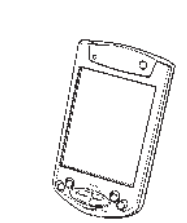
Workshop Manual

Group 30 Electrical system

B
2(0)

Volvo Penta IPS
EVC-C

Special tools



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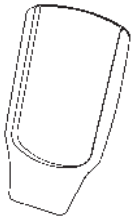

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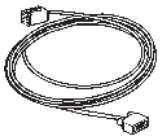
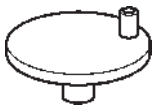


3838622

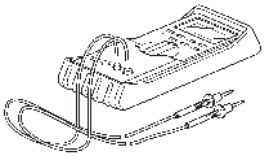
3838623

3838619

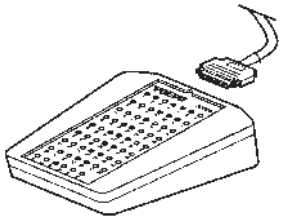


3809570

3812541

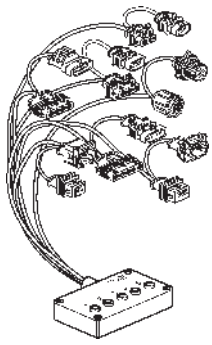


9812519



9998699

88890016



885675

3838619 VODIA complete diagnostic tool.* Components:

- 3838620 VODIA – palmtop computer (PDA) with SD card.
- 3838621 VODIA – docking station. Used with VODIA PDA (3838620).
- 3838622 VODIA – cable with connector. Used with docking station (3838621) on the engine's communication connector.
- 3838623 VODIA – EDC Adapter with external power supply. Used with docking station 3838621 and cable 3838622 connected to the engine's 2-pin connector.

*** Note.** More detailed information about using the VODIA tool can be found in the tool's instruction manual.

3809570 Cranking tool

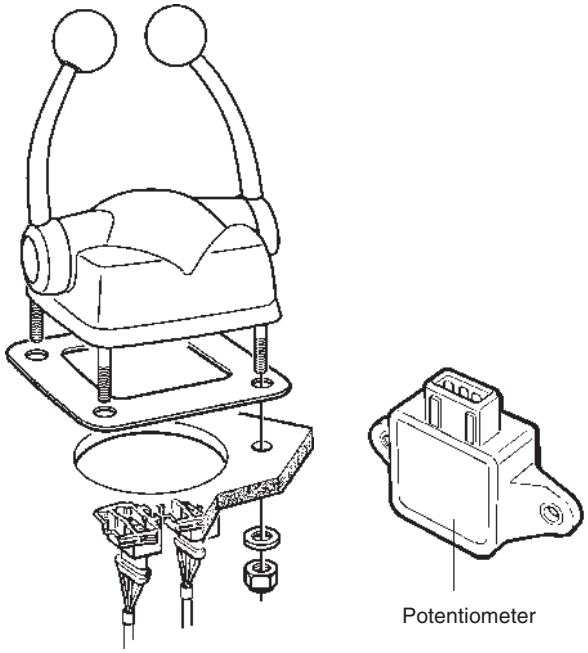
3812541 Brake release switch

9812519 Multimeter

9998699 Measurebox

88890016 Adapter cable for sensor test

885675 Adapter cable for sensor test



Control

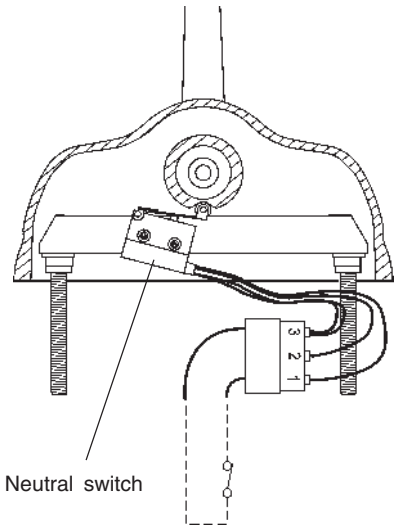
Only electronic controls can be used on the engines.

NOTE! If a control is changed, the control must be calibrated before starting (please refer to the “Calibration before starting” section).

Potentiometer

The potentiometer registers the movements of the control lever and gives the control module information about engine speed and gear shift demanded. The potentiometer is installed inside the control.

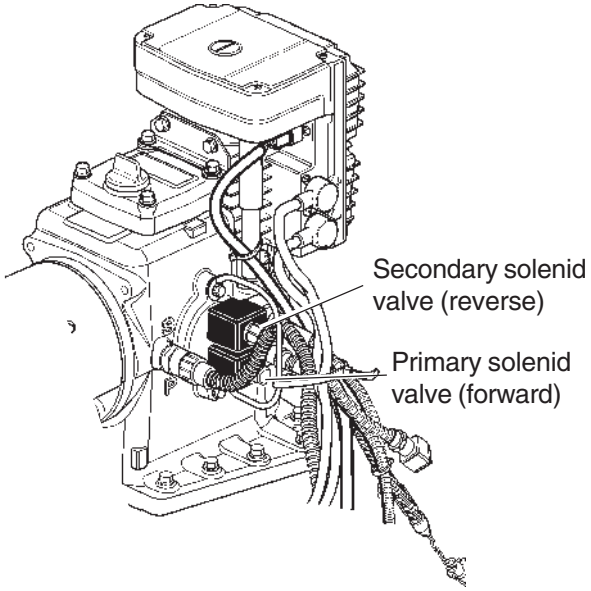
NOTE! If a potentiometer is changed, the control must be calibrated before starting (please refer to the “Calibration before starting” section).



Neutral switch

The neutral switch is a safety device that prevent the boat to began running when the control is in neutral mode.

The neutral switch is installed inside the control.



Solenoid valves, transmission

Solenoid valves (V) for gear shifting are located on the upper gear.

