INSTRUCTION MANUAL

FOR

DGC-2020HD

DIGITAL GENSET CONTROLLER

Configuration

Basler Electric®

Publication: 9469300995
Revision: A Dec-16

Preface

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

- Device information and security settings
- Configuration via BESTCOMS*Plus*® and the front panel
- Communication settings
- Timekeeping
- Inputs and outputs
- Breaker management, synchronizer, bias control, and multiple generator management
- Alarm configuration
- Protection settings
- BESTlogic™*Plus* programmable logic
- Troubleshooting

Conventions Used in this Manual

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

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

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

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

Other Instruction Manuals

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

Table 1. Instruction Manuals

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

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First printing: October 2016

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.

Contents

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 1.

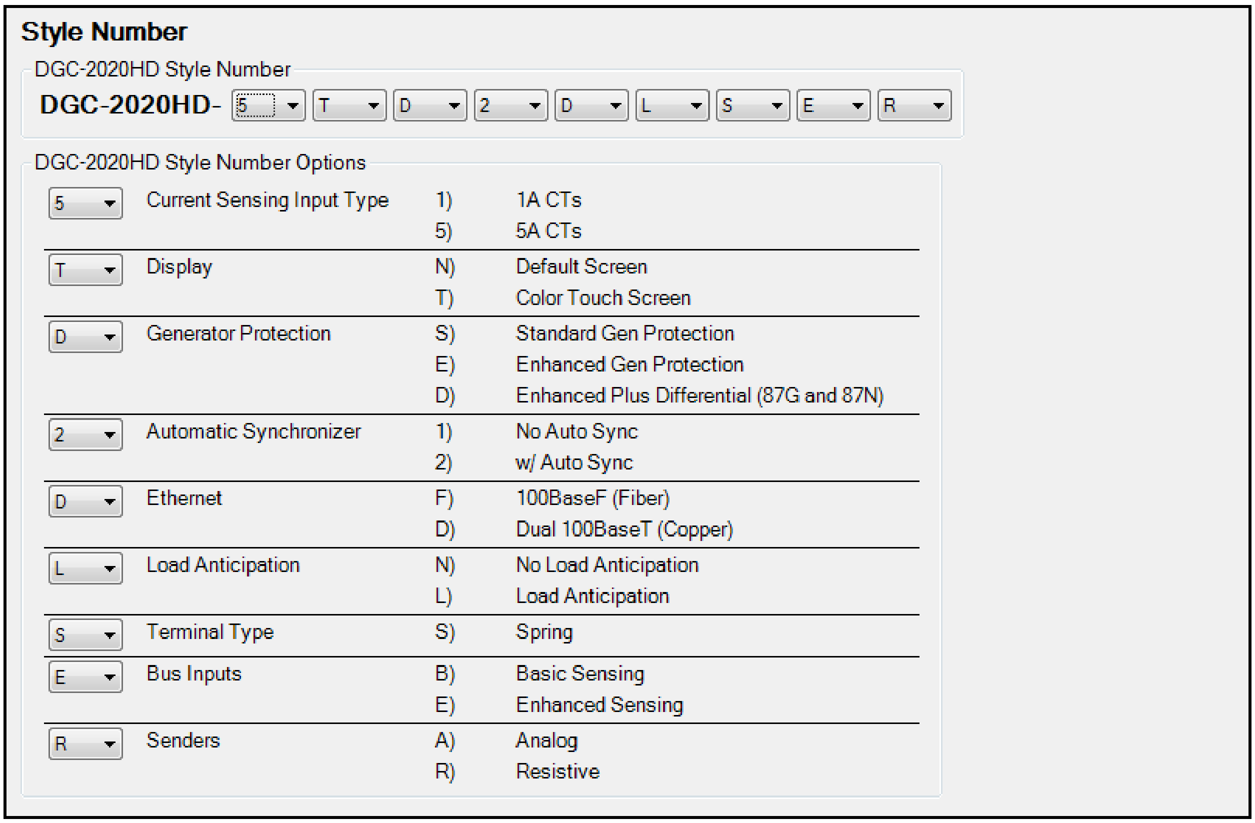


Figure 1. Style Number Screen

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 2.

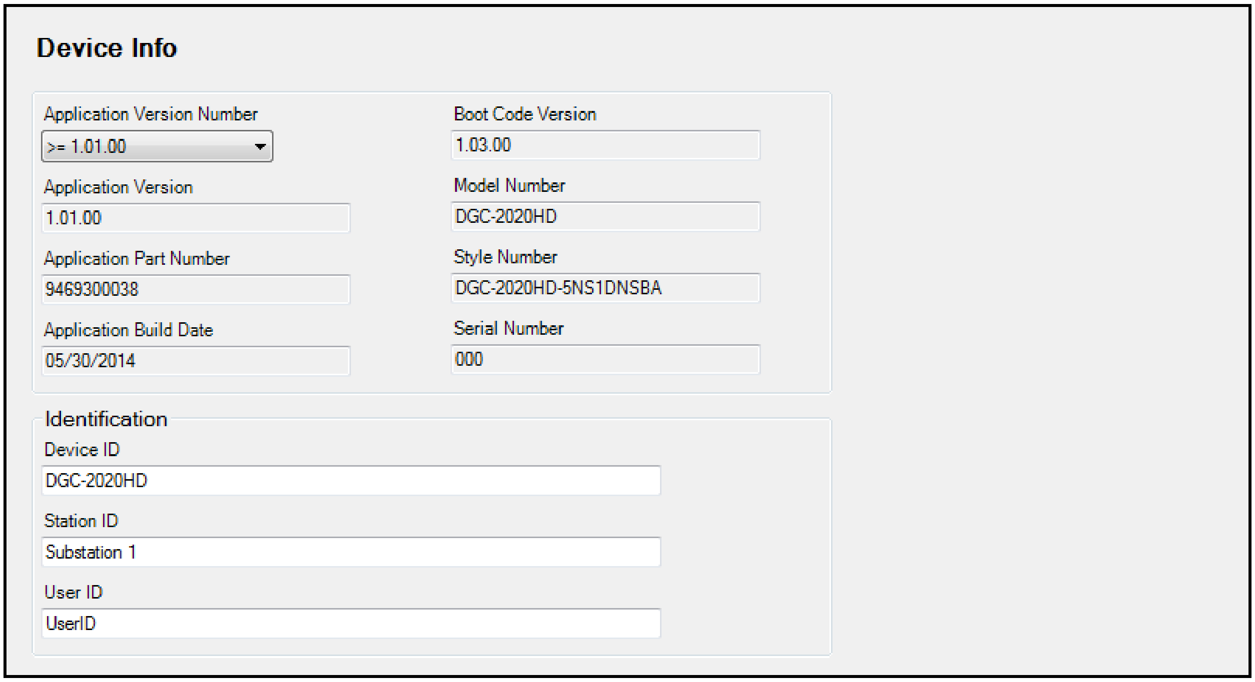


Figure 2. Device Info Screen

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), the optional Analog Expansion Module (AEM-2020), and the optional Voltage Regulation Module (VRM-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 and a single VRM-2020 module 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 3) 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.

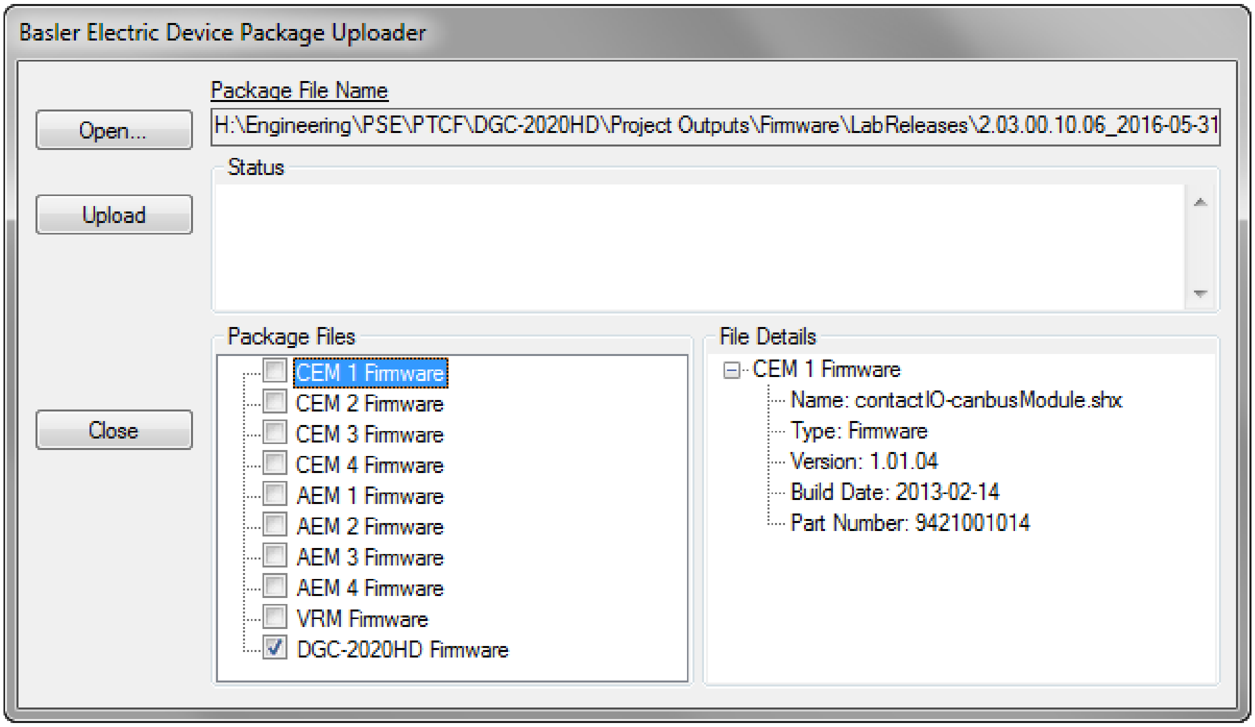


Figure 3. Basler Electric Device Package Uploader

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 BESTCOMS*Plus*. 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 clicking the *Open File* button in the BESTCOMS*Plus* lower menu bar (adjacent to the Connect/Disconnect button). Then browse for the file to upload.

e. When BESTCOMS*Plus* 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 BESTCOMS*Plus*.

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 1 lists the access levels and descriptions.

Table 1. Access Levels and Descriptions

Access Level	Description
6 - Admin (highest)	Users and channel authorizations can be created, edited, or deleted. Communication settings can be adjusted. Software upgrades can be performed. The event log can be reset.
5 - Design	Programmable logic can be created or changed.
4 - Settings	Values of all settings can be adjusted, but logic equations cannot be entered or edited.
3 - Operator	User can set date and time, clear and trigger logs, change LCD settings, control breakers, reset run statistics, start and stop engine, and change operating mode (run/off/auto).
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 BESTCOMS*Plus*® 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 BESTCOMS*Plus* to select User Name Setup under General Settings, Device Security Setup. The Login dialog box appears. See Figure 4. An administrator access level is required to set up usernames and passwords.

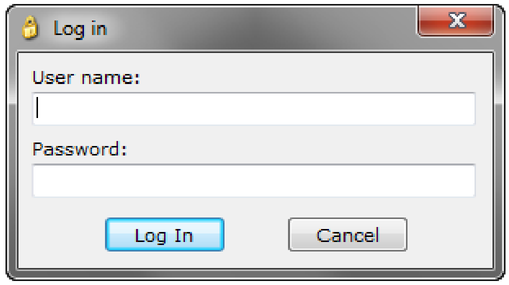


Figure 4. Login Screen

2. 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. Only the administrator can modify usernames and passwords on the User Name Setup screen (Figure 5). Usernames and passwords can be as many as 16 characters in length and consist of upper and lowercase letters, numbers, and special characters.

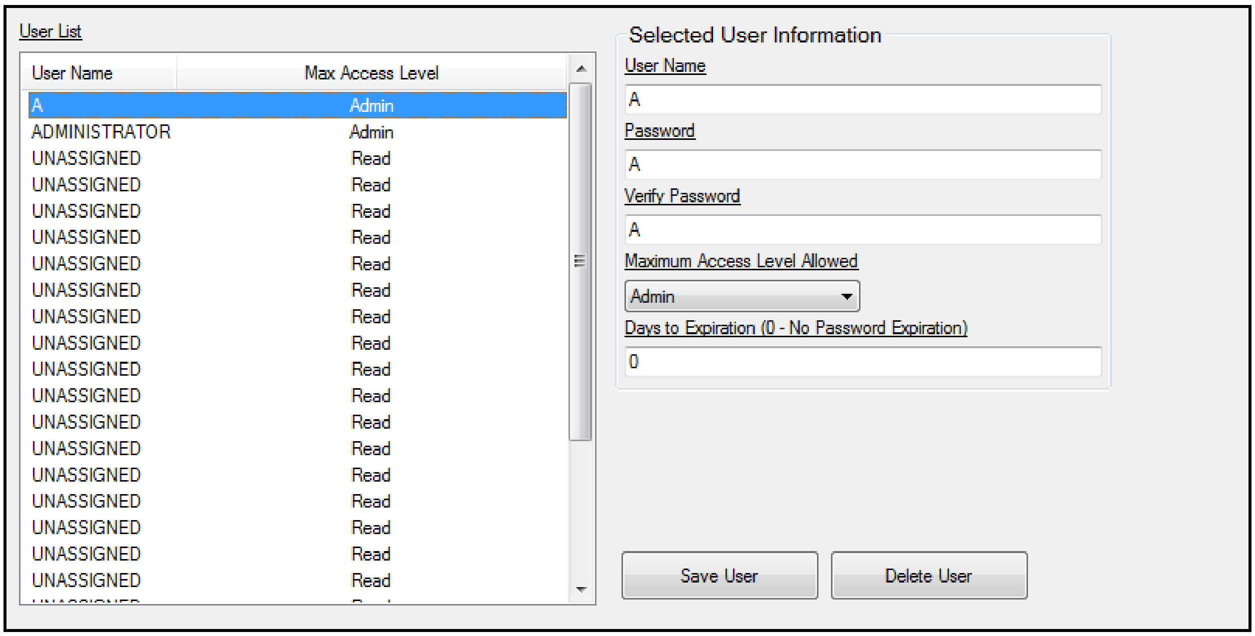


Figure 5. User Name Setup Screen

4. In the left-hand column, highlight any user name labeled UNASSIGNED or highlight a specific user name to change it.
5. On the right side of the screen, enter a User Name.
6. Enter a password for the user.
7. Re-enter the password to verify it.
8. Using Table 1 as a reference, enter the maximum access level allowed for the user.
9. Enter the number of days to expiration of the password or leave at default (0) for no expiration.
10. Click the Save User button to save to the settings to BESTCOMS*Plus* memory.
11. Pull down the Communication menu and select Upload Security to Device. The Login dialog box appears. An administrator level is required to upload security settings to the device.
12. 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**". BESTCOMS*Plus* notifies you when the upload is successful.

Port Access Setup

1. Use the Settings Explorer in BESTCOMS*Plus* to select Port Access Setup under General Settings, Device Security Setup. The Port List screen is shown in Figure 6.

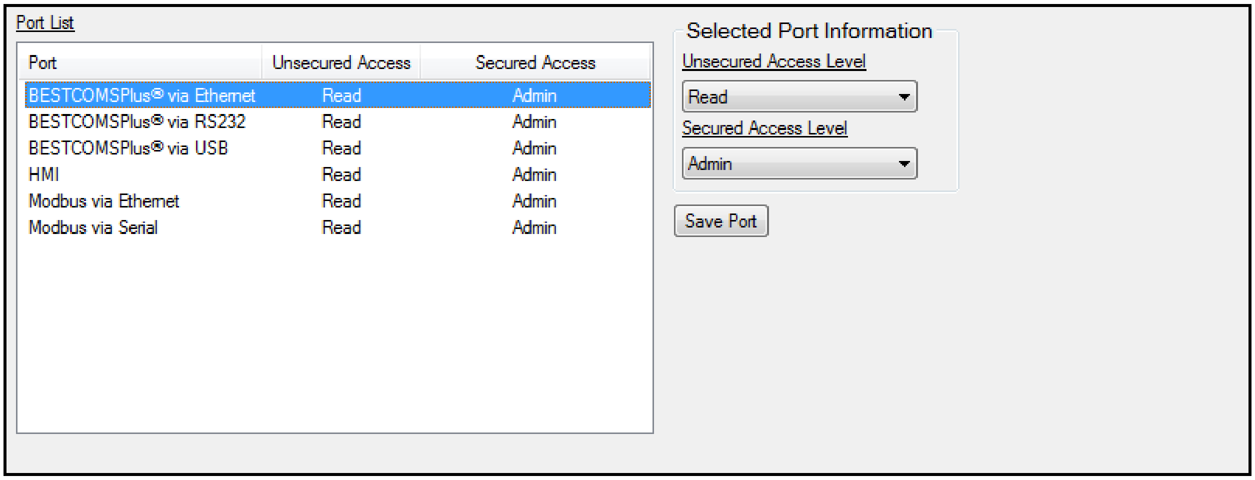


Figure 6. Port List Screen

2. The Login dialog box pops up. See Figure 4. 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 BESTCOMS*Plus* 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**”. BESTCOMS*Plus* 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 BESTCOMS*Plus* Access Control screen is illustrated in Figure 7. Settings are listed in Table 2.

Figure 7. Access Control Screen

Table 2. 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 BESTCOMS*Plus* to select Access Control under General Settings, Device Security Setup. The Access Control screen is shown in Figure 7.
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**". BESTCOMS*Plus* notifies you when the upload is successful.

Configuration through the Front Panel

This chapter provides information on configuring DGC-2020HD settings through the front panel.

Display Setup

BESTCOMS*Plus*® 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 BESTCOMS*Plus*. The display options are described below. Figure 8 shows the BESTCOMS*Plus* Front Panel HMI settings screen. Settings are listed in Table 3.

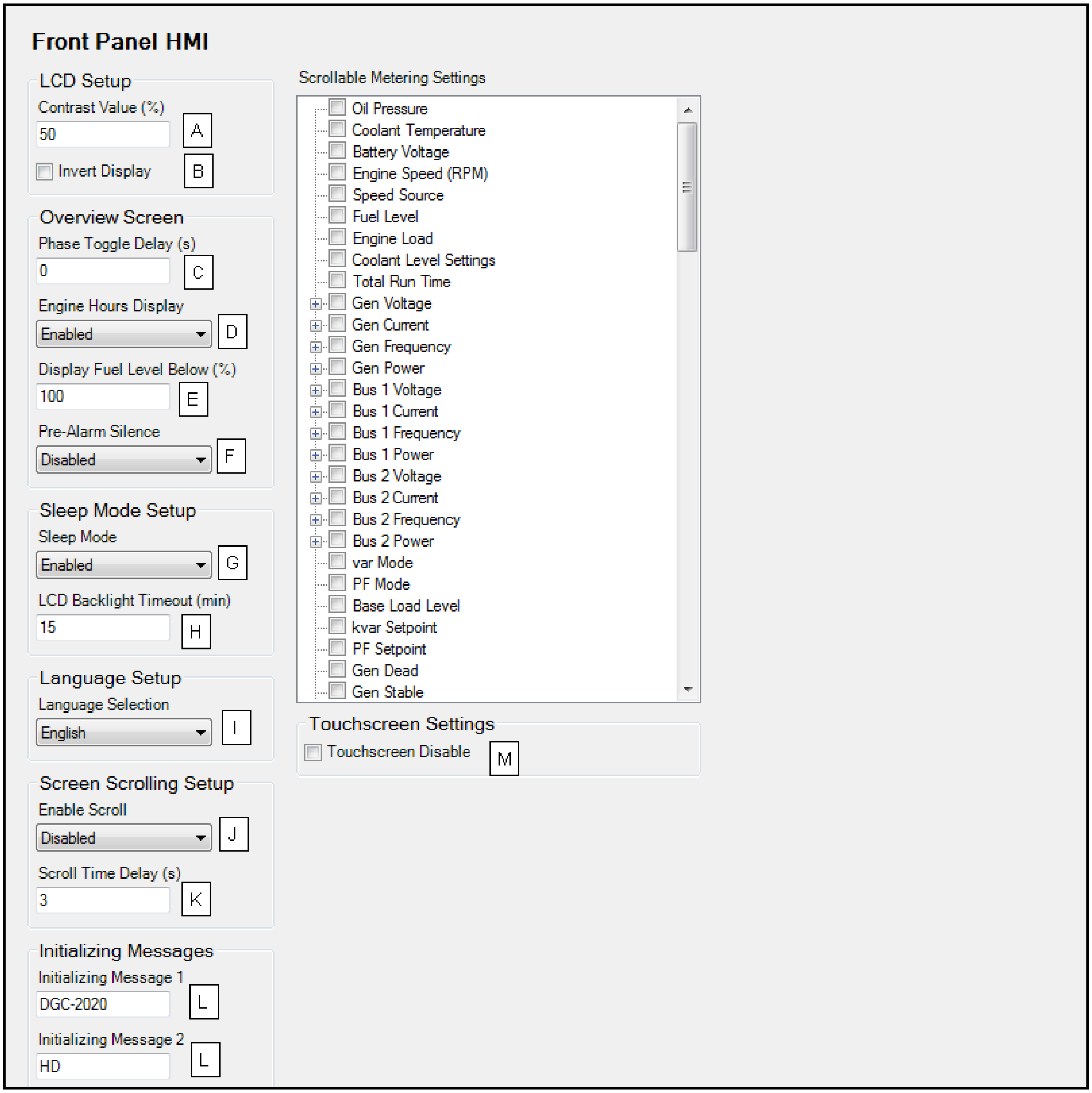


Figure 8. Front Panel Settings Screen

Table 3. Settings for Front Panel Settings Screen

Locator	Setting	Range	Increment	Unit
A	Contrast Value	0 to 100	1	%
B	Invert Display	Enabled or Disabled	n/a	n/a
C	Phase Toggle Delay	0 to 120	1	seconds
D	Engine Hours Display	Enabled or Disabled	n/a	n/a
E	Display Fuel Level Below	0 to 100	1	%
F	Pre-Alarm Silence	Enabled or Disabled	n/a	n/a
G	Sleep Mode	Enabled or Disabled	n/a	n/a
H	LCD Backlight Timeout	1 to 120	1	minutes
I	Language Selection	English, Chinese, Russian, French, Spanish, or German	n/a	n/a
J	Enable Scroll	Enabled or Disabled	n/a	n/a
K	Scroll Time Delay	1 to 600	varies	seconds
L	Initializing Message	Up to 16 alphanumeric characters	n/a	n/a
M	Touchscreen Disable	Enabled or Disabled	n/a	n/a

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.

Engine Hours Display

When enabled, engine run-time hours are displayed on the front-panel Overview screen. The display of engine run time hours is alternated with the Coolant Temperature and Battery Voltage readings on the front-panel Overview screen.

Display Fuel Level Below

Adjust this setting to display fuel level on the front-panel Overview screen only when the fuel level is below the desired value. This applies only when the DEF level is received from the engine ECU. If the DEF level is not received from the engine ECU, fuel level is displayed continuously regardless of the Display Fuel Level Below setting.

Pre-Alarm Silence

When enabled, pressing the Alarm Silence front-panel pushbutton disables the display of active alarms, pre-alarms, and MTU fault codes. When a new alarm, pre-alarm, or MTU fault code becomes active, the display is re-enabled. Refer to the *Reporting and Alarms* chapter in the *Operation* manual for more information.

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.

Screen Scrolling Setup

When scrolled metering is enabled, user-selected metering values are displayed on the overview screen. Any number of the available values can be displayed. Up to nine values are displayed on the screen at one time, after the scroll time delay has elapsed, the next set of values is displayed and so on.

Initializing Messages

Two custom initializing messages are displayed on the boot screen of the DGC-2020HD.

Touchscreen Disable

When checked, the touch screen controls are disabled.

Splash Screen

BESTCOMS*Plus*® Navigation Path: Settings Explorer, General Settings, Splash Screen
Front Panel Navigation Path: Not available through front panel

A splash screen, which is displayed for a few seconds upon powering up the DGC-2020HD, can be customized. The image must be exactly 480 pixels wide and 272 pixels high. Acceptable image formats are BMP, JPG, GIF, and PNG. This is only available to units with the optional color touch screen (style xTxxxxxxx).

Connect to the unit using BESTCOMS*Plus*. Click the Browse button on the Splash Screen, navigate to the desired image, select it, and click Open. If successful, the image appears in the Splash Screen in BESTCOMS*Plus*. Upload settings to the DGC-2020HD to transfer the image.

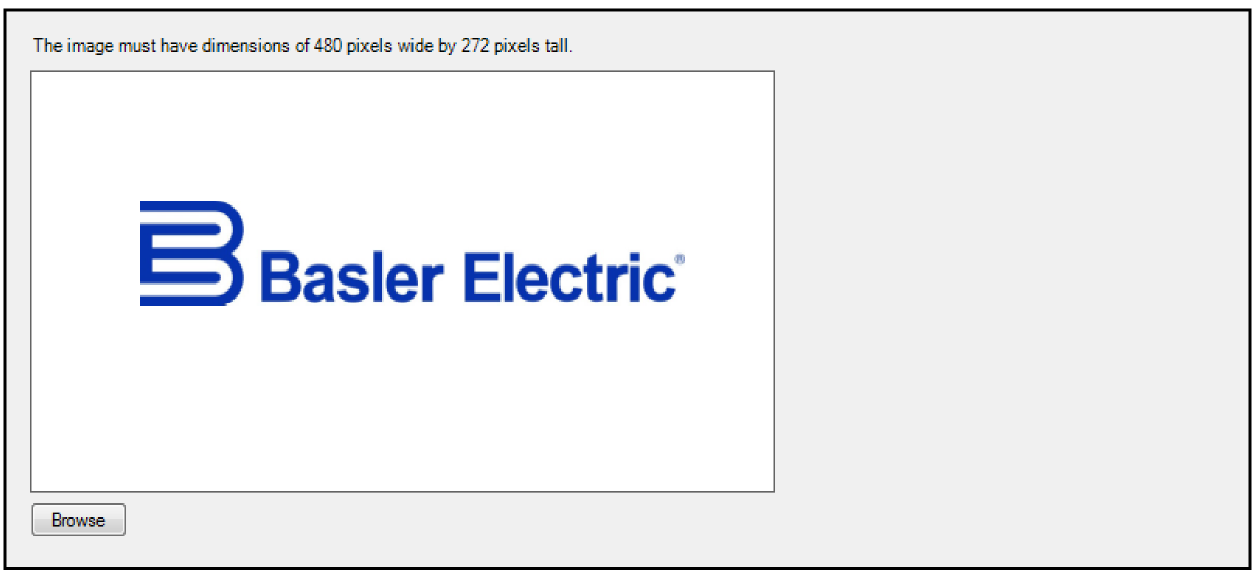


Figure 9. Settings Explorer, General Settings, Splash Screen

Settings Menu

The display structure of the Settings menu on the front panel is provided below. Refer to the *Controls and Indicators* chapter in the *Operation* manual for a full description of DGC-2020HD controls and indicators.

- **General Settings**
  - Front Panel HMI
  - Device Information
  - Access Control
  - Clock Setup
  - Display Units
- **Communication**
  - Ethernet
  - Ethernet 2 (Visible when redundant Ethernet is disabled.)
  - Redundant Ethernet
  - CAN Bus 1 (I/O) Setup
  - CAN Bus 2 (ECU) Setup
  - Modem Setup
  - RS485 Setup
  - RS232 Setup
  - Modbus® Setup
  - Email Setup
- **System Parameters**
  - System Settings
  - Group Settings
  - Rated Data
  - Sensing Transformers
  - Remote Module Setup
  - Crank Settings
  - Auto Restart
  - Exercise Timer
  - Relay Control
  - Auto Config Detect
  - Engine Statistics
  - Seven Day Timer
- **Report Configuration**
  - Data Log
  - Trending
  - Sequence of Events Setup
  - Configurable Log Params
- **Programmable Inputs**
  - Contact Inputs
  - Analog Inputs
  - Programmable Functions
  - Remote Contact Inputs
  - Remote Analog Inputs
  - Remote RTD Inputs
  - Remote Thermocouple Inputs
  - Remote Sys Manager Inputs
- **Programmable Outputs**
  - Output Contacts
  - Configurable Elements
  - Remote Contact Outputs
  - Remote Analog Outputs
- **Alarm Configuration**
  - Horn Configuration
  - Pre-Alarms
  - Alarms

- Sender Fail
- Prog Alarms

- **Protection**
  - Settings Group 0
  - Settings Group 1
  - Settings Group 2
  - Settings Group 3
  - Configurable Protection
  - Field Protection
- **Breaker Management**
  - Breaker Management
  - Breaker Hardware
  - Bus Condition
  - Synchronizer
  - Breaker Power Sum
- **Bias Control**
  - AVR Bias Control
  - GOV Bias Control
  - Mains Power Control
- **VRM Control Settings**
  - Field Rated Data
  - Startup
  - AVR
  - FCR
  - Limiters
  - Auto Tracking
- **Multigen Management**
  - AVR Output
  - GOV Output
  - LS (Load Share) Output
  - Demand Start/Stop
  - Sequencing
  - Network Configuration
  - Load Shedding
- **Logic**
  - Logic Timers (1-8)
  - Logic Timers (9-16)
  - Logic Counters
  - Logic Input Counters
  - Broadcast Logic

BESTCOMS*Plus*® Software

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

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

BESTCOMS*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 BESTCOMS*Plus* main shell. The same default logic scheme that is shipped with the DGC-2020HD is brought into BESTCOMS*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.

BESTCOMS*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 10 illustrates the typical user interface components of the DGC-2020HD plugin with BESTCOMS*Plus*.

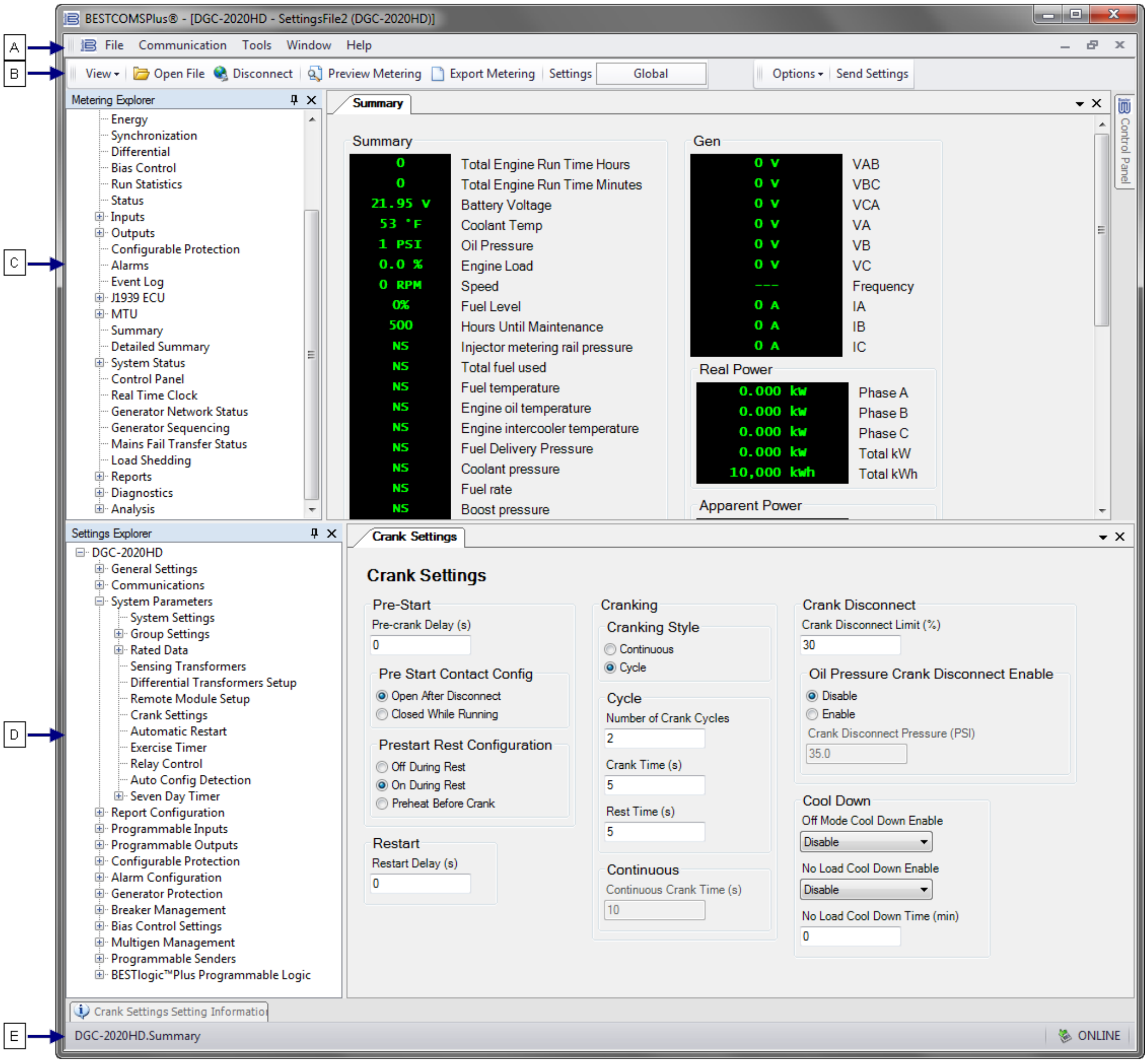


Figure 10. Typical User Interface Components

Table 4. Definitions for Locators in Figure 10.

Locator	Component
A	Upper Menu Bar
B	Lower Menu Bar
C	Metering Explorer
D	Settings Explorer
E	Status Bar

System Recommendations

BESTCOMS*Plus* software is built on the Microsoft® .NET Framework. The setup utility that installs BESTCOMS*Plus* on your PC also installs the DGC-2020HD plugin and the required version of .NET Framework (if not already installed). BESTCOMS*Plus* operates with systems using Windows® XP 32-bit SP3, Windows Vista 32-bit SP1, Windows 7, Windows 8, and Windows 10. Microsoft Internet Explorer 5.01 or later must be installed on your PC before installing BESTCOMS*Plus*. System recommendations for the .NET Framework and BESTCOMS*Plus* are listed in Table 5.

Table 5. System Recommendations for BESTCOMS*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 BESTCOMS*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.

Download BESTCOMS*Plus*

DGC-2020HD controllers are delivered with a CD-ROM that contains BESTCOMS*Plus* software and instruction manuals. If a CD-ROM is not available, use the following procedure to download BESTCOMS*Plus* from the Basler Electric website.

1. Navigate to https://www.basler.com/Downloads.
2. Select DGC-2020HD from the model drop down menu.
3. Under the Software heading, click the download link for BESTCOMS*Plus*.
4. Sign in or create an account to continue with the download.

Install BESTCOMS*Plus* from CD

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

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

Activate the DGC-2020HD Plugin for BESTCOMSPlus®

The DGC-2020HD plugin is a module that runs inside the BESTCOMS*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 BESTCOMS*Plus*. Manual activation is initiated by contacting Basler Electric for an activation key and entering the key into BESTCOMS*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 BESTCOMS*Plus* 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 control power to the DGC-2020HD. Wait until the boot sequence is complete.

Note
In some instances, the Found New Hardware Wizard will prompt you for the USB driver. If this happens, direct the wizard to the following folder: C:\Program Files\Basler Electric\USB Device Drivers\

If the USB driver does not install properly, refer to the *Troubleshooting* chapter.

Start BESTCOMS*Plus*® and Activate DGC-2020HD Plugin Automatically

To start BESTCOMS*Plus*, click the Windows Start button, point to Programs, Basler Electric, and then click the BESTCOMS*Plus* icon. During initial startup, the BESTCOMS*Plus* Select Language screen is displayed (Figure 11). You can choose to have this screen displayed each time BESTCOMS*Plus* is started, or you can select a preferred language and this screen will be bypassed in the future. Click OK to continue. This screen can be accessed later by selecting Tools and Select Language from the menu bar.

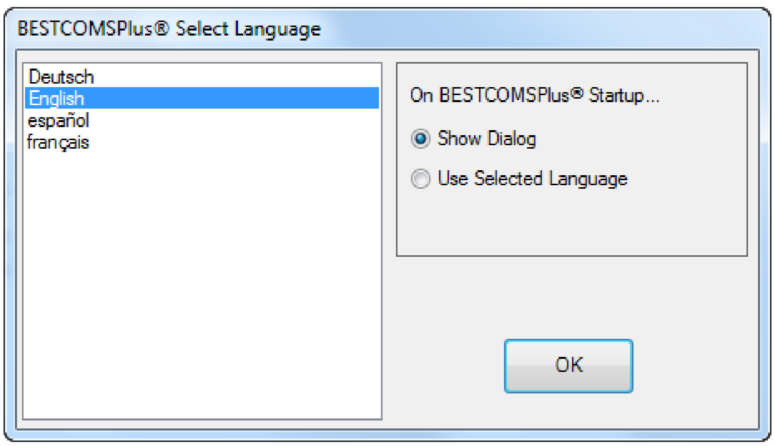


Figure 11. BESTCOMS*Plus* Language Selection Dialog

The BESTCOMS*Plus* platform window opens. Select New Connection from the Communication pull-down menu and select DGC-2020HD. See Figure 12. The DGC-2020HD plugin is activated automatically after connecting to a DGC-2020HD.

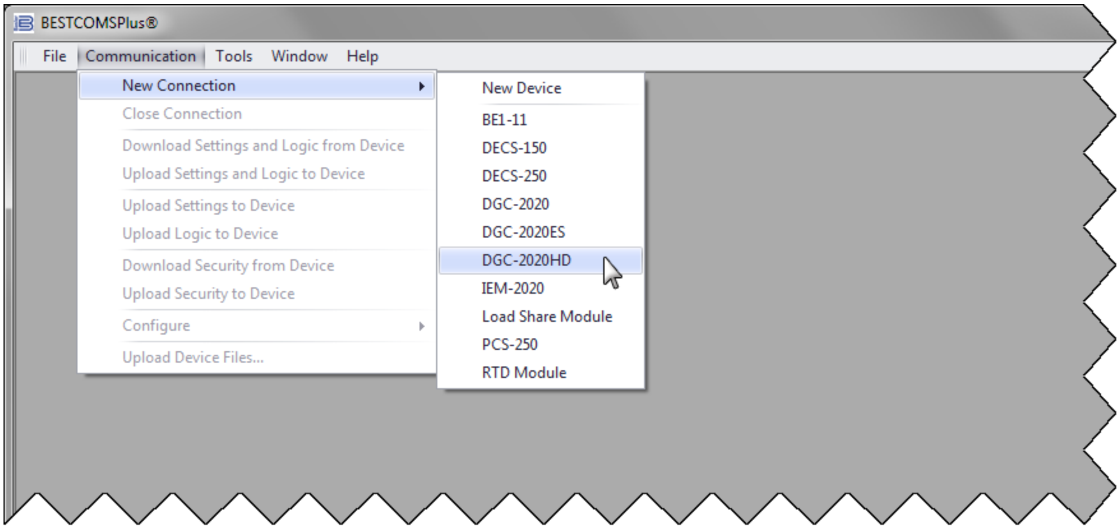


Figure 12. Communication Pull-Down Menu

The DGC-2020HD Connection screen, shown in Figure 13 appears. Select USB Connection and then click the Connect button.

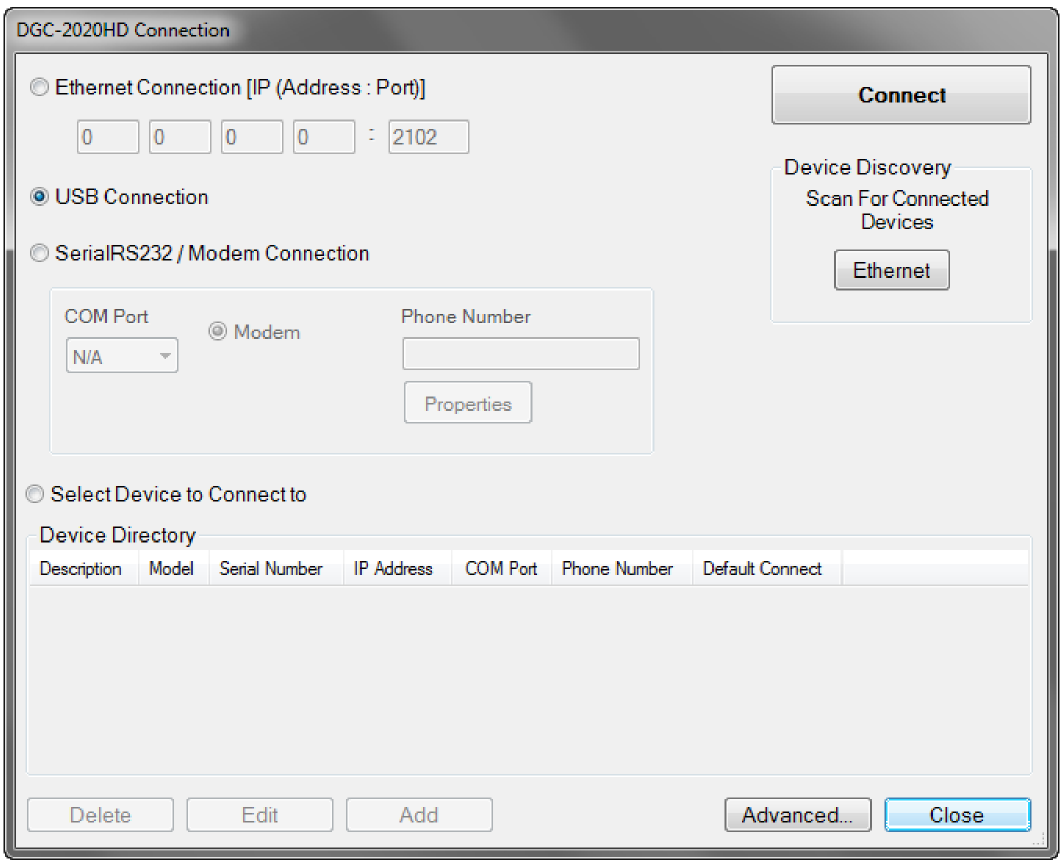


Figure 13. DGC-2020HD Connection Dialog

Manual Activation of the DGC-2020HD Plugin

Manual activation of the DGC-2020HD plugin is required only if your initial use of BESTCOMS*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 14.

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 BESTCOMS*Plus* main screen.

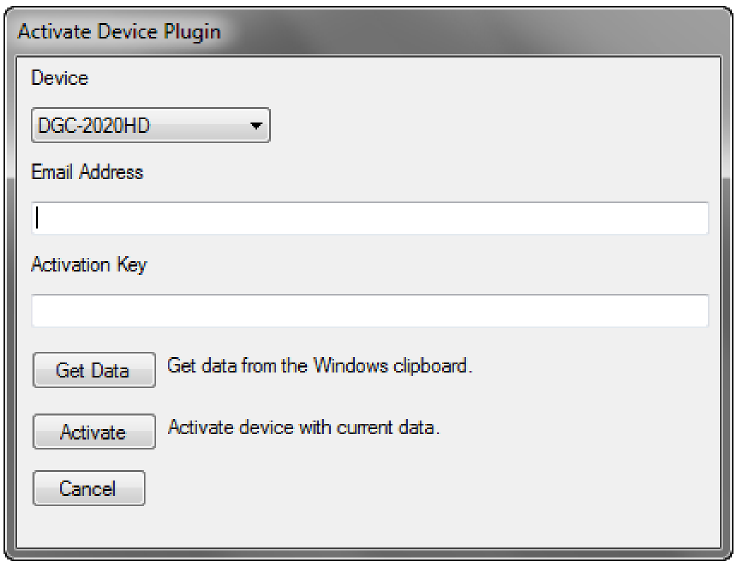


Figure 14. Activate Device Plugin

Establishing Communication

Communication between BESTCOMS*Plus* and the DGC-2020HD is established by clicking on the Connect button on the DGC-2020HD Connection screen (see Figure 13) or by clicking on the Connect button on the lower menu bar of the main BESTCOMS*Plus* screen (Figure 10). 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. BESTCOMS*Plus* will read all settings and logic from the DGC-2020HD and load them into BESTCOMS*Plus* memory. See Figure 15.

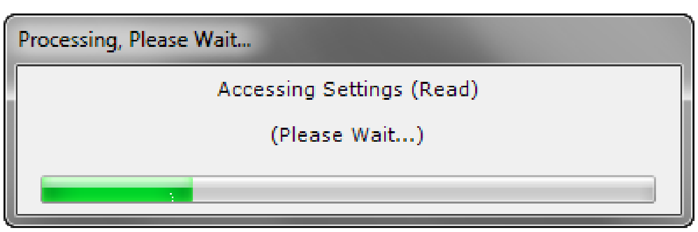


Figure 15. Processing, Please Wait…

Advanced Properties

Click the Advanced button on the Connection screen to display the Advanced Properties dialog. Default settings are shown in Figure 16.

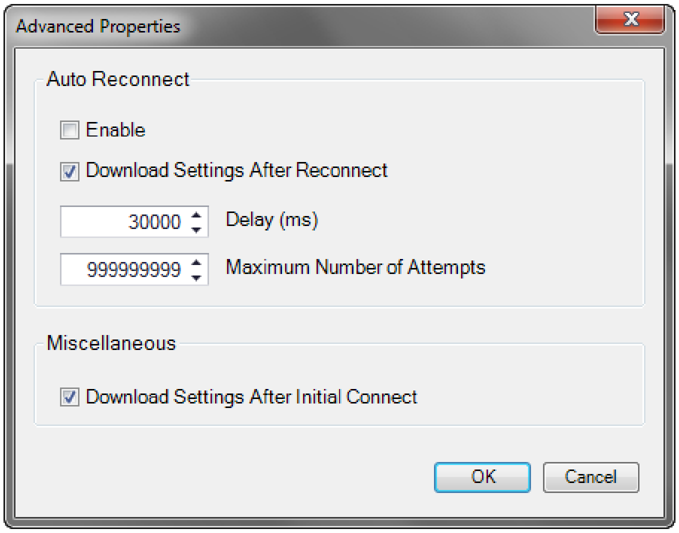


Figure 16. Advanced Properties Dialog

Menu Bars

The menu bars are located near the top of the BESTCOMS*Plus* window (see Figure 10). 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 BESTCOMS*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 (BESTCOMS*Plus*® Shell)

Upper menu bar functions are listed and described in Table 6.

Table 6. Upper Menu Bar (BESTCOMS*Plus* Shell)

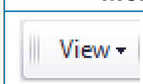
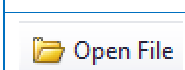
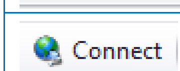
Menu Item	Description
File	
New	Create a new settings file
Open	Open an existing settings file
Open File As Text	Generic file viewer for *.csv, *,txt, etc. files
Close	Close settings file
Save	Save settings file
Save As	Save settings file with a different name
Export To File	Save settings as a *.csv file
Print	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 BESTCOMS*Plus* program
Communication	

Menu Item	Description
New Connection	Choose new device or DGC-2020HD
Close Connection	Close communication between BESTCOMS*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
Tools	
Select Language	Select BESTCOMS*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
Event Log - View	View the BESTCOMS*Plus* event log
Event Log - Clear	Clear the BESTCOMS*Plus* event log
Event Log - Set New File Name	Set a new file name for event log
Window	
Cascade All	Cascade all windows
Tile	Tile horizontally or vertically
Maximize All	Maximize all windows
Help	
Check for Updates	Check for BESTCOMS*Plus* 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 7.

Table 7. Lower Menu Bar (DGC-2020HD Plugin)

Menu Button	Description
	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.
	Opens a saved settings file.
	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.

Menu Button	Description
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*Plus* 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, Protection, breaker management, programmable senders, and BESTlogic*Plus* programmable logic.

Logic setup will be necessary after making certain setting changes. For more information, refer to the BESTlogic*Plus* chapter.

Metering Explorer

The Metering Explorer is a convenient tool within BESTCOMS*Plus* 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 in the *Operation* manual 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 BESTCOMS*Plus*. 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 17 illustrates the BESTspace options found under the View pull-down menu. Figure 18 illustrates the options included in the Load/Save Workspace File screen.

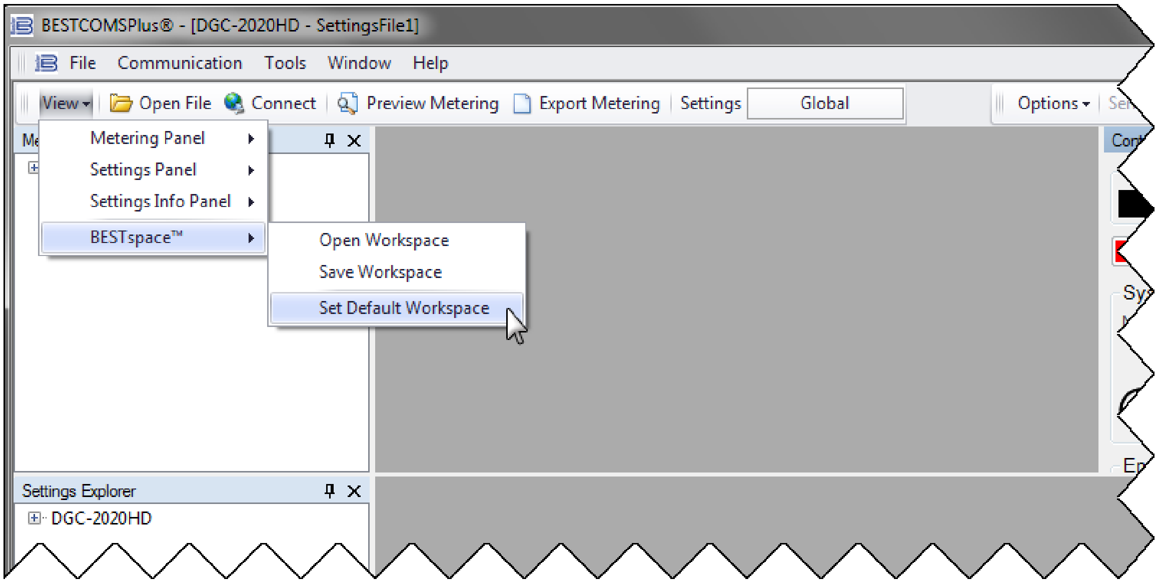


Figure 17. View Menu, BESTspace™ Options

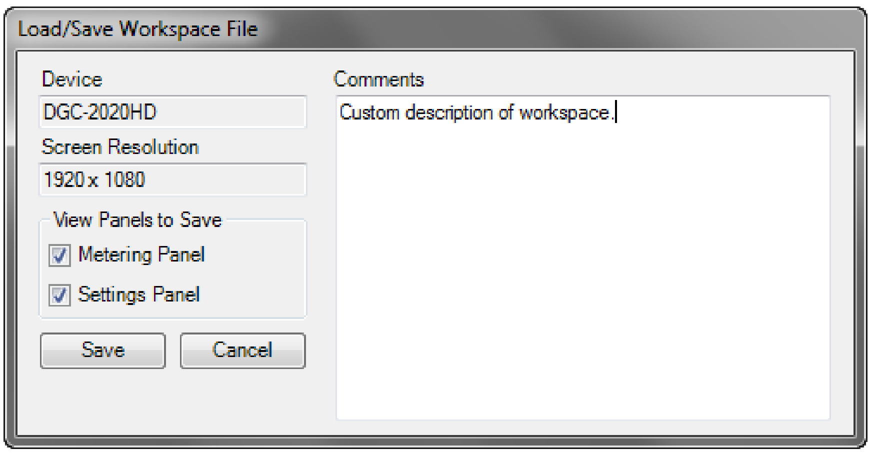


Figure 18. View Menu, BESTspace™, Save Workspace Screen

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 BESTlogic*Plus* 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 BESTCOMS*Plus*, pull down the File menu and choose Open. The Open dialog box appears. This dialog box allows you to use normal Windows techniques to select the file that you want to open. Select the file and 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 BESTCOMS*Plus* 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 BESTCOMS*Plus* or create the file using BESTCOMS*Plus*. 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 BESTCOMS*Plus* have changed, a dialog box will open prompting you to save or discard the current settings changes. After the choice is made, downloading begins. BESTCOMS*Plus* will read all settings and logic from the DGC-2020HD and load them into BESTCOMS*Plus* 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

BESTCOMS*Plus* has the ability to compare two settings files. To compare files, pull down the Tools menu and select Compare Settings Files. The BESTCOMS*Plus* Settings Compare Setup dialog box appears (Figure 19). 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.

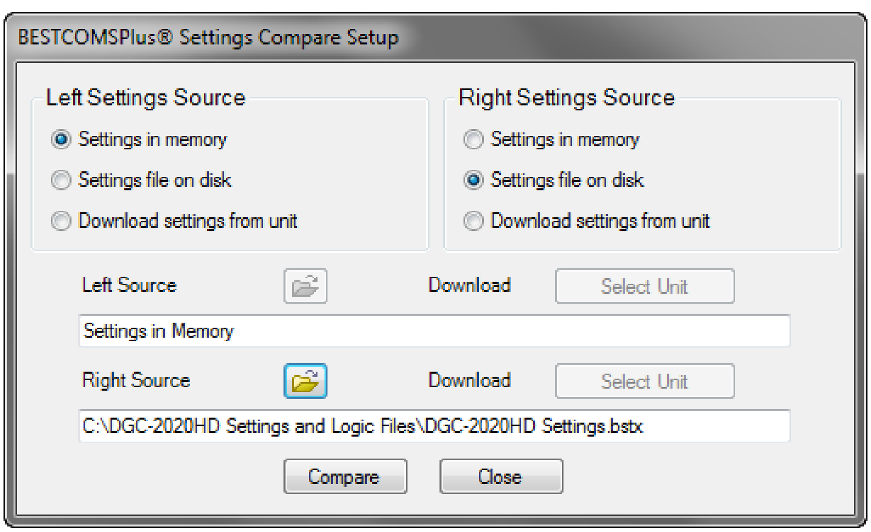


Figure 19. Tools, Compare Settings Files Screen

A dialog box appears, displaying the results of the comparison. The BESTCOMS*Plus* Settings Compare dialog box (Figure 20) 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.

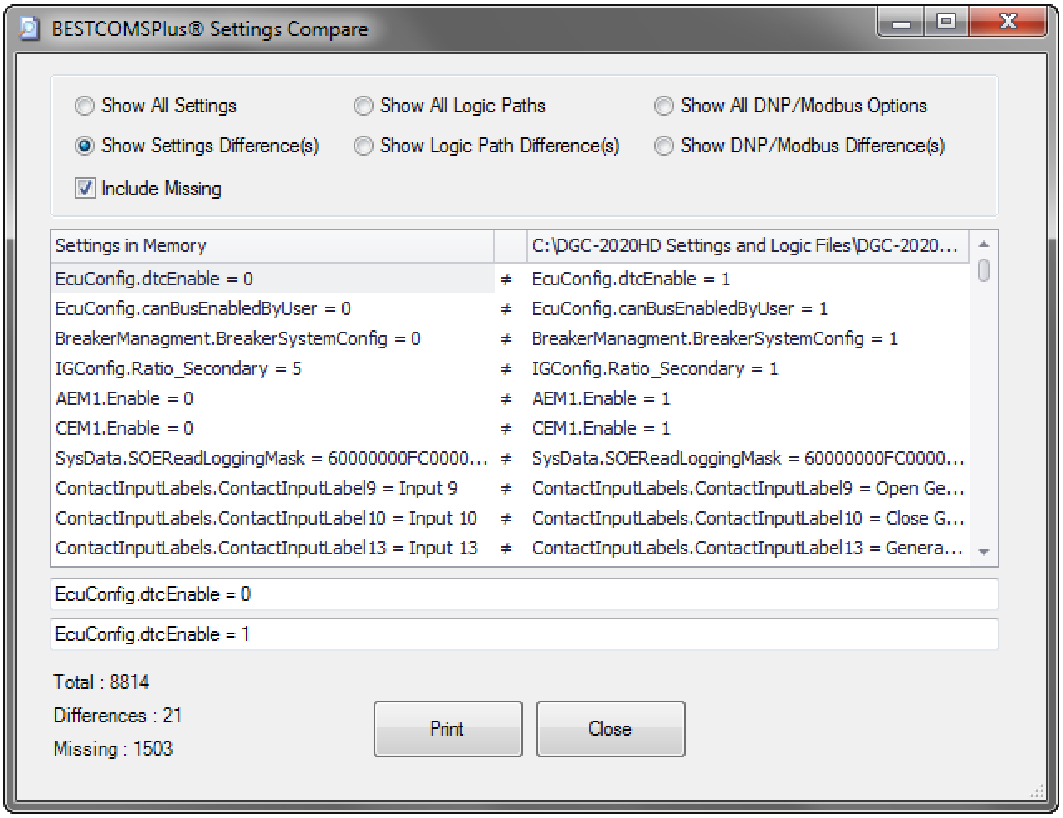


Figure 20. Settings Comparison Results Screen

Copy Settings Group

The Copy Settings Group tool allows the contents of one settings group to be copied into another.

Select the active settings group, which is the one that will be copied, by opening a protection screen in BESTCOMS*Plus*. The settings group selection drop-down menu is at top of screen in lower menu bar. Click Tools > Copy Settings Group and select the group to be the destination of the copied settings.

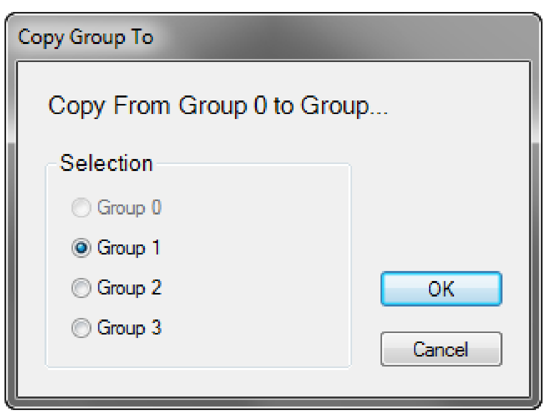


Figure 21. Copy Settings Group

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 22 illustrates the Auto Export Metering screen.

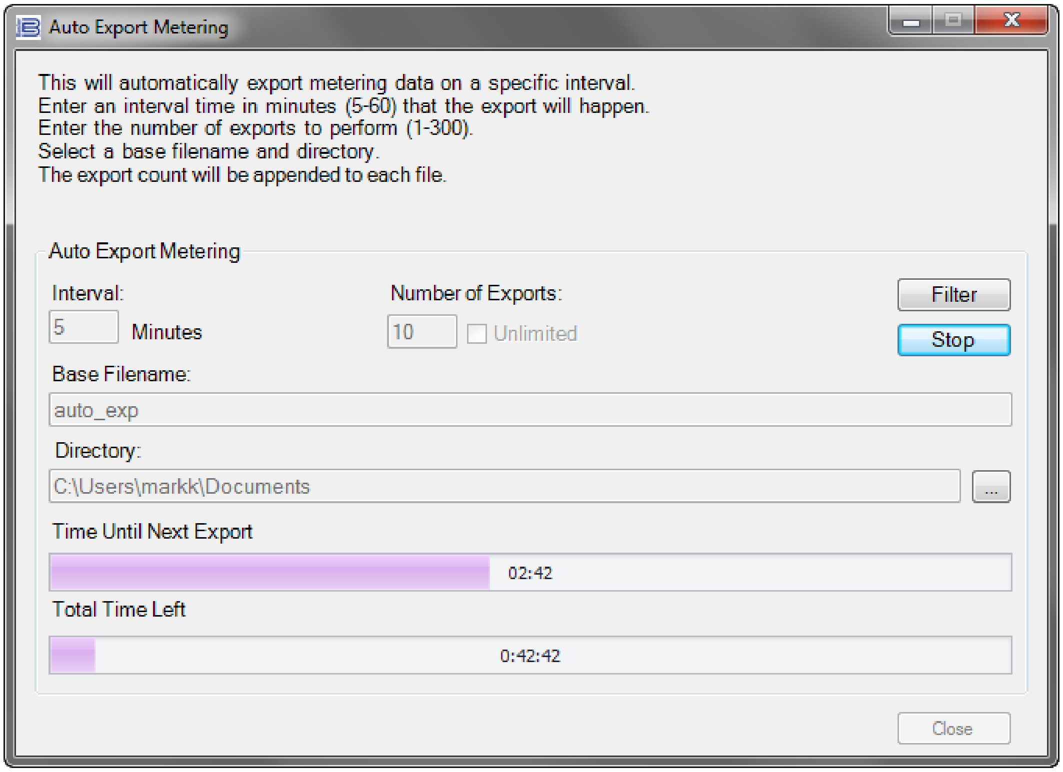


Figure 22. Auto Export Metering

BESTCOMSPlus® 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 BESTCOMS*Plus*. When a DGC-2020HD is updated with the latest version of firmware, the latest version of BESTCOMS*Plus* 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 BESTCOMS*Plus* software.
- You can check for BESTCOMS*Plus* 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 BESTCOMS*Plus* 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.

Communication

DGC-2020HD communication ports include a mini-B USB port, two RJ-45 Ethernet jacks or an ST 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.

Caution
This product contains one or more *nonvolatile memory* devices. Nonvolatile memory is used to store information (such as settings) that needs to be preserved when the product is power-cycled or otherwise restarted. Established nonvolatile memory technologies have a physical limit on the number of times they can be erased and written. In this product, the limit is 100,000 erase/write cycles. During product application, consideration should be given to communications, logic, and other factors that may cause frequent/repeated writes of settings or other information that is retained by the product. Applications that result in such frequent/repeated writes may reduce the useable product life and result in loss of information and/or product inoperability.

USB

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

Ethernet

Depending on style number, each DGC-2020HD is equipped with either dual copper (100Base-T) Ethernet communication ports (style xxxxDxxxx) or a fiber optic (100Base-FX) Ethernet communication port (style xxxxFxxxx). The ST type fiber optic port uses a 1300 nanometer, near-infrared (NIR) light wavelength transmitted via two strands of multimode optical fiber, one for receive (RX) and the other for transmit (TX).

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.

DGC-2020HD controllers can be monitored and controlled via Ethernet using the Modbus® TCP/IP. Up to six TCP/IP Modbus masters are supported. In addition, Modbus TCP/IP and RS-485 can be used simultaneously.

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.

See the *Terminals and Connectors* chapter for a diagram showing the Ethernet port locations.

Ethernet Setup through BESTCOMS*Plus*®

To configure Ethernet through BESTCOMS*Plus*, first establish a connection via USB, Modem, or Ethernet (if already configured). See the BESTCOMS*Plus* 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 23 illustrates the settings provided for dual copper Ethernet ports (style xxxxDxxxx). Figure 24 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.

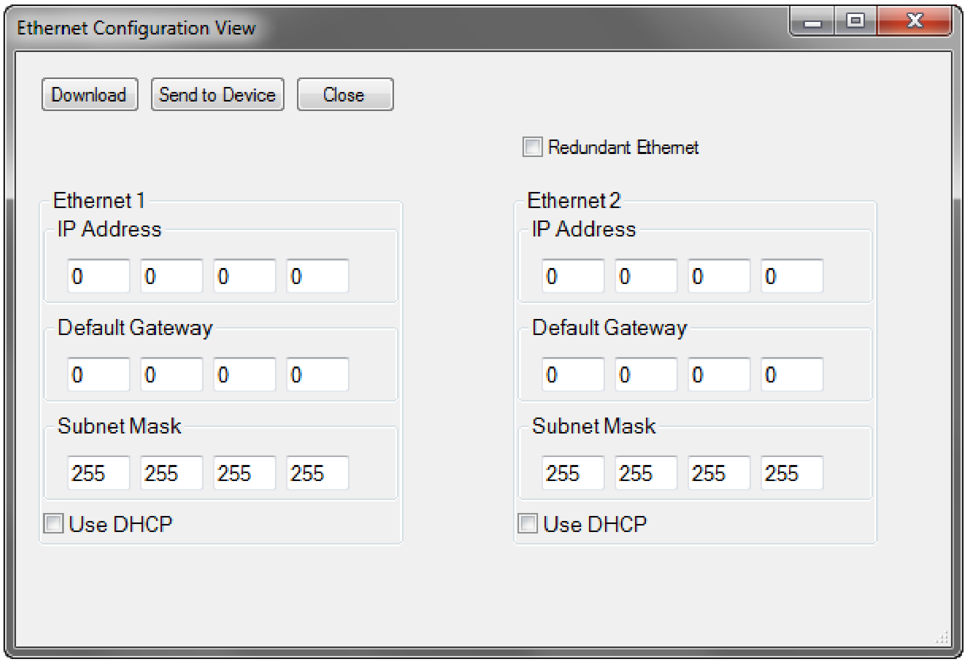


Figure 23. Dual Copper Ethernet Port Configuration

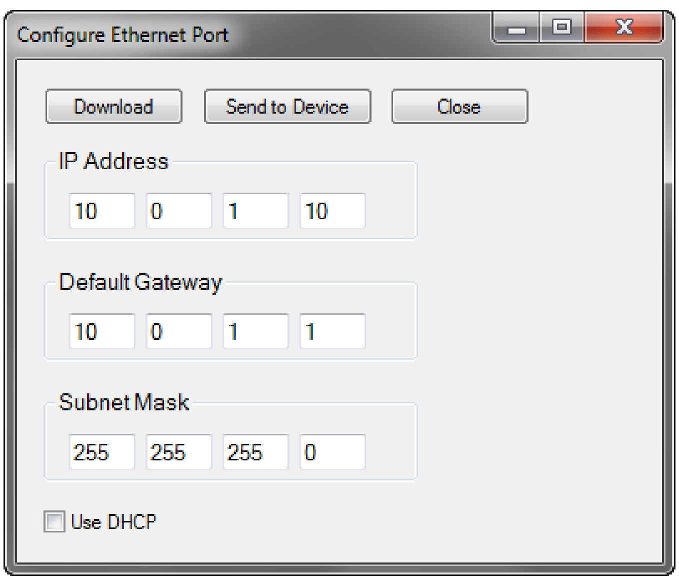


Figure 24. Fiber Optic Ethernet Port Configuration

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. If no DHCP server is available, the DGC-2020HD will automatically obtain a link local IP address in the range of 169.254.0.0 to 169.254.255.255 as described in IETF publication RFC 3927. DHCP and link local addresses are subject to change. It is recommended to use a unique device label other than IP address to identify units on the network when DHCP is enabled.

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 BESTCOMS*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.

Redundant Ethernet Setup

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Communications, Redundant Ethernet Setup
Front Panel Navigation Path: Settings > Communications > Redundant Ethernet

A redundant Ethernet configuration provides an automatic failover in case of a link or switch failure. When a network failure is detected, the redundant Ethernet port becomes active, attempting to maintain a healthy connection to the network.

To utilize a redundant Ethernet configuration, the DGC-2020HD must have dual copper Ethernet ports (style xxxxDxxxx) and the Redundant Ethernet setting must be checked on the Ethernet Port Configuration screen (Figure 23, above).

Settings

Redundant Ethernet settings are described in the following paragraphs. The Redundant Ethernet Setup screen is illustrated in Figure 25 and the settings are listed in Table 8.

Primary Interface settings consist of None, Ethernet 1, and Ethernet 2. If None is selected, the active port remains active until a network failure causes a failover. Selecting Ethernet 1 or Ethernet 2 designates the corresponding port as the primary port. The active port switches back to the primary port as soon as its link becomes healthy.

Redundant Mode settings consist of Link Monitor and ARP Ping. These are different methods for determining a healthy network. The Link Monitor method checks the active port for active link status, which means the active port is physically connected to the external device. ARP Ping mode is available only in DGC-2020HD units with application (firmware) version 1.02.00 or greater. To check your application (firmware) version, refer to the *Device Information* chapter. This method queries the user-defined list of IP hosts at a fixed interval. Upon receiving the proper amount of replies as determined by the Ping Mode setting below, the network is deemed healthy.

Ping Mode (ARP Ping mode only) settings consist of Any and All. With Any selected, only one of the queried IP hosts must reply to confirm a healthy network. With All selected, all of the queried IP hosts must reply to confirm a healthy network.

Ping IP 1 through Ping IP 16 (ARP Ping mode only) specify the IP hosts which are to be queried to confirm healthy network status. IP hosts with an address of "0.0.0.0" are not queried.

ARP Ping Fail Pre-Alarm

In certain network configurations where at least one device is not reachable from either Ethernet link, the ARP Ping Fail pre-alarm is annunciated. For example, another DGC-2020HD on the network is one of the queried IP hosts, but it is removed from the network for maintenance. The querying DGC-2020HD does not receive a reply from the offline DGC-2020HD and determines that both of its Ethernet links have failed, thus disconnecting it from the network completely. However, the DGC-2020HD recognizes this occurrence and automatically switches to Link Monitor mode to prevent disconnection from the network and annunciates the ARP Ping Fail pre-alarm. This pre-alarm can be cleared by pressing the front-panel Reset button, but will return if the fault is still present. Another way to clear the pre-alarm is to set the Redundant Mode to Link Monitor.

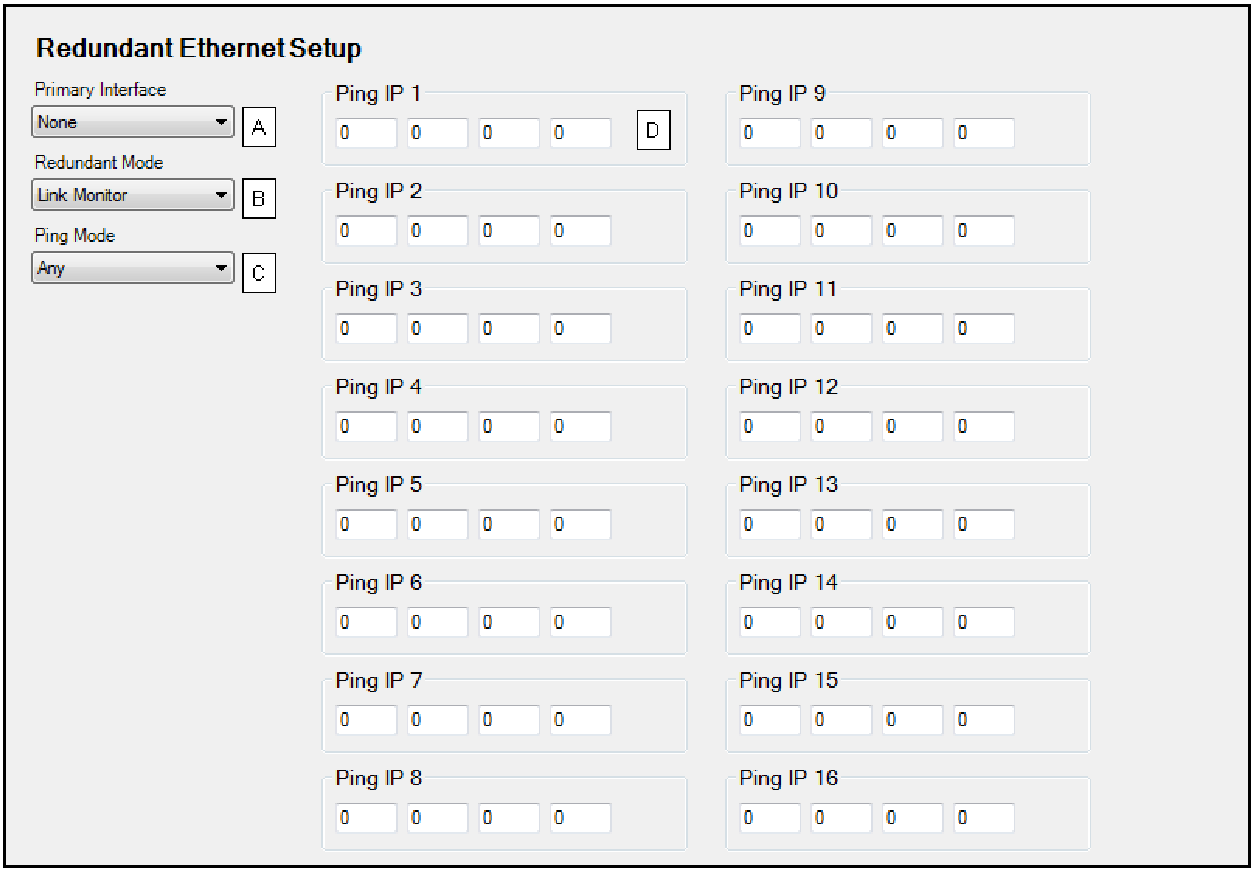


Figure 25. Settings Explorer, Communications, Redundant Ethernet Setup

Table 8. Settings for Redundant Ethernet Setup

Locator	Setting	Range	Increment	Unit
A	Primary Interface	None, Primary, or Secondary	n/a	n/a
B	Redundant Mode	Link Monitor or ARP Ping	n/a	n/a
C	Ping Mode	Any or All	n/a	n/a
D	Ping IP1-16	0 to 255	1	n/a

Establishing Ethernet Communication

Communication between BESTCOMS*Plus* and the DGC-2020HD is established by clicking the Connect button on the DGC-2020HD Connection screen, see Figure 26. 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.

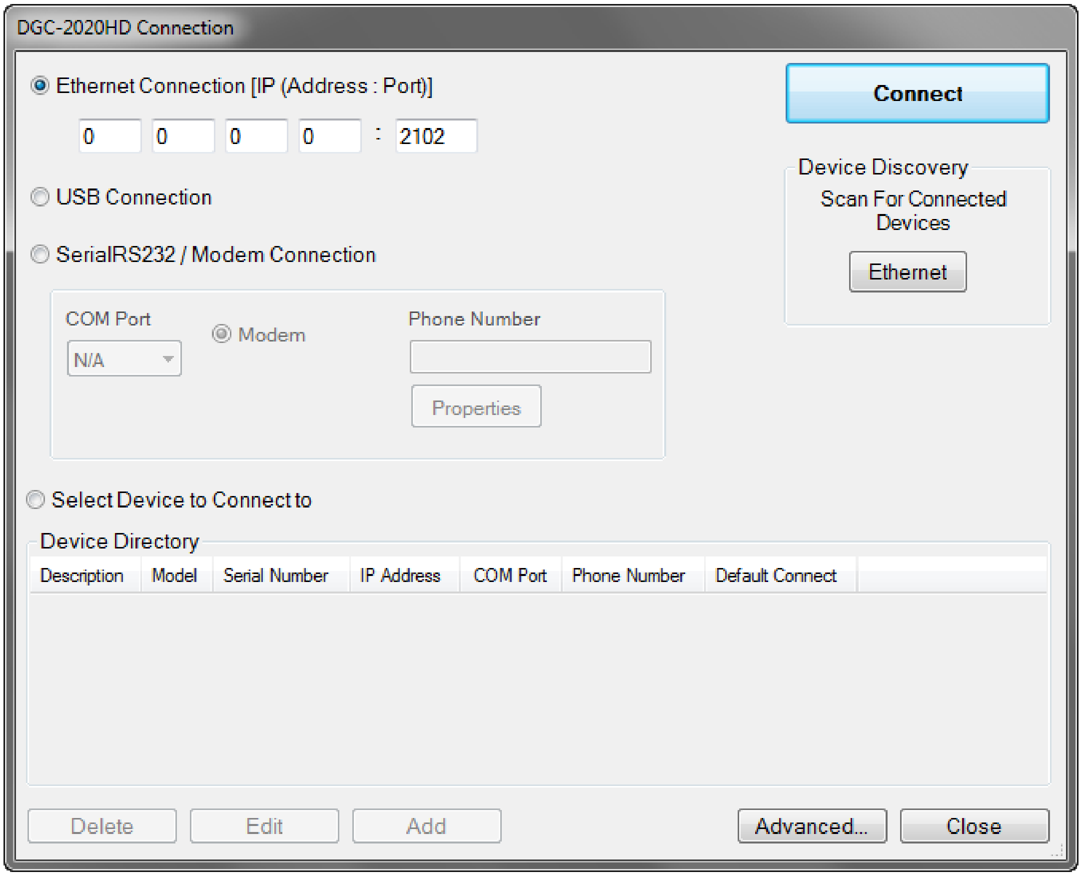


Figure 26. DGC-2020HD Connection Screen

When communication is established, BESTCOMS*Plus* reads all settings and logic from the DGC-2020HD and loads them into BESTCOMS*Plus* memory by default. This feature may be disabled in the Advanced Properties.

Advanced Properties

Click the Advanced… button on the Connections screen to display the Advanced Properties dialog. Default settings are shown in Figure 27.

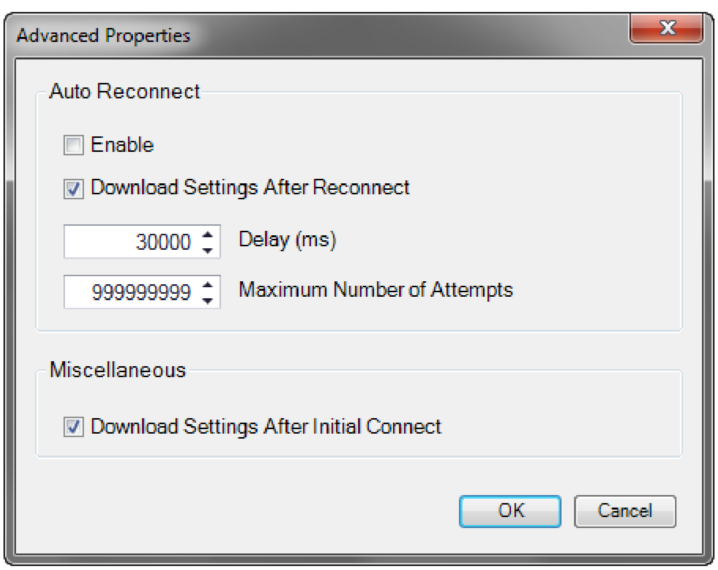


Figure 27. Advanced Properties Dialog

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 one VRM-2020, 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 9 lists the ECU parameters and Table 10 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 9 for transmission rates.

Table 9. 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 10. 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 BESTCOMS*Plus*:

- *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 11 lists the J1939 data transmitted from the DGC-2020HD.

Table 11. 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	898
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

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Communications, CAN Bus, CAN Bus Setup

Front Panel 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 28 illustrates the BESTCOMS*Plus* CAN Bus Setup screen. Settings are listed in Table 14.

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 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. See Table 12.

Table 12. CAN Bus Address per ECU Type

ECU Type	CAN Bus Address
Cummins	220
GM/Doosan	User-selectable
Isuzu	User-selectable
John Deere	User-selectable
MTU ADEC	1
MTU ECU7/ECU8	6
MTU MDEC	6
MTU Smart Connect	234
Scania	39
Standard	User-selectable
Volvo Penta	17

For more information on J1939 address handling, see *J1939 Addresses* below.

Engine ECU Address

Set this parameter to the address claimed by the Engine ECU operating on CAN 2 (ECU). In certain cases, there is more than one ECU transmitting data on the J1939 network. This setting specifies the

ECU on the network to which the DGC should transmit data. For more information on J1939 address handling, see *J1939 Addresses* below. When GM/Doosan is selected as the ECU type, the value of this setting is ignored and the Engine ECU Address value is always 0.

Generator Parameter Transmit

When the Generator Parameter Transmit setting is enabled, the DGC-2020HD broadcasts generator metered parameters over CAN as listed in Table 13. The Generator Parameter Transmit setting is not used when ECU Type is set for MTU MDEC, MTU ECU7/ECU8, or MTU Smart Connect.

Table 13. 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
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
	65263	100	Engine Oil Pressure (Not sent when CAN is enabled)	kPa * 4	n/a	4

PGN Name	PGN (Hex)	SPN	Parameter	Units	Scaling / Offset	Bytes Within PGN Data
Engine Fluid Level / Pressure	(FEEF)	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.

Coolant Temperature Source

With From ECU selected, the DGC-2020HD accepts coolant temperature data from the ECU on CAN 2 (ECU). With From DGC Input selected, the DGC-2020HD accepts coolant temperature data from the coolant temperature engine sender input.

Oil Pressure Source

With From ECU selected, the DGC-2020HD accepts oil pressure data from the ECU on CAN 2 (ECU). With From DGC Input selected, the DGC-2020HD accepts oil pressure data from the oil pressure engine sender input.

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.

If the PRE contact is selected, the RUN output still closes during cranking and genset operation to provide separate indication that the genset is cranking or running.

ECU Contact Control - Pulsing Enable

In applications where the ECU is not continuously powered, the DGC-2020HD can apply power to the ECU and pulse the ECU to update its engine monitoring data. For applications where pulsing of the ECU is not desired, the pulsing feature can be disabled.

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.

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.

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. The AEM-2020, CEM-2020, and VRM-2020 detect the baud rate used by the DGC-2020HD on CAN1 and are automatically configured to match that baud rate.

When the baud rate is set to 125 kbps and a VRM-2020 is enabled, a maximum of two AEM-2020s and four CEM-2020s can also be enabled on CAN1. At 125 kbps with no VRM-2020, a maximum of four AEM-2020s and four CEM-2020s can be enabled on CAN1. At 250 kbps, a maximum of one VRM-2020, four AEM-2020s, and four CEM-2020s can be enabled on CAN1.

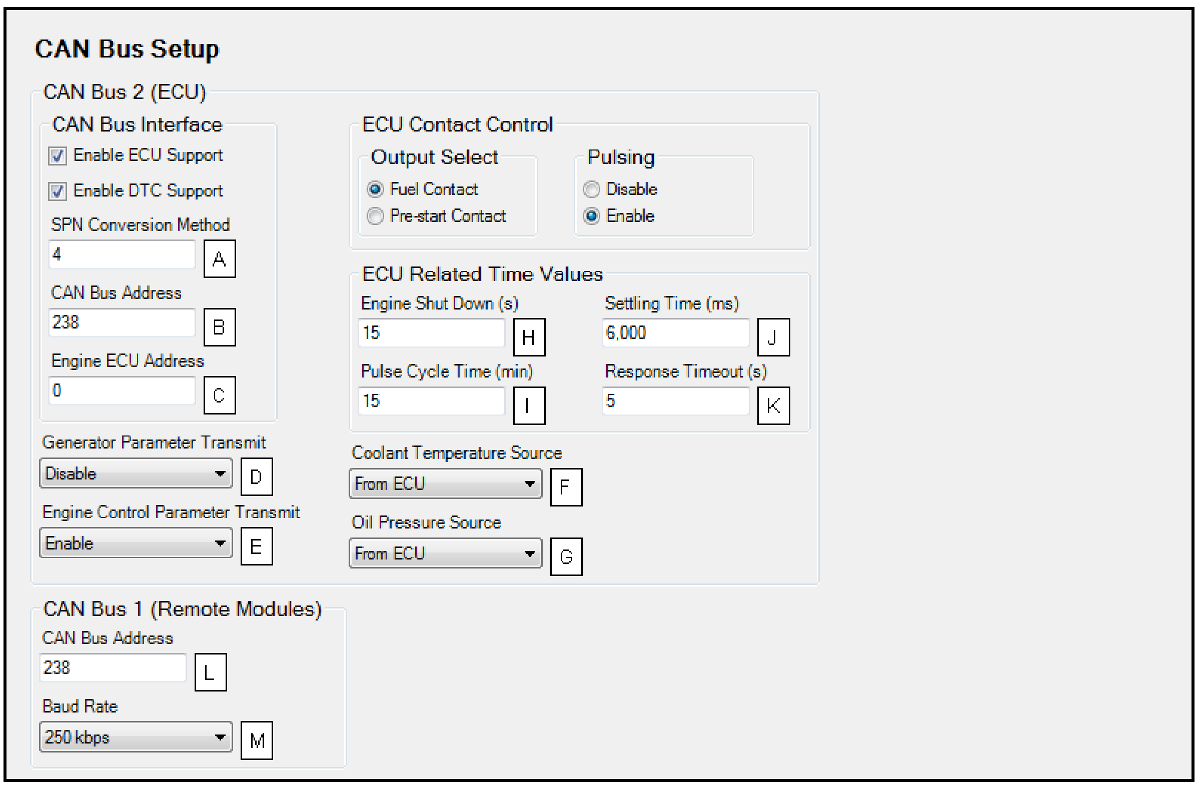


Figure 28. Settings Explorer, Communications, CAN Bus, CAN Bus Setup

Table 14. 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	Engine ECU Address	0 to 254	1	n/a
D	Generator Parameter Transmit	Enable or Disable	n/a	n/a
E	Engine Control Parameter Transmit	Enable or Disable	n/a	n/a
F	Coolant Temperature Source	From ECU, From DGC Input	n/a	n/a
G	Oil Pressure Source	From ECU, From DGC Input	n/a	n/a
H	Engine Shutdown	1 to 60	1	seconds
I	Pulse Cycle Time	1 to 60	1	minutes
J	Settling Time	5,500 to 30,000	1	milliseconds
K	Response Timeout	1 to 60	1	seconds
L	CAN Bus 1 Address	1 to 253	1	n/a
M	Baud Rate	125 kbps or 250 kbps	n/a	n/a

J1939 Addresses

Each device on a J1939 network must have a unique address. On power-up, each device issues an address claim request over the network. If there is no competing claim from another device, the claimed address becomes the address the unit uses for all J1939 communications. If there are competing requests, an arbitration process occurs. When complete, all devices that broadcast on the network will have a unique address. Once an address has been successfully claimed, all broadcast communications from the device use that address as the source address for all its broadcast communications. In addition, the device monitors all communications on the network and responds to address specific communications directed only to its address; communications to other addresses are ignored.

The address is also important for J1939 request communications. Certain J1939 parameters are broadcast by an engine ECU only when requested. Fuel Rate, Engine Run Time Hours, and Previously Active Diagnostic Trouble Codes are examples of request-only parameters. Thus, a device must request these from the ECU and the requests are address specific. System operating characteristics may also be requested via J1939 communications. Engine RPM is such an example; it is requested through the Torque/Speed Request 1 (TSC1) J1939 PGN.

Some engine ECUs respond to requests from a certain J1939 address, typically that of the system controller. This may be programmed into the ECU as a parameter using an ECU specific service tool, a fixed set of addresses, or one particular address depending on the manufacturer and model of the ECU.

Address 0 is specified by the J1939 committee as the default address for an engine ECU. Address 234 is specified by the J1939 committee as the default address for a genset controller. In a system where RPM control over CAN Bus is taking place, the genset controller (typically at address 234) sends RPM requests in the form of the Torque/Speed Request 1 (TSC1) J1939 PGN to the engine ECU (typically at address 0). If the requests are received from the wrong controller address, or sent to the wrong ECU address, RPM control over CAN Bus may not be achievable.

The DGC-2020HD determines the ECU address to be the source address of all engine operating RPM communications. All requests from the DGC-2020HD to the ECU will use this as the ECU address. However, some engines have multiple ECUs, each sending engine RPM to the DGC-2020HD. Therefore, the DGC-2020HD cannot determine which ECU to use as the destination address for RPM and data requests from the ECU. The source address of the update of engine RPM that is received first by the DGC-2020HD is the address the DGC-2020HD determines to be the ECU address.

The Engine ECU Address setting addresses this situation. If an RPM update is received from an address equal to the Engine ECU Address setting, that address is used as the ECU source address for all subsequent communications intended to be sent to the engine ECU.

If J1939 RPM control does not function as intended, verify that the Engine ECU Address setting is correct and consult the ECU Manufacturers document to determine if the ECU will respond only to communications from a specific J1939 address. If the ECU will respond only to communications from a specific address, the CAN Bus Address setting for the DGC-2020HD must be set to that address. The CAN Bus Address under the CAN Bus 2 (ECU) settings is the Address the DGC-2020HD claims on the J1939 network. The Engine ECU Address setting under the CAN Bus 2 (ECU) settings should be set to the address the engine ECU claims on the J1939 network.

ECU Setup

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Communications, CAN Bus, ECU Setup
Front Panel 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 29.

ECU Type

The DGC-2020HD can be configured for Standard, Volvo Penta, MTU MDEC, MTU ADEC, MTU ECU7/ECU8, GM/Doosan, Cummins, MTU Smart Connect, Scania, John Deere, or Isuzu.

Scania Engine ECU Communications

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

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, MTU Smart Connect, Scania, John Deere, or Isuzu. 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.

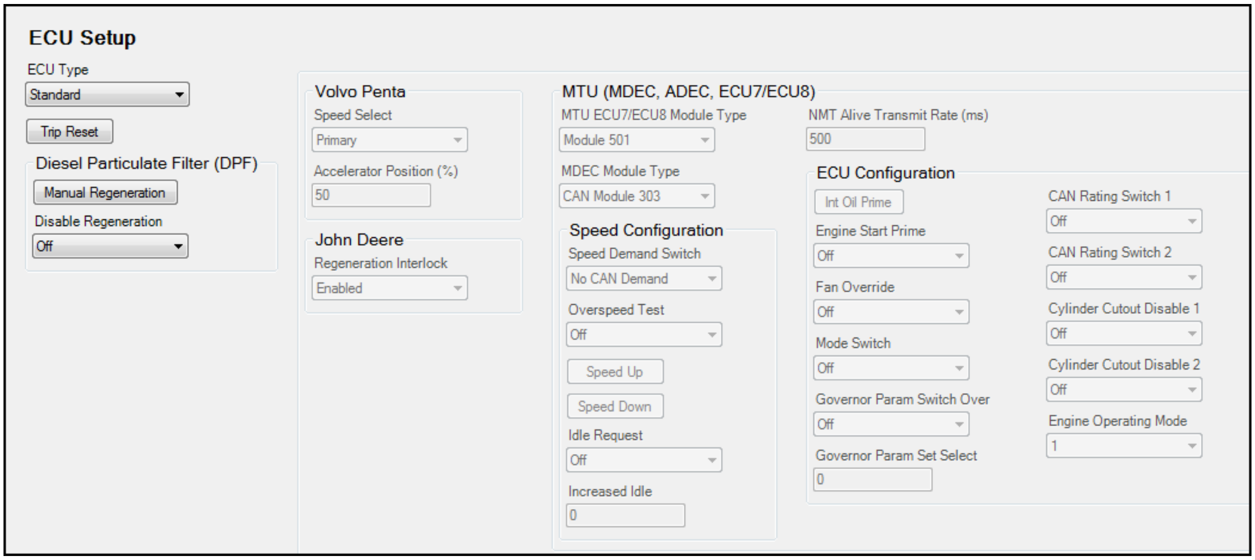


Figure 29. Settings Explorer, Communications, CAN Bus, ECU Setup

Speed Setup

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Communications, CAN Bus Setup, Speed Setup

Front Panel 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.

A Remember Speed Adjustments setting is provided to establish how RPM adjustments by raise/lower commands are saved. When Yes is selected, adjustments to RPM by raise/lower commands are saved to memory and used for all subsequent run sessions. This is true even when power is cycled to the DGC-2020HD. When No is selected, adjustments to RPM by raise/lower commands are retained for the duration of only the current run session. The adjustments are discarded the next time the engine is run or the DGC-2020HD is power cycled.

Figure 30 illustrates the BESTCOMS*Plus* Speed Setup screen. Settings are listed in Table 15.

Figure 30. Settings Explorer, Communications, CAN Bus, Speed Setup

Table 15. 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	Remember Speed Adjustments	Yes or No	n/a	n/a
D	Idle RPM	100 to 2,000	1	RPM
E	RPM Bandwidth	0 to 1,000	1	n/a

Voltage Regulator Setup

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Communications, CAN Bus Setup, Voltage Regulator Setup

Front Panel 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 31 illustrates the BESTCOMS*Plus* Voltage Regulator Setup screen. Settings are listed in Table 16.

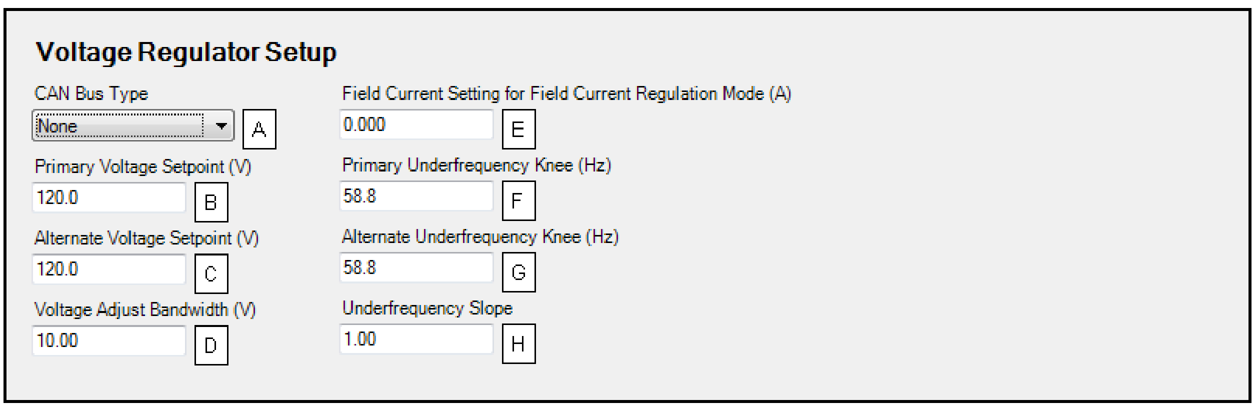


Figure 31. Settings Explorer, Communications, CAN Bus, Voltage Regulator Setup

Table 16. 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

Locator	Setting	Range	Increment	Unit
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

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Communications, RS232 Setup
Front Panel 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.

A Flow Control setting enables hardware (RTS/CTS) flow control. One device is often capable of sending data much faster than the other can receive. Flow Control allows the slower device to signal the faster device to pause and resume data transmission. The modem, connected to the PC, must also be configured to use flow control. This is configured using the Modem Initialization String setting on the New Connection screen in BESTCOMS*Plus*. The command to enable flow control to the modem is specific to the modem manufacturer. Refer to Figure 32.

Figure 32. Settings Explorer, Communications, RS232 Setup

External Modem

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Communications, Modem Setup
Front Panel Navigation Path: Settings > Communication > Modem Setup

A connection with an external, user-supplied modem provides communications between the DGC-2020HD and a PC via BESTCOMS*Plus.* Modem connection to a PC running BESTCOMS*Plus* 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 33. Settings are listed in Table 17.

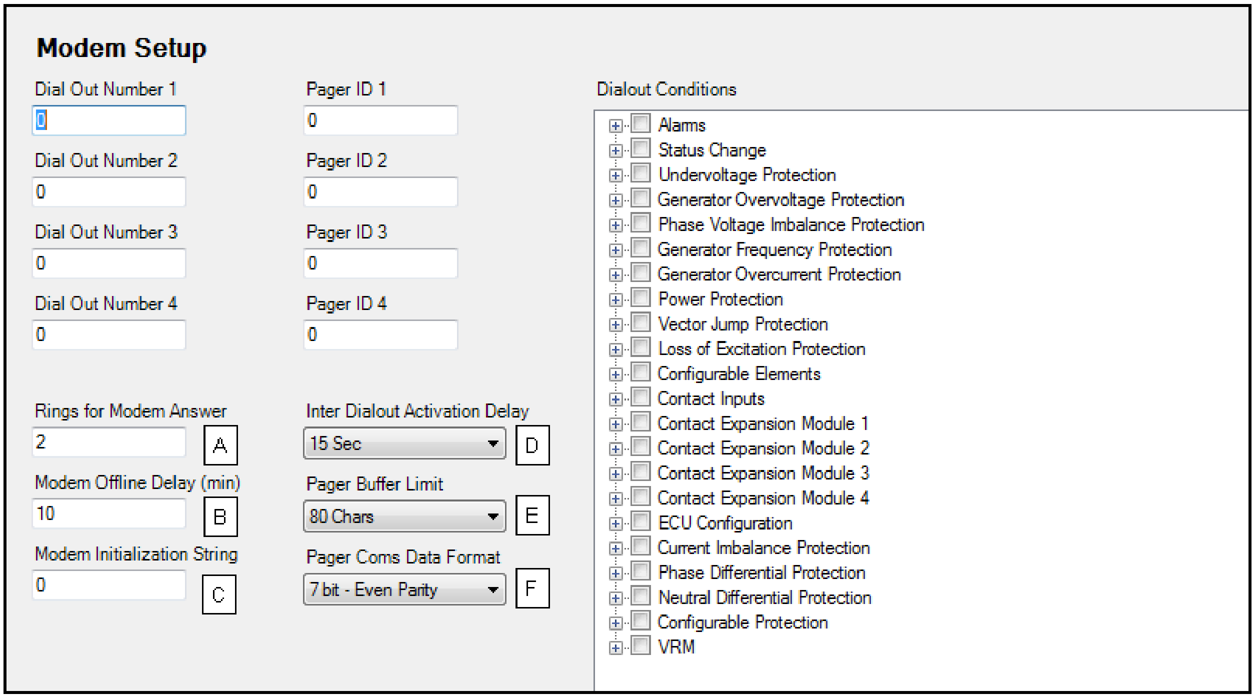


Figure 33. Settings Explorer, Communications, Modem Setup

Table 17. 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 BESTCOMS*Plus* via USB (local) or Ethernet (remote) connection. If using the front panel, navigate to Settings > Communication > RS-232 Setup. If using BESTCOMS*Plus*, navigate to Settings Explorer, Communications, RS-232 Setup (Figure 32). Set the baud rate to the desired value and send the settings, if using BESTCOMS*Plus*.

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 34 illustrates the Advanced Serial Port Properties dialog box.

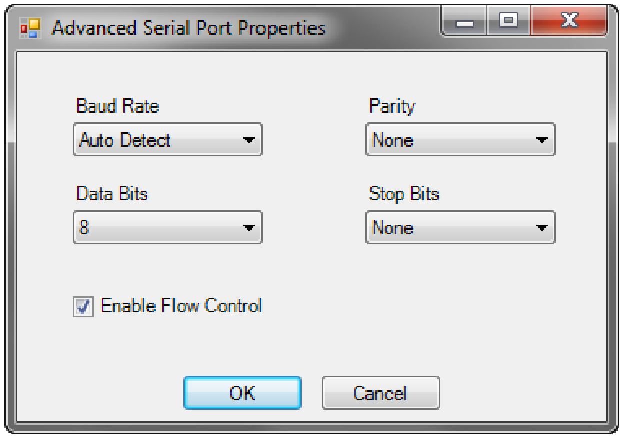


Figure 34. Advanced Serial Port Properties

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 BESTCOMS*Plus* Analysis metering screen is disabled.

RS-485

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Communications, RS485 Setup
Front Panel 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 35.

Figure 35. Settings Explorer, Communications, RS485 Setup

Modbus® Setup

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Communications, Modbus Setup
Front Panel Navigation Path: Settings > Communication > Modbus Setup

The DGC-2020HD employs the Modbus communication protocol over the Ethernet and RS-485 ports simultaneously. Up to six TCP/IP Modbus masters are supported. A list of Modbus registers can be found in Basler Electric publication 9469300998, *Modbus Protocol Instruction Manual.*

The Modbus Setup screen is illustrated in Figure 36. Settings are listed in Table 18.

Figure 36. Settings Explorer, Communications, Modbus Setup

Table 18. Settings for Modbus Setup

Locator	Setting	Range	Increment	Unit
Ethernet				
A	Unit ID	1 to 247	1	n/a
RS485				
B	Unit ID	1 to 247	1	n/a
C	Response Delay	10 to 10,000	10	milliseconds
Modbus				
D	Mapping	Default or Legacy	n/a	n/a

Email Setup

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Communications, Email Setup
Front Panel Navigation Path: Settings > Communication > Email Setup

The DGC-2020HD is capable of sending email alerts when triggered by user-selected events. Setup of email notifications is made on the BESTCOMS*Plus* Email Setup screen (Settings Explorer, Communications, Email Setup) illustrated in Figure 37. A notification is configured by entering the SMTP email server address and the email addresses of the intended recipients. Multiple email addresses can be entered in the “To” and “CC” fields. Email addresses must be separated by commas. The maximum number of email addresses per field is limited to a total of 650 characters, including commas. The Mail From Domain setting specifies what is displayed in the From field when an email alert is received. The “Subject” field accepts up to 64 characters.

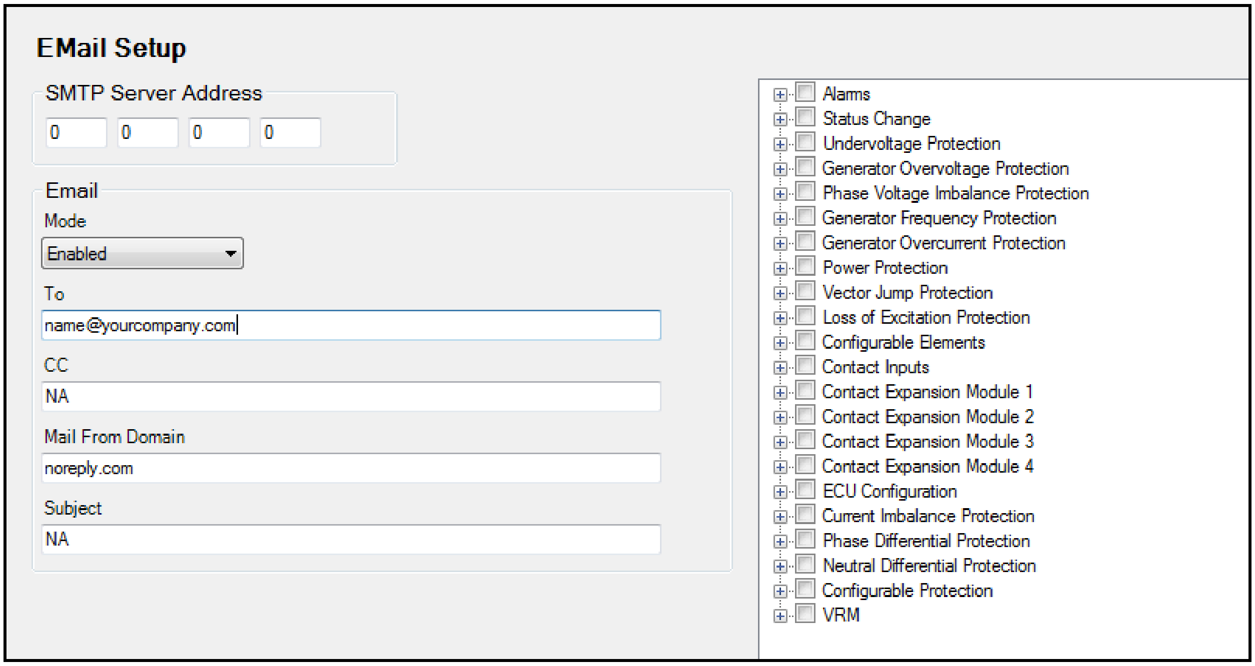


Figure 37. Settings Explorer, Communications, Email Setup

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 BESTlogic*Plus* 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 in the *Installation* manual 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.

Device 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, differential transformer settings, relay control settings, and system configuration detection settings.

System Settings

BESTCOMS*Plus* 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 38 illustrates the BESTCOMS*Plus* 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 BESTCOMS*Plus*.

Note

If using an analog input or resistive sender input for fuel level, coolant temperature, or oil pressure source, the sender characteristic curves must be configured using the instructions in the Engine Sender Inputs chapter. If the curves are not configured properly, the parameters will not display correctly on the front panel or in BESTCOMS*Plus*.

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 Cooldown 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 BESTCOMS*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.

A Swap Bus 1 with Bus 2 check box is provided to allow the metering of the bus VTs to be swapped internal to the DGC-2020HD, eliminating the need for physical swapping of the VT connections.

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 BESTCOMS*Plus* to aid in ease of configuration and programming.

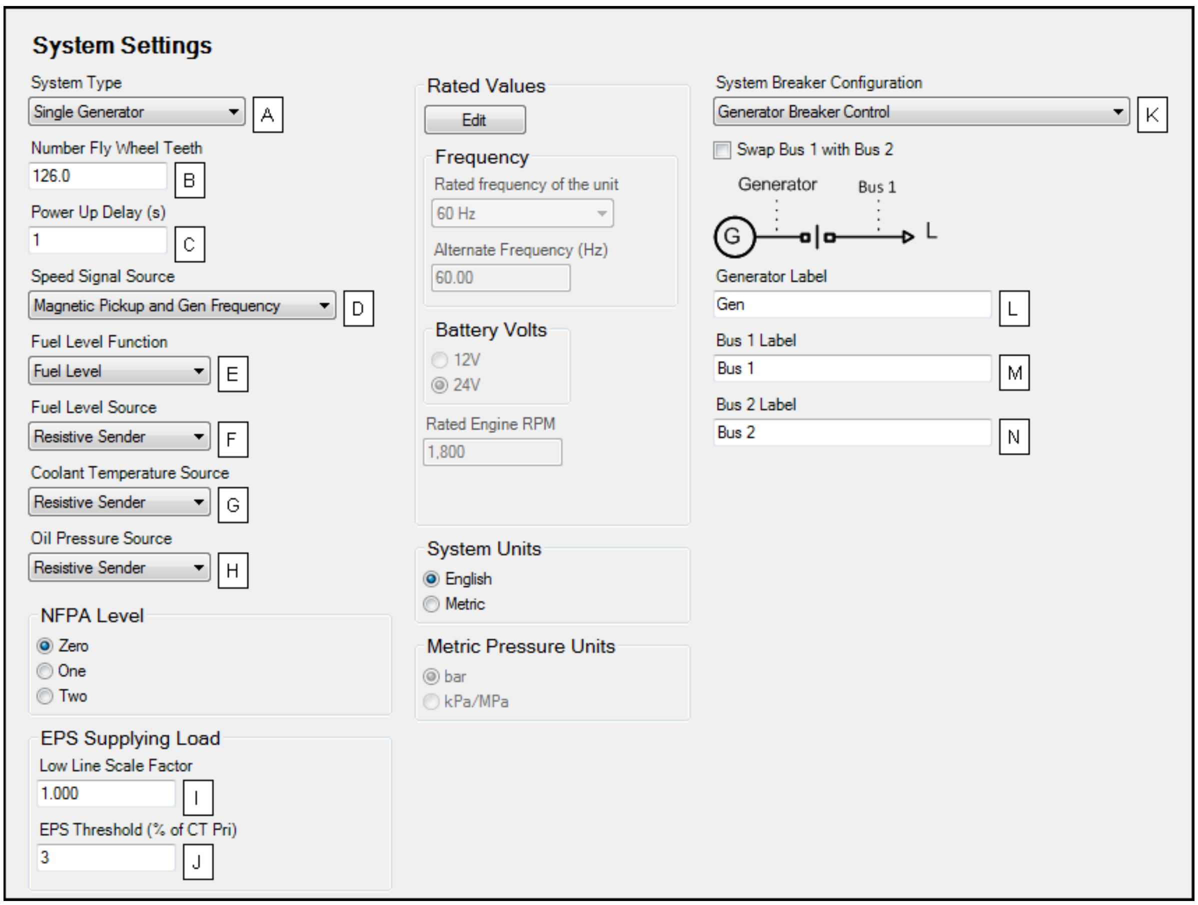


Figure 38. Settings Explorer, System Parameters, System Settings

Table 19. Settings for System Settings

Locator	Setting	Range	Increment	Unit
A	System Type	Single Generator, Multiple Generator, or Segmented Bus System	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
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, or 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, Generator and Mains Breaker Control with Load Bus, Generator and Group Breaker, Generator and Group Breaker with Load Bus, Generator, Group, and Mains Breaker, Generator Breaker to Segmented System, Generator and Group Breaker to Segmented System Tie Breaker Control, Generator and Tie Breaker Control, or Tie Breaker and Tie Breaker Control	n/a	n/a
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

BESTCOMS*Plus* 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 39), Bus 1(Figure 40), and optional Bus 2 (identical to Figure 40). 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 41 illustrates the floating Rated Data screen. Settings are listed in Table 20.

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 1xxxxxxxx uses a nominal CT secondary rating of 1 Aac. A DGC-2020HD with a style number of 5xxxxxxxx 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 1xxxxxxxx uses a nominal CT secondary rating of 1 Aac. A DGC-2020HD with a style number of 5xxxxxxxx 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 Volts Low-Line Scale Factor: Rated Volts Low-line Scale Factor is used to automatically adjust the Rated Volts 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 which drives the Low Line Override programmable function or the Low Line Override logic element in BESTlogic™*Plus*. When Low Line Override is active the DGC-2020HD activates scaling of the settings. The Scale Factor setting serves as a multiplier for the Rated Volts setting.

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 1. 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 2. Rated Phase Amps for Three-Phase Connections

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

Equation 3. 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 4. 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 5. Rated kVA

Rated kvar is calculated using the following equation:

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

Equation 6. 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 750 to 3,600, in increments of 1.

Ground Current Primary Amps

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 9,999, in increments of 1. The secondary value of the ground current sensing CT is determined by the style number of the controller. A DGC-2020HD with a style number of 1xxxxxxxx uses a nominal CT secondary rating of 1 Aac. A DGC-2020HD with a style number of 5xxxxxxxx uses a nominal CT secondary rating of 5 Aac.

Figure 39. Settings Explorer, System Parameters, Rated Data, Generator Rated Data Screen (Read Only)

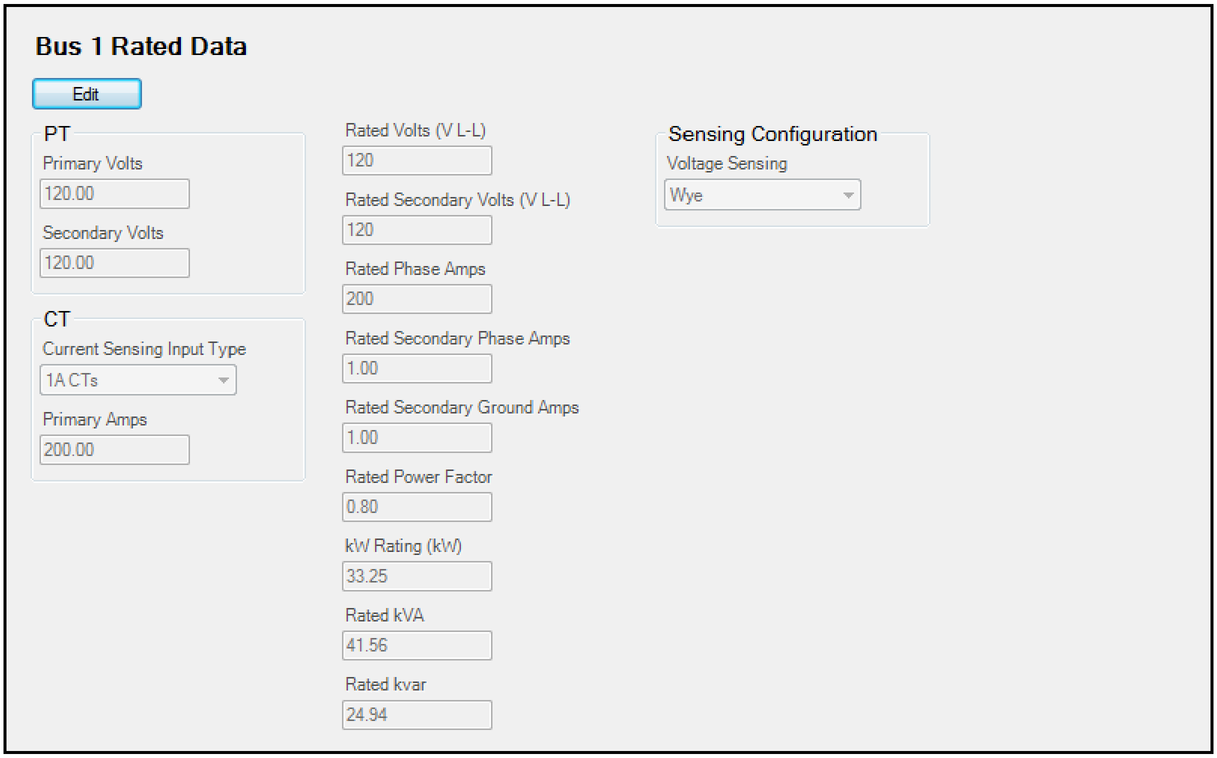


Figure 40. Settings Explorer, System Parameters, Rated Data, Bus Rated Data Screen (Read Only)

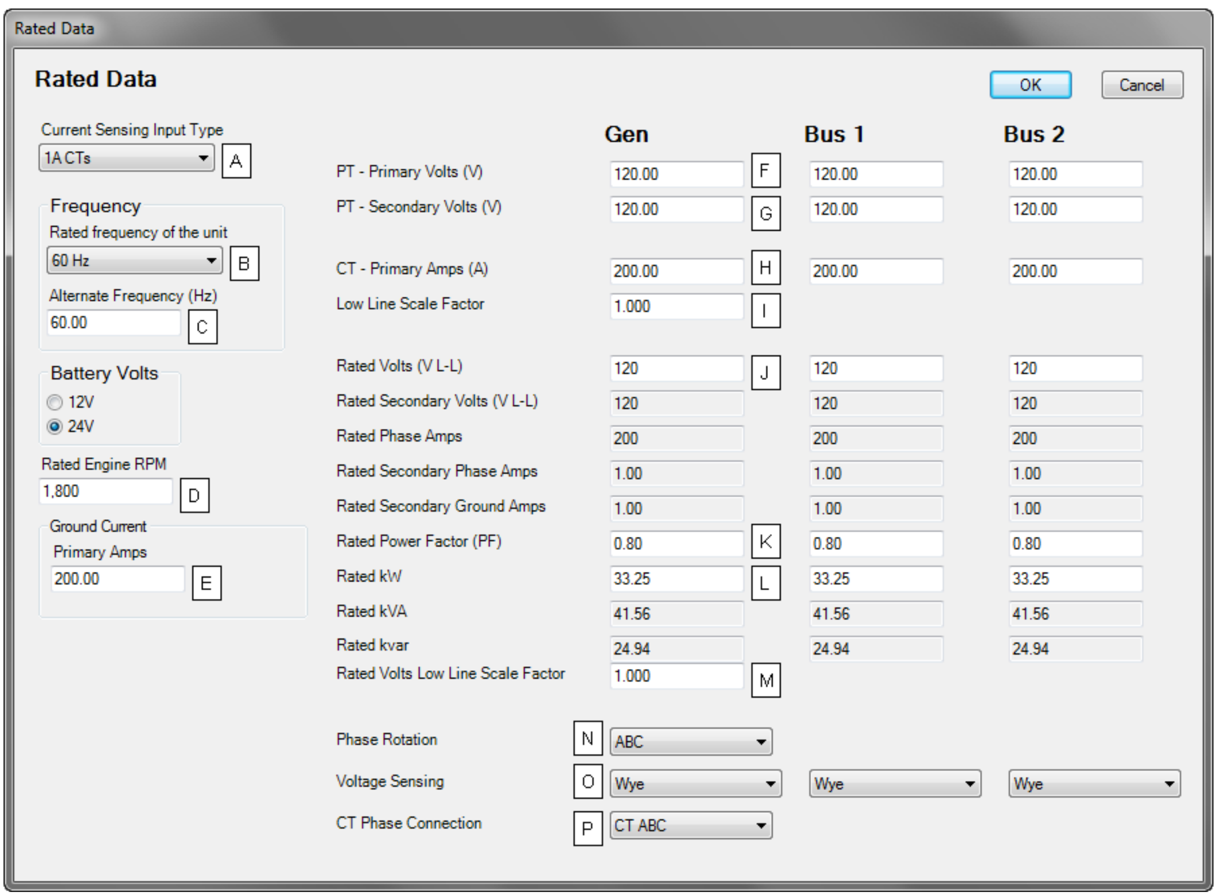


Figure 41. Floating Rated Data Screen

Table 20. 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	Ground Current – Primary Amps	1 to 9,999	1	amperes
F	PT – Primary Volts	1 to 500,000	1	volts
G	PT – Secondary Volts	1 to 600	1	volts
H	CT – Primary Amps	1 to 99,999	1	amperes
I	Low Line Scale Factor	0.001 to 3	0.001	n/a
J	Rated Volts	1 to 500,000	1	volts
K	Rated Power Factor	–1 to 1	0.01	n/a
L	Rated kW	0 to 1,000,000	0.01	kW
M	Rated Volts Low Line Scale Factor	0.001 to 3	0.001	n/a
N	Phase Rotation	ABC or ACB	n/a	n/a
O	Voltage Sensing	Delta, Wye, 1 Phase A-B, 1 Phase A-C, Grounded Delta	n/a	n/a
P	CT Phase Connection	A, B, C, AB, BC, CA, or CT ABC	n/a	n/a

Remote Module Setup

BESTCOMS*Plus* 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 42 illustrates the BESTCOMS*Plus* Remote Module Setup screen.

