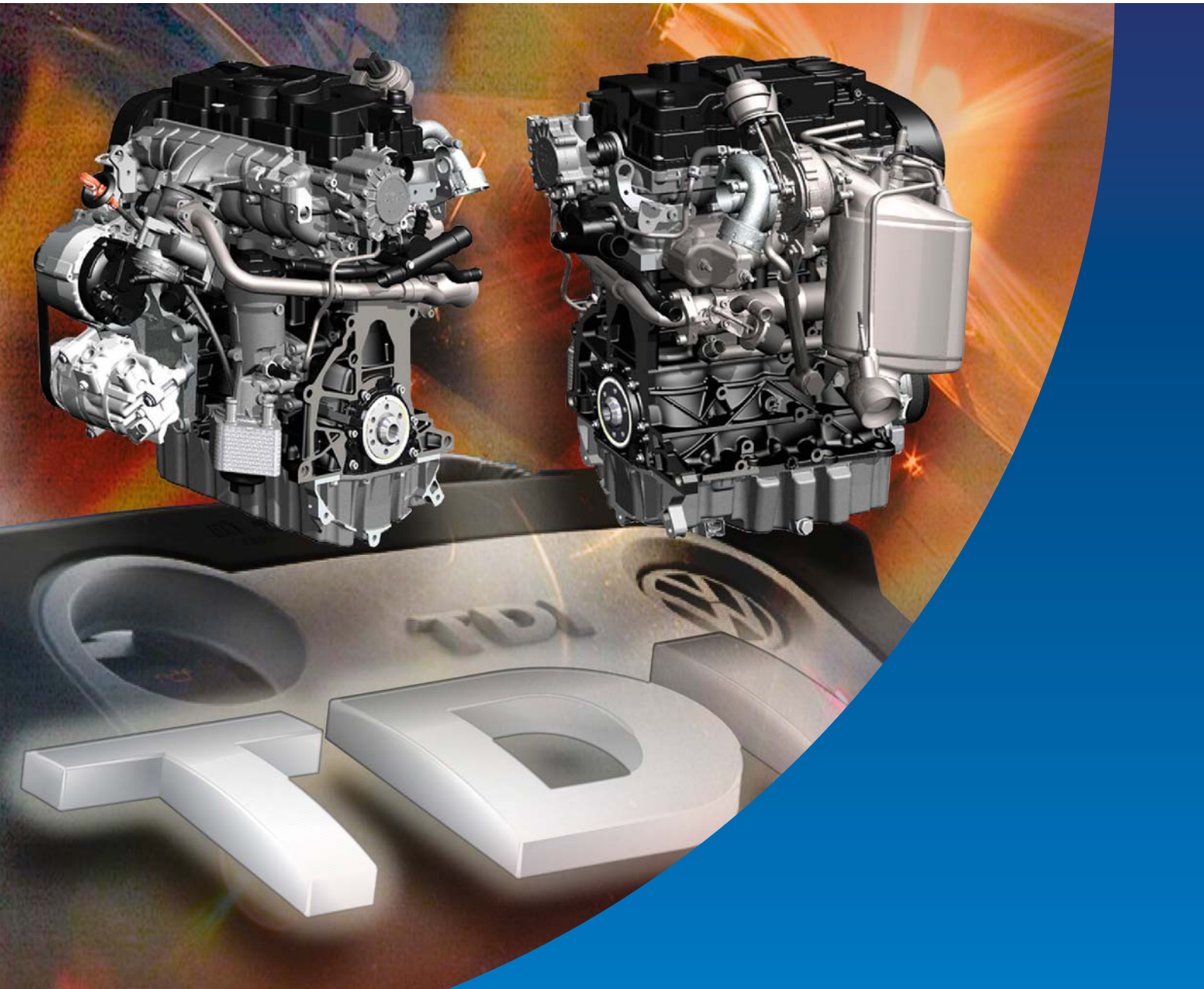
Service Training

Self-study Programme 368

The 2.0l 125 kW TDI Engine with 4-valve technology

Design and function



Following the 2.0l 103 kW TDI engine with 4-valve technology, the 2.0l TDI engine with 125 kW is now being launched onto the market.

In this document, we will introduce you to the design and function of the 2.0l 125 kW TDI engine with 4-valve technology, whereby we will concentrate extensively on the differences versus the 103kW variant.

The 2.0l 125 kW TDI engine with 4-valve technology will initially be fitted in the Passat.

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Information on the 2.0l 103 kW TDI engine with 4-valve technology can be found in self-study programme 316 "The 2.0l TDI Engine".

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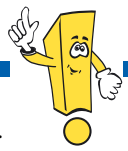

Important Note

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.

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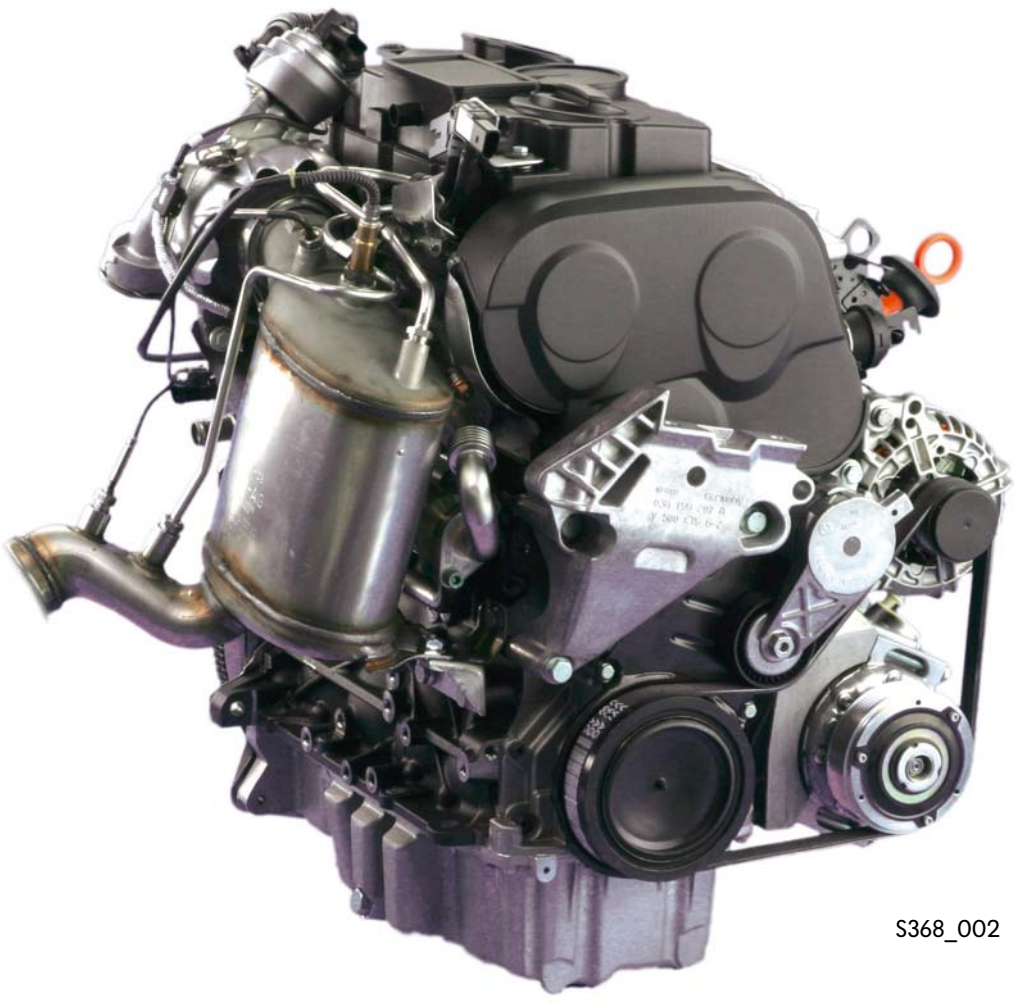
Introduction

The 2.0l 125 kW TDI engine with 4-valve technology

The 2.0l 125 kW TDI engine is based on the 2.0l TDI engine with 103 kW. With its output, the 125 kW TDI engine is the market leader amongst 2-litre diesel engines. This increased output has been achieved by consistently re-developing the tried-and-tested technology whilst simultaneously reducing consumption and pollutant emissions.



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Technical features

- New unit injector with piezo-electric valve and an injection pressure of up to 2200 bar
- Balancer shaft module *
- Pistons without valve pockets
- New ceramic glow plugs
- CTC toothed belt sprocket on the crankshaft
- Improved oil separation
- Turbocharger with travel feedback
- Maintenance-free diesel particulate filter

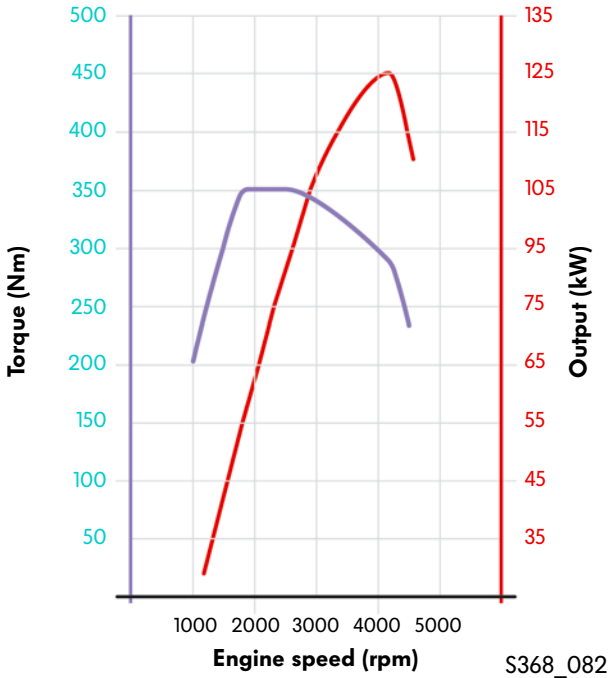
* In the Passat and with longitudinal mounting only

S368_001

Technical data

Engine codes	BMR, BMN
Type	4-cylinder in-line engine
Displacement	1968 cm^3
Bore	81 mm
Stroke	95.5 mm
Valves per cylinder	4
Compression ratio	18.5 : 1
Maximum output	125 kW at 4200 rpm
Maximum torque	350 Nm at 1800 rpm to 2500 rpm
Engine management	Simos PPD 1
Fuel	Diesel, at least 51CN
Exhaust gas treatment	Exhaust gas recirculation and diesel particulate filter
Emissions standard	EU4

Torque and output diagram



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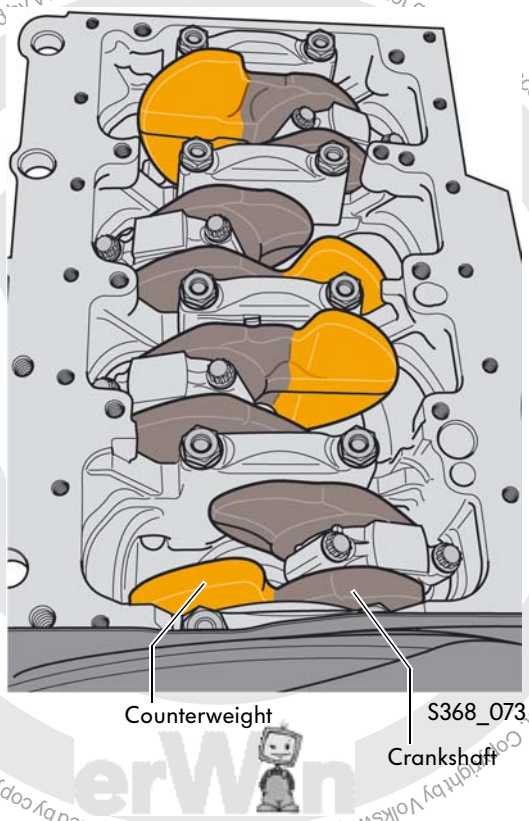
Crankshaft drive

The crankshaft

Due to the increase in output to 125 kW, the crankshaft is exposed to higher stresses. A reinforced, forged crankshaft is therefore used.

Instead of the usual eight, the crankshaft only has four counterweights, as a result of which weight has been reduced. The new design of the crankshaft helps to reduce the maximum crankshaft bearing strain. Noise emissions, which may be caused by the engine's inherent movement and vibrations, have also been reduced.



The pistons

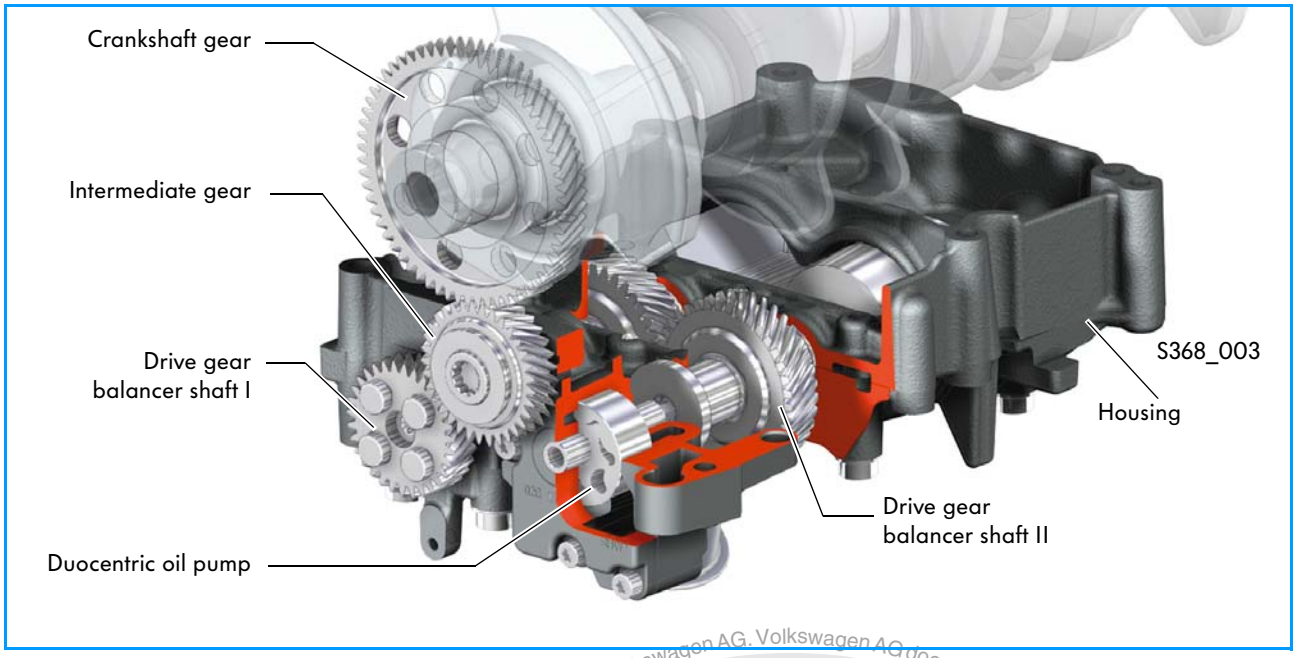
Thanks to the omission of the valve pockets on the top of the pistons, the chamber volume has been reduced and swirl generation in the cylinder has been improved. Swirl is the circular movement of flow around the vertical cylinder axis The swirl exerts a vital influence on the quality of the mixture.

Omission of the valve pockets has been achieved via the use of flatter valve heads on the valves and modified valve seats.


S368_078

The balancer shaft module

The 2.0l 125 kW TDI engine is only equipped with a balancer shaft module, which is housed in the oil pan beneath the crankshaft, in the Passat and when the engine is mounted longitudinally. The balancer shaft module is driven by the crankshaft via a gear drive. The duocentric oil pump is integrated into the balancer shaft module.



