Workshop Manual

Group 30 Electrical system

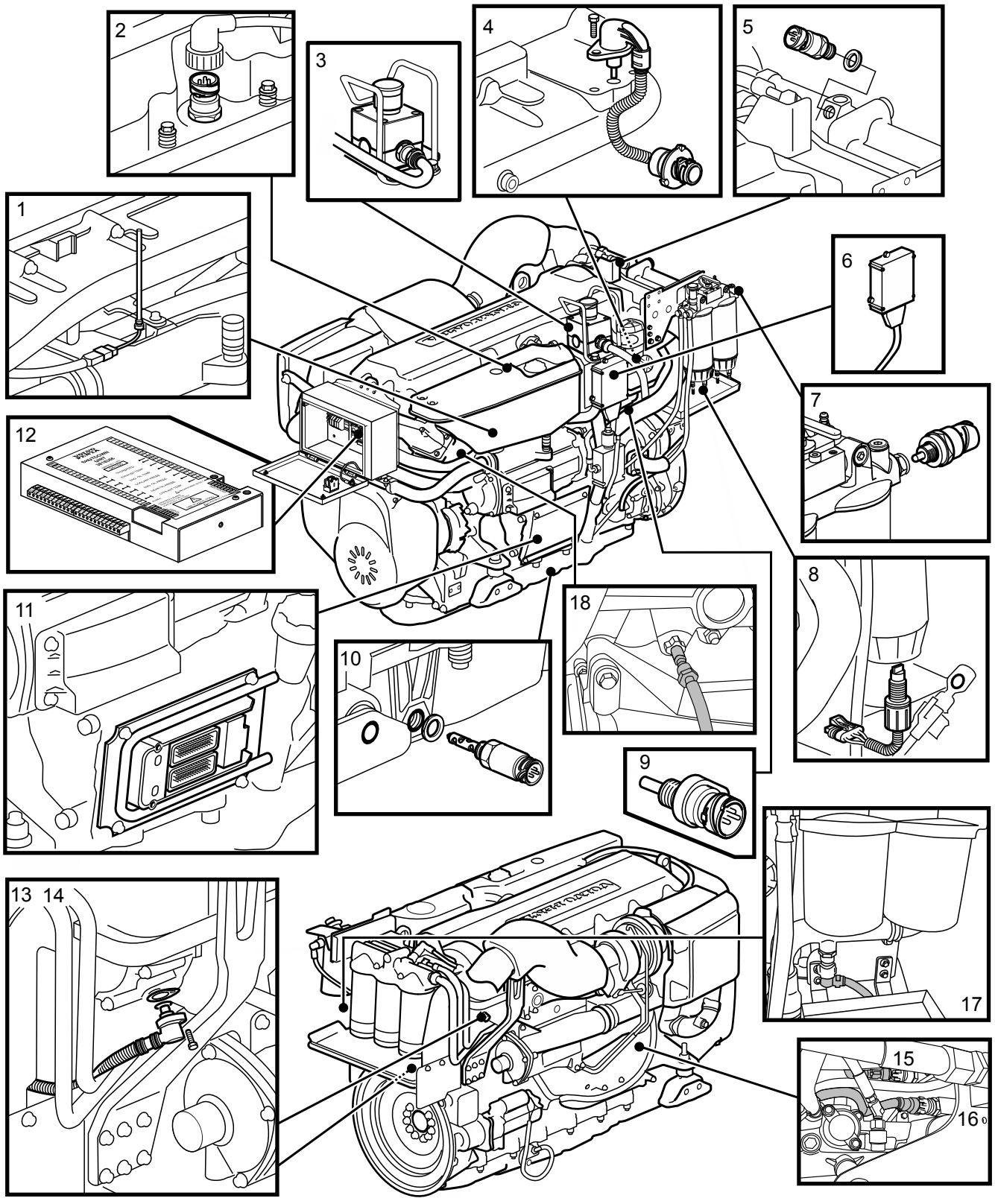
E
2(0)

D9, D11, D12, D13, D16
Marine Engines (EMS 2)

Engine Protection Map

All versions of Engine Protection Maps, are to be found at the Volvo Penta Sales Support Tool, Technical data for concerned engine type.

Location of sensors, D9 classified



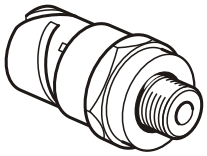
P0017067

p0007172

Unit injector

The unit injectors are installed on the cylinder head, underneath the valve cover.
The amount of fuel injected and injection duration is controlled by the control unit, via electromagnetically controlled fuel valves in the unit injectors. This means that the engine always receives the correct volume of fuel in all operating conditions, which offers lower fuel consumption, minimal exhaust emissions etc.
The unit injectors are made and classified by tolerance.

Each unit injector is marked with a code on the top side of the electric connection. If an injector is replaced, the new code must be programmed for the cylinder concerned using VODIA.



