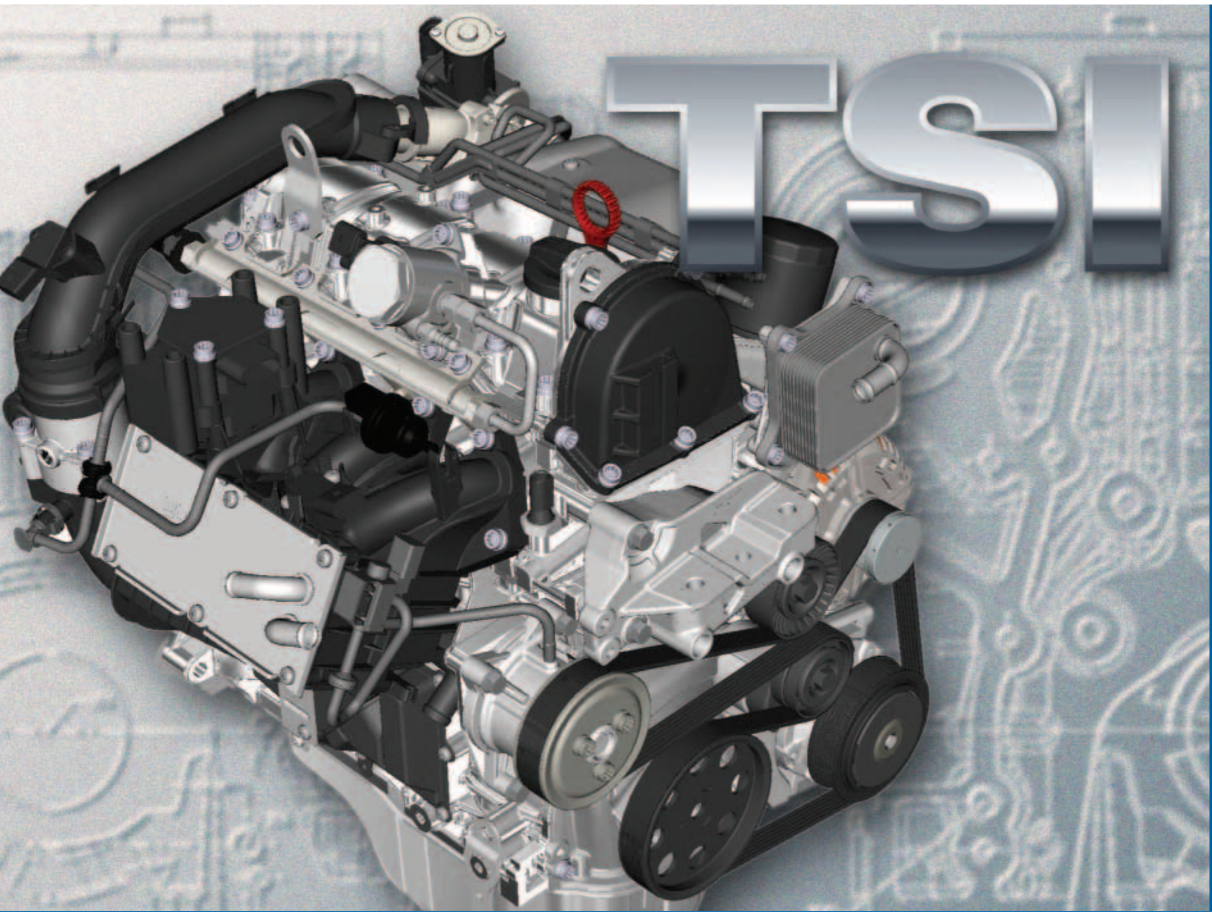
Service Training

Self-study Programme 443

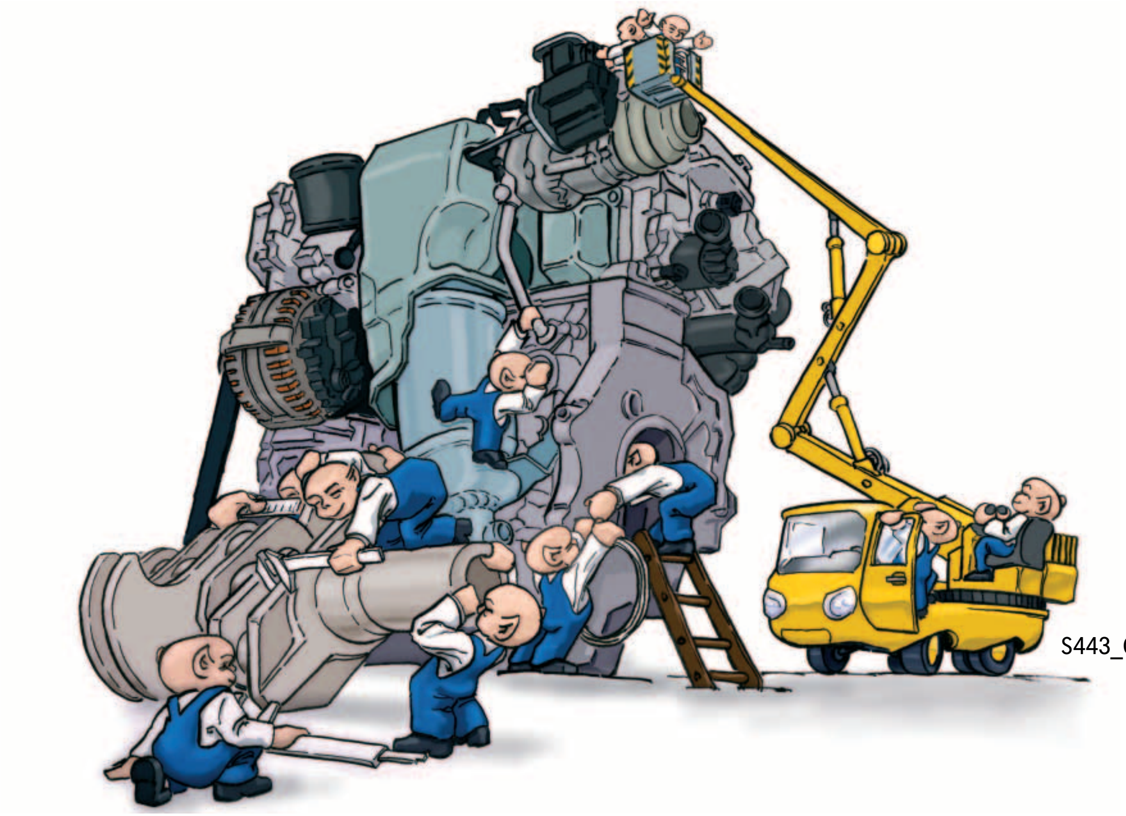
The 1.2l 77kW TSI engine with turbocharger

Design and Function



This 1.2l 77kW TSI engine replaces the 1.6l 75kW engine with intake manifold injection.
Compared with the latter, this engine achieves significantly better performance with significantly reduced fuel consumption and therefore lower CO_2 emissions. The aspect of CO_2 emissions has now become an important factor which influences the customer's purchasing decision.

Volkswagen is consistently pursuing its TSI strategy and is continuing this engine family's success story with the new 1.2l TSI engine. The further development of the engine technology used in this small but powerful engine model series is based on consistent output optimisation and lightweight design.
With its new aluminium cylinder block and a newly developed combustion process, this engine combines response plus low consumption and costs for Volkswagen's high-volume engines.



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On the following pages, we will introduce you to the design and function of the new 1.2l 77kW TSI engine with turbocharger.

Further information on engine mechanics and engine management can be found in self-study programme 405 "The 1.4l 90kW TSI Engine with Turbocharger".

The self-study programme portrays 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.

Attention
Note

Contents

1.2l 77kW TSI engine with turbocharger

This engine is based on the 1.4l 90kW TSI engine with turbocharger.
During the development of the 1.2l 77kW TSI engine, focus was placed on three objectives:

- Reducing weight in comparison with the 1.4l 90kW TSI engine,
- Reducing internal friction and
- Developing a swirl combustion process

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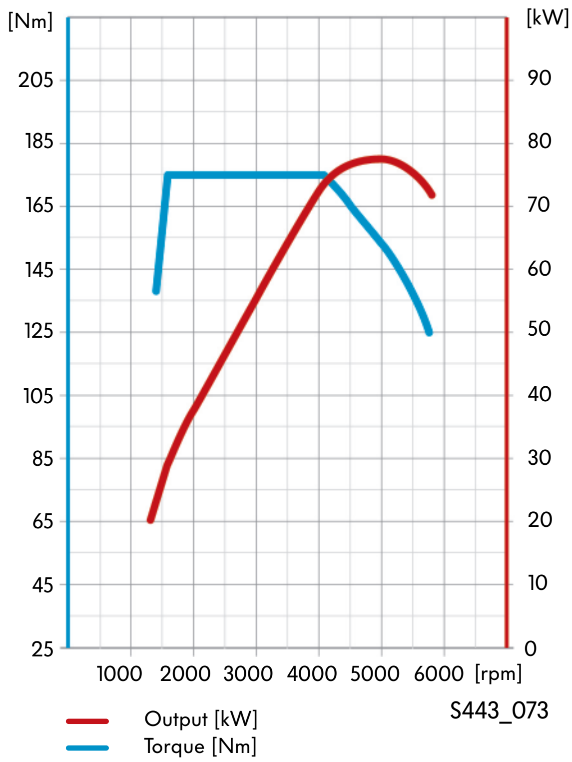
Technical features

- A newly developed aluminium cylinder block with innovative cylinder liners manufactured from grey cast iron
- The 2V cylinder head with inclined suspended valves and roller rocker finger valve gear with timing chain (valve angle 12°, roof combustion chamber)
- A steel crankshaft with connecting rod and main bearing diameters reduced to 42mm
- A low-friction lightweight design piston assembly with a ring package with reduced tangential forces
- An oil circuit with reduced oil throughput and an oil pump with optimised efficiency
- A coolant pump which can be shut off
- A split, lightweight design timing case with plastic and magnesium covers for ease of service
- A turbocharger module with electric charge pressure positioner
- A crankcase breather system integrated into the cylinder block and cylinder head with oil separation
- An ignition transformer

Technical data

Torque and output diagram

The maximum torque of 175Nm is achieved at an engine speed of 1550 to 4100 rpm. At 1550 rpm, the torque is therefore approx. 45% higher than that of the predecessor engine.
The engine achieves its maximum output of 77kW at an engine speed of 5000 rpm.



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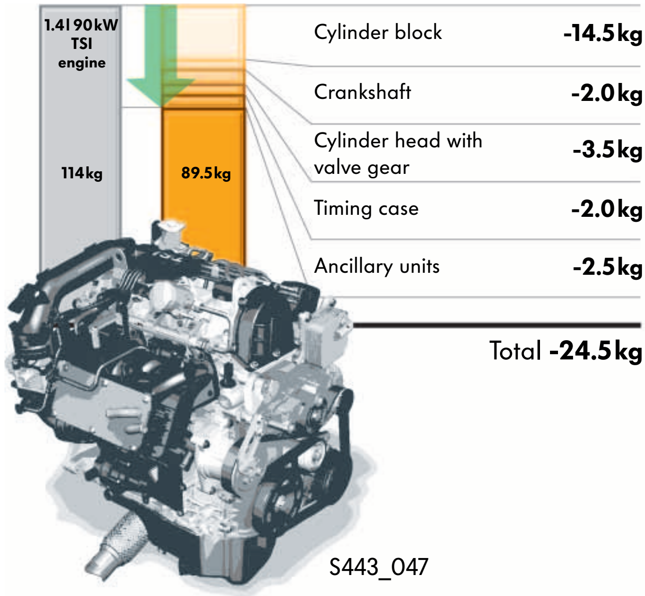
Engine code	CBZB
Type	4-cylinder in-line engine
Displacement	1197 cm^3
Bore	71mm
Stroke	75.6mm
Valves per cylinder	2
Compression ratio	10 : 1
Maximum output	77kW at 5000 rpm
Maximum torque	175Nm at 1550-4100 rpm
Engine management	Continental Simos 10
Fuel	Super unleaded RON 95
Exhaust gas treatment	Three-way catalytic converter with lambda control
Emissions standard	EU5

Engine mechanics

Engine

Design measures implemented to reduce weight enabled the weight of the 1.2l 77kW TSI engine to be reduced by 24.5 kg in comparison with that of the 1.4l 90kW TSI engine.
However, the reduction in friction and the new combustion process also contribute towards the achievement of the development objectives.

