

Installation
EMS 2
Industrial engines

I
1(1)

TAD734GE

Installation EMS 2

TAD734GE

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Safety regulations

Introduction

This installation manual contains the necessary information for installing and performing a functional check of the EMS 2 system (electronic control of the injection system).

Read the instructions carefully before starting the installation. If the installation is performed in an incorrect manner, it may cause personal injury or damage property and the mechanic.

Ask your Volvo Penta dealer for help if there is anything in this instruction manual that you do not understand or are uncertain about.

Installation

This instruction manual is intended only for professional use.

This Installation Manual is intended to be used together with the relevant Operators Manual for the Engine.

Volvo Penta take no responsibility for damage to persons or property that may occur as a result of not following the installation guide lines, or for work carried out by non-professional personnel.

The fitter is responsible for ensuring that the system functions in accordance with these installation instructions.

 It is not permitted to make alterations to the cable harness delivered with the engine.

Work methods

These instructions are intended for personnel with suitable qualifications. In these instructions such persons are named as fitters.

Also refer to the operators instructions for the engine in question, for relevant information as required, especially concerning information about safety and running the engine.

The work must be performed by a Volvo Penta workshop or other authorized, well equipped workshop by qualified and experienced personnel.

Important!

The following special warning symbols can be found in this manual and on the engine.

 **WARNING!** Warns for the risk of personal injury, damage to property, or that a mechanical fault may occur if the instructions are not followed.

 **IMPORTANT!** Used to draw your attention to something that can cause damage or malfunctions of the product or material damage.

NOTE: Used to draw your attention to important information that will facilitate the work or operation in progress.

Below, there is a summary of the risks and safety measures that you must follow or perform when you install and calibrate the EMS 2 system.

 The EMS system's connectors must be disconnected before electric welding is performed. Disconnect the engine from the system voltage by shutting off the main switch. Disconnect the connectors from the control unit. Reconnect the connectors to the EMS 2 control unit once the welding is completed and the welding equipment has been removed.

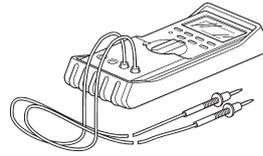
 Be careful, be aware of the engine's moving parts during the functional check and when running the engine. There is a risk for personal injury when approaching a running engine. Remember that loose clothing and long hair can fasten in rotating parts and cause serious injury.

-  Never work on an engine that is hanging from lifting gear (a crane or similar).
-  The engine shall not be operated in areas where there are explosive materials or gases.
-  Only start the engine if the ventilation is satisfactory. If the engine is operated in an enclosed area, you must ensure that there is sufficient ventilation to remove the exhaust gases and crankcase fumes from the workplace.
-  The battery box shall never be exposed to open flames or electrical sparks. Never smoke close to the batteries. The batteries generate hydrogen gas during charging, which can mix with air and form an explosive mixture. This gas is highly inflammable and explosive. Incorrect connection of the batteries can cause sparks that in turn can ignite an explosion with resulting damage. Do not change the battery connections when you try to start the engine (risk for sparks) and do not lean over the batteries. Refer to the instructions in the engine operators manual.
-  Make sure that the positive (+) and negative (-) battery cables are correctly connected to the corresponding battery terminals. You can cause serious damage to the electrical equipment if the cables are mixed up. Refer to the wiring diagram in the engine operators manual.
-  Always wear eye protection when you charge or handle the batteries. The battery electrolyte contains sulfuric acid which is highly corrosive. If the electrolyte comes into contact with bare skin, wash immediately with large quantities of clean water and soap. Then seek medical attention. If you get battery electrolyte in your eyes, immediately shower (preferably with an eye shower) with large quantities of clean water. Then seek immediate medical attention.

Special Tools



3838619



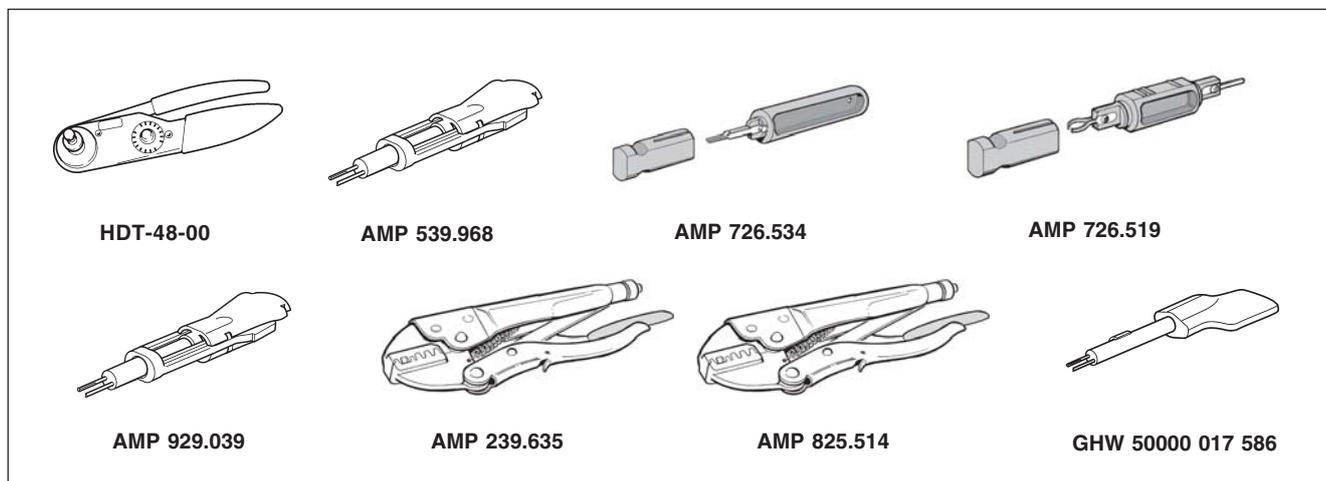
9510060

3838619 VODIA, complete with cable harness.
Refer to the VODIA operators manual
when ordering separate parts.

9510060-8 Multimeter

Other special equipment

The tools below are intended for work on the engine cable harness. The tools are not part of Volvo Pentas assortment, but must be ordered from **AMP** or **Deutsch** dealers. Contact Volvo Penta Quality Action Center if you have trouble finding a dealer.



Deutsch connectors

HDT-48-00 Pressing tool

AMP connector (42-pin CIU, 62-pin EMS, 2 and 3 pin Bosch etc.)

539968-1 Removal tool 1.5 mm pin width

726534-1 Removal tool 1.6 mm pin width

726519-1 Removal tool 2.8 mm pin width

929039-1 Removal tool 2.8 mm pin width

239635-1 Pressing tool

825514-1 Pressing tool

4.8 mm and 6.3 mm cable terminals. Blade connection

825514-1 Pressing tool

GHW connector (relay box)

50000017586 Removal tool 4.8 mm pin width

General information

EMS 2 – Engine Management System (engine control system)

EMS 2 is an electronic system with CAN communication (Controller Area Network) for controlling diesel engines. The system has been developed by Volvo and includes fuel regulation and diagnostic functions.

The system comprises a control unit, six injectors, a number of sensors that supply the control unit with values and connectors for diagnostics and functional checks. The engine can be connected to a communication interface comprising a CAN link and a serial link.

CAN – Controller Area Network

The CAN link J1939 is responsible for all communication between the engine control unit (EMS 2) and a communication interface (such as CIU/DCU) with the exception of diagnostics. Diagnostics is handled by the J1708/J1587 link. The CAN link is much faster than the J1708/J1587 link and has been constructed for connection to other components that support the SAE J1939 protocol, such as instrument panels and transmissions.

If a fault occurs in the CAN link, the signals from the engine speed potentiometer and start and stop buttons are taken over by the J1708/J1587 link. However, the instruments and tell-tale lamps are shut down.

If faults occur on both links, the engine will run at idle. In such a situation, the engine can only be shut down by using the auxiliary stop (AUX-STOP) located on the left of the engine.

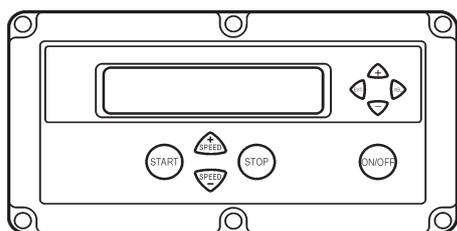


CIU (Control Interface Unit)

The CIU is a “translator” between the CAN bus and the customer’s own control panel. The unit has two serial communication links, a fast one and a slow one.

The fast link is the CAN link which offers a speed of 250 Kbit/s. All data concerning instruments, tell-tale lamps, connectors and potentiometers is transferred via this bus.

The slower link, J1708/1587 handles diagnostic information such as flash-codes. The diagnosis tool VODIA also uses the J1708/J1587 link to communicate with the system.



DCU (Display Control Unit)

The DCU is a digital instrument panel that communicates with the engine control unit via the CAN link. The DCU has several functions, such as:

Engine control

- Start, stop, engine speed regulation, pre-heating, etc.

Monitoring

- Engine speed, charge pressure, charge air temperature, coolant temperature, oil pressure, oil temperature, operating hours, battery voltage, instantaneous fuel consumption and fuel consumption (trip fuel).

Diagnostics

- Shows fault codes in text. Lists previous faults.

Parameter setting

- Idle speed, alarm limits for oil temperature/coolant temperature, speed drop
- Pre-heating before ignition.

Information

- Information about hardware, software and engine identification



DU (Display Unit)

The DU is an instrument panel that shows the engine's working values in graphical form on an LCD display. It consists of a computerized unit for permanent installation in a control panel.

The display communicates via the CAN link. It is connected to the CAN link between the engine control unit and the CIU or DCU.

Monitoring

- Engine speed, charge pressure, charge air temperature, coolant temperature, oil pressure, oil temperature, fuel pressure, operating hours, battery voltage, instantaneous fuel consumption and fuel consumption (trip fuel).

Diagnostics

- Shows active fault codes as text.

Fuel regulation

The engine's fuel requirement is analyzed up to 100 times per second (depending on engine rpm). The engine's injection volume and injection timing are controlled electronically via the fuel valves in the injectors.

This means that the engine always has the correct fuel volume under all running conditions, which gives lower fuel consumption, the smallest possible exhaust emission, etc.

The control unit controls and regulates the injectors connected to a common rail, to ensure that the correct fuel volume is injected into each cylinder. It also calculates and adjusts the injection timing. Regulation is performed mainly by using the engine speed sensor and combination sensor for charge air pressure/charge air temperature.

The control unit effects the unit injectors via an electronic signal to the solenoid fuel valve in each unit injector, which can be opened and closed.

When the fuel valve is open, the fuel flows past, through the hole in the unit injector and out via the fuel channel. In this state, no fuel is injected into the cylinders.

When the fuel valve is closed, pressure is built up by the mechanically driven piston in the unit injector. When sufficient pressure has been built up, the fuel is injected into the cylinder via the unit injector's injector.

The fuel valve opens again and the pressure in the unit injector drops at the same time as injection into the cylinder stops.

In order to decide when the fuel valve shall open and close, the control unit has access to signals from sensors and monitors.

Calculation of fuel volume

The control unit calculates the volume of fuel to be injected into the cylinder. The calculation determines the time during which the fuel valve is closed (when the fuel valve is closed, fuel is injected into the cylinder). The parameters that determine the volume of fuel injected are:

- Requested engine speed
- Engine protection functions
- The temperature
- Charge air pressure

High altitude adjustment

The control unit contains an air pressure sensor and high altitude compensation for engines operating at high altitudes.

The function limits the fuel volume in relation to the ambient air pressure (the engine output is reduced from approx. 1500 meters altitude). This is done to prevent smoking, high exhaust temperatures and to protect the turbocharger for overspeeding.

Diagnostic function

The purpose of the diagnostic function is to detect and localize any faults in the EMS 2 system, to protect the engine and inform about any problems that may occur.

If a fault is detected, this is shown with a warning lamp, a flashing diagnostic lamp or a text message on the instrument panel, depending on the type of equipment fitted. If a fault code is displayed as a flash code or as text, this information is used as a guide when fault tracing. Fault codes can also be read off by Volvos VODIA tool at authorized Volvo Penta workshops.

If a serious fault occurs, the engine may be shut down completely or the control unit may reduce the power output (depending on the application). A fault code is also displayed for guidance when fault tracing.