The valves are ordinary OFF–ON valves which allow oil to pass to the correct clutch when ON.

When sufficient oil pressure has been built up, the clutch is activated (the oil pressure is raised gradually to give a gentle engagement).

In the OFF position, the oil in the clutch is emptied and the reversing gear goes into neutral.

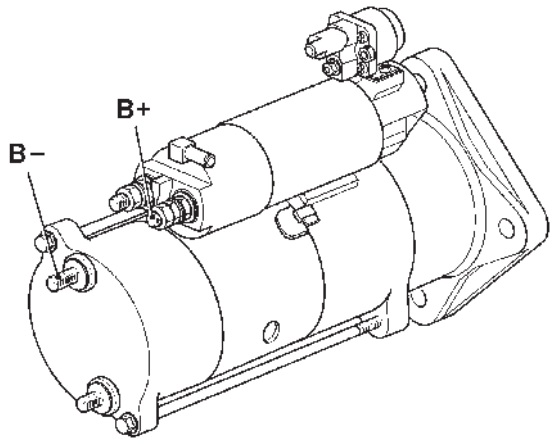
Fault tracing of the starter motor and windings

Special tools: Multimeter 981 2519

General

If battery voltage falls below 12.4 V* (12 V system voltage) alt. 24.7 V* (24 V system voltage), the starter motor will not be able to crank the engine at normal speed.

* **Note.** Measured on the batteries.



Voltage measurement, check

1
Check that the battery voltage is at least 12.4 V* (12 V system voltage) alt. 24.7 V* (24 V system voltage) when unloaded, by measuring between the battery poles with multimeter 981 2519.

* **Note.** Measured on the batteries.

2
Turn the main switch on.

3
Check that the voltage between terminals B+ and B– on the starter motor are the same as the battery voltage.

Checking the instruments

Special tools: Multimeter 9812519

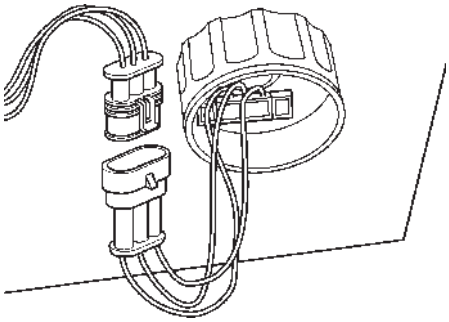
The instruments are “Easy Link” types and receive their signals from a serial bus consisting of a total of 3 conductors:

- Battery plus
- Battery minus
- Data bus

If a fault occurs in the “Easy Link” bus for the instruments, this can be discovered when the needles stop in the same positions on the instrument(s) (“frozen”). If no one of the instruments works, check with multimeter 9812519 if there is power supply voltage between red and blue conductors in the “Easy Link” harness.

Since common signals for various types of instruments pass through the same cable, it is difficult to determine whether information is missing from the serial bus, or if an individual instrument is faulty.

If you suspect an instrument fault, you can use the following procedure to determine whether the instrument is fault or not.



1
Start the engine and let it idle, with the control lever in the neutral position.

2
Disconnect the instrument which is suspected of being faulty.

3
The fault dissappears:

- Check that there is no oxide or moisture in the relevant instrument’s connector.
- Exchange the relevant instrument with a new one and check if the fault still is dissappeared.

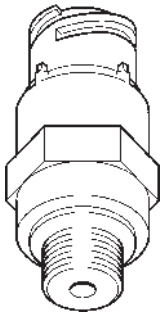
The fault remains:

Continue to disconnect instrument until remaining instruments starts to indicating correctly.

Re-connect the instruments again. Begin with the first disconnected instrument and continue to re-connect the other instruments until the connected instruments stops to indicating. Change the last re-connected instrument.

MID 128, PID 100

Oil pressure sensor (engine)



MID 128: Engine control unit

Fault code

FMI 0: The sensor value is valid but exceeds the normal working range.

FMI 1: The sensor value is valid but is less than the normal working range.

FMI 3: The voltage exceeds the normal value or is short circuited to higher voltage.

FMI 4: The voltage is less than the normal value or is short circuited to battery negative.

FMI 5: The current is less than the normal value or is open circuited.

FMI 6: The current is greater than the normal value or is short circuited to battery negative.

FMI 9: Abnormal updating rate.

FMI	Fault code explanation
0	Too high lube oil pressure
1	Too low lube oil pressure
3, 4, 5, 6, 9	Faulty sensor / Faulty sensor circuit

Fault indication

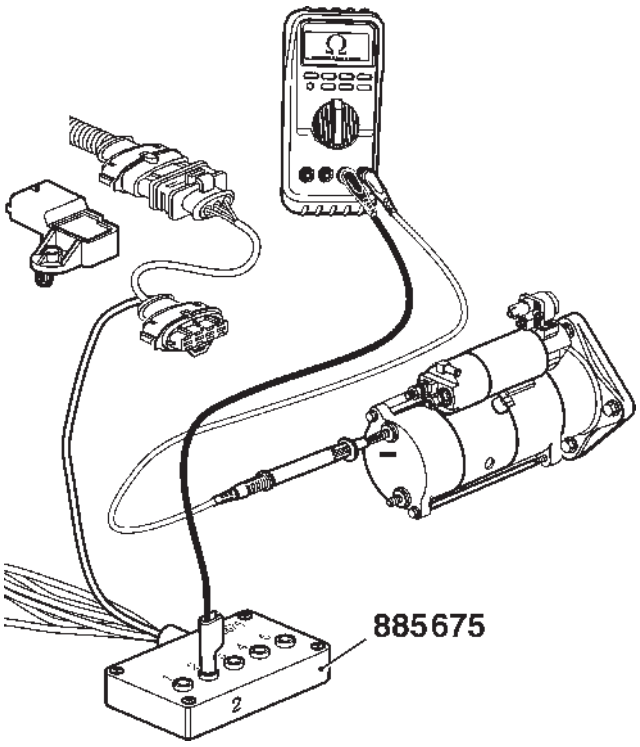
Warning is displayed in the tachometer/display.

