Workshop Manual

I
5(0)

Group 30 Electrical system

9L, 12L, 13L, 16L
Industrial Engines

Content

00-0 General

About this Workshop manual

General information

This Service Manual contains technical data, descriptions and maintenance and repair instructions for standard model Volvo Penta products. A list of these products may be found in the section ***Specifications***.

The product designation and the serial number and specification is indicated on the engine decal or type plate. This information must be included in all correspondence regarding the product.

The service manual is produced primarily for the use of Volvo Penta workshops and their qualified personnel. It is assumed that any person using the Service Manual has a fundamental knowledge of the product and is able to carry out mechanical and electrical work to trade standard.

Volvo Penta continually develops its products; we therefore reserve the right to make changes. All information in this manual is based on product data which was available up to the date on which the manual was printed. New working methods and significant changes introduced to the product after this date are communicated in the form of ***Service bulletins***.

Spare Parts

Spare parts for the electrical and fuel systems are subject to various national safety standards. Volvo Penta Original Spare Parts meet these standards. No damage of any kind caused by the use of spare parts not approved by Volvo Penta will be compensated by any warranty undertaking.

Certified engines

When carrying out service and repair on emission-certified engines, it is important to be aware of the following:

Certification means that an engine type has been inspected and approved by the relevant authority. The engine manufacturer guarantees that all engines of the same type are manufactured to correspond to the certified engine.
This places special demands on service and repair work, namely:

- Maintenance and service intervals recommended by Volvo Penta must be complied with.
- Only spare parts approved by Volvo Penta may be used.
- Service on injection pumps, pump settings and injectors must always be carried out by an authorized Volvo Penta workshop.
- The engine must not be converted or modified, except with accessories and service kits which Volvo Penta has approved for the engine.
- No changes to the exhaust pipe and engine air inlet duct installations may be made.
- No warranty seals (where present on the product) may be broken by unauthorized persons.

The general instructions in the Operator's Manual concerning operation, service and maintenance apply.

IMPORTANT!

Neglected or poorly-performed care/service and the use of spare parts not approved by Volvo Penta, will mean that AB Volvo Penta no longer guarantees that the engine conforms to the certified model.

Volvo Penta accepts no responsibility for damage or costs arising as a result of failure to follow the above mentioned standards.

Repair instructions

Introduction

The working methods described in this manual are based on a workshop scenario where the product is mounted in a holding fixture. Maintenance work is often carried out in situ, in which case – if nothing else is indicated – using the same working methods as the workshop.

Warning symbols that occur in the service manual. For significance, refer to ***Safety Information*** .

DANGER!

WARNING!

CAUTION!

IMPORTANT!, **NOTICE!**
are by no means comprehensive since not everything can be foreseen as service work is carried out in the most varied of circumstances. We call attention to risks that may occur due to incorrect handling during work in a well-equipped workshop using working methods and tools tried and tested by us.

The service manual describes work operations carried out with the aid of Volvo Penta Special Tools, where such have been developed. Volvo Penta Special Tools are designed to ensure the safest and most rational working methods possible. It is therefore the responsibility of anyone using tools or working methods other than those we recommend to ensure that no risk of personal injury or mechanical damage is present, or that malfunction can result.

In some cases, special safety regulations and user instructions may be in force for the tools and chemicals mentioned in the Service Manual. These regulations must always be followed, and no special instructions regarding this are to be found in the Service Manual.

By taking these basic precautions and using common sense it will be possible to guard against most elements of risk. A clean workplace and a clean product will eliminate many risks of personal injury and malfunction.

Above all, when working on fuel systems, hydraulic systems, lubrication systems, turbochargers, inlet systems, bearings and seals, it is of the utmost importance that dirt and foreign objects are kept away, as malfunctions or shortened service intervals may otherwise result.

Our mutual responsibility

Each product comprises a large number of interacting systems and components. A deviation from the technical specification may dramatically increase the environmental impact of an otherwise reliable system. It is therefore critical that the stated wear tolerances be adhered to, that systems which can be adjusted be correctly set up and that only Volvo Penta Original Parts are used. The intervals in the care and maintenance schedule must be followed.
Some systems, e.g. fuel systems, often require special expertise and test equipment. A number of components are factory-sealed, for among other things environmental reasons. Warranty-sealed components may not be worked on without authorization to perform such work.

Remember that most chemical products, incorrectly used, are harmful to the environment. Volvo Penta recommends the use of biodegradable degreasers whenever components are cleaned, unless otherwise specified in the Service Manual. When working outdoors, take especial care to ensure that oils and wash residues etc. are correctly properly for destruction.

Tightening torques

Tightening torques for vital fasteners that must be applied using a torque wrench are indicated in the Service Manual, chapter ***Tightening torques*** and in the Manual's work descriptions. All torque indications apply to clean threads, bolt heads and mating faces. Indicated torque data apply to lightly-oiled or dry threads. If lubricants, locking fluids or sealants are required for fasteners, the correct type will be noted in the job description.

Torque, angle tightening

When torque/angle tightening, the fastener is tightened to a specified torque, and tightening then continues through a pre-determined angle.

Example: For 90° angle tightening, the fastener is turned a further 1/4 turn in one sequence, after the specified tightening torque has been achieved.

Lock nuts

Removed locknuts may not be re-used; they must be replaced by new ones, as locking properties are impaired or lost with re-use.
In the case of lock nuts with plastic inserts the tightening torque indicated must be reduced if the nut has the same nut height as a standard, all-metal hexagonal nut.
Reduce the torque by 25% for bolt sizes of 8 mm or larger.
In the case of lock nuts with plastic inserts with a high nut-height (where the all-metal thread is as high as a standard hexagonal nut), the indicated torque applies.

Strength classes

Nuts and bolts are subdivided into different strength classes. The classification is shown by a marking on the bolt head. Markings of a higher number indicate stronger material. For example, a bolt marked 10-9 is stronger than one marked 8-8.

For this reason, it is important that when bolts are removed they are returned to their original locations on re-assembly. When replacing bolts check the applicable ***Spare parts catalogue*** to ensure the correct bolt is used.

Sealing compounds etc.

To ensure service work is correctly carried out it is important that the correct type of sealants and locking fluids are used on joints where such are required.

In each service manual section concerned, the sealants used in product manufacture are indicated. The same sealants, or sealants with equivalent properties, must be used for maintenance work.

Make sure that mating surfaces are dry and free from oil, grease, paint and anti-corrosion agent before applying sealant or locking fluid. Always follow the manufacturer's instructions regarding applicable temperatures, hardening times and such.

Two basic types of compound are used:

RTV preparations (Room Temperature Vulcanizing).
Used most often together with gaskets, e.g. sealing gasket joints, or are brushed on gaskets. RTV sealants are completely visible when the part has been removed. Old RTV sealant must be removed before the component is sealed again. Use denatured alcohol.

Anaerobic agents.
These agents cure (harden) in the absence of air. These preparations are used when two solid components, e.g. two cast components, are fitted together without a gasket. Common uses are also to lock and seal plugs, stud threads, taps, oil pressure monitors etc.

Hardened anaerobic preparations are glassy and for this reason, the preparations are colored to make them visible. Hardened anaerobic preparations are highly resistant to solvents, and old compound cannot be removed. On re-assembly, it is important to carefully degrease and wipe dry components first, before applying new sealant in accordance with the instructions.

Safety regulations for fluorocarbon rubber

Fluorocarbon rubber is a common material in sealing rings for shafts, and in O-rings, for example.

When fluorocarbon rubber is exposed to high temperatures (above 300°C/572°F), hydrofluoric acid can form. This is highly corrosive. Contact with the skin can result in severe chemical burns. Splashes in your eyes can result in chemical wounds. If you breathe in the fumes, your lungs can be permanently damaged.

⚠ WARNING!

Seals must never be cut with a torch, or be burnt afterwards in an uncontrolled manner. Risk for poisonous gases.

⚠ WARNING!

Always use chloroprene rubber gloves (gloves for chemicals handling) and goggles. Handle the removed seal in the same way as corrosive acid. All residue, including ash, can be highly corrosive. Never use compressed air to blow clean.

Put the remains in a plastic container, seal it and apply a warning label. Wash the gloves under running water before removing them.

The following seals are most probably made from fluorocarbon rubber:

Seal rings for the crankshaft, camshaft, idler shafts.

O-rings, regardless of where they are installed. O-rings for cylinder liner sealing are almost always made of fluorocarbon rubber.

Please note that seals which have not been exposed to high temperature can be handled normally.

03-3 Specifications, Electrical

Electrical System

Technical Data

Switch, water in fuel

Voltage	24 V
Connector	2 pin
Contact type	Closes when water is detected

Sensor, fuel pressure

Voltage	5 V
Connector	3 pin
Working pressure range	0–700 kPa (0-7 bar) (0–101.5 PSI)
Pressure signal	0.5–4.5 V
Working temperature range	-40 °C to +140 °C
Type	Linear
Max tightening torque	30 ±5 Nm (22 ±3.7 lbf.ft.)

Speed sensor, crankshaft / camshaft

Connector	2 pin
Working temperature range	-40 °C to +130 °C (-40 °F to +262 °F)
Type	Inductive sensor
Max. tightening torque	8 ±2 Nm (5.9 ±1.48 lbf.ft.)

Sensor, oil pressure

Voltage	5 V
Connector	3 pin
Working pressure range	0–700 kPa (0-7 bar) (0–101.5 kPa)
Pressure signal	0.5–4.5 V
Working temperature range	-40 °C to +140 °C (-40 °F to +284 °F)
Type	Linear
Max tightening tourque	30 ±5 Nm (22 ±3.7 lbf.ft.)

Combination sensor, air inlet pressure / inlet manifold temperature

Voltage	5 V
Connector	4 pin
Working pressure range	50–400 kPa (0.5-4 bar) (7.3–58.0 PSI)
Pressure signal	0.5–4.5 V
Working temperature range	-40 °C to +130 °C (-40 °F to +262 °F)
Type	Linear/NTC

Sensor, coolant temperature

Voltage	5 V
Connector	2 pin

Type	NTC
Max. tightening torque	25 Nm (18.4 lbf.ft.)

Switch, coolant level

Connector	2 pin
Contact type	Closing with low coolant level

Alternator

Voltage	24 V
Connector	2 pin
Capacity	80 A at 24 V

Starter motor

Voltage	12 V
Connector	1 pol
Capacity (TAD1341–1345)	5.5 kW (7 kW)

Sensor, crankcase pressure

Voltage	5 V
Connector	3 pin
Working pressure range	40–140 kPa (0.4–1.4 bar) (5.8–20.3 PSI)
Pressure signal	0.5–4.5 V
Working temperature range	-40 °C to +140 °C (-40 °F to +284 °F)
Type	Linear

Combination sensor, oil level / temperature

Voltage	5 V
Connector	4 pin
Working temperature range	-40 °C to +140 °C (-40 °F to +284 °F)
Type	NTC

Switch, piston cooling pressure

Connector	2 pin
Contact type	Closing for low piston cooling pressure

Combination sensor, air filter pressure/temperature

Voltage	Max 24 V
Connector	4 pin
Switch point	-5 ±0.5 kPa (-50 ±5 mbar) (-0.73 ±0.073 PSI)
Working temperature range	-40 °C to +100 °C (-40 °F to +244 °F)
Type	NTC

Engine Protection Map

TAD950-952VE, TAD1250-1252VE

Derate to engine protection map

Parameter	"Yellow lamp"	"Red lamp"	0 %	25 %	50 %	70 %	100 %	Action
High coolant temperature	98 °C (208.4 °F)	101 °C (213.8 °F)	-	103 °C (217.4 °F)	106 °C (222.8 °F)	-	-	Soft derate
High oil temperature	125 °C (257.0 °F)	128 °C (262.4 °F)	-	101 °C (213.8 °F)	-	135 °C (275.0 °F)	-	Soft derate
High boost temperature	80 °C (176.0 °F)	90 °C (194.0 °F)	-	-	95 °C (203.0 °F)	105 °C (221.0 °F)	-	Soft derate
High air inlet pressure (TAD950–952VE)	340 kPa (49.3 PSI)	365 kPa (52.9 PSI)	-	-	365 kPa (52.9 PSI)	-	-	Hard derate
High air inlet pressure (TAD1250–1252VE)	425 kPa (61.6 PSI)	425 kPa (61.6 PSI)	-	-	425 kPa (61.6 PSI)	-	-	Hard derate
Crankcase pressure	When rapid increase of pressure	-	-	-	-	When rapid increase of pressure	-	Hard derate
Piston cooling pressure	When switch is activated	-	-	-	-	When switch is activated	-	Hard derate
Low oil pressure	Limit	20 < limit	-	-	-	20 < limit	-	Hard derate

"Derate" means that the engine torque is limited. This means that engine speed is not affected or reduced as long as the torque limit isn't reached.

"Hard derate" means that the engine quickly will decrease the torque.

"Soft derate" means that the engine will decrease the torque according to a function as a result of how much the alarm value has been exceeded.

Low oil pressure limit

TAD950-952VE	500 rpm	1000 rpm	1800 rpm	2300 rpm
	160 kPa (23.2 PSI)	200 kPa (29.0 PSI)	225 kPa (32.6 PSI)	250 kPa (36.3 PSI)

TAD1250-1252VE	500 rpm	1000 rpm	1900 rpm	2300 rpm
	160 kPa (23.2 PSI)	180 kPa (26.1 PSI)	225 kPa (32.6 PSI)	250 kPa (36.3 PSI)

TAD1350-1355GE

Derate to engine protection map

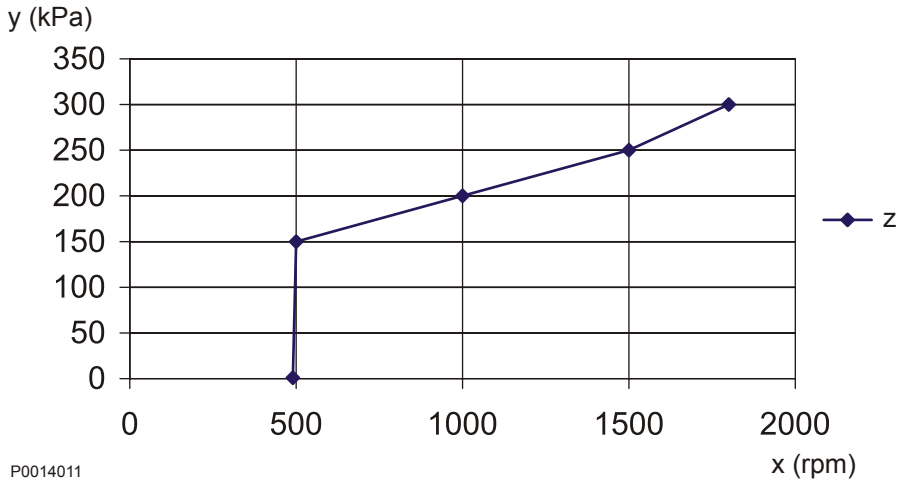
Parameter	"Yellow lamp"	"Red lamp"	Forced shutdown
High coolant temperature	98 °C (208.4 °F)	> 103 °C (217.4 °F)	> 103 °C (217.4 °F)
High oil temperature	125 °C (257.0 °F)	> 130 °C (266.0 °F)	> 130 °C (266.0 °F)
High inlet manifold temperature	80 °C (176.0 °F)	>85 °C (185.0 °F)	> 85 °C (185.0 °F)
High air inlet pressure	500 kPa (72.5 PSI)	510 kPa (74.0 PSI)	> 510 kPa (74.0 PSI)
High exhaust temperature	580 °C (1076.0 °F)	610 °C (1130.0 °F)	> 610 °C (1130.0 °F)
Crankcase pressure	-	When rapid increase of pressure	When rapid increase of pressure
Piston cooling pressure	-	When switch is activated	When switch is activated
Low coolant level	-	Switch	Switch
Low oil pressure	Limit	30 < limit	30 < limit

TWD1643GE

Derate to engine protection map

Parameter	"Yellow lamp"	"Red lamp"	Forced shutdown
High coolant temperature	98 °C (208.4 °F)	> 103 °C (217.4 °F)	> 103 °C (217.4 °F)
High oil temperature	125 °C (257.0 °F)	> 130 °C (266.0 °F)	> 130 °C (266.0 °F)
High inlet manifold temperature	80 °C (176.0 °F)	>85 °C (185.0 °F)	> 85 °C (185.0 °F)
High air inlet pressure	500 kPa (72.5 PSI)	510 kPa (74.0 PSI)	> 510 kPa (74.0 PSI)
High exhaust temperature	580 °C (1076.0 °F)	610 °C (1130.0 °F)	> 610 °C (1130.0 °F)
Crankcase pressure	-	When rapid increase of pressure	When rapid increase of pressure
Piston cooling pressure	-	When switch is activated	When switch is activated
Low coolant level	-	Switch	Switch
Low oil pressure	Limit	30 < limit	30 < limit

Oil pressure limit



x Engine speed

y Oil pressure

z Oil pressure limit

05-1 Safety Instructions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Safety Information

This Service Manual contains repair instructions, descriptions and technical data for products or product designs from Volvo Penta. Ensure that you are using the correct service manual.

Read the safety information below and the service manual section ***About this Workshop manual*** and ***Repair instructions*** carefully before repair and service work is begun.

⚠
This symbol is used in the service manual and on the product, to call attention to the fact that this is safety information. Always read such information very carefully.
Safety texts in the manual have the following order of priority:

⚠ DANGER!
Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING!
Indicates a hazardous situation which, if not avoided, could result in death or serious personal injury.

⚠ CAUTION!
Indicates a hazardous situation which, if not avoided, could result in minor or moderate personal injury.

IMPORTANT!
Is used to draw your attention to something that may cause minor damage or a minor malfunction to the product or property.

NOTICE! Is used to draw your attention to important information that will facilitate the work or operation in progress.


This symbol is used on our products in certain cases and refers to important information in the instruction book. Make sure that warning and information symbols on the engine are clearly visible and legible. Replace symbols which have been damaged or painted over.

A compilation of safety precautions that must be taken and risks which must be paid attention to is presented in the following pages.

Immobilize the engine by turning off the power supply to the engine at the main switch (switches) and lock it (them) in the off position before starting work. Post a warning notice at the main circuit breaker.

As a rule, all service operations must be carried out with the engine stopped. However, some work, such as adjustments, will require the engine to be running. Approaching an engine which is running is a safety risk. Bear in mind that loose clothing or long hair can fasten in rotating parts and cause serious personal injury.

Be aware of hot surfaces (exhaust pipes, turbos, charge air pipes, starting heaters etc.) and hot fluids in pipes and hoses on an engine that is running or has just stopped.
If work is done adjacent to a running engine, a careless movement or a dropped tool may in the worst case lead to personal injury.

Ensure that the warning symbols or information decals on the product are always clearly visible. Replace decals which have been damaged or painted over.

Avoid getting oil on your skin! Protracted or repeated exposure to oil can cause skin to become dry. Irritation, dryness, eczema and other skin problems may then result. From a health standpoint, used oil is more dangerous than new. Use protective gloves and avoid oil-soaked clothes and rags. Wash regularly, especially before eating. Use suitable barrier creams to counteract drying out of the skin and to aid dirt removal.

Stop the engine and turn off the electrical supply at the main switch(es) before carrying out work on the electrical system.

Avoid opening the coolant filling cap when the engine is hot. Steam or hot coolant can spray out and system pressure will be lost. Open the filler cap slowly, and release the pressure in the cooling system if the filler cap or valve has to be opened, or if a plug or coolant hose has to be removed when the engine is hot.

Hot oil can cause burns. Avoid skin contact with hot oil. Ensure that the lubrication system is not under pressure before any work is begun. Never start or operate the engine with the oil filler cap removed, because of the risk of oil ejection.

Never start the engine without installing the air filter. The rotating compressor turbine in the turbocharger can cause severe injury. Foreign objects entering the intake ducts can also cause mechanical damage. Install all protective covers before the engine is started.

Only start the engine in a well-ventilated space. When running in a confined space, exhaust fumes and crankcase gases must be led away from the engine bay or workshop area.

The majority of chemicals e.g. engine and transmission oils, glycol, gasoline, and diesel oil, together with chemicals for workshop use such as degreasing agents, paints and solvents, are injurious to health. Carefully read the instructions on the product packaging! Always follow a product's safety directions, e.g. use of protective mask, glasses, gloves etc. Ensure that other personnel are not exposed to substances that are injurious to health. Ensure good ventilation. Handle used and leftover chemicals in the prescribed manner.

Clutch adjustments must be carried out with the engine stopped.

Always use protective glasses or goggles when carrying out work where a risk of splinters, grinding sparks, splashes from acid or other chemicals is present. Your eyes are extremely sensitive; injury may cause blindness!

Never use start gas or similar products as a starting aid. They may cause an explosion in the inlet manifold. Danger of personal injury.

All fuels, as well as many chemicals, are flammable. Do not allow open flames or sparks in their vicinity. Gasoline, some thinners, and hydrogen gas from batteries are extremely flammable and explosive when mixed with air in the correct proportions. **No Smoking!** Ensure that the work area is well ventilated and take the necessary safety precautions before welding or grinding work is begun. Always ensure that there are fire extinguishers close at hand in the work area.

Batteries must never be exposed to open flames or electric sparks. Never smoke in the vicinity of the batteries; they generate hydrogen gas when charged, which is explosive when mixed with air. This gas is easily ignited and highly explosive. A spark, which can be caused by incorrect battery connection, is sufficient to cause a battery to explode and cause damage.

Do not touch the connections during start attempts. Sparking hazard! Do not lean over batteries.

Never transpose the positive (+) and negative (-) battery posts when installing batteries. Such a transposition can result in serious damage to electrical equipment. Refer to the wiring diagram.
Always use protective goggles when charging and handling the batteries. Battery electrolyte contains sulfuric acid which is highly corrosive. Should the battery electrolyte come into contact with unprotected skin, wash it off immediately using soap and copious amounts of water. If you get battery acid in your eyes, flush at once with copious amounts of water and seek medical assistance immediately.

Never start the engine with the valve cover removed. There is a risk of personal injury.

Stop the engine before working on the cooling system.
Marine engines: Close the sea cock / cooling water inlet valve before work on the cooling system is begun.

Make sure that oil, fuel-soaked rags, and used fuel and oil filters are stored in a safe manner. Rags soaked in oil can spontaneously ignite under certain circumstances. Used fuel and oil filters are environmentally hazardous waste and must be handed to an approved waste management facility for destruction, as must any used lubrication oil, contaminated fuel, paint residue, solvents, degreasers and wash residue.

Never work alone when removing heavy components, even when using lifting devices such as locking tackle lifts. When using a lifting device, two people are usually required to do the work - one to take care of the lifting device and the other to ensure that components are lifted clear and not damaged during the lifting operations.

The existing lugs on the engine should be used for lifting. Always check that the lifting equipment used is in good condition and has the load capacity to lift the engine (engine weight including gearbox or extra equipment). For safe handling and to avoid damaging components fitted to the top of the engine, the engine must be lifted with a correctly adjusted lifting boom. All chains or wires must run parallel to each other and as perpendicular to the engine as possible. If other equipment attached to the engine has altered its center of gravity, special lifting devices may be needed to obtain the correct balance for safe handling. Never perform any work on an engine that is only suspended from the lifting equipment.

The components in the electrical and fuel systems on Volvo Penta products are designed and manufactured to minimize the risk of fire and explosion. The engine must not be run in areas where there are explosive materials.

Only use fuels and lubricating oils recommended by Volvo Penta. Refer to the Operator's Manual for the product in question. Use of fuels that are of a lower grade may damage the engine, the injection pump and the injectors. On a diesel engine, low grade fuel can cause the control rod to bind and the engine to over-rev, with the risk of engine damage and personal injury as a result. Low fuel and oil grades may result in high service, maintenance and repair costs.

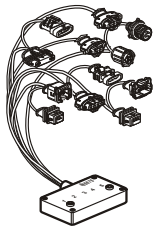
Fuel delivery pipes must not be bent or straightened under any circumstances. Cracks may occur. Damaged pipes must be replaced.

Exercise extreme caution when leak-detecting on the fuel system and testing the fuel injector nozzles. Use eye protection. The jet from a fuel nozzle has very high pressure and great penetration power. Fuel can force its way deep into body tissue and cause severe injury. There is a risk of blood poisoning (septicemia).

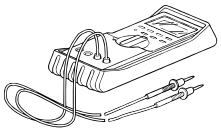
Never use a high-pressure washer for cleaning the engine.
Pay attention to the following when using a high-pressure washer on components other than the actual engine: Never direct the water jet at seals, rubber hoses or electrical components.

08-2 Special Service Tools

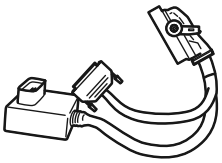
The following special tools are used when working on the engine. The tools can be ordered from AB Volvo Penta by specifying the number indicated.



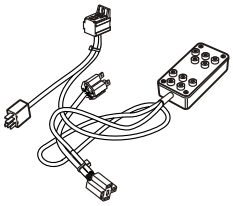
885675 Break out cable
Adapter cable for sensor test.



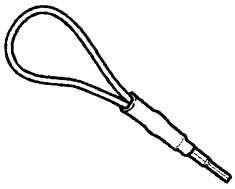
9812519 Multimeter
Used for measurements.



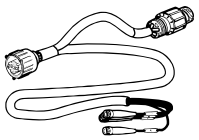
9990014 Break out cable
Adapter cable EMS2.



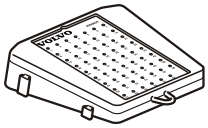
9990136 Break out cable
Adapter cable for relay test.



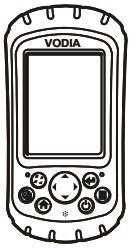
9998482 Measuring tool
Gauge for connector on control unit.



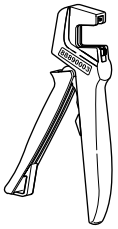
9998534 Break out cable
Used with 9812519 Multimeter.



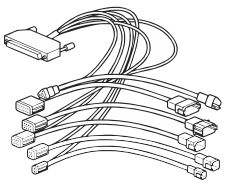
9998699 Break-out box
Used with 9990014 Break out cable.



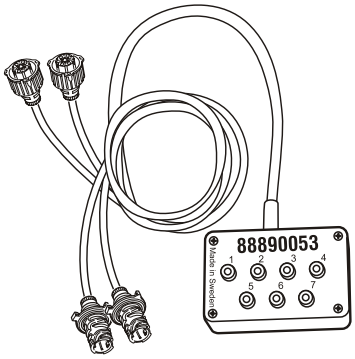
88820047 VODIA, diagnostic tool
Complete tool.



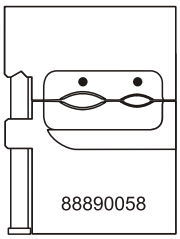
88890003 Press tool
Used for joining cables.



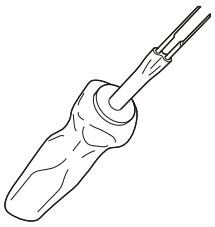
88890016 Break out cable
For use with 9998699 Break-out box.



88890053 Break out cable
Used with 9812519 Multimeter to measure on the ECU.



88890058 Pliers
Jaw, used with 88890003 Press tool.



88890028 Pin tool
Tool is included in 88890037
Extraction tool set.

30-0 General

Design and Function

EMS 2 (Engine Management System)

General Information

EMS 2 is an electronic system with CAN communication (Controller Area Network) for diesel engine control. The system has been developed by Volvo and includes fuel control and diagnostic function.

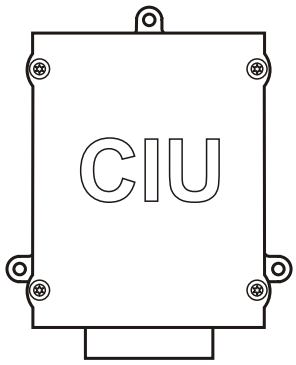
The system consists of a control unit, six unit injectors, a number of sensors that supply the control unit with measurements, sockets for diagnosis and functional checks. The engine can be connected to a communications interface consisting of a CAN link and a serial link.

CAN - Controller Area Network

The J1939 CAN link is responsible after all communication between the engine control unit (EMS 2) and a communication interface (such as CIU/DCU), except for diagnostics. Diagnostics are managed by the so-called J1708/J1587 link. The CAN link is much faster than the J1708/J1587 link and has been designed to connect to other components that support the SAE J1939 protocol, such as instrument panels and transmissions.

If a fault develops on the CAN link, signals for the engine speed potentiometer, and the start and stop knobs are taken over by the J1708/J1587 link. However, instrument and indicator lamps are completely turned off.

If faults occur in both links, the engine starts to idle. The only way to shut off the engine in this case is to use the auxiliary stop (AUX-STOP) placed on the engine’s left side.



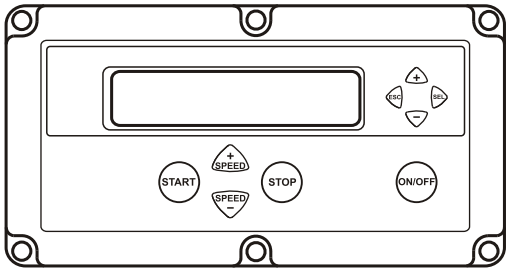
P0002060

CIU - Control Interface Unit

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

The fast one is a CAN link that features a bus speed of 250 Kbit/s. All data regarding instruments, indicator lamps, contacts and potentiometers are controlled by this bus.

The slower J1708/J1587 link handles diagnostic information for, among other things, the flashing code. The VODIA diagnosis tool also uses the J1708/J1587 link to communicate with the system.



P0002932

DCU - Display Control Unit

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

Engine control

- Start, stop, speed control, pre-heating etc.

Monitoring

- Engine speed, boost pressure, boost temperature, coolant temperature, oil pressure, oil temperature, engine hours, battery voltage, instantaneous fuel consumption and fuel consumption (trip fuel).

Diagnostics

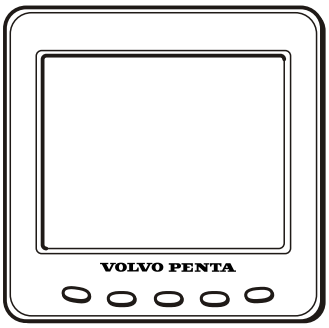
- Shows fault codes in text. Lists previous faults.

Parameter setting

- Idling speed, alarm limit for oil temperature/coolant temperature, droop.
- Preheating for ignition.

Information

- Information about hardware, software and engine identification.



P0002061

DU - Display Unit

The DU is an instrument panel which shows engine working values graphically on an LCD screen. It consists of an computerised 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, boost pressure, boost temperature, coolant temperature, oil pressure, oil temperature, fuel pressure, engine hours, battery voltage, instantaneous fuel consumption and average fuel consumption (trip fuel).

Diagnostics

- Shows active fault codes in plain language.

Fuel control

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

This means that the engine always receives the correct volume of fuel in all operating conditions, which offers lower fuel consumption, minimal exhaust emissions etc.

The control unit checks and controls the unit injectors, to ensure that the correct volume of fuel is injected into each cylinder. It calculates and sets the injection angle. The control is primarily performed using the speed sensors and the combined sensor for boost pressure/ boost temperature.

The control unit affects the unit injectors via an electronic signal to the unit injectors' electromagnetic fuel valve, which can open and close.

When the fuel valve is open, fuel flows past, through the unit injectors' holes and continuing out through the fuel channel. Fuel is not sprayed into the cylinder in this position.

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

The fuel valve is re-opened and pressure in the unit injector decreases at the same time as the fuel injection to the cylinder stops.

In order to determine when the fuel valve shall open or close, the control unit has access to signals from sensors and switch contacts.

Calculation of fuel quantity

The quantity of fuel to be injected into the cylinder is calculated by the control unit. The calculation determines the time that the fuel valve is closed (when the fuel valve is closed fuel is sprayed into the cylinder). The parameters which govern the amount of fuel injected are:

- Demanded engine speed
- Engine protector functions
- Temperature
- Boost pressure

Altitude correction

The control unit contains an atmospheric pressure sensor and an altitude compensation function for engines that operate at high altitude. This function limits the fuel volume in relation to ambient air pressure. This is to prevent smoke, high exhaust temperature and to protect the turbocharger from overspeeding.

Diagnostic function

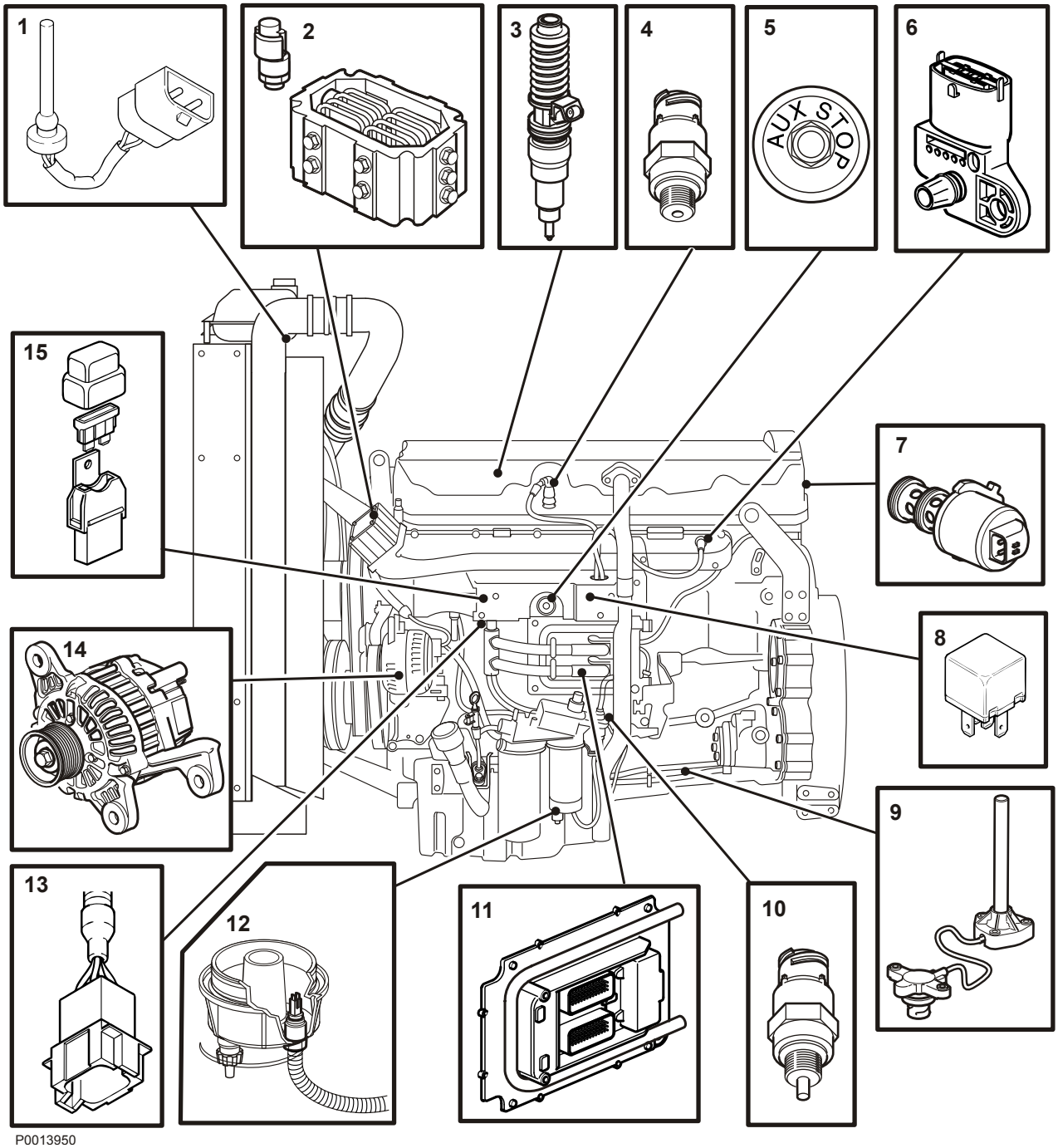
The task of the diagnostic function is to discover and localize any malfunctions in the EMS 2 system, to protect the engine and to inform about any problems that occur.

If a malfunction is discovered, this is announced by warning lamps, a flashing diagnostic lamp or in plain language on the instrument panel, depending on the equipment used. If a fault code is obtained as a flashing code or in plain language, this is used for guidance in any fault tracing. Fault codes can also be read by Volvo's VODIA tool at authorized Volvo Penta workshops.

In case of serious disturbances, the engine is shut down completely or the control unit decreases the power output (depending on the application). Once again, a fault code is set for guidance in any fault tracing.

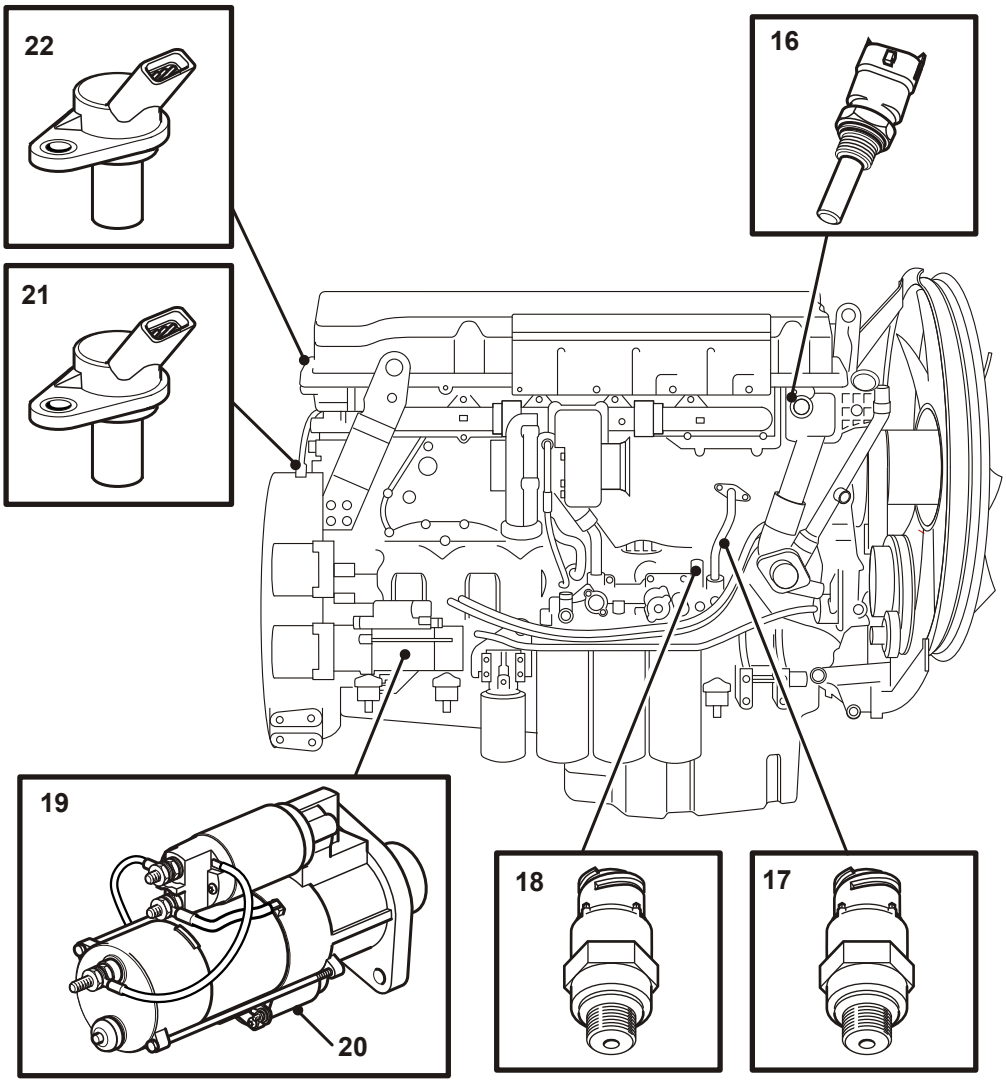
Component location

TAD950-952VE



1 Coolant level sensor
2 Preheater
3 Unit injector
4 Crankcase pressure sensor
5 Extra stop
6 Sensor, air inlet pressure/intake manifold temperature
7 IEGR valve
8 Main relay
9 Oil level/temperature sensor
10 Fuel pressure sensor
11 Engine control unit (ECU)
12 Water in fuel sensor
13 Diagnostic outlet
14 Alternator
15 Main fuse, 10 A

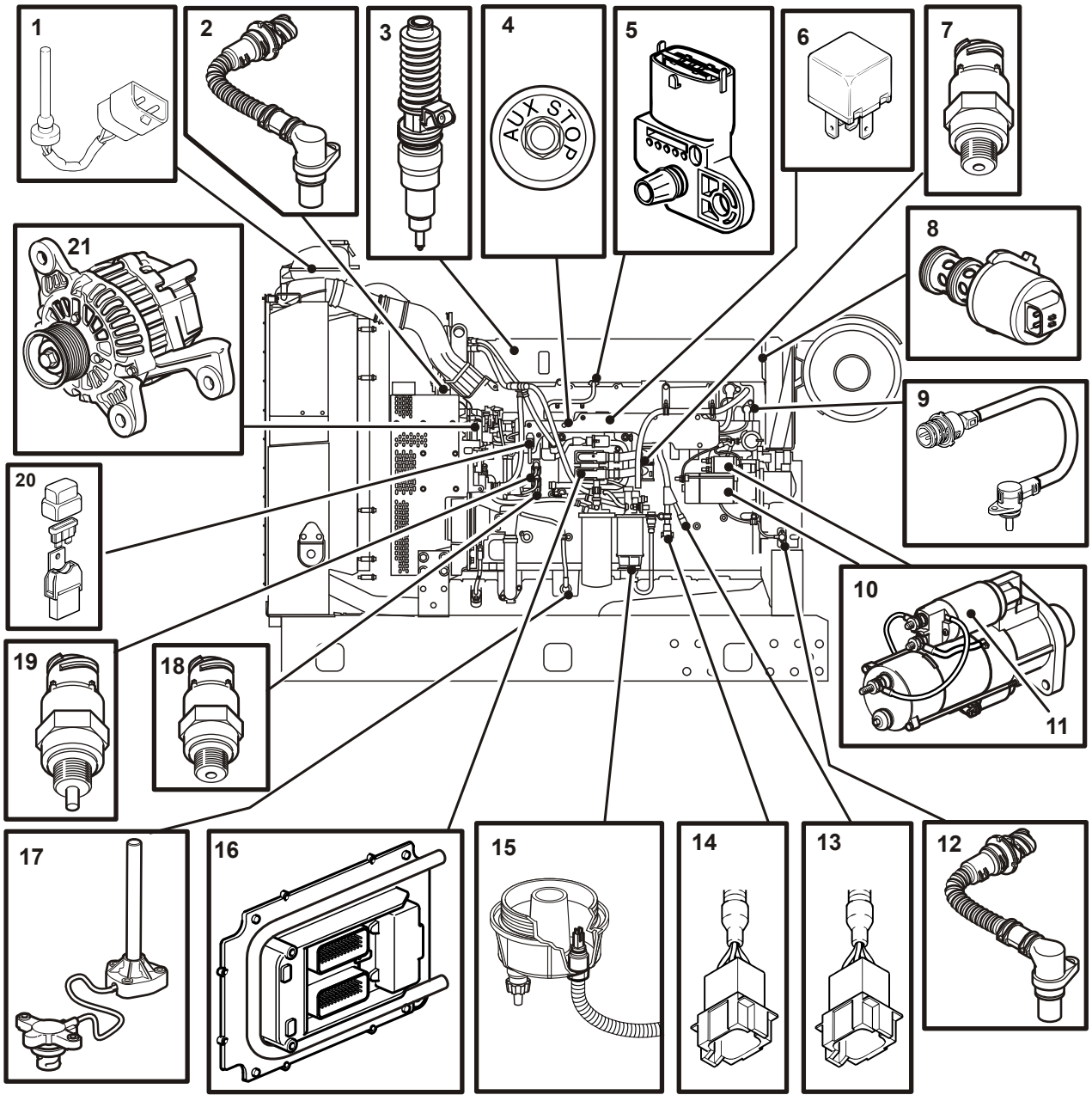
TAD950-952VE



P0013951

16 Coolant temperature sensor
17 Piston cooling pressure sensor
18 Oil pressure sensor
19 Starter motor
20 Starter motor relay
21 Speed sensor, crankshaft
22 Speed sensor, camshaft

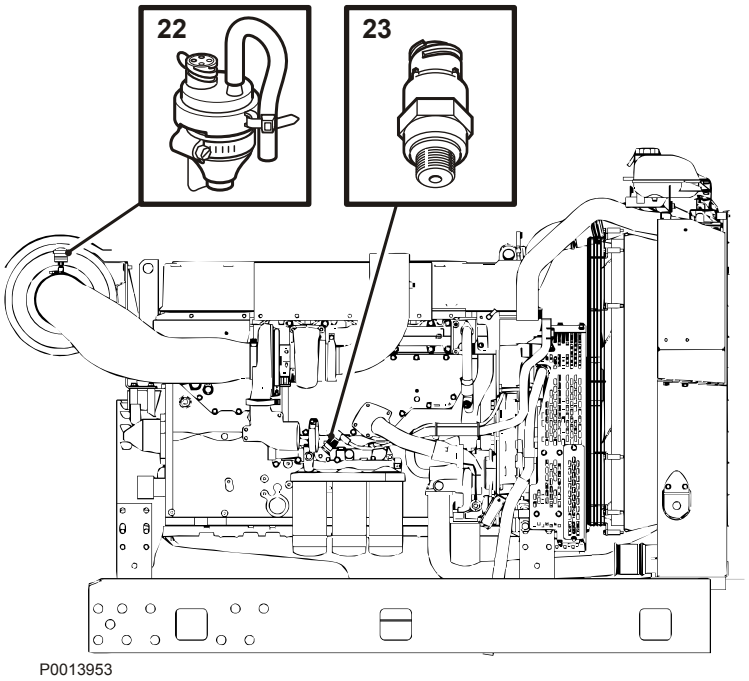
TAD1250-1252VE



P0013952

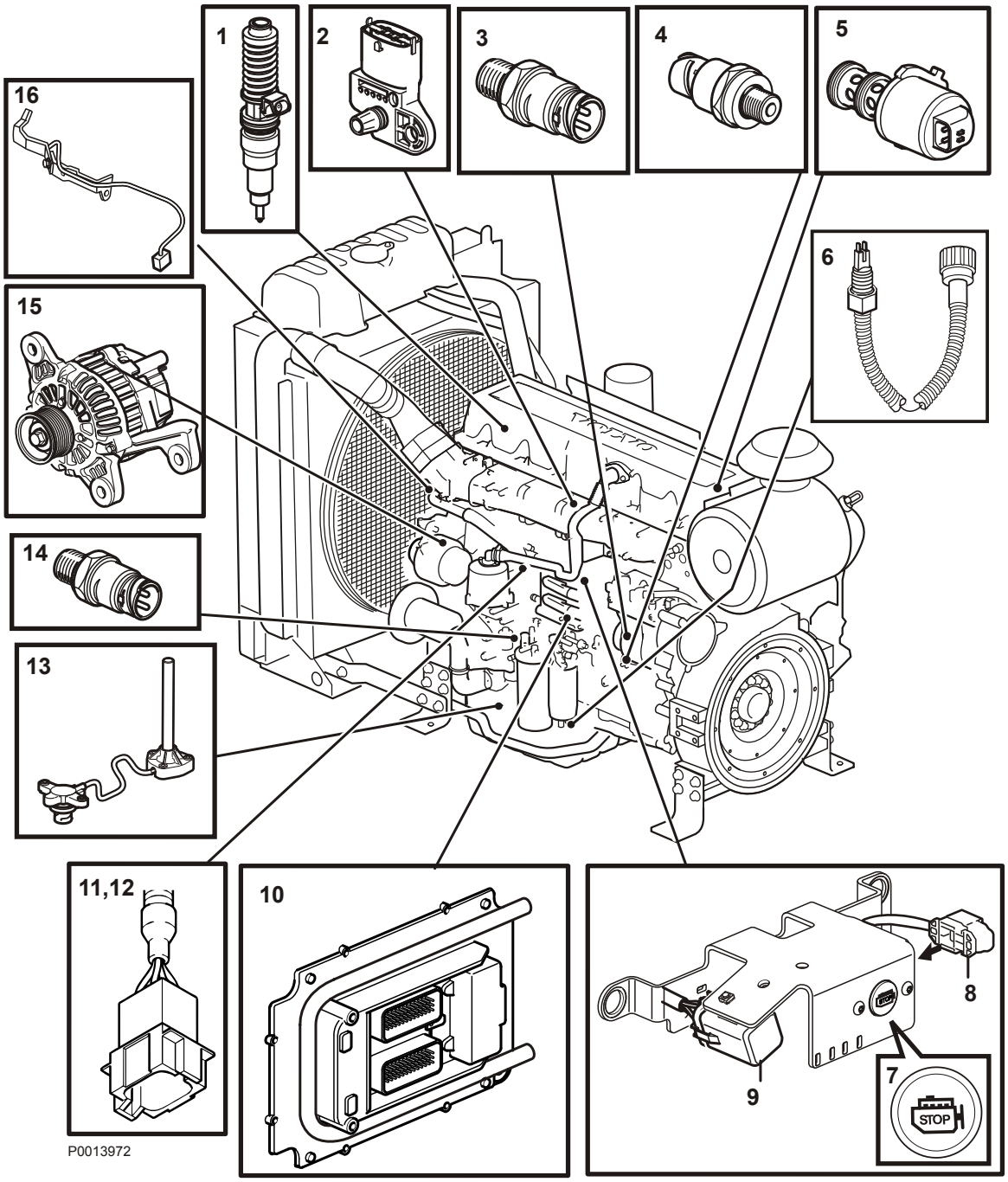
1 Coolant level sensor
2 Speed sensor, camshaft
3 Unit injector (one for each cylinder)
4 Extra stop
5 Sensor, air inlet pressure/intake manifold temperature
6 Main relay
7 Fuel pressure sensor
8 IEGR valve
9 Coolant temperature sensor
10 Starter motor
11 Starter motor relay
12 Speed sensor, crankshaft
13 Connector for diagnostic tool, 6-pin
14 Engine interface, 8-pin connector
15 Water in fuel sensor
16 Engine control unit (ECU)
17 Oil level/temperature sensor
18 Crankcase pressure sensor
19 Oil pressure sensor
20 Main fuse, 10 A
21 Alternator

