Service Training

Self-study Programme 360

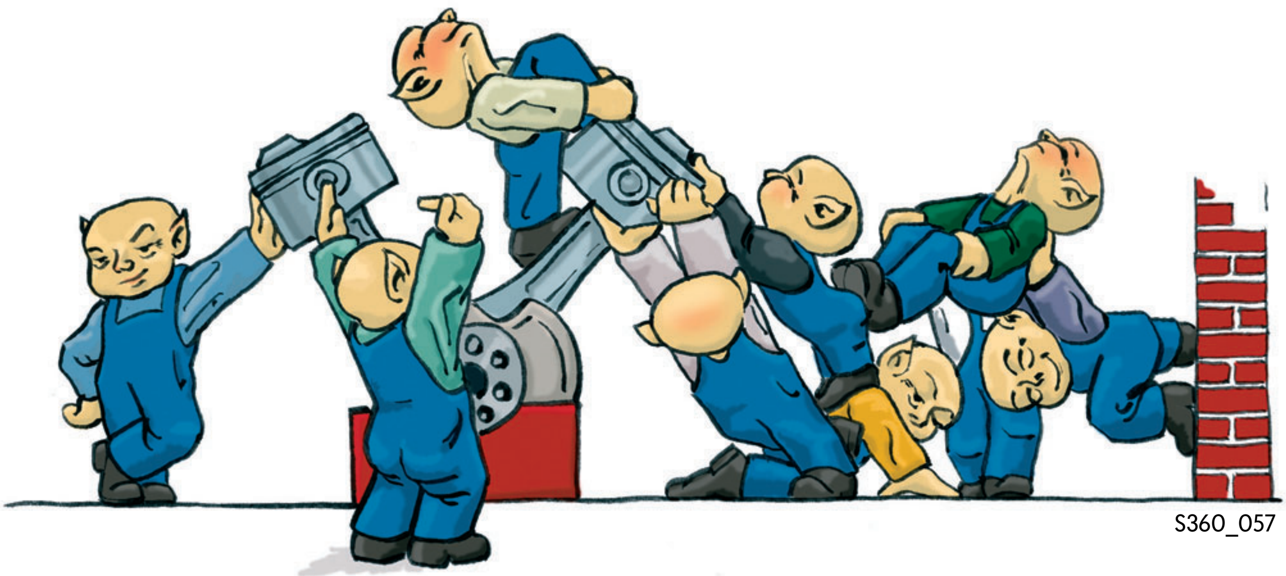
The 3.2l and 3.6l FSI Engine

Design and Function

The 3.2l, the 3.6l V6 FSI engine and the 3.6l V6 R36 FSI engine are VR engines. Having a smaller V-angle compared with a classic V engine, they have an extremely compact and space-saving design.

VR engines have a long tradition at Volkswagen. The VR success story started in 1991 with the production start of the 2.8l VR6 engine. The VR5 engine followed in 1997 and the VR6 was changed to four-valve technology in 1999. In 2000, the displacement of the VR6 was raised to 3.2 litres allowing outputs of up to 184kW.
The VR engines have a wide range of applications thanks to their compactness.

This self-study programme was conceived for use within Volkswagen Group. For this reason, it does not describe the use of the engine in one particular vehicle.
Where, however, a vehicle is referred to, it is only an example intended to help describe the design and functioning or to simplify the explanations.



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NEW

Important 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

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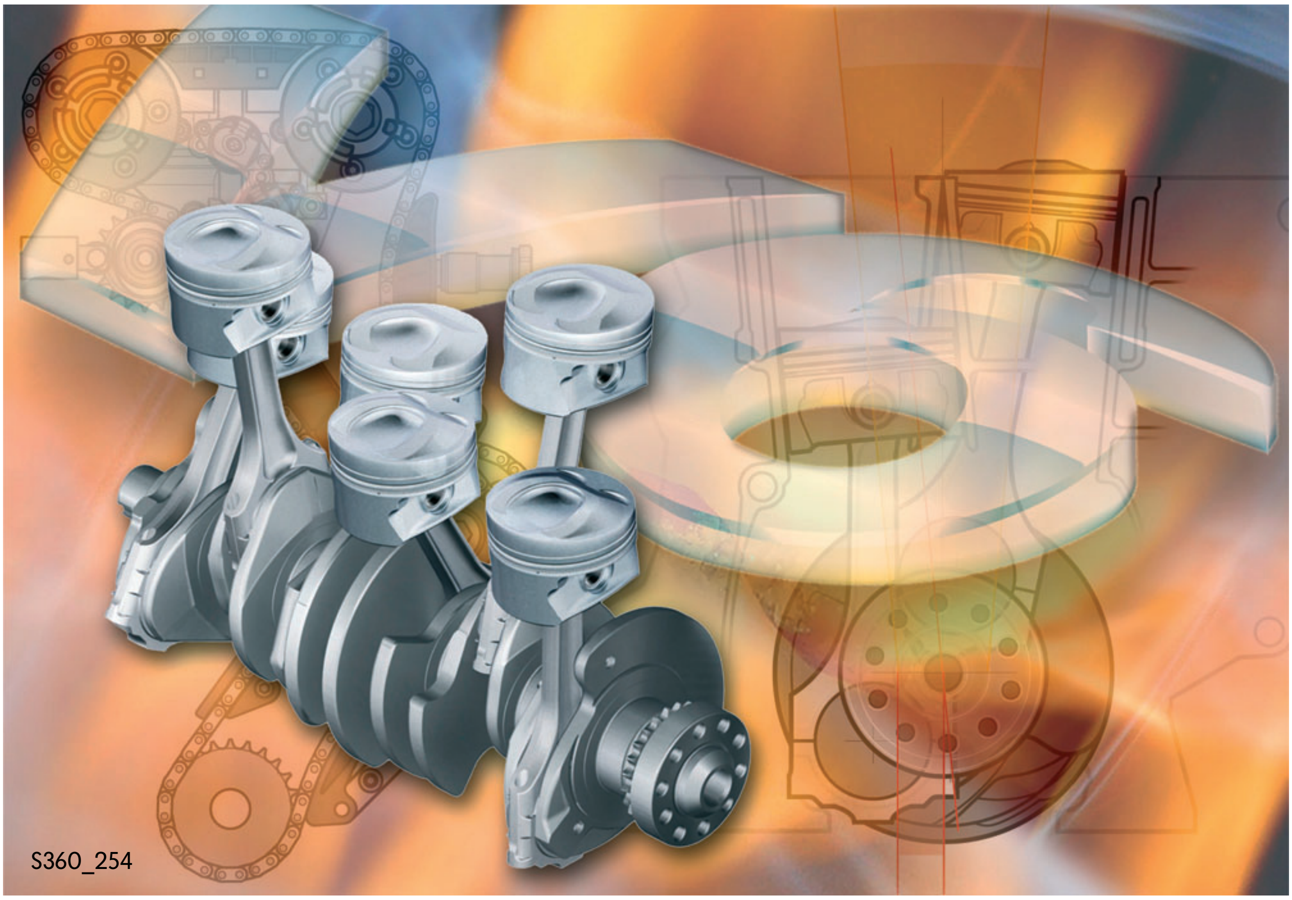
The new 3.2l and 3.6l V6 FSI engines as well as the 3.6l V6 R36 engines are the three latest products in the VR engine range. While the 3.2l version is being used in the Volkswagen Passat for the first time in Europe, the 3.6l version is being launched in the Volkswagen Passat in North America.
In Europe, the 3.6l V6 FSI engine will be available in the Audi Q7 and in the Volkswagen Touareg.

Increasing the displacement to 3.2l and 3.6l and switching to FSI technology leads to a considerable increase in power and torque compared with the previous model.
The 3.6l V6 R36 engine thus reaches a maximum rated power of 220kW and a maximum torque of 350Nm.
The three compact engines have substantial power outputs and a dynamic torque band.

Special features of the new V6 engines:

- Outside dimensions have been kept the same
- FSI petrol direct injection
- Four-valve technology with roller rocker arms
- Internal exhaust gas recirculation
- Single-piece variable intake manifold made from plastic on 3.2l V6 FSI engine, two-piece variable intake manifold made from plastic on 3.6l V6 FSI engine and 3.6l V6 R36 engine
- Lightweight crankcase made from grey cast iron
- Camshaft driving chain with integrated drive for high-pressure fuel and vacuum pump
- Continuous inlet and exhaust camshaft timing adjustment

Using the FSI direct injection technology allows the current emission levels EU4 and LEV2 to be fulfilled whilst saving fuel without secondary air injection.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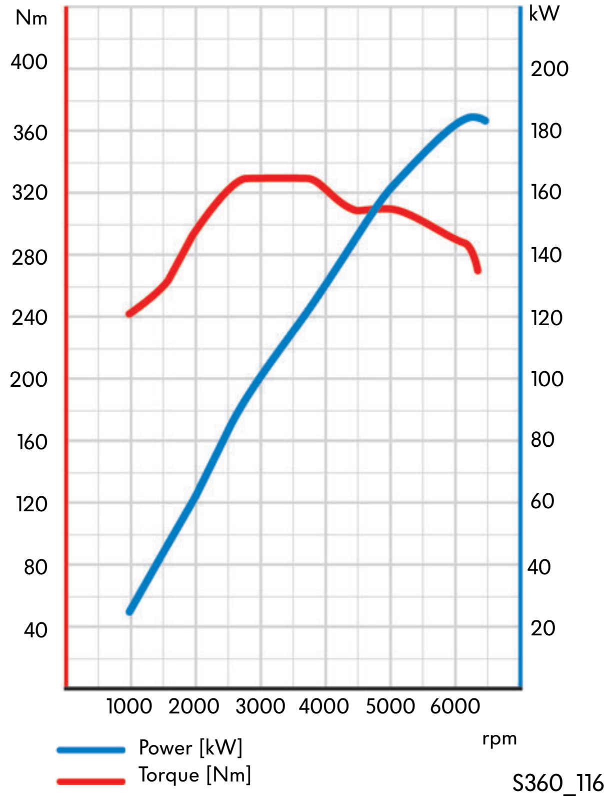
Technical data of 3.2l V6 FSI engine

Type	6-cylinder VR engine
Displacement	3168 cm^3
Bore	86.0 mm
Stroke	90.9 mm
V angle	10.6°
Valves per cylinder	4
Compression ratio	12 : 1
Maximum output	184kW at 6250 rpm
Maximum torque	330Nm at 2750 – 3750 rpm
Engine management	Motronic MED 9.1
Fuel	Super Plus unleaded at RON 98 (Super unleaded at RON 95 with reduction in performance)
Exhaust gas treatment	Two three-way catalytic converters with Lambda control
Emissions standard	EU4

Power and torque development graph



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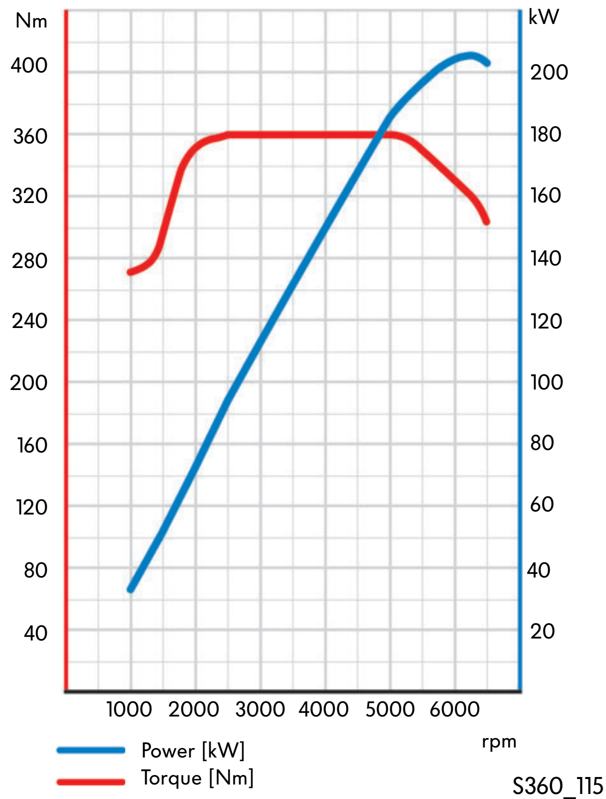
Technical data of 3.6l V6 FSI engine (Touareg)

Type	6-cylinder VR engine
Displacement	3597 cm^3
Bore	89 mm
Stroke	96.4 mm
V angle	10.6°
Valves per cylinder	4
Compression ratio	12 : 1
Maximum output	206kW at 6200 rpm
Maximum torque	360Nm at 2500 – 5000 rpm
Engine management	Motronic MED 9.1
Fuel	Super Plus unleaded at RON 98 (Super unleaded at RON 95 with reduction in performance)
Exhaust gas treatment	Two three-way catalytic converters with Lambda control
Emissions standard	EU4, LEV2

Power and torque development graph



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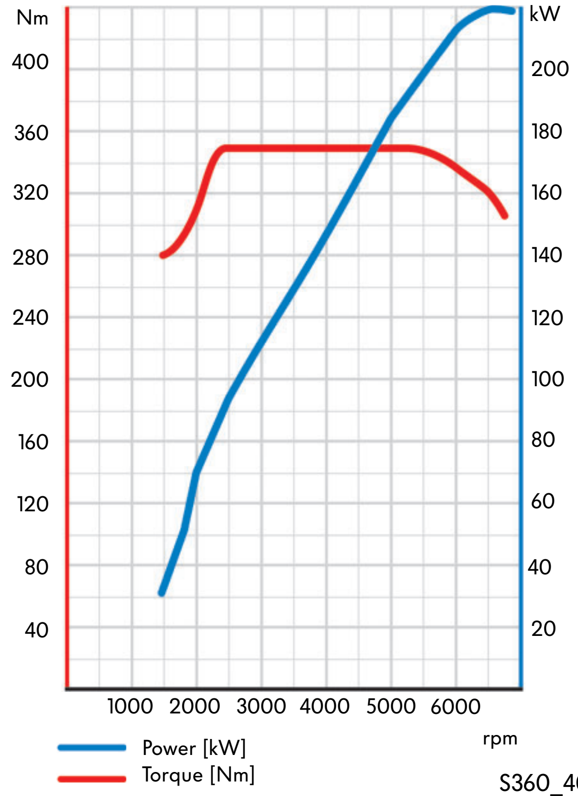
Technical data of 3.6l V6 R36 engine

Type	6-cylinder VR engine
Displacement	3597 cm^3
Bore	89 mm
Stroke	96.4 mm
V angle	10.6°
Valves per cylinder	4
Compression ratio	11.4 : 1
Maximum output	220kW at 6600 rpm
Maximum torque	350Nm at 2400 – 5000 rpm
Engine management	Motronic MED 9.1
Fuel	Super Plus unleaded at RON 98 (Super unleaded at RON 95 with reduction in performance)
Exhaust gas treatment	Two three-way catalytic converters with Lambda control
Emissions standard	EU4, LEV2

Power and torque development graph



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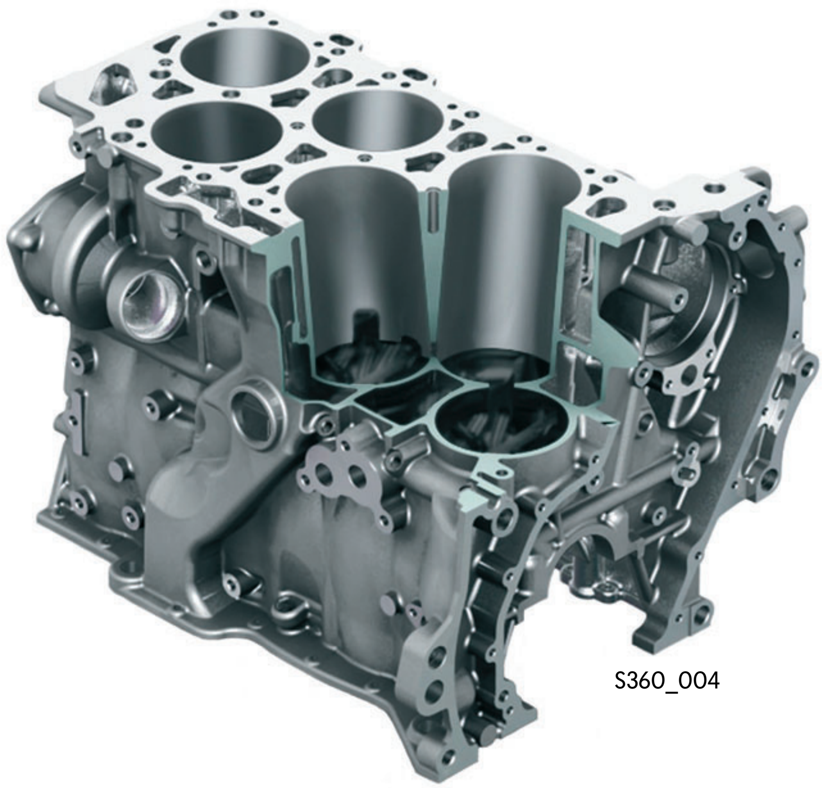
Crankshaft drive

Cylinder block



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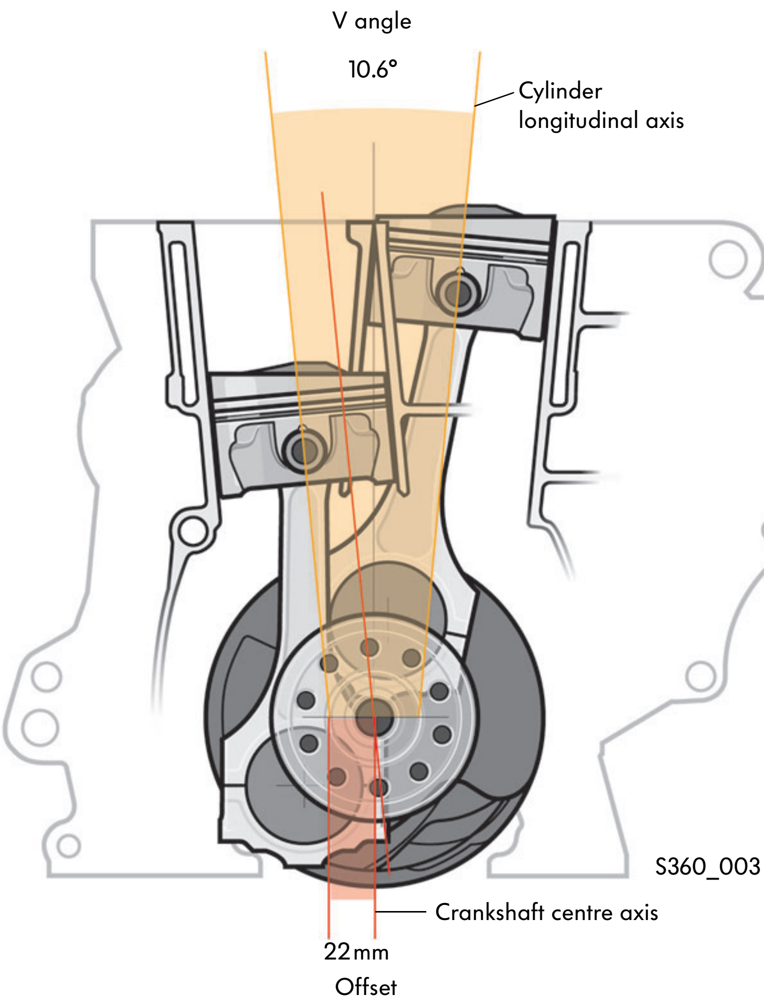
The cylinder block has been extensively revised compared with the 3.2l multi-point injection engine. The aim of the revision was to achieve a displacement of 3.6l without changing the outside dimensions of the engine. This aim was reached by changing the V-angle and the offset.
All three FSI engines, the 3.2l, the 3.6l engine and the 3.6l R36 engine have the new cylinder block. It is made from grey cast iron with lamellar graphite.

Further new features compared with 3.2l multi-point injection engine:

- The oil pump is integrated in the cylinder block.
- Greater oil return from the cylinder block into the oil sump
- Improved stiffness of cylinder block combined with weight reductions
- In the cylinder block, the volume of coolant has been reduced by 0.7 litres. This allows the coolant to heat up faster.



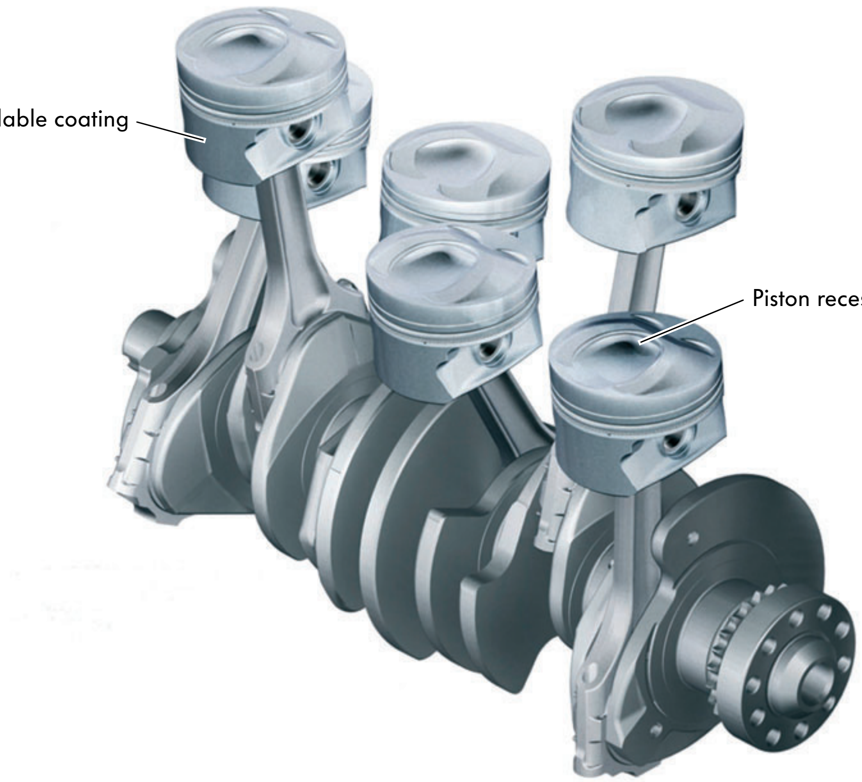
The V angle

The V angle of the cylinder block is 10.6°. Changing the V angle from 15° to 10.6° has allowed the necessary cylinder wall thickness to be ensured without having to change the dimensions of the engine.

Offset

Reducing the V angle has moved the cylinder longitudinal axis to the outside at the bottom compared with the crankshaft.
The spacing of the cylinder longitudinal axis from the crankshaft centre axis is the offset.
The offset has been increased from 12.5 mm to 22 mm compared with the multi-point injection engine.

Engine Mechanics



The crankshaft

The crankshaft is made from grey cast iron and is mounted on 7 bearings like the 3.2l multi-point injection engine.

The pistons

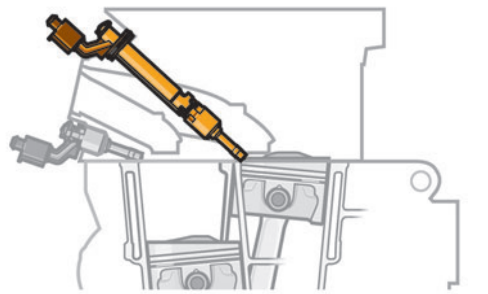
The pistons are recess-type and made from an aluminium alloy. They have a graphite abradable coating on the side to improve the run-in properties.
The pistons for cylinder bank 1 and cylinder bank 2 are different. The difference is in the arrangement of the valve pockets and the combustion chamber recess.
The injected fuel is swirled and mixed with the intake air due to the position and shape of the piston recess.

The connecting rod

The connecting rods are cut, not fracture-split. The connecting rod eye is trapezoidal.
The big end bearings are coated with molybdenum.
As a result, they have good run-in properties and are highly durable

Cylinder head

Injection valves 1, 3, 5



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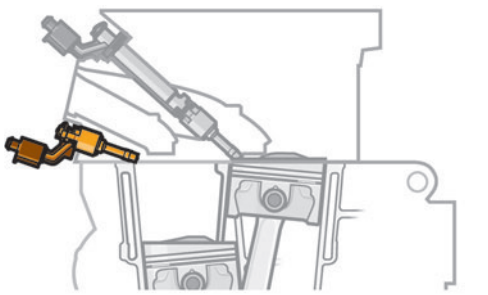
Injection valves 2, 4, 6



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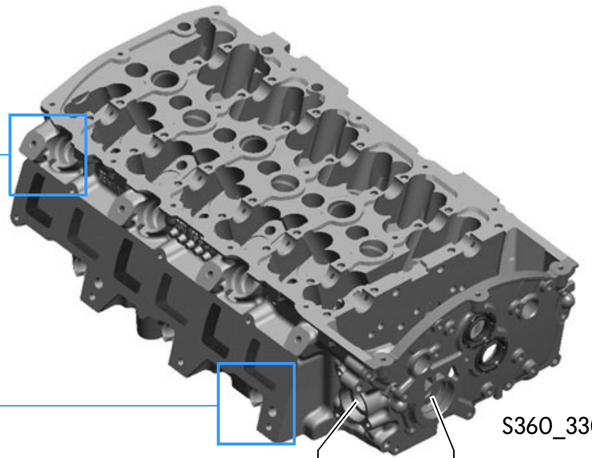
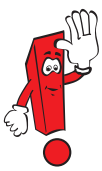


The cylinder head is made from an aluminium/silicon/copper alloy and is identical on the three engines. It is a new design due to the direct injection.
The cylinder head has been made longer to accommodate the camshaft timing chain and for a fixed connection of the high-pressure fuel pump and the vacuum pump.
The injection valves for both cylinder banks are on the intake side of the cylinder head.