Design

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

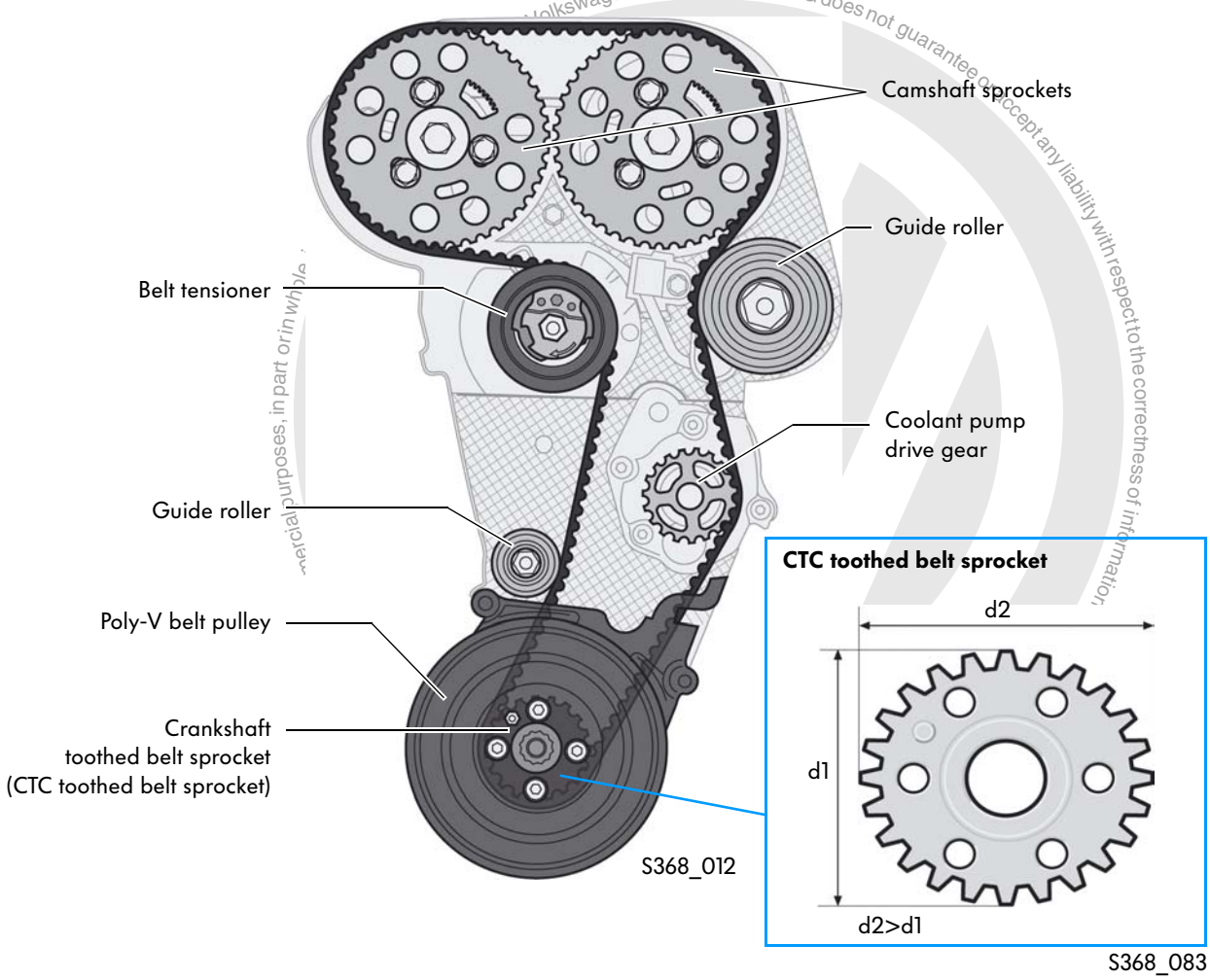
The gear drive is designed in such a way that the balancer shafts rotate at twice the speed of the crankshaft.

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

The intermediate gear must always be exchanged if the intermediate gear or the drive gear of balancer shaft I have been released.

Toothed belt drive

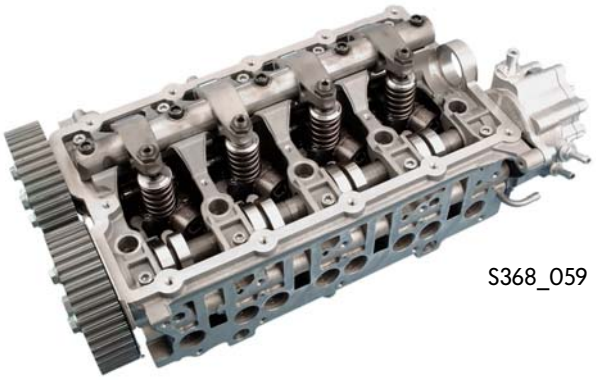
This drive is designed as a toothed belt drive. It includes the crankshaft's toothed belt sprocket, the two camshafts, the coolant pump, two guide rollers and a belt tensioner.



A CTC toothed belt sprocket is used as the drive gear for the CTC toothed belt sprocket. CTC is the abbreviation for Crankshaft Torsionals Cancellation. This name means that the camshaft's tensile forces and torsional vibrations are reduced.

During the combustion process, the narrow side of the toothed belt sprocket enables slight relaxation of the toothed belt drive. As a result of this, the tensile forces are reduced and the toothed belt drive's torsional vibrations are lessened. This has enabled the omission of a camshaft damper.

Cylinder head



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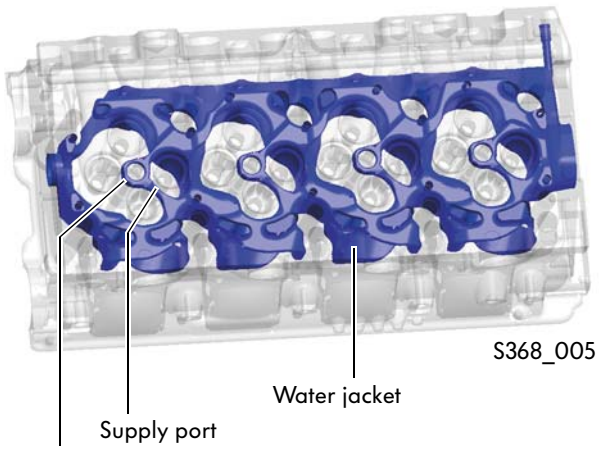
The cylinder head is manufactured from an aluminium-silicone-copper alloy and has been adapted to the 125 kW output.

The cylinder head cooling system



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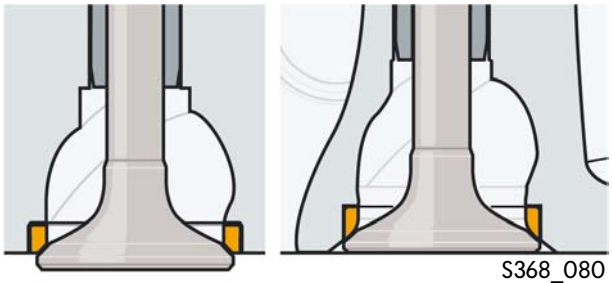
The cylinder head's water jacket has been completely re-engineered to improve thermal dissipation. Annular ports, which run around the injector orifice, are new. Via supply ports between the valves, the annular ports are supplied with coolant. As a result of this, the regions around the injectors and the exhaust ports, which are exposed to higher thermal strain due to the increase in output to 125kW, are relieved.

The layout of the valves, the unit injector and the glow plugs corresponds to that in the 103 kW TDI engine.

The valve seats in the cylinder head



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Valve with conventional valve seat

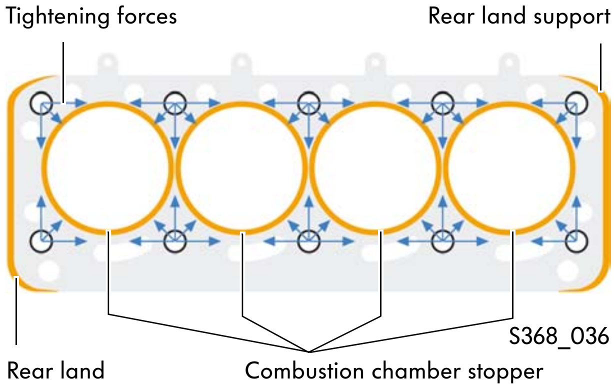
Valve with deeper valve seat

To enable the valve pockets to be omitted, the valve seats are integrated deeper into the cylinder head than in a cylinder head for pistons with valve pockets. This, together with the flatter valve heads, has enabled the chamber volume to be reduced.

Cylinder head gasket

A new cylinder head gasket reduces cylinder head and cylinder bore distortion. This improves combustion chamber sealing as a result. The gasket is structured in 5 layers and has two special features:

- Vertically profiled combustion chamber stoppers
- Rear land support



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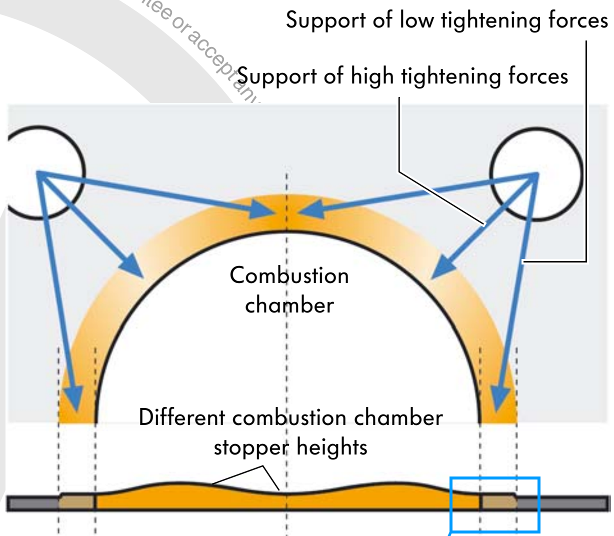
The vertically profiled combustion chamber stopper

Combustion chamber stopper refers to the sealing edge of the cylinder bore. This is of different heights along the edge to the combustion chamber.
Thanks to this special shape, distribution of the tightening forces at the combustion chambers is more even after tightening the cylinder head bolts.
This reduces the sealing gap vibrations and cylinder bore distortions which occur.

The trigger for this improved cylinder head gasket is the different distances between the cylinder head bolts and the cylinder bores. This means that sections of the combustion chamber stopper lie close to a cylinder head bolt and are therefore exposed to high tightening forces. Other sections are located further away from a cylinder head bolt and are therefore exposed to lower tightening forces. These differences are compensated by a higher combustion chamber stopper in sections with low tightening forces and a flat combustion chamber stopper in sections with higher tightening forces.



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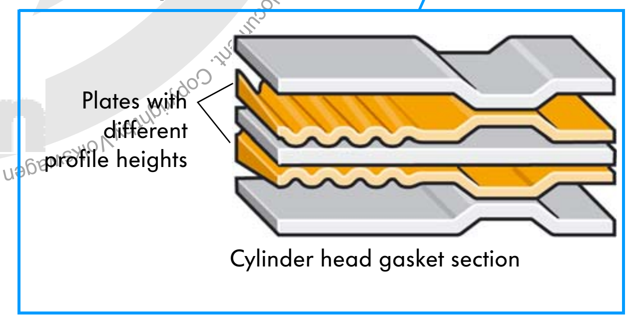
Schematic depiction



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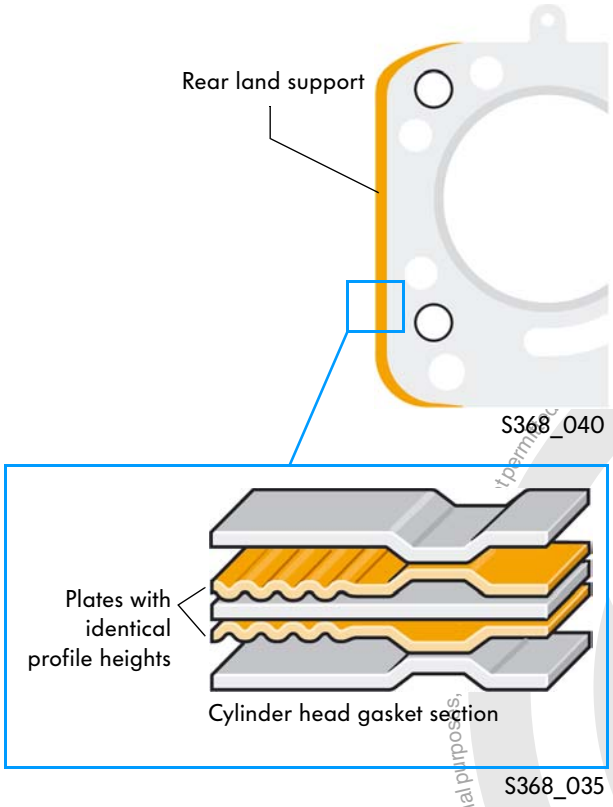
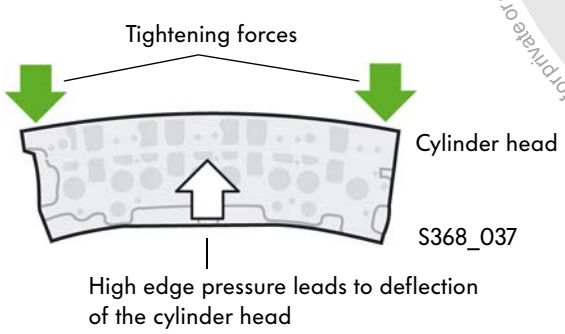


The rear land support

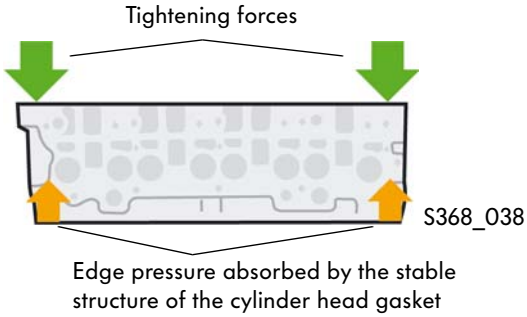
The cylinder head gasket's rear land supports are each located in the area of the two outer cylinders. In these areas, they achieve more even distribution of the outer cylinder head bolt tightening forces. Deflection of the cylinder head and distortion of the outer cylinder bores are reduced as a result.

Without rear land support



Due to the smaller cylinder head contact surface in the area of the two outer cylinders, the outer cylinder head bolts generate higher tightening forces. This leads to increased pressure on the cylinder head gasket and therefore deflection of the cylinder head. In turn, this deflection leads to distortion at the outer cylinder bores.

With rear land support



The rear land support absorbs this increased pressure on the edge of the cylinder head gasket, with the result that the cylinder head deflects less. Thanks to this improvement, the distribution of tightening forces at the outer combustion chamber stoppers has also been optimised. In addition, all cylinder head movement is reduced during engine operation.

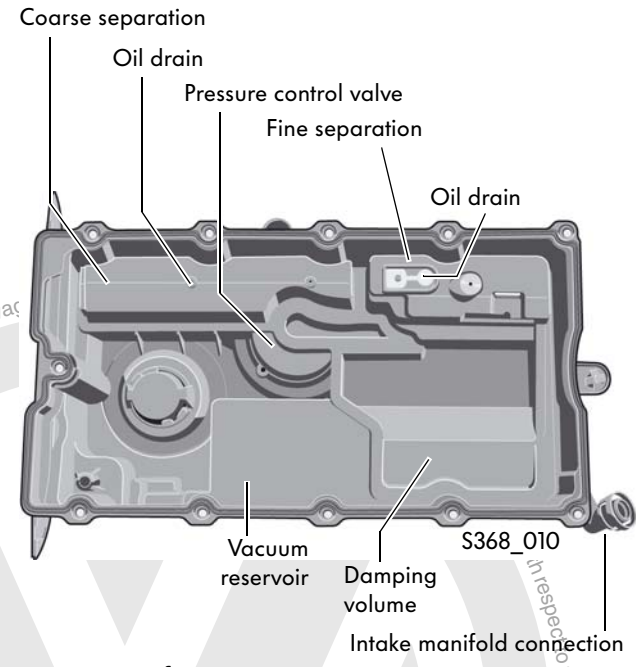
Cylinder head cover

It is manufactured from plastic and contains the crankcase ventilation system's oil separation facility. The oil separation facility is firmly integrated into the cover and cannot be opened or removed.

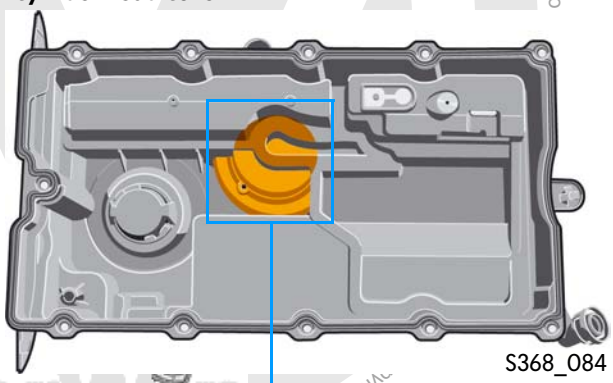
The oil separation facility is sub-divided into four areas:

- The pressure control valve
- Coarse separation
- Fine separation
- The damping volume

This staged structure of the oil separation facility has enabled oil entrainment from the crankcase ventilation system to be reduced.



