








8 COMMISSIONING

 **NOTE:** If satisfactory operation cannot be achieved, despite repeated checking of the connections between the module and the system, then contact DSE Technical Support Department: support@deepseaelectronics.com

8.1 BASIC CHECKS

 **NOTE:** If Emergency Stop feature is not required, link the input to the DC Positive.

Before the system is started, it is recommended that the following checks are made:

1. The unit is adequately cooled and all the wiring to the module is of a standard and rating compatible with the system. Check all mechanical parts are fitted correctly and that all electrical connections (including earths) are sound.
2. The unit DC supply is fused and connected to the battery and that it is of the correct polarity.
3. The Emergency Stop input is wired to an external normally closed switch connected to DC positive.
4. To check the start cycle operation, take appropriate measures to prevent the engine from starting (disable the operation of the fuel solenoid). After a visual inspection to ensure it is safe to proceed, connect the battery supply. Press the **Manual Mode**  button followed by the **Start**  button the unit start sequence commences.
5. The starter engages and operates for the pre-set crank period. After the starter motor has attempted to start the engine for the pre-set number of attempts, the LCD displays *Failed to Start*. Press the **Stop/Reset Mode**  button to reset the unit.
6. Restore the engine to operational status (reconnect the fuel solenoid). Press the **Manual Mode**  button followed by the **Start**  button. This time the engine should start and the starter motor should disengage automatically. If not then check that the engine is fully operational (fuel available, etc.) and that the fuel solenoid is operating. The engine should now run up to operating speed. If not, and an alarm is present, check the alarm condition for validity, then check input wiring. The engine should continue to run for an indefinite period. It is possible at this time to view the engine and alternator parameters - refer to the 'Description of Controls' section of this manual.
7. Press the **Auto Mode**  button, the engine runs for the pre-set cooling down period, then stop. The generator should stay in the standby mode. If it does not, check that the *Remote Start* input is not active.
8. Initiate an automatic start by supplying the remote start signal (if configured). The start sequence commences and the engine runs up to operational speed. Once the generator is available the delayed load outputs activate, the Generator accepts the load. If not, check the wiring to the delayed load output contactors. Check the Warming timer has timed out.
9. Remove the remote start signal. The return sequence begins. After the pre-set time, the generator is unloaded. The generator then runs for the pre-set cooling down period, then shutdown into its standby mode.
10. Set the modules internal clock/calendar to ensure correct operation of the scheduler and event logging functions. For details of this procedure see section entitled *Front Panel Configuration*.

8.2 DSE 4 STEPS TO SUCCESSFUL SYNCHRONISING

Synchronising and load sharing is often considered to be a complex subject. In fact, it is very simple when broken down into smaller steps.

After following the *Commissioning* section of this manual, the *DSE 4 Steps* **must** be followed before any parallel operation is attempted.

The following information covers the *DSE 4 Steps to Successful Synchronising* in full detail and must be completed on all generators in the system before they are placed in parallel with each other.

Once in parallel, further commissioning may be required to fine tune the Gain (P), Stability (I) and Derivative (D) of the governor/AVR and DSE module.

8.2.1 CONTROL

 **CAUTION!** Failure to perform the *Control* steps results in poor control over the engine and alternator. This causes long and unstable synchronising as well as unstable kW and kvar load sharing.

 **NOTE:** For further details of module configuration, refer to DSE Publication: 057-238 *DSE8610 MKII Configuration Suite PC Software Manual*.

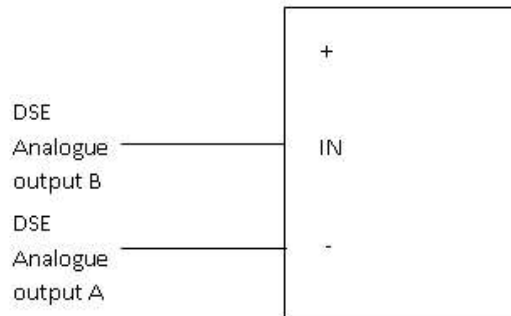
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8.2.1.1 DETERMINING CONNECTIONS AND SETTINGS FOR GOVERNORS

Setting up the Governor (Adjustment of SW1 and SW2)

Before You Start

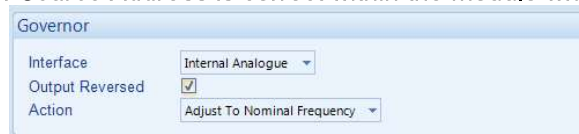
1. Ensure that generator bus is not live, has no load connected, the other generator's breakers are open, and the *Frequency Droop* function and *Mains Parallel Mode* digital input within the module are disabled.
2. With the generator breaker open, set the generator to run at the **Nominal Frequency** without the DSE module connected to the Governor. To achieve this, you will have to adjust the settings on the governor.
3. Stop the generator and connect the DSE module to the Governor. The DSE controller connects only to the "-" and "IN" terminals and provides the varying DC voltage to simulate the turning of a potentiometer. The Analogue output terminals of the DSE controller are connected as follows. Note that the "+" terminal of the governor is left unconnected.



4. With the generator stationary, adjust the Governor SW1 setting to 10 and measure the voltage across the "-" and "IN" governor terminals. Assuming the sensing probes had the correct polarity, the voltage across the "-" and "IN" governor terminals should be roughly +5 V. If this is not the case, check the polarity of the wiring and sensing probes.
5. Once successful, reset the Governor SW1 setting back to 0.

Adjustment of Governor SW1

6. Start the generator and ensure that the breaker is left open.
7. Check the direction of drive by increasing and decreasing SW1. If the frequency increases whilst SW1 is being decreased, enable the option 'Output Reversed'. If moving SW1 does not change the frequency, check the wiring to the governor for faults or, ensure the *Enhanced J1939* option is enabled and the *CAN Source Address* is correct within the module when connected to an ECU.