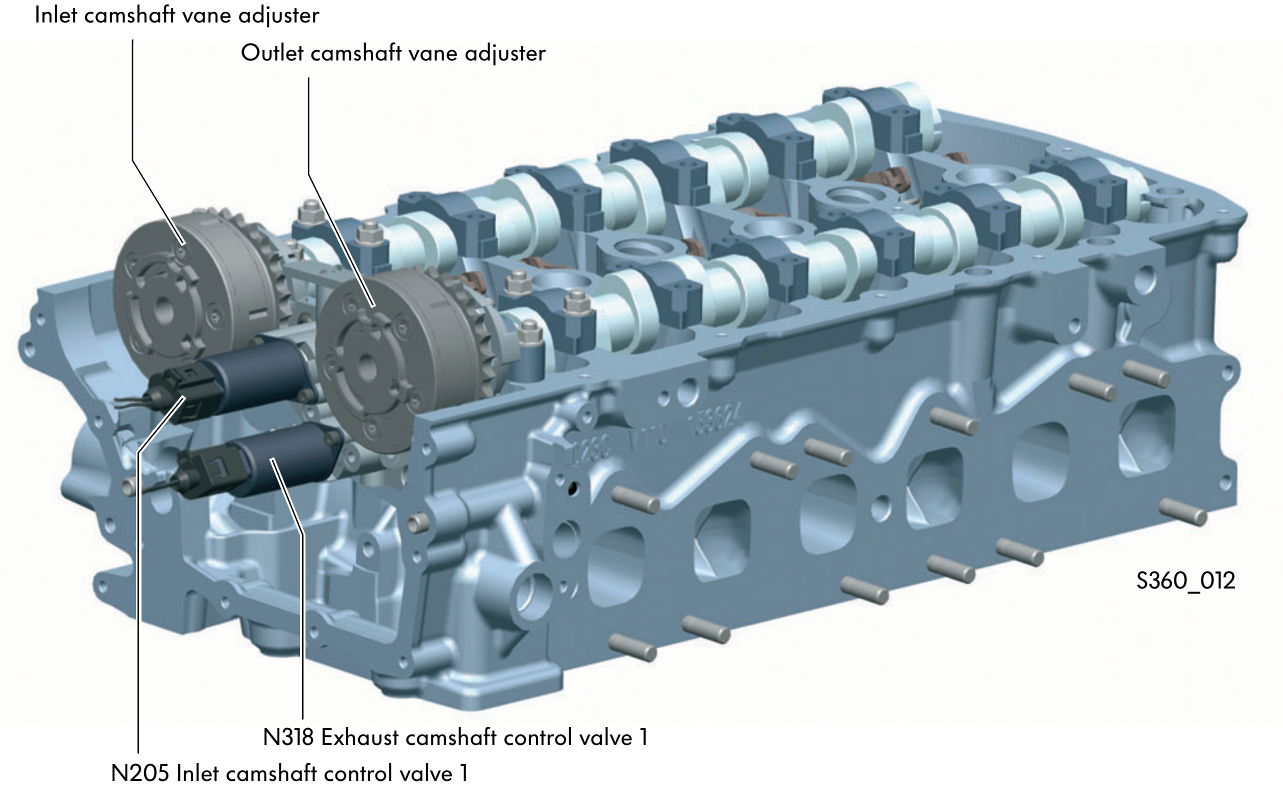
The bores for the injection valves on cylinders 1, 3 and 5 are above the intake manifold flange.
The injection valves for cylinders 2, 4 and 6 are inserted underneath the intake manifold flange.

In this arrangement, the injection valves for cylinders 1, 3 and 5 run through the intake ports of the cylinder head.
To compensate for the influence of the injectors on the flow behaviour in the intake port, the valve spacing for all cylinders has been increased from 34.5 to 36.5 mm. Therefore, when the cylinders are filled, flow diversion by the injection valves is minimised.



Please note that, due to the two different insertion positions for the injectors, two different injector lengths are also required.

Camshaft adjustment system



The adjustment of the camshafts allows the power and the torque to be increased as well as consumption and emissions to be reduced depending on the load behaviour of the engine.
The camshafts are adjusted by two vane adjusters.
Both camshafts can be continuously adjusted in the direction of early opening and in the direction of late opening of the valves.
The engine control unit controls the following solenoid valves to adjust the camshafts:

- N205 Inlet camshaft control valve 1 and
- N318 Exhaust camshaft control valve 1

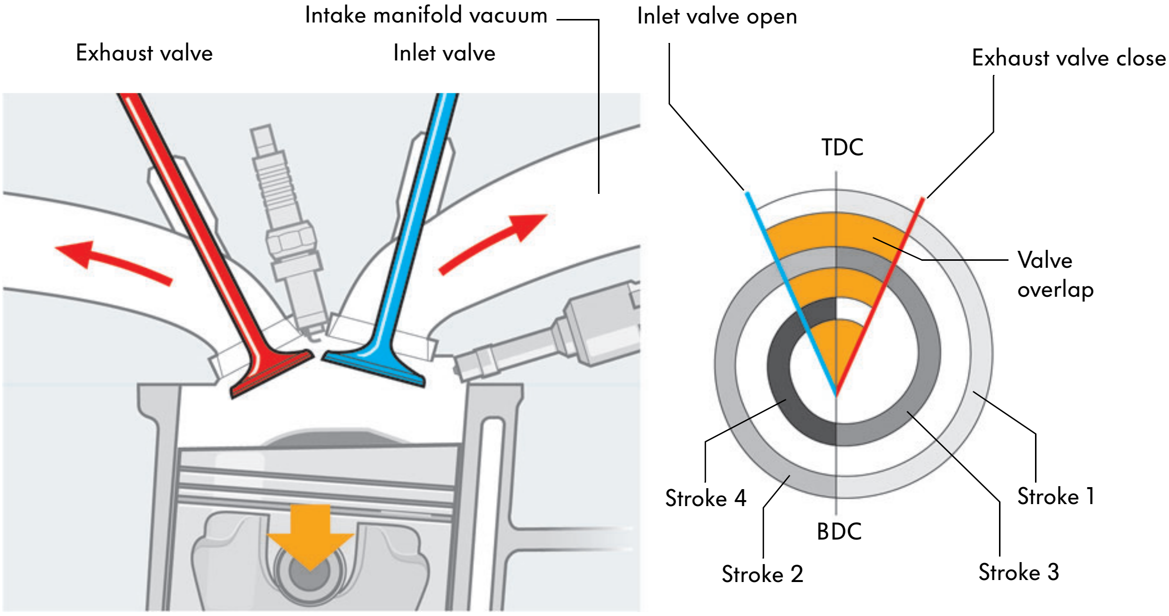
Maximum adjustment of the camshafts:

- Inlet camshaft 52° crank angle and
- exhaust camshaft 42° crank angle

Both camshaft adjusters are adjusted using two camshaft control valves with the aid of the engine oil pressure.

Adjusting both camshafts allows a maximum valve overlap of 42° crank angle. The valve overlap creates an internal exhaust gas return.

Internal exhaust gas recirculation system



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The internal exhaust gas recirculation counteracts the formation of nitrogen oxide NO_x.

As with the external exhaust gas recirculation system the reduced formation of NO_x results from the combustion temperature being reduced by feeding in combustion gases.
There is a slight shortage of oxygen due to the combustion gases in the fresh fuel-air mixture.
As a result the combustion is not as hot as when there is excess oxygen.
Nitrogen oxide is only formed in large concentrations above a relatively high temperature.
The formation of NO_x is reduced by lowering the combustion temperature in the engine and by creating a shortage of oxygen.

How it works

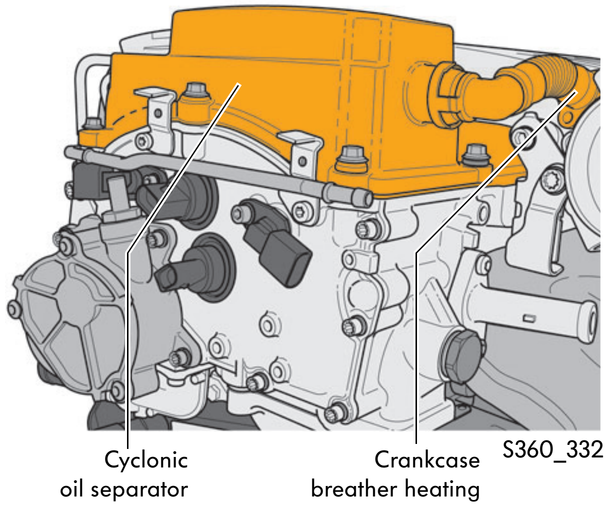
During the exhaust stroke the inlet and exhaust valves are open. Due to the high intake manifold vacuum, some of the
combustion gases from the combustion chamber are drawn into the intake port and fed back into the combustion
chamber for the next combustion.

Advantages of internal exhaust gas return:

- Fuel consumption saving due to reduced charge changing process
- Larger partial load range with exhaust recirculation
- Smoother running
- Exhaust gas recirculation possible when engine is still cold

Crankcase breather system

It prevents vapours enriched with hydrocarbons (blow-by gases) reaching the outside atmosphere from the crankcase. The crankcase breather system consists of vent ducts in the cylinder block and cylinder head, the cyclonic oil separator and the crankcase breather heating.

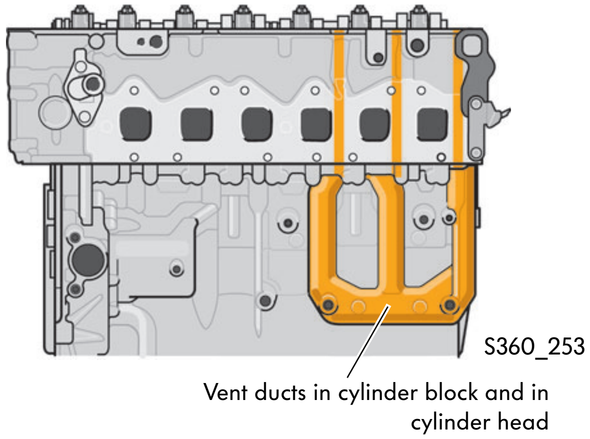


How it works

The blow-by gases in the crankcase are drawn in by the intake manifold vacuum via:

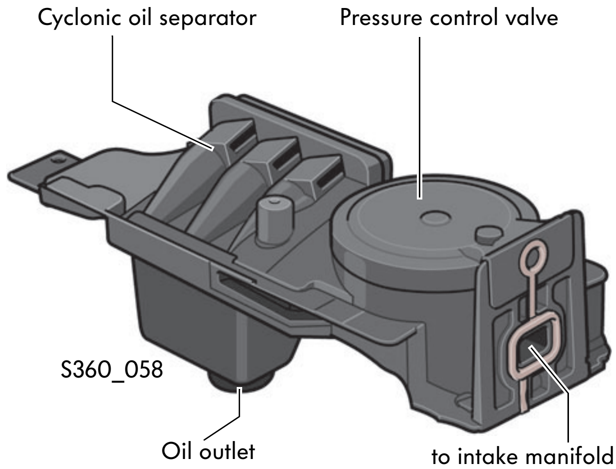
- the vent ducts in the cylinder block,
- the vent ducts in the cylinder head,
- the cyclonic oil separator,
- the pressure limiting valve and
- the crankcase breather heating

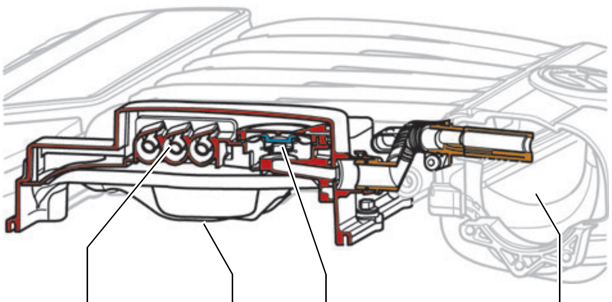
and then fed back into the intake manifold.



Cyclonic oil separator

The cyclonic oil separator is in the cylinder head cover. It has the task of separating oil from the blow-by gases in the crankcase and feeding it back to the oil system.
A pressure control valve limits the intake manifold vacuum from approx. 700 mbar to approx. 40 mbar. It prevents the same vacuum forming as in the intake manifold and thus engine oil being drawn in via the crankcase breather or seals being damaged.





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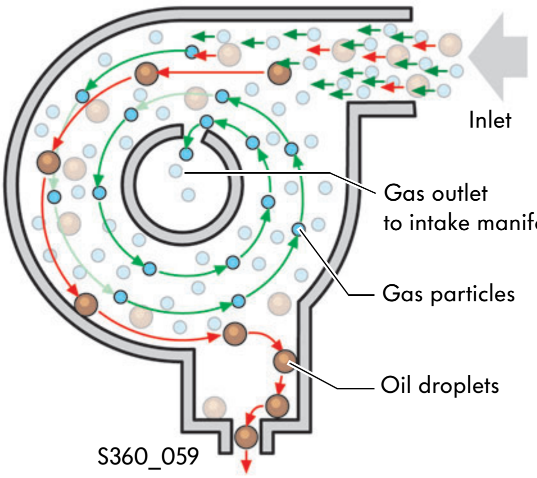

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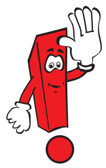
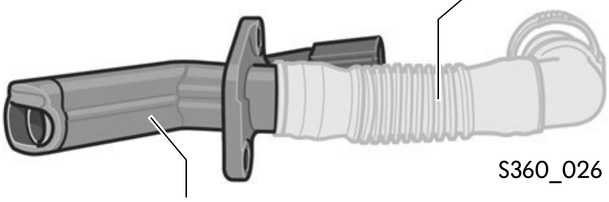
How it works

The cyclonic oil separator separates the oil from the oil vapours drawn in. It works according to the principle of centrifugal separation.
Due to the cyclonic design of the oil separator, the oil vapours are set in a spinning movement. The centrifugal force produced propels the oil onto the separator wall where it forms larger drops.

While the separated oil drips into the cylinder head, the gas particles are fed into the intake manifold via a flexible pipe.



If the pressure control valve is faulty, the pressure inside the crankcase corresponds with the intake manifold vacuum. As a result, a very large amount of oil is drawn out of the crankcase via the crankcase breather possibly causing damage to the engine.



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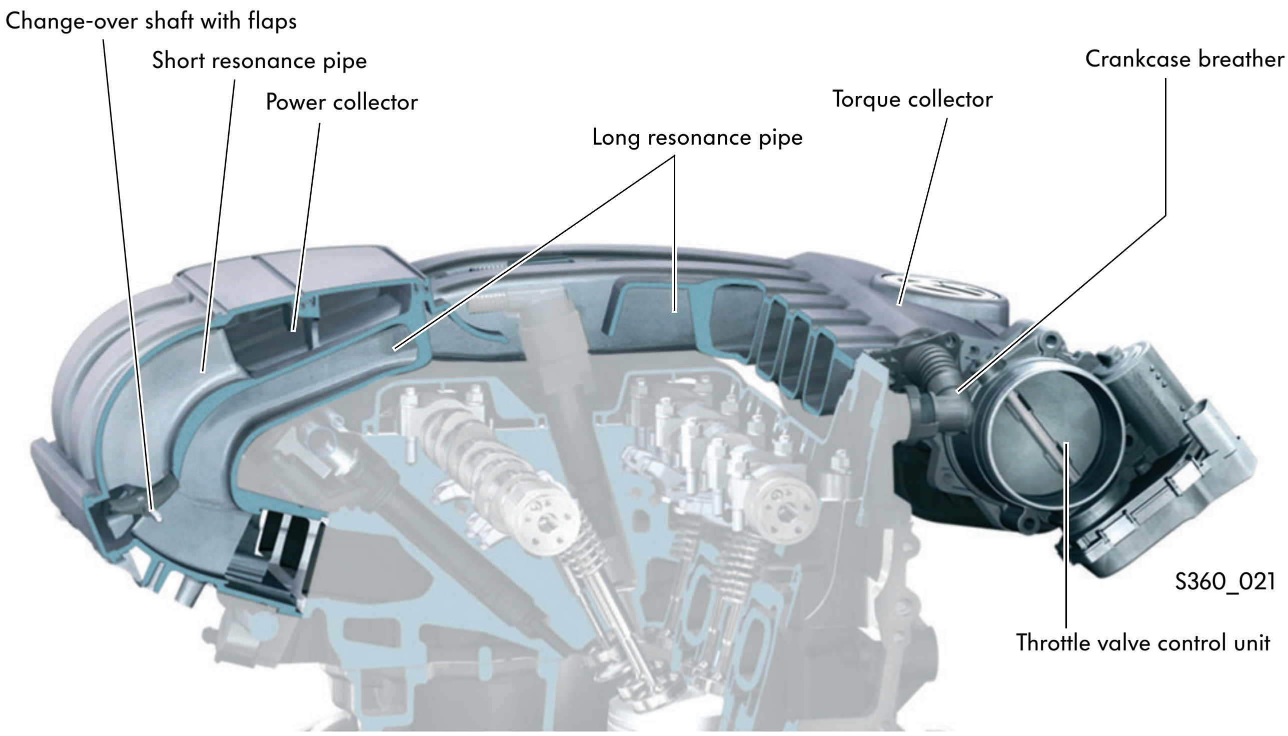
Crankcase breather heating

The heating element is inserted in the flexible hose that runs from the cyclonic oil separator to the intake manifold and is screwed to the intake manifold.
The crankcase breather heating prevents the blow-by gases freezing when the intake air is very cold.

Intake manifold

The 3.2l V6 FSI engine has a single-piece overhead variable intake manifold made from plastic. The 3.6l V6 FSI engine and the 3.6l V6 R36 FSI engine have been given a two-piece intake manifold made from plastic. In the Touareg, it is a variable intake manifold.

One-piece variable intake manifold on 3.2l V6 FSI engine



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Design

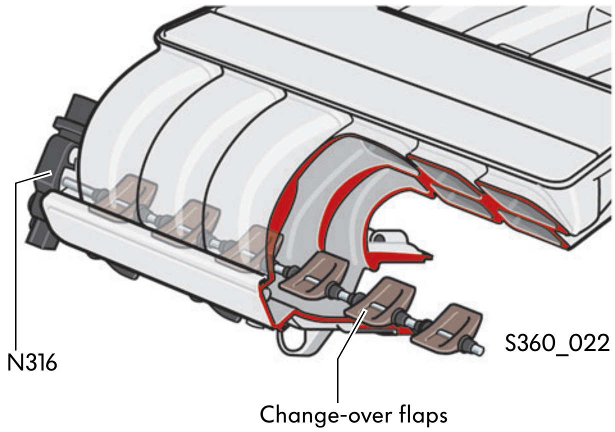
The 3.2l V6 FSI engine intake manifold consists of:

- the torque collector,
- two resonance pipes with different lengths for each cylinder,
- the change-over shaft,
- the power collector
- the vacuum reservoir and
- the intake manifold flap valve.

The two resonance pipes have different lengths because a long resonance pipe is required to reach a high torque and a short resonance pipe is required to attain high power.
The change-over shaft opens and closes the connection to the power collector.

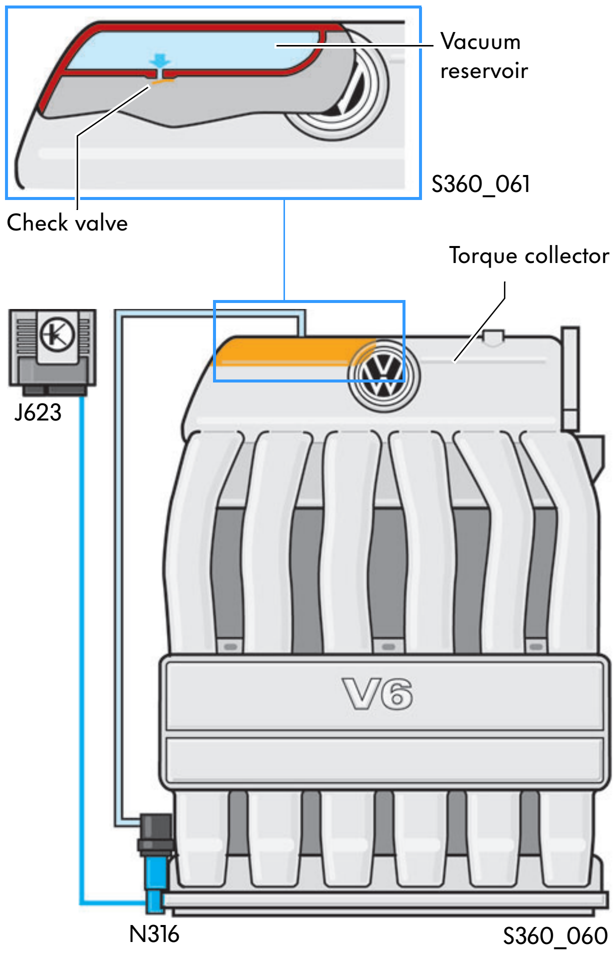
Change-over flaps

The system switches between power and torque setting with change-over flaps.
The change-over flaps are operated by engine control unit J623 via the intake manifold flap valve N316 by means of vacuum. When the valve is not powered, the flaps are open and thus in the power position.



Vacuum reservoir

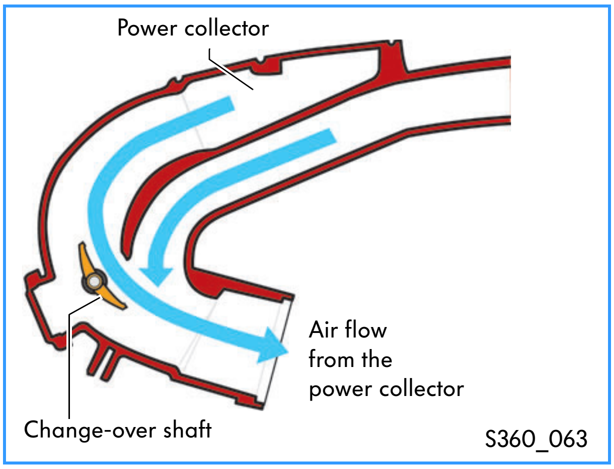
There is a vacuum reservoir inside the intake manifold in which a vacuum supply is kept ready to operate the change-over flaps. The air from the vacuum reservoir is drawn off via a check valve in the torque collector so that a vacuum builds up in the vacuum reservoir. If the check valve is faulty, the change-over flaps can no longer be operated.



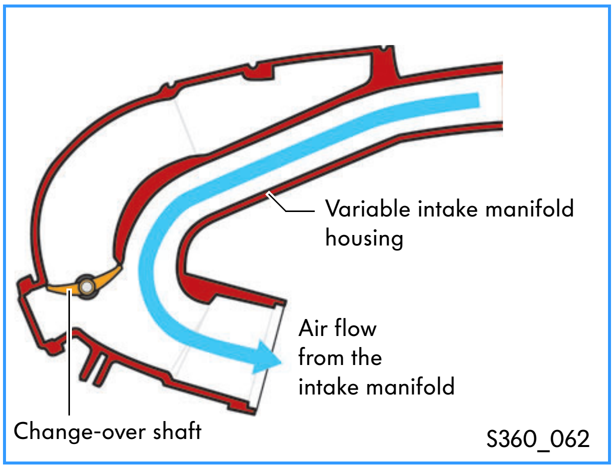
How the variable intake manifold works

The variable intake manifold works according to the principle of resonance charging and is designed so the valve timing, the intake strokes and the air oscillation is rhythmic. This leads to an increase in pressure in the cylinder and thus to good filling of the cylinders.

Power position of the variable intake manifold



Torque position of the variable intake manifold



Engine speed from 0 to approx. 1200 rpm

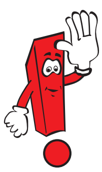
The variable intake manifold is in the power position. The intake manifold flap valve is not powered. The vacuum wave created from the start of the intake process is reflected at the end of the power pipe and returns to the intake valve after a brief time.

Engine speed between approx. 1200 and approx. 4000 rpm

The intake manifold flap valve is powered by the engine control unit. The change-over flaps and thus the power pipes are closed. The cylinders draw in the air directly from the torque collector through the torque pipes.

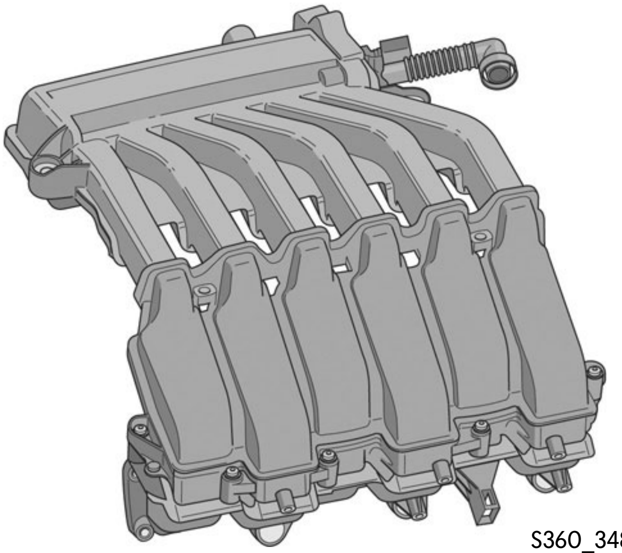
Engine speed above approx. 4000 rpm.