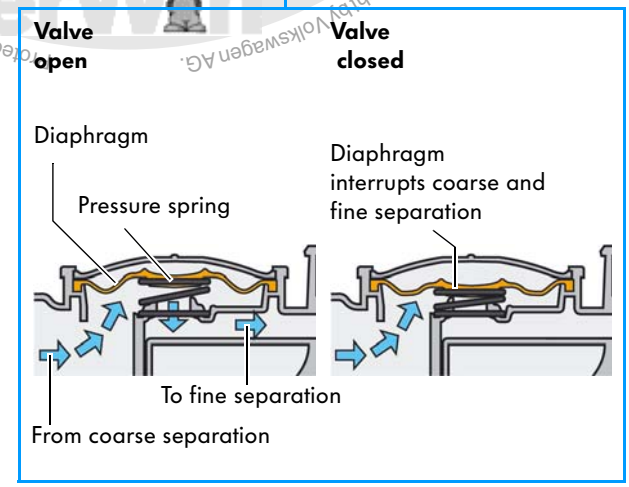
Inner view of cylinder head cover

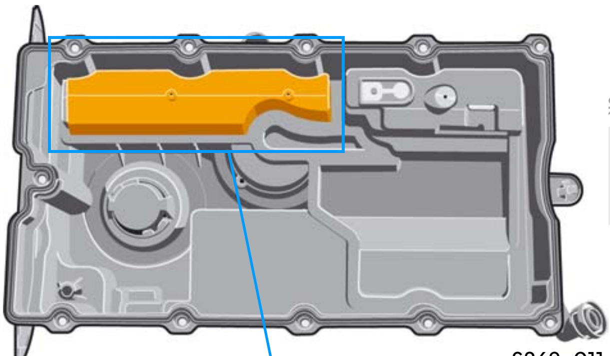


The pressure control valve

The pressure control valve is located between the coarse and the fine separation facility, and limits the vacuum in the crankcase. An excessively high vacuum may damage the engine's seals.

The valve is comprised of a diaphragm and a pressure spring. If the vacuum in the intake port is low, the valve opens due to the pressure spring's force. If the vacuum in the intake port is high, the pressure control valve closes and thereby interrupts the flow between coarse and fine separation.





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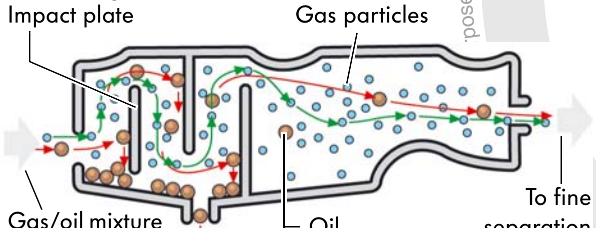

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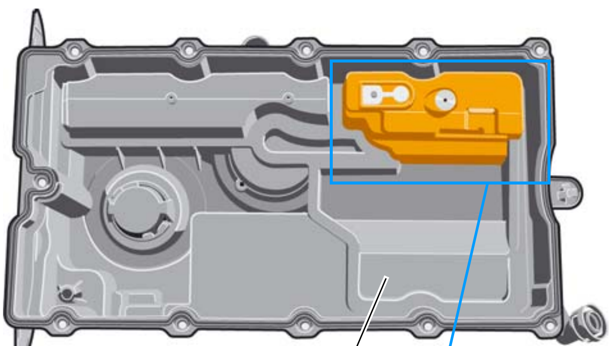
The coarse separation facility

The coarse separation facility consists of an impact plate separator. The larger oil droplets, which have been carried along out of the crankcase with the flow of gas, are separated off on the impact plates and collect on the floor of the coarse separation facility. Small bores in the plastic housing enable the oil to drip into the cylinder head.



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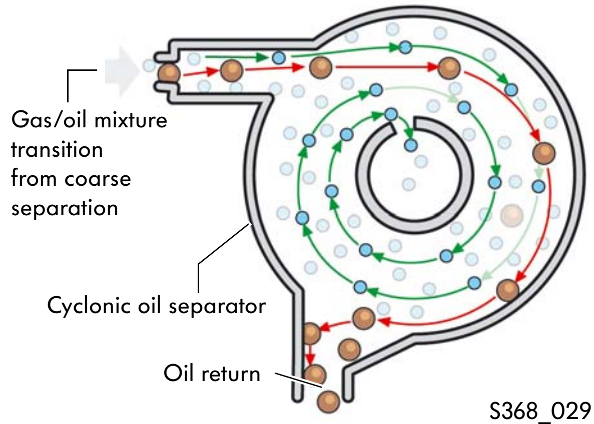


S368_029

The fine separation facility

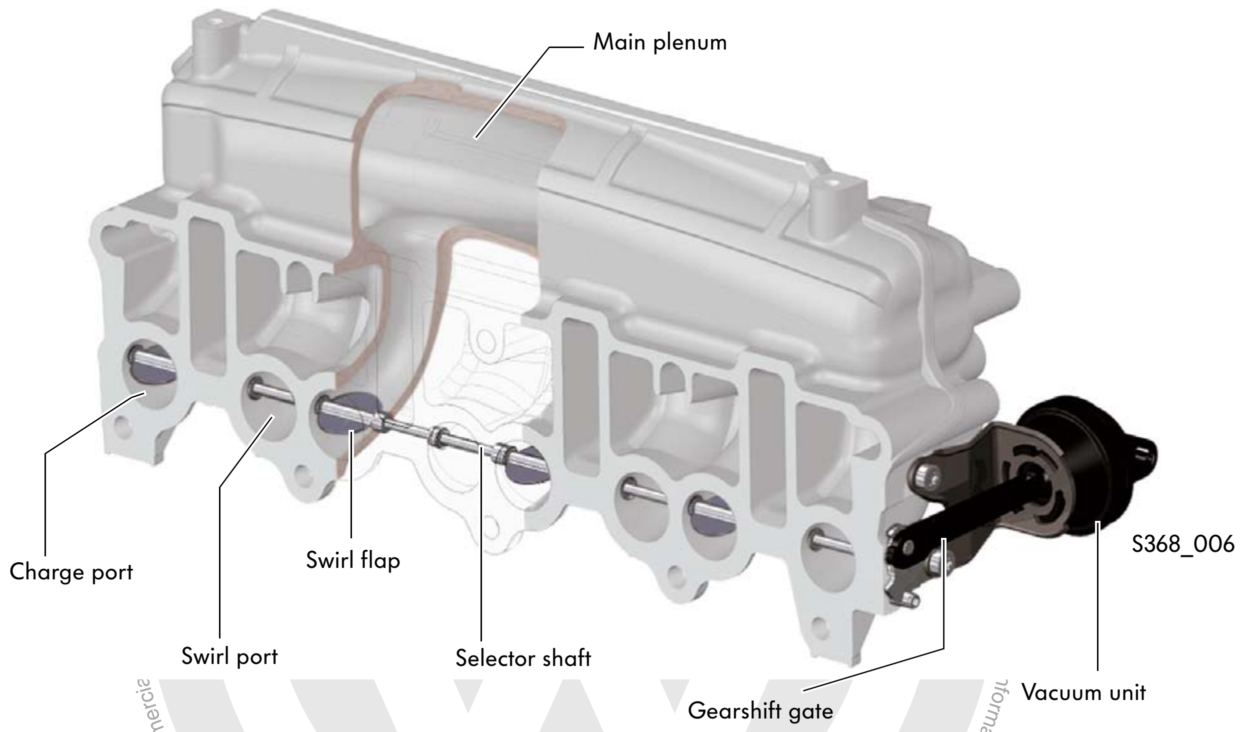
Fine separation is carried out via a cyclonic oil separator with pressure control valve. Cyclonic oil separators are also called centrifugal force oil separators. Their functional principle is based on the fact that the oil/gas mixture is caused to rotate via a corresponding guide. Due to the centrifugal force, the oil droplets, which are heavier than the gas, are accelerated outwards. They are separated off on the wall of the cyclonic oil separator housing and drip into the cylinder head via a drain bore. The cyclonic oil separator can also be used to catch very fine oil droplets.

To avoid disturbing flow swirl on induction into the intake manifold, a damping volume is connected to the cyclonic oil separator. In this, the kinetic energy of the gas is reduced. A residual quantity of oil is also separated off in the damping volume.

Engine mechanics

Intake manifold

The 125 kW TDI engine is equipped with an intake manifold with swirl flaps. It has the same connection dimensions as the rigid intake manifold and is manufactured as a one-piece aluminium housing. Carbon monoxide (CO) and hydrocarbon (HC) emissions are significantly reduced by closing the swirl flaps.



Design

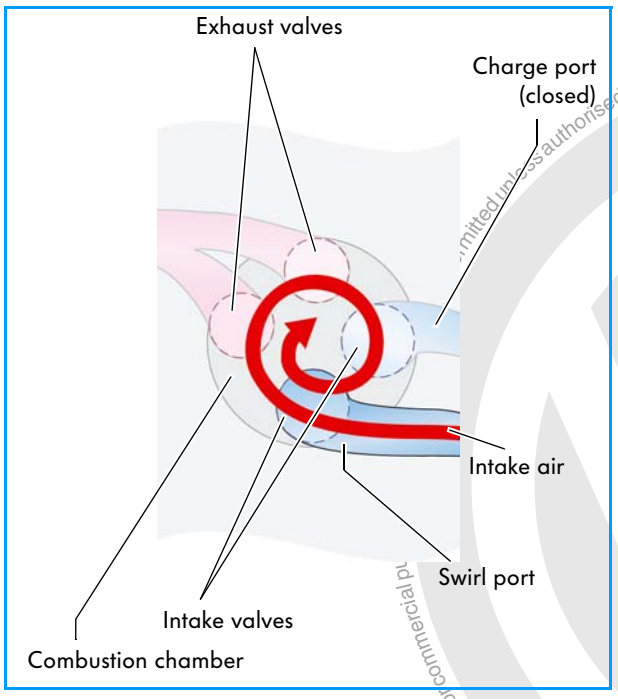
A steel selector shaft, which is actuated via a gearshift gate by a vacuum unit, is located inside the intake manifold. The vacuum unit is supplied with vacuum by an electric switching valve, the intake manifold flap valve N316. The vacuum which is required is generated by the tandem pump.

The special feature of the intake manifold is that each cylinder's intake port is sub-divided into a charge and a swirl port, but that the selector shaft only closes the charge port with a swirl flap. When the swirl flap is closed, intake takes place exclusively via the swirl port. This increases the flow speed in this port.

The swirl flaps can only assume the positions "open" or "closed". Without vacuum at the vacuum unit, the swirl flaps are set to the "open" position (emergency running position).

Function

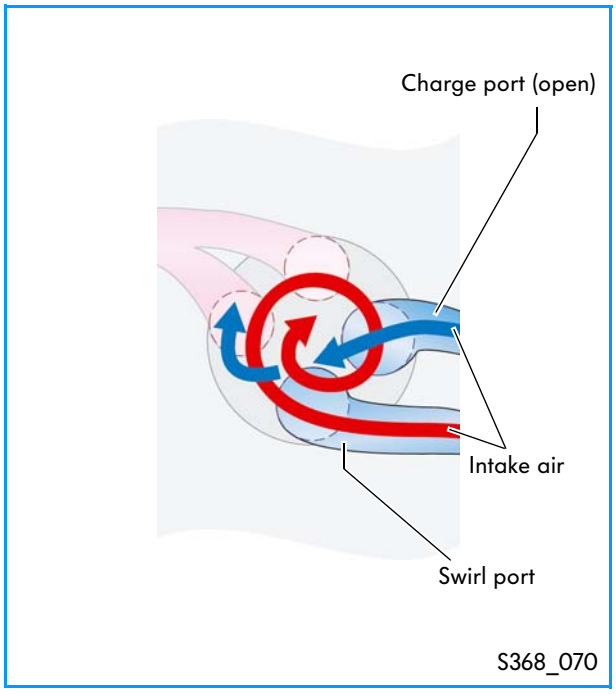
Swirl flaps in "closed" position



Due to the increased flow speed in the swirl port when the swirl flap is closed and the design and layout of the swirl port, the intake swirl in the cylinder is increased with low intake air throughput. When this desired effect occurs, the rotational movement of the inflowing gas intensifies. This rotation and the higher flow speed are required, particularly in the lower engine speed range and at lower engine torques, to guarantee better mixture formation.
Lower consumption and pollutant emission are thereby achieved.

In the engine speed range between 950 and 2200 rpm, the swirl flaps are kept closed depending on the engine torque. The swirl flaps are always open when starting the engine and during deceleration mode.

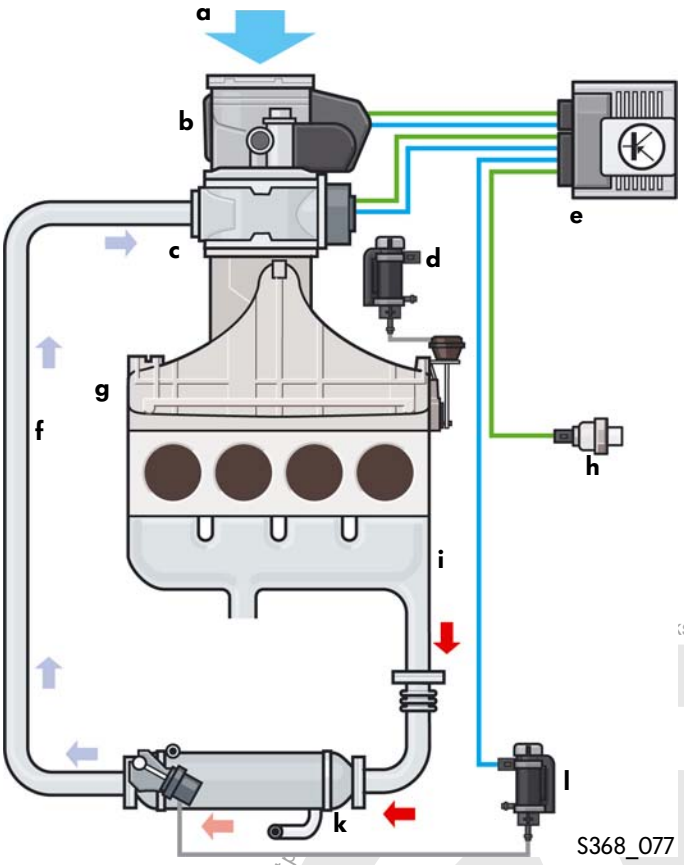
Swirl flaps in "open" position



At higher engine speeds and torques, the swirl flap is opened in order to achieve better volumetric efficiency. Intake air can now flow into the cylinder via both intake ports. The intake swirl required for mixture formation is achieved by means of the rapid gas exchange at high engine speeds.

The intake manifold flap valve N316 is controlled by the engine control unit via a performance map.

Exhaust gas recirculation system



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Legend

a - Intake air
b - Intake manifold flap with intake manifold flap position sender and intake manifold flap motor V157
c - Exhaust gas recirculation valve with exhaust gas recirculation potentiometer G212 and exhaust gas recirculation valve N18
d - Intake manifold flap valve N316
e - Engine control unit J623
f - Exhaust gas supply line
g - Intake manifold
h - Coolant temperature sender G62
i - Exhaust manifold
k - Exhaust gas cooler
l - Exhaust gas recirculation cooler change-over valve N345

The 125 kW TDI engine is equipped with a re-engineered exhaust gas recirculation system. The added diesel particulate filter, the new position of the turbocharger above the intake manifold and the increase in the engine's output made it necessary to adapt the exhaust gas recirculation system.

Design

The exhaust gas is taken off from the exhaust manifold on the engine's exhaust side, and is conducted to the exhaust gas cooler with switching valve. From there, the exhaust gas is conducted around the engine via a pipe and is introduced into the exhaust gas recirculation valve. The exhaust gas recirculation valve is located in the direction of flow downstream of the electrically actuated intake manifold flap.

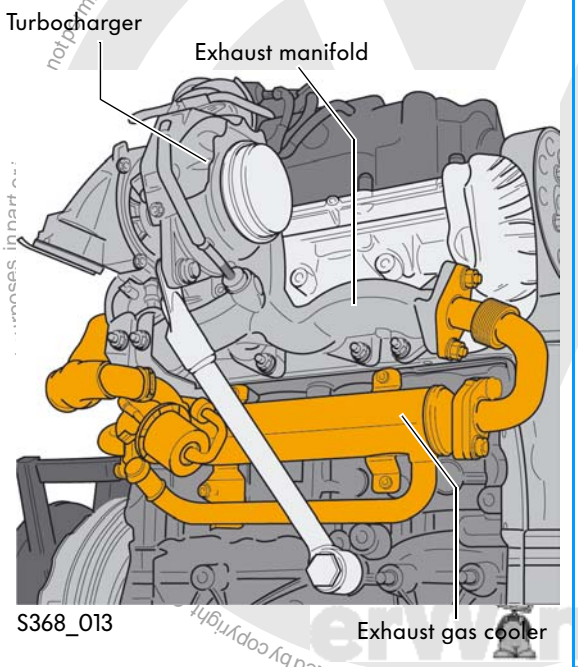
Task

The objective of the exhaust gas recirculation system is to reduce nitrogen oxide emissions. Exhaust gas recirculation reduces nitrogen oxide emissions because:

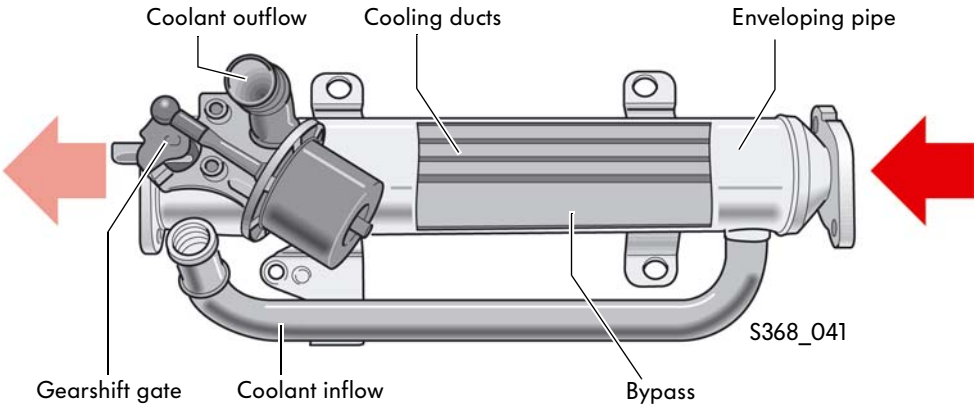
- Less oxygen is available for combustion due to the recirculated exhaust gas,
- The combustion speed and therefore the increase in temperature are reduced by the exhaust gas which is introduced.

