Service Training

Self-study Programme 403

2.0l TDI Engine with Common Rail Fuel Injection System

Design and Function

S403_051

The 2.0l TDI engine with common rail injection system is the first in a new generation of dynamic and efficient diesel engines from Volkswagen.

By combining the successful and proven 2.0l TDI engine with common rail technology, Volkswagen is setting new standards with regards to the characteristic TDI features of dynamics, driving fun, economy and reliability. These outstanding TDI qualities in the 2.0l TDI engine with common rail injection system are aimed at future challenges in terms of acoustics, comfort and exhaust gas treatment.

The leading role of Volkswagen, which began in 1993 with the introduction of the first turbocharged direct-injection diesel engine to be used in a car, successfully continues with the 2.0l TDI engine. This confirms Volkswagen's position as a pioneer in diesel technology.

The engine already fulfils the requirements of the Euro 5 emissions standard that will come into force at the end of 2009 and offers potential for future emissions standards and the associated technologies.

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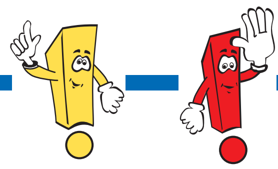

Warning
Note

The self-study programme shows the design and function of new developments.
The contents will not be updated.

For current testing, adjustment and repair instructions, refer to the relevant service literature.

Contents

In Brief

Introduction

The 2.0l TDI engine with common rail injection system is based on the 2.0l TDI engine with unit injector system. The predecessor engine is one the most frequently built diesel engines. It is also the engine with the widest range of applications at Volkswagen Group from cars to the Transporter.

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A multitude of engine components have been re-engineered to meet the increased acoustics, consumption and emissions requirements. Switching the injection system to common rail fuel injection technology is a particularly important factor in this regard.

Equipped with a diesel particulate filter, the engine meets the current EU 5 emissions standard that is planned for the end of 2009. Since the legal requirements for registration conditions for the EU 5 exhaust standard have not yet been agreed, the engine is approved with the EU 4 emissions standard.

In some markets, the engine is also available without diesel particulate filter. These engines meet the EU 3 emissions standard.

Technical features

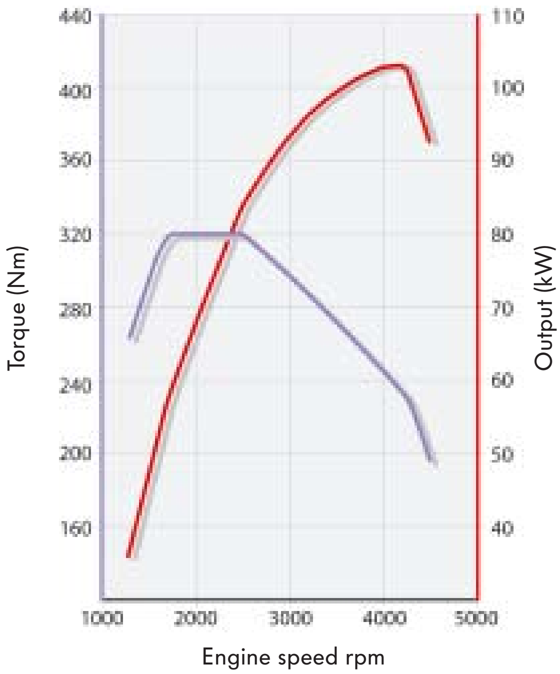
- Common rail injection system with piezo injectors
- Diesel particulate filter with upstream oxidation catalytic converter
- Intake manifold with swirl flap adjustment
- Electric exhaust gas recirculation valve
- Adjustable turbocharger with travel feedback
- Low-temperature exhaust gas recirculation cooling

S403_003

Technical data

Engine code	CBAB
Type	4-cylinder in-line engine
Valves per cylinder	4
Displacement	1968 cm^3
Stroke	95.5 mm
Bore	81 mm
Maximum output	103 kW at 4200 rpm
Maximum torque	320 Nm at 1750 to 2500 rpm
Compression ratio	16.5:1
Engine management	Bosch EDC 17 (common rail fuel injection system)
Fuel	Diesel, in accordance with DIN EN 590
Exhaust gas cleaning	Exhaust gas recirculation, diesel particulate filter
Emissions standard	EU 4

Power and torque development graph



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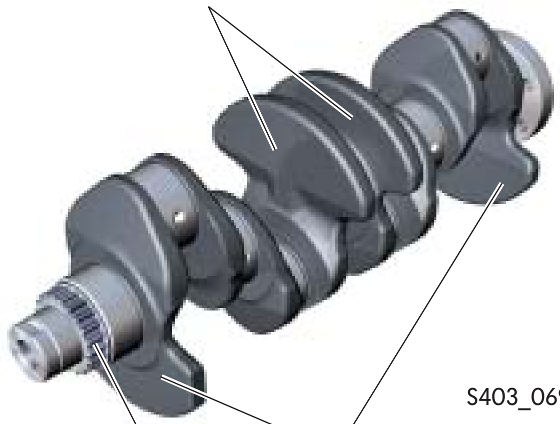
Engine Mechanics

Crankshaft

A forged crankshaft is used on the 2.0l TDI CR engine due to the high mechanical loads.
This crankshaft has just four counterweights instead of the normal eight counterweights. This reduces the loading on the crankshaft bearings. Noise emissions, which may be caused by the inherent movement and vibrations of the engine, have also been reduced.



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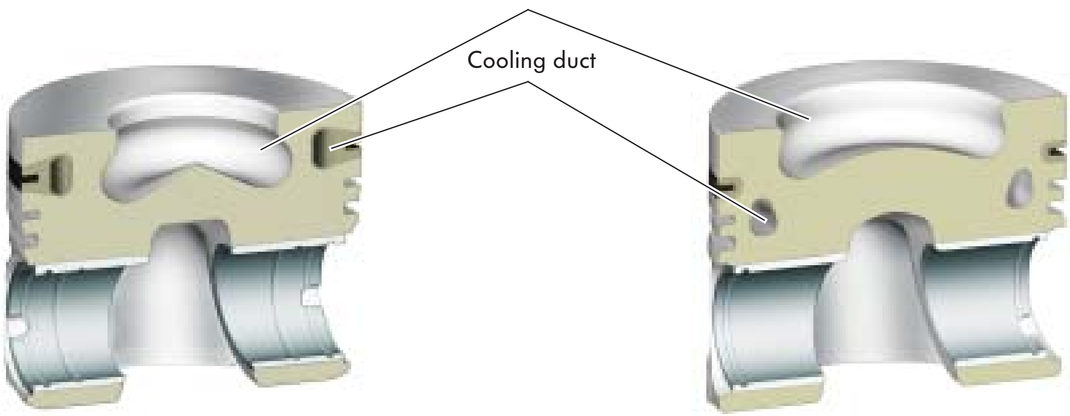
Pistons

Like the 2.0l/125 kW TDI engine with unit injector system, the pistons have no valve pockets. This feature has reduced the piston crown volume and improves the swirl generation in the cylinder. Swirl refers to the circular flow movement around the vertical cylinder axis. The swirl has an essential influence on the mixture formation.

Piston from 2.0l unit injector engine **Piston from 2.0l common rail engine**



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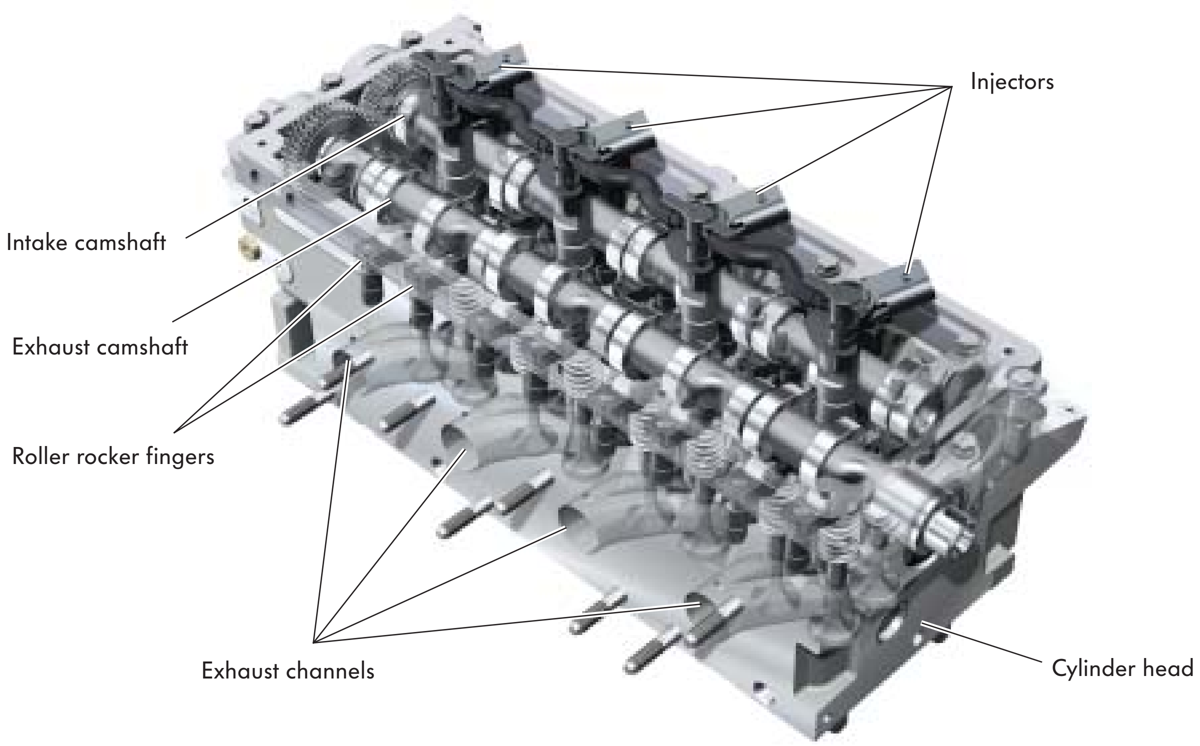
To cool the piston ring area, the pistons are equipped with an annular cooling duct, into which oil is sprayed via piston spray nozzles.
The piston recess, where the injected fuel is swirled and mixed with the air, has been tuned to the jet position of the injectors and has a wider and flatter geometry in comparison with the piston on the unit injector engine.
This allows a more homogenous mixture formation and reduces the formation of soot.

Cylinder head

The cylinder head of the 2.0l TDI engine with common rail injection system is a cross-flow aluminium cylinder head with two inlet and two exhaust valves per cylinder. The valves are arranged overhead vertically.
The two overhead camshafts are connected via spur gear teeth with integrated backlash compensation. They are driven by the crankshaft via a toothed belt and the camshaft wheel of the exhaust camshaft. The valves are actuated by low-friction roller rocker fingers with hydraulic valve clearance compensation elements.



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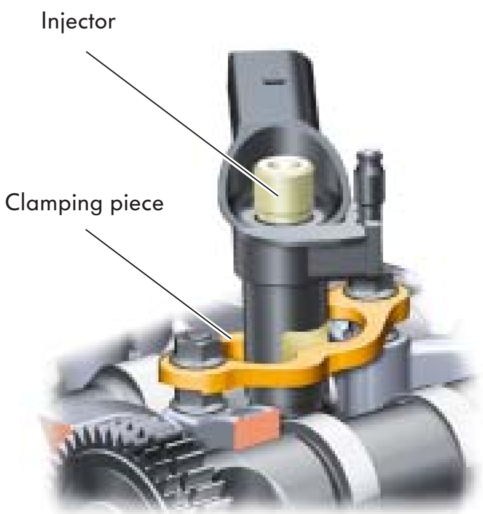
The injectors are secured in the cylinder head with clamping pieces. They can be removed via small covers in the cylinder head cover.



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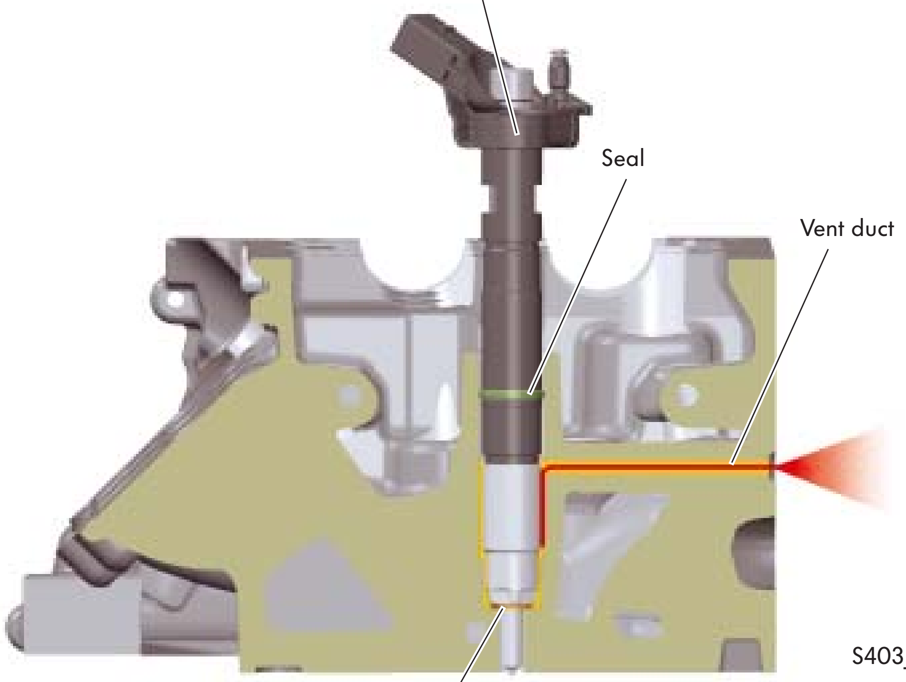
Vent ducts in cylinder head

If there are any leaks in the area of the copper injector seal, the air from the combustion chamber can escape via a port.
The breather port is in the cylinder head above the exhaust manifold.

It prevents overpressure from the combustion chamber escaping via the crankcase ventilation system to the compressor side of the turbocharger and causing any problems.



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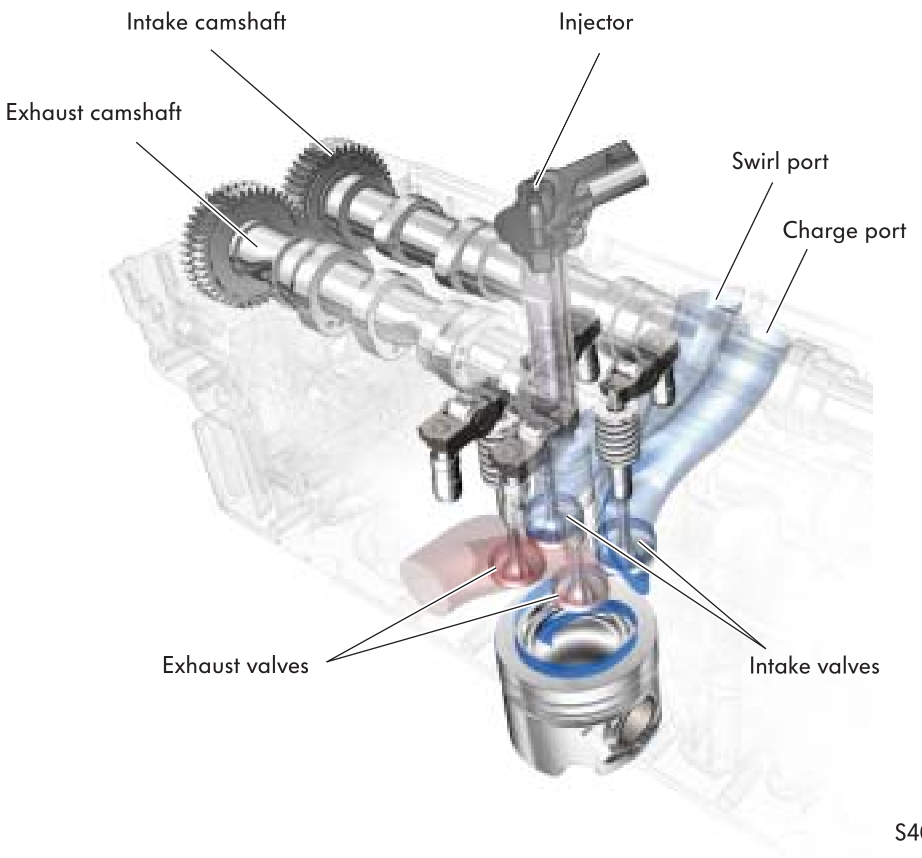
4-valve technology

Two intake and two exhaust valves per cylinder are arranged overhead vertically in the cylinder head.

The vertically positioned, centrally located injection valve is positioned directly over the central piston recess.



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The shape, size and layout of the intake and exhaust ports ensure good volumetric efficiency and a favourable gas cycle in the combustion chamber.

The intake ports are designed as swirl and charge ports. Thanks to the swirl port, the inflowing air generates the desired, high degree of in-cylinder flow.

Particularly at high speeds, the charge port leads to good combustion chamber filling.

Intake manifold with swirl flaps

There are infinitely variable swirl flaps in the intake manifold.

The swirl of the intake air is adjusted via the position of the swirl flaps depending on the engine speed and load.

The swirl flaps are moved by the intake manifold flap motor via a push rod. To do this, the positioning motor is actuated by the engine control unit. The intake manifold flap potentiometer G336 is integrated in the intake manifold flap motor V157. It is used by the engine control unit for feedback on the current position of the swirl flaps.

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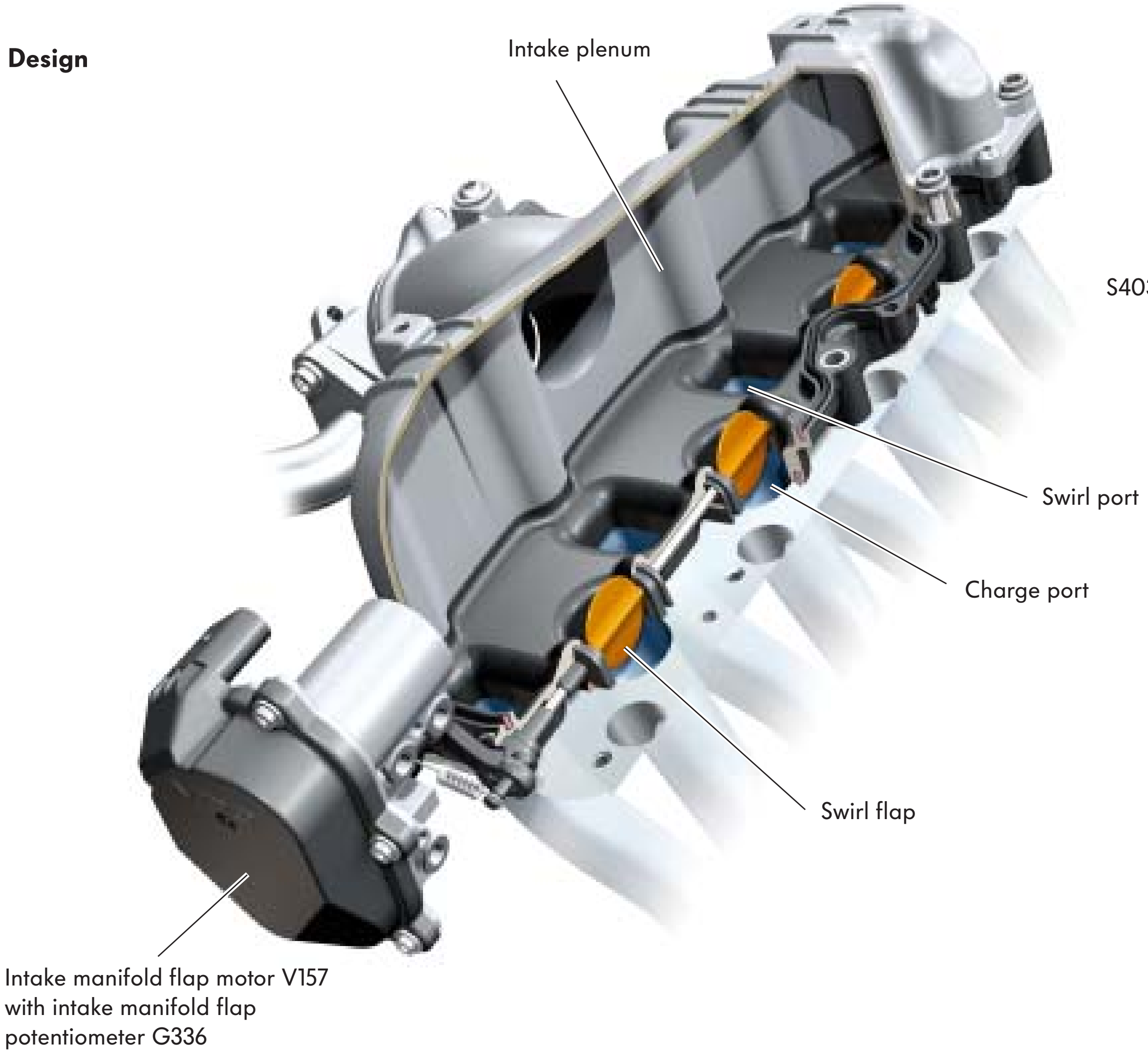
Design



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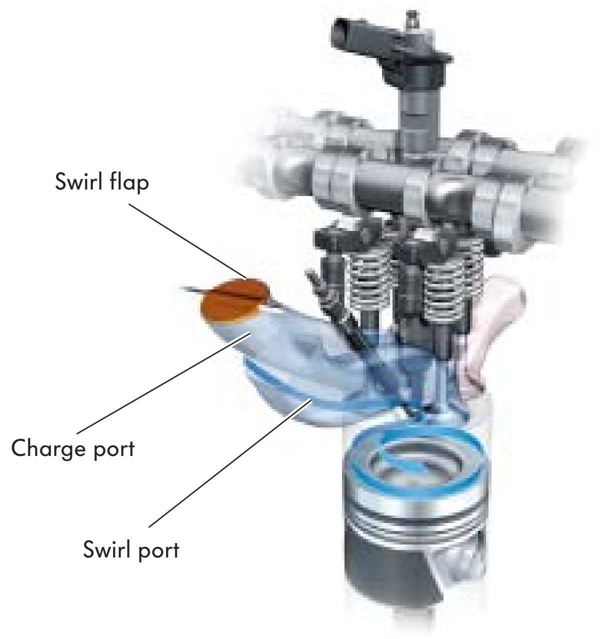
Function of the swirl flaps

The swirl flaps are closed when the engine is idling and at low engine speeds. This causes a high level of swirling, which leads to good mixture formation.



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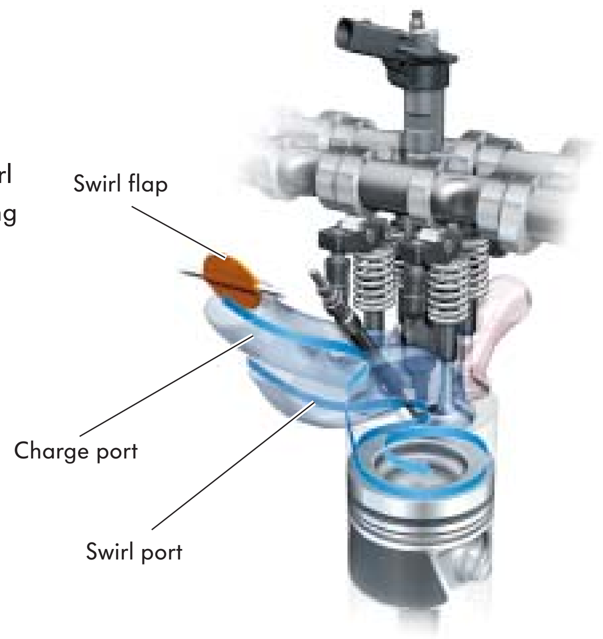
In driving mode, the swirl flaps are constantly adjusted in relation to the load and engine speed. This creates the optimum air movement in the combustion chamber for all operating ranges.

At engine speeds above approx. 3000 rpm, the swirl flaps are fully open. Good combustion chamber filling is achieved thanks to the increased air throughput.