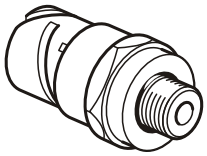
p0001348

Piston cooling switch (D12, D16)

A valve is installed in the oil filter bracket which opens or closes the oil supply for piston cooling, depending on oil pressure. If the oil pressure is below 240 kPa (35 PSI), the valve closes the oil supply for piston cooling. The piston cooling pressure is monitored by a pressure monitor. The output signal from the pressure monitor can only have two distinct positions, on/off, in the same way as a relay output. The monitor is supplied with current from the EMS2. A preset pressure limit of 150 kPa (22 PSI) determines when the monitor switches on. The monitor opens if the pressure exceeds this value.
At idle, the monitor can be closed without a fault code being set.

Sensor, piston cooling (D11)

The sensor measures piston cooling pressure and is located in front of the engine. The sensor is an active sensor, i.e. the sensor requires a supply voltage of +5 Volt. The sensor provides an output signal whose voltage is proportional to the pressure that the sensor measures.

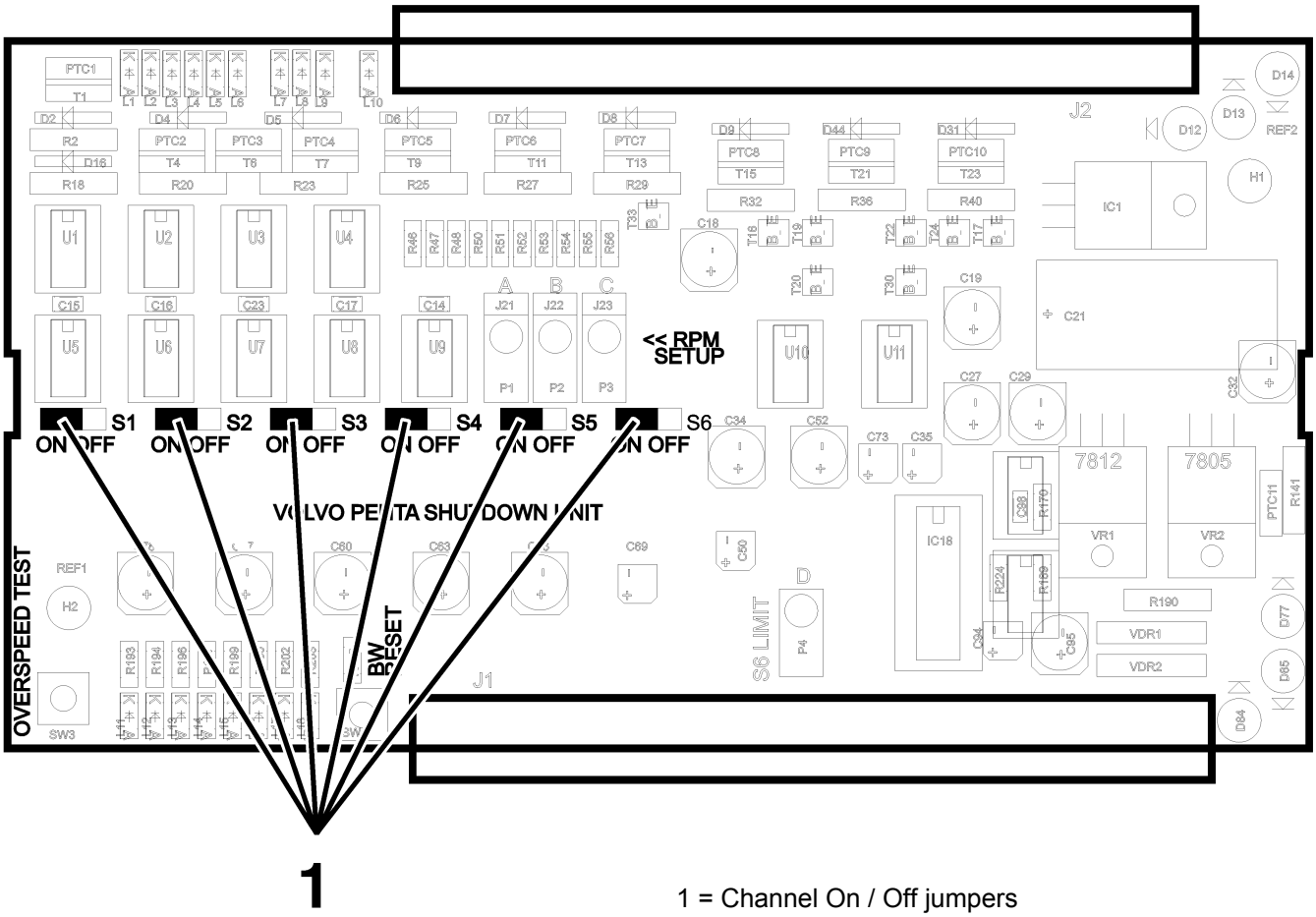


p0001348

Sensor, fuel pressure

The sensor measures fuel pressure and is located on the fuel filter bracket. The sensor is an active sensor, i.e. the sensor requires a supply voltage of +5 Volt. The sensor provides an output signal whose voltage is proportional to the pressure that the sensor measures.