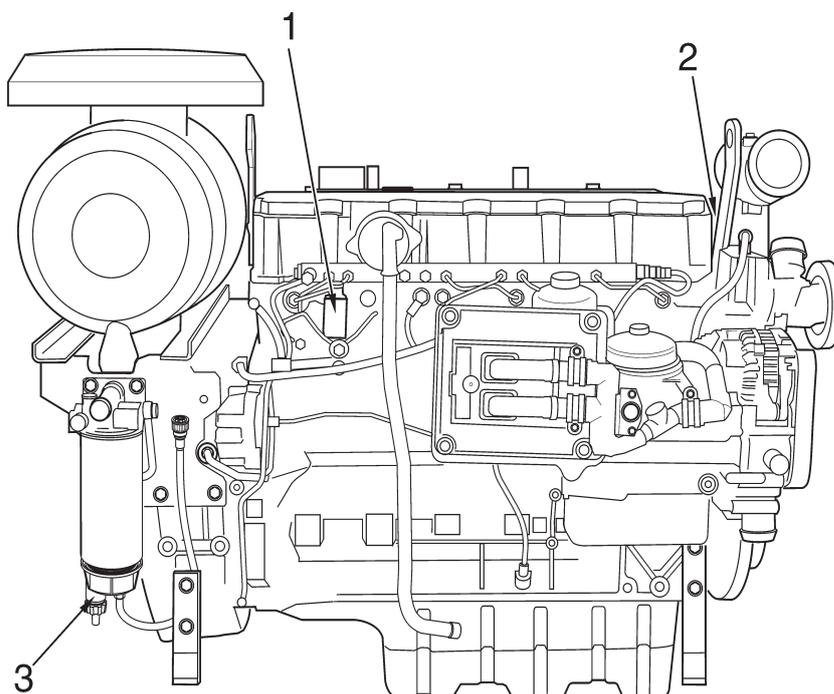
Connector for remote stop / connector for "AUX-STOP"

- Maximum cable length 8 meters (4 meters from connector and back).
- Minimum cable cross-section 2.5 mm²
- **Never** use the "AUX-STOP" as the normal stop button.
- It is not permitted to use the "AUX-STOP" at the same time as the normal stop button*.
- If an emergency stop is fitted, we cannot guarantee that the EMC requirements are fulfilled, since this can affect how the cabling is connected.

***NOTE!** If the "AUX-STOP" is used at the same time as the normal stop button, the Common Rail system may be seriously damaged.

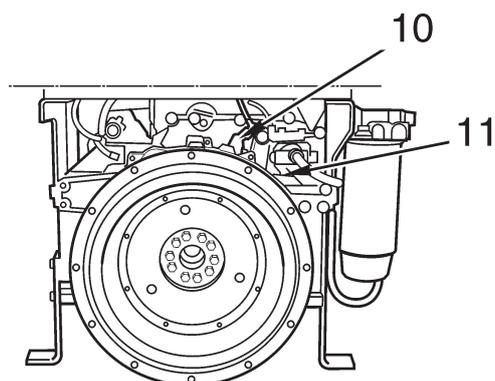
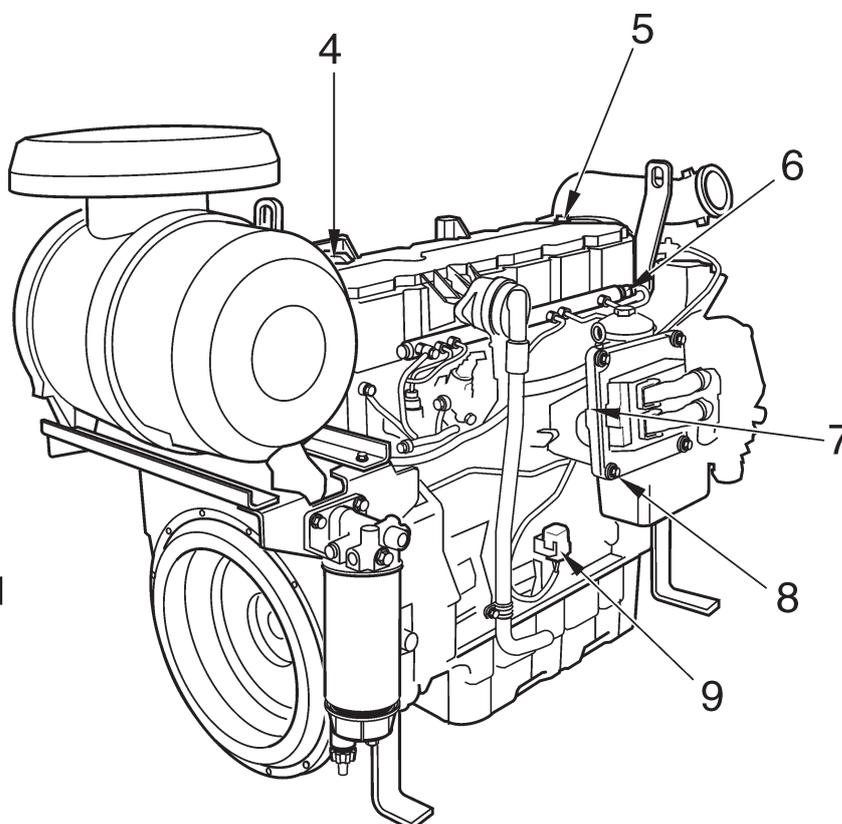
Component Location

NOTE: Locations can vary, depending on the engine model.



1. Solenoid proportional valve, high pressure pump – fuel (MPROP)
2. Coolant temperature
3. Water in fuel (mounted on primary fuel filter).

4. Charge air pressure and temperature
5. Pre-heating, inlet air
6. Fuel pressure, in Common Rail
7. Fuel pressure
8. Oil pressure sensor
9. Main relay
10. Speed sensor, flywheel
11. Speed sensor, camshaft



Power supply 24 V

The positive and negative cables from the batteries must be connected to the starter motor terminals.
 The battery positive cable shall be connected via a main switch to terminal 30 on the starter motor.
 The battery negative cable shall be connected directly to terminal 31 on the starter motor.

Battery cable cross-sectional area

The total length (L) of the positive **and** negative cables determines the cross-sectional area (A).

NOTE: Due to the risk of fire, the total cable cross-sectional area shall not be less than 70 mm²

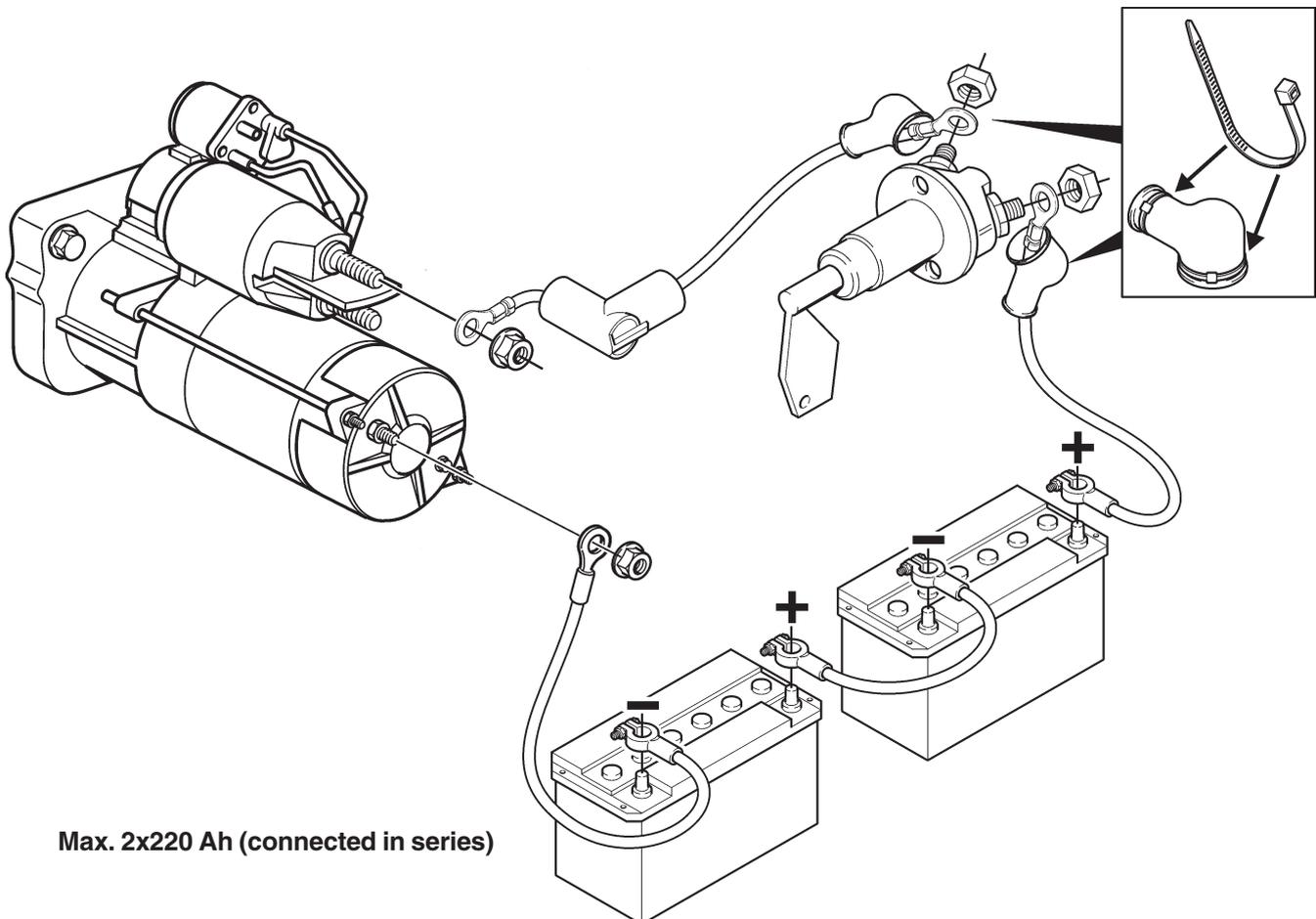
Battery specification

Max. battery 2x220 Ah (connected in series).

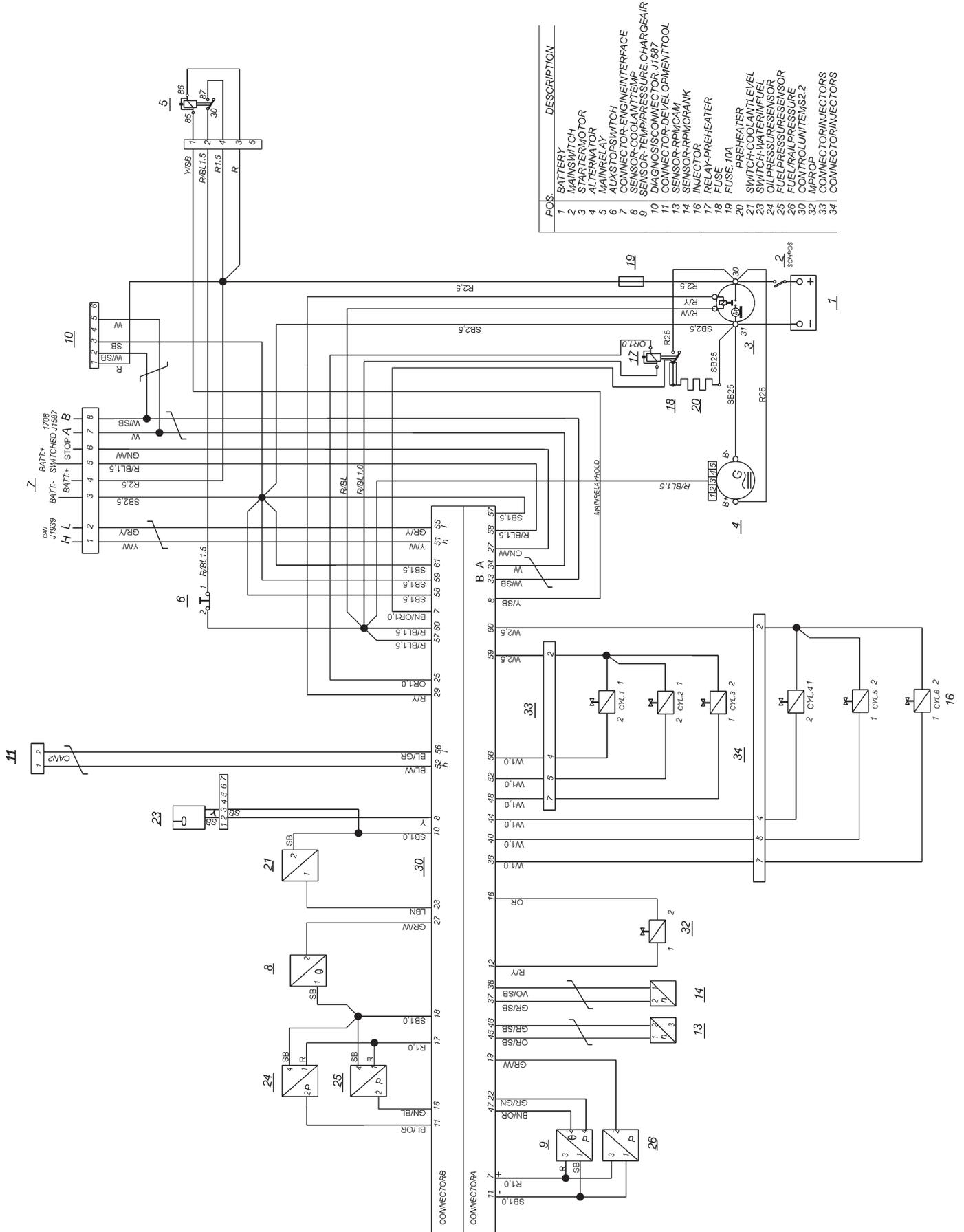
Battery charging

The standard connection for all engines is that the batteries are supplied with power from the alternator.