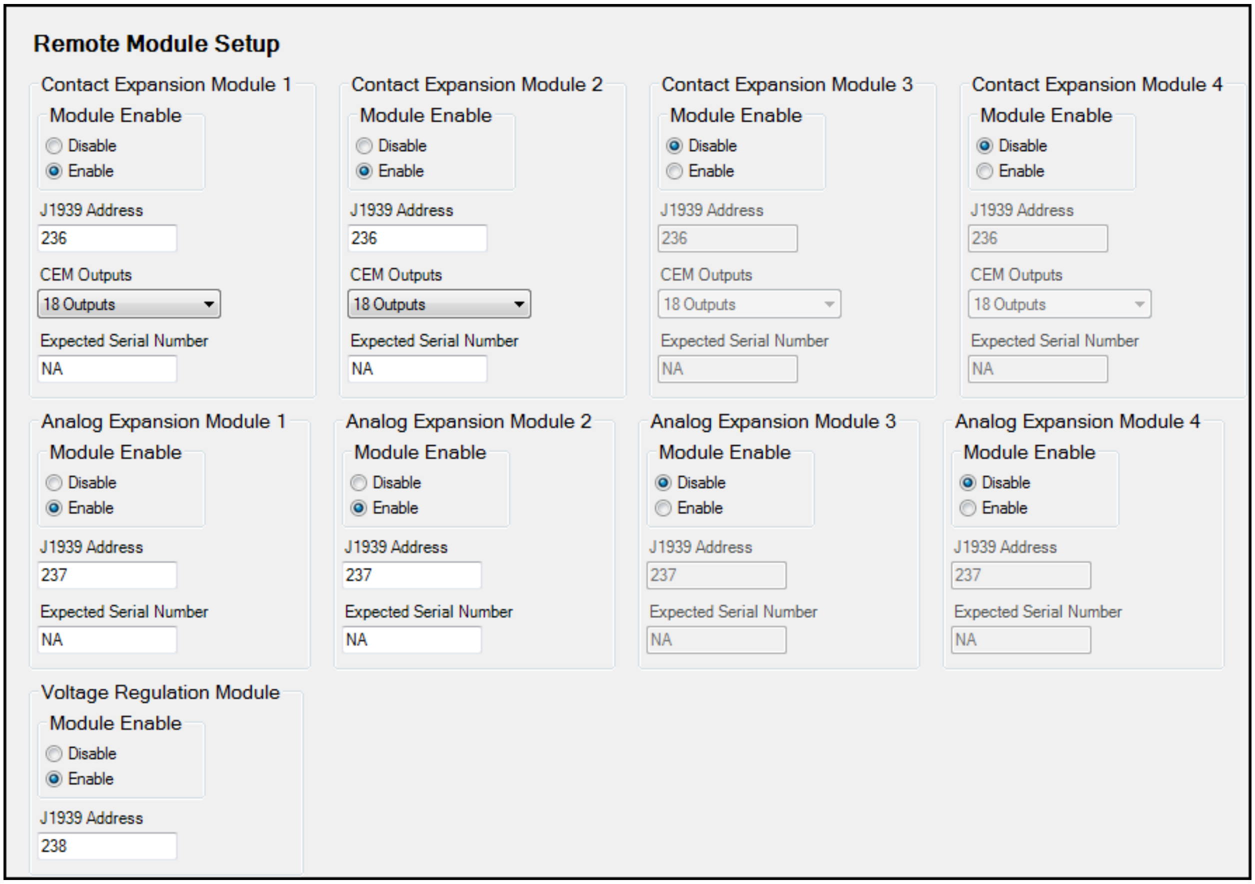


Figure 42. Settings Explorer, System Parameters, Remote Module Setup

Crank Settings

BESTCOMS*Plus* 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 cooldown. These settings are described in the paragraphs below.

Figure 43 illustrates the BESTCOMS*Plus* Crank Settings screen. Settings are listed in Table 21.

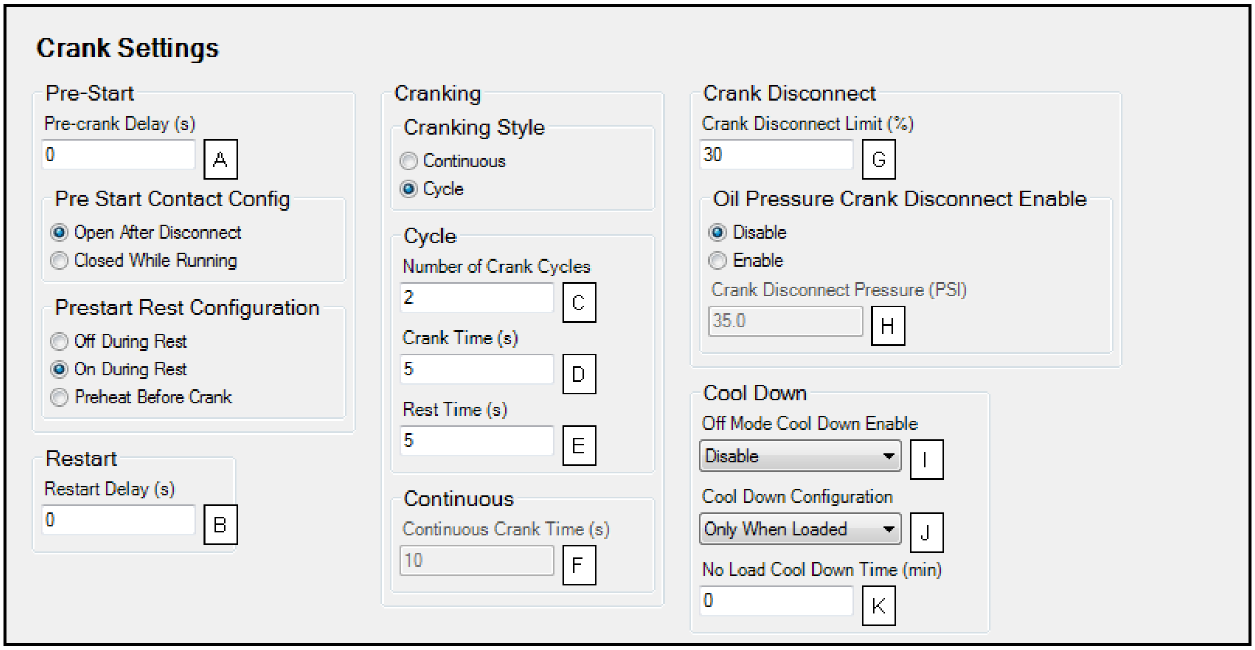


Figure 43. Settings Explorer, System Parameters, Crank Settings

Table 21. 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	Rest Time	5 to 15	1	seconds
F	Continuous Crank Time	5 to 60	1	seconds
G	Crank Disconnect Limit	10 to 100	1	%
H	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
I	Off Mode Cooldown Enable	Disable or Enable	n/a	n/a
J	Cooldown Configuration	Only When Loaded or Always	n/a	n/a
K	No Load Cooldown 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 an interval of engine cranking followed by a rest interval. 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

BESTCOMS*Plus* 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 BESTCOMS*Plus* Automatic Restart screen is illustrated in Figure 44.

Figure 44. Settings Explorer, System Parameters, Automatic Restart

Exercise Timer Settings

BESTCOMS*Plus* 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. If Weekday of Month is selected, Start Day of Week and Week of Month 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 BESTCOMS*Plus* Exercise Timer screen is illustrated in Figure 45.

Figure 45. Settings Explorer, System Parameters, Exercise Timer

Seven Day Timer

The seven day timer provides eight unique timers per day of the week (Sunday, Monday, etc) totaling 56 timers overall. Each timer is programmed with a start time and a run period. The starting time is expressed as start hour and minutes using a 24-hour clock, which specifies the local clock time to start the timer. The run period is expressed as hours and minutes. The total running time is Run Period Hours plus Run Period Minutes. In order to disable a timer, the Run Period Hours and Run Period Minutes settings must both be set to 0.

Timers may overlap into the following day. For example, a timer set to start on Sunday at 23 hours, 00 minutes with a run period of 4 hours, 00 minutes runs into the following Monday ending at 3:00 am.

Fifty-six unique status inputs are available in logic that are true when a timer is active.

Figure 46 illustrates the Seven Day Timer screen.

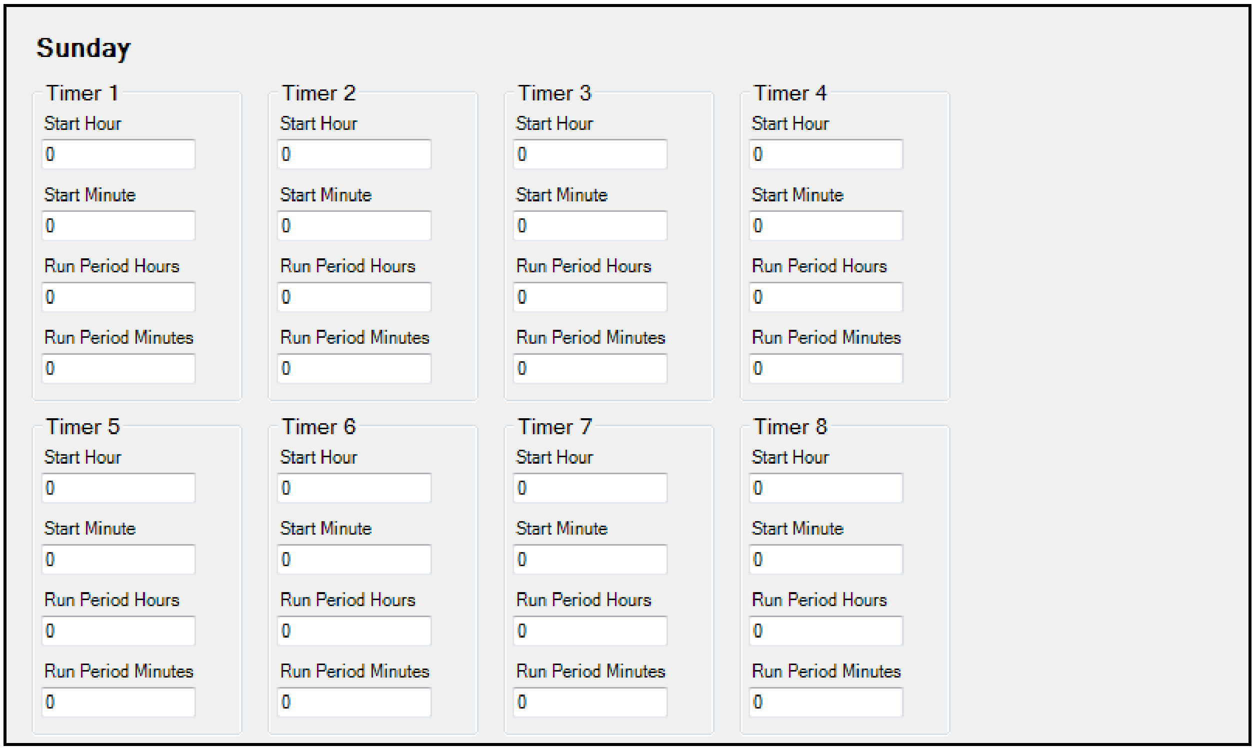


Figure 46. Settings Explorer, System Parameters, Seven Day Timer

Sensing Transformer Ratings

BESTCOMS*Plus* 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 protection.

Figure 47 illustrates the BESTCOMS*Plus* 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 41 illustrates the floating Rated Data screen. Settings are listed in Table 20.

Aux CT Mapping

DGC-2020HD controllers with style number xxxxxxxBx have one auxiliary CT and controllers with style number xxxxxxxEx have four. Specify the mappings for each auxiliary CT using these settings.

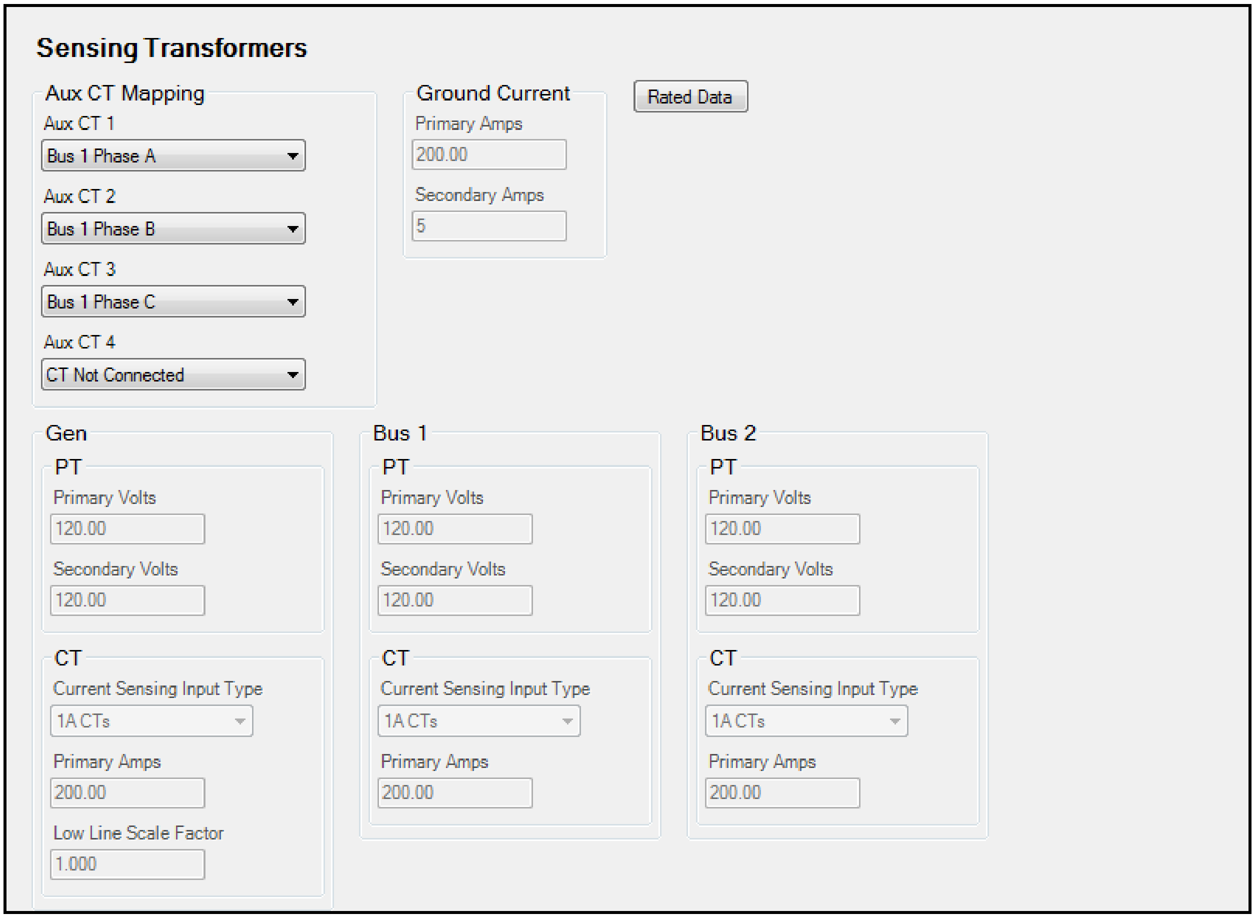


Figure 47. Settings Explorer, System Parameters, Sensing Transformers

Differential Transformer Ratings

BESTCOMS*Plus* Navigation Path: Settings Explorer, System Parameters, Differential Transformers Setup

Front Panel Navigation Path: Settings > System Parameters > Sensing Transformers

Differential transformer settings are available in DGC-2020HD controllers with the Enhanced Plus Differential option (style: xxDxxxxEx). These settings configure the differential protection.

87G Rated Volts

This value is used in the tap compensation calculation (kVn). It is the rated voltage of the non-generator side of the protected zone. Refer to the *Protection* chapter for details on tap compensation settings.

87G Primary Amps

87G auxiliary CT settings establish the nominal, primary (bus side) current level at the 87G current sensing transformer. This setting accepts values from 1 to 9,999, 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 1xxxxxxxx uses a nominal CT secondary rating of 1 Aac. A DGC-2020HD with a style number of 5xxxxxxxx uses a nominal CT secondary rating of 5 Aac.

Tap

Sensed current is divided by the tap value to eliminate magnitude mismatch. See the *Protection* chapter for details on tap compensation settings.

Differential Circuit

The value of this setting establishes the differential side of the protected zone. This is only used in reporting.

Transformer Connection

For differential protection to operate, the phase angle of the measured values for each circuit must be comparable. For example, measured current values for a transformer may be WYE on one side and delta on the other, and therefore could not be compared directly. The Gen Differential Transformer setting establishes the transformer connection type on the generator side of the protected zone. The 87G Differential Transformer setting establishes the transformer connection type on the other side of the protected zone.

Ground Compensate

When enabled, the zero-sequence value is subtracted from each phase of the circuit.

Reverse Current

When 180° Compensation is selected, the complex value of each phase is negated, simulating a 180° shift. This is the equivalent of physically flipping the direction of the CT on the 87G side of the protected zone.

Phase Relationship

This setting establishes the type of phase rotation compensation to be applied.

When set to A, no compensation is applied. When set to B, R2 compensation is applied. When set to C, R1 compensation is applied.

R1 Rotation Compensation Mode Equations

$I_A - comp = I_C$

$I_B - comp = I_A$

$I_C - comp = I_B$

R2 Rotation Compensation Mode Equations

$I_A - comp = I_B$

$I_B - comp = I_C$

$I_C - comp = I_A$

CT Connection Type

For differential protection to operate, the phase angle of the measured values for each circuit must be comparable. For example, measured current values for a transformer may be WYE on one side and delta on the other, and therefore could not be compared directly. The Gen Differential CT Connection Type setting establishes the CT connection type on the generator side of the protected zone. The 87G Differential CT Connection Type setting establishes the CT connection type on the other side of the protected zone.

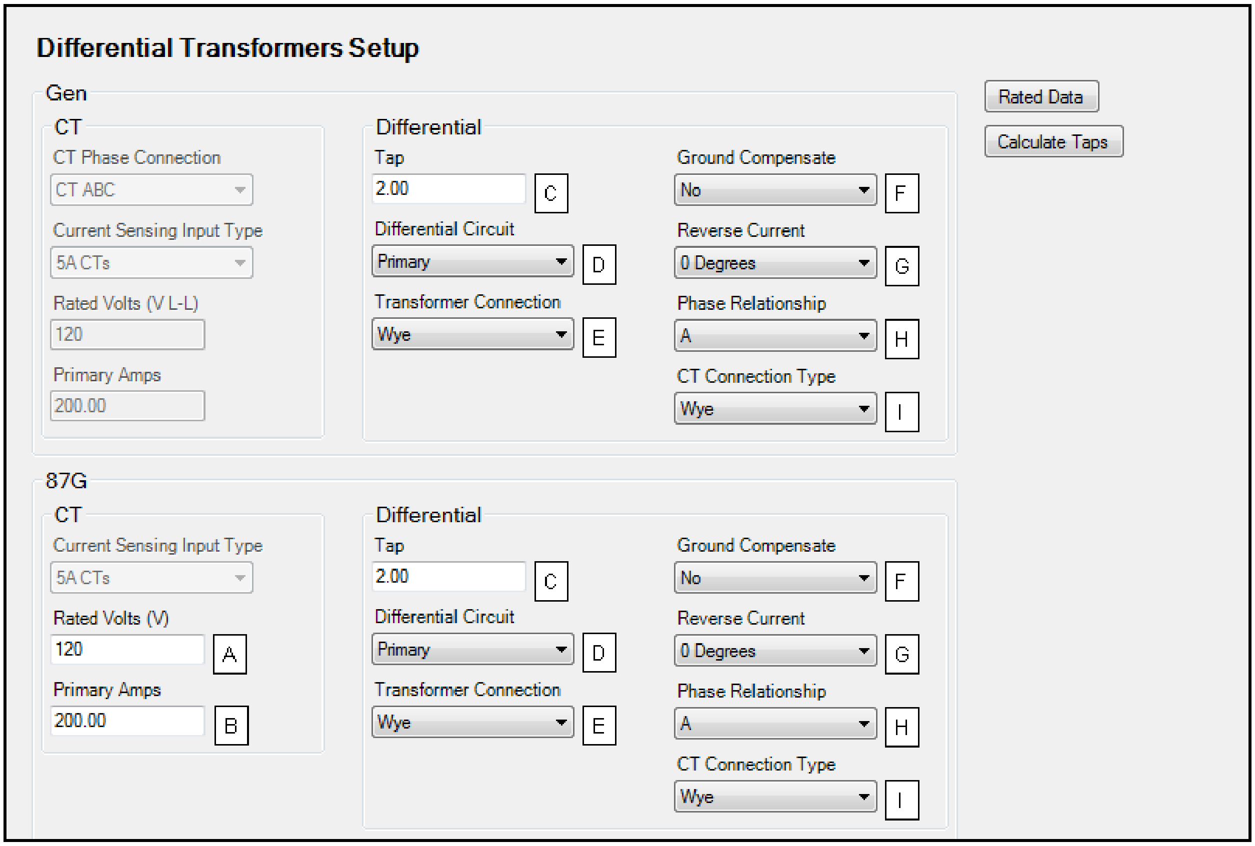


Figure 48. Settings Explorer, System Parameters, Differential Transformers Setup

Table 22. Settings for Differential Transformers Setup

Locator	Setting	Range	Increment	Unit
A	Rated Volts	1 to 1,000,000	1	volts
B	Primary Amps	100 to 9,999	1	amperes
C	Tap	0.4 to 4	0.01	n/a
D	Differential Circuit	Primary, Secondary, or None	n/a	n/a
E	Transformer Connection	Wye, DAB, DAC, ZAB, ZAC, or NA	n/a	n/a
F	Ground Compensate	No or Yes	n/a	n/a
G	Reverse Current	0 Degrees or 180 Degrees	n/a	n/a
H	Phase Relationship	A, B, or C	n/a	n/a
I	CT Connection Type	Wye, DAB, or DAC	n/a	n/a

Relay Control Settings

BESTCOMS*Plus* 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 BESTlogic*Plus*

Figure 49 illustrates the BESTCOMS*Plus* Relay Control screen.

Figure 49. Settings Explorer, System Parameters, Relay Control

System Configuration Detection Settings

BESTCOMS*Plus* 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 BESTCOMS*Plus* Auto Config Detection screen is illustrated in Figure 50. Settings are listed in Table 23.

Figure 50. Settings Explorer, System Parameters, Auto Config Detection

Table 23. 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.

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.

Refer to the *Maintenance* chapter in the *Installation* manual for information on replacing the backup battery.

Clock Setup

BESTCOMS*Plus* 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 BESTCOMS*Plus*® or through the front-panel interface. Write access to ports is required to program the clock.

The BESTCOMS*Plus* Clock Setup screen is illustrated in Figure 51. Settings are listed in Table 24.

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 51. 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 or another DGC-2020HD on the network 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.

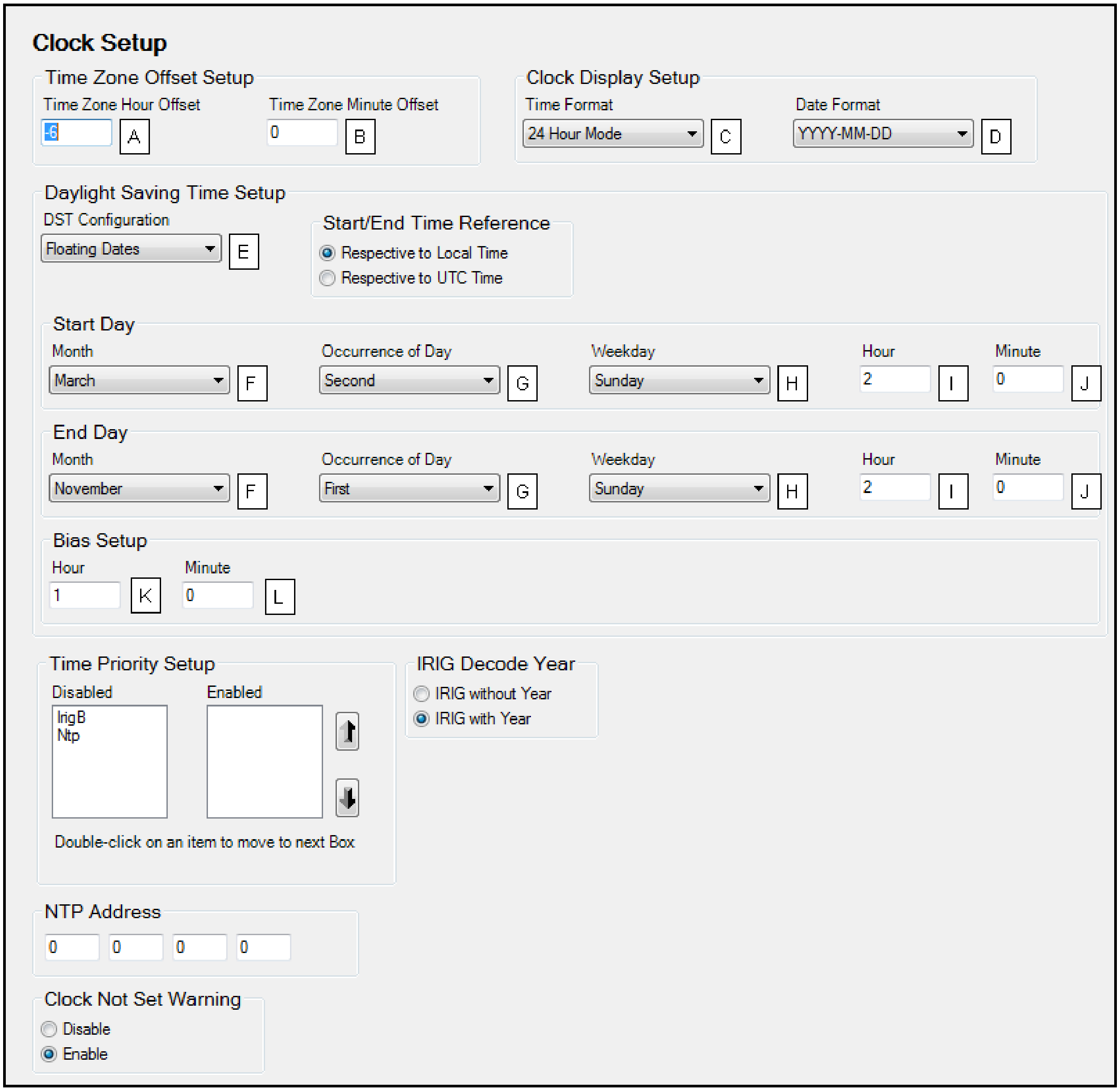


Figure 51. Settings Explorer, General Settings, Clock Setup Screen

Table 24. 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

BESTCOMS*Plus* Navigation Path: Metering Explorer, Real Time Clock
Front Panel Navigation Path: Metering > Status > Real Time Clock

Time and date settings can be made through BESTCOMS*Plus* on the Metering Explorer Real Time Clock screen (Figure 52). Settings can also be made through the front panel.

Figure 52. 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 control 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.

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.

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* for more information.

Characteristic Curves

Oil pressure, coolant temperature, and fuel level information can be obtained from resistive sender inputs or analog inputs. These inputs of the DGC-2020HD must be customized to obtain maximum accuracy of the measured data.

The characteristic curve of each input can be configured with up to 11 points. Each point can be assigned a resistance or analog 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 input 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 all analog inputs or resistive sender inputs. Note the fuel level is not received over CAN Bus, so the sender curve for the fuel level input must always be configured.

Fuel Level

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Programmable Senders, Percent Fuel Level
Front Panel Navigation Path: Not available through the front panel

Figure 53 illustrates the Fuel Level screen found in BESTCOMS*Plus*. Settings are listed in Table 25. 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 BESTCOMS*Plus* to send the sender settings to the DGC-2020HD.

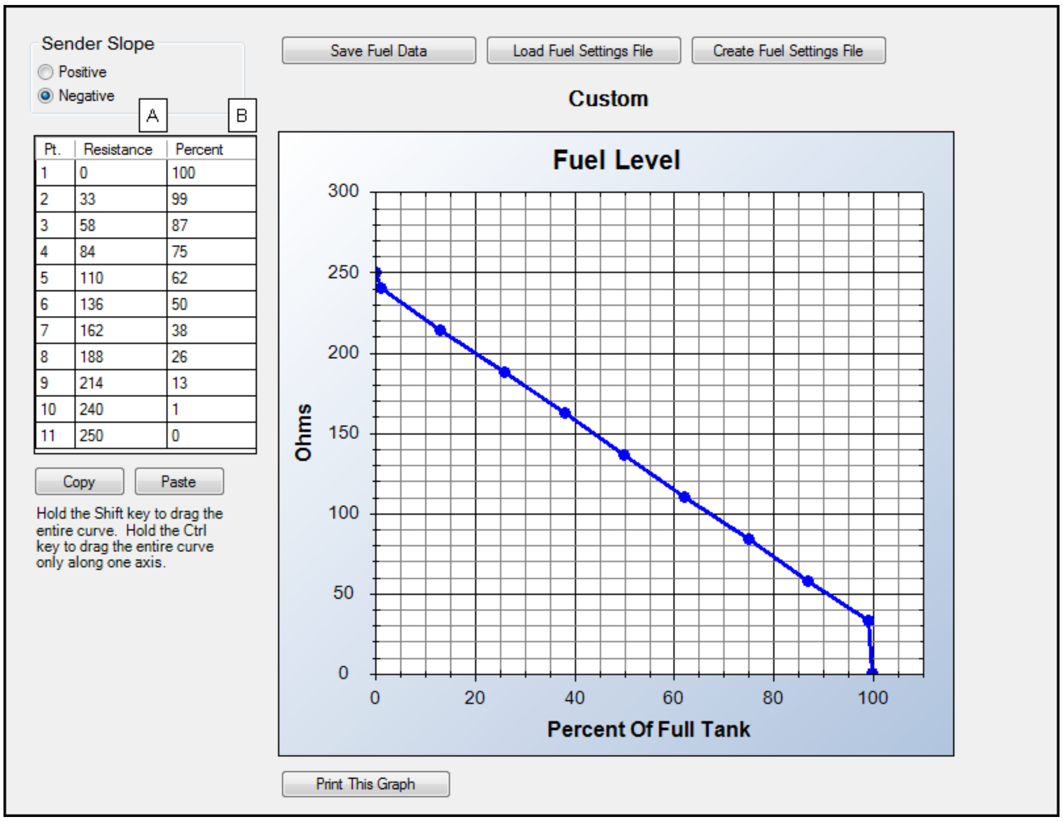


Figure 53. Settings Explorer, Programmable Senders, Fuel Level Screen

Table 25. 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

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Programmable Senders, Oil Pressure
Front Panel Navigation Path: Not available through the front panel

Figure 54 illustrates the Oil Pressure screen found in BESTCOMS*Plus*®. Settings are listed in Table 26. 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 BESTCOMS*Plus*® to send the sender settings to the DGC-2020HD.

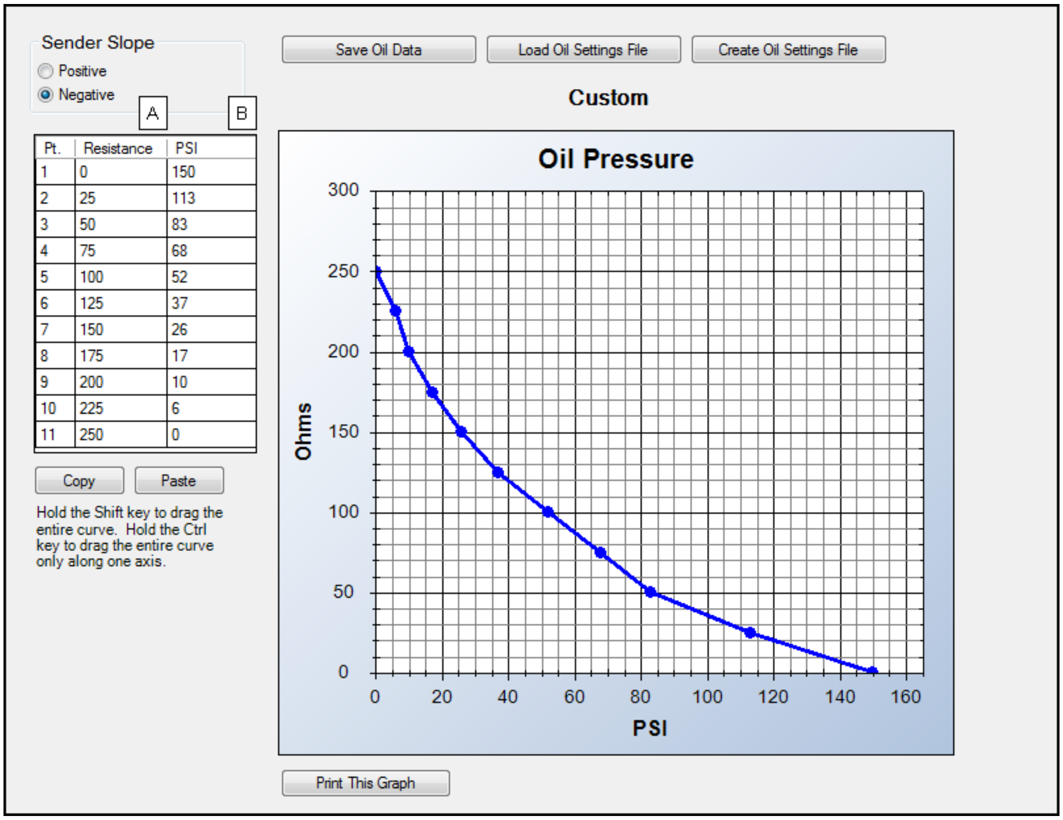


Figure 54. Settings Explorer, Programmable Senders, Oil Pressure Screen

Table 26. Settings for Oil Pressure Screen

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

Coolant Temperature

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Programmable Senders, Coolant Temperature
Front Panel Navigation Path: Not available through the front panel

Figure 55 illustrates the Coolant Temperature screen found in BESTCOMS*Plus*®. Settings are listed in Table 27. 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 BESTCOMS*Plus*® to send the sender settings to the DGC-2020HD.

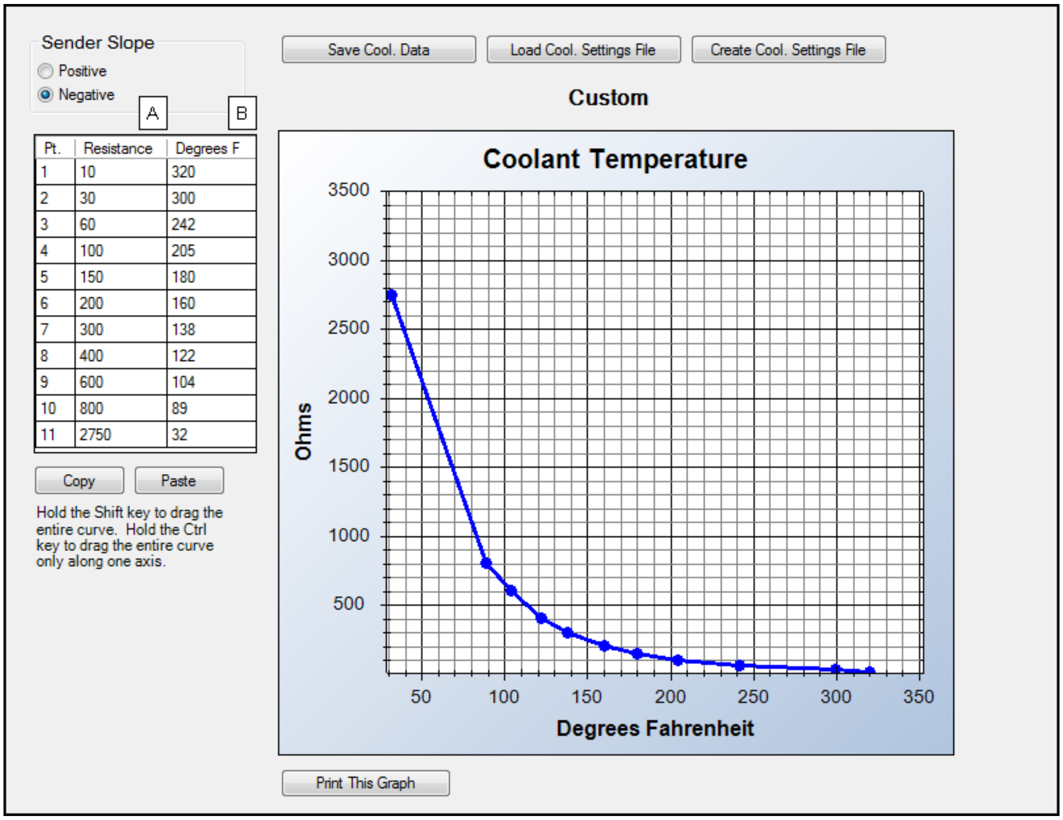


Figure 55. Settings Explorer, Programmable Senders, Coolant Temperature Screen

Table 27. 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.

When a loss of signal is detected, one of the following occurs depending on the Alarm Configuration setting. Alarm configurations are described in the *Alarm Configuration* chapter.

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 BESTCOMS*Plus* Sender Fail screen is illustrated in Figure 56 and is found in the Settings Explorer under Alarm Configuration.

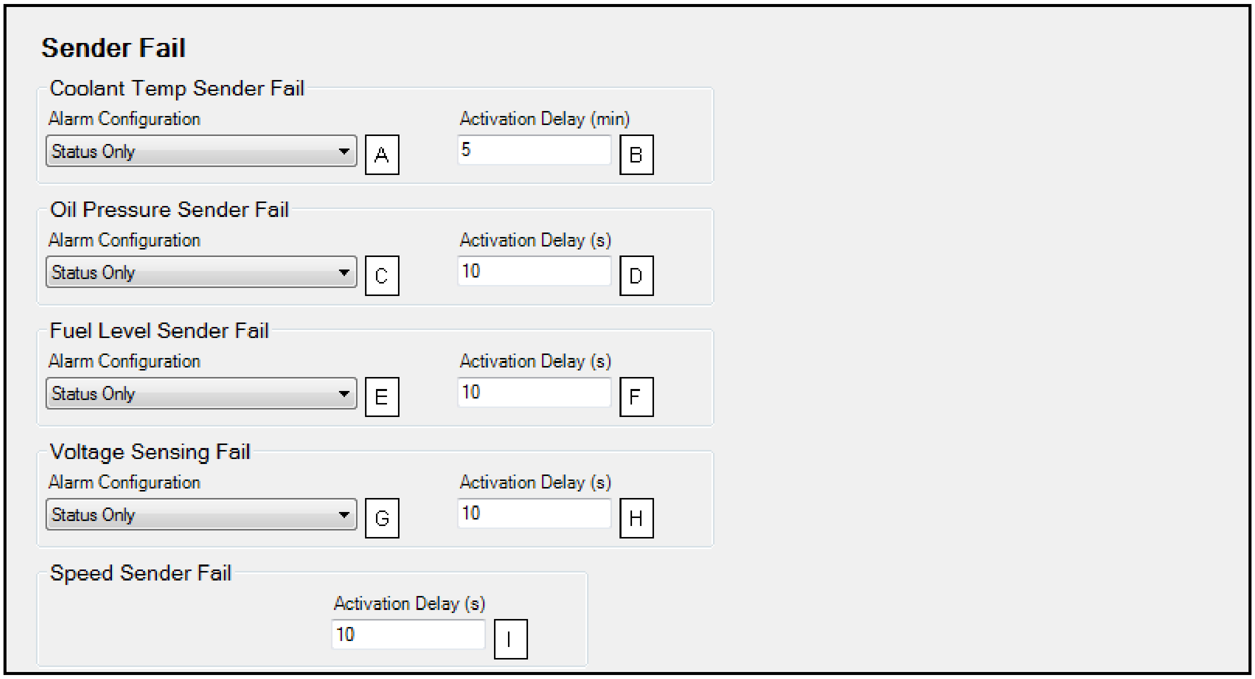


Figure 56. Settings Explorer, Alarm Configuration, Sender Fail Screen

Table 28. Settings for Sender Fail Screen

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

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

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 BESTCOMS*Plus*®, 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

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

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

Figure 57 illustrates the BESTCOMS*Plus* Contact Inputs screen. Settings are listed in Table 29.

For each contact input, configure the following parameters:

- Alarm Configuration - When the input senses a closed contact, one of the following occurs depending on the Alarm Configuration setting. Alarm configurations are described in the *Alarm Configuration* chapter.

- Activation Delay - This parameter defines the duration that the input must remain closed before any annunciation occurs.

- 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.

- 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 Type – Select whether the contact input should be normally open or normally closed.

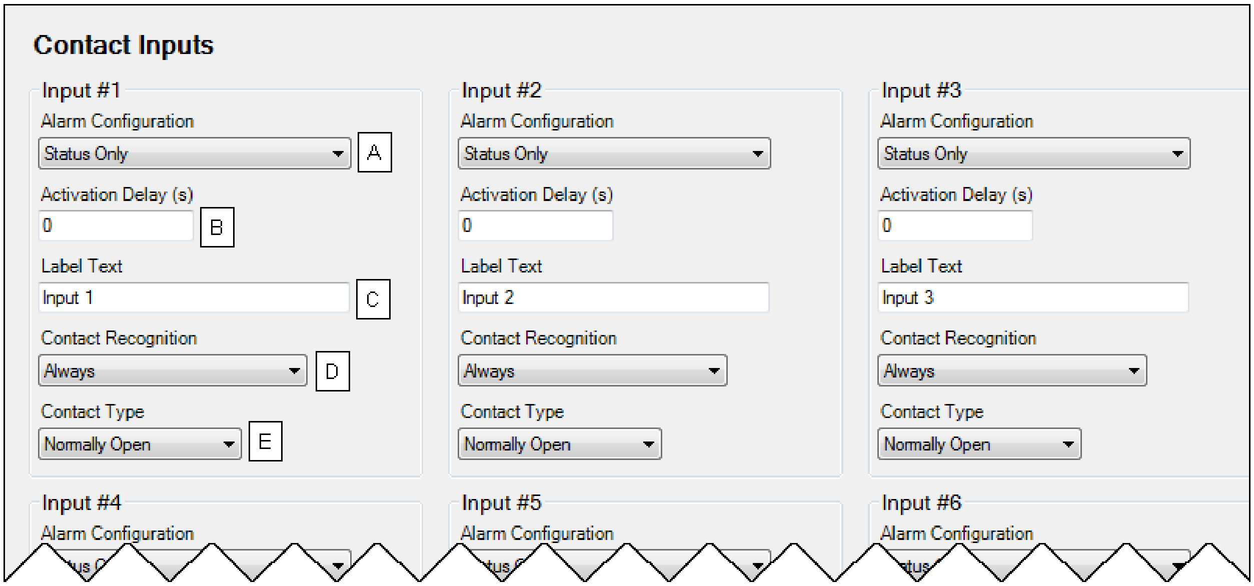


Figure 57. Settings Explorer, Programmable Inputs, Contact Inputs Screen

Table 29. Settings for Contact Inputs Screen

Locator	Setting	Range	Increment	Unit
A	Alarm Configuration	Status Only, Pre-Alarm, Alarm, Alarm with Unload, Alarm with Cool Down, or Alarm with Unload then Cool Down	n/a	n/a
B	Activation Delay	0 to 300	1	seconds
C	Label Text	Up to 64 alphanumeric characters	n/a	n/a
D	Contact Recognition	Always or While Engine Running Only	n/a	n/a
E	Contact Type	Normally Open or Normally Closed	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 – When an input is assigned to the Emergency Stop Programmable Function, the input functions in a normally-closed manner. When the input is closed, no alarm is annunciated. When the input is open, the DGC-2020HD will open the Start, Run, and Prestart relays and annunciate an Emergency Stop Alarm.

  Once an input is assigned to this programmable input, navigate to Settings Explorer > Programmable Inputs > Contact Inputs and configure the following settings:
    - Alarm Configuration: Status Only
    - Activation Delay: 0
    - Label Text: Any text is acceptable.
    - Contact Recognition: Always
    - Contact Type: Normally Open
- 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.

Alarm configurations are described in the *Alarm Configuration* chapter.

The BESTCOMS*Plus* Programmable Functions screen is illustrated in Figure 58. Settings are listed in Table 30.

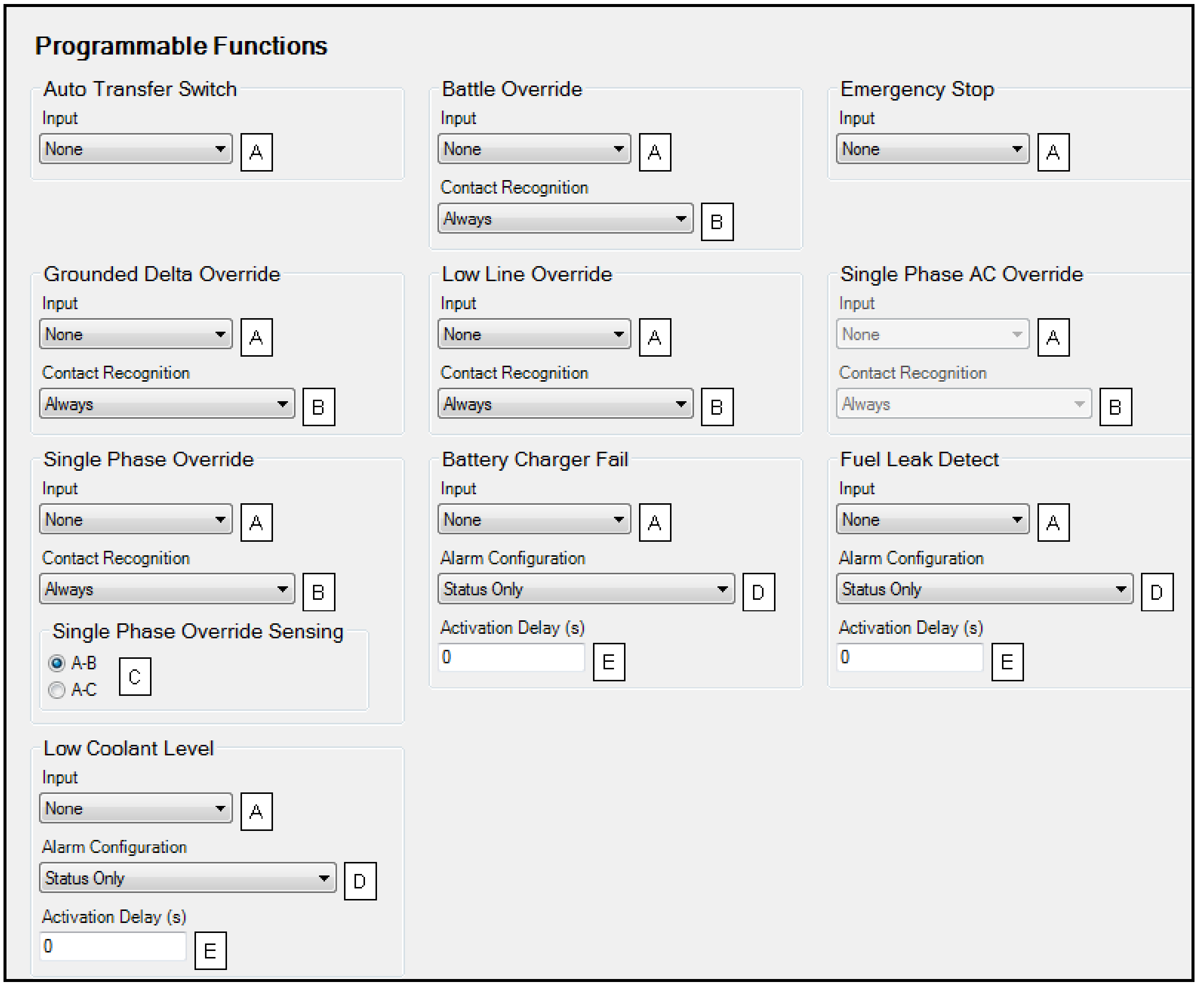


Figure 58. Settings Explorer, Programmable Inputs, Programmable Functions

Table 30. 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, Alarm, Alarm with Unload, Alarm with Cool Down, or Alarm with Unload then Cool Down	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. This setting determines the action that is taken when an input becomes out-of-range. Alarm configurations are described in the *Alarm Configuration* chapter.

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. Each threshold has a mode setting, threshold setting, activation delay setting, and an alarm configuration 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.

Threshold

When the metered input rises above or falls below this setting, depending on the Mode setting, (picks up) the activation delay timer begins counting.

Activation Delay

After the threshold has been exceeded for the duration of the activation delay, the selected alarm configuration action is performed. If the threshold detection drops out before the activation delay expires, the activation delay timer is reset.

Alarm Configuration

Each analog input threshold item can be independently configured to perform a different action depending on the alarm configuration setting. Alarm configurations are described in the *Alarm Configuration* chapter.

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 59) in BESTCOMS*Plus*. Settings are listed in Table 31.

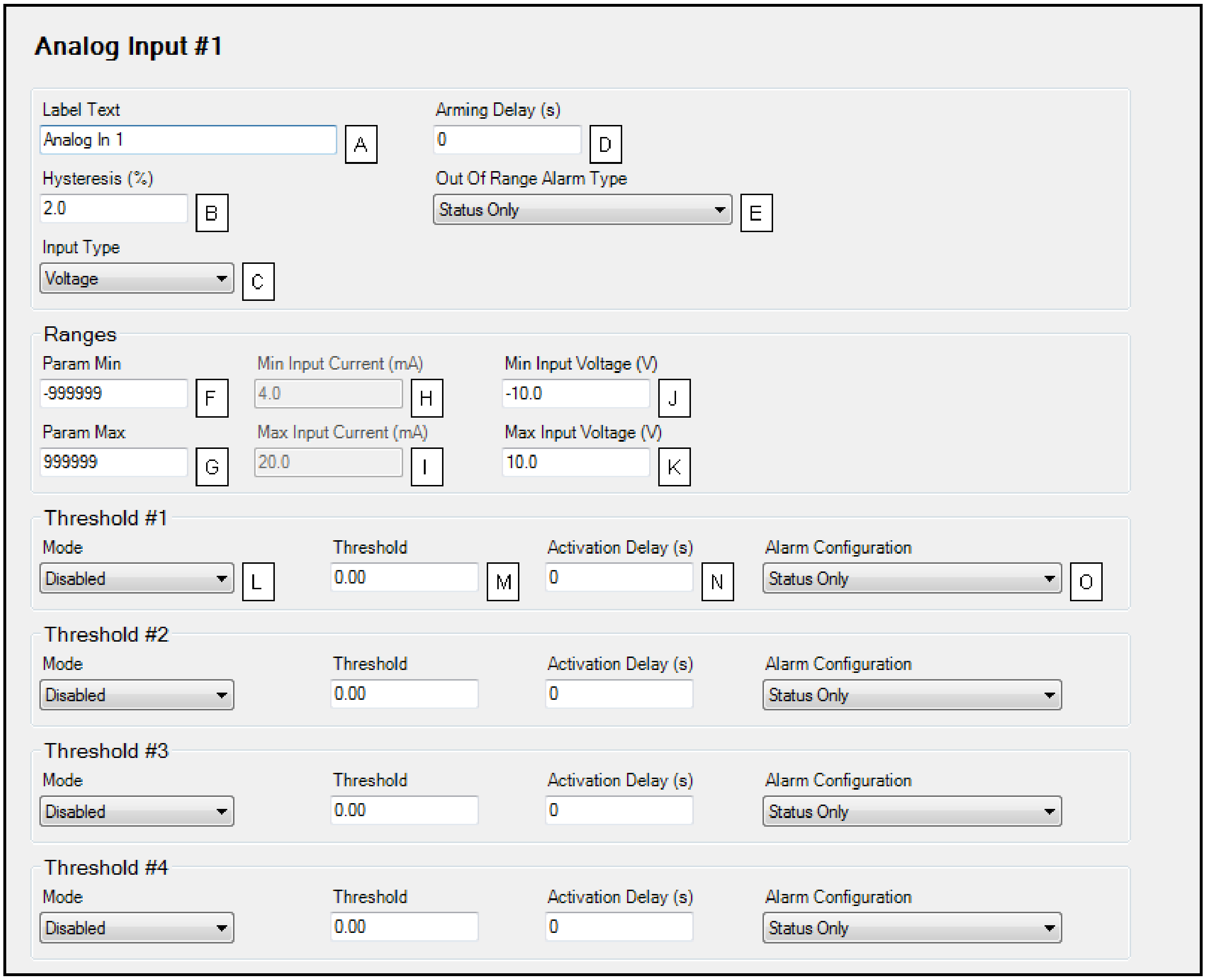


Figure 59. Settings Explorer, Programmable Inputs, Analog Inputs, Analog input #1

Table 31. Settings for Analog Inputs

Locator	Setting	Range	Increment	Unit
Input Setup				
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, Alarm, Alarm with Unload, Alarm with Cool Down, or Alarm with Unload then Cool Down	n/a	n/a
Ranges				
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

Locator	Setting	Range	Increment	Unit
J	Min Input Voltage	-10 to 10	0.1	volts
K	Max Input Voltage	-10 to 10	0.1	volts
Threshold Settings 1 to 4				
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, Alarm, Alarm with Unload, Alarm with Cool Down, or Alarm with Unload then Cool Down	n/a	n/a

Remote System Manager Input

BESTCOMS*Plus* Navigation Path: Settings Explorer, Programmable Inputs, Remote System Manager Inputs
Front Panel Navigation Path: Settings Explorer > Programmable Inputs > Remote Sys Manager Inputs

The selected analog input may be used as a setpoint source for var, PF, or kW control. The bias signal is broadcast to all units on the network by the system manager. Settings are provided for minimum and maximum input voltage, and minimum and maximum input current. All units in the network must have identical settings for the Type and Range settings (See Figure 60). Configure the Aux Input setting only for the system manager. This determines which analog input to broadcast to the other units on the network.

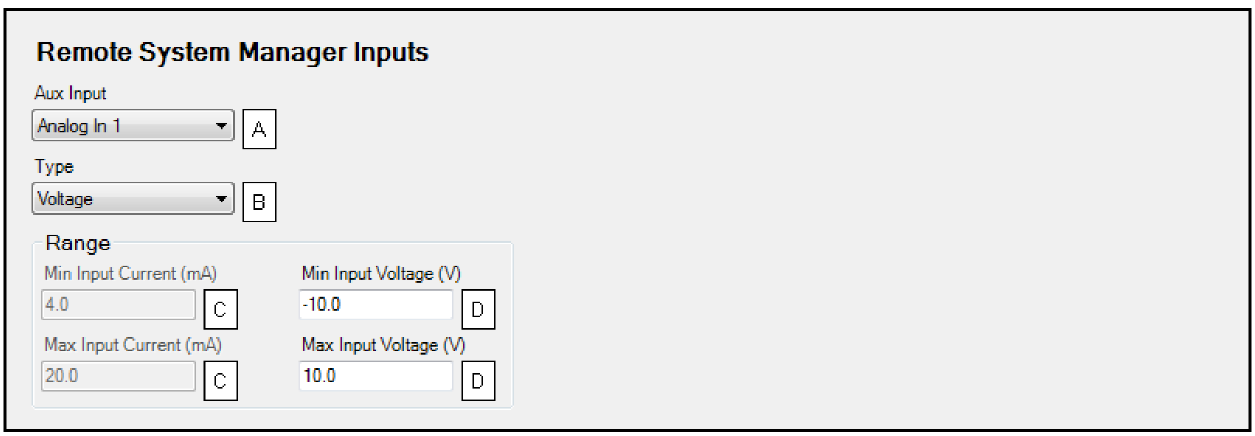


Figure 60. Settings Explorer, Programmable Inputs, Remote System Manager Inputs

Table 32. Settings for Remote System Manager Inputs

Locator	Setting	Range	Increment	Unit
A	Aux Input	Analog In 1 to 4, AEM1 In 1 to 8, AEM2 In 1 to 8, AEM3 In 1 to 8, or AEM4 In 1 to 8	n/a	n/a
B	Type	Voltage or Current	n/a	n/a
C	Min/Max Input Current	4 to 20	0.1	milliamps
D	Min/Max Input Voltage	-10 to 10	0.1	volts

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 61. The output is true during a trip condition. The alarm and pre-alarm logic blocks are similar.

Figure 61. 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 in the *Installation* manual 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 in the *Installation* manual 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 in the *Installation* manual for the location of the Run relay on the rear panel of the DGC-2020HD.

Relay Control

BESTCOMS*Plus*® 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 62). See the BESTlogic*Plus* chapter for more information about DGC-2020HD programmable logic.

Figure 62. 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 63.

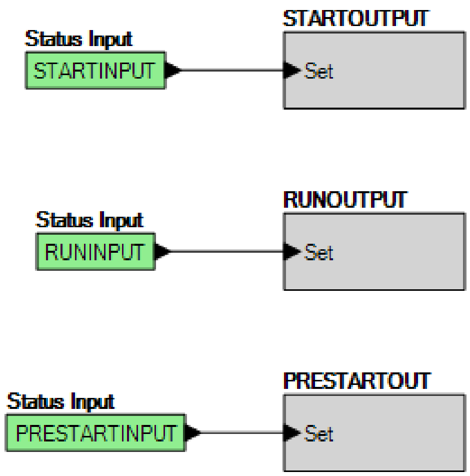


Figure 63. Example Logic Scheme of Programmable Relays

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

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Programmable Outputs, Contact Outputs
Front Panel Navigation Path: Settings Explorer > Programmable Outputs > Contact Outputs

Figure 64 illustrates the Contact Outputs screen found in BESTCOMS*Plus*.

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

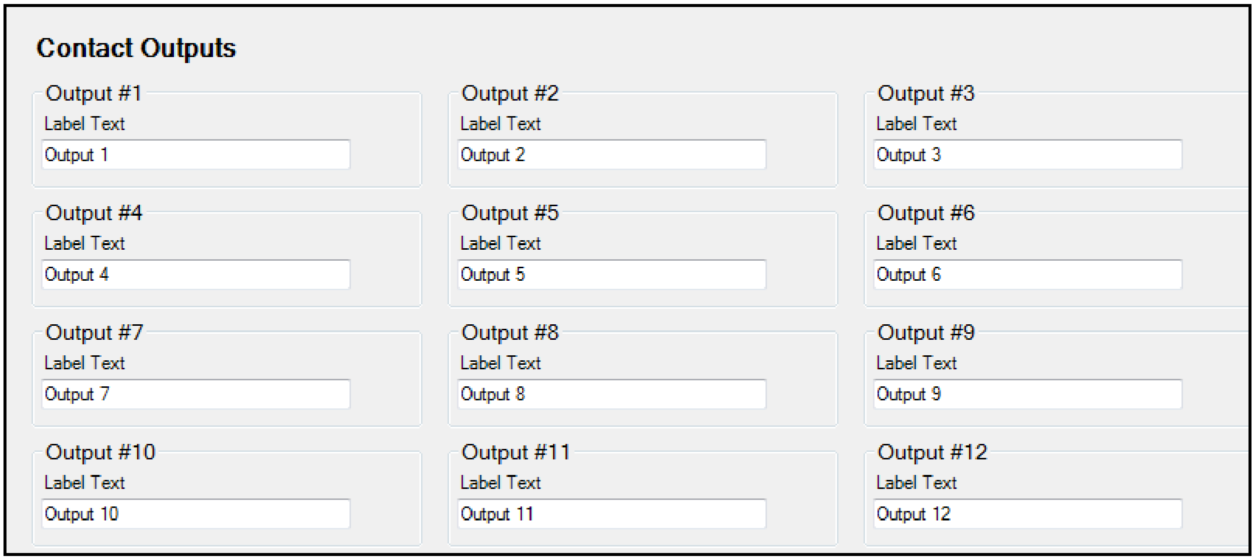


Figure 64. Settings Explorer, Programmable Outputs, Contact Outputs

Configurable Elements

BESTCOMS*Plus*® 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 BESTlogic*Plus* programmable logic scheme by selecting them from the Elements group in BESTlogic*Plus*. For more details, refer to the BESTlogic*Plus* chapter. Alarm configurations are described in the *Alarm Configuration* chapter.

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.

The BESTCOMS*Plus* Configurable Elements screen is illustrated in Figure 65. Settings are listed in Table 33.

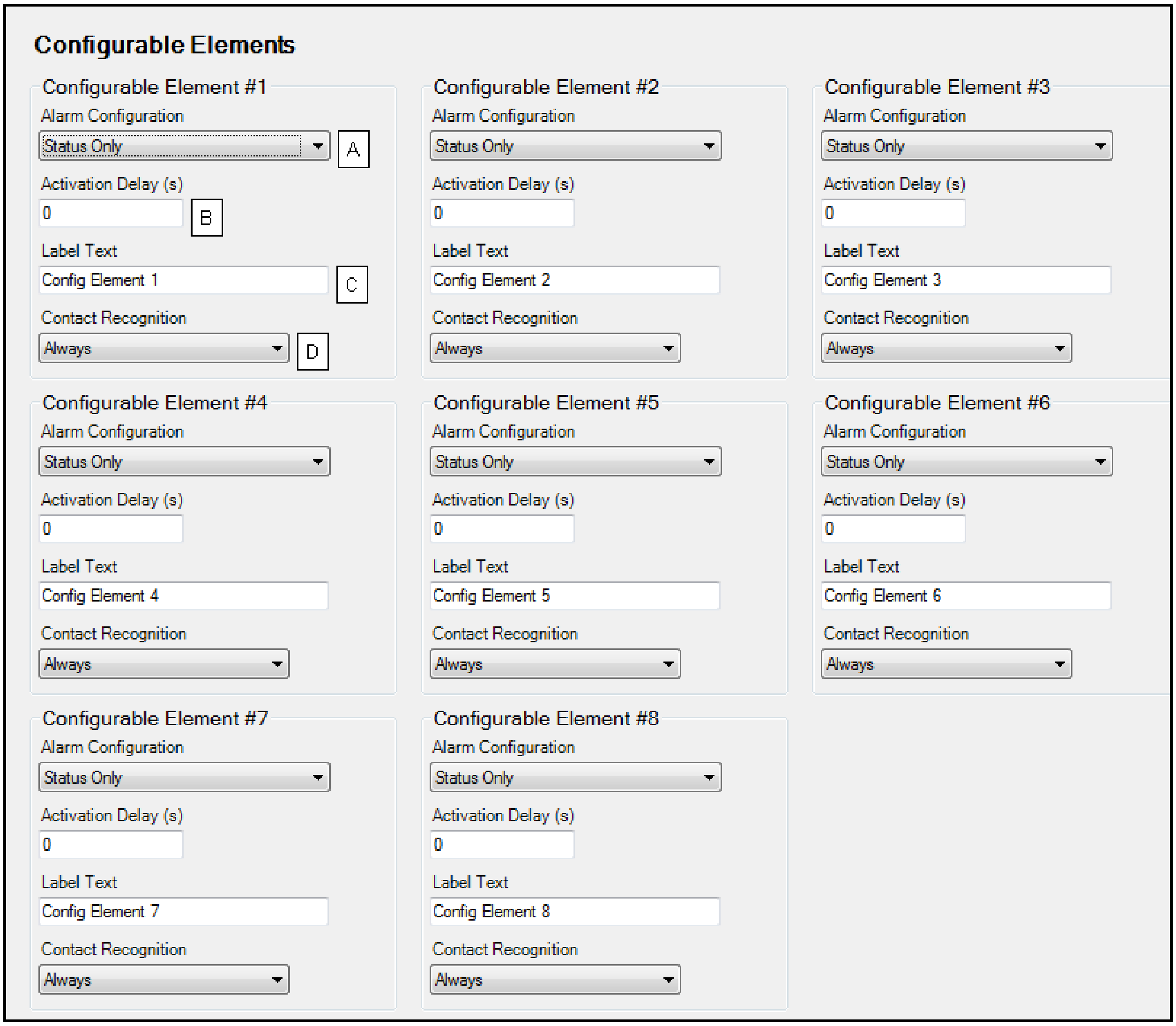


Figure 65. Settings Explorer, Programmable Outputs, Configurable Elements

Table 33. Settings for Configurable Elements

Locator	Setting	Range	Increment	Unit
A	Alarm Configuration	Status Only, Pre-Alarm, Alarm, Alarm with Unload, Alarm with Cool Down, or Alarm with Unload then Cool Down	n/a	n/a
B	Activation Delay	0 to 300	1	seconds
C	Label Text	Up to 64 alphanumeric characters	n/a	n/a
D	Contact Recognition	Always or While Engine Running Only	n/a	n/a

Breaker Management

DGC-2020HD breaker management features include the control of up to three, 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 many combinations of up to three breakers or none at all. Breaker management settings can be configured using BESTCOMS*Plus*® or through the front panel interface.

Breaker Status

The status of the breakers is retrieved by properly setting up the breaker control 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 Setup in BESTlogic™Plus*, below, for details on configuring the logic.

System Breaker Configuration

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

Initial System Setup

Connect the DGC-2020HD according to the appropriate figure in the *Typical Applications* chapter in the *Installation* manual 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 *Device Configuration* and *Alarm Configuration* chapters.

System Breaker Configuration Settings

BESTCOMS*Plus*® 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 on the System Settings screen illustrated in Figure 66. Available options include, No Breaker Control; Generator Breaker Control; Generator and Mains Breaker Control; Generator and Mains Breaker Control with Load Bus; Generator and Group Breaker; Generator and Group Breaker with Load Bus; Generator, Group, and Mains Breaker; Generator Breaker to Segmented System; Generator and Group Breaker to Segmented System; Tie Breaker Control; Generator and Tie Breaker Control; and Tie Breaker and Tie Breaker Control. System Breaker Configuration options are described in the following paragraphs. In BESTCOMS*Plus*, 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 BESTCOMS*Plus* to aid in ease of configuration and programming.

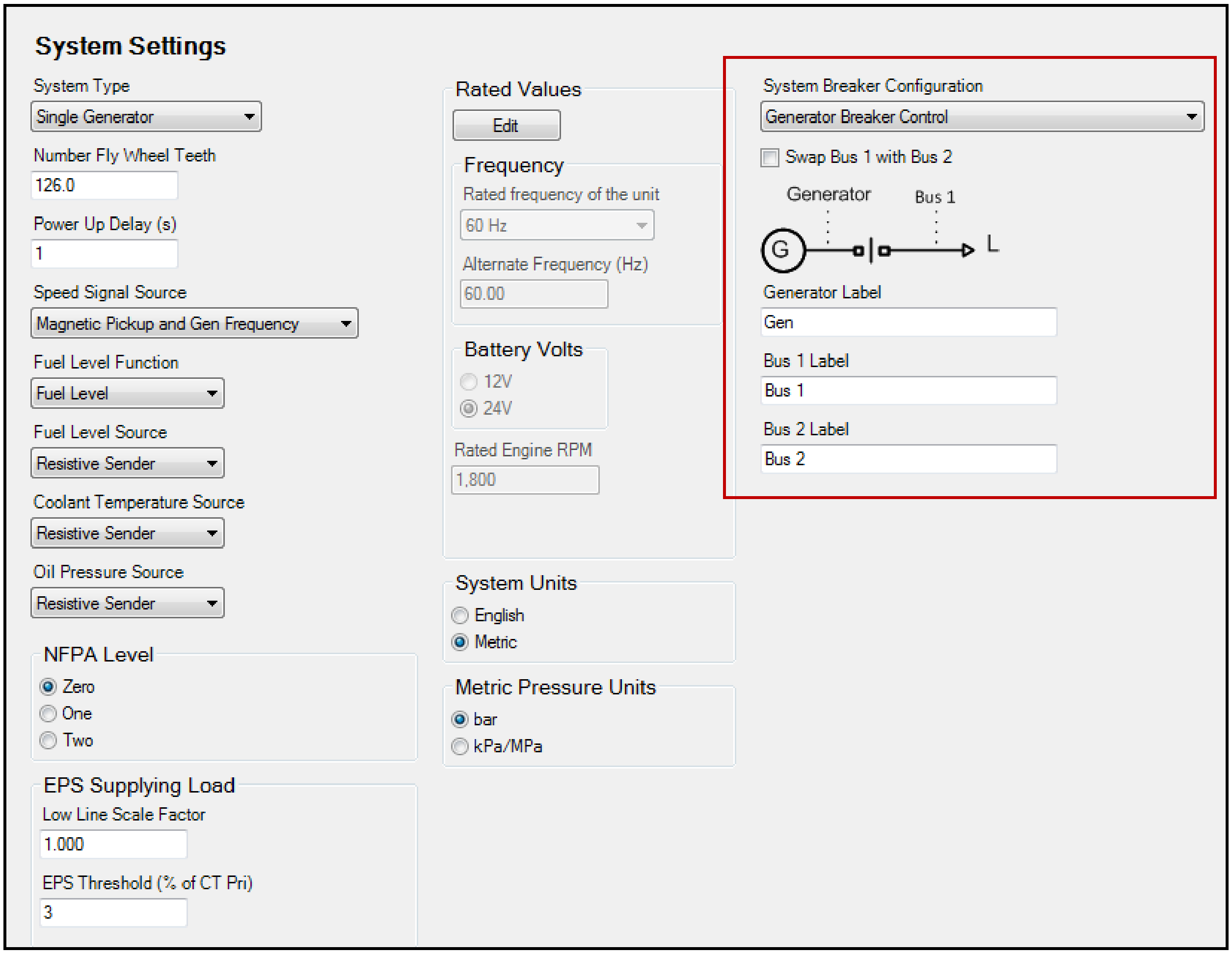


Figure 66. Settings Explorer, System Parameters, System Settings

Generator Breaker Control

A system breaker configuration of Generator Breaker Control consists of a single generator breaker controlled by the DGC-2020HD. Figure 67 illustrates the Generator Breaker Control system breaker configuration. Figure 68 shows the Generator Breaker Control system breaker configuration with a mains bus and externally controlled mains breaker. Figure 69 illustrates the one-line diagram of the Generator Breaker Control configuration as it appears in the BESTCOMS*Plus* System Settings screen.

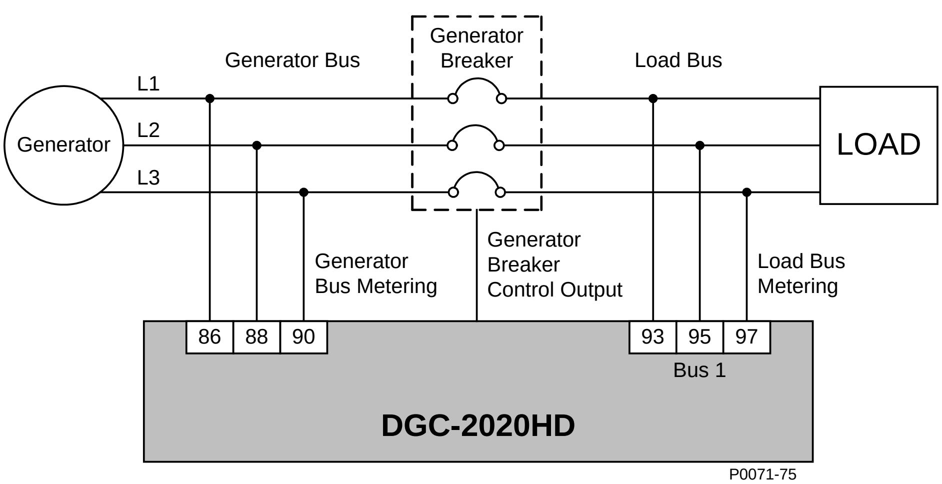


Figure 67. System Breaker Configuration: Generator Breaker Control

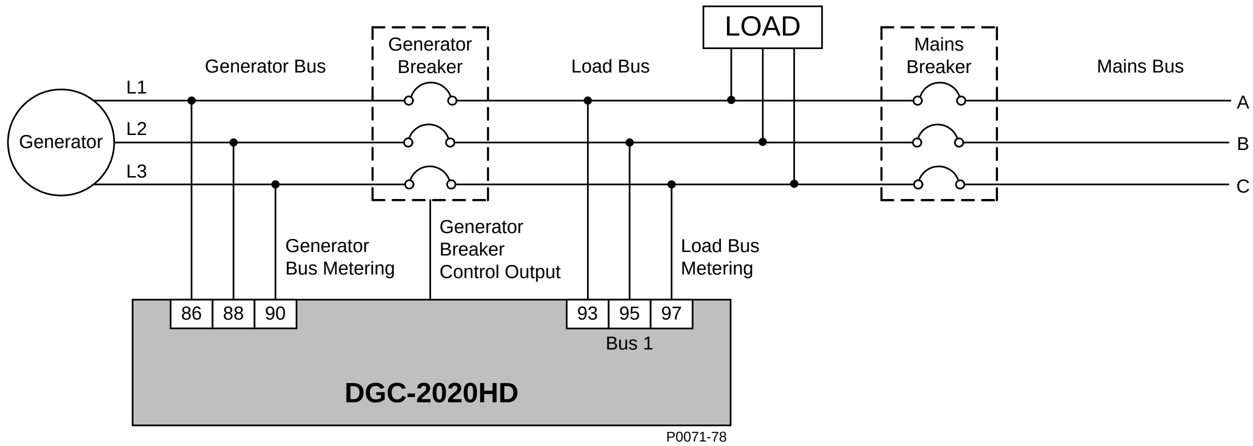


Figure 68. System Breaker Configuration: Generator Breaker Control with Externally Controlled Mains Breaker

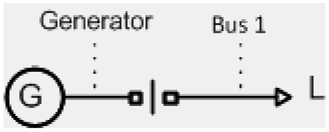


Figure 69. System Breaker Configuration: Generator Breaker Control as Displayed in BESTCOMS*Plus* System Settings.

Generator and Mains Breaker Control

Generator and Mains Breaker Control system breaker configurations consist of two breakers controlled by the DGC-2020HD. Figure 70 illustrates a Generator and Mains Breaker Control system breaker configuration without optional load bus metering. Figure 71 illustrates the one-line diagram of the Generator and Mains Breaker Control system breaker configuration as it appears in the BESTCOMS*Plus* System Settings screen. Figure 72 shows the same configuration with optional load bus metering. Figure 73 illustrates the one-line diagram of the Generator and Mains Breaker Control system breaker configuration as it appears in the BESTCOMS*Plus* System Settings screen. Optional load bus sensing provides more precise control over breaker closures. DGC-2020HD units must be equipped with enhanced bus sensing (style number xxxxxxxEx) in order to meter all three buses.

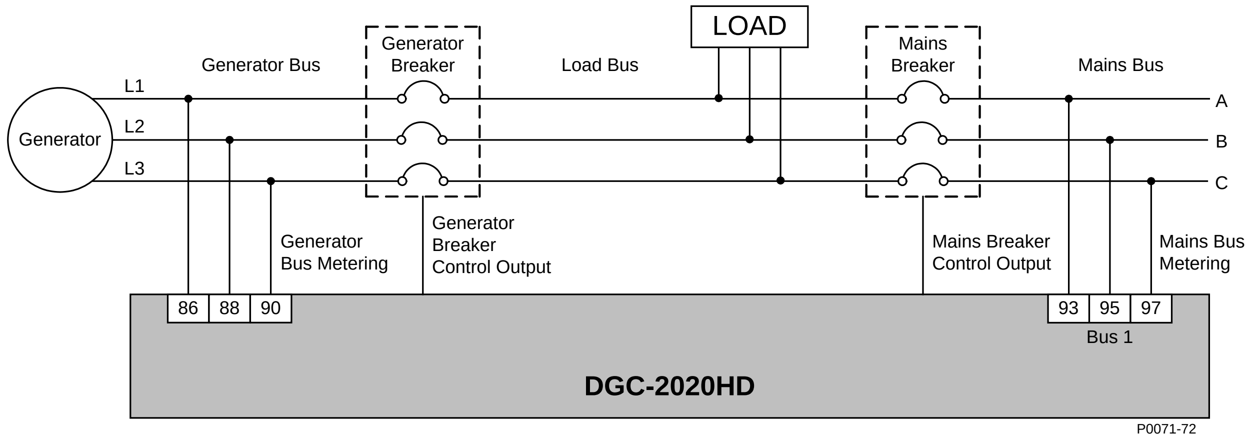


Figure 70. System Breaker Configuration: Generator and Mains Breaker Control

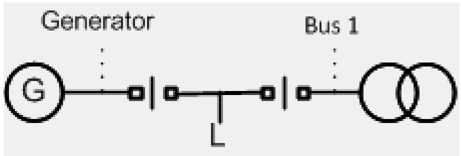


Figure 71. System Breaker Configuration: Generator and Mains Breaker Control as Displayed in BESTCOMS*Plus* System Settings

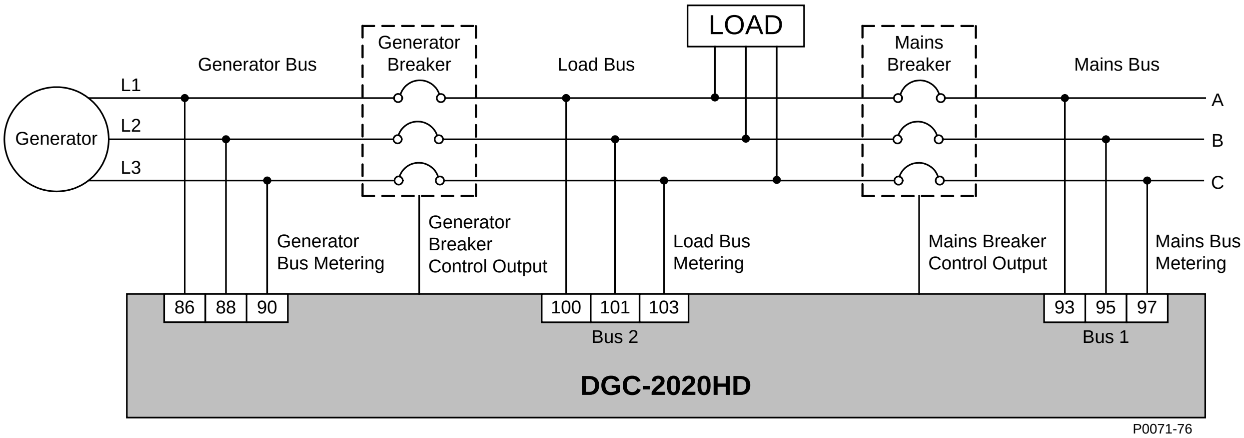


Figure 72. System Breaker Configuration: Generator and Mains Breaker Control with Optional Load Bus Metering

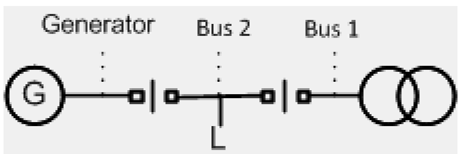


Figure 73. System Breaker Configuration: Generator and Mains Breaker Control with Optional Load Bus Metering as Displayed in BESTCOMS*Plus* System Settings

Generator and Group Breaker Control

Generator and Group Breaker Control system breaker configurations consist of two breakers controlled by the DGC-2020HD. Figure 74 illustrates a Generator and Group Breaker Control system breaker configuration without optional load bus metering. Figure 75 illustrates the one-line diagram of the Generator and Group Breaker Control system breaker configuration as it appears in the BESTCOMS*Plus* System Settings screen.

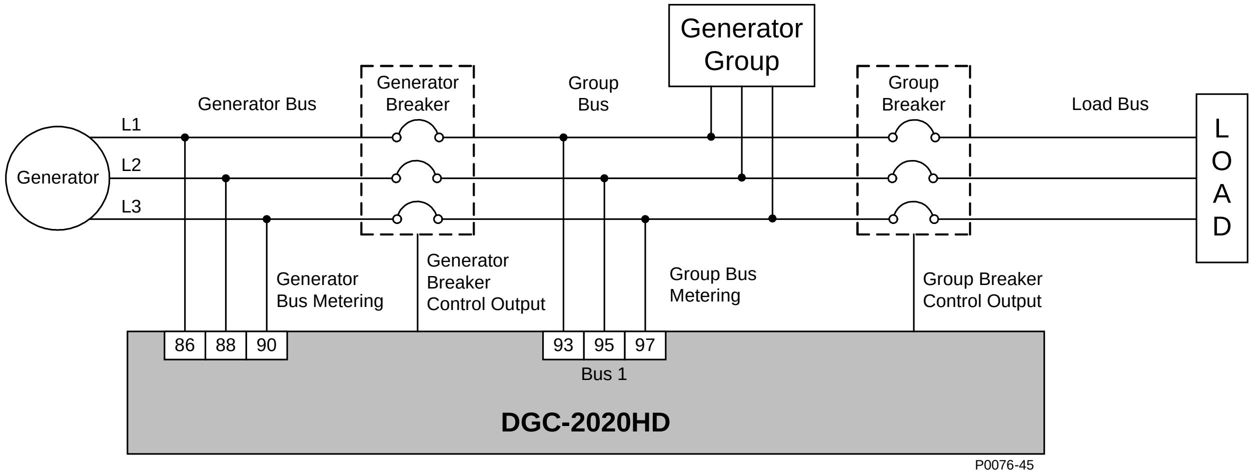


Figure 74. System Breaker Configuration: Generator and Group Breaker Control

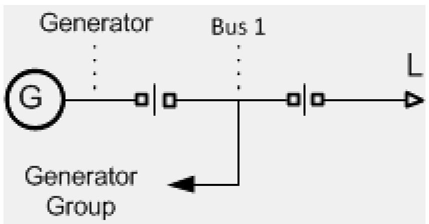


Figure 75. System Breaker Configuration: Generator and Group Breaker Control as Displayed in BESTCOMS*Plus* System Settings

Figure 76 illustrates a Generator and Group Breaker Control with Load Bus system breaker configuration. Figure 77 illustrates the one-line diagram of the Generator and Group Breaker Control with Load Bus system breaker configuration as it appears in the BESTCOMS*Plus* System Settings screen.

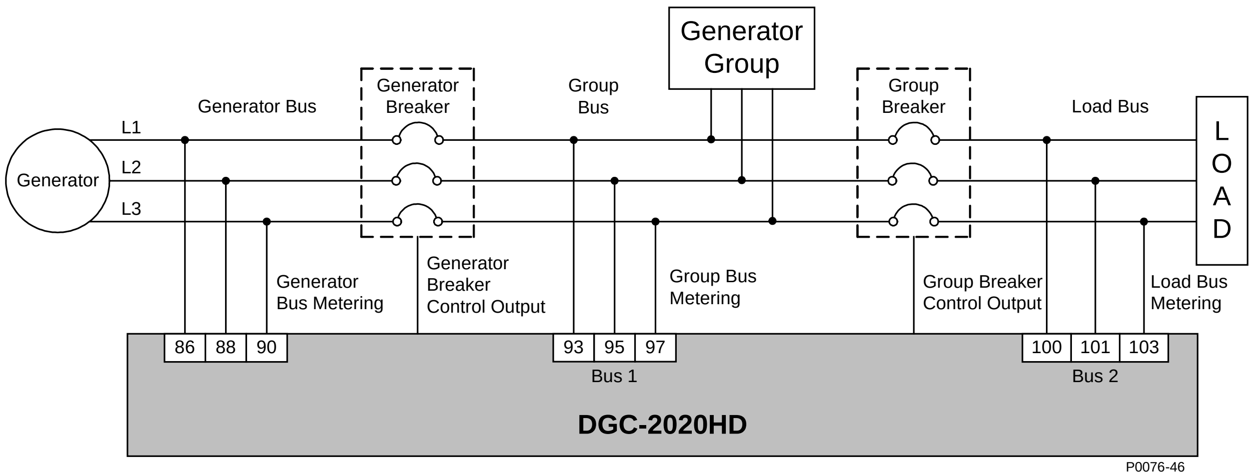


Figure 76. System Breaker Configuration: Generator and Group Breaker Control with Load Bus

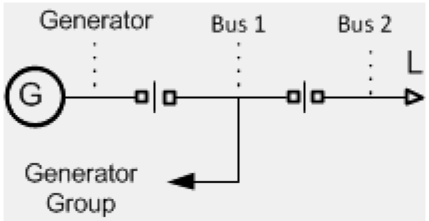


Figure 77. System Breaker Configuration: Generator and Group Breaker Control with Optional Load Bus Metering as Displayed in BESTCOMS*Plus* System Settings

Generator, Group, and Mains Breaker Control

The Generator, Group, and Mains Breaker Control system breaker configuration consists of three breakers controlled by the DGC-2020HD. Figure 78 illustrates a Generator, Group, and Mains Breaker Control system breaker configuration. Figure 79 illustrates the one-line diagram of the Generator, Group, and Mains Breaker Control system breaker configuration as it appears in the BESTCOMS*Plus* System Settings screen.

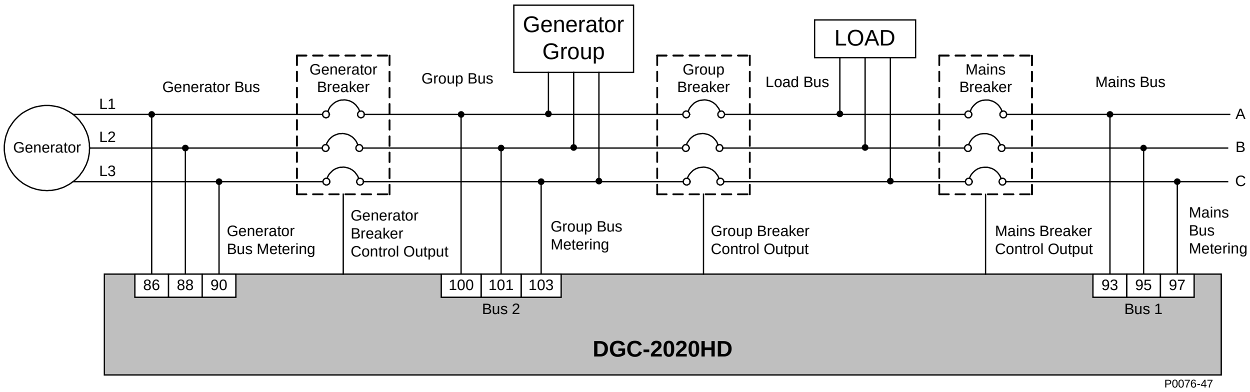


Figure 78. System Breaker Configuration: Generator, Group, and Mains Breaker Control

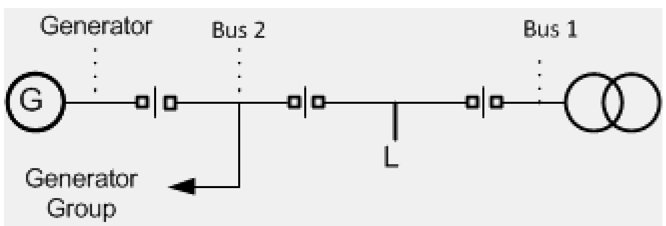


Figure 79. System Breaker Configuration: Generator, Group, and Mains Breaker Control as Displayed in BESTCOMS*Plus* System Settings

Generator Breaker to Segmented System

A system breaker configuration of Generator Breaker to Segmented System consists of a single generator breaker controlled by the DGC-2020HD. Figure 80 illustrates the Generator Breaker to Segmented System breaker configuration. Figure 81 illustrates the one-line diagram of the Generator Breaker to Segmented System configuration as it appears in the BESTCOMS*Plus* System Settings screen.

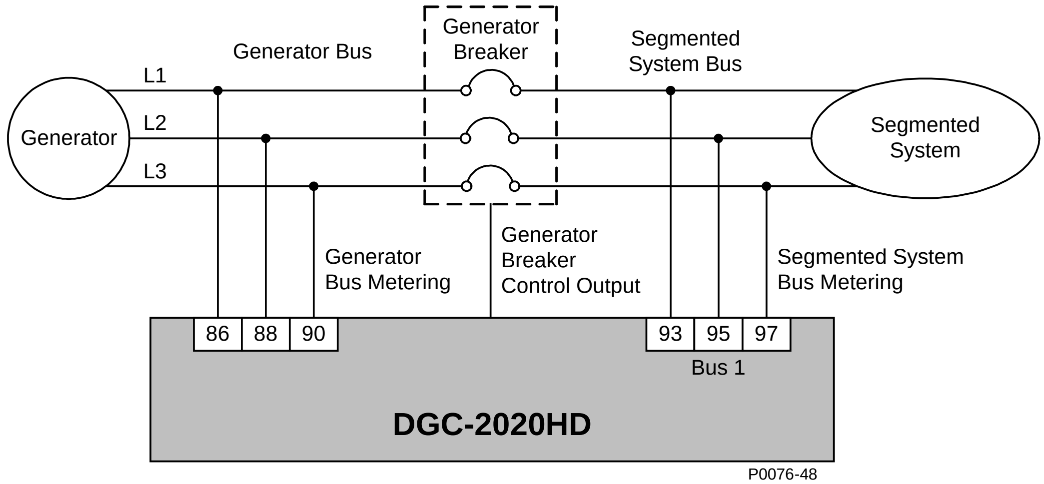


Figure 80. System Breaker Configuration: Generator Breaker to Segmented System

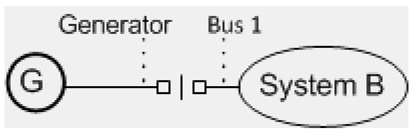


Figure 81. System Breaker Configuration: Generator Breaker to Segmented System as Displayed in BESTCOMS*Plus* System Settings

Generator and Group Breakers to Segmented System

The Generator and Group Breakers to Segmented System breaker configuration consists of two breakers controlled by the DGC-2020HD. Figure 82 illustrates a Generator and Group Breakers to Segmented System breaker configuration. Figure 83 illustrates the one-line diagram of the Generator and Group Breakers to Segmented System breaker configuration as it appears in the BESTCOMS*Plus* System Settings screen.

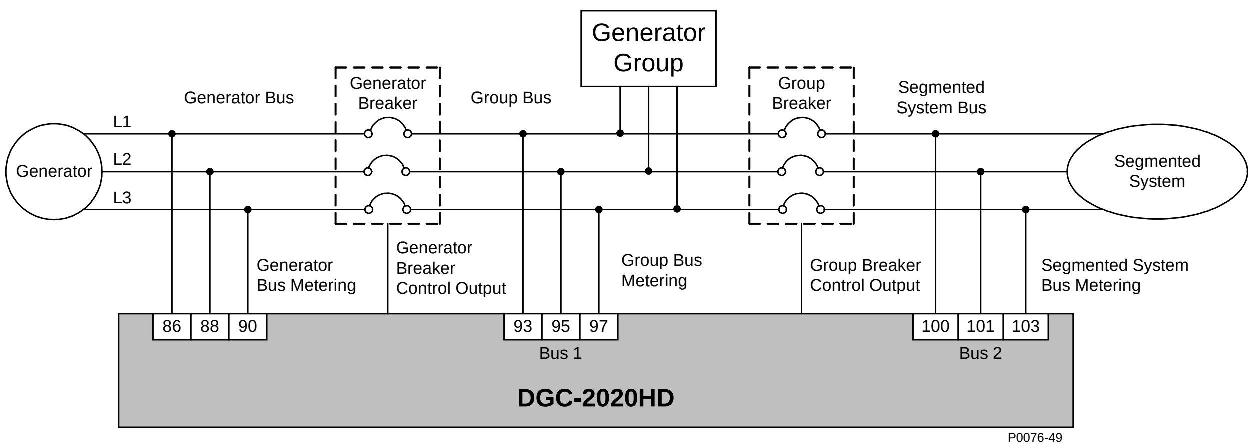


Figure 82. System Breaker Configuration: Generator and Group Breakers to Segmented System

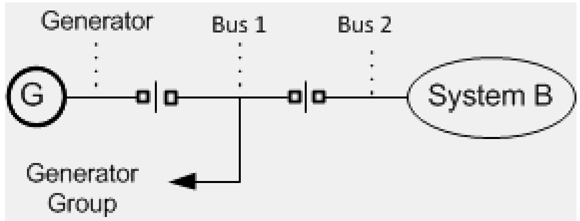


Figure 83. System Breaker Configuration: Generator and Group Breakers to Segmented System as Displayed in BESTCOMS*Plus* System Settings

Tie Breaker Control

A system breaker configuration of Tie Breaker Control consists of a single tie breaker controlled by the DGC-2020HD. Figure 84 illustrates the Tie Breaker Control system breaker configuration. Figure 85 illustrates the one-line diagram of the Tie Breaker Control system breaker configuration as it appears in the BESTCOMS*Plus* System Settings screen.

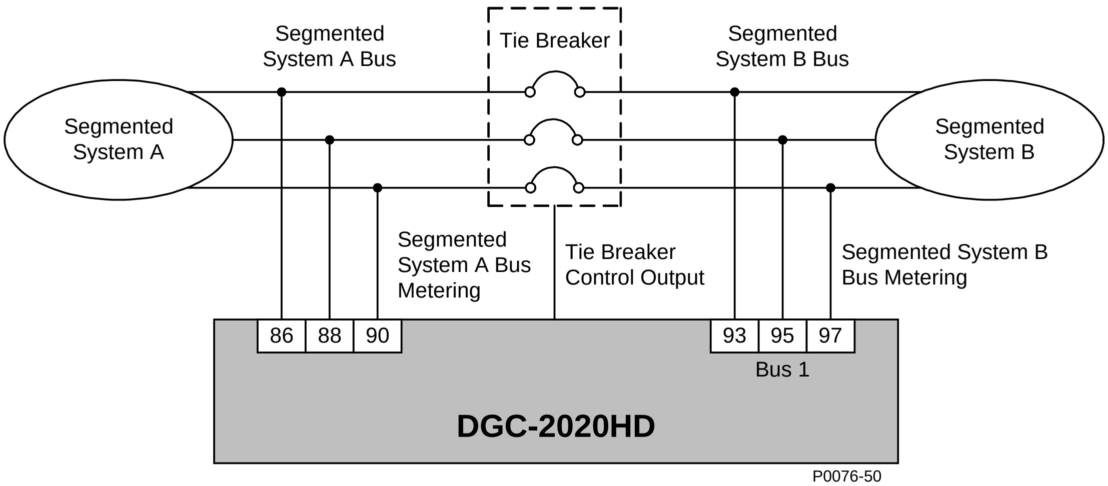


Figure 84. System Breaker Configuration: Tie Breaker Control

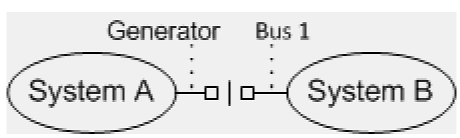


Figure 85. System Breaker Configuration: Tie Breaker Control as Displayed in BESTCOMS*Plus* System Settings

Generator and Tie Breaker Control

The Generator and Tie Breaker configuration consists of two breakers controlled by the DGC-2020HD. Figure 86 illustrates a Generator and Tie Breaker Control breaker configuration. Figure 87 illustrates the one-line diagram of the Generator and Tie Breaker Control breaker configuration as it appears in the BESTCOMS*Plus* System Settings screen.

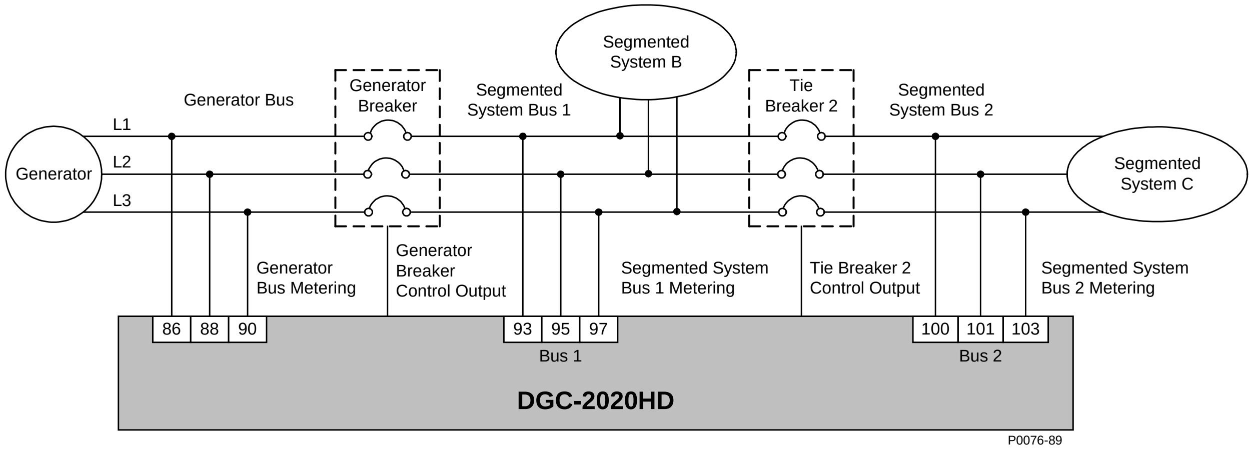


Figure 86. System Breaker Configuration: Generator and Tie Breaker Control

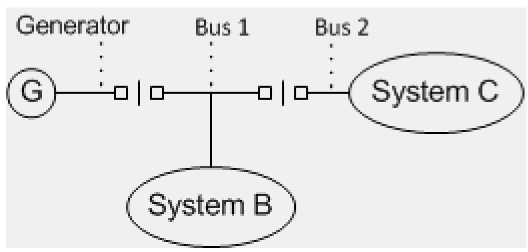


Figure 87. System Breaker Configuration: Generator and Tie Breaker Control as Displayed in BESTCOMS*Plus* System Settings

Tie Breaker and Tie Breaker Control

The Tie Breaker and Tie Breaker Control breaker configuration consists of two breakers controlled by the DGC-2020HD. Figure 88 illustrates a Tie Breaker and Tie Breaker Control breaker configuration. Figure 89 illustrates the one-line diagram of the Tie Breaker and Tie Breaker Control breaker configuration as it appears in the BESTCOMS*Plus* System Settings screen.

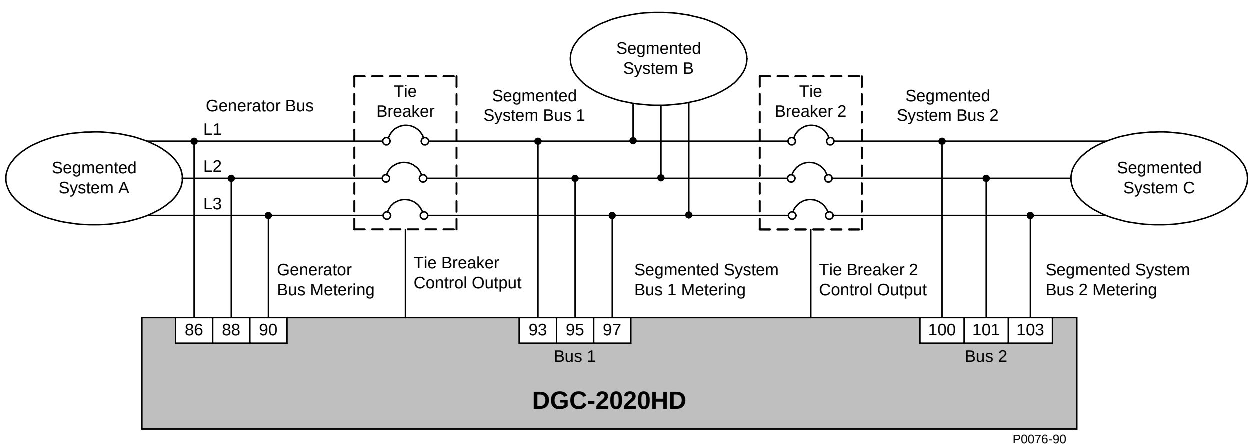


Figure 88. System Breaker Configuration: Tie Breaker and Tie Breaker Control

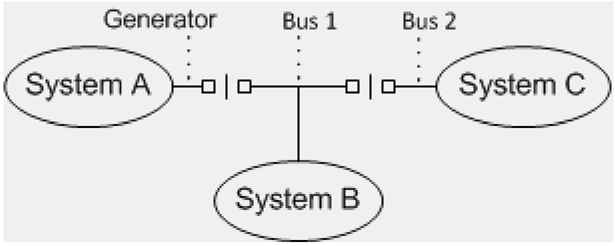


Figure 89. System Breaker Configuration: Tie Breaker and Tie Breaker Control as Displayed in BESTCOMS*Plus* System Settings

Generator Breaker Settings

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Breaker Management, Breaker Hardware, Gen Breaker

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

Breaker Label

A breaker label is a short designation that signifies the use of the breaker. This label appears in reports to provide a unique label for every breaker in the system. This label is also used to detect a lost controller monitoring a specific breaker in the system.

Contact Type, Open Pulse Time, and Close Pulse Time

Breakers controlled by pulse or continuous inputs are supported. Separate settings for the breaker's open and close pulse widths are provided.

Dead Bus Close Enable

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.

Breaker Fail Output Configuration

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.

External Status Change Action

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.

Dead Gen Close Enable

When enabled, the Dead Gen Close Enable setting allows closure of the breaker to a dead bus 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.

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.

Breaker Closing Time

The DGC-2020HD uses the Breaker Closing Time to calculate the optimum time to close the breaker during synchronization in Anticipatory mode.

Phase Angle Compensation

A phase angle compensation setting is provided to offset phase shift caused by transformers in the system. The phase angle compensation value is added to the metered slip angle of the buses on either side of the breaker. Equation 7 illustrates the DGC-2020HD slip angle calculation.

$$(G - B) + A = Slip\ Angle$$

Equation 7. DGC-2020HD Metered Slip Angle

Where:
- G = metered generator bus angle
- B = metered bus angle
- A = phase angle compensation value

Breaker Open Setpoint Level and Delay

This setting prevents the breaker from opening until the power through the breaker decreases below a user-defined level for the duration of a time delay. The level is a percentage of rated power for the bus.

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.

Open Attempts, Close Attempts, and Retry Delay

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.

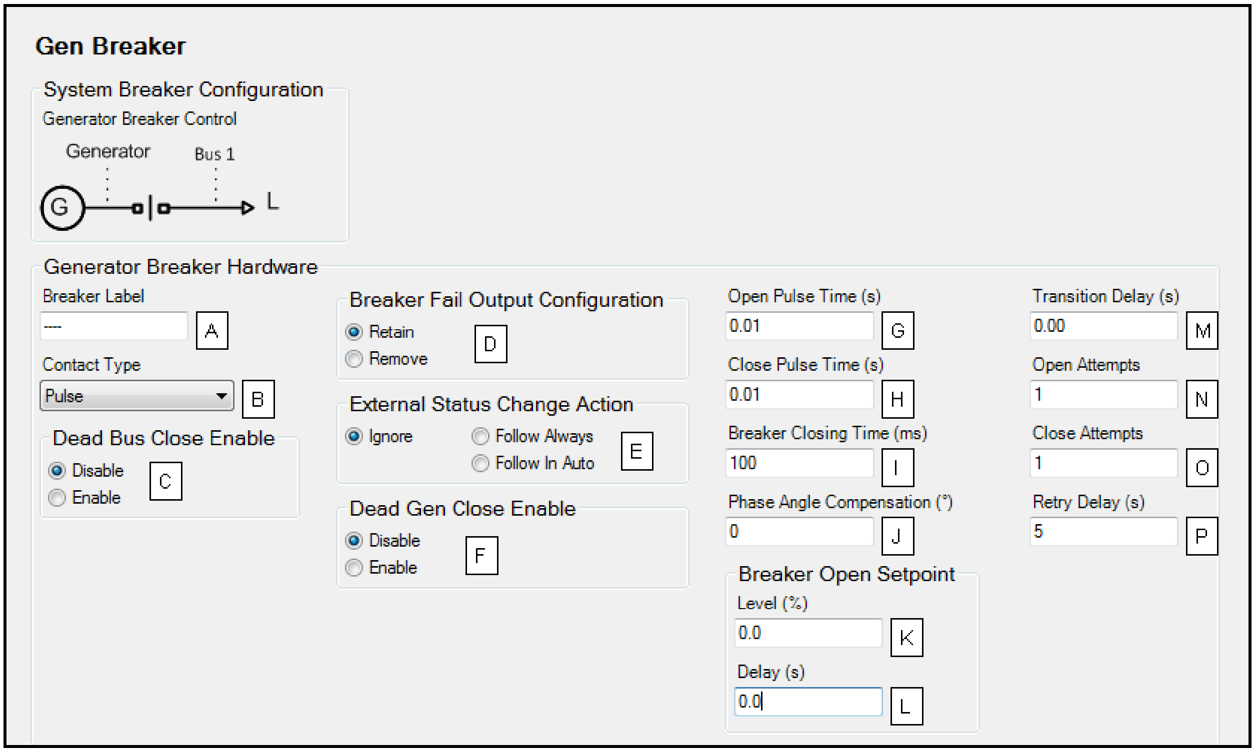


Figure 90. Settings Explorer, Breaker Management, Breaker Hardware, Gen Breaker Screen

Table 34. Settings for Gen Breaker Screen

Locator	Setting	Range	Increment	Unit
A	Breaker Label	Up to 4 alphanumeric characters	n/a	n/a
B	Contact Type	Continuous or Pulse	n/a	n/a
C	Dead Bus Close Enable	Disable or Enable	n/a	n/a
D	Breaker Fail Output Configuration	Retain or Remove	n/a	n/a
E	External Status Change Action	Ignore, Follow Always, or Follow in Auto	n/a	n/a
F	Dead Gen Close Enable	Disable or Enable	n/a	n/a
G	Open Pulse Time	0.01 to 10	0.01	seconds
H	Close Pulse Time	0.01 to 10	0.01	seconds
I	Breaker Closing Time	0 to 1,000	1	milliseconds
J	Phase Angle Compensation	-180 to 180	1	degrees
K	Breaker Open Setpoint Level	0 to 100	0.1	% of rated bus power
L	Breaker Open Setpoint Delay	0 to 60	0.1	seconds
M	Transition Delay	0 to 10	0.01	seconds
N	Open Attempts	1 to 20	1	attempts
O	Close Attempts	1 to 20	1	attempts
P	Retry Delay	0 to 1,200	1	seconds

Mains Breaker Settings

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Breaker Management, Breaker Hardware, Mains Breaker

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

Breaker Label

A breaker label is a short designation that signifies the use of the breaker. This label appears in reports to provide a unique label for every breaker in the system. This label is also used to detect a lost controller monitoring a specific breaker in the system.

Contact Type, Open Pulse Time, and Close Pulse Time

Breakers controlled by pulse or continuous inputs are supported. Separate settings for the breaker's open and close pulse widths are provided.

Breaker Fail Output Configuration

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.

External Status Change Action

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.

Mains to Mains Close Enable

This setting allows closing the breaker when it is determined that this will indirectly connect two mains feed ties together, possibly through a series of additional external tie breakers and mains breakers.

Live Bus Close Enable

When enabled, this setting allows closure of the mains breaker to a live bus.

Breaker Closing Time

The DGC-2020HD uses the Breaker Closing Time to calculate the optimum time to close the breaker during synchronization in Anticipatory mode.

Phase Angle Compensation

A phase angle compensation setting is provided to offset phase shift caused by transformers in the system. The phase angle compensation value is added to the metered slip angle of the buses on either side of the breaker. Equation 8 illustrates the DGC-2020HD slip angle calculation.

$$(B - M) + A = Slip\ Angle$$

Equation 8. DGC-2020HD Metered Slip Angle

Where:
- B = metered bus angle
- M = metered mains bus angle
- A = phase angle compensation value

Breaker Open Setpoint Level and Delay

This setting prevents the breaker from opening until the power through the breaker decreases below a user-defined level for the duration of a time delay. The level is a percentage of rated power for the bus.

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.

Open Attempts, Close Attempts, and Retry Delay

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.

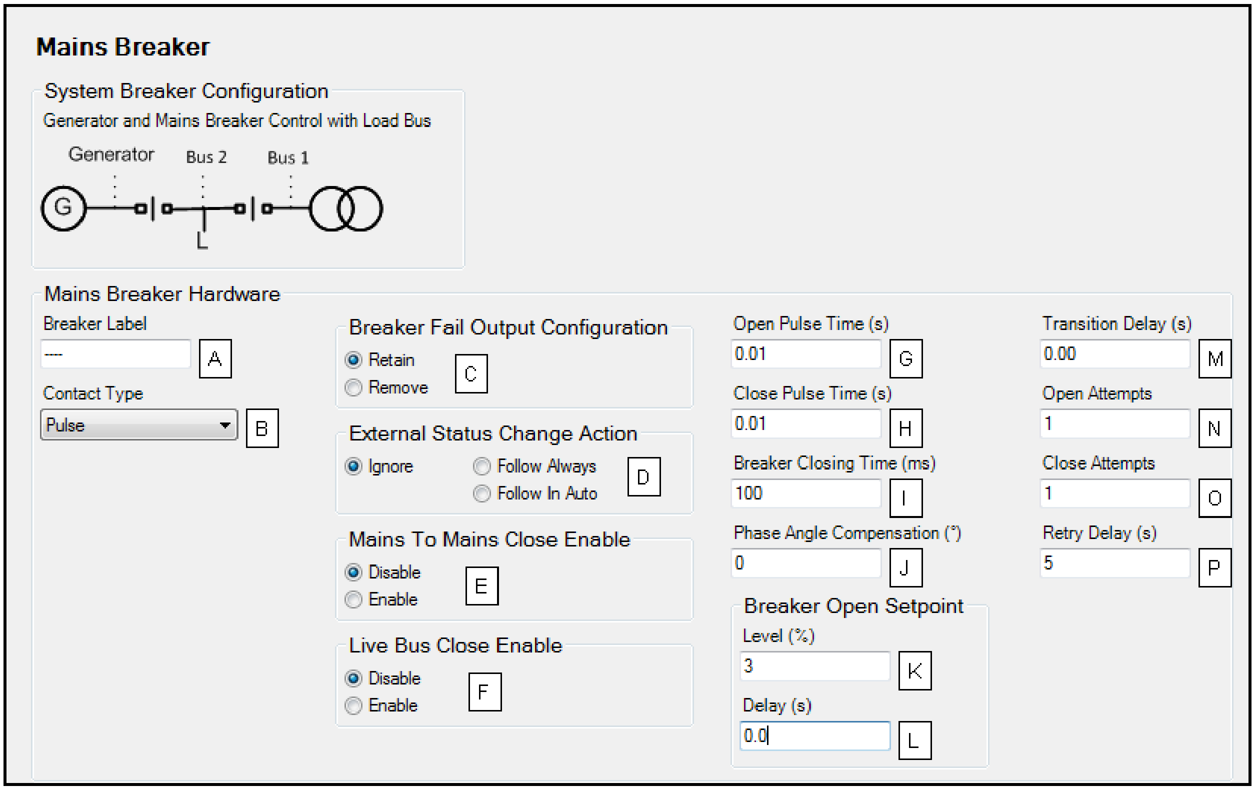


Figure 91. Settings Explorer, Breaker Management, Breaker Hardware, Mains Breaker Screen

Table 35. Settings for Mains Breaker Screen

Locator	Setting	Range	Increment	Unit
A	Breaker Label	Up to 4 alphanumeric characters	n/a	n/a
B	Contact Type	Continuous or Pulse	n/a	n/a
C	Breaker Fail Output Configuration	Retain or Remove	n/a	n/a
D	External Status Change Action	Ignore, Follow Always, or Follow in Auto	n/a	n/a
E	Mains to Mains Close Enable	Disable or Enable	n/a	n/a
F	Live Bus Close Enable	Disable or Enable	n/a	n/a
G	Open Pulse Time	0.01 to 10	0.01	seconds

Locator	Setting	Range	Increment	Unit
H	Close Pulse Time	0.01 to 10	0.01	seconds
I	Breaker Closing Time	0 to 1,000	1	milliseconds
J	Phase Angle Compensation	-180 to 180	1	degrees
K	Breaker Open Setpoint Level	0 to 100	0.1	% of rated bus power
L	Breaker Open Setpoint Delay	0 to 60	0.1	seconds
M	Transition Delay	0 to 10	0.01	seconds
N	Open Attempts	1 to 20	1	attempts
O	Close Attempts	1 to 20	1	attempts
P	Retry Delay	0 to 1,200	1	seconds

Group Breaker Settings

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Breaker Management, Breaker Hardware, Group Breaker

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

Breaker Label

A breaker label is a short designation that signifies the use of the breaker. This label appears in reports to provide a unique label for every breaker in the system. This label is also used to detect a lost controller monitoring a specific breaker in the system.

