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DEEP SEA ELECTRONICS

Electronic Engines and DSE Controllers

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ELECTRONIC ENGINES AND DSE CONTROLLERS
(Previously named CAN AND DSE CONTROLLERS)

Amendments since last publication

Amd. No.	Comments
1	Added DSE7000 Series
2	Updated most engines with more detail
3	Added 3110 controller

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.

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1 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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SAE	Society of Automotive Engineers (USA)

2 INTRODUCTION

2.1 CAN

Controller Area Network (CAN) is a serial bus standard, originally developed in the 1980s by Robert Bosch GmbH, for connecting electronic control units (ECUs). CAN was specifically designed to be robust in noisy environments. It can be even more robust against noise if twisted pair wire is used. Although initially created for automotive purposes, nowadays it is used in many embedded control applications (e.g., generator sets) that may be subject to noise.

2.2 SAE J1939

SAE J1939 is the Vehicle Network Communication standard using CAN for communication and diagnostics by the heavy duty truck industry.
As generator engines are usually based upon truck engines, this standard has also been adopted by the majority of (but not all) Generator Engine Manufacturers.
For instance MTU engines use CAN but have not adopted J1939. However DSE controllers are also compatible with and officially certified for use with MTU engines.

2.3 RS485

RS485 is is a serial bus standard for connecting multiple devices to the same bus.
This connection standard is used by Cummins on some engine ranges rather than the CAN standard adopted by other genset manufacturers. However DSE 5300 Series controllers are also compatible with the Cummins RS485 enabled engines.

2.4 TWISTED PAIR CABLING

Twisted pair (TP) cabling is a common form of wiring in which two conductors are wound around each other for the purposes of canceling out electromagnetic interference (known as crosstalk).
The number of twists in the cable per meter make up part of the specification for a given type of cable. The greater the number of twists, the more crosstalk is reduced.
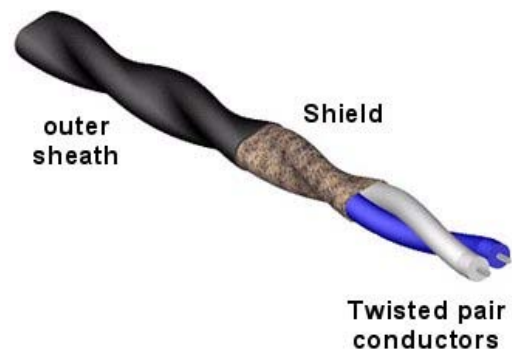
Twisting wires decreases interference because:
The loop area between the wires (which determines the magnetic coupling into the signal) is reduced as much as physically possible.
The directions of current generated by a uniform coupled magnetic field is reversed for every twist, canceling each other out.

The characteristic impedance of a twisted pair cable is around 100Ω making it suitable for both CAN or RS485 use. Screened, Shielded Twisted Pair is particularly suitable as the screening and shield offer even more protection.

If incorrect cable type is used it will lead to data transmission errors in the future, potentially after commissioning and the engineer has left site!

⚠**NOTE:- DSE stock and supply Belden cable 9841 which is a high quality 120Ω impedance cable suitable for CAN or RS485 use (DSE part number 016-030)**

2.5   IMPEDANCE MATCHING

When sending power down a transmission line, it is desirable that all the power is absorbed by the load and none of it is reflected back to the source. This can be ensured by making the source and load impedances equal in which case the line is said to be matched.
CAN and RS485 specifies 120Ω cable be used with 120Ω termination resistors at each end to match impedances. The termination resistor is fitted internally into the DSE CAN interface controller so is not required externally. Ensure that the DSE controller is the 'last' device on the communications link where more than one device is connected to the engine ECU's CAN connector.

If the cable impedance and/or termination resistors are not correctly fitted, this can cause some of the received signal to be 'reflected' back to the transmitting module. This reflection will 'collide' with further data transmissions, causing data transmission errors.

⚠NOTE:- The DSE RS485 interface does not include the 120Ω termination resistor internally so must be fitted externally.
The RS485 interface is NOT used for CAN engines.

3   ELECTRONIC ENGINES AND THE DSE MODULE

3.1   INSTRUMENTATION

As the Engine ECU is connected to measurement sensors on the engine, this instrumentation is available to be read into the DSE controller.
All DSE electronic engine enabled controllers will read engine oil pressure, engine coolant temperature and engine speed from the engine ECU.
In addition to this, 53xx, 55xx and 7xxx controllers will display "enhanced engine ECU instrumentation" when it is supported by the engine ECU.
This information can also be viewed using the *Engine instrumentation* pages of the configuration software.

Engine Oil Temperature	Inlet Manifold Temperature
	Temp. 1 Temp. 2
Exhaust Temperature	Coolant Pressure
Temp. 1 Temp. 2	Press. 1 Press. 2
Fuel Pressure	Turbo Pressure
Press. 1 Press. 2	Press. 1 Press. 2
Total Fuel Used	Fuel Consumption

When the ECU is not powered it is not possible to read the diagnostic trouble codes or instrumentation. See the section entitled *Turning on the ECU manually.*

NOTE:- 3110 controllers do not support SCADA monitoring by PC software.

NOTE:- 42xx controllers do not support 'enhanced engine ECU instrumentation'.

**NOTE:-   When connected to an active ECU supporting the instrument, the instrument's value is shown on the DSE module screen and also on the PC remote instrumentation page.
When the ECU is not powered, engine ECU instrumentation will indicate # # #
When instrument has an errors (for instance sensor errors), x x x is displayed.
Unsupported instruments have blank values (no indication).**

NOTE:- Some engine ECUs do not support all of the 'enhanced engine ECU instrumentation'. The unsupported displays will appear blank on the module display.

3.2   USE OF ENGINE MANUFACTURERS SOFTWARE TOOLS

Occasionally it is necessary to connect the engine manufacturers software tools to the engine ECU in order to make changes to the engine configuration.
The ECU may need to be powered up to perform this operation and as the ECU is normally only powered when the engine is running, it must be turned on manually as described in the following section.

**NOTE:- If the manufacturers software tool connects to the same CAN interface as the DSE module, ensure the DSE module is the 'last' device on the CAN interface.
If the tool does not operate when connected to the same CAN interface as the DSE module, you are referred to your engine manufacturer.**

3.3   TURNING ON THE ECU MANUALLY

When the ECU is not powered it is not possible to read the diagnostic trouble codes or instrumentation. Additionally, it is not possible to use the engine manufacturers configuration tools. As the ECU is unpowered when the engine is not running, it must be turned on manually as follows :

* Select STOP 🔴 mode on the DSE controller.
* Press and hold the START 🟢 button to power the ECU. As the controller is in STOP mode, the engine will not be started.
* Continue to hold the start button for as long as you need the ECU to be powered.
* The ECU will remain powered until a few seconds after the START button is released.

This is also useful if the engine manufacturer's tools need to be connected to the engine, for instance to configure the engine as the ECU needs to be powered up to perform this operation.

