



Self-study Programme 359

1.4l TSI Engine with Dual-charging

Design and Function



The 1.4l TSI* engine is the world's first petrol engine with direct petrol injection and dual-charging. Volkswagen is thus laying another milestone in engine development.

* The term "TSI" is a protected abbreviation of Volkswagen.



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On the following pages, we will introduce you to the design and function of the new 1.4l TSI engine with dual-charging.

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.



Introduction	4
Engine mechanics	6
Poly-V-belt drive	6
Timing chain	7
Cylinder block	8
Cylinder head and valve train	10
Dual-charging with supercharger and turbocharger	11
Crankcase breather and ventilation	21
Oil system	22
Dual-circuit cooling system	24
Demand-regulated fuel system	26
Exhaust system	27
Engine Management	28
System Overview	28
CAN networking	30
Engine Control Unit	31
Sensors	32
Actuators	46
Functional Diagram	58
Service	60
Test Yourself	62



Introduction



Special Technical Features

The special concept behind this engine is, above all, the combination of direct petrol injection, dual-charging and downsizing.

- Volkswagen used direct petrol injection for the first time in the Lupo FSI model year 2001.
- In dual-charging, the engine is charged by a mechanical compressor and/or a turbocharger.
- Downsizing is replacing a large-capacity engine with a powerplant with smaller displacement and/or fewer cylinders. This reduces the internal friction and thus the fuel consumption without the power or torque being reduced.



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Thanks to this concept, it has greater performance than engines with the same output and also consumes less fuel. It therefore meets customer demands for economic FSI engines with a high level of dynamism.

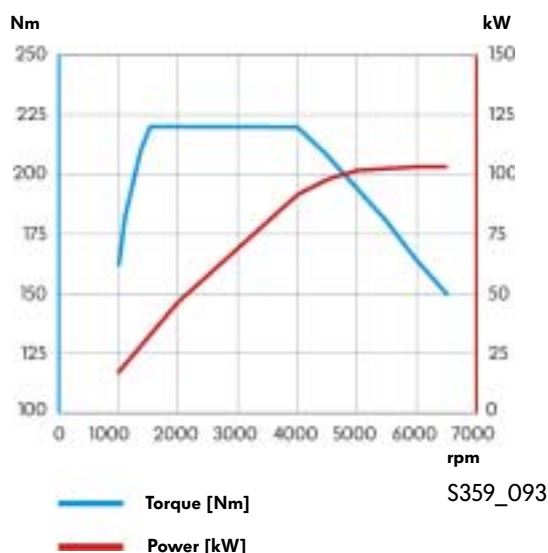
Technical features

- Two output versions delivering 103kW and 125kW
- Bosch Motronic MED 9.5.10
- Homogenous mode (Lambda 1)
- Double injection catalytic converter heating
- Turbocharger with waste gate
- Additional mechanical supercharger
- Intercooler
- Maintenance-free timing chain
- Engine cover with vacuum tank for the intake manifold flap control
- Plastic intake manifold
- Continuous inlet camshaft timing adjustment
- Grey cast iron cylinder block
- Steel crankshaft
- Duo-centric oil pump
- Dual-circuit cooling system
- Fuel system regulated according to requirements
- High-pressure fuel pump with a delivery pressure of up to 150 bar

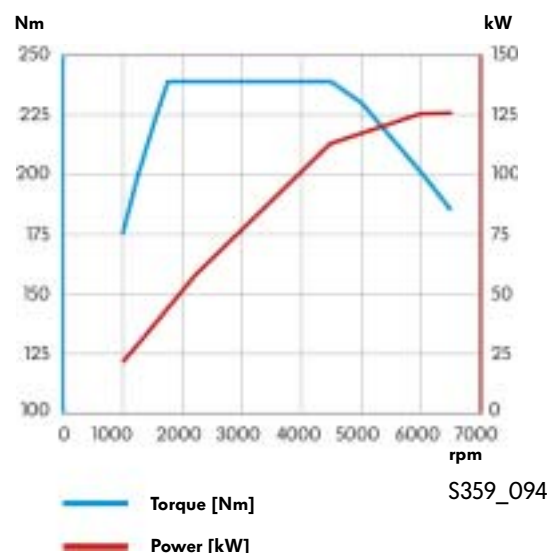
Technical data

Torque and power diagram

1.4I/103kW TSI engine



1.4I/125kW TSI engine



Technical data

Engine code	BMV	BLG
Type	4-cylinder in-line engine	4-cylinder in-line engine
Displacement	1390	1390
Bore	76.5	76.5
Stroke	75.6	75.6
Valves per cylinder	4	4
Compression ratio	10:1	10:1
Maximum output	103 kW at 6,000 rpm	125 kW at 6,000 rpm
Maximum torque	220 Nm at 1,500 – 4,000 rpm	240 Nm at 1,750 – 4,500 rpm
Engine management	Bosch Motronic MED 9.5.10	Bosch Motronic MED 9.5.10
Fuel	Super unleaded RON 95	Super Plus at RON 98 (Super unleaded at RON 95 with slightly higher consumption and torque reduction in the low rev ranges)
Exhaust gas treatment	Main catalytic converter, Lambda control	Main catalytic converter, Lambda control
Emissions standard	EU 4	EU 4



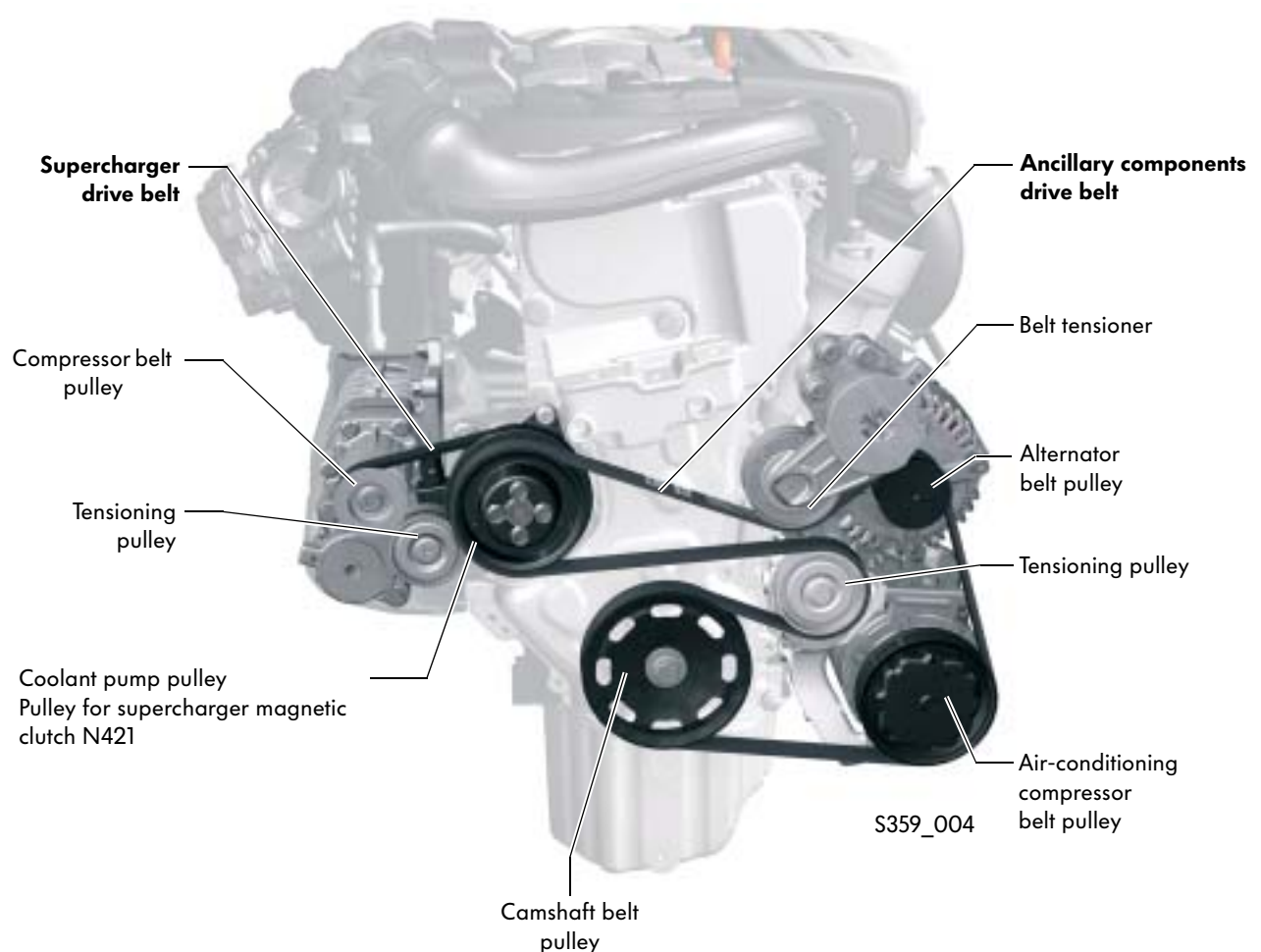
The different output and torque levels are achieved using software. The engine mechanics are the same in both engines.

Poly-V-belt drive

The 1.4l TSI engine has two poly-V-belts.

- The ancillary component drive belt is a six-groove poly-V-belt. It drives the coolant pump, the alternator and the air-conditioning compressor from the camshaft pulley.
- The supercharger drive belt is a five-groove poly-V-belt. It drives the compressor via the magnetic clutch pulley when the magnetic clutch is engaged.

A tensioning pulley ensures that the ancillary component and supercharger belts are correctly tensioned. The tensioning pulley after the crankshaft pulley also ensures that the poly-V-belt runs correctly around the crankshaft pulley and coolant pump pulley.



Chain drive

Both the camshafts and also the oil pump are driven by the crankshaft via a maintenance-free timing chain.

Camshaft drive

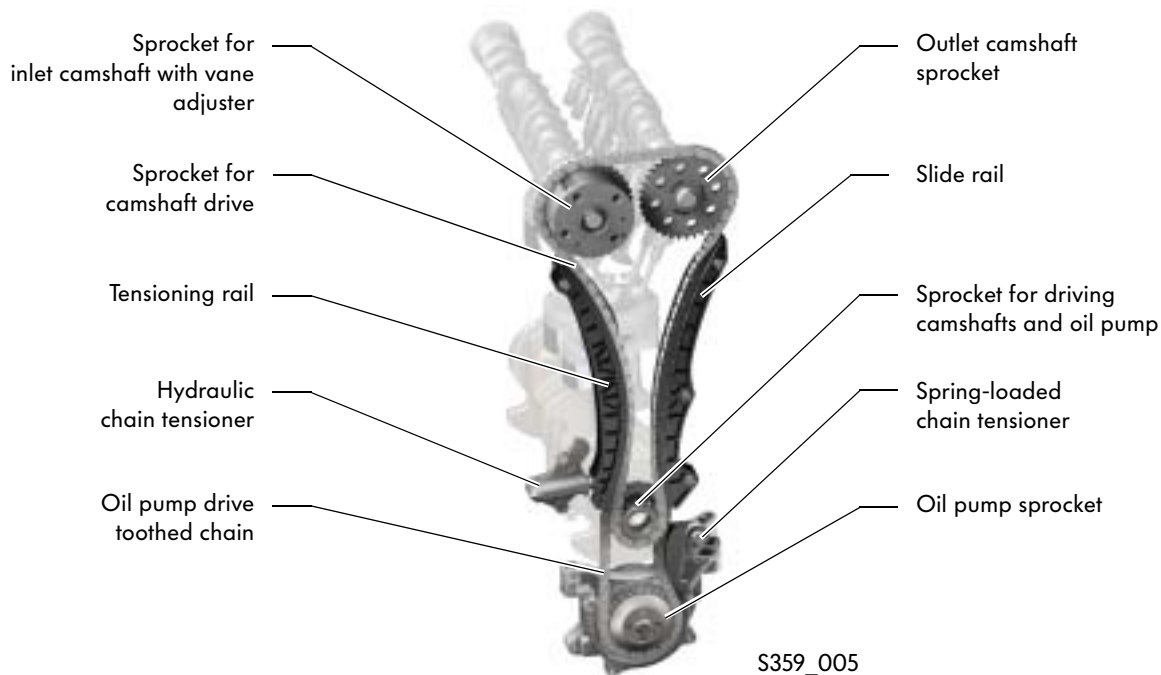
The toothed chain drive has been optimised due to the greater loading. The toothed chain has hardened pins and heavy-duty link plates that have been adapted to the chain forces.

The toothed chain is tensioned by a hydraulic chain tensioner.

Oil pump drive

The oil pump is driven by a toothed chain with 8 mm pitch for improved sound.

It is tensioned by a spring-loaded chain tensioner.



Camshaft timing adjustment

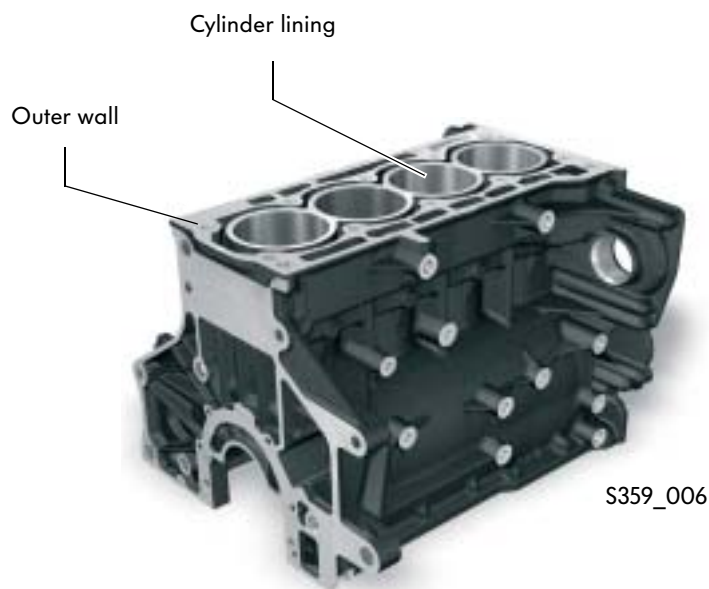
A load- and engine speed-dependent vane adjuster is used for the continuous inlet camshaft adjustment. The adjustment range is a maximum 40° crank angle.

The camshaft adjustment allows:

- Very good internal exhaust gas recirculation and
- improved torque band.

Cylinder block

The cylinder block on the 1.4l TSI engine is made from grey cast iron with lamellar graphite. This guarantees sufficient operating safety at the high combustion pressures of the TSI engine. Due to the high strength of a cylinder block made from grey cast iron with lamellar graphite compared with one made from diecast aluminium, the camshaft may be removed.



S359_006

As with the 1.4l/66kW and 1.6l/85kW FSI engines, the cylinder block has a so-called open-deck design. This means that there are no webs between the outer wall and the cylinder lining.

This has two advantages:

- No air bubbles can form in this area which would lead to ventilation and cooling problems particularly with the dual-circuit cooling system,
- When the cylinder head is bolted to the cylinder block, the cylinder liner deformation caused by the decoupling of the cylinder liner and cylinder block is less and more even than with a closed-deck design with webs. This results in lower oil consumption as the piston rings compensate this deformation better.



You will find further information on the 1.4l/66kW and 1.6l/85kW FSI engines in self-study programmes 296 “The 1.4l and 1.6l. FSI engine with timing chain” and 334 “The fuel system in FSI engines”.

Crankshaft drive

The crankshaft drive consists of the crankshaft, the connecting, the bearing shell, the piston and the piston pin. Several modifications have been made to the crankshaft drive as the forces occurring on the 1.4l TSI engine are considerably higher than with the previous FSI engines.



Piston

The pistons are made from diecast aluminium. A combustion chamber recess with a deflector has been worked into the piston base. This leads to a strong swirling of the intake air and thus to a very good mixture formation.

The outlet side of the piston is cooled with a piston cooling system. The jets open at 2.0 bar.

The friction of the piston package has been reduced by a graphite coating on the piston skirt and a greater skirt-to-wall clearance of 55 µm.

The piston pin diameter has been increased from 17 to 19 mm due to the high ignition pressure.

Camshaft

The forged crankshaft is made from steel and is stiffer than the cast crankshaft on the 1.4l/66kW FSI engine.

Above all, this reduces the noises from the engine.

Connecting rod

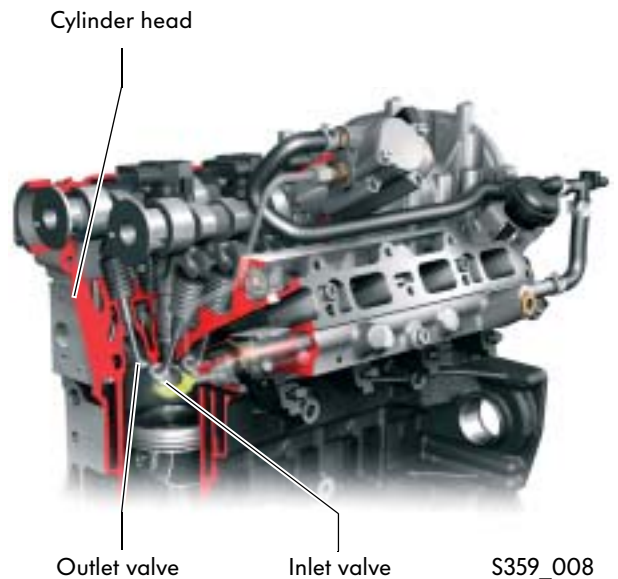
The connecting rods are fracture-split. Therefore only the same two components fit together, they are cheap to produce and good positive engagement is formed.

Cylinder head and valve train

The cylinder head is the same as on the 1.4l/66kW FSI engine except for a few modifications.

Several changes have been made to the valve train due to the greater loads and exhaust gas temperatures.

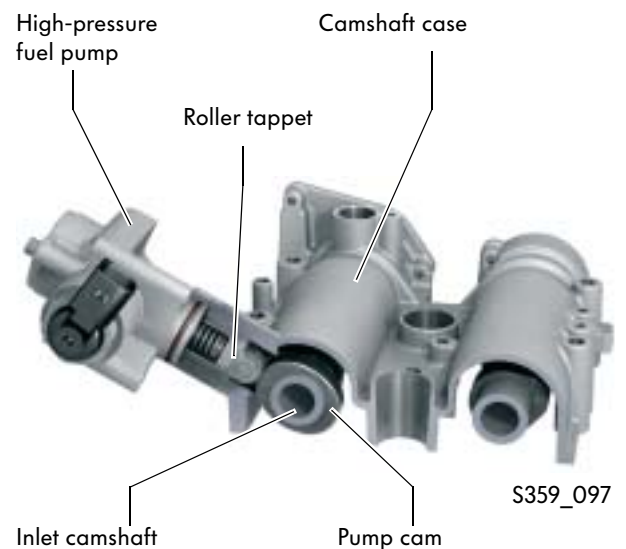
- Due to the higher loads, the outlet valves are reinforced on the valve seats and the valve springs are heat-treated.
- Due to the higher exhaust gas temperatures, the outlet valves are filled with sodium for better heat transfer. This reduces the temperature at the outlet valves by approx. 100°C.



Camshaft case

The camshafts, which are mounted on three bearings, are inserted into the camshaft case. Their axial play is limited by the cover and the camshaft case.

The high-pressure fuel pump is bolted to the camshaft case. It is driven by a double cam on the inlet camshaft. Due to the higher injection pressures and the fuel quantities to be delivered compared with previous FSI engines, the pump stroke has been increased from 5 to 5.7 mm. The friction is reduced by a roller tappet between the high-pressure fuel pump and camshaft and halves the drive moment of the high-pressure fuel pump.



