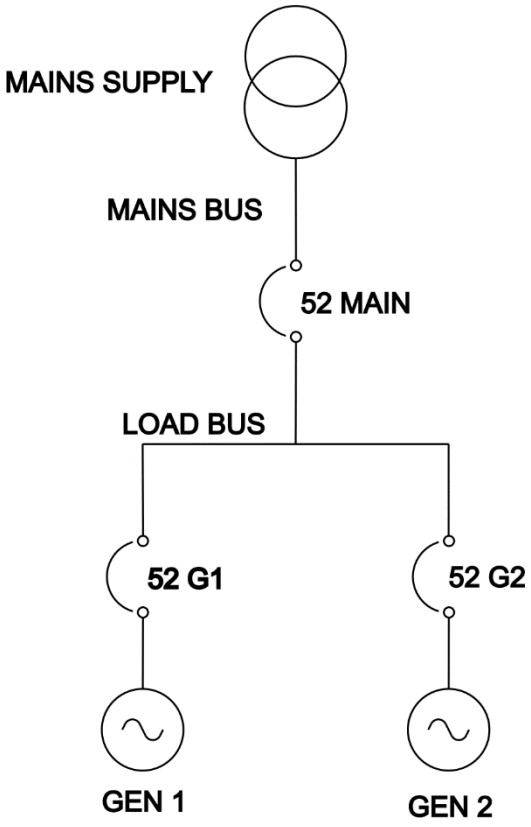
APPLICATION GUIDE

How to set up a system of DGC-2020HDs to achieve Generator and Mains Breaker Control



From a single-line diagram to a fully functional system!

Purpose

This application guide is intended to be used as a quick start reference guide for implementing the use of multiple DGC-2020HD controllers to achieve generator and mains breaker control. In this system configuration, DGC-2020HD devices control gensets as they would in a typical paralleling setup, and an additional DGC-2020HD controls a utility tie breaker. The purpose of this application guide is to provide users with direction on the minimum settings and logic that needs to be configured to meet the control needs of this application. This document is not a comprehensive instruction manual that covers all features and functions of the DGC-2020HD. Users should always refer to the DGC-2020HD instruction manuals available at www.basler.com for further details.

About Basler

Basler Electric is a manufacturer of excitation systems, voltage regulators, genset controls, protective relays, and custom transformers. Basler also offers turnkey engineering services through their Basler Services, LLC subsidiary.

Basler products control and manage the delivery of electricity and are commonly found in applications such as power plants, substations, hydro dams, agricultural facilities, airports, refineries, telecom facilities, factories, marine applications, and many others.

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First Printing March 2022 | Revised March 2025

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Application Overview

Consider the single-line diagram shown in Figure 1 below. Generator 1 and Generator 2 are capable of running in parallel. Each generator is controlled by a DGC-2020HD. Once the generators are running, either generator's breaker can be closed to the load bus when it is dead, and the other generator can then be synchronized and closed to the live load bus. For details on paralleling multiple generators to a common bus using the DGC-2020HD, review the application guide "*How to set up the DGC-2020HD for Paralleling in a Multiple Generator Setup*".

The system shown in Figure 1 entails a little more complexity than a simple paralleling setup, due to the presence of a utility breaker. The introduction of this tie breaker results in the load bus segment and the mains bus segment. A third DGC-2020HD set up for tie breaker control will control the mains breaker. The mains breaker controller communicates with the other two DGC-2020HDs over Ethernet communications to achieve system control.

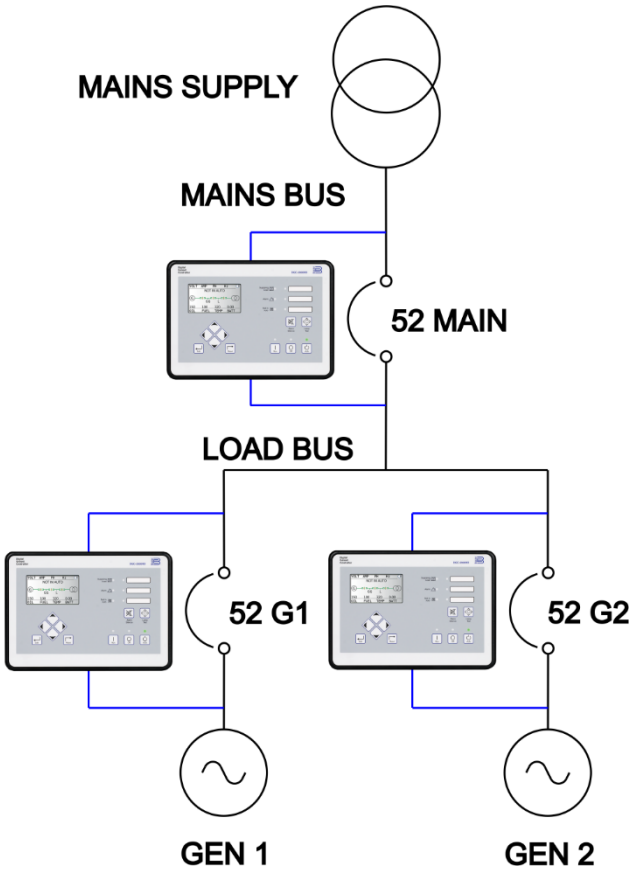

Figure 1. Single-Line Diagram for Generator and Mains Breaker Control

A DGC-2020HD configured for tie breaker control does not send raise/lower adjustments to a genset directly. It must be networked with one or more DGC-2020HDs configured for a breaker configuration that includes genset control. In our example, the genset controller's breaker configuration is generator breaker to segmented system.

There are two different uses of the DGC-2020HD in this application:

- Genset controller
- Mains tie breaker controller

First, we will explore the required settings and logic for the DGC-2020HDs functioning as genset controllers.

DGC-2020HDs Functioning as Genset Controllers

A DGC-2020HD that is controlling a genset in a generator and mains breaker system topology can be wired for current and voltage sensing as shown in Figure 2. Note that Bus 1 is the load bus.

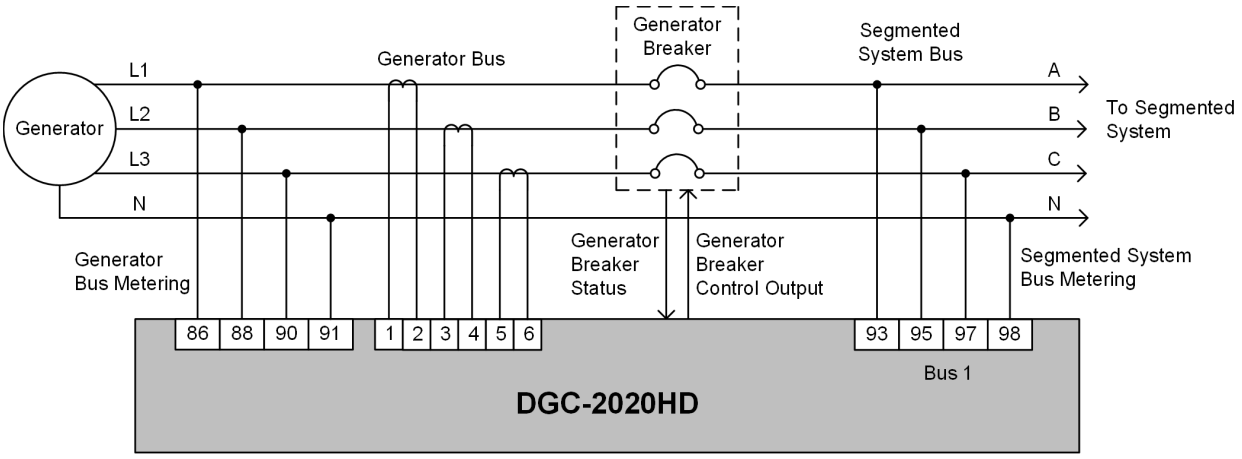

Figure 2. DGC-2020HD to Generator Wiring for Generator Breaker to Segmented Bus Configuration

Figure 3 illustrates DGC-2020HD to engine wiring.