TAD1250-1252VE



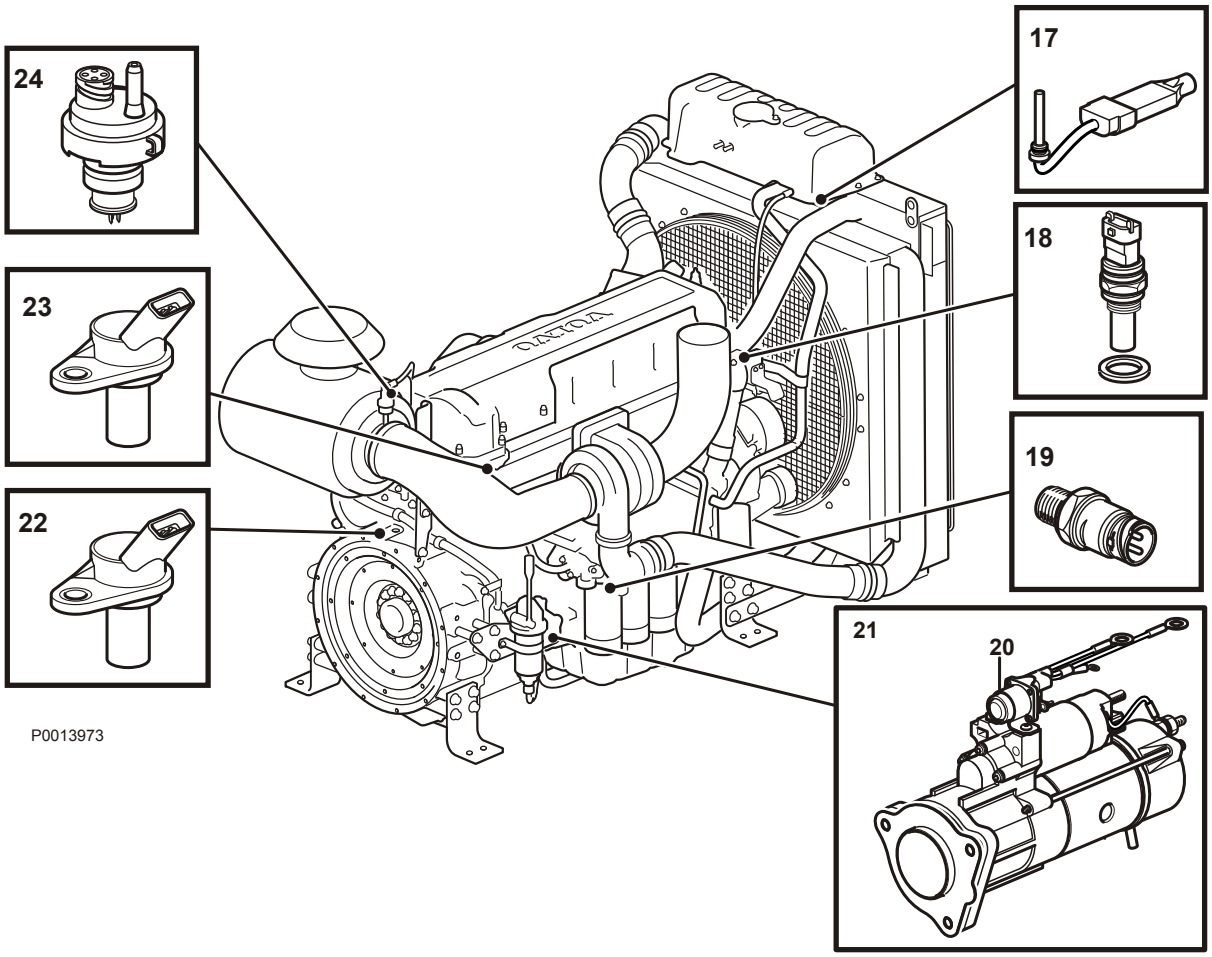
22 Air filter indicator
23 Piston cooling pressure

TAD1350-1355GE



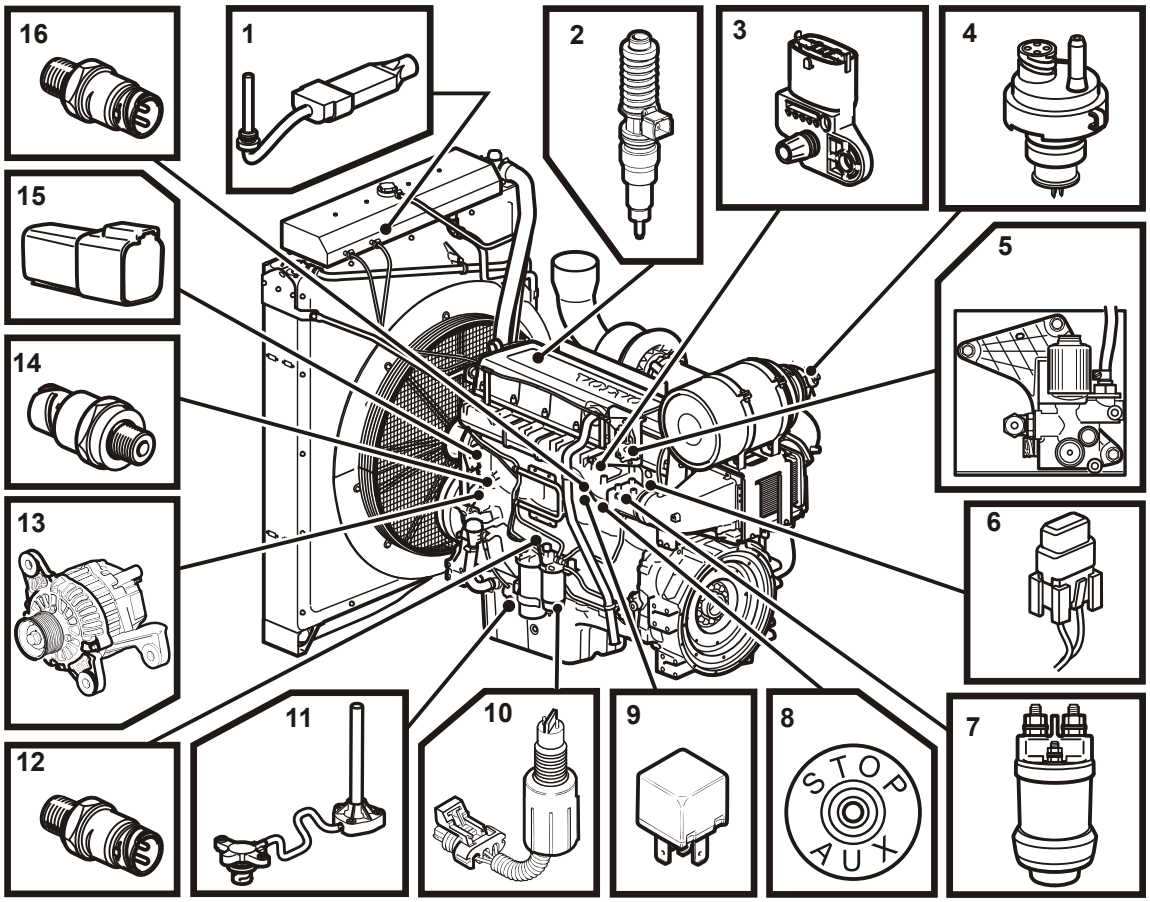
1 Injector
2 Sensor, air inlet pressure/intake manifold temperature
3 Oil pressure sensor
4 Crankcase pressure sensor
5 IEGR valve
6 Water in fuel sensor
7 AUX stop
8 Main fuse
9 Main relay
10 Engine control unit (ECU)
11 Connector for diagnostic tool, 6-pin
12 Engine interface, 8-pin connector
13 Oil level/temperature sensor
14 Fuel pressure sensor
15 Alternator
16 Pressure drop indicator/air temperature sensor

TAD1350-1355GE



17 Coolant level sensor
18 Coolant temperature sensor
19 Piston cooling oil pressure sensor
20 Starter motor relay
21 Starter motor
22 Flywheel position and rotation speed sensor
23 Camshaft position sensor
24 Air filter indicator

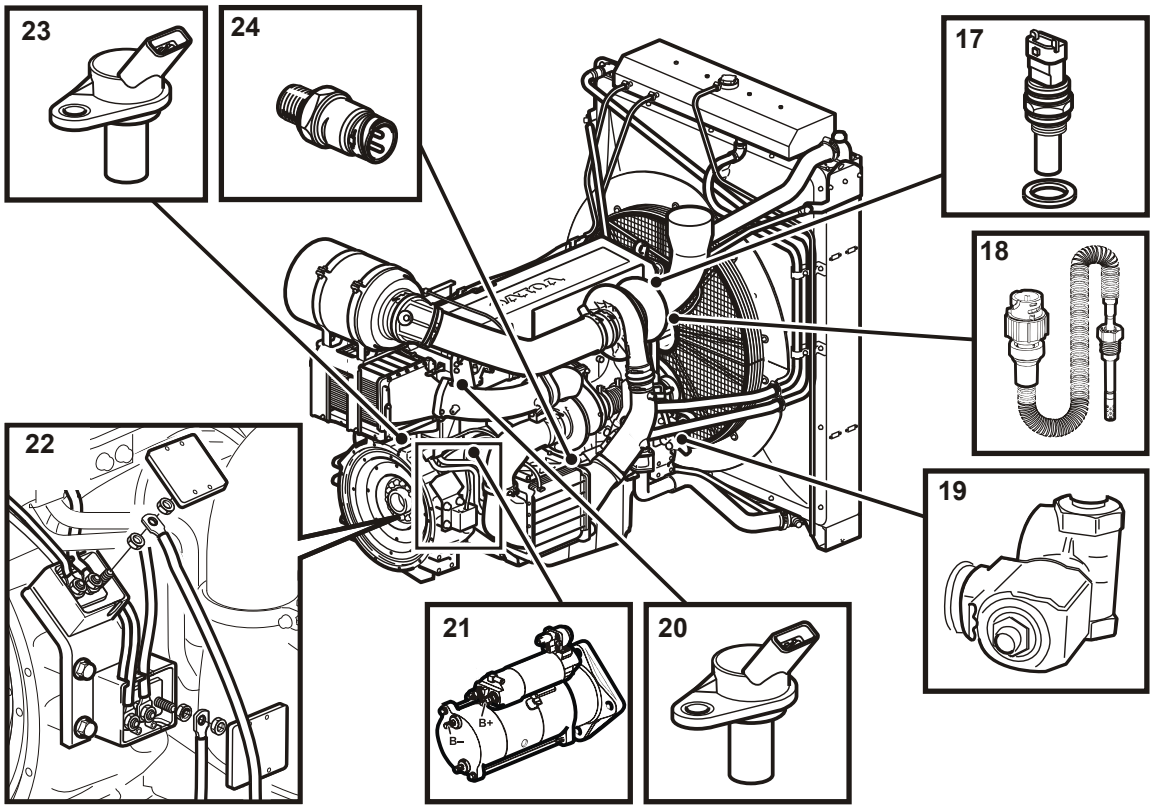
TWD1643GE



P0013954

1 Coolant level switch
2 Unit injector (one for each cylinder)
3 Sensor, air inlet pressure/intake manifold temperature
4 Sensor, air filter pressure/air temperature
5 Wastegate regulator
6 Main fuse
7 Preheat relay
8 AUX stop
9 Main relay
10 Water in fuel sensor
11 Sensor, oil level/oil temperature
12 Fuel pressure sensor
13 Alternator
14 Crankcase pressure sensor
15 Diagnosis tool connector
16 Oil pressure sensor

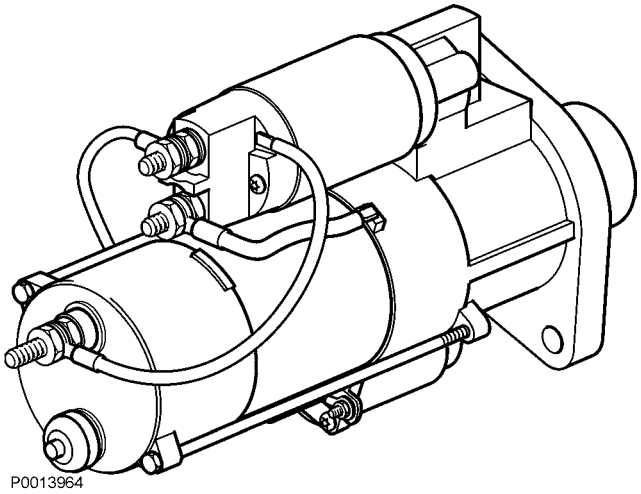
TWD1643GE



17 Coolant temperature sensor
18 Exhaust temperature
19 Cold start valve
20 Camshaft position sensor
21 Starter motor
22 Battery connection points
23 Crankshaft sensor
24 Piston cooling switch

Component description

Starter motor

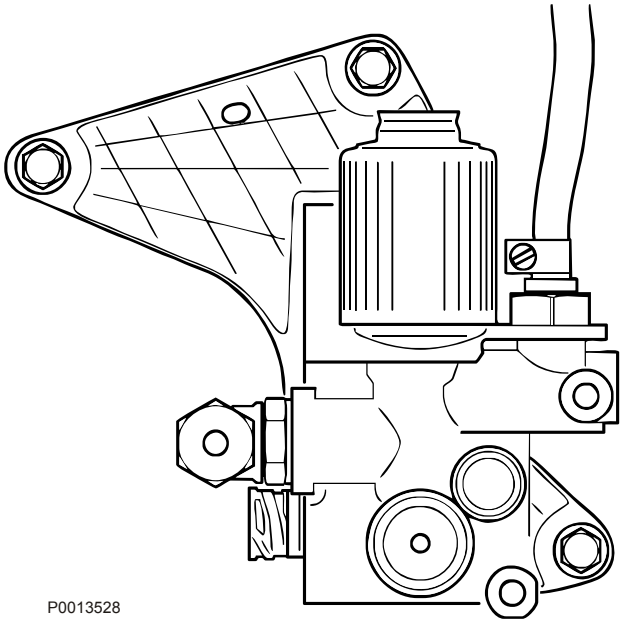

P0013964

During starting, a gear on the starter rotor shaft is moved axially so that it engages with the ring gear on the engine's flywheel. The axial movement as well as the activation of the starter motor is controlled by a solenoid on the starter motor.

The starter solenoid in turn is connected via the starter relay, which is activated when the starter key is turned to position III/the starter button is pressed.

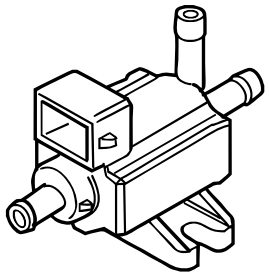
TWD1643GE

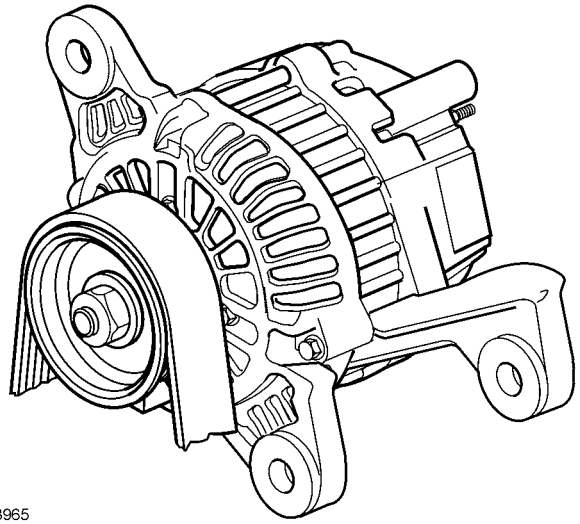
Wastegate regulator


P0013528

The TAD1350-55GE and TWD 1643 engine is equipped with a turbocharger with a wastegate valve. The wastegate valve controls the amount of exhaust gas flow which should pass through the exhaust turbine. An electronically controlled regulation valve, wastegate regulator, which is controlled by the engine control unit controls the air pressure supplied to the wastegate valve. Boost air pressure taken from the inlet manifold is used to control the amount that the wastegate opens.

TAD1350-55GE

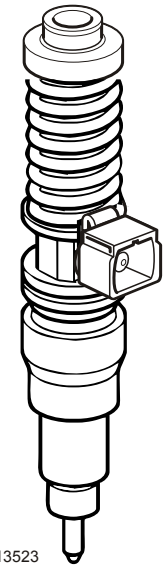

P0007171



P0013965

Alternator

The alternator is belt driven and is located at the left front of the engine.

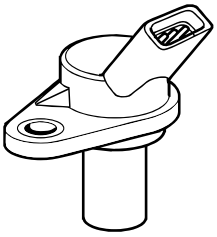


P0013523

Unit injector

The unit injectors are located under the valve cover, mounted in the cylinder head.

The engine's fuel requirement is analyzed up to 100 times per second (depending on engine rpm). The amount of fuel injected into the engine and the injection timing are electronically controlled via the unit injector's solenoid controlled fuel valves. This means that the engine always receives the correct volume of fuel in all operating conditions, which offers lower fuel consumption, minimal exhaust emissions etc.

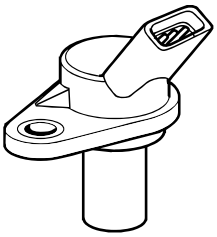


P0008694

Speed sensor, crankshaft

The sensor is located in the left side of the flywheel housing.

The flywheel speed sensor is of the inductive type. It reads off the crankshaft position and speed from grooves in the flywheel. The signal is sent to the control unit, which calculates injection timing and fuel quantity.

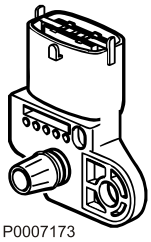


P0008694

Speed sensor, camshaft

The position sensor is located in the upper timing gear cover. The camshaft position sensor is of the inductive-sensor type. The sensor reads off a cogged wheel with 7 cogs. The impulses from the camshaft sensor give the control unit information about which cylinder is in turn for injection and when it is performed.

Air inlet pressure / inlet manifold temperature sensor



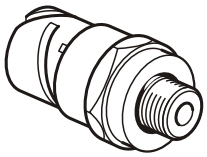
P0007173

The air inlet pressure and intake manifold temperature are measured via a combined sensor positioned on the inlet pipe.

The air inlet pressure sensor measures absolute pressure, which is the sum of air inlet pressure and atmospheric pressure. The sensor supplies the control unit with a voltage signal proportional to the absolute pressure. The sensor receives a reference signal of 5 Volts from the control unit.

The intake manifold temperature sensor comprises a non-linear resistor, where the resistance is dependant on the temperature of the resistor body. The resistance drops as temperature rises.

Oil pressure sensor

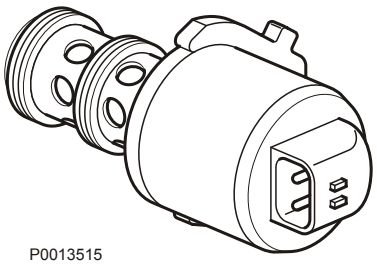


p0001348

The oil pressure is measured by a sensor located next to the control unit.

The sensor is fitted in the engine block so that measurements are performed in the lubrication systems main oil galley. The pressure signal is a voltage signal proportional to the pressure. The sensor reference voltage is 5 Volts.

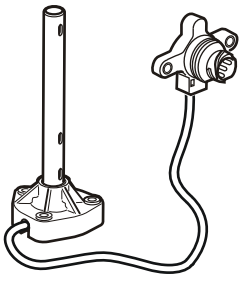
IEGR



P0013515

Internal exhaust gas recirculation, IEGR, is used for recirculation of exhaust gases. This for lowering the emissions from the engine. The IEGR control valve, is located on the cylinder head under the valve cover.

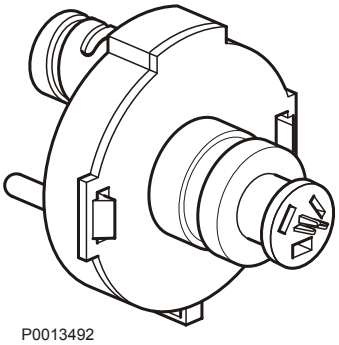
Oil level / temperature sensor



P0002878

The sensor is located in the oil sump.

The purpose of the level sensor is to detect if the oil level becomes too low. A current is passed through the sensor and the voltage measured across it is then proportional to the oil level. An alarm signal is sent when the oil level is too low. The temperature sensor consists of a non-linear resistor, where the resistance is dependent on the temperature of the resistor body. The resistance drops as temperature rises.



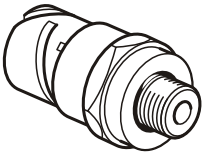
P0013492

Air filter pressure / temperature sensor

Air filter pressure and air filter temperature are measured by a combined sensor placed above the air filter.

The air filter pressure sensor measures absolute pressure, the sum of air filter pressure and atmospheric pressure. The sensor consists of a monitor that sends a signal to the control unit when the pressure in the air filter becomes too high.

The air filter temperature sensor consists of a non-linear resistor, where the resistance is dependant on the temperature of the resistor body. The resistance drops as temperature rises.

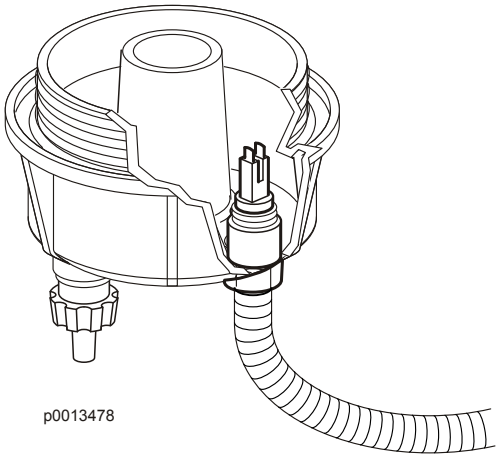


p0001348

Crankcase pressure sensor

The sensor is located on top of the engine in the middle of the valve cover on the engine's left side.

The pressure signal is a voltage signal proportional to the pressure. The sensor reference voltage is 5 Volts.

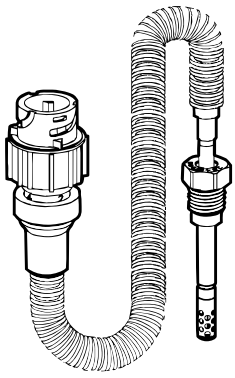


p0013478

Switch, water in fuel

The switch is located in the lower part of the fuel prefilter.

It's purpose is to detect water in the fuel system.The switch comprises two copper electrodes, between which the resistance is measured. When the resistance drops below a certain limit, which indicates that there is water in the fuel, a warning message is sent to the control unit.

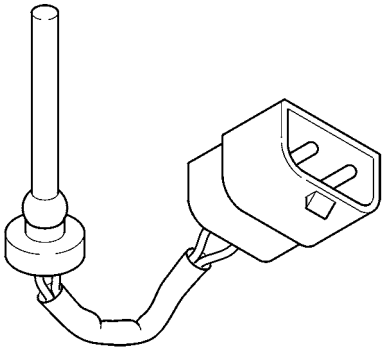


P0013504

Exhaust temperature sensor

The exhaust temperature sensor consists of a Pt-200 sensor where the resistance changes depending on exhaust temperature. The resistance increases with rising exhaust temperature.

Switch, coolant level

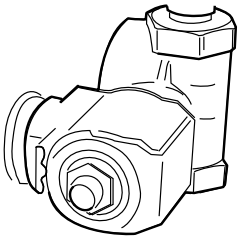


P0004033

The switch is located in the expansion tank.

It's purpose is to detect if the coolant level in the cooling system (expansion tank) becomes too low. The switch is a magnetically sensitive switch. A float located around the switch affects the switch differently depending on the coolant level. A alarm signal is sent when the coolant level is too low.

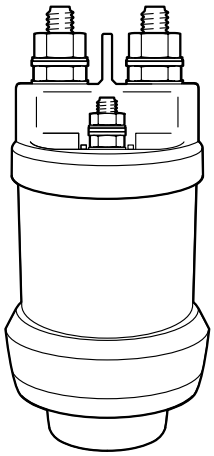
Cold start valve



P0013519

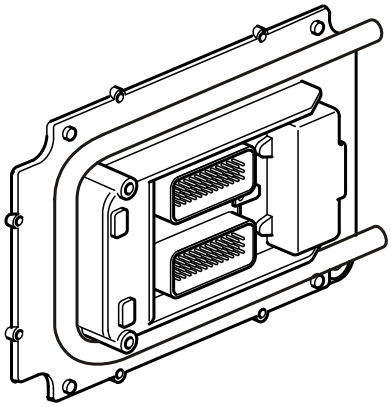
In order to avoid boiling in the charge air coolers at different loads and coolant temperatures, the system is fitted with a cold start valve that is controlled by the EMS2. The cold start valve is normally open i.e. without voltage supply the valve is open.

Preheat relay



P0013963

In cold climate the intake air might need to be pre-heated. This is done by the preheater located on the intake manifold. The preheater is controlled by the EMS2 via the pre-heat relay.



P0007254

Control unit EMS 2

The control unit checks and controls the unit injectors so that the correct amount of fuel is injected into each cylinder. It calculates and sets the injection angle. The control is primarily performed using the speed sensors and the combined sensor for boost pressure/ boost temperature.

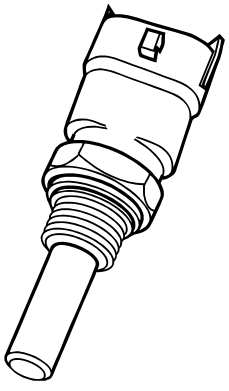
The EMS 2 system processor is located in the control unit, where it is protected from moisture and vibration.

The processor receives information continuously about:

- engine speed
- camshaft position
- boost pressure
- boost temperature
- coolant temperature
- oil pressure
- oil temperature
- oil level
- crankcase pressure
- piston cooling pressure
- water in fuel
- fuel pressure
- coolant level
- air filter pressure
- air filter temperature

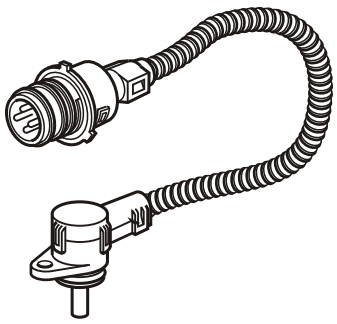
Information from the sensors provides exact information about current operation conditions and allows the processor to calculate the correct fuel volume, check engine status etc.

TAD950-952VE, TAD1350-1355GE, TWD1643GE



p0004941

TAD1250-1252VE

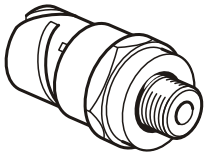


P0002859

Coolant temperature sensor

The sensor is located in the left rear part of the cylinder head.

The sensor senses the coolant temperature and sends the information to the control unit. The sensor comprises a non-linear resistor, where the resistance is dependant on the temperature of the resistor body. The resistance drops as temperature rises.



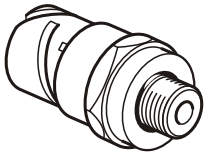
p0001348

Switch, piston cooling

A valve is installed in the oil filter bracket which opens or closes the oil supply for piston cooling, depending on oil pressure. If the oil pressure is below 250 kPa (36.3 PSI) (TAD950-952VE) or 300 kPa (43.5 PSI) (TAD1250-1252VE), the valve closes the oil supply for piston cooling.

The piston cooling pressure is monitored by a pressure monitor. The output signal from the pressure monitor can only have two distinct positions, on/off, in the same way as a relay output. The monitor is supplied with current from the engine control unit. A pre-set pressure limit of 150 kPa (21.8 PSI) determines when the monitor switches on. The monitor opens if the pressure exceeds this value.

At idle, the monitor can be closed without a fault code being set.



p0001348

Fuel pressure sensor

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

Repair Instructions

General advice on working with EMS engines

The following advice must be followed to avoid damage to the engine control unit and other electronics.

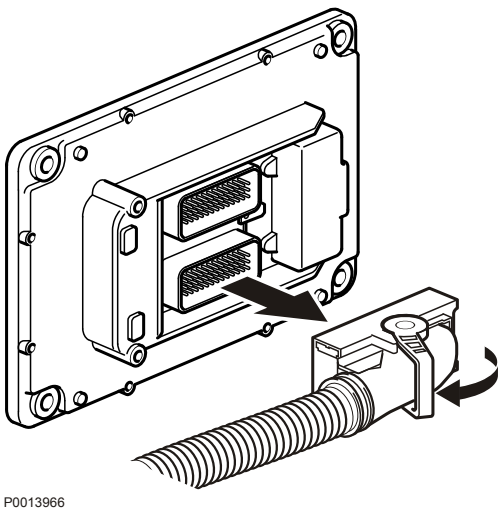
IMPORTANT!

The system must be disconnected from system voltage (by cutting the current with the main switch) and the starter key(s) must be in the 0 position when the engine control unit connectors are disconnected or connected.

- Never disconnect the current with the main switches when an engine is running.
- Never undo a battery cable when the engine is running.
- Turn the main switches off or disconnect the battery cables during quick charging of the batteries.

  NOTICE! During normal trickle charging, it is not necessary to turn the main switches off.
- Only batteries may be used for start help. A help start device can produce a very high voltage and damage the control unit and other electronics.
- If a connector is disconnected from a sensor, be very careful to avoid allowing the contact pins to come into contact with oil, water or dirt.

Electrical Welding



P0013966

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

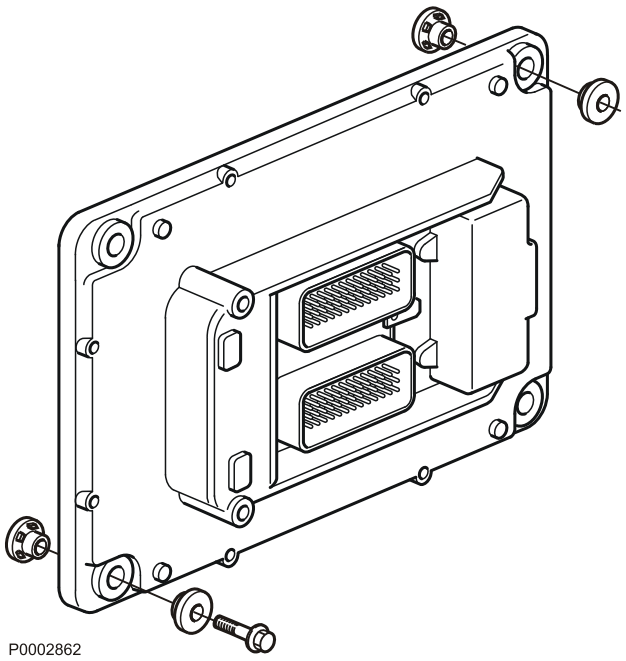
IMPORTANT!
The system must be disconnected from system voltage when the engine control unit connectors are disconnected or connected.

2 Undo the two connectors from the engine control unit before any electrical welding starts. Turn the locking arm down at the same time as the connector is pulled outwards.

3 Disconnect all connections to the alternator. Connect the welder earth clamp to the component to be welded, or as close as possible to the weld site. The clamp must never be connected to the engine or in such a way that current can pass through a bearing.

IMPORTANT!
After welding is completed, the disconnected components, such as alternator cables and battery cables must be connected in the correct order.

The battery cables must always be connected last.


P0002862

Engine Control Unit (ECU), Replace

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

IMPORTANT!
The system must be disconnected from system voltage when the engine control unit connectors are disconnected or connected.

2 Remove the two connectors from the engine control unit. Turn the locking arm down at the same time as the connector is pulled outwards.

3 Change the engine control unit.

4 If the new engine control unit has recently been programmed:
Start the engine and check whether any fault codes related to the engine control unit occur.

Reprogramming a control unit

IMPORTANT!

The CHASSIS ID number must be readily available to allow the software to be downloaded.

P0006430

Action:

1 Log in to *Volvo Penta Partner Network's* website: *www.vppn.com*

2 Choose "VODIA" in the left-hand menu.

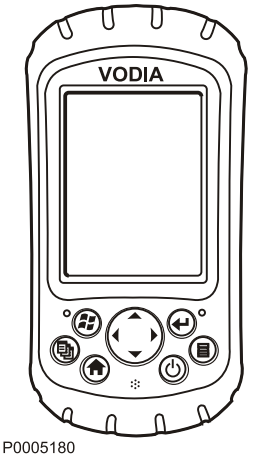
3 Choose "ECU programming" in the left-hand menu.

4 Follow the instructions under "Download software".
Choose the control units to be reprogrammed and click the "Download" button.
The software for the control units is now downloaded to the PDA(1).

5 Take a look under "Settings", "Software information" in VODIA to check that the software has been downloaded.

6 Connect the VODIA to the engine (control unit) to be programmed.

7 Start with the engine control unit.
Select "Engine with mounting and equipment" in the VODIA menu.
Select "MID 128 Control unit, programming".
VODIA will guide you through the entire programming process.



P0005180

8 The next control unit is the vehicle ECU.
Select "Electrical system and instruments" in the VODIA menu.
Select "MID 144 ECU, programming".
VODIA will guide you through the entire programming process.

9 **NOTICE!** Programming must be reported back to Volvo Penta within 28 days.
Log in to *Volvo Penta Partner Network's* web site (*www.vppn.com*).

10 Choose "VODIA" in the left-hand menu.

11 Choose "Report software" in the left-hand menu.

12 Follow the instructions for "Report software/parameter".
Click "Report software/parameter".

1. PDA = "Personal Digital Assistant" (palmtop computer).

Programming an empty control unit

When a new engine control unit is installed, where no software has been downloaded, the control unit must be programmed.

The new control unit must have the same part number as the old control unit. If the control units do not have the same part number, it will not be possible to program the new control unit until a “Conversion kit” has been ordered from Volvo Penta.

If the control units have the same part number, the new control unit can be programmed as usual. Please refer to *Reprogramming a control unit page 38*.

If the part numbers do not coincide – proceed as possible:

P0006430

1 Have both part numbers available.

2 Log in to *Volvo Penta Partner Network’s* web site: *www.vppn.com*

3 Choose “VODIA” in the left-hand menu.

4 Choose “Conversion kit” in the left-hand menu. A new page, “Conversion kit / Accessory kit”, opens up.

5 Click the text “Available conversions kits” which is shown in bold face.

6 A new window opens. Follow the instructions given in the window.

7 Return to the “Conversion kit / Accessory kit” page and follow the instructions to order a new “conversion kit”.

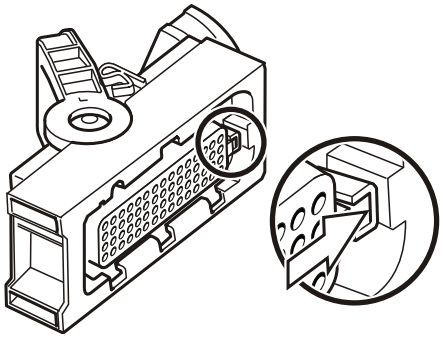
8 Volvo Penta’s database is now updated. It can take about a minute before a confirmation is sent.

9 Programing of the control unit can now start. Please refer to *Reprogramming a control unit page 38*.

Fault tracing of cables and connectors

Tools:
9812519 Multimeter
9998482 Measuring tool

Check all connectors visually


P0007178

Check the following:

- Look for oxidation which can impair contact in connectors.
- Check that terminals are undamaged, that they are correctly inserted into their connectors, and that the cable is correctly terminated in the terminal.
- Check that there is good mechanical contact in the connector. Use a loose pin to check this.

  IMPORTANT!
  The multi-pin connectors for the engine control unit must only be checked with 9998482 Measuring tool.
- Carefully insert 9998482 Measuring tool into the multi-pin connector. Pull and push the connector in and out a few times and feel whether the terminal socket grasps the tool. If the terminal socket does not grasp, or if it feels slack, the connection pins should be changed. Please refer to *Joining electrical cables for connectors page 42*. Check the secondary locking in the connector.
- If possible, shake the cables and pull the connectors during measurement to discover whether the cable harness is damaged.
- Check that the cables are not damaged. Avoid clamping cables in tight bends close to the connector.
- Check the function of the secondary locking.

Contact problems

Intermittent contact or temporary recurring faults can be difficult to fault trace, and are frequently caused by oxidation, vibration or poorly terminated cables.

Wear can also cause faults. For this reason, avoid disconnecting a connector unless it is necessary.

Other contact problems can be caused by damage to pins, sockets and connectors etc.

Shake cables and pull connectors during measurement, to find where the cable is damaged.

Contact resistance and oxidation

Resistance in connectors, cables and junctions should be approx. 0 Ω. A certain amount of resistance will occur, however, because of oxidation in connectors.

If this resistance is too great, malfunctions occur. The amount of resistance that can be tolerated before malfunctions occur varies, depending on the load in the circuit.

Open circuit

Possible reasons for faults could be chafed or broken cables, or connectors which have come undone.

Use the wiring schedule to check the cables which are relevant to the function. Start off with the most probable cable in the circuit.

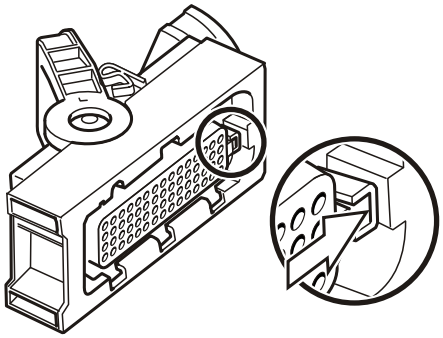
Check the following:

- Disconnect the relevant connector at each end of the cable harness.
- Use 9812519 Multimeter to measure the resistance between the ends of the cable.
  Nominal value ~ 0 Ω.
- If possible, shake the cables and pull the connectors during measurement to discover whether the cable harness is damaged.
- Check the next cable system in the wiring schedule if no fault has been found.

Joining electrical cables for connectors

Tools:
88890003 Press tool
88890028 Pin tool
88890058 Pliers

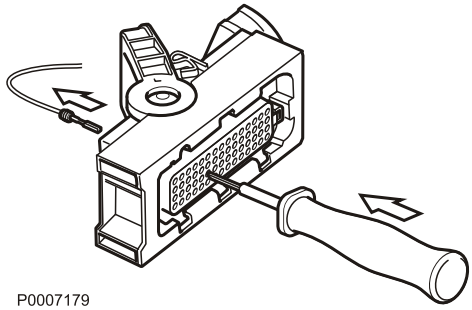
Repair kit:
1078054



P0007178

1 Disconnect the connector from the engine control unit or from the power supply unit, please refer to *Engine Control Unit (ECU), Replace page 37*. Undo the connector, to gain access to the cable leading to the pin which is to be changed.

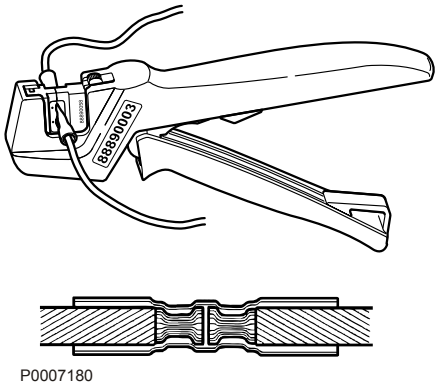
2 Undo the pin catch.



P0007179

3 Remove the pin with 88890028 Pin tool.

NOTICE! Only remove one pin at a time.



P0007180

4 Cut off the cable and the pin which is to be changed. Join the cable with the new one, using repair kit no. 1078054. Use 88890003 Press tool with 88890058 Pliers.

5 Carefully heat the joint with a hot air gun, to make the insulation shrink and seal tightly.

6 Put the pin back in the right place in the connector before removing the next pin, if several pins are to be changed. Check that the locking tongue locks the pin in the connector.

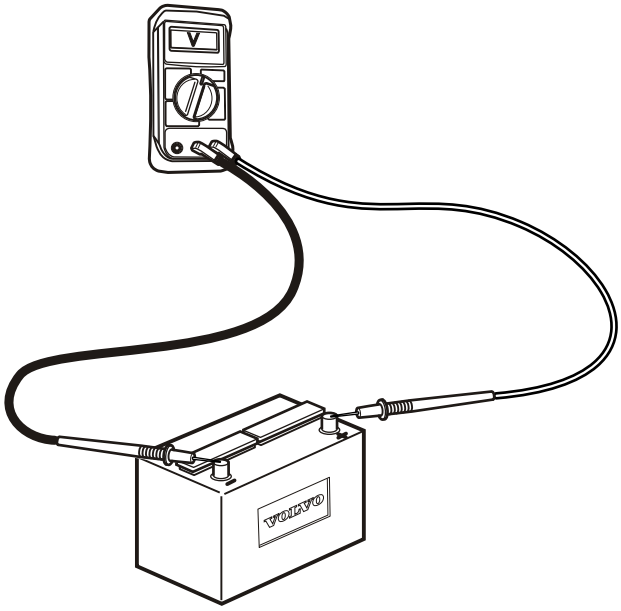
7 Install the cables with insulation and tie wraps in the connector, in the reverse order to disassembly.

8 Install the connector in the reverse order to disassembly.

9 Check that the connector and the mating connector on the engine control unit or power supply unit are clean and dry.

10 Join up the multi-pin connector. Please refer to *Engine Control Unit (ECU), Replace page 37* for advice on joining up the connector.

11 Start the engine and check carefully that no fault codes occur.



P0008397

Checking the starter motor voltage

Tools:
9812519 Multimeter

General

If battery voltage falls below 24.7 V*, the starter motor will not be able to crank the engine at normal speed.

A fully charged battery has an open circuit voltage of about 25.4 V.

NOTICE! * Measured on the batteries.

Voltage measurement, check

1 Check that the battery voltage is at least 24.7 V when unloaded by using 9812519 Multimeter to measure between the battery poles.

2 Turn the main switch on.

3 Check that the voltage between terminal B+ on the starter motor and battery negatives connection point is the same as the battery voltage.

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

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

Measurements

1 Engine off.

2 Use 9812519 Multimeter to do a voltage measurement over the battery. The nominal voltage over a full loaded battery is approx. 25.4 V.

3 Engine on. Run at 1500 rpm.

4 Use 9812519 Multimeter to do a voltage measurement over the battery and also over the alternator. The nominal charging voltage over the battery should be approx. 27.8-28.6 V.

Checking the charging system

Tools:
9812519 Multimeter

Fault tracing charging system

Battery check

1 Check that all connectors at the battery are correctly assembled.

2 Check the condition of the cables to the battery.Look for oxidation.

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 are correctly assembled.

3 Check the condition of all cables in the charging system.

4 Regulator fault. Replace regulator.

when undercharge

1 Check the alternator belt tension.

2 Check that all connectors at the alternator and at the battery are correctly assembled.

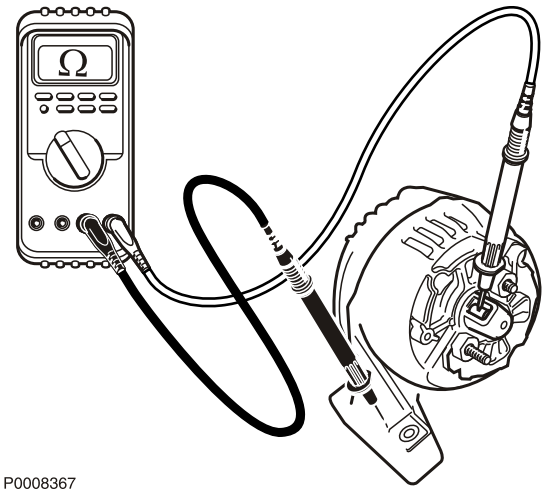
3 Check the condition of all cables in the charging system.

4 Regulator fault. Replace regulator.

when overcharge

1 Probably regulator fault. Replace regulator.

Alternator fault tracing



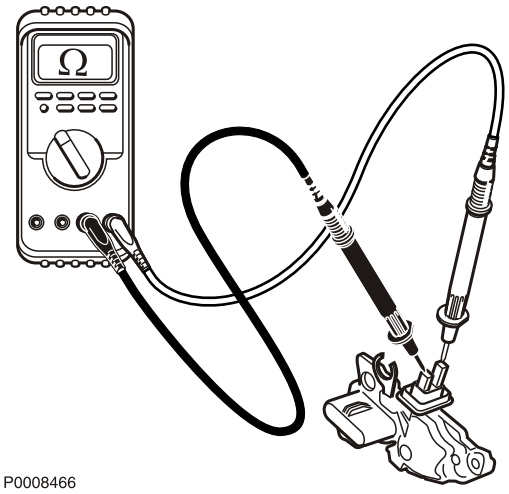
P0008367

Checking the brushes and the regulator

- **NOTICE!** Cut the current with the main switch.
- Remove all connectors on the alternator. B+, B-, etc.
- Remove the plastic cover over the diodes. The plastic cover is fixed with two nuts on B1+, B2+, and a pozidrive screw.
- Remove the three screws that holds the brushes and the regulator.

Checking the brushes

- Measure the length of the brushes between the brush mating surface and the brush holder. If any brush is damaged the brushes should be replaced.



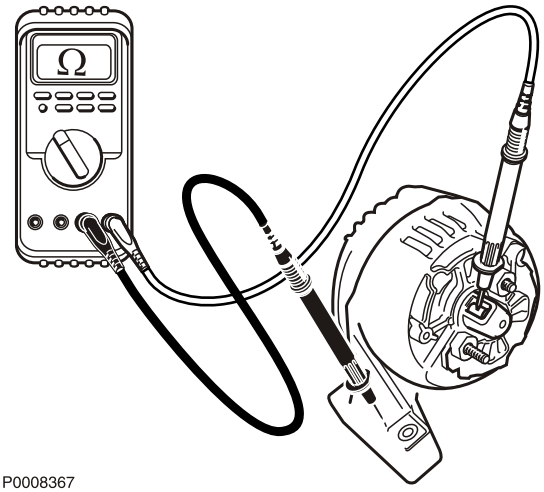
P0008466

Checking the regulator

- Set 9812519 Multimeter to diode measurement.
- Connect the probes between the brushes. Check that there is no short circuit.
- Switch the probe points and check that there is no short circuit.
- **NOTICE!** If a regulator fault is suspected install a new regulator and test operate the charge system.

Checking the rotor

- Set 9812519 Multimeter to diode measurement.
- Connect one probe to each slip ring. The multimeter should show low resistance but not 0 ohm (short circuit) or infinity (open circuit).
- Check that the slip rings do not have any burn marks or other damage.



P0008367

Short circuit test the rotor

1 Set the 9812519 Multimeter to diode measurement.

2 Connect the probes between one of the slip rings and the stator body. The multimeter should indicate OL otherwise the rotor has a short circuit.

Manual fault tracing in bus cables

Tools:
9812519 Multimeter

IMPORTANT!

Cut the current with the main switch before the cables are disconnected.

Use the multimeter to check the bus cables. The conductors in the bus cables should not be in contact with each other.

Disconnect a bus cable at each end and measure the resistance between the pins to check this. The multimeter should show infinite resistance between each pin. If the resistance is less than infinite, there is a fault.

Measuring the engine cables

Two types of measurements are done on the engine cable harness, both resistance measurement and voltage measurement.

The measurements are done to ensure that no open circuits or short circuits occur.

If there is an open circuit, the resistance is infinite, and if there is a short circuit, it is close to zero. The resistance values given in the workshop manual are approximate, and should be regarded as guidelines.

NOTICE! When resistance measurement is done, the engine should be stopped and system voltage should be cut off with the main switch.
All resistance measurement is done at +20 °C (68 °F) and with a cold engine.

Malfunctions

Fault code information

- **MID** (“Message Identification Description”):
  The MID consists of a number which designates the control unit that sent the fault code message. (e.g. the engine control unit).
- **PID** (“Parameter Identification Description”):
  The PID consists of a number that designates a parameter (value) to which the fault code relates (oil pressure, for example).
- **PPID** (“Proprietary PID”):
  The same as the PID, but this is a Volvo-specific parameter.
- **SID** (“Subsystem Identification Description”):
  The SID consists of a number that designates a component to which the fault code relates (tachometer, for example).
- **PSID** (“Proprietary SID”):
  The same as the SID, but this is a Volvo-specific component.
- **FMI** (“Failure Mode Identifier”):
  FMI indicates the type of fault (please refer to the FMI table below).
- **SPN**
  Suspect Parameter Number

FMI table

SAE standard

FMI	Display text	SAE text
0	“Value too high”	Data valid but above normal operational range.
1	“Value too low”	Data valid but below operational range.
2	“Faulty data”	Data erratic, intermittent, or incorrect
3	“Electrical fault”	Voltage above normal or shorted high.
4	“Electrical fault”	Voltage below normal or shorted to lower voltage.
5	“Electrical fault”	Current below normal or open circuit.
6	“Electrical fault”	Current above normal or short circuit to battery negative
7	“Mechanical fault”	Mechanical system not responding properly
8	“Mechanical or electrical fault”	Abnormal frequency, pulse width, or period
9	“Communication fault”	Abnormal update rate
10	“Mechanical or electrical fault”	Abnormally large variations
11	“Unknown fault”	Unidentifiable error.
12	“Component fault”	Faulty device or component
13	“Faulty calibration”	Calibration value out of range.
14	“Unknown fault”	Special instructions
15	“Unknown fault”	Reserved for future use

SAE standard

FMI	Help
2	Short circuit to battery voltage, injector high voltage side
3	Short circuit to battery voltage, injector low voltage side
4	Short circuit to battery negative, injector low voltage or high voltage side
9	Open circuit in injector circuit.