Weight comparison



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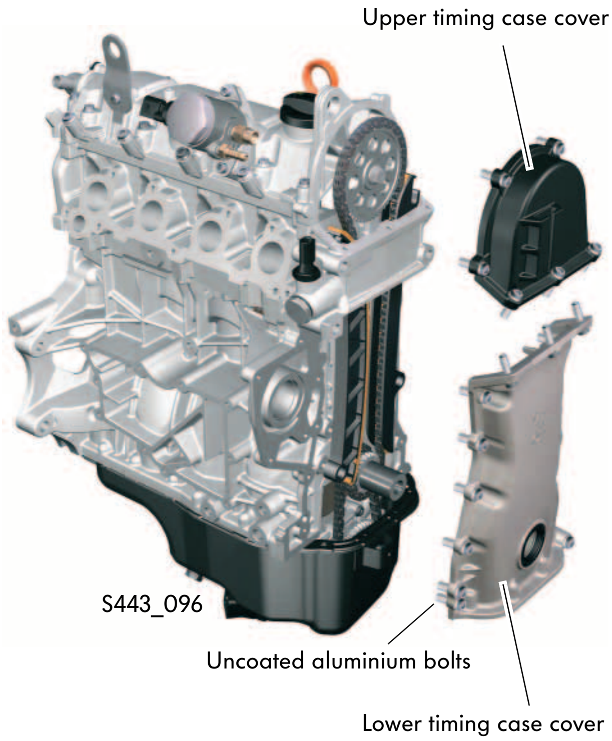
Two-piece timing case

The timing case consists of two component parts.
The upper cover is manufactured from plastic and can be removed individually.
The lower cover is manufactured from diecast magnesium. It is secured with special aluminium alloy bolts and can be removed without removing the cylinder head.



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Note that only the aluminium bolts required for the assembly of the lower timing case are to be used for this purpose.

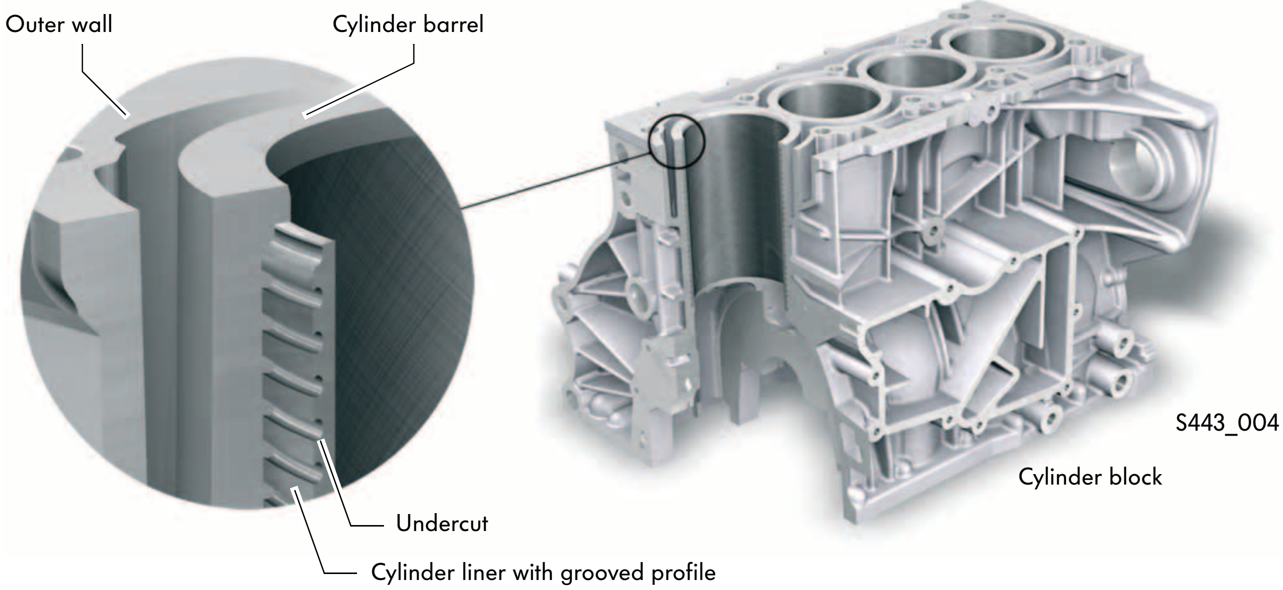
Cylinder block

The cylinder block is manufactured from diecast aluminium. As a result of this, its weight is 14.5 kg less than the grey cast iron cylinder block with lamellar graphite fitted in the 1.4l 90kW TSI engine.
As in the case of the 1.4l 90kW TSI engine, the cylinder block has what is called an open-deck design.
This means that there are no webs between the outer wall and the cylinder barrels.

This has two advantages:

- No air bubbles, which would lead to bleeding and cooling problems, particularly in the dual-circuit cooling system, are able to form in this area.

- The seperation of the cylinder liner and the cylinder block results in less distortion when the cylinder head is bolted to the cylinder block, than in the case of a closed-deck design with webs. This results in lower oil consumption, as the piston rings can compensate better for this reduced distortion.



Grey cast iron cylinder liners

The cast-in grey iron cylinder liners have a grooved profile with undercut towards the cylinder block. This profile ensures a firm, insoluble joint (clamping) between the cylinder block and the cylinder liners.
This leads to reduced cylinder block warping. Uneven heat distribution, such as that which occurs due to gap formation in the case of grey cast iron cylinder liners without undercut, is also avoided.

Valve gear and crankshaft drive

A range of measures have been implemented on the crankshaft drive and valve gear in order to reduce friction and weight and to increase the crankshaft's stiffness.

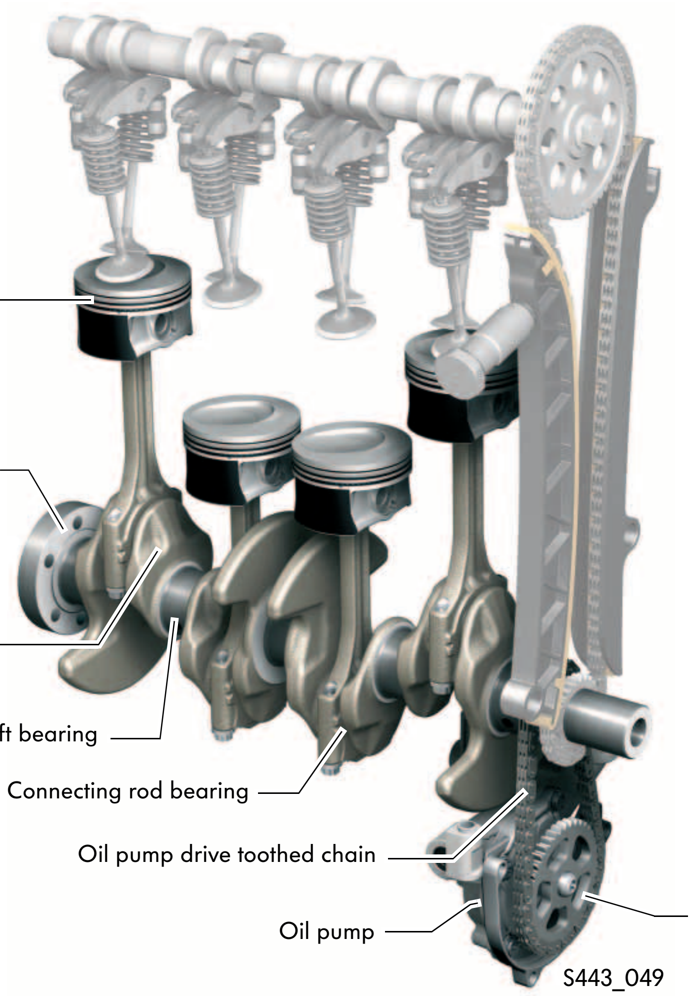
Valve gear

- The valve gear has been switched from 4-valve to 2-valve technology.
- The camshaft bearings have been reduced in size to further reduce friction and weight.
- The 2-valve technology has enabled the tensioning and guide rails to be designed with low-friction, large radii.

The camshaft is driven via a maintenance-free chain drive. The chain is tensioned by a hydraulic chain tensioner. This presses the tensioning rail against the chain below the camshaft sprocket. The guide rail located opposite the tensioning rail prevents the chain from vibrating too extensively.

Crankshaft drive

- The diameters of the crankshaft and the connecting rod bearings have been reduced to 42 mm.
- The widths of the crankshaft and connecting rod bearings have been reduced to increase the stiffness of the crankshaft.
- The webs are designed wider in the area of the crankshaft where balance is critical.
- The piston rings provide lower tangential stress.



The oil pump is also driven via a maintenance-free toothed chain.

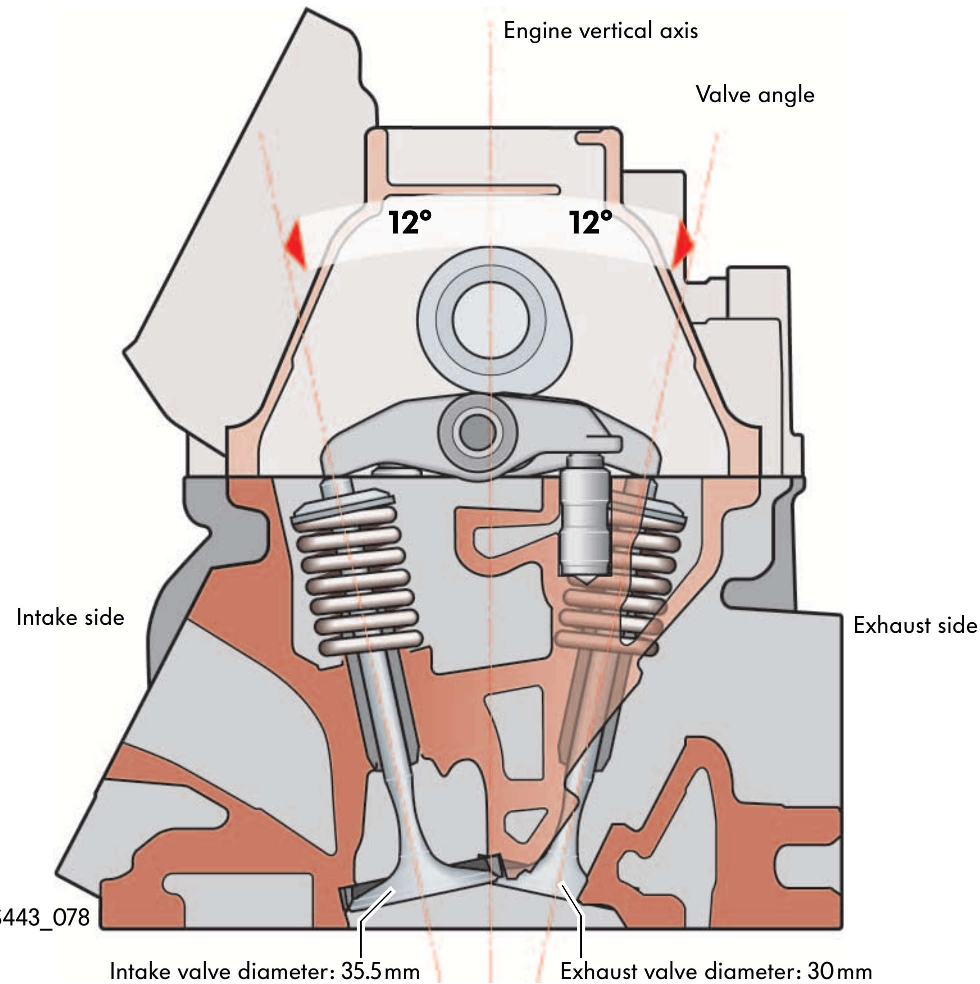
Cylinder head with two-valve technology

The switch from four- to two-valve technology reduces friction and weight. However, this also necessitates a new injector and spark plug arrangement. Experience obtained with direct injection in the TSI engine family enabled the requirements relating to mixture preparation, charge movement and combustion speed to be defined for this engine are transferred to the layout of a two-valve combustion process with fixed valve timing.

The technical features of the cylinder head are:

- Valves are each inclined at an angle of 12° from the engine's vertical axis
- Long-stroke design of the pistons with a stroke of 75.6 mm and a bore diameter of 71 mm increases charge movement during the intake and exhaust stroke
- Valve head diameter of the intake valves 35.5 mm and exhaust valves 30 mm
- Sodium-filled exhaust valves

The high-pressure injectors are installed on the intake side and the spark plugs on the exhaust side.