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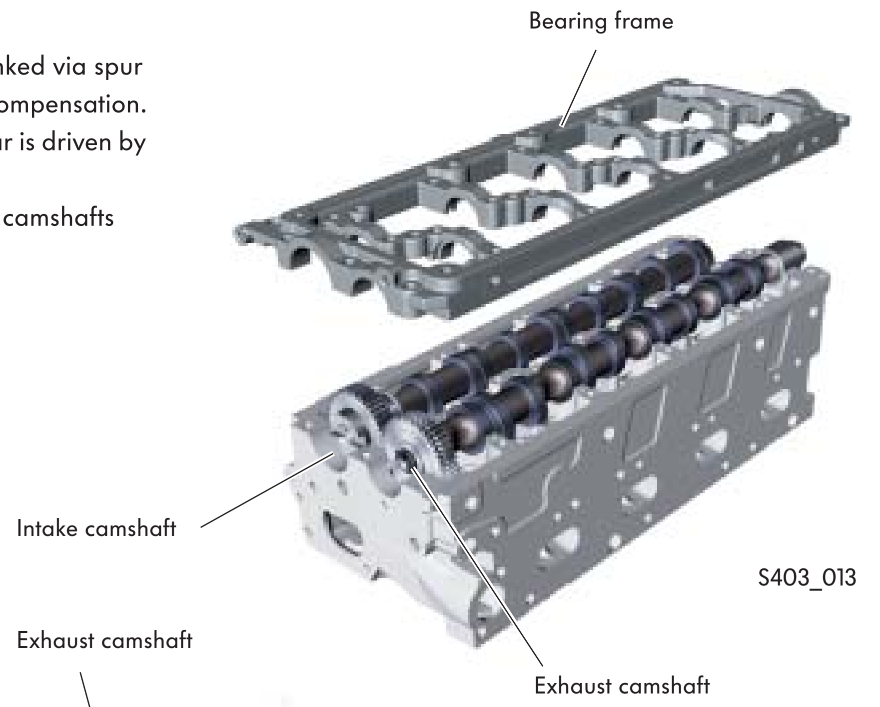
The swirl flaps are open when the engine is started, in limp-home mode and at full throttle.

Engine Mechanics

Camshaft drive

The intake and exhaust camshafts are linked via spur gear toothing with integrated backlash compensation. In this case, the intake camshaft spur gear is driven by the exhaust camshaft spur gear.
Backlash compensation ensures that the camshafts are driven with little noise.



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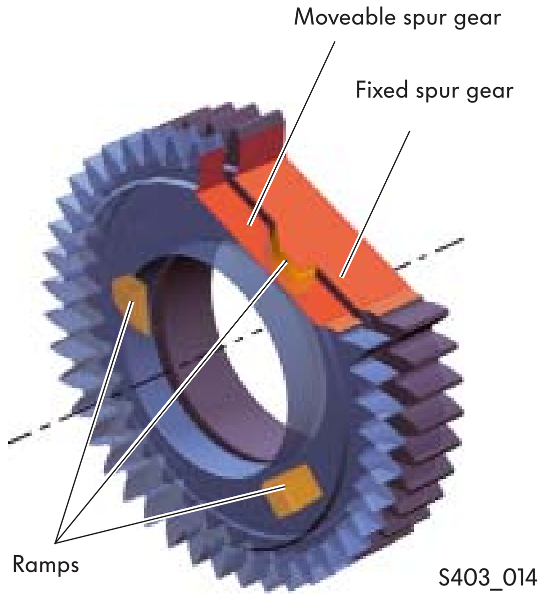
S403_012

Design

The broader part of the spur gear (fixed spur gear) is positively connected to the exhaust camshaft. Ramps are located on the front face. The narrower part of the spur gear (moveable spur gear) can be moved radially and axially. Recesses for the ramps are located on its rear side.



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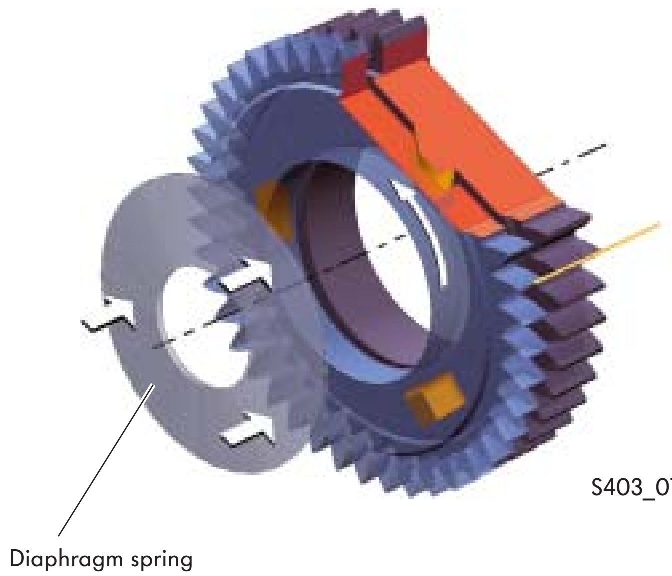
How it works:

Both spur gear parts are pushed axially together via the force exerted by a diaphragm spring. When this occurs, they are simultaneously caused to rotate via the ramps.



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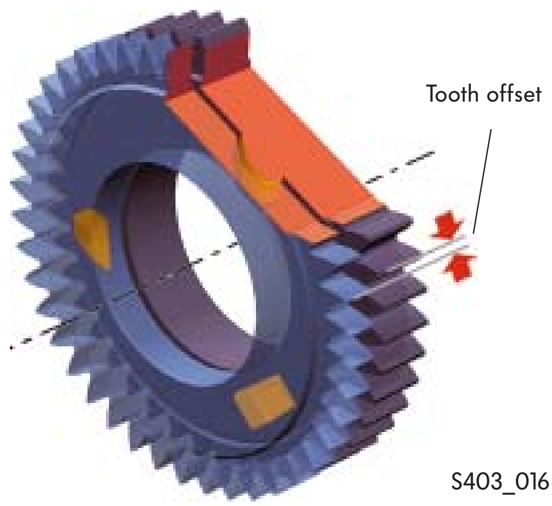
This rotational movement offsets the teeth of both spur gear parts and therefore leads to backlash compensation between the intake and exhaust camshaft gear wheels.

Backlash compensation



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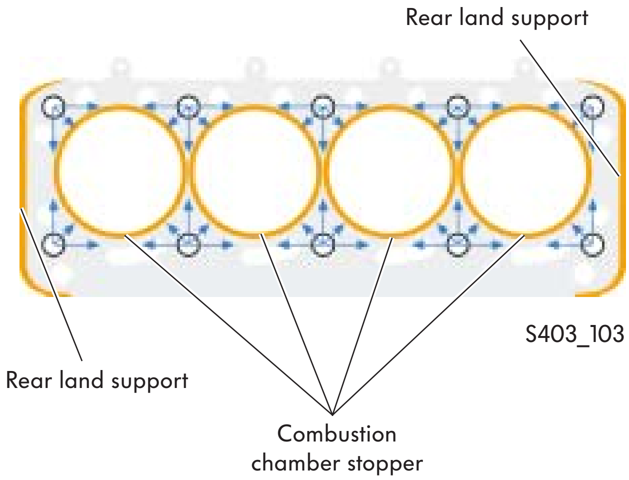
Cylinder head gasket

The cylinder head gasket consists of 4 layers and has two special features that improve the sealing of the combustion chambers.

- Vertically profiled combustion chamber stoppers
- “Rear land support”



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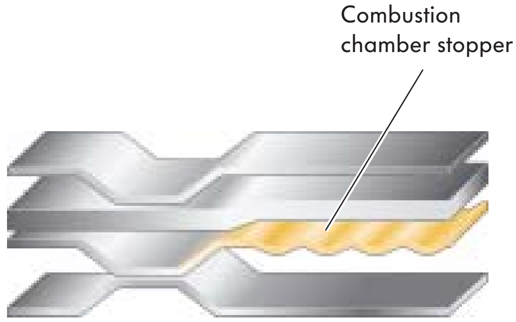
Vertically profiled combustion chamber stoppers

Combustion chamber stopper refers to the sealing edge of the cylinder bore. It is vertically profiled. This means that the profile of the edge along the combustion chamber has different heights. This special shaping achieves an even distribution of the tightening forces on the combustion chambers. This reduces cylinder bore warpage and sealing gap variations.



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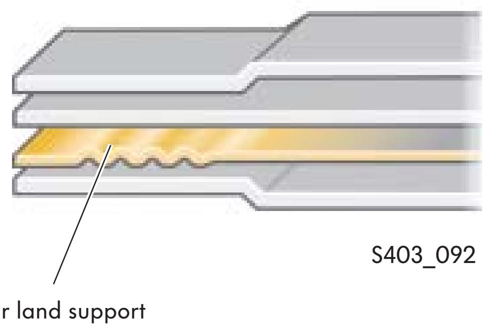
“Rear land support”

Rear land support is the profile around the two outer cylinders on the cylinder head gasket. The rear land support allows even distribution of the tightening forces in these areas. Deflection of the cylinder head and distortion of the outer cylinders are reduced as a result.



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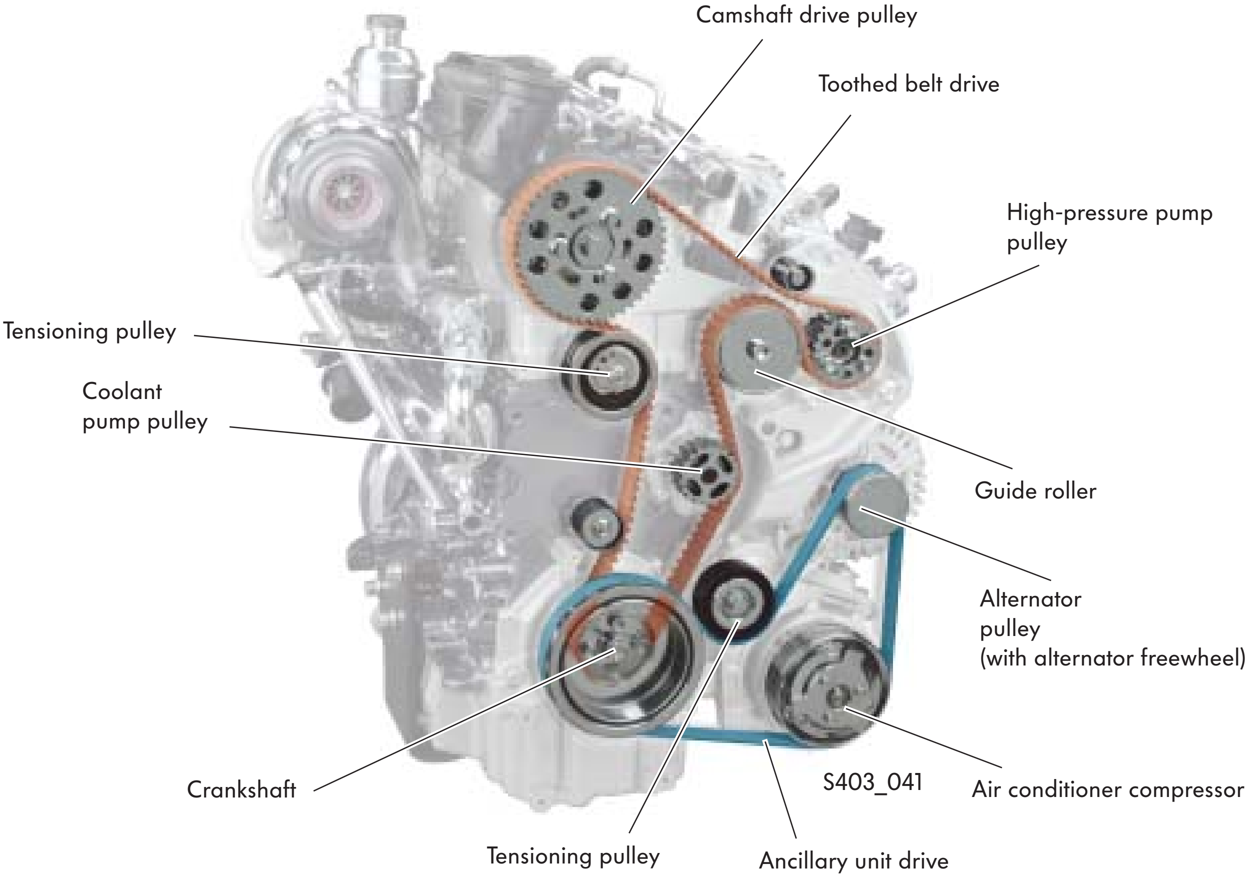
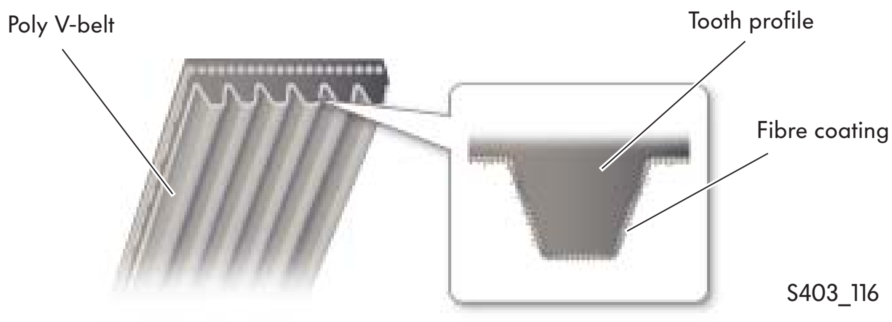
Toothed belt drive

The camshaft, coolant pump and the high-pressure pump for the common rail injection system are driven via the toothed belt.



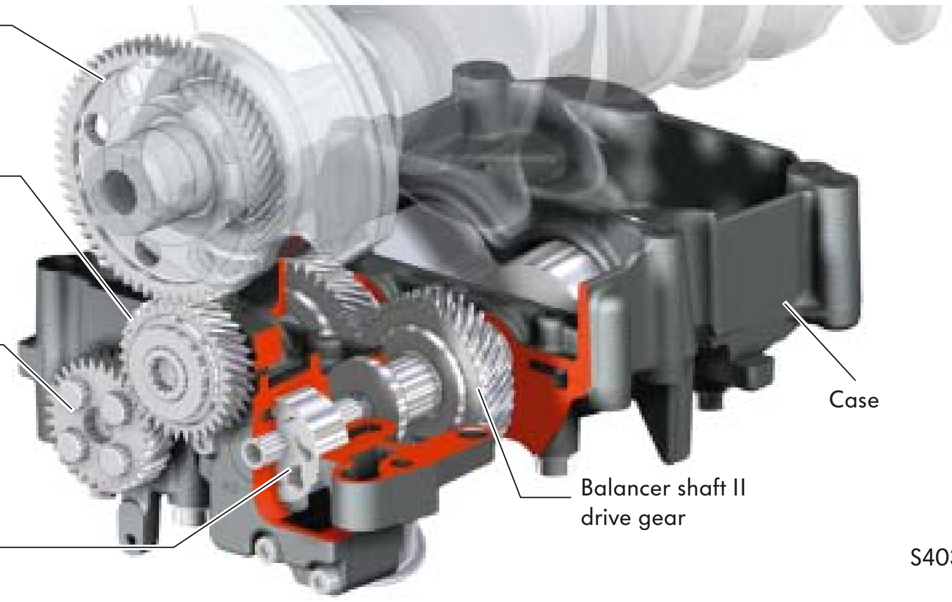
Ancillary component drive

The alternator and air-conditioning compressor ancillary components are driven by the crankshaft via a poly V-belt. The profile surface of the poly V-belt has a coating containing fibres. This improves the frictional properties of the belt. This reduces noises that can occur in the wet and cold.



Balancer shaft module

The 2.0l 103 kW TDI engine in the Tiguan is equipped with a balancer shaft module, which is housed in the oil sump beneath the crankshaft. The balancer shaft module is driven by the crankshaft via a gear drive. The duo-centric oil pump is integrated into the balancer shaft module.



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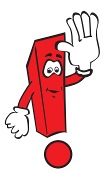
Design

The balancer shaft module consists of a housing made from grey cast iron, two contra-rotating balancer shafts, the gear drive with helical teeth and the integrated duo-centric oil pump. The rotation of the crankshaft is transmitted to the intermediate gear on the outer side of the housing. This drives balancer shaft I. From this balancer shaft, the movement is then transmitted, via a pair of gears within the housing, to balancer shaft II and the duo-centric oil pump.

The gear drive is designed in such a way that the balancer shafts rotate at twice the speed of the crankshaft.

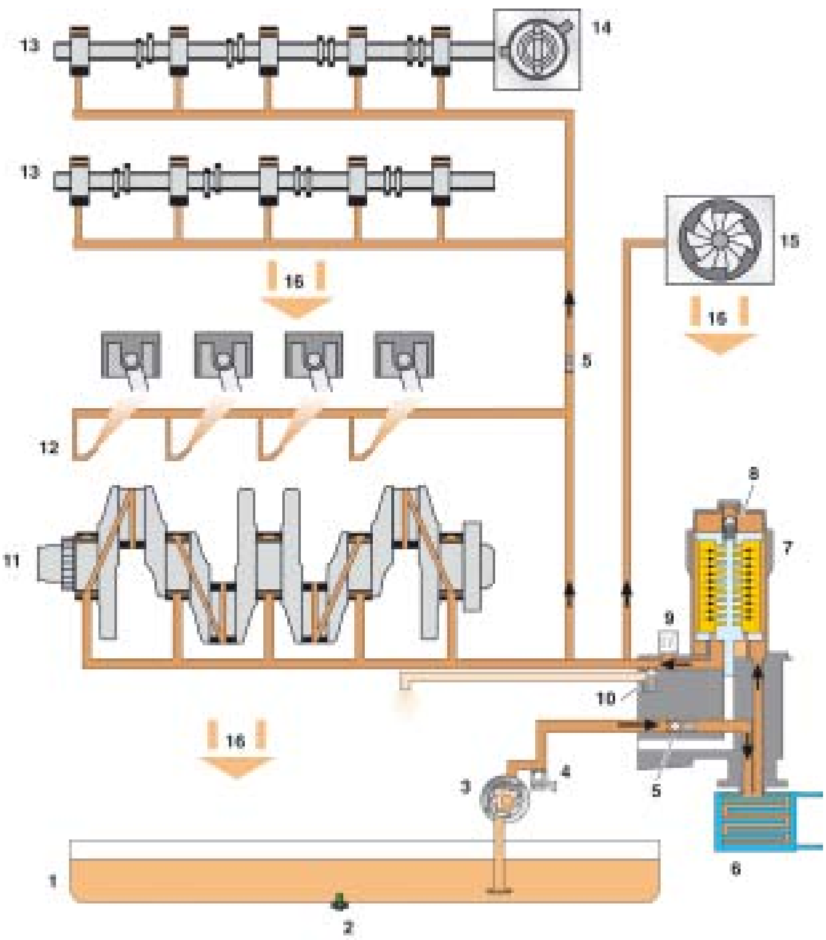
The backlash of the gear drive is adjusted with the aid of the coating on the intermediate gear. This coating wears off during engine start-up and results in a defined backlash.



The intermediate gear must always be exchanged if the intermediate gear or the drive gear of balancer shaft I have been removed.
Please note the instructions in workshop manual.

Oil system

A duo-centric oil pump generates the necessary oil pressure for the engine. It is integrated into the balancer shaft module and is driven via balancer shaft II.
The excess pressure valve is a safety valve. It prevents engine components being damaged by excessive oil pressure, for example, at low outside temperatures and high engine speeds.
The oil pressure regulating valve regulates the engine oil pressure. It opens as soon as the oil pressure reaches the maximum possible value.
The short-circuit valve opens if the oil filter is blocked and thus ensures lubrication of the engine.



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Legend

1 - Oil sump
2 - Oil level and oil temperature sender G266
3 - Oil pump
4 - Excess oil pressure valve
5 - Oil non-return valve
6 - Oil cooler
7 - Oil filter
8 - Short-circuit valve
9 - Oil pressure switch F1
10 - Oil pressure regulating valve
11 - Crankshaft
12 - Jets for piston cooling
13 - Camshaft
14 - Vacuum pump
15 - Turbocharger
16 - Oil return

Crankcase breather system

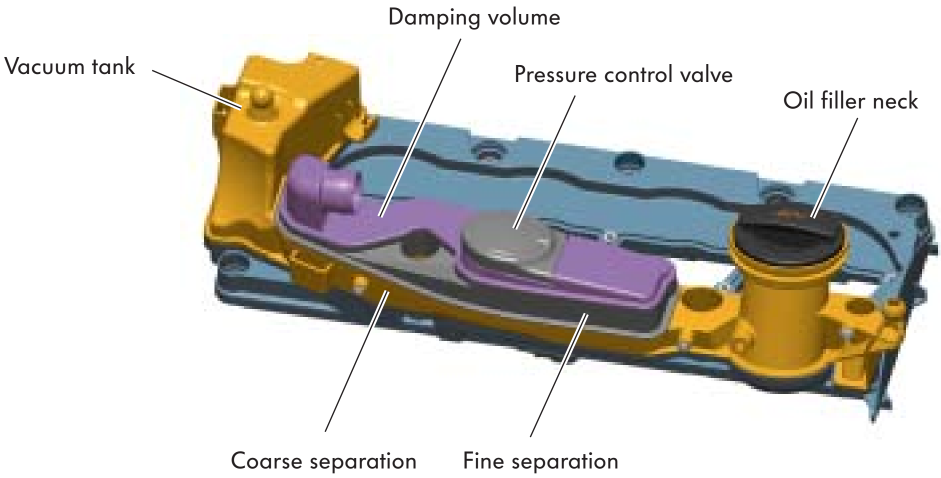
In combustion engines, pressure differences between the combustion chamber and the crankcase leads to air flows between the piston rings and cylinder contact surface; these are called blow-by gases.
These gases, which contain oil, are fed back to the intake system via the crankcase breather system to prevent environmental pollution.

The increased requirements for environmental protection set high requirements for efficient oil separation. Due to a step-shaped separation, only a small amount of oil enters the intake air and there are thus also fewer soot emissions.

The oil separation is in three stages:

- Coarse separation
- Fine separation
- Damping volume

The crankcase breather system components are integrated in the cylinder head cover except for the oil filler neck and the accumulator for the engine vacuum system.



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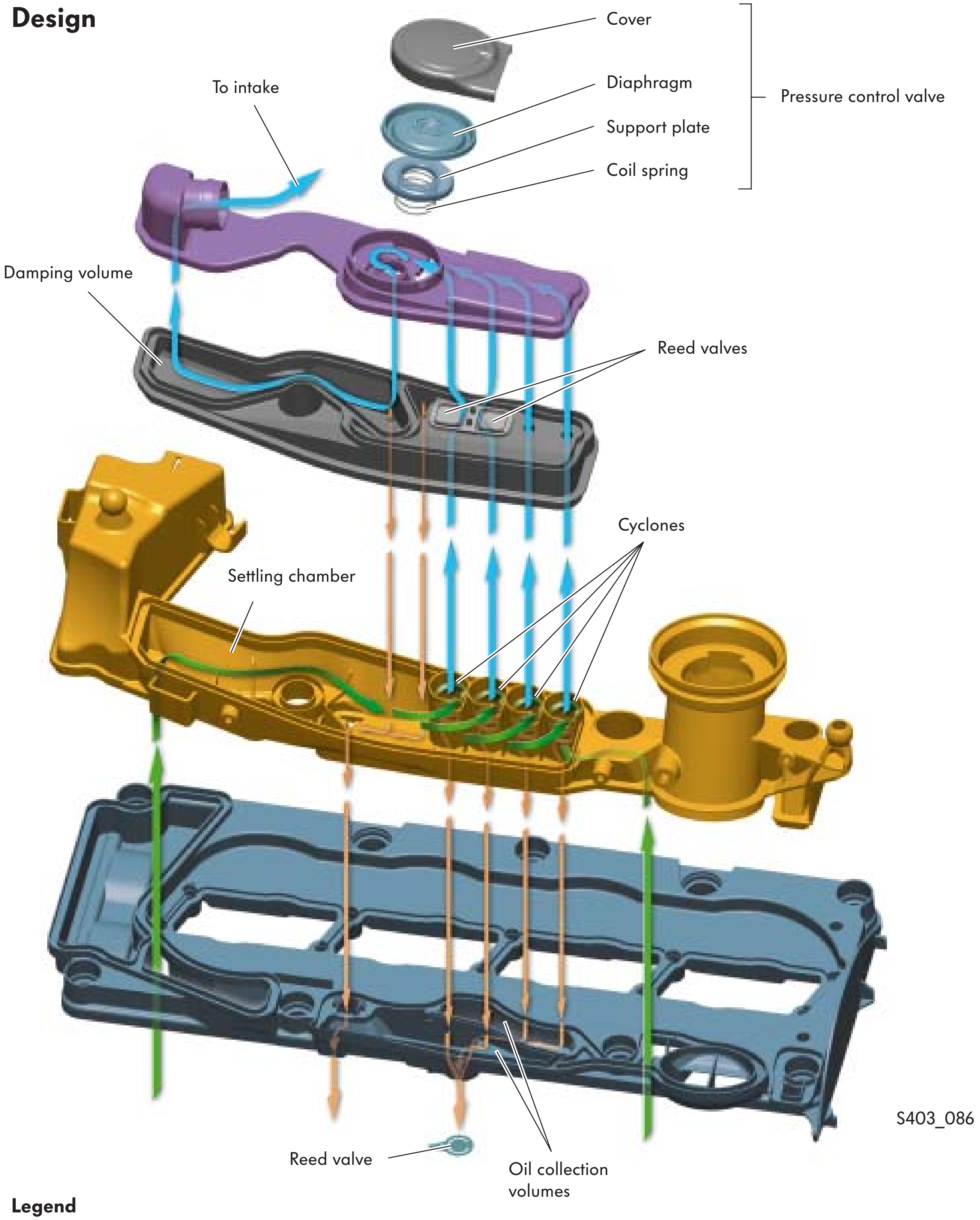
Coarse separation

The blow-by gases reach a settling chamber from the crankshaft and camshaft chamber. This is integrated in the cylinder head cover. The larger oil droplets separate on the walls in the settling chamber and collect on its floor. The holes in the settling chamber enable the oil to drip into the cylinder head.