Max L (m)	4	5	6,5
Min A (mm ²)	70	95	120



Wiring diagram EMS 2, engine cable harness

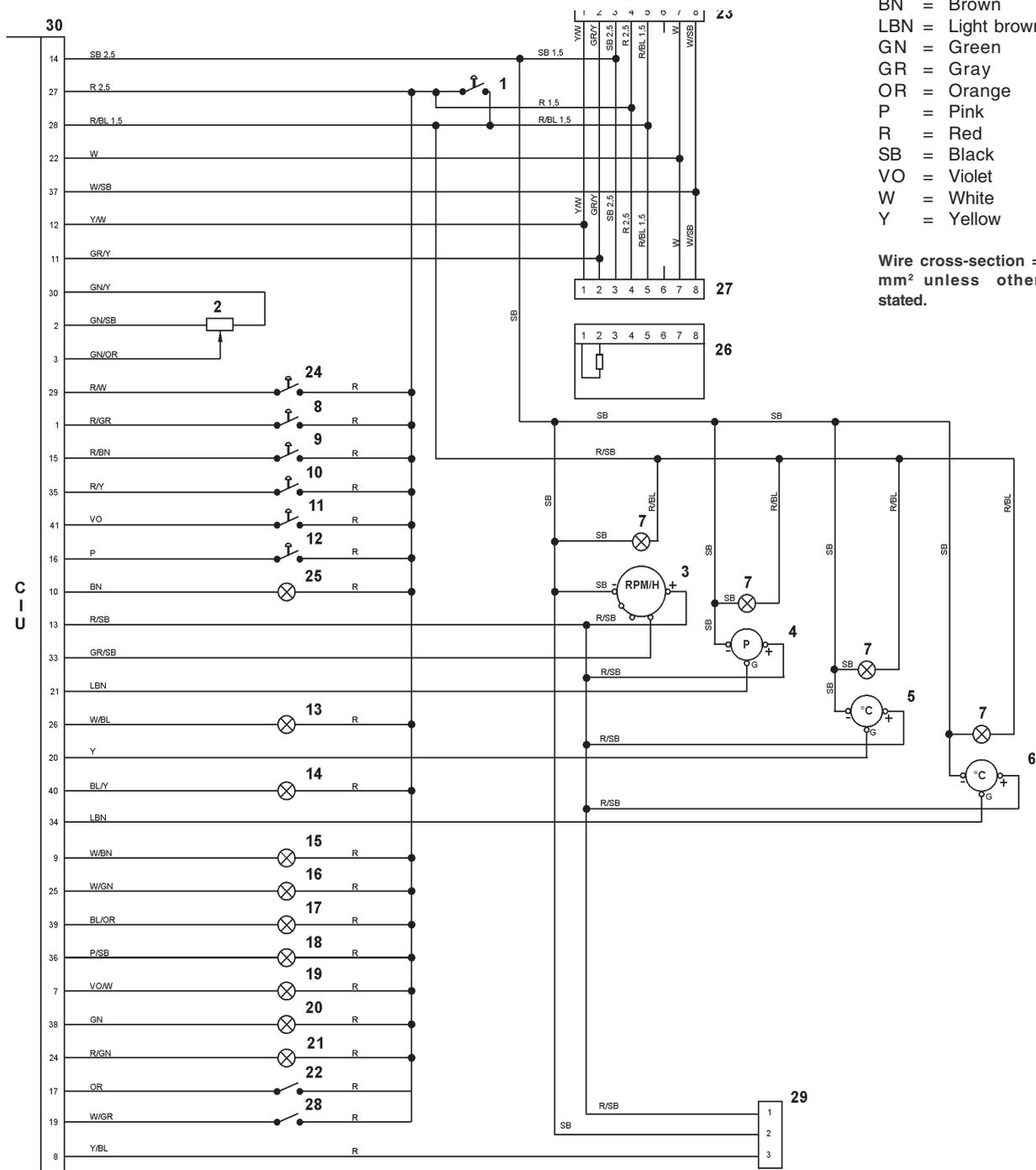


Wiring diagram, CIU

Cable colors

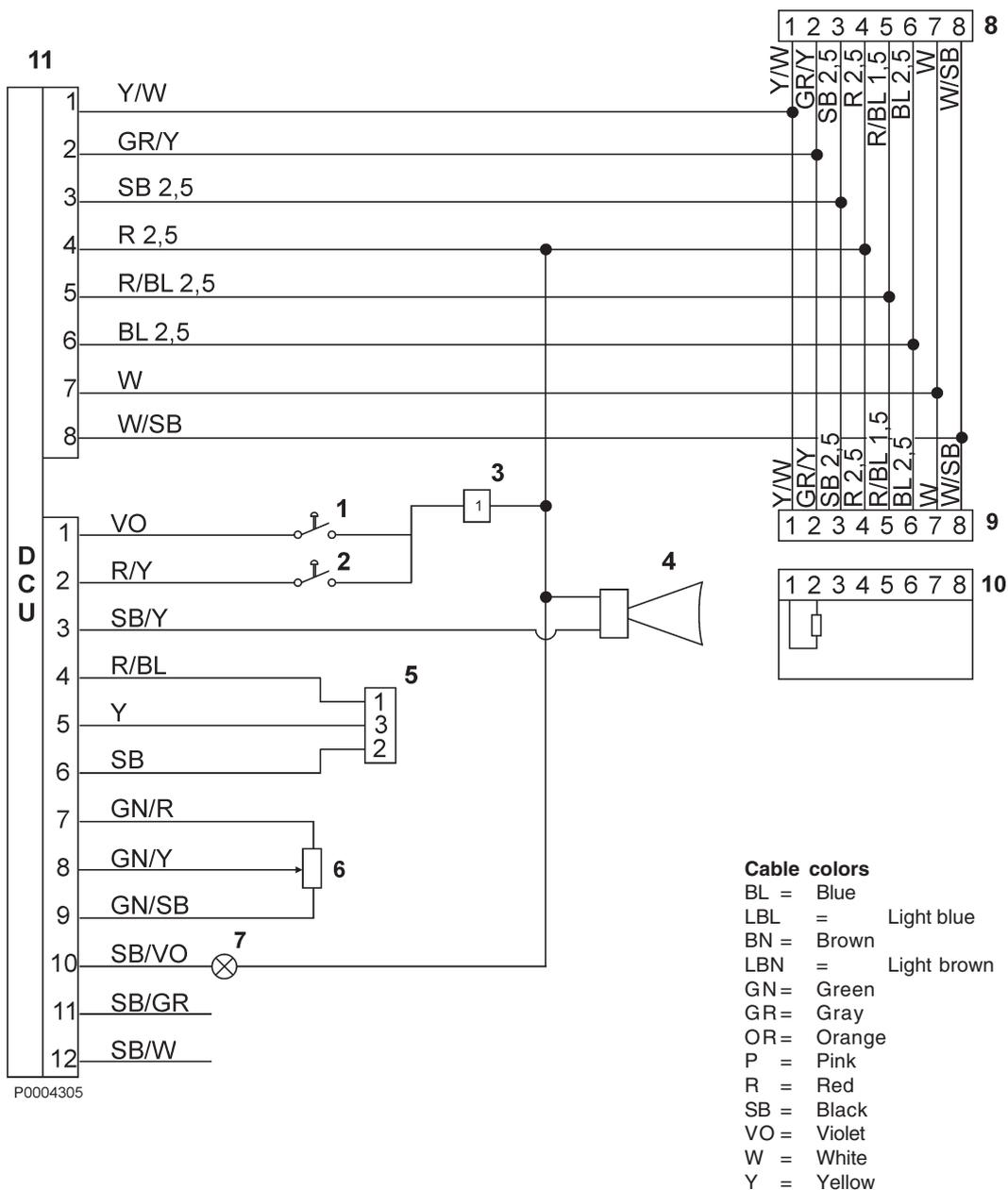
- BL = Blue
- LBL = Light blue
- BN = Brown
- LBN = Light brown
- GN = Green
- GR = Gray
- OR = Orange
- P = Pink
- R = Red
- SB = Black
- VO = Violet
- W = White
- Y = Yellow

Wire cross-section = 0.75 mm² unless otherwise stated.



- | | |
|---|---|
| <ol style="list-style-type: none"> 1. Ignition lock (15+) 2. RPM-potentiometer 3. Tachometer (code 14) 4. Oil pressure, instrument 5. Oil temperature, instrument (Does not apply for TAD734GE) 6. Coolant temperature, instrument 7. Instrument lighting 8. Idle contact, two-way 9. 1500 / 1800 rpm guard contact, two-way 10. Starter contact, spring loaded 11. Stop contact, spring loaded 12. Diagnostic switch, spring loaded 13. Alarm, low oil pressure 14. Alarm, high oil temperature 15. Alarm, high coolant temperature | <ol style="list-style-type: none"> 16. Alarm, low coolant level 17. Fuel alarm 18. Diagnostic lamp 19. Indicator, engine overspeed 20. Running lamp 21. Pre-heater indicator 22. Pre-heating contact 23. 8-pin connector block, engine interface 24. Primary control switch 25. Battery voltage alarm 26. Termination resistance 120 Ohm 27. 8-pin connector block, engine interface 28. Switch, engine protection disable 29. Connector block, Easy Link 30. CIU (Control Interface Unit) |
|---|---|

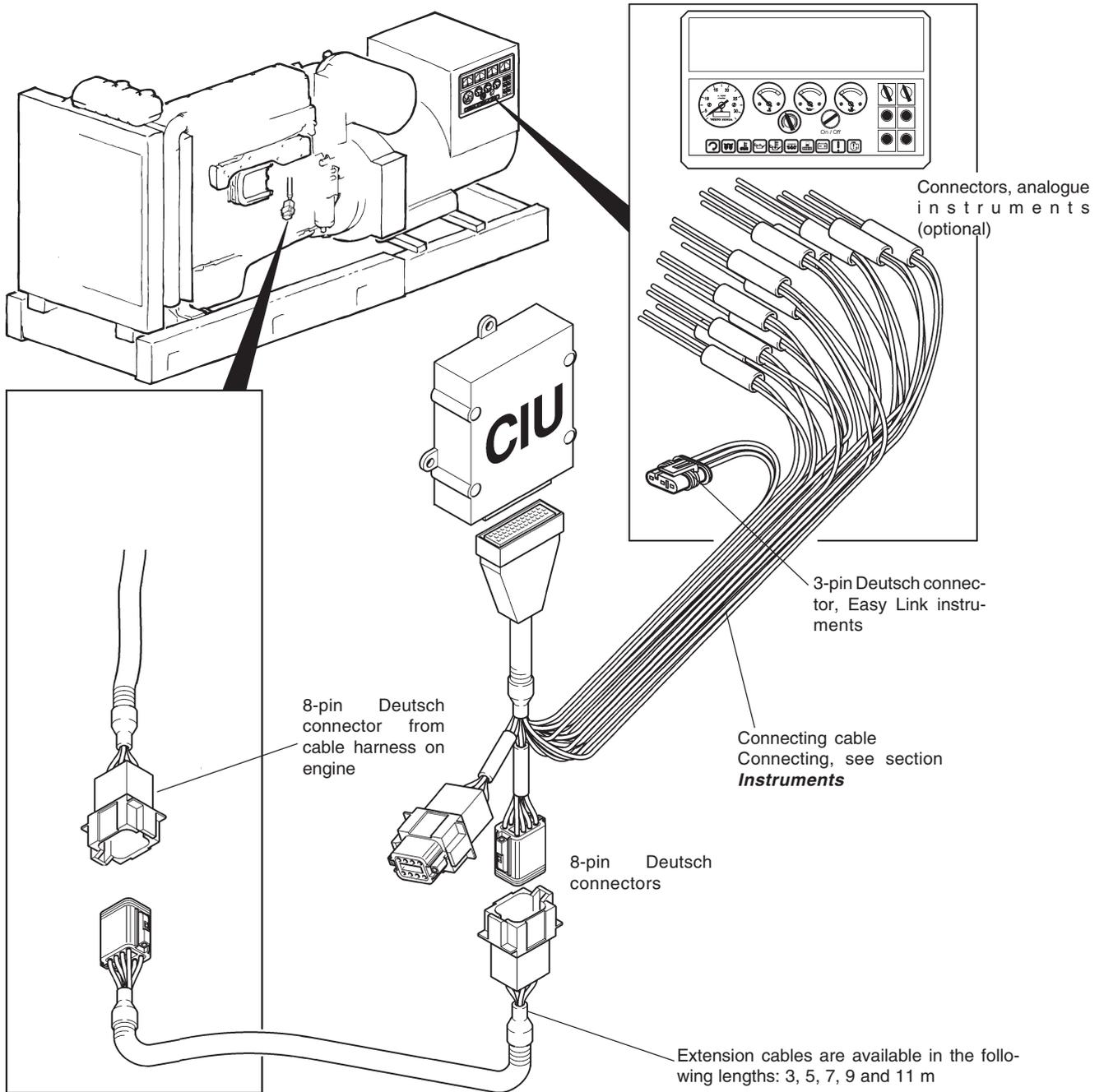
Wiring diagram DCU



P0004305

1. Stop switch
2. Start switch
3. 1-pin connector block
4. Horn, buzzer alarm
5. Easy Link connector block
6. RPM-potentiometer
7. Indicator engine operation
8. 8-pin connector engine interface
9. 8-pin connector engine interface
10. Termination resistance 120 Ohm
11. Display Control Unit (DCU)

CIU



General

The installation must be well prepared and performed with great care.