General advice

NOTICE! The following must be done before fault tracing continues, to avoid changing functional sensors:

If there is an active / inactive fault code

Remove the connector from the sensor. Check that there is no oxidation and that the connector pins are not damaged.
If there is a fault, please refer to the instructions in *Fault tracing of cables and connectors page 40*.

NOTICE! Some fault codes become inactive when the engine is stopped. Start the engine to check whether the fault code is still inactive with the engine running.

After an action with the connector

Put the connector back. Check if the fault code becomes inactive.
Check faults that could be related to that specific sensor.

If the fault remains, measure the cables and sensors to check them, as instructed.

Network

The system has two types of communication buses.

CAN

A data link (CAN bus) links the nodes to each other. CAN (“Controller Area Network”) is an industrial standard for distributed systems.

The CAN bus consists of a pair of copper conductors which are twisted 30 times per meter. The nodes communicate via the CAN bus and they form a network together, which exchanges information and benefits from each other’s services.

The CAN bus is a serial bus and is the primary control bus.

J1587

The communication bus, J1587, is also used for accessories and for diagnostics.

This is a serial bus in accordance with standard SAE J1708.

30-2 Fault Tracing

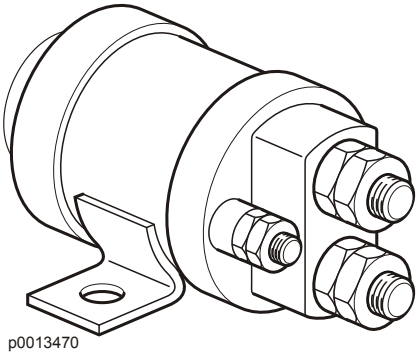
Fault Codes

MID 128, PID 45 Inlet air heater status

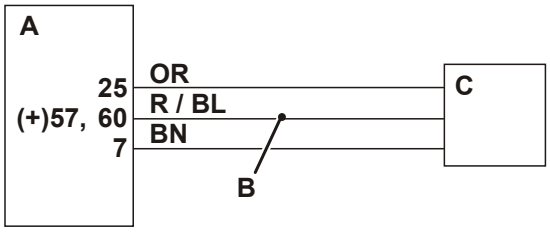
FMI 3 – Voltage above normal or shorted high	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 5.4 Value fault: None
Symptom:	Preheat relay never activated. White smoke for cold start.Start problems in cold climate.
Conditions for fault code:	The voltage on pin B25 or on pin B7 on the EMS2 deviates from normal voltage value.
Possible reason:	Short circuit to battery voltage in cable harness between EMS2 and preheat relay.
Suitable action:	1 Check all connections on the preheat relay and all cables between EMS2 and preheat relay.

FMI 4 – Voltage below normal or shorted to lower voltage	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 5.4 Value fault: None
Symptom:	Induction air is hot. Preheat relay is impossible to turn off. Preheat fuse will break.
Conditions for fault code:	The voltage on pin B25 or on pin B7 on the EMS2 deviates from normal voltage value.
Possible reason:	Short circuit to battery negative in cable harness between EMS2 and preheat relay.
Suitable action:	1 Check all connections on the preheat relay and all cables between EMS2 and preheat relay.

FMI 5 – Current below normal or open circuit	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 5.4 Value fault: None
Symptom:	Preheat relay never activated. White smoke for cold start.Start problems in cold climate.
Conditions for fault code:	The current through pin B25 or through pin B7 on the EMS2 deviates from normal current value.
Possible reason:	Open circuit in cable harness between EMS2 and preheat relay.
Suitable action:	1 Check all connections on the preheat relay and all cables between EMS2 and preheat relay. 2 Check the contact pressure in socket 25 and in socket 7 in the engine connector B.



p0013470



p0013471

A Connector B

B Junction point

C Preheat relay

Cable description

In cold climate the intake air might need too be preheated. This is done by the preheater located on the intake manifold. The activation of the preheater is controlled by the EMS2 via the preheat relay. EMS2 pin B25 activates the preheat relay. A sense wire is connected between the preheater relay output and B7. The sense wire checks that the preheat element and the preheat fuse are not damaged.

Measurements

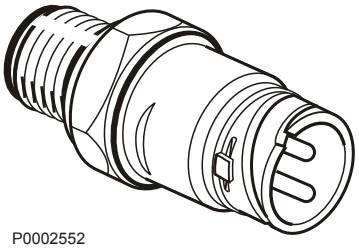
Checking the wiring page 125

MID 128, PID 94 Fuel Delivery Pressure

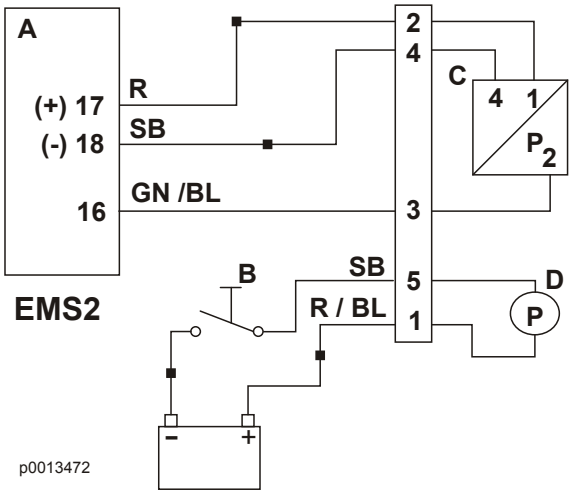
FMI 1 – Data valid but below operational range	
Fault code explanation:	Fuel pressure is too low.
Fault indication:	DCU: Engine warning in DCU display CIU: Flash code **Flash code** Electrical fault: 3.6 Value fault: 3.8
Symptom:	None.
Conditions for fault code:	The fuel pressure alarm depends on the engine revolution.
Suitable action:	1 Check the fuel level. 2 Open all fuel cocks and check that no leakage occurs. 3 Change all fuel filters. (pre- and fine filter) 4 Check that no fuel hose is squeezed or folded. 5 Check the fuel sensor by control measuring the fuel pressure. (see workshop manual) 6 Remove and clean the pressure release valve in the fuel feed pump.

FMI 3 – Voltage above normal or shorted high	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display CIU: Flash code **Flash code** Electrical fault: 3.6 Value fault: 3.8
Symptom:	None.
Conditions for fault code:	The voltage on pin B16 on the EMS2 is more than 4,77 Volt.
Possible reason:	• Open circuit in the sensors negative cable. • Short circuited fuel sensor signal cable to 5V voltage or to battery voltage. • Faulty sensor.
Suitable action:	1 Check the cable harness between the fuel sensor and EMS2. 2 Check the contact pressure in socket 18 in the engine connector B. 3 Check the sensor.

FMI 5 – Current below normal or open circuit	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display CIU: Flash code **Flash code** Electrical fault: 3.6 Value fault: 3.8
Symptom:	None.
Conditions for fault code:	The voltage on pin B16 on the EMS2 is less than 0.07 Volt.
Possible reason:	• Open circuit in fuel sensor 5V supply cable. • Open circuit in fuel sensor signal cable. • Short circuited sensor signal cable to battery negative. • Faulty sensor.
Suitable action:	1 Check the cable harness between the fuel sensor and EMS2. 2 Check the contact pressure in socket 16 and 17 in the engine connector B. 3 Check the sensor.



P0002552



p0013472

A Connector B

B Fuel press switch

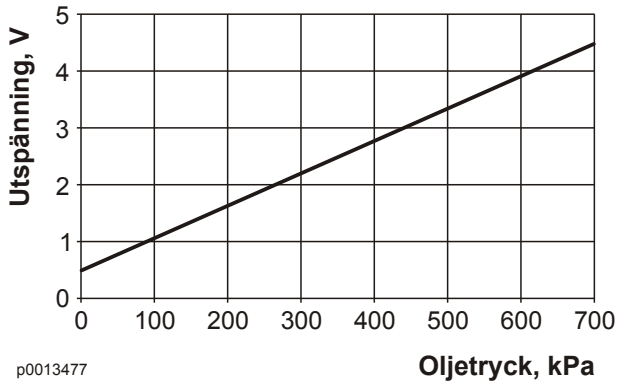
C Fuel pressure

D Fuel bleeding pump

Cable description

The sensor is an active sensor, i.e. the sensor must receive operating voltage. Pin 17 on the engine control unit (EMS2) connector B provides pin 1 on the sensor with an operating voltage of +5 Volt. Pin 4 on the sensor is connected to battery negative via pin 18 on the EMS2. The output signal from the pressure sensor, pin 2 on the sensor to pin 16 on the EMS2, is a voltage signal that is proportional to the fuel pressure. The output signal is linear within the sensors working range.

Some engines has a fuel bleeding pump. The fuel bleeding pump is used when the fuel system has to be bled.



Component specification

Working range: 0 – 7 bar = 0 – 700 kPa
Supply voltage: 5,00 +/- 0,25 VDC

Nominal output voltage at 25 °C and at supply voltage 5,00 VDC:
0,5 VDC @ 0 bar = 0 kPa
4,5 VDC @ 7 bar = 700 kPa

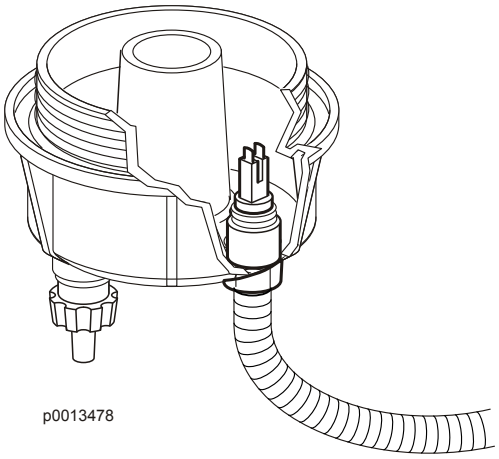
Measurements

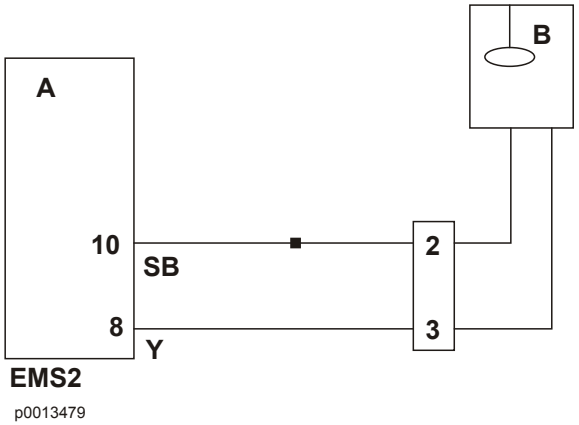
Checking supply cable, fuel sensor page 125
Checking negative cable, fuel sensor page 126
Checking the signal cable for interruption or shortcircuit page 127
Checking fuel pressure sensor page 128

MID 128, PID 97 Water in fuel indicator

FMI 0 – Data valid but above normal operational range	
Fault code explanation:	Water in fuel.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 2.9 Value fault: 2.1
Symptom:	None.
Possible reason:	• Water in the fuel trap has been detected. • Short circuit between both cables to the water in fuel switch.
Suitable action:	1 Empty the water trap. 2 Check the water in fuel switch. 3 Check the cable harness between water in fuel switch and EMS2.

FMI 3 – Voltage above normal or shorted high	
Fault code explanation:	Faulty monitor / Faulty monitor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 2.9 Value fault: 2.1
Symptom:	None.
Conditions for fault code:	The voltage potential on B8 is too high.
Possible reason:	The cable connected to B8 is short-circuited to battery voltage.
Suitable action:	1 Check the cable harness between water in fuel switch and EMS2.





A Connector B

B Water in fuel

Cable description

A sensor is located in the water trap under the fuel filter. Its task is to detect whether there is water in the fuel. The EMS 2 senses the voltage drop between the pins B10 and B8. The pins are in contact with the fuel. When there is no water in the fuel, the voltage is 0,8 x battery voltage. If there is any water in the fuel, voltage will drop.

The sensor is connected via pin B10 on the engine control unit to battery negative.

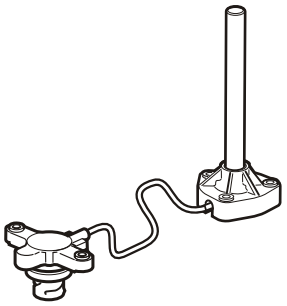
Measurements

Checking supply cable, water in fuel switch page 129
Checking negative cable, water in fuel switch page 130
Checking water in fuel switch page 130

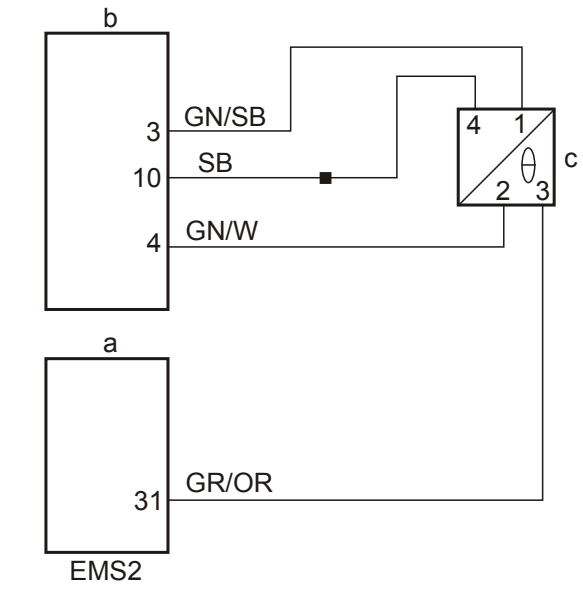
MID 128, PID 98 Engine oil level

FMI 1 – Data valid but below operational range	
Fault code explanation:	Oil level too low.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 5.9 Value fault: 5.7
Symptom:	Warning indication.
Suitable action:	1 Check the oil level in the engine. 2 Check that no oil leakage occurs. 3 Check the oil level sensor.

FMI 5 – Current below normal or open circuit	
Fault code explanation:	Faulty sensor / Fault in sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 5.9 Value fault: 5.7
Possible reason:	• Open circuit in the oil level sensor 5V supply cable. • Faulty sensor.
Suitable action:	1 Check the cable harness between the sensor and the EMS2. 2 Check the contact pressure in socket 3 and 4 in the engine connector B. 3 Check the sensor.



P0007203



a Connector A

b Connector B

c Oil temperature and level

Cable description

The oil temperature and the oil level sensor is a combined sensor. The oil level sensor, pin1, is fed a current pulse of approx. 250mA during approx. 600ms and the voltage output will be sampled three times during this time. To obtain the oil level the oil temperature has to be used as a reference due to that the oil level output voltage will alter depending on the oil temperature.

Measurements

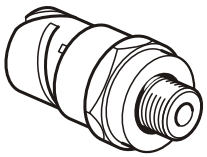
Checking oil level sensor page 131

MID 128, PID 100 Engine oil pressure

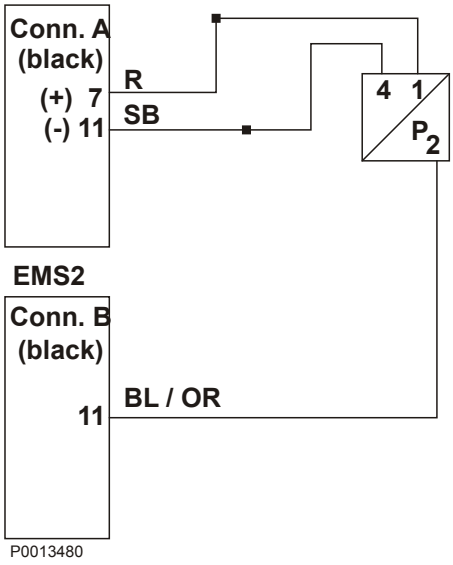
FMI 1 – Data valid but below operational range	
Fault code explanation:	Oil pressure is too low.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 3.1 Value fault: 6.6
Symptom:	Power is reduced due to error torque map if the engine protection parameter is activated.
Conditions for fault code:	Oil pressure depends on the engine revolution. Oil pressure exceeds the set value of the engine protection parameter.
Possible reason:	• Too low engine oil level. • Blocked oil filter. • Oil leakage. • Faulty oil pressure sensor.
Suitable action:	1 Check the engine oil level and the quality of the oil. 2 Change engine oil and oil filter to prevent blocked oil filter. 3 Check that no engine oil leakage occurs. 4 Check the sensor by control measuring the engine

FMI 3 – Voltage above normal or shorted high	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 3.1 Value fault: 6.6
Conditions for fault code:	The voltage on pin B11 on the EMS2 is more than 4,77 Volt.
Possible reason:	• Open circuit in the sensors negative cable. • Short circuit between signal cable and 5V supply to oil pressure sensor. • Faulty sensor.
Suitable action:	1 Check the cable harness between the oil pressure sensor and EMS2. 2 Check the contact pressure in socket 11 in the engine connector B. 3 Check the sensor.

FMI 5 – Current below normal or open circuit	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 3.1 Value fault: 6.6
Conditions for fault code:	The voltage on pin B11 on the EMS2 is less than 0.07 Volt.
Possible reason:	• Open circuit in 5V supply cable to oil pressure sensor. • Open circuit in signal cable to oil pressure sensor. • Short circuit between signal cable and battery negative to oil pressure sensor. • Short circuit between the sensor 5V supply cable and the sensor negative cable. • Faulty sensor.
Suitable action:	1 Check the cable harness between the oil pressure sensor and EMS2. 2 Check the contact pressure in socket 7 and 11 in the engine connector A and in socket 11 in engine connector B. 3 Check the sensor.



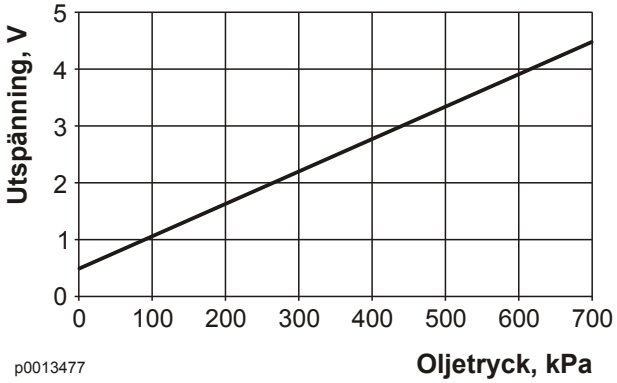
p0001348



a Connector A

b Connector B

c Oil pressure



Cable description

The sensor which measures the oil pressure is an active sensor, i.e. it must have operating voltage.

The engine control unit, connector A, pin 7, supplies the sensor, pin 1 with +5 Volt. The sensor, pin 4, is connected to battery negative via the engine control unit, connector A, pin 11.

The output signal from the pressure sensor, pin 2, to the engine control unit, connector B, pin 11, is a voltage signal which is proportional to the oil pressure (after the oil filters). The output signal is linear within the sensors working range.

Component specification

Working range: 0 – 7 bar = 0 – 700 kPa.
Supply voltage: 5,00 +/- 0,25 VDC.

Nominal output voltage at 25 °C and at supply voltage 5,00 VDC:
0,5 VDC ≈ 0 bar = 0 kPa
4,5 VDC ≈ 7 bar = 700 kPa

Measurements

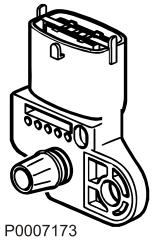
Checking supply cable, oil pressure sensor page 132
Checking negative cable, oil pressure sensor page 132
Checking signal cable, oil pressure sensor page 133
Checking oil pressure sensor page 133

MID 128, PID 105 Intake manifold temperature

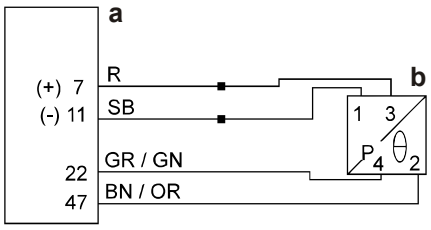
FMI 0 – Data valid but above normal operational range	
Fault code explanation:	Inlet manifold temperature is too high
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 3.2 Value fault: 6.2
Symptom:	Engine is derated if the engine protection parameter is activated.
Conditions for fault code:	Inlet manifold temperature exceeds the set value of the engine protection parameter.
Possible reason:	• Engine temperature is too high. • High surrounding temperature. (Faulty air inlet temperature sensor, only on TAD1250-1252VE and TAD1350-1352GE). • Dust or dirt on the outside of the intercooler and the radiator. • Faulty inlet manifold temperature sensor.
Suitable action:	1 Check that the engine temperature is normal. 2 Check the air inlet temperature sensor, only on TAD1250-1252VE and TAD1350-1352GE. 3 Clean the intercooler and the radiator. 4 Check the inlet manifold temperature sensor.

FMI 4 – Voltage below normal or shorted to lower voltage	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 3.2 Value fault: 6.2
Conditions for fault code:	The voltage on pin A47 on the EMS2 is less than 0.07 Volt.
Possible reason:	• Short circuited sensor signal cable to battery negative. • Faulty sensor.
Suitable action:	1 Check the cable harness between the inlet manifold temperature sensor and EMS2. 2 Check the sensor.

FMI 5 – Current below normal or open circuit	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 3.2 Value fault: 6.2
Conditions for fault code:	The voltage on pin A47 on the EMS2 is more than 4,95 Volt.
Possible reason:	• Open circuit in inlet manifold temperature signal cable. • Faulty sensor.
Suitable action:	1 Check the cable harness between the inlet manifold temperature sensor and EMS2. 2 Check the contact pressure in socket 47 in engine connector A. 3 Check the sensor.



P0007173



P0007209

a Connector A

b Intake manifold temperature

Cable description

The inlet manifold temperature sensor consists of a thermistor which forms a closed circuit with an internal resistor in the engine control unit (EMS2). The thermistor resistor changes in a non-linear manner, depending on the inlet manifold temperature. The EMS2 provides the circuit with a reference voltage of +5 Volt. The EMS2 measures the voltage drop over the thermistor via pin 47 and pin 11 on the EMS2. Pin 1 on the sensor is connected to battery negative via pin 11 on the EMS2. When the inlet manifold air is cold, the thermistor resistance is high and the EMS2 senses a high voltage drop. As the inlet manifold air 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.

Measurements

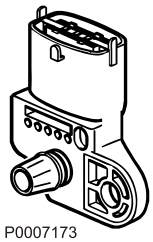
Checking signal cable voltage, inlet manifold (pressure/)temperature sensor page 134
Checking negative cable, inlet manifold pressure/temperature sensor page 135
Checking the sensor cable for open circuit or shortcircuit page 136
Checking inlet manifold temperature sensor page 137

MID 128, PID 106 Air inlet pressure

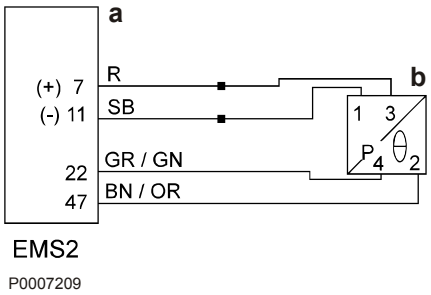
FMI 0 – Data valid but above normal operational range	
Fault code explanation:	Air inlet pressure is too high.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 3.4 Value fault: 3.5
Symptom:	Power is reduced due to error torque map if the engine protection parameter is activated.
Conditions for fault code:	Air inlet pressure exceeds the set value of the engine protection parameter.
Possible reason:	• The wastegate does not function properly. • Faulty air inlet pressure sensor. • Wrong turbo compressor unit according to the engine specification.
Suitable action:	1 Check the wastegate functionality. (see workshop manual Group 21-26) 2 Check the air inlet pressure sensor by control measuring the air inlet pressure using a measuring tap (see workshop manual Group 21-26) 3 Check that the turbo compressor unit is in according the engine specification.

FMI 3 – Voltage above normal or shorted high	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 3.4 Value fault: 3.5
Symptom:	Engine smokes more than normally during acceleration or load increase.
Conditions for fault code:	The voltage on pin A22 on the EMS2 is more than 4,77 Volt.
Possible reason:	• Open circuit in the sensors negative cable. • Short circuited sensor signal cable to 5V voltage or battery voltage. • Faulty sensor.
Suitable action:	1 Check the cable harness between the air inlet pressure sensor and EMS2. 2 Check the contact pressure in socket 11 in engine connector A. 3 Check the sensor.

FMI 5 – Current below normal or open circuit	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 3.4 Value fault: 3.5
Symptom:	Engine smokes more than normally during acceleration or load increase.
Conditions for fault code:	The voltage on pin A22 on the EMS2 is less than 0.07 Volt.
Possible reason:	• Open circuit in air inlet pressure signal cable. • Open circuit in 5V supply cable to sensor. • Short circuited air inlet pressure signal cable to sensor negative cable. • Faulty sensor.
Suitable action:	1 Check the cable harness between the boost pressure sensor and EMS2. 2 Check the contact pressure in socket 7 and 22 in engine connector A. 3 Check the sensor.



P0007173



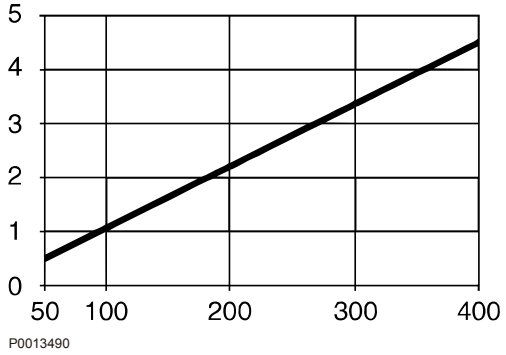
P0007209

a Connector A

b Intake manifold temperature

Cable description

The sensor is an active sensor, i.e. the sensor must receive operating voltage. The air inlet pessure sensor measures the absolute pressure, which is the sum of the air inlet pressure and atmospheric pressure (300 kPa thus corresponds to a boost pressure of 200 kPa when atmospheric pressure is 100 kPa).
Pin 7 on the engine control unit (EMS2) connector A provides pin 3 on the sensor with an operating voltage of +5 Volt. Pin 1 on the sensor is connected to battery negative via pin 11 on the EMS2. The output signal from the pressure sensor, pin 4 on the sensor to pin 22 on the EMS2, is a voltage signal that is proportional to the air inlet pressure. The output signal is linear within the sensors working range.



Component specification

Working range 0,5 – 4,0 bar = 50 – 400 kPa
Supply voltage: 5,00 +/- 0,25 VDC

Nominal output voltage at 25 °C and at supply voltage 5,00 VDC:
0,5 VDC ≈ 0,5 bar = 50 kPa
4,5 VDC ≈ 4 bar = 400 kPa

Measurements

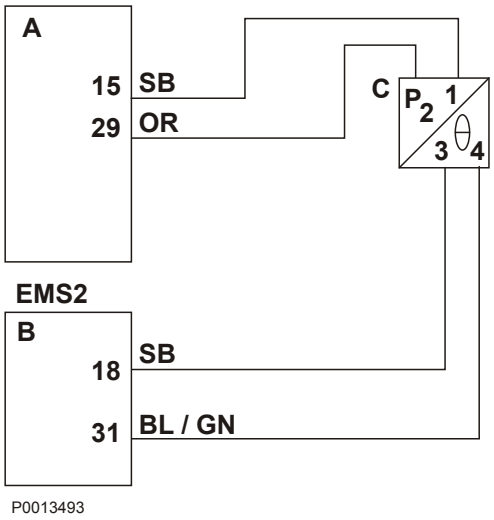
Checking supply cable, inlet manifold pressure sensor page 138
Checking negative cable, inlet manifold pressure/temperature sensor page 135
Checking signal cable, inlet manifold pressure sensor page 138
Checking air inlet pressure sensor page 139

MID 128, PID 107 Air filter pressure drop

FMI 1 – Data valid but below operational range	
Fault code explanation:	Air pressure is too low.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 5.5 Value fault: 5.6
Symptom:	None.
Possible reason:	Blocked air filter.
Suitable action:	1 Change the air filter.

FMI 3 – Voltage above normal or shorted high	
Fault code explanation:	Faulty monitor / Faulty monitor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 5.5 Value fault: 5.6
Symptom:	None.
Conditions for fault code:	The voltage on pin A29 on the EMS2 is too high.
Possible reason:	• Short circuit between the air pressure switch signal cable and battery voltage. • Faulty switch.
Suitable action:	1 Check the cable harness between the air pressure switch and EMS2. 2 Check the switch.

FMI 5 – Current below normal or open circuit	
Fault code explanation:	Faulty monitor / Faulty monitor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 5.5 Value fault: 5.6
Symptom:	None.
Conditions for fault code:	The voltage on pin A29 on the EMS2 is less than 0.07 Volt.
Possible reason:	• Open circuit in the air pressure switch signal cable. • Short circuit between the air pressure switch signal cable and battery negative. • Short circuit between the switch supply cable and the switch negative cable. • Faulty monitor.
Suitable action:	1 Check the cable harness between the air pressure switch and EMS2. 2 Check the contact pressure in socket 15 and 29 in engine connector A. 3 Check the switch.



P0013493

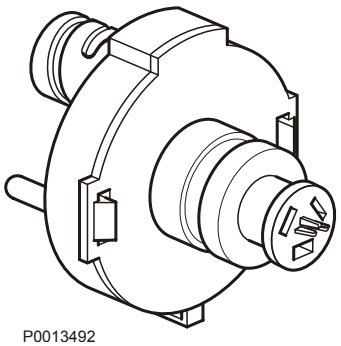
a Connector A

b Connector B

c Air filter pressure and temperature

Cable description

Air filter pressure and air filter temperature are measured by a combined switch/sensor placed above the air filter. The air filter pressure switch measures absolute pressure, the sum of air filter pressure and atmospheric pressure. The switch activates when the air pressure in the air filter becomes too low (the vacuum between the air filter and the turbo is too high). The engine control unit measures the voltage drop over the pressure switch to detect when the switch has been activated.



P0013492

Component specification

Supply voltage: max 24 VDC.
Switching point: -5kPa ±500Pa, -50±5 mbar

Measurements

Checking supply cable, air filter pressure switch page 139
Checking negative cable, air filter pressure switch page 153
Checking air pressure switch page 140

MID 128, PID 108 Barometric pressure

FMI 2 – Data erratic, intermittent, or incorrect	
Fault code explanation:	Plausibility
Fault indication:	DCU: None. CIU: None. **Flash code** Electrical fault: None. Value fault: None.
Conditions for fault code:	Internal fault in the engine control unit.
Suitable action:	1 Replace the engine control unit (EMS 2).

FMI 3 – Voltage above normal or shorted high	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: None. CIU: None. **Flash code** Electrical fault: None. Value fault: None.
Symptom:	Ambient pressure is set to 1.0 bar.
Conditions for fault code:	Internal fault in the engine control unit.
Suitable action:	1 Replace the engine control unit (EMS 2).

FMI 4 – Voltage below normal or shorted to lower voltage	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: None. CIU: None. **Flash code** Electrical fault: None. Value fault: None.
Symptom:	Ambient pressure is set to 1.0 bar.
Conditions for fault code:	Internal fault in the engine control unit.
Suitable action:	1 Replace the engine control unit (EMS 2).

Cable description

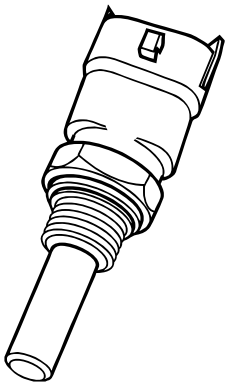
Sensor is placed inside the engine control unit.

MID 128, PID 110 Engine coolant temperature

FMI 0 – Data valid but above normal operational range	
Fault code explanation:	Coolant temperature too high.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 3.3 Value fault: 6.1
Symptom:	Engine is derated if the engine protection parameter is activated.
Conditions for fault code:	Coolant water temperature exceeds the set value of the engine protection parameter.
Possible reason:	• Coolant level too low. • Dust or dirt on the outside of the radiator. • Drive belt is not properly adjusted. • Worn impeller in the coolant pump. • There is air in the coolant water system. • Faulty thermostat. • Faulty temperature sensor. • Clogged cooling water system.
Suitable action:	1 Check the coolant level. 2 Check the outside of radiator for dust and dirt. 3 Check the drive belt adjustment. 4 Check the impeller in the coolant pump. 5 Bleed the coolant water system. 6 If low coolant level check the coolant water system for leakage by a pressure test. 7 Check the pressure valve in the coolant cup. 8 Check the coolant water thermostat or change the coolant water thermostat. 9 Check the coolant temperature sensor. 10 Clean the coolant water system.

FMI 4 – Voltage below normal or shorted to lower voltage	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 3.3 Value fault: 6.1
Conditions for fault code:	The voltage on pin B18 on the EMS2 is less than 0.07 Volt.
Possible reason:	• Short circuit between both cables to the coolant temperature sensor. • Faulty sensor.
Suitable action:	1 Check the cable harness between coolant temperature sensor and EMS2. 2 Check the sensor.

FMI 5 – Current below normal or open circuit	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 3.3 Value fault: 6.1
Conditions for fault code:	The voltage on pin B27 on the EMS2 is more than 4,95 Volt.
Possible reason:	• Open circuit in signal cable to temperature sensor. • Open circuit in negative cable to temperature sensor. • Faulty sensor.
Suitable action:	1 Check the cable harness between coolant temperature sensor and EMS2. 2 Check the contact pressure in socket 18 and 27 in the engine connector B. 3 Check the sensor.



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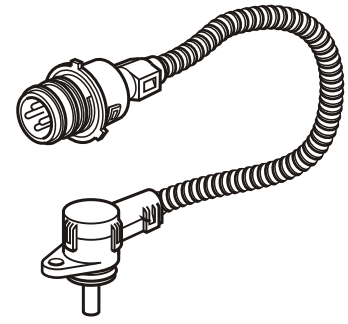
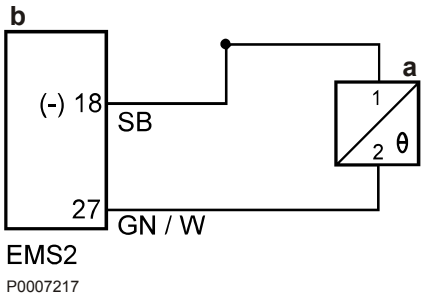
TAD950–952VE
TWD1643GE



P0002859

TAD1250–1252VE



a Coolant temperature

b Connector B

Cable description

The coolant temperature sensor consists of a thermistor which forms a closed circuit with an internal resistor in the engine control unit (EMS2). The thermistor resistor changes in a non-linear manner, depending on the coolant temperature. The EMS2 provides the circuit with a reference voltage of +5 Volt. The EMS2 measures the voltage drop over the thermistor via pin 27 and pin 18 on the EMS2. Pin 1 on the sensor is connected to battery negative via pin 18 on the EMS2. When the coolant is cold, the thermistor resistance is high and the EMS2 senses a high voltage drop. 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.

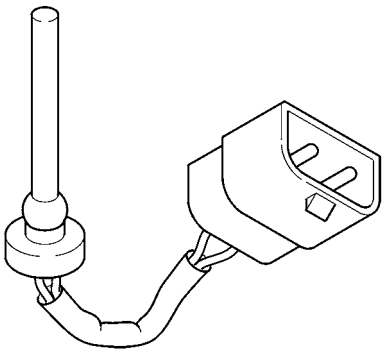
Measurements

Checking signal cable, coolant temperature switch page 155
Checking negative cable, coolant temperature switch page 156
Checking coolant temperature sensor page 141
Checking the sensor cable for open circuit or shortcircuit page 142

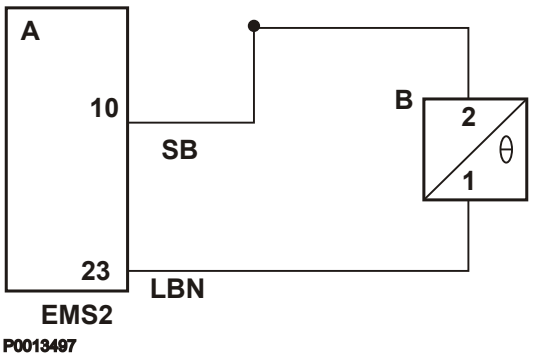
MID 128, PID 111 Coolant level

FMI 1 – Data valid but above normal operational range	
Fault code explanation:	Coolant level is too low.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 2.3 Value fault: 2.2
Symptom:	Engine is derated if the engine protection parameter is activated.
Suitable action:	1 Check the coolant level. 2 Bleed the coolant water system. 3 If low coolant level check the coolant water system for leakage by a pressure test. 4 Check the pressure valve in the coolant cup. 5 Check the wiring to the coolant level switch. 6 Check the coolant level switch.

FMI 3– Voltage above normal or shorted high	
Fault code explanation:	Faulty switch / Faulty switch circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 2.3 Value fault: 2.2
Conditions for fault code:	The voltage on pin B23 in the engine control unit is too high.
Possible reason:	Short circuit to battery voltage on pin B23.
Suitable action:	1 Check the cable harness between the coolant level switch and the EMS2.



P0004033



a Connector B

b Coolant level

Cable description

The coolant level in the engine is monitored by a level switch. Pin 23 on the engine control unit (EMS2) provides pin 1 on the level switch with supply voltage. Pin 2 on the level switch is connected to battery negative via pin 10 on the engine control unit. The level switch has two states: On/Off.
The level switch consists of two sections, the actual switch and a magnetic float which is built into the expansion tank. The switch senses the position of the magnetic float. When the coolant level falls, the float operates the switch and a closed circuit is formed.

Measurements

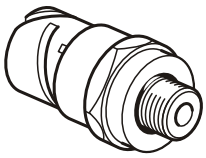
Checking supply cable, coolant level switch page 143
Checking negative cable, coolant level switch page 143
Checking coolant level switch page 144

MID 128, PID 153 Crankcase pressure

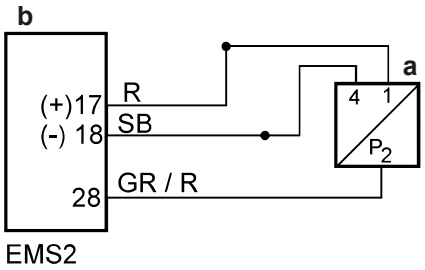
FMI 0 – Data valid but above normal operational range	
Fault code explanation:	Crankcase pressure is rising too fast.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 7.8 Value fault: 7.7
Symptom:	The engine is shut down if the engine protection parameter is activated.
Conditions for fault code:	Crankcase pressure rises too fast.
Possible reason:	• Blocked crankcase ventilation. • Faulty crankcase pressure sensor. • Worn or damaged cylinder liners, piston or piston rings.
Suitable action:	1 Check whether the crankcase ventilation is blocked. Clean the crankcase ventilation system. 2 Check all cable and connectors between the EMS2 and the crankcase pressure sensor. 3 Check the crankcase pressure sensor. 4 Control measure the crankcase pressure. 5 Check whether cylinder liner, piston or piston rings are worn or damaged.

FMI 3 – Voltage above normal or shorted high	
Fault code explanation:	Faulty sensor / Fault in sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 7.8 Value fault: 7.7
Conditions for fault code:	The voltage on pin B28 in the engine control unit exceeds 4.78 Volt.
Possible reason:	• Short circuit between sensor signal cable and 5V supply or battery voltage to crankcase pressure sensor. • Open circuit in the sensor negative cable. • Faulty sensor.
Suitable action:	1 Check the cable harness between the crankcase pressure sensor and the EMS2. 2 Check the contact pressure in socket 18 in the engine connector B. 3 Check the sensor.

FMI 5 – Current below normal or open circuit	
Fault code explanation:	Faulty sensor / Fault in sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 7.8 Value fault: 7.7
Conditions for fault code:	The voltage on pin B28 in the engine control unit is less than 0.30 Volt.
Possible reason:	• Open circuit in the sensor 5 Volt supply. • Open circuit in the sensor signal cable. • Short circuited sensor signal cable to battery negative. • Faulty sensor.
Suitable action:	1 Check the cable harness between the crankcase pressure sensor and the EMS2. 2 Check the contact pressure in socket 17 and 28 in the engine connector B. 3 Check the sensor.



p0001348



P0007226

a Crankcase pressure

b Connector B

Cable description

The sensor which measures the crankcase pressure is an active sensor, i.e. it must have operating voltage. The engine control unit, connector B, pin 17, supplies the sensor, pin 1 with +5 Volt. The sensor, pin 4, is connected to battery negative via the engine control unit, connector B, pin 18.
The output signal from the pressure sensor, pin 2, to the engine control unit, connector B, pin 28, is a voltage signal which is proportional to the crankcase pressure. It is the velocity of a rising crankcase sure that trigger the alarm. The output signal is linear within the sensors working range.

Component specification

Working range: 0.4 – 1.4 bar = 40 – 140 kPa
Supply voltage: 5.00 +/- 0.25 VDC

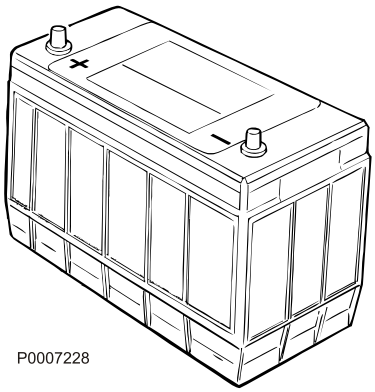
Nominal output voltage at 25 °C and at supply voltage 5.00 VDC:
0.5 VDC @ 0.4 bar = 40 kPa
4.5 VDC @ 1.4 bar = 140 kPa

Measurements

Checking negative cable, crankcase pressure sensor page 174
Checking signal cable, crankcase pressure sensor page 174
Checking supply cable, crankcase pressure sensor page 175
Checking crankcase pressure sensor page 144

MID 128, PID 158 ECU battery potential

FMI 1 – Data valid but below operational range	
Fault code explanation:	Battery voltage too low.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: None (EMS) Value fault: None (EMS) Electrical fault: None (CIU) Value fault: None (CIU)
Symptom:	Could be engine starting problems.
Conditions for fault code:	Battery voltage less than 25.5 V engine running.
Possible reason:	• Altenator belt • Flat / poor batteries • Fault in cables or connectors for battery / altenator • Faulty altenator
Suitable action:	1 Check battery cables. 2 Check / charge batteries. 3 Check altenator and drive belt.

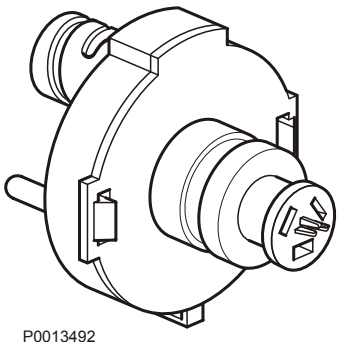


P0007228

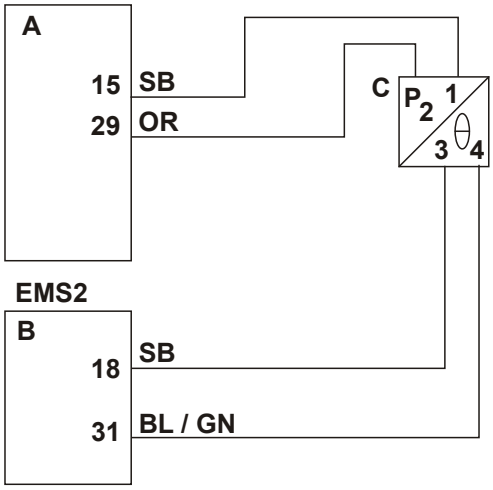
MID 128, PID 172 Inlet air temperature

FMI 4 – Voltage below normal or shorted to lower voltage	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 7.9 Value fault: None.
Symptom:	None.
Conditions for fault code:	The voltage on pin B18 on the EMS2 is less than 0.07 Volt.
Possible reason:	• Short circuit between both cables to the air filter temperature sensor. • Faulty sensor.
Suitable action:	1 Check the cable harness between air filter temperature sensor and EMS2. 2 Check the sensor.

FMI 5 – Current below normal or open circuit	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 7.9 Value fault: None.
Symptom:	None.
Conditions for fault code:	The voltage on pin B31 on the EMS2 is more than 4,95 Volt.
Possible reason:	• Open circuit in signal cable to the air filter temperature • Open circuit in negative cable to the air filter temperature sensor. • Faulty sensor.
Suitable action:	1 Check the cable harness between air filter temperature sensor and EMS2. 2 Check the contact pressure in socket 18 and 31 in the engine connector B. 3 Check the sensor.



P0013492



P0013493

a Connector A

b Connector B

c Air filter pressure and temperature

Cable description

The air filter temperature sensor consists of a thermistor which forms a closed circuit with an internal resistor in the engine control unit (EMS2). The thermistor resistor changes in a non-linear manner, depending on the air temperature. The EMS2 provides the circuit with a reference voltage of +5 Volt. The EMS2 measures the voltage drop over the thermistor via pin 18 and pin 31 on the EMS2. Pin 3 on the sensor is connected to battery negative via pin 18 on the EMS2. When the air into the filter is cold, the thermistor resistance is high and the EMS2 senses a high voltage drop. As the air into the filter 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.

Measurements

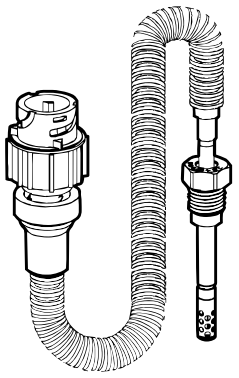
Checking signal cable, air filter temperature switch page 145
Checking negative cable, air filter temperature switch page 146
Checking the sensor cable for open circuit or shortcircuit page 147
Checking air inlet temperature sensor page 148

MID 128, PID 173 Exhaust gas temperature

FMI 0 – Data valid but above normal operational range	
Fault code explanation:	Exhaust gas temperature is too high.
Fault indication:	A red lamp flashes in the alarm panel + audible warning.
Symptom:	Engine is derated.
Conditions for fault code:	Exhaust temperature exceeds the set value of the engine protection parameter. (For parameters, see the engine protection map.)
Suitable action:	1 Check that the exhaust pipe has not been damaged and that there are no restrictions. 2 Check the sensor. 3 Check the exhaust back pressure.

FMI 4 – Voltage below normal or shorted to lower voltage	
Fault code explanation:	Faulty sensor / Fault in sensor circuit
Fault indication:	None.
Symptom:	None.
Conditions for fault code:	The voltage on pin B44 in the engine control unit is less than 0.07 Volt.
Possible reason:	• Short circuit between the sensor signal cable and the sensor negative cable. • Faulty sensor.
Suitable action:	1 Check the cable harness between the sensor and the EMS2. 2 Check the sensor.

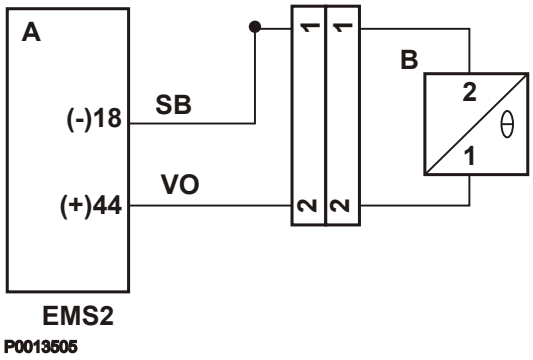
FMI 5 – Current below normal or open circuit	
Fault code explanation:	Faulty sensor / Fault in sensor circuit
Fault indication:	None.
Symptom:	None.
Conditions for fault code:	The voltage on pin B44 in the engine control unit exceeds 4.95 Volt.
Possible reason:	• Open circuit in the sensor signal cable. • Open circuit in the sensor negative cable. • Faulty sensor.
Suitable action:	1 Check the cable harness between the sensor and the EMS2. 2 Check the contact pressure in socket 18 and 44 in the engine connector B. 3 Check the sensor.



P0013504

Cable description

Exhaust temperature sensor consists of a Pt-200 sensor where the resistance changes depending on exhaust temperature. The resistance increases with rising exhaust temperature.
Pin 44 on the engine control unit (EMS2) connector B provides pin 2 on the sensor with an operating voltage of +5 Volt. Pin 1 on the sensor is connected to battery negative via pin 18 on the EMS2. The voltage drop across the sensor changes as exhaust temperature changes.



P0013505

A Connector B

B Exhaust temperature sensor

Measurements

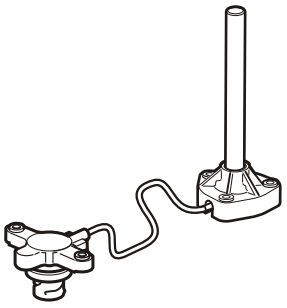
Checking signal cable, exhaust gas temperature sensor page 148
Checking negative cable, exhaust gas temperature sensor page 149
Checking exhaust gas temperature sensor page 149

MID 128, PID 175 Engine oil temperature

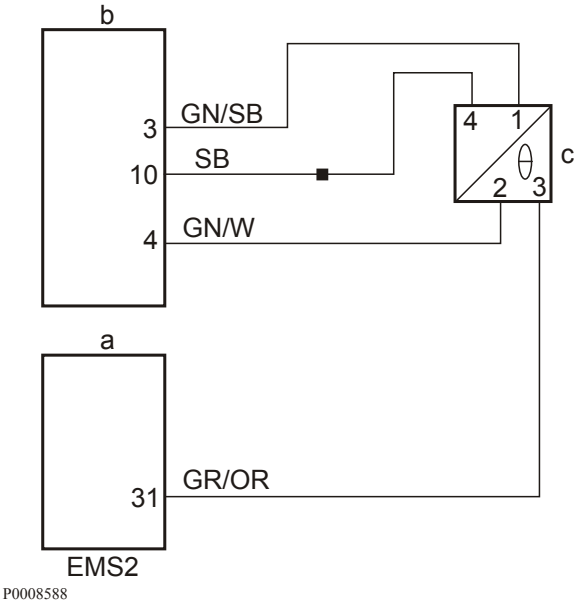
FMI 0 – Data valid but above normal operational range	
Fault code explanation:	Engine oil temperature too high.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 3.7 Value fault: 5.8
Symptom:	Power is reduced due to error torque map if the engine protection parameter is activated.
Conditions for fault code:	Engine oil temperature is too high.
Suitable action:	1 Check the oil level in the engine. 2 Check the coolant level and the engine temperature. 3 Check that no leakage occurs. 4 Check the sensor. 5 Clean the oil cooler system and check the bypass valve for the oil cooler. Please refer to more detailed instructions in the “Workshop manual group 22, Lubrication system”.