⚠**NOTE:-** DSE3110 does not include the ECU OVERRIDE function.

⚠**NOTE:-** When the ECU is not powered, engine ECU instrumentation will indicate ### on the display of the DSE controller.

⚠**NOTE:-** When it is required for the DSE controller to change ECU settings (ie when the Alternative Frequency setting is changed) the settings will the sent to the ECU the next time the ECU is turned on. "Setting ECU" will appear on the DSE display while this adjustment takes place.

3.4   ECU TROUBLE CODES AND DIAGNOSTICS

⚠**NOTE:-**   DSE3110 controllers display only the common ⛭ Check Engine indicator –
Contact your engine supplier for details.

3.4.1   SPN/FMI CODES

If the engine ECU detects a fault with the engine, it will communicate this problem to the DSE
controller in the form of a "trouble code". There are two levels to these trouble codes

1.   **SPN** = *Suspect Parameter Number*. This indicates what is wrong (i.e. Engine
     temperature).
2.   **FMI** = *Failure Mode Indicator*. This indicates the type of failure (i.e. High).

Example taken from Volvo Penta Engine Documentation :

Oil Pressure Sensor (PID / SPN 100)

The Oil Pressure sensor is used to measure the oil pressure in
the engine.

The Sensor is connected to analogue input with pull down.

Following diagnosis is supported: FMI 1   Value below normal
                                   FMI 3   SC +
                                   FMI 5   OC

SPN 100, FMI 1 = Means Oil Pressure Sensor - Value below Normal
SPN 100, FMI 3 = Means Oil Pressure Sensor - Short Circuit
SPN 100, FMI 5 = Means Oil Pressure Sensor - Open Circuit

The DSE controller will display these codes in text format :

Alarm
Can ECU fail
Low Oil Pressure

Where an 'unknown' code is sent by the ECU, the DSE controller will display the SPN/FMI
code number allowing the user to cross reference this information with the fault codes
supplied by the engine manufacturer.

The DSE fault text display replaces the flashing "twinkle code" lamp available on some trouble
code display systems giving a much more user friendly interface to the engine ECU.

Each alarm can be one of two types, **ECU ERROR** or **ECU FAIL**. These are detailed in the
following sections.

With DSE7000 Series controllers, these alarms are named **CAN ECU WARNING** and **CAN
ECU SHUTDOWN**.

⚠**NOTE:-**   DSE3110 controllers display only the common ⛭ Check Engine indicator –
Contact your engine supplier for details.

3.4.2 CAN ECU ERROR (CAN ECU WARNING)

⚠️**NOTE:-** DSE3110 controllers display only the common 🔧 ECM Check Engine indicator – Contact your engine supplier for details.

This is a "warning" type alarm (Sometimes called the *yellow lamp alarm* by engine manufacturers) – the engine ECU does not shutdown the engine, it continues to run. The DSE controller takes no action other than to generate a **warning alarm** and to indicate the alarm via the fascia display.

Example

Alarm
Can ECU error Exhaust high temperature

The display will alternate between the text display and the manufacturers error codes.

Alarm
Can ECU error SPNxx FMIxx

3.4.3 CAN ECU FAIL (CAN ECU SHUTDOWN)

⚠️**NOTE:-** DSE3110 controllers display only the common 🔧 ECM Check Engine indicator – Contact your engine supplier for details.

This is a "shutdown" type alarm (Sometimes called the *red lamp alarm* by engine manufacturers) – the engine has been shutdown by the ECU. The DSE controller performs the relevant shutdown procedure for the ECU as dictated by the *CAN file* selection, generates a **shutdown alarm** and indicates the alarm via the fascia display.

Example

Alarm
Can ECU fail Fuel pressure low

The display will alternate between the text display and the manufacturers error codes

Alarm
Can ECU fail SPNxx FMIxx

⚠️**NOTE: -** If the CAN message is a manufacturers specific code, it may not be displayed as text. If this is the case, the display will show the generic manufacturers code only, which must be cross-referenced with the engine manufacturer's literature. Please contact the engine manufacturer for further assistance.

The above displays show a standard J1939 based system. Other manufacturers systems supported by the module work in a similar way though the exact detail may vary from those illustrated.

Example

Alarm
Can ECU fail SPNxx FMIxx

To reset latched warning faults on the engine ECU, press the DSE controller mute 🔇 button. To reset latched shutdown faults on the engine ECU, press the DSE controller stop/reset 🔴 button.

3.4.4   CAN DATA FAIL

As the engine ECU CAN link is used to provide engine protection, it is a matter of safety that the CAN link remains intact.
If the link is not operative during normal running, an engine shutdown will occur and '**Can data fail**' is shown on the module's display :

Alarm
Shutdown
Can data fail

As the CAN link is not operative, shutdown of the engine cannot be made using a CAN message (!).
In this case, the only method of shutdown is via the **ECU STOP** output.

> ⚠**NOTE:-** The check for data on the ECU link takes place after the DSE controller's safety delay timer.

> ⚠**NOTE:-** DSE3110 controllers display ᶜᴬᴺ to indicate CAN Data Fail alarm.

4   CONNECTIONS

As the connections to DSE controllers are similar across the DSE range the engine ECU connections are common for all controllers. The following table details the differences between the different ranges.

4.1   OUTPUTS

	Fuel	Start	Output 1	Output 2
3110	Use output A (terminal 3)	Use output B (terminal 4)	5 (C)	6 (D)
42xx	Use output 1 (terminal 6)	Use output 5 (terminal 18,19)*	6*	7*
53xx	4	5	6	7
55xx	4	5	6	7
72xx	4	5	8 (E)	9 (F)
73xx	4	5	8 (E)	9 (F)

4.2   CAN / RS485

	CAN SCR	CAN H	CAN L	RS485 SCR	RS485 B	RS485 A
3110	N/A	10	11	N/A	N/A	N/A
42xx	10	11	12	N/A	N/A	N/A
53xx	20	21	22	23	24	25
55xx	23	24	25	29	30	31
72xx	27	25	26	SCR	B	A
73xx	27	25	26	SCR	B	A

⚠NOTE:- The CAN and RS485 specifications, require that a 120Ω terminator is fitted to each end of the communications link. This termination resistor is fitted internally into the DSE CAN interface so is not required externally. Ensure that the DSE controller is the 'last' device on the communications link where more than one device is connected to the engine ECU's CAN connector.
However, the DSE RS485 interface does not include the 120Ω termination resistor internally, this is supplied loose with the RS485 enabled controller.

⚠NOTE*:- 42xx Series controllers have 4 solid state outputs that switch to battery negative when active. For further information please see the relevant product operators manual.
**Additionally output 5 is a 16A volts-free relay.**

⚠NOTE:- 3000 Series fuel/start outputs are rated at 2A DC. 3000 Series auxiliary outputs are rated at 2A DC.

⚠NOTE:- 5000 Series fuel/start outputs are rated at 16A DC. 5000 Series auxiliary outputs are rated at 5A DC.