SDU adjustments



1 = Channel On / Off jumpers

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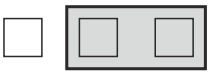
Channel set-up

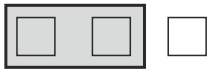
1 Locate the channel on/off jumper pins (1) on the SDU card.

2 Disable all the S1–S6 channels before configuring run detection and overspeed.



ON OFF

= Channel disabled



ON OFF

= Channel enabled

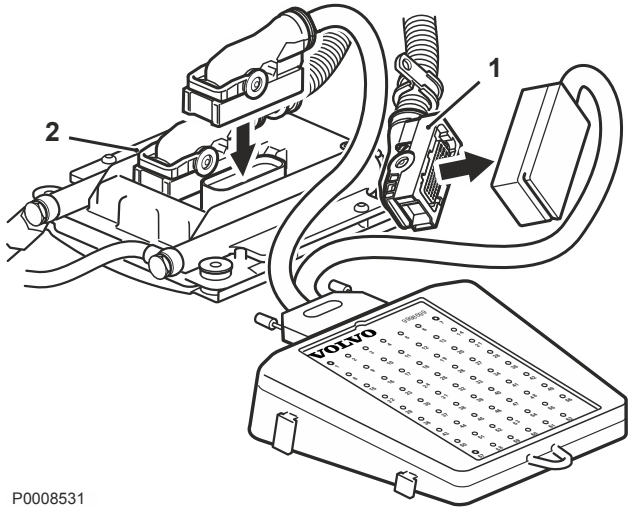
P0018656

Switches/sensors, engine protection system

The respective switch or sensor shuts down the engine at the preset values found at section *Engine Protection Map*.

Channel	Switch
S1.	Coolant temperature
S2.	Oil pressure, reverse gear(1)
S3.	Oil pressure, engine(1)
S4.	Coolant Pressure(2)
S5.	Oil temperature, engine
S6.	Exhaust temperature

1. ”Run detection S2, S3”
2. ”Run detection S4”



P0008531

4 Connect the engine control unit connector to the brakeout cable 9990014 (**1**). Connect the brakeout cable 9990014 to the engine control unit (**2**).
All pins from the engine control unit is accessible in the measurebox 9998699.

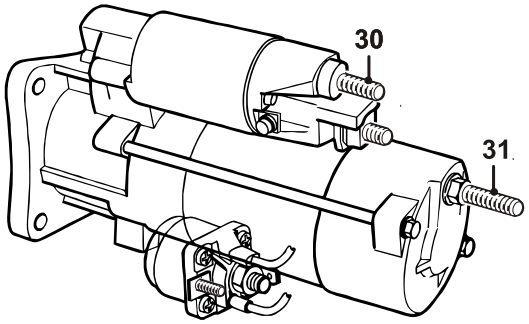
Fault tracing of the starter motor and windings

Special Tools: Multimeter 9812519.

General

If battery voltage falls below 24.7 V (measured at the battery), the starter motor will not be able to crank the engine at normal speed. A fully charged battery has an open circuit voltage of about 25.4 V.

Checking the power supply



P0007182

1 Check that the battery voltage is at least 24.7 V unloaded, by measuring the battery terminals with multimeter 9812519.

2 Turn on the main switch.

3 Check that the voltage between positions 30 and 31 on the starter motor is the same as the battery voltage.

30-2 Fault Tracing

Fault Codes

MID 128, PID 20, Extended Range Engine Coolant Pressure

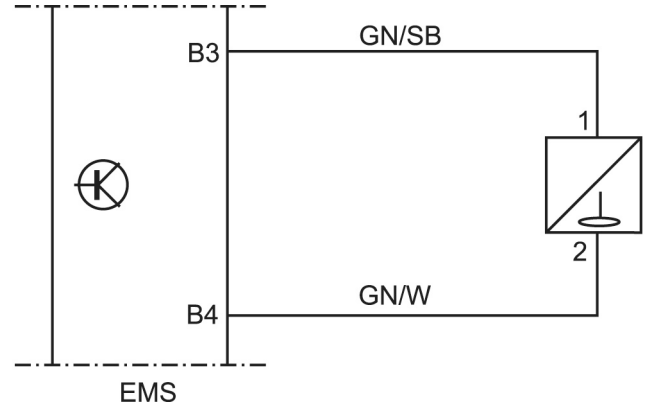
MID 128: Engine control unit

FMI 1 – Data valid but below operational range	
Fault code explanation:	Coolant pressure too low
Fault indication:	• Warning is displayed in the tachometer/display. • A red lamp flashes in the alarm display + audible warning.
Symptom:	Engine performance is reduced.
Preconditions:	Coolant pressure too low
Conditions for fault code:	Coolant pressure lower than the value specified in the engine protection parameter. For parameters, refer to the engine protection folder.
Suitable action:	1 Check the coolant level and the quality of the coolant. 2 Check that no leakage occurs. 3 Check the coolant circulation pump. 4 Check the sensor by control measuring the coolant pressure.

