle, the unit will display “COOLDOWN REQ” in addition to displaying the cooldown timer. After the cooldown timer expires, the unit will remain running in RUN mode. The Cool Down Request must be removed before the breaker can be closed again; this element blocks breaker closures. If the Cool Down Request is removed during the cool down process, the unit will remain running in RUN mode. Furthermore, if a condition occurs that normally causes the unit to close its breaker in RUN mode, the unit will close its breaker and reload. <u>AUTO Mode</u> If the unit is in AUTO mode and the Cool Down Request is received, the unit is forced to unload and open its breaker and go into a cooldown cycle. While in the cooldown cycle, the unit will display “COOLDOWN REQ” in addition to displaying the cooldown timer. After the cool down timer expires, the unit will remain running in AUTO mode, unless there are no conditions that cause the unit to run in AUTO mode, in which case it will shut down and remain in AUTO mode. The Cool Down Request must be removed before the breaker can be closed again; this element blocks breaker closures. If the Cool Down Request is removed during the cool down process and some condition that would normally cause the unit to run in AUTO mode is true, the unit will remain running in AUTO mode. Furthermore, if a condition occurs that normally causes the unit to close its breaker, the unit will close its breaker and reload.	COOLDOWNREQ 

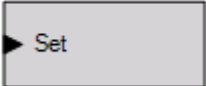
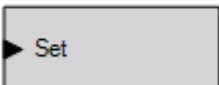
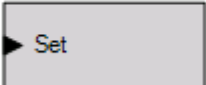
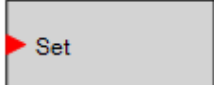
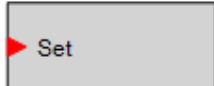
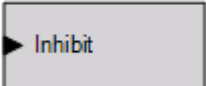
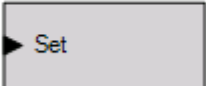
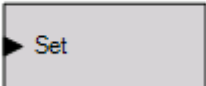
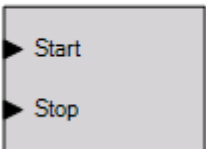
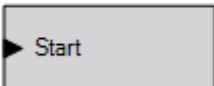
Name	Description	Symbol
Data Log Trigger	A data log is triggered when the Trigger input is pulsed true.	DATALOGTRIGGER 
DPF Manual Regeneration	Diesel Particulate Filter Regeneration is forced manually when the Set input is true.	DPFMANREGEN 
DPF Regeneration Inhibit	Diesel Particulate Filter Regeneration is inhibited when the Set input is true.	DPFREGENINHIBIT 
Droop Override	When the droop override logic element is true, the speed and voltage trim functions are disabled. The machine operates in speed droop and voltage droop to accomplish kW and kvar sharing. This is useful when it is desired to operate a system in droop rather than isochronous load sharing.	DROOPOVERRIDE 
Emergency Stop	When the Set input is true, an Emergency Shutdown alarm is annunciated and the Emergency Stop LED on the RDP-110 is illuminated.	ESTOP 
Engine Run	The Start input starts the generator. No load is applied. The breaker remains open. The Stop input stops the generator. The DGC-2020HD only responds to this logic element when in AUTO mode.	ENGINEERUN 
EPS Supplying Load	When true, the Set input forces a supplying load indication. This is useful when it is necessary for the supplying load indication to be true during test runs, but the system load is not enough to light the supplying load indication. A supplying load indication is true when the supplying load logic element is true and the generator is stable (voltage and frequency are within programmed limits). This is OR'ed with the traditional supplying load criteria that supplying load is true when the generator current is above a percentage of CT primary current (typically 3% minimum). When the supplying load indication has been driven from logic or from generator current levels, the DGC-2020HD will go through a cool down cycle when it is in AUTO mode and the ATS contact has been removed.	EPSSUPPLYINGLD 
External Start Delay	If the Set input is true while the DGC-2020HD is in the Pre Start state, the DGC-2020HD will remain in the Pre Start state until the Set input is false.	EXTSTARTDEL 

Name	Description	Symbol
Generator Breaker	This element is used to connect the breaker open and close output signals from the DGC-2020HD to physical output contacts to open and close the generator breaker, and map breaker status feedback to a contact input. In addition, contact inputs can be mapped to allow switches to be implemented to manually initiate breaker open and close requests. <u>Inputs</u> <i>Status</i>: This input allows a contact input to be mapped that will provide breaker status feedback to the DGC-2020HD. When the contact input is closed, the breaker is indicated to be closed. When the contact input is open, the breaker is indicated to be open. <i>Open</i>: This input allows a contact input to be mapped that can be used to initiate a manual breaker open request. When this input is pulsed closed while the DGC-2020HD is in RUN or AUTO mode, the breaker will open. <i>Close</i>: This input allows a contact input to be mapped that can be used to initiate a manual breaker close request. When this input is pulsed and the DGC-2020HD is in AUTO or RUN mode, and the generator is stable, a close request will be initiated. If the Dead Bus Close Enable parameter is true, and the bus is dead, the breaker will close. If the bus is stable, the DGC-2020HD will synchronize the generator to the bus, and then close the breaker. <u>Outputs</u> The outputs must be mapped to the contact outputs of the DGC-2020HD that will be used to drive the breaker. <i>Open</i>: This output is pulsed true (closes the output contact it is mapped to) when the DGC-2020HD is providing a signal to the breaker to open. It will be a pulse if the Breaker Output Contact Type is set to Pulse on the Breaker Hardware screen under Breaker Management in the Settings Explorer, and the length is determined by the Open Pulse Time. It will be a constant output if the Generator Breaker Hardware Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually open before the pulse is removed. <i>Close</i>: This output is pulsed true (closes the output contact it is mapped to) when the DGC-2020HD is providing a signal to the breaker to close. It will be a pulse if the Breaker Output Contact Type is set to Pulse on the Breaker Hardware screen under Breaker Management in the Settings Explorer, and the length is determined by the Open Pulse Time. It will be a constant output if the Generator Breaker Hardware Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually open before the pulse is removed. Note When using the DGC-2020HD synchronizer, it is recommended that local DGC-2020HD relay outputs be used for breaker closing commands to minimize the possibility of closures outside of desired breaker closing angles. If remote (CEM-2020) outputs are to be used for breaker close commands, it is recommended that the anticipatory synchronizer type be used, and the breaker close wait time be adjusted to account for possible CEM-2020 output delays (typically 50 ms) to achieve desired breaker closing angles.	GENBRK 

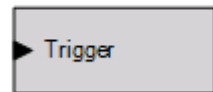
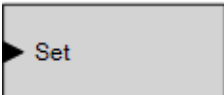
Name	Description	Symbol
GOV	Can be connected to inputs of other logic blocks. When the governor is being raised, the Raise output is true. When being lowered, the Lower output is true.	GOVR 
Idle Request	When the Set input is true, the DGC-2020HD sends an idle request to the ECU on J1939 engines that are equipped to receive such a request. The request consists of an enable bit command and an idle RPM setting. At this time, only Volvo and Cummins are implemented. ECUs that accept the idle RPM setting set the engine to the requested RPM. ECUs that accept only the enable bit command, set the engine to their internal idle speed setting, ignoring the requested idle RPM from the DGC-2020HD.	IDLEREQUEST 
Lamp Test	The lamp test will be performed when the Set input is true. The lamp test can also be accomplished by simultaneously pressing the Up and Down buttons on the front panel of the DGC-2020HD.	LAMPTEST 
Load Take Over	When the Set input is true, the generator is forced to start, assume load, and disconnect from the mains, in an open transition.	LOADTAKEOVER 
Logic Alarm	When the Set input is true, the DGC-2020HD goes into an alarm condition.	LOGICALM 
Logic Pre-Alarm	When the Set input is true, the DGC-2020HD goes into a Pre-alarm condition.	LOGICPALM 
Low Fuel Pre-Alarm	When the Set input is true, a Low Fuel Pre-Alarm is annunciated and the Low Fuel Level LED on the RDP-110 is illuminated.	LOWFUELPALM 
Low Line Override	When the Set input is true the 27, 59, 47, 51, 32, and 40Q settings and the configurable element settings and are scaled by the low-line scale factor setting.	LOWLINEOVER 

Name	Description	Symbol
Mains Breaker	This element is used to connect the breaker open and close output signals from the DGC-2020HD to physical output contacts to open and close the mains breaker and map breaker status feedback to a contact input. In addition, contact inputs can be mapped to allow switches to be implemented to manually initiate breaker open and close requests. This element is only available when the Mains Breaker Hardware is configured on the Breaker Hardware screen via the Breaker Management tree branch. Inputs <i>Status</i>: This input allows a contact input to be mapped that will provide breaker status feedback to the DGC-2020HD. When the contact input is closed, the breaker is indicated to be closed. When the contact input is open, the breaker is indicated to be open. <i>Open</i>: This input allows a contact input to be mapped that can be used to initiate a manual breaker open request. When this input is pulsed closed while the DGC-2020HD is in RUN or AUTO mode, the breaker will open. <i>Close</i>: This input allows a contact input to be mapped that can be used to initiate a manual breaker close request. When this input is pulsed, the mains is stable, and both breakers are open, a close request will be initiated. Outputs The outputs must be mapped to the contact outputs of the DGC-2020HD that will be used to drive the breaker. <i>Open</i>: This output is pulsed true (closes the output contact it is mapped to) when the DGC-2020HD is providing a signal to the breaker to open. It will be a pulse if the Breaker Output Contact Type is set to Pulse on the Breaker Hardware screen under Breaker Management in the Settings Explorer, and the length is determined by the Open Pulse Time. It will be a constant output if the Mains Breaker Hardware Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually open before the pulse is removed. <i>Close</i>: This output is pulsed true (closes the output contact it is mapped to) when the DGC-2020HD is providing a signal to the breaker to close. It will be a pulse if the Breaker Output Contact Type is set to Pulse on the Breaker Hardware screen under Breaker Management in the Settings Explorer, and the length is determined by the Open Pulse Time. It will be a constant output if the Mains Breaker Hardware Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually open before the pulse is removed. Note When using the DGC-2020HD synchronizer, it is recommended that local DGC-2020HD relay outputs be used for breaker closing commands to minimize the possibility of closures outside of desired breaker closing angles. If remote (CEM-2020) outputs are to be used for breaker close commands, it is recommended that the anticipatory synchronizer type be used, and the breaker close wait time be adjusted to account for possible CEM-2020 output delays (typically 50 ms) to achieve desired breaker closing angles.	MAINSBRK 
Mains Fail Test	When the Set input is true, the DGC-2020HD will exercise its mains fail transfer function exactly as it would if the mains were to fail on a mains fail machine. This can be used as a test of the mains fail transfer capability of the unit without having to cause a true mains failure.	MAINSFAILTEST 

Name	Description	Symbol
Mains Fail Transfer Inhibit	The mains fail transfer function is inhibited when the Set input is true.	MAINSFLTRINHIBIT 
Modem Control	Connect the Dialout input to the output of another logic block. When true, the modem will dial out.	MODEM 
MTU Cylinder Cutout Disable	When the Set input is true, Cylinder Cutout Disable 1 and Cylinder Cutout Disable 2 are both sent to the engine ECU with true status. When this logic element is false, Cylinder Cutout Disable 1 and Cylinder Cutout Disable 2 are sent to the engine ECU with states set by the values programmed for the Cylinder Cutout Disable 1 and Cylinder Cutout Disable 2 DGC-2020HD settings which are configured on the ECU Setup screen in BESTCOMSP ^{Plus} .	MTUCYLCUTOUTDISABLE 
Off Mode	When the Set input is true, the DGC-2020HD will switch to OFF mode. This is a pulsed input. It does not need to be held after the desired mode switch has occurred.	OFFMODE 
Paralleled to Mains	Setting the Paralleled input to true indicates to the DGC-2020HD that it is paralleled to a utility. When paralleled to the utility, the kW controller will regulate the machine's kW output at the Base Load Level (%) that is set on the Governor Bias Control Settings screen, where the Base Load Level is in percent of the machine's rated kW. Otherwise, the kW controller will implement kW load sharing when part of a load sharing system. If a load sharing system is not implemented, the speed controller can be set up to implement speed droop. When paralleled to the utility, the var/PF controller will regulate the machine's reactive power output according to the control mode setting. If the control mode is var Controller, the output will be regulated to the kvar Setpoint (%) that is set on the AVR Bias Control Settings screen, where the kvar Setpoint (%) is in percentage of the machines rated kvar. If the control mode is PF Control, the reactive power output is regulated to a level that maintains the machines power factor at the value specified by the PF setting on the AVR Bias Control Settings screen. When var/PF control is not active or not enabled, the voltage controller can be set up to implement voltage droop.	PARTOMAINS 
Prestart Output	This element is used to drive the prestart output relay from logic when the Prestart Output Relay configuration is set to "Programmable". When the Prestart Output Relay configuration is set to "Programmable", the prestart relay will not close unless logic is used to drive this element. When the Prestart Output Relay configuration is set to "Predefined", the prestart relay is closed according to the predefined prestart functionality of the DGC-2020HD. When the "Predefined" functionality is selected, the relay will not respond to this element.	PRESTARTOUT 
Programmable LED x	When the Set input is true, this element illuminates Programmable LED x on the front panel.	PROGLED1 

Name	Description	Symbol
RDP Programmable Alarm x	When the Set input is true, this element illuminates the Fuel Leak/Sender Failure LED on the Remote Display Panel RDP-110. When this element is connected in logic, it overrides all other commands to the LED. Otherwise, the LED operates as normal.	RDPPROGALM1 
RDP Programmable Pre-Alarm x	When the Set input is true, this element illuminates the Battery Overvoltage LED on the Remote Display Panel RDP-110. When this element is connected in logic, it overrides all other commands to the LED. Otherwise, the LED operates as normal.	RDPPROGPREALM1 
Reset	When the Set input is true, generator protection elements 78 and 81 are reset as well as all protection elements associated with Bus 1 and Bus 2. Reset can also be accomplished by pressing the Reset button on the front panel of the DGC-2020HD.	RESET 
Reset Bus 1	When the Set input is true, all protection associated only with Bus 1 is reset.	RESETBUS1 
Reset Bus 2	When the Set input is true, all protection associated only with Bus 2 is reset.	RESETBUS2 
Run Inhibit	When the Inhibit input is true, the DGC-2020HD is prevented from starting and running the generator, regardless of any condition that would normally cause the generator to run. If this element is false and there is <u>any</u> condition in effect which will cause the generator to run, the DGC-2020HD will start and run the generator.	RUNINHIBIT 
Run Mode	When the Set input is true, and the DGC-2020HD is in OFF mode, the DGC-2020HD will switch to RUN mode. This is a pulsed input. It does not need to be held after the desired mode switch has occurred.	RUNMODE 
Run Output	This element is used to drive the run output relay from logic when the Run Output Relay configuration is set to "Programmable". When the Run Output Relay configuration is set to "Programmable", the run relay will not close unless logic is used to drive this element. When the Run Output Relay configuration is set to "Predefined", the run relay is closed according to the predefined run functionality of the DGC-2020HD. When the "Predefined" functionality is selected, the relay will not respond to this element.	RUNOUTPUT 
Run with Load	The Start input starts the generator and closes the Gen breaker. The Stop input stops the generator and opens the Gen breaker. The DGC-2020HD only responds to this logic element when in AUTO mode.	RUNWLOAD 
Sequenced System Startup	When the Start input is true, this element starts a sequence system when no machines are running. This starts the first unit in a multiple unit system based on the sequencing criterion.	SEQSYSTEMSTART 

Name	Description	Symbol
Setting Group	There is a direct correlation between each logic input and the setting group that will be selected. That is, asserting input D0 selects SG0 (Setting Group 0) and asserting input D1 selects SG1 (Setting Group 1), etc. The active setting group latches-in after the input is read so they can be pulsed. It is not necessary that the input be maintained. If one or more inputs are asserted at the same time, the numerically higher setting group will be activated. A pulse must be present for approximately one second for the setting group change to occur.	
Single-Phase Override	When the Set input is true, the DGC-2020HD switches to single-phase sensing configuration and uses the Single Phase Override Sensing setting (A-B or A-C).	
Speed Lower	This element lowers the speed setting of the DGC-2020HD by up to 2 rpm per second. After the speed has not been lowered for 30 seconds, the modified speed is saved to nonvolatile memory.	
Speed Raise	This element raises the speed setting of the DGC-2020HD by up to 2 rpm per second. After the speed has not been raised for 30 seconds, the modified speed is saved to nonvolatile memory.	
Speed Trim Inhibit	When true, this element inhibits operation of the DGC-2020HD speed trim PID controller. For example, speed trim is not desired in multiple generator systems during start up synchronization until the generators are stable.	
Start Delay Bypass	This element allows the Pre Start state to be skipped based on logic. For example, a start delay may not be necessary when the engine is warm. This also allows an external device, such as an ECU, to control the pre start interval.	
Start Output	This element is used to drive the start output relay from logic when the Start Output Relay configuration is set to "Programmable". When the Start Output Relay configuration is set to "Programmable", the start relay will not close unless logic is used to drive this element. When the Start Output Relay configuration is set to "Predefined", the start relay is closed according to the predefined start functionality of the DGC-2020HD. When the "Predefined" functionality is selected, the relay will not respond to this element.	
Stop kvar Ramp	When the Set input is true, any kvar ramping in progress will be stopped at the current value. When the input is removed, ramping will resume.	
Stop kW Ramp	When the Set input is true, any kW ramping in progress will be stopped at the current value. When the input is removed, ramping will resume.	
Test Inhibit	When this logic element is true, the generator exercise timer cannot start the generator. If the TESTINHIBIT logic function is false during an exercise period, or transitions from true to false at any time during an exercise period, the DGC-2020HD will start and run the generator for the duration of the exercise period.	

Name	Description	Symbol
User Programmable Alarm x	When the Trigger input is true, the label of a user alarm is displayed on the Alarms screen on the front-panel display and in sequence of events report after the activation delay expires.	USERALM1 
Voltage Trim Inhibit	When true, this element inhibits operation of the DGC-2020HD voltage trim PID controller. For example, voltage trim is not desired in multiple generator systems during start up synchronization until the generators are stable.	VOLTTRIMINHIBIT 

Logic Schemes

A logic scheme is a group of logic variables written in equation form that defines the operation of a DGC-2020HD Digital Genset Controller. Each logic scheme is given a unique name. This gives you the ability to select a specific scheme and be confident that the selected scheme is in operation. One logic scheme is configured for typical control applications and is the default active logic scheme. Only one logic scheme can be active at a given time. In most applications, preprogrammed logic schemes eliminate the need for custom programming. Preprogrammed logic schemes may provide more inputs, outputs, or features than are needed for a particular application. This is because a preprogrammed scheme is designed for a large number of applications with no special programming required. Unneeded logic block outputs may be left open to disable a function or a function block can be disabled through operating settings.

When a custom logic scheme is required, programming time is reduced by modifying the default logic scheme.

The Active Logic Scheme

Digital Genset Controllers must have an active logic scheme in order to function. All Basler Electric DGC-2020HD units are delivered with a default, active logic scheme pre-loaded in memory. If the function block configuration and output logic of the default logic scheme meets the requirements of your application, then only the operating settings (power system parameters and threshold settings) need to be adjusted before placing the DGC-2020HD in service.

Sending a Logic Scheme to the DGC-2020HD

To send settings to the DGC-2020HD, it must be connected to a computer through a communications port. Once the necessary connections are made, settings can be uploaded to the DGC-2020HD by selecting Upload Settings and Logic to Device or Upload Logic to Device on the Communication pull-down menu.

Caution

Always remove the DGC-2020HD from service prior to changing or modifying the active logic scheme. Attempting to modify a logic scheme while the DGC-2020HD is in service could generate unexpected or unwanted outputs.

Modifying a logic scheme in *BESTCOMSPPlus* does not automatically make that scheme active in the DGC-2020HD. The modified scheme must be uploaded into the DGC-2020HD.

Operational settings are not included in the default logic scheme. Each element, function, alarm, etc. will have to be enabled and programmed separately using the Settings Explorer in *BESTCOMSPPlus*.

Retrieving a Logic Scheme from the DGC-2020HD

To retrieve settings from the DGC-2020HD, it must be connected to a computer through a communications port. Once the necessary connections are made, settings can be downloaded from the DGC-2020HD by selecting Download Settings and Logic from Device on the Communication pull-down menu.

Programming BESTlogic™Plus

Use BESTCOMSPlus to program BESTlogicPlus. Using BESTCOMSPlus is analogous to physically attaching wire between discrete DGC-2020HD terminals. To program BESTlogicPlus, use the Settings Explorer within BESTCOMSPlus to open the BESTlogicPlus Programmable Logic tree branch as shown in Figure 146.

The drag and drop method is used to connect a variable or series of variables to the logic inputs, outputs, components, and elements. To draw a wire/link from port to port (triangles), click the left mouse button on a port, pull the wire onto another port, and release the left mouse button. A red port indicates that a connection to the port is required or missing. A black port indicates that a connection to the port is not required. Drawing wires/links from input to input or output to output is not allowed. Only one wire/link can be connected to any one output. If the proximity of the endpoint of the wire/link is not exact, it may attach to an unintended port.

If an object or element is disabled, it will have a yellow X on it. To enable the element, navigate to the settings page for that element. A red X indicates that an object or element is not available per the style number of the DGC-2020HD.

The view of Logic Page 1 through 4, Physical Outputs, Remote Outputs, and LCR Outputs can be automatically arranged by clicking the right mouse button on the window and selecting Auto-Layout.

The following must be met before BESTCOMSPlus will allow logic to be uploaded to the DGC-2020HD:

- A minimum of two inputs and a maximum of 32 inputs on any multi-port (AND, OR, NAND, NOR, XOR, and XNOR) gate.
- A maximum of 32 logic levels for any particular path. A path being an input block or an output side of an element block through gates to an output block or an input side of an element block. This is to include any OR gates on the Physical Output or Remote Output tab/pages, but not the matched pairs of Physical Output blocks or Remote Output blocks.
- A maximum of 256 gates per logic level with a maximum of 256 gates allowed per diagram. All output blocks and input sides of element blocks are at the maximum logic level of the diagram. All gates are pushed forward/upwards in logic levels and buffered to reach the final output block or element block if needed.

Three status LEDs are located in the lower right corner of the BESTlogicPlus window. These LEDs show the Logic Save Status, Logic Diagram Status, and Logic Layer Status. Table 65 defines the colors for each LED.

Table 65. Status LEDs

LED	Color	Definition
Logic Save Status (Left LED)	Orange	Logic has changed since last save.
	Green	Logic has NOT changed since last save.
Logic Diagram Status (Center LED)	Red	Requirements NOT met as listed above.
	Green	Requirements met as listed above.
Logic Layer Status (Right LED)	Red	Requirements NOT met as listed above.
	Green	Requirements met as listed above.

Offline Logic Simulator

The offline logic simulator allows you to change the state of various logic elements to illustrate how that state travels through the system. Before running the logic simulator, you must click the Save button on the BESTlogicPlus toolbar to save the logic to memory. Changes to the logic (other than changing the state) are disabled when the simulator is enabled. Colors are selected by clicking the Options button on the BESTlogicPlus toolbar. By default, Logic 0 is red and Logic 1 is green. Using your mouse, double-click on a logic element to change its state.

An example of the offline logic simulator is shown in Figure 148. Output 1 is Logic 0 (red) when Virtual Switch 1 is Logic 0 (red) and Fixed 1 is Logic 1 (green).

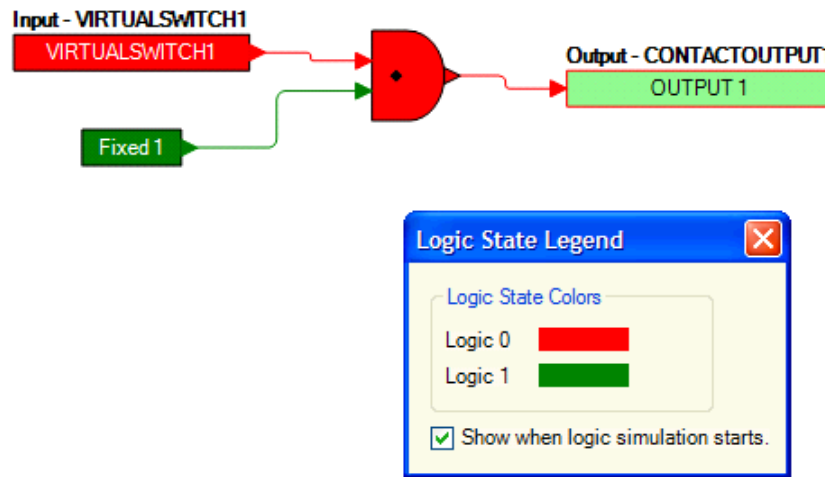


Figure 148. Offline Logic Simulator Example

BESTlogic™Plus File Management

To manage BESTlogicPlus files, use the Settings Explorer to open the BESTlogicPlus Programmable Logic tree branch. Use the BESTlogicPlus Programmable Logic toolbar to manage BESTlogicPlus files. Refer to Figure 149. For information on Settings Files management, refer to the *BESTCOMSPlus* chapter.

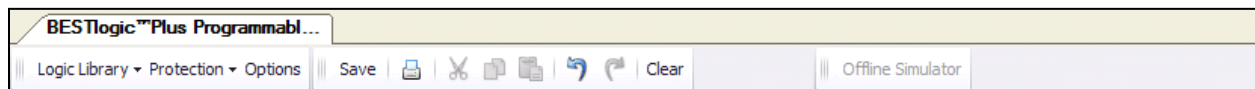


Figure 149. BESTlogicPlus Programmable Logic Toolbar

Saving a BESTlogicPlus File

After programming BESTlogicPlus settings, click on the Save button to save the settings to memory.

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

The user also has the option to save the BESTlogicPlus settings to a unique file that contains only BESTlogicPlus settings. Click on the Logic Library drop-down button and select Save Logic Library File. Use normal Windows® techniques to browse to the folder where you want to save the file and enter a filename.

Opening a BESTlogicPlus File

To open a saved BESTlogicPlus file, click on the Logic Library drop-down button on the BESTlogicPlus Programmable Logic toolbar and select Open Logic Library File. Use normal Windows techniques to browse to the folder where the file is located.

Protecting a BESTlogicPlus File

Objects in a logic diagram can be locked so that when the logic document is protected these objects cannot be changed. Locking and protecting is useful when sending logic files to other personnel to be modified. The locked object(s) cannot be changed. To view the lock status of the object(s), select Show Lock Status from the Protection drop-down menu. To lock object(s), use the mouse to select object(s) to be locked. Right click on the selected object(s) and select Lock Object(s). The gold colored padlock next to the object(s) will change from an open to a locked state. To protect a logic document, select Protect Logic Document from the Protection drop-down button. A password is optional.

Uploading a BESTlogicPlus File

To upload a BESTlogicPlus file to the DGC-2020HD, you must first open the file through BESTCOMSPlus or create the file using BESTCOMSPlus. Then pull down the Communication menu and select Upload Logic to Device.

Downloading a BESTlogicPlus File

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

Printing a BESTlogicPlus File

To view a preview of the printout, click on the Print Preview icon located on the BESTlogicPlus Programmable Logic toolbar. If you wish to print to a printer, select the printer icon in the upper left corner of the Print Preview screen.

You may skip the print preview and go directly to print by clicking on the Printer icon on the BESTlogicPlus Programmable Logic toolbar. A dialog box, Select Views to Print opens allowing you to check which views you would like to print. Next, the Print dialog box opens with the typical Windows choice to setup the properties of printer. Execute this command, as necessary, and then select Print.

A Page Setup icon is also provided on the BESTlogicPlus Programmable Logic toolbar allowing you to select Paper Size, Paper Source, Orientation, and Margins.

Clearing the On-Screen Logic Diagram

Click the Clear button to clear the on-screen logic diagram and start over.

BESTlogic™Plus Examples

Example 1 - GENBRK Logic Block Connections

Figure 150 illustrates the GENBRK logic block, three input logic blocks, and two output logic blocks. Output 3 is active while the GENBRK is sending an “open breaker” command and Output 4 is active while the GENBRK is sending the “close breaker” command.

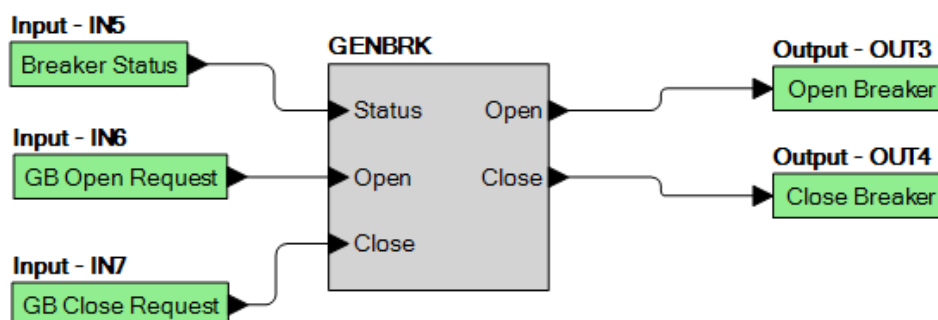


Figure 150. Example 1 – GENBRK Logic Block Connections

Example 2 - AND Gate Connections

Figure 151 illustrates a typical AND gate connection. In this example, Output 11 will become active when the Low Fuel alarm AND the Low Oil Pressure alarm are true.

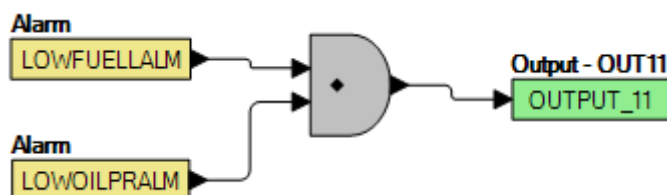


Figure 151. Example 2 – AND Gate Connections

Example 3 - Multiple Logic Connections

In this example, there are two comment boxes, which may be placed on the logic diagram. Double-click a comment box to modify the inside text. Output 3 becomes true when the 27TRIP is true. Output 1 becomes true when the High Coolant Temp is true. Output 2 becomes true when the DGC-2020HD is in RUN mode (RUN Mode true). Refer to Figure 152.

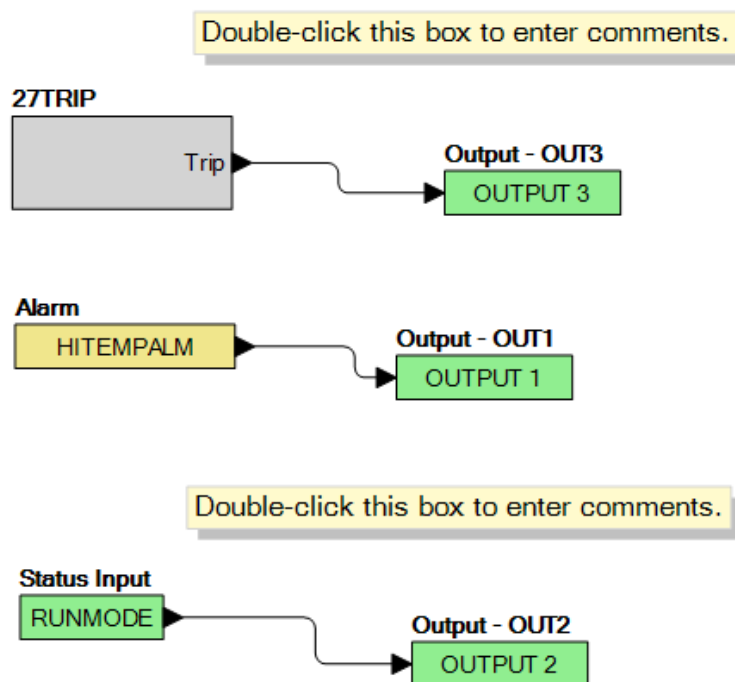


Figure 152. Example 3 – Multiple Logic Connections

Communication

DGC-2020HD communication ports include a mini-B USB port, two RJ-45 Ethernet jacks or BNC fiber optic port, Controller Area Network (CAN) terminals, RS-232 port, RS-485 terminals, and provisions for an optional Remote Display Panel. The following paragraphs describe the DGC-2020HD communication ports in detail.

USB

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

Ethernet

Depending on style number, each DGC-2020HD is equipped with either dual copper (100BaseT) Ethernet communication ports (style xxxxDxxxx) or a fiber optic (100BaseF) Ethernet communication port (style xxxxFxxxx).

Ethernet ports provide communications between the DGC-2020HD and a PC via *BESTCOMSPlus* or other DGC-2020HDs in a network. An Ethernet connection to a PC running *BESTCOMSPlus* provides remote metering, setting, annunciation, and control of the DGC-2020HD. Ethernet communication between DGC-2020HDs allows for generator sequencing on an islanded system.

DGC-2020HD controllers can be monitored and controlled via Ethernet using the Modbus TCP/IP.

Ethernet Port Designations

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 fiber optic port is designated as Ethernet port 1 and is reserved for intergenset communications (load sharing).

See the *Terminals and Connectors* chapter for a diagram showing the Ethernet port locations.

Ethernet Setup through *BESTCOMSPlus*®

To configure Ethernet through *BESTCOMSPlus*, first establish a connection via USB, Modem, or Ethernet (if already configured). See the *BESTCOMSPlus* chapter for instructions for connecting via USB. See RS-232, below, for details on connecting via modem.

Click Communication in the top menu, mouse-over Configure, and click Ethernet. The Configure Ethernet Port screen appears. Settings on this screen differ depending on the Ethernet port style of the connected DGC-2020HD. Figure 153 illustrates the settings provided for dual copper Ethernet ports (style xxxxDxxxx). Figure 154 illustrates the settings for a fiber optic Ethernet port (style xxxxFxxxx).

Retrieve current Ethernet settings from the DGC-2020HD using the Download button. This is helpful when it is desired to make minor changes to the current settings.

The dialog box is titled "Ethernet Configuration View". It contains three buttons at the top: "Download", "Send to Device", and "Close". Below these buttons is a checkbox labeled "Redundant Ethernet". The main area is divided into two columns for "Ethernet 1" and "Ethernet 2". Each column has three input fields: "IP Address" (four boxes with 0), "Default Gateway" (four boxes with 0), and "Subnet Mask" (four boxes with 255). At the bottom of each column is a checkbox labeled "Use DHCP".

Figure 153. Dual Copper Ethernet Port Configuration

The dialog box is titled "Configure Ethernet Port". It contains three buttons at the top: "Download", "Send to Device", and "Close". Below these buttons are three input fields: "IP Address" (four boxes with 0), "Default Gateway" (four boxes with 0), and "Subnet Mask" (four boxes with 255). At the bottom is a checkbox labeled "Use DHCP".

Figure 154. Fiber Optic Ethernet Port Configuration

Configurable options include:

- IP Address:** Internet Protocol Address to be used by the DGC-2020HD
- Default Gateway:** Default host to send data destined for a host not on the network subnet.
- Subnet Mask:** Mask used to determine the range of the current network subnet.
- Use DHCP:** Automatically configures IP Address, Default Gateway, and Subnet Mask via DHCP. This can be used only if the Ethernet network has a properly configured DHCP server running. The DGC-2020HD does not act as a DHCP server.
- Redundant Ethernet:** Available with dual copper Ethernet ports only. Checking this box disables the settings for Ethernet port 2 and designating it as a redundant port.

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

- 10.0.0.0 to 10.255.255.255
- 172.16.0.0 to 172.31.255.255
- 192.168.0.0 to 192.168.255.255

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

Click the Send to Device button located on the Configure Ethernet Port screen. A confirmation popup is displayed notifying the user that the DGC-2020HD will reboot after settings are sent. Click the Yes button to allow settings to be sent. After the unit has rebooted and the power-up sequence is complete, the DGC-2020HD is ready to be used on a network.

If desired, DGC-2020HD settings can be verified by selecting Download Settings and Logic from the Communication pull-down menu. Active settings are downloaded from the DGC-2020HD. Verify that the downloaded settings match the previously sent settings.

Note

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

Establishing Ethernet Communication

Communication between BESTCOMSP^{Plus} and the DGC-2020HD is established by clicking the Connect button on the DGC-2020HD Connection screen, see Figure 155. This screen is found under the Communication pull-down menu, New Connection, DGC-2020HD or by clicking the Connect button located on the lower menu bar. If an "Unable to Connect to Device" error message is received, verify that communications are configured properly.

CAN

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

Caution

DGC-2020HD controllers have two separate CAN ports: CAN 1 and CAN 2. CAN 1 consists of terminals 51 (CAN L), 52 (CAN H), and 53 (SHIELD) and communicates solely with Basler Electric expansion modules. This port accommodates up to four CEM-2020s and up to four AEM-2020s simultaneously. CAN 2 consists of terminals 54 (CAN L), 55 (CAN H), and 53 (SHIELD) and is dedicated for communication with Engine Control Units (ECU) and related devices.

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

The primary use of the CAN interface is to obtain engine operating parameters for monitoring speed, coolant temperature, oil pressure, coolant level, and engine hours without the need for direct connection to individual senders. Table 66 lists the ECU parameters and Table 67 lists the engine configuration parameters supported by the DGC-2020HD CAN interface. These parameters are transmitted via the CAN interface at preset intervals. See the column labeled Update Rate in Table 66 for transmission rates.

Table 66. ECU Parameters Obtained from CAN Interface

ECU Parameter	Metric Units	English Units	Update Rate	SPN*
Actual Engine Percent Torque	%	%	Engine Speed Dependent	513
Air Filter Differential Pressure	kPa	psi	500 ms	107
Air Inlet Temperature	°C	°F	1 s	172
Alarm Reset Feedback	Binary	Binary	1 s	2815
Ambient Air Temperature	°C	°F	1 s	171
Auxiliary Pressure 1	kPa	psi	On Request	1387
Auxiliary Pressure 2	kPa	psi	On Request	1388
Barometric Pressure	kPa	psi	1 s	108
Battery Voltage	Vdc	Vdc	1 s	168
Boost Pressure	kPa	psi	500 ms	102
Charge Air Temperature	°C	°F	1 s	2629
Coolant Level	%	%	500 ms	111
Coolant Pressure	kPa	psi	500 ms	109
DEF Inducement Level - Level of Inducement Not to Run the Engine	%	%	1,000 ms	5246
DEF Severity Level - Severity of Tank Low Level	%	%	1,000 ms	5245
DEF Tank 1 Level	%	%	1,000 ms	1761
DEF Tank 2 Level	%	%	1,000 ms	4367

ECU Parameter	Metric Units	English Units	Update Rate	SPN*
ECU Temperature	°C	°F	1 s	1136
Engine Coolant Preheated State	-	-	500 ms	3552
Engine Coolant Temperature	°C	°F	1 s	110
Engine Desired Operating Speed	rpm	rpm	250 ms	515
Engine Intake Manifold #1 Absolute Pressure	kPa	psi	500 ms	3563
Engine Intercooler Coolant Level	%	%	500 ms	3668
Engine Intercooler Temperature	°C	°F	1 s	52
Engine Oil Level	%	%	500 ms	98
Engine Oil Pressure	kPa	psi	500 ms	100
Engine Oil Temperature	°C	°F	1 s	175
Engine Speed	rpm	rpm	Engine Speed Dependent	190
Exhaust Gas Temperature	°C	°F	500 ms	173
Exhaust Temperature A	°C	°F	500 ms	2433
Exhaust Temperature B	°C	°F	500 ms	2434
Fuel Delivery Pressure	kPa	psi	500 ms	94
Fuel Leak Filter 1	Binary	Binary	1 s	1239
Fuel Leak Filter 2	Binary	Binary	1 s	1240
Fuel Rate	liter/hr	gal/hr	100 ms	183
Fuel Temperature	°C	°F	1 s	174
High Exhaust System Temp (HEST) Lamp/Indicator	-	-	500 ms	3698
Injection Control Pressure	MPa	psi	500 ms	164
Injector Metering Rail Pressure	MPa	psi	500 ms	157
Intake Manifold Temperature	°C	°F	500 ms	105
Particulate Filter (DPF) Lamp/Indicator	-	-	500 ms	3697
Percent Load at Current rpm	%	%	50 ms	92
Rated Power	watts	watts	On Request	166
Rated rpm	rpm	rpm	On Request	189
Regeneration Disabled (Inhibit) Lamp/Indicator	-	-	500 ms	3703
Shutdown from ECU	Binary	Binary	1 s	1110
Switched Battery Voltage (at ECU)	Vdc	Vdc	1 s	158
Throttle (Accelerator Pedal) Position	%	%	50 ms	91
Total Engine Hours	hours	hours	Requested 1.5 s	247
Total Fuel Used	liters	gallons	Requested 1.5 s	250
Transmission Oil Pressure	kPa	psi	1 s	127
Transmission Oil Temperature	°C	°F	1 s	177
Trip Average Fuel Rate	liters/hr	gallons/hr	On Request	1029
Trip Fuel	liters	gallons	Requested 1.5 s	182

ECU Parameter	Metric Units	English Units	Update Rate	SPN*
Winding 1 Temperature	°C	°F	1 s	1124
Winding 2 Temperature	°C	°F	1 s	1125
Winding 3 Temperature	°C	°F	1 s	1126

* SPN: Suspect Parameter Number

Table 67. Engine Configuration Parameters Obtained from CAN Interface

ECU Parameter	Metric Units	English Units	Update Rate	SPN*
Engine Speed at High Idle Point 6	rpm	rpm	5 s	532
Engine Speed at Idle Point 1	rpm	rpm	5 s	188
Engine Speed at Point 2	rpm	rpm	5 s	528
Engine Speed at Point 3	rpm	rpm	5 s	529
Engine Speed at Point 4	rpm	rpm	5 s	530
Engine Speed at Point 5	rpm	rpm	5 s	531
Gain (Kp) of End Speed Governor	%/rpm	%/rpm	5 s	533
Maximum Momentary Engine Override Speed Point 7	rpm	rpm	5 s	534
Maximum Momentary Engine Override Time Limit	seconds	seconds	5 s	539
Percent Torque at Idle Point 1	%	%	5 s	540
Percent Torque at Point 2	%	%	5 s	541
Percent Torque at Point 3	%	%	5 s	542
Percent Torque at Point 4	%	%	5 s	542
Percent Torque at Point 5	%	%	5 s	543
Reference Engine Torque	N•m	ft-lb	5 s	544
Requested Speed Control Range Lower Limit	rpm	rpm	5 s	535
Requested Speed Control Range Upper Limit	rpm	rpm	5 s	536
Requested Torque Control Range Lower Limit	%	%	5 s	537
Requested Torque Control Range Upper Limit	%	%	5 s	538

* SPN: Suspect Parameter Number

Caution

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

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

- *NC (Not Connected)* - String displayed for a J1939 parameter when the engine ECU is not connected to the DGC-2020HD.
- *SF (Sender Fail)* - String displayed for a J1939 parameter when the engine ECU sends a special code indicating a measurement failure for the parameter. For example, if oil sender is determined to be bad by the ECU, it sends a special code in place of the J1939 oil pressure data indicating a sender fail condition.

- *NS (Not Sent)* - String displayed for a J1939 parameter when the J1939 parameter has not been sent to the DGC-2020HD by the engine ECU.
- *NA (Not Applicable)* - String displayed for a J1939 parameter when the engine ECU sends a special code for the parameter indicating that the parameter is not implemented or not applicable in the ECU.
- *UF (Unknown Failure)* - String displayed when the J1939 parameter data received by the ECU is not within the valid J1939 data range for the parameter but is not one of the special codes above.

Table 68 lists the J1939 data transmitted from the DGC-2020HD.

Table 68. J1939 Data Transmitted from the DGC-2020HD

ECU Parameter	Update Rate	SPN*
Address Claim Request†	Once on power-up and any time a Global Request for Address Claim (GRAC) PGN is received	n/a
Auxiliary Analog Information	1.5 s	n/a
Battle Override Switch	100 ms	1237
Clear Currently Active Diagnostic Trouble Request†	Whenever a request to reset Currently Active Diagnostic Trouble Code Request is made	n/a
Clear Previously Active Diagnostic Trouble Codes Request†	Whenever a request to reset Previously Active Diagnostic Trouble Code Request is made	n/a
Electronic Engine Controller #4 (Rated Speed and Power) Request	1.5 s	n/a
Engine Hours/Revolutions Request	1.5 s	n/a
Fuel Consumption Request	1.5 s	n/a
Generator Frequency Selection (0000-50 Hz, 0001-60 Hz)	100 ms	4080
Generator Governing Speed Command (00-rated, 01-idle)	100 ms	4079
Governor Droop	100 ms	5568
Governor Gain Adjust	100 ms	5567
Liquid Fuel Information	1.5 s	n/a
Previously Active Diagnostic Trouble Codes Request	1.5 s	n/a
Speed Request	10 ms	518
Trip Fuel Reset	100 ms	988

* SPN: Suspect Parameter Number

† Requests from the DGC-2020HD to the ECU for various parameters are made by issuing the request.

ECU Limitations

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

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

CAN Bus Setup

BESTCOMSPlus® Navigation Path: Settings Explorer, Communications, CAN Bus, CAN Bus Setup

HMI Navigation Path: Settings > Communication > CAN Bus 1 (I/O) Setup and CAN Bus 2 (ECU) Setup

The following paragraphs describe the settings found on the CAN Bus Setup screen. Figure 157 illustrates the BESTCOMSPlus CAN Bus Setup screen. Settings are listed in Table 71.

