Service Training

Commercial Vehicles

Self-Study Programme 455

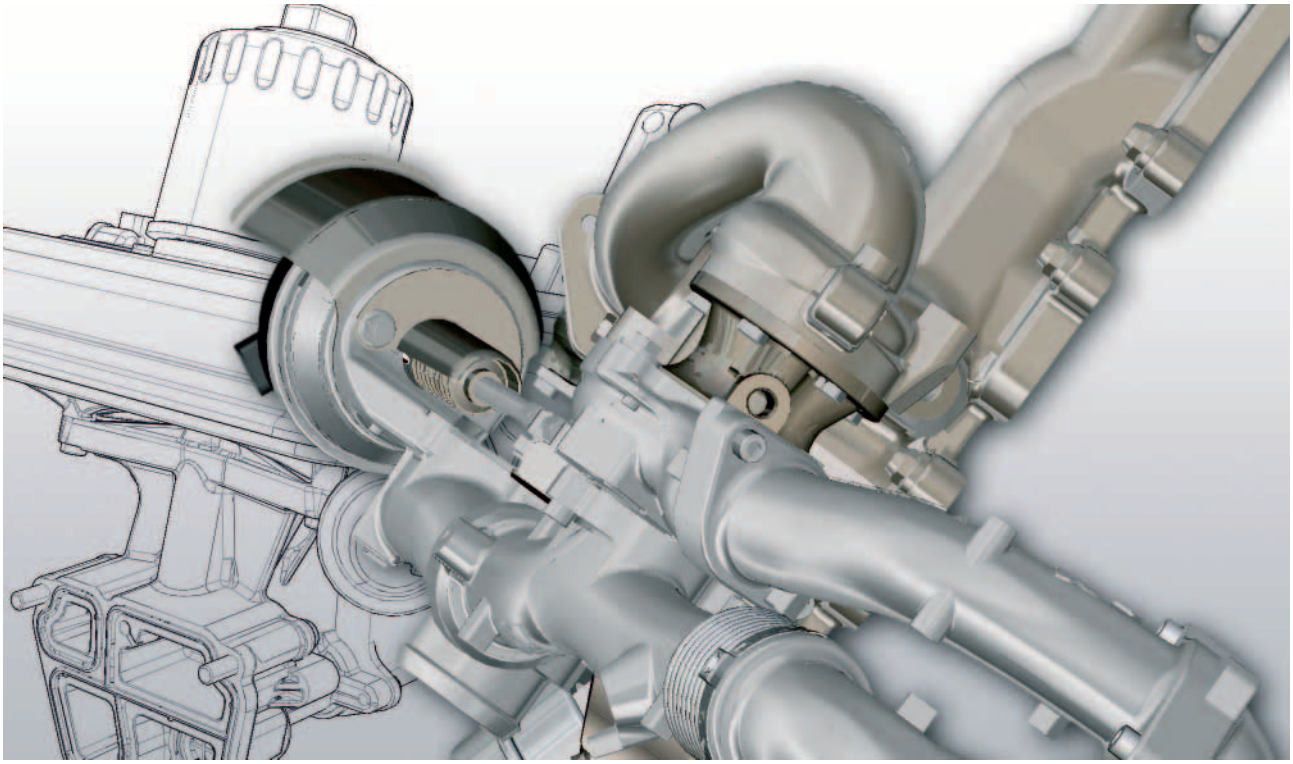
2.0l TDI engines in the T5 2010

Design and function

With the T5 2010, Volkswagen Commercial Vehicles is taking a new path in engine strategy.
The tried-and-tested 1.9l and 2.5l pump/nozzle engines used previously have been replaced by a new generation of the 2.0l common rail engines.

This new engine generation ensures that future, stricter exhaust standards will be complied with.
Further development targets included lower fuel consumption and reduced operating costs.

In this self-study programme, you can find out about the design and function of the new engine generation.



S455_039

Please also note the following self-study programmes that have been prepared for The new T5 2010 by Volkswagen Nutzfahrzeuge:
SSP 453 The T5 2010
SSP 454 The 7-speed dual clutch gearbox 0BT in the T5 2010

The self-study programme shows the design and function of new developments!
The content is not updated.

For current inspection and setting instructions, and workshop manuals, please refer to the service literature that is provided.

Important Note

At a glance

The technical features of the 2.0l TDI engines

The 2.0l diesel engines with VTG turbocharger are available in 62kW, 75kW and 103kW power levels.

The 2.0l TDI engines with VTG turbocharger

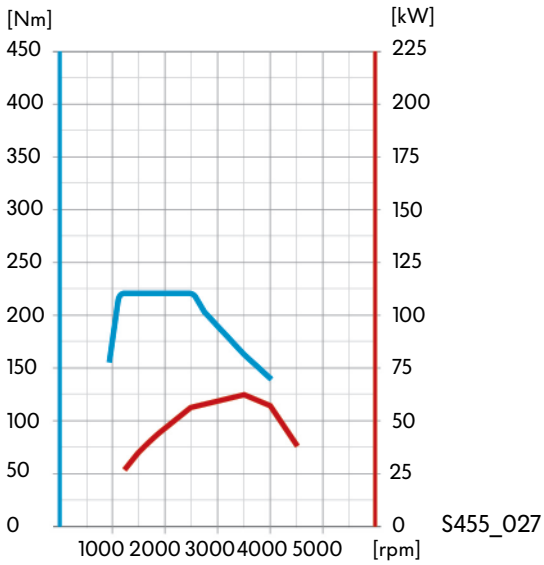
Shared technical features

- Common rail injection system
- Diesel particulate filter (EU5)
- Exhaust gas recirculation through the cylinder head
- Plastic intake manifold
- Turbocharger with variable turbine geometry (VTG turbocharger)

S455_004

Comparison of technical data

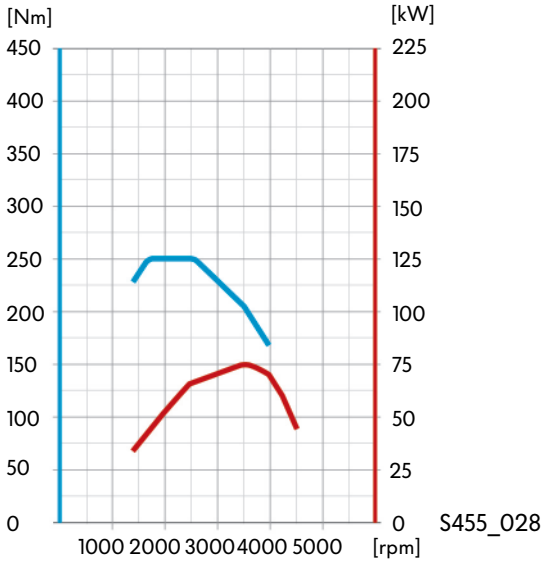
Engine code	CAAA	CAAB	CAAC, CCHA
Design	4-cylinder in-line engine		
Cubic capacity	1968cm^3		
Bore	81mm		
Stroke	95.5mm		
Valves per cylinder	4		
Compression ratio	16.5 : 1		
Max. power	62kW at 3500rpm	75kW at 3500rpm	103kW at 3500rpm
Max. torque	220Nm at 1250-2500rpm	250Nm at 1500-2500rpm	340Nm at 1750-2500rpm
Engine management	EDC 17CP 20		
Turbocharger	VTG turbocharger		
Exhaust gas recirculation	yes		
Emissions standard	EU5 with diesel particulate filter EU4 without diesel particulate filter EU3 without diesel particulate filter		



The power variant with 62 kW

This engine achieves its maximum torque of 220 Nm at an engine speed of as low as 1250 rpm, and maintains this over a wide rpm band up to an engine speed of 2500 rpm.

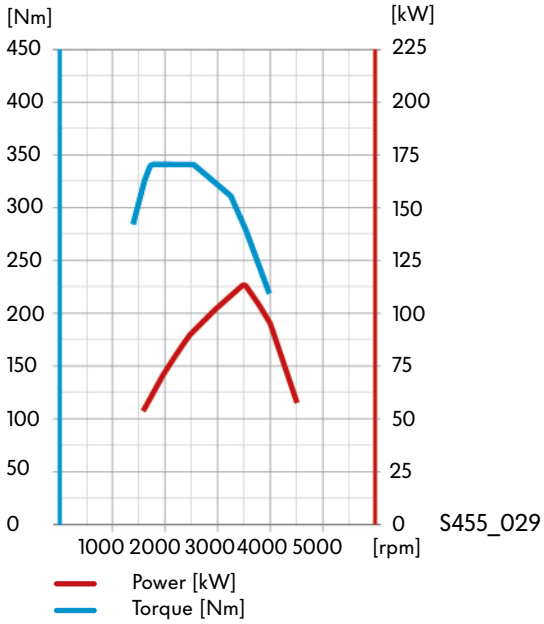
The maximum power of 62 kW is achieved at 3500 rpm.



The power variant with 75 kW

In this power variant too, the maximum torque is achieved in the lower engine speed range at 1500 rpm. The value is 250 Nm and it is upheld until 2500 rpm.

The maximum power of 75 kW is, like in the 62 kW power variant, available at 3500 rpm.



The power variant with 103 kW

This engine achieves its maximum torque of 340 Nm at 1750 rpm.

The power graph shows the maximum power of 103 kW at a speed of 3500 rpm.

Special feature

- Balance shaft module with engine codes CCHA

The 2.0l TDI engine with bi-turbo unit

Technical features

- Exhaust manifold module with bi-turbo unit
- Oil filter module with integrated exhaust gas recirculation cooler
- Cylinder block with additional cooling ducts
- Piston with cooled ring groove

This engine achieves its maximum torque of 400Nm at 1500rpm and maintains this across a band of 750rpm.

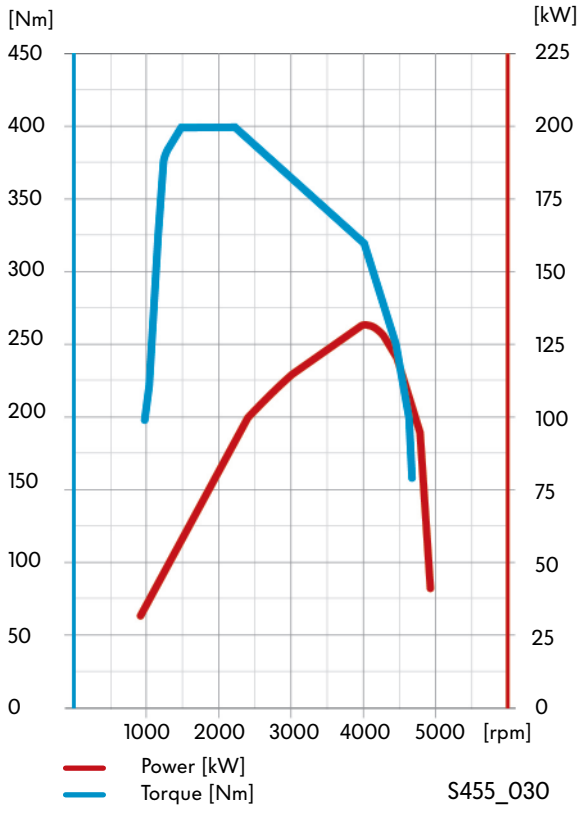
The maximum power of 132kW is achieved at 4000rpm.

S455_003

Technical data

Engine code	CFCA
Design	4-cylinder in-line engine
Cubic capacity	1968cm^3
Bore	81mm
Stroke	95.5mm
Valves per cylinder	4
Compression ratio	16.5 : 1
Max. power	132kW at 4000rpm
Max. torque	400Nm at 1500-2250rpm
Engine management	EDC 17CP 20
Turbocharger	Bi-turbo unit
Exhaust gas recirculation	yes
Emissions standard	EU5 with diesel particulate filter EU4 without diesel particulate filter EU3 without diesel particulate filter

Power and torque graph



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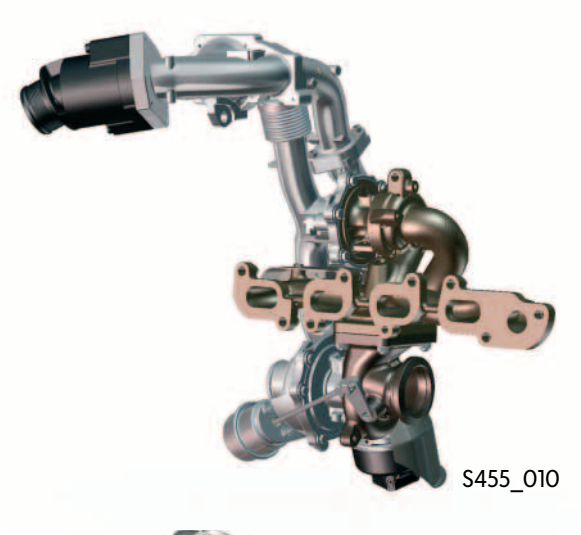
This is of particular interest: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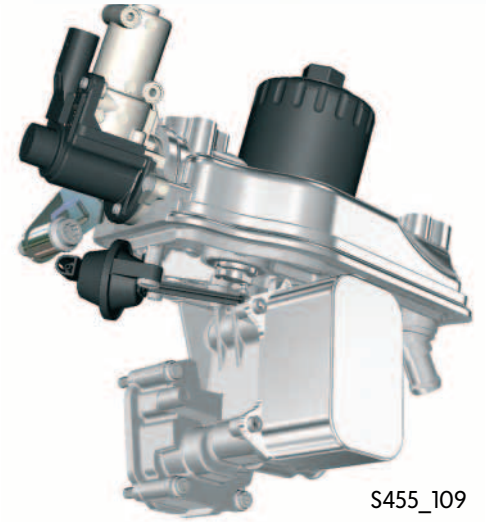
The new bi-turbo unit

The bi-turbo unit of the 2.0l TDI engine with 132kW has a combination of a low-pressure and high-pressure turbocharger to provide a charge air pressure that will meet all power requirements.
The charge air pressure is controlled using a control flap, a wastegate and a compressor bypass.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The new oil cooler module with integrated exhaust gas recirculation

As well as an oil cooler and oil filter, this new oil cooler module also includes the exhaust gas recirculation cooler and the exhaust gas recirculation valve.


S455_005

The new thermostat with ball valve

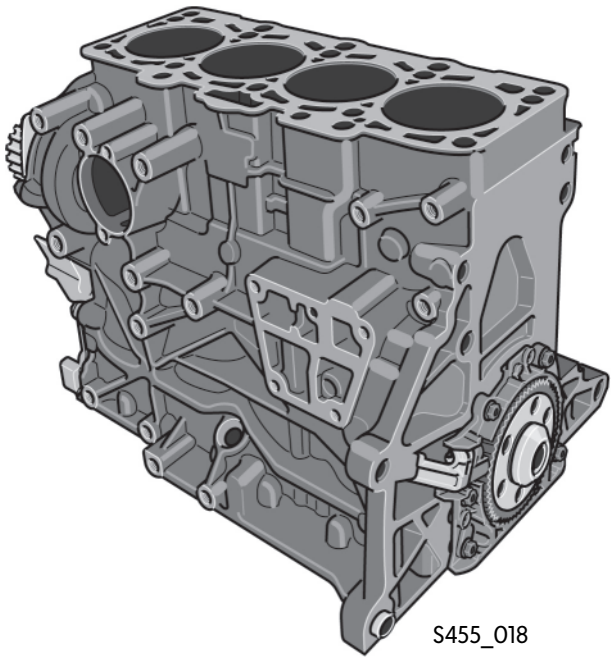
This ball thermostat is configured as a 4/2-way valve and improves the coolant flow rate.

For more information about the engine mechanism and engine management, refer to self-study programmes 223 "The 1.2l and 1.4l TDI engines" and 403 "The 2.0l TDI engine with common rail injection system".

The engine block

The crankcase

The crankcase of the 2.0l TDI engines is made from cast-iron with lamellar graphite.
A balance shaft module is installed in the 103kW engine with engine code CCHA.
This engine is used in the Multivan Comfortline/ Highline and in the California Comfortline.
Furthermore, it is used in all passenger transport vehicles with a 7-speed dual clutch gearbox (DSG).
This affects the window vans, the Multivan Startline, the California Beach and all Caravelles.

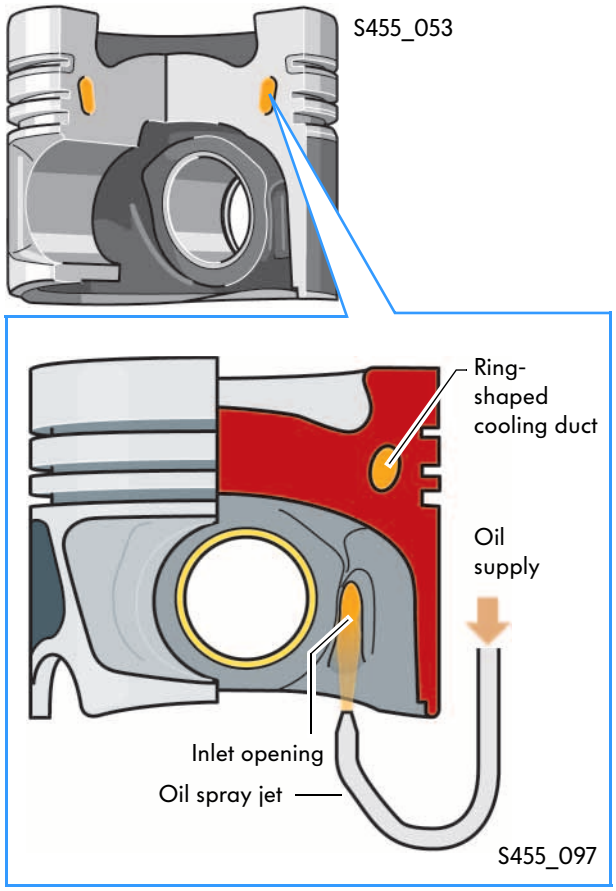


S455_018

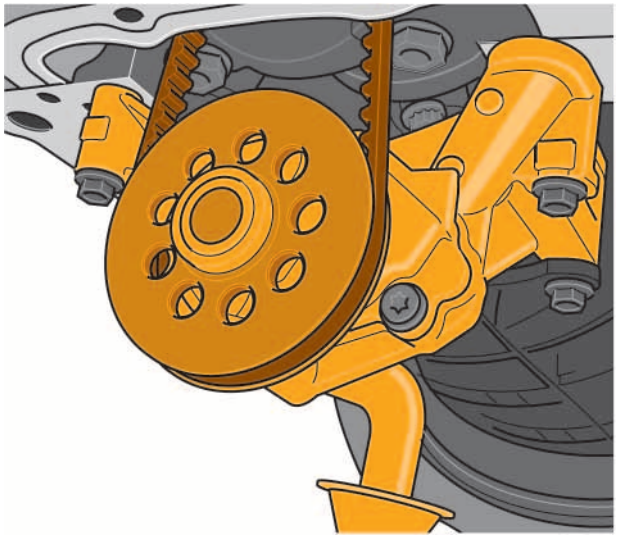
The pistons

There is a ring-shaped cooling duct inside the pistons. Via this, the pistons are cooled with engine oil from the oil circuit. The oil is injected through an oil spray jet which points from below at the inlet opening inside each piston. From there, the oil gets into the cooling duct.