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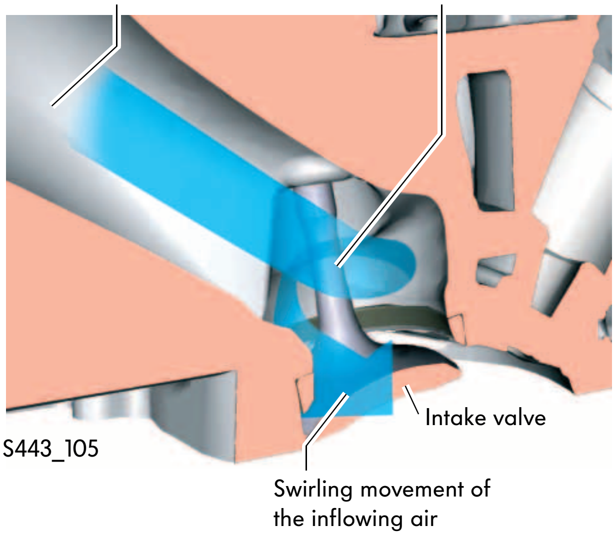
Swirl port

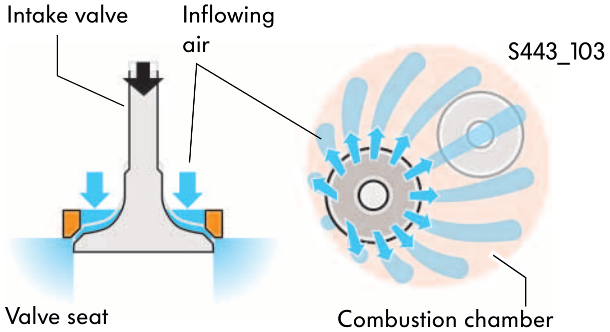
As a result of the two-valve technology, a new swirl combustion process was developed to achieve very good mixture formation.
In this case, the intake port is designed in such a way that the fresh air flows into the cylinder in a rotating motion. Together with valve masking, this therefore results in pronounced swirling of the inflowing air throughout the entire combustion chamber between the piston crown recess and the roof of the combustion chamber. This results in efficient mixture formation and spread in the combustion chamber, low ignition delay, a high combustion speed and high knock resistance.



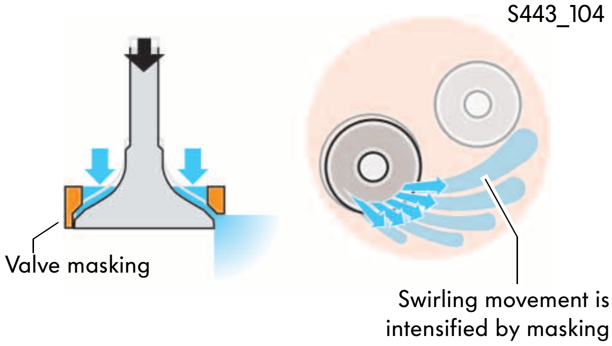
Intake valves

The intake valve seats have a special design (valve masking). This ensures that, in the case of slower valve strokes, the air is only able to flow into a certain area in the cylinder. In this case, it is conducted towards the cylinder wall in such a way that increased swirling and a higher flow speed are created. The formation of a homogeneous fuel/air mixture in the combustion chamber is obtained.

Flow behaviour without masking



Flow behaviour with masking

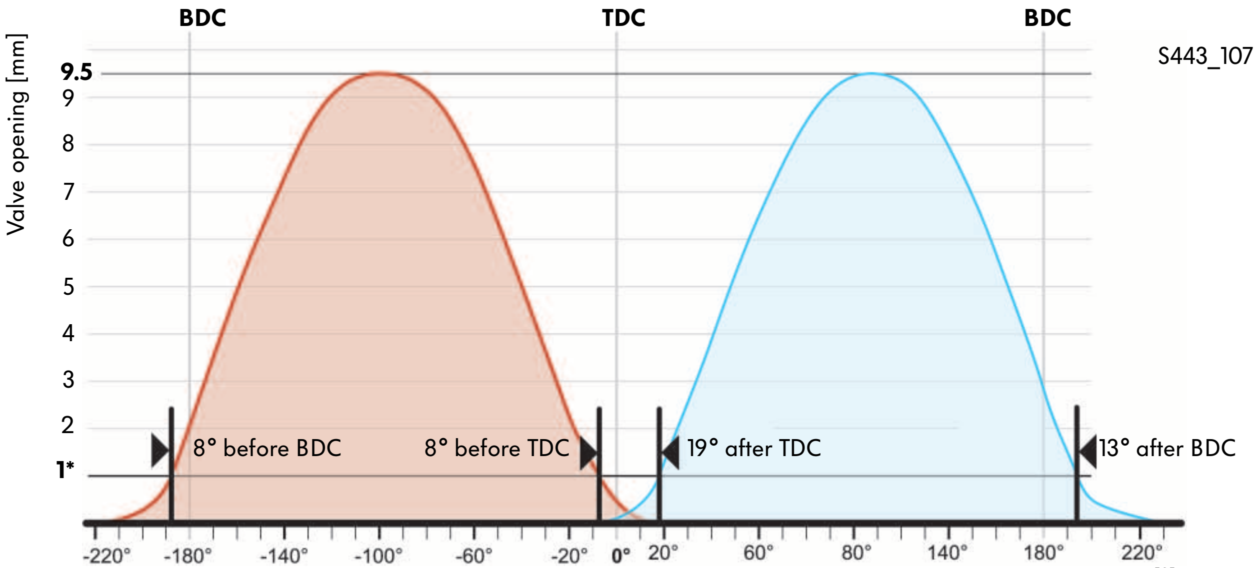


Engine mechanics

Valve timing

Attention was paid to the following objectives when determining the valve timing:

- Great running smoothness during idling
- Good full throttle acceleration at low engine speeds
- Little gas cycle losses



* The valve timing refers to valve opening of 1mm.

Measures

- Low valve overlap is required for good running smoothness during idling and during twin injection in the case of catalytic converter heating. This prevents the emitted exhaust gases from being drawn in again and deteriorating mixture formation.
- In order to prevent emitted exhaust gas from being drawn in by the cylinder which is engaged in the intake stroke, the exhaust valves are opened over a crank angle range of 180°. As a result of this, the exhaust valves of the emitting cylinder are closed in good time and the residual gases in the cylinder during the intake stroke are further reduced.
- To achieve good full throttle acceleration at low engine speeds, the intake valves are opened over a range of approx. 175°. This ensures that the intake valve is closed before the fresh gas is forced out again by the rising piston.
- In order to intake as much fresh gas as possible into the cylinders, the valve lift has been increased from 9 mm to 9.5 mm in comparison with the 1.4l 90kW TSI engine.

High-pressure injectors

The high-pressure injectors also exert a significant influence on mixture formation.
For example, the smaller the droplet size of the injected fuel is, the faster it is mixed with the fresh air flowing in.
The injection pressure is between 40 bar and 125 bar.

The variables which influence mixture formation are:

- The number and orientation of the injection jets
- Injection pressure
- Injection period
- Droplet size

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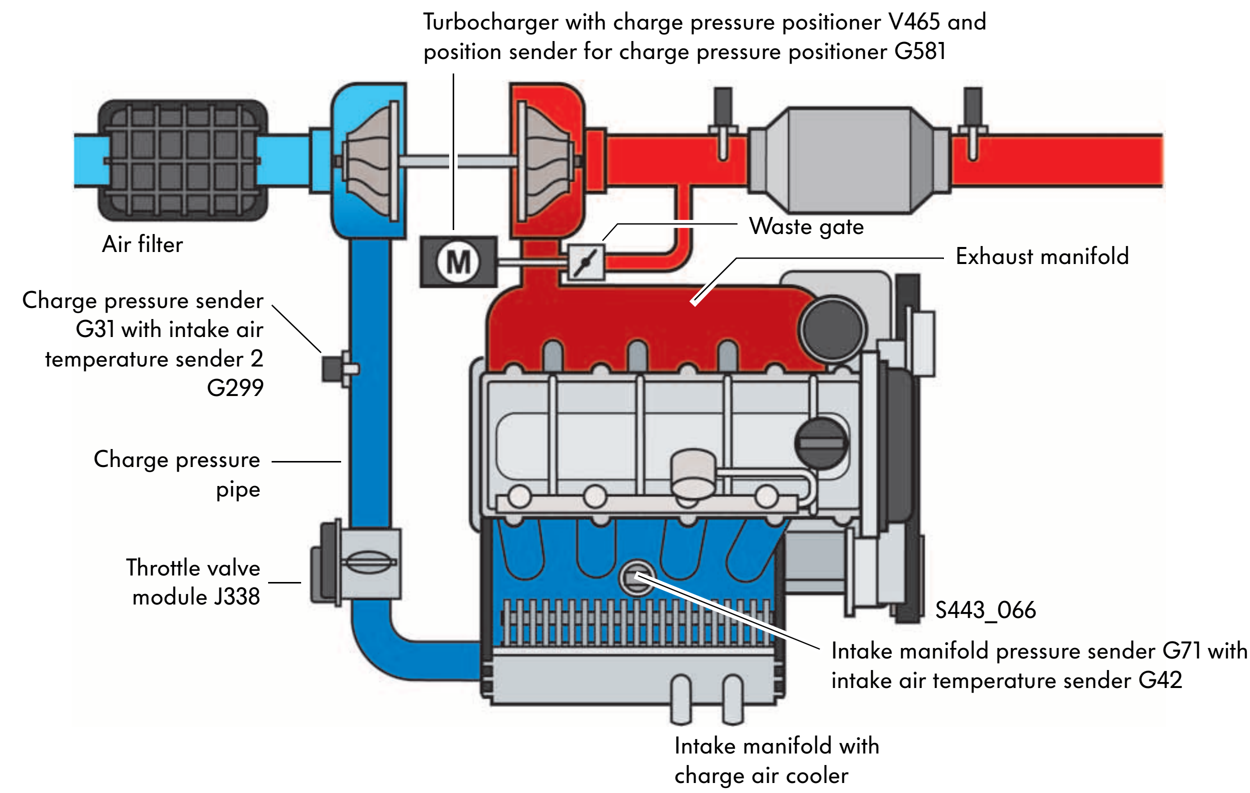
The six individual jets of each injector are arranged in such a way than optimal spatial orientation occurs. This guarantees fast and efficient mixing with the air flowing in from the swirl port.

Single-charging with turbocharger

Charge air route

As the driving impression gained in the case of a forced induction design depends extensively on the response of the turbocharger, the intake manifold volume was reduced. As a result of this, the turbocharger has to compress a smaller volume, and the necessary charge pressure is achieved faster.
As in the case of the 1.4l 90kW TSI engine, liquid-cooled charge air cooling is also implemented in this engine. In this case, the charge air is cooled by a charge air cooler, through which coolant flows, located in the intake manifold.



Differences in comparison with the 1.4l 90kW TSI engine

The charge pressure is regulated via an electric charge pressure positioner.
The charge pressure control solenoid valve N75, the vacuum unit and the turbocharger air recirculation valve N249 have been omitted.

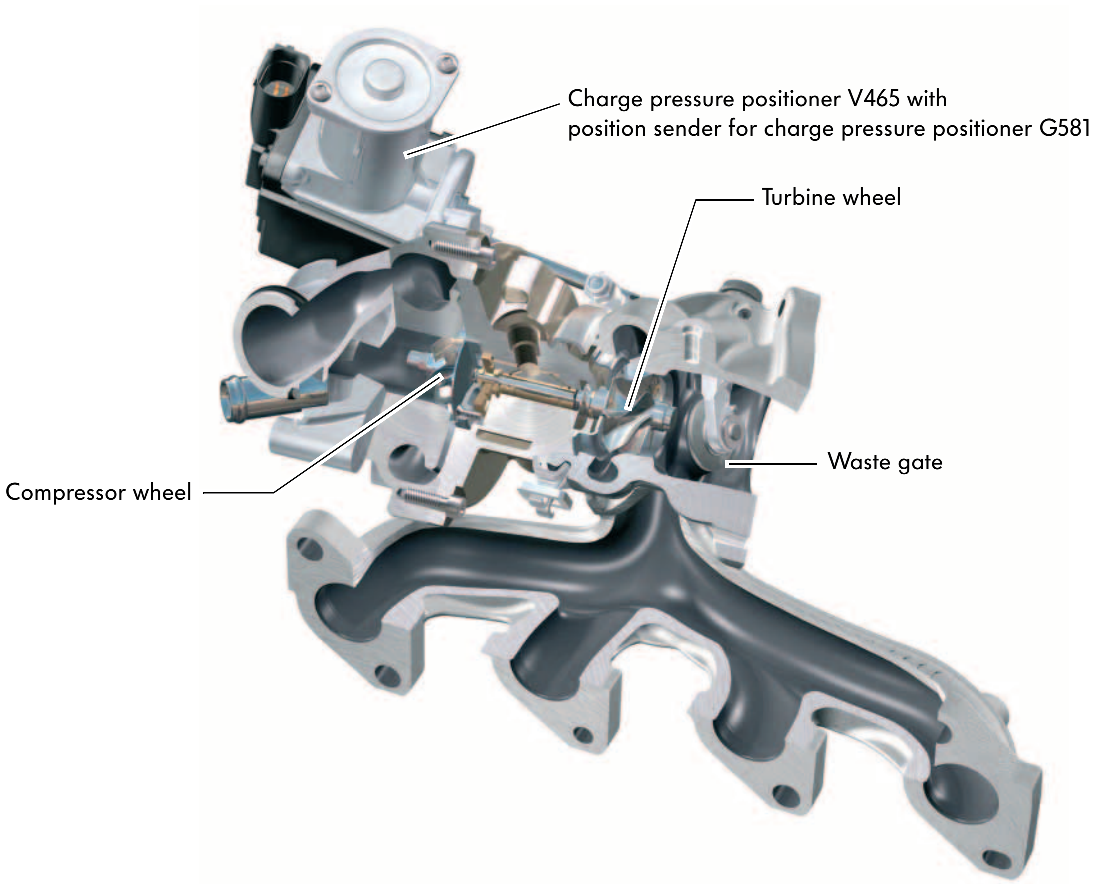
Thanks to the rapid response of the electric charge pressure positioner, the waste gate is opened rapidly in overrun mode, thereby reducing turbocharger pulsing.