FMI 1: Oil pressure indication in alarm display shows red. Audible warning.

FMI 0, 3, 4, 5, 6, 9: A red lamp flashes in the alarm display.

Symptom

Engine power is limited.



Signal cable

1
NOTE! Cut the current with the main switch.

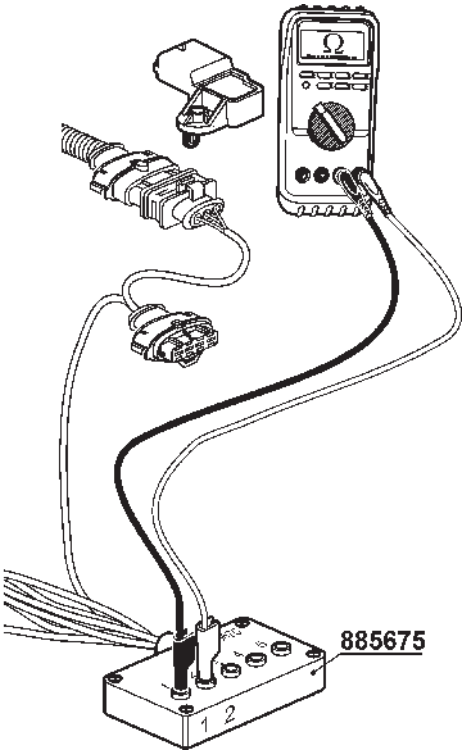
2
Remove the connector from the sensor. Connect adapter cable 885675 to cable harness connector to engine control unit (EDC7).

3
Use multimeter 9812519 to do resistance measurement against the engine control unit.

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

Measurement points	Nominal value
2 – Battery negative*	R ≈ 1,1–1.5 kΩ

* **Note.** Battery negative (–) on alternator or starter motor.



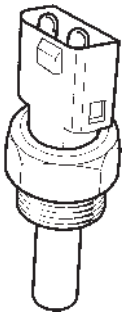
4
Turn the main switches on. Turn the starter key to **position I** (driving position).

5
Use multimeter 9812519 for voltage measurement.

Measurement points	Nominal value
1 – 2	U ≈ 5 V

MID 128, PID 110

Coolant temperature sensor



MID 128: Engine control unit

Fault code

FMI 0: The sensor value is valid but exceeds the normal working range.

FMI 3: The voltage exceeds the normal value or is short circuited to higher voltage.

FMI 4: The voltage is less than the normal value or is short circuited to battery negative.

FMI 9: Abnormal updating rate.

FMI	Fault code explanation
0	Excessive coolant temperature
3, 4, 9	Faulty sensor / Faulty sensor circuit

Fault indication

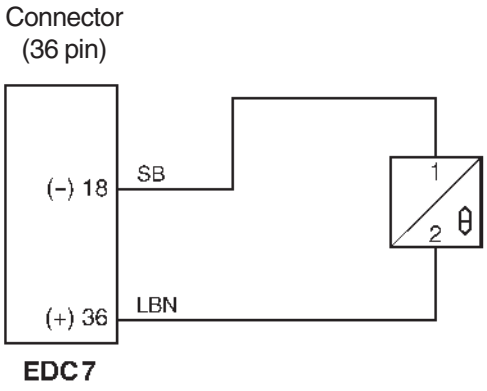
Warning is displayed in the tachometer/display.

FMI 0: High coolant temperature indication flashes red on the alarm display. Audible warning.

FMI 3, 4, 9: An orange lamp flashes in the alarm display.

Symptom

FMI 0: Engine power is cut.



Circuit description

The coolant temperature sensor consists of a thermistor which forms a closed circuit with the engine control unit (EDC7). The thermistor resistor changes in a non-linear manner, depending on the coolant temperature. The control unit (pin 36) provides the sensor (pin 1) with a reference voltage of +5 Volt. Pin 2 on the sensor is connected to battery negative via (pin 18) on the engine control unit.

When the coolant is cold, the thermistor resistance is high and the control unit senses a voltage close to the reference level. As the coolant warms up, the resistance in the thermistor falls and the voltage drop across it falls.

Please refer to the table, “resistance/temperature” in this fault code chapter.

FMI 5: Abnormally low current or open circuit has been detected.

Conditions for fault code

Voltage on pin 12 on engine control unit (EDC7) exceeds 5.20 Volt.

Possible reason

- Short circuited sensor 5V supply cable to battery voltage.
- Fault in sensor.

Suitable action

1
Check the cables and the connectors between the sensor and the engine control unit (EDC7).

2
Check sensor.

FMI 6: The current is greater than the normal value or is short circuited to battery negative

Conditions for fault code

Voltage on pin 12 on engine control unit (EDC7) is less than 4.50 Volt.

Possible reason

- Short circuited sensor 5V supply cable to battery negative.
- Fault in sensor.

Suitable action

1
Check the cables and the connectors between the sensor and the engine control unit (EDC7).

2
Check sensor.

FMI 9

Conditions for fault code

Abnormal updating rate.

Possible reason

- Fault in sensor.
- AD conversion failed (fault in engine control unit, EDC7).

Suitable action

1
Check sensor.

2
Change engine control unit.

Fault tracing

FMI 0: Fault in signal from flywheel sensor.

Possible reason

- Short circuited sensor power supply cable to battery voltage.
- Short circuited sensor negative cable to battery voltage.
- Short circuited sensor power supply cable to battery negative.
- Broken sensor power supply cable.
- Open circuit in sensor battery negative cable.
- Incorrectly installed sensor (wrong distance to flywheel).
- Electrical interference on engine speed signal.
- Damaged flywheel.
- Fault in sensor.