The cooling produces a more even heat distribution in the piston. This lowers the stresses within the piston and reduces wear.



The oil pump



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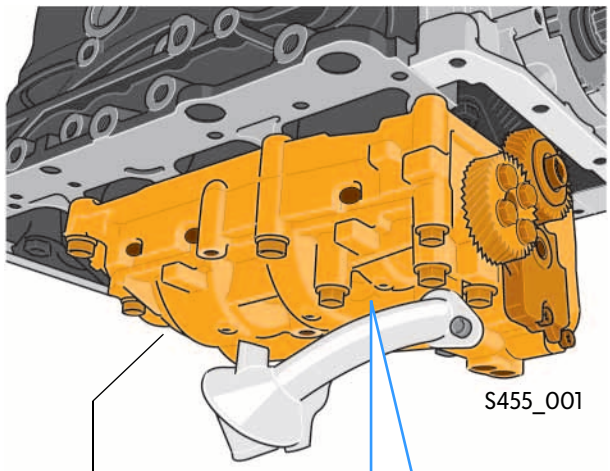
The oil pump in the 2.0l TDI engines without balance shaft module (engine codes CAAA, CAAB, CAAC) is bolted onto the crankcase from underneath. It is a duocentric oil pump.
It is driven from the crankshaft by a toothed belt.

The balance shaft module



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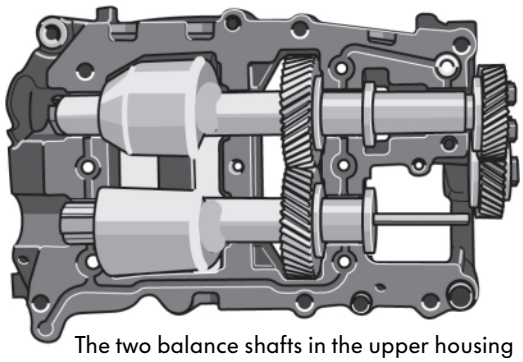
The balance shaft module on the underside of the crankcase with the sump removed.



The two balance shafts in the upper housing frame

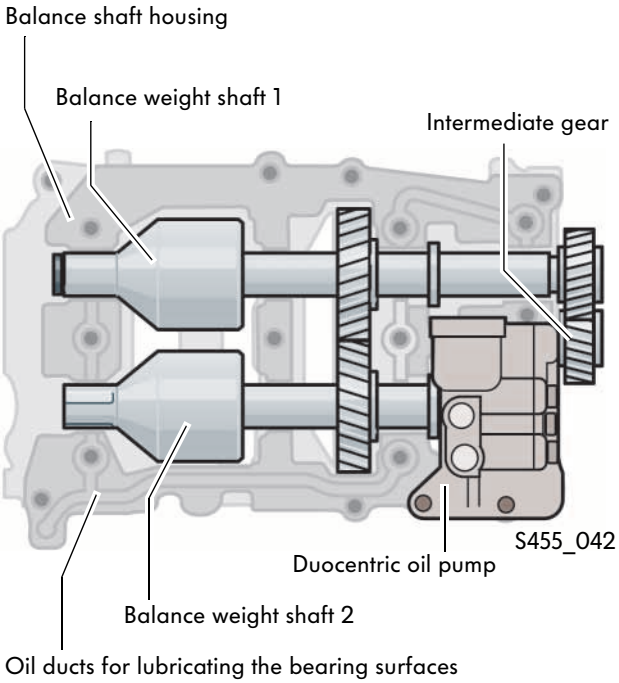
S455_017

In the power variant with 103kW CCHA, as well as in the 2.0l engine with bi-turbo unit, a balance shaft module is used. The duocentric oil pump is also accommodated in the housing of the balance shaft module.

The 2.0l TDI engine

Task

The balance shaft module is used as a vibration damper with variable rotation speed to suppress vibrations that arise in the drivelines at different engine speeds.
This means it makes a major contribution to the smooth running of the engine and thus driving comfort.

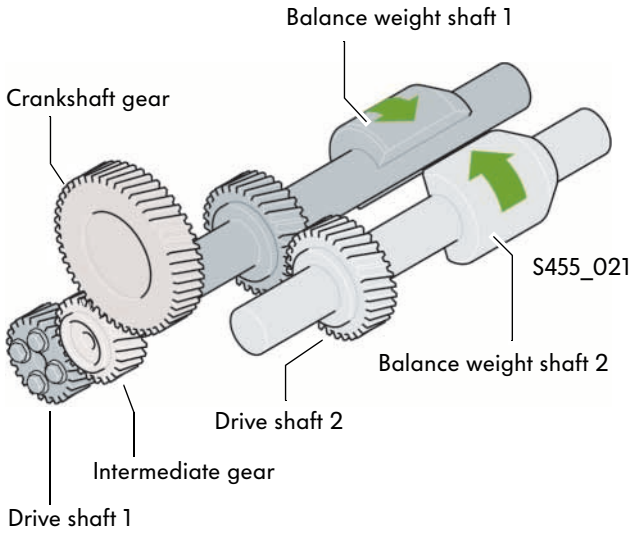


Structure

The balance shaft module consists of a two-piece cast-iron housing, the two balance shafts, the gear drive with helical gearing and the integrated duocentric oil pump.

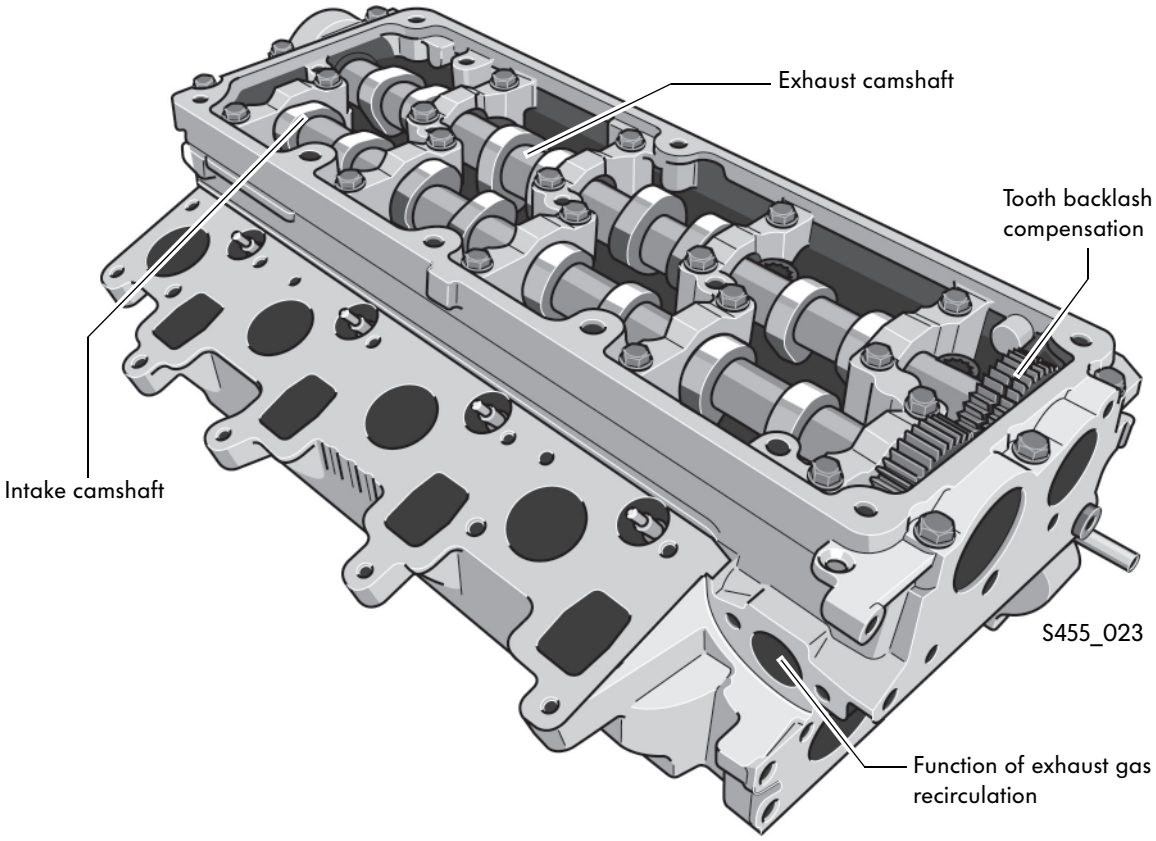
How it works

The balance shafts and the oil pump are driven by an intermediate helical gear on one of the two balance shafts. It engages in the crankshaft gear.
The transmission ratio is configured so that the balance shafts rotate at twice the crankshaft speed.
A pair of gears inside the housing connects both balance shafts together.
The balance weights on both shafts are configured in a mirror-image arrangement, but offset at 180° from one another. This means that the vibrations emanating from the balance shafts are superimposed with those from the crankshaft and the pistons, thereby canceling themselves out to a large extent.



For more information about the balance shaft module, refer to self-study programme 223 "The 1.2l and 1.4l TDI engines".

The cylinder head



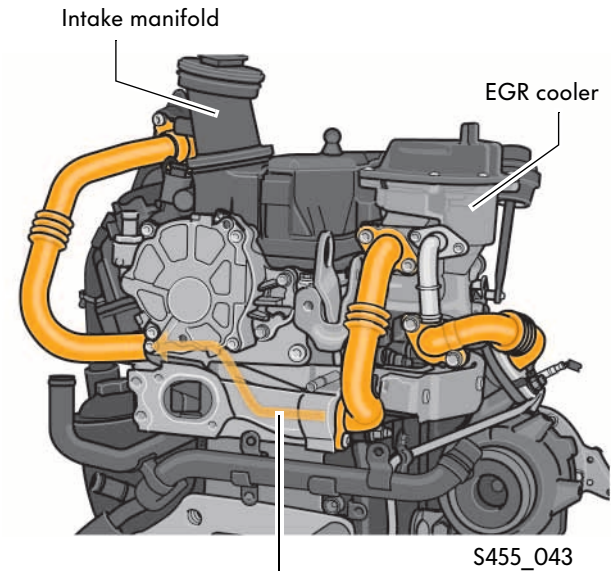
The cylinder head of the 2.0l TDI engine range is a cross-flow cylinder head made from aluminium. It is designed for use with a common rail injection system and has two overhead camshafts. The intake and exhaust camshafts are connected together via helical gearing with tooth backlash compensation.
The engine is configured with four-valve technology, therefore the camshafts have two cams each per cylinder. The valves are installed in parallel and hanging down.

The valves are actuated by roller rocker fingers.
The valve play is compensated by hydraulic tappets.
The injectors of the common rail injection system are secured in the cylinder head using clamping plates.

A new feature in the cylinder head of the 2.0l TDI engines is that the exhaust gas flow of the exhaust gas recirculation is channeled through the cylinder head. The advantage of this routing is that the exhaust gases are additionally cooled in the cylinder head before they are used in the combustion process. This measure contributes to reducing nitrous oxides (NO_x).

The exhaust gas recirculation

To reduce nitrous oxide emissions, the 2.0l TDI engines are equipped with exhaust gas recirculation (EGR). The exhaust gas is recirculated into the combustion chamber, which means that the combustion temperature is reduced, and the formation of nitrous oxides (NO_x) is reduced. Routing the exhaust gases through the cylinder head is a new feature. Not only does this mean pipes are removed, but the exhaust is also cooled additionally as it passes through the cylinder head, which means the cooling effect of the exhaust in the combustion chamber is increased.



Exhaust is channeled through the cylinder head for cooling.

The exhaust gas recirculation cooler

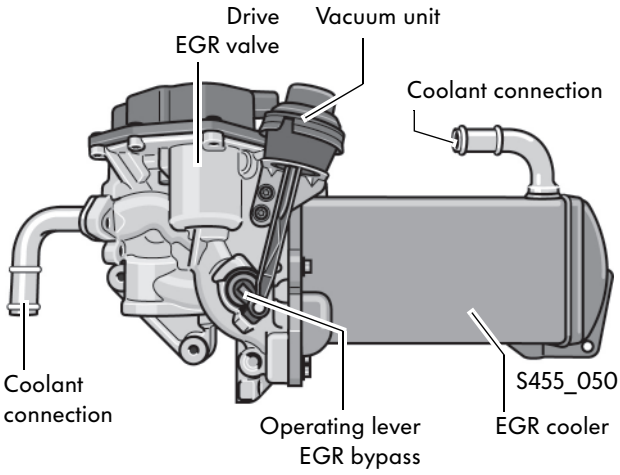
This engageable cooler for the exhaust gas recirculation is grouped together in a module together with the electrically operated EGR valve.

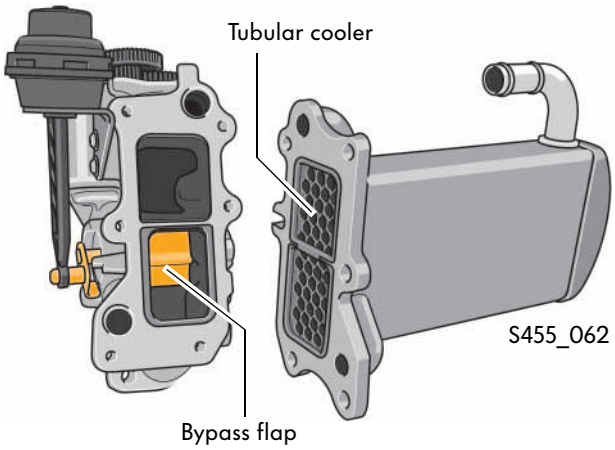
Task

The cooler ensures that the cooled and recirculated exhaust gases reduce the combustion temperature further. In addition, the higher density of the cooled exhaust gas compared to non-cooled exhaust gas allows a higher volume of exhaust to be recirculated.

Structure

The cooler is configured as a tubular cooler. A bypass flap operated by a vacuum unit as the actuator makes it possible to switch off the cooler if necessary and to recirculate non-cooled exhaust gas into the intake tract.



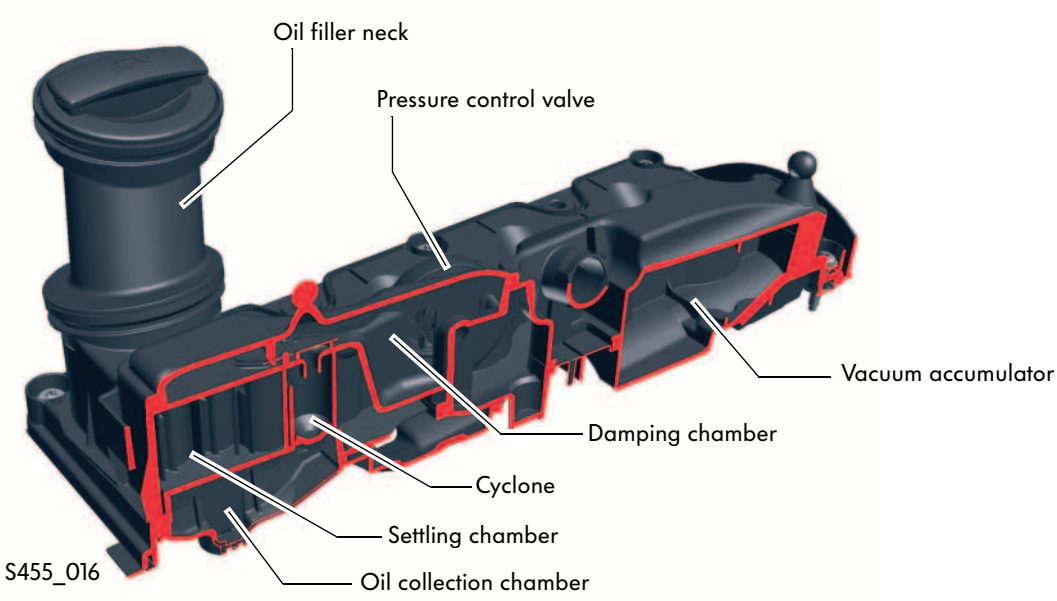


The crankcase breather

The crankcase breather in all 2.0l TDI engines presented in this document is integrated in the cylinder head cover.

Task

The blow-by gases containing oil are returned via the crankcase breather to the intake zone and the oil residues they contain are removed for the most part in this process. This is done by coarse and fine separation.