FMI 3 – Voltage above normal or shorted high	
Fault code explanation:	Faulty sensor/Fault in sensor circuit
Fault indication:	• Warning is displayed in the tachometer/display. • An orange lamp flashes in the alarm display.
Symptom:	None
Preconditions:	Abnormally high voltage or short circuit to higher voltage has been detected.
Conditions for fault code:	Voltage on engine control unit pin B20 exceeds 4.95 volts.
Possible reason:	• Open circuit in the sensor negative cable. • Short circuit between sensor signal cable and 5 V supply or battery voltage to coolant pressure sensor. • Faulty sensor
Suitable action:	1 Check the cable harness between the sensor and the EMS 2. 2 Check contact pressure in socket 18 in engine connector B. 3 Check the sensor.

Circuit description

D9CC



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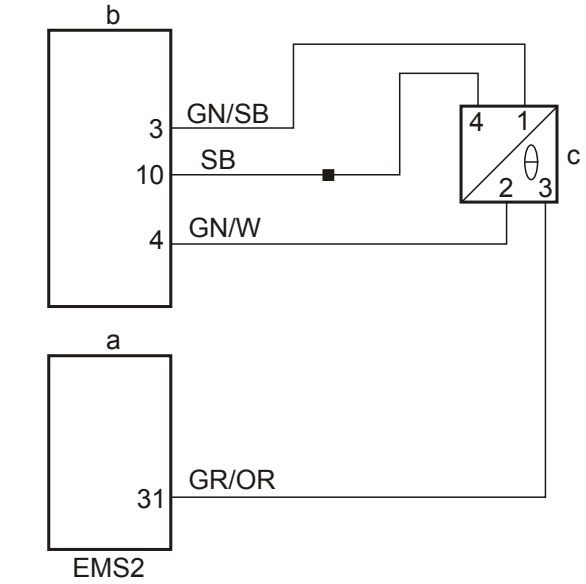
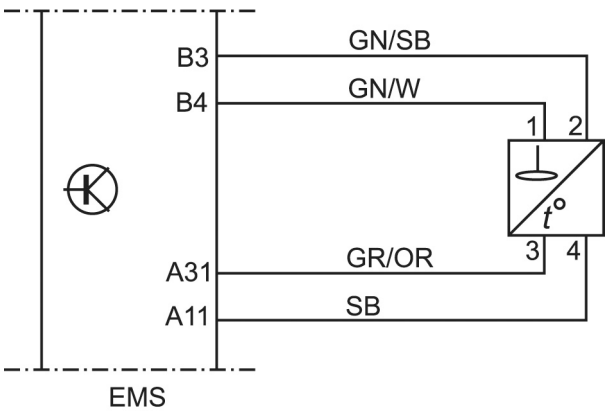
D16



P0008588

D13



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D9CC, D13, D16

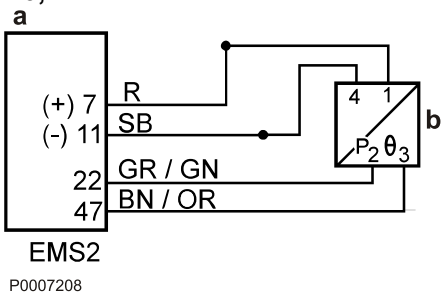
The oil temperature and oil level sensor is a combined sensor. The oil level sensor is supplied by a pulse of approximately 250 mA for approx 600 ms, and the voltage drop over the sensor is read off three times during this interval.
In order to obtain oil level, oil temperature must be used as a reference because oil level sensor output changes depending on oil temperature.

a Connector A

b Connector B

c Oil temperature and level sensor

D9, D12

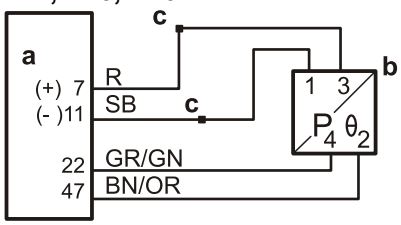


P0007208

a ConnectorA
Color: Black

b Air inlet pressure/intake manifold temperature

D11, D13, D16



P0007213

a ConnectorA

b Air inlet pressure/intake manifold temperature

c Joint

Circuit description

The charge air pressure sensor is a combined sensor that also measures intake manifold air temperature. The sensor is of active type, i.e. it must be supplied with operating voltage.
Engine control unit pin 7 supplies sensor pin 1 with +5 volts. Sensor pin 4 is connected to battery negative via engine control unit connector pin 11.
The pressure sensor output signal – sensor pin 2 to engine control unit connector A, pin 22 – is a voltage signal proportional to the pressure measured by the sensor. The output signal is linear within sensor working range.