Turbocharger module with electric charge pressure positioner

The requirements made on the turbocharger in this engine are particularly high, to ensure typical TSI performance such as rapid response and high torque at low engine speeds.

In addition to reducing the size of the intake manifold, further measures were also carried out on the turbocharger in order to achieve the required performance:

- The angle at which the exhaust gas flows onto the turbine wheel was designed so that the turbine wheel's moment of inertia is overcome as easily as possible and the turbine wheel therefore reaches a high speed faster.
- The waste gate is adjusted via an electric charge pressure positioner, which offers very fast response and a high actuation force.



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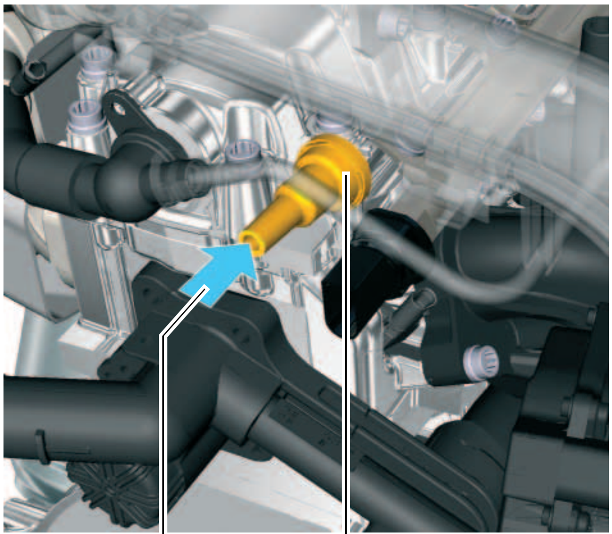
Crankcase breather and ventilation system

Crankcase breather system

The crankcase breather system allows the crankcase to be flushed through and 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.

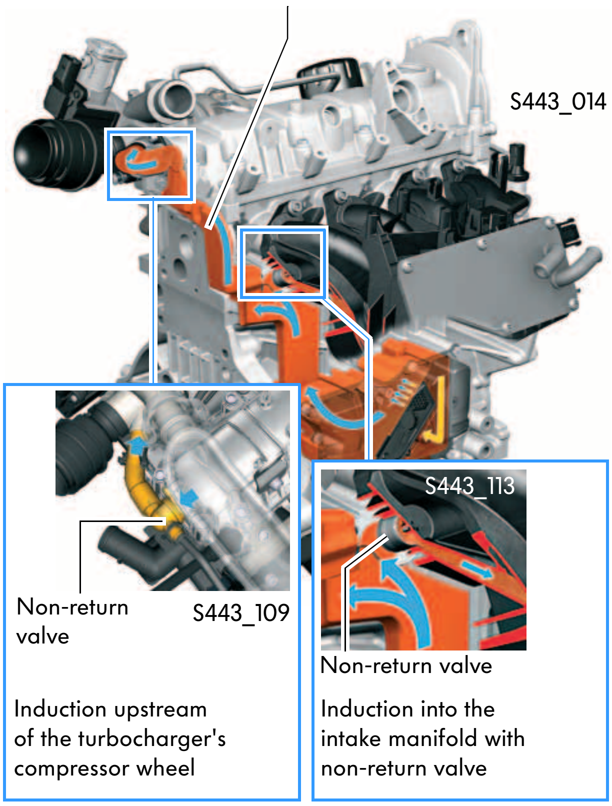
A non-return valve guarantees a continuous supply of air and prevents any blow-by gases from being extracted directly without filtering. In addition, the non-return valve is designed in such a way that it opens in the event of excess pressure in the crankcase. This prevents damage to gaskets as a result of excess pressure.



Crankcase ventilation system

Unlike in the 1.4l 90kW TSI engine, an internally routed crankcase ventilation system is used.
A plastic oil separator is bolted onto the cylinder block. In this, the oil is separated from the gases and drips back into the oil sump. The gases now flow from the cylinder block to the cylinder head.
Depending on where the highest vacuum is present, they are conducted directly into the intake manifold or flow on to the cylinder head cover up to the turbocharger's compressor wheel. This internal routing of the gases prevents the crankcase ventilation system from freezing.

Internal routing of the gases through the cylinder block, cylinder head and cylinder head cover

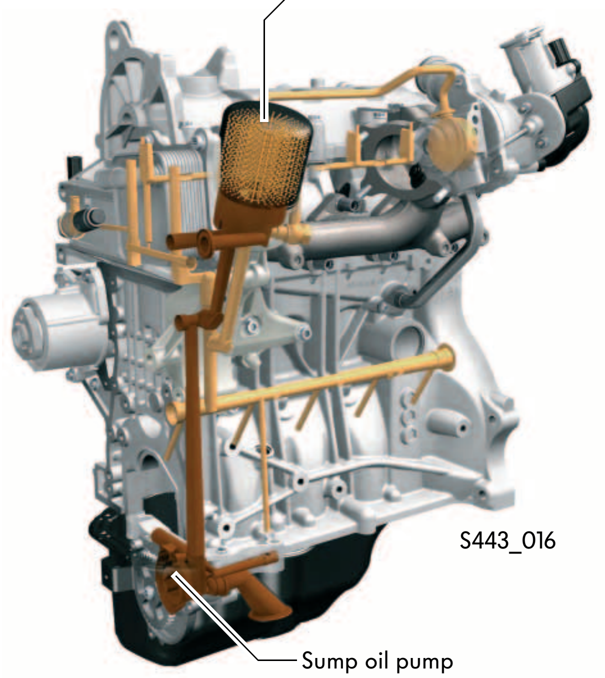


Oil supply

Oil circuit

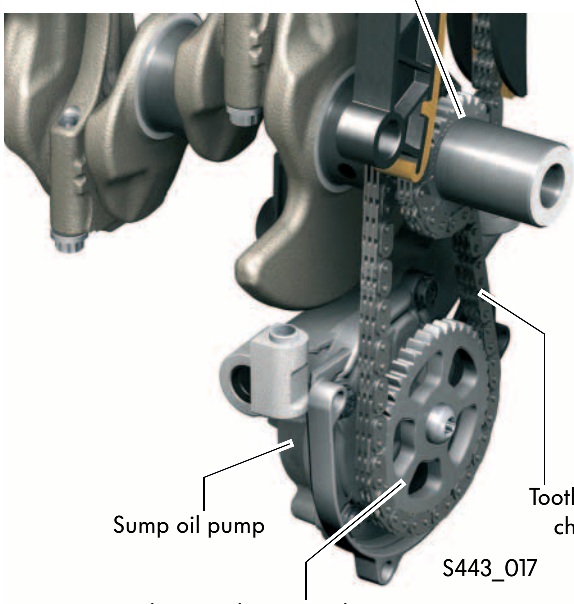
The reduced dimensions of the main and connecting rod bearings and the 2V valve gear with just one camshaft lead to a significant reduction in the engine's oil requirements.
This enables a smaller oil pump to be installed and allows the mean level of operation required to be reduced by approx. 50% in comparison with the regulated oil pump.

Pressure regulation is carried out by a pressure control valve downstream of the oil filter. This ensures that sufficient oil pressure is always available in the engine irrespective of how much the oil filter is blocked.



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.
To minimise friction, it is designed as a sump oil pump and is driven at low speed (gear ratio = 1 : 0.6).



Cooling systems

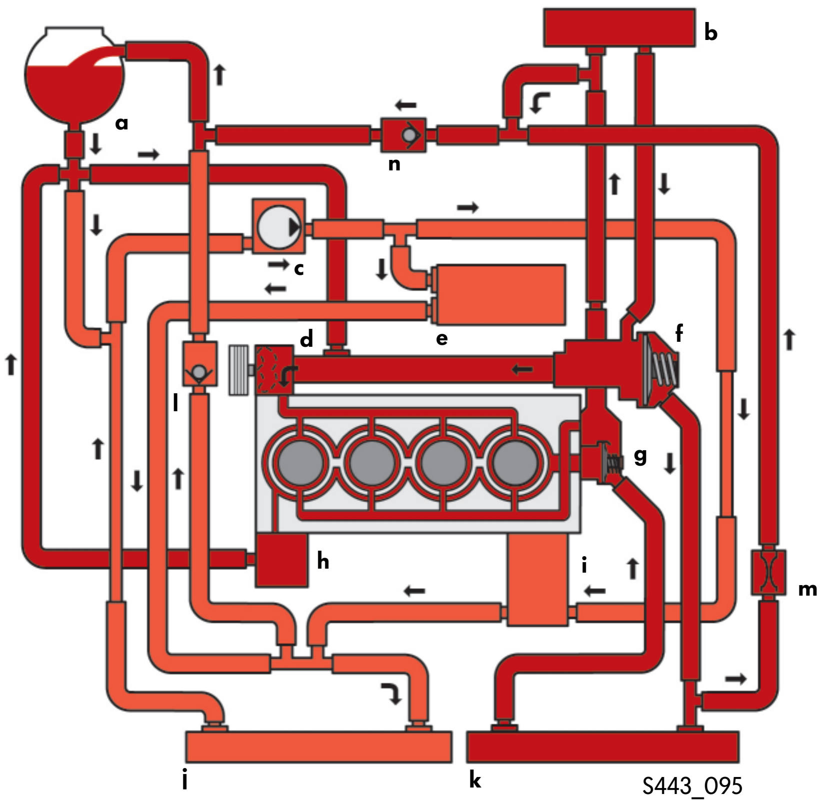
As in the case of the 1.4l 90 kW TSI engine, this engine also has two cooling systems which are independent of each other, with the exception of two connections. One system cools the engine as normal, and a second one cools the charge air. These connections enable the use of a common expansion tank.
The temperature difference between the engine cooling system and the charge air cooling system can be up to 100°C.

Special features of engine cooling system

- Mechanical coolant pump which can be shut off
- Dual-circuit cooling system for different coolant temperatures in the cylinder head and cylinder block

Special features of charge air cooling system

- Electric coolant circulation pump
- Liquid-cooled charge air cooler in the intake manifold



Legend

a Expansion tank
b Heat exchanger for heating system
c Coolant circulation pump V50
d Mechanical coolant pump which can be shut off
e Charge air cooler in the intake manifold
f Thermostat 1 from the cylinder head
g Thermostat 2 from the cylinder block
h Oil cooler
i Turbocharger
j Additional charge air system cooler
k Radiator
l Non-return valve
m Restrictor

Engine cooling system
Charge air cooling system

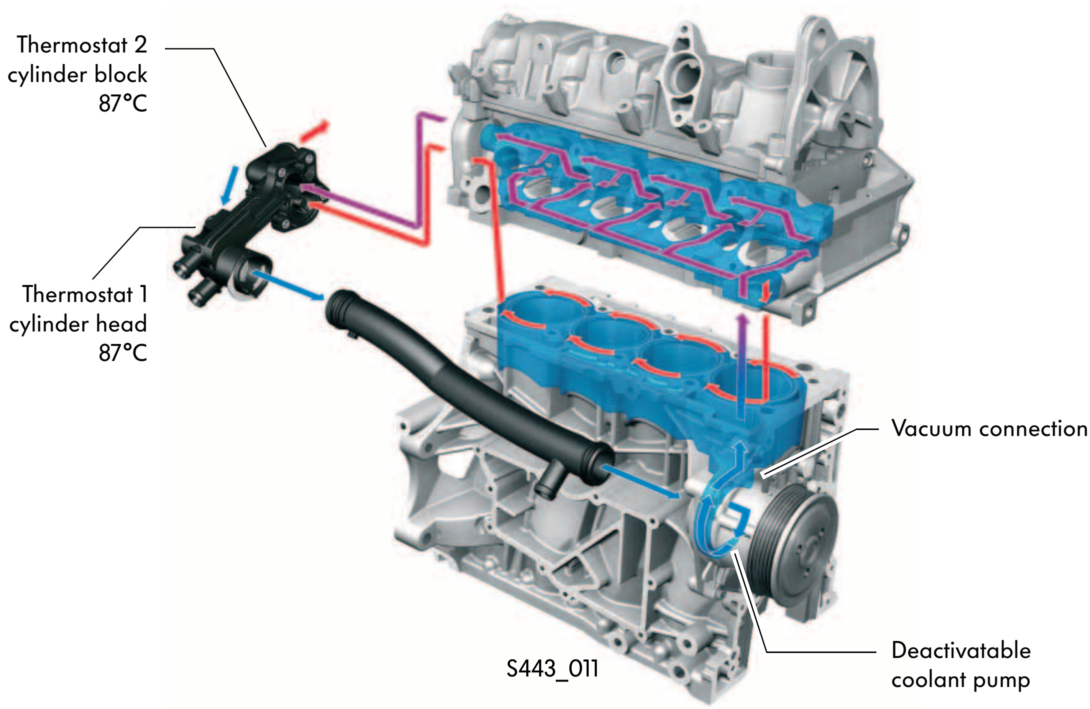
The charge air cooling circuit has to be bled each time after being opened to ensure its cooling performance. The system is bled either with the cooling system charge unit -VAS 6096- or the guided function "Filling and bleeding cooling system". Please note the instructions in ELSA.