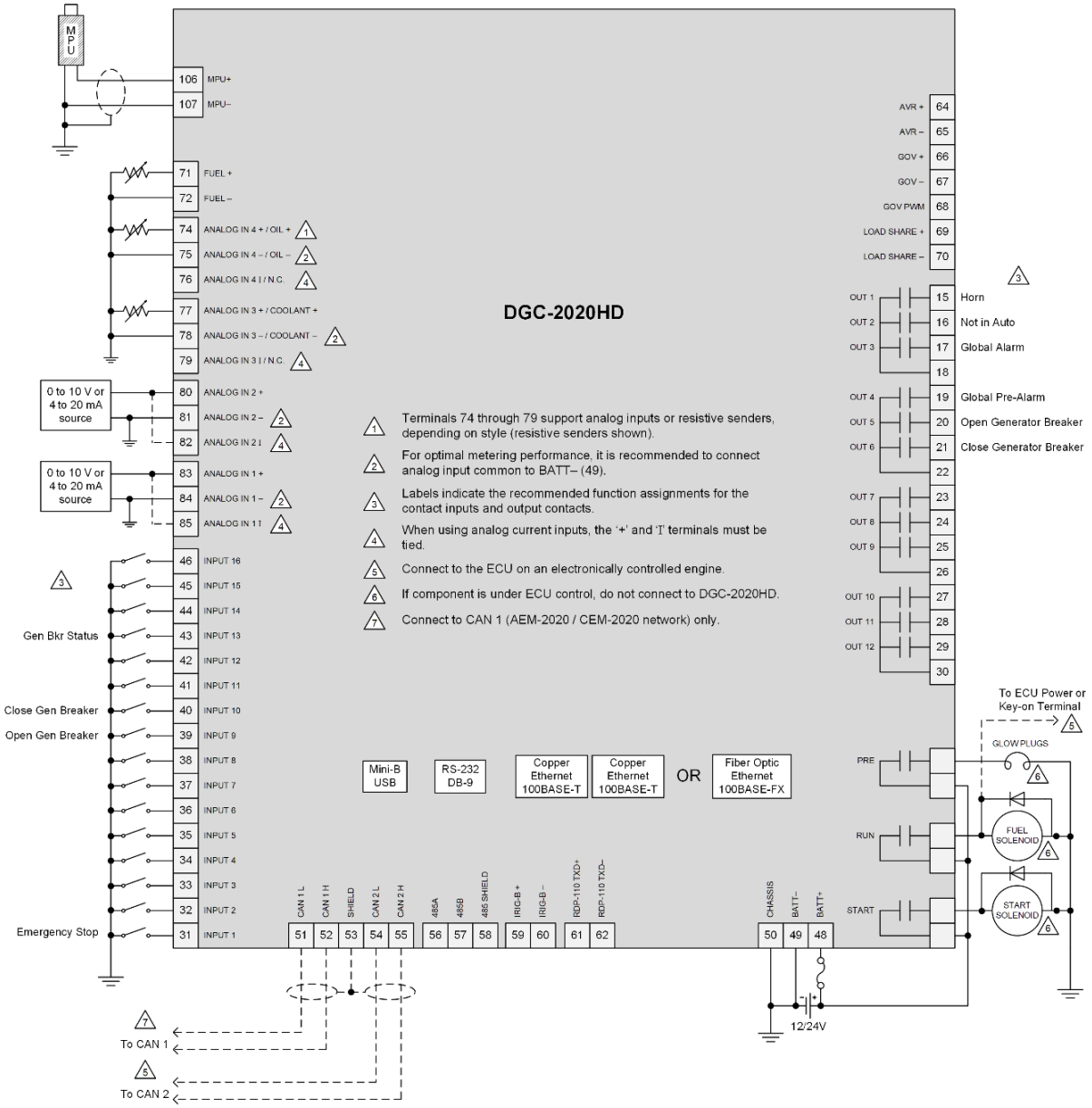

Figure 3. DGC-2020HD to Engine Wiring

Style Number

When the DGC-2020HD is configured for genset control, the auto-synchronizer option is needed for paralleling. Base option selections will suffice for the other options. Users can opt for higher tier style options if desired. Note that over current protection with inverse time curves is not available with the standard protection option. A snippet of the DGC-2020HD Style Number setting page is shown in Figure 4.

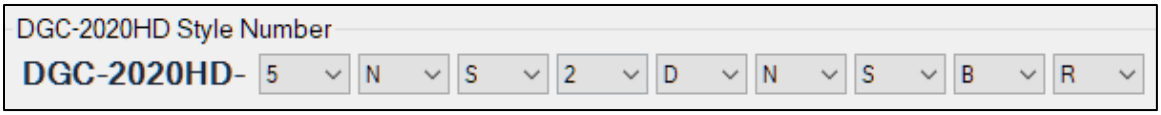

Figure 4. DGC-2020HD Style Number

Setting Summary

Most of the settings for paralleling multiple generators to a common bus can be carried over to the genset controllers in a generator and mains breaker control system configuration, with a few exceptions. Refer to the application guide "*How to set up the DGC-2020HD for Paralleling in a Multiple Generator Setup"* for guidance on the following settings:

- CAN Bus Setup
- ECU Setup
- Speed Setup
- Crank Settings
- Programmable Inputs
- Programmable Outputs
- Generator Breaker Settings
- Generator and Bus Condition Detection
- Bias Control Settings
- AVR Bias Control Settings
- Governor Bias Control Settings
- Multi Generator Management
- Programmable Senders

Moving forward, we will examine only the settings that need to be changed to create a generator and mains breaker control system configuration.

System Settings

When multiple generators are paralleled to a common bus, there is no bus segmentation (Figure 5). However, when a tie breaker is introduced into the system, the bus is now segmented (Figure 6).

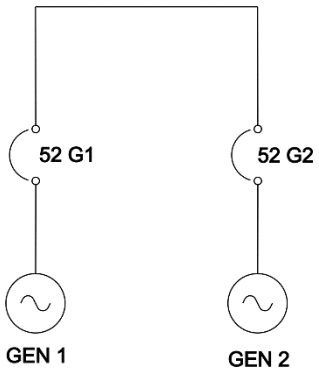

Figure 5. Non-Segmented Bus

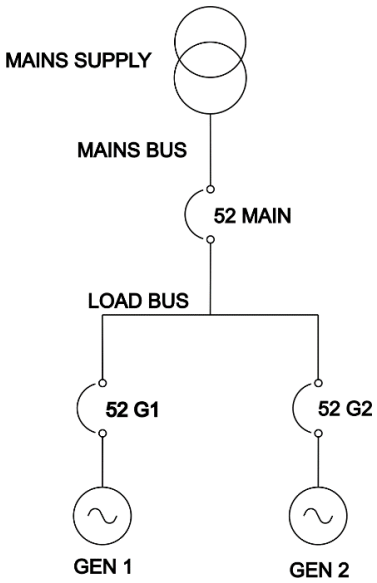

Figure 6. Segmented Bus

Hence, the System Type needs to be set to “Segmented Bus System”. In addition, the system breaker configuration needs to be set to “Generator Breaker to Segmented System”. Bus 1’s label can be changed to “Load” for proper identification. The System Settings screen is shown in Figure 7.