Component specification

D9, D12

Working range	40–400 kPa (0.4–4.0 bar)
Power supply	5.00 ± 0.25 VDC

Nominal output voltage at 25 °C (77 °F) and supply voltage 5.00 VDC:

0.5 VDC at	40 kPa (0.4 bar)
4.5 VDC at	400 kPa (4 bar)

D11, D16

Working range	50–400 kPa (0.5–4.0 bar)
Power supply	5.00 ± 0.25 VDC

Nominal output voltage at 25 °C (77 °F) and supply voltage 5.00 VDC:

0.5 VDC at	50 kPa (0.5 bar)
4.5 VDC at	400 kPa (4 bar)

D13

Working range	50–600 kPa (0.5–6.0 bar)
Power supply	5.00 ± 0.25 VDC

Nominal output voltage at 25 °C (77 °F) and supply voltage 5.00 VDC:

0.5 VDC at	50 kPa (0.5 bar)
4.5 VDC at	600 kPa (6 bar)

Measurements

Checking negative cable, air inlet pressure sensor
Checking signal cable, air inlet pressure sensor
Checking the air inlet pressure sensor
Checking supply cable, air inlet pressure sensor

MID 128, PID 163, Transmission range attained

MID 128: Engine control unit

FMI 9 – Abnormal update rate	
Fault code explanation:	Communication fault
Fault indication:	An orange lamp flashes in the alarm panel.
Symptom:	None
Conditions for fault code:	Timeout in communication on the secondary bus J1587.
Possible reason:	• Break in communication from the PCU. • Faulty PCU
Suitable action:	1 Check the communication cables between the engine and the PCU. 2 Check that the PCU is programmed for the correct engine type.

MID 128, PPID 3 Starter Output

MID 128: Engine control unit

FMI 3 – Voltage above normal or shorted high **FMI 4 – Voltage below normal or shorted to lower voltage** **FMI 5 – Current below normal or open circuit**	
Fault code explanation:	Faulty relay/Faulty relay circuit.
Fault indication:	• Warning is displayed in the tachometer/display. • An orange lamp flashes in the alarm display.
Symptom:	The starter motor is not activated.
Preconditions:	General checks for starter motor problems: • Check the starter motor cables and connections. • Check that the pre-start and start relay pull during a start attempt.
Conditions for fault code:	Faulty pre-start or start relay
Suitable action:	**NOTICE!** See correct wiring diagram for prestart / start relay wiring. 1 Check that the pre-start and start relay pull during a start attempt. 2 Check the cables between the engine control unit and the start relay. 3 Check contact pressure in socket B29 in engine connector. 4 Check that socket B29 in the engine connector is not pushed in.

Circuit description

When ignition is on the potential on pin B29 is approximately 10 V. When cranking is requested B29 is connected, via the EMS, to battery negative and the starter motor is engaged.

NOTICE! See correct wiring diagram for prestart / start relay wiring.

Measurements

Checking the starter motor solenoid
Checking the pre-start relay

MID 128, PPID 267, Sea water pressure

D13, D16, D9

MID 128: Engine control unit

FMI 1 – Data valid but below operational range	
Fault code explanation:	Seawater pressure too low
Fault indication:	• Warning is displayed in the tachometer/display. • A red lamp flashes in the alarm display + audible warning.
Symptom:	Engine performance is reduced.
Preconditions:	Seawater pressure too low
Conditions for fault code:	Seawater pressure is dependent on engine rpm. Seawater pressure is lower than the value specified in the engine protection parameter. For parameters, refer to the engine protection folder.
Suitable action:	1 Check that the seawater intake is not blocked. 2 Check that the seawater filter is not blocked.. 3 Check that no leakage occurs. 4 Check the impeller in the seawater pump.. 5 Check the sensor by checking the seawater pressure.

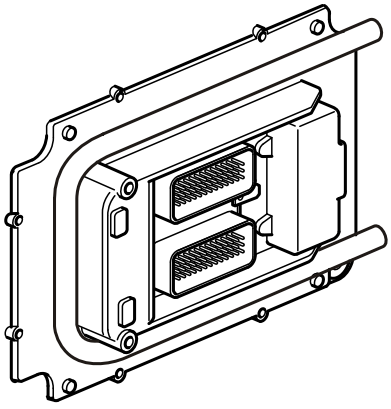
FMI 3 – Voltage above normal or shorted high	
Fault code explanation:	Defective sensor/Defect in sensor circuit.
Fault indication:	• Warning is displayed in the tachometer/display. • An orange lamp flashes in the alarm display.
Symptom:	None
Preconditions:	Voltage above normal or shorted high
Conditions for fault code:	Voltage on engine control unit pin A19 exceeds 4.95 volts.
Possible reason:	• Open circuit in the sensor negative cable. • Short circuit between the sensor signal cable and the sensor 5 V supply cable or battery voltage. • Faulty sensor.
Suitable action:	1 Check the cable harness between the sensor and the EMS 2. 2 Check contact pressure in socket 11 in engine connector A. 3 Check the sensor.