Suitable action

1
Check the cables and the connectors between the flywheel sensor and the engine control unit (EDC7).

2
Check that the flywheel sensor is correctly installed and that no swarf has collected on the sensor.

3
Check the flywheel sensor.

FMI: 1 Faulty signal from camshaft sensor.

Possible reason

- Short circuited sensor power supply cable to battery voltage.
- Short circuited sensor negative cable to battery voltage.
- Short circuited power supply cable to battery negative.
- Broken sensor supply cable.
- Open circuit in sensor battery negative cable.
- Incorrectly installed sensor (wrong distance to toothed wheel).
- Electrical interference on engine speed signal.
- Damaged toothed wheel.
- Fault in sensor.

Suitable action

1
Check the cables and the connectors between the camshaft sensor and the engine control unit (EDC7).

2
Check that the camshaft sensor is correctly installed and that no swarf has collected on the sensor.

3
Check the camshaft sensor.

4
Check that the camshaft chain is correctly installed.

Checking the camshaft position sensor (speed sensor, camshaft)

Special tools: 9812519, 885675

1
NOTE! Cut the current with the main switch.

2
Undo the connector from the sensor and remove the sensor from the cylinder head.

Check that the sensor does not have any external damage, or any swarf which has got stuck on it.

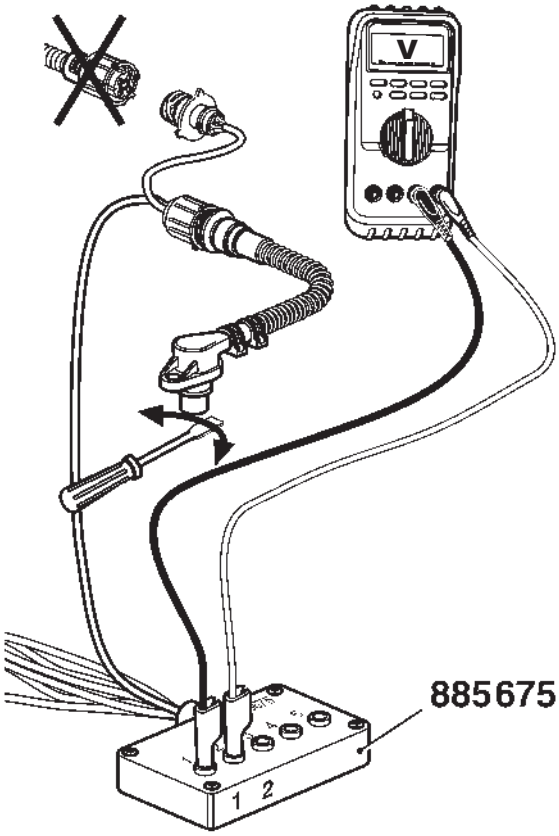
3
Connect adapter cable 885675 to sensor.*

* **NOTE!** Do **not** connect the other end of the adapter cable to the engine cable harness, since this can cause a measurement error.

4
Use multimeter 9812519 for resistance measurement.

Measurement points	Nominal value
1 – 2	R ≈ 0.9 kΩ*

* **Note.** ±10% at 20°C (68°F).



5
Use multimeter 9812519 for voltage measurement.

Move a metal object rapidly back and forwards not more than 1 mm in front of the sensor. Check that the multimeter gives a reading.

6
Install the sensor.

Checking the solenoid winding

Special tools: 9812519

1
NOTE! Cut the current with the main switch.

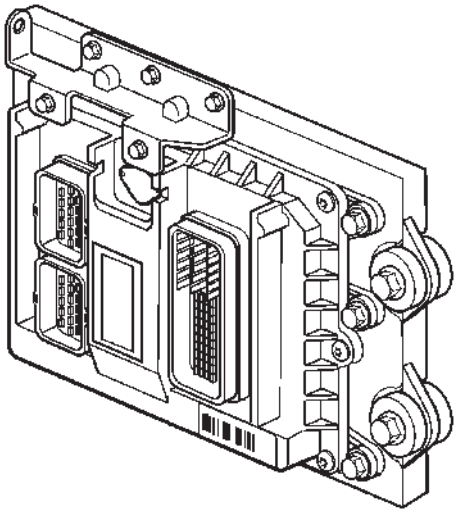
2
Remove the yellow/ red cable from the starter motor relay.

3
Use multimeter 9812519 to measure the resistance between the starter motor relay and the battery negative on the starter motor.

Nominal value: R ≈ 2–12 Ω

MID 128, SID 254

Engine control unit EDC 7



MID 128: Engine control unit

Fault code

FMI 3: Internal fault in engine control unit (overflow).

FMI	Fault code explanation
3	Internal fault in engine control unit (EDC7)

Fault indication

Warning is displayed in the tachometer/display.

A red lamp flashes in the alarm display + audible warning.

Symptom

Engine can temporarily run unevenly.

Fault tracing

FMI 3

Possible reason

Internal fault in engine control unit (overflow).

Fault code is set because the engine control unit (EDC7) receives more commands than it can execute. The control unit then shuts off for a few seconds before doing a restart.

Suitable action

Please contact Volvo Penta.

Fault code description

The engine control unit (EDC 7) continually monitors the fuel pressure (rail pressure) via the fuel pressure sensor and controls fuel pressure via the MPROP valve.

If the rail pressure rises too high, the engine control unit attempts to reduce the pressure by increasing the current going to the MPROP valve. If a fault occurs and the engine control unit still detects excessive pressure, despite attempts to reduce the pressure, the control unit expects that the pressure relief valve should open and thus reduce the pressure.

If the pressure relief valve has not opened after a certain time (at the same time as the high fuel pressure remains), the engine control unit interprets this as a fault and shuts the engine off as a protective measure.

Fault tracing

FMI: 0, 1

Reason for fault code

Threshold value for pressure relief valve is 185–195 MPa (1850–1950 bar / 26832–28282 psi).