Contact Type, Open Pulse Time, and Close Pulse Time

Breakers controlled by pulse or continuous inputs are supported. Separate settings for the breaker's open and close pulse widths are provided.

Dead Group Close Enable

Enabling this setting allows closure of the group breaker when the group bus is dead.

Breaker Fail Output Configuration

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.

External Status Change Action

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.

Live Bus Close Enable

When enabled, this setting allows closure of the group breaker to a live bus.

Breaker Closing Time

The DGC-2020HD uses the Breaker Closing Time to calculate the optimum time to close the breaker during synchronization in Anticipatory mode.

Phase Angle Compensation

A phase angle compensation setting is provided to offset phase shift caused by transformers in the system. The phase angle compensation value is added to the metered slip angle of the buses on either side of the breaker. Equation 9 illustrates the DGC-2020HD slip angle calculation.

$$(G - B) + A = Slip\ Angle$$

Equation 9. DGC-2020HD Metered Slip Angle

Where:

G = metered group bus angle
B = metered bus angle
A = phase angle compensation value

Breaker Open Setpoint Level and Delay

This setting prevents the breaker from opening until the power through the breaker decreases below a user-defined level for the duration of a time delay. The level is a percentage of rated power for the bus.

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.

Open Attempts, Close Attempts, and Retry Delay

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.

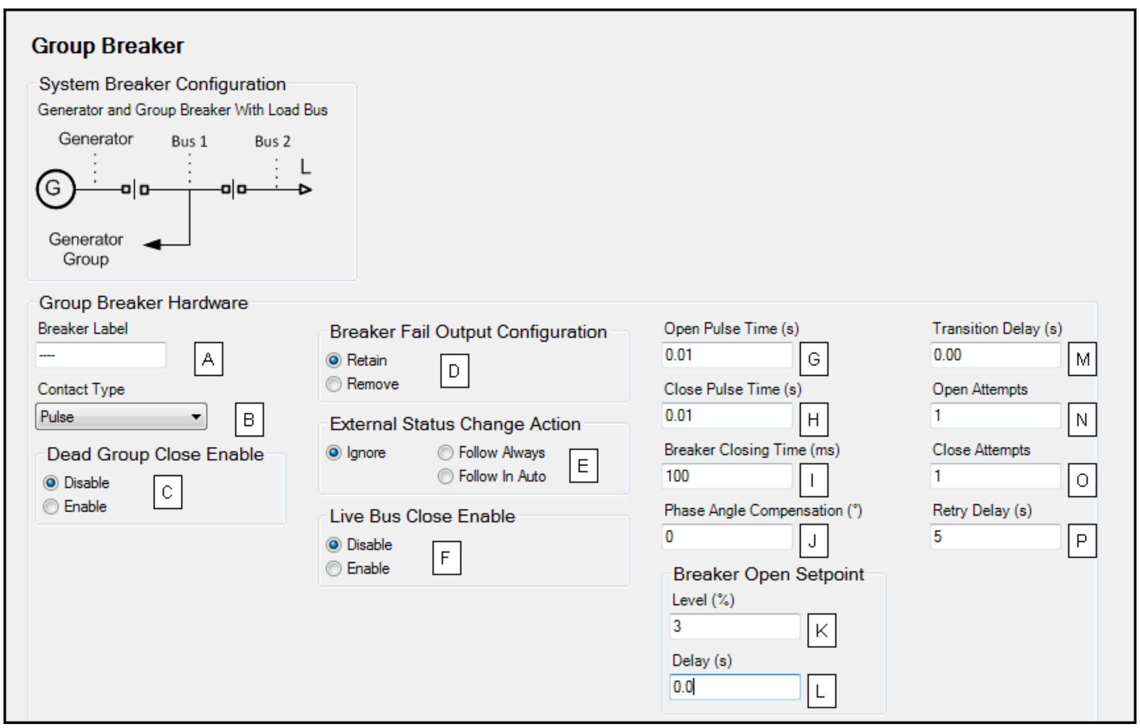


Figure 92. Settings Explorer, Breaker Management, Breaker Hardware, Group Breaker Screen

Table 36. Settings for Group Breaker Screen

Locator	Setting	Range	Increment	Unit
A	Breaker Label	Up to 4 alphanumeric characters	n/a	n/a
B	Contact Type	Continuous or Pulse	n/a	n/a
C	Dead Group Close Enable	Disable or Enable	n/a	n/a
D	Breaker Fail Output Configuration	Retain or Remove	n/a	n/a
E	External Status Change Action	Ignore, Follow Always, or Follow in Auto	n/a	n/a
F	Live Bus Close Enable	Disable or Enable	n/a	n/a
G	Open Pulse Time	0.01 to 10	0.01	seconds
H	Close Pulse Time	0.01 to 10	0.01	seconds
I	Breaker Closing Time	0 to 1,000	1	milliseconds
J	Phase Angle Compensation	-180 to 180	1	degrees
K	Breaker Open Setpoint Level	0 to 100	0.1	% of rated bus power
L	Breaker Open Setpoint Delay	0 to 60	0.1	seconds
M	Transition Delay	0 to 10	0.01	seconds
N	Open Attempts	1 to 20	1	attempts
O	Close Attempts	1 to 20	1	attempts
P	Retry Delay	0 to 1,200	1	seconds

Tie Breaker Settings

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Breaker Management, Breaker Hardware, Tie Breaker

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

Breaker Label

A breaker label is a short designation that signifies the use of the breaker. This label appears in reports to identify each breaker in the system. This label is also used to detect a lost controller monitoring a specific breaker in the system.

Contact Type, Open Pulse Time, and Close Pulse Time

Breakers controlled by pulse or continuous inputs are supported. Separate settings for the breaker's open and close pulse widths are provided.

Mains to Mains Close Enable

This setting allows closing the breaker when it is determined that this will indirectly connect two mains feed ties together, possibly through a series of additional external tie breakers and mains breakers.

Dead A to Dead B Close Enable

Enabling this setting allows the breaker to close when Bus A and Bus B are both dead.

Dead A to Live B Close Enable

When enabled, this setting allows the breaker to close when Bus A is dead and Bus B is live.

Live A to Dead B Close Enable

When enabled, this setting allows the breaker to close when Bus A is live and Bus B is dead.

Live A to Live B Close Enable

Enabling this setting allows the breaker to close when Bus A and Bus B are both live.

Dead Gen Close Enable

When enabled, this setting allows the breaker to close if both sides are dead and if generators are detected on either side of breaker connection. This also requires Dead A to Dead B Close Enable to be enabled.

Live Load Close Enable

Enabling this setting allows synchronizing and closing the breaker to a live load bus that is not being driven by any detected generator or mains connection in the system.

Breaker Fail Output Configuration

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.

External Status Change Action

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.

Breaker Closing Time

The DGC-2020HD uses the Breaker Closing Time to calculate the optimum time to close the breaker during synchronization in Anticipatory mode.

Phase Angle Compensation

A phase angle compensation setting is provided to offset phase shift caused by transformers in the system. The phase angle compensation value is added to the metered slip angle of the buses on either side of the breaker. Equation 10 defines the DGC-2020HD slip angle calculation.

$$(S_A - S_B) + A = Slip\ Angle$$

Equation 10. DGC-2020HD Metered Slip Angle

Where:

S_A = metered segmented system bus A angle
S_B = metered segmented system bus B angle
A = phase angle compensation value

Breaker Open Setpoint Level and Delay

This setting prevents the breaker from opening until the power through the breaker decreases below a user-defined level for the duration of a time delay. The level is a percentage of rated power for the bus.

Mains Tie Side

This setting defines the side of the breaker which may connect to the mains bus.

Sync Adjust Side

Sync Adjust Side defines the side of the breaker which is to be adjusted during synchronization. This setting is only available when Mains Tie Side is set to None.

Positive Power Sign

This setting establishes which direction metered positive power is flowing through the controlled tie breaker (depending on CT direction). This is used in zero power breaker open requests.

Power Measurement Side

This setting defines the side of the breaker from which power measurements are taken. These power measurements are used by various DGC-2020HD functions. Available selections are: Side A or Side B.

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.

Open Attempts, Close Attempts, and Retry Delay

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.

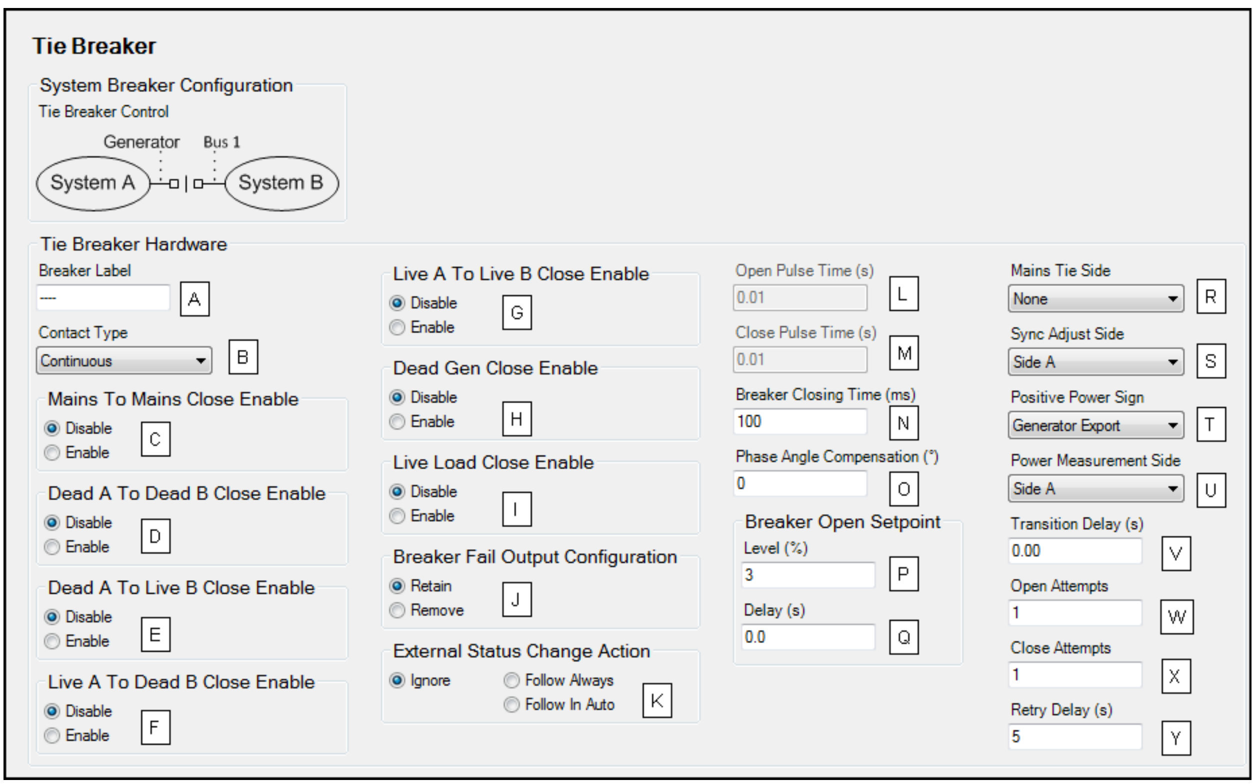


Figure 93. Settings Explorer, Breaker Management, Breaker Hardware, Tie Breaker Screen

Table 37. Settings for Tie Breaker Screen

Locator	Setting	Range	Increment	Unit
A	Breaker Label	Up to 4 alphanumeric characters	n/a	n/a
B	Contact Type	Continuous or Pulse	n/a	n/a
C	Mains to Mains Close Enable	Disable or Enable	n/a	n/a
D	Dead A to Dead B Close Enable	Disable or Enable	n/a	n/a
E	Dead A to Live B Close Enable	Disable or Enable	n/a	n/a
F	Live A to Dead B Close Enable	Disable or Enable	n/a	n/a
G	Live A to Live B Close Enable	Disable or Enable	n/a	n/a
H	Dead Gen Close Enable	Disable or Enable	n/a	n/a
I	Live Load Close Enable	Disable or Enable	n/a	n/a
J	Breaker Fail Output Configuration	Retain or Remove	n/a	n/a
K	External Status Change Action	Ignore, Follow Always, or Follow in Auto	n/a	n/a
L	Open Pulse Time	0.01 to 10	0.01	seconds
M	Close Pulse Time	0.01 to 10	0.01	seconds
N	Breaker Closing Time	0 to 1,000	1	milliseconds
O	Phase Angle Compensation	-180 to 180	1	degrees
P	Breaker Open Setpoint Level	0 to 100	0.1	% of rated bus power
Q	Breaker Open Setpoint Delay	0 to 60	0.1	seconds
R	Mains Tie Side	None, Side A, or Side B	n/a	n/a
S	Sync Adjust Side	Side A, or Side B	n/a	n/a
T	Positive Power Sign	Generator Export or Mains Import	n/a	n/a
U	Power Measurement Side	Side A or Side B	n/a	n/a
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

Tie Breaker 2 Settings

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Breaker Management, Breaker Hardware, Tie Breaker 2

Front Panel Navigation Path: Settings Explorer > Breaker Management > Breaker Hardware > Tie Breaker 2

The Tie Breaker 2 Settings are identical to the Tie Breaker settings listed above, except for the following:

Dead B to Dead C Close Enable

Enabling this setting allows the breaker to close when Bus B and Bus C are both dead.

Dead B to Live C Close Enable

When enabled, this setting allows the breaker to close when Bus B is dead and Bus C is live.

Live B to Dead C Close Enable

When enabled, this setting allows the breaker to close when Bus B is live and Bus C is dead.

Live B to Live C Close Enable

Enabling this setting allows the breaker to close when Bus B and Bus C are both live.

Mains Tie Side

This setting defines the side of the breaker which may connect to the mains bus. Available selections are: None, Side B, or Side C.

Sync Adjust Side

Sync Adjust Side defines the side of the breaker which is to be adjusted during synchronization. This setting is only available when Mains Tie Side is set to None. Available selections are: Side B or Side C.

Power Measurement Side

This setting defines the side of the breaker from which power measurements are taken. These power measurements are used by various DGC-2020HD functions. Available selections are: Side B or Side C.

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 AVRs are turned on. The user must develop logic to start the generators and turn on excitation in the voltage regulators at the correct time for orderly system startup.

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

Mains Fail Transfer

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Breaker Management, Breaker Management

Front Panel Navigation Path: Settings Explorer > Breaker Management > Breaker Management > Mains Fail Transfer

For system breaker configurations which include a mains breaker, the DGC-2020HD can automatically transfer load power from the mains to a single genset or a group of gensets during a mains failure. This feature also enables the DGC-2020HD to transfer the load back to the mains once mains power is restored.

The possible generator and breaker control configurations are described in the following paragraphs.

Single Generator with Two Breaker Control: In this configuration, a single generator start command is used to start the controlled generator upon mains fail. The transfer logic is configured in the controller which must be configured to sense mains power and control the mains breaker.

Generator Group with Two Breaker Control: In this configuration, group start commands are used to start multiple machines in the group simultaneously upon mains fail. The transfer logic can be configured in any controller in the system configured to sense mains power and control the mains breaker, or it can be on a separate tie breaker controller on the mains breaker. Every generator in the group must be large enough to pick up the entire load in the system by itself. One machine will always close onto the bus first, because there is no group bus and therefore must be capable of driving the load.

Generator Group with Three Breaker Control: In this configuration, group start commands are used to start multiple machines in the group simultaneously upon mains fail. The transfer logic can be configured in any controller in the system configured to sense mains power and control the mains breaker or it can be on a separate tie breaker controller on the mains breaker. The group breaker can be controlled by any controller sensing the group and load bus or by a separate tie breaker controller on the group breaker. This mode allows paralleling multiple machines onto the group bus before closing the group breaker to allow picking up larger load than any one machine could handle by itself.

Single Generator with Three Breaker Control: This configuration is supported, although it has little practical purpose.

Mains Fail Transfer Type

When Mains Fail Transfer is enabled, the generators controlled by the DGC-2020HD are configured as mains fail generators or standby power generators which take over when utility power fails. There are two types of transitions between the generators and the utility that are set with the Mains Fail Transfer Type setting: (1) Open transitions in which the generator and mains breakers are never closed at the same time, and (2) Closed transitions in which the generators parallel to the utility for a short time to transfer load to the generators from the utility (a load takeover) or transfer the load from the generators to the utility.

Open Transition

In open transitions, when a mains failure occurs, the DGC-2020HD starts the generators after the transfer time expires. The DGC-2020HD opens the mains breaker either before the generators start or after the generators are 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 or group breaker to drive the load. When the mains power returns, after the Mains Fail Return Delay time expires, the DGC-2020HD opens its generator or group breaker. Then, after the Open Transition Delay time expires, the mains breaker closes. If the In Phase Monitor setting 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 generators and the mains before performing the open transition from the generators 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.

Closed Transitions

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

Mains Fail Transfer Process

The steps taken by the DGC-2020HD during mains fail transfer and load takeover are listed below.

Single Generator with Two Breaker Control

Mains Fail Transfer

1. Mains provides power.
    a. Detect Mains Fail or Mains Fail Test logic element asserted.
2. Transition to generator power after mains fail transfer delay expires.
    a. If Open Mains Breaker on Generator Start is enabled, open mains breaker now.
    b. Start generator. Wait until generator bus is stable.
    c. If Open Mains Breaker on Generator Stable is enabled, open mains breaker now.
    d. Close generator breaker onto now dead load bus.
3. Generator provides power.
    a. Detect mains return.
4. Transition to mains after return delay.
    a. Open Transition
        i. Open generator breaker and close mains breaker (With In Phase Monitor or Open Transition Delay).
    b. Closed Transition
        i. Sync and close mains breaker.
        ii. Unload generator based on ramp rate.
        iii. Open generator breaker when Generator Breaker Open Setpoint is reached or after Max Parallel Time.
    c. Machine will automatically cool down and stop if no other run requests are active.
5. Back to 1.

Load Takeover Transfer

1. Mains provides power.
    a. Load Takeover is applied.
2. Transition to generator power.
    a. Start generator. Wait for generator to be stable.
    b. Open Transition
        i. Open mains breaker and close generator breaker (With In Phase Monitor or open transition delay).
    c. Closed Transition
        i. Sync and close generator breaker to load bus.
        ii. Soft load based on ramp rate.
        iii. Open mains breaker at Mains Breaker Open Setpoint (if mains CT is configured), when baseload level is reached, or after max parallel time.
3. Generator provides power.
    a. Load Takeover is removed.
4. Transition to mains as in Mains Fail Transfer step 4, above.
5. Back to 1.

Generator Group with Two Breaker Control

Mains Fail Transfer

1. Mains provides power.
    a. Detect Mains Fail or Mains Fail Test logic element asserted.
2. Transition to generator power after mains fail transfer delay expires.
    a. Start generators based on Group Start Mode. If Open Mains Breaker on Generator Start is enabled, open mains breaker now.

   b. Wait until at least one generator is stable.
   c. If Open Mains Breaker on Generator Stable is enabled, open mains breaker now.
   d. Wait until at least one generator breaker is closed onto the load bus. Each generator waits until the local generator bus is stable before closing. The first generator to close will close onto a dead bus, the rest will synchronize.
3. Generators provide power.
   a. Detect mains return.
4. Transition to mains after return delay.
   a. Open Transition
      i. Request all generators in the group to immediately open generator breaker.
      ii. When all generator breakers in the system are reported as open, close mains breaker. Open transition delay applies from time all generator breakers are open. **In Phase Monitor is not supported in this configuration as each generator is allowed to open their gen breaker independently**.
   b. Closed Transition
      i. Synchronize and close mains breaker. This occurs with a group sync request.
      ii. Group stop request is sent to all generators.
      iii. Each generator unloads based on individual ramp rates, opens local generator breaker when Generator Breaker Open Setpoint is reached, cools down and stops if no other run requests are active.
      iv. If the max parallel time expires and any generator breaker is still closed, request all generators in the group to immediately open generator breaker.
5. Back to 1.

Load Takeover Transfer

1. Mains provides power.
   a. Load Takeover is applied.
2. Transition to generator power.
   a. Start generators based on Group Start Mode.
   b. Open Transition
      i. Wait until at least one generator is stable. Generator breaker closure is inhibited until mains breaker is open.
      ii. Open mains breaker now.
      iii. Allow generator breaker closure now or after open transition delay. Wait until at least one generator breaker is closed onto the load bus. Each generator waits until the local generator bus is stable before closing. The first generator to close will close onto a dead bus, the rest will synchronize. **In Phase Monitor is not supported in this configuration as each generator is allowed to close their gen breaker independently**.
   c. Closed Transition
      i. Each generator synchronizes and closes generator breaker to load bus.
      ii. Each generator soft loads based on individual ramp rates. The ramp stop level is determined by the mains fail controller (tie breaker controller or genset controller sensing mains power).
      iii. Open mains breaker at Mains Breaker Open Setpoint or after max parallel time.
3. Generators provide power.
   a. Load Takeover removed.
4. Transition to mains as in mains fail step 4, above.
5. Back to 1.

<u>Generator Group with Three Breaker Control</u>

Mains Fail Transfer

1. Mains provides power.
    a. Detect Mains Fail or Mains Fail Test logic element is asserted.
2. Transition to generator power after mains fail transfer delay expires.
    a. Start generators based on Group Start Mode. If Open Mains Breaker on Generator Start is enabled, open mains breaker now.
    b. If group breaker is closed, open the group breaker now. Local generator breaker close and sync to group bus is inhibited until group breaker is open to prevent paralleling to failed mains.
    c. All generators start and synchronize onto group bus. Wait until enough generators are running to meet block load level demand setting.
    d. If Open Mains Breaker on Generator Stable is enabled, open mains breaker now.
    e. Close group breaker onto now dead load bus.
3. Generators provide power.
    a. Detect mains return.
4. Transition to mains after return delay.
    a. Open Transition
        i. Open group breaker and close mains breaker (With In Phase Monitor or open transition delay).
    b. Closed Transition
        i. Sync and close mains breaker. This will occur with a group sync request.
        ii. Unload request is sent to all generators. Each generator will unload based on individual ramp rates.
        iii. Open group breaker when Group Breaker Open Setpoint is reached or after max parallel time.
    c. Send group stop request to all generators. Since group breaker is already open, load on each generator should be zero. Therefore each generator should immediately open their local generator breakers with the stop request.
5. Back to 1.

Load Takeover Transfer

1. Mains provides power.
    a. Load Takeover is applied.
2. Transition to generator power.
    a. Start generators based on Group Start Mode.
    b. If group breaker is closed, open the group breaker now. Local generator breaker closure and sync to group bus is inhibited until group breaker is open. Group breaker must be open to allow fast closed transition times and prevent possibly overloading generators on open transitions.
    c. All generators start and sync onto group bus. Wait until enough generators are closed to the group bus to pick up the measured mains load.
    d. Open Transition
        i. Open mains breaker and close group breaker (With In Phase Monitor or open transition delay).
    e. Closed Transition
        i. Sync and close group breaker to load bus. This occurs with a group sync request.
        ii. Soft load request is sent to all generators. Each generator takes on load based on individual ramp rates. The ramp stop level is determined by the mains fail controller (tie breaker controller or genset controller sensing mains power).
        iii. Open mains breaker at Mains Breaker Open Setpoint or after max parallel time.

3. Generators provide power.
    a. Load Takeover removed.
4. Transition to mains as in mains fail step 4, above.
5. Back to 1.

Single Generator with Three Breaker Control

Mains Fail Transfer

1. Mains provides power.
    a. Detect Mains Fail or Mains Fail Test logic element is asserted.
2. Transition to generator power after mains fail transfer delay expires.
    a. Start generator. If Open Mains Breaker on Generator Start is enabled, open mains breaker now.
    b. If group breaker is closed, open the group breaker now.
    c. Wait until generator bus is stable. Sync and close generator breaker onto group bus. **The single machine rating must be greater than the block load level in this configuration otherwise the group breaker will never close.**
    d. If Open Mains Breaker on Generator Stable is enabled, open mains breaker now.
    e. Close group breaker onto now dead load bus.
3. Generator provides power.
    a. Detect mains return.
4. Transition to Mains after return delay.
    a. Open Transition
        i. Open group breaker and close mains breaker (With In Phase Monitor or open transition delay).
    b. Closed Transition
        i. Sync and close mains breaker.
        ii. Unload generator based on ramp rate.
        iii. Open group breaker when Group Breaker Open Setpoint is reached or after Max Parallel Time.
    c. Open generator breaker.
    d. Machine will automatically cool down and stop if no other run requests are active.
5. Back to 1.

Load Takeover Transfer

1. Mains is providing power.
    a. Load Takeover is applied.
2. Transition to generator power.
    a. Start generator.
    b. If group breaker is closed, open the group breaker now.
    c. Wait until generator bus is stable. Sync and close generator breaker onto group bus. **The single machine rating must be greater than the measured mains power in this configuration otherwise the group breaker will never close.**
    d. Open Transition
        i. Open mains breaker and close group breaker (With In Phase Monitor or open transition delay).
    e. Closed Transition
        i. Sync and close group breaker to load bus.
        ii. Soft load based on ramp rate.
        iii. Open mains breaker at Mains Breaker Open Setpoint (if mains CT is configured), when baseload level is reached, or after max parallel time.
3. Generator provides power.

    a. Load Takeover is removed.
4. Transition to mains as in mains fail step 4, above.
5. Back to 1.

Logic Elements

Several logic elements are present in BESTlogic*Plus* Programmable Logic that can be used on Mains Fail Transfer enabled machines. These logic elements are described below.

Parallel To Mains (PARTOMAINS)

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.

Auto Breaker Operation Inhibit (AUTOBRKOPINHIBIT)

When the Auto Breaker Operation Inhibit element is set true, it prevents all automatic breaker operation.

Mains Fail Transfer Inhibit (MAINSFLTRINHIBIT)

When the Mains Fail Transfer Inhibit element is set true, it prevents automatic load transfer due to a mains failure.

Closed Transition Override (CLOSEDTRANSITIONOVR)

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.

Mains Fail Test

When true, the Mains Fail Test logic element causes the DGC-2020HD to react exactly as if the mains has failed. The following sequence of events occurs:
1. Mains Fail Transfer Delay time expires
2. Generators start
3. Mains breaker is opened either before the generators start or after the generators become stable (based on the Mains Breaker Open Configuration setting)
4. Generators become stable
5. DGC-2020HD closes its generator or group breaker to drive the load

When the Mains Fail Test logic element is false, the DGC-2020HD reacts as if the mains has returned, the Mains Fail Return Delay time expires, and the controller transitions the load from the generators back to the utility in an Open or Closed transition, according to the Mains Fail Transfer Type setting.

Load Take Over

The Load Take Over logic element is similar to the Mains Fail Test element, 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. Generators start
2. Mains breaker is opened either before the generators start or after the generators become stable (based on the Mains Breaker Open Configuration setting)
3. Generators become stable
4. DGC-2020HD closes its generator or group breaker to drive the load

When the Load Take Over logic element is false, the DGC-2020HD opens its generator or group breaker and closes the mains breaker to transition the load back to the utility. If the In Phase Monitor setting 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 generators start, synchronize to the utility, and the DGC-2020HD closes the generator or group breaker. When an auxiliary CT is configured to meter the mains bus, the mains breaker power level is measured.

In this case, the generators take on load either until the power measured at the mains breaker is less than or equal to the Breaker Open Setpoint Level setting, or for the duration of the Max Parallel Time. Breaker Open Setpoint Level is found in the appropriate Breaker Hardware settings. Once one of these conditions has been reached, the mains breaker opens, leaving load on the generators. When no auxiliary CT is configured to meter the mains bus, the generators take on load either until they are 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 generators.

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

Mains Fail Transfer Alarms and Pre-Alarms

The following paragraphs describe the alarms and pre-alarms associated with mains fail transfer.

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 generators are 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.

With the Group Breaker Capacity Not Reached pre-alarm enabled, load will not be transferred to a generator group if the online capacity is not greater than or equal to the active block load level after the Capacity Not Reached Delay expires. When enabled, the Close Enable setting allows the group breaker to close when the Capacity Not Reached pre-alarm activates regardless of the online capacity. If the online capacity does not meet or exceed the active block load level within the Capacity Not Reached Fail Delay, the group breaker close request is aborted. It will not close the group breaker after this point even if additional generation comes online. To reset the pre-alarm, press the reset button on the front panel. The pre-alarm will also clear if a group breaker open request is given or if the group breaker is closed manually. See Multiple Generator Management chapter for more information on group starting.

Breaker Management and Mains Fail Transfer Settings

The BESTCOMS*Plus* Breaker Management settings screen is illustrated in Figure 94. Settings are listed in Table 38.

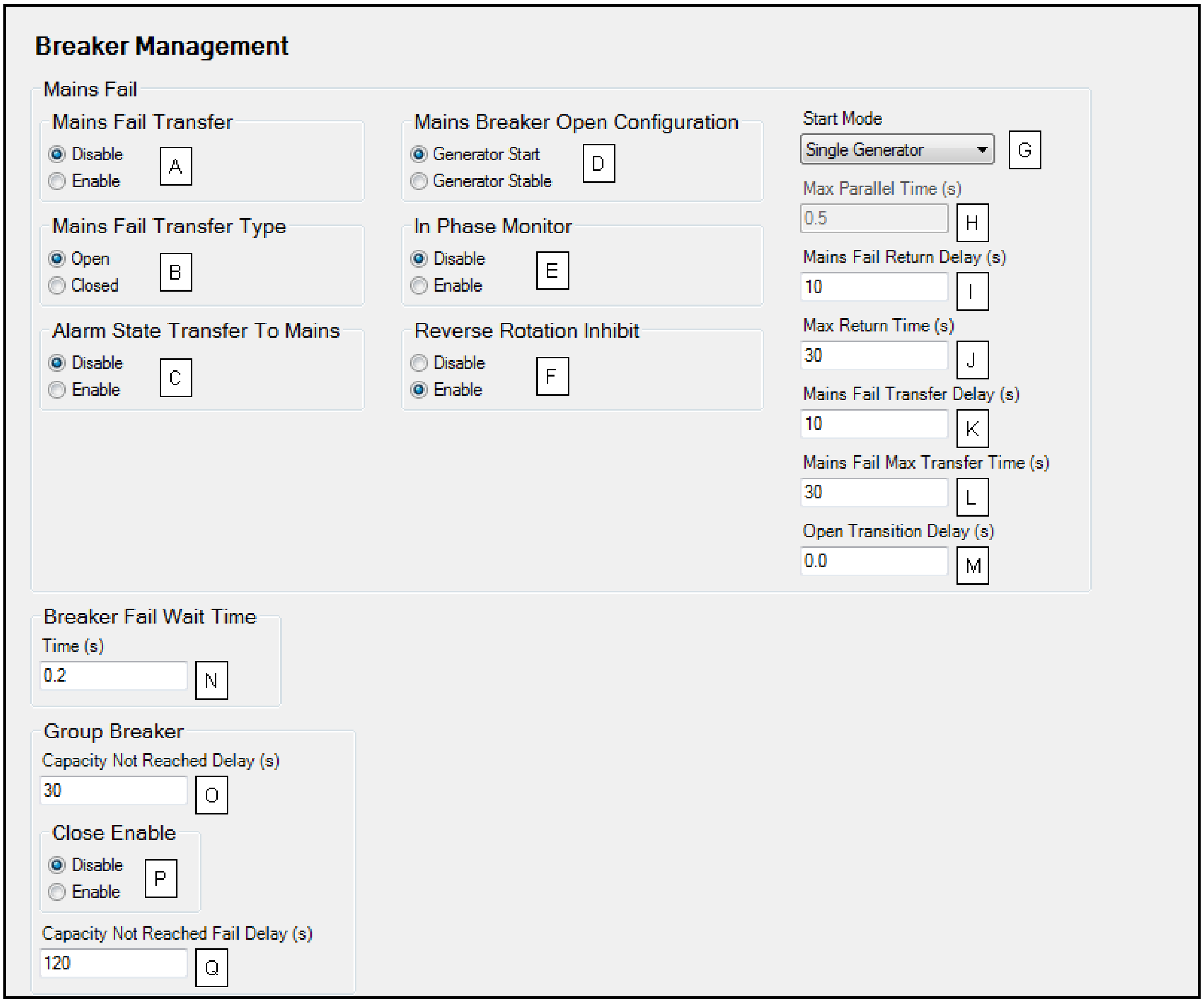


Figure 94. Settings Explorer, Breaker Management, Breaker Management Screen

Table 38. Settings for Breaker Management Screen

Locator	Setting	Range	Increment	Unit
Mains Fail Transfer Settings				
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	Start Mode	Single Generator or Group Start	n/a	n/a
H	Max Parallel Time	0.1 to 10,000	0.1	Seconds
I	Mains Fail Return Delay	0 o 1,800	1	Seconds
J	Max Return Time	10 to 3,700	1	Seconds
K	Mains Fail Transfer Delay	0 to 300	1	Seconds

Locator	Setting	Range	Increment	Unit
L	Mains Fail Max Transfer Time	0 to 300	1	Seconds
M	Open Transition Delay	0 to 3,600	0.1	Seconds
Breaker Fail Wait Time				
N	Time	0.1 to 600	0.1	Seconds
Group Breaker				
O	Capacity Not Reached Delay	10 to 3,700	1	Second
P	Close Enable	Disable or Enable	n/a	n/a
Q	Capacity Not Reached Fail Delay	10 to 3,700	1	Seconds

Breaker Setup in BESTlogic™Plus

Set up the generator breaker in BESTlogic*Plus* Programmable Logic under the BESTCOMS*Plus* Settings Explorer. Figure 95 illustrates the BESTlogic*Plus* Programmable Logic screen with an example breaker control logic scheme. The following paragraphs provide instructions for setting up the generator and mains breakers in BESTlogic*Plus*. Group and Tie breakers are set up in a similar fashion.

1. Generator Breaker
    a. Click and 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 when the 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 open and close command inputs are closed at the same time, the breaker will open. 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
    a. Click and 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 when the 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 open and close command inputs are closed at the same time, the breaker will open. 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.

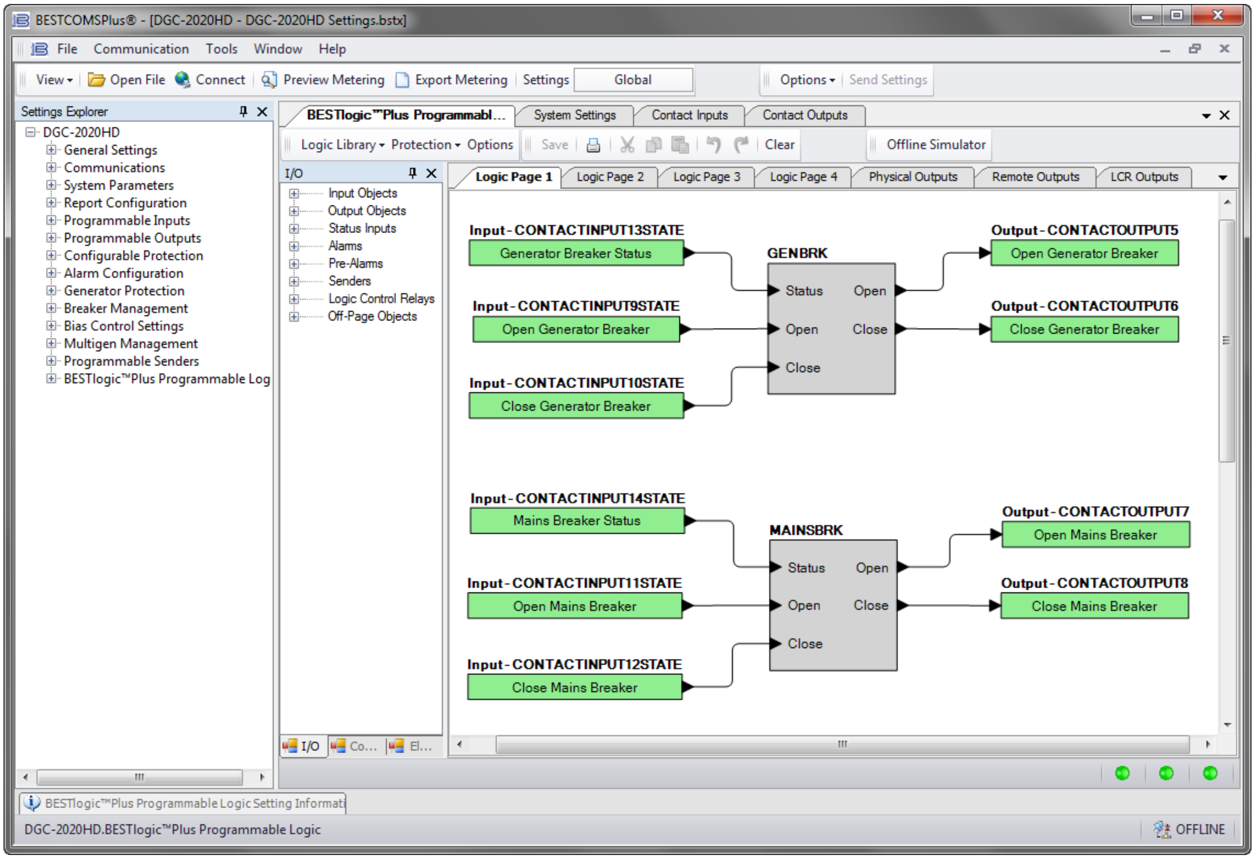


Figure 95. Settings Explorer, BESTlogic*Plus* Programmable Logic

Bus Condition Detection Settings

BESTCOMS*Plus*® 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 96. 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 39.

When the bus voltage is below the Dead Bus Threshold for the duration of the Activation Delay, the bus is deemed “dead” and “failed”.

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". A “dead” bus is also considered to be “failed”.

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

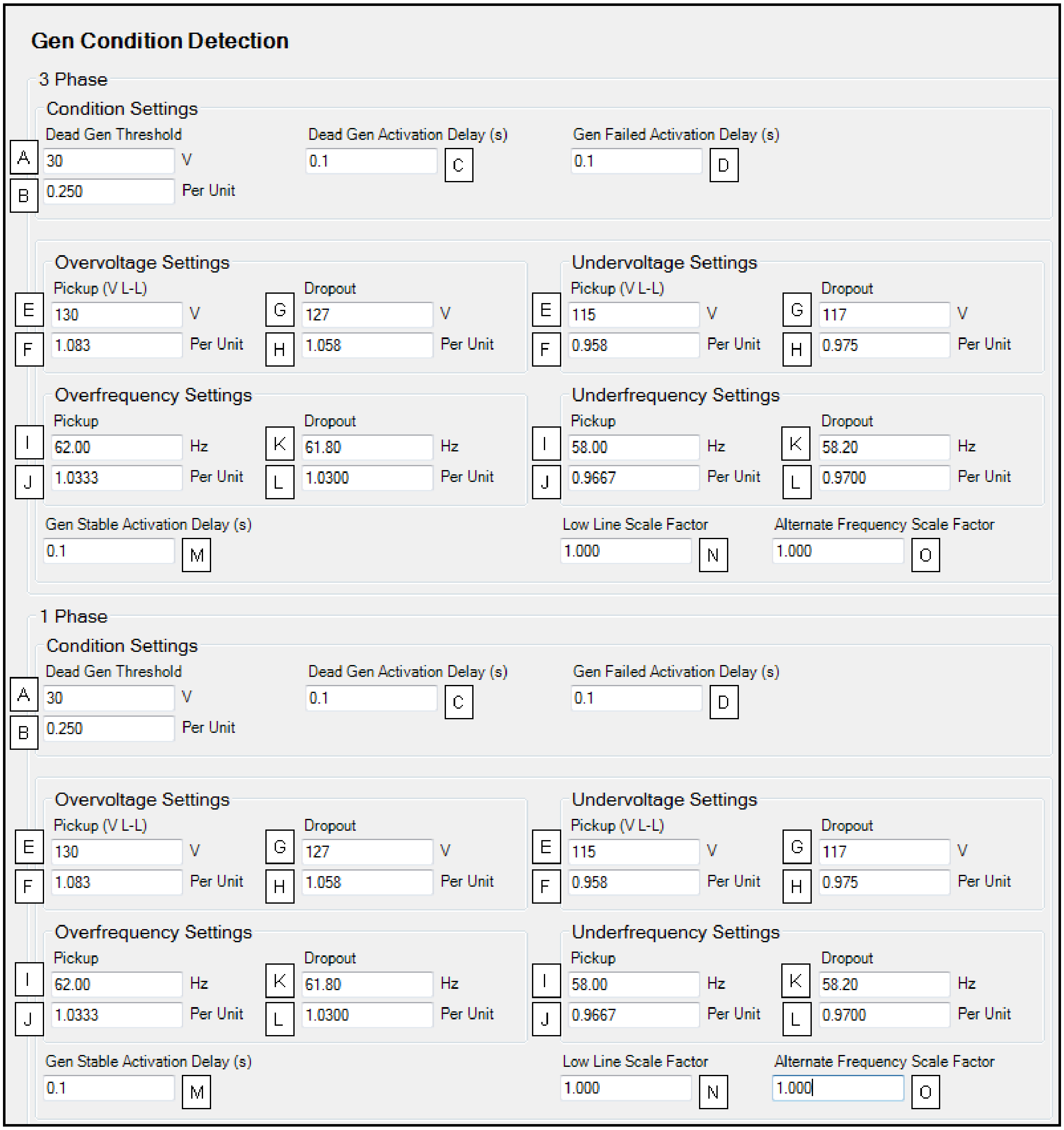


Figure 96. Settings Explorer, Breaker Management, Gen Condition Detection

Table 39. 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
3 Phase and 1 Phase 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
3 Phase and 1 Phase Overfrequency and Underfrequency Settings				
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
3 Phase and 1 Phase Settings				
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 100	0.001	n/a

Breaker Power Summing

Breaker Power Summing provides a way to calculate cumulative power measurements by summing the power measured across specified breakers. Any breaker in the system can be specified as long as it is controlled by a DGC-2020HD. Cumulative power measurements are available in metering and configurable protection which can be used in logic. There are eight independent power summing elements. Each element provides settings for up to 32 breakers. Elements provide cumulative kW and kvar measurements for the specified breakers.

Up to four alphanumeric characters are accepted for breaker labels. Breaker power summing operation is set to add by default. However, based on the CT connection, it may be desired to subtract (negate) the power measurement of the breaker from the cumulative sum.

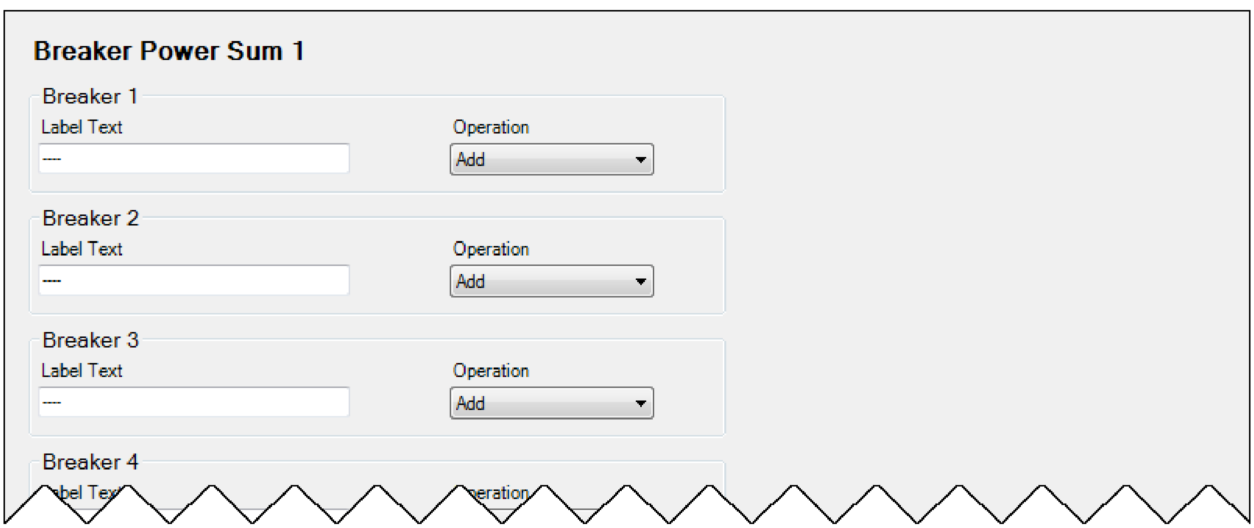


Figure 97. Settings Explorer, Breaker Management, Breaker Power Sum

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 BESTCOMS*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, breakers can be closed manually using contact inputs or the breaker buttons on the BESTCOMS*Plus* Control screen.

OFF or AUTO Mode (Not Running)

If operating in the OFF mode or AUTO and not running, the generator breaker cannot be closed 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 automatically controls applicable breakers. Alternatively, the external ATS (automatic transfer switch) starts the generators and controls the breakers itself. In addition, breakers can be automatically controlled by the demand start/stop function, the exercise timer function, or a RUNWLOAD (run with load) start from BESTlogic*Plus*. Breakers 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 BESTCOMS*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.

When a breaker closure request is received, certain conditions must be met before a breaker will close. Table 40 shows the conditions under which a generator breaker will close. The column labeled System A represents the local generator bus and System B represents the destination bus. Gen indicates a bus powered by a generator. Mains indicates a bus powered by an infinite source such as mains or utility power. Load indicates a bus which typically supports a load. A Dead Load Bus is currently unpowered, but capable of being powered by generators or a mains. When a load bus is powered by a source known to the intergenset network, it is considered to be an extension of that source, thus being labeled as *Gen* or Mains. A Stable Load Bus is currently powered, but the source is unknown to the DGC-2020HD network. This could mean that a breaker is missing from the network.

Condition A represents the condition of the System A bus as determined by bus condition settings and likewise for Condition B and System B. A bus is considered Stable when the measured voltage and frequency are within the bus condition detection parameters. A bus is considered Dead when the measured voltage is below the Dead Bus Threshold.

Required Setting to Operate indicates any settings which must be enabled in order for the breaker to close. These settings are found on the Generator Breaker screen.

Action indicates the type of action which will be taken if all other conditions are met. A Sync A to B action indicates that the source bus (System A) will be synchronized to the destination bus (System B), then the generator breaker will be closed. A Close action indicates that the generator breaker will simply close.

Table 40. Generator Breaker Closure Conditions

System A	Condition A	System B	Condition B	Required Setting to Operate	Action
Gen	Stable	Mains	Stable	None	Sync A to B
Gen	Stable	Gen	Stable	None	Sync A to B
Gen	Stable	Load	Dead	Dead Bus Close Enable	Close
Gen	Stable	Load	Stable	None	Sync A to B
Gen	Dead	Gen	Dead	Dead Gen Close Enable	Close
Gen	Dead	Load	Dead	Dead Gen Close Enable	Close

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.

Mains Breaker Closure Conditions

The conditions under which the DGC-2020HD will close the mains breaker are described in the following paragraphs.

When a breaker closure request is received, certain conditions must be met before a breaker will close. Table 41 shows the conditions under which a mains breaker will close. The column labeled System A represents the mains bus and System B represents the load bus. Gen indicates a load bus powered by a generator. Mains indicates a load bus powered by an infinite source such as mains or utility power. Load indicates a bus which typically supports a load. A Dead Load Bus is currently unpowered, but capable of being powered by generators or a mains. When a load bus is powered by a source known to the intergenset network, it is considered to be an extension of that source, thus being labeled as Gen or Mains. A Stable Load Bus is currently powered, but the source is unknown to the DGC-2020HD network. This could mean that a breaker is missing from the network.

Condition A represents the condition of the System A bus as determined by bus condition settings and likewise for Condition B and System B. A bus is considered Stable when the measured voltage and frequency are within the bus condition detection parameters. A bus is considered Dead when the measured voltage is below the Dead Bus Threshold.

Required Setting to Operate indicates any settings which must be enabled in order for the breaker to close. These settings are found on the Mains Breaker screen.

Action indicates the type of action which will be taken if all other conditions are met. A Sync B to A action indicates that System B will be synchronized to System A, then the mains breaker will be closed. A Sync Check action indicates that a sync check will be performed before closing the mains breaker. A Close action indicates that the mains breaker will simply close.

Table 41. Mains Breaker Closure Conditions

System A	Condition A	System B	Condition B	Required Setting to Operate	Action
Mains	Stable	Gen	Stable	None	Sync B to A
Mains	Stable	Mains	Stable	Mains to Mains Close Enable	Sync check
Mains	Stable	Load	Dead	None	Close
Mains	Stable	Load	Stable	Live Bus Close Enable	Sync check

Group Breaker Closure Conditions

The conditions under which the DGC-2020HD will close the group breaker are described in the following paragraphs.

When a breaker closure request is received, certain conditions must be met before a breaker will close. Table 42 shows the conditions under which a group breaker will close. The column labeled System A represents the group bus and System B represents the load bus. Gen indicates a bus powered by a generator. Mains indicates a bus powered by an infinite source such as mains or utility power. Load indicates a bus which typically supports a load. A Dead Load Bus is currently unpowered, but capable of being powered by generators or a mains. When a load bus is powered by a source known to the intergenset network, it is considered to be an extension of that source, thus being labeled as Gen or Mains. A Stable Load Bus is currently powered, but the source is unknown to the DGC-2020HD network. This could mean that a breaker is missing from the network.

Condition A represents the condition of the System A bus as determined by bus condition settings and likewise for Condition B and System B. A bus is considered Stable when the measured voltage and frequency are within the bus condition detection parameters. A bus is considered Dead when the measured voltage is below the Dead Bus Threshold.

Required Setting to Operate indicates any settings which must be enabled in order for the breaker to close. These settings are found on the Group Breaker screen.

Action indicates the type of action which will be taken if all other conditions are met. A Sync A to B action indicates that the group bus (System A) will be synchronized to the load bus (System B), then the group breaker will be closed. A Sync B to A action indicates that the load bus (System B) will be synchronized to the group bus (System A), then the group breaker will be closed. This is for uncommon cases where System B power can be controlled and System A cannot. A Sync Check action indicates that a sync check will be performed before closing the group breaker. A Close action indicates that the group breaker will simply close.

Table 43 shows the conditions under which a group breaker will close when at least one local generator is already closed onto the group bus.

Table 44 shows the conditions under which a group breaker will close when a mains is already tied directly onto the group bus. However, this is not a typical scenario.

Table 42. Typical Group Breaker Closure Conditions

System A	Condition A	System B	Condition B	Required Setting to Operate	Action
Load	Dead	Gen	Stable	Dead Group Close Enable	Close
Load	Dead	Mains	Stable	Dead Group Close Enable	Close
Load	Stable	Gen	Stable	Live Bus Close Enable	Sync B to A
Load	Stable	Mains	Stable	Live Bus Close Enable	Sync check
Load	Stable	Load	Stable	Live Bus Close Enable	Sync check
Load	Stable	Load	Dead	Live Bus Close Enable	Close
Load	Dead	Load	Stable	Live Bus Close Enable, Dead Group Close Enable	Close
Load	Dead	Load	Dead	Dead Group Close Enable	Close

Table 43. Group Breaker Closure Conditions when a Local Generator is Tied onto System A

System A	Condition A	System B	Condition B	Required Setting to Operate	Action
Gen	Stable	Mains	Stable	None	Sync A to B
Gen	Stable	Gen	Stable	None	Sync A to B
Gen	Stable	Load	Dead	None	Close
Gen	Stable	Load	Stable	Live Bus Close Enable	Sync A to B

Table 44. Group Breaker Closure Conditions when a Mains is Tied Directly onto System A

System A	Condition A	System B	Condition B	Required Setting to Operate	Action
Mains	Stable	Gen	Stable	None	Sync B to A
Mains	Stable	Load	Dead	None	Close
Mains	Stable	Load	Stable	Live Bus Close Enable	Sync check

Tie Breaker Closure Conditions

The conditions under which the DGC-2020HD will close the tie breaker are described in the following paragraphs.

When a breaker closure request is received, certain conditions must be met before a breaker will close. Table 45 shows the conditions under which a tie breaker will close. The columns labeled System A and System B represent the buses which will be tied together when the breaker closes. Gen indicates a bus powered by a generator. Mains indicates a bus powered by an infinite source such as mains or utility power. Load indicates a bus which typically supports a load. A Dead Load Bus is currently unpowered, but capable of being powered by generators or a mains. When a load bus is powered by a source known to the intergenset network, it is considered to be an extension of that source, thus being labeled as Gen or Mains. A Stable Load Bus is currently powered, but the source is unknown to the DGC-2020HD network. This could mean that a breaker is missing from the network.

Condition A represents the condition of the System A bus as determined by bus condition settings and likewise for Condition B and System B. A bus is considered Stable when the measured voltage and frequency are within the bus condition detection parameters. A bus is considered Dead when the measured voltage is below the Dead Bus Threshold.

Required Setting to Operate indicates any settings which must be enabled in order for the breaker to close. These settings are found on the Tie Breaker screen.

Action indicates the type of action which will be taken if all other conditions are met. A Sync A to B action indicates that System A will be synchronized to System B, then the tie breaker will be closed. A Sync B to A action indicates that System B) will be synchronized to System A, then the tie breaker will be closed. This is for uncommon cases where System B power can be controlled and System A cannot. A Sync Check action indicates that a sync check will be performed before closing the tie breaker. A sync side based on Sync Adjust Side setting action indicates that one system, as determined by the Sync Adjust Side setting, will be synchronized to the other before the tie breaker is closed. A Close action indicates that the tie breaker will simply close.

These closure conditions are identical for Tie Breaker 2 except references to System A and System B become System B and System C respectively.

Table 45. Tie Breaker Closure Conditions

System A	Condition A	System B	Condition B	Required Setting to Operate	Action
Gen	Stable	Mains	Stable	Live A to Live B Close Enable	Sync A to B
Mains	Stable	Gen	Stable	Live A to Live B Close Enable	Sync B to A
Gen	Stable	Gen	Stable	Live A to Live B Close Enable	Sync side based on Sync Adjust Side setting
Mains	Stable	Mains	Stable	Mains to Mains Close Enable	Sync check
Gen	Stable	Load	Dead	Live A to Dead B Close Enable	Close

System A	Condition A	System B	Condition B	Required Setting to Operate	Action
Mains	Stable	Load	Dead	Live A to Dead B Close Enable	Close
Load	Dead	Gen	Stable	Dead A to Live B Close Enable	Close
Load	Dead	Mains	Stable	Dead A to Live B Close Enable	Close
Gen	Stable	Load	Stable	Live A to Live B Close Enable Live Load Close Enable	Sync A to B
Mains	Stable	Load	Stable	Live A to Live B Close Enable Live Load Close Enable	Sync check
Load	Stable	Gen	Stable	Live A to Live B Close Enable Live Load Close Enable	Sync B to A
Load	Stable	Mains	Stable	Live A to Live B Close Enable Live Load Close Enable	Sync check
Load	Stable	Load	Stable	Live A to Live B Close Enable Live Load Close Enable	Sync check
Load	Stable	Load	Dead	Live A to Dead B Close Enable Live Load Close Enable	Close
Load	Dead	Load	Stable	Dead A to Live B Close Enable Live Load Close Enable	Close
Load	Dead	Load	Dead	Dead A to Dead B Close Enable	Close
Gen	Dead	Gen	Dead	Dead Gen Close Enable	Close
Gen	Dead	Load	Dead	Dead Gen Close Enable	Close
Load	Dead	Gen	Dead	Dead Gen Close Enable	Close

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 open.

Dead Bus Breaker Close Arbitration

Dead bus breaker close arbitration ensures that only one bus segment closes its breaker to a dead bus segment. This prevents multiple live buses from being tied while out of synchronization, which can result in equipment damage. After a unit issues a dead bus close request and the request is granted permission, the unit that received the grant closes its breaker onto the dead bus segment. Now that the bus segment is no longer dead, any other segment must synchronize to this bus segment before the breaker tying these two segments can be closed.

The dead bus breaker close arbitration process occurs via inter-genset communication among all DGC-2020HD controllers on the network. All controllers on the network must be configured as the same System Type: Multiple Generator or Segmented Bus System. The System Type setting is found in Settings > System Parameters > System Settings.

If a controller which is granted permission to close its breaker onto a dead bus fails to do so, the permission may be passed to another controller which has issued a dead bus close request.

Individual units issue dead bus close requests 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 via Ethernet inter-genset communication. The System Type parameter is found in Settings > System Parameters > System Settings. After an individual unit issues a dead bus close request and receives a dead bus close grant from, the unit maintains its dead bus close request unless one of the following occurs:

- The dead bus close grant is removed
- The generator breaker encounters a breaker close fail
- A generator breaker open request is received
- The generator becomes unstable
- Breaker closure is achieved

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.

All units in the system reporting a dead bus must be visible via Ethernet inter-genset communications before any dead bus close grant is issued. Any dead bus close grant is removed if any machine reports the bus is not dead. A dead bus close grant is not removed unless the unit that received the grant removes its request or another machine reports that the bus is not dead. When a dead bus close grant is removed, a Dead Bus Control Grant Fail pre-alarm is annunciated.

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. If multiple units have the same sequencing ID, a system manager is chosen based on the MAC address of the DGC-2020HD.

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, MAINSBRK, GROUPBRK, TIEBRK, and TIEBRK2 logic blocks contain Open and Close logic outputs that can be configured to energize an output contact, which would in turn operate the breaker. The Breaker Hardware screens in BESTCOMS*Plus* are used to set the output contact type to pulsed or continuous for each breaker.

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 adjusting the generator's speed control governor (GOV) and automatic voltage regulator (AVR). Synchronization can be achieved manually by an operator or automatically by 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: Phase Lock Loop and Anticipatory. A phase lock loop 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. An anticipatory 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.

The automatic synchronizer runs in one of three modes: Sync Active, Sync Check, or Sync Only. When in Sync Active mode, the DGC-2020HD issues bias correction outputs and closes the breaker when the slip values are within the programmed window. In Sync Check mode, the DGC-2020HD does not issue bias correction outputs, but closes the breaker when the slip values are within the programmed window. In Sync Only mode, the DGC-2020HD does not issue a breaker close pulse. It attempts to control the bias outputs to stay in sync until an open request is issued or a sync fail occurs.

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 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.
- The DGC-2020HD itself when started from any group start request (logic, mains fail, load takeover, or peak shaving).
- 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 BESTCOMS*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 in the *Installation* manual 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 in the *Installation* manual 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 *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.

Notes

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.

Sync Check Settings

The controller performs a sync check when a breaker closure request is issued and it is determined that the generator and bus will not be electrically tied. Otherwise, the active synchronizer (option) is used. In the following example, the System Breaker Configuration is set to Generator and Mains Breaker Control. If both breakers are open, a mains breaker closure is requested, and the mains and load buses are stable, a sync check is performed. In this case the sync check uses the sync check settings, which act similarly to the active sync settings. The active sync mode can be set to Sync Check, in which case the sync check settings are always used.

Figure 98 illustrates the BESTCOMS*Plus* Synchronizer screen. Settings are listed in Table 46.

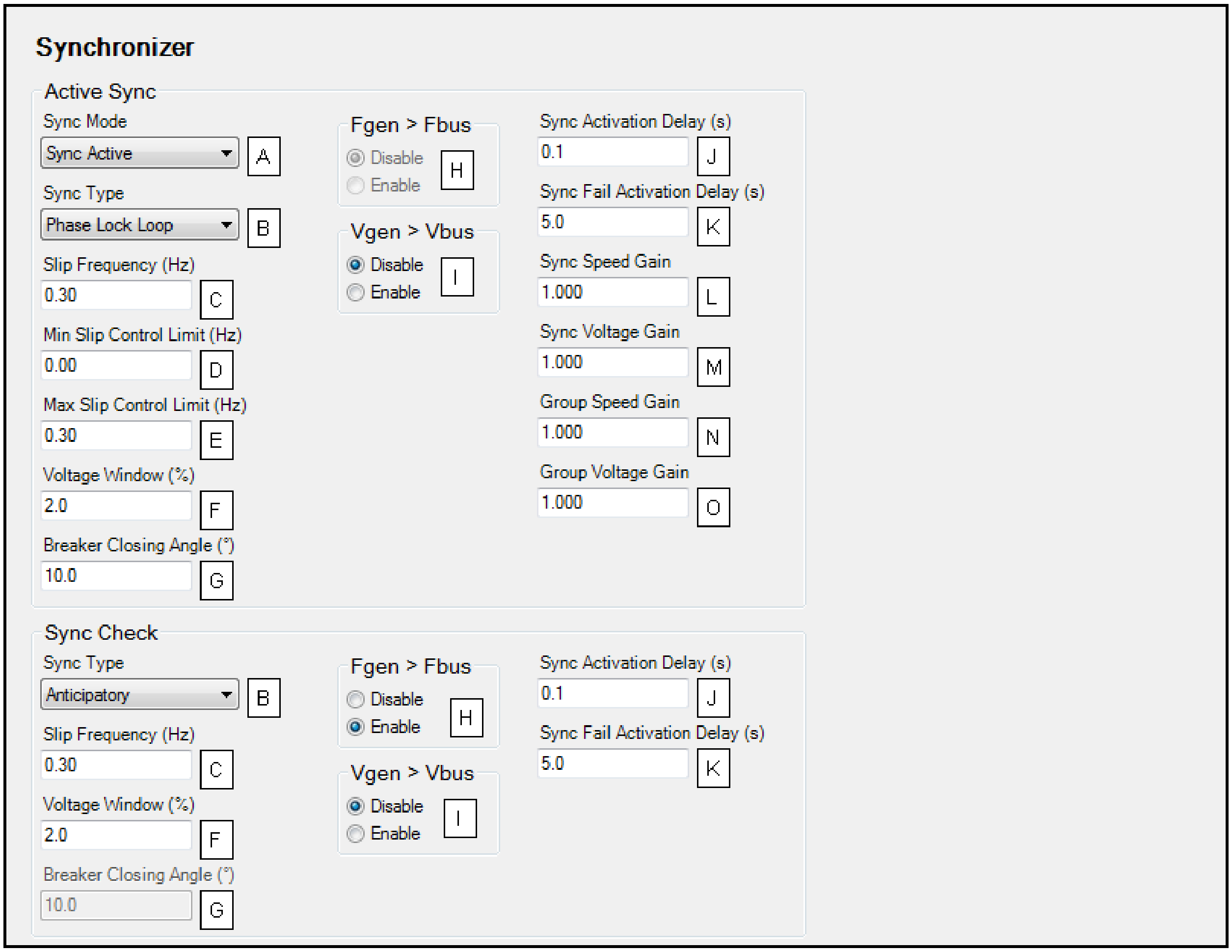


Figure 98. Settings Explorer, Breaker Management, Synchronizer Screen

Table 46. Settings for Synchronizer

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

Locator	Setting	Range	Increment	Unit
L	Sync Speed Gain	0.001 to 1,000	0.001	n/a
M	Sync Voltage Gain	0.001 to 1,000	0.001	n/a
N	Group Speed Gain	0.001 to 1,000	0.001	n/a
O	Group 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 BESTCOMS*Plus*:

1. Open the Style Number screen in the Settings Explorer, under General Settings. Verify the connected unit has the Automatic Synchronizer option.
2. Select the appropriate system breaker configuration on the System Parameters, System Settings screen. See the *Breaker Management* chapter for details. In this example, only the generator breaker is controlled by the DGC-2020HD.
3. Open the Contact Inputs screen, in the Settings Explorer, under Programmable Inputs. Enter “Open Generator Breaker” into the label text field of Input #9. Enter “Close Generator Breaker” into the label text field of Input #10. Finally, enter “Generator Breaker Status” into the label text field of Input #13. Up to 64 alphanumeric characters are accepted by a label text field. See Figure 99.

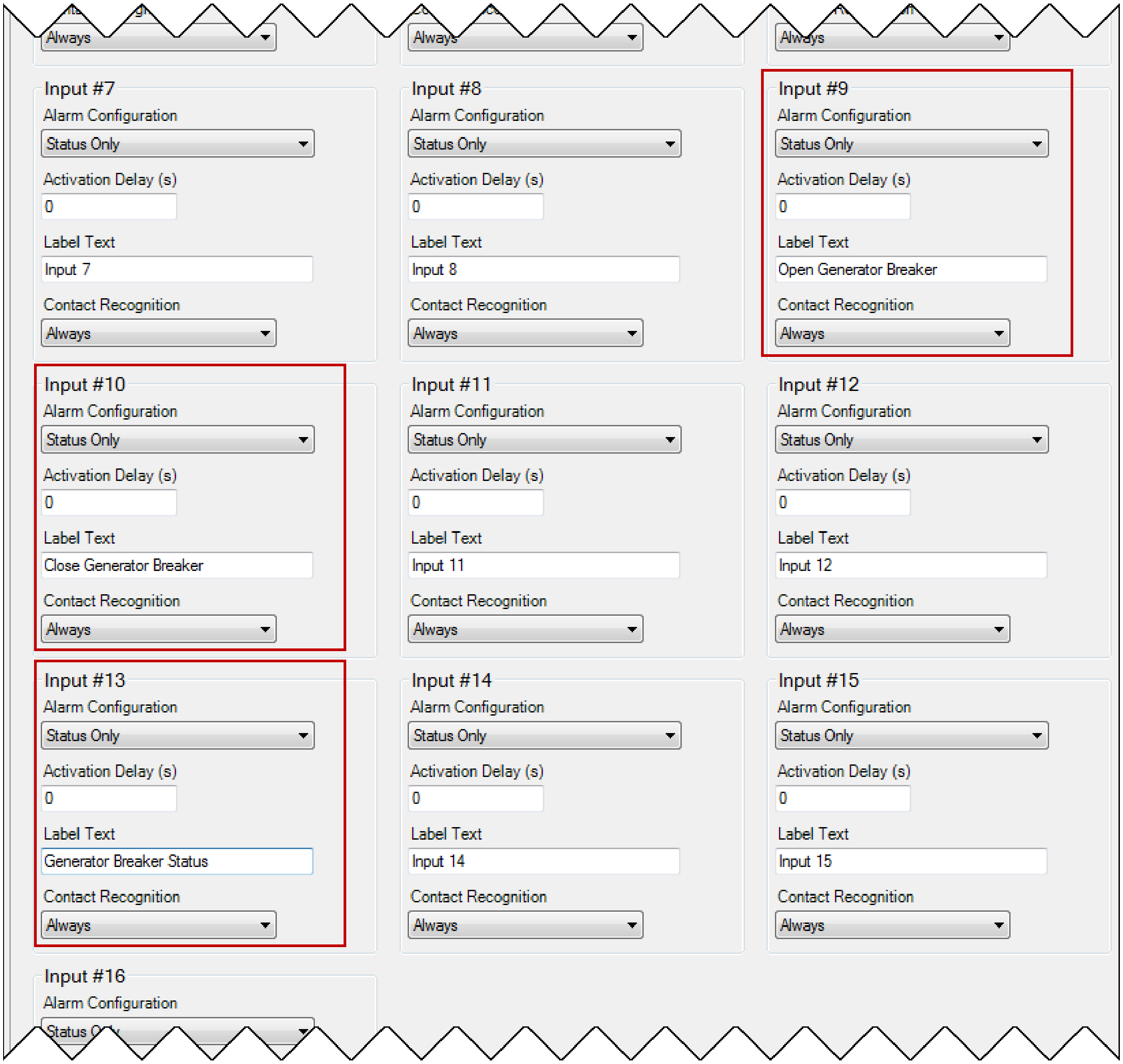


Figure 99. Settings Explorer, Programmable Inputs, Contact Inputs

4. Open the Contact Outputs screen in the Settings Explorer, under Programmable Outputs. Input label text "Generator Breaker Open" for Output #5 and "Generator Breaker Close" for Output #6.
   a. If using contact outputs to control the governor and voltage regulator, label Output #9 as "GOV Raise", Output #10 as "GOV Lower", Output #11 as "AVR Raise", and Output #12 as "AVR Lower". See Figure 100.

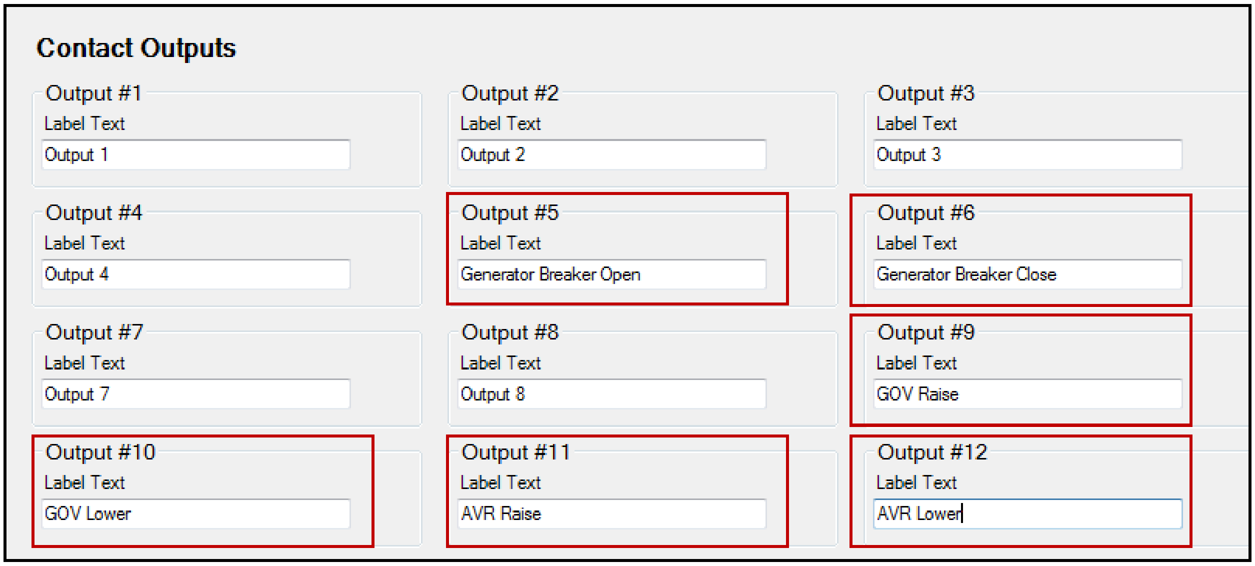


Figure 100. Settings Explorer, Programmable Outputs, Contact Outputs

5. Open the Breaker Management screen (Figure 101) in the Settings Explorer, under Breaker Management. Set Breaker Fail Wait Time.
    a. Breaker Fail Wait Time 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 breaker failure is annunciated.

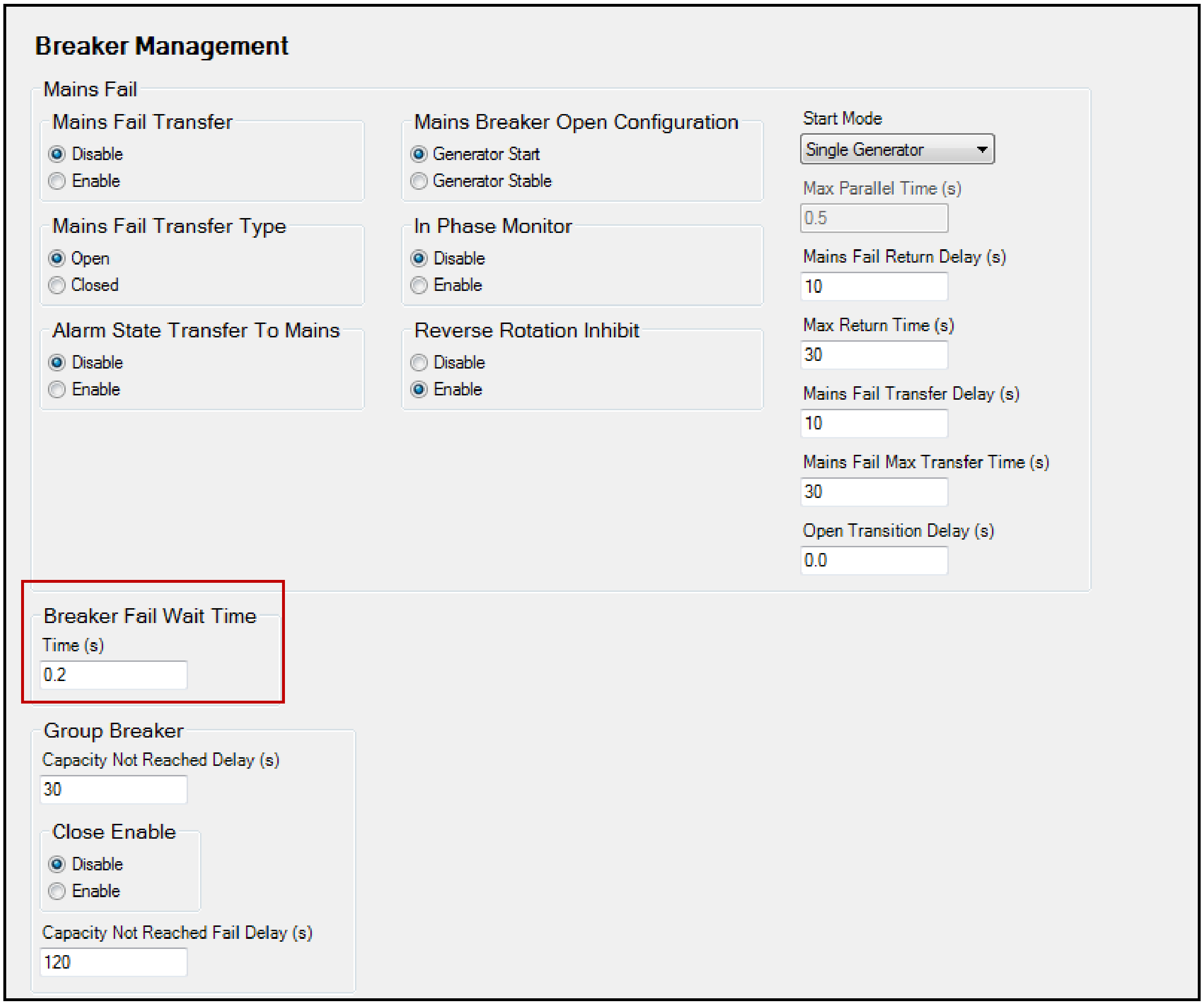


Figure 101. Settings Explorer, Breaker Management, Breaker Management

6. Open the Gen Breaker Hardware screen in the Settings Explorer, under Breaker Management, Breaker Hardware. On this screen, enter the settings for the following parameters. See Figure 102.
    a. Enable the Dead Bus Close Enable parameter if it is desired to close onto a dead bus.
    b. If pulsed contacts are used, set Contact Type to Pulsed and set appropriate open and close pulse times.
    c. Set 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.

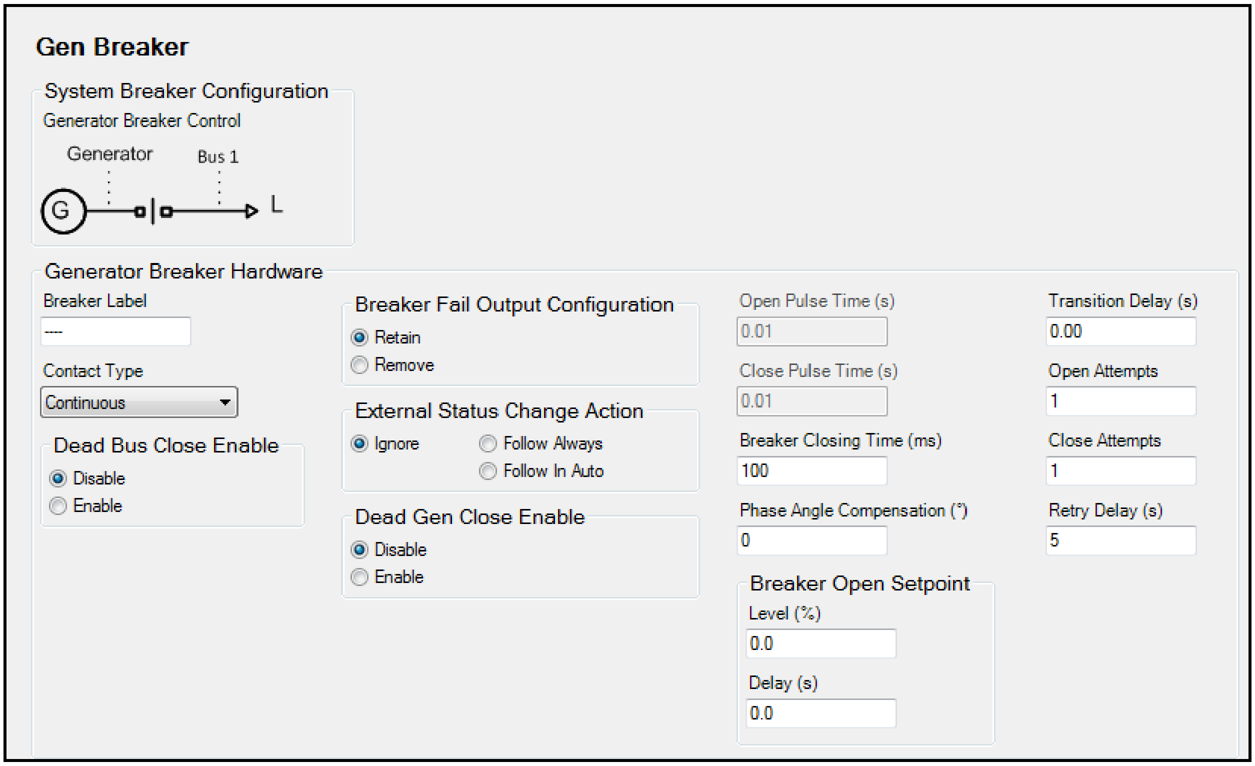


Figure 102. Settings Explorer, Breaker Management, Breaker Hardware

7. 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 here, 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 103. The Bus 1 Condition Detection and optional Bus 2 Condition Detection screens are also found in the Bus Condition Detection category.

Four thresholds determine a stable generator bus. These consist of overvoltage, undervoltage, overfrequency, and underfrequency. When the generator voltage and frequency stay within the thresholds for the duration of the Gen Stable Activation Delay, the generator bus is deemed “stable”. When the voltage and frequency are outside the stable ranges for the duration of the Gen Failed Activation Delay, the generator is deemed “failed”. When the generator voltage is below the Dead Gen Threshold for the duration of the Dead Gen Activation Delay, the generator bus is deemed “Dead”.

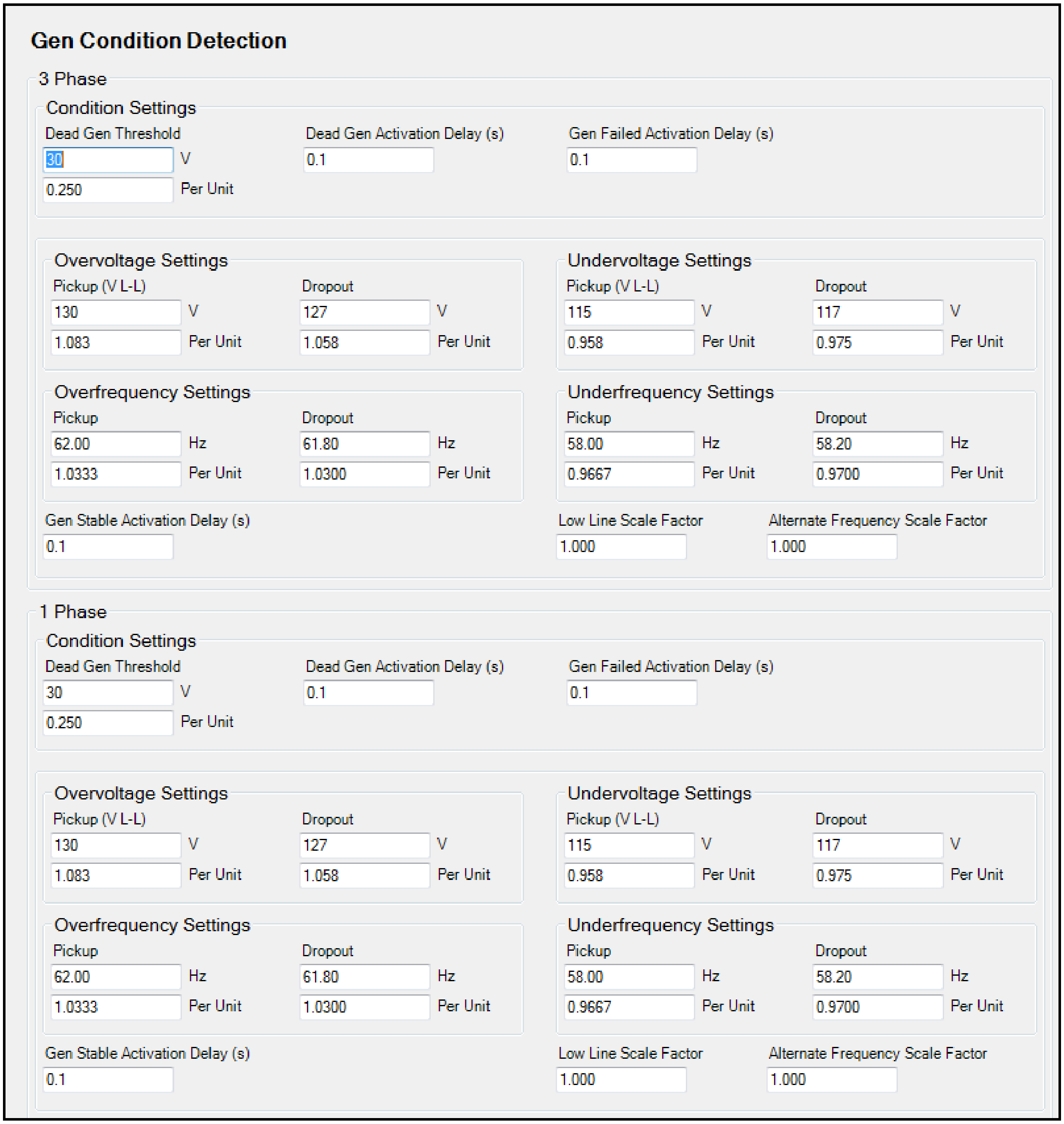


Figure 103. Settings Explorer, Breaker Management, Bus Condition Detection, Gen Condition Detection

If Phase Lock Loop synchronization is selected, the synchronizer drives the generator voltage and phase angle to match that of the bus, until the difference is within user-defined windows.

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.

8. Open the Synchronizer screen in the Settings Explorer, under Breaker Management. See Figure 98.
9. Sync Type - Select either Anticipatory or Phase Lock Loop as the synchronizer type.
10. Slip Frequency - The slip frequency setting is the maximum slip frequency that is in effect for a breaker close to occur.

11. 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”.
12. Min/Max Slip Control Limit - (Phase lock synchronizer only.) These settings provide continuous slip frequency control while in phase lock synchronization.
13. Breaker Closing Angle - (Phase lock synchronizer only.) The breaker closing 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”.
14. 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.
15. 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.
16. Fgen > Fbus - Enabling gen frequency > bus frequency forces kW to flow out of the generator when the breaker is closed.
17. Vgen > Vbus - Enabling gen voltage > bus voltage forces vars to flow out of the generator when the breaker is closed.
18. Sync Speed Gain and Sync Voltage Gain – Sync speed gain and sync voltage gain settings are provided to increase the loop gain of the automatic synchronizer. This allows the synchronizer function to be aggressive during synchronization and stable during speed trim operation.
19. Group Speed Gain and Group Voltage Gain – When synchronizing a group of paralleled generators to close the group breaker, the sync speed/volt error is multiplied by this gain to allow better control.
20. 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 104.
    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.

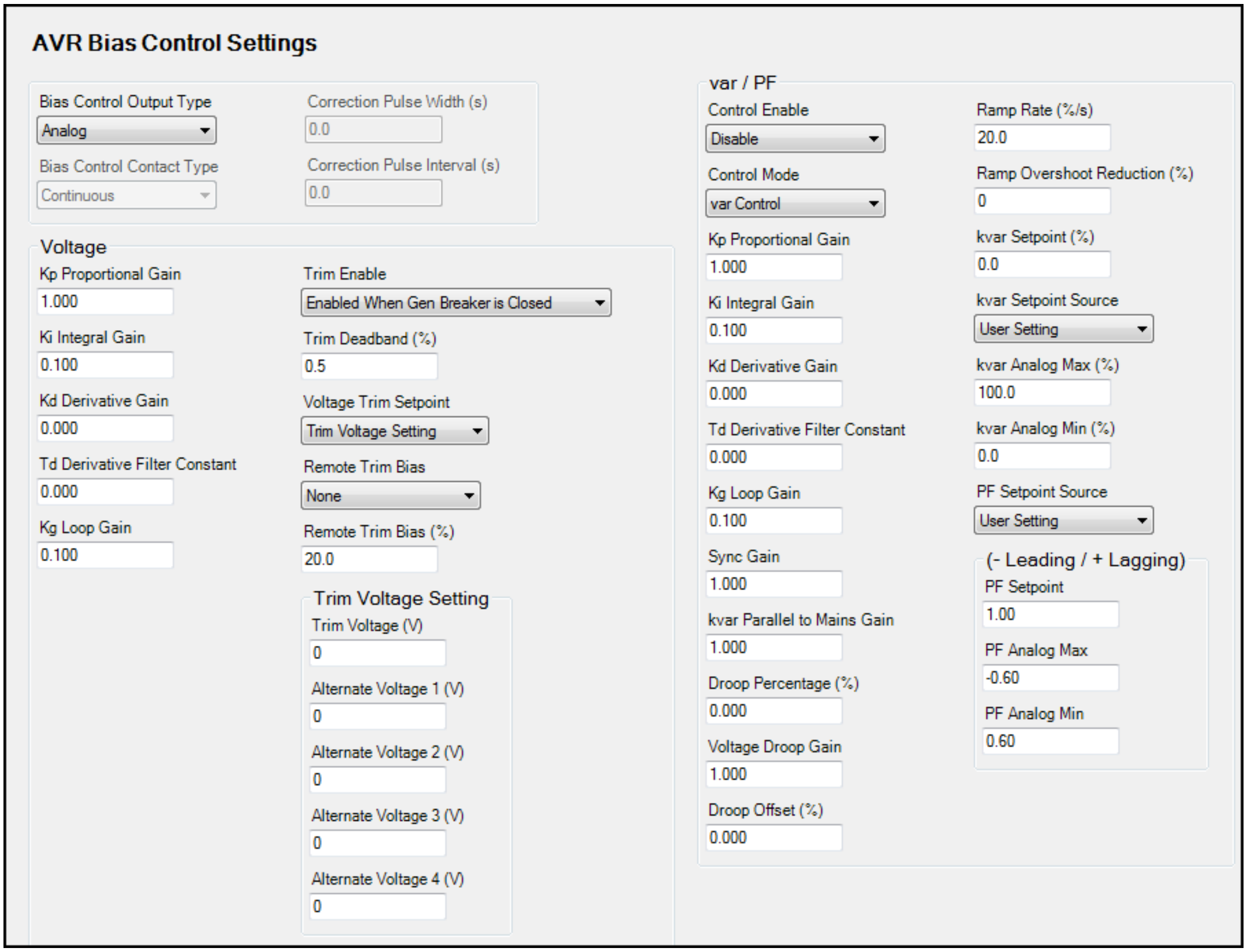


Figure 104. Settings Explorer, Bias Control Settings, AVR Bias Control Settings

21. 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. Follow the same steps as for the AVR bias control setup.
22. If controlling the voltage regulator and governor with contact outputs, skip to step 25. Otherwise, continue with step 23.
23. 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 105.
    a. Output Type - Select whether the AVR bias signal is 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 –10 V to +10 V.

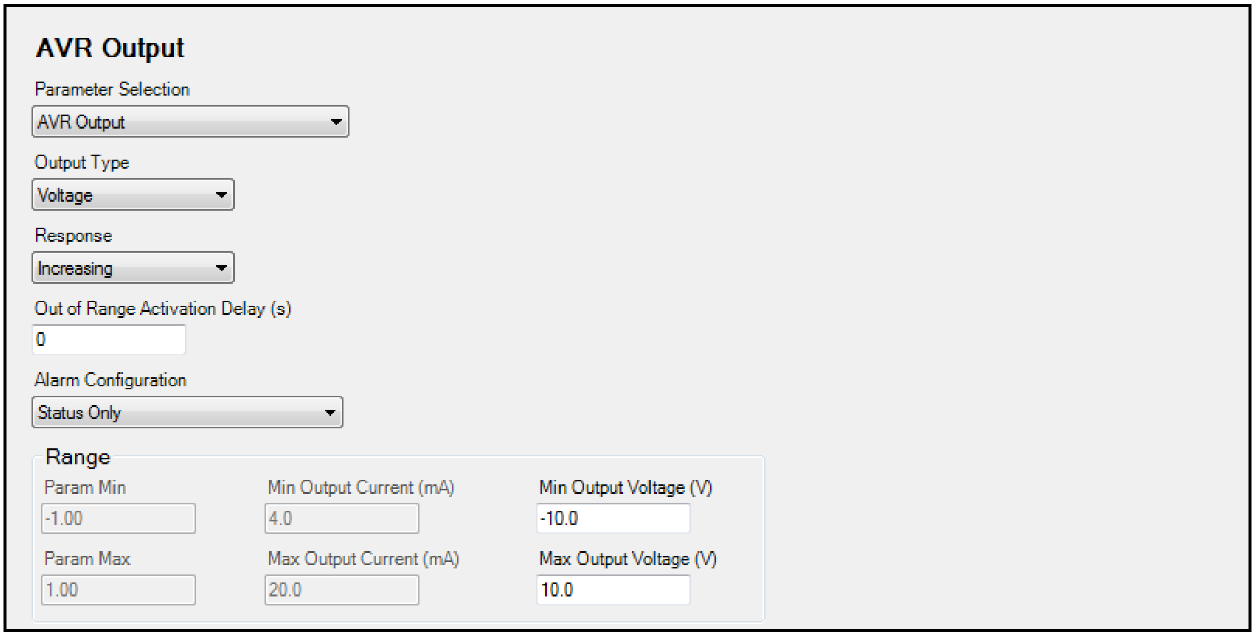


Figure 105. Settings Explorer, Multigen Management, AVR Output

24. 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.

25. Set up programmable logic to allow the DGC-2020HD to synchronize the generator and close the generator breaker. In BESTlogic*Plus* Programmable Logic, click on the Elements tab and drag the GENBRK (Generator Breaker) element into the main logic screen. See Figure 106.

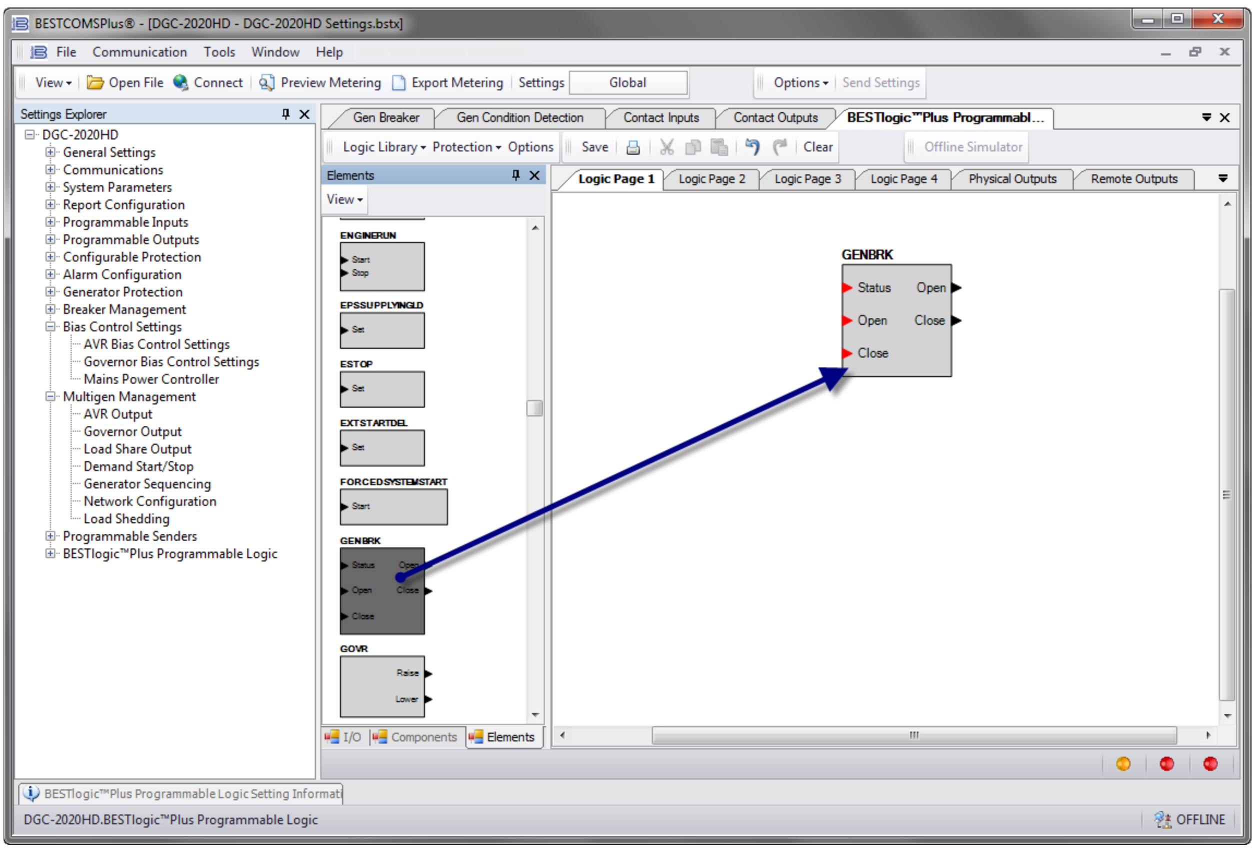


Figure 106. Synchronizer Setup in BESTlogic*Plus* Step 25

26. Click on the I/O tab and drag the inputs assigned in step 3, 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 107.

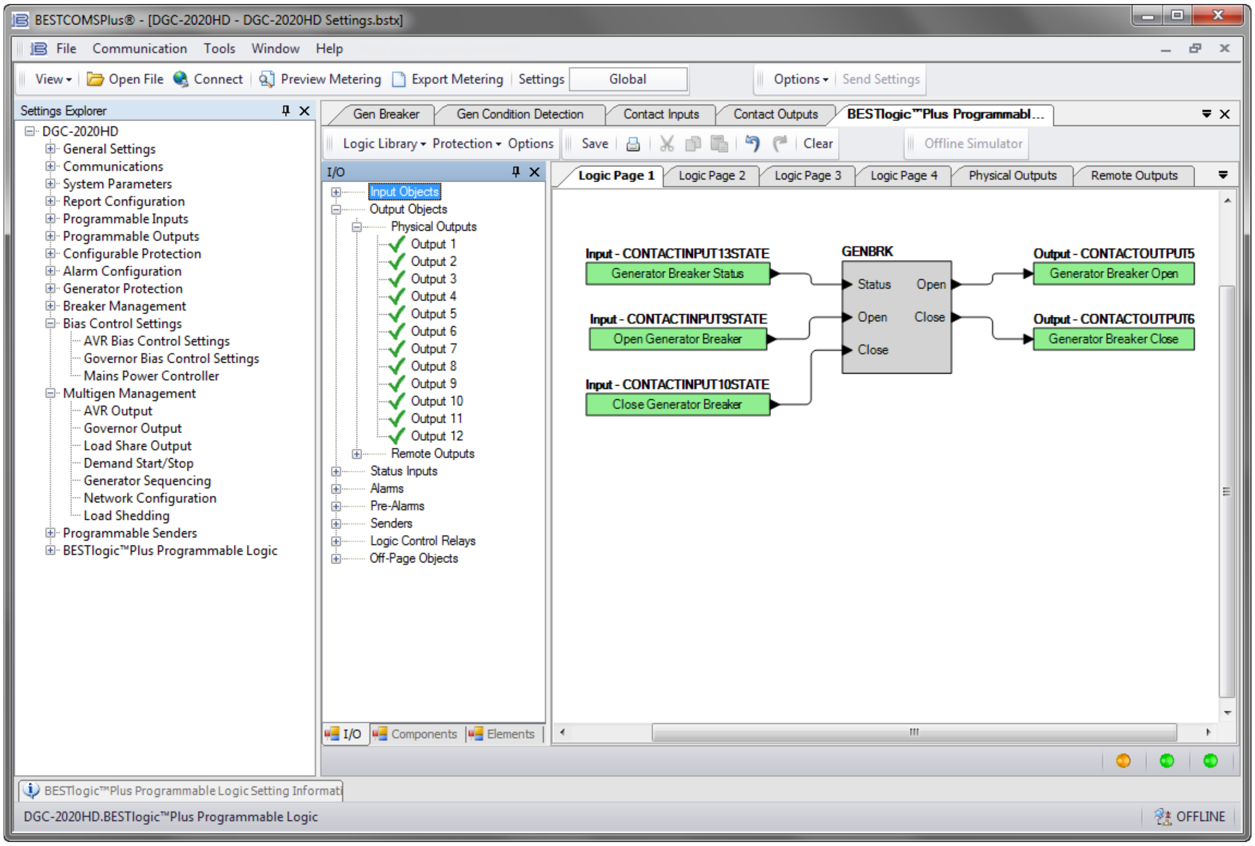


Figure 107. Synchronizer Setup in BESTlogic*Plus* Step 26

27. 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 BESTlogic*Plus* programmable logic, click on the Elements tab. Drag the GOVR and AVR logic blocks into the main logic screen. See Figure 108.

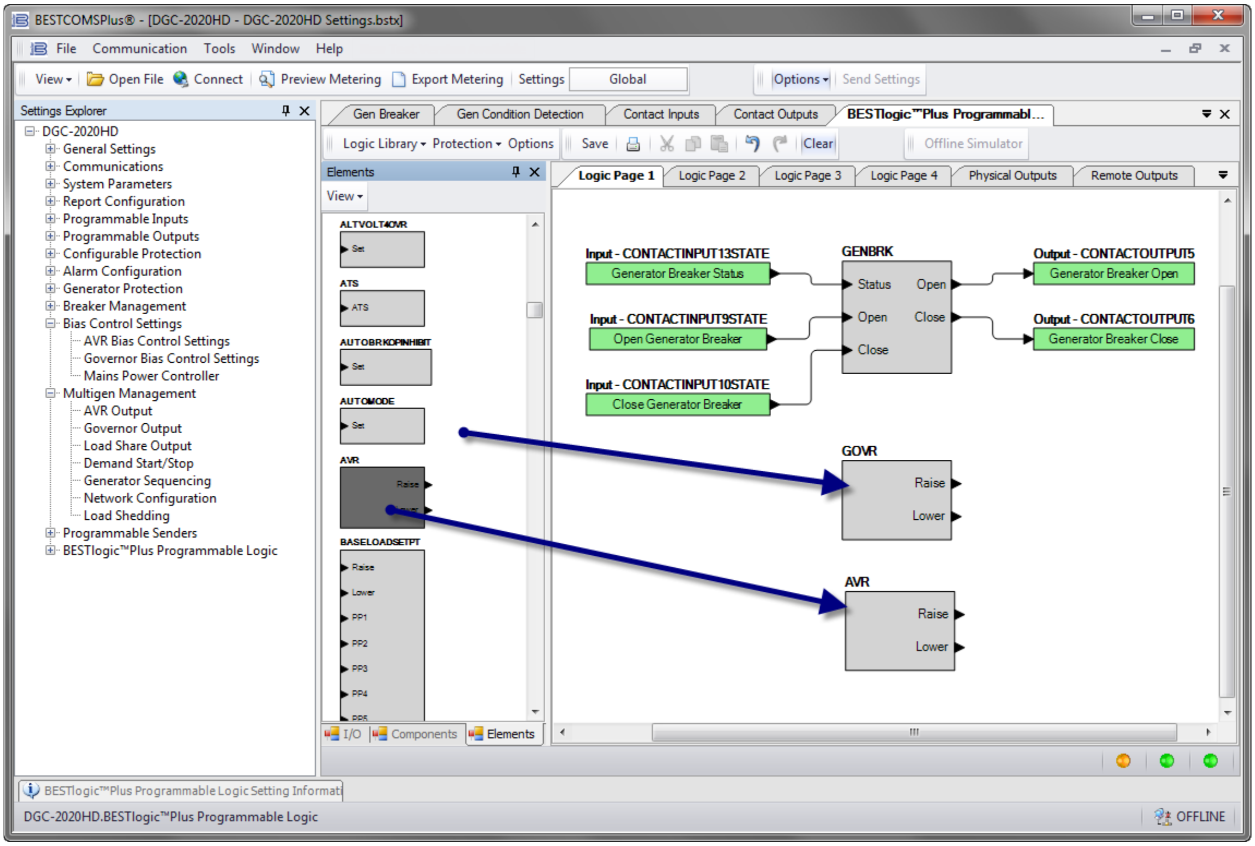


Figure 108. Synchronizer Setup in BESTlogic*Plus* Step 27

28. 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 109.

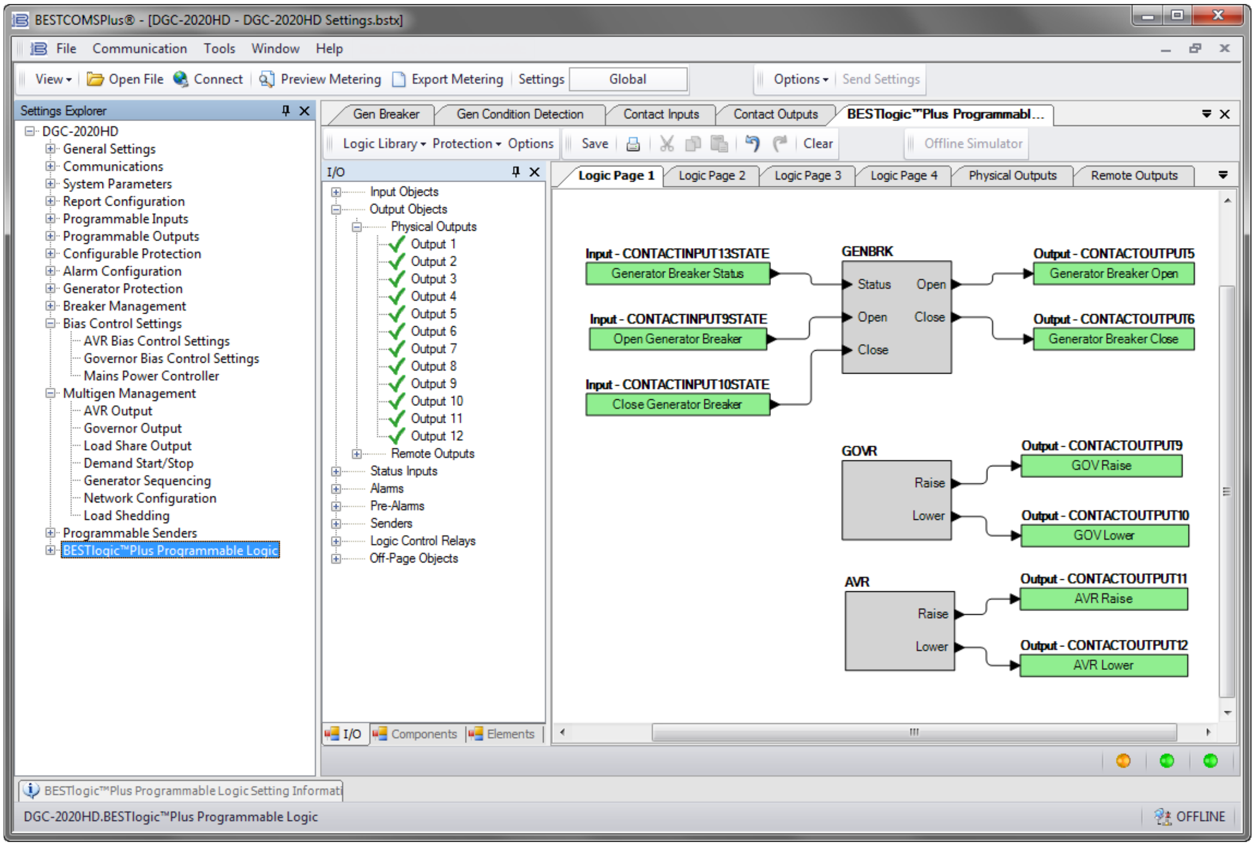


Figure 109. Synchronizer Setup in BESTlogic*Plus* Step 28

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

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Bias Control Settings, AVR Bias Control Settings
Front Panel Navigation Path: Settings > Bias Control > AVR Bias Control

Voltage biasing signals can be applied to an automatic voltage regulator using the analog output or contact outputs of the DGC-2020HD. Analog outputs provide a variable voltage from -10 to +10 Vdc or a variable current from 4 to 20 mAdc to the bias inputs of the AVR. Contact outputs provide raise and lower commands to the bias inputs of the AVR. Use the Bias Control Output Type setting to establish the appropriate bias control signal for your AVR.

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.

See *Contact Output Bias Control Setup in BESTlogic™Plus* below for instructions on setting up AVR bias control using DGC-2020HD contact outputs.

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.

See *Analog Output Bias Control Setup* below for instructions on setting up AVR bias control using DGC-2020HD analog outputs.

The BESTCOMS*Plus* AVR Output Configuration screen is illustrated in Figure 110. Settings are listed in Table 47.

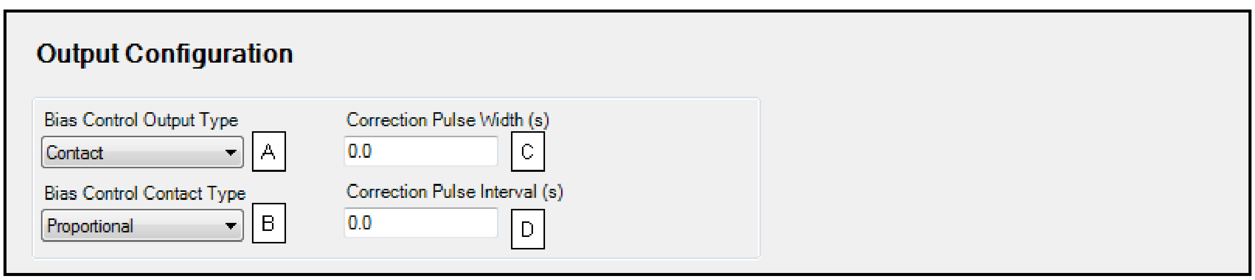


Figure 110. Settings Explorer, Bias Control Settings, AVR Bias Control Settings, Output Configuration

Table 47. Settings for AVR Output Configuration

Locator	Setting	Range	Increment	Unit
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

Voltage Control

Voltage trim is used to maintain the system voltage at the desired setpoint while the system is islanded and operating in var-sharing mode. Voltage trim operation is configured by enable, threshold, remote bias, and deadband settings.

A Trim Enable setting selects when voltage trim is enabled and disabled. The default selection of "Enable When Gen Breaker Closed" enables voltage trim when the generator breaker is closed and disables voltage trim when the generator breaker is open. Voltage trim is enabled continuously when "Enable Always" is selected.

Settings are provided for proportional gain, integral gain, derivative gain, derivative filter constant, and loop gain of the PID controller.

The Voltage Trim Setpoint Source setting determines the source from which the DGC-2020HD obtains the voltage trim setpoint. "Rated Voltage" or "Trim Voltage Setting" can be selected. When Rated Voltage is selected, the rated generator voltage is used as the voltage trim setpoint. When Trim Voltage Setting is selected, the voltage trim setpoint properties are determined by these settings: Trim Voltage, Setpoint Min, Setpoint Max, and Adjust Rate. The Trim Voltage setting establishes the voltage trim setpoint. The range of adjustment is defined by Setpoint Min and Setpoint Max settings that are expressed as a percentage of the rated generator voltage. The Adjust Rate is the rate, in percent per second, which the generator setpoint increases or decreases in response to raise/lower requests. Each regulation mode has five pre-position setpoints. Each pre-position setpoint can be assigned to a programmable contact input on the DGC-2020HD. When the appropriate contact input is closed, the setpoint is driven to the corresponding pre-position value. Each pre-position function has two settings: Setpoint and Adjust Rate. The setting range of each pre-position setpoint is identical to that of the corresponding control mode setpoint.

The Voltage Trim setpoint can be biased externally by an analog input of the DGC-2020HD, the optional AEM-2020, or the System Manager. The System Manager, which is the DGC-2020HD in the network with the lowest nonzero sequencing ID, can be set up to broadcast a bias signal for var, PF, or kW control. See the *Analog Inputs* chapter for more information. The source of the external bias is selected by the Remote Trim Bias setting which also permits the bias control to be disabled. Biasing is limited by the Remote Trim Bias setting to a range, expressed as a percentage, around the active Voltage Trim setpoint.

When voltage trim is active, the Trim Deadband setting may be used to improve system stability and/or kvar sharing. These improvements are implemented through the comparison of the Trim Deadband setting with the calculated voltage trim error. The voltage trim error is calculated as the difference between the measured voltage the voltage trim setpoint divided by the machine Rated Voltage setting. A calculated result that is less than the Trim Deadband setting is interpreted as zero error. A calculated result that is greater than the (nonzero) Trim Deadband setting triggers stability and/or kvar sharing improvements. The Trim Deadband setting is expressed as a percentage of rated voltage.

When the Auto Save setting is enabled, the DGC-2020HD automatically saves the active externally-driven raise/lower and pre-position setpoints 30 seconds after a change in value. The saved setpoint is retained even after power is cycled to the DGC-2020HD. When Auto Save is disabled, adjustments to setpoints by raise/lower and pre-position commands are retained only for the duration of the current run session. The DGC-2020HD returns to the configured Voltage Trim value when a new run session is started or when power is cycled to the DGC-2020HD.

When the voltage trim droop enable (VOLTTRIMDROOPENABLE) logic element input is true, the setpoint for the voltage trim controller is reduced by an amount dictated by the Droop Percent and Droop Offset Percent settings in Equation 11:

$$Droop\ PU = \left(\left(VoltTrim\ Droop\% \times \frac{Generated\ kvar}{Rated\ kvar}\right) - VoltTrim\ Droop\ Offset\%\right) \times 0.01$$

Equation 11. Voltage Trim Droop Mode Setpoint

When operating in droop mode, the voltage trim function is operational but the setpoint is calculated using Equation 11. Thus the machine trims output voltage to a setpoint calculated by the droop equation. This mode of operation allows reconfigurable machines that rely on voltage trim to set their output voltage to operate in droop mode.

The BESTCOMS*Plus* Voltage Control screen is illustrated in Figure 111. Settings are listed in Table 48.

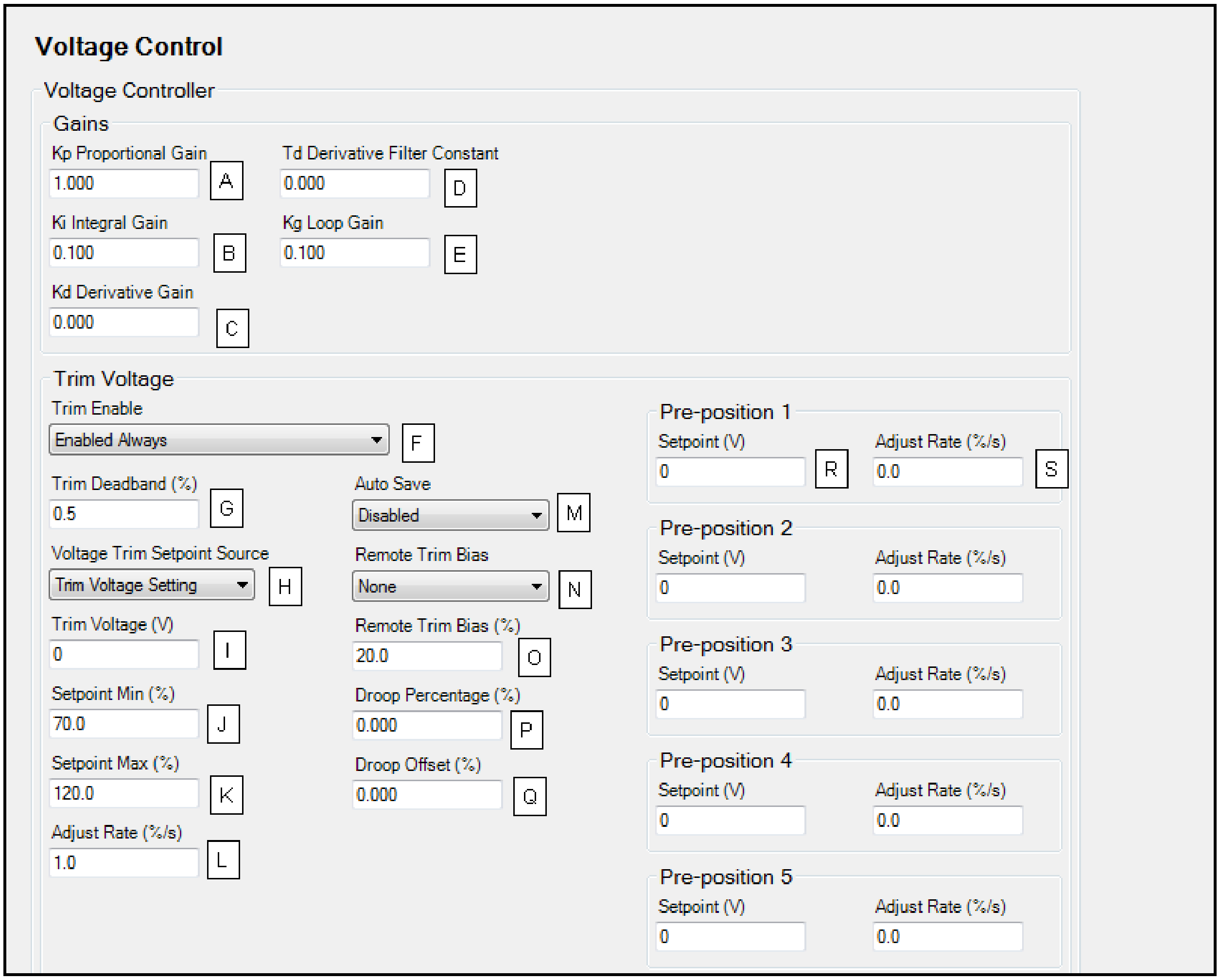


Figure 111. Settings Explorer, Bias Control Settings, AVR Bias Control Settings, Voltage Control

Table 48. Settings for Voltage Control

Locator	Setting	Range	Increment	Unit
A	Kp Proportional Gain	0 to 1,000	0.001	n/a
B	Ki Integral Gain	0 to 1,000	0.001	n/a
C	Kd Derivative Gain	0 to 1,000	0.001	n/a
D	Td Derivative Filter Constant	0 to 1	0.001	n/a
E	Kg Loop Gain	0 to 1,000	0.001	n/a
F	Trim Enable	Disabled, Enabled When Gen Breaker is Closed, or Enabled Always	n/a	n/a
G	Trim Deadband	0 to 2	0.1	% of rated volts
H	Voltage Trim Setpoint Source	Rated Voltage or Trim Voltage Setting	n/a	n/a

Locator	Setting	Range	Increment	Unit
I	Trim Voltage	0 to 999,999	1	volts
J	Setpoint Min	50 to 200	0.1	%
K	Setpoint Max	50 to 200	0.1	%
L	Adjust Rate	0.1 to 100	0.1	%
M	Auto Save	Disable or Enable	n/a	n/a
N	Remote Trim Bias (Source)	None, Analog Input 1 to 4, AEM1 Input 1 to 8, AEM2 Input 1 to 8, AEM3 Input 1 to 8, AEM4 Input 1 to 8, or System Manager	n/a	n/a
O	Remote Trim Bias (%)	0 to 100	0.1	% of rated voltage trim setpoint
P	Droop Percentage	0 or 0.5 to 10	0.001	%
Q	Droop Offset	0 to 10	0.001	%
R	Pre-position, Setpoint	0 to 999,999	1	volts
S	Pre-position, Adjust Rate	0 to 100	0.1	% per second

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 the Bias Control Output Type (on the Output Configuration screen) 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, loop gain, sync gain, and kvar parallel to mains gain of the PID controller.