Structure

The entire oil separation apparatus is accommodated in the cylinder head cover. It consists of:

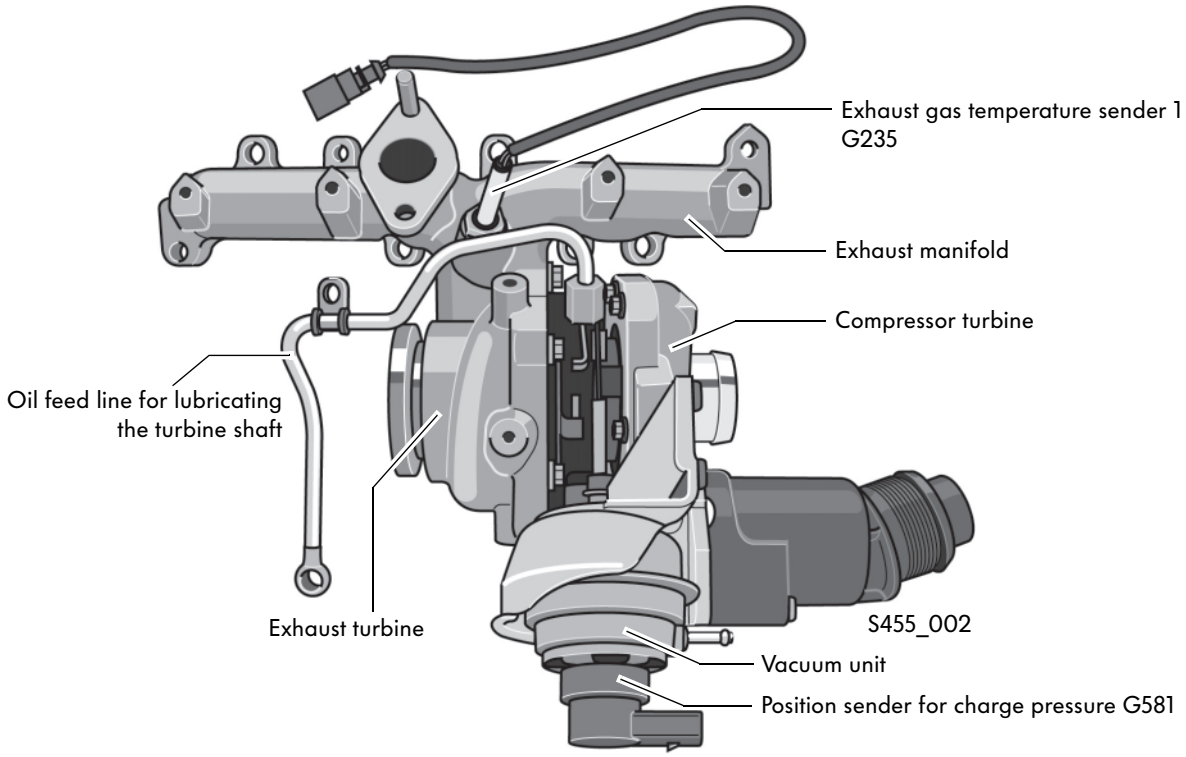
- the settling chamber
- the cyclones
- the damping chamber
- the pressure control valve

The cylinder head cover additionally houses a vacuum accumulator.

Coarse separation takes place in the settling chamber. This is where the larger oil droplets are separated out, and they drip back into the cylinder head.
The fine separation takes place in the cyclones. The oil separated out there returns to the cylinder head via a collection chamber. Finally, a residual amount of oil can be recovered in the settling chamber.
However, the primary task of this area is to prevent disruptive flow vortices in the intake manifold.

A detailed description of the procedure and function of the oil separation in the crankcase breather can be found in self-study programme 403 "The 2.0l TDI engine with common rail injection system".

The exhaust manifold



The 2.0l engines with power levels 62kW, 75kW and 103kW are equipped with an exhaust manifold module in which a VTG turbocharger is integrated. The installation space available means that the turbocharger is installed "hanging". The exhaust gas temperature sender is also integrated in the module and is located above the turbocharger in the 103kW engine.

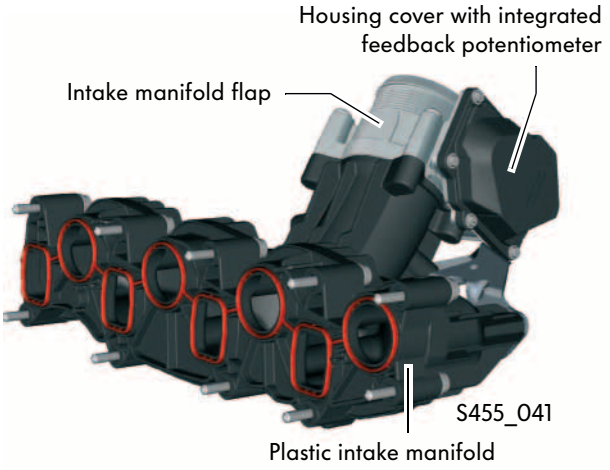
Task

The exhaust manifold module channels the exhaust gases to the turbocharger. In the turbocharger, the exhaust flow drives the turbine blades of the charger that are mounted on the same shaft as the compressor blades. The compressor blades build up the necessary charge air pressure in the charge air pressure section.

Structure

The VTG turbocharger has a variable turbine geometry. This means the rotation speed of the exhaust turbine and therefore the speed of the compressor turbine is regulated by guide vanes that change the angle of incidence of the flow on the turbine blades.
The position of the guide vanes is registered by the position sender for charge pressure G581 and is sent to the engine control unit.

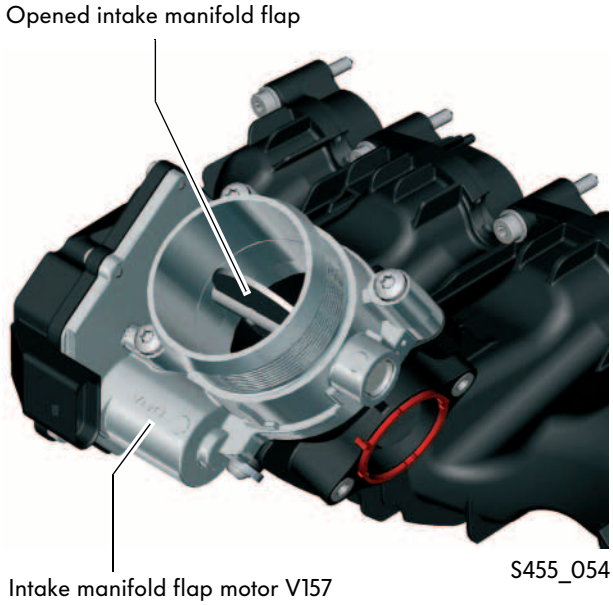
The intake manifold



The 2.0l TDI engines have an intake manifold made from plastic. The intake manifold has the electrically operated intake manifold flap with feedback potentiometer screwed onto it.

Advantages

- Lower weight
- Optimised intake air duct geometry for all engine speed ranges
- The same intake manifold for all power variants



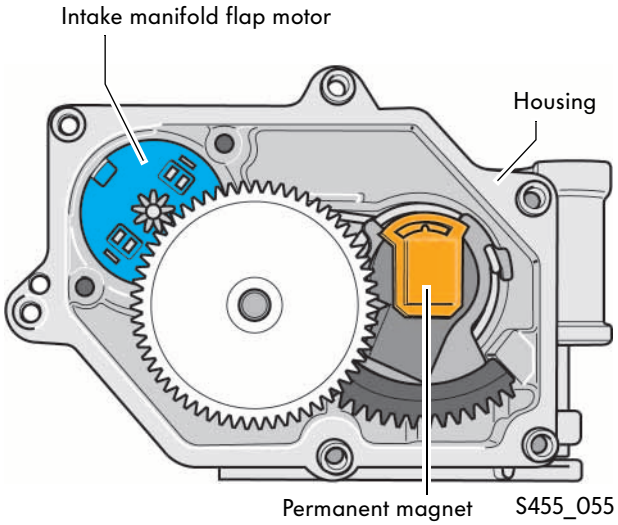
The intake manifold flap

The electrically operated intake manifold flap undertakes different tasks:

- The flap is closed when the engine is stopped. This means the air supply is cut off and the engine comes to a stop.
- During regenerative mode of the diesel particulate filter, the intake manifold flap controls the intake air quantity.
- The intake manifold flap is controlled accordingly in order to support the exhaust gas recirculation in that a differential pressure is generated between the intake manifold pressure and the exhaust pressure.

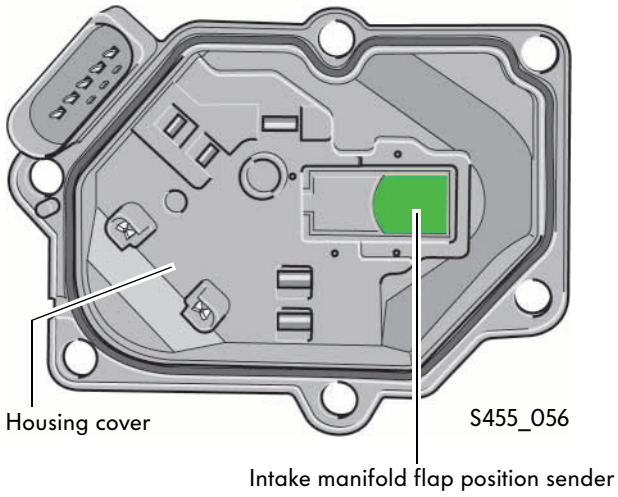
Structure

The electric drive for the intake manifold flap consists of the intake manifold flap motor V157 and the intake manifold flap position sender. Both are grouped together in one housing. The control motor V157 operates the intake manifold flap via a gear unit. The intake manifold flap position sender is integrated in the housing cover and sweeps a permanent magnet that is connected with the intake manifold flap gear unit and rotates with the intake manifold flap.



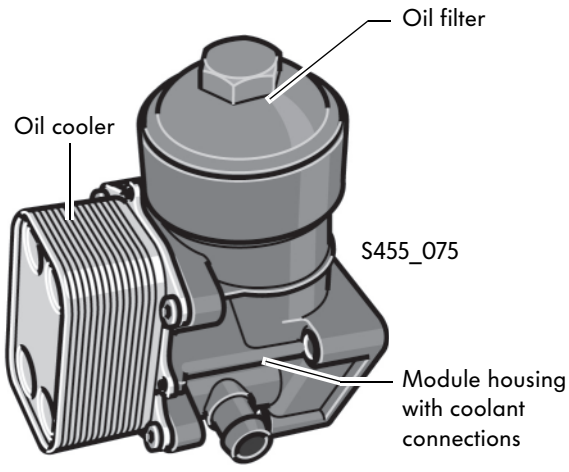
Effect on failure of the intake manifold flap.

If the intake manifold flap drive suffers a defect, the flap is help open by spring force. Correct control of the exhaust gas recirculation is no longer possible. Also, active regeneration of the diesel particulate filter is no longer possible if the intake manifold flap is defective.



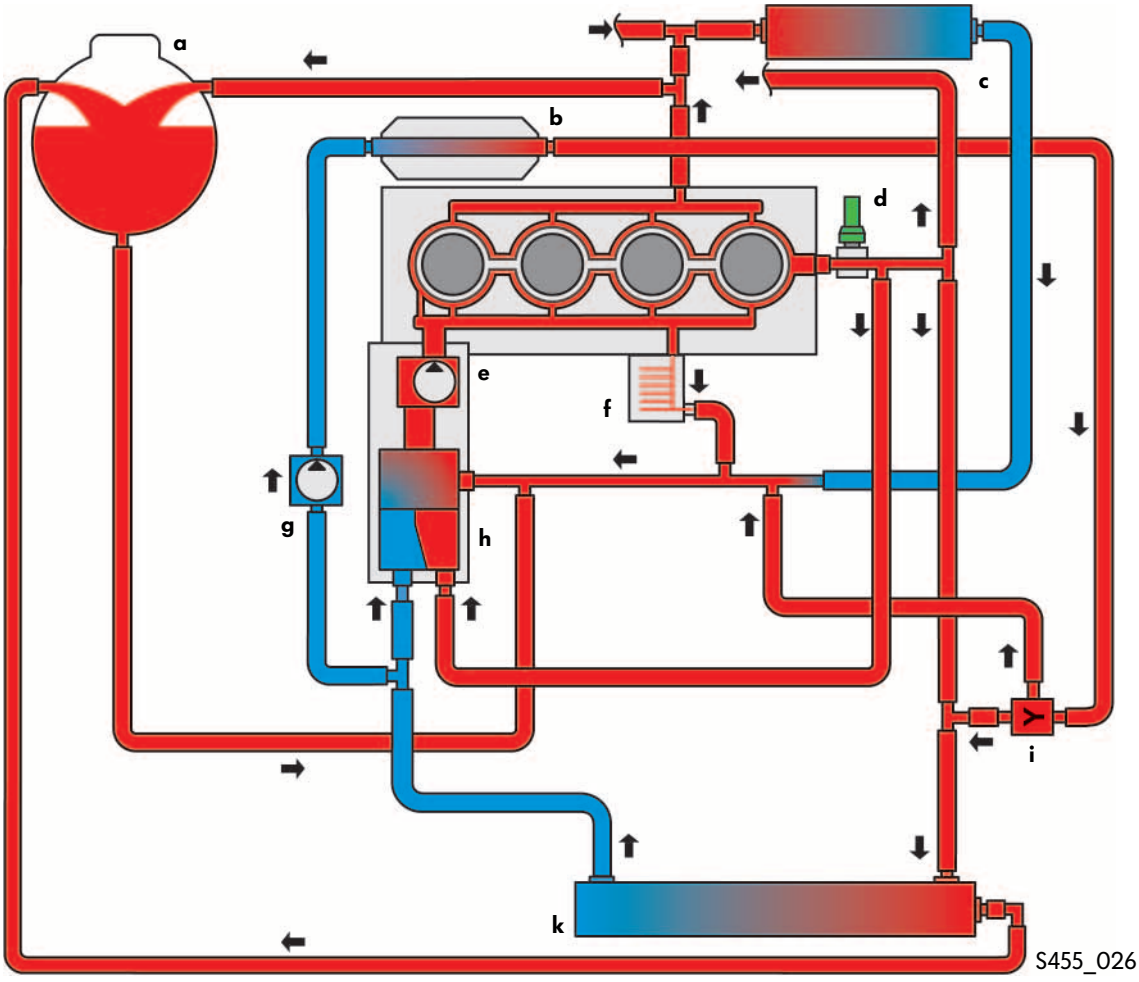
The oil filter module

The oil filter module consists of an oil cooler, oil filter and the module housing. The oil filter is made of plastic. Both components have been rearranged in view of the installation space.



The coolant circuit with ball thermostat

In the coolant circuit, the coolant is recirculated by a mechanical coolant pump that is driven by an ancillary drive. The circuit is controlled via the new ball thermostat (4/2-way valve).



Key

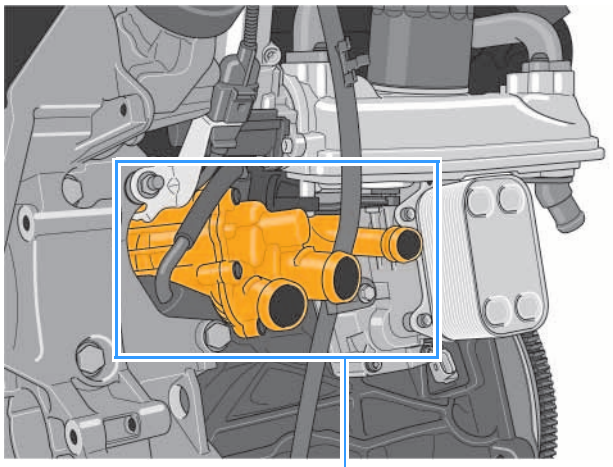
a Expansion tank
b Cooler for exhaust gas recirculation
c Heat exchanger for heating
d Coolant temperature sender G62
e Coolant pump
f Oil cooler
g Coolant circulation pump 2 V178
h Ball thermostat (4/2-way valve)
i Y-thermostat
k Engine cooling circuit radiator

The coolant circuit shown here is only a basic circuit of the T5 2010.
It is possible to distinguish between different versions of the coolant circuit depending on the equipment.

