Four Steps to Successful Synchronizing and Load Sharing

Overview:

1. Control
   a. Control of AVR (Voltage & kVAr)
   b. Control of Governor (Speed & kW)
   c. Direction of Control
2. Metering
   a. CTs on the correct phase
   b. CTs correct polarity/direction of current flow
3. Communications
   a. All Modules connected on the MSC Link
   b. Sync & Load control, Multi-Set
4. Sync Checks
   a. Sync Scope to Determine Correct Phase wiring/Phase Rotation
   b. Phase Checks Across the Breaker

Step 1 – Control

1. Control of Speed Governor/ECU
   a. Determine the proper SW1 and SW2 settings for the governor/ECU you are working with. Information on setting for ECUs can be found in document number 057-004, Electronic Engines and DSE Controllers. Information for speed governor settings can be found in document number 057-046, governor and AVR interfacing.

SW1 Setting	Bias Voltage	SW2 Setting	Voltage Range
0.0	0.0V	0	+/- 0.5
1.0	0.5V	1	+/- 1.0
2.0	1.0V	2	+/- 1.5
3.0	1.5V	3	+/- 2.0
4.0	2.0V	4	+/- 2.5
5.0	2.5V	5	+/- 3.0
6.0	3.0V	6	+/- 3.5
7.0	3.5V	7	+/- 4.0
8.0	4.0V	8	+/- 4.5
9.0	4.5V	9	+/- 5.0
10.0	5.0V	N/A	

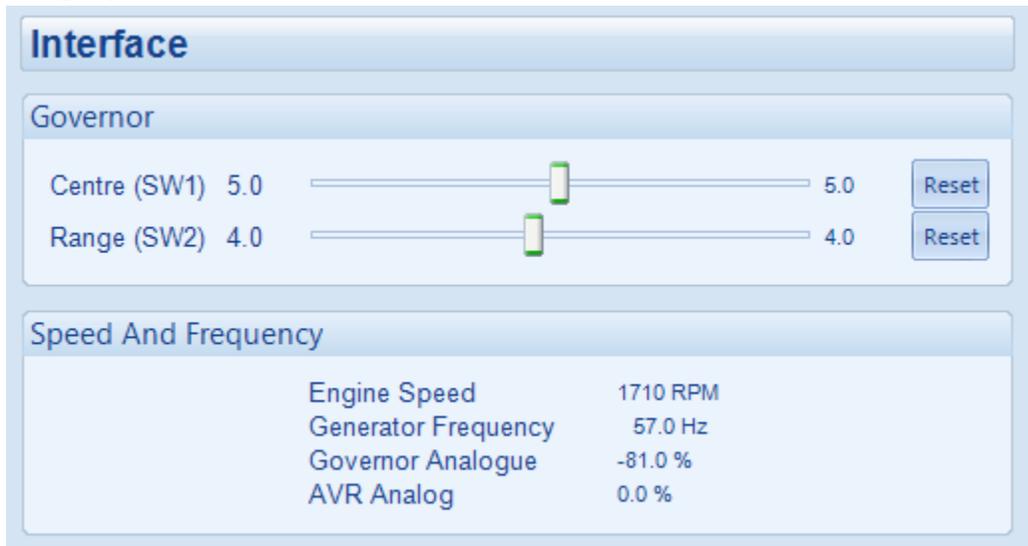A speed governor that needs 2.5V bias and 0 to 5 range of control would be set as follows:
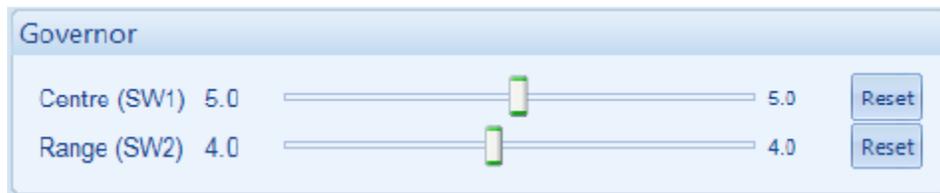
   b. Start the engine in Manual Mode. Once the safety on delay has expired increase the SW1 setting slowly in increments of 1.0. As the SW1 setting is increased RPM/Hz of the generator should also increase proportionately. At the maximum SW1 setting RPM/Hz should increase roughly 5% from nominal.