Enable ECU Support

Set to Enabled for the DGC-2020HD to communicate with the ECU.

Enable DTC (Diagnostic Trouble Code) Support

If the ECU is a J1939 ECU, enable DTC support. If the ECU does not support it, no diagnostic trouble codes will be logged by the DGC-2020HD.

SPN Conversion Method

Early versions of the J1939 specifications were unclear about how the 19 bits of the SPN were arranged within their allocated places in the data. While it was clear which bytes and bits contained the 19 bits of SPN data, it was not clear whether the data within the bytes was arranged with the most significant bit first or least significant bit first. It was also unclear which byte was most significant and which was least significant. The ambiguity led to various engine manufacturers adopting three different methods of converting the data into SPN numbers.

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

A DGC-2020HD operating on a CAN bus network is identified by a unique address number. The CAN bus address is set internally by the DGC-2020HD when certain types of ECUs are selected on the ECU Setup screen, and in this case, the user-entered value does not apply. See Table 69.

Table 69. CAN Bus Address per ECU Type

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

In applications where the ECU is not continuously powered, the DGC-2020HD has provisions for applying power to the ECU and pulsing the ECU to update its engine monitoring data. Either the DGC-2020 RUN or PRESTART relay output can be used to apply power to the ECU. If the PRESTART contact is selected, the RUN output will still close during cranking and genset operation to provide a separate indication that the genset is running. For applications where pulsing of the ECU is not desired, this pulsing feature can be disabled.

The most common SPN conversion method is 4 and is the default for the DGC-2020HD. Refer to ECU manufacturer documentation to determine the correct SPN conversion method of the ECU and set the SPN Conversion Method setting in the DGC-2020HD accordingly.

CAN Bus 2 Address

This parameter sets a unique address number for the DGC-2020HD operating on CAN 2 (ECU). The CAN Address is set internally by the DGC-2020HD when certain types of ECUs are selected on the ECU Setup screen, and in this case, the user-entered value does not apply.

ECU Related Time Values - Response Timeout

This setting defines the amount of time that the DGC-2020HD will wait to receive data from the ECU during a pulse cycle or start attempt. If no data is received during this time in a pulse cycle, a LOSS OF ECU COMMS pre-alarm is annunciated. If no data is received in this time during an engine starting attempt, a LOSS OF ECU COMMS alarm is annunciated.

Generator Parameter Transmit

When the Generator Parameter Transmit setting is enabled, the DGC-2020HD broadcasts generator metered parameters over CAN as listed in Table 70. The Generator Parameter Transmit setting is not used when ECU Type is set for MTU MDEC, MTU ECU7/ECU8, or MTU Smart Connect.

Table 70. Transmitted Generator Parameters

PGN Name	PGN (Hex)	SPN	Parameter	Units	Scaling / Offset	Bytes Within PGN Data
Generator Total AC Energy	65018 (FDFA)	2468	Generator Total kW Hours Export	kWH	n/a	1 to 4
		2469	Generator Total kW Hours Import	kWH	n/a	5 to 8
Generator Total AC Reactive Power	65028 (FE04)	2456	Generator Total Reactive Power	vars	n/a	1 to 4
		2464	Generator Overall Power Factor	PF * 16,384	-1 offset	5 to 6
		2518	Generator Overall Power Factor Lagging	n/a	00=leading 01=lagging 10=error 11=not available	7, bits 1 & 2
Generator Total AC Power	65029 (FE05)	2452	Generator Total Real Power	Watts	n/a	1 to 4
		2460	Generator Total Apparent Power	VA	n/a	5 to 8
Generator Average Basic AC Quantities	65030 (FE06)	2440	Generator Average L-L AC RMS Voltage	Volts	n/a	1 to 2
		2444	Generator Average L-N AC RMS Voltage	Volts	n/a	3 to 4
		2436	Generator Average AC Frequency	Hz * 128	n/a	5 to 6
		2448	Generator Average AC RMS Current	Amps	n/a	7 to 8

PGN Name	PGN (Hex)	SPN	Parameter	Units	Scaling / Offset	Bytes Within PGN Data
Engine Temperature	65262 (FEEE)	110	Engine Coolant Temperature (Not sent when CAN is enabled)	°C	-40°C offset	1
		174	0xFF	n/a	n/a	n/a
		175	0xFF	n/a	n/a	n/a
		52	0xFF	n/a	n/a	n/a
Engine Fluid Level / Pressure	65263 (FEEF)	100	Engine Oil Pressure (Not sent when CAN is enabled)	kPa * 4	n/a	4
		94	0xFF	n/a	n/a	n/a
		98	0xFF	n/a	n/a	n/a
		109	0xFF	n/a	n/a	n/a
		111	0xFF	n/a	n/a	n/a
Dash Display	65276 (FEFC)	96	Fuel Level	% * 2.5	n/a	2

Engine Control Parameter Transmit

When the Engine Parameter Transmit setting is enabled, the DGC-2020HD broadcasts engine metered parameters over CAN. When the Engine Parameter Transmit setting is disabled, transmission of J1939 commands from the DGC-2020HD to the engine are disabled, but commands from the engine to the DGC-2020HD are allowed.

ECU Contact Control - Output Select

Select whether the RUN output relay or the PRE (Prestart) output relay closes to give the ECU its “energize to run” signal. In some implementations, this relay may actually be providing ECU power.

ECU Contact Control - Pulsing Enable

Select if the ECU is not to be on line at all times. Often ECUs are allowed to go “off line” to conserve battery drain when the engine is not running. The DGC-2020HD will “pulse” it periodically to force it to be active to allow the DGC-2020HD to read data such as coolant temperature and coolant level. This is required if the DGC-2020HD is to report low coolant temperature conditions (which may indicate a failure of a block heater), or low coolant level conditions (if a leak occurs while the machine is not running). Pulsing is also used to check the integrity of CAN communications when the machine is not running.

ECU Related Time Values - Engine Shut Down

Set this parameter for a value longer than the duration required to stop the engine after being shut down. The ECU is pulsed after this time expires. If the time is too short, the pulse may occur while the engine is still turning which could cause a brief re-start and possibly damage the flywheel and starter system.

ECU Related Time Values - Pulse Cycle Time

Set this parameter for the desired time between ECU pulse cycles.

ECU Related Time Values - Settling Time

This parameter is the duration of the “on line” time of the pulse cycle during which the DGC-2020HD reads data from the ECU. The settling time should be set long enough so that any ECU parameters that require time to “settle down” after the ECU is on line can do so. Since the DGC-2020HD may use some of the ECU data for alarm or pre-alarm annunciation, it is important that the data have time to settle.

CAN Bus 1 Address

This parameter sets a unique address number for the DGC-2020HD operating on CAN 1 (Remote Modules).

Baud Rate

This setting dictates the rate at which the DGC-2020HD communicates with CAN 1. The selected baud rate must match the baud rate of the other nodes on the CAN. Both CEM-2020 and AEM-2020 baud rates are 250 kbps.

CAN Bus Setup

CAN Bus 2 (ECU)

CAN Bus Interface

- ☒ Enable ECU Support
- ☒ Enable DTC Support
- SPN Conversion Method: 4 **A**
- CAN Bus Address: 17 **B**
- Generator Parameter Transmit: Disable **C**
- Engine Control Parameter Transmit: Enable **D**

ECU Contact Control

Output Select

- ☐ Fuel Contact
- ☒ Pre-start Contact

Pulsing

- ☐ Disable
- ☒ Enable

ECU Related Time Values

- Engine Shut Down (s): 15 **E**
- Settling Time (ms): 6000 **G**
- Pulse Cycle Time (min): 15 **F**
- Response Timeout (s): 5 **H**

CAN Bus 1 (Remote Modules)

- CAN Bus Address: 238 **I**
- Baud Rate: 250 kbps **J**

Figure 157. Settings Explorer, Communications, CAN Bus, CAN Bus Setup

Table 71. Settings for CAN Bus Setup

Locator	Setting	Range	Increment	Unit
A	SPN Conversion Method	1 to 4	1	n/a
B	CAN Bus 2 Address	1 to 253	1	n/a
C	Generator Parameter Transmit	Enable or Disable	n/a	n/a
D	Engine Control Parameter Transmit	Enable or Disable	n/a	n/a
E	Engine Shutdown	1 to 60	1	seconds
F	Pulse Cycle Time	1 to 60	1	minutes
G	Settling Time	5,500 to 30,000	1	milliseconds
H	Response Timeout	1 to 60	1	seconds

Locator	Setting	Range	Increment	Unit
I	CAN Bus 1 Address	1 to 253	1	n/a
J	Baud Rate	125 kbps or 250 kbps	n/a	n/a

ECU Setup

BESTCOMSPlus® Navigation Path: Settings Explorer, Communications, CAN Bus, ECU Setup

HMI Navigation Path: Settings > Communication > CAN Bus 2 (ECU) Setup > ECU Setup

The following paragraphs describe the settings on the ECU Setup screen. Refer to Figure 158.

ECU Type

The DGC-2020HD can be configured for Standard, Volvo Penta, MTU MDEC, MTU ADEC, MTU ECU7/ECU8, GM/Doosan, Cummins, or MTU Smart Connect.

Diesel Particulate Filter (DPF)

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

Two parameters are provided to initiate or disable DPF regeneration. The first, *Manual Regeneration*, is transmitted to the engine via CAN to initiate DPF regeneration. The second, *Disable Regeneration*, is transmitted to the engine via CAN to disable DPF regeneration. Extended operation with regeneration disabled is not recommended.

ECU Setup

ECU Type: Standard

Trip Reset

Diesel Particulate Filter (DPF)

Manual Regeneration

Disable Regeneration: Off

Volvo Penta

Speed Select: Primary

Accelerator Position (%): 50

MTU (MDEC, ADEC, ECU7/ECU8)

MTU ECU7/ECU8 Module Type: Module 501

MDEC Module Type: CAN Module 303

NMT Alive Transmit Rate (msec): 500

Speed Configuration

Speed Demand Switch: No CAN Demand

Overspeed Test: Off

Speed Up

Speed Down

Idle Request: Off

Increased Idle: 0

ECU Configuration

Int Oil Prime

Engine Start Prime: Off

Fan Override: Off

Mode Switch: Off

Governor Param Switch Over: Off

Governor Param Set Select: 0

CAN Rating Switch 1: Off

CAN Rating Switch 2: Off

Cylinder Cutout Disable 1: Off

Cylinder Cutout Disable 2: Off

Engine Operating Mode: 1

Figure 158. Settings Explorer, Communications, CAN Bus, ECU Setup

Speed Setup

BESTCOMSPlus® Navigation Path: Settings Explorer, Communications, CAN Bus Setup, Speed Setup

HMI Navigation Path: Settings > Communication > CAN Bus 2 (ECU) Setup > ECU Setup > Speed Setup

Speed control over J1939 and ECU7/ECU8 is implemented over CAN when the CAN bus RPM Request setting is enabled. This is implemented for all ECUs. The Engine RPM setting defines the nominal requested engine rpm. The Idle RPM setting is the requested rpm when the IDLE REQUEST logic element is true.

Figure 159 illustrates the BESTCOMSPlus Speed Setup screen. Settings are listed in Table 72.

Speed Setup

CAN Bus RPM Request
 A

Engine RPM
 B

Idle RPM
 C

RPM Bandwidth
 D

Figure 159. Settings Explorer, Communications, CAN Bus, Speed Setup

Table 72. Settings for Speed Setup

Locator	Setting	Range	Increment	Unit
A	CAN Bus RPM Request	Disable or Enable	n/a	n/a
B	Engine RPM	750 to 3,600	1	RPM
C	Idle RPM	100 to 2,000	1	RPM
D	RPM Bandwidth	0 to 1,000	1	n/a

Voltage Regulator Setup

BESTCOMSPlus® Navigation Path: Settings Explorer, Communications, CAN Bus Setup, Voltage Regulator Setup

HMI Navigation Path: Settings, Communication > CAN Bus 2 (ECU) Setup > ECU Setup > Voltage Regulator Setup

The DGC-2020HD transmits voltage setpoint and underfrequency compensation parameters to a connected voltage regulator. Select the appropriate CAN bus type being used: None, Marathon, Basler, or J1939. The Primary Voltage Setpoint value represents the normal desired system voltage setpoint. Alternate Voltage Setpoint becomes the active system voltage setpoint when low line override is true. The range in which the DGC-2020HD biases voltage regulator var sharing and voltage trim is dictated by the Voltage Adjust Bandwidth setting. When the voltage regulator is in Field Current Regulation (FCR) mode, the normal desired field current setpoint is set using the *Field Current Setting for Field Current Regulation Mode*. The Primary Underfrequency Knee setting allows adjustment of the normal desired underfrequency knee-point. When low line override is true, the Alternate Underfrequency Knee becomes the active underfrequency knee-point. The desired Underfrequency slope can also be specified.

Figure 160 illustrates the BESTCOMSPlus Voltage Regulator Setup screen. Settings are listed in Table 73.

Voltage Regulator Setup

CAN Bus Type
 A

Field Current Setting for Field Current Regulation Mode (A)
 E

Primary Voltage Setpoint (V)
 B

Primary Underfrequency Knee
 F

Alternate Voltage Setpoint (V)
 C

Alternate Underfrequency Knee
 G

Voltage Adjust Bandwidth (V)
 D

Underfrequency Slope
 H

Figure 160. Settings Explorer, Communications, CAN Bus, Voltage Regulator Setup

Table 73. Settings for Voltage Regulator Setup

Locator	Setting	Range	Increment	Unit
A	CAN Bus Type	None, Basler, Marathon, or J1939	n/a	n/a
B	Primary Voltage Setpoint	100 to 600	0.1	volts
C	Alternate Voltage Setpoint	100 to 600	0.1	volts
D	Voltage Adjust Bandwidth	0 to 30	0.01	volts
E	Field Current Setting for Field Current Regulation Mode	0 to 3,000	0.001	amperes
F	Primary Underfrequency Knee	40 to 70	0.1	Hz
G	Alternate Underfrequency Knee	40 to 70	0.1	Hz
H	Underfrequency Slope	1 to 5	0.01	n/a

RS-232

DGC-2020HD controllers are equipped with an RS-232 port which communicates with an external user-supplied telephone modem with dial-in and dial-out capability.

RS-232 Setup

BESTCOMSPlus® Navigation Path: Settings Explorer, Communications, RS232 Setup

HMI Navigation Path: Settings > Communication > RS232 Setup

The RS-232 port supports a user-selectable baud rate of 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. Refer to Figure 161.

Figure 161. Settings Explorer, Communications, RS232 Setup

External Modem

BESTCOMSPlus® Navigation Path: Settings Explorer, Communications, Modem Setup

HMI Navigation Path: Settings > Communication > Modem Setup

A connection with an external, user-supplied modem provides communications between the DGC-2020HD and a PC via BESTCOMSPlus. Modem connection to a PC running BESTCOMSPlus provides remote metering, setting, annunciation, and control of the DGC-2020HD. Dial-out capability allows the DGC-2020HD to dial up to four telephone numbers and annunciate user-selected conditions to specified pagers.

Modem Setup

Dial-Out

An external modem gives the DGC-2020HD the ability to dial up to four telephone numbers and annunciate user-selected conditions to specified pager IDs. These user-selectable conditions are found in the following categories:

- Alarms
- Undervoltage Protection
- Generator Overvoltage Protection
- Phase Voltage Imbalance Protection
- Generator Frequency Protection
- Generator Overcurrent Protection
- Power Protection
- Vector Jump Protection
- Loss of Excitation Protection
- Configurable Elements
- Contact Inputs
- Status Change
- Contact Expansion Modules 1 through 4

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

Message strings sent by the DGC-2020HD can be limited to a length supported by the receiving pagers. If a message to be transmitted by the DGC-2020HD exceeds the pager message length limit, it will make multiple calls to transmit the complete message.

Dial-out messages are sent by the DGC-2020HD at a user-defined interval determined by the Inter Dialout Activation Delay. This interval gives an operator the opportunity to dial into the DGC-2020HD. A second user-defined interval, Modem Offline Delay, determines how frequently dial-out attempts are made following a dial-out failure.

A prefix of '1', the area code, or both may need to be included. This can be tested by dialing the number on a telephone. If the modem "handshake" is heard, then the prefixes used are correct.

Dial-In

When the external modem shares a line used for voice communication, the number of rings required for the modem to answer can be adjusted to allow time for an operator to answer an incoming telephone call.

Additional settings can be adjusted by use of modem initialization string commands. Modem initialization strings (AT commands) of up to 50 characters are accepted. Refer to the manufacturer documentation included with your modem for compatible initialization strings.

The Modem Setup screen is illustrated in Figure 162. Settings are listed in Table 74.

Modem Setup		
Dial Out Number 1	Pager ID 1	Dialout Conditions ☐ Alarms ☐ Undervoltage Protection ☐ Generator Overvoltage Protection ☐ Phase Voltage Imbalance Protection ☐ Generator Frequency Protection ☐ Generator Overcurrent Protection ☐ Power Protection ☐ Vector Jump Protection ☐ Loss of Excitation Protection ☐ Configurable Elements ☐ Contact Inputs ☐ Status Change ☐ Contact Expansion Module 1 ☐ Contact Expansion Module 2 ☐ Contact Expansion Module 3 ☐ Contact Expansion Module 4 ☐ ECU Configuration
Dial Out Number 2	Pager ID 2	
Dial Out Number 3	Pager ID 3	
Dial Out Number 4	Pager ID 4	
Rings for Modem Answer	Inter Dialout Activation Delay	
2 [A]	15 Sec [D]	
Modem Offline Delay (min)	Pager Buffer Limit	
10 [B]	80 Chars [E]	
Modem Initialization String	Pager Coms Data Format	
0 [C]	7 bit - Even Parity [F]	

Figure 162. Settings Explorer, Communications, Modem Setup

Table 74. Settings for Modem Setup

Locator	Setting	Range	Increment	Unit
A	Rings for Modem Answer	1 to 9	1	n/a
B	Modem Offline Delay	1 to 240	1	minutes
C	Modem Initialization String	n/a	n/a	n/a
D	Inter Dial Activation Delay	15, 30, 60, or 120	n/a	seconds
E	Pager Buffer Limit	80, 120, 160, or 200	n/a	characters
F	Pager Coms Data Format	7-bit Even Parity or 8-bit No Parity	n/a	n/a

Establishing Modem Communication

Prior to establishing modem communication, the baud rate used by the PC must match the baud rate used by the DGC-2020HD.

The baud rate used by the DGC-2020HD can be set directly through the front panel interface or through BESTCOMSPlus via USB (local) or Ethernet (remote) connection. If using the front panel, navigate to Settings > Communication > RS-232 Setup. If using BESTCOMSPlus, navigate to Settings Explorer, Communications, RS-232 Setup (Figure 161). Set the baud rate to the desired value and send the settings, if using BESTCOMSPlus.

Open the *Connection* screen by clicking the *Connect* button located on the lower menu bar. On the Connection screen, select SerialRS-232 / Modem Connection and click the *Properties* button. The *Advanced Serial Port Properties* dialog box appears. Set the baud rate to match the value found on the RS-232 screen. Figure 163 illustrates the Advanced Serial Port Properties dialog box.

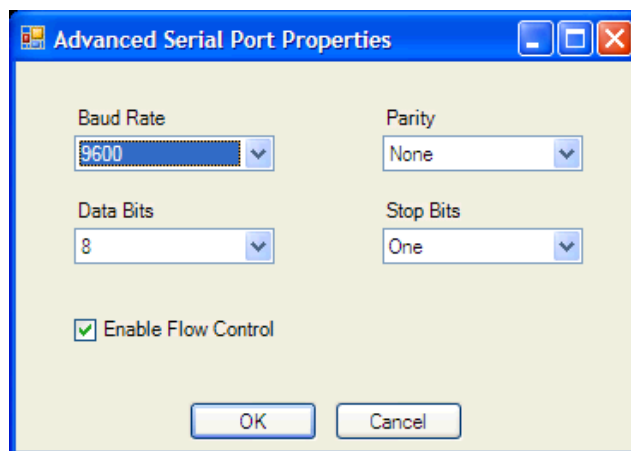


Figure 163. Advanced Serial Port Properties

On the *Connection* screen, select *SerialRS-232 / Modem Connection*, and enter the phone number of the modem connected to the DGC-2020HD. To select the correct COM Port, open Windows® Device Manager and expand the Modems branch. Right-click on the modem name and choose Properties. Open the Advanced tab to view the COM port. Click *Connect*.

Ensure that successful modem communication is achieved prior to installation at the application site as some modems are incapable of communicating with each other.

It is recommended that the fastest possible baud rate is chosen while still maintaining reliable communications.

When connected to the DGC-2020HD via modem, the BESTCOMSPlus *Analysis* metering screen is disabled.

RS-485

BESTCOMSPlus® Navigation Path: Settings Explorer, Communications, RS485 Setup

HMI Navigation Path: Settings > Communication > RS485 Setup

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.

The RS485 Setup screen is illustrated in Figure 164.

Figure 164. Settings Explorer, Communications, RS485 Setup

Modbus™ Setup

BESTCOMSPlus® Navigation Path: Settings Explorer, Communications, Modbus Setup

HMI Navigation Path: Settings > Communication > Modbus Setup

The DGC-2020HD employs the Modbus communication protocol over the Ethernet and RS-485 ports simultaneously. A list of Modbus registers can be found in Basler Electric publication 9469300991, *Modbus Protocol Instruction Manual*.

The Modbus Setup screen is illustrated in Figure 165. Settings are listed in Table 75.

Figure 165. Settings Explorer, Communications, Modbus Setup

Table 75. Settings for Modbus Setup

Locator	Setting	Range	Increment	Unit
<i>Ethernet</i>				

Locator	Setting	Range	Increment	Unit
A	Unit ID	1 to 247	1	n/a
<i>RS485</i>				
B	Unit ID	1 to 247	1	n/a
C	Response Delay	10 to 10,000	10	milliseconds
<i>Modbus</i>				
D	Mapping	Default or Legacy	n/a	n/a

Remote Display Panel (optional)

Applications that require remote annunciation can use Basler Electric's Remote Display Panel. This device provides remote indication of many pre-alarm and alarm conditions.

Remote Display Panel connections are made at 62 (RDP TxD–), 61 (RDP TxD+), 49 (BATT–), and 48 (BATT+).

The following pre-alarm conditions are indicated by LEDs on the Remote Display Panel when enabled in the DGC-2020HD:

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

The following alarm conditions are indicated by LEDs and an audible alarm on the Remote Display Panel when enabled in the DGC-2020HD. The Overcrank, Emergency Stop, Fuel Leak/Sender Failure, and Sender Failure alarms are always enabled.

- Low coolant level*
- High coolant temperature
- Low oil pressure
- Overcrank
- Overspeed
- Emergency stop activated†
- Fuel leak/Sender failure*‡
- Sender failure‡

* The LED on the Remote Display Panel illuminates when the input that is assigned to this programmable function is closed. This programmable function must be enabled in the DGC-2020HD.

† The LED on the Remote Display Panel illuminates when the input that is assigned to this programmable function is closed.

‡ This LED can be reprogrammed in the DGC-2020HD to suit the needs of a particular application. The condition listed above is annunciated by default. See the *BESTlogicPlus* chapter for information about configuring the RDP Programmable Alarm and Pre-Alarm logic blocks.

Additionally, the Remote Display Panel indicates when the DGC-2020HD is not operating in Auto mode and when the generator is supplying load. The Switch Not In Auto LED illuminates when the DGC-2020HD is in an alarm state not listed above.

See the *Terminals and Connectors* chapter for more information on connecting the Remote Display Panel to the DGC-2020HD. Refer to Basler Publication 9318100990 for more information on the Remote Display Panel.



Configuration

System parameters configure the DGC-2020HD for operation with a specific application. This chapter lists items to consider when configuring the DGC-2020HD. These items consist of system settings, rated data, remote module setup, crank settings, automatic restart settings, exercise timer settings, sensing transformer ratings, relay control settings, and system configuration detection settings.

System Settings

BESTCOMSPlus Navigation Path: Settings Explorer, System Parameters, System Settings

Front Panel Navigation Path: Settings > System Parameters > System Settings

The System Settings parameters consist of number of fly wheel teeth, speed signal source, power-up delay, fuel level function, NFPA compliance level, EPS supplying load, system units, and metric pressure units. Figure 166 illustrates the BESTCOMSPlus System Settings screen.

System Type

Select whether the system is a *Single Generator* or *Multiple Generator* system.

Number Flywheel Teeth

Number Fly Wheel Teeth is used when calculating engine rpm.

Speed Signal Source

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

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

When engine speed is obtained from an MPU, the DGC-2020HD uses the number of flywheel teeth when calculating engine rpm.

The speed signal from the MPU takes priority when both the genset frequency and MPU are selected as the engine speed source. If both MPU and genset frequency are selected and the MPU fails, the DGC-2020HD automatically switches to the genset frequency as the engine speed source. Also, a pre-alarm is issued to indicate the failure of the MPU.

Power-Up Delay

In some cases, the ECU may take longer than the DGC-2020HD to power up. To counteract this, the power up delay setting can be used to delay the initial pulsing of the ECU for data on DGC-2020HD power up.

Fuel Level Function

This setting determines whether the fuel level indications and the related alarm and pre-alarm are enabled or disabled. Setting selections include, Fuel Level, Natural Gas, Liquid Propane, or Disabled. Selecting a fuel type other than Fuel Level disables any fuel level indication, alarm, or pre-alarm. This includes the Fuel Level value on the *Metering Explorer, Engine* screen in BESTCOMSPlus.

Fuel Level Source

If using a resistive fuel level sender, select the Resistive Sender option. In cases where a fuel level transducer with a 4 to 20 mA or -10 to 10 Vdc signal is used, select the appropriate analog input. Analog

inputs 1 and 2 can always be selected. Analog inputs 3 and 4 are available to DGC-2020HD units with the analog sender inputs option (style number xxxxxxxxA).

Coolant Temperature Source

If using a resistive coolant temperature sender, select the Resistive Sender option. This option is only available to DGC-2020HD units with resistive sender inputs (style number xxxxxxxxR). If using a coolant temperature transducer with a 4 to 20 mA or -10 to 10 Vdc signal, select the appropriate analog input. Analog inputs 1 and 2 can always be selected. Analog inputs 3 and 4 are available to DGC-2020HD units with the analog sender inputs option (style number xxxxxxxxA).

Oil Pressure Source

If using a resistive oil pressure sender, select the Resistive Sender option. This option is only available to DGC-2020HD units with resistive sender inputs (style number xxxxxxxxR). If using an oil pressure transducer with a 4 to 20 mA or -10 to 10 Vdc signal, select the appropriate analog input. Analog inputs 1 and 2 can always be selected. Analog inputs 3 and 4 are available to DGC-2020HD units with the analog sender inputs option (style number xxxxxxxxA).

NFPA Compliance Level

The DGC-2020HD can be used in an application requiring compliance with NFPA Standard 110. Levels 1 and 2 of Standard 110 are supported. Selecting level 1 or 2 affects DGC-2020HD operation in the following ways:

- Number of crank cycles is fixed at 3
- Crank cycle time is fixed at 15 seconds
- Continuous crank time is fixed at 45 seconds
- Low coolant temperature pre-alarm setting is fixed at 70°F
- Off Mode Cool Down is disabled
- *Not In Auto Horn Enable* setting is Enabled
- *Horn* setting is Enabled

EPS Supplying Load

EPS Supplying Load options are Low-line Scale Factor and EPS Threshold. These settings are described in the following paragraphs.

Low-line Scale Factor

Low-line Scale Factor automatically adjusts the EPS threshold setting in applications utilizing more than one type of genset connection. The scale factor setting is implemented when the DGC-2020HD is determined to be in a low-line configuration. If the Low-Line Override function is assigned to a contact input via the Programmable Functions screen, the state of the contact input and the detected configuration are ORed. This means, if one or both are true, then the system is determined to be configured for low-line. The value of the scale factor setting serves as a multiplier for the threshold setting. For example, if a scale factor contact input is received by the DGC-2020HD and the scale factor setting is 2.000, the threshold setting is doubled (2.000 x Threshold setting).

EPS Threshold

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

This setting accepts values from 3 to 10, in increments of 1%.

System Units

Engine oil pressure and coolant temperature can be displayed in English or Metric units of measure.

Metric Pressure Units

When system units are displayed in Metric, this setting allows engine oil pressure to be displayed in either bar or kPa/MPa.

System Breaker Configuration

Select the appropriate breaker control configuration using the System Breaker Configuration setting. In BESTCOMSP^{Plus}, a one-line diagram is provided for each breaker configuration to aid in proper selection. Refer to the *Breaker Management* chapter for details on system breaker configurations.

Generator, Bus 1, and Bus 2 Labels

Each bus can be programmed with a text label describing its use. Up to 64 alphanumeric characters are accepted. This label appears in BESTCOMSP^{Plus} to aid in ease of configuration and programming.

System Settings

System Type: Single Generator [A]

Number Fly Wheel Teeth: 126.0 [B]

Power Up Delay (s): 1 [C]

Speed Signal Source: Magnetic Pickup and Gen Frequency [D]

Fuel Level Function: Fuel Level [E]

Fuel Level Source: Resistive Sender [F]

Coolant Temperature Source: Resistive Sender [G]

Oil Pressure Source: Resistive Sender [H]

NFPA Level: ☒ Zero ☐ One ☐ Two

EPS Supplying Load: Low Line Scale Factor: 1.000 [I]

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

Rated Values

Frequency: Rated frequency of the unit: 60 Hz

Alternate Frequency (Hz): 60.00

Battery Volts: ☐ 12V ☒ 24V

Rated Engine RPM (rpm): 1800

System Breaker Configuration

Generator Breaker Control: K

Generator Bus 1

Generator Label: Gen [L]

Bus 1 Label: Bus 1 [M]

Bus 2 Label: Bus 2 [N]

System Units

☒ English ☐ Metric

Metric Pressure Units

☒ bar ☐ kPa/MPa

Figure 166. Settings Explorer, System Parameters, System Settings

Table 76. Settings for System Settings

Locator	Setting	Range	Increment	Unit
A	System Type	Single Generator or Multiple Generator	n/a	n/a
B	Number Fly Wheel Teeth	1 to 500	0.1	n/a
C	Power Up Delay	0 to 60	1	seconds

Locator	Setting	Range	Increment	Unit
D	Speed Signal Source	Magnetic Pickup, Gen Frequency, or Magnetic Pickup and Gen Frequency	n/a	n/a
E	Fuel Level Function	Disable, Fuel Level, Natural Gas, Liquid Propane	n/a	n/a
F	Fuel Level Source	Resistive Sender or Analog Inputs	n/a	n/a
G	Coolant Temperature Source	Resistive Sender or Analog Inputs	n/a	n/a
H	Oil Pressure Source	Resistive Sender or Analog Inputs	n/a	n/a
I	Low-line Scale Factor	0.001 to 3	0.001	n/a
J	EPS Threshold	3 to 10	1	%
K	System Breaker Configuration	No Breaker Control, Generator Breaker Control, Generator and Mains Breaker Control, and Generator and Mains Breaker Control with Load Bus	n/a	n/
L	Generator Label	Up to 64 alphanumeric characters	n/a	n/a
M	Bus 1 Label	Up to 64 alphanumeric characters	n/a	n/a
N	Bus 2 Label	Up to 64 alphanumeric characters	n/a	n/a

Rated Data

BESTCOMSPlus Navigation Paths:

Settings Explorer, System Parameters, Rated Data, Generator Rated Data

Settings Explorer, System Parameters, Rated Data, Bus 1 Rated Data

Settings Explorer, System Parameters, Rated Data, Bus 2 Rated Data (optional)

Front Panel Navigation Paths:

Settings > System Parameters > Rated Data, Gen

Settings > System Parameters > Rated Data, Bus 1

Settings > System Parameters > Rated Data, Bus 2 (optional)

Rated Data parameters consist of sensing transformer ratings, voltage ratings, current ratings, power ratings, and sensing configuration. These ratings can be viewed on the following read-only screens: Generator (Figure 167), Bus 1(Figure 168), and optional Bus 2 (identical to Figure 168). To edit rated data settings for the generator, bus 1, or optional bus 2, click the *Edit* button found on any of these screens. Upon clicking the Edit button, the floating Rated Data screen appears. All rated data settings for

generator, bus 1, and optional bus 2 can be configured here. Figure 169 illustrates the floating Rated Data screen. Settings are listed in Table 77.

Sensing Transformer Ratings

Generator

Generator PT settings establish the nominal primary (generator side) and secondary (DGC-2020HD side) voltage levels at the generator voltage-sensing transformer.

Generator CT settings establish the nominal, primary (generator side) current level at the generator current sensing transformer. The secondary value of the generator CT is dictated by the style number of the controller. A DGC-2020HD with a style number of 1xxxxxxx uses a nominal CT secondary rating of 1 Aac. A DGC-2020HD with a style number of 5xxxxxxx uses a nominal CT secondary rating of 5 Aac.

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

Bus 1 and Bus 2

Primary and secondary bus transformer ratings are used by the optional automatic transfer switch function. This function monitors a three-phase bus input to detect mains failure. The primary setting establishes the nominal voltage present at phases A, B, and, C of the bus. The secondary setting establishes the nominal voltage detected at the bus voltage input of the DGC-2020HD.

Bus CT settings establish the nominal, primary (bus side) current level at the bus current sensing transformer. The secondary value of the bus CT is dictated by the style number of the controller. A DGC-2020HD with a style number of 1xxxxxxx uses a nominal CT secondary rating of 1 Aac. A DGC-2020HD with a style number of 5xxxxxxx uses a nominal CT secondary rating of 5 Aac.

Voltage Ratings

Rated Volts accepts a value from 1 to 500,000, in increments of 1 volt.

Rated Secondary Volts is calculated using the following equation:

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

Equation 4. Rated Secondary Volts

Current Ratings

Rated Phase Amps is calculated using the following equations:

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

Equation 5. Rated Phase Amps for Three-Phase Connections

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

Equation 6. Rated Phase Amps for Single-Phase Connections

Rated Secondary Phase Amps is calculated using the following equation:

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

Equation 7. Rated Secondary Phase Amps

Power Ratings

Rated Power Factor accepts a value from -1 to 1, in increments of 0.01.

Rated kW accepts a value from 0 to 1,000,000, in increments of 0.01.

Rated kVA is calculated using the following equation:

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

Equation 8. Rated kVA

Rated kvar is calculated using the following equation:

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

Equation 9. Rated kvar

Sensing Configuration

Phase Rotation

Select either ABC (clockwise rotation) or ACB (counterclockwise rotation).

Voltage Sensing Connection Type

This setting provides selections for the voltage sensing connection type. Select Delta, Wye, Single-phase A-B, Single-phase A-C, or Grounded Delta.

Current Sensing Connection Type

Selectable current sensing connections types are A, B, C, AB, BC, CA, or CT ABC.

Frequency

The frequency settings allow selection of the rated frequency of the generator and an alternate frequency.

Rated Frequency of the Unit

Rated frequency options are 50 and 60 Hz.

Alternate Frequency

This setting accepts values from 10 to 90, in increments of 0.01.

Battery Volts

Nominal voltage of the starter battery is used by the DGC-2020HD to detect and annunciate high, low, or weak battery voltage. Battery Volts options are 12 V and 24 V.

Rated Engine RPM

This field accepts values from 1,400 to 2,000, in increments of 1.

Generator Rated Data

[Edit](#)

PT

Primary Volts (V)

Secondary Volts (V)

CT

Current Sensing Input Type

Primary Amps (A)

Low Line Scale Factor

Rated Volts (V L-L)

Rated Secondary Volts (V L-L)

Rated Phase Amps

Rated Secondary Phase Amps

Rated Power Factor (PF)

kW Rating (kW)

Rated kVA

Rated kvar

Sensing Configuration

Phase Rotation

Voltage Sensing

CT Phase Connection

Figure 167. Settings Explorer, System Parameters, Rated Data, Generator Rated Data Screen (Read Only)

Bus 1 Rated Data

[Edit](#)

PT

Primary Volts (V)

Secondary Volts (V)

CT

Current Sensing Input Type

Primary Amps (A)

Rated Volts (V L-L)

Rated Secondary Volts (V L-L)

Rated Phase Amps

Rated Secondary Phase Amps

Rated Power Factor (PF)

kW Rating (kW)

Rated kVA

Rated kvar

Sensing Configuration

Voltage Sensing

CT Phase Connection

Figure 168. Settings Explorer, System Parameters, Rated Data, Bus Rated Data Screen (Read Only)

Rated Data

Current Sensing Input Type: 5A CTs [A]

Frequency: Rated frequency of the unit: 60 Hz [B]
Alternate Frequency (Hz): 60.00 [C]

Battery Volts: ☐ 12V ☒ 24V

Rated Engine RPM (rpm): 1800 [D]

	Generator	Bus 1	Bus 2
PT - Primary Volts (V)	120 [E]	120	120
PT - Secondary Volts (V)	120 [F]	120	120
CT - Primary Amps (A)	200 [G]	200	200
Low Line Scale Factor	1.000 [H]		
Rated Volts (V L-L)	120 [I]	120	120
Rated Secondary Volts (V L-L)	120	120	120
Rated Phase Amps	200	200	200
Rated Secondary Phase Amps	5.00	5.00	5.00
Rated Power Factor (PF)	0.80 [J]	0.80	0.80
Rated kW	33.26 [K]	33.26	33.26
Rated kVA	41.57	41.57	41.57
Rated kvar	24.94	24.94	24.94
Phase Rotation	[L] ABC [v]		
Voltage Sensing	[M] Wye [v]	Wye [v]	Wye [v]
CT Phase Connection	[N] CT ABC [v]		

OK Cancel

Figure 169. Floating Rated Data Screen

Table 77. Settings for Rated Data

Locator	Setting	Range	Increment	Unit
A	Current Sensing Input Type	5 A CTs or 1A CTs	n/a	n/a
B	Rated Frequency of the Unit	50 Hz or 60 Hz	n/a	n/a
C	Alternate Frequency	10 to 90	0.01	Hz
D	Rated Engine RPM	750 to 3,600	1	RPM
E	PT – Primary Volts	1 to 500,000	1	volts
F	PT – Secondary Volts	1 to 600	1	volts
G	CT – Primary Amps	1 to 99,999	1	amperes
H	Low-line Scale Factor	0.001 to 3	0.001	n/a
I	Rated Volts	1 to 500,000	1	volts
J	Rated Power Factor	–1 to 1	0.01	n/a
K	Rated kW	0 to 1,000,000	0.01	kW
L	Phase Rotation	ABC or ACB	n/a	n/a
M	Voltage Sensing	Delta, Wye, 1 Phase A-B, 1 Phase A-C, Grounded Delta	n/a	n/a
N	CT Phase Connection	A, B, C, AB, BC, CA, or CT ABC	n/a	n/a

Remote Module Setup

BESTCOMSPlus Navigation Path: Settings Explorer, System Parameters, Remote Module Setup

Front Panel Navigation Path: Settings > System Settings > Remote Module Setup

DGC-2020HD controllers are capable of communicating with up to four contact expansion modules (CEM-2020s) and up to four analog expansion modules (AEM-2020s) on a single network.

To set up an optional CEM-2020, select *Enable*, input the appropriate J1939 address, and select the appropriate number of outputs available to the module. The low current module (CEM-2020) provides 24 contact outputs and the high current module (CEM-2020H) provides 18 contact outputs.

For optional AEM-2020 setup, select *Enable*, input the appropriate J1939 address, and input the expected serial number. Expected serial numbers are used by the DGC-2020HD to determine which input/output points belong to a module when multiple modules are present. An AEM-2020 Not Configured pre-alarm occurs if the expected serial number does not match the serial number detected on the General Settings, Device Info screen.

Figure 170 illustrates the BESTCOMSPlus Remote Module Setup screen.

The screenshot displays the 'Remote Module Setup' interface, which is organized into two rows of four columns each. The top row is for 'Contact Expansion Modules' (CEM-2020s) and the bottom row is for 'Analog Expansion Modules' (AEM-2020s). Each column represents a single module, labeled 'Contact Expansion Module 1' through '4' and 'Analog Expansion Module 1' through '4'.

For each module, the configuration options are:

- Module Enable:** A group box containing two radio buttons: 'Disable' and 'Enable'. In the CEM modules, 'Enable' is selected for Modules 1, 2, and 4, while 'Disable' is selected for Module 3. In the AEM modules, 'Enable' is selected for Modules 1, 2, and 3, while 'Disable' is selected for Module 4.
- J1939 Address:** A text input field. For CEM modules, the address is '236'. For AEM modules, the address is '237'.
- CEM Outputs:** A dropdown menu (only present for CEM modules) set to '18 Outputs'.
- Expected Serial Number:** A text input field. For CEM modules, it is 'NA'. For AEM modules, it is 'NA'.

Figure 170. Settings Explorer, System Parameters, Remote Module Setup

Crank Settings

BESTCOMSPlus Navigation Path: Settings Explorer, System Parameters, Crank Settings

Front Panel Navigation Path: Settings > System Parameters > Crank Settings

Crank settings consist of pre-start, restart, cranking, crank disconnect, and cool down. These settings are described in the paragraphs below.

Figure 171 illustrates the BESTCOMSPlus Crank Settings screen. Settings are listed in Table 78.

Figure 171. Settings Explorer, System Parameters, Crank Settings

Table 78. Settings for Crank Settings

Locator	Setting	Range	Increment	Unit
A	Pre-crank Delay	0 to 30	1	seconds
B	Restart Delay	0 to 120	1	seconds
C	Number of Crank Cycles	1 to 7	1	n/a
D	Cycle Crank Time	5 to 15	1	seconds
E	Continuous Crank Time	5 to 60	1	seconds
F	Crank Disconnect Limit	10 to 100	1	%
G	Crank Disconnect Pressure	2.9 to 150	0.1	psi
		0.2 to 10.3	0.1	bar
		20 to 1,034.5	0.1	kPa
H	Off Mode Cool Down Enable	Disable or Enable	n/a	n/a
I	No Load Cool Down Time	0 to 60	1	minutes

Pre-Start

If desired, cranking can be delayed after initiating engine startup. During this delay, the Pre-Start output closes to energize glow plugs or pre-start lubrication pumps. The Pre-crank Delay setting accepts values from 0 to 30, in increments of 1 second.

The Pre-Start output can be configured to open upon conclusion of engine cranking or remain closed while the engine is running.

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

Restart

Attempting to start an engine after a normal shutdown but before the engine RPM has settled to zero can stress an engine in certain situations. The Restart Delay inhibits attempts to start the engine immediately after a normal shutdown for the duration of the Restart Delay timer. This delay should allow an engine to

properly spin down before attempting to restart. This setting accepts values from 0 to 120 seconds, in increments of 1 second.

Cranking

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

Crank Disconnect

Under normal operation, engine rpm is used to determine crank disconnect. The Crank Disconnect Limit setting establishes the engine rpm percentage at which the starter is disconnected.

Oil Pressure Crank Disconnect provides a secondary indication that the engine is running. This ensures that the starter is disconnected, even if no engine rpm sources are functioning. When enabled, oil pressure is used to determine if the engine is running when no valid speed source is detected. If the engine oil pressure is above the threshold and no valid speed source is detected, the starter is disconnected from the engine. If a valid speed source is detected, the oil pressure crank disconnect function is inhibited to prevent an undesired crank disconnect when oil pressure rises above the threshold during normal engine cranking.

Cool Down

After the load is removed from a genset, the DGC-2020HD implements a smart cool down function. This function ensures that the engine and turbocharger properly cool down by maintaining engine operation for a user-defined duration.

This cool down function is initiated for any one of the following conditions:

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

Smart Cool Down Function

The smart cool down function reduces unnecessary fuel expenditure by considering overall cool down time through multiple requests. For example, a new cool down request is initiated after a previous cool down sequence has already started. The cool down timer is not simply reset with each new request. Instead, the amount of time that the engine has spent cooling down is factored into the new request. This saves time and fuel by running the engine no longer than necessary to achieve proper cool down.

Automatic Restart Settings

BESTCOMSPlus Navigation Path: Settings Explorer, System Parameters, Automatic Restart

Front Panel Navigation Path: Settings > System Parameters > Auto Restart

When enabled, the Automatic Restart clears all alarms automatically if the DGC-2020HD shuts down due to an alarm condition. An attempt to restart the engine is made, after a predetermined time delay, if the ATS contact input is closed. If an ATS contact is not present, the unit remains in the READY state with alarms cleared. A restart is not attempted if a low fuel alarm or emergency stop is present. The number of restart attempts is programmable. Automatic restart attempts are recorded in the event log.

Auto Restart Interval accepts values from 0.5 to 30 minutes, in increments of 0.5 minutes. The Auto Restart Attempts setting accepts values from 1 to 10, in increments of 1.

The BESTCOMSPlus Automatic Restart screen is illustrated in Figure 172.

Automatic Restart

Auto Restart Enable

Auto Restart Interval (min)

Auto Restart Attempts

Figure 172. Settings Explorer, System Parameters, Automatic Restart

Exercise Timer Settings

BESTCOMSPlus Navigation Path: Settings Explorer, System Parameters, Exercise Timer

Front Panel Navigation Path: Settings > System Parameters > Exercise Timer

The exercise timer is used to start the genset at a predetermined time and run for a user-defined period. The mode defines how often the genset will run. If monthly is selected, the day of the month to start must also be selected. If weekly is selected, the day of the week to start must also be selected. Settings for Start Hour and Start Minute can also be defined. The Run Period Hours and Minutes define how long the genset will run each session. The Start Hour and Run Period Hours settings accept values from 0 to 23, in increments of 1 hour. The Start Minute and Run Period Minutes settings accept values from 0 to 59, in increments of 1. If Run with Load is enabled, the DGC-2020HD closes the generator breaker during the run time.