The Sync Gain value is applied to the kvar error while synchronizing the group bus to the load or across a tie breaker. When generators are synchronizing as a group the voltage and frequency of each generator is continuously adjusted to achieve synchronization. When load sharing, the output voltage of the generators is continuously adjusted to share the load. If load sharing and synchronization are active simultaneously, synchronization can take longer than desired because the generators are being adjusted to share load in reaction to the adjustments being made to synchronize. A Sync Gain setting is provided to adjust the responsiveness of the load share controller during group synchronization. A lower Sync Gain value causes the DGC-2020HD to focus less on load sharing adjustments and more on synchronizing adjustments and a higher Sync Gain value causes the DGC-2020HD to focus more on load sharing adjustments and less on synchronizing adjustments.

The Parallel to Mains Gain value is applied to kvar error while parallel to mains.

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 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 BESTCOMS*Plus* Var/PF Control screen is illustrated in Figure 112. Settings are listed in Table 49.

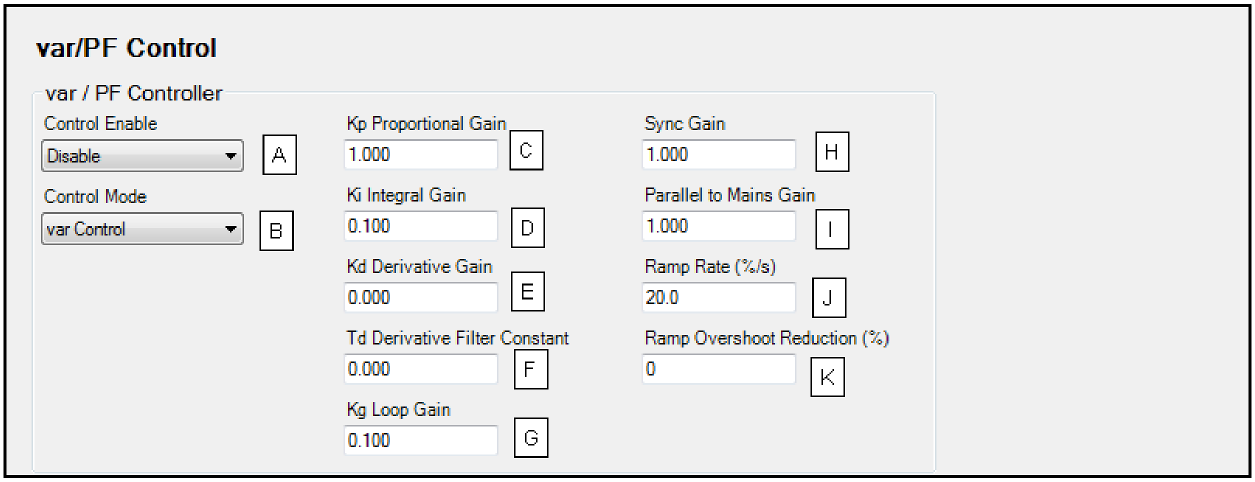


Figure 112. Settings Explorer, Bias Control Settings, AVR Bias Control Settings, Var/PF Control

Table 49. Settings for Var/PF Control

Locator	Setting	Range	Increment	Unit
A	Control Enable	Disable or Enable	n/a	n/a
B	Control Mode	var Control or PF Control	n/a	n/a
C	Kp Proportional gain	0 to 1,000	0.001	n/a
D	Ki Integral Gain	0 to 1,000	0.001	n/a
E	Kd Derivative Gain	0 to 1,000	0.001	n/a
F	Td Derivative Filter Constant	0 to 1	0.001	n/a
G	Kg Loop Gain	0 to 1,000	0.001	n/a
H	Sync Gain	0 to 1,000	0.001	n/a
I	Parallel to Mains Gain	0 to 1,000	0.001	n/a
J	Ramp Rate	0 to 100	0.1	% per second
K	Ramp Overshoot Reduction	0 to 100	1	%

Var Control

When control is enabled and the control mode is set to Var Control (on the Var/PF Control screen), the following settings are enabled.

The DGC-2020HD calculates an operating kvar setpoint based on the Setpoint Source setting. When the 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 Setpoint Source is set to User Setting, the Setpoint setting establishes the operating kvar setpoint. The range of adjustment is defined by Setpoint Min and Setpoint Max settings that are expressed as a percentage of the rated generator kvar. The Adjust Rate is the rate, in percent per second, which the generator setpoint increases or decreases in response to raise/lower requests. Settings are provided to allow bias adjustments of the setpoint. The Analog Bias Source setting establishes the analog input to provide the bias signal. The range of adjustment is defined by Bias Min and Bias Max settings that are expressed as a percentage of the kvar setpoint.

Each regulation mode has five pre-position setpoints. Each pre-position setpoint can be assigned to a programmable contact input on the DGC-2020HD. When the appropriate contact input is closed, the setpoint is driven to the corresponding pre-position value. Each pre-position function has two settings: Setpoint and Adjust Rate. The setting range of each pre-position setpoint is identical to that of the corresponding control mode setpoint.

When the Auto Save setting is enabled, the DGC-2020HD automatically saves the active externally-driven raise/lower and pre-position setpoints 30 seconds after a change in value. The saved setpoint is retained even after power is cycled to the DGC-2020HD. When Auto Save is disabled, adjustments to setpoints by raise/lower and pre-position commands are retained only for the duration of the current run session. The DGC-2020HD returns to the configured kvar setpoint value when a new run session is started or when power is cycled to the DGC-2020HD.

The BESTCOMS*Plus* Var Control screen is illustrated in Figure 113. Settings are listed in Table 50.

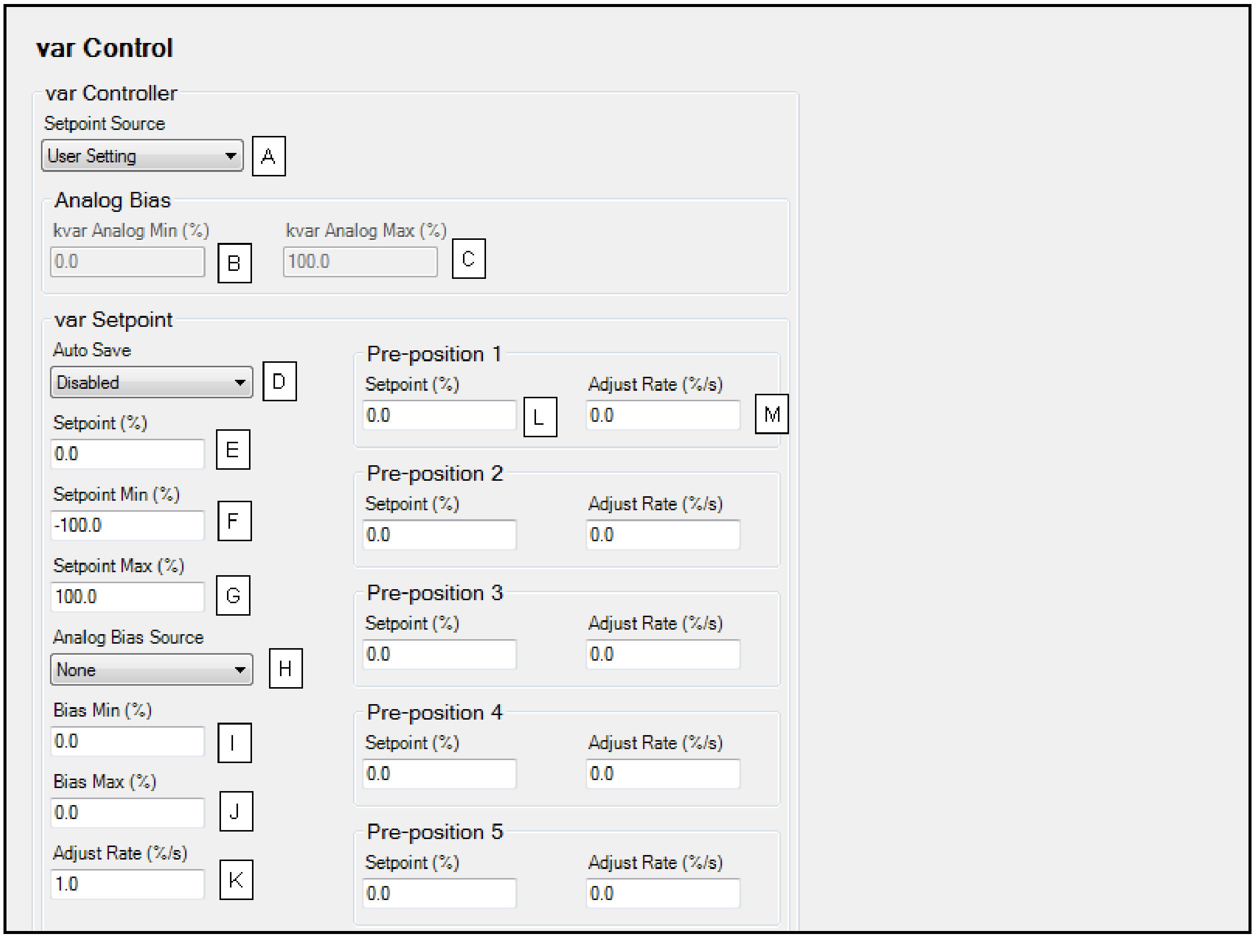


Figure 113. Settings Explorer, Bias Control Settings, AVR Bias Control Settings, Var Control

Table 50. Settings for Var Control

Locator	Setting	Range	Increment	Unit
A	Setpoint Source	None, Analog Input 1 to 4, AEM1 Input 1 to 8, AEM2 Input 1 to 8, AEM3 Input 1 to 8, AEM4 Input 1 to 8, or System Manager	n/a	n/a
B	kvar Analog Min	-100 to 100	0.1	%

Locator	Setting	Range	Increment	Unit
C	kvar Analog Max	-100 to 100	0.1	%
D	Auto Save	Disable or Enable	n/a	n/a
E	Setpoint	-100 to 100	0.1	%
F	Setpoint Min	-100 to 100	0.1	%
G	Setpoint Max	-100 to 100	0.1	%
H	Analog Bias Source	None, Analog Input 1 to 4, AEM1 Input 1 to 8, AEM2 Input 1 to 8, AEM3 Input 1 to 8, AEM4 Input 1 to 8, or System Manager	n/a	n/a
I	Bias Min	-100 to 100	0.1	%
J	Bias Max	-100 to 100	0.1	%
K	Adjust Rate	0.1 to 100	0.1	% per second
L	Pre-position, Setpoint	-100 to 100	0.1	%
M	Pre-position, Adjust Rate	0 to 100	0.1	% per second

Power Factor Control

When control is enabled and the control mode is set to Power Factor Control (on the Var/PF Control screen), the following settings are enabled.

The DGC-2020HD calculates an operating power factor setpoint based on the Setpoint Source setting. When the Setpoint Source setting is set to a DGC-2020HD analog input or an AEM-2020 input, the operating power factor setpoint is equal to the value calculated from the analog input. Parameters are available for PF analog max and PF analog min. When the Setpoint Source is set to User Setting, the Setpoint setting establishes the operating power factor setpoint. The range of adjustment is defined by Setpoint Min and Setpoint Max settings that are expressed as a percentage of the rated generator power factor. The Adjust Rate is the rate, in power factor per second, which the generator setpoint increases or decreases in response to raise/lower requests. Settings are provided to allow bias adjustments of the setpoint. The Analog Bias Source setting establishes the analog input to provide the bias signal. The range of adjustment is defined by Bias Min and Bias Max settings that are expressed as a portion of the power factor setpoint.

Each regulation mode has five pre-position setpoints. Each pre-position setpoint can be assigned to a programmable contact input on the DGC-2020HD. When the appropriate contact input is closed, the setpoint is driven to the corresponding pre-position value. Each pre-position function has two settings: Setpoint and Adjust Rate. The setting range of each pre-position setpoint is identical to that of the corresponding control mode setpoint.

When the Auto Save setting is enabled, the DGC-2020HD automatically saves the active externally-driven raise/lower and pre-position setpoints 30 seconds after a change in value. The saved setpoint is retained even after power is cycled to the DGC-2020HD. When Auto Save is disabled, adjustments to setpoints by raise/lower and pre-position commands are retained only for the duration of the current run session. The DGC-2020HD returns to the configured power factor setpoint value when a new run session is started or when power is cycled to the DGC-2020HD.

The BESTCOMS*Plus* Power Factor Control screen is illustrated in Figure 114. Settings are listed in Table 51.

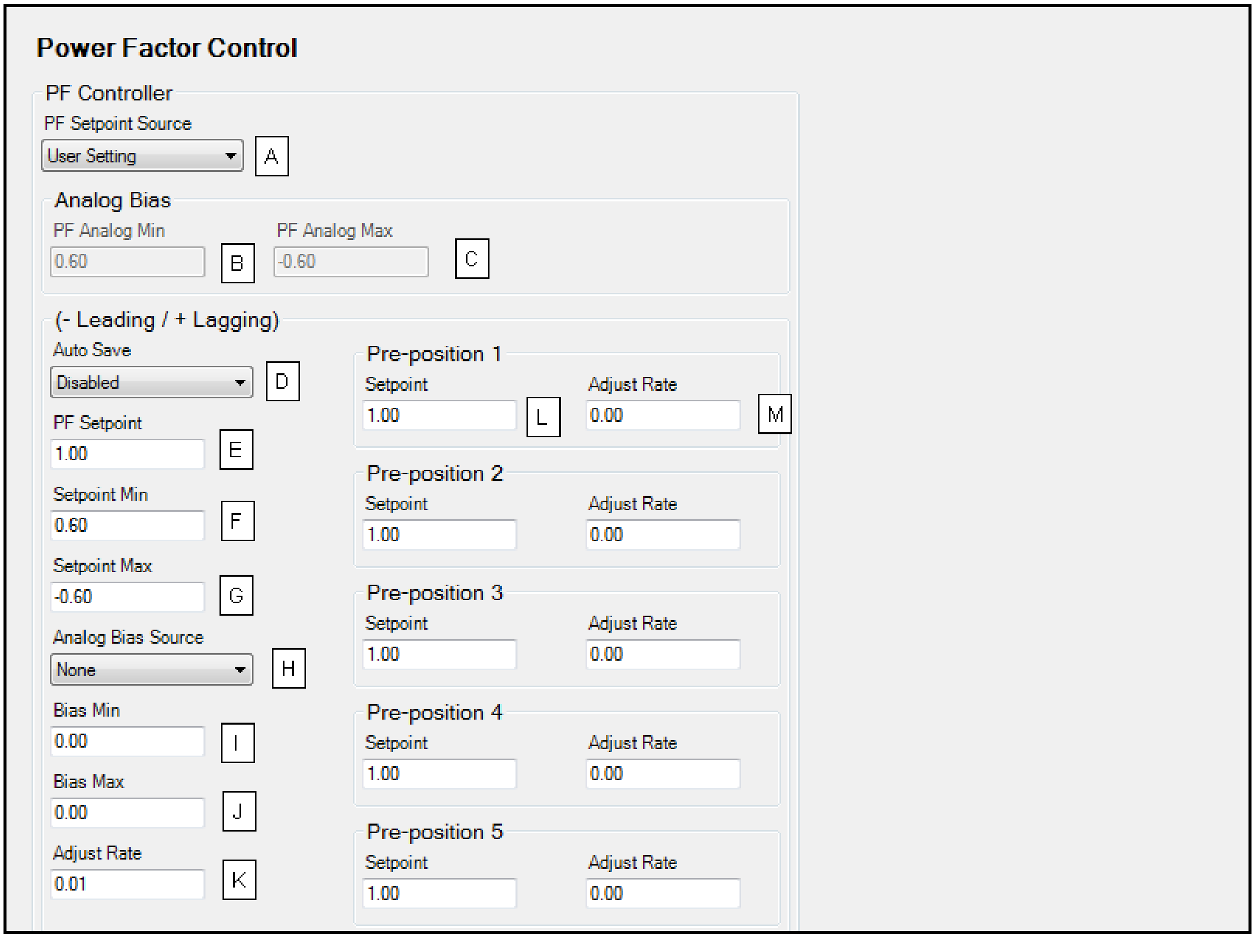


Figure 114. Settings Explorer, Bias Control Settings, AVR Bias Control Settings, Power Factor Control

Table 51. Settings for Power Factor Control

Locator	Setting	Range	Increment	Unit
A	PF Setpoint Source	None, Analog Input 1 to 4, AEM1 Input 1 to 8, AEM2 Input 1 to 8, AEM3 Input 1 to 8, AEM4 Input 1 to 8, or System Manager	n/a	n/a
B	PF Analog Min	0.6 to -0.6	0.01	per unit
C	PF Analog Max	0.6 to -0.6	0.01	per unit
D	Auto Save	Disable or Enable	n/a	n/a
E	PF Setpoint	0.6 to -0.6	0.01	per unit
F	Setpoint Min	0.6 to -0.6	0.01	per unit
G	Setpoint Max	0.6 to -0.6	0.01	per unit
H	Analog Bias Source	None, Analog Input 1 to 4, AEM1 Input 1 to 8, AEM2 Input 1 to 8, AEM3 Input 1 to 8, AEM4 Input 1 to 8, or System Manager	n/a	n/a

Locator	Setting	Range	Increment	Unit
I	Bias Min	-0.8 to 0.8	0.01	per unit
J	Bias Max	-0.8 to 0.8	0.01	per unit
K	Adjust Rate	0.01 to 1	0.01	PF unit per second
L	Pre-position, Setpoint	0.6 to -0.6	0.01	per unit
M	Pre-position, Adjust Rate	0 to 1	0.01	PF unit per second

Voltage Droop

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 Equation 12.

$$Expected\ voltage\ reduction\ in\ droop - \left\{\left(\frac{actual\ kvar\ load}{machine\ capacity}\right) * \left(\frac{droop\ percentage}{100}\right) - offset\right\} * rated\ voltage$$

Equation 12. Expected Voltage

If the actual voltage drop does not match the expected value, calculate the error by dividing the expected drop by the actual drop. Enter the result for the Voltage Droop Gain setting on the AVR Bias Control Settings screen.

When operating in Voltage Droop mode, the droop curve indicates operation at rated voltage when the machine is unloaded. The generator output voltage droops by the full Droop Percentage when fully loaded. A Droop Offset setting is provided to shift the droop curve up or down to achieve desired generator voltage when the machine is fully loaded with reactive power. For instance, with a Droop Percentage value of 5% and a Droop Offset value of 5%, the generator will operate 5% above rated voltage when unloaded and at rated voltage when fully loaded. To clarify, with the Droop Offset, the Expected voltage reduction in droop can be a negative value which results in an increase in voltage in certain ranges of machine kvar loading. The machine will still have a drooping characteristic, but the voltage will always be higher than or equal to rated if the Droop Offset is set equal to or greater than the Droop Percentage setting.

The BESTCOMS*Plus* Voltage Droop screen is illustrated in Figure 115. Settings are listed in Table 52.

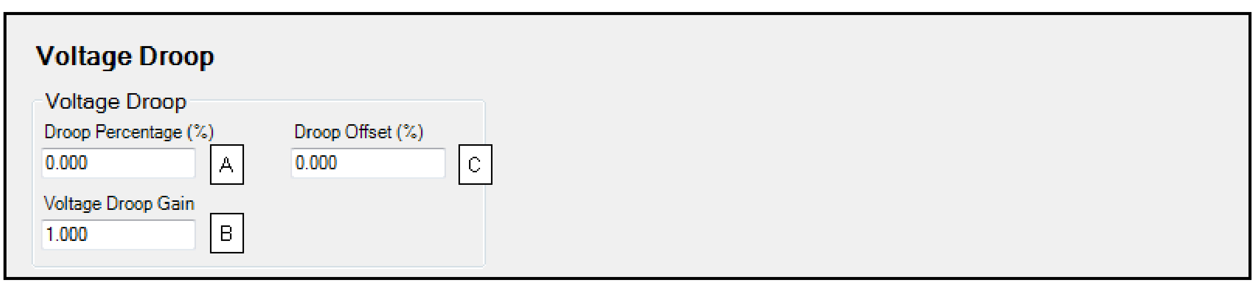


Figure 115. Settings Explorer, Bias Control Settings, AVR Bias Control Settings, Voltage Droop

Table 52. Settings for Voltage Droop

Locator	Setting	Range	Increment	Unit
A	Droop Percentage	0 or 0.5 to 10	0.001	%

Locator	Setting	Range	Increment	Unit
B	Voltage Droop Gain	0 to 1,000	0.001	n/a
C	Droop Offset	0 to 10	0.001	%

Governor Bias Control Settings

BESTCOMS*Plus* Navigation Path: Settings Explorer, Bias Control Settings, Governor Bias Control Settings

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

Speed biasing signals can be applied to a governor using the analog output or contact outputs of the DGC-2020HD. Analog outputs provide a variable voltage from -10 to +10 Vdc or a variable current from 4 to 20 mAdc to the bias inputs of the governor. Contact outputs provide raise and lower commands to the bias inputs of the governor. Use the Bias Control Output Type setting to establish the appropriate bias control signal for your governor.

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.

See *Contact Output Bias Control Setup in BESTlogicPlus* below for instructions on setting up governor bias control using DGC-2020HD contact outputs.

When the bias control output type is set to analog, a PID controller sends 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.

See *Analog Output Bias Control Setup* below for instructions on setting up governor bias control using DGC-2020HD analog outputs.

The BESTCOMS*Plus* Governor Output Configuration screen is illustrated in Figure 116. Settings are listed in Table 53.

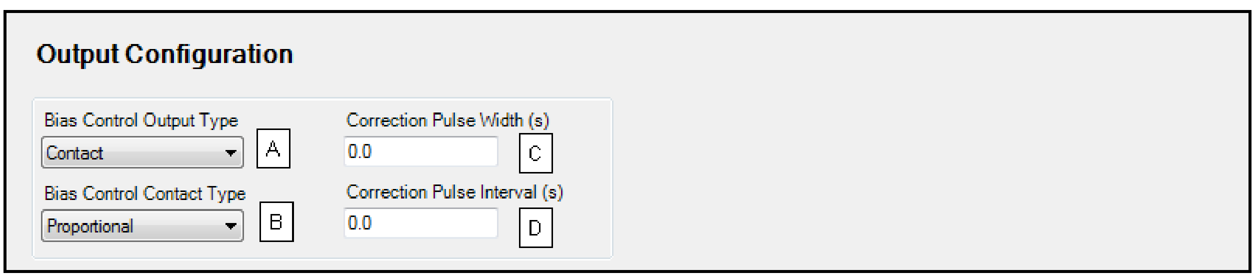


Figure 116. Settings Explorer, Bias Control Settings, Governor Bias Control Settings, Output Configuration

Table 53. Settings for Governor Output Configuration

Locator	Setting	Range	Increment	Unit
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

Speed Control

Settings are provided for proportional gain, integral gain, derivative gain, derivative filter constant, and loop gain of the PID controller.

When the speed trim enable setting is Enabled When Gen Breaker is Closed, the generator operates at the speed trim setpoint when the generator breaker is closed and not paralleled to the utility. When the speed trim enable setting is Enabled Always, the generator always operates at the speed trim setpoint, even when the generator breaker is open. This is useful in situations where it is desired to control machine speed from an external potentiometer or raise/lower commands for manual synchronization, for example.

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.

When the Auto Save setting is enabled, the DGC-2020HD automatically saves the active externally-driven raise/lower and pre-position setpoints 30 seconds after a change in value. The saved setpoint is retained even after power is cycled to the DGC-2020HD. When Auto Save is disabled, adjustments to setpoints by raise/lower and pre-position commands are retained only for the duration of the current run session. The DGC-2020HD returns to the configured Speed Trim value when a new run session is started or when power is cycled to the DGC-2020HD.

The Speed Trim Setpoint setting establishes the operating speed trim setpoint. The range of adjustment is defined by Setpoint Min and Setpoint Max settings that are expressed as a percentage of the rated generator frequency. The Adjust Rate is the rate, in percent per second, which the generator setpoint increases or decreases in response to raise/lower requests.

When speed trim is active, the Speed Trim Deadband setting may be used to improve system stability and/or kvar sharing. These improvements are implemented through the comparison of the Speed Trim Deadband setting with the calculated speed trim error. The speed trim error is calculated as the difference between the measured generator frequency and the speed trim setpoint divided by the machine Rated Frequency setting. A calculated result that is less than the Speed Trim Deadband setting is interpreted as zero error. A calculated result that is greater than the (nonzero) Speed Trim Deadband setting triggers stability and/or kvar sharing improvements. The Speed Trim Deadband setting is expressed as a percentage of rated frequency.

Settings are provided to allow remote bias adjustments of the setpoint. The Remote Speed Bias setting establishes the analog input to provide the bias signal. The range of adjustment is defined by the Remote Speed Bias (%) setting that is expressed as a percentage above and below the remote speed bias setpoint.

Each regulation mode has five pre-position setpoints. Each pre-position setpoint can be assigned to a programmable contact input on the DGC-2020HD. When the appropriate contact input is closed, the setpoint is driven to the corresponding pre-position value. Each pre-position function has two settings: Setpoint and Adjust Rate. The setting range of each pre-position setpoint is identical to that of the corresponding control mode setpoint.

When the speed trim droop enable (SPEEDTRIMDROOPENABLE) logic element input is true, the setpoint for the speed trim controller is reduced by an amount dictated by the Droop Percent and Droop Offset Percent settings in Equation 13:

$$Droop\ PU = \left(\left(SpeedTrim\ Droop\% \times \frac{Generated\ kW}{Rated\ kW}\right) - SpeedTrim\ Droop\ Offset\%\right) \times 0.01$$

Equation 13. Speed Trim Droop Mode Setpoint

When operating in droop mode, the speed trim function is operational but the setpoint is calculated using Equation 13. Thus the machine trims machine speed to a setpoint calculated by the droop equation. This mode of operation is necessary in situations where it is desired to control machine speed from an external potentiometer or raise/lower commands for manual synchronization, for example. This mode is also necessary in situations where it is desired to operate the machine in droop mode with the ability to shift the droop curve up or down to vary machine output at a given frequency using an external potentiometer or raise/lower commands.

The BESTCOMS*Plus* Speed Control screen is illustrated in Figure 117. Settings are listed in Table 54.

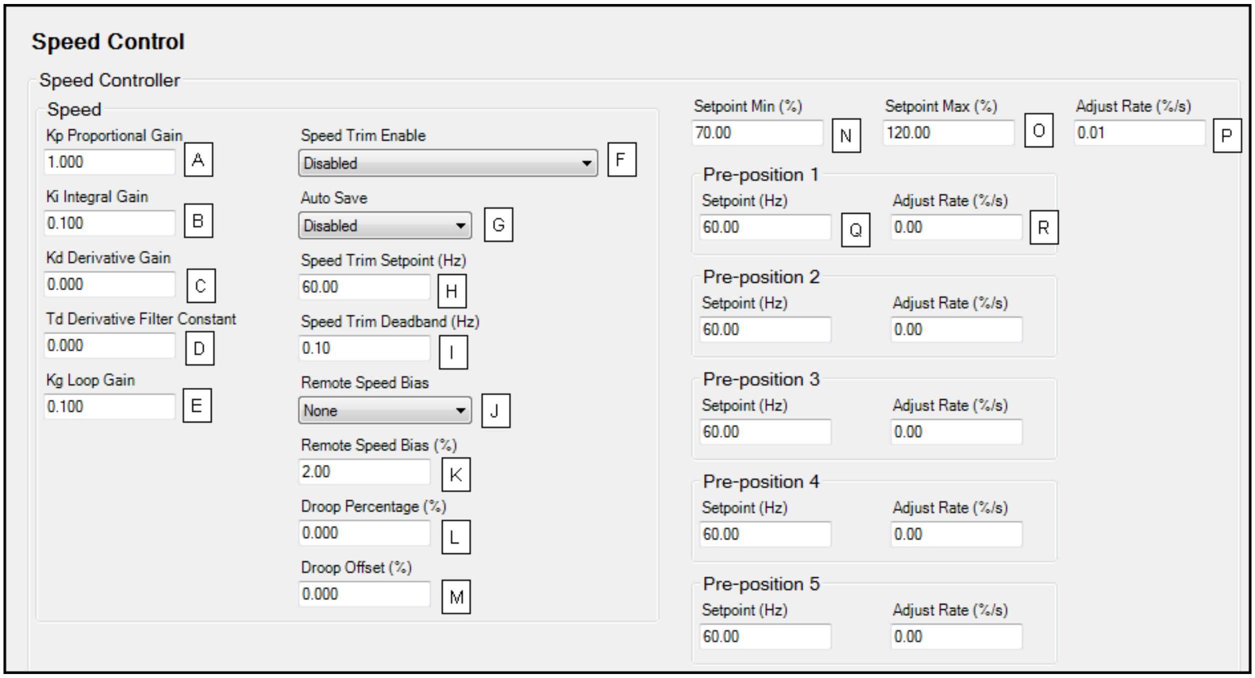


Figure 117. Settings Explorer, Bias Control Settings, Governor Bias Control Settings, Speed Control

Table 54. Settings for Speed Control

Locator	Setting	Range	Increment	Unit
A	Kp Proportional Gain	0 to 1,000	0.001	n/a
B	Ki Integral Gain	0 to 1,000	0.001	n/a
C	Kd Derivative Gain	0 to 1,000	0.001	n/a
D	Td Derivative Filter Constant	0 to 1	0.001	n/a
E	Kg Loop Gain	0 to 1,000	0.001	n/a
F	Speed Trim Enable	Disabled, Enabled When Gen Breaker is Closed, or Enabled Always	n/a	n/a
G	Auto Save	Disabled or Enabled	n/a	n/a
H	Speed Trim Setpoint	47 to 100	0.01	Hz
I	Speed Trim Deadband	0 to 1	0.05	Hz
J	Remote Speed Bias	None, Analog Input 1 to 4, AEM1 Input 1 to 8, AEM2 Input 1 to 8, AEM3 Input 1 to 8, AEM4 Input 1 to 8, or System Manager	n/a	n/a
K	Remote Speed Bias (%)	0 to 100	0.001	%

Locator	Setting	Range	Increment	Unit
L	Droop Percentage	0 or 0.5 to 10	0.001	%
M	Droop Offset	0 to 10	0.001	%
N	Setpoint Min	50 to 200	0.01	%
O	Setpoint Max	50 to 200	0.01	%
P	Adjust Rate	0.01 to 100	0.01	% per second
Q	Pre-position, Setpoint	47 to 100	0.01	Hz
R	Pre-position, Adjust Rate	0 to 100	0.01	% per second

Speed Droop

The percent speed droop to be used when the unit is in droop mode is determined by the droop percentage setting. Speed droop mode is entered when the generator breaker is open or when the generator breaker is closed with kW load sharing disabled. If it is desired to disable speed droop, set the droop percentage to 0. The value of the speed droop gain setting is applied to the speed droop percentage to compensate for governor differences and achieve desired droop performance. In order to test the operation of droop, the unit must be loaded to full load and the resulting generator speed should be compared to the desired droop. If it is not possible to load the unit to full load, the droop test can be performed at partial load. The expected speed is determined by Equation 14.

$$Expected\ RPM\ reduction\ in\ droop - \left\{\left(\frac{actual\ kW\ load}{machine\ rated\ kW\ capacity}\right) * \left(\frac{droop\ percentage}{100}\right) - offset\right\} * rated\ speed$$

Equation 14. Expected Speed

If the actual rpm drop does not match the expected value, calculate the error by dividing the expected drop by the actual drop, and inputting the result as the Droop Gain setting on the Governor Bias Control Settings screen.

When operating in Speed Droop mode, the droop curve indicates operation at rated frequency when the machine is unloaded. The generator droops by the full Droop Percentage when fully loaded. A Droop Offset setting is provided to shift the droop curve up or down to achieve desired generator frequency when the machine is fully loaded. For instance, with a Droop Percentage value of 5% and a Droop Offset value of 5%, the generator will run 5% above rated frequency when unloaded and at rated frequency when fully loaded. To clarify, with the Droop Offset, the Expected RPM reduction in droop can be a negative value which results in an increase in RPM at certain levels of machine load. The machine will still have a drooping characteristic, but the speed will always be higher than or equal to rated if the Droop Offset is set equal to or greater than the Droop Percentage setting.

The BESTCOMS*Plus* Speed Droop screen is illustrated in Figure 118. Settings are listed in Table 55.

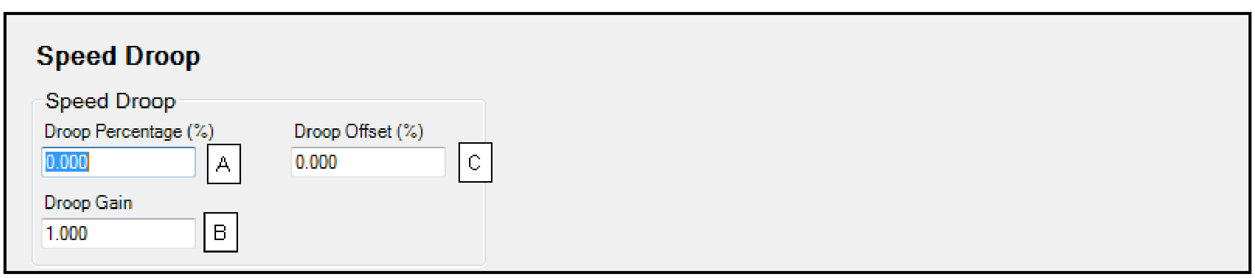


Figure 118. Settings Explorer, Bias Control Settings, Governor Bias Control Settings, Speed Droop

Table 55. Settings for Speed Droop

Locator	Setting	Range	Increment	Unit
A	Droop Percentage	0 or 0.5 to 10	0.001	%
B	Droop Gain	0 to 1,000	0.001	n/a

Locator	Setting	Range	Increment	Unit
C	Droop Offset	0 to 10	0.001	%

Load Anticipation (optional)

The optional load anticipation function (style xxxxxLxxx) improves speed recovery of a diesel genset during load application and rejection.

This feature is available in DGC-2020HD units with style xxxxxLxxx and application (firmware) version 1.02.00 or greater. To check your application (firmware) version, please refer to the *Device Information* chapter.

When a load is applied, the engine speed begins to decrease and the speed governor reacts in turn by increasing the engine speed. However, the change in engine speed due to load application is much slower than the change in real power. The DGC-2020HD senses the real power changes in load well before the engine speed is affected. Thus, a feed-forward signal, proportional to the real power change, is sent to the speed governor to make throttle adjustments in advance of the engine speed actually decreasing. This differs from conventional approaches which change the setpoint of the voltage regulator based on a specific underfrequency curve.

Operation

Figure 119 illustrates the basic operation of the load anticipation function.

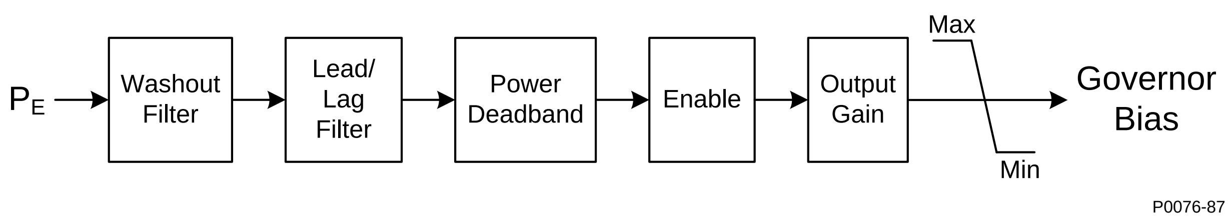


Figure 119. Load Anticipation Function

The following paragraph describes the load anticipation function blocks illustrated in Figure 119.

The Washout Filter block obtains the rate of change in generator's real power (PE) and filters out values below a user-defined level (Tla). This ensures that load anticipation provides output only when a large change in power occurs. Phase lag caused by the governor and actuator is compensated with the Phase Lead/Lag Filter block by user-defined levels (Tld, Tlg). The Power Deadband block obtains the generator's real power level and filters out values below a user-defined level. This ensures that load anticipation provides output only when a large load is applied. Load anticipation output is inhibited by the Enable block when *any* enable condition is not met. See *Enabling Load Anticipation* below. The Output Gain block applies the user-defined output gain (Kla) to the load anticipation output. Load anticipation output is trimmed to be within the minimum and maximum limits by the Min/Max block. Finally, load anticipation output is added to the governor bias output level which is sent to the ECU as an analog bias signal or as a speed request over CAN Bus.

Enabling Load Anticipation

Load anticipation is enabled when *all* of the following conditions are true:

- Load Anticipation and Load Control are both enabled on the Governor Bias Control Settings screen.
    - o Settings > Bias Control Settings > Governor Bias Control Settings
- Local Generator breaker is closed
- Local Generator is not parallel to mains
- Application (firmware) version is 1.02.00 or greater
- Load Anticipate Inhibit BESTlogic*Plus* logic element is not receiving a true input.

The BESTlogic™*Plus* LDANTICIPATEINHIBIT logic element (Figure 120) disables load anticipation when held true.

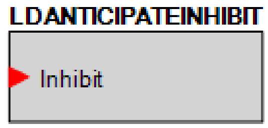


Figure 120. Load Anticipate Inhibit Logic Element

Tuning Parameters

For proper operation, load anticipation must be tuned to each system using the following parameters. These parameters are briefly described below and are found on the Load Anticipation settings screen (Figure 121). Settings are listed in Table 56. Refer to the *Tuning PID Settings* chapter for a load anticipation tuning procedure.

Tla Washout Filter Constant: Rate of change in real power is obtained with the washout filter (A washout filter only responds to changes, otherwise it is zero.)

Tld Lead Filter Constant: Phase lag caused by the governor and actuator is compensated with the phase lead filter

Tlg Lag Filter Constant: Phase lead caused by the governor and actuator is compensated with the phase lag filter

Kla Gain: Output gain of load anticipation function. Positive output results in higher engine speed, negative results in lower engine speed

Max Limit: Maximum output gain of load anticipation function

Min Limit: Minimum output gain of load anticipation function

Power Deadband: Minimum change in real power which will activate load anticipation

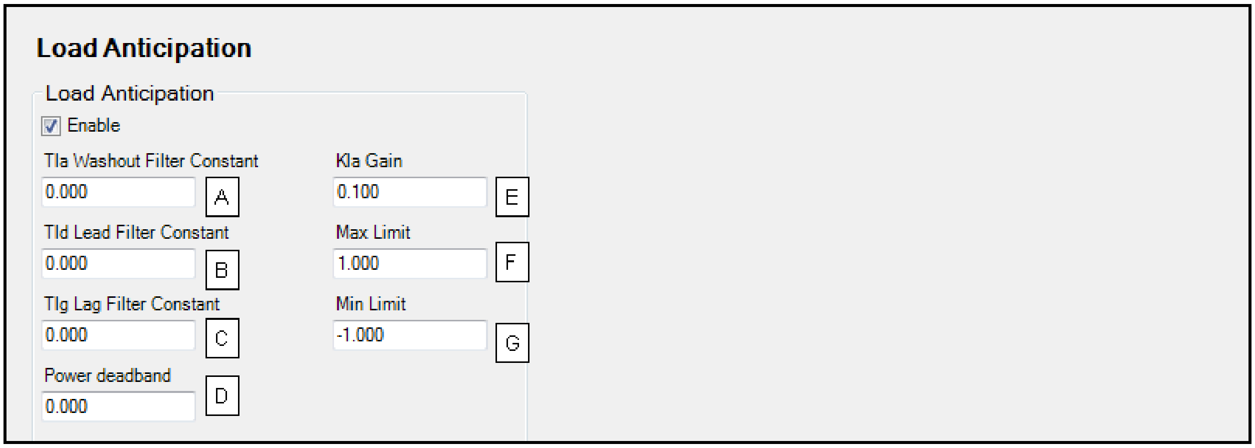


Figure 121. Settings Explorer, Bias Control Settings, Governor Bias Control Settings, Load Anticipation

Table 56. Settings for Load Anticipation

Locator	Setting	Range	Increment	Unit
A	Tla Washout Filter Constant	0 to 10	0.001	n/a
B	Tld Lead Filter Constant	0 to 10	0.001	n/a
C	Tlg Lag Filter Constant	0 to 10	0.001	n/a
D	Power Deadband	0 to 1	0.001	n/a
E	Kla Gain	0 to 1,000	0.001	n/a
F	Max Limit	0 to 10	0.001	n/a
G	Min Limit	-10 to 0	0.001	n/a

Load Control Settings

KW control is accomplished with a PID controller that controls the speed bias signal from the DGC-2020HD to the speed governor. The controller adjusts the bias output to drive the error between desired kW generation and measured kW generation to zero. Settings are provided for proportional gain, integral gain, derivative gain, derivative filter constant, loop gain, Sync Gain and Parallel to Mains Gain of the PID controller.

The Sync Gain value is applied to kW error while synchronizing the group bus to the load or across a tie breaker. When generators are synchronizing as a group the voltage and frequency of each generator is continuously adjusted to achieve synchronization. When load sharing, the output voltage of the generators is continuously adjusted to share the load. If load sharing and synchronization are active simultaneously, synchronization can take longer than desired because the generators are being adjusted to share load in reaction to the adjustments being made to synchronize. A Sync Gain setting is provided to adjust the responsiveness of the load share controller during group synchronization. A lower Sync Gain value causes the DGC-2020HD to focus less on load sharing adjustments and more on synchronizing adjustments and a higher Sync Gain value causes the DGC-2020HD to focus more on load sharing adjustments and less on synchronizing adjustments.

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 BESTCOMS*Plus* KW Control screen is illustrated in Figure 122. Settings are listed in Table 57.

Figure 122. Settings Explorer, Bias Control Settings, Governor Bias Control Settings, KW Control

Table 57. Settings for KW Control

Locator	Setting	Range	Increment	Unit
A	Load Control Enabled	Disable or Enable	n/a	n/a
B	Kp Proportional Gain	0 to 1,000	0.001	n/a
C	Ki Integral Gain	0 to 1,000	0.001	n/a
D	Kd Derivative Gain	0 to 1,000	0.001	n/a
E	kW Parallel to Mains Gain	0 to 1,000	0.001	n/a
F	Td Derivative Filter Constant	0 to 1	0.001	n/a
G	Kg Loop Gain	0 to 1,000	0.001	n/a
H	Sync Gain	0 to 1,000	0.001	n/a
I	Ramp Rate	0 to 100	0.1	% per second
J	Ramp Overshoot Reduction	0 to 100	1	%

KW Islanded Mode

Manual Operating Mode provides a constant output at the base load level or analog input level. Automatic Operating Mode enables kW load sharing.

KW sharing data can be transmitted via Ethernet or analog load share lines. The communication method is determined by the Load Share Interface setting.

When the Base Load Level Source is configured for an analog input, the operating kW controller setpoint is calculated based on the specific analog input. Parameters are available for baseload analog max and baseload analog min.

When User Setting is selected for the Base Load Level Source, the Base Load Level setting determines the percent of machine capacity at which the kW controller will regulate if the generator is paralleled to the utility. If paralleled to the utility, the Parallel to Mains logic element in BESTlogic*Plus* must be driven by logic or a contact input. If operating parallel to the utility and the Parallel to Mains logic element is not implemented, the DGC-2020HD remains in kW load share and may move toward operation at either 100% of capacity or 0% of capacity possibly resulting in machine shutdown or damage to the machine or system.

The Base Load Level range of adjustment is defined by Setpoint Min and Setpoint Max settings that are expressed as a percentage of the rated generator kW. The Adjust Rate is the rate, in percent per second, which the generator setpoint increases or decreases in response to raise/lower requests. Settings are provided to allow bias adjustments of the setpoint. The Analog Bias Source setting establishes the analog input to provide the bias signal. The range of adjustment is defined by Bias Min and Bias Max settings that are expressed as a percentage of the kW setpoint.

Each regulation mode has five pre-position setpoints. Each pre-position setpoint can be assigned to a programmable contact input on the DGC-2020HD. When the appropriate contact input is closed, the setpoint is driven to the corresponding pre-position value. Each pre-position function has two settings: Setpoint and Adjust Rate. The setting range of each pre-position setpoint is identical to that of the corresponding control mode setpoint.

When the Auto Save setting is enabled, the DGC-2020HD automatically saves the active externally-driven raise/lower and pre-position setpoints 30 seconds after a change in value. The saved setpoint is retained even after power is cycled to the DGC-2020HD. When Auto Save is disabled, adjustments to setpoints by raise/lower and pre-position commands are retained only for the duration of the current run session. The DGC-2020HD returns to the configured Base Load Level setting value when a new run session is started or when power is cycled to the DGC-2020HD.

The BESTCOMS*Plus* KW Control screen is illustrated in Figure 123. Settings are listed in Table 58.

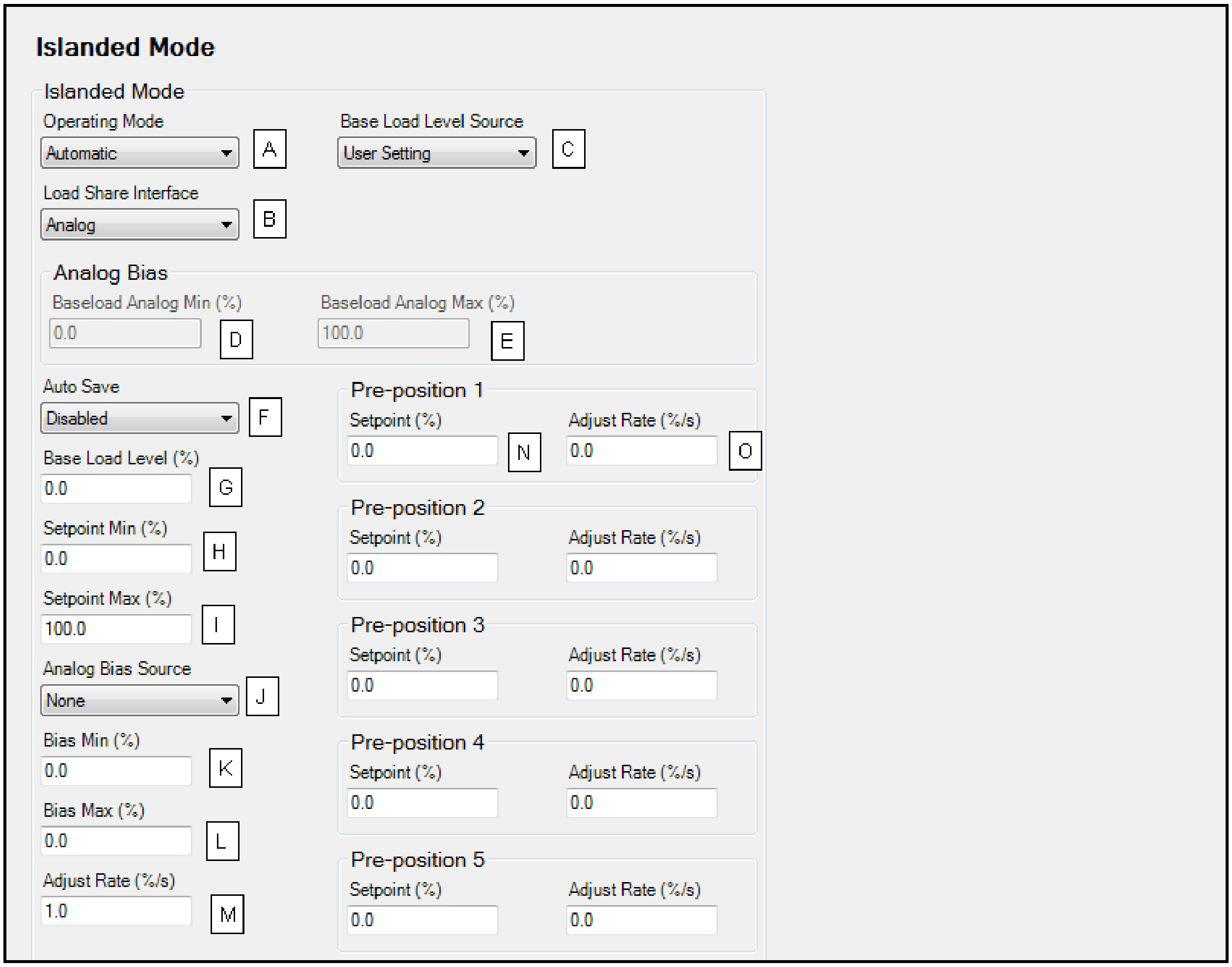


Figure 123. Settings Explorer, Bias Control Settings, Governor Bias Control Settings, Islanded Mode

Table 58. Settings for Islanded Mode

Locator	Setting	Range	Increment	Unit
A	Operating Mode	Manual or Automatic	n/a	n/a
B	Load Share Interface	Analog or Ethernet	n/a	n/a
C	Base Load Level Source	User Setting, Analog Input 1 to 4, AEM1 Input 1 to 8, AEM2 Input 1 to 8, AEM3 Input 1 to 8, AEM4 Input 1 to 8, or System Manager	n/a	n/a
D	Baseload Analog Min	0 to 100	0.1	%
E	Baseload Analog Max	0 to 100	0.1	%
F	Auto Save	Disabled or Enabled	n/a	n/a
G	Baseload Level	0 to 100	0.1	%
H	Setpoint Min	50 to 200	0.01	%
I	Setpoint Max	50 to 200	0.01	%

Locator	Setting	Range	Increment	Unit
J	Analog Bias Source	None, Analog Input 1 to 4, AEM1 Input 1 to 8, AEM2 Input 1 to 8, AEM3 Input 1 to 8, AEM4 Input 1 to 8, or System Manager	n/a	n/a
K	Bias Min	-100 to 100	0.1	%
L	Bias Max	-100 to 100	0.1	%
M	Adjust Rate	0.1 to 100	0.1	% per second
N	Pre-position, Setpoint	0 to 100	0.1	%
O	Pre-position, Adjust Rate	0 to 100	0.1	% per second

Mains Parallel Mode

Manual Operating Mode provides a constant output at the base load level or analog input level. Automatic Operating Mode enables peak shaving or import/export. Base load, import/export, and peak shaving are mains power control modes and are described under the Mains Power Controller heading below.

When the Base Load Level Source is configured for an analog input, the operating kW controller setpoint is calculated based on the specific analog input. Parameters are available for baseload analog max and baseload analog min.

When User Setting is selected for the Base Load Level Source, the Base Load Level setting determines the percent of machine capacity at which the kW controller will regulate if the generator is paralleled to the utility. If paralleled to the utility, the Parallel to Mains logic element in BESTlogic*Plus* must be driven by logic or a contact input. If operating parallel to the utility and the Parallel to Mains logic element is not implemented, the DGC-2020HD remains in kW load share and may move toward operation at either 100% of capacity or 0% of capacity resulting in damage to the machine or system.

The Base Load Level range of adjustment is defined by Setpoint Min and Setpoint Max settings that are expressed as a percentage of the rated generator kW. The Adjust Rate is the rate, in percent per second, which the generator setpoint increases or decreases in response to raise/lower requests. Settings are provided to allow bias adjustments of the setpoint. The Analog Bias Source setting establishes the analog input to provide the bias signal. The range of adjustment is defined by Bias Min and Bias Max settings that are expressed as a percentage of the kW setpoint.

Each regulation mode has five pre-position setpoints. Each pre-position setpoint can be assigned to a programmable contact input on the DGC-2020HD. When the appropriate contact input is closed, the setpoint is driven to the corresponding pre-position value. Each pre-position function has two settings: Setpoint and Adjust Rate. The setting range of each pre-position setpoint is identical to that of the corresponding control mode setpoint.

When the Auto Save setting is enabled, the DGC-2020HD automatically saves the active externally-driven raise/lower and pre-position setpoints 30 seconds after a change in value. The saved setpoint is retained even after power is cycled to the DGC-2020HD. When Auto Save is disabled, adjustments to setpoints by raise/lower and pre-position commands are retained only for the duration of the current run session. The DGC-2020HD returns to the configured Base Load Level setting value when a new run session is started or when power is cycled to the DGC-2020HD.

The BESTCOMS*Plus* KW Control screen is illustrated in Figure 124. Settings are listed in Table 59.

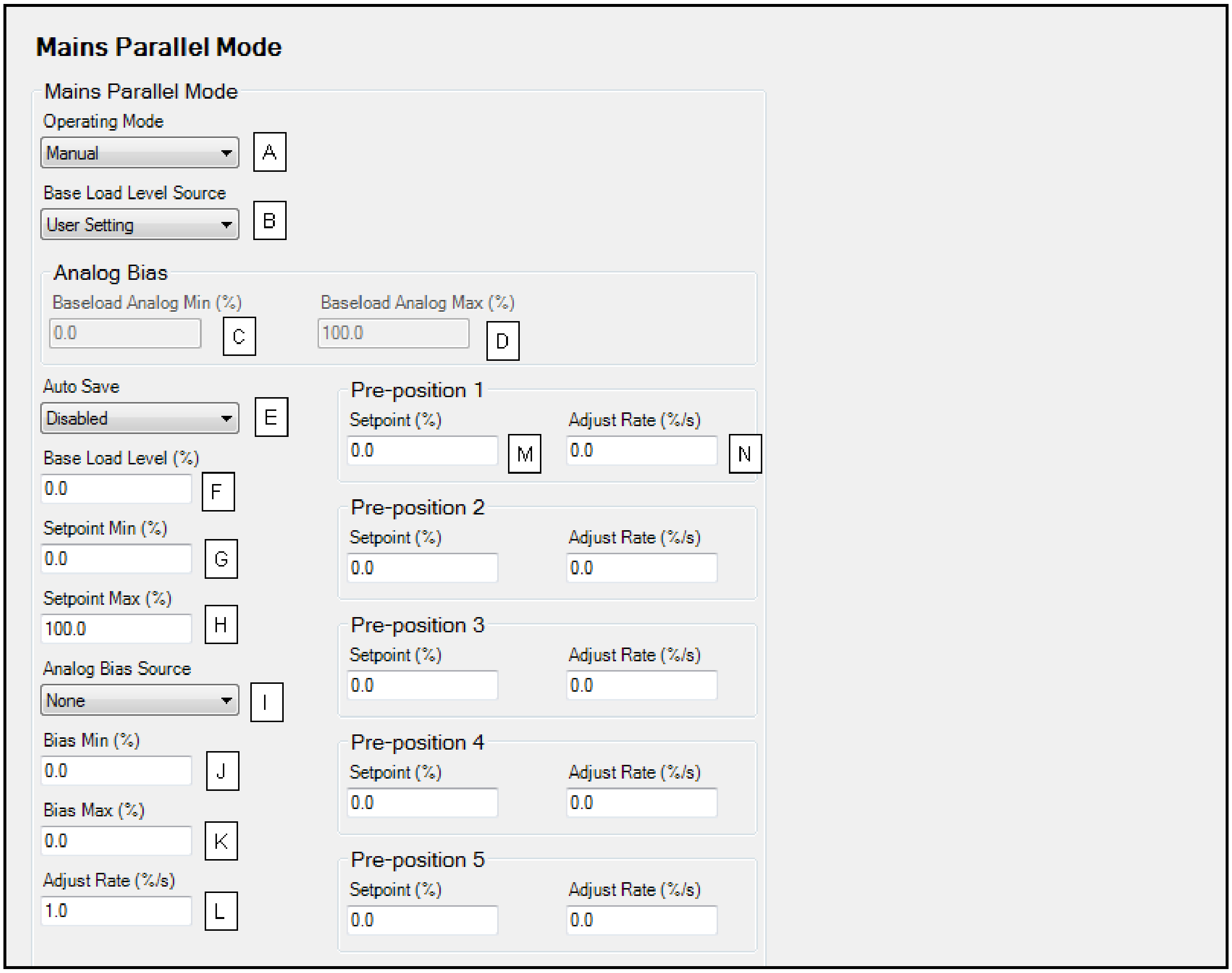


Figure 124. Settings Explorer, Bias Control Settings, Governor Bias Control Settings, Mains Parallel Mode

Table 59. Settings for Mains Parallel Mode

Locator	Setting	Range	Increment	Unit
A	Operating Mode	Manual or Automatic	n/a	n/a
B	Base Load Level Source	User Setting, Analog Input 1 to 4, AEM1 Input 1 to 8, AEM2 Input 1 to 8, AEM3 Input 1 to 8, AEM4 Input 1 to 8, or System Manager	n/a	n/a
C	Base Load Analog Max	0 to 100	0.1	%
D	Base Load Analog Min	0 to 100	0.1	%
E	Auto Save	Disabled or Enabled	n/a	n/a
F	Base Load Level	0 to 100	0.1	%
G	Setpoint Min	50 to 200	0.01	%
H	Setpoint Max	50 to 200	0.01	%

Locator	Setting	Range	Increment	Unit
I	Analog Bias Source	None, Analog Input 1 to 4, AEM1 Input 1 to 8, AEM2 Input 1 to 8, AEM3 Input 1 to 8, AEM4 Input 1 to 8, or System Manager	n/a	n/a
J	Bias Min	-100 to 100	0.1	%
K	Bias Max	-100 to 100	0.1	%
L	Adjust Rate	0.1 to 100	0.1	% per second
M	Pre-position, Setpoint	0 to 100	0.1	%
N	Pre-position, Adjust Rate	0 to 100	0.1	% per second

Contact Output Bias Control Setup in BESTlogic™Plus

The following steps describe how to configure DGC-2020HD contact outputs to control the voltage regulator and/or governor:

1. Ensure proper wiring connections are made between the DGC-2020HD and the AVR and/or governor. In this example, contact outputs 7 through 10 are being used, however any available contact outputs can be used.
    a. Connect terminal 23 (OUT 7) to the AVR raise input.
    b. Connect terminal 24 (OUT 8) to the AVR lower input.
    c. Connect terminal 25 (OUT 9) to the governor raise input.
    d. Connect terminal 26 (COM 7, 8, 9) to the AVR and governor common inputs.
    e. Connect terminal 27 (OUT 10) to the governor lower input.
    f. Connect terminal 30 (COM 10, 11, 12) to the governor common input.

   Refer to the *Terminals and Connectors* and *Typical Applications* chapters in the *Installation* manual for more information.
2. In BESTCOMS*Plus*, open the Contact Outputs screen in the Settings Explorer, under Programmable Outputs. Label Output #7 as "AVR Raise", Output #8 as "AVR Lower", Output #9 as "GOV Raise", and Output #10 as "GOV Lower". See Figure 125.

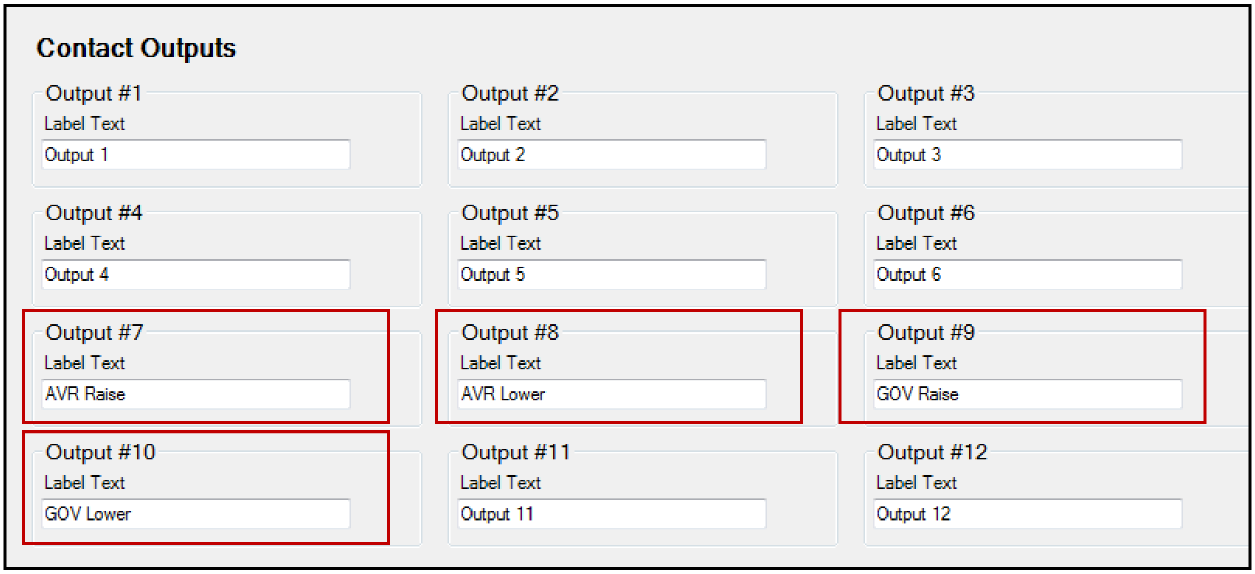


Figure 125. Settings Explorer, Programmable Outputs, Contact Outputs

3. In BESTlogic*Plus* Programmable Logic, click on the Elements tab and drag the AVR and GOVR elements into the main logic screen. See Figure 126.

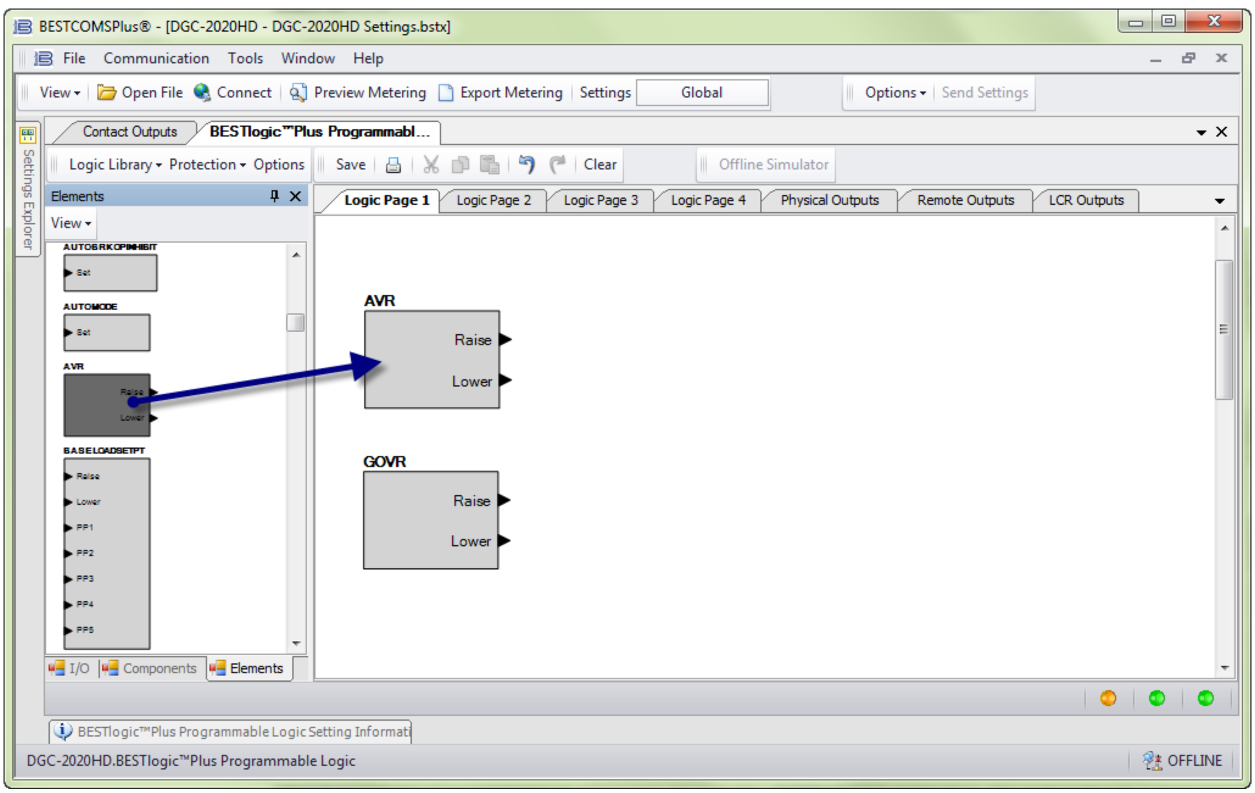


Figure 126. Contact Output Bias Control Setup, Step 3.

4. Click on the I/O tab and drag the outputs assigned in step 1 into the main logic screen and connect them to the appropriate outputs of the AVR and GOVR blocks. See Figure 127.
5. Upload settings and logic to the DGC-2020HD.

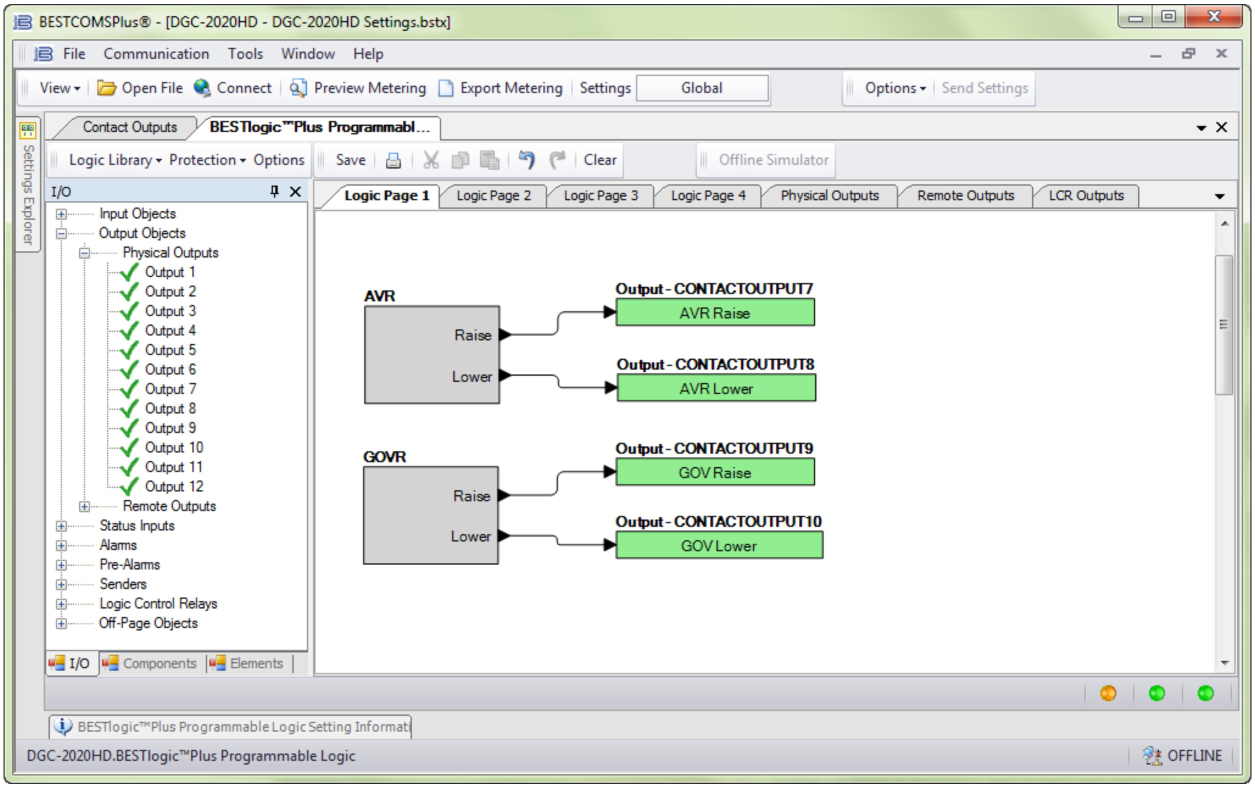


Figure 127. Contact Output Bias Control Setup, Step 4.

Analog Output Bias Control Setup

The following procedures provide instructions for setting up AVR bias control and governor bias control using analog outputs on the DGC-2020HD.

Analog AVR Bias Control Setup

1. Ensure proper wiring connections are made between the DGC-2020HD and the AVR. Use terminals AVR+ (64) and AVR- (65). Refer to the *Terminals and Connectors* and *Typical Applications* chapters in the *Installation* manual for more information.
2. In BESTCOMS*Plus*, open the AVR Output screen in the Settings Explorer, under Multigen Management. Select the bias output parameters and levels as required by the voltage regulator. See Figure 128.
    a. Output Type - Select whether the AVR bias signal is 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. Decreasing should be selected if an increase in the output parameter results in a decrease 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 current 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 –10 V to +10 V.
3. Upload settings to the DGC-2020HD.

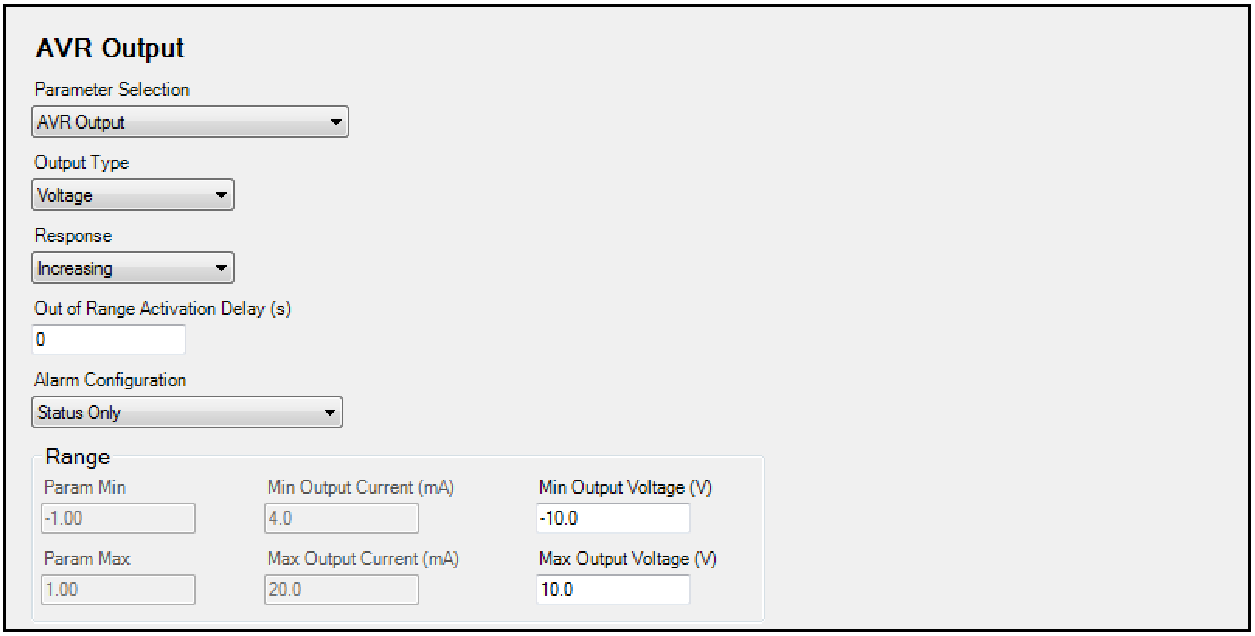


Figure 128. Settings Explorer, Multigen Management, AVR Output

Analog Governor Bias Control Setup

1. Ensure proper wiring connections are made between the DGC-2020HD and the governor. Use terminals GOV+ (66) and GOV- (67). Refer to the *Terminals and Connectors* and *Typical Applications* chapters in the *Installation* manual for more information.
2. In BESTCOMS*Plus*, open the Governor Output screen in the Settings Explorer, under Multigen Management. Select the bias output parameters and levels as required by the governor. See Figure 129.
    a. Output Type - Select whether the governor bias signal is Voltage or Current.
    b. Response - Select Increasing or Decreasing. Increasing should be selected if an increase in the output parameter results in an increase in generator speed. Decreasing should be selected if an increase in the output parameter results in a decrease in generator speed.
    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 current bias input range for the governor. 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 governor. The range on these parameters is –10 V to +10 V.
3. Upload settings to the DGC-2020HD.

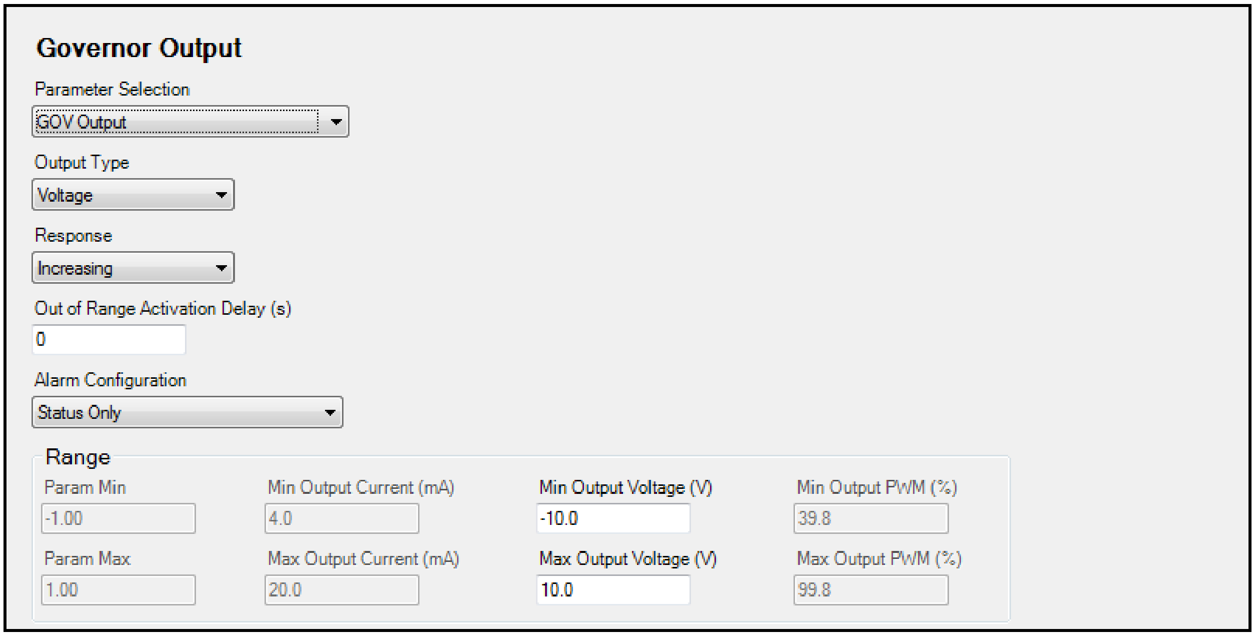


Figure 129. Settings Explorer, Multigen Management, Governor Output

Mains Power Controller

BESTCOMS*Plus* Navigation Path: Settings Explorer, Bias Control Settings, Governor Bias Control Settings

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

BESTCOMS*Plus* Mains Power Controller settings are illustrated in Figure 131 and settings ranges are listed in Table 60.

The DGC-2020HD controls mains power in one of three modes: Base Load, Import/Export, and Peak Shave. Base Load mode is typically used in applications where the controlled generators provide continuous power to the load. Import/Export mode is typically used in applications where the amount of real power imported from or exported to the mains must remain within certain limits. Peak Shaving mode is typically used, during peak load hours, to transfer some of the load from the mains to the generators. This is especially effective when used in conjunction with generators providing base load.

In each of these modes, the generators are driven to a common setpoint. The DGC-2020HD in the group which controls the breaker currently tied to a mains-powered bus is chosen to broadcast the setpoint to all participating generators. This DGC-2020HD is referred to as the Mains Power Controller.

A mains power controller operates in one of three modes: Base Load, Import/Export, or Peak Shave. In all modes, each generator-controlling DGC-2020HD must have Mains Parallel kW Control set to Automatic (Governor Bias Control screen) to accept the operating setpoint from the mains power controller. Mains power control modes control real power output from generators. Reactive power output from each individual generator is controlled by the var/PF control mode. Each mains power control mode is controlled through logic elements in BESTlogic*Plus*. The Base Load Setpoint, Import/Export Setpoint, and Peak Shave Setpoint logic elements provide five pre-position setpoints and discrete raise and lower inputs. Active operating mode can be overridden with the Mains Power Control logic element. See the *BESTlogicPlus* chapter for details.

Base Load Control Mode

In this mode, all paralleled generators are driven to the same base load setpoint. The setpoint is expressed as a percentage of each machine's rated capacity. The total real power output depends on the number of generators online and the base load setpoint. The setpoint is adjusted on the DGC-2020HD designated as the mains power controller and all paralleled generators are driven to that setpoint.

Generators must be manually started and stopped in this mode. Each generator breaker and group breaker must be closed manually.

Base Load Control Mode Settings

Auto Save

When the Auto Save setting is enabled, the DGC-2020HD automatically saves the active externally-driven raise/lower and pre-position setpoints 30 seconds after a change in value. The saved setpoint is retained even after power is cycled to the DGC-2020HD. When Auto Save is disabled, adjustments to setpoints by raise/lower and pre-position commands are retained only for the duration of the current operating session. These adjustments are discarded the next time the power is cycled to the DGC-2020HD.

Setpoint

Participating generators run at this percentage of their individual rated capacities.

Setpoint Min and Max

Setpoint Min and Setpoint Max are the upper and lower setpoint adjustment limits.

Analog Bias Source

This setting establishes the analog input which provides setpoint bias signals.

Bias Min and Max

Bias Min and Max specify the range over which the setpoint can be biased from an analog input signal. Bias Min establishes the lower limit of deviation from the setpoint for the lowest analog input signal. Bias Max establishes the upper limit of deviation from the setpoint for the highest analog input signal. For example, a 4 to 20 mA current transducer provides the signal to the analog input. The Setpoint is set to 50%. Bias Min is set to -30% and Bias Max is set to +30%. When the analog signal is 4 mA, the setpoint drops from 50% of rated machine capacity to 20% (Bias Min). When the analog signal is 20 mA, the setpoint increases from 50% of rated machine capacity to 80% (Bias Max).

Adjust Rate

This is the rate, in percent per second, which the generator setpoint increases or decreases in response to raise/lower requests from the Base Load Setpoint logic element in BESTlogic*Plus*.

Pre-position

Five pre-positions are provided to override the setpoint. These are activated through BESTlogic*Plus*. When the appropriate contact input is closed, the setpoint is driven to the corresponding pre-position value. Each pre-position function has two settings: Setpoint and Adjust Rate. The setting range of each pre-position setpoint is identical to that of the corresponding control mode setpoint. See the Base Load Setpoint logic element in the *BESTlogicPlus* chapter for details.

Import/Export Control Mode

This mode adjusts the base load setpoint of all paralleled generators to achieve a constant real power import or export level at the mains breaker.

Initially, at least one generator must be manually started and paralleled to the mains. Then, the Demand Start/Stop function brings additional generators online and offline as the setpoint or system load changes.

A positive setpoint represents a level of power imported from the mains. A negative setpoint represents a level of power exported to the mains. The metered real power level displays a positive or negative value which matches the polarity of the setpoint. It is crucial that the sensing CTs are wired to follow this convention.

Caution

Sensing CTs must be wired to match the following conventions. Positive power is imported from the mains. Negative power is exported to the mains.

Import power remains constant as long as the load is greater than the import setpoint while not exceeding full generation capacity. If the load is less than the import power setpoint, the import power level decreases to meet what is required by the load. If the load exceeds full generation capacity, the import power level increases as the generators approach full capacity.

Export power remains constant as long as the load plus export power level is within full generation capacity. If the load plus the export power level exceeds full generation capacity, the export power decreases while still fully supporting the load. If the load alone exceeds generation capacity, power begins to be imported.

Import/Export Control Mode Settings

Auto Save

When the Auto Save setting is enabled, the DGC-2020HD automatically saves the active externally-driven raise/lower and pre-position setpoints 30 seconds after a change in value. The saved setpoint is retained even after power is cycled to the DGC-2020HD. When Auto Save is disabled, adjustments to setpoints by raise/lower and pre-position commands are retained only for the duration of the current operating session. These adjustments are discarded the next time the power is cycled to the DGC-2020HD.

Setpoint

Participating generators import or export this amount of kW.

Setpoint Min and Max

Setpoint Min and Setpoint Max are the upper and lower setpoint adjustment limits.

Analog Bias Source

This setting establishes the analog input which provides setpoint bias signals.

Bias Min and Max

Bias Min and Max specify the range over which the setpoint can be biased from an analog input signal. Bias Min establishes the lower limit of deviation from the setpoint for the lowest analog input signal. Bias Max establishes the upper limit of deviation from the setpoint for the highest analog input signal. For example, a 4 to 20 mA current transducer provides the signal to the analog input. The Setpoint is set to 500 kW. Bias Min is set to -200 kW and Bias Max is set to +200 kW. When the analog signal is 4 mA, the setpoint drops from 500 kW to 300 kW (Bias Min). When the analog signal is 20 mA, the setpoint increases from 500 kW to 700 kW (Bias Max).

Adjust Rate

This is the rate, in percent per second, which the generator setpoint increases or decreases in response to raise/lower requests from the Import/Export Setpoint logic element in BESTlogic*Plus*.

Pre-position

Five pre-positions are provided to override the setpoint. These are activated through BESTlogic*Plus*. When the appropriate contact input is closed, the setpoint is driven to the corresponding pre-position value. Each pre-position function has two settings: Setpoint and Adjust Rate. The setting range of each pre-position setpoint is identical to that of the corresponding control mode setpoint. See the Import/Export Setpoint logic element in the *BESTlogicPlus* chapter for details.

Peak Shave Control Mode

In peak shave control mode, the operating base load level of all paralleled generators is adjusted to limit the peak imported power from mains. Once the power imported from mains reaches a predetermined level, generators are automatically started to pick up the load. The Demand Start/Stop function brings additional generators online and offline as the system load changes.

Figure 130 illustrates the generator response if system load were ramped from no load to 1,500 kW and back down to no load. The generators are shown to take on and shed load immediately. In actual operation, generator loading and unloading will occur.

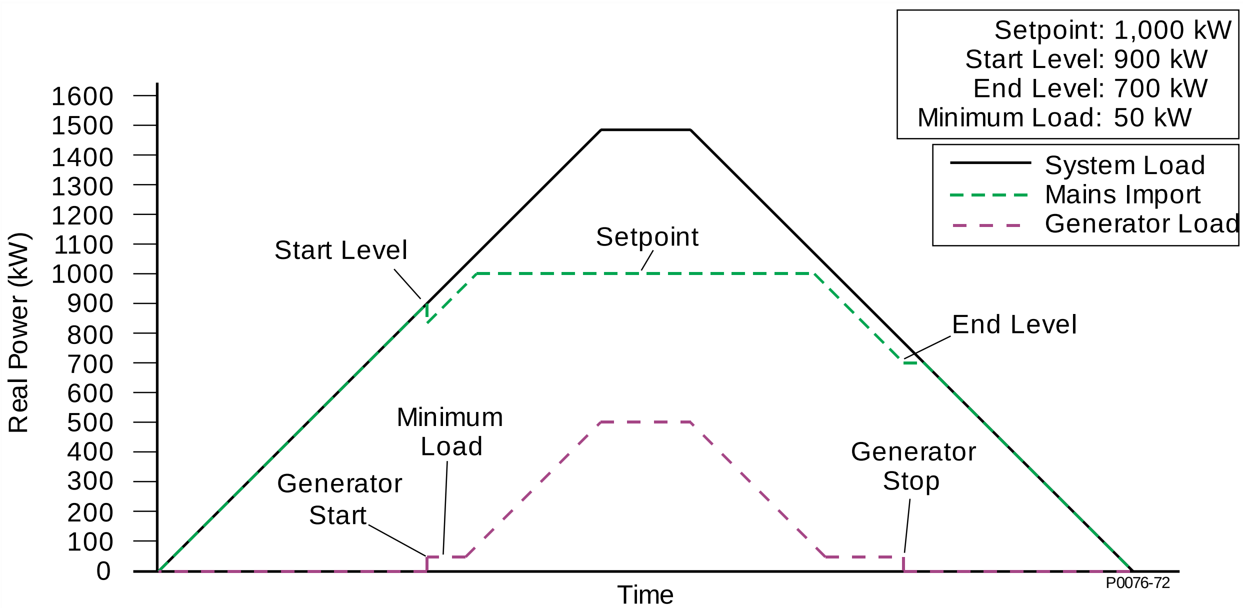


Figure 130. Generator Response in Peak Shave Control Mode

Peak shave control only responds to changes in load. Although the mains import power is depicted as a flat peak in Figure 130, the mains import power may briefly exceed the setpoint when the system load increases in reality. If strict power import restrictions are in place, set the setpoint low enough to allow for large load swings.

Demand Start/Stop Function in Group Start Mode

In Single Generator mode, the generator is stopped when the system load falls below the end level. When group start mode is used, a group stop request is issued to the generators that were started by the peak shave function when the system load falls below the end level.

Peak Shave Control Mode Settings

Minimum Load

This value is the minimum amount of kW that the generators should provide. This is used to prevent the generators from being too lightly loaded.

Start Level

When system load exceeds this level, participating generators are started after the Start Time Delay expires.

End Level

When system load drops below this level, participating generators are stopped after the End Time Delay expires.

Start Mode

This setting provides selections for Single Generator and Group Start. If Single Generator is selected, the DGC-2020HD sensing mains power starts the local generator to perform peak shaving even if there are other generators in the group. With Group Start selected, generators in a group are started as needed. When a remote tie breaker controller which has control over a mains breaker is running in peak shave control mode, group start mode must be selected.

Open Group Breaker on Stop

This setting is only available when Start Mode is set to Group Start. The group breaker is automatically closed when peak shaving starts. This setting specifies whether the group breaker is opened or left closed when peak shaving ends.

Auto Save

When the Auto Save setting is enabled, the DGC-2020HD automatically saves the active externally-driven raise/lower and pre-position setpoints 30 seconds after a change in value. The saved setpoint is retained even after power is cycled to the DGC-2020HD. When Auto Save is disabled, adjustments to setpoints by raise/lower and pre-position commands are retained only for the duration of the current operating session. These adjustments are discarded the next time the power is cycled to the DGC-2020HD.

Setpoint

This value is the maximum amount of kW to be imported from mains.

Setpoint Min and Max

Setpoint Min and Setpoint Max are the upper and lower setpoint adjustment limits.

Analog Bias Source

This setting establishes the analog input which provides setpoint bias signals.

Bias Min and Max

Bias Min and Max specify the range over which the setpoint can be biased from an analog input signal. Bias Min establishes the lower limit of deviation from the setpoint for the lowest analog input signal. Bias Max establishes the upper limit of deviation from the setpoint for the highest analog input signal. For example, a 4 to 20 mA current transducer provides the signal to the analog input. The Setpoint is set to 500 kW. Bias Min is set to -200 kW and Bias Max is set to +200 kW. When the analog signal is 4 mA, the setpoint drops from 500 kW to 300 kW (Bias Min). When the analog signal is 20 mA, the setpoint increases from 500 kW to 700 kW (Bias Max).

Adjust Rate

This is the rate, in percent per second, which the generator setpoint increases or decreases in response to raise/lower requests from the Peak Shave Setpoint logic element in BESTlogic*Plus*.

Pre-position

Five pre-positions are provided to override the setpoint. These are activated through BESTlogic*Plus*. When the appropriate contact input is closed, the setpoint is driven to the corresponding pre-position value. Each pre-position function has two settings: Setpoint and Adjust Rate. The setting range of each pre-position setpoint is identical to that of the corresponding control mode setpoint. See the Peak Shave Setpoint logic element in the *BESTlogicPlus* chapter for details.

Mains Power Controller Settings

Mode

This setting allows selection of mains power control mode: Base Load, Import/Export, or Peak Shave.

Power Filter Constant

This is the time constant of the low-pass filter applied to mains power. A value of 0 represents no filter and a value of 100 represents a heavy filter.

Mains Power Control with Tie Breakers and Multiple Mains Tie Systems

The use of peak shaving and import/export control modes are not limited to the predefined system breaker configurations. These control modes are supported in systems with custom system breaker configurations including tie breakers and multiple mains ties.

If there are multiple mains power controllers in the system, controlling multiple mains ties, the mains power control settings must be configured identically on each controller. In situations where there are multiple tie breakers or multiple mains ties, it is possible for more than one DGC-2020HD to be eligible for Mains Power Control. When there is more than one eligible Mains Power Controller, meaning that there is more than one breaker which is tied directly to a mains-powered bus, any one of them could become the DGC-2020HD which broadcasts the setpoint. However, this designation is not permanent. Each of the eligible Mains Power Controllers must have identical Mains Power Control settings. Without identical settings, if the Mains Power Control setpoint broadcast by one DGC-2020HD is different when the control is granted to another eligible DGC-2020HD, system behavior could become unstable.

Each mains power controller sums the total imported power from all connected mains power controllers when calculating system load. When peak shaving, for example, the peak import is limited based on the total import power from all connected mains.

If system breaker configuration is not known, peak shaving group starts are requested. However, no local breaker close requests are made to parallel the generators to mains. External PLC logic must control breaker closures paralleling to mains.

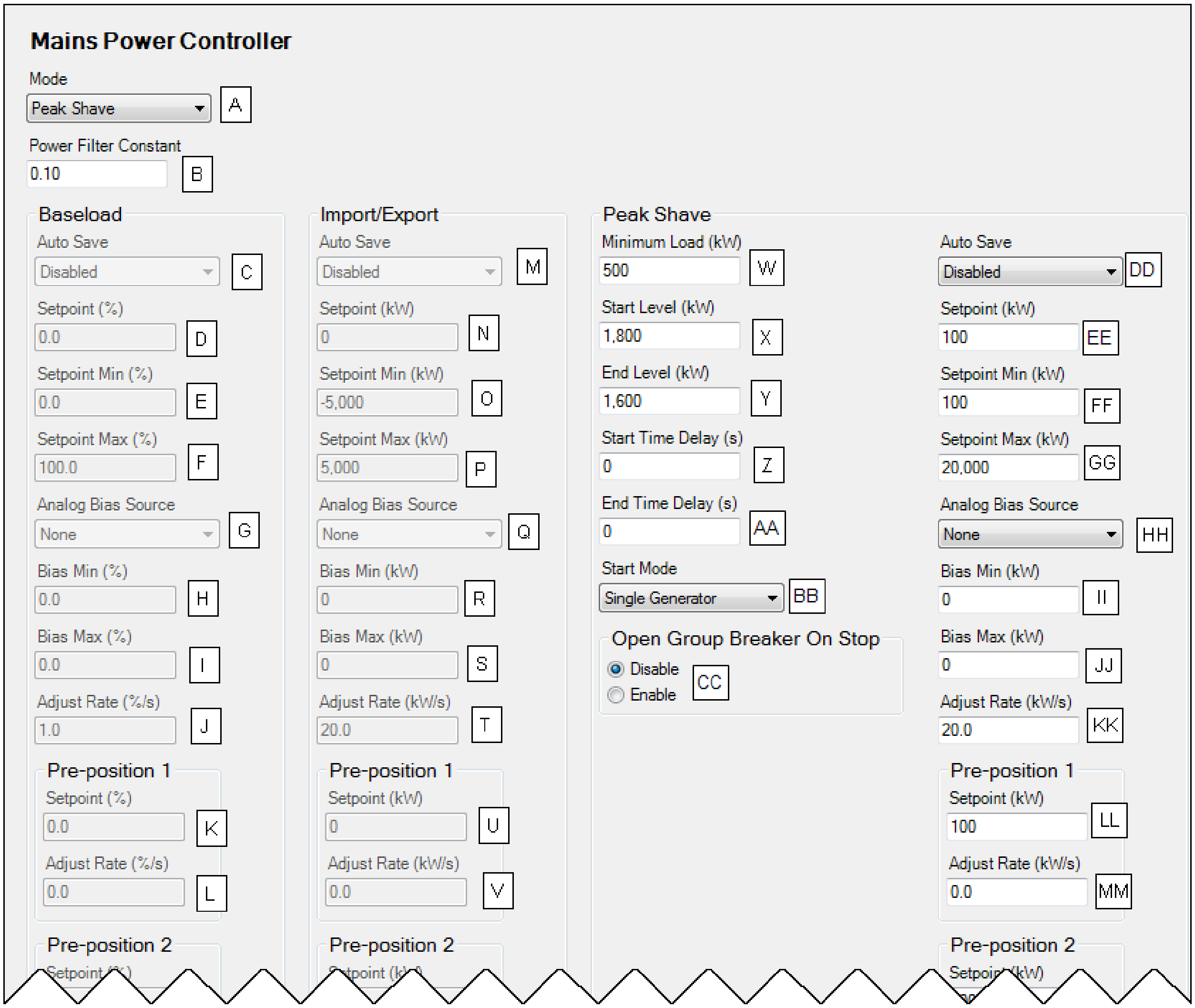


Figure 131. Settings Explorer, Bias Control Settings, Mains Power Controller Settings

Table 60. Settings for Mains Power Controller

Locator	Setting	Range	Increment	Unit
A	Mode	Base Load, Peak Shave, or Import/Export	n/a	n/a
B	Power Filter Constant	0 to 100	0.01	n/a
Base Load				
C	Auto Save	Disabled or Enabled	n/a	n/a
D	Setpoint	0 to 100	0.1	%
E	Setpoint Min	0 to 100	0.1	%
F	Setpoint Max	0 to 100	0.1	%
G	Analog Input Source	None, Analog Input 1 to 4, AEM1 Input 1 to 8, AEM2 Input 1 to 8, AEM3 Input 1 to 8, AEM4 Input 1 to 8,	n/a	n/a

Locator	Setting	Range	Increment	Unit
H	Bias Min	-100 to 100	0.1	%
I	Bias Max	-100 to 100	0.1	%
J	Adjust Rate	0.1 to 100	0.1	% per second
K	Pre-position, Setpoint	0 to 100	0.1	%
L	Pre-position, Adjust Rate	0 to 100	0.1	% per second
Import/Export				
M	Auto Save	Disabled or Enabled	n/a	n/a
N	Setpoint	-999,999 to 999,999	1	kW
O	Setpoint Min	-999,999 to 999,999	1	kW
P	Setpoint Max	-999,999 to 999,999	1	kW
Q	Analog Input Source	None, Analog Input 1 to 4, AEM1 Input 1 to 8, AEM2 Input 1 to 8, AEM3 Input 1 to 8, AEM4 Input 1 to 8,	n/a	n/a
R	Bias Min	-999,999 to 999,999	1	kW
S	Bias Max	-999,999 to 999,999	1	kW
T	Adjust Rate	1 to 1,000	0.1	kW per second
U	Pre-position, Setpoint	-999,999 to 999,999	1	kW
V	Pre-position, Adjust Rate	0 to 1,000	0.1	kW per second
Peak Shave				
W	Minimum Load	1 to 999,999	1	kW
X	Start Level	1 to 999,999	1	kW
Y	End Level	1 to 999,999	1	kW
Z	Start Time Delay	0 to 3,600	1	seconds
AA	End Time Delay	0 to 3,600	1	seconds
BB	Start Mode	Single Generator or Group Start	n/a	n/a
CC	Open Group Breaker On Stop	Disable or Enable	n/a	n/a
DD	Auto Save	Disabled or Enabled	n/a	n/a
EE	Setpoint	1 to 999,999	1	kW
FF	Setpoint Min	1 to 999,999	1	kW
GG	Setpoint Max	1 to 999,999	1	kW
HH	Analog Input Source	None, Analog Input 1 to 4, AEM1 Input 1 to 8, AEM2 Input 1 to 8, AEM3 Input 1 to 8, AEM4 Input 1 to 8,	n/a	n/a
II	Bias Min	-999,999 to 999,999	1	kW
JJ	Bias Max	-999,999 to 999,999	1	kW
KK	Adjust Rate	1 to 1,000	0.1	kW per second

Locator	Setting	Range	Increment	Unit
LL	Pre-position, Setpoint	1 to 999,999	1	kW
MM	Pre-position, Adjust Rate	0 to 1,000	0.1	kW per second

Multiple Generator Management

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

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 BESTCOMS*Plus*® AVR Output screen is illustrated in Figure 132. Settings are listed in Table 61.

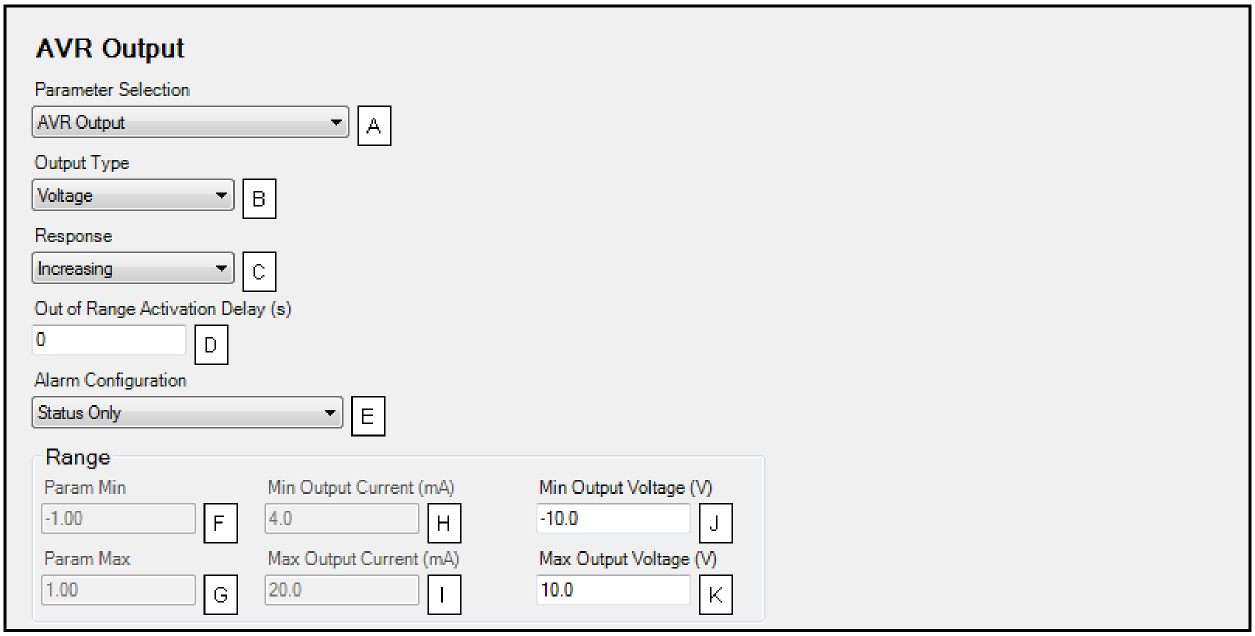


Figure 132. Settings Explorer, Multigen Management, AVR Output

Table 61. 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, Alarm, Alarm with Unload, Alarm with Cool Down, or Alarm with Unload then Cool Down	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

Locator	Setting	Range	Increment	Unit
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 BESTCOMS*Plus* Governor Output screen is illustrated in Figure 133. Settings are listed in Table 62.

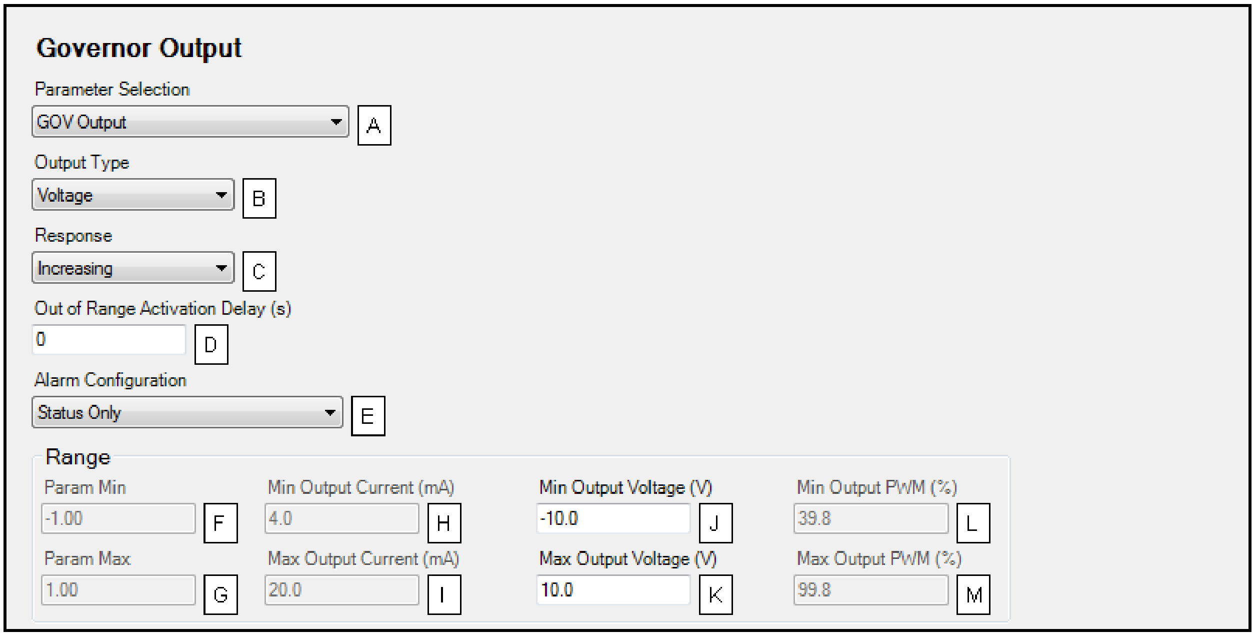


Figure 133. Settings Explorer, Multigen Management, Governor Output

Table 62. 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, Alarm, Alarm with Unload, Alarm with Cool Down, or Alarm with Unload then Cool Down	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

Locator	Setting	Range	Increment	Unit
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 DGC-2020HD 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 BESTCOMS*Plus* Load Share Output screen is illustrated in Figure 134.

Figure 134. Settings Explorer, Multigen Management, Load Share Output

Table 63. 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, Alarm, Alarm with Unload, Alarm with Cool Down, or Alarm with Unload then Cool Down	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 BESTCOMS*Plus* Demand Start/Stop screen is illustrated in Figure 135. Settings are listed in Table 64.

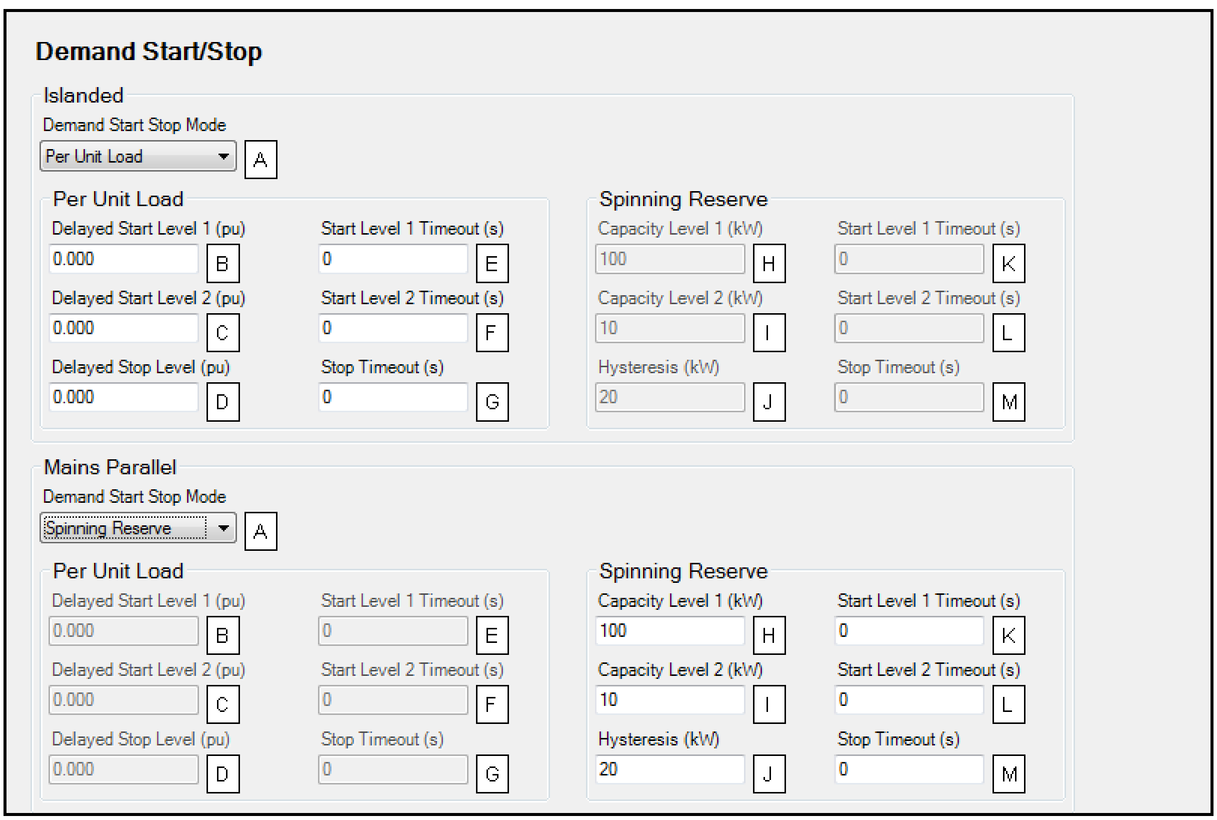


Figure 135. Settings Explorer, Multigen Management, Demand Start/Stop

Table 64. 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 BESTCOMSPlus 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 136. Settings are listed in Table 65.

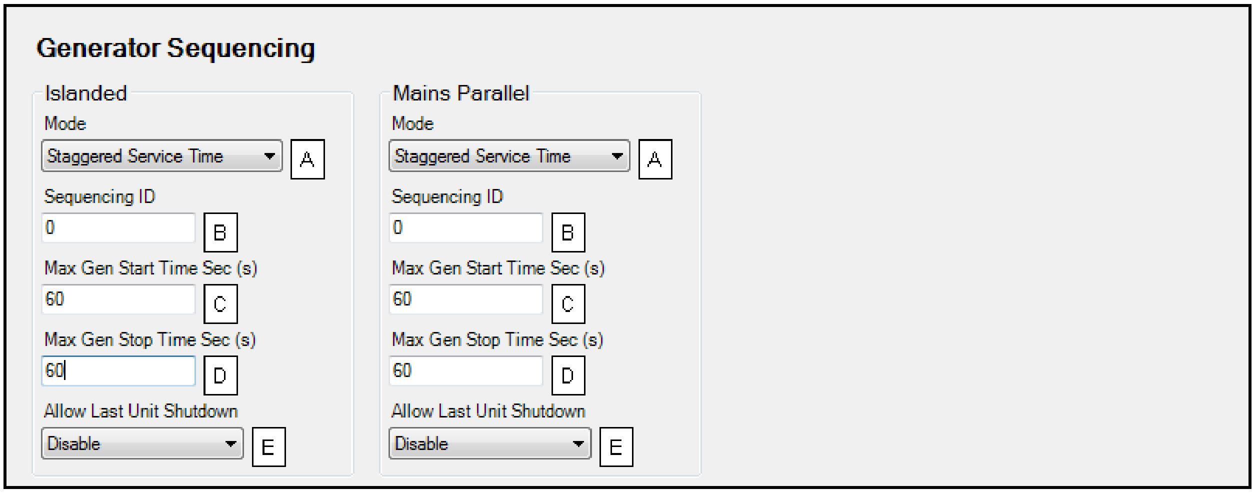


Figure 136. Settings Explorer, Multigen Management, Generator Sequencing

Table 65. 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 cumulative engine run hours is assigned highest start priority. Units in Auto Run mode with the highest number of service hours remaining respond to demand stop requests first. The sequencing order is re-assessed every 24 hours in a system that is running for long periods of time.

Balanced Engine Hours

If this mode is selected, units seek to sort the start priority of all non-disabled networked units in ascending order of cumulative engine run hours. In this configuration, a network of units will respond to a demand start request by starting the unit with the least number of cumulative engine run hours first. The sequencing order is re-assessed every 24 hours in a system that is running for long periods of time.

Balanced Service Time

In this mode, units seek to sort the start priority of all non-disabled networked units in descending 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 cumulative engine run hours is assigned highest start priority. Units in Auto Run mode with the lowest number of service hours remaining respond to demand stop requests first. The sequencing order is re-assessed every 24 hours in a system that is running for long periods of time.

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 137.

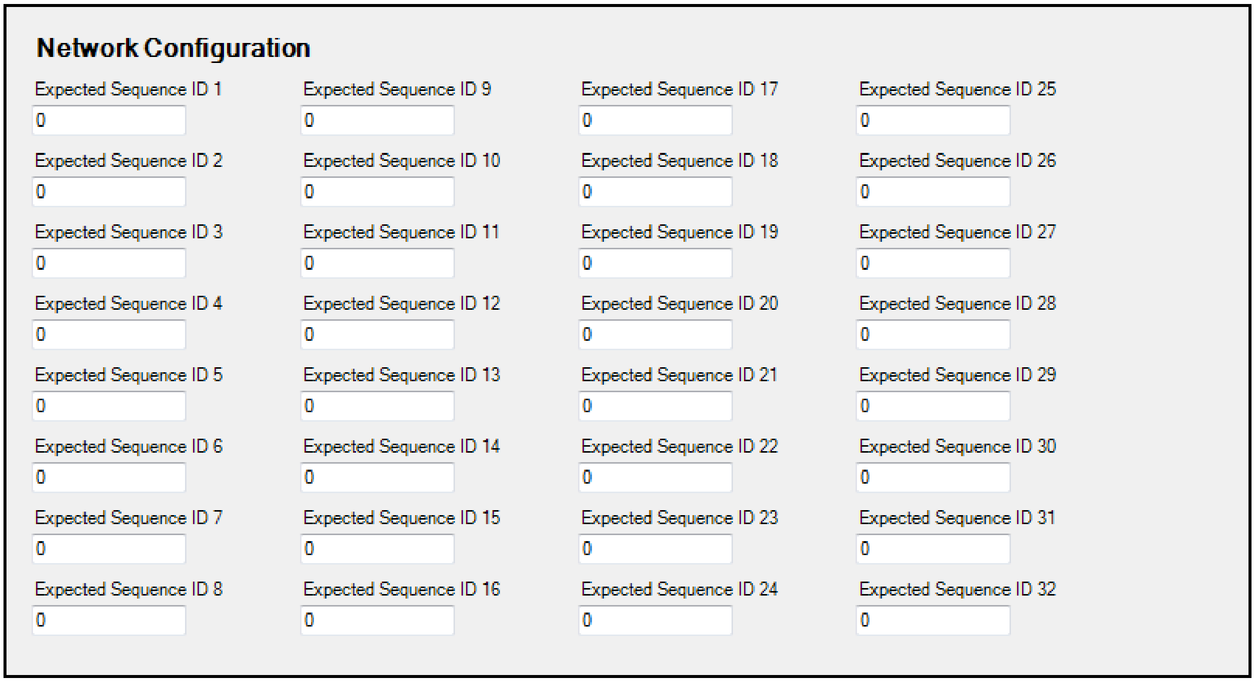


Figure 137. Settings Explorer, Multigen Management, Network Configuration

Load Shedding

The Load Shed function provides a way to manage up to 64 loads. Loads can be shed from the system, in lowest to highest priority order, with logic commands. Loads can be added back to the system automatically in priority order (reverse of shedding order) when sufficient online generation capacity becomes available.

Adding Loads

As available generators are brought online, the online kW capacity increases. When the online kW capacity becomes greater than the sum of a load priority level's Load kW value, the Add Reserve value, and any enabled Add Reserve Bias values for the duration of the Add Delay, the corresponding logic input (Figure 138) becomes true. The true input can be linked to an output which can in turn close the breaker to the corresponding load, thus adding it to the system. Loads with lower load priority numbers are added first, starting at one (1). A load priority with a number of zero (0) is disabled and excluded from load adding/shedding functions. Up to 16 Add Reserve Bias values can be added cumulatively to the default Add Reserve value by enabling the corresponding load shed bias enable (LDSHEDBIASENABLE1-16) logic elements.

Figure 138. Priority 1 Load Enabled Logic Input

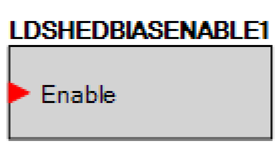


Figure 139. Load Shed Bias Enable 1 Logic Element

Shedding Loads

When the Shed Load input of the load shed (LOADSHED) logic element is true, the loads with higher load priority numbers are shed first and their corresponding logic inputs (Figure 138) become false. A load priority with a number of zero (0) is disabled and excluded from load adding/shedding functions. The first load is immediately shed and subsequent loads are shed after the duration of the Shed Delay. Loads are shed one at a time and the Shed Delay must elapse between iterations. The same process is followed when the Shed Load Fast input of the load shed (LOADSHED) logic element is true, except the Shed Fast Delay is used instead.