Possible reason

Pressure relief valve is open or does not open on request.

Suitable action

1
Check the fuel level. If air gets into the system, the high pressure pump can start to compensate for fuel pressure drop. The result can be oscillating fuel pressure.

2
Check fuel pipes for leakage on both suction and high pressure side.

3
Check / change the fuel filters. If the filters are blocked, the high pressure pump can start to compensate for fuel pressure drop. The result can be oscillating fuel pressure.

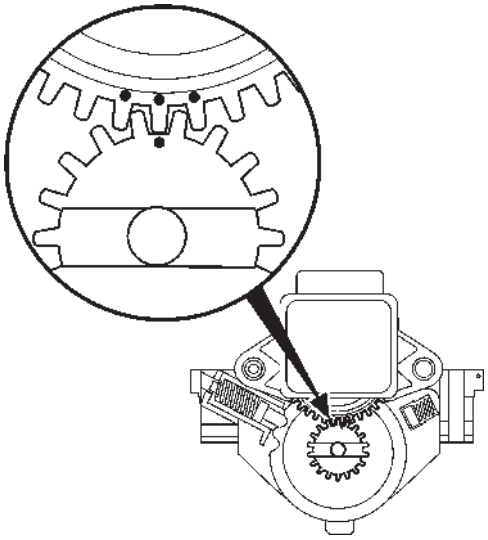
Check the negative pressure in the fuelpipe. Please refer to the instruction in the Workshop manual for D4/ D6 engines, group 23.

4
Check the connections and cables for the proportional valve (MPROP valve).

5
Check the fuel pressure sensor function, please refer to “Checking the fuel pressure sensor”.

6
Fault in injectors.

7
Change the pressure relief valve.



Changing the potentiometer in electronic controls

1
Cut the power with the ignition switch or main switch.

2
Remove the control from the instrument panel. Undo the connector and remove the defective potentiometer.

3
Install the new potentiometer. Check that the markings on the teeth line up before the potentiometer is screwed into place. Put a drop of thread locking fluid* on the screw that holds the control lever, and tighten the screw until the control lever has the correct friction.

* Volvo Penta part no. 1161053-2.

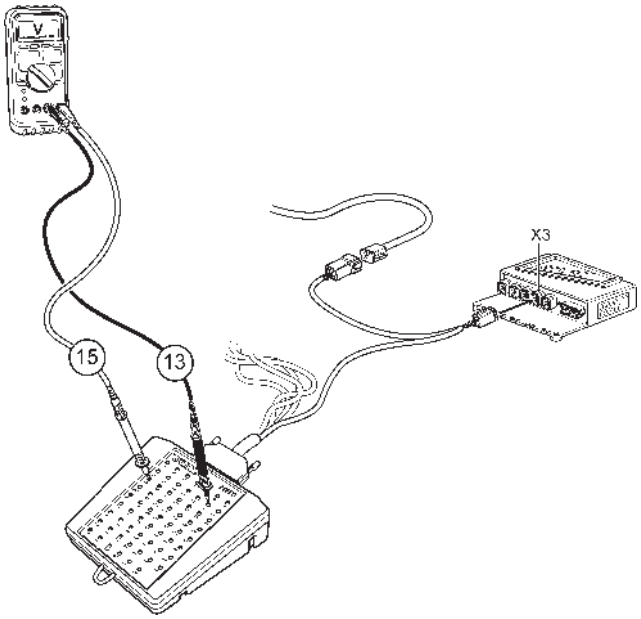
4
Connect the connector and screw the control down on the instrument panel.

5
Turn the main switch on.

6
Calibrate the controls.

7
Erase any fault codes by cutting the current with the starter switch.

8
Check the engine's speed regulation/gear changing functions.



Measurement

Special tools: Adapter cable 88890016, measurebox 9998699, multimeter 9812519.

Checking the power supply:

1

Note! Cut the current with the main switch.

2

Connect adapter cable 88890016 with measurebox 9998699 between the PCU and the SHCU.

3

Use multimeter 9812519 for voltage measurement.

4

Turn the main switch on.

5

Turn the ignition on.

Measurement points	Nominal value
13 - 15	U ≈ Battery voltage

MID 164, PSID 64

Joystick fault

MID 164: SHCU

FMI 9: Data missing or incorrect.

FMI 12: Faulty device or component.

FMI	Fault code explanation
9	SHCU unit has detected too may errors on the CAN communication and has shut down the interface or timeout on frame/frames from the joystick unit. SHCU unit has not detected any communication from the joystick unit.
12	SHCU unit has detected that the joysticks x, y, z value are out of range or faulty.

Fault indication

Warning is displayed in the tachometer/display.

Orange lamp flashes in alarmpanel.

Symptom

- Docking mode can not be activated. No steering pin functionality

MID 164, PSID 103

Neutral button

MID 164: SHCU

FMI 4: Voltage below normal or shorted low.

FMI	Fault code explanation
4	Fault on neutral button, either short to ground or supply in the SHCU, wire or panel or the button is mechanical stuck.

Fault indication

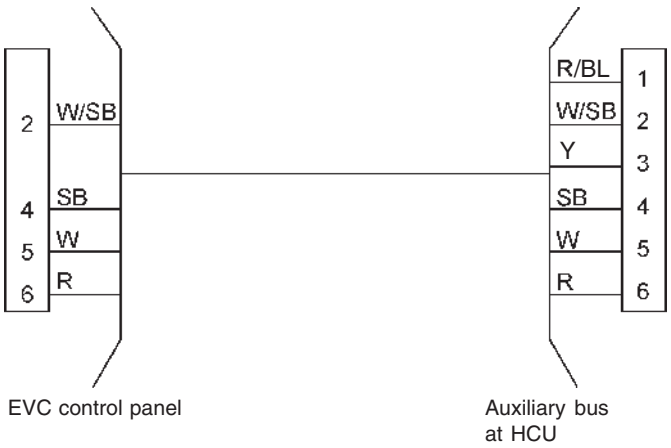
None. Fault only visible in Vodia.

