DEEP SEA ELECTRONICS

DSEA109 Operator Manual

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DSEA109 Operator Manual

Amendments Since Last Publication

Amd. No.	Comments
1	First release

Typeface. The typeface used in this document is *Arial*. Care should be taken not to mistake the upper case letter I with the numeral 1. The numeral 1 has a top serif to avoid this confusion.

Table of Contents

1 INTRODUCTION

WARNING!: LIVE PARTS exist within the AVR. To avoid damage to persons and/or property, only qualified personnel, having full understanding of the application must install the product.

This document details the installation requirements of the DSEA109 PMG powered Digital Automatic Voltage Regulator. The manual forms part of the product and should be kept for the entire life of the product. If the product is passed or supplied to another party, ensure that this document is passed to them for reference purposes.

This is not a *controlled document.* You will not be automatically informed of updates. Any future updates of this document will be included on the DSE website at www.deepseaelectronics.com

For details on configuring the DSEA109 using a PC, refer to the relevant configuration software manual.

1.1 CLARIFICATION OF NOTIFICATION

NOTE:	Highlights an essential element of a procedure to ensure correctness.
CAUTION!	Indicates a procedure or practice, which, if not strictly observed, could result in damage or destruction of equipment.
WARNING!	Indicates a procedure or practice, which could result in injury to personnel or loss of life if not followed correctly.

1.2 GLOSSARY OF TERMS

Term	Description
AVR	Automatic Voltage Regulator. A device that automatically adjusts alternator excitation, to maintain the desired generator output voltage and reactive power levels.
CAN	Controller Area Network Vehicle standard to allow digital devices to communicate to one another.
CT	Current Transformer An electrical device that takes a large AC current and scales it down by a fixed ratio to a smaller current.
DM1	Diagnostic Message 1 A DTC that is currently active.
DM2	Diagnostic Message 2 A DTC that was previously active on the module's internal memory.
DTC	Diagnostic Trouble Code The name for the entire fault code sent by a J1939 CAN device.
FMI	Failure Mode Indicator A part of DTC that indicates the type of failure, e.g. high, low, open circuit etc.
PGN	Parameter Group Number A CAN address for a set of parameters that relate to the same topic and share the same transmission rate.
PMG	Permanent Magnet Generator A Generator that controls the alternator excitation voltage via a Permanent Magnet type alternator (typically attached the shaft of the main alternator).
SPN	Suspect Parameter Number. A part of DTC that indicates what the failure is, e.g. oil pressure, coolant temperature, turbo pressure etc.

1.3 BIBLIOGRAPHY

This document refers to, and is referred by the following DSE publications which are obtained from the DSE website: www.deepseaelectronics.com or by contacting DSE technical support: support@deepseaelectronics.com.

1.3.1 INSTALLATION INSTRUCTIONS

DSE Part	Description
053-296	DSEA109 Installation Instructions

1.3.2 MANUALS

DSE Part	Description
057-294	DSEA109 Configuration Suite PC Software Manual

1.3.3 THIRD PARTY DOCUMENTS

The following third party documents are also referred to:

Reference	Description
ISBN 1-55937-879-4	IEEE Std C37.2-1996 IEEE Standard Electrical Power System Device Function Numbers and Contact Designations. Institute of Electrical and Electronics Engineers Inc
ISBN 0-7506-1147-2	Diesel generator handbook. L.L.J. Mahon
ISBN 0-9625949-3-8	On-Site Power Generation. EGSA Education Committee.

2 SPECIFICATIONS

2.1 TERMINAL SPECIFICATION

Connection Type	Description	Specifiction
CAN port	Terminal Block	Two-part connector. Male part fitted to module. Female part supplied in module packing case.
	Minimum Wire Size	0.25 mm^2 (AWG 24)
	Maximum Wire Size	3.0 mm^2 (AWG 12)
	Tightening Torque (Wire Clamp)	0.5 Nm (4.42 lbf.in)
	Tightening Torque (Connector to Connector)	0.5 Nm (4.42 lbf.in)
All other connections	Spade Terminals	6.3 mm male spade terminal fitted to module

2.2 PMG / AUXILIARY WINDING / SHUNT SUPPLY

NOTE: The DSEA109 AVR is suitable for alternators with *PMG*, *Auxiliary Winding* or *Shunt* connections.

CAUTION!: The source powering the AVR must have inrush protection if it's internal impedance is less than 3 Ω. This is typically the case when using a bench power supply. Failure to do so may result in the power source becoming damaged.

Parameter	Description
Arrangement	Single phase or phase to phase voltage.
Voltage	100 V AC to 270 V AC between terminals U, V & W
Frequency	40 Hz to 400 Hz.

2.3 GENERATOR VOLTAGE AND FREQUENCY SENSING

Parameter	Description
Arrangement	Single phase or phase to phase voltage.
Measurement Method	True RMS up to 11^{th} harmonic.
Primary To Ground Resistance	>4 MΩ from each phase to *A-* and *P2* (internally connected).
Phase to Phase Resistance	600 kΩ between terminals.
Voltage	15 V AC to 600 V AC between terminals.
Voltage Accuracy	±0.5 % of full scale.
Maximum Common Mode Voltage	500 V.
Frequency	40 Hz to 65 Hz.
Frequency Accuracy	±0.2 Hz.

2.4 GENERATOR CURRENT MEASUREMENT

The AVR measures current in a chosen phase for the purposes of quadrature droop using terminals *S1* and *S2*. For further details, refer to the section entitled *Quadrature Droop* elsewhere in this document.

Parameter	Description
Arrangement	Single phase on any phase.
Measurement Method	True RMS up to 11th harmonic.
Maximum Continuous Current	5 A
Burden on the CT	0.25 VA
Common Mode Offset	±1 V peak from *S2* terminal to *A-* and *P2* (internally connected).
Accuracy	±1 % of Nominal (5 A) excluding CT error.
Droop Adjustment	0% to 10%

2.5 EXTERNAL VOLTAGE BIAS

External voltage bias inputs allow an external circuit to influence the output of the generator.

Parameter	Description
Potentiometer Bias Input (terminals *P1* and *P2*)	0 Ω to 5 kΩ
DC Voltage Bias Input Range (terminals *A1* and *A2*)	-10 V to 10 V
DC Voltage Bias Input Impedance	> 10 kΩ
Resistive Bias Range	±1% to ±16% of Nominal Voltage set using PC software
DC Voltage Bias Range	±1% / V to ±16% / V of Nominal Voltage set using PC software

2.6 EXCITER FIELD OUTPUT

Parameter	Description
Exciter Winding Impedance	5 Ω to 50 Ω.
Exciter Winding Inductance	0.3 H to 1.2 H

2.6.1 CONTINUOUS RATINGS

Continuous rating is subject to output power being 500 W or below.

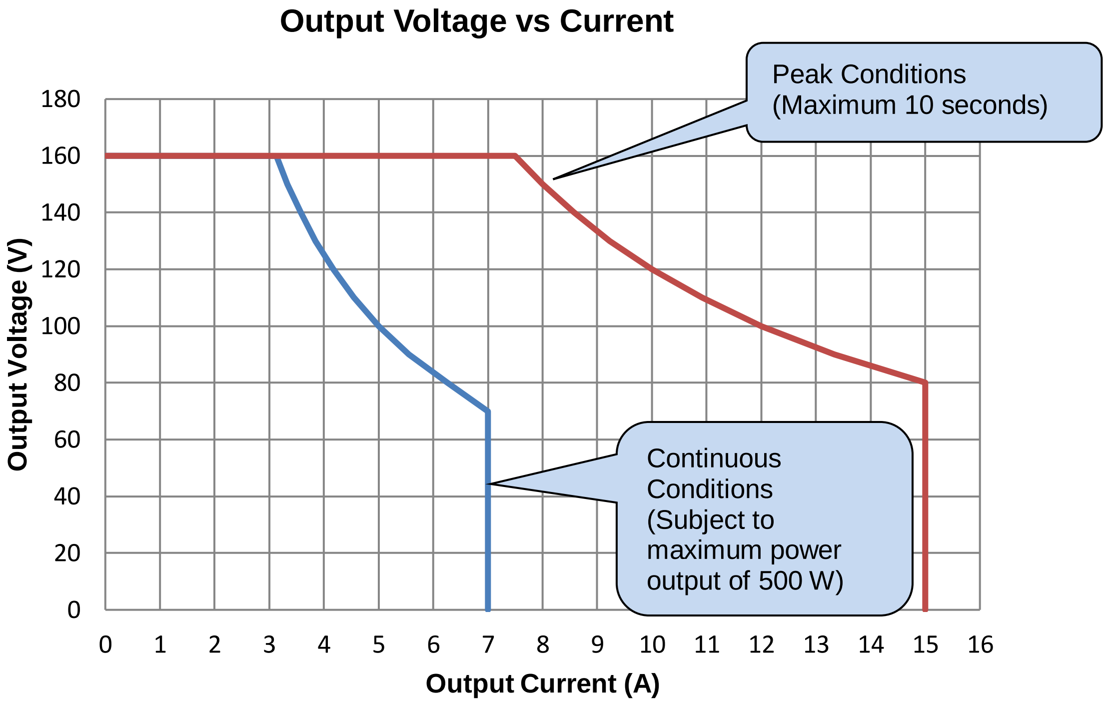
Parameter	Description
Output Voltage	0 V DC to 100 V DC.
Output Current	0 A DC to 7 A DC.

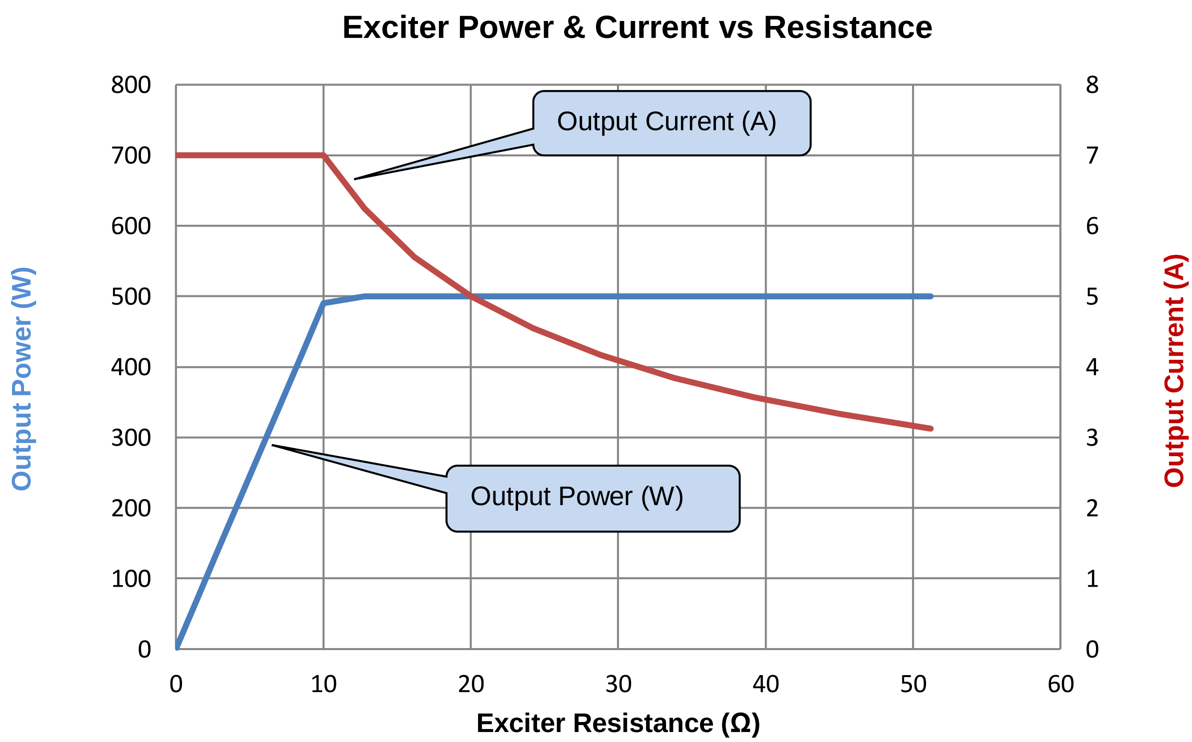
2.6.2 PEAK CONDITIONS

Peak conditions are for a maximum of 10 seconds.

Parameter	Description
Output Voltage (Overload)	150 V DC for 10 seconds.
Output Current (Overload)	15 A DC for 10 seconds.

2.7 OUTPUT POWER LIMITATION CURVES





2.8 DIMENSIONS

Parameter	Description
Overall Size	180 mm x 145 mm x 61 mm (7.0 " x 5.7 " x 2.4 ")
Mounting Type	Screw Mounting to Chassis.
Mounting Holes	Suitable for M5 bolts/screws. Outside diameter 5.5 mm (Outside diameter 0.2 ")
Mounting Hole Centres	150 mm x 120 mm (5.9 " x 4.7 ")

2.9 TEMPERATURE

Parameter	Description
Operating Temperature	-40 ºC to +70 ºC (-40 ºF to +158 ºF)
Storage Temperature	-40 ºC to +85 ºC (-40 ºF to + 185 ºF)

2.10 WEIGHT

Parameter	Description
Shipped Weight	0.68 kg
Module Weight	0.62 kg

2.11 COMMUNICATIONS

2.11.1 CAN

NOTE: For further details of CAN communication, see the section entitled *CAN Interface Specification* elsewhere in this document.

Parameter	Description
Protocol	S.A.E. J1939.
Bit Rate	250 kb/s
Isolation	±2.5 kVrms
Termination	External 120 Ω termination resistor required.

2.11.2 CONFIGURATION PORT

NOTE: For further details of module configuration, refer to DSE Publication: *057-283 DSEA109 Configuration Suite PC Software Manual.*

Caution: Do not disconnect the USB from DSE815 whilst it is connected to the AVR. Doing so results in loss of voltage control and potential damage to the generator.

WARNING! As the AVR is isolated from ground it is possible that the configuration is live during operation.

In conjunction with the DSE815 Configuration Interface, the Configuration Port is provided to give a simple means of connection between a PC and the controller.
Using the DSE Configuration Suite Software, the operator is then able to monitor the device and perform reset operations.

Additionally, the various operating parameters are available to be viewed or changed.