The intake manifold flap valve is not powered. As a result, the intake manifold flaps switch to the power position again.



You will find more detailed information on the design and function of resonance-pipe variable intake manifolds in self-study programme 212 “Variable Intake Manifold in VR Engines”.

Two-piece intake manifold on 3.6l V6 FSI engine



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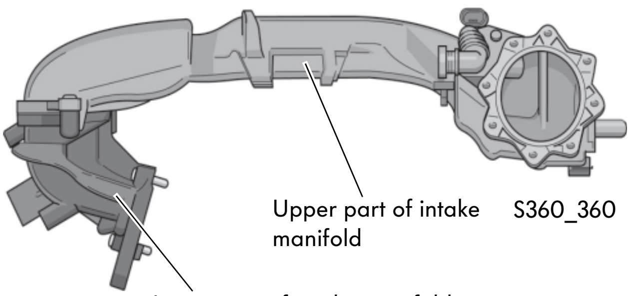
While the 3.2l V6 FSI engine has kept the single-piece variable intake manifold, a two-piece plastic intake manifold will be used from model year 2007 for the 3.6l V6 FSI engine in the Passat and R36. This manifold is not variable, but meets the requirements for power and torque in the different rev ranges with a modified duct geometry.

Compared with the 3.2l engine, there is no electric valve for intake manifold flap in the engine management and no vacuum control element with switching valve on the intake manifold.



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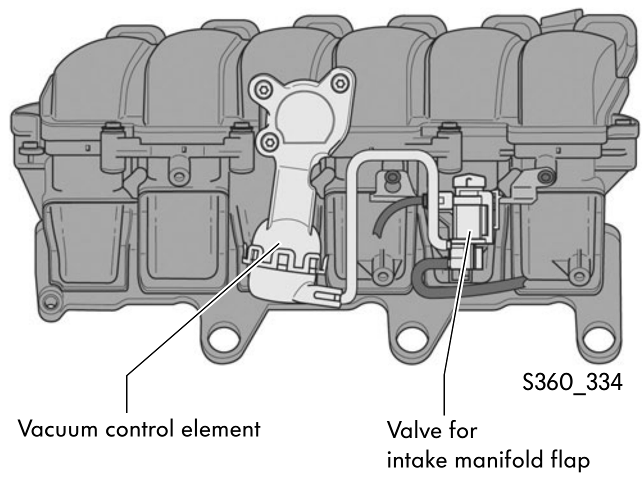
The two-piece intake manifold is made up of an upper part and a lower part that are screwed to each other. Splitting the intake manifold into two segments simplifies assembly and allows access to the components under the intake manifold.

Two-piece intake manifold on 3.6l V6 FSI engine

The 3.6l V6 FSI engine is equipped with a variable intake manifold specially for use in the Touareg.
It is based on the two-piece plastic intake manifold from the 3.6l V6 FSI engine. The intake manifold geometry has been adapted to the special power and torque requirements of this engine and a resonance flap has been added.
The resonance flap is operated as normal with a vacuum control element and the electrical valve for intake manifold flap that opens or closes the connection between the vacuum system and the vacuum control element and thus indirectly operates the resonance flap.

The variable intake manifold works according to the principle of combined oscillation pipe and resonance charging. By combining both charging techniques, dynamic charging over a broader rev range can be achieved.



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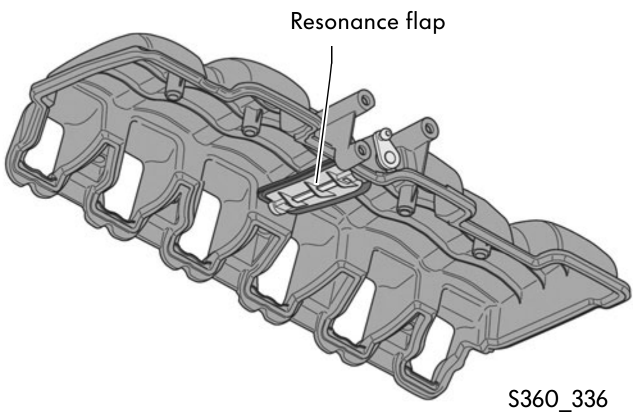

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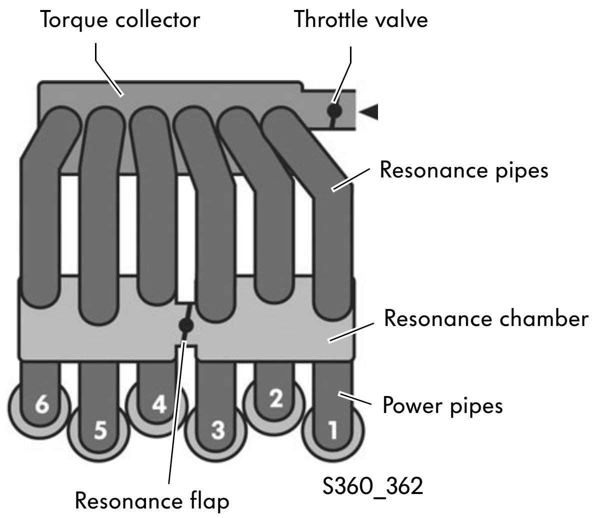
Design

The variable intake manifold comprises:

- the torque collector,
- the resonance pipes
- the resonance chamber,
- the power pipes
- the resonance flap
- the vacuum control element and
- the intake manifold flap valve.



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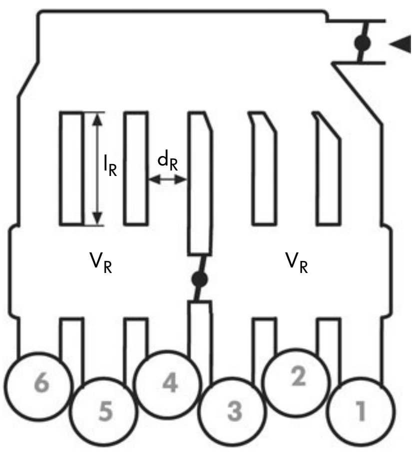
How the variable intake manifold works

For the first time, VW is using a variable intake manifold that works on the principle of resonance charging. Resonance charging means self-charging with pressure oscillations in resonance pipes that are open on both sides. Whereas in oscillation pipe charging only the pressure oscillation is used in the intake manifolds, the cylinders are charged by means of pressure increases in resonance charging. The piston movement causes a certain excitation frequency to be produced in the intake. If it coincides with the eigenfrequency of the configured resonance systems, a charging effect occurs due to resonance peaks, i.e. the cylinders are filled better with the fresh air required to burn the fuel.



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l_R - Length of resonance pipe
d_R - Diameter of resonance pipe
V_R - Volume of resonance chamber

The engine speed at which the resonance charging occurs can be influenced with the design of the variable intake manifold. This means that the resonance charging is dependent on the resonance pipe length, the pipe diameter and the resonance chamber volume. Resonance charging works ideally with 3, 6 or 12 cylinder engines.
One requirement is that the intake cycles of the cylinders are shifted 240° so that they do not overlap and weaken each other.

As the engine speed range at which the resonance peaks occur is very narrow, pure resonance intake systems are rarely used. By combining both charging techniques, oscillation pipe charging and resonance charging, dynamic charging over a broader rev range can be achieved.

How the two-piece variable intake pipe works

The two-piece variable intake manifold works according to the principle of resonance charging up to approx. 4500 rpm (torque position of the variable intake manifold). Above 4500 rpm, the variable intake manifold is in power position and charging uses the principle of oscillation pipe charging via the short power pipes.

Engine Mechanics

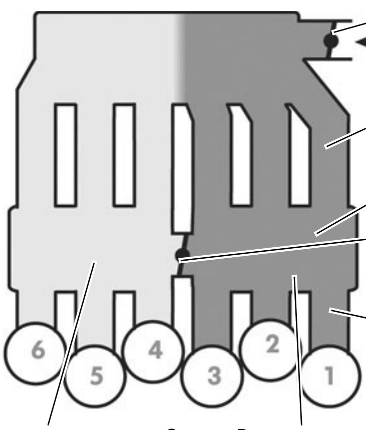
Resonance charging

The cylinders of the 3.6 l V6 FSI engine are divided into two groups of three cylinders when the resonance flap is closed. There are therefore two resonance systems. One resonance system is formed by three cylinders with 240° CA offset intake phases that do not have timing overlaps.
The groups of cylinders with the same firing intervals are connected to the resonance chambers and resonance pipes via individual resonance pipes (power pipes).

Oscillation pipe charging

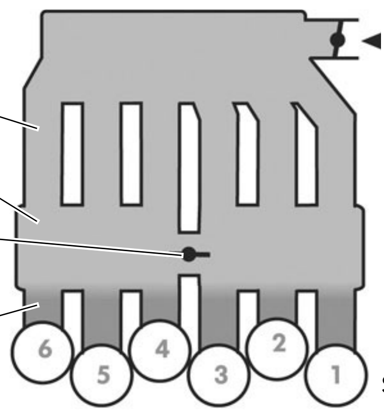
At higher rev ranges, there is a switch-over from resonance system to oscillation pipe system. Opening the resonance flap creates one large chamber out of the two chamber halves. This doubles the volume of the chamber.
The eigenfrequency of the resonance system is shifted to lower revs. In the rev range from 4500 rpm, there is no resonance excitation so that the dynamic charging now occurs from the open resonance chamber through the short power pipes that act as oscillation pipes.

Torque position of the variable intake manifold



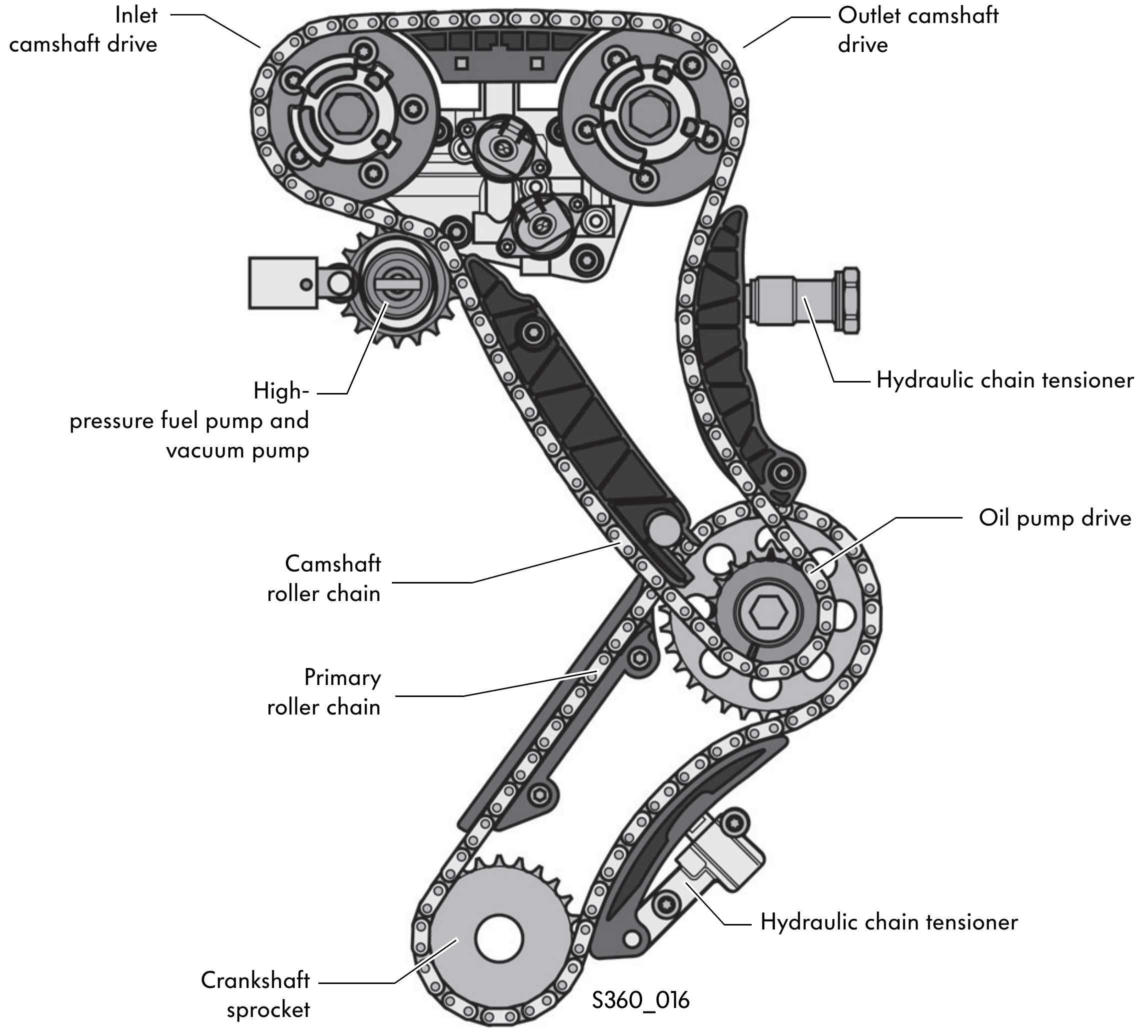
S360_364

Power position of the variable intake manifold



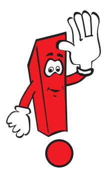
S360_366

Chain drive



The chain drive is located on the gearbox side of the engine. It is made up of the primary roller chain and the camshaft roller chain.
The primary roller chain is driven by the crankshaft. It drives the camshaft roller chain and the oil pump via a sprocket.

The camshaft roller chain drives the two camshafts and the high-pressure fuel pump. Both chains are held at the precise chain tension by hydraulic chain tensioners.

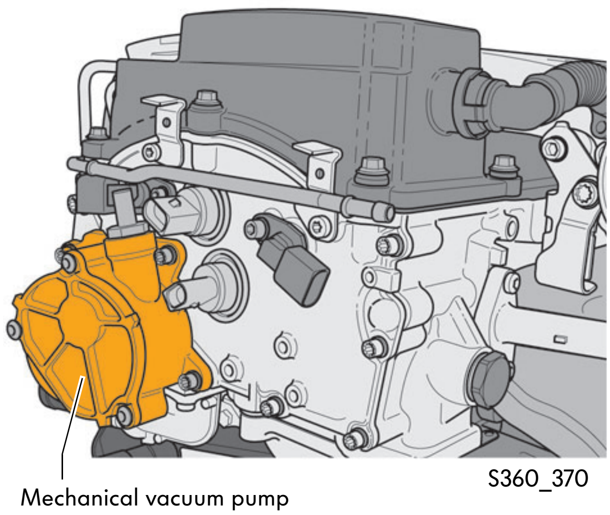


Please refer to the current workshop manual for information on setting the timing.
There is a new special tool T10332 for locking the high-pressure fuel pump sprocket.

Vacuum pump

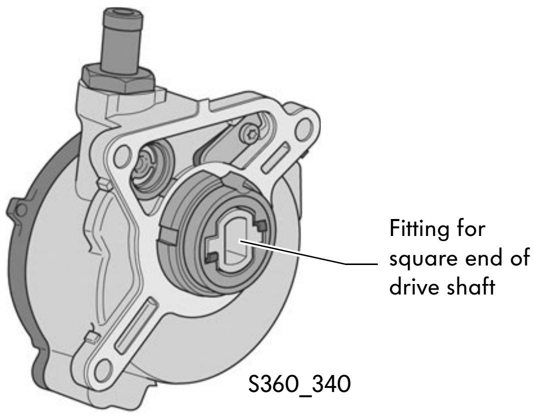
A mechanical vacuum pump is fitted instead of the electrical vacuum pump on the Touareg with 3.6l engine and automatic gearbox.

The vacuum pump ensures that sufficient vacuum can be maintained for all consumers that are connected to the engine vacuum system even at low revs.



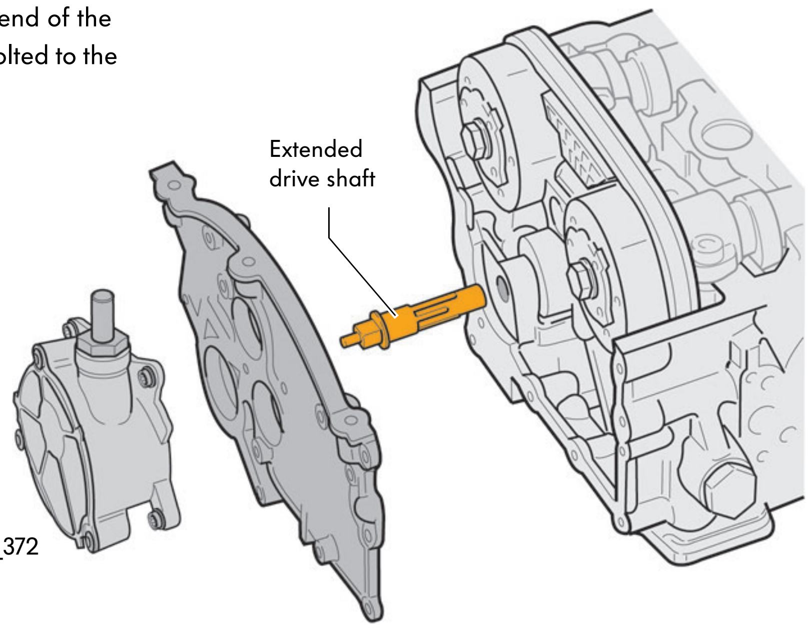
S360_370

Rear view



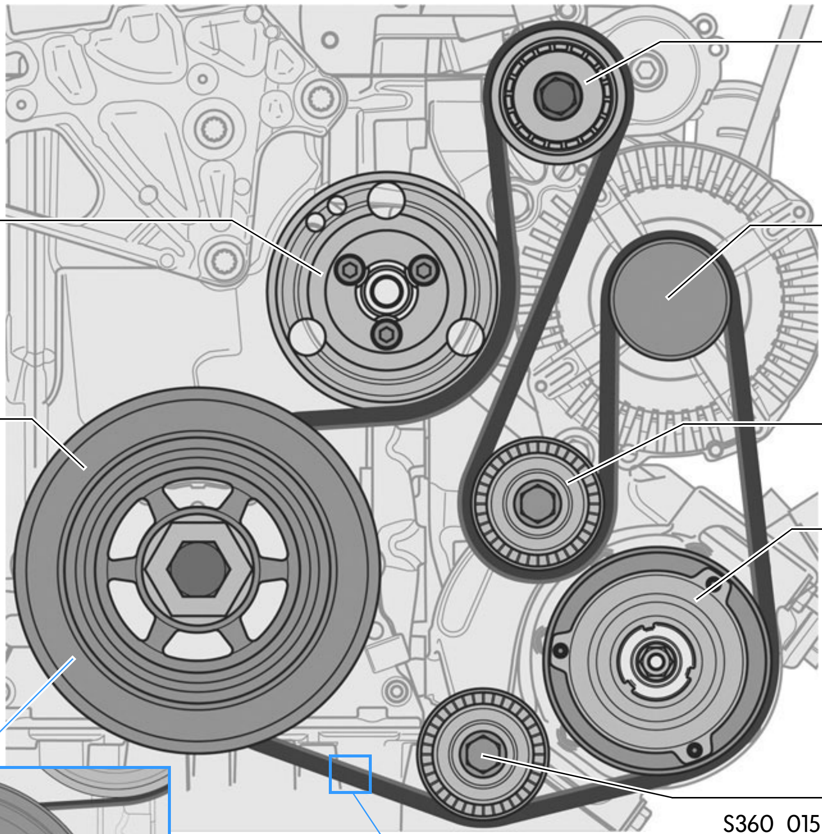
S360_340

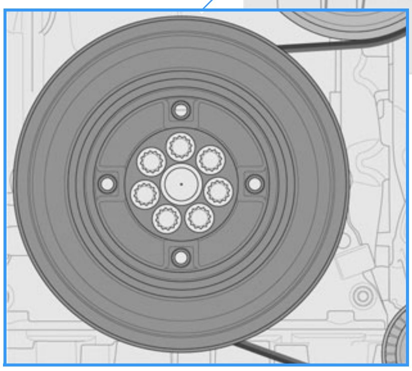
The vacuum pump is driven together with the high-pressure fuel pump via the engine
chain drive. The drive shaft of the high-pressure fuel pump has been extended for this.
The vacuum pump meshes into the square end of the drive shaft. The vacuum pump housing is bolted to the cylinder head.



S360_372

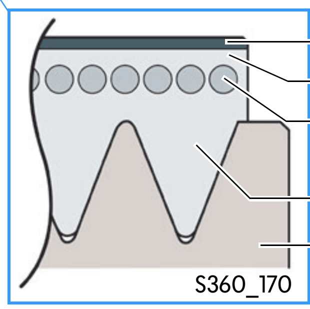
Poly V-belt drive





Poly V-belt pulley on 3.6l V6 R36 FSI engine

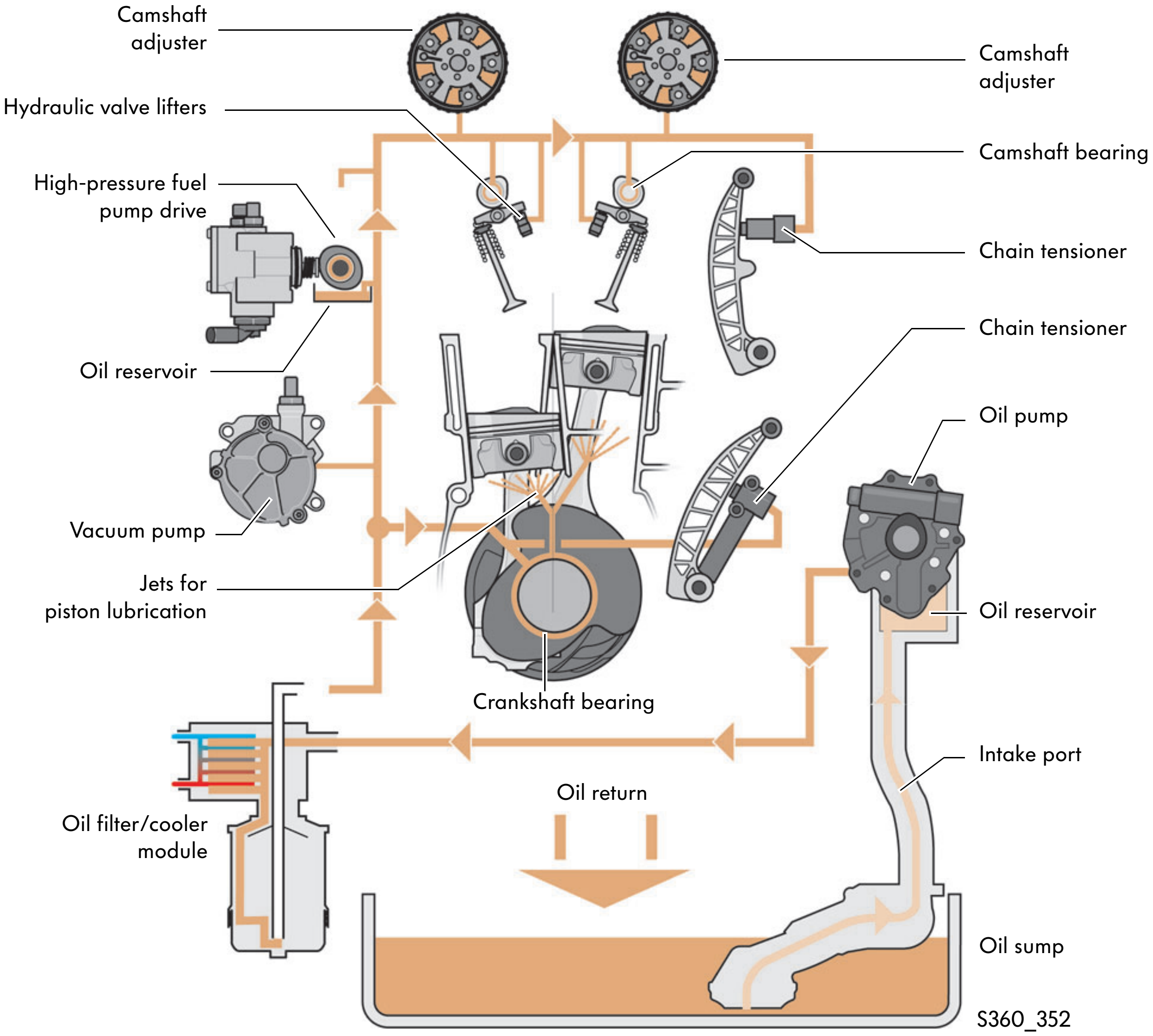
Structure of poly V-belt



A one-sided poly V-belt is used. It runs quietly and free of vibration even at high speeds.
The belt is driven by the crankshaft via the poly V-belt pulley with vibration damper.
On the 3.6l V6 R36 FSI engine, it is fastened to the crankshaft with seven screws due to the greater forces and moments.