Design

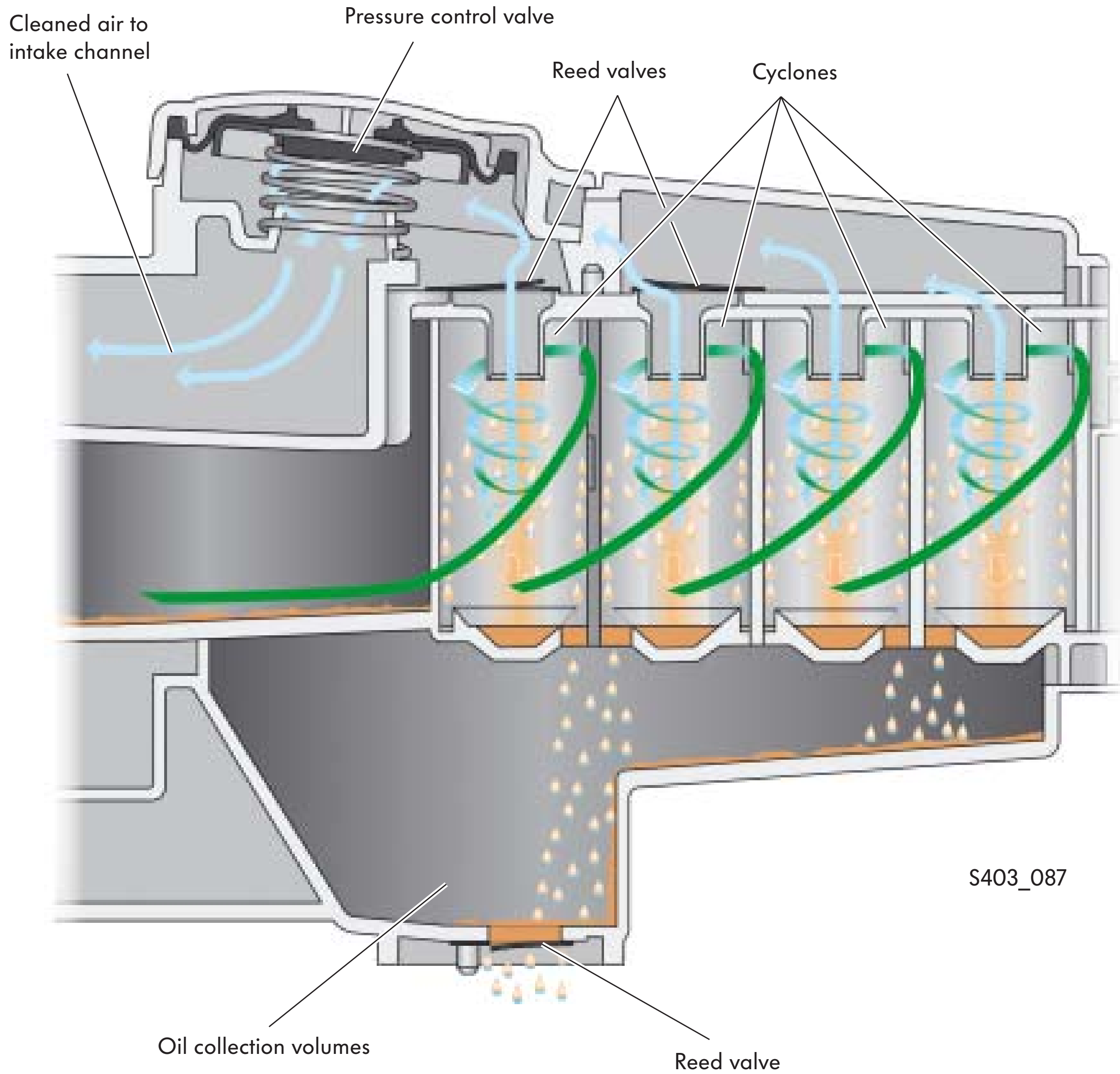


Legend

Air containing oil from crankcase
Air cleaned of air
Oil return

Fine separation

The fine separation is carried out by a cyclonic separator that consists of a total of four cyclones. Depending on the extent of the pressure difference between the intake manifold and the crankcase, two or four cyclones are activated by reed valves made from spring steel.
The air is set in a spinning motion by the shape of the cyclones. Due to the centrifugal force which occurs, the oil spray is spun onto the wall of the separator. The oil droplets separate on the wall of the cyclone and are collected in a collecting chamber.
The collecting chamber holds the maximum oil quantity that can occur after emptying the vehicle's fuel tank from full.



When the engine has stopped, a reed valve opens that is closed by the higher pressure in the cylinder head while the engine runs. The oil passes from the collecting chamber to the oil sump via the cylinder head.

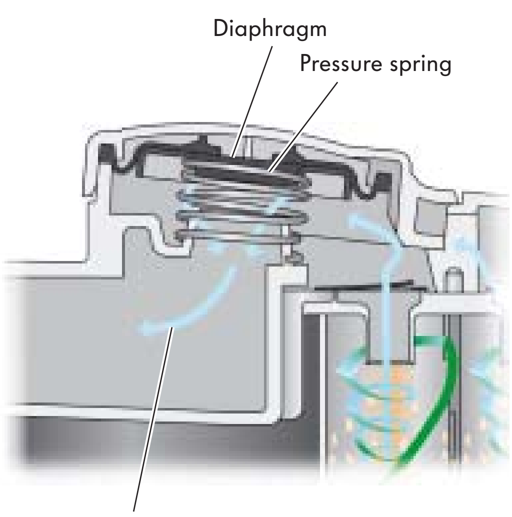
Pressure control valve

The pressure control valve regulates the pressure for venting the crankcase. It consists of a diaphragm and a pressure spring.
When the blow-by gases are fed in, the pressure regulating valve limits the vacuum in the crankcase. An excessively high vacuum in the crankcase may damage the engine gaskets.

If the vacuum in the intake port is low, the valve opens due to the force of the pressure spring.

If the vacuum in the intake port is high, the pressure control valve closes.

Pressure control valve open



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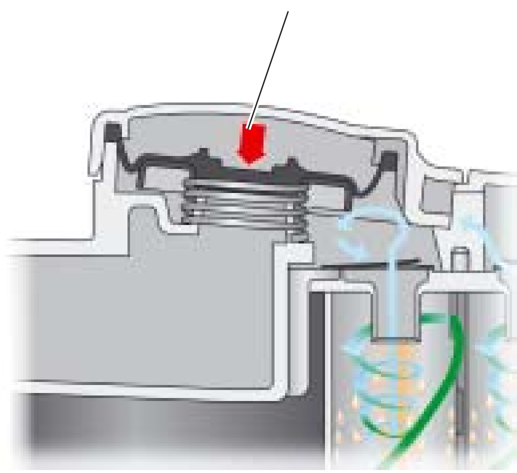
Pressure control valve closed



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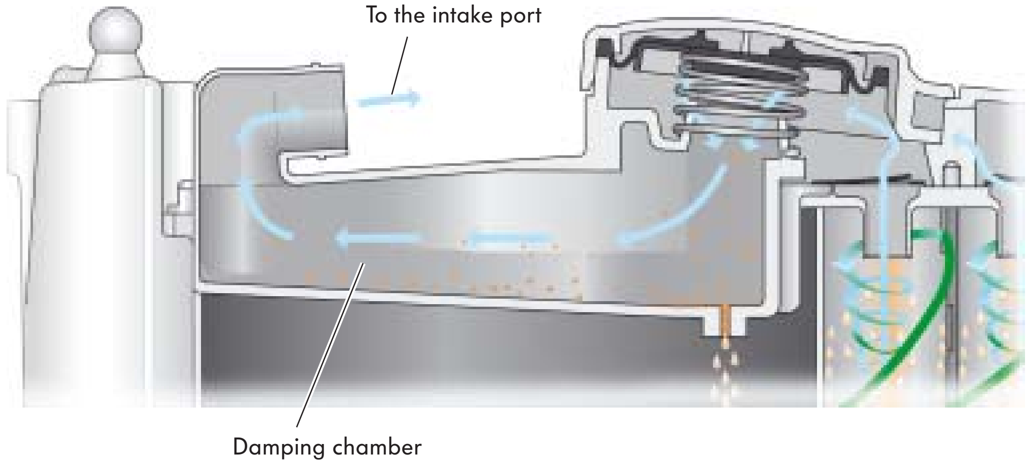
Damping volume

To avoid disturbing swirl flow of the induction gases into the intake manifold, a damping chamber is connected to the cyclonic oil separator. The movement energy of the gases from the cyclones is reduced in this chamber. Furthermore a remaining quantity of oil is separated in the damping chamber again.



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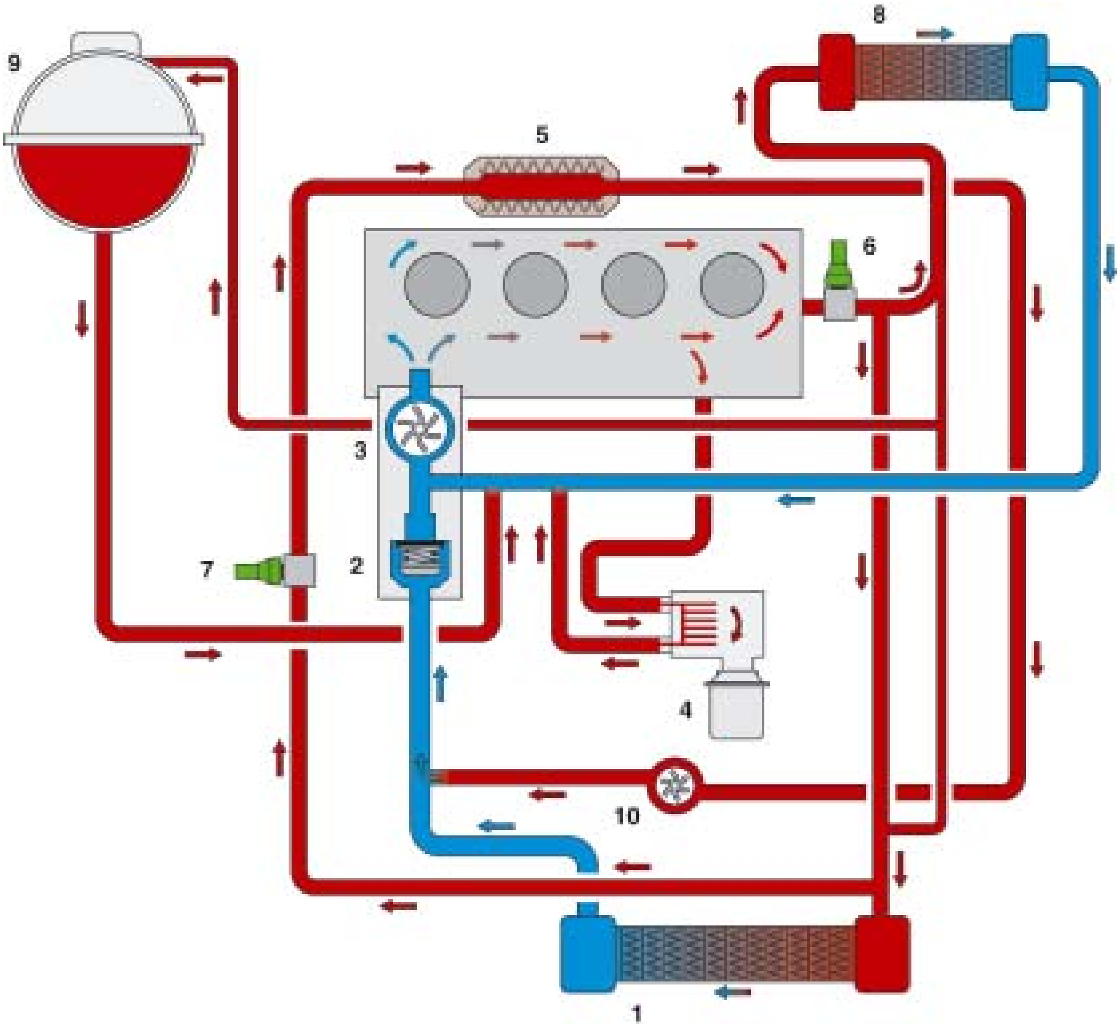
Cooling system

The coolant is circulated by a mechanical coolant pump in the cooling system. It is driven via the toothed belt. The circuit is controlled by the expansion-type thermostat.



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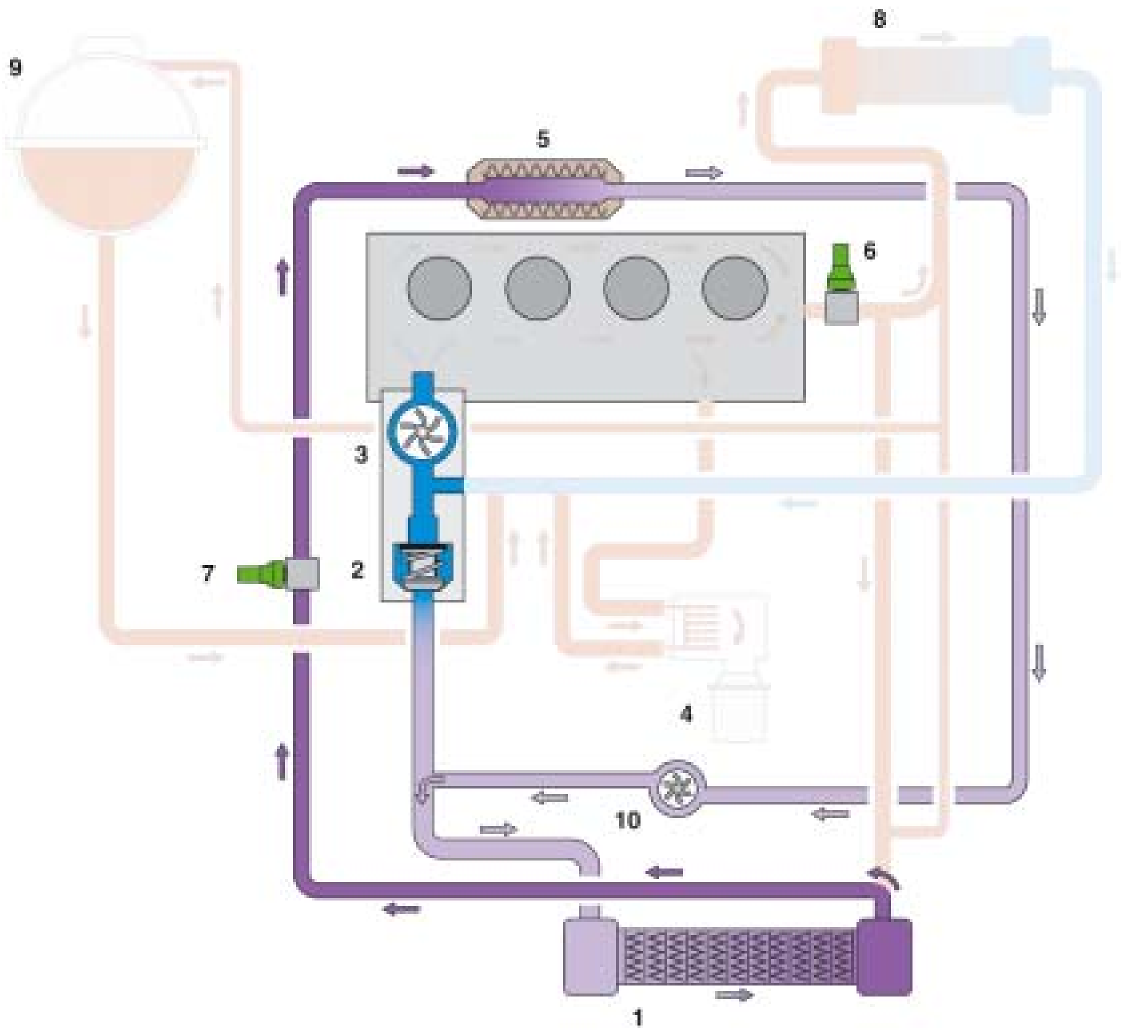
Legend

1 - Radiator for engine coolant circuit
2 - Thermostat
3 - Coolant pump
4 - Oil cooler
5 - Cooler for exhaust gas recirculation
6 - Coolant temperature sender G62
7 - Radiator outlet coolant temperature sender G83
8 - Heat exchanger for heating
9 - Expansion tank
10 - Coolant circulation pump 2 V178

Low-temperature exhaust gas recirculation

The engine is equipped with a low-temperature exhaust gas recirculation system to reduce NOx emissions.



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Function

When the thermostat is closed, the exhaust gas recirculation cooler is supplied with cold coolant directly by the engine radiator. Due to the resulting greater temperature drops, a greater quantity of exhaust gas can be fed back. This allows the combustion temperatures and consequently the nitrogen oxide emissions in the engine warm-up phase to be reduced further.
The electrical auxiliary coolant pump (coolant circulation pump 2 V178) will be activated by the engine control unit and runs constantly after the engine is started.

Fuel system

Schematics

1 - Fuel system pressurisation pump G6

Delivers fuel constantly to the supply line.

2- Fuel filter with pre-heater valve

The pre-heater valve prevents the filter clogging with crystallising paraffin crystals at low outside temperatures.

3 - Supplementary fuel pump V393

Delivers the fuel from the supply line to the fuel pump.

4 - Filter sieve

Protects the high-pressure pump against dirt particles.

5 - Fuel temperature sender G81

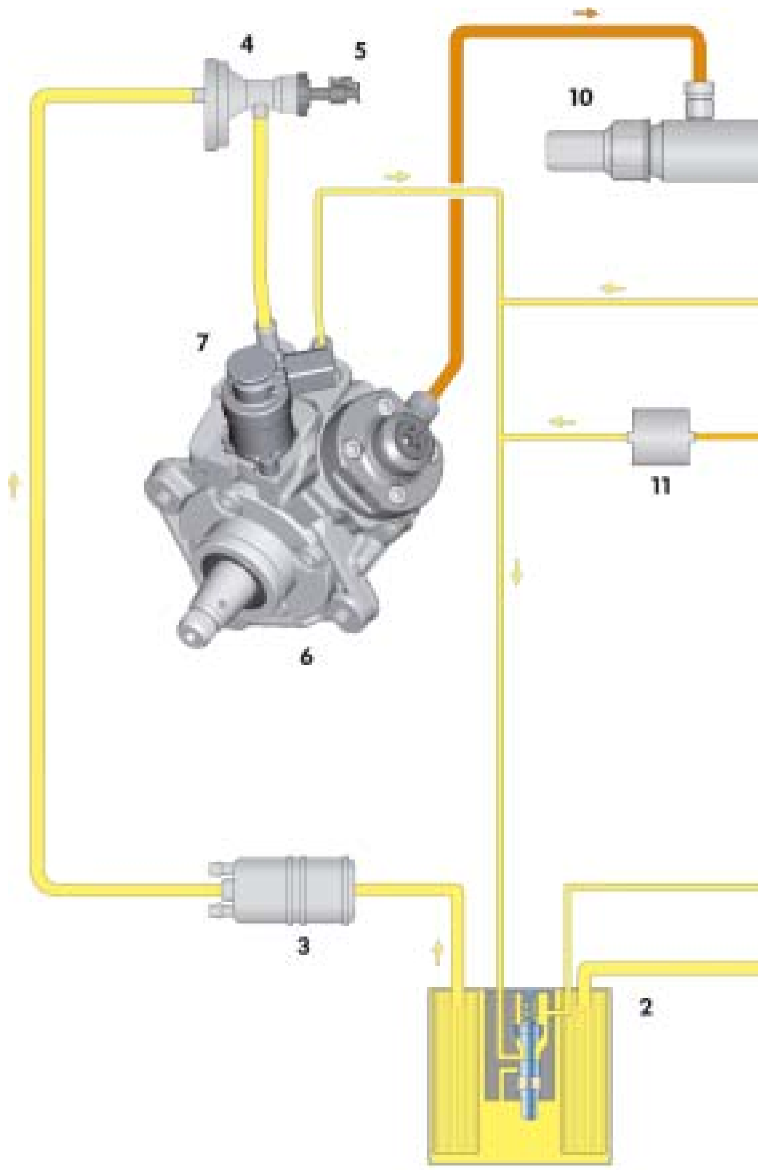
Measures the current fuel temperature.

6 - High-pressure fuel pump

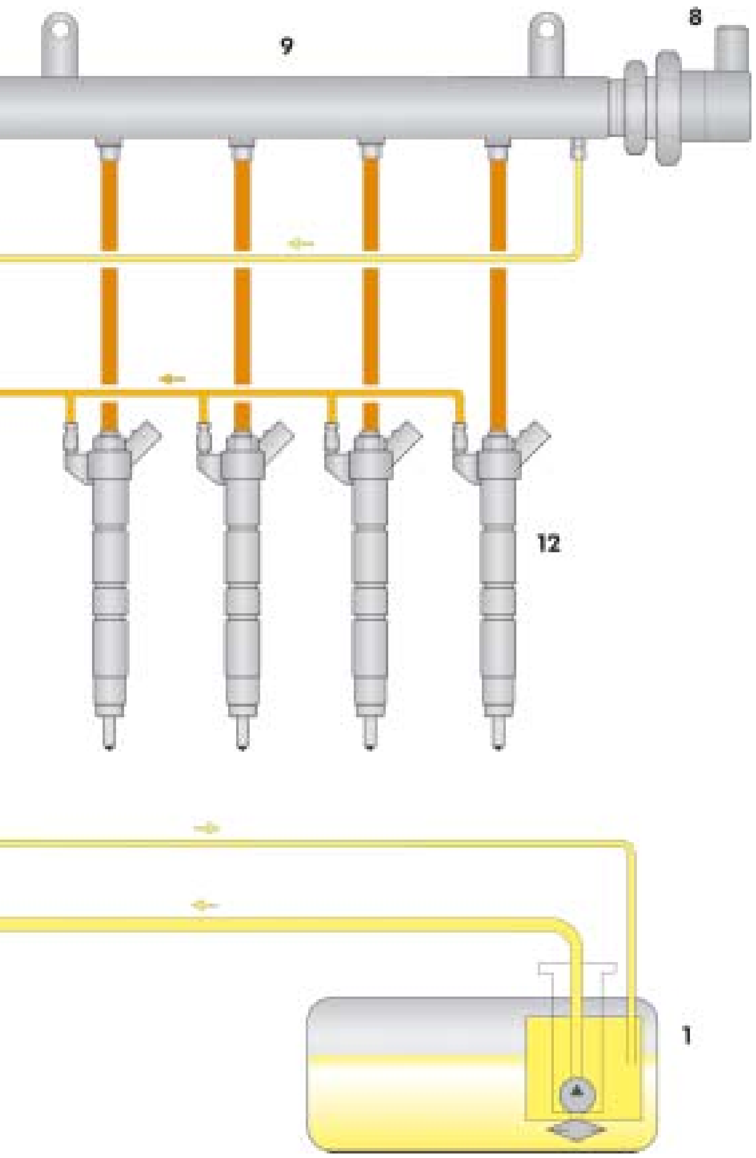
Generates the high fuel pressure required for injection.

