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DSE4400 Series Control Module Mk2

Document Number 057-111

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DSE Model 4400 series Control and Instrumentation System Mk2 Operators Manual

Amendments since last publication

Amd. No.	Comments
Issue 1	First release
Issue 2	Added display phase to phase and AC generator system
Issue 3	Changes to Mk2 controller. 3 phase generator sensing, change 2 digital inputs to analogue.
Issue 4	Added fast loading and changes to the flexible sensor alarms.

Clarification of notation used within this publication.

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.

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1.1 INSTALLATION INSTRUCTIONS

DSE PART	DESCRIPTION
053-056	4410 installation instructions sheet for Mark 1 controller
053-057	4420 installation instructions sheet for Mark 1 controller
053-078	4410 installation instructions sheet for Mark 2 controller
053-079	4420 installation instructions sheet for Mark 2 controller

1.2 MANUALS

DSE PART	DESCRIPTION
057-004	Electronic Engines and DSE wiring
057-092	DSE4410 / DSE4420 Mk1 operator manual
057-111	DSE4410 / DSE4420 Mk2 operator manual

2 INTRODUCTION

This document details the installation and operation requirements of the DSE4400 Series Mk2 modules, part of the DSEUltra® range of products. Mk1 modules are NOT covered in this manual.
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.deepseaplc.com

The **DSE 4400 series** module has been designed to allow the operator to start and stop the engine/generator, and if required, transfer the load.
The user also has the facility to view the system operating parameters via the LCD display.

The **DSE 4400** module monitors the engine, indicating the operational status and fault conditions, automatically shutting down the engine and giving a true first up fault condition of an engine failure. The LCD display indicates the fault.

The powerful microprocessor contained within the module allows for incorporation of a range of enhanced features:

- *icon based LCD display*
- ***True RMS** Voltage monitoring with 3 phase generator sensing (Mk2 models only)*
- *Engine parameter monitoring.*
- *Fully configurable inputs for use as alarms or a range of different functions.*
- *Engine ECU interface to **electronic engines** (specify on ordering)*
- *Magnetic pickup interface for engine only applications (specify on ordering)*

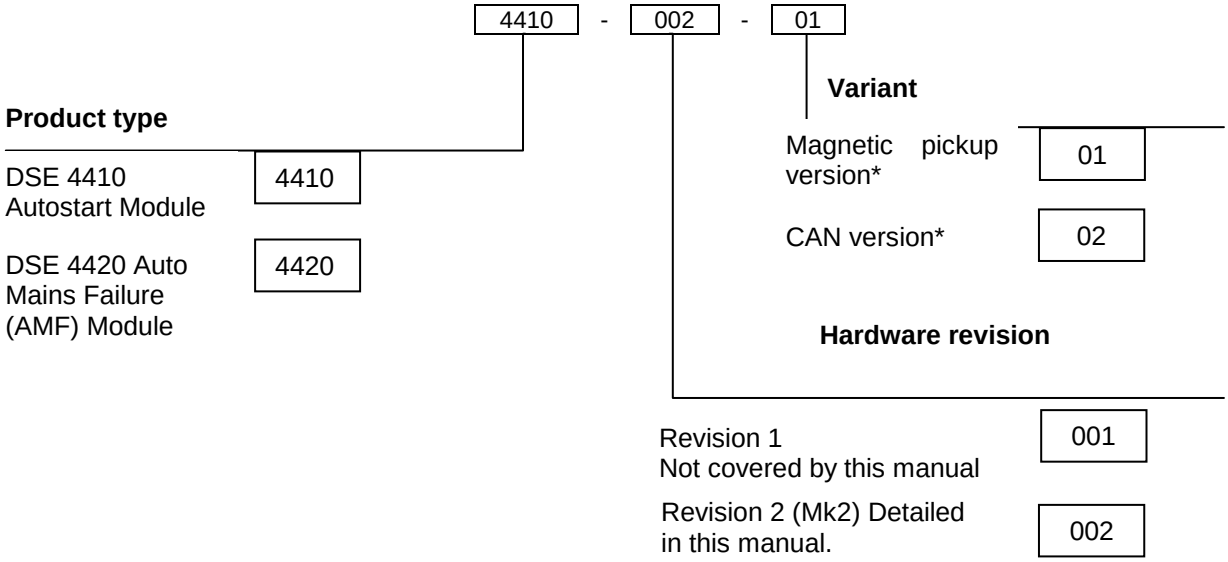
Using a PC and the 4400 series configuration software allows alteration of selected operational sequences, timers and alarm trips.

Additionally, the module's integral fascia configuration editor allows full adjustment of all this information.

A robust plastic case designed for front panel mounting houses the module. Connections are via locking plug and sockets.

3 SPECIFICATIONS

3.1 PART NUMBERING



NOTE*:-

Variant 01 has optional Magnetic Pickup input in the case of an engine only application. When the engine is fitted with a main AC alternator, the engine speed can be derived from the main AC alternator output.

Variant 02 is only suitable for CAN enabled engines (with CAN engine control unit (ECU))

3.1.1 SHORT NAMES

Short name	Description
44xx	DSE 4400 series control module
44x0-xxx-01	4410 or 4420 MPU version module
44x0-xxx-02	4410 or 4420 CAN version module

3.1 POWER SUPPLY REQUIREMENTS

Minimum supply voltage	8V continuous
Cranking dropouts	Able to survive 0V for 50mS providing the supply was at least 10V before the dropout and recovers to 5V afterwards.
Maximum supply voltage	35V continuous (60V protection)
Reverse polarity protection	-35V continuous
Maximum operating current (all inputs and sensor active)	146mA at 12V, 79mA at 24V
Nominal standby current (no inputs active)	72mA at 12V, 42mA at 24V
Power Save Mode Active	43mA at 12V, 28mA at 24V

Plant supply instrumentation display

Range	0V-60V DC (note Maximum continuous operating voltage of 35V DC)
Resolution	0.1V
Accuracy	1% full scale

3.2 TERMINAL SPECIFICATION

Connection type	Screw terminal, rising clamp, no internal spring
Min cable size	0.5mm² (AWG 24)
Max cable size	2.5mm² (AWG 10)

3.3 GENERATOR VOLTAGE / FREQUENCY SENSING

Measurement type	True RMS conversion
Sample Rate	5KHz or better
Harmonics	Up to 11th or better
Input Impedance	300K Ω ph-N
Phase to Neutral	15V to 333V AC (max)
Phase to Phase	25V to 576V AC (max)
Common mode offset from Earth	100V AC (max)
Resolution	1V AC phase to neutral 2V AC phase to phase
Accuracy	±1% of full scale phase to neutral ±2% of full scale phase to phase
Minimum frequency	3.5Hz
Maximum frequency	75.0Hz
Frequency resolution	0.1Hz
Frequency accuracy	±0.2Hz

3.4 INPUTS

3.4.1 DIGITAL INPUTS

Number	4
Arrangement	Contact between terminal and ground
Low level threshold	40% of DC supply voltage
High level threshold	60% of DC supply voltage
Maximum input voltage	DC supply voltage positive terminal
Minimum input voltage	DC supply voltage negative terminal
Contact wetting current	2.5mA @12V typical 5mA @ 24V typical
Open circuit voltage	Plant supply

3.4.2 ANALOGUE INPUTS

Oil Pressure

Measurement type	Resistance measurement by measuring voltage across sensor with a fixed current applied
Arrangement	Differential resistance measurement input
Measurement current	15mA
Full scale	240Ω
Over range / fail	350Ω
Resolution	1-2 PSI (0.1 Bar)
Accuracy	±2% of full scale resistance (±4.8Ω) excluding transducer error
Max common mode voltage	±2V
Display range	0-200 PSI (13.7 bar) subject to limits of the sensor

Coolant Temperature

Measurement type	Resistance measurement by measuring voltage across sensor with a fixed current applied
Arrangement	Differential resistance measurement input
Measurement current	10mA
Full scale	480Ω
Over range / fail	2kΩ (2000Ω)
Resolution	1°C, 2℉
Accuracy	±2% of full scale resistance (±9.6Ω) excluding transducer error
Max common mode voltage	±2V
Display range	0°C -140°C (32℉ - 284℉) Depending on sensor

Flexible Sensor

Measurement type	Resistance measurement by measuring voltage across sensor with a fixed current applied
Arrangement	Differential resistance measurement input
Measurement current	10mA
Full scale	480Ω
Over range / fail	540Ω
Resolution	1%
Accuracy	±2% of full scale resistance (±9.6Ω) excluding transducer error
Max common mode voltage	±2V
Display range	0-250%

3.4.3 CHARGE FAIL INPUT

Minimum voltage	0V
Maximum voltage	35V (plant supply)
Resolution	0.2V
Accuracy	± 1% of max measured voltage
Excitation	Active circuit constant power output
Output Power	2.5W nominal at 12V and 24V
Current at 12V	210mA
Current at 24V	105mA

3.4.4 MAGNETIC PICKUP

Not applicable to 44x0-xxx-02 CAN version module.

Type	Single ended input, capacitive coupled
Minimum voltage	0.5V RMS
Max common mode voltage	±2V
Maximum voltage	Clamped to ±70V by transient suppressers, dissipation not to exceed 1W.
Maximum frequency	10,000Hz
Resolution	6.25 RPM
Accuracy	±25 RPM
Flywheel teeth	10 to 500

3.5 OUTPUTS

3.5.1 OUTPUTS A & B (FUEL AND START)

Type	Fuel (A) and Start (B) outputs. Supplied from DC supply terminal 2. Fully configurable when CAN engine is selected.
Rating	2A @ 35V
Protection	Protected against over current & over temperature. Built in load dump feature.

3.5.2 CONFIGURABLE OUTPUTS C, D, E & F

Type	Fully configurable, supplied from DC supply terminal 2.
Rating	2A @ 35V
Protection	Protected against over current & over temperature. Built in load dump feature.

3.6 COMMUNICATION PORTS

USB Port	USB2.0 Device for connection to PC running DSE configuration suite only
CAN Port (not applicable to 4410-xxx-01 MPU version)	Engine CAN Port Standard implementation of 'Slow mode', up to 250 kbits/s Non Isolated. Internal Termination provided (120Ω)

3.7 ACCUMULATED INSTRUMENTATION

NOTE : When an accumulated instrumentation value exceeds the maximum number as listed below, it will reset and begin counting from zero again.

Engine hours run	Maximum 99999 hrs 59 minutes (approximately 11yrs 4months)
Number of starts	1,000,000 (1 million)

3.8 DIMENSIONS AND MOUNTING

3.8.1 DIMENSIONS

180mm x 116mm x 42mm
(7.1” x 4.6” x 1.7”)

3.8.2 PANEL CUTOUT

154mm x 98mm
(6” x 3.9”)

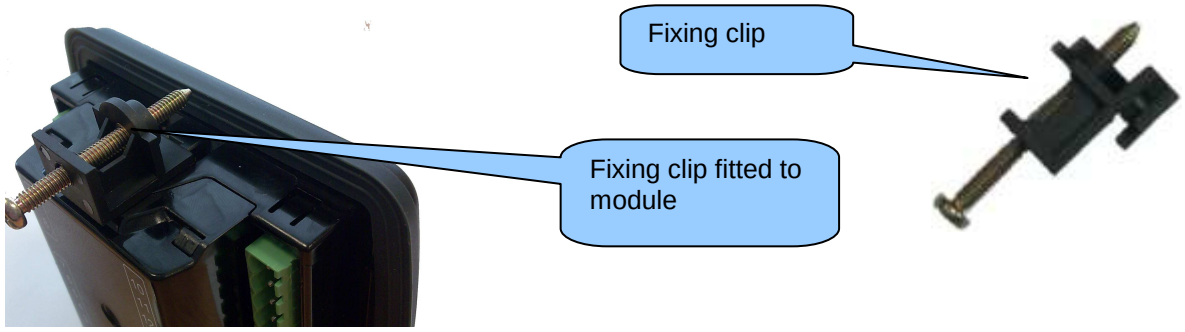
3.8.3 WEIGHT

400g (0.4kg)

3.8.4 FIXING CLIPS

The module is held into the panel fascia using the supplied fixing clips.