The exhaust gas cooler

Due to its higher output, the 125 kW TDI engine is equipped with a larger exhaust gas cooler than the 103 kW TDI engine. The exhaust gas cooler is bolted to the crankcase below the turbocharger.



Design



In contrast to the predecessor model, the new exhaust gas cooler is housed in a smooth, enveloping pipe. Internally, the enveloping pipe is split into two.
The upper area contains thin cooling ducts for the exhaust gas, around which the coolant flows.
The lower area contains an individual, thicker tube. As a bypass, this conducts the exhaust gas past the cooler and can be opened or closed by means of a flap.

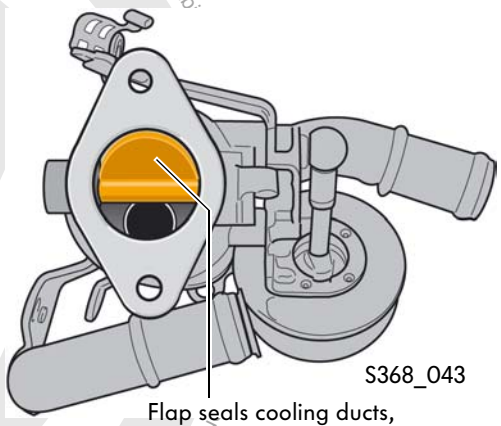
The flap is actuated via a vacuum unit with gearshift gate. If no vacuum is present, the flap closes the bypass. The vacuum unit is supplied with vacuum via an electric switching valve (exhaust gas recirculation cooler change-over valve N345).

Function

At a coolant temperature below 34°C, the exhaust gas cooling system is switched off. The flap seals the cooling pipes and the bypass is opened. The uncooled exhaust gas is conducted into the intake manifold.

On cold-starting the engine, the induction of uncooled exhaust gases enables the engine and the catalytic converter to reach their operating temperature faster.
The cooler therefore remains closed until the switching conditions are met.

Exhaust gas cooling system not active



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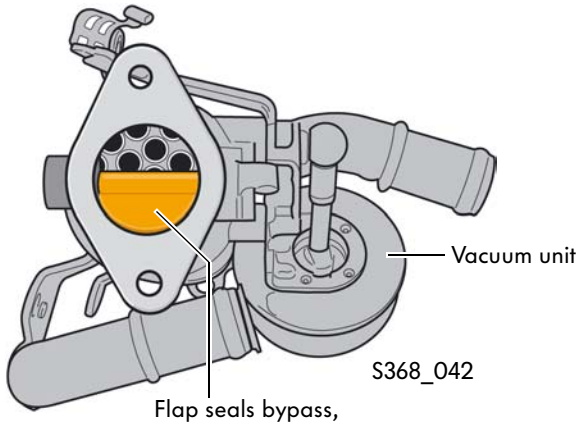
Flap seals cooling ducts, bypass open.

As of a coolant temperature of 35°C, the exhaust gas cooler is opened by the flap's sealing the bypass pipe. To achieve this, the engine control unit actuates the exhaust gas recirculation change-over valve N345. The recirculated exhaust gas now flows through the cooling ducts.

Nitrogen oxide is reduced by inducing cooled exhaust gas, particularly at high combustion temperatures.

Exhaust gas cooling system active



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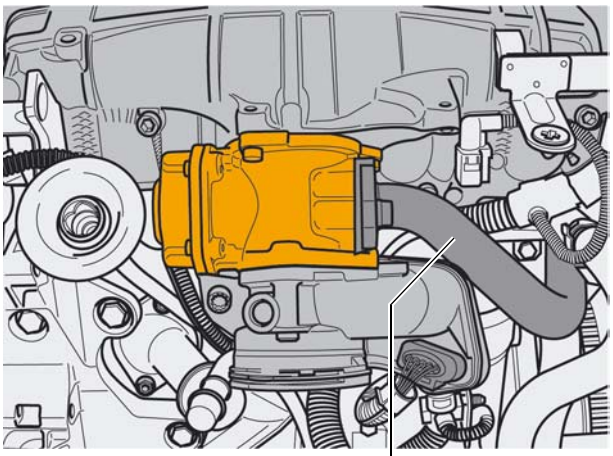
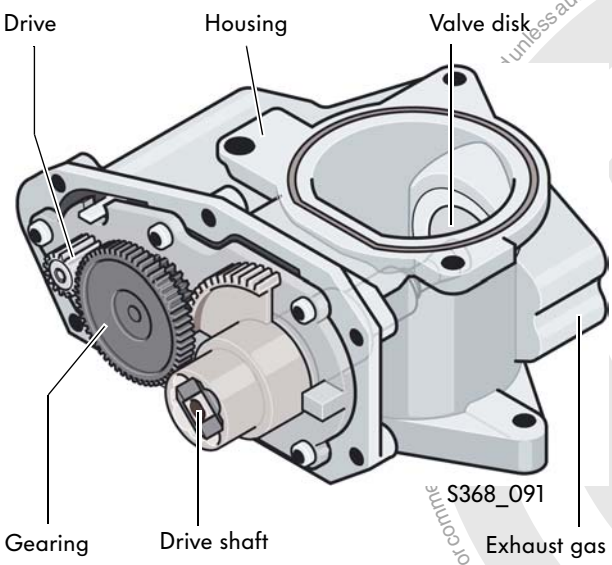
Flap seals bypass, cooling ducts open.

The exhaust gas recirculation valve

The 125 kW TDI engine is equipped with a new exhaust gas recirculation valve. It is located directly on the intake manifold inlet and is electrically actuated.





Design

The exhaust gas recirculation valve is equipped with a flange, which is connected to the exhaust gas supply line from the exhaust gas cooler. A valve disk, which is actuated by an electric motor (exhaust gas recirculation valve N18) opens or closes the connection to the exhaust gas supply line. The valve disk's lift can be infinitely adjusted via a worm gear. This enables the quantity of exhaust gas which is induced to be regulated. The valve disk's position is monitored by an integrated, contact-free sensor (exhaust gas recirculation potentiometer G212).
A return spring ensures that, in the event of exhaust gas recirculation valve failure, the valve is closed.

Function

The engine control unit actuates the valve disk drive via a performance map, and therefore defines how much exhaust gas is introduced into the variable intake manifold depending on the operating status.

Information on the exhaust gas recirculation potentiometer G212 can be found on Page 27 of this self-study programme.

The intake manifold flap

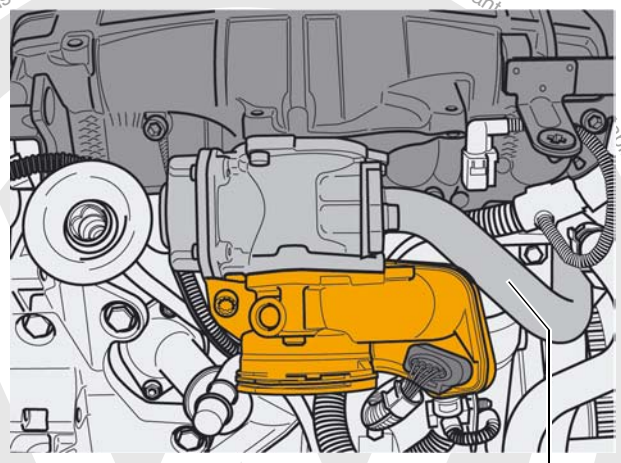
The 125 kW TDI engine is equipped with an electrically actuated intake manifold flap. It is mounted in the direction of flow upstream of the exhaust gas recirculation valve. The intake manifold flap has the task of supporting the induction of exhaust gas into the intake port by building up a vacuum downstream of the control flap. Adjustment is infinite and can therefore be adapted to the relevant load and engine speed. When the engine is switched off, the regulating flap is closed to prevent juddering on switching off.

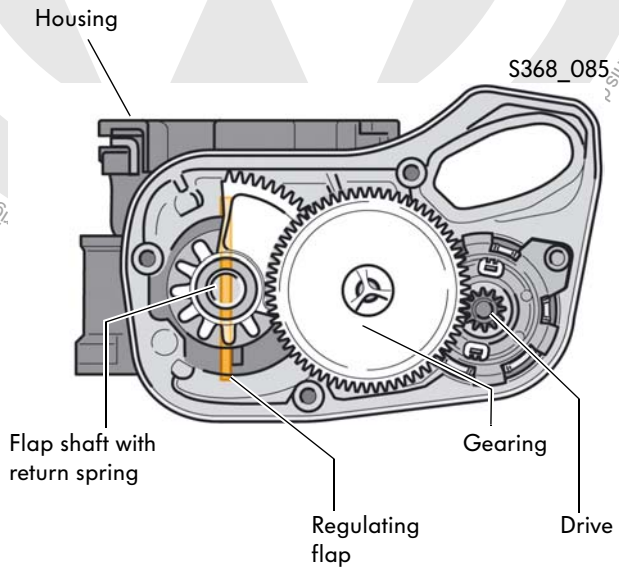
Design

The intake manifold flap is comprised of the housing, the regulating flap and the drive with an integrated, contact-free sensor for determining the position of the flap. The drive consists of an electric motor (intake manifold flap motor V157) with slightly inhibiting gearing. A return spring ensures that, when it is not supplied with current, the regulating flap is pulled to the "open" position (emergency running position). In this position, the flow of intake air is not impeded.

Function

The intake manifold flap motor is actuated directly by the engine control unit with a direct voltage.
The integrated sensor (intake manifold flap position sender) reports the actual flap position to the engine control unit.

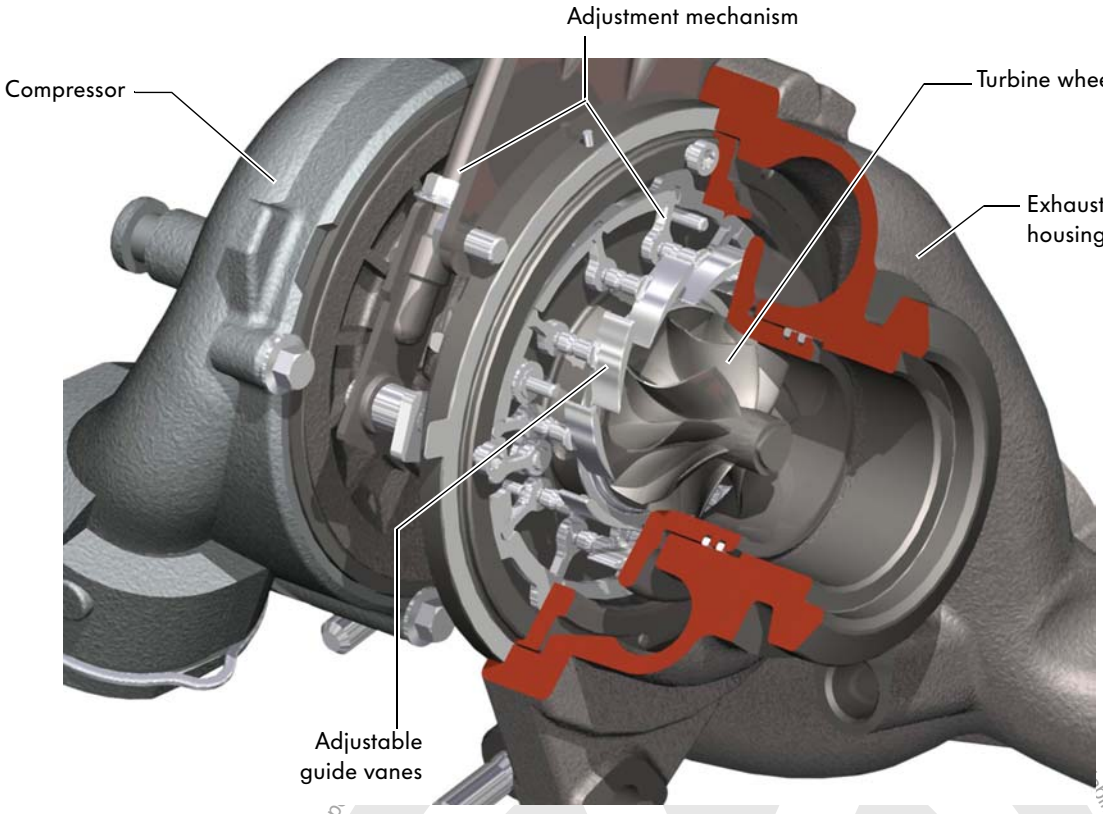




The intake manifold flap position sender is integrated into the housing of the intake manifold flap motor V157. The sender is not therefore listed in "Guided Fault Finding".

Information on the intake manifold flap position sender can be found on Page 29 of this self-study programme.

Turbocharger with travel feedback



Design

The 125 kW TDI engine is equipped with a re-engineered turbocharger. The turbocharger is integrated, together with the turbine housing, in the exhaust manifold. The compressor and turbine wheel have been flow-mechanically and thermodynamically optimised. This has enabled the achievement of faster charge pressure build-up, higher gas throughput with the same design size and better efficiency.

Due to the introduction of the near-engine mounted particulate filter, the turbocharger is now mounted above the exhaust manifold. It is supported on the crankcase via a tubular element.

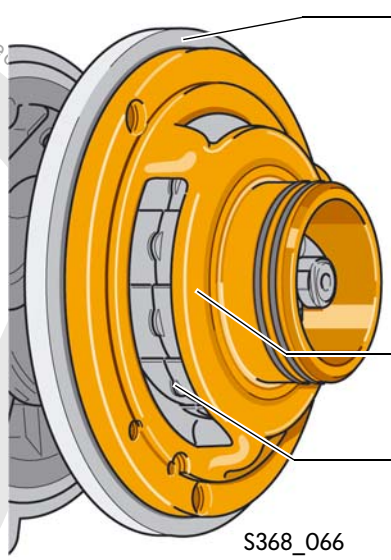
Function

The function of the turbocharger's adjustment mechanism has not changed. The current position of the adjustment mechanism is reported to the engine control unit by the position sender for charge pressure positioner G581 (travel feedback).

Further information on the turbocharger's adjustment mechanism can be found in self-study programme 190 "Adjustable Turbocharger".

Design

The design of the adjustment mechanism's connection to the turbocharger has been modified. Up to present, the adjustment mechanism has been joined to the turbine housing. In this turbocharger, the adjustment mechanism is held by a cage structure, the insert, which is bolted to the bearing housing. This has the advantage that the adjustment mechanism is decoupled from the turbine housing and that vibrations arising from the turbine therefore have less impact on the adjustment mechanism. The guide vane adjustment mechanism via an adjuster ring has not been modified.



Diesel particulate filter

S368_007

The diesel particulate filter is comprised, together with an oxidising catalytic converter, to form a single module. The module has been developed for all transversely mounted 3- and 4-cylinder engines. Due to its position close to the engine and the fact that the oxidising catalytic converter and the particulate filter are comprised together, the use of an additive is not necessary. As the diesel particulate filter reaches its operating temperature quickly, continuous, passive regeneration is possible.

In addition to passive regeneration, active regeneration of the particulate filter can also be induced. Active regeneration by the engine control unit is carried out when the particulate filter has become filled with soot particles, e.g. due to short journeys at partial load. In this case, the temperature required to carry passive regeneration out completely is not reached in the particulate filter.

Further information on the catalytically coated diesel particulate filter can be found in self-study programme 336 "The catalytic coated diesel particulate filter".

Engine management

Overview of the system

The overview of the system shows the 2.0l 125 kW TDI engine with 4-valve technology in the Passat.