7 - Fuel metering valve N290

Regulates the quantity of fuel to be compressed according to requirement.



1 - Fuel system pressurisation pump G6
2 - Fuel filter with pre-heater valve
3 - Supplementary fuel pump V393
4 - Filter sieve
5 - Fuel temperature sender G 81
6 - High-pressure pump



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8 - Fuel pressure regulating valve N276

Adjusts the fuel pressure in the high-pressure range.

9 - High-pressure accumulator (rail)

Stores the fuel required for injection in all cylinders at high pressure.

10 - Fuel pressure sender G247

Determines the current fuel pressure in the high-pressure range.

11 - Pressure retention valve

Maintains the return pressure of the injectors at 10 bar. This pressure is required for the injectors to work.

12 – Injection valves N30, N31, N32, N33

7 - Fuel metering valve N290
8 - Fuel pressure regulating valve N276
9 - High-pressure accumulator (rail)
10 - Fuel pressure sender G247
11 - Pressure retention valve
12 - Injection valves N30, N31, N32, N33

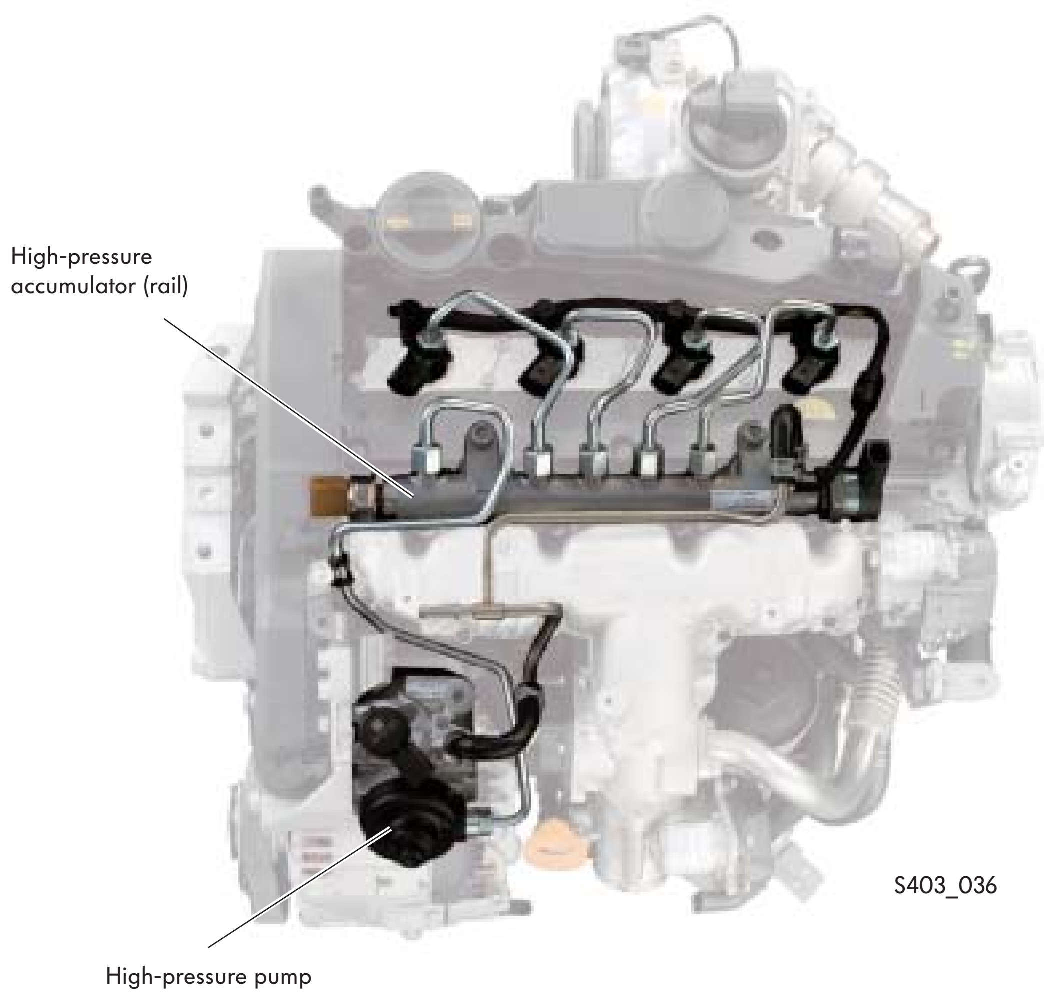
High pressure 230 – 1800 bar

Return pressure from the injectors 10 bar

Supply pressure
Return pressure

Common rail fuel injection system

The 2.0l TDI engine in the Tiguan is equipped with a common rail injection system for mixture preparation.
The common rail fuel injection system is a high-pressure accumulator fuel injection system for diesel engines. The term “common rail” means that all of the injectors for one cylinder bank have a common, high-pressure fuel accumulator.

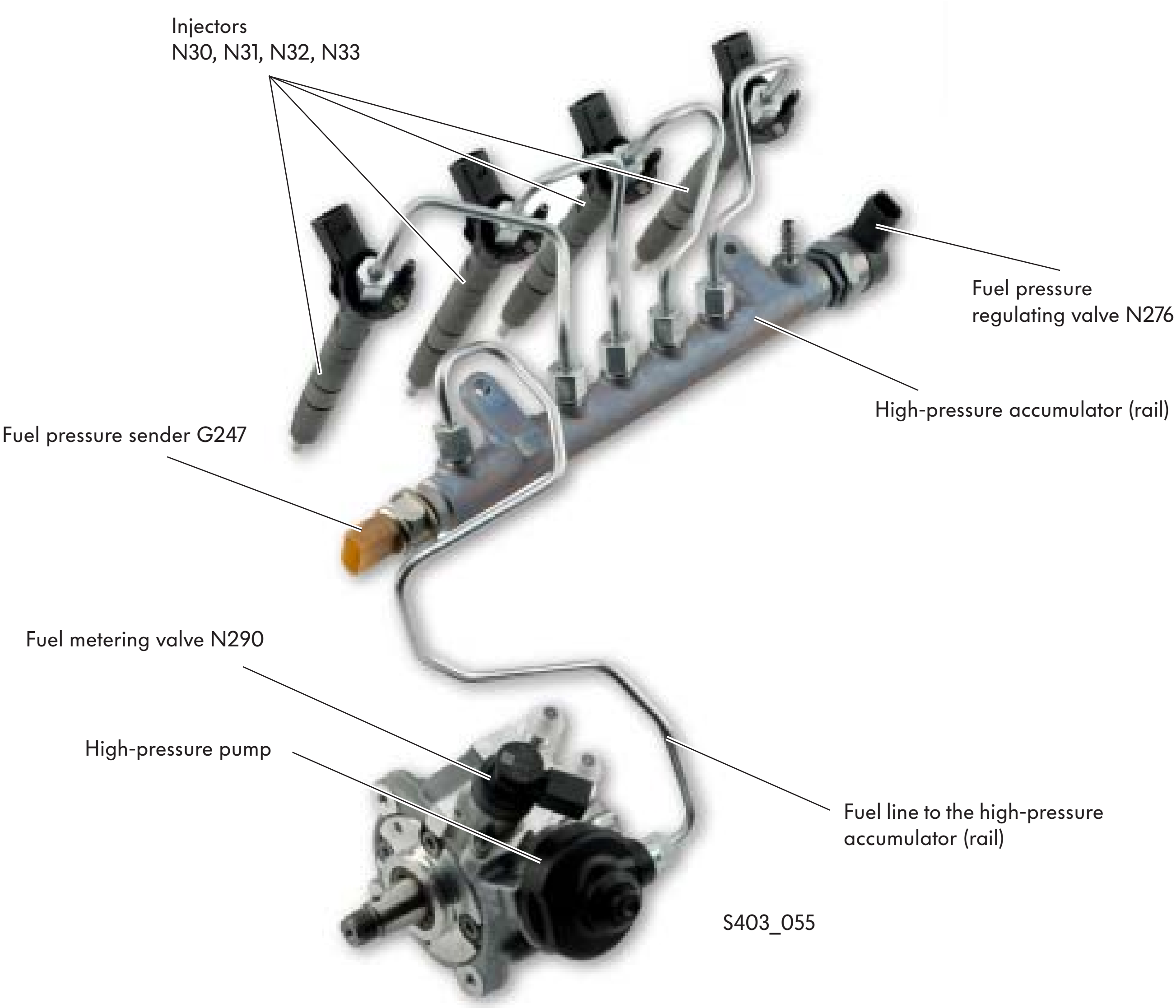


In this injection system, pressure generation and fuel injection are separate. A separate high-pressure pump generates the high fuel pressure required for injection.
This fuel pressure is stored in a high-pressure accumulator (rail) and is made available to the injectors via short injector pipes.
The common rail fuel injection system is controlled by the Bosch EDC 17 engine management system.

The characteristics of this fuel injection system include:

- The injection pressure can be selected almost infinitely and can be adapted to the relevant engine operating status.
- A high injection pressure up to a maximum of 1800 bar enables optimum mixture formation.
- A flexible fuel injection process, with several pilot and secondary injection processes.

The common rail fuel injection system offers many options for adapting the injection pressure and the injection process to the engine operating status.
It therefore offers very good prerequisites for meeting the constant increase in requirements relating to low fuel consumption, low exhaust emissions and smooth running characteristics.



S403_055

Self-study programme 351 “The common rail fuel injection system fitted in the 3.0l V6 TDI engine” describes how the common rail injection system with piezo injectors works.

Engine Mechanics

Injectors

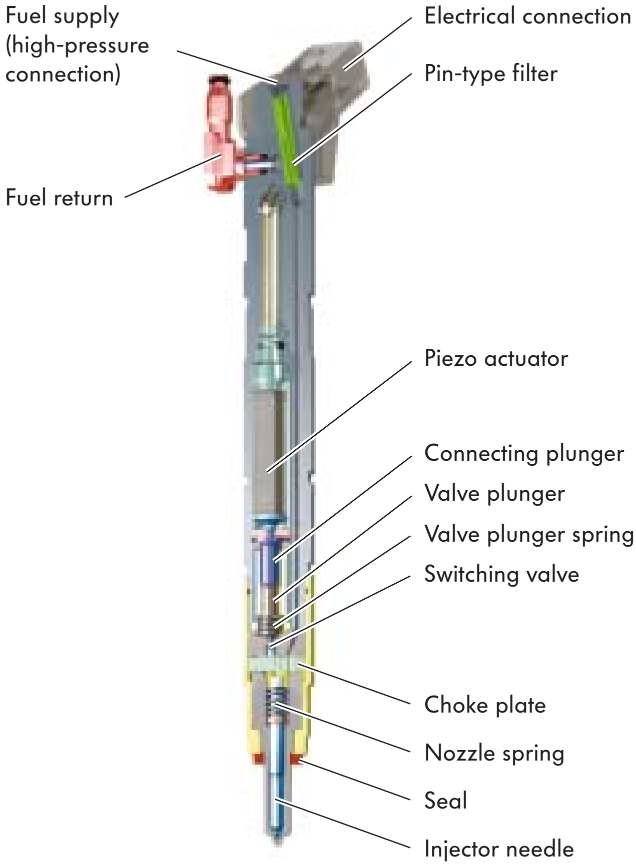
The common rail system on the 2.0l TDI engine uses piezo-controlled injectors.

In this case, the injectors are controlled via a piezo actuator. The switching speed of a piezo actuator is approximately four times faster than that of a solenoid valve.

In comparison with solenoid valve-controlled injectors, piezo technology has approximately 75 % less moved mass at the injector needle.

This has the following advantages:

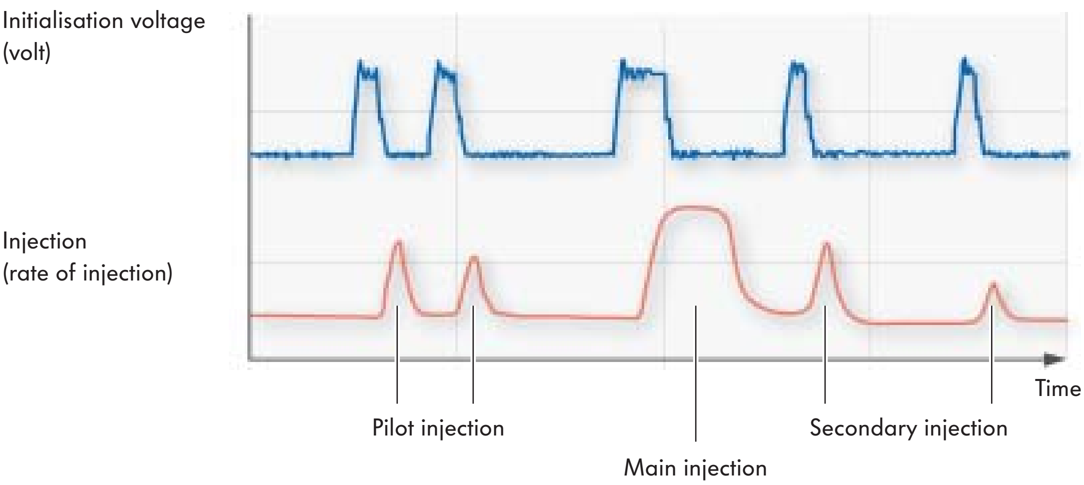
- Very short switching times
- Several injections per working cycle are possible
- Precisely apportionable injection quantities



S403_024

Injection process

The very short switching times of the piezo-controlled injectors enable flexible and precise control of the injection phases and injection quantities. As a result of this, the injection process can be adapted to the relevant operating requirements of the engine. Up to five partial injections are carried out per injection process.



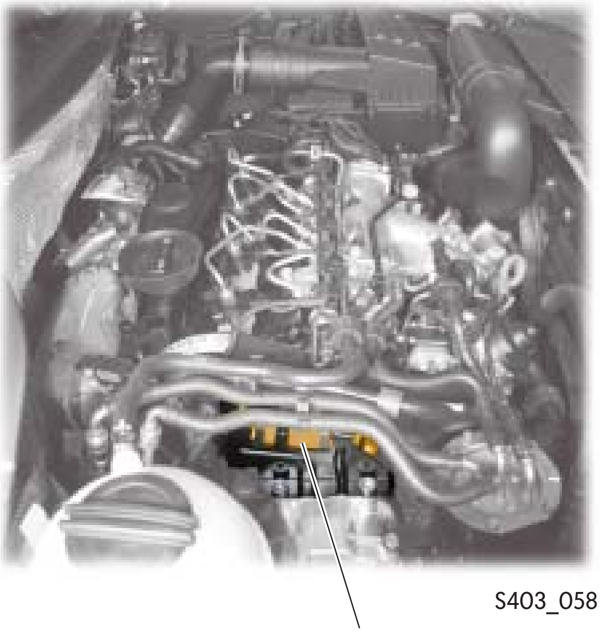
S403_025

Supplementary fuel pump V393

The supplementary fuel pump is a roller vane pump. It is located in the engine compartment of the Tiguan and has the task of conveying the fuel from the fuel tank along the supply line to the high-pressure pump. The supplementary fuel pump is activated by the engine control unit via a relay and increases the pressure of the fuel supplied by the electric fuel pump in the fuel tank to approx. 5 bar. This ensures that the high-pressure pump is supplied with fuel in all operating conditions.

Effects upon failure

If the supplementary fuel pump fails, the engine will continue to run with reduced performance. It will not be possible to start the engine.

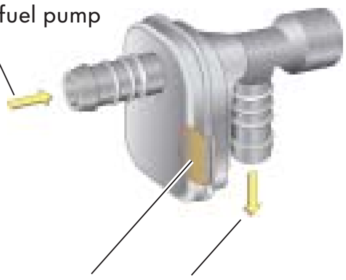


S403_058

S403_037

Filter sieve

To protect the high-pressure pump from particles of dirt, for example, from mechanical wear, there is a filter sieve in the fuel supply in front of the high-pressure pump.

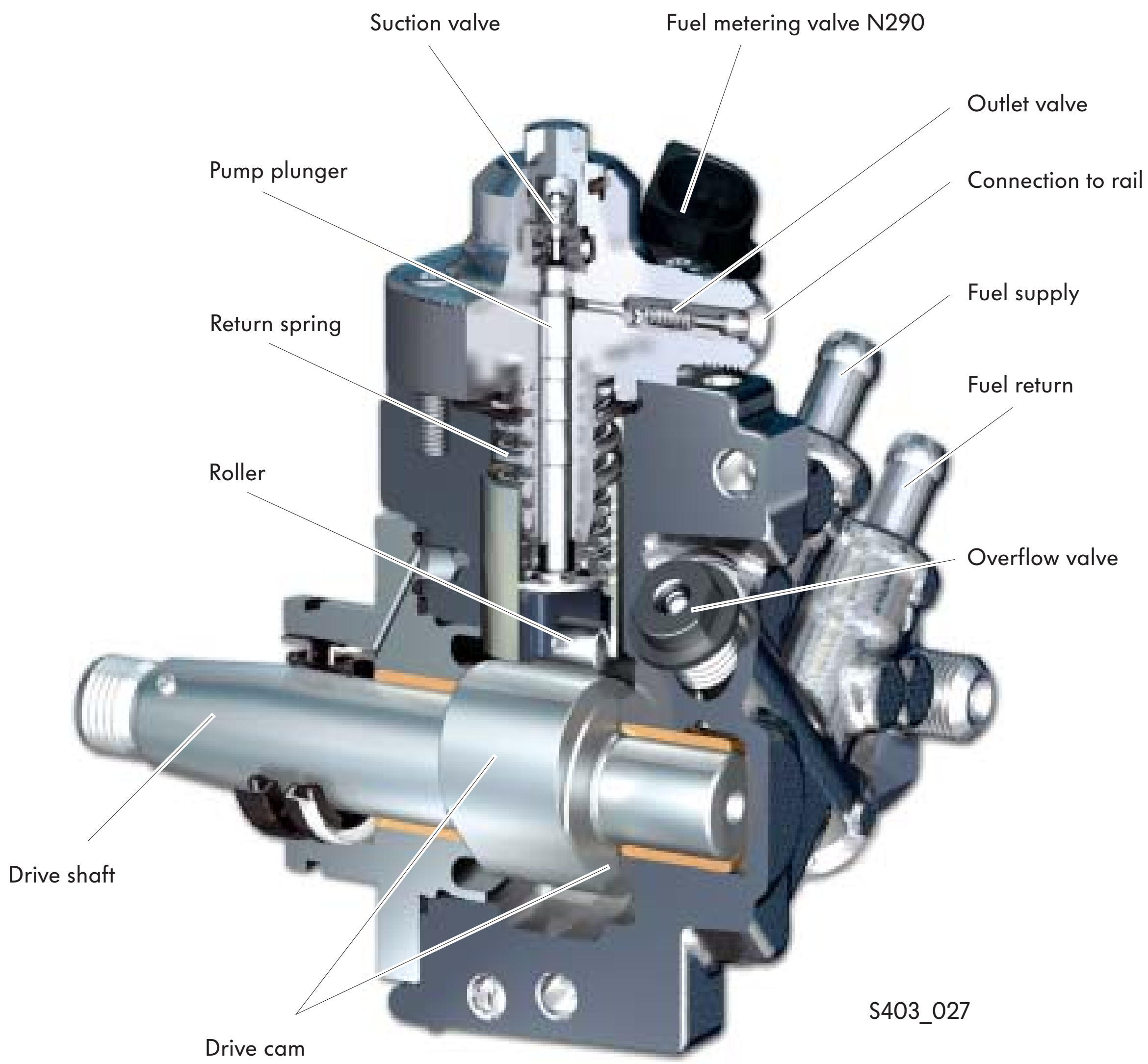


S403_094

High-pressure pump

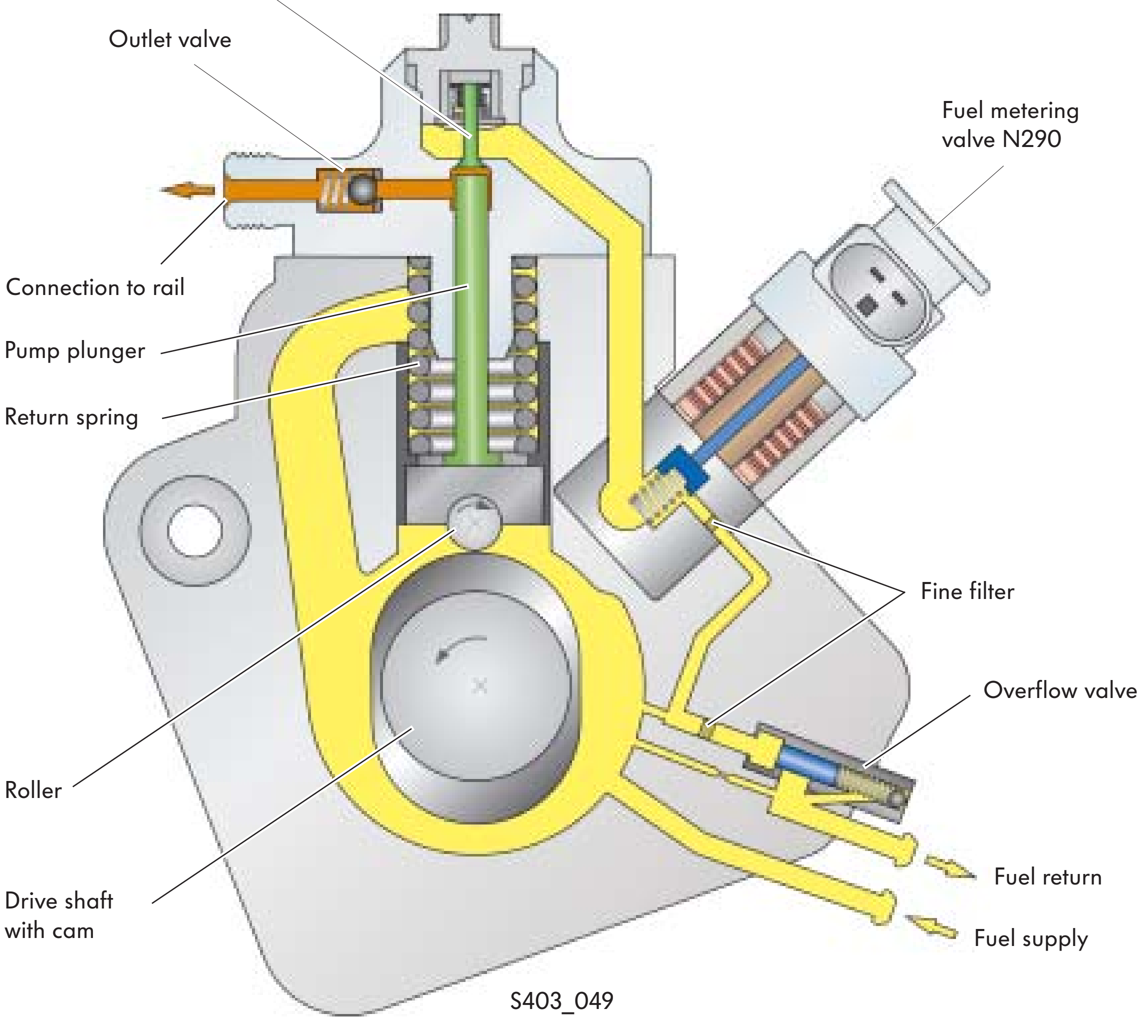
The high-pressure pump is a single-piston pump. It is driven by the crankshaft at the engine speed via the toothed belt.
The high-pressure pump has the task of generating the high fuel pressure of up to 1800 bar, which is required for fuel injection.
The two cams on the drive shaft that are offset by 180° produce the pressure in sync with the injection in the working cycle of the respective cylinder. The pump drive is loaded evenly as a result and pressure fluctuations in the high-pressure range are kept low.
A roller ensures low-friction power transmission from the drive cam to the pump piston.

High-pressure pump design



When the engine timing is set, the position of the drive shaft needs to be set for the high-pressure pump.
Please refer to the information in the repair guide.