To connect a module to a PC by USB, the following items are required:

- DSEA109

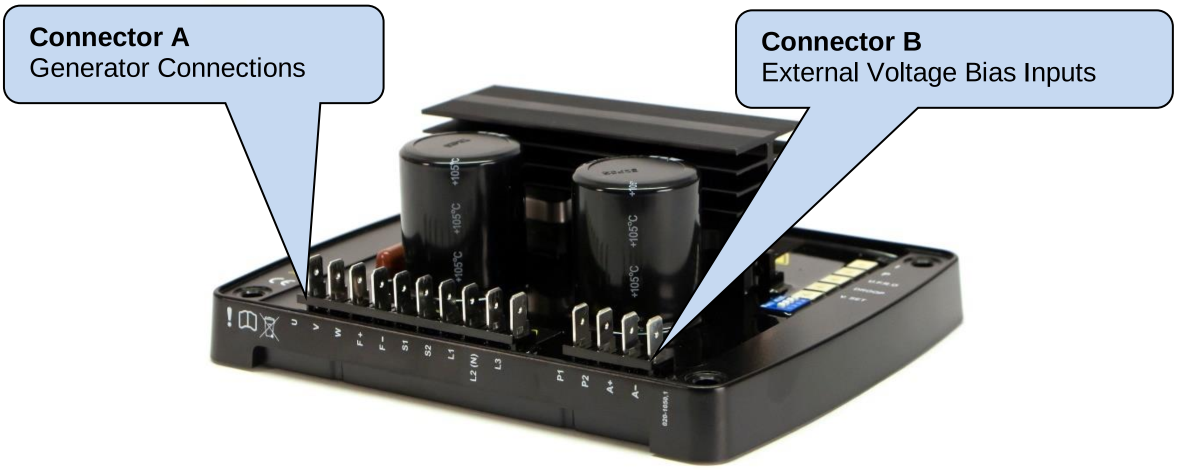
- DSE815 Configuration Interface

- DSE Configuration Suite PC Software (available from www.deepseaelectronics.com).

3 INSTALLATION

WARNING!: LIVE PARTS exist within the AVR. When powered avoid contact with components and terminals. Terminals remain live for up to 70 seconds after shutdown. Do not touch during this time. Only qualified personnel, having full understanding of the application must install the product.

The AVR is designed to be mounted on the control panel chassis or within the alternator housing utilising the integral mounting holes. For dimension and mounting details, see the section entitled *Specifications>Dimensions* elsewhere in this document.



3.1 USER CONNECTIONS

3.1.1 CONNECTOR A – GENERATOR CONNECTIONS

Terminal	Function	Recommended Size
U	Connection to the L1 terminal of the PMG Winding.	2.5 mm^2 (AWG13)
V	Connection to the L2 terminal of the PMG Winding.	2.5 mm^2 (AWG13)
W	Connection to the L3 terminal of the PMG Winding.	2.5 mm^2 (AWG13)
F+	Connection to the positive terminal of the generator Exciter Field Winding.	2.5 mm^2 (AWG13)
F-	Connection to the negative terminal of the generator Exciter Field Winding.	2.5 mm^2 (AWG13)
S1	Connection to the Droop CT S1 terminal.	2.5 mm^2 (AWG13)
S2	Connection to the Droop CT S2 terminal.	2.5 mm^2 (AWG13)
L1	Connection to L1 of the generator AC output phase.	2.5 mm^2 (AWG13)
N (L2)	Connection to N or L2 of the generator AC output phase.	2.5 mm^2 (AWG13)
L3	Connection to L3 of the generator AC output phase.	2.5 mm^2 (AWG13)

3.1.2 CONNECTOR B – EXTERNAL VOLTAGE BIAS INPUT

Terminal	Function	Recommended Size
P1	Connection to one side of a remote 5 kΩ adjustment potentiometer.	1.0 mm² (AWG18)
P2	Connection to one side of a remote 5 kΩ adjustment potentiometer.	1.0 mm² (AWG18)
A+	-10 V to 10 V remote adjustment input positive terminal.	1.0 mm² (AWG18)
A-	-10 V to 10 V remote adjustment input negative terminal.	1.0 mm² (AWG18)

3.1.3 CAN CONNECTOR

NOTE: Screened 120 Ω impedance cable specified for use with CAN must be used for the CAN link.
DSE stock and supply Belden cable 9841 which is a high quality 120 Ω impedance cable suitable for CAN use (DSE part number 016-030)

NOTE: As a termination resistor is internally fitted to the controller, the controller must be the 'first' unit on the DSENet® link. A termination resistor MUST be fitted to the 'last' unit on the DSENet® link. For connection details, refer to section entitled *Typical Wiring Diagram* elsewhere in this document.

Terminal	Function	Recommended Size
CAN Port H	Connection to the CAN H connection of the AVR	0.5 mm² AWG 20
CAN Port L	Connection to the CAN L connection of the AVR	0.5 mm² AWG 20
CAN Port Screen	Connection to the CAN SCR connection of the AVR	Shield

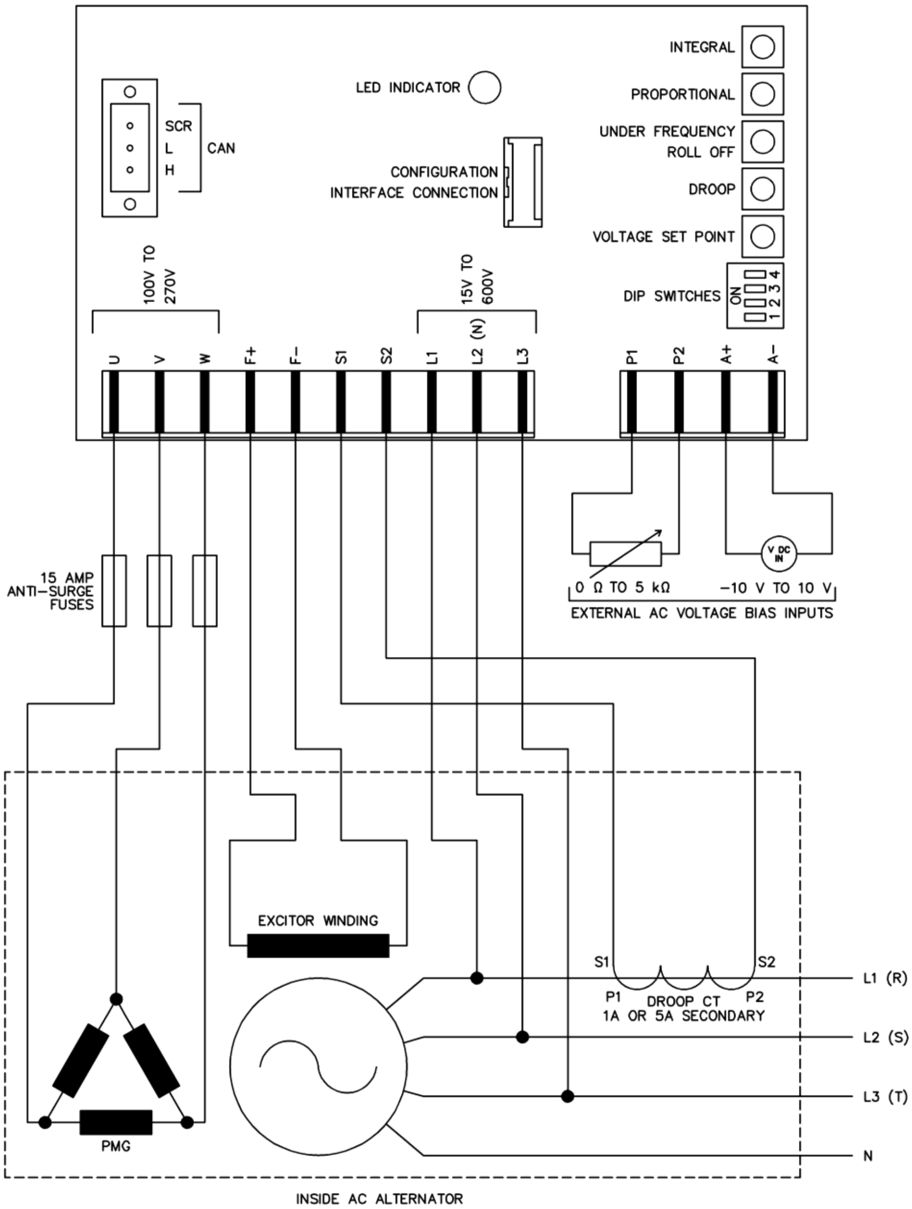
3.2 TYPICAL WIRING DIAGRAMS

NOTE: The DSEA109 AVR is suitable for alternators with a *Permanent Magnet Generator (PMG), Auxiliary Winding* or *Shunt* connections.

3.2.1 PMG WINDING CONNECTION

WARNING!: LIVE PARTS exist within the AVR. When powered avoid contact with components and terminals. Terminals remain live for up to 70 seconds after shutdown. Do not touch during this time. Only qualified personnel, having full understanding of the application must install the product.

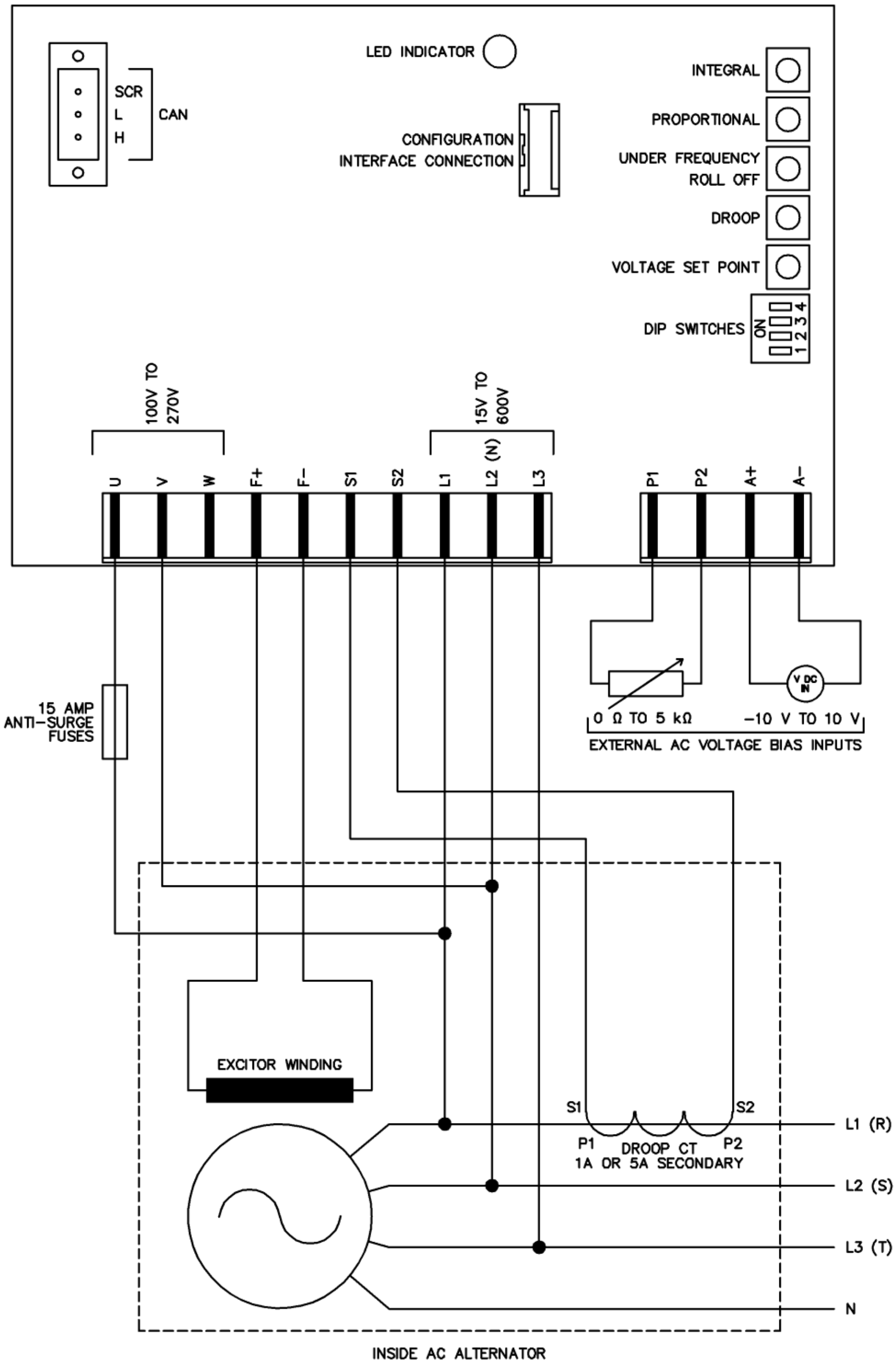
NOTE: A suitably located and easily reached switch or circuit breaker must be fitted and clearly marked as the disconnecting device for the AVR.



3.2.2 SHUNT CONNECTION

WARNING!: LIVE PARTS exist within the AVR. When powered avoid contact with components and terminals. Terminals remain live for up to 70 seconds after shutdown. Do not touch during this time. Only qualified personnel, having full understanding of the application must install the product.