Secure the connecting cable between motor and instrument panel with clamps. Remember that the strain on the coupling pieces must be relieved so that they are not subjected to any pull.

Cables must not be run too close to hot components on the engine or close to any other source of heat. Make sure that it is protected from mechanical wear,

sharp edges and water splashes. If necessary, run the cable through protective conduits.

Avoid making joints in the system as far as possible. Cables and any joints must be accessible for inspection and service.

NOTE! The connectors must be installed “dry”, they must not be packed with Vaseline etc.

Connecting the CIU

Engine control

See wiring diagram.

NO = Normally open

NC = Normally closed

Ignition key (system voltage OFF/ON)

NOTE! Start current for the engine's system voltage (the control module) is 10 A. Make sure that other components in the installation are dimensioned for this current.

Start contact

Contact type, closing (NO), spring biased.

Stop contact

Contact type, closing (NO), spring biased.

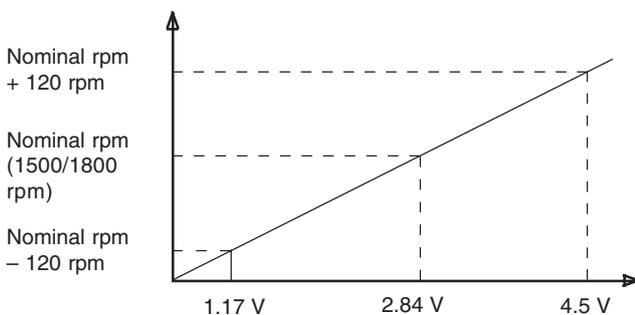
Via parameter setting, it can become energized during operation. In that case, use contact type closed (NC).

RPM-potentiometer

Nominal rpm minus 120 rpm: 0.3–1.9 V
(preset value 1.17 V)

Nominal rpm plus 120 rpm: 1.9–4.7 V
(preset value 4.5 V)

1500 / 1800 rpm contact



This function allows a change of frequency from 50 to 60 Hz.

Contact type two position.

Idle contact

Contact type two position.

Closed contact provides idling speed (900 rpm).

Speed droop contact

The contact must be closed to obtain speed droop.

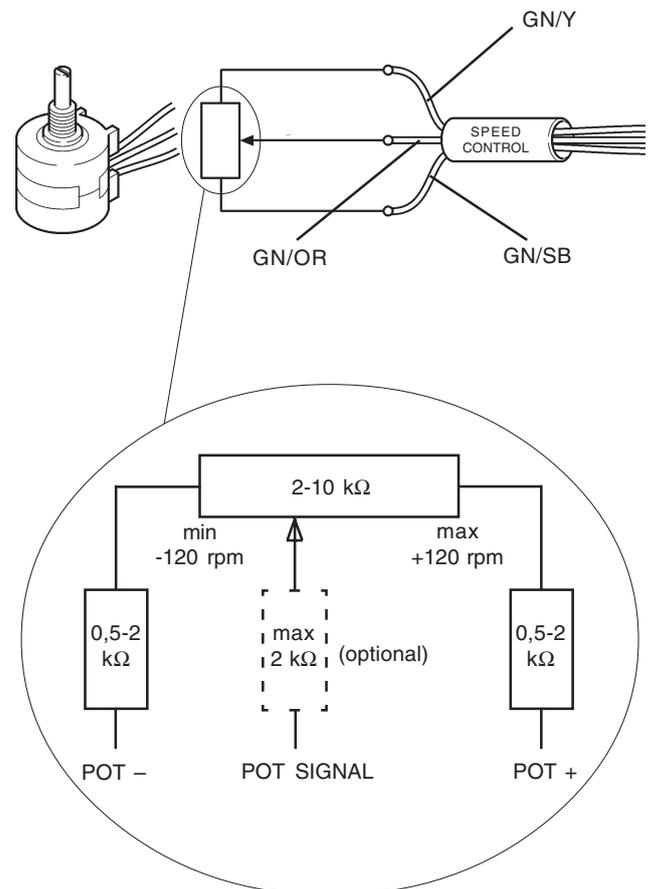
Contact type two position.

Governor contact

Contact type two position.

Preheat contact

Contact type two position.



Warning and indication lamps

The warning and indication lamps listed below are available. Specs for all lamps:

Max. load 3 W

Voltage 24 V

See ***Electrical diagram CIU***

- Alarm, low oil pressure
- Alarm, high oil temperature
- Alarm, high coolant temperature
- Alarm, low coolant level
- Alarm, fuel level
- Alarm, battery voltage
- Overspeed indication
- Operation indicator
- Diagnostic lamp
- Preheating indication

Instruments, Easy Link (optional)

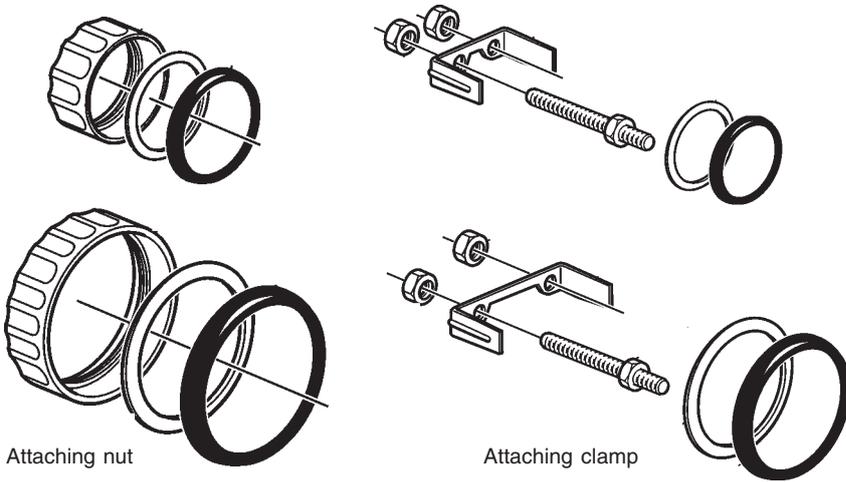
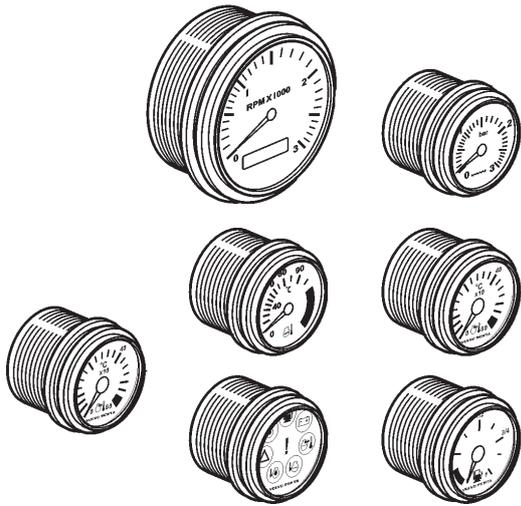
See wiring diagram

For parallel connection of up to 20 extra VDO-instruments.

The instruments automatically find their respective parameter group in the data bus. Max length of Easy-Link wiring is 3 m (10 ft).

The following instruments are available:

- Tachometer/operating hours
- Coolant temp
- Oil pressure
- Oil temp
- Battery voltage

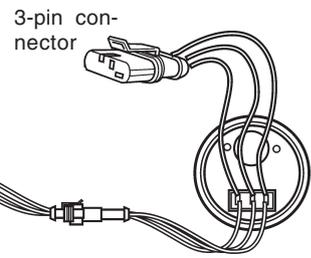


Attaching nut

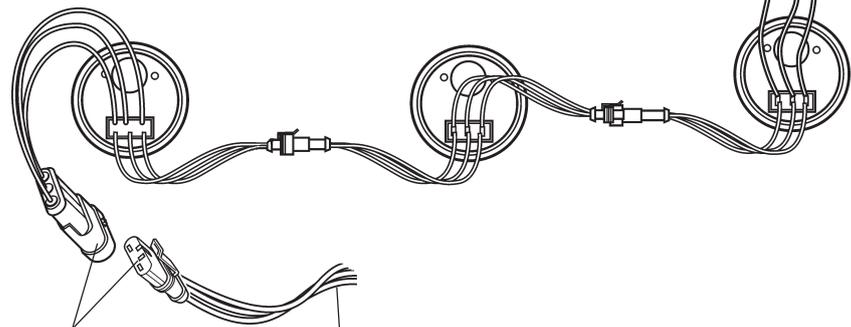
Attaching clamp



Extension cable,
3-pin
1.0 m (3 ft), 3.0 m
(10 ft)



3-pin con-
nector



3-pin con-
nectors

CIU cable
harness

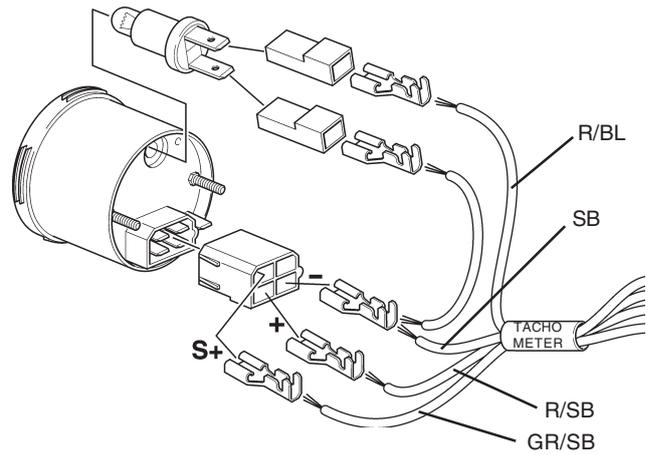
Instruments, analogue (optional)

See wiring diagram

Tachometer

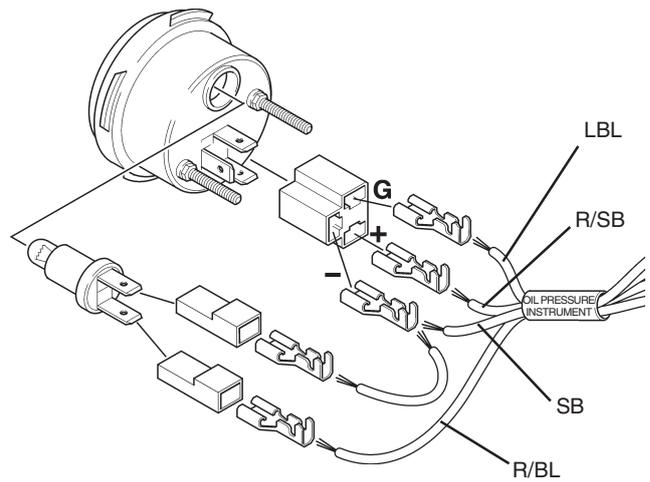
Use Volvo Penta universal tachometer, graduated 0–2600 rpm.

Set code 14. See *Installation instructions*.