Engine cooling system

The tried-and-tested dual-circuit cooling system is also fitted in this engine. The separate routing of the coolant in the cylinder head and in the crankcase enables cooling to start at different times in both components.
Coolant routing is controlled by two thermostats in the coolant distributor housing.
One thermostat is for the cylinder head and the other, for the cylinder block.

The dual-circuit cooling system has the following advantages:

- The cylinder block warms up faster because the coolant remains in the cylinder block until 87°C is reached. This faster cylinder wall heating reduces hydrocarbon emissions.
- Because the coolant in the cylinder head heats up more quickly than that in the cylinder block, this separate coolant routing enables the combustion chambers to be cooled at an early stage. A better charge, a reduced tendency to knock and fewer nitrogen oxide emissions are achieved as a result.



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Special features of the engine cooling system:

In order to further reduce fuel consumption and therefore CO_2 emissions, the mechanical coolant pump fitted can be deactivated. This does not pump coolant during the warming-up phase. To achieve this, the flow of coolant into the cylinder block and the cylinder head is blocked with a vacuum controlled shutter.

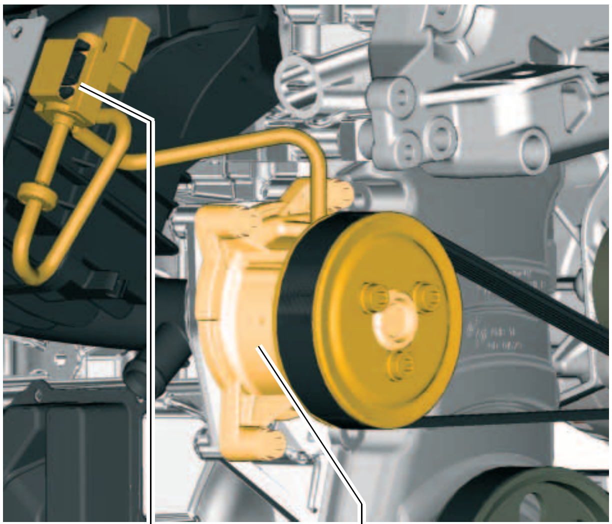
Engine mechanics

Deactivatable coolant pump

So that the engine reaches its operating temperature as quickly as possible, coolant pumping is shut off at a coolant temperature of less than 30°C. The coolant is therefore stationary in the engine and is heated faster. Fuel consumption as well as CO_2 and exhaust emissions are reduced.

Coolant pumping is shut off during engine starting and at a coolant temperature of less than 30°C, and remains shut off during the warm-up phase:

- With "heating system off", until the coolant temperature reaches 90°C and
- With "heating system on", for a duration of up to two minutes.



Coolant regulation valve N513

Coolant pump

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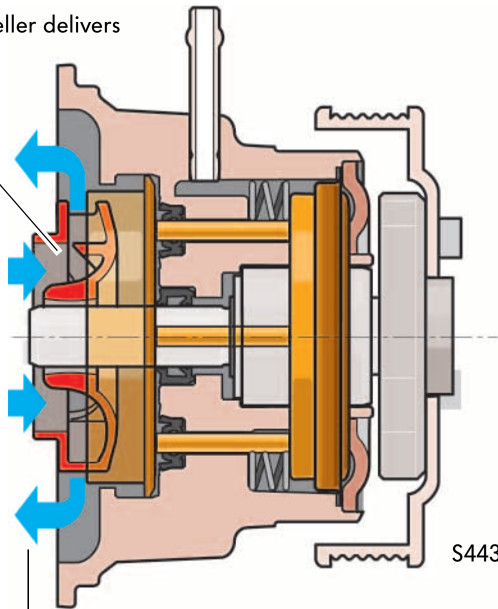
How it works

- The coolant pump is "switched on":

If the engine is started at a coolant temperature of 30°C or higher, the coolant pump is switched on from the beginning.
As in the case of a conventional coolant pump, the coolant is pumped to the cylinder block and the cylinder head.

Impeller delivers



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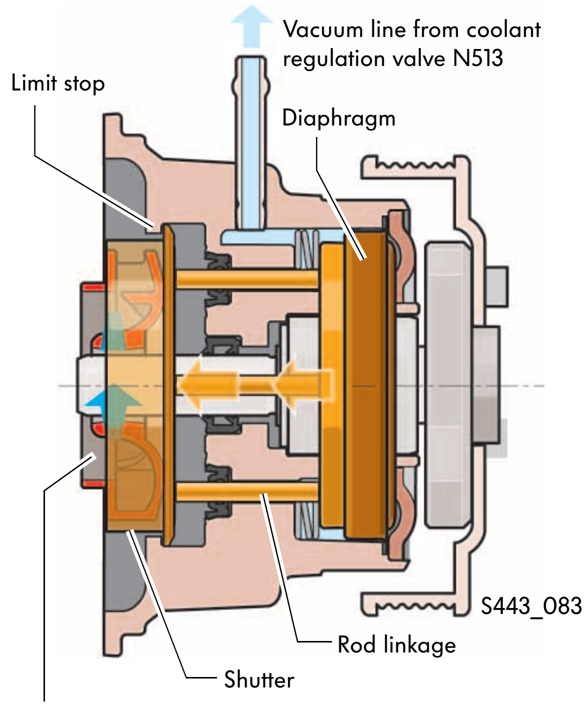
Coolant delivery flow to the cylinder block and the cylinder head

Until the thermostats in the coolant distributor housing open, the coolant remains in the cylinder block. From the cylinder head, it is pumped only in the direction of the heat exchanger, but not to the radiator.

If the coolant temperature is less than 30°C when the engine is started, the coolant pump is "shut off" via the coolant regulation valve.

- The coolant pump is "shut-off":

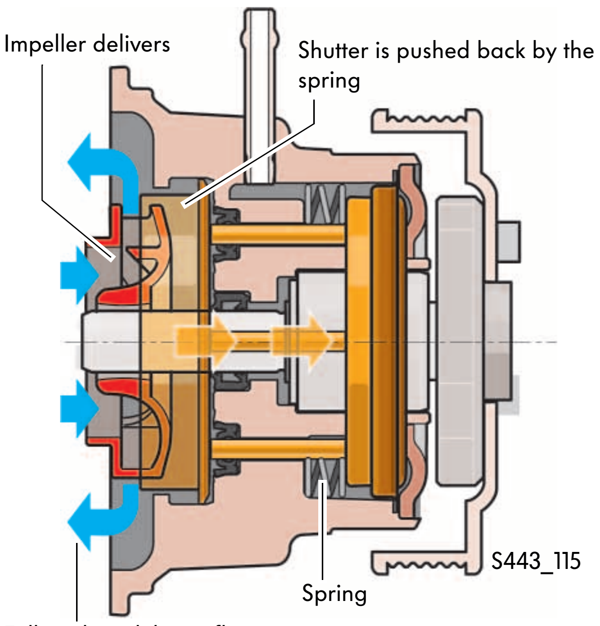
The coolant regulation valve is actuated by the engine control unit and releases the path to the intake manifold. The diaphragm is pulled to the left by the vacuum in the intake manifold. As the shutter and the diaphragm are linked together via a rod, the shutter is pushed over the impeller until it contacts the limit stop. No further coolant is delivered.



The coolant delivery flow is blocked by the shutter.

- The coolant pump is "switched on" again:

To switch on again, the coolant regulation valve is switched on and off several times for one second at intervals of approx. 7 seconds.
This ensures that the hot coolant from the engine is only mixed slowly with the cold coolant.
The coolant pump is switched on immediately when heating is required.
The coolant regulation valve is no longer actuated, the vacuum is dissipated and the spring pushes the shutter back to its initial position.
The impeller is released again and delivers the coolant in the direction of the engine.



Engine management

System overview

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

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

Engine speed sender **G28**

Hall sender **G40**

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

Accelerator position sender **G79** and accelerator position sender 2 **G185**

Position sender for charge pressure positioner **G581**

Clutch position sender **G476**

Brake pedal position sender **G100**

Fuel pressure sender **G247**

Knock sensor **G61**

Coolant temperature sender **G62**

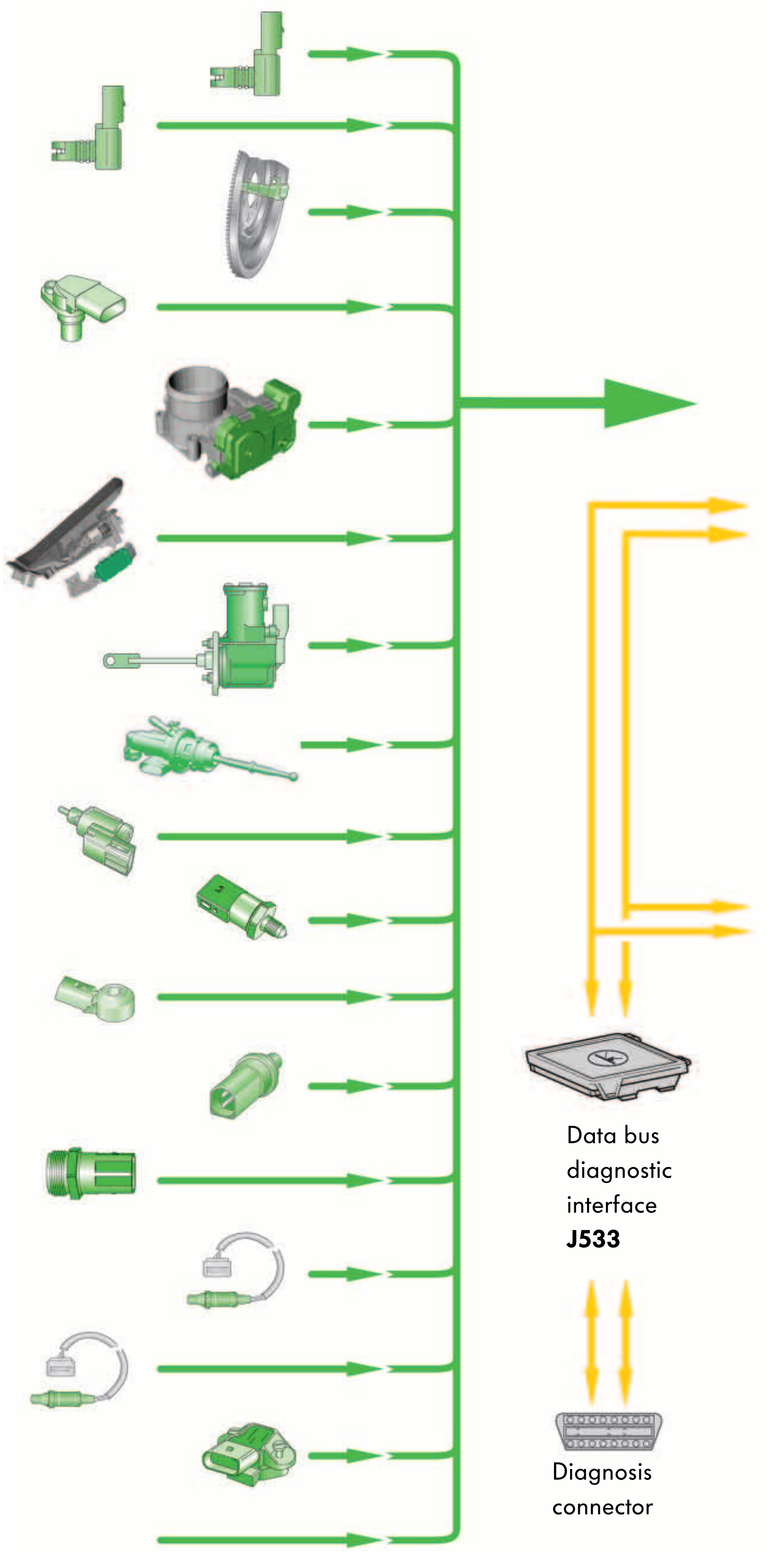
Radiator outlet coolant temperature sender **G83**