Sensors

Engine speed sender G28

Hall sender G40

Accelerator position sender G79
Accelerator position sender 2 G185

Air mass meter G70

Coolant temperature sender G62

Radiator outlet coolant temperature sender G83

Fuel temperature sender G81

Intake air temperature sender G42
Charge air pressure sender G31

Position sender for charge pressure positioner G581

Brake light switch F

Lambda probe G39

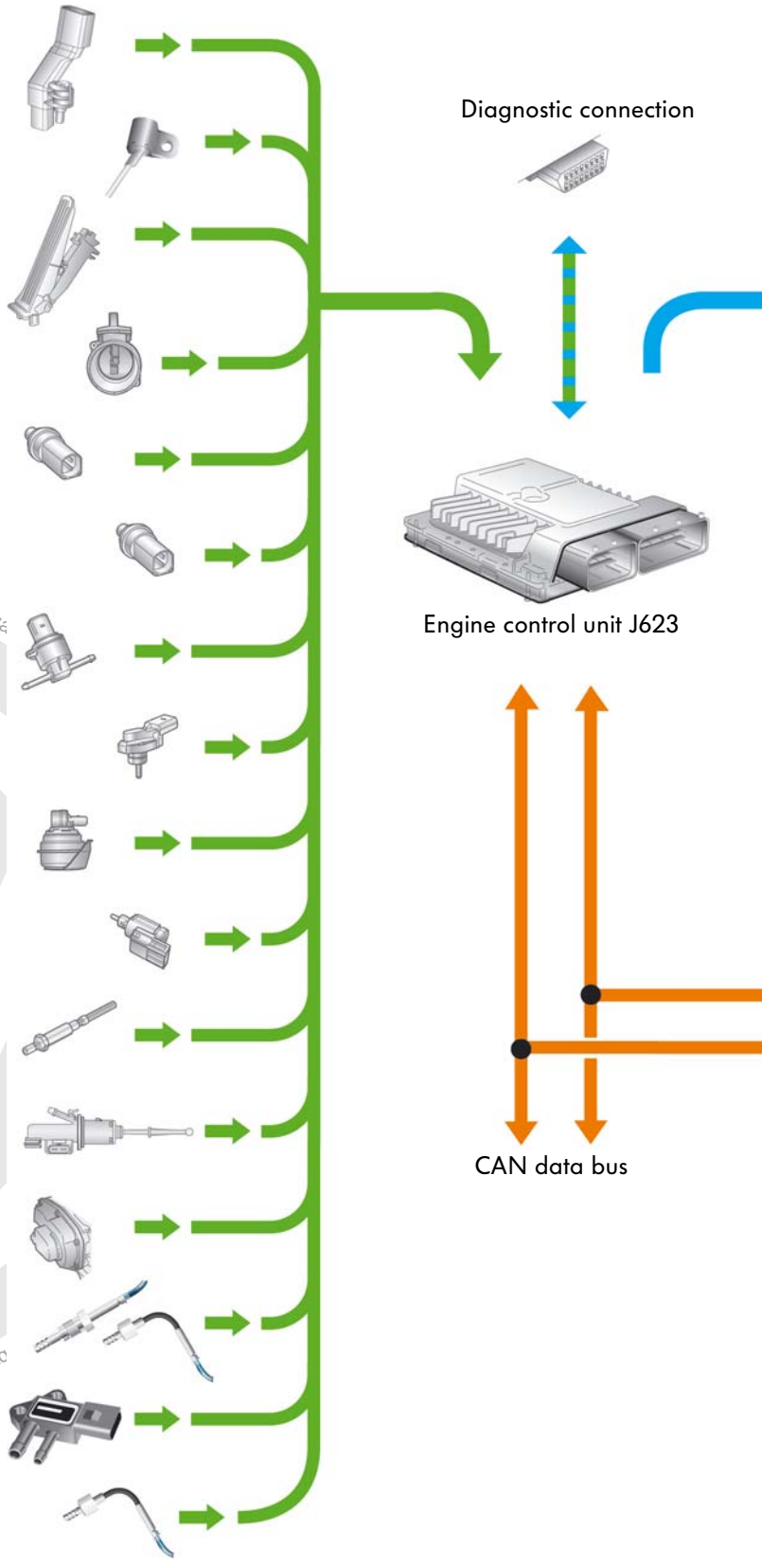
Clutch position sender G476
(for manual gearbox only)

Exhaust gas recirculation potentiometer G212

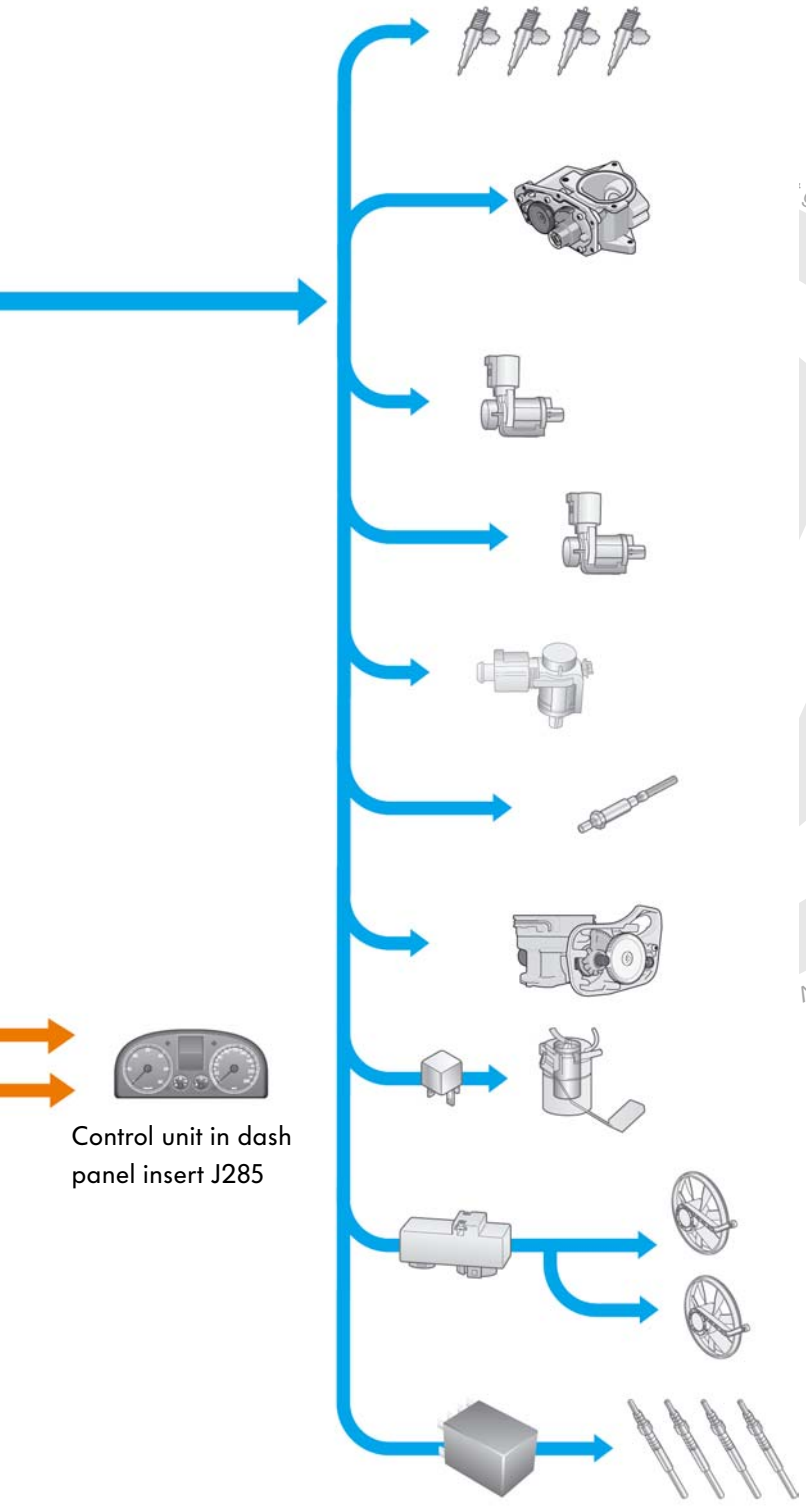
Exhaust gas temperature sender 1 G235
Bank 1 exhaust gas temperature sender 2 G448

Exhaust gas pressure sensor 1 G450

Temperature sender after particulate filter G527



Actuators



Unit injector valve, cyl. No. 1-4
N240, N241, N242, N243

Exhaust gas recirculation valve N18

Charge pressure control solenoid valve N75

Exhaust gas recirculation
cooler change-over valve N345

Intake manifold flap valve N316

Lambda probe heater Z19

Intake manifold flap motor V157

Fuel pump relay J17
Fuel system pressurisation pump G6

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

Automatic glow period control unit J179
Glow plugs 1-4 Q10, Q11, Q12, Q13

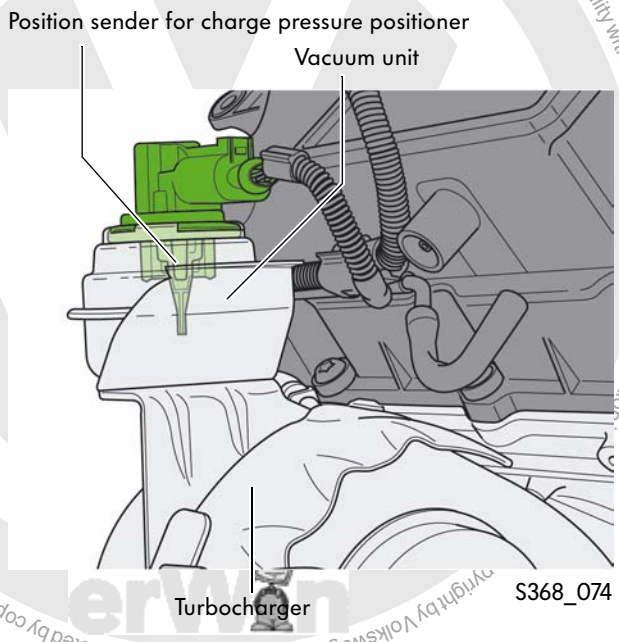
Control unit in dash
panel insert J285

S368_072

Sensors

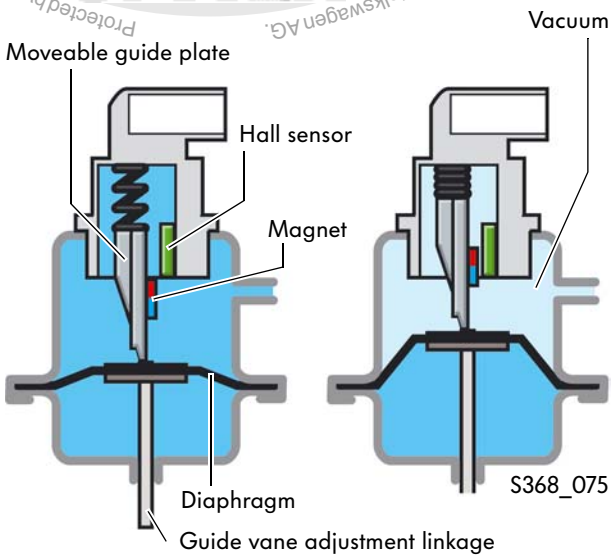
Position sender for charge pressure positioner G581

The position sender for charge pressure positioner is integrated into the turbocharger's vacuum unit. It is a travel sensor, which enables the engine control unit to determine the position of the turbocharger's guide vanes.



Design and function

Via a moveable guide plate, which bears a magnet, the position sender scans the diaphragm's travel in the vacuum unit. If the diaphragm moves on adjustment of the guide vanes, the magnet is moved past a Hall sensor. Based on the change in the magnetic field strength, the sensor electronics detect the position of the diaphragm and therefore the position of the guide vanes.



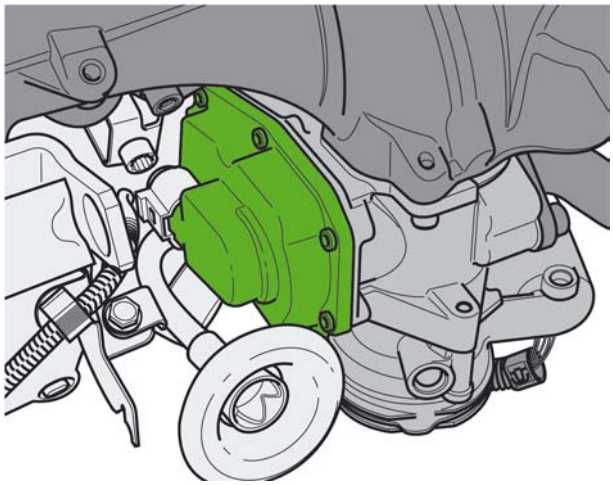
Signal use

The sensor signal directly provides the engine control unit with the current position of the turbocharger's guide vanes. Together with the signal from the charge air pressure sender G31, this can be used to determine the status of charge pressure control.

Effect in the event of failure

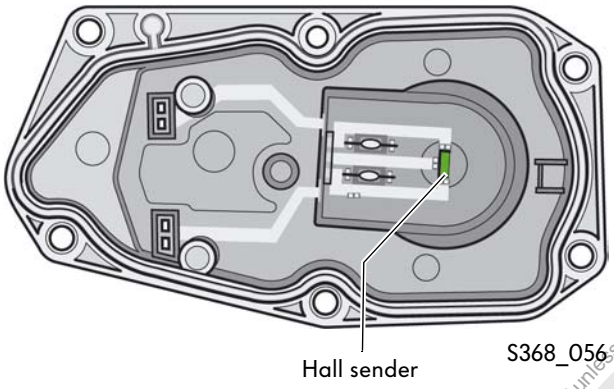
In the event that the sensor fails, the signal from the charge air pressure sender and the engine speed are used to determine the position of the guide vanes. The exhaust emissions warning lamp K83 is actuated.

Exhaust gas recirculation potentiometer G212



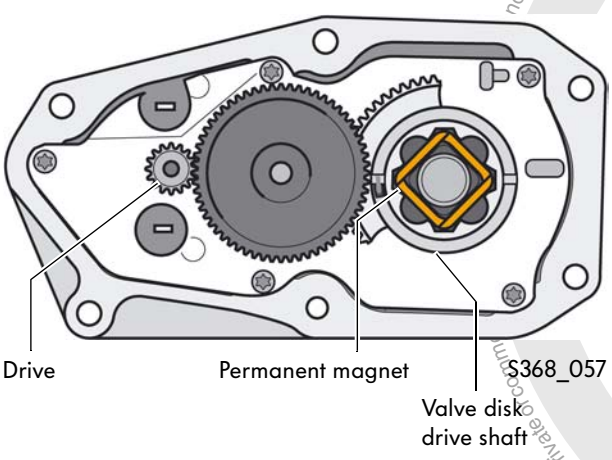
S368_017

EGR valve cover



S368_056

EGR valve housing



S368_057

The exhaust gas recirculation potentiometer records the position of the valve disk in the EGR valve (exhaust gas recirculation valve). The valve disk's lift controls the inflow of recirculated exhaust gas into the intake manifold.

Design

The sender is integrated into the EGR valve's plastic cover. It is a Hall sender, which scans a permanent magnet on the drive shaft without coming into contact with it. Based on the change in field strength, it supplies a signal, from which the valve disk's opening lift can be calculated.

Signal use

The signal informs the engine control unit of the valve disk's current position. Amongst other purposes, this is required to regulate the quantity of recirculated exhaust gas and therefore the nitrogen oxide content in the exhaust gas.

Effect in the event of failure

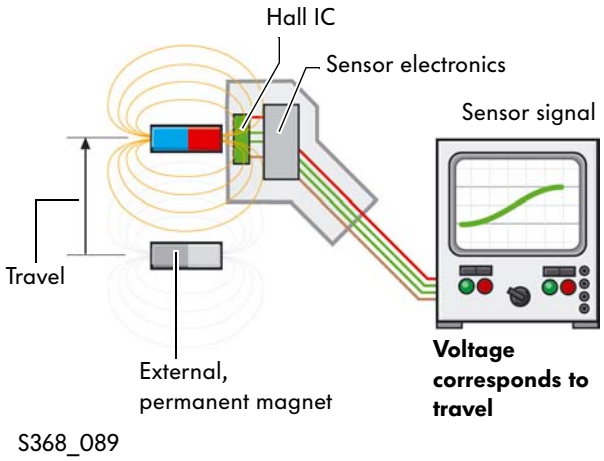
In the event that the sensor fails, exhaust gas recirculation is switched off. The EGR valve's current supply is also deactivated, with the result that the valve disk is pulled to the "closed" position by a return spring.