Contact inputs and outputs can be assigned to this function. Refer to the *BESTlogicPlus* chapter for more information.

The BESTCOMSPlus Exercise Timer screen is illustrated in Figure 173.

Exercise Timer

Mode

Start Day Of Month

Start Day Of Week

Start Hour

Start Minute

Run Period Hours

Run Period Minutes

☐ Run with Load

Figure 173. Settings Explorer, System Parameters, Exercise Timer

Sensing Transformer Ratings

BESTCOMSPlus Navigation Path: Settings Explorer, System Parameters, Sensing Transformers

Front Panel Navigation Path: Settings > System Parameters > Sensing Transformers

Sensing transformer settings configure the DGC-2020HD for operation with a specific system. These settings, along with the generator voltage, generator current, bus voltage, and bus current detected by the DGC-2020HD, enable it to accurately meter system values and offer generator protection.

Figure 174 illustrates the BESTCOMSPlus Sensing Transformers screen. To edit rated data settings for the generator, bus 1, or optional bus 2, click the *Rated Data* button found on this screen. Upon clicking the *Rated Data* button, the floating Rated Data screen appears. All rated data settings for generator, bus 1, and optional bus 2 can be configured here. Figure 169 illustrates the floating Rated Data screen. Settings are listed in Table 77.

Aux CT Mapping

DGC-2020HD controllers with style number xxxxxxxxBx have one auxiliary CT and controllers with style number xxxxxxxxEx have four. Specify the mappings for each auxiliary CT using these settings.

Ground Current

Ground Current auxiliary CT settings establish the nominal, primary (bus side) current level at the ground current sensing transformer. This setting accepts values from 1 to 99,999, in increments of 1. The secondary value of the ground current sensing CT is dictated by the style number of the controller. A DGC-2020HD with a style number of 1xxxxxxx uses a nominal CT secondary rating of 1 Aac. A DGC-2020HD with a style number of 5xxxxxxx uses a nominal CT secondary rating of 5 Aac.

Sensing Transformers

Aux CT Mapping

Aux CT 1: Ground Current

Aux CT 2: CT Not Connected

Aux CT 3: CT Not Connected

Aux CT 4: CT Not Connected

Ground Current

Primary Amps (A): 200

Secondary Amps (A): 1

Rated Data

Generator

PT

Primary Volts (V): 120

Secondary Volts (V): 120

CT

Current Sensing Input Type: 5A CTs

Primary Amps (A): 200

Low Line Scale Factor: 1.000

Bus 1

PT

Primary Volts (V): 120

Secondary Volts (V): 120

CT

Current Sensing Input Type: 5A CTs

Primary Amps (A): 200

Bus 2

PT

Primary Volts (V): 120

Secondary Volts (V): 120

CT

Current Sensing Input Type: 5A CTs

Primary Amps (A): 200

Figure 174. Settings Explorer, System Parameters, Sensing Transformers

Relay Control Settings

BESTCOMSPlus Navigation Path: Settings Explorer, System Parameters, Relay Control

Front Panel Navigation Path: Settings > System Parameters > Relay Control

The default operational setting for the Start, Run, and Pre-start relays is *Predefined* or standard. Any of these relays can be logic driven by selecting the *Programmable* setting. Logic driven programmable relays must be set up using BESTlogicPlus

Figure 175 illustrates the BESTCOMSPlus Relay Control screen.

Relay Control

Relay Control

Start: Programmable

Run: Predefined

Prestart: Predefined

Figure 175. Settings Explorer, System Parameters, Relay Control

System Configuration Detection Settings

BESTCOMSPi+ Navigation Path: Settings Explorer, System Parameters, Auto Config Detection

Front Panel Navigation Path: Settings > System Parameters > Auto Config Detect

When enabled, this feature allows the DGC-2020HD to automatically detect its sensing configuration in relation to the generator. Upon starting the genset, the configuration of the generator is automatically detected. Single-Phase Override and Low-Line Override statuses are set accordingly.

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

It is recommended that the Single-phase Override and Low-line Override programmable functions are not assigned to contact inputs when Automatic Configuration Detection is enabled.

The BESTCOMSPi+ Auto Config Detection screen is illustrated in Figure 176. Settings are listed in Table 79.

Figure 176. Settings Explorer, System Parameters, Auto Config Detection

Table 79. Settings for Auto Config Detection

Locator	Setting	Range	Increment	Unit
A	Enable	Disable or Enable	n/a	n/a
B	Single-phase Detect Threshold	0 to 480	1	volts
C	Low-line Detect Threshold	0 to 480	1	volts
D	Single-Phase Detect Generator Connection	A-B or A-C	n/a	n/a

Single-phase Detect Threshold

If the difference between the maximum and minimum line-to-line voltage exceeds this threshold, the unit is determined to be in single-phase configuration. If determined to be in single-phase configuration, the Single-phase Override programmable function forces the DGC-2020HD into single-phase mode. The single-phase mode connection is determined by the *Single-phase Detect Generator Connection*, below.

If the Single-phase Override function is assigned to a contact input via the Programmable Functions screen, the state of the contact input and the detected configuration are ORed. This means, if one or both are true, then the system is determined to be configured as single-phase.

Low-line Detect Threshold

If the average of the valid line-to-line voltages for the detected configuration meets or exceeds this threshold, the unit is determined to be in a high-line configuration. If the average is below this threshold, it

is determined to be in a low-line configuration. If determined to be in low-line configuration, the Low-Line Override function forces the DGC-2020HD into the low-line configuration.

If the Low-Line Override function is assigned to a contact input via the Programmable Functions screen, the state of the contact input and the detected configuration are ORed. This means, if one or both are true, then the system is determined to be configured for low-line.

Single-phase Detect Generator Connection

This setting specifies which single-phase connection to use when the system is determined to be single phase. Single-phase A-B or Single-phase A-C can be selected.

Device Information

DGC-2020HD identification labels, firmware version, serial number, and style number are found on the Device Info screen in BESTCOMS*Plus*®.

Style Number

BESTCOMS*Plus* Navigation Path: Settings Explorer, General Settings, Style Number

Front Panel Navigation Path: Not available through front panel

The model number, together with the style number, describes the options included in a specific device. The style number of the DGC-2020HD is displayed on the BESTCOMS*Plus* Style Number screen after downloading settings from the device. When configuring DGC-2020HD settings off-line, the style number for the unit to be configured can be entered into BESTCOMS*Plus* to enable configuration of the required settings. The BESTCOMS*Plus* Style Number screen is illustrated in Figure 177.

DGC-2020HD Style Number Options	
5	Current Sensing Input Type 1) 1A CTs 5) 5A CTs
N	Color LCD N) Default Screen C) Color LCD Screen
E	Generator Protection S) Standard Gen Protection E) Enhanced Gen Protection
1	Automatic Synchronizer 1) No Auto Sync 2) w/ Auto Sync
D	Ethernet F) 100BaseF (Fiber) D) Dual 100BaseT
N	AVR N) None A) AVR 3.5 Adc B) AVR 7.0 Adc
S	Terminal Type S) Spring
B	Bus Inputs B) Basic Sensing E) Enhanced Sensing
R	Senders A) Analog R) Resistive

Figure 177. Style Number Screen

Device Info

BESTCOMS*Plus* Navigation Path: Settings Explorer, General Settings, Device Info

Front Panel Navigation Path: Settings > General Settings > Device Information

Information about a DGC-2020HD communicating with BESTCOMS*Plus* can be obtained on the Device Info screen of BESTCOMS*Plus* after downloading settings from the device.

The application version must be selected when configuring DGC-2020HD settings off-line. When on-line, read-only information includes the application version, application part number, application build date, boot code version, model number, style number, and serial number.

DGC-2020HDs have three device identification fields: Device ID, Station ID, and User ID. These fields are used in the header information lines of the Fault Reports, Oscillograph Records, and Sequence of Events Records. Each ID can be up to 64 characters long.

The BESTCOMS*Plus* Device Info screen is illustrated in Figure 178.

Figure 178. Device Info Screen

Firmware Updates

Future enhancements to the DGC-2020HD functionality will make a firmware update desirable. Because default settings are loaded when DGC-2020HD firmware is updated, your settings should be saved in a file prior to upgrading firmware.

Note

The latest version of BESTCOMS*Plus* software should be downloaded from the Basler Electric website and installed before performing a firmware upgrade.

A device package contains firmware for the DGC-2020HD, the optional Contact Expansion Module (CEM-2020), and the optional Analog Expansion Module (AEM-2020). Embedded firmware is the operating program that controls the actions of the DGC-2020HD. The DGC-2020HD stores firmware in nonvolatile flash memory that can be reprogrammed through the communication ports. It is not necessary to replace EPROM chips when updating the firmware with a newer version.

The DGC-2020HD can be used in conjunction with multiple CEM-2020 or AEM-2020 expansion modules which expand the DGC-2020HD capabilities. When upgrading the firmware in any component of this system, the firmware in ALL of the components of the system should be upgraded to ensure compatibility of communications between the components.

Caution

The order in which the components are upgraded is critical. Assuming a system of a DGC-2020HD and expansion module(s) is in a state where the DGC-2020HD is communicating with the system expansion module(s), **the expansion module must be upgraded before the DGC-2020HD**. This is necessary because the DGC-2020HD must be able to communicate with the expansion module(s) before the DGC-2020HD can send firmware to it. If the DGC-2020HD were upgraded first, and the new firmware included a change to the expansion module communication protocol, it is possible that the expansion module(s) could no longer communicate with the upgraded DGC-2020HD. Without communications between the DGC-2020HD and the expansion module(s), upgrading the expansion module(s) is not possible.

Note

If power is lost or communication is interrupted during file transfer to the DGC-2020HD, the firmware upload will fail. The device will continue to use the previous firmware. Once communication has been restored, the user must start the firmware upload again. Select Upload Device Files from the Communication pull-down menu and proceed normally.

Upgrading Firmware in Expansion Modules

The following procedure is used to upgrade firmware in the expansion modules. This must be completed before upgrading firmware in the DGC-2020HD. If no expansion module is present, proceed to *Upgrading Firmware in the DGC-2020HD*.

1. Place the DGC-2020HD in OFF mode. This can be accomplished by clicking the Off button on the Control screen inside the Metering Explorer or by pressing the Off button on the DGC-2020HD front panel.
2. Enable the expansion module that is present in the system. If it has not already been enabled, enable the expansion module on the Settings > System Parameters > Remote Module Setup screen.
3. Verify that the DGC-2020HD and the associated expansion module are communicating. This can be verified by examining the pre-alarm status using the Metering Explorer in BESTCOMS*Plus* or from the front panel by navigating to Metering > Alarms. There should be no Loss of Comms pre-alarms in the pre-alarm status when communications are functioning properly.
4. Connect to the DGC-2020HD through the USB or Ethernet port if not already connected.
5. Select Upload Device Files from the Communication pull-down menu.
6. You will be asked to save the current settings file. Select Yes or No.
7. When the Basler Electric Device Package Uploader screen (Figure 179) appears, click on the Open button to browse for the device package you have received from Basler Electric. The Package Files along with File Details are listed. Place a check in the boxes next to the individual files you want to upload.

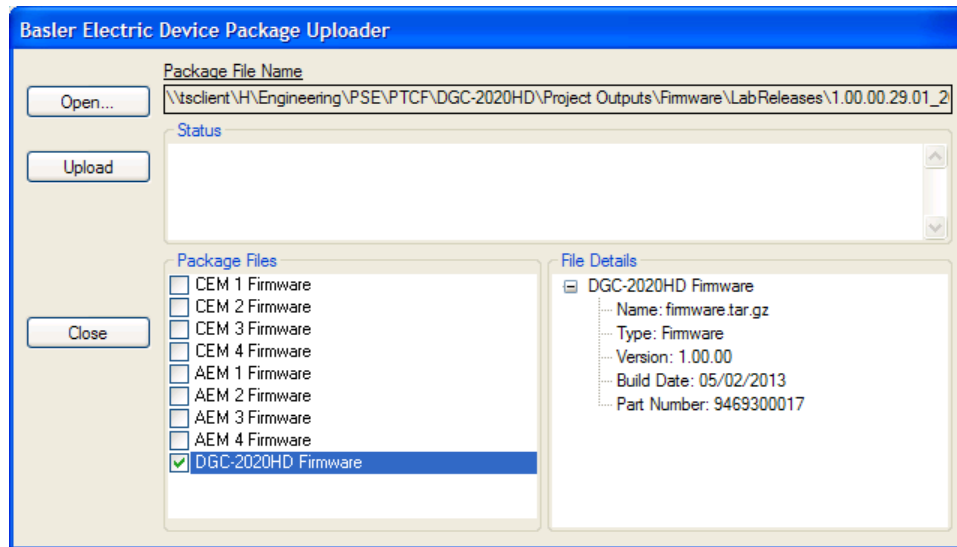


Figure 179. Basler Electric Device Package Uploader

8. Click on the Upload button and the Proceed with Device Upload screen will appear. Select Yes or No.
9. After selecting Yes, the DGC-2020HD Selection screen will appear. Select either USB or Ethernet.
10. After file(s) have been uploaded, click the *Close* button on the Basler Electric Device Package Uploader screen and disconnect communication to the DGC-2020HD.

Upgrading Firmware in the DGC-2020HD

Upgrade DGC-2020HD firmware and then load a saved settings file.

1. Upgrade the DGC-2020HD firmware.
 - a. Connect to the DGC-2020HD with *BESTCOMSPi.us*. Check the firmware Application Version on the General Settings > Device Info screen.
 - b. Select Upload Device Files from the Communication pull-down menu. You do not have to be connected to the DGC-2020HD at this time. Save settings when prompted, if desired.
 - c. Open the desired device package file (dgc-2020hd.bef).
 - d. Check the box for DGC-2020HD Firmware. Note the version number of the DGC-2020HD firmware; this is the version that will be used to set the Application Version in the settings file in a later step.
 - e. Click the Upload button and follow the instructions that appear to begin the upgrade process.
 - f. After the upload is complete, disconnect communication to the DGC-2020HD.
2. Load the saved settings file into the DGC-2020HD.
 - a. Close all settings files.
 - b. From the File pull-down menu, select New, DGC-2020HD.
 - c. Connect to the DGC-2020HD.
 - d. Once all settings have been read from the DGC-2020HD, open the saved settings file by selecting File, Open File in the *BESTCOMSPi.us* menu. Then browse for the file to upload.
 - e. When *BESTCOMSPi.us* asks if you wish to upload settings and logic to the device, click Yes.

- f. If you are receiving upload failures and indications that the logic is incompatible with the firmware version, check that the DGC-2020HD style number in the saved file matches that of the DGC-2020HD into which the file is being uploaded. The style number in the settings file is found under General Settings > Style Number in BESTCOMSP^{lus}.
- g. If the style number of the settings file does not match that of the DGC-2020HD into which it is to be loaded, disconnect from the DGC-2020HD, then modify the style number in the settings file. Then repeat the steps titled *Load the Saved Settings File into the DGC-2020HD*.



Security

Multiple levels of DGC-2020HD security give personnel the level of access appropriate for the tasks they routinely perform while securing critical settings from unauthorized access.

Access Levels

Passwords provide access security for six distinct functional access areas: Read, Control, Operator, Settings, Design, and Administrator (Admin). Each functional area can be assigned a unique password or one password can be assigned to multiple areas. Functional areas are not independent of one another. For example, an Admin password is used to access levels 6, 5, 4, 3, 2, and 1; a Design password is used to access levels 5, 4, 3, 2, and 1. Table 80 lists the access levels and descriptions.

Table 80. Access Levels and Descriptions

Access Level	Description
6 - Admin (highest)	Users and channel authorizations can be created, edited, or deleted.
5 - Design	Programmable logic can be created or changed.
4 - Settings	Values of all settings and cumulative run statistics can be changed, but logic equations cannot be entered or edited.
3 - Operator	Date and time can be set, accumulators can be reset (excluding cumulative run statistics), and event data can be erased.
2 - Control	Real time controls can be operated.
1 - Read	All system parameters can be read, but no changes or operation is allowed.
0 - None	All access is denied.

Additional security is provided by controlling the functional areas that can be accessed through a particular communication port. For example, security can be configured so that front panel access is permitted at a lower access level than BESTCOMSPlus® or Modbus™ access.

The communication ports and password parameters act as a two-dimensional control to limit changes. The entered password must be correct and the command must be entered through a valid port. Only one port at a time can be in use with higher than Read access. For example, if a user gains Settings access at the USB port, users at other ports (Ethernet, front panel, or RS-232) will not be able to gain higher than Read access. Only after the user with Settings access at the USB port logs out from the device, can other users gain higher than Read access. One exception to this, however, is with Modbus communication. When a connection is established via Modbus protocol with an unsecured access level of Control or Operator, the connection is maintained even if a user gains higher than Read access through another port.

If a port holding higher than Read access sees no activity for the duration of the Access Timeout setting, access privileges will automatically be lowered to Read access. This feature ensures that password protection cannot be accidentally left in a state where access privileges are enabled for one area and other areas locked out for an indefinite period.

User Name Setup

1. Use the Settings Explorer in BESTCOMSPlus to select User Name Setup under General Settings, Device Security Setup. The Login dialog box appears. See Figure 180. An administrator access level is required to set up usernames and passwords.

Port Access Setup

1. Use the Settings Explorer in BESTCOMSPlus to select Port Access Setup under General Settings, Device Security Setup. The Port List screen is shown in Figure 182.

Port	Unsecured Access	Secured Access
BESTCOMSPlus® via Ethernet	Read	Admin
BESTCOMSPlus® via RS232	Read	Admin
BESTCOMSPlus® via USB	Read	Admin
HMI	Read	Admin
Modbus via Ethernet	Read	Admin
Modbus via Serial	Read	Admin

Selected Port Information

Unsecured Access Level
Read

Secured Access Level
Admin

Save Port

Figure 182. Port List Screen

2. The Login dialog box pops up. See Figure 180. An administrator access level is required to set up port access. Enter the username and password of the administrator and then click the Log In button. The default administrator username is "A" and the default password is "A".
3. In the side column, highlight a port to change.
4. On the right side of the screen, use the drop-down menus to select the Unsecured Access Level and Secured Access Level for the highlighted port. The Unsecured Access Level setting sets the max level of access which can be gained without entering a username/password. The Secured Access Level setting sets the max level of access which can be gained with a password.
5. Click the Save Port button to save to the settings to BESTCOMSPlus memory.
6. Pull down the Communication menu and select Upload Security to Device. The Login dialog box appears. An administrator level is required to upload security to the device.
7. Enter the username and password of the administrator and then click the Log In button. The default administrator username is "A" and the default password is "A". BESTCOMSPlus notifies you when the upload is successful.

Access Control

The Access Timeout setting defines the amount of time before access expires. The timer resets every time a setting is changed. If a password is entered incorrectly more than x times (Login Attempts) in y seconds (Login Time Window), then access is prohibited for z seconds (Login Lockout Time).

The BESTCOMSPlus Access Control screen is illustrated in Figure 183. Settings are listed in Table 81.

Access Control

Access Timeout
 Delay (s)
 A

Login Failure
 Login Attempts
 B
 Login Time Window (s)
 C
 Login Lockout Time (s)
 D

Figure 183. Access Control Screen

Table 81. Settings for Access Control

Locator	Setting	Range	Increment	Unit
A	Access Timeout Delay	10 to 3,600	1	seconds
B	Login Failure Login Attempts	1 to 10	1	units
C	Login Failure Login Time Window	1 to 99,999	1	seconds
D	Login Failure Lockout Time	1 to 99,999	1	seconds

1. Use the Settings Explorer in BESTCOMSP^{lus} to select Access Control under General Settings, Device Security Setup. The Access Control screen is shown in Figure 183.
2. Configure the Access Timeout and Login Failure settings.
3. Pull down the Communication menu and select Upload Security to Device. The Login dialog box pops up. An administrator level is required to upload security to the device.
4. Enter the username and password of the administrator and then click the Log In button. The default administrator username is "A" and the default password is "A". BESTCOMSP^{lus} notifies you when the upload is successful.

Timekeeping

The DGC-2020HD provides a real-time clock with an internal backup battery. The battery will maintain timekeeping for approximately five years (depending on conditions) after power is removed from the controller.

The clock is used by the event recorder and sequence of events functions to time-stamp events and the exercise timer to start and stop the genset when the exercise feature is utilized.

Clock Setup

BESTCOMSPlus Navigation Path: Settings Explorer, General Settings, Clock Setup

Front Panel Navigation Path: Settings > General Settings > Clock Setup

Clock settings are made through the communication ports using BESTCOMSPlus® or through the front-panel interface. Write access to ports is required to program the clock.

The BESTCOMSPlus Clock Setup screen is illustrated in Figure 184. Settings are listed in Table 82.

The local time zone is configured on this screen. The Time Zone Offset is the local offset to UTC (Coordinated Universal Time). The Time Zone Offset is required if NTP or IRIG-B is used for time synchronization or when the Start/End Time Reference is set to UTC (Coordinated Universal Time). The Start/End Time Reference is set to UTC time if required by local daylight savings time rules. The Start/End Hour/Minute settings determine the time when the DST will go into effect. The Bias setting is the amount of time that the clock moves forward or backward. The default settings are configured for the Central Time Zone in the United States as shown in Figure 184. Using these settings, the clock would move forward 1 hour at 2:00 a.m. on the second Sunday in March and move backward 1 hour at 2:00 a.m. on the first Sunday in November. DST can also be configured for a specific day of the month by selecting Fixed Dates under DST Configuration.

Time Priority Setup

There are two available protocols (NTP and IRIG-B), which can be assigned priorities to update the date and time. Double-click on an available item to move it to the Enabled box. Use the arrow buttons to set the priority of the selected item.

The NTP (Network Time Protocol) synchronizes the real-time clock to a network time server when an Ethernet cable is connected. The address of the NTP server must be entered when NTP is selected in the Time Priority Setup, Enabled box.

IRIG Decoding

The IRIG Decoding signal defines whether or not to decode the year field in the IRIG signal. Refer to the manufacturer of your equipment to determine if the year field is being sent to the DGC-2020HD.

Clock Not Set Warning

When enabled, this alarm annunciates when the DGC-2020HD has powered up and the clock has not been set.

Clock Setup

Time Zone Offset Setup

Time Zone Hour Offset: **A**

Time Zone Minute Offset: **B**

Clock Display Setup

Time Format: **C**

Date Format: **D**

Daylight Saving Time Setup

DST Configuration: **E**

Start/End Time Reference

☒ Respective to Local Time

☐ Respective to UTC Time

Start Day

Month: **F**

Occurrence of Day: **G**

Weekday: **H**

Hour: **I**

Minute: **J**

End Day

Month: **F**

Occurrence of Day: **G**

Weekday: **H**

Hour: **I**

Minute: **J**

Bias Setup

Hour: **K**

Minute: **L**

Time Priority Setup

Disabled:

Enabled:

Double-click on an item to move to next Box

IRIG Decode Year

☐ IRIG without Year

☒ IRIG with Year

NTP Address

Clock Not Set Warning

☐ Disable

☒ Enable

Figure 184. Settings Explorer, General Settings, Clock Setup Screen

Table 82. Settings for Clock

Locator	Setting	Range	Increment	Unit
A	Time Zone Hour Offset	-12 to 12	1	hours
B	Time Zone Minute Offset	-59 to 59	1	minutes
C	Time Format	12 Hour or 24 Hour	n/a	n/a
D	Date Format	YYYY-MM-DD MM-DD-YYYY DD-MM-YYYY	n/a	n/a
E	DST Configuration	Floating Dates or Fixed Dates	n/a	n/a
F	Month	January, February, March, April, May, June, July, August, September, October, November, or December	n/a	n/a

Locator	Setting	Range	Increment	Unit
G	Occurrence of Day	First, Second, Third, Fourth, or Last	n/a	n/a
H	Weekday	Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, or Saturday	n/a	n/a
I	Hour	0 to 23	1	hours
J	Minute	0 to 59	1	minutes
K	Bias Setup (Hour)	-23 to 23	1	hours
L	Bias Setup (Minute)	-59 to 59	1	minutes

Setting the Time and Date

BESTCOMSPlus Navigation Path: Metering Explorer, Real Time Clock

Front Panel Navigation Path: Metering > Status > Real Time Clock

Time and date settings can be made through BESTCOMSPlus on the Metering Explorer Real Time Clock screen (Figure 185). Settings can also be made through the front panel.

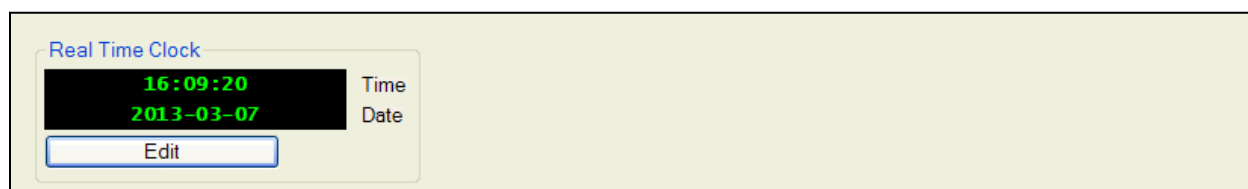


Figure 185. Metering Explorer, Real Time Clock

IRIG Port

IRIG time code signal connections are located on the rear panel. When a valid time code signal is detected at the port, it is used to synchronize the clock function. Note that the IRIG time code signal received from older IRIG receivers does not contain year information. If this is the case, it will be necessary to enter the date manually. Year information is stored in nonvolatile memory so that when operating power is restored after an outage and the clock is re-synchronized the current year is restored. When the clock rolls over to a new year, the year is automatically incremented in nonvolatile memory. A pre-alarm is annunciated for loss of IRIG signal. The pre-alarm monitors for IRIG signal loss once a valid signal is detected at the IRIG port.

Connections

IRIG connections are located on the terminal block closest to the USB port. Terminal designations and functions are shown in Table 83.

Table 83. IRIG Terminal Assignments

Terminal	Function
59	(+) Signal
60	(-) Reference

Specifications

Interface supports IRIG Standard 200-04, Format B006, and Standard 200-98, Format B002.

Input Signal Demodulated (dc level-shifted signal)

Input Voltage Range ± 10 Vdc maximum

Input Resistance Nonlinear, approximately 4 k Ω at 3.5 Vdc,
approximately 3 k Ω at 20 Vdc

Logic Voltage Threshold

High 3.5 Vdc minimum
Low 0.5 Vdc maximum

Real-Time Clock Specifications

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

Clock Holdup

Battery Holdup Time Approximately five years depending on conditions
Battery Type Rayovac BR2032, coin-type, 3 Vdc, 195 mAh
Basler Electric P/N 38526

Backup Battery for the Real-Time Clock

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.

Maintenance and Troubleshooting

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.

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

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.

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.

LCD is Blank and all LEDs are Flashing at Approximately 2 Second Intervals

This indicates that the DGC-2020HD does not detect that valid application firmware is installed. The unit is running its boot loader program, waiting to accept a firmware upload.

- Step 1. Start BESTCOMSPlus®. Use the top pull-down menu and select File, New, DGC-2020HD.
- Step 2. Select Communications, Upload Device Files and select the device package file that contains the firmware you want to upload.
- Step 3. Check the boxes for DGC-2020HD Firmware. Click the Upload button to start the upload process.

Generator Breaker and Mains Breaker

Generator Breaker Will Not Close to a Dead Bus

- Step 1: Review the description of how the generator breaker logic element functions contained in the GENBRK logic element description in the BESTlogic™Plus chapter.
- Step 2: Review the section on breaker close requests in the *Breaker Management* chapter.
- 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 BESTCOMSPlus 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 BESTCOMSPlus and verify that when the generator is running, the Bus Dead status LED is lit. If necessary, modify the settings on the Settings, Breaker Management, Bus Condition screen.
- Step 6: Verify the connections in BESTlogicPlus Programmable Logic to the generator breaker logic element. The Status input must be driven by an "A" or normally open contact from the generator breaker. The Open and Close command inputs on the left side of the logic block are inputs for open and close commands. These can be wired to physical inputs if it is desired to have open and close command switches. If they are wired, they must either be pulsed inputs, or some logic must be employed so that the open and close command inputs are never driven at the same time. If these are both driven at the same time, the breaker is receiving open and close commands simultaneously. The breaker will not change state if it is being commanded to open and close at the same time.
- Step 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 *BESTCOMSPPlus*, 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.
- Step 2: Review the section on breaker operation requests in the *Breaker Management* chapter.
- Step 3: Verify the connections in *BESTlogicPlus* Programmable Logic to the generator breaker logic element. The Status input must be driven by an “A” or normally open contact from the generator breaker. The Open and Close command inputs on the left side of the logic block are inputs for open and close commands. These can be wired to physical inputs if it is desired to have open and close command switches. If they are wired, they must either be pulsed inputs, or some logic must be employed so that the open and close command inputs are never driven at the same time. If these are both driven at the same time, the breaker is receiving open and close commands simultaneously. The breaker will not change state if it is being commanded to open and close at the same time.
- Step 4: Verify the breaker is receiving 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 *BESTCOMSPPlus*, 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 *BESTCOMSPPlus* 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 BESTCOMSPlus, and exercise the virtual switches using the Control panel located in the Metering Explorer. Never turn open and close on at the same time. This could damage the breaker and/or motor operator. If everything is working as expected, restore the logic to its original diagram.

Mains Breaker Does Not Close After Mains Returns

- Step 1: Verify that a Mains Breaker has been configured by examining the settings on the Settings, Breaker Management, Breaker Hardware screen.
- Step 2: Verify the mains breaker has been correctly included in the programmable logic.
- Step 3: Verify that the Mains Fail Transfer parameter is set to 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 BESTCOMSPlus 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 BESTCOMSPlus, and exercise the virtual switches using the Control panel located in the Metering Explorer. Never turn open and close on at the same time. This could damage the breaker and/or motor operator. If everything is working as expected, restore the logic to its original diagram.

Synchronizer

Determining if the Synchronizer is Active

- Step 1: Disable the speed trim function.
- Step 2: Initiate a breaker close request by one of the methods listed in the *Breaker Management* chapter.
- 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 BESTCOMSPlus® 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.

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 set Speed Response 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 set Voltage Response 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.

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 Speed 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 BESTCOMSP^{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 BESTCOMSP^{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 the DGC-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 the DGC-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 the DGC-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 BESTCOMSPlus® 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 the DGC-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 the DGC-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.

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, AEM, and CEM.

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 amount of var that the generator should produce. It is normalized such that 1.0 indicates the full var capacity of the generator, 0.5 indicates 50% of the generator's capacity, etc. When the generator breaker is closed, and the var/PF controller is enabled, the var demand indicates what level of reactive power should be generated. If the generator breaker is closed, and the Parallel To Mains logic element is true, the var Demand will be equal to the kvar set point (%) if the controller is in var control mode, or will equal the var value that will maintain the machine Power Factor at the PF set point if the controller is in Power Factor mode. When the generator breaker is open or the var/PF controller is disabled, the var Demand will always be 0.0 . When running with the generator breaker closed and the Parallel To Mains logic element is false (i.e. the generators are an islanded system), the var Demand will be 0.0 as well. The DGC-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 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.



AEM-2020

The AEM-2020 (Analog Expansion Module) is an optional remote device that provides additional DGC-2020HD analog inputs and outputs. Up to four AEM-2020s may be used with one DGC-2020HD.

Features

AEM-2020s have the following features:

- 8 Analog Inputs
- 8 RTD Inputs
- 2 Thermocouple Inputs
- 4 Analog Outputs
- Functionality of Inputs and Outputs assigned by BESTlogic™*Plus* programmable logic
- Communications via control area network (CAN)

Specifications

Operating Power

Nominal	12 or 24 Vdc
Range	8 to 32 Vdc (Withstands cranking ride-through down to 6 Vdc for 500 ms)
Maximum Consumption	5.1 W

Analog Inputs

The AEM-2020 contains eight programmable analog inputs.

Rating	4 to 20 mA _{dc} or 0 to 10 Vdc (user-selectable)

Burden

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

RTD Inputs

The AEM-2020 contains eight programmable RTD inputs.

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

Thermocouple Inputs

The AEM-2020 contains two thermocouple inputs.

Rating	2 K Type Thermocouples
Setting Range	0 to 1,375°C or 0 to 2,507°F
Display Range	Ambient to 1,375°C or Ambient to 2,507°F
Accuracy	± 40 μ V @ 25°C, ± 5 μ V/°C drift over ambient temperature

Analog Outputs

The AEM-2020 contains four programmable analog outputs.

Rating	4 to 20 mA _{dc} or 0 to 10 Vdc (user-selectable)

CAN Interface

Differential Bus Voltage	1.5 to 3 Vdc

Maximum Voltage–32 to +32 Vdc with respect to negative battery terminal
Communication Rate..... 250 kb/s

Type Tests

Shock

Withstands 15 G in 3 perpendicular planes.

Vibration

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

5 to 29 to 5 Hz 1.5 G peak for 5 minutes
29 to 52 to 29 Hz 0.036" Double Amplitude for 2.5 minutes
52 to 500 to 52 Hz 5 G peak for 7.5 minutes

Ignition System

Tested in close proximity to an unshielded, unsuppressed Altronic DISN 800 ignition system.

HALT (Highly Accelerated Life Testing)

HALT is used by Basler Electric to prove that our products will provide the user with many years of reliable service. HALT subjects the device to extremes in temperature, shock, and vibration to simulate years of operation, but in a much shorter period. HALT allows Basler Electric to evaluate all possible design elements that will add to the life of this device. As an example of some of the extreme testing conditions, the AEM-2020 was subjected to temperature tests (tested over a temperature range of –80°C to +130°C), vibration tests (of 5 to 50 G at +25°C), and temperature/vibration tests (tested at 10 to 20 G over a temperature range of –60°C to +100°C). Combined temperature and vibration testing at these extremes proves that the AEM-2020 is expected to provide long-term operation in a rugged environment. Note that the vibration and temperature extremes listed in this paragraph are specific to HALT and do not reflect recommended operation levels. These operational ratings are included in this section.

Environment

Temperature

Operating.....–40 to +70°C (–40 to +158°F)
Storage–40 to +85°C (–40 to +185°F)

Humidity

Meets IEC 68-2-38.

UL Approval

“cRUus” recognized to UL Standard 6200 & CSA Standard C22.2 No. 14.

CSA Certification

CSA certified to Standard C22.2 No.14.

NFPA Compliance

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

CE Compliance

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

LVD 2006/95/EC
EN 50178
EMC 2004/108/EC
EN 61000-6-4
EN 61000-6-2

Physical

Weight 1.80 lb (816 g)
Dimensions..... See *Mounting* later in this chapter.

Functional Description

A functional description of the AEM-2020's inputs and outputs is provided below.

Analog Inputs

The AEM-2020 provides eight analog inputs that are user-selectable for 4 to 20 mAdc or 0 to 10 Vdc. Each analog input has under/over thresholds that can be configured as status only, alarm, or pre-alarm. When enabled, an out of range alarm alerts the user of an open or damaged analog input wire. The label text of each analog input is customizable.

RTD Inputs

The AEM-2020 provides eight user-configurable RTD inputs for monitoring genset temperature. Each RTD input can be configured as status only, alarm, or pre-alarm to protect against high or low temperature conditions. When enabled, an out of range alarm alerts the user of an open or damaged RTD input wire. The label text of each RTD input is customizable.

Thermocouple Inputs

The AEM-2020 provides two thermocouple inputs for monitoring genset temperature. Each thermocouple input can be configured as status only, alarm, or pre-alarm to protect against high or low temperature conditions. The label text of each thermocouple input is customizable.

Analog Outputs

The AEM-2020 provides four analog outputs that are user-selectable for 4 to 20 mAdc or 0 to 10 Vdc. A wide selection of parameters including oil pressure, fuel level, generator voltage, and bus voltage can be configured as analog outputs.

Communications

A Control Area Network (CAN) is a standard interface that enables communication between the AEM-2020 and the DGC-2020HD.

Mounting

Analog Expansion Modules are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a module, check the part number against the requisition and packing list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify the Basler Electric regional sales office, your sales representative, or a sales representative at Basler Electric, Highland, Illinois USA.

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

Analog Expansion Modules are contained in a potted plastic case and may be mounted in any convenient position. The construction of an Analog Expansion Module is durable enough to mount directly on a genset using ¼-inch hardware. Hardware selection should be based on any expected shipping/transportation and operating conditions. The torque applied to the mounting hardware should not exceed 65 in-lb (7.34 N•m).

See Figure 186 for AEM-2020 overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.

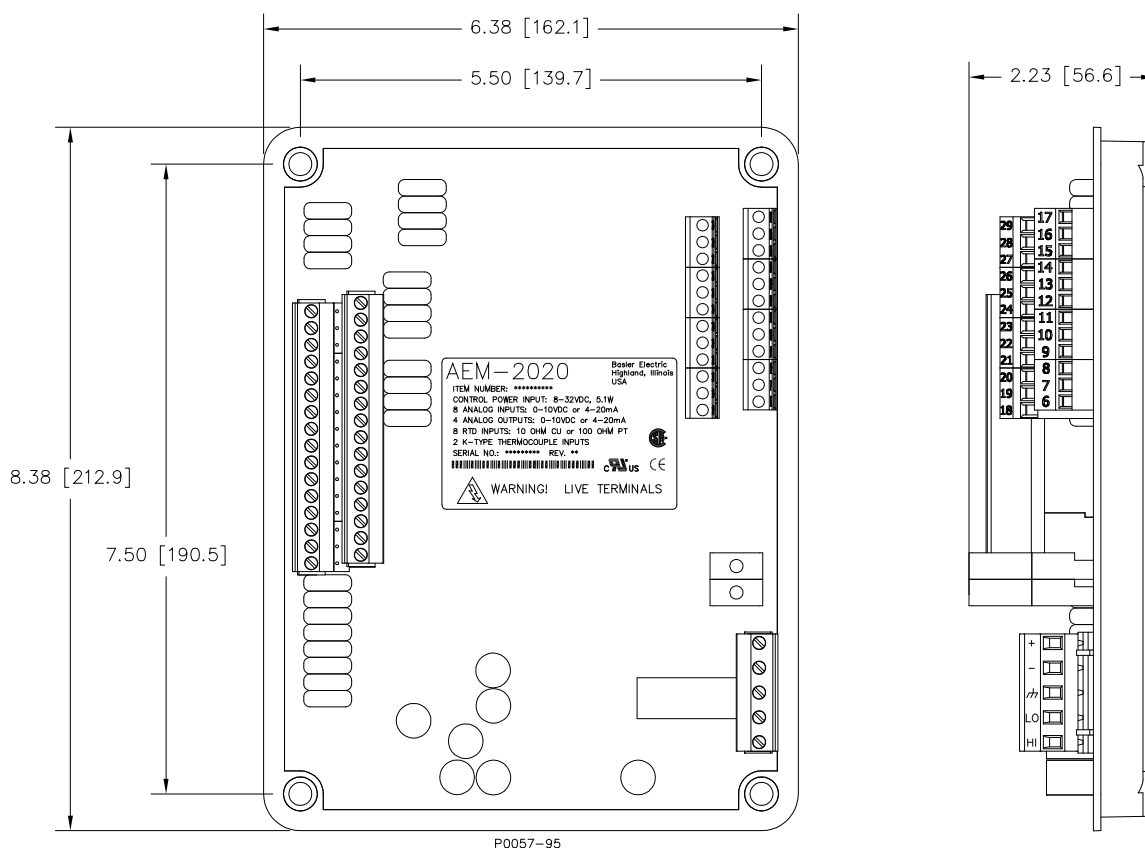


Figure 186. AEM-200 Overall Dimensions

Connections

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

Notes

Operating power from the battery must be of the correct polarity. While reverse polarity will not cause damage, the AEM-200 will not operate.

Be sure that the AEM-200 is hard-wired to earth ground with no smaller than 12 AWG (3.31 mm²) copper wire attached to the chassis ground terminal on the module.

Terminations

The terminal interface consists of both plug-in connectors and a permanently mounted connector with screw-down compression terminals.

AEM-200 connections are made with one 5-position connector, two 12-position connectors, two 16-position connectors, and two 2-position thermocouple connectors. The 16, 5, and 2-position connectors plug into headers on the AEM-200. The connectors and headers have dovetailed edges that ensure proper connector orientation. Also, the connectors and headers are uniquely keyed to ensure that the connectors mate only with the correct headers. The 12-position connector is not a plug-in connector and is mounted permanently to the board. Connectors and headers may contain tin- or gold-plated conductors. Tin-plated conductors are housed in a black plastic casing and gold-plated conductors are housed in an orange plastic casing. Mate connectors to headers of the same color only.

Caution

By mating conductors of dissimilar metals, galvanic corrosion could occur which may lead to signal loss.

Connector screw terminals accept a maximum wire size of 12 AWG (3.31 mm²). Thermocouple connectors accept a maximum thermocouple wire diameter of 0.177 inches (4.5 mm). Maximum screw torque is 5 inch-pounds (0.56 N•m).

Operating Power

The Analog Expansion Module operating power input accepts either 12 Vdc or 24 Vdc and tolerates voltage over the range of 6 to 32 Vdc. Operating power must be of the correct polarity. While reverse polarity will not cause damage, the AEM-2020 will not operate. Operating power terminals are listed in Table 84.

It is recommended that a fuse be added for additional protection for the wiring to the battery input of the Analog Expansion Module. A Bussmann ABC-7 fuse or equivalent is recommended.

Table 84. Operating Power Terminals

Terminal	Description
P1-  (SHIELD)	Chassis ground connection
P1- – (BATT–)	Negative side of operating power input
P1- + (BATT+)	Positive side of operating power input

AEM-2020 Inputs and Outputs

Input and output terminals are shown in Figure 187 and listed in Table 85.

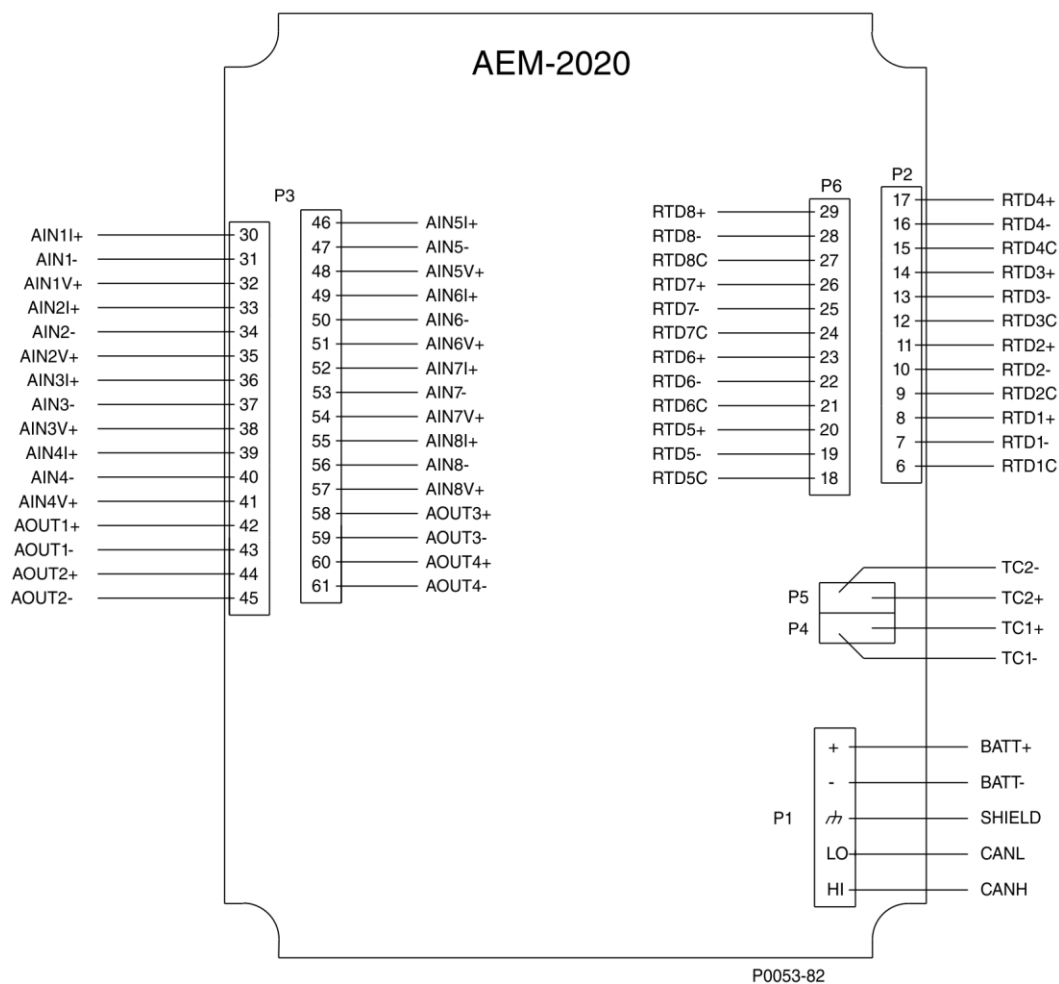


Figure 187. Input and Output Terminals

Table 85. Input and Output Terminals

Connector	Description
P1	Operating Power and CAN
P2	RTD Inputs 1 - 4
P3	Analog Inputs 1 - 8 and Analog Outputs 1 - 4
P4	Thermocouple 1 Input
P5	Thermocouple 2 Input
P6	RTD Inputs 5 - 8

External Analog Input Connections

Voltage input connections are shown in Figure 188 and current input connections are shown in Figure 189. When using the current input, AIN V+ and AIN I+ must be tied together.