8. Adjust the SW1 setting for the Governor until the generator runs at **Nominal Frequency (50 Hz or 60 Hz)**
9. Stop the generator. SW1 is now complete and must not be adjusted further.

Adjustment of Governor SW2

NOTE: If it is not possible to achieve ± 2.5 Hz adjustment with the governor, contact DSE Technical Support for further advice: support@deepseaelectronics.com

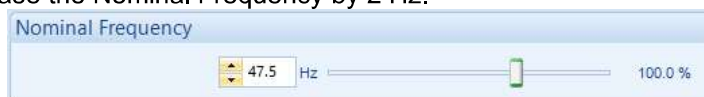
10. Increase the setting of the Nominal Frequency by **2.5 Hz** (52.5 Hz or 62.5 Hz). If *Frequency Droop* is enabled, increase the Nominal Frequency by the **Maximum Frequency Difference From Nominal** (Max Hz Up) within the *Droop Curve*. For example, if the *Droop Curve* is 52 Hz down to 49 Hz, increase the Nominal Frequency by 2 Hz.



11. Start the generator. With the breaker open the generator will run at setting of SW1 (50 Hz or 60 Hz).
12. Once the generator is detected as available, close the generator breaker onto a **DEAD BUS BAR WITH NO LOADS** connected. The generator frequency shall start to increase towards the new Nominal Frequency setting (52.5 Hz or 62.5 Hz or Max Hz Up), however it may not achieve this.
13. Adjust SW2 until the frequency increases to the new Nominal Frequency (52.5 Hz or 62.5 Hz or Max Hz Up).
14. Keep adjusting SW2 further to ensure Governor Drive reads between **75% to 85%**, the sign of the drive (+ or - percentage) does not matter. If the Governor Drive is between 100% and 85%, increase the SW2 setting until the Governor Drive reads ideally 80%. If the Governor Drive is between 75% and 0%, decrease the SW2 setting until the Governor Drive reads ideally 80%.

| Speed And Frequency | |
|---------------------|----------|
| Engine Speed | 1575 RPM |
| Generator Frequency | 52.5 Hz |
| Governor Analogue | 80.0 % |
| AVR Analog | 0.0 % |

15. Open the generator breaker and stop the generator.
16. Decrease the setting of the Nominal Frequency by **2.5 Hz** (47.5 Hz or 57.5 Hz). If *Frequency Droop* is enabled, decrease the Nominal Frequency by the **Maximum Frequency Difference From Nominal** (Max Hz Down) within the *Droop Curve*. For example, if the *Droop Curve* is 52 Hz down to 49 Hz, decrease the Nominal Frequency by 2 Hz.



17. Start the generator. With the breaker open the generator will run at setting of SW1 (50 Hz or 60 Hz).
18. Once the generator is detected as available, close the generator breaker onto a **DEAD BUS BAR WITH NO LOADS** connected. The generator frequency shall start to decrease towards the new Nominal Frequency (47.5 Hz or 57.5 Hz or Max Hz Down).
19. SW2 is then adjusted further to ensure Governor Drive reads within **75% to 85%**, the sign of the drive (+ or - percentage) does not matter. If the Governor Drive is between 100% and 85%, increase the SW2 setting until the Governor Drive reads ideally 80%. If the Governor Drive is between 75% and 0%, decrease the SW2 setting until the Governor Drive reads ideally 80%. **NOTE:** Any change made to the driving down percentage will be made to the driving up percentage. For example, if the driving down percentage is increased by 5% (70% to 75%), the driving up percentage will also increase by 5% (80% to 85%).

| Speed And Frequency | |
|---------------------|----------|
| Engine Speed | 1425 RPM |
| Generator Frequency | 47.5 Hz |
| Governor Analogue | -80.0 % |
| AVR Analog | 0.0 % |

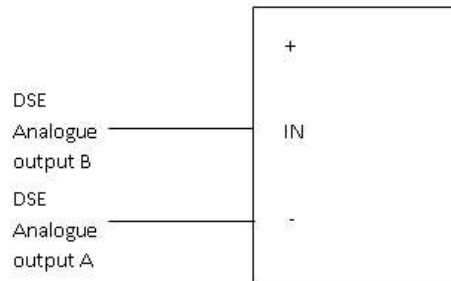
20. Change the setting of the Nominal Frequency back to the actual Nominal Frequency (50 Hz or 60 Hz).

8.2.1.2 DETERMINING CONNECTIONS AND SETTINGS FOR AVRS

NOTE: Determining the settings of SW1 and SW2 for the AVR **MUST** only be done once the setup for SW1 and SW2 for the governor has been complete. Changing engine speed affects the level of voltage produced.

Before You Start

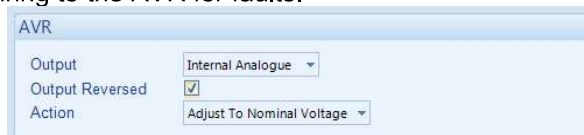
1. Ensure that generator bus is not live, has no load connected, the other generator's breakers are open, and the *Voltage Droop* function and *Mains Parallel Mode* digital input within the module are disabled.
2. With the generator breaker open, set the generator to run at the **Nominal Voltage** without the DSE module connected to the AVR. To achieve this, you will have to adjust the settings on the AVR.
3. Stop the generator and connect the DSE module to the AVR. The DSE controller connects only to the "-" and "IN" terminals and provides the varying DC voltage to simulate the turning of a potentiometer. The Analogue output terminals of the DSE controller are connected as follows. Note that the "+" terminal of the AVR is left unconnected.