Symptom

- No indication if gear is in neutral or not.
- Lamp can either be constantly on or constantly off independent of gearbox status.

Circuit description

The EVC control panel gets its power supply from the SHCU. The EVC control panel communicates over the auxiliary bus with the SHCU.



Buzzer positive

J1708B

Easy link data

Battery negative

J1708A

Battery positive

MID 164, PSID 133

Steering wheel data link

MID 164: SHCU

Fault code

FMI 2: Data erratic, intermittent or incorrect.

FMI 5: Open circuit.

FMI 9: Abnormal update rate.

FMI	Fault code explanation
2, 5, 9	SHCU unit has detected too may errors on the CAN communication and has shut down the interface or timeout on frame/frames from the Steering wheel unit. SHCU unit has not detected any communication from the Steering wheel unit.

Fault indication

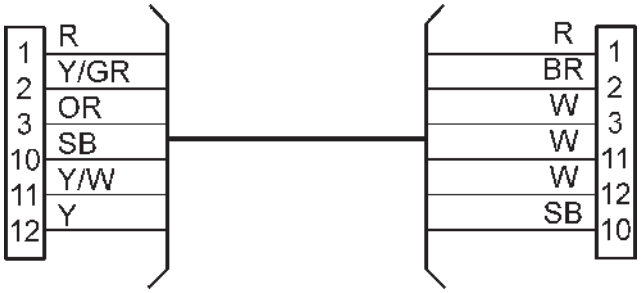
Warning is displayed in the tachometer/display.

Orange lamp flashes in the alarmpanel

Symptom

- No steering response and drive train to safe mode
- Only error information, the drive train operates on the other side steering wheel signals

Circuit description



SHCU connector
X8 Brown

Steering wheel

Power supply, 12V / 24V

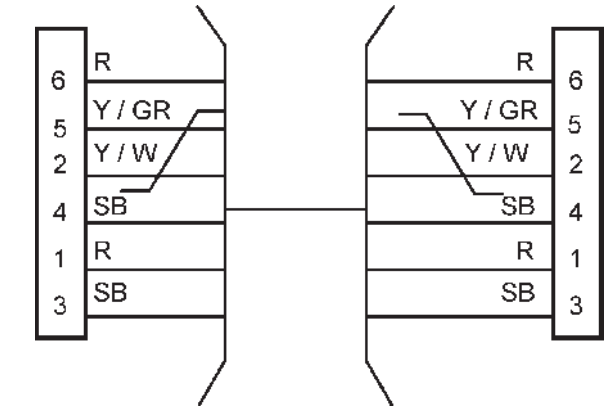
CAN H

Power supply, 0V

Back up power supply, 0 V

CAN L

Back up power supply, 12V / 24V



Connector SHCU

Connector PCU
Connector X2
Colour Green

Circuit description

Back up power supply, 12 V / 24 V

CAN H

CAN L

Back up power supply, 0 V

Power supply, 12 V / 24 V

Power supply, 0 V

Fault tracing

Preconditions

Passive helm:

- This SHCU has been configured on the network.

Active helm:

- Network configured.
- Helm is active.

FMI 8, 9

Conditions for fault code

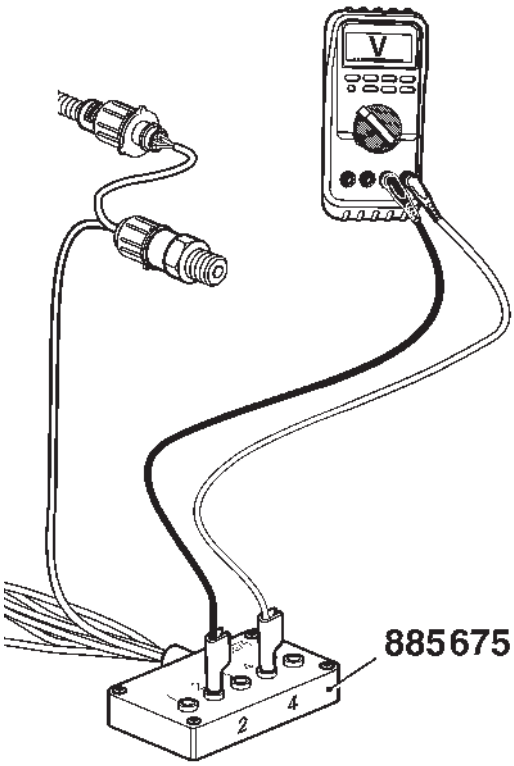
SHCU receives no frames from PCU for 5 seconds.

Possible reason

Open circuit in both CAN wires to SHCU.

Suitable action

1
Check connectors and wires between SHCU(s) and PCU for bad contact. See “Manual fault tracing in bus cables”.



Checking the sensor

Special tools: Adapter cable 885675, multimeter 9812519.

1

NOTE! Ignition off.

2

Disconnect wireharness to sensor.

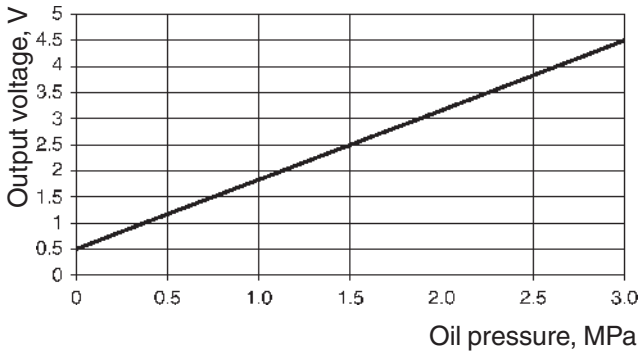
3

Connect adapter cable 885675 between sensor and the PCU.