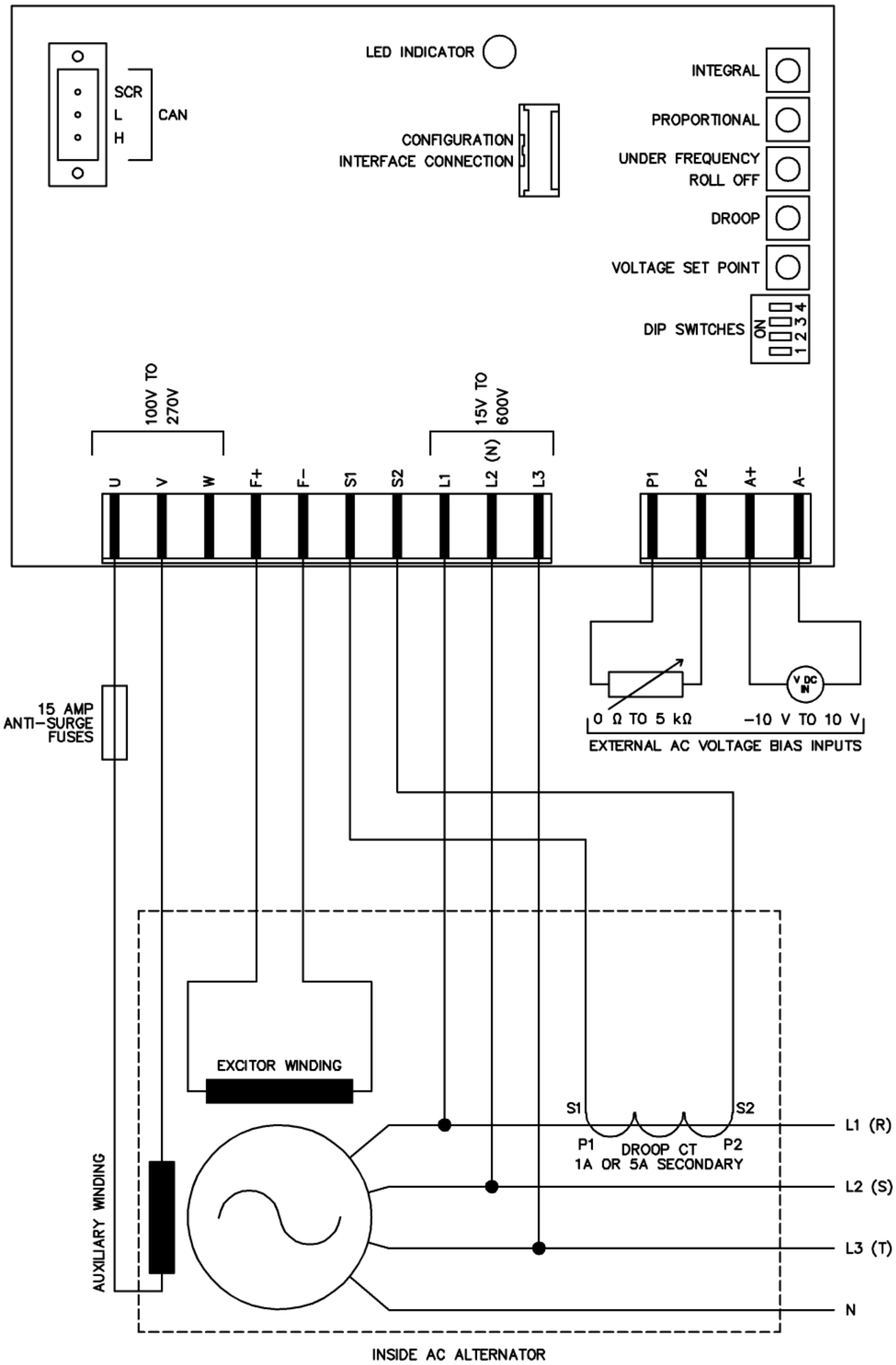
NOTE: A suitably located and easily reached switch or circuit breaker must be fitted and clearly marked as the disconnecting device for the AVR.



3.2.3 AUX WINDING CONNECTION

WARNING!: LIVE PARTS exist within the AVR. When powered avoid contact with components and terminals. Terminals remain live for up to 70 seconds after shutdown. Do not touch during this time. Only qualified personnel, having full understanding of the application must install the product.

NOTE: A suitably located and easily reached switch or circuit breaker must be fitted and clearly marked as the disconnecting device for the AVR.



4 SETUP PROCEDURE

CAUTION: To protect the alternator, 'De-excite' the alternator as described by the alternator manufacturer before commisioning the engine governor. Only re-enable the alternator after successful governor comissioning.

WARNING!: LIVE PARTS exist within the AVR. When powered avoid contact with components and terminals. Terminals remain live for up to 70 seconds after shutdown. Do not touch during this time. Only qualified personnel, having full understanding of the application must install the product.

NOTE: A suitably located and easily reached switch or circuit breaker must be fitted and clearly marked as the disconnecting device for the AVR.

CAUTION: Do not disconnect the USB from DSE815 whilst it is connected to the AVR. Doing so results in loss of voltage control and potential damage to the generator.

NOTE: For further details of module configuration, refer to DSE Publication: *057-271 DSEA109 Configuration Suite PC Software Manual.*

The engine must be commissioned as far as possible before this procedure is carried out, in particular the governor must be setup to produce stable speed control at 1500 RPM / 1800 RPM.

Use DSE Configuration Suite PC Software to upload the factory default configuration to the AVR if required.

4.1 AVR INITIAL SETTINGS

NOTE: For further details of module configuration, refer to DSE Publication: *057-271 DSEA109 Configuration Suite PC Software Manual.*

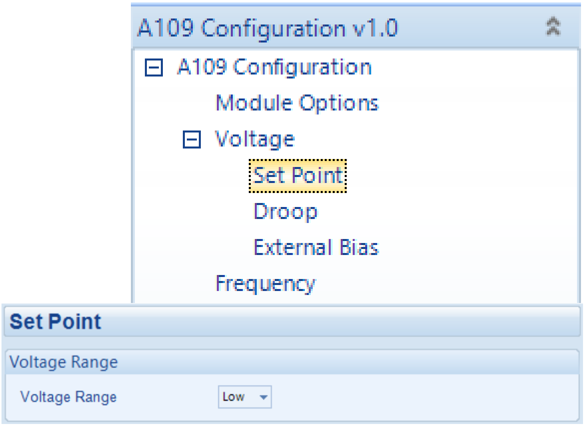
Before commencing the setup procedure, ensure all DIP switches are in the correct position to enable to appropriate *Stability* and *Main/Alternative Configuration* to be calibrated.

Function	DIP Switch 1
Stability Configuration 1	Off
Stability Configuration 2	On

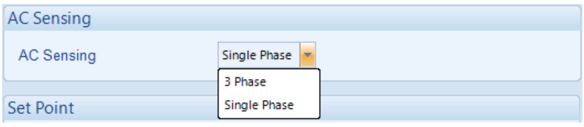
DIP Switch 2, 3 & 4 Functionality			
Function	**DIP Switch 2**	**DIP Switch 3**	**DIP Switch 4**
Main Configuration	Off	Off	Off
Alternative Configuration 1	Off	Off	On
Alternative Configuration 2	Off	On	Off
Alternative Configuration 3	Off	On	On
Alternative Configuration 4	On	Off	Off
Alternative Configuration 5	On	Off	On

Using DSE Configuration Suite PC Software, select the appropriate *Voltage Set Point*.

The *Low Voltage Range* (for 90 V to 300 V systems) or *High Voltage Range* (for 180 V to 600 V systems).
This voltage refers to the voltage applied to the AVR's L1, L2 (N) & L3 terminals (the sensing voltage).

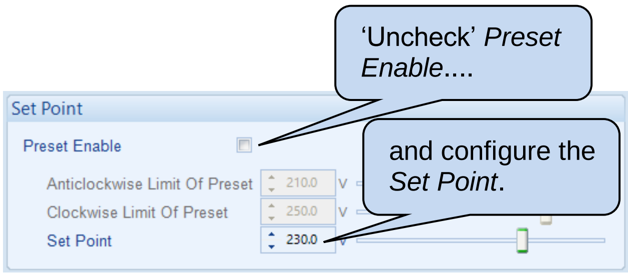


Select the appropriate *AC Sensing* topology being used for the AVR's L1, L2 (N) & L3 terminals



Now select the *Set Point* menu and 'uncheck' the *Preset Enable* option.

This allows the *Set Point* parameter to be configured to a specific value.



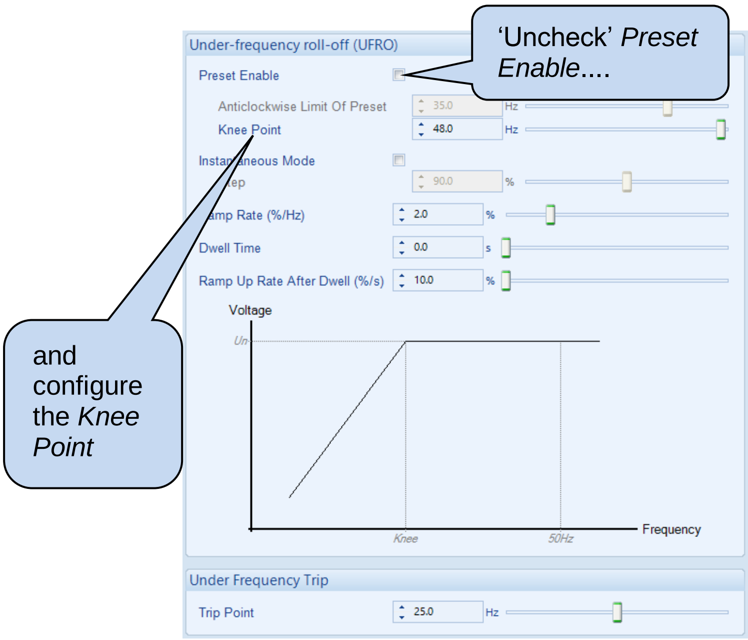
Leave the *Droop* and *External Bias* settings in their default states initially, these are to be addressed later.

Using DSE Configuration Suite PC Software, select the appropriate *Frequency Range* (50 Hz or 60 Hz).

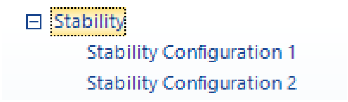
Uncheck the *Preset Enable* option.
This allows *Under Frequency Roll Off Knee Point* to be adjusted if required.

To ease setup, adjust *Knee Point* to a low value to prevent *Under Frequency Roll Off* from activating during the setup procedure.

Set the *Under Frequency Trip Point* as required.



Open *Stability Configuration* page that was previously selected by the DIP switches.

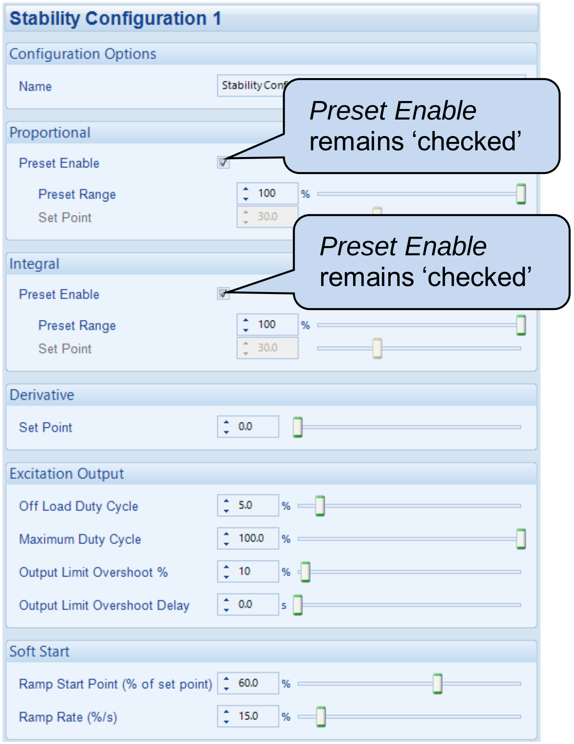


Ensure the *Proportional* and *Integral Preset Enable* options are checked and set the *Preset Range* of both to 100 %. This allows Proportional control via the module Pots.
Alternatively disabling the *Present Enables* allows the *Proportional* and *Integral* values to be adjusted using the PC via the *SCADA* | *Commissioning Screen* section.

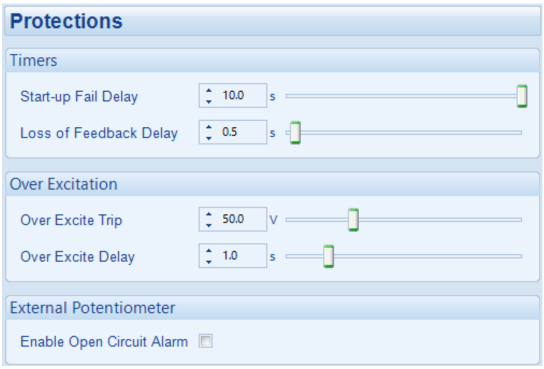
Set the *Derivative Set Point* to 0.

Set the *Maximum Duty Cycle* to 100 %. Leave all other *Excitation Output* values at default.

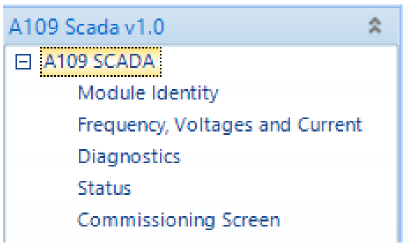
Leave the *Soft Start* values at default for the first start. If an excessive voltage spike occurs on start up, reduce the *Ramp Start Point*.



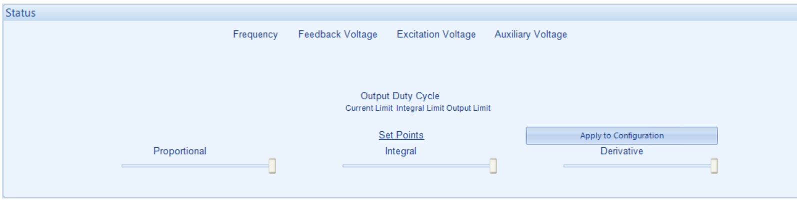
Choose the *Protections* tab and set *Start-up Fail Delay* to its maximum value. This prevents it interfering with the setup process.



Using DSE Configuration Suite PC Software, connect *SCADA* and select the *Commissioning Screen* display.



Set the *Proportional* preset on the AVR to approximately 10. Set the *Integral* preset on the AVR between 1 and 2. Ensure the derivative value is 0, and the *Output Duty Cycle* is 100 % with the engine not running.



Connect a voltmeter to the alternator output, preferably connected ‘phase to neutral’

NOTE: If an oscilloscope is not available, the voltmeter and SCADA screen are used solely. This does not show rapid oscillation of the voltage output and hence does not provide the optimum setup environment.

If available, connect an oscilloscope to the alternator output, preferably connected ‘phase to neutral’, and set it to a slow time-base so that the spot takes about 4 seconds to traverse the screen. Set it to ‘auto-trigger’ so that it keeps rolling continuously. It is the variation in the peak voltage that is of interest as it shows instability and settling time very clearly.

4.2 FIRST START

NOTE: It is impossible to predict exactly what happens when the set is first started! Observe carefully and be prepared to stop the generator. Test Emergency Stop operation prior to starting. Ensure the previous section is completed fully.

NOTE: Do not apply load to the set until instructed during the following procedure.

NOTE: For further details of module configuration, refer to DSE Publication: *057-271 DSEA109 Configuration Suite PC Software Manual.*

Start the generating set and observe the feedback voltage using the SCADA screen and the voltmeter.

4.2.1 AVR TRIPS AFTER FIRST START

If the AVR trips, the LED flashes. Immediately stop the generating set and then count the flashes.