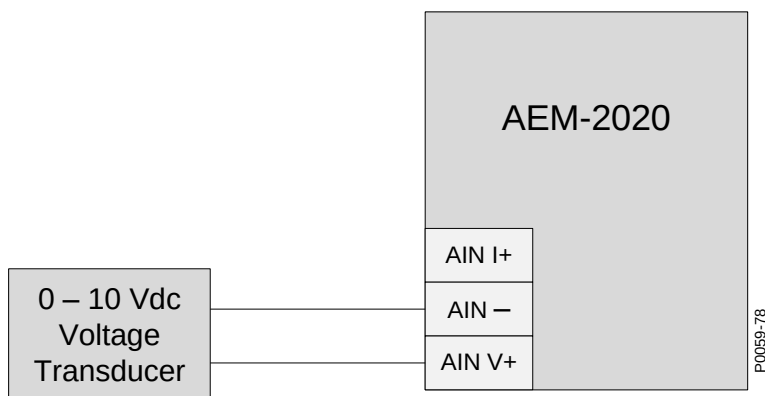


Figure 188. Analog Inputs - Voltage Input Connections

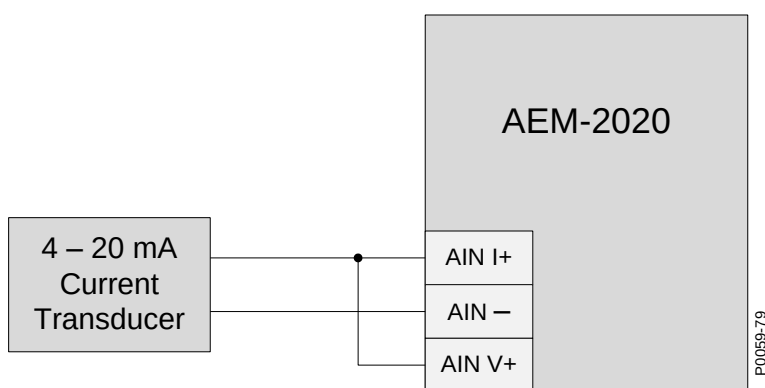


Figure 189. Analog Inputs - Current Input Connections

External RTD Input Connections

External 2-wire RTD input connections are shown in Figure 190. Figure 191 shows external 3-wire RTD input connections.

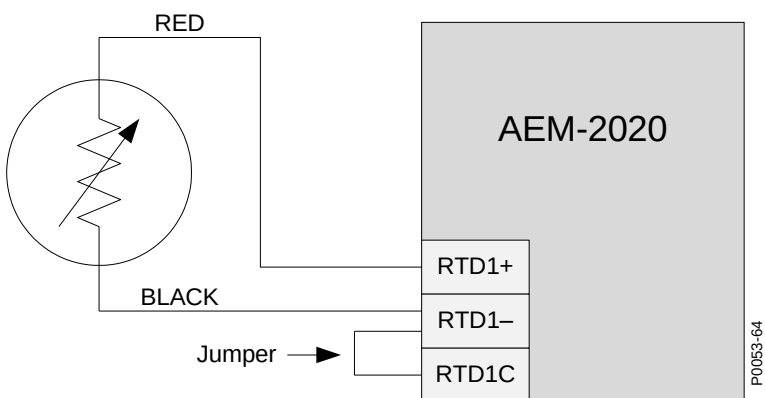


Figure 190. External Two-Wire RTD Input Connections

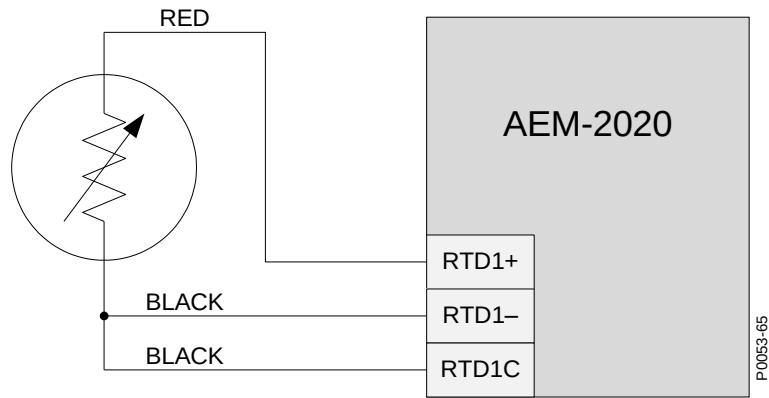


Figure 191. External Three-Wire RTD Input Connections

CAN Interface

These terminals provide communication using the SAE J1939 protocol and provide high-speed communication between the Analog Expansion Module and the DGC-2020HD. Connections between the AEM-2020 and DGC-2020HD should be made with twisted-pair, shielded cable. CAN interface terminals are listed in Table 86. Refer to Figure 192 and Figure 193.

Table 86. CAN Interface Terminals

Terminal	Description
P1- HI (CAN H)	CAN high connection (yellow wire)
P1- LO (CAN L)	CAN low connection (green wire)
P1- ⏏ (SHIELD)	CAN drain connection

Notes
1. If the AEM-2020 is providing one end of the J1939 bus, a 120 Ω, ½ watt terminating resistor should be installed across terminals P1- LO (CANL) and P1- HI (CANH). 2. If the AEM-2020 is not part of the J1939 bus, the stub connecting the AEM-2020 to the bus should not exceed 914 mm (3 ft) in length. 3. The maximum bus length, not including stubs, is 40 m (131 ft). 4. The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the AEM-2020.

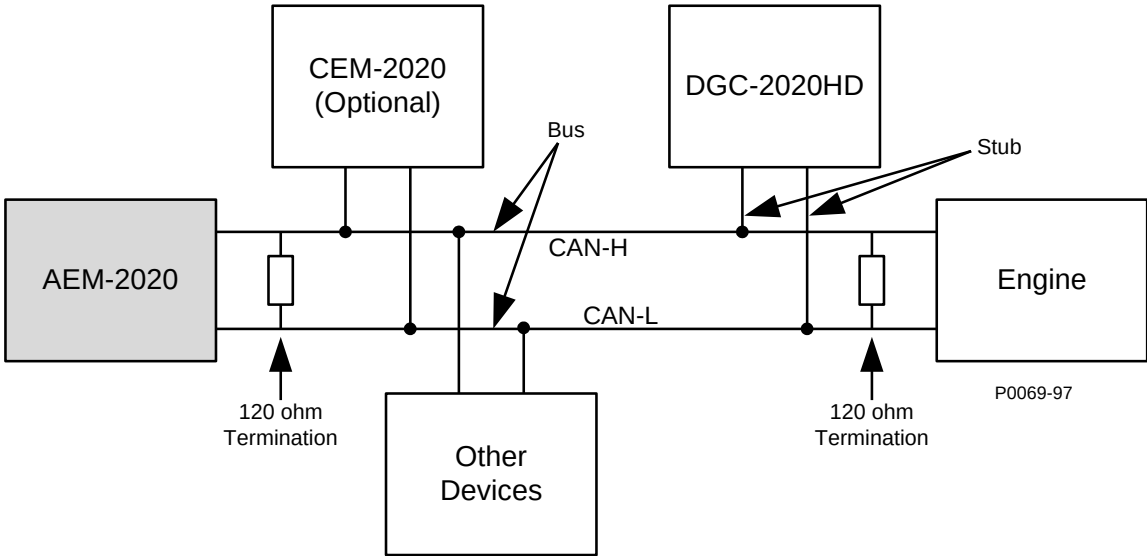


Figure 192. CAN Interface with AEM-2020 providing One End of the Bus

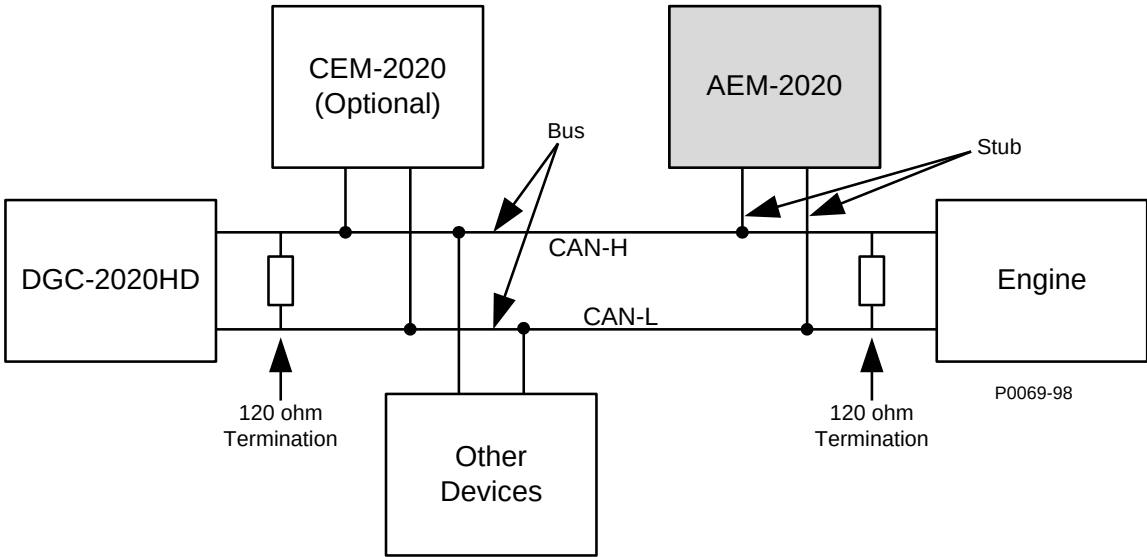


Figure 193. CAN Interface with DGC-2020HD providing One End of the Bus

AEM-2020 Configuration

AEM-2020s are enabled on the Remote Module Setup screen in BESTCOMS*Plus*. If more than one AEM-2020 is connected, the serial number of each module must be entered. An AEM Not Configured pre-alarm will occur if the expected serial number does not match the serial number detected on the General Settings, Device Info screen. The Remote Module Setup screen is illustrated in Figure 194.

Remote Module Setup

Contact Expansion Module 1	Contact Expansion Module 2	Contact Expansion Module 3	Contact Expansion Module 4
Module Enable ☐ Disable ☒ Enable	Module Enable ☒ Disable ☐ Enable	Module Enable ☒ Disable ☐ Enable	Module Enable ☒ Disable ☐ Enable
J1939 Address 236	J1939 Address 236	J1939 Address 236	J1939 Address 236
CEM Outputs 18 Outputs	CEM Outputs 18 Outputs	CEM Outputs 18 Outputs	CEM Outputs 18 Outputs
Expected Serial Number E01234567	Expected Serial Number NA	Expected Serial Number NA	Expected Serial Number NA

Analog Expansion Module 1	Analog Expansion Module 2	Analog Expansion Module 3	Analog Expansion Module 4
Module Enable ☒ Disable ☐ Enable	Module Enable ☒ Disable ☐ Enable	Module Enable ☒ Disable ☐ Enable	Module Enable ☒ Disable ☐ Enable
J1939 Address 237	J1939 Address 238	J1939 Address 237	J1939 Address 237
Expected Serial Number E01233345	Expected Serial Number E01223734	Expected Serial Number NA	Expected Serial Number NA

Figure 194. Settings Explorer, System Parameters, Remote Module Setup

Remote Analog Inputs Configuration

Eight remote analog inputs provide metering for a variety of industrial transducers. An element can be configured to trip when the metered input increases above or decreases below the user-defined threshold.

The eight, identical remote analog input protection elements are designated AEM x Input #1 through AEM x Input #8 (where x = 1 to 4). Element logic connections are made on the BESTlogic™*Plus* screen in BESTCOMS*Plus*® and element operational settings are configured on the AEM x Input #y (where x = 1 to 4 and y = 1 to 8) settings screen in BESTCOMS*Plus*.

BESTCOMS*Plus* Navigation Path: Settings Explorer, Programmable Inputs, Remote Analog Inputs

Front Panel Navigation Path: Settings Explorer > Programmable Inputs > Remote Analog Inputs

Input Setup

Label Text

In order to make identification of the remote analog inputs easier, each of the inputs can be given a user-assigned label. The label is an alphanumeric string with a maximum of 16 characters.

Hysteresis

The hysteresis setting provides a level of hysteresis between a threshold detection tripping and dropping out. For instance, if the hysteresis is set for 5% and the threshold is set as an over threshold, once the threshold detection trips, the measured value must drop to 95% of the threshold before the threshold detection will drop out. This hysteresis helps prevent rapid or repeated transitions between trip and dropout in cases where the measured input is nearly equal to a level equal to the threshold.

If the threshold is set as an under threshold with 5% hysteresis, once the threshold detection trips, the measured value must rise to 105% of the threshold before the threshold detection will drop out.

Input Type

A remote analog input can be configured to monitor a voltage or current signal.

Arming Delay

A user-adjustable arming delay disables remote analog input protection during engine startup. If the arming delay is set to zero (0), the input protection is active at all times, including when the engine is not running. If the arming delay is set to a non-zero value, the input protection is inactive when the engine is not running, and does not become active until after the engine is started and the arming delay has elapsed.

Out-of-Range Alarm Type

An out-of-range alarm alerts the user of an open or damaged remote analog input wire.

Ranges

Ranges must be set for the selected input type. Param Min correlates to Min Input Current or Min Input Voltage and Param Max correlates to Max Input Current or Max Input Voltage.

Thresholds

There are four programmable thresholds for each remote analog input element. Each threshold has a mode setting, threshold setting, activation delay setting, and an alarm setting.

Mode

The mode can be set for Over or Under. If Over mode is selected, an alarm is annunciated when the metered input increases above the Threshold setting for the duration of the Activation Delay. If Under mode is selected, an alarm is annunciated when the metered input decreases below the Threshold setting for the duration of the Activation Delay.

Alarm Configuration

Each remote analog input protection threshold item can be independently configured to annunciate an alarm or pre-alarm, or be configured as status only when the metered input falls beyond the threshold. A user-adjusted activation delay setting delays alarm annunciation until after the threshold has been exceeded. Remote analog input protection is disabled when Alarm Configuration is set to "None".

Logic Connections

Remote analog input protection logic connections are made on the BESTlogicPlus screen in BESTCOMSPlus. The Analog Input 1, Threshold 1 logic block is illustrated in Figure 195. The output is true during a trip condition. The alarm and pre-alarm logic blocks are similar.



Figure 195. Remote Analog Input Protection Logic Block

Operational Settings

Remote analog input protection operational settings are configured on the AEM x Input #y (where x = 1 to 4 and y = 1 to 8) settings screen (Figure 196) in BESTCOMSPlus.

AEM 1 Input #1

Label Text
Analog In 1 A

Arming Delay (s)
0 D

Hysteresis (%)
2.0 B

Out Of Range Alarm Type
Status Only E

Input Type
Voltage C

Ranges

Param Min
-999999 F

Min Input Current (mA)
4.0 H

Min Input Voltage (V)
0.0 J

Param Max
999999 G

Max Input Current (mA)
20.0 I

Max Input Voltage (V)
10.0 K

Threshold #1

Mode
Disabled L

Threshold
0.00 M

Activation Delay (s)
0 N

Alarm Configuration
Status Only O

Threshold #2

Mode
Over L

Threshold
0.00 M

Activation Delay (s)
0 N

Alarm Configuration
Pre-Alarm O

Threshold #3

Mode
Under L

Threshold
0.00 M

Activation Delay (s)
0 N

Alarm Configuration
Alarm O

Threshold #4

Mode
Disabled L

Threshold
0.00 M

Activation Delay (s)
0 N

Alarm Configuration
Status Only O

Figure 196. Settings Explorer, Programmable Inputs, Remote Analog Inputs, AEM 1 Input #1

Table 87. Settings for AEM x Input #y

Locator	Setting	Range	Increment	Unit
A	Label Text	n/a	n/a	n/a
B	Hysteresis	0 to 100	0.1	%
C	Input Type	Voltage or Current	n/a	n/a
D	Arming Delay	0 to 300	1	seconds
E	Out of Range Alarm Type	Status Only, Pre-Alarm, or Alarm	n/a	n/a
F	Param Min	-999,999 to 999,999	varies	n/a
G	Param Max	-999,999 to 999,999	varies	n/a
H	Min Input Current	4 to 20	0.1	milliamps
I	Max Input Current	4 to 20	0.1	milliamps
J	Min Input Voltage	0 to 10	0.1	volts
K	Max Input Voltage	0 to 10	0.1	volts
L	Mode	Disabled, Over, or Under	n/a	n/a
M	Threshold	-999,999 to 999,999	0.01	n/a

Locator	Setting	Range	Increment	Unit
N	Activation Delay	0 to 300	1	seconds
O	Alarm Configuration	Status Only, Pre-Alarm, or Alarm	n/a	n/a

Remote RTD Inputs Configuration

Eight remote RTD inputs provide metering of winding or bearing temperatures. An element can be configured to trip when the metered input increases above or decreases below the user-defined threshold.

The eight, identical remote RTD input protection elements are designated AEM x RTD Input #1 through AEM x RTD Input #8 (where x = 1 to 4). Element logic connections are made on the BESTlogic™Plus screen in BESTCOMSPlus® and element operational settings are configured on the AEM x RTD Input #y (where x = 1 to 4 and y = 1 to 8) settings screen in BESTCOMSPlus.

BESTCOMSPlus Navigation Path: Settings Explorer, Programmable Inputs, Remote RTD Inputs

Front Panel Navigation Path: Settings Explorer > Programmable Inputs > Remote RTD Inputs

Input Setup

Label Text

In order to make identification of the remote RTD inputs easier, each of the inputs can be given a user-assigned label. The label is an alphanumeric string with a maximum of 16 characters.

Hysteresis

The hysteresis setting provides a level of hysteresis between a threshold detection tripping and dropping out. For instance, if the hysteresis is set for 5% and the threshold is set as an over threshold, once the threshold detection trips, the measured value must drop to 95% of the threshold before the threshold detection will drop out. This hysteresis helps prevent rapid or repeated transitions between trip and dropout in cases where the measured input is nearly equal to a level equal to the threshold.

If the threshold is set as an under threshold with 5% hysteresis, once the threshold detection trips, the measured value must rise to 105% of the threshold before the threshold detection will drop out.

Input Type

A remote RTD input can be configured to monitor a 10 Ω copper or 100 Ω platinum RTD.

Arming Delay

A user-adjustable arming delay disables remote RTD input protection during engine startup. If the arming delay is set to zero (0), the input protection is active at all times, including when the engine is not running. If the arming delay is set to a non-zero value, the input protection is inactive when the engine is not running, and does not become active until after the engine is started and the arming delay has elapsed.

Out-of-Range Alarm Type

An out-of-range alarm alerts the user of an open or damaged remote RTD input wire.

Ranges

Ranges must be set for the selected input type. Param Min correlates to Min Input Current or Min Input Voltage and Param Max correlates to Max Input Current or Max Input Voltage.

Thresholds

There are four programmable thresholds for each remote RTD input element. Each threshold has a mode setting, threshold setting, activation delay setting, and an alarm setting.

Mode

The mode can be set for Over or Under. If Over mode is selected, an alarm is annunciated when the metered input increases above the Threshold setting for the duration of the Activation Delay. If Under mode is selected, an alarm is annunciated when the metered input decreases below the Threshold setting for the duration of the Activation Delay.

Alarm Configuration

Each remote RTD input protection threshold item can be independently configured to annunciate an alarm or pre-alarm, or be configured as status only when the metered input falls beyond the threshold. A user-adjusted activation delay setting delays alarm annunciation until after the threshold has been exceeded. Remote RTD input protection is disabled when Alarm Configuration is set to “None”.

Logic Connections

Remote RTD input protection logic connections are made on the BESTlogicPlus screen in BESTCOMSPUs. The RTD Input 1, Threshold 1 logic block is illustrated in Figure 197. The output is true during a trip condition. The alarm and pre-alarm logic blocks are similar.

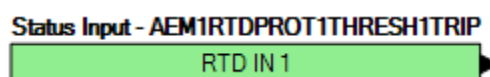


Figure 197. Remote RTD Input Protection Logic Block

Operational Settings

Remote RTD input protection operational settings are configured on the AEM x RTD Input #y (where x = 1 to 4 and y = 1 to 8) settings screen (Figure 198) in BESTCOMSPUs.

Figure 198. Settings Explorer, Programmable Inputs, Remote Analog Inputs, AEM 1 RTD Input #1

Table 88. Settings for AEM x RTD Input #y

Locator	Setting	Range	Increment	Unit
A	Label Text	n/a	n/a	n/a
B	Hysteresis	0 to 100	0.1	%
C	RTD Type	10 Ohm Copper or 100 Ohm Platinum	n/a	n/a
D	Arming Delay	0 to 300	1	seconds
E	Out of Range Alarm Type	Status Only, Pre-Alarm, or Alarm	n/a	n/a
F	Mode	Disabled, Over, or Under	n/a	n/a
G	Threshold	–50 to 250	1	degrees C
		–58 to 482	1	degrees F
H	Activation Delay	0 to 300	1	seconds
I	Alarm Configuration	Status Only, Pre-Alarm, or Alarm	n/a	n/a

Remote Thermocouple Inputs Configuration

Two remote thermocouple inputs provide metering of exhaust temperatures. An element can be configured to trip when the metered input increases above or decreases below the user-defined threshold.

The two, identical remote thermocouple input protection elements are designated AEM x Thermocouple Input #1 and AEM x Thermocouple Input #2 (where x = 1 to 4). Element logic connections are made on the BESTlogic™*Plus* screen in BESTCOMS*Plus*® and element operational settings are configured on the AEM x Thermocouple Input #y (where x = 1 to 4 and y = 1 or 2) settings screen in BESTCOMS*Plus*.

BESTCOMS*Plus* Navigation Path: Settings Explorer, Programmable Inputs, Remote Thermocouple Inputs

Front Panel Navigation Path: Settings Explorer > Programmable Inputs > Remote Thermocouple Inputs

Input Setup

Label Text

In order to make identification of the remote thermocouple inputs easier, each of the inputs can be given a user-assigned label. The label is an alphanumeric string with a maximum of 16 characters.

Hysteresis

The hysteresis setting provides a level of hysteresis between a threshold detection tripping and dropping out. For instance, if the hysteresis is set for 5% and the threshold is set as an over threshold, once the threshold detection trips, the measured value must drop to 95% of the threshold before the threshold detection will drop out. This hysteresis helps prevent rapid or repeated transitions between trip and dropout in cases where the measured input is nearly equal to a level equal to the threshold.

If the threshold is set as an under threshold with 5% hysteresis, once the threshold detection trips, the measured value must rise to 105% of the threshold before the threshold detection will drop out.

Arming Delay

A user-adjustable arming delay disables remote thermocouple input protection during engine startup. If the arming delay is set to zero (0), the input protection is active at all times, including when the engine is not running. If the arming delay is set to a non-zero value, the input protection is inactive when the engine

is not running, and does not become active until after the engine is started and the arming delay has elapsed.

Thresholds

There are four programmable thresholds for each remote thermocouple input element. Each threshold has a mode setting, threshold setting, activation delay setting, and an alarm setting.

Mode

The mode can be set for Over or Under. If Over mode is selected, an alarm is annunciated when the metered input increases above the Threshold setting for the duration of the Activation Delay. If Under mode is selected, an alarm is annunciated when the metered input decreases below the Threshold setting for the duration of the Activation Delay.

Alarm Configuration

Each remote thermocouple input protection threshold item can be independently configured to annunciate an alarm or pre-alarm, or be configured as status only when the metered input falls beyond the threshold. A user-adjusted activation delay setting delays alarm annunciation until after the threshold has been exceeded. Remote thermocouple input protection is disabled when Alarm Configuration is set to "None".

Logic Connections

Remote thermocouple input protection logic connections are made on the BESTlogicPlus screen in BESTCOMSPUs. The Thermocouple Input 1, Threshold 1 Status Input logic block is illustrated in Figure 199. The output is true during a trip condition. The alarm and pre-alarm logic blocks are similar.

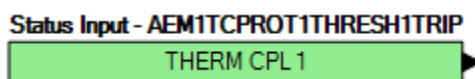


Figure 199. Remote Thermocouple Input Protection Logic Block

Operational Settings

Remote Thermocouple input protection operational settings are configured on the AEM x Thermocouple Input #y (where x = 1 to 4 and y = 1 or 2) settings screen (Figure 200) in BESTCOMSPUs. Settings are listed in Table 89.

AEM 1 Thermocouple Input #1

Label Text
Therm Cpl 1 | A

Arming Delay (s)
0 | B

Hysteresis (%)
2.0 | C

Threshold #1
Mode: Disabled | D | Threshold (C): 0 | E | Activation Delay (s): 0 | F | Alarm Configuration: Status Only | G

Threshold #2
Mode: Over | D | Threshold (C): 0 | E | Activation Delay (s): 0 | F | Alarm Configuration: Pre-Alarm | G

Threshold #3
Mode: Under | D | Threshold (C): 0 | E | Activation Delay (s): 0 | F | Alarm Configuration: Alarm | G

Threshold #4
Mode: Disabled | D | Threshold (C): 0 | E | Activation Delay (s): 0 | F | Alarm Configuration: Status Only | G

Figure 200. Settings Explorer, Programmable Inputs, Remote Analog Inputs, AEM 1 Thermocouple Input #1

Table 89. Settings for AEM x Thermocouple Input #y

Locator	Setting	Range	Increment	Unit
A	Label Text	n/a	n/a	n/a
B	Arming Delay	0 to 300	1	seconds
C	Hysteresis	0 to 100	0.1	%
D	Mode	Disabled, Over, or Under	n/a	n/a
E	Threshold	0 to 1,375	1	degrees C
		32 to 2,507	1	degrees F
F	Activation Delay	0 to 300	1	seconds
G	Alarm Configuration	Status Only, Pre-Alarm, or Alarm	n/a	n/a

Remote Analog Outputs Configuration

Four remote analog outputs provide voltage or current signals from the AEM-2020 to a variety of industrial transducers.

The four, identical remote analog outputs are designated AEM x Output #1 through AEM x Output #4 (where x = 1 to 4). Remote analog output operational settings are configured on the AEM x Output #y (where x = 1 to 4 and y = 1 to 4) settings screen in BESTCOMSPUs.

BESTCOMSPUs Navigation Path: Settings Explorer, Programmable Outputs, Remote Analog Outputs

Front Panel Navigation Path: Settings Explorer > Programmable Outputs > Remote Analog Outputs

Output Setup

Parameter Selection

The following parameters can be selected:

- AEM 1 Analog Input 1
- AEM 1 Analog Input 2
- AEM 1 Analog Input 3
- AEM 1 Analog Input 4
- AEM 1 Analog Input 5
- AEM 1 Analog Input 6
- AEM 1 Analog Input 7
- AEM 1 Analog Input 8
- AEM 1 RTD Input 1
- AEM 1 RTD Input 2
- AEM 1 RTD Input 3
- AEM 1 RTD Input 4
- AEM 1 RTD Input 5
- AEM 1 RTD Input 6
- AEM 1 RTD Input 7
- AEM 1 RTD Input 8
- AEM 1 TC Input 1
- AEM 1 TC Input 2
- AEM 2 Analog Input 1
- AEM 2 Analog Input 2
- AEM 2 Analog Input 3
- AEM 2 Analog Input 4
- AEM 2 Analog Input 5
- AEM 2 Analog Input 6
- AEM 2 Analog Input 7
- AEM 2 Analog Input 8
- AEM 2 RTD Input 1
- AEM 2 RTD Input 2
- AEM 2 RTD Input 3
- AEM 2 RTD Input 4
- AEM 2 RTD Input 5
- AEM 2 RTD Input 6
- AEM 2 RTD Input 7
- AEM 2 RTD Input 8
- AEM 2 TC Input 1
- AEM 2 TC Input 2
- AEM 3 Analog Input 1
- AEM 3 Analog Input 2
- AEM 3 Analog Input 3
- AEM 3 Analog Input 4
- AEM 3 Analog Input 5
- AEM 3 Analog Input 6
- AEM 3 Analog Input 7
- AEM 3 Analog Input 8
- AEM 3 RTD Input 1
- AEM 3 RTD Input 2
- AEM 3 RTD Input 3
- AEM 3 RTD Input 4
- AEM 3 RTD Input 5
- AEM 3 RTD Input 6
- BUS 1 IA
- BUS 1 IB
- BUS 1 IC
- BUS 1 kVA A
- BUS 1 kVA B
- BUS 1 kVA C
- BUS 1 kVA TOT
- BUS 1 kVAR A
- BUS 1 kVAR B
- BUS 1 kVAR C
- BUS 1 kVAR TOT
- BUS 1 kW A
- BUS 1 kW B
- BUS 1 kW C
- BUS 1 kW TOT
- BUS 1 kWH
- BUS 1 PF
- BUS 2 Hz
- BUS 2 kVA A
- BUS 2 kVA B
- BUS 2 kVA C
- BUS 2 kVA TOT
- BUS 2 kVAR A
- BUS 2 kVAR B
- BUS 2 kVAR C
- BUS 2 kVAR TOT
- BUS 2 kW A
- BUS 2 kW B
- BUS 2 kW C
- BUS 2 kW TOT
- BUS 2 VAB
- BUS 2 VBC
- BUS 2 VCA
- Charge air temperature
- Coolant pressure
- COOLANT TEMP
- Engine intercooler temperature
- Engine oil temperature
- Engine Percent Load
- FUEL LVL
- Fuel Pressure
- Fuel rate
- Fuel temperature
- GEN Hz
- GEN IA
- GEN IB
- GEN IC
- GEN kVA A
- GEN kVA B
- GEN kVA C

- AEM 3 RTD Input 7
- AEM 3 RTD Input 8
- AEM 3 TC Input 1
- AEM 3 TC Input 2
- AEM 4 Analog Input 1
- AEM 4 Analog Input 2
- AEM 4 Analog Input 3
- AEM 4 Analog Input 4
- AEM 4 Analog Input 5
- AEM 4 Analog Input 6
- AEM 4 Analog Input 7
- AEM 4 Analog Input 8
- AEM 4 RTD Input 1
- AEM 4 RTD Input 2
- AEM 4 RTD Input 3
- AEM 4 RTD Input 4
- AEM 4 RTD Input 5
- AEM 4 RTD Input 6
- AEM 4 RTD Input 7
- AEM 4 RTD Input 8
- AEM 4 TC Input 1
- AEM 4 TC Input 2
- Analog Input 1
- Analog Input 2
- Analog Input 3
- Analog Input 4
- AVR Output
- BATT V
- Boost pressure
- BUS 1 Hz
- BUS 1 VAB
- BUS 1 VBC
- BUS 1 VCA
- GEN kVA TOT
- GEN kVAR A
- GEN kVAR B
- GEN kVAR C
- GEN kVAR TOT
- GEN kW A
- GEN kW B
- GEN kW C
- GEN kW TOT
- GEN kWH
- GEN PF
- GEN VAB
- GEN VAN
- GEN VBC
- GEN VBN
- GEN VCA
- GEN VCN
- GOV Output
- IG
- Injector metering rail pressure
- Intake manifold temperature
- KW Load Percent
- LS Bias
- LS Output
- Number of units online
- OIL P
- RPM
- Speed Bias
- System KW Capacity
- System Total Generated Kvar
- System Total Generated KW
- Total fuel used
- Voltage Bias

Output Type

A remote analog output can be configured to provide a voltage or current signal.

Out-of-Range Alarm Type

An out of range alarm alerts the user of an open or damaged analog output wire.

Out-of-Range Activation Delay

An out of range activation delay setting delays alarm annunciation.

Ranges

Ranges must be set for the selected output type. Param Min correlates to Min Output Current or Min Output Voltage and Param Max correlates to Max Output Current or Max Output Voltage.

Operational Settings

Remote analog output operational settings are configured on the AEM x Output #y (where x = 1 to 4 and y = 1 to 4) settings screen (Figure 201) in BESTCOMSP^{Plus}. Settings are listed in Table 90.

AEM 1 Output #1

Parameter Selection: Battery Voltage (A) Out Of Range Alarm Type: Status Only (C)

Output Type: Voltage (B) Out of Range Activation Delay (s): 0 (D)

Ranges

Param Min: -999999.00 (E) Min Output Current (mA): 4.0 (G) Min Output Voltage (V): 0.0 (I)

Param Max: 999999.00 (F) Max Output Current (mA): 20.0 (H) Max Output Voltage (V): 10.0 (J)

Figure 201. Settings Explorer, Programmable Outputs, Remote Analog Outputs, AEM 1 Output #1

Table 90. Settings for AEM x Output #y

Locator	Setting	Range	Increment	Unit
A	Parameter Selection	*	n/a	n/a
B	Output Type	Voltage or Current	n/a	n/a
C	Out of Range Alarm Type	Status Only, Pre-Alarm, or Alarm	n/a	n/a
D	Out of Range Activation Delay	0 to 300	1	seconds
E	Param Min	–999,999 to 999,999	0.1	n/a
F	Param Max	–999,999 to 999,999	0.1	n/a
G	Min Output Current	4 to 20	0.1	milliamps
H	Max Output Current	4 to 20	0.1	milliamps
I	Min Output Voltage	0 to 10	0.1	volts
J	Max Output Voltage	0 to 10	0.1	volts

* See Parameter Selection, above.

Firmware Updates

Refer to the *Device Information* chapter for information on upgrading firmware in the AEM-2020.

Repair

Analog Expansion Modules are manufactured using state-of-the-art surface-mount technology. As such, Basler Electric recommends that no repair procedures be attempted by anyone other than Basler Electric personnel.

Before returning the AEM-2020 for repair, contact the Basler Electric Technical Services Department at 618-654-2341 for a return authorization number.

Maintenance

Preventive maintenance consists of periodically checking that the connections between the AEM-2020 and the system are clean and tight.

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.



CEM-2020

The Contact Expansion Module (CEM-2020) is an optional remote device that provides additional DGC-2020HD contact inputs and outputs. Two types of modules are available. A low current module (CEM-2020) provides 24 contact outputs and high current module (CEM-2020H) provides 18 contact outputs. Up to four CEM-2020s may be used with one DGC-2020HD.

Features

CEM-2020s have the following features:

- 10 Contact Inputs
- 18 Contact Outputs (CEM-2020H) or 24 Contact Outputs (CEM-2020)
- Functionality of Inputs and Outputs assigned by BESTlogic™*Plus* Programmable Logic
- Communications via CAN

Specifications

Operating Power

Nominal	12 or 24 Vdc
Range.....	8 to 32 Vdc (Withstands cranking ride-through down to 6 Vdc for 500 ms)

Maximum Consumption

CEM-2020	14 W
CEM-2020H.....	8 W

Contact Inputs

The CEM-2020 contains 10 programmable inputs that accept dry contacts.

Time from a CEM-2020 input application to:

- Shut down the generator via an alarm = 700 ms max
- Close a relay on board the DGC-2020HD = 300 ms max
- Close a relay on board the CEM-2020 = 550 ms max

Contact Outputs

Ratings

CEM-2020

Outputs 1 through 12	1 Adc at 30 Vdc, Form C, gold contacts
Outputs 13 through 24	4 Adc at 30 Vdc, Form C

CEM-2020H

Outputs 1 through 12	2 Adc at 30 Vdc, Form C, gold contacts
Outputs 13 through 18	10 Adc at 30 Vdc, Form C

CAN Interface

Differential Bus Voltage.....	1.5 to 3 Vdc
Maximum Voltage	–32 to +32 Vdc with respect to negative battery terminal
Communication Rate.....	250 kb/s

Type Tests

Shock

Withstands 15 G in 3 perpendicular planes.

Vibration

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

5 to 29 to 5 Hz 1.5 G peak for 5 minutes
29 to 52 to 29 Hz 0.036" Double Amplitude for 2.5 minutes
52 to 500 to 52 Hz 5 G peak for 7.5 minutes

Ignition System

Tested in close proximity to an unshielded, unsuppressed Altronic DISN 800 ignition system.

HALT (Highly Accelerated Life Testing)

HALT is used by Basler Electric to prove that our products will provide the user with many years of reliable service. HALT subjects the device to extremes in temperature, shock, and vibration to simulate years of operation, but in a much shorter period span. HALT allows Basler Electric to evaluate all possible design elements that will add to the life of this device. As an example of some of the extreme testing conditions, the CEM-2020 was subjected to temperature tests (tested over a temperature range of -80°C to +130°C), vibration tests (of 5 to 50 G at +25°C), and temperature/vibration tests (tested at 10 to 20 G over a temperature range of -60°C to +100°C). Combined temperature and vibration testing at these extremes proves that the CEM-2020 is expected to provide long-term operation in a rugged environment. Note that the vibration and temperature extremes listed in this paragraph are specific to HALT and do not reflect recommended operation levels. These operational ratings are included in this section.

Environment

Temperature

Operating..... -40 to +70°C (-40 to +158°F)
Storage -40 to +85°C (-40 to +185°F)

Humidity

Meets IEC 68-2-38.

UL Approval (CEM-2020 Only)

"cRUus" recognized to UL Standard 6200 & CSA Standard C22.2 No. 14.

UL Approval (CEM-2020H Only)

UL recognized to UL Standard 6200.

CSA Certification

CSA certified to Standard C22.2 No.14.

NFPA Compliance

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

CE Compliance

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

LVD 2006/95/EC
EN 50178

EMC 2004/108/EC
 EN 61000-6-4
 EN 61000-6-2

Physical

Weight

CEM-2020 2.25 lb (1.02 kg)
 CEM-2020H..... 1.90 lb (0.86 kg)

Dimensions

See *Mounting* later in this chapter.

Functional Description

A functional description of the CEM-2020s inputs and outputs is provided below.

Contact Inputs

The CEM-2020 provides 10 programmable contact inputs with the same functionality as the contact inputs on the DGC-2020HD. The label text of each contact input is customizable.

Contact Outputs

CEM-2020

The CEM-2020 provides 24 programmable contact outputs with the same functionality as the contact outputs on the DGC-2020HD. Outputs 1 through 12 can carry 1 A. Outputs 13 through 24 can carry 4 A. The label text of each contact output is customizable.

CEM-2020H

The CEM-2020H provides 18 programmable contact outputs with the same functionality as the contact outputs on the DGC-2020HD. Outputs 1 through 12 can carry 2 A. Outputs 13 through 18 can carry 10 A. The label text of each contact output is customizable.

Communications

A Control Area Network (CAN) is a standard interface that enables communication between the CEM-2020 and the DGC-2020HD.

Mounting

Contact Expansion Modules are delivered in sturdy cartons to prevent shipping damage. Upon receipt of a module, check the part number against the requisition and packing list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify the Basler Electric regional sales office, your sales representative, or a sales representative at Basler Electric, Highland, Illinois USA.

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

Contact Expansion Modules are contained in a potted plastic case and may be mounted in any convenient position. The construction of a Contact Expansion Module is durable enough to mount directly on a genset using ¼-inch hardware. Hardware selection should be based on any expected shipping/transportation and operating conditions. The torque applied to the mounting hardware should not exceed 65 in-lb (7.34 N•m).

See Figure 202 for CEM-2020 overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.

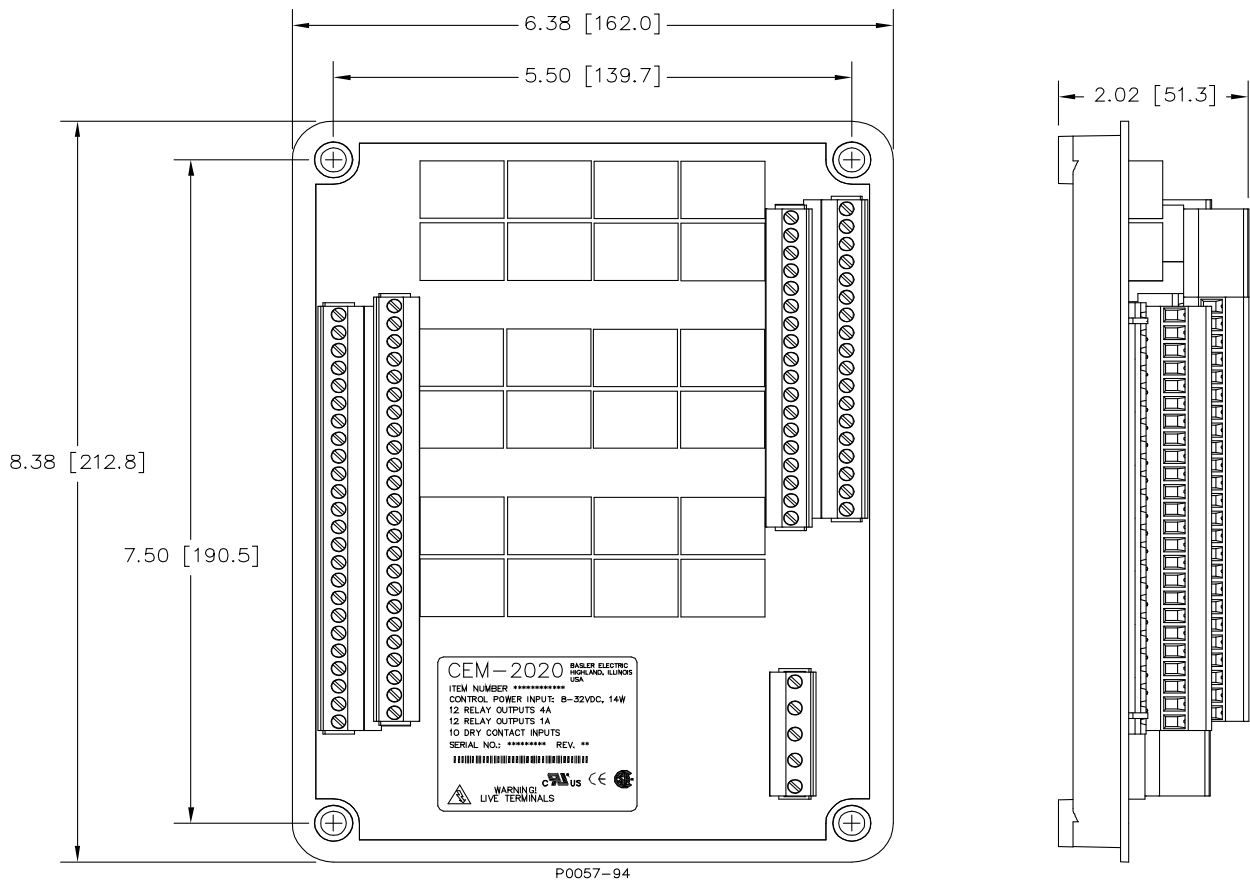


Figure 202. CEM-2020 Overall Dimensions

See Figure 203 for CEM-2020H overall dimensions. All dimensions are shown in inches with millimeters in parenthesis.

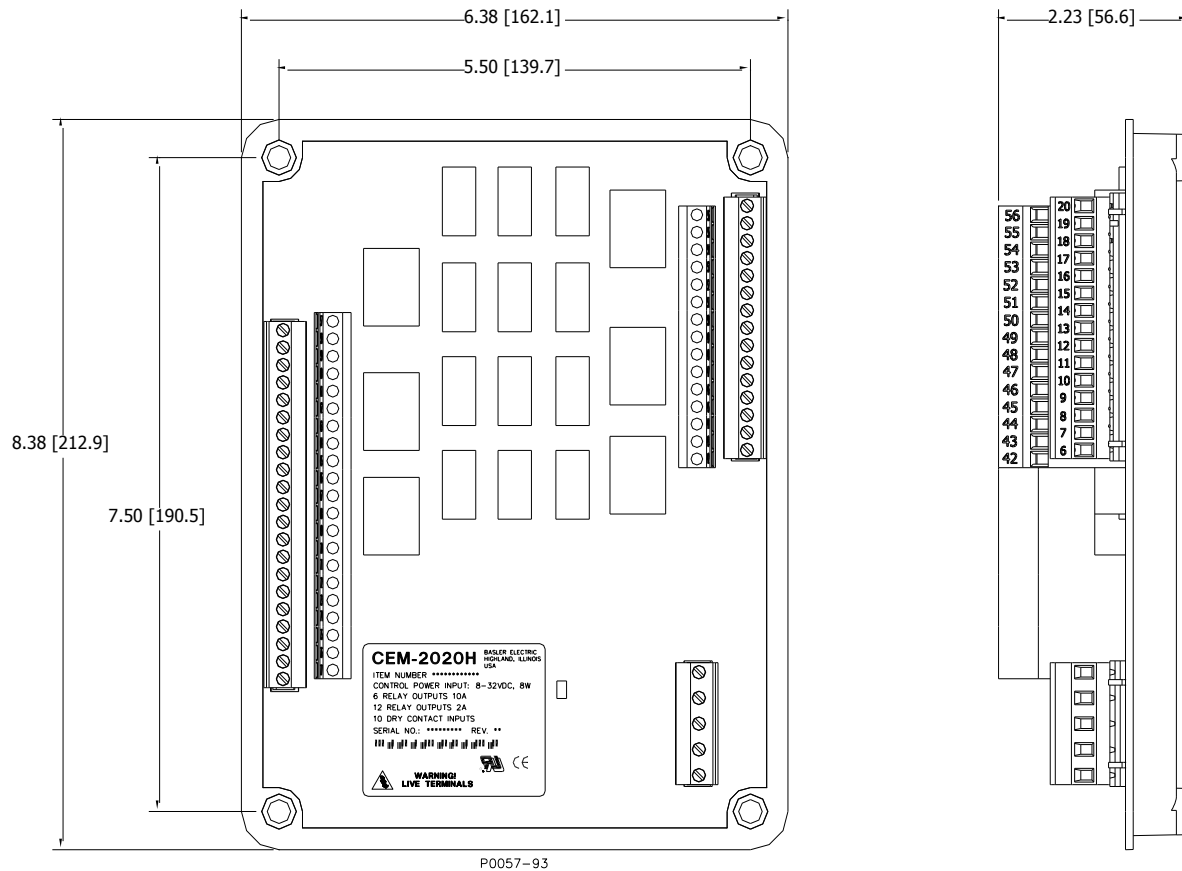


Figure 203. CEM-2020H Overall Dimensions

Connections

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

Notes

Operating power from the battery must be of the correct polarity. Although reverse polarity will not cause damage, the CEM-2020 will not operate.