4. With the generator stationary, adjust the AVR SW1 setting to 10 and measure the voltage across the "-" and "IN" AVR terminals. Assuming the sensing probes had the correct polarity, the voltage across the "-" and "IN" AVR terminals should be roughly +5 V. If this is not the case, check the polarity of the wiring and sensing probes.
5. Once successful, reset the AVR SW1 setting back to 0.

Adjustment of AVR SW1

6. Start the generator and ensure that the breaker is left open.
7. Check the direction of drive by increasing and decreasing SW1. If the voltage increases whilst SW1 is being decreased tick the option 'Output Reversed'. If moving SW1 does not change the voltage, check the wiring to the AVR for faults.

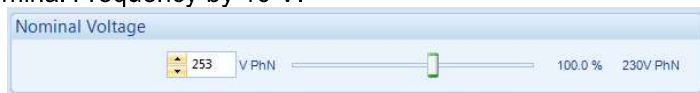


8. Adjust the SW1 setting for the AVR until the generator runs at **Nominal Voltage (230V for example)**.
9. Stop the generator. SW1 is now complete and must not be adjusted further.

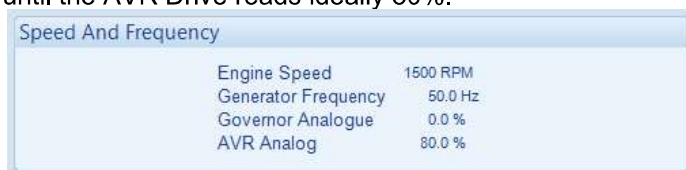
Adjustment of AVR SW2

NOTE: If it is not possible to achieve $\pm 10\%$ voltage adjustment with the AVR, contact DSE Technical Support for further advice: support@deepseaelectronics.com

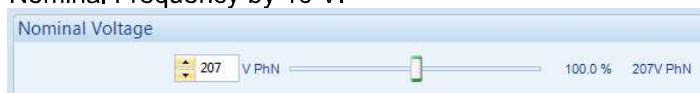
- Increase the setting of the Nominal Voltage by 10% (230 V to 253 V for example). If Voltage Droop is enabled, increase the Nominal Voltage by the **Maximum Voltage Difference From Nominal** (Max Volt Up) within the Droop Curve. For example, if the *Droop Curve* is 240 V down to 225 V, increase the Nominal Frequency by 10 V.



- Start the generator. With the breaker open the generator will run at setting of SW1 (230 V for example).
- Once the generator is detected as available, close the generator breaker onto a **DEAD BUS BAR WITH NO LOADS** connected. The generator voltage shall start to increase towards the new Nominal Voltage setting (+10% [253 V for example] or Max Volt Up), however it may not achieve this.
- Adjust SW2 to until the voltage increases to the new Nominal Frequency ((+10% [253 V for example] or Max Volt Up).
- Keep adjusting SW2 further to ensure AVR Drive reads between **75% to 85%**, the sign of the drive (+ or - percentage) does not matter. If the AVR Drive is between 100% and 85%, increase the SW2 setting until the AVR Drive reads ideally 80%. If the AVR Drive is between 75% and 0%, decrease the SW2 setting until the AVR Drive reads ideally 80%.

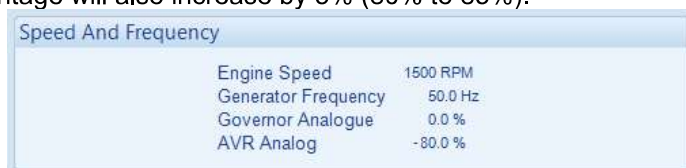


- Open the generator breaker and stop the generator.
- Decrease the setting of the Nominal Voltage by **10%** (230 V to 207 V for example). If *Voltage Droop* is enabled, decrease the Nominal Voltage by the **Maximum Voltage Difference From Nominal** (Max Volt Down) within the *Droop Curve*. For example, if the *Droop Curve* is 240 V down to 225 V, decrease the Nominal Frequency by 10 V.



- Start the generator. With the breaker open the generator will run at setting of SW1 (230V for example).
- Once the generator is detected as available, close the generator breaker onto a **DEAD BUS BAR WITH NO LOADS** connected. The generator voltage shall start to decrease towards the new Nominal Voltage ((-10% [207 V for example] or Max Volt Down)
- SW2 is then adjusted further to ensure AVR Drive reads within **75% to 85%**, the sign of the drive (+ or - percentage) does not matter. If the AVR Drive is between 100% and 85%, increase the SW2 setting until the AVR Drive reads ideally 80%. If the AVR Drive is between 75% and 0%, decrease the SW2 setting until the AVR Drive reads ideally 80%.

NOTE: Any change made to the driving down percentage will be made to the driving up percentage. For example, if the driving down percentage is increased by 5% (70% to 75%), the driving up percentage will also increase by 5% (80% to 85%).



- Change the setting of the Nominal Voltage back to the actual Nominal Voltage (230 V for example).

8.2.2 METERING



WARNING! Do not disconnect the CT wires from the DSE module when the CTs are carrying current. Disconnection open circuits the secondary of the CT's and dangerous voltages may then develop. Always ensure the CTs are not carrying current and the CTs are short circuit connected before making or breaking connections to the module.



CAUTION! Failure to perform the Metering steps results in incorrect power factor and kW calculations leading to problems with kW and kvar load sharing if not corrected.

8.2.2.1 CTS ON THE RIGHT PHASE

Check to ensure that the CTs on L1, L2 & L3 are connected to their respective connection on the DSE module.