The air-conditioning compressor, the alternator and the coolant pump are driven by the belt.
The poly V-belt is constantly held at the correct tension by a belt tensioner.

Oil system

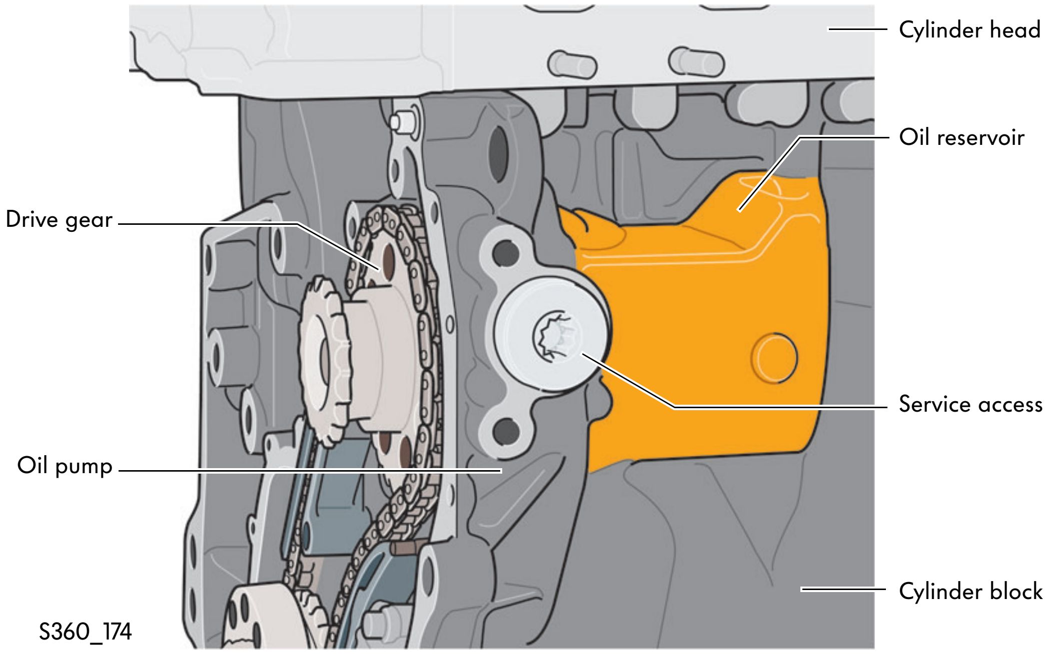


The oil pressure is generated by a self-priming duocentric oil pump. It is built into the cylinder block and is driven by the chain. The oil supply path is longer due to the position, which is disadvantageous for the initial oil supply of the components. For this reason, to ensure initial oil supply, oil is taken from an oil reservoir located behind the oil pump.

The oil pump draws the oil out of the oil sump and delivers it to the oil filter/cooler module. It is cleaned there and cooled before it is forwarded to the engine lubrication points.

Oil pump with oil reservoir

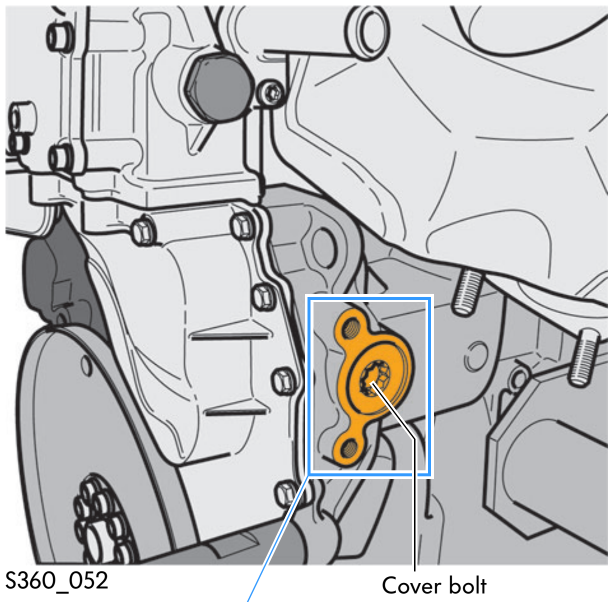
The oil reservoir is formed by a hollow space in the cylinder block behind the oil pump.
It has a volume of approx. 280 ml and remains filled after the engine is switched off.



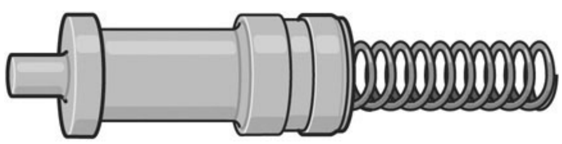
S360_174

Service access for oil pump

The service access allows you to reach the oil pressure relief valve of the oil pump while the engine is installed in the vehicle. After removing the cover bolt and a second bolt inside, you can remove the oil pump pressure relief valve through this opening and check its condition without having to remove the chain drive.



S360_052



S360_056

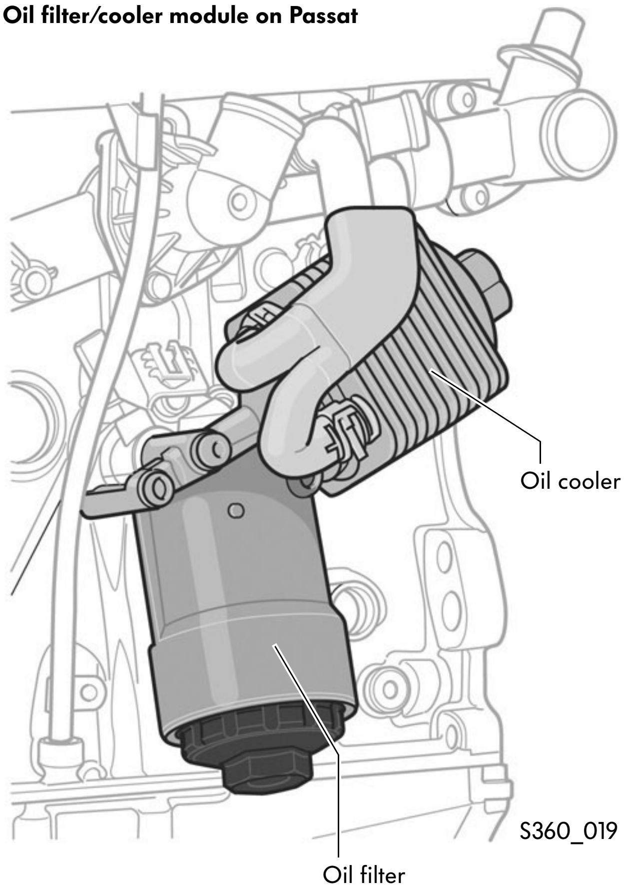
Oil filter/cooler module

The oil filter/cooler module is made up of

- oil filter,
- oil cooler,
- anti-drain valve and
- by-pass valve.

It is located on the engine and, on some vehicle types and engine mounting positions, it is also designed as an engine mount.

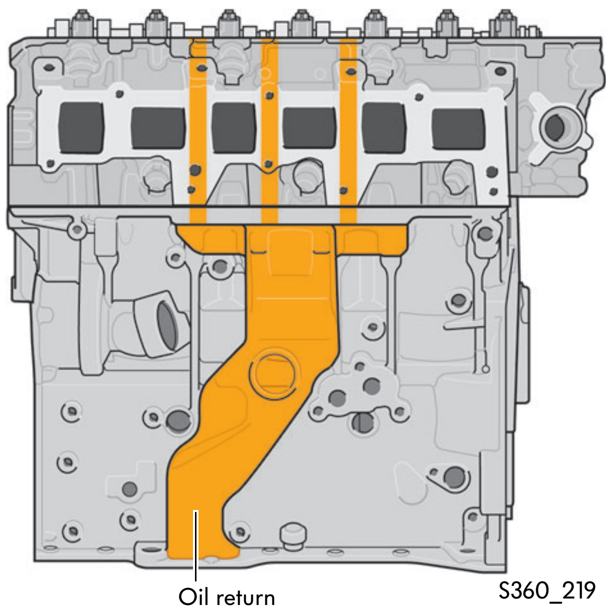
Oil filter/cooler module on Passat



S360_019

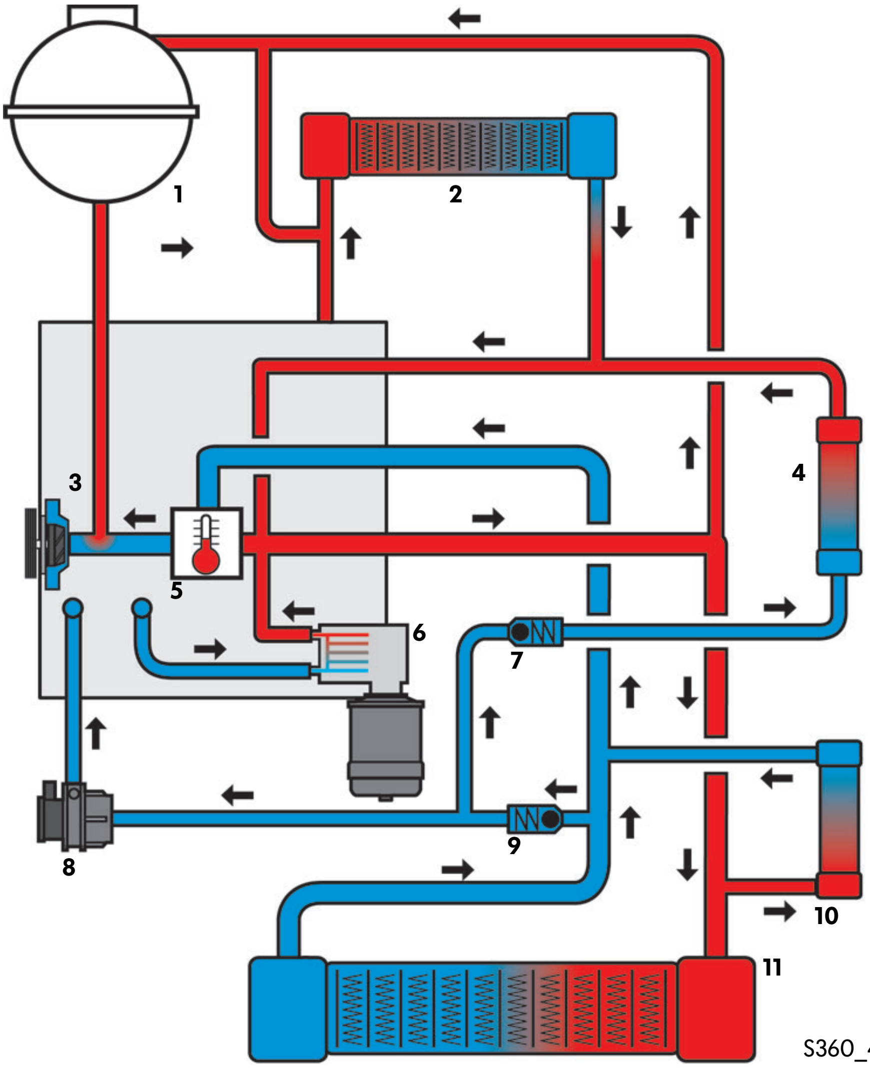
Oil return

The returned oil runs into a central oil return channel in the cylinder block via three return ducts in the cylinder head.
The oil then flows back into the oil sump below the oil level. In addition to the central oil return, oil runs into the sump via the camshaft timing chain shaft.



S360_219

Cooling circuit



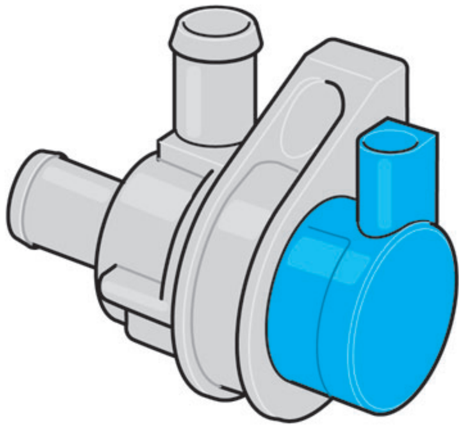
Legend
1 Expansion tank
2 Heat exchanger for heating
3 Coolant pump
4 Gearbox oil cooler
5 Thermostat
6 Oil cooler
7 Check valve
8 Circulation pump V55
9 Check valve
10 Auxiliary cooler
11 Cooler

The coolant is circulated by the mechanical coolant pump. It is driven by the poly V-belt.
The coolant circuit contains 9 litres of coolant.
Compared with the 3.2l multi-point injection engine, the total coolant quantity has been reduced by 2 litres. This allows the engine to reach its operating temperature faster.
The circuit is controlled by the expansion-type thermostat.

Depending on the vehicle, an auxiliary cooler may be integrated in the coolant circuit (10).
The one way valves are integrated into the coolant circuit so that they prevent backflow of the coolant.

Circulation pump V55

is an electric pump. It is integrated in the engine coolant circuit and is controlled by the engine control using a map.
After parking the vehicle and when there is no air flow, it is switched on at a certain coolant temperature.

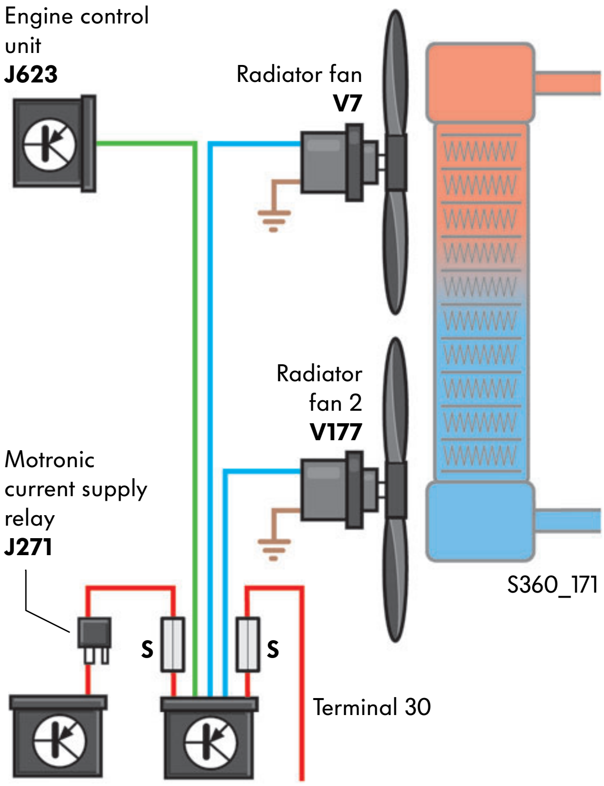


S360_169

Radiator fan

The V6 FSI engine uses two electric radiator fans. The radiator fans are controlled by the engine control unit as required.
The engine control unit J623 signals to the radiator fan control unit J293 when the radiator fan is needed.
The control unit J293 then supplies power to one or both of the fans as required.
The power from control unit J293 is supplied via the Motronic current supply relay J271 and onboard supply control unit J519.

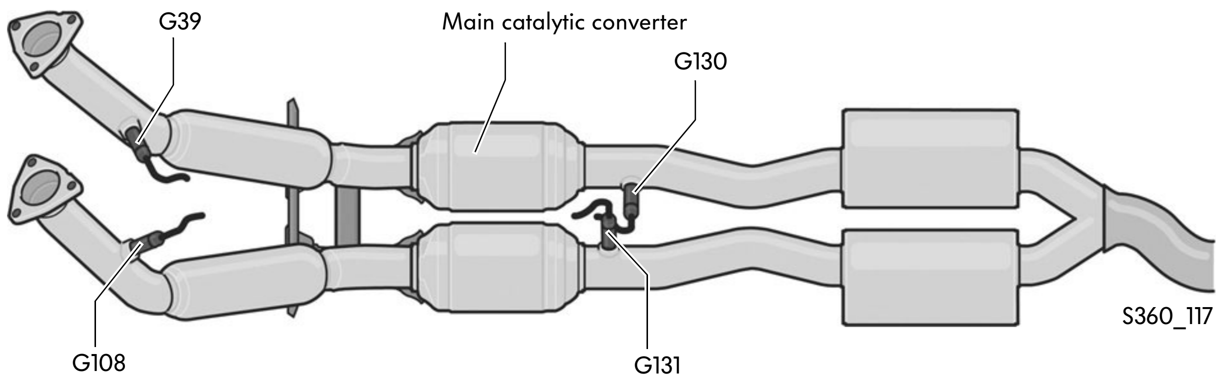
The fans can be switched on by the radiator fan control unit even after the vehicle has been parked.
The radiator fan control unit has a connection to terminal 30 to switch the fans on when the vehicle has been parked.



S360_171

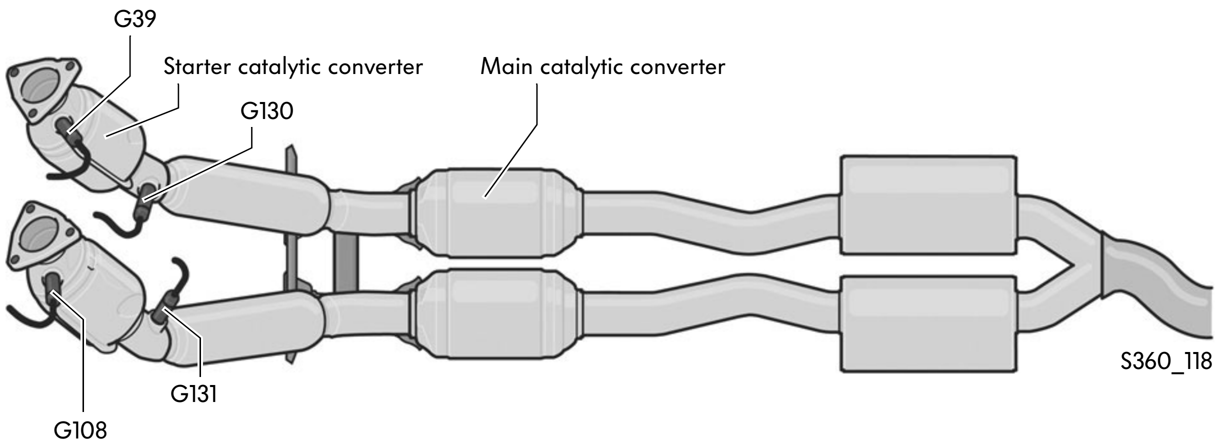
Exhaust system

3.2l V6 FSI engine



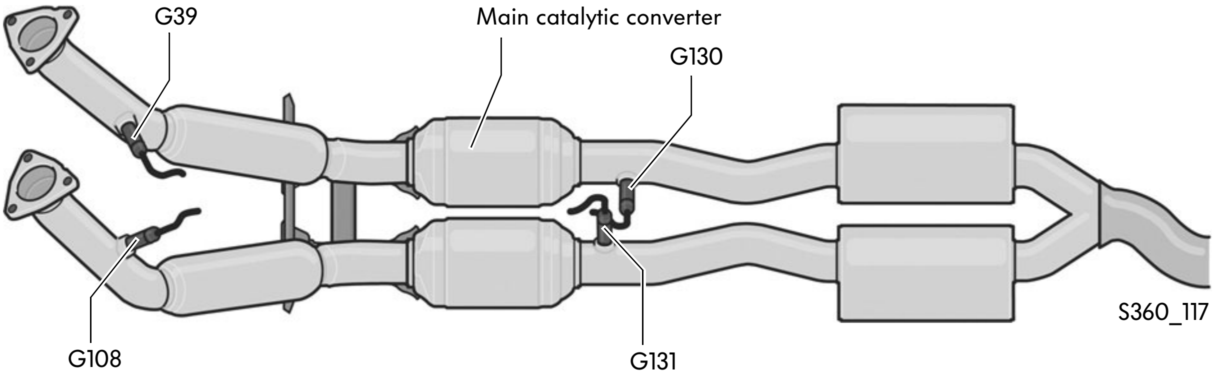
The exhaust system for the 3.2l engine has a main catalytic converter with ceramic substrate for each bank. The exhaust gas quality is monitored by two Lambda probes in front of and behind the catalytic converters. The exhaust gas system fulfils emission level EU4.

3.6l V6 FSI engine

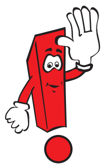


The exhaust gas system on the 3.6l FSI engine is equipped with two starter catalytic converters and two main catalytic converters. The exhaust gas quality is monitored by Lambda probes in front of the catalytic converter and two Lambda probes after the starter catalytic converter.
The exhaust system fulfils emission level EU4 and LEV2 (Low Emission Vehicles).

3.6l V6 R36 engine

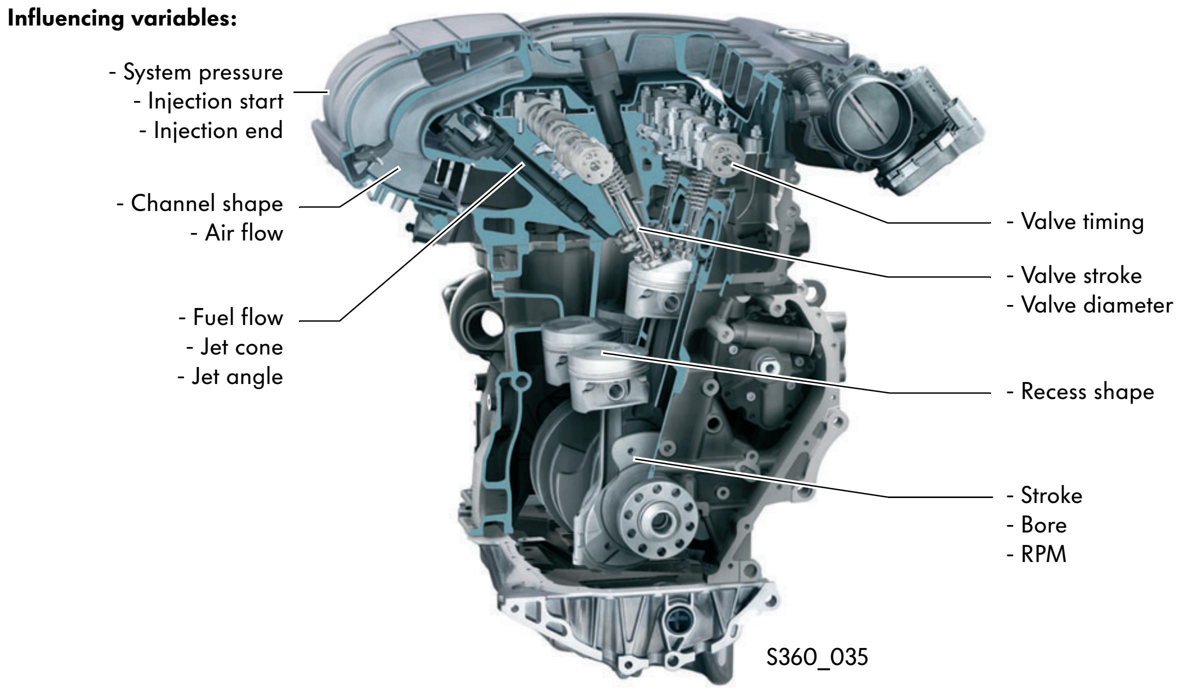


The exhaust system for the 3.6l V6 R36 FSI engine is the same as the system for the 3.2l V6 FSI engine. The pipe and connection cross-sections in the system have been adapted to the needs of the R36 engine.



Therefore, when carrying out repairs, check that the replacement parts are correct for the engine.

FSI technology



S360_035

Direct petrol injection requires precise tuning of the combustion process.
The following are influencing variables on the combustion process:

- the cylinder bore and stroke,
- the shape of the recess in the piston surface,
- the valve diameter and stroke,
- the valve timing,
- the geometry of the intake ports,
- the amount of air supplied,
- the characteristics of the injectors (jet cone, jet angle, flow quantity, system pressure and valve timing) as well as
- the engine speed.

Investigations of the flow behaviour in the combustion chamber are an essential part of combustion process optimisation. The flow behaviour of intake air and injected fuel influences the mixture formation considerably.

