DGC-2020 Product Notes

PRNote 128
April, 2015

Implementing an Auto-Synchronizer on a Generator Set using a DGC-2020

Some applications require a generator set to be paralleled with other generators or a utility bus. To parallel the generator, the speed and the voltage of the generator must be properly matched to the source to which the generator is being paralleled. In order to do this, the generator's speed control governor and automatic voltage regulator must be properly adjusted. This can be achieved manually by an operator or by the use of an automatic synchronizer.

The DGC-2020 Digital Genset Controller has an integrated automatic synchronizer as an option to perform this task. The controller monitors the voltages, frequencies, and phase relationships of both the generator and the bus. Then it sends a signal to the governor to increase or decrease the speed of the engine to match the frequency and match the generator phase angle to the bus 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.

Two types of automatic synchronizers are available:

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

In order to configure the DGC-2020 using BESTCOMS*Plus*® PC software, follow these steps:

1) Under the Settings Explorer, click on General Settings and then Style Number. Verify the unit being programmed has the Automatic Synchronizer option present.

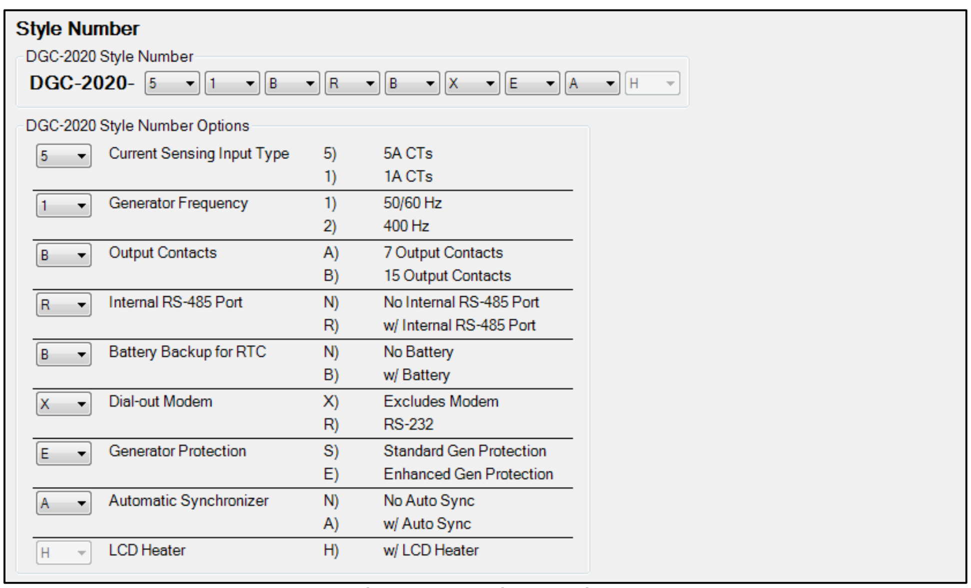

Figure 1: Style Number

2) If using a remote module to control the governor or voltage regulator e.g. LSM-2020) click on System Parameter, then Remote Module Setup. Enable the applicable module. This step is not necessary when using the DGC-2020's available contact outputs for AVR and governor control.

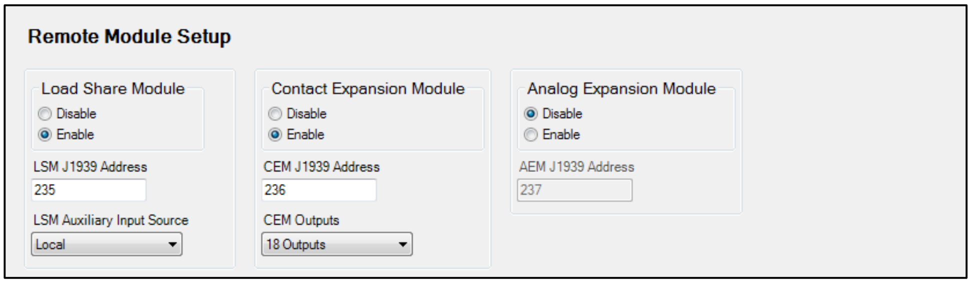

Figure 2: Remote Module Setup

3) Determine how governor and AVR biasing will be achieved.

- For analog bus signals, follow steps 11 and 12.
- For Contact output raise and lower, follow steps 15 and 16.
- When using J1939 CAN Bus, follow steps 17, 18, and 19.

4) Click Programmable Inputs, then Contact Inputs to Label the Generator Breaker Status input (the default status input is 13).