⚠NOTE:- 7000 Series fuel/start outputs are rated at 16A DC. 7000 Series auxiliary outputs are rated at 3A DC.

4.3 TYPICAL CONNECTIONS

Connections between the DSE controller and the engine system are similar for all engine types and includes connection to the Engine ECU link and in some engine types, ancilliary control is also required.
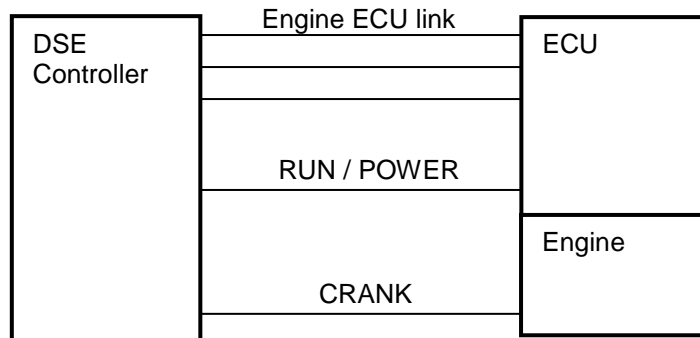
⚠NOTE:- RUN/POWER and CRANK are not required with all engine types. See specific connection lists elsewhere in this manual for further details.

4.4 ECU POWER AND ECU STOP OUTPUTS

DSE controllers have configurable ouput sources specifically designed to control the engine ECU. These are labelled CAN *ECU Power* and *ECU Stop* in the DSE configuration software.
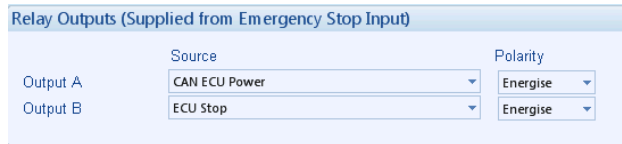
The exact timing/sequence of their operation varies slightly depending upon the configuration of "Electronic Engine type" but essentially their functions are as follows:

4.4.1 ECU POWER
Normally used to turn on the ECU (sometimes via an external slave relay).
Some engine ECUs are permanently powered in which case the ECU Power output is used to give input to a Run (or similarly named) input on the ECU.

4.4.2 ECU STOP
Used to give input to a Stop (or similarly named) input on the ECU. This is used as a backup stop system should the ECU Data link fail. In this instance, it's not possible to stop the engine using a data command as the link is not operative. As a backup, the STOP signal is given to the engine via a separate hardwired connection.

⚠CAUTION!: Check the current rating of the ECU terminals that ECU POWER and ECU STOP signals are connected to and ensure the DSE output rating is not exceeded.

4.5 REMOTE SPEED CONTROL

As the DSE module's analogue inputs for oil pressure and coolant temperature are not used when the module is configured for use with an electronic engine, it it possible to use the coolant temperature input as engine speed control by connecting a potentiometer. Contact Deep Sea Electronics Customer Support Department for further details and to confirm the list of engines that support this feature.

This is currently only support on DSE5300 series controllers.

4.6   CUMMINS

4.6.1   ISB / ISBE

DSE TERMINAL DESCRIPTION	Cummins ISB OEM Harness connector B	NOTES
Fuel relay output	39	Key switch input.
Start relay output	-	Connects directly to engine starter solenoid.
Aux output 1	Use to control a 30A external slave relay to supply DC battery power to 01,07,12,13	Using PC configuration software select the relevant engine and configure 'aux output 1' to be "ECU Power"

DSE TERMINAL DESCRIPTION	Cummins ISB 9 pin Deutsch connector	NOTES
	SAE J1939 shield	Screen for the J1939 cable. Connect at Cummins ECU end only.
CANbus H	SAE J1939 signal	J1939 + Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.
CANbus L	SAE J1939 return	J1939 - Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.

CAN SETUP

The DSE controller must be configured with the correct CAN file for the Cummins ISB engine ECU:

ECU (ECM) Options

Engine Type   Cummins ISB ▼
Enhanced J1939   ☑

4.6.2 QSL9

Engines in the QSL9 range are fitted with the CM850 Engine Control Module. (ECM). This system allows engine instrumentation and diagnostics via the J1939 link.

DSE TERMINAL DESCRIPTION	Cummins CM850 50 pin OEM connector	NOTES
Fuel relay output	39	Key switch input.
Start relay output	-	Connects directly to engine starter solenoid.

DSE TERMINAL DESCRIPTION	Cummins CM850 9 pin Deutsch connector	NOTES
	SAE J1939 shield - E	Screen for the J1939 cable. Connect at Cummins ECU end only.
CANbus H	SAE J1939 signal - C	J1939 + Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.
CANbus L	SAE J1939 return - D	J1939 - Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.

CAN SETUP

The DSE controller must be configured with the correct CAN file for the Cummins CM850 engine ECU:

ECU (ECM) Options

| Engine Type | Cummins CM850 |
| Enhanced J1939 | ☑ |

CONTROL FUNCTIONS SUPPORTED

The analogue input for "oil pressure" analogue can be used for idle speed adjust
The analogue input for "coolant temperature" analogue can be used for run speed adjust (+/-6Hz).

If the ECM has power applied by other means (other than the DSE fuel output) then the error codes 0286 and 0426 will be produced, these codes will clear when the DSE module sends the feeds (ECU override pressed when the module is in stop mode or the engine is started by the DSE controller)

Unlatched warning alarm:
Can ECU error / ECU Warning: Generated whenever a DM1 amber warning lamp is present

Latched shutdown alarm:
Can ECU fail / ECU Shutdown: Generated whenever a DM1 red shutdown lamp is present

4.6.3   QSM 11

⚠️ **NOTE:- 7000 Series modules do not currently support the QSM11 Cummins Modbus Engines.**

Engines in the QSM11 range are fitted with the CM570 Engine Control Module. (ECM). This system allows engine instrumentation and diagnostics via the J1939 link.

Cummins engines fitted with the CM570 ECM: QSM11 G1, QSM11 G2
(This list is not exhaustive, contact Cummins for further details)

DSE TERMINAL DESCRIPTION	Cummins QSM11 OEM connector C1	NOTES
Fuel relay output	5 & 8	Use DSE fuel relay to drive external relay closing Cummins terminals 5 (Run/Stop) and 8 (common return)
Start relay output	-	Connects directly to engine starter solenoid.

DSE TERMINAL DESCRIPTION	Cummins CM570 3 pin data link connector	NOTES
CANbus H	A	J1939 + Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.
CANbus L	B	J1939 - Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.
	C	Screen for the J1939 cable. Connect at Cummins ECU end only.