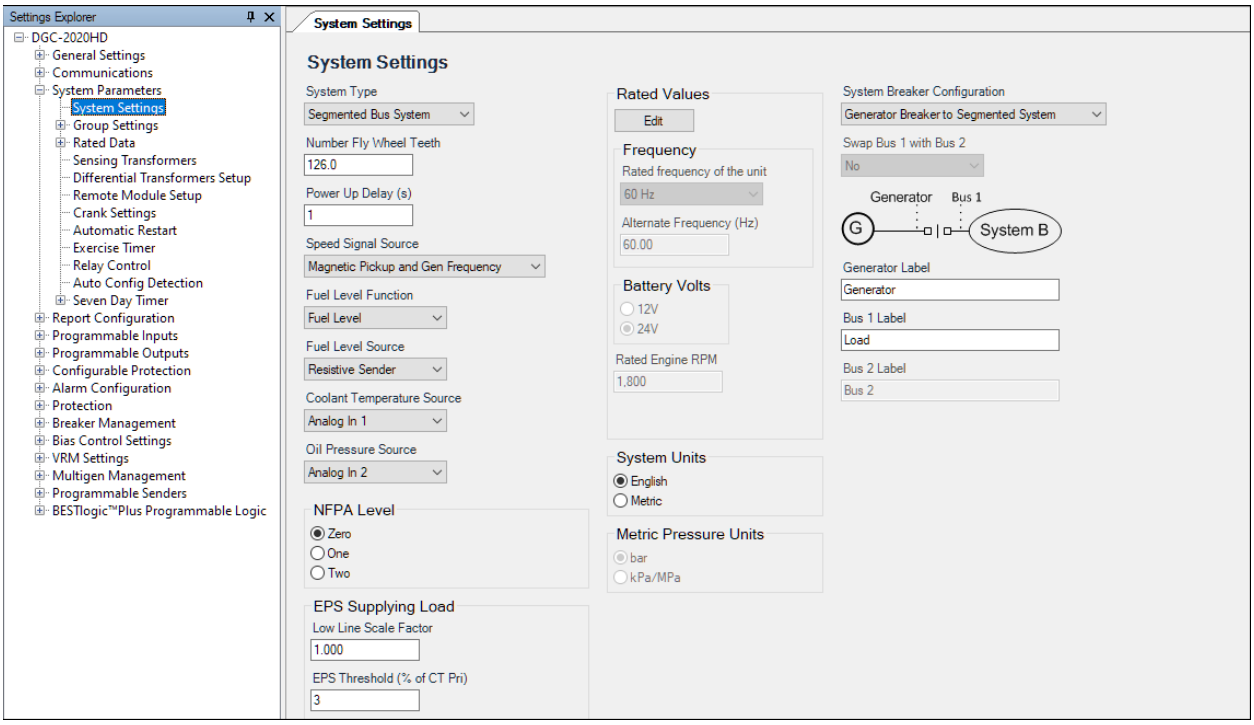

Figure 7. System Settings for Genset Controllers

Group Segment Settings

On the Group Segment settings screen, enable System Breaker Configuration Detection. This will allow the network of controllers to auto detect the system configuration. In our example, the system configuration is generator and mains breaker control.

The Group B segment is defined by the bus segment across the generator breakers. In this case, it is the Load Bus. See Figure 8 below.

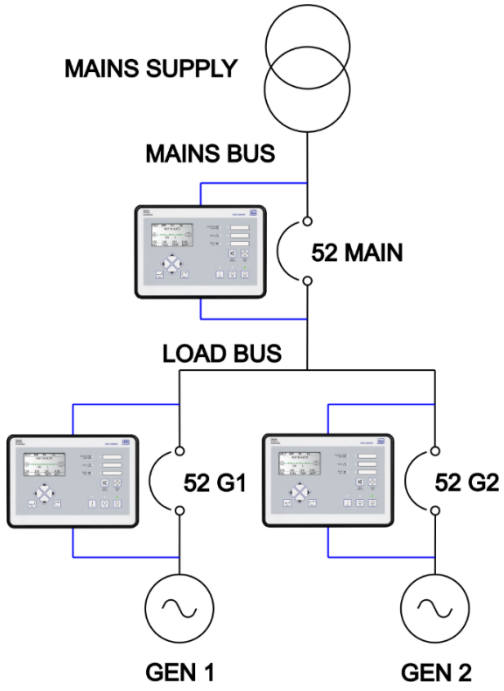

Figure 8. Segment B is the Mains Bus

Specific breakers can be designated as critical breakers in the system. If communication with the controller that is controlling a critical breaker is lost, the Critical Breakers Missing pre-alarm can be set up to annunciate that event.

The same breaker labels used to define breakers on the Breaker Hardware Settings screen must be used to identify critical breakers on the Group Segment Settings screen (Figure 9). Breaker labels are limited to four alphanumeric characters.

The expected number of tie breaker controllers needs to be set to the total number of tie breakers controlled by DGC-2020HDs in the system. For this example, enter “1” for the Expected Number of Tie Breaker Controllers setting.

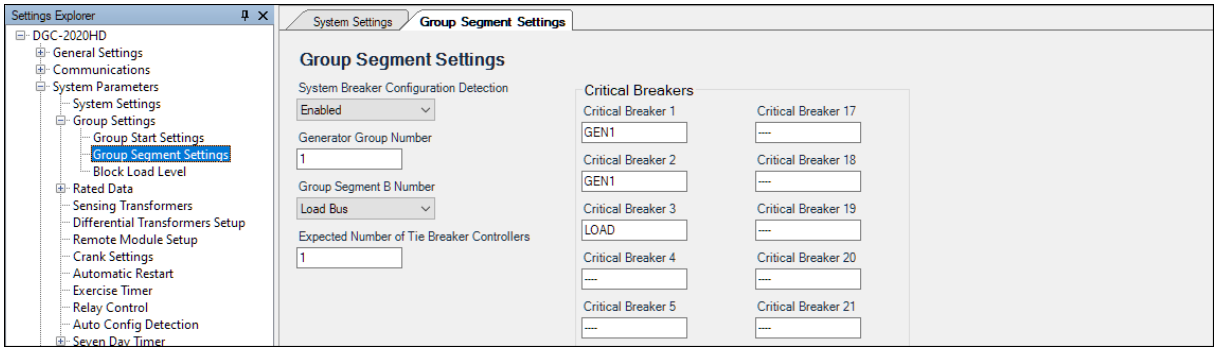

Figure 9. Group Segment Settings

Rated Data Settings

The Rated Data settings screen is shown in Figure 10.

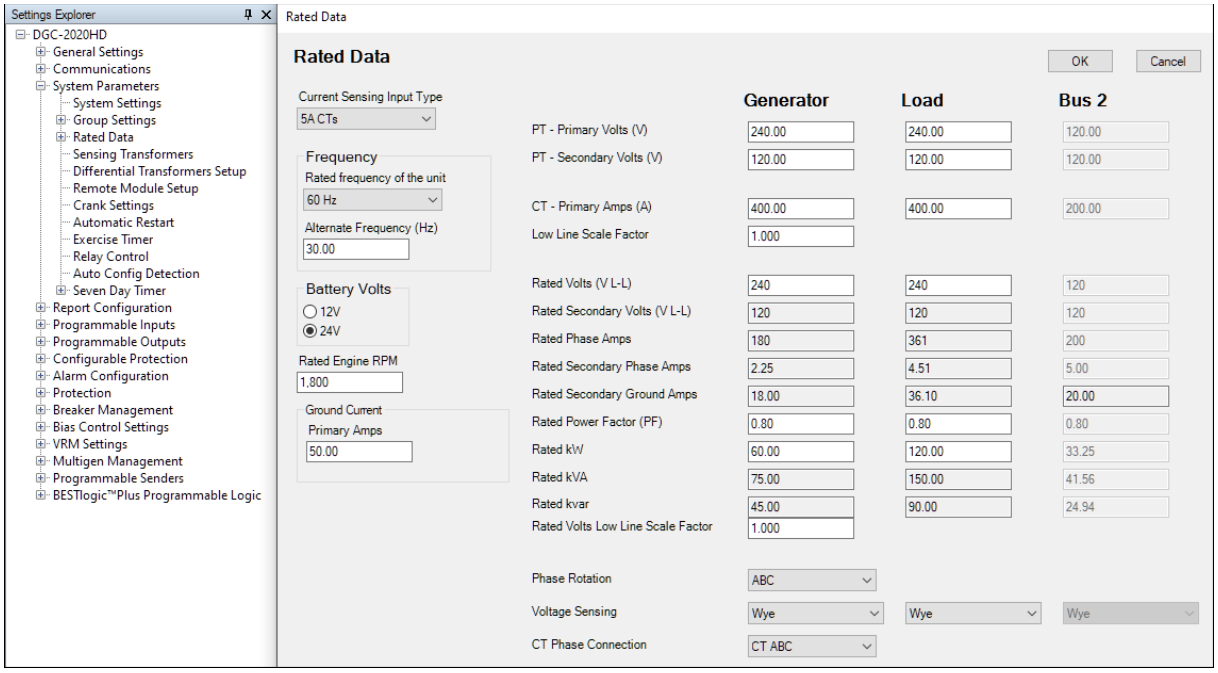

Figure 10. Rated Data Settings for DGC-2020HD Configured for Genset Control

BESTlogic™*Plus* Programmable Logic

The logic scheme for Generator Breaker to Segmented System Setup is shown in Figure 11. When the start input to the RUNWITHLOAD logic element is pulsed, the generator will start, get up to rated speed and voltage, and a breaker close request will be sent once the generator is stable. If the group bus is dead, the generator breaker will close to the dead bus. If the group bus is live, the DGC-2020HD’s auto-synchronizer will become active to synchronize the generator to the bus. A breaker close request will be permitted once a Synch Breaker Close Ok status is achieved. See the Sequence of Operations section at the end of this Application Guide for more information on how the DGC-2020HDs control a system in a generator and mains breaker system configuration.