Be sure that the CEM-2020 is hard-wired to earth ground with no smaller than 12 AWG (3.31 mm²) copper wire attached to the chassis ground terminal on the module.

Terminations

The terminal interface consists of plug-in connectors with screw-down compression terminals.

CEM-2020 connections are made with one 5-position connector, two 18-position connectors, and two 24-position connectors with screw-down compression terminals. These connectors plug into headers on the CEM-2020. Also, the connectors and headers have dovetailed edges that ensure proper connector orientation. The connectors and headers are uniquely keyed to ensure that the connectors mate only with the correct headers.

Caution

By mating conductors of dissimilar metals, galvanic corrosion could occur which may lead to signal loss.

Connectors and headers may contain tin- or gold-plated conductors. Tin-plated conductors are housed in a black plastic casing and gold-plated conductors are housed in an orange plastic casing. Mate connectors to headers of the same color only.

Connector screw terminals accept a maximum wire size of 12 AWG (3.31 mm²). Maximum screw torque is 5 inch-pounds (0.56 N•m).

Operating Power

The Contact Expansion Module operating power input accepts either 12 Vdc or 24 Vdc and tolerates voltage over the range of 6 to 32 Vdc. Operating power must be of the correct polarity. Although reverse polarity will not cause damage, the CEM-2020 will not operate. Operating power terminals are listed in Table 91.

It is recommended that a fuse be added for additional protection for the wiring to the battery input of the Contact Expansion Module. A Bussmann ABC-7 fuse or equivalent is recommended.

Table 91. Operating Power Terminals

Terminal	Description
P1-  (SHIELD)	Chassis ground connection
P1- – (BATT–)	Negative side of operating power input
P1- + (BATT+)	Positive side of operating power input

Contact Inputs and Contact Outputs

The CEM-2020 (Figure 204) has 10 contact inputs and 24 contact outputs. The CEM-2020H (Figure 205) has 10 contact inputs and 18 contact outputs.

Note

To follow UL guidelines, a fuse must be implemented in the 2Adc contact circuits (Outputs 5 through 16) of the CEM-2020H used in hazardous locations. The suggested fuse size in Adc = (100/Contact Voltage) with a maximum fuse size of 5 Adc.

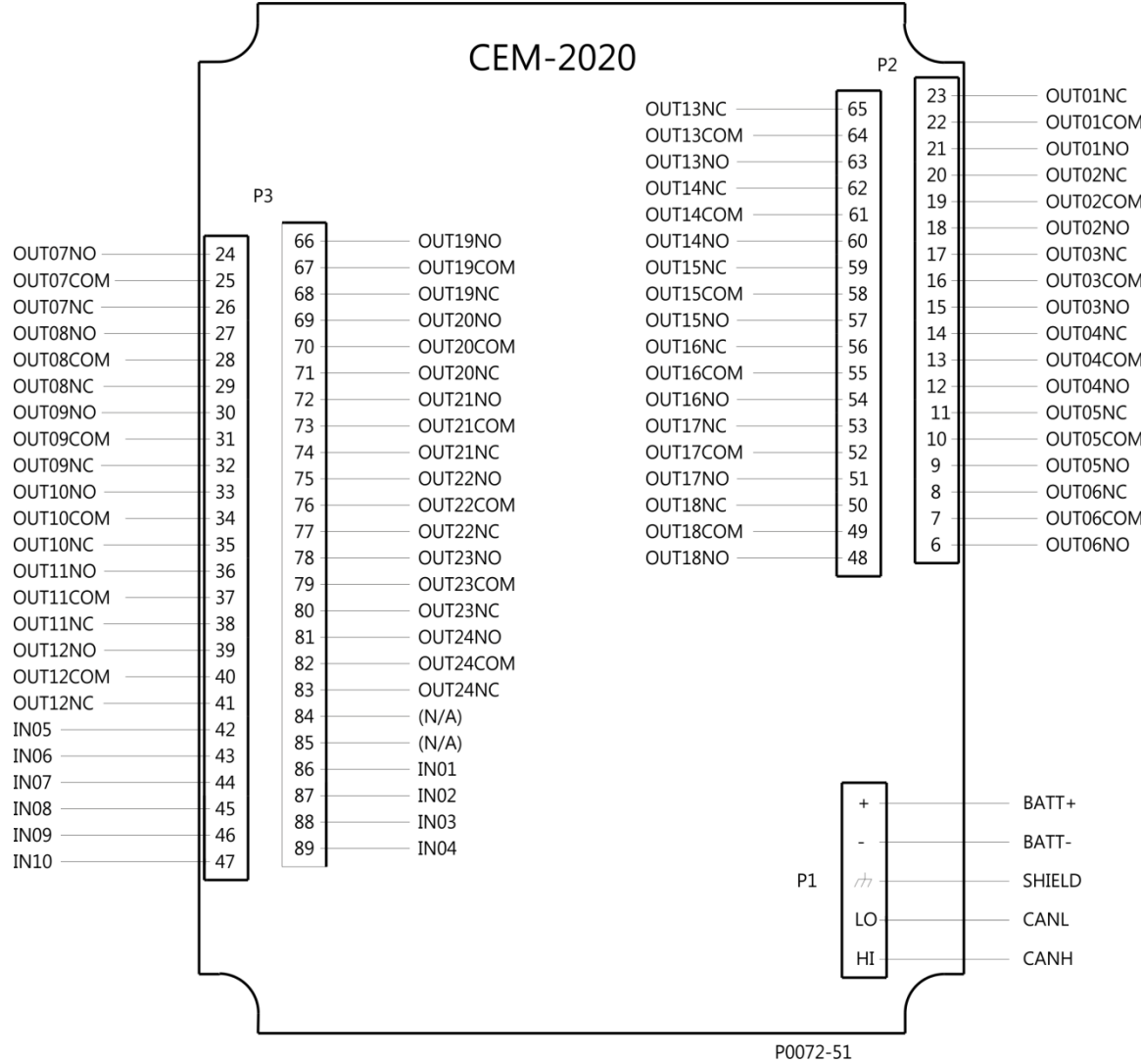


Figure 204. CEM-2020 Contact Input and Contact Output Terminals

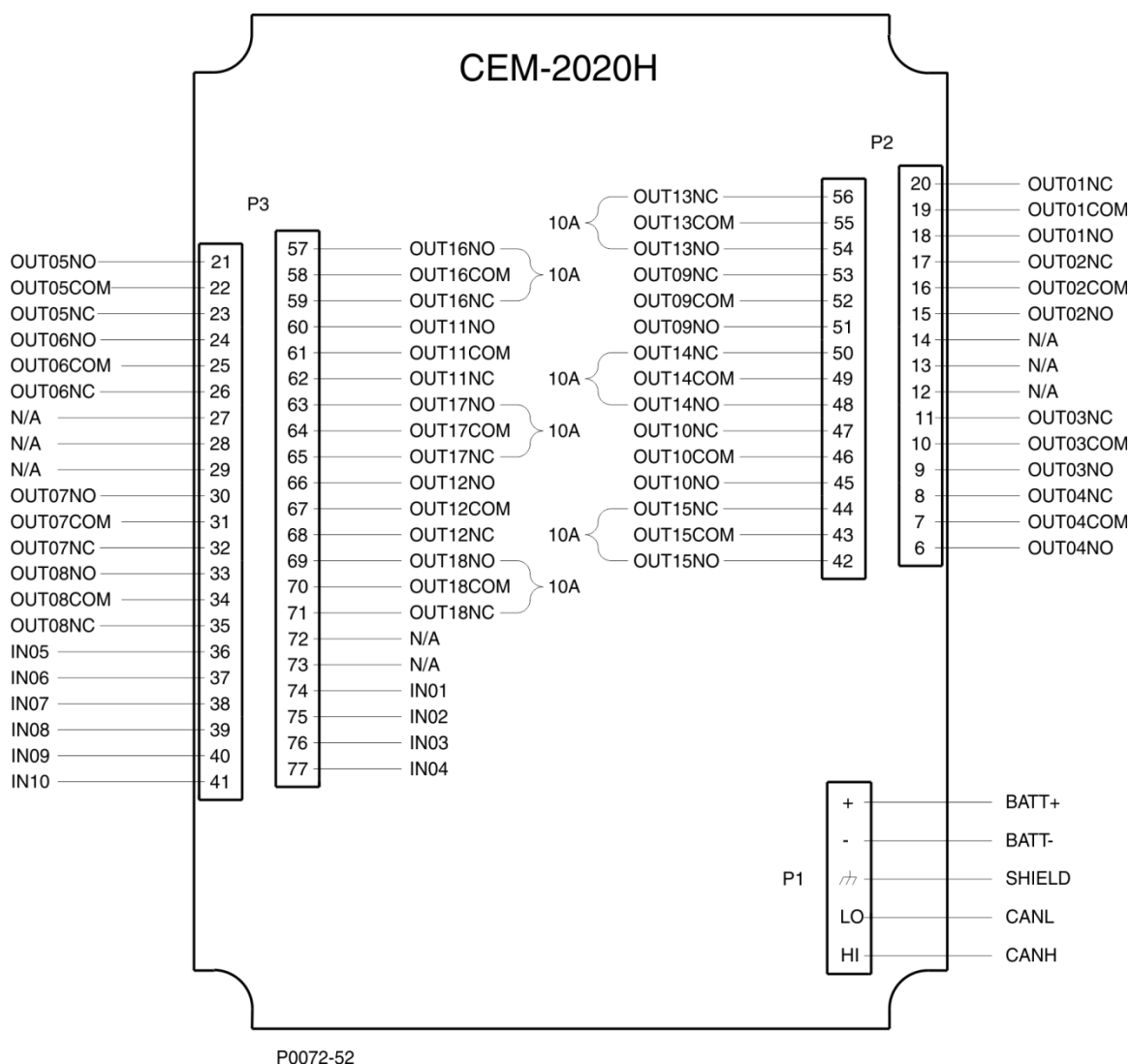


Figure 205. CEM-2020H Contact Input and Contact Output Terminals

CAN Interface

These terminals provide communication using the SAE J1939 protocol and provide high-speed communication between the Contact Expansion Module and the DGC-2020HD. Connections between the CEM-2020 and DGC-2020HD should be made with twisted-pair, shielded cable. CAN interface terminals are listed in Table 92. Refer to Figure 206 and Figure 207.

Table 92. CAN Interface Terminals

Terminal	Description
P1- HI (CAN H)	CAN high connection (yellow wire)
P1- LO (CAN L)	CAN low connection (green wire)
P1- (SHIELD)	CAN drain connection

Notes

1. If the CEM-2020 is providing one end of the J1939 bus, a 120 Ω , $\frac{1}{2}$ watt terminating resistor should be installed across terminals P1- LO (CANL) and P1- HI (CANH).
2. If the CEM-2020 is not part of the J1939 bus, the stub connecting the CEM-2020 to the bus should not exceed 914 mm (3 ft) in length.
3. The maximum bus length, not including stubs, is 40 m (131 ft).
4. The J1939 drain (shield) should be grounded at one point only. If grounded elsewhere, do not connect the drain to the CEM-2020.

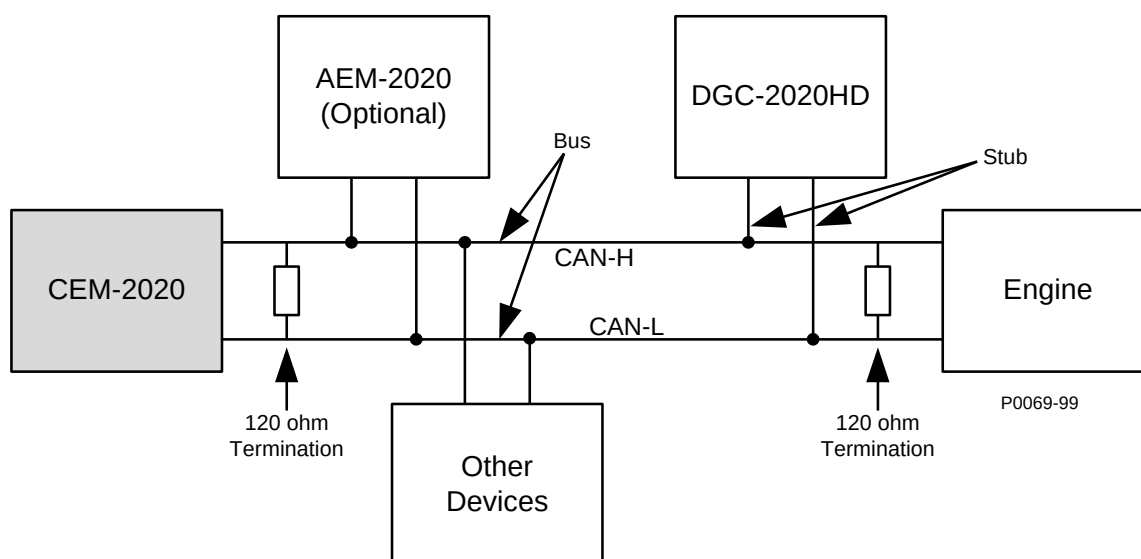


Figure 206. CAN Interface with CEM-2020 providing One End of the Bus

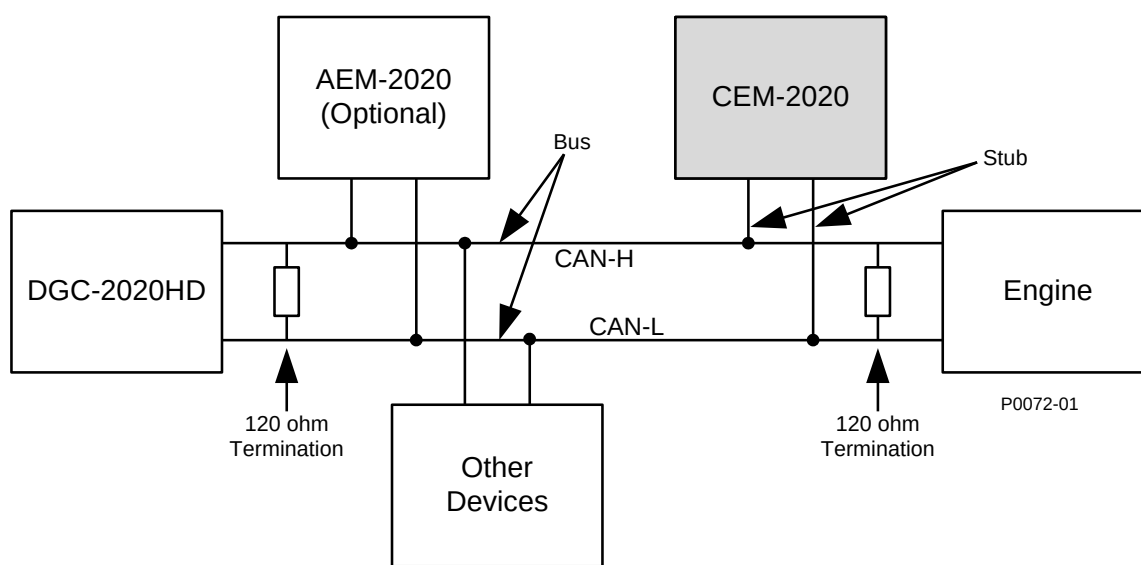


Figure 207. CAN Interface with DGC-2020HD providing One End of the Bus

CEM-2020 Configuration

CEM-2020s are enabled on the Remote Module Setup screen in BESTCOMSP^{Plus}. If more than one CEM-2020 is connected, the serial number of each module must be entered. A CEM Not Configured pre-alarm will occur if the expected serial number does not match the serial number detected on the General Settings, Device Info screen. The Remote Module Setup screen is illustrated in Figure 208.

Figure 208. Settings Explorer, System Parameters, Remote Module Setup

Remote Contact Inputs Configuration

Ten remote contact inputs provide additional sensing. The ten, identical inputs are designated CEM x Input #1 through CEM x Input #10 (where x = 1 to 4). Contact input logic connections are made on the BESTlogic^{Plus} screen in BESTCOMSP^{Plus} and contact input operational settings are configured on the CEM x Inputs (where x = 1 to 4) settings screen in BESTCOMSP^{Plus}.

BESTCOMSP^{Plus} Navigation Path: Settings Explorer, Programmable Inputs, Remote Contact Inputs

Front Panel Navigation Path: Settings Explorer > Programmable Inputs > Remote Contact Inputs

Input Setup

Alarm Configuration

Each remote contact input can be independently configured to annunciate an alarm or pre-alarm, or be configured as status only when the contact input falls beyond the threshold. By default, all inputs are configured for status only.

Activation Delay

A user-adjustable time delay can be set to delay recognition of a contact input.

Label Text

In order to make identification of the remote contact inputs easier, each of the inputs can be given a user-assigned label. The label is an alphanumeric string with a maximum of 16 characters.

Contact Recognition

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

Logic Connections

Remote contact input logic connections are made on the BESTlogicPlus screen in BESTCOMSPlus. The CEM 1 Input 1 logic block is illustrated in Figure 209. The output is true when the CEM-2020 senses a contact closure and after the activation delay expires. The alarm and pre-alarm logic blocks are similar.

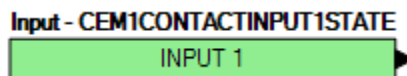


Figure 209. Remote Contact Input Logic Block

Operational Settings

Remote contact input operational settings are configured on the CEM x Inputs (where x = 1 to 4) settings screen (Figure 210) in BESTCOMSPlus. Settings are listed in Table 93.

Figure 210. Settings Explorer, Programmable Inputs, Remote Contact Inputs, CEM 1 Inputs

Table 93. Settings for CEM x Inputs

Locator	Setting	Range	Increment	Unit
A	Alarm Configuration	Status Only, Pre-Alarm, or Alarm	n/a	n/a
B	Activation Delay	0 to 300	1	seconds
C	Label Text	16 alphanumeric characters	n/a	n/a
D	Contact Recognition	Always or While Engine Running Only	n/a	n/a

Remote Contact Outputs Configuration

A CEM-2020 provides 24 contact outputs and a CEM-2020H provides 18 contact outputs. The outputs are designated CEM x Output #1 through CEM x Output #24 (where x = 1 to 4). Contact output logic connections are made on the BESTlogicPlus screen in BESTCOMSPlus and contact output operational settings are configured on the CEM x Outputs (where x = 1 to 4) settings screen in BESTCOMSPlus.

BESTCOMSPlus Navigation Path: Settings Explorer, Programmable Outputs, Remote Contact Outputs

Front Panel Navigation Path: Settings Explorer > Programmable Outputs > Remote Contact Outputs

Label Text

In order to make identification of the remote contact outputs easier, each of the outputs can be given a user-assigned label. The label is an alphanumeric string with a maximum of 16 characters.

Logic Connections

Remote contact output logic connections are made on the BESTlogicPlus screen in BESTCOMSPlus. The CEM 1 Output 1 logic block is illustrated in Figure 211.

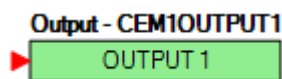


Figure 211. Remote Contact Output Logic Block

Operational Settings

Remote contact output labels are configured on the CEM x Outputs (where x = 1 to 4) settings screen (Figure 212) in BESTCOMSPlus.

Figure 212. Settings Explorer, Programmable Outputs, Remote Contact Outputs, CEM 1 Outputs

Firmware Updates

Refer to the *Device Information* chapter for information on upgrading firmware in the CEM-2020.

Repair

Contact Expansion Modules are manufactured using state-of-the-art surface-mount technology. As such, Basler Electric recommends that no repair procedures be attempted by anyone other than Basler Electric personnel.

Before returning the CEM-2020 for repair, contact the Basler Electric Technical Services Department at 618-654-2341 for a return authorization number.

Maintenance

Preventive maintenance consists of periodically checking that the connections between the CEM-2020 and the system are clean and tight.

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.



Time Curve Characteristics

The inverse time overcurrent characteristic curves provided by the DGC-2020HD (style xxExxxxxx only) closely emulate most of the common electromechanical, induction-disk, overcurrent relays sold in North America. To further improve proper relay coordination, a selection of integrated reset or instantaneous reset characteristics are also provided.

Curve Specifications

Timing Accuracy..... Within ± 500 milliseconds of indicated operating point.

Sixteen inverse time functions, one fixed time function, one 46 time function, and one programmable time function can be selected. Characteristic curves for the inverse and definite time functions are defined by the following equations and comply with IEEE Std C37.112 - *IEEE Standard Inverse-Time Characteristic Equations for Overcurrent Relays*.

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

Equation 10

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

Equation 11

T_T = Time to trip when $M \geq 1$

T_R = Time to reset if relay is set for integrating reset when $M < 1$. Otherwise, reset is 50 milliseconds or less

D = Time Dial setting (0.0 to 9.9) *

M = Multiple of Pickup setting (0 to 40)

A, B, C, N, K = Constants for the particular curve

R = Constant defining the reset time

Q = Denominator exponent

* Timing range is 0.0 to 7,200 seconds when the F (fixed) curve is selected.

Table 94 lists time characteristic curve constants. See the figures after the tables for graphs of the characteristics.

Table 94. 51 Time Characteristic Curve Constants

Curve Selection	Curve Name	Trip Characteristic Constants						Reset †
		A	B	C	N	K	Q	R
S1	Short Inverse	0.2663	0.03393	1	1.2969	0.028	1	0.5
S2	Short Inverse	0.0286	0.0208	1	0.9844	0.028	1	0.094
L1	Long Inverse	5.6143	2.18592	1	1	0.028	1	15.75
L2	Long Inverse	2.3955	0	1	0.3125	0.028	1	7.8001
D	Definite Time	0.4797	0.21359	1	1.5625	0.028	1	0.875
M	Moderately Inverse	0.3022	0.1284	1	0.5	0.028	1	1.75
I1	Inverse Time	8.9341	0.17966	1	2.0938	0.028	1	9
I2	Inverse Time	0.2747	0.10426	1	0.4375	0.028	1	0.8868
V1	Very Inverse	5.4678	0.10814	1	2.0469	0.028	1	5.5
V2	Very Inverse	4.4309	0.0991	1	1.9531	0.028	1	5.8231
E1	Extremely Inverse	7.7624	0.02758	1	2.0938	0.028	1	7.75
E2	Extremely Inverse	4.9883	0.0129	1	2.0469	0.028	1	4.7742
A	Standard Inverse	0.01414	0	1	0.02	0.028	1	2
B	Very Inverse (I^2t)	1.4636	0	1	1.0469	0.028	1	3.25
C	Extremely Inverse (I^2t)	8.2506	0	1	2.0469	0.028	1	8
G	Long Time Inverse (I^2t)	12.1212	0	1	1	0.028	1	29
F	Fixed Time *	0	1	0	0	0	1	1
46	Negative-Sequence Overcurrent	‡	0	0	2	0.028	1	100
P	User Programmable §	0 to 600	0 to 25	0 to 1	0.5 to 2.5	0.028	0.1 to 10	0 to 30

* Curve F has a fixed delay of one second times the Time Dial setting.

† Instantaneous or integrating reset is selected on the Overcurrent setup screen in BESTCOMSPlus®.

‡ Constant A is variable for the 46 curve and is determined, as necessary, based on system full-load current setting, minimum pickup, and K factor settings.

§ The programmable curve allows for four significant digits after the decimal place for every variable.

Time Overcurrent Characteristic Curve Graphs

The figures after the tables illustrate the characteristic curves of the DGC-2020HD. Table 95 cross-references each curve to existing electromechanical relay characteristics. Equivalent time dial settings were calculated at a value of five times pickup.

Table 95. Characteristic Curve Cross-Reference

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

Time Dial Setting Cross-Reference

While the time characteristic curve shapes have been optimized for each relay, time dial settings of Basler Electric relays are not identical to the settings of electromechanical induction disk overcurrent relays. Table 96 helps you convert the time dial settings of induction disk relays to the equivalent setting for Basler Electric relays. Enter time dial settings using BESTCOMS*Plus*. For more information, refer to the *Generator Protection* chapter.

Using Table 96

Cross-reference table values were obtained by inspection of published electromechanical time current characteristic curves. The time delay for a current of five times tap was entered into the time dial calculator function for each time dial setting. The equivalent Basler Electric time dial setting was then entered into the cross-reference table.

If your electromechanical relay time dial setting is between the values provided in the table, it will be necessary to estimate the correct intermediate value between the electromechanical setting and the Basler Electric setting.

The DGC-2020 has a maximum time dial setting of 9.9. When the F (fixed) curve is selected, the maximum timing range is 7,200 seconds. The Basler Electric equivalent time dial setting for the electromechanical maximum setting is provided in the cross-reference table even if it exceeds 9.9. This allows interpolation as noted above.

Basler Electric time current characteristics are determined by a linear mathematical equation. The induction disk of an electromechanical relay has a certain degree of non linearity due to inertial and friction effects. For this reason, even though every effort has been made to provide characteristic curves with minimum deviation from the published electromechanical curves, slight deviations can exist between them.

In applications where the time coordination between curves is extremely close, we recommend that you choose the optimal time dial setting by inspection of the coordination study. In applications where coordination is tight, it is recommended that you retrofit your circuits with Basler Electric electronic relays to ensure high timing accuracy.

Table 96. Time Dial Setting Cross-Reference

Curve	Equivalent To	Electromechanical Relay Time Dial Setting											
		0.5	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0
		Basler Electric Equivalent Time Dial Setting											
S1	ABB CO-2	0.3	0.8	1.7	2.4	3.4	4.2	5.0	5.8	6.7	7.7	8.6	9.7
L1	ABB CO-5	0.4	0.8	1.5	2.3	3.3	4.2	5.0	6.0	7.0	7.8	8.8	9.9
D	ABB CO-6	0.5	1.1	2.0	2.9	3.7	4.5	5.0	5.9	7.2	8.0	8.9	n/a
M	ABB CO-7	0.4	0.8	1.7	2.5	3.3	4.3	5.3	6.1	7.0	8.0	9.0	9.8
I1	ABB CO-8	0.3	0.7	1.5	2.3	3.2	4.0	5.0	5.8	6.8	7.6	8.7	n/a
V1	ABB CO-9	0.3	0.7	1.4	2.1	3.0	3.9	4.8	5.7	6.7	7.8	8.7	9.6
E1	ABB CO-11	0.3	0.7	1.5	2.4	3.2	4.2	5.0	5.7	6.6	7.8	8.5	n/a
I2	GE IAC-51	0.6	1.0	1.9	2.7	3.7	4.8	5.7	6.8	8.0	9.3	n/a	n/a
V2	GE IAC-53	0.4	0.8	1.6	2.4	3.4	4.3	5.1	6.3	7.2	8.4	9.6	n/a
S2	GE IAC-55	0.2	1.0	2.0	3.1	4.0	4.9	6.1	7.2	8.1	8.9	9.8	n/a
L2	GE IAC-66	0.4	0.9	1.8	2.7	3.9	4.9	6.3	7.2	8.5	9.7	n/a	n/a
E2	GE IAC-77	0.5	1.0	1.9	2.7	3.5	4.3	5.2	6.2	7.4	8.2	9.9	n/a

The 46 Curve

The 46 curve (Figure 229) is a special curve designed to emulate the $(I_2)^2t$ withstand ratings of generators using what is frequently referred to as the generator K factor.

The 46 Curve Characteristics

46 Pickup Current

Generators have a maximum continuous rating for negative sequence current. This is typically expressed as a percent of stator rating. When using the 46 curve, the user should convert the continuous I^2 rating data to actual secondary current at the relay. This value (plus some margin, if appropriate) should be entered as the pickup setting. For example, if a generator's rated full-load current is 5 amperes, a pu setting of 0.5 A would allow 10% continuous I_2 .

46 Time Dial (= Generator K factor)

The amount of time that a generator can withstand a given level of unbalance is defined by Equation 12.

$$t = \frac{K}{(I_2)^2}$$

Equation 12

The K factor gives the time that a generator can withstand 1 per unit negative sequence current. For example, with a K factor of 20, since $(I_2)^2$ becomes 1 at 1 per unit of current, the generator can withstand the condition for 20 seconds. Typical values for generator K factors are in the 2 to 40 range. The relay uses the "nominal current" setting of the relay to determine what corresponds to 1 per unit current in the generator.

When curve 46 is selected, the relay changes the range of the allowed time dial to 1 to 99 (instead of the time dial range of 0.1 to 9.9 for all the other curves). The user should enter the "K" factor of the generator into the time dial field.

Relay Equation

When the 46 function is used, the relay uses the K factor (i.e., 46 time dial setting), 46 minimum pickup setting, and generator full-load current to create a constant Z (see Equation 13).

$$Z = 46 \text{ Time Dial} \left(\frac{I_{Nom \text{ Setting}}}{46 \text{ Pickup Setting}} \right)^2$$

Equation 13

The time to trip equation used in the relay is:

$$T_T = \frac{Z}{M^2} + 0.028 \text{ seconds}$$

Equation 14

where:

$$M = \frac{\text{Measured } I_2}{46 \text{ Pickup Setting}}$$

Equation 15

which, when $M > 1$, reduces to:

$$T_T = 46 \text{ Time Dial} \left(\frac{I_{Nom \text{ Setting}}}{I_2 \text{ Measured}} \right)^2$$

Equation 16

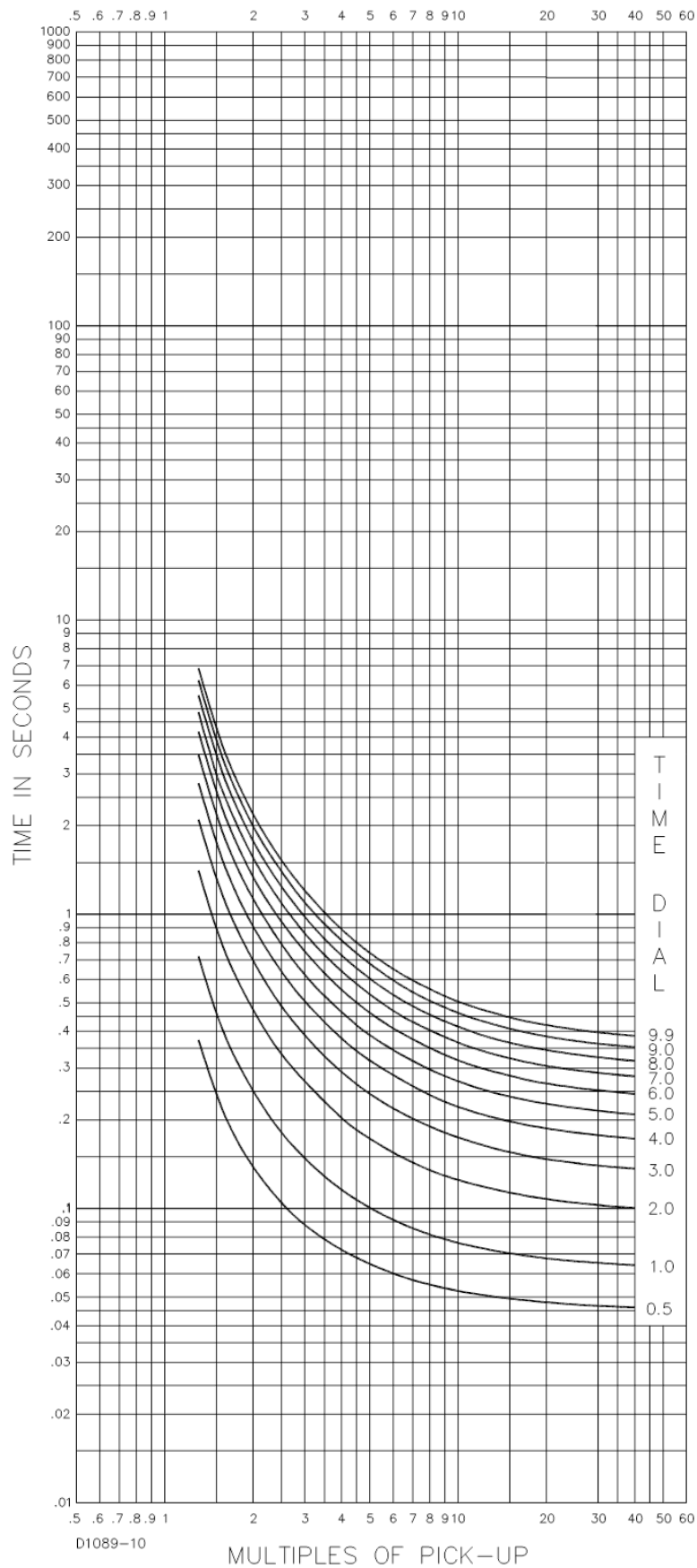


Figure 213. Time Characteristic Curve S1, Short Inverse (Similar to ABB CO-2)

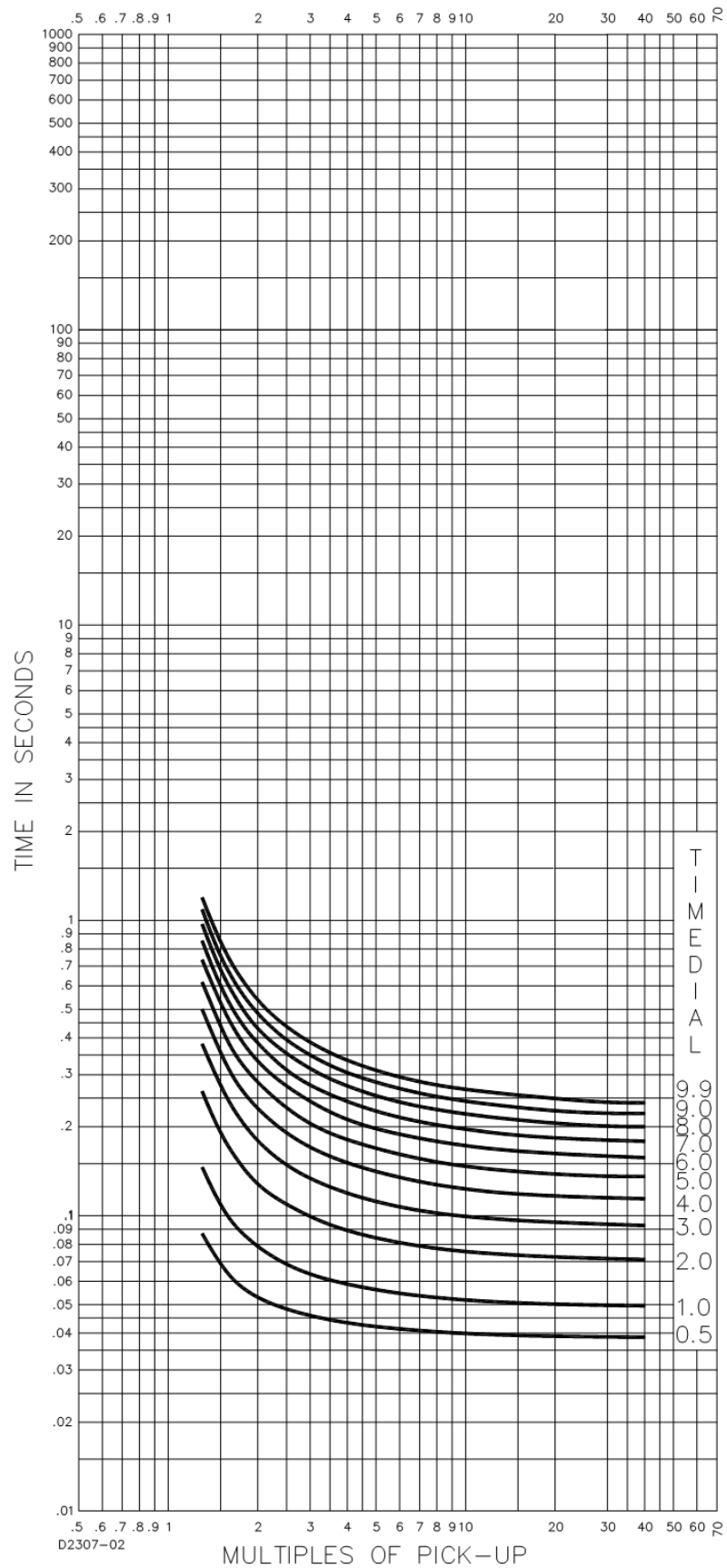


Figure 214. Time Characteristic Curve S2, Short Inverse (Similar To GE IAC-55)

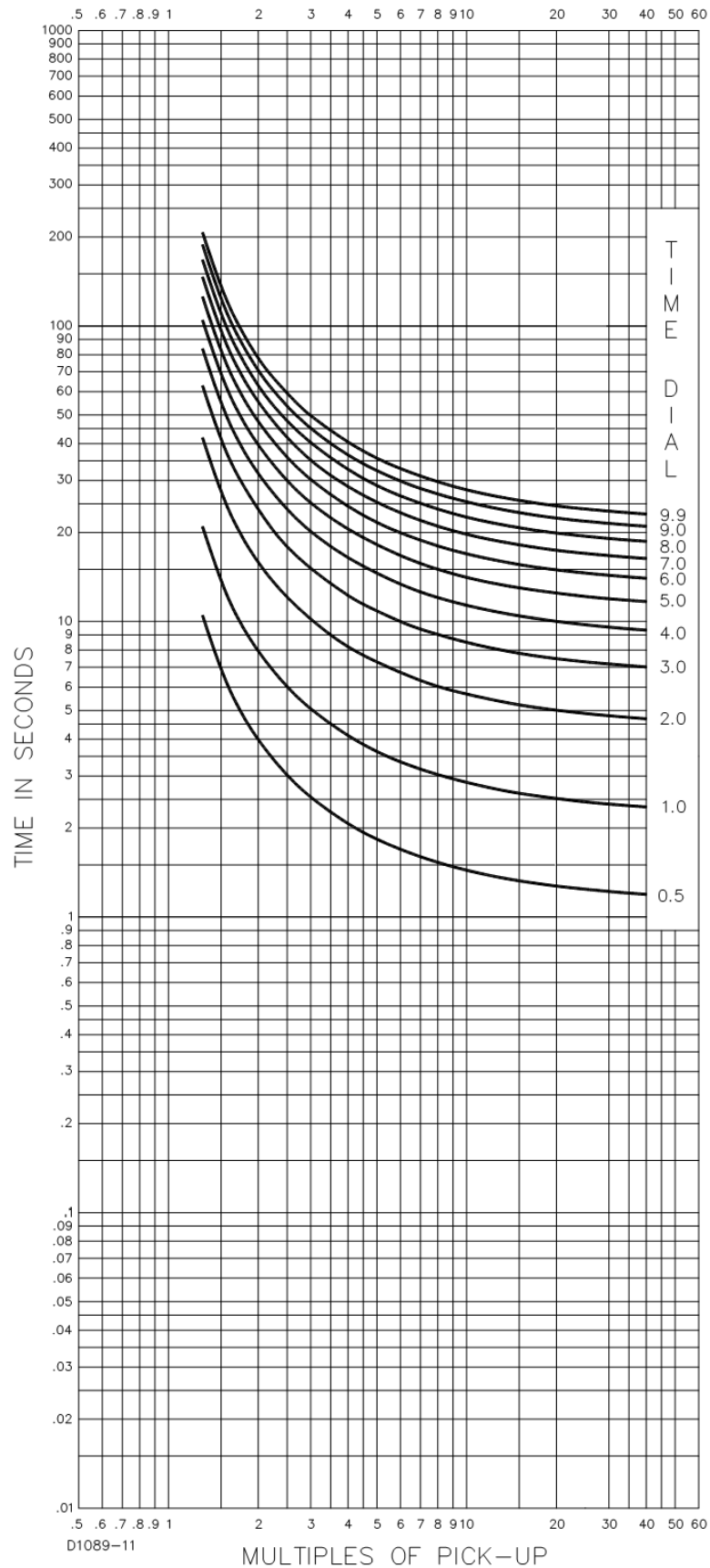


Figure 215. Time Characteristic Curve L1, Long Inverse (Similar to ABB CO-5)

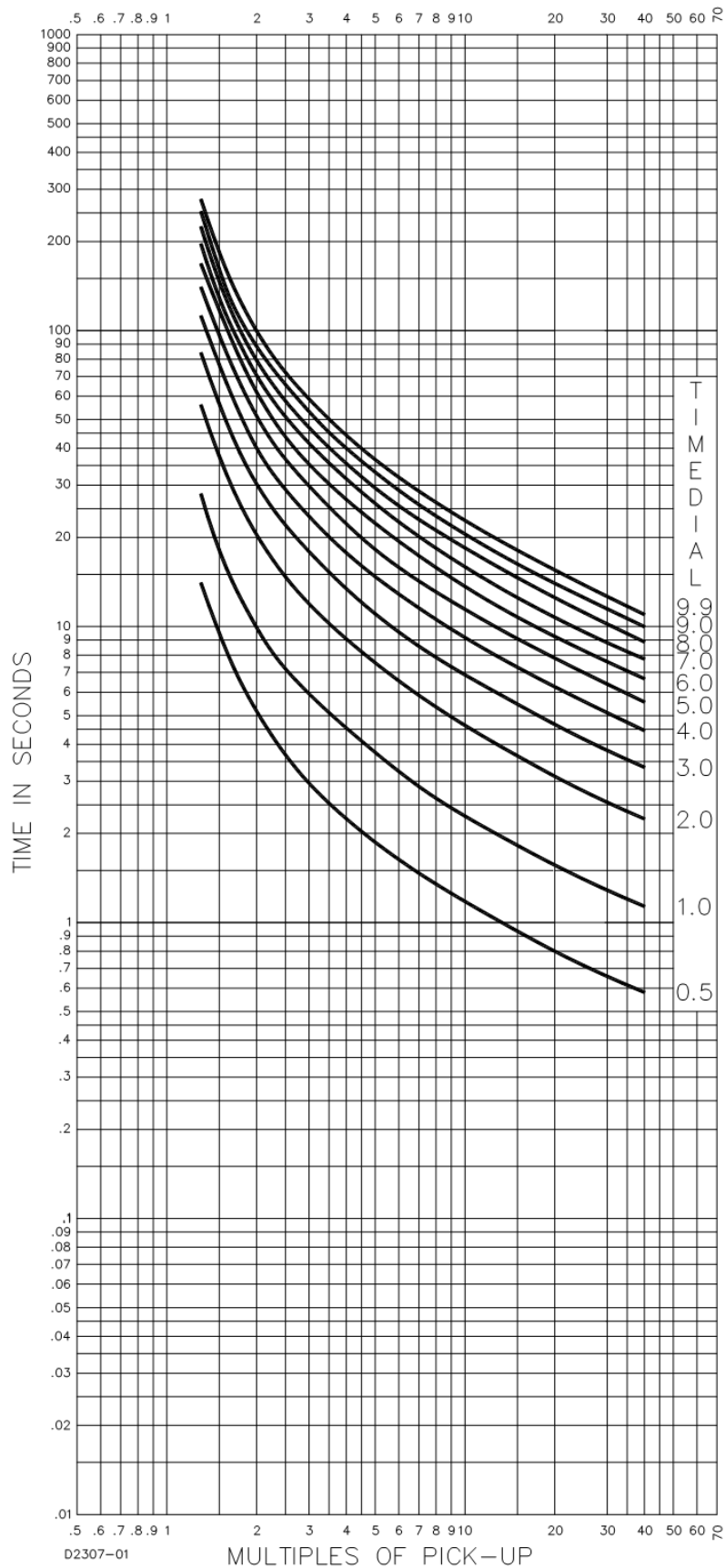


Figure 216. Time Characteristic Curve L2, Long Inverse (Similar To GE IAC-66)