CAN SETUP

The DSE controller must be configured with the correct CAN file for the Cummins CM570 engine ECM. This ECM is very similar to the Cummins ISB so we can use the CAN file for the ISB :

ECU (ECM) Options

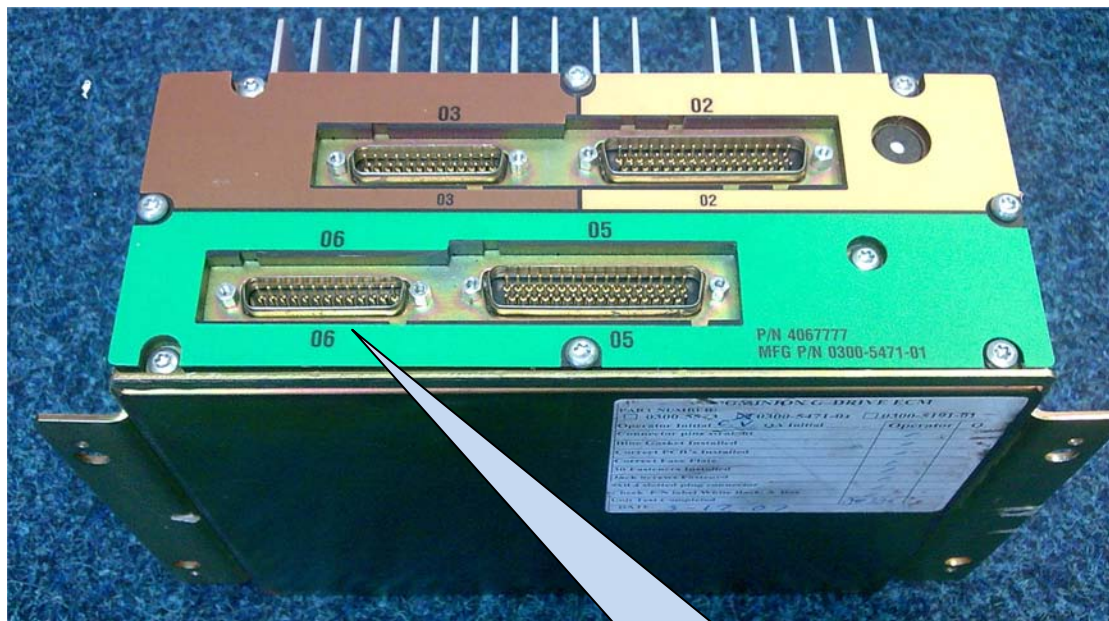Engine Type   Cummins ISB

Enhanced J1939   ☑

4.6.4   QSX15, QST30, QSK23, QKS45, QSK60, QSK78

These engines use a Modbus RS485 protocol and consequently a DSE controller with modbus engine control must be used with these engines (DSE 5310 and 5320 modules V5.0 onwards (RS485 version) or 5510 / 5520 modules V9.0 onwards).

The DSE implementation for *gdrive* allows the display of instrumentation, diagnostic information, and the sending of necessary commands for the normal functioning of the ECU. These engine systems allows engine instrumentation and diagnostics via the RS485 link.

DSE TERMINAL DESCRIPTION	Cummins connections D Sub connector 6	NOTES
Fuel relay output	5 & 8	Use DSE fuel relay to drive external relay closing Cummins terminals 5 (Run/Stop) and 8 (common return)
Start relay output	-	Connects directly to engine starter solenoid via slave relay if required.

DSE TERMINAL DESCRIPTION	Cummins connections D Sub connector 6	NOTES
RS485 A	18	RS485 -
RS485 B	21	RS485 +
	20	Screen for the RS485 cable. Connect at Cummins ECU end only.
	19	Link 19 and 22 together to enable
	22	Cummins ECU 120Ω termination resistor

Cummins D Sub Connector 6

CAN SETUP

The DSE controller must be configured with the correct CAN file for the Cummins engine type:

CANbus options
Engine type   Cummins-QSK-Modbu

CANbus options
Engine type   Cummins-QST-Modbu

CANbus options
Engine type   Cummins-QSX-Modbu

CONTROL FUNCTIONS SUPPORTED

The module displays Warnings and Shutdown messages when a Warning or Shutdown Lamp message is received. The display of diagnostic codes is suppressed if neither a Warning or Shutdown lamp message is present..

Diagnostic codes are shown as the Cummins Fault Code with a short message indicating the fault. The PC software decodes the messages and displays the full text of the Cummins message in addition to the shortened messages.

Shutdown diagnostic information is latched by the module until the stop/reset ⊙ button is pressed.
In addition, if the cause of the shutdown is from the ECU then the diagnostic codes present at the time of shutdown are added into the event log.

A Fault Acknowledge command is sent to controller when the Alarm Mute / Lamp Test 🔕 button is pressed. Diagnostic codes are latched in the module after an unexpected GCS shutdown.
A module alarm will need to be cleared by pressing the red stop button on the module.

⚠**NOTE**:- It may be necessary to press both Alarm Mute and Stop to restart an engine if the ECU is not switched off to clear the faults present.

INSTRUMENTATION AVAILABLE FROM THE MODBUS INTERFACE

- Engine Speed
- Oil Pressure
- Battery Voltage
- Engine Running Time
- Fuel Consumption Rate
- Cumulative Fuel Consumption
- Intake Manifold Pressure (QSX 15 only)
- Intake Manifold Temperature (QSX 15 only)
- Fuel Outlet Pressure (QSX 15 only)
- Oil Temperature (QSX 15 only)
- Intake Manifold Pressure (QSX 30 only)
- Intake Manifold Pressure (Left Bank) (QSX 30 only)
- Intake Manifold Temperature (QSX 30 only)
- Intake Manifold Temperature (Left Bank) (QSX 30 only)
- Coolant Pressure (QSX 30 only) (QSX 30 only)
- Oil Temperature (QSX 30 only)
- Fuel Supply Pressure (QSX 30 only)
- Fuel Temperature (QSX 30 only)
- Intake Manifold Pressure (QSK 23 / 45 / 60 / 78 only)
- Intake Manifold Temperature (QSK 23 / 45 / 60 / 78 only)
- Coolant Pressure (QSK 23 / 45 / 60 / 78 only)
- Fuel Rail Pressure (QSK 23 / 45 / 60 / 78 only)
- Fuel Inlet Temperature

DECODED ECM SWITCHES AS DISPLAYED ON THE DSE MODULE

IR	Idle/Rated
RS	Run/Stop
ES	Remote Emergency-Stop
CL	Coolant Level
FS	Fuel Shut-off Valve
CO	CENTINEL Oil Level
SO	Shutdown Override
FA	Fault Acknowledge

ALARMS AND DIAGNOSTIC CODES AVAILABLE FROM THE MODBUS INTERFACE

- Common shutdown lamp. Displayed as *Can ECU Fail*
- Common warning lamp. Displayed as *Can ECU error*
- Communications Failure. Displayed as *Can Data Fail*
- Active Warning Fault Events List
- Active Shutdown Fault Events List

4.7   DETROIT DIESEL DDEC III / IV

Select '*Generic J1939'* from the DSE PC configuration software.