The ball thermostat

The new ball thermostat (4/2-way valve) is part of the innovative thermo management. It replaces the thermostat used previously.
Advantages of the ball thermostat:

- Lower operating forces
- Compact design
- Higher flow rate with fully opened control flap



The ball thermostat on the bi-turbo engine

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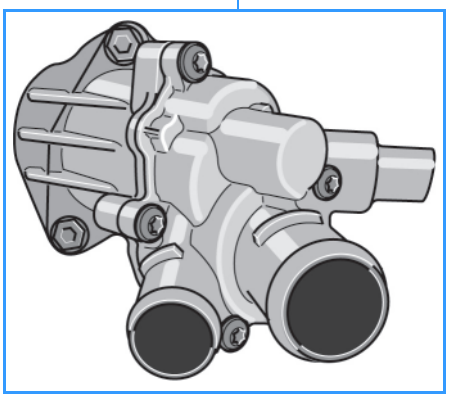

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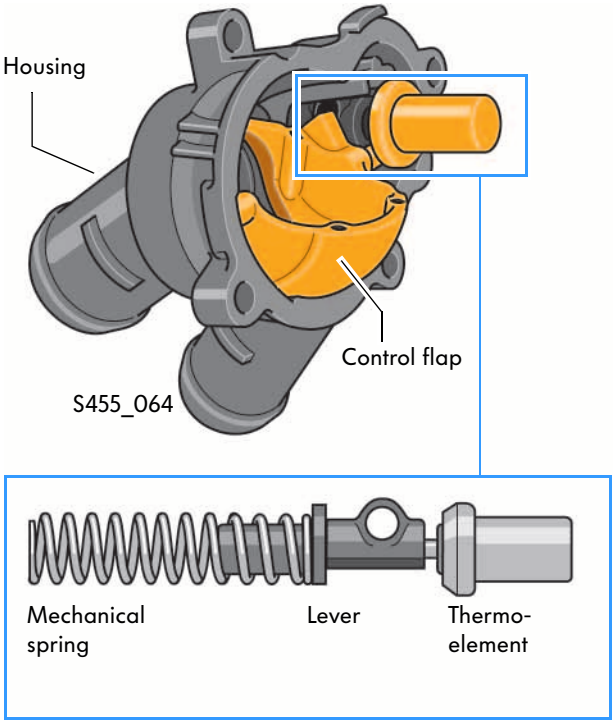
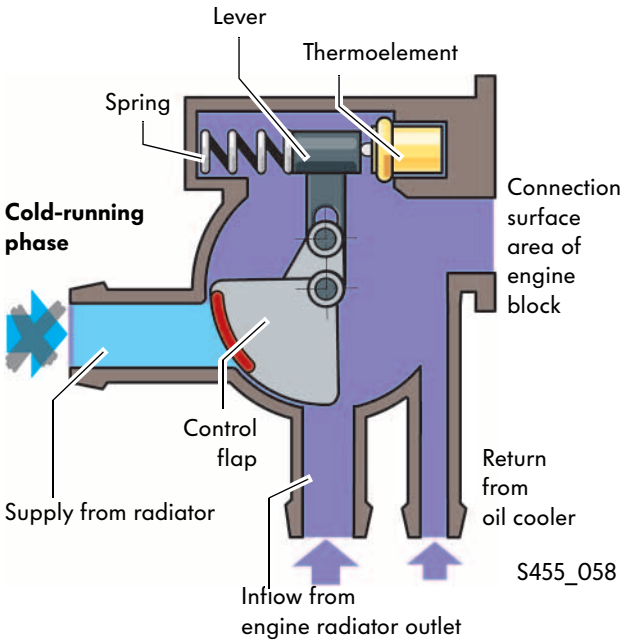
Task

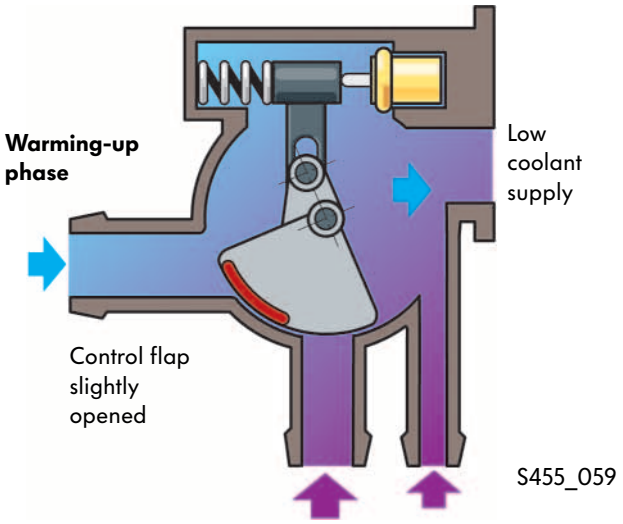
The ball thermostat controls the coolant flow according to the requirement, so that the engine quickly reaches its optimum operating temperature when started from cold, and is kept at this temperature in spite of the different power requirements.

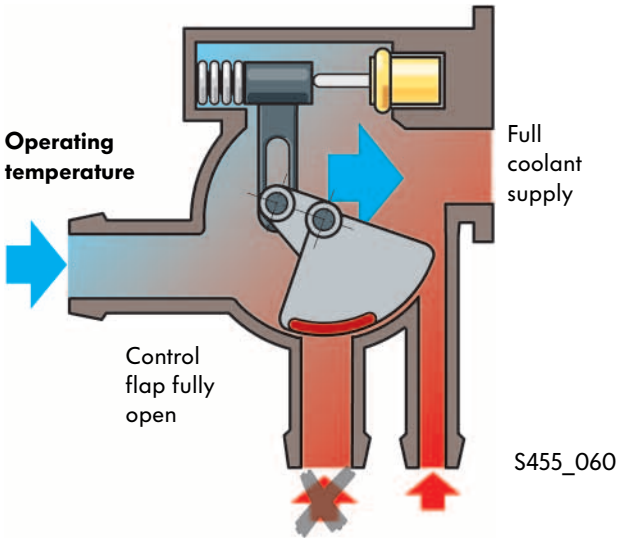
Structure

The heart of the ball thermostat is a swiveling control flap that provides infinitely variable control over the coolant flow that is channeled through the two coolant inlet ports. The control flap is operated by a thermoelement that is integrated in the housing of the ball thermostat. The flap is reset using a mechanical spring that counteracts the movement of the thermoelement.









How it works

Whilst the engine is running, it is possible to distinguish between the following control settings of the ball thermostat:

- in the cold running phase
- in the warming-up phase
- at operating temperature

The transitions between these examples are infinitely variable. The control flap adjusts itself directly to the changing temperature situation by means of the thermoelement.

- In the cold running phase

The supply flow from the engine circuit radiator is completely closed by the control flap.
The coolant only circulates in the small circuit. This means the power unit quickly reaches its optimum operating temperature.

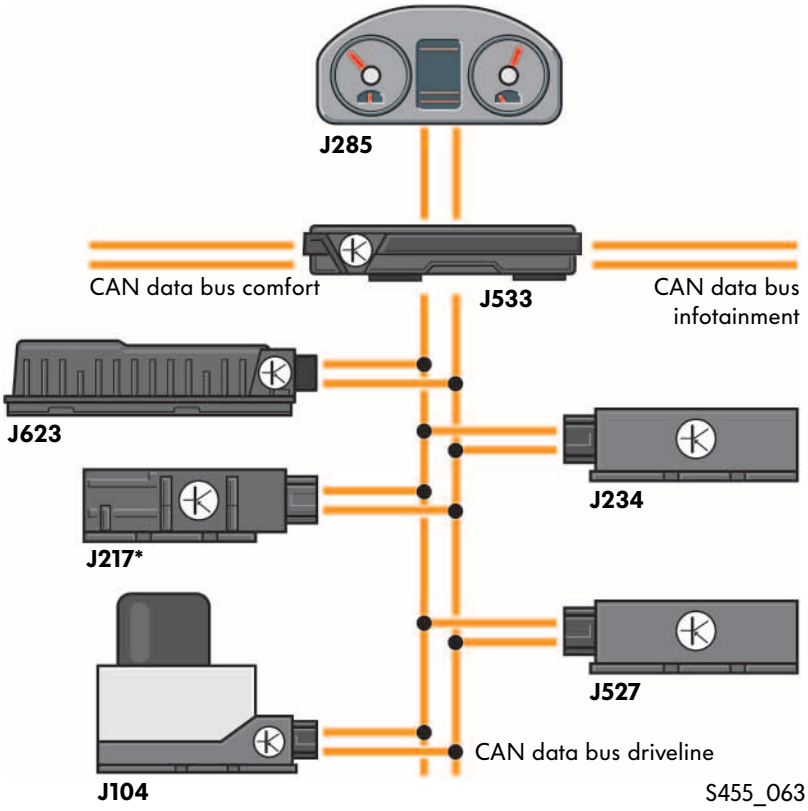
- In the warming-up phase

As the coolant temperature increases, the thermoelement starts to move the control flap so that the inflow of cold coolant from the radiator is partly opened. This allows surplus heat to be transported away, in order to keep the engine in the optimum temperature range.

- At operating temperature

Once the power unit has reached its operating temperature, the control flap for the inflow from the radiator is fully opened.
Maximum coolant flow is now channeled through the radiator.

The engine management system



Key

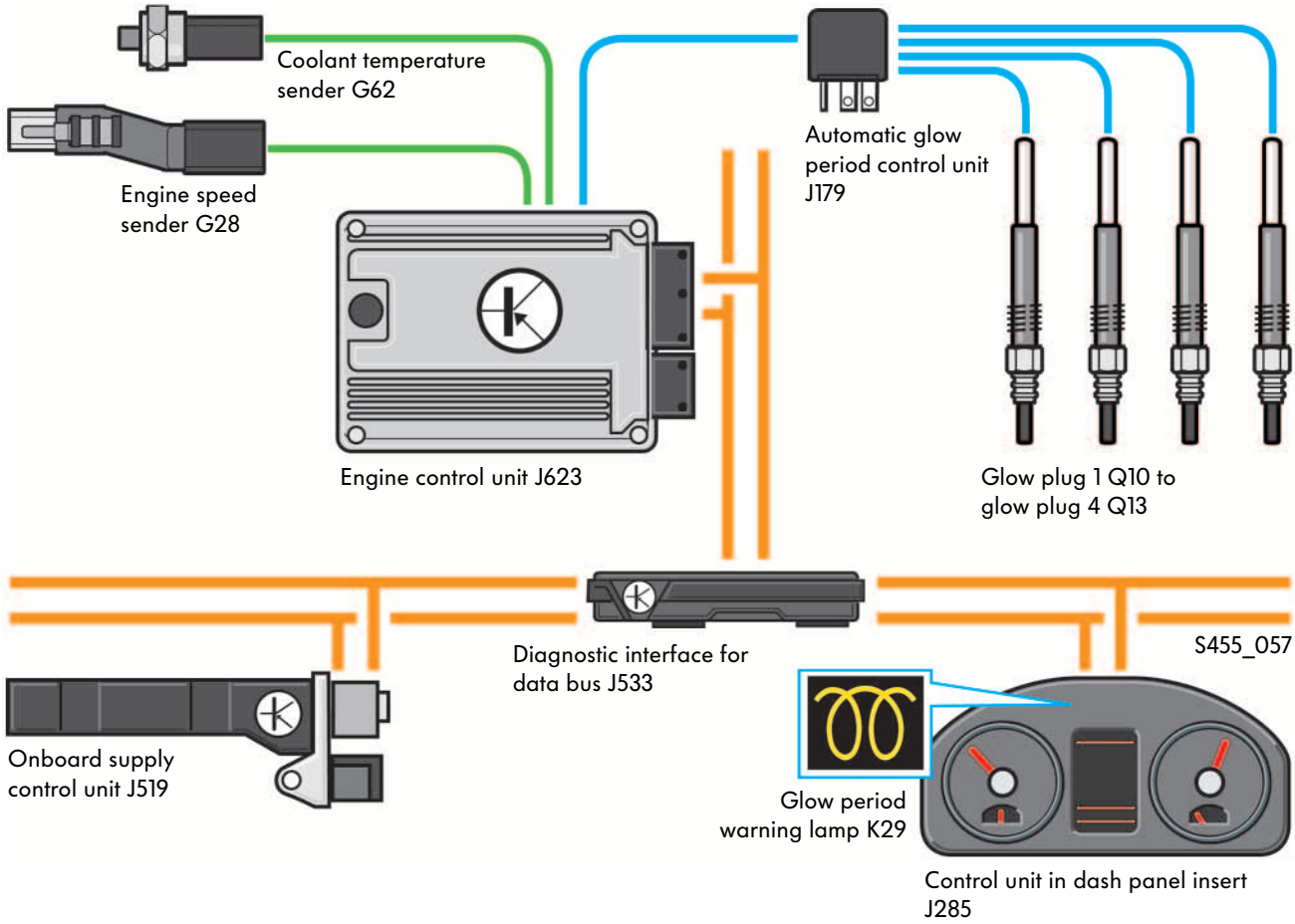
J104	ABS control unit
J217	Automatic gearbox control unit*
J234	Airbag control unit
J285	Control unit in dash panel insert
J527	Steering column electronics control unit
J533	Diagnostic interface for data bus
J623	Engine control unit

* only if equipped with automatic gearbox

The heart of the engine management system of the 2.0l TDI engines is the electronic diesel control EDC 17 CP20 manufactured by Bosch.

Depending on the equipment of the T5 2010, communication as part of the engine management system involves the various control units of the individual vehicle systems, such as the gearbox control unit and the ABS/ESP control unit. If data has to be exchanged via the CAN data bus driveline with other CAN data bus systems in the vehicle, for example with the CAN data bus comfort, then the data is carried via the diagnostic interface for data bus.
The diagnostic interface functions as an interface between the bus systems and for vehicle diagnosis.

The glow plug system



In order to achieve an engine start comparable to that of petrol engines under all climatic conditions without lengthy glow times, the 2.0l TDI engines with common rail injection system have a fast-start diesel glow system.

The advantages of the glow system are:

- Immediate engine start at temperatures down to minus 24 °Celsius.
- Extremely short heating-up time of the glow plugs (up to 1000 °C within 2 seconds)
- Controllable temperatures for pre- and post-glow time
- Self-diagnostic capability

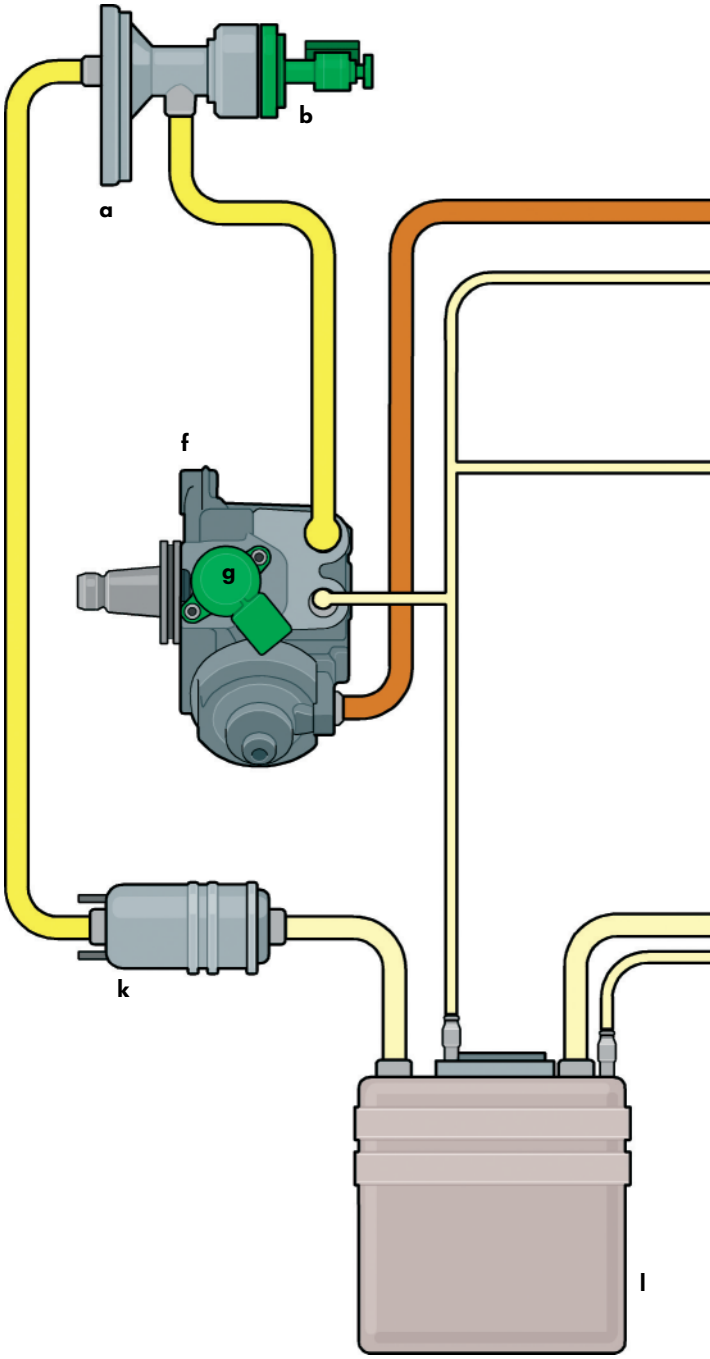
The common rail injection system

As is usual with the common rail system, pressure generation and fuel injection are spatially separate from one another. The heart of this is the high-pressure fuel pump that is driven by the camshaft.

It supplies the injectors with the optimum injection pressure of up to 1800bar. The fuel rail functions as a pressure accumulator. Fuel that is not required is returned to the fuel filter with preheating valve via a pressure retention valve.

Advantages of the injection system:

- The injection pressure is almost infinitely variable and can be adapted to the particular operating status of the engine.
- The high injection pressure of up to 1800bar permits a good mixture formation.
- A flexible injection profile is enabled by several pre- and post-injection phases.



