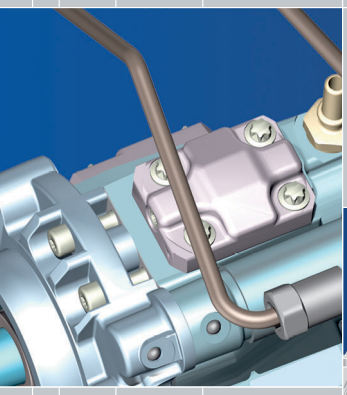
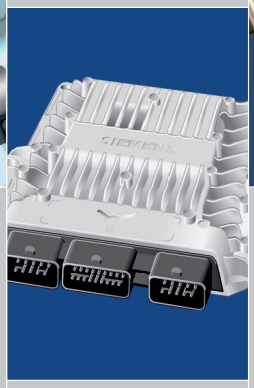
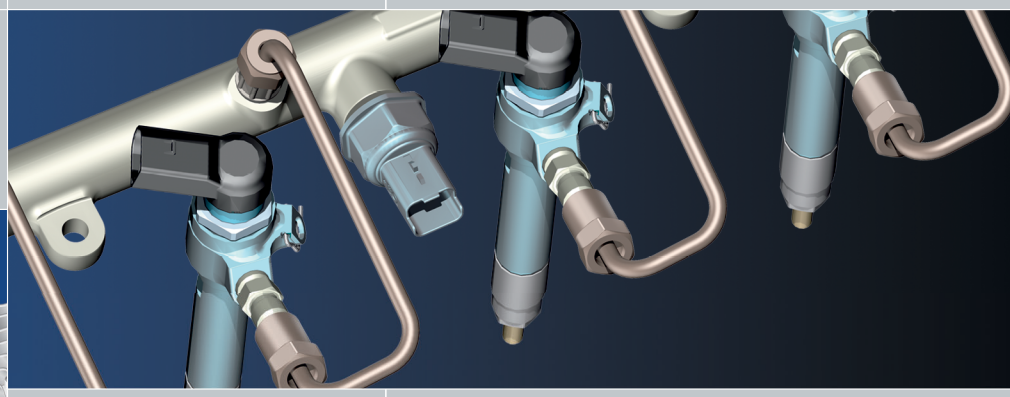
SIEMENS VDO
Automotive

Piezo Common Rail PCR 2.3 NGD 3.0E

»After Sales Documentation«







Diesel-Systems

Validity

This manual is valid for:

System:	Siemens VDO PCR 2.3 NGD 3.0E
Engine:	IESA NGD 3.0E
Vehicles:	FORD 2005 1/2 MY SA Ranger

Display symbols

This manual uses the following display symbols:

Danger

This sign tells you that the accident prevention regulations must be heeded. You could become seriously or fatally injured.

Important

This sign directs your attention to possible damage to the system, the engine or other components.

Note

This tip gives you advice on making work easier or gives you further information.

Version Table

Edition	Revisions / Extent
12 / 2004	Erstausgabe
04 / 2005	Update:
	A 3.1 Injector (A 3.1.5, A 3.1.6)
	A 3.2 Diesel Common Rail Pump
	A 3.3 Volume flow control valve (A 3.3.2, A 3.3.3)
	A 3.4 High-pressure control valve (A 3.4.2, A 3.4.3)
	A 3.5 High-pressure lines and rail (A 3.5.2)
	A 3.6 High-pressure sensor (A 3.6.2, A 3.6.3)
	A 3.7 Engine control unit (A 3.7.1)
	B 1.1 Nominal system values and operating conditions (B 1.1.1, B 1.2.1)
	B 2.0 Troubleshooting
	B 3.0 Fault code list
	B 4.2 Checking the low-pressure system (B 4.2.2)
	B 4.3 Checking the high-pressure system (B 4.3.1, B 4.3.2, B 4.3.3)
	B 4.4 Checking injectors (B 4.4.1, B 4.4.2)
	B 4.5 Checking the engine control unit
06 / 2005	Update:
	B 3.0 Fault code list
	B 4.2 Checking the low-pressure system (B 4.2.2)
	B 4.3 Checking the high-pressure system (B 4.3.1, B 4.3.2, B 4.3.3)
	B 4.4 Checking injectors (B 4.4.1, B 4.4.2)
	B 4.5 Checking the engine control unit

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System

Diagnostics

A System

1 Overall PCR2 system

1.1 General information on the PCR2 system

The diesel fuel injection technology which is available at the present time is separated into helical groove controlled, time controlled and into decoupled systems. The only decoupled system in which there is no direct angular dependence between the crankshaft and the high-pressure generating system is the common rail system.

The Siemens VDO Piezo Common Rail (PCR) diesel injection system is a second generation common rail injection system in which piezo-controlled injectors are used.

It consists of the Diesel Common Rail pump (DCP), the rail (storage line), the high-pressure lines and the piezo-controlled injectors.

Integrated into the DCP are:

- the high-pressure pump (HPP)
- the internal transfer pump (ITP)
- the volume flow control valve (VCV)
- and the pressure control valve (PCV)

The structure of the DCP allows the exact amount of fuel required to be delivered to the engine, thus increasing the efficiency of the diesel engine. The DCP is driven at a ratio of transmission of 2:3, relative to the crankshaft.

The diesel fuel is drawn from the fuel tank by an electrical transfer pump and delivered to the volume flow control valve (VCV).

The volume flow control valve controls the fuel quantity supplied to the high-pressure pump (HPP). The internal transfer pump and the high-pressure pump are directly driven by the engine. The high-pressure pump (HPP) delivers the fuel to the rail at a pressure of up to 1600 bar.

The rail and the injectors are connected to each other through the high-pressure lines. The piezo injectors allow extremely short response times and enable a free selection of the injection beginning and the fuel quantity according to the demands of the engine control unit (ECU).

Independently of the engine speed, the system pressure generated by the DCP will be optimally adjusted for every operating condition. Due to the storage volume of the rail, the injection pressure will remain practically constant over the entire duration of the injection process.

The system is operated with pre-injection and main injection. This reduces the combustion noise, lowers the mechanical stress and, in many cases, the exhaust emissions.

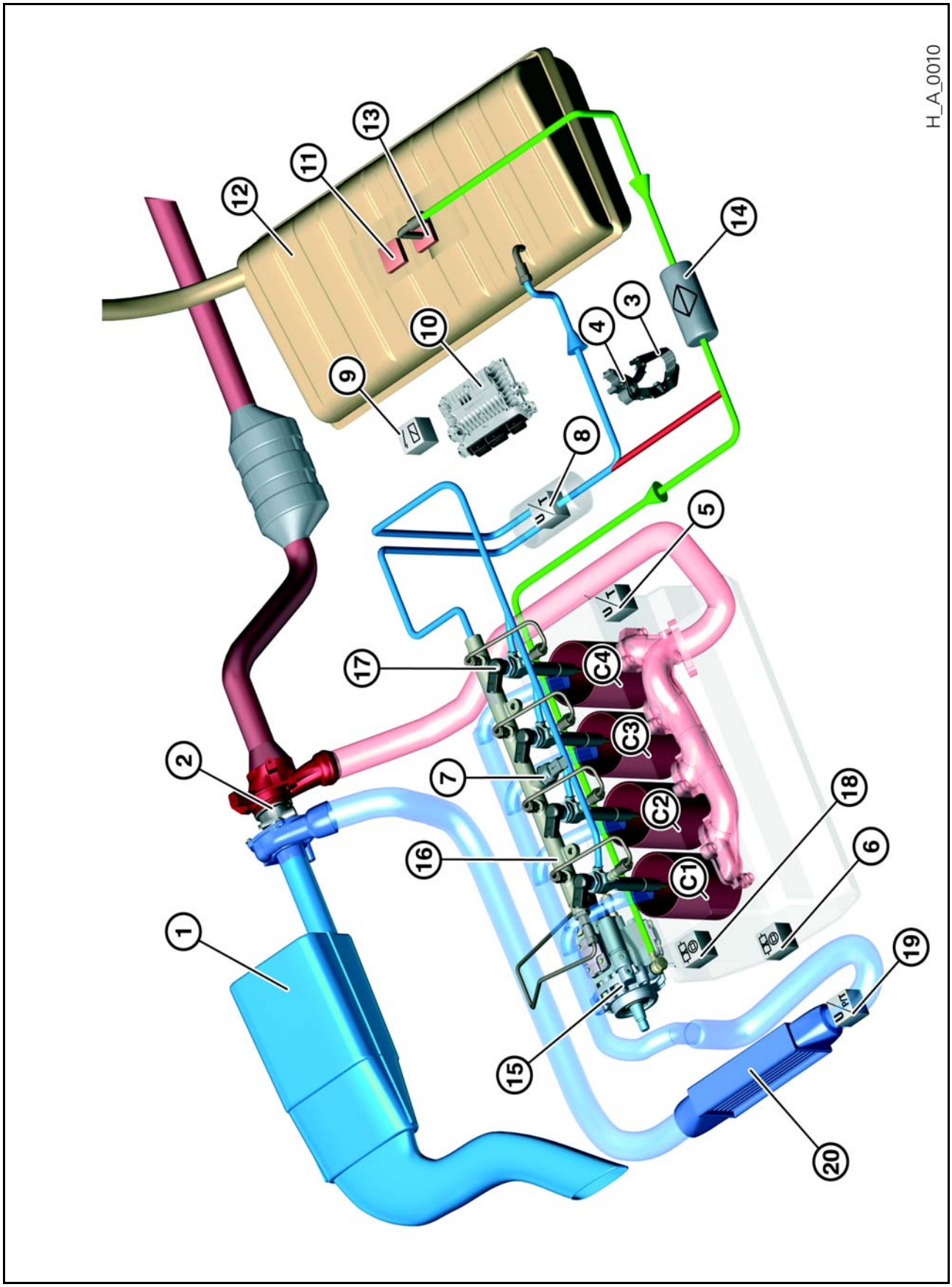


Fig. A - 1 Schematic representation of the overall system

1. Air filter
2. Turbocharger
3. Accelerator pedal
4. Accelerator pedal sensor
5. Coolant temperature sensor
6. Crankshaft sensor
7. High-pressure sensor
8. Fuel temperature sensor
9. Glow plug relay (optional)
10. Engine control unit (ECU)
11. Fuel gauge sender
12. Fuel tank
13. Electrical fuel transfer pump
14. Fuel filter
15. Diesel common rail (DCR) pump
    - a Pressure control valve (PCV)
    - b High-pressure pump (HPP)
    - c Volume flow control valve (VCV)
    - d Internal transfer pump (ITP)
16. Rail
17. Injector
18. Camshaft sensor
19. T-MAP sensor
20. Intercooler

Cylinder	Code
C1 cylinder 1	cyl 0
C2 cylinder 2	cyl 3
C3 cylinder 3	cyl 1
C4 cylinder 4	cyl 2

Firing order:

C1 - C3 - C4 - C2

2 System limits of the fuel supply system

Diesel Common Rail Pump (DCP)

D Diesel
C Common Rail
P Pump

The diesel common rail pump consists of the following components, which are all integrated into a single housing:

- Internal transfer pump (ITP)

  I Internal
  T Transfer
  P Pump

  The internal transfer pump, which is constructed as a vane-type pump, has the task of drawing fuel from the tank through the fuel filter and supplying the high-pressure pump (HPP) with diesel fuel. In addition, it supplies the high-pressure pump (HPP) with fuel for lubrication purposes.

- Volume flow control valve (VCV)

  V Volume flow
  C Control
  V Valve

  The volume flow control valve controls the flow rate of the fuel to the high-pressure pump, thereby enabling an exact supply to the high-pressure pump according to the demand of the high-pressure pump (HPP).

- High-pressure pump (HPP)

  H High
  P Pressure
  P Pump

  The high-pressure pump is constructed as a three-cylinder radial piston pump and supplies the rail with the necessary system pressure.

- Pressure control valve (PCV)

  P Pressure
  C Control
  V Valve

  The pressure control valve controls the exit pressure of the high-pressure pump (HPP).

Components of the high-pressure system

- Rail
- High-pressure sensor
- High-pressure line to the pump (DCP)
- Four high-pressure lines to the injectors

Piezo injectors

The piezo injectors allow an extremely quick and exact dosage of the fuel quantity.

- The response times of the piezo injectors at a speed four times higher than that of the previous systems allow short and variable intervals between the individual injections.
- The ability to recover energy considerably reduces the amount of activation energy required.
- The simplified electrical control produces a greater electromagnetic compatibility and, thus, a substantial reduction in the susceptibility to failure.

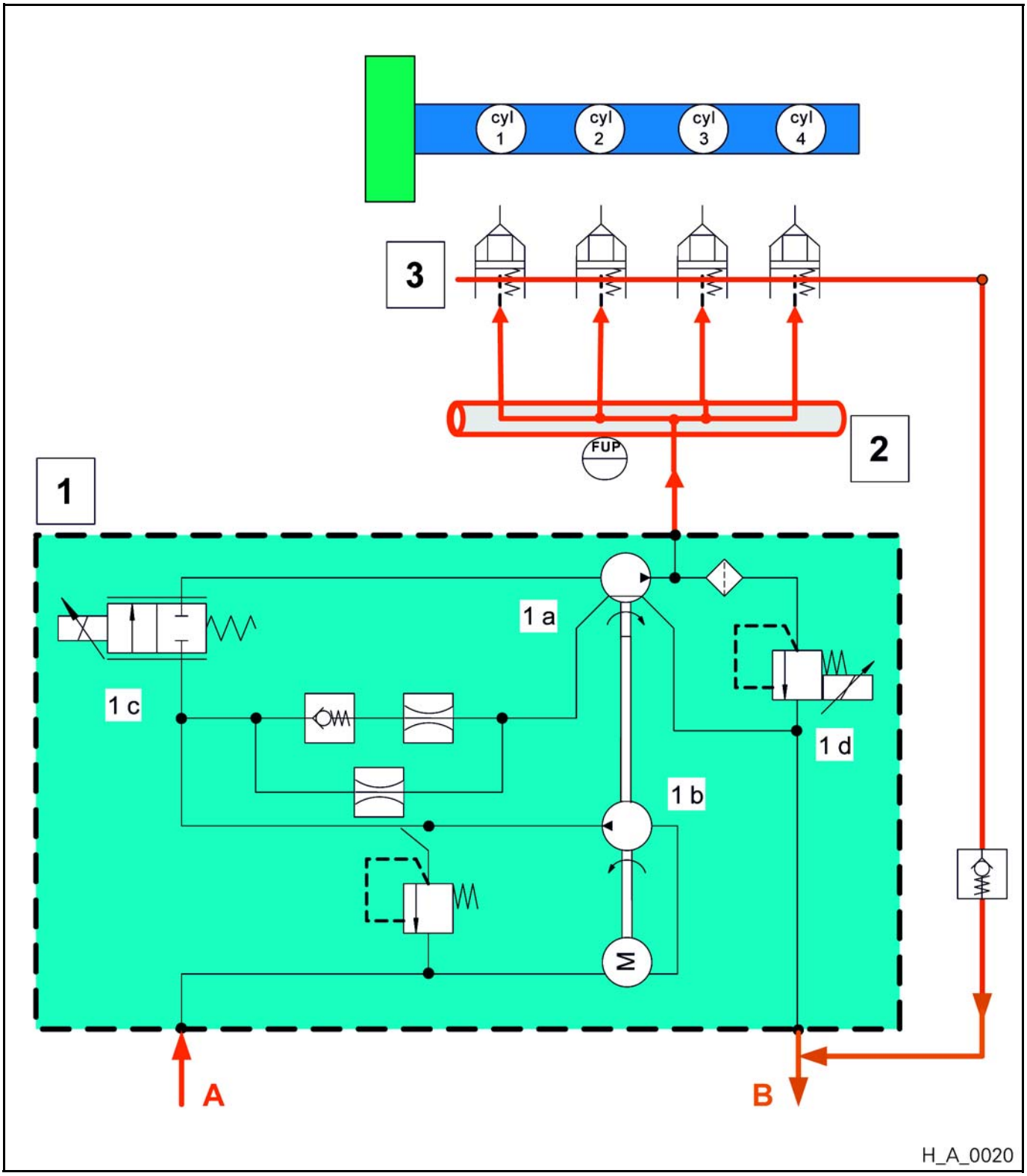


Fig. A - 2 Fuel supply

1. Diesel Common Rail Pump (DCP):
   a High-pressure pump (HPP)
   b Internal transfer pump (ITP)
   c Volume-flow control valve (VCV)
   d Pressure control valve (PCV)
2. Rail with high-pressure sensor
3. Injectors

A. Fuel feed
B. Fuel return

3 System components

3.1 Injector

The Piezo injectors, which are connected to the rail, inject the necessary fuel quantity into the combustion chamber for all operating conditions of the engine.
The injection quantity per stroke consists of a pre-injection quantity and a main injection quantity. This apportionment brings about a "soft" combustion process of the diesel engine.

Due to the use of the piezo actuators, extremely short response times are possible. This allows the injected fuel quantity and the dosage to be controlled with extreme accuracy. Furthermore, an excellent repeatability is ensured.

The injectors are activated by the engine control unit (ECU). Due to the possible energy recovery of piezo injectors, a substantially lower activation energy is required compared with previous systems.

Important

The connection cable connectors to the engine control unit and the injectors must not be disconnected when the engine is running.

Otherwise there is a danger of damaging the engine!

When repairs are required, the injectors must not be taken apart.
No part may be loosened or unscrewed as this could lead to the destruction of the injectors.

Danger

When performing work at the engine control unit (ECU) and the injectors, the accident prevention regulations for high-voltage equipment must be observed.

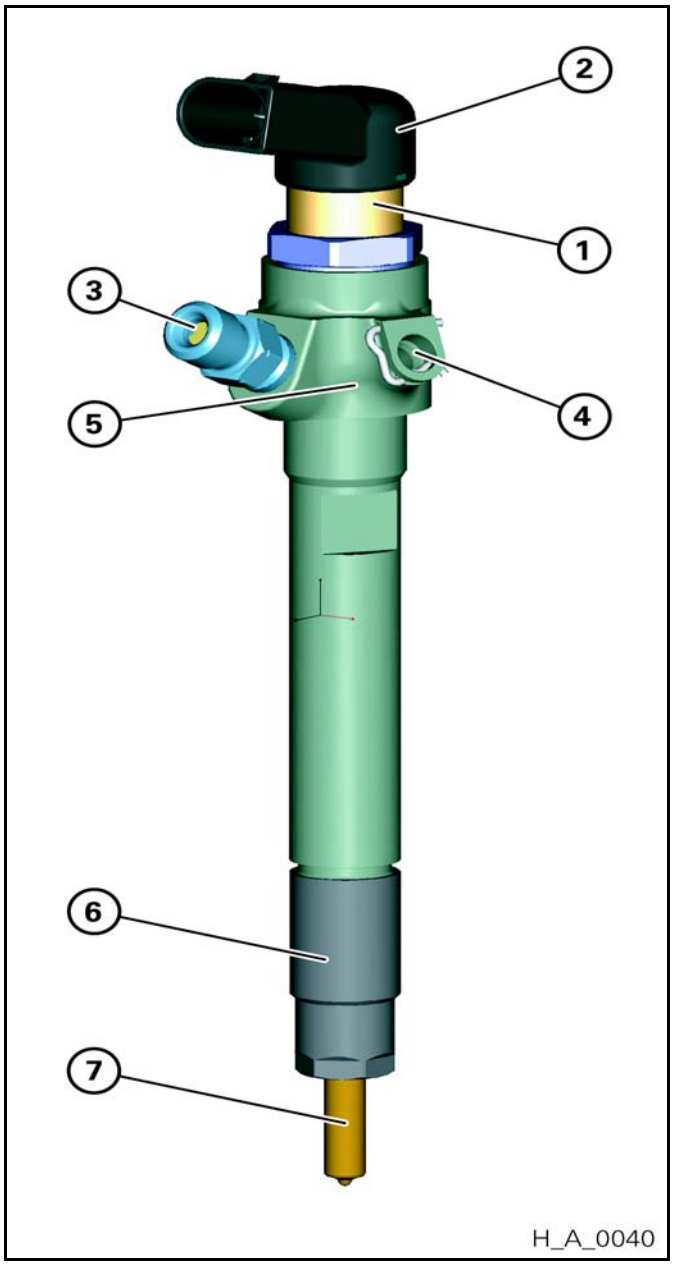


Fig. A - 3 Injector

1. Piezo actuator
2. Electrical connection
3. High-pressure connection
4. Fuel return
5. Injector head
6. Nozzle lock nut
7. Injection nozzle

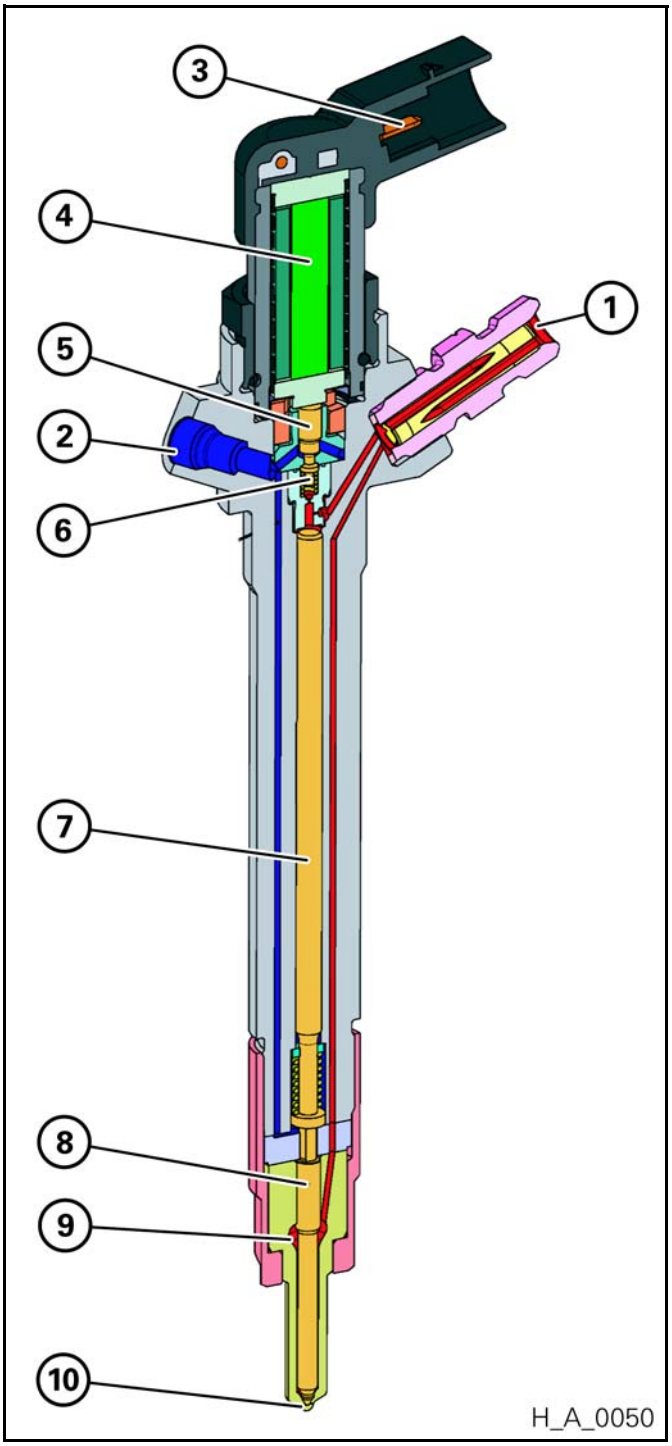


Fig. A - 4 Cross-section view of the injector

1. High-pressure connection
2. Fuel return
3. Connector the engine control unit (ECU)
4. Piezo actuator
5. Valve piston
6. Valve mushroom
7. Control piston
8. Nozzle needle
9. High-pressure chamber nozzle
10. Spray hole (6 each)

3.1.1 Function of the injector

Injector not activated

Fuel coming from the rail under high pressure reaches the control chamber (2) and the high-pressure chamber (3) of the jet through the high-pressure feed (1).

The borehole to the fuel return (5) is closed via the valve mushroom (4) which is actuated by a spring. The hydraulic force exerted (F1) by the high pressure of the fuel on the nozzle needle (6) in the control chamber (2) is greater than the hydraulic force exerted on the tip of the nozzle (F2), since the surface of the control piston in the control chamber is greater than the surface area of the tip of the nozzle.

The nozzle of the injector is closed.

Injector activated

The piezo actuator (7) presses on the valve piston (8), and the valve mushroom (4) opens the borehole which connects the control chamber (2) to the fuel return.

In this manner, a reduction in pressure occurs in the control chamber, and the hydraulic force that acts on the tip of the nozzle (F2x) is greater than the force on the control piston (F1x) in the control chamber. The nozzle needle (6) moves upwards, and the fuel reaches the combustion chamber via the six spray holes.

When the engine is at a standstill, the valve connecting the control chamber to the fuel return and the nozzles of the injectors are closed by the force of the springs. For lubrication purposes, a small amount of fuel will be passed directly into the return flow between the nozzle needle and the guide from the high-pressure side.

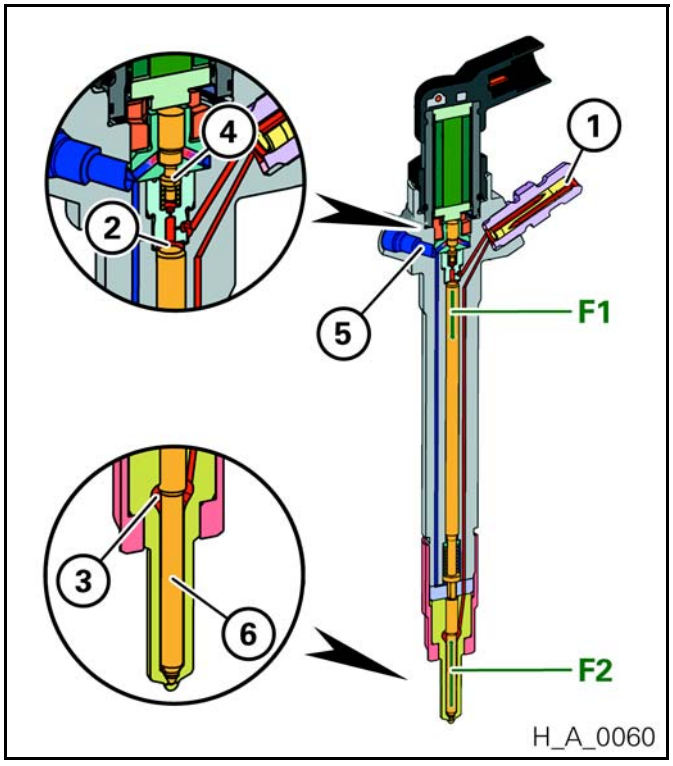


Fig. A - 5 Injector not activated

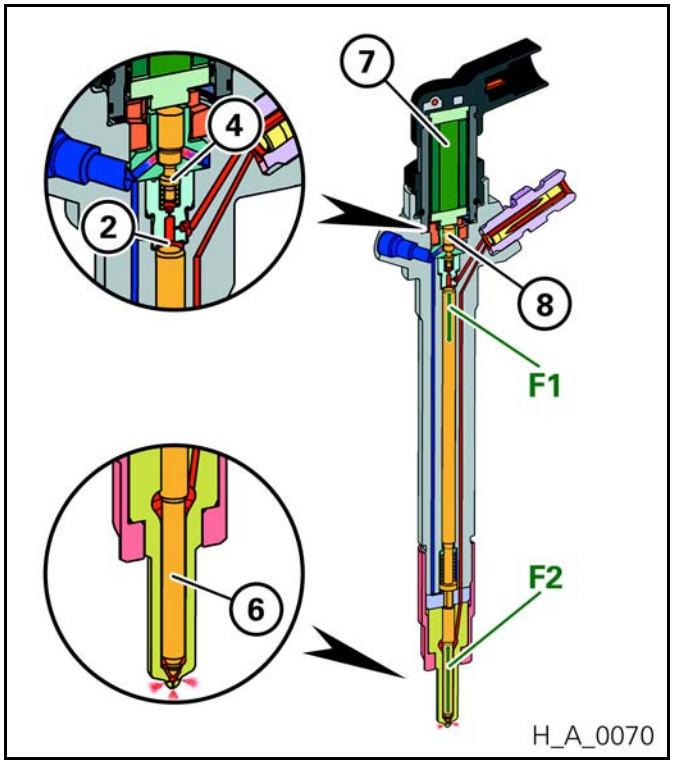


Fig. A - 6 Injector activated

Characteristic curve of the injector activation

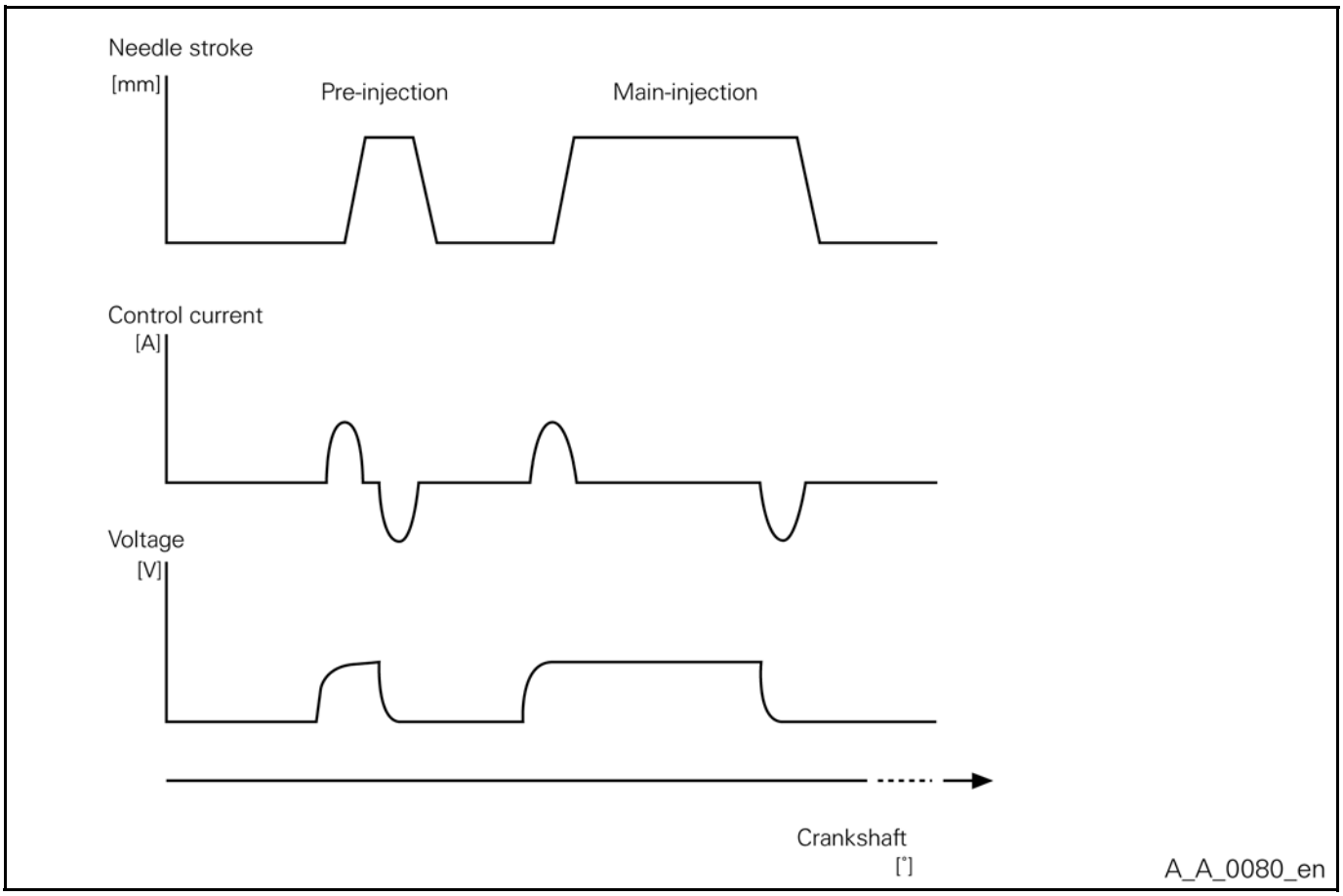


Fig. A - 7 Characteristic curve of the injector activation

3.1.2 Piezo actuators

The piezo actuator is a part of the injector that indirectly activates the nozzle needle, which in turn opens or closes the spray holes of the nozzle. The control duration of Piezo actuators is used to regulate the amount of fuel injected.

The charging time of the actuator is 0.15 ms. The actual injection time during which the valve is open is between 0.15 ms and 4.50 ms. After the injection, the valve is closed again by means of the discharge of the piezo actuator within 0.15 ms.

During the time the valve is open, between 1 mm^3 (during the pre-injection) and 80 mm^3 (during the main injection under full load) of fuel is injected into the combustion chamber.

3.1.3 Piezo stack

An actuator consists of a stack of about 350 ceramic sheets (a piezo stack). Each sheet is about 80 µm thick. After a control voltage is applied, the actuator expands by up to 40 µm.
Because this is such a small dimension, all surfaces must be ground to a tolerance of 1µm. This represents a great challenge for manufacturing technology.

This piezo stack is fitted with contacts and is cast into a plastic element to protect the ceramic elements from mechanical damage.

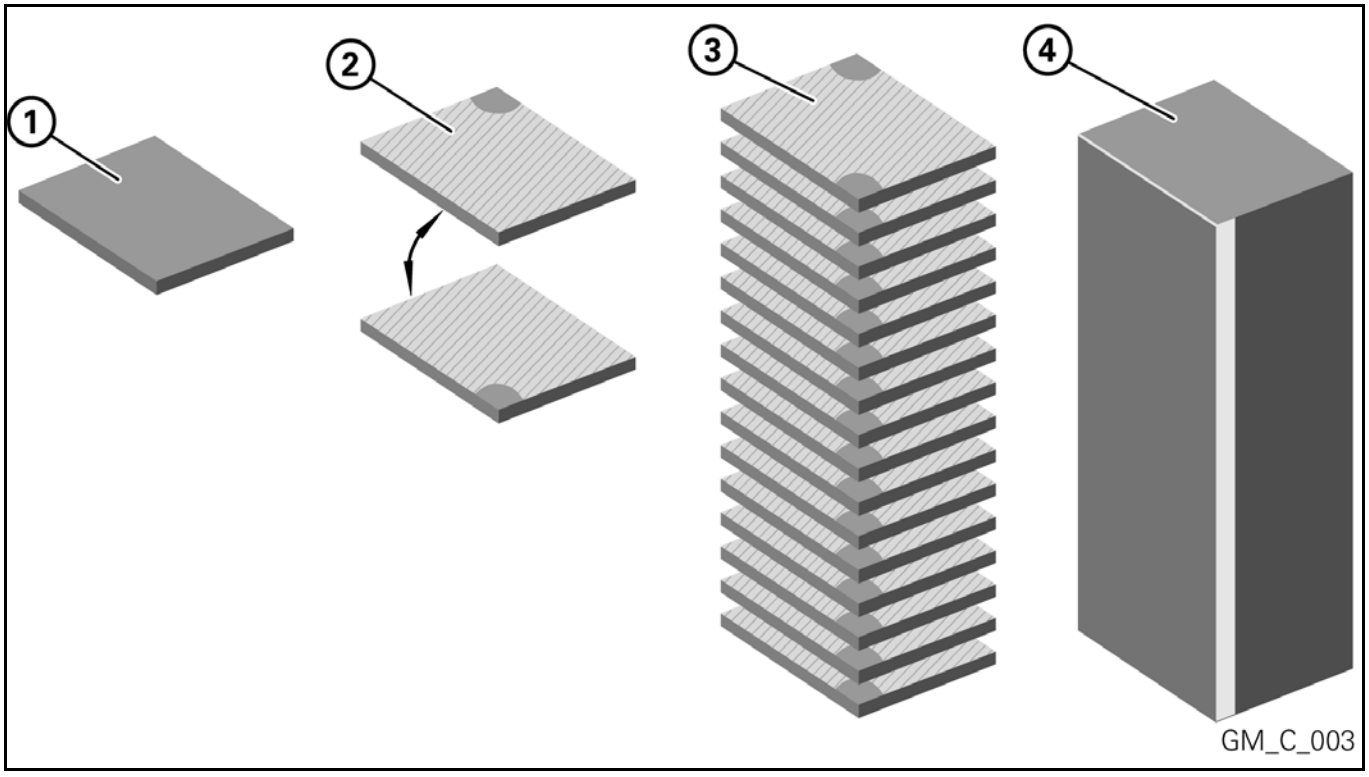


Fig. A - 8 Design of a piezo stack

1. Unprocessed ceramic sheet
2. Silver-coated ceramic sheets
3. Stacked ceramic sheets
4. Sintered ceramic sheet

Drive unit

The injector drive receives electrical signals from the control unit and converts them as required by the hydraulic control unit.

Acceleration forces of up to 1000 G occur in operation. To prevent tensile stress from occurring within the ceramic elements under these loads, a tube spring is mounted around the actuator to ensure a constant pretension.

The two end plates serve as counter-bearings.
The piezo forces that control the hydraulic valve are also dissipated through the plates.