The BESTCOMS*Plus* Load Shedding screen is illustrated in Figure 140.

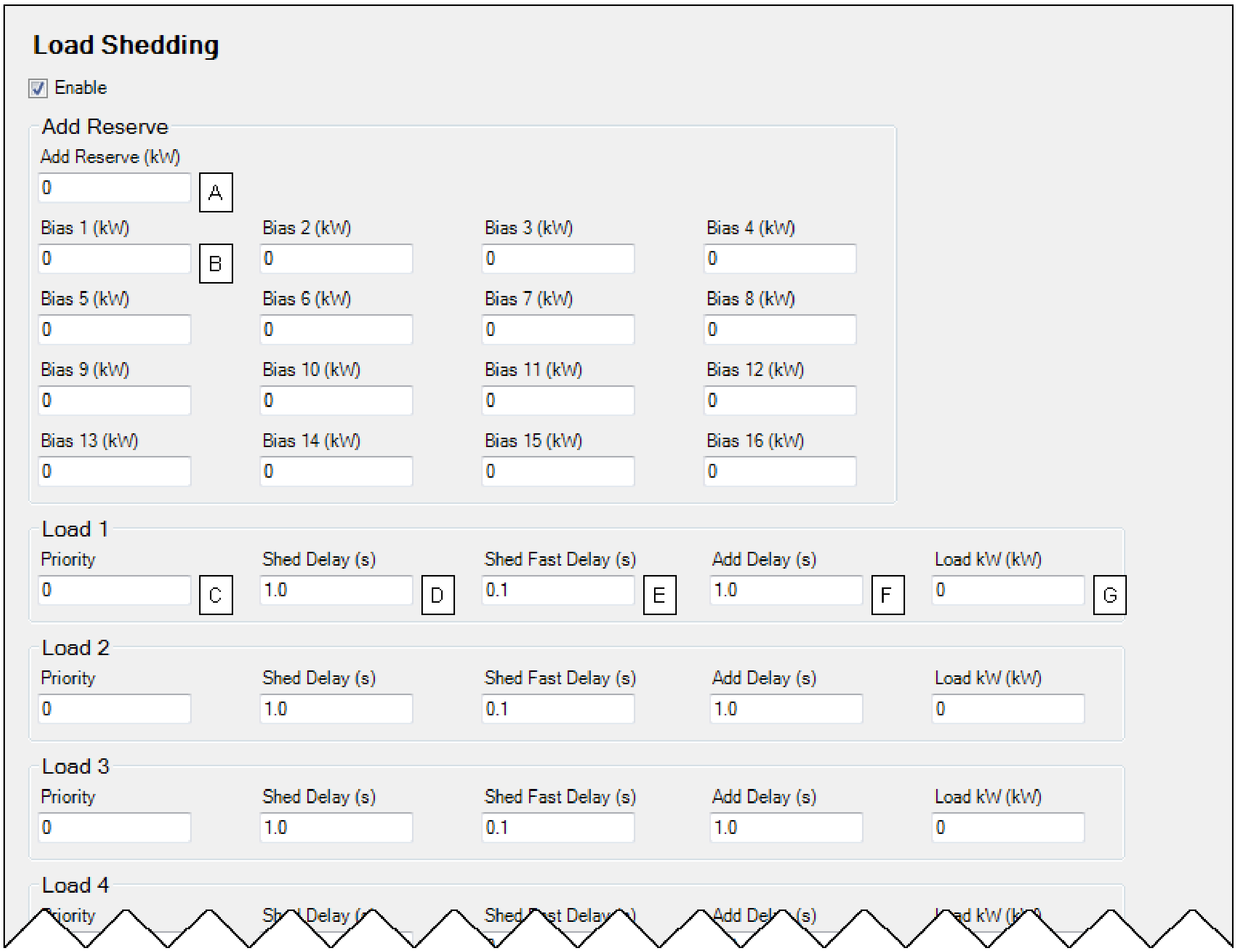


Figure 140. Settings Explorer, Multigen Management, Load Shedding

Table 66. Settings for Load Shedding

Locator	Setting	Range	Increment	Unit
A	Add Reserve	0 to 999,999	1	kW
B	Bias #	0 to 999,999	1	kW
C	Load # Priority	0 to 255	1	n/a
D	Load # Shed Delay	0 to 60	0.1	seconds
E	Load # Shed Fast Delay	0 to 60	0.1	seconds
F	Load # Add Delay	0 to 3,600	0.1	seconds
G	Load # Load kW	0 to 999,999	1	kW

Group Start Settings

A group start request starts multiple generators simultaneously within a group. The subset of generators chosen to start is determined by the start request type, demand level, and intended operating mode (islanded vs. mains parallel). A group start request also uses the generator sequencing and demand start/stop settings to determine the generator starting priority order. The generator group is defined by generators that share the same Generator Group Number setting value. Multiple generator groups can exist in the same system and each will respond only to start requests from within the same group.

Note
In order for a generator to respond to Group Start requests, the DGC-2020HD must be in AUTO mode, the System Type must be configured as Segmented Bus System, and Sequencing and Demand Start/Stop must both be enabled.

There are four types of group start requests: Mains Fail, Load Takeover, Peak Shave, and Logic. The Mains Fail, Load Takeover, and Peak Shave requests have a corresponding start mode setting in each genset controller. The Logic start mode depends on the logic input used. The demand level source varies based on the group start request. This is either the block load setting or an internally calculated demand level.

Mains Fail, Load Takeover, and Peak Shave have independent group start mode settings in each genset controller. This allows a different subset of generators to be started for each operating mode. These settings must be identical in each genset controller in the group to operate as intended.

Start One

When Start One is selected, the highest priority generator for the intended system type (islanded or mains parallel) is started. Additional generators may be started by the Demand Start/Stop function.

Start All

When Start All is selected, all generators enabled for sequencing for the intended system type are started.

Start Demand Based

When Start Demand Based is selected, only enough generators are started to pick up the expected load level. The started generators are chosen based on expected demand level and sequencing priority.

Figure 141. Settings Explorer, System Parameters, Group Settings

Table 67. Settings for Group Start

Locator	Setting	Range	Increment	Unit
A	Mains Fail	Start One, Start All, Start Demand Based	n/a	n/a

Locator	Setting	Range	Increment	Unit
B	Load Takeover	Start One, Start All, Start Demand Based	n/a	n/a
C	Peak Shave	Start One, Start All, Start Demand Based	n/a	n/a

Group Segment Settings

Group segment settings establish generator group number, group segment number, expected number of tie breakers in the system, and all breakers that are critical to the local DGC-2020HD.

These settings differ depending on the detected or selected system breaker configuration. When a configuration contains a connection to an arbitrary segmented system, additional settings are made available to allow the DGC-2020HD to properly map the entire system. Group Segment settings are described in the following paragraphs.

Settings for All System Breaker Configurations

Figure 142 illustrates the BESTCOMS*Plus* Group Segment Settings screen when the system breaker configuration is without a segmented system. Setting ranges are listed in Table 68.

System Breaker Configuration Detection

Enabling this setting allows the DGC-2020HD to automatically detect the system breaker configuration. The detected system breaker configuration is displayed on the BESTCOMS*Plus* Control Panel screen.

If the detected breaker configuration does not match one of the predefined system breaker configurations or if this setting is disabled, the user-selected system breaker configuration is used.

For details on the system breaker configuration setting, refer to the *Breaker Management* chapter.

Generator Group Number

A generator group comprises all of the components controlled by a DGC-2020HD. This includes generators, buses, and breakers.

This number assigns the DGC-2020HD and all of its associated system components to a generator group.

This setting is not available to DGC-2020HDs configured for tie breaker control.

Expected Number of Tie Breaker Controllers

Input the number of all DGC-2020HDs configured as tie breaker controllers in the same network. This allows the DGC-2020HD to detect when a tie breaker controller is available or offline. If an expected tie breaker is not detected, the Missing System Component pre-alarm is annunciated.

Critical Breakers

These labels define critical breakers in the system for the Critical Breakers Missing pre-alarm. They may be unique in each controller. Breaker labels are defined on the Breaker Hardware screens. See the *Breaker Management* chapter for more information. If the Critical Breakers Missing pre-alarm is not being used, the breaker labels are not required to be specified.

If communication with a critical breaker is lost, the Critical Breakers Missing pre-alarm annunciates. This pre-alarm can be disabled on the Pre-Alarms screen. See the *Alarm Configuration* chapter for more information.

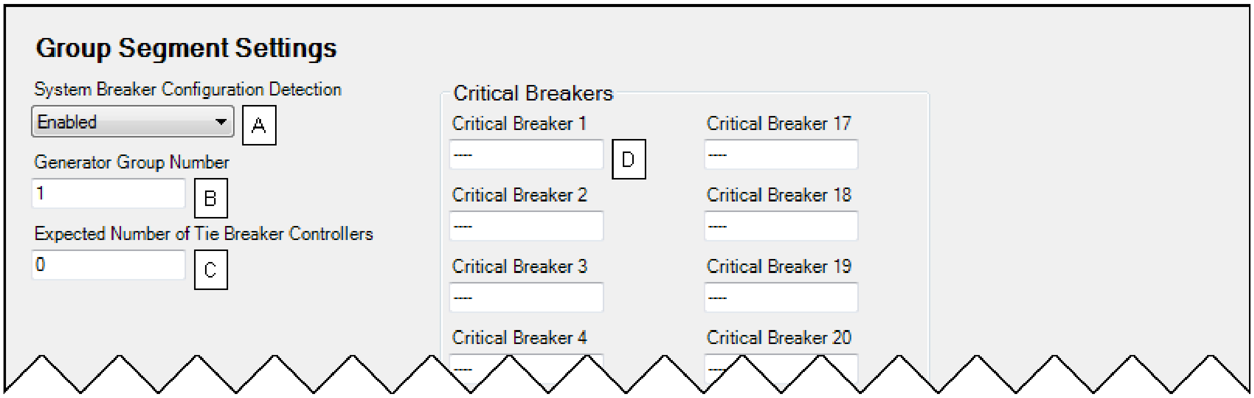


Figure 142. Settings Explorer, System Parameters, Group Segment Settings

Table 68 Settings for Group Segment Settings

Locator	Setting	Range	Increment	Unit
A	System Breaker Configuration Detection	Disabled or Enabled	n/a	n/a
B	Generator Group Number	1 to 32	1	n/a
C	Expected Number of Tie Breaker Controllers	0 to 32	1	Tie Breaker Controllers
D	Critical Breakers	Up to 4 alphanumeric characters	n/a	n/a

Settings for System Breaker Configurations with a Segmented System on One Side

Figure 143 illustrates the BESTCOMS*Plus* Group Segment Settings screen when the system breaker configuration is Generator Breaker to Segmented System or Generator and Group Breaker to Segmented System. Setting ranges are listed in Table 69.

Group Segment B Number

This selection labels the bus in the system for the system side of the group breaker.

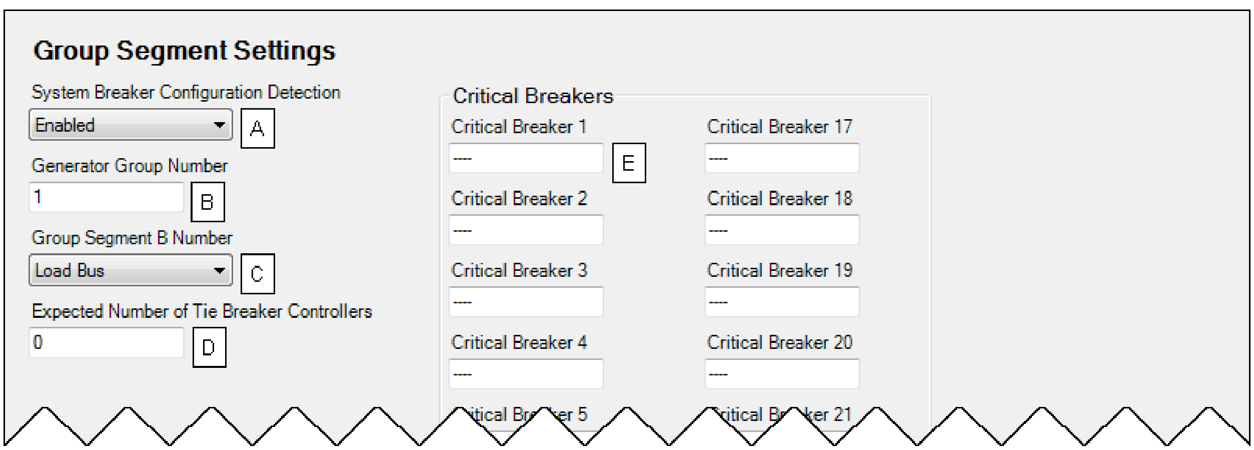


Figure 143. Settings Explorer, System Parameters, Group Segment Settings (Segmented System)

Table 69 Settings for Group Segment Settings (Segmented System)

Locator	Setting	Range	Increment	Unit
A	System Breaker Configuration Detection	Disabled or Enabled	n/a	n/a

Locator	Setting	Range	Increment	Unit
B	Generator Group Number	1 to 32	1	n/a
C	Group Segment B Number	Group Bus, Load Bus, Mains, 3 to 31	n/a	n/a
D	Expected Number of Tie Breaker Controllers	0 to 32	1	Tie Breaker Controllers
E	Critical Breakers	Up to 4 alphanumeric characters	n/a	n/a

Settings for Tie Breaker Controllers

Figure 144 illustrates the BESTCOMS*Plus* Group Segment Settings screen when the system breaker configuration is Tie Breaker. Setting ranges are listed in Table 70.

Generator Group A Number

This number defines the generator group connected to side A of the Tie Breaker.

Group Segment A Number

This selection labels the bus in the system for one side of the tie breaker.

If one side of the tie breaker (A or B) is tied directly to mains power, this can be specified in the Tie Breaker settings under the Breaker Management branch.

Generator Group B Number

This number defines the generator group connected to side B of the Tie Breaker.

Group Segment B Number

This selection labels the bus in the system for the side of the tie breaker opposite side A.

If one side of the tie breaker (A or B) is tied directly to mains power, this can be specified in the Tie Breaker settings under the Breaker Management branch.

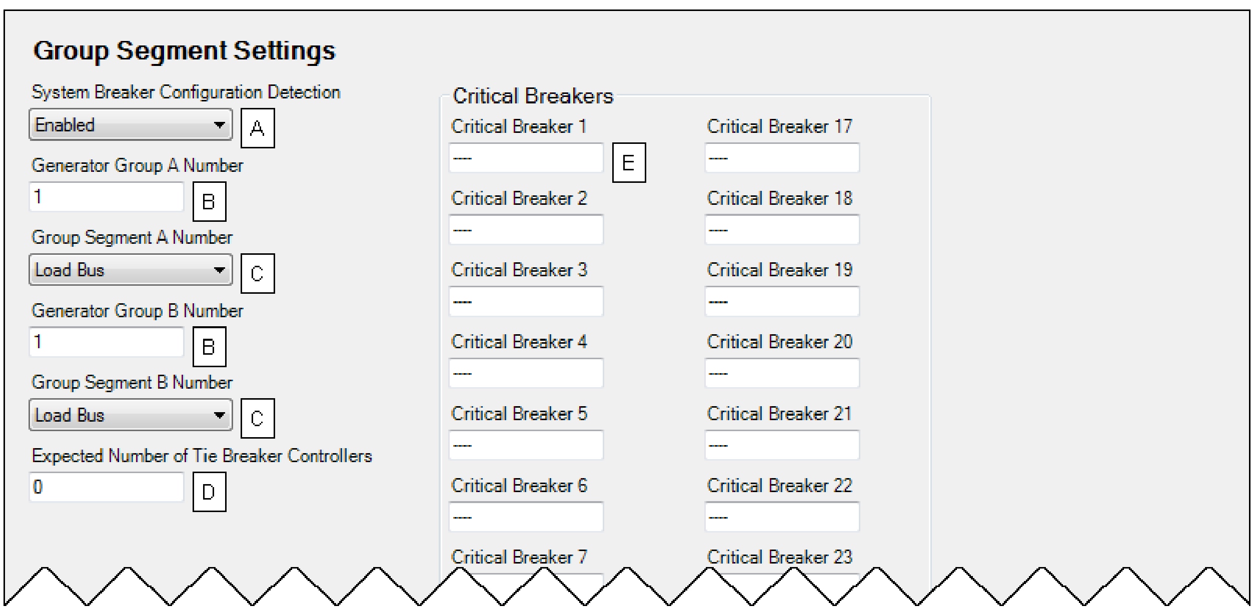


Figure 144. Settings Explorer, System Parameters, Group Settings (Tie Breaker Control Configuration)

Table 70. Settings for Group Segment Settings (Tie Breaker Control Configuration)

Locator	Setting	Range	Increment	Unit
A	System Breaker Configuration Detection	Disabled or Enabled	n/a	n/a
B	Generator Group A/B Number	1 to 32	1	n/a
C	Group Segment A/B Number	Group Bus, Load Bus, Mains, 3 to 31	n/a	n/a
D	Expected Number of Tie Breaker Controllers	0 to 32	1	Tie Breaker Controllers
E	Critical Breakers	Up to 4 alphanumeric characters	n/a	n/a

Settings for Generator and Tie Breaker Controllers

Figure 145 illustrates the BESTCOMS*Plus* Group Segment Settings screen when the system breaker configuration is Generator and Tie Breaker. Setting ranges are listed in Table 71.

Group Segment B Number

This selection labels the bus in the system for one side of the tie breaker.

If one side of the tie breaker (B or C) is tied directly to mains power, this can be specified in the Tie Breaker 2 settings under the Breaker Management branch.

Generator Group C Number

This number defines the generator group connected to side C of the Tie Breaker.

Group Segment C Number

This selection labels the bus in the system for the side of the tie breaker opposite side B.

If one side of the tie breaker (B or C) is tied directly to mains power, this can be specified in the Tie Breaker 2 settings under the Breaker Management branch.

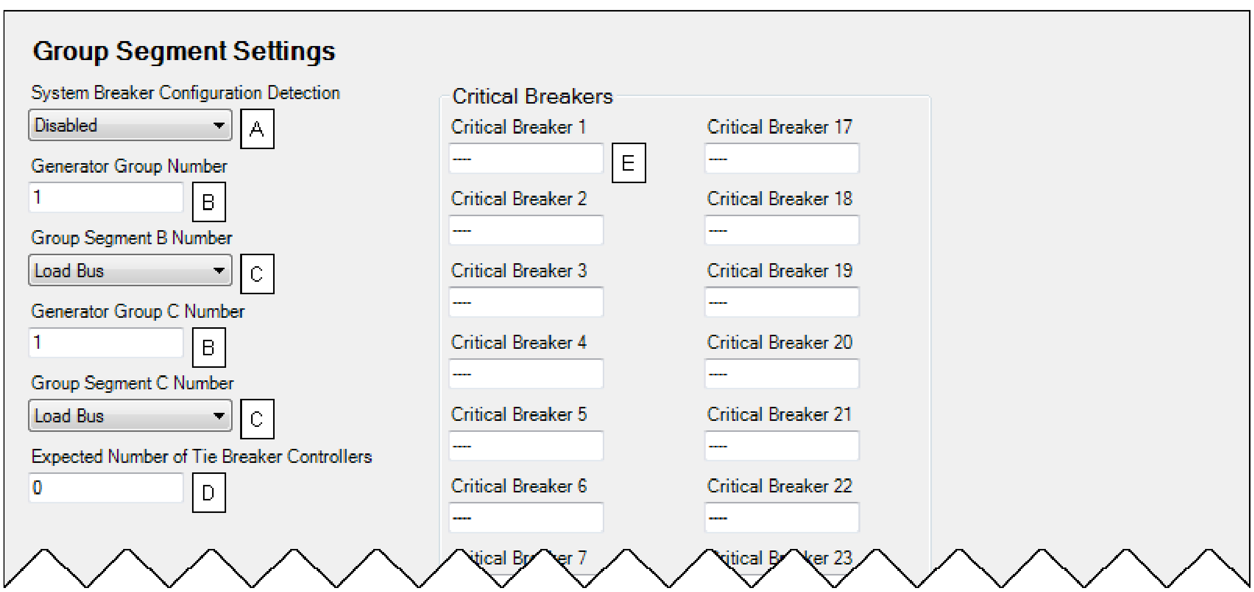


Figure 145. Settings Explorer, System Parameters, Group Settings (Generator and Tie Breaker Control Configuration)

Table 71. Settings for Group Segment Settings (Generator and Tie Breaker Control Configuration)

Locator	Setting	Range	Increment	Unit
A	System Breaker Configuration Detection	Disabled or Enabled	n/a	n/a
B	Generator Group B/C Number	1 to 32	1	n/a
C	Group Segment B/C Number	Group Bus, Load Bus, Mains, 3 to 31	n/a	n/a
D	Expected Number of Tie Breaker Controllers	0 to 32	1	Tie Breaker Controllers
E	Critical Breakers	Up to 4 alphanumeric characters	n/a	n/a

Settings for Tie Breaker and Tie Breaker Controllers

Figure 146 illustrates the BESTCOMS*Plus* Group Segment Settings screen when the system breaker configuration is Tie Breaker and Tie Breaker. Setting ranges are listed in Table 72.

Generator Group A Number

This number defines the generator group connected to side A of the first Tie Breaker.

Group Segment A Number

This selection labels the bus in the system for the side of the tie breaker opposite side B, but not C.

If one side of the first tie breaker (A or B) is tied directly to mains power, this can be specified in the Tie Breaker settings under the Breaker Management branch.

Generator Group B Number

This number defines the generator group connected to side B of both Tie Breakers.

Group Segment B Number

This selection labels the bus in the system shared by both tie breakers.

If one side of the tie breaker (A or B) is tied directly to mains power, this can be specified in the Tie Breaker settings under the Breaker Management branch.

If one side of the tie breaker (B or C) is tied directly to mains power, this can be specified in the Tie Breaker 2 settings under the Breaker Management branch.

Generator Group C Number

This number defines the generator group connected to side C of the second Tie Breaker.

Group Segment C Number

This selection labels the bus in the system for the side of the tie breaker opposite side B, but not A.

If one side of the tie breaker (B or C) is tied directly to mains power, this can be specified in the Tie Breaker 2 settings under the Breaker Management branch.

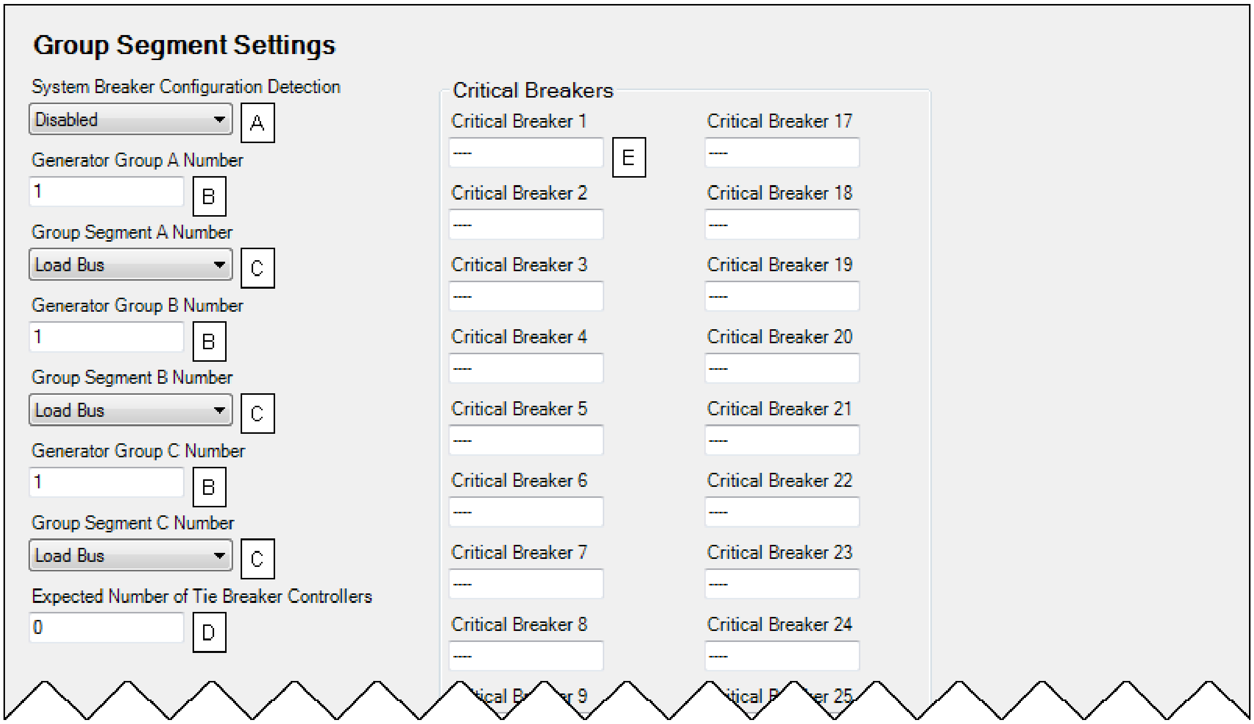


Figure 146. Settings Explorer, System Parameters, Group Settings (Tie Breaker and Tie Breaker Control Configuration)

Table 72. Settings for Group Segment Settings (Tie Breaker and Tie Breaker Control Configuration)

Locator	Setting	Range	Increment	Unit
A	System Breaker Configuration Detection	Disabled or Enabled	n/a	n/a
B	Generator Group A/B/C Number	1 to 32	1	n/a
C	Group Segment A/B/C Number	Group Bus, Load Bus, Mains, 3 to 31	n/a	n/a
D	Expected Number of Tie Breaker Controllers	0 to 32	1	Tie Breaker Controllers
E	Critical Breakers	Up to 4 alphanumeric characters	n/a	n/a

Block Load Level Settings

Block Load Level is the anticipated amount of power needed to pick up the load when the generator group bus is closed onto the load bus. This value must be as close to the actual load level as possible or system instability may occur. One default load level, 16 override load levels, and 16 load level offsets are provided.

Block Load Level is used to determine the number of generators to start when using the Start Demand input of the Islanded Group Request and Mains Parallel Group Request logic elements or when performing a group-based mains fail transfer. If a group breaker is to be used in a mains fail transfer, Block Load Level also determines how much generator capacity must be available before the group breaker closes to complete the transfer.

Block load level overrides and offsets are activated through BESTlogic™*Plus*.

When the BLKLOADLEVEL1OVRD logic element (Figure 147) receives a true input, the kW value associated with the level 1 override becomes the active block load level. Only one block load level override is active at one time, even if multiple elements are true.

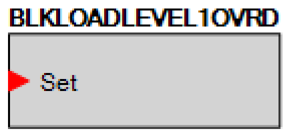


Figure 147. Block Load Level 1 Override Element

When the BLKLOADLEVEL1OFFSET logic element (Figure 148) receives a true input, the kW value associated with offset 1 is added to the currently active block load level. Multiple active block load level offsets can be active at one time and are cumulative.

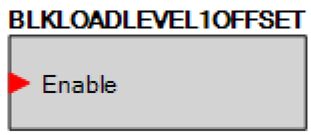


Figure 148. Block Load Level 1 Offset Element

The BESTCOMS*Plus* Block Load Level screen is illustrated in Figure 149.

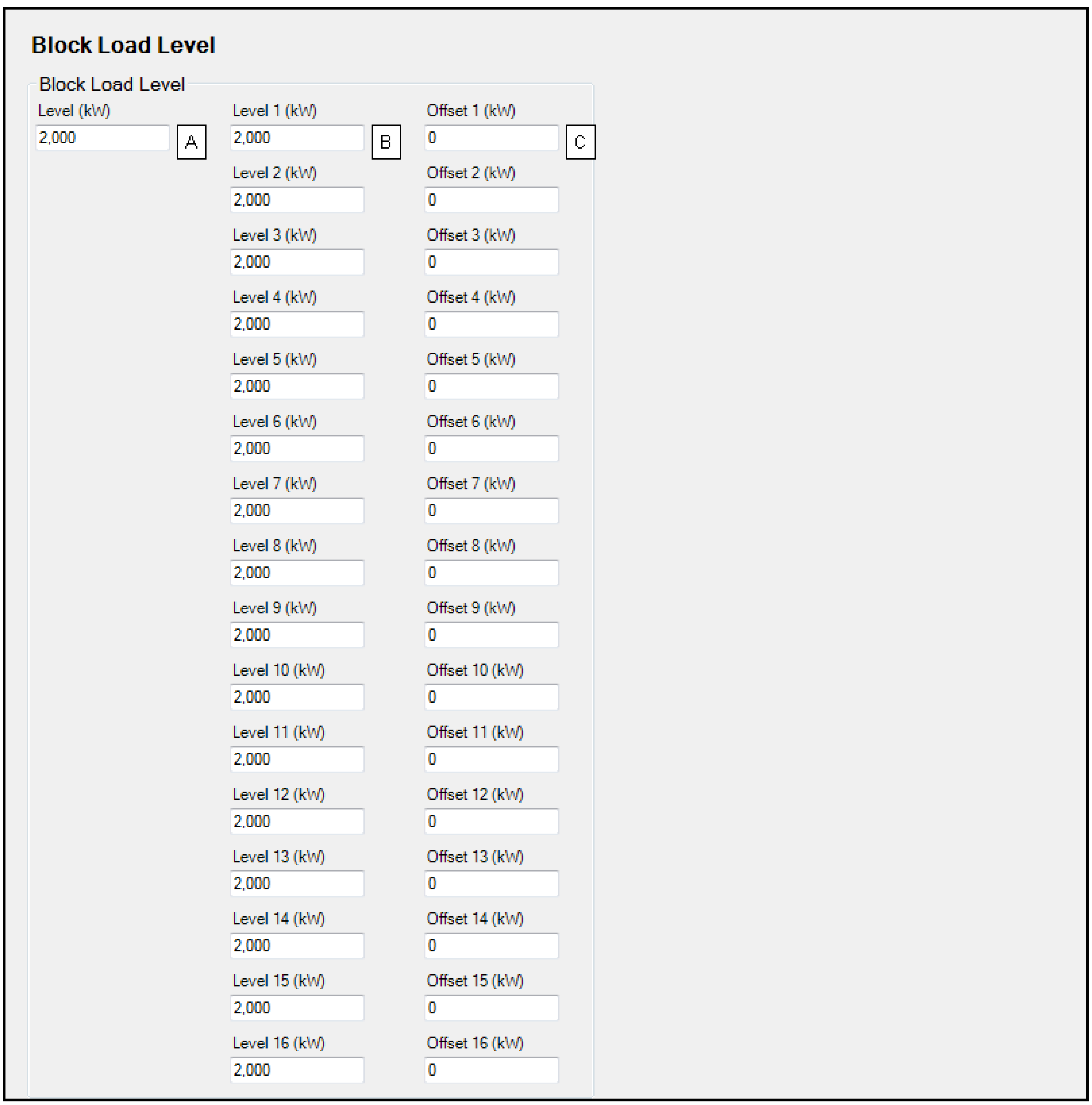


Figure 149. Settings Explorer, System Parameters, Group Settings, Block Load Level

Table 73. Settings for Block Load Level

Locator	Setting	Range	Increment	Unit
A	Level	1 to 999,999	1	kW
B	Level 1-16	1 to 999,999	1	kW
C	Offset 1-16	-999,999 to 999,999	1	kW

Group Configuration

The following information is provided to explain the group segment settings which must be made in DGC-2020HDs in order to achieve desired operation of a segmented system.

Figure 150 illustrates an example network topology consisting of four generators, two mains power sources, nine breakers, and seven DGC-2020HDs, split into two generator groups. A group tie breaker joins the two generator groups and the two loads.

Table 74 lists the pertinent System and Group Segment settings needed to support this topology.

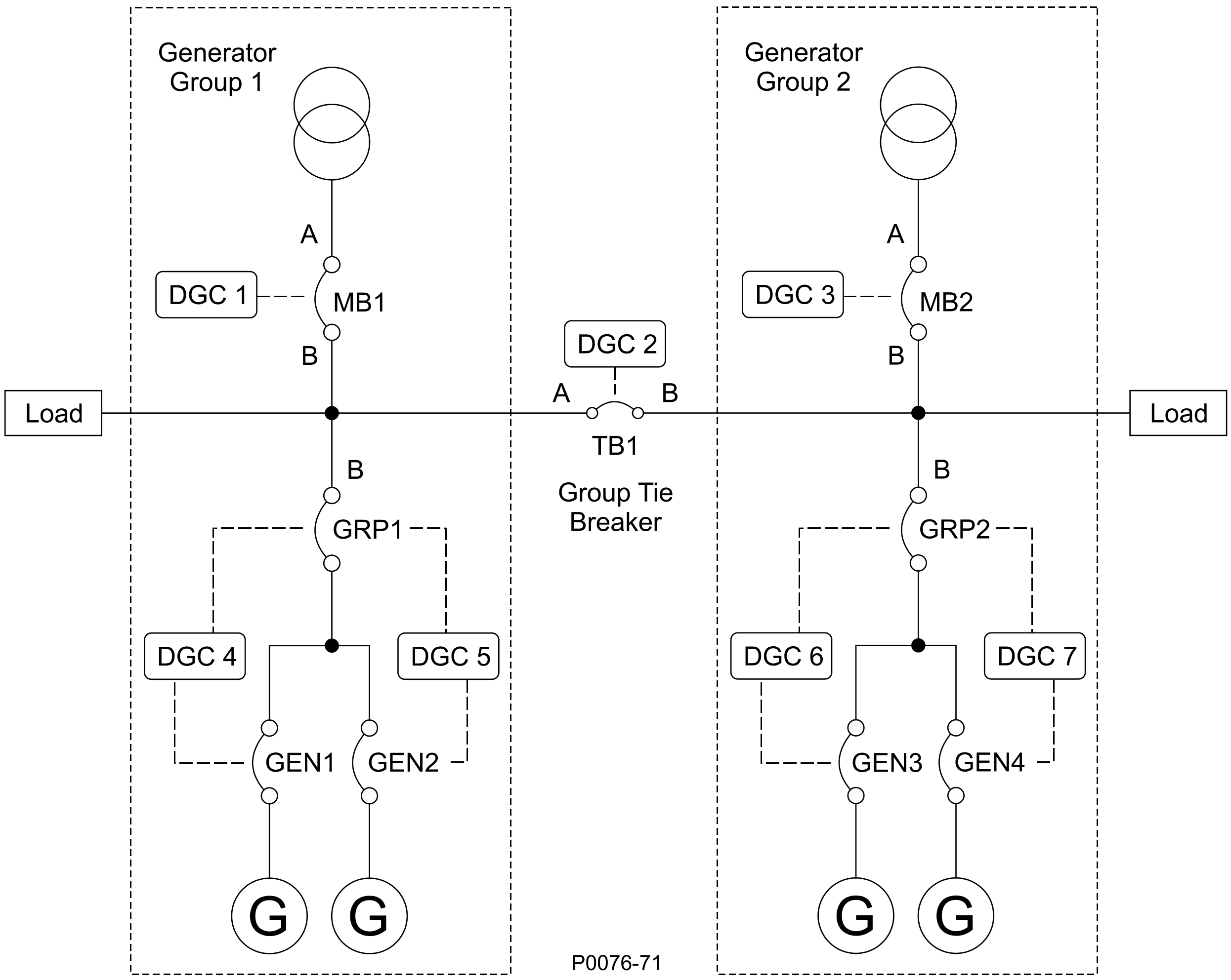


Figure 150. Example Network Topology

Table 74. Settings for DGC-2020HDs in Example Network Topology

Setting Name	DGC 1 Settings	DGC 2 Settings	DGC 3 Settings	DGC 4 Settings	DGC 5 Settings	DGC 6 Settings	DGC 7 Settings
Settings Explorer, System Parameters, System Settings							
System Breaker Configuration	Tie Breaker	Tie Breaker	Tie Breaker	Generator and Group Breaker to Segmented System	Generator and Group Breaker to Segmented System	Generator and Group Breaker to Segmented System	Generator and Group Breaker to Segmented System
System Type	Segmented Bus System	Segmented Bus System	Segmented Bus System	Segmented Bus System	Segmented Bus System	Segmented Bus System	Segmented Bus System
Settings Explorer, System Parameters, Group Settings, Group Segment Settings							
Generator Group Number	n/a	n/a	n/a	1	1	2	2
Generator Group A Number	1	1	2	n/a	n/a	n/a	n/a
Group Segment A Number	Mains	Load Bus	Mains	n/a	n/a	n/a	n/a
Generator Group B Number	1	2	2	n/a	n/a	n/a	n/a
Group Segment B Number	Load Bus	Load Bus	Load Bus	Load Bus	Load Bus	Load Bus	Load Bus
Expected Number of Tie Breaker Controllers	3	3	3	3	3	3	3
Critical Breaker 1	TB1	MB1	TB1	MB1	MB1	MB2	MB2
Critical Breaker 2	GRP1	MB2	GRP2	TB1	TB1	TB1	TB1
Critical Breaker 3	MB2	GRP1	MB1	GEN2	GEN1	GEN4	GEN3
Critical Breaker 4	GRP2	GRP2	GRP1	n/a	n/a	n/a	n/a

DGC1 Settings

DGC-2020HD #1 is set up as a Tie Breaker controller connected to Mains on the A side. The System Type is set to Segmented Bus System because all DGC-2020HDs in the network (segmented bus system) must have this setting.

Generator Group A Number is set to 1 because the A-side of the tie breaker is tied to a segment within Generator Group 1. Group Segment A Number is set to "Mains". Using the first three selections of the Group Segment A/B Number setting (Group Bus, Load Bus, or Mains) allows the DGC-2020HD to auto-detect the topology. However, buses can be assigned any of the selections if auto-detection is not desired. The DGC-2020HD internally maps the network by matching assigned segment numbers and breaker sides. Generator Group B Number is set to 1 because the B-side of the tie breaker is tied to a segment within Generator Group 1. Group Segment B is set to "Load Bus". Expected Number of Tie Breaker Controllers is set to three because there are three total tie breaker controllers in the network (DGC1, DGC2, and DGC3). Critical Breakers are not required to be assigned unless the Critical Breakers

Missing Pre-alarm is to be used. In this example, critical breakers for DGC1 are set forTB1, GRP1, MB2, and GRP2. If communication with the DGC-2020HD controlling MB2 is lost, the pre-alarm annunciates which can be used in logic to perform other actions. There isn't a set rule for determining critical breakers, use discretion based on what is appropriate for the application.

DGC2 Settings

DGC-2020HD #2 is set up as a Tie Breaker controller. The System Type is set to Segmented Bus System because all DGC-2020HDs in the network (segmented bus system) must have this setting.

Generator Group A Number is set to 1 because the A-side of the tie breaker is tied to a segment within Generator Group 1. Group Segment A Number is set to "Load Bus". Generator Group B Number is set to 2 because the B-side of the tie breaker is tied to a segment within Generator Group 2. Group Segment B is set to "Load Bus". Expected Number of Tie Breaker Controllers is set to three because there are three total tie breaker controllers in the network (DGC1, DGC2, and DGC3). Critical breakers for DGC2 are set for MB1, MB2, GRP1, and GRP2.

DGC3 Settings

DGC-2020HD #3 is set up as a Tie Breaker controller connected to Mains on the A side. The System Type is set to Segmented Bus System because all DGC-2020HDs in the network (segmented bus system) must have this setting.

Generator Group A Number is set to 2 because the A-side of the tie breaker is tied to a segment within Generator Group 2. Group Segment A Number is set to "Mains". Generator Group B Number is set to 2 because the B-side of the tie breaker is tied to a segment within Generator Group 2. Group Segment B is set to "Load Bus". Expected Number of Tie Breaker Controllers is set to three because there are three total tie breaker controllers in the network (DGC1, DGC2, and DGC3). Critical breakers for DGC3 are set for TB1, GRP2, MB1 and GRP1.

DGC4 Settings

DGC-2020HD #4's System Breaker Configuration is set up as Generator and Group Breaker to Segmented System. This is because the DGC-2020HD controls a generator, the generator breaker, and the group breaker and the group connects onto a segment which has arbitrary sources and connections. The System Type is set to Segmented Bus System because all DGC-2020HDs in the network (segmented bus system) must have this setting.

Generator Group Number is set to 1 because all of the components controlled by this DGC-2020HD are in Generator Group 1. Group Segment B is set to Load Bus. Side B of the group breaker should always be facing the system with controlled generators on side A. This is why there is no option for Group Segment A in this System Breaker Configuration. Expected Number of Tie Breaker Controllers is set to three because there are three total tie breaker controllers in the network (DGC1, DGC2, and DGC3). Critical breakers for DGC4 are set for MB1, TB1, and GEN2. GRP1 and GEN1 are directly controlled by DGC4 and therefore are not assigned as critical breakers because DGC4 does not rely on communications for breaker information from the breakers it directly controls.

DGC5 Settings

DGC-2020HD #5's System Breaker Configuration is set up as Generator and Group Breaker to Segmented System. This is because the DGC-2020HD controls a generator, the generator breaker, and the group breaker and the group connects onto a segment which has arbitrary sources and connections. The System Type is set to Segmented Bus System because all DGC-2020HDs in the network (segmented bus system) must have this setting.

Generator Group Number is set to 1 because all of the components controlled by this DGC-2020HD are in Generator Group 1. Group Segment B is set to Load Bus. Side B of the group breaker should always be facing the system with controlled generators on side A. This is why there is no option for Group Segment A in this System Breaker Configuration. Expected Number of Tie Breaker Controllers is set to three because there are three total tie breaker controllers in the network (DGC1, DGC2, and DGC3). Critical breakers for DGC5 are set for MB1, TB1, and GEN1. GRP1 and GEN2 are directly controlled by

DGC5 and therefore are not assigned as critical breakers because DGC5 does not rely on communications for breaker information from the breakers it directly controls.

DGC6 Settings

DGC-2020HD #6's System Breaker Configuration is set up as Generator and Group Breaker to Segmented System. This is because the DGC-2020HD controls a generator, the generator breaker, and the group breaker and the group connects onto a segment which has arbitrary sources and connections. The System Type is set to Segmented Bus System because all DGC-2020HDs in the network (segmented bus system) must have this setting.

Generator Group Number is set to 2 because all of the components controlled by this DGC-2020HD are in Generator Group 2. Group Segment B is set to Load Bus. Side B of the group breaker should always be facing the system with controlled generators on side A. This is why there is no option for Group Segment A in this System Breaker Configuration. Expected Number of Tie Breaker Controllers is set to three because there are three total tie breaker controllers in the network (DGC1, DGC2, and DGC3). Critical breakers for DGC6 are set for MB2, TB1, and GEN4. GRP2 and GEN3 are directly controlled by DGC6 and therefore are not assigned as critical breakers because DGC6 does not rely on communications for breaker information from the breakers it directly controls.

DGC7 Settings

DGC-2020HD #7's System Breaker Configuration is set up as Generator and Group Breaker to Segmented System. This is because the DGC-2020HD controls a generator, the generator breaker, and the group breaker and the group connects onto a segment which has arbitrary sources and connections. The System Type is set to Segmented Bus System because all DGC-2020HDs in the network (segmented bus system) must have this setting.

Generator Group Number is set to 2 because all of the components controlled by this DGC-2020HD are in Generator Group 2. Group Segment B is set to Load Bus. Side B of the group breaker should always be facing the system with controlled generators on side A. This is why there is no option for Group Segment A in this System Breaker Configuration. Expected Number of Tie Breaker Controllers is set to three because there are three total tie breaker controllers in the network (DGC1, DGC2, and DGC3). Critical breakers for DGC7 are set for MB2, TB1, and GEN3. GRP2 and GEN4 are directly controlled by DGC7 and therefore are not assigned as critical breakers because DGC7 does not rely on communications for breaker information from the breakers it directly controls.

Alarm Configuration

Configuration of DGC-2020HD alarms, pre-alarms, sender failure alarms, user programmable alarms, and the audible horn is described in the following paragraphs.

Alarms

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Alarm Configuration, Alarms
Front Panel Navigation Path: Settings > Alarm Configuration > Alarms

To configure alarms using BESTCOMS*Plus*, open the Alarm screen (Figure 151). Settings are listed in Table 75. 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 after a fixed four-second delay 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 for a fixed two-second delay. 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, an activation delay setting, and a hysteresis 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 user-defined hysteresis setting 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 after a fixed two-second delay 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 BESTlogic*Plus* logic element RDPPROGALM1 or RDPPROGALM2 receives a true input.

CAN Bus Low Coolant Level

CAN Bus Low Coolant Level alarm settings consist of a single enable/disable setting. Certain ECUs send a binary status to indicate low coolant level. If enabled, a CAN Bus Low Coolant Level alarm occurs when any binary status for low coolant level is received. ECU Support must be enabled on the Communications, CAN Bus, CAN Bus Setup screen before this alarm can be configured. When disabled, all Low Coolant Level indications received over CAN Bus are reported as pre-alarms rather than alarms. This allows the machine to remain operating while annunciating that a low coolant level indication has been received from the ECU.

When low coolant level indications are received from the ECU, the Low Coolant Level LED indicator is lit on the optional RDP-110 Remote Display Panel.

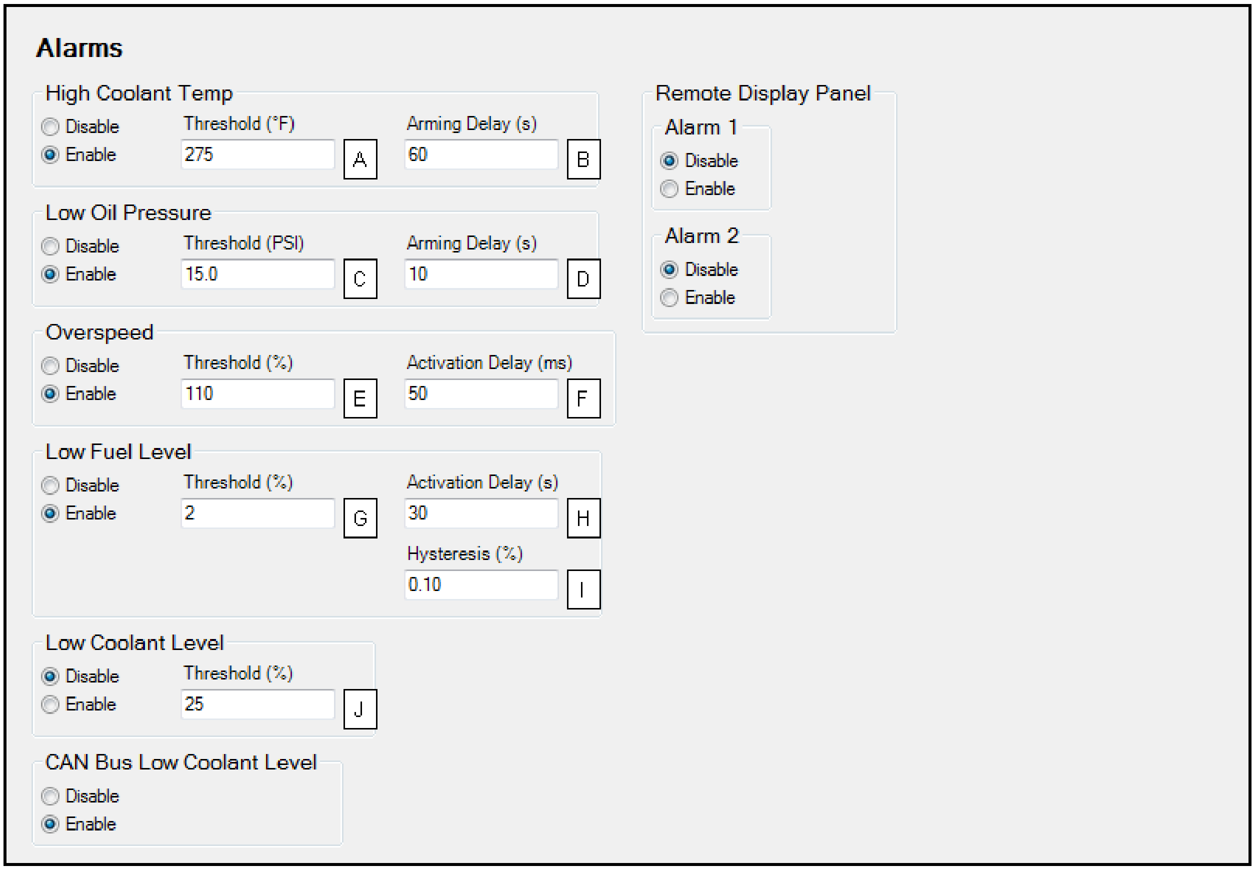


Figure 151. Settings Explorer, Alarm Configuration, Alarms

Table 75. Settings for Alarms

Locator	Setting	Range	Increment	Unit
High Coolant Temp Settings				
A	Threshold	100 to 280	1	degrees F
		38 to 138	1	degrees C
B	Arming Delay	0 to 150	1	seconds
Low Oil Pressure Settings				
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

Locator	Setting	Range	Increment	Unit
Overspeed Settings				
E	Threshold	105 to 140	1	%
F	Activation Delay	0 to 500	1	milliseconds
Low Fuel Level Settings				
G	Threshold	0 to 100	1	%
H	Activation Delay	0 to 30	1	seconds
I	Hysteresis	0 to 20	0.01	%
Low Coolant Level Settings				
J	Threshold	1 to 99	1	%

Pre-alarms

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Alarm Configuration, Pre-Alarms
Front Panel Navigation Path: Settings > Alarm Configuration > Pre-Alarms

To configure pre-alarms using BESTCOMS*Plus*, open the Pre-Alarms screen (Figure 152). Settings are listed in Table 76. 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.

Critical Breakers Missing

Critical breakers missing pre-alarm settings consist of a single enable/disable setting. If enabled, a Critical Breakers Missing pre-alarm is annunciated when expected critical breakers are not detected on the network.

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 Below 10 Hz

Generator Below 10 Hz pre-alarm settings consist of a single enable/disable setting. When enabled, a Gen Below 10 Hz pre-alarm is annunciated if the sensed generator frequency is less than 10 Hz. Gen Below 10 Hz pre-alarm detection is enabled only when a VRM-2020 is used and a regulator is started.

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.

Group Breaker Capacity Not Reached

Group breaker Capacity Not Reached pre-alarm settings consist of a single enable/disable setting. If enabled, a Group Capacity Not Reached pre-alarm is annunciated when enough generation is not online before the time delay expires. The Group Capacity Not Reached status may be used in logic to shed loads in the system for example. If enough generation is brought online or the demand reduces during this time, the group breaker will still close.

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 for a fixed two-second delay. 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 BESTCOMS*Plus*.

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 after a fixed four-second delay 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 BESTCOMS*Plus*.

High Fuel Level

High fuel level pre-alarm settings consist of an enable/disable setting, a threshold setting, an activation delay, and a hysteresis setting. 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 user-defined hysteresis setting 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 BESTCOMS*Plus*.

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 for a fixed two-second delay. 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 for a fixed four-second delay. 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 BESTCOMS*Plus*.

Low Fuel Level

Low fuel level pre-alarm settings consist of an enable/disable setting, a threshold setting, and a hysteresis setting. If enabled, a Low Fuel Level pre-alarm occurs when the metered fuel level decreases below the threshold setting for a fixed two-second delay. A user-defined hysteresis setting 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 after a fixed two-second delay 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 BESTCOMS*Plus*.

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 BESTCOMS*Plus*. See *Resetting Alarms and Pre-Alarms* below.

Missing System Components

Missing System Components pre-alarm settings consist of a single enable/disable setting. If enabled, a Missing System Components pre-alarm is annunciated when the expected number of tie breaker controllers is incorrect.

Open Generator Breaker on Trip

Open Generator Breaker on Trip pre-alarm settings consist of a single enable/disable setting. If enabled, an open request is sent to the generator breaker when communication with the VRM-2020 is lost. This may prevent equipment damage in case loss of communication with the VRM-2020 would cause loss of excitation control.

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.

System Segments Unreachable

System Segments Unreachable pre-alarm settings consist of a single enable/disable setting. If enabled, a System Segments Unreachable pre-alarm is annunciated when it is determined that a segment would not be connected to the system if all of the breakers were to be closed. This may indicate incorrect system settings or breaker loss.

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

VRM Comms Failure

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

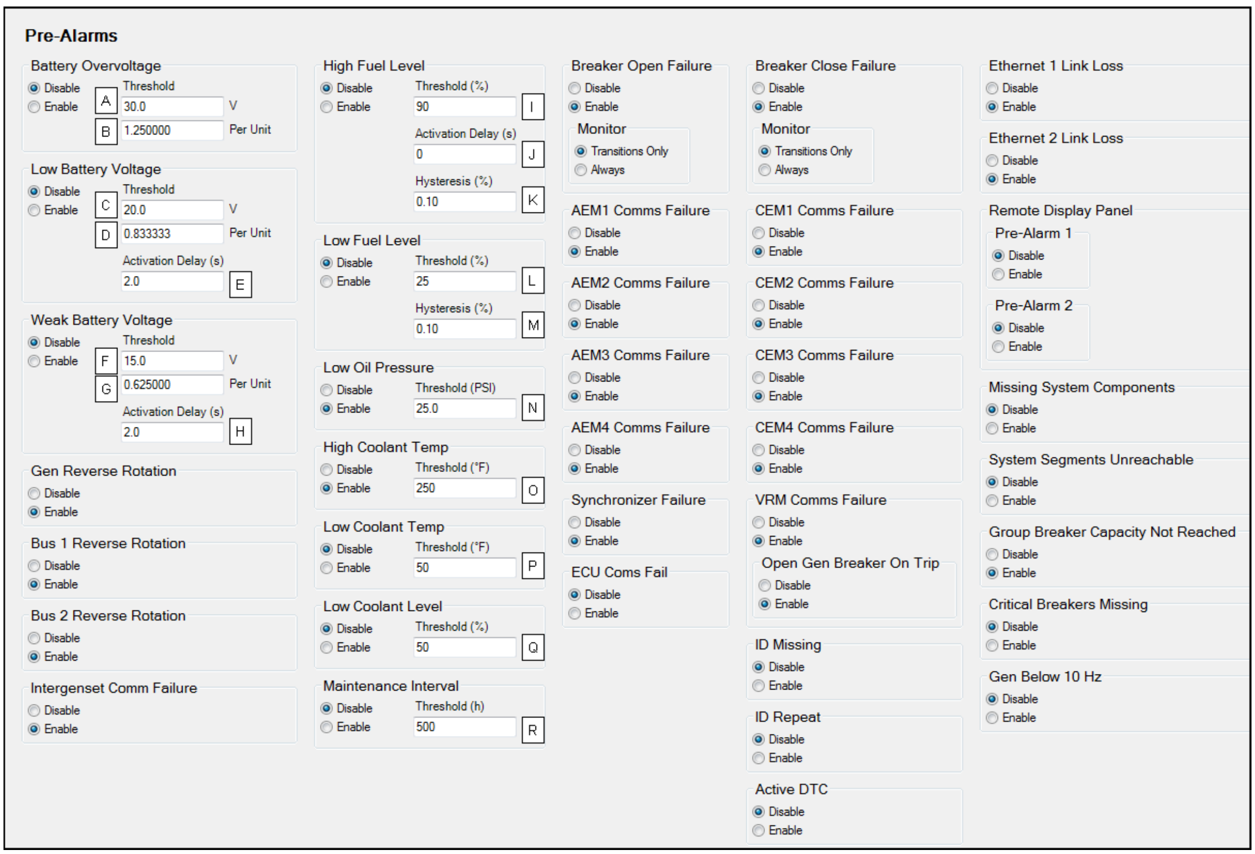


Figure 152. Settings Explorer, Alarm Configuration, Pre-Alarms

Table 76. 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

Locator	Setting	Range	Increment	Unit
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 60	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
K	Hysteresis	0 to 20	0.01	%
Low Fuel Level Settings				
L	Threshold	10 to 100	1	%
M	Hysteresis	0 to 20	0.01	%
Low Oil Pressure Settings				
N	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				
O	Threshold	100 to 280	1	degrees F
		38 to 138	1	degrees C
Low Coolant Temp Settings				
P	Threshold	0 to 151	1	degrees F
		–17 to 66	1	degrees C
Low Coolant Level Settings				
Q	Threshold	1 to 99	1	%
Maintenance Interval				
R	Threshold	0 to 5,000	1	hours

Horn Configuration

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Alarm Configuration, Horn Configuration
Front Panel Navigation Path: Settings > Alarm Configuration > Horn Configuration

To configure the audible horn using BESTCOMS*Plus*, open the Horn Configuration screen (Figure 153).

Figure 153. 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

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Alarm Configuration, Sender Fail
Front Panel Navigation Path: Settings > Alarm Configuration > Sender Fail

To configure sender failure alarms using BESTCOMS*Plus*, open the Sender Fail screen (Figure 154). Settings are listed in Table 77.

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. Selectable alarm configurations are described under the *Annunciation* heading, above.

The selected alarm type is triggered when a sender failure exists for the duration of the activation time delay.

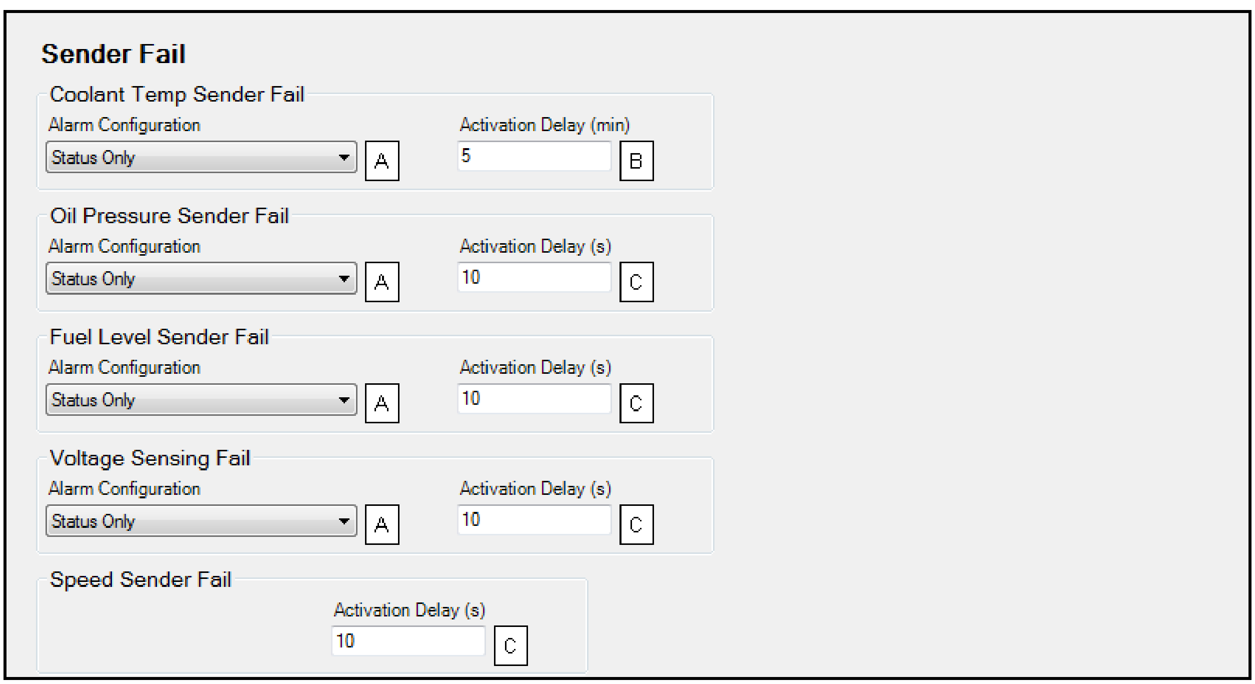


Figure 154. Settings Explorer, Alarm Configuration, Sender Fail

Table 77. Settings for Sender Fail

Locator	Setting	Range	Increment	Unit
A	Alarm Configuration	Status Only, Pre-Alarm, Alarm, Alarm with Unload, Alarm with Cooldown, or Alarm with Unload then Cooldown	n/a	n/a
B	Activation Delay (min)	5 to 30	1	minutes
C	Activation Delay (s)	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

BESTCOMS*Plus*® Navigation Path: Settings Explorer, Alarm Configuration, User Programmable Alarms

Front Panel Navigation Path: Not available through front panel

Sixteen user programmable alarms are available. BESTlogic*Plus* Programmable Logic is used to set up alarm logic. User alarm labels are programmed on the User Programmable Alarms screen (Figure 155) 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.

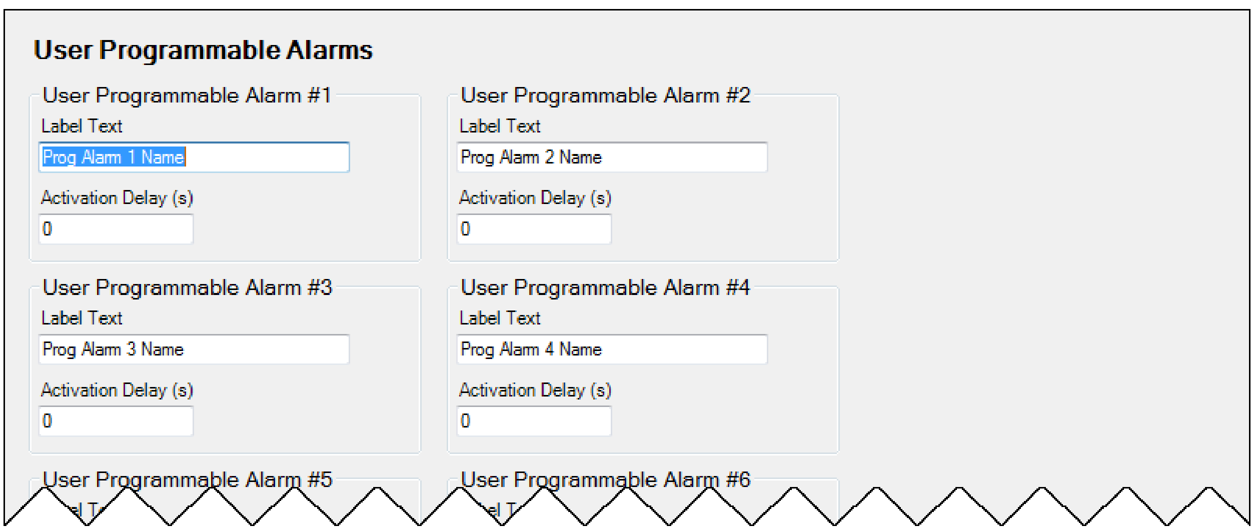


Figure 155. Settings Explorer, Alarm Configuration, User Programmable Alarms

Protection

Three tiers of 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 current imbalance (46), phase voltage imbalance (47), time overcurrent (51), vector shift (78), and frequency rate-of-change (ROC) elements. Controllers with style number xxDxxxxEx offer enhanced protection elements plus phase current differential (87G), and neutral current differential (87N). When a VRM-2020 is enabled, three field protection elements are provided: Field Overvoltage, Loss of Sensing, and Exciter Diode Monitor (optional).

Four setting groups enable independent protection coordination which is selectable in BESTlogic™*Plus*. 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 BESTCOMS*Plus*® and element operational settings are configured on the Undervoltage settings screen in BESTCOMS*Plus*.

BESTCOMS*Plus* Navigation Path: Settings Explorer, 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 BESTlogic*Plus*, 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. The value of the scale factor setting serves as a multiplier for the pickup settings. For example, if the DGC-2020HD is determined to be in a low-line configuration and the scale factor setting is 2.000, the pickup setting will be doubled (2.000 x PU).

The low-line configuration can be determined through the Auto Configuration Detection feature or the state of a contact input if the Low-Line Override function is assigned to a contact input via the Programmable Functions screen. If either method indicates a low-line configuration is in effect, then the DGC-2020HD is configured for low-line operation.

Alarm Configuration

An undervoltage trip can be user-selected to trigger a different action depending on the alarm configuration setting. Alarm configurations are described in the *Alarm Configuration* chapter.

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 156. 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.

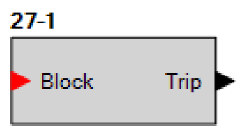


Figure 156. Undervoltage Element Logic Block

Operational Settings

Undervoltage element operational settings are configured on the Undervoltage settings screen (Figure 157) in BESTCOMS*Plus*. Setting ranges are defined in the *Specifications* chapter in the *Installation* manual.

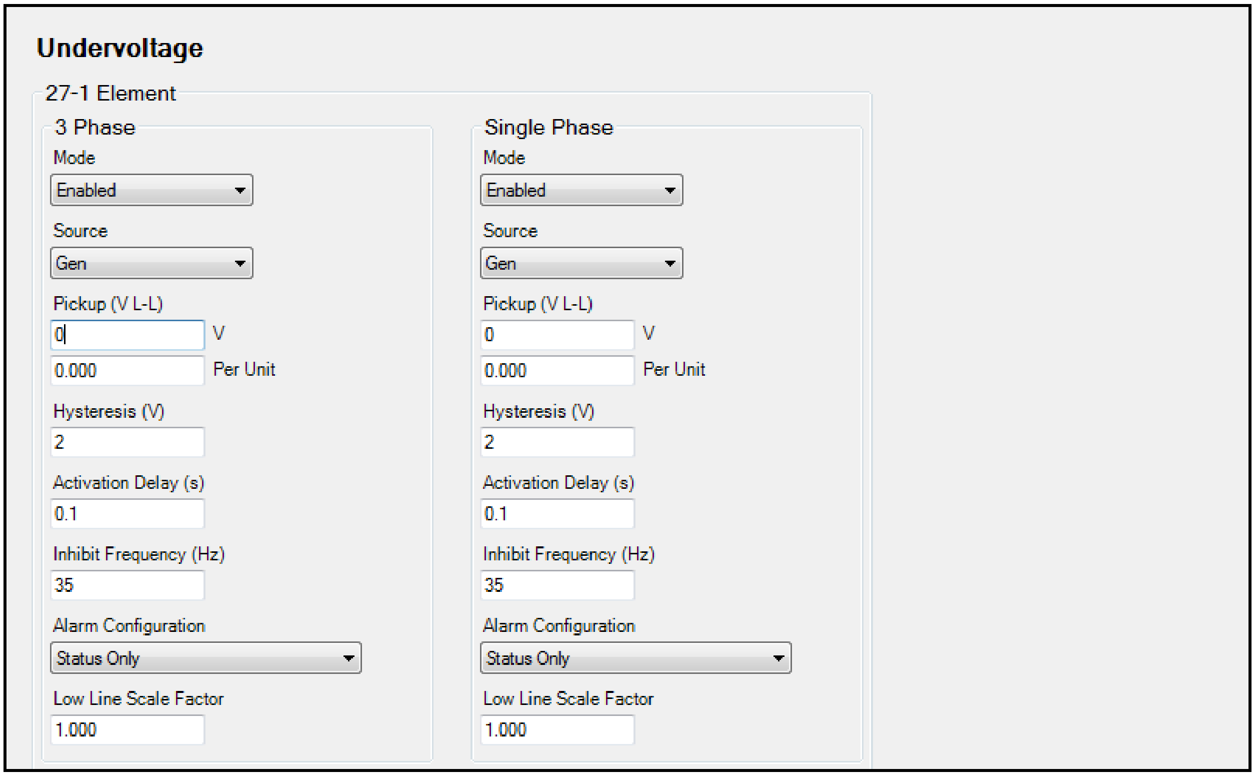


Figure 157. Settings Explorer, Protection, Voltage, Undervoltage

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, 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 BESTlogic*Plus*, 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, 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).

- 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 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. The value of the scale factor setting serves as a multiplier for the pickup settings. For example, if the DGC-2020HD is determined to be in a low-line configuration and the scale factor setting is 2.000, the pickup setting will be doubled (2.000 x PU).

The low-line configuration can be determined through the Auto Configuration Detection feature or the state of a contact input if the Low-Line Override function is assigned to a contact input via the Programmable Functions screen. If either method indicates a low-line configuration is in effect, then the DGC-2020HD is configured for low-line operation.

Alarm Configuration

An overvoltage trip can be user-selected to trigger a different action depending on the alarm configuration setting. Alarm configurations are described in the *Alarm Configuration* chapter.

Logic Connections

Overvoltage element logic connections are made on the BESTlogic*Plus* screen in BESTCOMS*Plus*. The overvoltage element logic block is illustrated in Figure 158. 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.

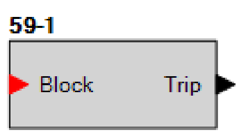


Figure 158. Overvoltage Element Logic Block

Operational Settings

Overvoltage element operational settings are configured on the Overvoltage settings screen (Figure 159) in BESTCOMS*Plus*. Setting ranges are defined in the *Specifications* chapter in the *Installation* manual.

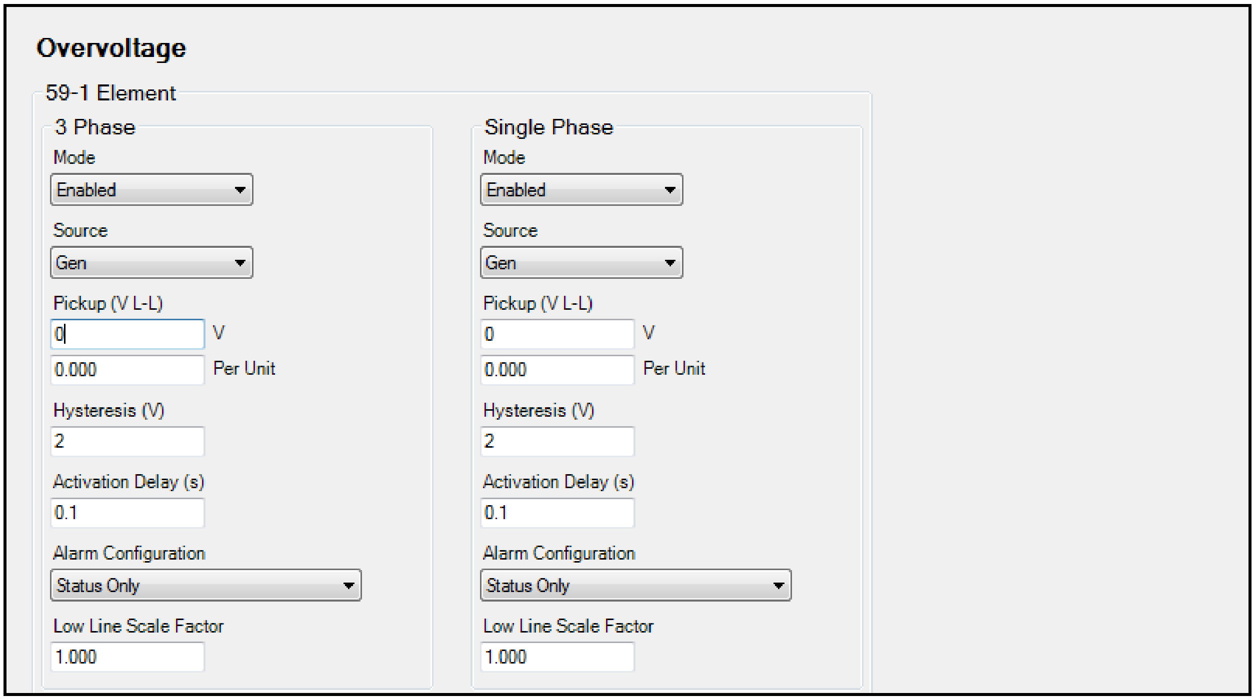


Figure 159. Settings Explorer, Protection, Voltage, Overvoltage

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 xxExxxxxx 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 BESTCOMS*Plus*® and element operational settings are configured on the Phase Voltage Imbalance settings screen in BESTCOMS*Plus*.

BESTCOMS*Plus* Navigation Path: Settings Explorer, 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 BESTlogic*Plus*, 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, 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 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 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. The value of the scale factor setting serves as a multiplier for the pickup settings. For example, if the DGC-2020HD is determined to be in a low-line configuration and the scale factor setting is 2.000, the pickup setting will be doubled (2.000 x PU).

The low-line configuration can be determined through the Auto Configuration Detection feature or the state of a contact input if the Low-Line Override function is assigned to a contact input via the Programmable Functions screen. If either method indicates a low-line configuration is in effect, then the DGC-2020HD is configured for low-line operation.

Alarm Configuration

A phase voltage imbalance trip can be user-selected to trigger a different action depending on the alarm configuration setting. Alarm configurations are described in the *Alarm Configuration* chapter.

Logic Connections

Phase voltage imbalance element logic connections are made on the BESTlogic*Plus* screen in BESTCOMS*Plus*. The phase voltage imbalance element logic block is illustrated in Figure 160. 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.

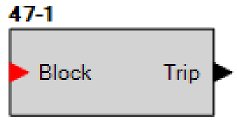


Figure 160. Phase Voltage Imbalance Element Logic Block

Operational Settings

Phase voltage imbalance element operational settings are configured on the Phase Voltage Imbalance settings screen (Figure 161) in BESTCOMS*Plus*. Setting ranges are defined in the *Specifications* chapter in the *Installation* manual.

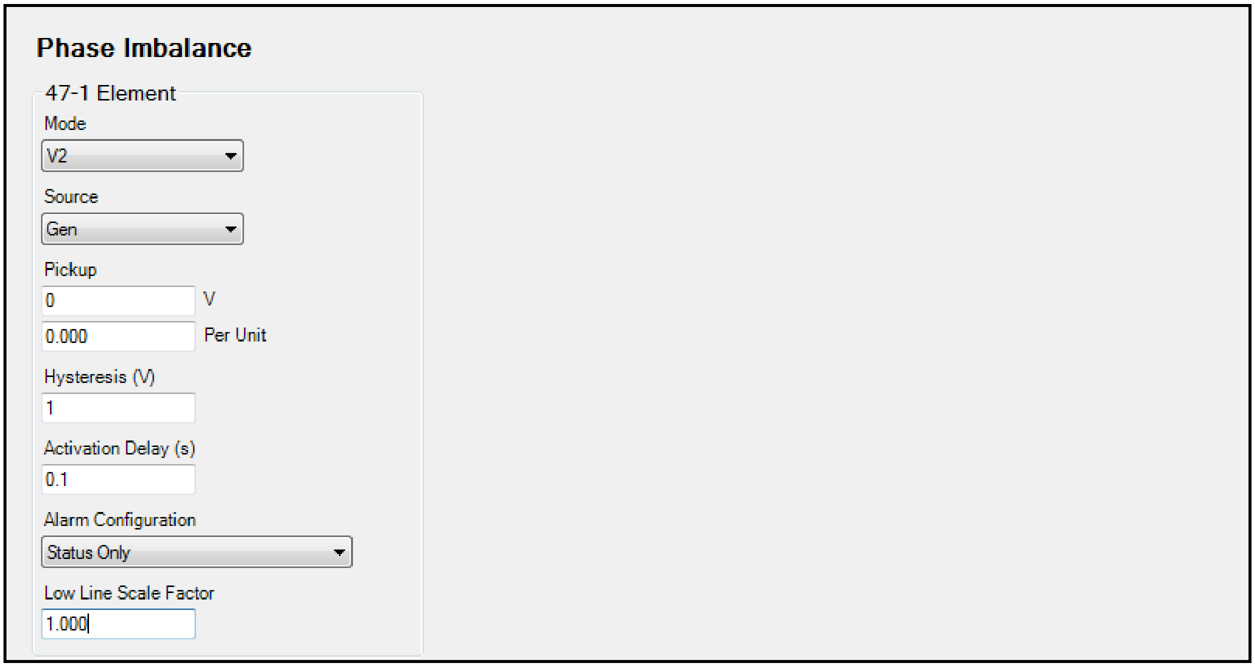


Figure 161. Settings Explorer, Protection, Voltage, Phase Imbalance

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 BESTCOMS*Plus*® and element operational settings are configured on the Vector Shift settings screen in BESTCOMS*Plus*.

BESTCOMS*Plus* Navigation Path: Settings Explorer, 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 BESTlogic*Plus*. 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.

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 BESTlogic*Plus*, 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

A vector shift trip can be user-selected to trigger a different action depending on the alarm configuration setting. Alarm configurations are described in the *Alarm Configuration* chapter.

Open Mains Breaker, Group 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 BESTlogic*Plus* screen in BESTCOMS*Plus*. The vector shift element logic block is illustrated in Figure 162. 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.

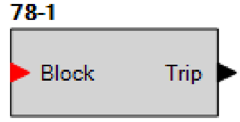


Figure 162. Vector Shift Element Logic Block

Operational Settings

Vector shift element operational settings are configured on the Vector Shift settings screen (Figure 163) in BESTCOMS*Plus*. Setting ranges are defined in the *Specifications* chapter in the *Installation* manual.

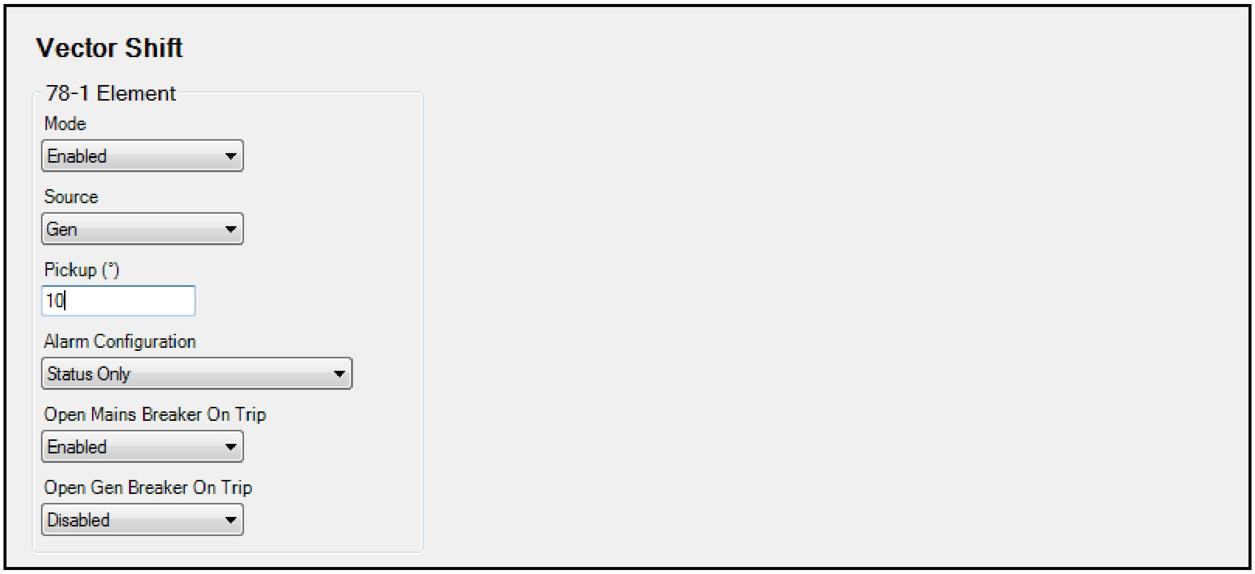


Figure 163. Settings Explorer, Protection, Loss of Mains Protection, Vector Shift

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, 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 BESTlogic*Plus*, 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, 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 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 BESTlogic*Plus* programmable logic. When the Alternate Frequency Override is true, the scale factor setting serves as a multiplier for the pickup settings. For example, if a scale factor contact input is received by the DGC-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 trip can be user-selected to trigger a different action depending on the alarm configuration setting. Alarm configurations are described in the *Alarm Configuration* chapter.

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 because 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.

Positive ROCOF and Negative ROCOF mode settings are provided for use in load shedding policy.

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 BESTlogic*Plus*. 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.

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.

Enable

This setting allows ROCOF protection to be enabled always or only when paralleled to mains.

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 BESTlogic*Plus*, 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 trip can be user-selected to trigger a different action depending on the alarm configuration setting. Alarm configurations are described in the *Alarm Configuration* chapter.

Open Mains Breaker, Group 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 BESTCOMS*Plus*. The frequency element logic block is illustrated in Figure 164. 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.

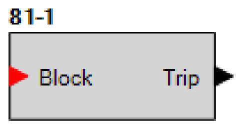


Figure 164. Frequency Element Logic Block

Operational Settings

Frequency element operational settings are configured on the Frequency settings screen (Figure 165) in BESTCOMS*Plus*. Setting ranges are defined in the *Specifications* chapter in the *Installation* manual.

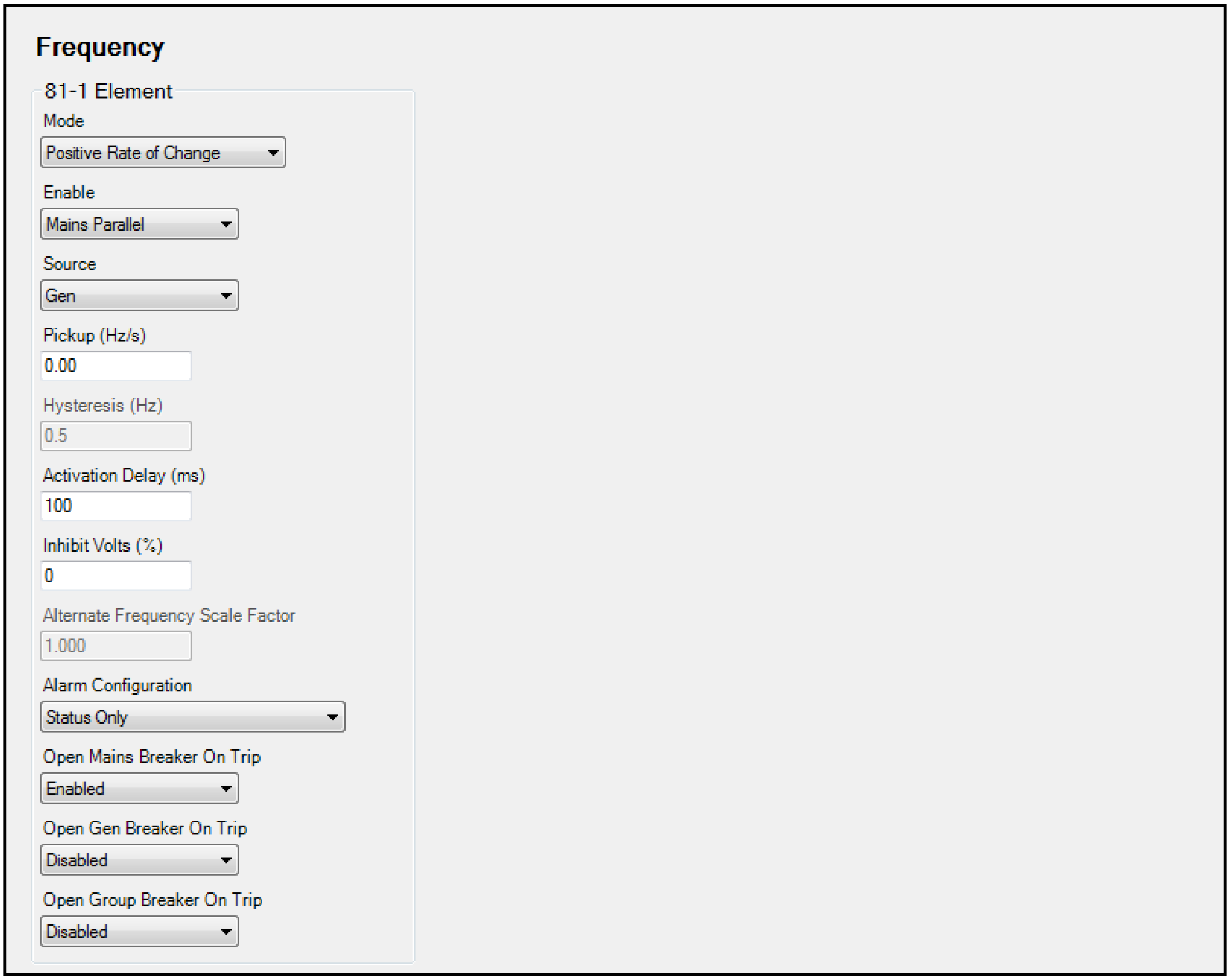


Figure 165. Settings Explorer, Protection, Frequency

Current Imbalance (46)

Six current imbalance protection (46) elements monitor the difference of phase current levels by calculating negative sequence current (I2) in three phase mode or calculating neutral current (I0) in single phase mode.

Ground relays can be set more sensitively than phase relays because a balanced load has no ground (3I0) current component. When using negative-sequence mode, the 46 element can provide similar increased sensitivity to phase-to-phase faults because a balanced load has no negative-sequence (I2) current component.

BESTCOMS*Plus* Navigation Path: Settings Explorer, Protection, Current, Current Imbalance (46)

HMI Navigation Path: Settings Explorer > Protection, Settings Group x (where x = 0 to 3) > Current Protection > Current Imbalance 46

Element Operation

A typical setting when using negative-sequence mode for the 46 element is one-half the phase pickup setting in order to achieve equal sensitivity to phase-to-phase faults as three-phase faults. This number comes from the fact that the magnitude of the current for a phase-to-phase fault is $\sqrt{3}/2$ (87%) of the three-phase fault at the same location. This is illustrated in Figure 166.

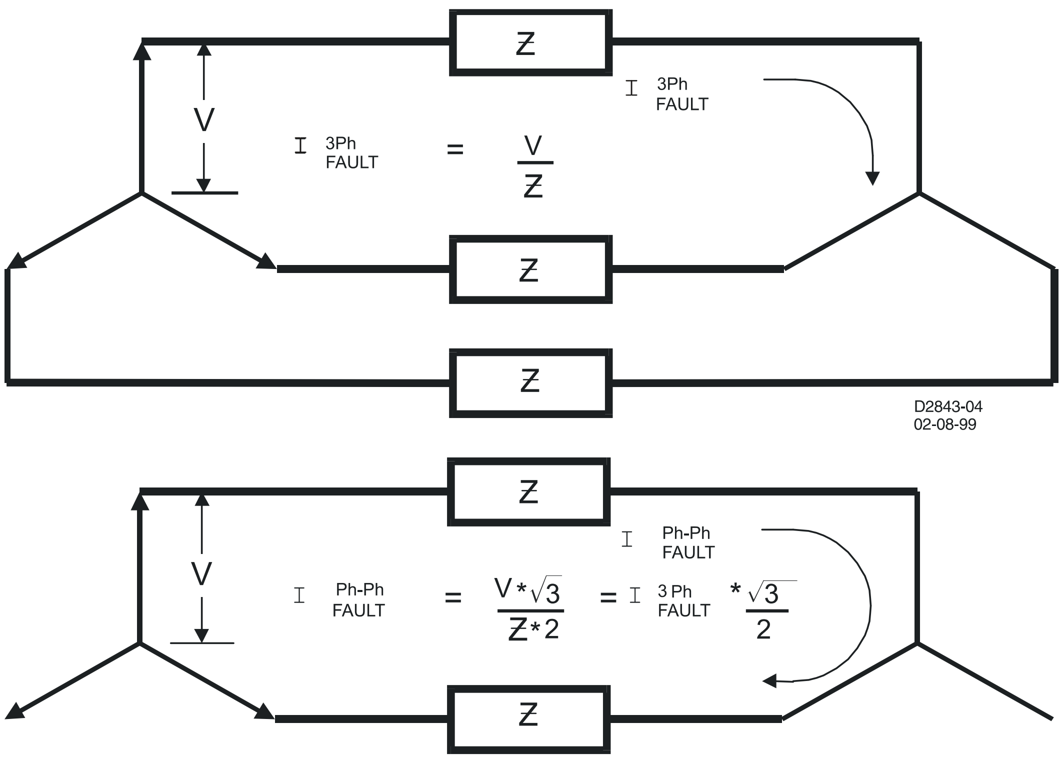


Figure 166. Phase-to-Phase Fault Magnitude

The phase-to-phase fault is made up of both positive and negative-sequence components as shown in Figure 167. The magnitude of the negative-sequence component is $1/\sqrt{3}$ (58%) of the magnitude of the total phase current. When these two factors ($\sqrt{3}/2$ and $1/\sqrt{3}$) are combined, the $\sqrt{3}$ factors cancel which leaves the one-half factor.

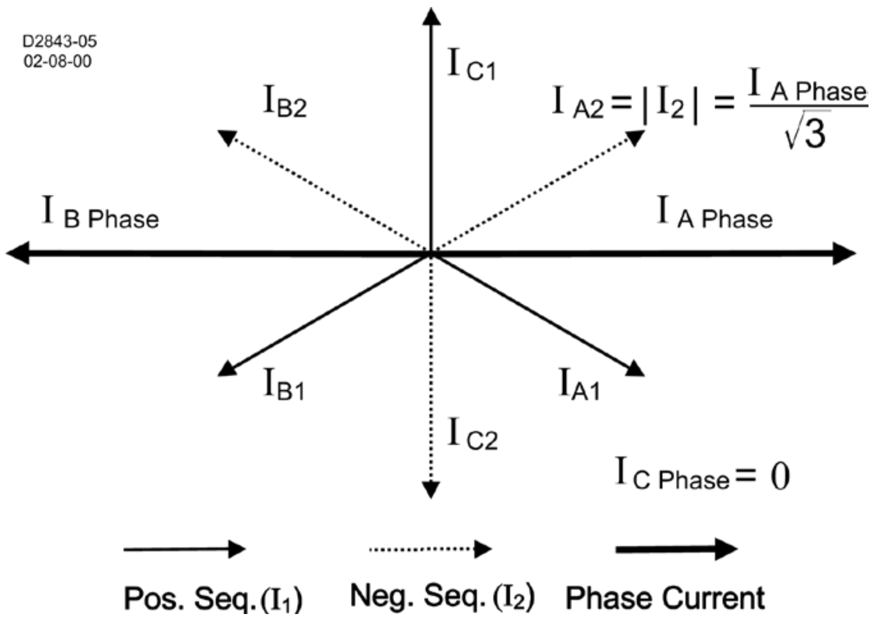


Figure 167. Sequence Components for an A-B Fault

Coordination Settings

The 46-x negative-sequence settings should be checked for coordination with phase-only sensing devices such as downstream fuses, reclosers, and/or ground relays. To plot the negative-sequence time current characteristics on the same plot for the phase devices, you need to multiply the negative-sequence element pickup value by the correct multiplier. The multiplier is the ratio of phase current to negative-sequence current for the fault type for which you are interested. To plot the negative-sequence time current characteristics on the same plot for the ground devices, you need to multiply the pickup value by the multiplier for phase-to-ground faults (see Table 78).

Table 78. Fault Type Multipliers

Fault Type	Multiplier
Ph-Ph	m = 1.732
Ph-Ph-G	m > 1.732
Ph-G	m = 3
three-phase	m = infinity

For example, a downstream phase 46-x element has a pickup of 150 amperes. The upstream 46-x negative-sequence element has a pickup of 200 amperes. To check the coordination between these two elements for a phase-to-phase fault, the phase overcurrent element would be plotted normally with pickup at 150 amperes. The 46-x negative-sequence element would be shifted to the right by the appropriate factor m. Thus, the characteristic would be plotted on the coordination graph with pickup at: (200 amperes) $*$ 1.732 = 346 amperes.

Generally, for coordination with downstream phase overcurrent devices, phase-to-phase faults are the most critical to consider. All other fault types result in an equal or greater shift of the time current characteristic curve to the right on the plot.

Logic Connections

Current Imbalance element logic connections are made on the BESTlogic*Plus* screen in BESTCOMS*Plus*. The Current Imbalance element logic block is illustrated in Figure 168. When the Block input is true, the 46 element is disabled. The Trip output is true when the 46 element is in a trip condition.

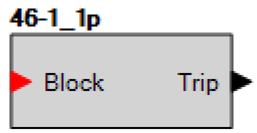


Figure 168. Current Imbalance Element Logic Block

Operational Settings

Current Imbalance element operational settings are configured on the Current Imbalance settings screen (Figure 169) in BESTCOMS*Plus*. Setting ranges are defined in the Specifications chapter.

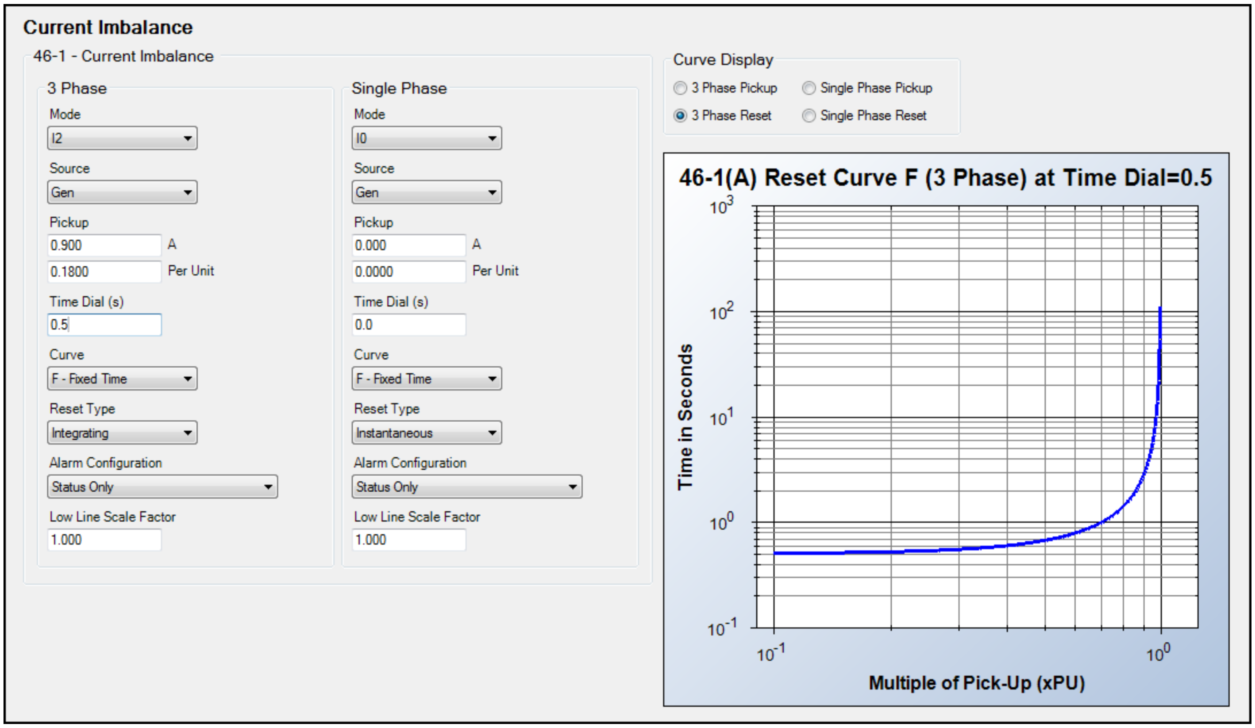


Figure 169. Settings Explorer, Protection, Current, Current Imbalance

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 BESTlogic*Plus* screen in BESTCOMS*Plus* and element operational settings are configured on the Overcurrent settings screen in BESTCOMS*Plus*.

BESTCOMS*Plus* Navigation Path: Settings Explorer, 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, Imax, 3I0, I1, I2, and IG. Descriptions of the protection modes in three-phase and single-phase systems are provided in Table 79.

Table 79. 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.
Imax	Imax mode provides overcurrent protection in a three-phase system when any one phase increases above the Pickup setting.	Imax mode provides overcurrent protection in a single-phase system when any one phase increases above the Pickup setting.
3I0	3I0 mode provides neutral overcurrent protection in a three-phase system.	3I0 mode is an invalid selection for a single-phase system.
I1	I1 mode provides positive-sequence overcurrent protection in a three-phase system.	I1 mode is an invalid selection for a single-phase system.
I2	I2 mode provides negative-sequence overcurrent protection in a three-phase system.	I2 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 BESTlogic*Plus*, 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, 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 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 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. The value of the scale factor setting serves as a multiplier for the pickup settings. For example, if the DGC-2020HD is determined to be in a low-line configuration and the scale factor setting is 2.000, the pickup setting will be doubled (2.000 x PU).

The low-line configuration can be determined through the Auto Configuration Detection feature or the state of a contact input if the Low-Line Override function is assigned to a contact input via the Programmable Functions screen. If either method indicates a low-line configuration is in effect, then the DGC-2020HD is configured for low-line operation.

Alarm Configuration

An overcurrent trip can be user-selected to trigger a different action depending on the alarm configuration setting. Alarm configurations are described in the *Alarm Configuration* chapter.

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 15 and Equation 16. 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 80.

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

Equation 15. Time OC Characteristics for Trip

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

Equation 16. Time OC Characteristics for Reset

Table 80. Definitions for Equation 15 and Equation 16

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.

Parameter	Description	Explanation
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 BESTCOMS*Plus*. 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

BESTCOMS*Plus* is used to set the 51 element Table Curves (T1, T2, T3, and T4). Using the Settings Explorer within BESTCOMS*Plus*, open the Protection, Current, Table Curve (1, 2, 3, or 4) tree branch and select the table curve to be modified. Refer to Figure 170. 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.

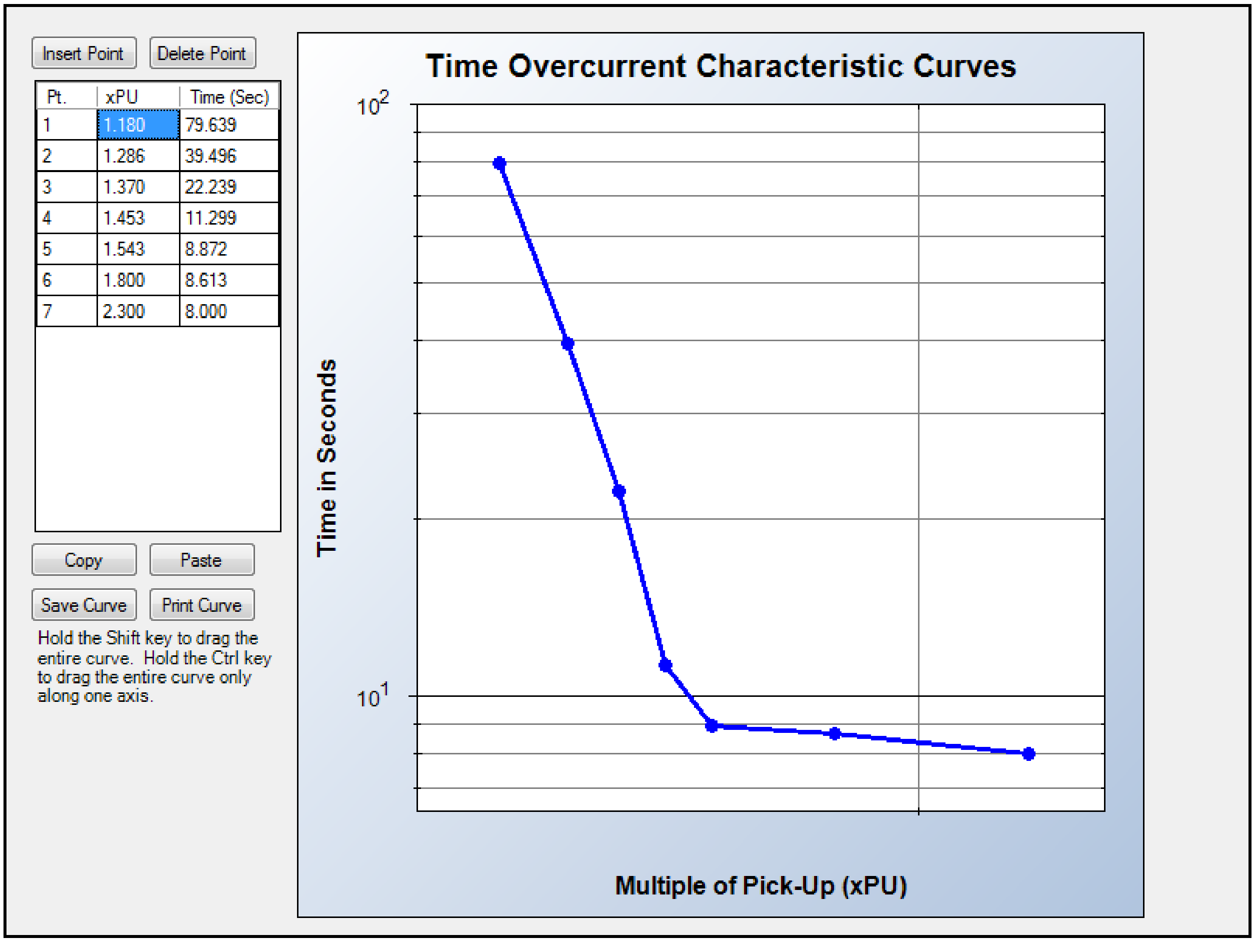


Figure 170. Inverse Overcurrent Table Curve

46 Curve

A 46 Curve is a special curve designed to emulate the I^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 $(I2)^2t$ 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 171 shows how the 51 Pickup setting is adjusted in response to the measured voltage level. Equation 17 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.

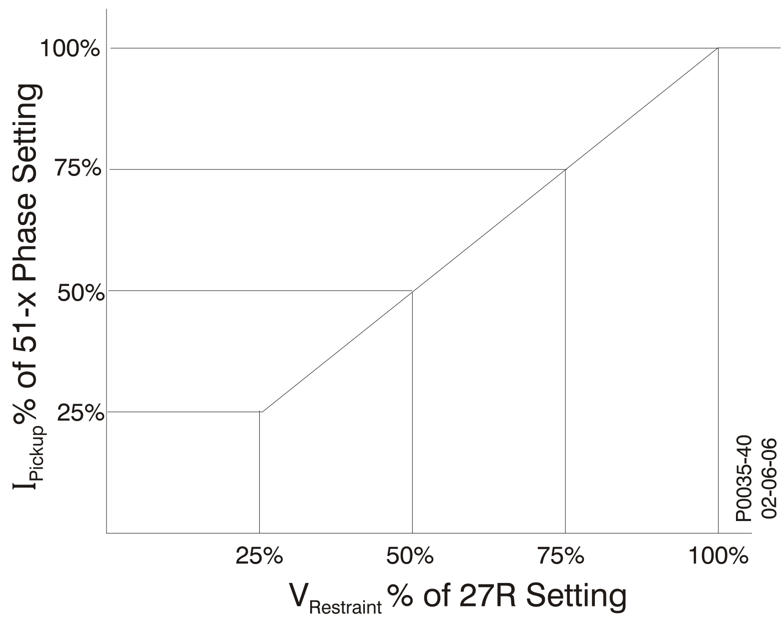


Figure 171. 51 Phase Pickup Level Compensation

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

Equation 17. Restraint Pickup Level

Phase VT Configuration

The 51/27R function monitors Vpp. Table 81 shows which voltage measurements are used by each 51 element for each possible phase VT connection.

Table 81. 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 BESTCOMS*Plus*. The overcurrent element logic block is illustrated in Figure 172. 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.

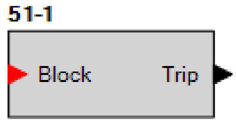


Figure 172. Overcurrent Element Logic Block

Operational Settings

Overcurrent element operational settings are configured on the Overcurrent settings screen (Figure 173) in BESTCOMS*Plus*. Setting ranges are defined in the *Specifications* chapter in the *Installation* manual.

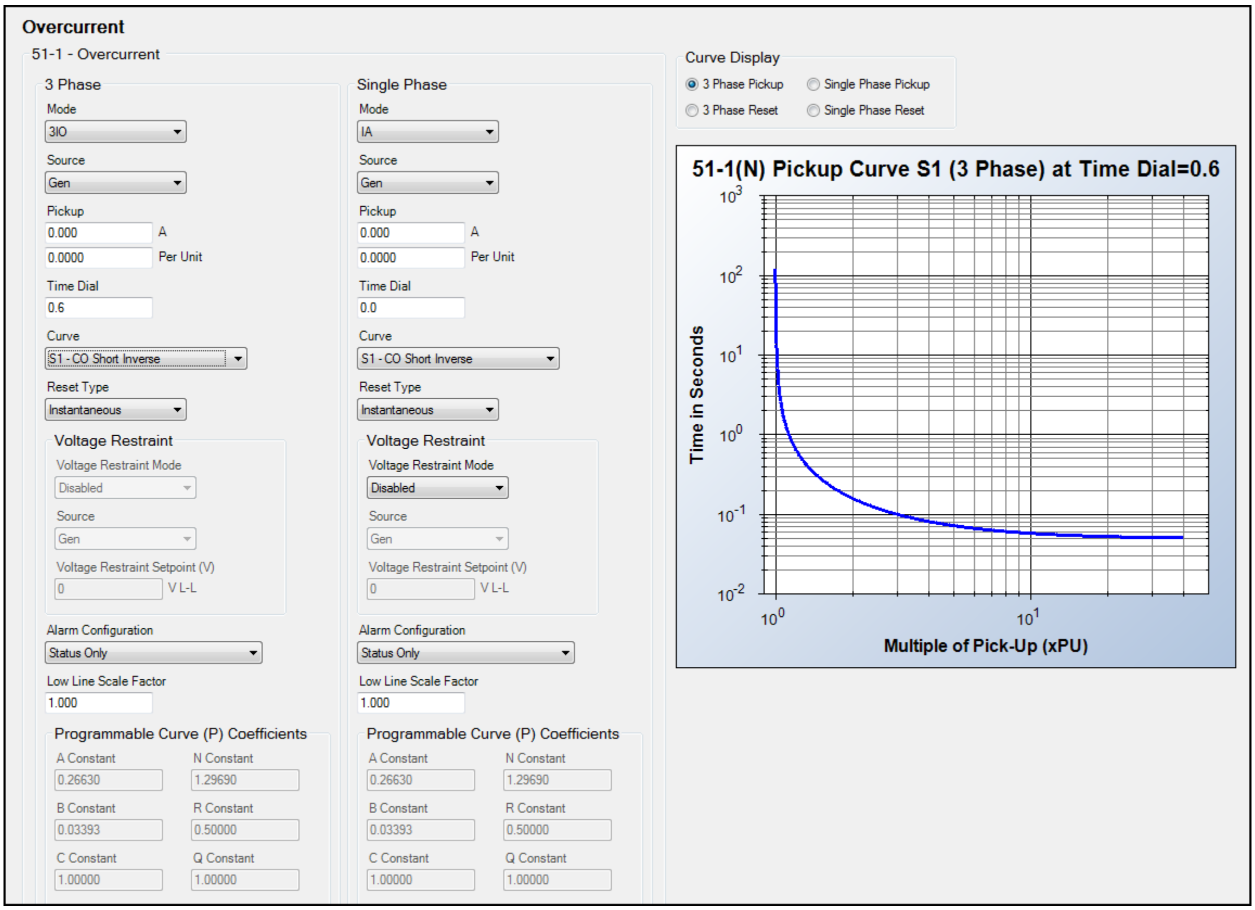


Figure 173. Settings Explorer, Protection, Current, Overcurrent

Phase Current Differential (87G)

The phase-current differential (87G) element monitors the differential current of the protected zone and provides primary protection for generators. This element is available only in style xxDxxxxEx.

Element logic connections are made on the BESTlogic™*Plus* screen in BESTCOMS*Plus*® and element operational settings are configured on the Phase Current Differential (87G) settings screen in BESTCOMS*Plus*.

BESTCOMS*Plus* Navigation Path: Settings Explorer, Protection, Current, Phase Differential (87G)

HMI Navigation Path: Settings Explorer > Protection, Settings Group x (where x = 0 to 3) > Current Protection > Differential 87G

Element Operation

The phase-current differential element compares the currents entering and leaving the zone of protection. In some applications, the zone of protection may include only the generator. In other applications, a power transformer may be included in the generator zone of protection. If a fault is detected, the DGC-2020HD initiates a trip signal to isolate the protected zone. This action limits equipment damage and minimizes impact on the power system.

Functional Description

Figure 179 shows a detailed functional diagram of one phase of the phase-current differential protection function. These functions and comparators are duplicated for each phase.

The measured currents are phase, zero-sequence, and tap compensated. The restraint current function uses the compensated current to calculate the restraint current magnitude (in multiples of tap). Depending on the setting, it calculates the maximum or average restraint current. The Operating Current function determines the magnitude of the fundamental, second, and fifth harmonic differential current as the phasor sum of those components of the compensated currents.

Figure 180 shows the characteristic of the phase current differential protection element. This comparator has two slope settings and a minimum pickup setting. The slope settings are the ratios of delta operating current to delta restraint current. The slope settings should be set above the maximum mismatch caused by excitation losses, tap mismatch, and load tap changers. The minimum pickup setting determines the minimum sensitivity of the restrained element.

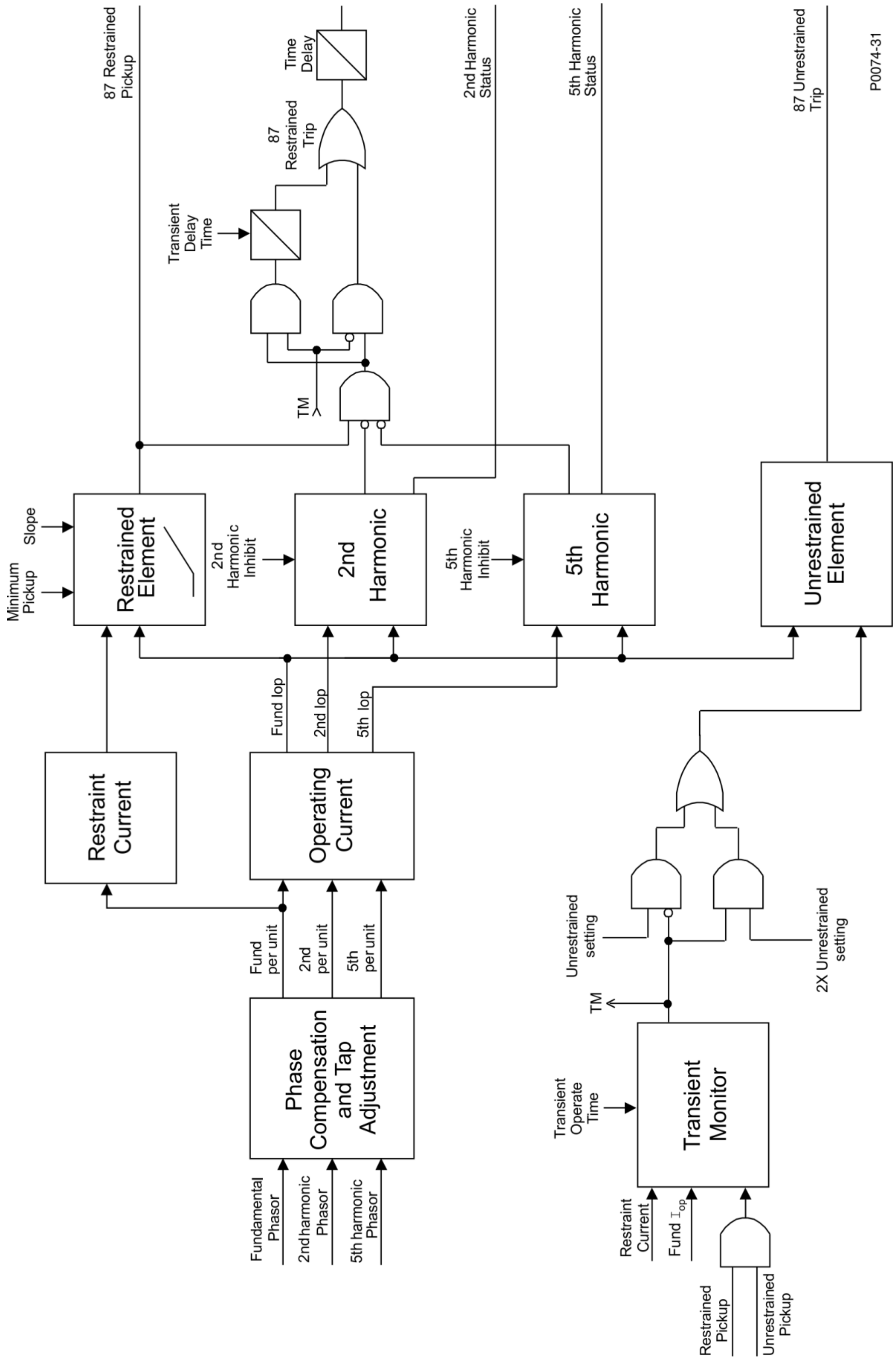


Figure 174. 87G Phase Differential Protection Functional Block Diagram

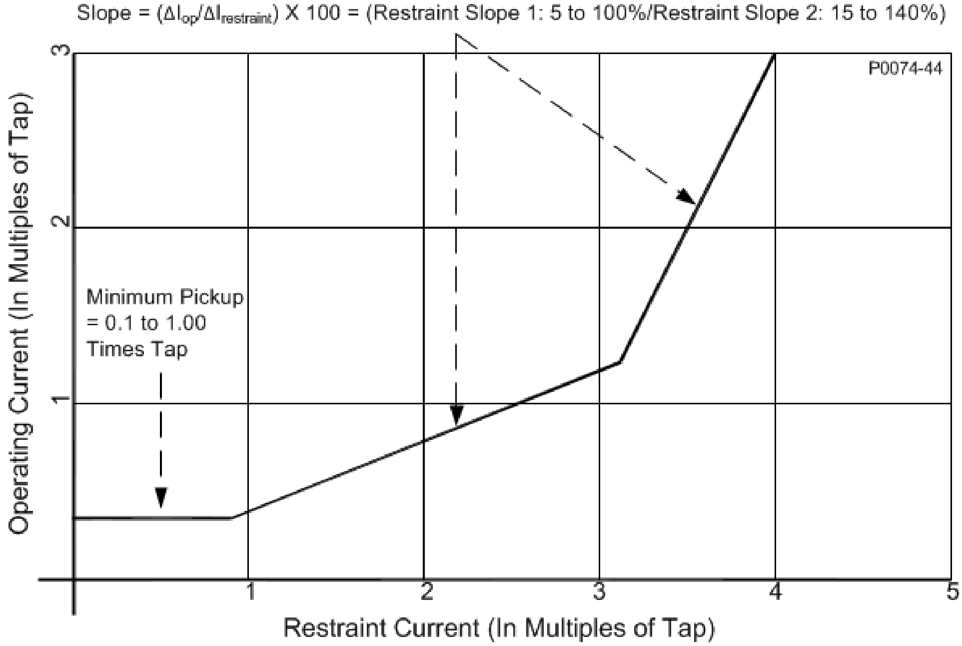


Figure 175. Percentage Restrained Differential Characteristic

Trip

The Trip output becomes true when a restrained pickup condition persists for the duration of the element Time Delay setting. In BESTlogic*Plus*, the Trip output can be connected to other logic elements and to a physical relay output to annunciate the condition and to initiate corrective action.