Key

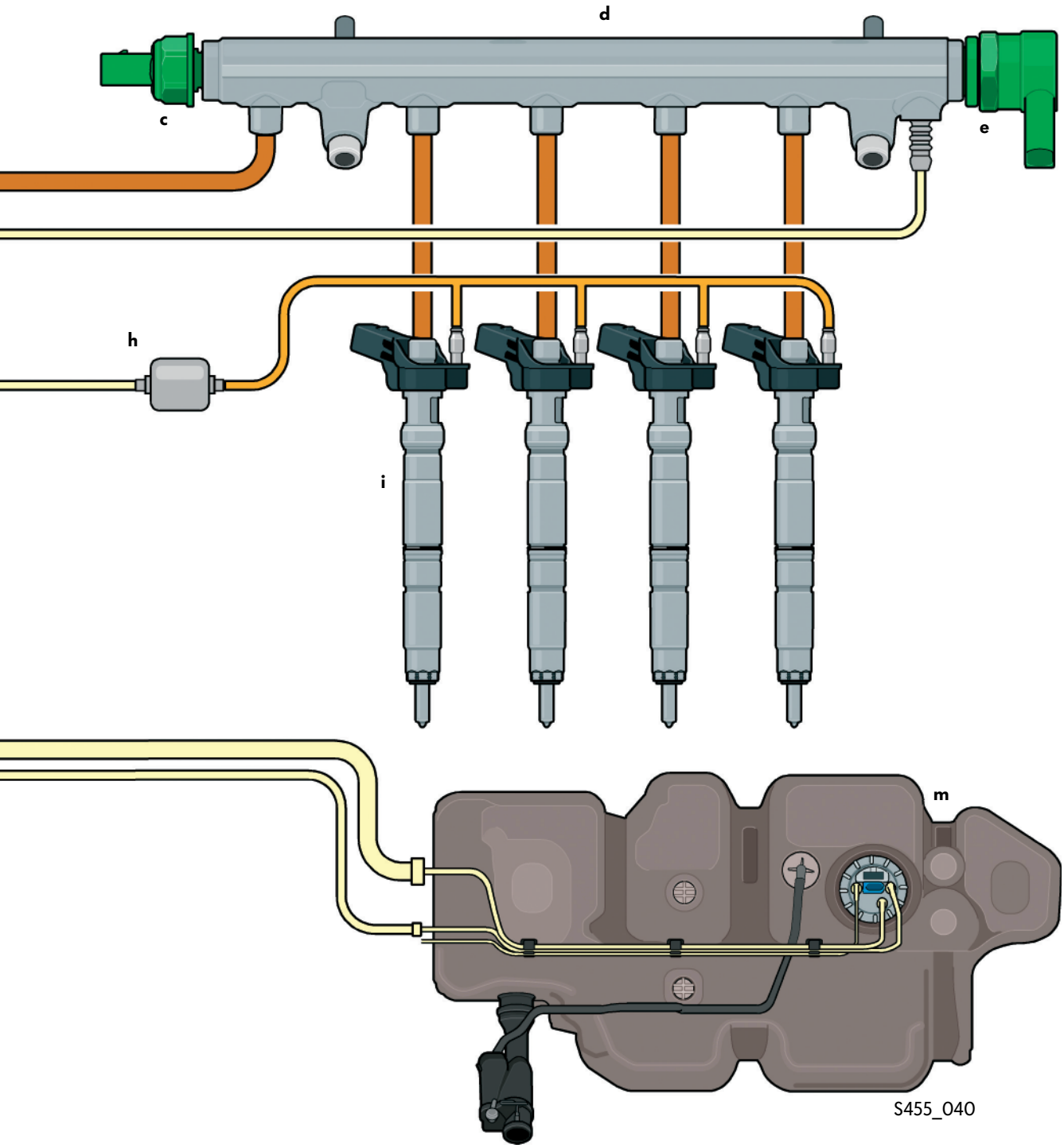
a Filter screen
b Fuel temperature sender G81
c Fuel pressure sender G247
d High-pressure accumulator (fuel rail)
e Fuel pressure regulating valve N276
f High-pressure fuel pump
g Fuel metering valve N290
h Pressure retention valve
i Injectors N30 to N33
k Supplementary fuel pump V393
l Fuel filter with preheating valve
m Fuel system pressurisation pump G6 in the fuel tank

High fuel pressure with 230 to 1800bar

Return pressure from the injectors of 10bar

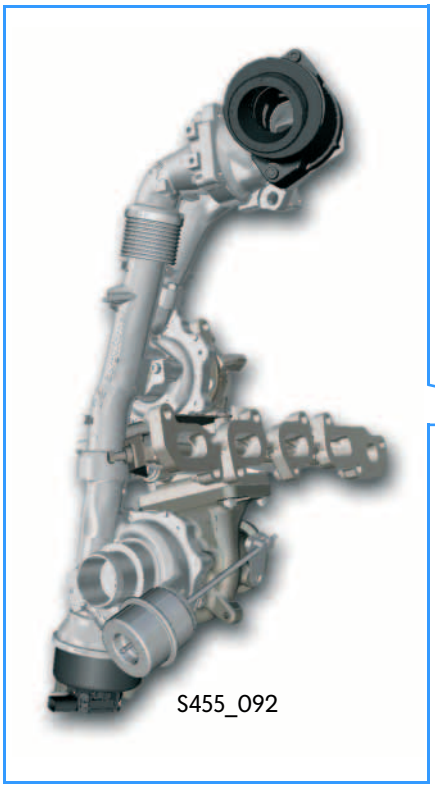
Pressure from fuel system pressurisation pump between supplementary fuel pump and high-pressure fuel pump of 6bar

Supply and return pressure

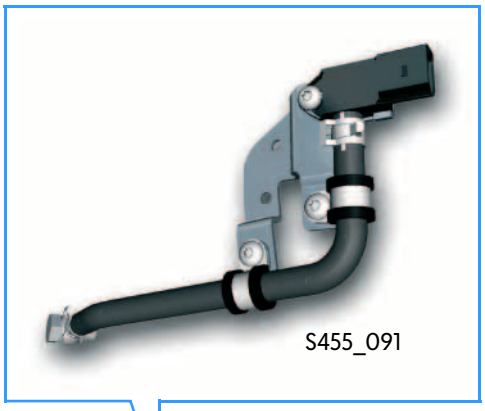


A detailed description of the common rail system can be found in self-study programme 403 "The 2.0l TDI engine with common rail injection system".

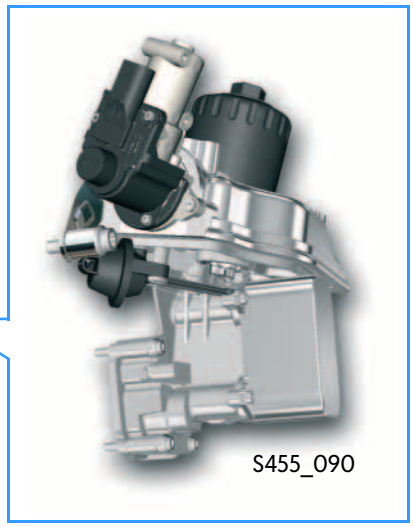
The engine and its special features



Bi-turbo unit with low-pressure and high-pressure turbocharger



Charge air pressure sensor 2 G447 connected to charge air section via pressure hose



Oil cooler, oil filter, EGR cooler and EGR valve grouped into one compact module

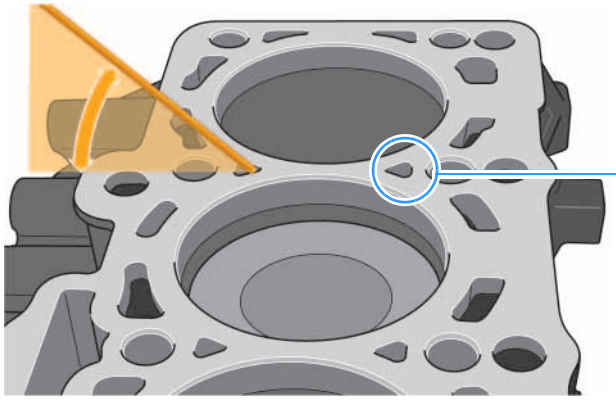
The two most striking engine components of the 2.0l TDI engine with 132kW (engine code CFCA) are the bi-turbo unit and the combined oil filter module with EGR valve and EGR cooler.
Both engine components are explained in detail below.

Another special feature is that the charge pressure sender 2 is not screwed directly into the charge air pressure pipes and does not protrude into the charge air flow, but rather is attached to the head of the bi-turbo unit with a holder, for reasons of installation space. The connection to the charge air section is by way of a pressure hose.

The crankcase

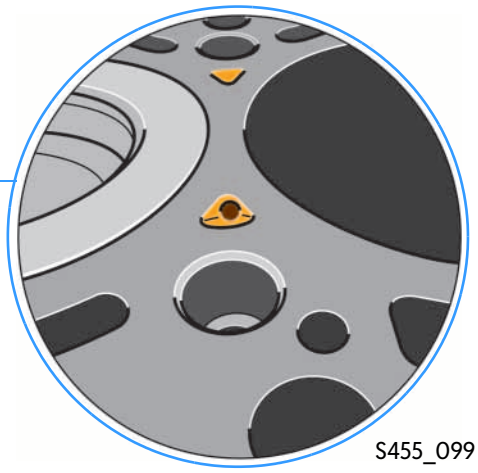
To meet the requirements on the cooling system of the 132kW engine in the commercial vehicle, the cylinder block has been revised.

The coolant ducts in the cylinder block have been connected with a 3mm wide hole. This hole passes through the bars of the cylinder bores diagonally.
This design change ensures that the heat is optimally transported away from this area as well. The improvement in cooling capacity achieved in this way reduces distortion of the cylinder blow in relation to the cylinder head.



S455_074

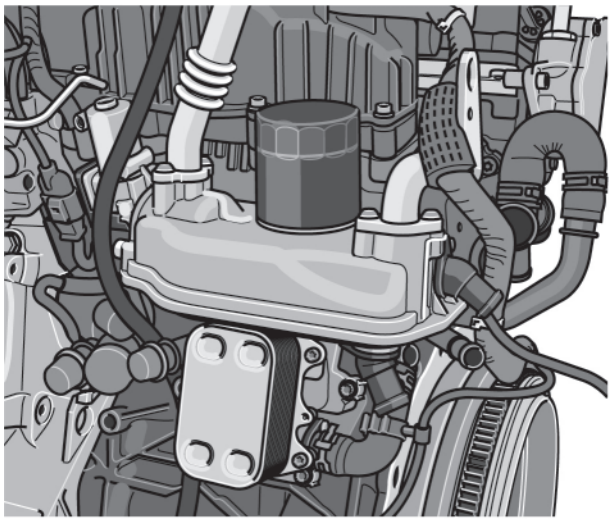
Check the coolant holes when working on the crankcase.



S455_099

The additional coolant holes on the upper side of the crankcase

The oil filter module



S455_061

In contrast to the three 2.0l engines with VTG turbocharger, the bi-turbo engine has an oil filter module in which the exhaust gas recirculation cooler is also integrated.

The 2.0l TDI engine with bi-turbo unit

Structure

The housing of the module is made from aluminium. This means good heat dissipation from the integrated components is guaranteed. The oil filter is mounted vertically.

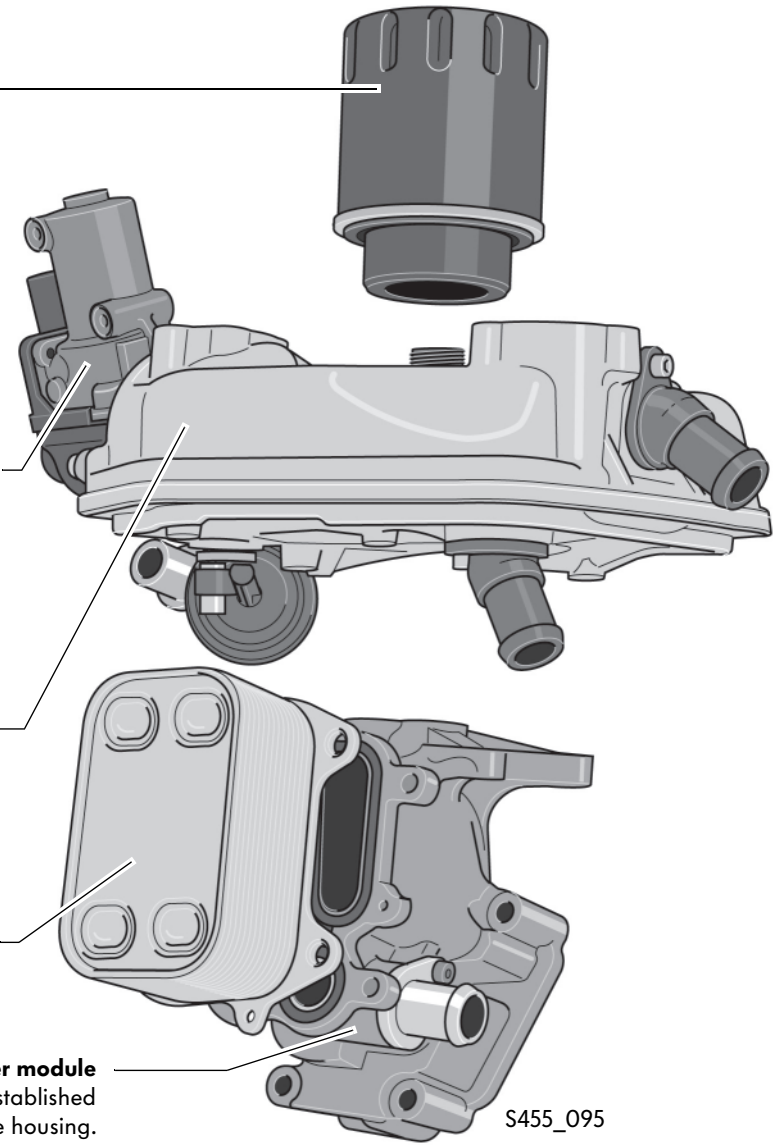
Oil filter
A spring-operated outlet barrier prevents oil from leaking out during a change of oil filter.

EGR valve
The electrically operated EGR valve controls the amount of exhaust gas that is returned to the combustion chamber.

EGR cooler
The connection between the oil filter and oil cooler is through the EGR cooler.

Oil cooler

The housing of the oil filter module
The connection to the oil circuit of the engine is established via the oil inflow and outflow openings on the housing.

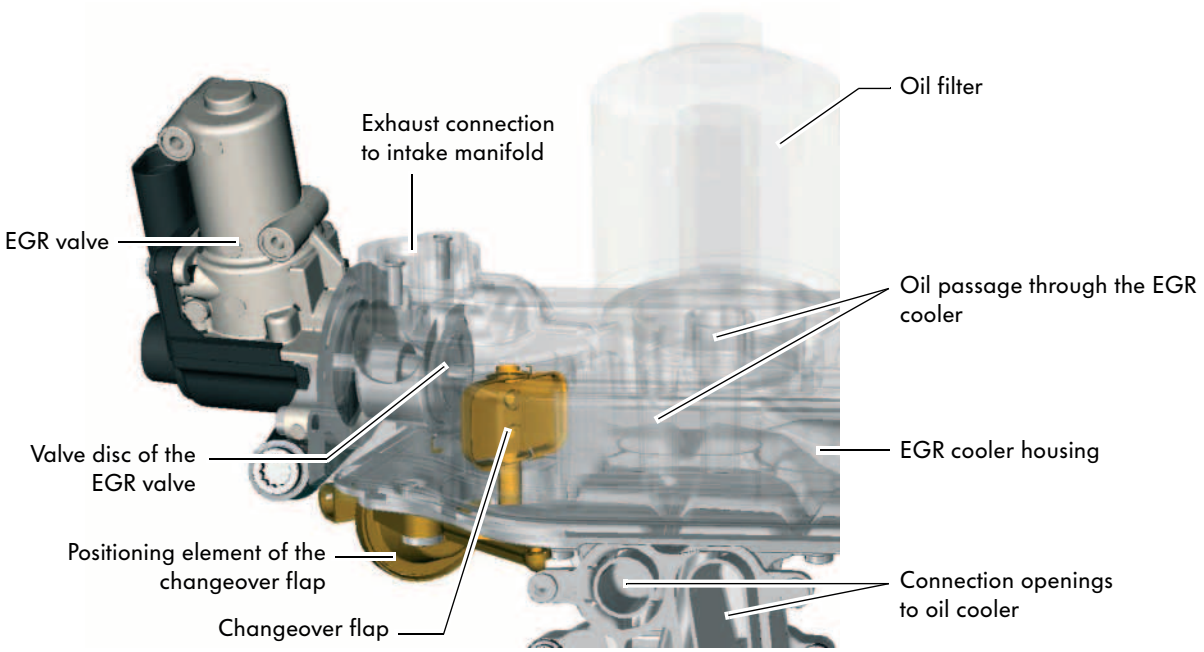


S455_095

It is essential to comply with the installation instructions in ELSA when working on the oil filter module of the 2.0l TDI engine with bi-turbocharger unit, because a new sequence of working steps must be followed.

The exhaust gas recirculation cooler

The EGR cooler is a controllable cooler. This means hot exhaust gases can bypass the cooler via a changeover flap. As a result, the temperature of the exhaust gases channeled into the combustion chamber can be optimally adapted to the particular operating conditions, in order for nitrogen oxide (NO_x) emissions to be kept as low as possible in all temperature phases. The changeover flap is operated by a vacuum unit.



Structure

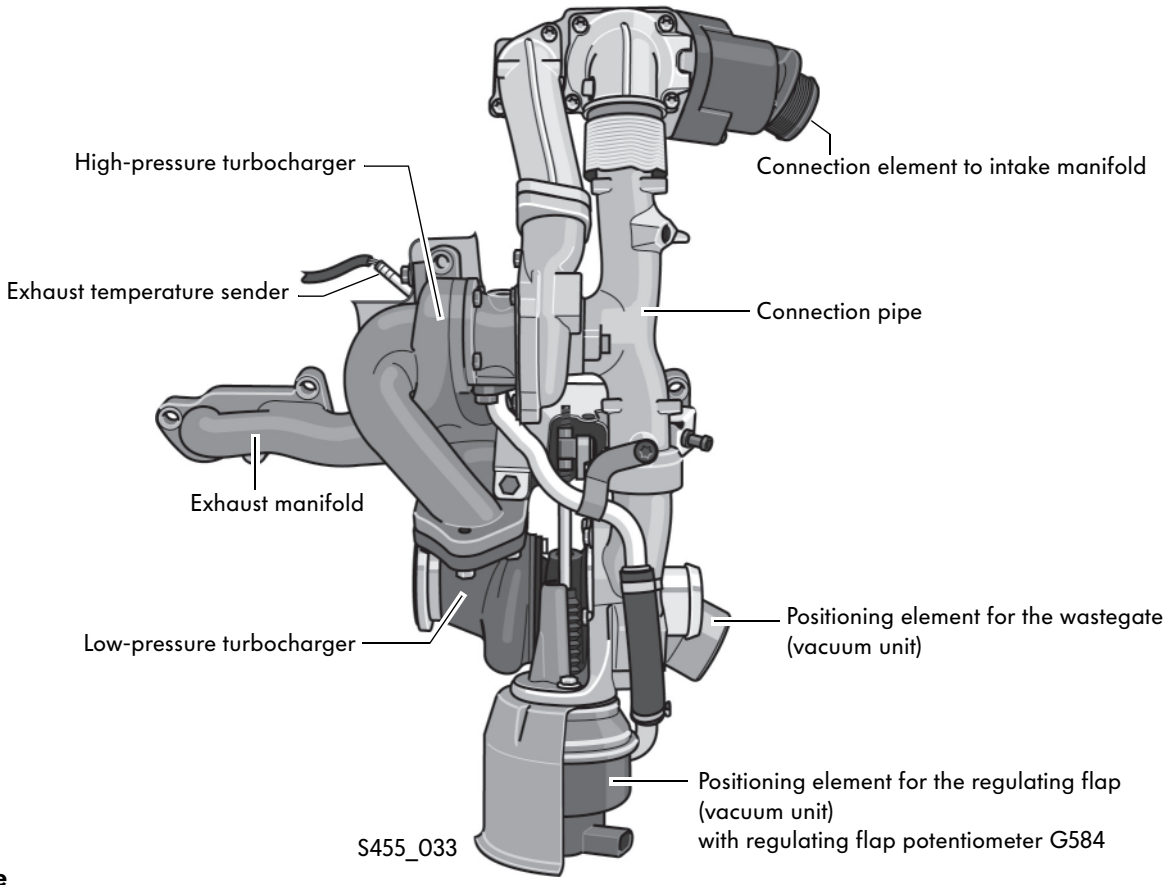
As well as the routing of the exhaust gas lines through the EGR cooler, the cooler housing also contains the valve seat of the EGR valve below the exhaust gas connection to the intake manifold. The EGR valve controls the quantity of exhaust gas that is returned to the combustion chamber.
The connection lines between the oil filter and oil cooler also form part of the cooler housing.