c. Decrease the nominal Hz setpoint to 5% below actual nominal, and write the change to the module.
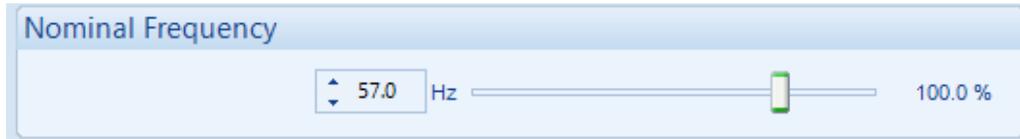
Nominal Frequency

57.0 | Hz ————————————————□———————— 100.0 %

d. Ensure the bus is not live, and all generator circuit breakers connected to the generator bus are open. Start the generator in manual mode and allow the safety on delay to expire, and issue the breaker close command.

e. Verify that the generator closed auxiliary input is active and bus voltage is reading correctly.

f. Generator Hz should decrease to the nominal Hz setpoint. Monitor the Governor Analog value in SCADA. Verify the Governor Analog value is roughly -80%. If the Governor Analog % is between -100% and -85% it will be necessary to increase the SW2 setting until the Governor Analog is close to -80% allowing for more range of control. If the Governor Analog % is between -75% and 0 it is necessary to decrease the range of control be decreasing the SW2 setting until it is roughly -80%.

Interface

Governor

Centre (SW1) 5.0 ——————————————□—————————— 5.0   Reset

Range (SW2) 4.0 ——————————————□—————————— 4.0   Reset

Speed And Frequency

Engine Speed	1710 RPM
Generator Frequency	57.0 Hz
Governor Analogue	-81.0 %
AVR Analog	0.0 %

g. Issue the breaker open command and stop the genset. Increase the Nominal Hz setpoint to 5% above nominal and write the change to the module.

h. Start the generator and issue the breaker close command once the safety on delay has expired. Generator Hz should increase to the Nominal Hz setpoint. Monitor the Governor Analog value in SCADA. Verify the Governor Analog value is roughly 80%.

Interface

Governor

Centre (SW1) 5.0		5.0	Reset
Range (SW2) 4.0		4.0	Reset

Speed And Frequency

Engine Speed	1887 RPM
Generator Frequency	62.9 Hz
Governor Analogue	80.9 %
AVR Analog	0.0 %

i. Adjust the SW2 setting as necessary if the Governor Analog value is not roughly 80%. If the Governor Analog % is between 85% and 100% it will be necessary to increase the SW2 setting until the Governor Analog is close to 80% allowing for more range of control. If the Governor Analog % is between 0% and 75% it is necessary to decrease the range of control be decreasing the SW2 setting until it is roughly 80%.

j. Set the Nominal Hz back to the correct nominal value, and write to the module.

2. Control of AVR
   a. Determine the proper SW1 and SW2 settings for the AVR you are working with. Information for speed AVR settings can be found in document number 057-046, governor and AVR interfacing.

AVR

Centre (SW1) 0.0   [slider]   0.0   [Reset]
Range (SW2)   0.0   [slider]   0.0   [Reset]

SW1 Setting	Bias Voltage	SW2 Setting	Voltage Range
0.0	0.0V	0	+/- 0.5
1.0	0.5V	1	+/- 1.0
2.0	1.0V	2	+/- 1.5
3.0	1.5V	3	+/- 2.0
4.0	2.0V	4	+/- 2.5
5.0	2.5V	5	+/- 3.0
6.0	3.0V	6	+/- 3.5
7.0	3.5V	7	+/- 4.0
8.0	4.0V	8	+/- 4.5
9.0	4.5V	9	+/- 5.0
10.0	5.0V	N/A	

A voltage regulator that needs 0 V bias and -2.5 to +2.5 voltage adjustment would be set as follows:

AVR

Centre (SW1) 0.0   [slider]   0.0   [Reset]
Range (SW2)   4.0   [slider]   4.0   [Reset]

   b. Start the engine in Manual Mode. Once the safety on delay has expired increase the SW1 setting slowly in increments of 1.0. As the SW1 setting is increased voltage output of the generator should also increase proportionately. At the maximum SW1 setting voltage should increase roughly 5% phase to phase from nominal.
   c. Change the nominal voltage setpoint to 5% phase to phase below nominal, and write to module.

Nominal Voltage

456 V PhPh ———————⊡———————— 100.0 %   398V PhPh

d. Ensure the bus is not live, and all generator circuit breakers connected to the generator bus are open. Start the generator in manual mode. Once the safety on delay has expired issue the breaker close command.

e. Verify that the generator closed auxiliary input is active and bus voltage is reading correctly.

f. Generator voltage should decrease to the nominal voltage setpoint.

g. Monitor the AVR Analog value in SCADA. AVR Analog should decrease to roughly -80%. It will be necessary to adjust the SW2 setting if the AVR Analog % is between -85% and -100% increase the SW2 setting, or if it is between -75% and 0% decrease the SW2.