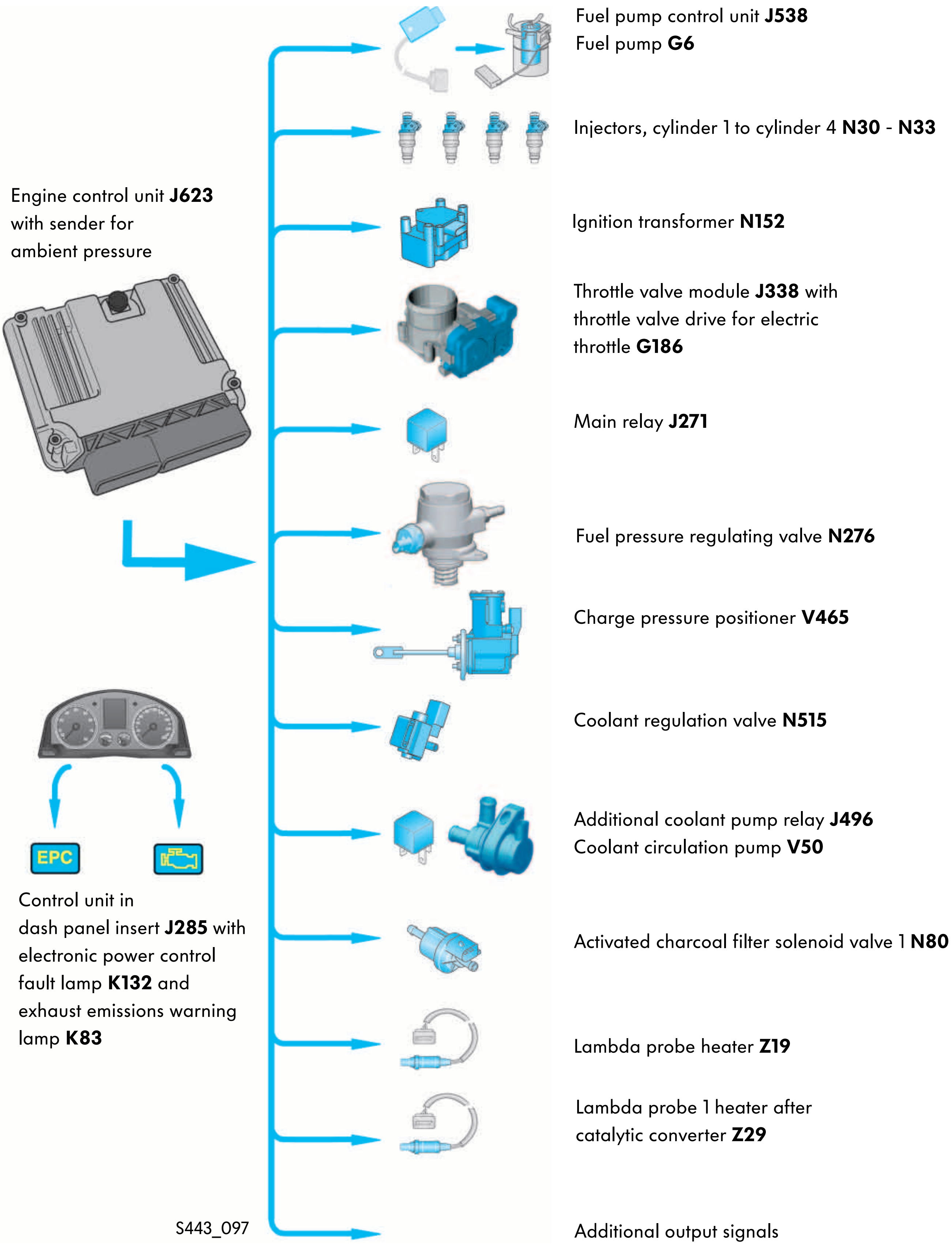
Lambda probe **G39**

Lambda probe after catalytic converter **G130**

Brake servo pressure sensor **G294**

Additional input signals





Engine control unit **J623** with sender for ambient pressure
Control unit in dash panel insert **J285** with electronic power control fault lamp **K132** and exhaust emissions warning lamp **K83**
EPC
Fuel pump control unit **J538**
Fuel pump **G6**
Injectors, cylinder 1 to cylinder 4 **N30** - **N33**
Ignition transformer **N152**
Throttle valve module **J338** with throttle valve drive for electric throttle **G186**
Main relay **J271**
Fuel pressure regulating valve **N276**
Charge pressure positioner **V465**
Coolant regulation valve **N515**
Additional coolant pump relay **J496**
Coolant circulation pump **V50**
Activated charcoal filter solenoid valve 1 **N80**
Lambda probe heater **Z19**
Lambda probe 1 heater after catalytic converter **Z29**
Additional output signals
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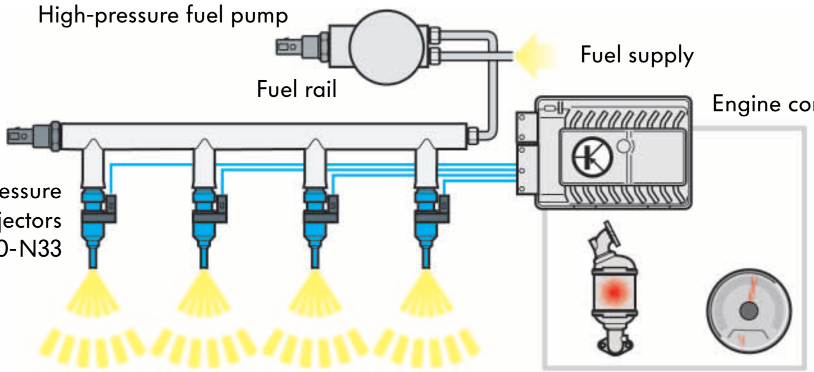
Engine control unit J623

The engine management system which is used is the Simos 10. It contains the same functions as those in the 1.4l 90kW TSI engine.

Twin injection system



Twin injection with catalytic converter heating

The catalytic converter is heated faster with twin injection than with individual injection. Twin injection enables
stable engine running with retarded ignition timing.
Thanks to retarded combustion, the catalytic converter is provided with increased exhaust gas temperatures and pressures.
All of these elements contribute towards reducing emissions and consumption.

The first part of injection, involving 80% of the total volume of fuel, takes place during the intake stroke. This enables even fuel/air mixture processing.

During secondary injection, a small volume of fuel is injected before ignition TDC.

Twin injection up to 3000 rpm

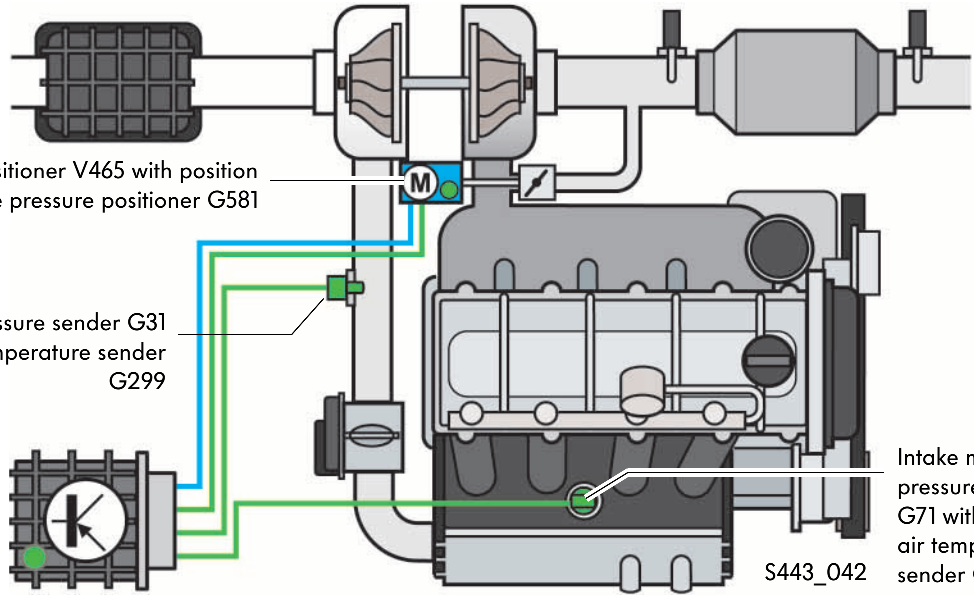
Twin injection from idle speed to full throttle at up to 3000 rpm ensures more even mixture preparation.

Initial injection takes place before ignition TDC during the intake stroke. Depending on the ignition map, 50 - 80% of the total fuel to be injected is injected in this case.

During secondary injection, the remaining volume of fuel is injected at the start of the compression stroke. Less fuel is deposited on the cylinder wall as a result of this. The fuel evaporates almost completely and mixture formation is improved.
In addition, the mixture which occurs in the area of the spark plug is slightly richer than that in the rest of the combustion chamber. This improves the combustion sequence and reduces the tendency to knock.

Charge pressure regulation

The charge pressure regulation system determines the air mass which is compressed by the turbocharger and pumped into the cylinders. Two pressure senders, each with an intake air temperature sender, are installed to ensure that regulation is as precise as possible.



Charge air pressure sender G31 with intake air temperature sender G299

The charge air pressure sender's signal is used to regulate and monitor the charge pressure. Based on the intake air temperature sender signal, the charge pressure is reduced to protect the components in the event of an excessive temperature.

Intake manifold pressure sender G71 with intake air temperature sender G42

The signals from the intake manifold pressure sender and the intake air temperature sender are used by the engine control unit to calculate the air mass in the intake manifold downstream of the charge air cooler. Depending on the calculated air mass, the charge pressure is adapted according to the ignition map and increased to up to 2.1 bar (absolute).

The intake air temperature sender signal is used as a correction value for the charge pressure, as the temperature influences the density of the charge air.

Ambient pressure sender

The ambient pressure sender in the control unit measures the ambient air pressure. This is used as a correction value for charge pressure regulation, as the density of the air drawn in decreases as the altitude increases.

Charge pressure positioner V465 with position sender for charge pressure positioner G581

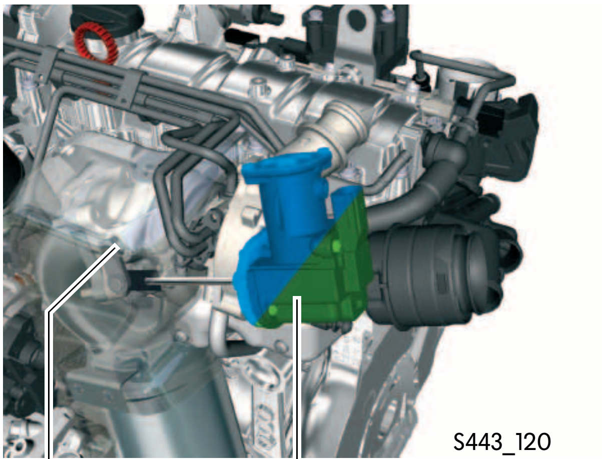
The charge pressure positioner is part of the turbocharger.

Task

It serves to regulate the charge pressure.

The advantages of the electric charge pressure positioner in comparison with the pneumatic charge pressure control solenoid valve are:

- A fast adjustment time and therefore faster charge pressure build-up
- A high actuation force, as a result of which the waste gate remains securely closed, even in the case of high exhaust gas mass flows, in order to achieve the nominal charge pressure.
- The waste gate can be actuated independently of the charge pressure. As a result of this, the waste gate can be opened in the lower load/engine speed range. The basic charge pressure is reduced and the engine has to carry out less gas cycle work.



S443_120

Waste gate

Charge pressure positioner V465 with position sender for charge pressure positioner G581

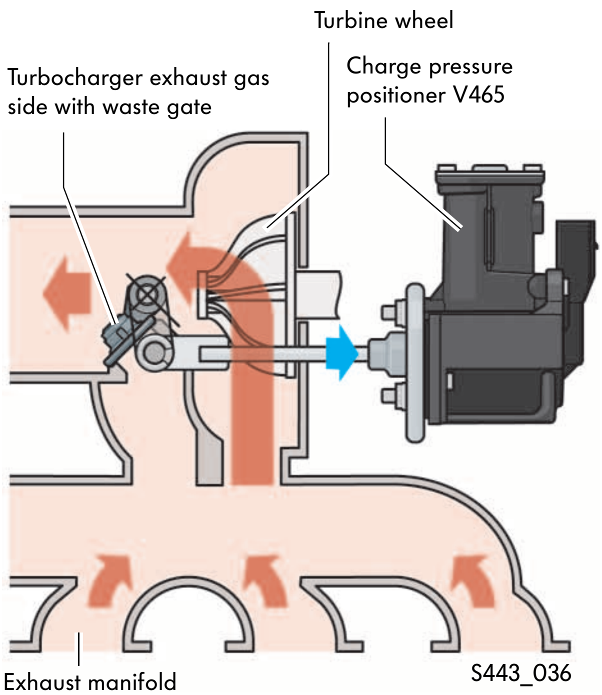
Effect in the event of failure

In the event of an electrical failure, the waste gate is pushed open by the exhaust gas mass flow.
In the event of a mechanical failure, the waste gate is opened by the electric charge pressure positioner or the throttle valve is closed accordingly.
Charge pressure is not built up in either case.