The bi-turbo unit

The bi-turbo unit, which is a striking feature of this power category, is located on the outlet end of the engine. The exhaust manifold is an integral part of the bi-turbo unit.

Task

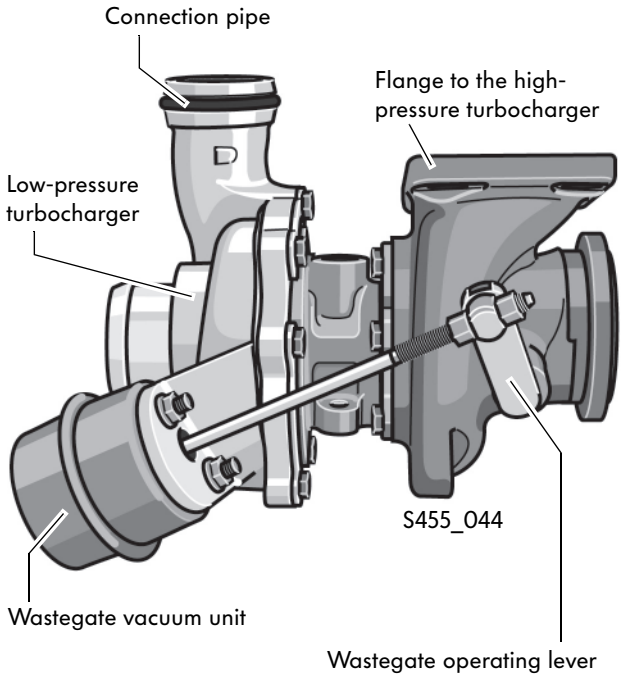
Depending on the power requirement, the two turbochargers work together to supply the engine with the necessary charge air pressure of max. 2 bar.



Structure

The bi-turbo unit consists of:

- A low-pressure turbocharger with fixed turbine geometry and wastegate
- The vacuum unit for operating the wastegate
- A high-pressure turbocharger with fixed turbine geometry and regulating flap
- The vacuum unit for operating the regulating flap with integrated regulating flap potentiometer G584
- The compressor bypass
- The charge pressure sender 2 G447
- The exhaust gas temperature sender 1 G235



The low-pressure turbocharger

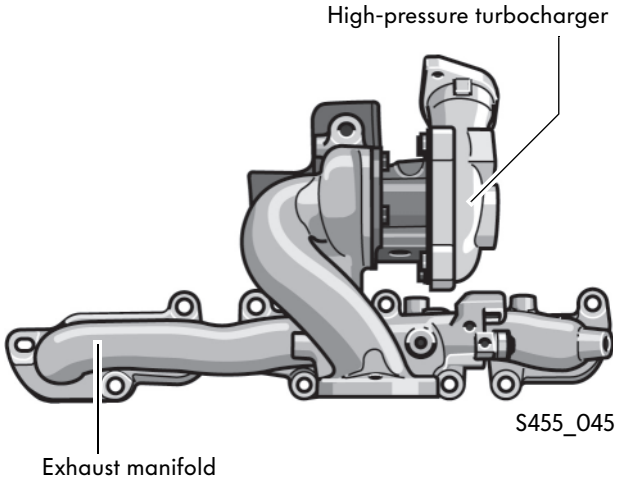
The low-pressure turbocharger is attached below the high-pressure turbocharger.
The flange of the exhaust pipe is screwed onto a flange
on the high-pressure turbocharger.
The connection pipe between the low-pressure and high-pressure turbocharger is plugged in.

Task

The low-pressure turbocharger supplies precompressed air to the high-pressure turbocharger. Depending on the control range, either both turbochargers or only the low-pressure turbocharger are involved in building up the charge pressure.

Structure

The low-pressure turbocharger is a turbocharger with fixed turbine geometry.



The high-pressure turbocharger

The high-pressure turbocharger is permanently connected to the exhaust manifold.

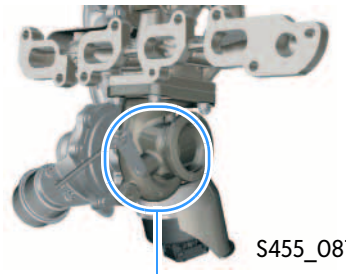
Task

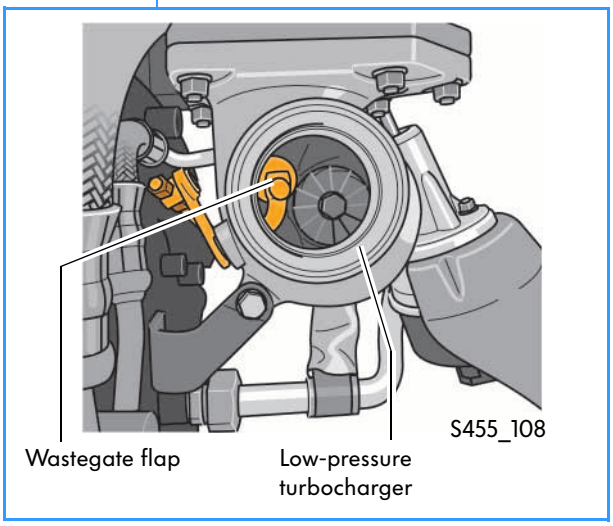
The high-pressure turbocharger ensures that the charge air pressure is built up to 2bar as quickly as possible.
It is supported in this by the precompressed air supplied by the low-pressure turbocharger.

The 2.0l TDI engine with bi-turbo unit

The wastegate

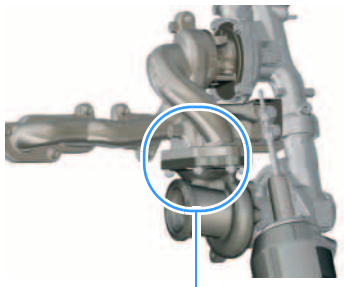
The wastegate flap controls what proportion of the exhaust gas volumetric flow bypasses the exhaust turbine of the low-pressure turbocharger. This means it determines the rotation speed of the compressor turbine, and therefore the charge pressure built up by the low-pressure turbocharger. The wastegate flap is fully closed in part-load operation.

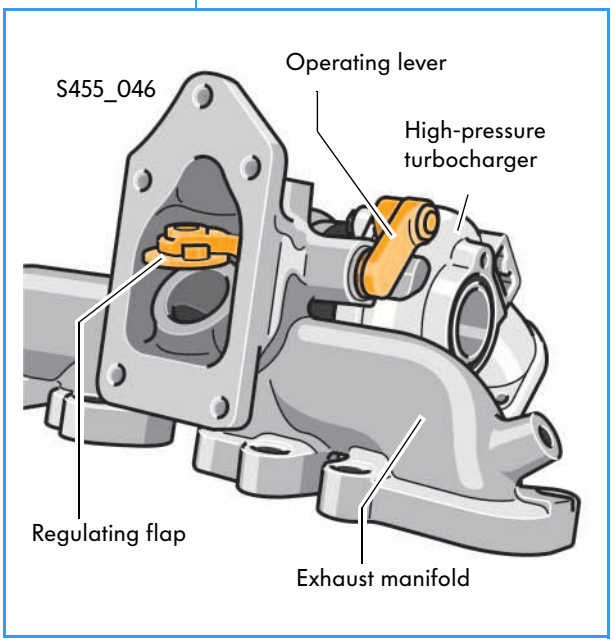


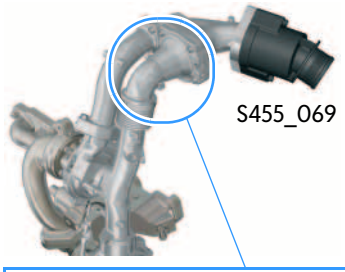


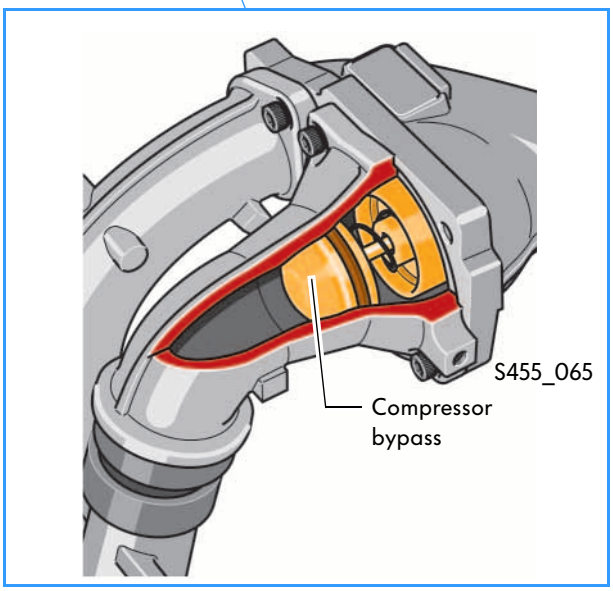
The regulating flap

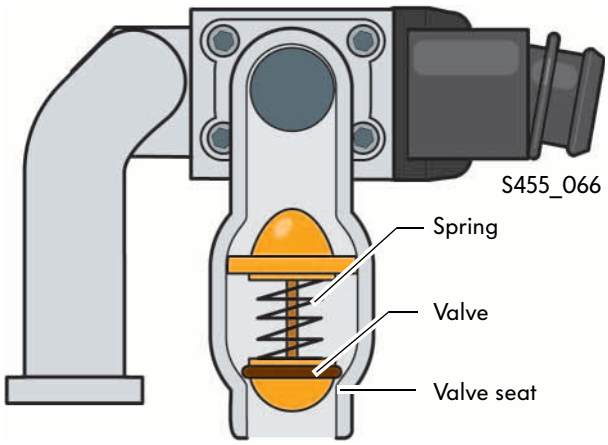
The large regulating flap is located on the exhaust manifold in the transitional area to the low-pressure turbocharger. It is operated by the large vacuum unit via an operating lever. The vacuum unit is located on the bottom end of the bi-turbo unit and operates via a linkage.
The control flap opens a bypass so that less of the exhaust flow reaches the high-pressure turbocharger for driving the exhaust turbine.
The turbine speed and therefore the charge pressure for the high-pressure turbocharger are controlled according to how far the control flap is open. The control flap can be fully opened by the engine control unit so that the complete exhaust gas flow bypasses the high-pressure turbine. The high-pressure turbocharger then makes no contribution to building up the charge pressure.

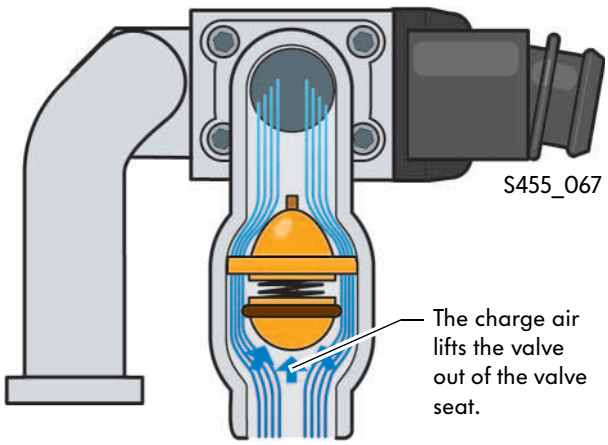












The compressor bypass

The compressor bypass is, alongside the regulating flap and the wastegate, the third element by means of which the charge air pressure is adapted to the various load conditions of the engine. It is operated by the charge air pressure itself and does not require any additional electrical or pneumatic positioning elements.

Task

The compressor bypass establishes a defined resistance against the charge air of the low-pressure turbocharger. This means is guarantees optimum supply of the high-pressure turbocharger with pre-compressed air.

Structure

The bypass is formed by a semi-spherical valve that closes the bypass charge air line which bypasses the compressor turbine of the high-pressure turbocharger. A mechanical spring presses the valve into the valve seat.

How it works:

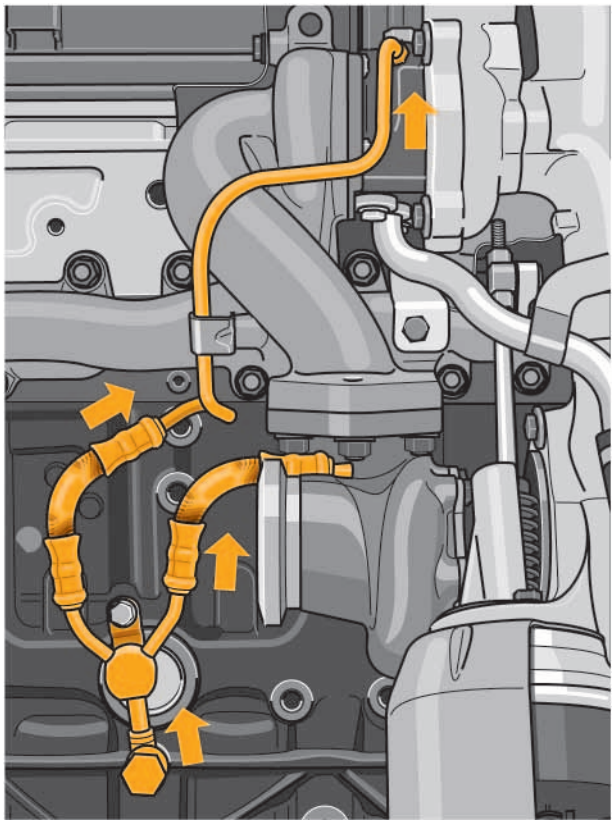
If the charge pressure of the low-pressure turbocharger is greater than the charge pressure of the high-pressure turbocharger then the charge air forces the valve out of its valve seat, thus opening the bypass line.

This means charge air is directed past the compressor turbine of the high-pressure turbocharger.

The 2.0l TDI engine with bi-turbo unit

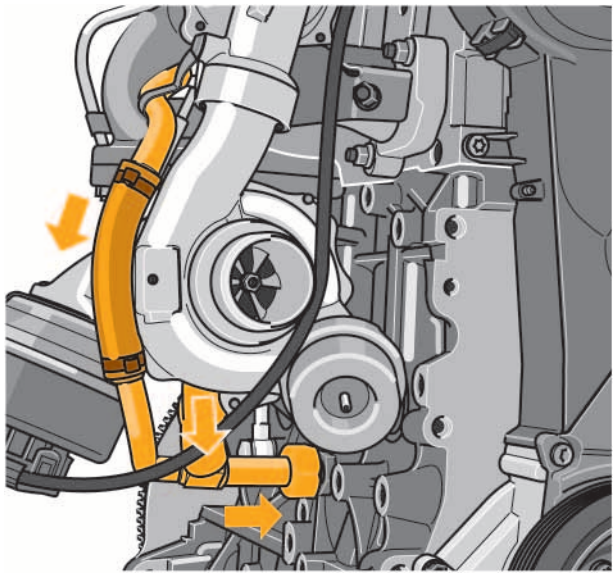
The oil supply to the bi-turbo unit

Low-pressure and high-pressure turbochargers are supplied with engine oil via their own oil lines.
Both lines are connected to the engine oil circuit at the crankcase by means of a distributor piece.



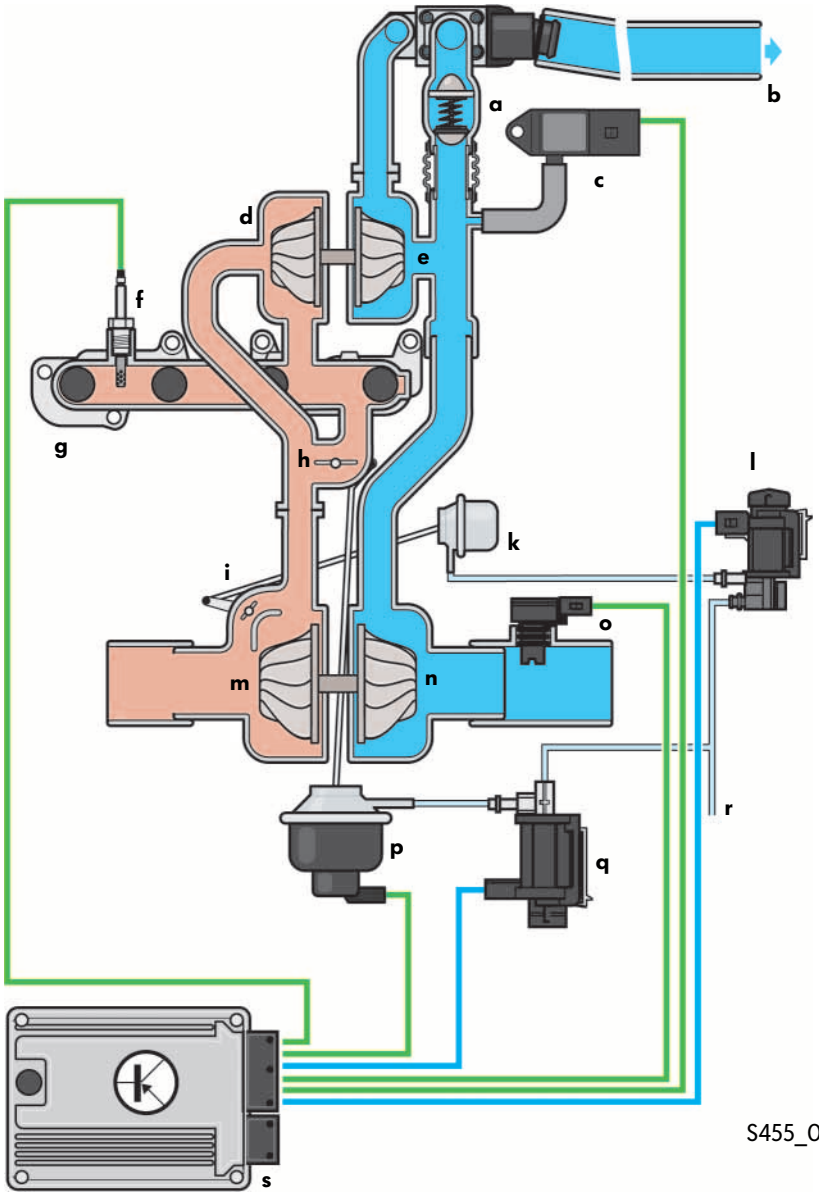
Oil supply line to low-pressure and high-pressure turbochargers S455_047

The oil return flow also passes through two separate return flow lines of the low-pressure and high-pressure turbocharger that are combined into a single connection below the low-pressure exhaust turbocharger. This connection is screwed onto the crankcase. From there, the oil flows through the crankcase and back into the sump.