Design and function of Hall sensors

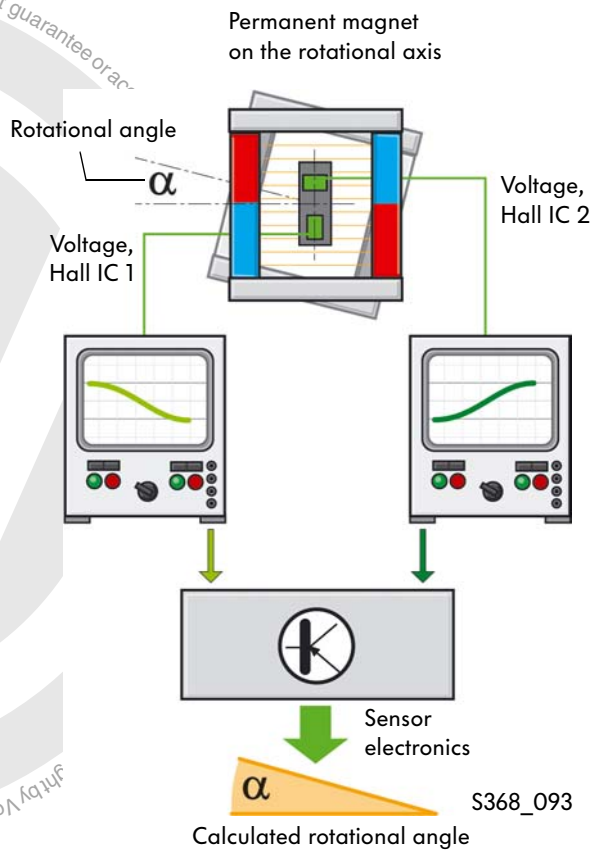
Hall sensors are used to measure rotational speed and detect positions. Both linear travel and rotational angles can be recorded by means of position detection.

Hall sensors for position detection

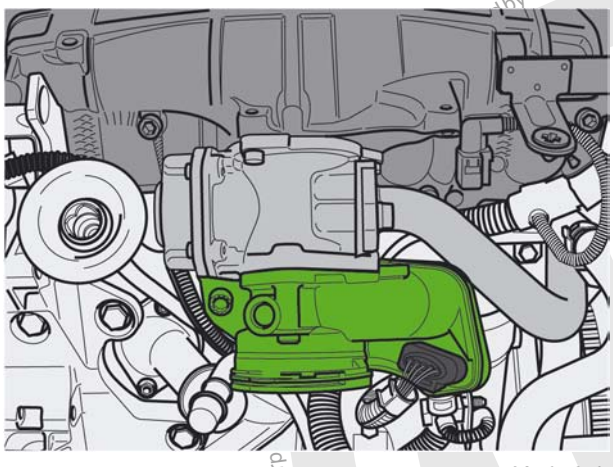
This type of sensor registers a voltage change within a voltage range. To measure a linear movement such as, e.g. in the position sender for charge pressure positioner G581, the magnet is separate from the Hall IC, with the result that the Hall IC passes by the magnet when it moves. The magnet's field strength changes along with its distance from the Hall IC. If the Hall IC moves towards the magnetic field, the Hall voltage increases; if it moves away from the magnet, the voltage decreases again. The sensor electronics can therefore conclude the travel which has been undertaken based on the change in Hall voltage.



Depending on the design of the Hall sensor and the permanent magnet, rotational angles can also be recorded and measured on the basis of the Hall principle. To achieve this, two Hall ICs are arranged in the sensor in such a way that they are at right angles to each other. Due to this position, the two Hall ICs supply opposing Hall voltages. These two voltages are used by the sensor electronics to calculate the adjustment angle of the rotational axis.
In this example, the permanent magnet consists of two rod magnets, which are connected via two metal bridges so that the field curves between the two rod magnets run parallel.

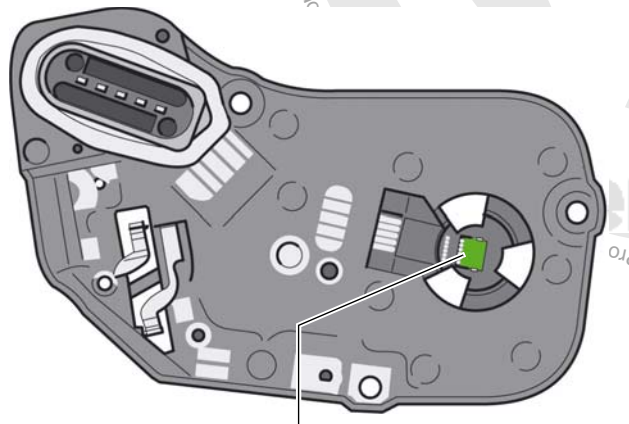


Intake manifold flap position sender



S368_018

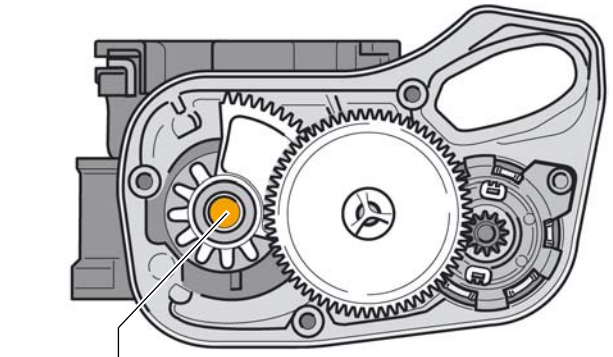
Printed circuit board



Magnetoresistive sensor element

S368_054

Intake manifold flap housing



Permanent magnet

S368_055

The sensor element is integrated into the intake manifold flap drive (intake manifold flap motor V157). It records the current position of the intake manifold flap.

Design

The sender is located on a printed circuit board beneath the plastic cover of the intake manifold flap module. It is a magnetoresistive sensor, which scans a permanent magnet on the control flap axis without coming into contact with it.

Signal use

The signal informs the engine control unit of the intake manifold flap's current position. Amongst other purposes, the control unit requires this position to control exhaust gas recirculation and particulate filter regeneration.

Effect in the event of failure

In the event that the sensor fails, exhaust gas recirculation is switched off. The intake manifold flap drive's current supply is also deactivated, with the result that the regulating flap is pulled to the "open" position by the reset spring. A fault is entered in the fault memory under the relevant intake manifold flap motor V157.

Design and function of magnetoresistive sensors

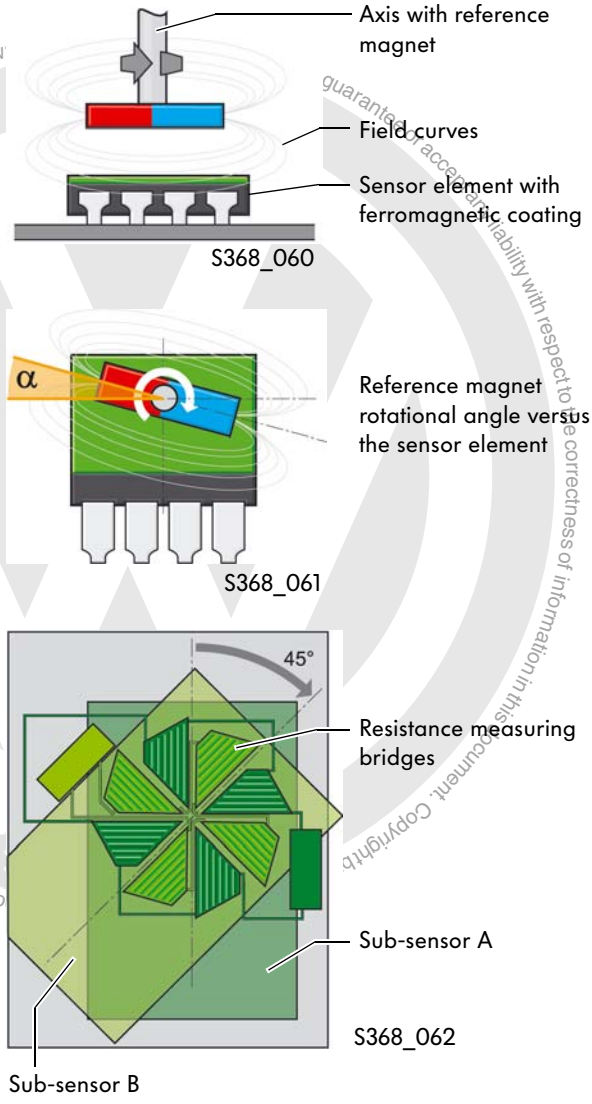
Magnetoresistive sensors operate without making contact. They are used to measure rotational angles such as, e.g. the adjustment angle of the intake manifold flap. The special, internal design of these sensors enables them to measure a rotational angle from 0° to 180°.
Further advantages include:

- Insensitivity to temperature-related magnetic field strength fluctuations,
- Insensitivity to reference magnet ageing,
- Insensitivity to mechanical tolerances.

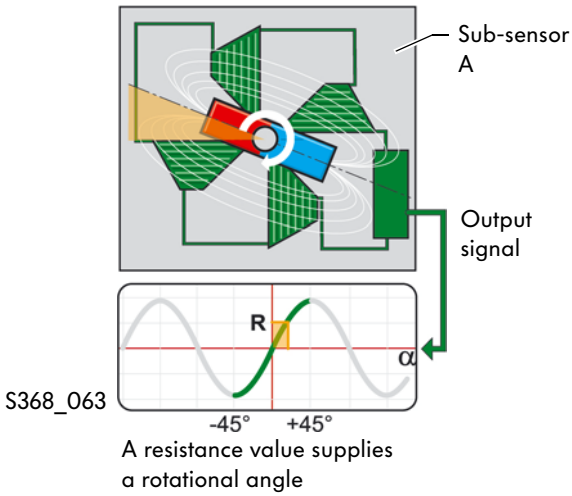
Design

A magnetoresistive sensor is comprised of an electronic sensor element, which is coated with a ferromagnetic material, and a magnet as a reference magnet. The magnet is joined to the axis whose rotational angle is to be measured. When the axis rotates together with the rod magnet, the position of the magnet's field curves change versus the sensor element. As a result, the sensor element's resistance changes. The sensor electronics then use this value to calculate the absolute rotational angle of the axis versus the sensor.

The sensor element consists of two sub-sensors A and B, which are offset by 45° from one another. In turn, each sub-sensor consists of four resistance measuring bridges, each of which is rotated by 90° around a common centre point.

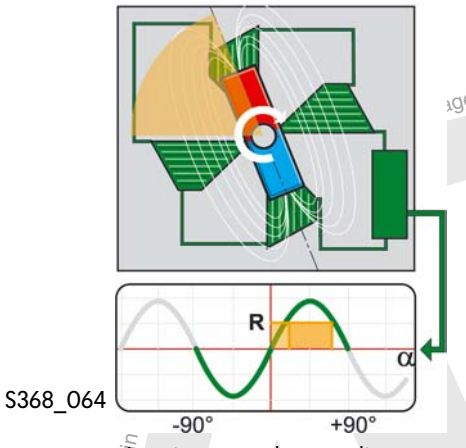


Function



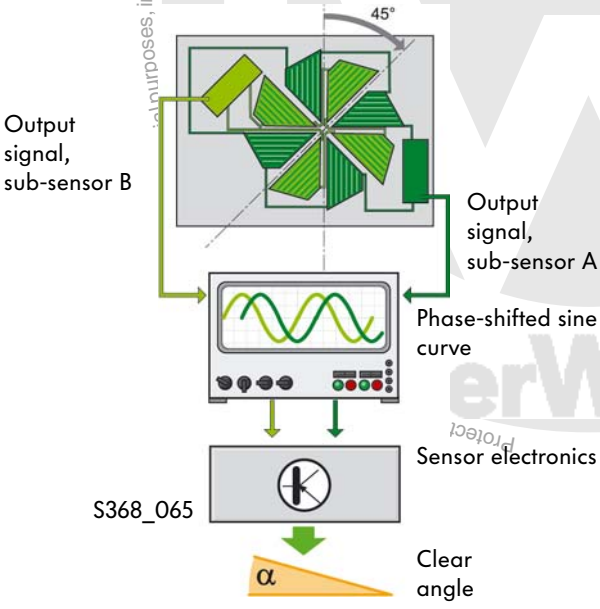
A resistance value supplies a rotational angle

If the axis is rotated versus a sub-sensor, this results in a sinusoidal change in this sub-sensor's resistance (R). Due to the shape of a sine curve, however, only a range from -45° to +45° can be determined as a clear angle by a sub-sensor.
Example:
Resistance R corresponds to a rotational angle of $\alpha = 22.5°$.



A resistance valve supplies two possible rotational angles

There are two possible angles for a resistance value in the range between -90° and +90°. One sub-sensor alone cannot therefore supply a clear signal in this measuring range.
Example:
Resistance R corresponds to a rotational angle of $\alpha = 22.5°$ and 67.5°.



The use of two sub-sensors and their arrangement, offset by 45° from each other, result in two sine curves with a phase-shift of 45° as the measurement signal. By means of a calculation function, the sensor electronics can now calculate a clear angle between 0° and 180° from the two curves and pass this on to the assigned control unit.

Actuators

Unit injector valve, cyl. No. 1-4 N240, N241, N242, N243

The unit injector valves are piezo-electric valves. They are components of the unit injector units and are connected directly to the engine control unit.
The engine control unit uses the valves to control the unit injectors' individual injection phases.

The advantages of piezo-electric valves versus a unit injector with solenoid valve are:

- Lower noise emissions,
- A wider range of injection pressures (130-2200 bar),
- More flexible pilot, primary and secondary injection design,
- Higher efficiency,
- Lower consumption,
- Lower pollutant emissions and
- Higher engine output.

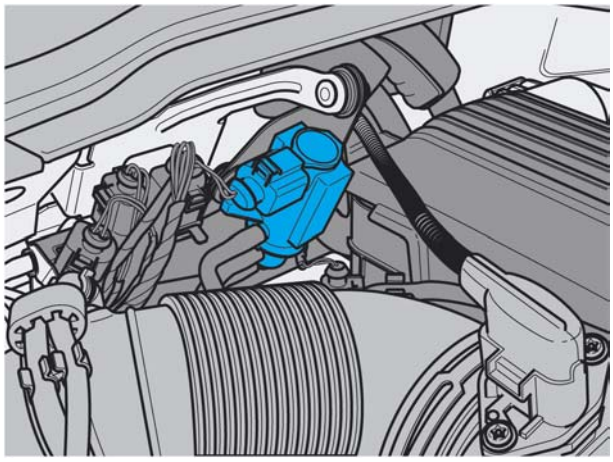
S368_021

Effects upon failure

If a unit injector valve fails, the corresponding cylinder's injection is deactivated. In the event of a slight deviation from the control limit, the unit injector valve continues to be actuated. In each case, an entry is made in the fault memory.

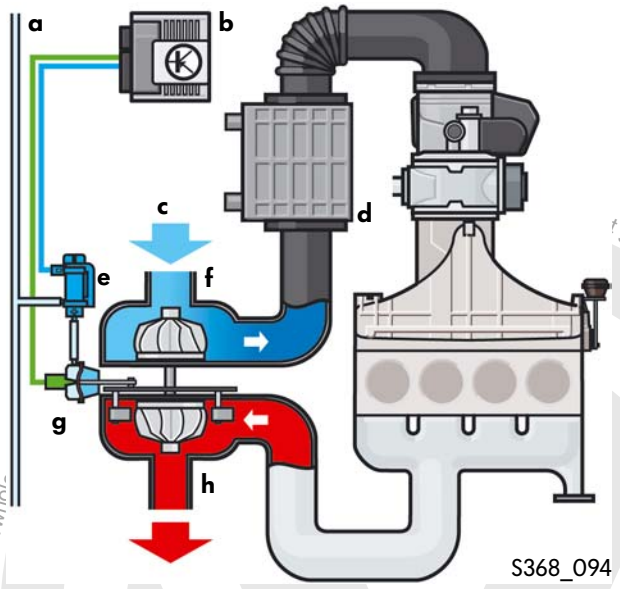
Detailed information can be found in self-study programme 352 "Unit Injectors with Piezo Valves".

Charge pressure control solenoid valve N75



S368_052

This valve is installed in the engine compartment, in the vicinity of the turbocharger on the plenum chamber. It supplies the turbocharger's vacuum unit with the vacuum required to adjust the guide vanes.