Transient Monitor

A transient monitor detects the effects of CT saturation during a through fault. The 87G element monitors the change in restraint current versus the change in operate current. For an internal fault, the restraint current and operate current will experience a step increase at the same time. For an external fault, there should be no operate current. If CT saturation occurs during a through fault, the operate current will increase at some time after the restraint current increases.

The restrained or unrestrained differential must be picked up for the transient monitor to detect a transient. The Transient Operate Time setting defines how long the transient remains detected after the restrained or unrestrained differential drops out. The Transient Delay setting affects only the restrained Trip output.

Harmonics

The second and fifth harmonic functions check the ratio of the second and fifth harmonic operate currents to the fundamental operate current. Traditional harmonic restraint protection operates on the ratio of harmonic current to total operate current. This contrasts with the DGC-2020HD method of operating on the ratio of total harmonic current to only the fundamental operate current. For this reason, the DGC-2020HD provides greater security for inrush and overexcitation with the same harmonic inhibit ratio settings used with traditional differential relays. When either of these two comparators is above the threshold, the percentage-restrained output is blocked from setting the Restrained Trip logic output. If the second or fifth harmonic inhibit comparators are picked up for any of the three phases, the Second Harmonic Inhibit and Fifth Harmonic Inhibit logic outputs respectively are also set.

In many cases, the second harmonic content of the inrush current may show up primarily in only one or two phases, which can cause one or two phases to not be inhibited. The DGC-2020HD allows the second harmonic currents to be shared between the three phases. When second harmonic sharing is enabled, the magnitude of the second harmonic operating current is summed from all three phases and this magnitude is used by the second harmonic comparator for each phase instead of the second harmonic operate current for only that phase. This is superior to other methods of cross blocking since each phase element operates independently in its comparison of operating current to harmonic current. Thus, security is enhanced without sacrificing dependability because a faulted phase will not be restrained by inrush on unfaulted phases as is the case with cross blocking schemes.

Unrestrained Tripping

The 87G element provides high-speed tripping for high-grade faults inside the zone of protection. If the operate current is above the Unrestrained Tripping threshold for any of the three phases, the Unrestrained Trip logic output becomes true. The transient monitor function also enhances security for this function by doubling the pickup threshold when CT saturation is detected. The minimum setting for the Unrestrained Tripping threshold should be the maximum inrush current with a small margin.

Alarm Configuration

A phase current differential trip can be user-selected to trigger a different action depending on the alarm configuration setting. Alarm configurations are described in the *Alarm Configuration* chapter.

Logic Connections

Phase-current, differential-element logic connections are made on the BESTlogic*Plus* screen in BESTCOMS*Plus*. The phase-current, differential-element logic block is illustrated in Figure 176. Logic inputs and outputs are summarized in Table 82.

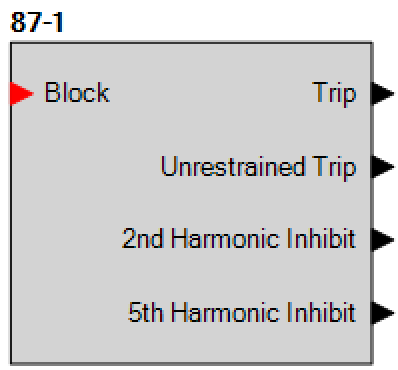


Figure 176. Phase Current Differential Element Logic Block

Table 82. Logic Inputs and Outputs

Name	Function	Purpose
Block	Input	Disables the 87G function when true
Trip	Output	True when the 87G element is in a trip condition
Pickup	Output	True when the 87G element is in a pickup condition
Unrestrained Trip	Output	True when the 87G element is in an unrestrained trip condition
2nd Harmonic Inhibit	Output	True when the 87G is inhibited by 2nd harmonic ratio
5th Harmonic Inhibit	Output	True when the 87G is inhibited by 5th harmonic ratio

Tap Compensation Settings

The measured currents must be tap adjusted to eliminate magnitude mismatch prior to being used by the Phase Current Differential Protection (87G) element. The tap adjust factors can be manually calculated per Equation 18. Or, the user can enter the MVA and kV base parameters (Equation 19) and the DGC-2020HD will calculate the tap-adjust factors using the CT Ratio (CTR) and Compensation Factor (COMP) parameters from the current measurement input function settings. For a transformer application, the mismatch will be at a minimum if the actual transformer voltage ratings are used.

$$TAPn = \frac{MVA \times 1000 \times COMPn}{\sqrt{3} \times kVn \times CTRn}$$

Equation 18. Calculate Tap Adjust Factors

Table 83. MVA and kVn Base Parameters

Parameter	Description	Explanation
TAPn	Restraint winding	The DGC-2020HD has two restraint windings (two taps).
MVA	MVA base	Full load MVA or top rating of the protected equipment.
kVn	kV base for CT input n	L-L Voltage in kV for each CT input circuit.
CTRn	CT ratio for CT input n	Actual ratio not effective ratio.
COMPn	Phase compensation adjustment factor for CT input n	√3 if CTs are connected in Delta (CTcon = DAB or DAC). 1 in all other cases.

The input currents can be tap adjusted up to a spread ratio of 10:1. If the ratio between TAP1 and TAP2 is greater than 10, it will be necessary to adjust the CT ratios to bring the tap factors closer together. When the auto-tap calculation feature is used, the DGC-2020HD will give an error message if the spread ratio is greater than 10.

If one of the calculated taps is outside the acceptable range (2 to 20 for 5 ampere units or 0.4 to 4 for 1 ampere units), the auto-tap calculation feature will select the nearest acceptable tap and calculate the other tap (two at a time) so that the correct spread ratio is maintained. If the user is manually calculating the taps, the same adjustment should be made.

BESTCOMS*Plus* is used to provide the auto tap calculation by filling in the appropriate fields on the Differential Transformers Setup screen and pressing the Calculate Taps button. Alternatively, tap values can be entered manually.

Operational Settings

The settings for restrained minimum pickup and unrestrained trip are set in multiples of tap. If the ideal taps calculated by Equation 18 fall within the acceptable range, the sensitivity settings will be in Per Unit on the MVA Base used in the equation. For example, a 100 MVA, 115 kV transformer has a full load (1 per unit) current of 500 amperes. A pickup setting of 10 times tap for the unrestrained output pickup (URO) element is equivalent to 5,000 primary amperes of differential current.

If the taps need to be adjusted upwards or downwards to fit within the acceptable range, the sensitivity settings for these protective elements should be adjusted as well. Equation 19 gives the adjustment factor. The definitions for the variables in Equation 19 are the same as those for Equation 18. For example, the ideal taps ($TAPn_I$) were calculated using Equation 19 and Equation 20 and found to be 1.6 and 5.0. They needed to be adjusted upwards so that the actual taps ($TAPn_A$) are 2.0 and 6.25. Per Equation 19, X = 0.8. It is desired that the minimum pickup of the restrained element be 0.35 per unit on the circuit base. The actual setting should be 0.35 ∗ 0.8 = 0.28 to achieve the same sensitivity.

The pickup settings in Times Tap can be related to primary amperes by Equation 20. Mpu is the minimum pickup setting in Times Tap. The definitions for the remaining variables in Equation 20 are the same as those for Equation 18.

$$X = \frac{TAPn_I}{TAPn_A} = \frac{MVA \times 1000 \times COMPn}{TAPn_A \times \sqrt{3} \times KVn \times CTRn}$$

Equation 19. Tap Adjustment Equation

$$Ipri = \frac{Mpu \times TAPn \times CTRn}{COMPn}$$

Equation 20. Calculate Primary Amps

% of Maximum - The maximum of the compensated input currents is used. For example, the restraint current for phase A would be I_{RA} = max ($I_{AXCOMPS}$) where x = 2 for two current inputs.

% of Average - The average of the compensated input currents is used. For example, the restraint current for phase A would be given by Equation 21.

$$I_{RA} = \frac{Sum\ of\ I_{AxCOMPS}}{Number\ of\ Inputs}$$

Equation 21. Calculate Restraint Current for Phase A, % of Average

Phase current differential element operational settings are configured on the Phase Current Differential (87G) settings screen (Figure 177) in BESTCOMS*Plus*. A legend for the chart (Figure 178) is shown by clicking the Help button on this screen. Setting ranges are defined in the *Specifications* chapter in the *Installation* manual.

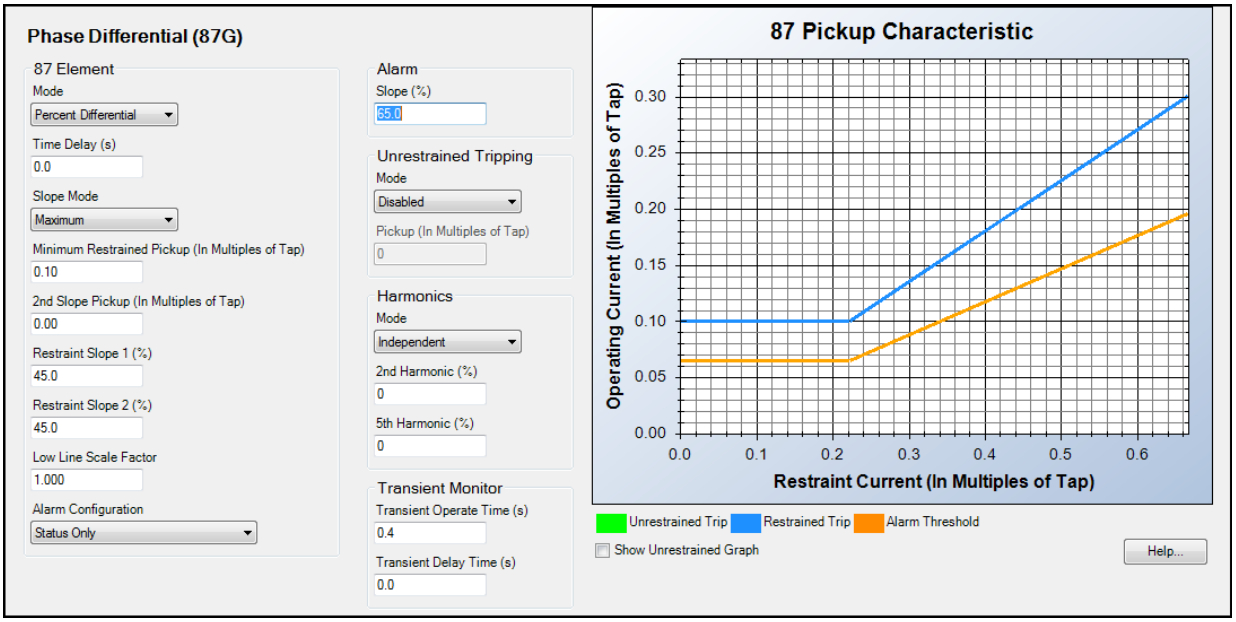


Figure 177. Settings Explorer, Protection, Current

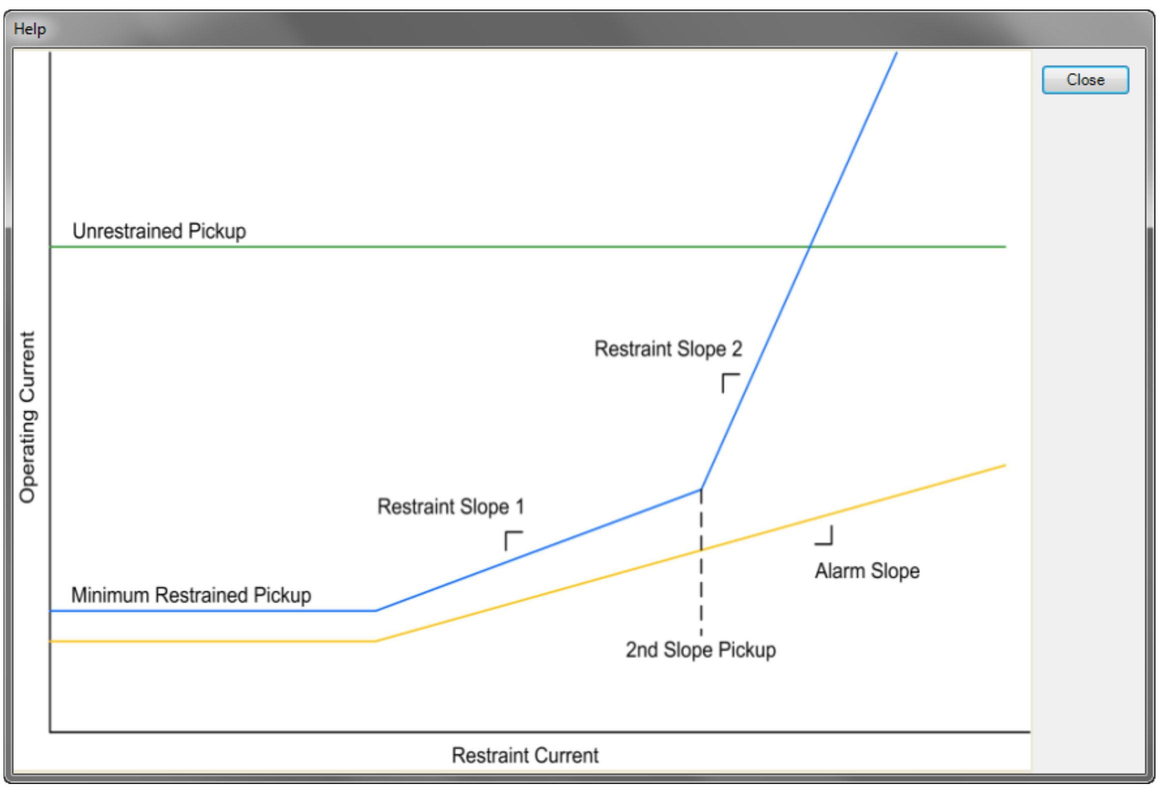


Figure 178. Phase Current Differential Operation Chart

Neutral Current Differential (87N)

The neutral current differential (87N) element provides sensitive differential protection from phase-to-ground faults in the wye-connected winding. On impedance grounded systems, ground fault levels may be reduced below the sensitivity of the phase differential protection. The result is that ground faults within the protected zone have to be cleared by time delayed backup overcurrent protection if sensitive differential protection is not available. This element is available only in style xxDxxxxEx.

Element logic connections are made on the BESTlogic™*Plus* screen in BESTCOMS*Plus*® and element operational settings are configured on the Neutral Current Differential (87N) settings screen in BESTCOMS*Plus*.

BESTCOMS*Plus* Navigation Path: Settings Explorer, Protection, Current, Neutral Differential (87N)

HMI Navigation Path: Settings Explorer > Protection, Settings Group x (where x = 0 to 3) > Current Protection > Neutral Differential 87N

Element Operation

The 87N element detects an imbalance between the neutral current (3I0) and ground current (IG).

CT Flip

For a legacy CT with an auxiliary CT installed, the CT Flip setting will correct the polarity of the 3I0. Setting the CT Flip to true will introduce a 180° phase shift internally in the 3I0 calculation.

Source

The Source setting configures the neutral current differential element to monitor the ground CT and Gen, Bus 1, or Bus 2 CTs.

For Protection, set one Aux CT up for ground current. For Bus 1 or Bus 2 protection, set one Aux CT for Bus x Phase A, one for Bus x Phase B, one for Bus x Phase C, and the last one for ground current.

To set up Aux CTs see the *Configuration* chapter. For Aux CT terminals, refer to the *Terminals and Connectors* chapter in the *Installation* manual.

Overcorrection Coefficient

The 87N element is directionally supervised by making a comparison of two vectors, the calculated IOP vector and the current present on the IG input terminals. First, the magnitude of the vector (IopMag) is checked by the equation IopMag = 3I0 + IG to determine if it is above the user defined pickup setting. Second, the IG quantity, as seen at the terminals, is used as the polarizing quantity to determine directionality (IopDir) by the equation IopDir = IG + (OVCR * 3I0). The overcorrection coefficient (OVCR) is used to add security to the directional element in the previous equation. For the IopDir check, OVCR is used to offset the 3I0 measurement by the quantity determined in the Overcorrection Coefficient setting, which at low levels of 3I0 and IG, will provide greater confidence that the directional criterion is met. The decision to trip will be made only when IopMag is above the user defined pickup setting and IopDir is within ±90° of the current present on the IG terminals.

Transient Delay

A user-defined transient delay time provides security from misoperation on false residual caused by CT saturation during a through fault. If the transient monitor function from the phase current differential (87) function detects CT saturation, the 87N Trip logic output is routed through a timer. The timer should be set longer than the normal clearing time for a fault just outside the zone of protection to allow it to ride-through until the external fault is cleared.

Pickup Calculations

The differential value is calculated as shown in Equation 22 and Equation 23 and displayed in BESTCOMS*Plus* metering and on the front-panel display.

$$\text{If CT Flip Setting} = \text{Yes, then Iop} = \text{IG}_{\text{sec}} - \left(\frac{\text{Phase CT Ratio}}{\text{Ground CT Ratio}} \times 3\text{I0}_{\text{sec}}\right)$$

Equation 22. Iop Calculation when CT Flip Setting = Yes

$$\text{If CT Flip Setting} = \text{No, then Iop} = \text{IG}_{\text{sec}} + \left(\frac{\text{Phase CT Ratio}}{\text{Ground CT Ratio}} \times 3\text{I0}_{\text{sec}}\right)$$

Equation 23. Iop Calculation when CT Flip Setting = No

Pickup and Trip

When the calculated Iop increases above the threshold established by the Iop Minimum setting, a timer begins timing towards a trip.

Timer duration is established by the Time Delay. A Time Delay of zero (0) makes the 87N element instantaneous with no intentional time delay.

If a neutral current differential pickup condition persists for the duration of the element Time Delay setting, the element Trip output becomes true. In BESTlogic*Plus*, 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 time delay expires, the timer is reset, no corrective action is taken, and the element is rearmed for any other occurrences of neutral current differential.

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. The value of the scale factor setting serves as a multiplier for the pickup settings. For example, if the DGC-2020HD is determined to be in a low-line configuration and the scale factor setting is 2.000, the pickup setting will be doubled (2.000 x PU).

The low-line configuration can be determined through the Auto Configuration Detection feature or the state of a contact input if the Low-Line Override function is assigned to a contact input via the Programmable Functions screen. If either method indicates a low-line configuration is in effect, then the DGC-2020HD is configured for low-line operation.

Alarm Configuration

A neutral current differential trip can be user-selected to trigger a different action depending on the alarm configuration setting. Alarm configurations are described in the *Alarm Configuration* chapter.

Logic Connections

Neutral current differential element logic connections are made on the BESTlogic*Plus* screen in BESTCOMS*Plus*. The neutral current differential element logic block is illustrated in Figure 179. When the Block input is true, the 87N element is disabled. The Trip output is true when the 87N element is in a trip condition.

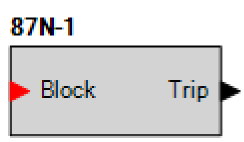


Figure 179. Neutral Current Differential Element Logic Block

Operational Settings

Neutral current differential element operational settings are configured on the neutral current differential settings screen (Figure 180) in BESTCOMS*Plus*. Setting ranges are defined in the *Specifications* chapter in the *Installation* manual.

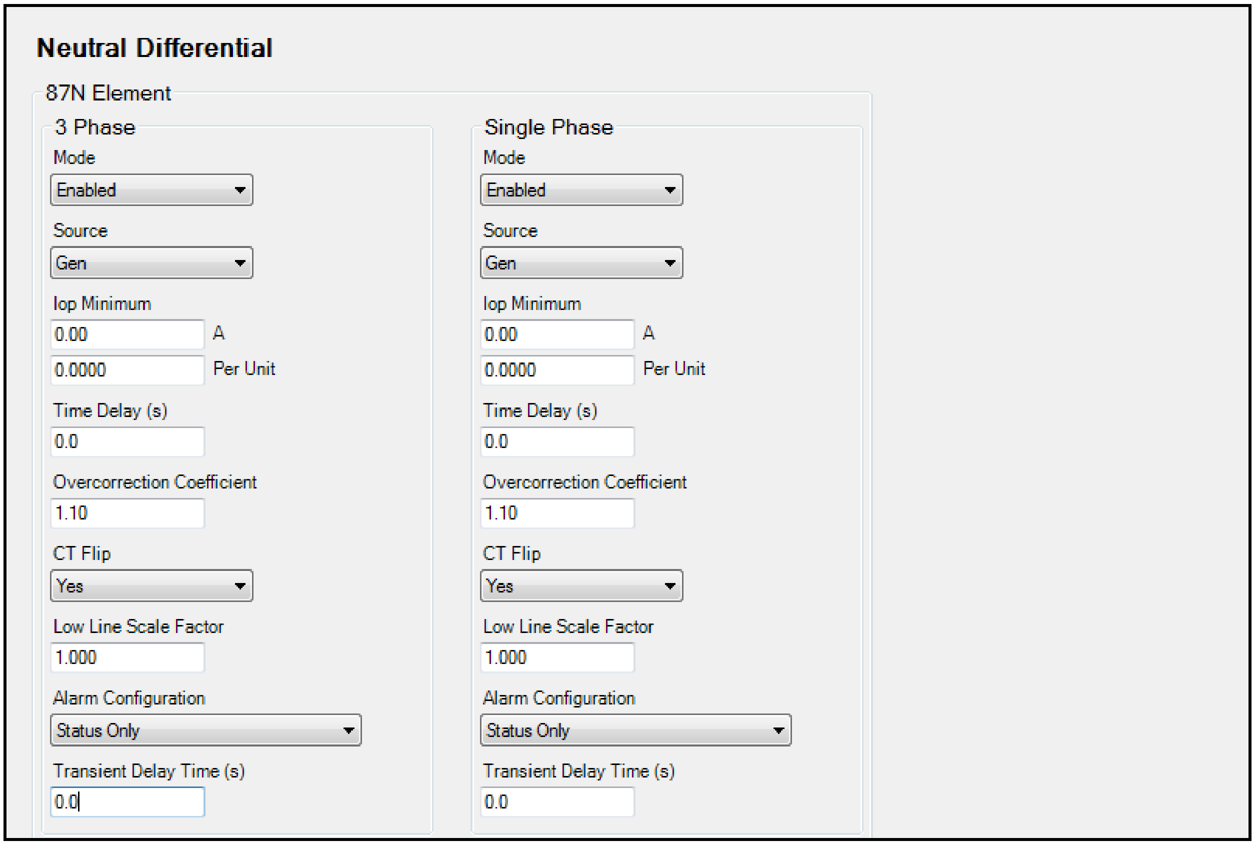


Figure 180. Settings Explorer, Protection, Current

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 BESTCOMS*Plus* and element operational settings are configured on the Power settings screen in BESTCOMS*Plus*.

BESTCOMS*Plus* Navigation Path: Settings Explorer, 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 181. Based on IEEE polarity convention, forward power is defined as bus to line and reverse power is defined as line to bus.

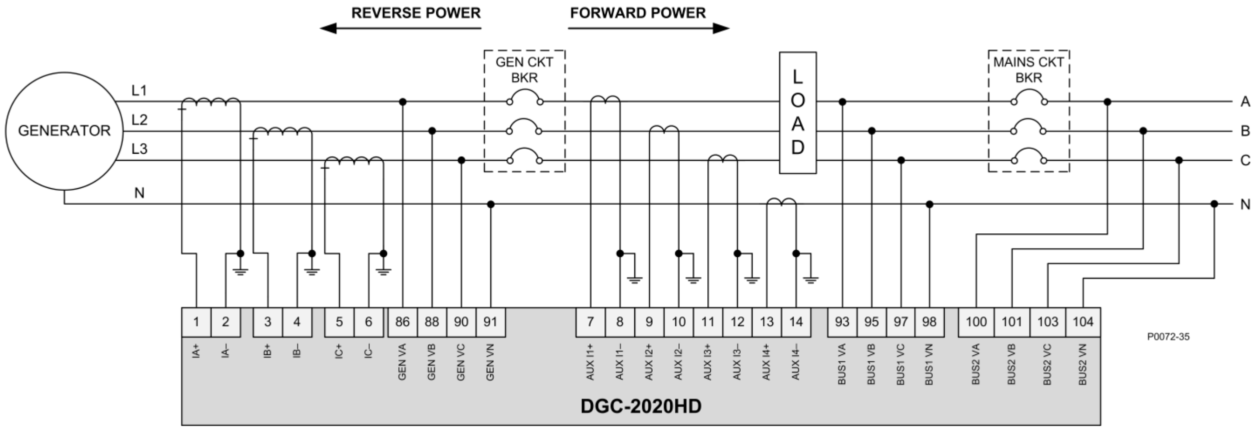


Figure 181. Direction of Power Flow Defined by the Polarity of Voltage and Current Connections

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 BESTlogic*Plus*, 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 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. The value of the scale factor setting serves as a multiplier for the pickup settings. For example, if the DGC-2020HD is determined to be in a low-line configuration and the scale factor setting is 2.000, the pickup setting will be doubled (2.000 x PU).

The low-line configuration can be determined through the Auto Configuration Detection feature or the state of a contact input if the Low-Line Override function is assigned to a contact input via the Programmable Functions screen. If either method indicates a low-line configuration is in effect, then the DGC-2020HD is configured for low-line operation.

Alarm Configuration

An over/under power trip can be user-selected to trigger a different action depending on the alarm configuration setting. Alarm configurations are described in the *Alarm Configuration* chapter.

Logic Connections

Power element logic connections are made on the BESTlogic*Plus* screen in BESTCOMS*Plus*. The power element logic block is illustrated in Figure 182. 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.

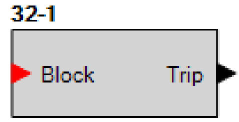


Figure 182. Power Element Logic Block

Operational Settings

Power element operational settings are configured on the Power settings screen (Figure 183) in BESTCOMS*Plus*. Setting ranges are defined in the *Specifications* chapter in the *Installation* manual.

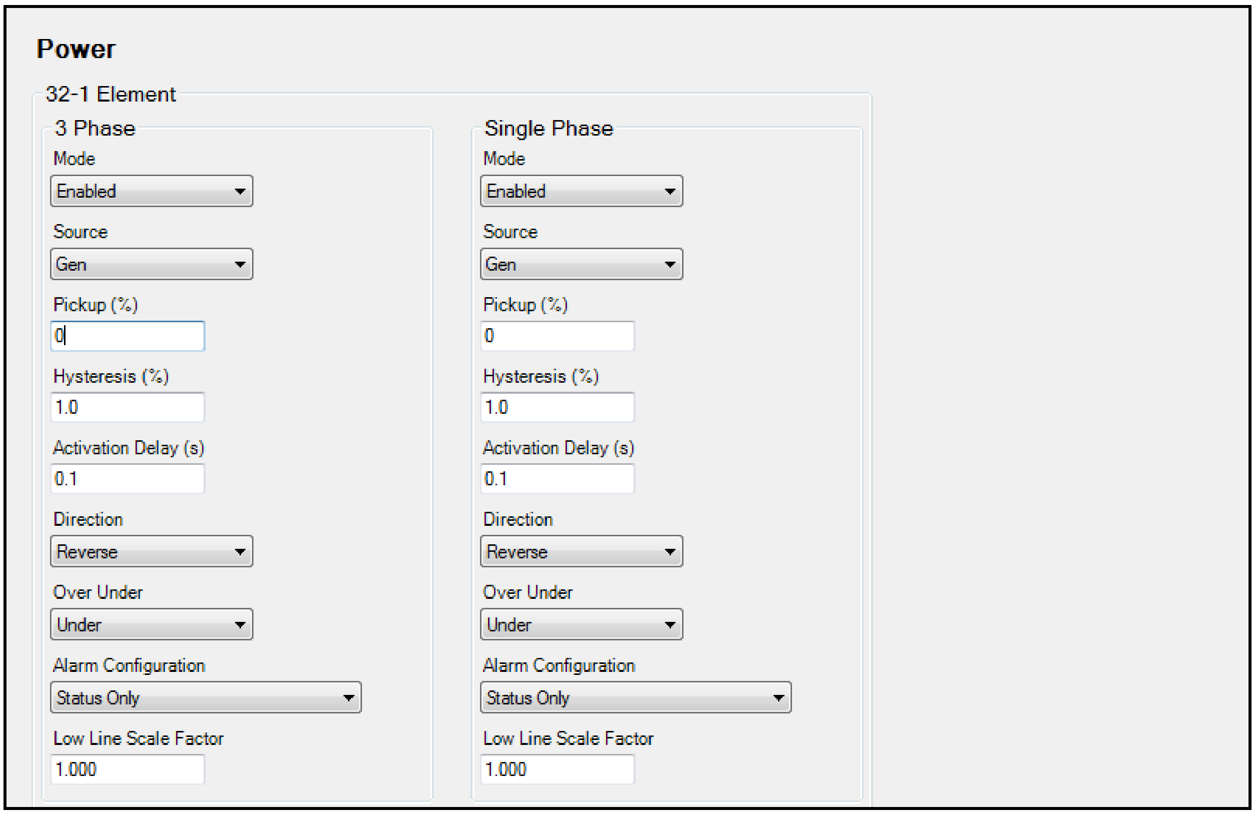


Figure 183. Settings Explorer, Protection, Power

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 BESTlogic*Plus* screen in BESTCOMS*Plus* and element operational settings are configured on the Loss of Excitation screen in BESTCOMS*Plus*.

BESTCOMS*Plus* Navigation Path: Settings Explorer, 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 184.

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 BESTlogic*Plus*, 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.

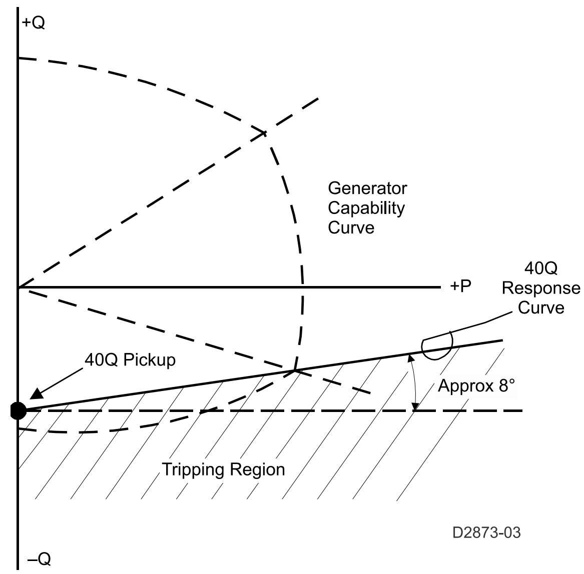


Figure 184. Generator Capability Curve vs. 40Q Response

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 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. The value of the scale factor setting serves as a multiplier for the pickup settings. For example, if the DGC-2020HD is determined to be in a low-line configuration and the scale factor setting is 2.000, the pickup setting will be doubled (2.000 x PU).

The low-line configuration can be determined through the Auto Configuration Detection feature or the state of a contact input if the Low-Line Override function is assigned to a contact input via the Programmable Functions screen. If either method indicates a low-line configuration is in effect, then the DGC-2020HD is configured for low-line operation.

Alarm Configuration

A loss of excitation trip can be user-selected to trigger a different action depending on the alarm configuration setting. Alarm configurations are described in the *Alarm Configuration* chapter.

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 185. 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.

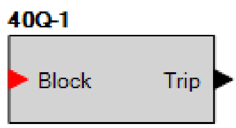


Figure 185. Loss of Excitation Element Logic Block

Operational Settings

Loss of Excitation element operational settings are configured on the Loss of Excitation settings screen (Figure 186) in BESTCOMS*Plus*. Setting ranges are defined in the *Specifications* chapter in the *Installation* manual.

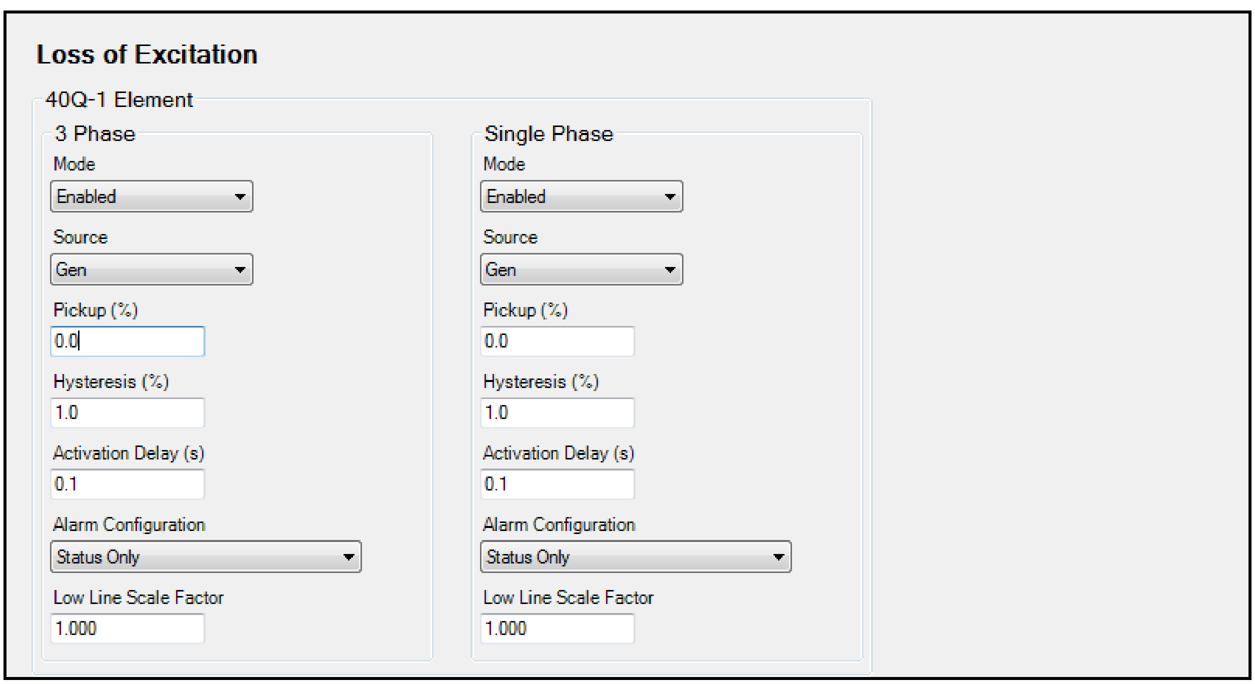


Figure 186. Settings Explorer, Protection, Power, Loss of Excitation

Field Overvoltage

One field overvoltage protection element is available when a VRM-2020 is enabled.

A field overvoltage condition occurs when the field voltage exceeds the pickup level for the duration of the Time Delay. Field overvoltage protection can be enabled and disabled without altering the Pickup and Time Delay settings. Field overvoltage pickup and trip elements in BESTlogic™*Plus* can be used in a logic scheme to initiate corrective action in response to the condition. Protection is inhibited when the regulator is not started.

BESTCOMS*Plus* Navigation Path: Settings Explorer, Protection, Field Protection, Field Overvoltage

Front Panel Navigation Path: Settings Explorer > Protection > Field Protection > Field Overvoltage

Element Operation

Field Overvoltage protection can be used to prevent equipment damage when a field overvoltage condition exists.

Pickup and Trip

When the field voltage 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 Time Delay setting. A setting of zero (0) makes the field overvoltage element instantaneous with no intentional time delay.

If a field overvoltage pickup condition persists for the duration of the element Time Delay setting, the element Trip output becomes true. In BESTlogic*Plus*, 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 field overvoltage.

Alarm Configuration

A field overvoltage trip can be user-selected to trigger a different action depending on the alarm configuration setting. Alarm configurations are described in the *Alarm Configuration* chapter.

Logic Connections

Field overvoltage logic connections are made on the BESTlogic*Plus* screen in BESTCOMS*Plus*. The field overvoltage element logic block is illustrated in Figure 187. When the Block input is true, the field overvoltage element is disabled. The Trip output is true when the field overvoltage element is in a trip condition.

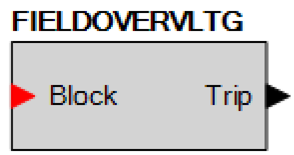


Figure 187. Field Overvoltage Logic Block

Operational Settings

Field overvoltage element operational settings are configured on the Field Overvoltage settings screen (Figure 188) in BESTCOMS*Plus*. Setting ranges are defined in the *Specifications* chapter in the *Installation* manual.

Figure 188. Settings Explorer, Protection, Field Protection, Field Overvoltage

Loss of Sensing

One loss of sensing (LOS) protection element is available when a VRM-2020 is enabled.

BESTCOMS*Plus* Navigation Path: Settings Explorer, Protection, Field Protection, Loss of Sensing
Front Panel Navigation Path: Settings Explorer > Protection > Field Protection > Loss of Sensing

Element Operation

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

Two sets of LOS settings are provided: one for three-phase generator connections and one for single-phase generator connections. Loss of sensing pickup is configured by voltage balance, voltage unbalance (three-phase only), and fault current levels. When a single-phase override contact input is received, the DGC-2020HD automatically switches from the three-phase LOS settings to the single-phase LOS settings. Protection is inhibited when the regulator is not started.

Pickup and Trip

The generator voltage is monitored for an LOS condition. For three-phase configurations, an LOS event is calculated using sequence components. An LOS event occurs when the positive-sequence voltage drops below the Voltage Balanced Level setting of the AVR setpoint, or when the negative-sequence voltage increases above the Voltage Unbalanced Level setting of the positive-sequence voltage. For single-phase configurations, an LOS event occurs when either measured L-N voltage (A-N or B-N for single-phase A-B, or C-N for single-phase CA) drops below the Voltage Level Setting of the AVR setpoint.

A time delay is started when the event occurs, delaying the alarm by a predetermined time. 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 field overvoltage.

LOS protection is automatically disabled when a short circuit exists. A short circuit is detected when the measured current is greater than the configured fault current setting for a single-phase CT connection and when the positive-sequence current is greater than the configured fault current setting for a three-phase CT connection.

Transfer to Manual

An LOS condition can be used to initiate transfer to manual (FCR) control mode. It also can be configured in BESTlogic™*Plus* to initiate other actions. Protection can be enabled and disabled without altering the individual LOS settings.

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. The value of the scale factor setting serves as a multiplier for the pickup settings. For example, if the DGC-2020HD is determined to be in a low-line configuration and the scale factor setting is 2.000, the pickup setting will be doubled (2.000 x PU).

The low-line configuration can be determined through the Auto Configuration Detection feature or the state of a contact input if the Low-Line Override function is assigned to a contact input via the Programmable Functions screen. If either method indicates a low-line configuration is in effect, then the DGC-2020HD is configured for low-line operation.

Alarm Configuration

An LOS trip can be user selected to trigger a different action depending on the alarm configuration setting. Alarm configurations are described in the *Alarm Configuration* chapter.

Logic Connections

LOS logic connections are made on the BESTlogic*Plus* screen in BESTCOMS*Plus*. The LOS element logic block is illustrated in Figure 189. When the Block input is true, the LOS element is disabled. The Trip output is true when the LOS element is in a trip condition.

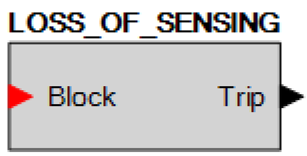


Figure 189. Loss of Sensing Logic Block

Operational Settings

LOS element operational settings are configured on the Loss of Sensing settings screen (Figure 190) in BESTCOMS*Plus*. Setting ranges are defined in the *Specifications* chapter in the *Installation* manual.

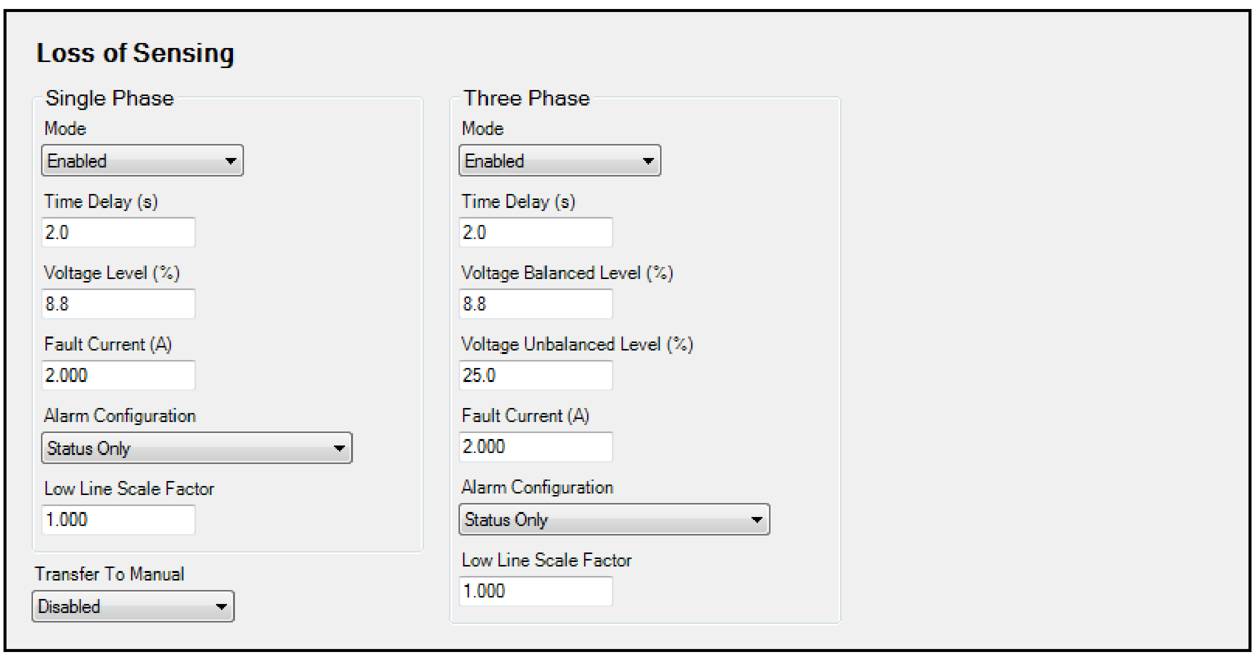


Figure 190. Settings Explorer, Protection, Field Protection, Loss of Sensing

Exciter Diode Monitor

The exciter diode monitor (EDM) monitors the condition of a brushless exciter's power semiconductors by monitoring the exciter field current. The EDM detects both open and shorted rotating diodes in the exciter bridge. Exciter diode monitoring is available when a VRM-2020, with optional exciter diode monitoring, is enabled.

BESTCOMS*Plus* Navigation Path: Settings Explorer, Protection, Field Protection, Exciter Diode Monitor
Front Panel Navigation Path: Settings Explorer > Protection > Field Protection > EDM

Element Operation

Exciter diode monitor protection can be used to prevent equipment damage when an exciter diode fault occurs. Protection is inhibited when the regulator is not started.

Pickup and Trip

When the RMS ripple of the exciter field current 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 Time Delay setting. A setting of zero (0) makes the exciter diode monitor element instantaneous with no intentional time delay.

If an exciter diode monitor pickup condition persists for the duration of the element Time Delay setting, the element Trip output becomes true. In BESTlogic*Plus*, 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 exciter diode faults.

Alarm Configuration

An exciter diode monitor trip can be user selected to trigger a different action depending on the alarm configuration setting. Alarm configurations are described in the *Alarm Configuration* chapter.

Logic Connections

Exciter diode monitor logic connections are made on the BESTlogic*Plus* screen in BESTCOMS*Plus*. The exciter diode monitor element logic block is illustrated in Figure 191. When the Block input is true, the exciter diode monitor element is disabled. The Trip output is true when the exciter diode monitor element is in a trip condition.

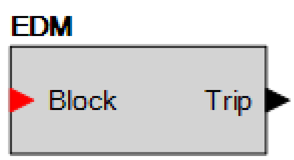


Figure 191. Exciter Diode Monitor Logic Block

Operational Settings

Exciter Diode Monitor element operational settings are configured on the Exciter Diode Monitor settings screen (Figure 190) in BESTCOMS*Plus*. Setting ranges are defined in the *Specifications* chapter in the *Installation* manual.

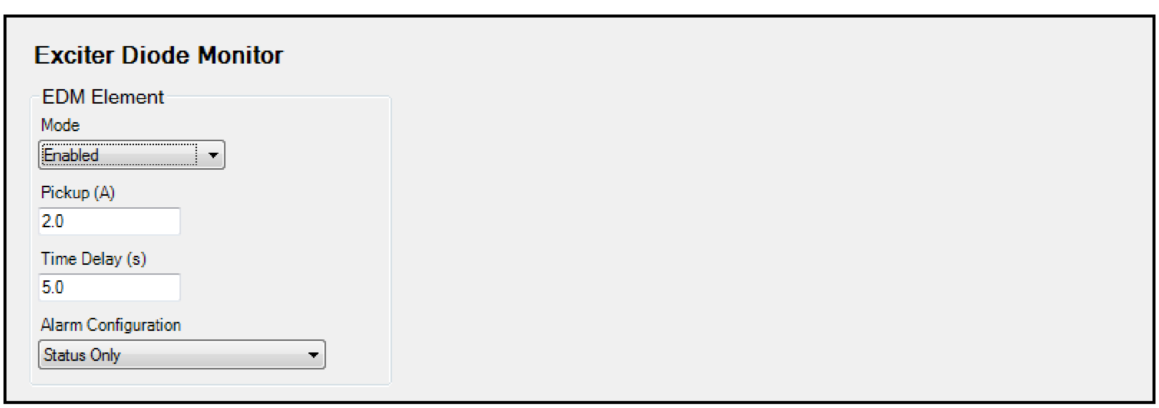


Figure 192. Settings Explorer, Protection, Field Protection, Exciter Diode Monitor

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 BESTlogic*Plus* screen in BESTCOMS*Plus*. The setting group logic block is illustrated in Figure 193.

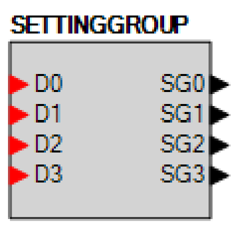


Figure 193. Setting Group Logic Block

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 24

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

Equation 25

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 84 lists time characteristic curve constants. See the figures after the tables for graphs of the characteristics.

Table 84. 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 BESTCOMS*Plus*®.

‡ 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 85 cross-references each curve to existing electromechanical relay characteristics. Equivalent time dial settings were calculated at a value of five times pickup.

Table 85. 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 86 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 *Protection* chapter.

Using Table 86

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 nonlinearity 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 86. 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 210) 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 26.

$$t = \frac{K}{(I_2)^2}$$

Equation 26

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 27).

$$Z = 46\ Time\ Dial\ \left(\frac{I_{Nom\ Setting}}{46\ Pickup\ Setting}\right)^2$$

Equation 27

The time to trip equation used in the relay is:

$$T_T = \frac{Z}{M^2} + 0.028\ seconds$$

Equation 28

where:

$$M = \frac{Measured\ I_2}{46\ Pickup\ Setting}$$

Equation 29

which, when M > 1, reduces to:

$$T_T = 46\ Time\ Dial\left(\frac{I_{Nom\ Setting}}{I_2 Measured}\right)^2$$

Equation 30

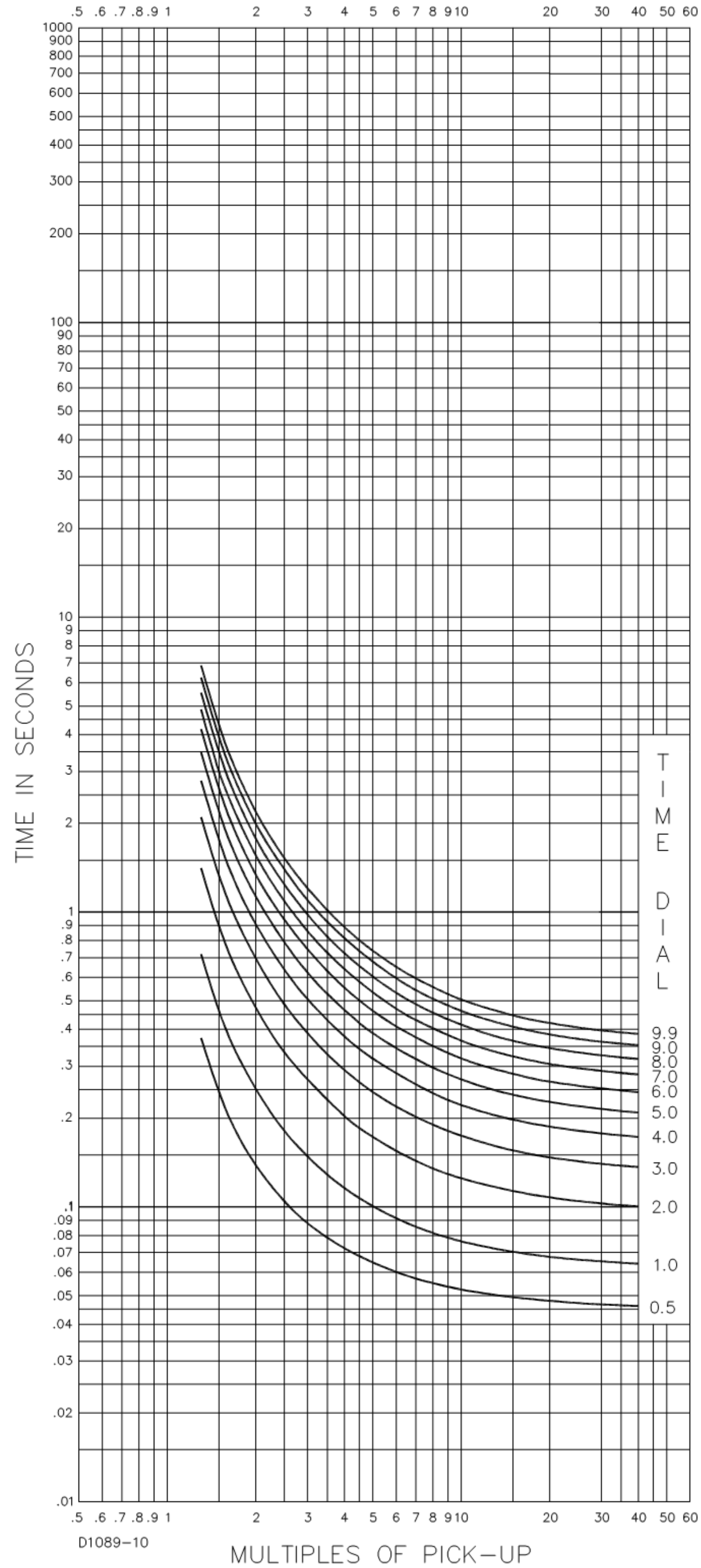


Figure 194. Time Characteristic Curve S1, Short Inverse (Similar to ABB CO-2)

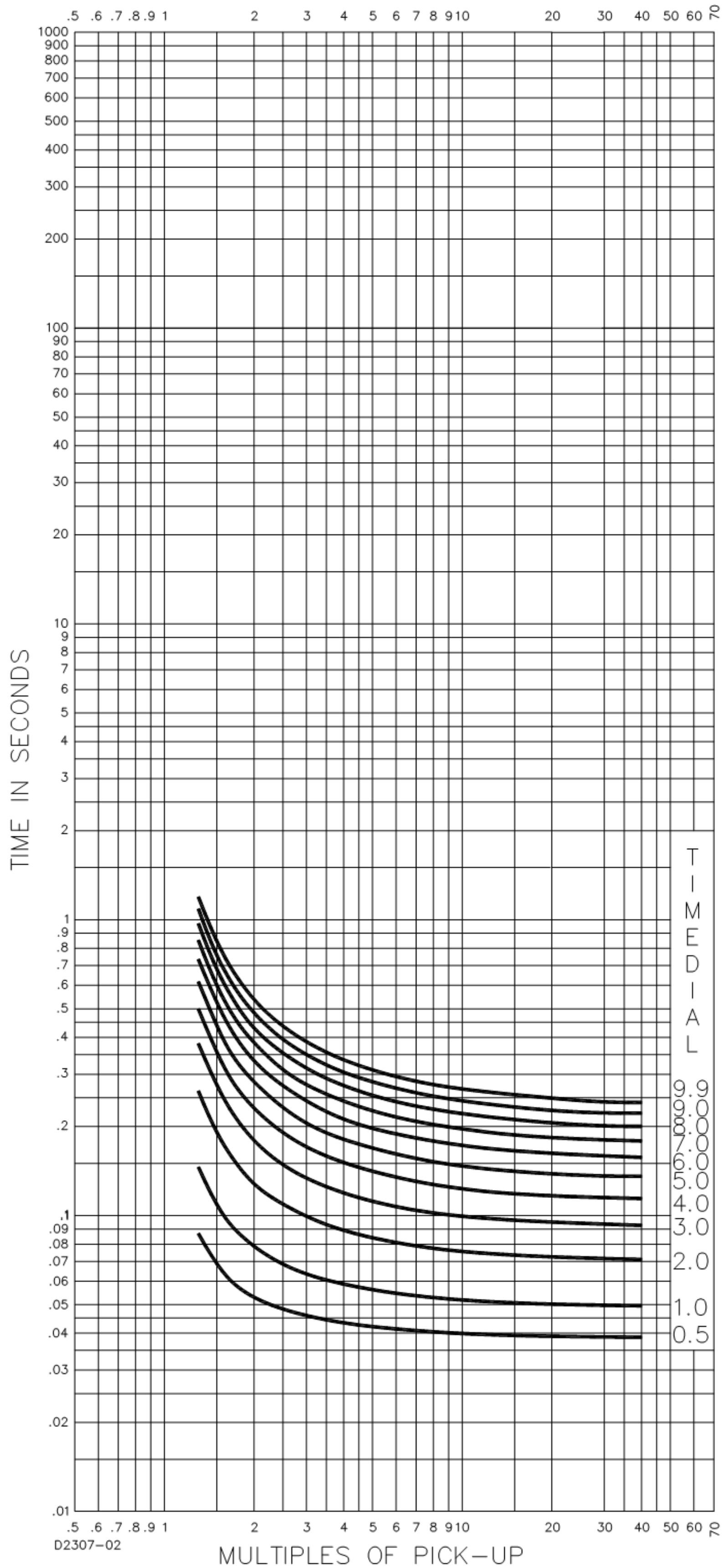


Figure 195. Time Characteristic Curve S2, Short Inverse (Similar To GE IAC-55)

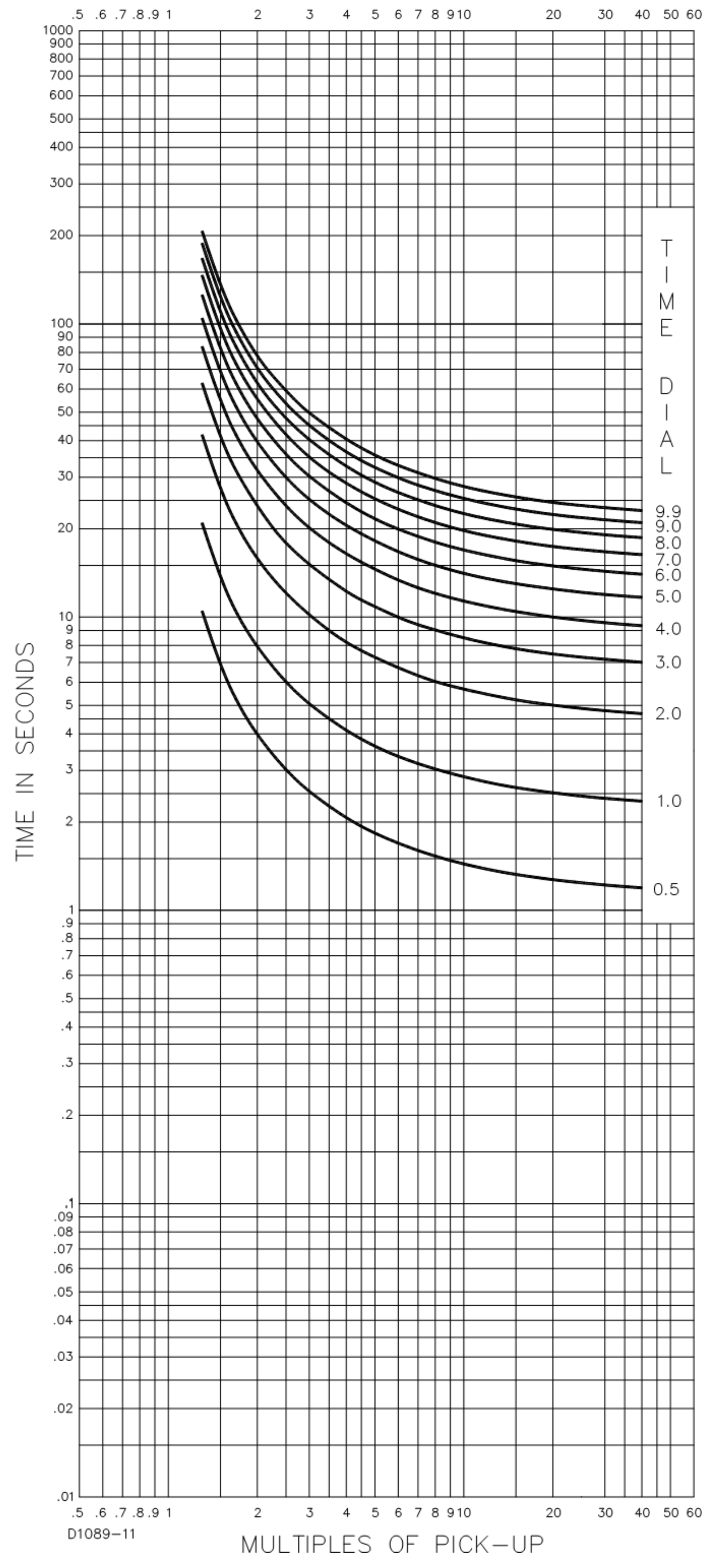


Figure 196. Time Characteristic Curve L1, Long Inverse (Similar to ABB CO-5)

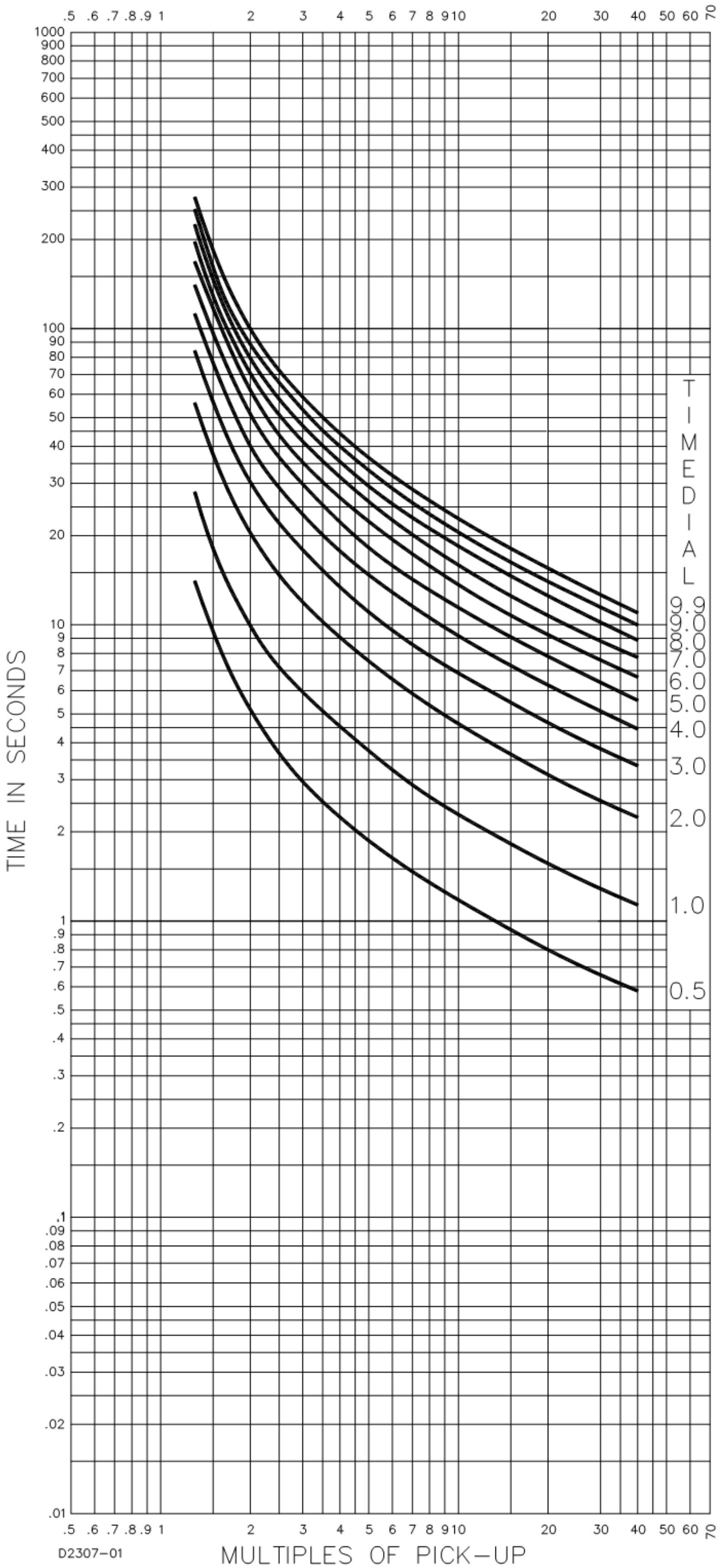


Figure 197. Time Characteristic Curve L2, Long Inverse (Similar To GE IAC-66)

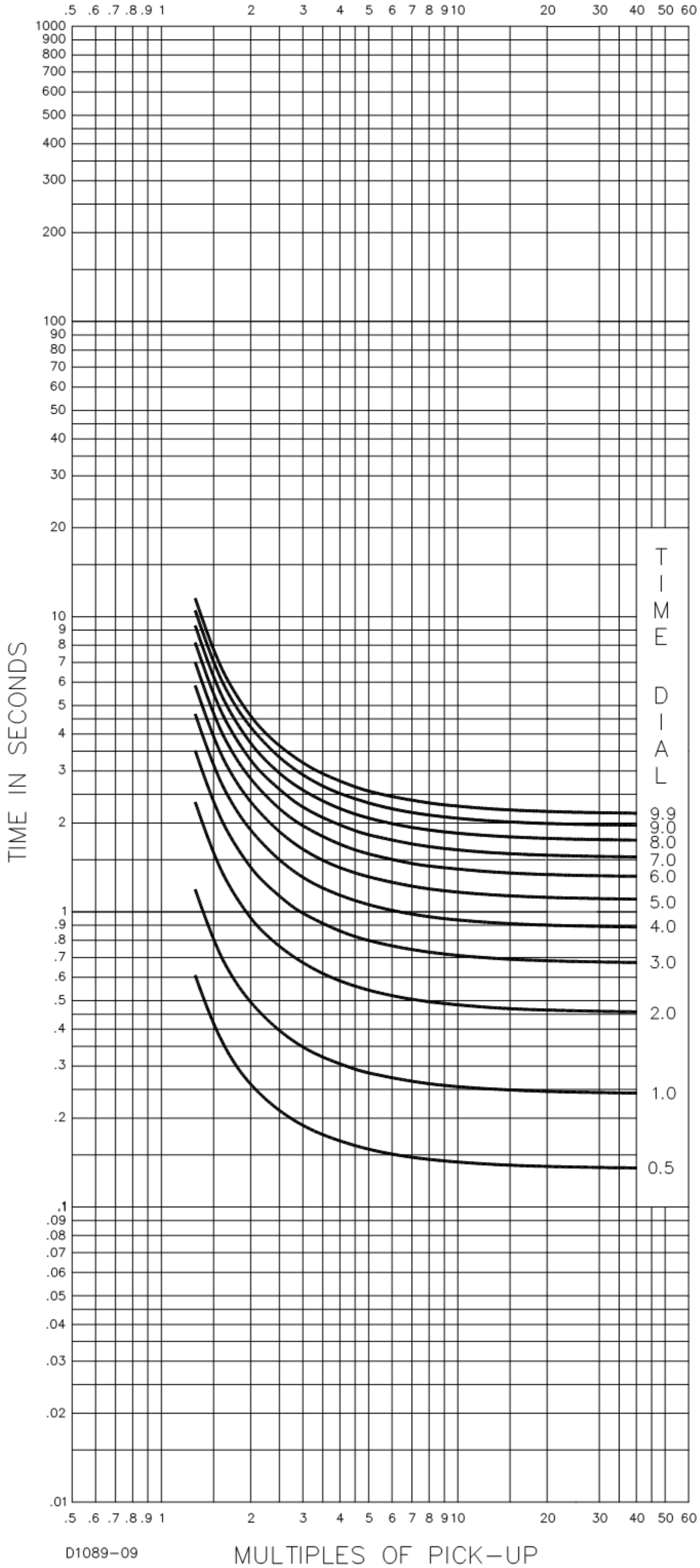


Figure 198. Time Characteristic Curve D, Definite Time (Similar To ABB CO-6)

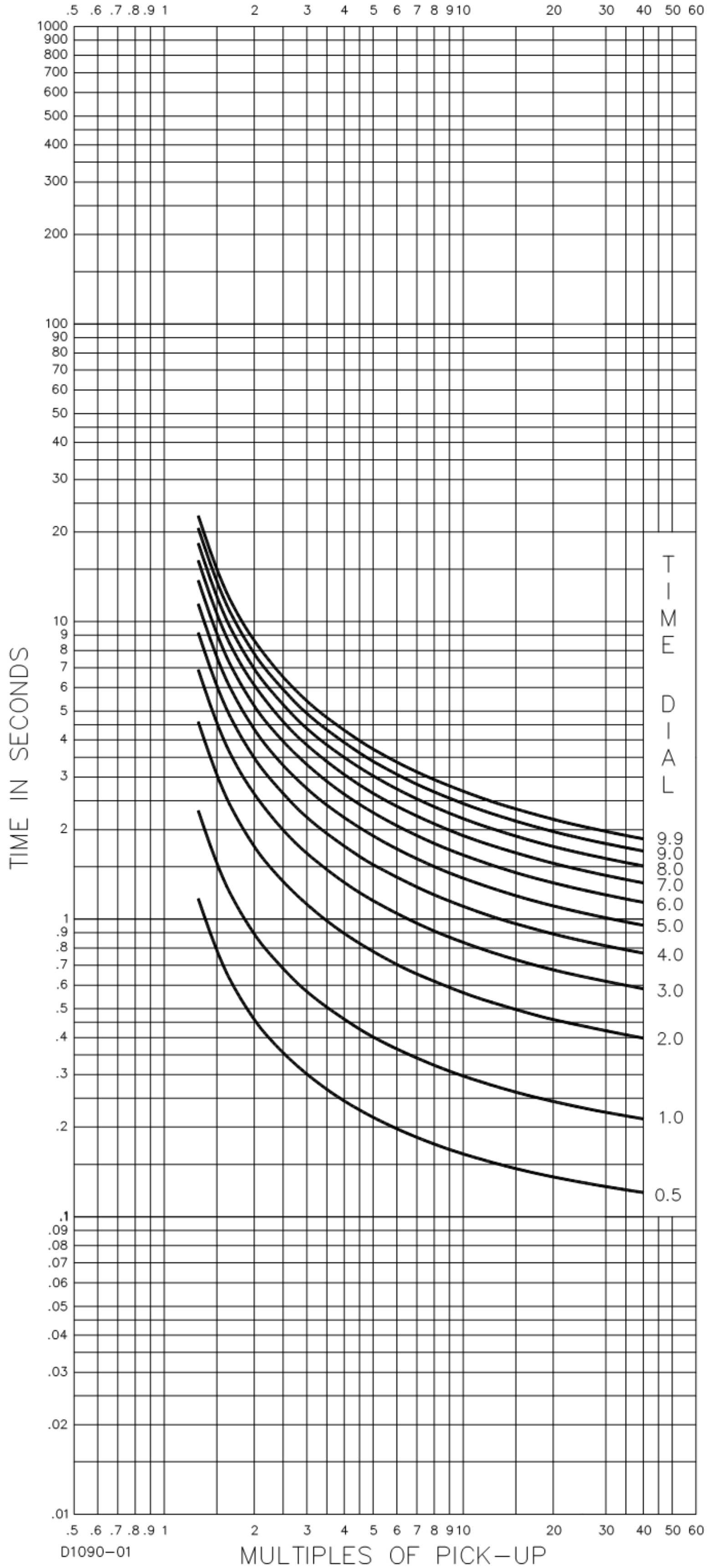


Figure 199. Time Characteristic Curve M, Moderately Inverse (Similar to ABB CO-7)

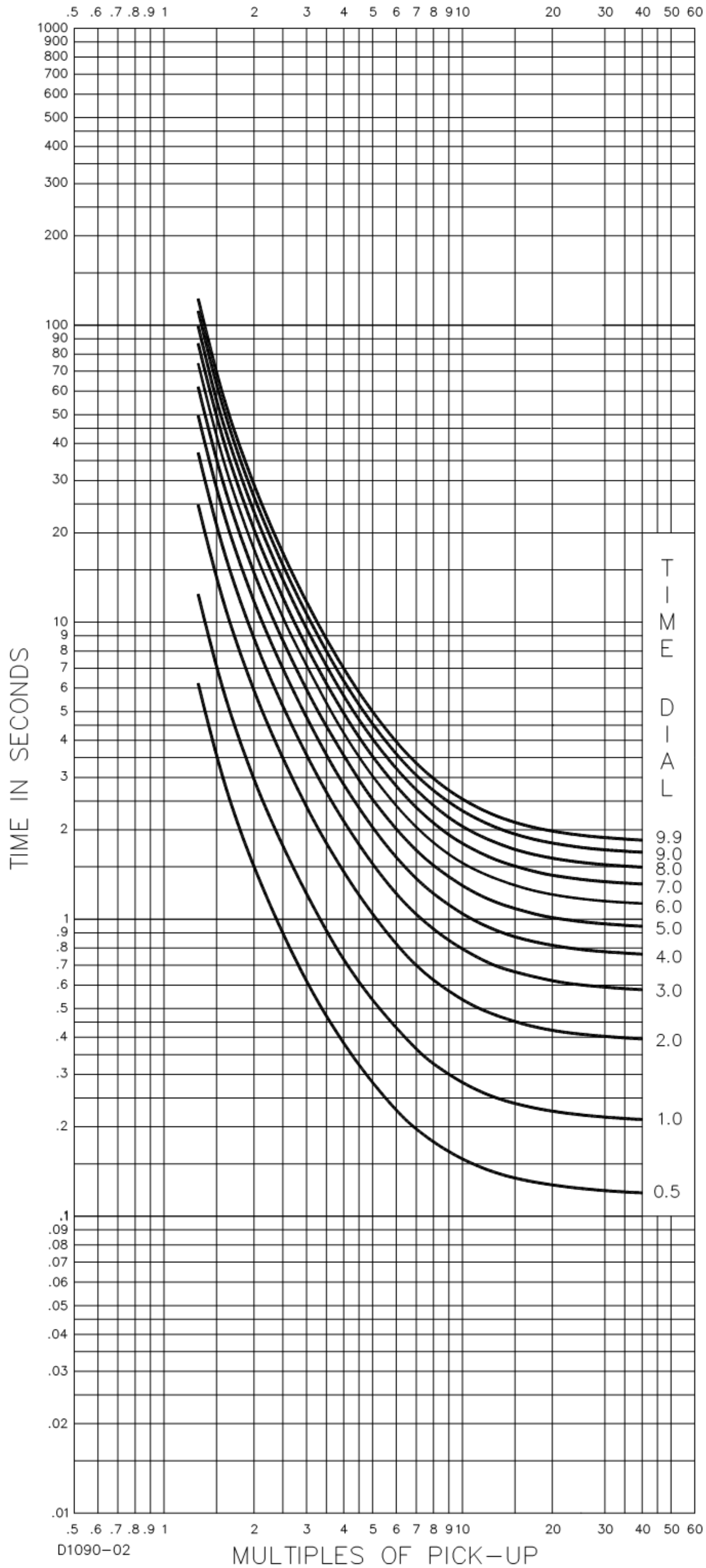


Figure 200. Time Characteristic Curve I1, Inverse Time (Similar to ABB CO-8)

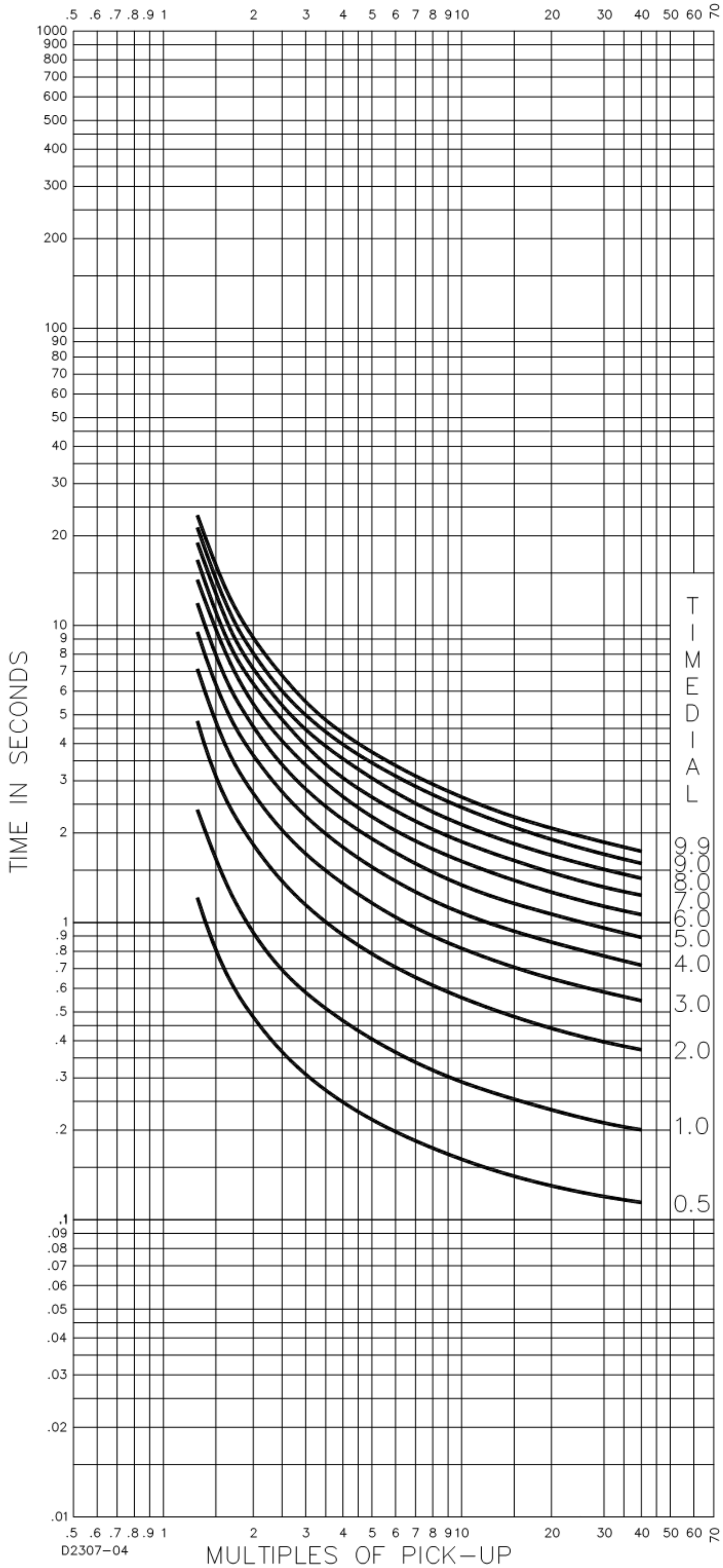


Figure 201. Time Characteristic Curve I2, Inverse Time (Similar to GE IAC-51)

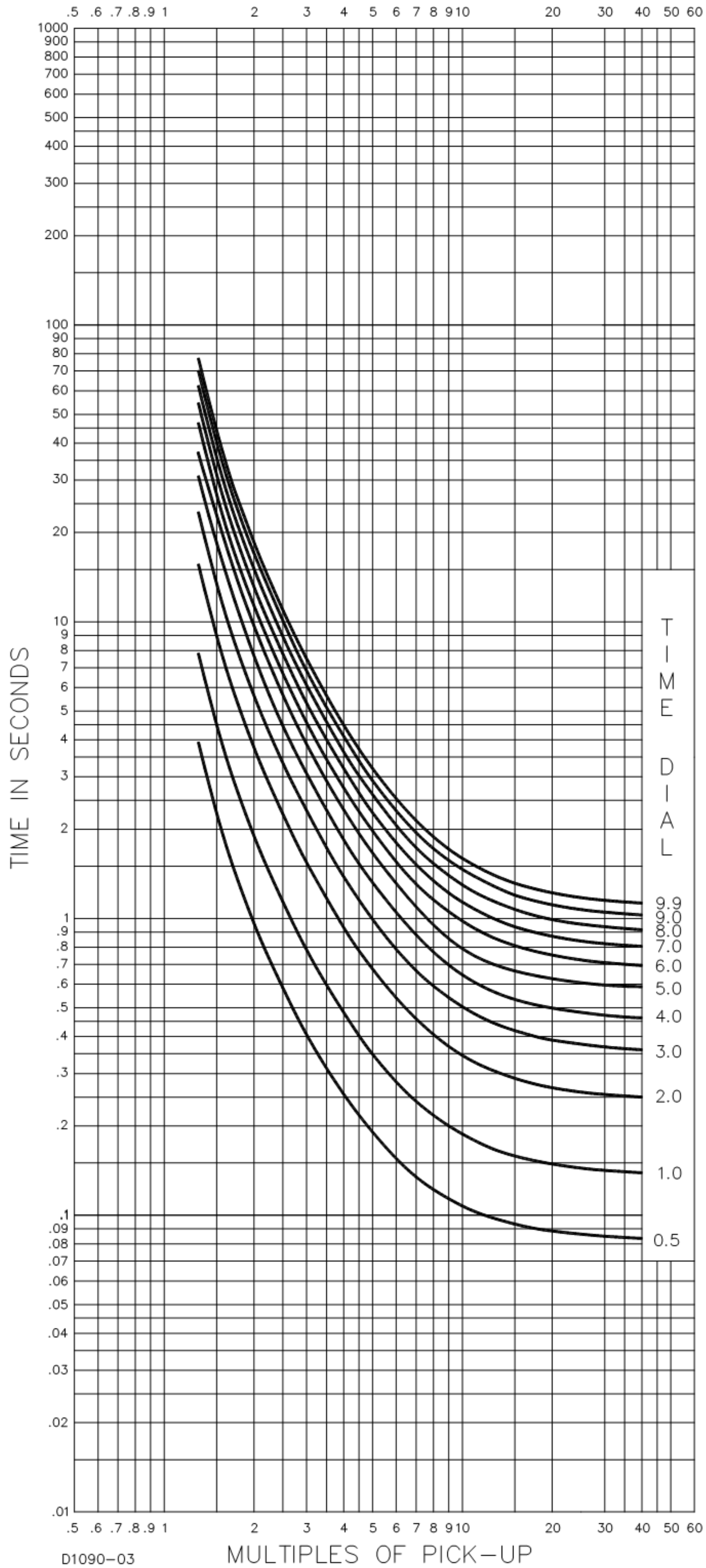


Figure 202. Time Characteristic Curve V1, Very Inverse (Similar to ABB CO-9)

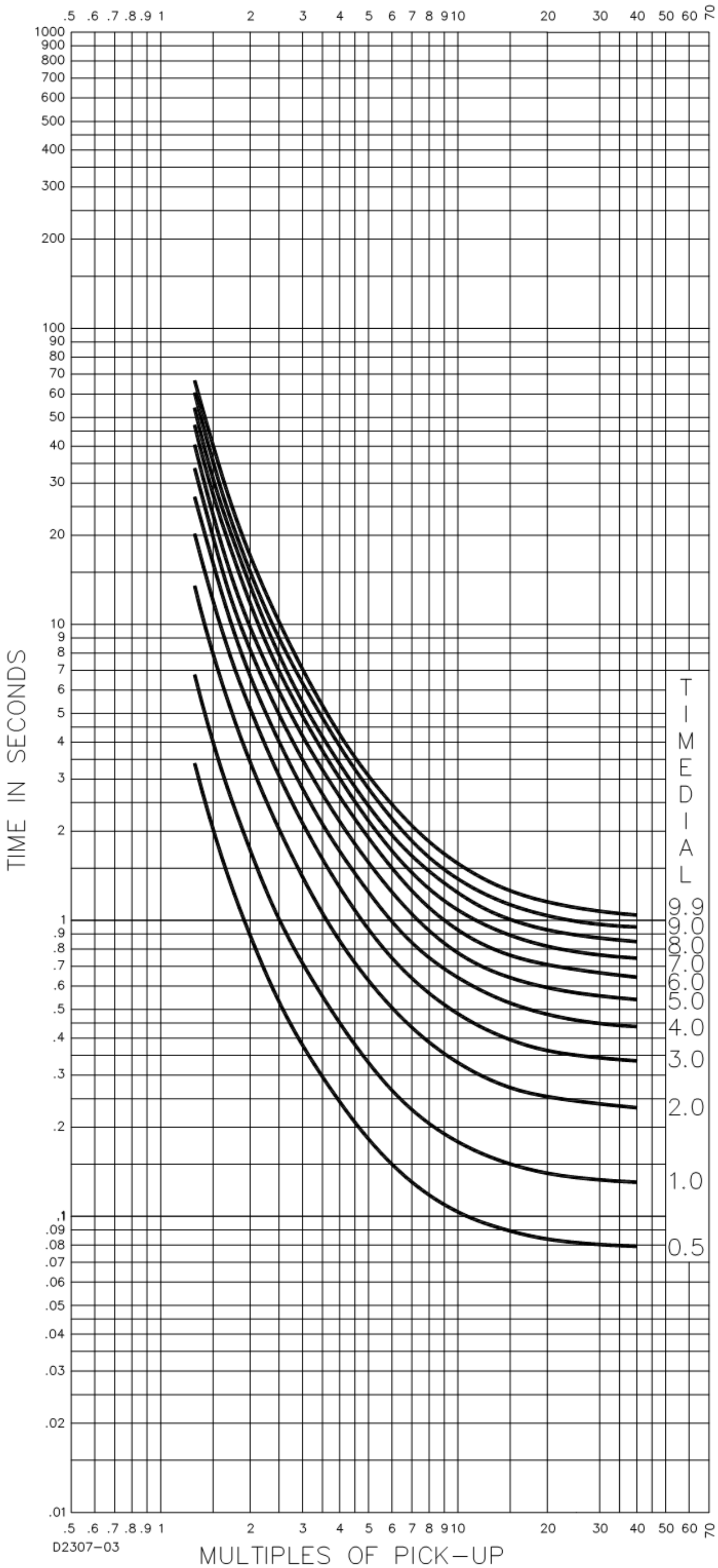


Figure 203. Time Characteristic Curve V2, Very Inverse (Similar to GE IAC-53)

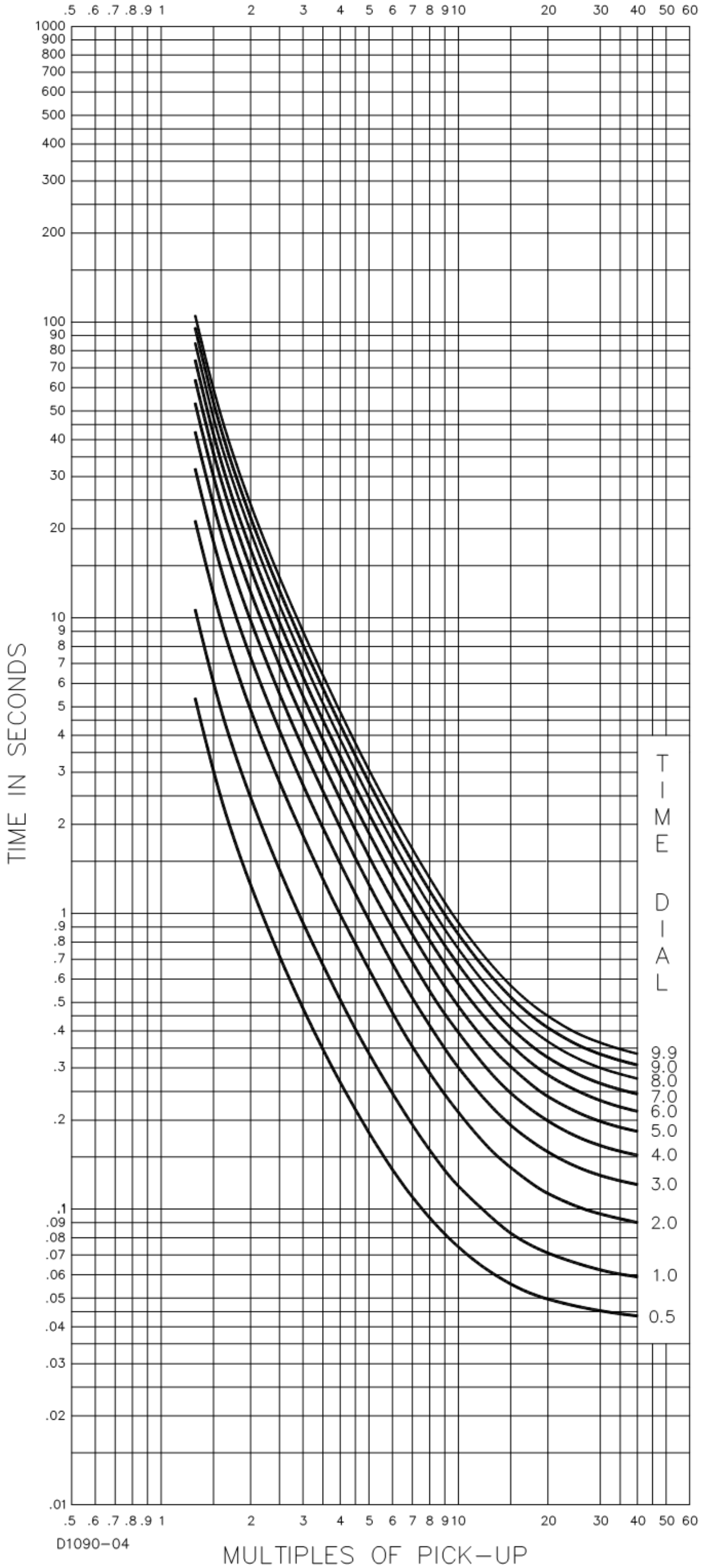


Figure 204. Time Characteristic Curve E1, Extremely Inverse (Similar to ABB CO-11)

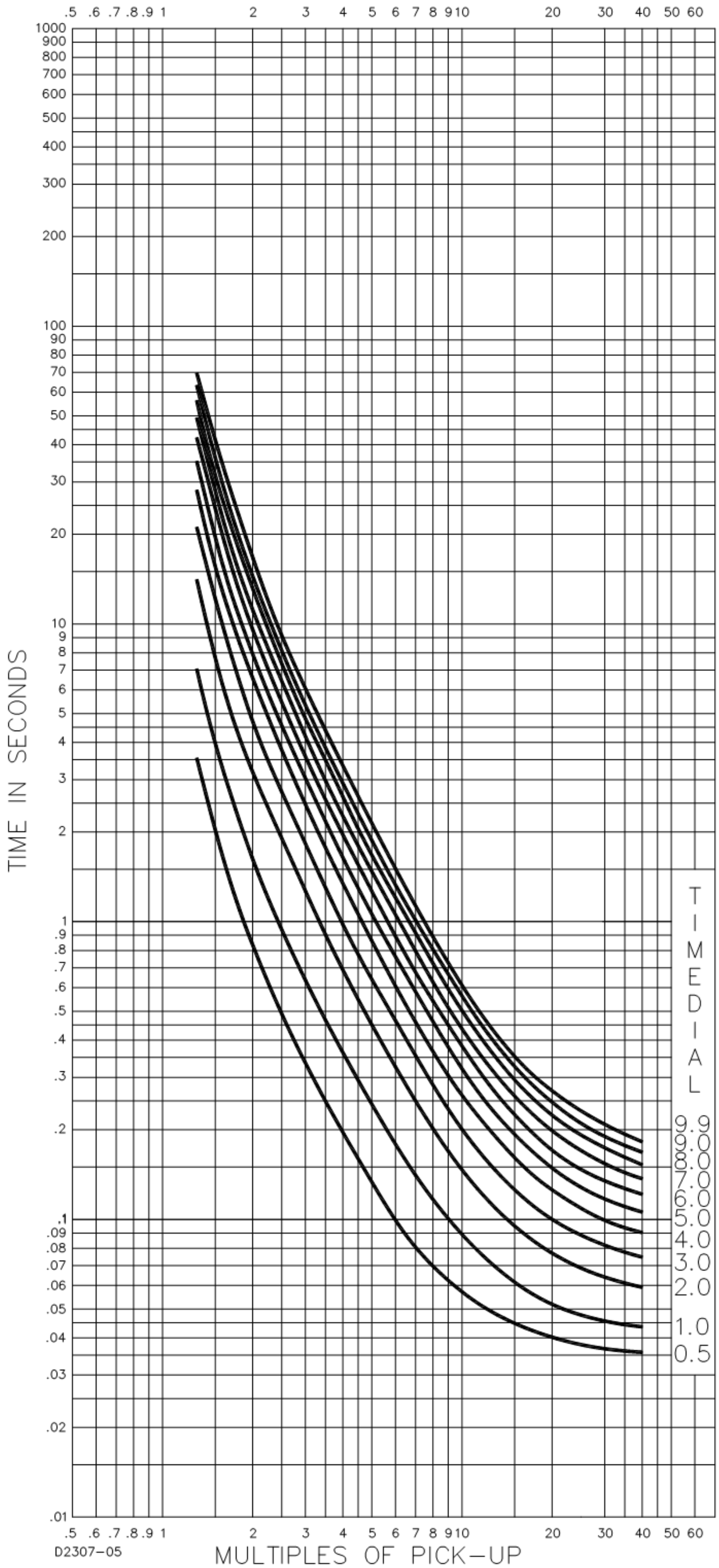


Figure 205. Time Characteristic Curve E2, Extremely Inverse (Similar to GE IAC-77)

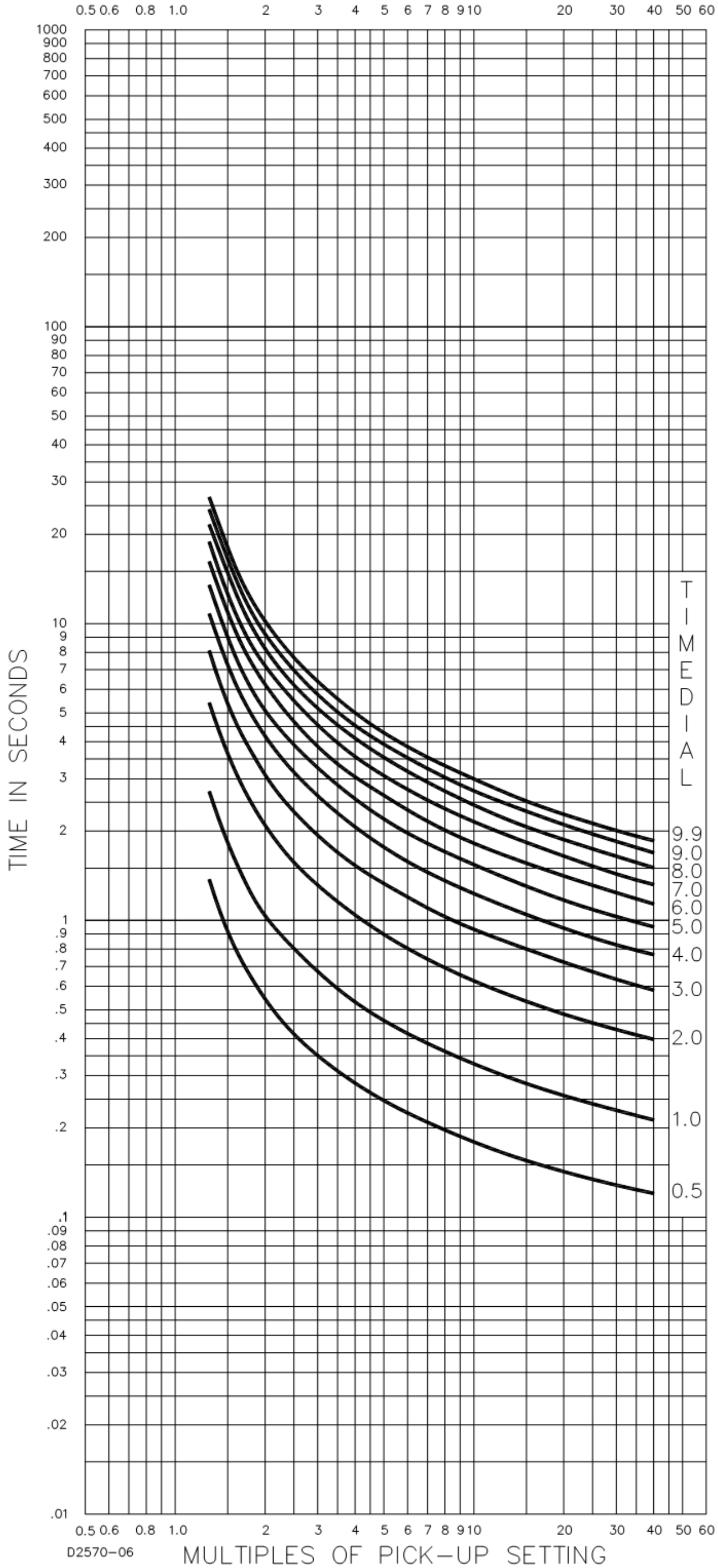


Figure 206. Time Characteristic Curve A, Standard Inverse (BS 142)

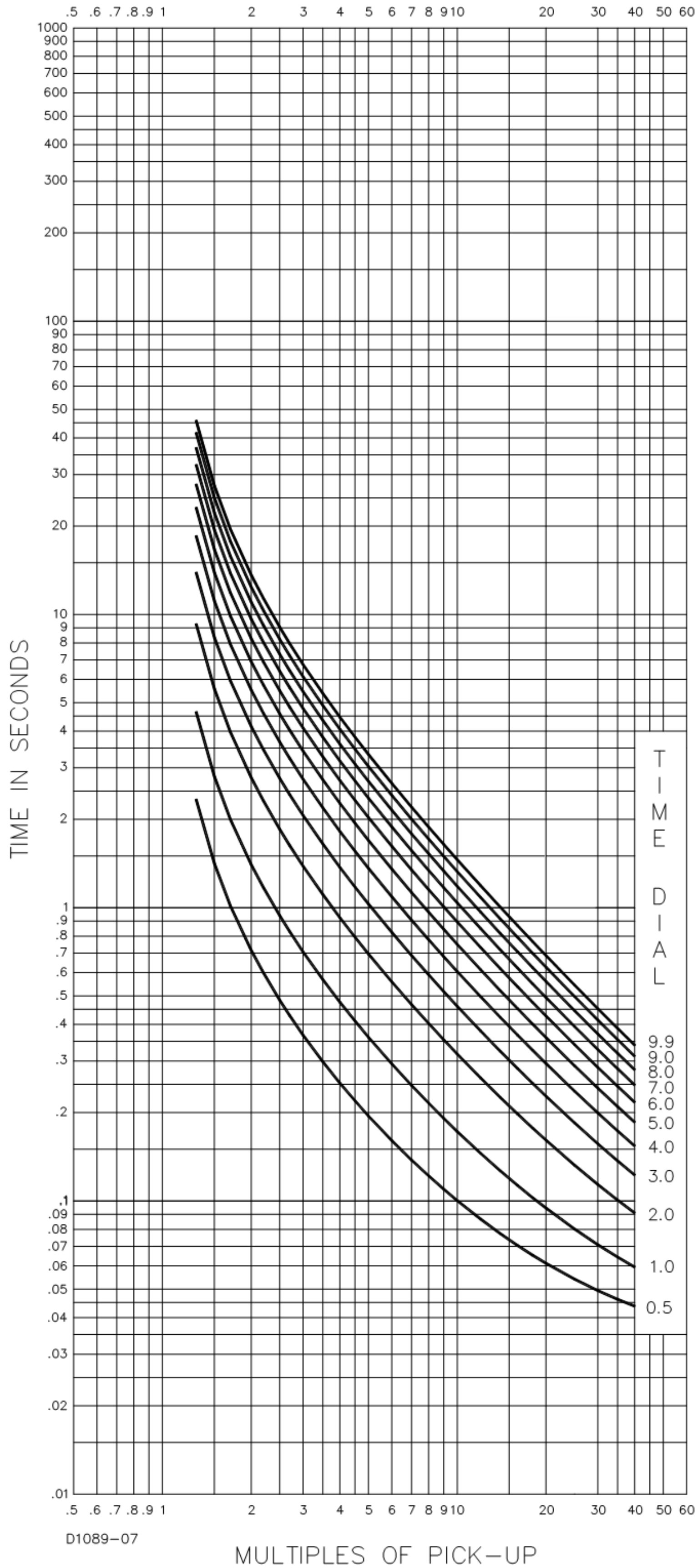


Figure 207. Time Characteristic Curve B, Very Inverse (BS 142)

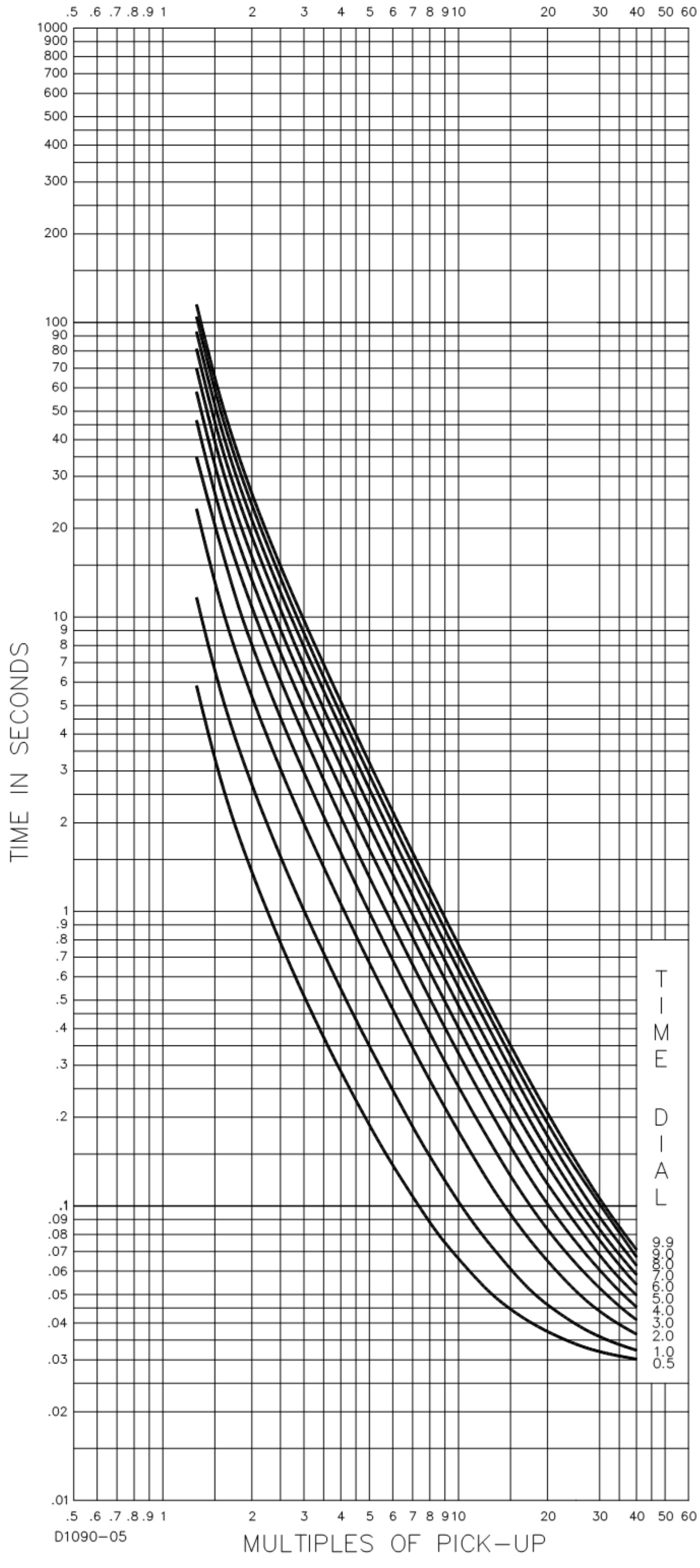


Figure 208. Time Characteristic Curve C, Extremely Inverse (BS 142)

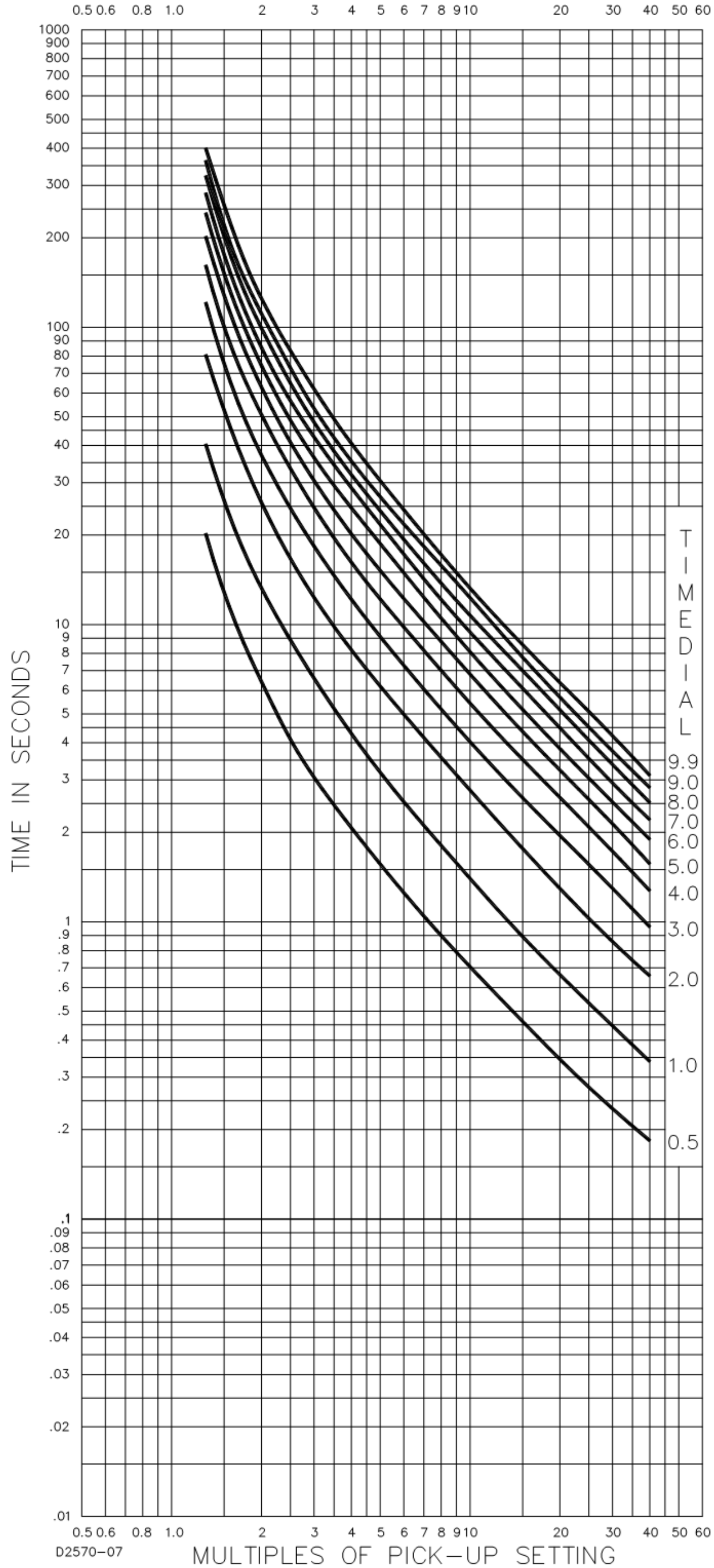
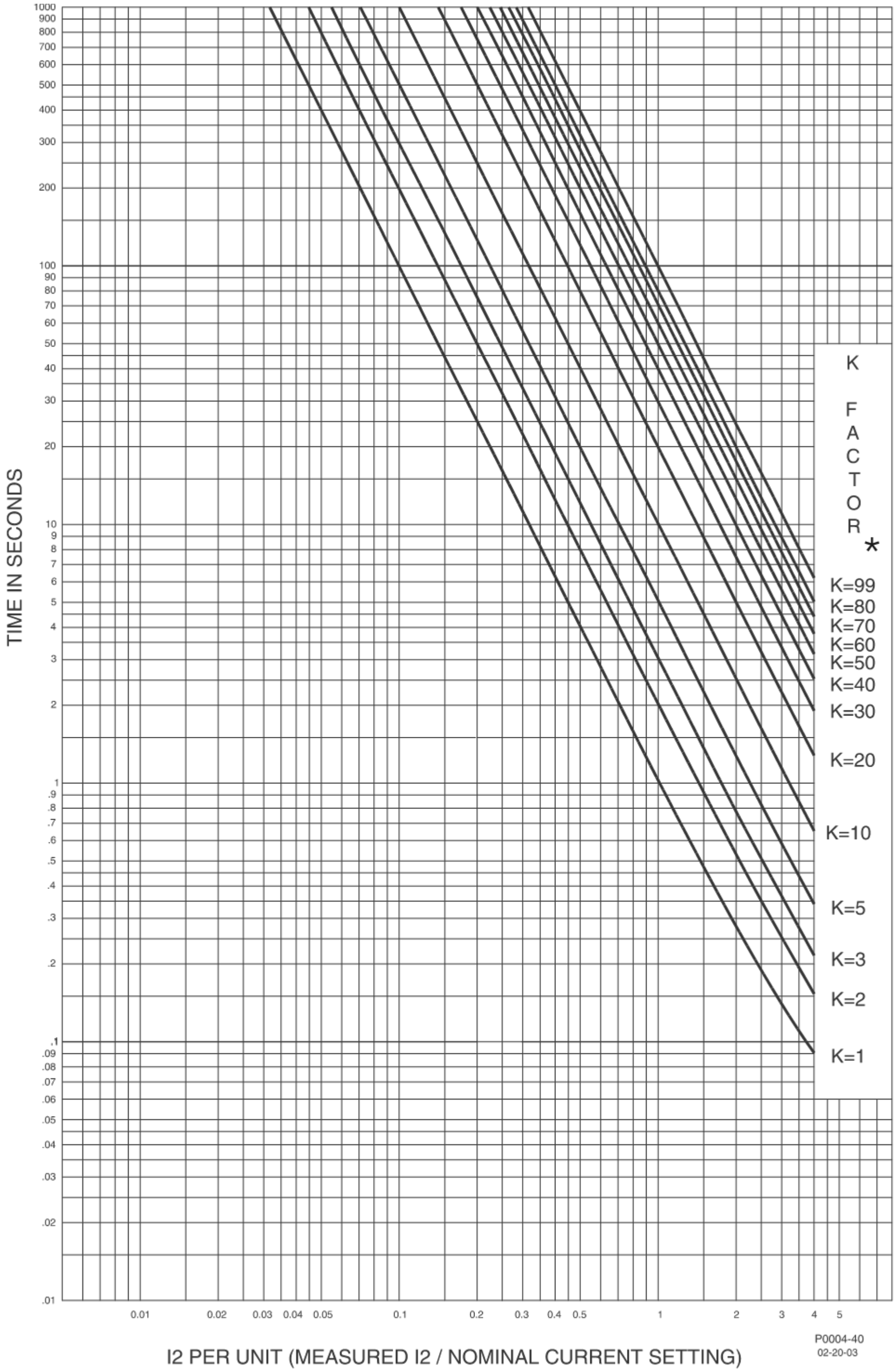


Figure 209. Time Characteristic Curve G, Long Time Inverse (BS 142)



* 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 210. 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.