High-pressure pump design - schematics



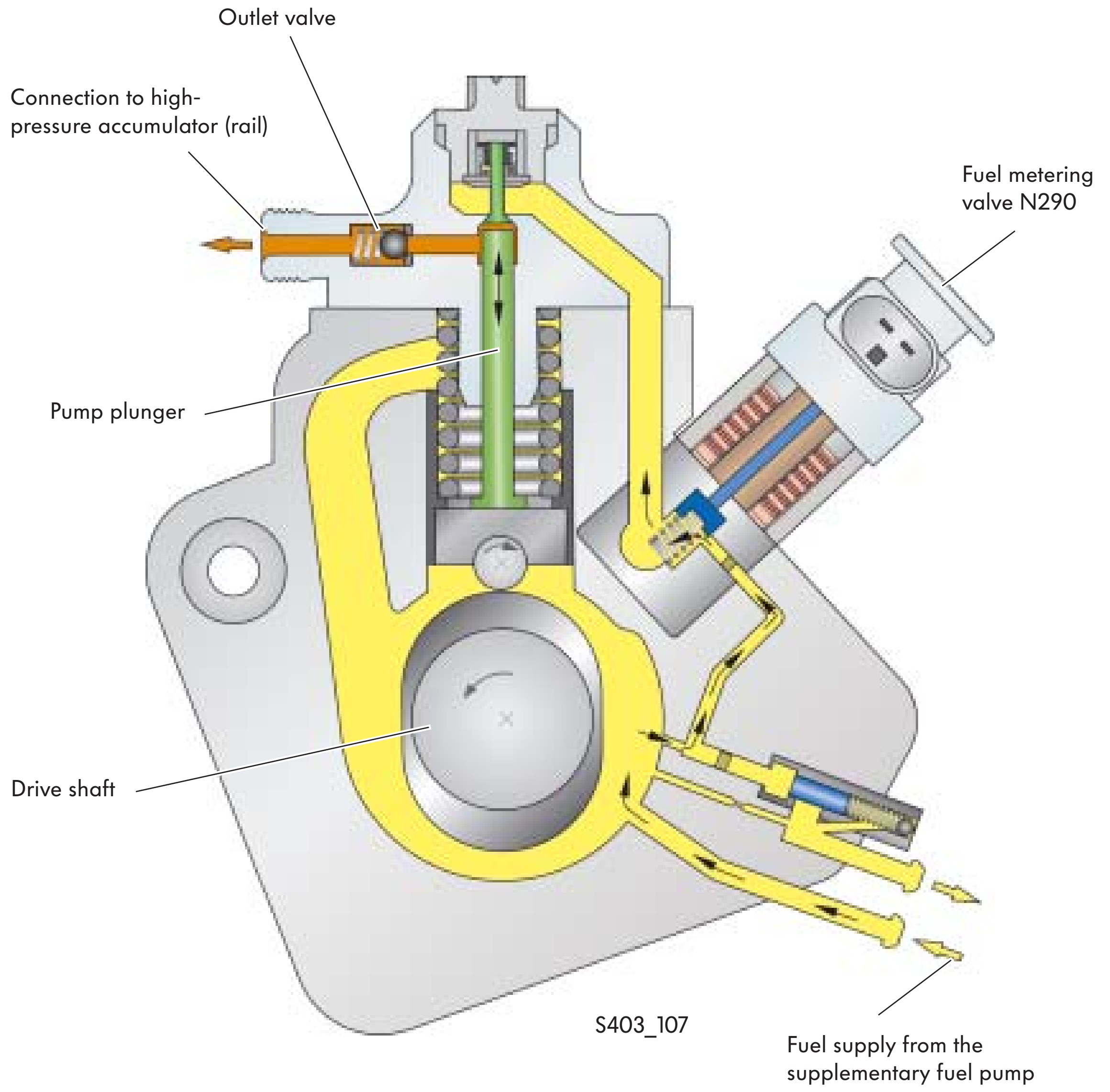
S403_049

High-pressure range

The high-pressure pump is supplied with sufficient fuel by the supplementary fuel pump in all engine operating ranges.

The fuel enters the high-pressure area of the engine via the fuel metering valve.

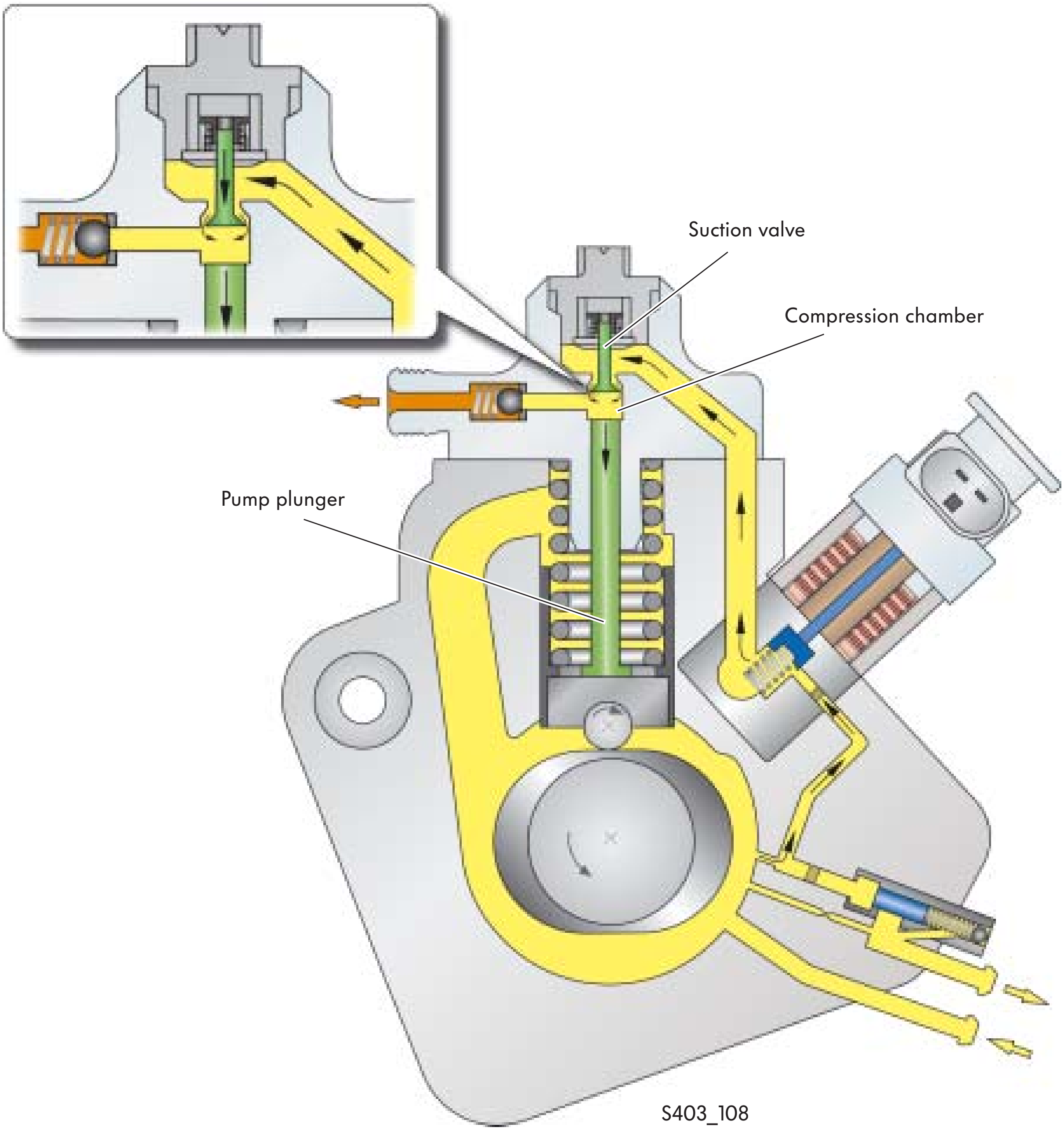
The pump piston is set in an up and down movement by the cams on the drive shaft.



S403_107

Suction stroke

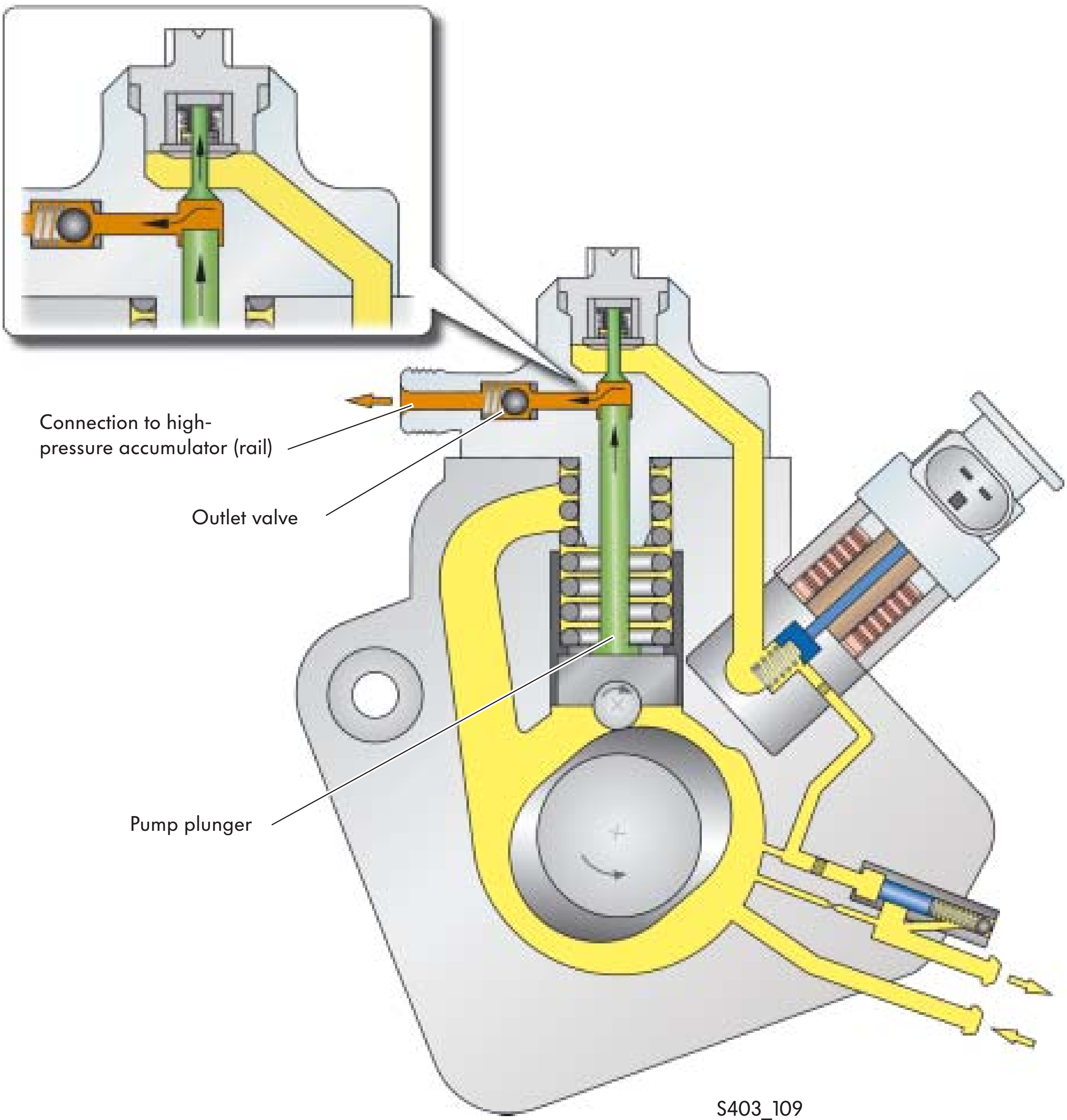
The downwards movement of the pump plunger increases the volume of the compression chamber. This creates a pressure difference between the fuel in the high-pressure pump and the compression chamber. The suction valve opens and fuel flows into the compression chamber.



S403_108

Delivery stroke

The pressure in the compression chamber increases when the pump plunger begins to move upwards and the suction valve closes. As soon as the fuel pressure in the compression chamber exceeds the pressure in the high-pressure area, the outlet valve (return valve) opens and the fuel enters the high-pressure accumulator (rail).



S403_109

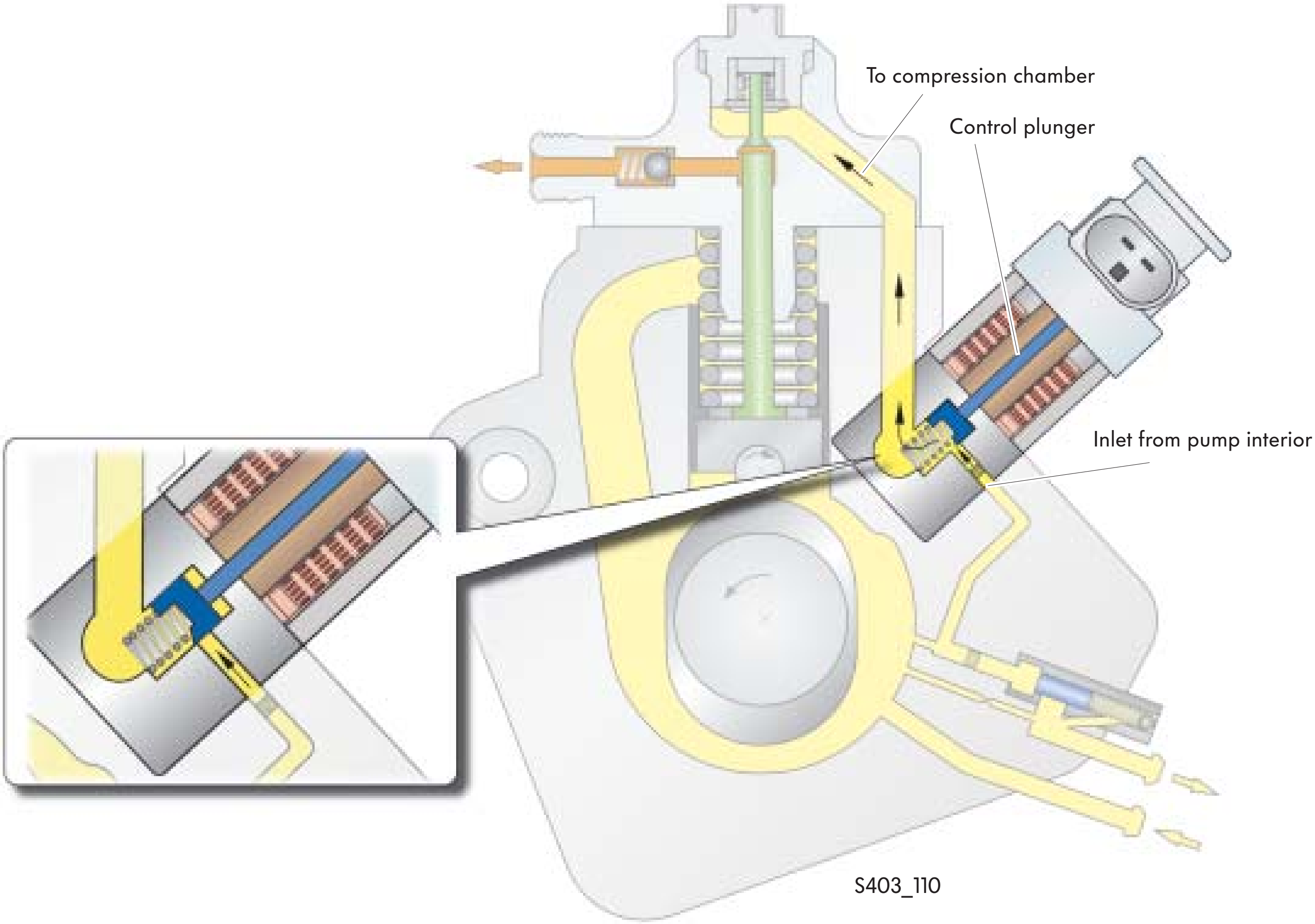
Fuel metering valve N290

The fuel metering valve is integrated into the high-pressure pump. It ensures on-demand regulation of the fuel pressure in the high-pressure area. The fuel metering valve regulates the quantity of fuel that is required for generating high pressure. The advantage of this is that the high-pressure pump only has to generate the pressure that is required for the current operating situation. This reduces the power consumption of the high-pressure pump and avoids unnecessary fuel heating.

Function

When no current is supplied, the fuel metering valve is open. To reduce the supply quantity to the compression chamber, the valve is activated by the engine control unit with a pulse width modulated signal (PWM).

Due to the PWM signal, the fuel metering valve is pulsed closed. Depending on the pulse duty factor, the position of the control plunger and thus the supply quantity of the fuel in the high-pressure pump compression chamber changes.



S403_110

Effects upon failure

The engine output is reduced. The engine management system operates in emergency running mode.

Low-pressure area

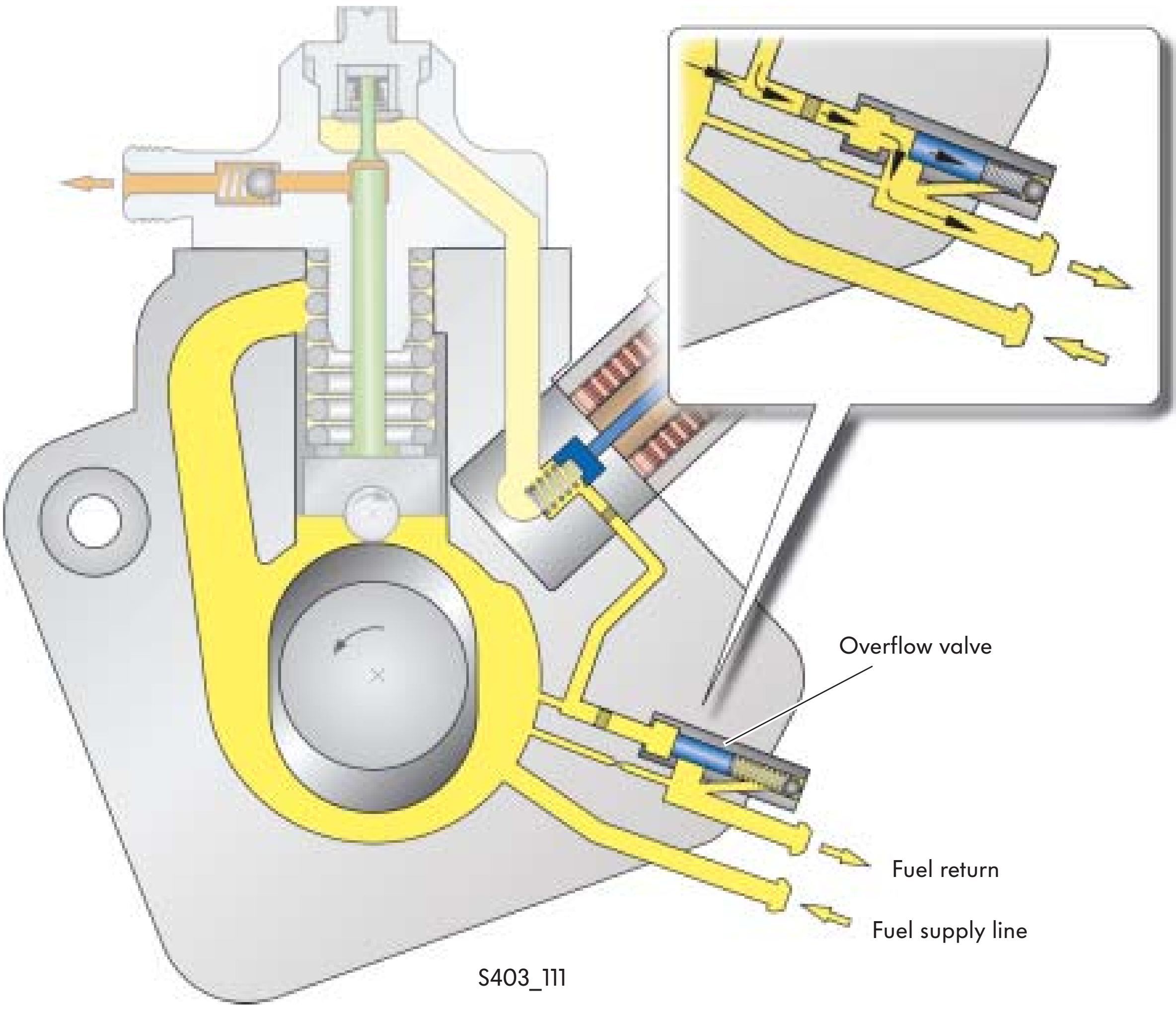
Overflow valve

The fuel pressure in the low-pressure area of the high-pressure pump is regulated by the overflow valve.

Function

The supplementary fuel pump delivers the fuel from the fuel tank to the high-pressure pump at a pressure of approx. 5 bar. This ensures that the high-pressure pump is supplied with fuel in all operating conditions. The overflow valve regulates the fuel pressure in the high-pressure pump to approx. 4.3 bar.

The fuel transported by the supplementary fuel pump acts against the piston and the piston spring of the overflow valve. At a fuel pressure above 4.3 bar, the overflow valve opens and opens the path to the fuel return. Any excess fuel flows back into the fuel tank via the fuel return.



S403_111

Regulation of high fuel pressure

In the common rail injection system in the Tiguan, the high fuel pressure is regulated by a so-called twin-regulator concept.
The fuel pressure regulating valve N276 and the fuel metering valve N290 are activated with a pulse-width modulated signal (PWM) for this.
Depending on the operating state of the engine, the high fuel pressure is regulated by one of the two valves.
The other valve is just controlled by the engine control unit.

Regulation by the fuel pressure regulating valve N276

When the engine is started, the high fuel pressure is regulated by the fuel pressure regulating valve N276 to warm up the fuel. To warm up the fuel quickly, more fuel is transported by the high-pressure pump and is compressed as required. The excess fuel is sent back to the fuel return by the fuel pressure regulating valve N276.

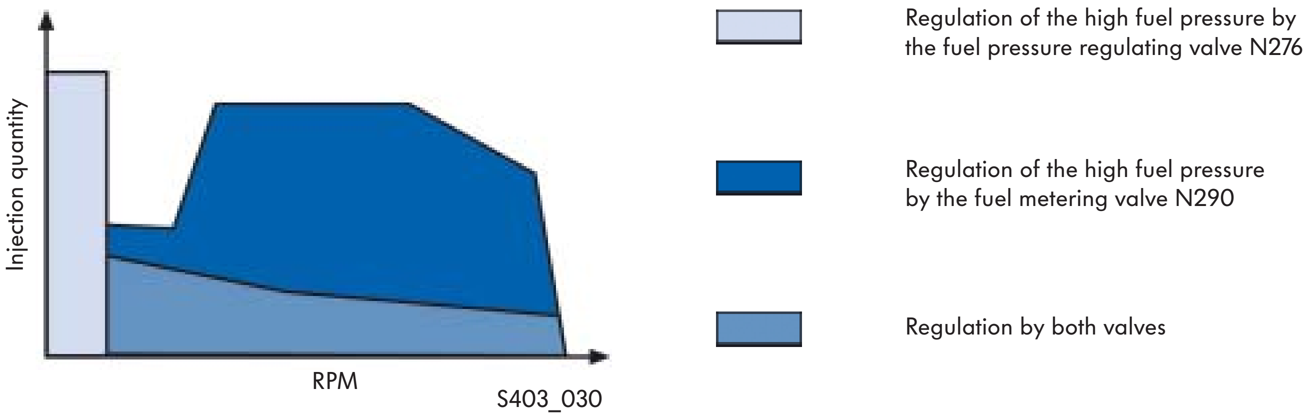
Regulation by the fuel metering valve N290

The high fuel pressure is regulated by the fuel metering valve N290 when there are high injection quantities and high rail pressures. This results in on-demand regulation of the high fuel pressure. The power consumption of the high-pressure pump is reduced and unnecessary fuel heating is avoided.

Regulation by both valves

At idle, when decelerating and with small injection quantities, the fuel pressure is regulated by both valves at the same time. This allows precise regulation that improves the idling quality and the change-over to deceleration.

Dual-regulator concept



Fuel pressure regulating valve N276

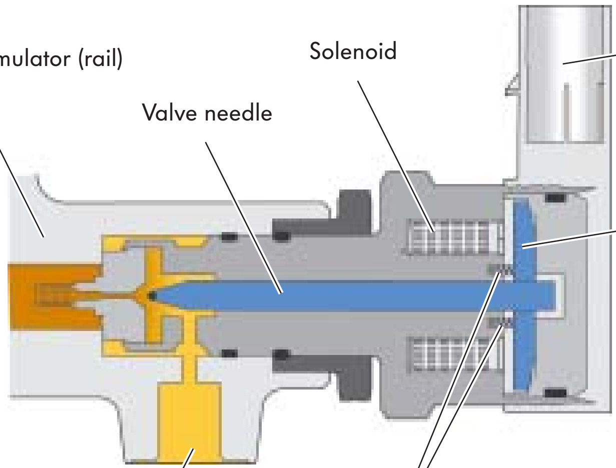
The fuel pressure regulating valve is located on the high-pressure accumulator (rail).