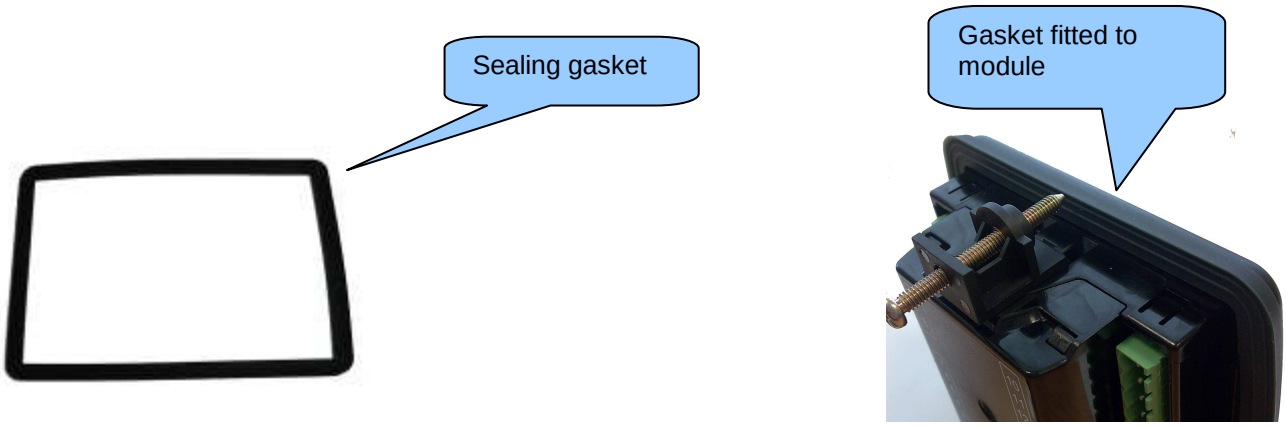
- Withdraw the fixing clip screw (turn anticlockwise) until only the pointed end is protruding from the clip.
- Insert the three ‘prongs’ of the fixing clip into the slots in the side of the 4400 series module case.
- Pull the fixing clip backwards (towards the back of the module) ensuring all three prongs of the clip are inside their allotted slots.
- Turn the fixing clip screws clockwise until they make contact with the panel fascia.
- Turn the screws a little more to secure the module into the panel fascia. Care should be taken not to over tighten the fixing clip screws.



NOTE:- In conditions of excessive vibration, mount the panel on suitable anti-vibration mountings.

3.8.5 OPTIONAL SILICON SEALING GASKET

The optional silicon gasket provides improved sealing between the 4400 series module and the panel fascia.
The gasket is fitted to the module before installation into the panel fascia.
Take care to ensure the gasket is correctly fitted to the module to maintain the integrity of the seal.



3.9 APPLICABLE STANDARDS

BS 4884-1	This document conforms to BS4884-1 1992 Specification for presentation of essential information.
BS 4884-2	This document conforms to BS4884-2 1993 Guide to content
BS 4884-3	This document conforms to BS4884-3 1993 Guide to presentation
BS EN 60068-2-1 (Minimum temperature)	-30°C (-22°F)
BS EN 60068-2-2 (Maximum temperature)	+70°C (158°F)
BS EN 60950	Safety of information technology equipment, including electrical business equipment
BS EN 61000-6-2	EMC Generic Immunity Standard (Industrial)
BS EN 61000-6-4	EMC Generic Emission Standard (Industrial)
BS EN 60529 (Degrees of protection provided by enclosures)	IP65 (front of module when installed into the control panel with the optional sealing gasket) IP42 (front of module when installed into the control panel WITHOUT being sealed to the panel)
UL508 **NEMA rating** (Approximate)	12 (Front of module when installed into the control panel with the optional sealing gasket). 2 (Front of module when installed into the control panel WITHOUT being sealed to the panel)
IEEE C37.2 (Standard Electrical Power System Device Function Numbers and Contact Designations)	Under the scope of IEEE 37.2, *function numbers can also be used to represent functions in microprocessor devices and software programs*. The 4000 series controller is device number 11L-4400 (Multifunction device protecting Line (generator) – 4400 series module). As the module is configurable by the generator OEM, the functions covered by the module will vary. Under the module's factory configuration, the device numbers included within the module are : 2 – Time delay starting or closing relay 6 – Starting circuit breaker 30 – annunciator relay 42 – Running circuit breaker 54 – turning gear engaging device 62 – time delay stopping or opening relay 63 – pressure switch 74– alarm relay 81 – frequency relay 86 – lockout relay

In line with our policy of continual development, Deep Sea Electronics, reserve the right to change specification without notice.

4 INSTALLATION

The DSE4400 Series module is designed to be mounted on the panel fascia. For dimension and mounting details, see the section entitled *Specification, Dimension and mounting* elsewhere in this document.

NOTE:- Note that these connection details are for Mk2 controllers. Connection details for Mk1 controllers are included in DSE publication 057-092

4.1 TERMINAL DESCRIPTION

4.1.1 DC SUPPLY, FUEL AND START OUTPUTS

	PIN No	DESCRIPTION	CABLE SIZE	NOTES
	1	DC Plant Supply Input (Negative)	2.5mm² AWG 13	
	2	DC Plant Supply Input (Positive)	2.5 mm² AWG 13	(Recommended Maximum Fuse 15A anti-surge) Supplies the module (2A anti-surge requirement) and all output relays
	3	Output A	1.0mm² AWG 18	Plant Supply Positive from terminal 2. 3 Amp rated. Normally used for FUEL control.
	4	Output B	1.0mm² AWG 18	Plant Supply Positive from terminal 2. 3 Amp rated. Normally used for START control.
D + W/L	5	Charge fail / excite	2.5mm² AWG 13	Do not connect to ground (battery negative). If charge alternator is not fitted, leave this terminal disconnected.
	6	Output C	1.0mm² AWG 18	Plant Supply Positive from terminal 2. 3 Amp rated. Normally used for Generator load switch control.
	7	Output D	1.0mm² AWG 18	Plant Supply Positive from terminal 2. 3 Amp rated. Normally used for Mains load switch control (DSE4420)
	8	Output E	1.0mm² AWG 18	Plant Supply Positive from terminal 2. 3 Amp rated.
	9	Output F	1.0mm² AWG 18	Plant Supply Positive from terminal 2. 3 Amp rated.

4.1.2 ANALOGUE SENSORS

	PIN No	DESCRIPTION	CABLE SIZE	NOTES
	10	Sensor Common Return	0.5mm² AWG 20	Return feed for sensor*
	11	Oil Pressure Sensor	0.5mm² AWG 20	
	12	Coolant Temp Sensor	0.5mm² AWG 20	
	13	Flexible Sensor	0.5mm² AWG 20	

NOTE*:- If using single terminal sensors refer to the Appendix section entitled "Sensor wiring recommendations" elsewhere in this manual.

4.1.3 MAGNETIC PICKUP

NOTE:- Magnetic Pickup is optional when the engine is fitted with a main AC alternator. In this instance the engine speed can be derived from the main AC alternator output.

NOTE:- Magnetic Pickup interface is not fitted to the 44x0-xxx-02 CAN version module

	PIN No	DESCRIPTION	CABLE SIZE	NOTES
	14	Magnetic pickup Positive	0.5mm² AWG 20	Connect to Magnetic Pickup device
	15	Magnetic pickup Negative	0.5mm² AWG 20	Connect to Magnetic Pickup device
	16	Magnetic pickup screen	0.5mm² AWG 20	Do not connect the other end to earth!

4.1.4 CAN

NOTE:- CAN interface is not fitted to the 44x0-xxx-01 Magnetic Pickup version module

NOTE:- Screened 120Ω 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 120Ω impedance cable suitable for CAN use (DSE part number 016-030)

	PIN No	DESCRIPTION	CABLE SIZE	NOTES
CAN	14	CAN port H	0.5mm² AWG 20	Use only 120Ω CAN approved cable
	15	CAN port L	0.5mm² AWG 20	Use only 120Ω CAN approved cable
	16	CAN port Common	0.5mm² AWG 20	Use only 120Ω CAN approved cable

4.1.5 GENERATOR / MAINS VOLTAGE SENSING

NOTE:- Terminals 21-24 are not fitted to the DSE4410.

	PIN No	DESCRIPTION	CABLE SIZE	NOTES
	17	Generator L1 (U) voltage monitoring	1.0mm² AWG 18	Connect to generator L1 (U) output (AC) (Recommend 2A fuse)
	18	Generator L2 (V) voltage monitoring	1.0mm² AWG 18	Connect to generator L2 (V) output (AC) (Recommend 2A fuse)
	19	Generator L3 (W) voltage monitoring	1.0mm² AWG 18	Connect to generator L3 (W) output (AC) (Recommend 2A fuse)
	20	Generator Neutral (N) input	1.0mm² AWG 18	Connect to generator Neutral terminal (AC)
	21	Mains L1 (R) voltage monitoring	1.0mm² AWG 18	Connect to Mains L1 (R) output (AC) (Recommend 2A fuse)
	22	Mains L2 (S) voltage monitoring	1.0mm² AWG 18	Connect to Mains L2 (S) output (AC) (Recommend 2A fuse)
	23	Mains 31 (T) voltage monitoring	1.0mm² AWG 18	Connect to Mains L3 (T) output (AC) (Recommend 2A fuse)
	24	Mains Neutral (N) input	1.0mm² AWG 18	Connect to Mains Neutral terminal (AC)

4.1.6 DIGITAL INPUTS

	PIN No	DESCRIPTION	CABLE SIZE	NOTES
	25	Configurable digital input A	0.5mm² AWG 20	Switch to negative
	26	Configurable digital input B	0.5mm² AWG 20	Switch to negative
	27	Configurable digital input C	0.5mm² AWG 20	Switch to negative
	28	Configurable digital input D	0.5mm² AWG 20	Switch to negative

This configuration cable is the same as normally used between a PC and a USB printer.

4.1.7 PC CONFIGURATION INTERFACE CONNECTOR

	DESCRIPTION	CABLE SIZE	NOTES
USB	Socket for connection to PC with DSE Configuration Suite PC software.	0.5mm² AWG 20	This is a standard USB type A to type B cable. 

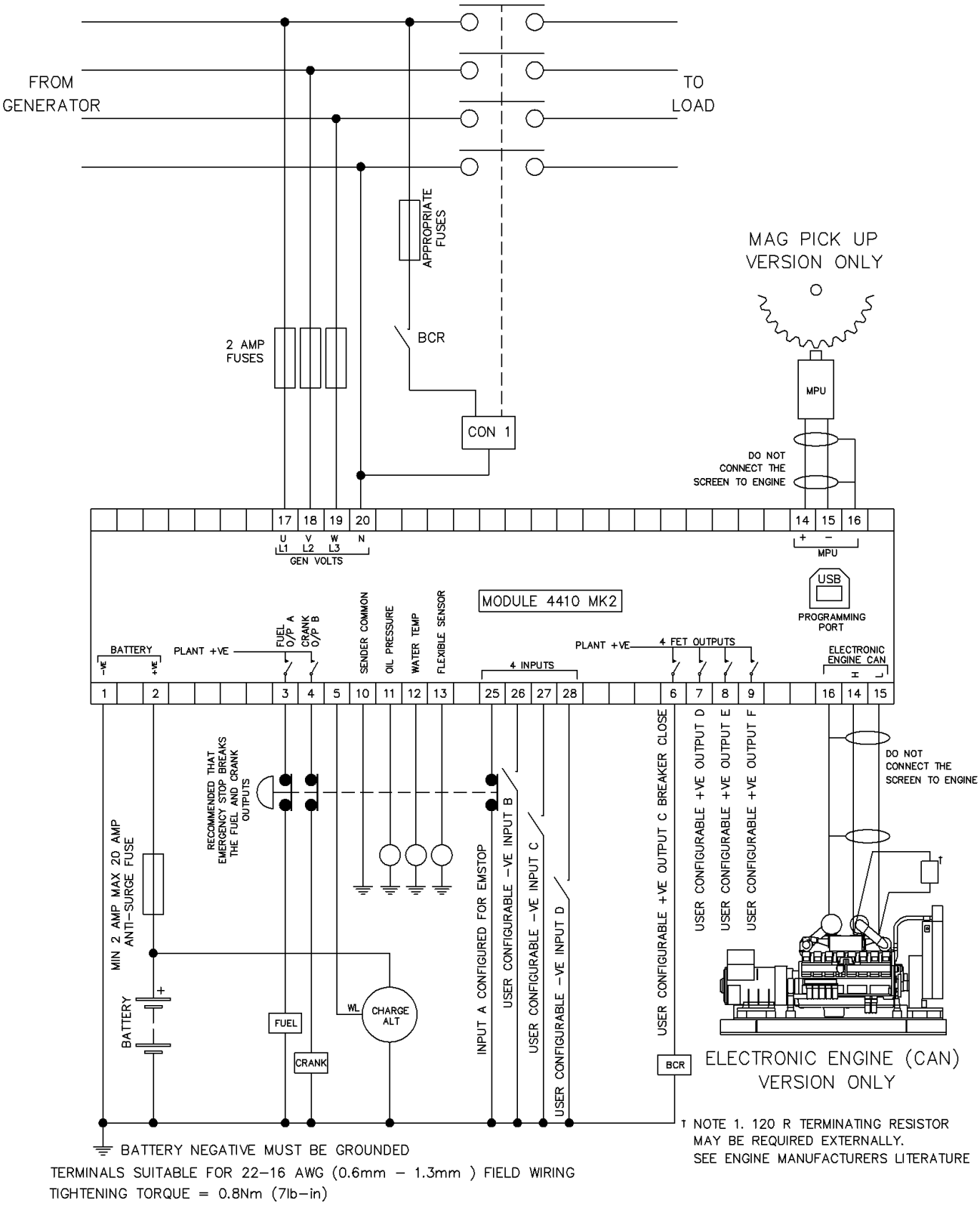
NOTE:- The USB connection cable between the PC and the 4400 series module must not be extended beyond 5m (5yds). For distances over 5m, it is possible to use a third party USB extender. Typically, they extend USB up to 50m (yds). The supply and support of this type of equipment is outside the scope of Deep Sea Electronics PLC.