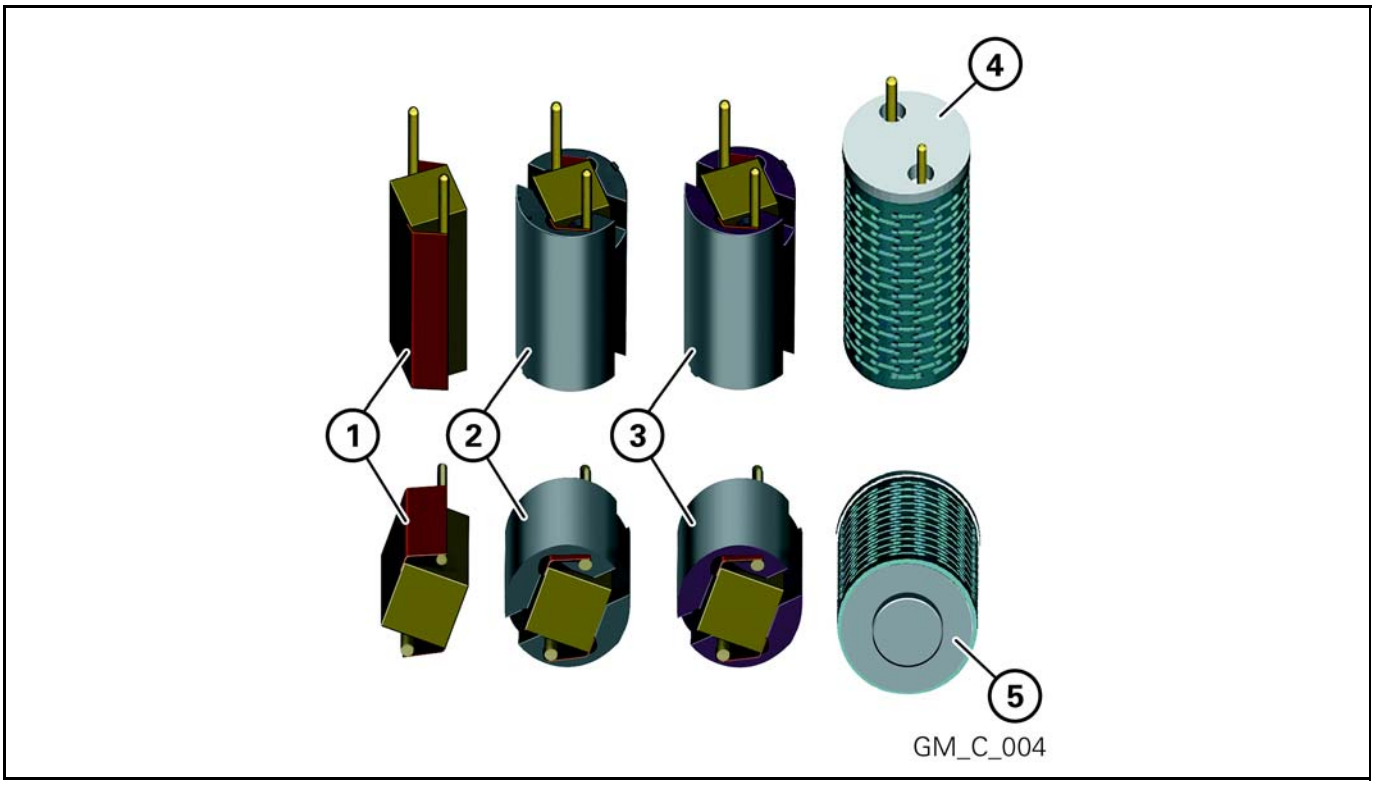


Fig. A - 9 Design of the drive unit

1. Piezo stack with contacts
2. Piezo stack, mounted
3. Piezo stack, mounted — cast with silicon
4. Piezo stack, mounted — head plate
5. Piezo stack, mounted — base plate

A steel membrane (7) hermetically separates the actuator unit (1) from the fuel.
The tube spring with built-in piezo stack, together with the external housing (2), the contacts (3) and the connector (4) form the drive unit of the injector.

Together with the housing, this creates a drive module that is temperature-balanced and protected from mechanical effects.

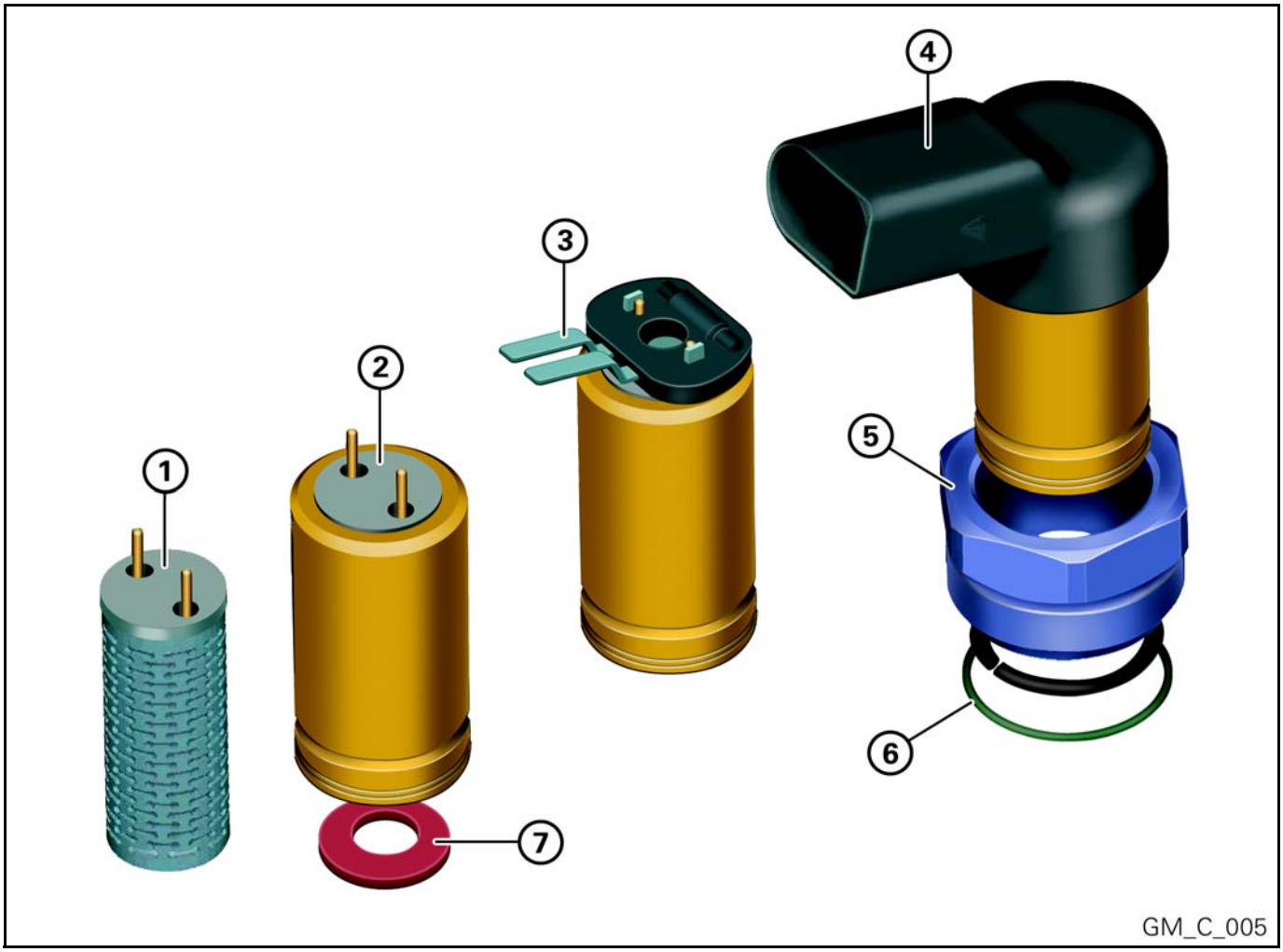


Fig. A - 10 Injector head

1. Actuator unit
2. Housing
3. Electrical contact
4. Connector
5. Spigot nut
6. O-ring
7. Membrane

3.1.4 Injection nozzles

The injection nozzle is the part of the injector that is responsible for atomizing the fuel in the combustion chamber.

The micro blind hole nozzles used in this system represent a further stage in the development of hole nozzles. In contrast to conventional hole nozzles, the new technology guarantees more uniform injection behavior of individual nozzle holes at a lower residual volume.

This is a particularly decisive advantage in low-quantity injection systems, such as are required for pre- and post-injections.

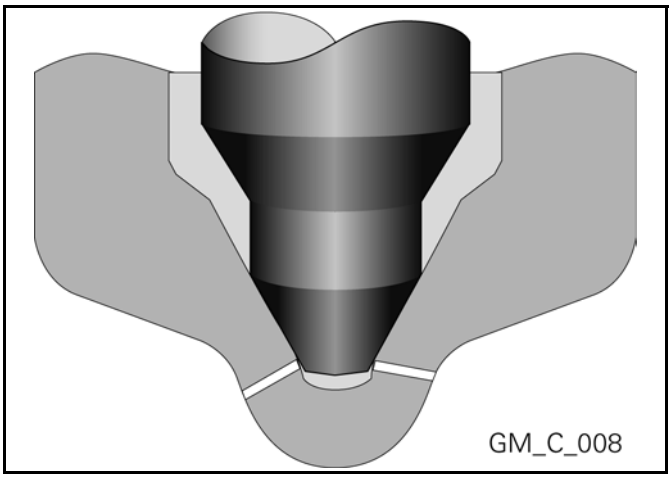


Fig. A - 11 Micro blind hole nozzle

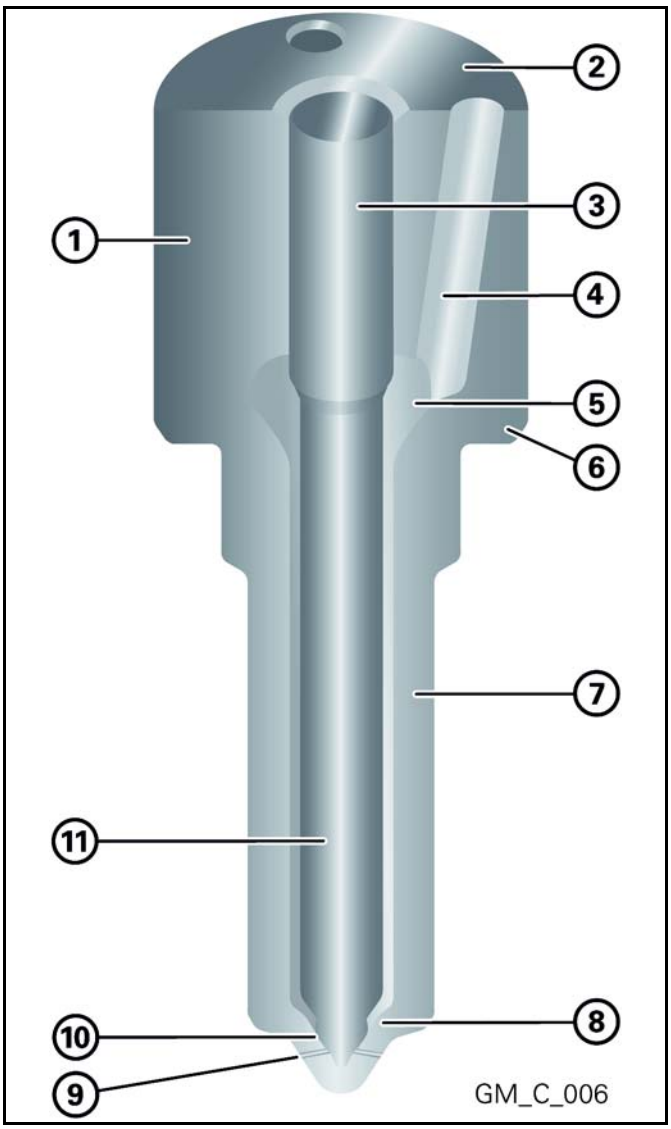


Fig. A - 12 Cross-section of injection nozzle

1. Nozzle body
2. High-pressure sealing surface
3. Needle guide
4. High-pressure borehole
5. High-pressure chamber
6. Nozzle shoulder
7. Nozzle shaft
8. Nozzle tip
9. Spray hole
10. Needle seat
11. Nozzle needle

Spray holes

The following general conditions apply to the design of the nozzle and the position, shape and number of the nozzle holes:

- Combustion chamber volume
- Shape of the piston
- Required injection rate
- Required injection quantity

Modern passenger car engines have nozzles with up to six spray holes and diameters as small as about 120 µm.

Spray holes are manufactured using an electro-erosive process that makes it possible to create conical holes.

The manufacturing process for spray holes produces a sharply angled entrance into the inside of the nozzle. This has a significant effect on the flow properties. Because of this, nozzles are rounded off by hydro-erosion. This method results in the following improvements:

- It limits the hydraulic flow tolerance
- It increases the flow coefficient
- It anticipates edge rounding in operation
- It reduces the roughness of the surface of the spray holes

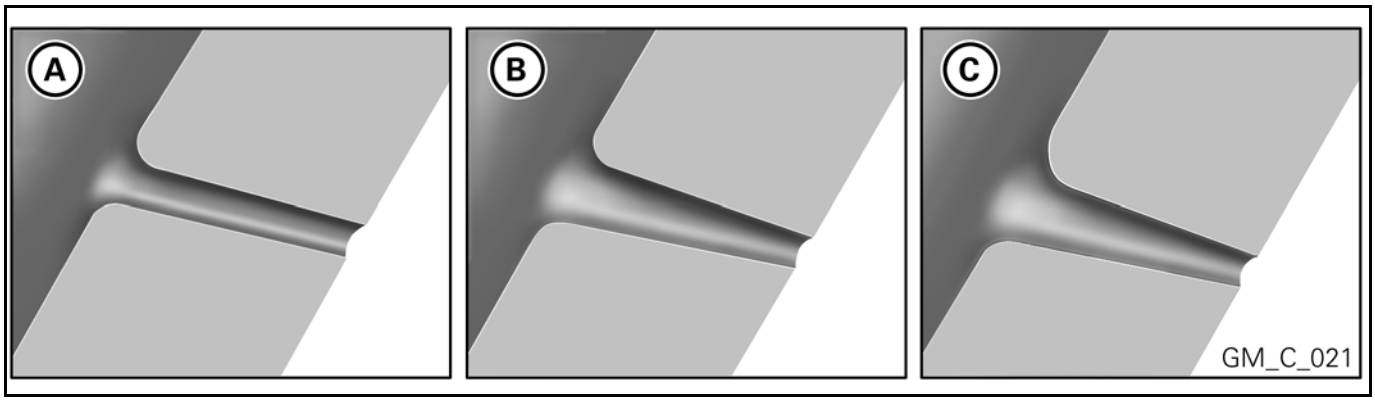


Fig. A - 13 Conicity

Figure A shows a cylindrical spray hole with reduced rounding.

A conical spray hole having the same rounding as in Figure A is shown in Figure B.
Here, a higher efficiency is already achieved by means of the conicity alone.

Figure C shows a conical spray hole with larger rounding. The larger rounding compared with Figure B increases the efficiency even further.

Jet curve as a function of time during an injection

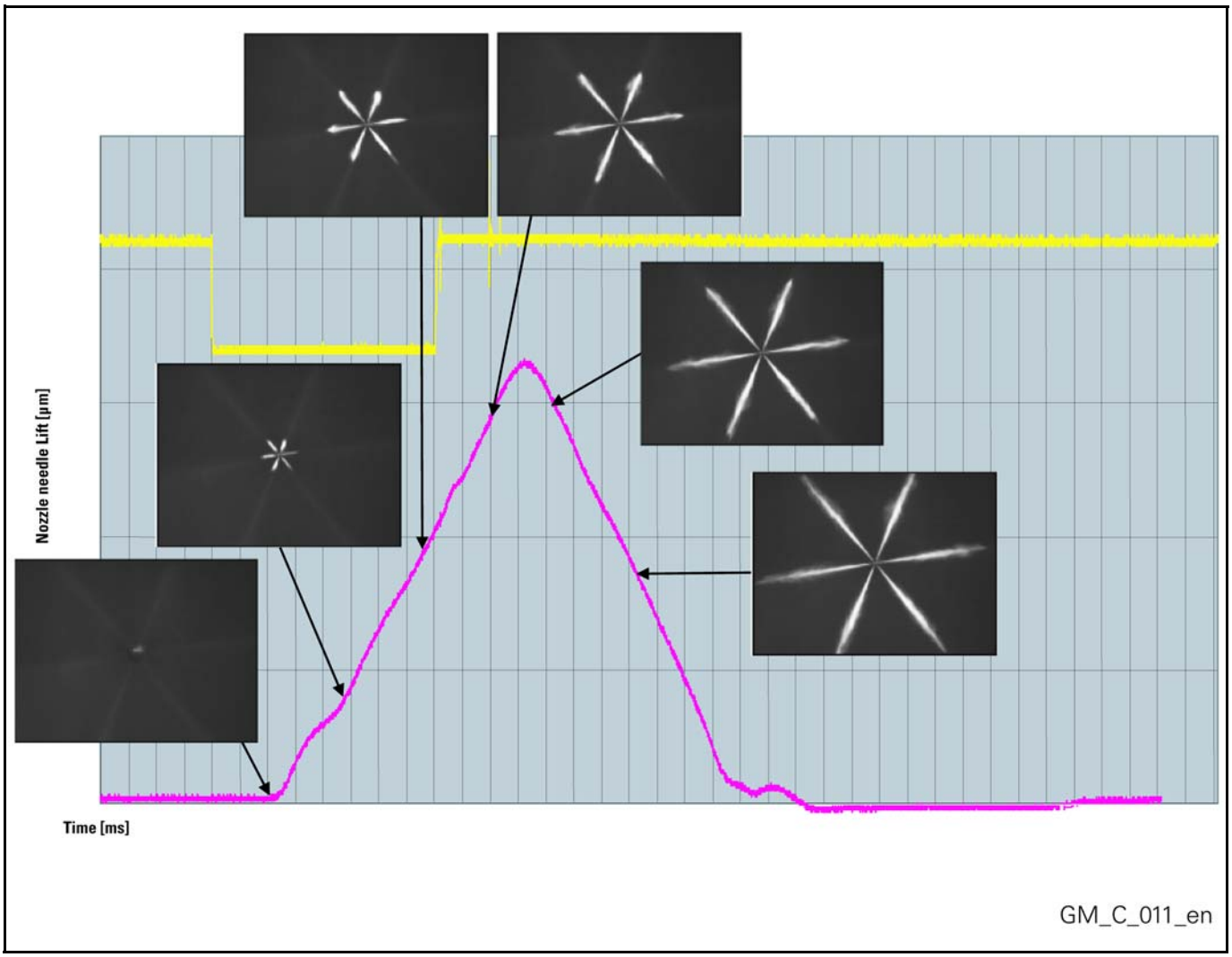


Fig. A - 14 Jet curve during injection

3.1.5 Pinning of the injector

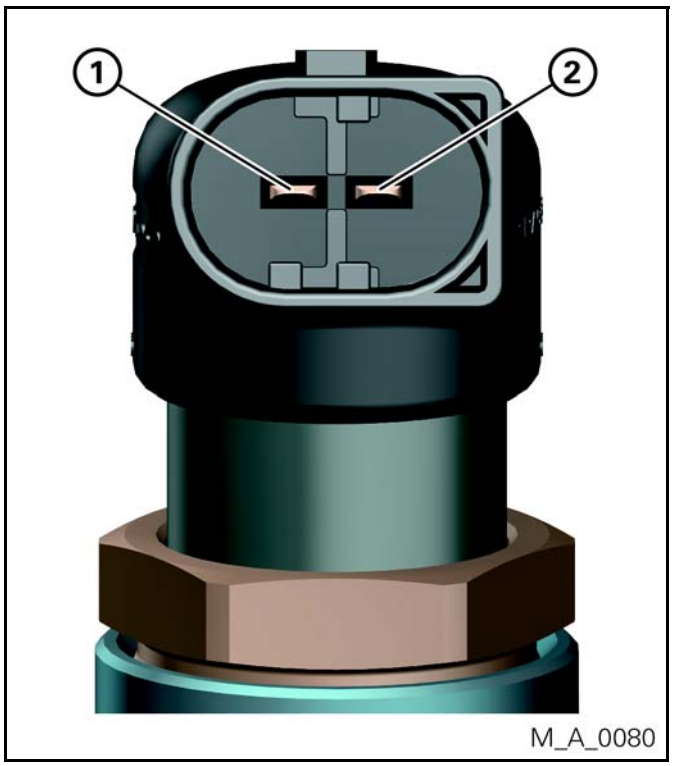


Fig. A - 15 Pinning of the injector

1. Activation injector (+)
2. Activation injector (ground)

3.1.6 Labelling of the injector

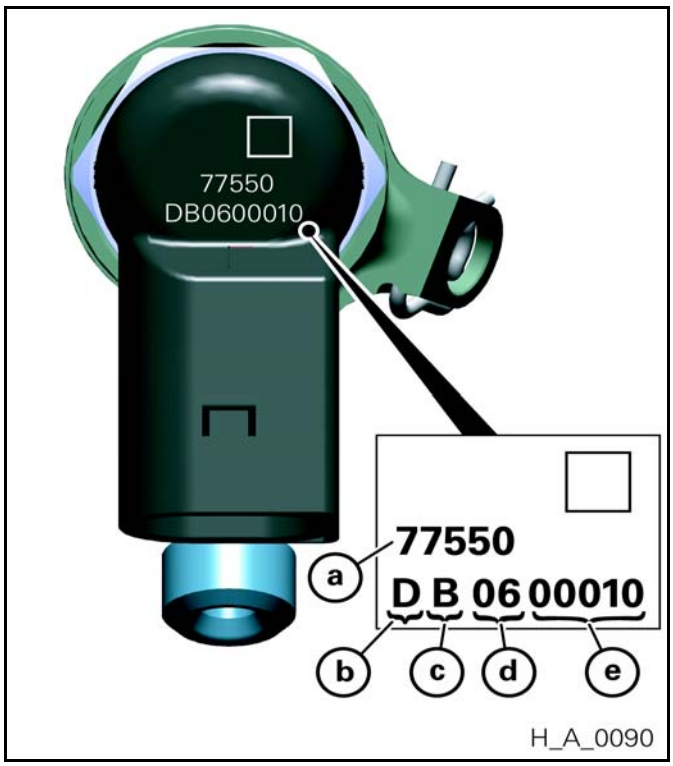


Fig. A - 16 Injector labelling

a Customer part number
b Year of construction
D = 2004 ...
E = 2005 ...
F = 2006 ...
c Month
A=January
B=February
...
L=December
d Day
1 - 31
e Part number
00001 - 99999

3.2 Diesel Common Rail Pump (DCP)

The Diesel Common Rail Pump (DCP) is a demand-controlled radial piston pump having three displacement units each offset by 120°.

The DCP supplies the volume flow for the generation of the high pressure of the fuel in the rail, and thus provides the necessary fuel quantity to the injectors for all operating conditions of the engine.

Important

When removing or mounting the diesel common rail pump, do not carry the pump at the connectors, line connections or casings of the volume flow control valve and pressure control valve.

Otherwise there is a risk of damage!

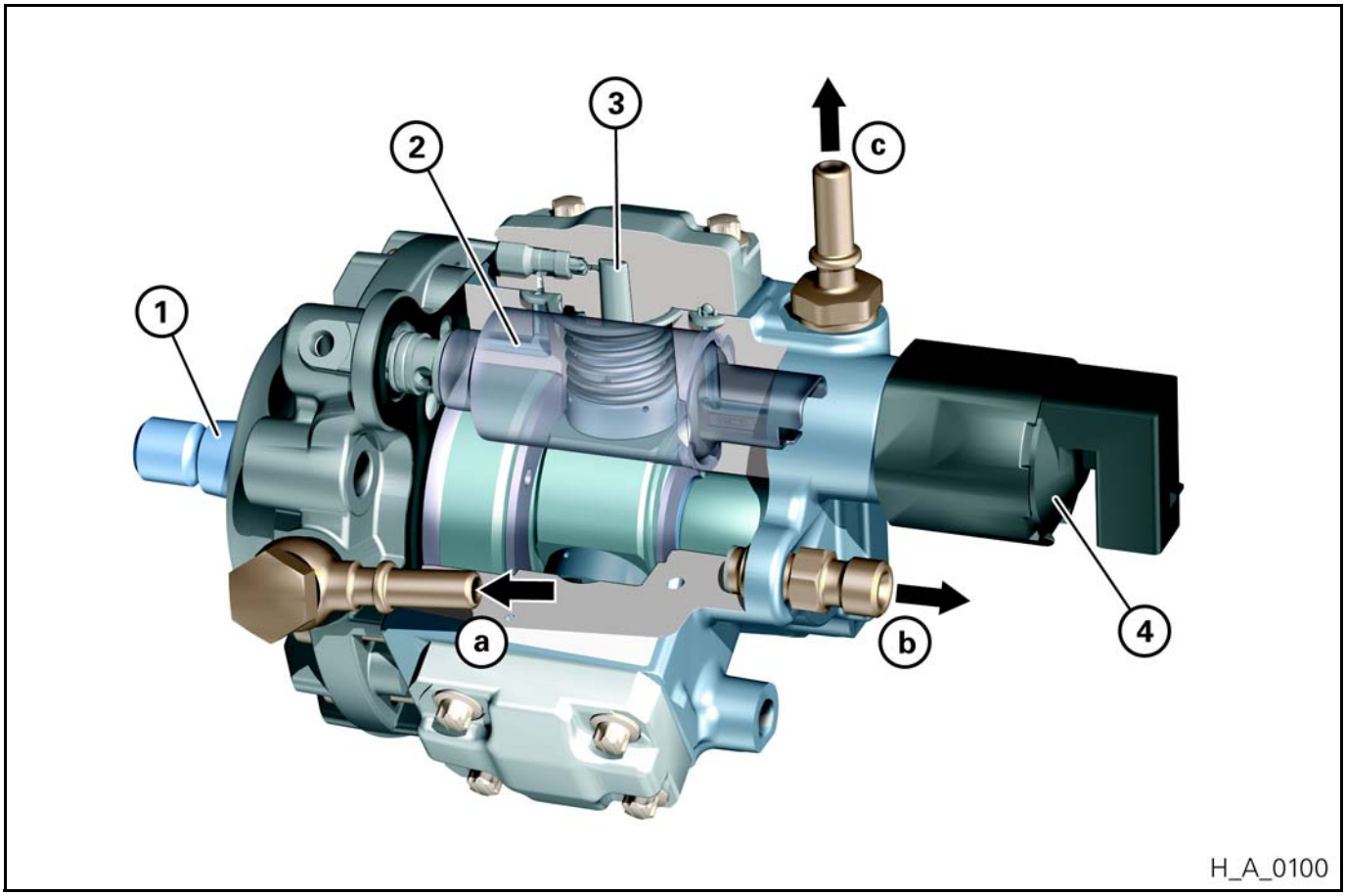


Fig. A - 17 Overview DCP

1. Internal transfer pump (ITP)
2. Volume flow control valve (VCV)
3. High-pressure pump element (displacement unit)
4. Pressure control valve (PCV)

a Fuel feed
b High-pressure connection
c Fuel return

3.2.1 Functional diagram of the Diesel Common Rail Pump

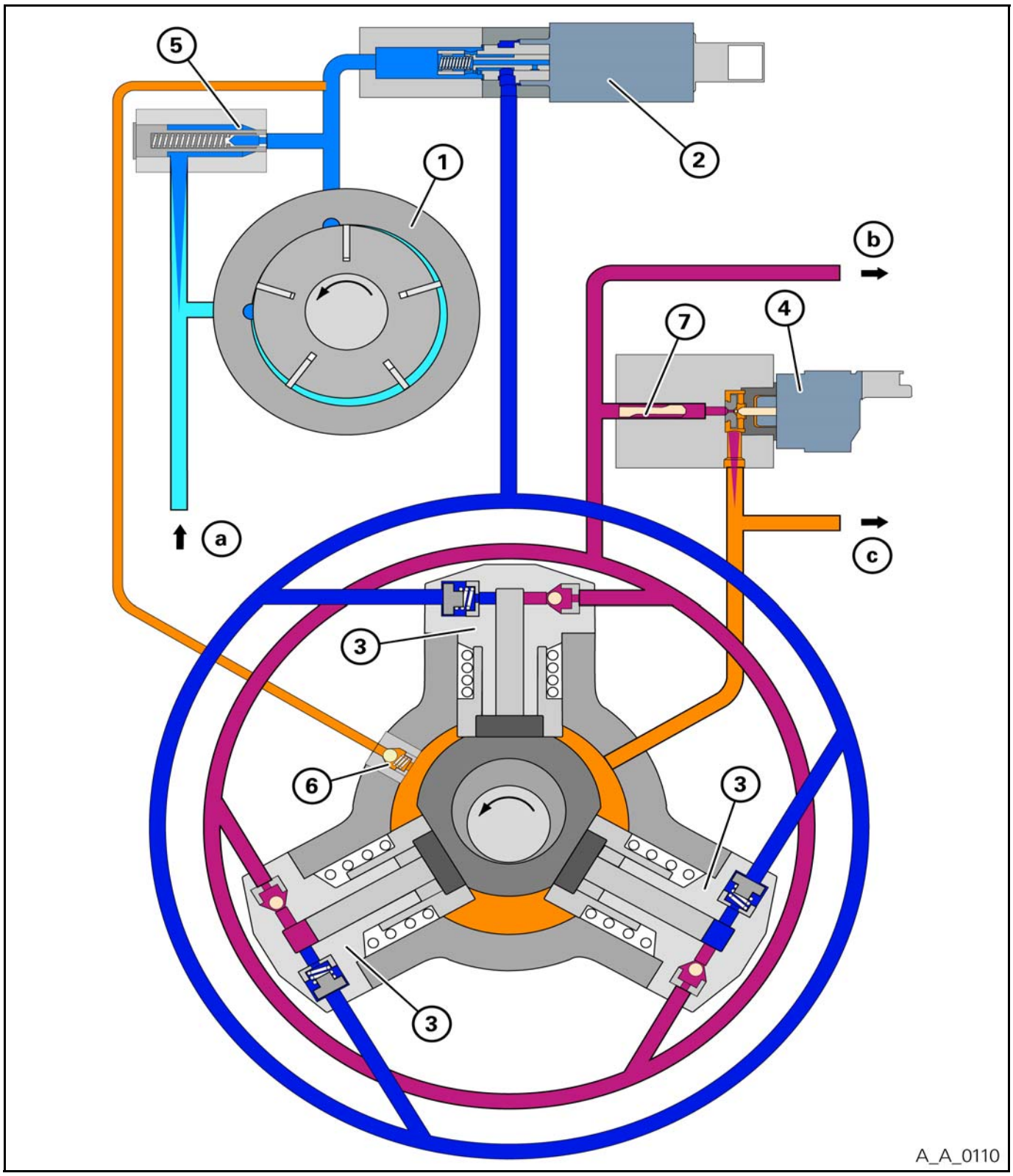


Fig. A - 18 Functional diagram DCP

1. Internal transfer pump (ITP)
2. Volume flow control valve (VCV)
3. High-pressure pump element
4. Pressure control valve (PCV)
5. Pre-pressure control valve
6. Scavenging valve
7. Edge filter

a Fuel feed
b High-pressure connection
c Fuel return

3.2.2 Fuel process in the DCP

An integrated internal transfer pump (1) is used to draw the diesel fuel from the tank through a fuel filter. The fuel is then passed to the scavenging valve (6) and to the volume flow control valve (2).

The pre-pressure control valve (5), which is located parallel to the internal transfer pump, opens when the volume flow control valve is closed and directs the fuel again to the suction side of the internal transfer pump. The fuel enters the inside of the pump through the scavenging valve (6), from where it is passed to the fuel return (c).

The volume flow control valve, activated by the engine control unit, determines the fuel quantity
which is delivered to the high-pressure pump element (3) and thus to the high-pressure pump HPP.
The high-pressure outlets of the three pump elements are combined and routed to the high-pressure outlet (b) of the DCP.

The pressure control valve (4), which controls the fuel quantity to the high-pressure outlet, and thus the fuel pressure in the rail, is arranged between the high-pressure channel and the return line.

3.2.3 Function of the high-pressure elements

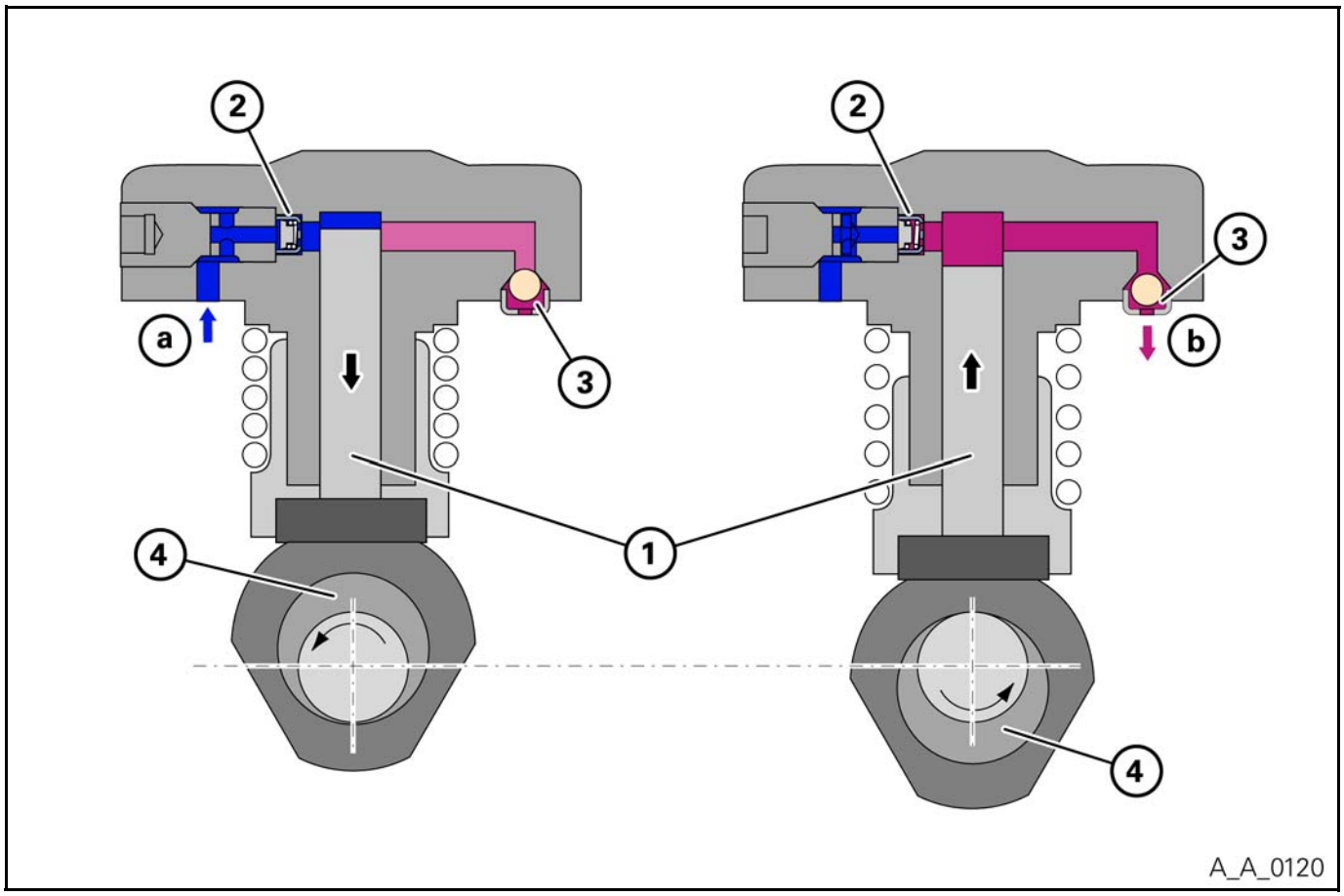


Fig. A - 19 Functional diagram of the high-pressure pump

Fuel intake

The downward movement of the piston (1) produces negative pressure in the pump cylinder, which opens the inlet valve (2) against the spring force.

The fuel (a) coming from the volume flow control valve is drawn in. At the same time, the outlet valve (3) is closed by the difference in pressure between the pump cylinder and the fuel pressure in the circular pipeline.

Fuel delivery

The cam (4) presses the piston (1) upwards.
The inlet valve (2) is closed by spring force and the pressure that builds up in the pump cylinder.

The outlet valve (3) opens as soon as the pressure on the inside of the pump cylinder becomes greater than the fuel pressure in the circular pipeline (b).