The regulating valve is opened and closed to adjust the fuel pressure in the high-pressure area.

It is controlled by the engine control unit with a pulse-width modulated signal.

S403_023

Design



S403_032

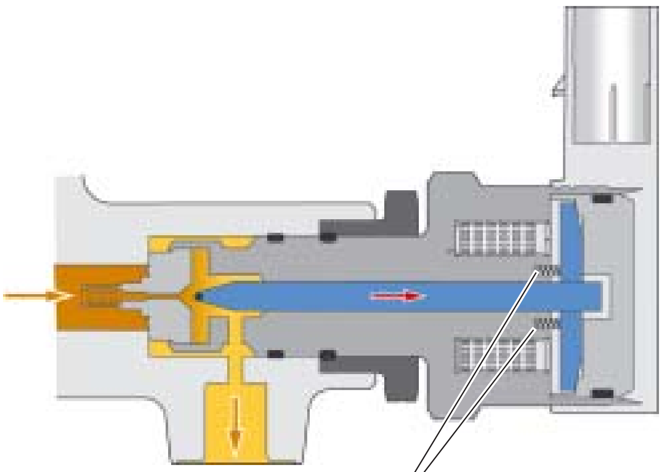
How it works

In contrast to previous regulating valves in common rail injection systems, this valve is open when not powered.

Regulating valve in resting position (engine "off")

If the regulating valve is not activated, the pressure regulating valve is opened by the valve springs.
The high-pressure area is connected to the fuel return.

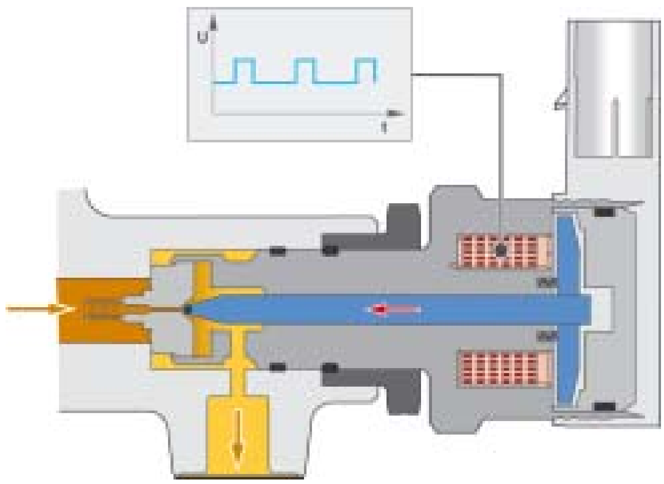
This ensures volume equalisation between the high-pressure and low-pressure fuel areas. Vapour lock that can occur in the rail during the cooling process when the engine is stopped is avoided and thus the starting behaviour of the engine is improved.



S403_033

Regulating valve initialised (engine "on")

To attain an operating pressure of 230 to 1800 bar in the high-pressure accumulator, the regulating valve is initialised by the engine control unit J623 using a pulse-width modulated (PWM) signal. This leads to a magnetic field in the solenoid. The valve armature is picked up and presses the valve needle into its seat. The fuel pressure in the high-pressure accumulator is therefore opposed by a magnetic force. Depending on the pulse duty factor of initialisation, the flow cross-section to the return pipe and therefore the quantity flowing off are varied. This also enables pressure fluctuations in the high-pressure accumulator to be compensated.



S403_034

Effects upon failure

Engine operation is impossible in the event of fuel pressure regulating valve failure as it is not possible to build up sufficiently high fuel pressure for fuel injection.

Engine Management

System overview

Sensors

Engine speed sender G28

Hall sender G40

Accelerator position sender G79/
accelerator position sender 2 G185

Air mass meter G70

Coolant temperature sender G62

Radiator outlet coolant temperature sender G83

Charge air pressure sender G31
Intake air temperature sender G42

Fuel temperature sender G81

Fuel pressure sender G247

Exhaust gas recirculation potentiometer G212

Lambda probe G39

Exhaust gas pressure sensor 1 G450

Exhaust gas temperature sender 1 G235

Exhaust gas temperature sender 3 G495

Exhaust gas temperature sender 4 G648

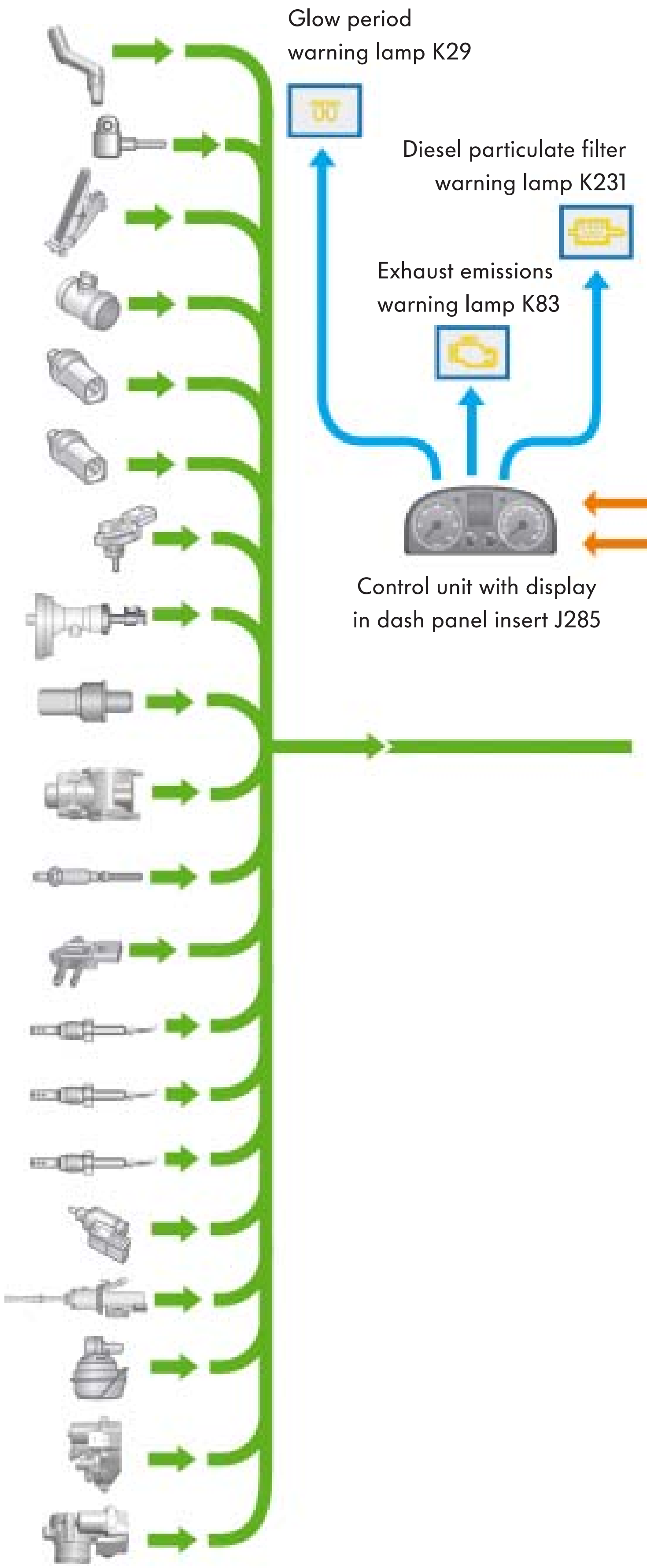
Brake light switch F

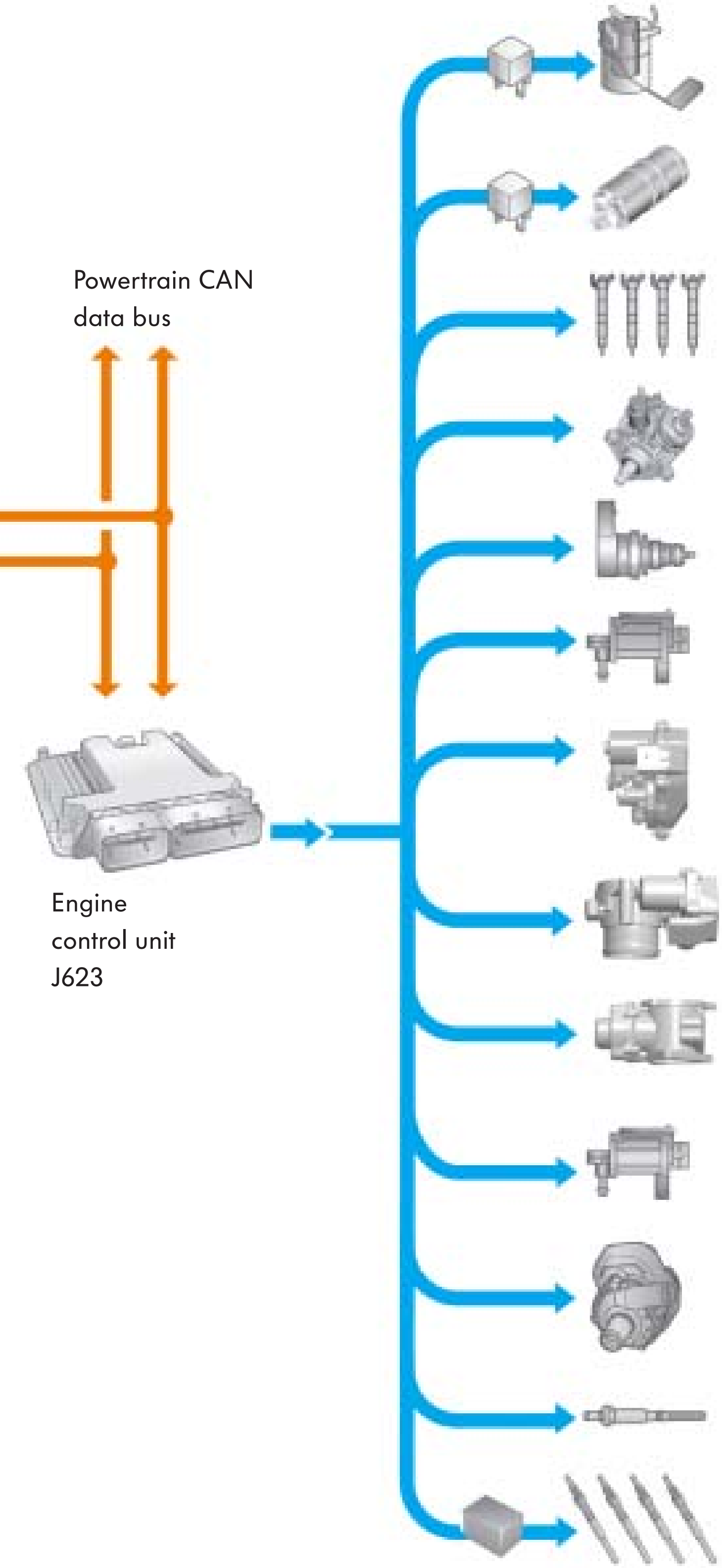
Clutch position sender G476

Position sender for charge pressure positioner G581

Intake manifold flap potentiometer G336

Throttle valve potentiometer G69





S403_028

Actuators

Fuel pump relay J17
Fuel system pressurisation pump G6

Relay for supplementary fuel pump J832
Supplementary fuel pump V393

Injector for cylinder 1 N30
Injector for cylinder 2 N31
Injector for cylinder 3 N32
Injector for cylinder 4 N33

Fuel metering valve N290

Fuel pressure regulating valve N276

Charge pressure control solenoid valve N75

Intake manifold flap motor V157

Throttle valve module J338

Exhaust gas recirculation valve N18

Exhaust gas recirculation cooler change-over valve N345

Coolant circulation pump 2 V178

Lambda probe heater Z19

Automatic glow period control unit J179
Glow plug 1 Q10
Glow plug 2 Q11
Glow plug 3 Q12
Glow plug 4 Q13

Engine management

The engine management system used for the 2.0l TDI engine with common rail injection system is the electronic diesel control EDC 17 from Bosch.

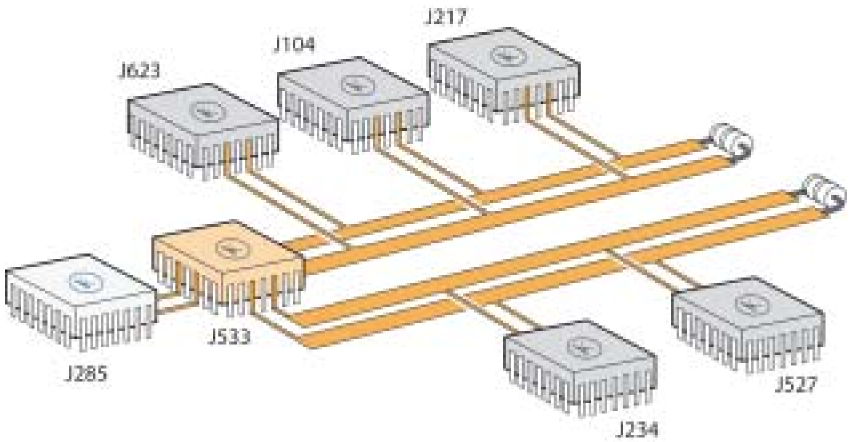
The EDC 17 engine management system is a further development of the EDC 16. The difference to the EDC 16 is increased performance and a larger memory capacity.

In addition, it allows control functions for future technologies to be integrated.

S403_052

Control units in the CAN data bus

The schematic diagram shows the integration of the engine control unit in the vehicle CAN data bus structure. Information is transmitted between the control units via the CAN data bus.



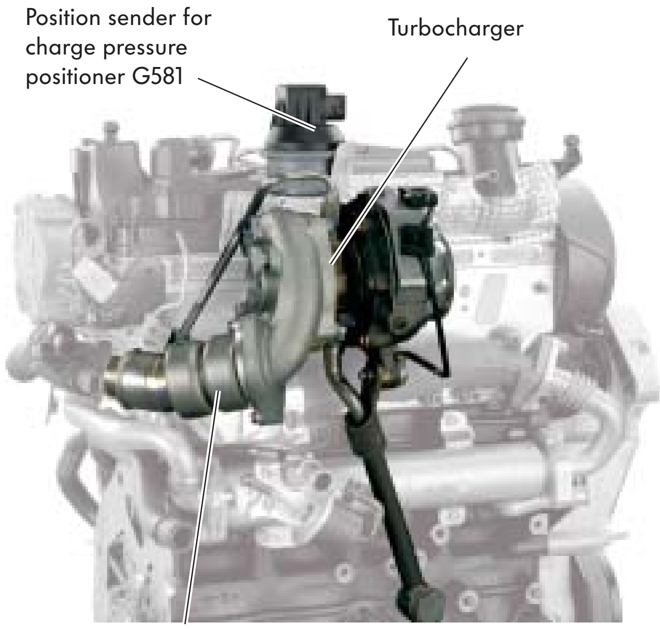
S403_090

Legend

J104 ABS control unit
J217 Automatic gearbox control unit
J234 Airbag control unit
J285 Control unit with display in dash panel insert
J527 Steering column electronics control unit
J533 Data bus diagnostic interface
J623 Engine control unit

Turbocharger

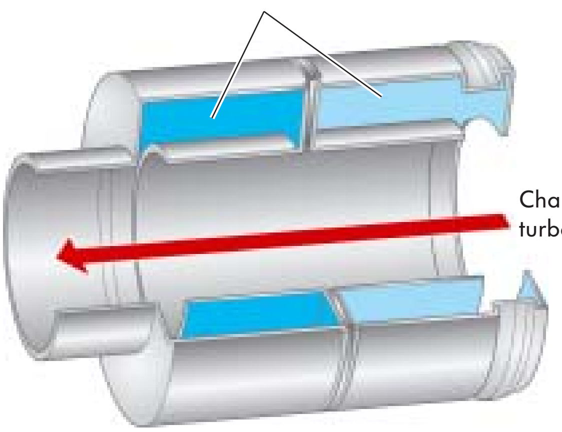
In the 2.0l TDI engine, the charge pressure is generated by an adjustable turbocharger.
This is equipped with adjustable guide vanes, which enable the flow of exhaust gas onto the turbine impeller to be influenced. The advantage of this is that optimal charge pressure and therefore good combustion are achieved throughout the entire engine speed range. In the lower engine speed range, the adjustable guide vanes offer high torque and good starting behaviour; in the upper engine speed range, they offer low fuel consumption and low emissions. The guide vanes are adjusted via a linkage by pressure.



S403_039

Flow silencer

A flow silencer is fitted behind the turbocharger outlet in the charge-air pipes.
It has the task of reducing loud turbocharger noises.



S403_098

Design and function

During full-load acceleration, the turbocharger needs to build up charge pressure very quickly. The turbine wheel and compressor wheel are quickly accelerated and the turbocharger approaches its pump limit. This can cause stalling air flow that lead to annoying noises and transfer of these to the charge-air pipes.

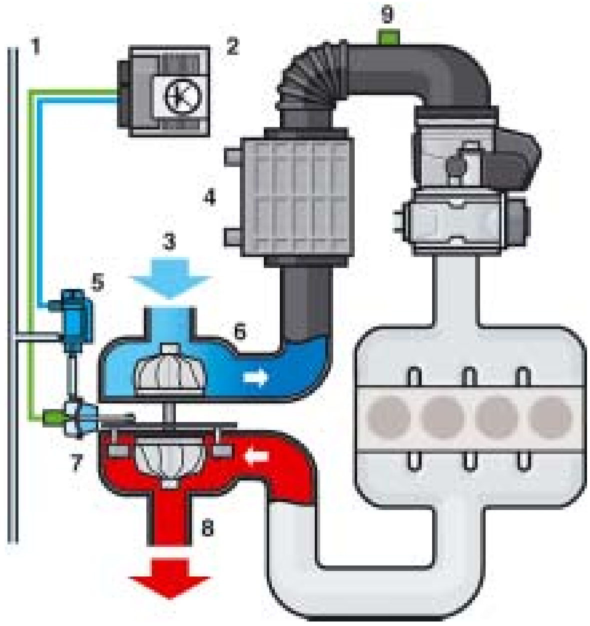
The charge air sets the air in the resonance chamber of the flow silencer in oscillation. These oscillations have about the same frequency as the charge-air noises. The annoying noises are minimised due to the combination of the sound waves from the charge air and the air oscillation from the resonance chamber of the flow silencer.

Charge air pressure regulation

The charge air pressure regulation controls the air mass that is compressed by the turbocharger.

Legend

1 - Vacuum system
2 - Engine control unit J623
3 - Intake air
4 - Intercooler
5 - Charge pressure control solenoid valve N75
6 - Turbocharger compressor
7 - Vacuum unit
8 - Exhaust turbine with guide vane adjustment
9 - Charge air pressure sender G31/intake air temperature sender G42



S403_040

Charge pressure control solenoid valve N75

The charge pressure control solenoid valve is an electropneumatic valve. The valve controls the vacuum that is required to adjust the guide vanes via the vacuum unit.

Effects upon failure

If the valve fails, the vacuum unit is not supplied with vacuum. A spring in the vacuum unit moves the adjustment mechanism linkage so that the turbocharger guide vanes are positioned at a sharp setting angle (emergency running position). Only a low charge pressure is available at a low engine speed and therefore a low exhaust gas pressure. The engine has less output and active regeneration of the particulate filter is not possible.

S403_097

Charge air pressure sender G31/intake air temperature sender G42

The charge air pressure sender G31 and intake air temperature sender G42 have been integrated into one component and are located in the intake manifold.

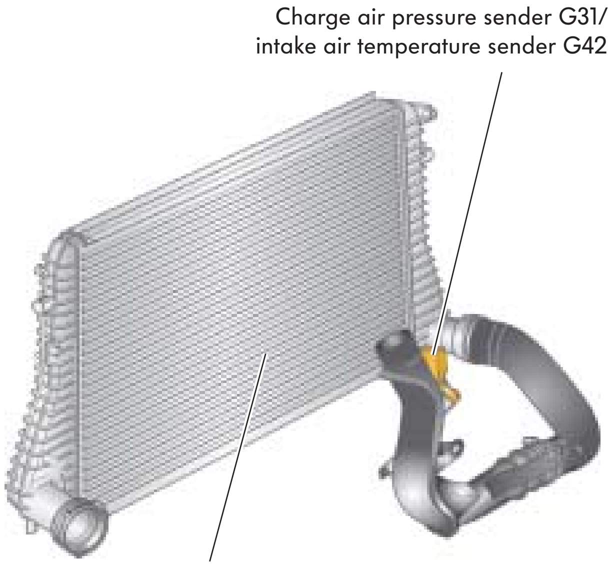
Charge air pressure sender G31

Signal use

The current air pressure in the intake manifold is determined from the charge air pressure sender signal. The engine control unit requires the signal to regulate the charge air pressure.

Effects upon failure

There is no substitute function in the event of signal failure. Charge air pressure regulation is shut off and the engine output is reduced significantly.
The particulate filter cannot be actively regenerated.



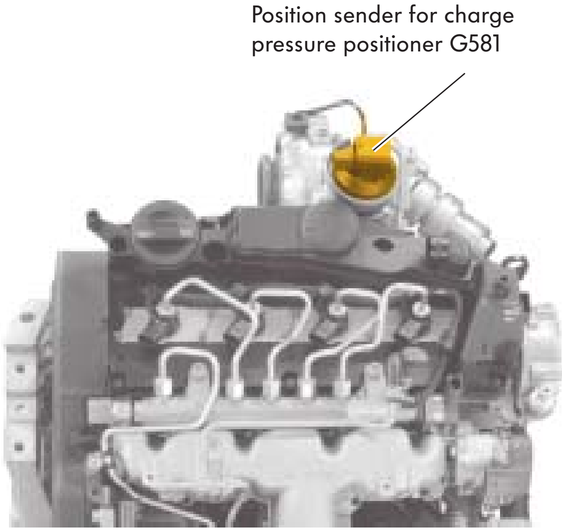
S403_096

Intake air temperature sender G42

The engine control unit uses the signal from the intake air temperature sender to regulate the charge air pressure. Since the temperature influences the density of the charge air, the signal is used as a correction value by the engine control unit.

Position sender for charge pressure positioner G581

The position sender for charge pressure positioner is integrated in the turbocharger vacuum unit. It is a travel sensor that enables the engine control unit to determine the position of the turbocharger guide vanes.



S403_095

Signal use

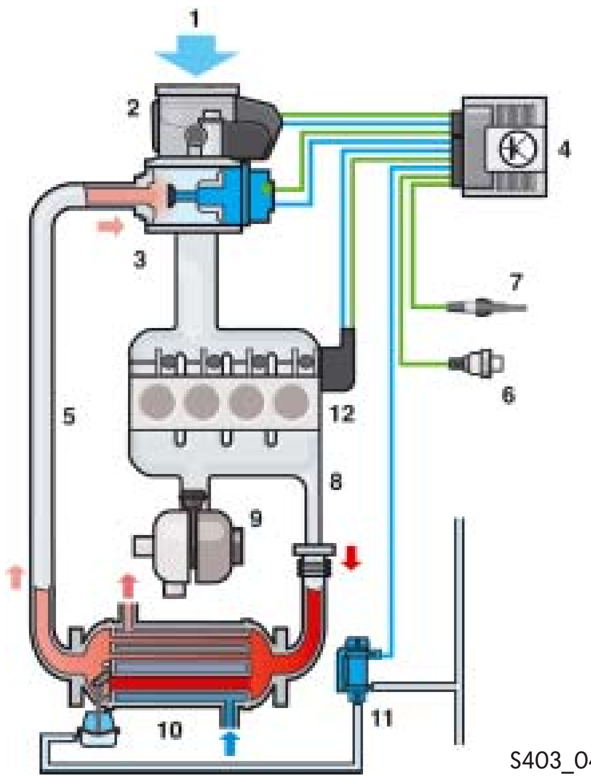
The sensor signal directly provides the engine control unit with the current position of the turbocharger guide vanes. Together with the signal from the charge air pressure sender G31, this allows the state of the charge air pressure regulation to be determined.

Effects of signal failure

If the sensor fails, the signal from the charge air pressure sender and the engine speed is used to establish the position of the guide vanes.
The exhaust emissions warning lamp K83 is actuated.