Take the following action:

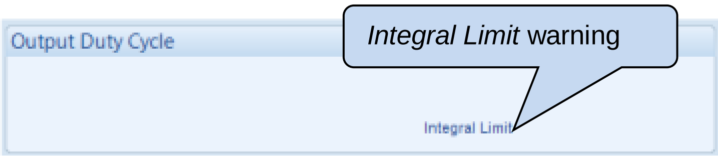
LED State	Cause	Action
Rapid Continuous Flashing	Corrupt configuration	Write the configuration to the AVR again, if this reoccurs the AVR is faulty and should be returned.
Single Flash	Start-up Failed Trip (Voltage Feedback Failed to Reach 70% of *Set Point*)	Delayed by 10 seconds if the setup instructions were correctly followed. Go to the next stability range using the DIP switches to increase the *Maximum Duty Cycle*. This may require repeating depending on the duty cycle the alternator needs.
Two Flashes	Over Excite Trip	Increase the *Over Excite Trip* on the Protections menu by 50%. This may require repeating depending on the excitation voltage the alternator needs.
Three Flashes	Loss of Sensing	Check the feedback wiring as this indicates a loose connection.
Four Flashes	Under Frequency Trip	Indicates the engine is not up to speed, check the governor.
Five Flashes	Potentiometer Fault	Indicates that the potentiometer connected to terminals P1 and P2 has become open circuit.
Steady	UFRO Active	Indicates the engine is not up to speed, check the governor.

4.2.2 LOW OUTPUT VOLTAGE AFTER FIRST START

If the generator output voltage is not reaching the configured *Set Point*, check that the voltmeter reading is consistent with the *Feedback Voltage* on the Commissioning Screen display. If there is a difference in the reading, this indicates a mistake in the alternator sensing wires or configuration.

For example, if a 440 V (phase to phase) alternator is connected ‘half phase’, this results in 220 V (phase to phase) being connected to the AVR’s L1, L2 (N) and L3 terminals. The *Feedback Voltage* shows 220 V as this is the voltage measured by the AVR. The AVR *Set Point* must be configured to match the sensing voltage as the AVR works to adjust the excitation to achieve and maintain the sensed voltage to match the configured set point.

If the voltmeter and SCADA display are consistent, but not reaching the full *feedback voltage*, then check if an *Integral Limit* warning is active. The *Integral Limit* warning is viewed in either the ‘Output Duty Cycle’ box on the Diagnostic Screen, or in the ‘Status’ box on the Commissioning Screen. This indicates that the *Maximum Duty Cycle* is set too low in the configuration. Stop the set and increase the value to 100 %, then repeat the test.



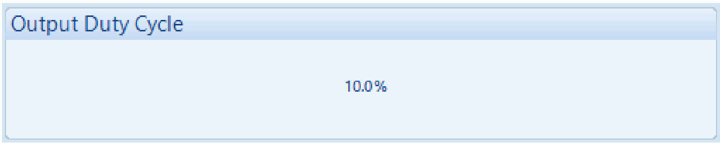
4.3 AFTER A SUCCESSFUL START

NOTE: Proceed below only when the generating set runs without the AVR tripping and when the feedback voltage reaches the set point and remains relatively stable.

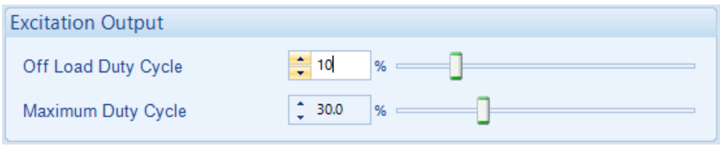
NOTE: For further details of module configuration, refer to DSE Publication: *057-271 DSEA109 Configuration Suite PC Software Manual.*

4.3.1 OFF LOAD DUTY CYCLE SETTING

With the set running **off load**, take note of the *Output Duty Cycle* being displayed on the Diagnostic or Commissioning Screen in SCADA.



Stop the set and configure the *Off Load Duty Cycle* to this value, i.e. *Off Load Duty Cycle* is the normal ‘off load’ operating point.



4.3.2 PID CALIBRATION

The following subsections details the procedure for calibrating the *Proportional*, *Integral*, and *Derivative* settings for optimal generator load acceptance and operation. Wherever possible, a load bank is to be used to ensure stable voltage control during different loading conditions. If a load bank is not available, the *Voltage Set Point Step* function is used to emulate load step changes.

4.3.2.1 PROPORTIONAL

NOTE: If an oscilloscope is not available, the voltmeter and SCADA screen are used solely. This does not show rapid oscillation of the voltage output and hence does not provide the optimum setup environment.

WARNING!: Use only a suitable insulated preset adjustment tool.

Start the set and wait for the voltage to reach the *Set Point*. Allow a little time for the voltage to stabilise

Gradually increase the *Proportional* setting, by turning the *Proportional* preset clockwise, until the generator output voltage becomes unstable. Very slowly decrease the *Proportional* setting, until the voltage stabilises. Make a note of the *Proportional* setting value, on the Commissioning Screen, and reduce the setting by approximately 20 %.

4.3.2.2 INTEGRAL

NOTE: Proceed below only after setting *Proportional.*

NOTE: If an oscilloscope is not available, the voltmeter and SCADA screen are used solely. This does not show rapid oscillation of the voltage output and hence does not provide the optimum setup environment.

WARNING!: Use only a suitable insulated preset adjustment tool.

Gradually increase the *Integral* setting by turning the *Integral* preset clockwise, until the generator output voltage becomes unstable. Very slowly decrease the *Integral* setting, until the voltage stabilises.

4.3.2.3 DERIVATIVE

NOTE: Proceed below only after setting both *Proportional* and *Integral*.

NOTE: If an oscilloscope is not available, the voltmeter and SCADA screen are used solely. This does not show rapid oscillation of the voltage output and hence does not provide the optimum setup environment.

NOTE: If the genset is intended for dual frequency operation, the *Voltage Set Point Step* test must be completed at both frequencies. If the response is stable at one frequency, but unstable at the other, adjust the *Derivative Set Point* and repeat the test.

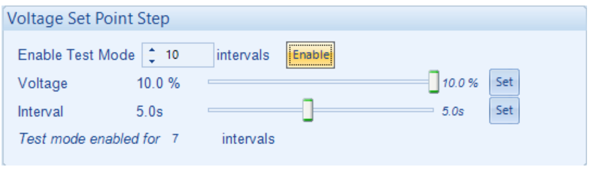
With the *Proportional* and *Integral* presets set as described in the procedure above, the initial response to the *Voltage Set Point Step* changes is likely to have been unstable. The next step to improve this response is to increase the *Derivative* preset.

The *Derivative* preset is be adjusted either by changing the AVR's configuration file or in the SCADA | Commissioning page.

The settings is found on the selected *Stability Configuration* page. To begin testing, increment the *Derivative Set Point* in steps of 20. After making each adjustment, write the configuration to the AVR, and then start the generator. Once this is done repeat the *Voltage Set Point Step* test and check the response. A good response should match the middle oscilloscope trace, shown below. Once this has been achieved, all the stability settings of the AVR have been satisfactorily set up and do not require further adjustment. Further load acceptance tests can be performed with a load bank, if deemed necessary.

4.3.2.4 VOLTAGE SET POINT STEP

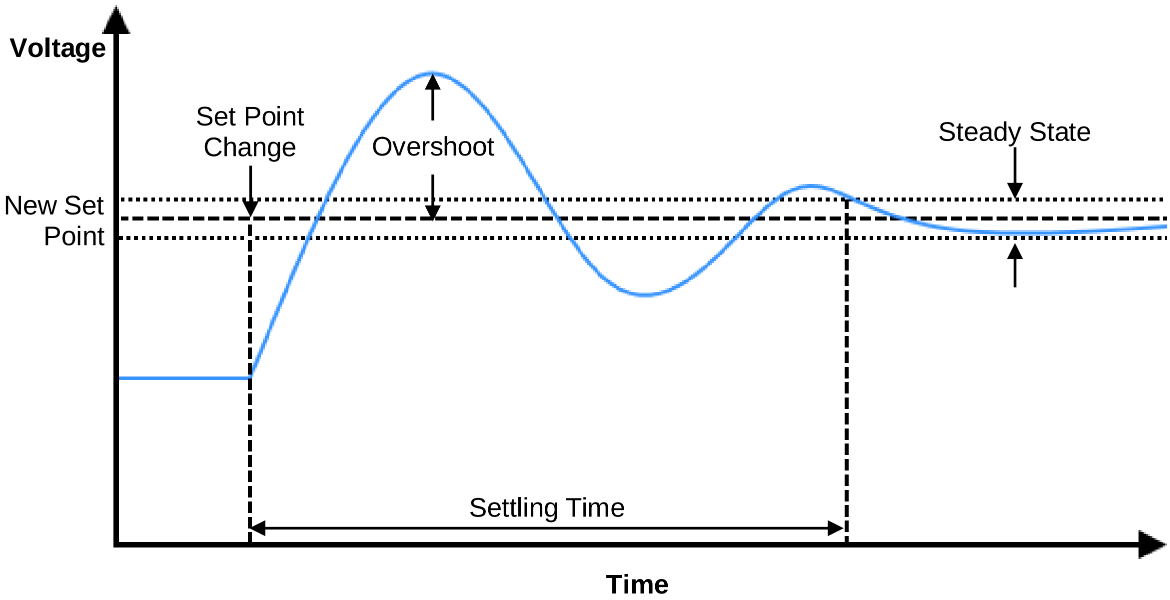
The *Voltage Set Point Step* feature allows the configured PID settings to be tested, without the use of a load bank and / or in addition to a load bank.



The voltage *Set Point* is increased and decreased by a pre-defined percentage, at the set interval for a set number of cycles. For commissioning the default values of 10 intervals, voltage steps of 10 % and interval delay of 5 seconds is used.

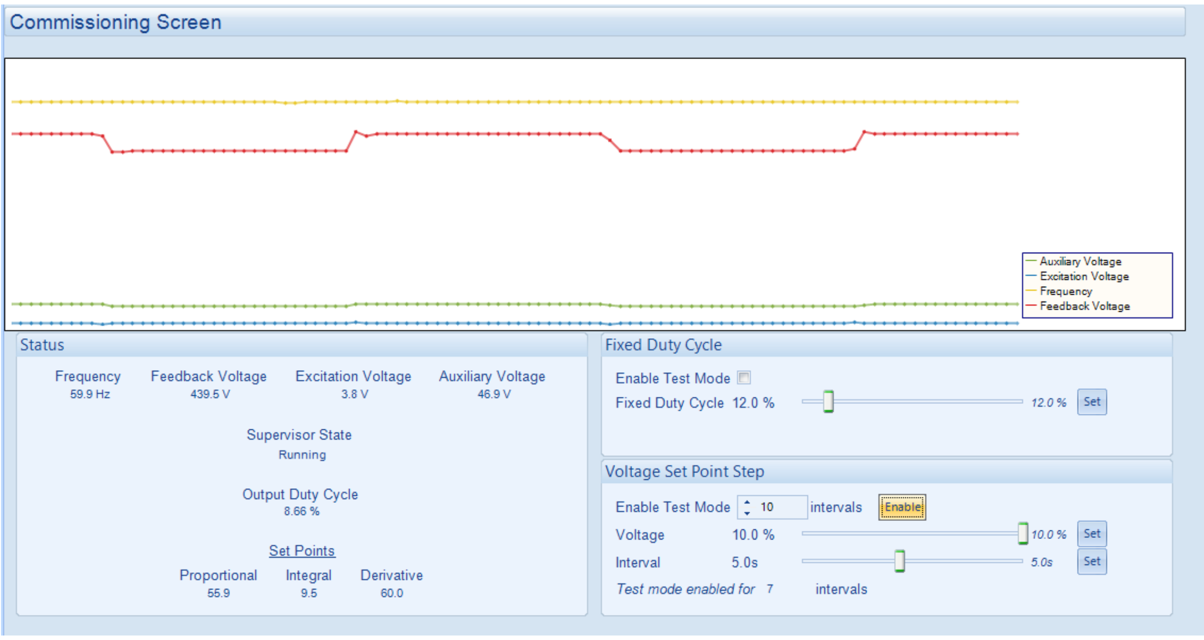
When the *Voltage Set Point Step* is activated, the AVR's *Set Point* is increased by the voltage step percentage. The AVR's then increases its excitation output to increases the generator's voltage to match the new *Set Point*. If the generator voltage increase surpasses the *Set Point*, the excitation output is decreased. The inverse of this process then occurs when the AVR's *Set Point* is decreased by the voltage step percentage. As with the step-up, if the decrease is too large, the set point is surpassed, requiring an increase in excitation.

The AVR's response to these *Voltage Set Point Step* changes indicate how well the current stability settings handle load changes, and what further adjustments may be required. Example oscilloscope traces of the AVR's 'transient response' to *Voltage Set Point Step* changes are shown below:



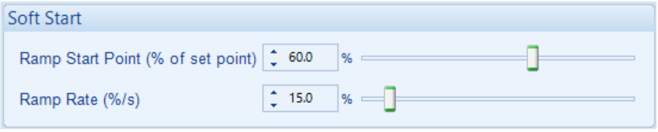
PID Adjustment	Overshoot	Settling Time	Steady State Error
Increase Gain (P)	Increases	Minimal Effect	Decreases
Increase Stability (I)	Increases	Increases	Eliminates
Increase Derivative (D)	Decrease	Decreases	No Effect

The below image illustrates the Commissioning Screen from a correctly configured AVR during *Voltage Set Point Step* testing:



4.3.2.5 SOFT START RAMP

Once the stability settings have been completed, the *Soft Start Ramp* values can be set.



The *Ramp Start Point* value determines the percentage of the configured voltage *Set Point* at which the *Soft Start Ramp* takes effect. If a voltage spike at a value below the voltage *Set Point* is shown on start up, decrease this value. The settings should then be adjusted to allow for the smoothest start up in the optimum time for your application.

The Ramp Rate value determines how fast the voltage ramps up from the Ramp Start Point to the Set Point on start up. If excessive overshoot past the Set Point is seen, decrease this value. The settings should then be adjusted to allow for the smoothest start up in the optimum time for your application.

4.3.3 DROOP SETTING

NOTE: Proceed with *Droop* setting only after the AVR has been correctly stabilised by following the *Stability Settings* section first.

Quadrature Droop monitors the reactive power provided by the generator to the load and is used to provide kvar sharing (reactive load sharing) between generators.

Droop is optional. If required, a Current Transformer (CT) must be fitted in one of the alternator phases. The AVR must be configured correctly to match which phase the CT is fitted to, relative to the voltage settings. This is performed in the DSE Configuration Suite PC Software.