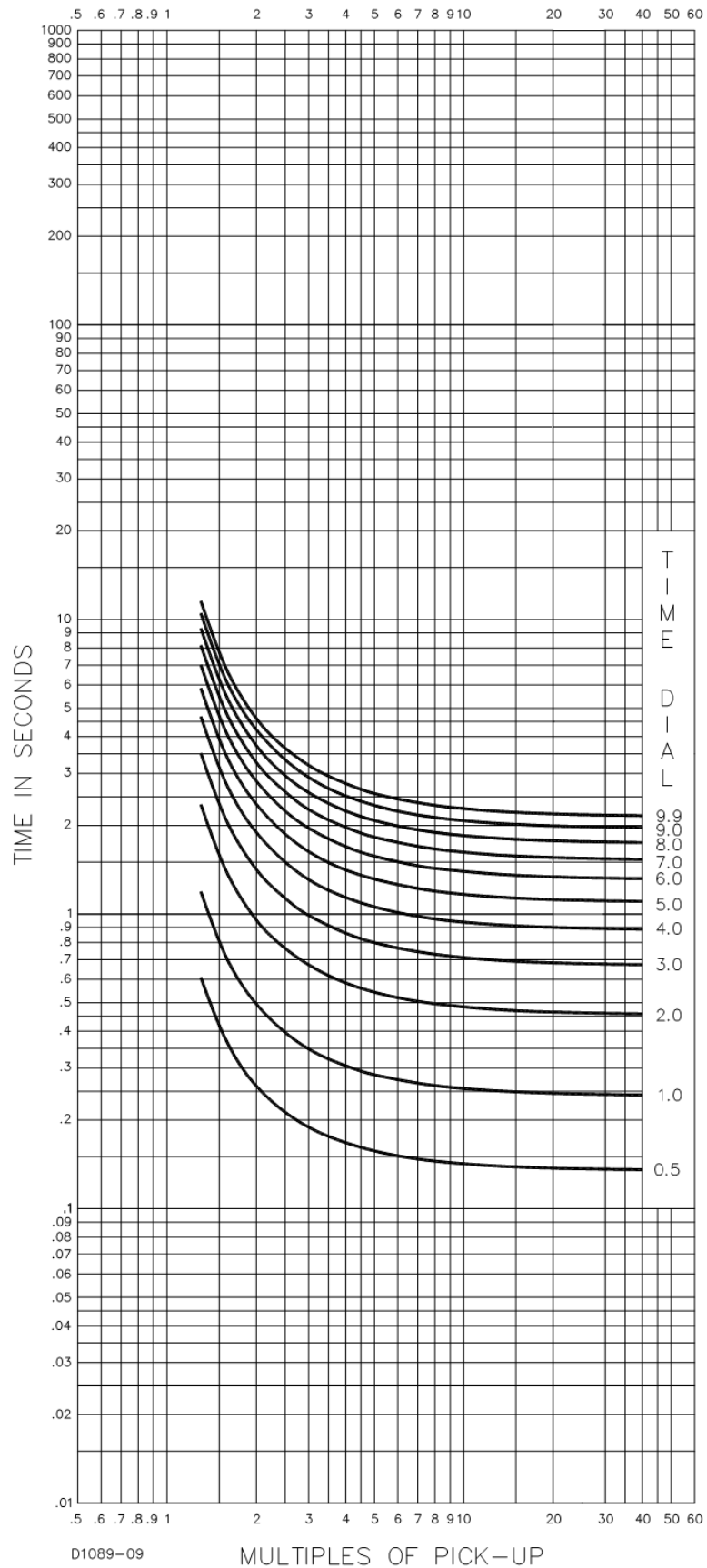


Figure 217. Time Characteristic Curve D, Definite Time (Similar To ABB CO-6)

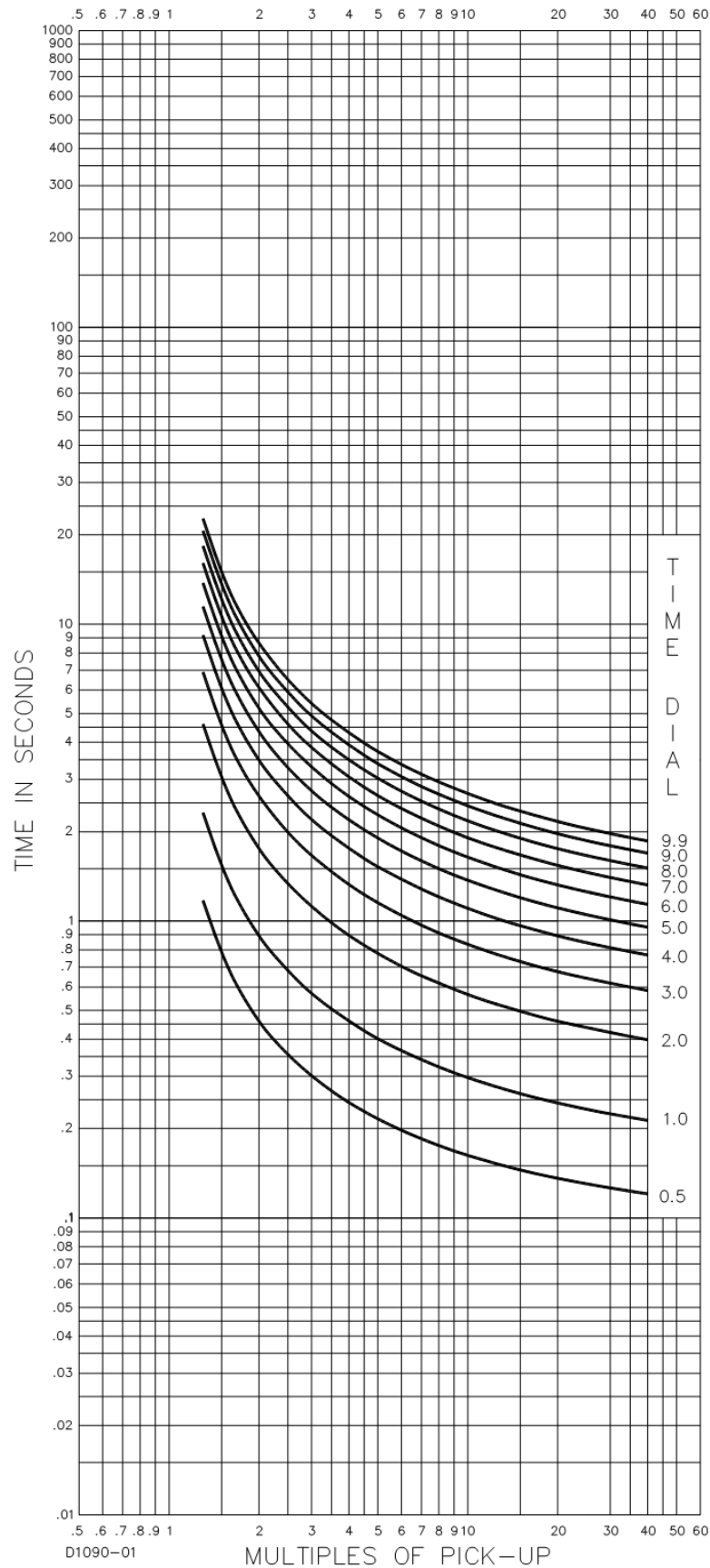


Figure 218. Time Characteristic Curve M, Moderately Inverse (Similar to ABB CO-7)

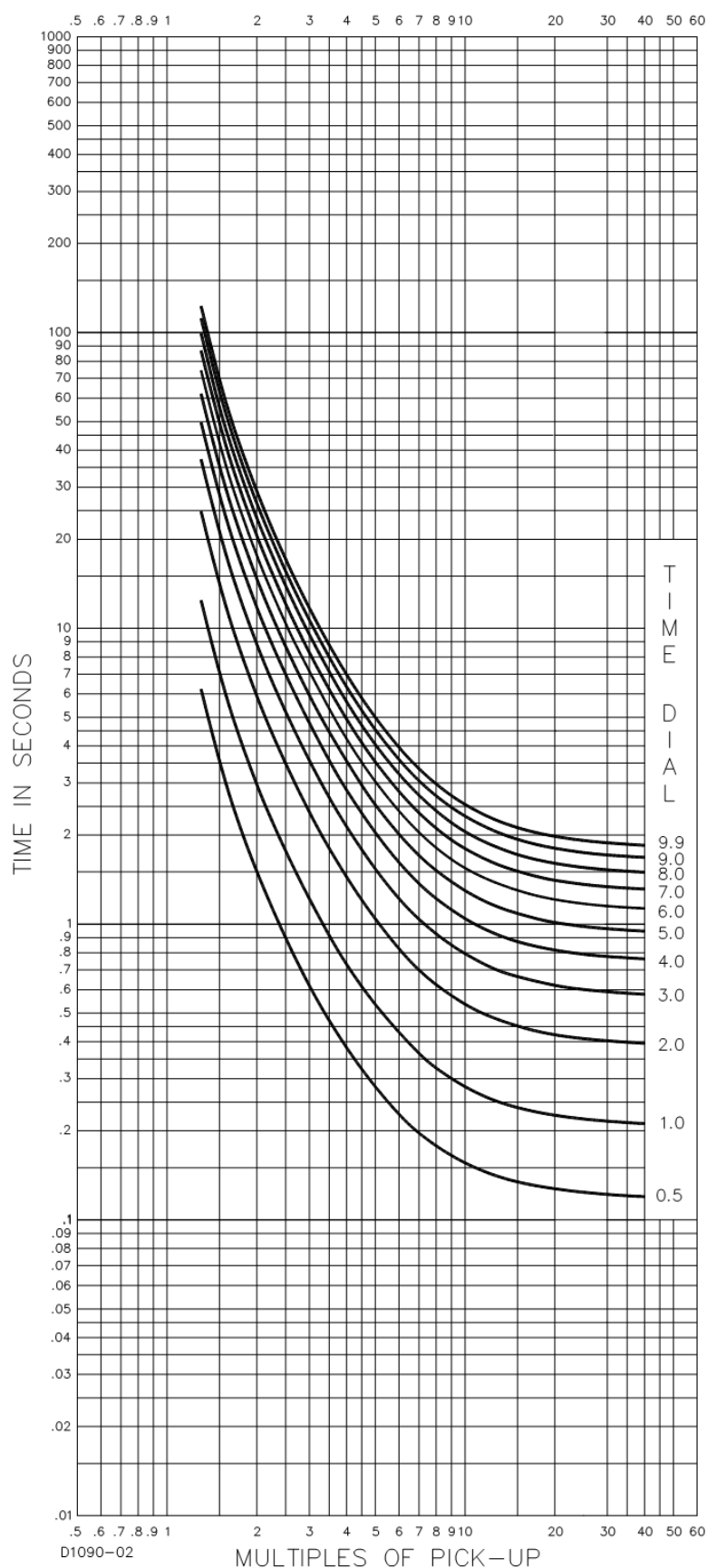


Figure 219. Time Characteristic Curve I1, Inverse Time (Similar to ABB CO-8)

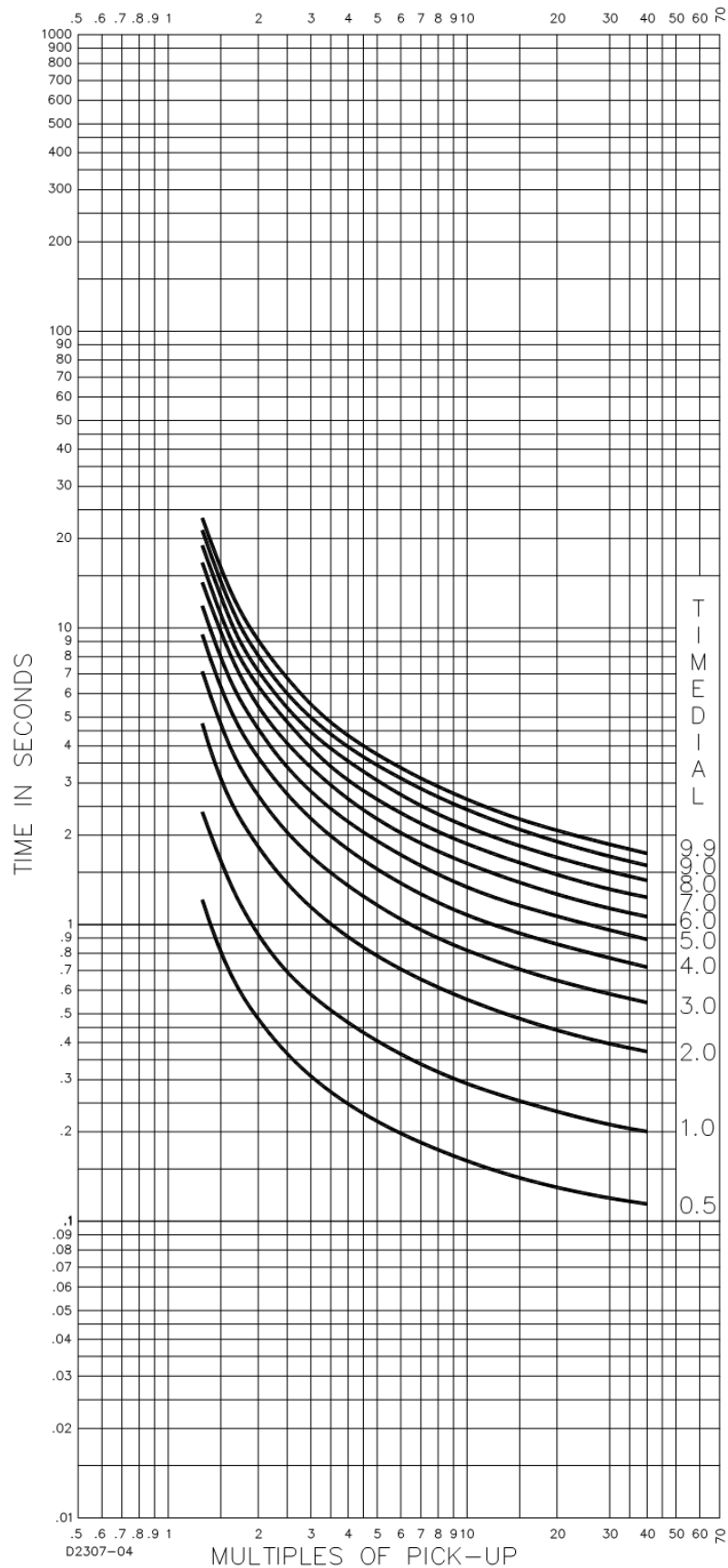


Figure 220. Time Characteristic Curve I2, Inverse Time (Similar to GE IAC-51)

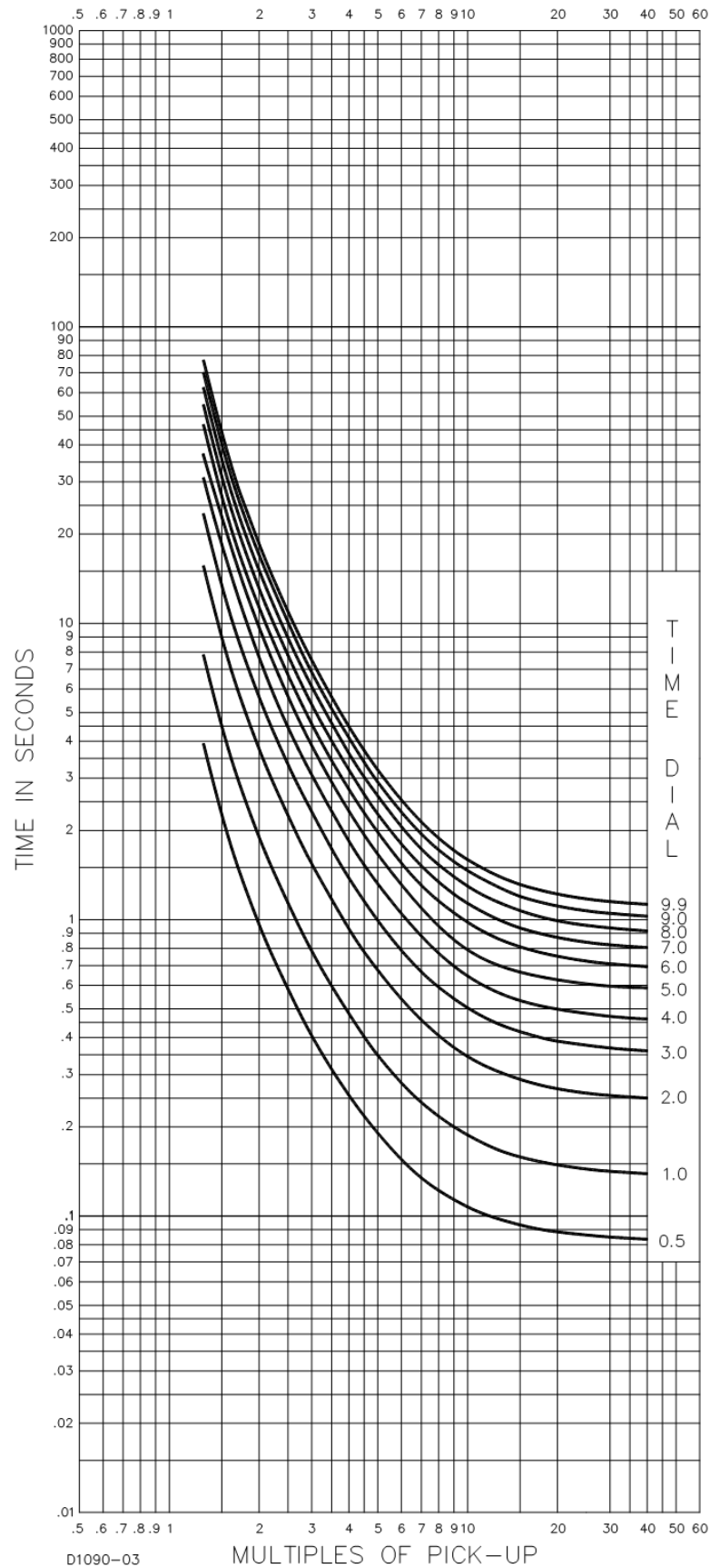


Figure 221. Time Characteristic Curve V1, Very Inverse (Similar to ABB CO-9)

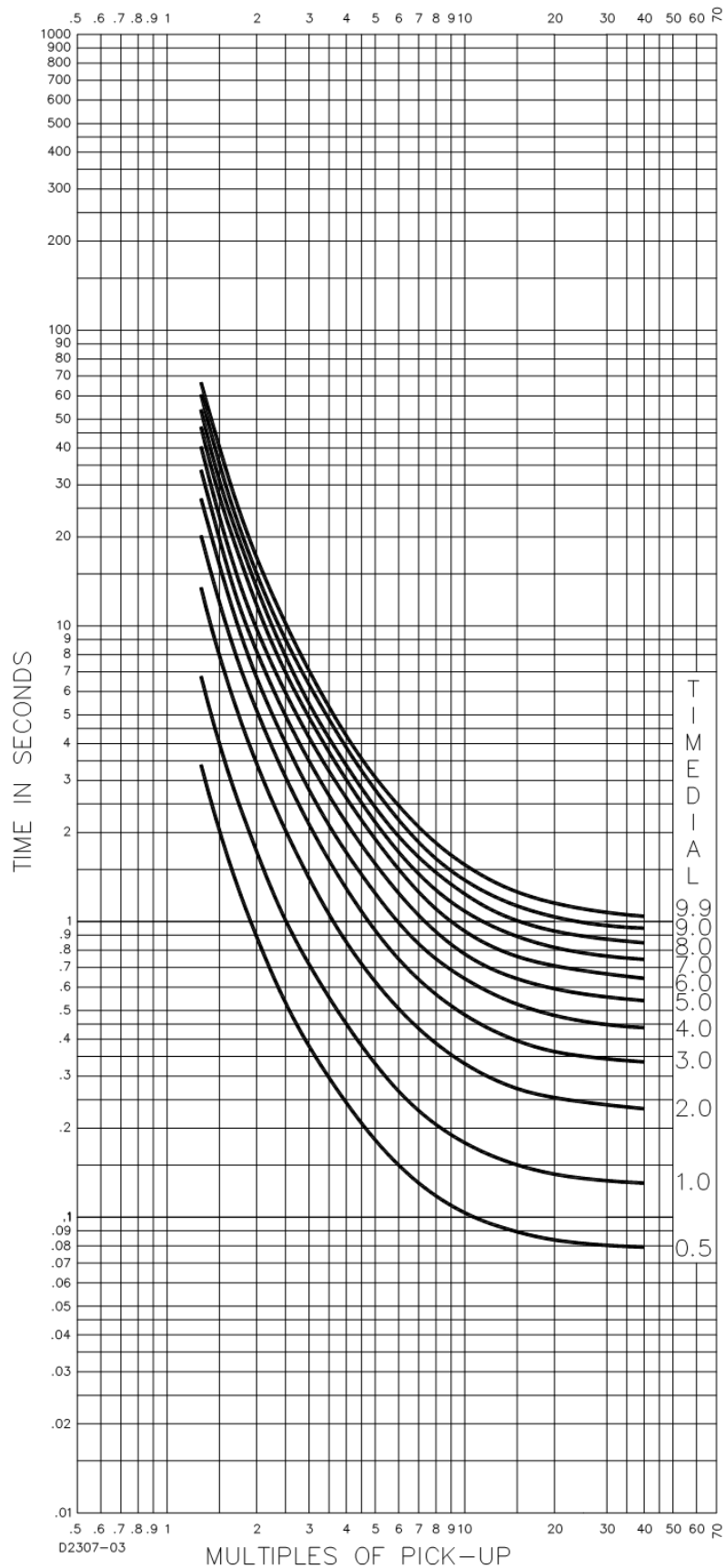


Figure 222. Time Characteristic Curve V2, Very Inverse (Similar to GE IAC-53)

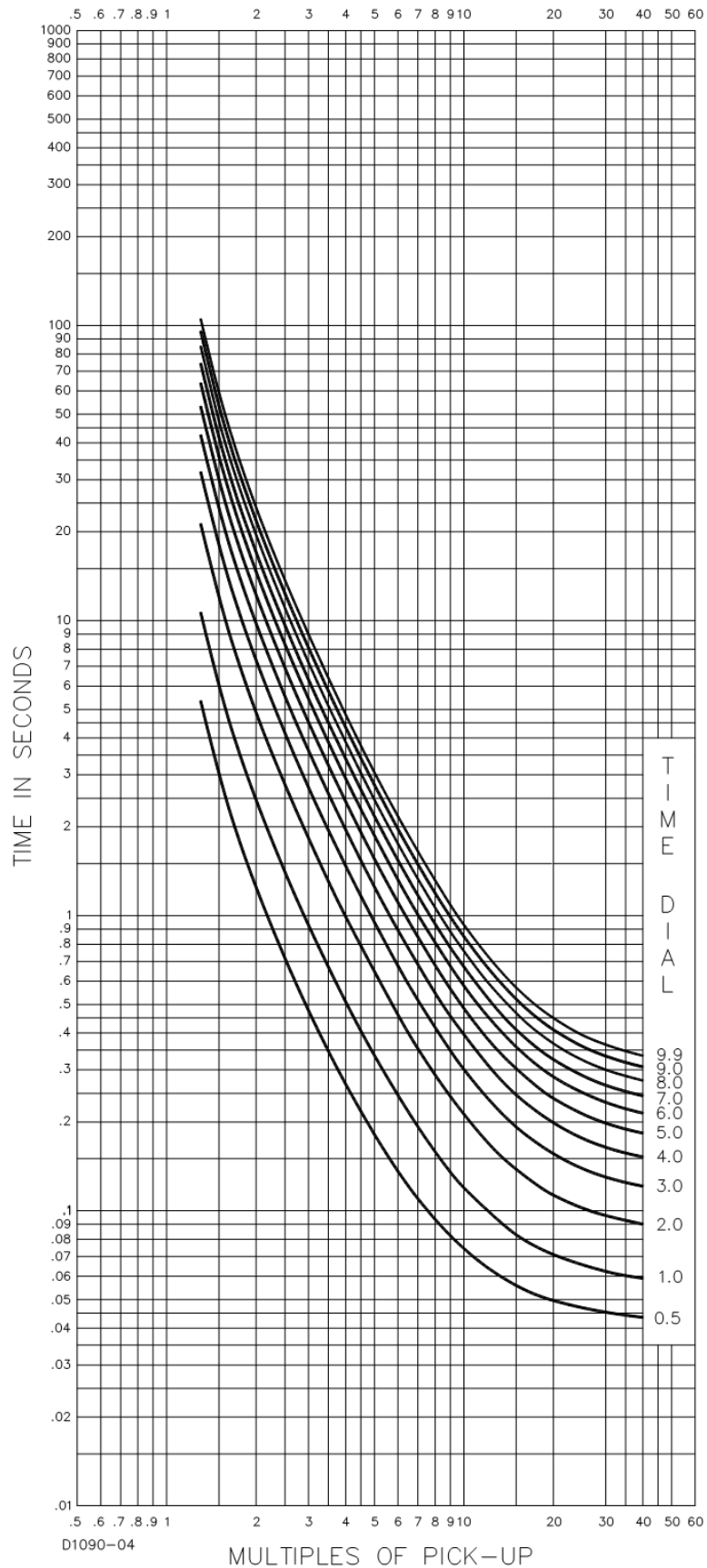


Figure 223. Time Characteristic Curve E1, Extremely Inverse (Similar to ABB CO-11)

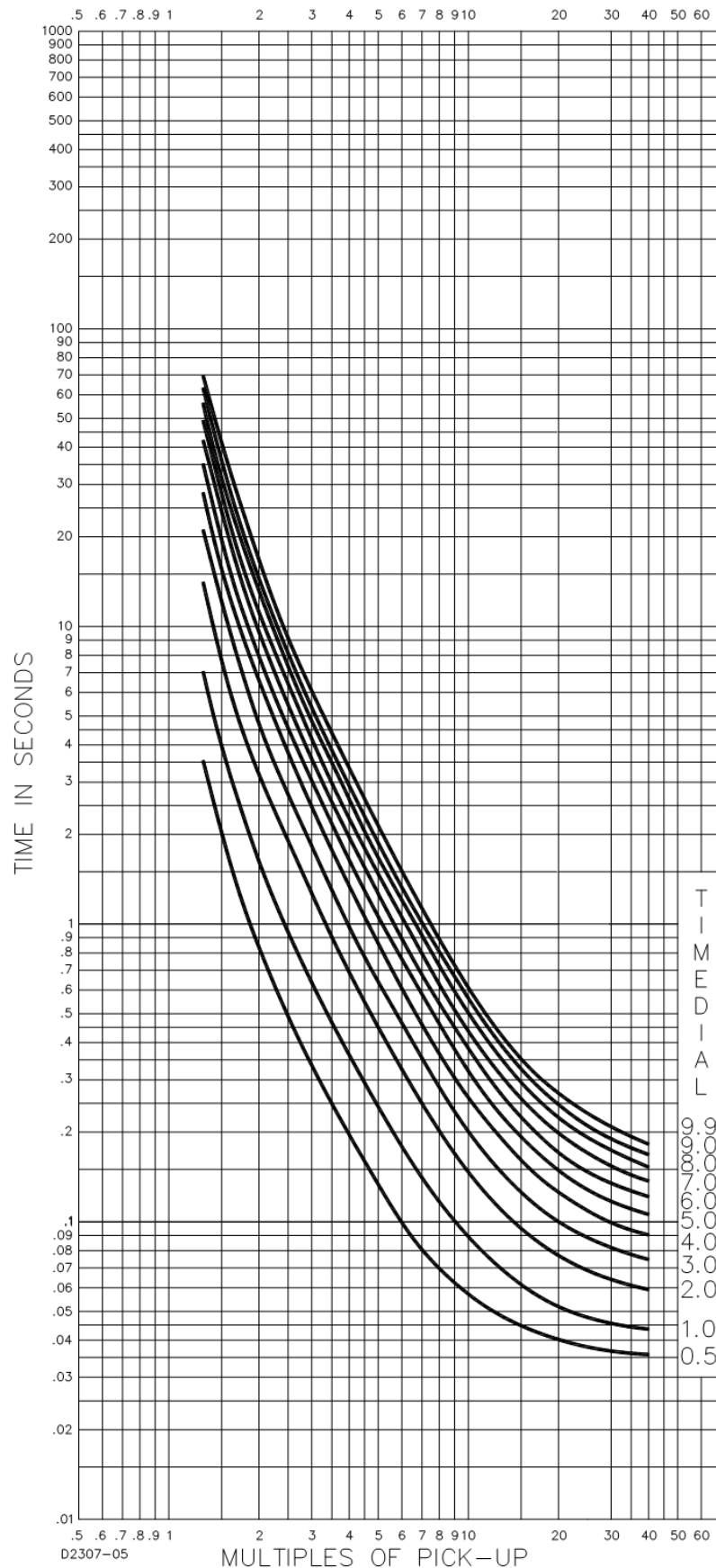


Figure 224. Time Characteristic Curve E2, Extremely Inverse (Similar to GE IAC-77)

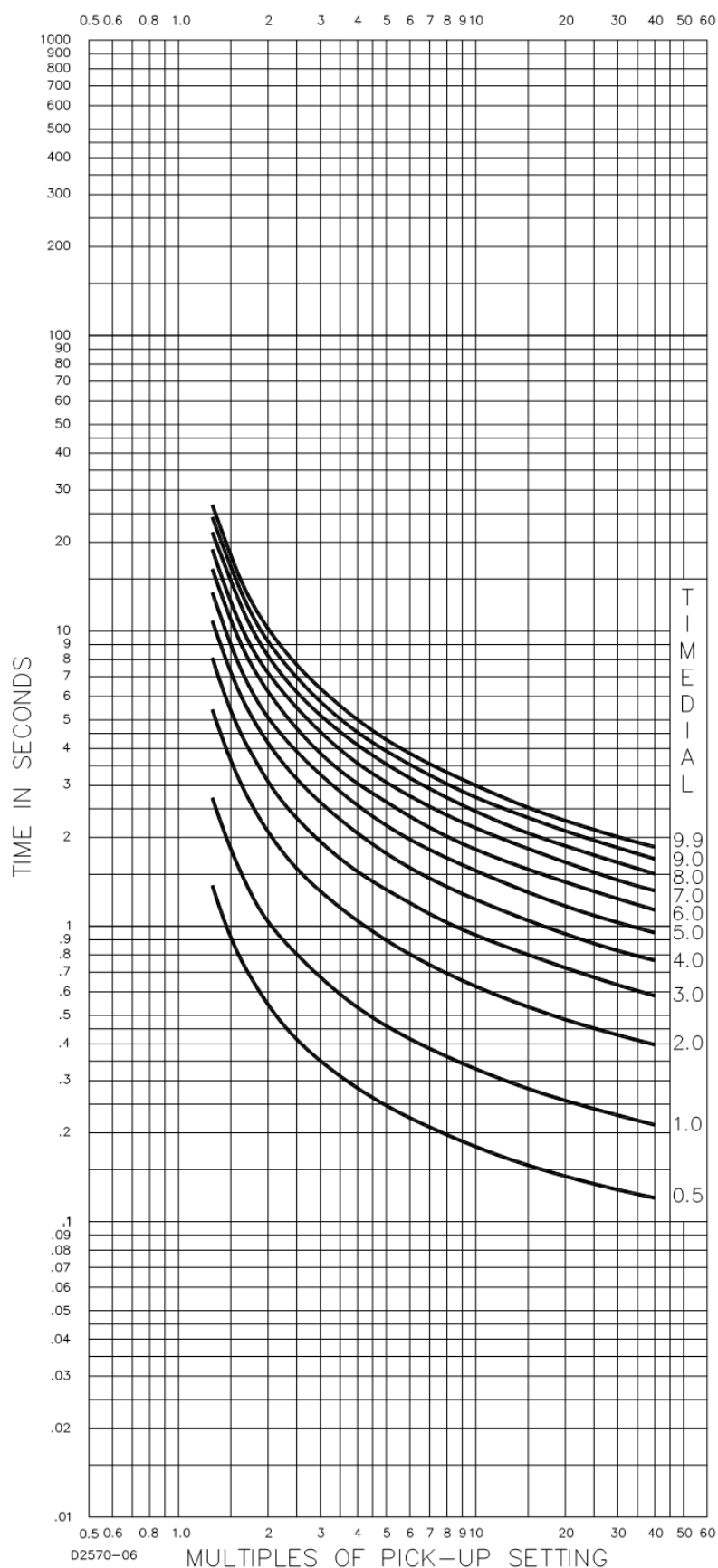


Figure 225. Time Characteristic Curve A, Standard Inverse (BS 142)

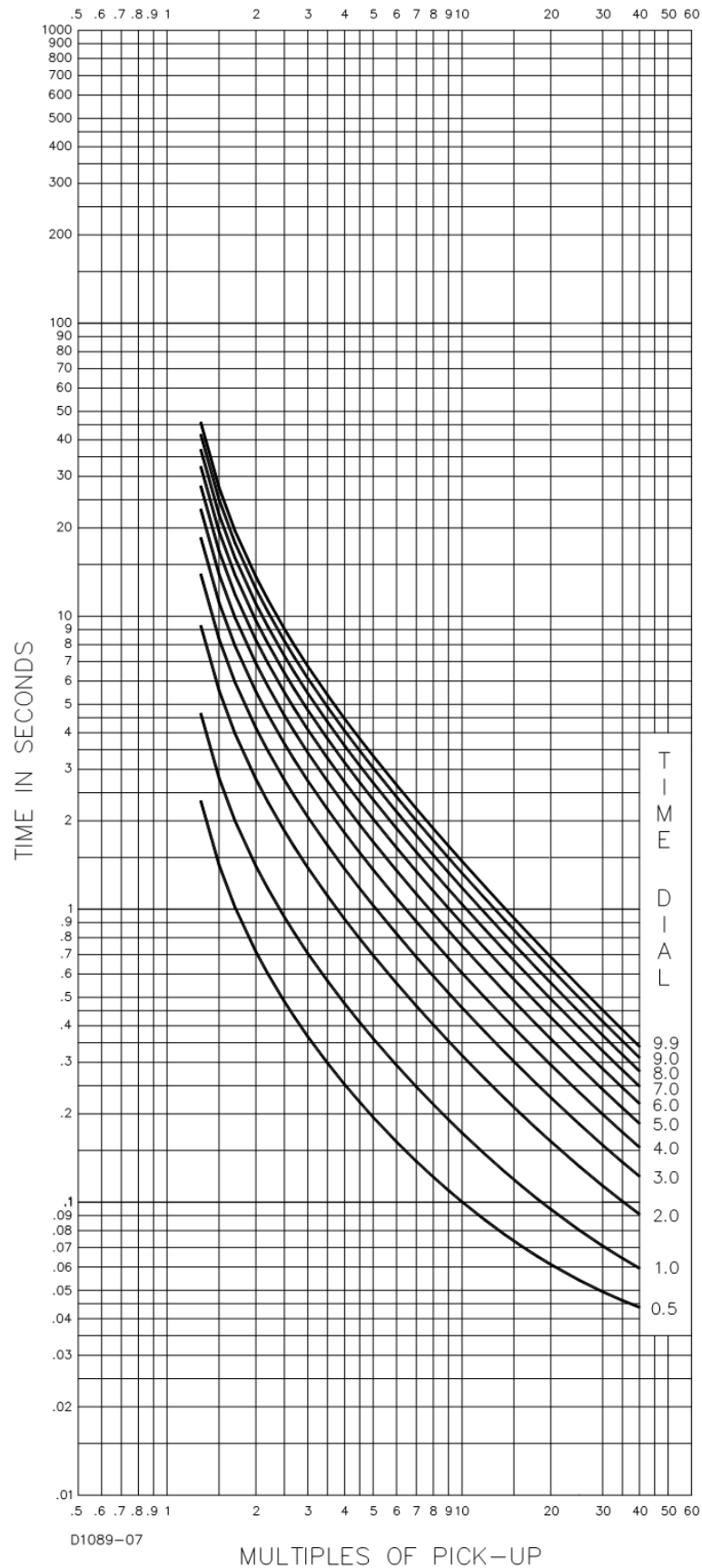


Figure 226. Time Characteristic Curve B, Very Inverse (BS 142)

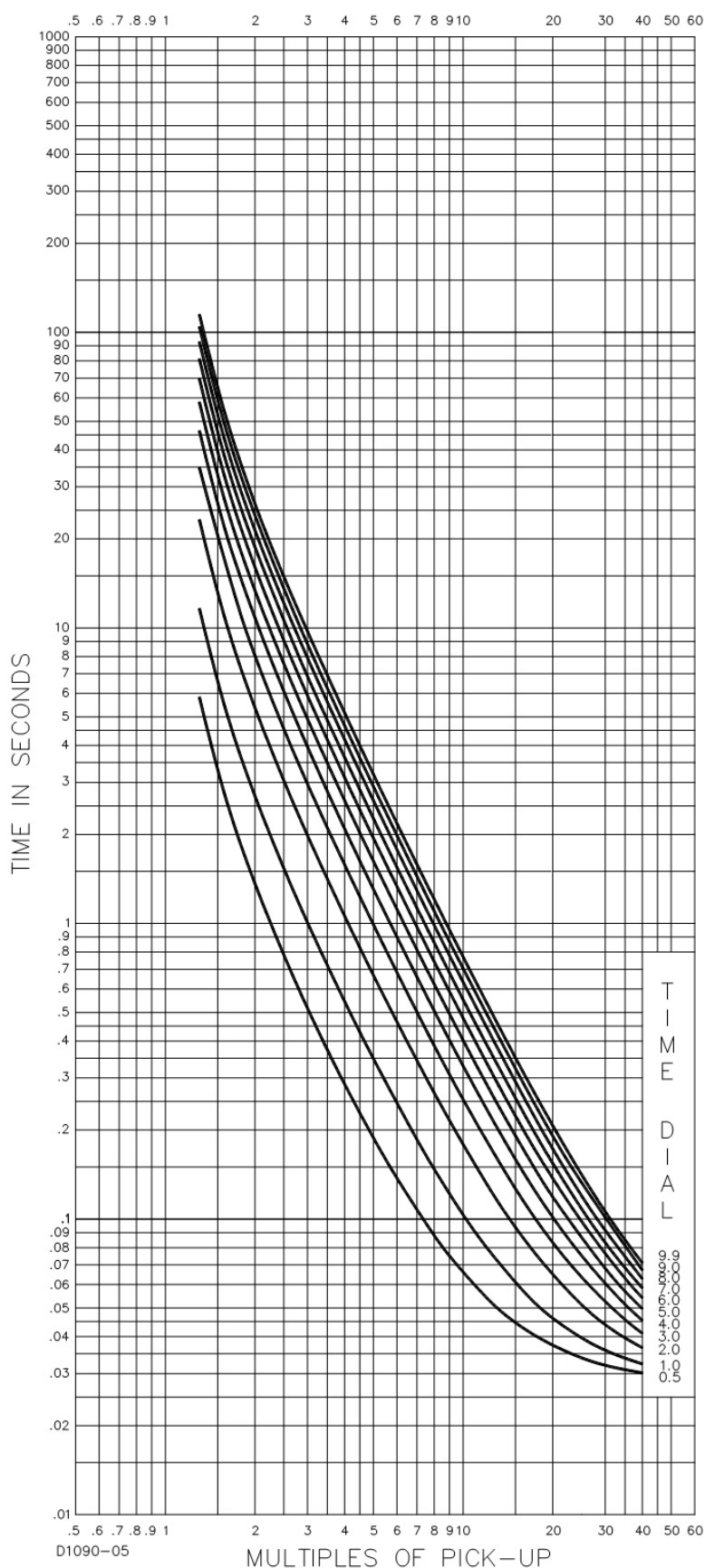


Figure 227. Time Characteristic Curve C, Extremely Inverse (BS 142)

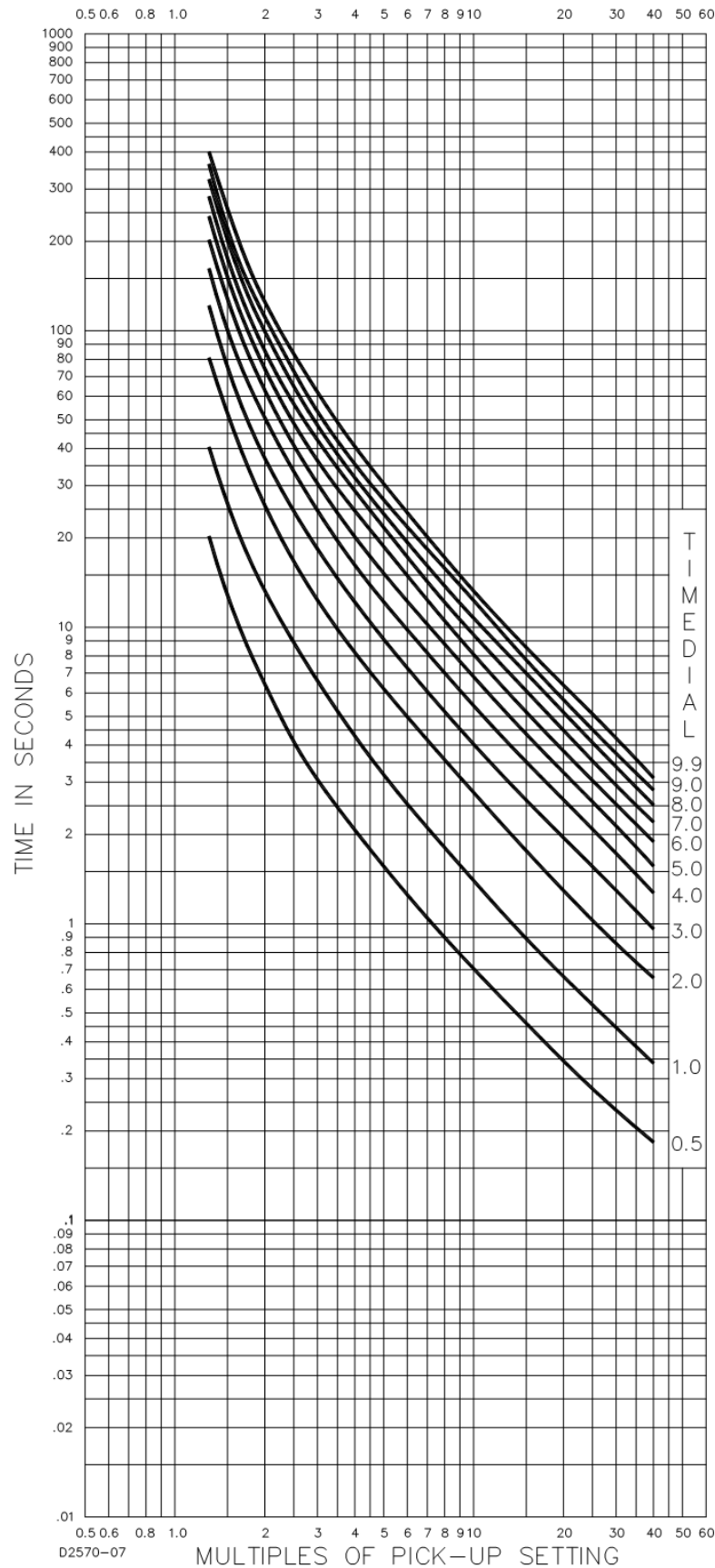
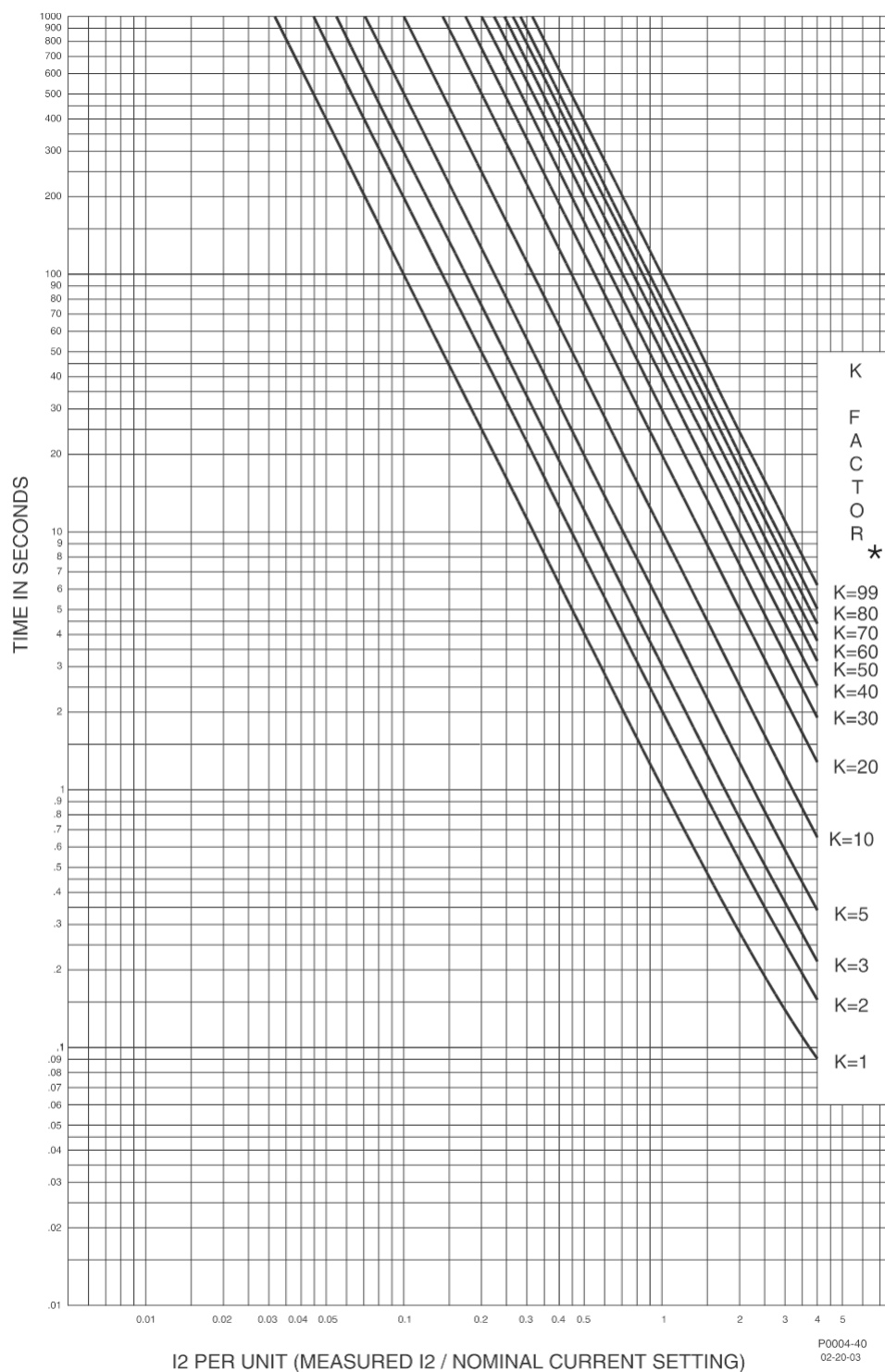


Figure 228. Time Characteristic Curve G, Long Time Inverse (BS 142)



★ The K factor is the time that a generator can withstand 1 per-unit I₂, where 1 pu is the user's setting for full-load current

Figure 229. 46 Time Characteristic Curve

Note

Curves are shown extending further to the left than they will in practice. Curves stop at pickup level. For example, if the user selects 5A FLC with a pickup setting of 0.5 A, the per-unit pickup is 0.1 A. The relay will not pick up at less than 0.1 pu I₂ for these settings.