DSE TERMINAL DESCRIPTION	Detroit connector	NOTES
Crank output		Connects directly to engine starter solenoid.
Fuel output	Use to control a 30A external slave relay to power the DDEC ECU	
CANbus common	-	Screen for the J1939 cable. Connect at one end only.
CANbus H	CAN_H	J1939 + Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.
CANbus L	CAN_L	J1939 - Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.

CAN SETUP

The DSE controller must be configured with the correct CAN file for the Detroit Diesel engine:

ECU (ECM) Options

Engine Type   Generic J1939
Enhanced J1939 ☑

4.8 DEUTZ EMR2

DSE TERMINAL DESCRIPTION	Deutz Vehicle side (F) connector	NOTES
Crank output		Connects directly to engine starter solenoid.
Fuel output	Use to control a 30A external slave relay to supply DC battery power to pin 14. Fuse at 16 amps.	
	1	Connects directly to battery negative
CANbus common	-	Screen for the J1939 cable. Connect at one end only.
CANbus H	12	J1939 + Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.
CANbus L	13	J1939 - Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.

CAN SETUP

As the EMR2 is the same ECU as the Volvo EDC4 (manufactured by Deutz), the DSE controller must be configured with the correct CAN file for the EDC4 ECU :

ECU (ECM) Options

Engine Type   Volvo EDC4

Enhanced J1939   ☑

⚠ **NOTE**:- It may be necessary to enable the Deutz ECU for CAN control. Using the Deutz service tool software, change parameter 4400 on Page 6 to '1'.
Once this is done, depending upon the Deutz ECU configuration the engine speed may change. If this occurs, terminals 17 & 18 of the Deutz ECU should be linked.

4.9   IVECO

> ⚠ NOTE: DSE7000 Series does not currently support Iveco Engines.
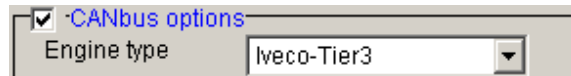
The DSE controller supports the Iveco Tier3 ECUs fitted to the Cursor and NEF engine ranges.
(This list is not exhaustive, contact Iveco for further details)

DSE TERMINAL DESCRIPTION	IVECO connections	NOTES
Crank output		Connects directly to engine starter solenoid.
Fuel output	Use to control a 30A external slave relay to supply DC battery power the ECU Ignition Switch terminal. Fuse at 16 amps.	
CANbus common	-	Screen for the J1939 cable. Connect at one end only.
CANbus H	CAN H	J1939 + Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.
CANbus L	CAN L	J1939 - Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.

CAN SETUP

The DSE controller must be configured with the correct CAN file for the Iveco engine:

☑ CANbus options
Engine type   Iveco-Tier3 ▼

> ⚠ NOTE: Some Iveco engines have been reported to not show the 'Hours Run' Instrumentation when used with the Generic can config.

> ⚠ NOTE: The start input on some ECUs will not start the engine, direct wiring to the starter motor needs to be made.

CAN INSTRUMENTS

Engine Speed
Engine Oil Pressure (See note below)
Coolant Temp
Engine Oil Temp
Inlet Manifold Temp
Fuel Temp
Fuel Consumption
Total Fuel Used
Turbo Pressure

⚠ NOTE: The Iveco Cursor78 ECU does not send engine oil pressure instrumentation.

⚠ NOTE: FUEL TEMP is shown on the module fascia but is not carried forward to the PC software remote instrumentation page.

UNIMPLEMENTED INSTRUMENTS:

Exhaust Temp
Coolant Pressure
Fuel Pressure
Water in Fuel

⚠ NOTE: These instruments will be shown as '###' until connected to an active ECU, They will then disappear from the display and the PC remote instrumentation values will be replaced by 'blanks'.

4.10 JOHN DEERE

DSE TERMINAL DESCRIPTION	John Deere 21-pin Deutsch connector	NOTES
Fuel relay output	**G, J**	**G = Switched ECU power,** **J = Ignition**
Start relay output	**D**	**Start**
CANbus common	**-**	**Screen for the J1939 cable. Connect at one end only.**
CANbus H	**V**	**J1939 + Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.**
CANbus L	**U**	**J1939 - Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.**

CAN SETUP

The DSE controller must be configured with the correct CAN file for the John Deere engine:

ECU (ECM) Options

Engine Type — John Deere

Enhanced J1939 — ☐

4.11 MTU

4.11.1 ADEC

MTU ADEC controlled engines must be fitted with the SAM module in order to interface with the DSE5300 Series controllers.
DSE4000/5500/7000 Series do not currently support the ADEC engines. Please contact DSE Technical Support for further advice.

DSE TERMINAL DESCRIPTION	ADEC	NOTES
Start output	X1 37	Start input of ADEC (DI 7). Also connect X1 22 to GND This terminal is optional. Start command is also sent by CAN message.
Fuel output	X1 43	Stop input of ADEC (DI 1). Also connect X1 28 to GND
CANbus common	X23 3	Screen for the CAN cable. Connect at one end only.
CANbus H	X23 2	CAN + Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.
CANbus L	X23 1	CAN - Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.

▲**NOTE:- The ADEC ECU is <u>designed to be permanently powered</u> via the emergency stop button on the control panel.**

▲**NOTE:- Cranking of the engine is managed by the ADEC controller following instruction from the DSE controller.**

▲**NOTE:- The MTU engine is used with the MTU SAM display module.**

ADEC ECU Mounted on the engine

SAM module mounted in the customer panel

CAN SETUP

The DSE controller must be configured with the correct CAN file for the MTU engine.

ECU (ECM) Options

Engine Type	MTU MDEC304 ▼
Enhanced J1939	☑

INSTRUMENTATION AVAILABLE

The instrumentation is updated via whenever the value changes and at least every 20 seconds otherwise.

BASIC INSTRUMENTATION

Engine speed
Oil pressure
Coolant temp

EXTENDED INSTRUMENTATION

Fuel temperature
Fuel pressure
Turbo pressure
Hours run

DIAGNOSTICS

Combined yellow alarm (ECU error)
Combined Red alarm (ECU fail)
Failure codes (current conditions every 20 sec)
Actual failure codes (on / off transitions only)
MTU Alive (Can data fail)

CONTROL

Command	Description
Speed Demand	Speed control, 1500RPM / 1800RPM +- 5%. Remote speed adjust potentiometer (480Ω) can be fitted to the controllers analogue input previously used for 'coolant temperature' on 'non-electronic' engines.
Engine Start	Sent during crank cycle. The start request remains active until the engine speed is detected.
Engine Stop	Sent if engine is detected as being running when the DSE controller requires the engine to be stopped.
Alarm Reset	Clear ECU alarm, and clears list of Failure codes in module.
Idle	Comes on with Smoke Limit and idle input to DSE controller.
CAN Speed Demand Switch	Makes the ECU respond to speed demand message.
Droop Enable	Turns engine droop on or off

The CAN DATA FAIL delay is set to 2 seconds. The automatic CAN system reset is performed every 2 seconds if there is no CAN data.