4.3.3.1 USER CONFIGURED DROOP SETUP

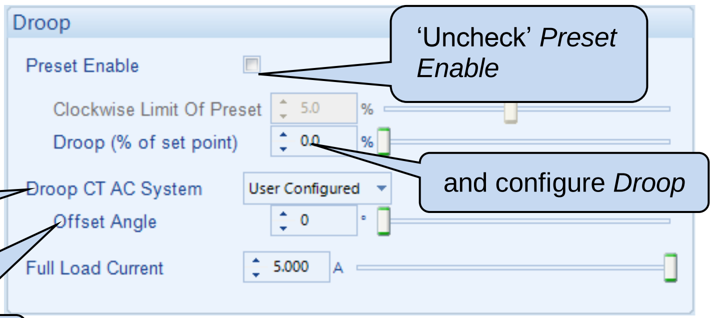
Set *Droop (% of set point)* to the desired level. This is defined as the percentage by which the output voltage will fall when the measured kvar corresponds to full load at 0.8 power factor.

For example: For a generator rated at 230 V and 100 kVA, with droop set to 10%.
When the load reaches 80 kW at 0.8 pf (60 kvar) lagging, the output voltage will fall by 10% to 207 V.
It is the **reactive** power that is measured and acted upon by the AVR.

Since there is only provision for one CT the AVR assumes that the load is balanced between the phases.

NOTE: When completing a *User Configured* droop setup, it is very important that *Droop CT AC System* is set to *User Configured*, and the *Offset Angle* is to 0 before proceeding.

Ensure *Droop CT AC System* is set as *User* Configured, and Offset *Angle* is set to zero. This is the factory default setting but must be verified before proceeding.



Set *Full Load Current* to match the CT secondary current when the generator is at full load.

For example: For a set rated at 230 V and 100 kVA, three phase, with a 200:5 CT:

- The full load current is (100000/3)/230 = 145 A per phase.
- Applying the CT ratio to find the secondary current 145 x (5/200) = 3.625 A
- *Full Load Current* should be set to 3.625 A

Write the configuration to the AVR.

4.3.3.2 OBTAINING AND CONFIGURING CT PHASE SHIFT

> **NOTE: It is very important that Droop *Initial Setup* procedure is followed before continuing.**

To account for the choices made for the CT, its location and which phases are used for voltage sensing, *Offset Angle* must be configured correctly. This is performed as follows:

Start the generator set and apply a purely resistive load of at least 5% of the generator capacity, it **must** be resistive only load, with no reactive element.

Using SCADA *Frequency, Voltage and Current*, note the current lag angle. This shows the phase shift caused by the Droop CT, its location and the AVR voltage sensing connections.

Remove the load, stop the generator and change *Offset Angle* to this noted angle and write the configuration to the AVR.

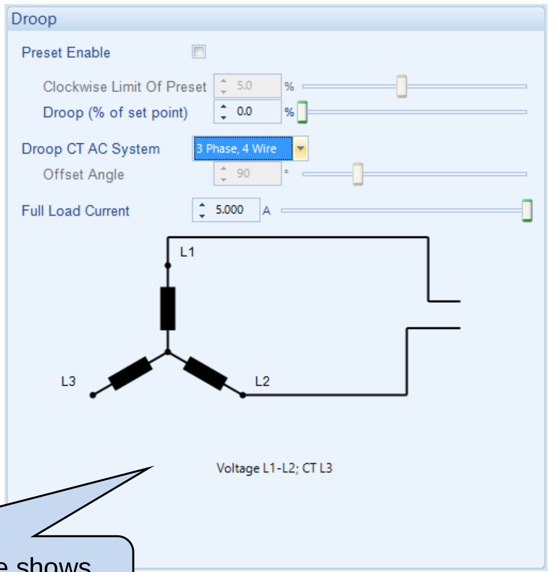
The AVR is now compensated for the choice of phase for the CT and voltage sensing.

Droop is now set, if required it can be tested using an inductive load bank.

4.3.3.3 PRE-DEFINED DROOP SETUP

> **NOTE: When using a pre-defined droop setup, the DSEA109 must be wired to match the selected topology as shown in *Configuration Suite*. Failure to do so causes erroneous droop operation.**

The pre-defined droop setup procedure is identical to the *User Configured* setup procedure in all aspects other than the *Droop CT AC System* and *Offset Angle* settings. When the alternator wiring topology is known, it may be selected from the *Droop CT AC System* drop-down menu. Pre-defined *Droop CT AC System* parameters automatically fix the *Offset Angle* to the correct value.



DSE Configuration Suite PC Software shows the location that the droop CT MUST be fitted.

4.3.4 EXTERNAL BIAS SETTING

NOTE: Proceed with *External Bias Setting* only after the AVR has been correctly stabilised by following the *Stability Settings* section first.

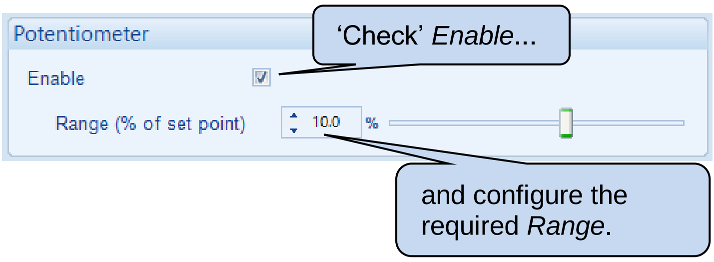
4.3.4.1 EXTERNAL POTENTIOMETER

NOTE: The external potentiometer is designed for manual adjustment of the output voltage. Where automatic voltage matching or kvar sharing is required, use the DC Voltage Input instead.

NOTE: Where both (External Potentiometer and DC Voltage Input) are used simultaneously, both inputs are summed to determine the output voltage.

Connect a 5 kΩ linear potentiometer (pot) to the AVR input terminals such that a clockwise rotation increases its resistance. The pot must be 'volt free' i.e. electrically isolated from all other potentials.

Check the 'Enable' check box and enter the desired control range of the pot. For example, a setting of 10% allows adjustment of a set point of 230 V over the range 207 V to 253 V. (230 V +/-10%)



An open circuit (disconnected or damaged) potentiometer is automatically detected by the AVR and the output returns to the set point.

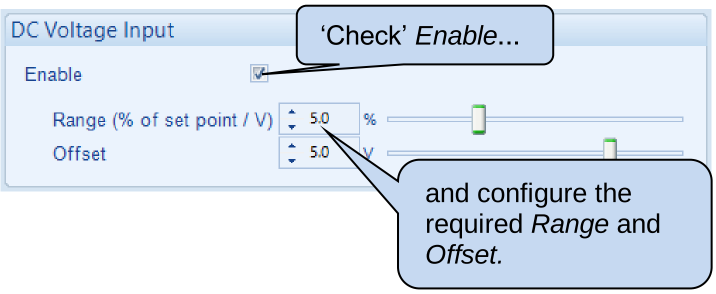
4.3.4.2 DC VOLTAGE INPUT

NOTE: The DC Voltage Input is designed for automatic voltage matching or kvar sharing. For manual adjustment, use the External Potentiometer input instead.

NOTE: Where both (External Potentiometer and DC Voltage Input) are used simultaneously, both inputs are summed to determine the output voltage.

Connect an external DC voltage to the input terminals. The source must be electrically isolated from all other potentials.

Check the 'Enable' check box and enter the desired control range of the pot.
For example with settings of *Offset* at 5 V and Range (% of set point / V) of 2% / V, this means at 5 V the generator runs at nominal (230 V) and is adjustable by +10% (+5V from *Offset*) and -30% (-15 V from *Offset).* This results in an adjustable range from 161 V to 253 V (230 V -30% to +10%).



An open circuit input is treated as a 0 V input and so reduces the output voltage to the appropriate percentage of the set point. Using the above example, an open circuit input would reduce the output voltage to 207 V.

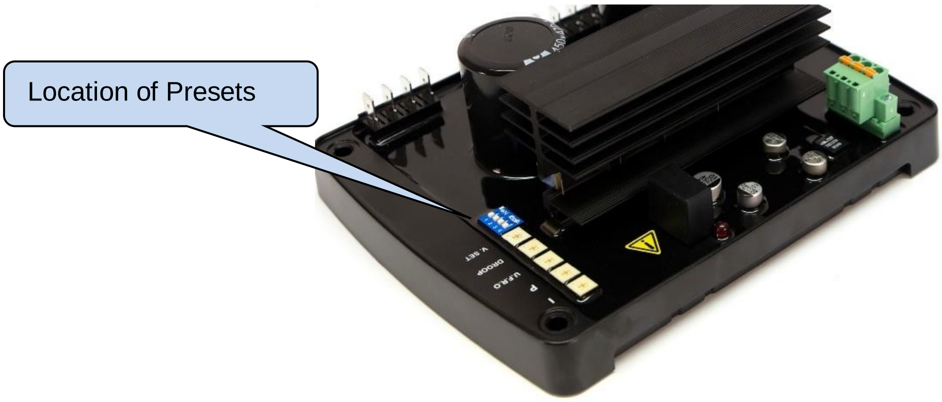
4.4 FINALISING SETUP

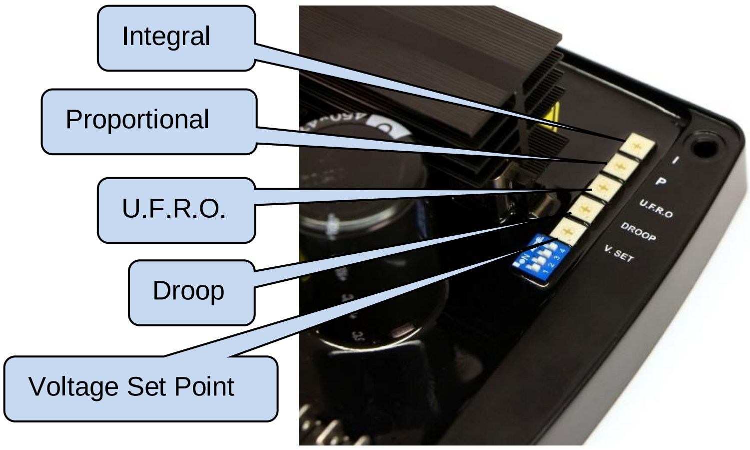
NOTE: For further details of module configuration, refer to DSE Publication: *057-271 DSEA109 Configuration Suite PC Software Manual.*

4.4.1 PRESETS

WARNING!: Use only a suitable insulated potentiometer (preset) adjustment tool.

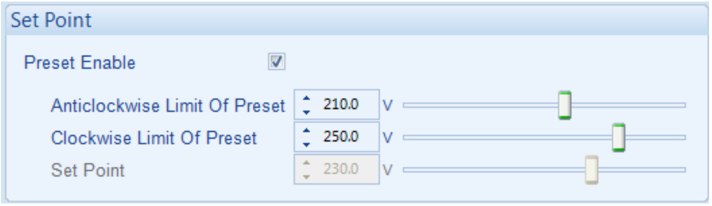
Presets are the adjusters fitted on the AVR and may be disabled if end user adjustment is not required.
When enabled, the range of the presets is configurable using the DSE Configuration Suite PC Software to enable the generator assembler to limit user adjustment within a range suitable for the completed generator.





4.4.1.1 VOLTAGE PRESET

If the voltage preset is required to be active, check the *Preset Enable* parameter in the configuration and set the *Anticlockwise Limit of Preset* and *Clockwise Limit of Preset* to give the desired control span.
Write the configuration to the AVR.

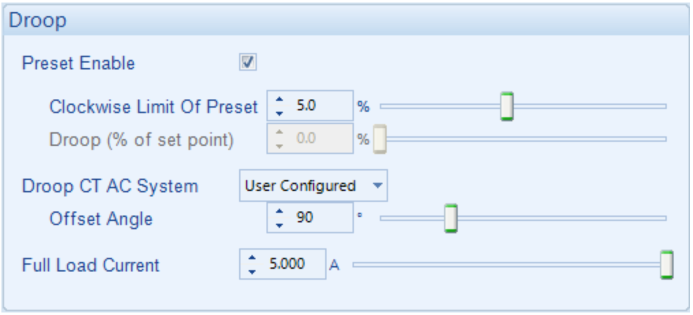


With the generator set stopped, observe the setting on the SCADA *Diagnostic* display and turn the preset to the desired voltage set point.

4.4.1.2 DROOP PRESET

NOTE: The droop function is described in the section entitled *Operation* elsewhere in this document.

If the droop preset is required to be active, check the *Preset Enable* parameter in the configuration and set the *Clockwise Limit of Preset* to give the desired control span for the preset.
Write the configuration to the AVR.
With the generator set stopped, observe the setting on the SCADA *Diagnostic* display and turn the preset to the desired droop set point.

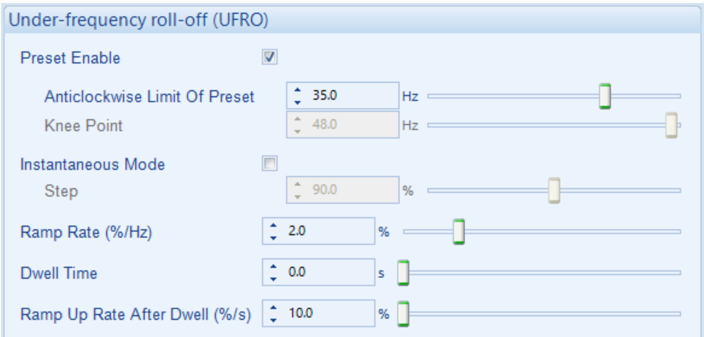


4.4.1.3 UNDER FREQUENCY ROLL OFF (UFRO) PRESET

NOTE: The UFRO function is described in the section entitled *Operation* elsewhere in this document.

NOTE: To disable the UFRO function, disable the Preset and adjust *Knee Point* to minimum value.

If the UFRO preset is required to be active, check the *Preset Enable* parameter in the configuration and set the *Anticlockwise Limit Of Preset* to give the desired control span for the preset.
Write the configuration to the AVR.
With the generator set stopped, observe the setting on the SCADA *Diagnostic* display and turn the preset to the desired UFRO set point.



Consult the alternator manufacturer's documentation in order to determine suitable settings for the UFRO function.

4.4.2 ALTERNATE STABILITIES

NOTE: Ensure the setup procedure had been carried out according to the *Stability Configuration* selected.

The AVR is provided with two *Alternator Stability* configurations (DIP Switch 1).

Function	DIP Switch 1
Stability Configuration 1	OFF
Stability Configuration 2	ON

4.4.3 ALTERNATE CONFIGURATIONS

DIP switches are used to select between different configurations within the device. Each configuration is adjusted using DSE Configuration Suite PC Software to suit the application's nominal Voltage and Frequency.