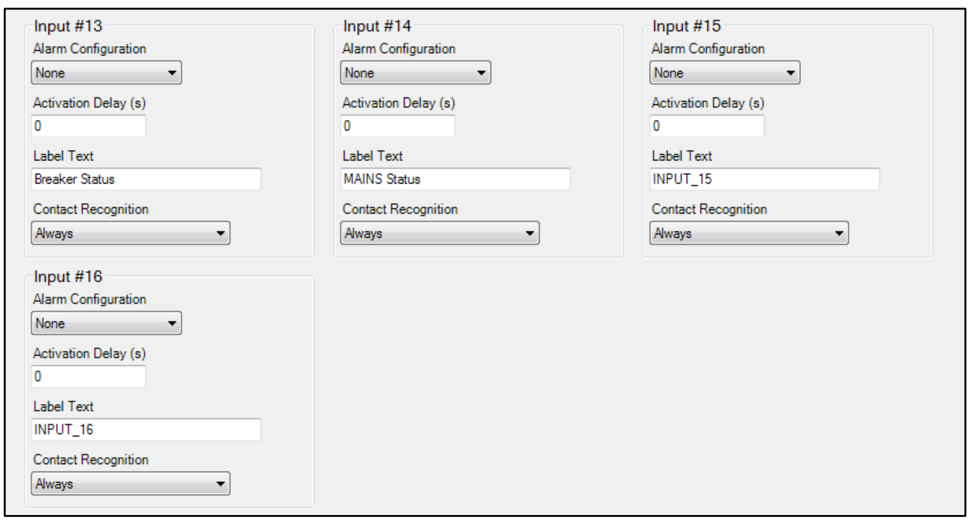

Figure 3: Contact Inputs

5) Click on Programmable Outputs, then Contact Outputs. Select and label the appropriate outputs for Breaker Close (default is Output 5), Breaker Open (default is Output 6). If using contact outputs on the DGC-2020 for Governor and Voltage Regulator control, the contact outputs also can be labeled. Default logic is Output 9 =GOV Raise, Output 10 = GOV Lower, Output 11 = AVR Raise, and Output 12 = AVR Lower.

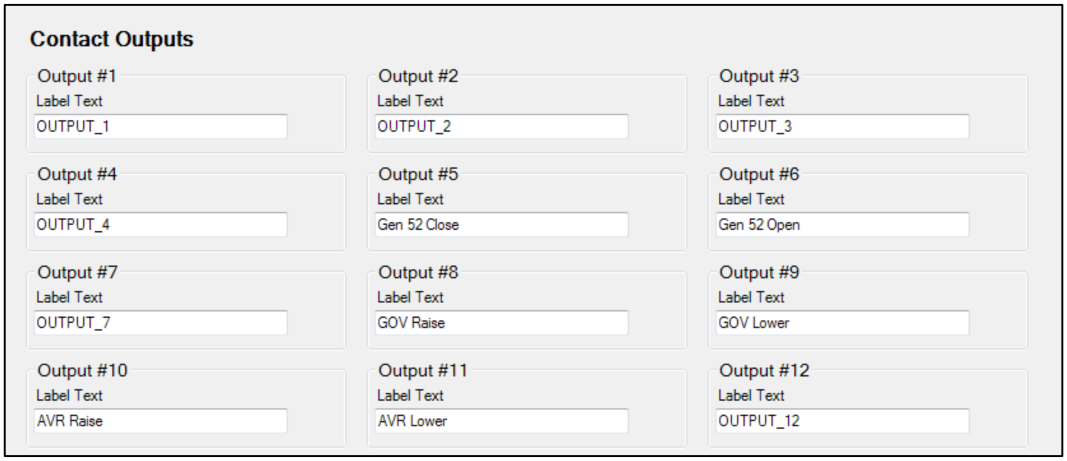

Figure 4: Contact Outputs

6) Click on Breaker Management, then Breaker Hardware. On this screen, enter the settings for the following parameters:

a) Set Configured on the Generator breaker and, if applicable, the Mains Breaker.
b) Set up the Breaker Close Wait Time. This is a 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 in that time, either a Gen Breaker Close Fail or Gen Breaker Open Fail will be annunciated as Generator breaker failures, and/or Mains Breaker Close Fail or Mains Breaker Open Fail will be annunciated as mains breaker failures.
c) Set up the Generator Breaker parameters:
    i. Enable the Dead Bus Close Enable parameter if it is desired to close to a dead bus.
    ii. Set the contact type and pulse times if pulsed contacts are used.
    iii. Set the breaker closing time. This is the time used by the Anticipatory Synchronizer to calculate the advance angle before 0 degrees slip angle at which to issue the breaker close command.
d) Set up the Mains Breaker parameters if the mains breaker is used:
    i. Set the mains breaker as configured if it is used, otherwise leave it not configured.
    ii. If the mains breaker is configured, set the contact type and pulse times if pulsed contacts are used.
    iii. If the mains breaker is configured, set the breaker close 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.
    iv. Set the transition delay, which is the length of time outputs are removed before a new output is applied.
    v. Set the number of open and close attempts and the retry delay for reclose capabilities.