The speed demand messages are being sent and controlled by the 50 / 60 Hz switch and potentiometer connected to the temperature input.

The Alarm-Mute / Lamptest button has three functions. When the button is pressed on the DSE module, the following functions are performed :

- Illuminate the Yellow Alarm and Red Alarm outputs of the ECU.
- Clear any alarms latched by the ECU.
- Erases the local list of failure codes held in the DSE module.

The list of failure codes is sent to the DSE module whenever a value changes and at least every 20 seconds. The DSE module keeps the values received for 20 seconds and if they have not been received again in that time it will delete them. However messages are received when fault codes become inactive so sometimes codes will clear themselves in less than 20 seconds.

The list of failure codes is held in the DSE module, in the event of a shutdown alarm then the list is frozen to enable it

to be viewed if the ECU (engine) has stopped. To clear a CAN shutdown alarm it may be neccessary to press the **alarm mute** button to clear the alarm on the ECU followed by pressing the **stop/reset** button to clear the alarm on the DSE module.

4.11.2 MDEC

Fitted to MTU Series 2000 and Series 4000 engines.

Although MTU MDEC communications is CAN based, it does not use the J1939 standard used by some other engine manufacturers. However, DSE has integrated the MTU protocol into the 5300 / 5500 Series controllers to enable MDEC CAN communications to be read from the ECU.

DSE TERMINAL DESCRIPTION	MDEC X1	NOTES
Start output	BE9	Start input of MDEC
Fuel output	BE1	Run input of MDEC
CANbus common	E	Screen for the CAN cable. Connect at one end only.
CANbus H	G	CAN + Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.
CANbus L	F	CAN - Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.

SPEED CONTROL (5500 SERIES CONTROLLERS ONLY)

As MTU MDEC has speed control via CAN, you must set the 5510/5520 speed control system to allow the engine to run at the correct speed. Set SW1 = 5.0, SW2 = 2.0. This setting is found on the 'recal' tab of the 5xxx software:
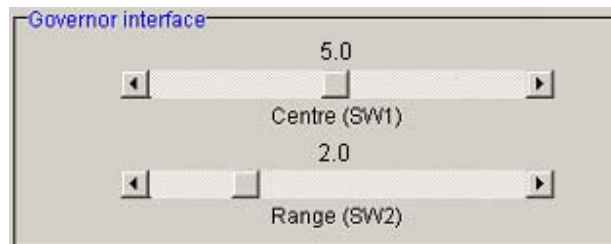
NOTE:- The MDEC ECU is <u>designed to be permanently powered</u> however the DSE controller can be configured to switch the ECU power by configuring an Auxiliary output to be "ECU power". This output should be used to control the ECU power relay and will turn off the MDEC ECU when the DSE controller is placed into STOP/RESET ⊙ mode.
Note that using this method, the MDEC ECU takes approximately 30 seconds to power up once the DSE controller is taken out of STOP/RESET ⊙ mode.

NOTE:- BE9 and BE1 have two terminals associated with them. Take care when wiring DSE controllers to these terminals as 42xx controllers have negative outputs !

NOTE:- Cranking of the engine is managed by the MDEC controller following instruction from the DSE controller.

NOTE:- For 55xx modules ensure *Charge Alternator Voltage* is disabled (not checked) on the *Edit Config | Engine | Crank disconnect* tab of the 5xxx configuration software as shown :

Continued overleaf…

…continued

> ⚠ **NOTE:- DSE 5510 and 5520 can perform synchronising and loadsharing using CAN instructions to the engine ECU when using the MTU-MDEC-304 configuration file in conjunction with compatible MDEC controllers. If in doubt about the MDEC version you have, you are referred to MTU.**

> ⚠ **NOTE:- The MTU engine can be used with or without the MTU PIM display module. Ensure that MTU are informed prior to the despatch of your engine whether or not you intend to fit the PIM module and also that you require CAN for connection to the DSE controller. This will ensure that you receive the engine with the relevant options enabled. Incorrectly set options for PIM and secondary CAN controller may lead to "CAN 1 NODE LOST 180" errors displayed by the DSE module (and MTU PIM module)**

> ⚠ **NOTE:- At the time of writing this manual, the DSE 42xx Series controller is not compatible with the CAN interface of the MTU MDEC controller. Contact DSE Customer Support department for latest information.**

> ⚠ **NOTE:- MDEC Speed control is configurable. Ensure it is set to receive speed control signals via the CAN interface.**

CAN SETUP

The DSE controller must be configured with the correct CAN file for the MTU engine, and also to inform it as to the MDEC version number.

ECU (ECM) Options

Engine Type	MTU MDEC303 ▾
Enhanced J1939	☑

303 and 304 are different versions of the MDEC ECU.

> ⚠ **NOTE:- If the MTU MDEC version 304 is connected to a DSE module incorrectly configured for mtu-MDEC-303, then the MTU warning error code "SD CAN SPEED DEMAND 250" will be displayed on the DSE module (and MTU PIM module).**

ECU (ECM) Options

Engine Type	MTU MDEC304 ▾
Enhanced J1939	☑

MTU-MDEC-304 ECU supports speed control via CAN, previously unsupported with the version 303.

If you are in any doubt as to the version of your ECU, you are referred to MTU.

INSTRUMENTATION AVAILABLE

The instrumentation is updated via whenever the value changes and at least every 20 seconds otherwise.

BASIC INSTRUMENTATION

Coolant Temp
Oil Pressure
Engine Speed
Charge Alt
Hours Run

EXTENDED INSTRUMENTATION

Oil Temp
Inlet Manifold Temp
Fuel Pressure
Fuel Consumption
Total Fuel Used
Turbo Pressure
Coolant Temp Intercooler (displayed as exhaust temp)

DIAGNOSTICS

Combined Yellow Alarm (ECU error)
Combined Red alarm (ECU fail)
Failure Codes (current conditions every 20 sec)
Actual Failure Codes (on / off transitions only)
MTU Alive (Can data fail)

CONTROL

Command	Description
MNT alive PDU	Prevents error from ECU.
Speed Demand	Speed control, 1500 / 1800 +- 5%. Remote speed adjust potentiometer (480Ω) can be fitted to the controllers analogue input previously used for 'coolant temperature' on 'non-electronic' engines.
Engine Start	Sent during crank cycle.
Engine Stop	Sent if engine not running.
Alarm Reset	Clear ECU alarm, and clears list of Failure codes in module.
Idle	Comes on with Smoke Limit and idle input to DSE controller.
Lamp Test	Illuminates Red and Amber connected to ECU.
CAN Speed Demand Switch	Makes the ECU respond to speed demand message.

The CAN DATA FAIL delay is set to 2 seconds. The automatic CAN system reset is performed every 2 seconds if there is no CAN data.

The speed demand messages are being sent and controlled by the 50 / 60 Hz switch and potentiometer connected to the temperature input.

The Alarm-Mute / Lamptest button has three functions. When the button is pressed on the DSE module, the following functions are performed :

- Illuminate the Yellow Alarm and Red Alarm outputs of the ECU.
- Clear any alarms latched by the ECU.
- Erases the local list of failure codes held in the DSE module.