CAUTION!: Care must be taken not to overload the PCs USB system by connecting more than the recommended number of USB devices to the PC. For further information, consult your PC supplier.

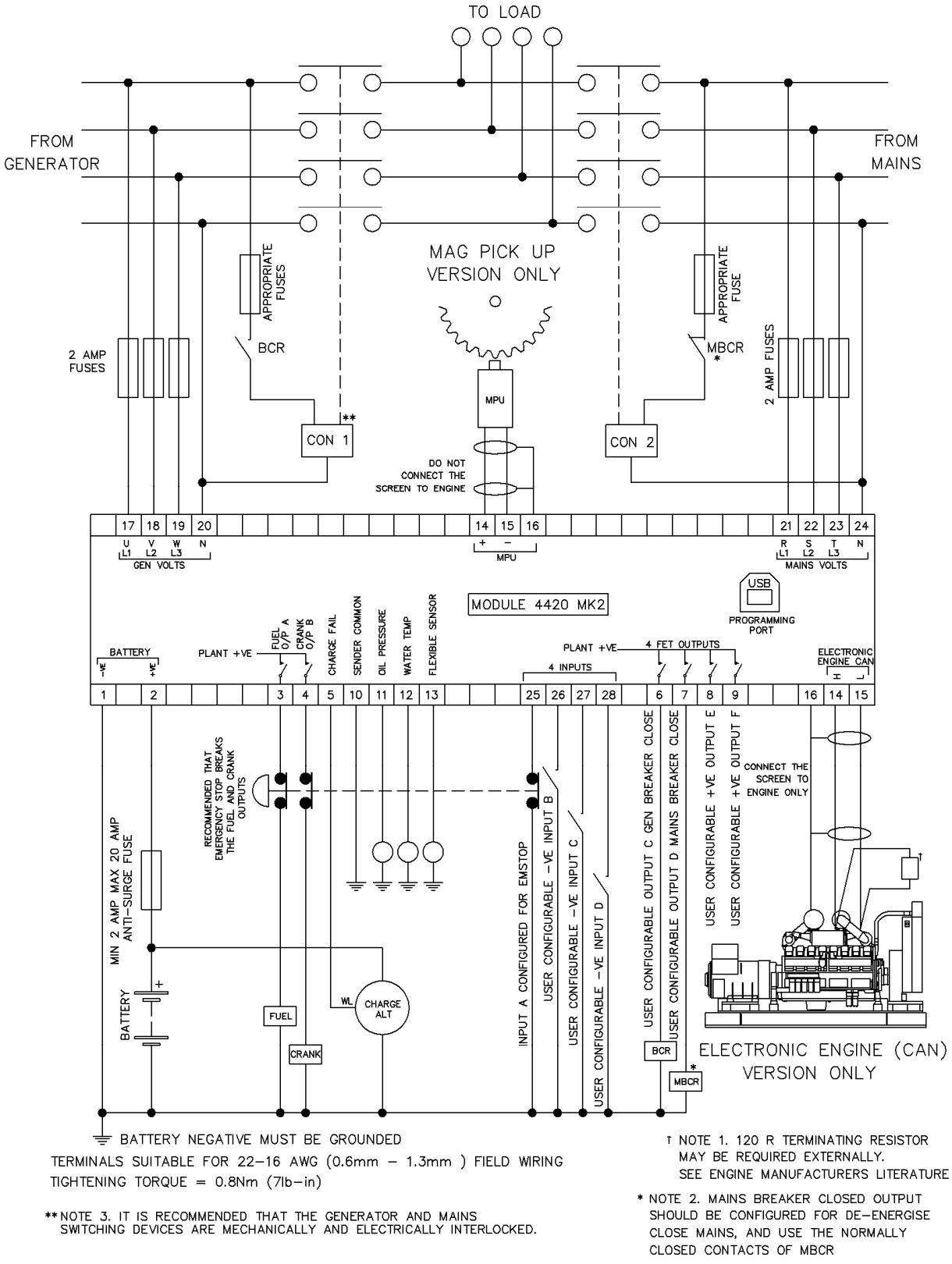
CAUTION!: This socket must not be used for any other purpose.

4.2 TYPICAL WIRING DIAGRAMS

4.2.1 DSE 4410 MK2 AUTOSTART MODULE



4.2.2 DSE 4420 MK2 AUTO MAINS FAILURE MODULE



BATTERY NEGATIVE MUST BE GROUNDED

TERMINALS SUITABLE FOR 22−16 AWG (0.6mm − 1.3mm) FIELD WIRING

TIGHTENING TORQUE = 0.8Nm (7lb−in)

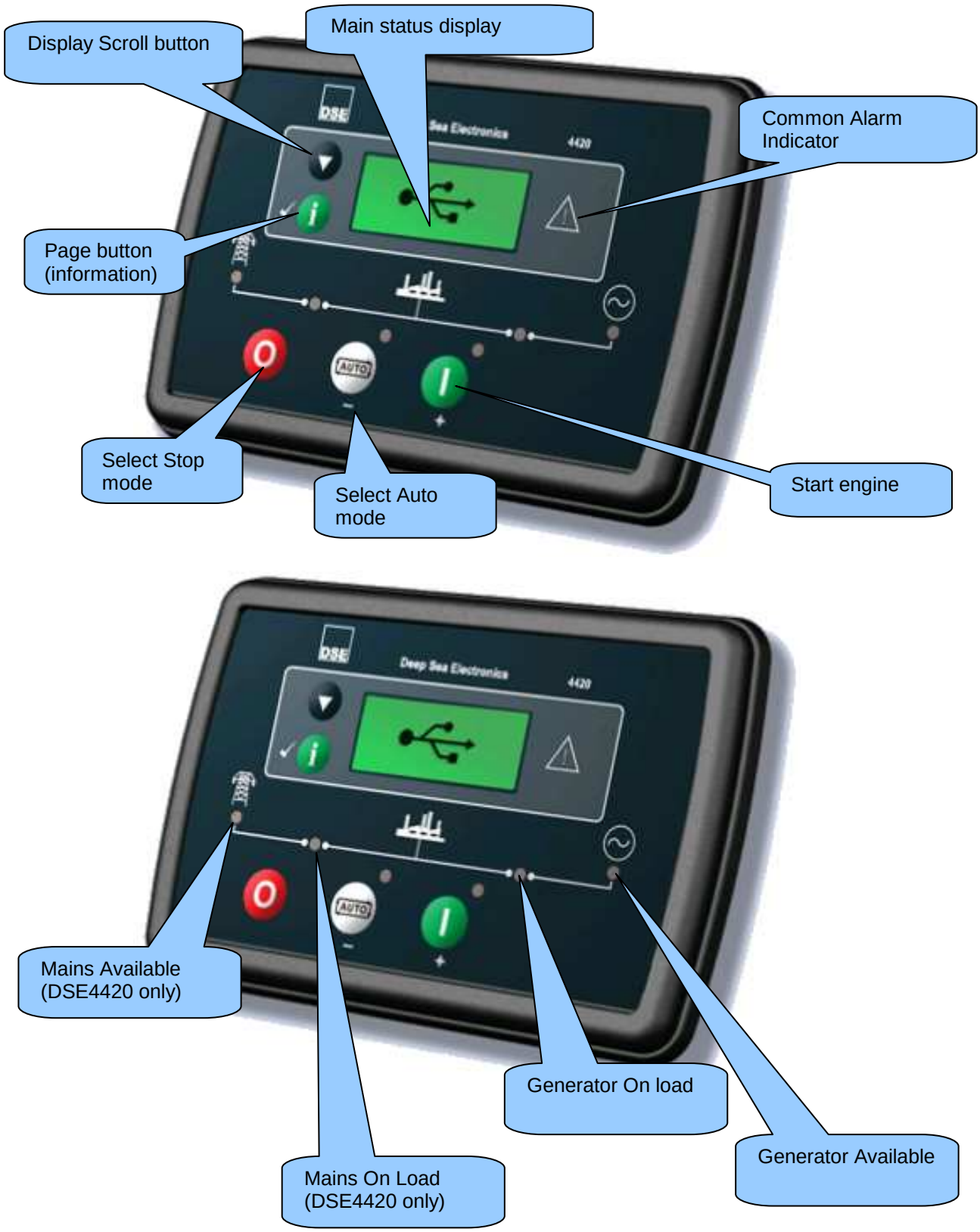
** NOTE 3. IT IS RECOMMENDED THAT THE GENERATOR AND MAINS SWITCHING DEVICES ARE MECHANICALLY AND ELECTRICALLY INTERLOCKED.

† NOTE 1. 120 R TERMINATING RESISTOR MAY BE REQUIRED EXTERNALLY. SEE ENGINE MANUFACTURERS LITERATURE

* NOTE 2. MAINS BREAKER CLOSED OUTPUT SHOULD BE CONFIGURED FOR DE−ENERGISE CLOSE MAINS, AND USE THE NORMALLY CLOSED CONTACTS OF MBCR

5 DESCRIPTION OF CONTROLS

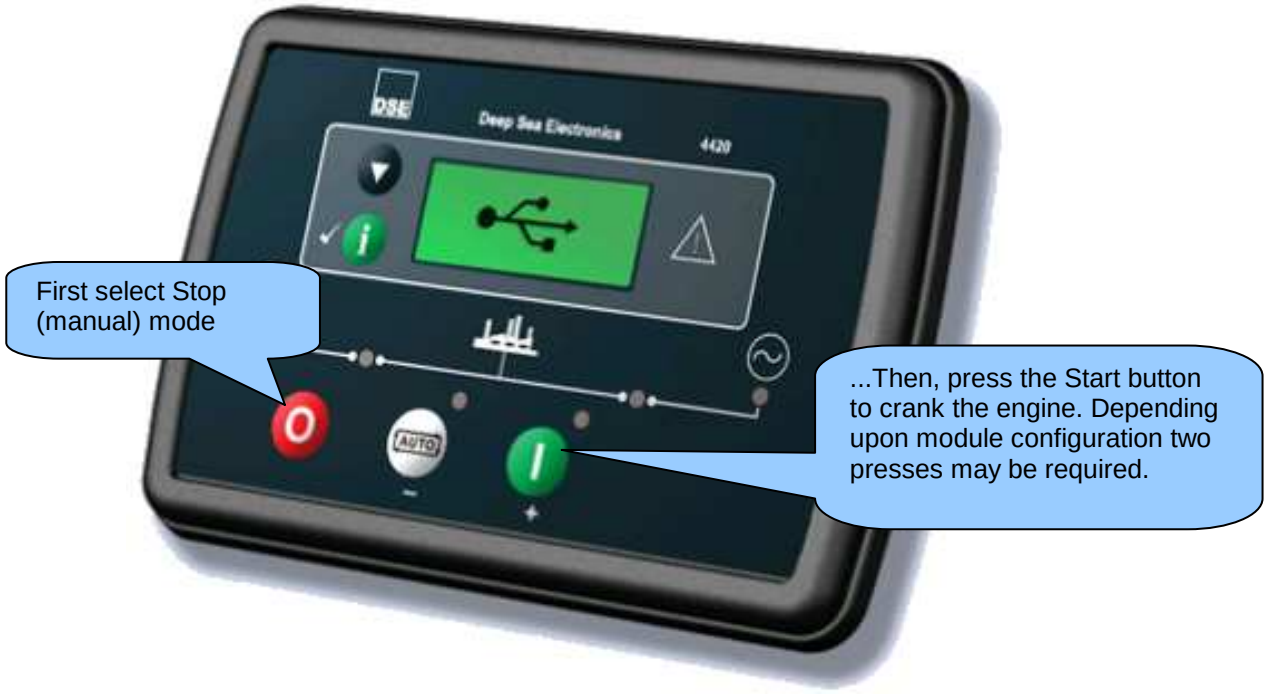
The following section details the function and meaning of the various controls on the module.