Oil return flow from low-pressure and high-pressure turbochargers S455_048

The charge air system of the bi-turbo unit



Key

a Compressor bypass
b to the intake valves
c Charge air pressure sender 2 G447
d Exhaust gas turbine of the high-pressure turbocharger
e Compressor turbine of the high-pressure turbocharger
f Exhaust gas temperature sender 1 G235
g Exhaust manifold
h Regulating flap
i Wastegate
k Wastegate vacuum unit
l Charge pressure control solenoid valve N75
m Exhaust gas turbine of the low-pressure turbocharger
n Compressor turbine of the low-pressure turbocharger
o Intake air temperature sender G42 with charge air sender G31
p Regulating flap vacuum unit with regulating flap potentiometer G584
q Exhaust flap valve N220
r to vacuum accumulator
s Engine control unit J623

Engine management with bi-turbo unit

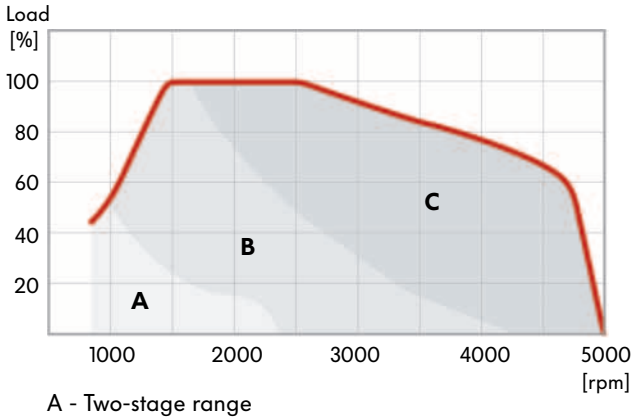
Control sequence of the charge air system

The control ranges

The bi-turbo unit is operated in three control ranges by the engine control unit in order to achieve the exacting power and torque requirements of the commercial vehicle sector as well as providing dynamic responsiveness:

- The two-stage range
- The two-stage controlled range
- The one-stage controlled range

The bi-turbo unit is controlled according to the load and engine speed.



A - Two-stage range
B - Two-stage controlled range
C - One-stage controlled range

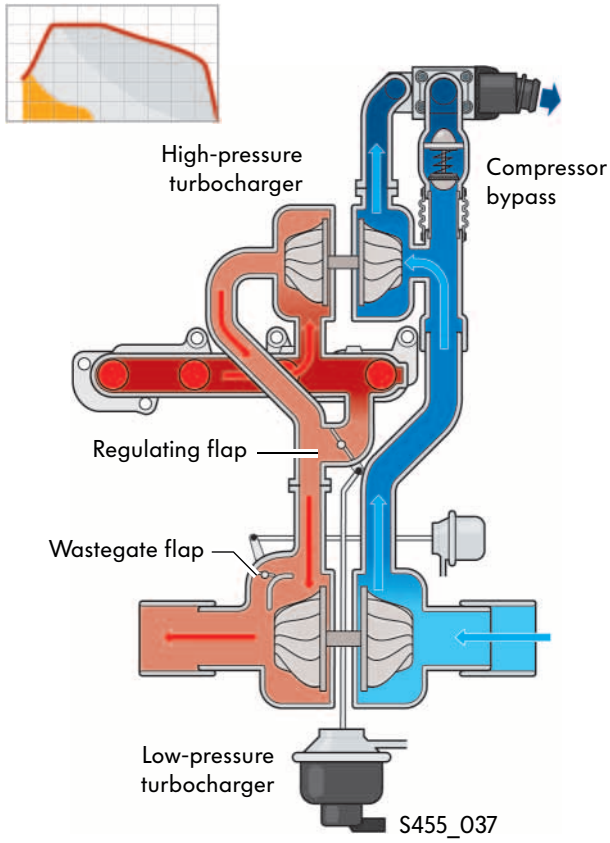
The two-stage range

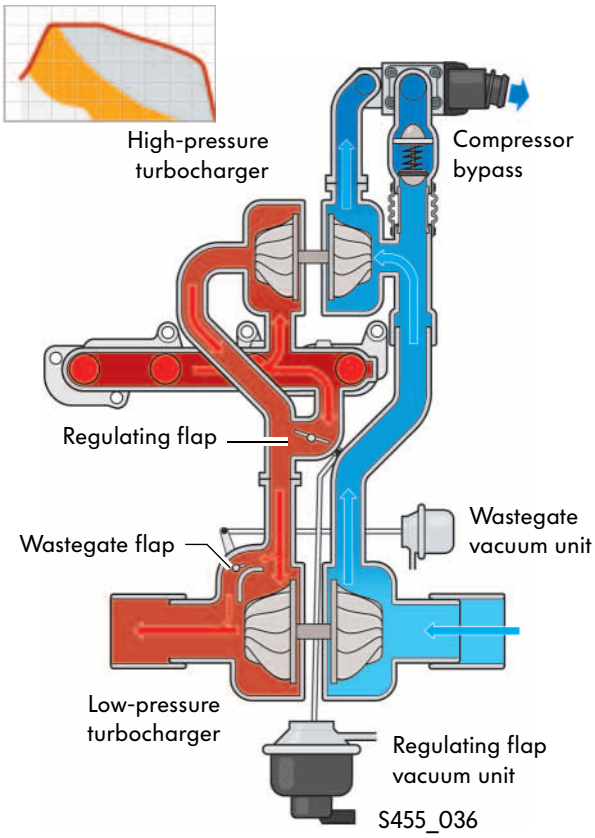
The control flap and the wastegate flap are

fully closed in the lower engine speed/load range. Both turbochargers are driven by the exhaust gas flow. This means maximum charge pressure can be built up, even in the lower engine speed range.

The compressor bypass is closed.

As the engine load increases, the speed threshold for the transition to the controlled range is reduced.



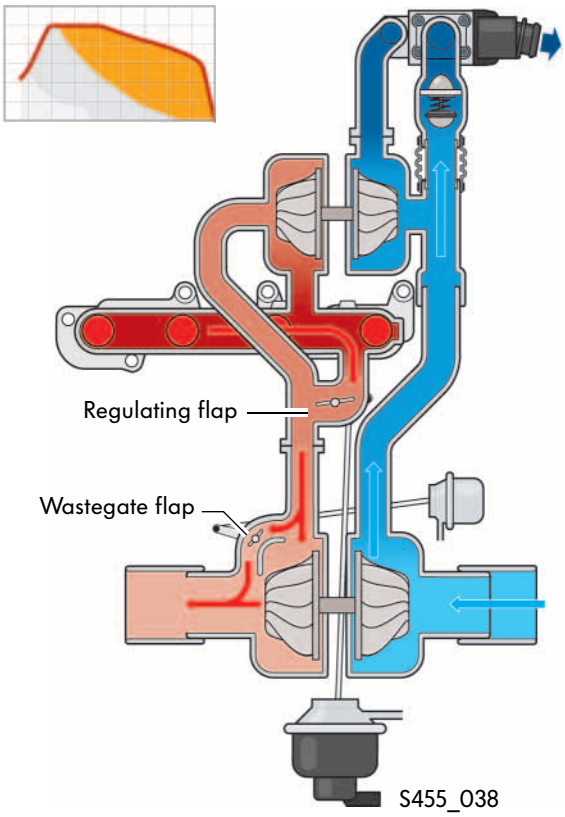


The two-stage controlled range

As the engine load and the engine speed increase, the bi-turbo unit undergoes a transition to the controlled range.
The control flap opens and directs the exhaust gas flow through the high-pressure turbocharger.
It is in controlled mode.

The wastegate flap controls the low-pressure turbocharger in high load ranges.

The compressor bypass remains closed.



The one-stage controlled range

The control flap is fully opened in the upper engine speed range and under high engine load.
The main exhaust gas flow now drives the low-pressure turbocharger.

The compressor bypass opens so the charge air flow bypasses the high-pressure turbocharger. This means the high-pressure turbocharger is no longer involved in building up the charge pressure.

The low-pressure turbocharger is controlled via the wastegate flap.

System overview

Sensors

Throttle valve module **J338**
Throttle valve potentiometer **G69**

Charge pressure sender 2 **G447** **

Intake manifold pressure sender **G71**

Clutch pedal switch **F36**

Position sender for charge pressure **G581** *
Regulating flap potentiometer **G584** **

Brake light switch **F**

Exhaust gas temperature sender 4 **G648**

Exhaust gas temperature sender 3 **G495**

Exhaust gas temperature sender 1 **G235**

Exhaust gas pressure sensor 1 **G450**

Lambda probe **G39**

Exhaust gas recirculation potentiometer **G212**

Fuel pressure sender **G247**

Fuel temperature sender **G81**

Charge air pressure sender **G31** with
intake air temperature sender **G42**

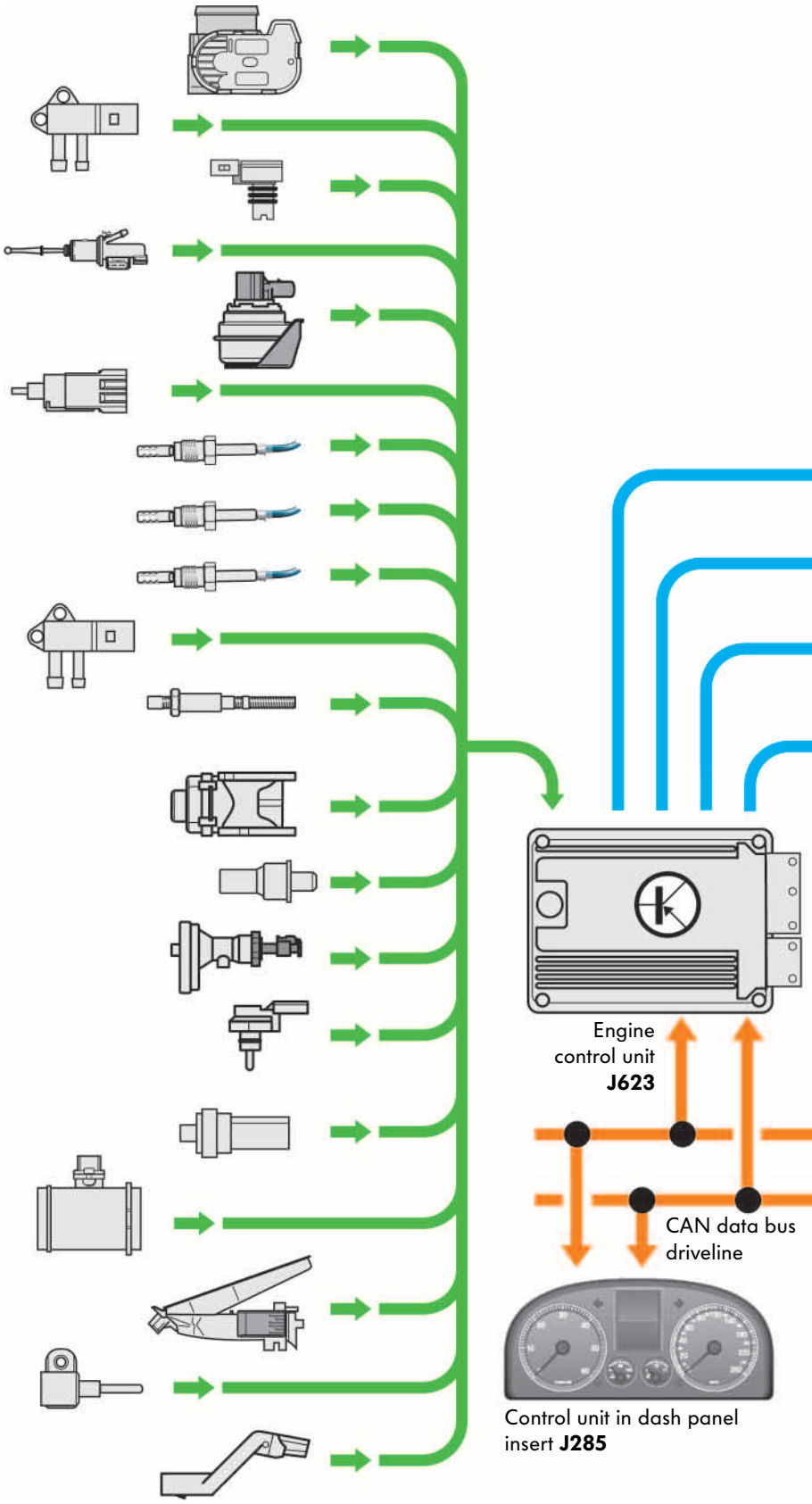
Coolant temperature sender **G62**

Air mass meter **G70**

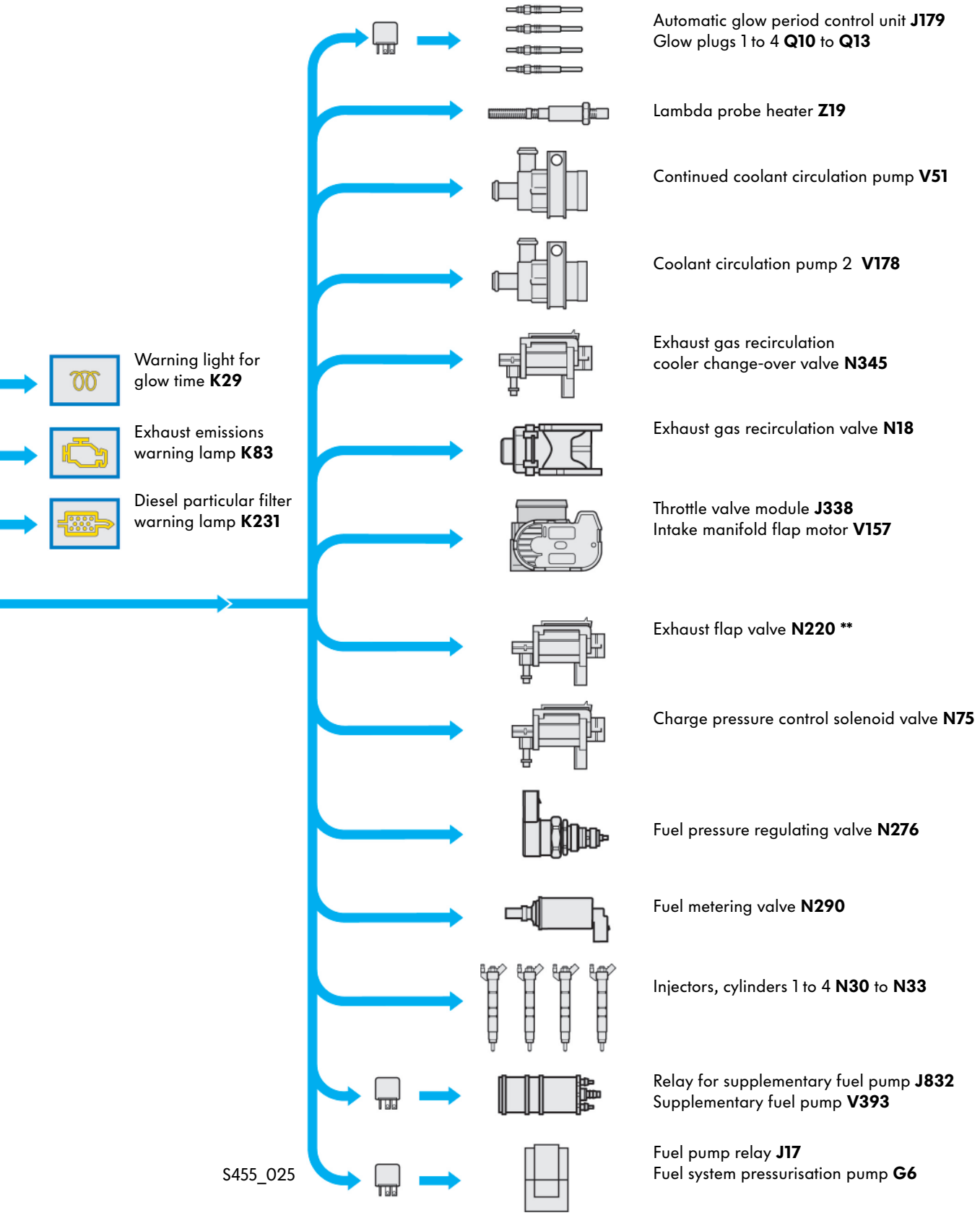
Accelerator position sender **G79**
Accelerator position sender 2 **G185**

Hall sender **G40**

Engine speed sender **G28**



* only 2.0l TDI engines with VTG turbocharger
** only 2.0l TDI engine with bi-turbo unit