Exhaust gas recirculation system

The exhaust gas recirculation is a measure for reducing the nitrogen oxide emissions. Thanks to exhaust gas recirculation, part of the exhaust gases are returned to the combustion process. The oxygen proportion of the fuel-air mixture is reduced which causes slower combustion. This reduces the combustion peak temperature and the nitrogen oxide emissions are reduced.



S403_046

Legend

1 - Intake air
2 - Throttle valve module J338 with throttle valve potentiometer G69
3 - Exhaust gas recirculation valve with exhaust gas recirculation potentiometer G212 and exhaust gas recirculation valve N18
4 - Engine control unit J623
5 - Exhaust gas supply line
6 - Coolant temperature sender G62
7 - Lambda probe G39
8 - Exhaust manifold
9 - Turbocharger
10 - Exhaust gas cooler
11 - Exhaust gas recirculation cooler change-over valve N345
12 - Intake manifold flap motor V157 with intake manifold flap potentiometer G336

The exhaust gas recirculation quantity is controlled according to a map in the engine control unit. The engine speed, injection quantity, intake air mass, intake air temperature and the air pressure are taken into consideration.

A broadband lambda probe is located upstream of the particulate filter in the exhaust system. The lambda probe enables measurement of the oxygen content in the exhaust gas over a wide measuring range. The signal from the Lambda probe is used as a correction value to regulate the exhaust gas recirculation quantity for the exhaust gas recirculation system.

An exhaust gas recirculation cooler ensures that the combustion temperature is additionally lowered by cooling the recirculated exhaust gases, and also an increased quantity of exhaust gases can be recirculated.

This effect is boosted further by the low-temperature exhaust gas recirculation.

The low-temperature exhaust gas recirculation function is explained in this book on page 23.

Exhaust gas recirculation valve N18

The exhaust gas recirculation valve N18 is a valve disk operated by an electric motor. It is controlled by the engine control unit and can be infinitely adjusted by an electric motor. The travel of the valve disk regulates the quantity of recirculated exhaust gas.

Effect upon failure

If the exhaust gas recirculating valve N18 fails, the valve disk will be closed by a valve spring. No exhaust gas can be recirculated.

Exhaust gas recirculation valve N18
with exhaust gas recirculation potentiometer G212

Exhaust gas recirculation potentiometer G212

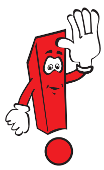
The exhaust gas recirculation potentiometer records the position of the valve disk in the exhaust gas recirculation valve.

Signal use

The signal informs the engine control unit about the current position of the valve disk. This regulates the amount of recirculated exhaust gas and thus the nitrogen oxide proportion in the exhaust gas.

Effect upon failure

If the sensor fails, exhaust gas recirculation is switched off. The power supply to the exhaust gas recirculation valve drive is disconnected and the valve disk is closed by a valve spring.



You find detailed information on the design and function of the exhaust gas recirculation potentiometer in self-study programme no. 368
"The 2.0l 125 kW TDI engine with 4-valve technology".

Exhaust gas recirculation cooler change-over valve N345

The exhaust gas recirculation cooler is a switchable cooler. It allows the engine and the diesel particulate filter to reach their operating temperature faster. The exhaust gas cooler is activated at coolant temperatures above 37 °C.

The exhaust gas recirculation cooler change-over valve is an electropneumatic valve.
It supplies the exhaust gas cooler vacuum unit with the pressure required to operate the bypass flap.

Effect upon failure

If the change-over valve fails, the bypass flap can no longer be operated by the vacuum unit for the exhaust gas recirculation cooler. The bypass flap remains open and the exhaust gas cooling thus stays active. This delays the engine and diesel particulate filter reaching operating temperature.

S403_100

Exhaust gas recirculation cooler change-over valve N345

Throttle valve module J338

The throttle valve module is mounted upstream from the exhaust gas recirculation valve.

The throttle valve module contains an electric motor that operates the throttle valve via a gear mechanism. Adjustment of the throttle valve is infinite and can be adapted to the relevant load and engine speed.

The throttle valve module has the following tasks:

In certain operating situations, the throttle valve causes a difference between the intake manifold pressure and the exhaust gas pressure. Effective exhaust gas recirculation is achieved as a result of the pressure difference.

The quantity of intake air is regulated with the throttle valve in diesel particulate filter regeneration mode.

The flap is closed when the engine is switched off. Less air is therefore taken in and compressed, as a result of which engine shut off is gentle.

S403_101

Throttle valve module J338 with throttle valve potentiometer G69

Effect upon failure

Correct regulation of the rate of exhaust gas recirculation is impossible. There is no active regeneration of the diesel particulate filter.

Throttle valve potentiometer G69

The throttle valve potentiometer is integrated in the throttle valve drive. The sensor element measures the current position of the throttle valve.

Signal use

The signal informs the engine control unit about the current position of the throttle valve. This information is required for regulation of the exhaust gas recirculation and regeneration of the particulate filter.

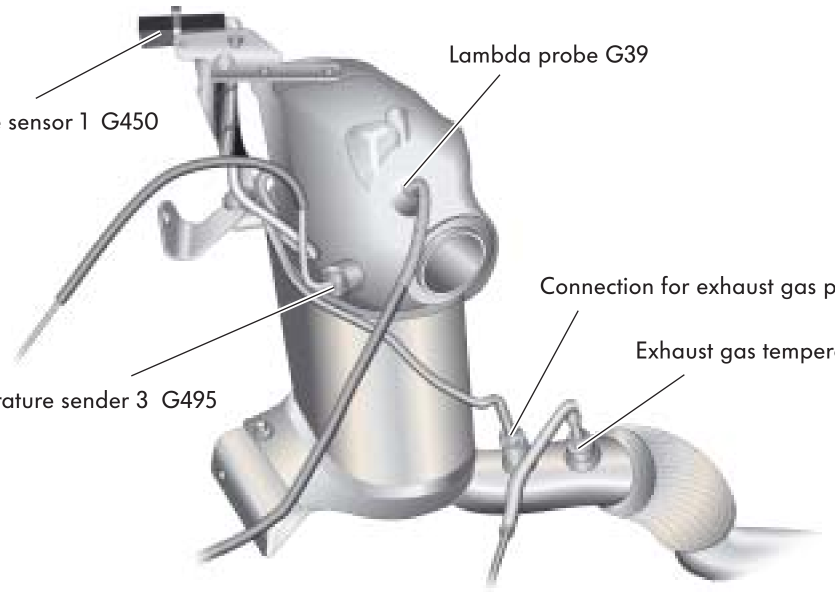
Effects upon failure

If the throttle valve potentiometer fails, the exhaust gas recirculation is switched off and there is no active regeneration of the diesel particulate filter.

Engine Management

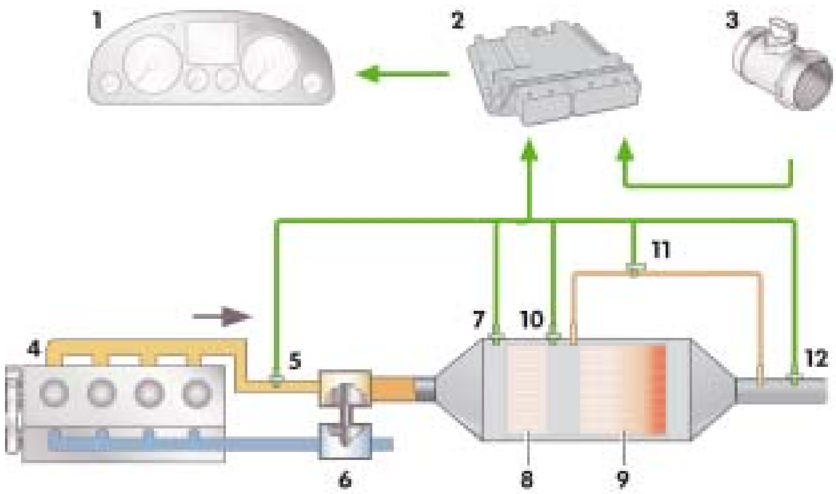
Diesel particulate filter system

In the 2.0l TDI CR engine, carbon particulate emissions are additionally reduced by means of a diesel particulate filter in addition to measures implemented inside the engine. In the Tiguan, the diesel particulate filter is in a housing together with the oxidation catalytic converter. It is located close to the engine so that it reaches the operating temperature quickly.



S403_054

Overview of system



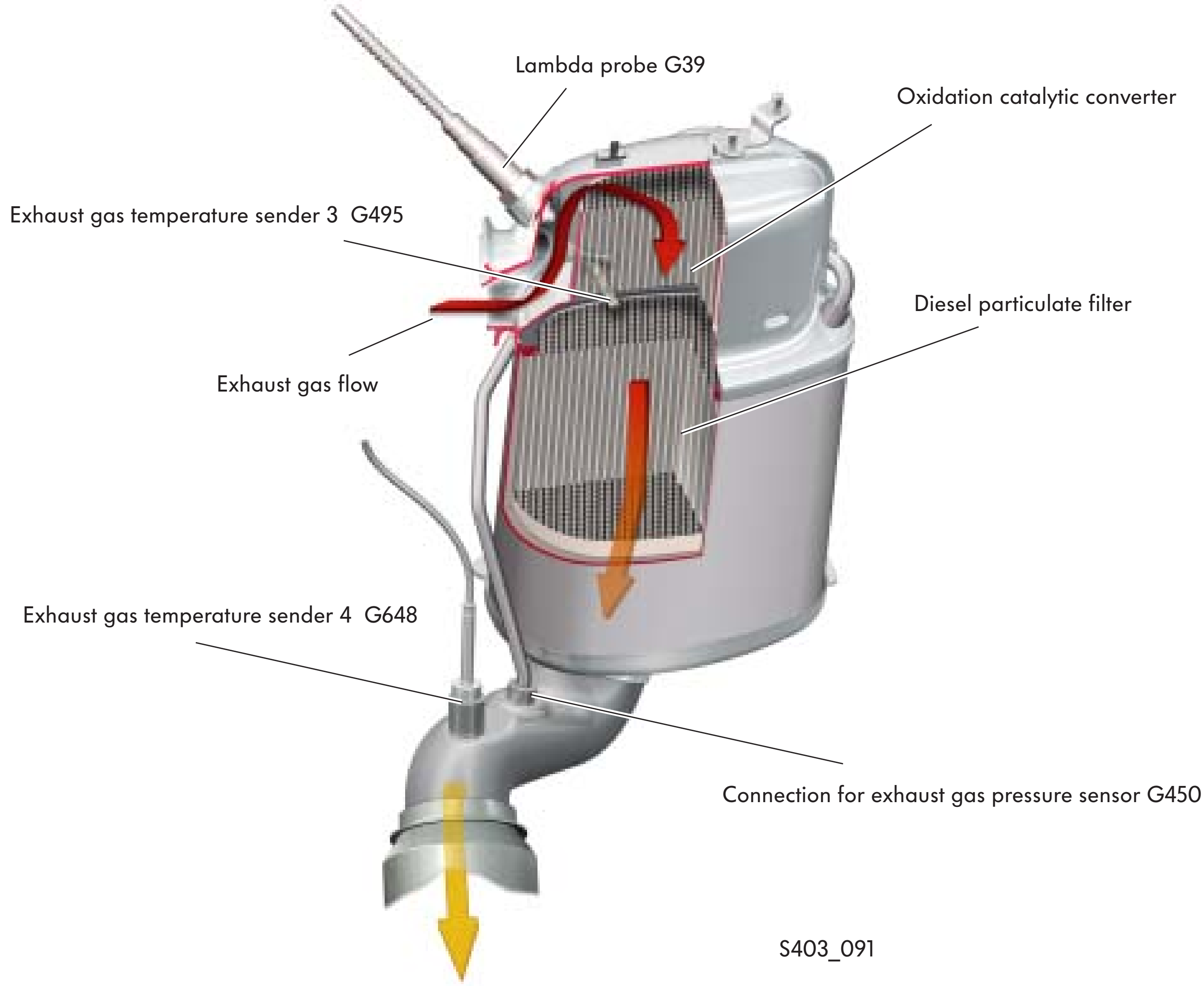
S403_073

Legend

1 - Control unit with display in dash panel insert J285
2 - Engine control unit J623
3 - Air mass meter G70
4 - Diesel engine
5 - Exhaust gas temperature sender 1 G235
6 - Turbocharger
7 - Lambda probe G39
8 - Oxidising catalytic converter
9 - Diesel particulate filter
10 - Exhaust gas temperature sender 3 G495
11 - Exhaust gas pressure sensor 1 G450
12 - Exhaust gas temperature sender 4 G648

Design

The diesel particulate filter and the oxidation catalytic converter are fitted separately from each other in a single housing. The oxidation catalytic converter is located upstream from the particulate filter.



S403_091

The setup with upstream oxidation catalytic converter has the following advantages in conjunction with the common rail injection system:

- The position of the oxidation catalytic converter increases the temperature of the exhaust gas ahead of the diesel particulate filter. This allows the diesel particulate filter to reach its operating temperature quickly.
- In boost mode, extreme cooling of the diesel particulate filter due to the cold intake air is avoided. In this case, the oxidation catalytic converter acts like a temperature store that releases heat through the exhaust gas flow to the particulate filter.
- In the regeneration process, the temperature of the exhaust gas can be regulated more precisely in comparison with the catalytic-coated diesel particulate filter. The exhaust gas temperature sender 3 determines the exhaust gas temperature immediately in front of the particulate filter. This allows the quantity of fuel for the secondary injection phase, which is used to increase the exhaust gas temperature during the regeneration process, to be calculated precisely.

Oxidation catalytic converter

The base material of the oxidation catalytic converter is made from metal to quickly reach the start-up temperature. There is a substrate of aluminium oxide on this metal body. Platinum is applied onto this as a catalyst for the hydrocarbons (HC) and the carbon monoxide (CO).

Function

The oxidation catalytic converter converts a large portion of the hydrocarbons (HC) and the carbon monoxide (CO) into water vapour and carbon dioxide.

The design and function of the oxidation catalytic converter is described in self-study programme no. 124 "Diesel engine with catalytic converter".

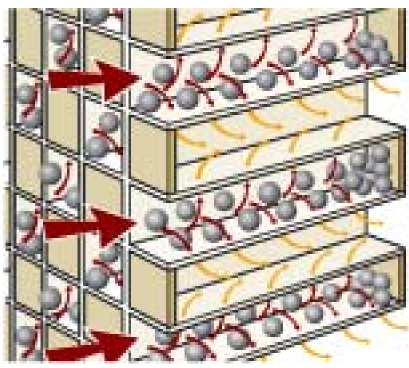
Diesel particulate filter

The diesel particulate filter consists of a honeycomb ceramic body made from silicon carbide. The ceramic body is sub-divided into a multitude of small channels, which are sealed on alternating sides. This results in intake and exhaust channels, which are separated by filter walls.

The filter walls are porous and are coated with a substrate comprised of aluminium oxide and cerium oxide. The precious metal platinum, which serves as the catalyst, is applied onto this substrate.

Function

The exhaust gas, which contains carbon, flows through the filter walls of the intake channels. Unlike the gaseous components of the exhaust gas, the carbon particles are retained in the intake channels.



S403_072

You will find basic information on the diesel particulate filter system in self-study programme no. 336 "The catalytic coated diesel particulate filter".

Regeneration

To prevent the particulate filter from becoming blocked with carbon particles, thereby impeding its function, it must be regularly regenerated. During the regeneration process, the carbon particles that have collected in the particulate filter are burned (oxidised).

The particulate filter is regenerated in the following steps:

- Passive regeneration
- Heat-up phase
- Active regeneration
- Regeneration drive by customer
- Service regeneration

Passive regeneration

During passive regeneration, the carbon particles are continuously combusted without engine management system intervention. This is primarily carried out at high engine loads, e.g. motorway driving, at exhaust gas temperatures of 350 °C – 500 °C.
In this case, the carbon particles are converted to carbon dioxide via a reaction with nitrogen dioxide.

Heat-up phase

To heat up a cold oxidation catalytic converter and particulate filter as fast as possible and thus bring them to operating temperature, a secondary injection phase is initiated by the engine management after the main injection phase.
This fuel combusts in the cylinder and raises the combustion temperature level. The heat generated reaches the oxidation catalytic converter and the particulate filter via the air flow in the exhaust gas train and heats it up.
The heat-up phase is complete once the operating temperature of the oxidation catalytic converter and the particulate filter has been reached for a specific time.

Engine Management

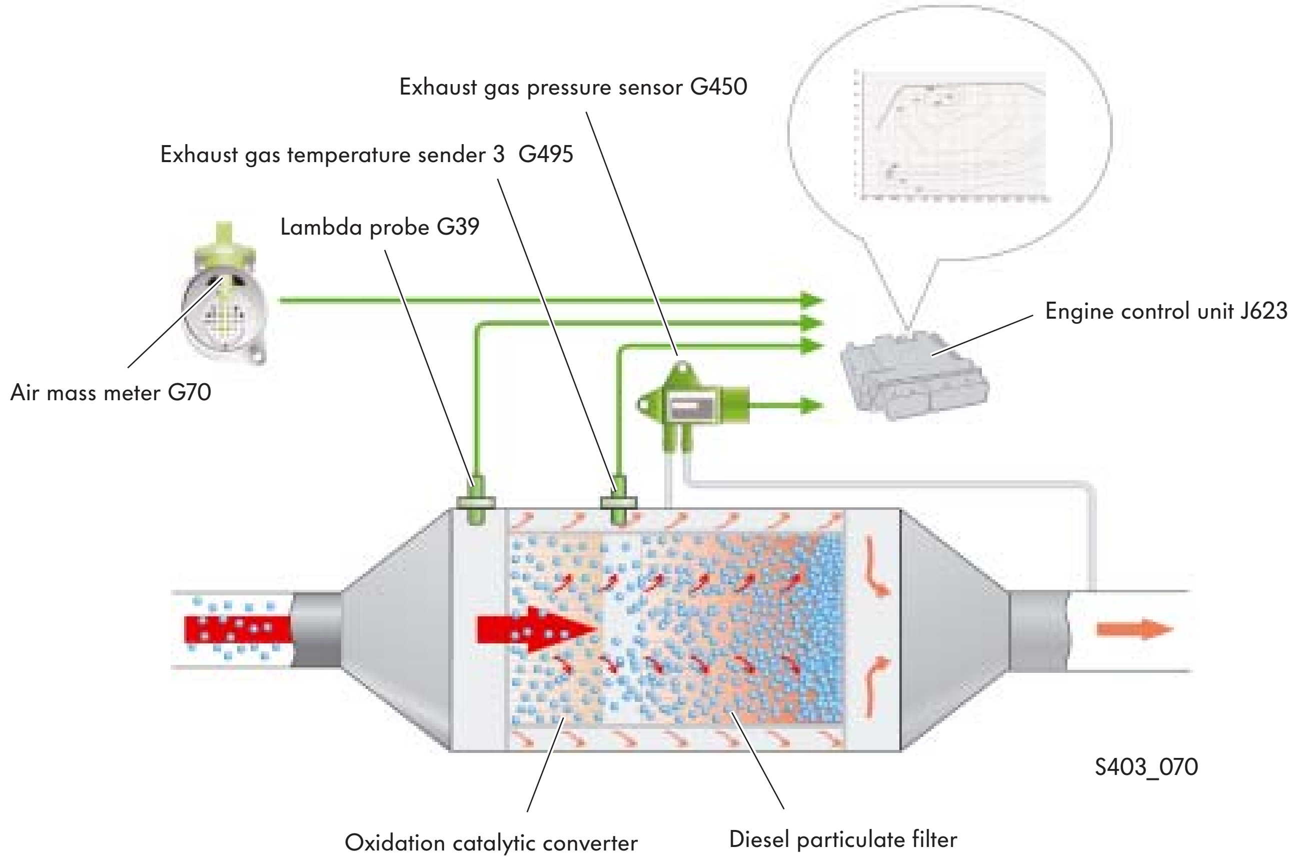
Active regeneration

The exhaust gas temperatures are too low for passive regeneration in a large part of the operating range. As no further carbon particles can be degraded passively, the carbon accumulates in the filter.
As soon as a specific level of carbon has been reached in the filter, active regeneration is introduced by the engine management system. The carbon particles are combusted at an exhaust gas temperature of 550 – 650 °C to form carbon dioxide.

Active regeneration function

The carbon level of the particulate filter is calculated by two pre-programmed level models in the engine control unit.
One carbon level model is determined from the user's driving style and the exhaust gas temperature sensor and lambda probe signals.

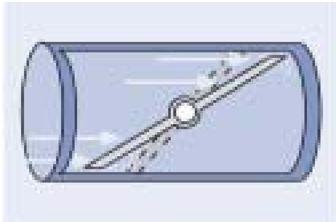
A further carbon level model is the flow resistance of the particulate filter. It is calculated using the signals from the exhaust gas pressure sensor 1, the exhaust gas temperature sensors and the air mass meter.



S403_070

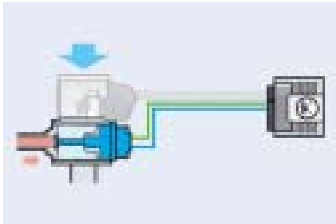
Measures carried out by the engine control unit during active regeneration to increase the exhaust gas temperature:

- The intake air supply is regulated via the throttle valve module.



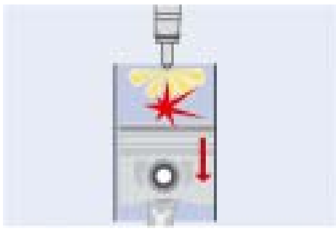
S403_074

- Exhaust gas recirculation is switched off to increase the combustion temperature and the oxygen content in the combustion chamber.



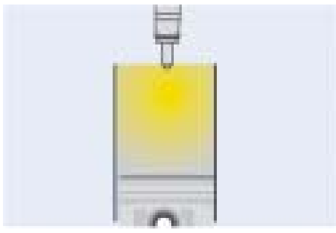
S403_075

- Shortly after a "retarded" main injection, the first secondary injection is initiated to increase the combustion temperature.



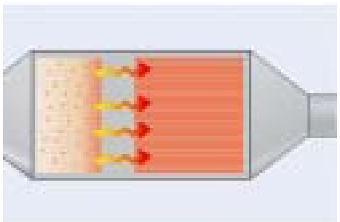
S403_076

- Further secondary injection is introduced long after main injection. This fuel does not combust in the cylinder, but evaporates in the combustion chamber.



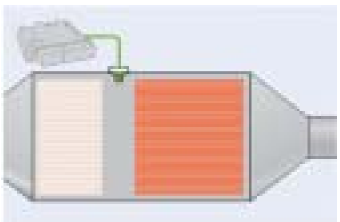
S403_077

- The uncombusted hydrocarbons contained in this fuel vapour are oxidised in the oxidising catalytic converter. The heat which is generated during this process reaches the particulate filter via the air flow and increases the exhaust gas temperature upstream of the particulate filter to approximately 620 °C.



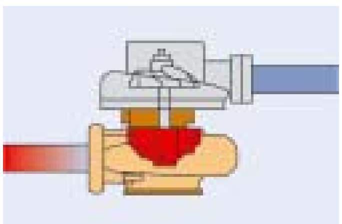
S403_078

- The signal from the exhaust gas temperature sender 3 G345 upstream of the particulate filter is used by the engine control unit to calculate the injection quantity for the late secondary injection phase.



S403_080

- The charge air pressure is adjusted so that the torque does not change noticeably for the driver during the regeneration process.



S403_079

Engine Management

Regeneration drive by customer

If the vehicle is only used for short journeys, the exhaust gas temperature is not sufficiently high to regenerate the filter. If the contamination status of the diesel particulate filter reaches a limit value, the diesel particulate filter warning lamp will illuminate in the dash panel insert.
This signal tells the driver to perform a regeneration drive. The vehicle needs to be driven at high speed for a short period so that a sufficiently high exhaust gas temperature is reached and the operating conditions for successful regeneration remain constant over the time period.

For detailed information on driving behaviour when the diesel particulate filter warning lamp lights up, please refer to the owner's manual.