5.1 QUICKSTART GUIDE

This section provides a quick start guide to the module's operation.

5.1.1 STARTING THE ENGINE



NOTE:- For further details, see the section entitled 'OPERATION' elsewhere in this manual.

5.1.2 STOPPING THE ENGINE

NOTE:- For further details, see the section entitled 'OPERATION' elsewhere in this manual.

5.2 GRAPHICAL DISPLAY

- 4- line, 64 x 132 small Graphic Display with LED Backlight
- Icon and numeric display.
- Software controlled contrast
- Mimic of 4 x indicators via LCD

5.3 VIEWING THE INSTRUMENTS

At power up, the display will show the software version and then show the default screen, which will display Generator Frequency.

It is possible to scroll to display the different pages of information by repeatedly operating the down button 

Pressing the information  button toggles between instrumenation and event log displays

Once selected the page will remain on the LCD display until the user selects a different page or after an extended period of inactivity, the module will revert to the status display.

When scrolling manually by pressing the  button, the display will automatically return to the Status page if no buttons are pressed for the duration of the *Page Timer* (fixed at 5 minutes).

If an alarm becomes active while viewing the status page, the display shows the Alarms page to draw the operator's attention to the alarm condition.

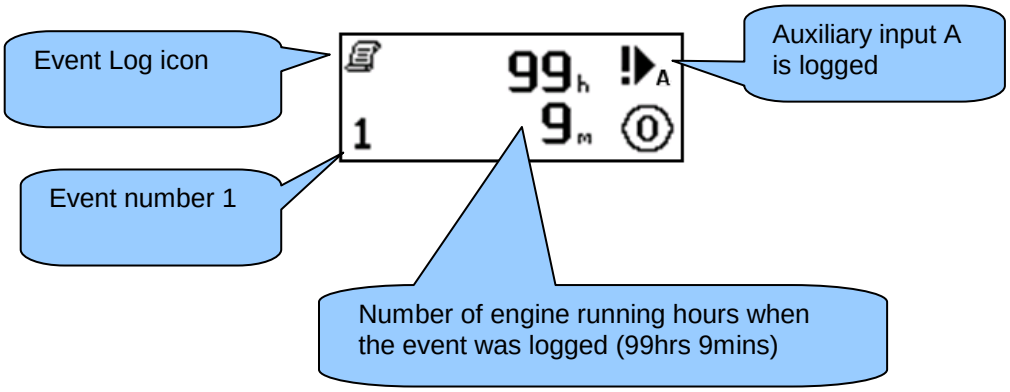
Metering:	Generator Voltage, 3-phase, L-L and L-N
	Generator Frequency
	Mains Voltage, 3-phase, L-L and L-N (Model 4420 only)
	Battery Voltage
	Engine hours Run
	Oil Pressure Gauge
	Engine Temperature Gauge
	Fuel Level

5.4 EVENT LOG

The info button toggles between the display of the instrumentation and the event log. Pressing the down button will move to the previous event, the event log entry at position 1 being the most recent. On moving from the instrumentation value to the event log the unit will display the most recent entry.

A number in the bottom left indicates the event log entry currently displayed. There are five event log entries in the 44xx units. When the event log is displayed the icon in the alarm icon area indicates the alarm type at that position of the event log. The hours run at the time of the alarm shows in the instrumentation area. The bottom right icon indicates the current mode as normal.

Example of Auxiliary Input Shutdown Alarm.



5.5 CONTROLS

Stop / Reset and **Manual** This button places the module into its **Stop/Reset** and **Manual** mode. This will clear any alarm conditions for which the triggering criteria have been removed. If the engine is running and the module is in Stop mode, the module will automatically instruct the changeover device to unload the generator *('**Close Generator**' becomes inactive (if used))*. The fuel supply de-energises and the engine comes to a standstill. Should a **remote start signal** be present while operating in this mode, a remote start will not occur. Once in **Manual mode** the module will respond to the start button, start the engine, and run off load. If the engine is running off-load in the **Manual mode** and a **remote start signal** becomes present, the module will automatically instruct the changeover device to place the generator on load *('**Close Generator**' becomes active (if used))*. Upon removal of the **remote start signal**, the generator remains on load until either selection of the **'STOP/RESET'** or **'AUTO'** modes. *For further details, please see the more detailed description of 'Manual operation' elsewhere in this manual.*	
Auto This button places the module into its **'Automatic'** mode. This mode allows the module to control the function of the generator automatically. The module will monitor the *remote start* input and mains supply status and once a start request is made, the set will be automatically started and placed on load. Upon removal of the starting signal, the module will automatically transfer the load from the generator and shut the set down observing the *stop delay* timer and *cooling* timer as necessary. The module will then await the next start event. *For further details, please see the more detailed description of 'Auto operation' elsewhere in this manual.*	
Start This button is only active in STOP/RESET or MANUAL mode. Pressing this button in manual or test mode will start the engine and run off load (manual) or on load (test). Pressing this button in STOP/RESET mode will turn on the CAN engine ECU (when correctly configured and fitted to a compatible engine ECU)	
Scroll This buttons scrolls through the instruments in the currently displayed page	
Page Toggles the display between instrumentation an event log mode,	

6 OPERATION

6.1 AUTOMATIC MODE OF OPERATION

NOTE:- If a digital input configured to *panel lock* is active, changing module modes will not be possible. Viewing the instruments and event logs is NOT affected by panel lock.

Activate auto mode by pressing the pushbutton. The icon is displayed to indicate Auto Mode operation if no alarms are present.

Auto mode will allow the generator to operate fully automatically, starting and stopping as required with no user intervention.

6.1.1 WAITING IN AUTO MODE

If a starting request is made, the starting sequence will begin.
Starting requests can be from the sources shown below. When the engine is running in AUTO mode, an icon is displayed to indicate the reason for the set being run :

Auto run reason	Icon
Remote start input	
Low battery run	
Scheduled run	
Mains failure (4420 only)	

6.1.2 STARTING SEQUENCE

To allow for 'false' start requests, the *start delay* timer begins.

Should all start requests be removed during the *start delay* timer, the unit will return to a stand-by state.

If a start request is still present at the end of the *start delay* timer, the fuel relay is energised and the engine will be cranked.

NOTE:- If the unit has been configured for CAN, compatible ECU's will receive the start command via CAN.

If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the *crank rest* duration after which the next start attempt is made. Should this sequence continue beyond the set number of attempts, the start sequence will be terminated and the display shows ***Fail to Start.***

When the engine fires, the starter motor is disengaged. Speed detection is factory configured to be derived from the main alternator output frequency but can additionally be measured from a Magnetic Pickup mounted on the flywheel (Selected by PC using the 4000 series configuration software).

Additionally, rising oil pressure can be used to disconnect the starter motor (but cannot detect underspeed or overspeed).

NOTE:- If the unit has been configured for CAN, speed sensing is via CAN.

After the starter motor has disengaged, the *Safety On* timer activates, allowing Oil Pressure, High Engine Temperature, Under-speed, Charge Fail and any delayed Auxiliary fault inputs to stabilise without triggering the fault.

6.1.3 ENGINE RUNNING

Once the engine is running and all starting timers have expired, the animated  icon is displayed.

The generator is placed on load if configured to do so.

NOTE:-The load transfer signal remains inactive until the Oil Pressure has risen. This prevents excessive wear on the engine.

If all start requests are removed, the *stopping sequence* will begin.

6.1.4 STOPPING SEQUENCE

The *return delay* timer operates to ensure that the starting request has been permanently removed and isn't just a short term removal. Should another start request be made during the cooling down period, the set will return on load.

If there are no starting requests at the end of the *return delay* timer, the load is removed from the generator to the mains supply and the *cooling* timer is initiated.

The *cooling* timer allows the set to run off load and cool sufficiently before being stopped. This is particularly important where turbo chargers are fitted to the engine.

After the *cooling* timer has expired, the set is stopped.

6.2 MANUAL OPERATION

Manual mode allows the operator to start and stop the set manually, and if required change the state of the load switching devices. Manual mode is active when the  button is pressed.

6.2.1 WAITING IN MANUAL MODE

To begin the starting sequence, press the  button. If 'protected start' is disabled, the start sequence begins immediately.

If 'Protected Start' is enabled , the  icon is displayed to indicate Manual mode and the manual LED flashes. The  button must be pressed once more to begin the start sequence.

6.2.2 STARTING SEQUENCE

NOTE:- There is no *start delay* in this mode of operation.

The fuel relay is energised and the engine is cranked.

NOTE:- If the unit has been configured for CAN, compatible ECU's will receive the start command via CAN.

If the engine fails to fire during this cranking attempt then the starter motor is disengaged for the *crank rest* duration after which the next start attempt is made. Should this sequence continue beyond the set number of attempts, the start sequence will be terminated and the display shows  ***Fail to Start.***

When the engine fires, the starter motor is disengaged. Speed detection is factory configured to be derived from the main alternator output frequency but can additionally be measured from a Magnetic Pickup mounted on the flywheel (Selected by PC using the 4000 series configuration software).

Additionally, rising oil pressure can be used disconnect the starter motor (but cannot detect underspeed or overspeed).

NOTE:- If the unit has been configured for CAN, speed sensing is via CAN.

After the starter motor has disengaged, the *Safety On* timer activates, allowing Oil Pressure, High Engine Temperature, Under-speed, Charge Fail and any delayed Auxiliary fault inputs to stabilise without triggering the fault.

6.2.3 ENGINE RUNNING

In manual mode, the load is not transferred to the generator unless a 'loading request' is made.
A loading request can come from a number of sources :

- Remote start input
- Low battery run
- Scheduled run
- Mains failure (4420 only)

NOTE:-The load transfer signal remains inactive until the Oil Pressure has risen. This prevents excessive wear on the engine.

Once the load has been transferred to the generator, it will not be automatically removed. To manually transfer the load back to the mains (DSE4420) or to remove the load from the generator (DSE4410) either:

- Press the *auto mode*  button to return to automatic mode. The set will observe all auto mode start requests and stopping timers before beginning the *Auto mode stopping sequence*.
- Press the *stop button* 

6.2.4 STOPPING SEQUENCE

In manual mode the set will continue to run until either :

- The *stop button*  is pressed – The set will immediately stop
- The *auto button*  is pressed. The set will observe all auto mode start requests and stopping timers before beginning the *Auto mode stopping sequence*.

7 MODULE DISPLAY

7.1 BACKLIGHT

The backlight will be on if the unit has sufficient voltage on the power connection while the unit is turned on, unless the unit is in Power Save mode, or if the engine is cranking for which the backlight will be turned off.

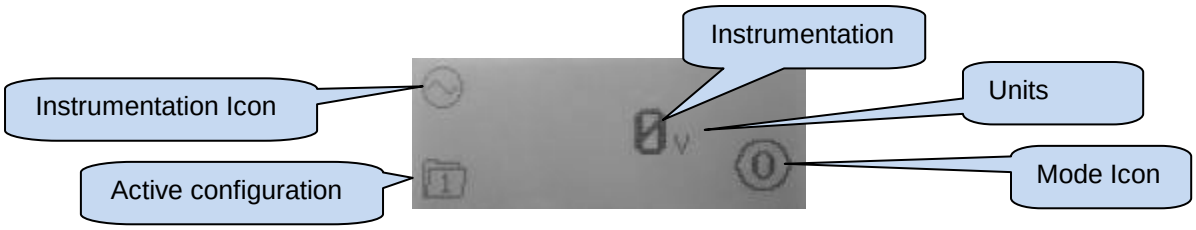
7.2 GRAPHICAL DISPLAY

A 48x132 pixel LCD is used for the display. The display is segmented into areas for instrumentation, units, alarm icons and various other icons.