1. Ensure that generator bus is not live and the other generator's breakers are open.
2. Start the generator and once available, close the generator breaker.
3. Apply purely resistive load (around 10% of the generator's size) across the three phases.
4. If the CTs on L1, L2 & L3 are wired to the correct terminals on the module, it displays unity power factor (1.0 pf) across all three phases. If unity power factor (1.0 pf) is not displayed across all three phases, the CTs have been wired to the wrong phases on the module.

| Watts | | | | |
|-------|----------|----------|---------|---------|
| | L1 | L2 | L3 | Total |
| | -1.66 kW | -1.66 kW | 3.33 kW | 0.00 kW |
| | -5.0 % | -5.0 % | 10.0 % | 0.0 % |

| VA | | | | |
|----|---------|---------|---------|----------|
| | L1 | L2 | L3 | Total |
| | 3.3 kVA | 3.3 kVA | 3.3 kVA | 10.0 kVA |

| VAr | | | | |
|-----|----------|-----------|----------|----------|
| | L1 | L2 | L3 | Total |
| | 2.8 kVAr | -2.8 kVAr | 0.0 kVAr | 0.0 kVAr |

| Power factor | | | | | |
|--------------|-------|-----|-------|---------|------|
| | L1 | L2 | L3 | Average | |
| Lead | -0.50 | Lag | -0.50 | Lag | 1.00 |
| Lag | | | | Lag | 0.00 |

Cables from the CTs on L1 and L2 are swapped over at the module's terminals.

| Watts | | | | |
|-------|---------|---------|---------|----------|
| | L1 | L2 | L3 | Total |
| | 3.33 kW | 3.33 kW | 3.33 kW | 10.00 kW |
| | 10.0 % | 10.0 % | 10.0 % | 10.0 % |

| VA | | | | |
|----|---------|---------|---------|----------|
| | L1 | L2 | L3 | Total |
| | 3.3 kVA | 3.3 kVA | 3.3 kVA | 10.0 kVA |

| VAr | | | | |
|-----|----------|----------|----------|----------|
| | L1 | L2 | L3 | Total |
| | 0.0 kVAr | 0.0 kVAr | 0.0 kVAr | 0.0 kVAr |

| Power factor | | | | | |
|--------------|------|-----|------|---------|------|
| | L1 | L2 | L3 | Average | |
| Lag | 1.00 | Lag | 1.00 | Lag | 1.00 |
| Lag | | | | Lag | 1.00 |

Cables from the CTs on L1 and L2 are connected correctly to module's terminals.

8.2.2.2 CTS IN THE RIGHT DIRECTION

NOTE: Checking that the CTs are on the right phase **MUST** be completed prior to checking if the CTs are in the correct direction. CTs on the wrong phase also cause negative kW's.

Check to ensure that the CTs on L1, L2 & L3 have been mounted for the correct orientation for current flow and that the s1 and s2 have not been swapped over.

1. Ensure that the CTs are connected on the correct phase by performing the previous test.
2. Ensure that generator bus is not live and the other generator's breakers are open.
3. Start the generator and once available, close the generator breaker.
4. Apply purely resistive load (around 10% of the generator's size) across the three phases.
5. If the CT's S1 and S2 are wired to correctly to the DSE module, it displays positive kW. If negative kW's is displayed, the CTs' s1 and s2 have been swapped around.

| Watts | | | | |
|-------|----------|---------|---------|---------|
| | L1 | L2 | L3 | Total |
| | -3.33 kW | 3.33 kW | 3.33 kW | 6.66 kW |
| | -10.0 % | 10.0 % | 10.0 % | 6.6 % |

| VA | | | | |
|----|---------|---------|---------|----------|
| | L1 | L2 | L3 | Total |
| | 3.3 kVA | 3.3 kVA | 3.3 kVA | 10.0 kVA |

| VAr | | | | |
|-----|----------|----------|----------|----------|
| | L1 | L2 | L3 | Total |
| | 0.0 kVAr | 0.0 kVAr | 0.0 kVAr | 0.0 kVAr |

| Power factor | | | | |
|--------------|-------|----------|----------|----------|
| | L1 | L2 | L3 | Average |
| Lag | -1.00 | Lag 1.00 | Lag 1.00 | Lag 0.33 |

The CT on L1 has been mounted with the incorrect orientation, or the s1 and s2 connections on the CT have been swapped over.

| Watts | | | | |
|-------|---------|---------|---------|----------|
| | L1 | L2 | L3 | Total |
| | 3.33 kW | 3.33 kW | 3.33 kW | 10.00 kW |
| | 10.0 % | 10.0 % | 10.0 % | 10.0 % |

| VA | | | | |
|----|---------|---------|---------|----------|
| | L1 | L2 | L3 | Total |
| | 3.3 kVA | 3.3 kVA | 3.3 kVA | 10.0 kVA |

| VAr | | | | |
|-----|----------|----------|----------|----------|
| | L1 | L2 | L3 | Total |
| | 0.0 kVAr | 0.0 kVAr | 0.0 kVAr | 0.0 kVAr |

| Power factor | | | | |
|--------------|------|----------|----------|----------|
| | L1 | L2 | L3 | Average |
| Lag | 1.00 | Lag 1.00 | Lag 1.00 | Lag 1.00 |

The CT on L1 has been mounted and wired correctly

8.2.3 COMMUNICATIONS

⚠ CAUTION! Failure to perform the Communications steps results in the controllers being unable to communicate to the other DSE controllers leading to problems during load sharing.

📌 NOTE: For further details of module configuration, refer to DSE Publication: 057-238 *DSE8610 MKII Configuration Suite PC Software Manual*.

Check to ensure that all the modules are connected are communicating correctly on the MSC link and Redundant MSC (if used).