The seal between the camshaft case and cylinder head is formed with a liquid gasket. Please note the repair instructions in ELSA.

Dual-charging with supercharger and turbocharger

Current charged engines mostly use turbochargers. The 1.4l TSI engine is the first to use a combination of supercharger and turbocharger. That means the engine is charged by a supercharger in addition to the turbocharger depending on the torque requirements.

Supercharger

The supercharger is a mechanical charger that is activated by a magnetic clutch.

Advantages:

- Faster build up of boost pressure
- High torque at low revs
- Only activated when required
- No external lubrication and cooling necessary

Disadvantages:

- Requires drive power from engine
- Boost pressure is produced at any engine speed and is then regulated with part of the generated power being lost again



Turbocharger

The turbocharger is constantly powered by the exhaust gas.

Advantages:

- Very good efficiency due to use of exhaust gas energy

Disadvantages:

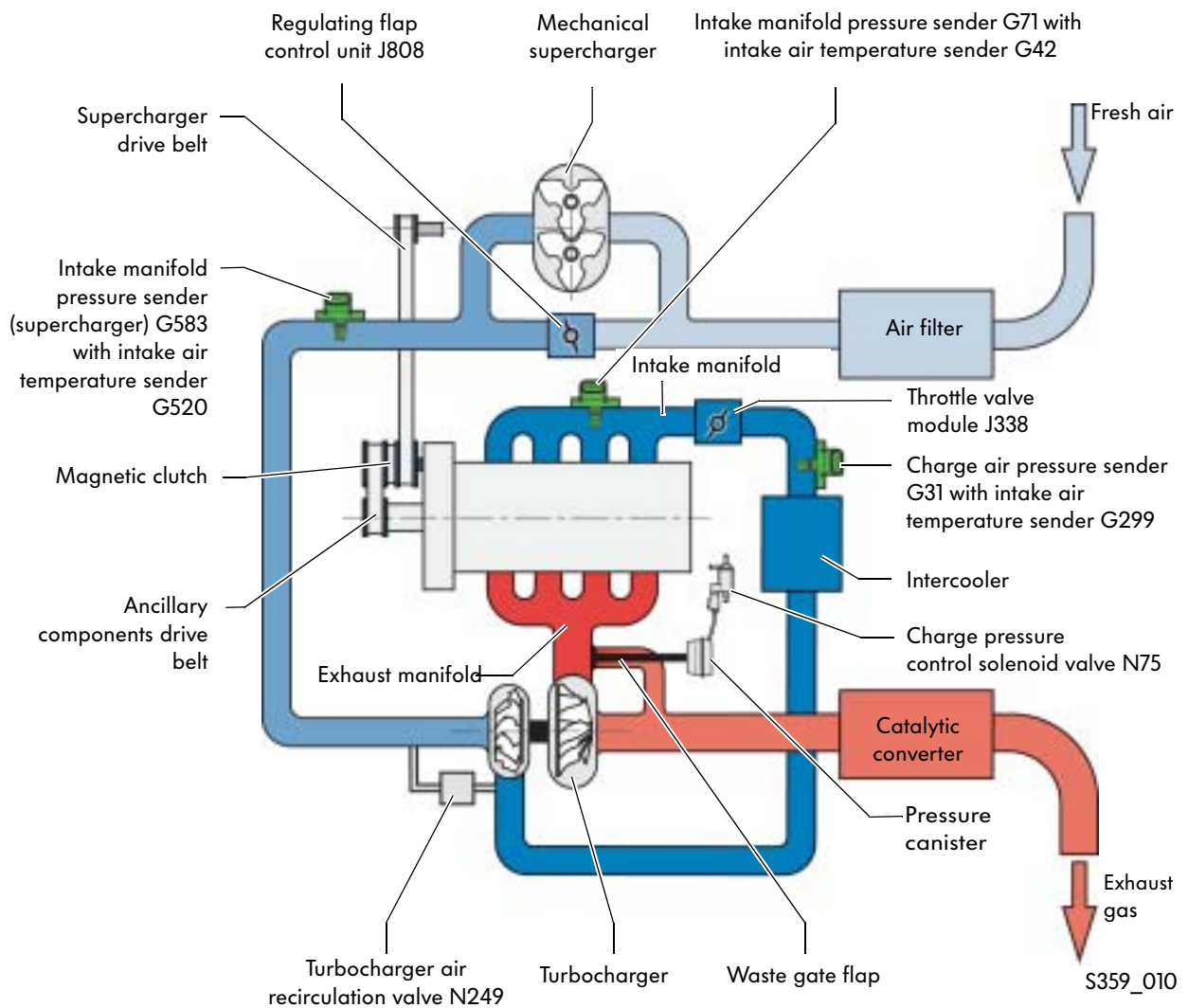
- In a small engine, the boost pressure produced in the low rev ranges is not sufficient to generate high torque
- High thermal loading



Engine Mechanics

Schematic diagram of all supercharging components

The schematic diagram shows the basic set-up of the “dual-supercharging” system and the path of the fresh intake air.



Air is drawn in through the air filter.

The position of the regulating flap is defined in the regulating flap control unit determining whether the air flows via the supercharger and/or straight to the turbocharger.

The air flows from the turbocharger via the intercooler and the throttle valve module into the intake manifold.

Working ranges of the supercharging components

The diagram shows the working ranges of the mechanical supercharger and the turbocharger. Depending on the torque requirements, the engine control unit determines whether the required boost pressure is generated and, if yes, how. The turbocharger works during the all of the coloured areas. The exhaust gas power is not sufficient in the lower rev ranges to produce the required boost pressure on its own, however.



Constant boost range of supercharger

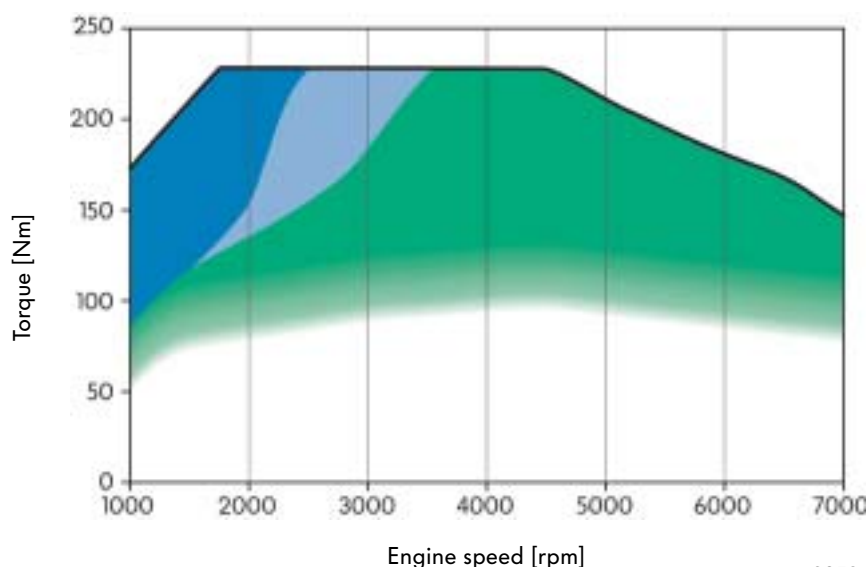
From a minimum torque requirement and up to an engine speed of 2,400 rpm, the supercharger is constantly activated. The supercharger boost pressure is controlled via the regulating flap control unit.

Requirement-dependent boost range of supercharger

Up to a maximum engine speed of 3,500 rpm, the supercharger is activated when necessary. This is, for example, necessary when the car is driven at a constant speed in this range and then accelerates quickly. Due to the slow response of the turbocharger, acceleration would be delayed (turbo lag). Therefore the supercharger is activated and the required boost pressure is reached as quickly as possible.

Exclusive turbocharger boost range

In the green area, the turbocharger manages to produce the necessary boost pressure on its own. The boost pressure is controlled by the charge pressure control solenoid valve.



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Engine Mechanics

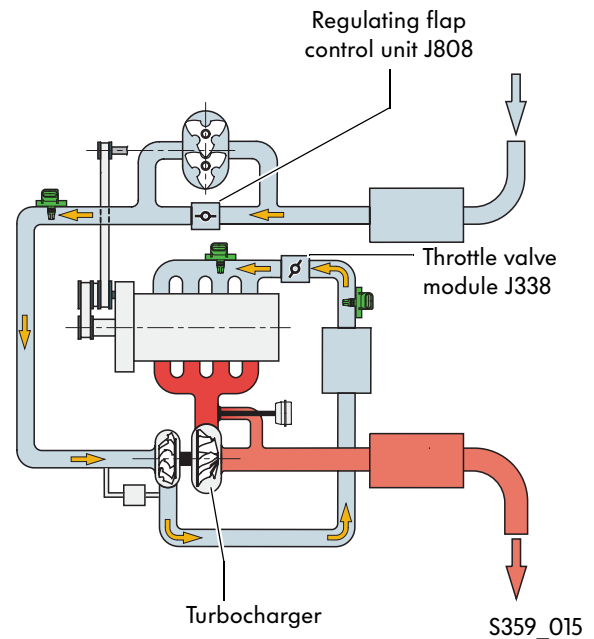
Implementation of working ranges

Depending on the load and rev range, the engine control unit calculates how the required quantity of fresh air should reach the cylinder to create the required torque. It determines whether the turbocharger can produce the boost pressure on its own or whether the compressor needs to be activated.

Naturally aspirated mode at low load

The regulating flap is fully open in naturally aspirated mode. The intake air flows via the regulating flap control unit to the turbocharger. The turbocharger is already driven by the exhaust gas, but the exhaust gas energy is so low that it only produces a small boost pressure.

The throttle valve is opened depending how far the driver presses the accelerator and there is a vacuum in the intake manifold.

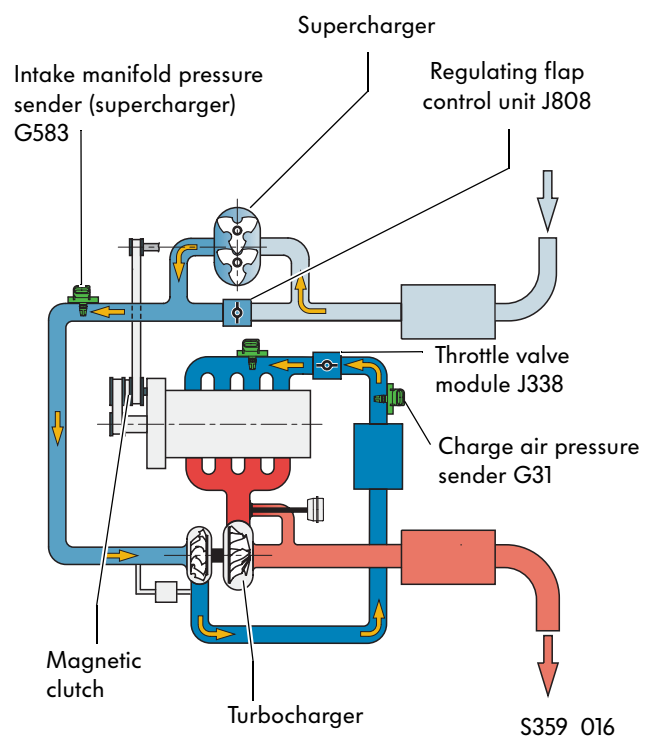


Supercharger and turbocharger operation at higher loads and engine speeds up to 2,400 rpm

In this range, the regulating flap is closed or partly opened to regulate the boost pressure. The supercharger is activated via a magnetic clutch and is driven by the supercharger drive belt. The supercharger draws in air and compresses it. The compressed fresh air is pumped by the supercharger to the turbocharger. There the compressed air is compressed even more.

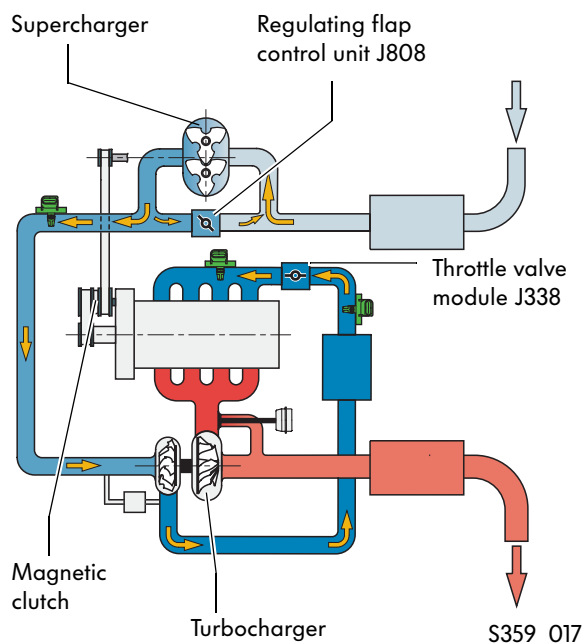
The boost pressure of the supercharger is measured by the intake manifold pressure sender G583 and regulated by the regulating flap control unit. The overall boost pressure is measured by the charge air pressure sender G31.

The throttle valve is completely open. A pressure of up to 2.5 bar (absolute) is built up in the intake manifold.



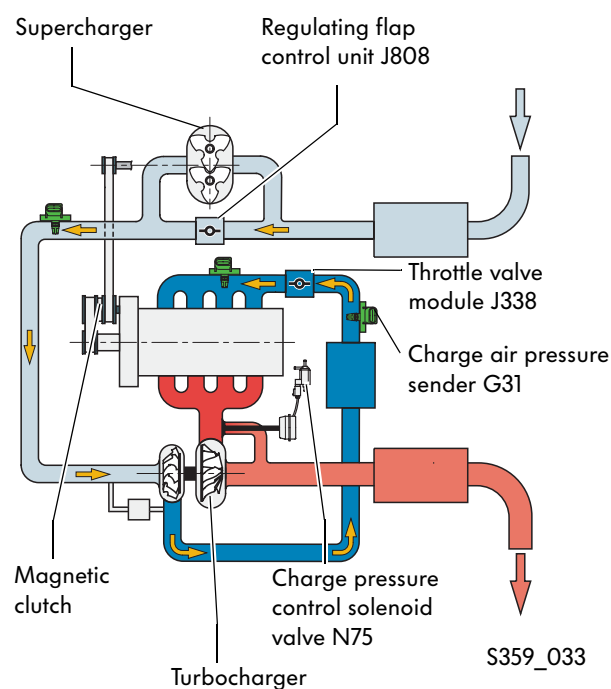
Turbocharger and supercharger operation at high loads and revs between 2,400 and 3,500 rpm

In this range, the boost pressure is produced at, for example, constant speed, by the turbocharger alone. If the car now accelerates quickly, the turbocharger would be too slow to generate the boost pressure fast enough. There would be turbo lag. To avoid this, the engine control unit activates the supercharger briefly and adjusts the regulating flap control unit according to the required boost pressure. It helps the turbocharger produce the necessary boost pressure.



Turbocharger operation

From an engine speed of approx. 3,500 rpm, the turbocharger can produce the required boost pressure on its own at any load point. The regulating flap is fully open and the intake air flows straight to the turbocharger. The exhaust gas energy is now sufficient in all conditions to produce the boost pressure with the turbocharger. The throttle valve is completely open. A pressure of up to 2.0 bar (absolute) is built up in the intake manifold. The boost pressure of the turbocharger is measured with the charge air pressure sender G31 and regulated by the charge pressure control valve.



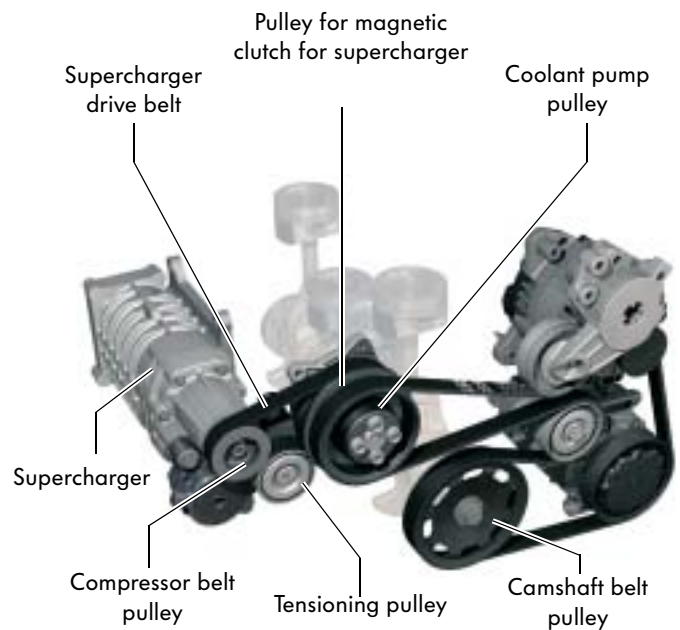
Supercharger

Supercharger drive

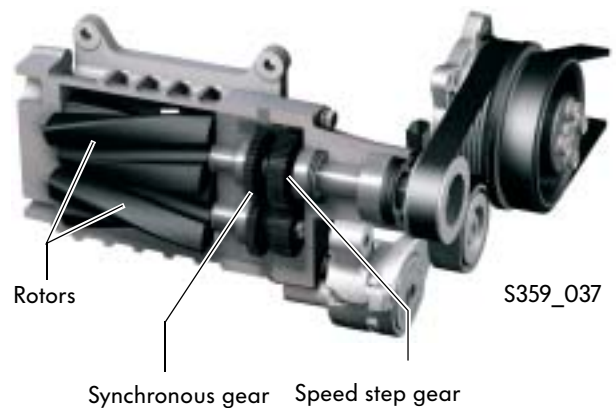
The supercharger is activated as required and is driven by the coolant pump via an auxiliary drive. The auxiliary drive is activated with a maintenance-free magnetic clutch on the coolant pump module. Due to the ratio of the crankshaft belt pulley to the supercharger belt pulley as well as an internal supercharger gear ratio, the supercharger turns at five times the crankshaft speed. The maximum speed of the supercharger is 17,500 rpm.



The supercharger may not be opened. The chamber containing the speed step gear and the synchronous gear is filled with oil. It is filled for life.



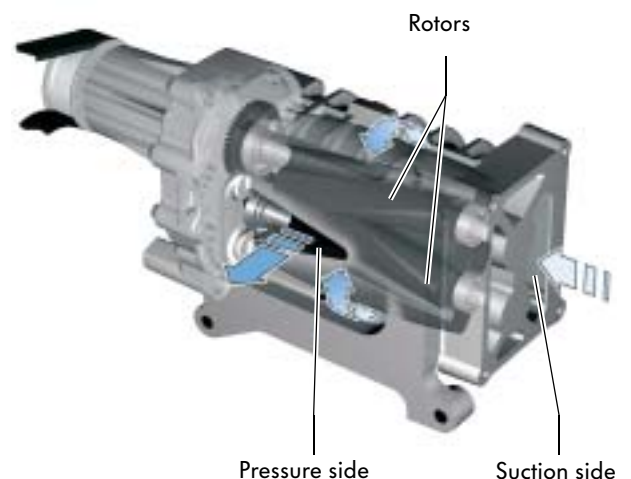
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Mechanical supercharger

The mechanical supercharger is bolted to the cylinder block on the intake manifold side after the air filter. Due to the shape of its two compressor rotors, it is also called a twin-screw supercharger. The boost pressure is controlled via a regulating flap control unit. The maximum boost pressure that the supercharger produces is about 1.75 bar (absolute).