<table>
<tr><td>Inst. Icon</td><td>Instrumentation</td><td>Units</td><td rowspan="2">Alarm Icon</td></tr>
<tr><td rowspan="3">Active config /FPE, event index</td><td>Instrumentation</td><td>Units</td></tr>
<tr><td>Instrumentation</td><td>Units</td><td rowspan="2">Mode Icon</td></tr>
</table>

7.2.1 DISPLAY EXAMPLE

This example shows Generator Volts as shown by the Generator symbol.



7.2.2 MODE ICON

An icon is displayed in the mode icon area of the display to indicate what mode the unit is currently in.

Icon	Graphic	Details
Stopped		Appears when the engine is at rest and the unit is in stop mode.
Auto		Appears when the engine is at rest and the unit is in auto mode.
Manual		Appears when the engine is at rest and the unit is in manual mode
Timer animation		Appears when a timer is active, for example cranking time, crank rest etc.
Running animation		Appears when the engine is running, and all timers have expired, either on or off load. The animation rate is reduced when running in idle mode.
Front panel editor		Appears when the unit is in the front panel editor.

7.2.3 AUTO RUN ICON

When the engine is running in AUTO mode, an icon is displayed to indicate the reason for the set being run.

Auto run reason	Icon
Remote start input	
Low battery run	
Scheduled run	
Mains failure	

7.2.4 INSTRUMENTATION ICONS

When displaying instrumentation a small icon is displayed in the instrumentation icon area to indicate what value is currently being displayed.

Icon	Graphic	Details
Generator		Used for generator voltage and generator frequency
Mains		Used for mains voltages and mains frequency
Engine speed		Engine speed instrumentation screen
Hours Run		Hours run instrumentation screen
Battery voltage		Battery voltage instrumentation screen
Engine temperature		Coolant temperature instrumentation screen
Oil pressure		Oil pressure instrumentation screen
Flexible sensor		Flexible sensor instrumentation screen
Event log		Appears when the event log is being displayed
Unit time		Current time held in the unit
Scheduler setting		The current value of the scheduler run time and duration
CAN DTC		ECU diagnostic trouble codes

7.2.5 ACTIVE CONFIGURATION

When not in the Front Panel Editor (FPE) mode, and with the alternative configuration enabled, the *active config* area of the display will be used to display the currently active configuration.

Icon	Graphic	Details
Main config		Appears when the main configuration is selected
Alternative config		Appears when the alternative configuration is selected

7.3 PROTECTIONS

When an alarm is present, the Common alarm LED will illuminate.

The LCD display will jump from the 'Information page' to display the Alarm Page. See section entitled Graphical Display for details of alarm icons.

The LCD will display multiple alarms E.g. "High Engine Temperature shutdown", "Emergency Stop" and "Low Coolant Warning". These will automatically scroll round in the order that they occurred;

In the event of a warning alarm, the LCD will display the appropriate icon. If a shutdown then occurs, the module will again display the appropriate icon, flashing.

7.4 WARNINGS

Warnings are non-critical alarm conditions and do not affect the operation of the generator system, they serve to draw the operators attention to an undesirable condition.

In the event of an alarm the LCD will jump to the alarms page, and scroll through all active warnings and shutdowns.

Warning alarms are self-resetting when the fault condition is removed.

Display		Reason
	Battery High Voltage	The DC supply has risen above the high volts setting level for the duration of the high battery volts timer
	Battery Low Voltage	The DC supply has fallen below the low volts setting level for the duration of the low battery volts timer
ECM	CAN ECU Warning	The engine ECU has detected a warning alarm and has informed the DSE module of this situation. The exact error is also indicated on the module's display.
	Charge Alternator Failure	The auxiliary charge alternator voltage is low as measured from the W/L terminal.
A	Digital Input A-D	Auxiliary Digital inputs can be user configured as Digital inputs and will display the relevant icon.
A	Analogue Input A-C	Auxiliary Analogue inputs can be user configured as Digital inputs and will display the relevant icon.
	Fail To stop	The module has detected a condition that indicates that the engine is running when it has been instructed to stop. **NOTE:- 'Fail to Stop' could indicate a faulty oil pressure sensor - If engine is at rest check oil sensor wiring and configuration.**
V	Generator High Voltage Warning	The generator output voltage has risen above the pre-set pre-alarm setting.
V	Generator Low Voltage Warning	The generator output voltage has fallen below the pre-set pre-alarm setting after the *Safety On* timer has expired.
	High Coolant Temperature Warning	The module detects that the engine coolant temperature has exceeded the high engine temperature pre-alarm setting level after the *Safety On* timer has expired.
	Low Oil Pressure Warning	The module detects that the engine oil pressure has fallen below the low oil pressure pre-alarm setting level after the *Safety On* timer has expired.
	Low Fuel Level	The module detects that the fuel level is below the configured setting
Hz	Over Frequency Warning	The generator output frequency has risen above the pre-set pre-alarm setting.
	Over Speed Warning	The engine speed has risen above the overspeed pre alarm setting
Hz	Under Frequency Warning	The generator output frequency has fallen below the pre-set pre-alarm setting after the *Safety On* timer has expired.
	Under Speed Warning	The engine speed has fallen below the underspeed pre alarm setting
	Flexible Sensor	The flexible sensor warning alarm has been triggered.

7.5 SHUTDOWN ALARMS

Shutdowns are latching alarms and stop the Generator. Clear the alarm and remove the fault then press Stop/Reset to reset the module.

NOTE:- The alarm condition must be rectified before a reset will take place. If the alarm condition remains, it will not be possible to reset the unit (The exception to this is the Low Oil Pressure alarm and similar 'delayed alarms', as the oil pressure will be low with the engine at rest).

Display		Reason
CAN	CAN ECU Data Fail	The module is configured for CAN operation and does not detect data on the engine Can datalink, the engine shuts down.
ECM	CAN ECU Shutdown	The engine ECU has detected a shutdown alarm and has informed the DSE module of this situation. The exact error is also indicated on the module's display.
A	Digital Input A-D	Auxiliary Digital inputs can be user configured as Digital inputs and will display the relevant icon.
A	Analogue Input A-C	Auxiliary Analogue inputs can be user configured as Digital inputs and will display the relevant icon.
	Emergency Stop	The emergency stop button has been depressed. This is a failsafe (normally closed to battery negative) input and will immediately stop the set should the signal be removed. **NOTE:- The Emergency Stop Negative signal must be present otherwise the unit will shutdown.**
	Fail To Start	The engine has not fired after the preset number of start attempts
V	Generator High Voltage Shutdown	The generator output voltage has risen above the preset level
V	Generator Low Voltage Shutdown	The generator output voltage has fallen below the preset level
	High Coolant Temperature Shutdown	The module detects that the engine coolant temperature has exceeded the high engine temperature shutdown setting after the *Safety On* timer has expired.
	Loss of Mag. Pickup Signal	The speed signal from the magnetic pickup is not being received by the DSE controller.
	Low Oil Pressure Shutdown	The engine oil pressure has fallen below the low oil pressure trip setting level after the *Safety On* timer has expired.
	Low Fuel Level	The module detects that the fuel level is below the configured setting
Hz	Over Frequency Shutdown	The generator output frequency has risen above the preset level
	Over Speed Shutdown	The engine speed has exceeded the pre-set trip
Hz	Under Frequency Shutdown	The generator output frequency has fallen below the preset level
	Under Speed Shutdown	The engine speed has fallen below the pre-set trip after the ***Safety On*** timer has expired.

Continued overleaf

Continued...

Display		Reason
	Temperature sensor open circuit	Temperature sensor has been detected as being open circuit.
	Oil pressure sensor open circuit	Oil pressure sensor has been detected as being open circuit.
	Flexible Sensor	The flexible sensor shutdown alarm has been triggered.
	Magnetic pickup open circuit	Magnetic pickup sensor has been detected as being open circuit.

7.6 ELECTRICAL TRIP ALARMS

Electrical trips are latching and stop the Generator but in a controlled manner. On initiation of the electrical trip condition the module will de-energise the **'Close Generator'** Output to remove the load from the generator. Once this has occurred the module will start the Cooling timer and allow the engine to cool off-load before shutting down the engine. The alarm must be accepted and cleared, and the fault removed to reset the module.

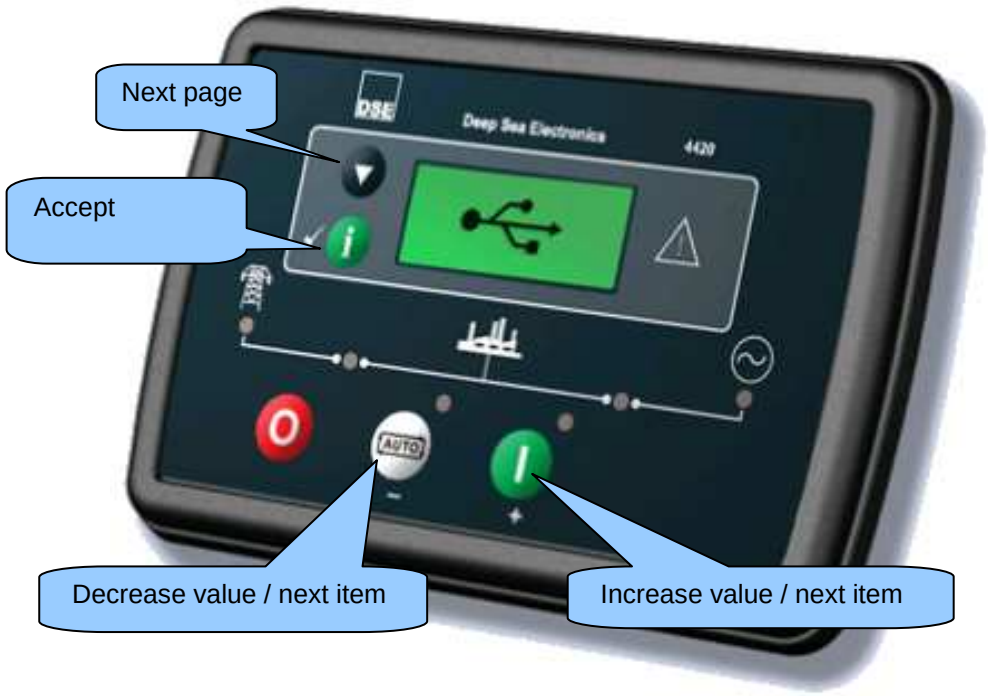
Electrical trips are latching alarms and stop the Generator. Remove the fault then press Stop/Reset to reset the module.

	Digital Input A-D	Auxiliary Digital inputs can be user configured as Digital inputs and will display the relevant icon.
	Analogue Input A-C	Auxiliary Analogue inputs can be user configured as Digital inputs and will display the relevant icon.

8 FRONT PANEL CONFIGURATION

This configuration mode allows the operator limited customising of the way the module operates.
All available parameters can be adjusted by this method, or alternatively by using the optional DSE Configuration Suite Software for Windows PC in conjunction with a USB A-B cable. Full details of this are contained in the 44xx Configuration Suite Software Manual.

Use the module's navigation buttons to traverse the menu and make value changes to the parameters:



8.1 ACCESSING THE FRONT PANEL EDITOR (FPE)

- Ensure the engine is at rest and the module is in STOP mode by pressing the Stop/Reset button.
- Simultaneously press the Stop/Reset and page buttons.
- The configuration icon is displayed, along with the first configurable parameter.

8.2 EDITING A PARAMETER

- Press to select the required 'page' as detailed in the configuration tables).
- Press (+) to select the next parameter or (-) to select the previous parameter within the current page.
- When viewing the parameter to be changed, press the button. The value begins to flash.
- Press (+) or (-) to adjust the value to the required setting.
- Press the save the current value, the value ceases flashing.
- Press and hold the button to exit the editor, the configuration icon will be removed from the display.

.

NOTE: - Values representing pressure are displayed as Bar, kPa and PSI. Values representing temperature are displayed as degrees Celsius and Degrees Farenheit.

NOTE: - When adjusting values in the FPE a press and hold of the increment button will cover the full range of the item being adjusted (min to max) in under 20 seconds.

NOTE: - When the editor is visible, it automatically closes after 5 minutes of inactivity to ensure security.