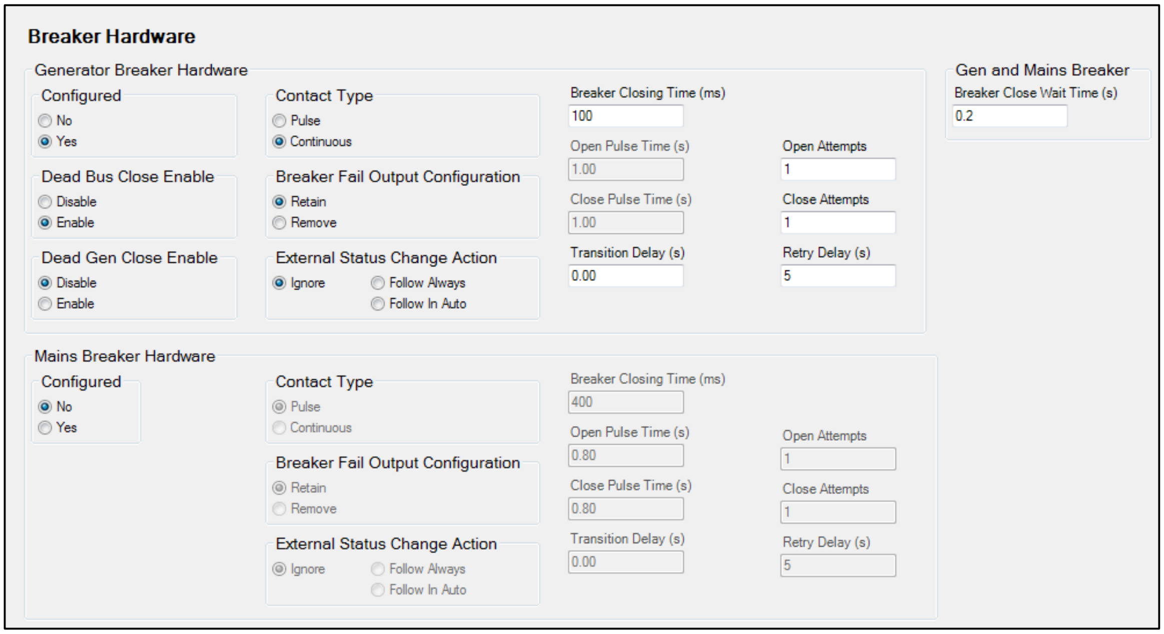

Figure 5: Breaker Hardware

7) Click on Bus Condition Detection under the Breaker Management portion of Settings Explorer. This is where the parameters are set to detect stable and failed bus and generator conditions. **The generator and bus condition parameters are critical because a breaker can be closed only when (1) the generator is stable and (2) the bus is either stable or dead**.

   a) Set the Dead Bus Voltage Threshold and Activation Delay. When the voltage of either the generator or bus is below this threshold for a time equal to the activation delay, the generator or bus is deemed to be "Dead".
   b) Set the Gen Stable Over and Under Voltage Thresholds and Over and Under Frequency thresholds and the Bus Stable and Bus Failed Activation Delay times. When the generator voltage and frequencies are within the specified ranges for a time equal to the Bus Stable Activation Delay, the generator is deemed to be "Stable". Otherwise, it is deemed to be "Failed".
   c) Set the Bus Stable Over and Under Voltage Thresholds and Over and Under Frequency Thresholds. When the bus input voltage and frequencies are within the specified ranges for a time equal to the Bus Stable Activation Delay, the bus input is deemed to be "Stable". Otherwise, it is deemed to be "Failed".