How it works

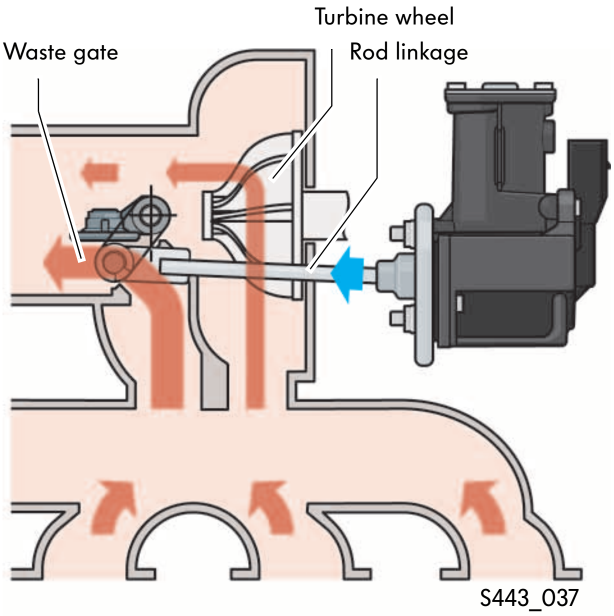
Depending on the torque requirement, the engine control unit calculates the nominal charge pressure needed to deliver the necessary air mass into the cylinder.
The waste gate remains closed until this nominal charge pressure has been attained. The entire exhaust gas flow is therefore conducted towards the turbine wheel and drives it. The turbine wheel is connected to the compressor wheel on the fresh air side via a common shaft. This compresses the air which was drawn in until the nominal charge pressure is achieved.

Waste gate closed



Once the nominal charge pressure has been achieved, the waste gate is regulated to the position required for the nominal/actual charge pressure.
If the waste gate is opened further, for example, part of the exhaust gas flow flows past the turbine wheel. The rotational speed of the turbine and the compressor wheel is reduced as a result of this. The air which is drawn in is no longer compressed so extensively, and the charge pressure is reduced.
The engine control unit calculates the necessary waste gate adjustment travel via the rod linkage on the basis of the actual and the nominal charge pressure.
The charge air pressure sender G31 measures the actual charge pressure.

Waste gate open

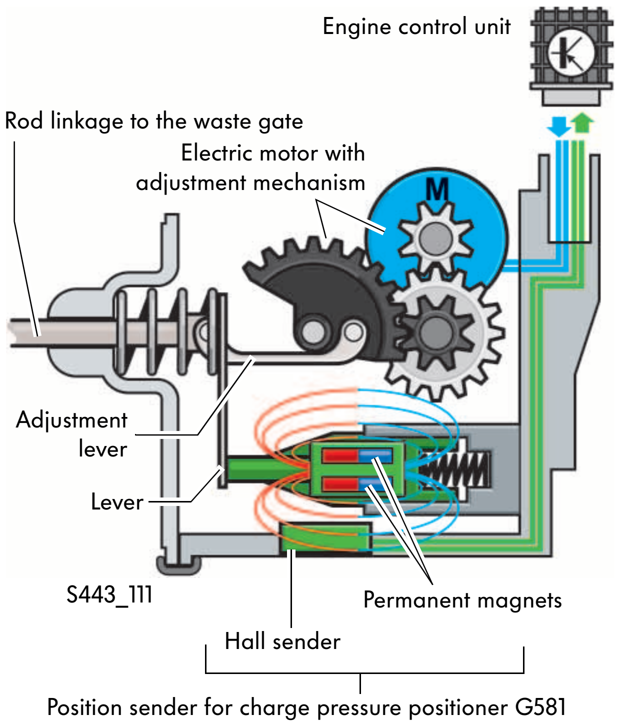


Regulation sequence

The engine control unit calculates the necessary nominal charge pressure from the torque request.
If the actual charge pressure deviates from the nominal charge pressure, the waste gate is opened further (charge pressure decreases) or is closed further (charge pressure increases). In the starting position, the waste gate is closed.

Waste gate closed/open

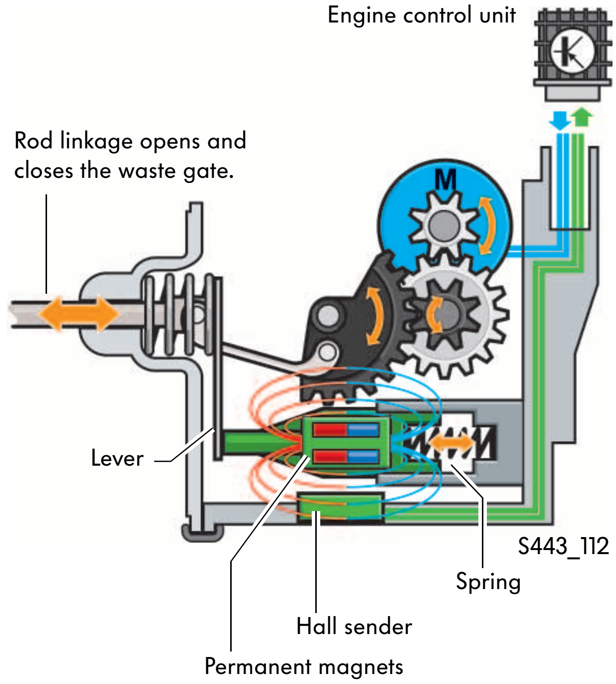
In order to achieve the nominal charge pressure, the engine control unit calculates the necessary waste gate position and actuates the electric charge pressure positioner with a PWM signal.
The position sender for charge pressure positioner is installed in the charge pressure positioner in order to enable the necessary waste gate position and therefore the nominal charge pressure to be set. This is a Hall sender, which is connected to the adjustment mechanism via a lever.



S443_111

A spring is used to press the permanent magnets against a lever, which moves together with the rod linkage. As a result of this, the two magnets slide past the Hall sender each time the waste gate is adjusted.

Based on the magnetic field strength, the sensor electronics or the engine control unit detect the position of the adjustment mechanism and therefore the position of the waste gate.



S443_112

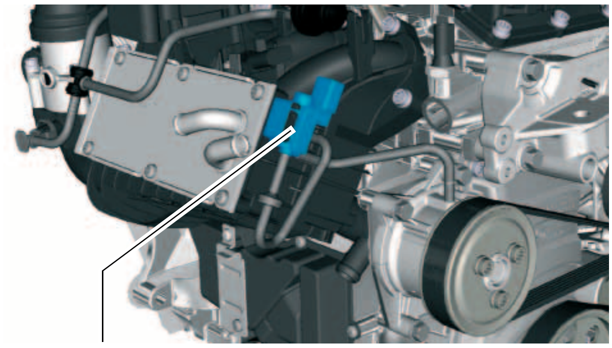
Actuators

Coolant regulation valve N513

The valve is bolted onto the side of the intake manifold on the engine's poly-V belt side.

Task

The coolant regulation valve is actuated with a PWM signal by the engine control unit. It opens the path to the engine's vacuum system.
The coolant pump is switched on and off using the vacuum from the intake manifold.



Coolant regulation valve N513 S443_116

Effect in the event of failure

If the valve fails, the coolant pump is no longer switched on and off as required.

If the coolant pump is switched on, it takes longer for the engine to reach its operating temperature.

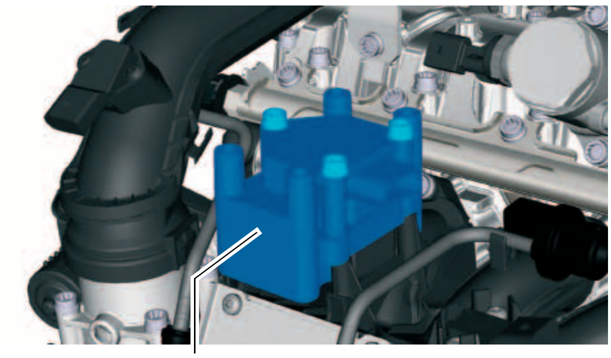
If it is shut off, the shutter is pressed into its initial position by springs. If this is not possible, the coolant temperature increases to a very high level, as the coolant pump does not circulate coolant.
The coolant temperature and coolant shortage warning lamp K28 is switched on.

Ignition transformer N152

The ignition transformer for the electronic ignition is bolted onto the ignition manifold.

Task

The ignition transformer has the task of igniting the fuel/air mixture below the spark plugs at the correct point in time. The ignition timing is controlled individually for each cylinder.

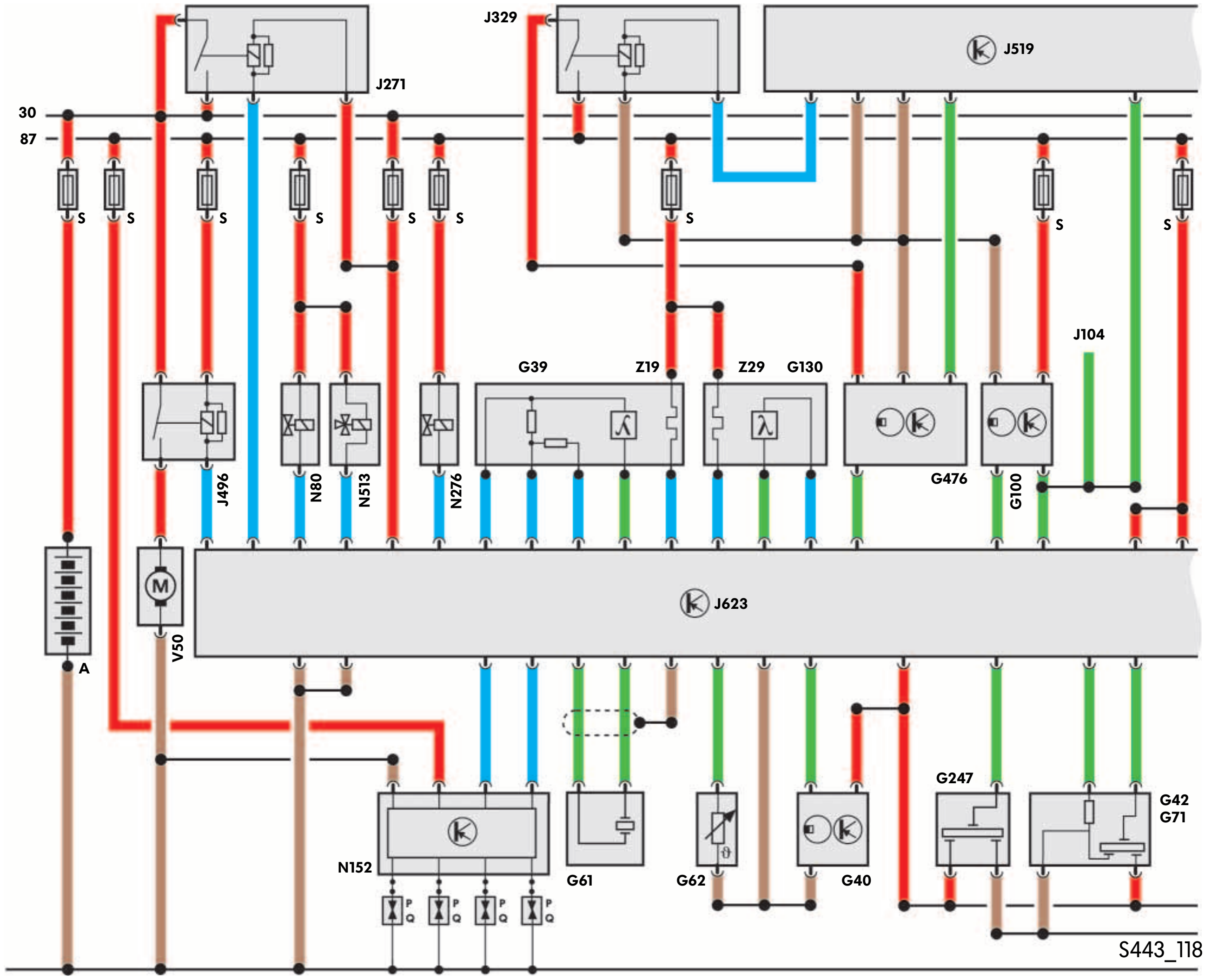


Ignition transformer N152 S443_077

Effect in the event of failure

If the ignition transformer fails, the engine is shut-off. An entry is written into the engine control unit's fault memory and the exhaust emissions warning lamp is switched on.