8.3 ADJUSTABLE PARAMETERS

CONFIGURATION PARAMETERS – MODULE (Page 1)				4410		4420	
				MPU	CAN	MPU	CAN
101		Contrast	000 (%)	✔	✔	✔	✔
102		Fast loading enable	On (1), Off (0)	✔	✔	✔	✔
103		RESERVED					
104		Lamp test at startup	On (1), Off (0)	✔	✔	✔	✔
105		Power save mode enable	On (1), Off (0)	✔	✔	✔	✔
106		Protected start enable	On (1), Off (0)	✔	✔	✔	✔
107		RESERVED					
108		Event log display format	On (1), Off (0)	✔	✔	✔	✔
109		Module powers up into AUTO mode	On (1), Off (0)	✔	✔	✔	✔
110		DTC string (English only) enable	On (1), Off (0)	X	✔	X	✔

CONFIGURATION PARAMETERS – APPLICATION (Page 2)				4410		4420	
				MPU	CAN	MPU	CAN
201		Alternate Engine Speed	On (1), Off (0)	X	✔	X	✔
202	CAN	CAN ECU data fail enable	On (1), Off (0)	X	✔	X	✔
203	CAN	CAN ECU data fail action	0 (Action)	X	✔	X	✔
204	CAN	CAN ECU data fail delay	0:00	X	✔	X	✔

CONFIGURATION PARAMETERS – INPUTS (Page 3)				4410		4420	
				MPU	CAN	MPU	CAN
301		Low oil pressure enable	On (1), Off (0)	X	✔	X	✔
302		Low oil pressure trip	0 PSI 0.00 bar 0 kPa	X	✔	X	✔
303		High engine temperature trip	00 deg C	X	✔	X	✔
304		Digital input A source	0 (Input source)	✔	✔	✔	✔
305		Digital input A polarity	0 (Polarity)	✔	✔	✔	✔
306		Digital input A action (if source = user config)	0 (Action)	✔	✔	✔	✔
307		Digital input A arming (if source = user config)	0 (Arming)	✔	✔	✔	✔
308		Digital input A activation delay (if source = user config)	0:00	✔	✔	✔	✔
309		Digital input B source	0 (Input source)	✔	✔	✔	✔
310		Digital input B polarity	0 (Polarity)	✔	✔	✔	✔
311		Digital input B action (if source = user config)	0 (Action)	✔	✔	✔	✔
312		Digital input B arming (if source = user config)	0 (Arming)	✔	✔	✔	✔
313		Digital input B activation delay (if source = user config)	0:00	✔	✔	✔	✔
314		Digital input C source	0 (Input source)	✔	✔	✔	✔
315		Digital input C polarity	0 (Polarity)	✔	✔	✔	✔
316		Digital input C action (if source = user config)	0 (Action)	✔	✔	✔	✔
317		Digital input C arming (if source = user config)	0 (Arming)	✔	✔	✔	✔
318		Digital input C activation delay (if source = user config)	0:00	✔	✔	✔	✔
319		Digital input D source	0 (Input source)	✔	✔	✔	✔
320		Digital input D polarity	0 (Polarity)	✔	✔	✔	✔
321		Digital input D action (if source = user config)	0 (Action)	✔	✔	✔	✔
322		Digital input D arming (if source = user config)	0 (Arming)	✔	✔	✔	✔
323		Digital input D activation delay (if source = user config)	0:00	✔	✔	✔	✔

Continued overleaf...

CONFIGURATION PARAMETERS – INPUTS (Page 3) continued				4410		4420	
				MPU	CAN	MPU	CAN
324	A	Analogue input A sensor type	0 (sensor type)				
325	A	Analogue input A sensor selection (temperature senor list)	0 (pressure sensor)				
326	A	Analogue input A (set as digital) source (oil pressure sender)	0 (Input source)	✔	✔	✔	✔
327	A	Analogue input A (set as digital) polarity	0 (Polarity)	✔	✔	✔	✔
328	A	Analogue input A (set as digital) action (if source = user config)	0 (Action)	✔	✔	✔	✔
329	A	Analogue input A (set as digital) arming (if source = user config)	0 (Arming)	✔	✔	✔	✔
330	A	Analogue input A (set as digital) activation delay (if source = user config)	0:00	✔	✔	✔	✔
331	B	Analogue input B sensor type	0 (sensor type)				
332	B	Analogue input B sensor selection (temperature senor list)	0 (temp sensor)				
333	B	Analogue input B (set as digital) source (temperature sender)	0 (Input source)	✔	✔	✔	✔
334	B	Analogue input B polarity	0 (Polarity)	✔	✔	✔	✔
335	B	Analogue input B (set as digital) action (if source = user config)	0 (Action)	✔	✔	✔	✔
336	B	Analogue input B (set as digital) arming (if source = user config)	0 (Arming)	✔	✔	✔	✔
337	B	Analogue input B (set as digital) activation delay (if source = user config)	0:00	✔	✔	✔	✔
338	C	Analogue input C sensor type	0 (sensor type)				
339	C	Analogue input C sensor selection (temperature senor list)	0 (pressure, temperature or percentage sensor)				
340	C	Analogue input C (set as digital) source (flexible sender)	0 (Input source)	✔	✔	✔	✔
341	C	Analogue input C (set as digital) polarity	0 (Polarity)	✔	✔	✔	✔
342	C	Analogue input C (set as digital) action (if source = user config)	0 (Action)	✔	✔	✔	✔
343	C	Analogue input C (set as digital) arming (if source = user config)	0 (Arming)	✔	✔	✔	✔
344	C	Analogue input C (set as digital) activation delay (if source = user config)	0:00	✔	✔	✔	✔
345		Oil pressure sender OC	On (1), Off (0)	✔	✔	✔	✔
346		Temperature sender OC	On (1), Off (0)	✔	✔	✔	✔

CONFIGURATION PARAMETERS – OUTPUTS (Page 4)				4410		4420	
				MPU	CAN	MPU	CAN
401		Digital output A source	0 (Output source)	X	✔	X	✔
402		Digital output A polarity	0 (Output source Polarity)	X	✔	X	✔
403		Digital output B source	0 (Output source)	X	✔	X	✔
404		Digital output B polarity	0 (Output source Polarity)	X	✔	X	✔
405		Digital output C source	0 (Output source)	✔	✔	✔	✔
406		Digital output C polarity	0 (Output source Polarity)	✔	✔	✔	✔
407		Digital output D source	0 (Output source)	✔	✔	✔	✔
408		Digital output D polarity	0 (Output source Polarity)	✔	✔	✔	✔
409		Digital output E source	0 (Output source)	✔	✔	✔	✔
410		Digital output E polarity	0 (Output source Polarity)	✔	✔	✔	✔
411		Digital output F source	0 (Output source)	✔	✔	✔	✔
412		Digital output F polarity	0 (Output source Polarity)	✔	✔	✔	✔

CONFIGURATION PARAMETERS – TIMERS (Page 5)				4410		4420	
				MPU	CAN	MPU	CAN
501		Mains transient delay	0 s	X	X	✔	✔
502		Start Delay	0:00	✔	✔	✔	✔
503		Preheat	0:00	✔	✔	✔	✔
504		Cranking	0 s	✔	✔	✔	✔
505		Crank rest time	0 s	✔	✔	✔	✔
506		Smoke limiting	0:00	✔	✔	✔	✔
507		Smoke limiting off	0 s	✔	✔	✔	✔
508		Safety On Delay	0 s	✔	✔	✔	✔
509		Warming up time	0:00	✔	✔	✔	✔
510		Return Delay	0:00	✔	✔	✔	✔
511		Cooling Time	0:00	✔	✔	✔	✔
512		ETS Solenoid Hold	0:00	✔	✔	✔	✔
513		Failed to stop delay	0:00	✔	✔	✔	✔
514		Generator transient delay	0.0 s	✔	✔	✔	✔
515		Power save mode delay	0:00	✔	✔	✔	✔
516		Transfer time	0.0 s	X	X	✔	✔
517		Breaker trip pulse	0.0 s	✔	✔	✔	✔
518		Breaker close pulse	0.0 s	✔	✔	✔	✔

CONFIGURATION PARAMETERS – GENERATOR (Page 6)				4410		4420	
				MPU	CAN	MPU	CAN
601		Alternator Fitted	On (1), Off (0)	✔	✔	✔	✔
602		Alternator Poles	0	✔	✔	✔	✔
603		Enable generator fail to close warning	On (1), Off (0)n (1),				
604		Generator failed to close delay	0.0	✔	✔	✔	✔
605		Under Voltage shutdown enabled	On (1), Off (0)	✔	✔	✔	✔
606		Under Voltage shutdown level	0 V	✔	✔	✔	✔
607		Loading Voltage	0 V	✔	✔	✔	✔
608		Over Voltage shutdown level	0 V	✔	✔	✔	✔
609		Under frequency shutdown enable	On (1), Off (0)	✔	✔	✔	✔
610		Under frequency shutdown level	0.0 Hz	✔	✔	✔	✔
611		Loading Frequency	0.0 Hz	✔	✔	✔	✔
612		Nominal Frequency	0.0 Hz	✔	✔	✔	✔
613		Over frequency shutdown enable	On (1), Off (0)	✔	✔	✔	✔
614		Over Frequency shutdown level	0.0 Hz	✔	✔	✔	✔
615		AC System	0 (AC system)	✔	✔	✔	✔

CONFIGURATION PARAMETERS – MAINS (Page 7)				4410		4420	
				MPU	CAN	MPU	CAN
701		AC system	0 (AC system)	X	X	✔	✔
702		Mains failure detection	On (1), Off (0)	X	X	✔	✔
703		Immediate mains dropout	On (1), Off (0)	X	X	✔	✔
704		Mains under voltage enable	On (1), Off (0	X	X	✔	✔
705		Mains under voltage trip level	0 V 00	X	X	✔	✔
706		Mains under voltage return	0 V	X	X	✔	✔
707		Mains over voltage enable	On (1), Off (0	X	X	✔	✔
708		Mains over voltage return	0 V	X	X	✔	✔
709		Mains over Voltage trip level	0 V	X	X	✔	✔
710		Mains under frequency trip enable	On (1), Off (0)	X	X	✔	✔
711		Mains under frequency trip level	0.0 Hz	X	X	✔	✔
712		Mains under frequency return	0.0 Hz	X	X	✔	✔
713		Mains over frequency trip enable	On (1), Off (0)	X	X	✔	✔
714		Mains over frequency return	0 Hz	X	X	✔	✔
715		Mains over frequency trip level	0.0 Hz	X	X	✔	✔

Generator and Mains AC System	
0	2 Phase 3 wire (L1-L2)
1	2 Phase 3 wire (L2-L3)
2	3 Phase 3 wire
3	3 Phase 4 wire
4	3 Phase 4 wire delta
5	Single Phase 2 wire

CONFIGURATION PARAMETERS – ENGINE (Page 8)				4410		4420	
				MPU	CAN	MPU	CAN
801		Magnetic pickup fitted	On (1), Off (0)	✔	X	✔	X
802		Flywheel teeth	000	✔	X	✔	X
803		Start Attempts	0	✔	✔	✔	✔
804		Over speed Overshoot %	00	✔	✔	✔	✔
805		Over speed Delay	0 s	✔	✔	✔	✔
806		Gas choke timer (Gas engine only)	0:00	✔	X	✔	X
807		Gas on delay (Gas engine only)	0:00	✔	X	✔	X
808		Gas ignition off delay (Gas engine only)	0:00	✔	X	✔	X
809		Crank disconnect on Oil pressure enable	On (1), Off (0)	✔	✔	✔	✔
810		Check oil pressure prior to starting	On (1), Off (0)	✔	✔	✔	✔
811		Crank disconnect on Oil pressure	0.00 Bar	✔	✔	✔	✔
812		Crank disconnect on frequency	0.0Hz	✔	✔	✔	✔
813		Crank disconnect on Engine Speed	000 rpm	✔	✔	✔	✔
814		Under speed enable	On (1), Off (0)	✔	✔	✔	✔
815		Under speed shutdown	0000 rpm	✔	✔	✔	✔
816		Over speed shutdown	0000 rpm	✔	✔	✔	✔
817		Low battery volts enable	On (1), Off (0)	✔	✔	✔	✔
818		Low battery volts warning	00.0 V	✔	✔	✔	✔
819		Low battery volts return	00.0 V	✔	✔	✔	✔
820		Low battery volts delay	0:00:00	✔	✔	✔	✔
821		High battery volts enable	On (1), Off (0)	✔	✔	✔	✔
822		High battery volts return	00.0 V	✔	✔	✔	✔
823		High battery volts trip	00.0 V	✔	✔	✔	✔
824		High battery volts delay	0:00:00	✔	✔	✔	✔
825		Charge alt shutdown enable	On (1), Off (0)	✔	✔	✔	✔
826		Charge alt shutdown trip	00.0 V	✔	✔	✔	✔
827		Charge alt shutdown delay	0:00:00	✔	✔	✔	✔
828		Charge alt warning enable	On (1), Off (0)	✔	✔	✔	✔
829		Charge alt warning trip	00.0 V	✔	✔	✔	✔
830		Charge alt warning delay	0:00:00	✔	✔	✔	✔
831		Low battery start arming	On (1), Off (0)	✔	✔	✔	✔
832		Low battery start threshold	00.0 V	✔	✔	✔	✔
833		Low battery start delay	0:00:00	✔	✔	✔	✔
834		Low battery start run time	0:00:00	✔	✔	✔	✔