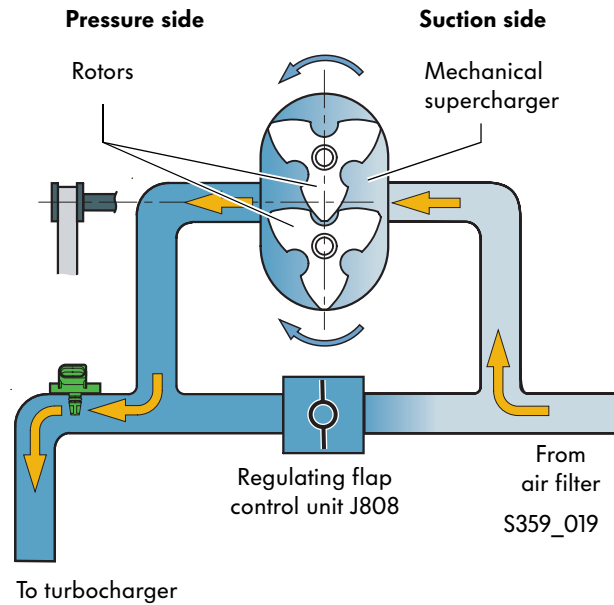
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How it works:

Supercharger function

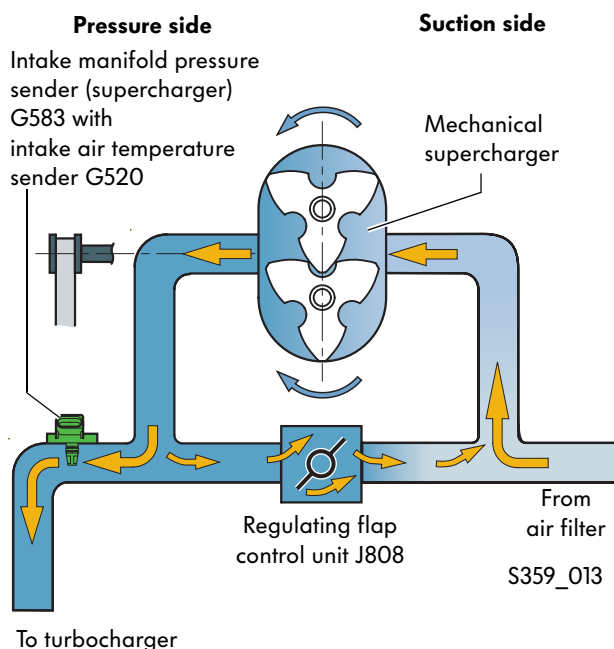
The two supercharger rotors have been designed so that, when they rotate, the space on the intake side becomes larger. The fresh air is drawn in and transferred to the pressure side of the supercharger by the rotors.

On the pressure side, the chamber between the two supercharger rotors becomes smaller again. The air is pushed towards the turbocharger.



Supercharger boost pressure regulation

The boost pressure is regulated by the position of the regulating flap. When the regulating flap is closed, the supercharger produces the maximum boost pressure at this engine speed. The compressed fresh air is pumped to the turbocharger. If the boost pressure is too high, the regulating flap is opened slightly. Now part of the intake air is sent to the turbocharger and the rest via the partly opened regulating flap to the intake side of the supercharger. The boost pressure is reduced. On the intake side, the air is drawn in again and compressed. This relieves supercharger and the required drive power for the supercharger is reduced. The boost pressure is measured by the intake manifold pressure sender (supercharger) G583.



Noise insulation of supercharger

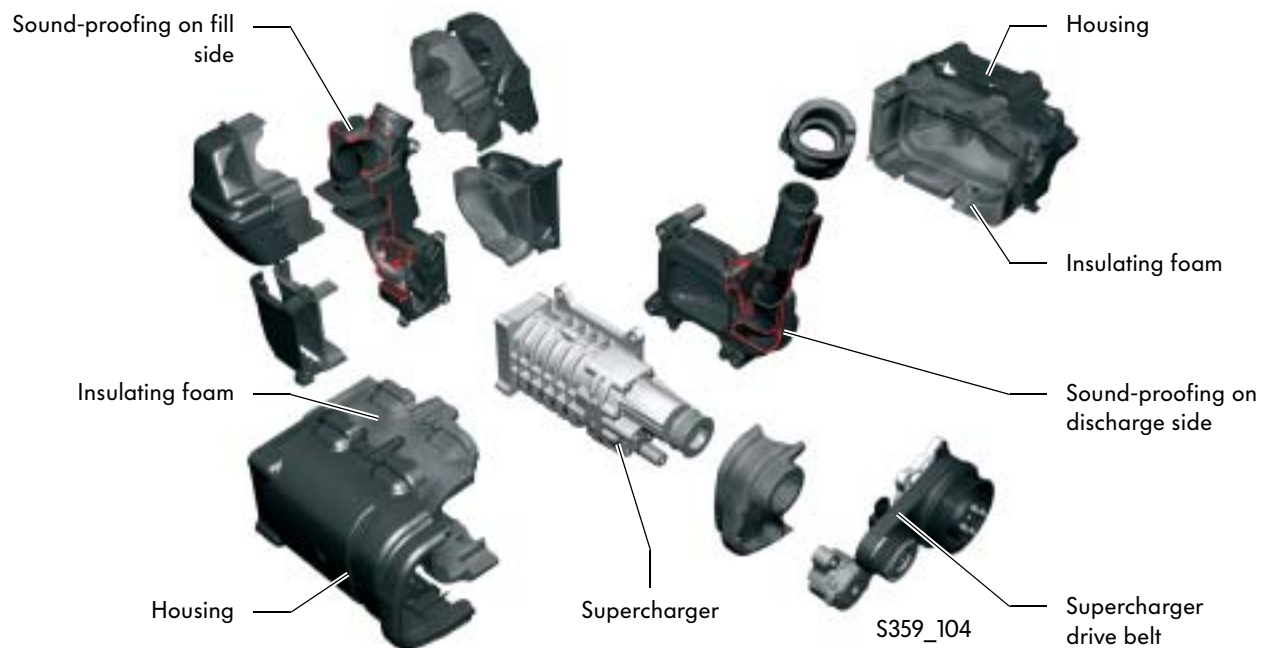
Due to the arrangement of the supercharger in the direction of the passenger cell, the remaining noises can be heard by the occupants. Several measures have been taken to reduce the noise level.

To keep the mechanical noise from the supercharger low ...

- the gearing has been modified, e.g. meshing angle and twisting play,
- the supercharger shafts have been stiffened and
- the supercharger case has been reinforced with special ribs.

To reduce the noises upon intake and compression ...

- both sides (fill and discharge side) of the supercharger have been sound-proofed,
- the supercharger has been encapsulated and the housing parts also lined with insulating foam.



Supercharger

During fast acceleration, the supercharger can “whine” at rev ranges between 2,000 – 3,000 rpm. This is the normal turbine-like operating noise of a supercharger.



Magnetic clutch

When the magnetic clutch is switched off, three leaf springs pull the friction plate back to the starting position. Due to the high forces, a normal “clicking” of the magnetic clutch can occur. This can occur up to an engine speed of 3,400 rpm.

Turbocharger system components

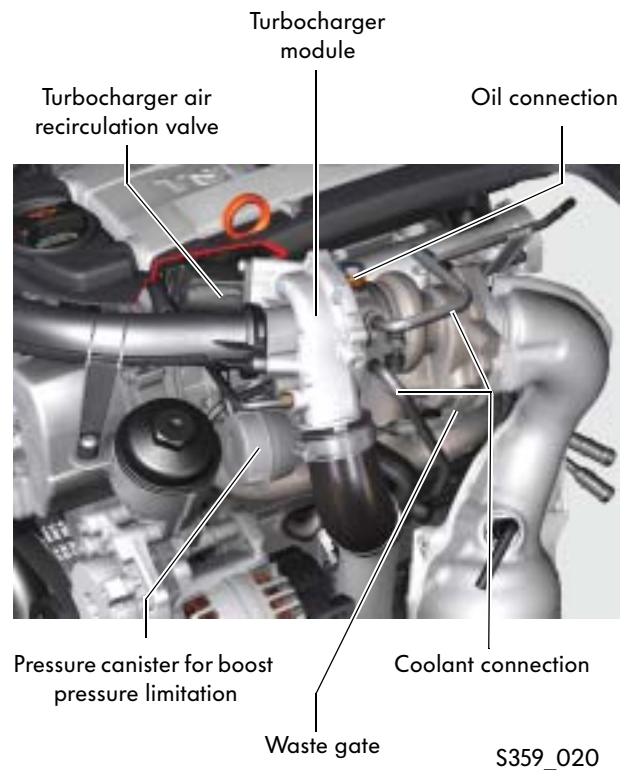
Turbocharger module

The turbocharger forms a module with the exhaust manifold.

Both are made from highly heat-resistant cast steel due to the exhaust gas temperatures.

The turbocharger has been incorporated in the cooling system to protect the shaft bearings from high temperatures. A circulating pump ensures that the turbocharger does not overheat for up to 15 minutes after the engine has been turned off. This prevents steam bubbles forming in the cooling system. The shaft bearings are connected to the oil system for lubrication.

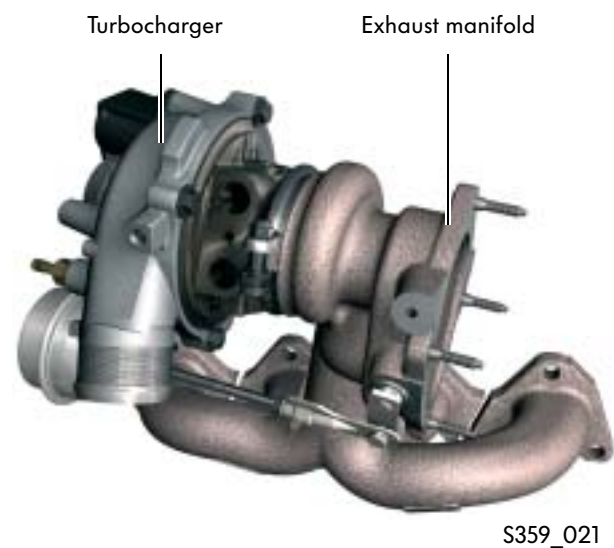
Furthermore the electrical recirculation valve for the turbocharger and a pressure canister for boost pressure limitation with the waste gate are part of the turbocharger module.



Exhaust manifold

Up to now in petrol engines, the mixture was enriched early due to the high exhaust gas temperatures.

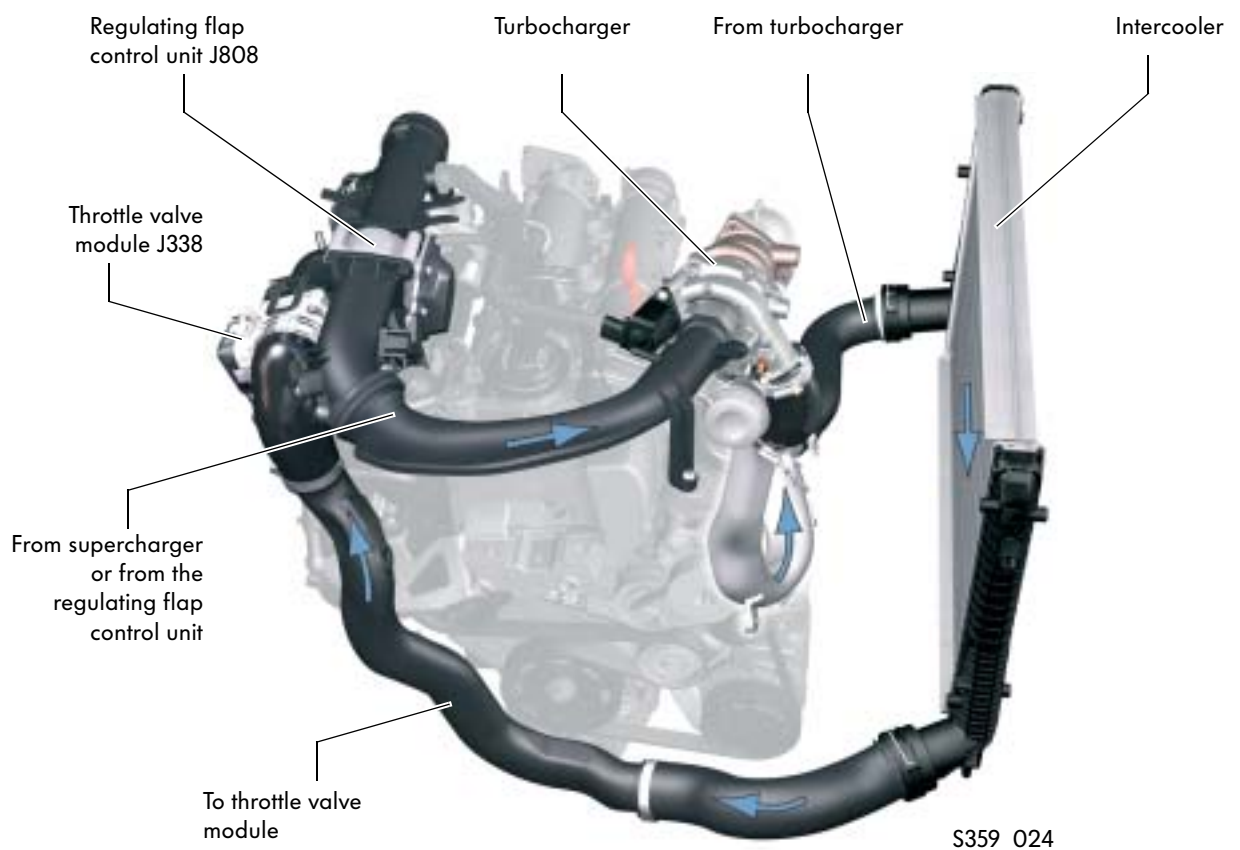
The exhaust manifold on the 1.4l TSI engine is designed for exhaust gas temperatures up to 1,050 °C. As a result, the engine can be run with a high boost pressure and with Lambda 1 in almost all map ranges.



Engine Mechanics

Intercooler

The TSI engine uses an intercooler. This means that the charge air flows through a cooler and releases its heat via the aluminium fins. These are cooled by the surrounding air.



Once the intake air has passed the turbocharger, it is very hot. It is heated to up to 200°C mainly by the compression process, but also by the high temperature of the turbocharger.

As a result, the air has a lower density and less oxygen will reach the cylinder. Cooling the air to just above the ambient temperature, will increase the density and more oxygen is fed to the cylinders.

Furthermore the knocking tendency and the production of nitrogen oxide are reduced.

Crankcase breather and ventilation

Crankcase breather

The crankcase breather allows the crankcase to be rinsed out and thus reduces the formation of water in the oil. The breather is in the form of a hose from the air filter to the camshaft housing.

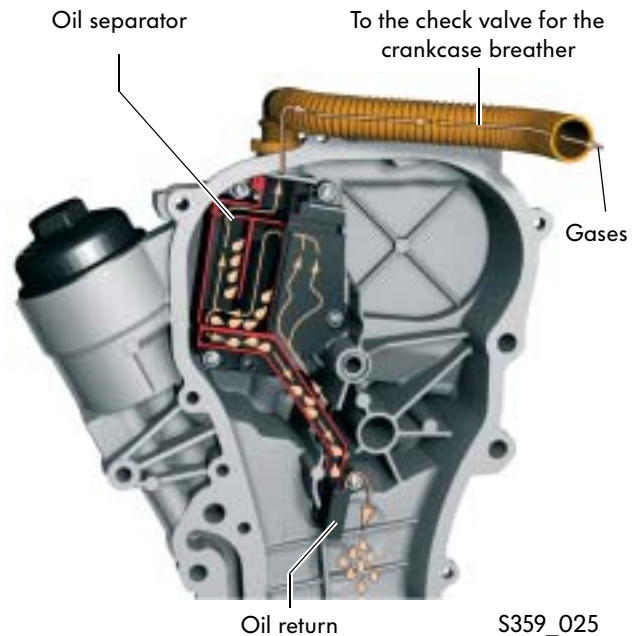
Crankcase ventilation

Unlike conventional naturally-aspirated engines, the crankcase ventilation system for a charged engine is more complex. While there is a constant vacuum in the intake manifold of a naturally aspirated engine, it is up to 2.5 bar (absolute) in the TSI engine.

Oil separation

The gases are drawn out of the crankcase by the vacuum.

In the labyrinth and in the cyclone oil separator, the oil is separated from the gases and drips back into the oil sump.

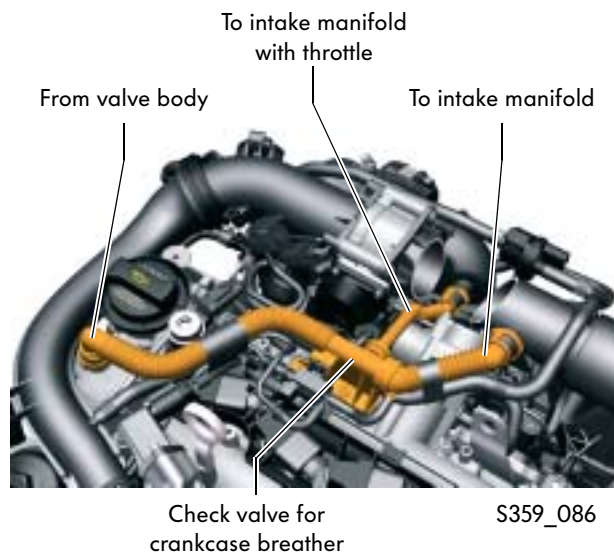


Gases are sent to the intake air as follows

The gases flow from the timing chain case to the check valve for the crankcase ventilation.

Depending on whether the pressure is lower in the intake manifold or in front of the regulating flap control unit, the return valve will open and allow the gases to pass through. In the intake manifold or in front of the regulating flap control unit, the gases mix with the intake air and are fed to the combustion chamber.

A throttle in the connecting hose to the intake manifold limits the throughput when the vacuum pressure becomes too high in the intake manifold. A pressure regulating valve is therefore no longer necessary.



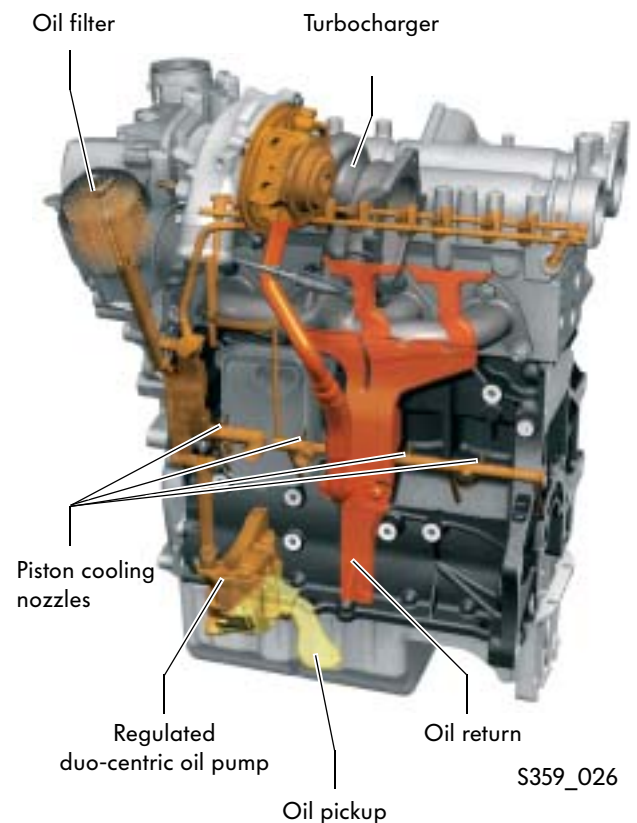
Oil supply

Oil circuit

The oil circuit differs from the one used in the 1.6l/85kW FSI engine because of the turbocharger and the piston cooling system.