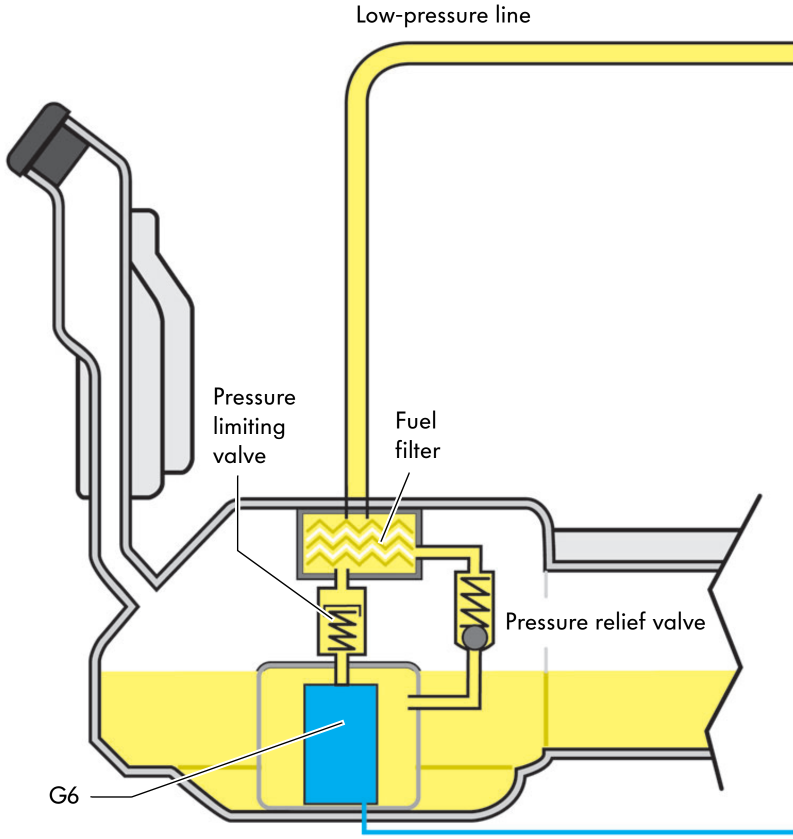
The Doppler Global Velocimetry method was used to determine the optimum flow behaviour and thus determine the optimum piston design for both cylinder banks.
This method allows the flow behaviour and thus the mixture formation to be investigated while the engine is running.

Using this method and the adaptation of the injector characteristics, the flow speeds and the mixture formation in the combustion chambers of the two cylinder banks can be configured in the same way and be tuned to each other.
The engine runs only in homogeneous mode.

The homogeneous split catalytic converter heating method for heating the catalytic converter is new.

Fuel system

G6 Fuel system pressurisation pump
G247 Fuel pressure sender
G410 Fuel pressure sender for low pressure
J538 Fuel pump control unit
J623 Engine control unit
N276 Fuel pressure regulating valve



Low-pressure fuel system

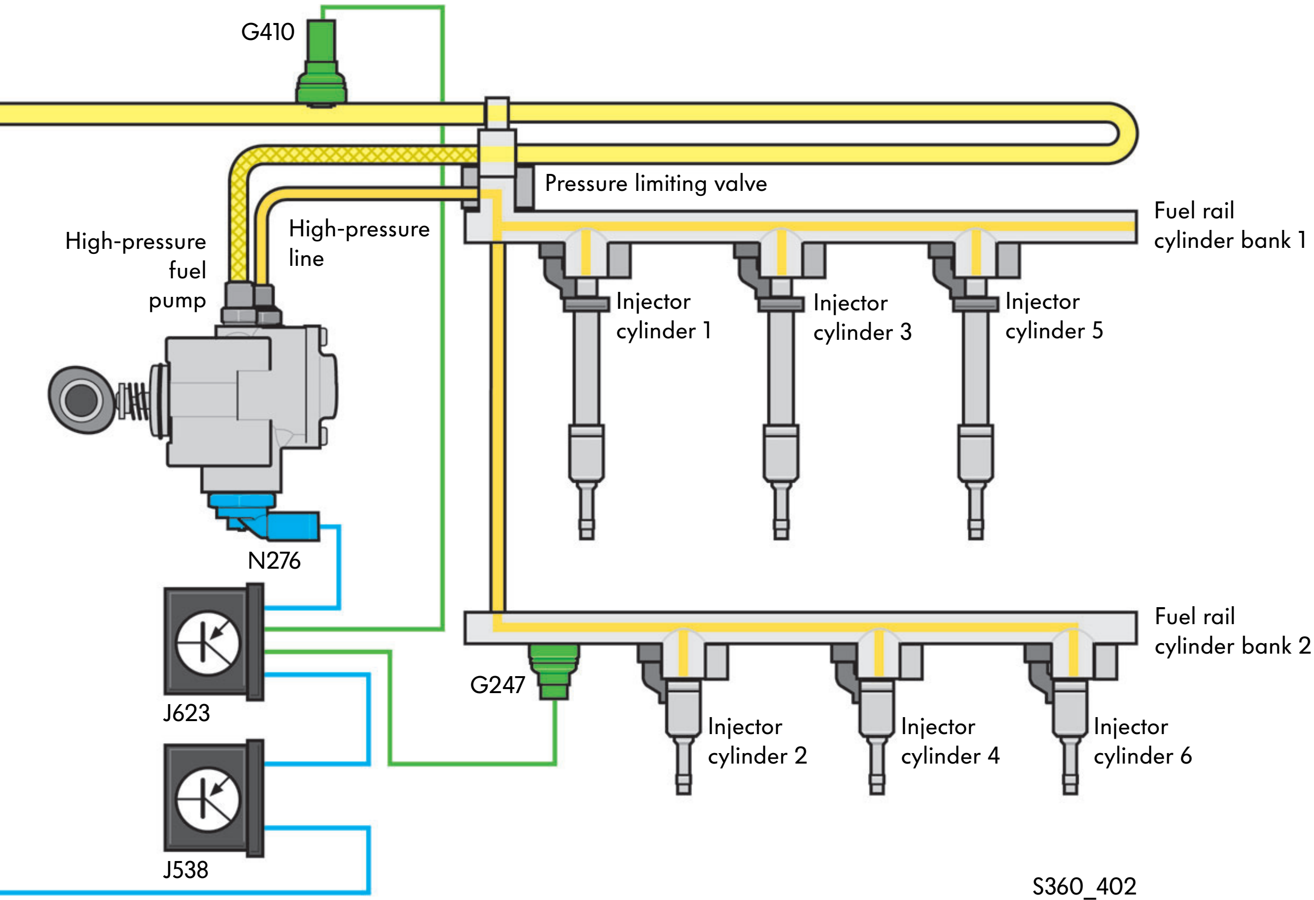
The low-pressure system delivers fuel from the fuel tank.
The fuel system pressurisation pump is operated by the engine control unit via the fuel pump control unit at an operating pressure between 2 and 5bar as required.

How it works

The signal from the fuel pressure sender for low pressure G410 constantly indicates the current fuel pressure for the engine control unit. The fuel pressure sender for low pressure N410 is screwed into the low-pressure line from model year 2007. Before model year 2007, the sender is on the high-pressure fuel pump.
The engine control unit compares the current pressure with the current fuel pressure requirement. If the current fuel pressure is not sufficient to cover this fuel requirement, the engine control unit sends a signal to the fuel pump control unit J538. This then sends a signal to the fuel system pressurisation pump that raises the operating pressure.
When the fuel requirement decreases again, the working pressure of the pump will be reduced accordingly.

The pressure relief valve holds the fuel pressure when the engine is turned off. If the fuel line is broken in an accident, the pressure relief valve prevents the fuel leaking.

The pressure limiting valve opens at a pressure of 6.4bar and thus prevents the fuel pressure in the low-pressure line becoming too high.
The extra fuel then flows into the reservoir chamber.



High-pressure fuel system

The fuel pressure sender G247

is mounted on the fuel rail for cylinder bank 2 and informs the engine control unit about the current pressure in the high-pressure fuel system.

The fuel pressure regulating valve N276

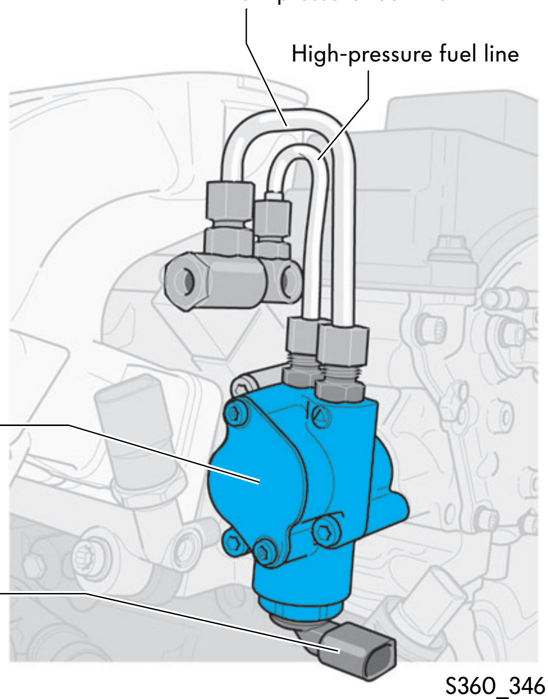
is screwed into the high-pressure fuel pump and regulates the pressure in the high-pressure fuel system depending on the signal from the engine control unit.

The pressure limiting valve

is on the fuel rail for cylinder bank 1. The valve opens a connection to the low-pressure fuel system when the fuel pressure in the high pressure system rises above 120 bar.

The high-pressure fuel pump

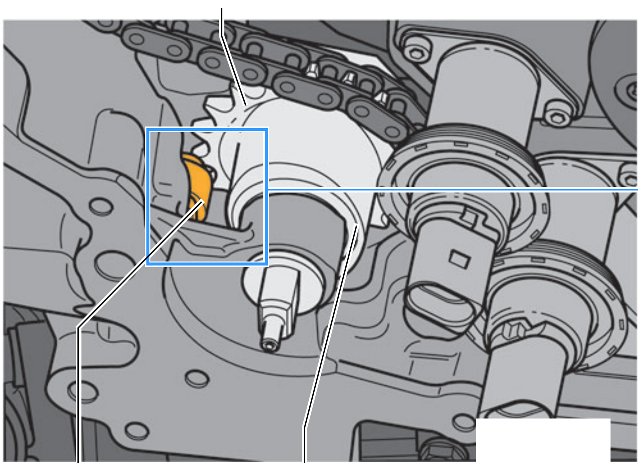
is located on the cylinder head and is a piston pump.
It is driven by the camshaft and produces a maximum fuel pressure of 105bar.



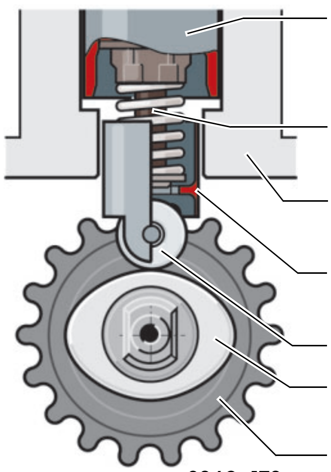
S360_346

High-pressure fuel pump drive

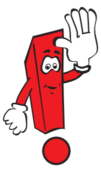
The high-pressure fuel pump is driven by a sprocket with double cam.
The double cam operates the pump piston that generates the high pressure via a roller.



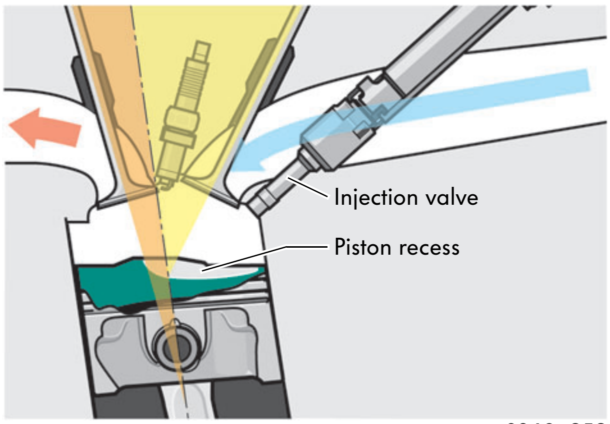
S360_354



S360_173

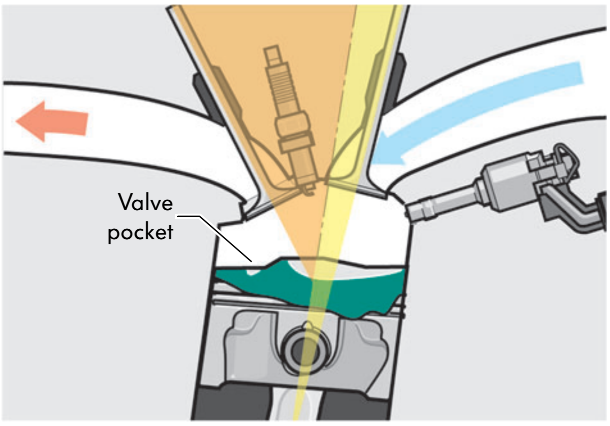


The high-pressure fuel pump sprocket needs to be locked using special tool T10332 when the camshaft roller chain is fitted.
You will find more information on the high-pressure fuel pump in self-study programme 296 “The 1.4 ltr. and 1.6 ltr. FSI engine with timing chain”.



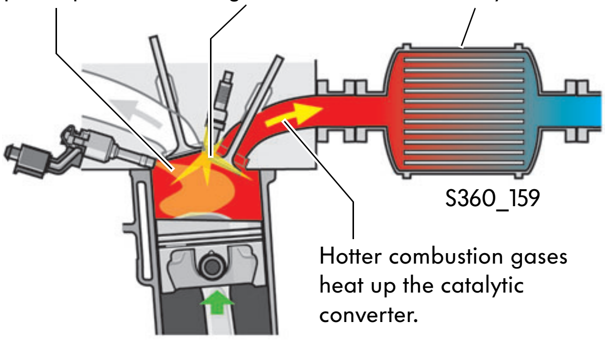
Valve angle cylinders 1, 3, 5

S360_252



Valve angle cylinders 2, 4, 6

S360_251



Injector characteristics

The piston recesses need to have different shapes as the injectors are fitted on the same side on both cylinder banks. This is necessary because the injectors and intake valves on both cylinder banks are arranged at different angles.
In addition to the injection quantity and the injection duration, the shape and direction of the fuel jet plays an important part.

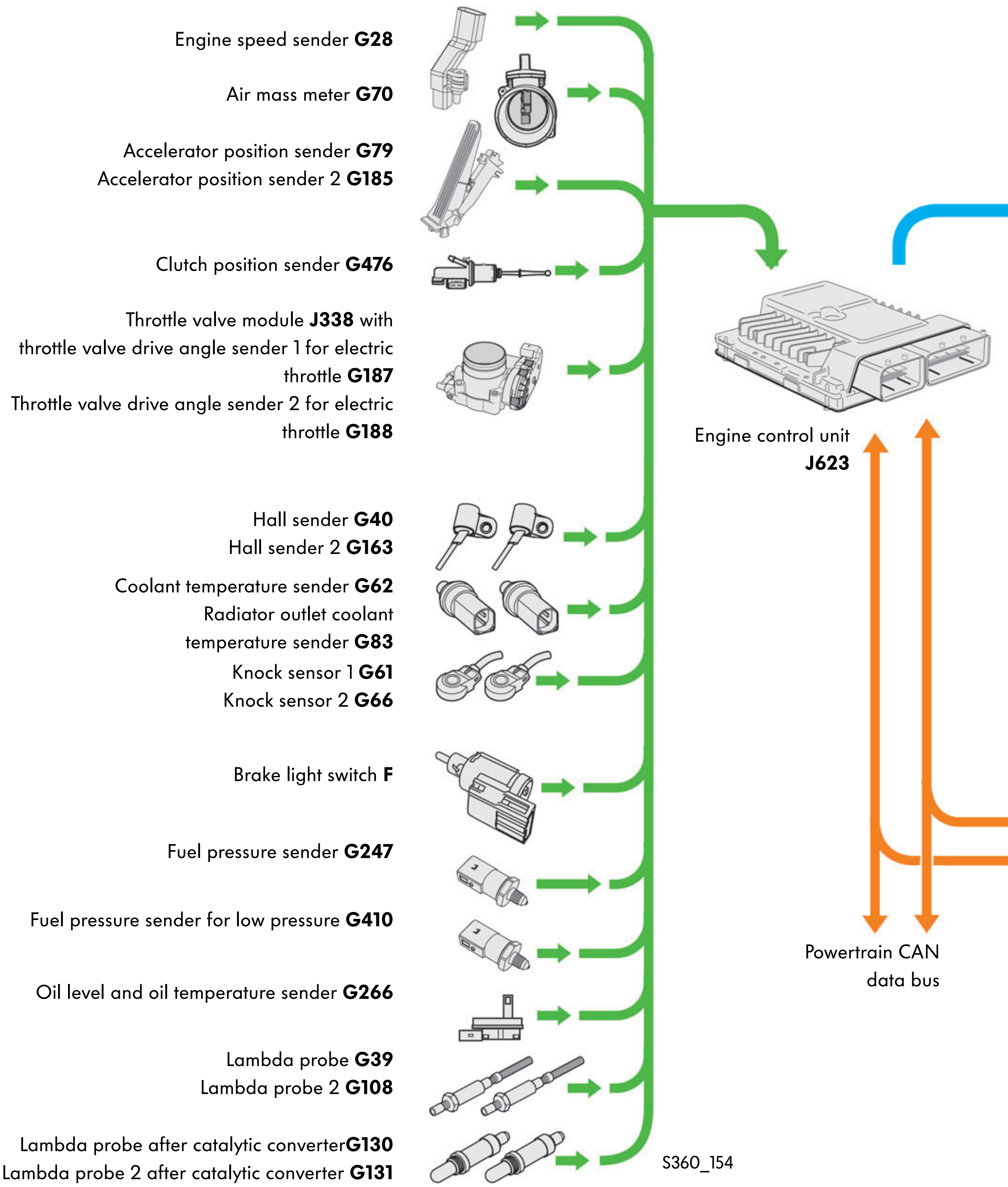
Homogeneous split catalytic converter heating method

This system has the task of quickly heating the catalytic converters to operating temperature for cold starts.
Fuel is injected twice in a combustion stroke.
The first injection occurs in the intake stroke. This creates an even distribution of the fuel/air mixture.
In the second injection, a small additional amount of fuel is injected just before ignition TDC.
The late injection increases the exhaust gas temperature. The hot exhaust gas heats up the catalytic converter so that it reaches its operating temperature faster.

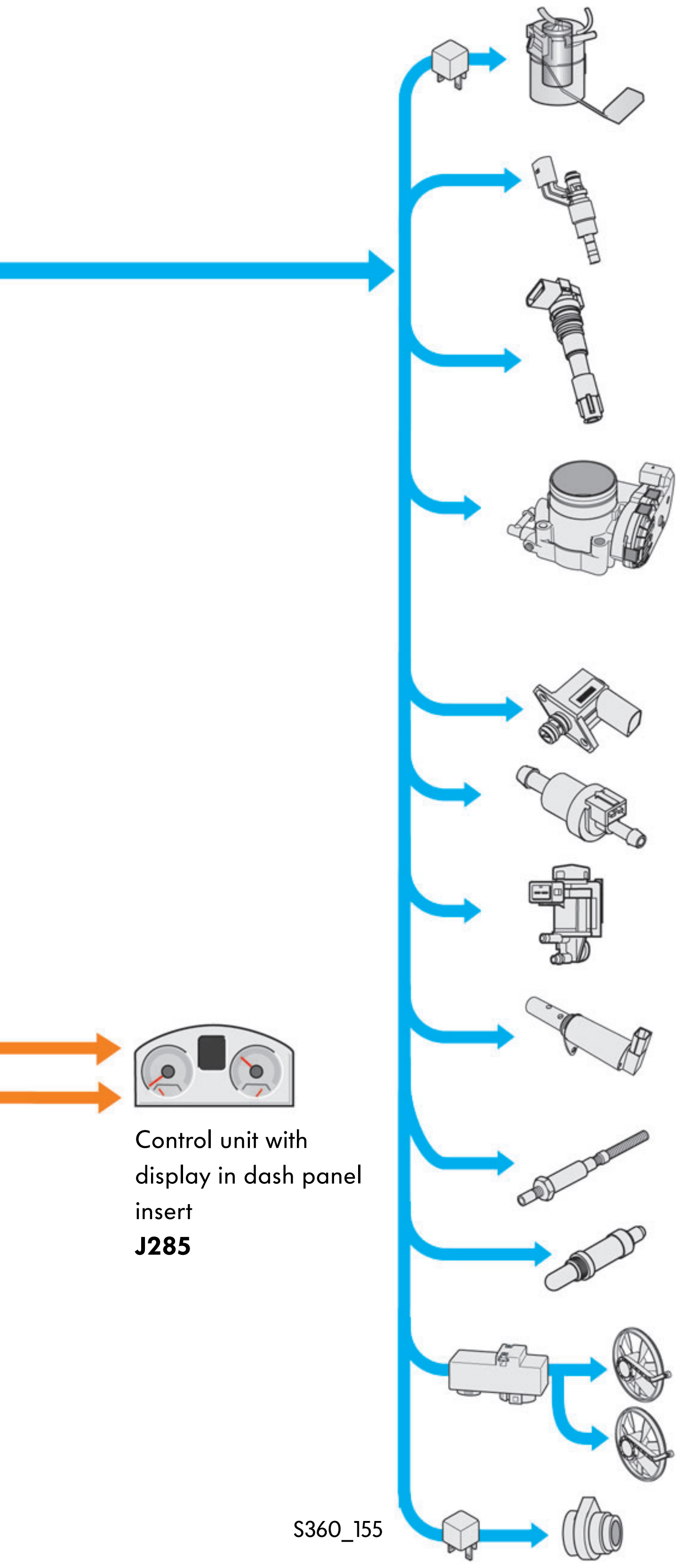
Engine Management

System overview

Sensors



Actuators



Fuel pump control unit **J538**
Fuel system pressurisation pump **G6**

Injectors for cylinders 1-6
N30, N31, N32, N33, N83, N84

Ignition coils 1 -6 with output stage
N70, N127, N291, N292, N323, N324

Throttle valve module **J338** with
throttle valve drive for electric
throttle **G186**

Fuel pressure regulating valve
N276

Active charcoal filter system solenoid valve
N80

Valve for intake manifold flap
N316

Inlet camshaft control valve 1 **N205**
Exhaust camshaft control valve 1
N318

Lambda probe heater **Z19**
Lambda probe 2 heater **Z28**

Lambda probe 1 heater after catalytic converter **Z29**
Lambda probe 2 heater after catalytic converter **Z30**

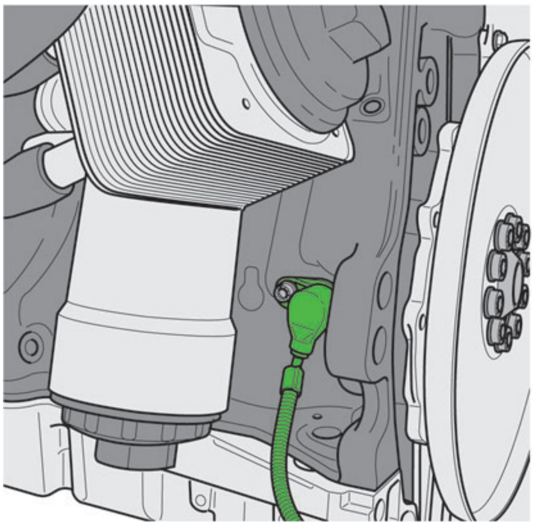
Radiator fan control unit **J293**
Radiator fan **V7**
Radiator fan 2 **V177**

Circulation pump relay **J160**
Circulation pump **V55**

Sensors

The engine speed sender G28

is bolted to the side of the cylinder block. It monitors the sender wheel on the crankshaft.



S360_111

Signal use

The engine speed and the precise position of the crankshaft compared with the camshaft are determined with the signal from the engine speed sender. This information is used to calculate the injection quantity and the start of injection.

Effects of signal failure

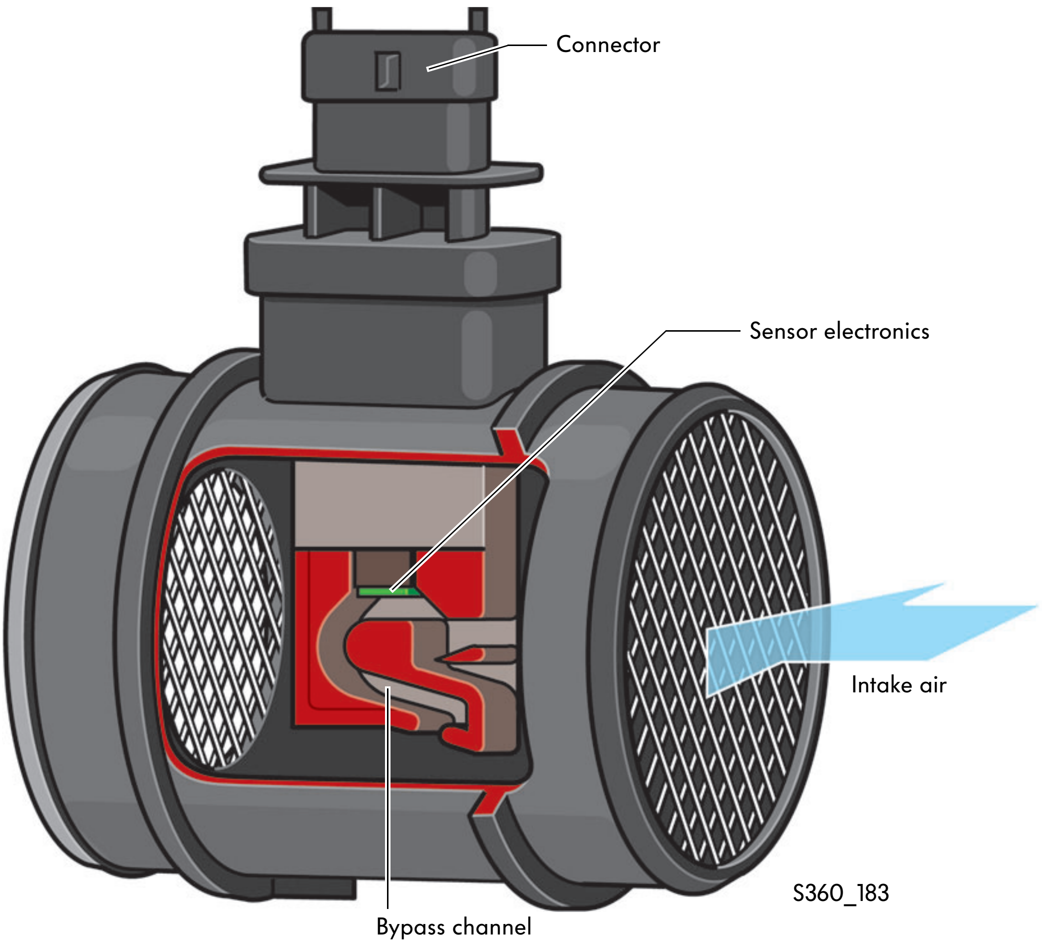
In the event of signal failure, the engine is shut off and can no longer be started.