CONFIGURATION PARAMETERS – ALT' CONFIGURATION (PAGE 9)				4410		4420	
				MPU	CAN	MPU	CAN
901		Default configuration	Main(0), Alternative(1)	✔	✔	✔	✔
902		Alt config - Enable configuration	On (1), Off (0)	✔	✔	✔	✔
903		Alt config - Alternative Engine Speed	On (1), Off (0)	X	✔	X	✔
904		Alt config - Under Voltage Shutdown enable	On (1), Off (0)	✔	✔	✔	✔
905		Alt config - Under Voltage Shutdown trip	0 V	✔	✔	✔	✔
906		Alt config - Loading Voltage	0 V	✔	✔	✔	✔
907		Alt config - Over Voltage trip	0 V	✔	✔	✔	✔
908		Alt config - Under frequency shutdown enable	On (1), Off (0)	✔	✔	✔	✔
909		Alt config - Under frequency shutdown trip	0.0 Hz	✔	✔	✔	✔
910		Alt config - Loading Frequency	0.0 Hz	✔	✔	✔	✔
911		Alt config - Nominal Frequency	0.0 Hz	✔	✔	✔	✔
912		Alt config - Over Frequency shutdown enable	On (1), Off (0)	✔	✔	✔	✔
913		Alt config - Over Frequency shutdown trip	0.0 Hz	✔	✔	✔	✔
914		Alt config - AC system	0 (AC system)	X	X	✔	✔
915		Alt config - Mains failure detection	On (1), Off (0)	X	X	✔	✔
916		Alt config - Immediate mains dropout	On (1), Off (0)	X	X	✔	✔
917		Alt config - Mains under volt enable	On (1), Off (0)	X	X	✔	✔
918		Alt config - Mains under volt trip	0 V	X	X	✔	✔
919		Alt config - Mains under volt return	0 V	X	X	✔	✔
920		Alt config - Mains over volt enable	On (1), Off (0)	X	X	✔	✔
921		Alt config - Mains over volt return	0 V	X	X	✔	✔
922		Alt config - Mains over volt trip	0 V	X	X	✔	✔
923		Alt config - Mains under frequency enable	On (1), Off (0)	X	X	✔	✔
924		Alt config - Mains under frequency trip	0.0 Hz	X	X	✔	✔
925		Alt config - Mains under frequency return	0.0 Hz	X	X	✔	✔
926		Alt config - Mains over frequency enable	On (1), Off (0)	X	X	✔	✔
927		Alt config - Mains over frequency return	0.0 Hz	X	X	✔	✔
928		Alt config - Mains over frequency trip	0.0 Hz	X	X	✔	✔
929		Alt config - Alternative Under speed shutdown enable	On (1), Off (0)	✔	✔	✔	✔
930		Alt config - Alternative Under speed shutdown trip	0000 rpm	✔	✔	✔	✔
931		Alt config - Alternative Over speed shutdown trip	0000 rpm	✔	✔	✔	✔

CONFIGURATION PARAMETERS – FLEXIBLE SENSOR (PAGE 10)				4410		4420	
				MPU	CAN	MPU	CAN
1001	C	Flexible sensor alarm arming	0 (Arming)	✔	✔	✔	✔
1002	C	Flexible sensor - Low alarm enable	0 (Arming)	✔	✔	✔	✔
1003	C	Flexible sensor - Low alarm trip (units depend upon sensor type)	0 % 0.00 bar 0 ℃	✔	✔	✔	✔
1004	C	Flexible sensor - High alarm enable	0 % 0.00 bar 0 ℃	✔	✔	✔	✔
1005	C	Flexible sensor - High alarm trip (units depend upon sensor type)	0 (Action)	✔	✔	✔	✔
1006	C	Flexible sensor - Low warning enable	0 % 0.00 bar 0 ℃	✔	✔	✔	✔
1007	C	Flexible sensor - Low warning trip (units depend upon sensor type)	On (1), Off (0)	✔	✔	✔	✔
1008	C	Flexible sensor – High warning enable	0 % 0.00 bar 0 ℃	✔	✔	✔	✔
1009	C	Flexible sensor – High warning trip (units depend upon sensor type)	On (1), Off (0)	✔	✔	✔	✔

Flexible sensor type selection	
0	None
1	Digital input
2	Percentage sensor
3	Pressure sensor
4	Temperature sensor

CONFIGURATION PARAMETERS – SCHEDULER (PAGE 11)			4410		4420	
			MPU	CAN	MPU	CAN
1101	Enable scheduler	On (1), Off (0)	✔	✔	✔	✔
1102	On or off load	On (1), Off (0)	✔	✔	✔	✔
1103	Start time	0:00:00	✔	✔	✔	✔
1104	Day	0 (Day, 0=Monday)	✔	✔	✔	✔
1105	Duration	0:00:00	✔	✔	✔	✔

CONFIGURATION PARAMETERS – TIME (PAGE 12)			4410		4420	
			MPU	CAN	MPU	CAN
1201	Time of day	0:00	✔	✔	✔	✔
1202	Day of week	0 (Day, 0=Monday)	✔	✔	✔	✔

Parameters with multiple choices use the following identification tables for the parameter values.

INPUT SOURCE LIST		4410	4420
0	User Configured	✔	✔
1	Alarm Mute	✔	✔
2	Alarm Reset	✔	✔
3	Alternative Configuration	✔	✔
4	Auto restore inhibit	X	✔
5	Auto start inhibit	✔	✔
6	Auxiliary mains fail	X	✔
7	Coolant Temperature Switch	✔	✔
8	Emergency Stop	✔	✔
9	External Panel Lock	✔	✔
10	RESERVED		
11	Generator load inhibit	✔	✔
12	Lamp Test	✔	✔
13	Low Fuel Level Switch	✔	✔
14	RESERVED		
15	Mains load inhibit	X	✔
16	Oil Pressure Switch	✔	✔
17	Remote Start Off Load	✔	✔
18	Remote Start On Load	✔	✔
19	Simulate mains available	X	✔
20	Smoke Limiting	✔	✔
21	Transfer to Generator/Open Mains (4420) Close Generator (4410)	✔	✔
22	Transfer to Mains/Open Generator (4420) Open Generator (4410)	✔	✔

INPUT ACTION LIST	
Index	**Action**
0	Electrical Trip
1	Shutdown
2	Warning

INPUT ARMING LIST	
Index	**Arming**
0	Always
1	From Safety On
2	From Starting
3	Never

INPUT POLARITY LIST	
Index	**Action**
0	Close to Activate
1	Open to Activate

OUTPUT POLARITY LIST	
Index	**Arming**
0	Energise
1	De-energise

CAN DATA FAIL ACTION	
Index	**Action**
0	None
1	Shutdown
2	Warning always latched

CAN DATA FAIL ARMING	
Index	**Arming**
0	From Safety On
1	From Starting

Oil pressure Sensor selection	
0	Not used
1	Digital closed for alarm
2	Digital open for alarm
3	VDO 5 Bar
4	VDO 10 Bar
5	Datacon 5 Bar
6	Datacon 10 Bar
7	Datacon 7 Bar
8	Murphy 7 Bar
9	CMB812
10	Veglia
11	User defined

Coolant temperature sensor selection	
0	Not used
1	Digital closed for alarm
2	Digital open for alarm
3	VDO 120 ℃
4	Datacon high
5	Datacon low
6	Murphy
7	Cummins
8	PT100
9	Veglia
10	Beru
11	User defined

Flexible sensor selections for Percentage type	
0	Not used
1	Digital closed for alarm
2	Digital open for alarm
3	VDO Ohm range (10-180)
4	VDO Tube (90-0)
5	US Ohm range (240-33)
6	GM Ohm range (0-90)
7	GM Ohm range (0-30)
8	Ford (73-10)
9	User defined

OUTPUT SOURCE LIST		4410		4420	
		MPU	CAN	MPU	CAN
0	Not used	✔	✔	✔	✔
1	Air Flap relay (1)	✔	✔	✔	✔
2	Arm safety on alarms	✔	✔	✔	✔
3	Audible Alarm	✔	✔	✔	✔
4	Battery over volts warning	✔	✔	✔	✔
5	Battery under volts warning	✔	✔	✔	✔
6	CAN ECU data fail	X	✔	X	✔
7	CAN ECU error	X	✔	X	✔
8	CAN ECU fail	X	✔	X	✔
9	CAN ECU power	X	✔	X	✔
10	CAN ECU stop	X	✔	X	✔
11	Charge alternator shutdown	✔	✔	✔	✔
12	Charge alternator warning	✔	✔	✔	✔
13	Close Gen output	✔	✔	✔	✔
14	Close Gen output pulse	✔	✔	✔	✔
15	Close Mains output	X	X	✔	✔
16	Close Mains output pulse	X	X	✔	✔
17	Combined mains failure	X	X	✔	✔
18	Common Alarm	✔	✔	✔	✔
19	Common Electrical Trip	✔	✔	✔	✔
20	Common Shutdown	✔	✔	✔	✔
21	Common Warning	✔	✔	✔	✔
22	Cooling down	✔	✔	✔	✔
23	Dig Input A	✔	✔	✔	✔
24	Dig Input B	✔	✔	✔	✔
25	Dig Input C	✔	✔	✔	✔
26	Dig Input D	✔	✔	✔	✔
27	Dig Input E	✔	✔	✔	✔
28	Dig Input F	✔	✔	✔	✔
29	Emergency stop	✔	✔	✔	✔
30	Energise to stop	✔	✔	✔	✔
31	Fail to come to rest	✔	✔	✔	✔
32	Fail to start	✔	✔	✔	✔
33	Fuel relay	✔	✔	✔	✔
34	Gas choke on	✔	X	✔	X
35	Gas ignition	✔	X	✔	X
36	Generator Available	✔	✔	✔	✔
37	Generator over voltage shutdown	✔	✔	✔	✔
38	RESERVED	✔	✔	✔	✔
39	RESERVED	✔	✔	✔	✔
40	Loss of magnetic pickup signal	✔	X	✔	X
41	Low fuel level	✔	✔	✔	✔
42	Low oil pressure (shutdown)	✔	✔	✔	✔
43	Mains high frequency	X	X	✔	✔
44	Mains high voltage	X	X	✔	✔
45	Mains low frequency	X	X	✔	✔
46	Mains low voltage	X	X	✔	✔
47	Open Gen Output	✔	✔	✔	✔
48	Open Gen Output pulse	✔	✔	✔	✔
49	Open Mains Output	X	X	✔	✔
50	Open Mains Output Pulse	X	X	✔	✔
51	Over Frequency shutdown	✔	✔	✔	✔
52	Over speed shutdown	✔	✔	✔	✔
53	Preheat During Preheat Timer	✔	✔	✔	✔
54	Preheat Until End of Crank	✔	✔	✔	✔
55	Preheat Until End of Safety Timer	✔	✔	✔	✔
56	Preheat Until End of Warming Timer	✔	✔	✔	✔
57	Smoke limiting	✔	✔	✔	✔
58	Start relay	✔	✔	✔	✔
59	Under frequency shutdown	✔	✔	✔	✔
60	Under speed shutdown	✔	✔	✔	✔
61	Waiting for manual restore	X	X	✔	✔

9 COMMISSIONING

9.1.1 PRE-COMMISSIONING

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

- 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.
- The unit **DC** supply is fused and connected to the battery and that it is of the correct polarity.
- The Emergency Stop input is wired to an external normally closed switch connected to **DC** negative. Check the module configuration to determine which input (if any) is configured to *Emergency Stop.*

NOTE:- If Emergency Stop feature is not required, ensure there is no input configured to this function.