FMI 3 – Voltage above normal or shorted high	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	Yellow alarm status
Fault stored in memory:	Yes
Symptom:	• The engine start time will increase. • Engine is running with imprecise timing causing risk of high fuel consumption and smoke. • Cylinder balancing not working with risk of uneven running.
Conditions for fault code:	No crank signal.
Possible reason:	• Open circuit or short circuited sensor cables. • Faulty sensor.
Suitable action:	1 Check cables and connectors between the sensor and engine control unit. 2 Check contact pressure in sockets 37 and 38 in engine connector A. 3 Check the sensor.

MID 128, SID 254 Controller 1

MID 128: Engine control unit

FMI 3 – Voltage above normal or shorted high FMI 12 – Faulty device or component	
Fault code explanation:	Defective component.
Fault indication:	• Warning is displayed in the tachometer/display. • An orange lamp flashes in the alarm display.
Symptom:	None
Conditions for fault code:	Internal fault in engine control unit
Suitable action:	1 Change the engine ECU.

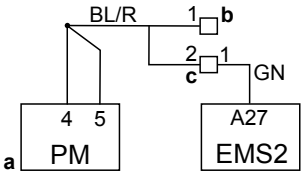


P0007254

MID 158, PSID 6, Extra supply fuse

MID 158: Power module

FMI 6 – Current above normal or short circuit to battery negative	
Fault code explanation:	Too high current output
Fault indication:	• Warning is displayed in the tachometer/display. • A red lamp flashes in the alarm display + audible warning.
Symptom:	None
Preconditions:	Faulty supply voltage to the engine control unit
Conditions for fault code:	Excessive power in the 24 V supply from the power module. - Water monitor, fuel filter - ”Easy Link” - External stop
Possible reason:	• Short circuit on pin 4 and pin 5 on power module. • Too high load Continuously more than 7A.
Suitable action:	1 Check the cable harness from the power module for short circuit. 2 Reduce load.



P0017253

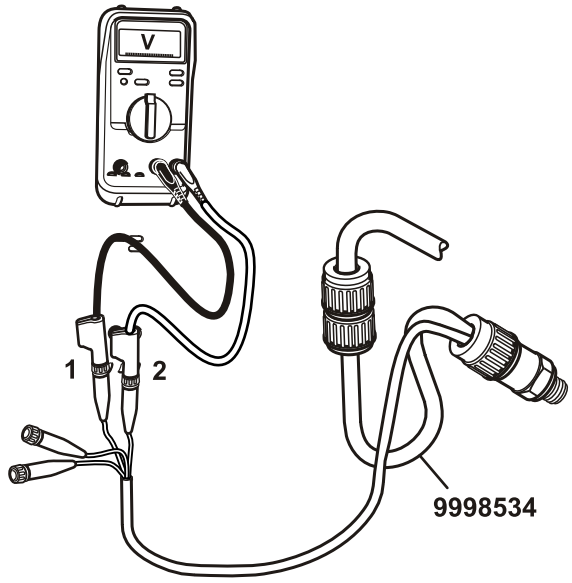
a Power Module

b Easy Link connector

c External stop

Circuit description

As soon as the power module receives power from the primary battery or the secondary battery, with main battery switches on, the 30 supply output is powered (connected to key switch and MCC / EVC). If the power module receives a +15 ignition signal it will activate EMS2 and extra power outputs (engine mounted instruments such as EasyLink, External stop and Water in fuel).
The power module internal relay function switches between primary battery and secondary battery depending on highest voltage. The two battery groups are never active at the same time. The power module monitors the battery voltage level.



P0007200

Checking supply cable, oil level switch

Tools:
9998534 Break-out cable
885675 Break-out cable
88890074 Multimeter

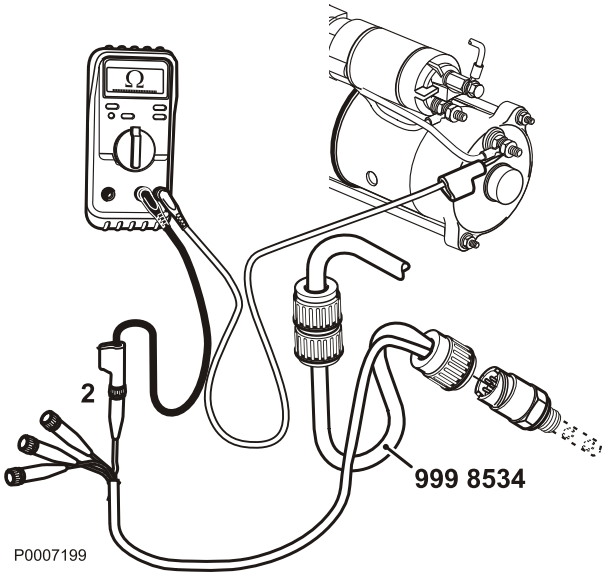
1 **NOTICE!** Turn the starter key to position 0. (If MCC, turn main battery switches off.)