Air mass meter G70

In the 3.2l and 3.6l FSI engine, the hot-film air mass meter from the 6th generation (HFM6) is used.
It is located in the engine intake duct and uses a thermal measuring principle like its predecessor.

It characteristics:

- a micro-mechanical sensor element with return flow detection,
- signal processing with temperature compensation,
- high measuring accuracy and
- high sensor stability.



S360_183

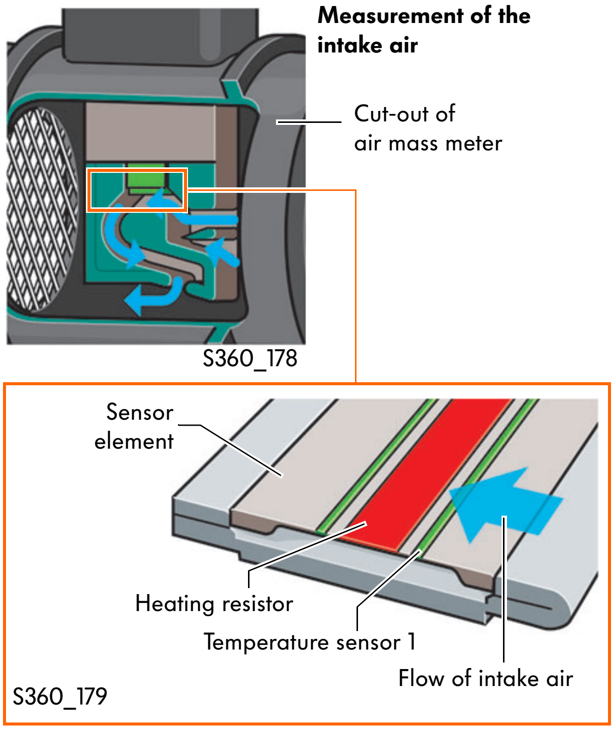
Engine Management

How it works

The sensor element of the air-mass meter protrudes into the flow of intake air drawn in by the engine. Part of the air flows through the bypass channel in the air mass meter.
The sensor electronics are in the bypass channel.
A heating resistor and two temperature sensors are integrated in the sensor electronics.
The two temperature sensors recognise the direction of air flow:

- intake air passes temperature sensor 1 first and
- air flowing back from the closed valves passes temperature sensor 2 first.

In conjunction with the heating resistor, the engine control unit can determine the oxygen content of the intake air.

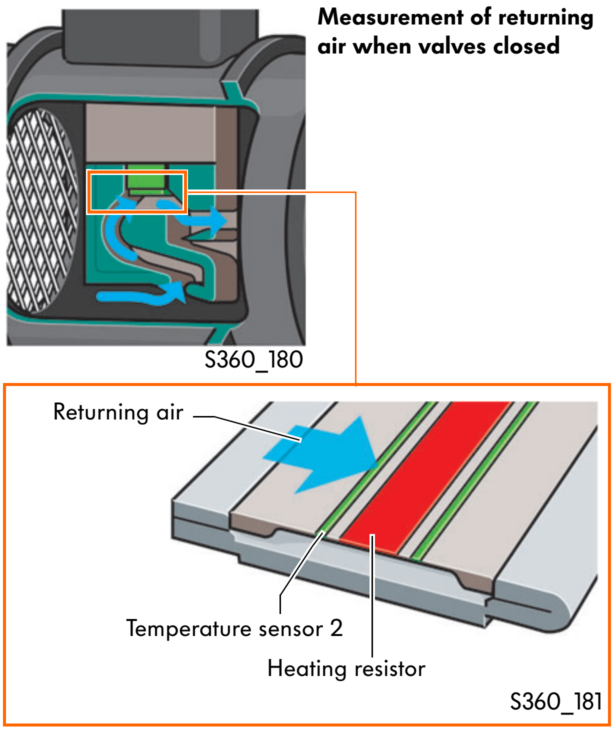


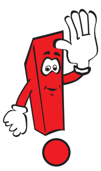
Signal use

The signal from the air mass meter is used by the engine control unit to calculate the volumetric efficiency. The control unit calculates the engine torque with the volumetric efficiency taking the Lambda value and the ignition time into consideration.

Effects of signal failure

If the air mass meter fails, the engine management calculates a substitute value.

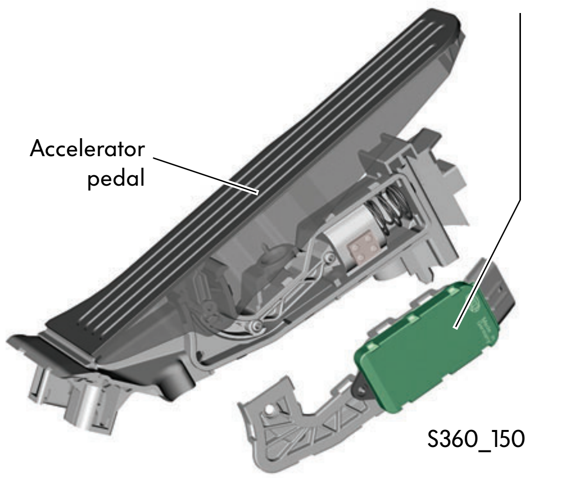




You will find more information on how the air mass meter G70 works and its measuring principle in self-study programmes 358 “Hot-film Air-mass Meter HFM 6” and 195 “The 2.3 ltr. V5 engine”.

Accelerator position sender G79 and accelerator position sender 2 G185

The two accelerator position senders are part of the accelerator pedal module and work contactless.
The engine control unit recognises the driver's wishes with the signals from these sensors.



S360_150

Signal use

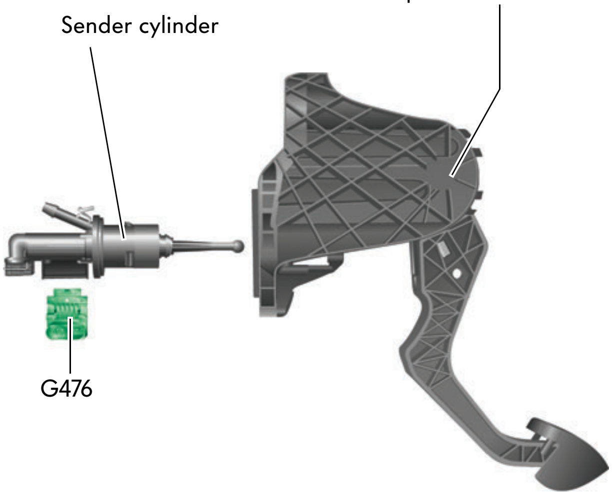
The engine control unit uses the signals from the accelerator position sender to calculate the injection quantity.

Effects of signal failure

If one or both senders fail, an entry is made in the fault memory and the electronic power control fault lamp illuminates.
The convenience functions, for example, the cruise control or the engine braking control, are switched off.

Clutch position sender G476

This is a mechanically operated switch that is located on the clutch pedal.
The clutch position sender is only required on vehicles with manual gearbox.



S360_163

Signal use

The signal is required to control the cruise control and to control the ignition advance and injection quantity when changing gear.

Effects of signal failure

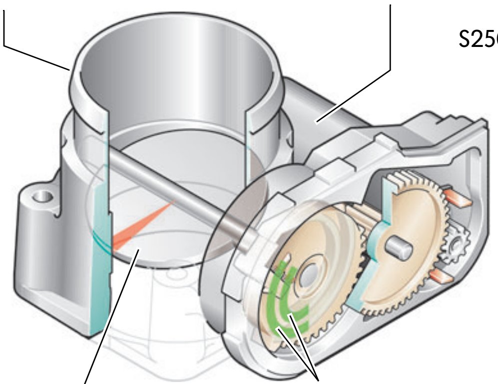
The cruise control cannot be switched on. There are driveability problems like engine judder and raised engine speed when changing gear.

Angle sender 1 G187 and angle sender 2 G188 in the throttle valve module

These senders determine the current position of the throttle valve and send this information to the engine control unit.

Signal use

The engine control unit recognises the position of the throttle valve by the throttle angle sender signals. The signals from both senders are redundant. This means that both senders supply the same signal for reasons of driving safety.



Effects of signal failure

Example 1
The engine control unit receives an implausible signal or no signal from an angle sender:

- An entry is made in the fault memory and the electronic power control fault lamp illuminates.
- Subsystems that influence the torque (e.g. cruise control or engine braking control) are switched off.
- The load signal is used to check the other angle sender.
- The accelerator pedal responds normally.

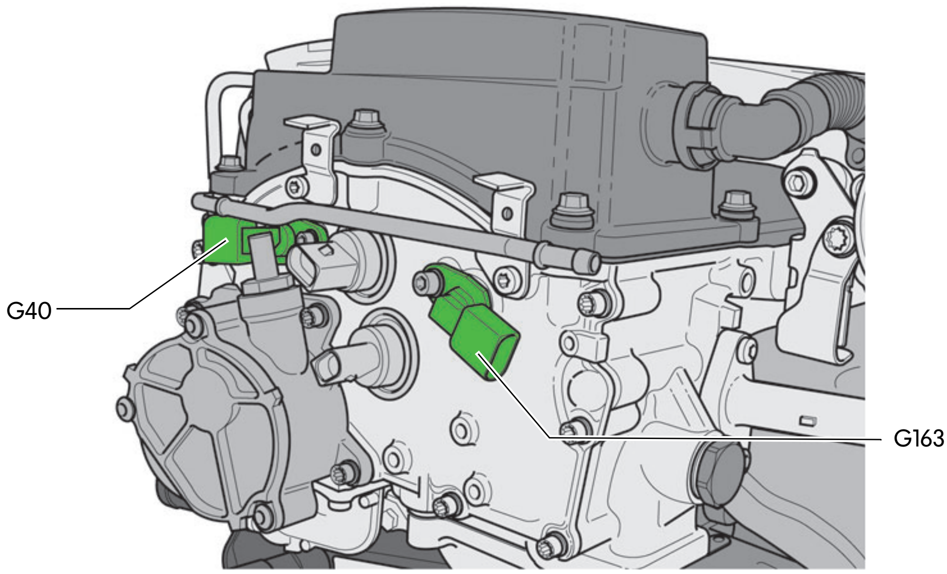
Example 2
The engine control unit receives an implausible signal or no signal from both angle senders:

- An entry is made in the fault memory for both senders and the electronic power control fault lamp illuminates.
- The throttle valve drive is switched off.
- The engine will only run with an increased idle speed of 1500 rpm and will no longer respond to the accelerator pedal.

Hall senders G40 and G163

Both Hall senders are located in the engine timing chain cover. They have the task of informing the engine control unit about the position of the intake and exhaust camshafts.

They monitor a quick-start sender wheel, which is on the respective camshaft.
Using Hall sender G40, the engine control unit recognises the position of the intake camshaft and, using Hall sender 2 G163, the position of the exhaust camshaft.



S360_356

Signal use

The signal from the Hall sender allows the exact position of the camshaft compared with the crankshaft to be recognised when the engine is started. Together with the signal from the engine speed sender G28, the system recognises which cylinder is at ignition TDC.
This allows the system to inject and ignite precisely in the corresponding cylinder.

Effects of signal failure

If the signal fails, the signal from the engine speed sender G28 will be used. It may take longer to start the engine since the camshaft position and the crank position cannot be determined so quickly.

Coolant temperature sender G62

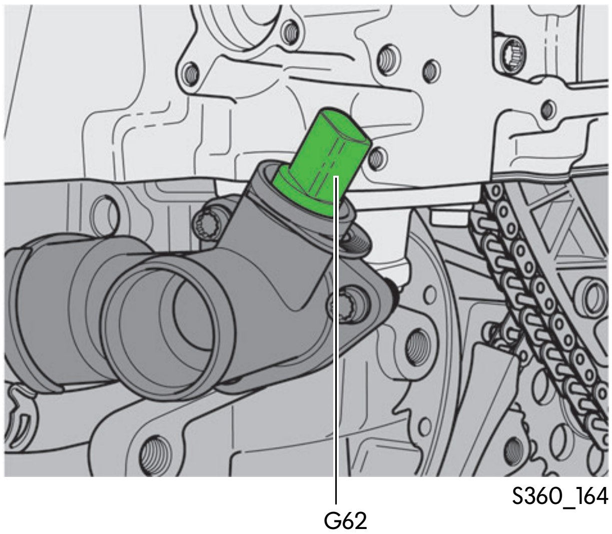
This sender is on the coolant pump above the oil filter on the engine and informs the engine control unit about the coolant temperature.

Signal use

The coolant temperature is used by the engine control unit for various engine functions. For example, the injection quantity is calculated, the charge air pressure, the start of transport and the exhaust gas recirculation amount.

Effects of signal failure

If the signal fails, the engine control unit will use the signal from the coolant temperature sender G83.



S360_164

Radiator outlet coolant temperature sender G83

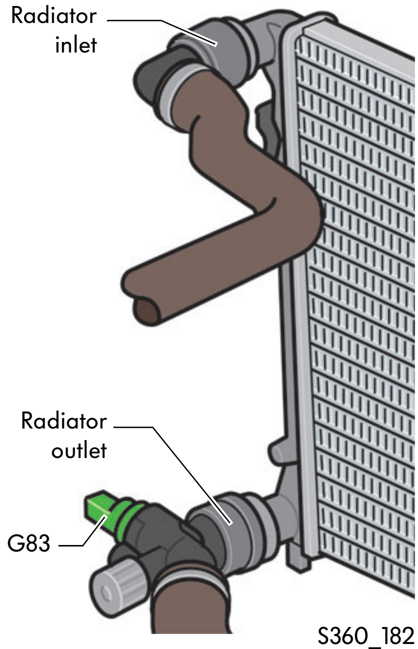
The coolant temperature sender G83 is in the hose on the radiator outlet and measures the temperature of the coolant leaving the radiator.

Signal use

The radiator fan is controlled by comparing both signals from the coolant temperature senders G62 and G83.

Effects of signal failure

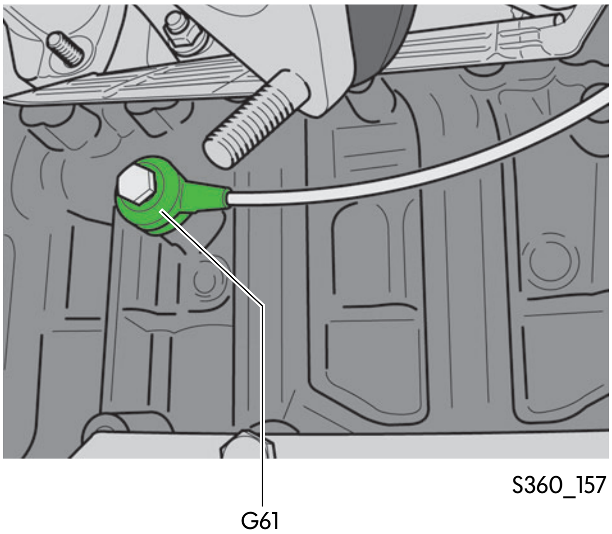
If the signal from the coolant temperature sender G83 fails, radiator fan speed 1 is activated constantly.



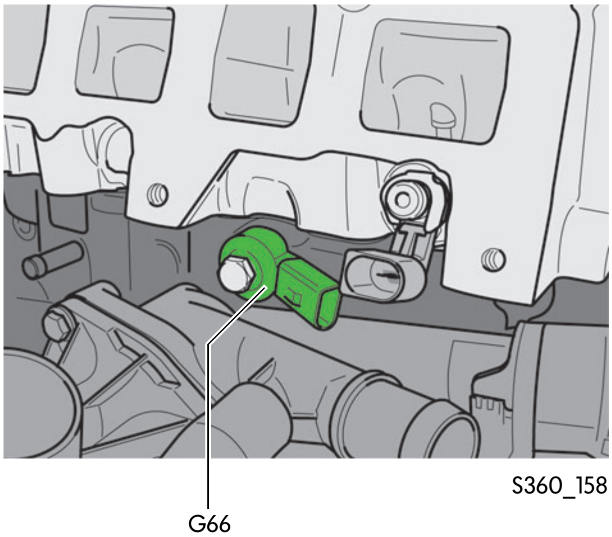
S360_182

Knock sensors G61 and G66

The knock sensors are bolted to the crankcase. They recognise engine knock in the individual cylinders. To avoid engine knock, individual cylinder knock control takes over the electronic control of the ignition timing.



S360_157



S360_158

Signal use

Using the signals from the knock sensors, the engine control unit adjusts the ignition angle until there is no longer engine knock.

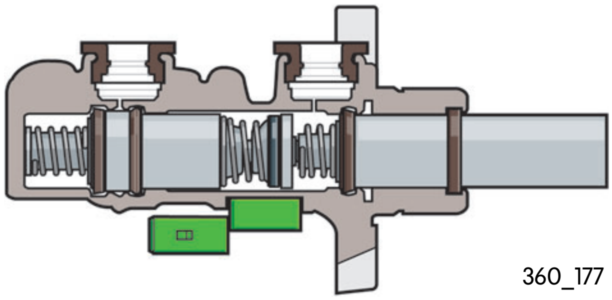
Effects of signal failure

If a knock sensor fails, the ignition angles of the affected cylinder group are cancelled. Then a retarded, default ignition angle is used. This can lead to an increase in fuel consumption. The knock control for the cylinder group of the other functioning knock sensor continues.

If both knock sensors fail, the engine management will switch to knock control limp-home mode, in which the ignition angles are retarded.
The full engine performance will then no longer be available.

Brake light switch F

The brake light switch is on the tandem master cylinder and monitors a magnetic ring on the tandem master cylinder piston contact-free using a Hall element.
The switch sends the “brake pressed” signal to the engine control unit via the powertrain CAN data bus.



360_177

Signal use

The cruise control is switched off when the brake is pressed. If first “accelerator pedal pressed” and also “brake pressed” is recognised, the system switches to a higher idling speed.

Effects of signal failure

If the sender signal fails, the injection quantity is reduced and the engine has less performance.
The cruise control system is also switched off.

Fuel pressure sender for high pressure G247

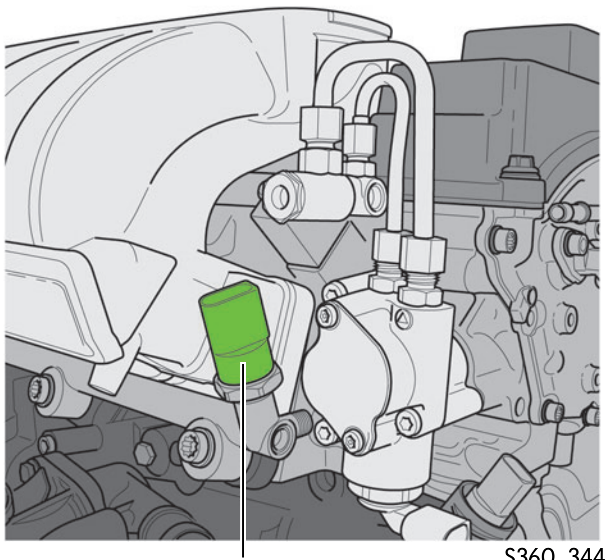
This sender is located on the lower fuel rail and measures the fuel pressure in the high-pressure fuel system.

Signal use

The engine control unit evaluates the signal and regulates the fuel high pressure using the fuel pressure regulating valve N276 in the high-pressure pump.

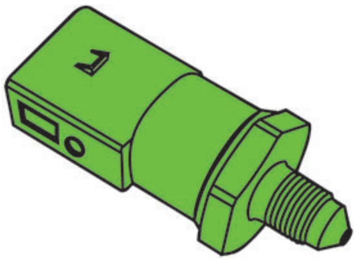
Effects of signal failure

If the fuel pressure sender fails, the fuel pressure regulating valve is controlled by the engine control unit with a fixed value.



S360_344

Fuel pressure sender for low pressure G410



S360_376

The fuel pressure sender for low pressure is on the low-pressure line and measures the fuel pressure in the low-pressure fuel system.

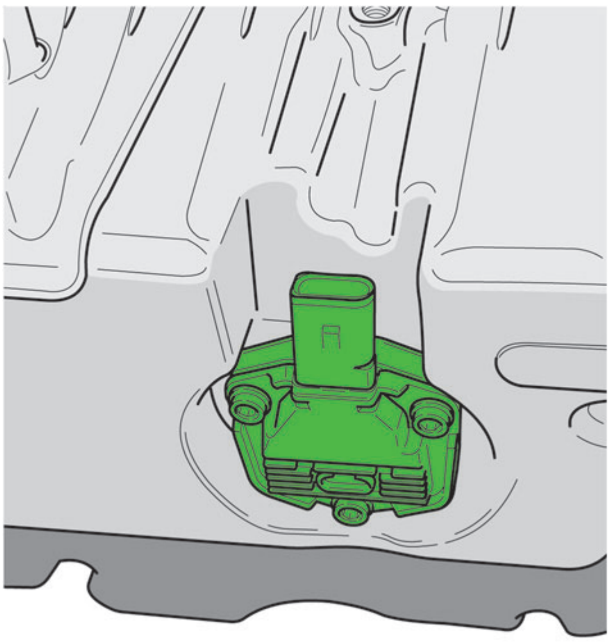
Signal use

The signal is used by the engine control unit to regulate the low-pressure fuel system.
Following the sender signal, the engine control unit transmits a signal to the fuel pump control unit J538, which then regulates the fuel pump as required.

Effects of signal failure

If the fuel pressure sender fails, there is no longer fuel pressure control. The fuel pressure is held constant at 5 bar.

Oil level and oil temperature sender G266



S360_156

This sender is screwed into the bottom of the oil sump. The signal is used by several control units. The control unit with display in dash panel insert J285 uses this signal to increase the service interval.

Signal use

The engine control unit receives the signal via the powertrain CAN data bus and uses the oil temperature signal to control the late adjustment of the exhaust camshaft at high oil temperatures.

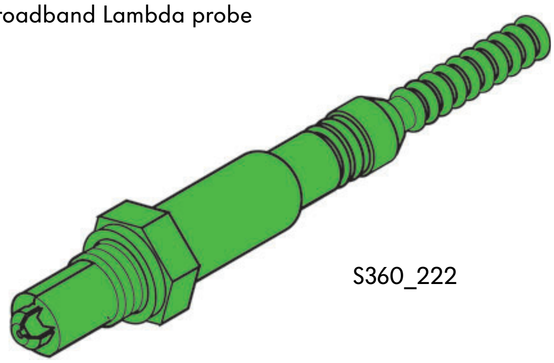
Effects of signal failure

The control unit uses the signal from the coolant temperature sender instead.

Lambda probes G39 and G108

A broadband Lambda probe has been placed in front of each starter catalytic converter.
The broadband Lambda probes can determine the oxygen concentration in a wide range and thus establish the air/fuel ratio in the combustion chamber.
Both Lambda probes are heated so that the operating temperature is reached faster.

Broadband Lambda probe



S360_222

Signal use

The Lambda probe signals are one input for calculating the injection time.

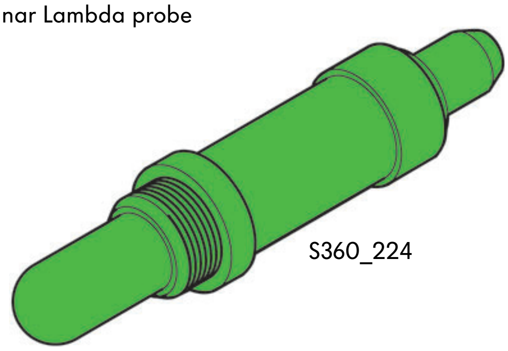
Effects of signal failure

There is no Lambda control if the pre-catalytic converter probe fails. No adjustment is made. A map is used for a limp-home mode.

Lambda probes G130 and G131

The planar Lambda probes come after the starter catalytic converter. They measure the residual oxygen in the exhaust gas. The engine can evaluate the operation of the catalytic converter using the residual oxygen in the exhaust gas.

Planar Lambda probe



S360_224

Signal use

The engine control unit uses the signals from the probes after the catalytic converter to check the catalytic converter function and the Lambda control circuit.

Effects of signal failure

There is no Lambda control if the pre-catalytic converter probe fails. The catalytic converter function cannot be checked.