Colour legend

Oil pickup	
Oil send	
Oil return	

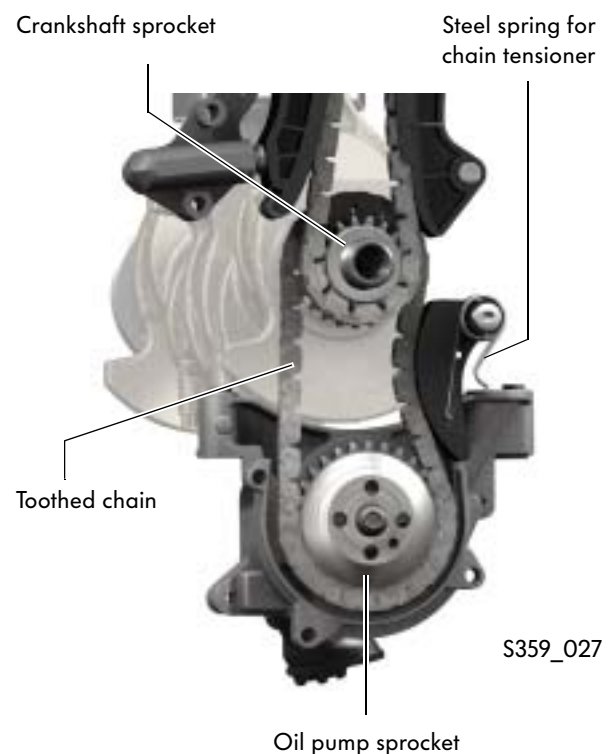


Oil pump drive

The duo-centric oil pump is bolted to the bottom of the cylinder block and is driven by the crankshaft via a maintenance-free toothed chain.

Due to the exhaust gas turbocharger and the piston cooling system, a greater oil delivery volume is required. This has been achieved with a greater transmission ratio from the crankshaft sprocket to the oil pump sprocket.

The chain is tensioned by a steel spring on the chain tensioner.



Regulated duo-centric oil pump

The regulated duo-centric oil pump has been taken from the current FSI engines. The oil pressure of 3.5 bar is regulated with the oil delivery quantity over almost the whole rev range.

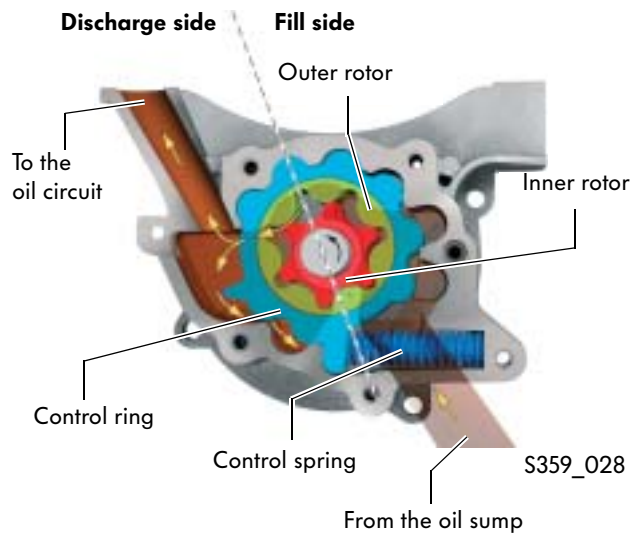
This has the following advantages:

- the drive power of the oil pump is reduced by up to 30%,
- the oil quality is not affected so much as less oil is circulated,
- the oil foaming in the oil pump is minimised because the oil pressure is the same across the whole rev range.



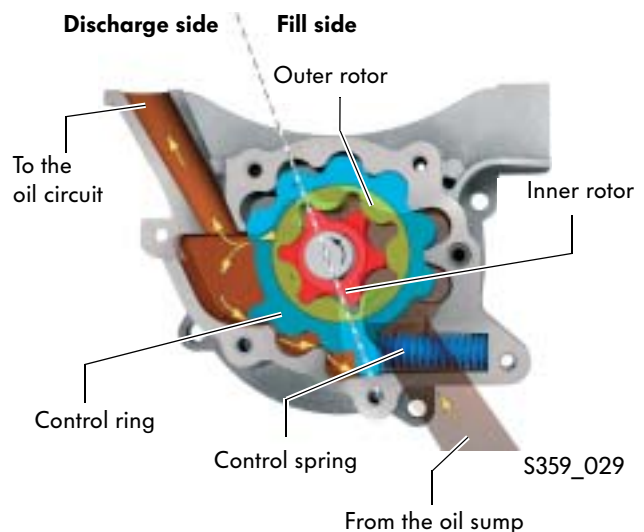
Oil pressure below 3.5 bar

The control spring presses the control ring against the oil pressure (yellow arrows). The outer rotor also turns with the control ring and thus enlarges the space between the inner and outer rotor. As a result, more oil is transported from the fill to the discharge side and pushed into the oil circuit. The oil pressure also increases with the oil quantity.



Oil pressure above 3.5 bar

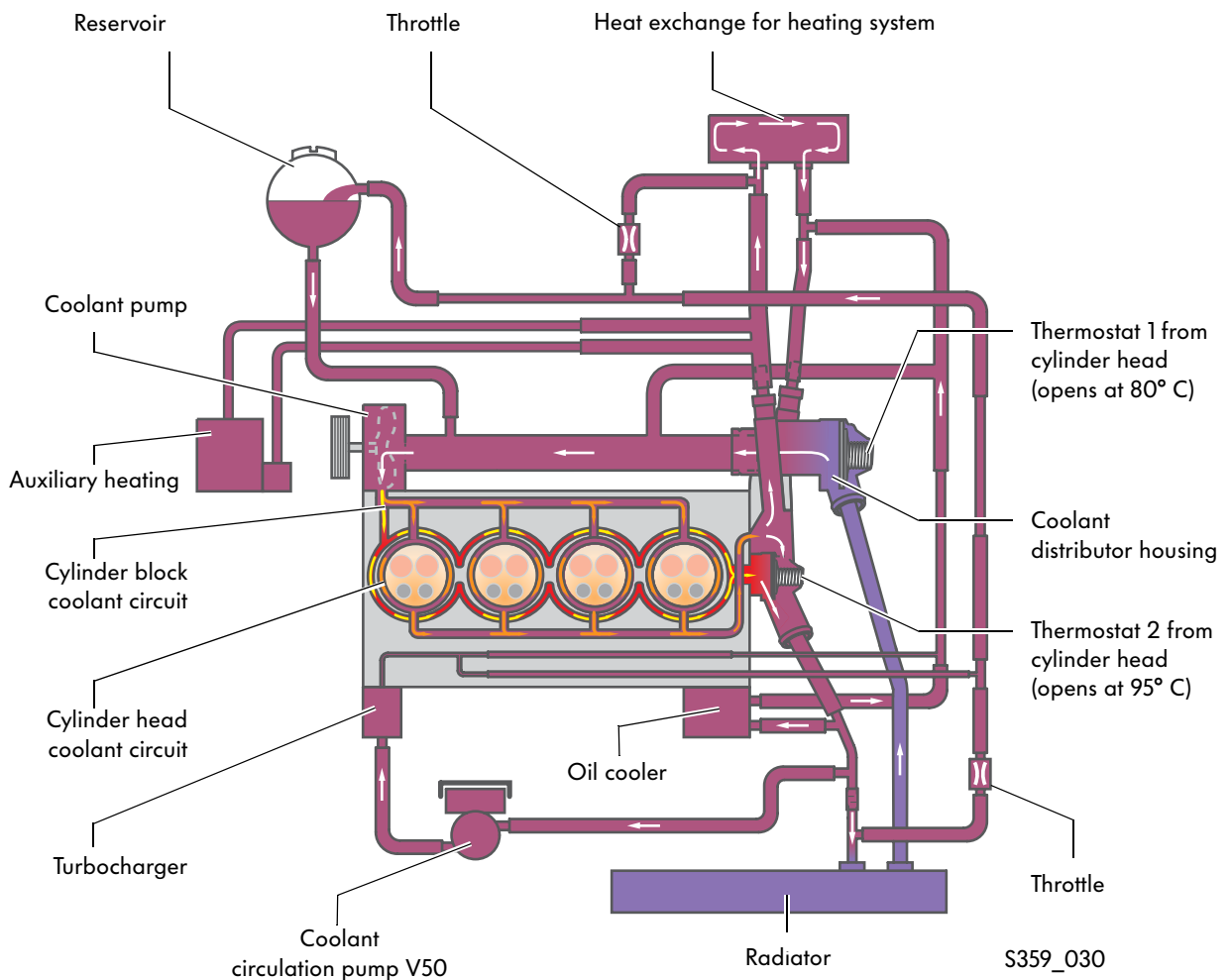
The oil pressure (yellow arrows) presses the control ring against the control spring. The outer rotor is also rotated in the direction of the arrows and the space between the inner and outer rotor becomes smaller. As a result, less oil is transported from the fill to the discharge side and pushed into the oil circuit. The oil pressure also decreases with the oil quantity.



Dual-circuit cooling system

The cooling system development is to a great extent the same as that used with the 1.6l/85kW FSI engine in the Golf. It is a dual-circuit cooling system with separate coolant flow and different temperatures due to the cylinder block and cylinder head.

In the cylinder head, the coolant is sent from the outlet to inlet side. An even temperature level is thus reached in the cylinder head. This method is called crossflow cooling.



Compared with the 1.6l/85kW FSI engine the following has changed:

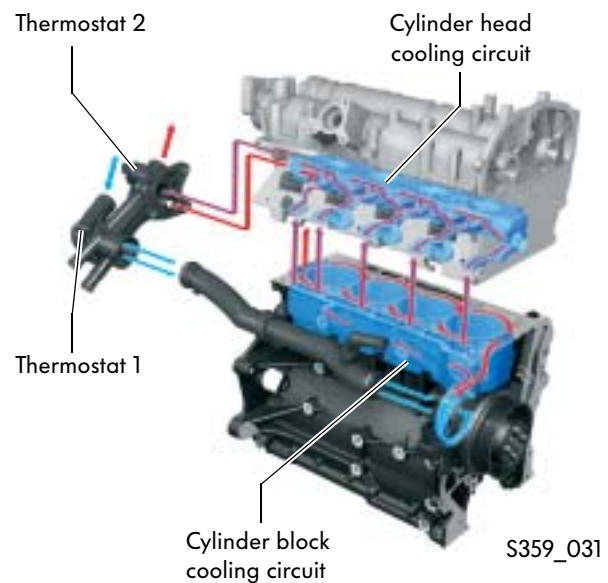
- due to a greater transmission ratio, the delivery quantity of the coolant pump has been increased and sufficient heating power obtained at idle,
- thermostat 1 in the coolant distributor housing is a two-stage type,
- a coolant circulation pump V50 has been added,
- coolant flows through the turbocharger,
- the exhaust gas recirculation valve is not required.

Dual-circuit cooling system

The cooling system is divided into two circuits in the engine. Around a third of the coolant in the engine flows to the cylinders and two thirds to the combustion chambers in the cylinder head.

The dual-circuit cooling system has the following advantages:

- The cylinder block warms up faster because the coolant remains in the cylinder block until 95°C is reached.
- Less friction in the crankshaft drive due to the higher temperature level in the cylinder block.
- Better cooling of the combustion chambers due to the lower temperature level of 80°C in the cylinder head. This achieves better filling with a lower knocking tendency.

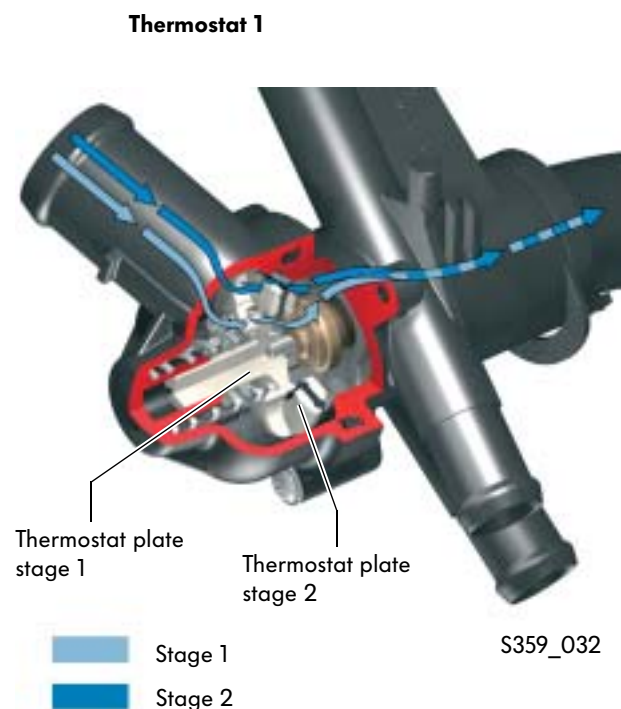


Coolant distributor housing with two-stage thermostat

Due to the high coolant delivery quantity, there is a high system pressure in the cooling system at high revs. The two-stage thermostat 1 also opens at the exact temperature in these conditions.

If a single-stage thermostat was used, a large thermostat plate would have to be opened against the high pressure. Due to the counteracting forces, the thermostat would only open at high temperature, however.

The two-stage thermostat only opens a small thermostat plate at first when the opening temperature is reached. The counterforces are lower due to the smaller surface and the thermostat opens at the exact temperature. After a specific path, the small thermostat plate moves a larger plate and the maximum possible cross-section is opened.



Engine Mechanics

Demand-regulated fuel system

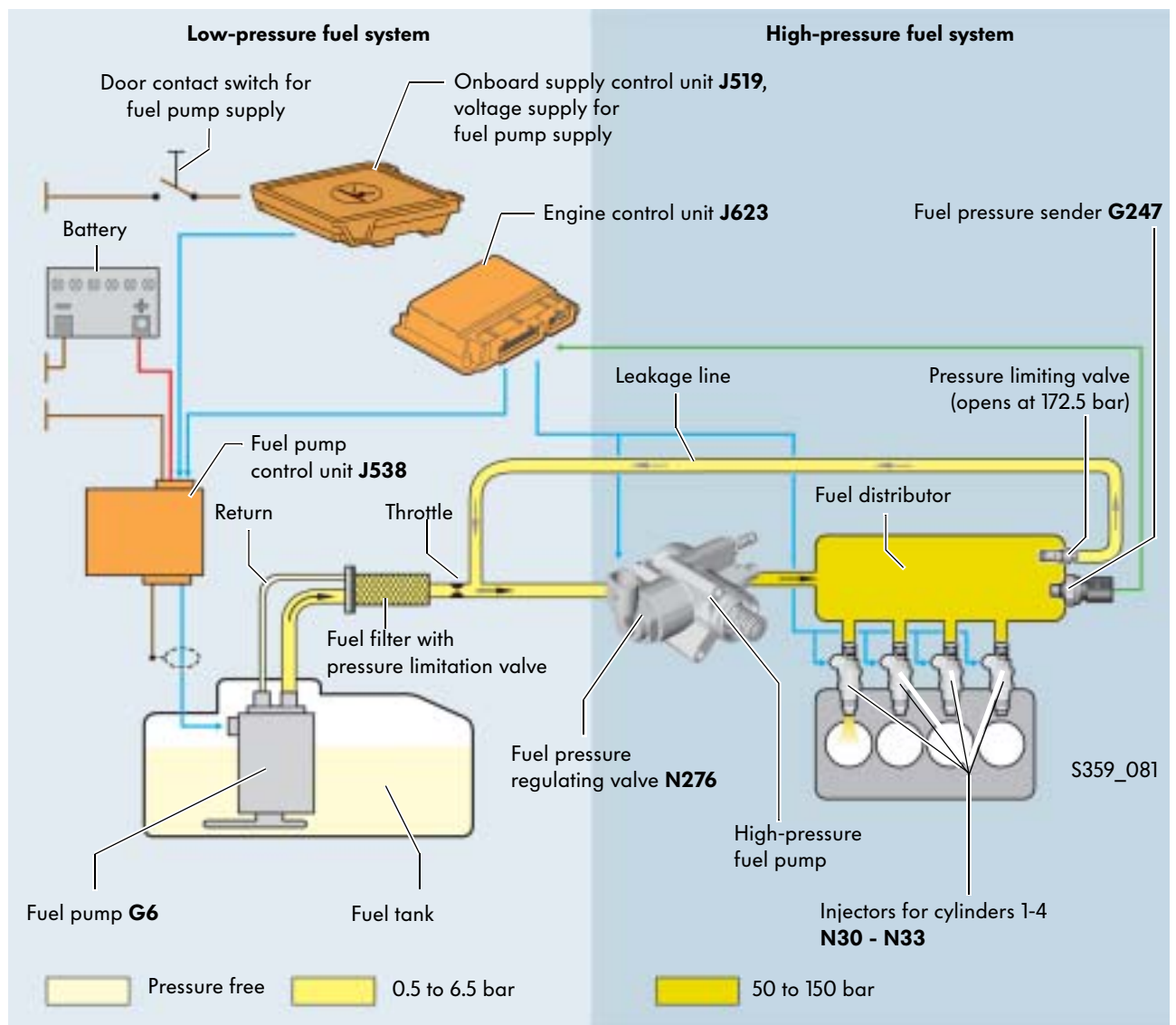
The demand-regulated fuel system has been taken from the 1.6l/85kW FSI engine.

It has the advantage that both the electrical fuel pump and the high-pressure fuel pump only deliver the amount of fuel required by the engine at that moment. This reduces electrical and mechanical drive power of the fuel pumps and fuel is saved.



As the engine control unit checks the control of the electrical fuel pump, the fuel pressure sender for low pressure is not required.

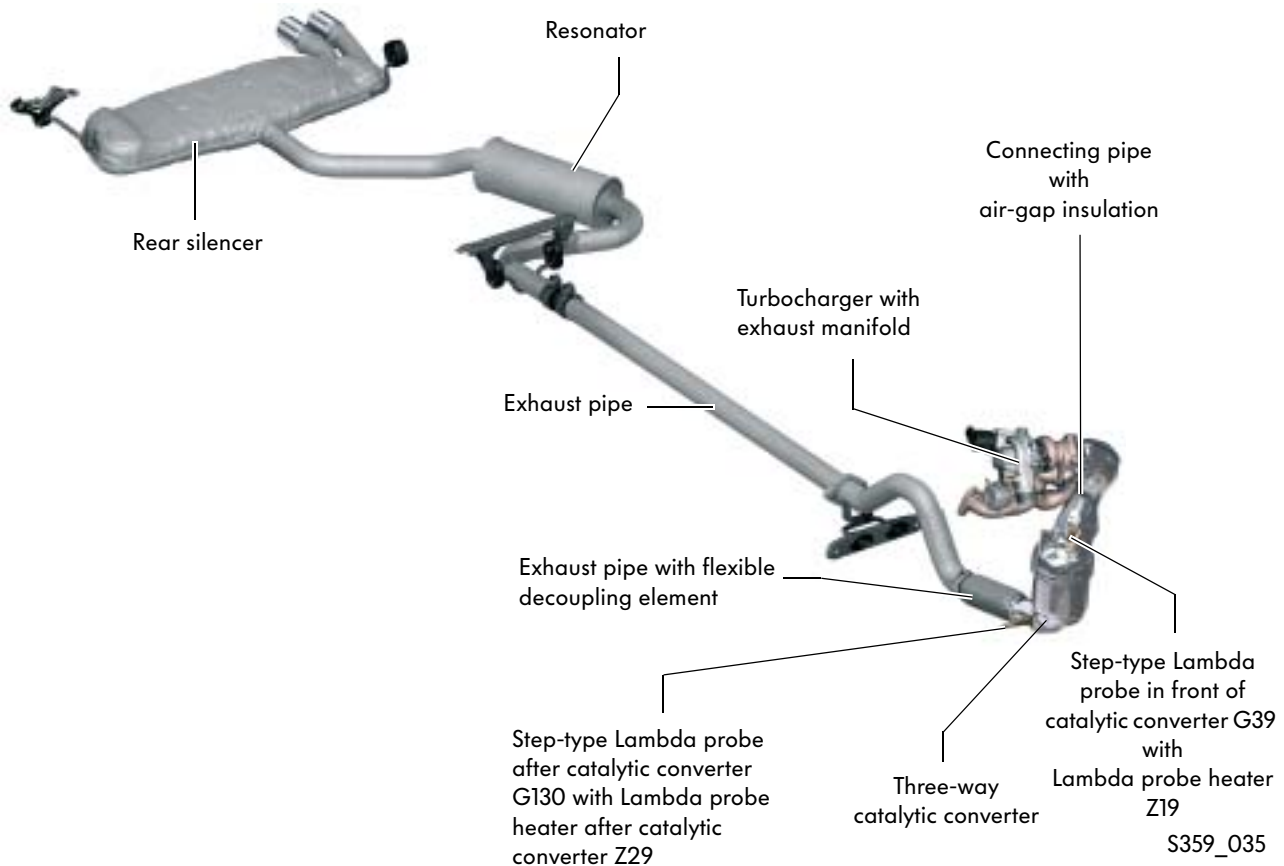
In each driving cycle, the delivery amount of the electrical fuel pump is throttled once until a certain pressure can no longer be maintained in the high-pressure fuel system. The engine control unit now compares the PWM signal (pulse-width modulation) to control the electrical fuel pump with the PWM signal stored in the engine control unit. The signal is adjusted in the engine control unit if there are deviations.