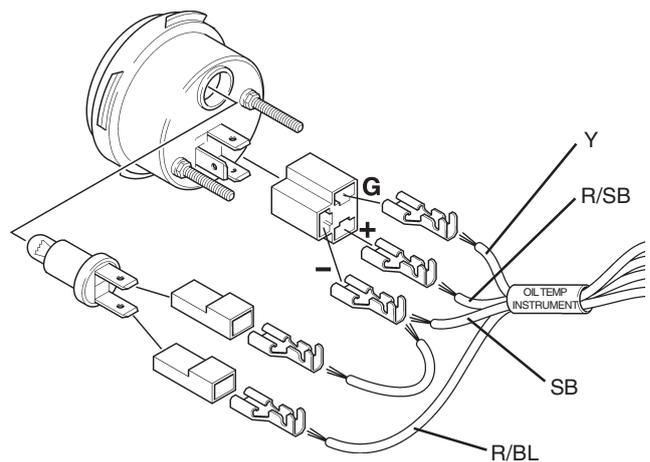
Oil pressure instrument

Use Volvo Penta oil pressure instrument, graduated 0–10 bar (0–145 psi).



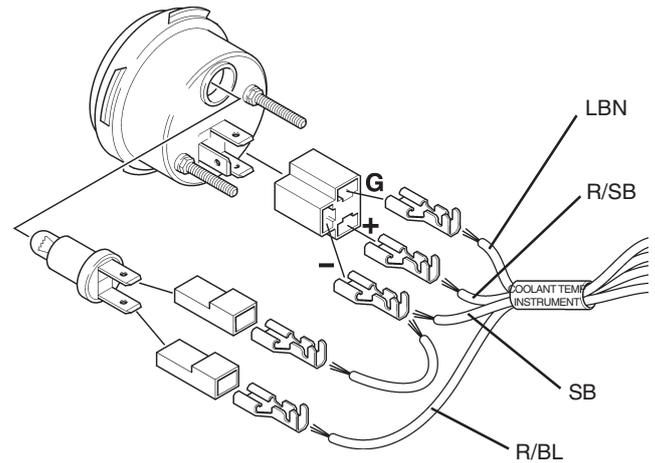
Oil temperature instrument

Use Volvo Penta oil temperature instrument, graduated 40–150°C (104–302°F).



Coolant temperature instrument

Use Volvo Penta oil temperature instrument, graduated 40–150°C (104–302°F).



Diagnostic connector

Contact type, closing (NO), spring biased.

For reading of fault codes, see chapter **Fault tracing**.

Preheating contact

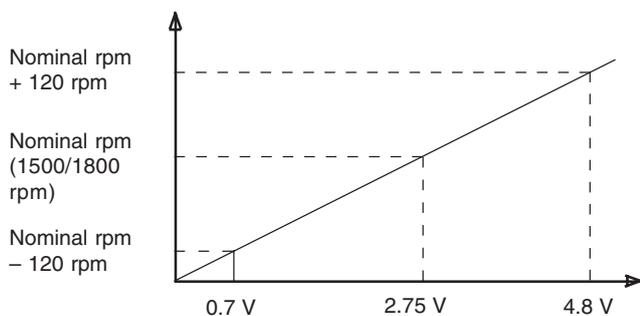
Contact type, closing (NO), spring biased.

This contact will activate the pre-heating.

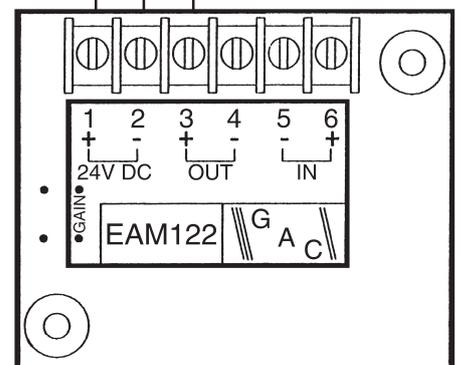
Synchronization/load distribution

The system has been adapted to GAC synchronization and load distribution system. When connecting this system, use interface module EAM122 . The voltage levels must simultaneously be adjusted using the VODIA tool, as shown below, when this system is used.

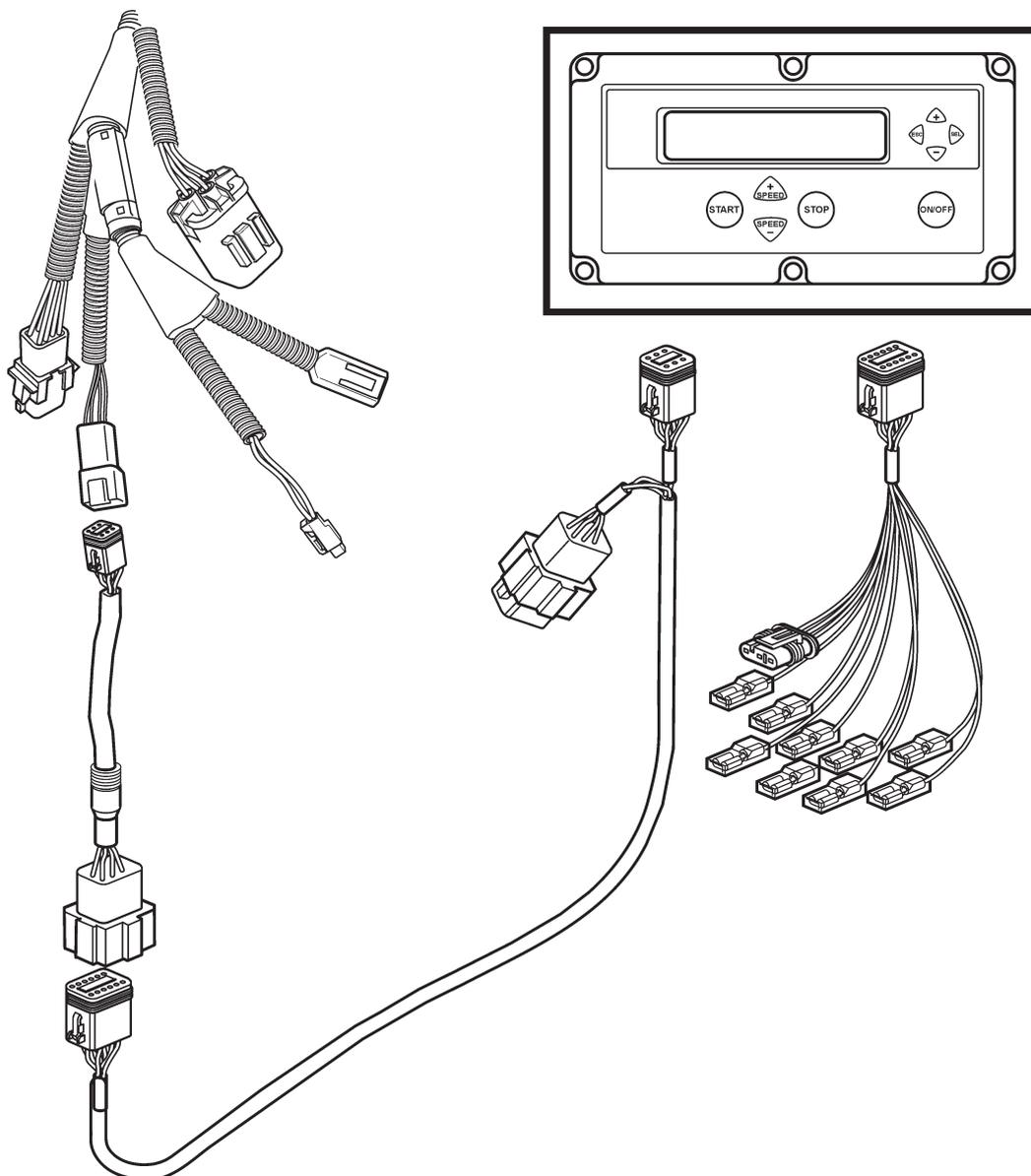
NOTE! The interface module EAM122 is not sold by Volvo Penta. Contact the local representative for GAC (Governors of America Corporation).



SPEED CONTROL (GN/OR)
 SPEED CONTROL (GN/SB)
 ON SWITCH (R/BL 1.5)



DCU



General

Installation must be planned very carefully and performed with great care.

Fix the connecting cable between the engine and instrument panel with clamps. Make sure there is no mechanical load placed on the connector block, it must not be subjected to pulling strains.

The cables shall not be drawn close to hot components on the engine or close to any other heat source. Ensure that the cables are protected from mechanical wear, sharp edges and water splashes. If necessary, the cables can be feed through conduits.

Avoid having to make splices in the system wiring, if at all possible. The cables and any splices must be accessible for inspection and service.

NOTE: Connectors must be assembled “dry”, they shall not be filled with Vaseline or similar.

Connecting DCU

DCU (Display Control Unit)

The DCU is connected via the 8-pin databus connector block. Refer to "Wiring diagram DCU".

Starter switch

Switch type: closing (NO), spring loaded.

Stop switch

Switch type: closing (NO), spring loaded.

Easy Link

For parallel connection of up to 20 extra VDO instruments. The meters will automatically find their own parameter group from the databus. Maximum length of Easy Link cables is 3 m.

The following meters are available:

- Tachometer/operating hours
- Coolant temperature
- Oil pressure
- Oil temperature
- Battery voltage
- Charge pressure
- Alarm panel

Warning and tell-tale lamps

Engine running indicator

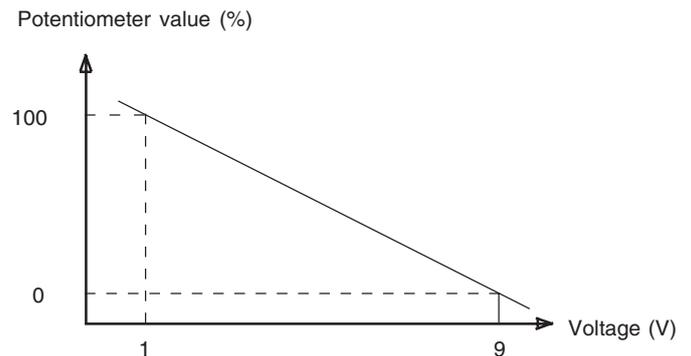
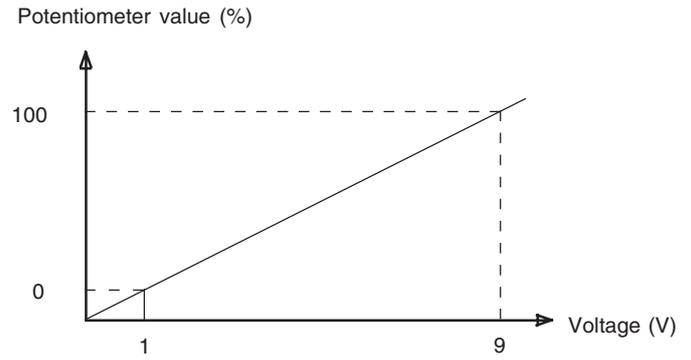
Max. power 3 W
 Voltage 24 V

RPM-potentiometer

Max. potentiometer value: 0-10 V (preset value 9 V)

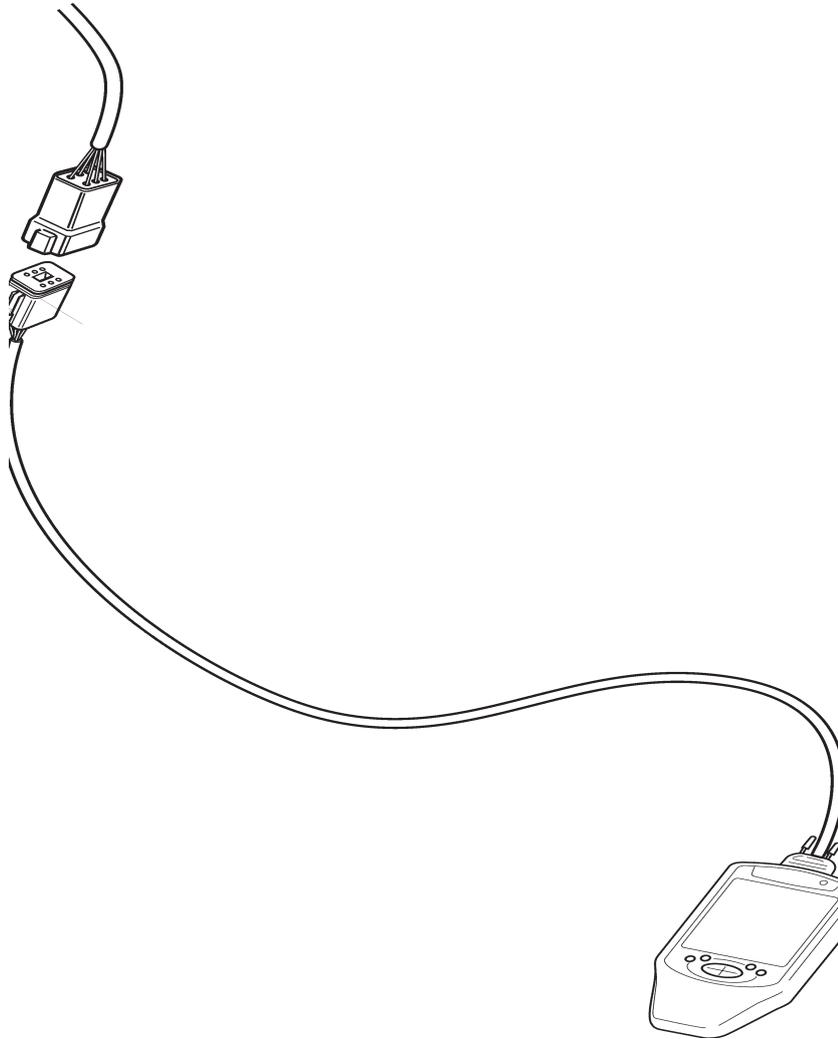
Min. potentiometer value 0-10 V (preset value 1 V)

The signal can be inverted, refer to diagram below.