S368_094

Legend

a - Vacuum system
b - Engine control unit J623
c - Intake air
d - Charge air cooler
e - Charge pressure control solenoid valve N75
f - Compressor
g - Vacuum unit with position sender for charge pressure positioner G581
h - Exhaust turbine with guide vane adjustment

Effect in the event of failure

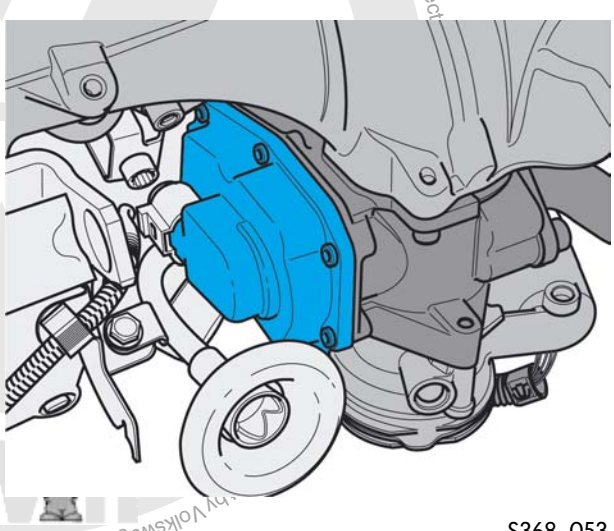
When it is not supplied with current, the valve isolates the vacuum unit from the vacuum system. A spring in the vacuum unit moves the adjustment mechanism's linkage in such a way that the turbocharger's guide vanes are positioned to a sharp setting angle (emergency running position). Only a low charge pressure is available at a low engine speed and therefore a low exhaust gas pressure.

Exhaust gas recirculation valve N18

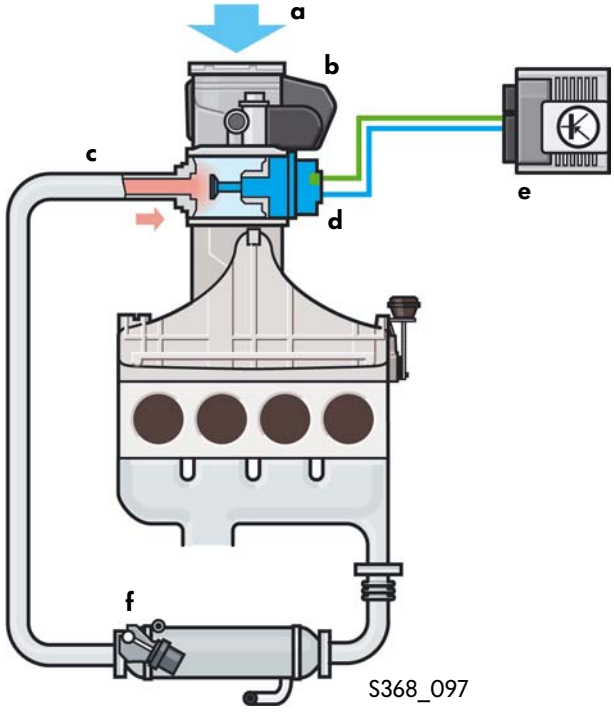
This is an electric motor, which actuates the exhaust gas recirculation valve disk, causing it to effect a lifting movement by means of gearing. To do this, it is actuated by the engine control unit with an analogue signal.

Effect in the event of failure

When it is not supplied with current, the valve is pulled into an emergency running position (closed) by a return spring. In this position, exhaust gas recirculation is switched off.



S368_053

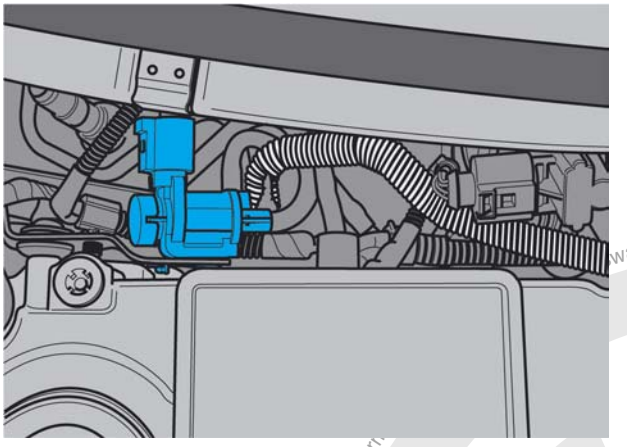


S368_097

Legend

a - Intake air
b - Intake manifold flap
c - Exhaust gas supply line
d - Exhaust gas recirculation valve N18 with exhaust gas recirculation potentiometer G212
e - Engine control unit J623
f - Exhaust gas cooler

Exhaust gas recirculation cooler change-over valve N345

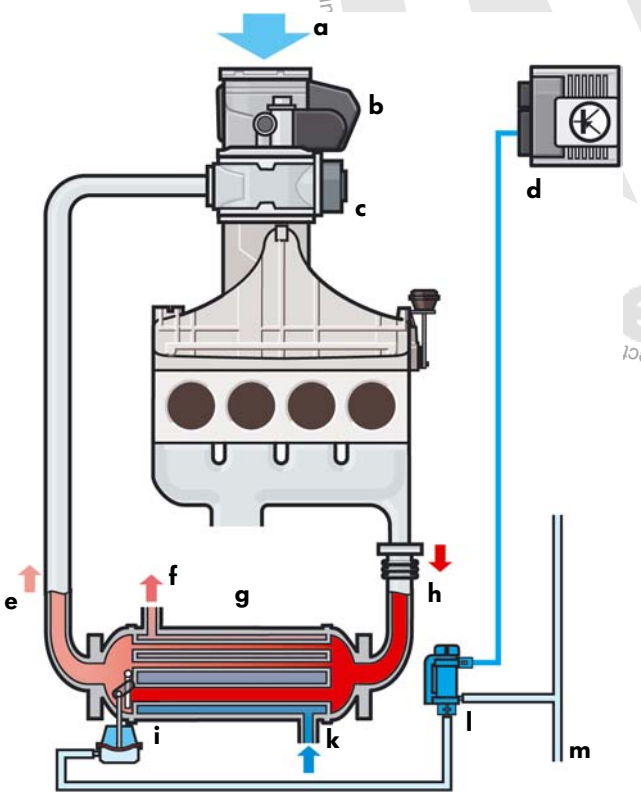


S368_051

This valve is installed in the engine compartment next to the turbocharger. It supplies the exhaust gas cooler's vacuum unit with the vacuum required to switch the bypass flap.

Effect in the event of failure

When it is not supplied with current, the valve isolates the vacuum unit from the vacuum system. The exhaust gas cooler's bypass flap therefore remains closed, with the result that no exhaust gas is able to flow through the cooler.



S368_096

Legend

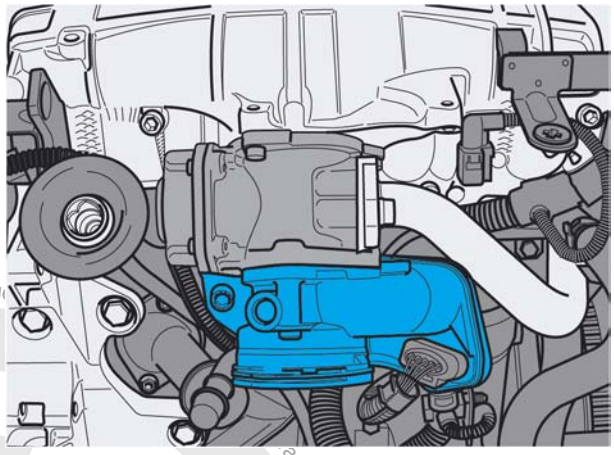
a - Intake air
b - Intake manifold flap
c - Exhaust gas recirculation valve
d - Engine control unit J623
e - Cooled exhaust gas
f - Coolant outlet
g - Exhaust gas cooler
h - Hot exhaust gas
i - Vacuum unit
k - Coolant inlet
l - Exhaust gas recirculation cooler change-over valve N345
m - Vacuum system

Intake manifold flap motor V157

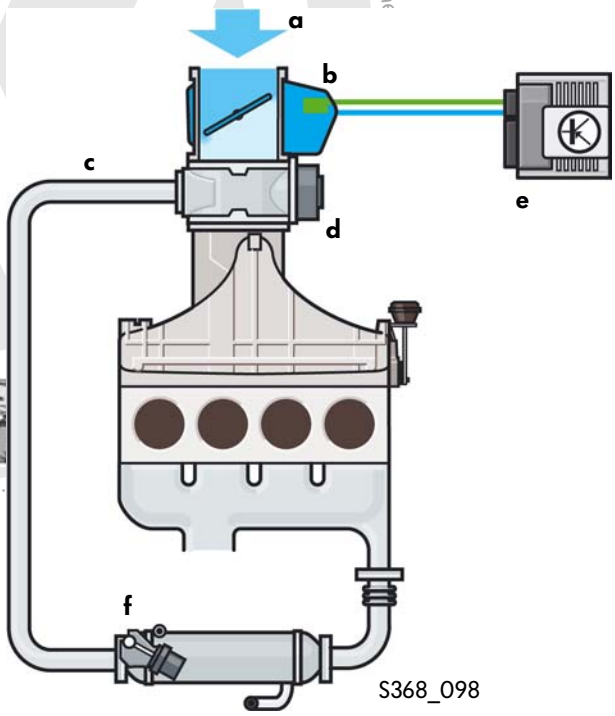
The intake manifold flap contains a regulating flap, which is driven by an electric motor. The regulating flap serves to control the intake air, and is infinitely adjusted by the engine control unit.

Effect in the event of failure

When it is not supplied with current, the regulating flap is pulled into an emergency running position (open) by a return spring. In this position, the intake air is not impeded by the regulating flap.



S368_058

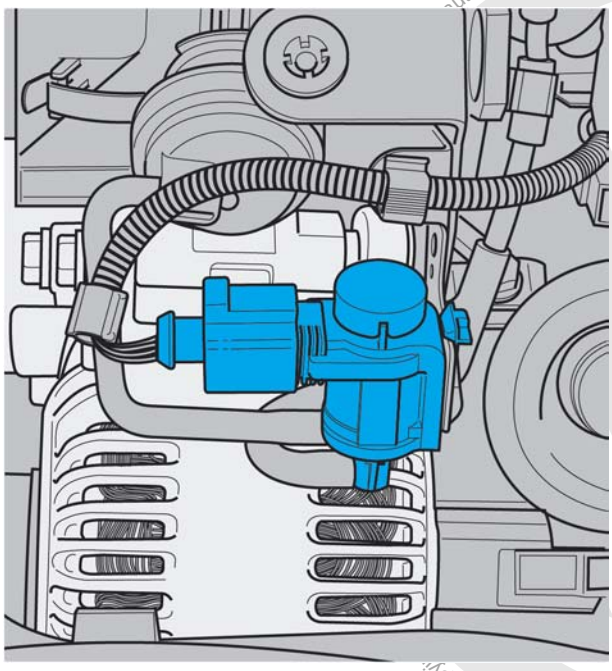


S368_098

Legend

a - Intake air
b - Intake manifold flap with intake manifold flap position sender and intake manifold flap motor V157
c - Exhaust gas supply line
d - Exhaust gas recirculation valve
e - Engine control unit J623
f - Exhaust gas cooler

Intake manifold flap valve N316

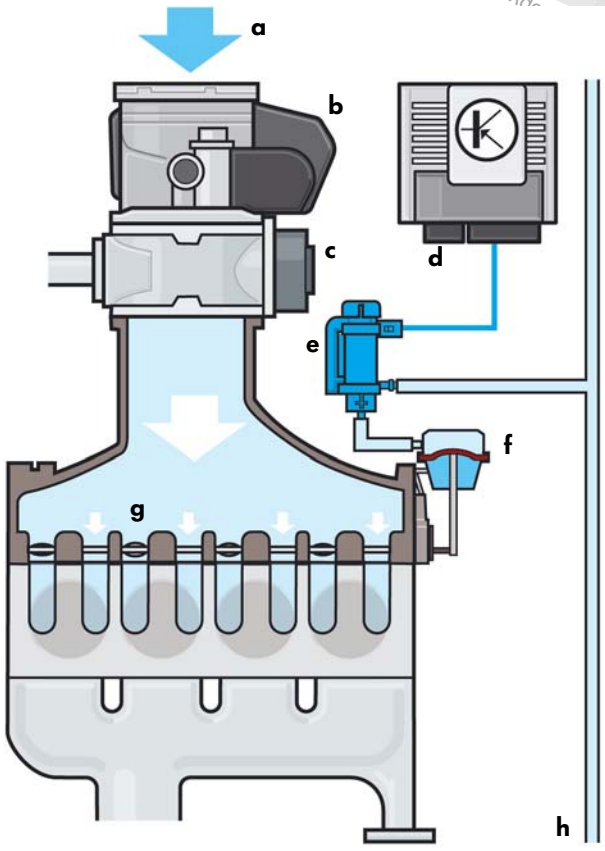


S368_050

The intake manifold flap valve is a solenoid valve. It supplies the intake manifold's vacuum unit with the vacuum required to open and close the swirl flaps. The intake manifold flap valve is installed in the engine compartment above the alternator. It is actuated by the engine control unit depending on a performance map.

Effect in the event of failure

In the event of failure, it is no longer possible to close the swirl flaps in the intake manifold. The intake manifold's swirl flaps are set to the "open" position.

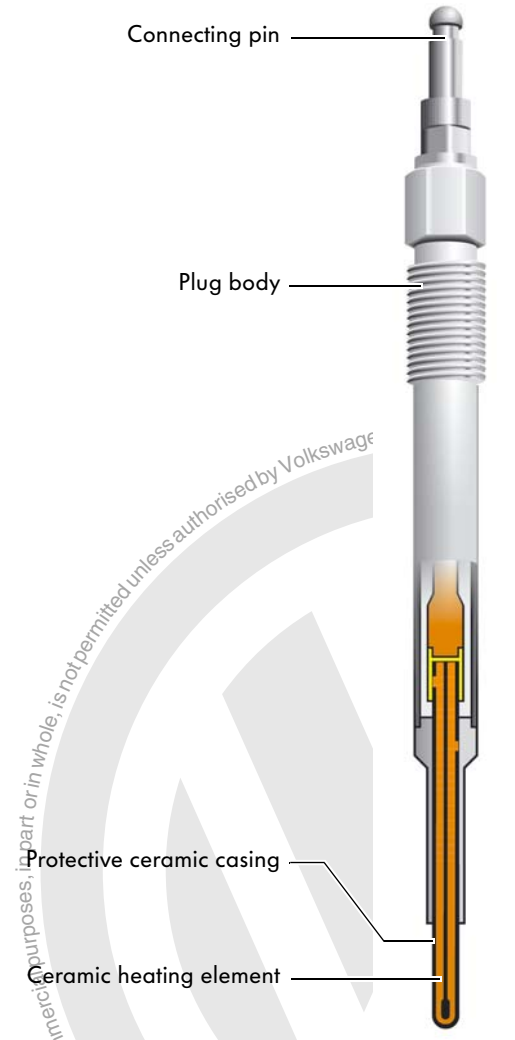


S368_095

Legend

a - Intake air
b - Intake manifold flap
c - Exhaust gas recirculation valve
d - Engine control unit J623
e - Intake manifold flap valve N316
f - Vacuum unit
g - Variable intake manifold with selector shaft
h - Vacuum system

Glow plugs 1 to 4 Q10, Q11, Q12, Q13



S368_020

The new, ceramic glow plugs are a special feature of the glow plug system. They are subject to minimal ageing and therefore have a long service life. Further advantages include better cold-starting behaviour and improved exhaust emission values.

Design

The ceramic glow plugs are comprised of the plug body, the connecting pin and the heating element, which is manufactured from ceramic materials.
The heating element consists of an insulating, protective ceramic casing and an inner, conductive ceramic heating element. The ceramic heating element replaces the regulating and heating coil in a metal glow plug.

Effect in the event of failure

If, when the glow plugs are connected, the automatic glow period control unit determines excessive current consumption or excessive resistance, the corresponding glow plugs are no longer actuated.

Make sure that ceramic glow plugs are only installed in engines designed to accommodate them. If you install ceramic glow plugs in an engine which is not designed for this purpose, difficulties will inevitably arise during cold-starting, as the engine control system cannot make use of the full potential offered by the ceramic glow plugs.

Note that the ceramic glow plugs for 2-valve and 4-valve TDI engines differ as regards their length and screw-in threads.

The ceramic glow plugs are sensitive to impact and bending.
Further information can be found in the Workshop Manual.

Function

Glowing

The ceramic glow plugs are actuated sequentially by the engine control unit via the automatic glow period control unit J179 with the aid of a pulse width-modulated signal (PWM). The voltage at the individual glow plug is adjusted via the frequency of the PWM pulses in this case. For rapid starting at an exterior temperature of less than 14°C, the maximum voltage of 11.5V is applied. This guarantees that the glow plug is heated to over 1000°C within the shortest possible space of time (max. 2 seconds). This reduces the engine's glow period.