FMI 4 – Voltage below normal or shorted to lower voltage	
Fault code explanation:	Faulty sensor / Fault in sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 3.7 Value fault: 5.8
Conditions for fault code:	The voltage on pin A31 in the engine control unit is less than 0.07 Volt.
Possible reason:	• Short circuit between the oil temperature signal cable to the sensor negative cable. • Short circuit between the oil temperature signal cable and the sensor 5V supply cable. • Short circuit between oil temperature signal cable and oil level signal cable. • Fault in sensor.
Suitable action:	1 Check the cable harness between the sensor and the EMS2. 2 Check the sensor.

FMI 5 – Current below normal or open circuit	
Fault code explanation:	Faulty sensor / Fault in sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 3.7 Value fault: 5.8
Conditions for fault code:	The voltage on pin A31 in the engine control unit exceeds 4,95 Volt.
Possible reason:	• Open circuit in the oil temperature signal cable. • Open circuit in the oil temperature negative cable. • Fault in sensor.
Suitable action:	1 Check the cable harness between the sensor and the EMS2. 2 Check the contact pressure in socket 31 in the engine connector A and in socket 10 in engine connector B. 3 Check the sensor.



P0007203



P0008588

a Connector A

b Connector B

c Oil temperature and level

Cable description

The oil temperature and the oil level sensor is a combined sensor. The oil temperature sensor consists of a thermistor which forms a closed circuit with an internal resistor in the engine control unit (EMS2). The thermistor resistor changes in a non-linear manner, depending on the oil temperature. The EMS2 provides the circuit with a reference voltage of +5 Volt via pin 31 in connector A. The EMS2 measures the voltage drop over the thermistor via pin 18 and pin 31 on the EMS2. Pin 4 on the sensor is connected to battery negative via pin 18 in connector B on the EMS2. When the oil is cold, the thermistor resistance is high and the EMS2 senses a high voltage drop. As the oil 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.

Measurements

Checking negative cable, oil temperature switch page 150
Checking signal cable, oil temperature switch page 151
Checking oil temperature sensor page 152

MID 128, PID 190 Engine speed

FMI 0 – Data valid but above normal operational range	
Fault code explanation:	Engine is / was overspeeding
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: None. Value fault: 2.6
Symptom:	Engine speed limited.
Possible reason:	Too high engine speed.
Suitable action:	1 After the engine has stopped search for the reason for the high speed.

MID 128, PPID 3 Starter Output

FMI 3 – Voltage above normal or shorted high	
Fault code explanation:	Starter output failure.
Fault indication:	EMS: Flashcode **Flash code** Electrical fault: 4.6 Value fault: None.
Symptom:	The engine cannot be started. The engine starts immediately when ignition is turned on.
Preconditions:	**General check for starter motor problems** • Check the starter motor cables and the connections. • Check that the starter relay pull during the start attempt.
Possible reason:	• Short circuited ignition cable to 5V voltage or to battery voltage. • Ignition signal activated too long. • Faulty start button/key switch.
Suitable action:	1 Check that the key switch is connected correctly. 2 Check cable harness between EMS2 and the CIU key switch. 3 Check the function of the key switch. 4 Faulty start button on the DCU.

FMI 4 – Voltage below normal or shorted to lower voltage	
Fault code explanation:	Starter output failure.
Fault indication:	EMS: Flashcode **Flash code** Electrical fault: 4.6 Value fault: None.
Symptom:	The engine cannot be started. The engine starts immediately when ignition is turned on.
Preconditions:	**General check for starter motor problems** • Check the starter motor cables and the connections. • Check that the starter relay pull during the start attempt.
Conditions for fault code:	The voltage on pin B29 in the engine control unit is less than normal voltage.
Possible reason:	• Short circuited ignition cable to battery negative. • Faulty key switch.
Suitable action:	1 Check the ignition cable. 2 Check that the key switch is connected correctly. 3 Check cable harness between EMS2 and the CIU key switch. 4 Check the function of the key switch.

FMI 5 – Current below normal or open circuit	
Fault code explanation:	
Fault indication:	EMS: Flashcode **Flash code** Electrical fault: 4.6 Value fault: None.
Symptom:	The engine cannot be started. The engine starts immediately when ignition is turned on.
Preconditions:	**General check for starter motor problems** • Check the starter motor cables and the connections. • Check that the starter relay pull during the start attempt.
Conditions for fault code:	The voltage on pin B29 in the engine control unit is less than normal voltage.
Possible reason:	• Open circuit in ignition cable. • Faulty start relay.
Suitable action:	1 Check the ignition cable. 2 Check the start relay on the starter motor. 3 Check the prestart relay. (only on TAD1250-1252VE) 4 Check the contact pressure in socket 29 in the engine connector B.

Cable description

The engine control unit pin B29 senses when ignition is switched on that the start relay coil is intact. When ignition on there is battery voltage potential on pin B29. When the starter is activated the voltage potential on pin B29 drops to 0V. On the TAD950-952VE and on the TAD1350-1355GE engines there is one starter relay on the startermotor. The TAD1250-1252VE engine also has a prestart relay.

Measurements

Checking starter motor relay page 153

MID 128 / 144, PPID 4 Starter input sensor

FMI 3 – Voltage above normal or shorted high	
Fault code explanation:	Starter input failure.
Fault indication:	CIU: Flashcode **Flash code** Electrical fault: 4.7 (EMS) Value fault: None (EMS) Electrical fault: 5.2 (CIU) Value fault: None (CIU)
Symptom:	The engine cannot be started. The engine starts immediately when ignition is turned on.
Possible reason:	• Ignition signal activated too long. • Faulty key swich.
Suitable action:	1 Check that the key switch is connected correctly. 2 Check cable harness between EMS2 and the CIU key switch. 3 Check the function of the key switch.

FMI 4 – Voltage below normal or shorted to lower voltage	
Fault code explanation:	Starter input failure.
Fault indication:	CIU: Flashcode **Flash code** Electrical fault: 4.7 (EMS) Value fault: None (EMS) Electrical fault: 5.2 (CIU) Value fault: None (CIU)
Symptom:	The engine cannot be started. The engine starts immediately when ignition is turned on.
Possible reason:	• Short circuited ignition cable to battery negative. • Faulty key swich.
Suitable action:	1 Check that the key switch is connected correctly. 2 Check cable harness between EMS2 and the CIU key switch. 3 Check the function of the key switch.

MID 128, PPID 6 Key off input sensor

FMI 4 – Voltage below normal or shorted to lower voltage	
Fault code explanation:	Faulty circuit.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 4.8 (EMS) Value fault: None (EMS) Electrical fault: 5.3 (CIU) Value fault: None (CIU)
Symptom:	Engine can only be stopped using the auxiliary stop.
Conditions for fault code:	Engine can only be stopped using the auxiliary stop.
Possible reason:	Short circuit between the engine stop signal in engine connector and battery negative.
Suitable action:	1 Check the stop signal cable between the engine control unit A27 and the CIU/DCU.

Cable description

The stop input signal to the engine control unit pin A27 can have one of two signal levels, high/low. The A27 stop input on the EMS2 can be set via a parameter in Vodia to work in one of two ways.

Either the EMS2 stop input is set to “energized to run” which means that the stop input signal to the EMS2 pin A27 must be high in order for the engine to be able to run or the EMS2 stop input is set to “energized to stop” which means that the stop input signal on the EMS2 pin A27 must be high in order for the engine to stop.

In the first case the stop input signal level has to be low to shut down the engine.
In the second case the stop input signal level has to be high to shut down the engine.

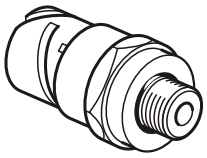
Measurements

Checking stop signal cable between ECU and CIU/DCU page 154

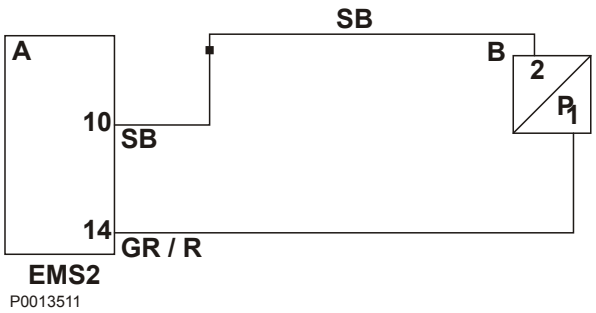
MID 128, PPID 8 Piston Cooling Oil Pressure

FMI 1 – Data valid but below operational range	
Fault code explanation:	Piston cooling oil pressure is too low.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 6.8 Value fault: 6.7
Symptom:	Engine is derated. The fault code is deactivated at engine speed below 1000 rpm.
Conditions for fault code:	Piston cooling pressure is too low.
Suitable action:	1 Re-check the piston cooling pressure. If measurement shows that the piston cooling pressure is correct, change the piston cooling pressure switch.

FMI 3 – Voltage above normal or shorted high	
Fault code explanation:	Faulty sensor / Fault in sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 6.8 Value fault: 6.7
Conditions for fault code:	The voltage on pin B14 in the engine control unit exceeds normal voltage value.
Possible reason:	Short circuited piston cooling signal cable to battery voltage.
Suitable action:	1 Check cable harness between EMS2 and the piston cooling switch.



p0001348



A Connector B

B Piston cooling pressure

Cable description

A valve is installed in the oil filter bracket which opens or closes the oil supply for piston cooling, depending on oil pressure. If the oil pressure is below 250 kPa (TAD950-952VE) or 300 kPa (TAD1250-1252VE), the valve closes the oil supply for piston cooling.

The piston cooling pressure is monitored by a pressure switch. The output signal from the pressure switch, pin 1 to the engine control unit, can only have two distinct positions, on/off. The switch is supplied with current from the engine control unit pin 10. A pre-set pressure limit of 150 kPa determines when it switches on. The switch opens if the pressure exceeds this value.

At idle, the switch can be closed without a fault code being set.

Component specification

Switching point: 150kPa = 1.5bar
Supply voltage: 12-24 VDC

Measurements

Checking negative cable, piston cooling oil temperature switch page 156
Checking supply cable, piston cooling oil temperature switch page 157

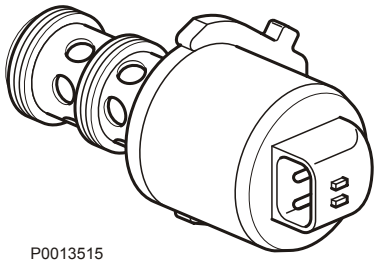
MID 128, PPID 19 Internal EGR Status

FMI 3 – Voltage above normal or shorted high	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 8.5 Value fault: None.
Symptom:	IEGR can not be turned on. If the IEGR function would fail (not being activated) the result will be an increased exhaust production with high NOX and possible over speeding of the turbocharger.
Conditions for fault code:	The voltage on pin B30 on the EMS2 deviates from normal voltage value.
Possible reason:	Short circuited IEGR signal cable to 5V voltage or to battery voltage.
Suitable action:	1 Check cable harness between EMS2 and the IEGR.

FMI 4 – Voltage below normal or shorted to lower voltage	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 8.5 Value fault: None.
Symptom:	IEGR can not be turned on. If the IEGR function would fail (not being activated) the result will be an increased exhaust production with high NOX and possible over speeding of the turbocharger.
Conditions for fault code:	The voltage on pin B30 on the EMS2 deviates from normal voltage value.
Possible reason:	Short circuited IEGR signal cable to battery negative.
Suitable action:	1 Check cable harness between EMS2 and the IEGR.

FMI 5 – Current below normal or open circuit	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 8.5 Value fault: None.
Symptom:	IEGR can not be turned on. If the IEGR function would fail (not being activated) the result will be an increased exhaust production with high NOX and possible over speeding of the turbocharger.
Possible reason:	Open circuit in one or both of the cables to the IEGR.
Suitable action:	1 Check cable harness between EMS2 and the IEGR. 2 Check the contact pressure in socket 30, 57 and 60 in the engine connector B. 3 Check the IEGR coil.

FMI 7 – Mechanical system not responding properly	
Fault code explanation:	Mechanical fault.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 8.5 Value fault: None.
Symptom:	IEGR can not be turned on. If the IEGR function would fail (not being activated) the result will be an increased exhaust production with high NOX and possible over speeding of the turbocharger.
Possible reason:	• IEGR solenoid mechanically stucked. • Too low oil pressure to activate the IEGR.
Suitable action:	1 Check the function of the IEGR solenoid. 2 Check the engine oil pressure.



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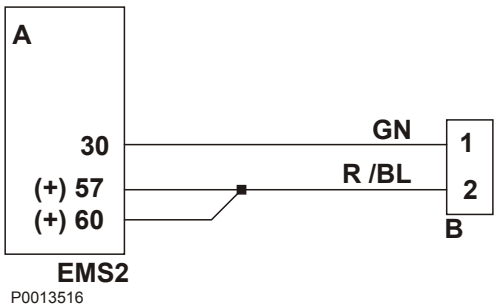


a Connector B

b IEGR

Cable description

Internal exhaust gas recirculation, IEGR, is like the name says used for recirculation of exhaust gases. This for lowering the emissions from the engine. The IEGR control valve, is located on the cylinder head under the valve cover. It is used to regulate the oil pressure to the rocker arm shaft and from there to the IEGR double rocker. The IEGR valve is a 2-way solenoid valve controlled by the engine control unit. When the IEGR not activated an oil pressure on one side of the solenoid and the solenoid spring force on the other side of the solenoid keeps the solenoid in balance. When the IEGR function is activated the solenoid changes position and the oil pressure to the rocker arm shaft increases. The solenoid is activated when pin 30 in connector B changes its potential.

Measurements

Checking IEGR wiring page 163
Checking the IEGR coil page 157
Checking IEGR solenoid page 158

MID 128, PPID 55 ECU temperature

FMI 0 – Data valid but above normal operational range	
Fault code explanation:	ECU temperature is too high.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 8.4 Value fault: None.
Symptom:	None.
Conditions for fault code:	The temperature inside the engine control unit is too high.
Possible reason:	• High surrounding temperature. • Fault in sensor.
Suitable action:	1 Check if the surrounding temperature is high or if the EMS 2 unit is exposed to heat radiation. 2 Change EMS 2 unit.

FMI 4 – Voltage below normal or short circuit to lower voltage	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 8.4 Value fault: None.
Symptom:	None.
Possible reason:	Fault in sensor circuit.
Suitable action:	1 Change EMS 2 unit.

FMI 5 – Current below normal or open circuit	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 8.4 Value fault: None.
Symptom:	None.
Possible reason:	Fault in sensor circuit.
Suitable action:	1 Change EMS 2 unit.

Cable description

The temperature sensor is installed inside of the EMS 2 unit.

MID 128, PPID 98 Engine sync acknowledge

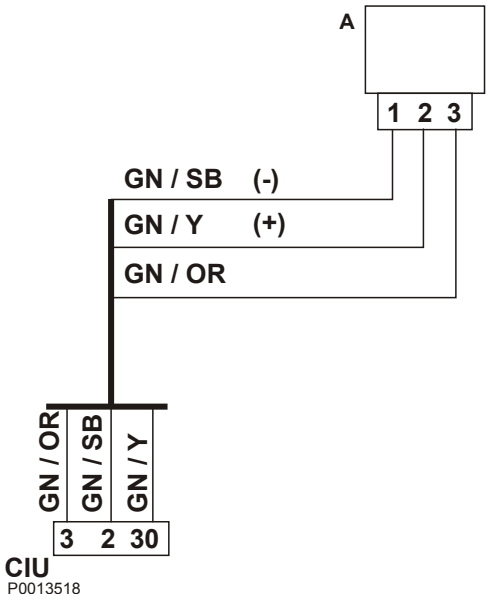
FMI 9 – Abnormal update rate	
Fault code explanation:	Communication fault.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: None. Value fault: None.
Preconditions:	**NOTICE!** If the control panel ONLY communicates on the J1939 communication and NOT the redundancy of J1587 for start, stop and throttle this fault code is active in the VODIA and that is normal.
Conditions for fault code:	“Time-out” on the J1587 bus.
Possible reason:	• Fault in the communication with the DCU/CIU. • No DCU/CIU found. • Open circuit in the power supply cable between the engine control unit and the DCU/CIU. • Faulty DCU/CIU.
Suitable action:	1 Check the communication cables to the DCU/CIU. 2 Check the power supply cable between the engine control unit and the DCU/CIU. 3 Check that the DCU/CIU is programmed for the correct engine type.

MID 128 / 144, PPID 132 Throttle calibrated position

FMI 3 – Voltage above normal or shorted high	
Fault code explanation:	Faulty throttle potentiometer / Faulty throttle potentiometer circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 2.8 Value fault: None.
Symptom:	Engine goes to idle. If the accelerator is released at first and then pressed down again the engine can be forced to run using the idle contact.
Preconditions:	**NOTICE!** If the control panel ONLY communicates on the J1939 communication and NOT the redundancy of J1587 for start, stop and throttle this fault code is active in the VODIA and that is normal.
Possible reason:	• Open circuit in any or all of the throttle signals. • Short circuited throttle potentiometer signal cable to 5V voltage or to battery voltage. • Faulty sensor.
Suitable action:	1 Check that the throttle potentiometer is connected correctly. 2 Check cable harness between CIU and the CIU throttle potentiometer. 3 Check the function of the throttle potentiometer. Check the contact pressure in socket 2, 3 and 3 in the CIU connector.

FMI 4 – Voltage below normal or shorted to lower voltage	
Fault code explanation:	Faulty throttle potentiometer / Faulty throttle potentiometer circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 2.8 Value fault: None.
Symptom:	Engine goes to idle. If the accelerator is released at first and then pressed down again the engine can be forced to run using the idle contact.
Preconditions:	**NOTICE!** If the control panel ONLY communicates on the J1939 communication and NOT the redundancy of J1587 for start, stop and throttle this fault code is active in the VODIA and that is normal.
Possible reason:	• Short circuited throttle potentiometer signal cable to battery negative. • Faulty sensor.
Suitable action:	1 Check that the throttle potentiometer is connected correctly. 2 Check cable harness between CIU and the CIU throttle potentiometer. 3 Check the function of the throttle potentiometer.

FMI 9 – Abnormal update rate	
Fault code explanation:	EMS2 is missing the throttle signal.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 2.8 Value fault: None.
Symptom:	Engine goes to idle. If the accelerator is released at first and then pressed down again the engine can be forced to run using the idle contact.
Preconditions:	**NOTICE!** If the control panel ONLY communicates on the J1939 communication and NOT the redundancy of J1587 for start, stop and throttle this fault code is active in the VODIA and that is normal.
Conditions for fault code:	EMS2 recieves no throttle signal on the J1939 bus from the CIU.
Suitable action:	1 Check that the throttle potentiometer is connected correctly. 2 Check cable harness between CIU and the CIU throttle potentiometer. 3 Check the function of the throttle potentiometer.



A Throttle pot.

Cable description

Measurements

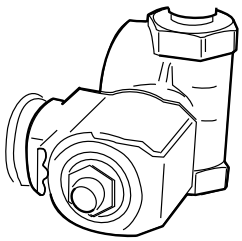
Vodia logging throttle signal page 175

MID 128, PPID 332 Thermostat

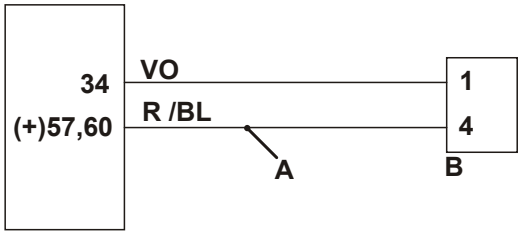
FMI 3 – Voltage above normal or shorted high	
Fault code explanation:	Faulty sensor / Faulty circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: None. **Flash code** Electrical fault: None. Value fault: None.
Conditions for fault code:	The voltage on pin B34 on the EMS2 deviates from normal voltage value.
Possible reason:	• Short circuited coldstart valve signal cable to 5V voltage or to battery voltage. • Faulty coldstart valve.
Suitable action:	1 Check all cable and connectors between EMS2 and coldstart valve. 2 Check coldstart valve.

FMI 4 – Voltage below normal or shorted to lower voltage	
Fault code explanation:	Faulty sensor / Faulty circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: None. **Flash code** Electrical fault: None. Value fault: None.
Conditions for fault code:	The voltage on pin B34 on the EMS2 deviates from normal voltage value.
Possible reason:	• Short circuited coldstart valve signal cable to battery negative or to lower voltage. • Faulty coldstart valve.
Suitable action:	1 Check all cable and connectors between EMS2 and coldstart valve. 2 Check coldstart valve.

FMI 5 – Current below normal or open circuit	
Fault code explanation:	Faulty sensor / Faulty circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: None. **Flash code** Electrical fault: None. Value fault: None.
Conditions for fault code:	The voltage on pin B34 on the EMS2 deviates from normal voltage value.
Possible reason:	• Open circuit in coldstart valve signal cable. • Open circuit in coldstart valve battery voltage cable. • Faulty coldstart valve.
Suitable action:	1 Check all cable and connectors between EMS2 and coldstart valve. 2 Check contact pressure in socket 34 engine connector B. 3 Check coldstart valve.



P0013519



P0013520

A Junction point

B Cold start valve

Cable description

In order to avoid boiling in the charge air coolers at different loads and coolant temperatures, the system is fitted with a cold start valve that is controlled by the EMS2. The cold start valve is normally open i.e. without voltage supply the valve is open. The cold start valve is supplied with battery voltage at pin 4. Pin 1 is connected to pin B34 at the EMS2. When the cold start valve is activated(valve closes) pin B34 alter its voltage potential from battery voltage to approx. 0.2 Volt.
If the intake manifold temperature signal or the coolant temperature signal is lost the cold start valve opens.

Under normal conditions, the cold start valve is opened at:
intake manifold temperature>50° AND coolant water temperature<86°.

Under normal conditions, the cold start valve is closed at:
intake manifold temperature<45° OR coolant water temperature>92°.

Measurements

Checking supply cable, coldstart valve page 159
Checking negative cable, coldstart valve page 160

MID 128, SID 1/2/3/4/5/6 Injector # 1-6

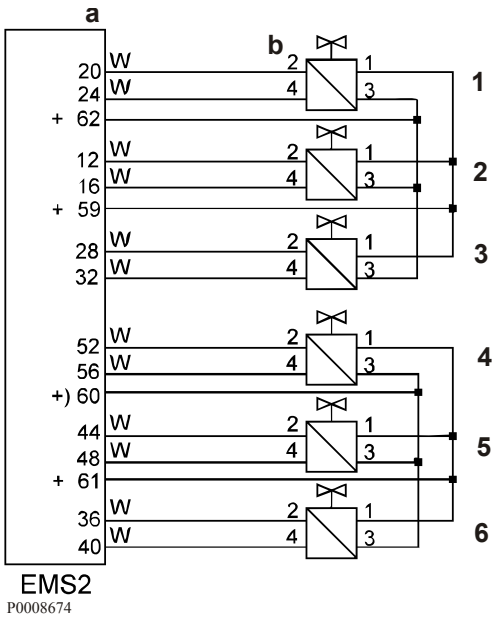
FMI 3 – Voltage above normal or shorted high (Short to battery voltage, injector low voltag side)	
Fault code explanation:	Fault in the injection system.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 7.1–7.6 Value fault: None.
Symptom:	Faulty unit injector is shut off, engine runs on 5 cylinders. Limp home on rest of unit injectors. Engine performance is reduced. Abnormal sound.
Preconditions:	**NOTICE!** Identify which injector by the SID number.
Conditions for fault code:	Injector activated and faulty voltage in injector low side.
Possible reason:	• Short circuit to battery voltage on the pin on the respective injector's low voltage side. (EMS2 pin: 36, 40, 44, 48, 52, 56 and 12, 16, 20, 24, 28, 32) • Short circuit between high voltage and low voltage sides. • Short circuit to battery voltage in low voltage injector wire.
Suitable action:	1 Check the cable harness between injectors and engine control unit (EMS2).

FMI 4 – Voltage below normal or shorted to lower voltage (Short to battery negative, injector high voltage side)	
Fault code explanation:	Fault in the injection system.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 7.1–7.6 Value fault: None.
Symptom:	Faulty unit injector is shut off, engine runs on 5 cylinders. Limp home on rest of unit injectors. Engine performance is reduced. Abnormal sound.
Preconditions:	**NOTICE!** Identify which injector by the SID number.
Conditions for fault code:	Injector activated and faulty voltage in injector high side.
Possible reason:	• Short circuit to battery negative on the pin on the respective injector's high voltage side. (EMS2 pin: 59, 60, 61 and 62) • Short circuit to battery negative in high voltage injector wire.
Suitable action:	1 Check the cable harness between injectors and engine control unit (EMS2).

FMI 5 – Current below normal or open circuit **(Break in injector circuit.)**	
Fault code explanation:	Fault in the injection system.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 7.1–7.6 Value fault: None.
Symptom:	Faulty unit injector is shut off, engine runs on 5 cylinders. Limp home on rest of unit injectors. Engine performance is reduced. Abnormal sound.
Preconditions:	**NOTICE!** Identify which injector by the SID number.
Conditions for fault code:	Injector activated and faulty voltage in injector high or low side.
Possible reason:	• Open circuit in low voltage wiring side or high voltage wiring side. If three injection fault codes are set there is an Open circuit on the high side. If one injection fault code is set there is an Open circuit on the low side. • Short circuit to battery voltage on the pin on the respective injector's high voltage side. (EMS2 pin: 59, 60, 61 and 62) • Short circuit to battery negative on the pin on the respective injector's low voltage side. (EMS2 pin: 36, 40, 44, 48, 52, 56 and 12, 16, 20, 24, 28, 32)
Suitable action:	1 Check the cable harness between injectors and engine control unit (EMS2). 2 Check the contact pressure in all sockets regarding the unit injectors in engine connector A.

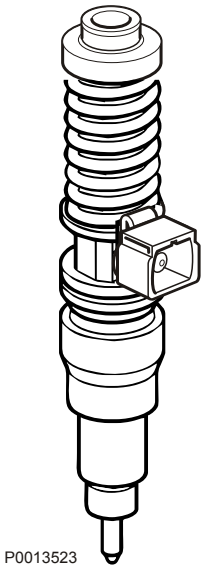
FMI 7 – Mechanical system not responding properly	
Fault code explanation:	Fault in the injection system.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 7.1–7.6 Value fault: None.
Symptom:	Faulty unit injector is shut off, engine runs on 5 cylinders. Limp home on rest of unit injectors. Engine performance is reduced. Abnormal sound.
Preconditions:	**NOTICE!** Identify which injector by the SID number.
Conditions for fault code:	Injector activated and cylinder balancing above limit. If a fault code is set when the engine has an unsymmetrical load it can not be rectified. At idle speed the engine control unit is trying to compensate for uneven running by adding more or less fuel to the injectors, cylinder balancing. If the engine load is too unsymmetrical the compensation is not enough and a fault code will be set.
Possible reason:	• Unsymmetrical load of the engine. • Poor / uneven compression. • Faulty injector.
Suitable action:	1 Clear the fault code with the Vodia tool. Let the engine run at idle speed without any load and see if the faultcode reappear. 2 Perform test of cylinder compression using the VODIA tool. 3 Change only the faulty injector.

FMI 12 – Faulty device or component **(Low unit injector hold current)**	
Fault code explanation:	Fault in the injection system.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 7.1–7.6 Value fault: None.
Symptom:	Faulty unit injector is shut off, engine runs on 5 cylinders. Limp home on rest of unit injectors. Engine performance is reduced. Abnormal sound.
Preconditions:	**NOTICE!** Identify which injector by the SID number.
Conditions for fault code:	Low injector hold current. Injector activated.
Possible reason:	Intermittent fault.
Suitable action:	1 Check the cables between the injector and the engine control unit. 2 Check the contact pressure in all sockets regarding the unit injectors in engine connector A. 3 Check the cable connection to the injector.



a Connector A

b Cylinder



Cable description

The Delphi E3 electronic unit injectors used on the tier3 engines have two electronically controlled solenoids. Each solenoid is individual controlled by the engine control unit.
The unit injectors receive voltage from pin 59, 60, 61 or 62 on the engine control unit. To activate a unit injector solenoid the engine control unit connects the unit injectors low side to battery negative.

Measurements

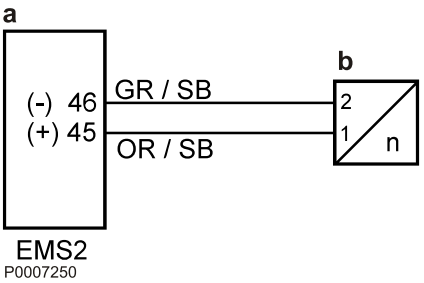
Trimming the injector page 161
Checking the injector wiring page 162

MID 128, SID 21 Engine position

FMI 2 – Data erratic, intermittent, or incorrect	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 2.5 Value fault: None.
Symptom:	The engine start time will increase, uses only crankshaft sensor.
Conditions for fault code:	Incorrect timing.
Possible reason:	• Polarity fault. The cables to the cam speed sensor is shifted. • Intermittent fault. • Incorrectly mounted cam speed sensor.
Suitable action:	1 Check the cable harness between the cam speed sensor and EMS2. 2 Check that the cam speed sensor is connected as in the circuit description. 3 Check the cam speed sensor.

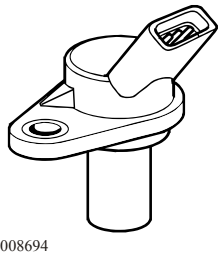
FMI 3 – Voltage above normal or shorted high **(No signal)**	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 2.5 Value fault: None.
Symptom:	The engine start time will increase, uses only crankshaft sensor.
Conditions for fault code:	No camsignal when expected.
Possible reason:	• Incorrectly mounted cam speed sensor. • Open circuit in any or both of the cables to the crank speed sensor. • Short circuit between the cables to the cam speed sensor. • Faulty cam speed sensor.
Suitable action:	1 Check the installation of the cam speed sensor. 2 Check the cable harness between the cam speed sensor and EMS2. 3 Check the cam speed sensor. 4 Check the contact pressure in socket 45 and 46 in engine connector A.

FMI 8 – Abnormal frequency, pulse width, or period	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 2.5 Value fault: None.
Symptom:	The engine start time will increase, uses only crankshaft sensor.
Conditions for fault code:	Incorrect sensor signal.
Possible reason:	• Incorrectly mounted cam speed sensor. • Electrical interference in the cam speed signal.
Suitable action:	1 Check wiring between cam spped sensor and EMS2. 2 Check the installation of the cam speed sensor. 3 Attempt to localize the source of interference. 4 Check and clean the cam speed sensor. 5 Check the contact pressure in socket 45 and 46 in engine connector A.

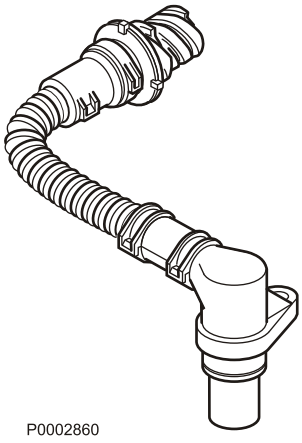


a Connector A

b Engine speed sensor, camshaft



TAD950–952VE
TAD1350–1352GE



TAD1250–1252VE

Cable description

The camshaft sensor is an inductive sensor. The camshaft sensor is used in the first instance to determine the cylinder which is next in line for injection. A toothed wheel installed on the camshaft is used to determine the cylinder which is next in line for injection. The toothed wheel has 7 teeth, one for each cylinder plus an extra tooth for cylinder 1. When the camshaft with toothed wheel rotates, impulses are generated in the sensor. The impulses generated by in the sensor is used by the engine control unit to determine the cylinder which is next in line for injection.

Measurements

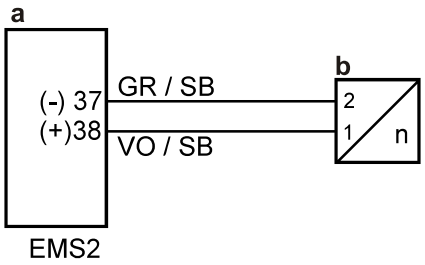
Checking camshaft sensor wiring page 164
Checking camshaft sensor page 165

MID 128, SID 22 Timing sensor, crank

FMI 2 – Data erratic, intermittent, or incorrect	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 2.4 Value fault: None.
Symptom:	Engine is difficult to start, uses only cam sensor.
Conditions for fault code:	Incorrect signal.
Possible reason:	• Short circuit between the cables to the flywheel sensor. • Polarity fault. The cables to the flywheel sensor is shifted.
Suitable action:	1 Check the cable harness between the flywheel sensor and EMS2. 2 Check that the flywheel sensor is connected as in the circuit description. 3 Check the flywheel sensor.

FMI 3 – Voltage above normal or shorted high **(No signal)**	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 2.4 Value fault: None.
Symptom:	Engine is running with imprecise timing causing risk of high fuel consumption and smoke. Cylinder balancing not working with risk of uneven running.
Conditions for fault code:	No cranksignal when expected or permanent loss of sensor signal.
Possible reason:	• Open circuit in any or both of the cables to the flywheel sensor. • Incorrectly mounted flywheel sensor. • Faulty flywheel sensor.
Suitable action:	1 Check the cable harness between the flywheel sensor and EMS2. 2 Check the installation of the flywheel sensor. 3 Check the flywheel sensor. 4 Check the contact pressure in socket 37 and 38 in engine connector A.

FMI 8 – Abnormal frequency, pulse width, or period	
Fault code explanation:	Faulty sensor / Faulty sensor circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 2.4 Value fault: None.
Symptom:	Engine is difficult to start, uses only cam sensor.
Conditions for fault code:	Incorrect flywheel sensor signal.
Possible reason:	• Incorrectly mounted flywheel sensor. • Electrical interference in the flywheel signal.
Suitable action:	1 Check wiring between flywheel sensor and EMS2. 2 Check the installation of the flywheel sensor. 3 Attempt to localize the source of interference. 4 Check and clean the flywheel sensor. 5 Check the contact pressure in socket 37 and 38 in engine connector A.



P0007252

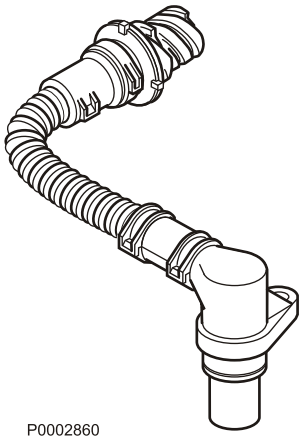
a Connector A

b Engine speed sensor, crankshaft


P0008694

TAD950-952VE
TAD1350-1352GE

TWD 1643GE


P0002860

TAD1250-1252VE

Cable description

The flywheel sensor is an inductive sensor. The flywheel sensor is used to monitor engine speed. It is also used to measure the cylinder acceleration. The flywheel has three times eighteen depressions for one rotation. These depressions are detected by the flywheel sensor and generate a pulsed signal which the engine control unit uses to detect flywheel rotation speed. Two cylinders share one sector of the depressions (cylinders 1 and 6, 2 and 5, 3 and 4) on the flywheel. This means that it is not possible to know which cylinder.

Measurements

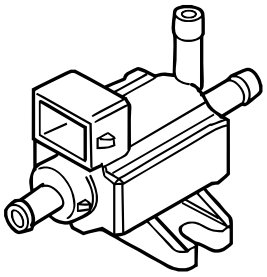
Checking flywheel sensor wiring page 166
Checking flywheel sensor page 167

MID 128, SID 32, Wastegate output driver

FMI 3 – Voltage above normal or shorted high	
Fault code explanation:	Faulty regulator / Faulty regulator circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: None. **Flash code** Electrical fault: None. Value fault: None.
Conditions for fault code:	The voltage on pin B38 on the EMS2 deviates from normal voltage value.
Possible reason:	• Short circuited wastegate regulator signal cable to 5V voltage or to battery voltage. • Faulty wastegate regulator.
Suitable action:	1 Check all cable and connectors between EMS2 and wastegate regulator. 2 Change wastegate regulator.

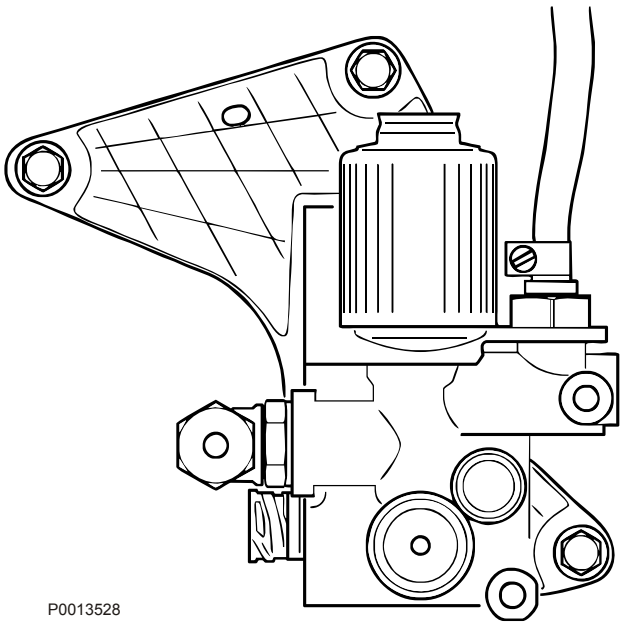
FMI 4 – Voltage below normal or shorted to lower voltage	
Fault code explanation:	Faulty regulator / Faulty regulator circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: None. **Flash code** Electrical fault: None. Value fault: None.
Conditions for fault code:	The voltage on pin B38 on the EMS2 deviates from normal voltage value.
Possible reason:	• Open circuit in wastegate battery voltage supply cable. • Short circuited wastegate regulator signal cable to battery negative or to lower voltage. • Faulty wastegate regulator.
Suitable action:	1 Check all cable and connectors between EMS2 and wastegate regulator. 2 Change wastegate regulator.

FMI 5 – Current below normal or open circuit	
Fault code explanation:	Faulty regulator / Faulty regulator circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: None. **Flash code** Electrical fault: None. Value fault: None.
Conditions for fault code:	The voltage on pin B38 on the EMS2 deviates from normal voltage value.
Possible reason:	• Open circuit in wastegate regulator signal cable. • Open circuit in wastegate regulator battery negative cable. • Faulty wastegate regulator.
Suitable action:	1 Check all cable and connectors between EMS2 and wastegate regulator. 2 Check contact pressure in socket 38 engine connector B. 3 Change wastegate regulator.



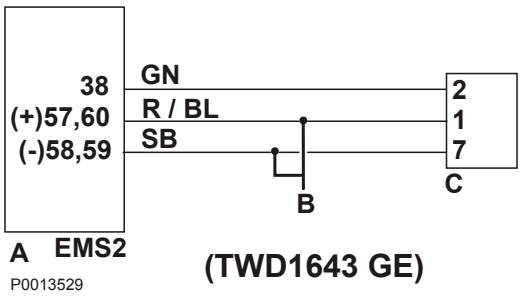
P0007171

TAD1350-52 GE



P0013528

TWD1643 GE

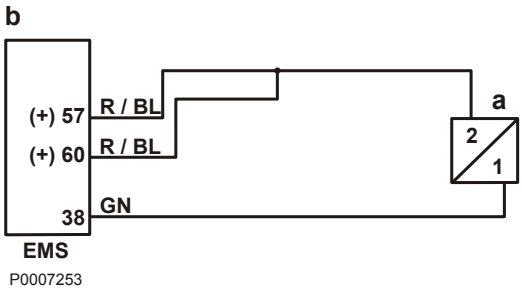


A Connector B

B Junction points

C Wastegate

TWD1643 GE



a Wastegate

b Connector B

TAD1350-52 GE

Cable description

The engine is equipped with a turbocharger with a wastegate valve. The wastegate valve controls the amount of exhaust gas flow which should pass through the exhaust turbine. An electronically controlled regulation valve, wastegate regulator, which is controlled by the engine control unit controls the air pressure supplied to the wastegate valve. Air pressure taken from the inlet manifold is used to control the amount that the wastegate opens. As the air pressure supplied by the control valve to the wastegate valve increases, the valve opens wider. When the wastegate valve is fully open, the exhaust gas flow to the exhaust turbine is at its lowest.

The control valve is current controlled by the engine control valve, using a PWM signal. As the current supplied to the control valve increases, the boost air pressure increases. The boost air pressure is constantly monitored by a sensor installed in the inlet manifold.

Measurements

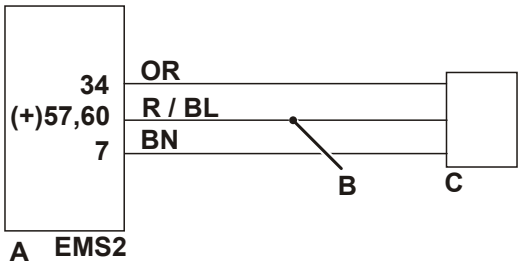
Checking negative cable, wastegate valve page 168
Checking supply cable, wastegate valve page 169
Checking the wastegate valve page 170

MID 128, SID 70 Air inlet heater driver #1

FMI 3 – Voltage above normal or shorted high	
Fault code explanation:	Faulty relay / Faulty relay circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: None. **Flash code** Electrical fault: None. Value fault: None.
Symptom:	Fuse for shorting wire breaks.
Possible reason:	• Short circuit to battery voltage in sense wire. • Heating element broken.
Suitable action:	1 Check all cable and connections to heating element. 2 Check function of preheat relay. 3 Check heating element.

FMI 4 – Voltage below normal or shorted to lower voltage	
Fault code explanation:	Faulty relay / Faulty relay circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: None. **Flash code** Electrical fault: None. Value fault: None.
Symptom:	Start problems in cold climate.
Possible reason:	Short circuit to battery negative in sense wire.
Suitable action:	1 Check function of preheat relay. 2 Check all cable and connections to heating element.

FMI 5 – Current below normal or open circuit	
Fault code explanation:	Faulty relay / Faulty relay circuit
Fault indication:	DCU: Engine warning in DCU display. CIU: None. **Flash code** Electrical fault: None. Value fault: None.
Symptom:	Might get start problems in cold climate.
Possible reason:	• Preheater fuse broken. • An open circuit in sense wiring. • Heating element broken.
Suitable action:	1 Check preheater fuse. 2 Check contact pressure in socket 7 in engine connector B. 3 Check all cable and connections to heating element. 4 Check heating element.



P0013533

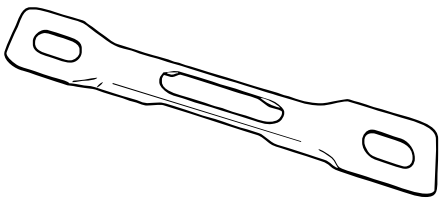
A Connector B

B Junction point

C Preheat relay

Cable description

In cold climate the intake air might need too be pre-heated. This is done by the preheater located on the intake manifold. A sense wire is connected between the preheater relay output and B7. The sense wire checks that the preheat element and the preheat fuse are not damaged. The activation of the preheater is controlled by the EMS2 via the preheat relay. EMS2 pin B25 activates the preheat relay.


P0013532

Preheater fuse is located between preheat relay and heating element.

Measurements

Checking preheater relay page 171

MID 128, SID 211 Sensor Supply Voltage #2 (+5V DC)

FMI 3 – Voltage above normal or shorted high	
Fault code explanation:	Fault in circuit.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 9.3 Value fault: None.
Symptom:	None.
Conditions for fault code:	Abnormally high voltage or short circuit to higher voltage on pin B17.
Possible reason:	Short circuit to battery voltage.
Suitable action:	1 Check the supply voltage to the sensors which have set fault codes. 2 Check sensor cables. 3 Check the sensors.

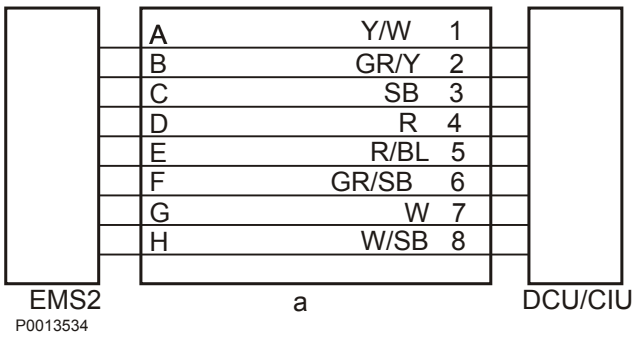
FMI 4 – Voltage below normal or shorted to lower voltage	
Fault code explanation:	Fault in circuit.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 9.3 Value fault: None.
Symptom:	None.
Conditions for fault code:	Abnormally low voltage or short circuit to battery negative has on pin B17.
Possible reason:	• Short circuit sensor supply voltage cable to battery negative, fuel pressure sensor. • Short circuit sensor supply voltage cable to battery negative, crankcase sensor.
Suitable action:	1 Check the supply voltage to the above-mentioned sensors. 2 Check sensor cables. 3 Check the sensors.

Cable description

Pin B17 on the EMS2 distributes 5 Volt supply voltage to the crankcase pressure sensor and the fuel pressure sensor.

MID 128 / 144, SID 231 SAE J1939 data link

FMI 2 – Data erratic, intermittent, or incorrect	
Fault code explanation:	Communication fault J 1939
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 6.5 (EMS) Value fault: None (EMS) Electrical fault: 6.4 (CIU) Value fault: None (CIU)
Symptom:	Engine can not be started or if engine is running it can only be stopped by pushing the aux-stop. Instruments and warning lamps stop working.
Conditions for fault code:	CAN communication is missing.
Possible reason:	• CAN H and CAN L short circuited to eachother. • CAN H or CAN L short circuited to battery negative on pin 3. • CAN L short circuited to power supply on pin 4. • CAN H or CAN L short circuited to any of the J1708 links.
Suitable action:	1 Check all data links between DCU/CIU and EMS2. 2 Check the contact pressure in socket 51 and 55 in the engine connector B. 3 Check that the socket 11 and 12 in the CIU connector is undamaged.



a Engine connector

Cable description

A CAN H – Engine connector

B CAN L – Engine connector

C Power supply, 0 V

D Power supply, input

E Ignition

F Stop

G J1708A – Engine connector

H J1708B – Engine connector

Measurements

Checking CAN bus cable page 171

MID 128, SID 232 5 V supply

FMI 3 – Voltage above normal or shorted high	
Fault code explanation:	Fault in circuit.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 9.3 Value fault: None.
Symptom:	None.
Conditions for fault code:	Abnormally high voltage or short circuit to higher voltage on pin A7.
Possible reason:	Short circuit to battery voltage.
Suitable action:	1 Check the supply voltage to the sensors which have set fault codes. 2 Check sensor cables. 3 Check the sensors.

FMI 4 – Voltage below normal or shorted to lower voltage	
Fault code explanation:	Fault in circuit.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 9.3 Value fault: None.
Symptom:	None.
Conditions for fault code:	Abnormally low voltage or short circuit to battery negative on pin A7.
Possible reason:	• Short circuit sensor supply voltage cable to battery negative, oil pressure sensor. • Short circuit sensor supply voltage cable to battery negative, air inlet pressure sensor.
Suitable action:	1 Check the supply voltage to the above-mentioned sensors. 2 Check sensor cables. 3 Check the sensors.

Cable description

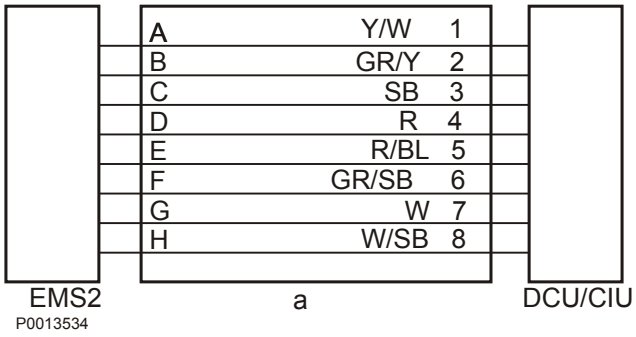
Pin A7 on the EMS2 distributes 5 Volt supply voltage to the oil pressure sensor and the air inlet pressure sensor.

MID 128, SID 240 Program memory

FMI 2 – Data erratic, intermittent, or incorrect **FMI 7 – Mechanical system not responding properly** **FMI 11 – Unidentifiable error** **FMI 14 – Special instructions**	
Fault code explanation:	Communication fault.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 9.9 Value fault: None.
Symptom:	Engine might not start.
Conditions for fault code:	Signal value is irregular, intermittent or incorrect. Data communication interrupted.
Possible reason:	Memory fault in the EMS2.
Suitable action:	1 Reprogram the EMS2. 2 Change the EMS2.