Functional diagram

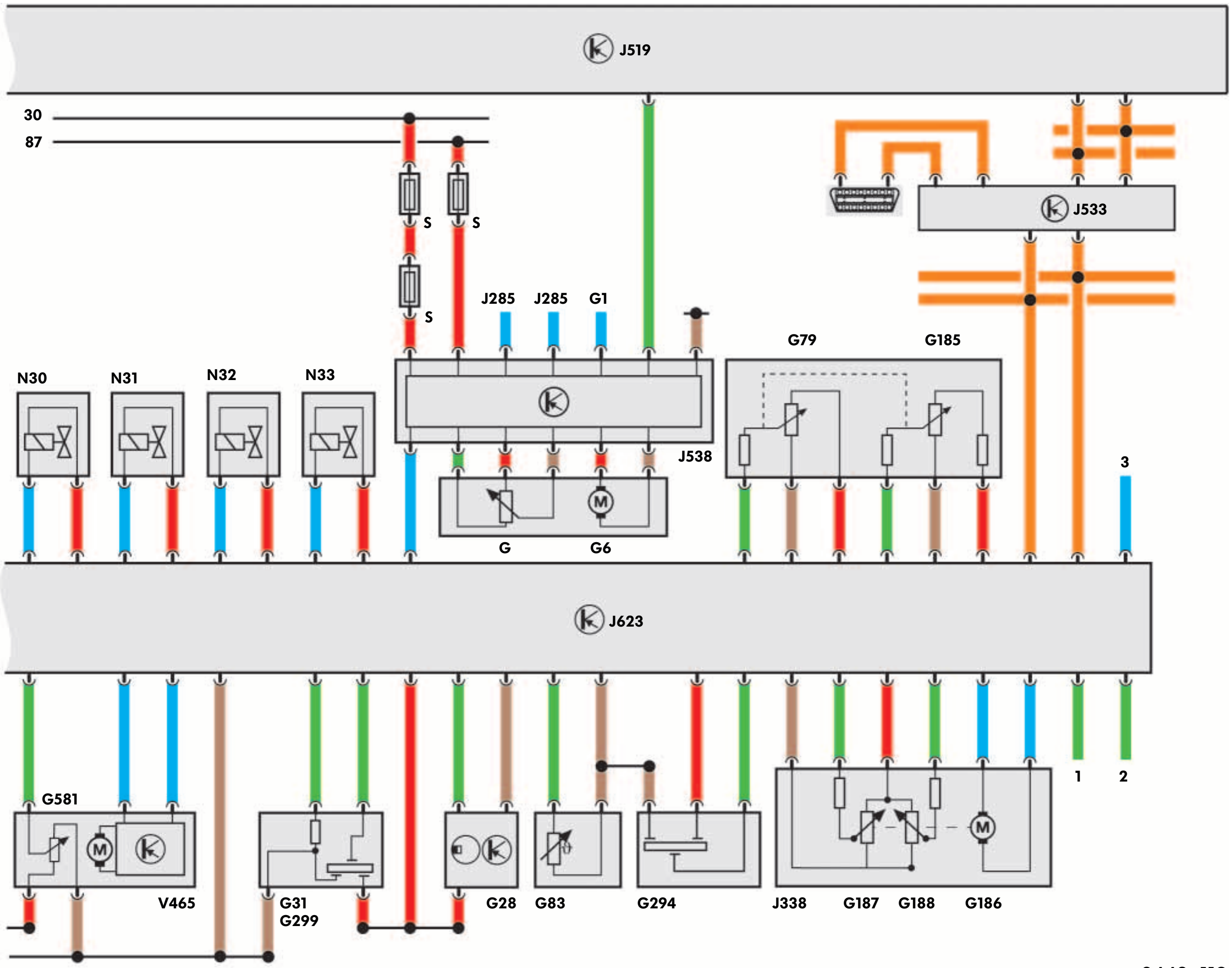


S443_118

A Battery

G Fuel gauge sender
G1 Fuel gauge
G6 Fuel system pressurisation pump
G28 Engine speed sender
G31 Charge air pressure sender
G39 Lambda probe
G40 Hall sender
G42 Intake air temperature sender
G61 Knock sensor 1
G62 Coolant temperature sender
G71 Intake manifold pressure sender
G79 Accelerator position sender
G83 Radiator outlet coolant temperature sender
G100 Brake pedal position sender
G130 Lambda probe after catalytic converter
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
G247 Fuel pressure sender
G294 Brake servo pressure sensor
G299 Intake air temperature sender 2
G476 Clutch position sender
G581 Position sender for charge pressure positioner

J104 ABS control unit
J271 Motronic current supply relay
J285 Control unit in dash panel insert



S443_119

J329 Terminal 15 voltage supply relay
J338 Throttle valve module
J496 Additional coolant pump relay
J519 Onboard supply control unit
J533 Data bus diagnostic interface
J538 Fuel pump control unit
J623 Engine control unit

N30 - Injectors, cylinders 1 - 4
N33
N80 Activated charcoal filter solenoid valve 1
N152 Ignition transformer
N276 Fuel pressure regulating valve
N513 Coolant circuit solenoid valve

Q Spark plugs

R Spark plug connector

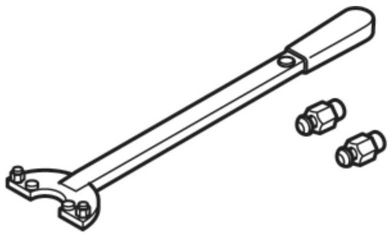
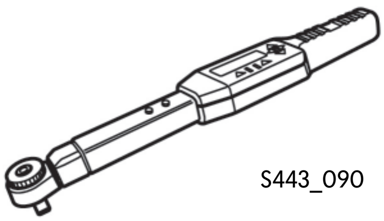
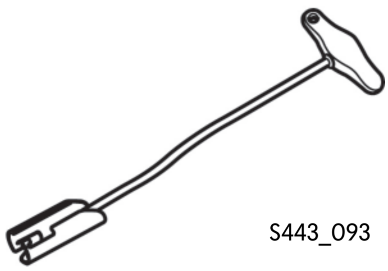
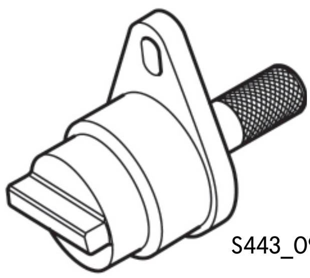
V50 Coolant circulation pump
V465 Charge pressure positioner

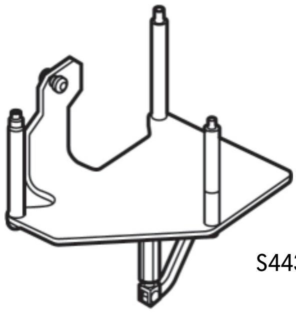
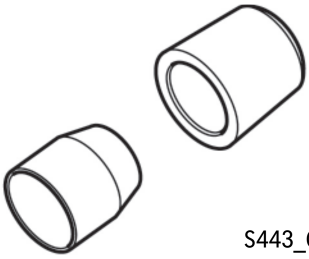
Z19 Lambda probe heater
Z29 Lambda probe 1 heater after catalytic converter

1 Alternator terminal 0FM
2 Cruise control system switch
3 Radiator fan stage 1

Positive
Earth
Output signal
Input signal
CAN data bus

Special tools

Designation	Tool	Application
Counter-hold tool 3415 with adapter 3415/2	 S443_092	The counter-hold tool and the adapter are used to hold the belt pulley and to loosen or tighten the belt pulley securing bolt.
Torque wrench (angle controlled) VAS 6583	 S443_090	The angle-controlled torque wrench is used e.g. to tighten the bolts for the upper and lower timing case.
Puller T10112A	 S443_093	The puller is used to pull the spark plug connectors off the spark plugs.
Locking pin T10414	 S443_091	The locking pin is used to lock the camshaft.

Designation	Tool	Application
Engine bracket T10416	 S443_089	The engine bracket enables the engine and the gearbox to be lowered.
Assembly device T10417	 S443_094	The assembly device is used to fit the seal on the crankshaft's belt pulley end.

Test yourself

Which answer is correct?

One or several of the given answers may be correct.

1. Which statement about the mechanical coolant pump is correct?

☐ a) The mechanical coolant pump has been omitted. The electric coolant circulation pump V50 has taken over its task.

☐ b) The mechanical coolant pump has been replaced by an electric coolant pump. This is not switched on when the engine is started, as a result of which the cold engine heats up faster.

☐ c) The mechanical coolant pump is shut-off when cold-starting the engine, as a result of which the cold engine heats up faster.

2. Which statement on the crankcase breather system is correct?

☐ a) Crankcase breathing is carried out from the cylinder block into the intake manifold via a hose.

☐ b) Crankcase breathing is carried out internally, and the gases are conducted into the intake manifold or upstream of the turbocharger's compressor wheel depending on the vacuum conditions.

☐ c) Crankcase breathing is carried out internally via the cylinder block, where it is conducted into the intake manifold.

3. How is charge pressure control carried out?

☐ a) Charge pressure control is carried out via the charge pressure control solenoid valve N75 and a vacuum unit.

☐ b) Charge pressure control is carried out via the electric charge pressure positioner V465 and the position sender for charge pressure positioner G581.

☐ c) Charge pressure control is carried out via the regulating flap control unit J808.

4. Which statement on the timing case is correct?

☐ a) The timing case is designed in one piece.

☐ b) The timing case is designed in two pieces. The timing case upper part and the timing case lower part are manufactured from plastic.

☐ c) The timing case is designed in two pieces. The upper part of the timing case is manufactured from plastic, and
the lower part is manufactured from magnesium and is secured using special aluminium bolts.

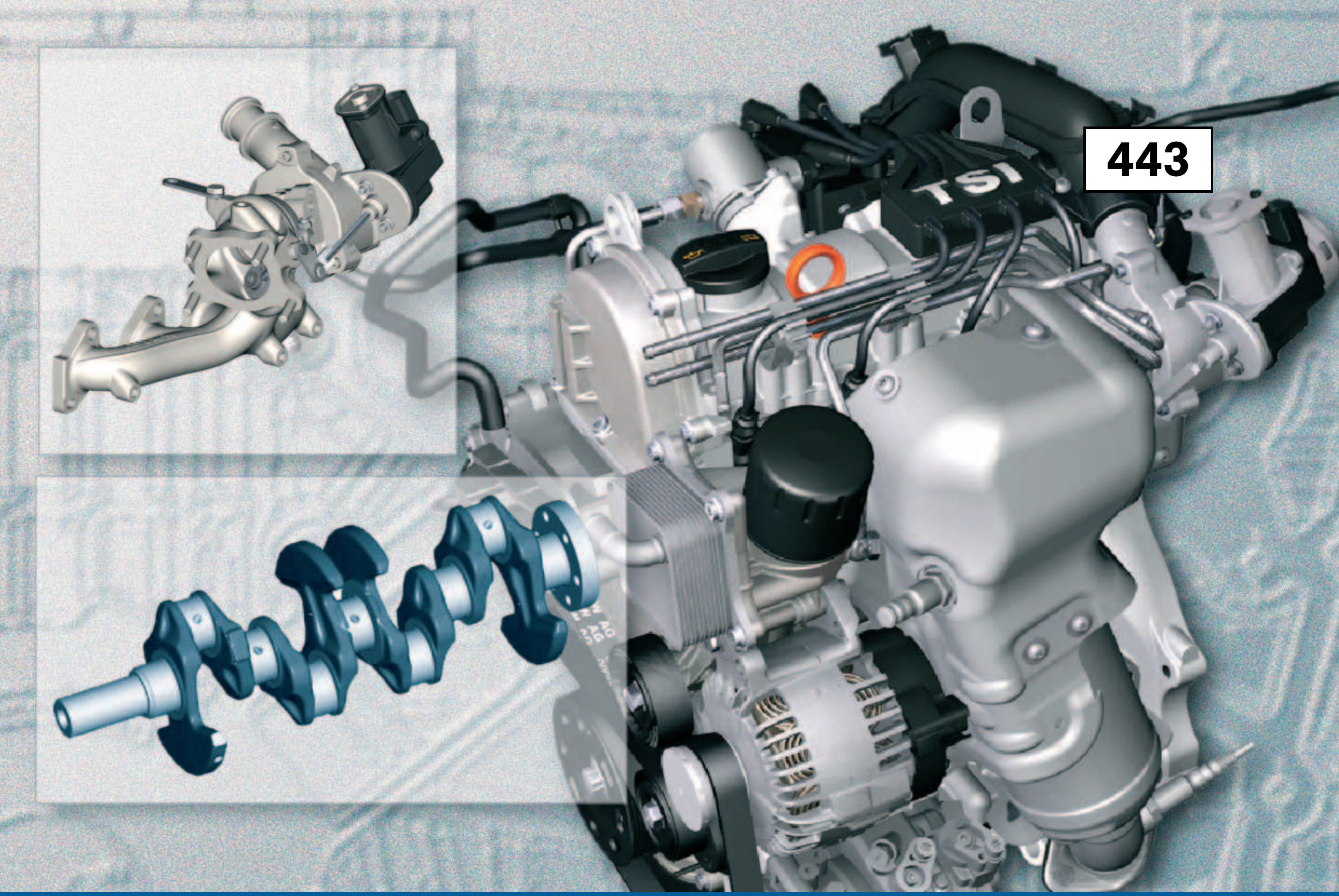
5. What are the advantages of the electric charge pressure positioner?

☐ a) Rapid adjustment time, therefore faster pressure build-up.

☐ b) High actuation force, as a result of which the waste gate remains securely closed even in the case of high pressure fluctuations.

☐ c) The waste gate can be actuated at any time. As a result of this, it can be opened in the lower load/engine speed range, the basic charge pressure declines and the engine has to carry out less gas cycle work.

Answers
1. c)
2. b)
3. b)
4. c)
5. a) , b), c)



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