Parameter settings

Connecting the VODIA parameter tool



Function, VODIA

By using the VODIA tool (3838619) in position “Parameters, reprogramming” you can read off and adjust the parameters stated below. The VODIA tool is connected to the diagnostics connector (6-pin connector block) located beneath the “cable cover” on the left side of the engine, or by using T-diagnostic connector no. 874427. Refer to the “VODIA user guide” for help in using the tool.

Engine protector

Engine protector coolant temperature

Determines if engine protection shall be activated in response to high coolant temperature.

A fault code is registered and the engine is shut down.

Alternative position "Off" or "On"

Preset value "On"

Engine protector coolant level

Determines if engine protection shall be activated in response to low coolant level.

A fault code is registered and the engine is shut down.

Alternative position "Off" or "On"

Preset value "On"

Engine protector charge air temperature

Determines if engine protection shall be activated in response to high charge air temperature.

A fault code is registered and the engine is shut down.

Alternative position "Off" or "On"

Preset value "On"

Engine protection, charge air pressure

Determines if engine protection shall be activated in response to high charge air pressure.

A fault code is registered and the engine is shut down.

Alternative position "Off" or "On"

Preset value "On"

Engine protection, oil pressure

Determines if engine protection shall be activated in response to low oil pressure.

A fault code is registered and the engine is shut down.

Alternative position "Off" or "On"

Preset value "On"

Engine speed regulator, adjustment

The regulator has a factory setting that has been optimized to suit the most common generator set applications. Use the VODIA tool (including EMS software), to read and adjust the P, I and D sections of the engine speed regulator. Adjustment is done to obtain more stable and even engine running, and to configure the engine for specific generator set applications.

PID = Proportional, Integrating, Differentiating

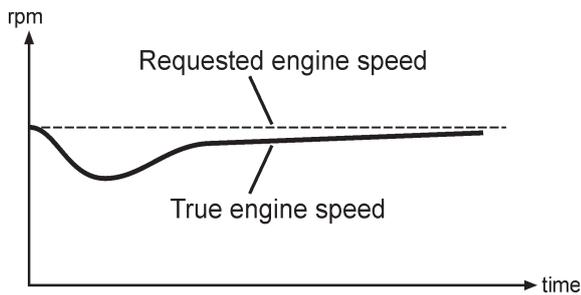


Fig 1. P section too low

P-value amplifier (Gain), amplification of the difference between the actual value and the set value.

A reduced value (Fig. 1) gives a weaker reaction to engine speed differences. Reduce the P-value to reduce oscillations arising from large differences in speed/load application.

An increased value (Fig. 2) gives a shorter response time. Increase the P section for faster compensation to large differences in engine speed / engine loading.

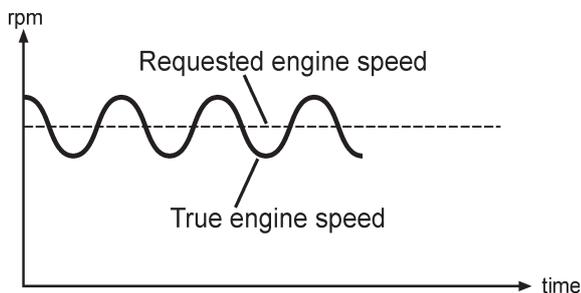


Fig 2. P section too high

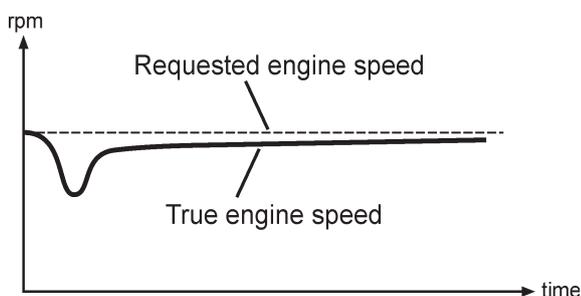


Fig. 3 I section too low

I-value stabilizes (Stability), reacts to the time of the speed deviation.

A reduced value (Fig. 3) increases the time taken by the system to respond after a load change. Reduce the I section to reduce the oscillations which are caused by slow application of engine loading.

An increased value (Fig 4) gives a shorter response time. Increase the I-value to provide better load response for slowly increasing loads.

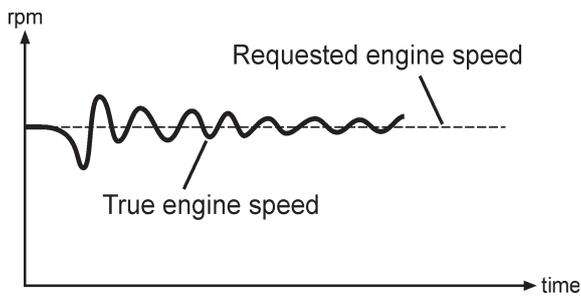


Fig 4. I-value too high or D-value too low

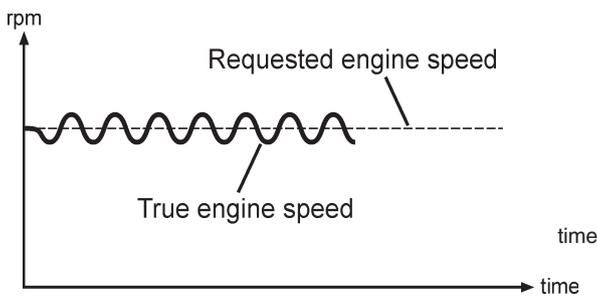


Fig 5. D-value too high

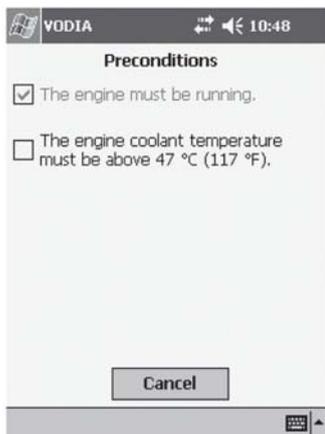
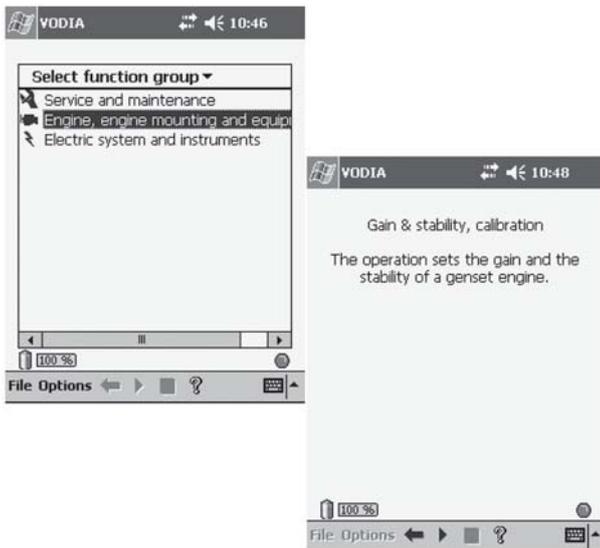
D-value compensates (Derivative). Reacts to fast changes of engine speed/load.

A reduced value (Fig 4.) gives a greater sensitivity to fast changes of engine speed/load. Reduce the D-value to reduce oscillations caused by fast changes.

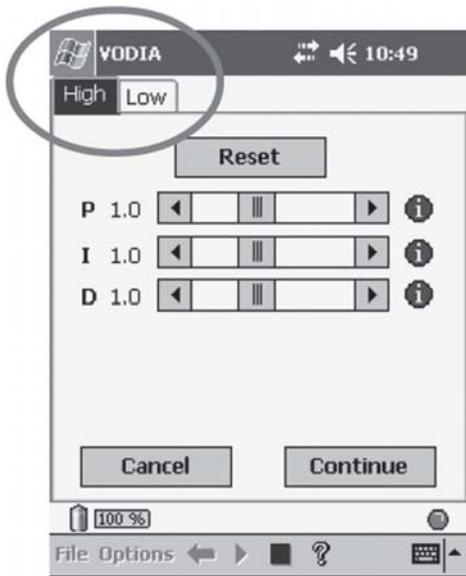
An increased value (Fig. 5) gives a reduced sensitivity to fast load changes. Increase the D-value to provide a better ability to compensate for fast changes.

Adjustment of PID regulator

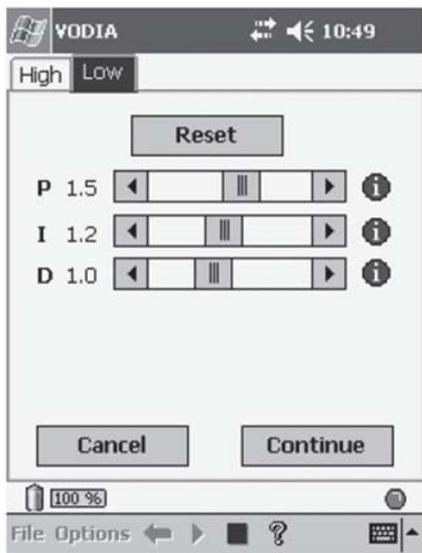
1. Start the engine.
2. Select the “Engine with mounting and equipment” and then “Reinforcement and Stability, calibration” function groups in the VODIA tool.



3. When calibration is started, certain conditions must be met, such as that the engine must be running and must have reached a certain engine temperature.



4. Select "High" or "Low".
 High: when one is far from the nominal engine speed, i.e. to improve load response.
 Low: when one is close to the nominal engine speed point, i.e. to increase stability.



5. Run the engine at the working speed and working temperature.
 In cases where the engine needs to be adjusted, increase or reduce the values of the P and I sections until unstable (oscillating) engine speed is obtained. Then increase/decrease the parameters until the engine speed is stable again.
6. If the engine is still unstable, increase/reduce the D section until engine speed only increases slightly when load is applied (or removed), please refer to figure 6.

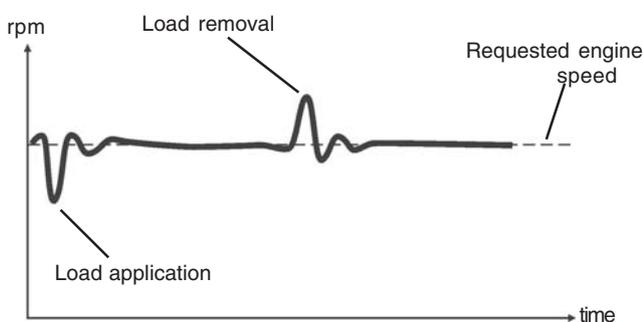
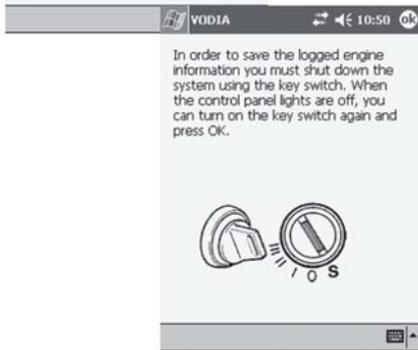
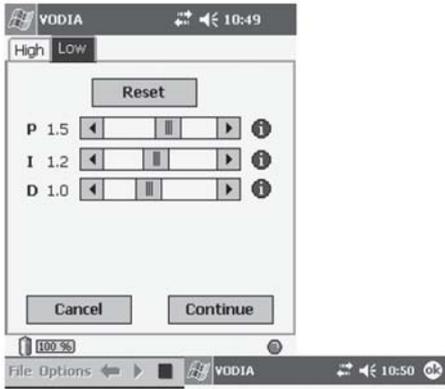


Fig. 6 Requested response

NOTE: The few times that the D-value may need to be adjusted include cases where the application has a flexible coupling or extremely low flywheel inertia.