This is tested by connecting the DSE module to a PC with the DSE Configuration Suite PC Software installed and going to the *SCADA | Generator | Multi-Set* section. The information shown in this section changes dynamically depending on whether the MSC Link or Redundant MSC Link is in use. The number of *Sets On The Bus* must be the same as the number of DSE8x10s on the link. The number of *Mains Controllers ON The Bus* must be the same as the combined number of DSE8x60s and DSE8x80s on the link.

| Bus | |
|------------------------------|---|
| Sets On The Bus | 2 |
| Sets On Load | 1 |
| Mains Controllers On The Bus | 1 |

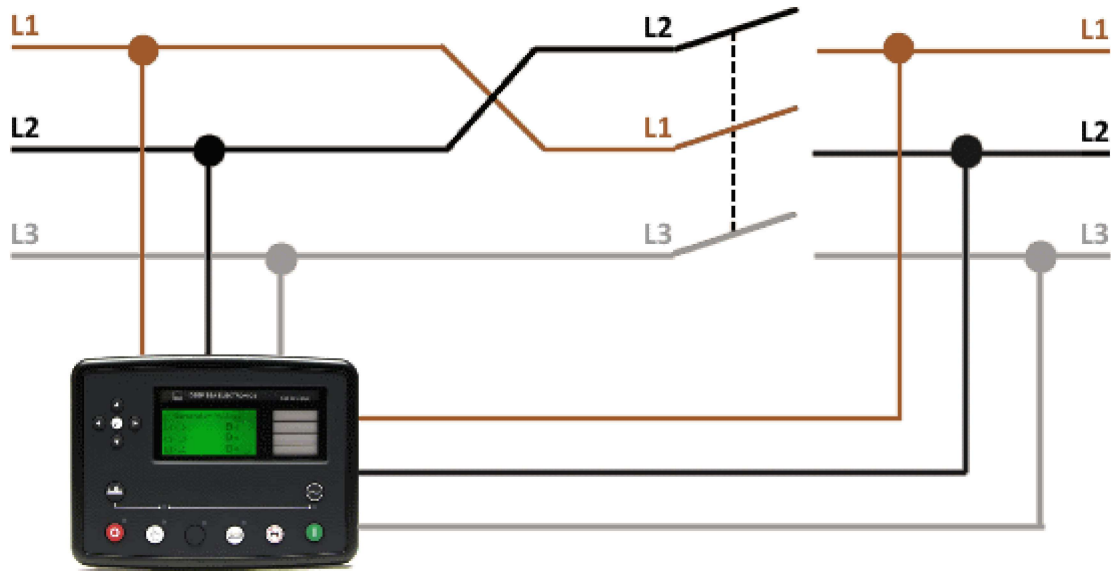
If these numbers do not match up there is a fault on the active link. To find the module with the fault, connect into each module individually until the *Sets On The Bus* or *Mains Controllers ON The Bus* reports 1. Check the wiring to the module that reports only 1 module on the MSC link, ensuring that the H and L are connected the correct way around and the 120 Ω termination resistors are correctly fitted.

If these numbers do match up, then the link which is currently in use is working correctly. To test the redundant MSC link, remove the active link connection from any module. All the modules should then alarm with the same number link failure (*MSC 1 Link Failure* or *MSC 2 Link Failure*). If all the modules do not have the same number link failure then at some point the MSC and CAN connections have been crossed. If all the modules do have the same number link failure, the communication is automatically transferred onto the other link. Check the numbers in SCADA again to ensure the other link is operating correctly.

8.2.4 SYNC CHECKS

⚠ CAUTION! Failure to perform the Sync Check steps results in in serious damage to the system (breakers, bus bars, alternators, engines etc) caused by out of sync closures.

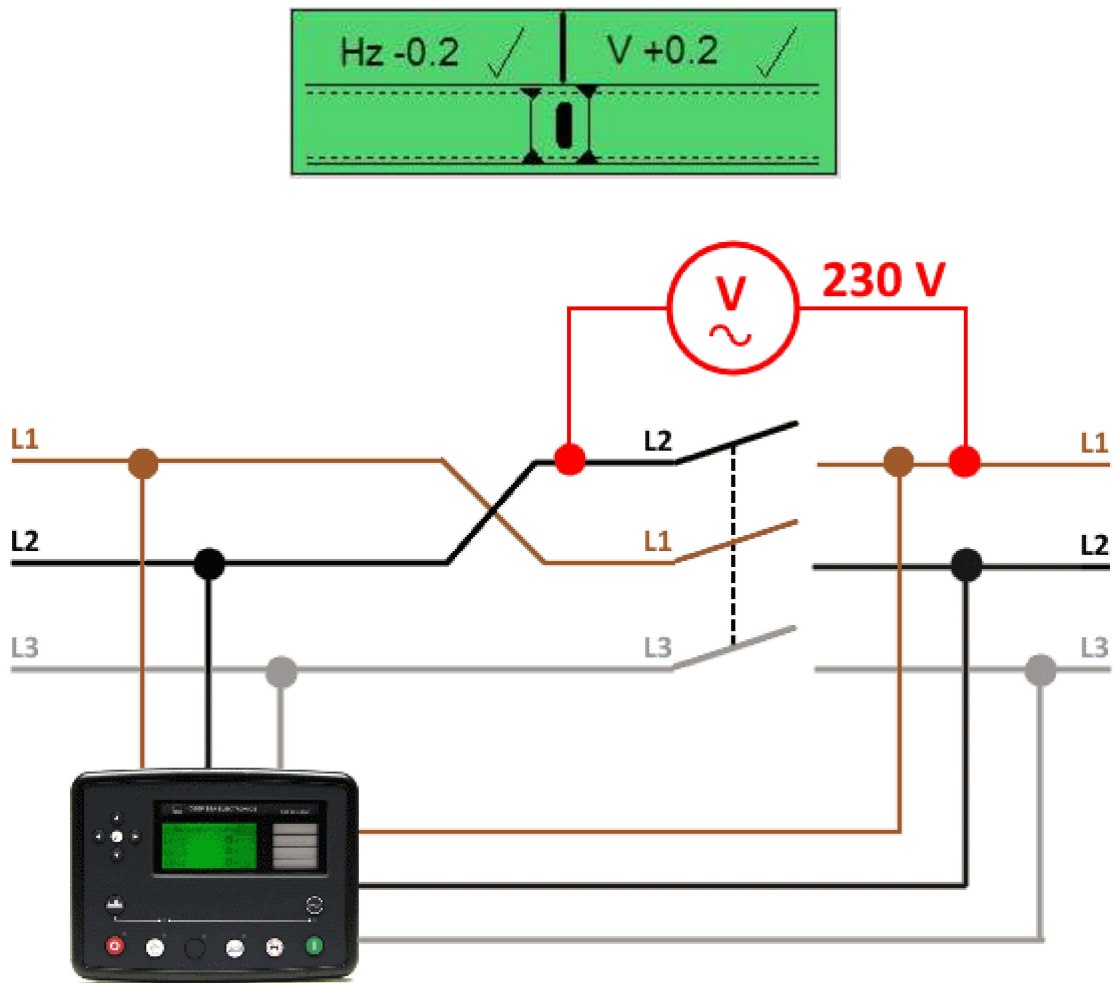
Check to ensure that all the module's sensing cables have been connected to the correct phases and that the generator's load switch has been correctly connected. Failing to perform such tests may lead to the DSE module sensing both sides of the breaker as in sync