The list of failure codes is sent to the DSE module whenever a value changes and at least every 20 seconds. The DSE module keeps the values received for 20 seconds and if they have not been received again in that time it will delete them. However messages are received when fault codes become inactive so sometimes codes will clear themselves in less than 20 seconds.

The list of failure codes is held in the DSE module, in the event of a shutdown alarm then the list is frozen to enable it to be viewed if the ECU (engine) has stopped. To clear a CAN shutdown alarm it may be neccessary to press the

alarm mute button to clear the alarm on the ECU followed by pressing the **stop/reset** button to clear the alarm on the DSE module.

4.12 PERKINS

Engines in the Perkins range are fitted with the ADEM3 or ADEM4 Engine control module. This system allows engine control and diagnostics via the J1939 link.

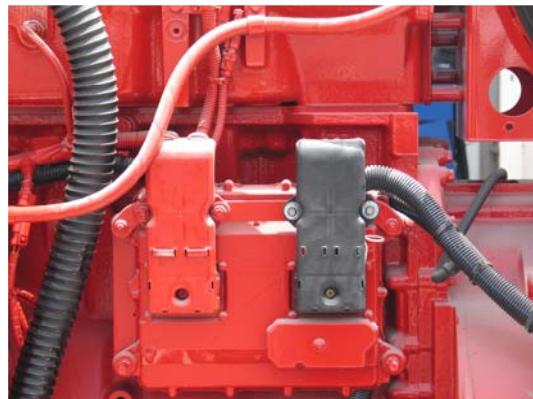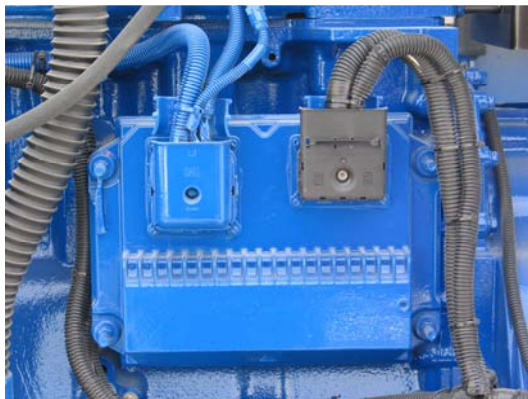**Perkins engines fitted with the ADEM3 / ADEM4:**
2306
2506
1106
2806
(This list is not exhaustive, contact Perkins for further details)

> ⚠ **NOTE:- Perkins 1300 Series engines are NOT J1939 compatible.**

DSE TERMINAL DESCRIPTION	Perkins Customer interface connector	NOTES
Fuel relay output	1, 10, 15, 33, 34	Use to control an external slave relay to powers up ECU and enable the injectors. Ensure maximum rating of DSE fuel relay is not exceeded.
Start relay output	-	Use to control an external slave relay to supply DC battery power to engine starter solenoid.
CANbus common	-	Screen for the J1939 cable. Connect at one end only.
CANbus H	31	J1939 + Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.
CANbus L	32	J1939 - Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.

> ⚠ **NOTE:- According to Perkins, warning lamps or equivalent must be connected to Perkins customer interface connector terminals 3, 4, 5, 8, 9, 16, 17. Failure to connect to these terminals will result in "open circuit" alarms from the ECU. Perkins have advised that a suitable equivalent for the warning lamp is a 220Ω 5W resistor. Be aware that outputs on terminals 4,5, & 16 are battery positive outputs. The outputs on terminals 3, 6, 8, 9 & 17 are battery negative outputs.**

CAT ADEM ECUs (also fitted to Perkins Engines)

CAN SETUP

The DSE controller must be configured with the correct CAN file for the Perkins engine, and also to inform it as to whether the coordinator is fitted or not :

ECU (ECM) Options		
Engine Type	Perkins ADEM3 ▼	
Enhanced J1939	☑	

ECU (ECM) Options		
Engine Type	Perkins ADEM4 ▼	
Enhanced J1939	☑	

4.13 SCANIA

Engines in the Scania range are fitted with the S6 Engine control module. This system allows engine control and diagnostics via the J1939 link.
Scania diagnostics is known as Keyword 2000™ and is fully compatible with the DSE controllers controllers when configured correctly.

Scania engines fitted with the S6 ECU:
DC 9
DC 12
DC 16

This list is not exhaustive, contact Scania for further details

The functions of the S6 coordinator are built within the DSE controller negating the need to fit this device to the engine controller.

DSE TERMINAL DESCRIPTION	Scania EMS B1 connector	NOTES
Fuel relay output	3	Ignition U15
Start relay output	-	Connects directly to engine starter solenoid. (Not required on 'later' Scania S6 engines as cranking is performed by the ECU)
CANbus common	-	Screen for the J1939 cable. Connect at DSE end only.
CANbus H	9	J1939 + Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.
CANbus L	10	J1939 - Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.

CAN SETUP (7000 SERIES)

The Scania Co-ordinator device must not be connected to the engine.

CAN SETUP (5000 SERIES)

The DSE controller must be configured with the correct CAN file for the Scania engine, and also to inform it as to whether the coordinator is fitted or not :

 Coordinator is fitted to the engine

 Coordinator is NOT fitted to the engine. The DSE controller will perform some additional functions normally performed by the coordinator.

SPEED CONTROL (5500 SERIES CONTROLLERS ONLY)

As Scania S6 has speed control via CAN, you must set the 5510/5520 speed control system to allow the engine to run at the correct speed. Set SW1 = 5.0, SW2 = 2.0. This setting is found on the 'recal' tab of the 5xxx software:
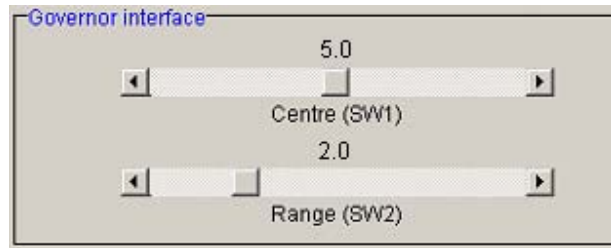
SCANIA COORDINATOR

DSE 7000 Series controllers do not support the Scania Coordinator.
DSE 5000 Series controllers can operate both with and without the Scania Coordinator.

CAN SETUP

The DSE controller must be configured with the correct CAN file for the EDC3 ECU :

7000 Series

ECU (ECM) Options	
Engine Type	Volvo EDC3 ▼
Enhanced J1939	☑

5000 Series

☑ CANbus options
Engine type | Volvo ▼

CONTROL FUNCTIONS SUPPORTED

The module displays Warnings and Shutdown messages when a Warning or Shutdown Lamp message is received. The display of diagnostic codes is suppressed if neither a Warning or Shutdown lamp message is present..

Diagnostic codes are shown as the Volvo Fault Code with a short message indicating the fault. The PC software also displays the full SPN/FMI codes and the text of the Volvo message.