Exhaust system

The exhaust gases are treated by a three-way catalytic converter. To ensure quick warm-up of the catalytic converter despite the heat loss via the turbocharger, the connecting pipe between the turbocharger and the catalytic converter has air-gap insulation.

The Lambda probe in front of the catalytic converter is a step-type Lambda probe. It is mounted in the inlet funnel of the three-way catalytic converter, which is located near the engine. Due to this arrangement, it is exposed evenly to the exhaust gas from all cylinders. At the same time, a fast start of the Lambda regulation is reached.



External exhaust gas return not needed

The external exhaust gas return has been omitted on the TSI engines. Due to the charging components, the proportion in which the engine works as a purely naturally aspirated engine is low. This is, however, necessary to draw the exhaust gases.

The mapped range with external exhaust gas return would be very small and the fuel savings in the overall consumption due to the dethrottling of the further opened throttle valve would be small.

Engine management

System overview

Sensors

Intake manifold pressure sender **G71** with intake air temperature sender **G42**

Intake manifold pressure sender (supercharger) **G583** with intake air temperature sender **G520**

Charge air pressure sender (turbocharger) **G31** with intake air temperature sender **G299**

Engine speed sender **G28**

Hall sender **G40**

Throttle valve module **J338**

Angle sender for throttle valve drive **G187, G188**

Regulating flap control unit **J808**

Regulating flap potentiometer **G584**

Accelerator position sender **G79** and **G185**

Clutch position sender **G476**

Brake pedal position sender **G100**

Fuel pressure sender **G247**

Knock sensor **G61**

Coolant temperature sender **G62**

Radiator outlet coolant temperature sender **G83**

Intake manifold flap potentiometer **G336**

Lambda probe **G39**

Lambda probe after catalytic converter **G130**

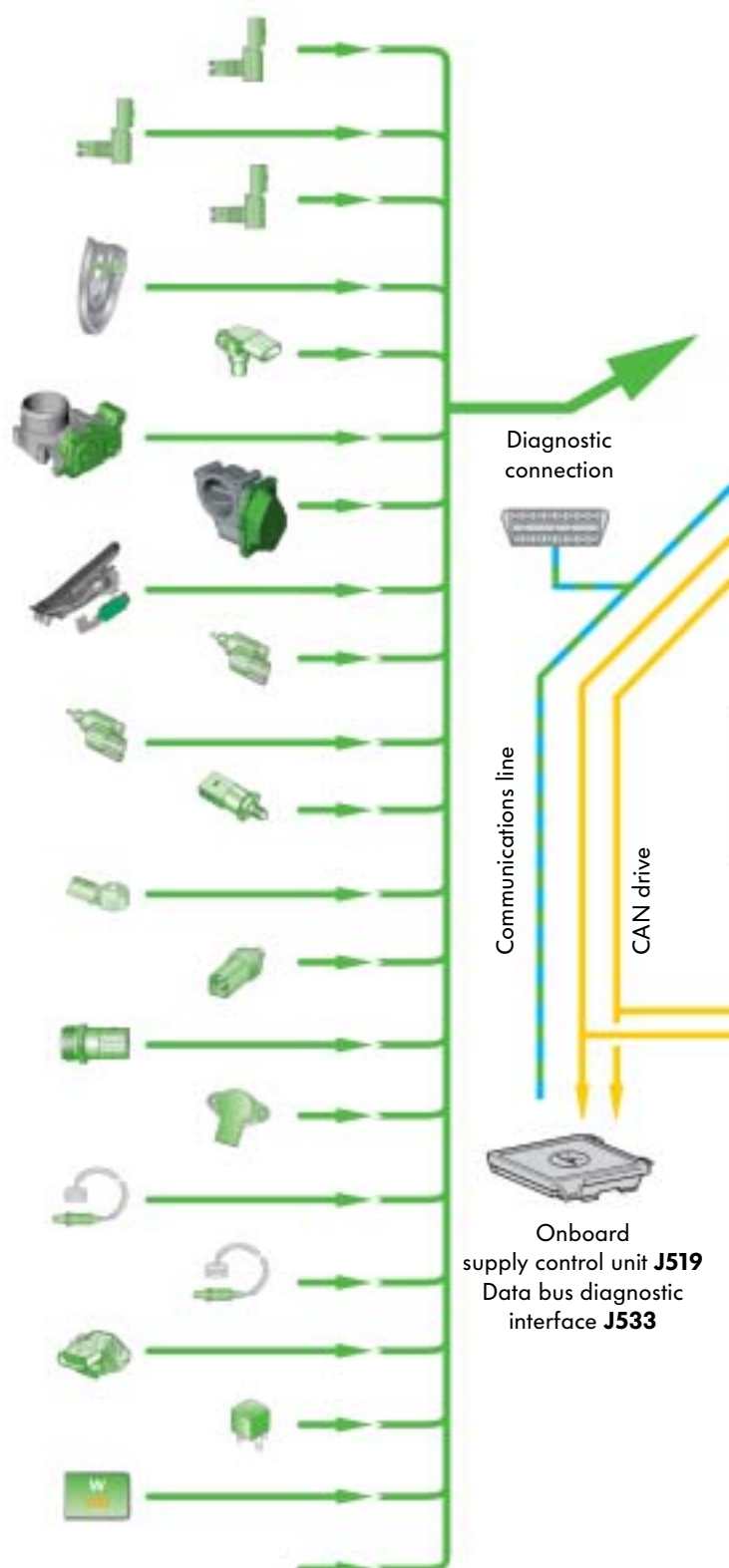
Brake servo pressure sensor **G294**

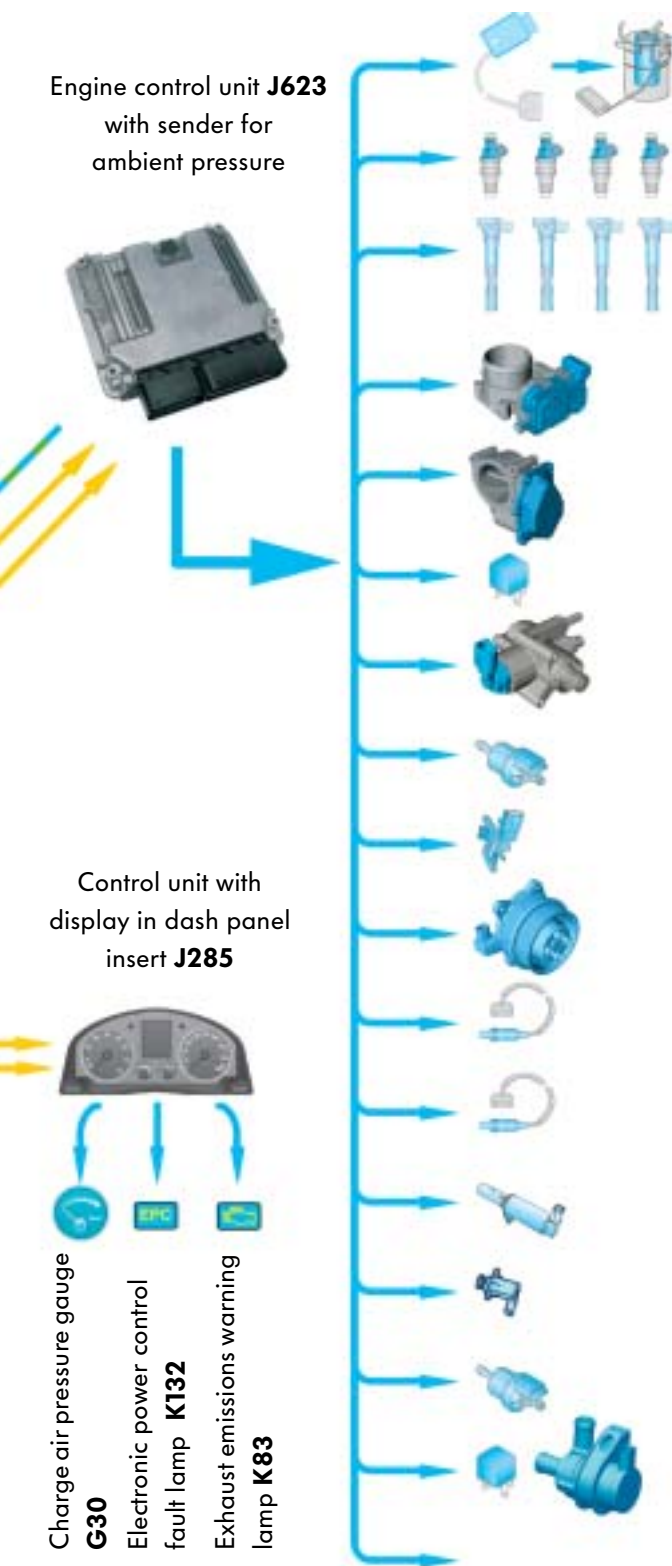
Sensor for current measurement **G582**

Winter driving program button **E598***

Additional input signals

* Only used in 1.4l/125kW TSI engine





Control elements

Fuel pump control unit **J538**

Fuel pump **G6**

Injectors for cylinders 1 - 4 **N30-33**

Ignition coil 1 - 4 with output stage
N70, N127, N291, N292

Throttle valve module **J338**

Throttle valve drive **G186**

Regulating flap control unit **J808**

Regulating flap position control motor **V380**

Motronic current supply relay **J271**

Fuel pressure regulating valve **N276**

Active charcoal filter system solenoid valve **N80**

Intake manifold flap air flow control valve **N316**

Magnetic clutch for supercharger **N421**

Lambda probe heater **Z19**

Lambda probe heater after catalytic converter **Z29**

Inlet camshaft timing adjustment valve **N205**

Turbocharger air recirculation valve **N249**

Charge pressure control solenoid valve **N75**

Additional coolant pump relay **J496**

Coolant circulation pump **V50**

Additional output signals



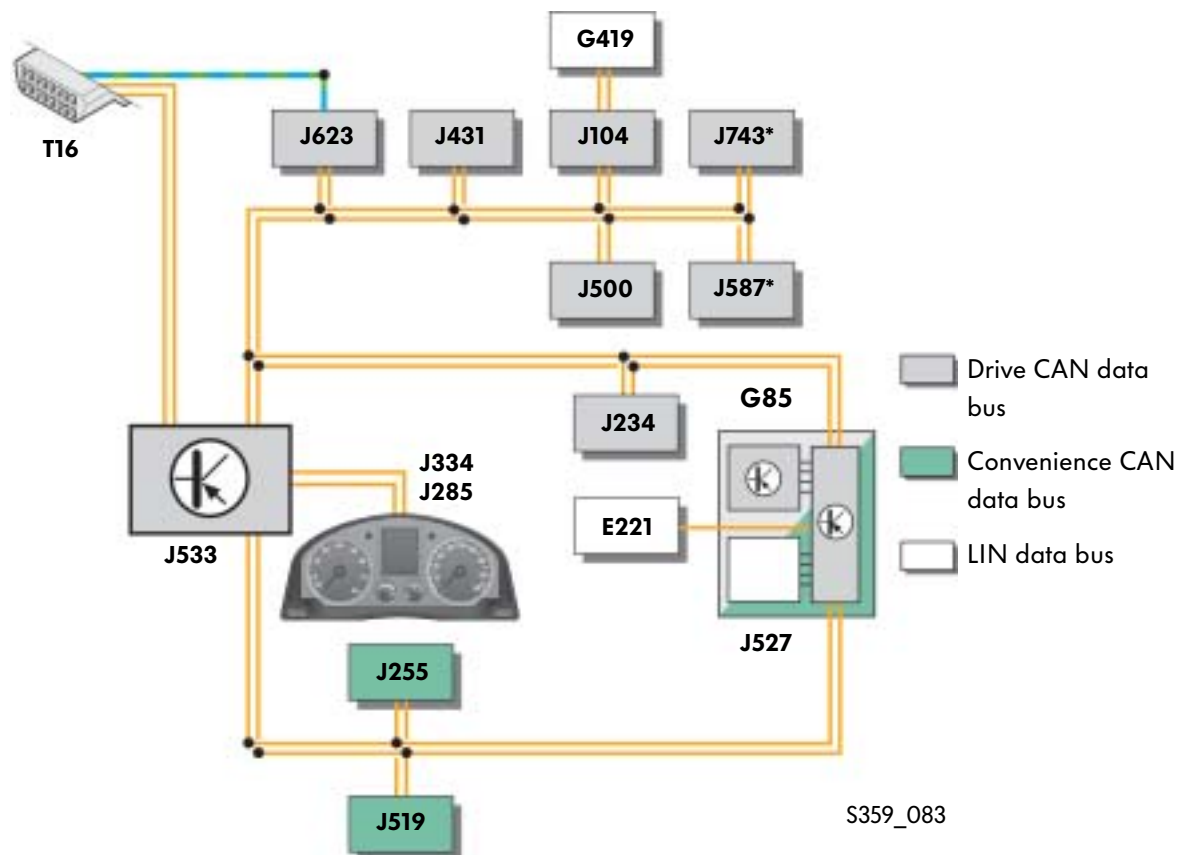
S359_036

Engine Management

CAN networking

The diagram below shows the control units with which the engine control unit J623 communicates via the CAN data bus and exchanges data.

For example, the control unit in dash panel insert J285 receives the current boost pressure from the engine control unit J623 via the CAN data bus. The information is used to display the boost pressure.



E221	Operating unit in steering wheel (multifunction steering wheel)
G85	Steering angle sender
G419	ESP sensor unit
J104	ABS control unit
J234	Airbag control unit
J255	Climatronic control unit
J285	Control unit with display in dash panel insert
J334	Immobilizer control unit
J431	Control unit for headlight range control

J500	Power steering control unit
J519	Onboard supply control unit
J527	Steering column electronics control unit
J533	Data bus diagnostic interface
J587*	Selector lever sensors control unit
J623	Engine control unit
J743*	Mechatronic unit for direct shift gearbox
T16	Diagnosis connector

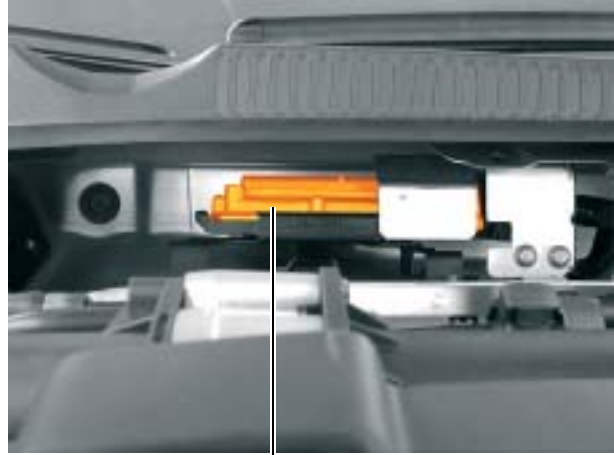
* only with direct shift gearbox

Engine control unit J623

The engine control unit is installed in the centre of the plenum chamber. The engine management system is the

Bosch Motronic MED 9.5.10.

The additional functions compared with the 1.6l/85kW FSI engine include the boost pressure regulation, a winter driving program, the circulating pump control and the starter Lambda probe control. The operating modes are homogeneous mode and the double-injection catalytic converter heating mode.



Engine control unit J623

S359_038



Exhaust gas-related faults are indicated by the exhaust emissions warning lamp K83 and functional errors in the system by the electronic power control fault lamp K132.



To protect the clutch, the engine speed is limited to approx. 4,000 rpm when the car is stationary.



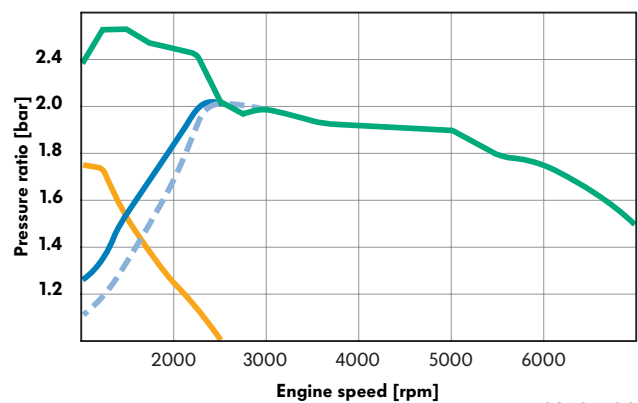
Boost pressure regulation

One new function in the engine management system is boost pressure regulation.

The diagram shows the boost pressure of the charging components at full load.

As the speed increases, the boost pressure of the turbocharger and the supercharger can be reduced. As a result, less drive power is required from the engine.

Furthermore the supercharger supplies a large amount of air at low revs. Subsequently a high flow of exhaust gases is available that is supplied to the turbocharger turbine. It can therefore generate the necessary boost pressure in the low rev ranges unlike pure turbocharged engines. The turbocharger is in principle “pushed” by the supercharger.



S359_109

- Compressor boost pressure
- Turbocharger boost pressure
- Boost pressure of the turbocharger and supercharger together
- - - Boost pressure of turbocharger in engine with simple turbocharging

Engine Management

Sensors

Intake manifold pressure sender G71 with intake air temperature sender G42

This combined sender is screwed into the plastic intake manifold. It measures the pressure and the temperature in the intake manifold.

Signal use

The engine control unit calculates the air mass drawn in from the signals and engine speed.

Effects of signal failure

If the signal fails, the throttle valve position and the temperature of the intake air temperature sender G299 is used as a replacement signal.

The turbocharger is only operated with regulation. If other sensors fail, the supercharger can be switched off.



Intake manifold pressure sender G71
with intake air temperature sender
G42

S359_047

Intake manifold pressure sender (supercharger) G583 with intake air temperature sender G520

This combined sender is screwed to the intake manifold behind the supercharger or behind the regulating flap control unit. It measures the pressure and temperature of the intake air in this area.

Signal use

Using the signals, the supercharger boost pressure is regulated via the regulating flap control unit. At the same time, the signal of the intake air temperature sender is used to protect components against high temperatures. Above a temperature of 130°C, the supercharger power is throttled.



Intake manifold pressure sender G583 with
intake air temperature sender G520

S359_049

Effects of signal failure

If the combined sender fails, regulation of the supercharger boost pressure is no longer possible. Supercharger operation is no longer allowed and the

turbocharger is only operated with regulation. The engine power is reduced in the lower rev ranges.