This is tested by starting the generator with the DSE module and ensuring the generator load switch is left open (activate an input configured for *Generator Load Inhibit*). Then the generator common bus is to be made live, this is achieved by starting another generator and closing its load switch. Across the open load switch, connect a voltage meter to measure the AC voltage when the DSE module shows the two supplies in sync.

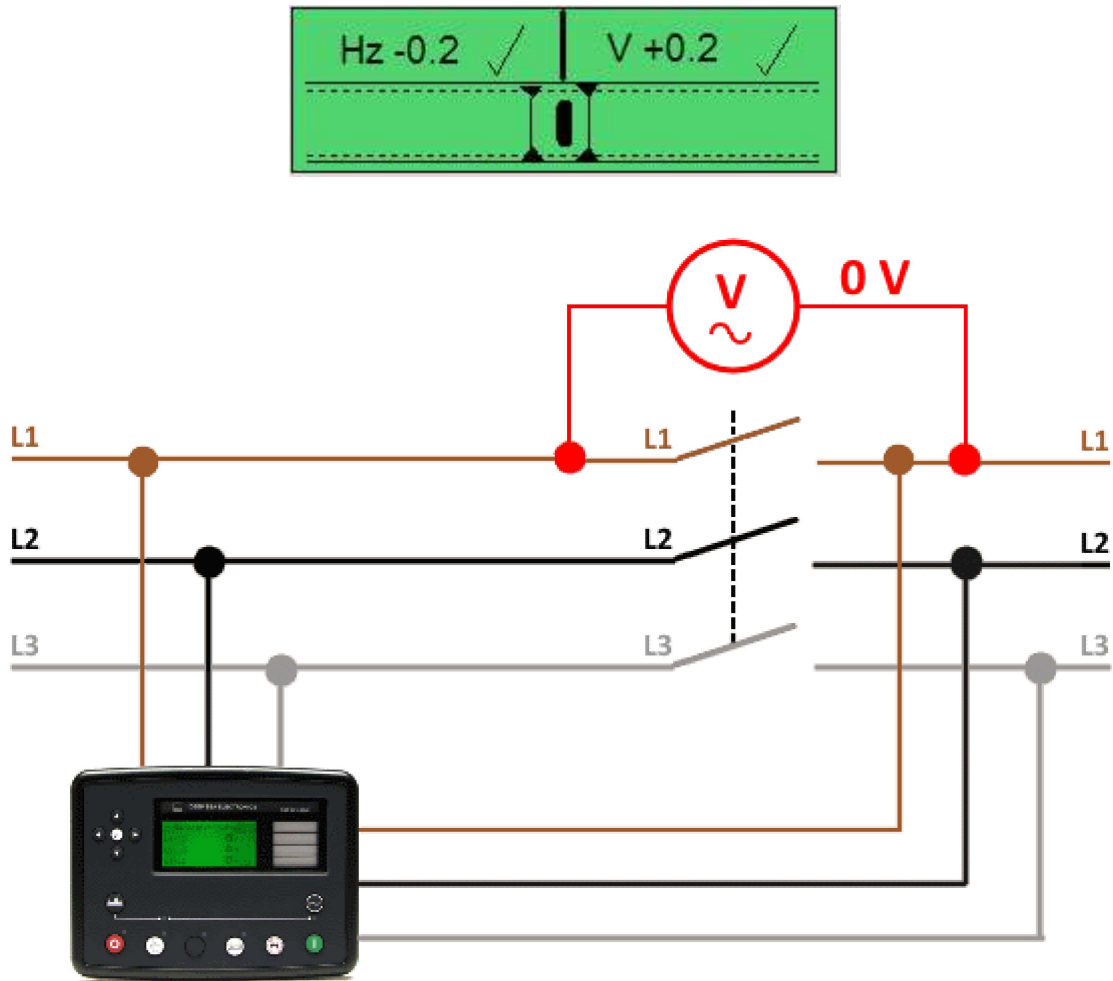
8.2.4.1 INCORRECTLY WIRED BREAKER

When the DSE module's synchroscope shows the two supplies in sync, if the voltage meter shows a voltage difference the breaker is wired incorrectly. This is shown in the example below.



8.2.4.2 CORRECTLY WIRED BREAKER

When the DSE module's synchroscope shows the two supplies in sync, if the voltage meter shows no voltage difference the breaker is wired correctly. This is shown in the example below.