3.2.4 Labelling of the Diesel Common Rail Pump

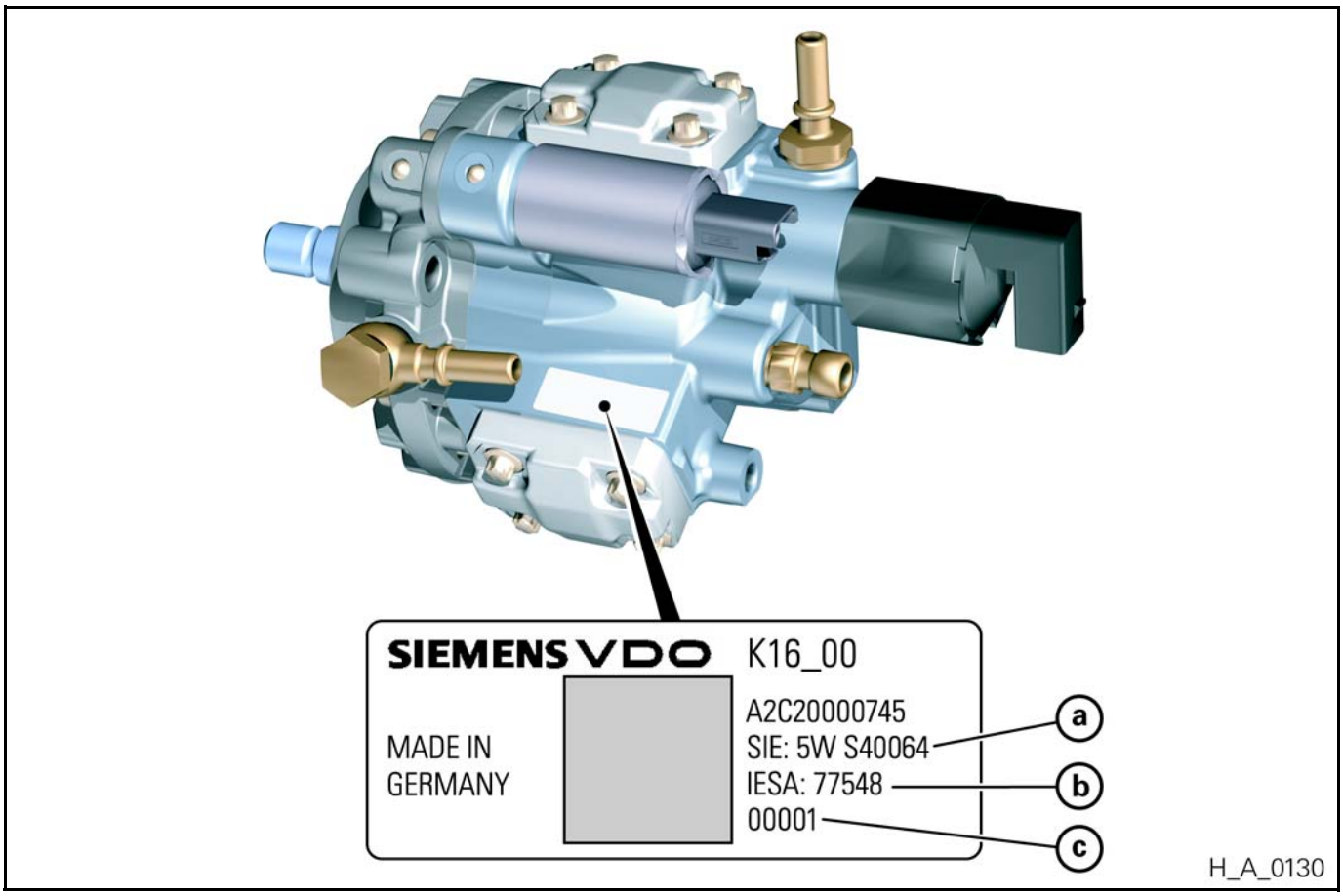


Fig. A - 20 Labelling of the DCP

a Manufacturer's number
b Customer part number
c Consecutive number

3.3 Volume flow control valve (VCV)

The volume flow control valve (VCV) regulates the delivery of fuel from the internal transfer pump, which is integrated into the diesel common rail pump (DCP), to the high-pressure pump elements.

Thus, the fuel quantity delivered by the high-pressure pump (HPP) can be adjusted to the requirements of the engine already on the low-pressure side of the system. The power consump-tion of the high-pressure pump is reduced, thus improving the efficiency of the engine.

The volume flow control valve (VCV) is directly screwed to the diesel common rail pump (DCP).

Important

When repairs are required, the volume flow control valve (VCV) must not be detached from the Diesel Common Rail Pump (DCP).

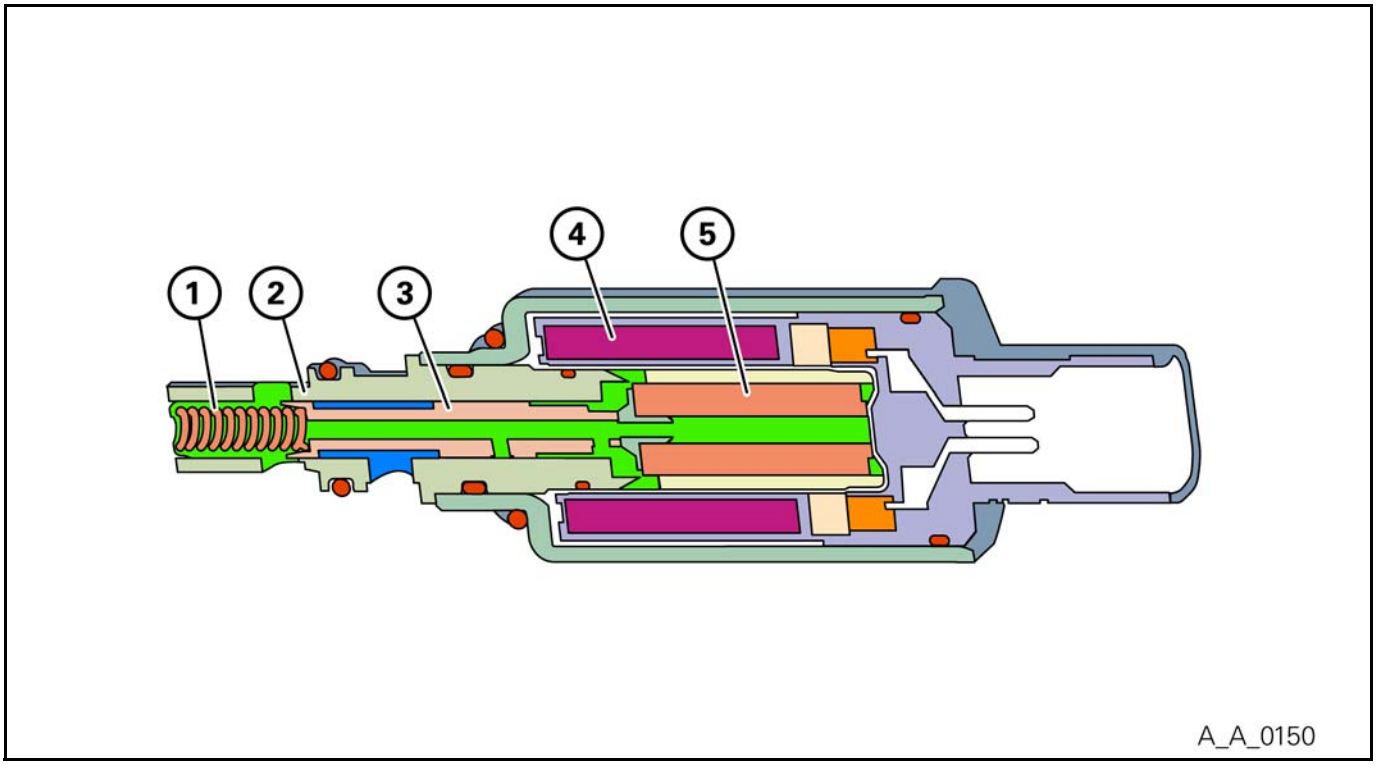


Fig. A - 21 Cross section of the VCV

1. Compression spring
2. Sleeve
3. Piston
4. Solenoid
5. Anchor

3.3.1 Function of the volume flow control valve (VCV)

Volume flow control valve (VCV) not activated

The piston closes the link between the two connections by means of the force generated by the spring, without using electrical current.

The fuel delivery to the high-pressure pump (HPP) is interrupted.

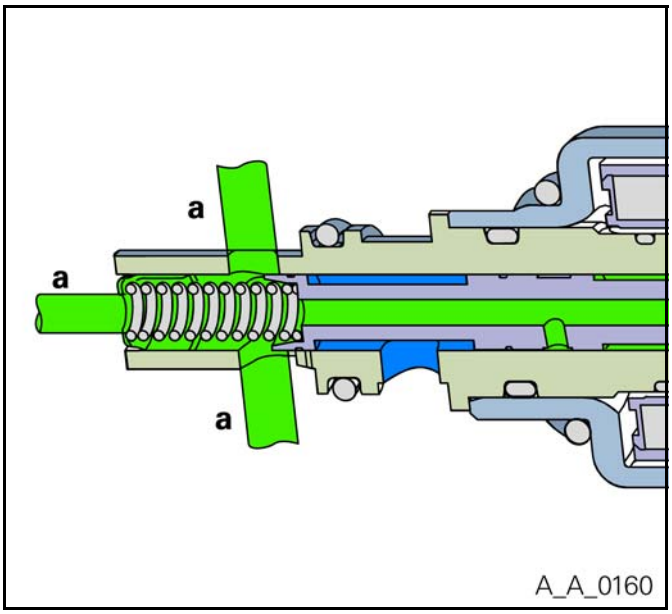


Fig. A - 22 VCV not activated

a Fuel feed from the internal transfer pump (ITP)

Volume flow control valve (VCV) not activated:

The force exerted by the anchor is proportional to the electrical current and acts against the force of the compression spring.

For this reason, the opening between the two connections is proportional to the electrical current (proportional directional control valve).

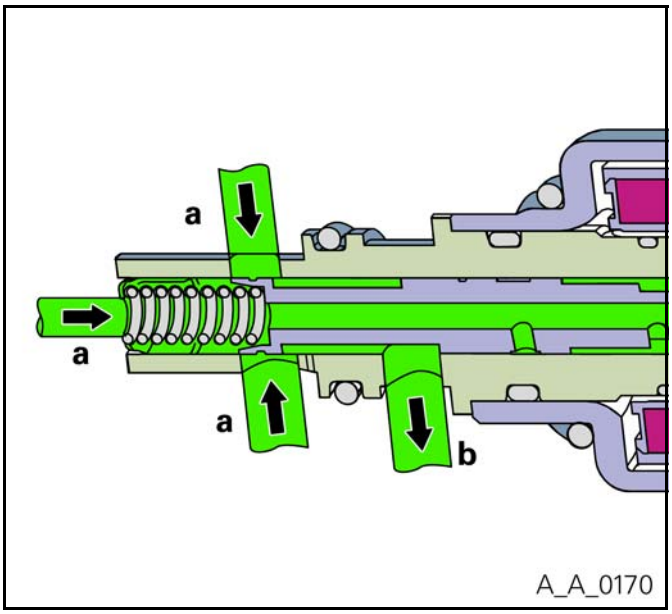


Fig. A - 23 VCV activated

a Fuel feed from the internal transfer pump (ITP)
b Fuel quantity to the high-pressure pump (HPP)

3.3.2 Characteristic curve of the volume flow control valve

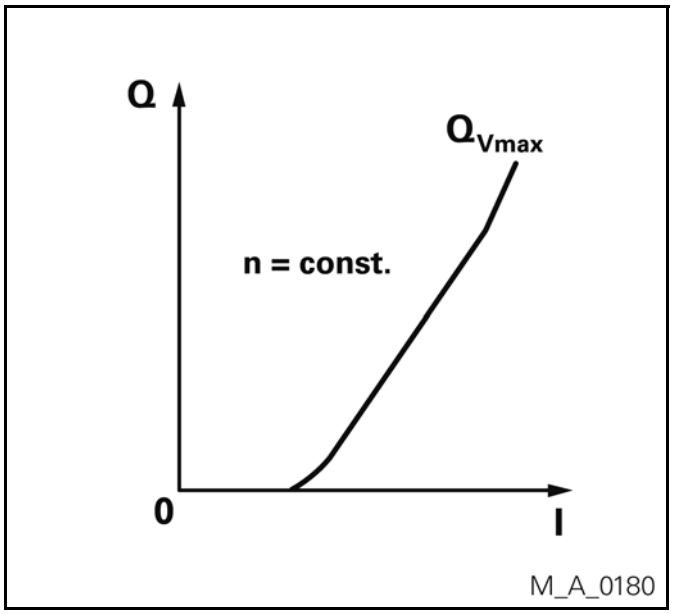


Fig. A - 24 Characteristic curve of the VCV

Q Fuel volume flow

I Control current

3.3.3 Pinning of the volume flow control valve

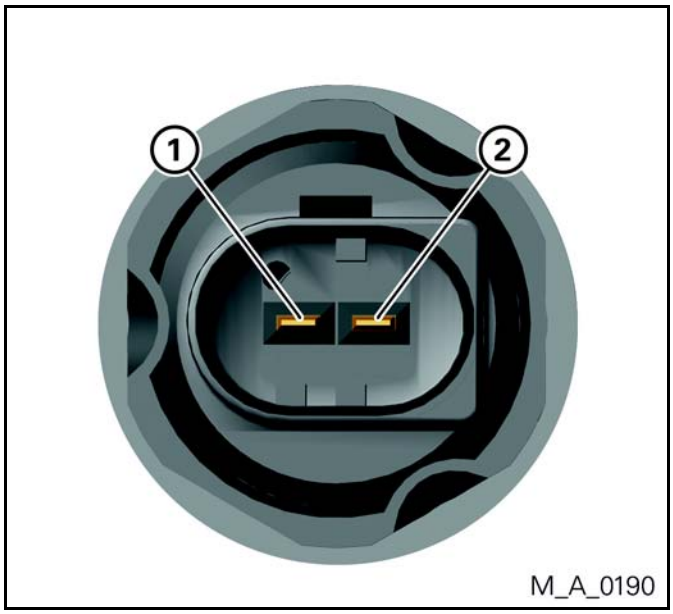


Fig. A - 25 Pinning of the VCV

1. Ignition (Pin 15)
2. PWM signal (ECU)

Note

Measure the current at the volume flow control valve using a diagnostic tool or a multimeter.

3.4 Pressure control valve (PCV)

The high-pressure control valve (PCV) controls the fuel pressure at the high-pressure outlet of the diesel common rail pump (DCP) and thus the fuel pressure within the rail.
In addition, the pressure control valve dampens the fluctuations in pressure which occur during the delivery of fuel through the diesel common rail pump (DCP) and through the injection process.

The pressure control valve (PCV) is activated by the engine control unit (ECU) in such a way that the optimal pressure is produced in the rail for every operating condition of the engine.

The pressure control valve (PCV) is directly flanged to the diesel common rail pump (DCP).

Important

When repairs are required, the pressure control valve (PCV) must not be disconnected from the diesel common rail pump (DCP).

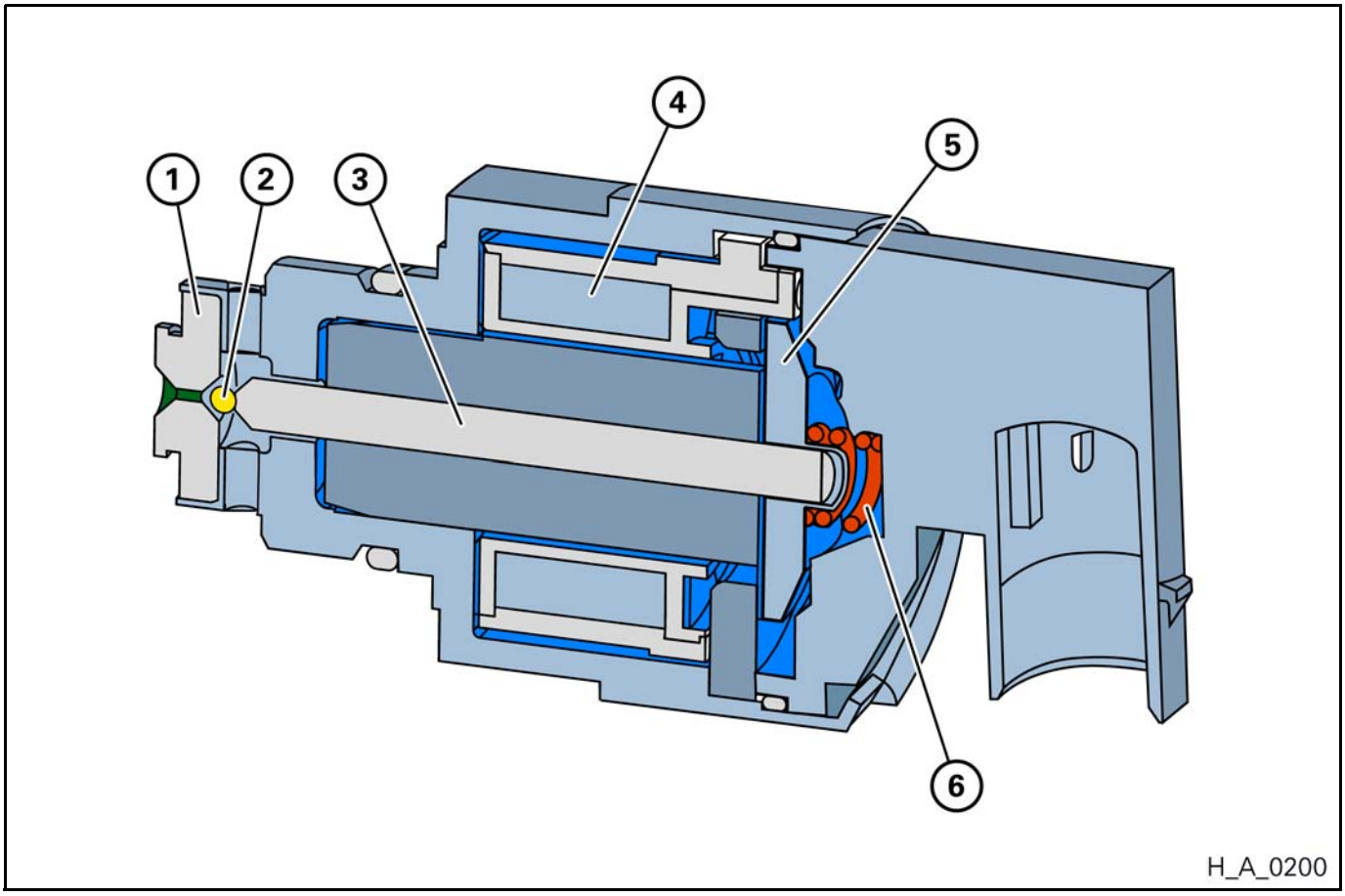


Fig. A - 26 Cross section of the PCV

1. Valve seat
2. Valve ball
3. Pin
4. Solenoid
5. Anchor
6. Spring

3.4.1 Function of the pressure control valve (PCV)

Pressure control valve (PCV) not activated:

The valve ball is operated by the spring force only. Thus, a lower fuel pressure is provided.

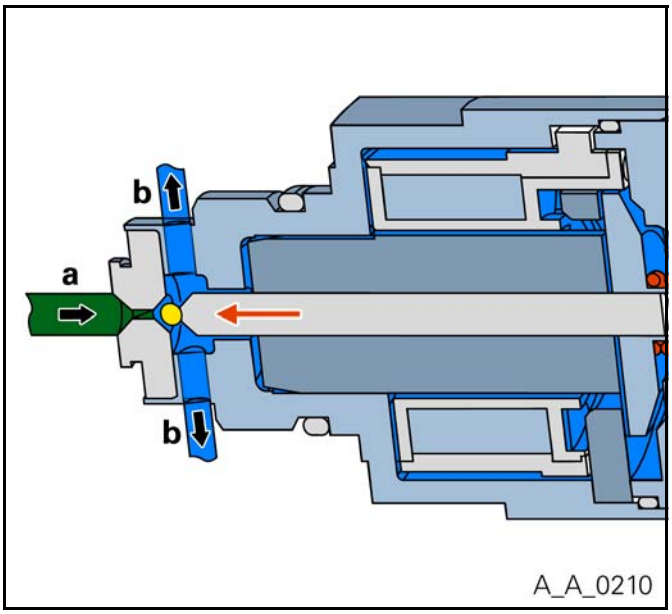


Fig. A - 27 PCV not activated

a Fuel pressure at the DCP high-pressure connection (= fuel pressure in the rail)
b to the fuel return

Pressure control valve (PCV) activated

The current flowing through the solenoid attracts the anchor, which in turn transfers the magnetic force via the pin to the valve ball.

The pull of the anchor and thus the pressure on the valve ball is proportional to the valve flow (proportional pressure control valve).

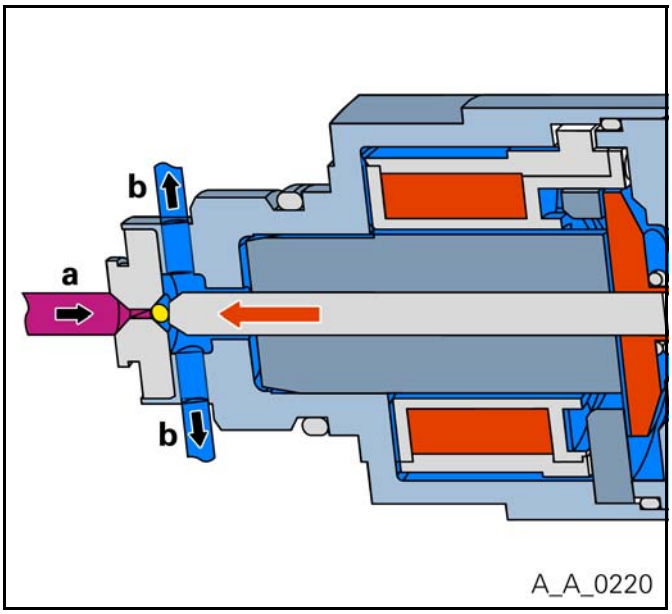


Fig. A - 28 PCV activated

a Fuel pressure at the DCP high-pressure connection (= fuel pressure in the rail)
b to the fuel return

3.4.2 Characteristic curve of the pressure control valve

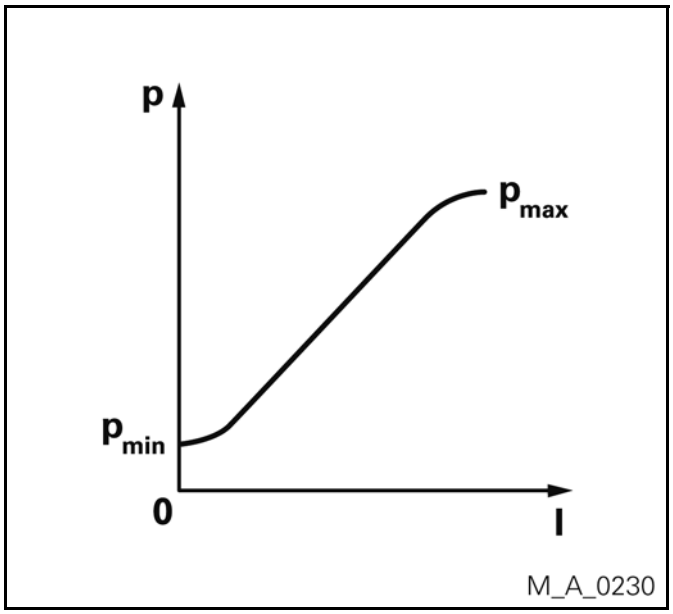


Fig. A - 29 Characteristic curve of the PCV

p Fuel pressure
I Control current

Note

Measure the current at the high-pressure control valve using a diagnostic tool or a multimeter.

3.4.3 Pinning of the pressure control valve

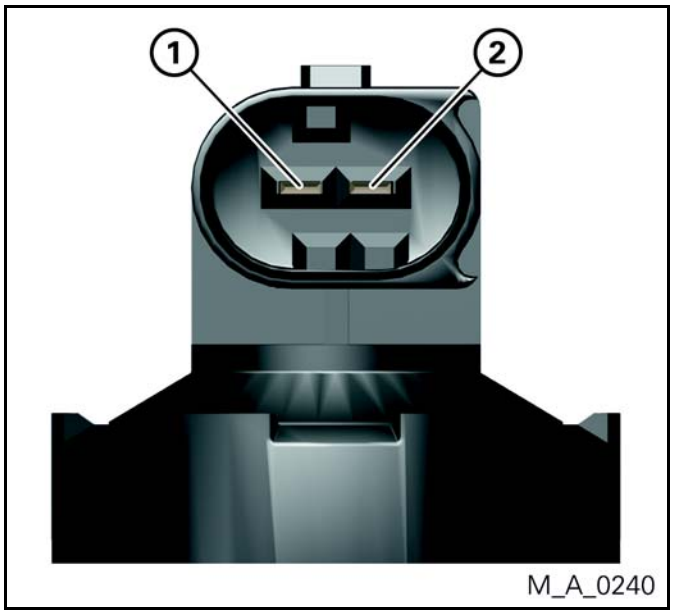


Fig. A - 30 Pinning of the PCV

1. Ignition (Pin 15)
2. PWM signal (ECU)

3.5 High-pressure lines and rail

3.5.1 High-pressure lines

The high-pressure lines connect the diesel common rail pump (DCP) to the rail and the rail to the injectors.

Note

The high-pressure lines always have to be replaced when repairs are required as the sealing cone will be plastically deformed during tightening of the spigot nut.

3.5.2 Rail

The rail is used as a high-pressure storage for fuel which is delivered by the diesel common rail pump (DCP), and supplies the injectors with the necessary fuel quantity for every operating condition.

The storage function dampens the pressure fluctuations which occur during the injection process.

The fuel pressure in the rail will be measured by means of a high-pressure sensor, which is screwed into the rail at the connection (3).

Note

When repairs are required (when replacing the lines only once), the high-pressure sensor must not be unscrewed from the rail.

Important

When mounting or removing the rail, do not carry it or pull it out at the high-pressure sensor.

Otherwise there is a risk of damage!

Labelling of the rail

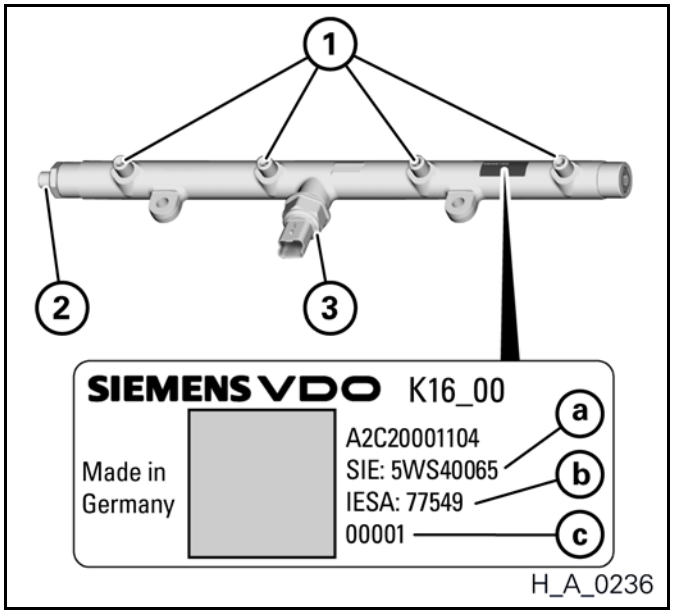


Fig. A - 31 Rail connections and labelling

1. Connections of the high-pressure lines to the injectors
2. Connection of the high-pressure line to the diesel common rail pump (DCP)
3. Connection of the high-pressure sensor

a Siemens VDO part number
b Customer part number
c Consecutive number

3.6 High-pressure sensor

The high-pressure sensor measures the pressure of the fuel in the rail. The current pressure is converted into a voltage signal which is evaluated by the engine control unit (ECU).

In accordance with the recorded characteristics in the engine control unit (ECU), the pressure signal is used for calculating the activation duration for the injectors and the high-pressure regulation by the pressure control valve (PCV).

The high-pressure sensor is directly connected to the rail and sealed with a soft iron washer.

Important

When repairs are required, the high-pressure sensor must not be screwed out of the rail.

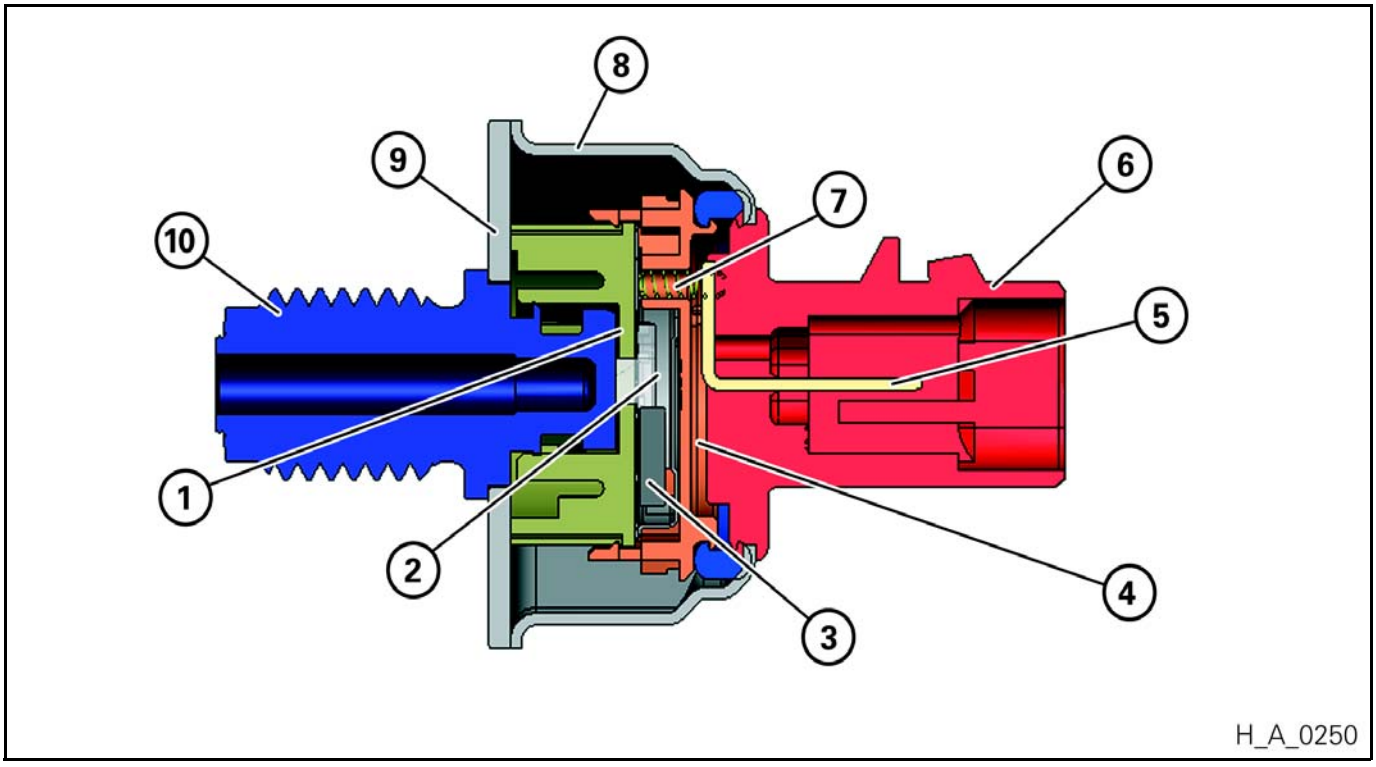


Fig. A - 32 Cross section of the high-pressure sensor

1. Membrane
2. EMC (Electro Magnetic Compatibility)
3. EMA (Electronic Module Assembly)
4. Cover
5. Connection
6. Connector housing
7. Contact springs
8. Metal housing
9. Metal flange
10. Pressure connection

3.6.1 Function of the high-pressure sensor:

The membrane (1) is deformed in dependence of the fuel pressure present in the rail. The deformation of the membrane (1) alters the resistance value of the membrane resistance bridge.
The EMA (3) evaluates the changes in the resistance value and converts them to voltage signals. Subsequently, the voltage signal is passed on by the EMA (3) to the engine control unit (ECU).

3.6.2 Characteristic curve of the high-pressure sensor

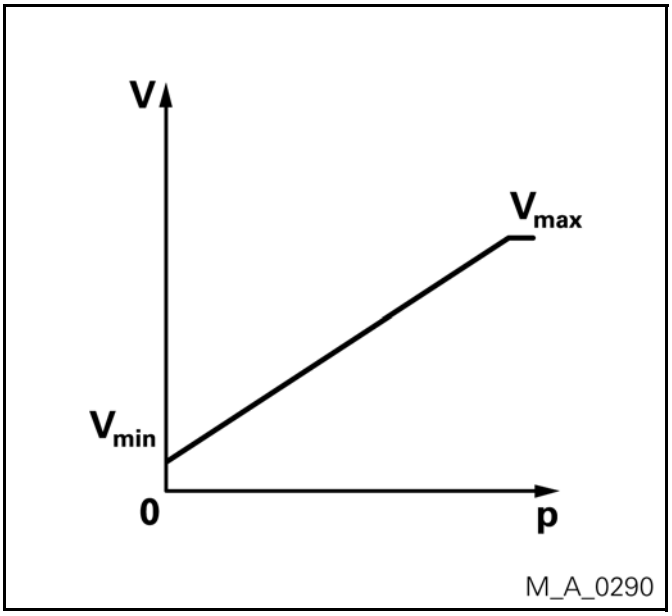


Fig. A - 33 Characteristic curve of the high-pressure sensor

V Voltage
p Fuel pressure

3.6.3 Pinning of the high-pressure sensor

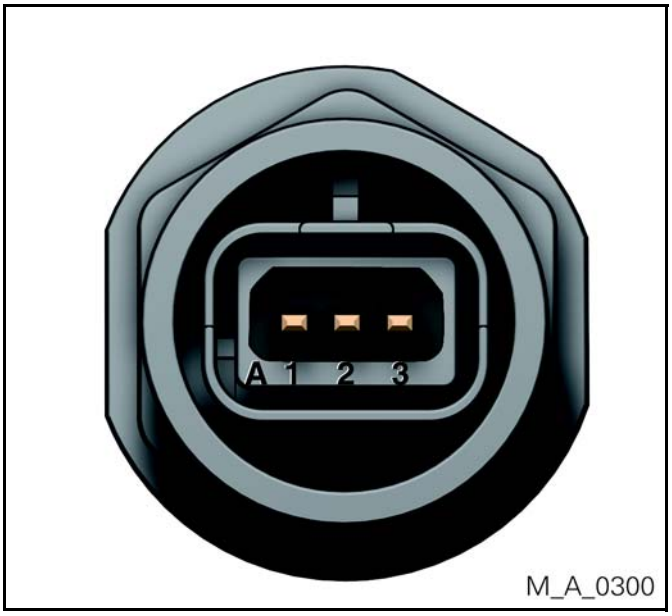


Fig. A - 34 Pinning of the high-pressure sensor

1. Output (signal)
2. Ground cable
3. Supply voltage

3.6.4 Labelling of the high-pressure sensor

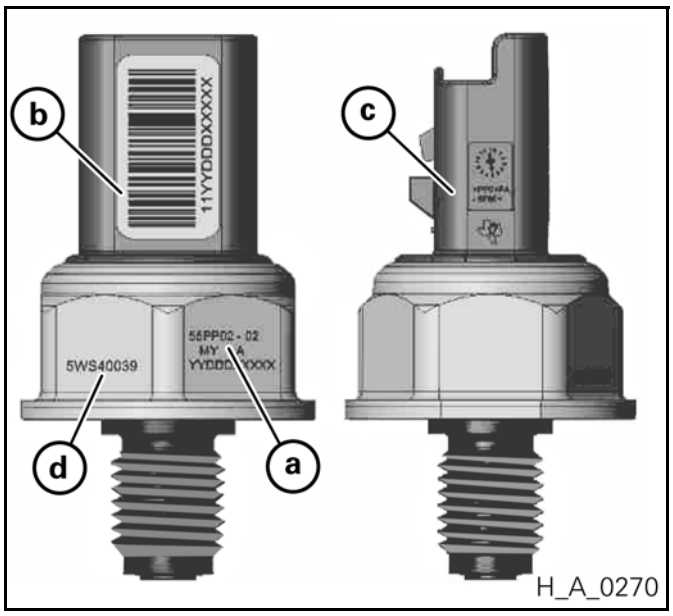


Fig. A - 35 Labelling of the high-pressure sensor

a Type 55P02-01
b Data code and serial number:
1st and 2nd digits: 11 = Connector SICMA2
3rd and 4th digits: Year - e.g. 04
5th to 7th digits: Day of manufacture
8th to 12th digits: Current serial number
c Manufacturer's logo
d Siemens VDO part number

3.7 Engine control unit (ECU)

The engine control unit ECU checks all processes which are necessary for controlling the engine system.
It computes the necessary output data for the engine (e.g. en-gine speed, vehicle speed, engine coolant temperature, intake air mass, etc.) in accordance with the driver's requirements and the engine and vehicle data (e.g. amount of fuel injected, exhaust gas recirculation rate, ...).

In addition, other functions will be checked, such as the coded engine immobiliser.

The engine control unit communicates with other control devices (e.g. ABS, ASR, ESP) via the CAN bus.

Danger

When performing work at the engine control unit (ECU) and the injectors, the accident prevention regulations for high-voltage equipment must be observed.

Important

When the engine is running, the connection cables to the engine control unit (ECU) must not be disconnected.

Otherwise there is a danger of damaging the engine!

Note

The engine control unit may become very hot in operation. A high temperature at the housing does not indicate that the engine control unit is damaged.

The engine control unit is checked by following the test instructions (chapter B, section 4.5).