Configurable Protection

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

Element Setup

Parameter Selection

The following parameters can be selected:

- Oil Pressure
- Temperature
- Battery Voltage
- RPM
- Fuel Level
- **ProgMenuLabels.GenName** Hz
- **ProgMenuLabels.GenName** VAB
- **ProgMenuLabels.GenName** VBC
- **ProgMenuLabels.GenName** VCA
- **ProgMenuLabels.GenName** V Avg (L-L)
- **ProgMenuLabels.GenName** VAN
- **ProgMenuLabels.GenName** VBN
- **ProgMenuLabels.GenName** VCN
- **ProgMenuLabels.GenName** V Avg (L-N)
- **ProgMenuLabels.Bus1Name** Hz
- **ProgMenuLabels.Bus1Name** VAB
- **ProgMenuLabels.Bus1Name** VBC
- **ProgMenuLabels.Bus1Name** VCA
- **ProgMenuLabels.Bus1Name** V Avg (L-L)
- **ProgMenuLabels.Bus1Name** VAN
- **ProgMenuLabels.Bus1Name** VBN
- **ProgMenuLabels.Bus1Name** VCN
- **ProgMenuLabels.Bus1Name** V Avg (L-N)
- **ProgMenuLabels.Bus2Name** Hz
- **ProgMenuLabels.Bus2Name** VAB
- **ProgMenuLabels.Bus2Name** VBC
- **ProgMenuLabels.Bus2Name** VCA
- **ProgMenuLabels.Bus2Name** V Avg (L-L)
- **ProgMenuLabels.Bus2Name** VAN
- **ProgMenuLabels.Bus2Name** VBN
- **ProgMenuLabels.Bus2Name** VCN
- **ProgMenuLabels.Bus2Name** V Avg (L-N)
- **ProgMenuLabels.GenName** PF
- **ProgMenuLabels.Bus1Name** PF
- **ProgMenuLabels.Bus2Name** PF
- **ProgMenuLabels.GenName** Positive kWH
- **ProgMenuLabels.GenName** Negative kWH
- **ProgMenuLabels.Bus1Name** Positive kWH
- **ProgMenuLabels.Bus1Name** Negative kWH
- **ProgMenuLabels.Bus2Name** Positive kWH
- **ProgMenuLabels.Bus2Name** Negative kWH
- **ProgMenuLabels.GenName** IA
- **ProgMenuLabels.GenName** IB
- **ProgMenuLabels.GenName** IC
- **ProgMenuLabels.GenName** I Avg
- **ProgMenuLabels.Bus1Name** IA
- **ProgMenuLabels.Bus1Name** IB
- **ProgMenuLabels.Bus1Name** IC
- **ProgMenuLabels.Bus1Name** I Avg
- **ProgMenuLabels.Bus2Name** IA
- **ProgMenuLabels.Bus2Name** IB
- **ProgMenuLabels.Bus2Name** IC
- **ProgMenuLabels.Bus2Name** I Avg
- IG
- **ProgMenuLabels.GenName** kW A
- **ProgMenuLabels.GenName** kW B
- **ProgMenuLabels.GenName** kW C
- **ProgMenuLabels.GenName** kW Total
- **ProgMenuLabels.Bus1Name** kW A
- **ProgMenuLabels.Bus1Name** kW B
- **ProgMenuLabels.Bus1Name** kW C
- **ProgMenuLabels.Bus1Name** kW Total
- **ProgMenuLabels.Bus2Name** kW A
- **ProgMenuLabels.Bus2Name** kW B
- **ProgMenuLabels.Bus2Name** kW C
- **ProgMenuLabels.Bus2Name** kW Total
- **ProgMenuLabels.GenName** kVA A
- **ProgMenuLabels.GenName** kVA B
- **ProgMenuLabels.GenName** kVA C
- **ProgMenuLabels.GenName** kVA Total
- **ProgMenuLabels.Bus1Name** kVA A
- **ProgMenuLabels.Bus1Name** kVA B
- **ProgMenuLabels.Bus1Name** kVA C
- **ProgMenuLabels.Bus1Name** kVA Total
- **ProgMenuLabels.Bus2Name** kVA A
- **ProgMenuLabels.Bus2Name** kVA B
- **ProgMenuLabels.Bus2Name** kVA C
- **ProgMenuLabels.Bus2Name** kVA Total
- **ProgMenuLabels.GenName** kvar A
- **ProgMenuLabels.GenName** kvar B
- **ProgMenuLabels.GenName** kvar C
- **ProgMenuLabels.GenName** kvar Total
- **ProgMenuLabels.Bus1Name** kvar A
- **ProgMenuLabels.Bus1Name** kvar B
- **ProgMenuLabels.Bus1Name** kvar C
- **ProgMenuLabels.Bus1Name** kvar Total
- **ProgMenuLabels.Bus2Name** kvar A
- **ProgMenuLabels.Bus2Name** kvar B
- **ProgMenuLabels.Bus2Name** kvar C
- **ProgMenuLabels.Bus2Name** kvar Total
- Fuel Pressure
- Injector metering rail pressure
- Total fuel used
- Fuel temperature
- Engine oil temperature
- Engine intercooler temperature
- Coolant pressure
- Fuel rate

- Boost pressure
- Intake manifold temperature
- Charge air temperature
- Engine Percent Load
- **AI1Label.Label**
- **AI2Label.Label**
- **AI3Label.Label**
- **AI4Label.Label**
- kW Load Percent
- Number of units online
- System Online kW Capacity
- System Generated kW
- System Generated kvar
- Number of Units
- Diesel Exhaust Fuel Tank Level 1
- Diesel Exhaust Fuel Tank Level 2
- 87G Iop Phase A
- 87G Ir Phase A
- 87G Iop 2nd Phase A
- 87G Iop 5th Phase A
- 87G Iop Phase B
- 87G Ir Phase B
- 87G Iop 2nd Phase B
- 87G Iop 5th Phase B
- 87G Iop Phase C
- 87G Ir Phase C
- 87G Iop 2nd Phase C
- 87G Iop 5th Phase C
- 87N Iop
- System Total kW Capacity
- System Generated kW Percent
- DPF Outlet Gas Temperature
- System Group Bus Frequency
- System Group Bus V Avg L-L
- System Group Bus I Avg
- System Group Bus Total Watts
- System Group Bus Total var
- System Group Total PF
- System Load Bus Frequency
- System Load Bus V Avg L-L
- System Load Bus I Avg
- System Load Bus Total Watts
- System Load Bus Total var
- System Load Total PF
- System Mains Bus Frequency
- System Mains Bus V Avg L-L
- System Mains Bus I Avg
- System Mains Bus Total Watts
- System Mains Bus Total var
- System Mains Total PF
- Voltage Bias Output
- Speed Bias Output
- Speed PID
- Volt PID
- kW PID
- kvar PID
- Ramped Watt Demand per unit
- Watt Demand per unit
- Ramped var Demand per unit
- var Demand per unit
- Speed error
- Volt error
- kW error
- kvar error
- Power Factor Setpoint
- System Online kvar Capacity
- Number of units in active segment
- Reserve available
- Adjusted Reserve available
- Mains Baseload
- Total System kW Load
- Sync Slip Angle
- Sync Slip Frequency
- Sync Volt Difference
- Load share input
- Load anticipation washout output
- Load anticipation lead-lag output
- Load anticipation output
- **AEM1_Labels.AnalogInputLabel1**
- **AEM1_Labels.AnalogInputLabel2**
- **AEM1_Labels.AnalogInputLabel3**
- **AEM1_Labels.AnalogInputLabel4**
- **AEM1_Labels.AnalogInputLabel5**
- **AEM1_Labels.AnalogInputLabel6**
- **AEM1_Labels.AnalogInputLabel7**
- **AEM1_Labels.AnalogInputLabel8**
- **AEM1_Labels.RTDInputLabel1**
- **AEM1_Labels.RTDInputLabel2**
- **AEM1_Labels.RTDInputLabel3**
- **AEM1_Labels.RTDInputLabel4**
- **AEM1_Labels.RTDInputLabel5**
- **AEM1_Labels.RTDInputLabel6**
- **AEM1_Labels.RTDInputLabel7**
- **AEM1_Labels.RTDInputLabel8**
- **AEM1_Labels.ThermalCoupleLabel1**
- **AEM1_Labels.ThermalCoupleLabel2**
- **AEM2_Labels.AnalogInputLabel1**
- **AEM2_Labels.AnalogInputLabel2**
- **AEM2_Labels.AnalogInputLabel3**
- **AEM2_Labels.AnalogInputLabel4**
- **AEM2_Labels.AnalogInputLabel5**
- **AEM2_Labels.AnalogInputLabel6**
- **AEM2_Labels.AnalogInputLabel7**
- **AEM2_Labels.AnalogInputLabel8**
- **AEM2_Labels.RTDInputLabel1**
- **AEM2_Labels.RTDInputLabel2**
- **AEM2_Labels.RTDInputLabel3**
- **AEM2_Labels.RTDInputLabel4**
- **AEM2_Labels.RTDInputLabel5**
- **AEM2_Labels.RTDInputLabel6**
- **AEM2_Labels.RTDInputLabel7**
- **AEM2_Labels.RTDInputLabel8**
- **AEM2_Labels.ThermalCoupleLabel1**
- **AEM2_Labels.ThermalCoupleLabel2**
- **AEM3_Labels.AnalogInputLabel1**
- **AEM3_Labels.AnalogInputLabel2**
- **AEM3_Labels.AnalogInputLabel3**
- **AEM3_Labels.AnalogInputLabel4**
- **AEM3_Labels.AnalogInputLabel5**
- **AEM3_Labels.AnalogInputLabel6**
- **AEM3_Labels.AnalogInputLabel7**
- **AEM3_Labels.AnalogInputLabel8**
- **AEM3_Labels.RTDInputLabel1**
- **AEM3_Labels.RTDInputLabel2**

- **AEM3_Labels.RTDInputLabel3**
- **AEM3_Labels.RTDInputLabel4**
- **AEM3_Labels.RTDInputLabel5**
- **AEM3_Labels.RTDInputLabel6**
- **AEM3_Labels.RTDInputLabel7**
- **AEM3_Labels.RTDInputLabel8**
- **AEM3_Labels.ThermalCoupleLabel1**
- **AEM3_Labels.ThermalCoupleLabel2**
- **AEM4_Labels.AnalogInputLabel1**
- **AEM4_Labels.AnalogInputLabel2**
- **AEM4_Labels.AnalogInputLabel3**
- **AEM4_Labels.AnalogInputLabel4**
- **AEM4_Labels.AnalogInputLabel5**
- **AEM4_Labels.AnalogInputLabel6**
- **AEM4_Labels.AnalogInputLabel7**
- **AEM4_Labels.AnalogInputLabel8**
- **AEM4_Labels.RTDInputLabel1**
- **AEM4_Labels.RTDInputLabel2**
- **AEM4_Labels.RTDInputLabel3**
- **AEM4_Labels.RTDInputLabel4**
- **AEM4_Labels.RTDInputLabel5**
- **AEM4_Labels.RTDInputLabel6**
- **AEM4_Labels.RTDInputLabel7**
- **AEM4_Labels.RTDInputLabel8**
- **AEM4_Labels.ThermalCoupleLabel1**
- **AEM4_Labels.ThermalCoupleLabel2**
- AVR Output
- GOV Output
- LS Output
- Logic Input 1
- Logic Input 2
- Logic Input 3
- Logic Input 4
- Logic Input 5
- Logic Input 6
- Breaker Power Sum 1 kW
- Breaker Power Sum 1 kvar
- Breaker Power Sum 2 kW
- Breaker Power Sum 2 kvar
- Breaker Power Sum 3 kW
- Breaker Power Sum 3 kvar
- Breaker Power Sum 4 kW
- Breaker Power Sum 4 kvar
- Breaker Power Sum 5 kW
- Breaker Power Sum 5 kvar
- Breaker Power Sum 6 kW
- Breaker Power Sum 6 kvar
- Breaker Power Sum 7 kW
- Breaker Power Sum 7 kvar
- Breaker Power Sum 8 kW
- Breaker Power Sum 8 kvar
- Configurable Protection Output 1
- Configurable Protection Output 2
- Configurable Protection Output 3
- Configurable Protection Output 4
- Configurable Protection Output 5
- Configurable Protection Output 6
- Configurable Protection Output 7
- Configurable Protection Output 8
- Configurable Protection Output 9
- Configurable Protection Output 10
- Configurable Protection Output 11
- Configurable Protection Output 12
- Configurable Protection Output 13
- Configurable Protection Output 14
- Configurable Protection Output 15
- Configurable Protection Output 16
- Configurable Protection Output 17
- Configurable Protection Output 18
- Configurable Protection Output 19
- Configurable Protection Output 20
- Configurable Protection Output 21
- Configurable Protection Output 22
- Configurable Protection Output 23
- Configurable Protection Output 24
- Configurable Protection Output 25
- Configurable Protection Output 26
- Configurable Protection Output 27
- Configurable Protection Output 28
- Configurable Protection Output 29
- Configurable Protection Output 30
- Configurable Protection Output 31
- Configurable Protection Output 32
- Exciter Field Current
- Exciter Field Voltage
- VRM Control Output
- VRM Tracking Error
- VRM AVR Setpoint
- VRM AVR Final Reference
- VRM AVR Error
- VRM FCR Setpoint
- VRM FCR Final Reference
- VRM FCR Error
- VRM OEL Reference
- VRM OEL Takeover Error
- VRM OEL Summing Error
- VRM OEL Summing Bias
- VRM UEL Reference
- VRM UEL Error
- VRM UEL Bias
- **VRM1.RTDInputLabel1**
- **VRM1.RTDInputLabel2**
- **VRM1.RTDInputLabel3**
- **VRM1.RTDInputLabel4**
- **VRM1.RTDInputLabel5**
- **VRM1.RTDInputLabel6**
- **VRM1.RTDInputLabel7**
- **VRM1.RTDInputLabel8**
- Configurable Log Parameter 1
- Configurable Log Parameter 2
- Configurable Log Parameter 3
- Configurable Log Parameter 4
- Configurable Log Parameter 5
- Configurable Log Parameter 6

** Custom user label.

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.

Parameter 1 and 2

Two parameters may be selected for use in simple mathematical equations. The result of the equation is compared to the configurable protection thresholds. Scale factors and offsets are also provided for each parameter.

Operator

The Operator is used in the mathematical equation between parameters 1 and 2. If None is selected, no mathematical equation is performed.

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 picks up, the measured parameter must drop to 95% of the threshold before the threshold detection drops 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 configurable protection element. Each threshold has a mode setting, threshold setting, activation delay setting, and an alarm configuration setting.

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.

Threshold

When the selected parameter rises above or falls below this setting, depending on the Mode setting, (picks up) the activation delay timer begins counting.

Activation Delay

After the threshold has been exceeded for the duration of the activation delay, the selected alarm configuration action is performed. If the threshold detection drops out before the activation delay expires, the activation delay timer is reset.

Alarm Configuration

Each configurable protection threshold item can be independently configured to perform a different action depending on the alarm configuration setting. Alarm configurations are described in the *Alarm Configuration* chapter.

Note
The Arming Delay should not 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.

Logic Connections

Configurable protection logic connections are made on the BESTlogic*Plus* screen in BESTCOMS*Plus*. The Configurable Protection 1, Threshold 1 logic block is illustrated in Figure 211. Block output is true during a trip condition. Alarm and pre-alarm logic blocks are similar.

Figure 211. Configurable Protection Logic Block

Operational Settings

BESTCOMS*Plus* 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 212) in BESTCOMS*Plus* or through the front panel. Settings are listed in Table 87.

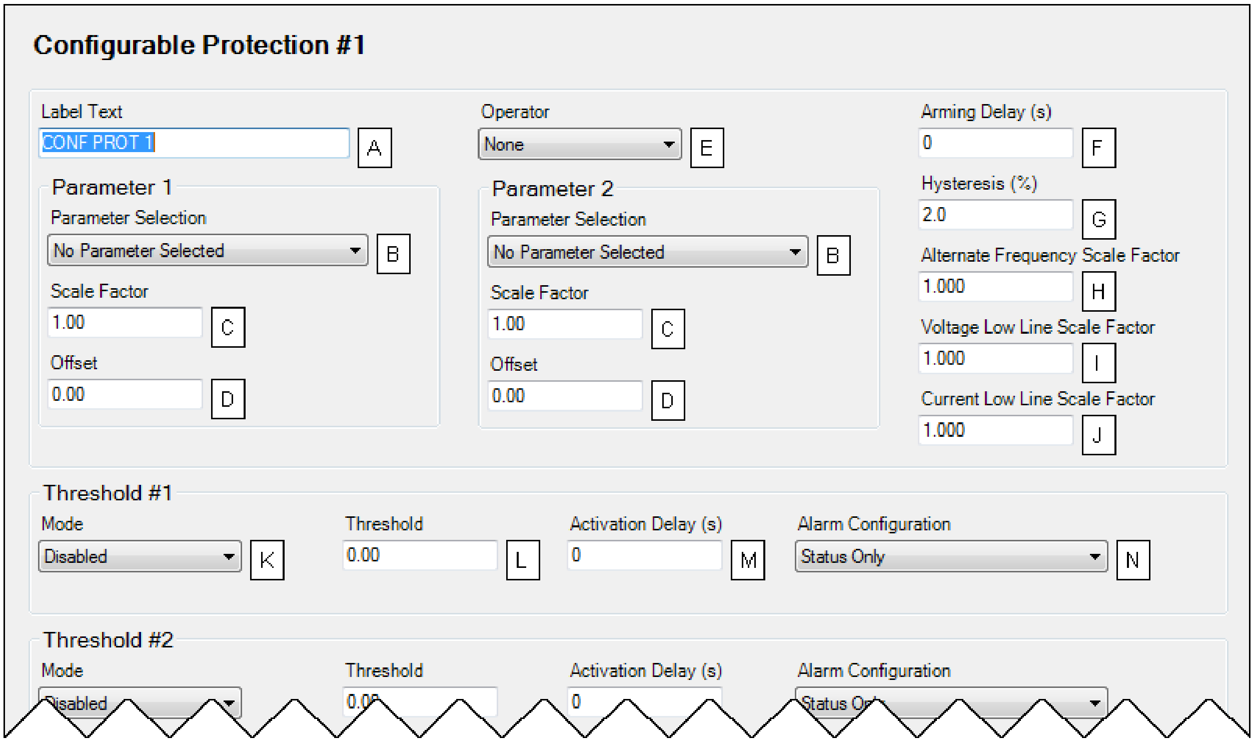


Figure 212. Settings Explorer, Configurable Protection, Configurable Protection #1

Table 87. 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	Scale Factor	–999,999 to 999,999	0.01	n/a
D	Offset	–999,999 to 999,999	0.01	n/a
E	Operator	None, Plus (+), Minus (-), Multiply (x), or Divide (/)	n/a	n/a
F	Arming Delay	0 to 300	1	seconds
G	Hysteresis	0 to 100	0.1	%
H	Alternate Frequency Scale Factor	0.001 to 100	0.001	n/a
I	Voltage Low Line Scale Factor	0.001 to 3	0.001	n/a
J	Current Low Line Scale Factor	0.001 to 3	0.001	n/a
K	Mode	Disabled, Over, or Under	n/a	n/a
L	Threshold	–999,999 to 999,999	0.01	n/a
M	Activation Delay	0 to 300	1	seconds

Locator	Setting	Range	Increment	Unit
N	Alarm Configuration	Status Only, Pre-Alarm, Alarm, Alarm with Unload, Alarm with Cool Down, or Alarm with Unload then Cool Down	n/a	n/a

∗See *Parameter Selection*, above, for a complete listing of selectable parameters.

BESTlogic™*Plus*

BESTlogic*Plus* Programmable Logic is a programming method used for managing the input, output, protection, control, monitoring, and reporting capabilities of Basler Electric's DGC-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 BESTlogic*Plus*. BESTlogic*Plus* 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. BESTCOMS*Plus*® 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.

BESTlogic*Plus* is not used to define the operating settings (modes, pickup thresholds, and time delays) of the individual protection and control functions. Operating settings and logic settings are interdependent but separately programmed functions. Changing logic settings is similar to rewiring a panel and is separate and distinct from making the operating settings that control the pickup thresholds and time delays of a DGC-2020HD. Detailed information about operating settings is provided in the *BESTCOMSPlus* chapter.

Caution
This product contains one or more *nonvolatile memory* devices. Nonvolatile memory is used to store information (such as settings) that needs to be preserved when the product is power-cycled or otherwise restarted. Established nonvolatile memory technologies have a physical limit on the number of times they can be erased and written. In this product, the limit is 100,000 erase/write cycles. During product application, consideration should be given to communications, logic, and other factors that may cause frequent/repeated writes of settings or other information that is retained by the product. Applications that result in such frequent/repeated writes may reduce the useable product life and result in loss of information and/or product inoperability.

Overview of BESTlogic™Plus

BESTlogic*Plus* settings are made through BESTCOMS*Plus.* Use the Settings Explorer to open the BESTlogic*Plus* Programmable Logic tree branch as shown in Figure 213.

The BESTlogic*Plus* Programmable Logic screen contains a logic library for opening and saving logic files, tools for creating and editing logic documents, and protection settings.

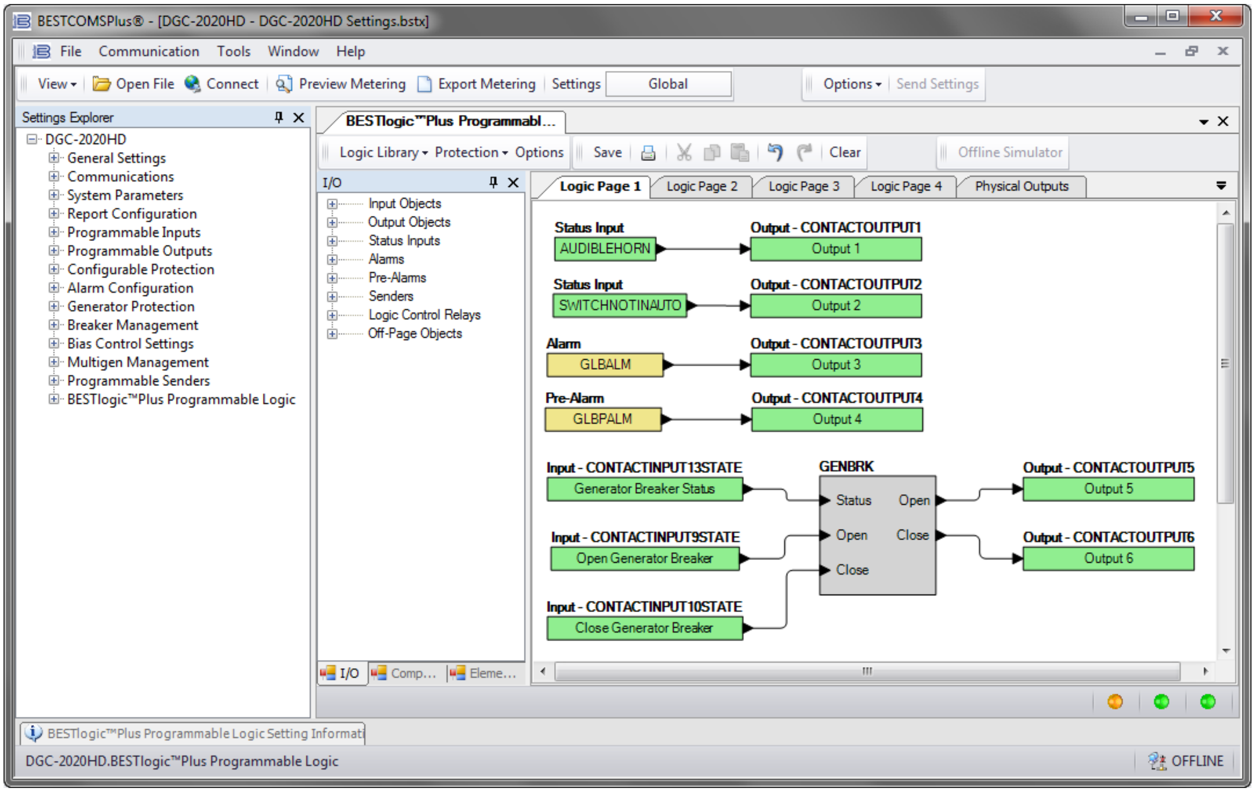


Figure 213. Settings Explorer, BESTlogic™*Plus* Programmable Logic Screen

BESTlogic™Plus Composition

There are three main groups of objects used for programming BESTlogic*Plus*. These groups are I/O, Components, and Elements. For details on how these objects are used to program BESTlogic*Plus*, see the paragraphs on *Programming BESTlogicPlus* 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 88. I/O Group, Input Objects

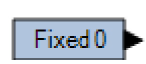
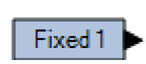
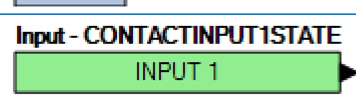
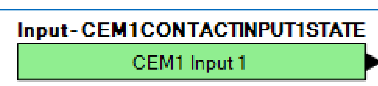
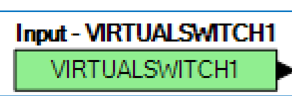
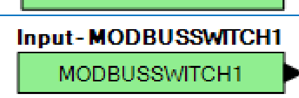
Name/Description	Element
Logic 0 Always false (Low).	
Logic 1 Always true (High).	
Input x True when Contact Input x is active, the Alarm Configuration is set to Status Only, and the activation delay has expired.	
Input x True when Remote Contact Input x is active, the Alarm Configuration is set to Status Only, and the activation delay has expired.	
Input x True when Virtual Input x is active.	
Input x True when Modbus Switch x is active.	

Table 89. I/O Group, Output Objects

Name/Description	Element
Output x Closes the corresponding contact output on the DGC-2020HD when true (high).	Output - CONTACTOUTPUT1 OUTPUT 1
Output x Closes the corresponding remote contact output on an optional CEM-2020 when true (high).	Output - CEM1OUTPUT1 CEM1 Output 1

Table 90. I/O Group, Status Inputs

Name/Description	Symbol
Alarm Silence Active True when the Alarm Silence logic element is true or the Alarm Silence button is pressed on the front panel.	Status Input ALMSILENCEACTIVE
Alternate Frequency Override True when the Alternate Frequency Override logic element is true.	Status Input ALTFREQOVERRIDE
ATS Input True when the ATS (Auto Transfer Switch) input is true or the ATS logic element is true.	Status Input ATSINPUT
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
Base load Mode Active True when the DGC-2020HD is in base load mode.	Status Input BASELOADMODEACTIVE
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 BATTLEOVERRIDEPF
Breaker Control Granted One breaker may be controlled by multiple DGC-2020HDs, however only one unit is granted control over the breaker at a time. This input is true on the DGC-2020HD which is currently granted control over the breaker.	Status Input BKRCTLGRANTED
Breaker Status, Generator Breaker, State True when the local generator breaker is closed.	Status Input GENBREAKERSTATUS
Breaker Status, Generator Breaker, OK to Close True when the local generator breaker is OK to close.	Status Input GENBREAKEROKTOCLOSE
Breaker Status, Generator Breaker, Open Setpoint Reached True when the local generator breaker open setpoint has been reached.	Status Input GENBREAKEROPNSETPTRCHD
Breaker Status, Generator Breaker, Fail to Close True when the local generator breaker has failed to close.	Status Input GENBKRFAILTOCLOSESTAT

Name/Description	Symbol
Breaker Status, Generator Breaker, Fail to Open True when the local generator breaker has failed to open.	Status Input GENBKRFAILTOOPENSTAT
Breaker Status, Group Breaker, State True when the group breaker is closed.	Status Input GROUPBREAKERSTATUS
Breaker Status, Group Breaker, OK to Close True when the local group breaker is OK to close.	Status Input GROUPBREAKEROKTOCLOSE
Breaker Status, Group Breaker, Open Setpoint Reached True when the local group breaker open setpoint has been reached.	Status Input GROUPBREAKEROPNSETPTRCHD
Breaker Status, Group Breaker, Fail to Close True when the local group breaker has failed to close.	Status Input GROUPBKRFAILTOCLOSESTAT
Breaker Status, Group Breaker, Fail to Open True when the local group breaker has failed to open.	Status Input GROUPBKRFAILTOOPENSTAT
Breaker Status, Mains Breaker, State True when the mains breaker is closed.	Status Input MAINSBREAKERSTATUS
Breaker Status, Mains Breaker, OK to Close True when the local mains breaker is OK to close.	Status Input MAINSBREAKEROKTOCLOSE
Breaker Status, Mains Breaker, Open Setpoint Reached True when the local mains breaker open setpoint has been reached.	Status Input MAINSBREAKEROPNSETPTRCHD
Breaker Status, Mains Breaker, Fail to Close True when the local mains breaker has failed to close.	Status Input MAINSBKRFAILTOCLOSESTAT
Breaker Status, Mains Breaker, Fail to Open True when the local mains breaker has failed to open.	Status Input MAINSBKRFAILTOOPENSTAT
Breaker Status, Tie Breaker, State True when the first tie breaker is closed.	Status Input TIEBREAKERSTATUS
Breaker Status, Tie Breaker, OK to Close True when the first tie breaker is OK to close.	Status Input TIEBREAKEROKTOCLOSE
Breaker Status, Tie Breaker, Open Setpoint Reached True when the first tie breaker open setpoint has been reached.	Status Input TIEBREAKEROPNSETPTRCHD
Breaker Status, Tie Breaker, Fail to Close True when the first tie breaker has failed to close.	Status Input TIEBKRFAILTOCLOSESTAT
Breaker Status, Tie Breaker, Fail to Open True when the first tie breaker has failed to open.	Status Input TIEBKRFAILTOOPENSTAT
Breaker Status, Tie Breaker 2, State True when the second tie breaker is closed.	Status Input TIEBREAKER2STATUS
Breaker Status, Tie Breaker 2, OK to Close True when the second tie breaker is OK to close.	Status Input TIEBREAKER2OKTOCLOSE
Breaker Status, Tie Breaker 2, Open Setpoint Reached True when the second tie breaker open setpoint has been reached.	Status Input TIEBREAKER2OPNSETPTRCHD
Breaker Status, Tie Breaker 2, Fail to Close True when the second tie breaker has failed to close.	Status Input TIEBKR2FAILTOCLOSESTAT

Name/Description	Symbol
Breaker Status, Tie Breaker 2, Fail to Open True when the second tie breaker has failed to open.	Status Input TIEBKR2FAILTOOPENSTAT
Bus Status, Bus x, Dead True when Bus x voltage is below the dead bus threshold.	Status Input - BUS1CONDITIONDEAD Bus 1 Dead
Bus Status, Bus x, Fail True when Bus x is outside the appropriate stable bus conditions.	Status Input - BUS1CONDITIONFAILED Bus 1 Fail
Bus Status, Bus x, Forward Rotation True when the bus rotation matches the Phase Rotation setting.	Status Input - BUS1FORWARDROTATION Bus 1 Forward Rotation
Bus Status, Bus x, Reverse Rotation True when the bus rotation is opposite of the Phase Rotation setting.	Status Input - BUS1REVERSEROTATION Bus 1 Reverse Rotation
Bus Status, Bus x, Stable True when Bus x is within the appropriate stable bus conditions.	Status Input - BUS1CONDITIONSTABLE Bus 1 Stable
Bus Status, Gen, Dead True when the Gen voltage is below the dead gen threshold.	Status Input - GENCONDITIONDEAD Gen Dead
Bus Status, Gen, Fail True when the Gen is outside the appropriate stable gen conditions.	Status Input - GENCONDITIONFAILED Gen Fail
Bus Status, Gen, Forward Rotation True when the generator rotation matches the Phase Rotation setting.	Status Input - GENFORWARDROTATION Gen Forward Rotation
Bus Status, Gen, Reverse Rotation True when the generator rotation is opposite of the Phase Rotation setting.	Status Input - GENREVERSEROTATION Gen Reverse Rotation
Bus Status, Gen, Stable True when the Gen is within the appropriate stable gen conditions.	Status Input - GENCONDITIONSTABLE Gen Stable
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
Communications, Analog Expansion Modules, AEM x Connected True when an optional AEM-2020 is connected to the DGC-2020HD.	Status Input AEM1CONNECTED
Communications, Contact Expansion Modules, CEM x Connected True when an optional CEM-2020 is connected to the DGC-2020HD.	Status Input CEM1CONNECTED
Configurable Protection, Configurable Protection #x, Threshold x Trip True when the Alarm Configuration is set to Status Only and the threshold has been exceeded.	Status Input - CONFIGPROT1THRESH1TRIP CONF PROT 1

Name/Description	Symbol
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
DPF Lamp Command True when DPF lamp is lit. This status input mimics the state of the DPF lamp. It remains true when the DPF lamp is constantly lit and toggles true and false at a rate of 1 Hz when DPF lamp is blinking.	Status Input DPFLAMPCMD
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
Front Panel Buttons, Auto True while the Auto front panel button is pressed.	Status Input AUTOBUTTON
Front Panel Buttons, Down True while the Down front panel button is pressed.	Status Input DOWNBUTTON
Front Panel Buttons, Edit True while the Edit front panel button is pressed.	Status Input EDITBUTTON
Front Panel Buttons, Lamp True while the Lamp front panel button is pressed.	Status Input LAMPBUTTON
Front Panel Buttons, Left True while the Left front panel button is pressed.	Status Input LEFTBUTTON
Front Panel Buttons, Off True while the Off front panel button is pressed.	Status Input OFFBUTTON
Front Panel Buttons, Reset True while the Reset front panel button is pressed.	Status Input RESETBUTTON
Front Panel Buttons, Right True while the Right front panel button is pressed.	Status Input RIGHTBUTTON
Front Panel Buttons, Run True while the Run front panel button is pressed.	Status Input RUNBUTTON
Front Panel Buttons, Silence True while the Silence front panel button is pressed.	Status Input SILENCEBUTTON
Front Panel Buttons, Up True while the Up front panel button is pressed.	Status Input UPBUTTON
Generator Protection, Power, Power Trip (32-x) True when the 32-x element is tripped.	Status Input 32PROT1TRIP

Name/Description	Symbol
Generator Protection, Power, Loss of Excitation Trip (40Q-x) True when the 40Q-x element is tripped.	Status Input 40QTRIP1
Generator Protection, Loss of MAINS Protection, Vector Shift Trip (78-x) 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
Generator States, In Connecting State True when the DGC-2020HD is in the connecting state.	Status Input INCONNECTINGSTATE
Generator States, In Cooling State True when the DGC-2020HD is in the cooling state.	Status Input INCOOLINGSTATE
Generator States, In Cranking State True when the DGC-2020HD is in the cranking state.	Status Input INCRANKINGSTATE
Generator States, In Disconnect State True when the DGC-2020HD is in the disconnect state.	Status Input INDISCONNECTSTATE
Generator States, In Prestart State True when the DGC-2020HD is in the pre-start state.	Status Input INPRESTARTSTATE
Generator States, In Pulsing State True when the DGC-2020HD is in the pulsing state.	Status Input INPULSINGSTATE
Generator States, In Ready State True when the DGC-2020HD is in the ready state.	Status Input INREADYSTATE
Generator States, In Resting State True when the DGC-2020HD is in the resting state.	Status Input INRESTINGSTATE
Generator States, In Running State True when the DGC-2020HD is in the running state.	Status Input INRUNNINGSTATE
Generator States, In Unloading State True when the DGC-2020HD is in the unloading state.	Status Input INUNLOADINGSTATE
Mains Fail Transfer, Power from Mains True when power to the load is being supplied by the mains bus.	Status Input MF_XFR_POWER_FROM_MAINS
Off Mode True when the DGC-2020HD is in Off Mode or the Off Mode logic element is true.	Status Input OFFMODE
Off Mode Cool Down True when the DGC-2020HD is in Off Mode and cooling down.	Status Input OFFMODECOOLDOWN
Online Capacity Greater Than Block Load True when online generator capacity is greater than the active block load level.	Status Input ONLINECAPGRTRTHANBLKLOAD
Online Capacity Greater Than System Load True when online generator capacity is greater than the system load.	Status Input ONLINECAPGRTRTHANSYSLOAD
Open Transition Delay Active True when the open transition delay is actively counting.	Status Input OPENTRANSITIONDELAYACTIVE
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

Name/Description	Symbol
Parallel to Mains Detected True when the generator is parallel to mains based on known closed breakers in system. This status can be connected directly to the PARTOMAINS logic element or combined with additional logic to determine unit is parallel to mains.	Status Input PARALLELEDTOMAINSDETECTED
Peak Shave Mode Active True when Peak Shave control mode is active.	Status Input PEAKSHAVEMODEACTIVE
Peak Shave In Progress True when peak shaving is in progress.	Status Input PEAKSHAVEINPROGRESS
PF Mode Active True when PF mode is active.	Status Input PFMODEACTIVE
Pre Start Relay Status True when the DGC-2020HD is indicating that the Pre Start relay should be closed.	Status Input PRESTART
Predefined Prestart State True when the DGC-2020HD commands the Prestart relay to close under default (predefined) operation.	Status Input PREDEFINEDPRESTART
Predefined Run State True when the DGC-2020HD commands the Run relay to close under default (predefined) operation.	Status Input PREDEFINEDRUN
Predefined Start State True when the DGC-2020HD commands the Start relay to close under default (predefined) operation.	Status Input PREDEFINEDSTART
Programmable Inputs, Analog Inputs, Input #x, Threshold x True when the threshold has been exceeded.	Status Input - AI1PROTTHRESH1TRIP Analog In 1
Programmable Inputs, Analog Inputs, Input #x, Out of Range True when the analog input connection is open.	Status Input - AI1INPUTRANGE Analog In 1
Programmable Inputs, Remote Analog Inputs, AEM x, Input #x, Threshold x Trip True when the threshold has been exceeded.	Status Input - AEM1PROT1THRESH1TRIP AEM1 In1
Programmable Inputs, Remote Analog Inputs, AEM x, Input #x, Out of Range True when the remote analog input connection is open.	Status Input - AEM1INPUT1RANGE AEM1 In1
Programmable Inputs, Remote RTD Inputs, AEM x, RTD Input #x, Threshold x Trip True when the threshold has been exceeded.	Status Input - AEM1RTDPROT1THRESH1TRIP AEM1 RTD1
Programmable Inputs, Remote RTD Inputs, AEM x, RTD Input #x, Out of Range True when the remote RTD input connection is open.	Status Input - AEM1RTDINPUT1RANGE AEM1 RTD1
Programmable Inputs, Remote Thermocouple Inputs, AEM x, Thermocouple Input #x, Threshold x Trip True when the threshold has been exceeded.	Status Input - AEM1TCPROT1THRESH1TRIP AEM1 TC1
Programmable Outputs, Configurable Elements, Element x True when the Configurable Element x logic element is true.	Status Input - CONFIGELEMENT1OUTPUT Config Element 1
Programmable Outputs, Remote Analog Outputs, AEM x, Output #x, Out of Range True when the remote analog output connection is open.	Status Input - AEM1OUTPUT1RANGE No Parameter Selected
Seven Day Timer, Sunday through Saturday, Timer x True while timer x is active.	Status Input SUNDAY1_EVENTACTIVE

Name/Description	Symbol
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
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 SYNCPHASEOK
Sync Slip Frequency OK True when the auto synchronizer is running and the slip frequency between the bus voltage input and the generator voltage input are within the limits indicated by the slip frequency setting.	Status Input SYNCFREQOK
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 SYNCVOLTOK
System Breaker Status, Gen Breaker, System Gen Breaker Closed True when any generator breaker in the segmented system is closed.	Status Input SYSGENBKRCLOSED
System Breaker Status, Group Breaker, State True when the group breaker of the segmented system is closed.	Status Input SYSGROUPBREAKERSTATUS
System Breaker Status, Group Breaker, OK to Close True when the group breaker of the segmented system is OK to close.	Status Input SYSGROUPBREAKEROKTOCLOSE
System Breaker Status, Group Breaker, Fail to Close True when the group breaker of the segmented system fails to close.	Status Input SYSGROUPBKRFAILTOCLOSE
System Breaker Status, Group Breaker, Fail to Open True when the group breaker of the segmented system fails to open.	Status Input SYSGROUPBKRFAILTOOPEN
System Breaker Status, Mains Breaker, State True when the mains breaker of the segmented system is closed.	Status Input SYSMAINSBREAKERSTATUS
System Breaker Status, Mains Breaker, OK to Close True when the mains breaker of the segmented system is OK to close.	Status Input SYSMAINSBREAKEROKTOCLOSE
System Breaker Status, Mains Breaker, Fail to Close True when the mains breaker of the segmented system fails to close.	Status Input SYSMAINSBKRFAILTOCLOSE
System Breaker Status, Mains Breaker, Fail to Open True when the mains breaker of the segmented system fails to open.	Status Input SYSMAINSBKRFAILTOOPEN
System Bus Status, Group Bus, Dead True when the group bus voltage of the segmented system is below the dead bus threshold.	Status Input SYSGROUPBUSDEAD

Name/Description	Symbol
System Bus Status, Group Bus, Fail True when the group bus of the segmented system is outside the appropriate stable bus conditions.	Status Input SYSGROUPBUSFAILED
System Bus Status, Group Bus, Forward Rotation True when the group bus rotation of the segmented system matches the Phase Rotation setting.	Status Input SYSGROUPBUSFWROTATION
System Bus Status, Group Bus, Reverse Rotation True when the group bus rotation of the segmented system is opposite of the Phase Rotation setting.	Status Input SYSGROUPBUSREVROTATION
System Bus Status, Group Bus, Stable True when the group bus of the segmented system is within the appropriate stable bus conditions.	Status Input SYSGROUPBUSSTABLE
System Bus Status, Load Bus, Dead True when the load bus voltage of the segmented system is below the dead bus threshold.	Status Input SYSLOADBUSDEAD
System Bus Status, Load Bus, Fail True when the load bus of the segmented system is outside the appropriate stable bus conditions.	Status Input SYSLOADBUSFAILED
System Bus Status, Load Bus, Forward Rotation True when the load bus rotation of the segmented system matches the Phase Rotation setting.	Status Input SYSLOADBUSFWROTATION
System Bus Status, Load Bus, Reverse Rotation True when the load bus rotation of the segmented system is opposite of the Phase Rotation setting.	Status Input SYSLOADBUSREVROTATION
System Bus Status, Load Bus, Stable True when the load bus of the segmented system is within the appropriate stable bus conditions.	Status Input SYSLOADBUSSTABLE
System Bus Status, Mains Bus, Dead True when the mains bus voltage of the segmented system is below the dead bus threshold.	Status Input SYSMAINSBUSDEAD
System Bus Status, Mains Bus, Fail True when the mains bus of the segmented system is outside the appropriate stable bus conditions.	Status Input SYSMAINSBUSFAILED
System Bus Status, Mains Bus, Forward Rotation True when the mains bus rotation of the segmented system matches the Phase Rotation setting.	Status Input SYSMAINSBUSFWROTATION
System Bus Status, Mains Bus, Reverse Rotation True when the mains bus rotation of the segmented system is opposite of the Phase Rotation setting.	Status Input SYSMAINSBUSREVROTATION
System Bus Status, Mains Bus, Stable True when the mains bus of the segmented system is within the appropriate stable bus conditions.	Status Input SYSMAINSBUSSTABLE
Using Trim Voltage Setting True when voltage trim is active.	Status Input USINGTRIMVOLTAGESETTING
var Mode Active True when var mode is active.	Status Input VARMODEACTIVE
VRM, Connected True when an optional VRM-2020 is connected to the DGC-2020HD.	Status Input VRM_CONNECTED
VRM, EDM Pickup True when the optional VRM-2020 Exciter Diode Monitor has picked up.	Status Input EDMPICKUP

Name/Description	Symbol
VRM, Field Overvoltage Pickup True when the Field Overvoltage element has picked up.	Status Input FOVPICKUP
VRM, Loss of Sensing Pickup True when the Loss of Sensing element has picked up.	Status Input LOSSOFSENSINGPICKUP
VRM, AVR Active True when AVR operating mode is active.	Status Input AVR_ACTIVE
VRM, FCR Active True when FCR operating mode is active.	Status Input FCR_ACTIVE
VRM, OEL Active True when the overexcitation limiter is active.	Status Input OEL_ACTIVE
VRM, UEL Active True when the underexcitation limiter is active.	Status Input UEL_ACTIVE
VRM, Underfrequency Active True when the underfrequency limiter is active.	Status Input UNDERFREQUENCY_ACTIVE
VRM, Setpoint Upper Limit True when the active operating mode setpoint has reached the upper limit.	Status Input SETPOINT_UPPER_LIMIT
VRM, Setpoint Lower Limit True when the active operating mode setpoint has reached the lower limit.	Status Input SETPOINT_LOWER_LIMIT
VRM, Pre-position X Active True when pre-position X is enabled for the active operating mode.	Status Input PP1_ACTIVE
VRM, Soft Start Active True when the soft start function is active.	Status Input SOFT_START_ACTIVE
VRM, Regulator Started True when the DGC-2020HD is regulating with the VRM-2020.	Status Input REGULATOR_STARTED
VRM, Gen Below 10 Hz True when the measured generator frequency is less than 10 Hz.	Status Input GENBELOW10HZ
VRM, Null Balance True when the setpoint of the inactive operating modes match the setpoint of the active mode.	Status Input NULLBALANCE
VRM, RTDs, RTD Input X, Threshold X Trip True when the Alarm Configuration is set to Status Only and the threshold has been exceeded for the duration of the activation delay.	Status Input - VRM1RTDPROT1THRESH1TRIP VRM RTD1
VRM, RTDs, RTD Input X, Out of Range	Status Input - VRM1RTDINPUT1RANGE VRM RTD1

Table 91. I/O Group, Alarms

Name/Description	Symbol
Auto Restart Fail True after the Automatic Restart function fails to restart the generator.	Alarm AUTORESTARTFAILALM

Name/Description	Symbol
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 AVROUTPUTRANGEALM
Battery Charger Fail True when the Battery Charger Fail function is configured as an alarm and the activation delay has expired.	Alarm BATTERYCHARGERFAILPFALM
Configurable Protection, Configurable Protection #x, Threshold x True when the Alarm Configuration is set to Alarm and the threshold has been exceeded.	Alarm - CONFIGPROT1THRESH1ALM CnfPrt 1
DEF Severe Inducement This 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.	Alarm DEFSEVINDUCEMENTALM
ECU Comm Loss True when communication to the ECU has been lost.	Alarm LOSSOFECUCOMMALM
ECU Shutdown True when the ECU has shut down the engine.	Alarm ECUCONFIGSHUTDOWNALM
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
Generator Protection, Voltage, Undervoltage (27-x) True when the 27-x element is configured as an alarm and has tripped.	Alarm 27PROT1ALM
Generator Protection, Voltage, Overvoltage (59-x) True when the 59-x element is configured as an alarm and has tripped.	Alarm 59PROT1ALM
Generator Protection, Voltage, Phase Imbalance (47-x) True when the 47-x element is configured as an alarm and has tripped.	Alarm 47PROT1ALM
Generator Protection, Frequency, Frequency (81-x) True when the 81-x element is configured as an alarm and has tripped.	Alarm 81PROT1ALM
Generator Protection, Current, Current Imbalance (46-x_1P) True when the 46-x single-phase element is configured as an alarm and has tripped.	Alarm 46_1P_PROT1ALM
Generator Protection, Current, Current Imbalance (46-x_3P) True when the 46-x three-phase element is configured as an alarm and has tripped.	Alarm 46_3P_PROT1ALM
Generator Protection, Current, Overcurrent Trip (51-x) True when the 51-x element is configured as an alarm and has tripped.	Alarm 51PROT1ALM
Generator Protection, Current, Phase Differential Trip (87-1) True when the 87-1 element is configured as an alarm and has tripped.	Alarm 87PROT1ALM
Generator Protection, Current, Neutral Differential Trip (87N-1) True when the 87N-1 element is configured as an alarm and has tripped.	Alarm 87NPROT1ALM
Generator Protection, Power, Power (32-x) True when the 32-x element is configured as an alarm and has tripped.	Alarm 32PROT1ALM

Name/Description	Symbol
Generator Protection, Power, Loss of Excitation (40Q-x) True when the 40Q-x element is configured as an alarm and has tripped.	Alarm 40QPROT1ALM
Generator Protection, Loss of MAINS Protection, Vector Shift (78-x) True when the 78-x element is configured as an alarm and has tripped.	Alarm 78PROT1ALM
Overspeed True when the Overspeed Alarm settings have been exceeded.	Alarm OVERSPEEDALM
Programmable Inputs, 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
Programmable Inputs, Analog Inputs, Input #x, Threshold x True when the Alarm Configuration is set to Alarm and the threshold has been exceeded.	Alarm - AI1PROTTHRESH1ALM Analog In 1
Programmable Inputs, Analog Inputs, Input #x, 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 In 1
Programmable Inputs, Remote Contact Inputs, CEM x, 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 CEM1 Input 1
Programmable Inputs, Remote Analog Inputs, AEM x, Input #x, Threshold #x True when the Alarm Configuration is set to Alarm and the threshold has been exceeded.	Alarm - AEM1PROT1THRESH1ALM AEM1 In1
Programmable Inputs, Remote Analog Inputs, AEM x, Input #x, 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 AEM1 In1
Programmable Inputs, Remote RTD Inputs, AEM x, RTD Input #x, Threshold x True when the Alarm Configuration is set to Alarm and the threshold has been exceeded.	Alarm - AEM1RTDPROT1THRESH1ALM AEM1 RTD1
Programmable Inputs, Remote RTD Inputs, AEM x, RTD Input #x, 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 AEM1 RTD1
Programmable Inputs, Remote Thermocouple Inputs, AEM x, Thermocouple Input #x, Threshold x True when the Alarm Configuration is set to Alarm and the threshold has been exceeded.	Alarm - AEM1TCPROT1THRESH1ALM AEM1 TC1
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 Config Element 1
Programmable Outputs, Remote Analog Outputs, AEM x, Output #x, 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
Sender Fail, 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
Sender Fail, Coolant Temp Sender Fail True when the Coolant Temp Sender Fail is configured as an alarm and the activation delay has expired.	Alarm COOLANTTEMPSFALM
Sender Fail, Oil Pressure Sender Fail True when the Oil Pressure Sender Fail is configured as an alarm and the activation delay has expired.	Alarm OILPRESSURESFALM

Name/Description	Symbol
Sender Fail, Fuel Level Sender Fail True when the Fuel Level Sender Fail is configured as an alarm and the activation delay has expired.	Alarm FUELLEVELSFALM
Sender Fail, Voltage Sensing Fail True when the Voltage Sensing Fail is configured as an alarm and the activation delay has expired.	Alarm VOLTAGESENSINGSFALM
Sender Fail, Speed Sender Fail True when the Speed Sender Fail activation delay has expired.	Alarm SPEEDSFALM
Unexpected Shutdown True when the metered engine speed (RPM) unexpectedly drops to zero (0) while the engine is running.	Alarm UNEXPECTEDSHUTDOWNALM
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 Prog Alarm 1 Name
VRM, Crowbar Activated True when the crowbar circuit has activated.	Alarm CROWBARACTIVATED
VRM, EDM Alarm True when the Exciter Diode Monitor is configured as an alarm and has tripped.	Alarm EDMALARM
VRM, Field Overvoltage Alarm True when the Field Overvoltage element is configured as an alarm and has tripped.	Alarm FLD_OV_ALARM
VRM, Field Short Circuit Status True when the field current exceeds approximately 10.8 A and the VRM-2020 stops regulation.	Alarm FIELDSHORTCIRCUITSTATUS
VRM, Loss of Sensing Alarm True when the Loss of Sensing element is configured as an alarm and has tripped.	Alarm LOSS_OF_SENSING_ALARM
VRM, OEL Alarm True when the overexcitation limiter is configured as an alarm and has activated.	Alarm OEL_ALARM
VRM, UEL Alarm True when the underexcitation limiter is configured as an alarm and has activated.	Alarm UEL_ALARM
VRM, V/Hz Alarm True when the underfrequency limiter is configured as an alarm and has activated.	Alarm VHZ_ALARM
VRM, RTDs, RTD Input #X, Threshold X True when the Alarm Configuration is set to Alarm and the threshold has been exceeded for the duration of the activation delay.	Alarm - VRM1RTDPROT1THRESH1ALARM VRM RTD1
VRM, RTDs, RTD Input X, Out of Range True when the RTD input connection is open and the Out of Range Alarm Type is set to Alarm.	Alarm - VRM1RTDINPUT1RANGEALARM VRM RTD1

Table 92. I/O Group, Pre-Alarms

Name/Description	Symbol
ARP (Address Resolution Protocol) Ping Fail True when at least one device is not reachable from either Ethernet link. See Redundant Ethernet settings in the *Communication* chapter for more information.	Pre-Alarm ARPPINGFAIL
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

Name/Description	Symbol
Battery Charger Fail True when the Battery Charger Fail function is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm BATTERYCHARGERFAILPFPALM
Battle Override True when battle override is configured as a pre-alarm and the assigned contact input is true.	Pre-Alarm BATTLEOVERRIDEPFPALM
Breaker Control Grant Fail True when no DGC-2020HDs are granted control over a breaker after a fixed five second delay.	Pre-Alarm BREAKERCONTROLGRANTFAIL
Breaker Status, 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 fail wait time has expired.	Pre-Alarm GENBREAKERFAILTOCLOSE
Breaker Status, 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 fail wait time has expired.	Pre-Alarm GENBREAKERFAILTOOPEN
Breaker Status, 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
Breaker Status, Group Breaker, Close Failure True when a group breaker close fail pre-alarm occurs. The pre-alarm occurs when the DGC-2020HD has issued a group breaker close output but does not receive a group breaker status input that indicates the breaker has closed before the breaker fail wait time has expired.	Pre-Alarm GROUPBREAKERFAILTOCLOSE
Breaker Status, Group Breaker, Open Failure True when a group breaker open fail pre-alarm occurs. The pre-alarm occurs when the DGC-2020HD has issued a group breaker open output but does not receive a group breaker status input that indicates the breaker has opened before the breaker fail wait time has expired.	Pre-Alarm GROUPBREAKERFAILTOOPEN
Breaker Status, Group Breaker, Sync Failure True when a group breaker sync fail pre-alarm occurs. The pre-alarm occurs when the synchronizer is running and attempting to close the group breaker but the sync fail activation delay expires prior to achieving breaker closure.	Pre-Alarm GROUPBREAKERSYNCFAIL
Breaker Status, 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 fail wait time has expired.	Pre-Alarm MAINSBREAKERFAILTOCLOSE
Breaker Status, 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 fail wait time has expired.	Pre-Alarm MAINSBREAKERFAILTOOPEN
Breaker Status, Mains Breaker, Sync Failure True when a mains breaker sync fail pre-alarm occurs. 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 MAINSBREAKERSYNCFAIL

Name/Description	Symbol
Breaker Status, Tie Breaker, Close Failure True when a tie breaker close fail pre-alarm occurs. The pre-alarm occurs when the DGC-2020HD has issued a tie breaker close output but does not receive a tie breaker status input that indicates the first tie breaker has closed before the breaker fail wait time has expired.	Pre-Alarm TIEBREAKERFAILTOCLOSE
Breaker Status, Tie Breaker, Open Failure True when a tie breaker open fail pre-alarm occurs. The pre-alarm occurs when the DGC-2020HD has issued a tie breaker open output but does not receive a tie breaker status input that indicates the first tie breaker has opened before the breaker fail wait time has expired.	Pre-Alarm TIEBREAKERFAILTOOPEN
Breaker Status, Tie Breaker, Sync Failure True when a tie breaker sync fail pre-alarm occurs. The pre-alarm occurs when the synchronizer is running and attempting to close the first tie breaker but the sync fail activation delay expires prior to achieving breaker closure.	Pre-Alarm TIEBREAKERSYNCFAIL
Breaker Status, Tie Breaker 2, Close Failure True when a Tie Breaker 2 close fail pre-alarm occurs. The pre-alarm occurs when the DGC-2020HD has issued a tie breaker close output but does not receive a Tie Breaker 2 status input that indicates the breaker has closed before the breaker fail wait time has expired.	Pre-Alarm TIEBREAKER2FAILTOCLOSE
Breaker Status, Tie Breaker 2, Open Failure True when a Tie Breaker 2 open fail pre-alarm occurs. The pre-alarm occurs when the DGC-2020HD has issued a tie breaker open output but does not receive a Tie Breaker 2 status input that indicates the breaker has opened before the breaker fail wait time has expired.	Pre-Alarm TIEBREAKER2FAILTOOPEN
Breaker Status, Tie Breaker 2, Sync Failure True when a Tie Breaker 2 sync fail pre-alarm occurs. The pre-alarm occurs when the synchronizer is running and attempting to close Tie Breaker 2 but the sync fail activation delay expires prior to achieving breaker closure.	Pre-Alarm TIEBREAKER2SYNCFAIL
Bus Status, Bus x, Reverse Rotation True when the Bus x rotation is opposite of the Phase Rotation setting.	Pre-Alarm - BUS1REVERSEROTATIONPALM Bus 1 Reverse Rotation
Bus Status, Gen, Reverse Rotation True when the generator bus rotation is opposite of the Phase Rotation setting.	Pre-Alarm - GENREVERSEROTATIONPALM Gen Reverse Rotation
Communications, Analog Expansion Modules, AEM Unsupported Number True when more AEM-2020s are connected than are configured on the System Parameters, Remote Module Setup screen in BESTCOMS*Plus*.	Pre-Alarm UNSUPPORTEDNUMAEM
Communications, Analog Expansion Modules, AEM x Comm Fail True when communication from the AEM-2020 to the DGC-2020HD has been lost.	Pre-Alarm AEM1COMMSFAILURE
Communications, Analog Expansion Modules, AEM x Not Configured True when the expected serial number on the System Parameters, Remote Module Setup screen in BESTCOMS*Plus* does not match the serial number detected on the General Settings, Device Info screen.	Pre-Alarm AEM1NOTCONFIGURED
Communications, Contact Expansion Modules, CEM Unsupported Number True when more CEM-2020s are connected than are configured on the System Parameters, Remote Module Setup screen in BESTCOMS*Plus*.	Pre-Alarm UNSUPPORTEDNUMCEM
Communications, Contact Expansion Modules, CEM x Comm Fail True when communication from the CEM-2020 to the DGC-2020HD has been lost.	Pre-Alarm CEM1COMMSFAILURE

Name/Description	Symbol
Communications, Contact Expansion Modules, 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 BESTCOMS*Plus*.	Pre-Alarm CEM1HWMISMATCH
Communications, Contact Expansion Modules, CEM x Not Configured True when the expected serial number on the System Parameters, Remote Module Setup screen in *BESTCOMSPlus* does not match the serial number detected on the General Settings, Device Info screen.	Pre-Alarm CEM1NOTCONFIGURED
Communications, Ethernet Link 1 Loss True when Ethernet Link 1 connection is lost.	Pre-Alarm ETH1LLALM
Communications, Ethernet Link 2 Loss True when Ethernet Link 2 connection is lost.	Pre-Alarm ETH2LLALM
Communications, VRM Comm Fail True when communication from the VRM-2020 to the DGC-2020HD has been lost.	Pre-Alarm VRMCOMMSFAILURE
Configurable Protection, Configurable Protection #x, Threshold x True when the Alarm Configuration is set to Pre-Alarm and the threshold has been exceeded.	Pre-Alarm - CONFIGPROT1THRESH1PALM CnfPrt 1
DEF Tampering True when the engine ECU reports "DEF Tampering" via CAN Bus.	Pre-Alarm DEFTAMPERING
DEF Warning This pre-alarm indicates the first level of warning when EATS is not functioning properly or DEF quality or level is not sufficient for proper operation.	Pre-Alarm DEFWARNING
DEF Warning Level 2 This pre-alarm indicates the second level of warning when EATS is not functioning properly or DEF quality or level is not sufficient for proper operation.	Pre-Alarm DEFWARNINGLVL2
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
Generator Protection, Frequency, Frequency (81-x) True when the 81-x element is configured as a pre-alarm and has tripped.	Pre-Alarm 81PROT1PALM

Name/Description	Symbol
Generator Protection, Power, Loss of Excitation (40Q-x) True when the 40Q-x element is configured as a pre-alarm and has tripped.	Pre-Alarm 40QPROT1PALM
Generator Protection, Current, Current Imbalance (46-x_1P) True when the 46-x single-phase element is configured as a pre-alarm and has tripped.	Pre-Alarm 46_1P_PROT1PALM
Generator Protection, Current, Current Imbalance (46-x_3P) True when the 46-x three-phase element is configured as a pre-alarm and has tripped.	Pre-Alarm 46_3P_PROT1PALM
Generator Protection, Current, Overcurrent (51-x) True when the 51-x element is configured as a pre-alarm and has tripped.	Pre-Alarm 51PROT1PALM
Generator Protection, Current, Phase Differential (87-1) True when the 87-x element is configured as a pre-alarm and has tripped.	Pre-Alarm 87PROT1PALM
Generator Protection, Current, Neutral Differential (87N-1) True when the 87N-x element is configured as a pre-alarm and has tripped.	Pre-Alarm 87NPROT1PALM
Generator Protection, Voltage, Overvoltage (59-x) True when the 59-x element is configured as a pre-alarm and has tripped.	Pre-Alarm 59PROT1PALM
Generator Protection, Voltage, Phase Imbalance (47-x) True when the 47-x element is configured as a pre-alarm and has tripped.	Pre-Alarm 47PROT1PALM
Generator Protection, Power, Power (32-x) True when the 32-x element is configured as a pre-alarm and has tripped.	Pre-Alarm 32PROT1PALM
Generator Protection, Voltage, Undervoltage (27-x) True when the 27-x element is configured as a pre-alarm and has tripped.	Pre-Alarm 27PROT1PALM
Generator Protection, Loss of MAINS Protection, Vector Shift (78-x) True when the 78-x element is configured as a pre-alarm and has tripped.	Pre-Alarm 78PROT1PALM
Maintenance Interval True when the Maintenance Interval Pre-Alarm threshold has been exceeded.	Pre-Alarm GENRUNSTATSMAINTENANCEDUE
Missing System Components True when the expected number of tie breaker controllers is incorrect.	Pre-Alarm MISSINGSYSTEMCOMP
MPU Fail True when the MPU has failed.	Pre-Alarm MPUFAILPALM
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 UNITIDMISSINGPALM
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 UNITIDREPEATPALM
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 NTPALM
Programmable Inputs, Analog Inputs, Input #x, 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

Name/Description	Symbol
Programmable Inputs, Analog Inputs, Input #x, Threshold x True when the Alarm Configuration is set to Pre-Alarm and the threshold has been exceeded.	Pre-Alarm - AI1PROTTHRESH1PALM Analog Input 1
Programmable Inputs, 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
Programmable Inputs, Remote Analog Inputs, AEM x, Input #x, 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 AEM1 In1
Programmable Inputs, Remote Analog Inputs, AEM x, Input #x, Threshold True when the Alarm Configuration is set to Pre-Alarm and the threshold has been exceeded.	Pre-Alarm - AEM1PROT1THRESH1PALM AEM1 In1
Programmable Inputs, Remote Contact Inputs, CEM1, 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 CEM1 Input 1
Programmable Inputs, Remote RTD Inputs, AEM x, RTD Input #x, 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 AEM1 RTD1
Programmable Inputs, Remote RTD Inputs, AEM x, RTD Input #x, Threshold True when the Alarm Configuration is set to Pre-Alarm and the threshold has been exceeded.	Pre-Alarm - AEM1RTDPROT1THRESH1PALM AEM1 RTD1
Programmable Inputs, Remote Thermocouple Inputs, AEM x, Thermocouple Input #x, Threshold True when the Alarm Configuration is set to Pre-Alarm and the threshold has been exceeded.	Pre-Alarm - AEM1TCPROT1THRESH1PALM AEM1 TC1
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 Config Element 1
Programmable Outputs, Remote Analog Outputs, AEM x, Output #x, 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
Sender Fail, 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
Sender Fail, 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
Sender Fail, 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
Sender Fail, Voltage Sensing Fail True when the Voltage Sensing Fail is configured as a pre-alarm and the activation delay has expired.	Pre-Alarm VOLTAGESENSINGSFPALM
VRM, EDM Pre-Alarm True when the Exciter Diode Monitor is configured as a pre-alarm and has tripped.	Pre-Alarm EDMPREALARM
VRM, Field Overvoltage Pre-Alarm True when the Field Overvoltage element is configured as a pre-alarm and has tripped.	Pre-Alarm FLD_OV_PREALARM

Name/Description	Symbol
VRM, Loss of Sensing Pre-Alarm True when the Loss of Sensing element is configured as a pre-alarm and has tripped.	Pre-Alarm LOSS_OF_SENSING_PREALARM
VRM, OEL Pre-Alarm True when the overexcitation limiter is configured as a pre-alarm and has activated.	Pre-Alarm OEL_PALM
VRM, UEL Pre-Alarm True when the underexcitation limiter is configured as a pre-alarm and has activated.	Pre-Alarm UEL_PALM
VRM, V/Hz Pre-Alarm True when the underfrequency limiter is configured as a pre-alarm and has activated.	Pre-Alarm VHZ_PALM
VRM, Gen Below 10 Hz Pre-Alarm True when the Gen Below 10 Hz pre-alarm is enabled and the generator frequency is below 10 Hz.	Pre-Alarm GENBELOW10HZPREALARM
VRM, RTDs, RTD Input X, Threshold X True when the Alarm Configuration is set to Pre-Alarm and the threshold has been exceeded for the duration of the activation delay.	Pre-Alarm - VRM1RTDPROT1THRESH1PALM VRM RTD1
VRM, RTDs, RTD Input X, Out of Range True when the RTD input connection is open and the Out of Range Alarm Type is set to Pre-Alarm.	Pre-Alarm - VRM1RTDINPUT1RANGEPALM VRM RTD1

Table 93. 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
Voltage Sensing Fail True when the Voltage Sensing Fail is configured as either a pre-alarm or alarm and the activation delay has expired.	Sender Fail VOLTAGESENSINGSF

Table 94. I/O Group, Logic Control Relays

Name/Description	Symbol
Input 1-64 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 64) 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.	LCR Input LCRINPUT1

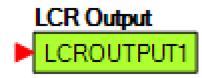
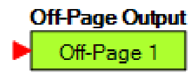
Name/Description	Symbol
Output 1-64 See description above.	

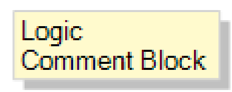
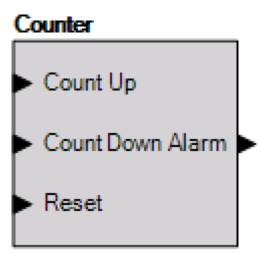
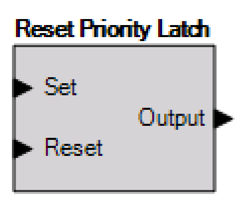
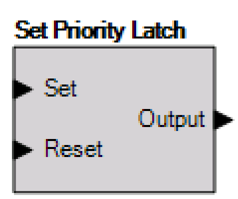
Table 95. I/O Group, Off-Page Objects

Name/Description	Description	Symbol
Off-Page Output	When the input is true, the corresponding input of the same name becomes true. When placing an Off-Page Output into the logic diagram, the user is prompted to name the output. Then, the corresponding input becomes available in the Input List.	
Off-Page Input	True when the corresponding Off-Page Output of the same name is true.	

Components

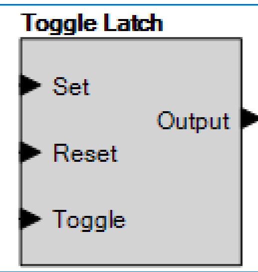
This group contains Comment Blocks, Latches, Logic Counters, Logic Gates, Logic Gates, Pickup and Dropout Timers, Latches, Logic Counters, and Comment Blocks. Table 96 lists the names and descriptions of the objects in the Components group.

Table 96. 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	
Counter 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.	
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.	

Name/Description	Symbol

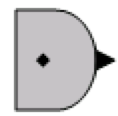
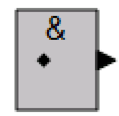
Toggle Latch
The latch is set when the Set input is true. The latch is cleared when the Set input is false and the Reset input is true. The latch is toggled when the Set and Reset inputs are false and the Toggle input is true.



Logic Gates — ANSI* / IEC*

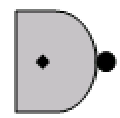
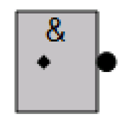
AND

Input		Output
0	0	0
0	1	0
1	0	0
1	1	1

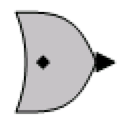
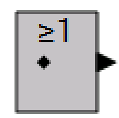
NAND

Input		Output
0	0	1
0	1	1
1	0	1
1	1	0

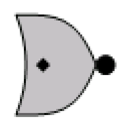
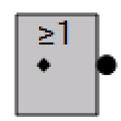
OR

Input		Output
0	0	0
0	1	1
1	0	1
1	1	1

NOR

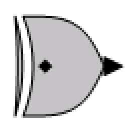
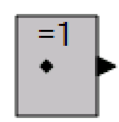
Input		Output
0	0	1
0	1	0
1	0	0
1	1	0

XOR

Input		Output
0	0	0
0	1	1
1	0	1
1	1	0

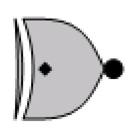
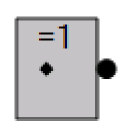
When an XOR gate has more than 2 inputs, the output is true whenever an odd number of inputs are true.

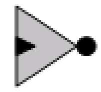
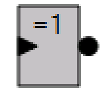
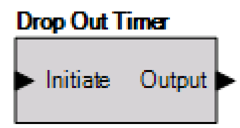
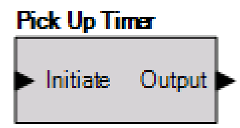
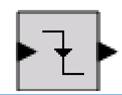
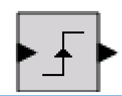



XNOR

Input		Output
0	0	1
0	1	0
1	0	0
1	1	1

When an XNOR gate has more than 2 inputs, the output is true whenever an even number of inputs are true. The output is also true if no inputs are true.

Name/Description	Symbol
NOT (INVERTER) Input | Output 0 | 1 1 | 0	 
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 *Pickup and Dropout Timers*. 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 *Pickup and Dropout Timers*. 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 BESTlogic*Plus* toolbar.

Programming Pickup and Dropout Timers

To program logic timer settings, use the Settings Explorer within BESTCOMS*Plus* to open the BESTlogic*Plus* Programmable Logic/Logic Timers tree branch. Enter a Name label that you want to appear on the timer logic block. The Time Delay value range is 0 to 250 hours in 1 hour increments, 0 to 250 minutes in 1 minute increments, or 0 to 1,800 seconds in 0.1 second increments.

Next, open the Components tab inside the BESTlogic*Plus* window and drag a timer onto the program grid. Right click on the timer to select the timer you want to use that was previously set on the Logic Timers tree branch. The Logic Timer Properties Dialog Box will appear. Select the timer you want to use.

Pickup and dropout logic timer logic blocks are shown in Figure 214*.* Timing accuracy is ±15 milliseconds.

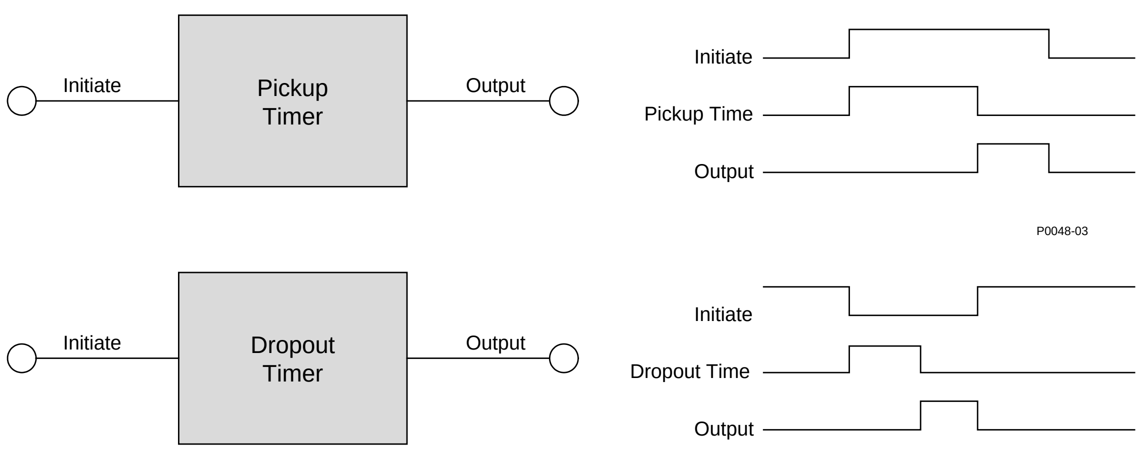


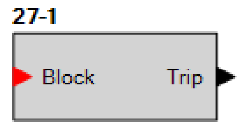
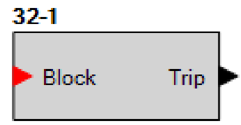
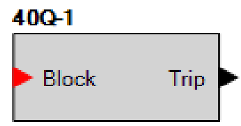
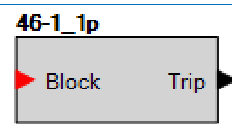
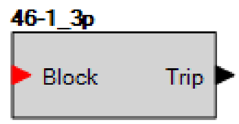
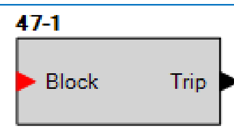
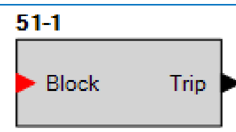
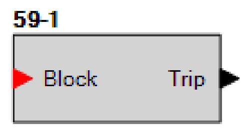
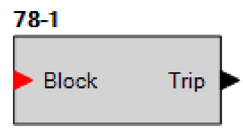
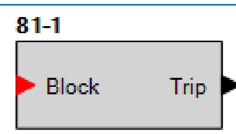
Figure 214. Pickup and Dropout Timer Logic Blocks

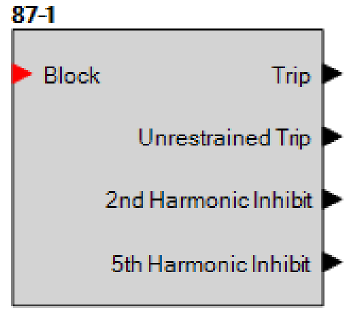
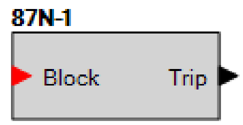
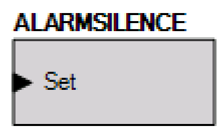
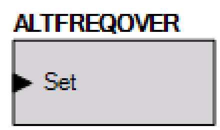
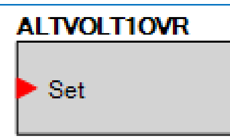
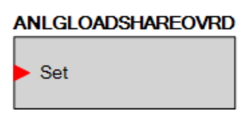
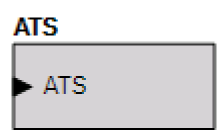
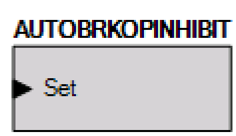
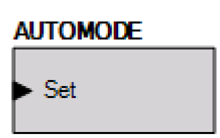
Elements

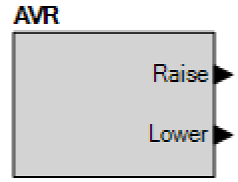
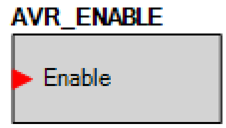
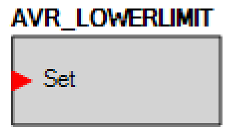
This group contains protection and control elements.

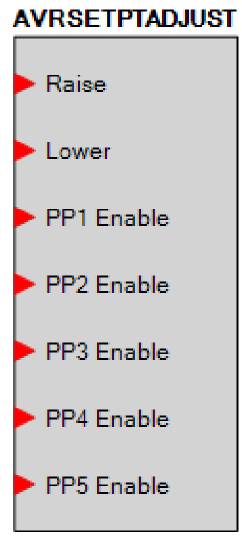
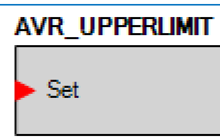
Table 97 lists the names and descriptions of the elements in the Elements group.

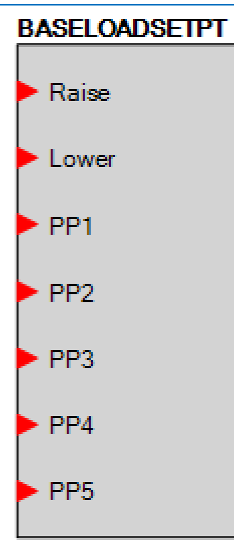
Table 97. Elements Group, Names and Descriptions

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.	
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.	
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.	
46-x_1P When the Block input is true, the 46-x_1P element is disabled. The Trip output is true when the 46-x_1P single-phase current imbalance element is in a trip condition. Connect to another logic block input.	
46-x_3P When the Block input is true, the 46-x_3P element is disabled. The Trip output is true when the 46-x_3P three-phase current imbalance element is in a trip condition. Connect to another logic block input.	
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.	
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.	
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.	
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.	
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.	

Name/Description	Symbol
87-1 When the Block input is true, the 87-1 element is disabled. The Trip output is true when the 87-1 phase differential element is tripped in the restrained area or unrestrained is disabled. The Unrestrained Trip output is true when the 87-1 element is tripped above the unrestrained level. The 2nd Harmonic Inhibit output is true when 2nd harmonic is blocking trip. The 5th Harmonic Inhibit output is true when 5th harmonic is blocking trip. Connect the outputs to other logic block inputs.	
87N-1 When the Block input is true, the 87N-1 element is disabled. The Trip output is true when the 87N-1 neutral differential element is in a trip condition. Connect to another logic block input.	
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.	
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.	
Alternate Voltage Override When the Set input is true, the alternate voltage value associated with this element becomes the active voltage trim value.	
Analog Load Share Override When the Set input is true, the DGC-2020HD utilizes analog load share lines, rather than Ethernet, for load sharing.	
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.	
Automatic Breaker Operation Inhibit Automatic breaker operation is inhibited when the Set input is true.	
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.	

<table>
<tr><th>Name/Description</th><th>Symbol</th></tr>
<tr><td>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.</td><td>
</td></tr>
<tr><td>AVR Enable (VRM-2020)
When true, this element sets the unit to AVR mode.</td><td>
</td></tr>
<tr><td>AVR Lower Limit
(VRM-2020)
When true, the integration of negative error into the voltage trim and var/PF controllers is prevented. Positive error integration is allowed. This is especially useful when the UEL is active.</td><td>
</td></tr>
<tr><td>AVR Setpoint Adjust
(VRM-2020)
Raise/lower: When true, the raise and lower inputs adjust the operating setpoint.

Pre-position X Enable: When true, the associated pre-position becomes the active AVR setpoint.</td><td>
</td></tr>
<tr><td>AVR Upper Limit
(VRM-2020)
When true, the integration of positive error into the voltage trim and var/PF controllers is prevented. Negative error integration is allowed. This is especially useful when the OEL is active.</td><td>
</td></tr>
<tr><td>Base Load Setpoint
Raise/lower: When true, the raise and lower inputs adjust the operating setpoint.

Pre-position x: When true, the associated pre-position becomes the active base load setpoint.</td><td>
</td></tr>
</table>

<table>
<tr><th>Name/Description</th><th>Symbol</th></tr>
<tr><td>

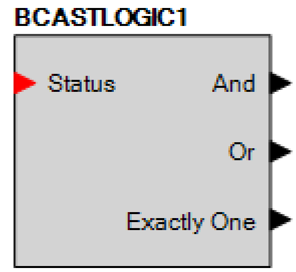
Broadcast Logic x
<u>Status</u> input is driven individually by each controller. Status input of every element of each controller is broadcast over communications.

<u>And</u> provides logical AND output of all status inputs from every controller. This output is true when the Status input of all controllers is true.

<u>Or</u> provides logical OR output of all status inputs from every controller. This output is true when the Status input of any controllers is true.

<u>Exactly One</u> provides logical XOR output of all status inputs from every controller. This output is true when the Status input of only one controller is true.

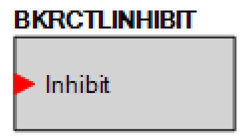
</td><td>



</td></tr>
<tr><td>

Breaker Control Inhibit
One breaker may be controlled by multiple DGC-2020HDs, however only one unit is granted control over the breaker at a time.
When true, this element prevents the DGC-2020HD from being granted control of a breaker.

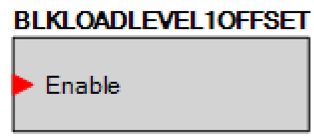
</td><td>



</td></tr>
<tr><td>

Block Load Level x Offset
When true, the value associated with this offset is added to the currently active block load level. Multiple active block load level offsets can be active at one time and are cumulative.

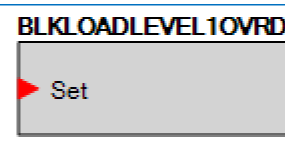
</td><td>



</td></tr>
<tr><td>

Block Load Level x Override
When true, the value associated with this level override becomes the active block load level. Only one block load level override is active at one time, even if multiple elements are true.

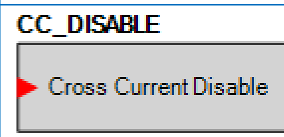
</td><td>



</td></tr>
<tr><td>

Cross Current Disable
(VRM-2020)
When true, cross-current compensation is disabled.

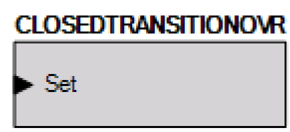
</td><td>



</td></tr>
<tr><td>

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.

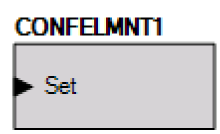
</td><td>



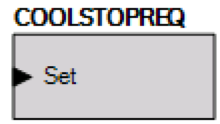
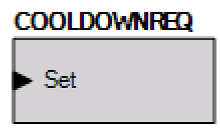
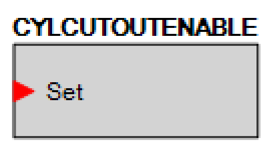
</td></tr>
<tr><td>

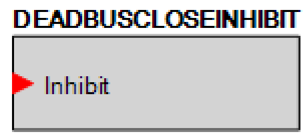
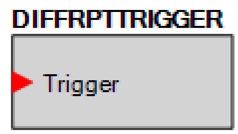
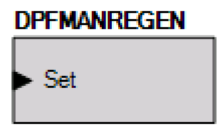
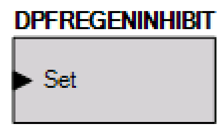
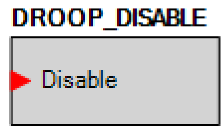
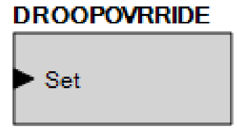
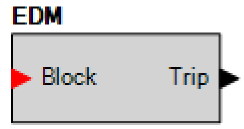
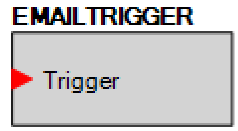
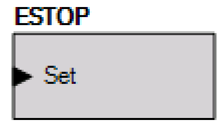
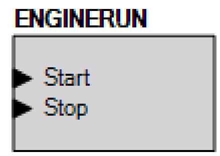
Configurable Element x
Configurable elements 1 through 8 are connected to the logic scheme as outputs. These elements are configurable in BESTCOMS*Plus* under Programmable Outputs, Configurable Elements. The user can assign a string of up to 16 characters, configure whether the element should generate an alarm or pre-alarm. If used for alarm or pre-alarm, the user's text is what will appear in the alarm or pre-alarm annunciation and in the DGC-2020HD event log.

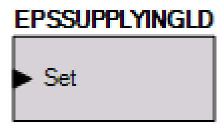
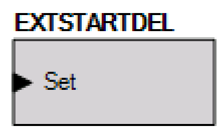
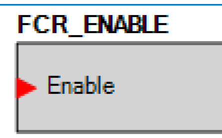
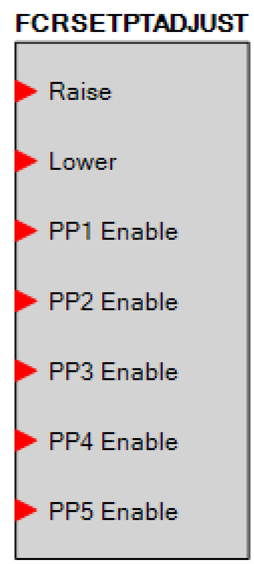
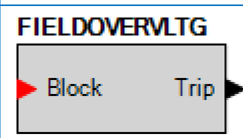
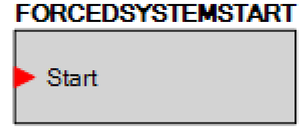
</td><td>



</td></tr>
</table>

Name/Description	Symbol
Cool Down and Stop Request RUN Mode If the unit is in RUN mode when the Cool Stop Request is received, the unit will unload, open its breaker, and go into a cooldown cycle. While in the cooldown cycle, the unit will display “COOL & STOP REQ” in addition to displaying the cooldown timer. After the cooldown timer expires, the unit will go to OFF mode. The Cool Stop Request must be removed before the unit can be run again. If the Cool Stop Request is removed during the cooldown process, the unit will remain running. Furthermore, if a condition occurs that normally causes the unit to close its breaker in RUN mode, the unit will close its breaker and reload. AUTO Mode If the unit is in AUTO mode when the Cool Stop Request is received, all conditions that would normally cause the unit to run in AUTO mode are cleared. Since all conditions that cause the unit to run have been removed, the unit goes into a cooldown cycle. While in the cooldown cycle, the unit will display “COOL & STOP REQ” in addition to displaying the cooldown timer. After the cooldown timer expires, the unit will shut down, remaining in AUTO. The Cool Stop Request must be removed before the unit can be run again. If the Cool Stop Request is removed during the cooldown process and some condition that would normally cause the unit to run in AUTO mode is true, the unit will remain running. Furthermore, if a condition occurs that normally causes the unit to close its breaker, the unit will close its breaker and reload.	
Cool Down Request RUN Mode If the unit is in RUN mode when the Cool Down Request is received, the unit is forced to unload and open its breaker and then go into a cooldown cycle. While in the cool down cycle, the unit will display “COOLDOWN REQ” in addition to displaying the cooldown timer. After the cooldown timer expires, the unit will remain running in RUN mode. The Cool Down Request must be removed before the breaker can be closed again; this element blocks breaker closures. If the Cool Down Request is removed during the cool down process, the unit will remain running in RUN mode. Furthermore, if a condition occurs that normally causes the unit to close its breaker in RUN mode, the unit will close its breaker and reload. AUTO Mode If the unit is in AUTO mode and the Cool Down Request is received, the unit is forced to unload and open its breaker and go into a cooldown cycle. While in the cooldown cycle, the unit will display “COOLDOWN REQ” in addition to displaying the cooldown timer. After the cool down timer expires, the unit will remain running in AUTO mode, unless there are no conditions that cause the unit to run in AUTO mode, in which case it will shut down and remain in AUTO mode. The Cool Down Request must be removed before the breaker can be closed again; this element blocks breaker closures. If the Cool Down Request is removed during the cool down process and some condition that would normally cause the unit to run in AUTO mode is true, the unit will remain running in AUTO mode. Furthermore, if a condition occurs that normally causes the unit to close its breaker, the unit will close its breaker and reload.	
Cylinder Cutout Enable Override When true, cylinder cutout is enabled. When false, Cylinder Cutout is disabled when any of the following are true: • Synchronization is in progress • The machine is operating with the generator breaker closed • The Cylinder Cutout Disable setting is true • The Cylinder Cutout Disable logic element is true	

Name/Description	Symbol
Data Log Trigger A data log is triggered when the Trigger input is pulsed true.	
Dead Bus Close Inhibit When true, the DGC-2020HD is prevented from closing a breaker onto a dead bus.	
Differential Report Trigger A differential report is triggered when the Trigger input is pulsed true.	
DPF Manual Regeneration Diesel Particulate Filter Regeneration is forced manually when the Set input is true.	
DPF Regeneration Inhibit Diesel Particulate Filter Regeneration is inhibited when the Set input is true.	
Droop Disable **(VRM-2020)** When true, droop compensation is disabled in the VRM-2020.	
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.	
EDM (Exciter Diode Monitor) When the Block input is true, the EDM element is disabled. The Trip output is true when the EDM element is in a trip condition. Connect to another logic block input.	
Email Trigger When true, an email, containing user-specified parameters, is sent to recipients. The recipients and parameters may be specified on the Email Setup screen.	
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.	
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.	

Name/Description	Symbol
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 the limits programmed on the Gen Condition Detection screen under Breaker Management, Bus Condition Detection in the BESTCOMS*Plus* Settings Explorer). 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.	
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.	
FCR Enable **(VRM-2020)** When true, this element switches the unit to manual (FCR) mode.	
FCR Setpoint Adjust **(VRM-2020)** *Raise/lower:* When true, the raise and lower inputs adjust the operating setpoint. *Pre-position X Enable:* When true, the associated pre-position becomes the active FCR setpoint.	
Field Overvoltage **(VRM-2020)** When the Block input is true, the Field Overvoltage element is disabled. The Trip output is true when the field overvoltage element is in a trip condition. Connect to another logic block input.	
Forced System Start When the Start input is true, this element starts the next unit in a multiple unit system based on the sequencing criterion (demand start/stop).	

<table>
<tr><th>Name/Description</th><th>Symbol</th></tr>
<tr><td>

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.

This element is available only when it is included in the selected System Breaker Configuration setting.

<u>Inputs</u>
Status: 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.

Open: This input allows a contact input to be mapped that can be used to initiate a manual breaker open request. When this input is pulsed closed while the DGC-2020HD is in RUN or AUTO mode, the breaker will open.

Close: This input allows a contact input to be mapped that can be used to initiate a manual breaker close request. When this input is pulsed and the DGC-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.

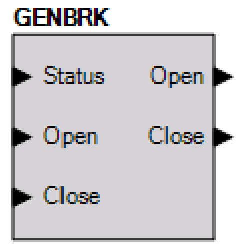
Open: This output is pulsed true (closes the output contact it is mapped to) when the DGC-2020HD is providing a signal to the breaker to open. It will be a pulse if the Breaker Output Contact Type is set to Pulse on the Breaker Hardware screen under Breaker Management in the Settings Explorer, and the 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.

Close: 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 close before the pulse is removed.

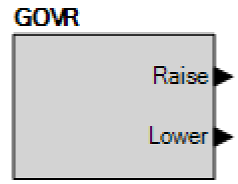
<table>
<tr><th>Notes</th></tr>
<tr><td>When using the DGC-2020HD synchronizer, it is recommended that local DGC-2020HD relay outputs be used for breaker closing commands to minimize the possibility of closures outside of desired breaker closing angles.

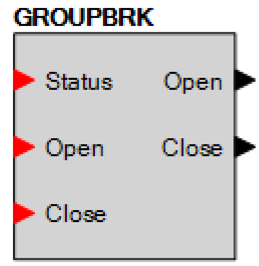
If remote (CEM-2020) outputs are to be used for breaker close commands, it is recommended that the anticipatory synchronizer type be used, and the breaker fail wait time be adjusted to account for possible CEM-2020 output delays (typically 50 ms) to achieve desired breaker closing angles.</td></tr>
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

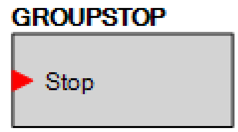
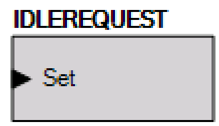
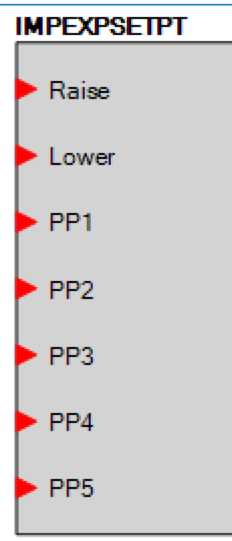
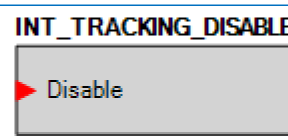
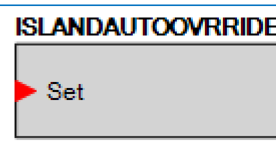
</td><td>

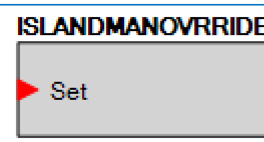
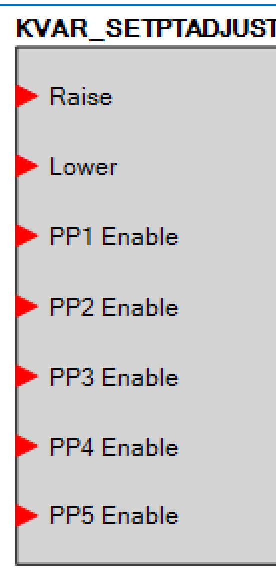
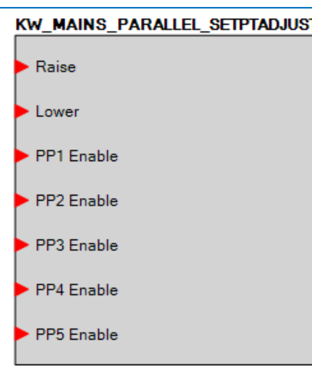


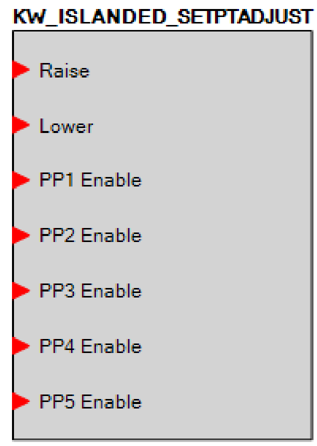
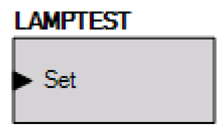
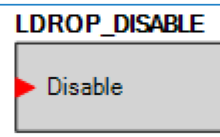
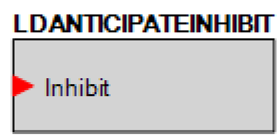
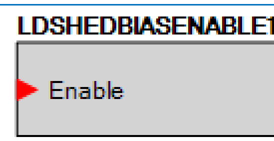
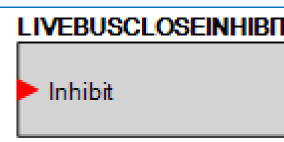
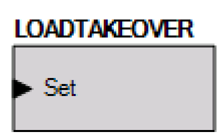
</td></tr>
</table>

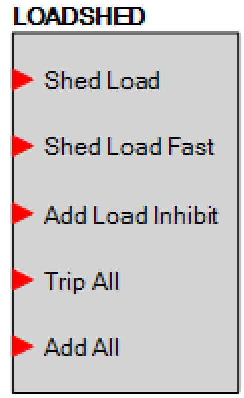
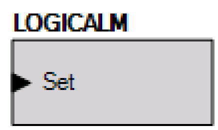
Name/Description	Symbol
Governor Can be connected to inputs of other logic blocks. When the governor is being raised, the Raise output is true. When being lowered, the Lower output is true.	

Name/Description	Symbol
Group 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 group 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 available only when it is included in the selected System Breaker Configuration setting. Inputs *Status*: 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. *Open*: This input allows a contact input to be mapped that can be used to initiate a manual breaker open request. When this input is pulsed closed while the DGC-2020HD is in RUN or AUTO mode, the breaker will open. *Close*: This input allows a contact input to be mapped that can be used to initiate a manual breaker close request. When this input is pulsed and the DGC-2020HD is in AUTO or RUN mode, and the group bus is stable, a close request will be initiated. If the Dead Group Close Enable parameter is true, and the destination bus is dead, the breaker will close. If the destination bus is stable, the DGC-2020HD will synchronize the generators to the bus, and then close the breaker. Outputs The outputs must be mapped to the contact outputs of the DGC-2020HD that will be used to drive the breaker. *Open*: This output is pulsed true (closes the output contact it is mapped to) when the DGC-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 Group Breaker screen, and the length is determined by the Open Pulse Time. It will be a constant output if the Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually open before the pulse is removed. *Close*: This output is pulsed true (closes the output contact it is mapped to) when the DGC-2020HD is providing a signal to the breaker to close. It will be a pulse if the Contact Type is set to Pulse on the Group Breaker screen, and the length is determined by the Close Pulse Time. It will be a constant output if the Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually close before the pulse is removed. **Notes** 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 fail wait time be adjusted to account for possible CEM-2020 output delays (typically 50 ms) to achieve desired breaker closing angles.	

Name/Description	Symbol
Group Stop When the stop input is true, any group start requests, which originated in logic, are cleared and the generators in the group are shut down. **Note** In order for a generator to respond to Group Stop requests, the DGC-2020HD must be in AUTO mode and generator must have been started by a Demand Start or a Group Start request. The Group Stop logic element will not stop a generator that was started by a Run with Load Start or an ATS contact input.	
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.	
Import/Export Setpoint *Raise/lower:* When true, the raise and lower inputs adjust the operating setpoint. *Pre-position x:* When true, the associated pre-position becomes the active import/export setpoint.	
Internal Tracking Disable **(VRM-2020)** When true, internal automatic setpoint tracking is disabled.	
Islanded Automatic Override When true, islanded kW control is set to automatic.	

Name/Description	Symbol
Islanded Group Request *Start One:* When true, the highest priority generator for this operating mode is started. *Start All:* When true, all generators enabled for sequencing for this operating mode are started. *Start Demand:* When true, a subset of generators is started, based on expected demand level and sequencing priority. Expected demand level is established using Block Load Level settings. Refer to the *Multiple Generator Management* chapter for more information. *Start with Group Breaker Close:* Set this true simultaneously with one of the above starting modes. The group breaker closes when the user-selected group breaker closure conditions are met and group capacity is sufficient. **Note** In order for a generator to respond to Group Start requests, the DGC-2020HD must be in AUTO mode, the System Type must be configured as Segmented Bus System, and Sequencing and Demand Start/Stop must both be enabled.	
Islanded Manual Override When true, islanded kW control is set to manual.	
Kvar Setpoint Adjust *Raise/lower:* When true, the raise and lower inputs adjust the operating setpoint. *Pre-position X Enable:* When true, the associated pre-position becomes the active kvar setpoint.	
KW Mains Parallel Setpoint Adjust *Raise/lower:* When true, the raise and lower inputs adjust the KW Mains Parallel setpoint. *Pre-position X Enable:* When true, the associated pre-position becomes the active KW Mains Parallel setpoint.	

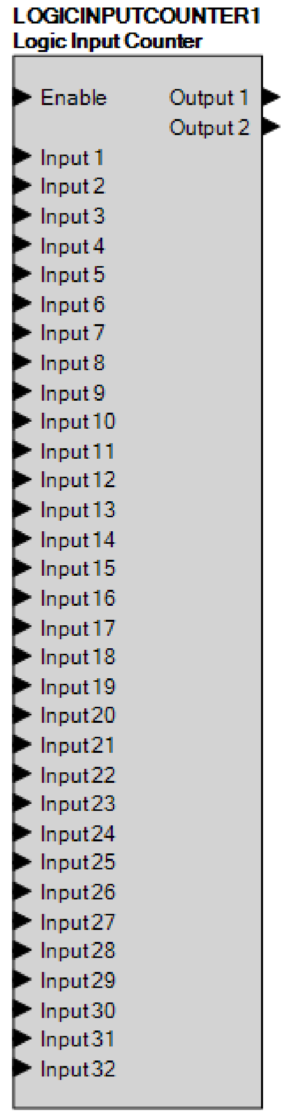
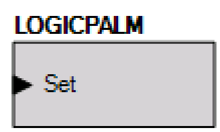
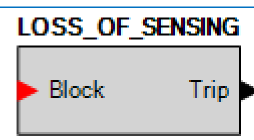
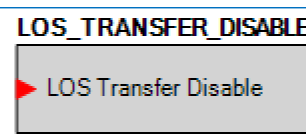
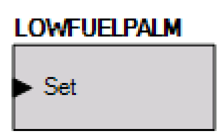
Name/Description	Symbol
KW Islanded Setpoint Adjust *Raise/lower:* When true, the raise and lower inputs adjust the KW Islanded setpoint. *Pre-position X Enable:* When true, the associated pre-position becomes the active KW Islanded setpoint.	
Lamp Test The lamp test will be performed when the Set input 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.	
Line Drop Disable **(VRM-2020)** When true, line drop compensation is disabled.	
Load Anticipation Inhibit When true, the load anticipation function is disabled.	
Load Shed Bias Enable X When true, the corresponding Add Reserve Bias value is added to the calculation for determining when to add a load. If multiple Load Shed Bias Enable elements are true simultaneously, the sum of all Add Reserve Bias values is added to the calculation.	
Live Bus Close Inhibit When true, the DGC-2020HD is prevented from closing a breaker onto a live bus.	
Load Take Over When the Set input is true, the generator is forced to start and either an open or closed transition is executed depending on the Mains Fail Transfer Type setting. Refer to the *Breaker Management* chapter for more information.	

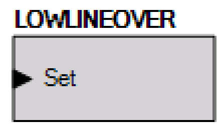
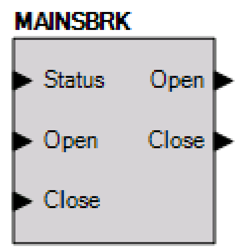
Name/Description	Symbol
Load Shed *Shed Load:* Begins shedding loads from the system starting with the lowest priority enabled loads. On the rising edge of the Shed Load input going true, the lowest priority load is immediately shed. Subsequent loads will be shed after each load's programmed Shed Delay setting if the Shed Load input continues to be held true. The first load is shed with no delay to provide immediate load relief. *Shed Load Fast:* This input is the same as the Shed Load input, but uses the programmed Shed Fast Delay settings during timing. On the rising edge of the Shed Load Fast input going true, the lowest priority load is immediately shed. This is done regardless of the state of the Shed Load input. *Load Add Inhibit:* This input prevents load from being added to the system. This can be used in cases where the system must operate at reduced generator capacity to prevent overloading the available machines. *Trip All:* This input forces an immediate trip of all loads without time delay. If the Load Add Inhibit element is not held true, loads can begin sequencing back on from the highest priority load when this is removed. Note that loads with priority of 0 are disabled, and are not tripped when Trip All is true. *Add All:* This enables all loads without time delay. The Shed Load, Shed Load Fast, and Trip All inputs have priority over this input to allow the load shed function to operate. Note that loads with priority of 0 are disabled, thus they are not enabled when Add All is true.	
Logic Alarm When the Set input is true, the DGC-2020HD goes into an alarm condition.	

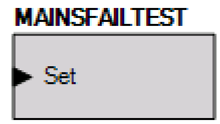
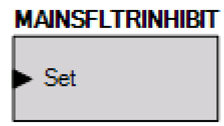
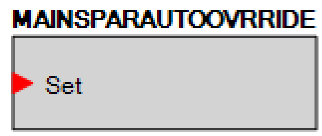
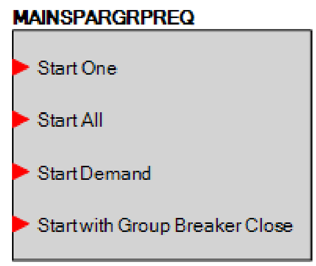
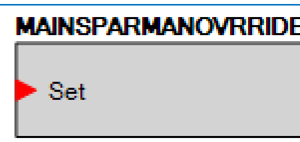
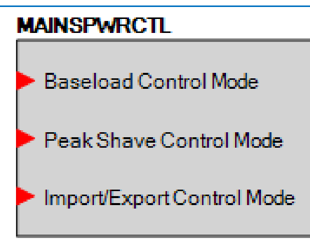
<table>
<tr><th>Name/Description</th><th>Symbol</th></tr>
<tr><td>Logic Input Counter X
The Logic Input Counter element continuously counts the number of true inputs. As long as the number of true inputs meets or exceeds a user-defined threshold, the output for that threshold is held true.

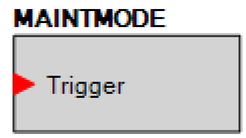
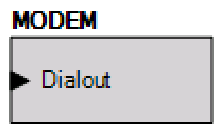
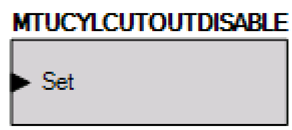
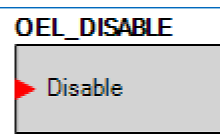
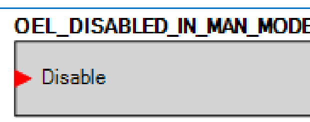
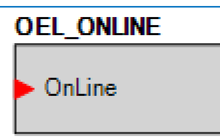
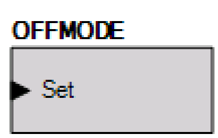
Two thresholds are provided for each Logic Input Counter.

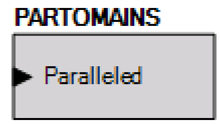
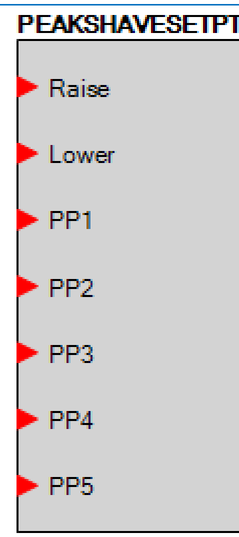
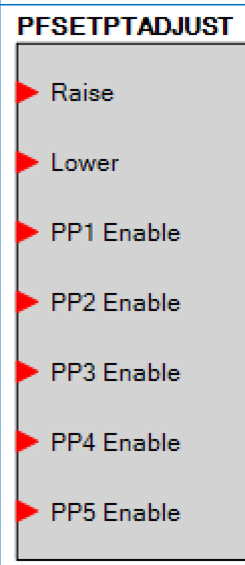
This element is active only when the Enable input is held true.

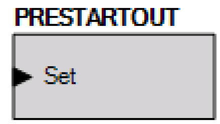
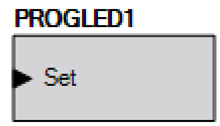
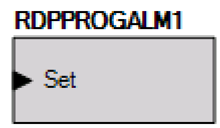
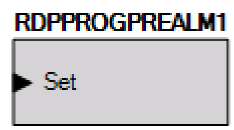
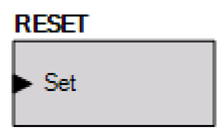
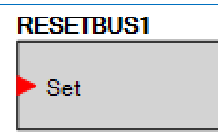
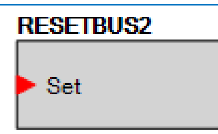
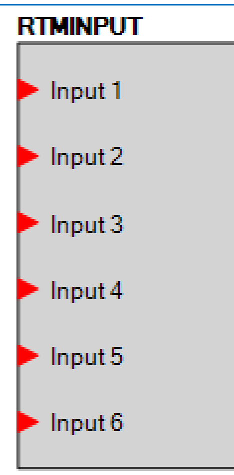
See Logic Input Counter Threshold Settings, below, for more information on threshold settings.</td><td>
</td></tr>
<tr><td>Logic Pre-Alarm
When the Set input is true, the DGC-2020HD goes into a Pre-alarm condition.</td><td>
</td></tr>
<tr><td>Loss of Sensing
(VRM-2020)
When the Block input is true, the Loss of Sensing element is disabled. The Trip output is true when the Loss of Sensing element is in a trip condition. Connect to another logic block input.</td><td>
</td></tr>
<tr><td>Loss of Sensing Transfer Disable
(VRM-2020)
When true, a Loss of Sensing trip will not trigger a transfer to manual mode.</td><td>
</td></tr>
<tr><td>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.</td><td>
</td></tr>
</table>

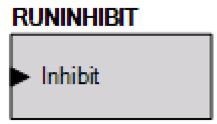
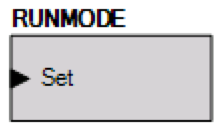
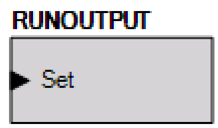
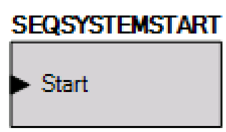
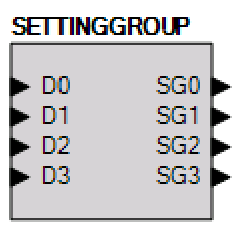
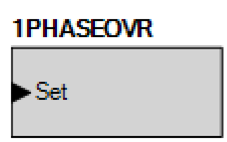
Name/Description	Symbol
Low Line Override When the Set input is true the 27, 59, 47, 51, 32, and 40Q settings and the configurable element settings and are scaled by the low-line scale factor setting.	
Mains Breaker This element is used to connect the breaker open and close output signals from the DGC-2020HD 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 available only when it is included in the selected System Breaker Configuration setting. Inputs *Status*: 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. *Open*: This input allows a contact input to be mapped that can be used to initiate a manual breaker open request. When this input is pulsed closed while the DGC-2020HD is in RUN or AUTO mode, the breaker will open. *Close*: This input allows a contact input to be mapped that can be used to initiate a manual breaker close request. When this input is pulsed, 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. *Open*: 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 Contact Type is set to Pulse on the Mains Breaker screen, and the length is determined by the Open Pulse Time. It will be a constant output if the Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually open before the pulse is removed. *Close*: This output is pulsed true (closes the output contact it is mapped to) when the DGC-2020HD is providing a signal to the breaker to close. It will be a pulse if the Contact Type is set to Pulse on the Mains Breaker screen, and the length is determined by the Close Pulse Time. It will be a constant output if the Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually close before the pulse is removed. **Notes** 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 fail wait time be adjusted to account for possible CEM-2020 output delays (typically 50 ms) to achieve desired breaker closing angles.	

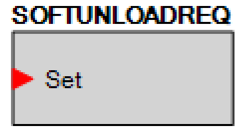
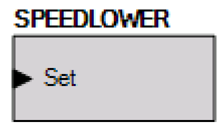
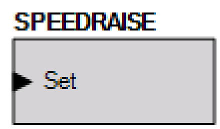
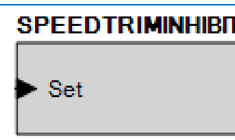
Name/Description	Symbol
Mains Fail Test When the Set input is true, the DGC-2020HD will exercise its mains fail transfer function exactly as it would if the mains were to fail on a mains fail machine. This can be used as a test of the mains fail transfer capability of the unit without having to cause a true mains failure.	
Mains Fail Transfer Inhibit The mains fail transfer function is inhibited when the Set input is true.	
Mains Parallel Automatic Override When true, mains parallel kW control is set to automatic.	
Mains Parallel Group Request *Start One:* When true, the highest priority generator for this operating mode is started. *Start All:* When true, all generators enabled for sequencing for this operating mode are started. *Start Demand:* When true, a subset of generators is started, based on expected demand level and sequencing priority. Expected demand level is established using Block Load Level settings. Refer to the *Multiple Generator Management* chapter for more information. *Start with Group Breaker Close:* Set this true simultaneously with one of the above starting modes. The group breaker closes when the user-selected group breaker closure conditions are met and group capacity is sufficient. **Note** In order for a generator to respond to Group Start requests, the DGC-2020HD must be in AUTO mode, the System Type must be configured as Segmented Bus System, and Sequencing and Demand Start/Stop must both be enabled.	
Mains Parallel Manual Override When true, mains parallel kW control is set to manual.	
Mains Power Control When an input is true, the associated mode becomes the active control mode.	

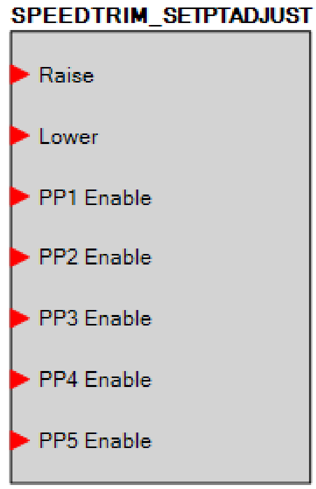
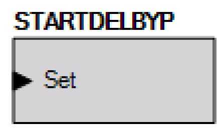
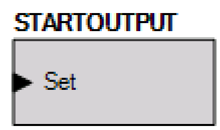
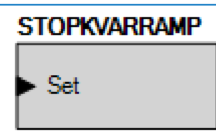
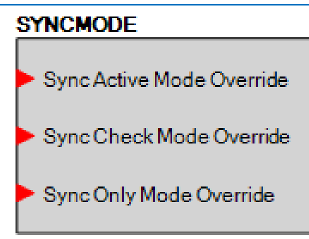
Name/Description	Symbol
Maintenance Mode The maintenance mode logic element allows for a unit to be taken offline for maintenance through normal generator sequencing measures. When this element is set true, the unit will be placed as the lowest priority unit in the sequencing table. Once a running unit is in maintenance mode, the sequence algorithm will eventually cause the unit to shut down by starting the next highest priority generator(s) if the remaining generators can drive the demand below the start levels. If the remaining generators cannot drive the demand below the start levels, then the generator in maintenance mode will not be shut down. The logic element must be held true until the generator is manually placed in OFF mode. Once the element goes false and the unit is placed back in AUTO, the unit's priority will be determined by the current sequencing mode. If multiple units are put in maintenance mode, then they will be sorted amongst themselves by the current sequencing mode.	
Modem Control Connect the Dialout input to the output of another logic block. When true, the modem will dial out.	
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 BESTCOMS*Plus*.	
MTU Speed Demand Switch When an input is true, the associated switch becomes the active speed demand switch.	
OEL Disable **(VRM-2020)** When true, the overexcitation limiter is disabled.	
OEL Disabled in Manual Mode **(VRM-2020)** When true, the overexcitation limiter is disabled when manual (FCR) mode is active.	
OEL Online **(VRM-2020)** When true, this element enables the use of OEL when the unit is considered to be online.	
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.	

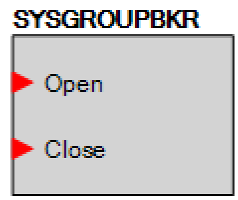
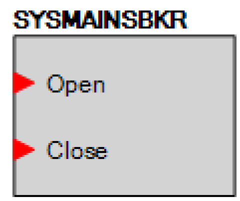
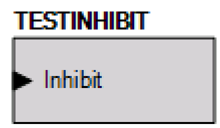
Name/Description	Symbol
Paralleled to Mains Setting the Paralleled input to true indicates to the DGC-2020HD that it is paralleled to a utility. When paralleled to the utility, the kW controller will regulate the machine's kW output at the Base Load Level (%) that is set on the Governor Bias Control 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.	
Peak Shave Setpoint *Raise/lower:* When true, the raise and lower inputs adjust the operating setpoint. *Pre-position x:* When true, the associated pre-position becomes the active peak shave setpoint.	
Power Factor Setpoint Adjust *Raise/lower:* When true, the raise and lower inputs adjust the Power Factor setpoint. *Pre-position x:* When true, the associated pre-position becomes the active Power Factor setpoint.	

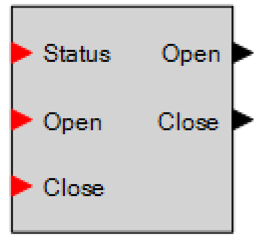
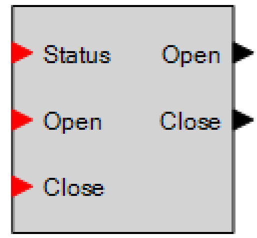
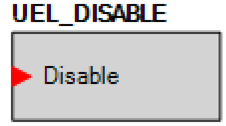
Name/Description	Symbol
Prestart Output This element is used to drive the prestart output relay from logic when the Prestart Output Relay configuration is set to “Programmable”. When the Prestart Output Relay configuration is set to “Programmable”, the prestart relay will not close unless logic is used 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.	
Programmable LED x When the Set input is true, this element illuminates Programmable LED x on the front panel.	
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.	
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.	
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 Bus 1 When the Set input is true, all protection associated only with Bus 1 is reset.	
Reset Bus 2 When the Set input is true, all protection associated only with Bus 2 is reset.	
RTM Input The states of Input 1 through Input 6 are capable of being monitored in the analysis tool. See the Metering chapter for details.	

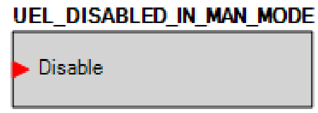
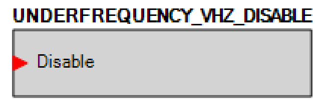
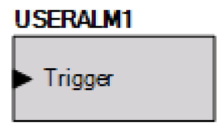
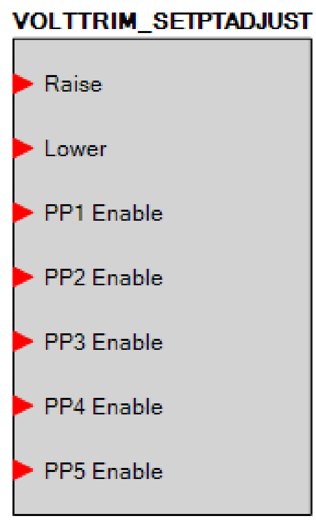
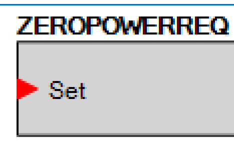
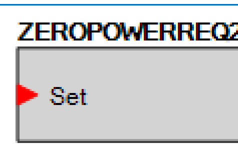
Name/Description	Symbol
Run Inhibit When the Inhibit input is true, the DGC-2020HD is prevented from starting and running the generator, regardless of any condition that would normally cause the generator to run. If this element is false and there is <u>any</u> condition in effect which will cause the generator to run, the DGC-2020HD will start and run the generator.	
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.	
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.	
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. In order for Run With Load and Sequencing to operate reliably, it is recommended that the inputs to the Run with Load logic element be pulsed rather than held constant. For example, if a unit was started by sequencing, a pulse on the Run with Load Stop will shut down the unit. However, if the Run with Load Stop is held constant, sequencing could never start a unit because the sequencing starts would be immediately negated by Run with Load stop requests. Similarly, if a Run with Load Start is applied and held constant, sequencing cannot shut down the unit. Any stop requests generated by sequencing would immediately be negated by the Run with Load start request.	
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.	
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).	

Name/Description	Symbol
Soft Unload Request When true, generators connected through a breaker onto mains connection are unloaded. The unload operation depends on connected segment types on System A and System B after the breaker is opened. Gen segment types are driven only by generators. Mains segment types are driven by mains feeds optionally paralleled with generators. Load segment types are not driven (become dead upon open). This is useful for unloading generators to reduce current through the group breaker before opening.	
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. If the Remember Speed Adjustments Setting is set to Yes, the adjusted speed is saved to nonvolatile memory after the speed has not been raised or lowered for 30 seconds. Otherwise, the adjusted speed is retained for the duration of the current run session, but reverts to the configured Engine RPM setting when a new run session is started. The Remember Speed Adjustments setting is found under Communications > CAN Bus > Speed Setup on the front panel and in BESTCOMS*Plus*.	
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. If the Remember Speed Adjustments Setting is set to Yes, the adjusted speed is saved to nonvolatile memory after the speed has not been raised or lowered for 30 seconds. Otherwise, the adjusted speed is retained for the duration of the current run session, but reverts to the configured Engine RPM setting when a new run session is started. The Remember Speed Adjustments setting is found under Communications > CAN Bus > Speed Setup on the front panel and in BESTCOMS*Plus*.	
Speed Trim Droop Enable When true, this element enables droop mode for the speed trim function. The calculated setpoint for the speed trim controller is reduced by the Droop Percentage and Droop Offset settings. See the *Bias Control* chapter for details on these settings and the calculated setpoint equation. The kW controller is disabled because the system is operating in Trimmed Speed Droop mode to accomplish kW control.	
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.	

Name/Description	Symbol
Speed Trim Setpoint Adjust *Raise/lower:* When true, the raise and lower inputs adjust the Speed Trim setpoint. *Pre-position x:* When true, the associated pre-position becomes the active Speed Trim setpoint.	
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.	
Regulator Start Stop (VRM-2020) *Start:* When the Start input is true, the DGC-2020HD starts regulation with the VRM-2020. *Stop:* When the Stop input is true, the DGC-2020HD stops regulation with the VRM-2020. If the Start and Stop inputs are true simultaneously, the Stop input has priority. For reliable operation, it is recommended that the inputs to the Reg_Start_Stop logic element be pulsed rather than held constant. For example, if regulation was started, a pulse on the Stop input will shut down the regulation. However, if the Reg_Start_Stop Stop input is held constant, regulation could never start because the Start input would be immediately negated by the Stop input.	
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.	
Sync Mode When an input is true, the associated mode becomes the active sync mode.	