Charge air pressure sender G31 with intake air temperature sender 2 G299

This combined sender is screwed into the intake manifold just in front of the throttle valve module. It measures the pressure and temperature in this area.

Signal use

The signal from the charge air pressure sender is used by the engine control unit to control the boost pressure of the turbocharger via the charge pressure control solenoid valve.

The signal from the intake air temperature sender is used to calculate a correction value for the boost pressure. The temperature influence on the density of the charge air is taken into consideration.



Charge air pressure sender G31 with
intake air temperature sender 2 G299

S359_062

Effects of signal failure

If the sender fails, the turbocharger is only operated with regulation. If other sensors fail, the supercharger can also be switched off.



Ambient pressure sender

The sender is installed in the engine control unit and measures the ambient pressure.

Signal use

The ambient air pressure is required as a correction value for boost pressure regulation as the density of the air falls as the altitude rises.

Effects of signal failure

If the sender for ambient pressure fails, the turbocharger is only operated with regulation. Higher emissions values and a loss in power can occur here.

Engine control unit with
ambient pressure sender



S359_039

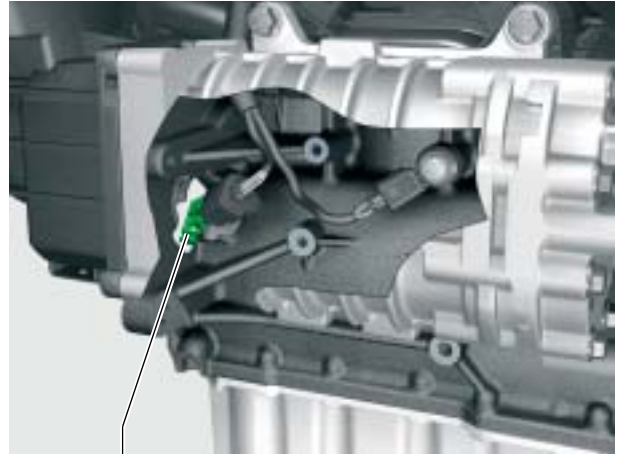
Engine Management

Engine speed sender G28

The engine speed sender is mounted on the cylinder block. It scans a sender wheel in the crankshaft sealing flange. Using these signals, the engine control unit calculates the engine speed and the position of the crankshaft in relation to the camshaft using the Hall sender G40.

Signal use

The calculated injection time, the injection duration and the ignition timing are determined with the signal. It is also used to adjust the camshaft.



Engine speed sender G28

S359_089

Effects of signal failure

If the sender fails, the engine will no longer run and can also not be started.

Hall sender G40

The Hall sender is on the flywheel side of the camshaft case above the inlet camshaft. It scans four teeth cast on the inlet camshaft.

Signal use

Together with the engine speed sender, it is used to recognise the ignition TDC of the first cylinder and the position of the inlet camshaft. The signals are used to determine the injection time, the ignition time and for adjusting the camshaft.



Hall sender G40

S359_057

Effects of signal failure

The engine continues to run if the sender fails. However, it cannot be started again. The camshaft adjustment is switched off and the inlet

camshaft is held in the "late position". A loss in torque results.

Throttle valve module J338 with angle sender for throttle valve drive G187 and G188

The throttle valve module with the angle sender for throttle valve drive is in the intake duct in front of the intake manifold.

Signal use

Using the signals from the angle sender, the engine control unit recognises the position of the throttle valve and can control it accordingly. For safety reasons, there are two senders whose values are compared with each other.

Effects of signal failure

If a sender fails, system components like the cruise control system will be switched off.

If both senders fail, the throttle valve drive will be



Throttle valve module J338 with angle sender for throttle valve drive G187 and G188

S359_050

switched off and the engine speed limited to 1,500 rpm.



Regulating flap control unit J808 Regulating flap potentiometer G584

The regulating flap potentiometer is in the regulating flap control unit. The regulating flap control unit is installed in the intake duct after the air filter.

Signal use

The engine control unit recognises the position of the regulating flap potentiometer. The engine control unit can then position the regulating flap in any position required.

Effects of signal failure

If the signal fails, the regulating flap remains constantly open and the supercharger is no longer activated.



Regulating flap control unit J808 with regulating flap potentiometer G584

S359_052

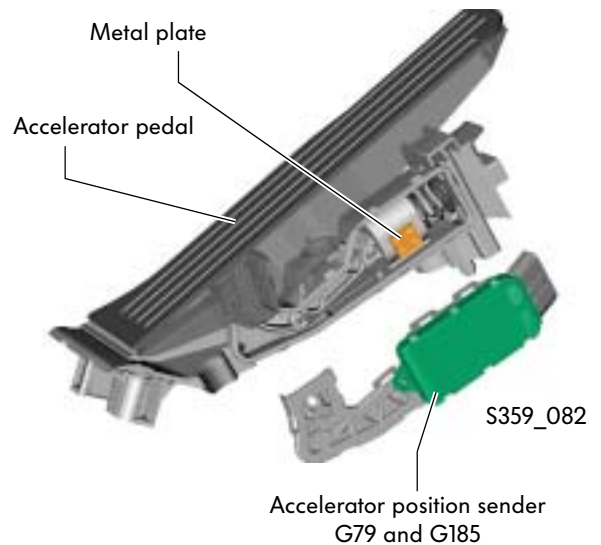
Engine Management

Accelerator position sender G79 and G185

The two accelerator position senders are part of the accelerator module and work as contact-free as inductive pickups. The accelerator position is recognised using the signals from the accelerator position sender.

Signal use

The engine control unit uses the signals to calculate the torque required by the driver. For safety reasons, there are two senders whose values are compared with each other as with the throttle valve module.



Effects of signal failure

If one or both senders fail, the convenience functions (e.g. cruise control, engine braking control) will be switched off.

Failure of one sender

If one sender fails, the system initially switches to idle. If the second sender is recognised in the idle position within a certain test time, driving will be possible again.

At the required full load, the engine speed is only increased slowly.

Failure of both senders

If both senders fail, the engine will only run with an increased idle speed (maximum 1,500 rpm) and will no longer respond to the accelerator pedal.

Clutch position sender G476

The clutch position sender is clipped to the sender cylinder. It indicates that the clutch pedal has been pressed.

Signal use

When clutch is pressed ...

- the cruise control is switched off.
- the injection quantity is reduced briefly so that engine judder is prevented when you change gear.
- the supercharger magnetic clutch can be activated when the car is stationary. This ensures that the boost pressure is reached very quickly when the car pulls away.



Clutch pedal with
clutch position sender

S359_084

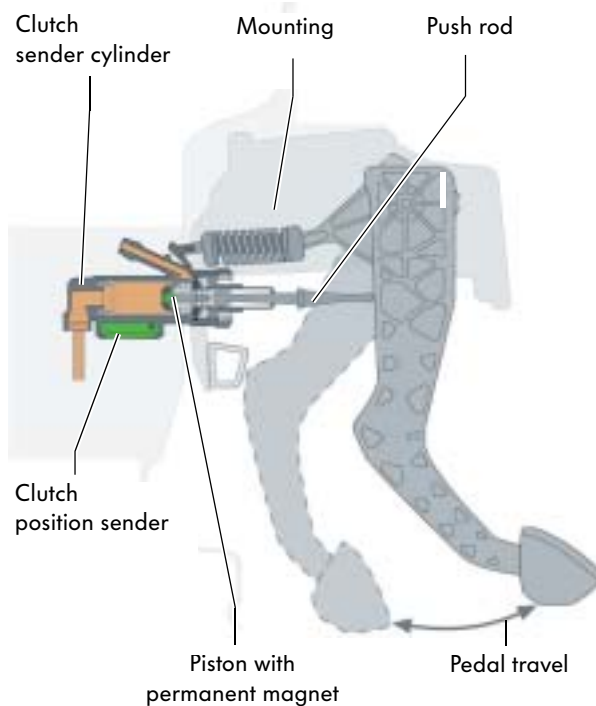


Design

The sender cylinder is fastened to the mounting using a bayonet connection. When the clutch pedal is pressed, the push rod pushes the piston in the sender cylinder.

Effects of signal failure

If the clutch position sender fails, the cruise control system will not work and there could be engine judder when you change gear.



S359_085

Engine Management

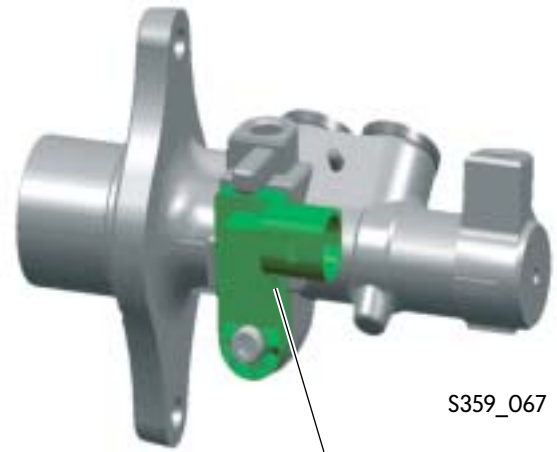
Brake pedal position sender G100

The brake pedal position sender is screwed to the main brake cylinder. It recognises whether the brake pedal is being pressed.

Signal use

The brake lights are operated via the onboard supply control unit.

Furthermore the engine control unit prevents the car accelerating if the brake and accelerator pedals are pressed at the same time. The injection quantity is reduced or the ignition time and the throttle valve are adjusted.



S359_067

Brake pedal position sender G100

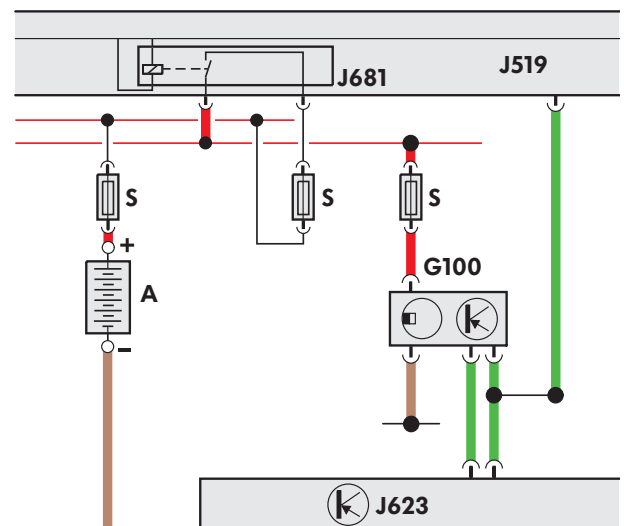
Effects of signal failure

If the signal of one of the two senders fails, the injection quantity is reduced and the engine has less power.

Furthermore the control cruise is switched off.

Electrical circuit:

- The voltage for the brake pedal position sender G100 is supplied via the voltage supply relay, terminal 15 J681.
- The earth connection is via the body earth point.
- The two signal lines go to the engine control unit J623. The signal also goes to the onboard supply control unit J519 from one cable. This operates the brake lights.



S359_096

- Voltage supply
- Earth connection
- Input signal
- A** Battery
- S** Fuse

How it works:

When the brake pedal is pressed, the pressure rod in the brake master cylinder moves the piston with magnetic ring (permanent magnet). Two Hall senders have been fitted in the brake pedal position sender for safety reasons.

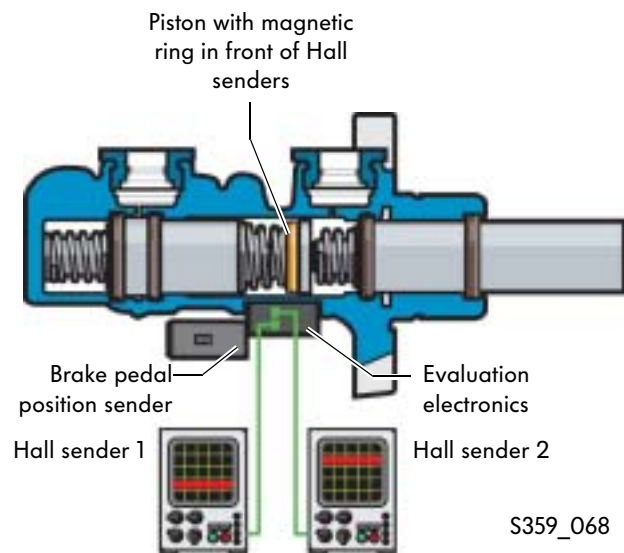
In the following explanation, only Hall sender 1 with its signal patterns is described for reasons of simplification. The signals from sender 2 are in the opposite direction.

Brake pedal not pressed:

When the brake pedal is not pressed, the piston with the magnet ring is in the rest position.

The evaluation electronics of the brake pedal position sender issue a signal voltage of 0 - 2 Volt to the engine control unit and the onboard supply control unit.

This indicates that the brake pedal has not been pressed.

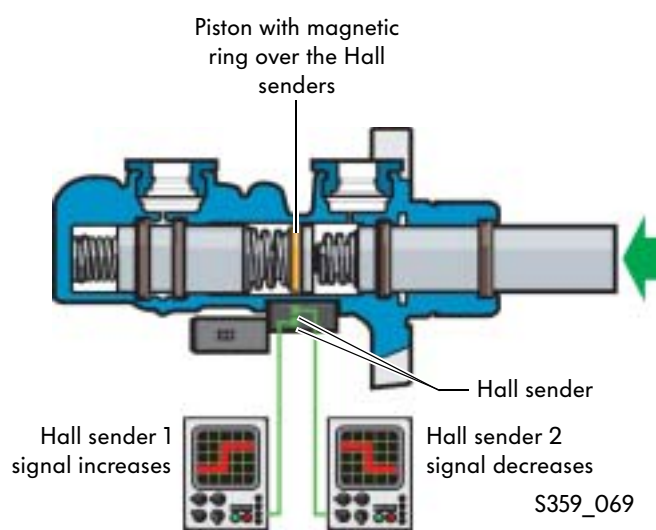


Brake pedal pressed:

When the brake pedal is pressed, the piston is pushed over the Hall sender.

When the magnetic ring of the piston crosses the switching point of the Hall sender, the evaluation electronics issues a signal voltage, which is up to 2 volt below the onboard supply voltage, to the engine control unit.

This indicates that the brake pedal has been pressed.



Engine Management

Fuel pressure sender G247

The sender is on the lower part of the intake manifold on the flywheel side and is screwed into the plastic fuel distribution pipe.

It measures the fuel pressure in the high-pressure fuel system and sends the signal to the engine control unit.

Signal use

The engine control unit evaluates the signals and regulates the pressure in the fuel distribution pipe using the fuel pressure regulating valve.



Fuel pressure sender G247

S359_090

Effects of signal failure

If the fuel pressure sender fails, the fuel pressure regulating valve is switched off, the electrical fuel pump is triggered fully and the engine is run with

the existing fuel pressure. This reduces the engine torque drastically.

Knock sensor G61

The knock sensor is screwed to the cylinder block below the supercharger. The signals from the knock sensor are used to detect knocking combustion in specific cylinders.

Signal use

When engine knock is recognised in the corresponding cylinder, the ignition angle is adjusted until there is no more knocking.



Knock sensor G61

S359_080

Effects of signal failure

If the knock sensor fails, the ignition angle of all cylinders is set to a fixed value in the "late" direction.

This leads to an increase in fuel consumption and the power and torque fall.

Coolant temperature sender G62

The coolant temperature sender is on the coolant distributor. It measures the coolant temperature and forwards it to the engine control unit.

Signal use

The coolant temperature is used to calculate the injection quantity, the injection timing and to control the handling functions.



Coolant temperature sender G62

S359_091

Effects of signal failure

If the signal fails, a temperature is calculated by the engine control unit according to the engine map and used for the individual functions.



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 there.

Signal use

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



Radiator outlet coolant temperature sender G83

S359_088

Effects of signal failure

If the signal from the coolant temperature sender G83 fails, the temperature from the coolant temperature sender G62 is used as a substitute value.

Engine Management

Lambda probe G39 with Lambda probe heating Z19

A step-type Lambda probe is used in front of the catalytic converter. This is possible because you can drive with Lambda 1 in almost all engine modes. It is screwed into the exhaust pipe in front of the catalytic converter close to the engine. It is used to determine the residual oxygen content in the exhaust in front of the catalytic converter.

The Lambda probe heating ensures that the Lambda probe reaches its operating temperature very quickly.

Signal use

Using the signal voltage, the engine control unit recognises whether the engine is running with a rich or lean air/fuel mixture.



S359_063

Effects of signal failure

If the signal fails, there will be no Lambda control, but pre-control of the injection quantity, the Lambda adjustment will be blocked and the activated charcoal filter system will switch to emergency mode.

Lambda probe after catalytic converter G130 with Lambda probe heating Z29

This Lambda probe is also a step-type Lambda probe.

The Lambda probe heating ensures that the Lambda probe reaches its operating temperature very quickly.

Signal use

The Lambda probe after the catalytic converter is used to check the catalytic converter function.

Effects of signal failure

If the signal fails, the catalytic converter function will no longer be monitored.



Lambda probe G130 with Lambda probe heating Z29

S359_064

Intake manifold flap potentiometer G336

It is mounted on the lower part of the intake manifold and is connected to the shaft for the intake manifold flaps. It recognises the position of the intake manifold flaps.

Signal use

The position is important because the intake manifold flap control has an effect on the air flow in the combustion chamber and the supplied air mass. The position of the intake manifold is therefore related to the exhaust gas and needs to be checked by the self-diagnosis system.

Effects of signal failure

If the signal from the potentiometer fails, the system can no longer recognise whether the intake manifold flaps are open or closed. A middle setting of the intake manifold flap is used as a substitute value and

Intake manifold flap potentiometer G336



S359_061

the corresponding ignition angle is set. There is a loss in power and torque and the fuel consumption also rises.



Brake servo pressure sensor G294

It is located in the hose between the intake manifold and the brake servo and measures the pressure in the brake servo.

Signal use

Using the voltage signal from the pressure sensor, the engine control unit recognises whether the vacuum is sufficient for the brake servo to work. If the vacuum pressure is too low, the air-conditioning system will be switched off. This closes the throttle valve slightly and the vacuum pressure rises again.

Brake servo
pressure sensor G294



S359_099

Effects of signal failure

If the signal fails, the system switches to a map-related pressure value with which the corresponding function is calculated.

Engine Management

Sensor for current measurement G582

The sensor for current measurement is located on the left of the engine compartment in the E-box. It recognises the current path upon activation of the supercharger magnetic clutch.

Signal use

Using the power consumption, the engine control unit regulates the PWM signal, with which the magnetic clutch is operated and closes it gently.

Effects of signal failure

If the signal fails, the current path is no longer recognised and the magnetic clutch is engaged with more of a jolt.

Electrical circuit

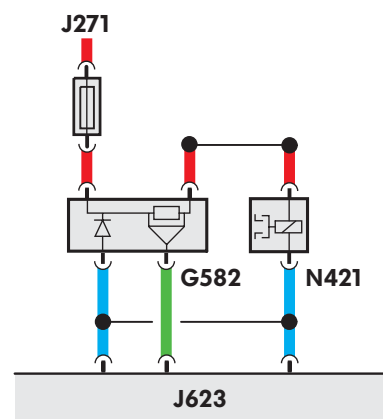
- The voltage for the magnetic clutch for supercharger N421 is supplied via the current supply relay J271 and the sensor for current measurement G582.
- The magnetic clutch is controlled by the engine control unit J623 via the ground connection with a PWM signal.
- In the sensor, a voltage measurement on a low-ohm resistor is used to determine the current path, which is then sent to the engine control unit. The magnet clutch is operated depending on the signal.
- If the magnetic clutch is no longer triggered, the magnetic field in the coil will collapse and a high induction voltage results. To protect the engine control unit against damage, this induction voltage is sent to the sensor for current measurement. The sensor contains a diode that conducts when a specific voltage difference between both sides is reached. This reduces the voltage peaks.