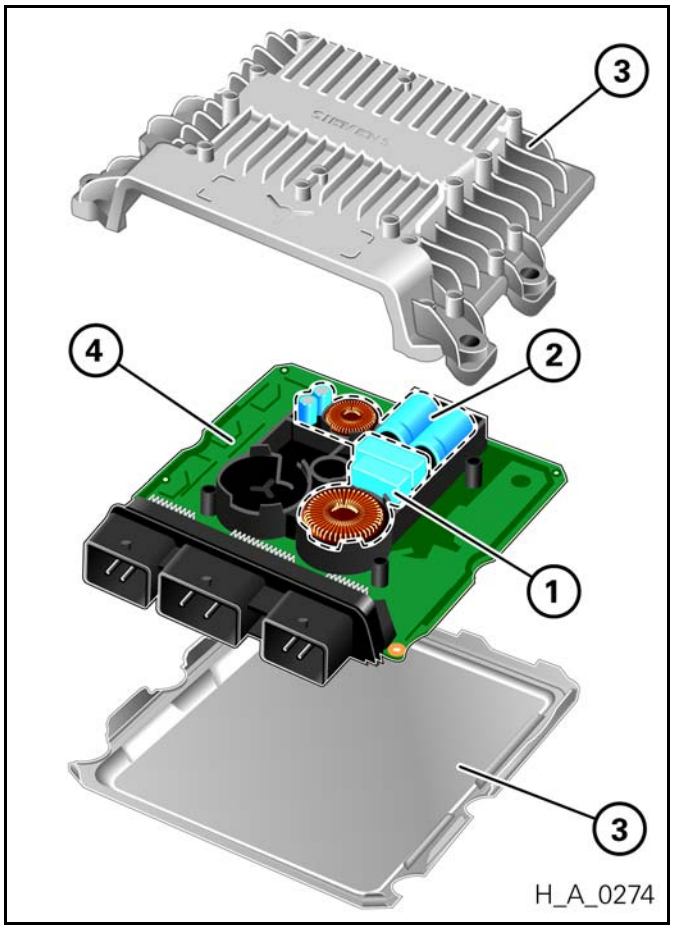


Fig. A - 36 Engine control unit

1. Power stage
2. Output stage
3. ECU housing
4. ECU circuit board

3.7.1 Input and output signals of the engine control unit (ECU)

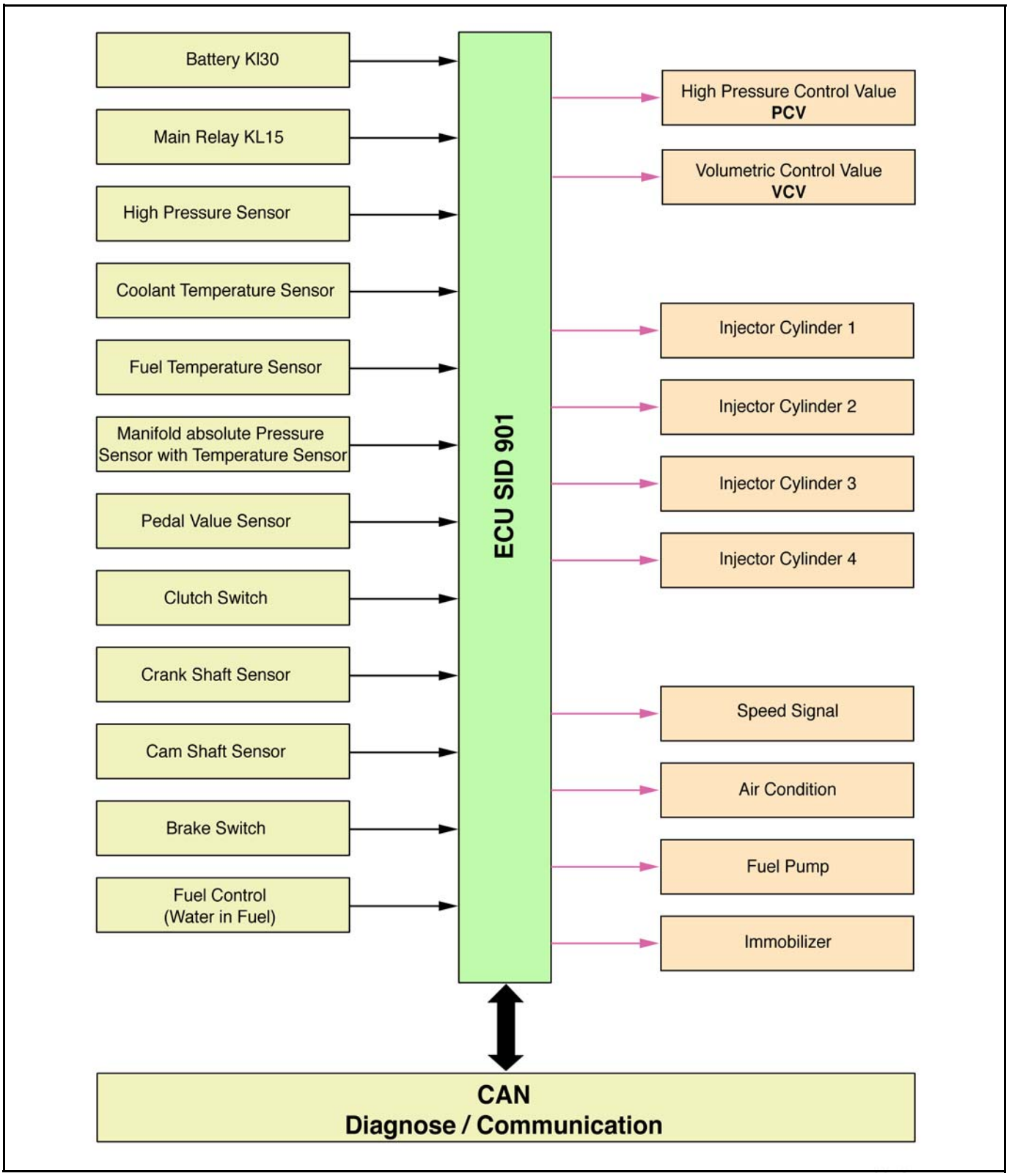


Fig. A - 37 Engine control unit signals

3.7.2 Injector control

Circuit diagram

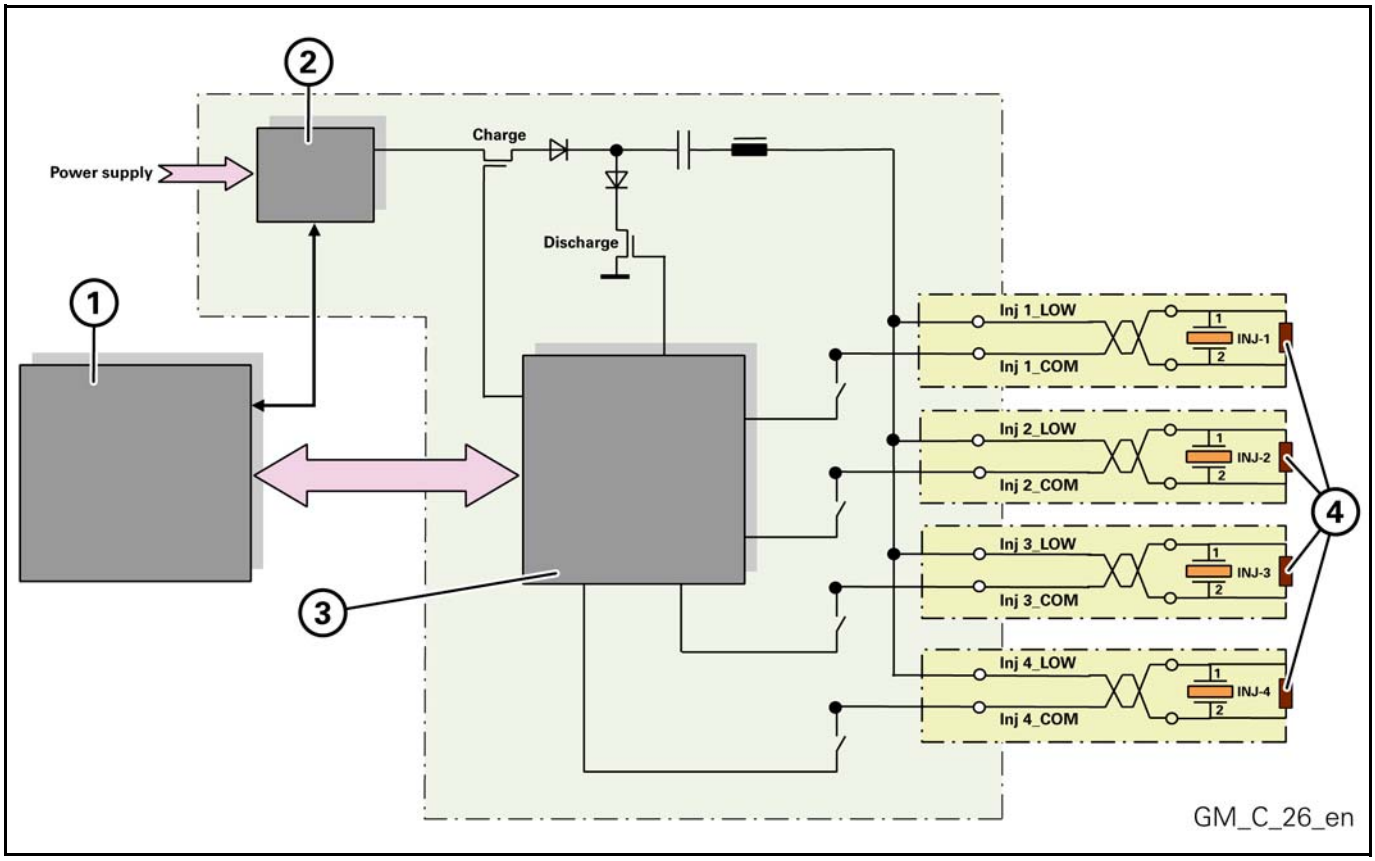


Fig. A - 38 Circuit diagram — injector control

1. Microprocessor
2. DC / DC converter
3. Control IC
4. Discharge delay resistor

Piezo charging

While the piezo is charging, switch S1 is closed and switch S2 is open. The piezo is being charged. The diode connected in-between prevents current from flowing from the piezo while being charged.

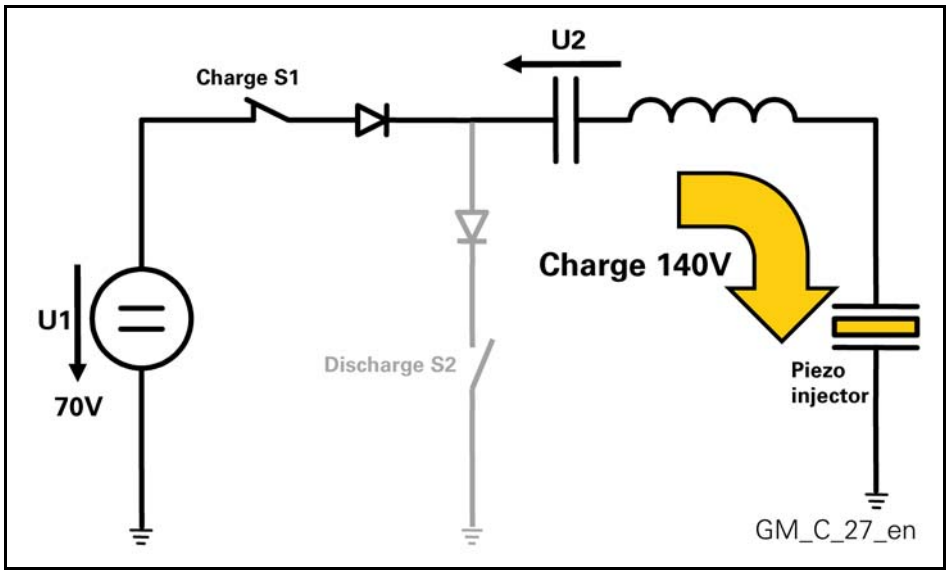


Fig. A - 39 Piezo charging circuit

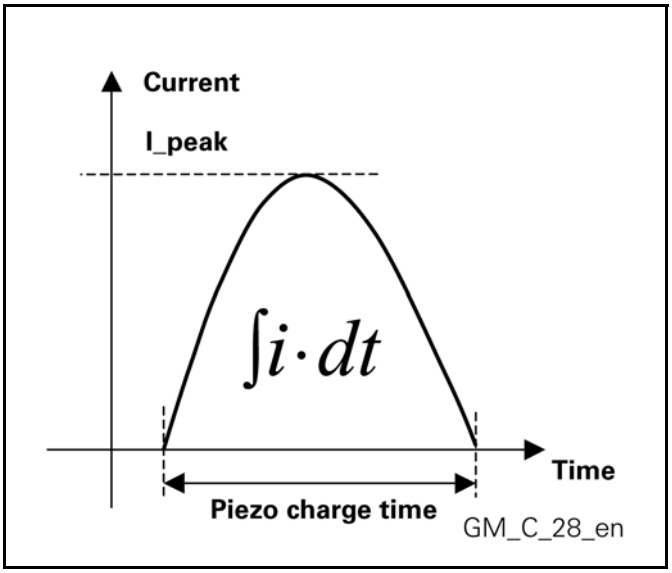


Fig. A - 40 Piezo charging — current over time

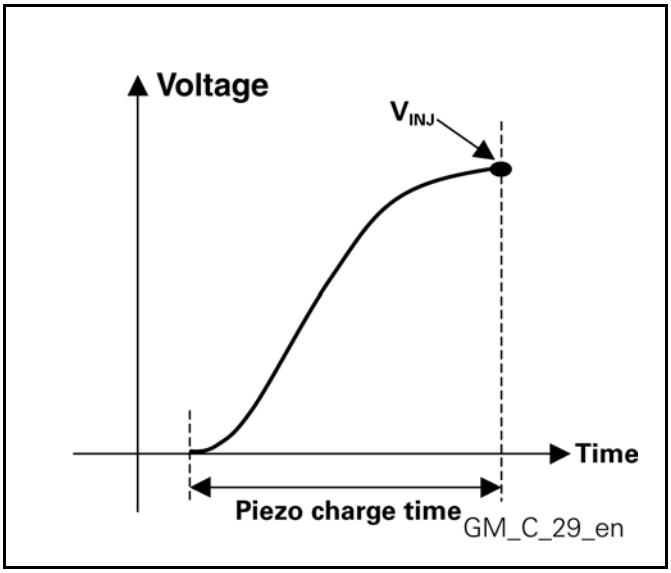


Fig. A - 41 Piezo charging — voltage over time

Piezo discharging

While the piezo is being discharged, switch S1 is open and switch S2 is closed. The piezo is being discharged. The diode connected in-between prevents current from flowing from the piezo while being discharged.

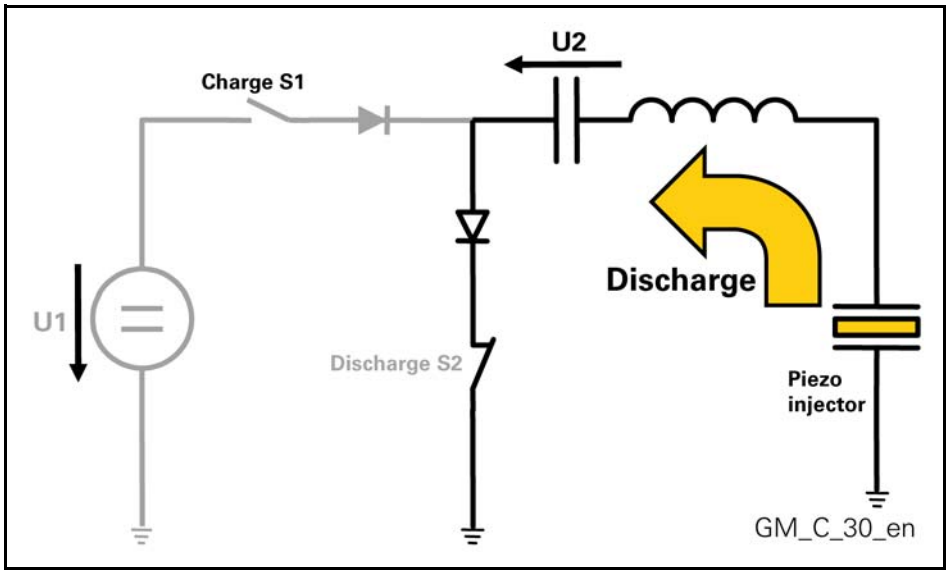


Fig. A - 42 Piezo discharging circuit

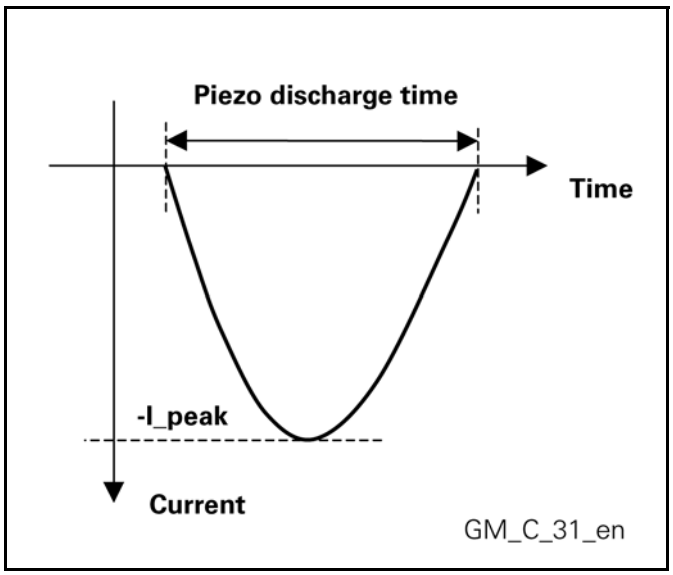


Fig. A - 43 Piezo discharging — current over time

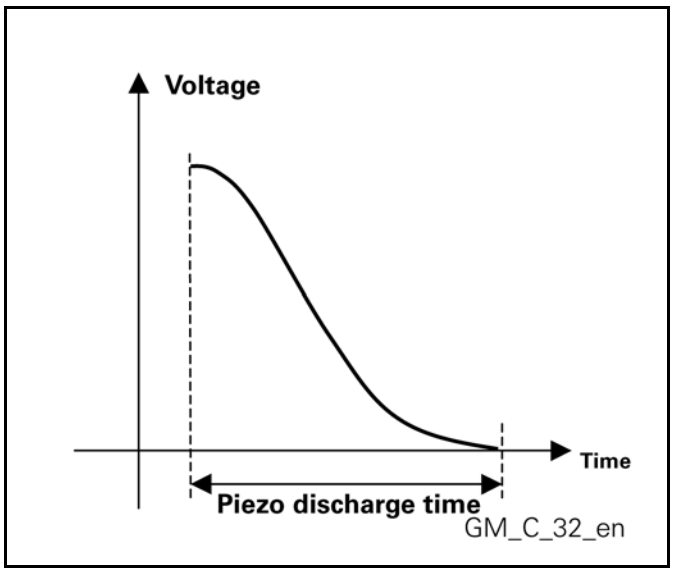


Fig. A - 44 Piezo discharging — voltage over time

3.7.3 PIN assignment at the engine control unit (ECU):

Connector A

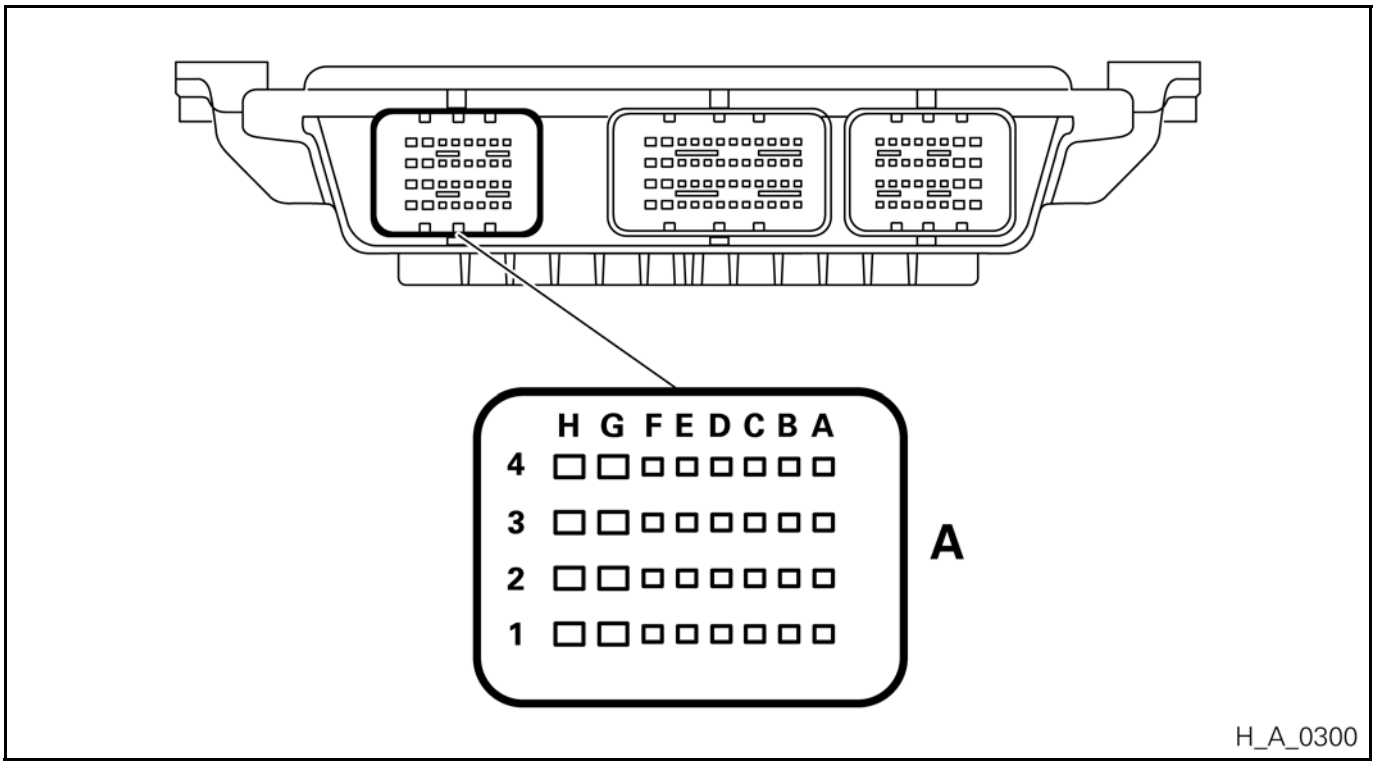


Fig. A - 45 PIN assignment - connector A

A1 RX-PATS
A2 Not occupied
A3 CAN_LOW
A4 CAN_HIGH
B1 Not occupied
B2 Not occupied
B3 Air-conditioning system
B4 Not occupied
C1 Not occupied
C2 Accelerator pedal sensor, signal 2
C3 Battery Pin 30 on ignition
C4 Not occupied
D1 Not occupied
D2 TX-PATS
D3 Not occupied
D4 Not occupied

E1 Not occupied
E2 Not occupied
E3 Clutch switch
E4 Brake light switch (redundant)
F1 Not occupied
F2 Accelerator sensor pedal, supply 1
F3 Not occupied
F4 Accelerator pedal sensor, ground
G1 Not occupied
G2 Accelerator pedal sensor, supply 2
G3 Accelerator pedal sensor, signal 2
G4 Ground Pin 31
H1 Not occupied
H2 Not occupied
H3 Accelerator pedal sensor, ground
H4 Ground Pin 31

Connector B

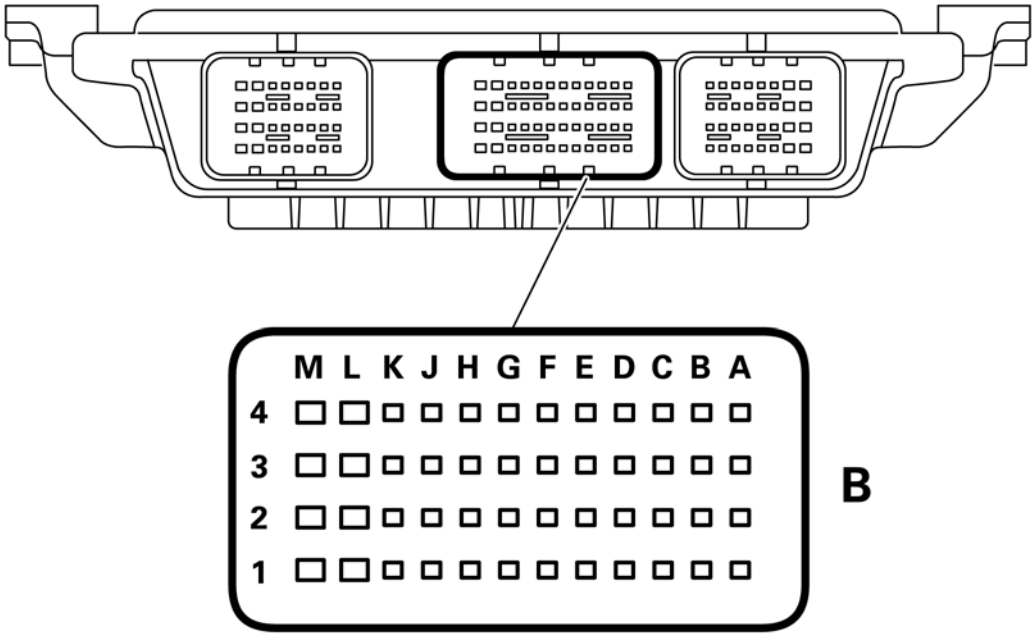


Fig. A - 46 PIN assignment - connector B

A1 Air conditioning system signal
A2 T-MAP sensor input
A3 Not occupied
A4 Not occupied
B1 Water in fuel
B2 Not occupied
B3 Not occupied
B4 Not occupied
C1 Not occupied
C2 Not occupied
C3 T-MAP sensor, supply
C4 Not occupied
D1 High-pressure sensor, supply
D2 Brake light switch
D3 Not occupied
D4 Not occupied
E1 Not occupied
E2 Camshaft sensor, ground
E3 Crankshaft sensor, signal
E4 Crankshaft sensor, ground
F1 Not occupied
F2 Water in fuel, ground
F3 Not occupied
F4 Not occupied
G1 Not occupied
G2 Not occupied
G3 Not occupied
G4 Battery voltage (Pin 30)
H1 Not occupied
H2 Not occupied
H3 Not occupied
H4 Not occupied
J1 Not occupied
J2 Fuel temperature sensor, ground
J3 Not occupied
J4 T-MAP sensor input, ground
K1 Coolant temperature sensor, ground
K2 Ground Pin 31
K3 Not occupied
K4 Not occupied
L1 Not occupied
L2 Not occupied
L3 Not occupied
L4 Pressure control valve (PCV)
M1 Not occupied
M2 Not occupied
M3 Not occupied
M4 Volume flow control valve (VCV)

Connector C

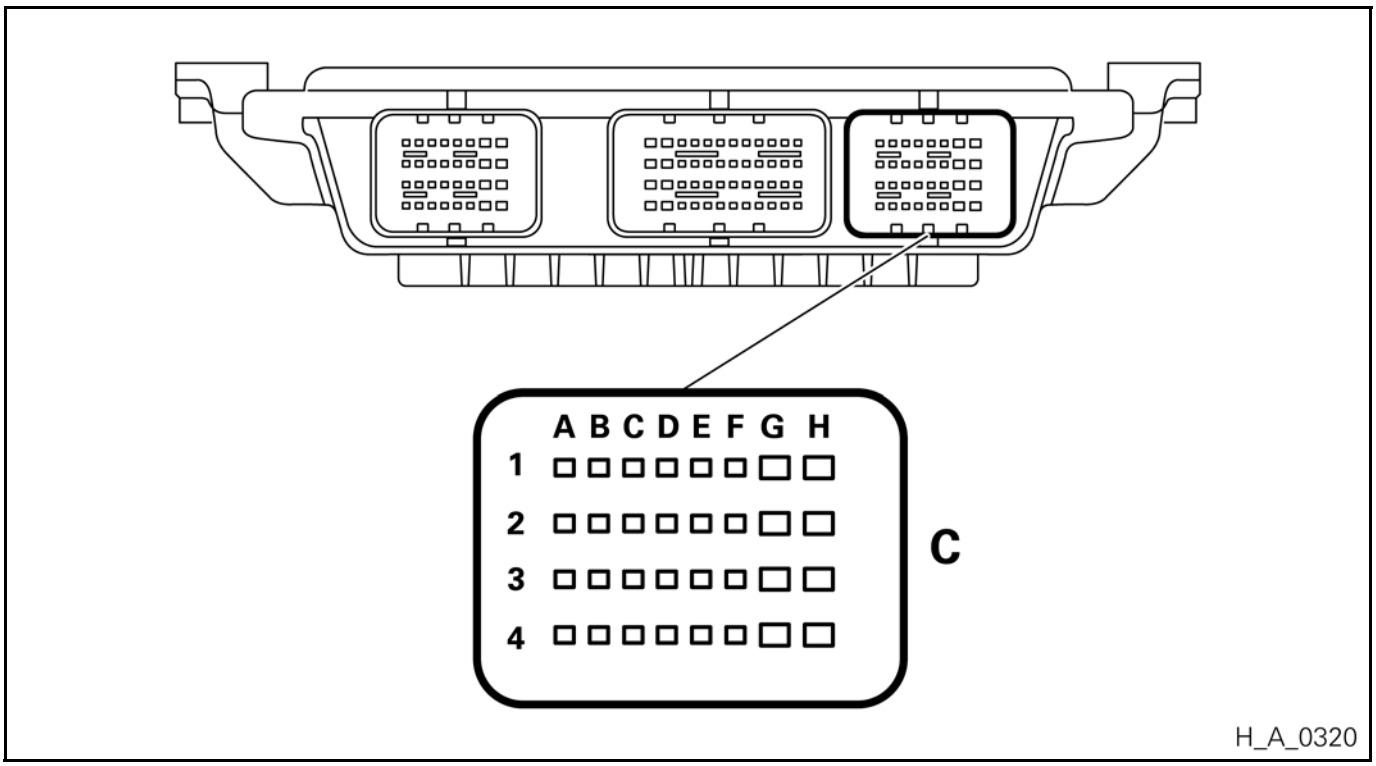


Fig. A - 47 PIN assignment - connector C

A1 Not occupied
A2 Coolant temperature
A3 Fuel temperature
A4 Fuel pump repeating
B1 Boost pressure
B2 High-pressure sensor signal
B3 High-pressure sensor, ground
B4 Not occupied
C1 Camshaft sensor signal
C2 Vehicle speed signal
C3 Engine immobiliser
C4 Ground Pin 31
D1 Not occupied
D2 PCM relay signal
D3 Not occupied
D4 Fuel pump

E1 Not occupied
E2 Vehicle speed (output)
E3 Switched plus from main relay
E4 Not occupied
F1 Not occupied
F2 Switched plus from main relay
F3 Switched plus from main relay
F4 Air-conditioning coupling relay
G1 Injector cylinder 2 (+)
G2 Injector cylinder 3 (+)
G3 Injector cylinder 4 (+)
G4 Injector cylinder 1 (+)
H1 Injector cylinder 1 ground
H2 Injector cylinder 2 ground
H3 Injector cylinder 4 ground
H4 Injector cylinder 3 ground

3.7.4 Labelling of the engine control unit (ECU

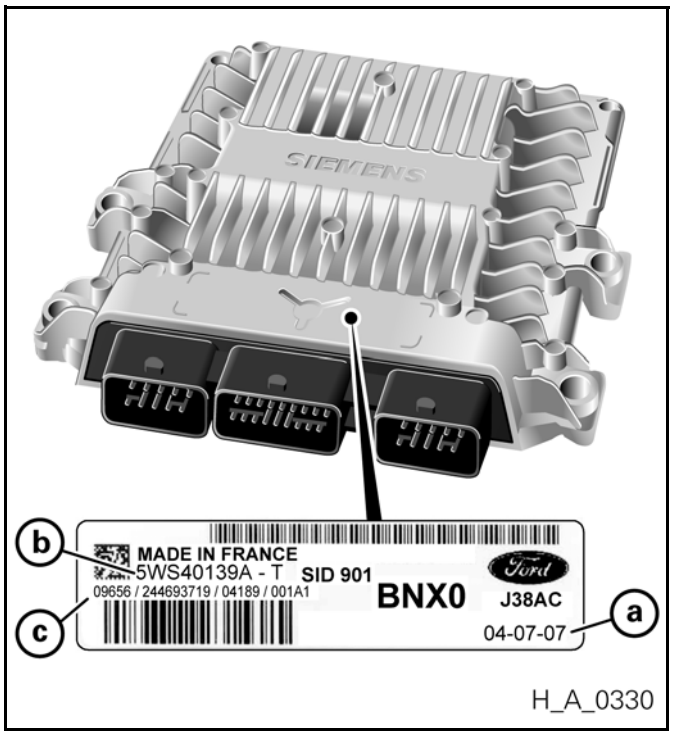


Fig. A - 48 Labelling of the engine control unit

a Ford part number
b Manufacturer's number
c Serial number

3.8 Sensors of the system

3.8.1 T-MAP sensor

As a Temperature Manifold Absolute Pressure (T-MAP) sensor, it measures pressure and temperature in the suction tube.
The suction tube pressure and temperature are converted to a voltage and a resistance signal, respectively, which are evaluated by the engine control unit (ECU).

The T-MAP sensor is located in the intake area of the system.

Labelling of the T-MAP sensor

a International logo
b Ford part number
c Siemens VDO logo
d Siemens VDO part number
e Data code and serial number:
  1st and 2nd digits: 17 = Type
  3rd and 4th digits: Index
  5th digit: Year of manufacture
  6th and 7th digits: Week of manufacture
  8th digit: Day of manufacture
f Serial number

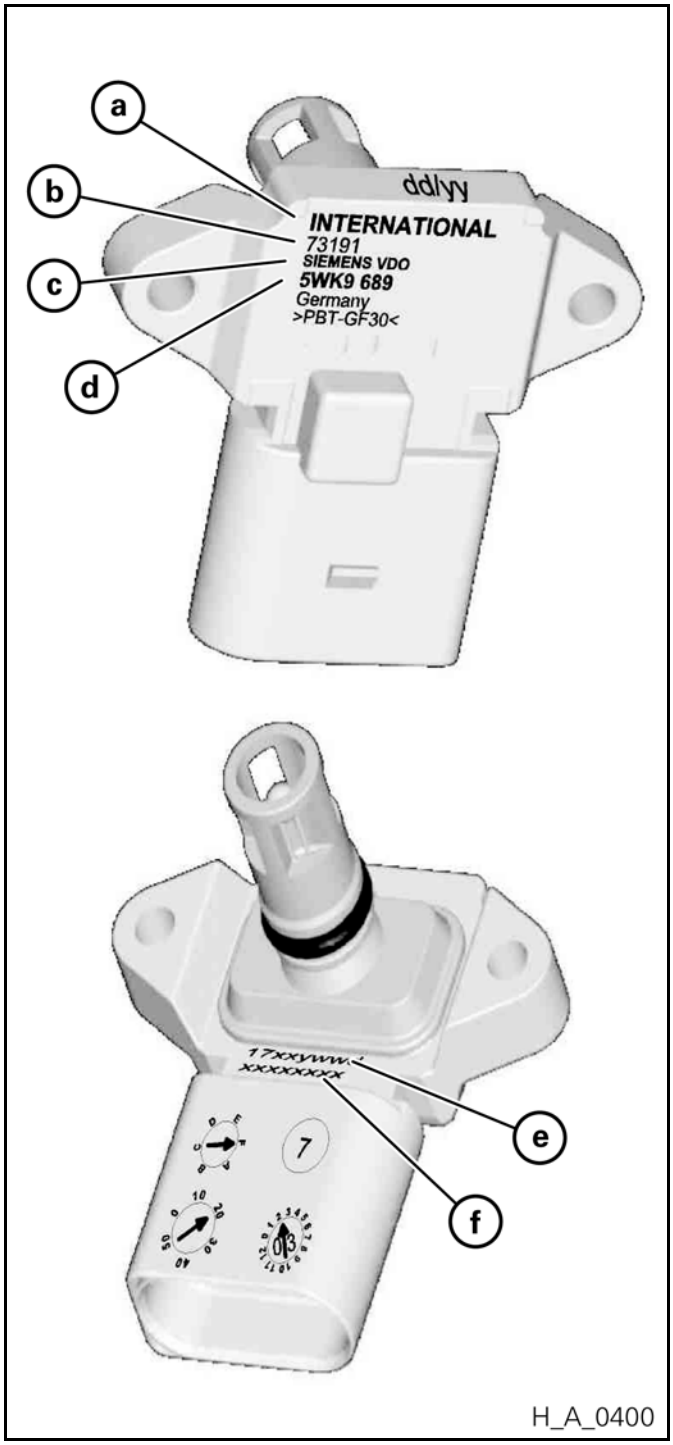


Fig. A - 49 Labelling of the T-MAP sensor

Function of the T-MAP sensor

The air enters through the pressure connection (1) and goes past the temperature sensor (7) to the pressure sensor (4). The pressure sensor converts the air pressure to a voltage signal and sends it to the ECU.
The temperature sensor used is a thermistor (NTC). The drop in voltage is measured by the ECU based on the resistance of the NTC.

The ECU compares the measured voltage with the recorded characteristics. This gives the data required by the system control unit.