MID 128, SID 250 SAE J1708/J1587 data link

FMI 12 – Faulty device or component	
Fault code explanation:	Communication fault J1587/J1708
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 9.2 Value fault: None.
Symptom:	None.
Conditions for fault code:	Faulty data link.
Suitable action:	1 Check all data links between DCU/CIU and EMS2. 2 Check the contact pressure in socket 33 and 34 in engine connector A. 3 Check that the socket 22 and 37 in the CIU connector is undamaged.



a Engine connector

Cable description

A CAN H – Data Link to Engine

B CAN L – Data Link to Engine

C Power supply, 0 V

D Power supply, input

E Ignition

F Stop

G J1708A – Data Link to Engine

H J1708B – Data Link to Engine

MID 128 / 144, SID 253 Calibration memory EEPROM

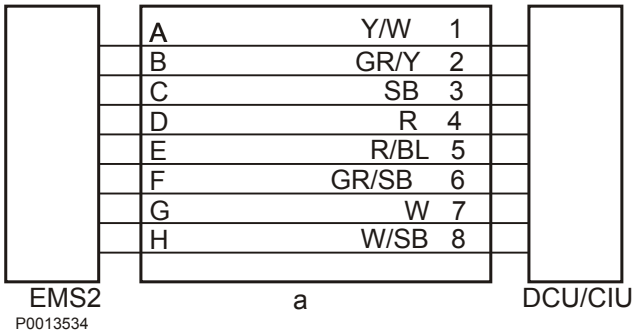
FMI 2 – Data erratic, intermittent, or incorrect **FMI 12 – Faulty device or component** **FMI 14 – Special instructions**	
Fault code explanation:	Communication fault.
Fault indication:	DCU: Engine warning in DCU display. CIU: Flash code **Flash code** Electrical fault: 9.9 (EMS) Value fault: None (EMS) Electrical fault: 9.8 (CIU) Value fault: None (CIU)
Symptom:	Engine does not start.
Possible reason:	• Internal fault in control unit. • Program fault.
Suitable action:	1 Reprogram the unit which set the faultcode. 2 Change the unit which set the faultcode.

MID 128 / 144, SID 254 Controller 1

FMI 3 – Voltage above normal or shorted high **FMI 8 – Abnormal frequency, pulse width, or period** **FMI 12 – Faulty device or component**	
Fault code explanation:	Communication fault.
Fault indication:	CIU: Flash code **Flash code** Electrical fault: 9.9 (EMS) Value fault: None (EMS) Electrical fault: 9.8 (CIU) Value fault: None (CIU)
Possible reason:	• If faultcode MID 144, SID 254, FMI 11 appears the CIU throttle positive and negative supply wire could be short circuited to eachother. • Faulty EEPROM, CIU. • Faulty flash memory, CIU. • Fault in control unit, CIU.
Suitable action:	1 Check for short circuit in the supply cables to the CIU throttle potentiometer. 2 Reprogram the unit which set the faultcode.

MID 128, PSID 201 Data link, MID144

FMI 9– Abnormal update rate	
Fault code explanation:	Communication error.
Fault indication:	DCU: Engine warning in DCU display. CIU: None. **Flash code** Electrical fault: None. Value fault: None.
Symptom:	None.
Conditions for fault code:	No communication with the engine control unit.
Possible reason:	• An open circuit in CAN H or CAN L or both CAN links between EMS 2 and DCU/CIU. • An open circuit in Power supply 0V cable between EMS 2 and DCU/CIU. • An open circuit in Power supply input cable between EMS 2 and DCU/CIU. • CAN H short circuited to power supply in pin 4.
Suitable action:	1 Check contact pressure in socket 51 and 55 in engine connector B. 2 Check for an open circuit or short circuit between cables in the cable harness between the DCU/CIU and EMS 2, via the engine connector.



a A27 Engine connector

Cable description

A CAN H – Data Link to Engine

B CAN L – Data Link to Engine

C Power supply negative

D Power supply positive

E Ignition

F Stop

G J1708A – Data Link to Engine

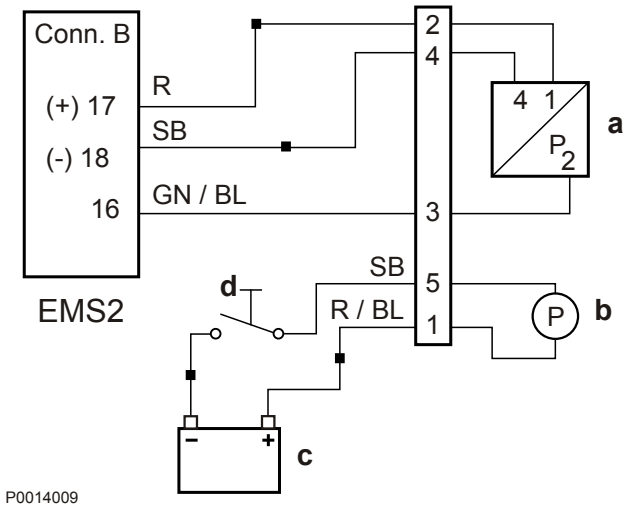
H J1708B – Data Link to Engine

Measurements

Checking the CAN bus cable page 173

No fault code

Fuel bleeding pump (only TAD950–952VE)	
Symptom:	Fuel bleeding pump doesn't start when the fuel press switch is activated.
Possible reason:	• Open circuit in any of the cables to the pump motor. • Faulty fuel press switch. • Faulty pump motor.
Suitable action:	1 Check the cables to the pump motor. 2 Check the fuel press switch. 3 Try another pump motor.



a Fuel pressure

b Fuel bleeding pump (P)

c Start

d Fuel press switch

Cable description

The fuel system has a fuel bleeding pump that is used when the fuel system has to be bled. A manual fuel press switch is situated on the left side of the engine. When the fuel press switch is activated the fuel bleeding pump starts to pump round the fuel.

Measurements

Checking the wiring

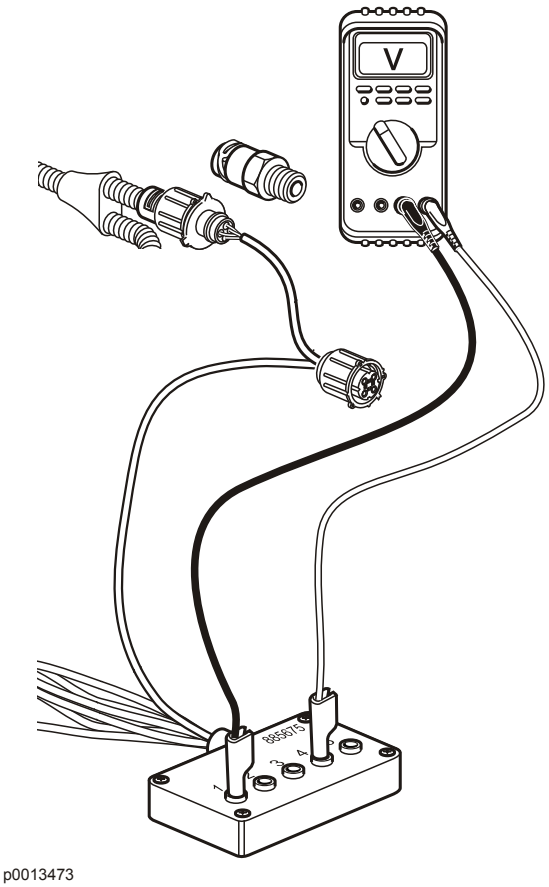
Tools:
9812519 Multimeter

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

2 Remove the wire to be measured from the preheat relay.

3 Remove connector B from the EMS2.

4 Use multimeter 9812519 to do a resistance measurement between connector B (see circuit description) to the loosen wire.
R ≈ 0Ω.



p0013473

Checking supply cable, fuel sensor

Tools:
885675 Break out cable
88890053 Break out cable
9812519 Multimeter

1 **NOTICE!** Turn ignition off.

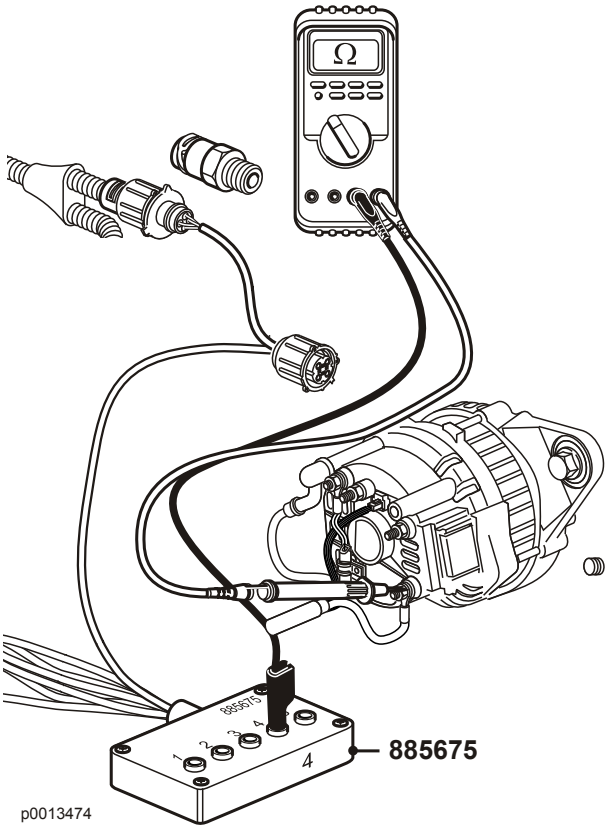
2 Disconnect the connector from the sensor.

3 TAD1250-1252 and TWD1643:
Connect adapter cable 885675 to the cable harness connector to the engine control unit.
TAD950-952 (with bleeding pump):
Connect adapter cable 88890053 to the cable harness connector to the engine control unit.

4 Use multimeter 9812519 for voltage measurement.

5 Turn ignition on.

Measurement points	Nominal value
1 – 4 (no fuel bleeding pump)	U ≈ 5 V
2 – 4 (with fuel bleeding pump)	U ≈ 5 V



Checking negative cable, fuel sensor

Tools:
885675 Break out cable
88890053 Break out cable
9812519 Multimeter

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

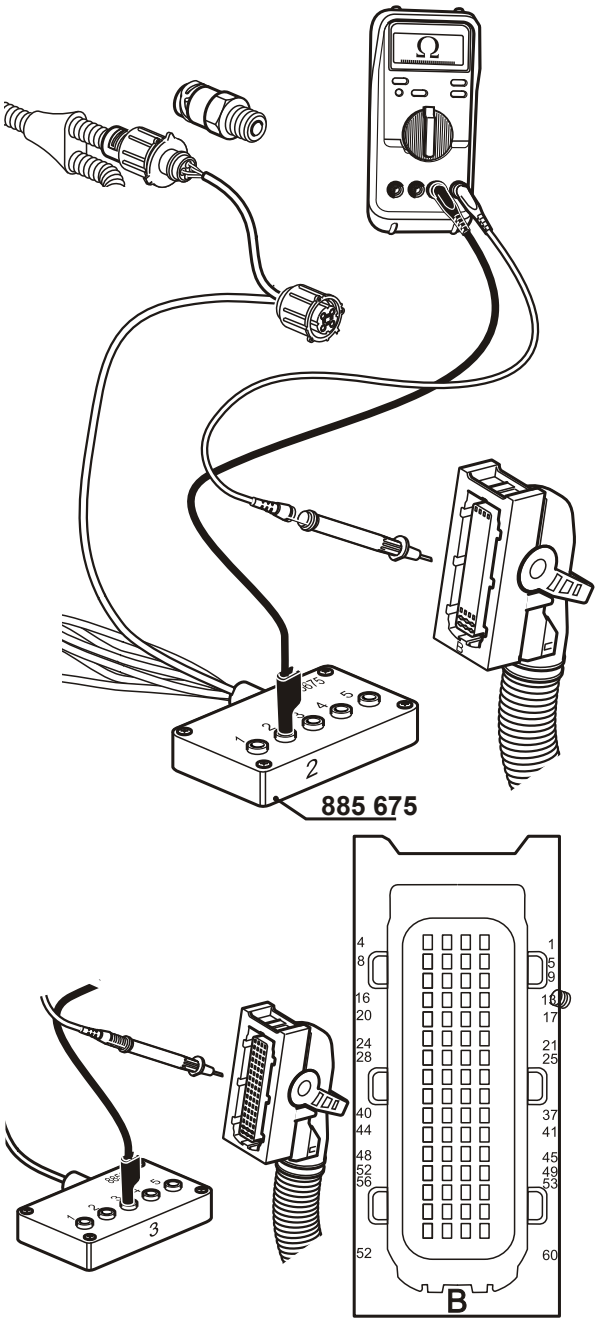
2 Disconnect the connector from the sensor.

3 TAD1250-1252 and TWD1643:
Connect adapter cable 885675 to the cable harness connector to the engine control unit.
TAD950-952:
Connect adapter cable 88890053 to the cable harness connector to the engine control unit.

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

Measurement points	Nominal value
4 – Battery negative (no fuel bleeding pump)	R ≈ 0 Ω
4 – Battery negative (with fuel bleeding pump)	R ≈ 0 Ω

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



Checking the signal cable for interruption or shortcircuit

Tools:
885675 Break out cable
88890053 Break out cable
9812519 Multimeter

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

2 Disconnect the connector from the sensor.

3 TAD1250-1252 and TWD1643:
Connect adapter cable 885675 to the cable harness connector to the engine control unit.
TAD950-952:
Connect adapter cable 88890053 to the cable harness connector to the engine control unit.

4 Remove connector B from the engine control unit.

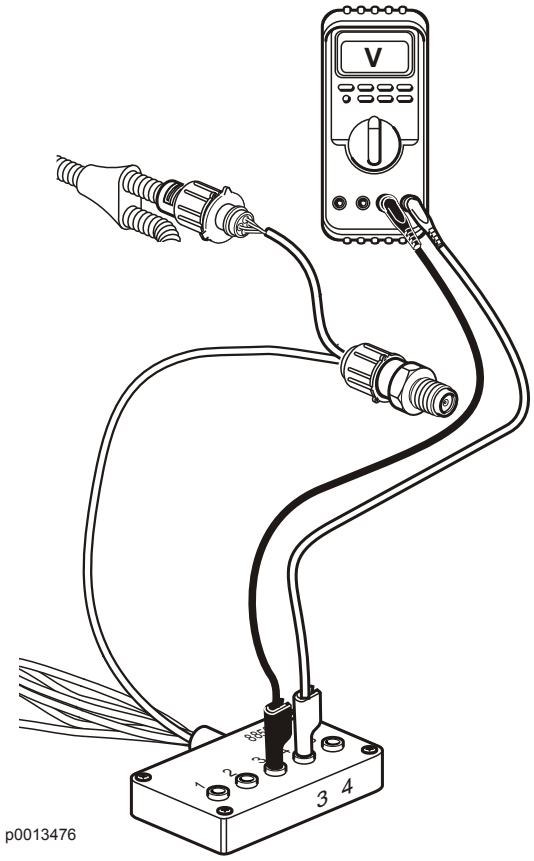
5 Use multimeter 9812519 to do a resistance measurement against the engine control unit connector B.

Measurement points	Nominal value
2(885675)– 16(EMS2, conn.B) (no fuel bleeding pump)	R ≈ 0 Ω
2(885675)– 18(EMS2, conn.B) (no fuel bleeding pump)	R ≈ ∞ Ω
2(885675)– 17(EMS2, conn.B) (no fuel bleeding pump)	R ≈ ∞ Ω
3(88890053) – 16(EMS2, conn.B) (with fuel bleeding pump)	R ≈ 0 Ω
3(88890053) – 18(EMS2, conn.B) (with fuel bleeding pump)	R ≈ ∞ Ω
3(88890053) – 17(EMS2, conn.B) (with fuel bleeding pump)	R ≈ ∞ Ω

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

IMPORTANT!

Be very careful when measuring inside the connector, to ensure that no pin is damaged.



Checking fuel pressure sensor

Tools:
885675 Break out cable
88890053 Break out cable
9812519 Multimeter

1 **NOTICE!** Turn ignition off.

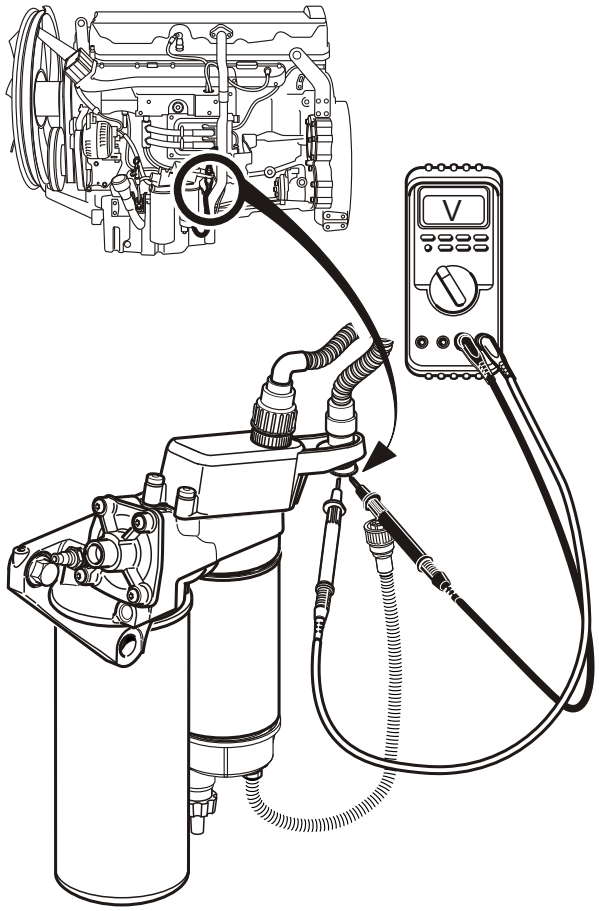
2 Disconnect the connector from the sensor.

3 TAD1250-1252 and TWD1643:
Connect adapter cable 885675 between the sensor and the engine control unit.
TAD950-952:
Connect adapter cable 88890053 between the sensor and the engine control unit.

4 Use multimeter 9812519 for voltage measurement.

5 Turn ignition on.

Measurement points	Nominal value
4–3 (no fuel bleeding pump)	U ≈ 0,5 V (at normal atmospheric pressure)
4–3 (with fuel bleeding pump)	U ≈ 0,5 V (at normal atmospheric pressure)



p0013376

Checking supply cable, water in fuel switch

Tools:
9812519 Multimeter

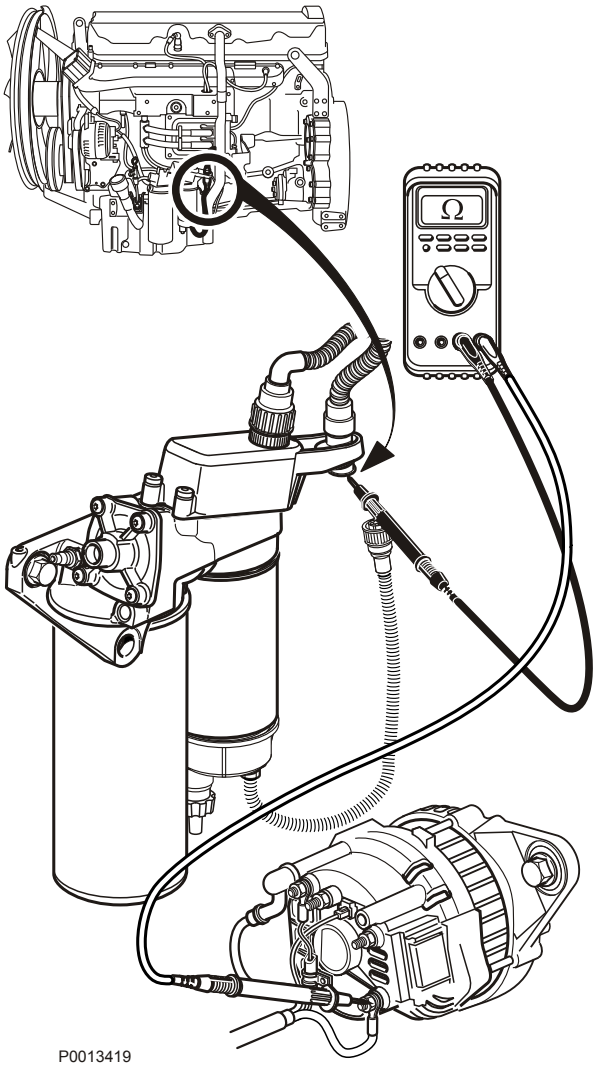
1 **NOTICE!** Turn ignition off.

2 Disconnect the connector from the switch.

3 Use multimeter 9812519 to do voltage measurement towards the engine control unit.

4 **NOTICE!** Turn ignition on.

Measurement points	Nominal value
Yellow conductor – Black conductor	U ≈ Battery voltage x 0.8



Checking negative cable, water in fuel switch

Tools:
9812519 Multimeter

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

2 Disconnect the connector from the switch.

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

Measurement points	Nominal value
Black conductor – Battery negative	R ≈ 0 Ω

Checking water in fuel switch

Tools:
9990014 Break out cable
9998699 Break-out box
9812519 Multimeter

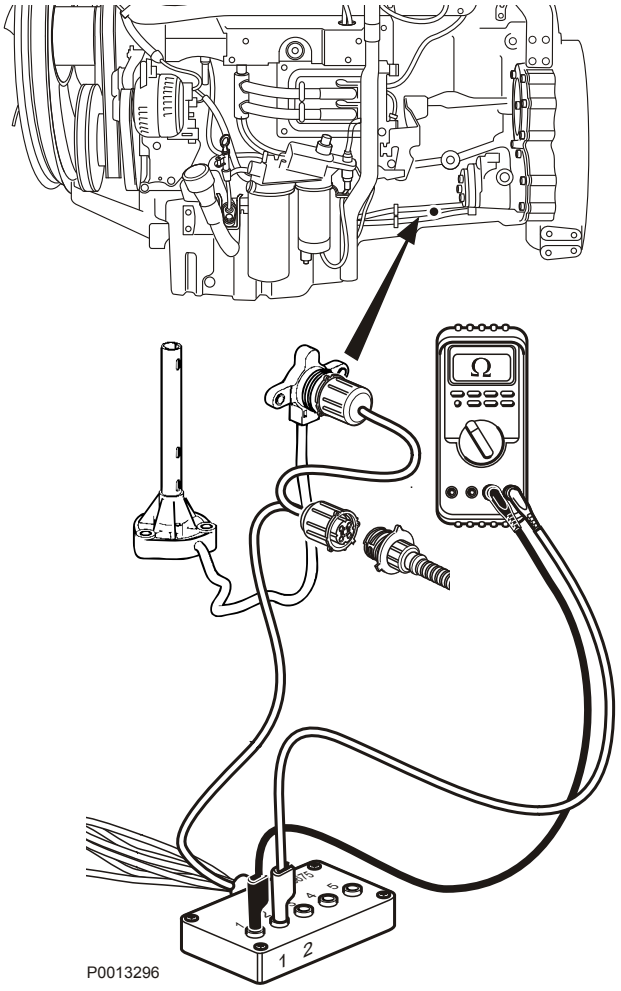
1 **NOTICE!** Cut the current with the main switch.

2 Connect adapter cable 9990014 with measurebox 9998699 between EMS 2 (connector B) and the switch.

3 Use multimeter 9812519 for voltage measurement.

4 Turn ignition on.

Measurement points	Nominal value
10 - 8 Switch immersed in fuel	U ≈ 0,8 x battery voltage
10 - 8 Switch immersed in water	U ≈ 0,8 x battery voltage - 5 V



Checking oil level sensor

Tools:
885675 Break out cable

Tools:
9812519 Multimeter

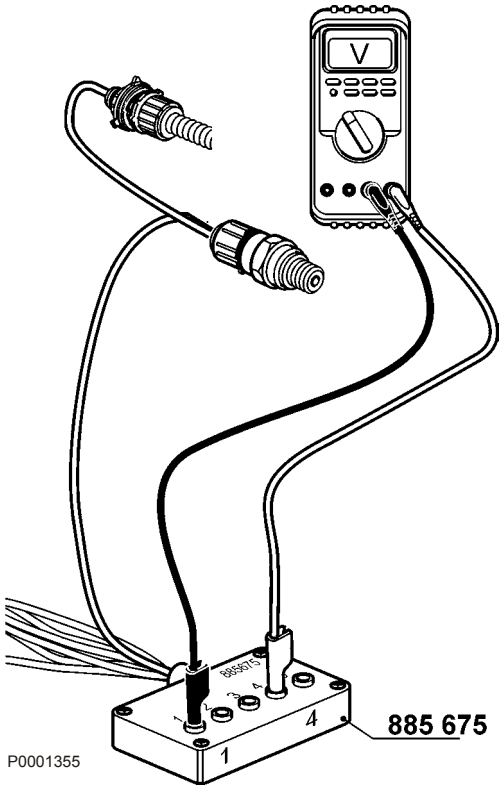
1 **NOTICE!** Cut the current with the main switch.

2 Connect adapter cable (885675) to the sensor. Do not connect the other end of the adapter cable.

3 Use multimeter 9812519 to do resistance measurement.

Measurement points	Nominal value
1–2	R ≈ 10 – 14 Ω

NOTICE! Even if the nominal value is correct the sensor could be faulty.



Checking supply cable, oil pressure sensor

Tools:
885675 Break out cable
9812519 Multimeter

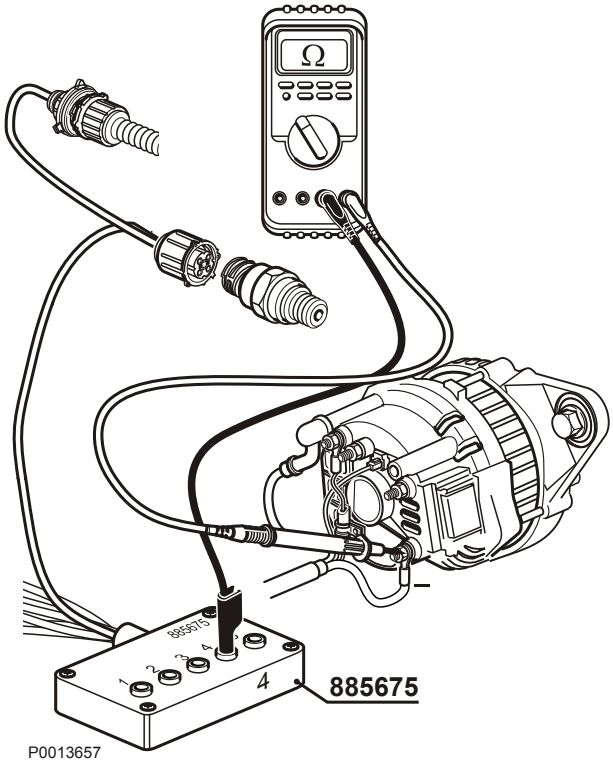
1 **NOTICE!** Turn ignition off.

2 Remove the connector from the sensor. Connect adapter cable 885675 between the sensor and engine control unit.

3 Use multimeter 9812519 for voltage measurement.

4 **NOTICE!** Turn ignition on.

Measurement points	Nominal value
1–4	U ≈ 5 V



Checking negative cable, oil pressure sensor

Tools:
885675 Break out cable
9812519 Multimeter

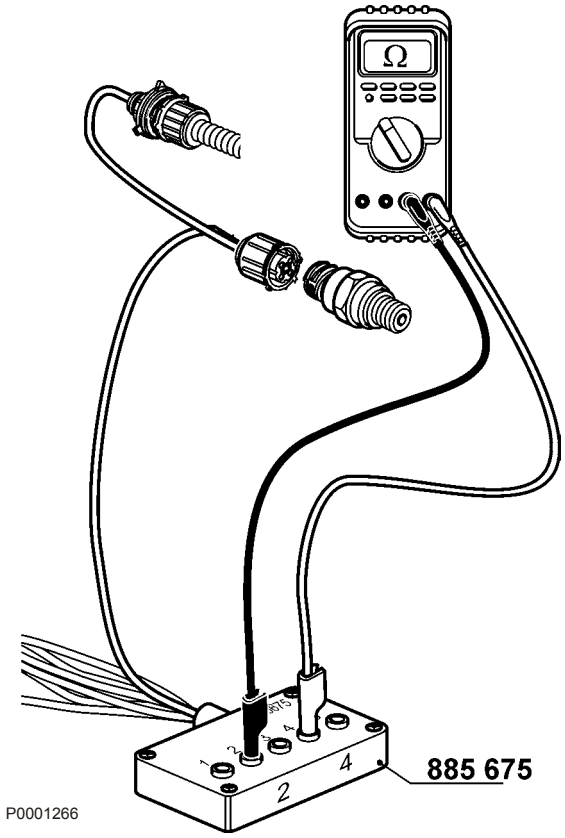
1 **NOTICE!** Cut the current with the main switch.

2 Disconnect the connector from the sensor.

3 Connect adapter cable 885675 to the cable harness connector to the engine control unit.

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

Measurement points	Nominal value
4 – Battery negative	R ≈ 0 Ω



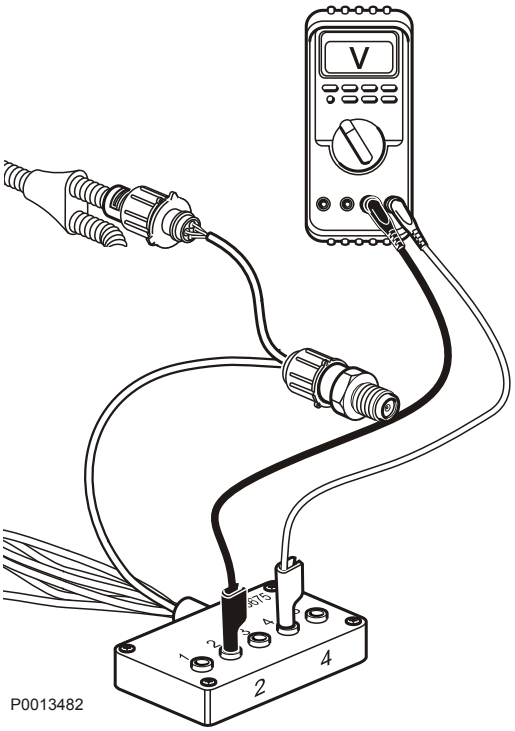
Checking signal cable, oil pressure sensor

Tools:
885675 Break out cable
9812519 Multimeter

1 **NOTICE!** Cut the current with the main switch.
2 Disconnect the connector from the sensor.
3 Connect adapter cable 885675 to the cable harness connector to the engine control unit.
4 Use multimeter 9812519 to do resistance measurement against the engine control unit.

Measurement points	Nominal value
2–4	R ≈ 80 – 120 kΩ

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

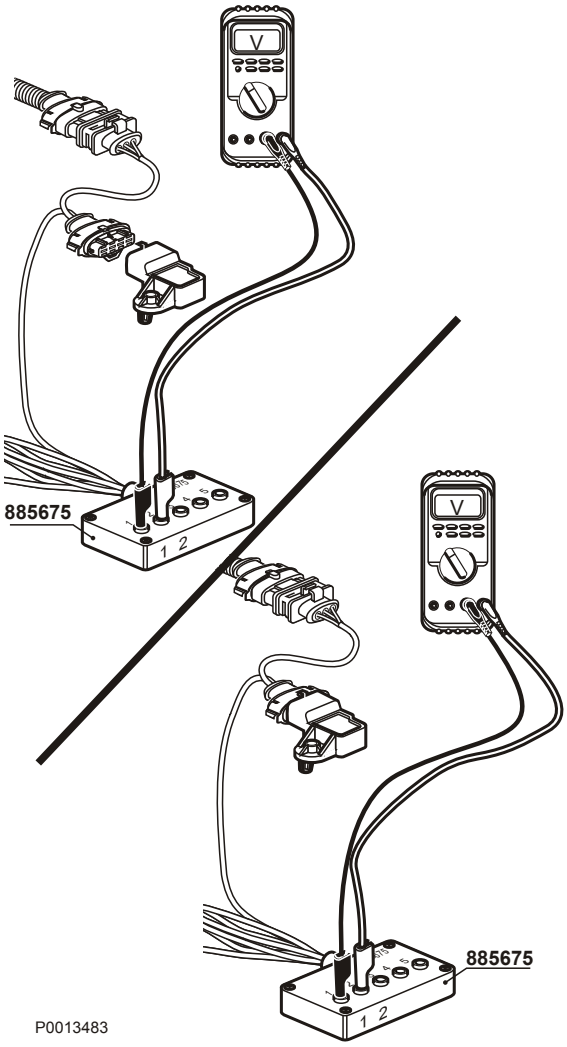


Checking oil pressure sensor

Tools:
885675 Break out cable
9812519 Multimeter

1 **NOTICE!** Turn ignition off.
2 Disconnect the connector from the sensor.
3 Connect adapter cable 885675 between the sensor and the engine control unit.
4 Use multimeter 9812519 for voltage measurement.
5 Turn ignition on.

Measurement points	Nominal value
2–4	U ≈ 0,5 V (at normal atmospheric pressure)



Checking signal cable voltage, inlet manifold (pressure/)temperature sensor

Tools:
885675 Break out cable
9812519 Multimeter

1 **NOTICE!** Turn ignition off.

2 Disconnect the connector from the sensor.

3 Connect adapter cable 885675 to the cable harness connector to the engine control unit.

4 Use multimeter 9812519 for voltage measurement.

5 Turn ignition on.

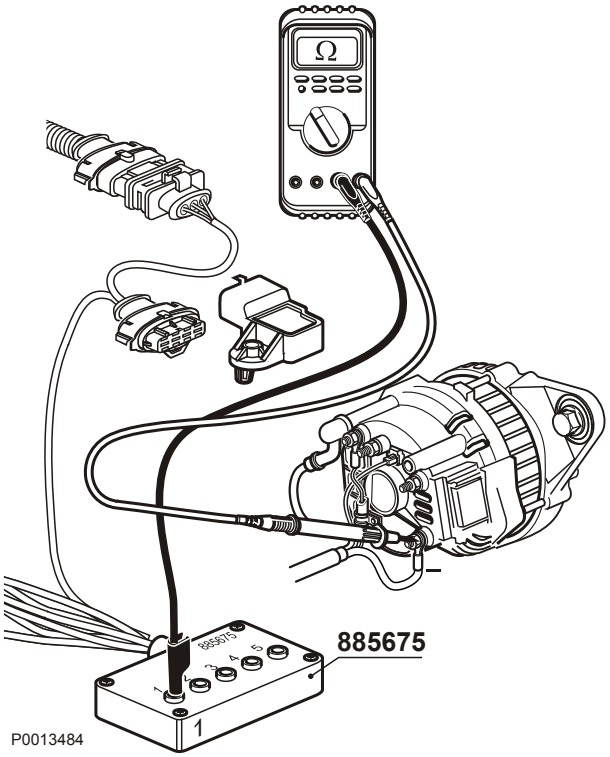
Measurement points	Nominal value
1–2	U ≈ 5 V

1 Turn ignition off.

2 Connect adapter cable 885675 between the sensor and the engine control unit.

3 Turn ignition on.

Measurement points	Nominal value
1–2	U ≈ 0.5– 4.5 V (depended of the temperature)



Checking negative cable, inlet manifold pressure/temperature sensor

Tools:
885675 Break out cable
9812519 Multimeter

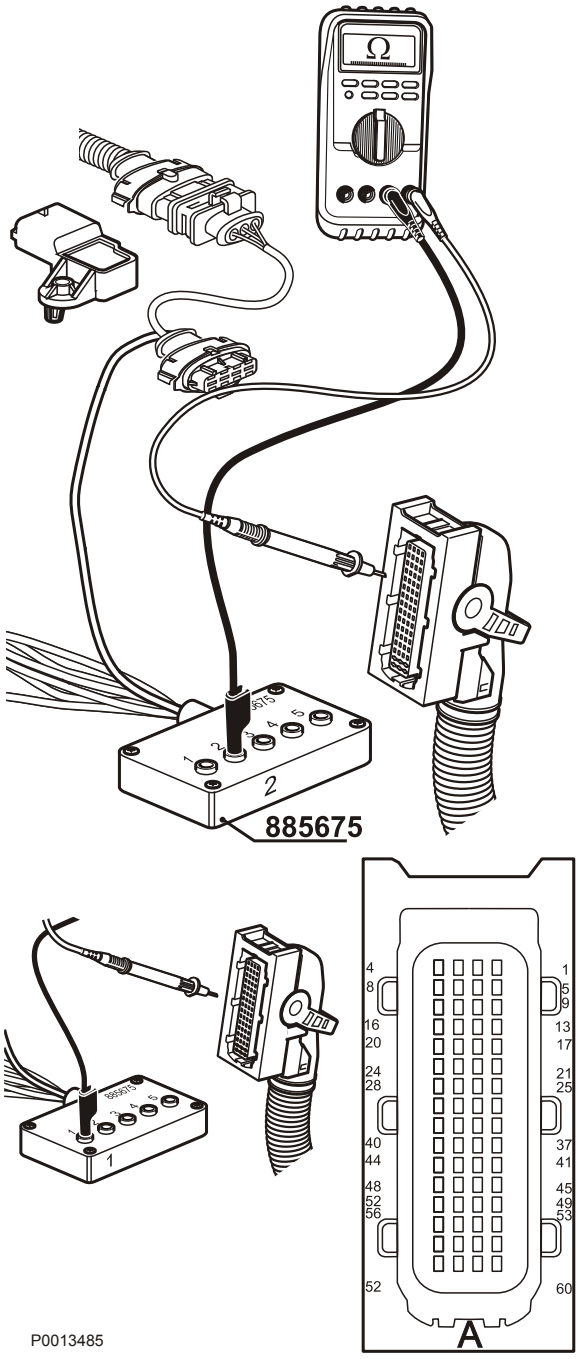
1 **NOTICE!** Cut the current with the main switch.

2 Disconnect the connector from the sensor.

3 Connect adapter cable 885675 to the cable harness connector to the engine control unit.

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

Measurement points	Nominal value
1 – Battery negative	R ≈ 0 Ω



Checking the sensor cable for open circuit or shortcircuit

Inlet manifold temperature sensor

Tools:
885675 Break out cable
9812519 Multimeter

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

2 Disconnect the connector from the sensor.

3 Connect adapter cable 885675 to the cable harness connector to the engine control unit.

4 Remove connector A from the engine control unit.

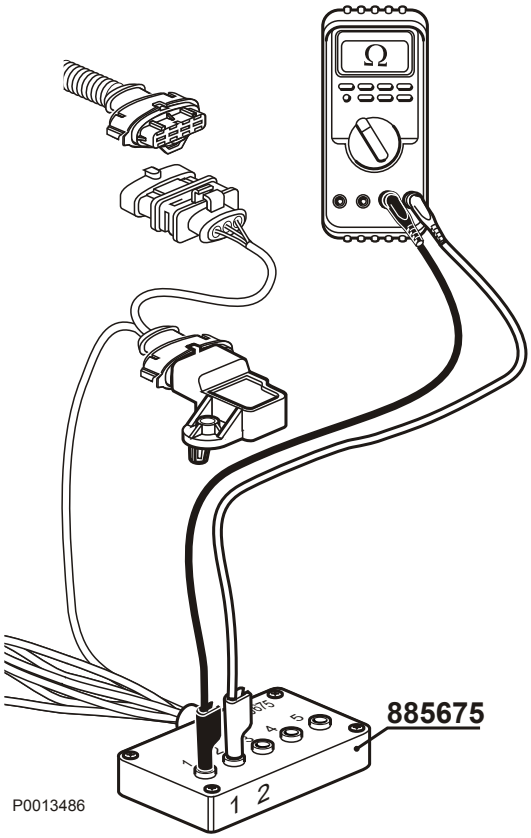
5 Use multimeter 9812519 to do a resistance measurement against engine control unit connector A.

Measurement points	Nominal value
2 (885675)– 47(EMS2, conn.A)	R ≈ 0 Ω
2 (885675)– 11(EMS2, conn.A)	R ≈ ∞ Ω
1 (885675)– 47(EMS2, conn.A)	R ≈ ∞ Ω
1 (885675)– 11(EMS2, conn.A)	R ≈ 0 Ω

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

IMPORTANT!

Be very careful when measuring inside the connector, to ensure that no pin is damaged.



Checking inlet manifold temperature sensor

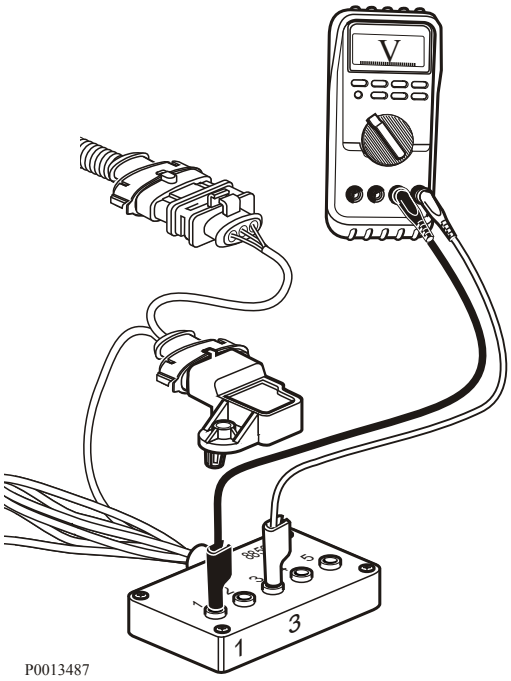
Tools:
885675 Break out cable
9812519 Multimeter

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

2 Connect adapter cable (885675) to the sensor. Do not connect the other end of the adapter cable.

3 Use multimeter 9812519 to do resistance measurement.

Measurement points	Nominal value
1–2	R ≈ 9426 Ω +/- 470 Ω (vid -10° C)
1–2	R ≈ 5896 Ω +/- 332 Ω (vid 0° C)
1–2	R ≈ 2511 Ω +/- 109 Ω (vid 20° C)
1–2	R ≈ 1200 Ω +/- 47 Ω (vid 40° C)
1–2	R ≈ 612 Ω +/- 22 Ω (vid 60° C)
1–2	R ≈ 329 Ω +/- 11 Ω (vid 80° C)
1–2	R ≈ 186 Ω +/- 5 Ω (vid 100° C)
1–2	R ≈ 110 Ω



Checking supply cable, inlet manifold pressure sensor

Tools:
885675 Break out cable
9812519 Multimeter

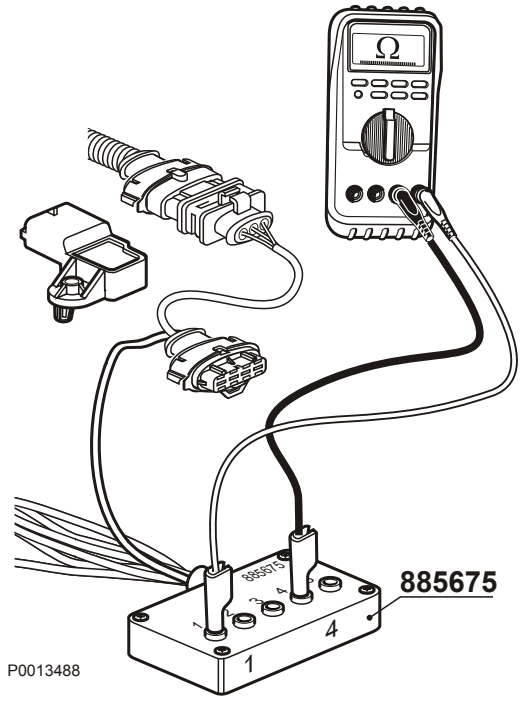
1 **NOTICE!** Turn ignition off.

2 Remove the connector from the sensor. Connect adapter cable 885675 between the sensor and engine control unit.

3 Use multimeter 9812519 for voltage measurement.

4 Turn ignition on.

Measurement points	Nominal value
1–3	U ≈ 5 V



Checking signal cable, inlet manifold pressure sensor

Tools:
885675 Break out cable
9812519 Multimeter

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

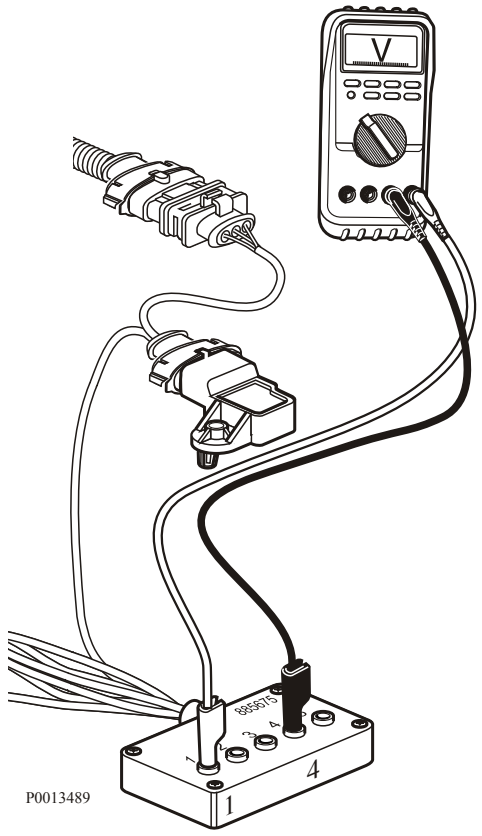
2 Disconnect the connector from the sensor.

3 Connect adapter cable 885675 to the cable harness connector to the engine control unit.

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

Measurement points	Nominal value
4–1	R ≈ 80 – 120 k Ω

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



Checking air inlet pressure sensor

Tools:
885675 Break out cable
9812519 Multimeter

1 **NOTICE!** Turn ignition off.

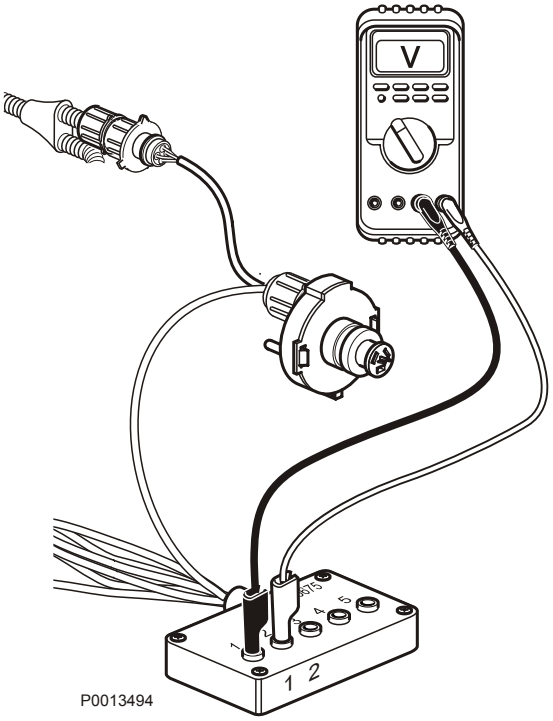
2 Disconnect the connector from the sensor.

3 Connect adapter cable 885675 between the sensor and the engine control unit.

4 Use multimeter 9812519 for voltage measurement.

5 Turn ignition on.

Measurement points	Nominal value
1–4	U ≈ 1,1 V (at normal atmospheric pressure)



Checking supply cable, air filter pressure switch

Tools:
885675 Break out cable
9812519 Multimeter

1 **NOTICE!** Turn ignition off.

2 Disconnect the connector from the switch.

3 Connect adapter cable 885675 between the switch and engine control unit.

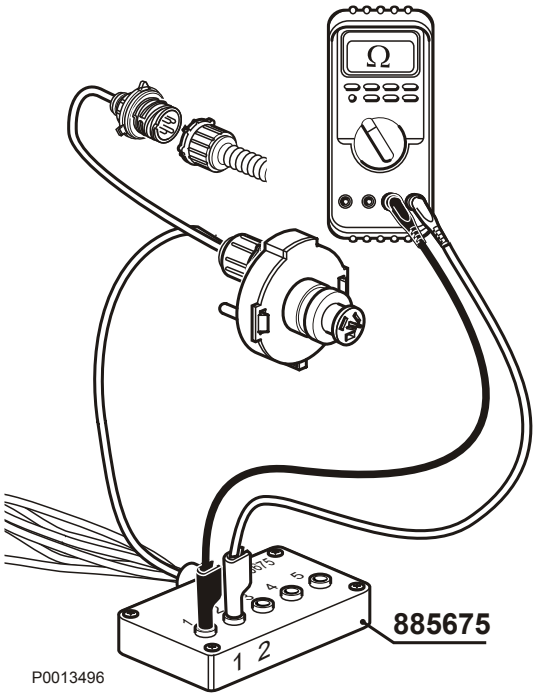
4 Use multimeter 9812519 for voltage measurement.

5 **NOTICE!** Turn ignition on.

Measurement points	Nominal value
1–2	U ≈ 2.9 V

1 Disconnect the connector from the switch.

Measurement points	Nominal value
1–2	U ≈ 0.8 x battery voltage



Checking air pressure switch

Tools:
885675 Break out cable
9812519 Multimeter

1 **NOTICE!** Turn ignition off.

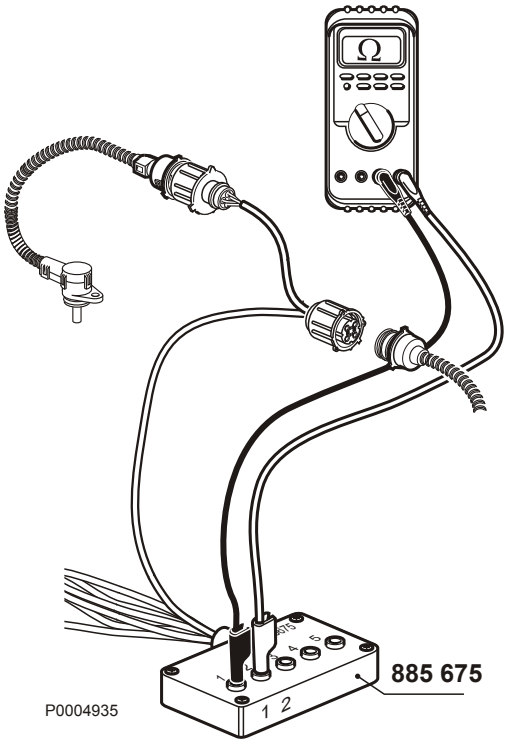
2 Disconnect the connector from the switch.
Do **not** connect the other end of the adapter cable.

3 Connect adapter cable 885675 to the switch.

4 Use multimeter 9812519 for resistance measurement.

Measurement points	Nominal value
1–2	R ≈ 330 Ω

NOTICE! If the measured value is 2.2 kOhm when the engine is shut down the switch inside is stuck in active position.