4

Use multimeter 9812519 for measuring voltage.

Measuring points	Set point
2 - 4	U ≈ 0,5 V



Specification

Operating range ..... 0–3 MPa (0–30 bar)

Supply voltage ..... 5,00 ±0,25 V DC

Nominal output voltage at 25 °C and supply voltage 5,00 VDC:

0,5 V DC at ..... 0 kPa (0 bar)*

4,5 V DC at ..... 3 MPa (30 bar)*

* **Note.** At normal atmospheric pressure.

FMI 12

Conditions for fault code

Fault has occurred during power up or power down the EMS does not respond or does not respond in a correct way.

Suitable action

1
Check that AUX button is not activated or stucked.

2

Check battery voltage.

3

Disconnect and inspect X3 connector at the PCU, reconnect.

4

Check wire harness and connectors between engine and PCU for damages.

5

Reprogram engine ECU.

6
Re-program the PCU.

MID 187, PSID 20

Primary solenoid (high side switch)

MID 187: PCU

Fault code

FMI 4: Voltage below normal or shorted low.

FMI 5: Current below normal or open circuit.

FMI 6: Current above normal or short circuit to battery negative.

FMI	Fault code explanation
4, 5, 6	Error on the primary solenoid high side driver. This output is normally driven high when forward gear is engaged.

Fault indication

Warning is displayed in the tachometer/display.

Red lamp flashes in alarmpanel + Audible warning.

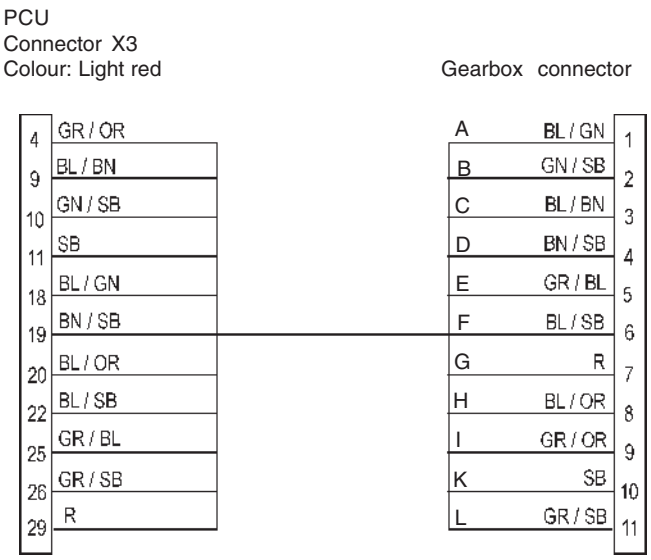
Symptom

- Not possible to engage any gear.
- Cranking disabled. Cranking permitted after acknowledge.

Circuit description

When the gear is in neutral position the voltage output from the PCU is approx. 0.1-0.2 V on both the solenoid connections. If the solenoid is missing or broken the potential on the solenoid connections are not equal and the PCU detects it and sets a faultcode.

When a gear is engaged the high side cable to the solenoid changes potential to approx. battery voltage.



A. Primary solenoid 5A ”High side”

B. Primary solenoid 5A ”Low side”

C. Secondary solenoid 5A ”High side”

D. Secondary solenoid 5A ”Low side”

E. Not used

F. Not used

G. Not used

H. Not used

I. Not used

K. Level/RPM negative

L. Not used

Fault tracing

Preconditions

Engine is power on(Engine ECU is up and running)

FMI 8, 9, 12

Conditions for fault code

No communication with the engine.

Possible reason

- AUX stop button depressed or stucked or Open circuit in wires to button.
- Engine stop relay (Fire shutdown system) has been activated (if installed).
- Open circuit in both CAN L and CAN H between engine and PCU.
- Open circuit in CAN L between engine and PCU.
- Open circuit in CAN H between engine and PCU.
- Open circuit ignition output wire.
- CAN H and CAN L between engine and PCU shorted together, short to battery negative or short to supply.
- Software problem in the engine.

Suitable action

1

Check that AUX button is not activated or stucked.

2

Check what triggered the engine stop relay (Fire shutdown system) to be activated.

3

Disconnect and inspect X3 connector at the PCU, reconnect.

4

Check wire harness between engine and PCU for damages.

5

Reprogram engine ECU.

MID 187 / MID 164 / MID 250, PPID 393

Data bus power input

MID 164: SHCU
MID 187: PCU
MID 250: SUS

Fault code

FMI 4: Voltage below normal or shorted to low. Too low voltage detected under running conditions.

FMI 11: Failure mode not identifiable. Other error except low voltage such as high battery negative voltage or overloaded bus.

FMI	Fault code explanation
4, 11	There is a problem with the power supplied by the data bus. Will only be set in units that are supplied from the data bus, in most installations this will be the SHCU.

Fault indication

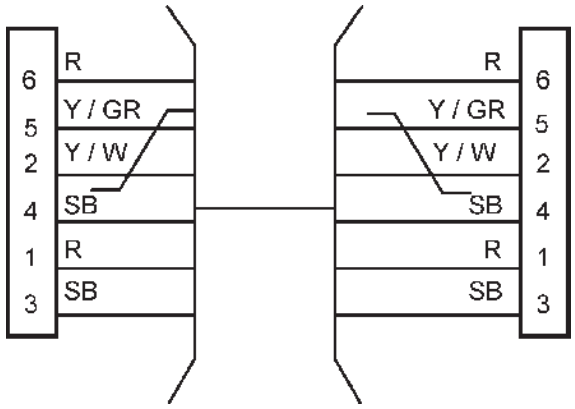
Warning is displayed in the tachometer/display.