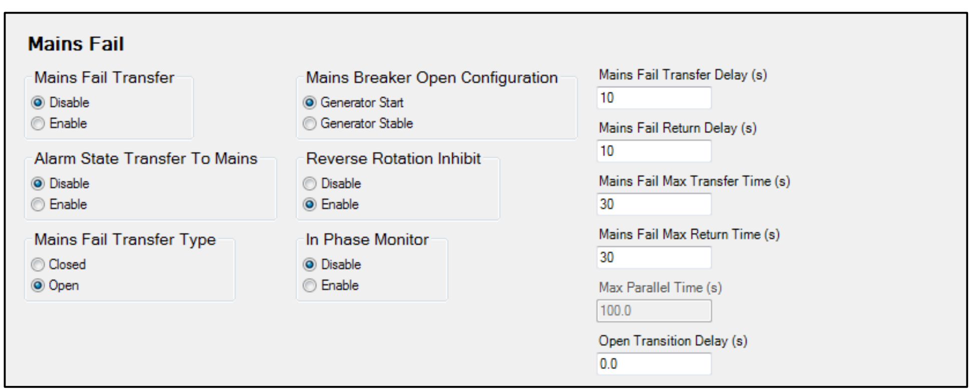

Figure 6: Mains Fail

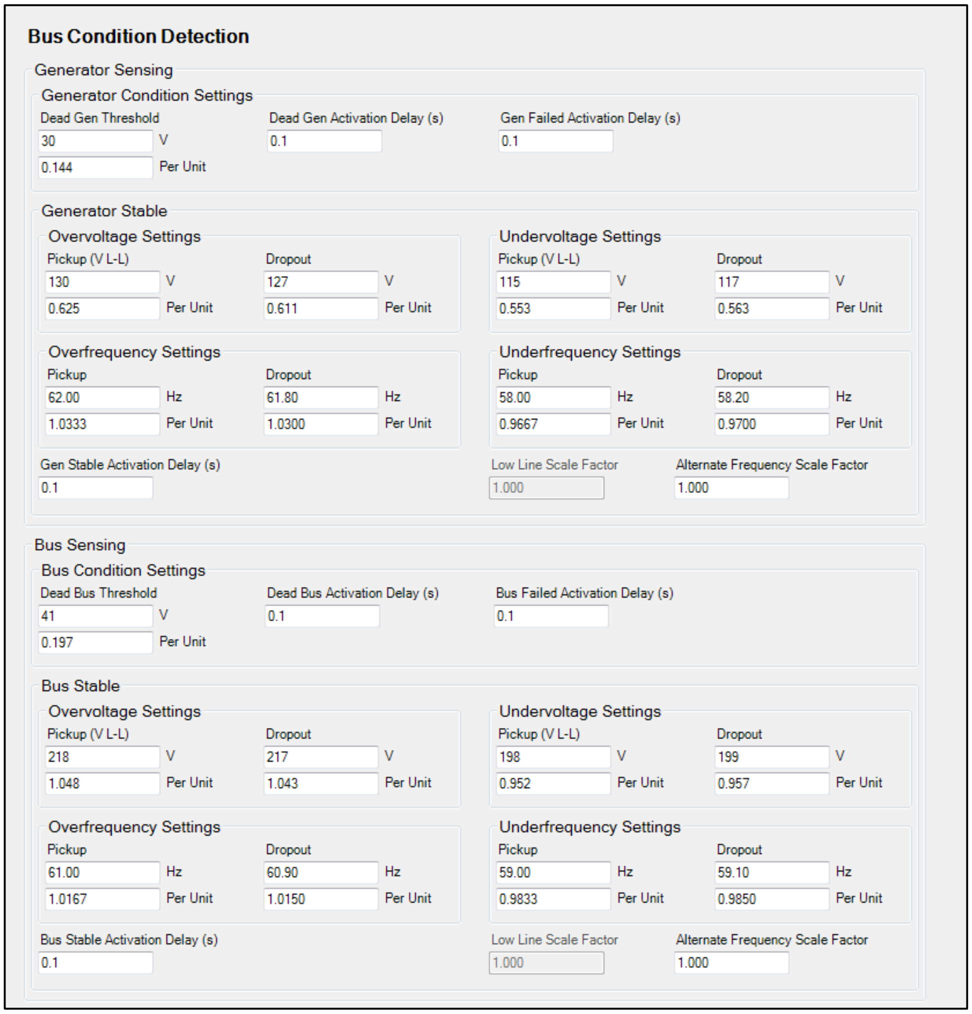

Figure 7: Bus Condition Detection

8) Click on the Synchronizer menu under the Breaker Management section of the Settings Explorer.

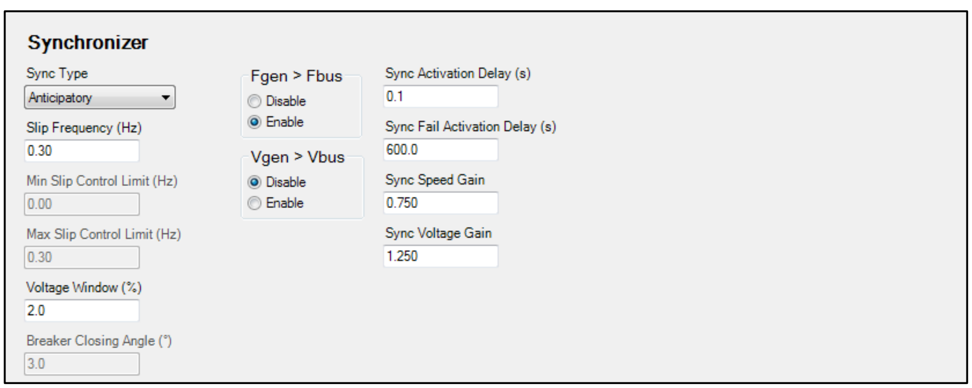

Figure 8: Synchronizer

For either synchronizer type, enter settings for the following parameters:

a) Sync Type – Select either Anticipatory or Phase Lock Loop (PLL) as the synchronizer type.
b) Slip Frequency – The maximum slip frequency that can be in effect for a breaker close to occur. When PLL is the sync type, the control limits are utilized.

i. Min Slip Control Limit – When the slip error is below this limit, the DGC-2020 recognizes it as zero and responds accordingly.
ii. Max Slip Control Limit – When the slip error is above this limit, the DGC-2020 recognizes it as max. error and responds accordingly.

c) Voltage Window – The maximum percentage of deviation between the generator and bus voltages.
d) Breaker Close Angle – (Phase lock synchronizer only). The breaker close angle is the maximum phase angle from the 0 degree phase angle that can be in effect for a breaker close to occur. This is sometimes referred to as the “angle window” or “phase window”.
e) Sync Activation Delay – The sync activation delay is a delay from the time a breaker close request is received by the synchronizer. After this delay expires, the synchronizer begins running to adjust phase angle and generator voltage to the levels desired for breaker closure.
f) Sync Fail Activation 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 Prealarm is annunciated and the synchronizer is reset. The synchronization attempt is aborted if the sync fail delay expires. This should be set to allow ample time for synchronization and breaker closure to occur.
g) Gen Frequency > Bus Frequency – Enable gen frequency > bus frequency if desired. Enabling gen frequency > bus frequency forces real power to flow out of the generator when the breaker is closed.
h) Gen voltage > Bus voltage – Enable gen voltage > bus voltage if desired. Enabling gen voltage > bus voltage ensures that reactive power flows out of the generator when the breaker is closed.
i) Sync Speed and Voltage Gaines – These alter the speed and voltage controllers’ loop gains (Kg) during synchronizing, allowing for aggressive gains while maintaining stability during speed and voltage trim.

9) Click on Bias Control Settings, then AVR Bias Control settings in the Settings Explorer. If using the DGC-2020 only, select Contact as the bias control output type. Then select either continuous or proportional for the bias control output type.

   If using the DGC-2020 in conjunction with an LSM-2020, Analog may be selected as the bias control output type. This should also be selected if using J1939 CAN Bus for AVR or speed control. If this is chosen, you will need to enter gains for the voltage PID controller. These settings may need to be adjusted to achieve the desired response from the voltage regulator. Controller tuning procedures may be found in Appendix C of the DGC-2020 manual or the Tuning Guide.