Tuning PID Settings

The DGC-2020HD utilizes four controllers to accomplish synchronization, load sharing, and speed trim functions. These consist of a voltage controller, a var/PF controller, a speed controller, and a kW load controller.

Voltage and Speed Controllers

The voltage and speed controllers are in effect when the DGC-2020HD is synchronizing the generator to a bus. When synchronizing, these controllers adjust the speed and voltage output of the generator to match that of the bus.

kW Load Controller

After the generator is paralleled to a bus, the kW load controller controls the kW output of the machine to share equally on a percentage basis with the other generators on the bus. All generators participating in load sharing are connected together with load share lines which are used to communicate load share information between the machines. When the generator is paralleled to the utility, the kW load controller causes the unit to produce wattage at a level equal to the base load setpoint.

Var/PF Controller

When the generator is not paralleled to the utility, the var/PF controller operates in voltage droop mode for var/PF sharing between the machines. The var/PF controller can operate in either var or PF control mode when the generator is paralleled to the utility.

When operating in var control mode, the machine produces reactive power at a level equal to the kvar Setpoint setting. When in PF control mode, the var/PF controller regulates the reactive power output of the machine to maintain the power factor specified by the PF Setpoint setting.

Speed Trim Function

When the generator is paralleled to the bus and load sharing is enabled, the speed trim function, if enabled in all machines on the bus, ensures that the bus frequency is maintained at the frequency set by the speed trim setting. Speed trim is in effect only in the situation where the generator breaker is closed and load control is enabled. Speed trim is not in effect when the breaker is open, since the default mode when the breaker is open is droop, and speed trim would counteract droop.

When load control is enabled, it is possible that load control could cause the system frequency to drift, and speed trim can be employed to counteract the drift. The drift can occur due to inaccuracies in measured kW vs. desired kW, since kW measurement accuracy is around 3%.

Tuning Parameters

The DGC-2020HD load share function utilizes PID (Proportional, Integral, Derivative) control to accomplish load sharing, speed control, and voltage control. A brief description of the three main tuning parameters, and their effects on system behavior, is presented below.

- K_p - *Proportional Gain* - The proportional term makes a change to the output that is proportional to the current error value. The proportional response can be adjusted by multiplying the error by a constant K_p , called the proportional gain. Larger K_p typically means faster response since the larger the error, the larger the feedback to compensate. An excessively large proportional gain will lead to process instability.

- K_i - *Integral Gain* - The contribution from the integral term is proportional to both the magnitude of the error and the duration of the error. Some integral gain is required in order for the system to achieve zero steady-state error. The integral term (when added to the proportional term) accelerates the movement of the process towards setpoint and eliminates the residual steady-state error that occurs with a proportional only controller. Larger K_i implies steady state errors are eliminated quicker. The trade-off is larger overshoot: any negative error integrated during transient response must be integrated away by positive error before reaching steady state.
- K_d - *Derivative Gain* - The derivative term slows the rate of change of the controller output and is used to reduce the magnitude of the overshoot produced by the integral component and improve the combined controller-process stability. However, differentiation of a signal amplifies noise in the signal and thus this term in the controller may be sensitive to noise in the error term, and can cause a process to become unstable if the noise and the derivative gain are sufficiently large. Larger K_d decreases overshoot, but slows down transient response and may lead to instability.

Table 97 shows the effects of increasing parameters.

Table 97. Effects of Increasing Parameters

Parameter	Rise Time	Overshoot	Settling Time	Steady State Error
Kp	Decrease	Increase	Small Change	Decrease
Ki	Decrease	Increase	Increase	Eliminate
Kd	Small Change	Decrease	Decrease	None

Tuning Procedures

Voltage Controller Tuning Procedure

The voltage controller is tuned prior to the speed controller. Set all Kp, Ki, and Kd gains in the voltage controller, speed controller, and kW load controller to 0. Set the Kg values to 0.1. Start the generator.

The voltage controller is only active during synchronization when the DGC-2020HD is trying to close the generator breaker. In order to tune it, a variable AC voltage source must be connected across the bus input of the DGC-2020HD. The generator must be started, then a breaker close sequence initiated by applying a breaker close pulse to a discrete contact input to cause the synchronizer to become active. In addition the *Breaker Close Wait Time* parameter and the *Sync Fail Activation Delay* should be set to a large value such as 120 seconds or more. This will allow the voltage controller to run for a long enough time to get meaningful response information.

If the synchronizer times out during the tuning process resulting in a synchronizer fail pre-alarm or a breaker close failure occurs while tuning, press the *Reset* button on the front of the DGC-2020HD to clear the associated pre-alarm. Then, issue a breaker open pulse to a discrete contact input. The synchronizer is now reset, so a pulse can be applied to the breaker close discrete contact input to restart the synchronizer. Tuning can resume at this point.

KP - Proportional Gain

Set an initial value of 1 for KP.

Each time KP is set, disturb the system by changing the voltage on the bus input of the DGC-2020HD so that the DGC-2020HD will try to follow it. Verify that the generator's output approaches the new value in a stable manner. Since KI is zero at this point, there may be some small difference between the generator's output and the bus it is trying to follow. The important thing is that the generator's output behaves in a stable manner. If it is not stable, lower the value of KP and repeat.

Repeat this procedure, raising KP until the system is unstable, and then lower it to half the value where instability is first attained.

If it is not possible to obtain stable voltage operation, it may be necessary to reduce the control gains in the voltage regulator that has its analog bias input driven by the DGC-2020HD.

KI - Integral Gain

Set the initial value of KI to be a tenth of the value set for KP.

After setting a value for KI, disturb the system by changing the voltage on the bus input of the DGC-2020HD so that the DGC-2020HD will try to follow it. Verify that the DGC-2020HD controls the voltage to go to the new value in a stable manner. If it is not stable, lower the value of KI and repeat.

Repeat this procedure, raising KI until the system is unstable, and then lower it to half the value where instability is first attained.

KD - Derivative Gain

If the performance with KP and KI alone is satisfactory, you may stop here. Otherwise, KD, the derivative controller gain, can be used in conjunction with TD, the noise filter constant, to reduce overshoot obtained with the PI control. Setting KD and TD is an iterative process. Start with small values of KD such as 0.1 or half the KI value, whichever is less.

TD is the constant of the low-pass filter which filters the controller input if high frequency interference presents a problem when derivative control is employed. TD ranges from 0 to 1. TD=0 is no filtering. TD=1 is heaviest filtering.

Tuning of KD can be achieved through the following steps. First set TD=0 to eliminate filtering. Raise speed KD and check for stability. Each time KD is raised, disturb the system by changing the voltage on the bus input of the DGC-2020HD so that the DGC-2020HD will try to follow it. Verify that the DGC-2020HD controls the voltage to go to the new value in a stable manner. Raise KD until the system is unstable, and then lower it to half the value where instability is first attained.

If high frequency noise seems to be entering the system, set TD to 0.001 and see if the noise induced behavior is reduced. Raise TD until desired reduction of noise behavior is achieved. Once KD has been set, tune KD again. TD ranges from 0 to 1 with an increment of 0.001. If noise again appears to be a problem, adjust TD until desired behavior is achieved, and then retune KD.

var/PF Controller Tuning Procedure

Once desired voltage controller performance is obtained, the var/PF controller can be tuned. Set the Kp, Ki, and Kd gains in the var/PF controller to 0. Set the Kg value to 0.1. Enable the var/PF controller, and set the control mode to var control. The generator must be paralleled to the utility (as indicated by the Parallel to Mains element in logic) in any of the tuning steps where the system is being tested for stable operation.

KP - Proportional Gain

Set an initial value of KP = 1 in the var/PF Controller. Set the control mode to var control.

Set KP on var/PF controller. Synchronize the generator to the utility so that var control becomes active. Verify that stable var control occurs. If the var control seems unstable, cut Kp in half and try again. Assuming operation appears stable, change the var setpoint in 10% steps and check for stable operation. Since KI is zero at this point, there may be slight error. Most importantly, stable var control is achieved.

Raise KP and repeat the test until unstable operation occurs. Then lower KP to half the value where unstable operation was first attained.

If it is not possible to obtain stable var controller operation, it may be necessary to reduce the control gains in the voltage regulator with a bias input driven by the DGC-2020HD.

KI - Integral Gain

Set the initial value of KI to be a tenth of the value set for KP.

Each time KI is set, synchronize the generator to the utility so that var control becomes active. Check that operation appears stable. Change the var setpoint in 10% steps and check for stable operation. If the system is not stable, lower KI and repeat the test.

Repeat this procedure, raising KI until the system is unstable, and then lower it to half the value where instability is first attained.

KD - Derivative Gain

If the performance with KP and KI alone is satisfactory, you may stop here. Otherwise, KD, the derivative controller gain, can be used in conjunction with TD, the noise filter constant, to reduce overshoot obtained with the PI control. Setting KD and TD is an iterative process. Start with small values of KD such as 0.1 or half the KI value, whichever is less.

TD is the constant of the low-pass filter, which filters the controller input if high frequency interference presents a problem when derivative control is employed. TD ranges from 0 to 1. TD=0 is no filtering, TD=1 is heaviest filtering.

Tuning of KD can be achieved through the following steps. Raise KD, synchronize the generator to the utility so that var control becomes active, and check for stability. Change the var setpoint in 10% steps and check for stable operation. Raise KD repeating the tests until the system is unstable, and then lower it to half the value where instability is first attained. If high frequency noise seems to be entering the system, raise TD and tune KD again. TD ranges from 0 to 1.

If high frequency noise seems to be entering the system, set TD to 0.001 and see if the noise induced behavior is reduced. Raise TD until desired reduction of noise behavior is achieved. Once TD has been set, tune KD again. TD ranges from 0 to 1 with an increment of 0.001. If noise again appears to be a problem, adjust TD until desired behavior is achieved, then retune KD.

Speed Controller Tuning Procedure

The speed controller is tuned prior to the kW load controller. Set Load Control to enabled, and speed trim to enabled. Set all Kp, Ki, and Kd gains in both speed controller and kW load controller to 0. Set the Kg values to 0.1. Start the generator and close the breaker onto some load.

KP - Proportional Gain

Set an initial value of 1 for KP.

Each time KP is set, manually displace the governor lever if possible and see that control is regained in a stable manner. If the governor cannot be perturbed in this manner, execute step responses by changing the speed trim set point and check that the generator's output approaches the new value in a stable manner. Since KI is zero at this point, there may be some small difference between the generator's output and the speed it is trying to reach. The important thing is that the generator's output behaves in a stable manner. If the system is unstable, lower KP and repeat.

Repeat this procedure, raising KP until the system is unstable, and then lower it to half the value where instability is first attained.

If it is not possible to obtain stable speed operation, it may be necessary to reduce the control gains in the governor that has its analog bias input driven by the DGC-2020HD.

KI - Integral Gain

Set the initial value of KI to be a tenth of the value set for KP.

Each time KI is set, manually displace the governor lever or change the speed trim set point and verify that control is regained in a stable manner. If the system is not stable, lower KI and repeat.

Repeat this procedure, raising KI until the system is unstable, and then lower it to half the value where instability is first attained.

KD - Derivative Gain

If the performance with KP and KI alone is satisfactory, you may stop here. Otherwise, KD, the derivative controller gain, can be used in conjunction with TD, the noise filter constant, to reduce overshoot obtained with the PI control. Setting KD and TD is an iterative process. Start with small values of KD such as 0.1 or half the KI value, whichever is less.

TD is the constant of the low pass filter which filters the controller input if high frequency interference presents a problem when derivative control is employed. TD ranges from 0 to 1. TD=0 is no filtering. TD=1 is heaviest filtering.

Tuning of KD can be achieved through the following steps. First set TD=0 to eliminate filtering. Raise speed KD and check for stability. Each time KD is raised, manually displace the governor lever or change the speed trim set point and see that control is regained in a stable manner. Raise KD until the system is unstable, and then lower it to half the value where instability is first attained.

If high frequency noise seems to be entering the system, set TD to 0.001 and see if the noise induced behavior is reduced. Raise TD until desired reduction of noise behavior is achieved. Once TD has been set, tune KD again. TD ranges from 0 to 1 with an increment of 0.001. If noise again appears to be a problem, adjust TD until desired behavior is achieved, and then retune KD.

kW Load Controller Tuning Procedure

Once desired voltage and speed controller performance is obtained, the kW load controller can be tuned. Set the Kp, Ki, and Kd gains in kW load controller to 0. Set the Kg value to 0.1.

KP - Proportional Gain

Set an initial value of 1 for KP.

Close the breaker onto a load. Parallel a second generator with the unit being tuned and check for stable load sharing. Then open the generator breaker on the second generator and check that the unit being tuned is still stable. Since KI is zero at this point, there may be some small error in the load sharing. The important thing is that stable load sharing is achieved.

Raise KP and repeat the test until unstable operation occurs. Lower KP to half the value where unstable operation was first attained.

If it is not possible to obtain stable kW operation, it may be necessary to reduce the control gains in the governor that has its analog bias input driven by the DGC-2020HD.

KI - Integral Gain

Set the initial value of KI to be a tenth of the value set for KP.

Each time KI is set, parallel a second generator with the unit being tuned, and check for stable load sharing then open the generator breaker on the second generator and check that the unit being tuned is still stable. If the system is not stable, lower KI and repeat the test.

Repeat this procedure, raising KI until the system is unstable, and then lower it to half the value where instability is first attained.

KD - Derivative Gain

If the performance with KP and KI alone is satisfactory, you may stop here. Otherwise, KD, the derivative controller gain, can be used in conjunction with TD, the noise filter constant, to reduce overshoot obtained with the PI control. Setting KD and TD is an iterative process. Start with small values of KD such as 0.1 or half the KI value, whichever is less.

TD is the constant of the low pass filter which filters the controller input if high frequency interference presents a problem when derivative control is employed. TD ranges from 0 to 1. TD=0 is no filtering, TD=1 is heaviest filtering.

Tuning of KD can be achieved through the following steps. Raise load control KD and check for stability. Each time KD is raised, parallel another generator with the unit being tuned, and check for stable load sharing. Then drop the second generator and check that the unit being tuned is still stable. Raise KD until the system is unstable, and then lower it to half the value where instability is first attained. If high frequency noise seems to be entering the system, raise TD and tune KD again. TD ranges from 0 to 1.

If high frequency noise seems to be entering the system, set TD to 0.001 and see if the noise induced behavior is reduced. Raise TD until desired reduction of noise behavior is achieved. Once TD has been set, tune KD again. TD ranges from 0 to 1 with an increment of 0.001. If noise again appears to be a problem, adjust TD until desired behavior is achieved, then retune KD.

Generic Gains for Multiple Machine Types

The following method is suggested for determining generic gains for multiple machine types.

1. Decide what levels of reverse power and reverse var (loss of excitation) protection you need to use.
2. Once the criteria of step 1 have been established, tune a unit so that you can parallel to another unit at no load and not cause any trips.
3. Parallel two machines onto a load, and verify that acceptable load sharing occurs.
4. Add and drop loads with machines paralleled to verify acceptable load sharing occurs, and no trips occur.
5. Once the settings are deemed “good”, save them as initial settings for a given machine configuration for all future jobs. You shouldn’t need to change them unless you get trips or need to change load sharing characteristics.
6. Test the units paralleled under no load and verify that no trips occur.
7. Parallel two machines onto a load, and verify that acceptable load sharing occurs.
8. Add and drop loads with machines paralleled to verify acceptable load sharing occurs and no trips occur.
9. If you need to modify settings for a particular machine type, keep those settings to be used as initial settings for all future machines of that type.
10. Test every machine with steps 6, 7, and 8.

It is not expected that you will ever get one set of numbers that will work for all machines, but it is probable that you may end up with 6 to 12 sets of settings that cover a wide range of machine sizes and engine manufacturers. However, once a set of gains has been determined for a particular machine type, the same gains should work in all identical machines.

MTU Fault Codes

A DGC-2020HD connected to a genset equipped with an MTU engine ECU tracks and displays the active fault codes issued by the MTU engine ECU. Active MTU fault codes can be viewed through BESTCOMSPlus® by using the *Metering Explorer* to expand the *MTU* tree or through the front panel display by navigating to Metering > Status > MTU Fault Codes.

Each fault code is displayed with a fault description and the fault number. If the DGC-2020HD does not have descriptive information about a fault number that was received, the fault description will display as “NO TEXT AVAILABLE”. Fault codes displayed by the DGC-2020HD are listed in Table 98.

Table 98. MTU Fault Codes

Fault Code	String	Description
3	HI T FUEL	Fuel temperature too high (limit 1).
4	SS T FUEL	Fuel temperature too high (limit 2).
5	HI T CHRG AIR	Charge air temperature too high (limit 1).
6	SS T CHRG AIR	Air temperature too high (limit 2).
9	HI T INTERCOOLER	Coolant temperature of intercooler too high (limit 1).
10	SS T INTERCOOLER	Coolant temperature of intercooler too high (limit 2).
15	LO P LUBE OIL	Pressure of lube oil too low (limit 1).
16	SS P LUBE OIL	Pressure of lube oil too low (limit 2).
19	HI T EXHAUST A	Exhaust gas temperature (A-side) too high (limit 1).
20	SS T EXHAUST A	Exhaust gas temperature (A-side) too high (limit 2).
21	HIT T EXHAUST B	Exhaust gas temperature (B-side) too high (limit 1).
22	SS T EXHAUST B	Exhaust gas temperature (B-side) too high (limit 2).
23	LO COOLANT LEVEL	Coolant level too low (limit 1).
24	SS COOLANT LEVEL	Coolant level too low (limit 2).
25	HI P DIFF LUBE OIL	Differential pressure of oil filter too high (limit 1).
26	SS P DIFF LUBE OIL	Differential pressure of oil filter too high (limit 2).
27	HI LEVEL LEAKAGE FUEL	Level of leakage fuel too high (limit 1).
29	HI ETC IDLE SPD TOO HI	Idle speed of one of the switchable chargers too high.
30	SS ENGINE OVERSPEED	Engine overspeed (limit 2).
31	HI ETC1 OVERSPEED	Speed of basic charger too high (limit 1).
32	SS ETC1 OVERSPEED	Speed of basic charger too high (limit 2).
33	L1 P FUELFLT DIF	Differential pressure of fuel filter too high (limit 1).
36	HI ETC2 OVERSPEED	Speed of 1 st switchable charger too high (limit 1).
37	SS ETC2 OVERSPEED	Speed of 1 st switchable charger too high (limit 2).
38	AL ETC SPEED DEVIATION	Speed deviation between basic turbocharger and one of the switchable chargers.
39	AL ETC2 CUTIN FAIL	Switching of charger ETC2 failed.
44	LO LEVEL INTRCLR	Coolant level of intercooler too low (limit 1).
45	FAULT L2 LEVEL INTRCLR	Coolant level of intercooler too low (limit 2).
51	HI T LUBE OIL	Lube oil temperature too high (limit 1).
52	SS T LUBE OIL	Lube oil temperature too high (limit 2).
57	LO P COOLANT	Coolant pressure too low (limit 1).
58	SS P COOLANT	Coolant pressure too low (limit 2).

Fault Code	String	Description
59	SS T COOLANT L3	Coolant temperature too high/too low (limit 3).
60	SS T COOLANT L4	Coolant temperature too high/too low (limit 4).
63	HI P CRANKCASE	Crankcase pressure too high (limit 1).
64	SS P CRANK CASE	Crankcase pressure too high (limit 2).
65	LO P FUEL	Fuel supply pressure too low (limit 1).
66	SS P FUEL	Fuel supply pressure too low (limit 2).
67	HI T COOLANT	Coolant temperature too high (limit 1).
68	SS T COOLANT	Coolant temperature too high (limit 2).
69	L1 T EXTERN 1	Limit 1, out of range.
70	L2 T EXTERN 1	Limit 2, out of range.
71	L1 T EXTERN 2	Limit 1, out of range.
72	L2 T EXTERN 2	Limit 2, out of range.
73	L1 P EXTERN 1	Limit 1, out of range.
74	L2 P EXTERN 1	Limit 2, out of range.
75	L1 P EXTERN 2	Limit 1, out of range.
76	L2 P EXTERN 2	Limit 2, out of range.
77	LIM EXT CLNT LEV	Binary signal 1 Plant active.
78	LIM INTERCLR LEV	Binary signal 2 Plant active.
79	L BIN EXTERN 3	Binary signal 3 Plant active.
80	L BIN EXTERN 4	Binary signal 4 Plant active.
81	AL RAIL LEAKAGE	Rail pressure gradient too low for Start or too high for Stop.
82	HI P FUEL COMON RAIL	Rail pressure > setpoint value.
83	LO P FUEL COMMON RAIL	Rail pressure < setpoint value.
85	HI T UMBLASSEN	'Umblasen' temperature too high (limit 1).
86	SS T UMBLASSEN	'Umblasen' temperature too high (limit 2).
89	SS SPEED TOO LOW	Engine is being stalled. The engine speed of the normally operating engine dropped below the limit from parameter 2.2500.027 Limit Engine Speed Low without any stop request. For safety reason the engine is stopped when this event occurs.
90	SS IDLE SPEED LOW	Idle speed not reached.
91	SS RELEASE SPEED LO	Acceleration speed not reached.
92	SS STARTER SPEED LO	Starter speed not reached.
93	SS PREHT TMP	Preheat temperature too low (limit 2).
94	LO PREHT TMP	Preheat temperature too low (limit 1).
95	AL PRELUBE FAULT	Pre-lubrication fault.
100	EDM NOT VALID	Checksum fault EDM.
101	IDM NOT VALID	Checksum fault IDM.
102	INVLD FUEL CNS 1	Fuel consumption counter detect.
103	INVLD FUEL CNS 2	Consumption monitoring 2 not valid.
104	ENG HRS INVALID 1	Engine Hours Counter defect.
105	ENG HRS INVALID 2	Checksum fault.
106	ERR REC1 INVALID	Checksum fault.
107	ERR REC2 INVALID	Checksum fault.

Fault Code	String	Description
118	LO ECU SUPPLY VOLTS	Power supply voltage too low (limit 1).
119	LOLO ECU SUPPLY VOLTS	Power supply voltage too low (limit 2).
120	HI ECU SUPPLY VOLTS	Power supply voltage too high (limit 1).
121	HIHI ECU SUPPLY VOLTS	Power supply voltage too high (limit 2).
122	HI T ECU	Temperature of electronic too high (limit 1).
134	15v POSECU DEFCT	Internal electronic fault.
136	15V NEGECU DEFCT	Internal electronic fault.
137	L1 5V BUFFR TEST	Pressure-sensor fault, pressure-sensor wiring, or internal electronic fault.
138	SENSOR PWR DEFCT	Pressure-sensor fault, pressure-sensor wiring, or internal electronic fault.
139	L1 TE BUFFR TEST	Internal electronic fault.
140	TE BUF ECU DEFCT	Internal electronic fault.
141	AL POWER TOO HIGH	AL power too high.
142	MCR EXCEEDED 1 HR STR	AL MCR exceeded 1 hour.
143	BANK1 ECU DEFECT	Internal electronic fault.
144	BANK2 ECU DEFECT	Internal electronic fault.
145	15V GOODECU DFCT	Internal electronic fault.
147	AD TST1ECU DEFCT	Internal electronic fault.
149	AD TST2ECU DEFCT	Internal electronic fault.
151	AD TST3ECU DEFCT	Internal electronic fault.
170	MI MODULE FAIL	Module in maintenance indicator defect.
171	MI NOT ACTIVE	WI not active anymore.
172	TBO EXPIRED	TBO expired.
173	MODL WRITE LIMIT	EEPROM write limit reached.
176	AL LIFE DATA NA	No (fitting) LifeData-Backup-System is available within a delay time after ECU Reset.
177	AL LIFE DATA INCPLT	If the ADEC has to restore the LifeData from the backup-system and at least one checksum is wrong after the upload or the upload is incomplete, then this failure is set.
180	AL CAN1 NODE LOST	Connection to a node on CAN 1 lost.
181	AL CAN2 NODE LOST	Connection to a node on CAN 2 lost.
182	AL CAN WRONG PARAMS	Incorrect CAN parameter values have been entered.
183	AL CAN NO PU DATA	A CAN mode is selected which the communication is initialized aided of the PU data module. However, required PU data module is not present or is not valid.
184	AL CAN PUDATA ERR	During attempt to copy a received PU data module to Flash module, a program error occurred.
185	CAN LESS MAILBXS	CAN less mailboxes.
186	AL CAN1 BUS OFF	CAN controller 1 is in "Bus Off" state.
187	AL CAN1 ERR PASSV	CAN controller 1 has signaled a warning.
188	AL CAN2 BUS OFF	CAN controller 2 is in "Bus Off" state.
189	AL CAN2 ERROR PASSV	CAN controller 2 has signaled a warning.
190	AL EMU PARAM NO SUPPORT	EMU parameters are not supported.
201	SD T COOLANT	Coolant temperature-sensor defect.

Fault Code	String	Description
202	SD T FUEL	Fuel temperature-sensor defect.
203	SD T CHARGE AIR	Charge air temperature-sensor defect.
205	SD T CLNT INTERC	Intercooler coolant temperature-sensor defect.
206	SD T EXHAUST A	Exhaust gas temperature-sensor on A-side defect.
207	SD T EXHAUST B	Exhaust gas temperature-sensor on B-side defect.
208	SD P CHARGE AIR	Charge air pressure-sensor defect.
211	SD P LUBE OIL	Lube oil pressure-sensor defect.
212	SD P COOLANT	Coolant pressure-sensor defect.
213	SD P COOLANT INTRCOOLR	Intercooler coolant pressure-sensor defect.
214	SD P CRANKCASE	Crankcase pressure-sensor defect.
215	SD P HD	Rail pressure-sensor defect.
216	SD T LUBE OIL	Lube oil temperature-sensor defect.
219	SD T INTAKE AIR	Intake air temperature-sensor defect.
220	SD COOLANT LEVEL	Sensor for coolant level defect.
221	SD P DIFF LUBE OIL	Sensor for differential pressure of lube oil defect.
222	SL LVL LKG FUEL	Sensor for leakage level of fuel defect.
223	SD LVL INTERCLR	Sensor for coolant level of intercooler defect.
227	SD PRE FILT P LUBE OIL	Pressure sensor for lube oil before filter defect.
229	AL SD CAM STOP	Sensor of Camshaft defect and sensor of crankshaft defect before.
230	SD CRANKSHFT SPD	Sensor defect on crankshaft.
231	SD CAMSHAFT SPD	Sensor defect on camshaft.
232	SD CHARGER1 SPEED	Speed-sensor of basic charger defect.
233	SD CHARGER2 SPEED	Speed-sensor of switching charger defect.
240	SD P FUEL	Fuel pressure-sensor defect.
241	SD T UMBLASSEN	Temperature-sensor of recirculated charge air defect.
242	SD T COOLANT R	Redundant coolant temperature-sensor defect.
244	SD P LUBE OIL R	Redundant pressure sensor for lube oil defect.
245	SD POWER SUPPLY	Internal ECU error.
246	SD T ELECTRONIC	Internal ECU fault.
249	SD CAN STOP	Missing data CAN.
250	SD CAN SPD DEMND	Missing data CAN.
251	SD CAN UP DOWN	Missing data CAN.
252	SD CAN NOTCH POS	Missing data CAN.
253	SD CAN OVERRIDE	Missing data CAN.
254	SD CAN TST OVRSP	Missing data CAN.
255	SD CAN ENGAGE SIG	Missing data CAN.
256	SD CAN CYL CUTOUT	Missing data CAN.
257	SD CAN LOCAL	Missing data CAN.
258	SD CAN RCS ENGAGE	Missing data CAN.
259	SD CAN RCS CYL CT	Missing data CAN.
260	SD 15V POS SPPLY	Internal ECU fault.
261	15V POS SPPLY	Internal ECU fault.

Fault Code	String	Description
262	SD 5V BUFFR TEST	Internal ECU fault.
263	SD TE BUFFR TEST	Internal ECU fault.
264	SD BANK 1 TEST	Internal ECU fault.
265	SD BANK 2 TEST	Internal ECU fault.
266	SD SPD DEMAND AN	Analog speed demand defect.
267	SD SPDTEST BNCH	Short circuit, cable breakage.
268	SD SPINUT	Analog spinning value defect.
269	SD LOAD ANLG FLT	Filtered analog load pulse signal not available.
270	SD FREQUENCY INPUT	Frequency input defect.
271	SD T EXTERN 1	Missing data CAN.
272	SD T EXTERN 2	Missing data CAN.
273	SD P EXTERN 1	Missing data CAN.
274	SD P EXTERN 2	Missing data CAN.
275	SD EXT CLNT LVL	Missing data CAN.
276	SD INTERCLER LVL	Missing data CAN.
277	SD BIN EXT3	Missing data CAN.
278	SD BIN EXT4	Missing data CAN.
279	SD CANRES TRIPFL	Missing data CAN.
280	SD CAN ALRM RST	Missing data CAN.
281	SD ADTEST1 SPPLY	Internal ECU fault.
282	SD ADTEST 2 SPPLY	Internal ECU fault.
283	SD ADTEST3 SPPLY	Internal ECU fault.
284	SD CAN LAMP TEST	Missing data CAN.
285	SD CAN IDLE RQ SR	Missing data CAN.
286	SD CAN IDLE REQ	Missing data CAN.
287	SD CAN IDLE REQ	Missing data CAN.
288	SD CAN TRBOSW LCK	Missing data CAN.
301	TIMING CYLNR A1	Error in timing of injector cylinder A1: timing value too low/high.
302	TIMING CYLNR A2	Error in timing of injector cylinder A2: timing value too low/high.
303	TIMING CYLNR A3	Error in timing of injector cylinder A3: timing value too low/high.
304	TIMING CYLNR A4	Error in timing of injector cylinder A4: timing value too low/high.
305	TIMING CYLNR A5	Error in timing of injector cylinder A5: timing value too low/high.
306	TIMING CYLNR A6	Error in timing of injector cylinder A6: timing value too low/high.
307	TIMING CYLNR A7	Error in timing of injector cylinder A7: timing value too low/high.
308	TIMING CYLNR A8	Error in timing of injector cylinder A8: timing value too low/high.
309	TIMING CYLNR A9	Error in timing of injector cylinder A9: timing value too low/high.
310	TIMING CYLNR A10	Error in timing of injector cylinder A10: timing value too low/high.
311	TIMING CYLNR B1	Error in timing of injector cylinder B1: timing value too low/high.
312	TIMING CYLNR B2	Error in timing of injector cylinder B2: timing value too low/high.
313	TIMING CYLNR B3	Error in timing of injector cylinder B3: timing value too low/high.
314	TIMING CYLNR B4	Error in timing of injector cylinder B4: timing value too low/high.
315	TIMING CYLNR B5	Error in timing of injector cylinder B5: timing value too low/high.

Fault Code	String	Description
316	TIMING CYLNDR B6	Error in timing of injector cylinder B6: timing value too low/high.
317	TIMING CYLNDR B7	Error in timing of injector cylinder B7: timing value too low/high.
318	TIMING CYLNDR B8	Error in timing of injector cylinder B8: timing value too low/high.
319	TIMING CYLNDR B9	Error in timing of injector cylinder B9: timing value too low/high.
320	TIMING CYLNDR B10	Error in timing of injector cylinder B10: timing value too low/high.
321	WIRING CYLNDR A1	Short circuit in injector cable of cylinder A1.
322	WIRING CYLNDR A2	Short circuit in injector cable of cylinder A2.
323	WIRING CYLNDR A3	Short circuit in injector cable of cylinder A3.
324	WIRING CYLNDR A4	Short circuit in injector cable of cylinder A4.
325	WIRING CYLNDR A5	Short circuit in injector cable of cylinder A5.
326	WIRING CYLNDR A6	Short circuit in injector cable of cylinder A6.
327	WIRING CYLNDR A7	Short circuit in injector cable of cylinder A7.
328	WIRING CYLNDR A8	Short circuit in injector cable of cylinder A8.
329	WIRING CYLNDR A9	Short circuit in injector cable of cylinder A9.
330	WIRING CYLNDR A10	Short circuit in injector cable of cylinder A10.
331	WIRING CYLNDR B1	Short circuit in injector cable of cylinder B1.
332	WIRING CYLNDR B2	Short circuit in injector cable of cylinder B2.
333	WIRING CYLNDR B3	Short circuit in injector cable of cylinder B3.
334	WIRING CYLNDR B4	Short circuit in injector cable of cylinder B4.
335	WIRING CYLNDR B5	Short circuit in injector cable of cylinder B5.
336	WIRING CYLNDR B6	Short circuit in injector cable of cylinder B6.
337	WIRING CYLNDR B7	Short circuit in injector cable of cylinder B7.
338	WIRING CYLNDR B8	Short circuit in injector cable of cylinder B8.
339	WIRING CYLNDR B9	Short circuit in injector cable of cylinder B9.
340	WIRING CYLNDR B10	Short circuit in injector cable of cylinder B10.
341	OPN LD CYLNDR A1	Open load in injector cable of cylinder A1.
342	OPN LD CYLNDR A2	Open load in injector cable of cylinder A2.
343	OPN LD CYLNDR A3	Open load in injector cable of cylinder A3.
344	OPN LD CYLNDR A4	Open load in injector cable of cylinder A4.
345	OPN LD CYLNDR A5	Open load in injector cable of cylinder A5.
346	OPN LD CYLNDR A6	Open load in injector cable of cylinder A6.
347	OPN LD CYLNDR A7	Open load in injector cable of cylinder A7.
348	OPN LD CYLNDR A8	Open load in injector cable of cylinder A8.
349	OPN LD CYLNDR A9	Open load in injector cable of cylinder A9.
350	OPN LD CYLNDR A10	Open load in injector cable of cylinder A10.
351	OPN LD CYLNDR B1	Open load in injector cable of cylinder B1.
352	OPN LD CYLNDR B2	Open load in injector cable of cylinder B2.
353	OPN LD CYLNDR B3	Open load in injector cable of cylinder B3.
354	OPN LD CYLNDR B4	Open load in injector cable of cylinder B4.
355	OPN LD CYLNDR B5	Open load in injector cable of cylinder B5.
356	OPN LD CYLNDR B6	Open load in injector cable of cylinder B6.
357	OPN LD CYLNDR B7	Open load in injector cable of cylinder B7.

Fault Code	String	Description
358	OPN LD CYLNDR B8	Open load in injector cable of cylinder B8.
359	OPN LD CYLNDR B9	Open load in injector cable of cylinder B9.
360	OPN LD CYLNDR B10	Open load in injector cable of cylinder B10.
361	AL POWER STAGE LOW	Internal error of electronic.
362	AL POWER STAGE HIGH	Internal error of electronic.
363	AL STOP POWER STAGE	Internal error of electronic.
364	AL STOP POWER STAGE 2	Internal error of electronic.
365	AL MV WIRING GND	Cable line error.
371	AL WIRING TO 1	Short circuit or open load on transistor output 1 (TO 1).
372	AL WIRING TO 2	Short circuit or open load on transistor output 2 (TO 2).
373	AL WIRING TO 3	Short circuit or open load on transistor output 3 (TO 3).
374	AL WIRING TO 4	Short circuit or open load on transistor output 4 (TO 4).
381	AL WIRING TOP 1	Short circuit or open load on transistor output plant 1 (TOP 1).
382	AL WIRING TOP 2	Short circuit or open load on transistor output plant 2 (TOP 2).
383	AL WIRING TOP 3	Short circuit or open load on transistor output plant 3 (TOP 3).
384	AL WIRING TOP 4	Short circuit or open load on transistor output plant 4 (TOP 4).
385	AL WIRING TOP 5	Short circuit or open load on transistor output plant 5 (TOP 5).
386	AL WIRING TOP 6	Short circuit or open load on transistor output plant 6 (TOP 6).
390	AL MCR EXCEEDED	DBR/MCR Function: MCR (Maximum Continuous Rating) in exceeded.
392	HI T COOLNT R	Redundant coolant temperature too high (limit 1).
393	SS T COOLNT R	Redundant coolant temperature too high (limit 2).
394	LO P LUBE OIL R	Redundant pressure of lube oil too low (limit 1).
395	SS P LUBE OIL R	Redundant pressure of lube oil too low (limit 2).
396	TD T COOLANT	Maximum deviation of T-Coolant sensors.
397	TD P LUBE OIL	Maximum deviation of P-Oil sensors.
399	AL INTERFACE ECU	Interface ECU.
400	AL OPN LD DIGIN 1	Open load on digital input 1.
401	AL OPN LD DIGIN 2	Open load on digital input 2.
402	AL OPN LD DIGIN 3	Open load on digital input 3.
403	AL OPN LD DIGIN 4	Open load on digital input 4.
404	AL OPN LD DIGIN 5	Open load on digital input 5.
405	AL OPN LD DIGIN 6	Open load on digital input 6.
406	AL OPN LD DIGIN 7	Open load on digital input 7.
407	AL OPN LD DIGIN 8	Open load on digital input 8.
408	AL OPN LD E STOP	Open load on input for emergency stop.
410	LO U PDU	Power driver voltage (injectors) too low (limit 1).
411	LOLO U PDU	Power driver voltage (injectors) too low (limit 2).
412	HI U PDU	Power driver voltage (injectors) too high (limit 1).
413	HIHI U PDU	Power driver voltage (injectors) too high (limit 2).
414	HI L WATER FUEL PREFILT	Water level of fuel prefilter too high (limit 1).
415	LO P COOLANT INTRCOOLR	Coolant pressure of intercooler too low (limit 1).
416	SS P COOLANT INTRCOOLR	Coolant pressure of intercooler too low (limit 2).

Fault Code	String	Description
417	SD L WATER FUEL PREFILT	Water level-sensor of fuel pre-filter defect.
420	AL L1 AUX 1	Input of Aux 1 injured limit 1.
421	AL L2 AUX 1	Input of Aux 1 injured limit 2.
428	AL L1 T AUX 1	Temperature input of Aux 1 injured limit 1.
438	LO P FUEL RAIL 2 STR	Low pressure on fuel rail 2.
439	HI P FUEL RAIL 2 STR	Hi pressure on fuel rail 2.
440	AL L1 P AUX 1	Pressure input of Aux 1 injured limit 1.
441	AL RAIL 2 LEAKAGE STR	Alarm fuel rail 2 leak detected.
442	AL L2 P AUX 1	Pressure input of Aux 1 injured limit 2.
444	SD U PDU	Sensor defect of Injector Power driver unit.
445	SD P AMBIENT AIR	Ambient air pressure-sensor defect.
448	HI P CHARGE AIR	Pressure of charge air too high (limit 1).
449	SS P CHARGE AIR	Pressure of charge air too high (limit 2).
450	SD IDLE END TRQ IN	Input of Idle/End-Torque defect
454	SS PWR RED ACT	Power Reduction is activated.
455	AL L1 AUX1 PLANT	Input of Aux 1 (plant) injured limit 1.
456	AL L2 AUX1 PLANT	Input of Aux 1 (plant) injured limit 2.
461	LO T EXHAUST EMU	Exhaust gas temperature of EMU too low (limit 1).
462	HI T COOLANT EMU	Coolant temperature of EMU injured limit 1.
463	SD AUX 2	Sensor defect on Aux 2.
464	SD P AUX 1	Analog input for pressure Aux 1 defect.
467	AL L2 T AUX 1	Temperature input of Aux 1 injured limit 2.
468	SD T AUX 1	Analog input for Temperature Aux 1 defect.
469	SD AUX 1	Analog input for Aux 1 defect.
470	SD T ECU	ECU temperature-sensor defect.
471	SD COIL CURRENT	Coil Current sensor defect.
472	AL STOP SD	Engine stop, because critical channel has sensor defect.
473	AL WIRING PWM CM2	Open load or short circuit on channel PWM_CM2.
474	AL WIRING FREQ OUT	Open load or short circuit on frequency output (FO) channel.
475	AL CR TRIG ENG ST	Released in case of an engine stop in order to trigger the crash recorder.
476	AL CRASH REC ERR	Initial error of crash recorder.
478	AL COMB ALM YEL	Combined Alarm YELLOW (Plant).
479	AL COMB ALM RED	Combined Alarm RED (Plant).
480	AL EXT ENG PROT	External Engine Protection function active.
500	AL WIRING POM STARTER 1	A wiring fault has been detected in the connection of starter 1 of POM.
501	AL WIRING POM STARTER 2	A wiring fault has been detected in the connection of starter 2 of POM.
502	AL OPEN LD POM ALTRNATR	An open load on POM's alternator output has been detected.
503	AL BATT NOT CHARGING	Battery is not being charged by alternator.
504	AL CAN POM NODE LOST	POM is missing on CAN bus.
505	AL NEW POM FOUND	New POM found.

Fault Code	String	Description
506	AL LOW STARTER VOLTS	Battery voltage is too low for starting.
507	AL POM ERROR	A general POM error has been detected.
508	AL WRONG POM ID	POM sends a different identification number (ID) than expected.
509	AL CHECK POM FUSE	Check POM fuse.
510	AL OVERRIDE APPLIED	Override applied.
515	STARTER NOT ENGAGED	Starter of POM could not be engaged.
543	MULTIPLE FDH SLAVES	There is more than one device which is configured as Backup for FDH-Functionality.
544	CONFIGURATION CHANGED	Gets active in case of changing system configuration e.g. by changing ECU- or SAM-Device. Remains until undo procedure or data is transferred by a valid maintenance case. Is cancelled automatically.
549	AL PWR CUTOFF STR	This is the alarm from the function Emergency Stop Counter. ECU power was disconnected while the engine was still running. This could lead to a possible overpressure in the high pressure system which might damage the engine.
555	AL CALL FIELD SERVICE	Gets active in case of completing a maintenance-case which manipulates Engine-Parameters. Remains also after switching on-off ECU until a valid release code is entered via Display- and Button-Control of SAM-Device. Release Code is available via Internet by a special procedure.
576	AL ESCM OVERRIDE STR	Exceeding of the corrected current MCR - odr DBR/MCR value.
594	AL L1 PRV 1 DEFECT STR	Yellow alarm pressure relief valve first rail.
595	AL L2 PRV 1 DEFECT STR	Red alarm pressure relief valve first rail.
598	AL L1 PRV 2 DEFECT STR	Yellow alarm pressure relief valve second rail.
599	AL L2 PRV 2 DEFECT STR	Red alarm pressure relief valve second rail.
610	AL WIRING SUCK RESTRCT 1 STR	Open load or short circuit on PWM HP fuel control block channel.
611	AL WIRING SUCK RESTRCT 2 STR	Open load or short circuit on PWM HP fuel control block channel 2.
612	AL WIRING PRESS CTRL VLV 1 STR	Open load or short circuit on PWM pressure regulating valve channel.
613	AL WIRING PRESS CTRL VLV 2 STR	Open load or short circuit on PWM pressure regulating valve channel 2.
615	AL EIL PROTECTION STR	Alarm for Protection Module in response to faulty or manipulated EIL.
692	AL ECU PWR OFF ON REQ STR	ECU configuration changed, switch power off/on.
696	AL SMARTCONCT USB ERR STR	Alarm configuration parameter.
697	AL SMARTCONCT RS485 ERR STR	Alarm configuration parameter.
698	AL SD STOP BUTTON STR	Channel signals open load or internal error.
700	AL SD START BUTTON STR	Channel signals open load.
701	AL SD UP BUTTON STR	Channel signals open load.
702	AL SD DN BUTTON STR	Channel signals open load or internal error.
703	AL SD EXT SPEED DMD SW STR	Channel signals open load.
704	AL SD SPEED DMD INCREASE STR	Channel signals open load or internal error.