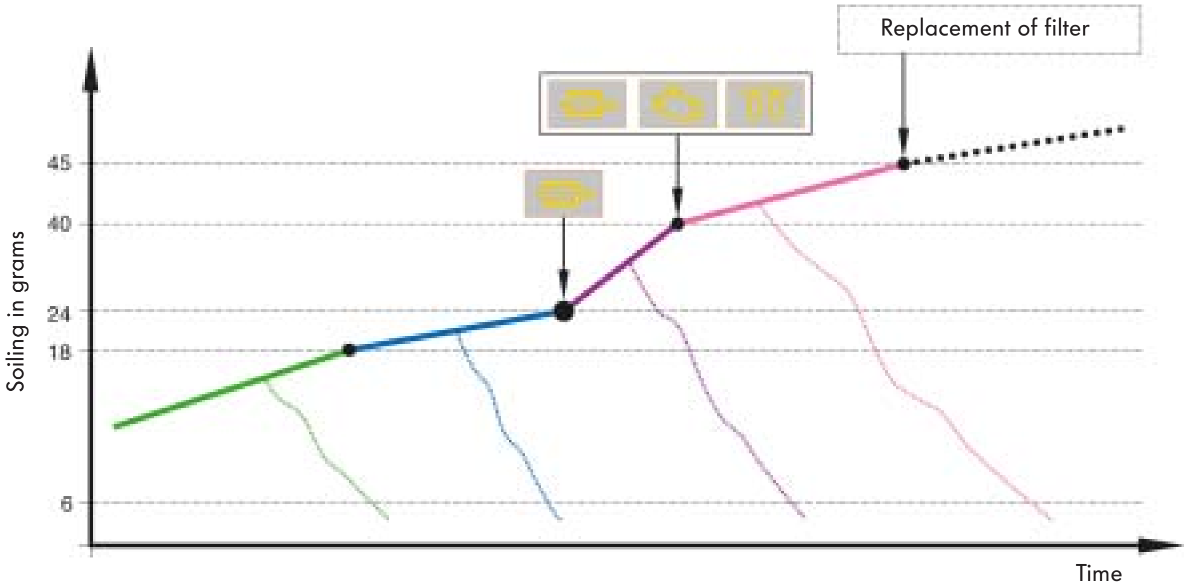
Service regeneration

If the regeneration drive is not successful and the contamination status of the diesel particulate filter has reached 40 grams, the glow period warning lamp will light up in addition to the diesel particulate filter warning lamp. The text "Engine malfunction – workshop" appears in the dash panel insert display.
The driver is thereby requested to seek the next workshop. In this case, the active regeneration of the diesel particulate filter is prevented by the engine control unit to avoid damage to the diesel particulate filter.

The diesel particulate filter can only be regenerated in the workshop by means of service regeneration with the VAS 5051.

Above a soiling state of 45 grams, service regeneration is no longer possible as the risk of destroying the filter is too great. In this case, the filter should be replaced.

Regeneration stages of 2.0l TDI CR engine in the Tiguan



S403_105

Example:
Increase in soot

Example:
Curve after successful regeneration in the respective stage

Passive regeneration

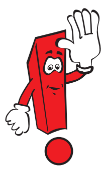
Active regeneration

Regeneration drive by customer

Service regeneration

"Kilometre regeneration"

The "kilometre regeneration" is a route-dependent regeneration of the diesel particulate filter.
The engine control unit automatically initiates active regeneration if there has been no successful regeneration or no regeneration at all in the last 750 - 1000 km regardless of the soiling status of the diesel particulate filter.
The "kilometre regeneration" serves as an additional safeguard to keep the contamination state of the diesel particulate filter low.



A small amount of engine oil is always burnt while the engine is running. Some of the burnt engine oil collects in the diesel particulate filter in the form of ash. This oil ash can also not be decomposed during active regeneration.
To ensure efficient functioning of the diesel particulate filter, the limit value for the ash mass in the measured value block needs to be checked during the inspection service.
The diesel particulate filter should be replaced if this limit value is exceeded.
Please refer to the information in "Maintenance Manual" in ELSA.

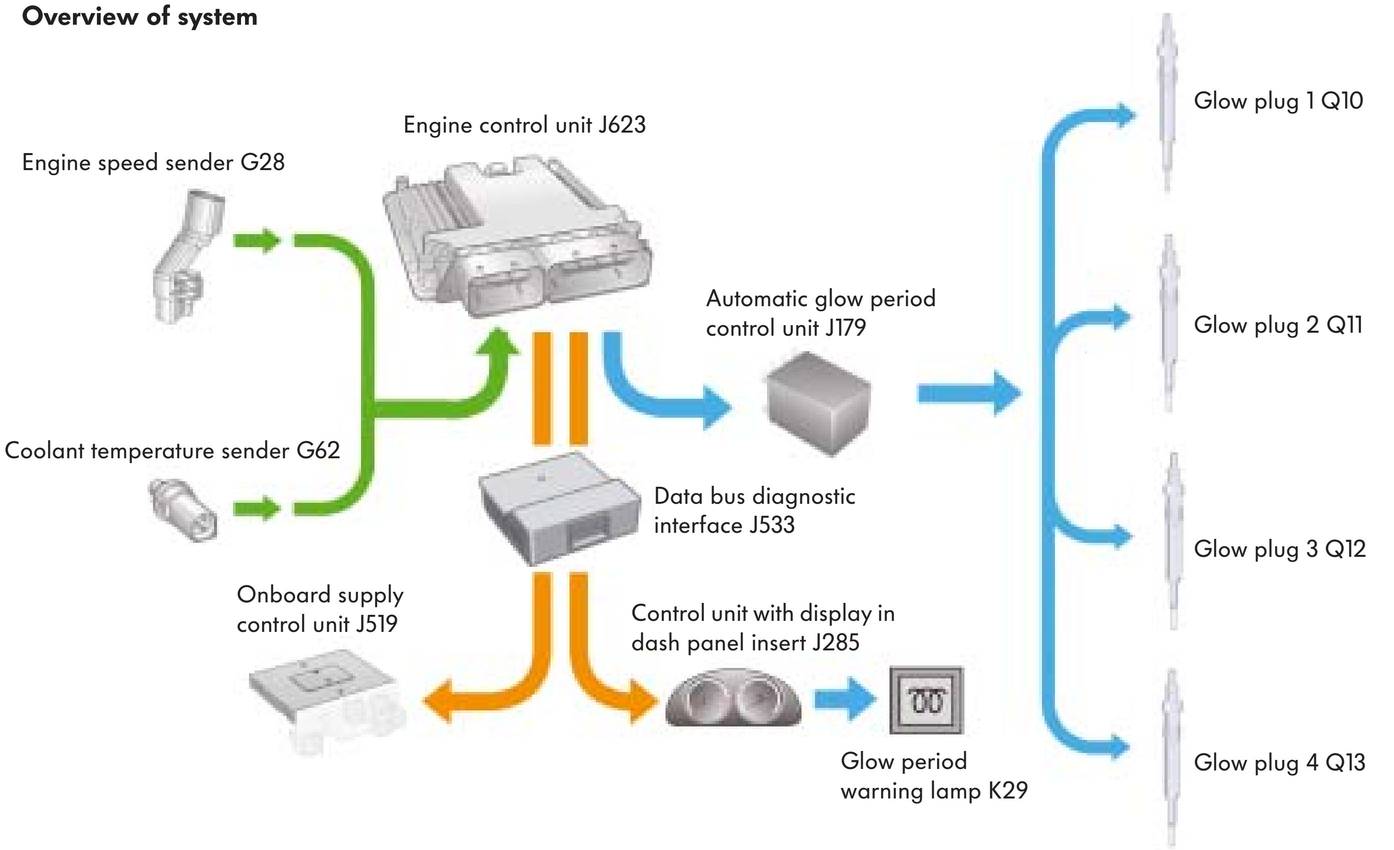
Glow plug system

The 2.0l TDI engine with common rail injection system has a diesel fast start glow plug system. This enables immediate starting, like that of a petrol engine, without a long glow period under practically all climatic conditions.

Advantages of this glow plug system:

- Petrol engine-like start at temperatures down to minus 24 °C.
- Extremely fast heat-up time. Up to 1000 °C are reached at the glow plug within 2 seconds.
- Controllable glow and post-start glow temperatures
- Self-diagnosis-capable
- Part of European On-Board Diagnosis glow plug system

Overview of system



S403_057

Function

Glowing

The steel glow plugs are actuated out of phase by the engine control unit via the automatic glow period control unit J179 with the aid of a pulse-width modulated signal (PWM). The voltage at the individual glow plug is adjusted via the frequency of the PWM pulses in this case. For rapid starting at outside temperatures below 18 °C, the maximum voltage of 11.5 V is applied for heating. This guarantees that the glow plug is heated to over 1000 °C within the shortest possible space of time (max. 2 seconds). This reduces the engine glow period.

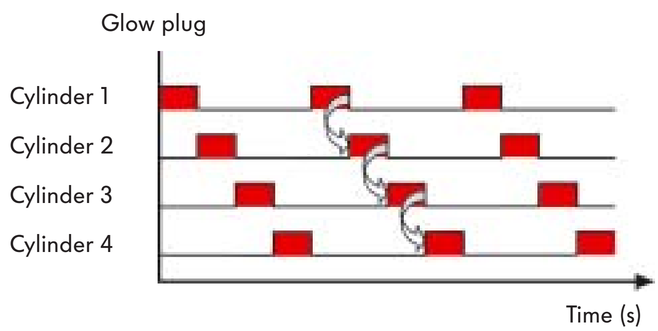
Post-start glowing

By continuously reducing the pulse duty factor of the PWM signal, the voltage for post-start glowing is adjusted to the rated voltage of 4.4 V depending on the operating point.

The post-start glowing is carried out for max. 5 minutes after the engine is started up to a coolant temperature of 18 °C. The post-start glowing helps reduce the hydrocarbon emissions and combustion noises during the engine warm-up phase.

Offset-phase control of glow plugs

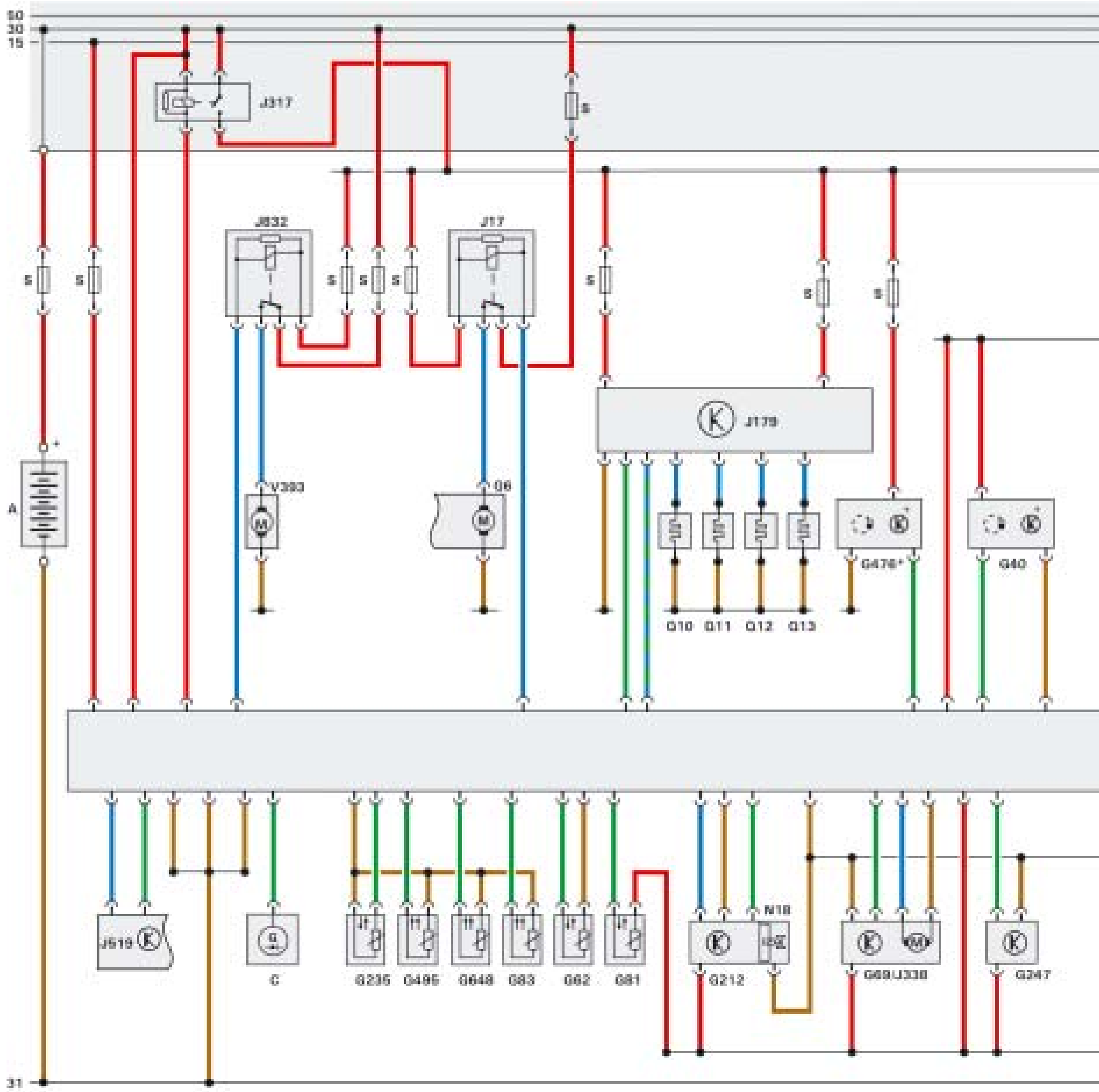
The glow plugs are activated in offset phases to relieve the burden on the onboard supply during the glow phases. The falling signal edge always activates the next glow plug.



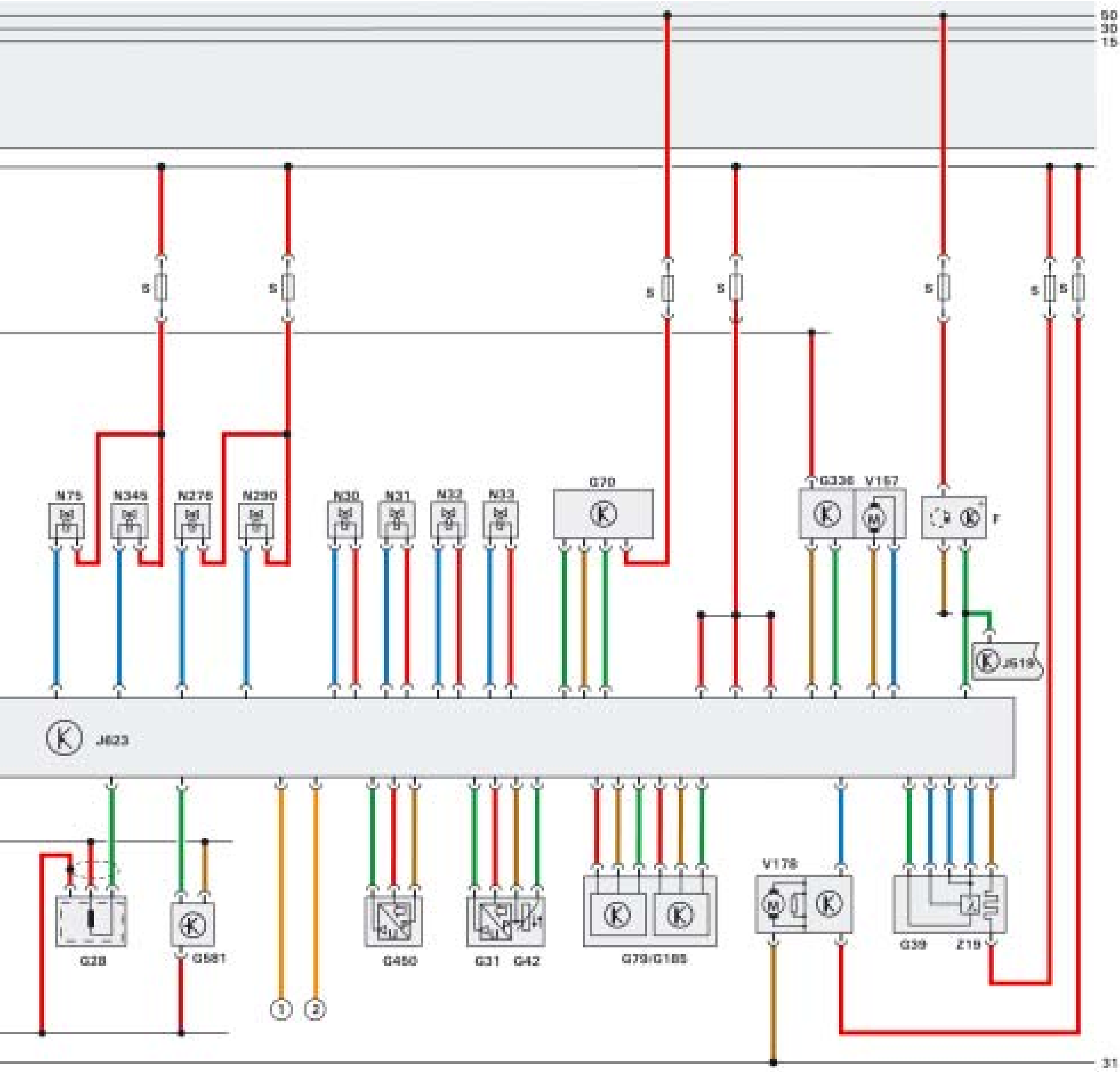
S403_056

Engine Management

Functional diagram



A	Battery
C	Alternator
F	Brake light switch
G6	Fuel system pressurisation pump
G28	Engine speed sender
G31	Charge air pressure sender
G39	Lambda probe
G40	Hall sender
G42	Intake air temperature sender
G62	Coolant temperature sender
G69	Throttle valve potentiometer
G70	Air mass meter
G79	Accelerator position sender
G81	Fuel temperature sender
G83	Radiator outlet coolant temperature sender
G185	Accelerator position sender 2
G212	Exhaust gas recirculation potentiometer
G235	Exhaust gas temperature sender 1
G247	Fuel pressure sender
G336	Intake manifold flap potentiometer
G450	Exhaust gas pressure sensor 1
G476*	Clutch position sender
G495	Exhaust gas temperature sender 3
G581	Position sender for charge pressure positioner
G648	Exhaust gas temperature sender 4
J17	Fuel pump relay
J179	Automatic glow period control unit
J317	Terminal 30 voltage supply relay
J338	Throttle valve module
J519	Onboard supply control unit
J623	Engine control unit
J832	Relay for supplementary fuel pump
N18	Exhaust gas recirculation valve
N30-33	Injectors for cylinders 1-4



S403_048

N75 Charge pressure control solenoid valve
N276 Fuel pressure regulating valve
N290 Fuel metering valve
N345 Exhaust gas recirculation cooler change-over valve
Q10-13 Glow plugs 1-4
S Fuse
V157 Intake manifold flap motor
V178 Coolant circulation pump 2
V393 Supplementary fuel pump
Z19 Lambda probe heater

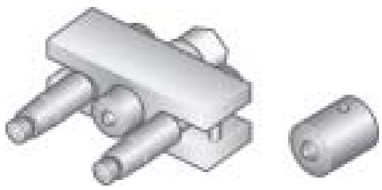
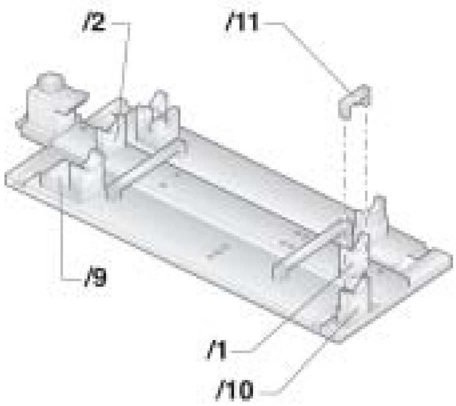
① CAN data bus low
② CAN data bus high

Input signal
Output signal
Positive
Earth
CAN BUS
Bi-directional

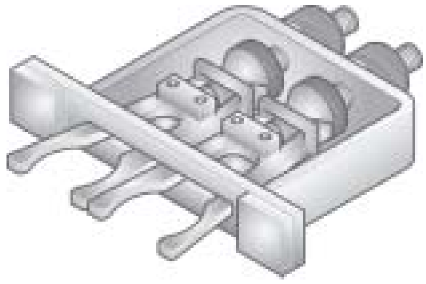
* only in vehicles with manual gearbox

Special tools

Description	Tool	Application
T10172/9 Adapter	 S403_113	Adapter for counter-hold tool T10172 for counter-holding sprocket of high-pressure pump
T10377 Assembly sleeve	 S403_068	For fitting the O-ring on the injector
T10384 Ratchet wrench	 S403_114	For fitting and removing the diesel particulate filter

Description	Tool	Application
T10385 Socket	 S403_112	For removing and fitting the exhaust gas recirculation pipe
T40064/1 Thrust piece	 S403_066	Thrust piece for puller T40064 for removing the toothed belt sprocket for the high-pressure pump
T40094 Camshaft fitting tool T40094/1 Mount T40094/2 Mount T40094/9 Mount T40094/10 Mount T40094/11 Lid	 S403_063	For removing and fitting the camshaft

Special tools

Description	Tool	Application
T40095 Clamping tool	 S403_064	For removing and fitting the camshaft
T40096/1 Clamping tool	 S403_065	For clamping the split camshaft wheel when fitting and removing camshaft
T40159 Socket with ball head	 S403_067	For assembly work on intake manifold

Which answer is correct?

One or several of the answers which are provided may be correct.

1. What is the purpose of the intake manifold with swirl flaps?

☐ a) The swirl of the intake air is adjusted via the position of the swirl flaps depending on the engine speed and load.

☐ b) On the basis of the position of the swirl flaps, the system switches between a short and long intake manifold according to a map.

☐ c) The swirl flaps are closed when the engine switched off and the air supply is interrupted so that engine runs to a stop smoothly.

2. Which statement about the low-temperature exhaust gas recirculation is correct?

☐ a) The cooling of the recirculated exhaust gases allows a larger quantity of exhaust gases to be recirculated and further reduces the nitrogen oxide emissions from the engine.

☐ b) The cooling of the recirculated exhaust gases protects the diesel particulate filter against overheating.

☐ c) The recirculated exhaust gases are cooled so that the engine achieves a higher maximum output.

3. What is the purpose of the overflow valve in the high-pressure pump?

☐ a) The overflow valve regulates the quantity of fuel that enters the high-pressure area.

☐ b) It regulates the fuel pressure in the low-pressure area of the high-pressure pump.

☐ c) It is a safety valve that protects the high-pressure pump from excessively high fuel temperatures.

Test Yourself

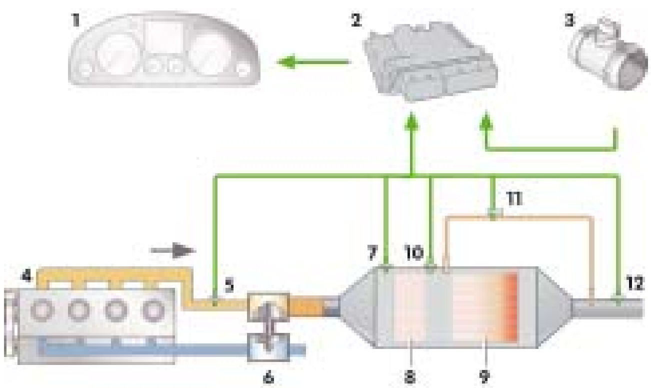
4. Which statement about the supplementary fuel pump V393 is correct?

☐ a) The supplementary fuel pump V393 supplies the auxiliary heater with diesel fuel.

☐ b) No fuel system pressurisation pump is required in the fuel tank due to the use of the supplementary fuel pump V393.

☐ c) The supplementary fuel pump increases the fuel pressure in the supply line and supplies the high-pressure pump with sufficient fuel in all operating modes.

5. Please fill in the missing terms:



S403_073

1 - Control unit with display in dash panel insert J285

2 - ....

3 - ....

4 - Diesel engine

5 - ....

6 - Turbocharger

7 - ....

8 - ....

9 - ....

10 - ....

11 - ....

12 - ....

6. What is this special tool required for?

S403_068

for ....

Answers:

1. a;
2. a;
3. b;
4. c;
5. 2 - Engine control unit J623
   3 - Air mass meter G70
   5 - Exhaust gas temperature sender 1 G235
   7 - Lambda probe G39
   8 - Oxidising catalytic converter
   9 - Particulate filter
   10 - Exhaust gas temperature sender 3 G495
   11 - Exhaust gas pressure sensor 1 G450
   12 - Exhaust gas temperature sender 4 G648
6. For fitting the O-ring on the injector

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