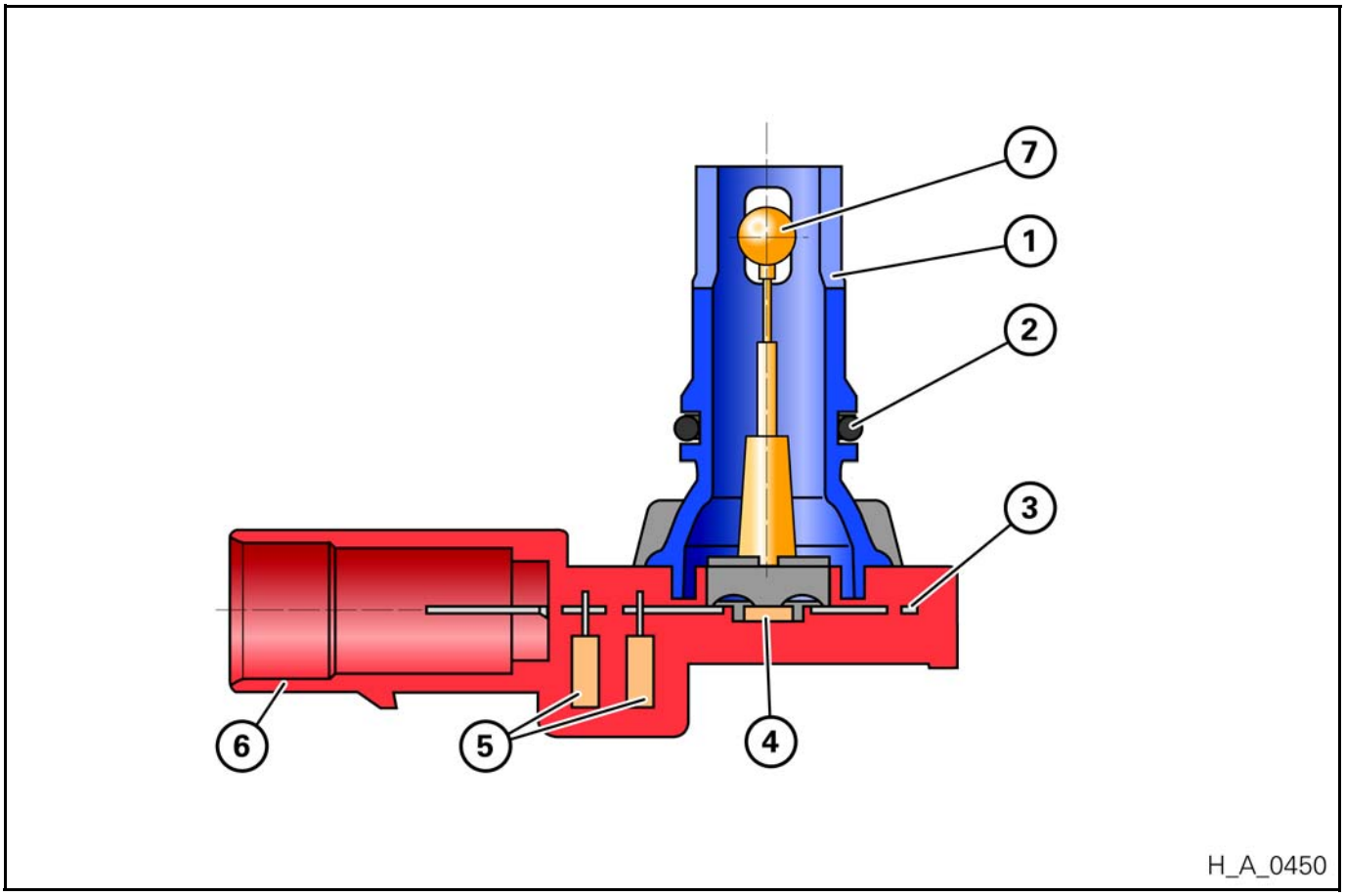


Fig. A - 50 Cross section of the T-MAP sensor

1. Pressure connection
2. O-ring
3. Guide frame
4. Pressure sensor
5. EMC shield
6. Connector housing
7. Temperature sensor

3.8.2 Camshaft sensor

The camshaft sensor samples a spur ring on the camshaft. The rotation of the spur ring changes the Hall voltage of the Hall IC in the sensor head. This change in voltage is evaluated by the engine control unit (ECU).

Depending on what characteristics are recorded in the engine control unit (ECU), the information will be used to calculate the position of the camshaft.

The camshaft sensor is secured directly on the cylinder head.

Labelling of the camshaft sensor

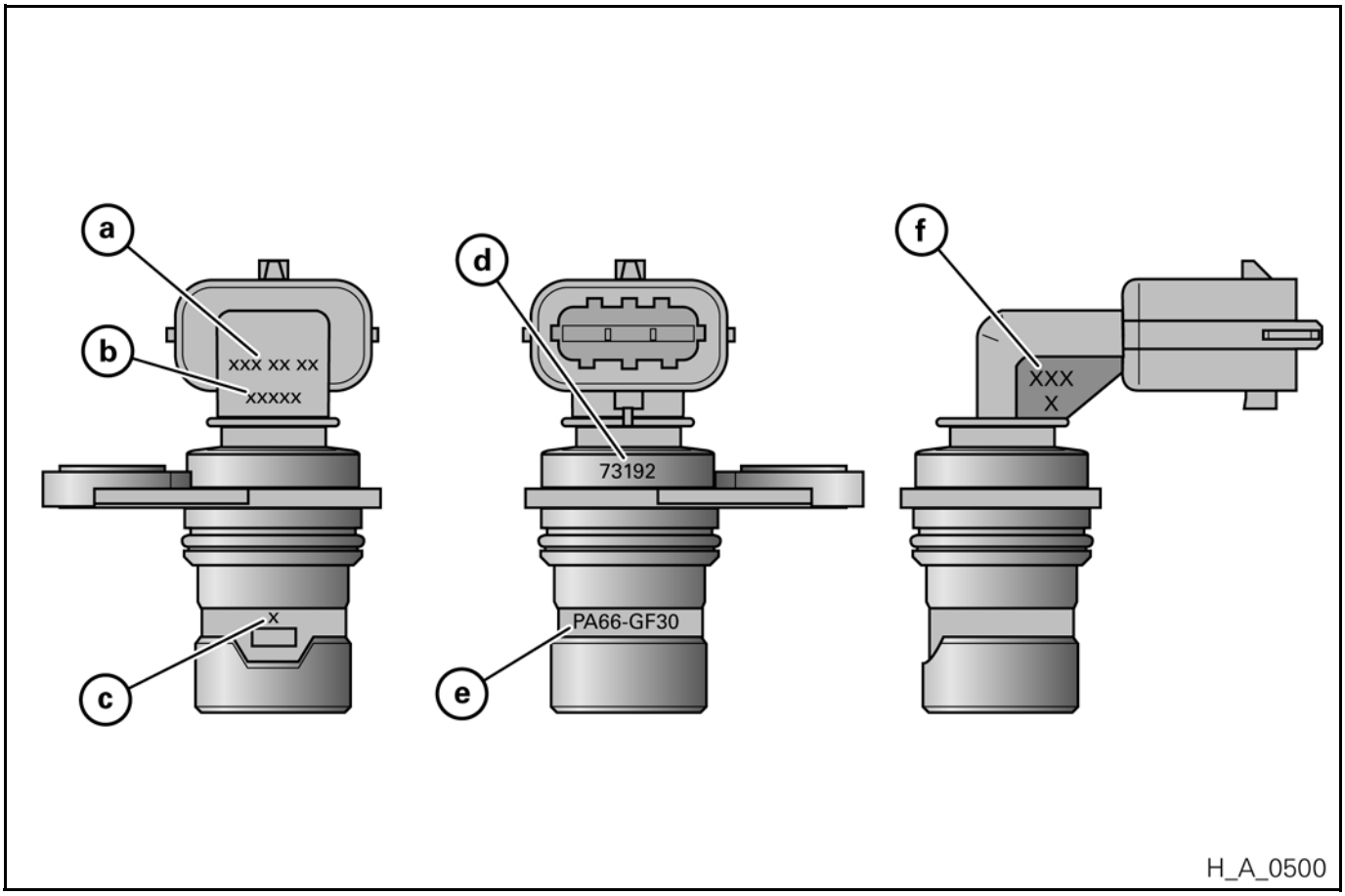


Fig. A - 51 Labelling of the camshaft sensor

a Data code:
1st to 3rd digits: Day of manufacture
4th and 5th digits: Year of manufacture
6th and 7th digits: Index

b Serial number
c Housing number
d Ford part number
e Housing material index
f Connector code according to specification

3.8.3 Crankshaft sensor

The crankshaft sensor samples a spur ring on the engine flywheel. The rotation of the spur ring changes the Hall voltage of the Hall IC in the sensor head. This change in voltage is evaluated by the engine control unit (ECU).

Depending on what characteristics are recorded in the engine control unit (ECU), the information will be used to calculate the position of the camshaft and of the speed.

The crankshaft sensor is located close to the crankshaft flywheel.

Labelling of the crankshaft sensor

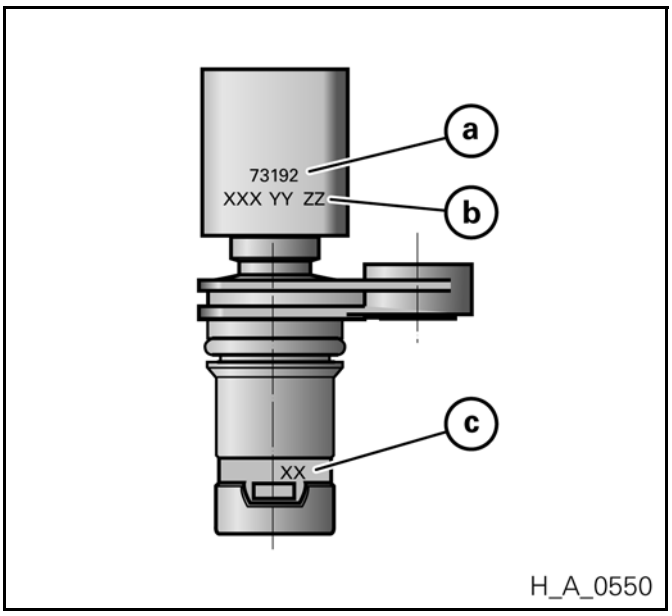


Fig. A - 52 Labelling of the crankshaft sensor

a Ford part number
b Data code:
1st to 3rd digits: Day of manufacture
4th and 5th digits: Year of manufacture
6th and 7th digits: Index
c Housing number

3.8.4 Temperature sensors

The system is equipped with sensors for fuel temperature and coolant temperature. Thermistors (NTC) are used as the temperature sensors.
The drop in voltage is measured by the ECU based on the resistance of the NTC.

The ECU compares the measured voltage with the recorded characteristics. This gives the data required by the system control unit.

The temperature sensors are connected to the engine's fuel and cooling water circuits.

Labelling of the temperature sensors

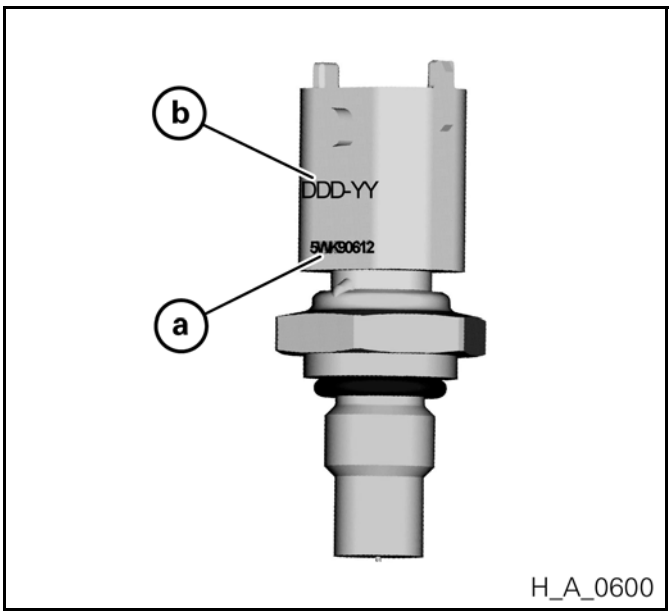


Fig. A - 53 Labelling of temperature sensor

a Siemens VDO part number
b Data code:
1st to 3rd digits: Day of manufacture
4th and 5th digits: Year of manufacture

B Diagnostics

1 Nominal system values and operating conditions

1.1 Typical values for various operating conditions

1.1.1 Conditions:

- Vehicle is stopped
- Tank: at least half full
- Battery voltage: 12-14.7 V
- Ambient temperature: approx. 20 °C
- Engine operating temperature: 80-90 °C

Note

All the electrical and mechanical consumers must be switched off.

Ignition on:

		min	max
Engine speed	rpm	0	0
Coolant temperature	°C	15	25
Air intake temperature	°C	15	25
Accelerator pedal sensor value	%	0	0
Battery voltage	V	8	13
Injection quantity complete injection	mg/stroke	32	36
Injection quantity pre-injection	mg/stroke	0	0
Injection quantity main injection	mg/stroke	0	0
Activation duration of main injection	ms	0	0
Activation duration of pre-injection	ms	0	0
Start of main injection	°after TDC	0	0
Start of pre-injection	°after TDC	0	0
Rail pressure - nominal value	MPa	0	0
Rail pressure - actual value	MPa	0	0.5
PCV PWM	%	0	0
Current PCV	A	0	0.3
VCV PWM	%	0	0
Current VCV	A	0	0.33
Fuel temperature	°C	15	25
Smoke limitation	mg/stroke	240	270
Intake air mass actual value	mg/stroke	0	0
Absolute pressure prior to the fuel filter (static)	bar	0.9	1.1
Absolute pressure in the pump return flow (static)	bar	0.9	1.1
Absolute pressure in the injector return flow (static)	bar	0.9	1.1
Absolute pressure in the complete return flow (static)	bar	0.9	1.1

Idle cold:

		min	max
Engine speed	rpm	790	860
Coolant temperature	°C	18	25
Air intake temperature	°C	15	25
Accelerator pedal sensor value	%	0	0
Battery voltage	V	12	15
Injection quantity complete injection	mg/stroke	12	17.5
Injection quantity pre-injection	mg/stroke	2.5	3
Injection quantity main injection	mg/stroke	9	14.5
Activation duration of main injection	ms	0.7	1.1
Activation duration of pre-injection	ms	0.4	0.6
Start of main injection	°after TDC	-10.5	-6.6
Start of pre-injection	°after TDC	-25	-20
Rail pressure - nominal value	MPa	21.5	23
Rail pressure - actual value	MPa	19.5	25
PCV PWM	%	11	14
Current PCV	A	0.26	0.37
VCV PWM	%	20	24
Current VCV	A	0.7	0.85
Fuel temperature	°C	20	25
Smoke limitation	mg/stroke	35	39
Intake air mass actual value	mg/stroke	700	750
Absolute pressure prior to the fuel filter (static)	bar	1.3	1.7
Absolute pressure in the pump return flow (static)	bar	1.3	1.7
Absolute pressure in the injector return flow (static)	bar	1.8	2.4
Absolute pressure in the complete return flow (static)	bar	1.3	1.7

Idle warm:

		min	max
Engine speed	rpm	775	825
Coolant temperature	°C	82	95
Air intake temperature	°C	15	40
Accelerator pedal sensor value	%	0	0
Battery voltage	V	12	15
Injection quantity complete injection	mg/stroke	4.5	7
Injection quantity pre-injection	mg/stroke	1.5	2.5
Injection quantity main injection	mg/stroke	3	4.5
Activation duration of main injection	ms	0.4	0.6
Activation duration of pre-injection	ms	0.3	0.45
Start of main injection	°after TDC	-5	-3.5
Start of pre-injection	°after TDC	-17	-15.5
Rail pressure - nominal value	MPa	21	23
Rail pressure - actual value	MPa	20	24
PCV PWM	%	12	13.5
Current PCV	A	0.3	0.4
VCV PWM	%	18	21
Current VCV	A	0.5	0.7
Fuel temperature	°C	38	50
Smoke limitation	mg/stroke	34	40
Intake air mass actual value	mg/stroke	675	710
Absolute pressure prior to the fuel filter (static)	bar	1.3	1.7
Absolute pressure in the pump return flow (static)	bar	1.3	1.7
Absolute pressure in the injector return flow (static)	bar	1.8	2.4
Absolute pressure in the complete return flow (static)	bar	1.3	1.7

2000 rpm, without load:

		min	max
Engine speed	rpm	1900	2100
Coolant temperature	°C	89	92
Air intake temperature	°C	15	45
Accelerator pedal sensor value	%	9	14
Battery voltage	V	12	15
Injection quantity complete injection	mg/stroke	4.2	8.5
Injection quantity pre-injection	mg/stroke	1.5	1.9
Injection quantity main injection	mg/stroke	2.7	6.7
Activation duration of main injection	ms	0.4	0.6
Activation duration of pre-injection	ms	0.25	0.34
Start of main injection	°after TDC	-13.3	-11.7
Start of pre-injection	°after TDC	-34	-29.5
Rail pressure - nominal value	MPa	21.5	27.1
Rail pressure - actual value	MPa	21.5	27.1
PCV PWM	%	12	14
Current PCV	A	0.3	0.5
VCV PWM	%	20	22
Current VCV	A	0.6	0.75
Fuel temperature	°C	40	50
Smoke limitation	mg/stroke	40	43
Intake air mass actual value	mg/stroke	700	750
Absolute pressure prior to the fuel filter (static)	bar	1.3	1.7
Absolute pressure in the pump return flow (static)	bar	1.3	1.7
Absolute pressure in the injector return flow (static)	bar	1.8	2.4
Absolute pressure in the complete return flow (static)	bar	1.3	1.7

4000 rpm, without load:

		min	max
Engine speed	rpm	3900	4100
Coolant temperature	°C	85	100
Air intake temperature	°C	15	50
Accelerator pedal sensor value	%	11	15.5
Battery voltage	V	12	15
Injection quantity complete injection	mg/stroke	10.5	15
Injection quantity pre-injection	mg/stroke	0	0
Injection quantity main injection	mg/stroke	10.5	15
Activation duration of main injection	ms	0.5	0.7
Activation duration of pre-injection	ms	0	0
Start of main injection	°after TDC	-21	-22
Start of pre-injection	°after TDC	-21	-21.5
Rail pressure - nominal value	MPa	21.5	27.1
Rail pressure - actual value	MPa	21.5	27.1
PCV PWM	%	12	14
Current PCV	A	0.3	0.5
VCV PWM	%	20	22
Current VCV	A	0.6	0.75
Fuel temperature	°C	40	50
Smoke limitation	mg/stroke	40	43
Intake air mass actual value	mg/stroke	700	750
Absolute pressure prior to the fuel filter (static)	bar	1.3	1.7
Absolute pressure in the pump return flow (static)	bar	1.3	1.7
Absolute pressure in the injector return flow (static)	bar	1.8	2.4
Absolute pressure in the complete return flow (static)	bar	1.3	1.7

1000 rpm, 1st gear:

		min	max
Engine speed	rpm	900	1100
Coolant temperature	°C	85	95
Air intake temperature	°C	45	46
Accelerator pedal sensor value	%	2.6	4.8
Battery voltage	V	12	15
Injection quantity complete injection	mg/stroke	2.5	6.5
Injection quantity pre-injection	mg/stroke	0	1.8
Injection quantity main injection	mg/stroke	2	5
Activation duration of main injection	ms	0.25	0.65
Activation duration of pre-injection	ms	0	0.4
Start of main injection	°after TDC	-12	-9
Start of pre-injection	°after TDC	-26	-9
Rail pressure - nominal value	MPa	21	23
Rail pressure - actual value	MPa	21	23
PCV PWM	%	12	16
Current PCV	A	0.3	0.5
VCV PWM	%	19	22
Current VCV	A	0.5	0.7
Fuel temperature	°C	40	60
Smoke limitation	mg/stroke	38	41
Intake air mass actual value	mg/stroke	660	710
Absolute pressure prior to the fuel filter (static)	bar	1.3	1.7
Absolute pressure in the pump return flow (static)	bar	1.3	1.7
Absolute pressure in the injector return flow (static)	bar	1.8	2.4
Absolute pressure in the complete return flow (static)	bar	1.3	1.7

2000 rpm, 1st gear:

		min	max
Engine speed	rpm	1900	2100
Coolant temperature	°C	80	95
Air intake temperature	°C	15	45
Accelerator pedal sensor value	%	10	17
Battery voltage	V	12	15
Injection quantity complete injection	mg/stroke	5	10.5
Injection quantity pre-injection	mg/stroke	1.5	2
Injection quantity main injection	mg/stroke	3.5	9
Activation duration of main injection	ms	0.4	0.65
Activation duration of pre-injection	ms	0.25	0.4
Start of main injection	°after TDC	-13	-11
Start of pre-injection	°after TDC	-34	-29
Rail pressure - nominal value	MPa	21	31
Rail pressure - actual value	MPa	21	31
PCV PWM	%	12	15
Current PCV	A	0.3	0.5
VCV PWM	%	21	23
Current VCV	A	0.6	0.8
Fuel temperature	°C	40	60
Smoke limitation	mg/stroke	40	43
Intake air mass actual value	mg/stroke	700	740
Absolute pressure prior to the fuel filter (static)	bar	1.3	1.7
Absolute pressure in the pump return flow (static)	bar	1.3	1.7
Absolute pressure in the injector return flow (static)	bar	1.8	2.4
Absolute pressure in the complete return flow (static)	bar	1.3	1.7

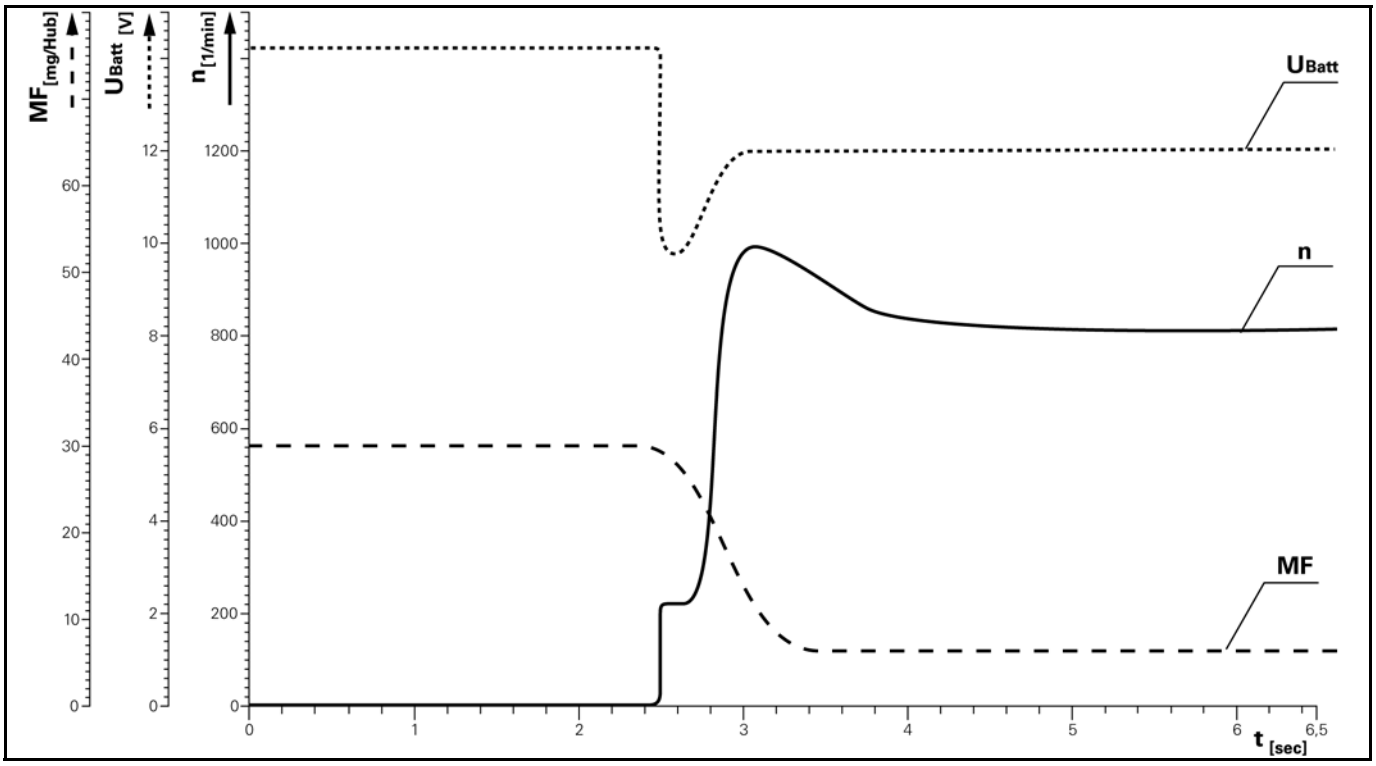
1.2 Typical start performance

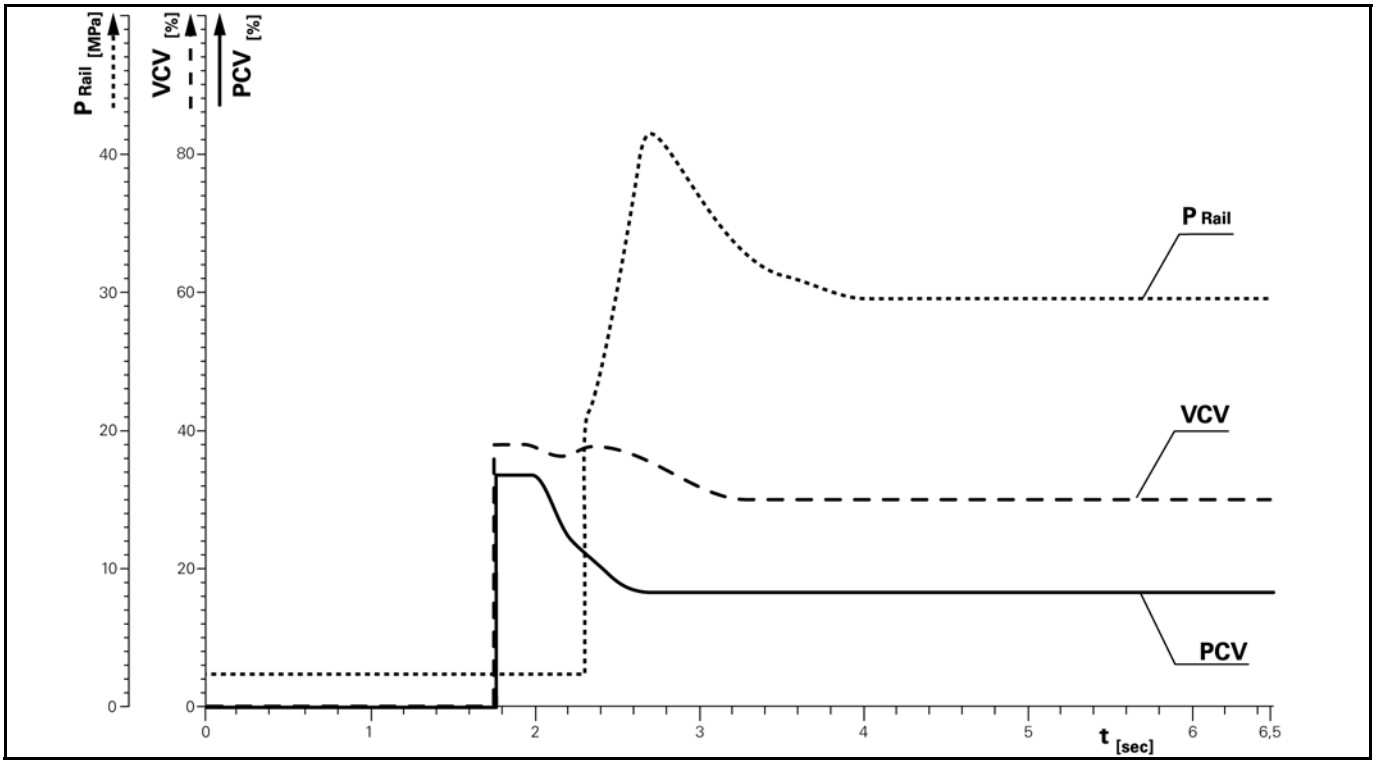
1.2.1 Tolerance bands

Speed	**n**	Start: 150 - 250 rpm (cold start) 200 - 300 rpm (warm start) Idle: ± 30 rpm
Battery voltage	**$U_{Batt.}$**	± 10% (max. 14.7) V
Injection quantity	**MF**	± 10%
Rail pressure	**P_{Rail}**	± 20%
Pressure control valve Pulse duty factor	**PCV**	± 10%
Volume flow control valve Pulse duty factor	**VCV**	+ 20%

Cold start

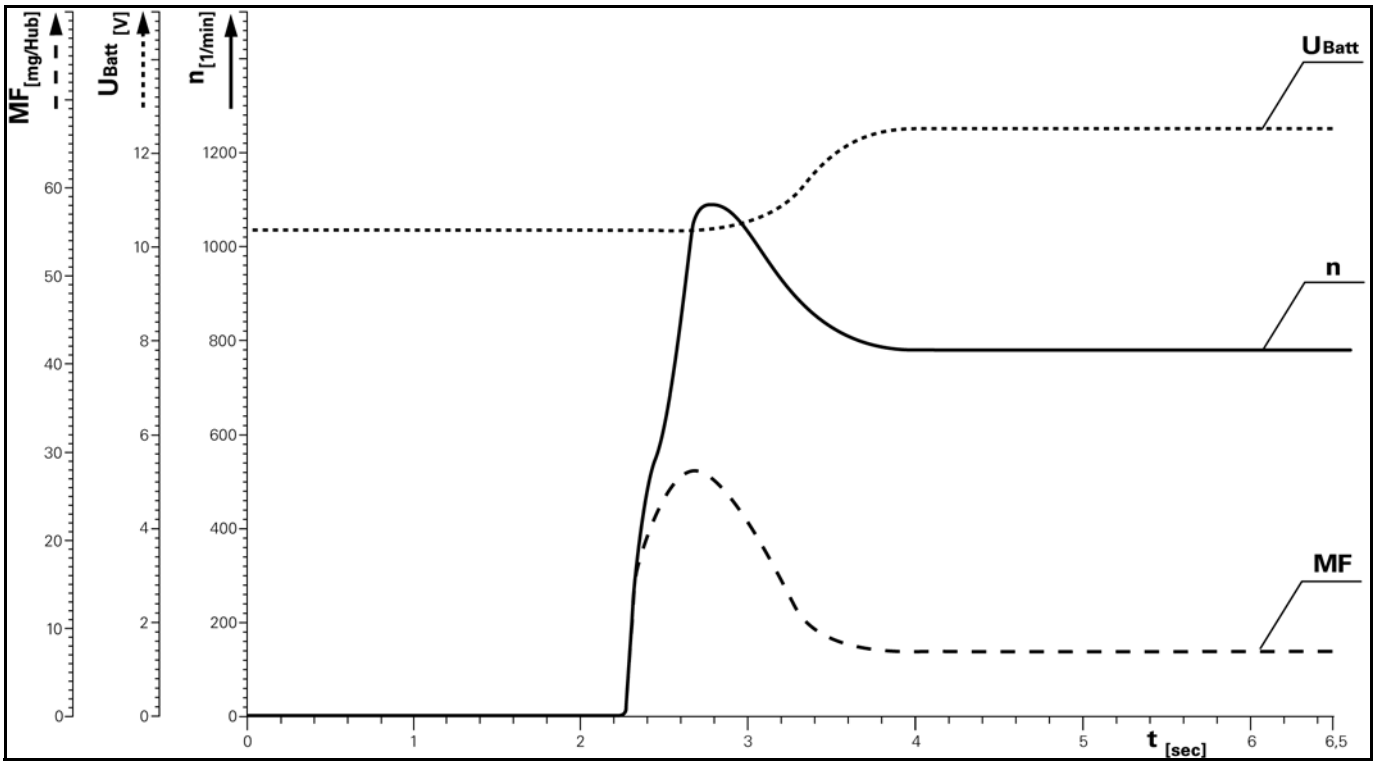
Coolant temperature: 20 °C

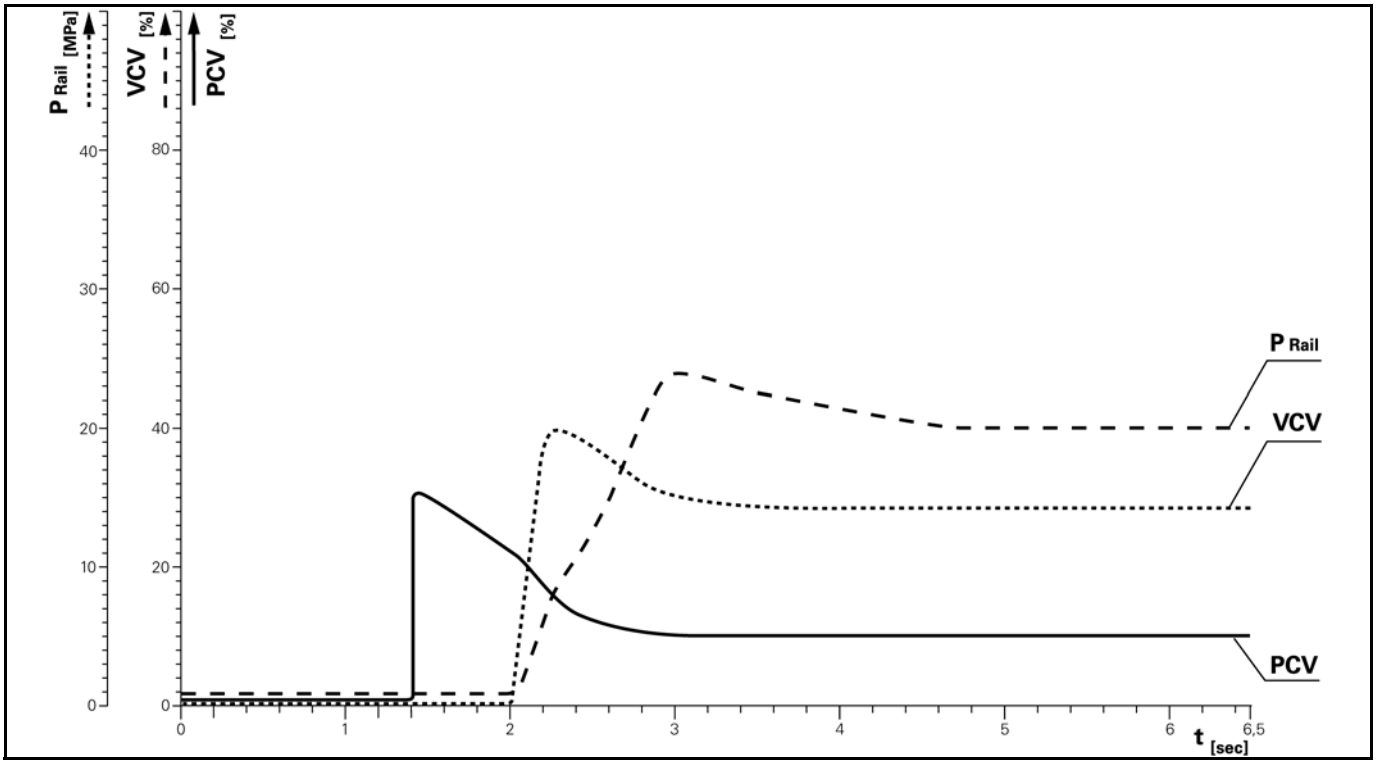




Warm start

Coolant temperature: 80 °C





2 Troubleshooting

Note

System faults may cause sequential faults which are to be handled secondarily during fault elimination. At the beginning of troubleshooting, all sensors and actuators are to be checked and faults corrected.

Defective and unconnected sensors can impair troubleshooting.

If no fault codes are shown or no possibility to read them out is available, all suitable tests must be carried out.

(S): Siemens test instructions

(C): Customer test instructions

Process for fault elimination:

A fault code may be caused by a number of factors. You can find the possible causes in this chapter. To do this, use the Search feature in Acrobat Reader.

For a detailed description of the individual faults, see chapter “Fault code list”.