Sensor for current measurement G582



S359_070

If the sensor for current measurement fails completely, the supercharger can no longer be activated.



S359_058

- Voltage supply
- Input signal
- Output signal

Winter driving program button E598

The winter driving program button is clipped into the centre console in front of the gearstick. The winter driving program is intended for driving on slippery surfaces.

It is only used with the 1.4l/125kW TSI engine.



The winter driving program remains active until the button is pressed again or the ignition has been switched off for longer than 5 seconds. This ensures that the winter driving program is also active if the engine is stalled and is started again straightaway.



S359_073



S359_074

Winter driving program button E598



Signal use

When pressed, a comfort-oriented engine map and a flatter accelerator characteristic curve is activated. This limits the torque provided according to the gear and engine speed. It is therefore easier to pull away on slippery surfaces (wet, ice, snow, mud etc.). On cars with direct shift gearbox, the winter driving program can be activated in the D and R positions.

Effects of signal failure

If the button fails, only the normal driving program will be available.

Engine Management

Actuators

Motronic current supply relay J271

The Motronic current supply relay is located on the left of the engine compartment in the E-box.

Task

Using the current supply relay, certain functions can also be used and work in run-on mode after the engine has been turned off (ignition OFF). In this operating mode, the pressure senders are compared and the ignition coils or radiator fan are operated.



Motronic current supply relay J271

S359_071

Effects upon failure

If the relay fails, the corresponding sensors and actuators are no longer triggered. The engine

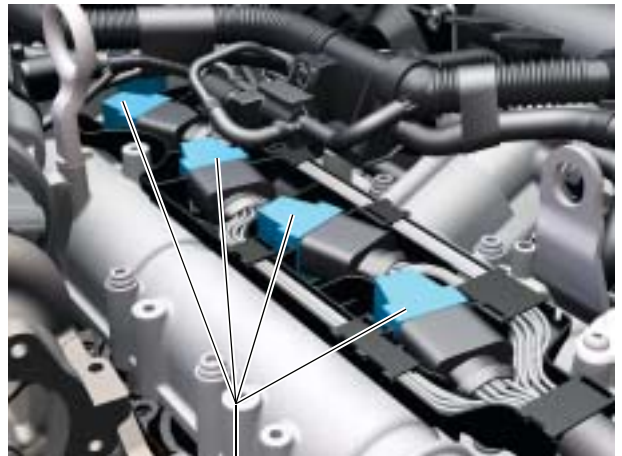
is turned off and can also no longer be started.

Ignition coils 1 - 4 with output stage N70, N127, N291, N292

The ignition coils with output stages are located in the centre of the cylinder head.

Task

The ignition coils with output stages have the task of igniting the fuel-air mixture at the right time. The ignition angle is controlled individually for each cylinder.



Ignition coils output stages N70, N127, N291, N292

S359_054

Effects upon failure

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

Throttle valve module J338 with throttle valve drive G186

The throttle valve module with the throttle valve drive is in the intake duct in front of the intake manifold.

Task

The throttle valve drive is an electric motor that is operated by the engine control unit. It operates the throttle valve via a small gear mechanism. 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 to the emergency mode position. Only the emergency mode properties are available and the



Throttle valve module J338 with throttle valve drive G186

S359_108

convenience functions (e.g. cruise control) are switched off.



Regulating flap control unit J808 with regulating flap position control motor V380

The regulating flap control unit with the regulating flap position control motor is located in the intake duct behind the air filter.

Task

The control motor is controlled by the engine control unit and operates the control flap continuously. Depending on the regulating flap position more or less compressed air flows back to the mechanical supercharger. This regulates the boost pressure after the supercharger.

Effects upon failure

If the control motor fails, the regulating flap will move to the emergency mode position (fully open). At the same time, the supercharger may not be activated.



Regulating flap control unit J808 with regulating flap position control motor V380

S359_107

No more boost pressure is built up by the supercharger.

Engine Management

Intake manifold flap air flow control valve N316

The valve is screwed onto the intake duct behind the regulating valve control unit.

Task

It is controlled by the engine control unit and opens the path from the vacuum reservoir to the vacuum control element. The intake manifold flaps are then operated by the vacuum control element.



Intake manifold flap air flow control valve N316 S359_051

Effects upon failure

If the valve fails, it will not be possible to adjust the intake manifold flaps and the flaps will be moved

to the open position. This worsens the combustion.

Inlet camshaft timing adjustment valve N205

This valve is in the camshaft housing and is incorporated in the engine oil circuit.

Task

Triggering the valve for the inlet camshaft control valve distributes the oil in the vane adjuster.

Depending on which oil channel is opened, the inner rotor is adjusted in the “early” or “late” direction or kept in its position. As the inner rotor is screwed to the inlet camshaft, it is also adjusted in the same way.



Inlet camshaft timing adjustment valve N205 S359_059

Effects upon failure

If the valve for camshaft adjustment fails, camshaft adjustment will no longer be possible and

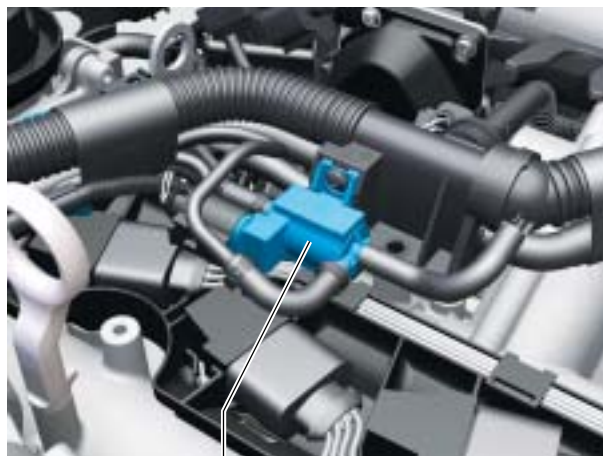
the inlet camshaft is held in the “late” position. A loss in torque results.

Charge pressure control solenoid valve N75

The electro-pneumatic charge pressure control valve is screwed to the return valve for the crankcase breather.

Task

The solenoid valve is clocked by the engine control unit and switches the control pressure in the pressure cell for the turbocharger. This operates the waste gate flap and diverts part of the exhaust gases past the turbine to the exhaust system. This regulates the turbine power and the boost pressure.



Charge pressure
control solenoid valve N75

S359_055

Effects upon failure

If the valve fails, boost pressure is applied to the pressure cell. The boost pressure is thus lower and the engine power is reduced.



Turbocharger air recirculation valve N249

The electrical turbocharger air recirculation valve is screwed to the turbocharger housing.

Task

The recirculation valve for turbocharger prevents noises upon switchover to boost mode and damage to the compressor wheel of the turbocharger. Upon switchover to boost mode, the compressor wheel is still rotating at speed and compressing the air. The compressed air is pumped to the closed throttle flap and reflected by it. It flows back to the turbocharger and meets the compressor wheel. Noise can result.

To avoid this, the circulation valve is opened and the turbine and compressor sides of the turbocharger are connected. The boost pressure is suddenly reduced and backflow is prevented. Furthermore a back pressure in the compressor housing is prevented and the turbocharger speed is not braked so greatly.



Turbocharger air recirculation valve N249

S359_056

Effects upon failure

If the circulation valve is leaking, the boost pressure is reduced and therefore also the engine output. If the valve can no longer be operated, there will be noise from the turbocharger in boost mode.

Engine Management

Magnetic clutch for supercharger N421

The maintenance-free magnetic clutch for the supercharger is part of the coolant pump module. It is used to activate the supercharger whenever necessary.

Task

The magnetic clutch is engaged by the engine control unit when necessary. The magnetic clutch then closes and forms a positive connection between the coolant pump pulley and the magnetic clutch pulley for the supercharger. The supercharger is then driven by the supercharger belt drive.



On cars with manual gearboxes, the magnetic clutch is operated with the onboard supply voltage up to an engine speed of 1,000 rpm and above that with a PWM signal.

On cars with the direct shift gearbox, the magnetic clutch is always controlled with a PWM signal.

If the magnetic clutch is closed, it is controlled with the onboard supply voltage.

Design

The magnetic clutch consists of ...

- a coolant pump pulley with a spring-loaded friction plate. It is screwed to the coolant pump drive shaft.
- a magnetic clutch pulley mounted on bearings for the supercharger with a clutch lining. It is mounted in a two-row deep-groove ball bearing on the coolant pump housing so it rotates.
- The solenoid is permanently mounted to the coolant pump housing.

Magnetic clutch for supercharger N421

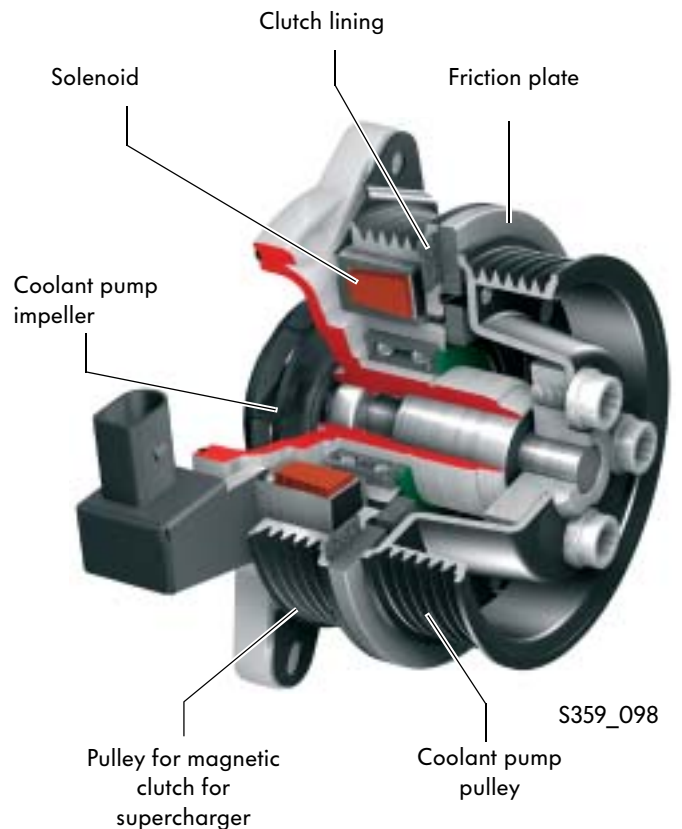


Coolant pump module

S359_060

Effects upon failure

If the magnetic clutch fails, the supercharger can no longer be operated.

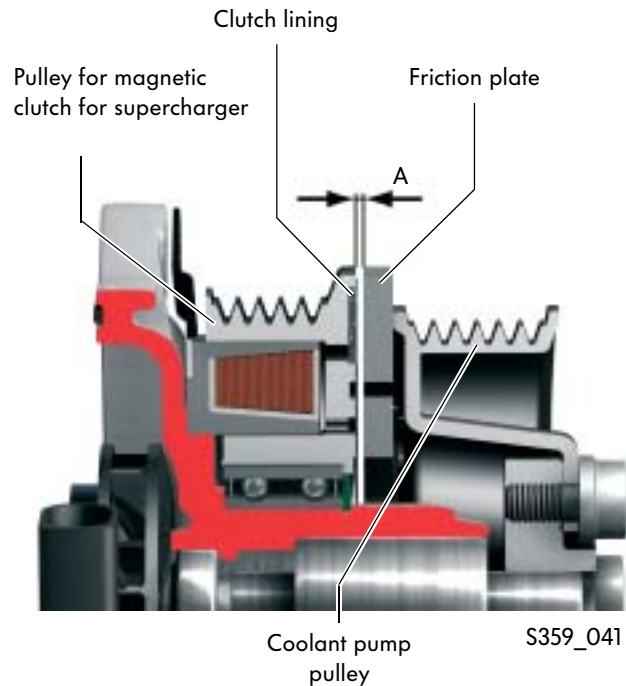


S359_098

How it works:

Magnetic clutch not engaged

The coolant pump pulley is driven by the crankshaft via the ancillary components drive belt. As the magnetic clutch is not engaged, the compressor belt pulley does not turn. The supercharger is not driven. Gap "A" is between the clutch lining and friction plate.



Magnetic clutch engaged

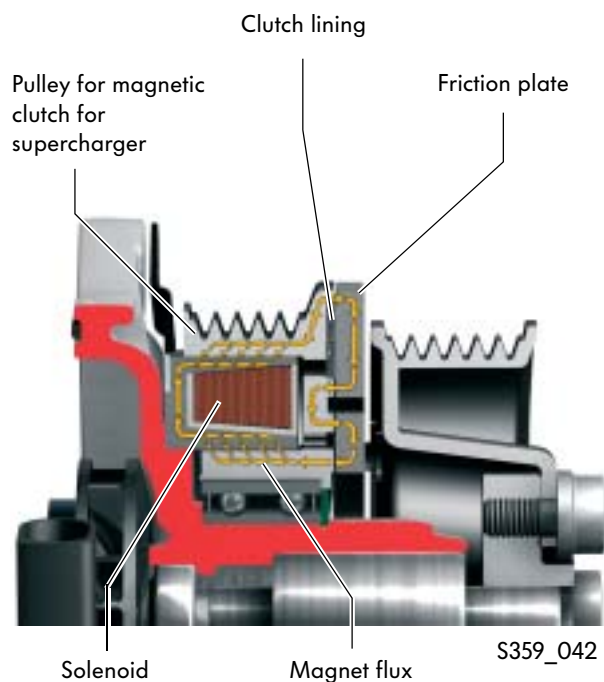
When the supercharger should be activated, a voltage is applied to the solenoid. A magnetic field is formed. This pulls the friction plate against the clutch lining and forms a positive connection between the supercharger magnetic clutch pulley and the coolant pump pulley.

The mechanical supercharger is driven.

It runs until the power circuit for the solenoid is interrupted.

The friction plate is then returned by springs on the coolant pump pulley.

The supercharger pulley then no longer rotates.



Engine Management

Fuel pump control unit J538

The control unit is mounted under the rear bench in the cover for the electrical fuel pump.

Task

The fuel pump control unit receives a signal from the engine control unit and controls the electrical fuel pump with a PWM signal (pulse-width modulation). It regulates the pressure in the low-pressure fuel system between 0.5 and 5 bar.

The pressure is raised to up to 6.5 bar for warm and cold starts.



Fuel pump control unit J538

S359_075

Effects of signal failure

If the fuel pump control unit fails, the engine will not run.

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.

Task

The electrical fuel pump delivers the fuel in the low-pressure fuel system to the high-pressure fuel pump. It is controlled with a PWM signal from the fuel pump control unit.

The electrical fuel pump supplies as much fuel as the engine requires.



Fuel pump G6

S359_076

Effects upon failure

If the electrical fuel pump fails, the engine will not run.

High-pressure injectors N30 - N33

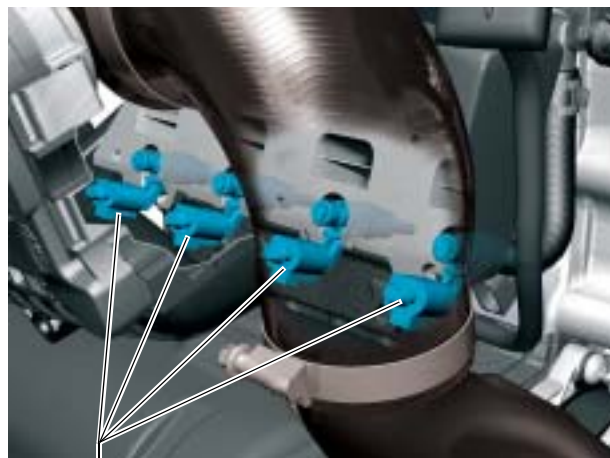
The high-pressure injectors are fitted in the cylinder head. They inject the fuel into the cylinders at high pressure.

Task

The injectors need to precisely inject and atomise the fuel in a very short time.

In the double injection catalytic converter heating mode, fuel is therefore injected twice. The first time during the intake stroke and the second time approx. 50° KW before ignition TDC to warm up the catalytic converter quickly.

In homogeneous mode, the fuel is injected during the intake stroke and is distributed evenly around the whole combustion chamber.



Injectors N30 - N33

S359_079



Multi-port injector

The high-pressure injector has 6 fuel outlet bores. The individual jets are arranged so that the combustion chamber parts do not become wet and air-fuel mixture is distributed evenly.

The maximum injection pressure is 150 bar to ensure very good preparation and atomising of the fuel. Even at full load, this ensures that enough fuel is injected.



S359_105

Effects upon failure

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

Engine Management

Fuel pressure regulating valve N276

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

Task

It has the task of supplying the required quantity of fuel at the required fuel pressure in the fuel rail.

Effects upon failure

The regulating valve is open and not powered. This means that high pressure is not built up and the engine is run with the existing fuel pressure from the



Fuel pressure
regulating valve N276

High-pressure
fuel pump

S359_053

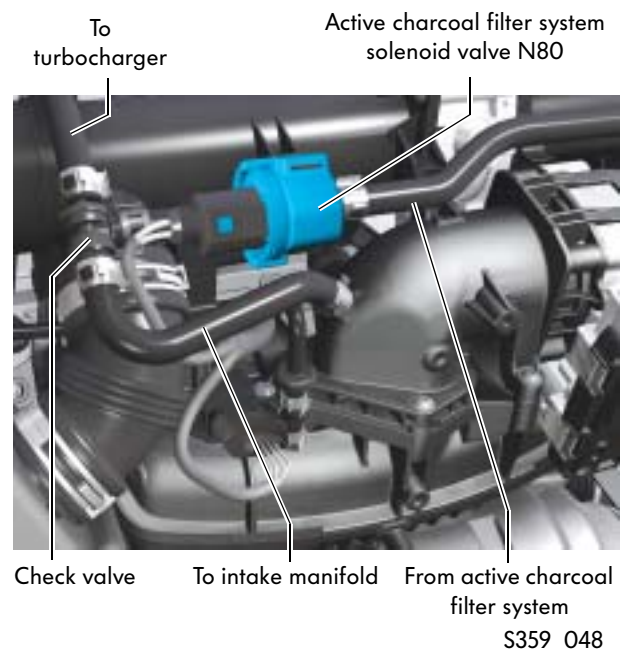
electrical fuel pump. This reduces the engine torque drastically.

Active charcoal filter system solenoid valve N80

The solenoid valve for the active charcoal filter system is mounted near to the throttle valve module.

Task

The valve is operated at a certain frequency and ventilates the activated charcoal canister. The fuel vapours are delivered to the intake duct behind the throttle valve module or in front of the turbocharger depending on the pressure conditions. A specific pressure drop is required to draw the fuel vapours from the activated charcoal canister. The check valve ensures that no air is pushed in the direction of the activated charcoal canister.



To
turbocharger

Active charcoal filter system
solenoid valve N80

Check valve

To intake manifold

From active charcoal
filter system

S359_048

Effects of signal failure

If the power supply is interrupted, the valve remains closed.

The tank is not ventilated and there may be a smell of fuel.

Additional coolant pump relay J496

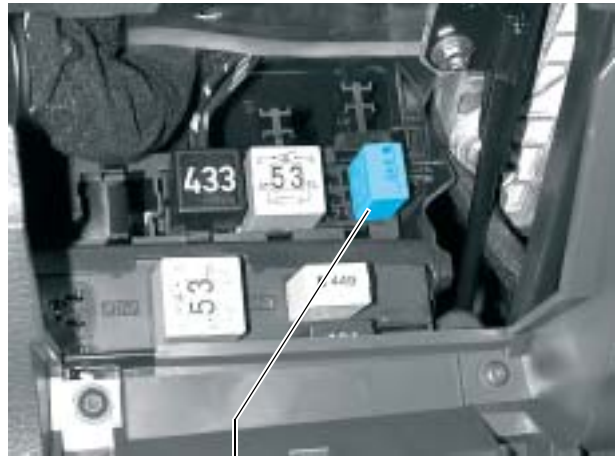
The additional coolant pump relay is on the left under the dash panel.