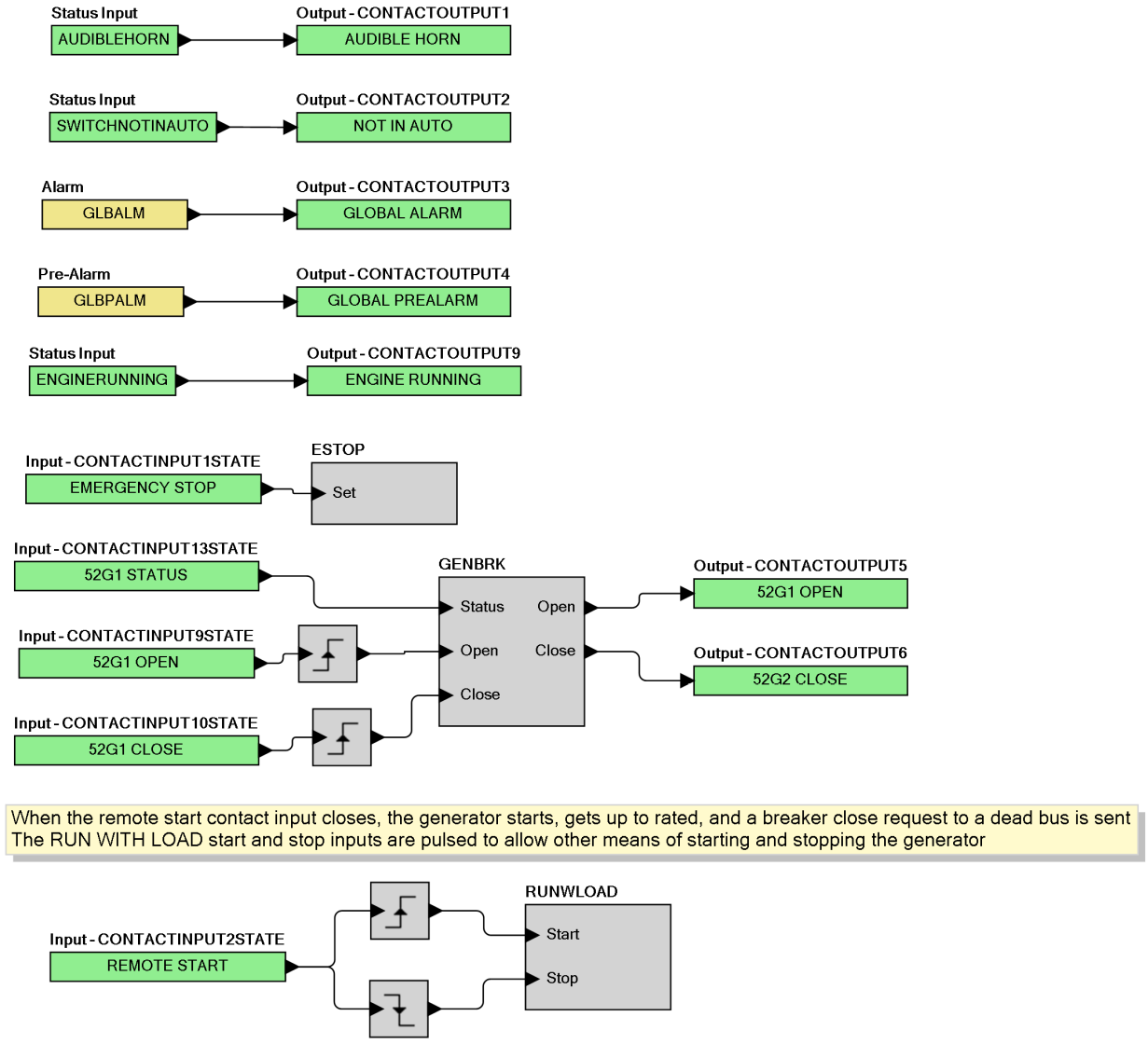

Figure 11. Logic Scheme for Generator Breaker to Segmented Setup

The remaining settings also need to be set up in the Generator Controllers. Refer to the application guide *How to set up the DGC-2020HD for Paralleling in a Multiple Generator Setup* for guidance on the following settings:

- CAN Bus Setup
- ECU Setup
- Speed Setup
- Crank Settings
- Programmable Inputs
- Programmable Outputs
- Generator Breaker Settings
- Generator and Bus Condition Detection
- Bias Control Settings
- AVR Bias Control Settings
- Governor Bias Control Settings

- Multi Generator Management
    - Demand Start/Stop – Demand Start Stop must be enabled in the Generator DGC-2020HD's in any segmented bus system where a Tie Breaker Controller is controlling the Mains Fail Transfer Functionality. If Demand Start Stop is not enabled, no generators will start in such a system.
    - Generator Sequencing - Generator Sequencing must be enabled, and each Generator in the system must be given a non-zero sequencing ID in any segmented bus system where a Tie Breaker Controller is controlling the Mains Fail Transfer Functionality. If this is not done correctly, no generators will start when the Tie Breaker Controller sends Mains Fail Start Requests to the generators because Mains Power has failed.
- Programmable Senders

DGC-2020HD Functioning as a Tie Breaker Controller

A DGC-2020HD that is functioning as a tie breaker controller can be wired for current and voltage sensing as shown in Figure 12.

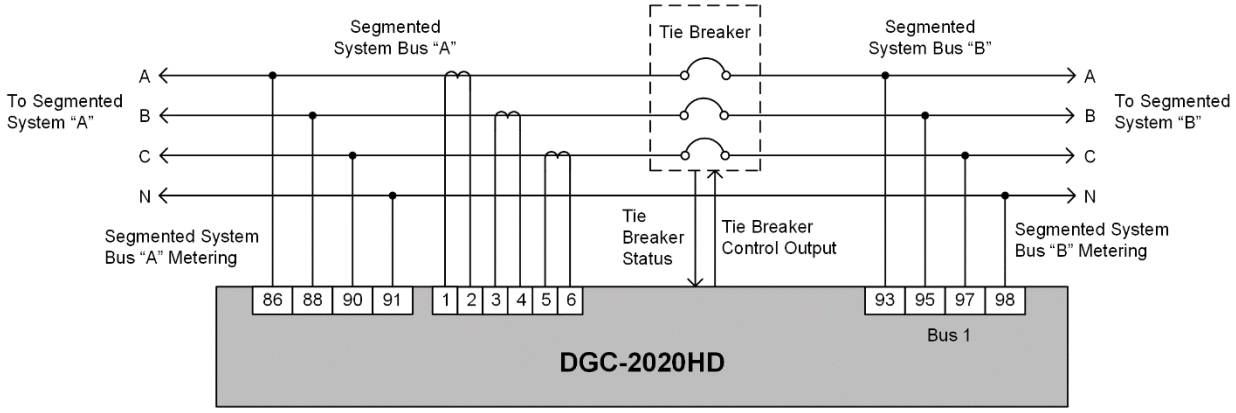

Figure 12. DGC-2020HD to Generator Wiring for Tie Breaker Control

In our example, Segment A is the mains bus and Segment B is the load bus. Bus 2 is unused since the DGC-2020HD is only controlling one tie breaker.