2.1 MIL control lamp does not light up with the ignition switched on

Cause of fault	Location of fault	Code	Fault elimination
Control lamp defective	Control lamp	No entry	Check vehicle electric system (P)
No voltage supply	Fault in vehicle electric system	No entry	

2.2 MIL control lamp lights up when the engine is running

Cause of fault	Location of fault	Code	Fault elimination
Entry of a fault diagnosis	Read out fault diagnosis	No entry	Correct relevant faults

2.3 Engine does not start

Cause of fault	Location of fault	Code	Fault elimination
Engine start speed too low	Battery capacity too low	P0562; P0563	Check battery capacity (P)
	Faulty starter or relay	P0615;	Check starter and relay (P)
Engine control unit does not work	No voltage supply to the engine control unit	No entry	Supply via the ignition switch / check the continual voltage supply to the engine control unit (C)
Engine control unit has no function	Hardware or software in the engine control unit	P0602; P0606; P0608; P0610; P0A09; P0A10; B1600; B1602; B1681; B2103; B2139; B2141; B2431; U2510;	Check engine control unit and replace it, if necessary (see chapter 4.5)
	ECU ground connection defective		Check ECU ground connection (P)
No main voltage supply to engine control unit and actuators	Main relay defective	P0685; P0687;	Check main relay and ignition switch (P) Check pins 15 / 30 on the engine control unit (ECU) (P)
	Wiring harness or plug-in connections defective	No entry	Check electrical connections (P)
No voltage supply to the sensors (5 V)	Faulty engine control unit	P0642; P0643; P0652; P0653; B1600; B1602; B1681; B2103; B2139; B2141; B2431; U2510;	Check the wire connection and power supply (+) on the sensors (P) Replace engine control unit if necessary
	Defective wiring harness or plug-in connections	P0642; P0643; P0652; P0653;	
Incorrect or no sensor signal	Faulty sensors	No entry	Replace sensors
Engine immobiliser active	Incorrect code communicated	B1600; B1602; B1681; B2103; B2139; B2141; B2431; U2510;	Not defined yet
Limp home activated		No entry	

Cause of fault	Location of fault	Code	Fault elimination
No engine speed detected in the engine control unit	Incorrect or no camshaft signal	P0340; P0341;	Check camshaft sensor and electrical connections (P)
	Incorrect or no crankshaft signal	P0335; P0336	Check crankshaft sensor and electrical connections (P)
Too little or no fuel intake	Internal transfer pump faulty; fuel filter blocked	P0087; P0088; P0089; P0090; P0091; P0092; P0001; P0191; P0192; P0193;	Check low-pressure system (see chapter 4.2)
	Air in low-pressure line; leaky low-pressure line		
	Fuel filter blocked		
	Empty tank	P0460;	Top up fuel
Too little or no pressure at the rail	Too little or no fuel intake	P0087; P0088; P0089; P0090; P0091; P0092; P0001; P0191; P0192; P0193;	Check low-pressure system (see chapter 4.2)
	High-pressure pump defective	P0087; P0088; P0089; P0090; P0091; P0092; P0002;	Check high-pressure system (see chapter 4.3)
	PCV / VCV defective	P0002; P0003; P0004; P0087; P0088; P0089; P0090; P0091; P0092; P0001;	
	Leaky high-pressure lines / rail	P0087; P0088; P0089; P0090; P0091; P0092; P0001; P0191; P0192; P0193;	
	High-pressure signal missing or incorrect	P0191; P0192; P0193;	Check high-pressure sensor (S) Check high-pressure system (S)
	Faulty engine control unit	B1600; B1602; B1681; B2103; B2139; B2141; B2431; U2510;	Check engine control unit (S), replace it, if necessary (see chapter 4.5)
	High injector leakage	P0087; P0088; P0090; P0091; P0092; P0089; P0001;	Check injectors (see chapter 4.4.)

Cause of fault	Location of fault	Code	Fault elimination
Free water or gasoline in the tank	Fuel tank soiled or incorrectly filled	P1140;	Empty tank and clean it, if necessary
Some or all cylinders are not working	Injectors defective	P0201; P0202; P0203; P0204; P0200; P1201; P1202; P1203; P1204;	Check injectors (see chapter 4.4) Check wire connection (P)
	Defective wiring harness or plug-in connections	P0201; P0202; P0203; P0204; P0200; P1201; P1202; P1203; P1204; P0603; P0604; P0605; P0606; P1601;	Check electrical connections (P)
	Faulty engine control unit	P0603; P0604; P0605; P0606; P1601; P0A09; P0A10; B1600; B1602; B1681; B2103; B2139; B2141; B2431; U2510;	Replace engine control unit if necessary (see chap-ter 4.5)
	Compression too low	No entry	Check compression (P)
Too little air intake	Air filter is blocked or intake line is bent,	P0107; P0108; P0012; P0113; P1193;	Check air intake system (P)

2.4 Engine starts poorly

Cause of fault	Location of fault	Code	Fault elimination
Faulty engine control unit	Various effects possible	B1600; B1602; B1681; B2103; B2139; B2141; B2431;	Replace engine control unit if necessary (see chap-ter 4.5)
Sporadic loss of sensor or actuator signals	Defective wiring harness or plug-in connections	No entry	Check electrical connections (P)
Engine start speed too low	Battery capacity too low	P0562; P0563;	Check battery capacity (P)
	Faulty starter or relay	P0615;	Check starter and relay (P)
Voltage drop at the engine control unit during start	Poor ground connections	P0562;	Check ground connections (P)
	Faulty voltage supply		Check voltage supply system (P)
Too little or no fuel intake	Faulty internal transfer pump	P0087; P0088; P0089; P0090; P0089; P0090; P0091; P0092; P0001; P0191; P0192; P0193;	Check low-pressure system (S) (see chapter 4.2)
	Air in the low-pressure line		
	Leaky low-pressure line		
	Fuel filter blocked		
	Empty tank		Top up fuel
Rail pressure too low	Too little or no fuel intake	P0087; P0088; P0089; P0090; P0089; P0090; P0091; P0092; P0001; P0191; P0192; P0193;	Check low-pressure system (S) (see chapter 4.2)
	High-pressure pump defective	P0087; P0088; P0089; P0090; P0089; P0090; P0091; P0092; P0001;	Check high-pressure system (S) (see chapter 4.3)
	PCV / VCV defective	P0002; P0003; P0004; P0087; P0088; P0089; P0090; P0089; P0090; P0091; P0092; P0001;	
	Faulty engine control unit	B1600; B1602; B1681; B2103; B2139; B2141; B2431;	Replace engine control unit, if none of the previous tests have achieved any improvement (see chapter 4.5)

Cause of fault	Location of fault	Code	Fault elimination
Rail pressure too low	Leaky high-pressure lines / rail	P0087; P0088; P0089; P0090; P0091; P0092; P0001; P0191; P0192; P0193;	Check high-pressure system (S) (see chapter 4.3)
	High-pressure signal missing or incorrect	P0191; P0192; P0193;	Check high-pressure system (S) (see chapter 4.3)
	High injector leakage	P0087; P0088; P0089; P0090; P0091; P0092; P0001;	Check injectors (S) (see chapter 4.4)
Free water or gasoline in the tank	Fuel tank soiled or incorrectly filled	P1140;	Empty tank and clean it, if necessary
One or more cylinders are not working	Injectors defective	P1201; P1202; P1203; P1204; P0201; P0202; P0203; P0204; P0200;	Check injectors (S) (see chapter 4.4);
	Defective wiring harness or plug-in connections	P1201; P1202; P1203; P1204; P0200; P0603; P0604; P0606; P1601; P0605;	Check electrical connections (P)
	Faulty engine control unit	P0A09; P0A10; P0603; P0604; P0606; P1601; P0605; B1600; B1602; B1681; B2103; B2139; B2141; B2431;	If other measures have no effect, check the engine control unit and replace it if necessary (see chapter 4.5)
	Compression too low	No entry	Check compression (P)
Too little air intake	Air filter is blocked or intake line is bent	P0103;	Check air intake system (P)

2.5 Poor cold start performance (occurs primarily at cold temperatures)

Cause of fault	Location of fault	Code	Fault elimination
Engine start speed too low	Battery capacity too low	P0562; P0563	Check battery capacity (P)
	Incorrect engine oil viscosity	No entry	Carry out oil change
	Faulty starter	No entry	Check starter (P)
Too little rail pressure as well as too little injection quantity during the start process	Air intake temperature signal too high	No entry	Check air intake temperature sensor (P)
	Coolant temperature signal too high	P0116; P0117; P0118;	Check coolant temperature sensor (P)
	Fuel temperature signal too high	P0181; P0183;	Check fuel temperature sensor (P)
Faulty glow plug system (optional)*	One or more glow plugs defective	No entry	Check glow plug system (P)
	Glow plug relay defective	No entry	
	Glow plug control lamp defective	No entry	
Too little or no fuel intake	Fuel filter soiled	No entry	Replace fuel filter (P)
	Fuel filter iced up by free water	No entry	Replace the fuel filter and clean the tank if necessary (P)
	Fuel filter blocked by wax deposits from the fuel	No entry	Replace the fuel filter and change the fuel (P)
	Air in low-pressure line	No entry	Check low-pressure system (S)
Low compression	Heavy wear on the piston rings or leakage at the valves	No entry	Check compression

Note

*The glow plug system is an optional component of the system provided by Siemens VDO.

2.6 Engine cannot be turned off

Cause of fault	Location of fault	Code	Fault elimination
Engine control unit does not react	Ignition switch defective	No entry	Check pin 15 on the control unit (P)
	Faulty engine control unit	B1600; B1602; B1681; B2103; B2139; B2141; B2431; P1563;	Check engine control unit (S)
	Defective wiring harness	No entry	Check electrical connections

2.7 Engine stalls

Cause of fault	Location of fault	Code	Fault elimination
Faulty engine control unit	Various effects possible	B1600; B1602; B1681; B2103; B2139; B2141; B2431;	If other measures have no effect, check the engine control unit and replace it if necessary (S)
Too little or no pressure at the rail	Too little or no fuel intake	P0087; P0088; P0089; P0090; P0091; P0092; P0191; P0192; P0193;	Check low-pressure system (see chapter 4.2)
	High-pressure pump defective	P0263; P0266; P0269; P0272; P0087; P0088; P0089; P0090; P0091; P0092; P0001;	Check high-pressure system (see chapter 4.3)
	PCV / VCV defective	P0002; P0003; P0004; P0087; P0088; P0089; P0090; P0091; P0092; P0263; P0266; P0269; P0272; P0001;	Check high-pressure system (see chapter 4.3)
	Leaky high-pressure lines / rail	P0087; P0088; P0089; P0090; P0091; P0092; P0001; P0191; P0192; P0193;	

Cause of fault	Location of fault	Code	Fault elimination
Too little or no pressure at the rail	High-pressure signal missing or incorrect	P0191; P0192; P0193;	Check high-pressure system (see chapter 4.3)
	High injector leakage	P0263; P0266; P0269; P0272; P0087; P0088; P0089; P0090; P0091; P0092; P0001;	Check injectors (see chapter 4.4)
	Faulty engine control unit	B1600; B1602; B1681; B2103; B2139; B2141; B2431;	Check engine control unit (S)
Sporadic voltage drop at the engine control unit	Poor ground connections:	No entry	Check ground connections (P)
	Faulty voltage supply		Check voltage supply system (P)
Sporadic loss of sensor or actuator signals	Defective wiring harness	No entry	Check electrical connections (P)
Too little or no fuel intake	Faulty internal transfer pump	P0087; P0088; P0089; P0090; P0091; P0092; P0191; P0192; P0193;	Check low-pressure system (see chapter 4.2)
	Air in low-pressure line		
	Leaky low-pressure line		
	Fuel filter heavily soiled		
	Empty tank		
Too little air intake	Air filter is blocked or intake lines are bent	P0103;	Check air intake system (P)
	Leakage in the intake line downstream of the turbocharger		
False or no recognition of the gear by the engine control unit (-> no anti-jerk control)	Clutch pedal slightly activated	No entry	
	Clutch switch incorrectly adjusted or faulty	No entry	
	Faulty CAN connection between ABS control unit and engine control unit	PC001;	
	Vehicle speed signal missing or incorrect	P0608; P0500; P0812;	

2.8 Engine idle speed too high

Cause of fault	Location of fault	Code	Fault elimination
Faulty engine control unit	Various effects possible	B1600; B1602; B1681; B2103; B2139; B2141; B2431;	If other measures have no effect, check the engine control unit and replace it if necessary (S)
On-board voltage too low	On-board voltage controller defective	No entry	Check vehicle electric system (P)
	Too many consumers turned on	No entry	
Coolant temperature signal too low	Faulty coolant temperature sensor	P0116; P0117; P0118;	Check coolant temperature sensor and electrical connections (P)
Faulty accelerator pedal signal	Faulty accelerator pedal position	No entry	Check accelerator pedal (P)
	Defective wiring harness or plug-in connections	P0122; P0123; P0222; P0223; P2135; P2299;	Check accelerator pedal sensor and electrical connections (P)
	Faulty accelerator pedal sensor		
Limp home activated	Read out fault memory	No entry	Correct relevant faults

2.9 Engine idle speed too slow / rough

Cause of fault	Location of fault	Code	Fault elimination
Faulty engine control unit	Various effects possible	B1600; B1602; B1681; B2103; B2139; B2141; B2431;	If other measures have no effect, check the engine control unit and replace it if necessary (S)
Too little air intake	Air filter is blocked or intake lines are bent	P0263; P0266; P0269; P0272; P0103;	Check air intake system (P)
	Leakage in the intake line downstream of the turbocharger		
Too little or no fuel intake	Faulty internal transfer pump	P0087; P0088; P0089; P0090; P0091; P0092; P0263; P0266; P0269; P0272; P0191; P0192; P0193;	Check low-pressure system (see chapter 4.2)
	Air in low-pressure line		
	Leaky low-pressure line		
	Fuel filter blocked		
	Empty tank	No entry	Top up fuel

Cause of fault	Location of fault	Code	Fault elimination
Rail pressure fluctuations	PCV / VCV defective	P0002; P0003; P0004; P0087; P0088; P0089; P0090; P0091; P0092; P0263; P0266; P0269; P0272; P0001;	Check high-pressure system (see chapter 4.3)
	High-pressure pump defective	P0087; P0088; P0089; P0090; P0091; P0092; P0001; P0263; P0266; P0269; P0272;	
	Leaky high-pressure line / rail	P0087; P0088; P0089; P0090; P0091; P0092; P0001; P0263; P0266; P0269; P0272; P0191; P0192; P0193;	
	High-pressure signal missing or incorrect	P0191; P0192; P0193;	Check high-pressure system (see chapter 4.3)
	Leaky low-pressure line	No entry	Check low-pressure system (see chapter 4.2)
	Injectors defective	P0263; P0266; P0269; P0272;	Check injectors (see chapter 4.4)
	Defective wiring harness or plug-in connections	No entry	Check wire connections (P)
	Faulty engine control unit	B1600; B1602; B1681; B2103; B2139; B2141; B2431;	Replace engine control unit, if none of the previous tests have achieved any improvement (see chapter 4.5)
ECU is not responding to additional load on the air conditioning system compressor	Air conditioning system pressure sensor defective	P0532; P0533;	Check air conditioning system pressure sensor (P)

2.10 No / low vehicle acceleration, engine speed does not increase / too low

Cause of fault	Location of fault	Code	Fault elimination
Faulty engine control unit	Various effects	B1600; B1602; B1681; B2103; B2139; B2141; B2431;	If other measures have no effect, check the engine control unit and replace it if necessary (see chapter 4.5)
Too little air intake	Air filter is blocked or intake lines are bent	P0263; P0266; P0269; P0272;	Check air intake system (P)
	Leakage in the intake line downstream of the turbocharger		
	Turbocharger defective		Check boost pressure (P)
Too little or no fuel intake	Faulty internal transfer pump	P0087; P0088; P0089; P0090; P0091; P0092; P0001; P0263; P0266; P0269; P0272; P0191; P0192; P0193;	Check low-pressure system (see chapter 4.2)
	Air in low-pressure line		
	Fuel filter blocked		
	Leaky low-pressure line		
	Empty tank		Top up fuel
Accelerator pedal signal incorrect or missing	Faulty accelerator pedal position	No entry	Check accelerator pedal sensor and electrical connections (P)
	Defective wiring harness or plug-in connections	P0122; P0123; P0222; P0223; P2135; P2299;	
	Faulty accelerator pedal sensor		
Faulty brake light signal (if a brake light signal and a constant accelerator pedal signal appear at the same time, the accelerator pedal signal will be reduced for reasons of safety)	Faulty brake switch	P0571; P0572; P0573;	Check ABS (P)
	Defective wiring harness or plug-in connections		
Too little injection quantity or incorrect injection timing	Faulty injectors, wiring harness or plug-in connection	P0101; P0104; P0263; P0266; P0269; P0272;	Check injectors (see chapter 4.4)
Too little injection quantity or incorrect injection timing	Air-mass flow sensor signal too low (->reduction in injection quantity to prevent black smoke from developing)	P0101; P0104; P0263; P0266; P0269; P0272;	Check air-mass flow sensor (P) Check exhaust gas recirculation system Check air intake system (P)

Cause of fault	Location of fault	Code	Fault elimination
Too little injection quantity or incorrect injection timing	Leakage in the intake line upstream of the turbocharger (->reduction in injection quantity to prevent black smoke from developing)	P0101; P0104; P0263; P0266; P0269; P0272;	Check air-mass flow sensor (P) Check exhaust gas recirculation system Check air intake system (P)
	Faulty engine control unit	B1600; B1602; B1681; B2103; B2139; B2141; B2431;	Replace engine control unit, if none of the previous tests have achieved any improvement (see chapter 4.5)
Rail pressure too low	Too little or no fuel intake	P0087; P0088; P0089; P0090; P0091; P0092; P0001; P0263; P0266; P0269; P0272; P0191; P0192; P0193;	Check low-pressure system (see chapter 4.2)
	High-pressure pump defective	P0087; P0088; P0089; P0090; P0091; P0092; P0002;	Check high-pressure system (see chapter 4.3)
	PCV / VCV defective	P0002; P0003; P0004; P0087; P0088; P0089; P0090; P0091; P0092; P0001;	Check high-pressure system (see chapter 4.3)
	Leaky high-pressure lines / rail	P0087; P0088; P0089; P0090; P0091; P0092; P0001; P0191; P0192; P0193;	
	High injector leakage	P0087; P0088; P0089; P0090; P0091; P0092; P0002;	Check injectors (see chapter 4.4)
Rail pressure too low	High-pressure signal missing or incorrect	P0263; P0266; P0269; P0272; P0191; P0192; P0193;	Check high-pressure system (see chapter 4.3)
	Faulty engine control unit	B1600; B1602; B1681; B2103; B2139; B2141; B2431;	Replace engine control unit, if none of the previous tests have achieved any improvement (see chapter 4.5)

2.11 Vehicle jerks at constant speed

Cause of fault	Location of fault	Code	Fault elimination
Faulty engine control unit	Various effects possible	B1600; B1602; B1681; B2103; B2139; B2141; B2431;	If other measures have no effect, check the engine control unit and replace it if necessary (S)
False or no recognition of the gear by the engine control unit (-> no anti-jerk control)	Clutch pedal slightly activated	P0704;	Check clutch switch (P)
	Clutch switch incorrectly adjusted or faulty		
	Faulty engine control unit	B1600; B1602; B1681; B2103; B2139; B2141; B2431;	Replace engine control unit, if none of the previous tests have achieved any improvement (see chapter 4.5)
	Faulty CAN connection between ABS control unit and engine control unit	PC001; U0415; U0416; U1218;	Check CAN connection (P)
	Speed signal missing or incorrect	P0500; P0503; P0502; P0503;	Check speed signal (P)
Faulty injection	Faulty injectors	P0263; P0266; P0269; P0272;	Check injectors (see chapter 4.4)
Faulty accelerator pedal signal	Faulty accelerator pedal position	No entry	Check accelerator pedal (P)
	Defective wiring harness or plug-in connections	P0122; P0123; P0222; P0223; P2135; P2299;	Check accelerator pedal sensor and electrical connections (P)
	Faulty accelerator pedal sensor		Check accelerator pedal sensor and electrical connections (P)
Signal fluctuations from the T-MAP sensor	Water in the air intake system	P0263; cyl. 1 P0266; cyl. 4 P0269; cyl. 2 P0272; cyl. 3	Check air intake system (P)
	T-MAP sensor or electrical connections defective	No entry	Check T-MAP sensor (P) Check electrical connections (P)
Sporadic loss of sensor or actuator signals	Defective wiring harness or plug-in connections	No entry	Check wire connections (P)

Cause of fault	Location of fault	Code	Fault elimination
Rail pressure fluctuations	PCV / VCV defective	P0002; P0003; P0004; P0087; P0088; P0089; P0090; P0091; P0092; P0263; P0266; P0269; P0272; P0001;	Check high-pressure system (see chapter 4.3)
	High-pressure pump defective	P0087; P0088; P0089; P0090; P0091; P0092; P0001; P0263; P0266; P0269; P0272;	Check high-pressure system (see chapter 4.3)
	Leaky high-pressure lines / rail	P0002; P0003; P0004; P0087; P0088; P0089; P0090; P0091; P0092; P0263; P0266; P0269; P0272; P0001;	
	High-pressure signal missing or incorrect	P0263; P0266; P0269; P0272; P0191; P0192; P0193;	Check high-pressure system (see chapter 4.3)
	Leaky low-pressure line	P0002; P0003; P0004; P0087; P0088; P0089; P0090; P0091; P0092; P0263; P0266; P0269; P0272; P0001;	Check low-pressure system (see chapter 4.2)
	Faulty injectors	P0263; P0266; P0269; P0272;	Check injectors (see chapter 4.4)
	Defective wiring harness	No entry	Check wire connections (P)
	Faulty engine control unit	B1600; B1602; B1681; B2103; B2139; B2141; B2431;	Replace engine control unit, if none of the previous tests have achieved any improvement (see chapter 4.5)

2.12 Vehicle accelerates without actuation of the accelerator pedal

Cause of fault	Location of fault	Code	Fault elimination
Faulty engine control unit	Various effects possible	B1600; B1602; B1681; B2103; B2139; B2141; B2431;	Replace engine control unit, if none of the previous tests have achieved any improvement (see chapter 4.5)
Too high or uncontrolled injection quantity	Injector jammed open	P0263; P0266; P0269; P0272;	Check injectors (see chapter 4.4)
Faulty accelerator pedal signal	Faulty accelerator pedal position	No entry	Check accelerator pedal (P)
	Defective wiring harness or plug-in connections	P0122; P0123; P0222; P0223; P2135; P2299;	Check accelerator pedal sensor and electrical connections (P)
	Faulty accelerator pedal sensor		
Sudden increase in rail pressure	PCV / VCV defective	P0002; P0003; P0004; P0089; P0090; P0091; P0092; P0263; P0266; P0269; P0272; P0001; P0087; P0088;	Check high-pressure system (see chapter 4.3)
	High-pressure pump defective	P0087; P0088; P0089; P0090; P0091; P0092; P0001;	
	Faulty high-pressure signal	P0263; P0266; P0269; P0272; P0191; P0192; P0193;	Check high-pressure system (see chapter 4.3)
False or no recognition of the gear by the engine control unit (-> faulty torque control)	Clutch pedal slightly activated	P0704;	
	Clutch switch incorrectly adjusted or faulty	No entry	Check clutch switch (P)
	Faulty CAN connection between ABS control unit and engine control unit	PC001;	Check CAN connection
	Vehicle speed signal missing or incorrect	P0500; P0608; P0812;	Check speed signal (P)

2.13 Vehicle does not decelerate (no overrun condition)

Cause of fault	Location of fault	Code	Fault elimination
Faulty engine control unit	Various effects possible	B1600; B1602; B1681; B2103; B2139; B2141; B2431;	Replace engine control unit, if none of the previous tests have achieved any improvement (see chapter 4.5)
Faulty accelerator pedal signal	Faulty accelerator pedal position	No entry	Check accelerator pedal (P)
	Faulty accelerator pedal sensor	P0122; P0123; P0222; P0223; P2135; P2299;	Check accelerator pedal sensor and electrical connections (P)
	Defective wiring harness or plug-in connections		
Too high or uncontrolled injection quantity	Injector jammed open	P0263; P0266; P0269; P0272;	Check injectors (see chapter 4.4)

2.14 Vehicle jerks while coasting with gear engaged

Cause of fault	Location of fault	Code	Fault elimination
False or no recognition of the gear by the engine control unit (-> no anti-jerk control)	Clutch switch incorrectly adjusted or faulty	P0704;	Check clutch switch (P)
	Clutch pedal slightly activated	No entry	
	Faulty engine control unit	No entry	Replace engine control unit, if none of the previous tests have achieved any improvement (see chapter 4.5)
	Faulty CAN connection between ABS control unit and engine control unit	PC001; U0415; U0416; U1113; U1218;	Check CAN connection (P)
	Speed signal missing or incorrect	P0500; P0502; P0503;	Check speed signal (P)
Gear engaged is too high		No entry	

2.15 Power too low

Cause of fault	Location of fault	Code	Fault elimination
Faulty engine control unit	Various effects possible	B1600; B1602; B1681; B2103; B2139; B2141; B2431;	Replace engine control unit, if none of the previous tests have achieved any improvement (see chapter 4.5)
Coolant temperature signal too high (-> max. rail pressure and injection quantity reduction)	Faulty cooling system	No entry	Check cooling system (P)
	Faulty coolant temperature sensor or connector	P0116; P0117; P0118;	Check coolant temperature sensor and electrical connections (P)
Coolant temperature signal too high (-> max. rail pressure and injection quantity reduction to protect plastic lines)	Not enough fuel in the tank with heavy engine load and high temperature	No entry	
	Faulty fuel temperature sensor	P0181; P0183;	Check fuel temperature sensor (P)
False or no recognition of the gear by the engine control unit (-> faulty torque control)	Clutch pedal slightly activated		
	Clutch switch incorrectly adjusted or faulty	P0704;	Check clutch switch (P)
	Faulty CAN connection between ABS control unit and engine control unit	PC001;	Check CAN connection (P)
	Speed signal missing or incorrect	P0500;	Check speed signal (P)
Limp home	Read out fault diagnosis	No entry	
Too little air intake	Air filter is blocked or intake lines are bent	P0490; P1461; P2141; P2145;	Check air intake system (P)
	Leakage in the intake line downstream of the turbocharger	No entry	
	Air intake system blocked	No entry	Clean intake system (P)
	Faulty turbocharger or vacuum control	No entry	Check boost pressure (P)
Faulty accelerator pedal signal	Faulty accelerator pedal position	No entry	Check accelerator pedal (P)
	Faulty accelerator pedal sensor	P0122; P0123; P0222; P0223; P2135; P2299;	Check accelerator pedal sensor and electrical connections (P)
	Defective wiring harness or plug-in connections		

Cause of fault	Location of fault	Code	Fault elimination
Injection quantity too small	Faulty or heavily soiled injectors	P0263; P0266; P0269; P0272;	Check injectors (see chapter 4.4)
	Air-mass flow sensor signal missing or too low (-> reduction in injection quantity to prevent black smoke from developing)	P0101; P0104; P0263; P0266; P0269; P0272;	Check air-mass flow sensor (P) Check exhaust gas recirculation system (P)
	Leakage in the intake line upstream of the turbocharger (-> reduction in injection quantity to prevent black smoke from developing)		Check air-mass flow sensor (P) Check air intake system (P) Check exhaust gas recirculation system (P)
	Faulty high-pressure signal	P0263; P0266; P0269; P0272; P0191; P0192; P0193;	Check high-pressure system (see chapter 4.3)
Rail pressure too low	Too little fuel intake	P0263; P0266; P0269; P0272; P0087; P0088; P0089; P0090; P0091; P0092; P0001;	Check low-pressure system (see chapter 4.2)
	High-pressure pump defective	P0089; P0090: P0002;	Check high-pressure system (see chapter 4.3)
	PCV / VCV defective	P0002; P0003; P0004; P0087; P0088; P0089; P0090; P0091; P0092; P0001;	Check high-pressure system (see chapter 4.3)
	Leaky high-pressure lines / rail	P0002; P0003; P0004; P0087; P0088; P0089; P0090; P0091; P0092; P0263; P0266; P0269; P0272; P0001;	
	Faulty high-pressure signal	P0191; P0192; P0193; P0263; P0266; P0269; P0272;	
Incorrect air intake	Intercooler clogged	No entry	Clean and if necessary replace it Check air intake system (P)

2.16 Power too high

Cause of fault	Location of fault	Code	Fault elimination
Faulty or modified engine control unit (chip tuning)		B1600; B1602; B1681; B2103; B2139; B2141; B2431;	Replace engine control unit, if none of the previous tests have achieved any improvement (see chapter 4.5)
Injection quantity too high	Faulty injectors	P0263; P0266; P0269; P0272;	Check injectors (see chapter 4.4)
	Coolant temperature signal incorrect	P0116; P0117; P0118;	Check coolant temperature sensor (P)
Rail pressure too high	PCV / VCV defective	P0002; P0003; P0004; P0087; P0088; P0089; P0090; P0091; P0092; P0001;	Check high-pressure system (see chapter 4.3)
	High-pressure pump defective	P0087; P0088; P0089; P0090; P0091; P0092; P0001;	
	Faulty high-pressure signal	P0191; P0192; P0193;	Check high-pressure system (see chapter 4.3)
False or no recognition of the gear by the engine control unit (-> faulty torque control)	Clutch pedal slightly activated	No entry	
	Clutch switch incorrectly adjusted or faulty	P0704;	Check clutch switch (P)
	Faulty CAN connection between ABS control unit and engine control unit	PC001;	Check CAN connection (P)
	Speed signal missing or incorrect	P0500;	Check speed signal (P)
Boost pressure too high	Faulty boost pressure control	No entry	Check boost pressure (P)

2.17 Load kick when accelerating or decelerating

Cause of fault	Location of fault	Code	Fault elimination
False or no recognition of the gear by the engine control unit (-> no damping of the load kick)	Clutch pedal slightly activated	No entry	
	Clutch switch incorrectly adjusted or faulty	P0704;	Check clutch switch (P)
	Faulty CAN connection between ABS control unit and engine control unit	PC001;	Check CAN connection (P)
	Faulty engine control unit	B1600; B1602; B1681; B2103; B2139; B2141; B2431;	Replace engine control unit, if none of the previous tests have achieved any improvement (see chapter 4.5)
	Speed signal missing or incorrect	P0500;	Check speed signal (P)

2.18 Vehicle accelerates fast while coasting after releasing the brake

Cause of fault	Location of fault	Code	Fault elimination
No brake detection in the engine control unit (-> faulty idle controller)	Faulty CAN connection between ABS control unit and engine control unit	PC001;	Check CAN connection (P)
	Faulty brake switch in the ABS system	No entry	Check ABS (P)
	Faulty engine control unit	B1600; B1602; B1681; B2103; B2139; B2141; B2431;	Replace engine control unit, if none of the previous tests have achieved any improvement (see chapter 4.5)

2.19 Engine smoking at start

Cause of fault	Location of fault	Code	Fault elimination
Too high rail pressure and too high injection quantity during the start process	Coolant temperature signal too low	P0116; P0117; P0118;	Check coolant temperature sensor (P) Check high-pressure system (see chapter 4.3)
	Fuel temperature signal too low	P0181; P0182; P0183;	Check fuel temperature sensor (P) Check high-pressure system (see chapter 4.3)

2.20 Engine smokes / blue smoke

Cause of fault	Location of fault	Code	Fault elimination
Engine oil level too high		No entry	Draw off excess oil quantity (P)
High oil consumption	Engine wear	No entry	
Dripping injectors	Faulty injectors	No entry	Check injectors (S)
	Coolant temperature signal incorrect	P0116; P0117; P0118;	Check coolant temperature sensor (P)
Injection quantity too high	Faulty engine control unit	B1600; B1602; B1681; B2103; B2139; B2141; B2431;	
	Faulty injectors	P0263; P0266; P0269; P0272;	
Poor mixture preparation	Injectors heavily soiled	P0263; P0266; P0269; P0272;	
Unsuitable fuel		No entry	Exchange fuel
Too little air intake	Air filter is blocked or intake lines are bent	P0263; P0266; P0269; P0272; P0103;	Check air intake system (P);
	Leakage in the intake line downstream of the turbocharger		
	Faulty turbocharger or vacuum control		Check boost pressure (P)
	Air intake system heavily soiled	No entry	Clean intake system
Rail pressure too high (-> resulting in a too high exhaust gas recirculation rate)	High-pressure pump defective	P0087; P0088; P0089; P0090; P0091; P0092; P0001;	Check high-pressure system (see chapter 4.3)
	PCV / VCV defective	P0002; P0003; P0004; P0087; P0088; P0089; P0090; P0091; P0092; P0001;	
	Faulty high-pressure signal	P0191; P0192; P0193;	Check high-pressure sensor and electrical connections (P) Check high-pressure system (see chapter 4.3)
	Faulty engine control unit	B1600; B1602; B1681; B2103; B2139; B2141; B2431;	Replace engine control unit, if none of the previous tests have achieved any improvement (see chapter 4.5)

2.21 Engine smokes while climbing passes

Cause of fault	Location of fault	Code	Fault elimination
Air pressure signal too high	Faulty air pressure sensor	No entry	Check air pressure sensor. If necessary replace engine control unit (see chapter 4.5)
Air temperature sensor signal too low	T-MAP sensor faulty	P0112; P0113;	Check T-MAP sensor (P)

2.22 Engine develops white smoke (particularly after start)

Cause of fault	Location of fault	Code	Fault elimination
Faulty glow plug system (optional)*	One or more glow plugs defective	P0263; P0266; P0269; P0272;	Check glow plug system (P)
	Glow plug relay or wiring harness defective	P0263; P0266; P0269; P0272;	
Frequent cold starts without warm-up period	Unburned fuel in the exhaust gas system	No entry	Run engine until hot (observe oil level)
Faulty injection	Injector jammed open	P0263; P0266; P0269; P0272;	Check injectors (see chapter 4.4)

Note

*The glow plug system is an optional component of the system provided by Siemens VDO.

2.23 High fuel consumption

Cause of fault	Location of fault	Code	Fault elimination
Faulty engine control unit	Various effects possible	B1600; B1602; B1681; B2103; B2139; B2141; B2431;	Replace engine control unit, if none of the previous tests have achieved any improvement (see chapter 4.5)
Too little air intake	Air filter is blocked or intake lines are bent	P0263; P0266; P0269; P0272; P0103;	Check air intake system (P)
	Faulty turbocharger or vacuum control		Check boost pressure (P)
	Air intake system heavily soiled		Clean intake system
Fuel - leakage	Leakage in high-pressure / low-pressure system	P0087; P0088; P0089; P0090; P0091; P0092; P0001;	Check high-pressure system (see chapter 4.3) Check low-pressure system (see chapter 4.2)
Rail pressure too high	PCV / VCV defective	P0002; P0003; P0004; P0087; P0088; P0089; P0090; P0091; P0092; P0001;	Check high-pressure system (see chapter 4.3)
	High-pressure pump defective	P0087; P0088; P0089; P0090; P0091; P0092; P0001;	
	Faulty high-pressure signal	P0191; P0192; P0193;	Check high-pressure system (see chapter 4.3)
Injection quantity too high	Coolant temperature signal incorrect	P0116; P0117; P0118;	Check coolant temperature sensor (P)
	Faulty engine control unit	B1600; B1602; B1681; B2103; B2139; B2141; B2431;	Replace engine control unit, if none of the previous tests have achieved any improvement (see chapter 4.5)

Cause of fault	Location of fault	Code	Fault elimination
Faulty accelerator pedal signal	Faulty accelerator pedal position	No entry	Check accelerator pedal sensor (P)
	Faulty accelerator pedal sensor	P0122; P0123; P0222; P0223; P2135; P2299;	
	Defective wiring harness		
Poor mixture preparation	Faulty or heavily soiled injectors	P0263; P0266; P0269; P0272;	Check injectors (see chapter 4.4)
Poor or no cooling	Faulty radiator fan or radiator	No entry	Check cooling system (P)
	Coolant temperature signal incorrect	P0116; P0116; P0117; P0118;	Check coolant temperature sensor (P)
	Thermostat defective	No entry	
	Coolant level too low / leakage in the system	No entry	

2.24 Engine knocks

Cause of fault	Location of fault	Code	Fault elimination
Rail pressure too high	PCV / VCV defective	P0002; P0003; P0004; P0087; P0088; P0089; P0090; P0091; P0092; P0001;	Check high-pressure system (see chapter 4.3)
	High-pressure pump defective	P0087; P0088; P0089; P0090; P0091; P0092; P0001;	
	Faulty high-pressure signal	P0191; P0192; P0193;	Check electrical connections (S) Check high-pressure system (see chapter 4.3)
	Faulty engine control unit	B1600; B1602; B1681; B2103; B2139; B2141; B2431; U2510;	Replace engine control unit, if none of the previous tests have achieved any improvement (see chapter 4.5)
Poor mixture preparation	Faulty injectors / jets	P0263; P0266; P0269; P0272;	Check injectors (see chapter 4.4)
Bad fuel		No entry	

2.25 Engine gets too hot

Cause of fault	Location of fault	Code	Fault elimination
Faulty engine control unit	Various effects possible	B1600; B1602; B1681; B2103; B2139; B2141; B2431; U2510;	Replace engine control unit, if none of the previous tests have achieved any improvement (see chapter 4.5)
Poor or no cooling	Faulty radiator fan or radiator	No entry	Check cooling system
	Coolant temperature signal incorrect	P0116; P0117; P0118;	Check coolant temperature sensor (P)
	Defective wiring harness	No entry	Check wire connections (P)
	Defective degasification valve	No entry	
	Thermostat defective	No entry	
	Coolant level too low / leakage in the system	No entry	
Incorrect air intake	Intercooler clogged	No entry	Clean and if necessary replace it Check air intake system (P)

3 Fault code list

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
B1213	Engine immobiliser: • Programmed key numbers are used	No start	At next restart
B1600	Engine immobiliser: • Ignition key transfer failed • Transceiver signal not received • Not enough positions for the key code	No start	At next restart
B1602	Engine immobiliser: • Invalid data	No start	At next restart
B1681	Engine immobiliser: • Transceiver signal not received	No start	At next restart
B2103	Engine immobiliser: • Antenna not connected	No start	At next restart
B2139	Engine immobiliser: • No suitable answer found to problem request	No start	At next restart
B2141	Engine immobiliser: • PCM ID transfer failed	No start	At next restart
B2431	Engine immobiliser: • Transponder (transfer) fault	No start	At next restart

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P0001	VCV with reset spring not closed or has no electrical signal		As far as the factors are in the tolerances.
	Rail pressure function: • VCV adaptation exceeds a specified threshold • Leakage amount of injectors too high • Check injectors and high-pressure system		
P0002	Wire connection to the VCV: • Short circuit to ground (VCV closed) • VCV electric power consumption excessive • Short circuit to ground or wire interruption in the current measurement feedback		As far as the factors are in the tolerances.
P0003	Wire connection to the VCV: • Wire interruption (VCV open)	Engine stalls. Not possible to restart: • FUP limitation • Torque limitation Engine runs: • FUP limitation • Torque limitation	As far as the factors are in the tolerances.
P0004	Wire connection to the VCV: (VCV closed) • Short circuit to + or in the winding • Short circuit to + in the current measurement feedback	Engine stalls. Not possible to restart: • FUP limitation • Torque limitation Engine runs: • Torque reduction • Limitation of VCV	As far as the factors are in the tolerances.
P0089	Rail pressure control: • Fault in rail pressure control	• Torque limitation	As far as the controllers are in the tolerances.
P0090	Wire connection to the PCV (PCV open): • Short circuit to + or in the winding • Short circuit to + in the current measurement feedback • Short circuit to ground • Wire interruption		As far as the factors are in the tolerances.