2 Disconnect the connector from the sensor Connect break-out cable 9998534 or 885675 between the sensor and engine control unit.

3 Use multimeter 88890074 for voltage measurement.

4 **NOTICE!** Turn the starter key to position 1.

Measurement points	Nominal value
1 - 2	U ≈ Battery voltage



P0007199

Checking negative cable, oil level switch

Tools:
9998534 Break-out cable
885675 Break-out cable
88890074 Multimeter

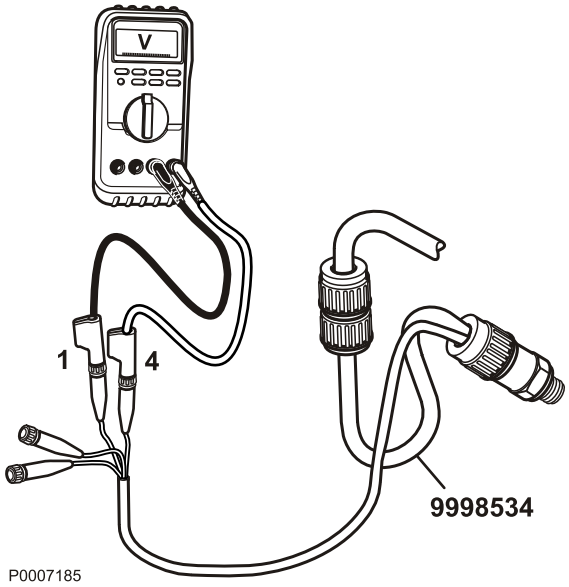
1 **NOTICE!** Cut the current with the main switch.

2 Disconnect the connector from the sensor Connect break-out cable 9998534 or 885675 to the cable harness connector to the engine control unit.

3 Use multimeter 88890074 to do resistance measurement towards the engine control unit.

Measurement points	Nominal value
2 - Battery negative	R ≈ 0 Ω

NOTICE! Battery negative (–) on alternator or starter motor.



Checking supply cable, seawater pressure sensor

Tools:
9998534 Break-out cable
885675 Break-out cable
88890074 Multimeter

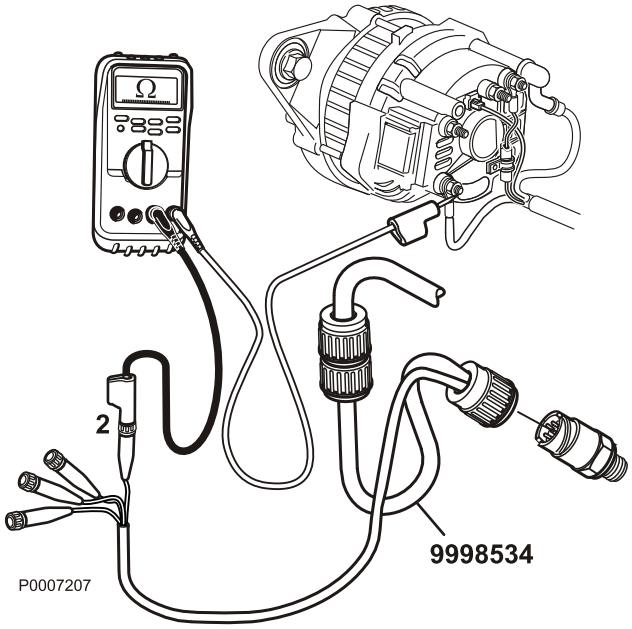
1 **NOTICE!** Turn off ignition.
(If MCC, turn main battery switches off.)

2 Disconnect the connector from the sensor Connect break-out cable 9998534 or 885675 between the sensor and engine control unit.

3 Use multimeter 88890074 for voltage measurement.

4 **NOTICE!** Turn on ignition.

Measurement points	Nominal value
1–4	U ≈ 5 V



Checking signal cable, seawater pressure sensor

Tools:
9998534 Break-out cable
885675 Break-out cable
88890074 Multimeter

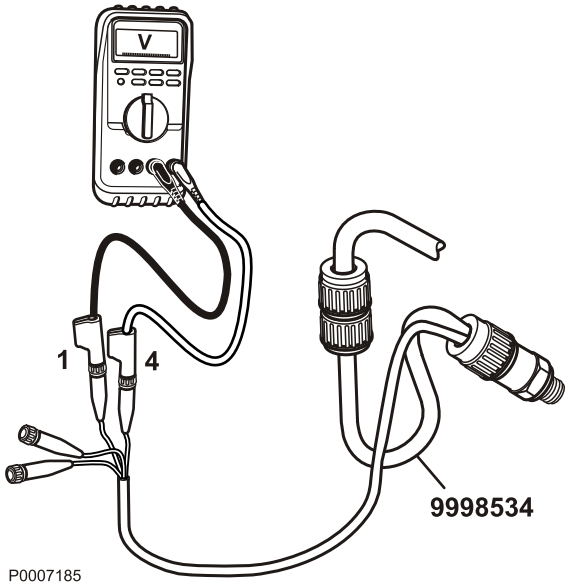
1 **NOTICE!** Cut the current with the main switch.