Checking coolant temperature sensor

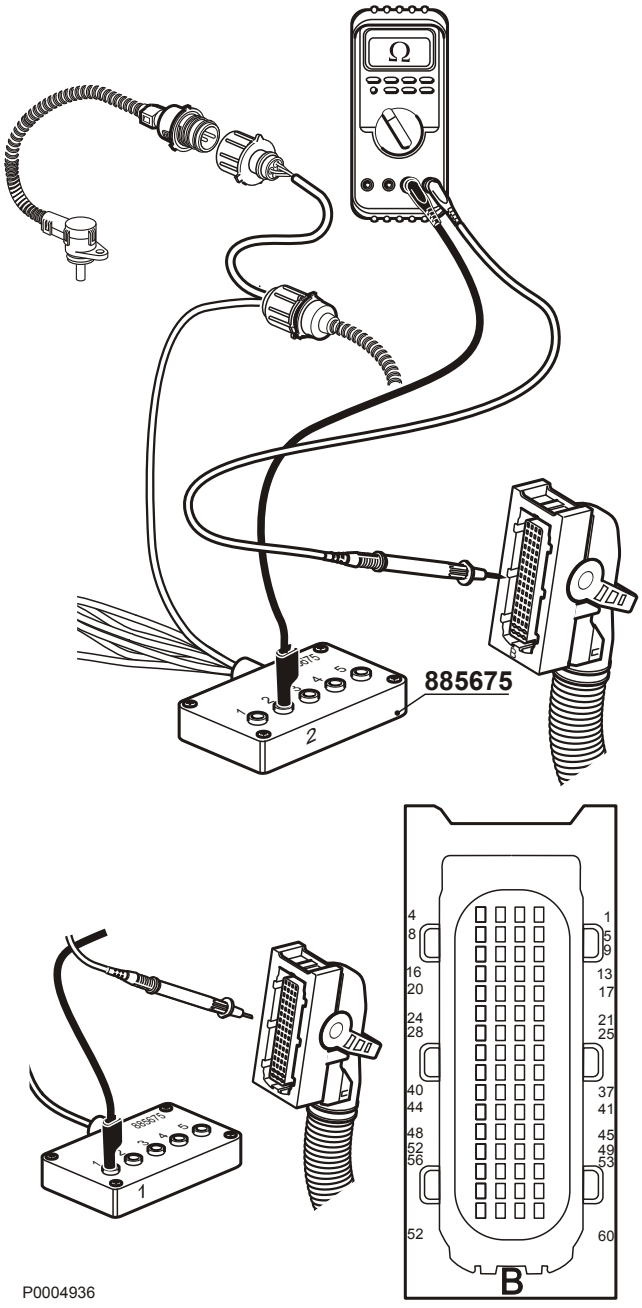
Tools:
885675 Break out cable
9812519 Multimeter

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

2 Connect adapter cable (885675) to the sensor. Do **not** connect the other end of the adapter cable.

3 Use multimeter 9812519 to do resistance measurement.

Measurement points	Nominal value
1–2	R ≈ 9397 Ω +/- 755 Ω (at -10° C)
1–2	R ≈ 5896 Ω +/- 430 Ω (at 0° C)
1–2	R ≈ 2500 Ω +/- 148 Ω (at 20° C)
1–2	R ≈ 1175 Ω +/- 56 Ω (at 40° C)
1–2	R ≈ 596 Ω +/- 22 Ω (at 60° C)
1–2	R ≈ 323 Ω +/- 10 Ω (at 80° C)
1–2	R ≈ 186 Ω +/- 5 Ω (at 100° C)
1–2	R ≈ 113 Ω



Checking the sensor cable for open circuit or shortcircuit

Coolant temperature sensor

Tools:
885675 Break out cable
9812519 Multimeter

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

2 Disconnect the connector from the sensor.

3 Connect adapter cable 885675 to the cable harness connector to the engine control unit.

4 Remove connector B from the engine control unit.

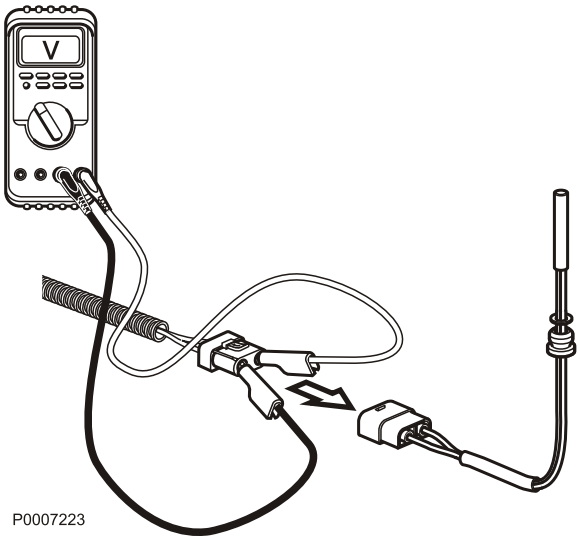
5 Use multimeter 9812519 to do a resistance measurement against the engine control unit connector B.

Measurement points	Nominal value
2 (885675)– 27 (EMS2, conn.B)	R ≈ 0 Ω
2 (885675)– 18 (EMS2, conn.B)	R ≈ ∞ Ω
1 (885675)– 27 (EMS2, conn.B)	R ≈ ∞ Ω
1 (885675)– 18 (EMS2, conn.B)	R ≈ 0 Ω

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

IMPORTANT!

Be very careful when measuring inside the connector, to ensure that no pin is damaged.



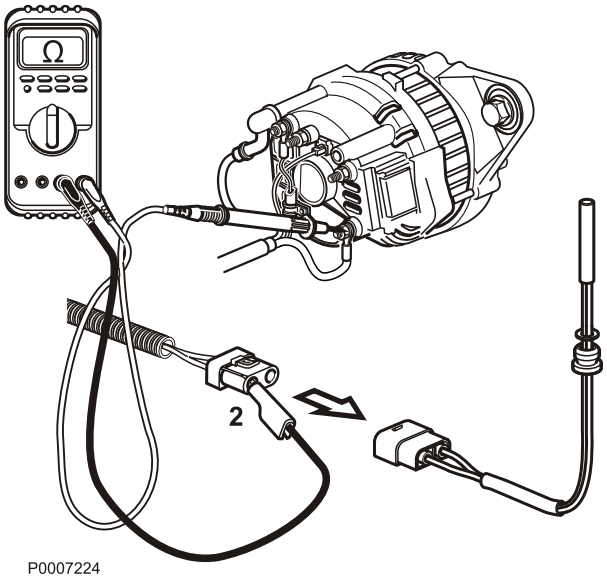
P0007223

Checking supply cable, coolant level switch

Tools:
885675 Break out cable
9812519 Multimeter

1 **NOTICE!** Turn ignition off.
2 Disconnect the connector from the switch.
3 Connect adapter cable 885675 to the cable harness connector to the engine control unit.
4 Use multimeter 9812519 for voltage measurement.
5 **NOTICE!** Turn ignition on.

Measurement points	Nominal value
1–2	U ≈ Battery voltage x 0.8



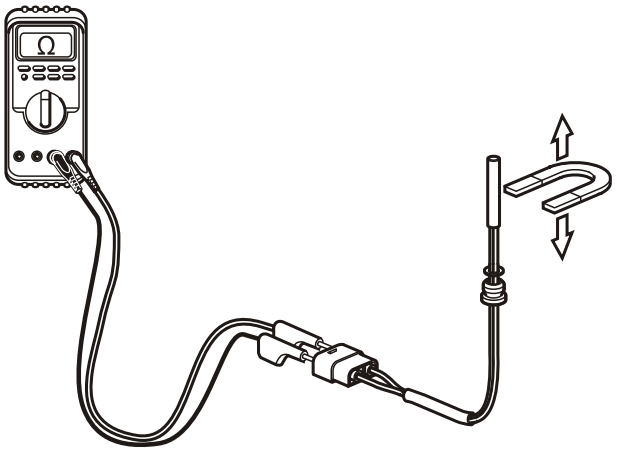
P0007224

Checking negative cable, coolant level switch

Tools:
885675 Break out cable
9812519 Multimeter

1 **NOTICE!** Cut the current with the main switch.
2 Disconnect the connector from the switch.
3 Connect adapter cable 885675 to the cable harness connector to the engine control unit.
4 Use multimeter 9812519 to do resistance measurement against the engine control unit.

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



P0007225

Checking coolant level switch

Tools:
9812519 Multimeter

NOTICE! The coolant level switch can be removed without having to drain the coolant.

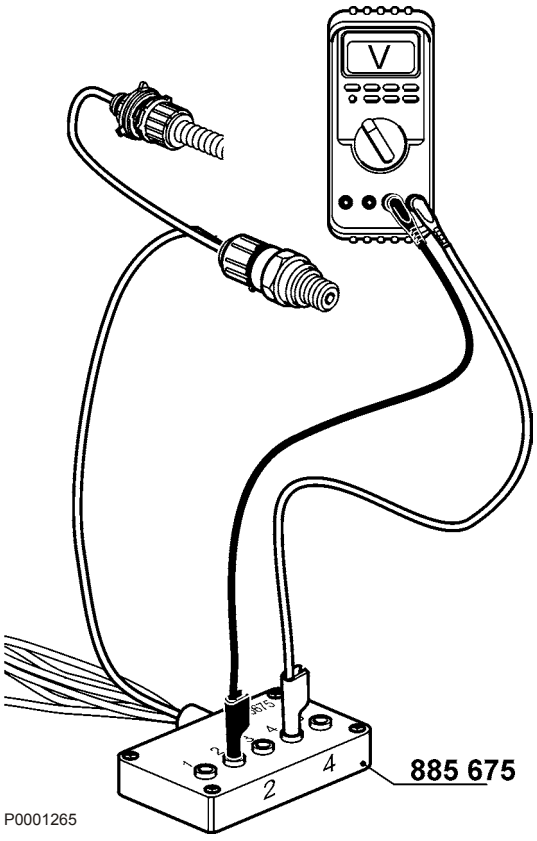
1 Undo the connector and remove the switch from the expansion tank.

2 Use multimeter 9812519 to do resistance measurement against the switch.

Measurement points	Nominal value
Blue – Black	R ≈ ∞ Ω

3 Move a magnet along the switch and observe the resistance value. The resistance should drop to approx. 0 Ohm.

Measurement points	Nominal value
Blue – Black	R ≈ 0 Ω



P0001265

Checking crankcase pressure sensor

Tools:
885675 Break out cable
9812519 Multimeter

1 **NOTICE!** Turn ignition off.

2 Disconnect the connector from the sensor.

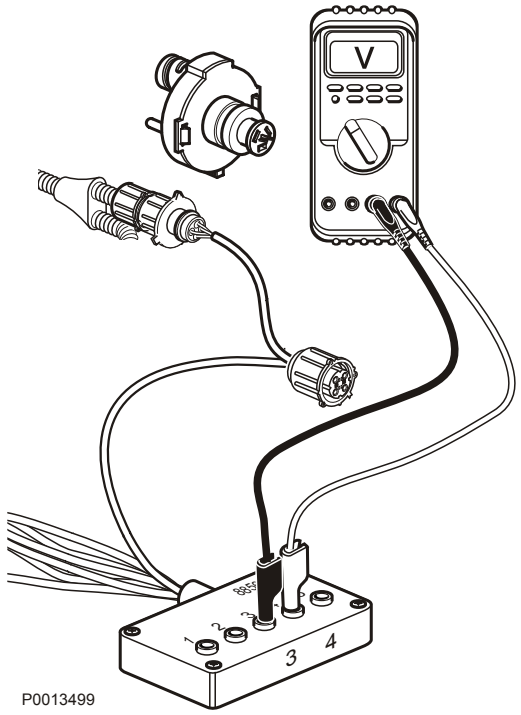
3 Connect adapter cable 885675 between the sensor and the engine control unit.

4 Use multimeter 9812519 for voltage measurement.

5 Turn ignition on.

Measurement points	Nominal value
2–4	U ≈ 2.9 V (at normal atmospheric pressure)

Checking signal cable, air filter temperature switch



Tools:
885675 Break out cable
9812519 Multimeter

1 **NOTICE!** Turn ignition off.

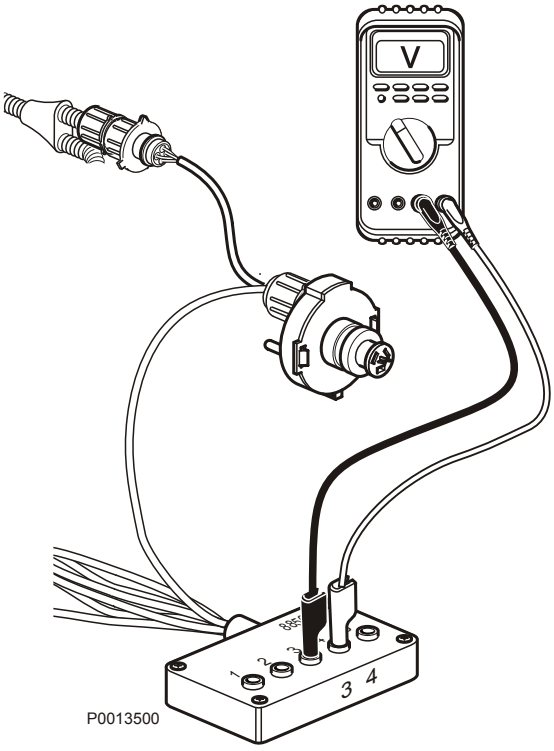
2 Disconnect the connector from the sensor.

3 Connect adapter cable 885675 to the cable harness connector to the engine control unit.

4 Use multimeter 9812519 for voltage measurement.

5 **NOTICE!** Turn ignition on.

Measurement points	Nominal value
3–4	U ≈ 5 V

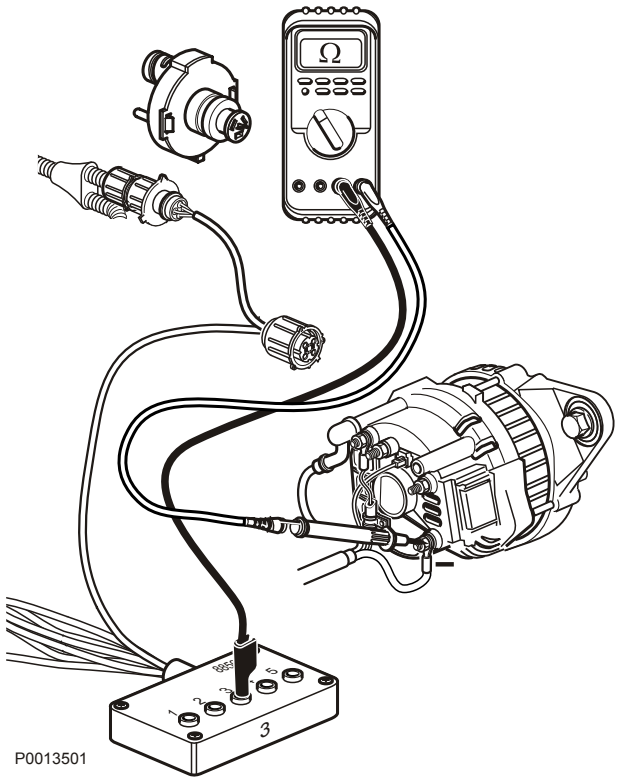


1 Turn ignition off.

2 Connect adapter cable 885675 between the sensor and the engine control unit.

3 Turn ignition on.

Measurement points	Nominal value
3–4	U ≈ 0.5 – 4.5 V (depended of the temperature)



Checking negative cable, air filter temperature switch

Tools:
885675 Break out cable
9812519 Multimeter

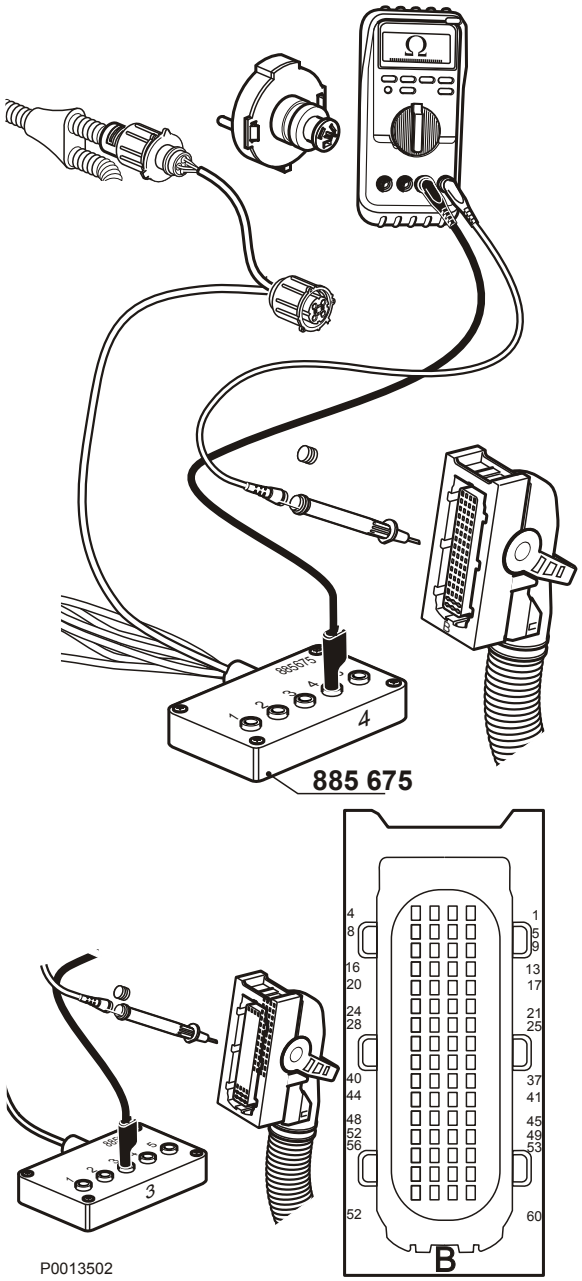
1 **NOTICE!** Cut the current with the main switch.

2 Disconnect the connector from the sensor.

3 Connect adapter cable 885675 to the cable harness connector to the engine control unit.

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

Measurement points	Nominal value
3 — Battery negative	R ≈ 0 Ω



Checking the sensor cable for open circuit or shortcircuit

Air filter temperature sensor

Tools:
885675 Break out cable
9812519 Multimeter

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

2 Disconnect the connector from the sensor.

3 Connect adapter cable 885675 to the cable harness connector to the engine control unit.

4 Remove connector B from the engine control unit.

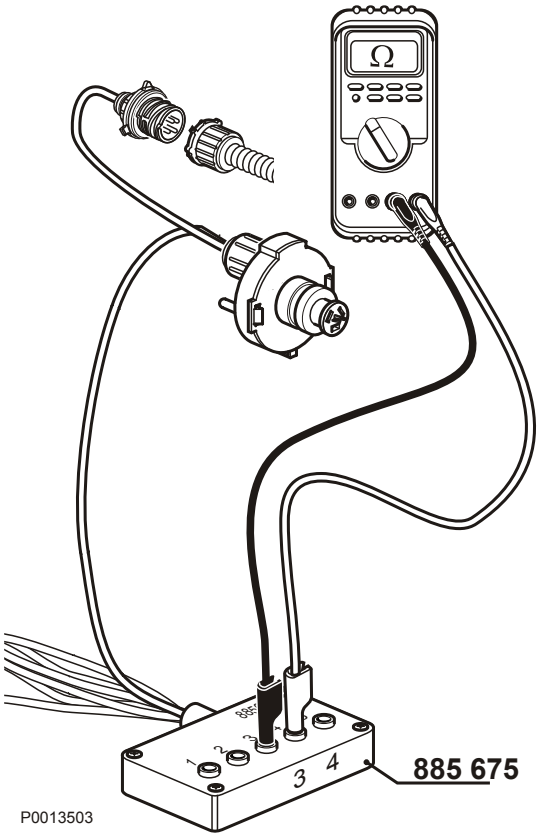
5 Use multimeter 9812519 to do a resistance measurement against the engine control unit connector B.

Measurement points	Nominal value
4 (885675) – 31(EMS2, conn.B)	R ≈ 0 Ω
4 (885675) – 18(EMS2, conn.B)	R ≈ ∞ Ω
3 (885675) – 31(EMS2, conn.B)	R ≈ ∞ Ω
3 (885675) – 18(EMS2, conn.B)	R ≈ 0 Ω

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

IMPORTANT!

Be very careful when measuring inside the connector, to ensure that no pin is damaged.



Checking air inlet temperature sensor

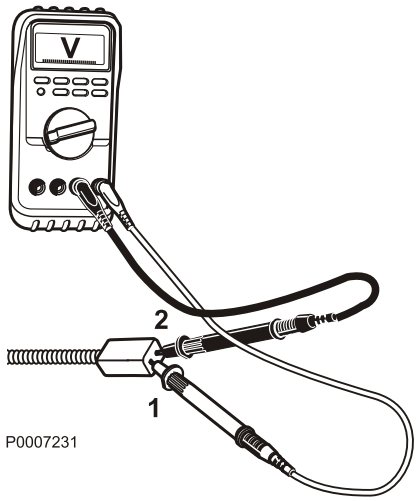
Tools:
885675 Break out cable
9812519 Multimeter

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

2 Connect adapter cable (885675) to the sensor. Do **not** connect the other end of the adapter cable.

3 Use multimeter 9812519 to do resistance measurement.

Measurement points	Nominal value
3–4	R ≈ 16445 Ω +/- 822 Ω (at 0°C)
3–4	R ≈ 5000 Ω +/- 220 Ω (at 25°C)
3–4	R ≈ 4027 Ω +/- 160 Ω (at 30°C)
3–4	R ≈ 1247 Ω +/- 40 Ω (at 60°C)
3–4	R ≈ 463 Ω +/- 19 Ω (at 90°C)
3–4	R ≈ 199 Ω +/- 10 Ω (at 120°C)



Checking signal cable, exhaust gas temperature sensor

Tools:
9812519 Multimeter

1 **NOTICE!** Turn ignition off.

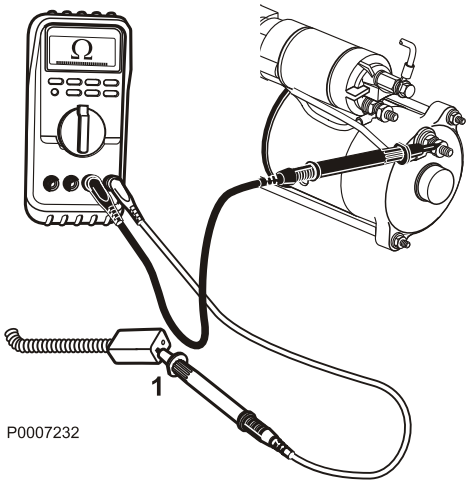
2 Remove the connector from the sensor.

3 Use multimeter 9812519 for voltage measurement.

4 **NOTICE!** Turn ignition on.

Measurement points	Nominal value
1–2	U ≈ 5 V

Checking negative cable, exhaust gas temperature sensor



Tools:
9812519 Multimeter

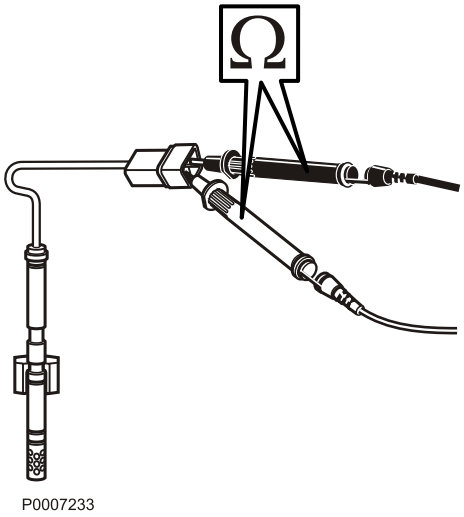
1 **NOTICE!** Cut the current with the main switch.

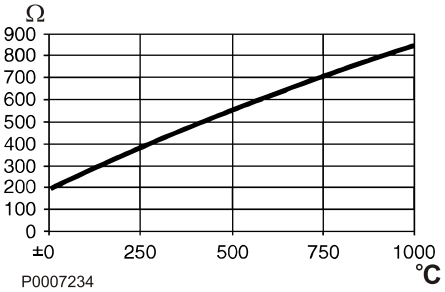
2 Disconnect the connector from the sensor.

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

Measurement points	Nominal value
1 — Battery negative	R ≈ 0 Ω

Checking exhaust gas temperature sensor





Tools:
9812519 Multimeter

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

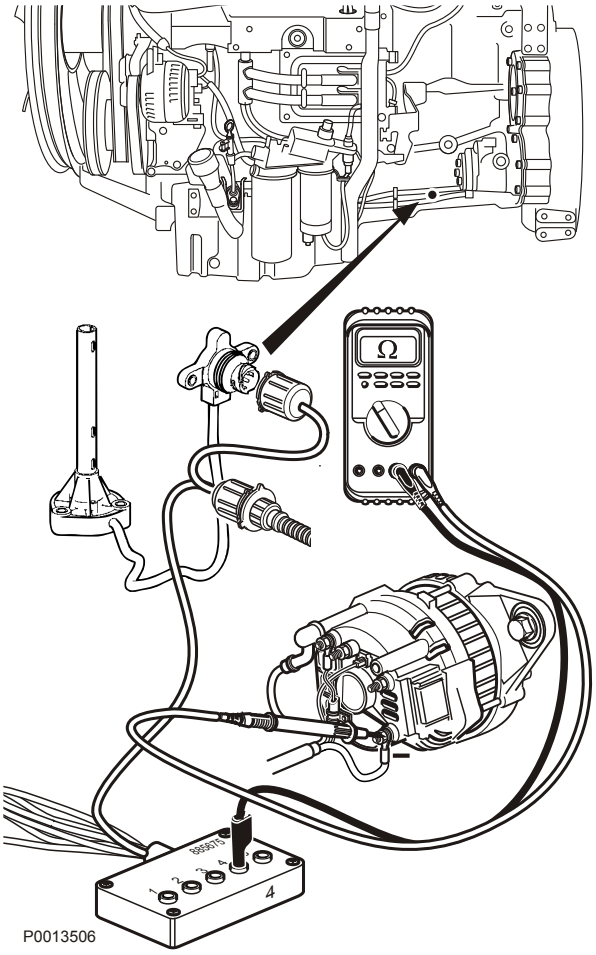
2 Remove the connector from the sensor and remove the sensor from exhaust bend to check that the sensor has no visible damage.

3 Use multimeter 9812519 to measure resistance between the two contact pins on the sensor. The resistance shall agree with the values in the chart.

Measurement value points	Nominal resistance value	Nominal voltage measured over the sensor
1–2	R ≈ 185 Ω at -20° C	U ≈ 0.78 V at -20° C
1–2	R ≈ 200 Ω at 0° C	U ≈ 0.84 V at 0° C
1–2	R ≈ 220 Ω at 25° C	U ≈ 0.90 V at 25° C
1–2	R ≈ 238 Ω at 50° C	U ≈ 0.96 V at 50° C
1–2	R ≈ 276 Ω at 100° C	U ≈ 1.08 V at 100° C
1–2	R ≈ 313 Ω at 150° C	U ≈ 1.19 V at 150° C
1–2	R ≈ 349 Ω at 200° C	U ≈ 1.29 V at 200° C
1–2	R ≈ 385 Ω at 250° C	U ≈ 1.39 V at 250° C

1–2	R ≈ 420 Ω at 300° C	U ≈ 1.48 V at 300° C
1–2	R ≈ 454 Ω at 350° C	U ≈ 1.56 V at 350° C
1–2	R ≈ 488 Ω at 400° C	U ≈ 1.64 V at 400° C
1–2	R ≈ 521 Ω at 450° C	U ≈ 1.71 V at 450° C
1–2	R ≈ 554 Ω at 500° C	U ≈ 1.78 V at 500° C
1–2	R ≈ 618 Ω at 600° C	U ≈ 1.91 V at 600° C
1–2	R ≈ 679 Ω at 700° C	U ≈ 2.02 V at 700° C
1–2	R ≈ 738 Ω at 800° C	U ≈ 2.12 V at 800° C
1–2	R ≈ 795 Ω at 900° C	U ≈ 2.21 V at 900° C
1–2	R ≈ 849 Ω at 1000° C	U ≈ 2.30 V at 1000° C

Checking negative cable, oil temperature switch



Tools:
885675 Break out cable
9812519 Multimeter

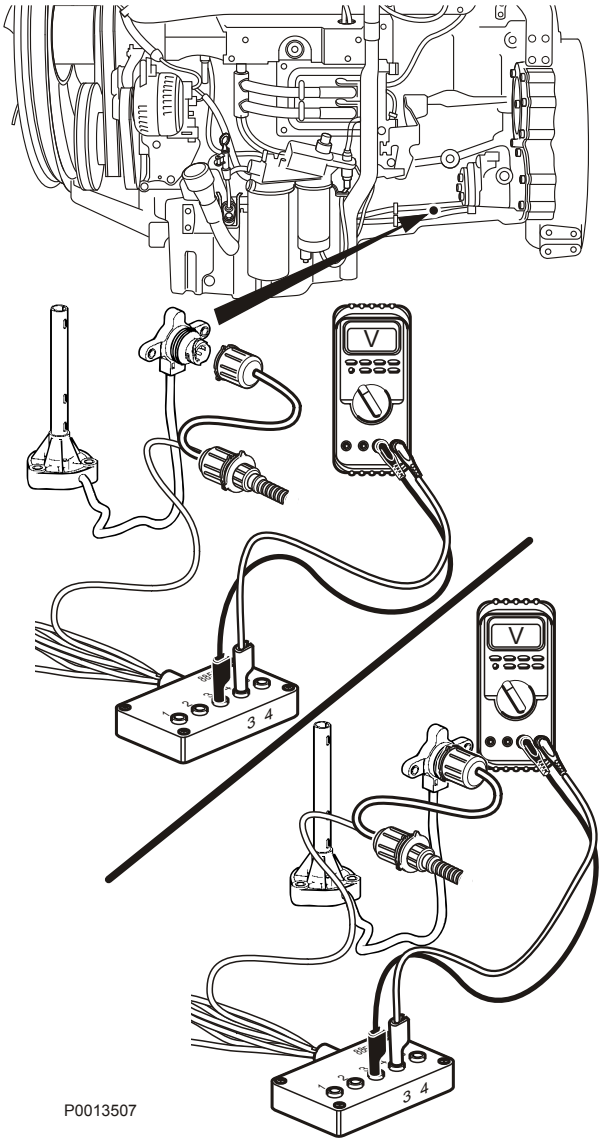
1 **NOTICE!** Cut the current with the main switch.

2 Disconnect the connector from the sensor.

3 Connect adapter cable 885675 to the cable harness connector to the engine control unit.

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

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



Checking signal cable, oil temperature switch

Tools:
885675 Break out cable
9812519 Multimeter

1 **NOTICE!** Turn ignition off.

2 Disconnect the connector from the sensor.

3 Connect adapter cable 885675 to the cable harness connector to the engine control unit.

4 Use multimeter 9812519 for voltage measurement.

5 Turn ignition on.

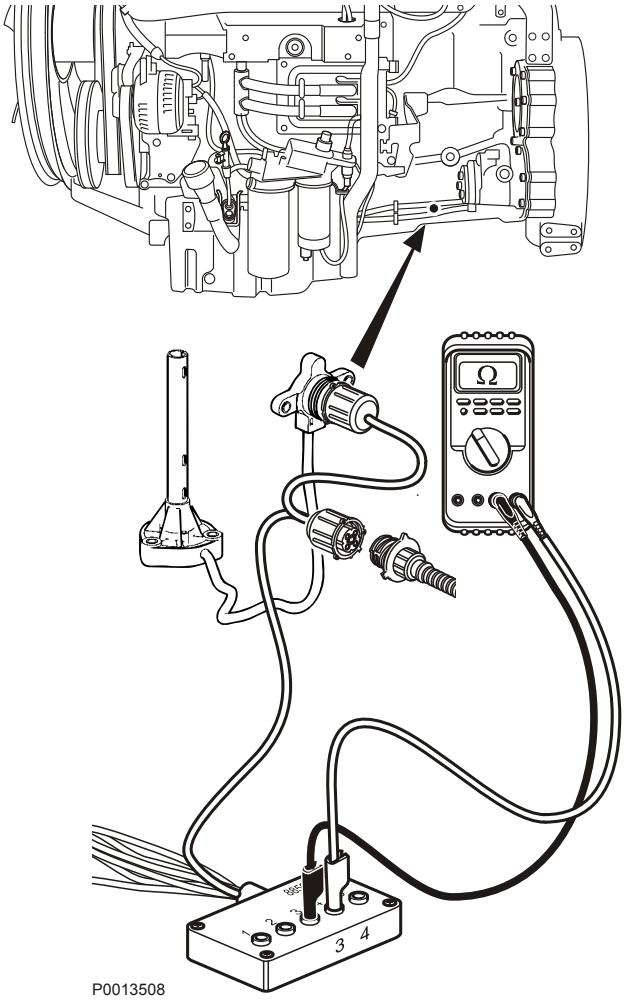
Measurement points	Nominal value
3–4	U ≈ 5 V

1 Turn ignition off.

2 Connect adapter cable 885675 between the sensor and the engine control unit.

3 Turn ignition on.

Measurement points	Nominal value
3–4	U ≈ 0.5-4.5 V (depended of the temperature)



Checking oil temperature sensor

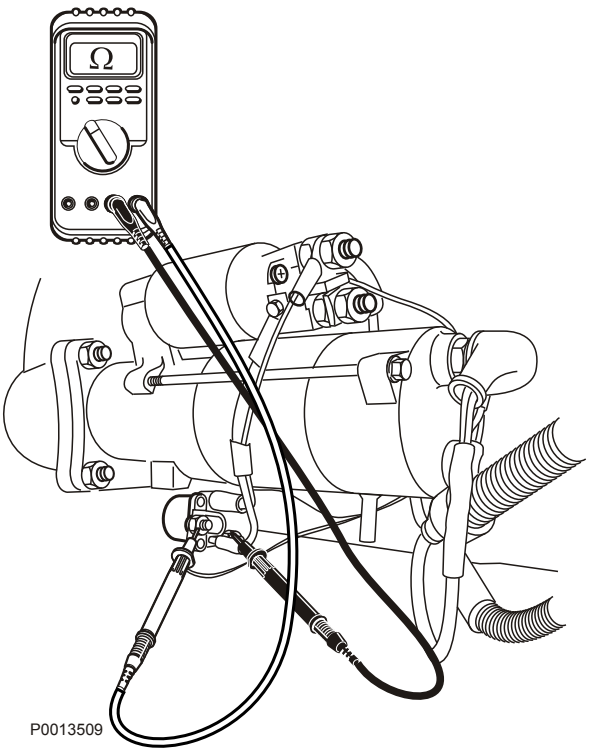
Tools:
885675 Break out cable
9812519 Multimeter

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

2 Connect adapter cable (885675) to the sensor. Do not connect the other end of the adapter cable.

3 Use multimeter 9812519 to do resistance measurement.

Measurement points	Nominal value
3–4	R ≈ 4981 Ω +/- 503 Ω (at 0°C)
3–4	R ≈ 1900 Ω +/- 163 Ω (at 20°C)
3–4	R ≈ 809 Ω +/- 59 Ω (at 40°C)
3–4	R ≈ 378 Ω +/- 24 Ω (at 60°C)
3–4	R ≈ 191 Ω +/- 10 Ω (at 80°C)
3–4	R ≈ 104 Ω +/- 5 Ω (at 100°C)
3–4	R ≈ 60 Ω +/- 3 Ω (at 120°C)



Checking starter motor relay

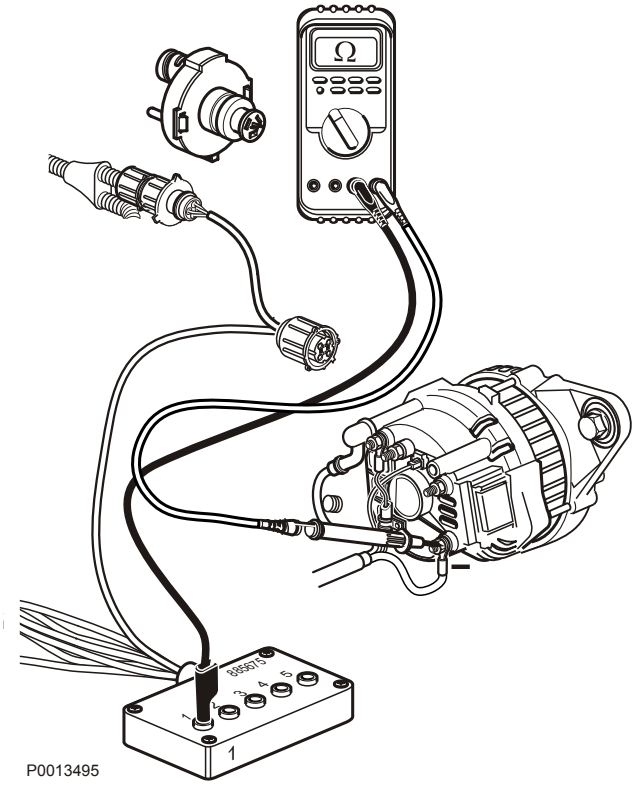
Tools:
9812519 Multimeter

1 **NOTICE!** Turn off the main switch.

2 Undo the red/yellow cable on the startermotor.

3 Use multimeter 9812519 to do resistance measurement towards the relay.

Nominal value
R ≈ 8 – 14 Ω



Checking negative cable, air filter pressure switch

Tools:
885675 Break out cable
9812519 Multimeter

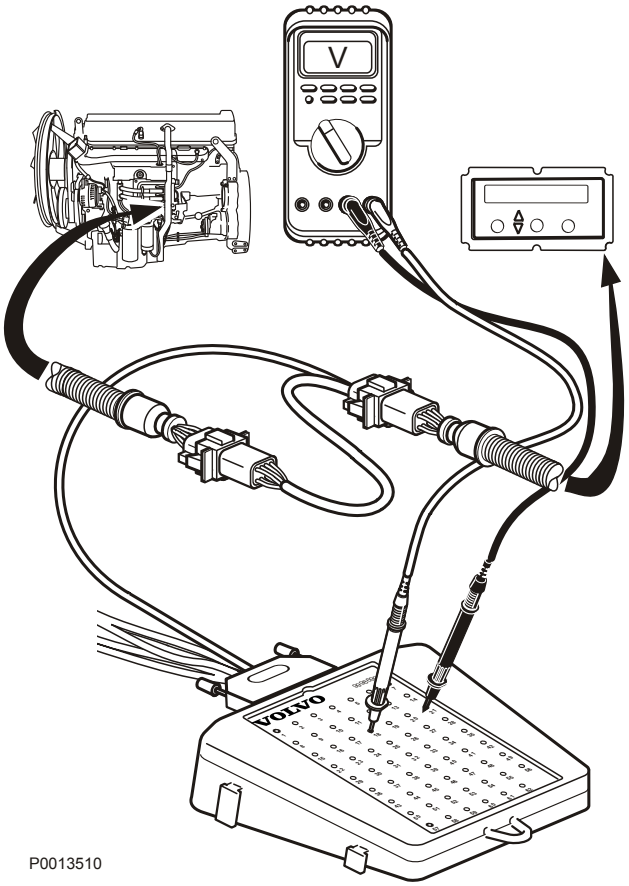
1 **NOTICE!** Cut the current with the main switch.

2 Disconnect the connector from the switch.

3 Connect adapter cable 885675 to the cable harness connector to the engine control unit.

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

Measurement points	Nominal value
1 – Battery negative	R ≈ 0 Ω



P0013510

Checking stop signal cable between ECU and CIU/DCU

Tools:
88890016 Break out cable
9998699 Break-out box
9812519 Multimeter

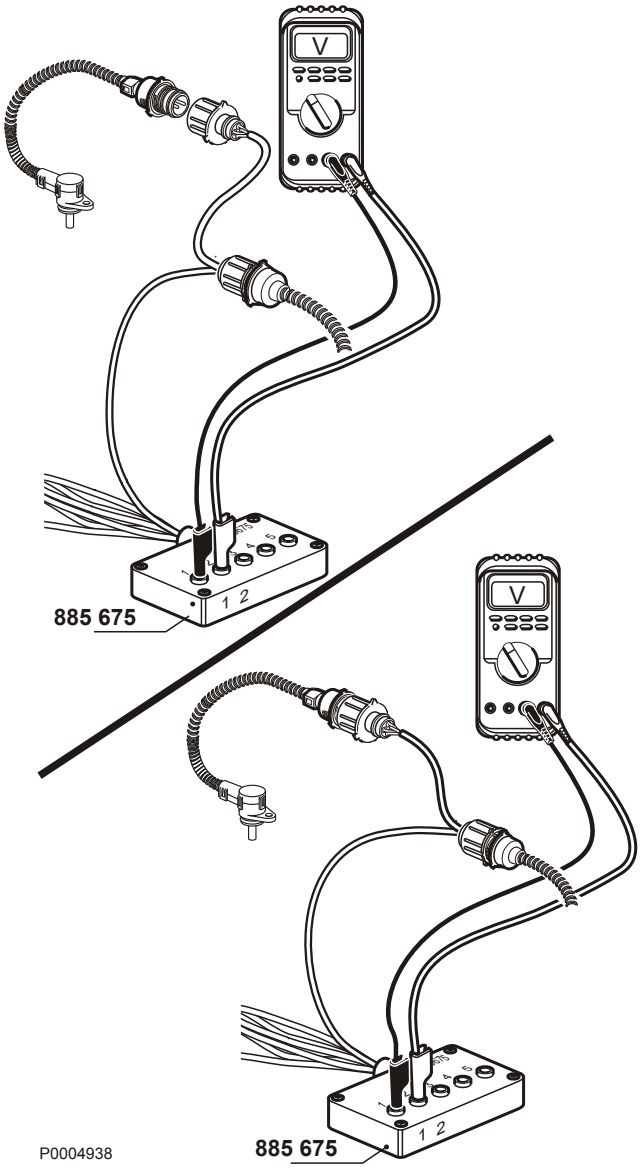
1 **NOTICE!** Cut the current with the main switch.

2 Connect adapter cable 88890016 with measurebox 9998699 between the engine and the CIU/DCU. Use the engine connector.

3 Use multimeter 9812519 for voltage measurement.

4 Turn ignition on.

Measurement points in measurebox	**Nominal value**
18 – 21 (energized to stop)	U ≈ 0,8 x battery voltage
18 – 21 (energized to run)	U ≈ Battery voltage



Checking signal cable, coolant temperature switch

Tools:
885675 Break out cable
9812519 Multimeter

1 **NOTICE!** Turn ignition off.

2 Disconnect the connector from the sensor.

3 Connect adapter cable 885675 to the cable harness connector to the engine control unit.

4 Use multimeter 9812519 for voltage measurement.

5 **NOTICE!** Turn ignition on.

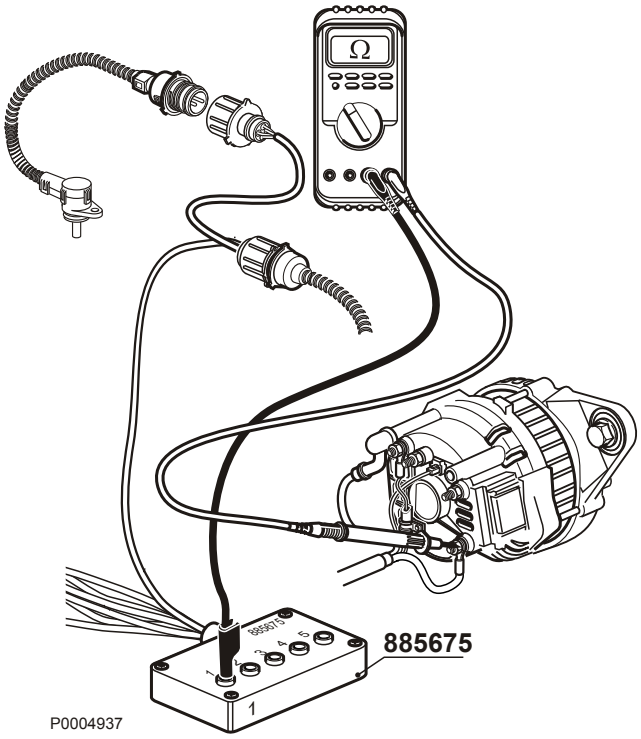
Measurement points	Nominal value
1–2	U ≈ 5 V

1 Turn ignition off.

2 Connect adapter cable 885675 between the sensor and the engine control unit.

3 Turn ignition on.

Measurement points	Nominal value
1–2	U ≈ 0.5 – 4.5 V (depended of the temperature)



Checking negative cable, coolant temperature switch

Tools:
885675 Break out cable
9812519 Multimeter

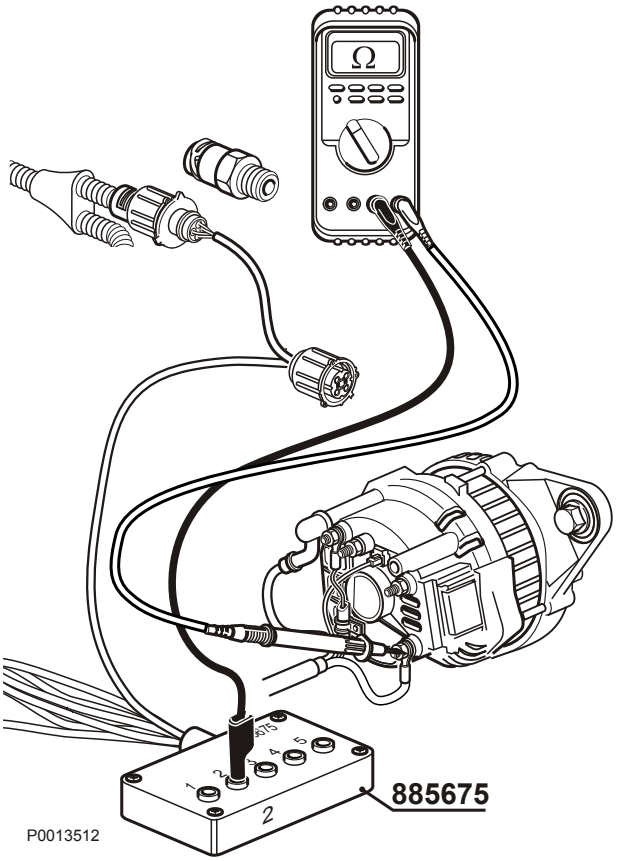
1 **NOTICE!** Cut the current with the main switch.

2 Disconnect the connector from the sensor.

3 Connect adapter cable 885675 to the cable harness connector to the engine control unit.

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

Measurement points	Nominal value
1 – Battery negative	R ≈ 0 Ω



Checking negative cable, piston cooling oil temperature switch

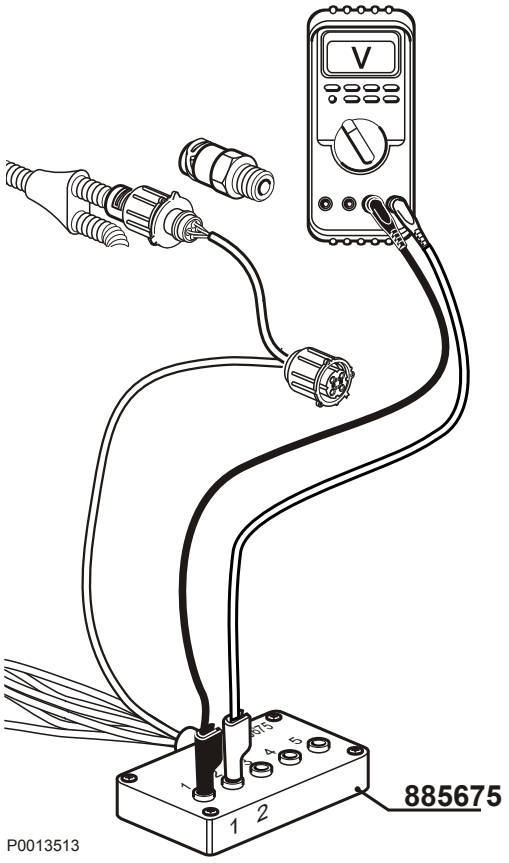
Tools:
9998534 Break out cable
9812519 Multimeter

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

2 Undo the connector from the switch. Connect the adapter cable (9998534) to the cable harness connector that is connected to the engine control unit.

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

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



Checking supply cable, piston cooling oil temperature switch

Tools:
9998534 Break out cable
9812519 Multimeter

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

2 Undo the connector from the switch. Connect the adapter cable (9998534) to the cable harness connector that is connected to the engine control unit.

3 Use multimeter (9812519) for voltage measurement.

4 Turn the starter key to position I (drive position).

Measurement points	Nominal value
1–2	U ≈ 0.8 x Battery voltage

Checking the IEGR coil

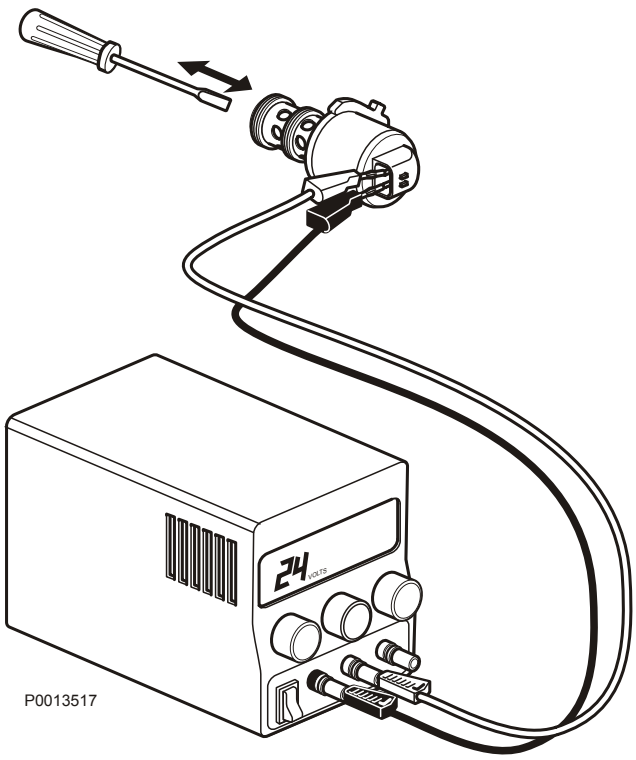
Tools:
9990014 Break out cable
9998699 Break-out box
9812519 Multimeter

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

2 Connect adapter cable 9990014 with measurebox 9998699 between EMS 2 (connector B) and the IEGR.

3 Use multimeter 9812519 to measure the resistance in the IEGR coil and cable harness.

Measurement points	Nominal value
30 – 60	R ≈ 33 – 49 Ω



Checking IEGR solenoid

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

2 Remove the IEGR solenoid. Please see workshop manual Group 21-26 for reference how to remove the IEGR solenoid.

3 One part of the solenoid is spring loaded. Press gently down that part with a screwdriver and hold.

4 Connect a 24 volt power supply to the IEGR electrical connection. The solenoid should now make a click when alter its position and one should feel a pressure in the screwdriver.