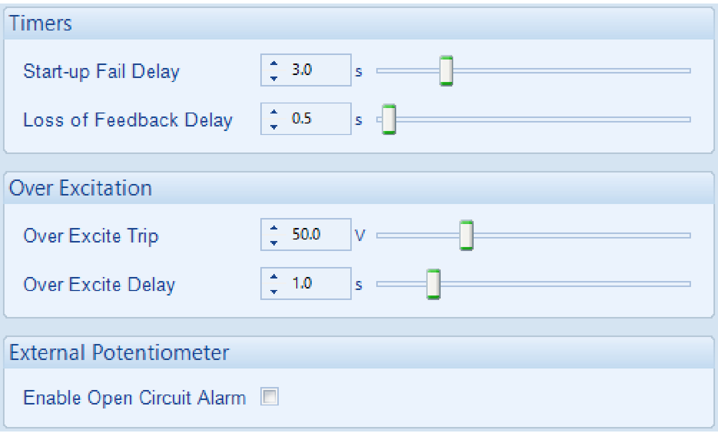
DIP Switches 2, 3 & 4 selects one of six Configurations.

With the generator set stopped, observe the settings on the SCADA *Diagnostic* display and set the dip switches to the desired positions.

Function	DIP Switch 2	DIP Switch 3	DIP Switch 4
Main Configuration	OFF	OFF	OFF
Alternative Configuration 1	OFF	OFF	ON
Alternative Configuration 2	OFF	ON	OFF
Alternative Configuration 3	OFF	ON	ON
Alternative Configuration 4	ON	OFF	OFF
Alternative Configuration 5	ON	OFF	ON

4.4.4 PROTECTIONS

Verify the setting on the *Protections* menu.
Change *Start-up Fail Delay* to the desired time (this was changed earlier in the setup procedure to ease the setup process), the factory default 3.0 seconds is suitable for most generator sets.



Use the SCADA section of the Configuration Suite PC Software to check the *Excitation Voltage* during normal operation, at a high load level. Set the *Over Excite Trip* slightly above this level.

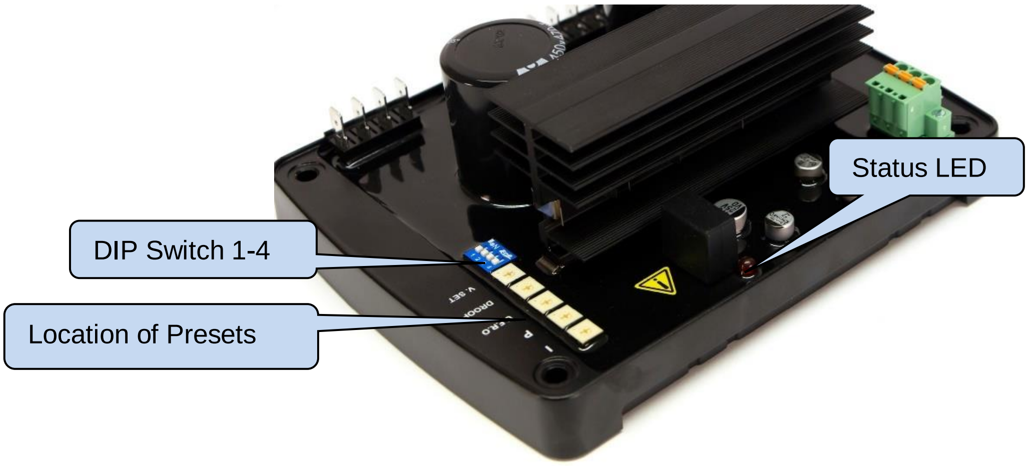
4.5 FINAL CHECK

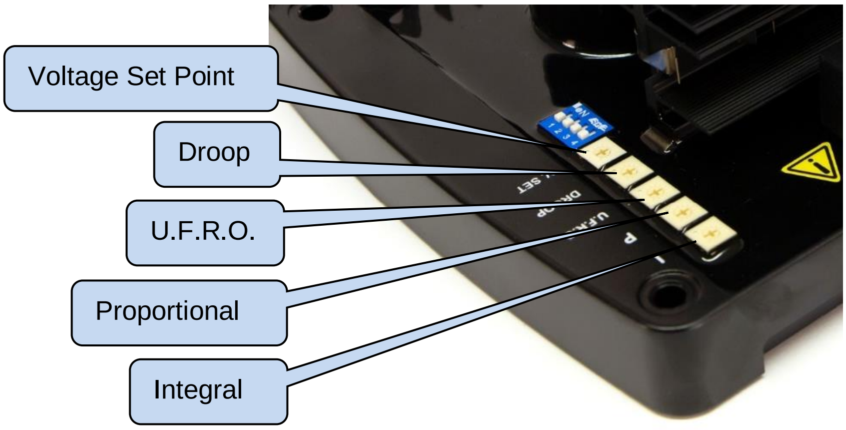
Start the generator set and check that it reaches the set voltage and is stable.
Test with various step loads within the limits of the generator and check that the voltage is stable with good transient response.
Increase to full load and check that the alternator output remains at the *Set Point* and is stable.
Check the droop, UFRO and external bias inputs as appropriate.
Remove the load and stop the set.

5 OPERATION

NOTE: For further details of module configuration, refer to DSE Publication: *057-271 DSEA109 Configuration Suite PC Software Manual.*

5.1 CONTROLS AND INDICATIONS





5.1.1 PRESETS

It is possible to disable the operation of the preset using DSE Configuration Suite PC Software in conjunction with DSE815 Interface. In this instance, the value of the disabled preset is fixed by the PC Software.

5.1.1.1 VOLTAGE SET POINT

The Setting for the alternators output voltage. Turning the preset clockwise raises the output voltage.

5.1.1.2 DROOP

> **⚠ NOTE: Use of the Droop functions requires a droop CT to be fitted. See the section entitled *Setup Procedure* elsewhere in this document.**

Setting for the Quadrature Droop function. Turning the preset clockwise increases the amount of Quadrature Droop.

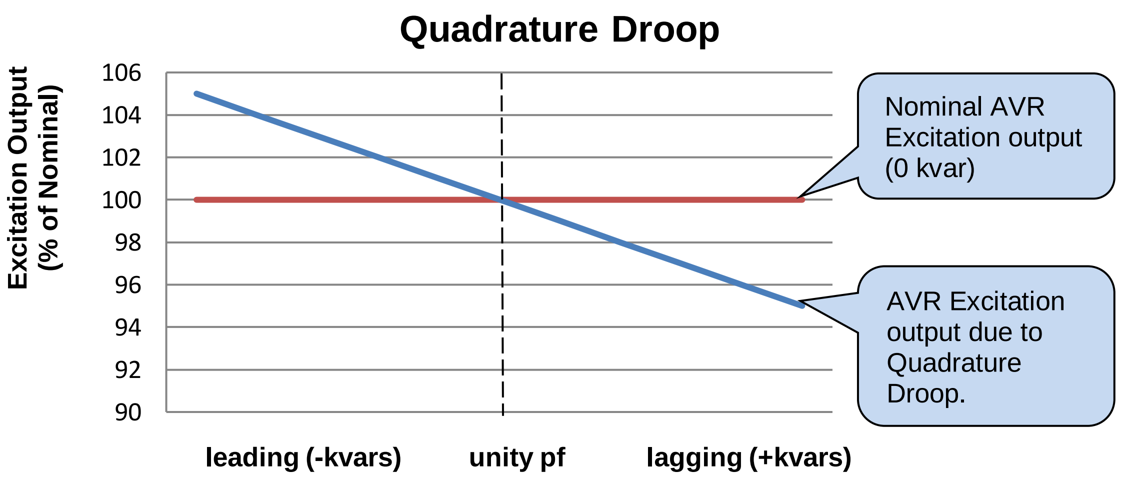
Quadrature Droop monitors the reactive power provided by the generator to the load and is to provide kvar sharing (reactive load sharing) between generator or to limit kvar output when paralleling a generator with the mains supply.

Reactive Power is the power used to supply the capacitive and inductive elements of the load.
Power supplied to a load that is more capacitive than inductive has a leading power factor.
Power supplied to a load that is more inductive than capacitive has a lagging power factor.

Lagging Power Factor	Leading Power Factor
Lagging pf	Leading pf
+kvar	-kvar
Inductive	Capacitive

As the AVR monitors the reactive power from the generator, its measurements are used to control the excitation output:

- Lagging reactive power (+kvars) causes a decrease in AVR excitation output to provide more “leading” power to the load.
- Leading reactive power (-kvars) causes an increase in AVR excitation output to provide more “lagging” power to the load.



Multiple Generators

In a multiple generator system, the droop on the AVR is working to minimise the alternators kvar production. If the droop on each AVR is set identically, it balances the kvars between all the alternators as they each try to produce the minimum reactive power.

This enables a basic form of reactive power (kvar) sharing between connected generators, providing each AVR is configured to provide the same amount of droop.
However, this has the effect on the alternator output voltage as it varies depending upon the changing nature of the reactive load.
Where a continuous voltage is required, the use of a generator load share controller with active kvar sharing and voltage compensation is recommended. Such controllers include the DSE8xxx series of load share controllers. Contact DSE Technical Support for more information.

To set the droop function for paralleling multiple generators:

> **NOTE: If it is required that the generator output voltage droops to the nominal voltage, ensure that *Voltage Setpoint* is set higher than the nominal by the appropriate amount.**

1. With the generator running off load, adjust the *Voltage Setpoint* so that the generator is providing the desired voltage.
2. Put the generator to the ‘typical’ reactive load level that the set is to be connected to.
3. Increase the *Droop* setting until the generator output voltage drops by the required amount (typically 3% to 5%).
4. Ensure all generators in the system are set with exactly the same nominal voltage and droop setting.

For example:

The generator *off load* is producing 230 V.
Place the generator *on load* at typical load levels and adjust the *Droop* until the output voltage is 218 V. (this is 5% below nominal voltage).
When reactive power is zero (pf 1.0 or unity), the generator output voltage is 230 V.
When reactive power is negative (capacitive or leading pf) the output voltage is raised to increase inductive current from the generator.
When reactive power is positive (inductive of lagging pf) the output voltage is lowered to decrease inductive current from the generator.

Mains Parallel

When paralleling with mains supply, the use of a generator load share controller with active kvar sharing and voltage compensation is recommended. Such controllers include the DSE8xxx series of load share controllers. Contact DSE Technical Support for more information.

Where such a mains controller does not exist, the droop setting is used to provide stabilisation to the output of kvar when in parallel with the mains.

To set the droop function when paralleling with mains and no other form of kvar control exists:

1. With the generator running off load, adjust the *Voltage Setpoint* so that the generator is providing the desired voltage.
2. Adjust the *Droop* setting as required (typically 2.5%).
3. When in parallel with the mains, adjust the *Voltage Setpoint* while monitoring the kvar output from the alternator to set the amount of kvar desired from the alternator. Increase the *Voltage Setpoint* to increase the kvar.

5.1.1.3 UNDER FREQUENCY ROLL OFF (UFRO)

NOTE: For further details of module configuration, refer to DSE Publication: *057-271 DSEA109 Configuration Suite PC Software Manual.*

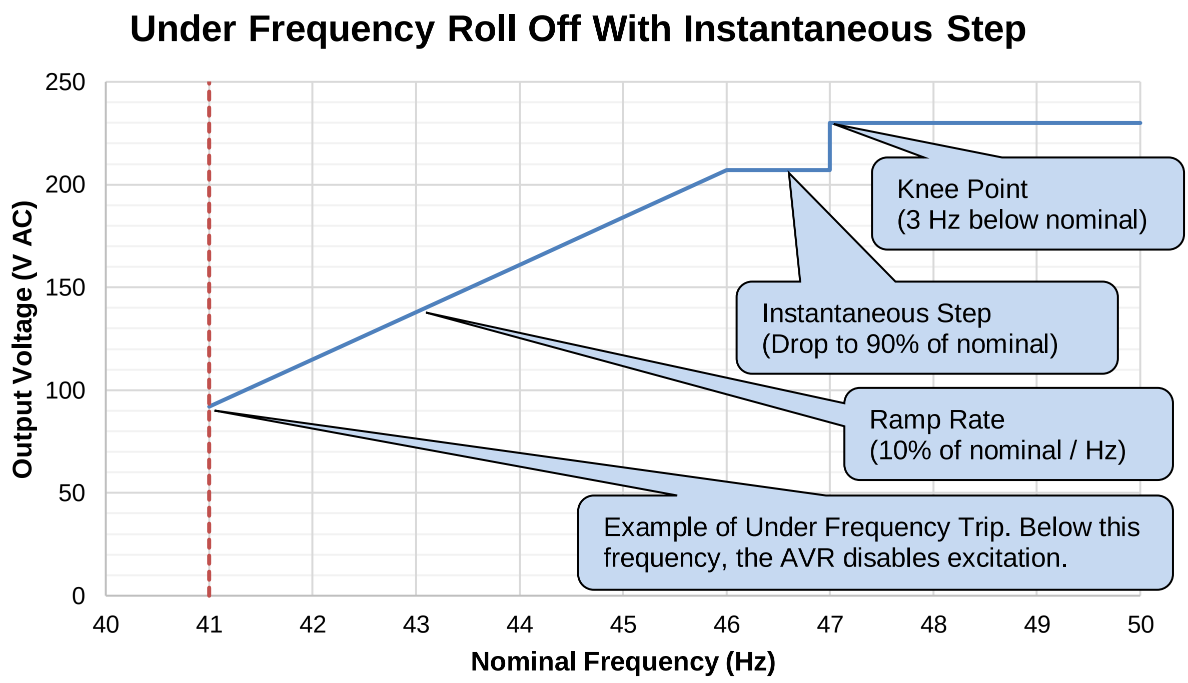
To help protect the alternator, output excitation is limited when generator output frequency is low, this is known as Under Frequency Roll Off. This reduces the alternator output voltage which in turn, reduces the load on the generator. This can help to improve the generator's reaction to step load changes.

Turning the potentiometer clockwise increases the *Knee Point* frequency. Below this frequency, the generator output voltage is reduced. An *Instantaneous Step* can be enabled to reduce the voltage to a percentage of the nominal frequency as soon as the frequency falls below the *Knee Point* setting. After which the rate of reduction is configurable using DSE Configuration Suite PC Software between 0 % / Hz and 10% / Hz.

A typical setting to start the *Under Frequency Roll Off* function is 3 Hz below nominal frequency.

As the frequency falls, the lower level is protected by the *Under Frequency* trip. Should the frequency fall below the trip level, the AVR excitation is disabled.

Example.
The following chart demonstrates Under Frequency Roll Off on a 50 Hz nominal system. The *Knee Point* is set to 47 Hz, *Instantaneous Drop* is set to 90% and *Ramp Rate* is set to 10% / Hz.