Post-start glowing

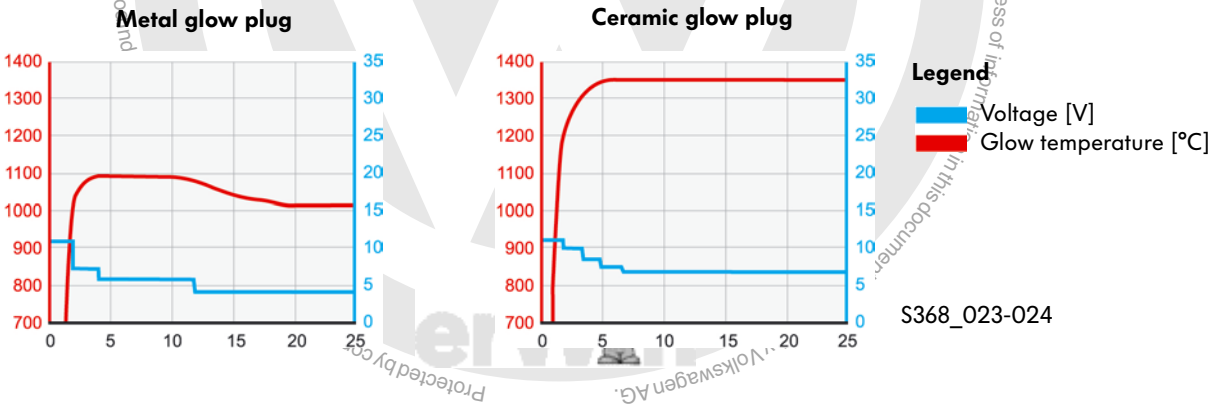
By continuously reducing the control frequency of the PWM signal, the voltage for post-start glowing is adjusted to the rated voltage of 7V. During post-start glowing, the ceramic glow plug reaches a temperature of approx. 1350°C. Post-start glowing is carried out for a maximum of 5 minutes after starting the engine, up to a coolant temperature of 20°C. The high glow temperature helps to reduce hydrocarbon emissions and combustion noise during the warm-up phase.

Intermediate glowing

To regenerate the particulate filter, the glow plugs are actuated by the engine control unit for intermediate glowing. Intermediate glowing improves the combustion conditions during the regeneration process. Due to their low ageing, intermediate glowing during particulate filter regeneration makes no special demands on the ceramic glow plugs.

For comparison purposes

In comparison with metal glow plugs, ceramic glow plugs have significantly higher glow temperatures with similar voltage requirements.



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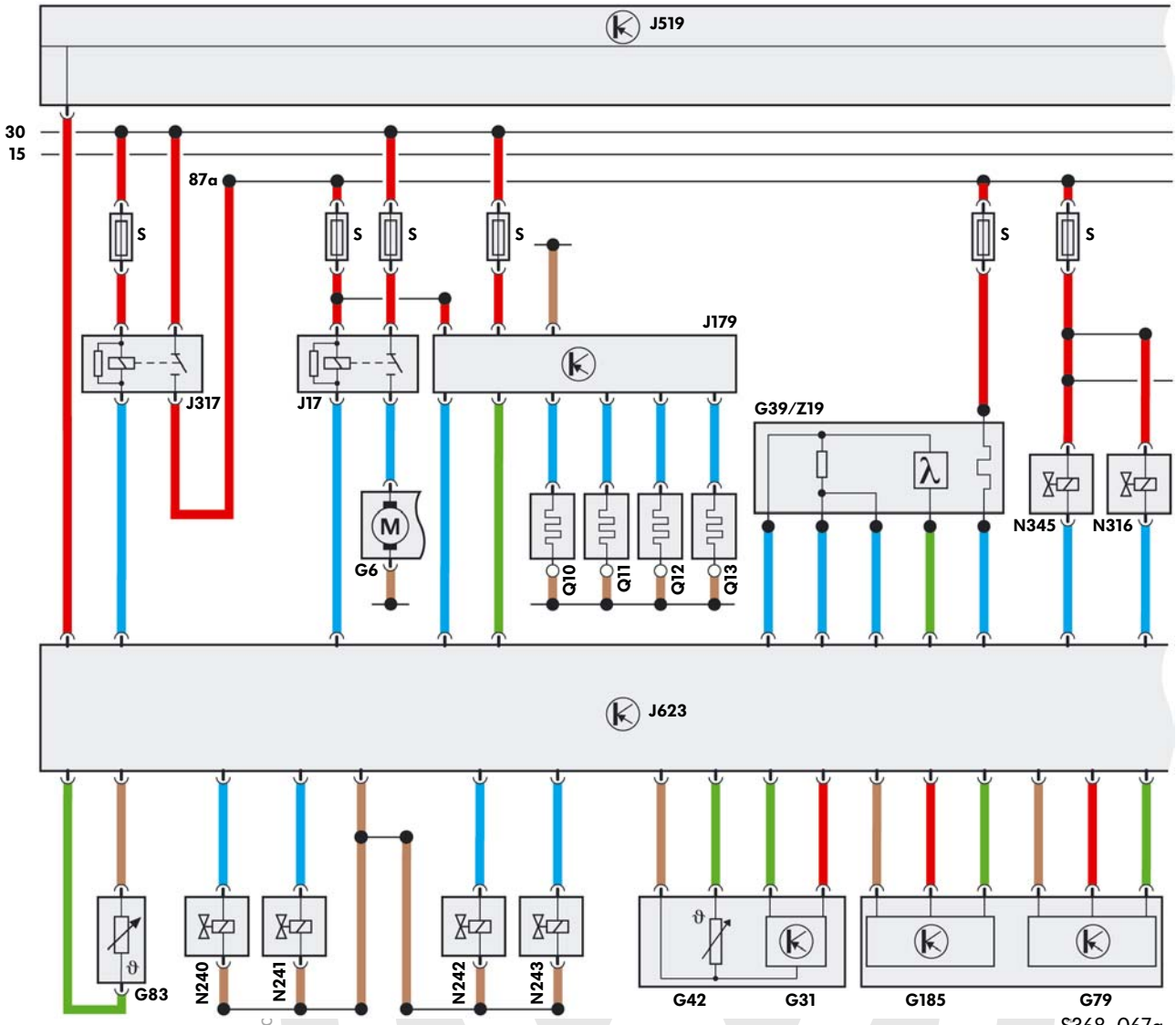
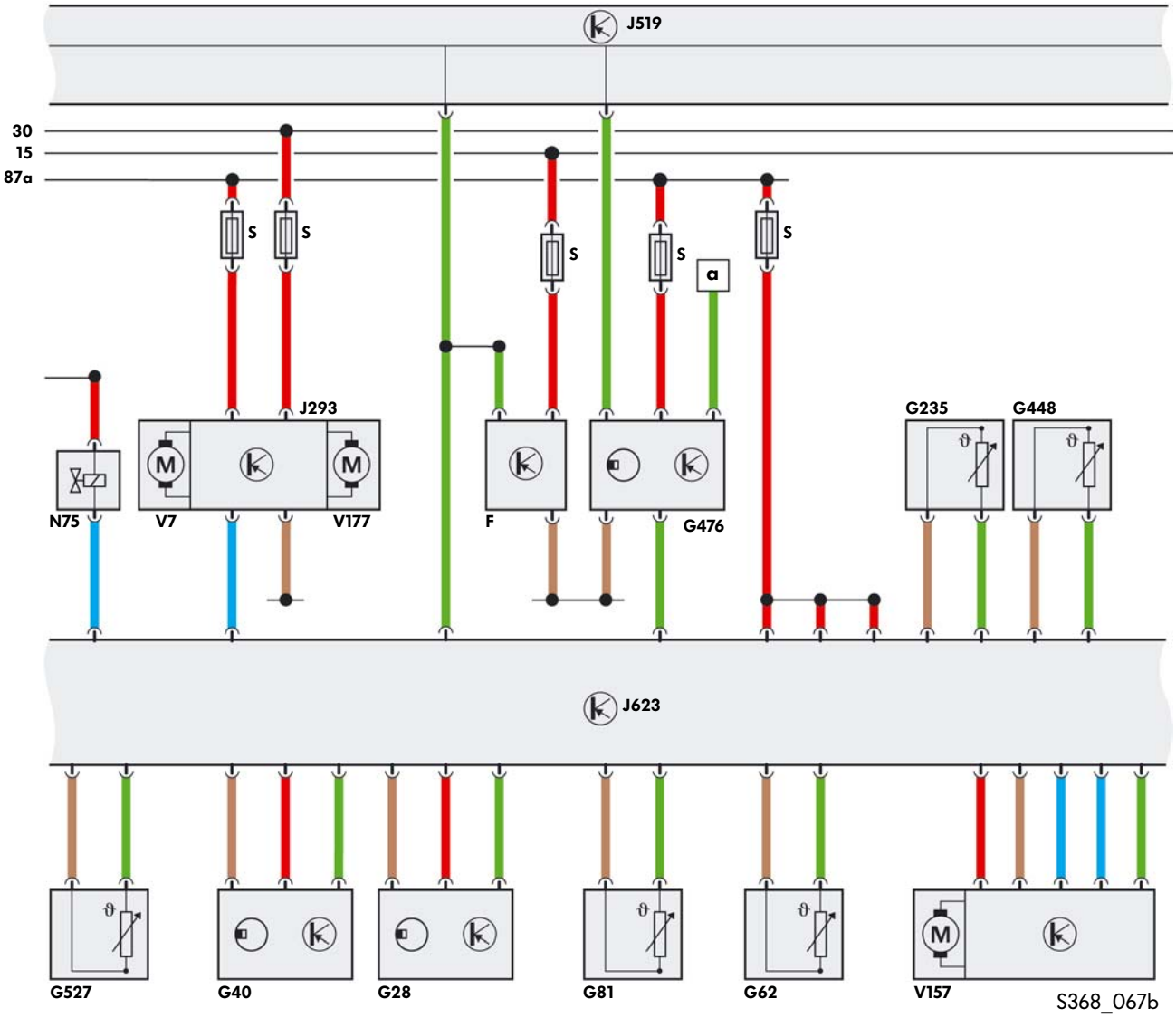
Functional diagram

This functional diagram shows the 2.0l 125 kW TDI engine in the Passat as an example.



G6	Fuel system pressurisation pump
G31	Charge air pressure sender
G39	Lambda probe
G42	Intake air temperature sender
G79	Accelerator position sender
G83	Radiator outlet coolant temperature sender
G185	Accelerator position sender 2
J17	Fuel pump relay
J179	Automatic glow period control unit
J317	Terminal 30 voltage supply relay
J519	Onboard supply control unit
J623	Engine control unit
N240	Unit injector valve, No. 1 cyl.
N241	Unit injector valve, No. 2 cyl.
N242	Unit injector valve, No. 3 cyl.
N243	Unit injector valve, No. 4 cyl.
N316	Intake manifold flap valve
N345	Exhaust gas recirculation cooler change-over valve
Q10	Glow plug 1
Q11	Glow plug 2
Q12	Glow plug 3
Q13	Glow plug 4
S	Fuse
Z19	Lambda probe heater



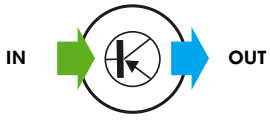
F Brake light switch
G28 Engine speed sender
G40 Hall sender
G62 Coolant temperature sender
G81 Fuel temperature sender
G235 Exhaust gas temperature sender 1
G448 Bank 1 exhaust gas temperature sender
G476 Clutch position sender
(vehicles with manual gearbox only)
G527 Temperature sender after particulate filter
J293 Radiator fan control unit
J519 Onboard supply control unit
J623 Engine control unit
N75 Charge pressure control solenoid valve

S Fuse

V7 Radiator fan
V157 Intake manifold flap motor
V177 Radiator fan 2

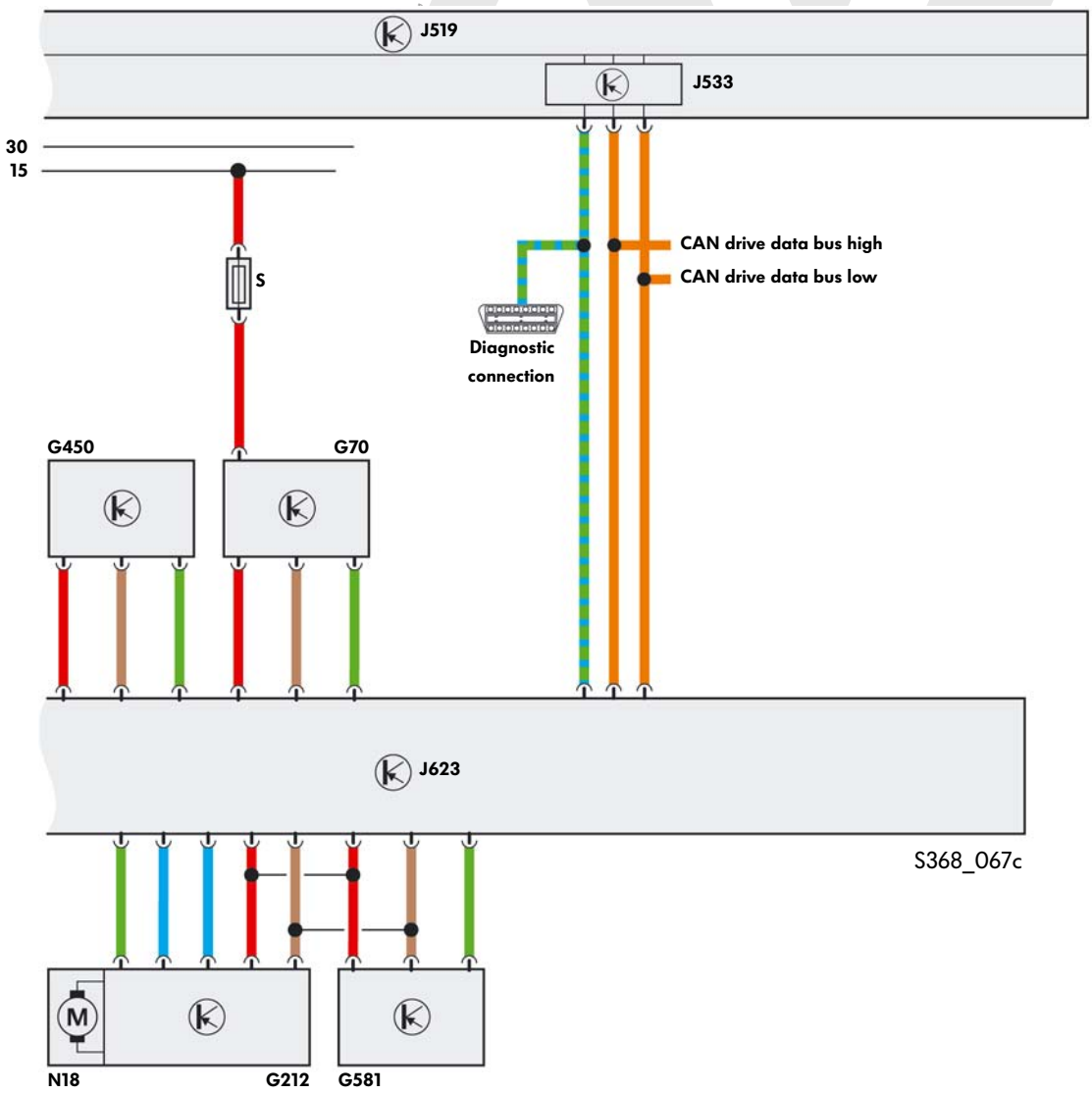
a Control unit for electromechanical parking brake J540

Colour code/legend



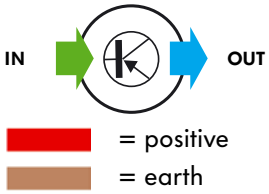
= positive
= earth

Functional diagram



G70	Air mass meter
G212	Exhaust gas recirculation potentiometer
G450	Exhaust gas pressure sensor 1
G581	Position sender for charge pressure positioner
J519	Onboard supply control unit
J623	Engine control unit
J533	Data bus diagnostic interface
N18	Exhaust gas recirculation valve
S	Fuse

Colour code/legend



Test yourself

Which answers are correct?

One, several or all answers may be correct.

1. How is the balancer shaft module driven in the 2.0l 125 kW TDI engine?

☐ a) The crankshaft drives the balancer shaft module via a chain drive.

☐ b) The balancer shaft module is driven via a toothed belt drive.

☐ c) The balancer shaft module is driven by the crankshaft.

2. The exhaust gas recirculation valve ...

☐ a) Has a valve disk which is actuated by an electric motor.

☐ b) Is controlled by means of a vacuum.

☐ c) Is equipped with a contact-free sensor for determining the valve disk position.

3. How are the swirl flaps in the intake manifold switched?

☐ a) With the aid of an electrically driven positioning motor

☐ b) With the aid of a vacuum unit

☐ c) With the aid of an electric switching valve

4. The balancer shaft's backlash is adjusted ...

☐ a) With the aid of a dial gauge.

☐ b) With the aid of a feeler gauge.

☐ c) Via a special coating.

☐ d) With the aid of a new, special tool.

Answers

1. b), c); 2. a), c); 3. b), c); 4. c)

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