Name/Description	Symbol
System Group Breaker When an input is true, the associated group breaker command is requested for the remotely controlled group breaker in the segmented system.	
System Mains Breaker When an input is true, the associated mains breaker command is requested for the remotely controlled mains breaker in the segmented system.	
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
Tie Breaker and Tie Breaker 2 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 tie 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 available only when it is included in the selected System Breaker Configuration setting. <u>Inputs</u> *Status*: 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. *Open*: This input allows a contact input to be mapped that can be used to initiate a manual breaker open request. When this input is pulsed closed while the DGC-2020HD is in RUN or AUTO mode, the breaker will open. *Close*: This input allows a contact input to be mapped that can be used to initiate a manual breaker close request. When this input is pulsed, a close request will be initiated. <u>Outputs</u> The outputs must be mapped to the contact outputs of the DGC-2020HD that will be used to drive the breaker. *Open*: This output is pulsed true (closes the output contact it is mapped to) when the DGC-2020HD is providing a signal to the breaker to open. It will be a pulse if the Contact Type is set to Pulse on the Mains Breaker screen, and the length is determined by the Open Pulse Time. It will be a constant output if the Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually open before the pulse is removed. *Close*: This output is pulsed true (closes the output contact it is mapped to) when the DGC-2020HD is providing a signal to the breaker to close. It will be a pulse if the Contact Type is set to Pulse on the Mains Breaker screen, and the length is determined by the Close Pulse Time. It will be a constant output if the Contact Type is set to continuous. Note the pulse time must be set long enough for the breaker to actually close before the pulse is removed. **Notes** 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 fail wait time be adjusted to account for possible CEM-2020 output delays (typically 50 ms) to achieve desired breaker closing angles. The TIEBRK2 element is used by the *Generator and Tie Breaker* and *Tie Breaker and Tie Breaker* system breaker configurations.	**TIEBRK**  **TIEBRK2** 
UEL Disable **(VRM-2020)** When true, the underexcitation limiter is disabled.	**UEL_DISABLE** 

Name/Description	Symbol
UEL Disabled in Manual Mode **(VRM-2020)** When true, the underexcitation limiter is disabled when manual (FCR) mode is active.	
Underfrequency V/Hz Disable **(VRM-2020)** When true, the underfrequency limiter is disabled.	
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.	
Voltage Droop Override When true, this element causes the DGC-2020HD to switch from kvar sharing over Ethernet to voltage droop mode.	
Voltage Trim Droop Enable When true, this element enables droop mode for the voltage trim function. The calculated setpoint for the voltage trim controller is reduced by the Droop Percentage and Droop Offset settings. See the *Bias Control* chapter for details on these settings and the calculated setpoint equation. The kvar controller is disabled because the system is operating in Trimmed Voltage Droop mode to accomplish kvar control.	
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.	
Voltage Trim Setpoint Adjust *Raise/lower:* When true, the raise and lower inputs adjust the Voltage Trim setpoint. *Pre-position x:* When true, the associated pre-position becomes the active Voltage Trim setpoint.	
Zero Power Request This element is available only to DGC-2020HDs configured as tie breaker controllers. When true, system generators adjust power output until there is zero power flow through the first tie breaker tying them to mains power, which is then opened.	
Zero Power Request 2 This element is available only to DGC-2020HDs configured as *Generator and Tie Breaker* or *Tie Breaker and Tie Breaker* controllers. When true, system generators adjust power output until there is zero power flow through the second tie breaker tying them to mains power, which is then opened.	

Logic Input Counter Threshold Settings

BESTCOMS*Plus*® Navigation Path: Settings Explorer, BESTlogic*Plus* Programmable Logic, Logic Input Counters

The Logic Input Counters screen provides settings for each Logic Input Counter. These settings consist of a label, two operations, and two thresholds. The Label setting accepts up to 64 alphanumeric characters and appears above the element in the logic diagram. An Operation setting allows the user to establish the type of comparison that is performed on the number of true inputs and the threshold. These operations include Equals (=), Less Than (<), Less Than or Equal (<=), Greater Than (>), and Greater Than or Equal (>=). The Threshold accepts a value from 0 to 32 in increments of 1.

When the Logic Input Counter is enabled, the number of true inputs are continuously counted and as long as that number meets or exceeds a user-defined threshold, the output for that threshold is held true. For example, Operation 1 is set to Less Than (<), Threshold 1 is set to 3, Operation 2 is set to Greater Than or Equal (>=), and Threshold 2 is also set to 3. With no true inputs, Threshold 1 is met because the number of true inputs is less than 3 and Output 1 is held true. With four true inputs Threshold 1 is not met and Threshold 2 is met. This results in Output 1 being false and Output 2 being true.

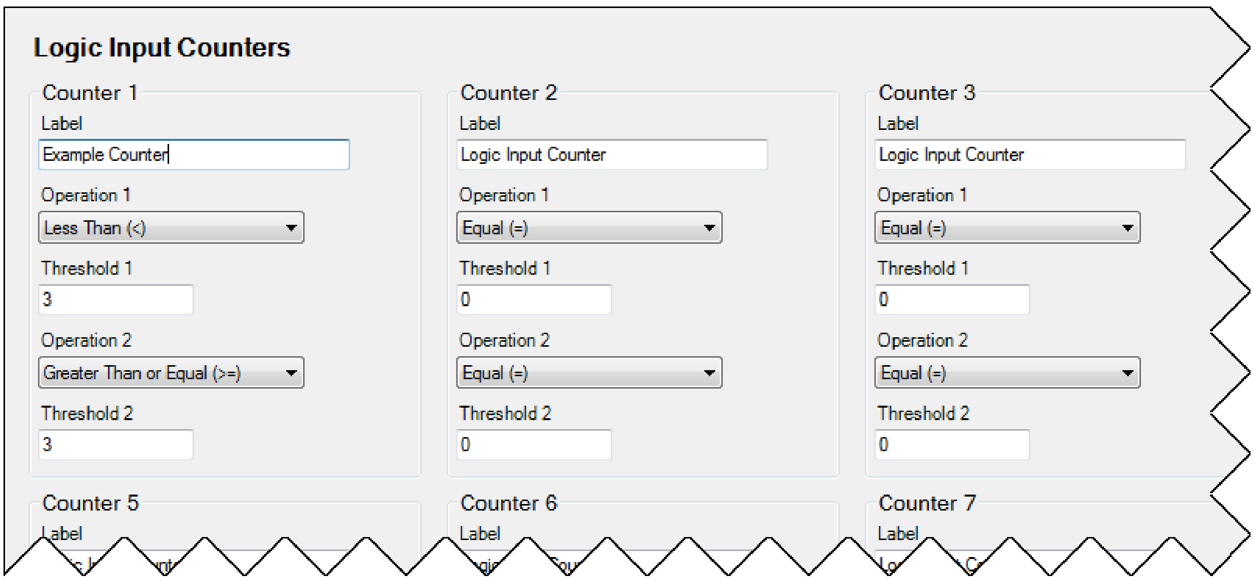


Figure 215. Settings Explorer, BESTlogic*Plus* Programmable Logic, Logic Input Counters

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. The default active logic scheme is configured for typical control applications. Only one logic scheme can be active at a 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 may be 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 logic to the DGC-2020HD, it must be connected to a computer through a communications port. Once the necessary connections are made, logic 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 BESTCOMS*Plus* 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 BESTCOMS*Plus*.

Retrieving a Logic Scheme from the DGC-2020HD

To retrieve logic from the DGC-2020HD, it must be connected to a computer through a communications port. Once the necessary connections are made, logic 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 BESTCOMS*Plus* to program BESTlogic*Plus*. Using BESTCOMS*Plus* is analogous to physically attaching wire between discrete DGC-2020HD terminals. To program BESTlogic*Plus*, use the Settings Explorer within BESTCOMS*Plus* to open the BESTlogic*Plus* Programmable Logic tree branch as shown in Figure 213.

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 BESTCOMS*Plus* 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 BESTlogic*Plus* window. These LEDs show the Logic Save Status, Logic Diagram Status, and Logic Layer Status. Table 98 defines the colors for each LED.

Table 98. 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 BESTlogic*Plus* 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 BESTlogic*Plus* 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 216. Output 1 is Logic 0 (red) when Virtual Switch 1 is Logic 0 (red) and Fixed 1 is Logic 1 (green).

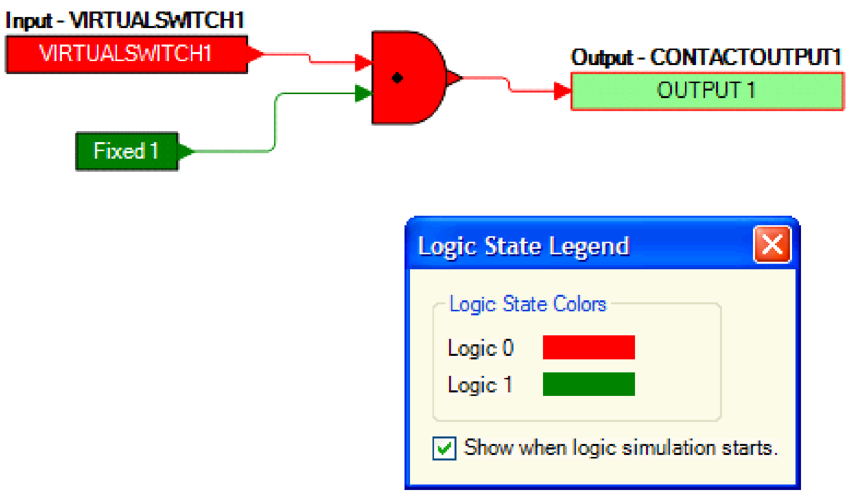


Figure 216. Offline Logic Simulator Example

BESTlogic™Plus File Management

To manage BESTlogic*Plus* files, use the Settings Explorer to open the BESTlogic*Plus* Programmable Logic tree branch. Use the BESTlogic*Plus* Programmable Logic toolbar to manage BESTlogic*Plus* files. Refer to Figure 217. For information on Settings Files management, refer to the *BESTCOMSPlus* chapter.

Figure 217. BESTlogic*Plus* Programmable Logic Toolbar

Saving a BESTlogic*Plus* File

After programming BESTlogic*Plus* settings, click on the Save button to save the settings to memory.

Before the new BESTlogic*Plus* settings can be uploaded to the DGC-2020HD, you must select Save from the File pull-down menu located at the top of the BESTCOMS*Plus* main shell. This step will save both the BESTlogic*Plus* settings and the operating settings to a file.

The user also has the option to save the BESTlogic*Plus* settings to a unique file that contains only BESTlogic*Plus* settings. Click on the Logic Library drop-down button and select Save Logic Library File. Use normal Windows® techniques to browse to the folder where you want to save the file and enter a filename.

Opening a BESTlogic*Plus* File

To open a saved BESTlogic*Plus* file, click on the Logic Library drop-down button on the BESTlogic*Plus* Programmable Logic toolbar and select Open Logic Library File. Use normal Windows techniques to browse to the folder where the file is located.

Protecting a BESTlogic*Plus* File

Objects in a logic diagram can be locked so that when the logic document is protected these objects cannot be changed. Locking and protecting is useful when sending logic files to other personnel to be modified. The locked object(s) cannot be changed. To view the lock status of the object(s), select Show Lock Status from the Protection drop-down menu. To lock object(s), use the mouse to select object(s) to be locked. Right click on the selected object(s) and select Lock Object(s). The gold colored padlock next to the object(s) will change from an open to a locked state. To protect a logic document, select Protect Logic Document from the Protection drop-down button. A password is optional.

Uploading a BESTlogic*Plus* File

To upload a BESTlogic*Plus* file to the DGC-2020HD, you must first open the file through BESTCOMS*Plus* or create the file using BESTCOMS*Plus*. Then pull down the Communication menu and select Upload Logic to Device.

Downloading a BESTlogic*Plus* File

To download a BESTlogic*Plus* 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 BESTCOMS*Plus* has changed, a dialog box will open asking you if want to save the current logic changes. You may choose Yes or No. After you have taken the required action to save or not save the current logic, the downloading is executed.

Printing a BESTlogic*Plus* File

To view a preview of the printout, click on the Print Preview icon located on the BESTlogic*Plus* Programmable Logic toolbar. If you wish to print to a printer, select the printer icon in the upper left corner of the Print Preview screen.

You may skip the print preview and go directly to print by clicking on the Printer icon on the BESTlogic*Plus* Programmable Logic toolbar. A dialog box, Select Views to Print opens allowing you to check which views you would like to print. Next, the Print dialog box opens with the typical Windows choice to setup the properties of printer. Execute this command, as necessary, and then select Print.

A Page Setup icon is also provided on the BESTlogic*Plus* Programmable Logic toolbar allowing you to select Paper Size, Paper Source, Orientation, and Margins.

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 218 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.

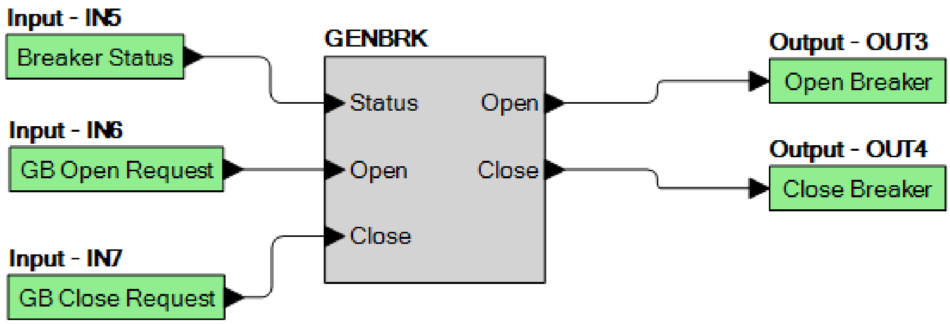


Figure 218. Example 1 – GENBRK Logic Block Connections

Example 2 - AND Gate Connections

Figure 219 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.

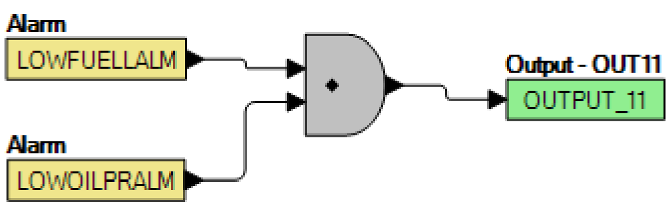


Figure 219. Example 2 – AND Gate Connections

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 220.

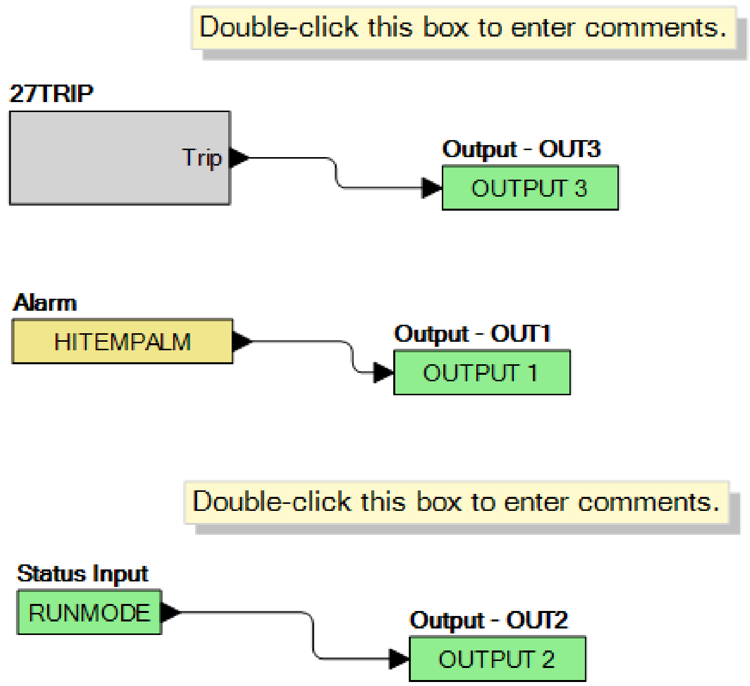


Figure 220. Example 3 – Multiple Logic Connections

Tuning PID Settings

Introduction

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 99 shows the effects of increasing parameters.

Table 99. Effects of Increasing Parameters

Parameter	Rise Time	Overshoot	Setting Time	Steady State Error
K_p	Decrease	Increase	Small Change	Decrease
K_i	Decrease	Increase	Increase	Eliminate
K_d	Small Change	Decrease	Decrease	None

Tuning Procedures

Prior to performing any controller tuning, it is strongly recommended that Generator Protection, in particular Reverse Power protection and Loss of Excitation protection, be configured to protect the machine in case any reverse power or reverse var situations occur during the tuning process.

Voltage Controller Tuning Procedure

The voltage controller is tuned prior to the speed controller. Set all K_p, K_i, and K_d gains in the voltage controller, speed controller, kW load controller and var/PF controller to 0. Set the K_g values to 0.1.

The voltage controller is active during synchronization when the DGC-2020HD is trying to close the generator breaker, and also when the generator breaker is closed and the generator is not paralleled to utility power and the voltage trim function is enabled. In order to tune the voltage controller, the unit is operated with the generator breaker closed and voltage trim enabled. We can then change the rated voltage of the machine to change the voltage controller set point and observe the response. Set the Voltage Trim function and the var/PF controller to enabled, and verify in logic that when the generator breaker is closed, the Parallel to mains logic element is not true. When the engine is running and the generator breaker is closed, the voltage controller should be operating to accomplish voltage trim, driving the system voltage to the level set by the Rated Voltage setting in the system ratings.

K_p - Proportional Gain

Each time K_p is set, we will modify the rated voltage setting in the Rated Data and observe how the generator output voltage responds to the change.

Set an initial value of 1 for K_p. Start the generator and close the generator breaker to the dead bus.

Verify that the generator's output approaches the Rated Voltage in a stable manner. Since K_i is zero at this point, there may be a difference between the generator's output and the Rated Voltage set point. The important thing is that the generator's output behaves in a stable manner. If it is not stable, lower the value of K_p and repeat.

Next, modify the Rated Voltage setting to a level that is 3% to 5% higher than the initial setting. Verify that the generator's output approaches the new value in a stable manner. Set the Rated Voltage Setting back to its original value and observe the generator's output. Next, modify the Rated Voltage setting to a level that is 3% to 5% lower than the initial setting observe the generator output voltage. Finally, set the Rated

Voltage back to its initial value, and observe the generator output voltage to verify it operates in a stable manner.

Repeat this procedure, raising K_p until the system begins to operate in an unstable manner, and then lower it back to the highest value where stable operation was achieved. Note that if the generator output is not coming very close to the set point value, it is often an indication that the value of K_p is too low.

If it is not possible to obtain stable voltage operation, it may be necessary to reduce the control gains in the voltage regulator which has its analog bias input driven by the DGC-2020HD.

K_i - Integral Gain

Set the initial value of K_i to be a tenth of the value set for K_p. Start the generator and close the generator breaker to the dead bus.

Next, modify the Rated Voltage setting to a level that is 3% to 5% higher than the initial setting. Verify that the generator's output approaches the new value in a stable manner. Set the Rated Voltage Setting back to its original value and observe the generator's output. Next, modify the Rated Voltage setting to a level that is 3% to 5% lower than the initial setting observe the generator output voltage. Finally, set the Rated Voltage back to its initial value, and observe the generator output voltage to verify it operates in a stable manner. If stable operation is not achievable, it may be necessary to lower the value for K_i. Repeat this procedure, raising K_i until the system is unstable, and then lower it to the highest value that achieved stable operation.

K_d - Derivative Gain

If the performance with K_p and K_i alone is satisfactory, it is recommended K_d be left at a value of zero. K_d can amplify noise in a system so it should be used with great care. Otherwise K_d, the derivative controller gain, can be used in conjunction with T_d, the noise filter constant, to reduce overshoot obtained with PI control. Setting K_d and T_d is an iterative process.

Tuning of K_d can be achieved through the following steps. Set an initial value of K_d that is 1/10th the value of K_p or 1/10th the value of K_i, whichever is smaller. Start the generator and close the generator breaker to the dead bus.

Modify the Rated Voltage setting to a level that is 3% to 5% higher than the initial setting. Verify that the generator's output approaches the new value in a stable manner. Set the Rated Voltage Setting back to its original value and observe the generator's output. Next, modify the Rated Voltage setting to a level that is 3% to 5% lower than the initial setting observe the generator output voltage. Finally, set the Rated Voltage back to its initial value, and observe the generator output voltage to verify it operates in a stable manner. Repeat with higher values of K_d until the system begins to be unstable, then enter half this value as the K_d gain.

If high frequency noise seems to be entering the system, T_d is the constant of the low pass filter which filters the controller input to reduce the effects of such interference when derivative control is employed. T_d ranges from 0 to 1 with an increment of 0.001. T_d=0 is no filtering, T_d=1 is heaviest filtering. If T_d adjustment is necessary, set T_d to 0.001 and see if the noise induced behavior is reduced. Raise T_d until desired reduction of noise behavior is achieved. Once T_d has been set, tune K_d again. If noise again appears to be a problem, adjust T_d until desired behavior is achieved, then retune K_d.

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 K_p, K_i, and K_d gains in both speed controller and kW load controller to 0. Set the K_g values to 0.1.

K_p - Proportional Gain

Set an initial value of 1 for K_p. Start the generator and close the breaker to the dead bus.

Each time K_p is set, execute step responses in the following manner to observe the machine's response to the change in the Speed Trim set point.

Next, modify the Speed Trim set point to a level that is one or two hertz higher than the initial setting. Verify that the generator's output frequency approaches the new value in a stable manner. Set the Speed

Trim set point back to its original value and observe the generator's output frequency. Next, modify the Speed Trim set point to a level that is one or two hertz lower than the initial setting observe the generator output frequency. Finally, set the Speed Trim set point back to its initial value, and observe the generator frequency to verify it operates in a stable manner.

Since K_i is zero at this point, there may be some 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 K_p and repeat.

Repeat this procedure, raising K_p until the system begins to operate in an unstable manner, and then lower it back to the highest value where stable operation is attained. Note that if the generator output is not coming very close to the set point value, it is often an indication that the value of K_p is too low.

If it is not possible to obtain stable speed operation, it may be necessary to reduce the control gains in the governor which has its analog bias input driven by the DGC-2020HD.

K_i - Integral Gain

Set the initial value of K_i to be a tenth of the value set for K_p. Start the generator and close the breaker to the dead bus.

Next, modify the Speed Trim set point to a level that is one or two hertz higher than the initial setting. Verify that the generator's output frequency approaches the new value in a stable manner. Set the Speed Trim set point back to its original value and observe the generator's output frequency. Next, modify the Speed Trim set point to a level that is one or two hertz lower than the initial setting observe the generator output frequency. Finally, set the Speed Trim set point back to its initial value, and observe the generator output frequency to verify it operates in a stable manner. If stable operation is not achievable it may be necessary to lower the value for K_i. Repeat this procedure, raising K_i until the system is unstable, and then lower it to the highest value that achieved stable operation.

K_d - Derivative Gain

If the performance with K_p and K_i alone is satisfactory, it is recommended you leave K_d at a value of zero. K_d can amplify noise in a system so it should be used with great care. Otherwise K_d, the derivative controller gain, can be used in conjunction with T_d, the noise filter constant, to reduce overshoot obtained with P_i control. Setting K_d and Td is an iterative process which can be accomplished by performing the following steps.

Set an initial value of K_d that is $1/10^{th}$ the value of K_p or $1/10^{th}$ the value of K_i, whichever is smaller.

Modify the Speed Trim set point to a level that is one or two hertz higher than the initial setting. Verify that the generator's output approaches the new value in a stable manner. Set the Speed Trim set point back to its original value and observe the generator's output frequency. Next, modify the Speed Trim set point to a level that is one or two hertz lower than the initial setting observe the generator output frequency. Finally, set the Speed Trim set point back to its initial value, and observe the generator output frequency to verify it operates in a stable manner. Repeat with higher values of K_d until the system begins to be unstable, and then enter half this value as the K_d gain.

If high frequency noise seems to be entering the system, T_d is the constant of the low pass filter which filters the controller input to reduce the effects of such interference when derivative control is employed. T_d ranges from 0 to 1 with an increment of 0.001. T_d=0 is no filtering, T_d=1 is heaviest filtering. If T_d adjustment is necessary, set T_d to 0.001 and see if the noise induced behavior is reduced. Raise T_d until desired reduction of noise behavior is achieved. Once T_d has been set, tune K_d again. If noise again appears to be a problem, adjust T_d until desired behavior is achieved, then retune K_d.

var/PF Controller Tuning Procedure

Once desired voltage controller performance is obtained, the var/PF controller can be tuned. Two tuning methods are presented, one where the machine is paralleled to the utility to tune systems that are used for utility parallel operation and a second method where machines are paralleled together to tune systems employing island parallel operation.

var/PF Controller Tuning Procedure Using Parallel to Mains Operation

In Parallel to Mains operation the var/PF controller regulates the kvar output of the machine at a level specified by the kvar Setpoint % setting when the control mode is kvar control, or it regulates the kvar output to maintain the power factor specified by the PF Setpoint setting when the control mode is set to PF control.

Set the K_p, K_i, and K_d gains in the var/PF controller to 0. Set the K_g 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.

K_p - Proportional Gain

Set an initial value of K_p = 1 in the var/PF Controller. Enable the var/PF controller, and set the control mode to Var Control.

Set K_p 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, lower K_p and try again. Assuming operation appears stable, change the var setpoint in 10% steps and check for stable operation. Since K_i is zero at this point, there may be some error. Most importantly, verify that stable var control is achieved.

Raise K_p and repeat the test until unstable operation occurs. Then lower K_p to the highest value where stable operation was 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 which has its bias input driven by the DGC-2020HD.

K_i - Integral Gain

Set the initial value of K_i to be a tenth of the value set for K_p.

Each time K_i 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 K_i and repeat the test.

Repeat this procedure, raising K_i until the system is unstable, and then lower it to the highest value for which stable operation is achieved.

K_d - Derivative Gain

If the performance with K_p and K_i alone is satisfactory, it is recommended K_d be left at a value of zero. K_d can amplify noise in a system so it should be used with great care. Otherwise K_d, the derivative controller gain, can be used in conjunction with T_d, the noise filter constant, to reduce overshoot obtained with PI control. Setting K_d and T_d is an iterative process. Start with small values of K_d such as 1/10th the value of K_p or 1/10th the value of K_i, whichever is smaller.

Tuning of K_d can be achieved through the following steps. Set an initial value of K_d, then 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 K_d, 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, T_d is the constant of the low pass filter which filters the controller input to reduce the effects of such interference when derivative control is employed. T_d ranges from 0 to 1 with an increment of .001. T_d=0 is no filtering, T_d=1 is heaviest filtering. If T_d adjustment is necessary, set T_d to 0.001 and see if the noise induced behavior is reduced. Raise T_d until desired reduction of noise behavior is achieved. Once T_d has been set, tune K_d again. If noise again appears to be a problem, adjust T_d until desired behavior is achieved, then retune K_d.

var/PF Controller Tuning Procedure Using Multiple Machines in Island Parallel operation

In Island Parallel operation the var/PF controller regulates the kvar output of the machine to a level determined from inter-genset communications to accomplish kvar sharing with the other machines in the system. When properly tuned, the var/PF controller regulates the kvar output of the machine to a level equal to the average system kvar load, on a percentage of capacity basis. Thus, each machine will share kvar equally on a percentage of capacity basis.

The procedure below is written for the case where you have two machines that need to be tuned. Thus, any time a PID gain change is made, the change should be replicated in both machines before any testing for stability.

If a machine is available that is already tuned, but another one needs tuned against it, the following procedure still applies, except that PID values in the machine that have already been tuned should not be changed.

K_p - Proportional Gain

On both machines set the K_p, K_i, and K_d gains in var/PF controller to 0. Set the K_g value to 0.1. Set an initial value of 1 for K_p.

Close the breaker of the first machine onto a load. Parallel the second generator and check for stable kvar sharing between the two machines. Then, open the generator breaker on the second generator and check that both units are still stable. Since K_i is zero at this point, there may be some error in the kvar sharing. The important thing is to verify stable sharing is achieved. Repeat for various levels of kvar load if a means of varying kvar load is available.

Raise K_p in both machines and repeat the test until unstable operation occurs. Lower K_p to the highest value yielding stable operation. If one machine becomes unstable before the other as gains are raised, it may be necessary to do any further gain increases in only one machine. If the machines are not similar, you may end up with different gains in each machine. If it is not possible to obtain stable kvar sharing, it may be necessary to reduce the control gains in the AVR which has its analog bias input driven by the DGC-2020HD.

K_i - Integral Gain

Set the initial value of K_i to be a tenth of the value set for K_p in both machines.

Each time K_i is set in both machines, parallel the machines and check for stable kvar sharing. Then, open the generator breaker on the second generator and check that both units are still stable. If the system is not stable, lower K_i and repeat the test.

Repeat this procedure, raising K_i in both machines until the system is unstable, and then lower it to the highest value yielding stable operation.

Repeat for various levels of kvar load if a means of varying kvar load is available.

K_d-Derivative Gain

If the performance with K_p and K_i alone is satisfactory, it is recommended K_d be left at a value of zero. K_d can amplify noise in a system so it should be used with great care. Otherwise K_d, the derivative controller gain, can be used in conjunction with T_d, the noise filter constant, to reduce overshoot obtained with PI control. Setting K_d and T_d is an iterative process.

In both machines start with mall values of K_d that are $1/10^{th}$ K_p or $1/10^{th}$ K_i, whichever is smaller. Tuning of K_d can be achieved through the following steps. Set kvar control K_d in both machines, parallel them together, and check for stability. Then, drop the second generator and check that both units are still stable. Raise K_d in both machines until the system is unstable, and then lower it to half the value where instability is first attained. Test at various levels of kvar load if a means of varying kvar load is available.

If high frequency noise seems to be entering the system, T_d is the constant of the low pass filter which filters the controller input to reduce the effects of such interference when derivative control is employed. T_d ranges from 0 to 1 with an increment of 0.001. T_d=0 is no filtering, T_d=1 is heaviest filtering. If T_d adjustment is necessary, set T_d to 0.001 and see if the noise induced behavior is reduced. Raise T_d until desired reduction of noise behavior is achieved. Once T_d has been set, tune K_d again. If noise again appears to be a problem, adjust T_d until desired behavior is achieved, then retune K_d.

kW Load Controller Tuning Procedure

Once desired voltage and speed controller performance is obtained, the kW load controller can be tuned.

Two tuning methods are presented, one where the machine is paralleled to the utility to tune systems that are used for utility parallel operation and a second method where machines are paralleled together to tune systems employing island parallel operation.

kW Load Controller Tuning Procedure Using Parallel to Mains Operation

In Parallel to Mains operation the kW Load Controller regulates the kW output of the machine to the level of kW indicated by the Base Load Level setting.

Set the K_p, K_i, and K_d gains in the kW Load Controller to 0. Set the K_g value to 0.1. Enable the kW Load Controller. 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.

K_p - Proportional Gain

Set an initial value of K_p = 1 in the kW Load Controller.

Set K_p on kW Load Controller. Synchronize the generator to the utility so that kW control becomes active. Verify that stable kW control occurs. If the kW control seems unstable, lower K_p and try again. Assuming operation appears stable, change the base load setpoint in 10% steps and check for stable operation. Since K_i is zero at this point, there may be some error. Most importantly, verify stable kW control is achieved.

Raise K_p and repeat the test until unstable operation occurs. Then lower K_p to the highest value where stable operation was attained.

If it is not possible to obtain stable kW controller operation, it may be necessary to reduce the control gains in the engine governor which has its bias input driven by the DGC-2020HD.

K_i - Integral Gain

Set the initial value of K_i to be a tenth of the value set for K_p.

Each time K_i is set, synchronize the generator to the utility so that kW control becomes active. Check that operation appears stable. Change the base load setpoint in 10% steps and check for stable operation. If the system is not stable, lower K_i and repeat the test.

Repeat this procedure, raising K_i until the system is unstable, and then lower it to the highest value yielding stable operation.

K_d - Derivative Gain

If the performance with K_p and K_i alone is satisfactory, it is recommended K_d be left at a value of zero. K_d can amplify noise in a system so it should be used with great care. Otherwise K_d, the derivative controller gain, can be used in conjunction with T_d, the noise filter constant, to reduce overshoot obtained with P_i control. Setting K_d and T_d is an iterative process. Start with small values of K_d such as $1/10^{th}$ the value of K_p or $1/10^{th}$ the value of K_i, whichever is smaller.

Tuning of K_d can be achieved through the following steps. Set an initial value of K_d, then synchronize the generator to the utility so that kW control becomes active, and check for stability. Change the base load setpoint in 10% steps and check for stable operation. Raise K_d, 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, T_d is the constant of the low pass filter which filters the controller input to reduce the effects of such interference when derivative control is employed. T_d ranges from 0 to 1 with an increment of 0.001. T_d=0 is no filtering, T_d=1 is heaviest filtering. If T_d adjustment is necessary, set T_d to 0.001 and see if the noise induced behavior is reduced. Raise T_d until desired reduction of noise behavior is achieved. Once T_d has been set, tune K_d again. If noise again appears to be a problem, adjust T_d until desired behavior is achieved, then retune K_d.

kW Load Controller Tuning Procedure Using Multiple Machines in Island Parallel Operation

In Island Parallel operation the kW Load Controller regulates the kW output of the machine to a level determined from the analog load share line or inter-genset communications to accomplish kW sharing with the other machines in the system. When properly tuned, the kW controller regulates the kW output of the machine to a level equal to the average system kW load, on a percentage of capacity basis. Thus, each machine will share kW equally on a percentage of capacity basis.

The procedure below is written for the case where two machines need to be tuned. Thus, any time a PID gain change is made, the change should be replicated in both machines before any testing for stability.
If a machine is available that is already tuned, but you need to tune another one against it, the following procedure still applies, except that PID values in the machine that has already been tuned should not be changed.

K_p - Proportional Gain

Disable the Speed Trim function in all machines when tuning the kW load controller gains.

On both machines set the K_p, K_i, and K_d gains in kW load controller to 0. Set the K_g value to 0.1. Set an initial value of 1 for K_p.

Close the breaker of the first machine onto a load. Parallel the second generator and check for stable load sharing between the two machines. Then open the generator breaker on the second generator and check that both units are still stable. Since K_i is zero at this point, there may be error in the load sharing. The important thing is to verify stable load sharing is achieved.

Raise K_p in both machines and repeat the test until unstable operation occurs. Lower K_p to the highest value yielding stable operation. If one machine becomes unstable before the other as gains are raised, it may be necessary to do any further gain increases in only one machine. If the machines are not similar, you may end up with different gains in each machine. If it is not possible to obtain stable kW operation, it may be necessary to reduce the control gains in the governor which has its analog bias input driven by the DGC-2020HD. Test at various levels of kW load if a means of varying kW load is available.

K_i - Integral Gain

Set the initial value of K_i to be a tenth of the value set for K_p in both machines.

Each time K_i is set in both machines, parallel the machines and check for stable load sharing then open the generator breaker on the second generator and check that both units are still stable. If the system is not stable, lower K_i and repeat the test. Test at various levels of kW load if a means of varying kW load is available. Repeat this procedure, raising K_i in both machines until the system is unstable, and then lower it to the highest value yielding stable operation.

K_d-Derivative Gain

If the performance with K_p and K_i alone is satisfactory, it is recommended K_d be left at a value of zero. K_d can amplify noise in a system so it should be used with great care. Otherwise K_d, the derivative controller gain, can be used in conjunction with T_d, the noise filter constant, to reduce overshoot obtained with PI control. Setting K_d and T_d is an iterative process. In both machines start with small values of K_d that are $1/10^{th}$ K_p or $1/10^{th}$ K_i, whichever is smaller.

Tuning of K_d can be achieved through the following steps. Set load control K_d in both machines, parallel them together, and check for stability. Then, drop the second generator and check that both units are still stable. Raise K_d in both machines until the system is unstable, and then lower it to half the value where instability is first attained. Test at various levels of kW load if a means of varying kW load is available.

If high frequency noise seems to be entering the system, T_d is the constant of the low pass filter which filters the controller input to reduce the effects of such interference when derivative control is employed. T_d ranges from 0 to 1 with an increment of 0.001. T_d=0 is no filtering, T_d=1 is heaviest filtering. If T_d adjustment is necessary, set T_d to 0.001 and see if the noise induced behavior is reduced. Raise T_d until desired reduction of noise behavior is achieved. Once T_d has been set, tune K_d again. If noise again appears to be a problem, adjust T_d until desired behavior is achieved, then retune K_d.

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 are needed.

2. Once the criteria of step 1 have been established, tune a unit so that one machine can be paralleled 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. The settings shouldn't need changed unless there is tripping or load sharing characteristics need to be changed.
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 the settings for a particular machine type need to be modified, 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 one set of numbers works for all machines, but it is probable to have 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.

Load Anticipation Tuning Procedure

When properly tuned, the load anticipation function improves speed recovery of a diesel genset during load application. The DGC-2020HD senses real power change in load well before the engine speed is affected. A feed-forward signal, proportional to the real power change, is sent to the speed governor to make throttle adjustments in advance.

The BESTCOMS*Plus*® Analysis screen, found in the Metering Explorer, is used to plot DGC-2020HD control signals. Using a load bank for load application and rejection during the procedure is required.

The following parameters will be monitored in the Analysis screen during the tuning procedure:

- Gen Hz – Generator Frequency (caption depends on programmable bus label)
- GOV Output – Governor control analog output signal. Scaled version of Speed Bias Output. This is scaled based on the range configured for "Governor Output" settings. This output is also trimmed to valid output ranges.
- Load Anticipation Washout Output – Output of load anticipation washout block.
- Load Anticipation Output – Output of load anticipation function, after Kla gain and power deadband have been factored in.
- Load Anticipation lead-lag Output – Output of load anticipation lead-lag block.
- Gen kW Total – Generator kW (caption depends on programmable bus label)
- Speed Bias Output – Per unit speed output signal. Output is not limited.

1. In BESTCOMS*Plus*, navigate to Settings Explorer > Bias Control Settings > Governor Bias Control Settings. Configure the following settings:
    - Speed Trim Enable = Disabled
    - Control, Kg Loop Gain = 0
    - Load Anticipation, Enable = Disabled
    - Tla Washout Filter Constant = 0
    - Tld Lead Filter Constant = 0
    - Tlg Lag Filter Constant = 0

- Power Deadband = 0
- Kla Gain = 0
- Max Limit = +1
- Min Limit = –1

Set the Analysis screen to plot Gen Hz, GOV Output, Gen kW Total, and Speed Bias Output.
Apply load to the machine.
Figure 221 illustrates the plot of the load application response as seen on the analysis screen. All plots are based on a simulation of a PID-style governor. User results may vary.

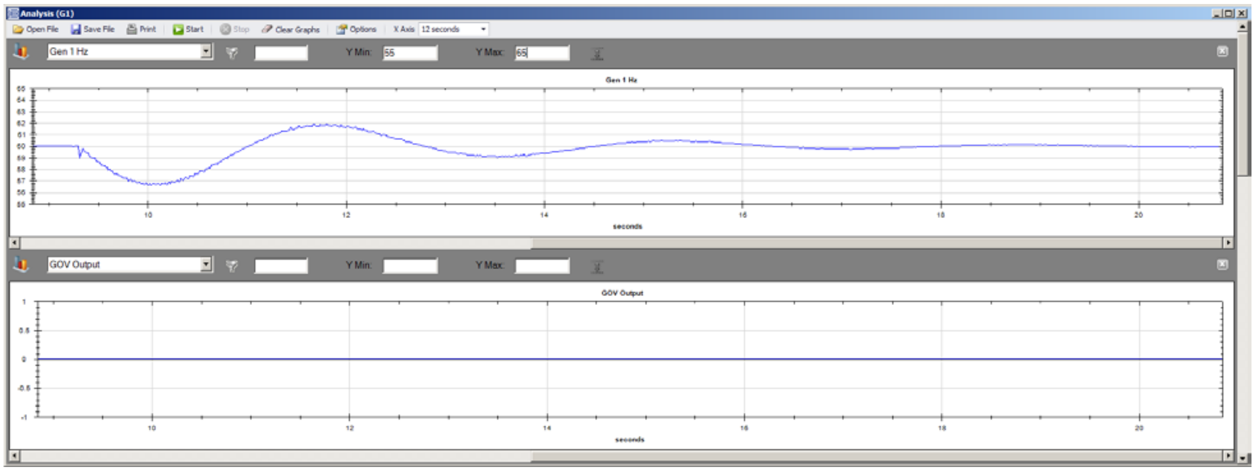


Figure 221. Load Application Response – No DGC Influence - ~3Hz Drop

2. Measure the time from load application to first local minimum of speed signal. Set the Tla Washout Filter Constant to roughly half of this value. The example plot in Figure 222 shows the local speed minimum being reached 750 ms after load application. Thus, the Tla Washout Filter Constant should be set to 0.375, half of the measured time.

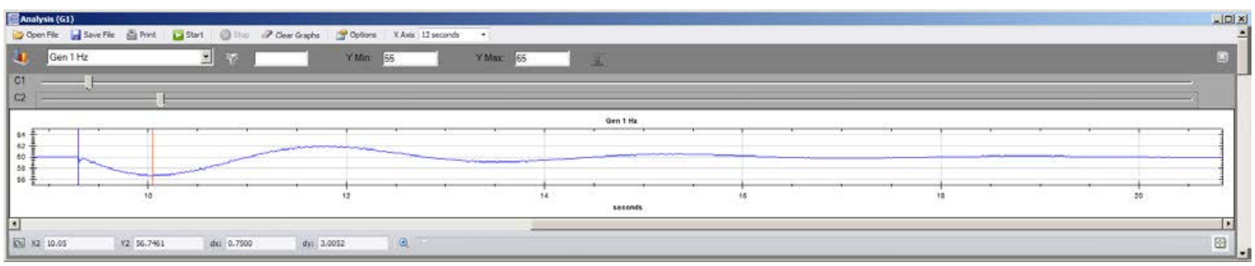


Figure 222. 750 ms time to local speed minimum – Initial Tla 0.375

3. Enable Load Anticipation.
Set the Analysis screen to plot Gen Hz and Load Anticipation Washout Output.
Apply load.
See Figure 223. Verify washout output has mostly decayed before the speed first returns to nominal value. Load anticipation assists the governor during the first portion of the transient before the speed dip is measured. After this, normal governor action compensates for changes.

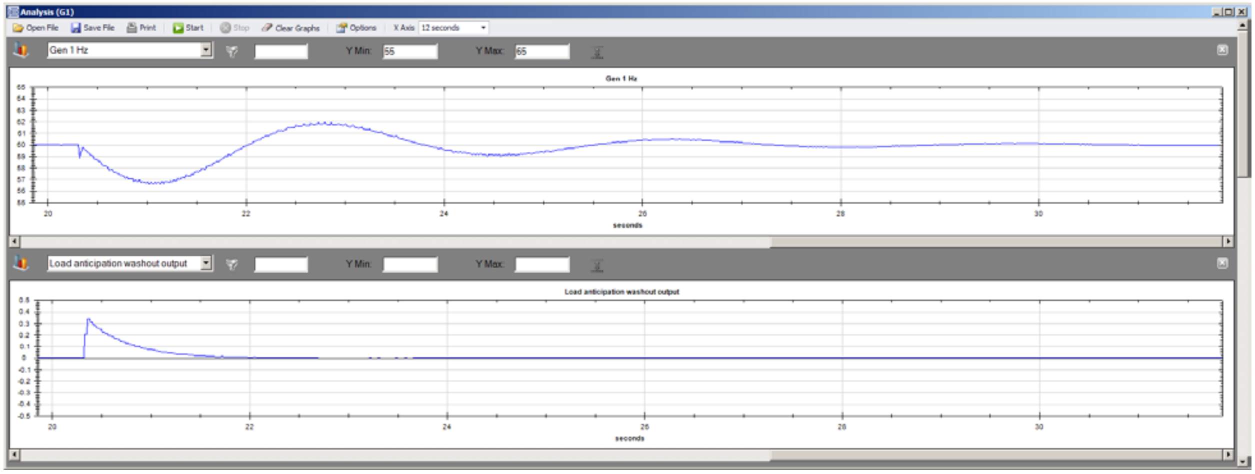


Figure 223. Washout Only Active During First Portion of Transient

4. Set the Analysis screen to plot Gen Hz, Load Anticipation Output, and GOV Output.
   Apply load and measure output frequency response.
   Increase Kla Gain, apply load, and measure output frequency response again. Repeat until output frequency response improves upon load application. If frequency overshoots on recovery, reduce Kla Gain. If GOV Output begins clipping, do not increase Kla Gain much further. If Load Anticipation Output begins clipping, but GOV Output is not clipping, increase Min/Max limit.
   Figure 224 illustrates the plot with a Kla Gain that is too low. Frequency recovery has improved, but it still has approximately 2 Hz deviation. Figure 225 illustrates the plot with a Kla Gain that is too high which causes the GOV Output signal to clip and frequency overshoot to be too high. Figure 226 illustrates the plot with a clipped Load Anticipation Output signal. Increase Max and Min Limits. Figure 227 illustrates the plot with a good response with less than 0.5 Hz deviation on load application with minimum overshoot.

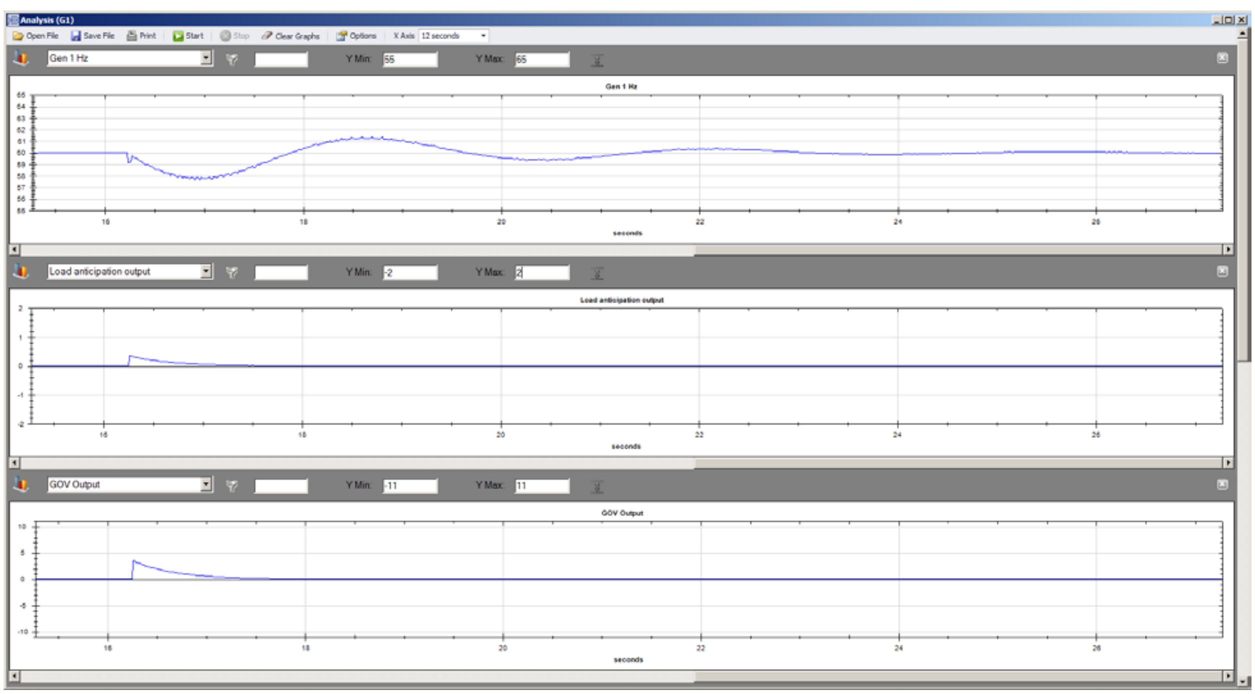


Figure 224. Kla Too Low – Frequency Recovery Improved with ~2 Hz Deviation

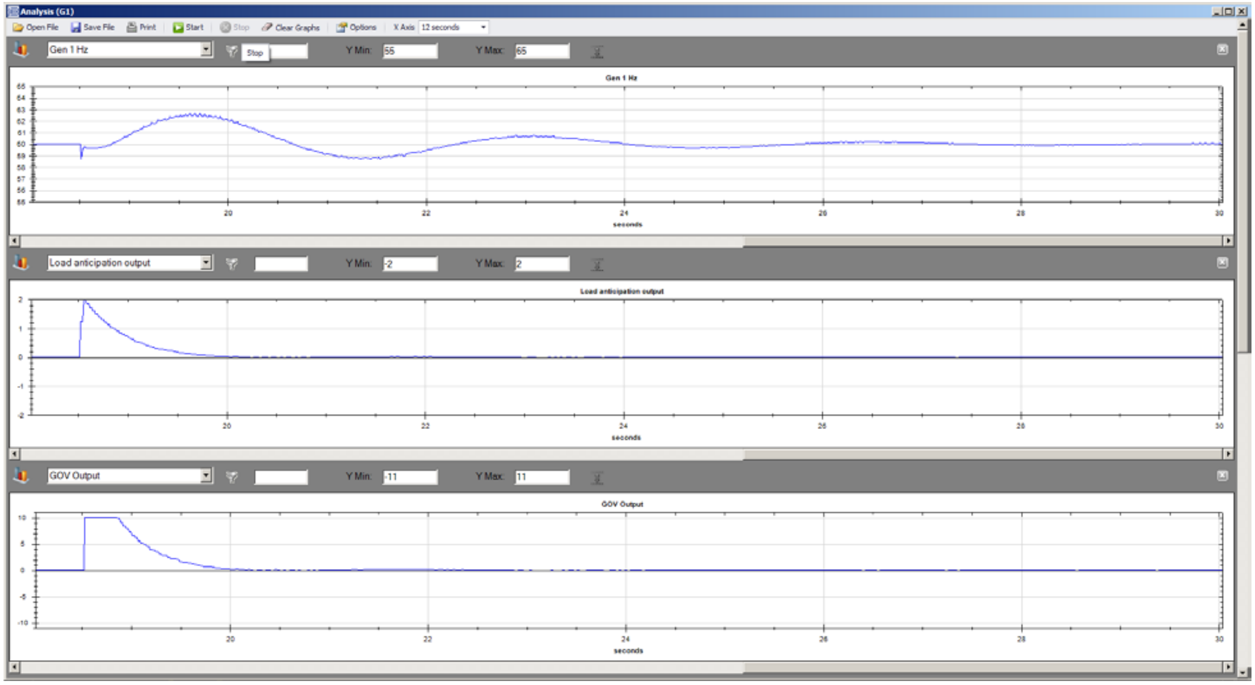


Figure 225. Kla Gain Too High, GOV Output Saturated, Frequency Overshoots on Recovery.

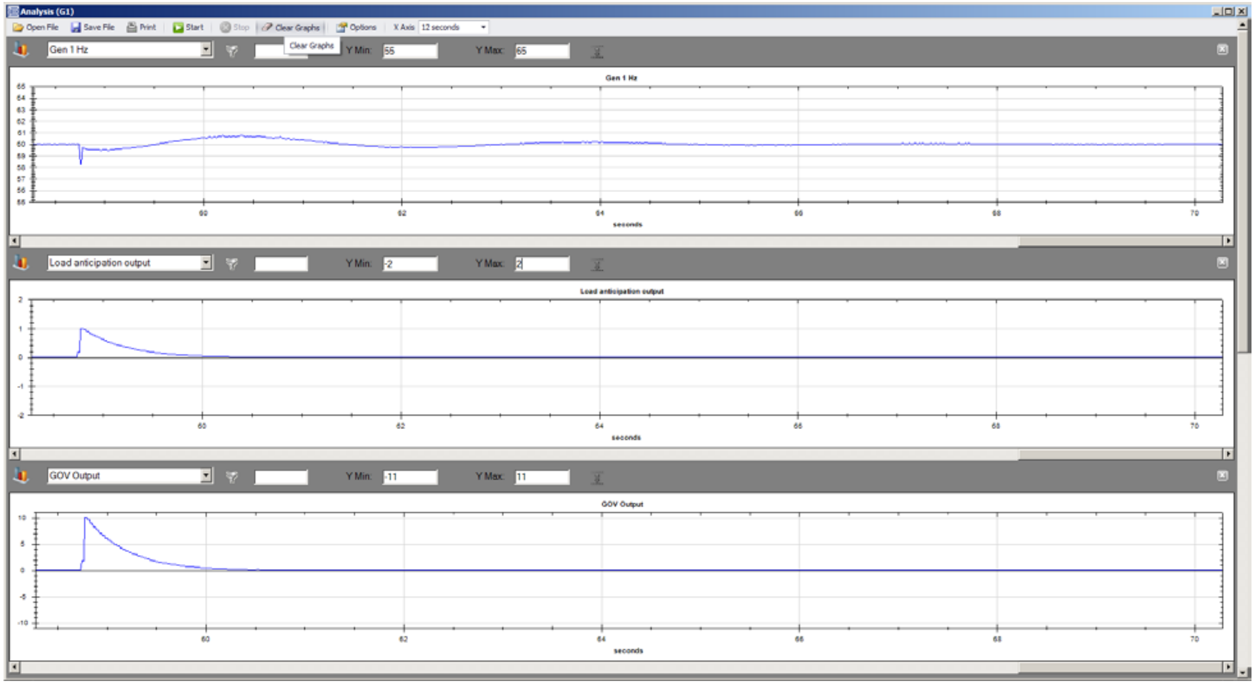


Figure 226. Load Anticipation Output Clipped.

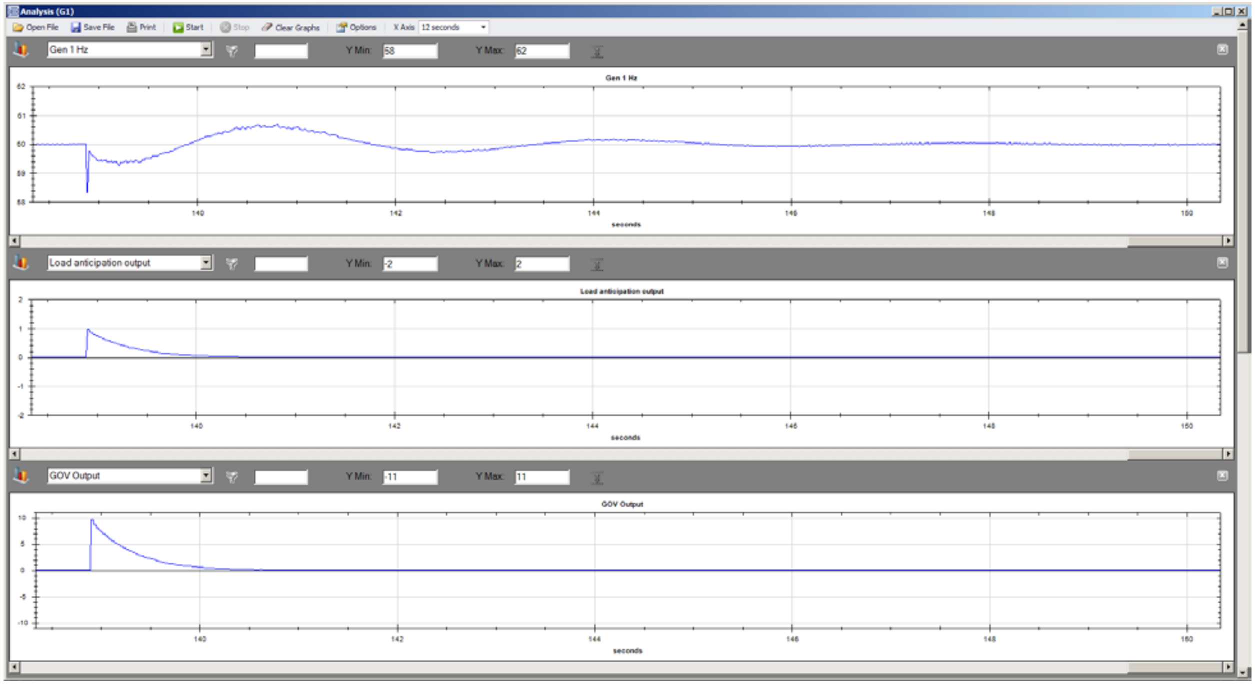


Figure 227. Good Response. < 0.5Hz Deviation on Load Application with Minimal Overshoot.

5. Set the Analysis screen to plot Load Anticipation Lead-Lag Output.
   Achieve steady state operation.
   Set the Power Deadband to the highest magnitude seen on the lead-lag output during steady state operation. Increase the Power Deadband to prevent Load anticipation from responding to small load applications if desired.

If load anticipation does not seem to operate properly, refer to the *Troubleshooting* chapter.

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 BESTCOMS*Plus*®. 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 BESTCOMS*Plus*.

Regeneration can also be disabled by turning on the Disable Regeneration setting on the ECU Setup screen in BESTCOMS*Plus*.

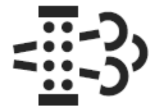
BESTlogic*Plus* programmable logic can also be used to inhibit regeneration by setting the DPF Regeneration Inhibit (DPFREGENINHIBIT) logic element true.

DPF Status and Pre-Alarms

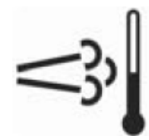
The DGC-2020HD receives DPF status information which is broadcast from the engine ECU in various Parameter Group Numbers (PGN) and Suspect Parameter Numbers (SPN). This information is displayed on the front panel and in BESTCOMS*Plus*, via DPF related pre-alarms. The J1939 parameters and the resulting DGC-2020HD pre-alarms are summarized in the following paragraphs.

- PGN 64892 (0xFD7C) Diesel Particulate Filter Control 1
  - *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.

    
  - *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.

    
  - *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 INHBTD. The regeneration inhibited symbol, shown to the right, will accompany the text when the pre-alarm appears on the DGC-2020HD front panel.

    
  - *SPN 3703 Diesel Particulate Filter Status*

    SPN 3703 indicates that regeneration is required at the lowest level, moderate level, or most severe level. The DGC-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.

  - 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.
  - 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.

- 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 CAN Bus and displays the DEF level within the DEF tank(s), and also displays several pre-alarms related to the EATS system. Any DEF related pre-alarms annunciated on the front panel display the symbol used for DEF functions which is shown to the right.

Most systems will contain one DEF tank, while some may contain two tanks. The DGC-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 LOW SEVERE: 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 WARNING: This pre-alarm displays when SPN 5246 has a value of 1. This is the lowest level of warning which indicates the EATS is not functioning properly or DEF quality or level is insufficient for proper operation.
- DEF WARNING LVL2: This pre-alarm displays when SPN 5246 has a value of 2. This is a higher level of warning which indicates the EATS is not functioning properly or DEF quality or level is insufficient for proper operation. If the problem causing this warning is not corrected, the system will eventually enter the DEF inducement states. In these states, the engine power or operating speed may be derated depending on the engine manufacturer and engine application.
- DEF INDUCEMENT: This pre-alarm displays when SPN 5246 has a value of 3, indicating the 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.

Troubleshooting

If you do not get the results that you expect from the DGC-2020HD, first check the programmable settings for the appropriate function. Use the following troubleshooting procedures when difficulties are encountered in the operation of your genset control system.

Communications

Ethernet Communication Does Not Work Properly

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

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.

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

Step 1. If the message in Figure 228 is shown, close all programs and restart the computer.

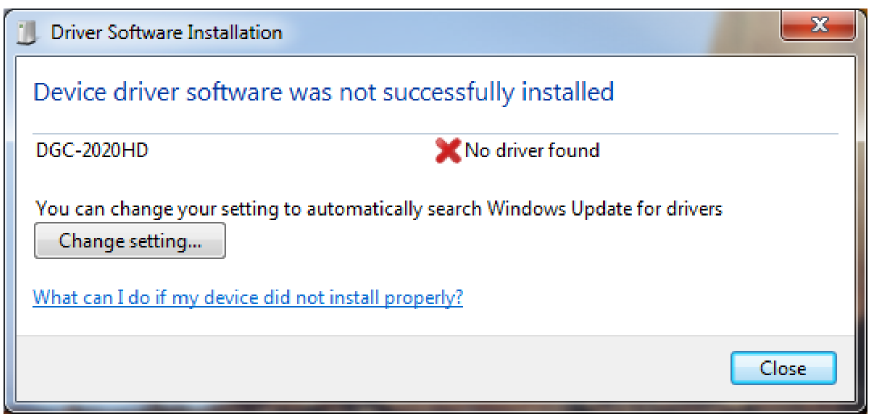


Figure 228. Driver Software Installation

Step 2. Open the Windows® Device Manger as shown in Figure 229. Right-click on DGC-2020HD (or Unknown Device) under Other Devices and select Properties.

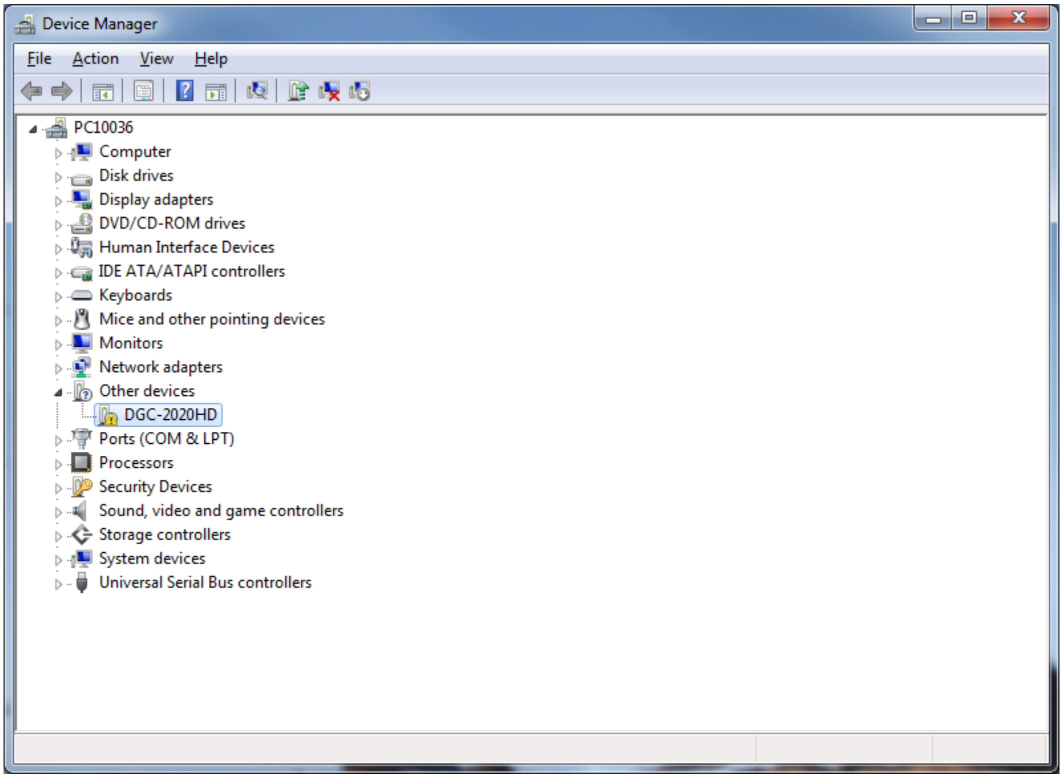


Figure 229. Device Manager

Step 3. In the Properties windows, select the Driver tab and click Update Driver. See Figure 230.

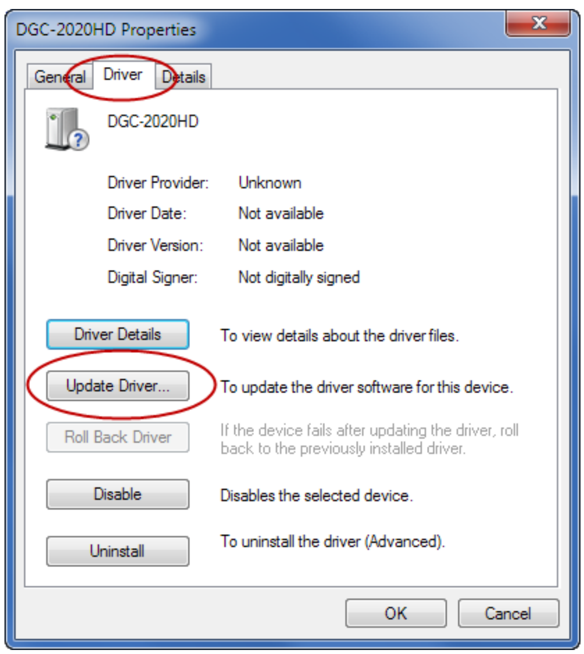


Figure 230. DGC-2020HD Properties

Step 4. Select Browse My Computer for Driver Software as shown in Figure 231.

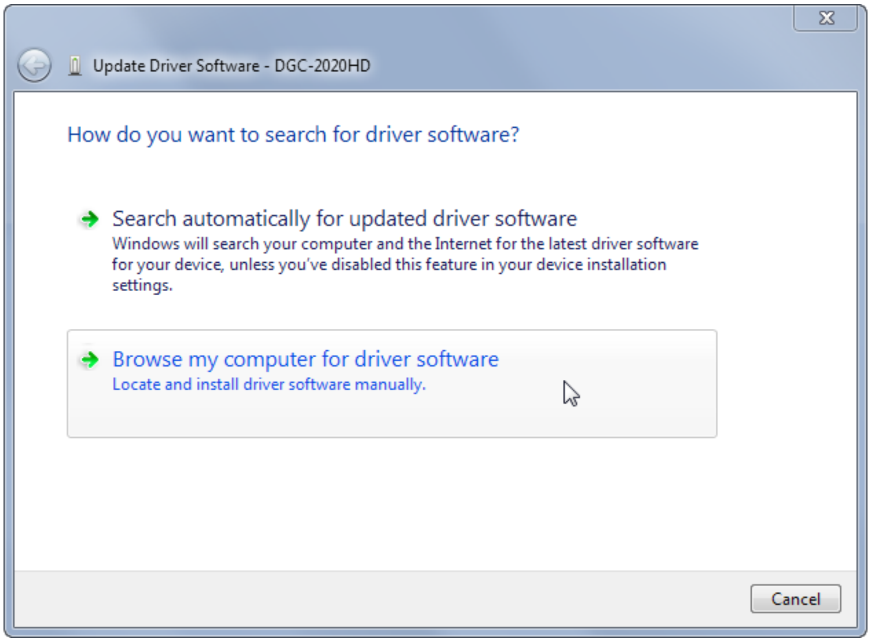


Figure 231. Update Driver Software - DGC-2020HD

Step 5. Click Browse and navigate to C:\Program Files\Basler Electric\USB Device Drivers\USBIO. Click Next. See Figure 232.

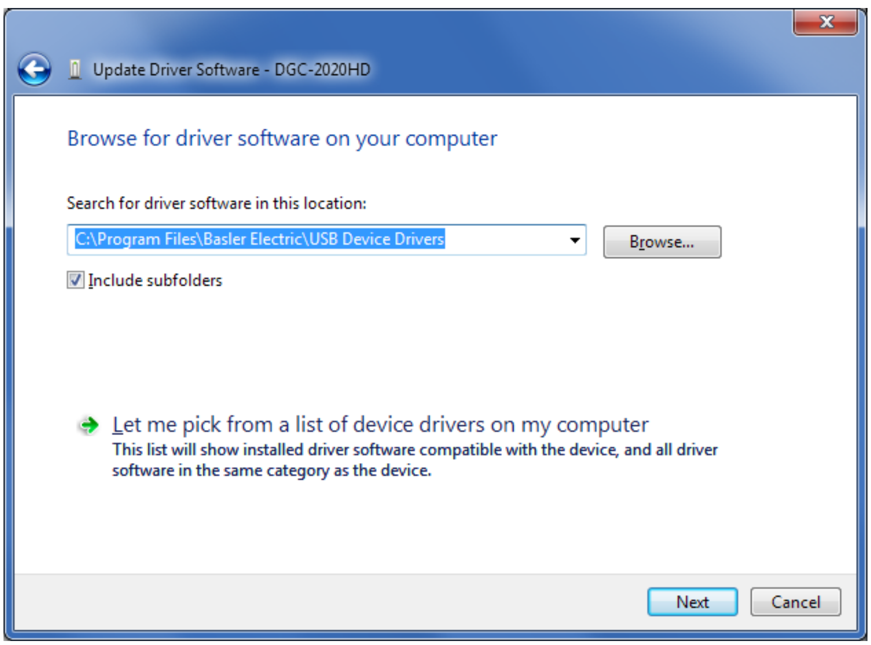


Figure 232. Update Driver Software - DGC-2020HD

Step 6. If a Windows Security window (Figure 233) appears, click Install.

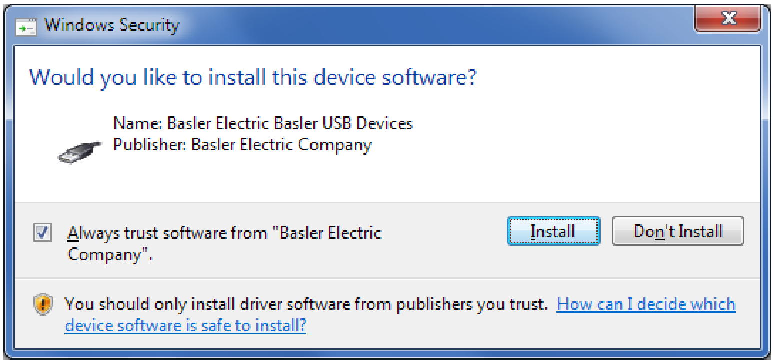


Figure 233. Windows Security

Step 7. The window in Figure 234 appears if driver installation was successful.

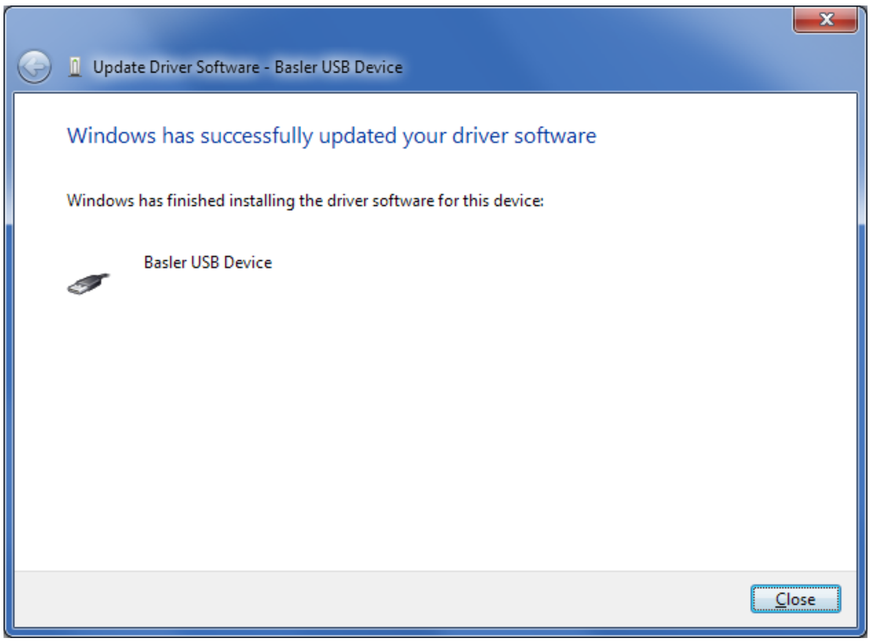


Figure 234. Driver Software Update Successful

CAN Communication Does Not Work Properly

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

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

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

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

RPM Control over CAN Bus Does Not Function

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

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

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

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

Inputs and Outputs

Programmable Inputs Do Not Operate as Expected

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

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 in the *Installation* manual.

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 in the *Installation* manual.

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 in the *Installation* manual.

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 in the *Installation* manual.

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 in the *Installation* manual.

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 BESTCOMS*Plus*®. 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.

Ground Faults Detected in Ungrounded System Applications

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

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

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

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

Generator Breaker and Mains Breaker

Generator Breaker Will Not Close to a Dead Bus

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

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 BESTCOMS*Plus* and verify that when the generator is running, the Generator Stable status LED is lit. If necessary, modify the settings on the Settings, Breaker Management, Bus Condition screen.

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

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

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

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

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

Generator Breaker Does Not Open When It Should

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

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

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

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

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

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

Mains Breaker Does Not Open When Mains Fails

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

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

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

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

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

Mains Breaker Does Not Close After Mains Returns

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

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

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

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

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

Synchronizer

Determining if the Synchronizer is Active

Step 1: Disable the speed trim function.

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

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

Step 4: Check the governor and/or AVR bias analog outputs on the DGC-2020HD with a volt meter if the governor or AVR bias control output type is analog.

Step 5: The voltages or raise/lower pulses should be changing when the synchronizer is active. If there are no raise/lower pulses, or if the analog bias voltages do not change, the synchronizer is not active.

Synchronizer Not Active

Step 1: Check style number to verify that the DGC-2020HD has the synchronizer option. If the synchronizer option does not exist in the style number, you may contact Basler Electric and request a style number change.

Step 2: Check status using the Metering Explorer in BESTCOMS*Plus*® and verify that when the generator is running, the Generator Stable status LED is lit and the Bus Stable LED is lit. Adjust the Bus Condition Detection settings accordingly. The synchronizer will never activate if the Bus is Dead or Failed (i.e. not stable).

Step 3: Check that the DGC-2020HD is trying to initiate a breaker closure. To determine the sources of breaker close requests, refer to the *Breaker Management* chapter.

Synchronizer Active for a Short Time, Then Stops

Step 1: Check if a Sync Fail pre-alarm or a Breaker Close Fail pre-alarm is occurring or has occurred. The synchronizer stops acting when such a pre-alarm occurs. Press the Off button or the Reset button on the DGC-2020HD front panel to clear these pre-alarms.

Step 2: Verify that the Sync Fail Activation delay is sufficiently long to allow the synchronizer to complete the synchronization process.

Step 3: Verify that the Breaker Close Wait time is not too short causing a pre-alarm to occur before the breaker closes when a breaker close is initiated by the DGC-2020HD.

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

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

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

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

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

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

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

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

Speed Bias

Engine Speed Does Not Change When Speed Bias Voltage Changes

Verify that the engine speed will change when the speed bias changes. As a test, you can force a voltage on the speed bias output by setting the Min Output Voltage and Max Output Voltage to the same value by navigating to Settings, Programmable Outputs, Analog Output Settings, GOV Output. If the bias is current based, you can force a fixed current by setting the Governor Output Voltage Minimum and Maximum to the same value by navigating to Settings, Programmable Outputs, Analog Output Settings, GOV Output.

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

- Verify that the governor or ECU is equipped and configured to accept bias inputs.
- Check connections to verify the wiring to the governor bias is correct.
- If you have an engine with an ECU, check ECU programming to verify it is set up to accept a speed bias input.

Engine Speed Decreases When Speed Bias is Increased

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

Engine Speed Increases When Speed Bias is Decreased

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

Load Anticipation

Large Frequency Overshoot on Recovery

Kla Gain may be too high and GOV output may be saturated. See Figure 235. Navigate to Settings, Bias Control Settings, Governor Bias Control Settings and decrease Load Anticipation, Kla Gain.

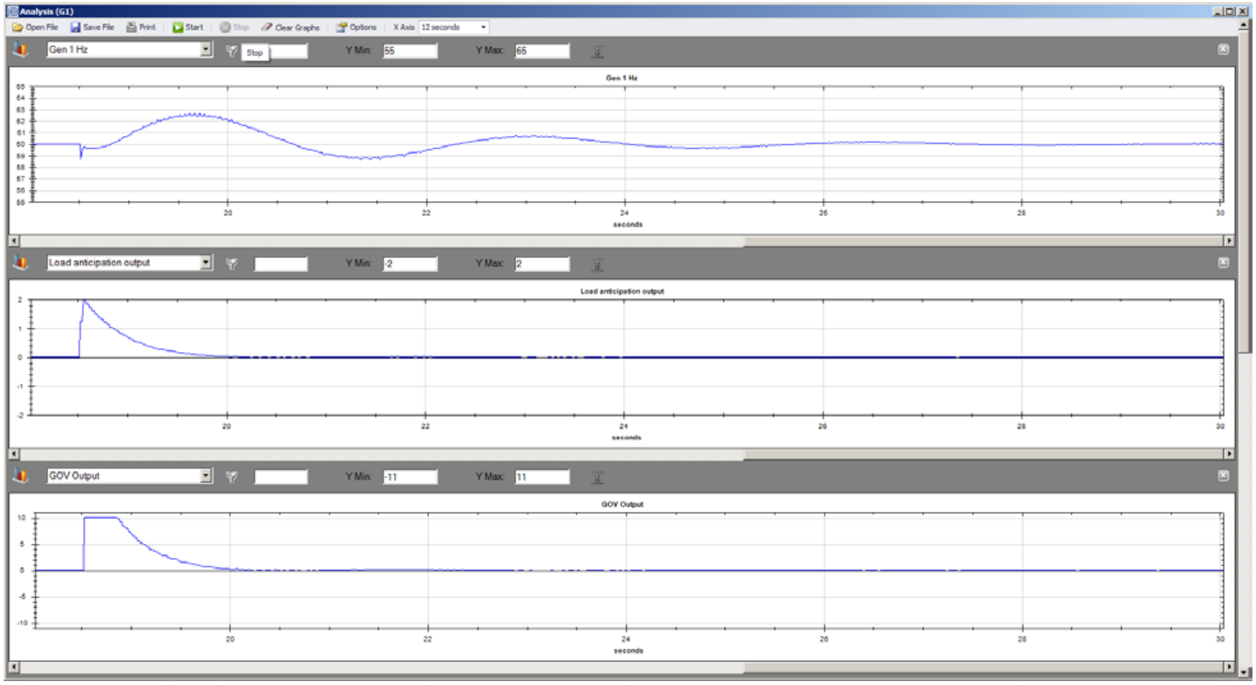


Figure 235. Kla Gain Too High, GOV Output Saturated, Frequency Overshoots on Recovery

Tla Washout Filter Constant may be too high. Load anticipation output bias is held too long and has significant magnitude after frequency reached nominal. See Figure 236. Navigate to Settings, Bias Control Settings, Governor Bias Control Settings and decrease Load Anticipation, Tla Washout Filter Constant.

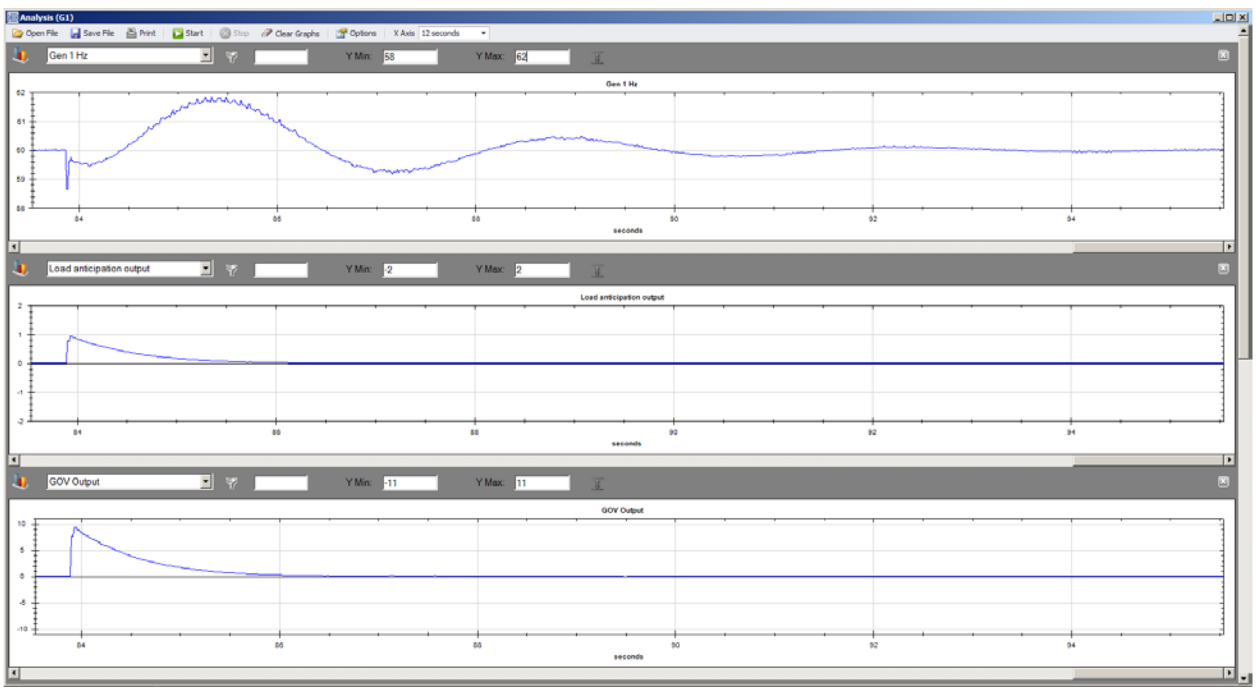


Figure 236. Tla Too High Causing Recovery Overshoot

Poor Recovery

Kla Gain may be too low. See Figure 237. Navigate to Settings, Bias Control Settings, Governor Bias Control Settings and increase Load Anticipation, Kla Gain.

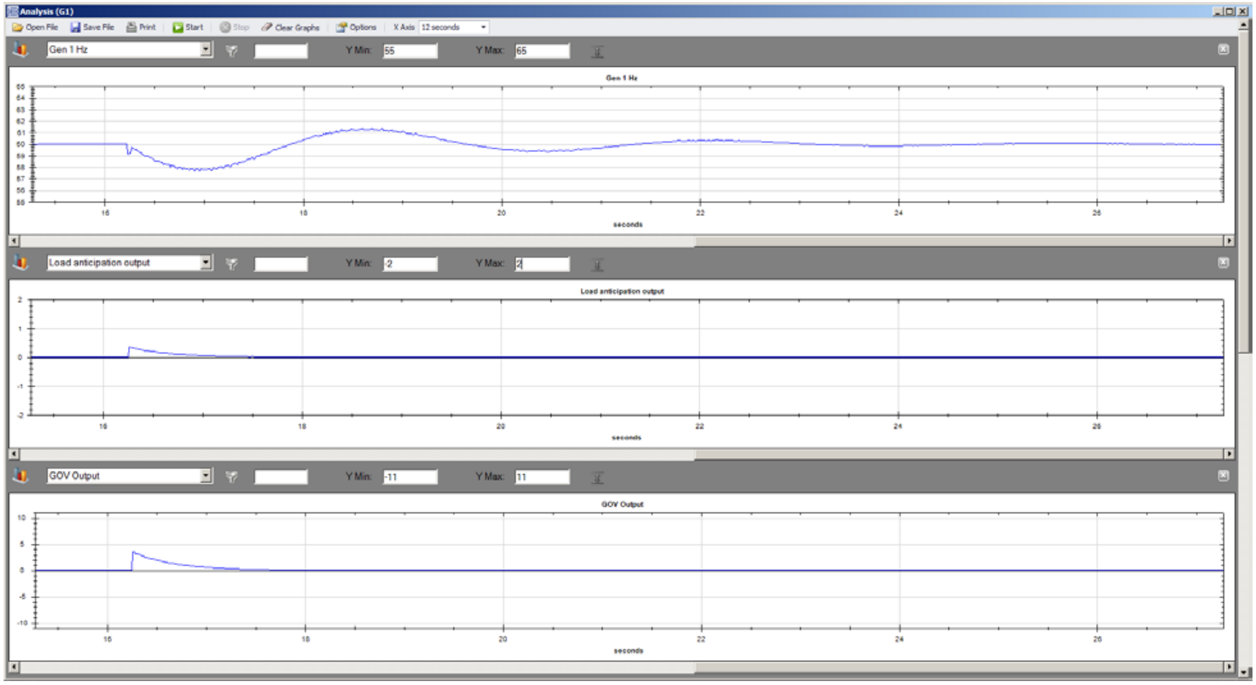


Figure 237. Kla Too Low – Frequency Recovery Improved with ~2 Hz Deviation

Tla Washout Filter Constant may be too low. GOV output decays rapidly before speed dip has finished. See Figure 238. Navigate to Settings, Bias Control Settings, Governor Bias Control Settings and increase Load Anticipation, Tla Washout Filter Constant.

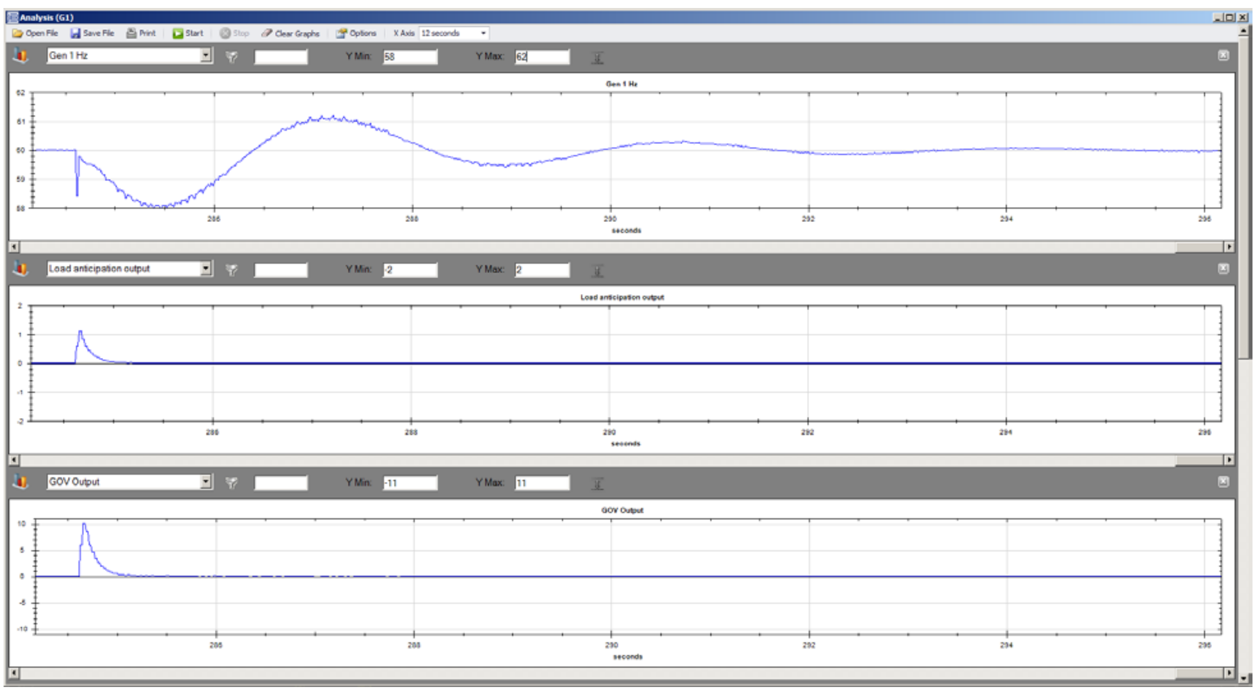


Figure 238. Tla Too Low Causing Poor Recovery

Voltage Bias

Generator Voltage Does Not Change When Voltage Bias Changes

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

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

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

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

Generator Voltage Decreases When AVR Speed Bias is Increased

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

Generator Voltage Increases When AVR Bias is Decreased

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

Load Sharing

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

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

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

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

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

Generator Runs at Incorrect Speed when Generator Breaker is Closed

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

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

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

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

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

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

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

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

Generators Do Not Share Load Equally

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

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

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

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

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

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

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

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

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

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

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

Load Sharing Works Correctly, but a Single Unit Slows Down

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

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

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

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

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

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

Group Start and Group Stop Requests

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

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

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

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

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

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

Generator Does Not Stop During a Group Stop Request

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

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

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

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

DGC-2020HD Front Panel Diagnostics Screens

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

Load Share Line

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

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

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

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

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

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

Control

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

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

The following parameters are visible on the Control diagnostics screen:

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

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

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

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

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

AEM-2020

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

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

The following parameters are visible on the AEM diagnostics screen:

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

CEM-2020

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

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

The following parameters are visible on the CEM diagnostics screen:

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

VRM

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

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

The following parameters are visible on the VRM diagnostics screen:

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

Mains Power

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

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

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

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

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

VRM Control

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

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

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

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

BESTCOMS*Plus*® Settings Loader Tool

Introduction

The BESTCOMS*Plus*® Settings Loader Tool is a software application which allows the user to instantly upload settings to Basler BESTCOMS*Plus*-compatible products by scanning a pre-registered bar code which promotes consistency, reduces potential errors, and saves time.

Setup

The BESTCOMS*Plus* Settings Loader Tool software and a bar code reader (acquired separately) must be installed on the same PC.

BESTCOMS*Plus* Settings Loader Tool Installation

System Recommendations

The BESTCOMS*Plus*® Settings Loader Tool is bundled with BESTCOMS*Plus* software. BESTCOMS*Plus* software is built on the Microsoft® .NET Framework. The setup utility that installs BESTCOMS*Plus* on your PC also installs the BESTCOMS*Plus* Settings Loader Tool and the required version of .NET Framework (if not already installed). BESTCOMS*Plus* operates with systems using Windows® XP 32-bit SP3, Windows Vista 32-bit SP1, Windows 7 32-bit (all editions), Windows 7 64-bit (all editions), Windows 8, and Windows 10. Microsoft Internet Explorer 5.01 or later must be installed on your PC before installing BESTCOMS*Plus*. System recommendations for the .NET Framework and BESTCOMS*Plus* are listed in Table 100.

Table 100. System Recommendations for BESTCOMS*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 BESTCOMS*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 BESTCOMS*Plus* CD-ROM into the PC CD-ROM drive.
2. When the BESTCOMS*Plus* Setup and Documentation CD menu appears, click the Install button for the BESTCOMS*Plus* application. The setup utility installs BESTCOMS*Plus*, the .NET Framework (if not already installed), the USB driver, and the BESTCOMS*Plus* Settings Loader Tool on your PC.

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

Bar Code Reader and Bar Codes

The BESTCOMS*Plus*® Settings Loader Tool is compatible with bar code readers which conform to UnifiedPOS specifications. Bar code readers and bar code labels are not provided and must be acquired separately. Refer to the bar code reader's documentation for installation instructions.

Any bar code compatible with your bar code reader may be used.

BESTCOMSPlus® Settings Loader Tool Settings

BESTCOMS*Plus* Settings Loader Tool settings are found on two main screens, the Loader Grid and Configuration screen. The Loader Grid contains management options for the product settings files and their associated bar codes. The Configuration screen contains product-specific options for the default behavior of the BESTCOMS*Plus* Settings Loader Tool. These settings are described in the following paragraphs.

Loader Grid

One entry, or row, in the Loader Grid contains all of the necessary data to associate a product settings file with a bar code. New entries can be added. Existing entries can be edited, deleted, and uploaded to a Basler product.

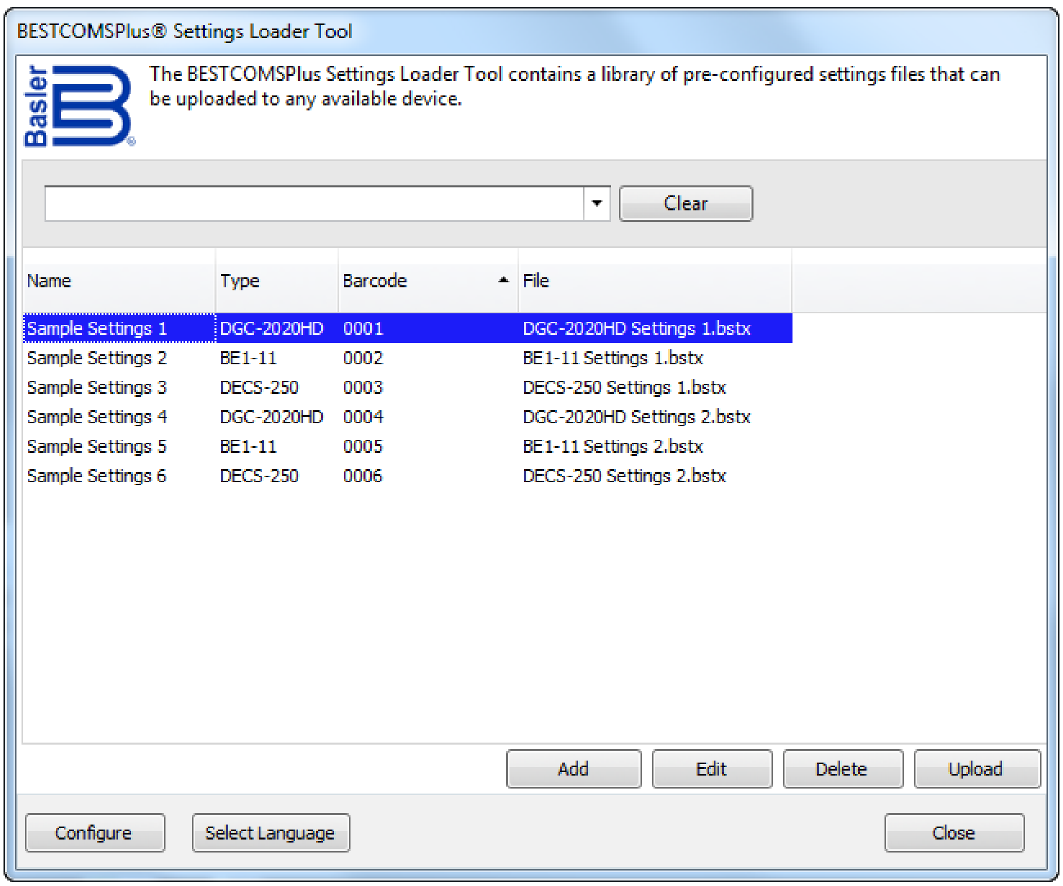


Figure 239. Loader Grid

Scanning Bar Codes

Place the cursor in the text field, found at the top of the Loader Grid screen, and scan a bar code. If successful, the digits which comprise the bar code appear in the text field. The BESTCOMS*Plus* Settings Loader Tool automatically searches for this bar code among the entries in the Loader Grid and displays the matching entry. Click Clear to remove the digits from the text field.

Adding an Entry

Click Add to create an entry. The BESTCOMS*Plus*® Settings Loader Tool: Add Device dialog box appears (Figure 240).

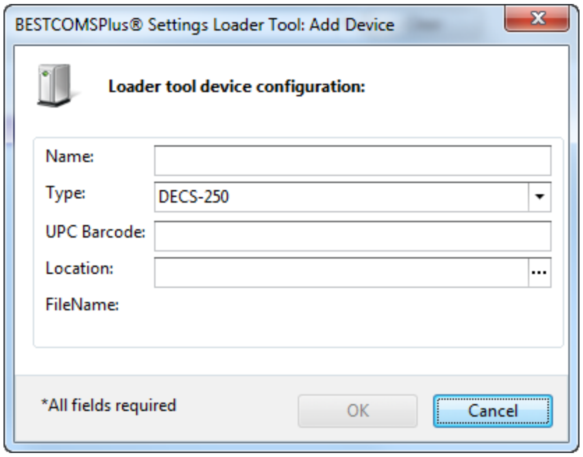


Figure 240. Add Device Screen

Enter the name of the entry in the Name field. This appears in the first column of the Loader Grid.

Select the product type from the Type drop-down menu. This appears in the second column of the Loader Grid.

Enter the bar code of the entry in the UPC Barcode field by placing the cursor in the UPC Barcode field and scanning the bar code.

To select the product settings file for the entry, click the browse (…) button in the Location field. Use standard Windows methods to navigate to the desired product settings file and click Open. Ensure that the selected product type in the Type field matches that of the product settings file specified in the Location field.

Click OK when finished.

Editing an Entry

To Edit an existing entry, select the entry in the Loader Grid and click Edit. The BESTCOMSPlus Settings Loader Tool: Edit Device dialog box appears. The options are identical to those of the Add Device dialog. When the desired changes have been made, click OK.

Deleting an Entry

To delete an entry from the Loader Grid, select the entry and click the Delete button. A prompt appears providing the option to confirm or cancel the deletion.

Uploading an Entry

Select an entry and click Upload. A dialog appears which provides connection options for the appropriate type of device. Refer to the Basler product instruction manual for detailed connection information. Once a connection is established, the product settings associated with the entry are uploaded.

Configuration Settings

For configuration settings, click the Configure button in the bottom left of the Loader Grid. The product tabs on the left represent the compatible Basler products. Each product tab contains tabs for Settings Files and Connection Options. The options on these tabs are described below.

Setting Files Options

Use Saved Path: When enabled, the path specified in the Loader Grid entry is used when uploading the settings file.

Single Folder: When enabled, this specifies a single folder which contains all settings files for the product. The Windows filename specified in the Location field of the Loader Grid entry is searched for in the Single Folder location. For example, all settings files for a product are located in "C:\files". The Location field in the Loader Grid entry for a device contains "C:\documents\settings\DECS-250 Settings.bstx". The BESTCOMS*Plus* Settings Loader Tool searches in "C:\files" for the file named "DECS-250 Settings.bstx".

Append Bar-Code to Location: When enabled, the bar code is appended to the specified location when uploading the settings file. For example, an entry with the bar code "0002" is located in C:\files\0002 and an entry with the bar code "0003" is located in C:\files\0003.

Logon: If User Name and Password are specified, you will not be prompted for credentials when required.

Save After Upload: After uploading a settings file, the settings are downloaded from the connected device and saved to the specified location, when enabled.

Upload Security: When enabled, the security settings stored in the settings file are uploaded to the device. Credentials will be requested if not already specified.

Figure 241 illustrates the Setting Files tab.

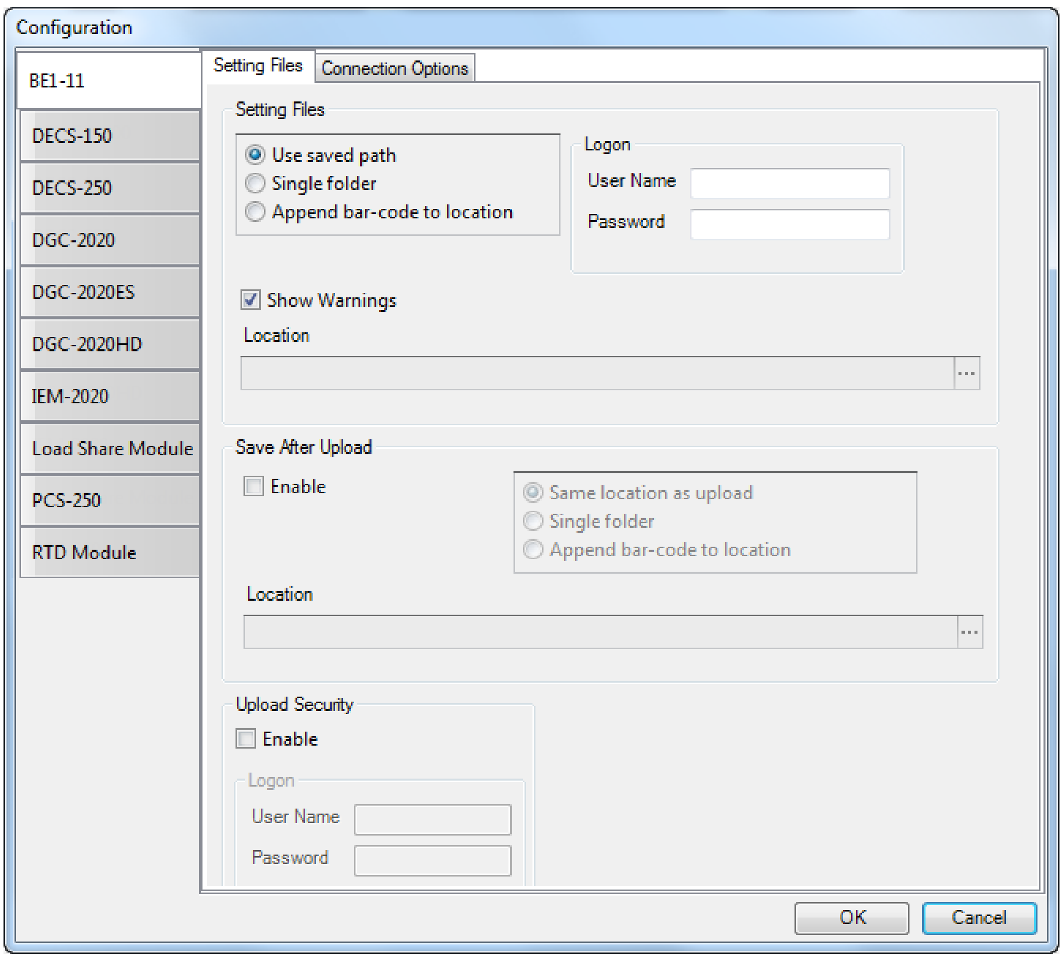


Figure 241. Configuration, Settings Files Tab

Connection Options

Connection options consist of the three selections described below. Refer to the Basler product instruction manual for detailed connection information.

Always Prompt for Connection: When enabled, a dialog appears which provides connection options for the appropriate type of device each time a connection attempt is made.

Ethernet Connection: When enabled, the BESTCOMS*Plus* Settings Loader Tool automatically attempts to connect to the specified IP address before uploading settings.

USB Connection: When enabled, the BESTCOMS*Plus*® Settings Loader Tool automatically attempts to connect to the device via USB port before uploading settings.

Figure 242 illustrates the Connection Options tab.

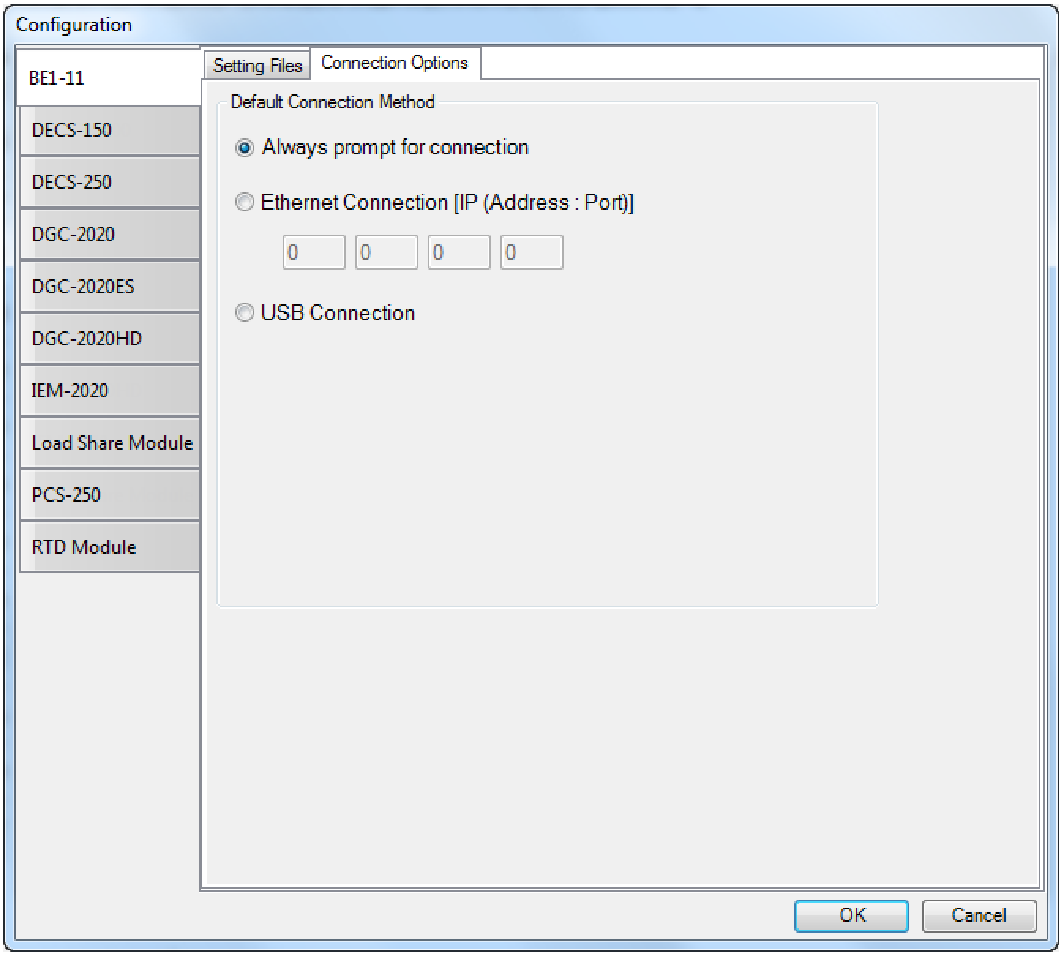


Figure 242. Configuration, Connection Options Tab

General Operation

The steps listed below are provided as a general guideline for how to operate the BESTCOMS*Plus* Settings Loader Tool when the initial setup is complete and the settings files are associated with bar codes.

1. Power on the device which will receive the new settings. Ensure proper communication connections have been made between the device and the PC running BESTCOMS*Plus* Settings Loader Tool.
2. Run BESTCOMS*Plus* Settings Loader Tool.
3. Place cursor in search bar.
4. Scan bar code.
5. Settings file is automatically highlighted and isolated in the grid.
6. Click Upload.
7. BESTCOMS*Plus* Settings Loader Tool automatically connects to device and uploads settings. Device connection is automatic unless “Always prompt for connection” is enabled.

Revision History

Table 101 provides a historical summary of the changes made to the DGC-2020HD hardware. Application firmware changes are listed in Table 102 and BESTCOMS*Plus*® changes are listed in Table 103. The corresponding revisions made to this instruction manual are summarized in Table 104. Revisions are listed in chronological order.

Table 101. Hardware Revision History

Hardware Version and Date	Change
A, Jan-14	• Initial release
B, Mar-14	• Released firmware version 1.00.02
C, May-14	• Changes invisible to the user
D, May-14	• Released firmware version 1.00.03 and BESTCOMS*Plus* version 3.06.00
E, May-14	• Changes invisible to the user
F,Sep-14	• Changes invisible to the user
G, Sep-14	• Released firmware version 1.00.05 and BESTCOMS*Plus* version 3.08.02
H, Jun-15	• Released firmware version 1.01.00 and BESTCOMS*Plus* version 3.09.00
I	• Version letter not used
J, Aug-15	• Changes invisible to the user
K, Oct-15	• Released firmware versions 1.02.00 and 2.02.00 and BESTCOMS*Plus* version 3.11.00 • Added Color Touch Screen LCD style option.
L, Feb-16	• Changes invisible to the user
M, Sep-16	• Released firmware version 2.03.00 and BESTCOMS*Plus* version 3.15.00

Table 102. Application Firmware Revision History

Firmware Version and Date	Change
1.00.00, Jan-14	• Initial release
1.00.02, Feb-14	• Added configurable hysteresis settings to generator protection elements • Added Return Timer to Mains Fail Transfer Status screen on DGC-2020HD front panel
1.00.03, Apr-14	• Corrected a firmware conflict with the disconnect timer • Minor firmware improvements
1.00.05, Sep-14	• Changed legacy Modbus registers 94812 bit 22, 94814 bit 12, and 94832 bit 16 for global low coolant level and 94813 bit 24 for global emergency stop alarm
1.01.00, Apr-15	• Added new features and enhancements for complex bus control including current imbalance protection, generator differential protection, automatic mains fail enhancements, Ethernet load sharing enhancements, mains power control modes, kW and var/PF controller enhancements, segmented bus system support, breaker management enhancements, multiple controller breaker operation, auto synchronizer enhancements, seven-day timer, rest timer, configurable alarm levels for protection, contact output text strings on front panel, real-time clock enhancements, selectable event log parameters, configurable protection parameters, remote speed biasing, ability to select whether positive power indicates mains import or generator

<table>
<tr><th>Firmware
Version and Date</th><th>Change</th></tr>
<tr><td></td><td>export, email capabilities, programmable logic enhancements, load shedding, demand start/stop enhancements, breaker power sum
• Enhanced J1939 communications
• Added ability to enable or disable memory of raise/lower commands
• Enhanced voltage trim function
• Added various alarms and pre-alarms for Tier 4 Selective Catalytic Reduction (SCR) and Diesel Particulate Filter (DPF) exhaust systems
• Added user-programmable initializing message on HMI
• Extended activation delay for low battery voltage detection
• Increased range of Over and Undervoltage protection
• Increased number of configurable protection elements
• Added Droop Offset setting for AVR and Governor bias controllers
• Added positive and negative ROCOF modes to the 81 function
• Improved breaker operation sequence
• Modified Raise/Lower speed commands to be bound by the RPM Bandwidth setting
• Modified generator protection to be active only when generator is running, where applicable
• Improved Reset button operation security
• Added an activation delay to prevent nuisance reverse rotation pre-alarms
• Improved generator breaker and alarm indication
• Improved Engine RPM Modbus™ register
• Added name of the generator protection to the alarm on the HMI
• Modified Intergenset Communications Fail pre-alarm
• Corrected Modbus access level issue
• Fixed a few logic points not latching appropriately
• Improved arming delay and cooldown mode interaction
• Modified exercise timer
• Improved real and reactive power ramping in the controllers
• Corrected legacy Modbus map
• Consolidated configurable protection and metering to a single list
• Corrected 81O/U inhibit in single-phase configuration
• Improved synchronizer
• Shortened Ethernet connection timeout
• Improved control sequence during a power cycle
• Improved MCS5 protocol interpretation
• Improved logic timers resolution
• Improved kW and kvar controllers
• Increased number of configurable protection elements to 32</td></tr>
<tr><td>2.02.00, Oct-15</td><td>• Added Color Touch Screen LCD style option
• Added Load Anticipation function
• Increased number of Logic Control Relays (LCR) from 16 to 64
• Added Engine ECU Address setting to specify which ECU to correspond with when multiple ECUs are detected on the network
• Added support for Volvo EMS2.3 Tier 4 SCR Exhaust System parameter annunciation via proprietary J1939 PGN
• Added configurable math functions
• Added new system breaker configurations: Generator and Tie Breaker Control and Tie Breaker and Tie Breaker Control
• Added metering screen to display state of all Broadcast Logic elements for all DGC-2020HDs in network
• Added metering screen to display state of all Modbus virtual switches.
• Added Logic Input Counter Gate element</td></tr>
</table>

Firmware Version and Date	Change
	• Added 96 Modbus virtual switches • Added Cylinder Cutout Enable Override logic element • Added setting to enable retention of speed adjustments after shutdown • Added setting to specify normally open or normally closed operation for all programmable contact inputs • Added Weekday of Month mode for generator Exercise Timer • Added hysteresis settings for Low Fuel Alarm and Pre-alarm and High Fuel Level Pre-alarm • Improved redundant Ethernet handling and diagnostic capabilities • Added droop offset setting for AVR and GOV droop modes • Added synchronizer mode selections • Added setting to specify which side of tie breaker is used for power measurements • Added setting to specify ECU or sender as source for coolant temperature and oil pressure data • Added engine hours to the alternating display with the battery voltage and coolant temperature on the front panel overview screen
2.03.00, Jul-16	• Added configuration, protection, limiting, and control support for VRM-2020 Voltage Regulator Expansion Module • Added style option for Load Anticipation function • Added parsing of Proprietary Isuzu Engine ECU J1939 CAN Bus communication to annunciate Tier 4 Exhaust System Parameter Information • Added logic elements for "AVR Lower Limit" and "AVR Upper Limit" • Added Speed Trim and Droop Features • Added Voltage Trim and Droop Features • Added a Logic Element for Analog Load Share Override • Added Settings to configure Run Time Hours Display, Fuel Level Display, and Pre-Alarm annunciation Display on the Overview Screen • Added a setting to allow user to modify the domain name used in emails from Basler products • Added more setpoint adjustment capability to volt trim, speed trim, kW, var, and PF controllers • Added Balanced Engine Hours sequencing mode and use engine hours as secondary sort for Balanced/Staggered Service Time • Added Automatic IP address assignment when no DHCP server available • Added Chinese and Russian language support
2.03.03, Oct-16	• Enhanced readability of monochrome LCD • Changed to prevent issuing of breaker open request on power up when configured as a segmented system

Table 103. BESTCOMS*Plus*® Software Revision History

Software Version and Date	Change
3.05.02, Dec-14	• Initial Release
3.05.03, Feb-14	• Updated to support firmware version 1.00.02
3.06.00, May-14	• Maintenance release (BE1-11 changes)

Software Version and Date	Change
3.07.00, Oct-14	• Removed duplicate results in the device discovery list • Improvements to device directory on Connection screen • Changed to allow a comma in the Device ID • Changed to annunciate a connection failure message when a device is not present on a selected port • Improved prompts to save settings when choosing to close all open views • Changed to allow the middle mouse button to close the security view • Improved display of raw analog input currents • Changed to make BESTlogic*Plus* status LEDs report all logic errors
3.07.03, Jan-15	• Maintenance release (DECS-250 changes)
3.08.00, Feb-15	• Maintenance release (DECS-250 changes)
3.08.02, Mar-15	• Minor regional settings improvement
3.09.00, Apr-15	• Added support for firmware version 1.01.00 (see firmware revision history above) • Analysis view updated with support for 6 plots
3.10.00, Oct-15	• Maintenance release (DECS-150 launch)
3.11.00, Oct-15	• Added support for firmware version 2.02.00 (see firmware revision history above) • Added BESTCOMS*Plus* Settings Loader Tool
3.12.00, Apr-16	• Maintenance release (DECS-250 changes)
3.14.00, Jul-16	• Maintenance release (DECS-250E launch, DECS-150 and BE1-11 changes)
3.15.00, Jul-16	• Added support for firmware version 2.03.00 (see firmware revision history above) • Added Chinese and Russian language support • Added Windows 10 compatibility

Table 104. Instruction Manual Revision History

Manual Revision and Date	Change
—, Oct-16	• Initial release
A, Dec-16	• Added Group Start and Group Stop Requests to the *Troubleshooting* chapter • Expanded coverage of the Emergency Stop Programmable Function • Added caution statement about nonvolatile memory

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