8.3 DSE STEPS TO SUCCESSFUL LOADSHARING


Synchronising and load sharing is often considered to be a complex subject. In fact, it is very simple when broken down into smaller steps.

Before parallel operation between generators or another electrical supply is attempted, the *DSE Four Steps to Successful Synchronising* **must** be followed and completed on each of the generators.

The following information covers the *DSE Steps to Successful Loadsharing*, detailing the procedure to fault find and fine tune loadsharing applications.

8.3.1 EXPECTED OPERATION

8.3.1.1 ISOCHRONOUS LOADSHARING

 **NOTE: For further details about *Isochronous Loadsharing* operation, refer to section entitled *Prime Power (Load Share)* elsewhere within this document.**

When generators are running in parallel isochronously (zero droop), the amount of power they produce to the load is controlled to ensure each generator is doing an equal amount of work, whilst still running at nominal frequency and voltage.

It is the job of the DSE8x10 to make precise changes to the amount of power supplied to the resistive element (*Active Power (kW)*) and capacitive/inductive element (*Reactive Power (kvar)*) by each generator. The DSE8x10 modules communicate with one another using the MSC link, passing information and instructions between themselves to ensure they produce equal percentage of their full load rating. This process is displayed on the module's *Commissioning Screen*, found at the bottom of the *Generator* section of the module's display.

In the example below, the MSC link has derived that the total load equates to both generators running at 80% of their kW rating and 40% of their kvar rating. Hence, the value of target kW is 80% and the value for target (tgt) kvar is 40%.

Each DSE8x10 then regulates their generator's kW and kvar production to match their respective target values. In a correctly commissioned system with a steady load, the actual kW/kvar percentage would be within $\pm 1\%$ of the target kW/kvar percentage. This results in a maximum difference between generators of 2%. The DSE8x10 modules achieve this by adjusting the *Gov* percentage to affect kW's and the *AVR* percentage to affect kvars. Typical magnitudes of the *Gov* and *AVR* percentage at full load, with the switchgear closed and running in parallel are as follows:

- No more than 10% when there is no external droop enabled
- No more than 30% when external droop is enabled

| Generator 1 | | | | Generator 2 | | | |
|-------------|-------|------|-------|-------------|-------|------|-------|
| Tgt | 80.0% | kW | 81.0% | Tgt | 80.0% | kW | 79.0% |
| Tgt | 40.0% | kVAr | 39.0% | Tgt | 40.0% | kVAr | 41.0% |
| Pf | 0.94 | Ramp | 80.0% | Pf | 0.93 | Ramp | 80.0% |
| Gov | 5.1% | Avr | 3.5% | Gov | 4.6% | Avr | 3.7% |

If the actual kW/kvar percentage is not within $\pm 1\%$ of the target kW/kvar percentage, and the target kW/kvar percentage is not changing with a steady load, it suggests that the *Gain (P)*, *Stability (I)* and *Derivative (D)* settings need adjusting. Refer to section entitled *Adjusting Gain (P)*, *Stability (I)* and *Derivative (D)* for further details.

If the target kW/kvar percentage is changing rapidly or remains at 0% with a steady load, repeat the *DSE Four Steps to Successful Synchronising* as it suggests there is an issue with MSC link or wiring of the CTs. Refer to section entitled *DSE Four Steps to Successful Synchronising* for further details.

8.3.1.2 DROOP LOADSHARING

NOTE: For further details about *Isochronous Loadsharing* operation, refer to section entitled *Prime Power (Load Share)* elsewhere within this document.

When generators are running in parallel in *Droop* only, the amount of power they produce to the load has to be controlled to ensure it is shared between the generators, by varying the frequency and voltage the system is running at.

It is the job of the DSE8x10's the *Droop* functions to minimise the generators power production using the configured *Droop Curve*. Typically, the *Droop Curve* on each generator is identical to ensure the generators are producing an even percentage of *Active Power (kW)* / *Reactive Power (kvar)*.

The *Active Power (kW)* sharing is achieved by the *Frequency Droop*. This is done by monitoring the *Active Power (kW)* the generator produces and altering the amount of fuel supplied to the engine to adjust the *Frequency* in accordance with the *Droop Curve*. The *Reactive Power (kvar)* sharing is achieved by the *Voltage Droop*. This is done by monitoring the *Reactive Power (kvar)* the generator produces and altering the field excitation supplied to the alternator to adjust the *Voltage* in accordance with the *Droop Curve*. This process is displayed on the module's *Commissioning Screen*, found at the bottom of the *Generator* section of the module's display.

In the example below, the *Droop Curves* have derived that the target frequency and voltage the generators should run at is 50.50 Hz and 237.9 V, based on the load the generators are running at. Each DSE8x10 then regulates their generator's frequency and voltage to match their respective target values. In a correctly commissioned system with a steady load, the actual frequency/voltage would be within ± 1 % of the target frequency/voltage. This results in a maximum difference between generators of 2%. The DSE8x10 modules achieve this by adjusting the *Gov* percentage to affect frequency (and intern kW) and the *AVR* percentage to affect voltage (and intern kvars). Typical magnitudes at no load, with the switchgear closed are as follows:

- No more than 85%

| Generator 1 | | | | Generator 2 | | | |
|-------------|--------|------|--------|-------------|--------|------|--------|
| Tgt | 50.50 | Hz | 50.52 | Tgt | 50.50 | Hz | 50.52 |
| Tgt | 237.9V | L-N | 238.1V | Tgt | 237.9V | L-N | 238.1V |
| kW | 80.0% | kvar | 40.0% | kW | 80.0% | kvar | 40.0% |
| Gov | 16.0% | Avr | 24.0% | Gov | 16.0% | Avr | 24.0% |

If the actual frequency/voltage values are not within ± 1 % of the target frequency/voltage values, it suggests that the *Gain (P)*, *Stability (I)* and *Derivative (D)* settings need adjusting. Refer to section entitled *Adjusting Gain (P), Stability (I) and Derivative (D)* for further details.