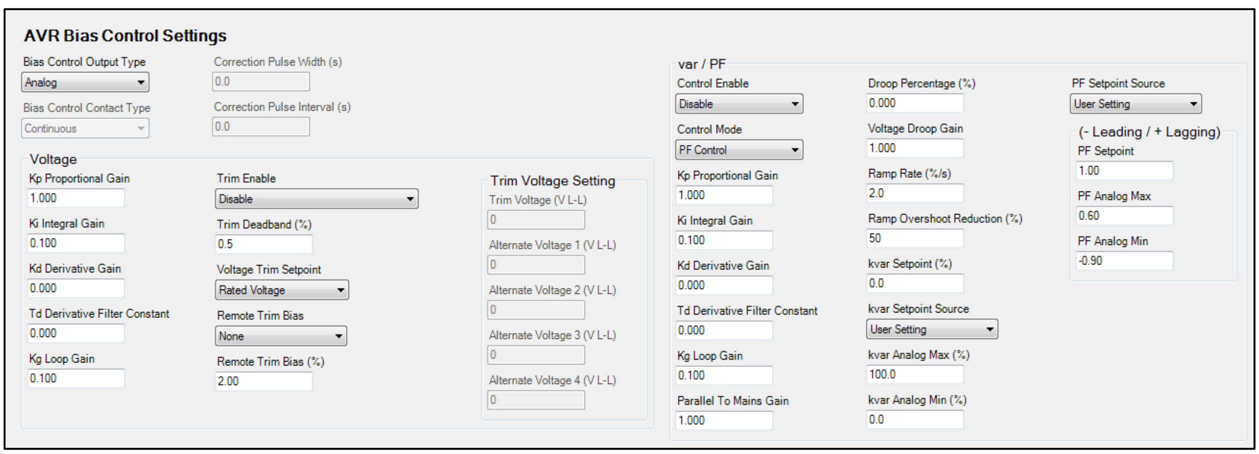

Figure 9: AVR Bias Control Settings

10) Click on the Governor Bias Control screen. The parameters for the governor bias control are similar to those of the AVR bias control and are set in a similar manner. Follow the same steps as for the AVR bias control setup.

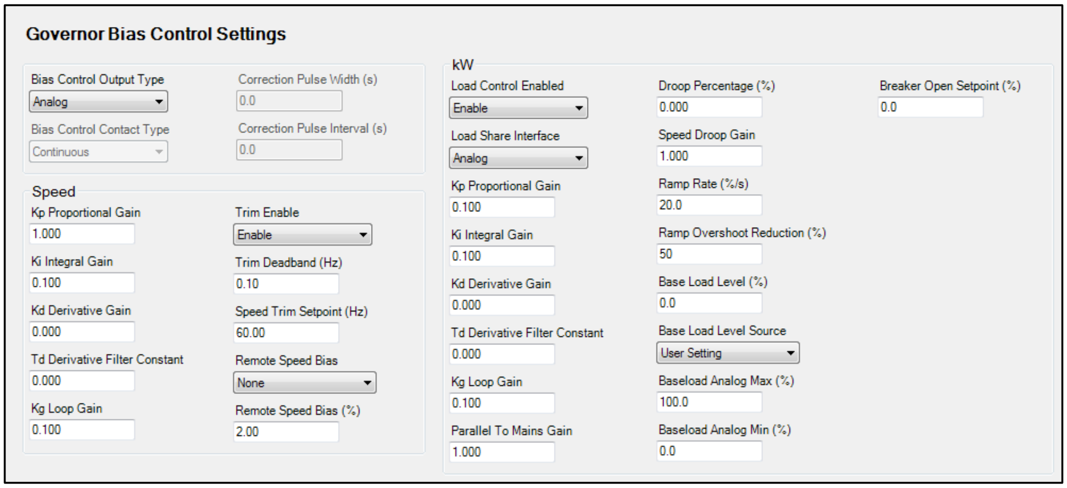

Figure 10: Governor Bias Control Settings

11) If using the LSM-2020 to control the voltage regulator with an analog signal, click on Multigen Management, then AVR Output. On this screen, select the bias output parameters and levels as required by the voltage regulator.

Figure 11: AVR Output

Enter settings for each of the following parameters when appropriate:

a) Output Type – Select whether the AVR bias signal should be Voltage or Current.
b) Response – Select Increasing or Decreasing. Increasing should be selected if an increase in the output parameter results in an increase of generator output voltage.
c) Min Output Current (Ma) and Max Output Current (Ma) – If the Output Type is current, these parameters must be configured. Set the minimum and maximum current to a range that matches 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 that matches the voltage bias input range for the voltage regulator. The range on these parameters is ±10Vdc.

12) Click on Governor Output and select the appropriate bias output parameters as required by the speed governor. These parameters are identical to those of the AVR output, and should be set in a similar manner.

Figure 12: Governor Output

13) Put all of the programmable logic in place to allow the DGC-2020 to synchronize the generator and close the generator breaker. In the programmable logic section, click on Elements and drag the Gen breaker element into the Main Logic.