5.1.1.4 PROPORTIONAL

NOTE: For more detailed information on the set up procedure for *Proportional*, see the section entitled *Setup Procedure* elsewhere in this document.

Adjusts the *Proportional* gain of the AVR output control. Turning the preset clockwise raises the Proportional gain.

Should the generator output be different from the AVR *Voltage Set Point*, a jump in Excitation Output is made to correct the error. The amplitude of this jump is governed by the Proportional Gain.
Too high a proportional gain setting results in an unstable output voltage, typically characterised by a fast changing, fast oscillating alternator output.
Too low a proportional gain setting may result in the *Voltage Set Point* not being reached or being reached a long time after a system disturbance such as the generator starting, or a change in load levels.

5.1.1.5 INTEGRAL

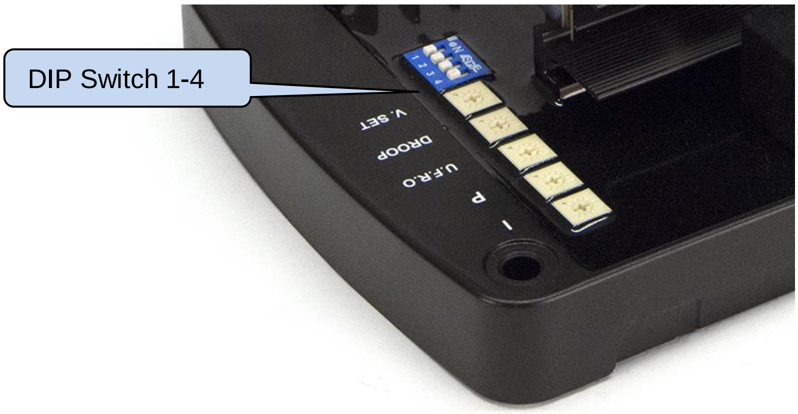
NOTE: For more detailed information on the set-up procedure for *Integral*, see the section entitled *Setup Procedure* elsewhere in this document.

Adjusts the *Integral* gain of the AVR output control. Turning the preset clockwise increases the Integral gain.

Should the generator output differ from the AVR *Voltage Set Point*, the difference is summed over time and the Excitation Output ramps to correct the accumulated error. The speed of this change is governed by the Integral Gain.
Too high an integral gain setting results in an unstable output voltage, typically characterised by a slow changing, slow oscillating alternator output.
Too low an integral setting may result in the *Voltage Set Point* not being reached or being reached a long time after a system disturbance such as the generator starting, or a change in load levels.

5.1.2 DIP SWITCHES

DIP switches are used to select between different configurations within the device. Each configuration is adjusted using DSE Configuration Suite PC Software.



5.1.2.1 DIP SWITCH 1

Function	DIP Switch 1
Stability Configuration 1	Off
Stability Configuration 2	On

5.1.2.2 DIP SWITCH 2 AND 3

Function	DIP Switch 2	DIP Switch 3	DIP Switch 4
Main Configuration	OFF	OFF	OFF
Alternative Configuration 1	OFF	OFF	ON
Alternative Configuration 2	OFF	ON	OFF
Alternative Configuration 3	OFF	ON	ON
Alternative Configuration 4	ON	OFF	OFF
Alternative Configuration 5	ON	OFF	ON

5.2.1 STATUS LED

An LED shows operating status of the A.V.R.

LED state	Cause	Possible Solution
Off	Running, or stationary but powered by U.S.B.	N/A
Rapid Continuous Flashing	Corrupt configuration	Write the configuration to the AVR again, if this reoccurs the AVR is faulty and should be returned.
Single Flash	Start-up Failed Trip (Voltage Feedback Failed to Reach 70% of *Set Point*)	Delayed by 10 seconds if the setup instructions were correctly followed. Increase *Maximum Duty Cycle* on the appropriate stability menu by 50%. This may require repeating depending on the duty cycle the alternator needs.
Two Flashes	Over Excite Trip	Increase the *Over Excite Trip* on the Protections menu by 50%. This may require repeating depending on the excitation voltage the alternator needs.
Three Flashes	Loss of Sensing	Check the feedback wiring as this indicates a loose connection.
Four Flashes	Under Frequency Trip	Indicates the engine is not up to speed, check the governor.
Five Flashes	Potentiometer Fault	Indicates that the potentiometer connected to terminals P1 and P2 has become open circuit.
Steady	UFRO Active	Indicates the engine is not up to speed, check the governor.

5.3 EXTERNAL AC VOLTAGE BIAS

⚠NOTE: Voltage adjust range is configured using DSE Configuration Suite PC Software. For further details, refer to DSE Publication: *057-271 DSEA109 Configuration Suite PC Software Manual.*

Two external bias inputs are provided to allow remote adjustment of the alternator output.

Input type	Description
DC Voltage Level (A+, A-)	-10 V DC to 10 V DC to provide voltage adjustment from the *Voltage Set Point.* The range and centre voltage are configurable using the DSE Configuration Suite PC Software. Typically, this input is provided by external Synchroniser / Load Share devices.
Potentiometer input (P1,P2)	0 Ω to 5 kΩ (centre 2.5 kΩ) to provide voltage adjustment from the *Voltage Set Point.* Typically, this input is provided by a hand or automatically operated potentiometer.

6 ALARMS

Activation of the following alarms disable the AVR excitation and flash the Status LED accordingly. For further information, see the section entitled *Status LED* elsewhere in this document.

6.1 START-UP TRIP

During start-up, the main generator output is monitored. If it fails to reach 70% of the *Voltage Set Point*, the *Startup Trip* alarm occurs.

6.2 LOSS OF FEEDBACK

NOTE: Loss of Feedback Delay is configured using DSE Configuration Suite PC Software. For further details, refer to DSE Publication: *057-271 DSEA109 Configuration Suite PC Software Manual.*

During normal running operation the main generator output is monitored. If this drops below 5% of the *Voltage Set Point* for the duration of the *Loss of Feedback Delay* time, the *Loss of Feedback* alarm occurs.

6.3 OVER EXCITATION

NOTE: Over Excitation trip level is configured using DSE Configuration Suite PC Software. For further details, refer to DSE Publication: *057-271 DSEA109 Configuration Suite PC Software Manual.*

The excitation of the alternator is monitored and an alarm triggered when the excitation level exceeds the adjustable trip point. This inhibits further excitation of the alternator.

6.4 UNDER FREQUENCY

NOTE: Under Frequency trip level is configured using DSE Configuration Suite PC Software. For further details, refer to DSE Publication: *057-271 DSEA109 Configuration Suite PC Software Manual.*

Indicates that the alternator output has fallen below the setting of the *Under Frequency* alarm. This inhibits further excitation of the alternator.

6.5 POTENTIOMETER FAULT

NOTE: External Potentiometer Open Circuit Fault is configured using DSE Configuration Suite PC Software. For further details, refer to DSE Publication: *057-271 DSEA109 Configuration Suite PC Software Manual.*

Indicates that the potentiometer connected to terminals P1 and P2 has become open circuit.

7 FAULT DIAGNOSIS

Nature of Problem	Suggestion
The Status LED is flashing.	See section entitled *Status LED* elsewhere in this document.
The Status LED is not lit.	The generator may be stopped and the communication lead (DSE815 interface is not connected). See section entitled *Status LED* elsewhere in this document.
The Status LED is lit, but the generator is stopped.	The AVR is powered by the DSE815 interface. This allows configuration of the AVR when the generator is not running.
Loss of Feedback alarm.	Check Voltage sensing connections on L1 and N(L2) terminals.
Startup Trip alarm.	Check Voltage sensing connections on L1 and N(L2) terminals.
Unstable voltage levels.	Check *Integral* and *Proportional* settings.
Voltage drops when load is applied.	This may be normal depending upon the settings of the *Droop* function and/or *Under Frequency Roll Off* function.
Voltage fails when load is applied.	This may be normal depending upon the settings of the *Under Frequency* alarm.
Voltage fails to reach set point.	Follow the Setup Procedure elsewhere in this manual.
Instability occurs in the voltage output.	Follow the Setup Procedure elsewhere in this manual.

8 CAN INTERFACE SPECIFICATION

In addition to the Configuration port, the DSEA109 features a CAN communication port. The CAN port is used for live operational communications between the DSEA109 and compatible DSE genset controllers, encompassing both the transmission of AVR data and the receipt of external commands where applicable.

Parameter	Description
Protocol	S.A.E. J1939 with PGNs as listed in the following subsections.
Bit Rate	250 kb/s
Isolation	±2.5 kVrms
Termination	120 Ω termination resistor, with the option for direct PCB installation.

8.1 INSTRUMENTATION AND CONTROL

8.1.1 BROADCAST MESSAGES

NOTE: All broadcast CAN messages are priority 3 by default, however it is possible to change the priority of the configurable CAN messages utilising DSE Configuration Suite PC Software. For further details of module configuration, refer to DSE Publication: *057-283 DSEA109 Configuration Suite PC Software Manual.*

Parameter Groups below are broadcast by the DSEA109 AVR and are detailed in the following subsections.

NOTE: SPNs that are not implemented in the DSEA109 have all bits set to ‘1’.

NOTE: *PDU Format* and *PDU Specific* are shown in Hexadecimal.

NOTE: Values larger than 8 bits utilise *Little-Endian* format. For example a 16 bit value, occupying two Bytes has Byte1 as the most significant Byte and Byte2 as the least significant Byte.

8.1.1.1 VREP – VOLTAGE REGULATOR EXCITATION STATUS

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
3	0	0	FD	A6	8	100 ms

SPN						
Hex	Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0D34	3380	Generator Excitation Field Voltage	Byte 1 to 2	0.05 V/bit	-1606.0 V	V
0D36	3382	Generator Output Voltage Bias Percentage	Byte 5 to 6	0.1 %/bit	-100	%

8.1.1.2 VROM – VOLTAGE REGULATOR OPERATING MODE

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
3	0	0	FD	A7	8	1 s

SPN Hex	SPN Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0D31	3377	Voltage Regulator Under Frequency Compensation	Byte 1 Bits 7 to 8	***00:*** UFRO Not Active ***01:*** UFRO Active	0	N/A
0D32	3378	Voltage Regulator Soft Start State	Byte 2 Bits 1 to 2	***00:*** Normal Operating Conditions ***01:*** Soft Ramp Timer in Progress	0	N/A
0D33	3379	Voltage Regulator Enabled	Byte 2 Bits 3 to 4	***00:*** Voltage Regulator Fixed or Power Save Mode ***01:*** Voltage Regulator PID Control Active	0	N/A

8.1.1.3 GAAC – GENERATOR AVERAGE BASIC AC QUANTITIES

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
3	0	0	FE	06	8	100 ms

SPN Hex	SPN Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0988	2440	Generator Avg. L-L AC Voltage	Byte 1 to 2	1	0	V
0984	2436	Generator Avg. AC Frequency	Byte 5 to 6	1/128 Hz/bit	0	Hz

8.1.1.4 GPAAC - GENERATOR PHASE A BASIC AC QUANTITIES

PGN 65027

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
3	0	0	FE	03	8	100 ms

SPN Hex	SPN Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0985	2437	Generator Phase A AC Frequency	Byte 5 to 6	128	0	V
0989	2441	Generator Phase A Line Line AC RMS Voltage	Byte 1 to 2	1	0	V
098D	2445	Generator Phase A Line Neutral AC RMS Voltage	Byte 3 to 4	1	0	A
0991	2449	Generator Phase A AC RMS Current	Byte 7 to 8	1	0	Hz

8.1.1.5 GPBAC - GENERATOR PHASE B BASIC AC QUANTITIES

PGN 65024

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
3	0	0	FE	00	8	100 ms

SPN Hex	SPN Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0986	2438	Generator Phase B AC Frequency	Byte 5 to 6	0.0078125	0	Hz
098A	2442	Generator Phase B Line Line AC RMS Voltage	Byte 1 to 2	1	0	V
098E	2446	Generator Phase B Line Neutral AC RMS Voltage	Byte 3 to 4	1	0	V
0992	2450	Generator Phase B AC RMS Current	Byte 7 to 8	1	0	A

8.1.1.6 GPCAC - GENERATOR PHASE C BASIC AC QUANTITIES

PGN 65021

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
3	0	0	FD	FD	8	100 ms

SPN						
Hex	Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
0987	2439	Generator Phase C AC Frequency	Byte 5 to 6	0.0078125	0	Hz
098B	2443	Generator Phase C Line Line AC RMS Voltage	Byte 1 to 2	1	0	V
098F	2447	Generator Phase C Line Neutral AC RMS Voltage	Byte 3 to 4	1	0	V
0993	2451	Generator Phase C AC RMS Current	Byte 7 to 8	1	0	A

8.1.1.7 DM1 (DIAGNOSTIC MESSAGE 1)

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
3	0	0	FE	CA	8	100 ms

An alarm resulting in the shutdown of AVR excitation sets the DM1 Red Stop Lamp bits.
The only exception to this is the *Under Frequency* alarm as this condition occurs during a normal generator stop sequence.

AVR alarms are indicated by the following SPN / FMI combinations.