There is no engine interface wiring for the mains tie breaker controller.

Style Number

The style options shown below will generally work for most mains tie breaker controller applications. The Auto Sync option is needed for synchronization purposes. The Analog option is recommended because resistive sender inputs are typically used on engines.

The DGC-2020HD Style Number screen is shown in Figure 13.

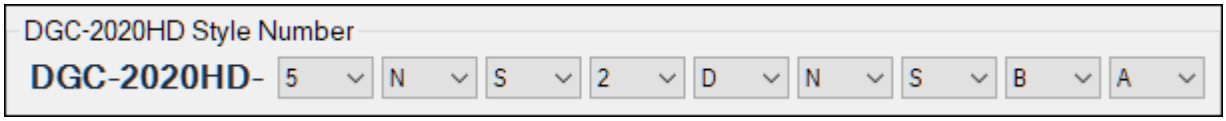

Figure 13. DGC-2020HD Style Number

Setting Summary

The key settings that need to be changed for the mains tie breaker controller are discussed in the sections below.

System Settings

On the System Settings screen (Figure 14), change the System Type to "Segmented Bus System". Change the System Breaker Configuration to "Tie Breaker Control".

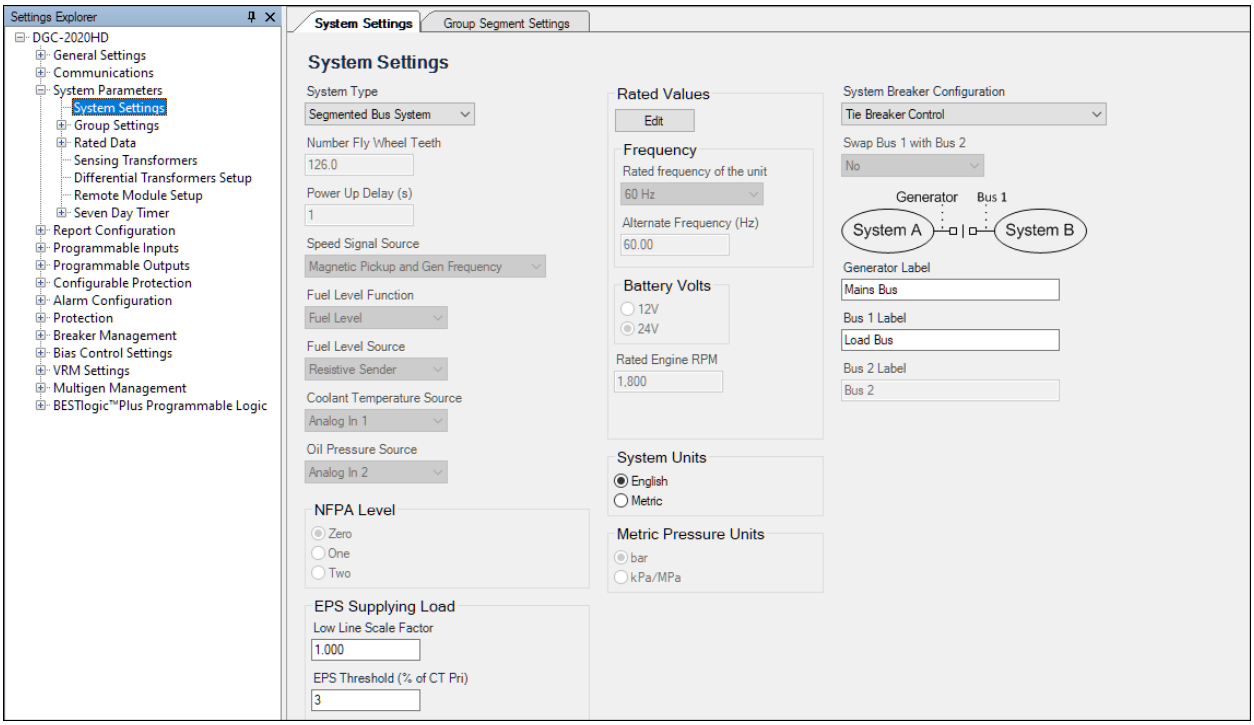

Figure 14. System Settings for Tie Breaker Control

Group Segment Settings

On the Group Segment Settings screen (Figure 15):

- Set the System Breaker Configuration Detection setting to “Enabled”.
- Since there is only one generator group:
  - Set the Generator Group A Number to “1”.
  - Set the Generator Group B Number to “1”.
- Set the Group Segment A Number to “Mains Bus”.
- Set the Group Segment B Number to “Load Bus”.
- Set the Expected Number of Tie Breaker Controllers to “1”.

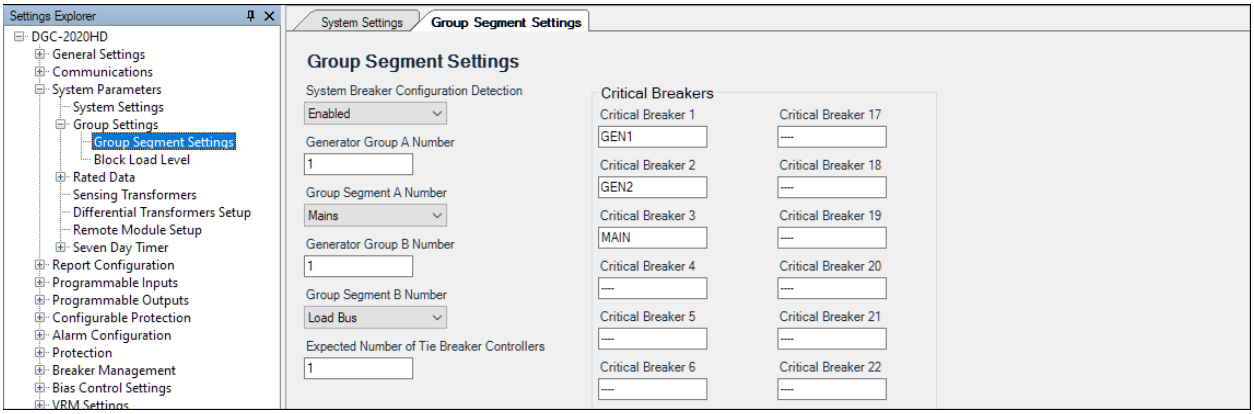

Figure 15. Group Settings for Tie Breaker Control

This completes the segmented bus setup.

Critical breakers can be defined. See page 5 for the definition of critical breakers.

Rated Data Settings

The rated data for each bus monitored by the mains tie controller must be entered on the Rated Data settings screen shown in Figure 16.