Actuators

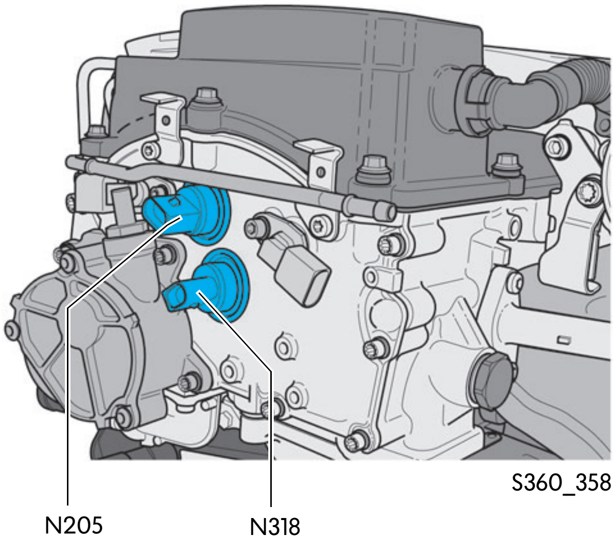
Inlet camshaft control valve 1 N205, exhaust camshaft control valve 1 N318

The solenoid valves are integrated into the camshaft housing.
They distribute the oil pressure according to the requirements of the engine control unit in relation to the adjustment direction and the adjustment travel on the camshaft adjuster.

Both camshafts are infinitely adjustable:

- Intake camshaft 52° crank angle
- Exhaust camshaft 42° crank angle
- Maximum valve overlap angle 47° Crank angle

When no oil pressure is available (engine stationary), the exhaust camshaft is mechanically locked.



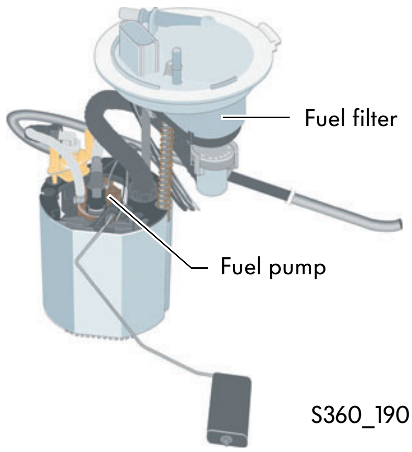
S360_358

Effects of signal failure

If an electrical cable to the camshaft adjusters is defective or a camshaft adjuster fails due to mechanical failure or insufficient oil pressure, no further camshaft adjustment is performed.

Electric fuel pump G6

The electrical fuel pump and the fuel filter are combined in the fuel supply unit. The fuel supply unit is in the fuel tank.



S360_190

Task

The electronic fuel pump delivers the fuel in the low-pressure fuel system to the high-pressure fuel pump. It is actuated with a PWM signal by the fuel pump control unit.

The electronic fuel pump always supplies the quantity of fuel required by the engine at the correct moment in time.

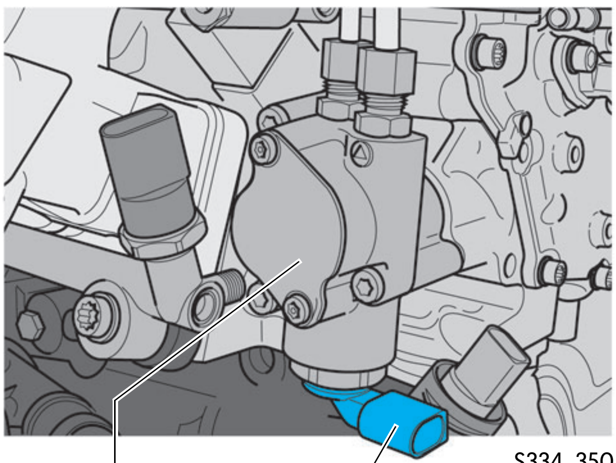
Effects upon failure

If the electronic fuel pump fails, the engine will no longer run.

Fuel pressure regulating valve N276

The fuel pressure regulating valve is located on the bottom of the high-pressure fuel pump.

The engine control unit regulates the high-pressure fuel between 35 and 100 bar using the regulating valve.



S334_350

Effects upon failure

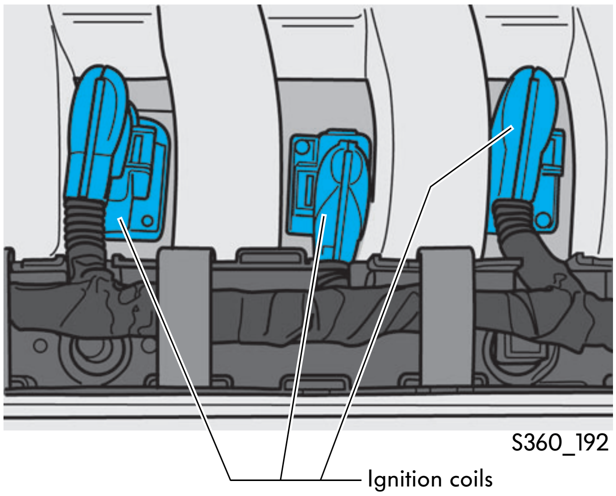
The engine control unit switches to limp-home mode.

Ignition coils 1-6 with output stage N70, 127, 291, 292, 323, 324

The ignition coil and output stage are one component. The ignition angle is controlled individually for each cylinder.

Effects upon failure

If an ignition coil fails, the injection for the corresponding cylinder will be deactivated. This is possible with a maximum of two cylinders.



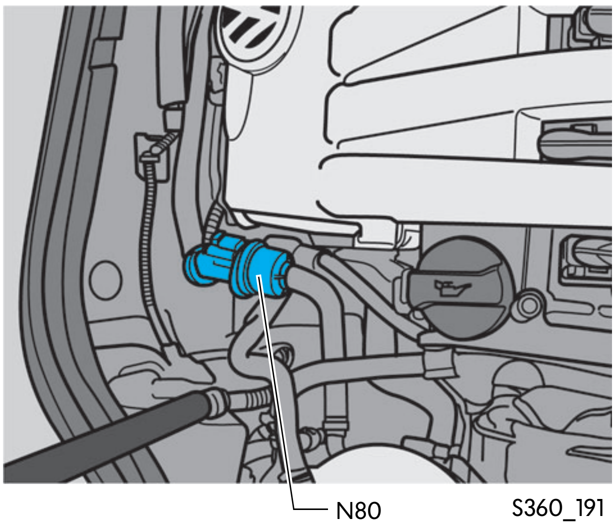
S360_192

The activated charcoal filter system solenoid valve N80

is on the rear side (belt drive) of the engine and is controlled by the engine control unit.
The fuel vapours collected in the activated charcoal filter are transported for combustion thus emptying the activated charcoal filter.

Effects of signal failure

If the power supply is interrupted, the valve remains closed. The tank is not ventilated.



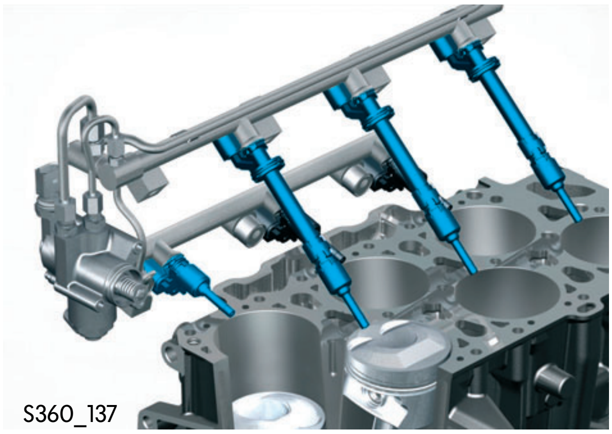
S360_191

Engine Management

Injectors cylinders 1-6 N30, N31, N32, N33, N83, N84

The high-pressure injectors are fitted in the cylinder head. They are actuated by the engine control unit according to the firing order. After actuation, they inject fuel straight into the cylinder.

The fuel is injected on one side due to the design of the engine. The injectors are therefore longer on cylinder banks 1, 3 and 5 than the injectors on cylinder bank 2, 4 and 6.



S360_137

Effects upon failure

A faulty injector is detected by the fault recognition system and is no longer operated.

The throttle valve drive for electric throttle G186

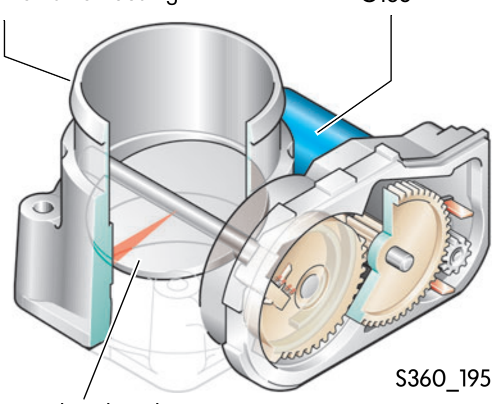
is an electric motor that operates the throttle valve via gears.

The adjustment range is continuous from the idle to the full load setting.

Effects upon failure

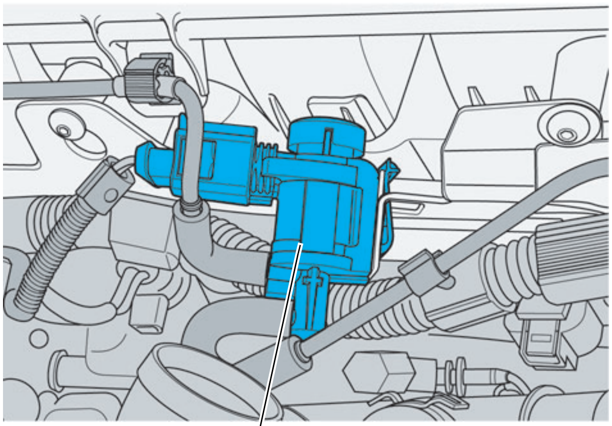
If the throttle valve drive fails, the throttle valve will move automatically to the limp-home mode position. An entry is made in the fault memory and the electronic power control fault lamp illuminates.

Only limp-home mode features are available to the driver. The convenience functions are switched off.



S360_195

Intake manifold flap valve N316



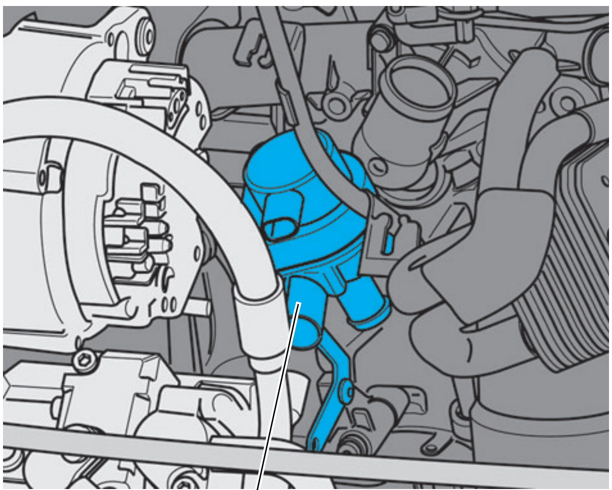
N316 S360_374

Only the 3.2l V6 FSI engine and the 3.6l V6 R36 FSI engine have a variable intake manifold and therefore an electrical switching valve to connect or disconnect the vacuum control element for the switching mechanism to or from the vacuum system and thus perform the switching operation.

Effects upon failure

If the valve fails, the intake manifold flaps are moved to limp-home mode position by a mechanical spring. It corresponds with the power position of the intake manifold.

The circulation pump V55



V55 S360_194

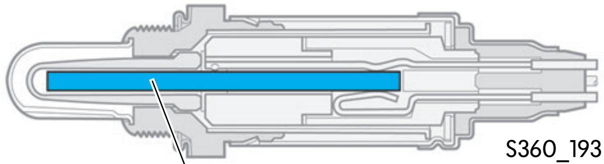
is controlled by the engine control unit.
It supports the mechanical coolant pump when the engine is running. Once you have parked the vehicle and when there is no air flow, it is switched on depending on the coolant temperature and thus prevents heat accumulation in the engine.

Effects upon failure

If the recirculation pump fails, the engine may overheat.

Lambda probe heaters Z19, Z28, Z29 and Z30

The Lambda probe heaters have the task of quickly heating the ceramic part of the probes to an operating temperature of approx. 900°C when the engine is started and at low temperatures. The Lambda probe heater is controlled by the engine control unit.

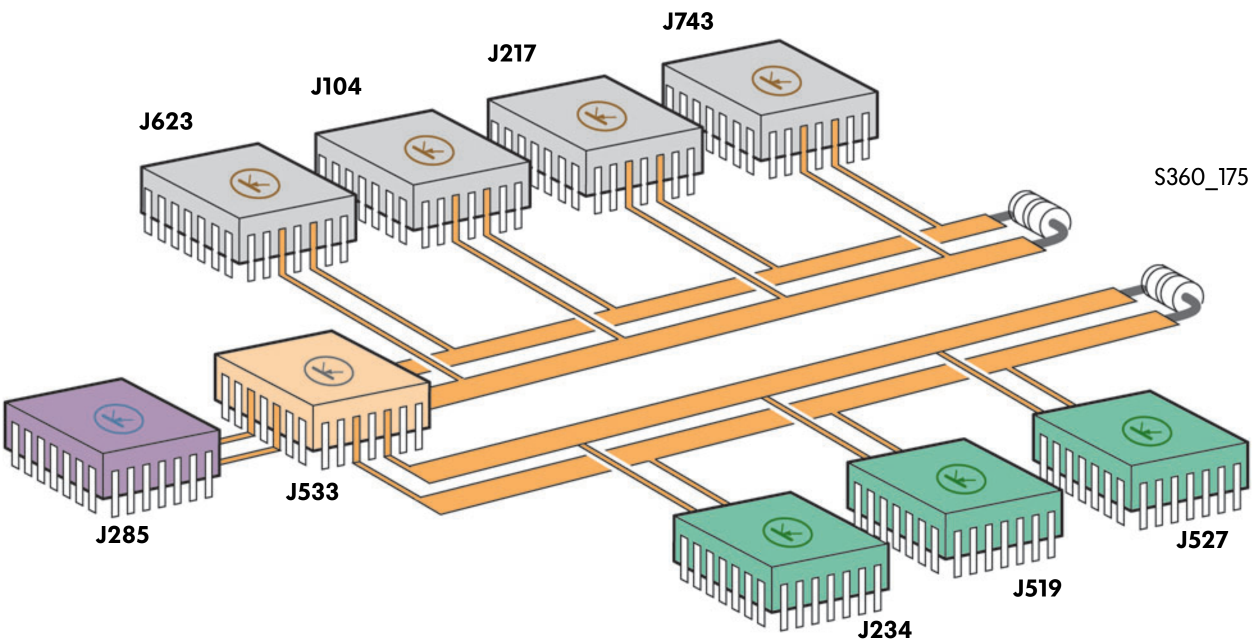


Effects upon failure

The engine can no longer be controlled for emissions.

Control units in the CAN data bus

The schematic shown below shows the integration of the engine control unit J623 into the vehicle CAN data bus structure. Information is transmitted between the control units via the CAN data bus.



Legend
J623 Engine control unit
J104 ABS control unit
J217 Automatic gearbox control unit
J234 Airbag control unit
J285 Control unit with display in dash panel insert
J519 Onboard supply control unit
J527 Steering column electronics control unit
J533 Data bus diagnostic interface
J743 Mechatronic unit for direct shift gearbox

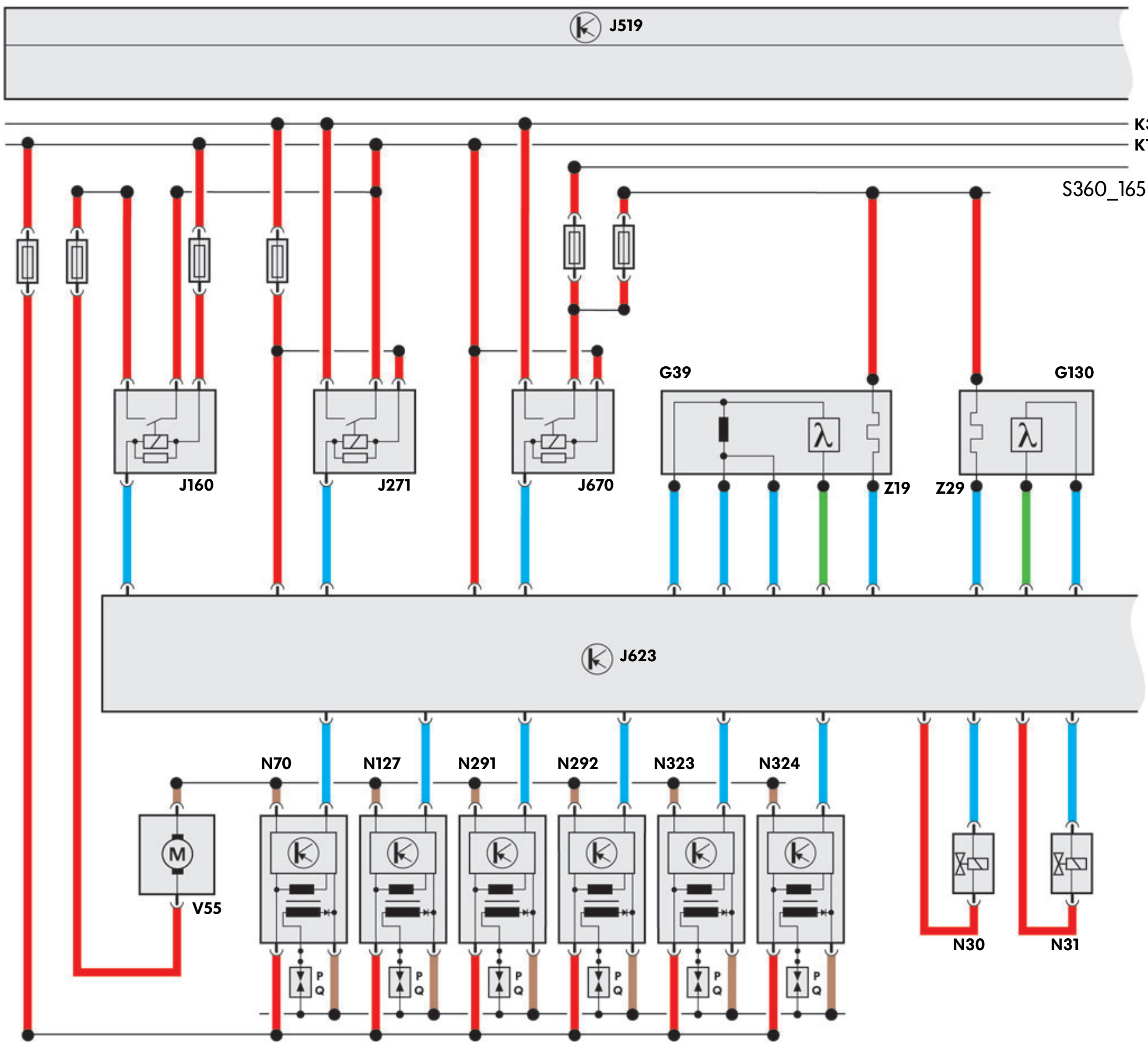
Colour coding

Powertrain CAN data bus

Convenience CAN data bus

Infotainment CAN data bus

Functional Diagram

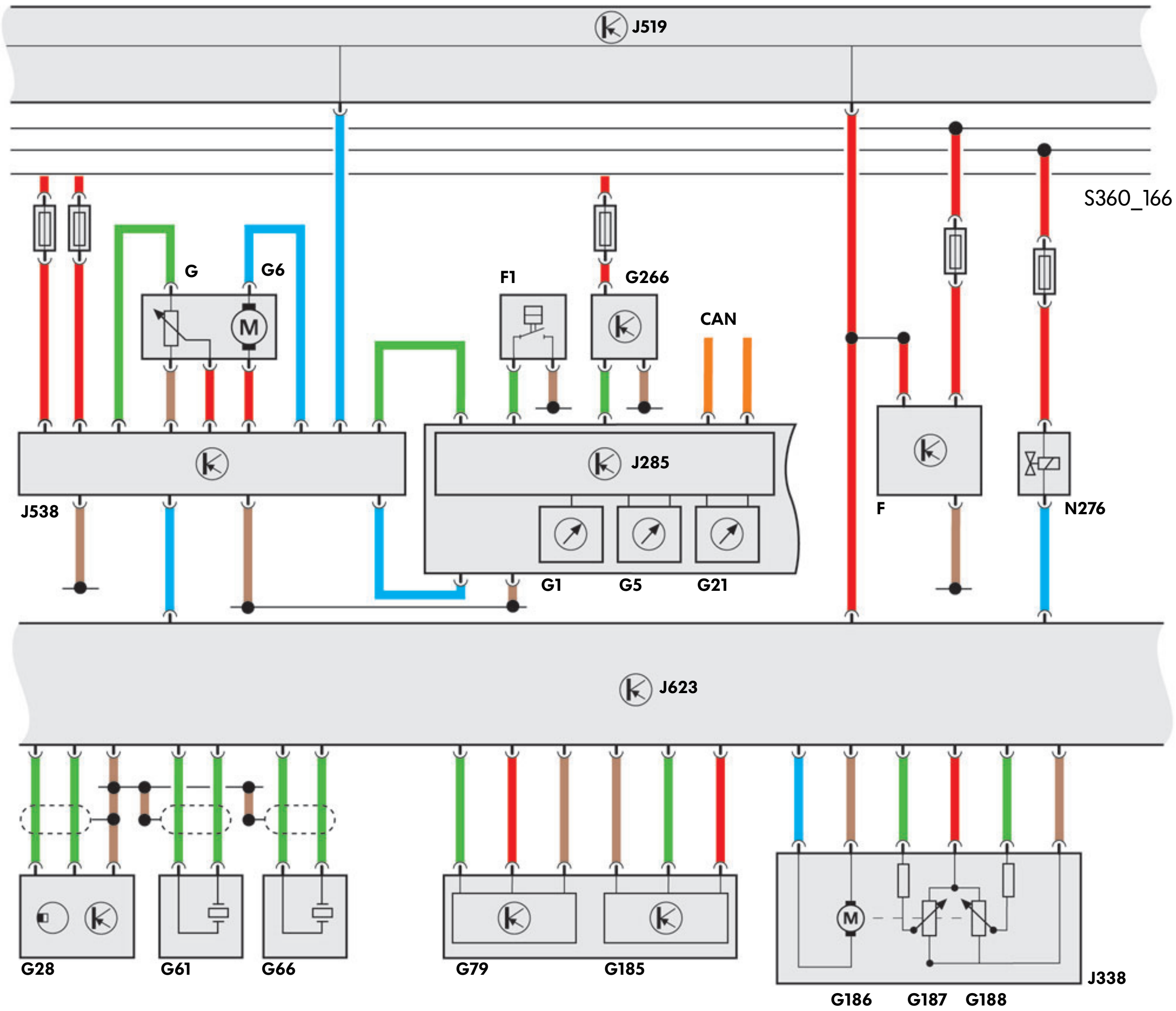


G39 Lambda probe
G130 Lambda probe after catalytic converter

J160 Circulation pump relay
J271 Motronic current supply relay
J519 Onboard supply control unit
J623 Engine control unit
J670 Motronic current supply relay 2