- 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. Select **"MANUAL"** and then press **"START"** the unit start sequence will commence.
- The starter will engage and operate 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 will display 'Failed *to start*. Select the **STOP/RESET** position to reset the unit.
- Restore the engine to operational status (reconnect the fuel solenoid). Select **"MANUAL"** and then press **"START"**. 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 will be possible at this time to view the engine and alternator parameters - refer to the 'Description of Controls' section of this manual.
- Select **"AUTO"** on the front panel, the engine will run for the pre-set cooling down period, then stop. The generator should stay in the standby mode. If not, check that there is no signal present on the **Remote start** input.
- Initiate an automatic start by supplying the remote start signal (if configured). The start sequence will commence and the engine will run up to operational speed. Once the generator is available a load transfer will take place (if configured), the Generator will accept the load. If not, check the wiring to the Generator Contactor Coil *(if used)*. Check the Warming timer has timed out.
- Remove the remote start signal. The return sequence will begin. After the pre-set time, the generator is unloaded. The generator will then run for the pre-set cooling down period, then shutdown into its standby mode.
- Set the module 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 – Editing the date and time.*
- If, despite repeated checking of the connections between the **4000** series controller and the customer's system, satisfactory operation cannot be achieved, then the customer is requested to contact the factory for further advice on:-

INTERNATIONAL TEL: +44 (0) 1723 890099
INTERNATIONAL FAX: +44 (0) 1723 893303
E-mail: Support@Deepseaplc.com
Website : www.deepseaplc.com

10 FAULT FINDING

SYMPTOM	POSSIBLE REMEDY
Unit is inoperative Read/Write configuration does not operate	Check the battery and wiring to the unit. Check the DC supply. Check the DC fuse.
Unit shuts down	Check DC supply voltage is not above 35 Volts or below 9 Volts Check the operating temperature is not above 70℃. Check the DC fuse.
Unit locks out on Emergency Stop	If no Emergency Stop Switch is fitted, ensure that a DC positive signal is connected to the Emergency Stop input. Check emergency stop switch is functioning correctly. Check Wiring is not open circuit.
Intermittent Magnetic Pick-up sensor fault	Ensure that Magnetic pick-up screen only connects to earth at one end, if connected at both ends, this enables the screen to act as an aerial and will pick up random voltages. Check pickup is correct distance from the flywheel teeth.
Low oil Pressure fault operates after engine has fired	Check engine oil pressure. Check oil pressure switch/sensor and wiring. Check configured polarity (if applicable) is correct (i.e. Normally Open or Normally Closed) or that sensor is compatible with the 4400 Module and is correctly configured.
High engine temperature fault operates after engine has fired.	Check engine temperature. Check switch/sensor and wiring. Check configured polarity (if applicable) is correct (i.e. Normally Open or Normally Closed) or that sensor is compatible with the 4400 series module.
Shutdown fault operates	Check relevant switch and wiring of fault indicated on LCD display. Check configuration of input.
Warning fault operates	Check relevant switch and wiring of fault indicated on LCD display. Check configuration of input.
Fail to Start is activated after pre-set number of attempts to start	Check wiring of fuel solenoid. Check fuel. Check battery supply. Check battery supply is present on the Fuel output of the module. Check the speed-sensing signal is present on the 4400 series module inputs. Refer to engine manual.
Continuous starting of generator when in **AUTO**	Check that there is no signal present on the “Remote Start” input. Check configured polarity is correct.
Generator fails to start on receipt of Remote Start signal.	Check Start Delay timer has timed out. Check signal is on “Remote Start” input. Confirm correct configuration of input is configured to be used as “Remote Start”. Check that the oil pressure switch or sensor is indicating low oil pressure to the controller. Depending upon configuration, the set will not start if oil pressure is not low.
Pre-heat inoperative	Check wiring to engine heater plugs. Check battery supply. Check battery supply is present on the Pre-heat output of module. Check pre-heat configuration is correct.
Starter motor inoperative	Check wiring to starter solenoid. Check battery supply. Check battery supply is present on the Starter output of module. Ensure that the Emergency Stop input is at Positive. Ensure oil pressure switch or sensor is indicating the “low oil pressure” state to the 4400 series controller.
Engine runs but generator will not take load	Check Warm up timer has timed out. Ensure generator load inhibit signal is not present on the module inputs. Check connections to the switching device. Note that the set will not take load in manual mode unless there is an active remote start on load signal.

SYMPTOM	POSSIBLE REMEDY
Incorrect reading on Engine gauges Fail to stop alarm when engine is at rest	Check engine is operating correctly. Check sensor and wiring.
Module appears to 'revert' to an earlier configuration	When editing a configuration using the PC software it is vital that the configuration is first 'read' from the controller before editing it. This edited configuration must then be "written" back to the controller for the changes to take effect. When editing a configuration using the Front Panel Editor, be sure to press the Save button to save the change before moving to another item or exiting the Front Panel Editor.
Set will not take load	Ensure the generator is available. Check that the output configuration is correct to drive the load switch device and that all connections are correct. Remember that the set will not take load in manual mode unless a remote start on load input is present.
Inaccurate generator measurements on controller display	The 4000 series controller is true RMS measuring so gives more accurate display when compared with an 'average' meter such as an analogue panel meter or some lower specified digital multimeters. Accuracy of the controller is better than 1% of full scale. Ie Gen volts full scale is 333V ph-n so accuracy is ±3.33V (1% of 333V).

NOTE:- The above fault finding is provided as a guide check-list only. As the module can be configured to provide a wide range of different features, always refer to the source of your module configuration if in doubt.

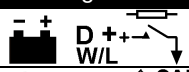
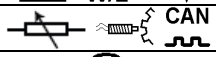
11 MAINTENANCE, SPARES, REPAIR AND SERVICING

The DSE4400 Series controller is designed to be *Fit and Forget*. As such, there are no user serviceable parts within the controller.
In the case of malfunction, you should contact your original equipment supplier (OEM).

11.1 PURCHASING ADDITIONAL CONNECTOR PLUGS FROM DSE

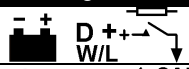
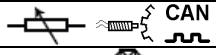
If you require additional plugs from DSE, please contact our Sales department using the part numbers below.

11.1.1 DSE4410

4410 terminal designation	Plug description	Part No.
1-9 	9 way 5.08mm	007-167
10-16 	7 way 5.08mm	007-155
17-20 	4 way 7.62mm	007-171
25-28 	4 way 5.08mm	007-444

NOTE:- Terminals 21-24 are not fitted to DSE4410 controller.

11.1.2 DSE4420

4410 terminal designation	Plug description	Part No.
1-9 	9 way 5.08mm	007-167
10-16 	7 way 5.08mm	007-155
17-24 	8 way 7.62mm	007-454
25-28 	4 way 5.08mm	007-444

11.2 PURCHASING ADDITIONAL FIXING CLIPS FROM DSE

Item	Description	Part No.
	4400 series fixing clips (packet of 4)	020-294

11.3 PURCHASING SEALING GASKET FROM DSE

The optional sealing gasket is not supplied with the controller but can be purchased separately.

Item	Description	Part No.
	4400 series silicon sealing gasket	020-313

12 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).

13 DISPOSAL

13.1 WEEE (WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT)

Directive 2002/96/EC
If you use electrical and electronic equipment you must store, collect, treat, recycle and dispose of WEEE separately from your other waste.

13.2 ROHS (RESTRICTION OF HAZARDOUS SUBSTANCES)

Directive 2002/95/EC:2006
To remove specified hazardous substances (Lead, Mercury, Hexavalent Chromium, Cadmium, PBB & PBDE´s)

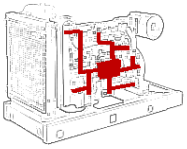
Exemption Note: Category 9. (Monitoring & Control Instruments) as defined in Annex 1B of the WEEE directive will be exempt from the RoHS legislation. This was confirmed in the August 2005 UK´s Department of Trade and Industry RoHS REGULATIONS Guide (Para 11).

Despite this exemption DSE has been carefully removing all non RoHS compliant components from our supply chain and products.
When this is completed a Lead Free & RoHS compatible manufacturing process will be phased into DSE production.

This is a process that is almost complete and is being phased through different product groups.

14 APPENDIX

14.1 CAN INTERFACE



44x0-xxx-02 Modules are fitted with the CAN interface and are capable of receiving engine data from engine CAN controllers compliant with the CAN standard.
CAN enabled engine controllers monitor the engines operating parameters such as engine speed, oil pressure, engine temperature (among others) in order to closely monitor and control the engine. The industry standard communications interface (CAN) transports data gathered by the engine controller interface (CAN). This allows generator controllers such as the DSE 4400 to access these engine parameters with no physical connection to the sensor device.

NOTE:- For further details for connections to CAN enabled engines and the functions available with each engine type, refer to the manual *Electronic Engines and DSE Wiring.* Part No. 057-004

14.2 COMMUNICATIONS OPTION CONNECTIONS

14.2.1 DESCRIPTION

The 4400 series configuration software allows the controller to communicate with a PC. The computer connects to the module as shown below and allows easy adjustment of the operating parameters and firmware update of the controller.

14.2.2 PC TO CONTROLLER (DIRECT) CONNECTION

To connect a 4400 series module to a PC the following items are required: -

- 4400 series module

- 4400 series configuration software (Supplied on configuration suite software CD or available from www.deepseaplc.com free of charge).

- USB cable Type A to Type B.

NOTE:- The DC supply must be connected to the module for configuration by PC.

NOTE:- Refer to 44xx software Manual for further details on configuring the module by PC.

14.3 ENCLOSURE CLASSIFICATIONS

IP CLASSIFICATIONS

4400 series specification under BS EN 60529 Degrees of protection provided by enclosures

IP65 (Front of module when module is installed into the control panel with the supplied sealing gasket).
IP42 (front of module when module is installed into the control panel WITHOUT being sealed to the panel)

First Digit Protection against contact and ingress of solid objects		Second Digit Protection against ingress of water	
0	No protection	0	No protection
1	Protected against ingress solid objects with a diameter of more than 50 mm. No protection against deliberate access, e.g. with a hand, but large surfaces of the body are prevented from approach.	1	Protection against dripping water falling vertically. No harmful effect must be produced (vertically falling drops).
2	Protected against penetration by solid objects with a diameter of more than 12 mm. Fingers or similar objects prevented from approach.	2	Protection against dripping water falling vertically. There must be no harmful effect when the equipment (enclosure) is tilted at an angle up to 15° from its normal position (drops fal ling at an angle).
3	Protected against ingress of solid objects with a diameter of more than 2.5 mm. Tools, wires etc. with a thickness of more than 2.5 mm are prevented from approach.	3	Protection against water falling at any angle up to 60° from the vertical. There must be no harmful effect (spray water).
4	Protected against ingress of solid objects with a diameter of more than 1 mm. Tools, wires etc. with a thickness of more than 1 mm are prevented from approach.	4	Protection against water splashed against the equipment (enclosure) from any direction. There must be no harmful effect (splashing water).
5	Protected against harmful dust deposits. Ingress of dust is not totally prevented but the dust must not enter in sufficient quantity to interface with satisfactory operation of the equipment. Complete protection against contact.	5	Protection against water projected from a nozzle against the equipment (enclosure) from any direction. There must be no harmful effect (water jet).
6	Protection against ingress of dust (dust tight). Complete protection against contact.	6	Protection against heavy seas or powerful water jets. Water must not enter the equipment (enclosure) in harmful quantities (splashing over).

NEMA CLASSIFICATIONS

4400 series NEMA Rating (Approximate)
12 (Front of module when module is installed into the control panel with the optional sealing gasket).
2 (front of module when module is installed into the control panel WITHOUT being sealed to the panel)

NOTE: - There is no direct equivalence between IP / NEMA ratings. IP figures shown are approximate only.

1 **IP30**	Provides a degree of protection against contact with the enclosure equipment and against a limited amount of falling dirt.
2 **IP31**	Provides a degree of protection against limited amounts of falling water and dirt.
3 **IP64**	Provides a degree of protection against windblown dust, rain and sleet; undamaged by the formation of ice on the enclosure.
3R **IP32**	Provides a degree of protection against rain and sleet:; undamaged by the formation of ice on the enclosure.
4 (X) **IP66**	Provides a degree of protection against splashing water, windblown dust and rain, hose directed water; undamaged by the formation of ice on the enclosure. (Resist corrosion).
12/12K **IP65**	Provides a degree of protection against dust, falling dirt and dripping non corrosive liquids.
13 **IP65**	Provides a degree of protection against dust and spraying of water, oil and non corrosive coolants.