7. Adjust the P and I sections again as above, if necessary.
8. Check engine response as fig. 6.
9. Repeat the procedure in the other position, "High"/"Low" if necessary.
10. To reset to factory settings, use the reset button above the PID settings.
11. Click "Continue" to finish calibration and follow the instructions to save the current settings in the control unit.

Frequency alteration, EMS2

The routine for altering the engine speed on the TAD734GE is not the same as for, i.e. D12. There is no system reset on the EMS2 unit, and the routine is therefore completely different.

With Volvo Penta CIU

If the engine is a 1500 rpm or 1800 rpm, the frequency selector must be OPEN when you start the adjustment. OPEN selects the primary engine speed, CLOSED selects the secondary engine speed.

Routine, with **no** system voltage applied:

1. Turn on the ignition with the starter key or switch.
2. Change the frequency selector (open or closed).
3. Send a stop request by pressing on the stop button.

The whole procedure (steps 1 to 3) may not take longer than **10 seconds**.

Routine, **with** system voltage applied:

1. Send a stop request by pressing on the stop button.
2. Change the frequency selector (open or closed).
3. Send a stop request by pressing on the stop button.

The whole procedure (steps 1 to 3) may not take longer than **10 seconds**.

With DCU

Turn on the ignition and change the parameter in the DCU.

With SAE J1939 (CAN)

Customers who use their own CAN bus-based control unit, must send certain messages to the engine (TAD734GE) in the same way as for the Volvo Pentas CIU, in order to change from 1500 to 1800 rpm (or vice-versa).

Routine, with **no** system voltage applied:

1. Turn on ECU.
2. Change the frequency selection in the VP_STATUS-message (open or closed).
3. Send a stop request in a VP_STATUS-message.

The whole procedure (steps 1 to 3) may not take longer than **10 seconds**.

Routine, **with** system voltage applied:

1. Send a stop request in a VP_STATUS-message.
2. Change the frequency selection in the VP_STATUS-message (open or closed).
3. Send a stop request in a VP_STATUS-message.

The whole procedure (steps 1 to 3) may not take longer than **10 seconds**.

Fault tracing

A number of symptoms and possible causes of engine malfunctions are described in the table below. Always contact your Volvo Penta dealer if any problems occur that you cannot solve yourself.

⚠ WARNING! Read through the safety instructions for care and service in chapter “Safety information” before you start working.

Symptoms and possible causes

☼ The Diagnostic button tell-tale lamp flashes	Refer to chapter “Diagnostics information”.
The engine cannot be shut off.	2, 5
The starter motor is not working	1, 2, 3, 4, 5, 6, 7, 24
The starter motor runs slowly	1, 2
The starter motor runs normally, but the engine does not start	8, 9, 10, 11
Engine starts, but stops again	8, 9, 10, 11, 13
The engine does not reach the correct operational speed at full throttle	9, 10, 11, 12, 13, 21, 25, 26
Engine runs roughly	10, 11
High fuel consumption	12, 13, 15, 25
Black exhaust smoke	12, 13
Blue or white exhaust smoke	15, 22
Lubrication oil pressure too low	16
Coolant temperature too high	17, 18, 19, 20
Coolant temperature too low	20
No, or low charge	2, 23

- | | | |
|---|--|---|
| 1. Flat batteries | 11. Water/contamination in fuel | 21. Blocked charge air cooler |
| 2. Poor contact/open circuit in cables | 12. Faulty injector | 22. Oil level too high |
| 3. Main switch turned off. | 13. Insufficient air supply to engine:
– blocked air filter
– air leak between turbo and inlet manifold
– coked-up compressor parts in the turbocharger
– defective turbocharger
– poor ventilation in engine bay | 23. Alternator drive belt slips |
| 4. Main automatic breaker defective | | 24. Water entry in engine |
| 5. Defective ignition switch | | 25. High back pressure in exhaust system |
| 6. Defective main relay | | 26. Open circuit in “Pot+” cable to pedal |
| 7. Defective starter motor/sole-noid valve | | |
| 8. Fuel shortage:
– fuel taps closed
– fuel tank empty/faulty tank connection | 14. Coolant temperature too high | |
| 9. Blocked secondary fuel filter/primary filter (due to contamination, separation due to low fuel level | 15. Coolant temperature too low | |
| 10. Air in the fuel system | 16. Too low oil level | |
| | 17. Coolant level too low | |
| | 18. Air in cooling system | |
| | 19. Defective circulation pump | |
| | 20. Defective thermostat | |

Diagnostic function

The diagnostic function monitors and checks that the EMS 2 system functions normally.

The diagnostic function has the following tasks:

- Detect and locate functional faults
- Inform that a functional fault has been detected
- Give guidance during fault tracing

Fault code

If the diagnostic function discovers a fault in the EMS -2 system, this is indicated via the fault code/fault reason on the instrument.

Both active (unrectified) and passive (rectified) faults are registered in the control system.

Refer to heading "Running" to read off fault codes/fault messages.

The fault code list contains all the fault codes and fault messages, together with information about causes, reactions and remedies that should be taken. Refer to chapter "Fault codes".

NOTE: All instruments are options

Active faults

DCU (Display Control Unit)

- the text "!! ENGINE WARNING !!" is shown on the display.

NOTE: You can select the language for the information shown on the display.

CIU (Control Interface Unit)

- the diagnostic lamp starts to flash.
- Easy Link instrument (only with a CIU)
 - the relevant lamp on the alarm panel lights
 - once you have pressed the diagnostics button, the fault code is shown as text on the tachometer display.

DU (Display Unit)

- Either "WARNING!" or "ALARM STOP" (with buzzer) is shown on the display depending on how serious the fault is.

NOTE: You can select the language for the information shown on the display.

- Fault codes can also be read off using the VODIA tool. For information about using the tool, refer to the VODIA user guide.

Simultaneously, the fault will be stored in the control module memory. When the fault has been rectified and the ignition switch cycled off/on, the fault will no longer be active.

Inactive faults

- DCU - the fault is indicated as passive
- CIU - the diagnostic lamp goes out
- DU - the fault message disappears (inactive fault codes cannot be read off)
- Easy Link - the warning lamp on the alarm panel goes out

Effect on the engine

The engine is effected differently depending on how serious the fault detected by the diagnostic function is.

A fault message comprising the fault code is always created when the diagnostic function finds a functional fault.

The engine is effected differently depending on how serious the fault is.

- The engine is not effected
- The engine goes to idle
- The engine torque is limited to a certain degree
- Engine is stopped

Function

When a functional fault has occurred and the diagnostics system has created one or more fault codes, then these can be read off in different ways depending on which equipment is used. Refer to section “Fault codes”.

If the system indicates that a fault code has been registered:

1. Lower the engine speed to idle or shut off the engine.
2. **For DCU/DU**
Read off the fault code registered on the display and refer to “Reading off fault codes via DCU” or “Reading off fault codes via DU”.

For CIU

press the diagnostics button and read off the fault code by observing the diagnostic lamp flashes. Refer to “Reading off fault codes via the diagnostics lamp, CIU”.

3. Look up the fault code in chapter “Fault codes” and take the recommended actions.

Check the fault cause via DCU (Display Control Unit)

When a fault code has been created, the following text is shown on the display:

“!! ENGINE WARNING !!”

alternating with

“Press SEL for information”.

NOTE: You can select the language for the information shown on the display.

Read the fault code as follows:

1. Press the SEL button (to come to the fault list).
The fault list shows:
 - Operation hours
 - Fault cause
 - Active/inactive
2. Look up the fault code in chapter “Fault codes” and take the recommended actions.
3. Press the ESC-button to leave the fault list.

NOTE: To open the fault list when no fault codes are set, press the SEL-button and select “Diagnostics” from the menu.

Read off the fault codes via DU (Display Unit)

Depending on how serious the fault is, one of the following texts will be displayed: “**WARNING!**” or “**ALARM STOP**” (buzzer sounds).

1. Press any button to get to the fault list.
The fault list shows:
 - Operation hours
 - Fault message
2. Look up the fault code in chapter “Fault codes” and take the recommended actions.
3. Press **ACK** to acknowledge the code. The display background color changes (buzzer is muted).
4. Press **EXIT** to leave the fault list.

Reading off the fault code via the diagnostics lamp on the instrument panel, CIU

When the system has detected a functional fault, the diagnostic lamp starts flashing. If you press and release the diagnostics button, a fault code will be flashed out.

The fault code consists of two groups of flashes, separated by a pause of two seconds. The fault codes are read by counting the number of flashes in each group.

Example: ✨ ✨ pause ✨ ✨ ✨ ✨ = Fault code 2.4

The fault code is registered and can be read off as long as the fault exists. You can find information concerning causes, reaction and remedies in chapter "Fault codes".

Read the fault code as follows:

1. Press the diagnostics button.
2. Release the diagnostics button and note the fault which is displayed as flashes.
3. Repeat steps 1-2. A new fault code will be flashed out if there are any more registered. Repeat until the first fault code is repeated.

NOTE: When the first fault code is shown again, all fault codes have been shown.

If you press the diagnostics button after a fault has been rectified and the fault codes erased, code 1.1 will be shown "No faults".

Reading off a fault code via Easy Link instruments (only with CIU)

When the system has detected a functional fault, this will be reported by the diagnostics lamp flashing.

1. Press the diagnostics button. The fault code is shown as text in the tachometer display.
2. Look up the fault code in chapter "Fault codes" and take the recommended actions.
3. When the fault has been rectified, the fault code disappears from the display and the diagnostic lamp goes out.

Erasing fault codes

Fault codes can only be erased with the VODIA tool.

Fault codes

⚠ WARNING! Read the safety instructions for handling and service in chapter “Safety information” before starting work.

NOTE: Reading the fault codes below, such as **Code 2.1, PID /SPN 97**, where **2.1** is a flash code indicated by a flashing diagnostic lamp. **PID / SPN 97** is read with the VODIA diagnostic tool. When using DCU or DU, the fault code is displayed as plain text.

For a further explanation, see “Reading fault codes”.

NOTE: Please refer to “Wiring schedule CIU and DCU” for references to the sockets in the electrical connectors on the engine control unit.

Code 1.1 No faults

There are no active faults.

Code 2.1, PID / SPN 97. Water in fuel

Reason:

- Water in fuel.

Reaction:

- None.

Action:

- Empty the fuel pre-filter.

Code 2.2, PID / SPN 111. Coolant level

Reason:

- Low coolant level.

Reaction:

- Engine control module reduces engine power (unless the protection has been shut off with the VODIA diagnostic tool).
- Engine stopped

Action:

- Check the coolant level.
- Check coolant level monitor function.

Code 2.3, PID / SPN 111. Coolant level sensor

Reason:

- Short circuit to positive (+).
- Fault in sensor.

Reaction:

- None.

Action:

- Check that the coolant level sensor cable is not damaged.
- Check coolant level sensor function.

Code 2.4, SID 22 / SPN 637 Engine speed sensor, flywheel

Reason:

- No signal.
- Abnormal frequency.
- Intermittent signal from the sensor.
- Fault in sensor.

Reaction:

- Engine is very difficult to start and runs roughly when it starts.

Action:

- Check that the sensor connector is correctly installed.
- Check that the engine speed sensor cable is not damaged.
- Check that the engine speed sensor is correctly installed in the flywheel casing.
- Check engine speed sensor function.

**Code 2.5, SID 21 / SPN 636
Engine speed sensor, camshaft**
Reason:

- No signal.
- Abnormal frequency.
- Fault in sensor.

Reaction:

- Engine takes longer to start than normal. Engine runs normally when running.

Action:

- Check that the engine speed sensor connector is correctly installed.
- Check that the wiring to the engine speed sensor is not damaged.
- Check that the engine speed sensor is correctly installed in the upper timing gear cover.
- Check engine speed sensor function.

Code 2.6, PID / SPN 190. Engine speed
Reason:

- Engine speed too high.

Reaction:

- None.

Action:

- After the engine has stopped, look for the reason for the high speed.

Code 2.8, PPID 132 / SPN 608 Engine speed potentiometer connected to CIU
Reason:

- Short circuit to positive (+) or earth (ground) (-).
- Fault in sensor.

Reaction:

- Engine goes to idle.
- rpm is frozen.

Action:

- Check that the potentiometer is correctly connected.
- Check that the potentiometer cable is not damaged.
- Check potentiometer function.

**Code 2.9, PID / SPN 97
Indicator for water in fuel**
Reason:

- Short circuit.
- Open circuit.
- Fault in indicator.

Reaction:

- None.