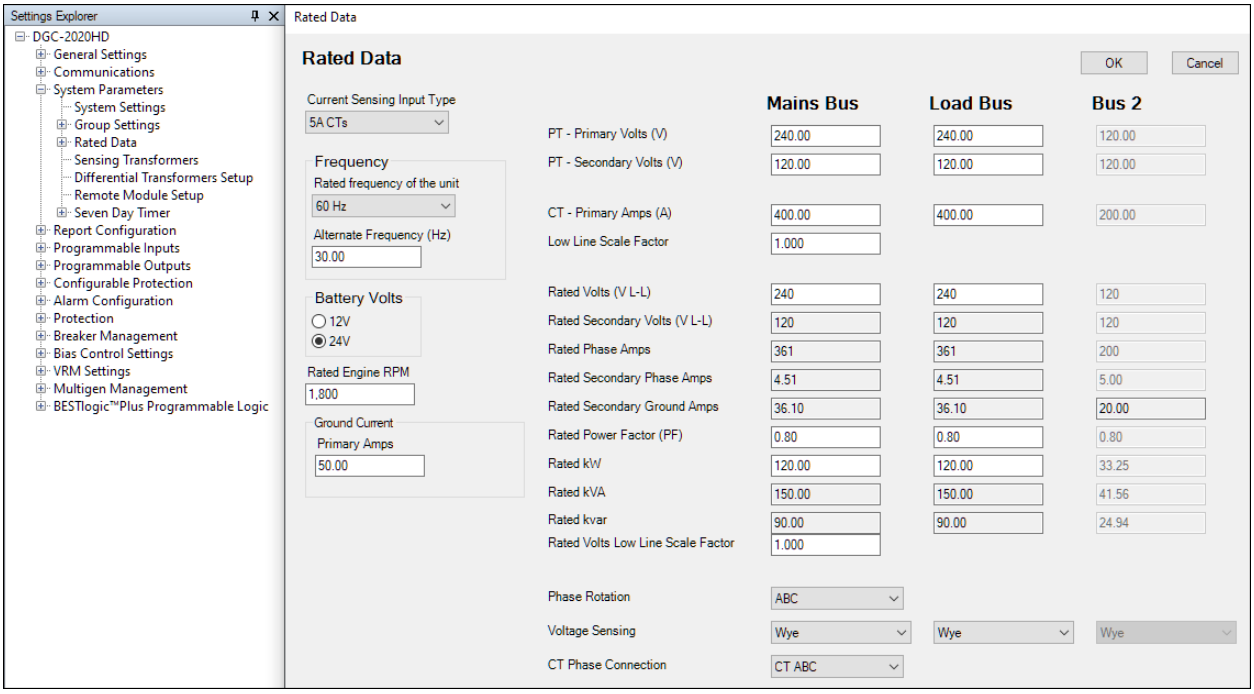

Figure 16. Rated Data Settings for Mains Breaker Controller

Sensing CT Settings

On a DGC-2020HD configured for tie breaker control, CT secondary input terminals 1 through 6 can be used to monitor the current from the mains. On controllers equipped with the enhanced sensing option, four auxiliary CT inputs are available for current metering. In this example, three of the four auxiliary CT inputs are being used to meter the load bus current.

The Sensing Transformers screen is shown in Figure 17.

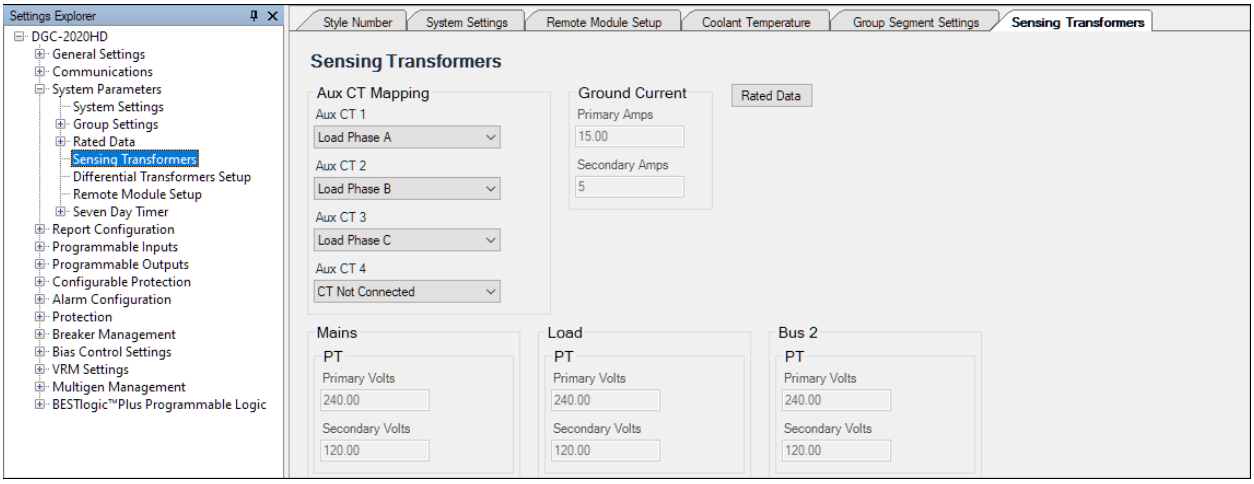

Figure 17. CT Input Settings for Load Bus Metering

On controllers with the basic sensing style option, only one auxiliary CT input is available.

Inputs and Outputs

Digital inputs and outputs are needed to control the mains tie breaker. For simplicity, minimal inputs and outputs are used in this example.

- Input 13 – Tie breaker status
- Contact inputs are not assigned to the open and close input bits on the Tie Breaker Control logic element because manual breaker operations are not needed for this example. Manual breaker control logic can be added if desired.

Protection

Multiple protection elements are available for use. For each protection element, the source can be defined, whether the mains bus or the load bus. It is up to the user to determine the appropriate levels of protection for the application. For details on the protective relay capabilities of the DGC-2020HD, refer to Chapter 17 of the "*DGC-2020HD Configuration Instruction Manual".*

The Protection Settings tree in BESTCOMS*Plus*® is shown in Figure 18.

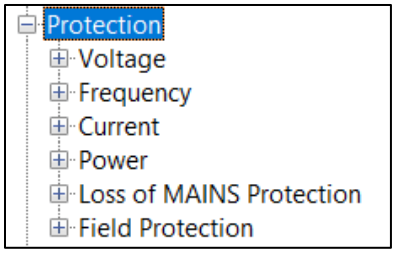

Figure 18. Protection Settings

Breaker Settings

Refer to the Tie Breaker settings screen shown in Figure 19. Use up to four alphanumeric characters to enter the breaker label. Set the contact type according to the requirements of the breaker control mechanism. For example, motor operated breakers typically require a short duration pulse for opening and closing. Several settings are available to determine when to allow and disallow the tie breaker to close. In this example, we want to be able to close the tie breaker to a dead bus, or synchronize the generators and close to a live bus.

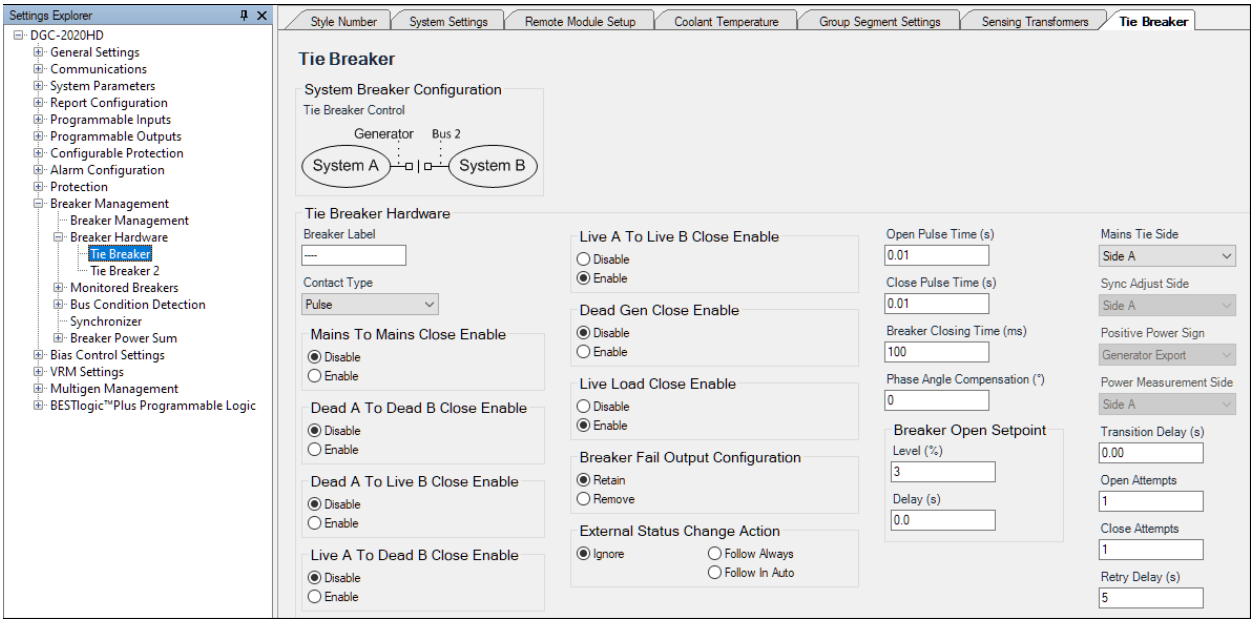

Figure 19. Breaker Settings

Bus Condition Detection

The Bus Condition Detection settings (Figure 20) are automatically updated when the rated data settings are changed. However, it is important to review these settings to ensure that the frequency and voltage ranges that define each bus condition are acceptable for the application. The bus condition is either stable, dead, or failed.