Speed And Frequency

Engine Speed	1800 RPM
Generator Frequency	60.0 Hz
Governor Analogue	-1.4 %
AVR Analog	-79.1 %

AVR

Centre (SW1) 0.0 ⊡——————————————— 0.0   Reset
Range (SW2) 4.0 ————————⊡——————— 4.0   Reset

Phase To Neutral Voltages

L1 - N	L2 - N	L3 - N
260.0 V	260.4 V	263.7 V

Phase To Phase Voltages

L1 - L2	L2 - L3	L3 - L1
449.6 V	453.8 V	454.8 V

h. Issue the breaker open command and ensure the breaker opens and the generator close auxiliary input deactivates.
i. Increase the Nominal Voltage setpoint to roughly 5% above nominal.
j. Start the generator in manual mode. Once the safety on delay has expired issue the breaker close command. Monitor the AVR Analog value in SCADA. AVR Analog should increase to roughly 80%.

Interface

Governor

Centre (SW1) 5.0	5.0	Reset
Range (SW2) 4.0	4.0	Reset

Speed And Frequency

Engine Speed	1800 RPM
Generator Frequency	60.0 Hz
Governor Analogue	1.0 %
AVR Analog	79.3 %

AVR

Centre (SW1) 0.0	0.0	Reset
Range (SW2) 4.0	4.0	Reset

Phase To Neutral Voltages

L1 - N	L2 - N	L3 - N
288.7 V	289.5 V	292.1 V

Phase To Phase Voltages

L1 - L2	L2 - L3	L3 - L1
500.0 V	502.6 V	505.1 V

k. Adjust the SW2 setting as necessary if the AVR Analog value is not roughly 80%.
l. Set the Nominal Voltage setpoint back to the correct nominal value, and write to module.

Step 2 – Metering

1. Ensure the bus is not live. Start the generator in manual mode and issue the breaker close command once the safety on delay has expired.
2. Apply a small load to the generator, use an amp meter to verify the current on each phase is displayed correctly.
3. Monitor the kW on each phase, and verify each phase is displaying the correct kW.
4. Monitor Power Factor on each phase, and verify the PF on each phase is displayed correctly.

Correct | L1 & L2 Voltage wiring incorrect

Correct

Power

Watts
L1	L2	L3	Total
85.8 kW	83.8 kW	84.7 kW	254.2 kW
74.6 %	72.8 %	73.5 %	73.6 %

VA
L1	L2	L3	Total
85.7 kVA	83.8 kVA	84.8 kVA	254.2 kVA

VAr
L1	L2	L3	Total
4.3 kVAr	4.3 kVAr	4.4 kVAr	13.1 kVAr

Power factor
L1	L2	L3	Average
1.00	1.00	0.99	1.00

Accumulated Power
-kWh	kWh	kVAh	kVArh
	2133.2 kWh	2391.4 kVAh	887.1 kVArh

L1 & L2 Voltage wiring incorrect

Power

Watts
L1	L2	L3	Total
-39.0 kW	-44.1 kW	84.6 kW	1.4 kW
-33.9 %	-38.3 %	73.5 %	0.4 %

VA
L1	L2	L3	Total
85.8 kVA	83.1 kVA	84.5 kVA	253.5 kVA

VAr
L1	L2	L3	Total
76.6 kVAr	74.3 kVAr	75.5 kVAr	226.4 kVAr

Power factor
L1	L2	L3	Average
Lead -0.45	Lead -0.53	1.00	Lead 0.00

Accumulated Power
-kWh	kWh	kVAh	kVArh
	2149.7 kWh	2408.5 kVAh	887.9 kVArh

Step 3 – Communications

1. Verify the correct number of sets on the bus is shown in SCADA

Multiset

Bus		
Sets On The Bus	2	
Mains Controller Present		🟢

Step 4 – Synch Checks

1. Start additional generator and close to the dead bus. Ensure generator is running at 60.0Hz
2. Set the generator nominal frequency on the non running genset to 60.1 Hz. Start generator. While the generator is running with the circuit breaker open measure voltage Phase A to Phase A across the paralleling breaker. Watch the volt meter while also watching the digital synch scope on the display. When the synch scope indicated the generator is in phase with the bus verify the volt meter reads low voltage.
3. Repeat step 2 measuring voltage Phase B to Phase B across the paralleling breaker and ensure low voltage is measured when the digital synch scope shows the generator is in phase with the bus.