If the kW/kvar percentage does not represent the loading on the generator, repeat the *DSE Four Steps to Successful Synchronising* as it suggests there is an issue with MSC link or wiring of the CTs. Refer to section entitled *DSE Four Steps to Successful Synchronising* for further details.

8.3.2 ADJUSTING GAIN (P), STABILITY (I) AND DERIVATIVE (D)

8.3.2.1 INITIAL SETUP

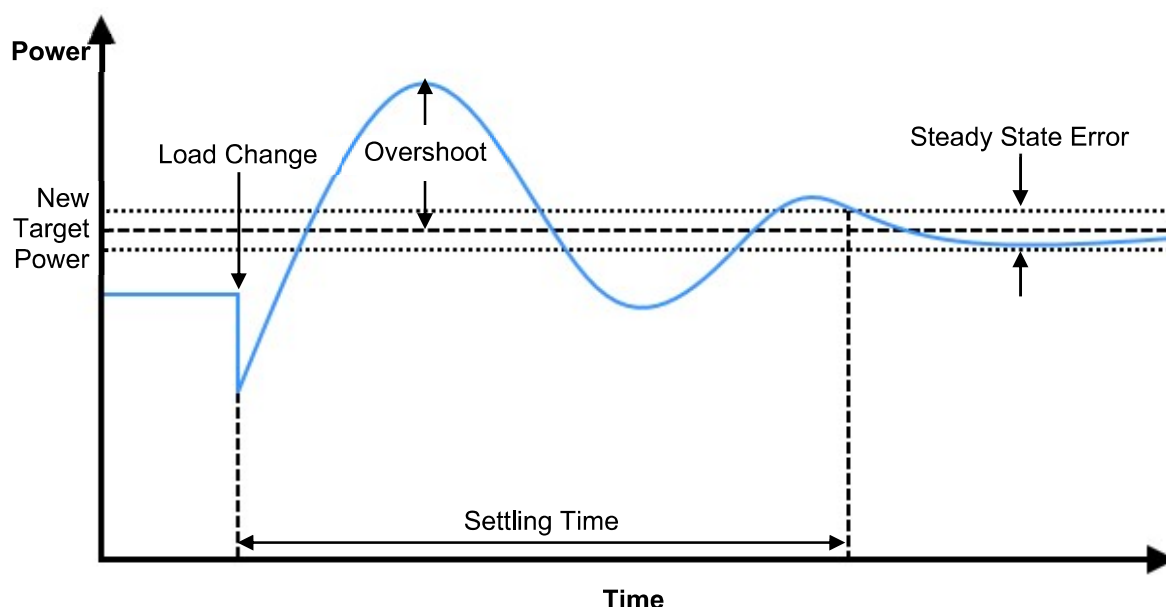
In most cases the DSE factory settings of 20% for *Gain (P)*, *Stability (I)* and 0 % for *Derivative (D)* are suitable for most systems. This is because the DSE module's control is limited by the *Gain (P)*, *Stability (I)* and *Derivative (D)* settings of the engine's governor / alternator's AVR. Before adjusting the DSE module's settings, adjust the *Gain (P)*, *Stability (I)* and *Derivative (D)* settings of the engine's governor / alternator's AVR in accordance with the manufacturer's recommendations.

8.3.2.2 CALIBRATION

If the loadsharing response of the system is not satisfactory after adjusting the *Gain (P)*, *Stability (I)* and *Derivative (D)* settings of the engine's governor / alternator's AVR, then start to adjust the DSE's settings by:


1. Starting with the *Gain (P)*, *Stability (I)* at 5 % and *Derivative (D)* at 0%. Place the generators in parallel with no load.
2. Gradually increase the *Gain (P)* setting until the generator power production becomes unstable. Very slowly decrease the *Gain (P)* setting, until the power production stabilises. Reduce the setting further by approximately 10 %.
3. Gradually increase the *Stability (I)* setting until the generator power production becomes unstable. Very slowly decrease the *Stability (I)* setting, until the power production stabilises.
4. Apply and remove load to the generators using a loadbank to test response and ensure no oscillation of power between generators. If a load bank is not available repeat the synchronising process several times to see the effect of the changes. Also attempt to 'knock' the governor actuator or change the 'slip frequency' setting to disturb the engine speed and force the controller into making further changes.
5. To improve the load change reponse, increase the *Derivative (D)* setting to decrease the overshoot and settling time.

The affect the *Gain (P)*, *Stability (I)* and *Derivative (D)* settings have on the response of a load step being applied to the generator are shown below.



| PID Adjustment | Overshoot | Settling Time | Steady State Error |
|-------------------------|-----------|----------------|--------------------|
| Increase Gain (P) | Increases | Minimal Effect | Decreases |
| Increase Stability (I) | Increases | Increases | Eliminates |
| Increase Derivative (D) | Decrease | Decreases | No Effect |

8.3.2.3 TROUBLESHOOTING

 **NOTE: An over damped response results in a slower control process. An under damped response (overshooting the target) leads to an unstable control process. Either case leads to undesirable consequences such as overcurrent or reverse power, resulting in generator shutdown, and loss of supply to the load.**

If the load is oscillating quickly between the generators it suggests that the setting for the *Gain (P)* on the generator(s) is too high or too low. A slow rolling oscillation usually indicates that the *Stability (I)* is too high or too low. These oscillations are caused by incorrect settings on the engine's governor / alternator's AVR and/or the DSE module.

It is possible for the loadsharing stability to change as different generators are go in and out of parallel with one another. Ensure that the *Gain (P)*, *Stability (I)* and *Derivative (D)* are calibrated to give a stable condition when all generators are running in parallel.