Checking supply cable, coldstart valve

Tools:
885675 Break out cable
9812519 Multimeter

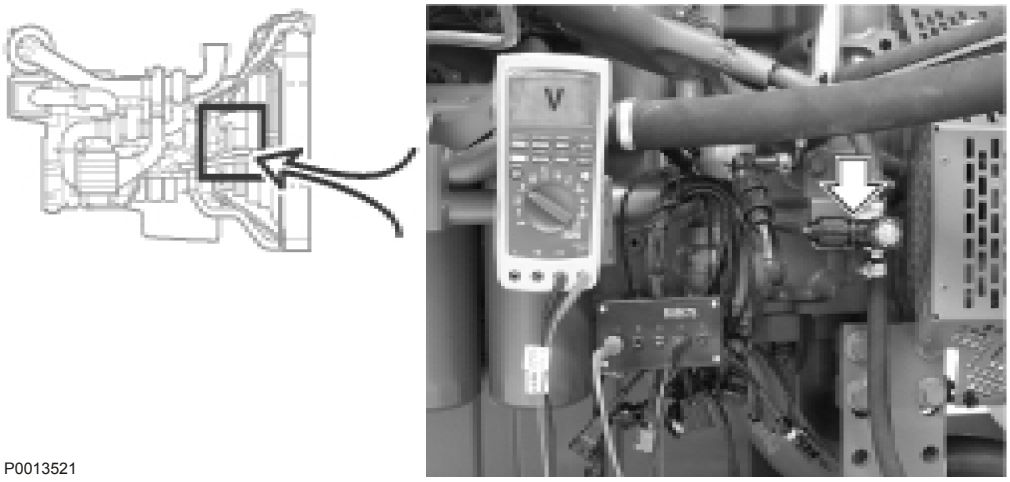
1 **NOTICE!** Turn ignition off.

2 Remove the connector from the valve. Connect adapter cable 885675 between the valve and engine control unit.

3 Use multimeter 9812519 for voltage measurement.

4 Turn ignition on.

Measurement points	Nominal value
1 - 4 (valve activated)	U ≈ battery voltage
1 - 4 (valve not activated)	U ≈ 0V



P0013521

Checking negative cable, coldstart valve

Tools:
885675 Break out cable
9812519 Multimeter

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

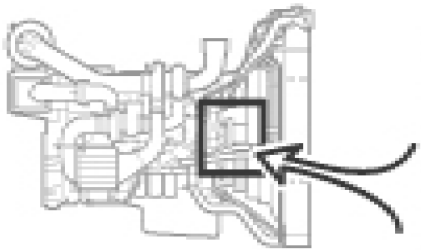
2 Disconnect the connector from the valve.

3 Connect adapter cable 885675 to the valve.

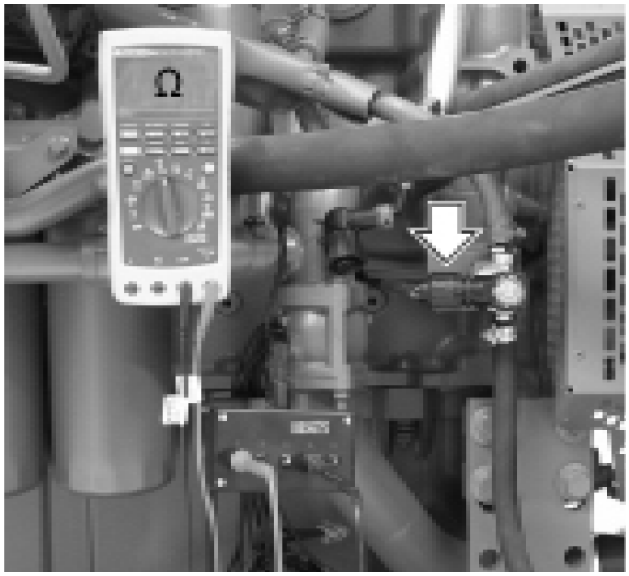
4 Use multimeter 9812519 to do resistance measurement.

Measurement points	Nominal value
1 – Battery negative	R ≈ 0 Ω

Also do a continuity test between 1 - 4 to verify that the coil inside the valve is intact.



P0013522



Trimming the injector

The electronic trim strategy is used to ensure that all injectors run with nominal timing and fuel delivery. This is achieved by adjusting the beginning and end of the electronic drive waveform for each actuator to compensate for spread in actuation and deactuation times of the two actuators in each injectors and to correct for variations in fuelling due to nozzle flow variations.

NOTICE! Write down the new injector's code before installation. The code consists of 9 characters and is on the injector's electric connector under the SN number.

1 Connect Vodia and switch on the current for the engine.

2 Go into the ”Service and maintenance” menu in Vodia.

3 Select ”Parameter, programming”.

4 Press ”Play”.

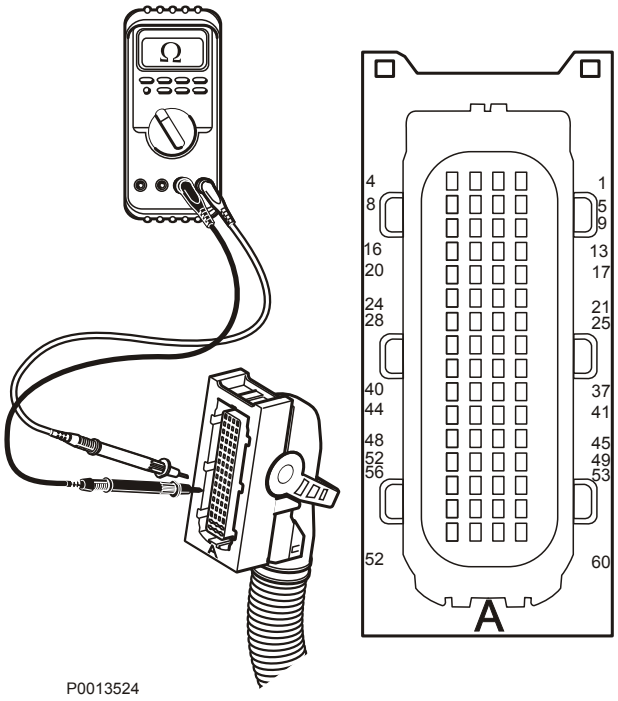
5 Select the cylinder number corresponding to the injector which has been changed.

6 Enter the new injector's code. Click ”OK”.

7 Close ”Parameter, programming”.

8 Vodia will ask you to ”Turn off the main switch”, then follow the instructions.

9 Report the parameters back as in items 10 - 13 in ”Programming the control unit”.



Checking the injector wiring

Tools:
9812519 Multimeter

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

2 Turn the main switch off.

IMPORTANT!
The system must be disconnected from system voltage and the starter key must be in position 0 when the engine control unit connector is disconnected or connected.

3 Remove the connector from the engine control unit. Move the lock catch (1) upwards and pull the connector (2) out.

4 Use multimeter 9812519 to measure the resistance in the engine cable's black (upper) connector for the injectors.

IMPORTANT!
Be very careful when measuring inside the connector, to ensure that no pin is damaged.

NOTICE! The measurement should exclude short circuiting or open circuit in the cable to the injector.

Measurement points in connector A		**Nominal value**
20 – 62	Cylinder 1	R ≈ 1.4 – 3 Ω (at 20° C)
12 – 62	Cylinder 2	R ≈ 1.4 – 3 Ω (at 20° C)
28 – 62	Cylinder 3	R ≈ 1.4 – 3 Ω (at 20° C)
24 – 59	Cylinder 1	R ≈ 1.4 – 3 Ω (at 20° C)
16 – 59	Cylinder 2	R ≈ 1.4 – 3 Ω (at 20° C)
32 – 59	Cylinder 3	R ≈ 1.4 – 3 Ω (at 20° C)
52 – 61	Cylinder 4	R ≈ 1.4 – 3 Ω (at 20° C)
44 – 61	Cylinder 5	R ≈ 1.4 – 3 Ω (at 20° C)
36 – 61	Cylinder 6	R ≈ 1.4 – 3 Ω (at 20° C)
56 – 60	Cylinder 4	R ≈ 1.4 – 3 Ω (at 20° C)
48 – 60	Cylinder 5	R ≈ 1.4 – 3 Ω (at 20° C)
40 – 60	Cylinder 6	R ≈ 1.4 – 3 Ω (at 20° C)

Checking IEGR wiring

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

2 Remove the valve cover.

3 Remove the connector from the IEGR solenoid.

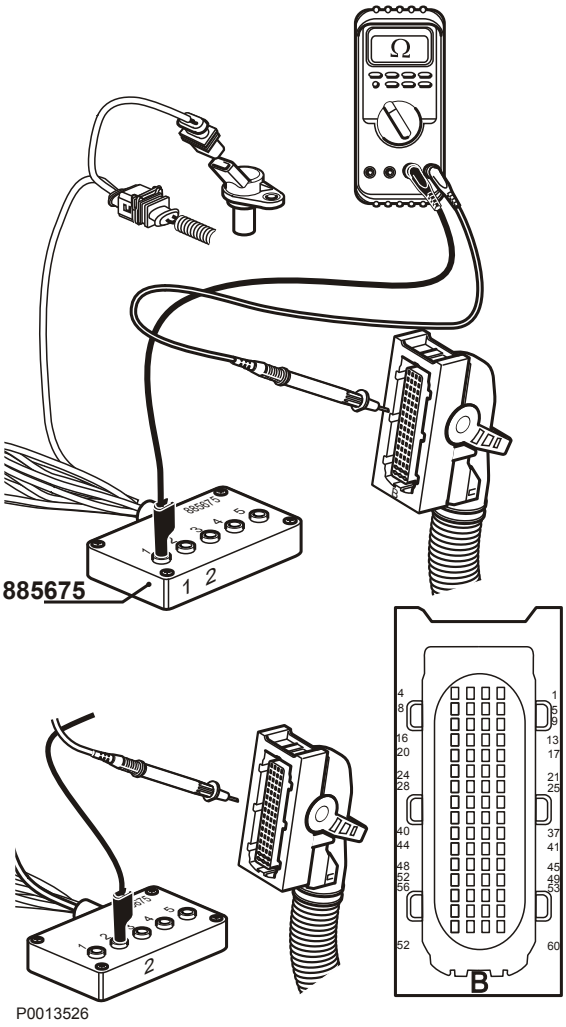
4 Remove connector B from the EMS2.

5 Use multimeter 9812519 to do a resistance measurement between connector B from the EMS2 to the loosend connector.

Measurement points	Nominal value
B30 – 1 (IEGR connector)	R ≈ 0 Ω
B57 – 2 (IEGR connector)	R ≈ 0 Ω
B60 – 2 (IEGR connector)	R ≈ 0 Ω
B30 – 2 (IEGR connector)	R ≈ ∞ Ω
B57 – 1 (IEGR connector)	R ≈ ∞ Ω
B60 – 1 (IEGR connector)	R ≈ ∞ Ω

IMPORTANT!

Be very careful when measuring inside the connector, to ensure that no pin is damaged.



Checking camshaft sensor wiring

Tools:
885675 Break out cable
9812519 Multimeter

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

2 Remove the connector from the sensor. Connect adapter cable 885675 to the connector.

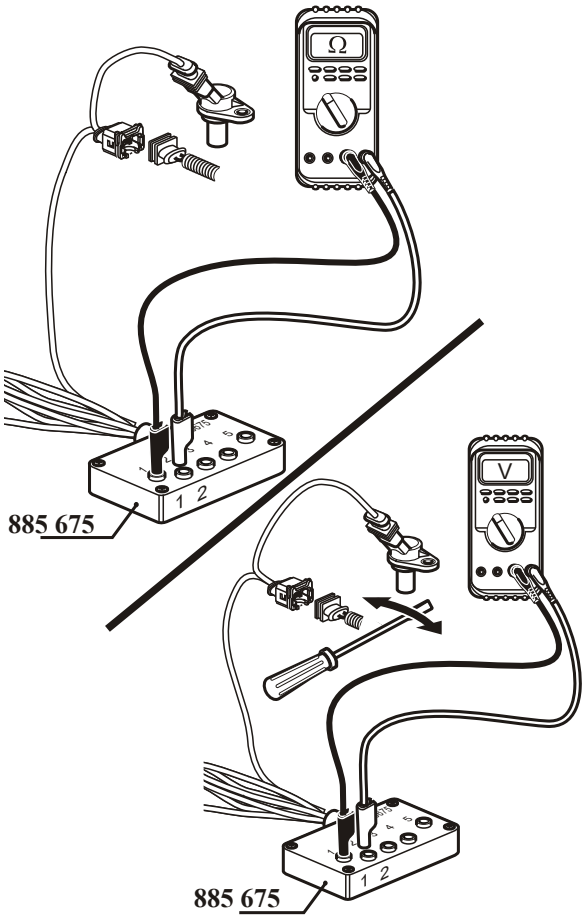
3 Remove connector A from the EMS2.

4 Use multimeter 9812519 to do a resistance measurement from the sensor connector to connector A to verify that neither of the wires are broken or short circuited.

Measurement points	Nominal value
1 (sensor conn.) – 38 (conn. A)	R ≈ 0 Ω
2 (sensor conn.) – 37 (conn. A)	R ≈ 0 Ω
1 (sensor conn.) – 2 (sensor conn.)	R ≈ ∞ Ω

IMPORTANT!

Be very careful when measuring inside the connector, to ensure that no pin is damaged.



P0008931

Checking camshaft sensor

Tools:
885675 Break out cable
9812519 Multimeter

1 **NOTICE!** 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.

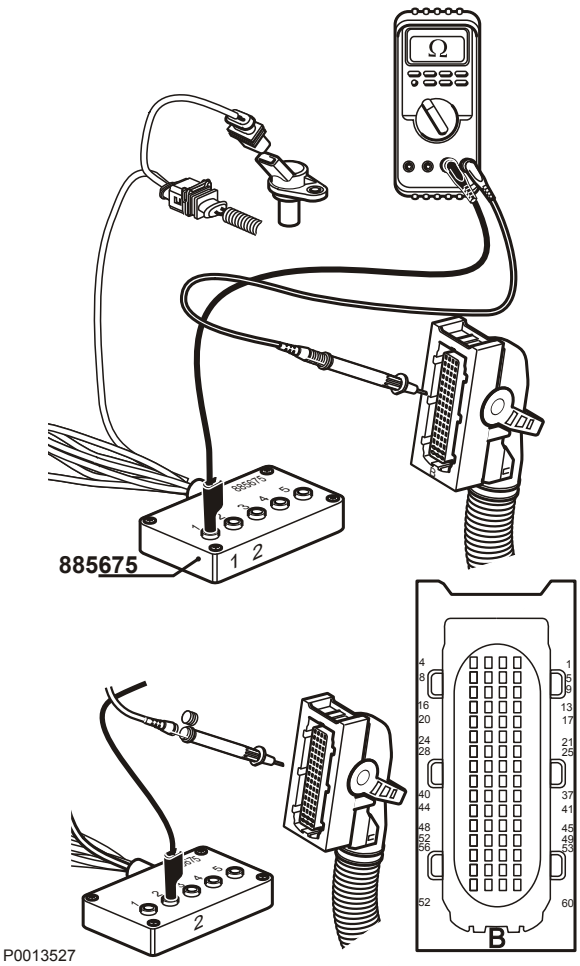
NOTICE! Do not connect the other end of the adapter cable to the engine cable harness, since this can cause a measurement error.

4 Use multimeter 9812519 for resistance measurement.

Measurement points	Nominal value
1 – 2	R ≈ 0,9 kΩ at 20°C

5 Use multimeter 9812519 for a AC 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 flywheel sensor wiring

Tools:
885675 Break out cable
9812519 Multimeter

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

2 Remove the connector from the sensor. Connect adapter cable 885675 to the connector.

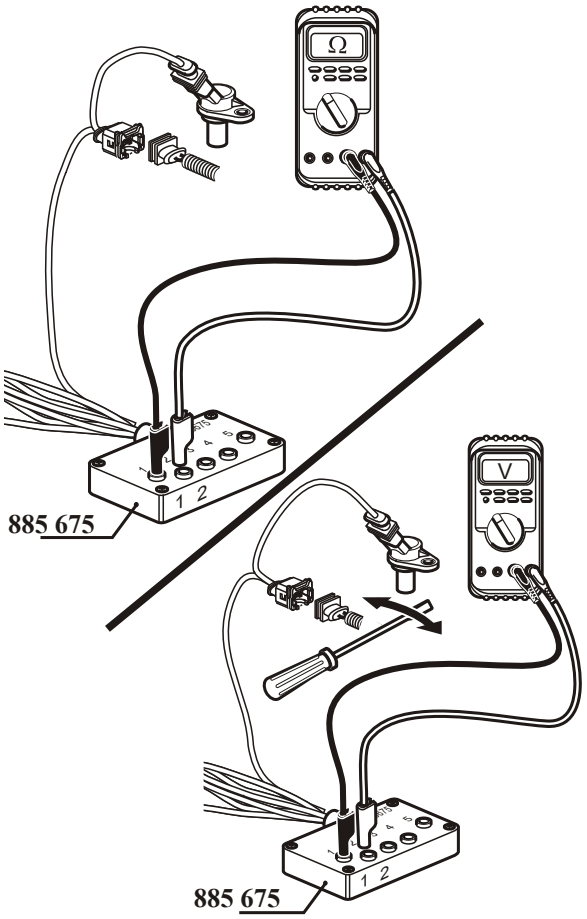
3 Remove connector A from the EMS2.

4 Use multimeter 9812519 to do a resistance measurement from the sensor connector to connector A to verify that neither of the wires are broken or short circuited.

Measurement points	Nominal value
1 (sensor conn.) – 38 (conn. A)	R ≈ 0 Ω
2 (sensor conn.) – 37 (conn. A)	R ≈ 0 Ω
1 (sensor conn.) – 2 (sensor conn.)	R ≈ ∞ Ω

IMPORTANT!

Be very careful when measuring inside the connector, to ensure that no pin is damaged.



P0008931

Checking flywheel sensor

Tools:
885675 Break out cable
9812519 Multimeter

1 **NOTICE!** 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.

NOTICE! 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 at 20°C

5 Use multimeter 9812519 for a AC 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 negative cable, wastegate valve

Tools:
88890053 Break out cable
9812519 Multimeter

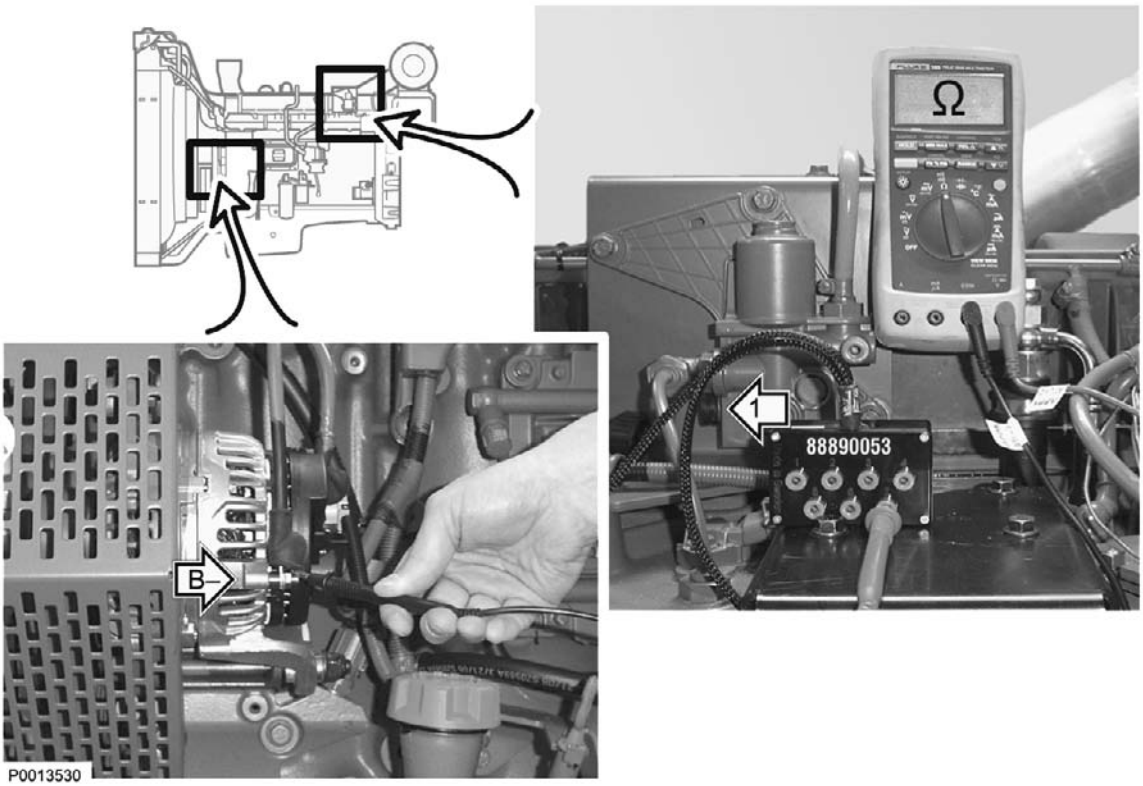
1 **NOTICE!** Cut the current with the main switch.

2 Disconnect the connector from the wastegate regulator(1).

3 Connect adapter cable 88890053 to the cable harness connector to the engine control unit.

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

Measurement points	Nominal value
7 – Battery negative(B-)	R ≈ 0 Ω



Checking supply cable, wastegate valve

Tools:
88890053 Break out cable
9812519 Multimeter

1 **NOTICE!** Turn ignition off.

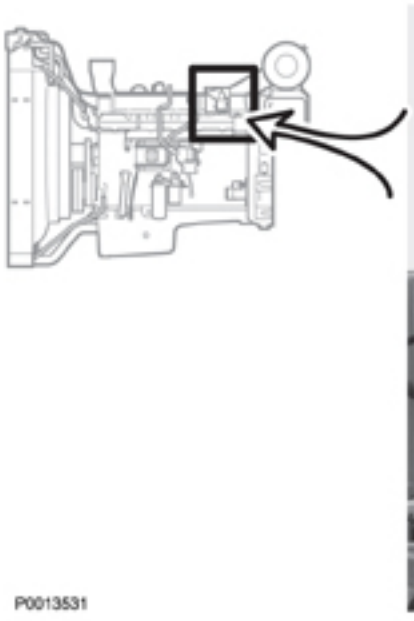
2 Remove the connector from the wastegate regulator.

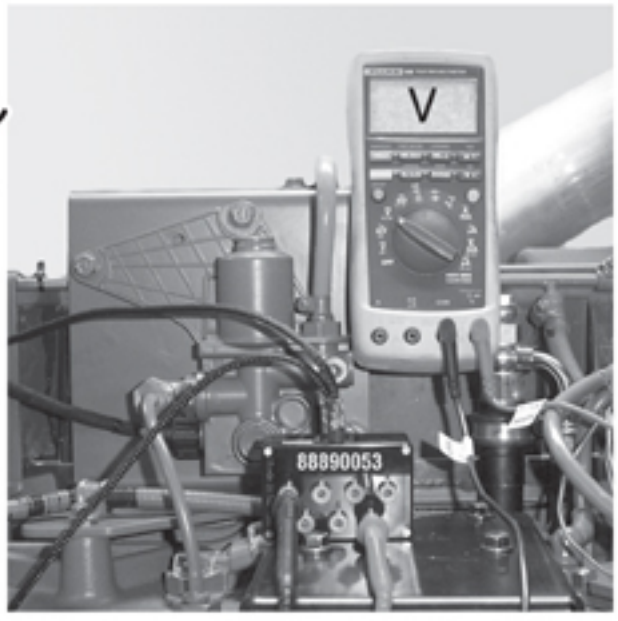
3 Connect adapter cable 88890053 between the wastegate regulator and engine control unit.

4 Use multimeter 9812519 for voltage measurement.

5 **NOTICE!** Turn ignition on.

Measurement points	Nominal value
1 – 7	U ≈ Battery voltage





Checking the wastegate valve

Tools:
885675 Break out cable
9812519 Multimeter

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

2 Remove the connector from the wastegate valve. Connect adapter cable 885675 to the valve.

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

3 Use multimeter 9812519 to check the resistance in the wastegate valve.

NOTICE! Measurement is done to eliminate short circuiting or breaks in the wastegate valve.

Measurement points	Nominal value
1–2	R = 90 ± 4.5 Ω at 20 °C (68°F)

Checking preheater relay

Tools:
9990014 Break out cable
9812519 Multimeter

1 **NOTICE!** Turn ignition off.

2 Remove connector B from the EMS2.

3 Connect adapter cable 9990014 between connector B and engine control unit.

4 Use multimeter 9812519 for voltage measurement.

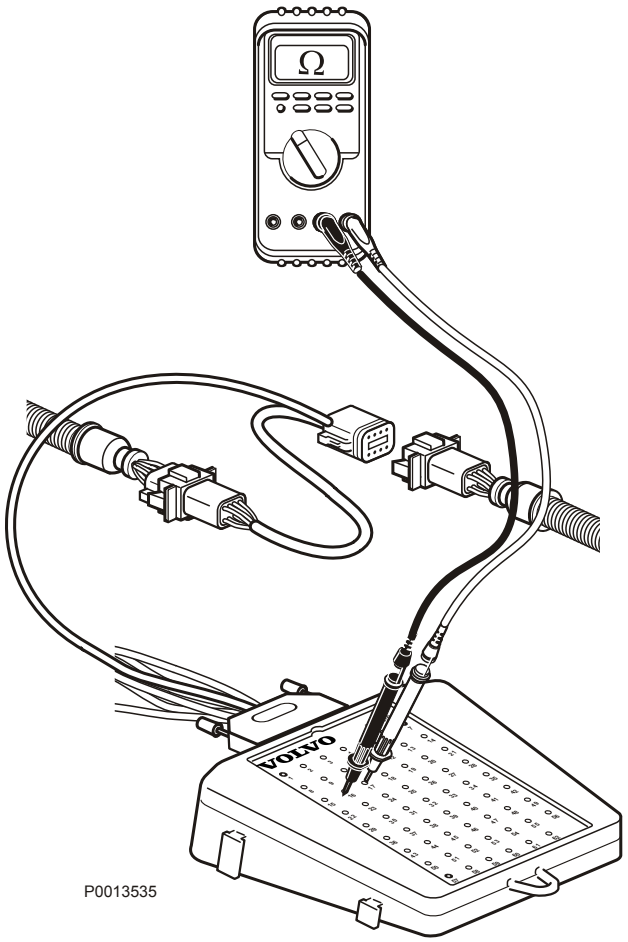
5 **NOTICE!** Turn ignition on.

Measurement points	Nominal value
B7 – B59	U ≈ 0 V

If there is an open circuit in the sense wiring circuit the multimeter will show:

Measurement points	Fault value
B7 – B59	U ≈ 19.5 V

Checking CAN bus cable



Tools:
9998699 Break-out box
88890016 Break out cable
9812519 Multimeter

The resistance of the CAN bus termination resistors, one 120 Ω resistor in the ECU and one 120 Ω resistor in the cable harness, are measured.

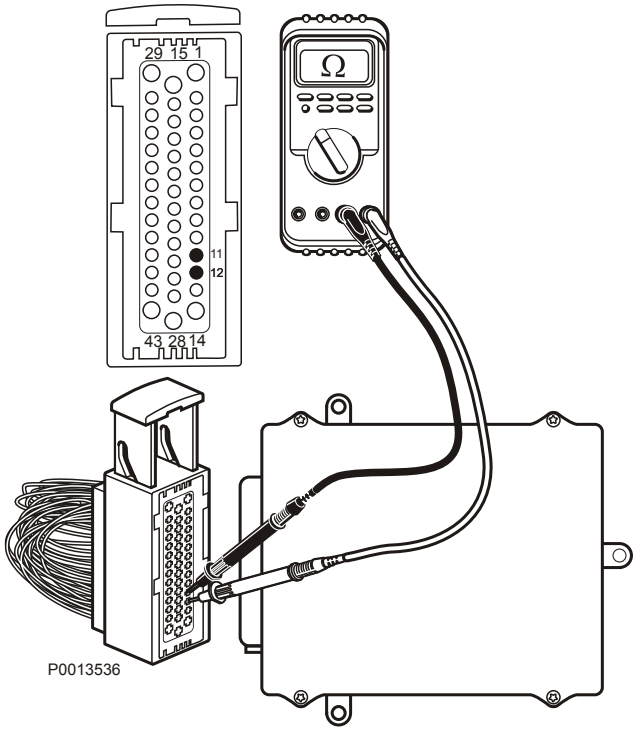
1 **NOTICE!** Cut the current with the main switch.

2 Disconnect the 8-pin Deutsch connector at the DCU or disconnect at the CIU.

3 Connect measurebox 9998699 with adaptercable 88890016 between the engine control unit and the DCU.

4 Use multimeter 9812519 to do resistance measurement towards the EMS 2.

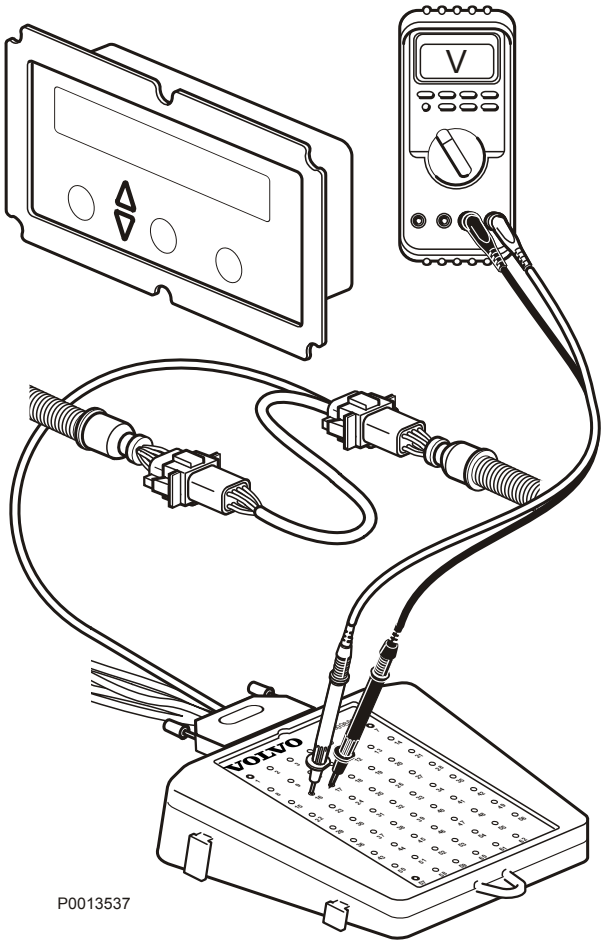
Measurement points	Nominal value
16–17	U ≈ 60 Ω



or

Measurement points in the CIU connector	Nominal value
11–12	U ≈ 60 Ω

NOTICE! Even if the measured value equals the nominal value the data bus cable could be faulty due to short circuit between a data bus cable and another cable in the harness.



1 Connect adapter cable 88890016 with measurebox 9998699 between the EMS 2 and the CIU/DCU.

2 Use multimeter 9812519 to a voltage measurement.

Measurement points in the measurebox	Nominal value
16 (CAN-H) – 18 (power supply 0V)	U ≈ 2.3 V – 2.7 V
17 (CAN-L) – 18(power supply 0V)	U ≈ 2.3 V – 2.7 V

NOTICE! Even if the measured value equals the nominal value the data bus cable could be faulty due to short circuit between a data bus cable and another cable in the harness.

Checking the CAN bus cable

Tools:
9812519 Multimeter
88890016 Break out cable
9998699 Break-out box

The resistance of the CAN bus termination resistors, one 120 Ω resistor in the ECU and one 120 Ω resistor in the cable harness, are measured.

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

2 Disconnect the 8-pin Deutsch connector at the DCU or disconnect at the CIU.

3 Use multimeter 9812519 to do resistance measurement towards the EMS 2.

Measurement points in the engine connector at the DCU	**Nominal value**
1–2	U ≈ 60 Ω

or

Measurement points in the CIU connector	**Nominal value**
11–12	U ≈ 60 Ω

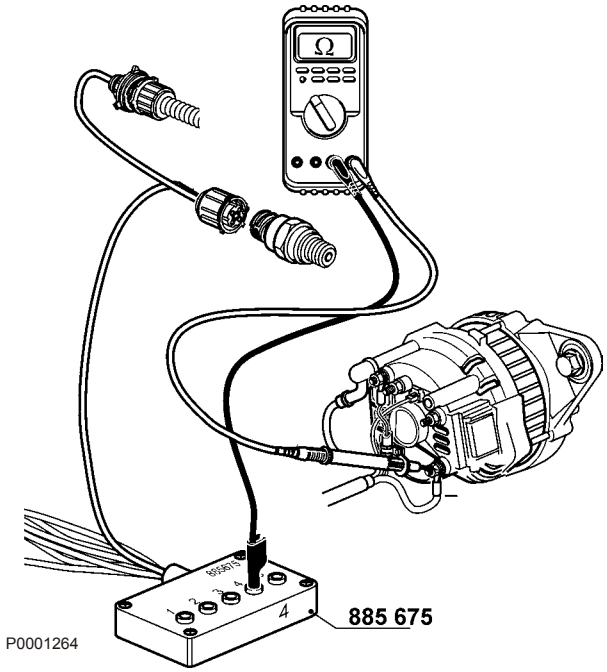
NOTICE! Even if the measured value equals the nominal value the data bus cable could be faulty due to short circuit between a data bus cable and another cable in the harness.

1 Connect adapter cable 88890016 with measurebox 9998699 between the EMS 2 and the CIU/DCU.

2 Use multimeter 9812519 to a voltage measurement.

Measurement points in the measurebox	**Nominal value**
16 – 17 (between CAN bus)	U ≈ 2.3 V – 2.7 V

NOTICE! Even if the measured value equals the nominal value the data bus cable could be faulty due to short circuit between a data bus cable and another cable in the harness.



Checking negative cable, crankcase pressure sensor

Tools:
885675 Break out cable
9812519 Multimeter

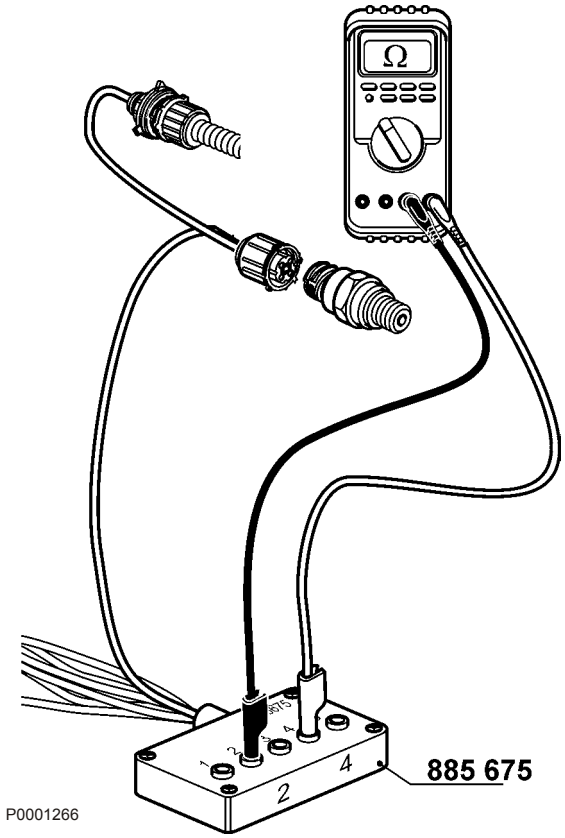
1 **NOTICE!** Cut the current with the main switch.

2 Disconnect the connector from the sensor.

3 Connect adapter cable 885675 to the cable harness connector to the engine control unit.

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

Measurement points	Nominal value
4 – Battery negative	R ≈ 0 Ω



Checking signal cable, crankcase pressure sensor

Tools:
885675 Break out cable
9812519 Multimeter

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

2 Disconnect the connector from the sensor.

3 Connect adapter cable 885675 to the cable harness connector to the engine control unit.

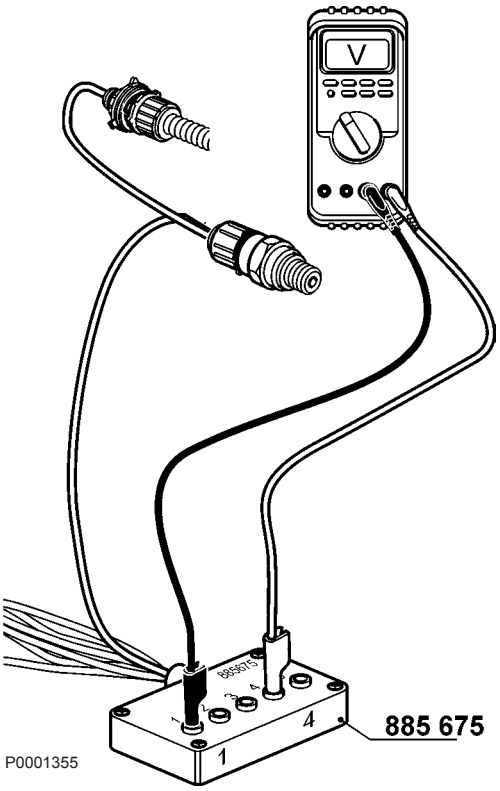
4 Use multimeter 9812519 to do resistance measurement against the engine control unit.

Measurement points	Nominal value
2 – 4	R ≈ 80 -120 kΩ

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

Checking supply cable, crankcase pressure sensor

Tools:
885675 Break out cable
9812519 Multimeter



1 **NOTICE!** Turn ignition off.

2 Remove the connector from the sensor. Connect adapter cable 885675 between the sensor and engine control unit.

3 Use multimeter 9812519 for voltage measurement.

4 **NOTICE!** Turn ignition on.

Measurement points	Nominal value
1 – 4	U ≈ 5 V

Vodia logging throttle signal

To verify the throttle signal on the J1587 bus do as follow:

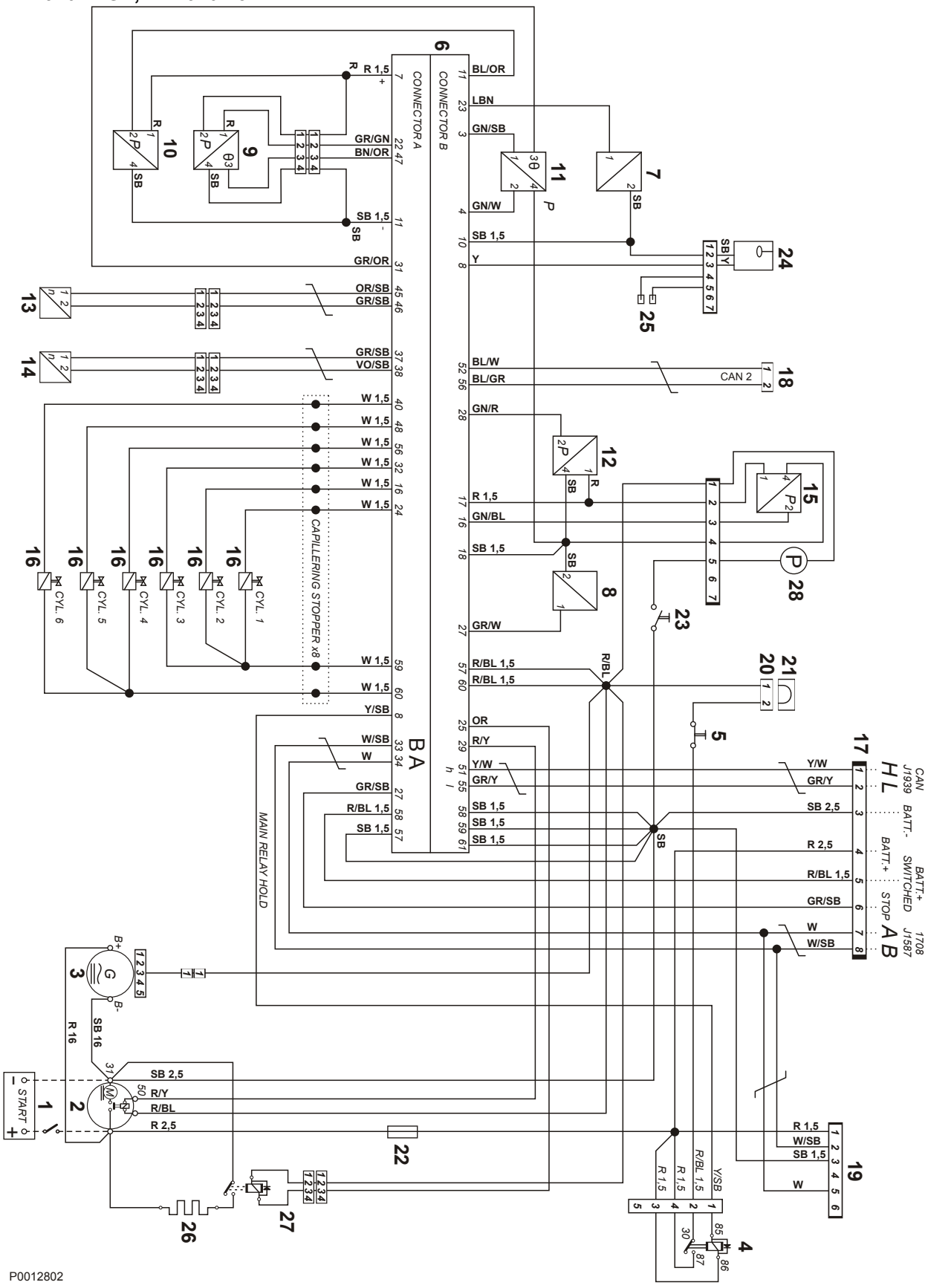
1 Choose “Log test” under the “Service and maintenance” menu.

2 Choose “MID 128, Accelerator Pedal Position” and “MID 144, Throttle Calibrated Position” and press play.

3 Verify that booth throttle values displayed in percentage by Vodia changes simultaneous while moving the throttle.

37-0 Wiring Diagrams

TAD940-41GE, TAD940-43



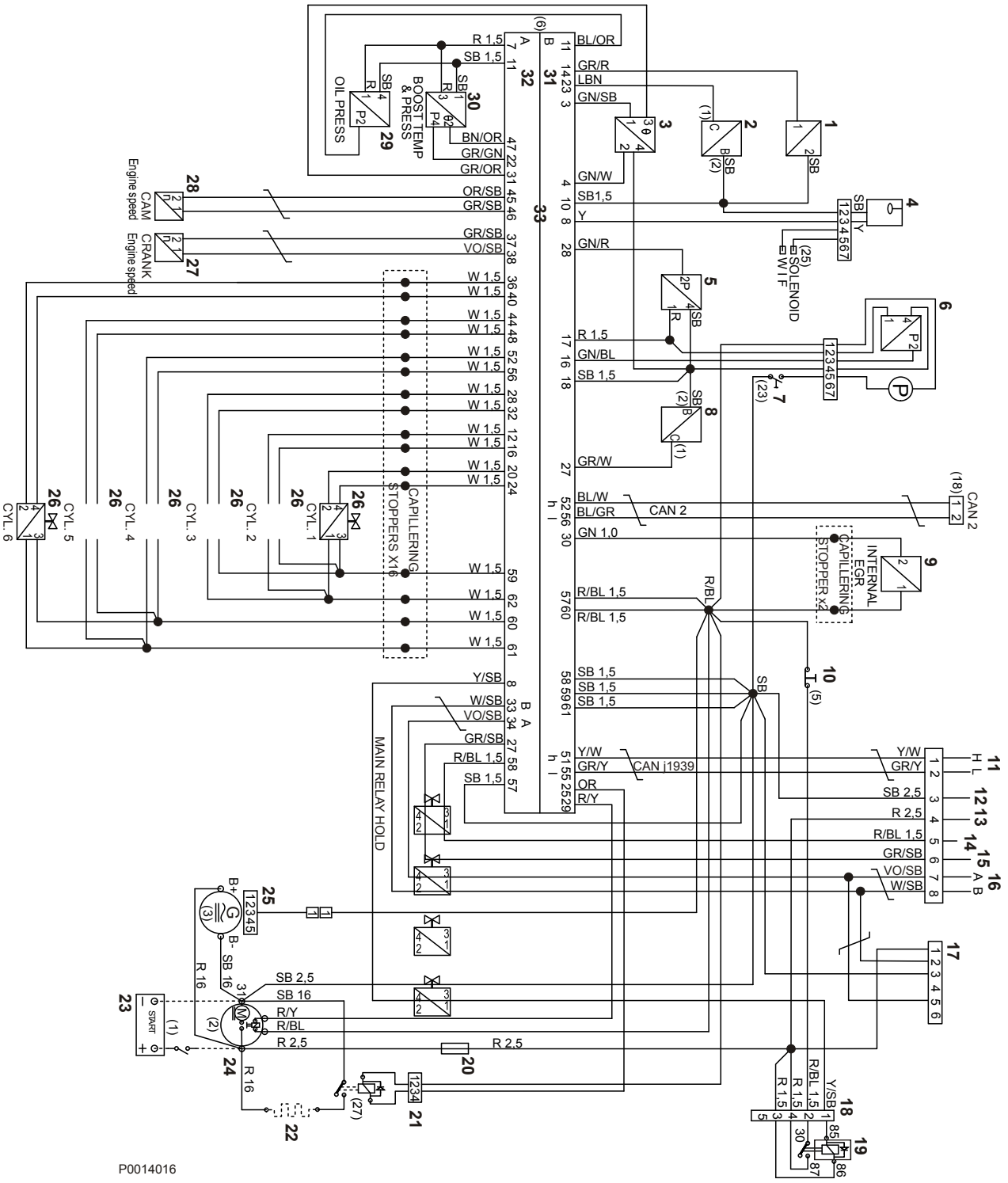
1 Battery
2 Starter motor
3 Alternator
4 Main relay
5 Stop switch
6 Control unit EDC
7 Sensor, coolant level
8 Sensor, coolant temperature
9 Sensor, air inlet pressure / inlet manifold temperature
10 Sensor, oil pressure
11 Sensor, oil level / oil temperature
12 Sensor, crankcase pressure
13 Sensor, camshaft
14 Sensor, flywheel
15 Sensor, fuel pressure
16 Unit injector (Cyl. 1-6)
17 Connector - engine interface
18 Connector - application tool
19 Connector - serial J1587
20 AUX STOP
21 Jumper - removeable
22 Fuse 10A
23 Switch - fuel pump
24 Switck - water in fuel
25 Connector - remote water in fuel
26 Pre-heater
27 Pre-heater relay
28 Fuel pump

Cable colors

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

Cable cross section = 0.75 mm^2 unless otherwise stated.