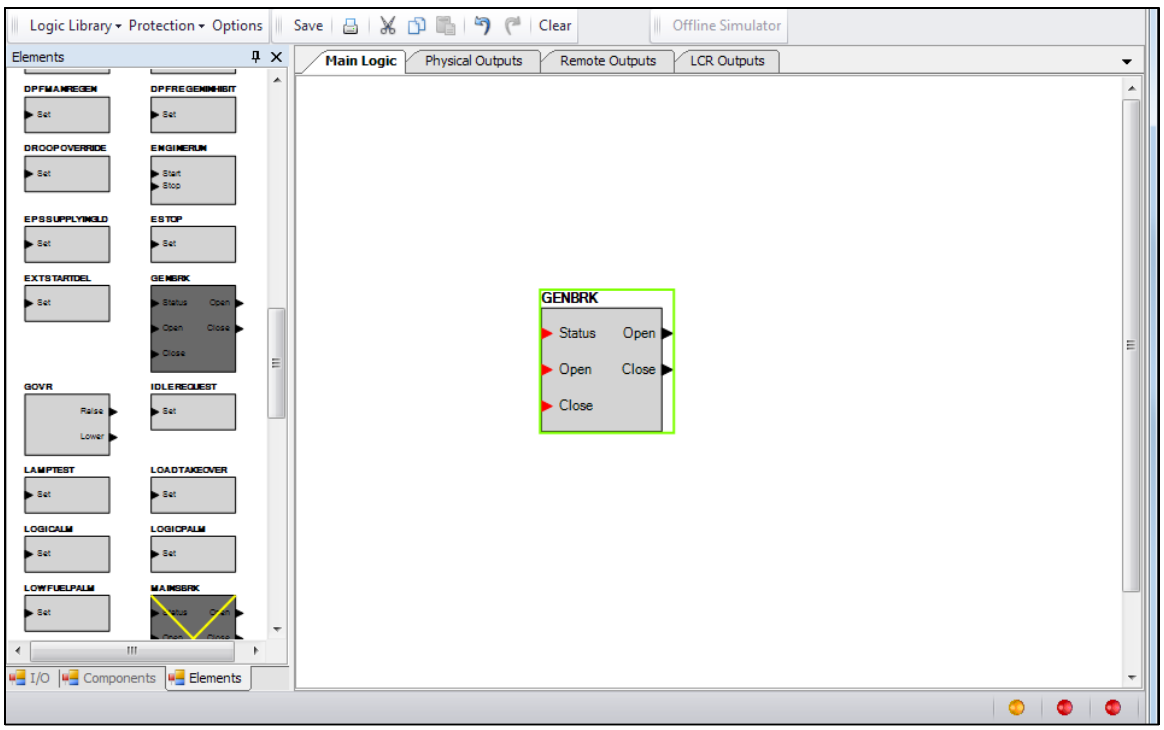

Figure 13: BESTlogic™Plus

14) Click on I/O, drag the Inputs assigned in Step 4 to the main logic, and connect to the appropriate input or output of the Generator Breaker block. Note that “Open Gen Breaker” and “Close Gen Breaker” are inputs to the generator breaker block and are used to request a breaker open or close through contact inputs. The “Gen 52 Open” and “Gen 52 Close” are outputs from the DGC-2020 to the physical breaker. These are the control signals through which the DGC-2020 opens or closes the generator breaker.

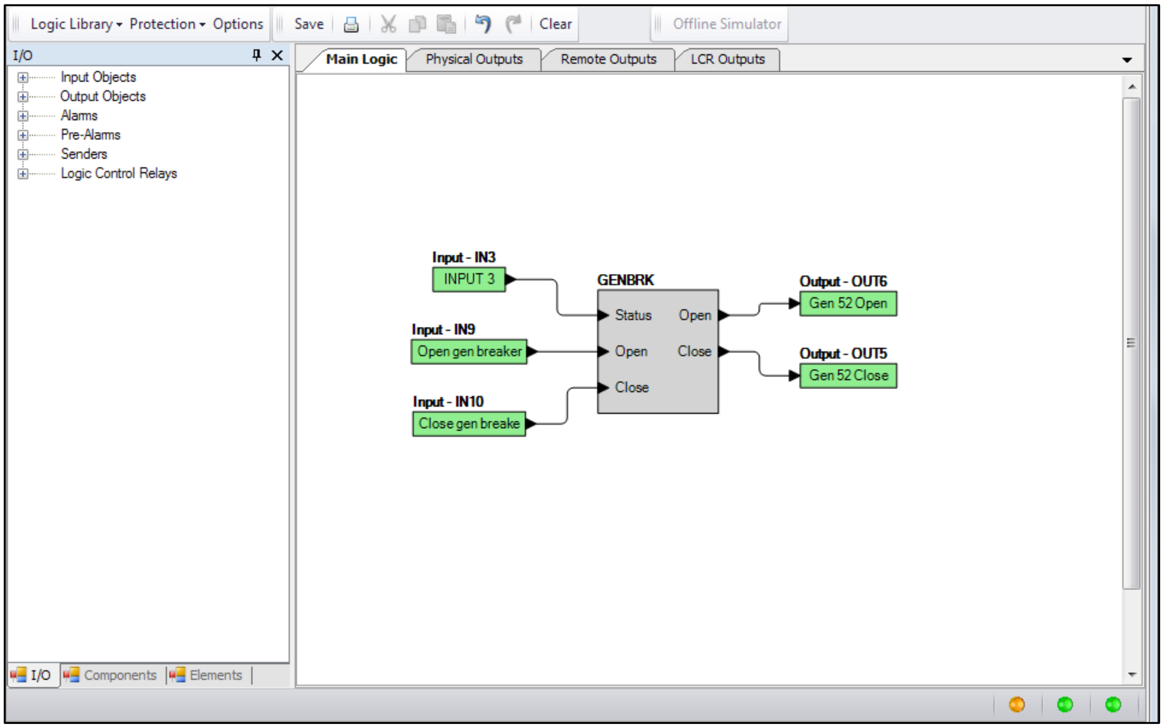

Figure 14: Input/Output

15) If using the LSM-2020 to bias the voltage regulator and governor, programming is complete. If using contact outputs, at this point the output contacts need to be assigned to drive these functions. In the programmable logic, click on Elements. Locate the Governor and AVR logic blocks and drag them into the main logic.