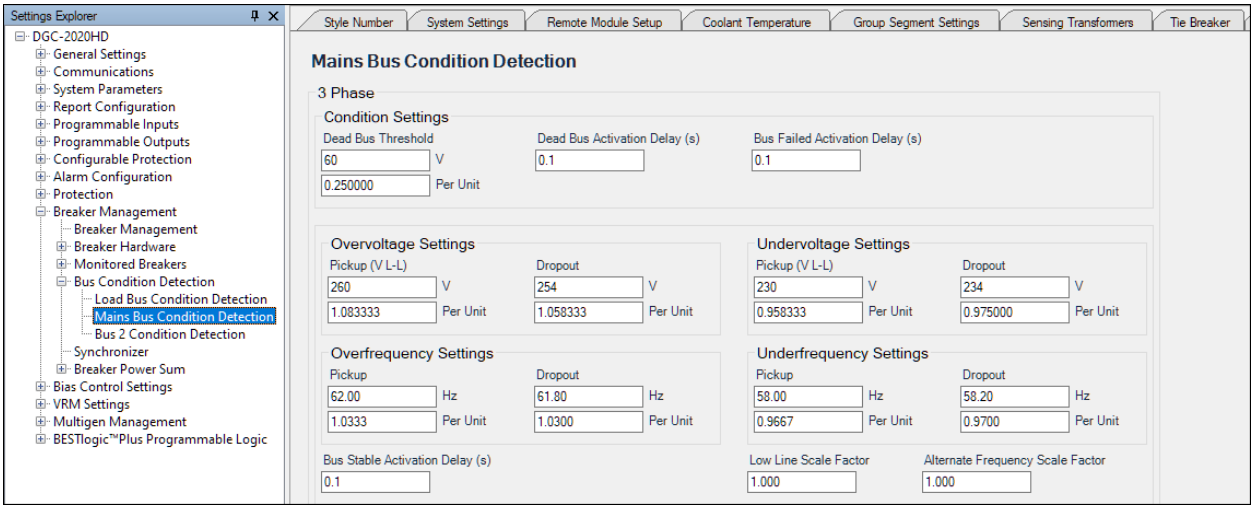

Figure 20. Mains Bus Condition Detection Settings

Synchronization

For applications that involve auto synchronization across the mains breaker, it is important to review the synchronization settings in the group breaker controller to ensure the synchronizer delivers satisfactory performance during the synchronization process. Synchronization settings may need to be adjusted during commissioning to obtain best results.

The Synchronizer settings screen is shown in Figure 21. Refer to chapter 13 of the "*DGC-2020HD Configuration Instruction Manual*" for more information on synchronization.

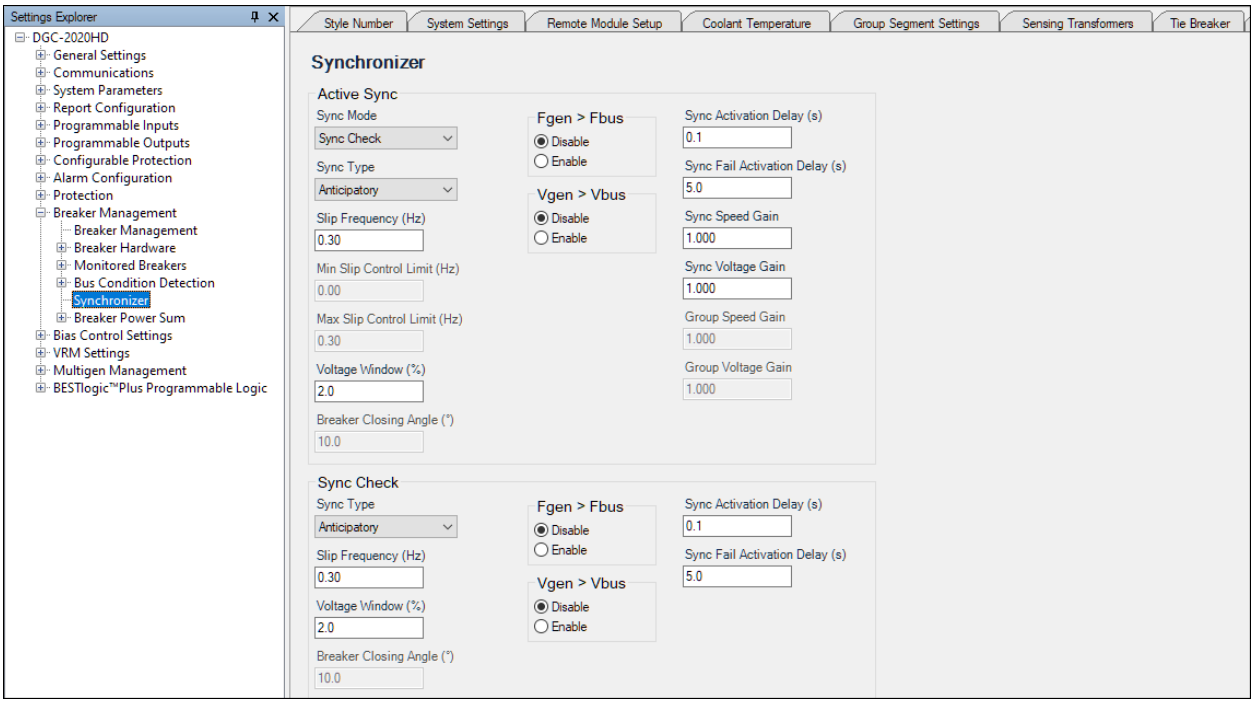

Figure 21. Synchronization Settings

Mains Fail Transfer

Mains Fail Transfer functionality causes the system of generators to start and provide power when utility power fails. The settings are found under Breaker Management as illustrated below in Figure 22.

These settings must be configured in the Tie Breaker Controller that controls the Mains Breaker. They do not need to be set in the Generator Controllers in a Segmented Bus System – in fact they have no effect in such a system.

The Start Mode setting specifies whether a single generator start or a group start – multiple generators – will be started when Mains Fail Transfer issues a start request to the Generators.

Refer to the Breaker Management section of the *DGC-2020HD Configuration Instruction Manual* for more information on Mains Fail Transfer configuration.

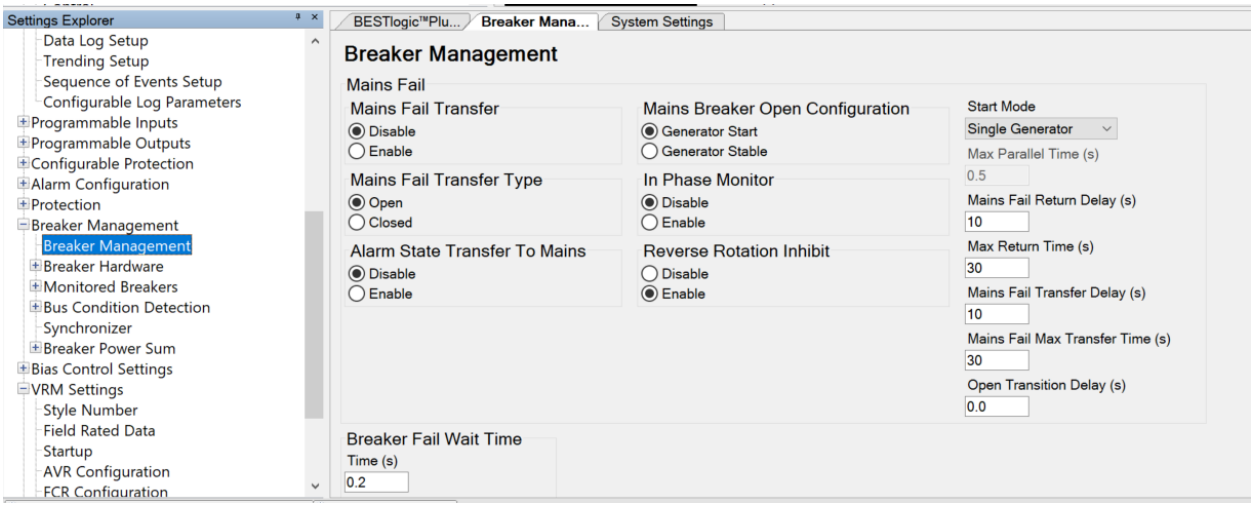

Figure 22. Mains Fail Transfer Settings

Network Configuration

The same expected sequence IDs that were entered in the settings for the DGC-2020HDs functioning as genset controllers need to be entered in the settings for the mains breaker controller as shown in Figure 23.