Action:

- Check the indicator cables for breaks and short circuits.
- Check indicator function. Change indicator as necessary.

Code 3.1, PID / SPN 100. Oil pressure sensor
Reason:

- Short circuit to positive (+) or earth (ground) (-).
- Open circuit.

Reaction:

- None.

Action:

- Check that the potentiometer cable is not damaged.
- Check that the oil pressure sensor is correctly connected.

**Code 3.2, PID / SPN 105
Charge air temperature sensor**
Reason:

- Short circuit to positive (+) or earth (ground) (-).
- Open circuit.

Reaction:

- None.

Action:

- Check that the charge air temperature sensor connector is correctly installed.
- Check that the charge air temperature sensor cable is not damaged.
- Check that the charge air temperature sensor is correctly installed.
- Check charge air temperature sensor function.

**Code 3.3, PID / SPN 110
Coolant temperature sensor**

Reason:

- Short circuit to positive (+) or earth (ground) (-).
- Open circuit.

Reaction:

- Pre-heating is also activated when the engine is hot.

Action:

- Check that the coolant temperature sensor connector is correctly installed.
- Check that the coolant temperature sensor cable is not damaged.
- Check that the coolant temperature sensor is correctly installed.
- Check coolant temperature sensor function.

Code 3.4, PID / SPN 106/102. Charge Pressure sensor

Reason:

- Short circuit to positive (+) or earth (ground) (-).
- Open circuit.

Reaction:

- Engine smokes more than normally during acceleration/load increase.

Action:

- Check that the charge pressure sensor connector is correctly installed.
- Check that the charge air pressure sensor cable is not damaged.
- Check that the charge air pressure sensor is correctly installed.
- Check the function of the charge air pressure sensor.

Code 3.5, PID / SPN 106/102. Charge pressure

Reason:

- Charge pressure too high.

Reaction:

- Engine control module reduces engine power (unless the protection has been shut off with the VODIA diagnostic tool).

Action:

- Check turbocharger compressor function.
- Check the function of the charge air pressure sensor.
- Check fuel volume/injector.

Code 3.6, PID / SPN 94. Fuel pressure sensor

Reason:

- Short circuit to positive (+) or earth (ground) (-).
- Open circuit.

Reaction:

- None.

Action:

- Check that the fuel pressure sensor connector is correctly installed.
- Check that the fuel pressure sensor cable is not damaged.
- Check that the fuel pressure sensor cable is correctly installed.
- Check fuel pressure sensor function.

Code 3.8, PID / SPN 94. Fuel pressure

Reason:

- Low supply pressure.

Reaction:

- None.

Action:

- Check if it is possible to build up pressure with the hand pump.
- Check the fuel filter.
- Check the fuel pre-filter.

Code 3.9, PID / SPN 158. Battery voltage, EMS

Reason:

- Faulty alternator.
- Faulty battery cables, faulty battery.

Reaction:

- None.

Action:

- Check the supply voltage to the control unit.

Code 4.6, PPID 3 / SID 39 / SPN 677
Start output / Starter motor relay
Reason:

- Short circuit to positive (+) or earth (ground) (-).
- Activated for too long time.

Reaction:

- Engine can not be started.
- The engine starts as soon as the ignition is switched on.

Action:

- Check that the starter switch connections are not damaged.
- Check that the wiring to the starter key is not damaged.

Code 4.8, PPID 6 / SPN 970
Stop input EMS
Reason:

- Short circuit to negative (-).
- Open circuit.

Reaction:

- The engine can only be stopped via the auxiliary stop (Or via the CAN link.)

Action:

- Check that the connections and cables are not damaged.

Code 5.2, PPID 4 / SPN 520194
Start input CIU
Reason:

- Short circuit to negative (-).
- Activated for too long time.

Reaction:

- Engine can not be started.
- The engine starts as soon as the ignition is switched on.

Action:

- Check that the starter switch connections are not damaged.
- Check that the wiring to the starter key is not damaged.

Code 5.3, PPID 6 / SPN 520195. Stop input CIU
Reason:

- Short circuit to negative (-).
- Open circuit.
- Activated for too long time.

Reaction:

- Engine can only be stopped with the auxiliary stop (AUX STOP) on engine.
- Engine stops. A fault code is displayed for 40 seconds and the engine cannot be started during this time. When a fault code is active, the engine can be started but not stopped.

Action:

- Check that the starter switch connections are not damaged.
- Check that the wiring to the starter key is not damaged.

Code 5.4, PID 45 / SPN 626. Pre-heater relay
Reason:

- Short circuit to positive (+) or earth (ground) (-).
- Open circuit.

Reaction:

- Pre-heating can not be activated.
- Pre-heating is constantly connected.

Action:

- Check that the relay input cable is not damaged.
- Check relay function.

Code 6.1, PID / SPN 110. Coolant temperature

Reason:

- Coolant temperature is too high.

Reaction:

- Engine control module reduces engine power (unless the protection has been shut off with the VODIA diagnostic tool).

Action:

- Check the coolant level.
- Check the charge air cooler (cleanliness).
- Check if there is air in the cooling system.
- Check the pressure cap on the expansion tank.
- Check coolant temperature sensor function.
- Check thermostat function.

Code 6.2, PID / SPN 105. Charge air temperature

Reason:

- The charge air temperature is too high.

Reaction:

- Engine control module reduces engine power (unless the protection has been shut off with the VODIA diagnostic tool).

Remedy:

- Check coolant level.
- Check the charge air cooler (cleanliness).
- Check charge air temperature sensor function.
- Check thermostat function.

Code 6.4, SID 231 / SPN 639. Data link (CAN), CIU

Reason:

- Faulty data link (CAN), CIU.

Reaction:

- Instruments and warning lamps stop working.

Action:

- Check that the 8-pin connector is not damaged.
- Check that the cables between the CIU and the engine management unit are not damaged.

**Code 6.5, SID 231 / SPN 639/2017 / PSID 201
Data link (CAN), EMS 2**

Reason:

- Internal fault in control module.

Reaction:

- Engine not operating: engine cannot be started.
Engine running: engine idles and can only be stopped with the emergency stop (AUX-stop).

Action:

- Check that the 8-pin connector is not damaged.
- Check that the cables between the CIU and the engine management unit are not damaged.
- Check that sockets 11 and 12 in the connector on the CIU are not damaged.

Code 6.6, PID / SPN 100. Oil pressure

Reason:

- Oil pressure is too low.

Reaction:

- Engine control module reduces engine power (unless the protection has been shut off with the VODIA diagnostic tool).

Action:

- Check oil level.
- Check that the air filters are not blocked.
- Check system pressure valves and safety valves in the oil system.
- Check oil pressure sensor function.

**Code 6.9, PID / SPN 158
Battery voltage, CIU**

Reason:

- Short circuit to negative (-).
- Faulty alternator.
- Faulty battery, battery cables.

Reaction:

- Problems in engine starting.

Action:

- Check the supply voltage from the control unit.
- Check the battery.
- Check the alternator.
- Check the 8-pin connector.

**Code 7.1, SID 1 / SPN 651
Injector, cylinder #1****Reason:**

- Electrical fault.
- Faulty compression or injector.

Reaction:

- Engine runs on 5 cylinders.
- Abnormal sound.
- Reduced performance.

Action:

- Check that the unit injector cables are not damaged.
- Check that the injector connections are not damaged.
- Check fuel supply pressure.
- Check the valve clearance.
- Perform a compression test and check cylinder #1.

**Code 7.2, SID 2 / SPN 652
Injector, cylinder #2****Reason:**

- Electrical fault.
- Faulty compression or injector.

Reaction:

- Engine runs on 5 cylinders.
- Abnormal sound.
- Reduced performance.

Action:

- Check that the unit injector cables are not damaged.
- Check that the injector connections are not damaged.
- Check fuel supply pressure.
- Check the valve clearance.
- Perform a compression test and check cylinder #2.

**Code 7.3, SID 3 / SPN 653
Injector, cylinder #3****Reason:**

- Electrical fault.
- Faulty compression or injector.

Reaction:

- Engine runs on 5 cylinders.
- Abnormal sound.
- Reduced performance.

Action:

- Check that the unit injector cables are not damaged.
- Check that the injector connections are not damaged.
- Check fuel supply pressure.
- Check the valve clearance.
- Perform a compression test and check cylinder #3.

**Code 7.4, SID 4 / SPN 654
Injector, cylinder #4****Reason:**

- Electrical fault.
- Faulty compression or injector.

Reaction:

- Engine runs on 5 cylinders.
- Abnormal sound.
- Reduced performance.

Action:

- Check that the unit injector cables are not damaged.
- Check that the injector connections are not damaged.
- Check fuel supply pressure.
- Check the valve clearance.
- Perform a compression test and check cylinder #4.

**Code 7.5, SID 5 / SPN 655
Injector, cylinder #5**

Reason:

- Electrical fault.
- Faulty compression or injector.

Reaction:

- Engine runs on 5 cylinders.
- Abnormal sound.
- Reduced performance.

Action:

- Check that the unit injector cables are not damaged.
- Check that the injector connections are not damaged.
- Check fuel supply pressure.
- Check the valve clearance.
- Perform a compression test and check cylinder #5.

**Code 7.6, SID 6 / SPN 656
Injector, cylinder #6**

Reason:

- Electrical fault.
- Faulty compression or injector.

Reaction:

- Engine runs on 5 cylinders.
- Abnormal sound.
- Reduced performance.

Action:

- Check that the unit injector cables are not damaged.
- Check that the injector connections are not damaged.
- Check fuel supply pressure.
- Check the valve clearance.
- Perform a compression test and check cylinder #6.

Code 8.3, SID 42 / SPN 679. Injection pressure, regulator

Reason:

- Faulty cables.
- Faulty actuator.
- Fault in MPROP.

Reaction:

- Engine control unit reduces engine power.

Action:

- Please contact an authorized Volvo Penta workshop.

**Code 8.3, PSID 96 / SPN 1239
Pressure in Common Rail**

Reason:

- Leakage in the high pressure fuel system.
- Leakage in the high pressure supply pipe to the injector.

Reaction:

- Engine control unit reduces engine power.

Action:

- Please contact an authorized Volvo Penta workshop.

Code 8.3, PSID 97 / SPN 679. Pressure valve

Reason:

- Leakage in the PRV (Pressure Release Valve).
- The PRV has stuck closed.
- The PRV has stuck open.

Reaction:

- Engine control unit reduces engine power.

Action:

- Please contact an authorized Volvo Penta workshop.

Code 8.3, PID / SPN 164. Injection pressure**Reason:**

- Fault in fuel supply.
- Faulty fuel pump.
- Faulty cables.
- Fault in sensor.

Reaction:

- Warning lamp lights up.
- Engine control unit reduces engine power.

Action:

- Check the cables.
- Check sensor.
- Check the filter.
- Check the fuel pumps.

Code 8.4 PPID 55 / SPN 1136 EMS temperature**Reason:**

- Electrical fault, damaged sensor.
- Control unit incorrectly installed, too hot.

Reaction:

- None

Action:

- Check the control unit installation. Recommended ambient temperature is 50 °C.

Code 8.6, SID 70 / SPN 729. Pre-heating sensor**Reason:**

- Faulty cables.
- Faulty pre-heating relay.

Reaction:

- It is not possible to activate pre-heating.

Action:

- Check cables.
- Check the pre-heating relay.

**Code 9.3, SID 232/221 / SPN 620/1079/1080
Voltage supply to sensor****Reason:**

- Short circuit.
- Fault in one of the sensors.

Reaction:

- Faulty values in oil pressure and charge air pressure sensors.
- Fault code for oil pressure and charge air pressure sensors.
- Low power.
- Oil pressure and oil temperature instruments show 0.

Action:

- Check that the oil pressure and charge air pressure sensors are not damaged.
- Check the oil pressure sensor and charge air pressure sensor.

Code 9.8, SID 254/SPN 629. Fault in control unit, CIU**Reason:**

- Faulty EEPROM, CIU.
- Faulty flash memory, CIU.
- Fault in control module, CIU.

Reaction:

- CIU returns to factory setting.
- Engine goes to idle.
- Engine cannot be started.

Action:

- Re-program the unit.

Code 9.9, SID 240 / SPN 639. Memory fault in EMS

Reason:

- Memory fault in engine management system (EMS).

Reaction:

- Engine might not start.

Action:

- Re-program the unit.

Code 9.9, SID 254 / SPN 629. Control unit EMS

Reason:

- Internal fault in control module.

Reaction:

- Engine misfires.
- Engine does not start.

Action:

- Change engine control unit.

Notes

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Report form

Do you have any comments or complaints about this manual? Please take a copy of this page, write your comments on it and send it to us. The address is at the bottom. We would appreciate it if you were to write in English or Swedish.

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