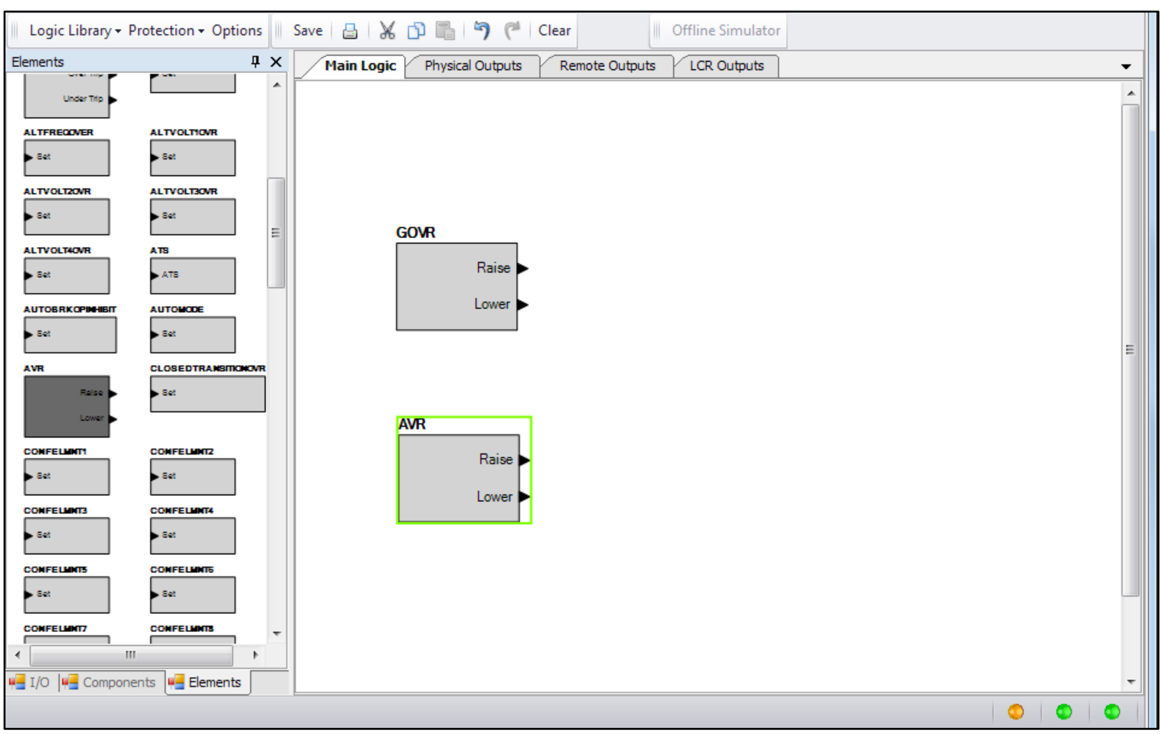

Figure 15: Main Logic

16) Click on I/O and drag the selected output contacts into the main logic. Connect the Governor and AVR block to the appropriate outputs. The automatic synchronizer function is now implemented.

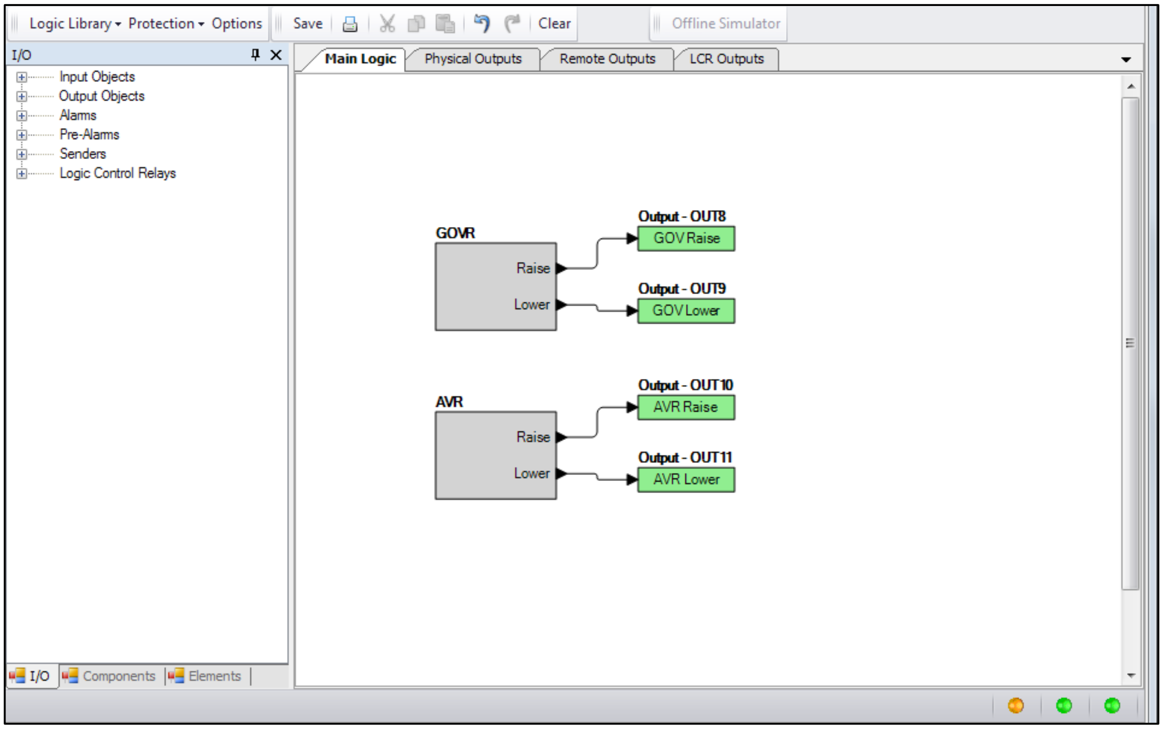

Figure 16: Automatic Synchronizer Function is Implemented

17) For capable Engine ECUs and regulators, synchronization control may be achieved through CAN Bus. The first step is enabling ECU Support.