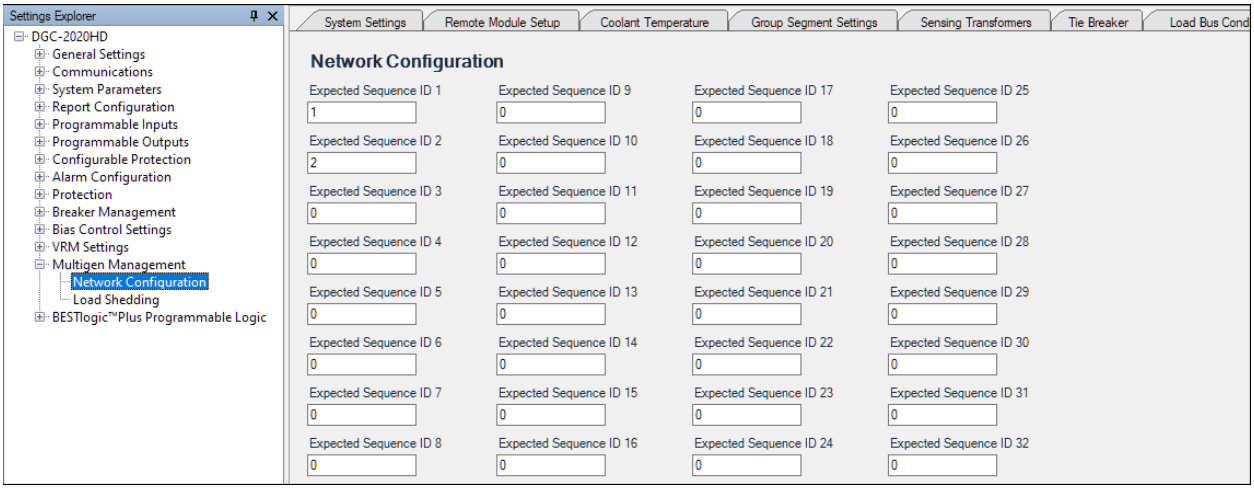

Figure 23. Network Configuration Settings

BESTlogic™*Plus* Programmable Logic

Programmable logic for Tie Breaker Control is shown in Figure 23.

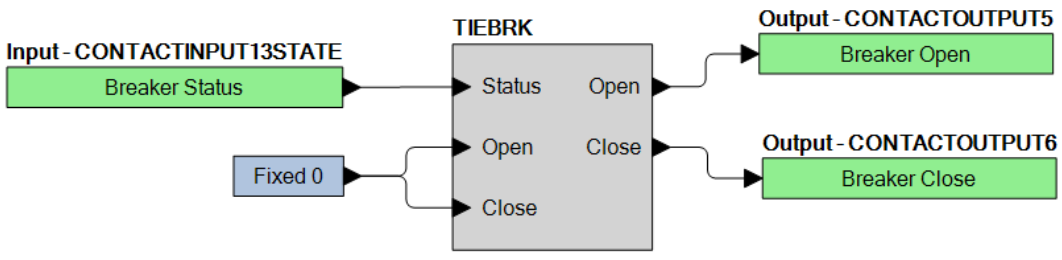

Figure 24. Programmable Logic for Tie Breaker Control

System Breaker Configuration

Once all settings configuration is complete in the DGC-2020HDs controlling generators and the DGC-2020HD controlling the mains breaker, all the DGC-2020HD controllers are networked together to form a Generator and Mains System Breaker Configuration. When connected to any DGC-2020HD on the network, the System Breaker Configuration can be seen on the System Breaker Status screen (Figure 25) under System Status in the Metering Explorer.

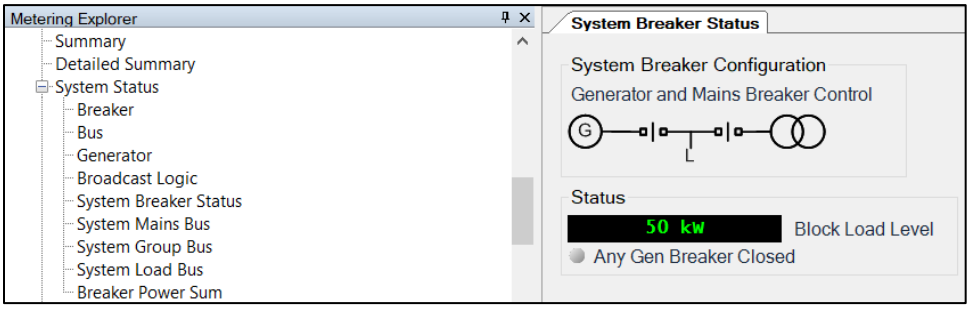

Figure 25. System Breaker Status

Sequence of Operations

In a generator and mains breaker control system configuration, the network of DGC-2020HDs have responsibility for transferring loads from the mains supply to the on-site generators during a utility outage, and returning to the mains supply when the utility power is restored. This process works as follows:

Loss of Normal Power

- The utility is the normal source of power and it is available. The loads are being driven by the utility.
- Utility power is lost.
- The mains DGC-2020HD senses a dead mains bus.
- The Mains Fail Transfer Delay Timer starts timing.
- Once the Mains Fail Transfer Delay Timer expires, the generators start and the mains breaker opens. Note that there is an option to open the mains breaker when the generators are stable.
- When the generator becomes stable, the generator breaker closes to a dead bus and picks up the load.

Restoration of Normal Power

Open Transition

- When the utility power is restored, the mains DGC-2020HD senses a live mains bus.
- When the DGC-2020HD determines that the mains bus is stable, the Mains Fail Return Delay Timer starts timing.
- Once the Mains Fail Return Delay Timer has expired, the generator breakers open and the generators begin their cooldown cycle.
- After the generator breakers open, the mains breaker closes.
- The generators will shut down once their cooldown timers expire.
- The load is now transferred to the mains, and the system is restored to its normal configuration.

Closed Transition

- When the utility power is restored, the mains DGC-2020HD senses a live mains bus.
- When the DGC-2020HD determines that the mains bus is stable, the Mains Fail Return Delay Timer starts timing.
- Once the Mains Fail Return Delay Timer has expired, a mains breaker close request is sent.
- Since the load bus is live, the mains controller’s auto synchronizer becomes active.
- The mains DGC-2020HD synchronizes the generators to the mains bus.

- Once a Synch Breaker Close Ok status has been achieved, the mains breaker closes and the transfer of load begins. The load will transfer at the kW Ramp Rate setting in the DGC-2020HDs configured for genset control.
- Either of two events will initiate a generator breaker open request:
    - The Breaker Open Setpoint has been reached
    - The Max Parallel Time has expired
- Once the generator breakers open, the generators begin their cooldown cycle.
- The generators will shut down once their cooldown timers expire.
- The load is now transferred to the mains, and the system is restored to its normal configuration.

To Learn More

To learn more, please email usatechsupport@basler.com or call 618.654.2341 to speak with a Basler representative.