	SPN		FMI	
Alarm Condition	Hex	Decimal	Hex	Decimal
Over Excite Trip	0D34	3380	00	0
Loss of Sensing	0988	2440	02	2
Corrupt Configuration	7F000	520192	1F	31
Start-up Failed Trip	7F001	520193	1F	31
Potentiometer Fault Alarm	7F002	520194	02	2

8.1.1.8 PROPB 01 – AVR SETTINGS

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
3	0	0	FF	01	8	1 s

SPN						
Hex	Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
7F006	520198	Proportional Gain Setting	Byte 1 to 2	0.1 %/bit	0	%
7F007	520199	Integral Gain Setting	Byte 3 to 4	0.1 %/bit	0	%
7F008	520200	Derivative Gain Setting	Byte 5 to 6	0.1 %/bit	0	%
7F009	520201	Droop Setting	Byte 7 to 8	0.1 %/bit	0	%

8.1.1.9 PROPB 02 – AVR EXTERNAL BIAS

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
3	0	0	FF	02	8	1 s

SPN						
Hex	Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
7F002	520194	External Potentiometer Bias	Byte 1 to 2	0.1 %/bit	-100 %	%
7F003	520195	External Voltage Input Bias	Byte 3 to 4	0.1 %/bit	-100 %	%
7F004	520196	J1939 Requested Bias	Byte 5 to 6	0.1 %/bit	-100 %	%
7F005	520197	Voltage Set Point	Byte 7 to 8	0.1 %/bit	0	%

8.1.1.10 PROPB 03 – AVR STATUS AND VERSION

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
3	0	0	FF	03	8	1 s

SPN Hex	Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
7F00C	520204	Software Version Major	Byte 1	N/A	N/A	N/A
7F00D	520205	Software Version Minor	Byte 2	N/A	N/A	N/A
7F00E	520206	Software Version Build	Byte 3	N/A	N/A	N/A
7F00F	520207	Selected Alternative Configuration	Byte 4	N/A	N/A	N/A
7F010	520208	State Machine Status	Byte 5	*State Machine Status List*	N/A	N/A
7F012	520210	Stability Selection	Byte 6	N/A	N/A	N/A
7F013	520211	Actual UFRO Knee Point	Byte 7 to 8	0.1 Hz/bit	0	Hz

State Machine Status List

State	Description
1	Running
2	Under Frequency Roll Off Active
3	Over Excitation Trip
4	Loss of Sensing Trip
5	Failed to Excite Trip
6	Under Frequency Trip
7	Invalid Configuration
8	Excitation Overload Trip
9	External Potentiometer Open Circuit

8.1.1.11 PROPB 04 – AVR EXCITATION VALUES

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
3	0	0	FF	04	8	1 s

Hex	Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
7F00A	520202	Auxiliary Voltage	Byte 1 to 2	1 V/bit	0	V
7F00B	520203	Output Duty Cycle	Byte 3 to 4	0.1 %/bit	0	%
7F011	520209	Droop Current	Byte 5 to 6	1 mA/bit	0	mA
7F014	520212	CAN Bias Percentage Limit	Byte 7 to 8	0.1 %/bit	0	%

8.1.1.12 CONFIGURABLE CAN MESSAGE 1

PGN 65312

NOTE: The Values in Configurable CAN Message 1 are selected using DSE Configuration Suite PC Software. For further details of module configuration, refer to DSE Publication: *057-283 DSEA109 Configuration Suite PC Software Manual.*

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
3	0	0	FF	32	8	100 ms

Hex	Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
User Defined	User Defined	Configurable Value 1	Byte 1 to 4	User Defined	User Defined	User Defined
User Defined	User Defined	Configurable Value 2	Byte 5 to 8	User Defined	User Defined	User Defined

8.1.1.13 CONFIGURABLE CAN MESSAGE 2

PGN 65313

> ⚠ **NOTE: The Values in Configurable CAN Message 2 are selected using DSE Configuration Suite PC Software. For further details of module configuration, refer to DSE Publication: *057-283 DSEA109 Configuration Suite PC Software Manual.***

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
3	0	0	FF	33	8	100 ms

Hex	Decimal	Instrument	Byte / Bit	Scaling	Offset	Units
User Defined	User Defined	Configurable Value 1	Byte 1 to 4	User Defined	User Defined	User Defined
User Defined	User Defined	Configurable Value 2	Byte 5 to 8	User Defined	User Defined	User Defined

8.1.2 RECEIVED MESSAGES

The following messages are sent to the DSEA109 specific node address (PDU Specific).

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)	Rate
3	0	0	EF	DSEA109 address	8	50 ms

Configuration Item	Byte / Bit	Scaling	Offset	Units
Voltage Bias	Byte 1 to 2	0.1 %/bit	-100 %	%
Alternative Configuration	Byte 3	***0:*** Main Configuration ***1 to 5:*** Alternative Configuration 1 to 5	N/A	N/A
Stability Selection	Byte 4	***0:*** Stability Selection 1 ***1:*** Stability Selection 2 ***FF:*** Maintain Existing Stability Selection	N/A	N/A
Not Used	Byte 7 to 8	N/A	N/A	N/A

8.1.2.1 VOLTAGE BIAS

> ⚠ **NOTE: If no message is received by the AVR within 200 ms, Voltage Bias defaults to 0 %.**

This value allows the voltage setpoint to be biased.
When writing to this PGN and it is desired to continue with the existing bias value, set Voltage Bias to 0xFFFF (Decimal 65535).

8.1.3 ALTERNATIVE CONFIGURATION

Where enabled in the DSEA109 Configuration, this allows the default configuration to be selected. Selecting a disabled configuration or attempting to select a configuration when this feature is disabled results in the DSEA109 continuing to use the previously selected configuration.

8.1.4 STABILITY SELECTION

Where enabled in the DSEA109 Configuration, this allows the Stability Selection to be adjusted.
If this function is disabled, the DSEA109 continues to use the previously selected option.

8.2 PROPRIETARY COMMANDS

8.2.1 CONFIGURATION

NOTE: To differentiate between the instrumentation/control and configuration, all configuration commands in the following subsections use *Data Page 1*.

DSEA109 additionally supports configuration changes using the following CAN commands. DSEA109 also confirms receipt of the configuration commands.

8.2.2 MESSAGE FORMAT

Priority	Ext Data Page	Data Page	PDU Format	PDU Specific	Size (Bytes)
3	0	1	EF	DSEA109 address	8

8.2.3 DATA BYTE FORMAT

The data bytes within the Configuration Message contain the command or response information being sent.

NOTE: Unused Bytes must be set to 0xFF (255 decimal).

Data Byte1	Data Bytes 2 to 8
Command or Response Code	Command Specific Data. Content varies depending upon the command / response code in Data Byte 1.

8.2.3.1 WRITE COMMAND

NOTE: Configuration Changes actioned by writing a new value to a Data Address are held in *Volatile Memory* until the *Store Configuration* command is used to 'commit' the changes to *Non-Volatile Memory.* Should the AVR be powered down, any values not committed to *Non-Volatile Memory* revert to their previous values.

This command is used to write the requested data to the specified data address.

Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7	Byte8
0x01	Data Address (16 bit)		Value (32 bit)				Unused

<u>Write Response</u>

A Write Command is responded to with the Write Response to confirm the receipt of the command. *Error Code* is be used to indicate any problems writing the value (refer to section entitled *Error Codes* elsewhere in this document.).
If the Write Command is successful *Updated Value* is the same as *Value* in the Write Command.
If there was an error, *Updated Value* is the current value at the specified address.
For a list of the supported Addresses, see the section entitled *Data Addresses* elsewhere in this document.

Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7	Byte8
0x81	Data Address (16 bit)		Updated value (32 bit)				Error Code

8.2.3.2 READ COMMAND

This command is used to write the requested data to the specified data address.

Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7	Byte8
0x02	Data Address (16 bit)		Unused				

Read Response

A Read Command is responded to with the Read Response to confirm the receipt of the command and return the data requested.
The only valid Error Code for a Read Command is to indicate an Invalid Read Address.

Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7	Byte8
0x82	Data Address (16 bit)		Value (32 bit)				Error Code

8.2.3.3 STORE CONFIGURATION COMMAND

This command is used to instruct the DSEA109 to store the configuration in *Non*-Volatile *Memory*. This ensures all changed values are retained should the DSEA109 be powered down.

Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7	Byte8
0x03	Unused						

Store Configuration Response

A Store Configuration Command is responded to with the Store Configuration Response to confirm the receipt of the command.
The only valid Error Code for a Read Command is to indicate Configuration Write Failure.

Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7	Byte8
0x83	Error Code						

8.2.3.4 ALARM RESET COMMAND

This command is used to instruct the DSEA109 to reset any active alarm.

Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7	Byte8
0x04	Unused						

Alarm Reset Response

An Alarm Reset Command is responded to with the Alarm Reset Response to confirm the receipt of the command.

Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7	Byte8
0x84	Error Code						

8.2.4 ERROR CODES

Error code	Description
0	No Error
1	Invalid Address
2	Attempting to Write to a Value That is 'Read Only'.
3	Value Out of Range
4	Failed to Write

8.2.5 DATA ADDRESSES

R/W: Read/Write
R: Read Only

Address	Description	Range	Type	Scaling and units
0	Voltage Range Selection	0 / 1	R/W	***0:*** High (180 V to 600 V) ***1:*** Low (90 V to 300 V)
1	Voltage Set Point Preset Enable	0 / 1	R/W	
2	Voltage Set Point	1800 to 16000 (High range) 900 to 13000 (Low range)	R/W	0.1 V
3	Droop Preset Enable	0 / 1	R/W	***0:*** Disabled ***1:*** Enabled
4	Droop (% of Set Point)	0 to1100	R/W	0.1 %
5	Offset Angle (any change to this value also changes *Droop CT AC System* to *User Configured*)	0 to1360	R/W	degrees
6	Full Load Current	100 to 15000	R/W	0.001 A
7	External Bias Potentiometer Enable	0 / 1	R/W	***0:*** Disabled ***1:*** Enabled
8	External Potentiometer Range	10 to1100160	R/W	0.1 %
9	External Bias Voltage Enable	0 / 1	R/W	***0:*** Disabled ***1:*** Enabled
10	External Voltage Range	1 to 160	R/W	0.1%
11	External Voltage Offset	-100 to 100	R/W	0.1 V
12 to 29	Reserved			
30	Nominal Frequency	0 / 1	R/W	***0:*** 50 Hz ***1:*** 60 Hz
31	UFRO Preset Enable	0 / 1	R/W	***0:*** Disabled ***1:*** Enabled
32	UFRO Knee Point (Must be higher than *Under Frequency Trip*)	1 to 499 (50 Hz) 1 to 599 (60 Hz)	R/W	0.1 Hz
33	Instantaneous UFRO Mode Enable	0 / 1	R/W	***0:*** Disabled ***1:*** Enabled
34	Instantaneous UFRO Step	800 to 1000	R/W	0.1 %
35	Ramp Rate	0 to 100	R/W	0.1 %/Hz
36	Dwell Time	0 to 100	R/W	0.1 sec
37	Ramp Up Rate After Dwell	100 to 1000	R/W	0.1 %/s
38	Under Frequency Trip (Must be lower than UFRO Knee Point)	1 to 498 (50 Hz) 1 to 598 (60 Hz)	R/W	0.1 Hz
39 to 49	Reserved			
50	Proportional Preset Enable	0 / 1	R/W	***0:*** Disabled ***1:*** Enabled
51	Proportional Preset Range	10 to 100	R/W	0.1 %
52	Proportional Set Point	1 to 1000	R/W	0.1 %
53	Integral Preset Enable	0 / 1	R/W	***0:*** Disabled ***1:*** Enabled
54	Integral Preset Range	10 to 100	R/W	0.1 %
55	Integral Set Point	0 to 1000	R/W	0.1 %
56	Derivative Set Point	0 to 1000	R/W	0.1 %
57	Excitation Output Offset (Cannot be set higher than Excitation output limit – AVR will return out of range error code)	0 to 500	R/W	0.1 %
58	Excitation Output Limit (Cannot be set lower than Excitation output offset – AVR will return out of range error code)	10 to 1000	R/W	0.1 %

Continued Overleaf.

Data Addresses Continued.
R/W: Read/Write
R: Read Only

Index	Description	Range	Type	Scaling and units
59	Output limit overshoot	0 to 300	R/W	1 %
60	Output limit overshoot delay	0 to 100	R/W	0.1 s
61	Soft Start Ramp Start Point (%)	100 to 900	R/W	0.1 %
62	Soft Start Ramp Rate (% / Hz)	50 to 1000	R/W	0.1 %/Hz
63	Start-up Fail Delay	10 to 100	R/W	0.1 s
64	Loss of Feedback Delay	1 to 100	R/W	0.1 s
65	Over Excite Trip	100 to 1500	R/W	0.1 V
66	Over Excite Delay	1 to 50	R/W	0.1 s
67	External Potentiometer OC Alarm Enable	0 / 1	R/W	***0:*** Disabled ***1:*** Enabled
66-199	Reserved			
200	Generator Frequency		R	0.1 Hz
201	Generator Voltage		R	0.1 V
202	Droop Current		R	0.001 A
203	Excitation Voltage		R	0.1 V
204	Auxiliary Voltage		R	0.1 V
205	External Potentiometer		R	Ohms
206	External Voltage		R	0.01 V
207	Status Flags		R	See *Status Flag List*
208	DIP Switch Positions		R	See *DIP Switch Position List*
209	Software Version		R	***Byte3:*** 0 ***Byte2:*** Major Version ***Byte1:*** Minor Version ***Byte0:*** Build Nuber
210	Bootloader Version		R	***Byte3:*** 0 ***Byte2:*** Major Version ***Byte1:*** Minor Version ***Byte0:*** Build
211	Generator L1 to L2 Voltage		R	0.1 V
212	Generator L2 to L3 Voltage		R	0.1 V
213	Generator L3 to L1 Voltage		R	0.1 V
214-299	Unimplemented			
300	Number of stability selections		R	
301	Number of alternative selections		R	
302	Maximum Excitation Output Offset		R	0.1 %
303	Soft Start Ramp Start Point Minimum		R	0.1 %
304	Soft Start Ramp Start Point Maximum		R	0.1 %
305	Soft Start Ramp Rate Point Minimum		R	0.1 %/Hz
306	Soft Start Ramp Rate Point Maximum		R	0.1 %/Hz
307	Droop Maximum		R	0.1 %

8.2.5.1 STATUS FLAG LIST

Status Flags (Address 207) are described as follows:

Bits	Description
0 & 1	Configuration File Lost
2 & 3	Start-up Fail Trip
4 & 5	Over Excite Trip
6 & 7	Loss of Feedback Trip
8 & 9	Under Frequency Trip
10 & 11	Potentiometer Fault
12 & 13	UFRO Active
14 & 15	Integral Limit Active
16 & 17	Current Limit Reached
18 to 31	Not Used (all bits set to 1)

Where the status is shown by the following bit patterns:

Value (binary)	Meaning
00	Off
01	On
10	Error (Not Used)
11	Unimplemented

8.2.5.2 DIP SWITCH POSITION LIST

DIP Switch Positions (Address 208) are described as follows:

Bit	Description
0 & 1	Switch 1 (Stability selection)
2 & 3	Switch 2 (Alternative Configuration Selection)
4 & 5	Switch 3 (Alternative Configuration Selection)
6 & 7	Switch 4 (Alternative Configuration Selection)
8 & 31	Not Used (all bits set to 1)

Where the status is shown by the following bit patterns:

Value (binary)	Meaning
00	Off
01	On
10	Error (Not Used)
11	Unimplemented

9 MAINTENANCE, SPARES, REPAIR AND SERVICING

The module is designed to be *Fit and Forget*. As such, there are no user serviceable parts. In the case of malfunction, you should contact your original equipment supplier (OEM).

Connection	Description	Part No.
USB	Requires DSE815 interface and connection lead.	0815-01

9.1 WARRANTY

DSE provides limited warranty to the equipment purchaser at the point of sale. For full details of any applicable warranty, you are referred to your original equipment supplier (OEM).

9.2 DISPOSAL

If you use electrical and electronic equipment you must store, collect, treat, recycle and dispose of WEEE separately from your other waste.

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