2 Disconnect the connector from the sensor Connect break-out cable 9998534 or 885675 to the cable harness connector to the engine control unit.

3 Use multimeter 88890074 to do resistance measurement towards the engine control unit.

Measurement points	Nominal value
2 - Battery negative terminal	R ≈ 80 - 120 kΩ

NOTICE! Measurement is done to eliminate short circuiting or breaks in the cable to the engine control unit.



P0007185

Checking supply cable, crankcase pressure sensor

Tools:
9998534 Break-out cable
885675 Break-out cable
88890074 Multimeter

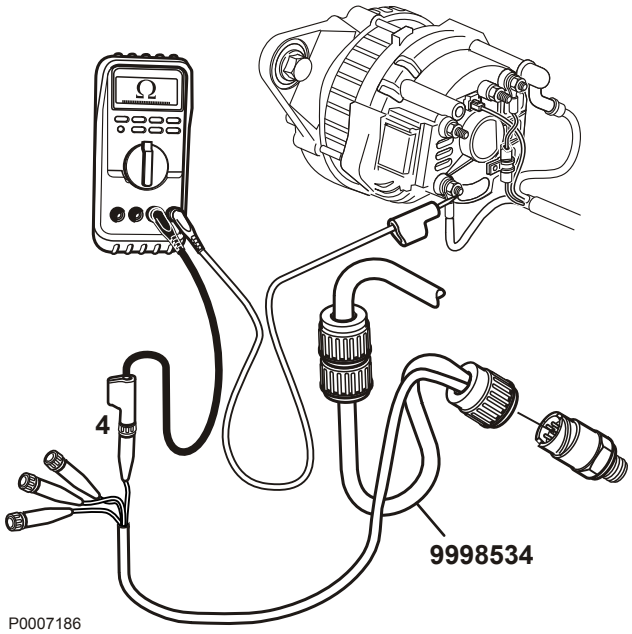
1 **NOTICE!** Turn the starter key to position 0. (If MCC, turn main battery switches off.)

2 Disconnect the connector from the sensor Connect break-out cable 9998534 or 885675 between the sensor and engine control unit.

3 Turn the starter key to position 1.

4 Use multimeter 88890074 for voltage measurement.

Measurement points	Nominal value
1 - 4	U ≈ 5 V



P0007186

Checking negative cable, crankcase pressure sensor

Tools:
9998534 Break-out cable
885675 Break-out cable
88890074 Multimeter

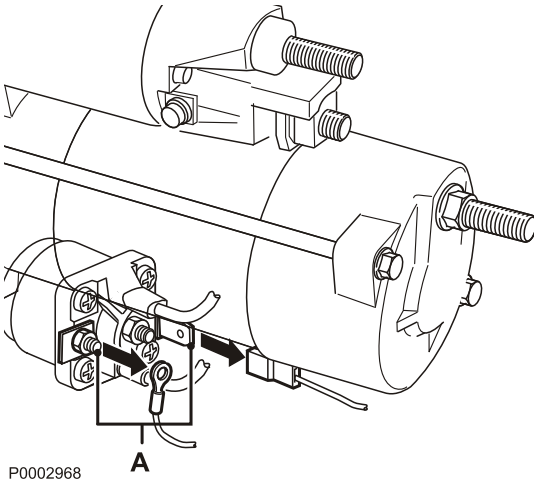
1 **NOTICE!** Cut the current with the main switch.

2 Disconnect the connector from the sensor Connect break-out cable 9998534 or 885675 to the cable harness connector to the engine control unit.

3 Use multimeter 88890074 to do resistance measurement towards the engine control unit.

Measurement points	Nominal value
4 - Battery negative*	R ≈ 0 Ω

NOTICE! Battery negative (–) on alternator or starter motor.



A Measurement points

Checking the starter motor solenoid

Tools:
88890074 Multimeter

1 **NOTICE!** Turn the starter key to position 0. (If MCC, turn main battery switches off.)

2 Undo the red/yellow cable.

3 Use multimeter 88890074 to do resistance measurement towards the relay.

Nominal value
R ≈ 2-12 Ω*

NOTICE! * Depending on whether the engine is equipped with 12 V or 24 V.

Checking the pre-start relay

1 **NOTICE!** Turn the starter key to position 0. (If MCC, turn main battery switches off.)

2 Access the fuses by removing the cover.

3 Identify the pre-start relay.

4 Remove the relay from its protective box.

5 Undo the relay from the relay socket.

6 Measure the resistance between pins 85 and 86 on the relay. Check that there is no short circuit or open circuit.