Shutdown diagnostic information is latched by the module until the red stop button is pressed. In addition, if the cause of the shutdown is from the ECU then the diagnostic codes present at the time of shutdown are added into the event log.

A module alarm will need to be cleared by pressing the red stop button on the module.

INSTRUMENTATION AVAILABLE FROM THE CAN INTERFACE

- Engine Speed
- Oil Pressure
- Coolant Temperature
- Charge Alternator Voltage
- Engine Running Time

ALARMS AND DIAGNOSTIC CODES AVAILABLE FROM THE CAN INTERFACE

- Common shutdown lamp. Displayed as *Can ECU Fail / ECU Shutdown*
- Common warning lamp. Displayed as *Can ECU error / ECU Warning*
- Communications failure. Displayed as *Can Data Fail*
- Active Warning fault events list
- Active Shutdown fault events list

4.14.2 EDC4

Fitted to Volvo Penta engine types : TD520, TAD520 (optional), TD720, TAD720 (optional), TAD721, TAD722 (This list is not exhaustive, contact Volvo Penta for further details)

DSE TERMINAL DESCRIPTION	Volvo EDC 4 connector terminal	NOTES
Crank output		Connects directly to engine starter solenoid.
Fuel output	Use to control a 30A external slave relay to supply DC battery power to pin 14. Fuse at 16 amps.	
	1	Connects directly to battery negative
CANbus common	-	Screen for the J1939 cable. Connect at one end only.
CANbus H	12	J1939 + Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.
CANbus L	13	J1939 - Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.

CAN SETUP

The DSE controller must be configured with the correct CAN file for the EDC4 ECU :

ECU (ECM) Options

Engine Type — Volvo EDC4
Enhanced J1939 — ☑

4.14.3 EMS2

Fitted to Volvo Penta engine types : TAD734, TAD940, TAD941, TAD1640, TAD1641, TAD1642 (This list is not exhaustive, contact Volvo Penta for further details)

DSE TERMINAL DESCRIPTION	Volvo EMS2 connector terminal	NOTES
Aux output 1	6	Using PC software select the relevant engine and configure 'aux output 1' to be "ECU STOP"
Aux output 2	5	Using PC software select the relevant engine and configure 'aux output 2' to be "ECU POWER"
	3	DC Supply negative
	4	DC Supply positive
CANbus common	-	Screen for the J1939 cable. Connect at one end only.
CANbus H	1 (Hi)	J1939 + Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.
CANbus L	2 (Lo)	J1939 – Use only screened 120Ω impedance cable approved specifically for use in CANbus applications.

⚠**NOTE:- Cranking of the engine is managed by the EMS2 controller following instruction from the DSE controller.**

⚠**NOTE:- DSE 5510 and 5520 can perform synchronising and load sharing using CAN instructions to the engine ECU.**

Volvo EMS2 ECU

CONTROL FUNCTIONS SUPPORTED

The module displays Warnings and Shutdown messages when a Warning or Shutdown Lamp message is received. The display of diagnostic codes is suppressed if neither a Warning or Shutdown lamp message is present.

Diagnostic codes are shown as the Volvo Fault Code with a short message indicating the fault. The PC software also displays the full SPN/FMI codes and the text of the Volvo message.

Shutdown diagnostic information is latched by the module until the red stop button is pressed. In addition, if the cause of the shutdown is from the ECU then the diagnostic codes present at the time of shutdown are added into the event log.

A module alarm will need to be cleared by pressing the red stop button on the module.

The following commands are sent via the CAN interface :
Command is sent to the EMS2 ECU to instruct the engine to run at idle speed during activation of the DSE module *Smoke Limit* input or during the DSE module's *Smoke Limit* timer

- Command is sent to the EMS2 ECU to instruct the engine to run at it's 'alternative speed' upon activation of this function in the DSE module. (not available on Variable Speed (VE engines)
- Command is sent to the EMS2 ECU to enable and disable the engine droop upon activation of this function in the DSE module.
- Speed commands are sent to the EMS2 ECU during synchronising and load sharing (5510/5520 modules only) (not available on Variable Speed (VE engines)
- Start / Stop commands are sent to the EMS2 ECU when required.
- Remote speed adjust potentiometer (480Ω) can be fitted to the 5300 Series controllers analogue input previously used for 'coolant temperature' on 'non-electronic' engines. (750RPM – 1800RPM on variable speed (VE) engines).

SPEED CONTROL (5500 SERIES CONTROLLERS ONLY)

As Volvo EMS2/EMS2b has speed control via CAN, you must set the 5510/5520 speed control system to allow the engine to run at the correct speed.
Set SW1 = 5.0, SW2 = 2.0.
This setting is found on the 'recal' tab of the 5xxx software:
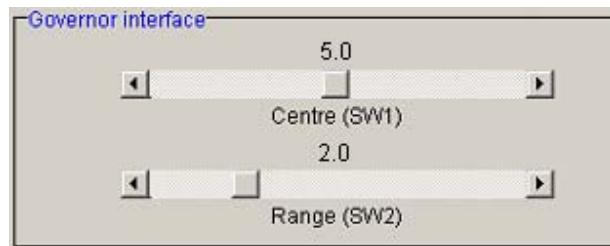
⚠NOTE:- Speed control via CAN is not possible if the Volvo CIU is fitted to the engine.

INSTRUMENTATION AVAILABLE FROM THE CAN INTERFACE

- Engine Speed
- Oil Pressure
- Oil Temperature
- Coolant Temperature
- Inlet Temperature
- Turbo Pressure
- Fuel Pressure
- Fuel Consumption
- Total Fuel Used
- Charge Alternator Voltage
- Engine Running Time

ALARMS AND DIAGNOSTIC CODES AVAILABLE FROM THE CAN INTERFACE

- Common Shutdown Lamp. Displayed as *Can ECU Fail / ECU Shutdown*
- Common Warning Lamp. Displayed as *Can ECU error / ECU Warning*
- Communications Failure. Displayed as *Can Data Fail*
- Active Warning Fault Events List
- Active Shutdown Fault Events List

CAN SETUP

The DSE controller must be configured with the correct CAN file for the EMS2 ECU. EMS2 and EMS2b are different versions of the same ECU. EMS2b is a later version with some issues with the original EMS2 diagnostic reporting having been addressed.

Using the EMS2b CANfile with an EMS2 engine will result in an alarm being continuously present.

Using the EMS2 CANfile with an EMS2b engine will result in some alarms not being annunciated on the DSE controller.

If you are in any doubt as to the version of your ECU, you are referred to Volvo Penta.

VOLVO CIU

The DSE 5000 Series controllers can be used with or without the Volvo CIU module being fitted to the TAD9 / TAD16 engines. These engines can be ordered without the CIU module. (contact Volvo Penta for details).

If the Volvo CIU IS fitted, you must use the *Volvo* CAN file instead of the *EMS2* file. In this situation speed control by CAN is NOT possible.