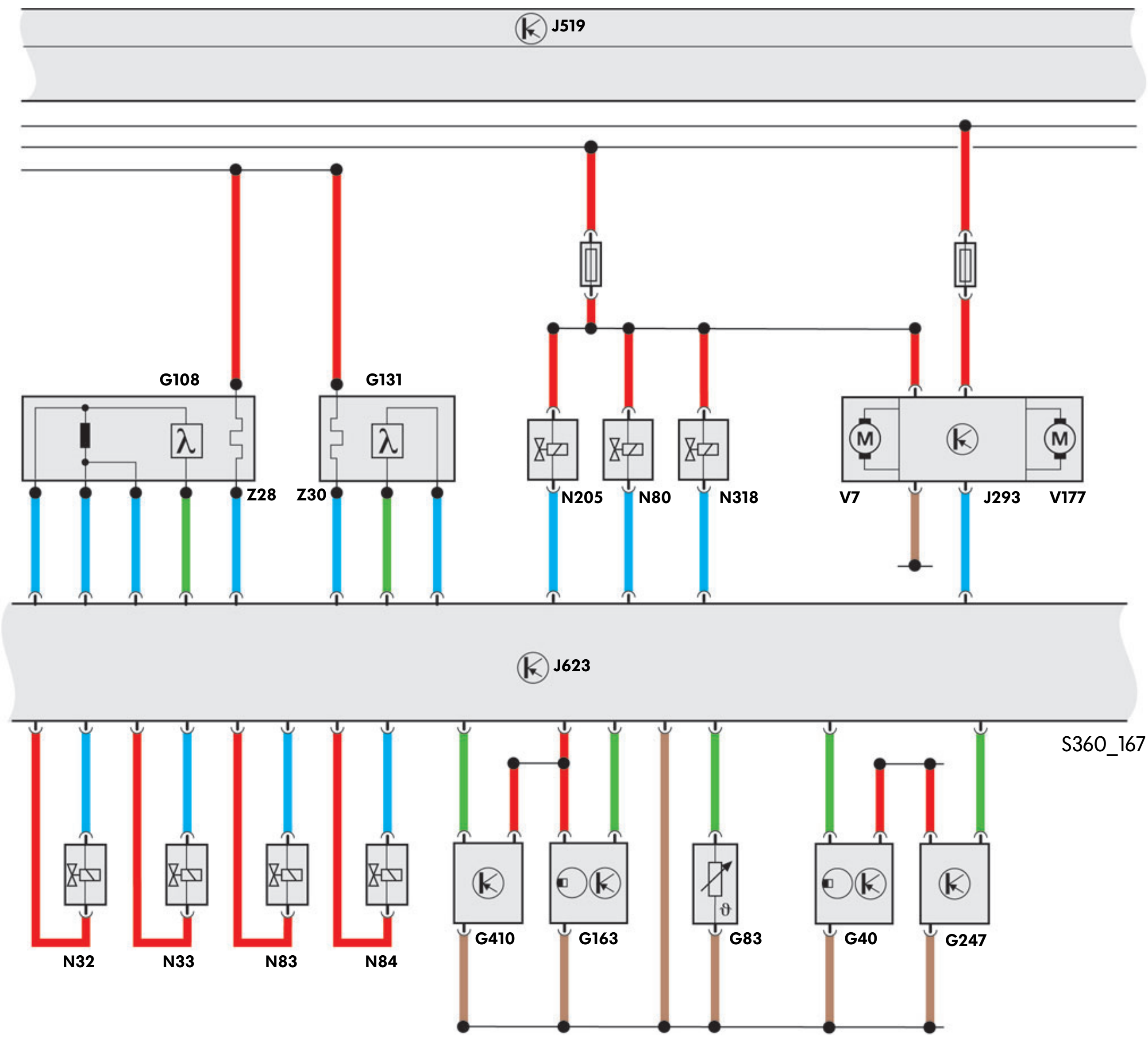
N30 Injector, cylinder 1
N31 Injector, cylinder 2
N70 Ignition coil 1 with output stage
N127 Ignition coil 2 with output stage
N291 Ignition coil 3 with output stage
N292 Ignition coil 4 with output stage
N323 Ignition coil 5 with output stage
N324 Ignition coil 6 with output stage

Z19 Lambda probe heater
Z29 Lambda probe 1 heater after catalytic converter



F	Brake light switch
F1	Oil pressure switch
G	Fuel gauge sender
G1	Fuel gauge
G5	Rev. counter
G6	Fuel system pressurisation pump
G21	Speedometer
G28	Engine speed sender
G61	Knock sensor 1
G66	Knock sensor 2
G79	Accelerator position sender
G185	Accelerator position sender 2
G186	Throttle valve drive for electric throttle
G187	Throttle valve drive angle sender 1 for electric throttle
G188	Throttle valve drive angle sender 2 for electric throttle
G266	Oil level and oil temperature sender
J285	Control unit with display in dash panel insert
J338	Throttle valve module
J538	Fuel pump control unit
J623	Engine control unit
N276	Fuel pressure regulating valve

Functional Diagram

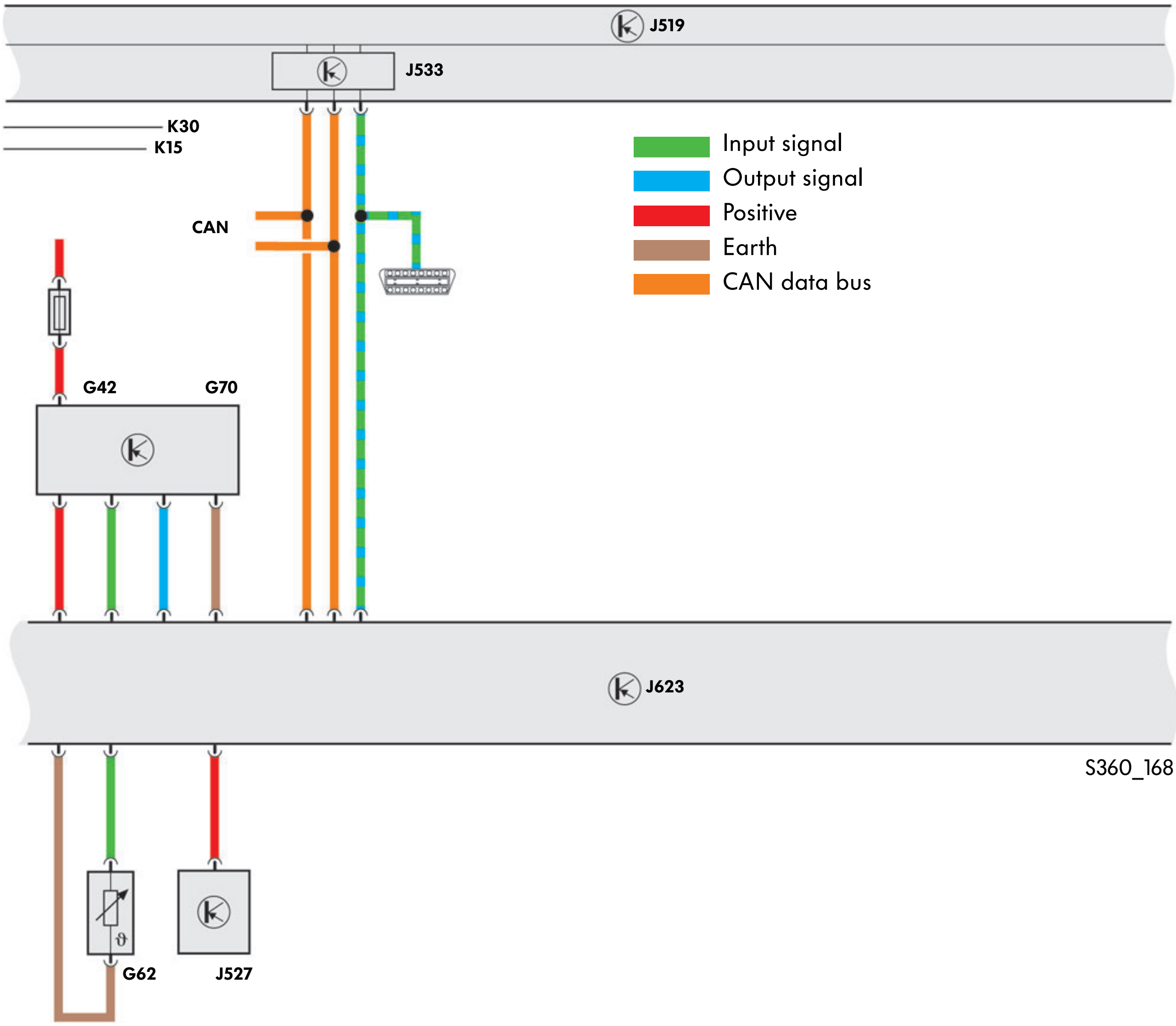


G40 Hall sender
G83 Radiator outlet coolant temperature sender
G108 Lambda probe 2
G131 Lambda probe 2
after catalytic converter
G163 Hall sender 2
G247 Fuel pressure sender
G410 Fuel pressure sender for low pressure

J293 Radiator fan control unit
J519 Onboard supply control unit
J623 Engine control unit

N32 Injector, cylinder 3
N33 Injector, cylinder 4
N80 Active charcoal filter system solenoid valve
N83 Injector, cylinder 5
N84 Injector, cylinder 6
N205 Inlet camshaft control valve 1
N318 Exhaust camshaft control valve 1

V7 Radiator fan
V177 Radiator fan 2



G62 Coolant temperature sender
G42 Intake air temperature sender
G70 Air mass meter

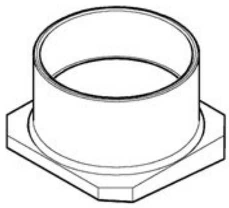
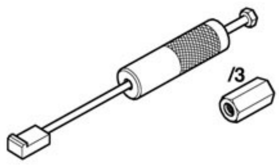
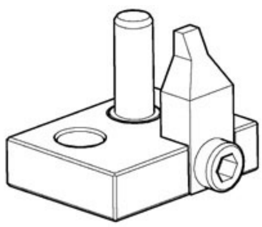
J519 Onboard supply control unit
J527 Steering column electronics control unit
J533 Data bus diagnostic interface
J623 Engine control unit

Z28 Lambda probe 2 heater
Z30 Lambda probe 2 heater after catalytic converter

This functional diagram shows the 3.6l FSI engine in the Passat as an example.

Service

Special tools

Designation	**Tool**	**Application**
T 10333 Funnel	 S360_189	The funnel T 10333 is used to fit the pistons.
T 10055 Puller T 10055/3 Adapter	 S360_184	The puller T10055 with the adapter T 10055/3 is used to remove the oil pump.
T 10133 Tool set for FSI engines T 10133/10 Puller	 S360_186  S360_187	The tool set T 10133 with puller T 10133/10 is needed to remove the injectors.
T 10332 Setting tool	 S360_188	The setting tool T 10332 is needed to lock the sprocket on the high-pressure fuel pump drive.

Which answers are correct?
One or several of the answers could be correct.

1. By how many degrees has the V-angle of the 3.2l and 3.6l FSI engines changed compared with the VR6 multi-point injection?

☐ a) 3.4°

☐ b) 4.4°

☐ c) 4.6°

2. Which statement about the pistons is correct?

☐ a) The pistons have a graphite abradable coating.

☐ b) The pistons in cylinder bank 1 and 2 differ in the arrangement of the recesses.

☐ c) The injected fuel is swirled due to the position and shape of the piston recess.

3. What is the advantage of the large maximum adjustment travel of the camshafts? Which statement is correct?

☐ a) There is no external exhaust gas recirculation.

☐ b) The exhaust gas recirculation is internal.

☐ c) There is no exhaust gas recirculation is some cases.

4. What intake manifold length achieves a high engine torque?

☐ a) A long intake manifold.

☐ b) A short intake manifold.

☐ c) The intake manifold length does not have an influence on the engine torque.

Test Yourself

5. Please fill in the missing terms.

Engine speed sender **G28**

a) _______________

b) _______________

Clutch position sender **G476**

Throttle valve module **J338** with
throttle valve drive angle sender 1 for electric throttle **G187**
Throttle valve drive angle sender 2 for electric throttle **G188**

c) _______________

d) _______________

e) _______________

Brake light switch **F**

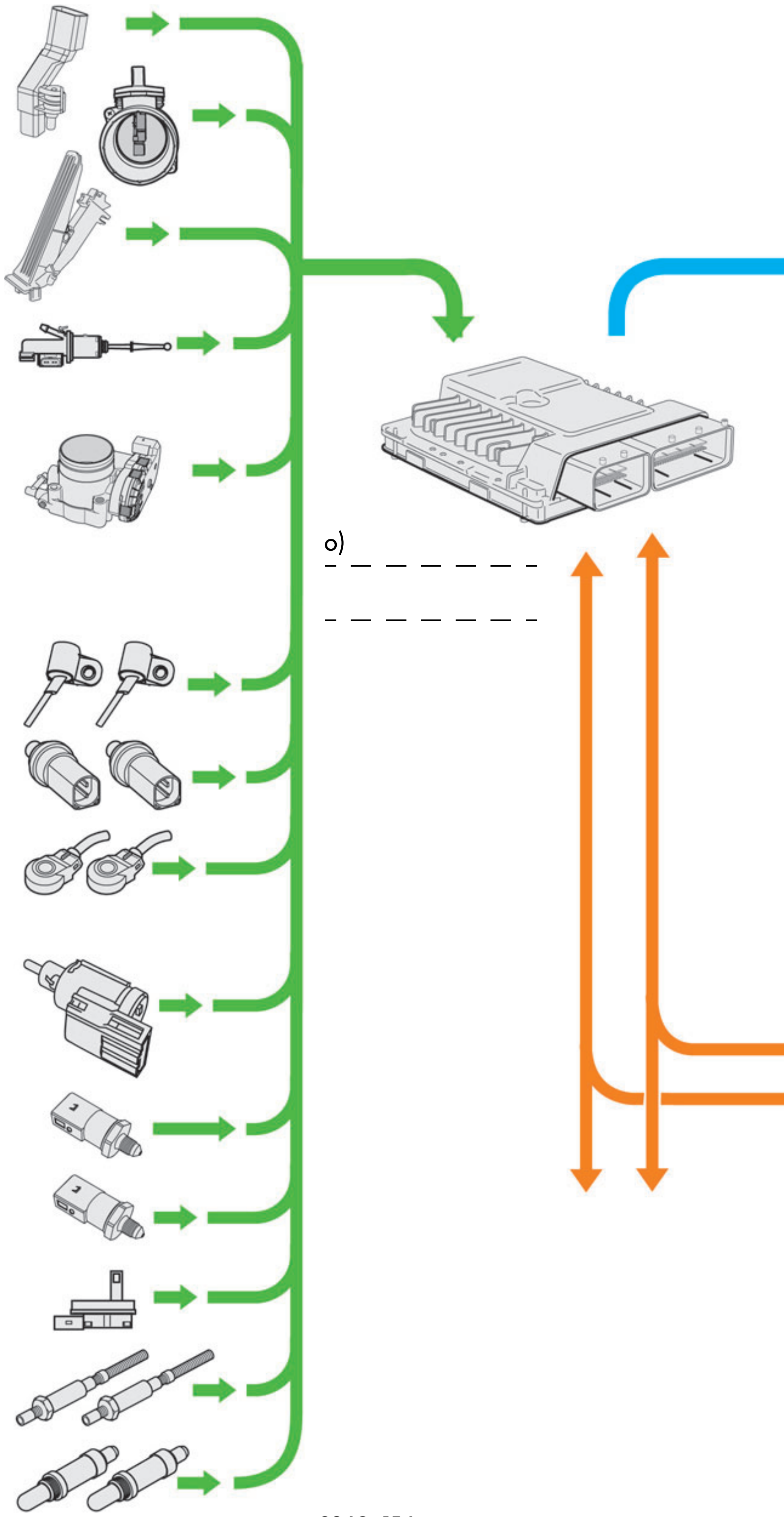
f) _______________

g) _______________

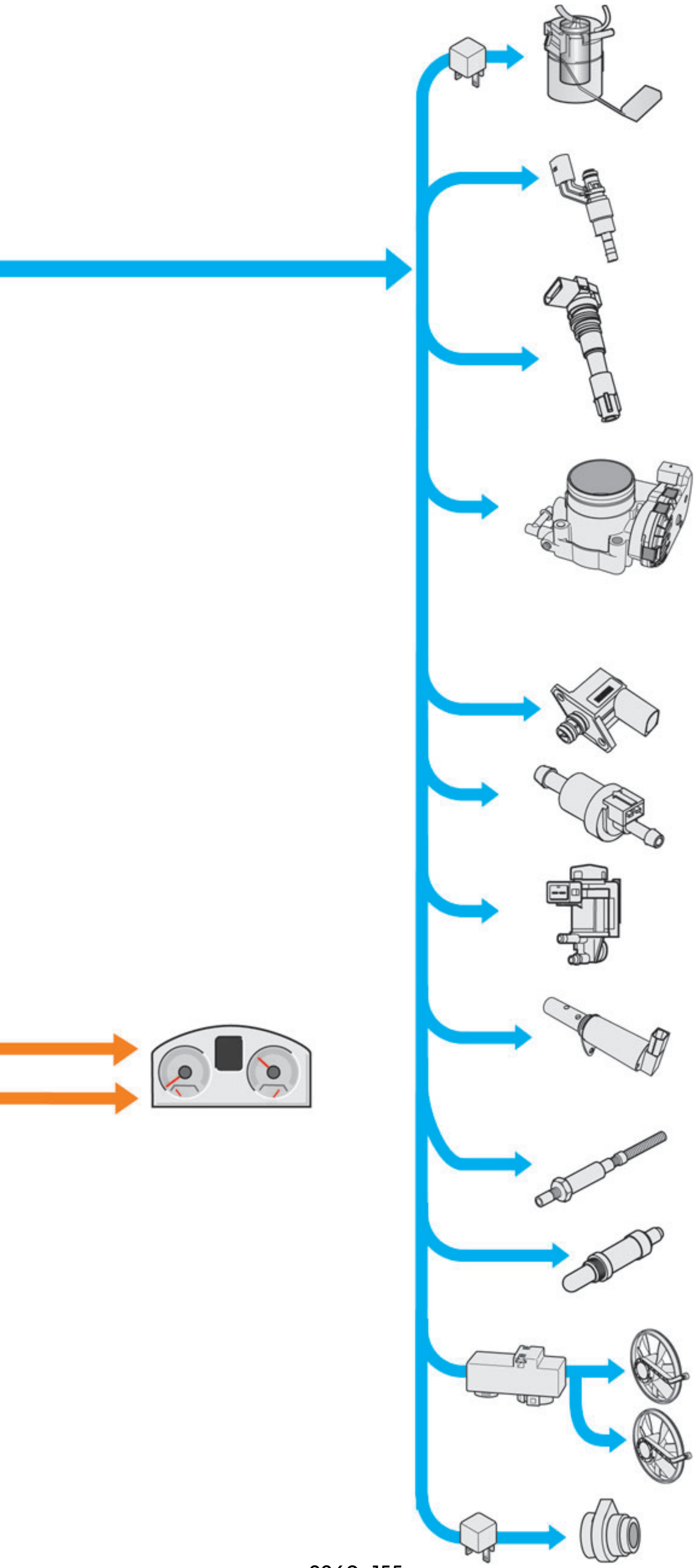
Oil level and oil temperature sender **G266**

h) _______________

i) _______________



S360_154



S360_155

k) ____________________

Injectors for cylinders 1-6
N30, N31, N32, N33, N83, N84

Ignition coils 1 -6 with output stage
N70, N127, N291, N292, N323, N324

Throttle valve module **J338** with
throttle valve drive for electric
throttle **G186**

l) ____________________

m) ____________________

n) ____________________

Inlet camshaft control valve 1 **N205**
Exhaust camshaft control valve 1 **N318**

Lambda probe heater **Z19**
Lambda probe 2 heater **Z28**

Lambda probe 1 heater after catalytic converter **Z29**
Lambda probe 2 heater after catalytic converter **Z30**

o) ____________________

p) ____________________

Circulation pump relay **J160**
Circulation pump **V55**

Test Yourself

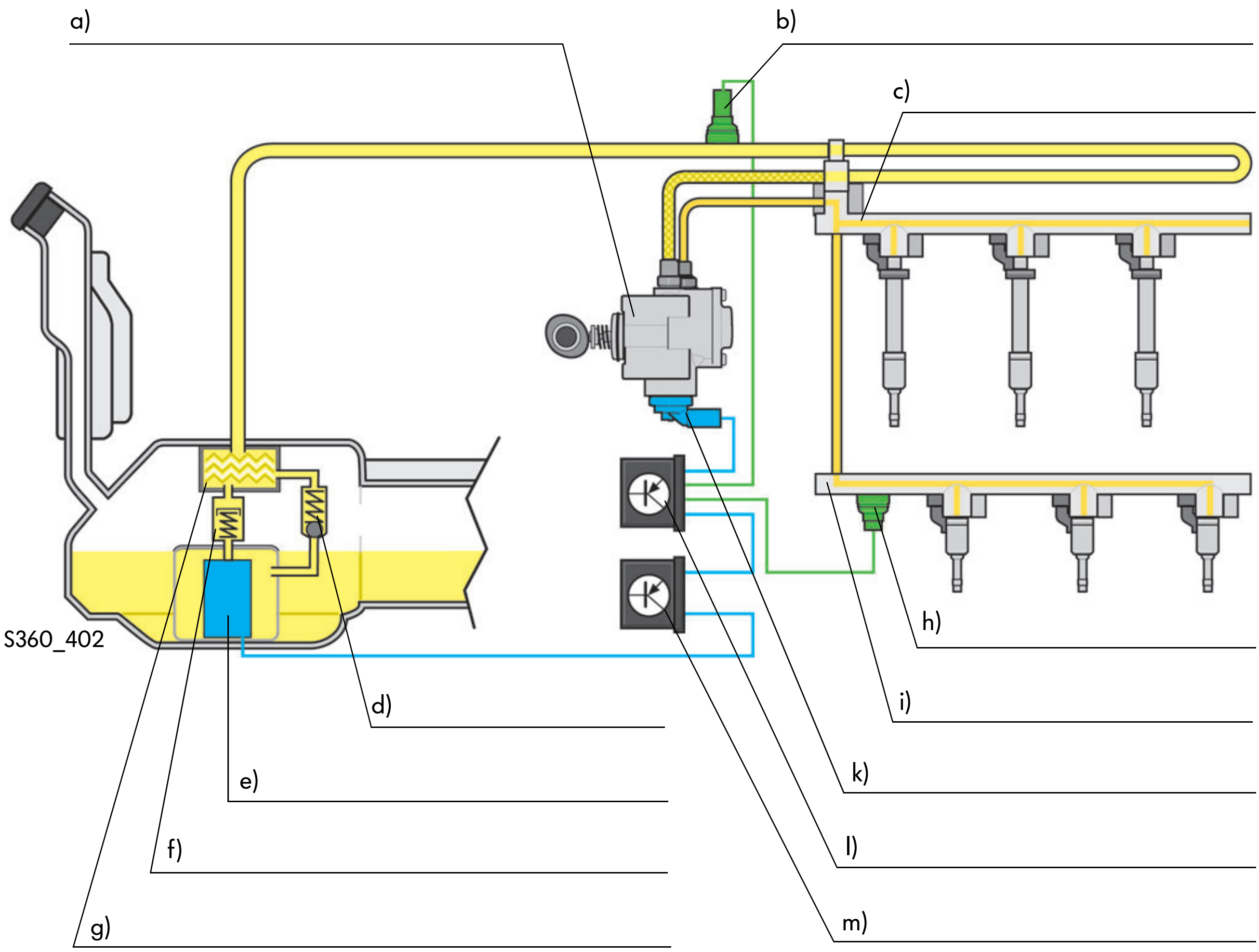
6 Which statement about the adjustment of the valve timing is correct?

☐ a) The high-pressure fuel pump drive sprocket needs to be locked.

☐ b) Setting the valve timing has not changed due to the high-pressure fuel pump drive.

☐ c) There is a special tool for locking the drive sprocket on the high-pressure fuel pump.

7. Please fill in the missing terms.



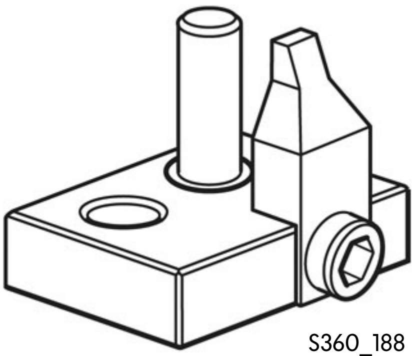
8. What can be checked through the oil pump service access?

☐ a) The chain tension of the primary roller chain.

☐ b) The mechanical wear of the oil pump.

☐ c) The condition of the pressure relief valve without the chain drive being removed.

9. What work requires the special tool T 10332?



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Answer:

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Test Yourself

Answers

1. b); 2. a),b),c); 3 a), b); 4 a);
5. a) Air mass meter G70, b) Accelerator position sender G79 and accelerator position sender 2 G185, c) Hall sender G40 and Hall sender 2 G163, d) Coolant temperature sender G62 and radiator outlet coolant temperature sender G83, e) Knock sensor 1 G61 and knock sensor 2 G66, f) Fuel pressure sender G247, g) Fuel pressure sender for low pressure G410, h) Lambda probe G39 and Lambda probe 2 G108, i) Lambda probe after catalytic converter G130 and Lambda probe 2 after catalytic converter G131, k) Fuel pump control unit J538 and fuel system pressurisation pump G6, l) Fuel pressure regulating valve N276, m) Activated charcoal filter solenoid valve 1 N80, n) Intake manifold flap valve N316, o) Radiator fan control unit J283 and radiator fan V7, p) Radiator fan 2 V177;
6. a), c); 7. a) High-pressure fuel pump, b) Fuel pressure sender for low pressure G410, c) Cylinder bank 1 fuel rail, d) Pressure retention valve, e) Fuel system pressurisation pump G6, f) Pressure limiting valve, g) Fuel filter, h) Fuel pressure sender G247, i) Cylinder bank 2 fuel rail, k) Fuel pressure regulating valve N276, l) Engine control unit J623, m) Fuel pump control unit J358
8.) c),
9.) The setting tool T 10332 is needed to lock the sprocket on the high-pressure fuel pump drive.

Notes

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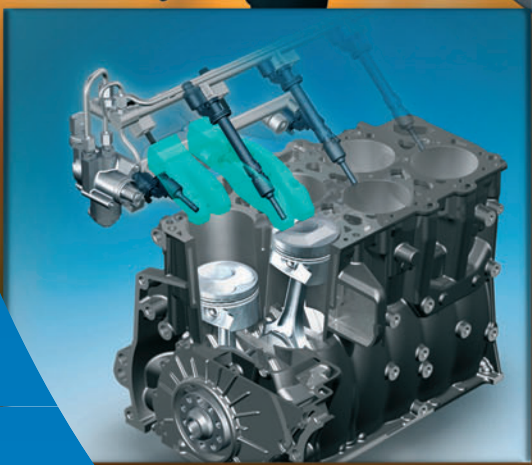

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