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P0091	Rail pressure control: • Nominal rail pressure was not reached • Rail pressure controller (PI) is at the lower stop / end position (MIN)	Engine stalls. Not possible to restart: • FUP limitation • Torque limitation	As far as the factors are in the tolerances.
P0092	Rail pressure control: • Nominal rail pressure was not reached • Rail pressure controller (PI) is at the upper stop / end position (MAX)	Engine stalls. Not possible to restart: • FUP and Torque limitation • Torque reduction / Limitation of PCV	As far as the factors are in the tolerances.
P0105	Ambient pressure sensor: • Fault in control loop		
P0107	Ambient pressure sensor: Ambient pressure falls below a spcified threshold: (MIN) • Short circuit to + • Ambient pressure too low • Ambient pressure in idle/at start is too low compared to suction tube pressure	Substitute value: 1000 mbar	As far as the factors are in the tolerances.
P0108	Ambient pressure sensor: Ambient pressure exceeds a specified threshold: (MAX) • Short circuit to ground • Wire interruption • Ambient pressure too high • Ambient pressure in idle/at start is too low compared to suction tube pressure	Substitute value: 1000 mbar	As far as the factors are in the tolerances.
P0109	Ambient pressure sensor: • Ambient pressure gradient (increase) too high	Substitute value: 1000 mbar	As far as the factors are in the tolerances.

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P0110	Air intake temperature sensor: • Fault in control loop	Problem to start. No start possible due to FUP building problem	As far as no error is detected.
P0112	Air intake temperature sensor: Air intake temperature is too low compared to boost air temperature (MIN)	Substitute value: 100 °C	As far as no error is detected.
P0113	Air intake temperature sensor: Air intake temperature is too high compared to boost air temperature (MAX)	Substitute value: 100°C	As far as no error is detected.
P0114	Air intake temperature sensor: • Gradient (increase) too high	Substitute value: 100 °C	As far as no error is detected.
P0115	Coolant temperature sensor: • Fault in control loop		As far as the factors are in the tolerances.
P0116	Coolant temperature sensor: • Coolant temperature implausible	Substitute value: 10 °C	As far as the factors are in the tolerances.
P0117	Coolant temperature sensor: Coolant temperature drops below a specified threshold: (MIN) • Short circuit to ground	Substitute value: 10 °C	As far as the factors are in the tolerances.
P0118	Coolant temperature sensor: Coolant temperature exceeds a specified threshold: (MAX) • Short circuit to + • Wire interruption		
P0119	Coolant temperature sensor: • Gradient (increase) too high	Substitute value: 10 °C	As far as the factors are in the tolerances.
P0122	Pedal value sensor: Accelerator pedal signal from channel 1 is below a specified threshold (MIN) • Short circuit to ground • Wire interruption	• Torque limitation • Engine speed limitation	Return in the tolerances and after key off / key on.

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P0123	Pedal value sensor: Accelerator pedal signal from channel 1 exceeds a specified threshold (MAX) • Short circuit to +	• Torque limitation • Engine speed limitation	Return in the tolerances and after key off / key on
P0180	Fuel temperature sensor: • Fault in control loop		As far as the factors are in the tolerances.
P0182	Fuel temperature sensor: Fuel temperature falls below a specified threshold: (MIN) • Short circuit to + • Wire interruption	Substitute value: 115 °C	As far as the factors are in the tolerances.
P0183	Fuel temperature sensor: Fuel temperature exceeds a specified threshold: (MAX) • Short circuit to ground	Substitute value: 115 °C	As far as the factors are in the tolerances.
P0184	Fuel temperature sensor: • Fuel air temperature gradient (increase) too high	Substitute value: 115 °C	As far as the factors are in the tolerances.
P0190	Rail pressure sensor: • Fault in control loop	• FUP limitation • Torque limitation • Fuel pressure limitation	As far as the factors are in the tolerances.
P0191	Rail pressure sensor: • Rail pressure offset • Rail pressure> threshold value • Rail pressure between current value and open loop is implausible	• FUP limitation • Torque limitation • Fuel pressure limitation	As far as the factors are in the tolerances.
P0192	Rail pressure sensor: Voltage of the rail pressure sensor exceeds a specified threshold: (MAX) • Short circuit to + • Wire interruption	• FUP limitation • Torque limitation • Fuel pressure limitation	As far as the factors are in the tolerances.

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P0193	Rail pressure sensor: Voltage of the rail pressure sensor drops below a specified threshold: (MIN) • Short circuit to ground	• FUP limitation • Torque limitation • Fuel pressure limitation	As far as the factors are in the tolerances.
P0194	Rail pressure sensor: • Rail pressure offset • Rail pressure> threshold value • Differential pressure test: (between current pressure – old pressure) < threshold value • Gradient (increase) too high	• FUP limitation • Torque limitation • Fuel pressure limitation	As far as the factors are in the tolerances.
P0200	Piezo power stage: • Initialisation of power stage faulty • Fault, driver ATIC20 Voltage check: • Injector or wiring harness fault	Engine stalls and no start possible	After key off / key on if failure is not present anymore.
P0201	Piezo power stage: • Faulty injector cylinder 1 • Faulty boost or discharge operation	• Torque limitation • Engine speed limitation Engine runs on 2 cylinders min. Impacted injectors are shut off. Cylinder-balancing and anti-jerk are shut off.	After key off / key on if failure is not present anymore.
P0202	Piezo power stage: • Faulty injector cylinder 2 • Faulty boost or discharge operation	• Torque limitation • Engine speed limitation Engine runs on 2 cylinders min. Impacted injectors are shut off. Cylinder-balancing and anti-jerk are shut off.	After key off / key on if failure is not present anymore.
P0203	Piezo power stage: • Faulty injector cylinder 3 • Faulty boost or discharge operation	• Torque limitation • Engine speed limitation Engine runs on 2 cylinders min. Impacted injectors are shut off. Cylinder-balancing and anti-jerk are shut off.	After key off / key on if failure is not present anymore.
P0204	Piezo power stage: • Faulty injector cylinder 4 • Faulty boost or discharge operation	• Torque limitation • Engine speed limitation Engine runs on 2 cylinders min. Impacted injectors are shut off. Cylinder-balancing and anti-jerk are shut off.	After key off / key on if failure is not present anymore.

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P0222	Pedal value sensor: Accelerator pedal signal from channel 2 is below a specified threshold (MIN) • Short circuit to ground	• TQ limitation • Engine speed limitation	Return in the tolerances and after key off / key on.
P0223	Pedal value sensor: Accelerator pedal signal from channel 2 exceeds a specified threshold (MAX) • Short circuit to + • Wire interruption	• TQ limitation • Engine speed limitation	Return in the tolerances and after key off / key on.
P0235	Boost pressure sensor: • Fault in control loop	Substitute value: 1500 mbar	As far as the factors are in the tolerances.
P0236	Boost pressure sensor: • Boost pressure offset • Boost pressure >threshold value • Differential pressure test: (between current pressure – old pressure) < threshold value • Gradient (increase) too high	Substitute value: 1500 mbar	As far as the factors are in the tolerances.
P0237	Boost pressure sensor: Boost pressure falls below a specified threshold: (MIN) • Short circuit to + • Suction tube pressure too low • Suction tube pressure in idle/at start is too low compared to ambient pressure	Substitute value: 1500 mbar	As far as the factors are in the tolerances.
P0238	Boost pressure sensor (EURO 4-specific): Boost pressure exceeds a specified threshold: (MAX) • Short circuit to ground • Wire interruption • Suction tube pressure too high • Suction tube pressure in idle/at start is too low compared to ambient pressure	Substitute value: 1500 mbar	As far as the factors are in the tolerances.

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P0263	Cylinder balancing control: • Cylinder balancing factor of cylinder 1 is exceeding or falling below a specified threshold. • Excessive dispersion of the injection quantity from the injectors among each other. ⇨ Check injectors		As far as the factors are in the tolerances.
P0266	Cylinder balancing control: • Cylinder balancing factor of cylinder 2 is exceeding or falling below a specified threshold. • Excessive dispersion of the injection quantity from the injectors among each other. ⇨ Check injectors		As far as the factors are in the tolerances.
P0269	Cylinder balancing control: • Cylinder balancing factor of cylinder 3 is exceeding or falling below a specified threshold. • Excessive dispersion of the injection quantity from the injectors among each other. ⇨ Check injectors		As far as the factors are in the tolerances.
P0272	Cylinder balancing control: • Cylinder balancing factor of cylinder 4 is exceeding or falling below a specified threshold. • Excessive dispersion of the injection quantity from the injectors among each other. ⇨ Check injectors		As far as the factors are in the tolerances.
P0335	Crankshaft sensor: • Crankshaft signal outside range of tolerance	System reaction: Engine stalls	After reconnection.
P0336	Crankshaft sensor: • Line to crankshaft sensor interrupted • No crankshaft signal present	System reaction: Engine stalls	After reconnection.

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P0340	Camshaft sensor: • Camshaft signal outside range of tolerance	During engine running no reaction, but no restart possible	After reconnection.
P0341	Camshaft sensor: • No camshaft signal present	During engine running no reaction, but no restart possible	After reconnection.
P0501	Speed sensor: • Speed signal exceeds a specified threshold (MAX) • Speed signal implausible during cold start (plausibility test with V = 0)		As far as no error is detected.
P0562	Battery voltage too low		As far as the factors are in the tolerances.
P0563	Battery voltage too high		As far as the factors are in the tolerances.
P0571	Brake test switch sensor: • Brake light signal via CAN faulty		As far as no error is active.
	Brake test switch sensor: • Brake light signal implausible during brake test		
	Brake test switch sensor: • Brake light signal with brake test signal implausible		
P0602	Powertrain module: • Programming error		
P0606	Piezo power stage: • Initialisation of power stage faulty • Fault, driver ATIC20 • SPI / PR /ID / T55 fault	Engine stalls and no start possible	After key off / key on if failure is not present anymore.

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P0606	Internal monitoring fault in the engine control unit: • Microunit • Injection (fuel) cut off implausible • CAN monitoring faulty • Control of maximum engine speed limiting implausible • Accelerator pedal monitoring implausible ⇨ Comparison of signal and value calculated from torque • Engine speed implausible • Service tool monitoring • A/D converter (conversion) implausible • MSR monitoring • Tempomat monitoring	Engine stalls. No restart possible. • Cruise off • Reset. Engine stalls. • Disablement of CAN. • Engine speed limitation.	Irreversible.
	FIFO	Engine stalls. No restart possible.	Irreversible.
P0608	Speed signal output (hardware) • Short circuit to + • Short circuit to ground		As far as no error is detected.
P0610	Variant coding: • Coding faulty • Coding not completed		As far as no error is detected.
P0615	Wire connection to starter relay: • Short circuit to +		As far as no error is detected.
P0627	Fuel pump: • Control loop interrupted		As far as no error is detected.
P0629	Fuel pump: • Power supply for the fuel pump exceeds a specified threshold		As far as no error is detected.

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P0642	5V voltage supply (VCC_1) for rail pressure sensor falls below a specified threshold (MIN)	• TQ limitation • FUP limitation • Engine speed limitation If VCC_1 and VCC_2 also engine speed in IS t0 1200 rpm and no pedal reaction	Return in the tolerances and after key off / key on.
P0643	5V voltage supply (VCC_1) for rail pressure sensor exceeds a specified threshold (MAX)	• TQ limitation • FUP limitation • Engine speed limitation If VCC_1 and VCC_2 also engine speed in IS t0 1200 rpm and no pedal reaction	Return in the tolerances and after key off / key on.
P0652	5V voltage supply (VCC_2) for accelerator pedal sensor falls below a specified threshold (MIN)	• Engine speed limitation If VCC_1 and VCC_2 also engine speed in IS t0 1200 rpm and no pedal reaction	Return in the tolerances and after key off / key on.
P0653	5V voltage supply (VCC_2) for accelerator pedal sensor exceeds a specified threshold (MAX)	• Engine speed limitation If VCC_1 and VCC_2 also engine speed in IS t0 1200 rpm and no pedal reaction	Return in the tolerances and after key off / key on.
P0654	Signal "Engine running": • Short circuit to +		Return in the tolerances and after key off / key on.
P0685	Wire connection to main relay: • Short circuit to ground • Wire interruption	Engine stalls. No restart possible.	As far as the factors are in the tolerances.
P0687	Wire connection to main relay: • Short circuit to +	Engine stalls. No restart possible.	As far as the factors are in the tolerances.
P0704	Clutch switch sensor: (not used if the clutch switch is not via CAN) • Clutch switch signal via CAN faulty • Change in speed signal if clutch switch signal does not change • Clutch switch signal implausible in comparison with speed signal	ACC off.	As far as no error is detected.

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P0A09	Piezo power stage: • Voltage of the power stage for the injectors in the engine control unit too low (MIN)		As far as the factors are in the tolerances.
P0A10	Piezo power stage: • Voltage of the power stage for the injectors in the engine control unit too high (MAX)		As far as the factors are in the tolerances.
PE051	Internal self-test 1 in engine control unit: • CRC boot software error • CRC ECU software error • CRC calibration data error		Irreversible.
P1140	Fuel warning: • Water in tank		
P1201	Piezo power stage: • Faulty injector cylinder 1 • Faulty injector voltage	• Torque limitation • Engine speed limitation Engine runs on 2 cylinders min. Impacted injectors are shut off. Cylinder-balancing and anti-jerk are shut off.	After key off / key on if failure is not present anymore.
P1202	Piezo power stage: • Faulty injector cylinder 2 • Faulty injector voltage	• Torque limitation • Engine speed limitation Engine runs on 2 cylinders min. Impacted injectors are shut off. Cylinder-balancing and anti-jerk are shut off.	After key off / key on if failure is not present anymore.
P1203	Piezo power stage: • Faulty injector cylinder 3 • Faulty injector voltage	• Torque limitation • Engine speed limitation Engine runs on 2 cylinders min. Impacted injectors are shut off. Cylinder-balancing and anti-jerk are shut off.	After key off / key on if failure is not present anymore.
P1204	Piezo power stage: • Faulty injector cylinder 4 • Faulty injector voltage	• Torque limitation • Engine speed limitation Engine runs on 2 cylinders min. Impacted injectors are shut off. Cylinder-balancing and anti-jerk are shut off.	After key off / key on if failure is not present anymore.

Specific DTC	Type of fault	Limp home strategy Substitute value	Reset conditions for limp home
P1563	Engine switch-off: • Engine switch-off via injectors (electrical) faulty • Engine switch-off via pump faulty	• Engine stops via injektion off • Engine stops via hydraulic path	As far as no error is detected.
P1577	Pedal value sensor: • Value of accelerator pedal sensor implausible		
P1639	Variant coding: • Coding faulty • Coding not completed	• No start possible	Irreversible.
P1933	Fuel: • Fuel reserve signal implausible • CAN fault, fuel reserve signal		As far as no error is detected.
	• Fuel level too low		
P2135	Pedal value sensor: • Value of accelerator pedal sensor between channel 1 and channel 2 implausible	• TQ limitation • Engine speed limitation	Return in the tolerances and after key off key on.
P2299	Pedal value sensor: • Trigger signal from brake switch retained • Gradient of accelerator pedal sensor between channel 1 and channel 2 implausible		Return in the tolerances and after key off key on.
U0001	CAN communication: • CAN connection faulty		As far as no error is detected.
U0155	CAN communication: • Engine control unit unable to send data via CAN • CAN-ISU fault		As far as no error is detected.
U2510	• Engine immobiliser: Data problem with data connection		As far as no error is detected.

4 Test instructions

4.1 Prerequisites of working on the diesel fuel system

4.1.1 Recommendations

Important

The use of agents containing additives such as fuel line cleaners / metal coatings is prohibited.

4.1.2 Work safety instructions

Introduction

Any work on the injection system is subject to the relevant regulations and provisions:

- of accident prevention
- of environmental protection
- of the competent health authorities

Any work must be carried out by skilled personnel that is familiar with the safety instructions and the special safety precautions.

Safety instructions

Owing to the extremely high pressures (1600 bar) that may occur in the fuel system, the following instructions must be heeded:

- do not work in the proximity of flames or sparks
- do not carry out any work on the high-pressure fuel system with the engine running
- wait for 30 seconds after turning off the engine before carrying out any work
- it is absolutely prohibited to smoke in the immediate proximity of the high-pressure system while work is being carried out

Note

This waiting time is required to allow ambient pressure to be restored in the high-pressure fuel system.

When the engine is running

- do not let your hands come near a leak in the high-pressure fuel system
- always remain out of reach of a possible jet of fuel, which could result in serious injury
- do not pull the plugs from the injectors and the engine control unit (ECU), this could result in damage to the engine

Danger

When performing work at the engine control unit (ECU) and the injectors, the accident prevention regulations for high-voltage equipment must be observed.

Working area

The working area must be clean (floor, etc.) and without any obstacles; parts that are being repaired must be stored dustproof.

Preparatory work

Prior to working on the system, it may be necessary to clean the components of this sensitive system (see relevant instructions).

Components of the sensitive system:

- Injectors
- High-pressure fuel pump
- Injection distributing tube (rail)
- High-pressure fuel lines

Important

When removing or mounting the diesel common rail pump, do not carry the pump at the connectors, line connections or casings of the volume flow control valve and pressure con-trol valve.
When mounting or removing the rail, do not carry it or pull it out at the high-pressure sensor.

Otherwise there is a risk of damage!

Note

The engine control unit may become very hot in operation. A high temperature at the housing does not indicate that the engine control unit is damaged.

The engine control unit is checked by following the test instructions (chapter B, section 4.5).

Important

- Cleanliness regulations:
  All staff must wear clean clothing.
- Directly after being disassembled, all connections of the high-pressure system must be sealed with plugs to prevent pollutants from entering the high-pressure system.
- Safety torques: The tightening torques for the high-pressure system (lines, injector
  flanges, rail) must always be observed.
- Use regularly checked torque wrenches.

4.1.3 Information regarding the exchange of parts and the procedures

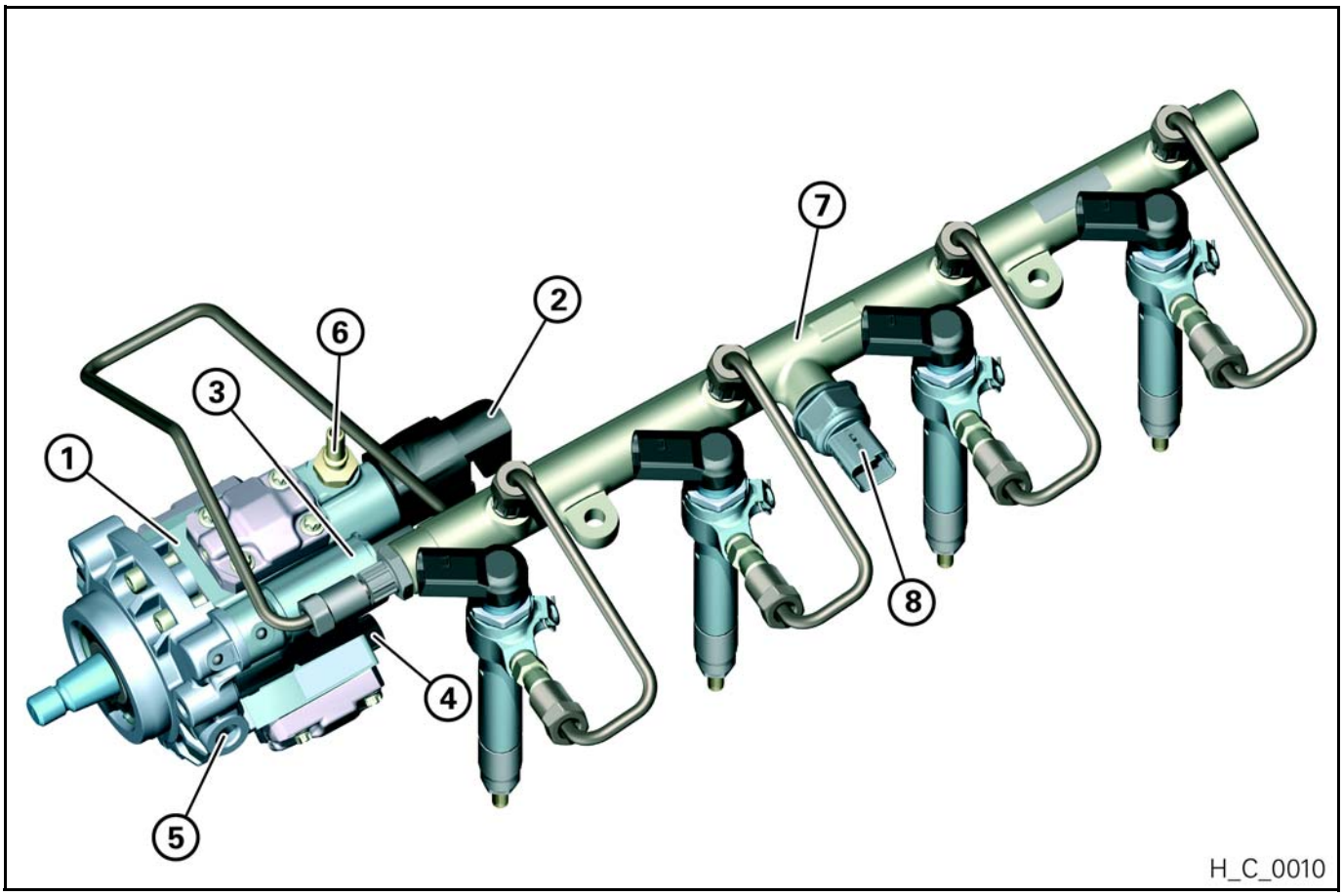


Fig. B - 1 Overview of the main components

Do not disconnect the following parts from the high-pressure pump (1):

- High-pressure control valve (PCV) (2)
- Volume flow control valve (VCV) (3)
- High-pressure outlet port (4)
- Ring nipple banjo bolt of the pump supply (5)
- Ring nipple banjo bolt of the pump return (6)

Important

Should one of these parts become damaged, the pump must always be sent to Siemens VDO for analysis.

Do not disconnect the high-pressure sensor (8) from the rail (7).

Important

In case of damage, the rail, the high-pressure lines or the high-pressure sensor must always be sent back to Siemens VDO for analysis.

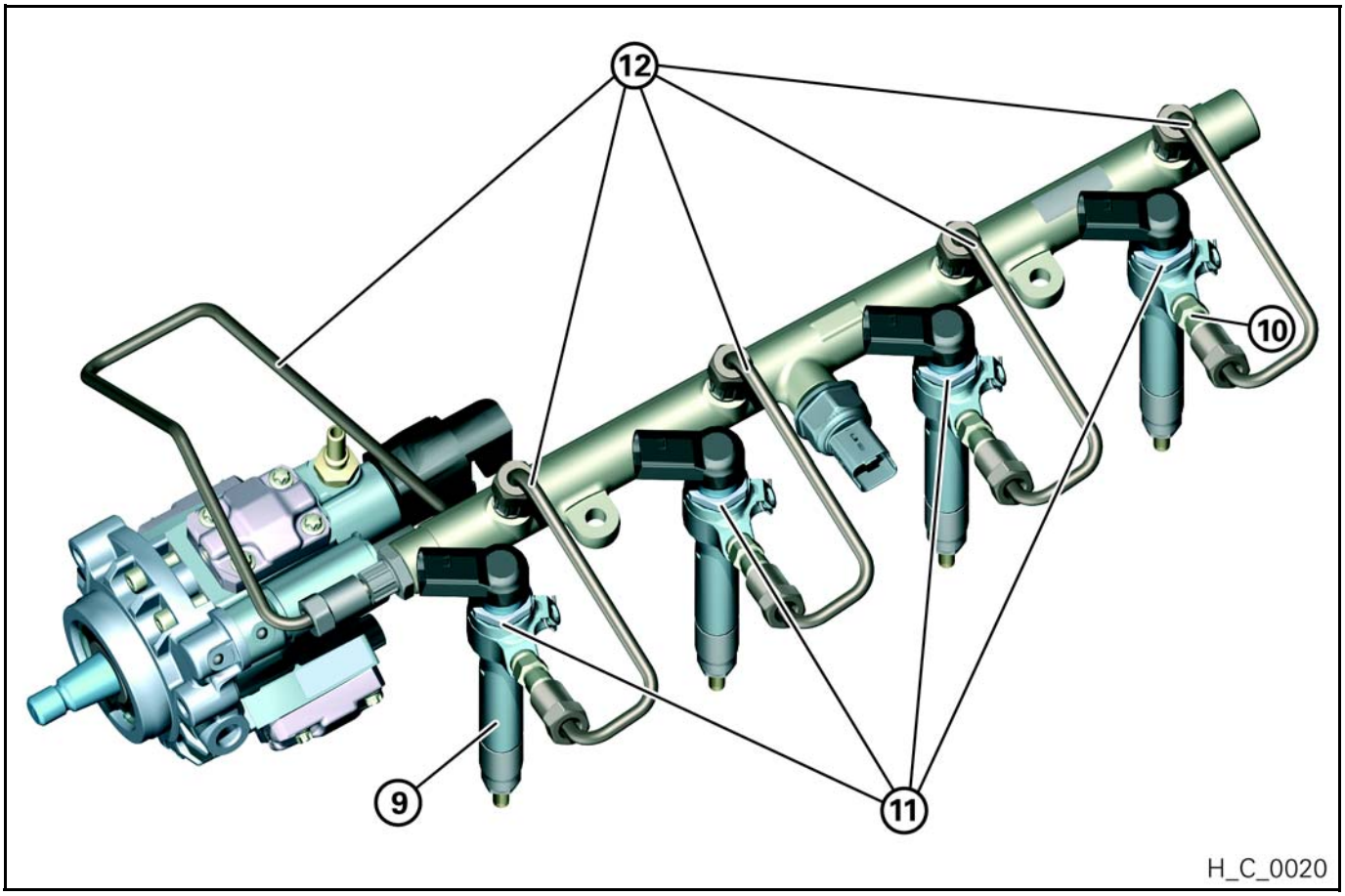


Fig. B - 2 Overview of the main components

Do not disassemble the injector (9).

- Do not disconnect the high-pressure connection (10).
- Do not unscrew the nut (11).

Note

When reusing an injector, the nozzle shaft must be cleaned using a soft cloth (if required, by means of a brake cleaner) to remove all loose impurities.
To prevent impurities from entering the nozzle holes, the nozzle cap must **not** be cleaned mechanically (e.g. wiping off with a cloth, using a steel wire brush).

Important

In case of damage, the injector must be sent back to Siemens VDO for analysis.

It is prohibited to clean the injection nozzle of the injector by ultrasound!

Any work carried out at the high-pressure lines (12) always requires their replacement.

The high-pressure lines are not part of the system delivered by Siemens VDO.

Do not open the engine control unit (13).

Important

In case of damage, the engine control unit (ECU) must always be sent back to Siemens VDO for analysis.

The engine control unit (ECU) must not be opened!

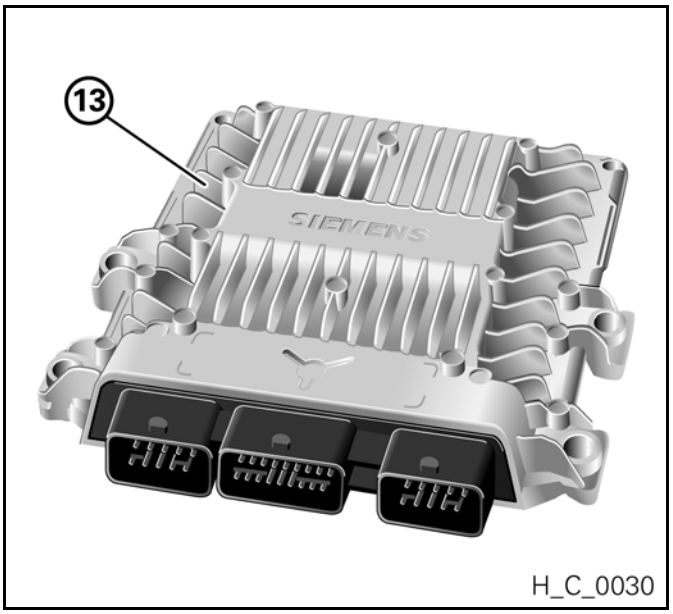


Fig. B - 3 Engine control unit

4.2 Checking the low-pressure system

4.2.1 Checking the internal fuel transfer system

Symptom

Air bubbles in the supply line to the DCP. Engine does not start.

Prerequisite

- Read the fault codes and carry out the appropriate checks.

Check steps

- Bleed the internal fuel transfer system according to the manufacturer's specifications.
- Check the electrical internal transfer pump and check for sufficient pumping output.

If no or too little fuel is being delivered, then check the following components:

- Check fuel filter for dirt accumulation.
- Check contents of the tank (gazoline instead of diesel, soiled fuel).
- Check supply and return lines for leakage, damage, as well as for a proper installation of the lines.
- Dismantle surge chamber and check for leaks (acc. to the manufacturer's specifications).
  Check strainer in surge chamber for blockage.

Important

The fuel line between the fuel filter and the diesel common rail pump (DCP) must not be opened in the field.

It is recommended that the fuel lines to the fuel filter not be opened, since otherwise the system must be evacuated of air (bled).

In the event of the following fault code entries, the engine control unit must be reprogrammed or replaced:

Possible fault code entries	Possible sequential faults
P0001	P0191

4.2.2 Checking the internal transfer pump (ITP)

Symptom

Fuel is present in the supply line to the DCP, however the fuel column does not move during the start.

Prerequisite

- Read the fault codes and carry out the appropriate checks.
- Internal fuel transfer system is found to be in a proper condition.
  See section "4.2.1 Checking the internal fuel transfer system" for information concerning this process.

Note

The fuel is pumped to the DCP by the electrical fuel pump (EFP) in the tank. Then the IPT leads the fuel to the high-pressure pump (HPP) via the VCV. For the lubrication of the pump elements, the fuel is also fed to the inside of the pump via the scavenger valve from where it is passed to the fuel return.
During the start phase, the EFP pumps more fuel than can be taken in by the ITP.
Because of this, the EFP must be disconnected from the DCP!

Check steps

- Switch the ignition off
- Pull the connector off the VCV (colour: orange)
- Disconnect the fuel supply line prior to the fuel filter
- Put the tank-side end of the fuel supply line in a suitable container
- Use an additional line to connect the container to the fuel filer
- Disconnect the bypass fuel line and close both ends of the bypass line (see Page A-2, bypass is the red line in the picture)

Important

- The opening of the additional line must be immersed in the fuel. The additional line must be filled with bubble-free fuel.

- Open the fuel return line of the DCP
- Start the engine for at least 15 s at an engine start speed of 250 rpm
- Measure the amount of fuel delivered (V_{ITP}) on the return flow connection of the DCP
- Compare the amount of fuel delivered (V_{ITP}) with the minimum amount of fuel delivered ($V_{ITP,min}$)

Minimum amount of fuel delivered $V_{ITP,min}$ = 130 ml/min (engine start speed of 250 rpm).

If $V_{ITP} < V_{ITP,min}$, then exchange the DCP.

Possible fault code entries	Possible sequential faults
P0001	P0191

4.3 Checking the high-pressure system

4.3.1 Checking the PCV

Symptom

Rail pressure approx. 50 bar during the start phase (holding pressure PCV).

Prerequisite

- Read the fault codes and carry out the appropriate checks.
- The entire low-pressure system is found to be in a proper condition. See section "4.2 Checking the low-pressure system" for information concerning this process.
- High-pressure lines and high-pressure connections have been checked for leaks.

Note

In the case of a faulty PCV (e.g. without power), a rail pressure of only 50 bar will be reached during the start phase. This holding pressure develops by the closing pressure of a spring in the PCV. Nominal rail pressure during the start phase: min. 150 bar

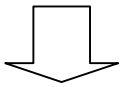
Possible fault code entries	Possible sequential faults
P0002 P0004 P0090 P0092	P0001

Important

Measure the current at the pressure control valve using a diagnostic tool or a multimeter.

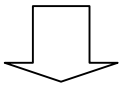
Check steps

Withdraw the PCV connector (colour: white) and measure the resistance at the PCV.
Nominal resistance: 1,5Ω – 15Ω



Resistance OK? → NO → Replace DCP.

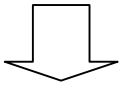
Measure the voltage at the PCV connector (PIN 1 and ground) when the ignition is on.
(Ignition switched on)
Nominal voltage: battery voltage

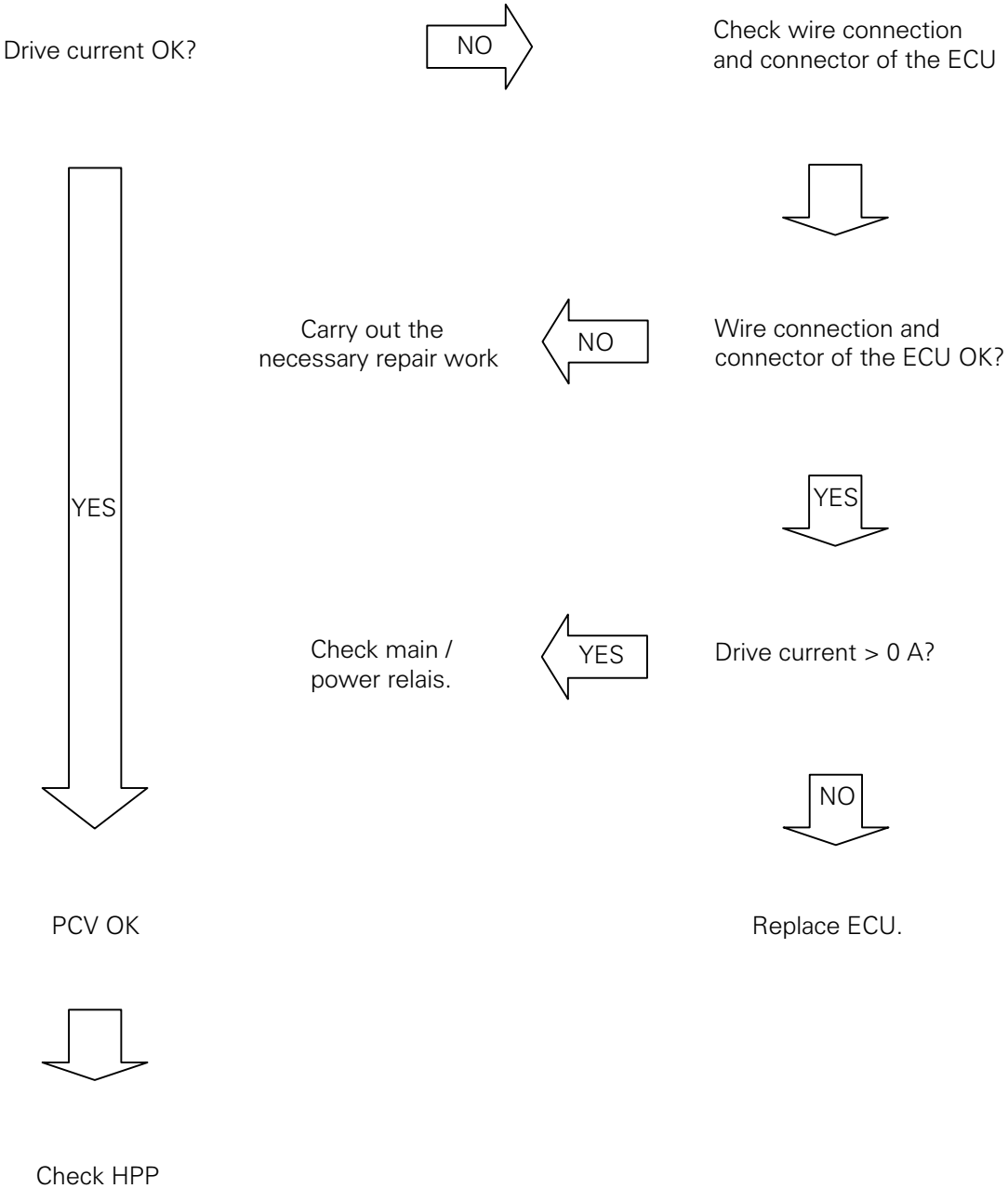


Voltage OK? → NO → Check main / power relais.