Fault Code	String	Description
705	AL SD BINARY SPD DMD LMT STR	Channel signals open load or internal error.
706	AL SD DROOP 2 SWITCH STR	Channel signals open load or internal error.
707	AL SD FREQUENCY SWITCH STR	Channel signals open load or internal error.
709	AL SD OVERRIDE BUTTON STR	Channel signals open load or internal error.
710	AL SD ALARM RESET STR	Channel signals open load or internal error.
711	AL SD CYLINDER CUTOFF STR	Channel signals open load or internal error.
712	AL SD RQST BIN OUT TST STR	Channel signals open load or internal error.
713	AL SD EXT ENGINE PROTECTN STR	Channel signals open load or internal error.
714	AL SD PRELUBE SIGNAL STR	Channel signals open load.
715	AL SD EXT INC IDLE BIN STR	Channel signals open load.
716	AL SD EXT INC IDLE BIN BRK STR	Channel signals open load.
717	AL SD RQST PLANT DBR STR	Channel signals open load.

Exhaust Treatment

Diesel Particulate Filter (DPF)

In order to meet Tier 4 emission requirements, some engine manufacturers are applying Diesel Particulate Filters (DPF) to the exhaust system of the engine. A Diesel Particulate Filter traps particulate matter contained in diesel exhaust and prevents it from distributing into the air. The particulate matter is later burned off during a regeneration process.

The DGC-2020HD communicates DPF control and status information to and from the engine ECU via J1939 communications in the form of various Parameter Group Numbers (PGN) and Suspect Parameter Numbers (SPN). These are summarized in the following paragraphs.

Regeneration

Regeneration is accomplished by operating the engine at elevated exhaust temperatures where the accumulated particulate is burned off. If, in normal operation, the engine can be loaded to a high enough level to achieve the elevated exhaust temperature, then regeneration can occur as a part of normal operation. This is known as *passive regeneration*.

High exhaust temperatures can also be accomplished by methods such as providing dampers in the exhaust stream or heating the exhaust through the burning of fuel. This is known as *active regeneration* since it is outside of normal engine operation.

Heavily loaded engines will seldom require active regeneration. A lightly loaded engine will likely undergo active regeneration when regeneration is required.

DPF Control

DPF control information is sent from the DGC-2020HD to the Engine ECU through PGN Number 57244 (0xE000). A manual regeneration request is sent using SPN 3696, Diesel Particulate Filter Regeneration Force Switch. Regeneration can be inhibited by SPN 3695, Diesel Particulate Filter Regeneration Inhibit Switch.

Manual Regeneration

The operator can force a regeneration cycle by turning on the Manual Regeneration setting found on the front panel under Settings > Communication > CANbus Setup > ECU Setup > DPF Regenerate Setup. The parameter will remain on for a few seconds then go off. The ECU will respond to the momentary setting by logging the request to force a manual regeneration. A continuous request is not used because this can be problematic for some engine ECUs.

Manual regeneration can also be initiated by clicking the *Manual Regeneration* button on the ECU Setup screen in BESTCOMSPlus®. BESTlogic™Plus programmable logic can also be used to initiate manual regeneration by setting the DPF Manual Regeneration (DPFMANREGEN) logic element true.

Regeneration Inhibit

The operator can inhibit regeneration by turning on the DPF Regeneration Disable setting found on the ECU Setup screen in BESTCOMSPlus.

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

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

DPF Status and Pre-Alarms

The DGC-2020HD receives DPF status information which is broadcast from the engine ECU in various Parameter Group Numbers (PGN) and Suspect Parameter Numbers (SPN). This information is displayed on the front panel and in BESTCOMSP^{Plus}, via DPF related pre-alarms. The J1939 parameters and the resulting DGC-2020HD pre-alarms are summarized in the following paragraphs.

- PGN 64892 (0xFD7C) Diesel Particulate Filter Control 1

- o *SPN 3697, Diesel Particulate Filter Lamp Command*

REGEN REQUIRED Pre-Alarm: When SPN 3697 has a value of 1 or 4 indicating the DPF lamp is on, the DGC-2020HD will annunciate a pre-alarm with text of REGEN REQUIRED. The symbol, shown to the right, will accompany the text when the pre-alarm appears on the DGC-2020HD front panel.



- o *SPN 3698, Exhaust System High Temperature Lamp Command*

HIGH EXHAUST TEMP Pre-Alarm: When SPN 3698 has a value of 1 indicating the high exhaust temperature lamp is on, the DGC-2020HD will annunciate a pre-alarm with text of HIGH EXHAUST TEMP. The high exhaust temperature symbol, shown to the right, will accompany the text when the pre-alarm appears on the DGC-2020HD front panel.



- o *SPN 3703 Diesel Particulate Filter Active Regeneration Inhibited Due to Inhibit Switch*

REGEN INHIBITED Pre-Alarm: When SPN 3703 has a value of 1 indicating that regeneration is inhibited due to the inhibit switch being set, the DGC-2020HD annunciates a pre-alarm with text of REGEN INHBT. The regeneration inhibited symbol, shown to the right, will accompany the text when the pre-alarm appears on the DGC-2020HD front panel.



- o *SPN 3703 Diesel Particulate Filter Status*

SPN 3703 indicates that regeneration is required at the lowest level, moderate level, or most severe level. The DGC-2020HD uses this parameter for Soot Level Pre-alarms which are described in the following paragraphs.

- Soot Level Annunciation

The DGC-2020HD annunciates Soot Level pre-alarms which are described in the following paragraphs.

- o SOOT LEVEL HIGH Pre-Alarm

This pre-alarm is annunciated when one of the following occurs.

- A DTC is received with SPN 3719 (Diesel Particulate Filter Soot Load Percent) with FMI = 15 (*Data Valid But Above Normal Operating Range Least Severe Level*)
- SPN 3703 (Diesel Particulate Filter Status) is received with a value of 001 (*regeneration is needed – lowest level*)

The pre-alarm text is SOOT LVL HI.

The symbol, shown to the right, accompanies the text when the pre-alarm appears on the DGC-2020HD front panel.



- o SOOT LEVEL MODERATELY HIGH Pre-Alarm

This pre-alarm is annunciated when one of the following occurs.

- A DTC is received with SPN 3719 (Diesel Particulate Filter Soot Load Percent) with FMI = 16 (*Data Valid But Above Normal Operating Range Moderately Severe Level*)

- SPN 3703 (Diesel Particulate Filter Status) is received with a value of 010 (*regeneration is needed – moderate level*)

The pre-alarm text is SOOT LVL MOD HI.

The warning symbol, shown to the right, accompanies the text when the pre-alarm appears on the DGC-2020HD front panel.



o SOOT LEVEL EXTREMELY HIGH Pre-Alarm

This pre-alarm is annunciated when one of the following occurs.

- A DTC is received with SPN 3719 (Diesel Particulate Filter Soot Load Percent) with FMI = 0 (*Data Valid But Above Normal Operating Range Most Severe Level*)
- SPN 3703 (Diesel Particulate Filter Status) is received with a value of 011 (*regeneration is needed – highest level*)

The pre-alarm text is SOOT LVL EXT HI.

The stop symbol, shown to the right, accompanies the text when the pre-alarm appears on the DGC-2020HD front panel. If the soot level reaches the most severe level, the engine ECU may shut the engine down, preventing it from running, or allow it to run, but at a reduced power level. The DGC-2020HD only indicates a pre-alarm, it does not prevent the engine from running or cause operation at a reduced power level. However, the operator should be aware that the engine ECU or after treatment system may cause such behavior.



Exhaust After-Treatment Systems (EATS)

In order to meet Tier 4 emission requirements, some engine manufacturers are adding Exhaust After Treatment Systems (EATS) which treat the engine exhaust within the exhaust system to reduce particulate matter and harmful contaminants prior to releasing the exhaust into the atmosphere. One such system uses urea-based Diesel Exhaust Fluid (DEF) catalyst which is combined with the exhaust gasses in the EATS to bring the emissions to acceptable levels.

The DGC-2020HD meters EATS information from the engine ECU via J1939 CANbus and displays the DEF level within the DEF tank(s), and also displays several pre-alarms related to the EATS system. Any DEF related pre-alarms annunciated on the front panel display the symbol used for DEF functions which is shown to the right.



Most systems will contain one DEF tank, while some may contain two tanks. The DGC-2020HD front panel displays the level of DEF in each tank under Metering→Alarms-Status→J1939 Status→DEF Tank1 LVL% and Metering > Alarms-Status > J1939 Status > DEF Tank2 LVL%. The tank 1 level is sent from the ECU via SPN 1761 in J1939 PGN 65110 - After Treatment 1 Reagent Tank 1 Information. The tank 2 level is sent from the ECU via SPN 4367 in J1939 PGN 64829 - After Treatment 1 Reagent Tank 2 Information. Tank levels are in units of percent.

Pre-Alarms

Diesel Exhaust Fluid Level diagnostics are sent to the DGC-2020HD from the ECU as SPNs 5245 and 5246 in PGN 65110 (the AT1TI PGN). Suspect Parameter Number 5245 communicates DEF level diagnostics, whereas SPN 5246 communicates DEF Inducement Level status.

There are several alarms related to the EATS which annunciate DEF Level Diagnostics and DEF Inducement Level status. They are always enabled and will annunciate when received from the engine ECU. Each of them contains the symbol for DEF functions when annunciated on the front panel; however it will not be displayed in BESTCOMS*Plus*. The pre-alarms are summarized in the following paragraphs.

- DEF FLUID LOW: This pre-alarm displays when SPN 5245 has a value of 1 indicating that the DEF tank level is low. A DEF level of 8% to 23% causes this annunciation.

- **DEF FLUID EMPTY:** This pre-alarm displays when SPN 5245 has a value of 4 indicating that the DEF tank level is low. The low condition is announced when the tank level is below 8%. When this occurs and is not remedied, the engine ECU may enter a mode of inducement not to operate the engine where some of the conditions in the pre-alarms descriptions below may occur.
- **DEF ENGINE DERATE:** This pre-alarm displays when SPN 5246 has a value of 3, indicating the Engine Derate level of inducement. This indicates that the engine is going into a reduced power mode indicating the lowest level of inducement not to operate the engine when the EATS is not functioning properly or out of DEF.
- **DEF PRESEVERE INDUCEMENT:** This pre-alarm displays when SPN 5246 has a value of 4, indicating the Pre-Severe Inducement level of inducement. This indicates that the engine has entered the second highest level of inducement not to operate the engine when the EATS is not functioning properly or the DEF level is low. The ECU will allow the engine to run for a maximum of 3 hours in this condition. After expiration of the 3 hours, the engine will enter the severe inducement state and cannot be restarted until the DEF level is raised above 14%.
- **DEF SEVERE INDUCEMENT:** This pre-alarm displays when SPN 5246 has a value of 5, indicating the Severe Inducement level of inducement. This indicates that the engine has entered the highest level of inducement not to operate the engine when the EATS is not functioning properly or DEF level is low. The ECU will allow the engine to run for a maximum of 3 hours in this condition. After expiration of the 3 hours, the engine will enter the severe inducement state and cannot be restarted until the DEF level is raised above 14%.
- **DEF INDUCEMENT OVERRIDE:** This pre-alarm displays when SPN 5246 has a value of 6, indicating temporary override of inducement. This indicates DEF inducement is temporarily overridden. The engine may operate with reduced power, or for a limited time, after which time it may re-enter the SEVERE INDUCEMENT state.

Exit Conditions for DEF Severe Inducement

- **First Restart:** Return to 0% torque reduction in exit condition, until proper DEF level and quality evaluation. If low level or poor DEF quality is detected during the next monitoring cycle, the severe inducement will be active after the next restart. After the second restart, a service tool is required to exit the severe inducement.
- **With Service Tool Clearing:** Invoke 0% torque reduction with service tool clearing until proper DEF level and quality evaluation. If low level or poor DEF quality is detected during the next monitoring cycle, the severe inducement will be active after the next restart.

Diagnostic Trouble Codes

DGC-2020HD controllers obtain diagnostic engine information from a compatible engine control unit (ECU). The DGC-2020HD receives an unsolicited message of a currently active diagnostic trouble code (DTC). Previously active DTCs are available upon request. Active and previously active DTCs can be cleared on request.

Active and previously active DTCs can be viewed through BESTCOMS^{Plus}® by using the *Metering Explorer* to expand the J1939 ECU tree or through the front panel display by navigating to Metering, J1939 Active DTC.

Table 99 lists the diagnostic information that the DGC-2020HD obtains over the CAN interface.

Table 99. Diagnostic Information Obtained Over the CAN Interface

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

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

For certain DTCs, if the DGC-2020HD recognizes a pair of SPN and FMI numbers, it displays a single string as listed in Table 100. If the DGC-2020HD recognizes an SPN in Table 100, but the FMI does not match the FMI in Table 100, then it displays the string from Table 100 corresponding to the table entry where the FMI is # and a second string corresponding to the FMI number listed in Table 101. For example, if the DGC-2020HD receives SPN 29 and FMI 13, it displays ACCEL PEDAL 2 POSITN and OUT OF CALIBRATION. If the DGC-2020HD does not have descriptive information about an SPN and FMI that was received, the description will display as "NO TEXT AVAILABLE".

Table 100. DTCs Displayed by the DGC-2020HD

SPN	FMI	String Displayed	Description
28	3	Throttle Volt HI	Throttle Voltage High
28	4	Throttle Volt LO	Throttle Voltage Low
28	14	Throttle Volt OOR	Throttle Input Voltage Out of Range
29	3	Throttle Volt HI	Throttle Voltage High
29	4	Throttle Volt LO	Throttle Voltage Low
29	14	Throttle Volt OOR	Throttle Input Voltage Out of Range
29	#	ACCEL PEDAL 2 POSITN	Caption string for accelerator pedal 2 position
52	15	INTERCOOLER TEMP HI	Engine Intercooler Temperature is above the HIGH threshold
91	3	Thr Pos Sns Volt HI	Throttle Position Sensor Input Voltage (High)
91	4	Thr Pos Sns Volt LO	Throttle Position Sensor Input Voltage (Low)
91	14	Thr Pos Sns Volt OOR	Throttle Voltage (Out of Range)
94	1	FUEL DELIV PRS LO LO	Engine Fuel Delivery Pressure is below the LOW LOW threshold

SPN	FMI	String Displayed	Description
94	3	Fuel Pmp Prs Volt HI	Fuel Pump Pressure Input Voltage (High)
94	4	Fuel Pmp Prs Volt LO	Fuel Pump Pressure Input Voltage (Low)
94	17	Fuel Pressure LO	Fuel Supply Pressure (Low Least Severe)
97	3	Water In FI Volt HI	Water In Fuel Signal Voltage High
97	4	Water In FI Volt LO	Water In Fuel Signal Voltage Low
97	16	Water in Fuel	Water In Fuel Detected
98	#	ENG OIL LEVEL	Caption used on front panel for Display of J1939 Parameter
99	#	OIL FILTER DIFF PRESS	Caption string for oil filter differential pressure parameter
100	1	ENG OIL PRESS LO LO	Engine Oil Pressure is below the LOW LOW threshold
100	3	Oil Prs Snsr Volt HI	Oil Pressure Sensor Input Voltage (High)
100	4	Oil Prs Snsr Volt LO	Oil Pressure Sensor Input Voltage (Low)
100	17	ENG OIL PRESS LO	Engine Oil Pressure is below the LOW threshold
100	18	Oil Prs Snsr Volt MLO	Oil Pressure Sensor Input Voltage (Moderately Low)
100	31	Oil Pressure INVLD	Oil Pressure (Invalid)
101	#	CRANKCASE PRESSURE	Caption string for crankcase pressure
102	2	Manifld Air Prs INVLD	Manifold Air Pressure Invalid
102	3	Mnflld AirP SnsVlt HI	Manifold Air Pressure Sensor Input Voltage High
102	4	Mnflld AirP SnsVlt LO	Manifold Air Pressure Sensor Input Voltage Low
103	0	Trbo Overspd Severe	Turbo Overspeed (Most Severe)
103	2	Trbo Speed MisMatch	Turbo Speed (Mismatch)
103	5	Trbo Spd Sns Curr LO	Turbo Speed Sensor Current (Low)
103	6	Trbo Spd Sns Curr HI	Turbo Speed Sensor Current (High)
103	8	Trbo Speed INVLD	Turbo Speed (Invalid)
103	31	Trbo Speed MISSING	Turbo Speed (Missing)
105	0	EGR Mixed Air Tmp HI	Exhaust Gas Recirculation Mixed Air High (Least Severe)
105	3	EGR Air Temp Vlt HI	Exhaust Gas Recirculation Mixed Air Temp Voltage (High)
105	4	EGR Air Temp Vlt LO	Exhaust Gas Recirculation Mixed Air Temp Voltage (Low)
105	15	EGR Mixed Air Tmp HI	Exhaust Gas Recirculation Mixed Air High (Least Severe)
105	16	EGR MxdAir Tmp MHI	Exhaust Gas Recirculation Mixed Air Temp (Moderately High)
107	0	Air Filt Restricted	Air Filter Restriction (High)
108	2	Barometrc Prs INVLD	Barometric Pressure (Invalid)
108	31	Barometrc Prs ERR	Barometric Pressure (Error)
109	1	ENG COOLNT PRS LO LO	Engine Coolant Pressure is below the LOW LOW threshold
109	17	ENG COOLANT PRS LO	Engine Coolant Pressure is below the LOW threshold
110	0	ENG COOLNT TMP HI HI	Engine Coolant Temperature is above the HIGH HIGH threshold
110	3	Cool Tmp Sns Volt HI	Coolant Temp Sensor Input Voltage (High)
110	4	Cool Tmp Sns Volt LO	Coolant Temp Sensor Input Voltage (Low)
110	15	ENG COOLANT TEMP HI	Engine Coolant Temperature is above the HIGH threshold
110	16	Cool Temp MHI	Coolant Temp Sensor Input (Moderately High)
110	17	Cool Temp LO	Coolant Temp Sensor Input (Low Least Severe)
111	1	Coolnt Lvl LO	Coolant Level (Low)
111	17	ENG COOLANT LVL LO	Engine Coolant Level is below the LOW threshold

SPN	FMI	String Displayed	Description
111	#	LOW COOL LEVEL	Low Coolant Level string used in event log and/or Alarm and Prealarm annunciation
157	3	Fuel Rail Prs Vlt HI	Fuel Rail Pressure Input Voltage (High)
157	4	Fuel Rail Prs Vlt LO	Fuel Rail Pressure Input Voltage (Low)
157	10	Fuel Rail Prs LOSS	Fuel Rail Pressure Loss Detected
157	17	Fuel RI Prs NOT DEV	Fuel Rail Pressure Not Developed
158	0	KSW BATT VOLTS HI HI	Key Switch Battery Potential is above the HIGH HIGH threshold
158	1	KSW BATT VOLTS LO LO	Key Switch Battery Potential is below the LOW LOW threshold
158	15	KSW BATT VOLTS HI	Key Switch Battery Potential is above the HIGH threshold
158	17	KSW BATT VOLTS LO	Key Switch Battery Potential is below the LOW threshold
168	#	LOW BATT VOLT	Low Battery Voltage string used in event log and/or Alarm and Prealarm annunciation
174	0	Fuel Temp EXT HI	Fuel Temp (Extremely High)
174	3	Fuel Tmp Sns Volt HI	Fuel Temp Sensor Input Voltage (High)
174	4	Fuel Tmp Sns Volt LO	Fuel Temp Sensor Input Voltage (Low)
174	16	Fuel Temp MHI	Fuel Temp (Moderately High)
175	#	ENG OIL TEMP	Caption used on front panel for Display of J1939 Parameter
188	17	SPEED AT IDLE LO	Metering string for ECU trouble code metering indicates Engine Idle speed is below the LOW threshold
189	0	Engine Spd DERATE	Engine Speed Derate
190	0	Engine OvrSpd EXTRM	Engine Overspeed (Extreme)
190	1	ENGINE SPEED LOW	Engine speed is below the LOW threshold
190	16	Engine OvrSpd MODRT	Engine Overspeed (Moderate)
190	17	SPEED AT IDLE LO	Engine Idle speed is below the LOW threshold
190	#	ENGINE SPEED	Caption used on front panel for Display of J1939 Parameter
237	2	VIN Data MisMatch	VIN Data Mismatch with other controllers
412	0	EGR Temp EXT HI	Exhaust Gas Recirculation Temp (Extremely High)
412	3	EGR Temp In Vlt HI	Exhaust Gas Recirculation Temp Input Voltage (High)
412	4	EGR Temp In Vlt LO	Exhaust Gas Recirculation Temp Input Voltage (Low)
412	16	EGR Temp MHI	Exhaust Gas Recirculation Temp (Moderately High)
520	#	RETARDER % TORQUE	Caption string for retarder % torque
563	#	ABS ACTIVE	Caption String for Antilock Brake System (ABS) active
611	0	Loss of Voltage Sensing	Loss of Sensing
611	3	Inj Short to PWR	Injector Wiring Shorted to Power
611	4	Inj Short to GND	Injector Wiring Shorted to Ground
612	14	EDM Fault	Exciter Diode Monitor Open or Shorted Diode
624	#	DIAGNOSTIC LAMP	Caption String for Diagnostic Lamp
627	1	Inj Sply Vlt Problm	Injector Supply Voltage Problem
627	16	ECU Power Volt HI	ECU Power High Voltage
627	18	ECU Power Volt LO	ECU Power Low Voltage
627	13	ECU ERROR	ECU Error
630	#	ECU INTERNAL ERROR	Caption string for ECU Internal Error
636	2	Pump Pos Sns Noisy	Pump Position Sensor Input Noise
636	5	Pump Pos Sns Curr LO	Pump Position Sensor Current (Low)

SPN	FMI	String Displayed	Description
636	6	Pump Pos Sns Curr HI	Pump Position Sensor Current (High)
636	8	Pump Pos Sns In MSNG	Pump Position Sensor Input Missing
636	10	Pump Pos Sns In ERR	Pump Position Sensor Input Pattern Error
637	2	Crank Pos Sns Noisy	Crank Position Input Noise
637	5	Crank Pos Sns Curr LO	Crank Position Sensor Current (Low)
637	6	Crank Pos Sns Curr HI	Crank Position Sensor Current (High)
637	7	Crnk/Pmp Pos Tmg OOS	Crank/Pump Position Timing Moderately Out of Sync
637	8	Crank Pos Sns MSNG	Crank Position Missing
637	10	Crank Pos Sns In ERR	Crank Position Input Pattern Error
639	#	J1939 NETWORK 1	Caption String for J1939 Network number 1
641	4	Trbo Actuator ERR	Turbo Actuator Error
641	12	ECU/Trbo Comm ERR	ECU/Turbo Communication Error
641	13	TrboAct Lrnd Val ERR	Turbo Actuator Learned Value Error
641	16	Trbo Act Temp MHI	Turbo Actuator Temp (Moderately High)
651	2	Cyl 1 EUI PN INVLD	Cylinder #1 EUI Part Number (Invalid)
651	5	Cyl 1 EUI Ckt OPEN	Cylinder #1 EUI Circuit (Open)
651	6	Cyl 1 EUI Ckt SHORT	Cylinder #1 EUI Circuit (Shorted)
651	7	Cyl 1 EUI Ckt MECH FL	Cylinder #1 EUI Circuit (Mechanical Failure)
651	13	Cyl 1 EUI QR INVLD	Cylinder #1 EUI Circuit QR Code (Invalid)
651	#	CYLINDER 1 INJECTOR	Caption String for Cylinder 1 Injector
652	2	Cyl 2 EUI PN INVLD	Cylinder #2 EUI Part Number (Invalid)
652	5	Cyl 2 EUI Ckt OPEN	Cylinder #2 EUI Circuit (Open)
652	6	Cyl 2 EUI Ckt SHORT	Cylinder #2 EUI Circuit (Shorted)
652	7	Cyl 2 EUI Ckt MECH FL	Cylinder #2 EUI Circuit (Mechanical Failure)
652	13	Cyl 2 EUI QR INVLD	Cylinder #2 EUI Circuit QR Code (Invalid)
652	#	CYLINDER 2 INJECTOR	Caption String for Cylinder 2 Injector
653	2	Cyl 3 EUI PN INVLD	Cylinder #3 EUI Part Number (Invalid)
653	5	Cyl 3 EUI Ckt OPEN	Cylinder #3 EUI Circuit (Open)
653	6	Cyl 3 EUI Ckt SHORT	Cylinder #3 EUI Circuit (Shorted)
653	7	Cyl 3 EUI Ckt MECH FL	Cylinder #3 EUI Circuit (Mechanical Failure)
653	13	Cyl 3 EUI QR INVLD	Cylinder #3 EUI Circuit QR Code (Invalid)
653	#	CYLINDER 3 INJECTOR	Caption String for Cylinder 3 Injector
654	2	Cyl 4 EUI PN INVLD	Cylinder #4 EUI Part Number (Invalid)
654	5	Cyl 4 EUI Ckt OPEN	Cylinder #4 EUI Circuit (Open)
654	6	Cyl 4 EUI Ckt SHORT	Cylinder #4 EUI Circuit (Shorted)
654	7	Cyl 4 EUI Ckt MECH FL	Cylinder #4 EUI Circuit (Mechanical Failure)
654	13	Cyl 4 EUI QR INVLD	Cylinder #4 EUI Circuit QR Code (Invalid)
654	#	CYLINDER 4 INJECTOR	Caption String for Cylinder 4 Injector
655	2	Cyl 5 EUI PN INVLD	Cylinder #5 EUI Part Number (Invalid)
655	5	Cyl 5 EUI Ckt OPEN	Cylinder #5 EUI Circuit (Open)
655	6	Cyl 5 EUI Ckt SHORT	Cylinder #5 EUI Circuit (Shorted)
655	7	Cyl 5 EUI Ckt MECH FL	Cylinder #5 EUI Circuit (Mechanical Failure)
655	13	Cyl 5 EUI QR INVLD	Cylinder #5 EUI Circuit QR Code (Invalid)

SPN	FMI	String Displayed	Description
655	#	CYLINDER 5 INJECTOR	Caption String for Cylinder 5 Injector
656	2	Cyl 6 EUI PN INVLD	Cylinder #6 EUI Part Number (Invalid)
656	5	Cyl 6 EUI Ckt OPEN	Cylinder #6 EUI Circuit (Open)
656	6	Cyl 6 EUI Ckt SHORT	Cylinder #6 EUI Circuit (Shorted)
656	7	Cyl 6 EUI Ckt MECH FL	Cylinder #6 EUI Circuit (Mechanical Failure)
656	13	Cyl 6 EUI QR INVLD	Cylinder #6 EUI Circuit QR Code (Invalid)
656	#	CYLINDER 6 INJECTOR	Caption String for Cylinder 6 Injector
657	#	CYLINDER 7 INJECTOR	Caption String for Cylinder 7 Injector
658	#	CYLINDER 8 INJECTOR	Caption String for Cylinder 8 Injector
659	#	CYLINDER 9 INJECTOR	Caption String for Cylinder 9 Injector
660	#	CYLINDER 10 INJECTOR	Caption String for Cylinder 10 Injector
661	#	CYLINDER 11 INJECTOR	Caption String for Cylinder 11 Injector
662	#	CYLINDER 12 INJECTOR	Caption String for Cylinder 12 Injector
663	#	CYLINDER 13 INJECTOR	Caption String for Cylinder 13 Injector
664	#	CYLINDER 14 INJECTOR	Caption String for Cylinder 14 Injector
665	#	CYLINDER 15 INJECTOR	Caption String for Cylinder 15 Injector
666	#	CYLINDER 16 INJECTOR	Caption String for Cylinder 16 Injector
667	#	CYLINDER 17 INJECTOR	Caption String for Cylinder 17Injector
668	#	CYLINDER 18 INJECTOR	Caption String for Cylinder 18 Injector
669	#	CYLINDER 19 INJECTOR	Caption String for Cylinder 19 Injector
670	#	CYLINDER 20 INJECTOR	Caption String for Cylinder 20 Injector
671	#	CYLINDER 21 INJECTOR	Caption String for Cylinder 21 Injector
672	#	CYLINDER 22 INJECTOR	Caption String for Cylinder 22 Injector
673	#	CYLINDER 23 INJECTOR	Caption String for Cylinder 23 Injector
674	#	CYLINDER 24 INJECTOR	Caption String for Cylinder 24 Injector
676	#	ENG GLOW PLUG RELAY	Caption String for Engine Glow Plug Relay
677	#	ENGINE START RELAY	Caption String for Engine Start Relay
701	#	AUX I/O 1	Caption String for Auxiliary I/O 1
702	#	AUX I/O 2	Caption String for Auxiliary I/O 2
703	#	AUX I/O 3	Caption String for Auxiliary I/O 3
704	#	AUX I/O 4	Caption String for Auxiliary I/O 4
705	#	AUX I/O 5	Caption String for Auxiliary I/O 5
706	#	AUX I/O 6	Caption String for Auxiliary I/O 6
707	#	AUX I/O 7	Caption String for Auxiliary I/O 7
708	#	AUX I/O 8	Caption String for Auxiliary I/O 8
709	#	AUX I/O 9	Caption String for Auxiliary I/O 9
710	#	AUX I/O 10	Caption String for Auxiliary I/O 10
711	#	AUX I/O 11	Caption String for Auxiliary I/O 11
712	#	AUX I/O 12	Caption String for Auxiliary I/O 12
713	#	AUX I/O 13	Caption String for Auxiliary I/O 13
714	#	AUX I/O 14	Caption String for Auxiliary I/O 14
715	#	AUX I/O 15	Caption String for Auxiliary I/O 15
716	#	AUX I/O 16	Caption String for Auxiliary I/O 16

SPN	FMI	String Displayed	Description
898	2	REQ SPD DATA ERRATIC	Speed Demand Data is erratic
898	9	Spd/Trq Msg INVLD	Vehicle Speed/Torque Message Invalid
898	#	ENGINE REQSTED SPEED	Caption String for Engine Requested Speed
923	#	PWM OUTPUT	Caption String for Engine PWM Output
970	2	Aux Eng SD SW INVLD	Auxiliary Engine Shutdown Switch (Invalid)
970	31	Aux Eng SD SW ACTV	Auxiliary Engine Shutdown Switch Active
971	31	Eng Derate SW ACTV	External Engine Derate Switch Active
975	#	FAN SPEED	Caption String for Engine Fan Speed
1072	#	ENG BRAKE OUTPUT 1	Caption String for Engine Brake Output 1
1074	#	ENG EXHAUST BRAKE OUT	Caption String for Engine Exhaust Brake Output
1075	5	Fuel TR Pump Curr LO	Fuel Transfer Pump Current (Low)
1075	6	Fuel TR Pump Curr HI	Fuel Transfer Pump Current (High)
1075	12	Fuel TR Pump ERR	Fuel Transfer Pump (Error)
1079	#	SENSOR SUPPLY VOLTS 1	Caption String for Sensor Supply Voltage 1
1080	3	Snsr Supp 1 Volt LO	Sensor Supply 1 Voltage (Low)
1080	4	Snsr Supp 1 Volt HI	Sensor Supply 1 Voltage (High)
1080	#	SENSOR SUPPLY VOLTS 2	Caption String for Sensor Supply Voltage 2
1081	#	ENG WAIT TO START LMP	Caption String for Engine Wait to Start Lamp
1109	31	Eng Shutdown WARNING	Engine Shutdown Warning
1109	#	EPS SHUTDN APPROACHG	Caption String for indication that Engine Protective System Shutdown Is Approaching
1110	31	Eng Prot Shutdown	Engine Protection Shutdown
1136	0	ECU Temp EXT HI	ECU Temperature (Extremely High)
1136	15	ENG ECU TEMP HI	ECU Temperature has exceeded the HIGH level
1136	16	ECU Temp MHI	ECU Temperature (Moderately High)
1172	3	Trbo Cmp Tmp Volt HI	Turbo Compressor Inlet Temp Input Voltage (High)
1172	4	Trbo Cmp Tmp Volt LO	Turbo Compressor Inlet Temp Input Voltage (Low)
1172	16	Trbo Cmp In Tmp MHI	Turbo Compressor Inlet Temp (Moderately High)
1180	0	Trbo Trbn Tmp EXT HI	Turbo Turbine Inlet Temp (Extremely High)
1180	16	Trbo Trbn In Tmp MHI	Turbo Turbine Inlet Temp (Moderately High)
1231	#	J1939 NETWORK 2	Caption String for J1939 Network number 2
1235	#	J1939 NETWORK 3	Caption String for J1939 Network number 3
1237	#	ENG SHUTDN ORIDE SW	Caption String for Engine Shutdown Override Switch
1322	#	MULTI CYL MISFIRE	Caption String for Misfire detected on multiple engine cylinders
1323	#	MISFIRE CYLINDER 1	Caption String for Misfire detected on a single engine cylinder
1324	#	MISFIRE CYLINDER 2	Caption String for Misfire detected on a single engine cylinder
1325	#	MISFIRE CYLINDER 3	Caption String for Misfire detected on a single engine cylinder
1326	#	MISFIRE CYLINDER 4	Caption String for Misfire detected on a single engine cylinder
1327	#	MISFIRE CYLINDER 5	Caption String for Misfire detected on a single engine cylinder
1328	#	MISFIRE CYLINDER 6	Caption String for Misfire detected on a single engine cylinder
1329	#	MISFIRE CYLINDER 7	Caption String for Misfire detected on a single engine cylinder
1330	#	MISFIRE CYLINDER 8	Caption String for Misfire detected on a single engine cylinder
1331	#	MISFIRE CYLINDER 9	Caption String for Misfire detected on a single engine cylinder

SPN	FMI	String Displayed	Description
1332	#	MISFIRE CYLINDER 10	Caption String for Misfire detected on a single engine cylinder
1333	#	MISFIRE CYLINDER 11	Caption String for Misfire detected on a single engine cylinder
1334	#	MISFIRE CYLINDER 12	Caption String for Misfire detected on a single engine cylinder
1335	#	MISFIRE CYLINDER 13	Caption String for Misfire detected on a single engine cylinder
1336	#	MISFIRE CYLINDER 14	Caption String for Misfire detected on a single engine cylinder
1337	#	MISFIRE CYLINDER 15	Caption String for Misfire detected on a single engine cylinder
1338	#	MISFIRE CYLINDER 16	Caption String for Misfire detected on a single engine cylinder
1339	#	MISFIRE CYLINDER 17	Caption String for Misfire detected on a single engine cylinder
1340	#	MISFIRE CYLINDER 18	Caption String for Misfire detected on a single engine cylinder
1341	#	MISFIRE CYLINDER 19	Caption String for Misfire detected on a single engine cylinder
1342	#	MISFIRE CYLINDER 20	Caption String for Misfire detected on a single engine cylinder
1343	#	MISFIRE CYLINDER 21	Caption String for Misfire detected on a single engine cylinder
1344	#	MISFIRE CYLINDER 22	Caption String for Misfire detected on a single engine cylinder
1345	#	MISFIRE CYLINDER 23	Caption String for Misfire detected on a single engine cylinder
1346	#	MISFIRE CYLINDER 24	Caption String for Misfire detected on a single engine cylinder
1347	3	Pump Ctrl Vlv Curr HI	Pump Control Valve Current (High)
1347	5	Pmp Ctrl Vlv C MSMCH	Pump Control Valve Current (Mismatch)
1347	7	Fuel RI Prs Ctrl ERR	Fuel Rail Pressure Control (Error)
1569	31	Fuel Derate	Fuel Derate
1638	#	HYDRAULIC TEMP	Caption String for Hydraulic Temperature
1639	1	Fan Speed Zero	Fan Speed Detected (Zero)
1639	16	Fan Speed HI	Fan Speed Detected (High)
1639	18	Fan Speed LO	Fan Speed Detected (Low)
2000	13	Security Violation	Security Violation
2005	9	TSC CAN Msg NT RCV	TSC CAN Message Not Received
2030	9	AC Clutch Msg NT RCV	A/C Clutch Status CAN Message Not Received
2071	9	Tr Oil Can Msg NT RCV	Trans. Oil, Tier Size, Vehicle Speed CAN Message Not Received
2440	#	Gen LL Voltage	Generator LL Voltage
2456	#	Gen Var	Generator Reactive Power (Vars)
2629	0	TRBO 1 OUT TMP HI HI	Turbocharger 1 outlet pressure is above the HIGH HIGH threshold
2629	15	TURBO 1 OUT TMP HI	Turbocharger 1 outlet pressure is above the HIGH threshold
2630	0	EGR FrAir Tmp EXT HI	Exhaust Gas Recirculation Fresh Air Temp (Extremely High)
2630	3	EGR FrAir Tmp Vlt HI	Exhaust Gas Recirculation Fresh Air Temp Input Voltage (High)
2630	4	EGR FrAir Tmp Vlt LO	Exhaust Gas Recirculation Fresh Air Temp Input Voltage (Low)
2630	15	EGR FrAir Tmp HI	Exhaust Gas Recirculation Fresh Air Temp (High Least Severe)
2630	16	EGR FrAir Tmp MHI	Exhaust Gas Recirculation Fresh Air Temp (Moderately High)
2634	#	POWER RELAY	Caption String for main Power Relay
2659	2	EGR Flo/Tmp MISMATCH	Exhaust Gas Recirculation Flow/Temp Mismatch
2659	15	EGR Flo Rt High	Exhaust Gas Recirculation Flow Rate (High Least Severe)
2659	17	EGR Flo Rt LO	Exhaust Gas Recirculation Flow Rate (Low Least Severe)
2790	16	Trbo Cmp Out Tmp HI	Turbo Compressor Outlet Temp (Moderately High)
2791	2	EGR Vlv Pos Invld	Exhaust Gas Recirculation Valve Position Invalid

SPN	FMI	String Displayed	Description
2791	3	EGRVlv Pos In Vlt HI	Exhaust Gas Recirculation Valve Position Input Voltage (High)
2791	4	EGRVlv Pos In Vlt LO	Exhaust Gas Recirculation Valve Position Input Voltage (Low)
2791	13	EGR Vlv Control ERR	Exhaust Gas Recirculation Valve Control Error
2791	31	EGR Valve Cal ERR	Exhaust Gas Recirculation Valve Calibration Error
2791	#	EGR VALVE CONTROL	Caption String for EGR Valve Control
2795	7	Trbo Act Pos MSMATCH	Turbo Actuator Position Mismatch
3380	#	Field Voltage	Generator Field Voltage
3381	#	Field Current	Generator Field Current
3719	0	DPF SOOT LVL EXT HI	String for Diagnostic Trouble Code Indicating Diesel Particulate Filter Soot Level High - Most Severe Level
3719	15	DPF SOOT LVL HI	String for Diagnostic Trouble Code Indicating Diesel Particulate Filter Soot Level High - Least Severe Level
3719	16	DPF SOOT LVL MOD HI	String for Diagnostic Trouble Code Indicating Diesel Particulate Filter Soot Level High - Moderately Severe Level
520837	1	STARTER SPEED LO LO	Starter Speed is below the LOW LOW threshold
520838	1	RUN UP SPEED LO LO	Run Up Speed is below the LOW LOW threshold
522192	12	MTU ENGINE BAD	Component failure of the MTU engine control ECU
523212	#	ENGPRT CAN MSG	Caption String for CANBus Message
523216	#	PREHTENCMD CAN MSG	Caption String for CANBus Message
523218	#	RxCCVS CAN MSG	Caption String for CANBus Message
523222	#	TC01 CAN MSG	Caption String for CANBus Message
523238	#	SWTOUT CAN MSG	Caption String for CANBus Message
523239	#	DECV1 CAN MSG	Caption String for CANBus Message
523240	#	FUNMODCTL CAN MSG	Caption String for CANBus Message
523350	#	CYL BANK 1 INJECTORS	Caption String for Cylinder Bank 1 Injectors
523351	#	CYL BANK 1 INJECTORS	Caption String for Cylinder Bank 1 Injectors
523352	#	CYL BANK 2 INJECTORS	Caption String for Cylinder Bank 2 Injectors
523353	#	CYL BANK 2 INJECTORS	Caption String for Cylinder Bank 2 Injectors
523354	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523355	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523370	#	RAIL PRESSURE	Caption String for Rail Pressure
523420	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523450	#	MULTI STATE SWITCH 1	Caption String for Multi State Switch 1
523451	#	MULTI STATE SWITCH 2	Caption String for Multi State Switch 2
523452	#	MULTI STATE SWITCH 3	Caption String for Multi State Switch 3
523470	#	RAIL PRESSURE LMT VLV	Caption String for Rail Pressure Limit Valve
523490	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523500	#	CAN MSG TIMEOUT	Caption String indicating Can Message Timeout has occurred
523550	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523561	#	INJECTN PERIOD CYL 1	Caption String for Single Cylinder Injection Period
523562	#	INJECTN PERIOD CYL 2	Caption String for Single Cylinder Injection Period
523563	#	INJECTN PERIOD CYL 3	Caption String for Single Cylinder Injection Period
523564	#	INJECTN PERIOD CYL 4	Caption String for Single Cylinder Injection Period
523565	#	INJECTN PERIOD CYL 5	Caption String for Single Cylinder Injection Period

SPN	FMI	String Displayed	Description
523566	#	INJECTN PERIOD CYL 6	Caption String for Single Cylinder Injection Period
523567	#	INJECTN PERIOD CYL 7	Caption String for Single Cylinder Injection Period
523568	#	INJECTN PERIOD CYL 8	Caption String for Single Cylinder Injection Period
523600	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523601	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523602	#	FAN SPEED	Caption String for Engine Fan Speed
523604	#	RXENGTMP CAN MSG	Caption String for CANBus Message
523605	#	TSC1-AE MSG MISSING	Caption String for CANBus Message
523606	#	TSC1-AR MSG MISSING	Caption String for CANBus Message
523607	#	TSC1-DE MSG MISSING	Caption String for CANBus Message
523608	#	TSC1-DR MSG MISSING	Caption String for CANBus Message
523609	#	TSC1-PE MSG MISSING	Caption String for CANBus Message
523610	#	TSC1-VE MSG MISSING	Caption String for CANBus Message
523611	#	TSC1-VR MSG MISSING	Caption String for CANBus Message
523612	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error
523613	#	RAIL PRESSURE	Caption String for Rail Pressure
523615	#	METERING UNIT VALVE	Caption String for Metering Unit Valve
523617	#	ECU ERROR	String for Diagnostic Trouble Code Indicating ECU Error

Table 101. DTCs Displayed by the DGC-2020HD (FMI Strings)

FMI	String Displayed	Description
0	DATA HI MOST SEVERE	Data is higher than expected at the most severe level
1	DATA LO MOST SEVERE	Data is lower than expected at the most severe level
2	DATA ERRATIC OR BAD	Data is erratic, intermittent, or incorrect
3	VOLTS HI OR SHORTED	Measured voltage is higher than expected or shorted to a high source
4	VOLTS LO OR SHORTED	Measured voltage is lower than expected or shorted to a low source
5	CURRENT LO OR OPEN	Measured current is lower than expected or the circuit is open
6	CURRENT HI OR SHORTED	Measured current is higher than expected or shorted
7	MECHANICAL SYSTM ERR	Mechanical system error
8	FREQ OR PWM ERROR	Error in frequency, pulse width or period of any frequency or PWM signal is outside its predetermined limits
9	ABNORMAL UPDATE RATE	Update rate of parameter is abnormal
10	DATA RT OF CHG ERR	Rate of change of data is abnormal
11	FAILURE CAUSE UNKNOWN	String indicating failure cause is unknown
12	BAD INTELLIGNT DEVICE	Engine ECU is reporting that an intelligent device or component failure has been detected
13	OUT OF CALIBRATION	Device or parameter is out of calibration
14	CONSULT ENG MFG DATA	User should consult engine manufacturer's data
15	DATA HI LST SEVERE	Data is higher than expected at the least severe level
16	DATA HI MODERATE SVR	Data is higher than expected at a moderately severe level
17	DATA LO LST SEVERE	Data is lower than expected at the least severe level
18	DATA LO MODERATE SVR	Data is lower than expected at a moderately severe level
19	NETWORK DATA ERR	String Indicating Network Data contained an error indication



Revision History

The following information provides a historical summary of the changes made to the Digital Genset Controller hardware, firmware, and software. The corresponding revisions made to this instruction manual (9469300990) are also summarized. Revisions are listed in chronological order.

Hardware Version and Date	Change
A, Sep-13	Initial release
Firmware Version and Date	Change
1.00.00, Sep-13	Initial release
1.00.02, Mar-14	- Added configurable hysteresis settings to generator protection elements. - Added Return Timer to Mains Fail Transfer Status screen on DGC-2020HD front panel.
Software Version and Date	Change
3.05.02, Dec-13	Initial Release
3.05.03, Mar-14	Updated to support firmware version 1.00.02.
Manual Revision and Date	Change
A, Nov-13	Initial release
B, Mar-14	- Added configurable hysteresis settings to generator protection elements. - Removed product registration information.





12570 State Route 143
Highland IL 62249-1074 USA
Tel: +1 618.654.2341
Fax: +1 618.654.2351
email: info@basler.com

P.A.E. Les Pins
67319 Wasselonne Cedex
FRANCE
Tel: +33 3.88.87.1010
Fax: +33 3.88.87.0808
email: franceinfo@basler.com

No. 59 Heshun Road Loufeng District (N)
Suzhou Industrial Park
215122 Suzhou
P.R. CHINA
Tel: +86 512.8227.2888
Fax: +86 512.8227.2887
email: chinainfo@basler.com

111 North Bridge Road
15-06 Peninsula Plaza
Singapore 179098
Tel: +65 68.44.6445
Fax: +65 68.44.8902
email: singaporeinfo@basler.com