Orange lamp flashes in the alarmpanel

Symptom

None

Circuit description



HCU connector or
SUS connector

PCU connector
Conn. X2
Colour Green

Back up power supply, 12 V / 24 V

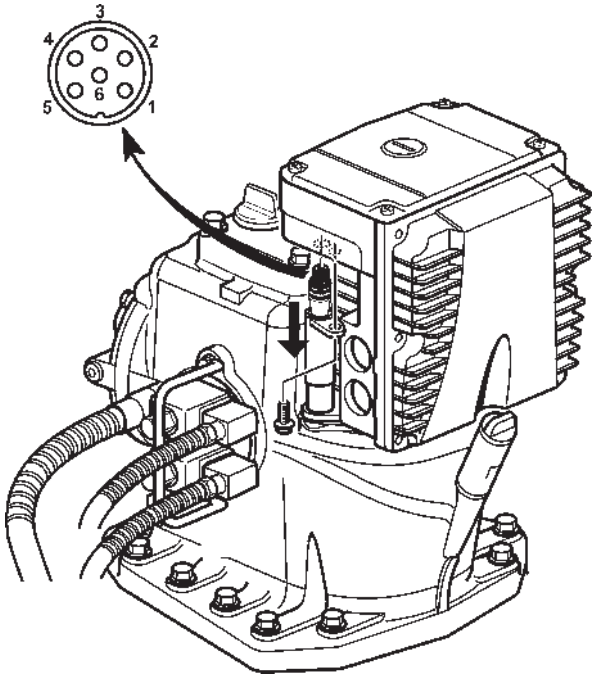
CAN H

CAN L

Back up power supply, 0 V

Power supply, 12 V / 24 V

Power supply, 0 V



Measurements

- **NOTE!** Main switch **off**.
- Disconnect resolver wireharness.
- Use multimeter 9812519 for measuring resistance.

Measuring points	Set point
1 – 2	R ≈ 100 Ω
3 – 4	R ≈ 100 Ω
5 – 6	R ≈ 37 Ω

NOTE! Measurement is done to eliminate short circuiting or breaks in the cable

MID 250, PSID 4

Electro mechanical rudder brake

MID 250: SUS

Fault code

FMI 5: Current below normal or open circuit.

FMI 6: Current above normal or battery negative circuit.

FMI 7: Mechanical system not responding properly.

FMI 14: Special instructions.

FMI	Fault code explanation
5, 6, 7, 14	The SUS unit has internal diagnostics for the mechanical brake. This fault describes different typs of fault.

Fault indication

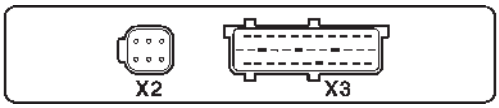
Warning is displayed in the tachometer/display.

Red lamp flashes in alarmpanel + Audible warning.

Symptom

Not possible to become active or the steering stops working, goes to safe mode.

Pin configuration, PCU



X2 (Green) Data link – EVC bus cable

X3 (Pink) Engine and transmission

X2

1.	System voltage 12 / 24 V
2.	CAN L
3.	System voltage, 0 V
4.	Back-up, power supply, 0 V
5.	CAN H
6.	Back-up, power supply, 12 / 24 V

X3

1.	Not used
2.	Not used
3.	Not used
4.	Gearbox temp
5.	J1708B – Diagnostic bus
6.	Not used
7.	CAN L – Data link to engine
8.	Input signal, fuel level sensor
9.	Gearshift control, secondary (“high-side switch”)
10.	Gearshift control, primary (“low side switch”)
11.	Battery negative (–), fuel level sensor
12.	Not used
13.	Not used
14.	Negative (-) voltage, Engine and diagnostic connector
15.	J1708A – Diagnostic bus
16.	Not used
17.	CAN H – Data link to engine
18.	Gearshift control, primary (“high side switch”)
19.	Gearshift control, secondary (“low side switch”)
20.	Gearbox pressure
21.	Not used
22.	Lowspeed solenoid
23.	Ignition signal, key switch
24.	Not used
25.	Lowspeed solenoid
26.	Gearbox revolution pick up
27.	Not used
28.	Power supply, Engine and diagnostic connector
29.	Power supply, Gearbox connector

Checking the charging system

Special tools: 9812519

Generally about alternators:

The voltage output from an alternator must be limited to prevent the elecrolyte in the battery to evaporate. The alternator output is regulated (limited) by the voltage regulator in the alternator. The maximum current that the alternator can deliver at regulated voltage output depends on the alternator revolution. To make the alternator charging more efficient a sense cable between the alternator and the battery+ can be added to compensate if there is a voltage drop in the cable between the alternator and the battery+.

When the engine is started an excitation current is needed to “wake up” the alternator.

NOTE! It is the consumers (batteries included) which decides the output current from the alternator.

Measurements

1. Engine off.
2. Use multimeter 9812519 to do a voltage measurement over the battery. The nominal voltage over a full loaded battery is approx. 12.6V or 25.2V.
3. Engine on. Run at 1500 rpm.
4. Use multimeter 9812519 to do a voltage measurement over the battery. The nominal charging voltage over the battery should be approx. 13.6-14.4V or 27.8-28.6V (if the sense cable is connected).

Fault tracing the charging system

Battery

1. Check that all connectors at the battery is correct assembled.
2. Check the conditions of the cables to the battery.
3. Check the water level in the battery.
4. Check, if possible, the specific gravity of all cells.

when no charge

1. Check the alternator belt tension.
2. Check that all connectors at the alternator and at the battery is correct assembled.
3. Check the conditions of all cables in the charging system.
4. Check the brushes length and condition.
5. Change, if possible, the regulator.

when undercharge

1. Check the alternator belt tension.
2. Check that all connectors at the alternator and at the battery is correct assembled.
3. Check the conditions of all cables in the charging system.
4. Check the brushes length and condition.
5. Change, if possible, the regulator.

when overcharge

1. Change, if possible, the regulator.