TAD950-952VE



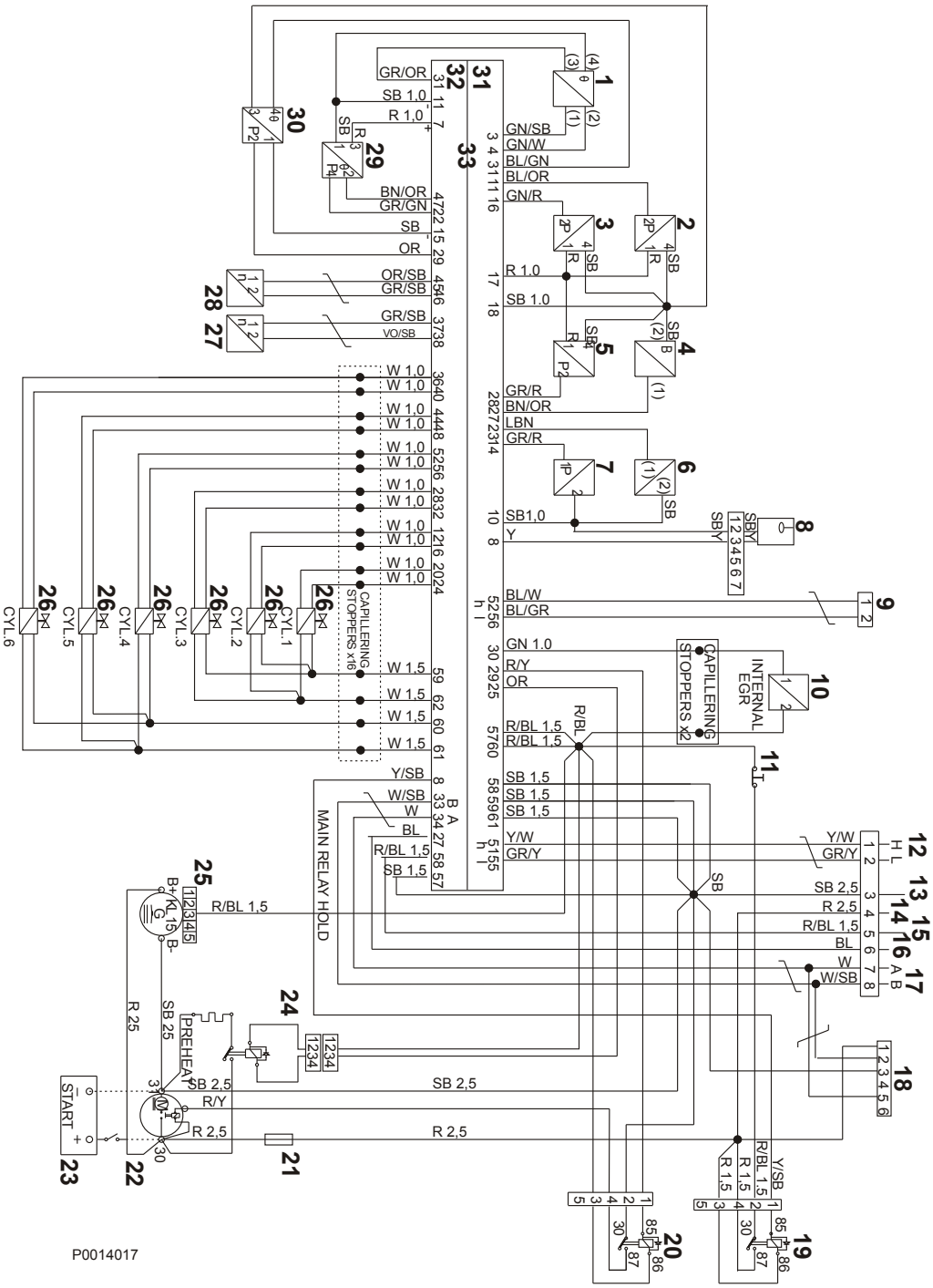
1 Switch, piston cooling
2 Switch, coolant level
3 Sensor, oil temperature and oil level
4 Switch, water in fuel
5 Sensor, crankcase pressure
6 Sensor, fuel pressure / fuel temp.
7 Switch for electric feed pump switch
8 Sensor, coolant temperature
9 Internal EGR
10 Extra stop
11 J1939 CAN (bus)
12 Battery negative
13 Battery plus
14 Voltage after key
15 Connection for stop button
16 J1587 / 1708 (bus)
17 Diagnostic outlet
18 Relay socket
19 Main relay
20 Main circuit breaker 10 A
21 Relay pre-heating
22 Pre-heating
23 Battery (24 V)
24 Starter motor
25 Alternator
26 Unit injector (Cyl. 1-6)
27 Sensor, flywheel
28 Sensor, camshaft
29 Sensor, oil pressure
30 Sensor, air inlet pressure / temperature
31 Connector block B
32 Connector block A
33 Control unit EMS 2

Cable colors

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

Cable cross section = 0.75 mm^2 unless otherwise stated.

TAD1250-1252VE



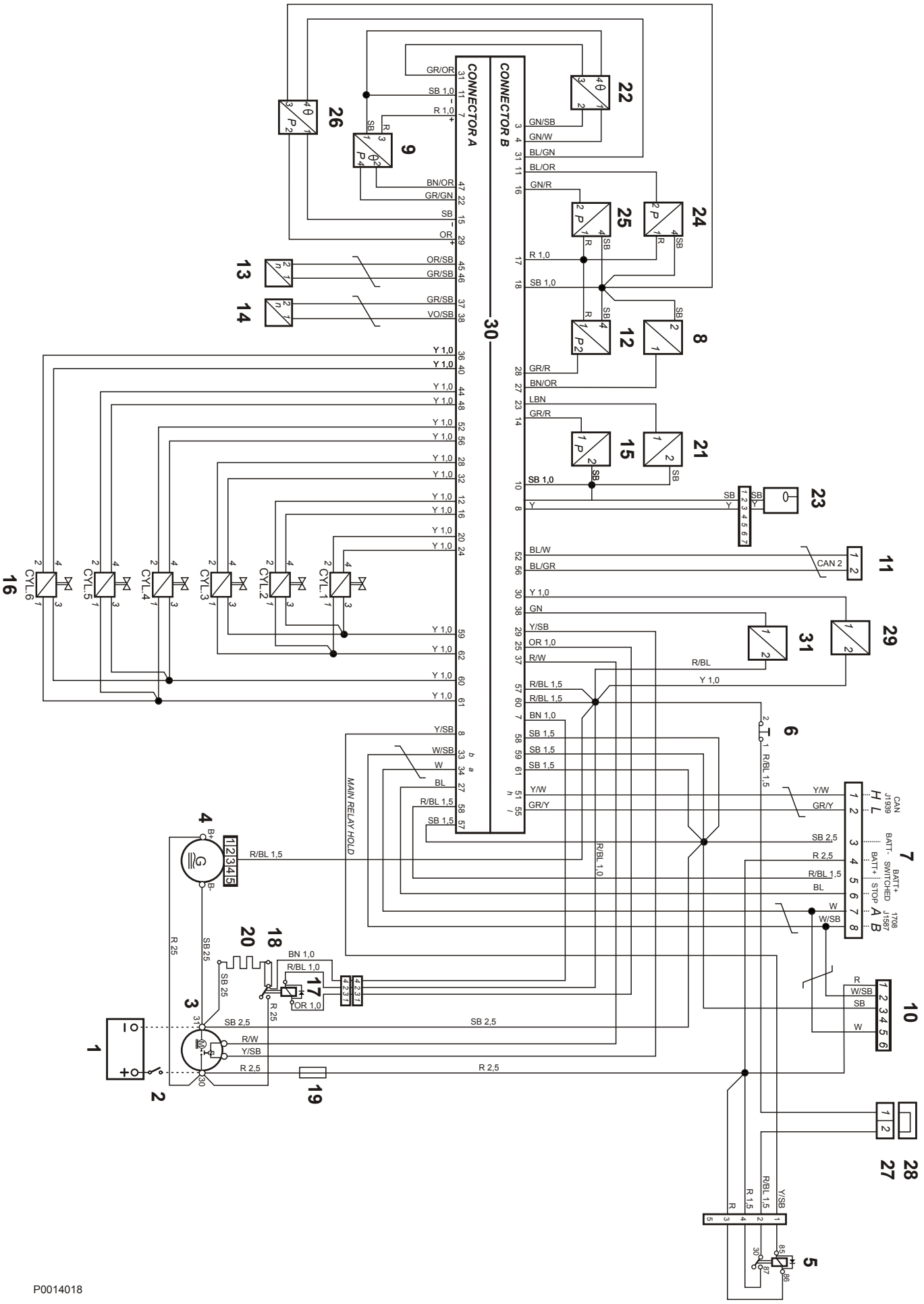
1 Sensor, oil level / oil temperature
2 Sensor, oil pressure
3 Sensor, fuel pressure
4 Sensor, coolant temperature
5 Sensor, crankcase pressure
6 Switch, coolant level
7 Switch, piston cooling pressure
8 Switch, water in fuel
9 Connector block (not used)
10 Internal EGR
11 Extra stop
12 J1939 CAN (bus)
13 Battery negative
14 Battery plus
15 Voltage after key
16 Stop button
17 J1587 / J1708 (bus)
18 Diagnostic tool
19 Main relay
20 Starter motor relay
21 Main circuit breaker 10 A
22 Starter motor
23 Battery (24 V)
24 Pre-heating
25 Alternator
26 Unit injector (Cyl. 1-6)
27 Sensor, flywheel
28 Sensor, camshaft
29 Sensor, air inlet pressure / temperature
30 Air filter indicator
31 Connector block B
32 Connector block A
33 Control unit EMS 2

Cable colors

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

Cable cross section = 0.75 mm^2 unless otherwise stated.

TAD1350-1352GE



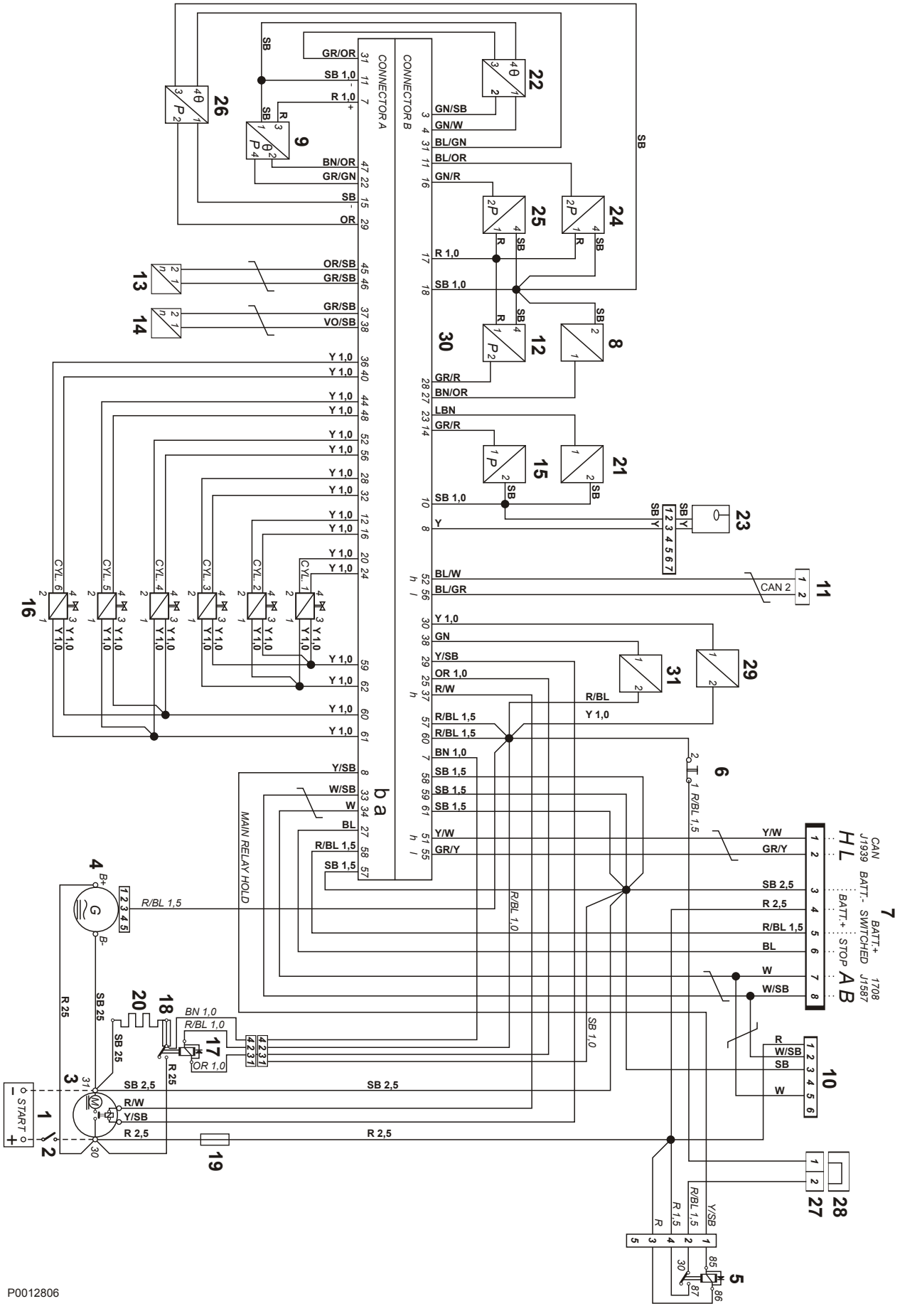
1 Battery
2 Main switch
3 Starter motor
4 Alternator
5 Main relay
6 Aux stop
7 Connector, engine interface
8 Sensor, coolant temperature
9 Sensor, air inlet pressure / inlet manifold temperature
10 VODIA input (diagnosis conn.)
11 Connector, development tool (not used)
12 Sensor, crankcase pressure
13 Sensor, camshaft
14 Sensor, flywheel
15 Switch, piston cooling
16 Unit injector (Cyl. 1-6)
17 Relay preheating
18 Fuse, preheating
19 Main circuit breaker 10 A
20 Preheater
21 Switch, coolant level
22 Sensor, oil level / oil temperature
23 Switch, water in fuel
24 Sensor, oil pressure
25 Sensor, fuel pressure
26 Air filter indicator
27 Connector, remote stop
28 Jumper removable
29 EGR internal
30 Control unit EMS 2.2
31 Wastegate valve

Cable colors

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

Cable cross section = 0.75 mm^2 unless otherwise stated.

TAD1353–55GE



P0012806

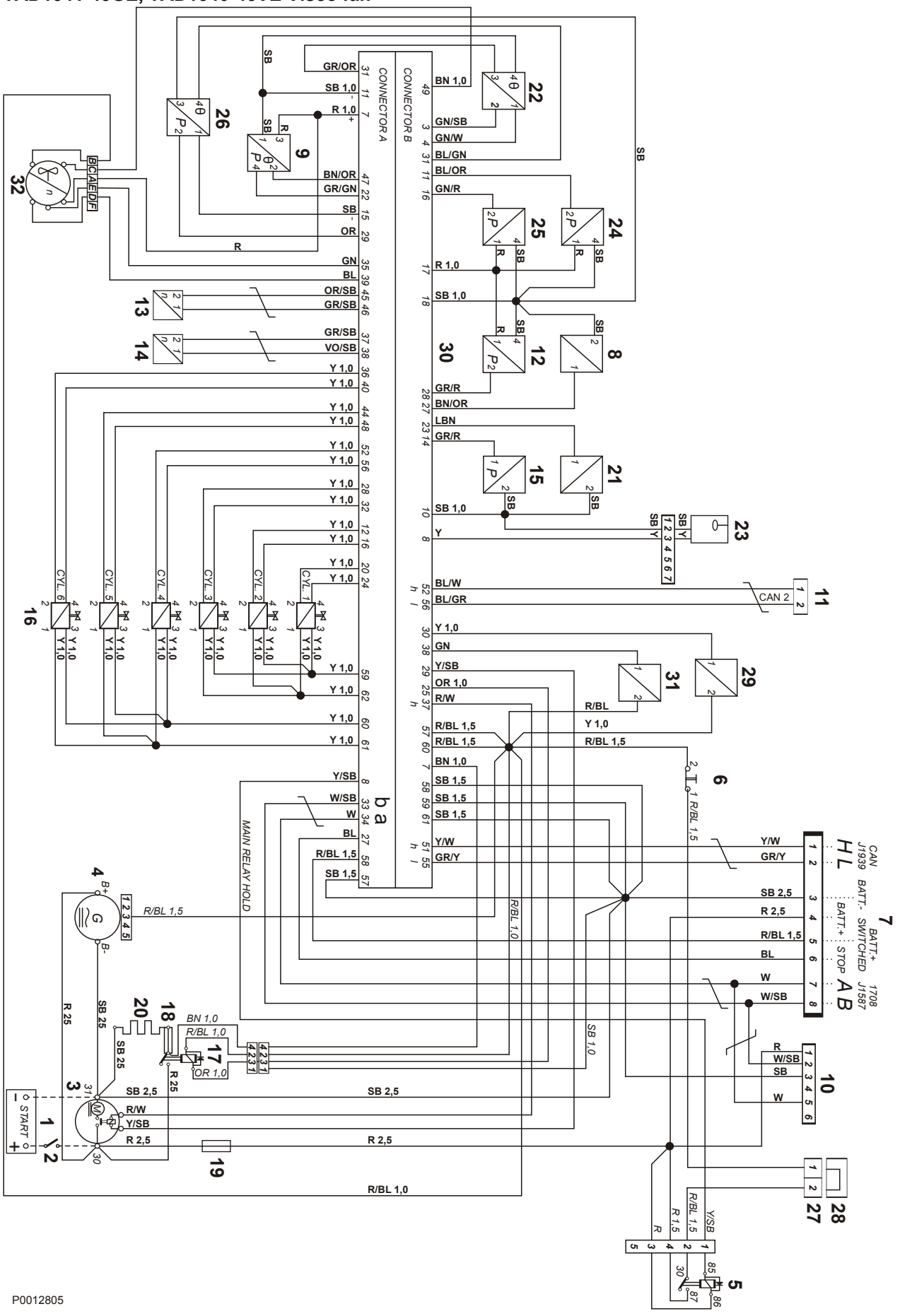
1 Battery
2 Main switch
3 Starter motor
4 Alternator
5 Main relay
6 Aux stop
7 Connector, engine interface
8 Sensor, coolant temperature
9 Sensor, air inlet pressure / inlet manifold temperature
10 VODIA input (diagnosis conn.)
11 Connector, development tool (not used)
12 Sensor, crankcase pressure
13 Sensor, camshaft
14 Sensor, flywheel
15 Switch, piston cooling
16 Unit injector (Cyl. 1-6)
17 Relay preheating
18 Fuse, preheating
19 Main circuit breaker 10 A
20 Preheater
21 Switch, coolant level
22 Sensor, oil level / oil temperature
23 Switch, water in fuel
24 Sensor, oil pressure
25 Sensor, fuel pressure
26 Air filter indicator
27 Connector, remote stop
28 Jumper removable
29 EGR internal
30 Control unit EMS 2.2
31 Wastegate valve

Cable colors

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

Cable cross section = 0.75 mm^2 unless otherwise stated.

TAD1341-45GE, TAD1340-45VE Visco fan



1 Battery
2 Main switch
3 Starter motor
4 Alternator
5 Main relay
6 Aux stop
7 Connector, engine interface
8 Sensor, coolant temperature
9 Sensor, air inlet pressure / inlet manifold temperature
10 VODIA input (diagnosis conn.)
11 Connector, development tool (not used)
12 Sensor, crankcase pressure
13 Sensor, camshaft
14 Sensor, flywheel
15 Switch, piston cooling
16 Unit injector (Cyl. 1-6)
17 Relay preheating
18 Fuse, preheating
19 Main circuit breaker 10 A
20 Preheater
21 Switch, coolant level
22 Sensor, oil level / oil temperature
23 Switch, water in fuel
24 Sensor, oil pressure
25 Sensor, fuel pressure
26 Air filter indicator
27 Connector, remote stop
28 Jumper removable
29 EGR internal
30 Control unit EMS 2.2
31 Wastegate valve
32 Visco elecric fan

Visco electric fan

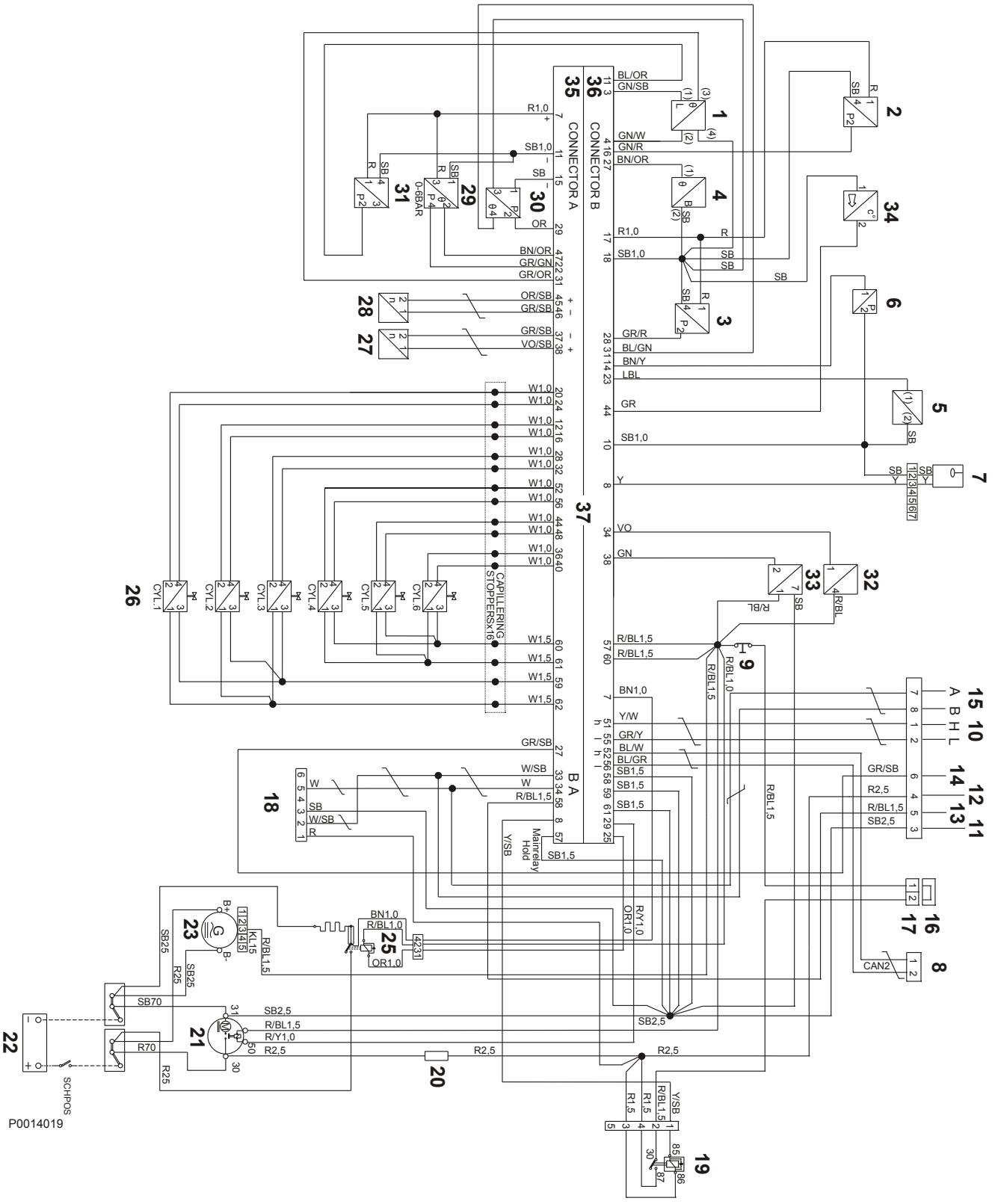
A = Fan speed sensor supply
B = Clutch contol high
C = Clutch control low
D = Fan speed sensor ground
E = Fan speed output
F = Not connected

Cable colors

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

Cable cross section = 0.75 mm^2 unless otherwise stated.

TWD1643GE


CONNECTOR A
CONNECTOR B
CAPILLERING STOPPERSx16
CYL.1
CYL.2
CYL.3
CYL.4
CYL.5
CYL.6
Mainrelay Hold
SCHPOS
CAN2
0-6BAR
P0014019

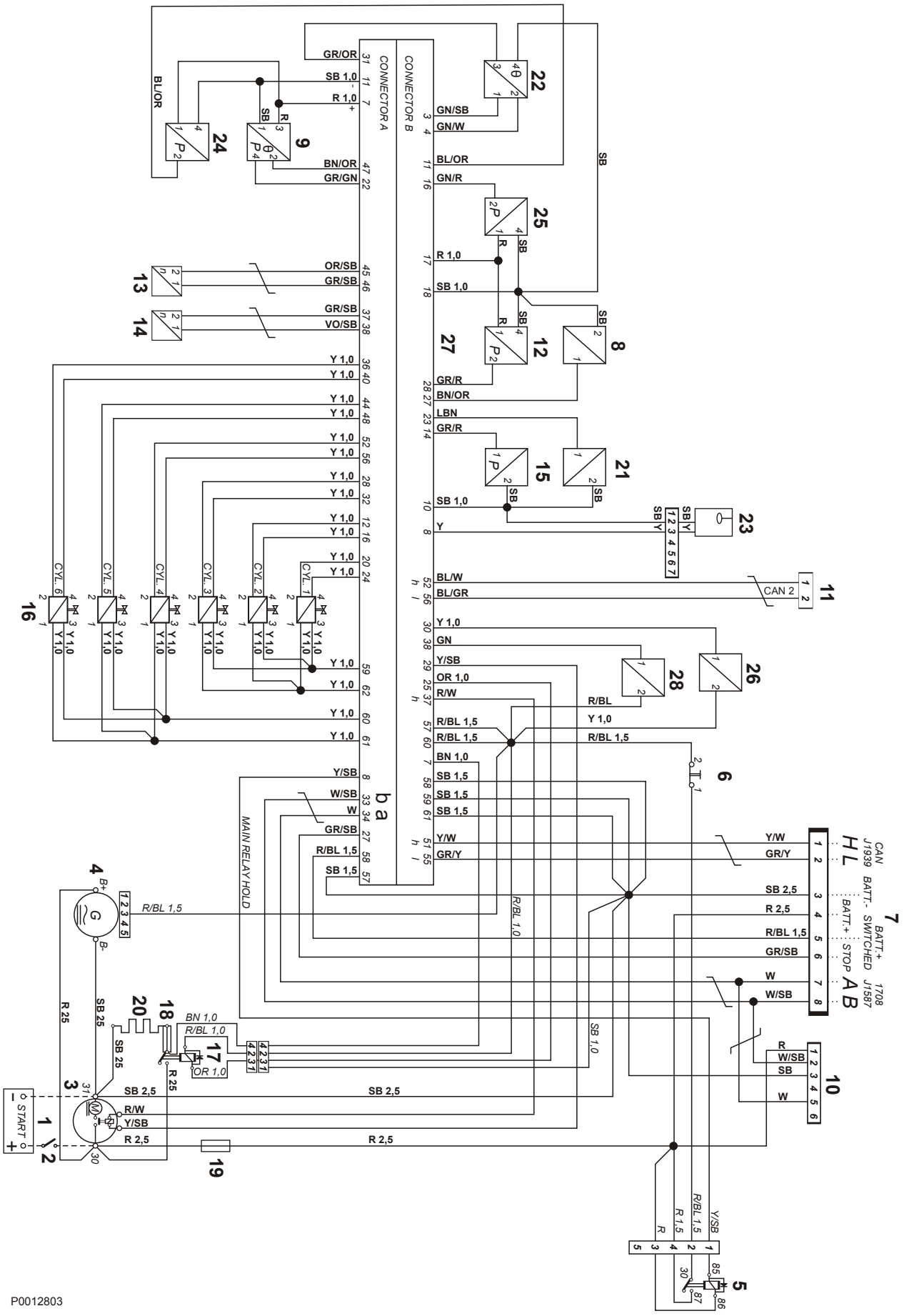
1 Sensor, oil level / oil temperature
2 Sensor, fuel pressure
3 Sensor, crankcase pressure
4 Sensor, coolant temperature
5 Switch, coolant level
6 Switch, piston cooling pressure
7 Switch, water in fuel
8 Connector (not used)
9 Extra stop
10 J1939 CAN (bus)
11 Battery negative
12 Battery plus
13 Voltage after key
14 Stop button (press button)
15 J1587 (bus)
16 Jumper
17 Aux stop
18 VODIA input (diagnosis conn.)
19 Main relay
20 Main circuit breaker 10 A
21 Starter motor
22 Battery (24 V)
23 Alternator
24 Pre-heating
25 Relay pre-heating
26 Unit injector (Cyl. 1-6)
27 Sensor, flywheel
28 Sensor, camshaft
29 Sensor, air inlet pressure / inlet manifold temperature
30 Air filter indicator
31 Sensor, oil pressure
32 Thermostat by-pass valve
33 Wastegate valve
34 Sensor, exhaust temperature
35 Connector A
36 Connector B
37 Control module EMS 2

Cable colors

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

Cable cross section = 0.75 mm^2 unless otherwise stated.

TAD1650VE



P0012803

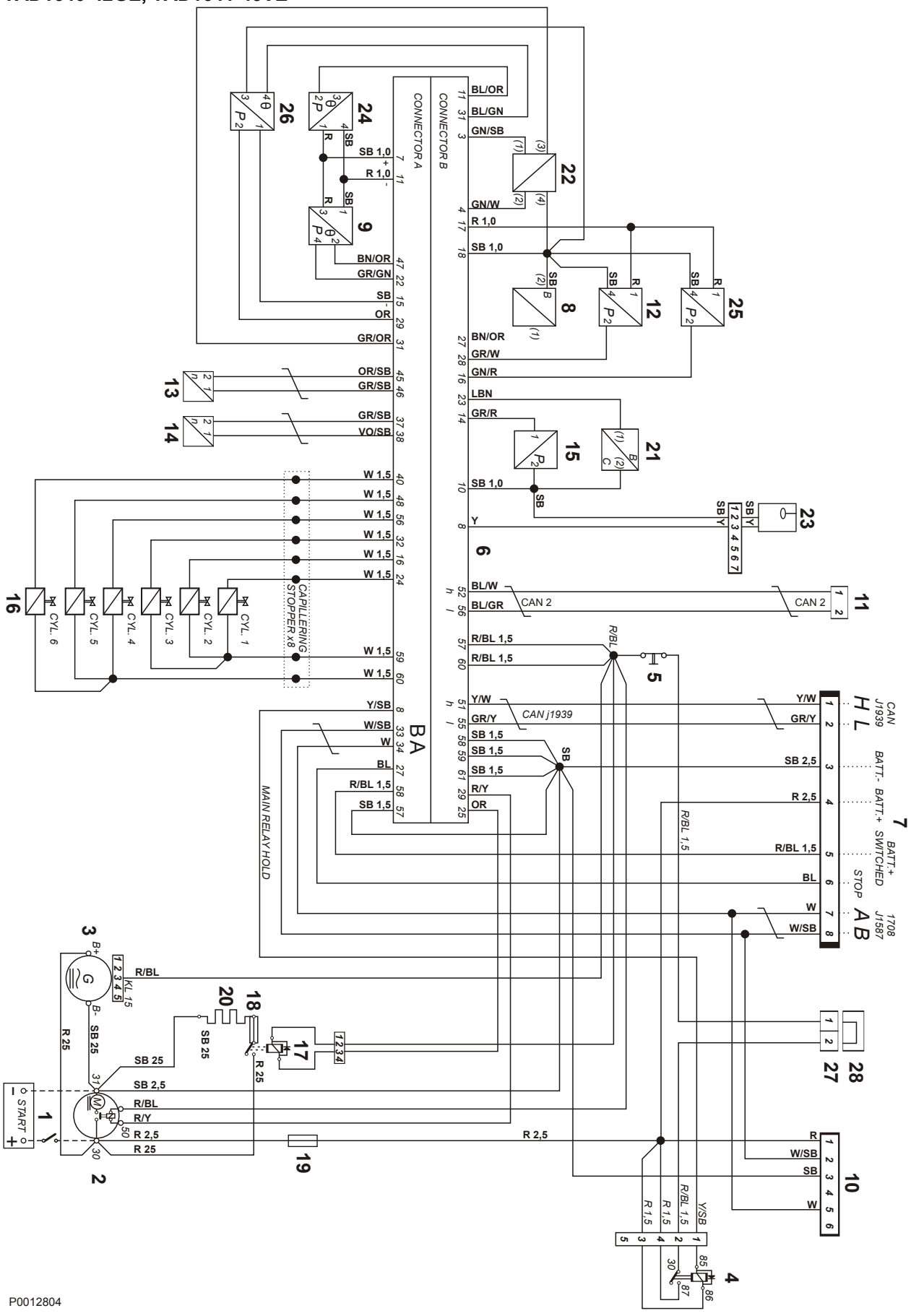
1 Battery
2 Main switch
3 Starter motor
4 Alternator
5 Main relay
6 Aux stop
7 Connector, engine interface
8 Sensor, coolant temperature
9 Sensor, air inlet pressure / inlet manifold temperature
10 VODIA input (diagnosis conn.)
11 Connector, development tool (not used)
12 Sensor, crankcase pressure
13 Sensor, camshaft
14 Sensor, flywheel
15 Switch, piston cooling
16 Unit injector (Cyl. 1-6)
17 Relay preheating
18 Fuse, preheating
19 Main circuit breaker 10 A
20 Preheater
21 Switch, coolant level
22 Sensor, oil level / oil temperature
23 Switch, water in fuel
24 Sensor, oil pressure
25 Sensor, fuel pressure
26 EGR internal
27 Control unit EMS 2.2
28 Wastegate valve

Cable colors

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

Cable cross section = 0.75 mm^2 unless otherwise stated.

TAD1640-42GE, TAD1641-43VE



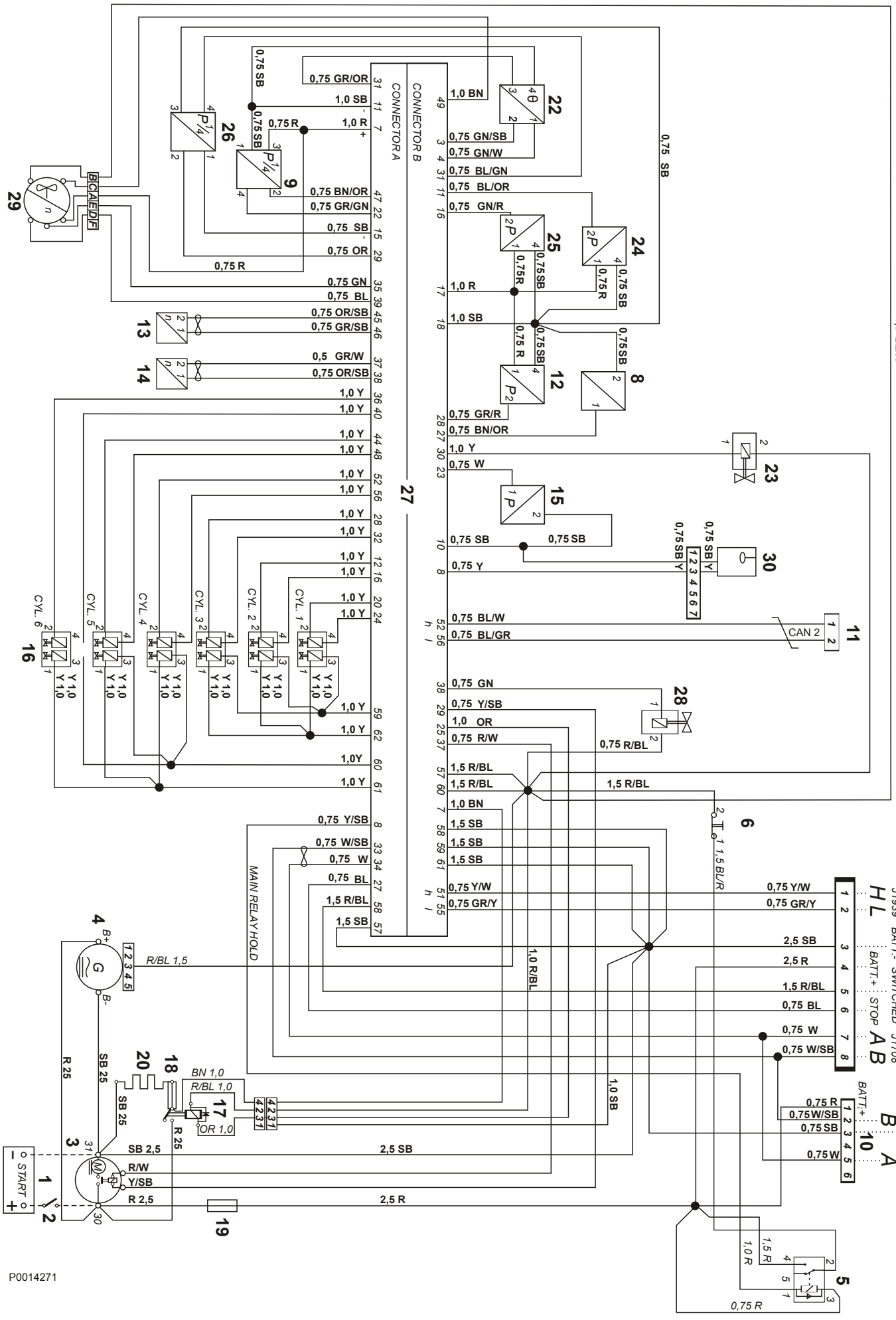
1 Battery
2 Starter motor
3 Alternator
4 Main relay
5 Stop switch
6 Control unit EMS 2
7 Connector - engine interface
8 Sensor, coolant temperature
9 Sensor, air inlet pressure / inlet manifold temperature
10 Connector diagnostic J1587
11 Connector - application tool
12 Sensor, crankcase pressure
13 Sensor, camshaft
14 Sensor, flywheel
15 Switch, piston cooling pressure
16 Unit injector (Cyl. 1-6)
17 Pre-heater relay
18 Fuse
19 Fuse 10A
20 Pre-heater
21 Switch, coolant level
22 Sensor, oil level
23 Switch, water in fuel
24 Sensor, oil pressure
25 Sensor, fuel pressure
26 Air filter indicator
27 Aux stop
28 Jumper - removable

Cable colors

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

Cable cross section = 0.75 mm^2 unless otherwise stated.

TAD1650-51GE Visco fan



1 Battery
2 Main switch
3 Starter motor
4 Alternator
5 Main relay
6 Aux stop
7 Connector, engine interface (8-pin)
8 Sensor, coolant temperature
9 Sensor, air inlet pressure / inlet manifold temperature
10 VODIA input (diagnosis conn., 6-pin)
11 Connector, development tool (not used)
12 Sensor, crankcase pressure
13 Sensor, camshaft
14 Sensor, flywheel
15 Switch, coolant level
16 Unit injector (Cyl. 1-6)
17 Relay, preheating
18 Fuse, preheating
19 Main circuit breaker, 10 A
20 Preheater
21 Preheat connector (4-pin)
22 Sensor, oil level / oil temperature
23 EGR internal
24 Sensor, oil pressure
25 Sensor, fuel pressure
26 Air filter indicator
27 Control unit EMS 2.2
28 Wastegate valve
29 Visco elecric fan
30 WIF connector

Visco electric fan

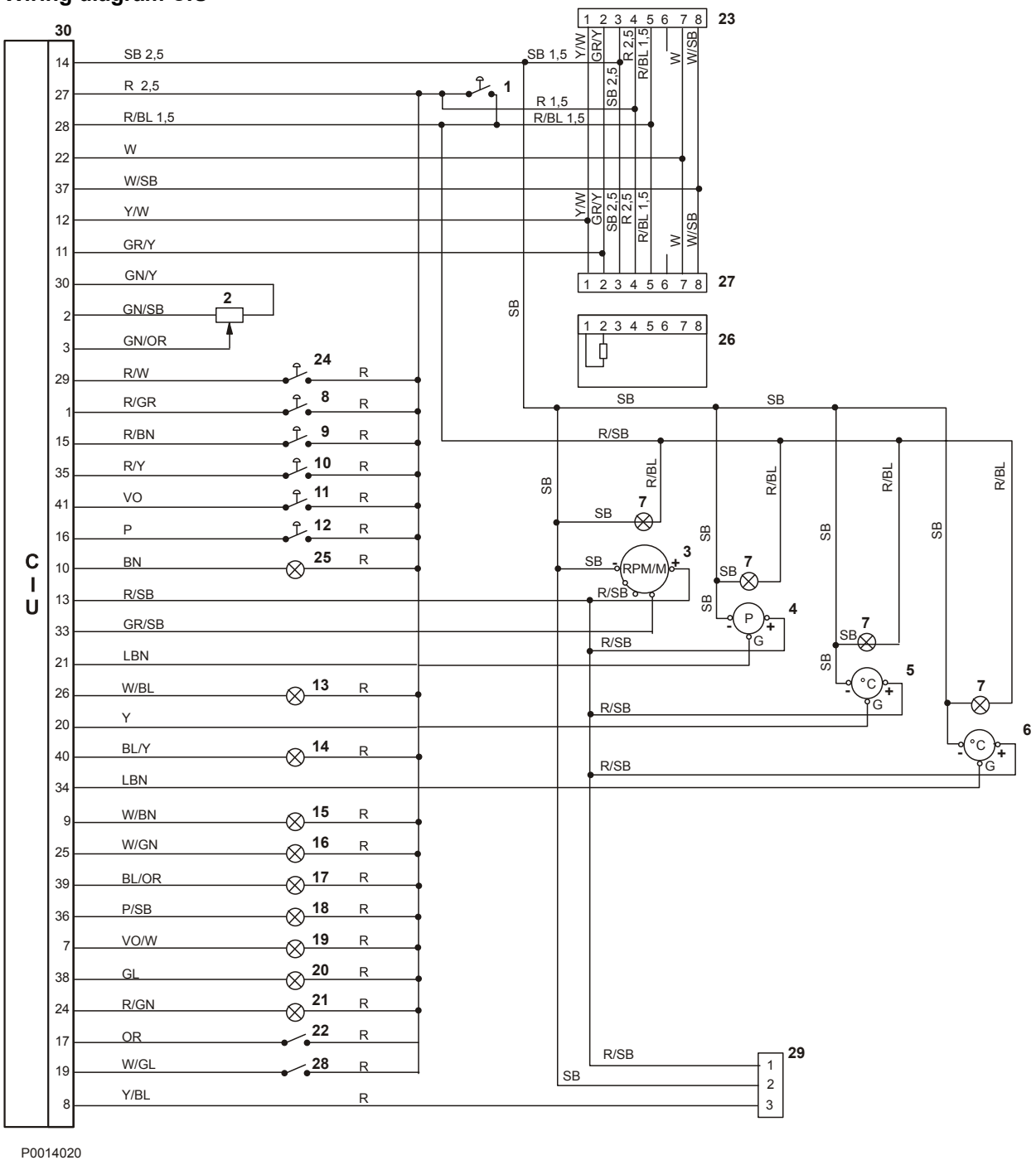
A = Fan speed sensor supply
B = Clutch contol high
C = Clutch control low
D = Fan speed sensor ground
E = Fan speed output
F = Not connected

Cable colors

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

Cable cross section = 0.75 mm^2 unless otherwise stated.

Wiring diagram CIU



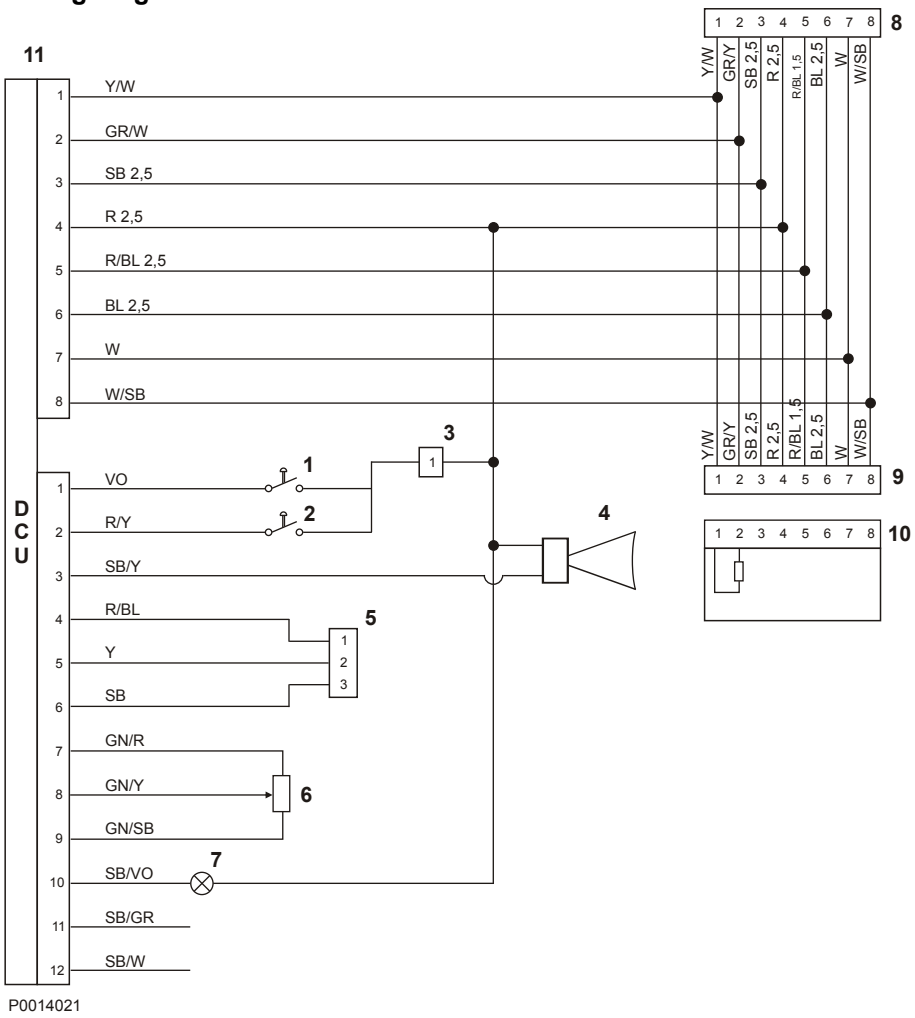
1 Key switch (15+)
2 RPM potentiometer
3 Tachometer (code 14)
4 Oil pressure, instrument
5 Oil temperature, instrument
6 Coolant temperature, instrument
7 Instrument illumination
8 Idling contact, two-way
9 1500 / 1800 rpm switch, two-way
10 Starter contact, spring biased
11 Stop switch, spring biased
12 Diagnosis contact, spring return
13 Alarm, low oil pressure
14 Alarm, high oil temperature
15 Alarm, high coolant temperature
16 Alarm, low coolant level
17 Fuel alarm
18 Diagnostic lamp
19 Engine overspeed indication (GE) Horn (VE)
20 Operation indicator
21 Pre-heating indication
22 Pre-heating contact
23 8-pin connector engine interface
24 Governor switch
25 Battery voltage alarm
26 Termination resistance 120 Ohm
27 8-pin connector engine interface
28 Contact, engine protector disconnect
29 Easy Link connector block
30 Control Interface Unit (CIU)

Cable colors

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

Cable cross section = 0.75 mm^2 unless otherwise stated.

Wiring diagram DCU



1 Stop contact
2 Start contact
3 1-pin connector
4 Horn, buzzer alarm
5 Easy Link connector
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)

Cable colors

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

Cable cross section = 0.75 mm^2 unless otherwise stated.

39-0 General

Index

MID 128

Caption	SPN	Flashcode Electrical fault / value fault	FMI
MID 128, PID 45 Inlet air heater status page 50	626	5.4/-	3, 4, 5
MID 128, PID 94 Fuel Delivery Pressure page 52	94	3.6/3.8	1, 3, 5
MID 128, PID 97 Water in fuel indicator page 55	97	2.9/2.1	0, 3
MID 128, PID 98 Engine oil level page 57	98	5.9/5.7	1, 5
MID 128, PID 100 Engine oil pressure page 59	100	3.1/6.6	1, 3, 5
MID 128, PID 105 Intake manifold temperature page 62	105	3.2/6.2	0, 4, 5
MID 128, PID 106 Air inlet pressure page 64	106	3.4/3.5	0, 3, 5
MID 128, PID 107 Air filter pressure drop page 67	107	5.5/5.5	1, 3, 5
MID 128, PID 108 Barometric pressure page 70	108	-/-	2, 3, 4
MID 128, PID 110 Engine coolant temperature page 71	110	3.3/6.1	0, 4, 5
MID 128, PID 111 Coolant level page 74	111	2.3/2.2	1, 3
MID 128, PID 153 Crankcase pressure page 76	153	7.8/7.7	0, 3, 5
MID 128, PID 158 ECU battery potential page 79	158	-/3.9 (EMS) -/6.9 (CIU)	1
MID 128, PID 172 Inlet air temperature page 80	172	7.9/-	4, 5
MID 128, PID 173 Exhaust gas temperature page 82	1184	-/-	0, 4, 5
MID 128, PID 175 Engine oil temperature page 84	175	3.7/5.8	0, 4, 5
MID 128, PID 190 Engine speed page 87	190	-/2.6	0
MID 128, PPID 3 Starter Output page 88	677	4.6/-	3, 4, 5
MID 128 / 144, PPID 4 Starter input sensor page 90	-	4.7/5.2	3, 4
MID 128, PPID 6 Key off input sensor page 91	520195 970	4.8/- (EMS) 5.3/- (CIU)	4
MID 128, PPID 8 Piston Cooling Oil Pressure page 92	520192	6.8/6.7	1, 3
MID 128, PPID 19 Internal EGR Status page 94	2791	5.5/-	3, 4, 5, 7
MID 128, PPID 55 ECU temperature page 97	-	-	0, 4, 5
MID 128, PPID 98 Engine sync acknowledge page 98	608	-/-	9
MID 128 / 144, PPID 132 Throttle calibrated position page 99	608	2.8/-	3, 4, 9
MID 128, PPID 332 Thermostat page 101	2988	-/-	3, 4, 5
MID 128, SID 1/2/3/4/5/6 Injector # 1-6 page 103	651–656	7.1/7.6/-	3, 4, 5, 7, 12
MID 128, SID 21 Engine position page 107	636	2.5/-	2, 3, 8
MID 128, SID 22 Timing sensor, crank page 109	637	2.4/-	2, 3, 8
MID 128, SID 32, Wastegate output driver page 111	1188	-/-	3, 4, 5
MID 128, SID 70 Air inlet heater driver #1 page 114	729	-/-	3, 4, 5
MID 128, SID 211 Sensor Supply Voltage #2 (+5V DC) page 116	-	9.3/-	3, 4
MID 128 / 144, SID 231 SAE J1939 data link page 117	639	6.5/- (EMS) 6.4/- (CIU)	2
MID 128, SID 232 5 V supply page 118	620	9.3/-	3, 4
MID 128, SID 240 Program memory page 119	639	9.9/-	2, 7, 11, 14

MID 128, SID 250 SAE J1708/J1587 data link page 120	608	9.2/-	12
MID 128 / 144, SID 253 Calibration memory EEPROM page 121	630	9.9/- (EMS) 9.8/- (CIU)	2, 12, 14
MID 128 / 144, SID 254 Controller 1 page 122	629	9.9/- (EMS) 9.8/- (CIU)	3, 8, 12
MID 128, PSID 201 Data link, MID144 page 123	639/1675	-/-	9

Alphabetical index

References to Service Bulletins

Group No.	Date	Refers to

Report form

Do you have any comments or other views about this manual? If so, make a copy of this page, write down your views and send them to us. The address is at the bottom. We would prefer you to write in Swedish or English.

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Refers to publication: .....

Publication No.:.....Date of issue: .....

Proposal/motivation: .....

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Date:.....

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AB Volvo Penta
Service Communication
Dept. 42200
SE-405 08 Göteborg
Sweden

47701632 English 10-2010