Task

The high working currents for the coolant circulation pump V50 are switched by the relay.

Effects upon failure

If the relay fails, continued coolant circulation will not be possible and there could be overheating.



Additional coolant pump relay J496

S359_034



Coolant circulation pump V50

The coolant circulation pump is on the left-hand side of the engine compartment near the three-way catalytic converter. It is connected to the coolant return from the coolant distributor housing to the radiator.

Task

After the engine has been turned off, overheating can occur (steam bubbles) near the turbocharger as the coolant is still being heated.

To avoid this, the coolant recirculation pump is activated by the engine control unit for a maximum of 15 minutes.

The switch-on conditions for the coolant circulation pump result from the following signals:

- Coolant temperature sender (G62)
- Oil level and oil temperature sender (G266)



Coolant circulation pump V50

S359_095

Effects upon failure

If the coolant circulation pump fails, continued coolant circulation will no longer be possible and there could be overheating. A faulty pump will not be recognised by the self-diagnosis system.

Engine Management

Charge air pressure gauge G30

The boost gauge is located in the dash panel insert underneath the multi-function display.

The signal comes from the engine control unit to the dash panel insert via the CAN data bus.

There is no coolant temperature gauge. Warnings will appear in the multi-function display as before.

Task

When boost pressure is required, the boost gauge shows the relationship between the actual and maximum boost pressure at the current engine speed. This type of display should counteract a possible problem of “boost pressure falling as rpm rises”. The maximum boost pressure at full load and an engine speed of 1,500 rpm is around 2.5 bar (absolute) and at full load and an engine speed of 5,500 rpm 1.8 bar (absolute).



Charge air pressure gauge G30

S359_077

Effects upon failure

If the gauge fails, the boost pressure will no longer be indicated. Failure has no effect on the system.

Boost gauge

Here is an example to explain the gauge.

The supercharging components can produce a maximum boost pressure of 2.5 bar (absolute) at an engine speed of 1,500 rpm and full load.

Needle position with medium charging

The needle is in the middle.

This means that the engine is running at partial load and the supercharging components have produced medium boost pressure at the engine speed of 1,500 rpm.



S359_078



Needle position with maximum charging

The needle is at the end of the gauge.

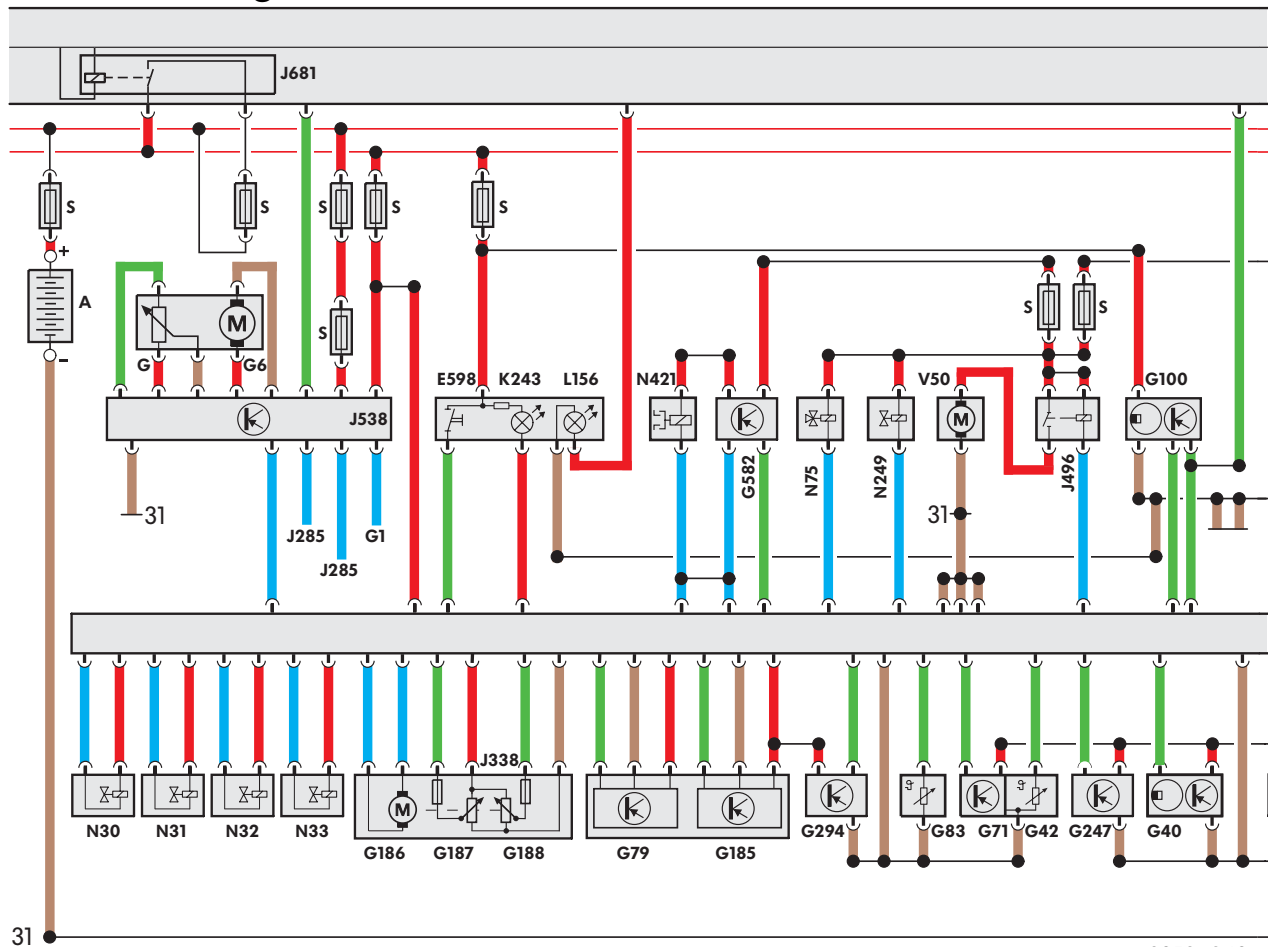
This means that the supercharging components have produced the maximum possible boost pressure at an engine speed of 1,500 rpm.



S359_106

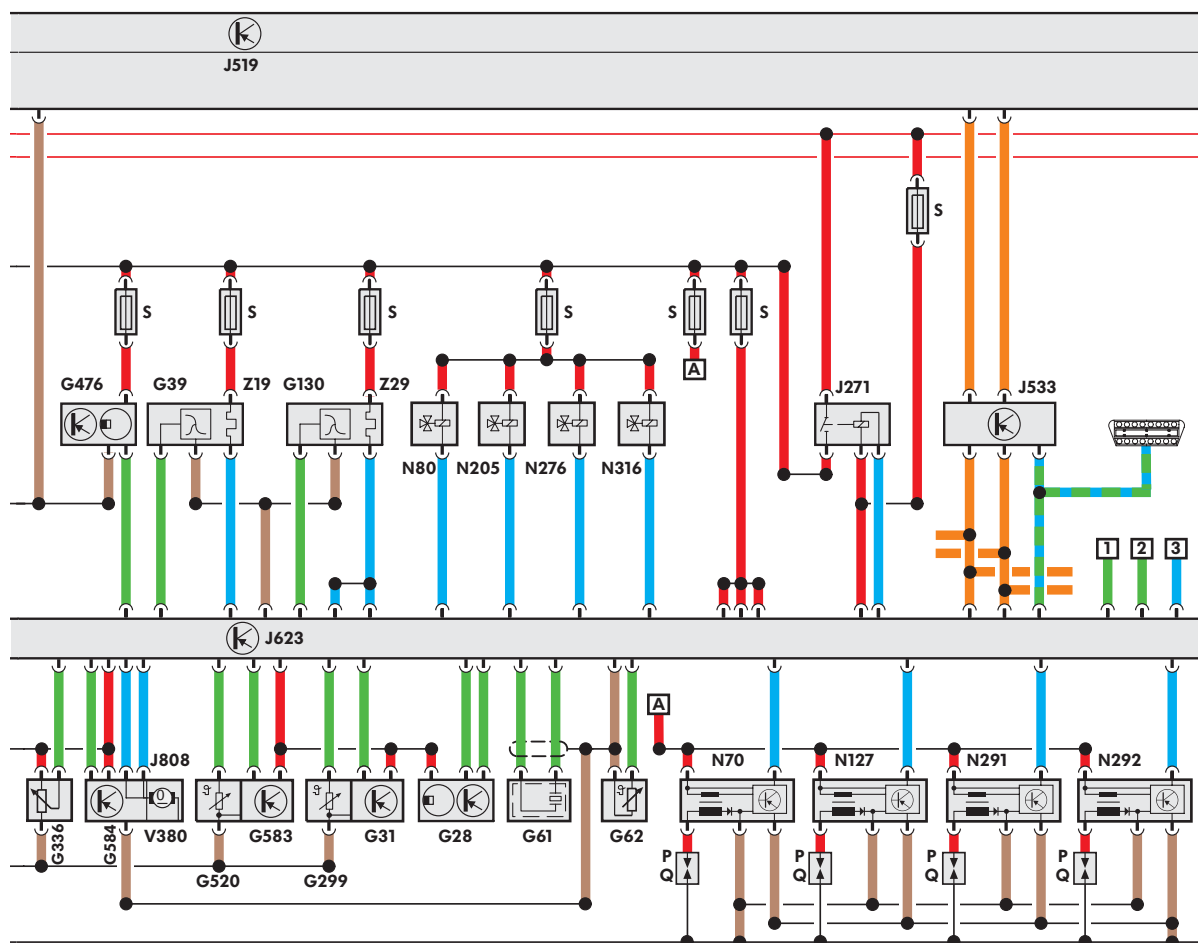
Engine Management

Functional diagram



S359_043





- | | | | |
|-------------|--|-------------|--|
| A | Battery | G294 | Brake servo pressure sensor |
| E598 | Winter driving program button | G582 | Sensor for current measurement |
| G | Fuel gauge sender | J285 | Control unit with display in dash panel insert |
| G1 | Fuel gauge | J338 | Throttle valve module |
| G6 | Fuel pump | J496 | Additional coolant pump relay |
| G40 | Hall sender | J538 | Fuel pump control unit |
| G42 | Intake air temperature sender | J681 | Terminal 15 voltage supply relay |
| G71 | Intake manifold pressure sender | K243 | Winter program warning lamp |
| G79 | Accelerator position sender | L156 | Switch illumination bulb |
| G83 | Radiator outlet coolant temperature sender | N30- | Injectors for cylinders 1 - 4 |
| G100 | Brake pedal position sender | N33 | |
| G185 | Accelerator position sender 2 | N75 | Charge pressure control solenoid valve |
| G186 | Throttle valve drive | N249 | Turbocharger air recirculation valve |
| G187 | Throttle valve drive angle sender | N421 | Magnetic clutch for supercharger |
| G188 | Throttle valve drive angle sender | S | Fuse |
| G247 | Fuel pressure sender | V50 | Coolant circulation pump |



- | | | | |
|-------------|--|-------------|---|
| G28 | Engine speed sender | N205 | Inlet camshaft timing adjustment valve |
| G31 | Charge air pressure sender (turbocharger) | N276 | Fuel pressure regulating valve |
| G39 | Lambda probe | N291 | Ignition coil 3 with output stage |
| G61 | Knock sensor | N292 | Ignition coil 4 with output stage |
| G62 | Coolant temperature sender | N316 | Intake manifold flap air flow control valve |
| G130 | Lambda probe after catalytic converter | P | Spark plug connector |
| G299 | Intake air temperature sender | Q | Spark plugs |
| G336 | Intake manifold flap potentiometer | V380 | Regulating flap position control motor |
| G476 | Clutch position sender | Z19 | Lambda probe heater |
| G520 | Intake air temperature sender | Z29 | Lambda probe heater |
| G583 | Intake manifold pressure sender | 1 | Cruise control system switch |
| G584 | Regulating flap potentiometer | 2 | Alternator terminal DFM |
| J271 | Motronic current supply relay | 3 | Radiator fan level 1 |
| J519 | Onboard supply control unit | | |
| J533 | Data bus diagnostic interface | | |
| J623 | Engine control unit | | |
| J808 | Regulating flap control unit | | |
| N70 | Ignition coil 1 with output stage | | |
| N80 | Active charcoal filter system solenoid valve | | |
| N127 | Ignition coil 2 with output stage | | |
-
- | | |
|--|----------------------|
| — | Output signal |
| — | Input signal |
| — | Positive |
| — | Earth |
| — | Bi-directional cable |
| — | CAN data bus |



Special tools

Name	Tool	Application
Locking pin –T10340-	 <p>S359_045</p>	<p>The locking bolt locks the crankshaft in the engine rotation direction.</p> <p> Please note the repair instructions in ELSA when fitting the crankshaft pulley.</p>
Guide pins –T10341-	 <p>S359_044</p>	<p>The two guide pins hold the supercharger in the correct position during installation.</p>
Engine support –T40075- with adapters -/4, -/5, -/6	 <p>S359_087</p>	<p>The engine support allows you to lower the engine together with the gearbox.</p>

Compressor belt pulley mounting bolt

You need to hold the supercharger shaft with a spanner when loosening and tightening the supercharger pulley bolt.



Please note the further information in the repair guide.

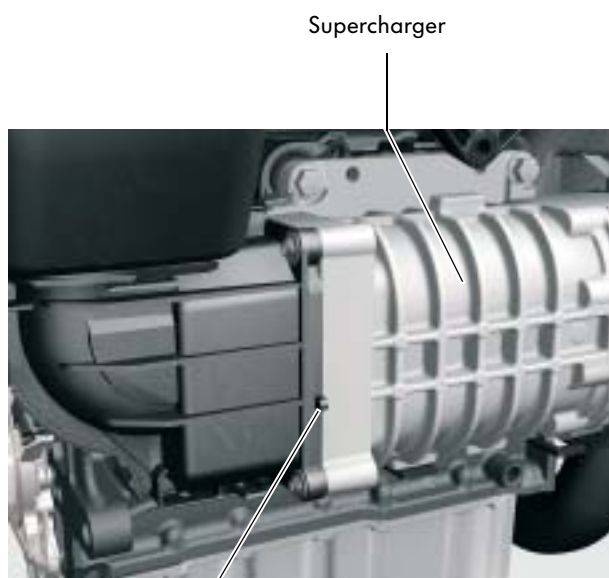


Inspection window for seals

Inspection windows are provided for some parts of the intake system. You can use these windows to check whether the seals are fitted without removing the parts.



Please note that you cannot see whether the seal is fitted properly.



Supercharger

S359_100

Inspection flap for seal between soundproofing and supercharger

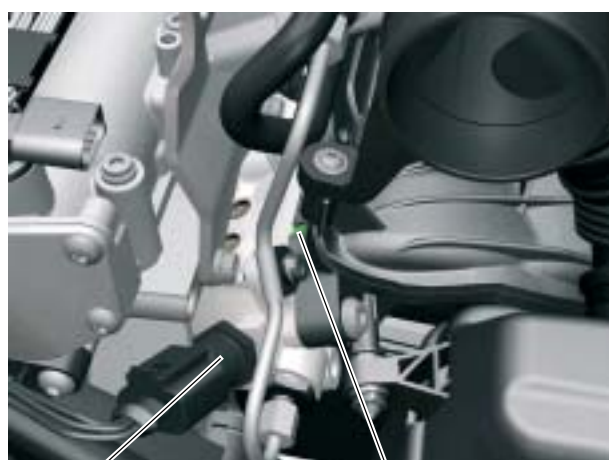


Inspection window for seal between intake manifold and lower part of intake manifold

S359_101

Regulating flap control unit

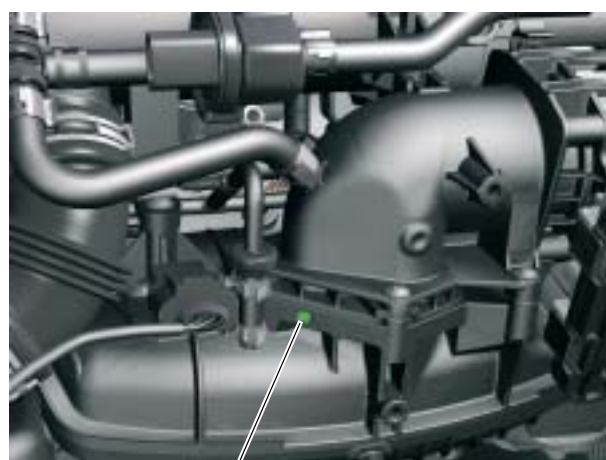
Inspection window for seal between intake manifold and regulating flap control unit



S359_102

Sender for fuel pressure

Inspection window for seal between intake manifold and lower part of intake manifold



S359_103

Inspection window for seal between intake manifold and intake manifold flange



Test Yourself

Which answers are correct?

One or several of the answers could be correct.

1. What is meant by “downsizing”?

- ☐ a) Downsizing means the output of an engine with large displacement is decreased thus reducing the fuel consumption.
- ☐ b) Downsizing involves reducing the displacement of an engine while keeping the same output, for example. This reduces the internal friction and cuts fuel consumption.
- ☐ c) Downsizing involves increasing the displacement, raising the torque and saving fuel.

2. How many poly-V-belts does the TSI engine have?

- ☐ a) It has just one poly-V-belt for driving the ancillary components.
- ☐ b) It has two poly-V-belts. One to drive the ancillary components and one to drive the supercharger.
- ☐ c) It has three poly-V-belts to drive the ancillary components, the supercharger and the oil pump.

3. Above which engine speed is the supercharger no longer activated?

- ☐ a) 1,500 rpm
- ☐ b) 2,200 rpm
- ☐ c) 3,500 rpm

4. The signal from the sensor for current measurement G 582 can be used

- ☐ a) ... to regulate the clocking of the magnetic clutch.
- ☐ b) ... to regulate the mixture composition.
- ☐ c) ... to control the regulating flap.

5. Which statements about the supercharger magnetic clutch are correct?

- ☐ a) The magnetic clutch is part of the coolant pump module.
- ☐ b) The mechanical supercharger is activated using the magnetic clutch as required.
- ☐ c) The magnetic clutch is maintenance-free.

6. When do the two supercharging components produce boost pressure?

- ☐ a) The turbocharger produces the boost pressure immediately if the exhaust gas energy is sufficient.
- ☐ b) The supercharger is only activated when the boost pressure produced by the turbocharger is not sufficient.
- ☐ c) Both charging components are always activated and produce boost pressure.

7. How is the boost pressure of the charging components regulated?

- ☐ a) The turbocharger boost pressure is controlled by the charge pressure control solenoid valve.
- ☐ b) The boost pressure of the supercharging components is controlled via the throttle valve module.
- ☐ c) The supercharger boost pressure is controlled via the regulating flap control unit.

8. What kind of Lambda probe is used in the 1.4I TSI engine as a pre-catalytic converter probe?

- ☐ a) A broadband Lambda probe
- ☐ b) A step-type Lambda probe
- ☐ c) A NOx sender

Answers
1. b
2. b
3. c
4. a
5. a,b,c
6. a,b
7. a,c
8. b





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Volkswagen AG
Service Training VSQ-1
Brieffach 1995
38436 Wolfsburg

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