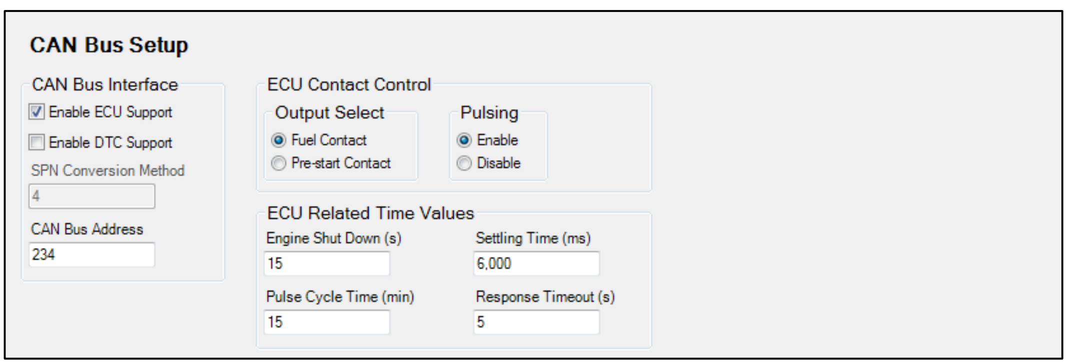

Figure 17: Communications -> CAN Bus Setup

a. Verify the CAN Bus address to which the ECU looks for control.

b. Verify the ECU type on the ECU setup.

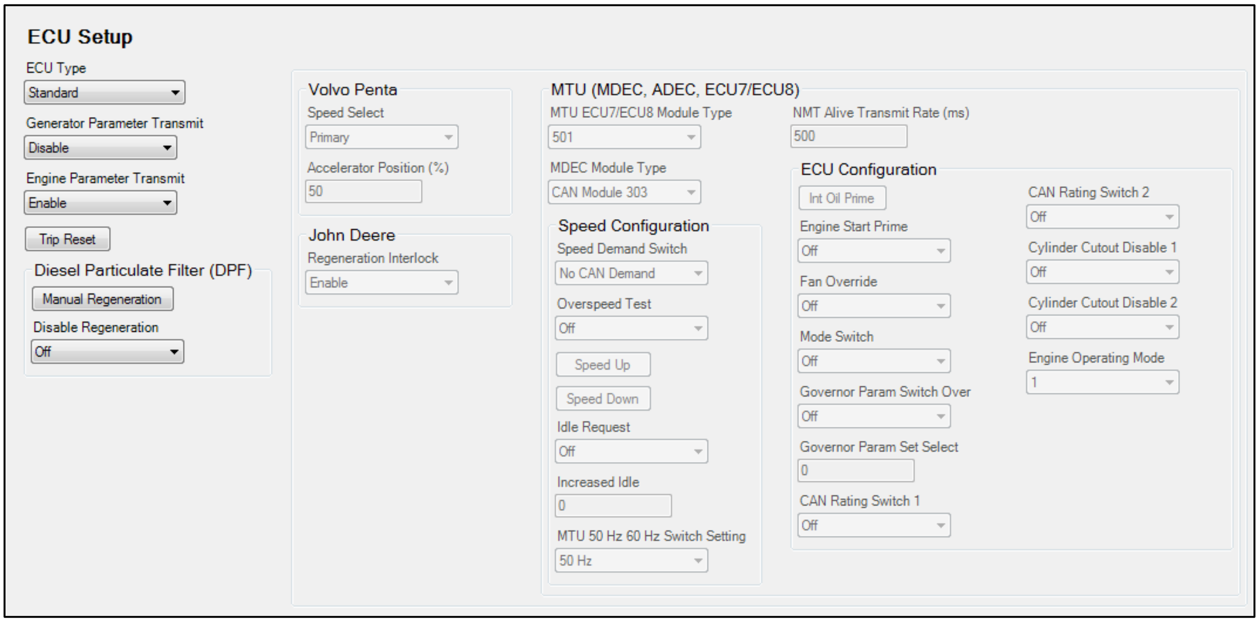

Figure 18: ECU Setup

18) For Speed Control, enable CAN Bus RPM Requests, set Nominal RPM, Idle RPM, and RPM Bandwidth values

Figure 19: Speed Setup

19) For AVR control, select the CAN Bus type regulator and program all necessary settings, especially the Voltage Adjust Bandwidth.

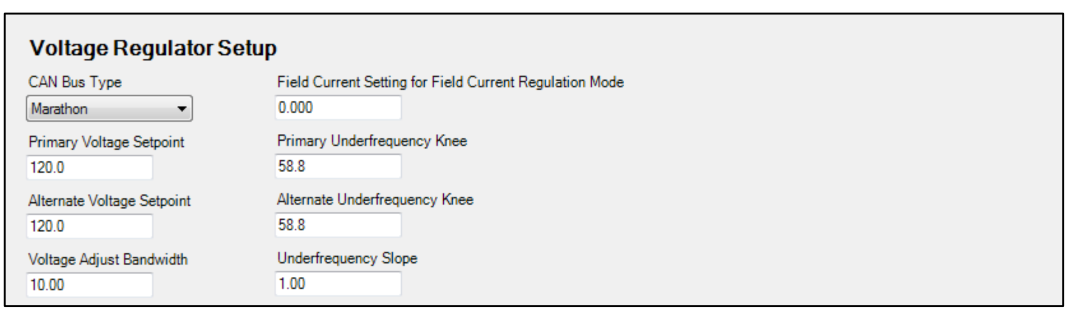

Figure 20: Voltage Regulator Setup

For more information about the DGC-2020, consult the Basler factory at 618/654-2341 or visit **www.basler.com**.

NOTE: Basler Electric attempts to make settings and configuration updates as easy as possible for the user. However, product enhancements, updates, and feature additions may create differences between devices. It is recommended that all settings are reviewed and system performance is verified. It is not the intention of this document to identify all changes or differences between devices. For more information, please refer to the appropriate instruction manual. If there are questions or concerns, contact our Technical Sales Support staff for assistance.

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