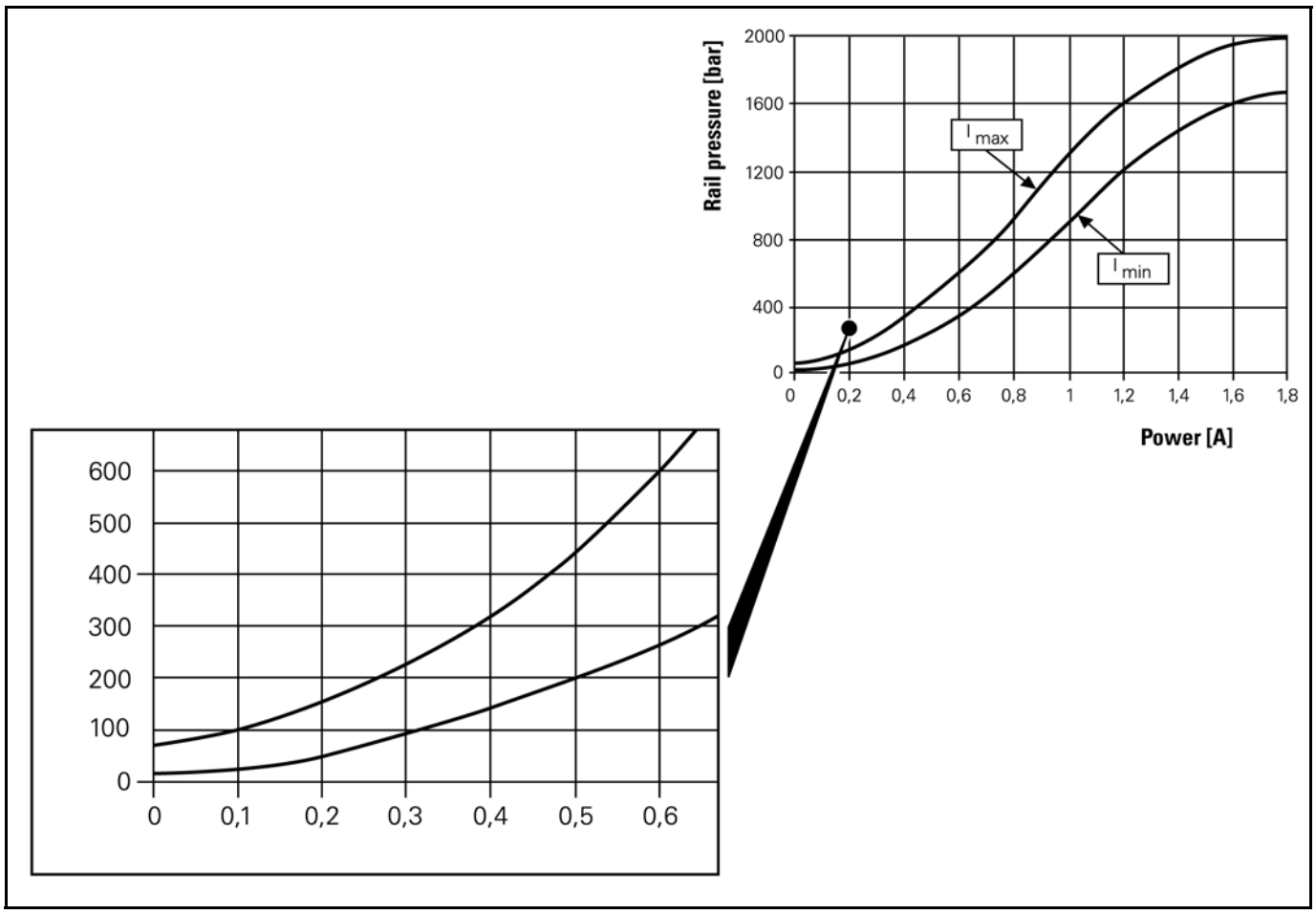
Measure the drive current at the connected PCV connector during the start phase.

Nominal current: 0,6 – 1,0 A (start phase)
(See rail pressure current diagram)




Drive current OK?
NO
Check wire connection and connector of the ECU
Carry out the necessary repair work
NO
Wire connection and connector of the ECU OK?
YES
YES
Check main / power relais.
YES
Drive current > 0 A?
NO
PCV OK
Replace ECU.
Check HPP

Rail pressure current diagram



4.3.2 Checking the high-pressure pump (HPP) and VCV

Symptom

Too little or no rail pressure during the start phase.

Prerequisite

- Read the fault codes and carry out the appropriate checks.
- High-pressure lines and high-pressure connections have been checked for leaks.
- PCV was checked.
  See also section "4.3.1 Checking the PCV" for information concerning this process.
- The entire low-pressure system is found to be in a proper condition.
  See section "4.2 Checking the low-pressure system" for information concerning this process.

Note

Nominal rail pressure during the start phase: min. 150 bar

During the test, the EFP (electrical fuel transfer pump) must be disconnected.
See section "4.2.2 Checking the internal transfer pump (ITP)" for information concerning this process.

Possible fault code entries	Possible sequential faults
P0002 P0004 P0090 P0092	P0001 P0191

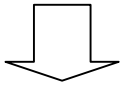
Important

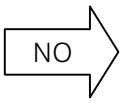
Measure the current at the volume flow control valve using a diagnostic tool or a multimeter.

Check steps

Pull the VCV connector (colour: orange) off and measure the resistance at the VCV.

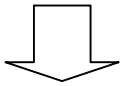
Nominal resistance: 1,5Ω – 15Ω

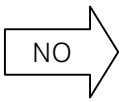


Resistance OK?  NO → Replace DCP.

Measure the voltage at the VCV connector (PIN 1 or 2) when the ignition is switched on.

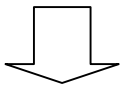
Nominal voltage: battery voltage

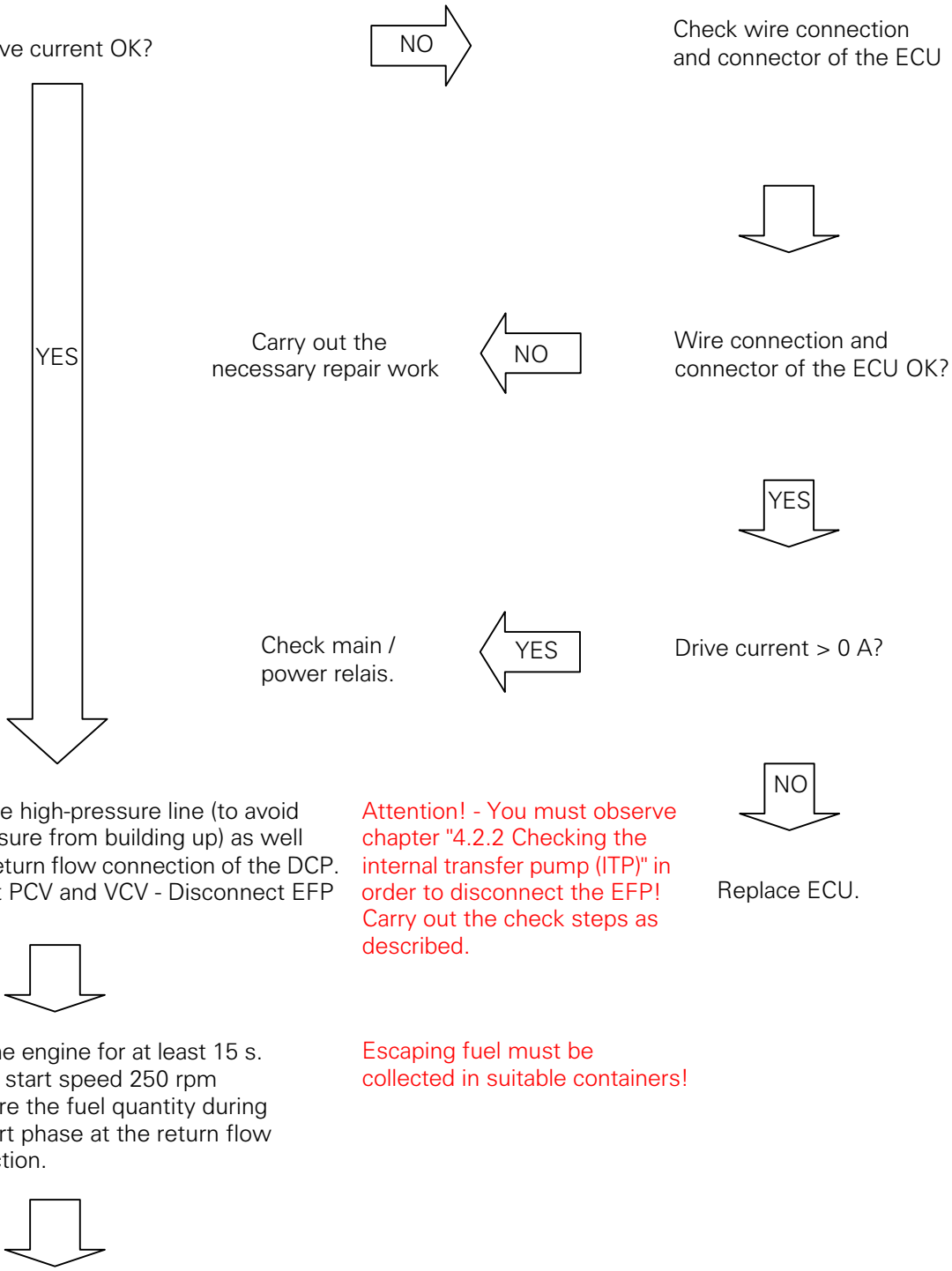


Voltage OK?  NO → Check main / power relais.

Measure the drive current at the connected VCV connector during the start phase.

Nominal current: 0,8 – 1,0 A (start phase)




Drive current OK?
NO
Check wire connection and connector of the ECU
YES
Carry out the necessary repair work
NO
Wire connection and connector of the ECU OK?
YES
Check main / power relais.
YES
Drive current > 0 A?
NO
Replace ECU.
Open the high-pressure line (to avoid rail pressure from building up) as well as the return flow connection of the DCP. Connect PCV and VCV - Disconnect EFP
Attention! - You must observe chapter "4.2.2 Checking the internal transfer pump (ITP)" in order to disconnect the EFP! Carry out the check steps as described.
- Start the engine for at least 15 s.
- Engine start speed 250 rpm
- Measure the fuel quantity during the start phase at the return flow connection.
Escaping fuel must be collected in suitable containers!

Measured fuel quantity exceeding 440 ml/min? (During a start time of at least 15 s and at 250 rpm engine start speed)

YES

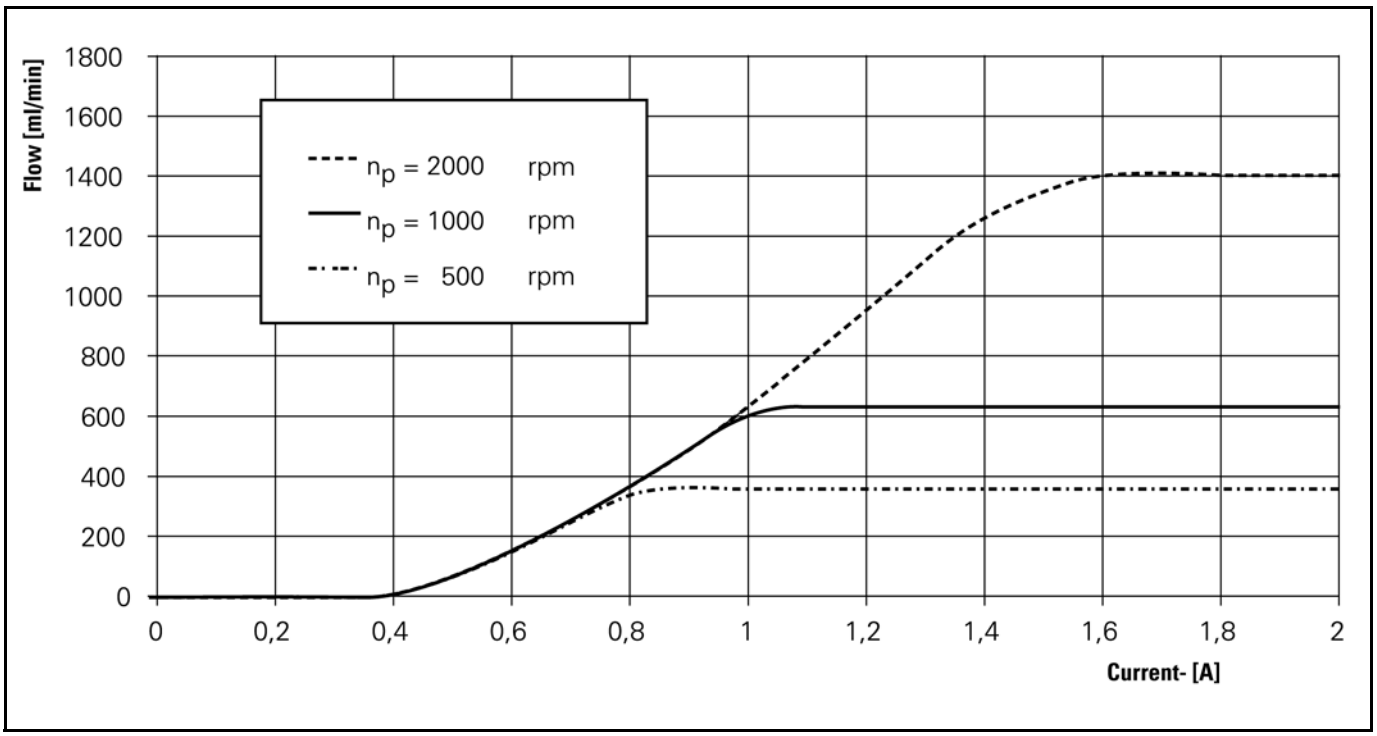
Replace DCP (The scavenger valve in the DCP is open or the VCV is mechanically jammed while it is closed)

NO

HPP OK

Note:
If the nominal rail pressure is not reached during the start phase, the injector leakage is possibly too high or the pressure signal is not correct.

Characteristic flow rate graph of the VCV depending on the pump speed (n_p)



4.3.3 Checking the rail pressure control loop

Symptom

- Unstable idling
- Rail pressure fluctuations
- Nominal rail pressure was not reached
- Loud or untypical combustion noises possible

Prerequisite

- Read the fault codes and carry out the appropriate checks.
- Air-conditioning is switched off.
- The tank is at least half full.
- Coolant temperature 80 - 90°C.
- All electrical consumers must be switched off.
- Hydraulic lines have been checked and there are no leaks.
- Connectors and wire connections have been checked.

Note

The appropriate rail pressure will be set for every engine operating condition. The engine control unit monitors continually the momentary rail pressure via the high-pressure sensor, adjusts this to the nominal value stored in the characteristics and regulates the pressure control valve PCV and the volume flow control valve VCV.
This results in a closed rail pressure control loop.

The VCV serves the purpose of customising the delivered amount of fuel from the high-pressure pump according to the needs of the engine.
This will reduce the power requirement of the high-pressure pump.

Important

If the DCP is blocked, i.e. if the pump shaft cannot be turned by hand even with the impeller mounted, or if heavy soiling (filings) in the transparent fuel return line can be discerned, then the complete injection system
(injectors, DCP, rail, high-pressure lines and all fuel return lines) has to be replaced.

Possible fault code entries	Possible sequential faults
P0002 P0004 P0089 P0090 P0092 P0192 P0193	P0001 P0263 P0266 P0269 P0272

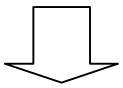
If more than one cylinder balancing DTC is shown, you must proceed as follows:

- Warm up the engine up to min. 60°C.
- Delete all DTCs in the fault memory.
- Start the engine and and wait until the follow-up time has expired.
- Run the engine at idle speed, do not move the vehicle.
- Wait until the first cylinder balancing DTC is shown.
- Then replace the injector shown (see also chapter C - "Mounting/Dismounting the injectors").

For the final test, you must erase the fault memory again and restart the engine (observe again the follow-up time of the control unit).

Check steps

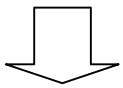
Start the engine and
run it while idling.



Are there larger air bubbles
in the transparent supply line
to the DCP?

YES → Check low-pressure system

Pull the VCV connector
(colour: orange) off.

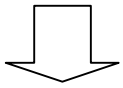


Does the engine stop?

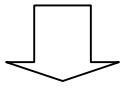
NO → Replace DCP
(VCV remains mechanically open)

Connect the VCV connector,
restart the engine and run it
while idling.

Note:
Before restarting the engine,
switch the ignition off and
wait for approx. 20 seconds
(follow-up time of the ECU).



Pull the PCV connector
(colour: white) off.



Does the engine stop?

NO → Replace DCP
(VCV remains mechanically jammed while it is closed)

YES

Connect the PCV connector, restart the engine and run it while idling.

Read out Cylinder balancing factors online.

Cylinder balancing fault?
Nominal value: 1
Admissible deviation: ±0,4

YES → Check the injectors.

NO

Read out the fuel temperature and cooling water temperature online.
Nominal value for coolant temperature: 80-90°C
Nominal value for fuel temperature while idling: 20-65°C

Note → Technical Background:
- at high fuel temperatures, the maximum rail pressure is reduced to protect the plastic lines.
- at high coolant temperatures, the maximum rail pressure is reduced to protect the engine.

Are the fuel and engine coolant temperature within the nominal range?

NO → Check the corresponding sensors.

YES

Turn the engine off.

Measure the resistances at the PCV and vCV, check the wire connections.
Nominal resistance PCV: 1,5Ω – 15Ω
Nominal resistance VCV: 1,5Ω – 15Ω

Resistances OK?

NO → Replace DCP

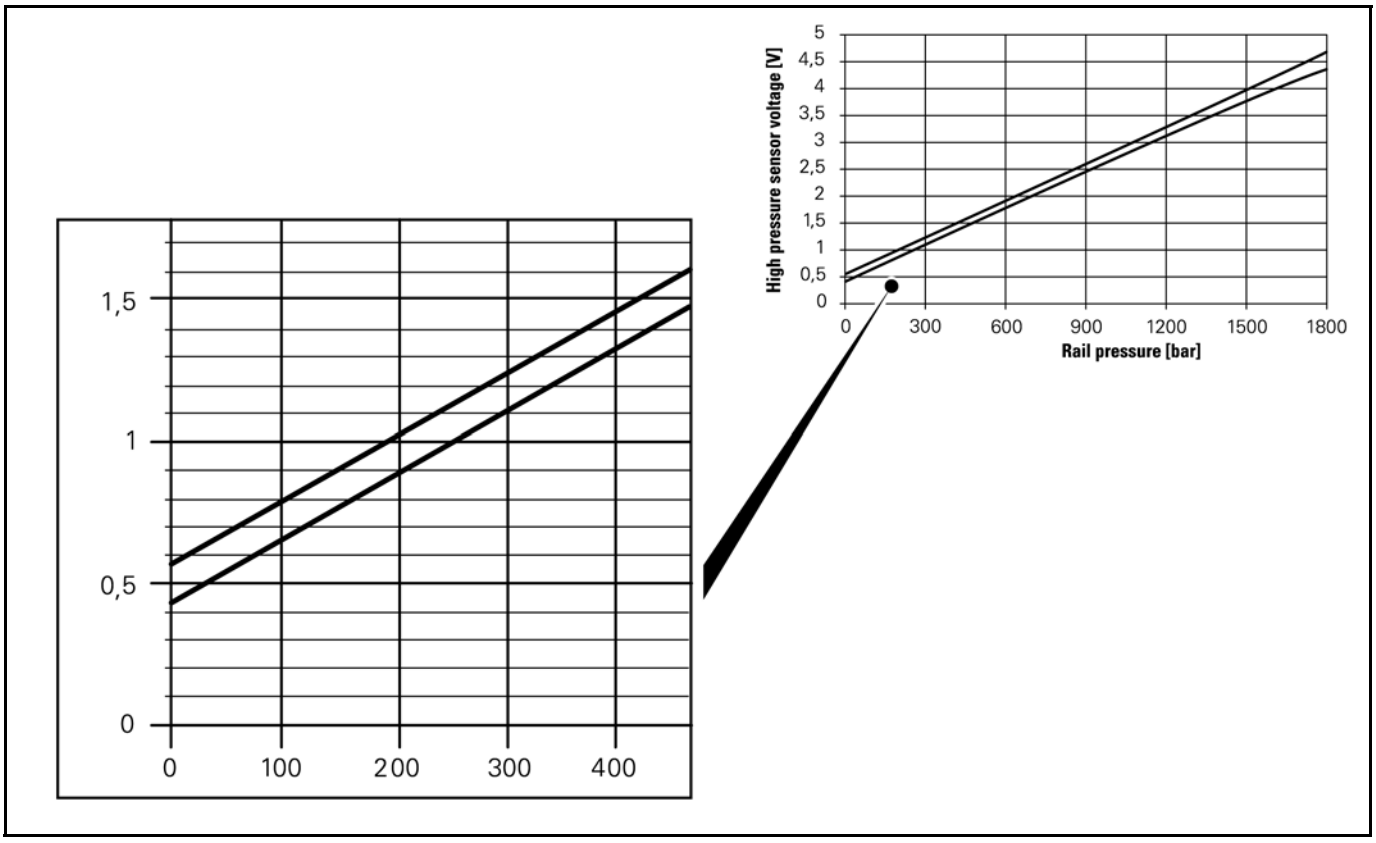
YES

Ignition ON
Connector connected to the high-pressure sensor.

1.) Measure the power supply at the high-pressure sensor between PIN 3 and 2.
Nominal power supply: 5V
2.) Measure the sensor voltage at the high-pressure sensor between PIN 1 and 2.
Nominal sensor voltage: 0,5V
(See high-pressure sensor voltage-rail pressure diagram)

Attentation:
Do not carry out any resistance or capacitance measuring at the high-pressure sensor!

Risk of destruction!



Power supply and sensor voltage OK?

YES

Start the engine and run it while idling.

Measure the parameters indicated in table A at different speed rates.

NO

1.) In case of incorrect supply voltage, check the wire connection and replace the engine control unit, if necessary.
2.) In case of incorrect sensor voltage, check the contacts of the high-pressure sensor and replace them, if necessary. If the contacts are OK, then replace the high-pressure sensor.

Do the measurements correspond to the nominal values indicated in table A?

YES → Rail pressure control loop OK.

NO

Are there any loud or un-typical combustioen noises?

YES

Replace the high-pressure sensor and carry out the measurement again.

Do the measurements now correspond to the nominal values indicated in table A?

NO → Replace DCP.

YES

Rail pressure control loop OK.

Technical Background:
Nominal value deviations in the rail pressure control loop can be caused by abrasive wear, contamination or defective sensors or actuators. These deviations can only be compensated within certain limits by the pressure regulator. As a consequence, the rail pressure may be too high, too low or oscillating.

Table A

Speed (no load) [rpm]	**Rail pressure** [MPa]	**Voltage at high-pressure sensor between PIN 1 and PIN 2** [V]	**PWM signal at PCV** [%]	**Current at PCV** [A]
1000	21 - 23	0.8 - 1.1	12 - 14	0.3 - 0.4
2000	21 - 28	0.8 - 1.2	12 - 14	0.3 - 0.5
3000	24 - 35	0.9 - 1.4	12 - 15	0.3 - 0.5
4000	29 - 39	1.1 - 1.5	14 - 16	0.3 - 0.5

4.4 Checking the injectors

4.4.1 High injector leakage / injectors staying open

Symptom

Too low or no rail pressure during the start phase.
Engine does not start.

Possible fault code entries	Possible sequential faults
P0001	

Prerequisite

- Read the fault codes and carry out the appropriate checks.
- High-pressure lines and high-pressure connections have been checked for leaks.
- PCV was checked.
  See also section "4.3.1 Checking the PCV" for information concerning this process.
- Pressure sensor has been checked. See also section
  "4.3.3 Checking the rail pressure control loop" for information concerning this process.
- The entire low-pressure system is found to be in a proper condition. See
  section "4.2 Checking the low-pressure system" for information concerning this process.
- The high-pressure pump (HPP) and VCV were checked. See section "4.3.2 Checking the high-pressure
  pump (HPP) and VCV" for information concerning this process.

Danger

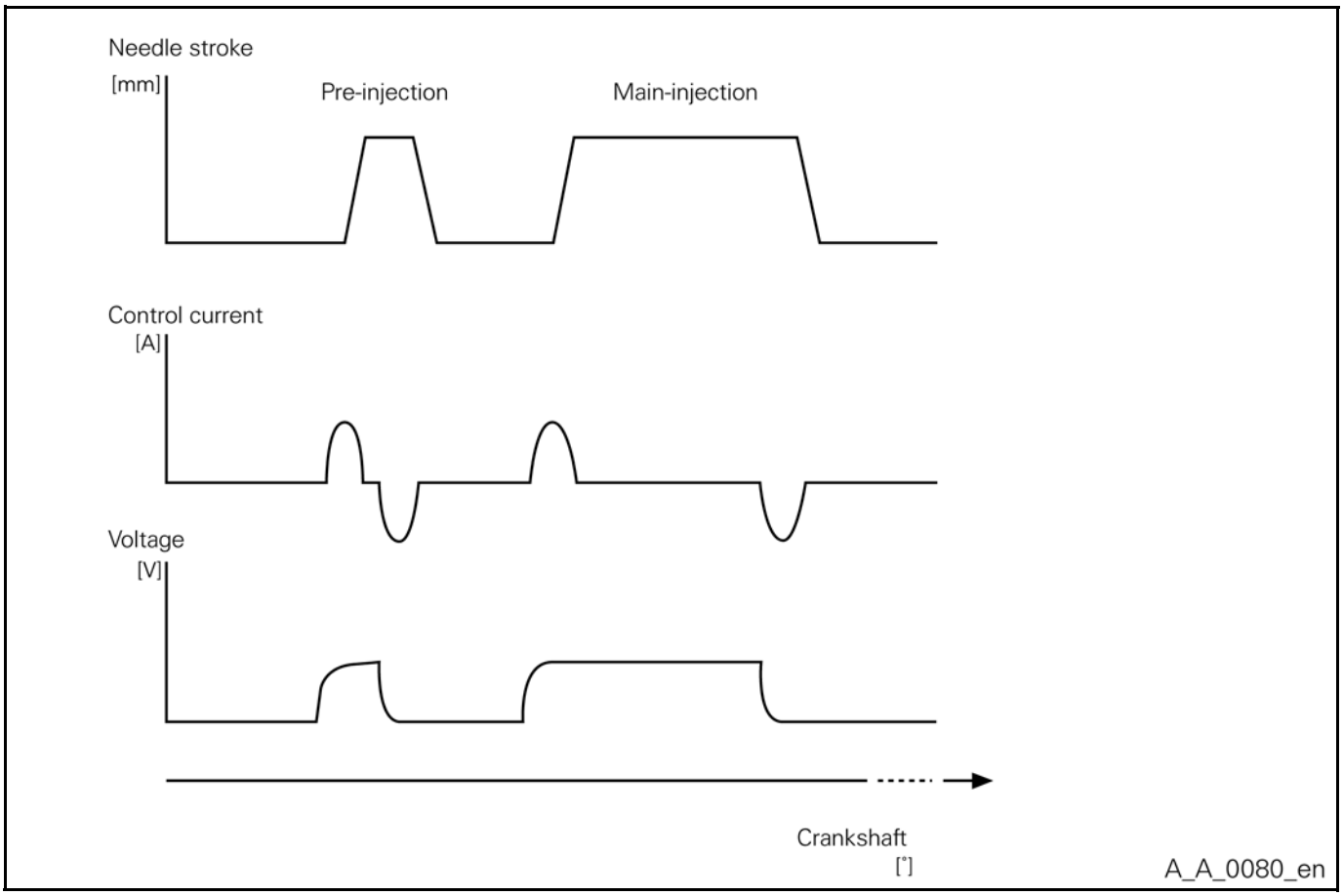
When performing work at the engine control unit (ECU) and the injectors, the accident prevention regulations for high-voltage equipment must be observed.

Note

Abrasive wear or dirt particles in the injector may cause the amount of return flow in the injectors to rise above
permissible levels or may cause the injector to be open to the cylinder.
This has the result that the amount of fuel delivered by the high-pressure pump (HPP) is no longer sufficient to build up an adequate pressure in the rail.

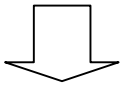
The injectors will not be triggered at a rail pressure which lies below 150 bar.

Characteristic curve of the injector activation

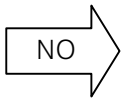


Check steps:

Check the capacitances and resistances of the injector connections.
Nominal capacitance: > 3,0 µF
Nominal resistance: 150 – 250kΩ
(Measure at room temperature (about 20°C), allow the engine to cool down for at least 30 min.!)

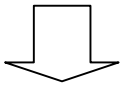


Capacitances and resistances OK?

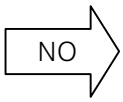


Replace the corresponding injector.

Disconnect the return flow connections of the injectors and seal the open lines. Start the engine and chech the return flow in the injector.



Is the return flow during the start phase and idling at maximum in the drop range?



Replace the corresponding injector.

Dismantle the glow plugs and check them for humidity. If the glow plugs are moistened with fuel, this could indicate that an injector is open towards the cylinder or is leaking.

Note:
The glow plugs are an optional component of the system.

Are the glow plugs moistened with fuel?

YES → Replace the corresponding injector.

NO ↓

- Remove all high-pressure lines between the injector and rail.
- Seal the high-pressure connections at the rail.
  Note: Seal the rail at the sealing cone in the high-pressure connection.
- Pull the connector off the injector and start the engine.
- Check the rail pressure that develops

Nominal rail pressure: min. 150 bar

Note:
Check each injector one after another.
In comparison to the other injectors you are able to detect a defective injector.

↓

Is the nominal rail pressure reached during the start phase?

YES → Install the high-pressure lines of cylinders 1-4 in succession until the rail pressure decreases.

↓

Replace the corresponding injector.

↓

Is the nominal rail pressure reached?

YES ↓

System OK.

NO ↓

Replace the high-pressure sensor.

4.4.2 Incorrect injection quantities

Symptom

Engine idle runs rough, possibly produces white smoke.

Prerequisite

- Read the fault codes and carry out the appropriate checks.
- Air-conditioning is switched off.
- Engine temperature minimum 80°C.
- All electrical consumers must be switched off.
- High-pressure lines and high-pressure connections have been checked for leaks.
- PCV was checked.
  See also section "4.3.1 Checking the PCV" for information concerning this process.
- The entire low-pressure system is found to be in a proper condition. See
  section "4.2 Checking the low-pressure system"
  for information concerning this process.
- The high-pressure pump (HPP) and VCV were checked. See section "4.3.2 Checking the high-pressure
  pump (HPP) and VCV" for information concerning this process.

Note

Abrasive wear or dirt particles in the injectors may lead to the injection quantities passed through the injectors deviating from one another, or may cause the sealing of the injectors to the cylinder to no longer be guaranteed.
Different injection quantities between the individual cylinders lead to power variations, which causes the crankshaft to be accelerated with differing forces.
The allocation of injection quantities to the individual cylinders can be compensated by the cylinder balancing factors. This results in an engine that runs smoothly.

Possible fault code entries	Possible sequential faults
P0263 P0266 P0269 P0272 P1201 P1202 P1203 P1204	

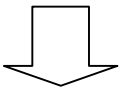
If more than one cylinder balancing DTC is shown, you must proceed as follows:

- Warm up the engine up to min. 60°C.
- Delete all DTCs in the fault memory.
- Start the engine and and wait until the follow-up time has expired.
- Run the engine at idle speed, do not move the vehicle.
- Wait until the first cylinder balancing DTC is shown.
- Then replace the injector shown (see also chapter C - "Mounting/Dismounting the injectors").

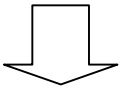
For the final test, you must erase the fault memory again and restart the engine (observe again the follow-up time of the control unit).

Check steps

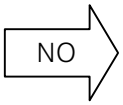
Turn off the engine.



Measure the capacitances and resistances of the injector connections and check the wire connections.
Nominal capacitance: > 3,0 µF
Nominal resistance: 150 – 250kΩ
(Measure at room temperature (about 20°C), allow the engine to cool down for at least 30 min.!)

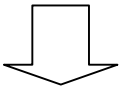


Capacitances, resistances and wire connections OK?

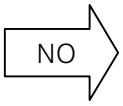


Carry out the necessary repair work.

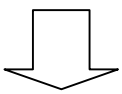
Start the engine and run it while idling. Then read out the cylinder balancing factors online.



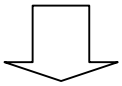
Cylinder balancing fault?
Nominal value: 1
Admissible deviation:
± 0,4



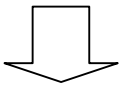
Disconnect the return flow connections of the injectors and seal the open lines. Check the return flow in the injector while idling.



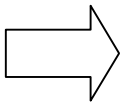
Identify the corresponding injector and replace it by an injector without deviation.



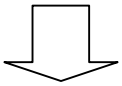
Does the cylinder balancing deviation follow the injector?



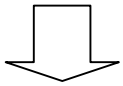
Check wire connection and engine compression, if necessary.
Replace the engine control unit, if necessary.



Is the return flow in the injectors at maximum in the drop range?



Replace the corresponding injector.



Injectors OK.

4.5 Checking the engine control unit (ECU)

Danger

In case work has to be carried out on the engine control unit, the rules and regulations for accident prevention when using high-voltage equipment must be observed.

Note

System errors may cause sequential faults which are to be handled secondarily during fault elimination. At the beginning of troubleshooting, all sensors and actuators as well as the wiring harness and the hydraulic system are to be checked and faults corrected.

Prior to the replacement of the engine control unit (ECU), all other possible fault sources should be excluded.

The engine control unit may become very hot in operation. A high temperature at the housing does not indicate that the engine control unit is damaged.

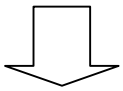
In the event of the following fault code entries, the engine control unit has to be replaced:

Fault code	Cause
P0200	Injector power stage fault in the engine control unit. Note: The fault may also be entered in the case of a faulty wire connection. - If so, check the wire connections (see below)! - Otherwise, if the wire connections are checked and OK, replace the ECU.
PE051	Internal software error.
P0606	Monitoring fault Injector power stage fault in the engine control unit.
P0642	5V voltage supply 1 too low. Note: The fault may also be entered in the case of a faulty wire connection.
P0643	5V voltage supply 1 too high. Note: The fault may also be entered in the case of a faulty wire connection.
P0652	5V voltage supply 2 too low. Note: The fault may also be entered in the case of a faulty wire connection.
P0653	5V voltage supply 2 too high. Note: The fault may also be entered in the case of a faulty wire connection.

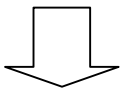
Fault code	Cause
P0A10	Voltage of the power stage too high.
P0A09	Voltage of the power stage too low.
P1639	Faulty or incorrect variant coding.
P0107	Defective atmospheric pressure sensor: Short circuit to -
P0108	Defective atmospheric pressure sensor: Short circuit to -
P0109	Defective atmospheric pressure sensor: Gradient fault

Check steps to the event of the code P0200:

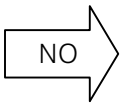
Turn off the engine.



Check the capacitances and resistances
of the injector connections.
Nominal capacitance: > 3,0 µF
Nominal resistance: 150 – 250kΩ
(Measure at room temperature (about 20°C),
allow the engine to cool down for at least 30 min.!)

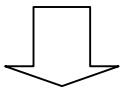


Capacitances and resistances OK?

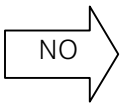


Replace the relevant injector.

Disconnect injectors 1 ... 4

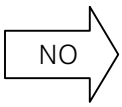


Measure the resistance between
PIN 1 of injector 1 ... 4 and ground
> 10MΩ



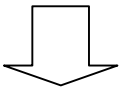
Injector damaged.

Measure the resistance between
PIN 2 of injector 1 ... 4 and ground
> 10MΩ

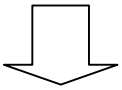


Injector damaged.

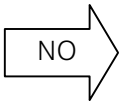
Check wiring harness



Disconnect the c-connector on the ECU side and the eletrical connectors of the injectors

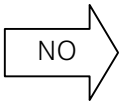


Measure the resistance between PIN 1 of injector 1 ... 4 and ground on the wiring harness of the injector side > 10MΩ



Check the wiring harness.

Measure the resistance between PIN 2 of injector 1 ... 4 and ground on the wiring harness of the injector side > 10MΩ



Check the wiring harness.

Reconnect the c-connector on the ECU side and the eletrical connectors of the injectors

Turn on ignition - Do not start engine!

Disconnect the injectors 1 ... 4

YES

Measure the voltage between PIN 1 of injector 1 ... 4 and ground on the wiring harness of the injector side / Voltage (DC) < 3V

NO → Check the wiring harness.

YES

Measure the resistance between PIN 2 of injector 1 ... 4 and ground on the wiring harness of the injector side / Voltage (DC) < 3V

NO → Check the wiring harness.

YES

Reconnect the c-connector on the ECU side and the eletrical connectors of the injectors

YES

Check again if error occours

NO → Check connectors.

YES

Internal ECU failure. Replace ECU!

5 Diagnostic tools

Contact:

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