Actuators

Automatic glow period control unit **J179**
Glow plugs 1 to 4 **Q10** to **Q13**

Lambda probe heater **Z19**

Continued coolant circulation pump **V51**

Coolant circulation pump 2 **V178**

Exhaust gas recirculation cooler change-over valve **N345**

Exhaust gas recirculation valve **N18**

Throttle valve module **J338**
Intake manifold flap motor **V157**

Exhaust flap valve **N220** **

Charge pressure control solenoid valve **N75**

Fuel pressure regulating valve **N276**

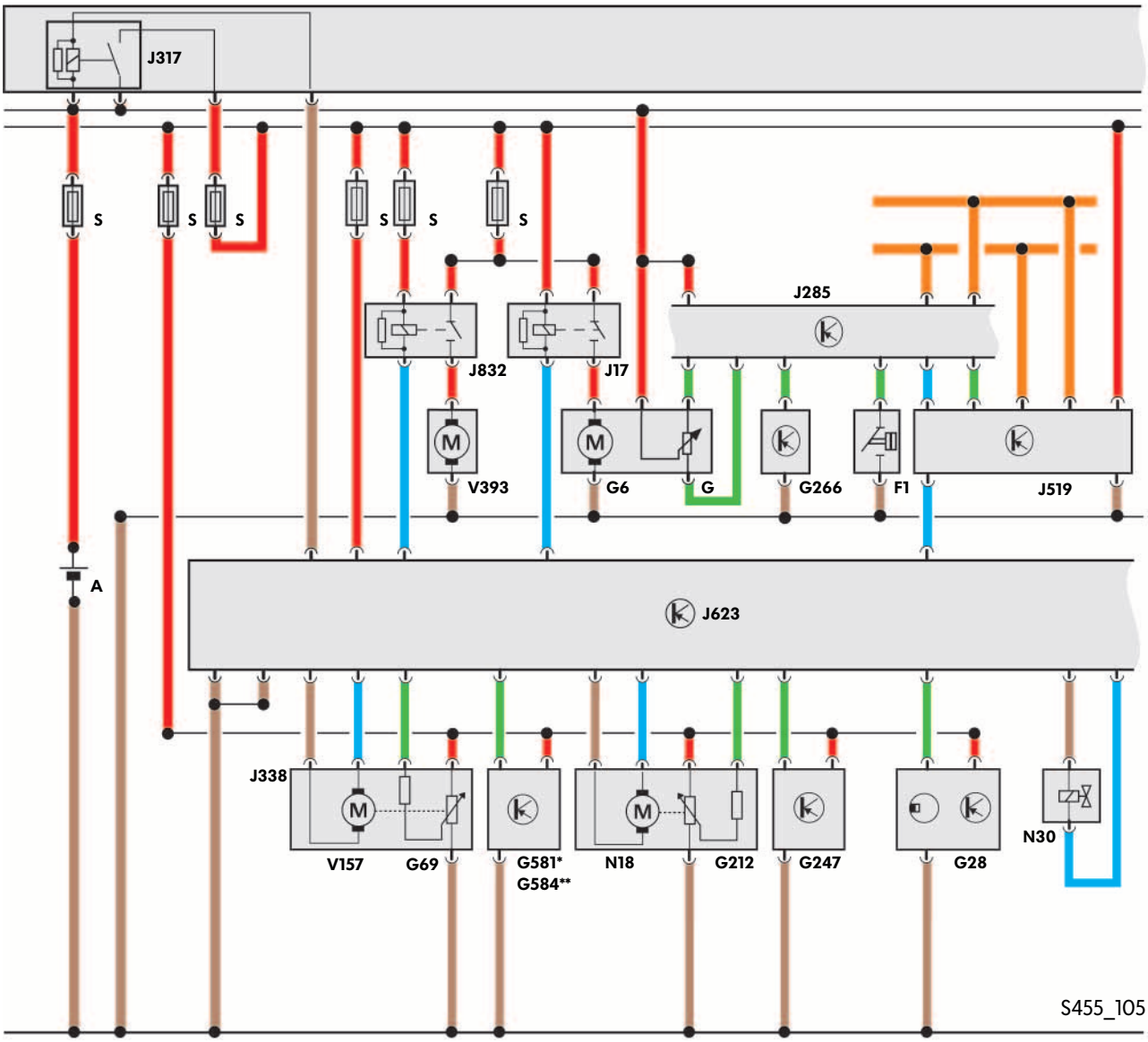
Fuel metering valve **N290**

Injectors, cylinders 1 to 4 **N30** to **N33**

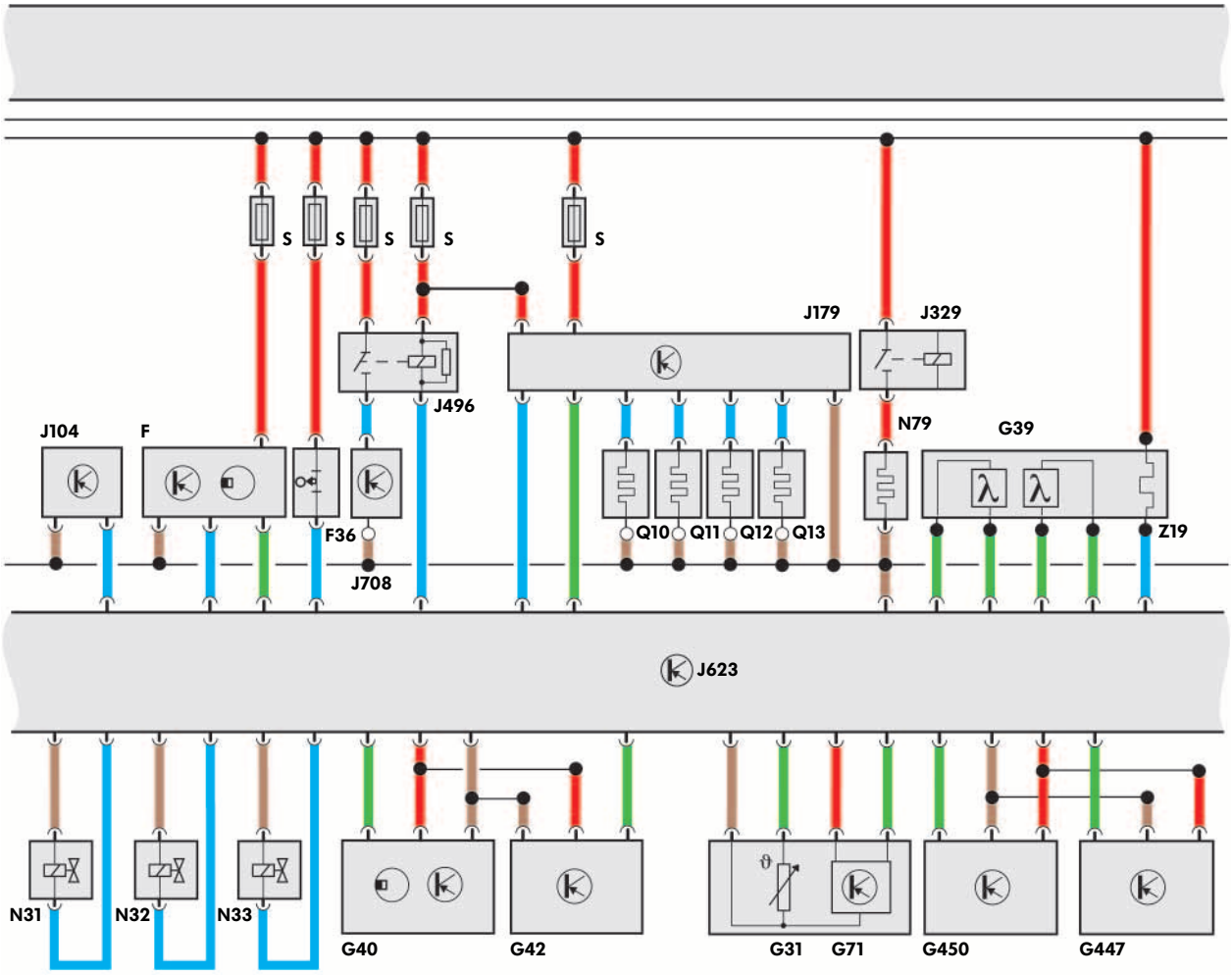
Relay for supplementary fuel pump **J832**
Supplementary fuel pump **V393**

Fuel pump relay **J17**
Fuel system pressurisation pump **G6**

Function diagram



A	Battery
F	Brake light switch
F1	Oil pressure switch
F36	Clutch pedal switch
G	Fuel gauge sender
G6	Fuel system pressurisation pump
G28	Engine speed sender
G31	Charge air sender
G39	Lambda probe
G40	Hall sender
G42	Intake air temperature sender
G69	Throttle valve potentiometer
G71	Intake manifold pressure sender
G212	Exhaust gas recirculation potentiometer
G247	Fuel pressure sender
G266	Oil level and oil temperature sender
G450	Exhaust gas pressure sensor 1
G447	Charge pressure sender 2 **
G581	Position sender for charge pressure *
G584	Regulating flap potentiometer **
J17	Fuel pump relay
J104	ABS control unit
J179	Automatic glow period control unit
J285	Control unit in dash panel insert
J317	Terminal 30 voltage supply relay
J329	Terminal 15 voltage supply relay
J338	Throttle valve module
J496	Additional coolant pump relay
J519	Onboard supply control unit
J623	Engine control unit
J708	Residual heat relay
J832	Relay for supplementary fuel pump



S455_106

Q10 Glow plug 1
Q11 Glow plug 2
Q12 Glow plug 3
Q13 Glow plug 1

N18 Exhaust gas recirculation valve
N30 Injector, cylinder 1
N31 Injector, cylinder 2
N32 Injector, cylinder 3
N33 Injector, cylinder 4
N79 Heater element for crankcase breather

S Fuse

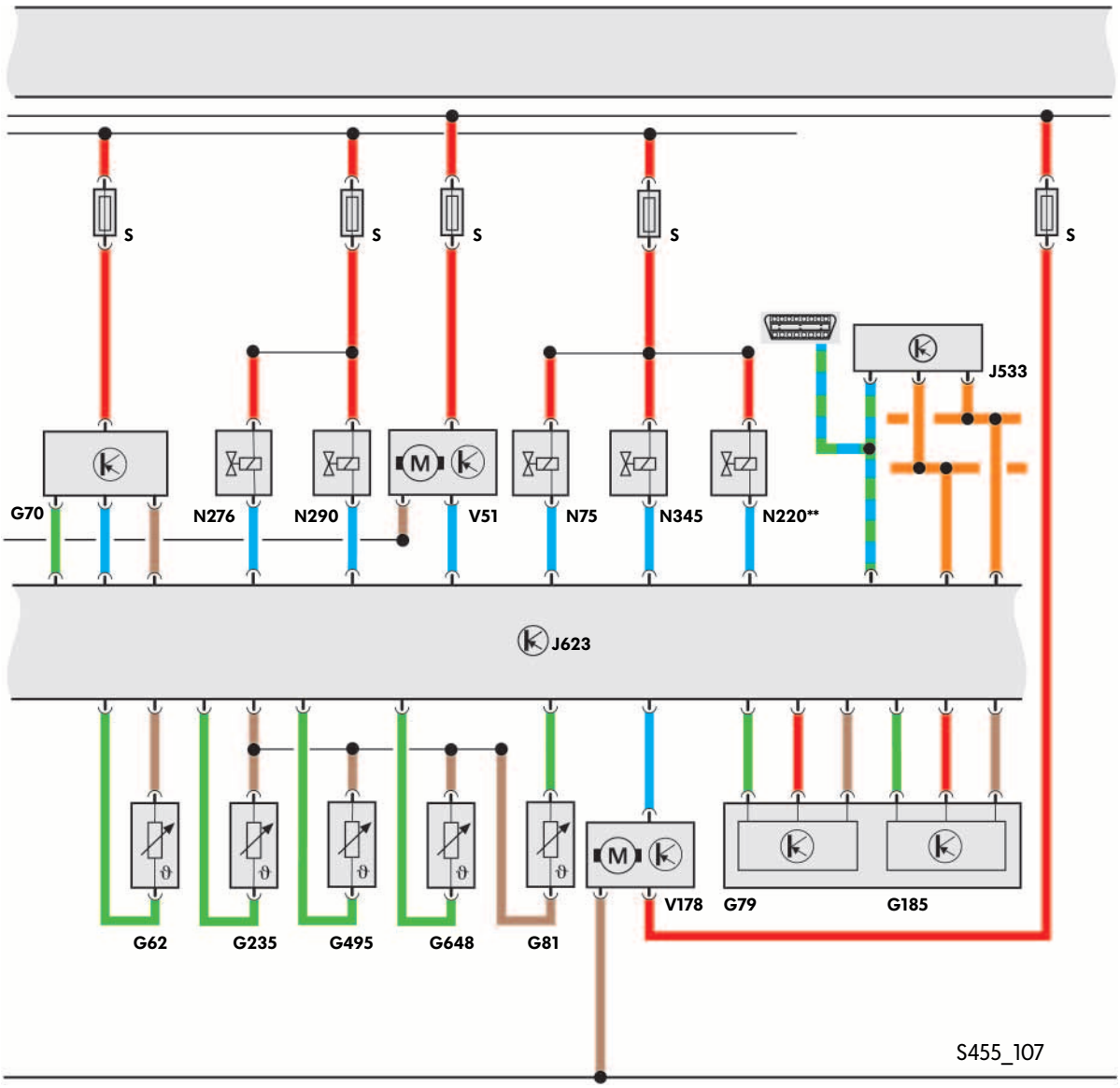
V157 Intake manifold flap motor
V393 Supplementary fuel pump

Z19 Lambda probe heater

Positive
Earth
Output signal
Input signal
Bi-directional signal
CAN data bus

* only 2.0l TDI engines with VTG turbocharger
** only 2.0l TDI engine with bi-turbo unit

Function diagram



G62 Coolant temperature sender
G70 Air mass meter
G79 Accelerator position sender
G81 Fuel temperature sender
G185 Accelerator position sender 2
G235 Exhaust gas temperature sender 1
G495 Exhaust gas temperature sender 3
G648 Exhaust gas temperature sender 4

J533 Data bus diagnostic interface
J623 Engine control unit

N75 Charge pressure control solenoid valve
N220 Exhaust flap valve **
N276 Fuel pressure regulating valve
N290 Fuel metering valve
N345 Exhaust gas recirculation cooler change-over valve

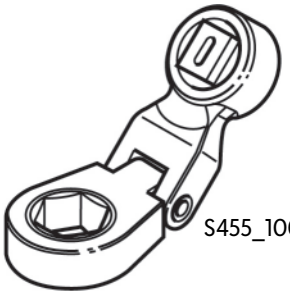
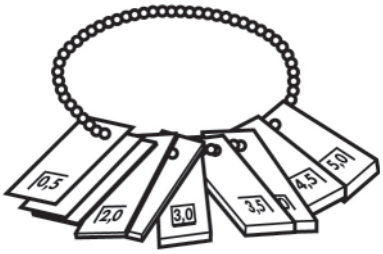
S Fuse

V51 Continued coolant circulation pump
V178 Coolant circulation pump 2

Positive
Earth
Output signal
Input signal
Bi-directional signal
CAN data bus

** only 2.0l TDI engine with bi-turbo unit

The special tools

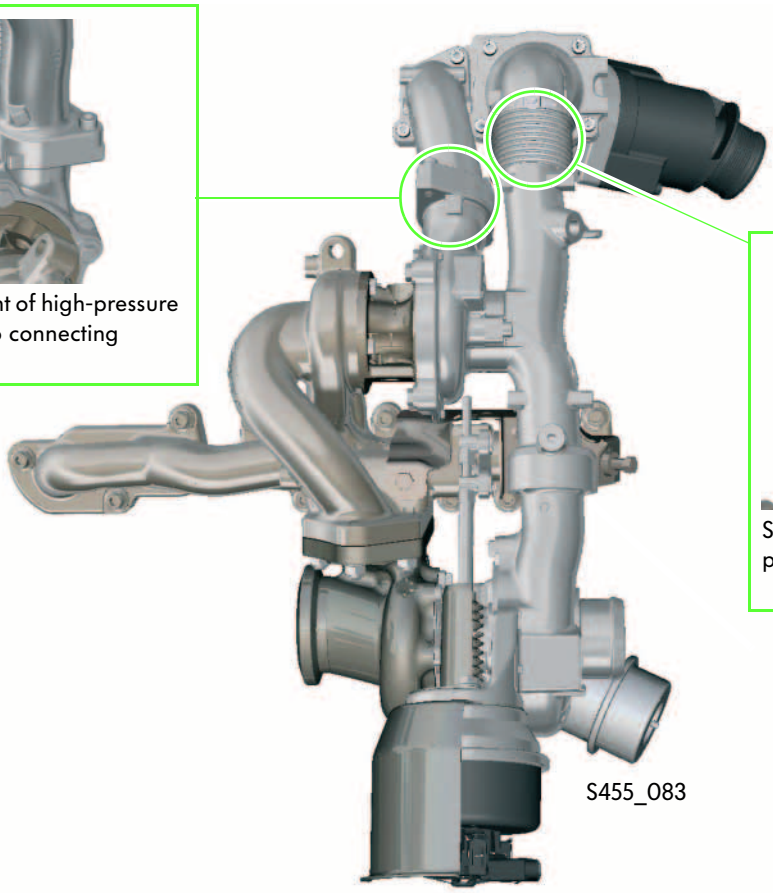
Designation	Tool	Use
T 10384 Socket	 S455_100	For tightening the securing nuts on the holder of the connection pipes
VAS 3371 Test gauge	 S455_101	For checking the gap size of the connecting pipes

Notes on work on the bi-turbo unit

To facilitate removal and installation of the bi-turbo unit, the entire module has two defined separating points, which are partly connected and partly bolted together via flanges. The bi-turbo unit is only allowed to be separated at these points in the workshop.

Separating point of high-pressure turbocharger to connecting pipe 2

S455_085

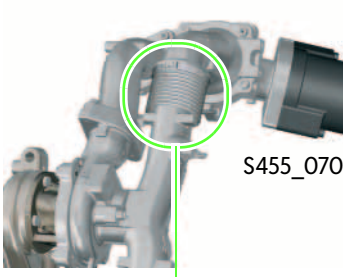


S455_083

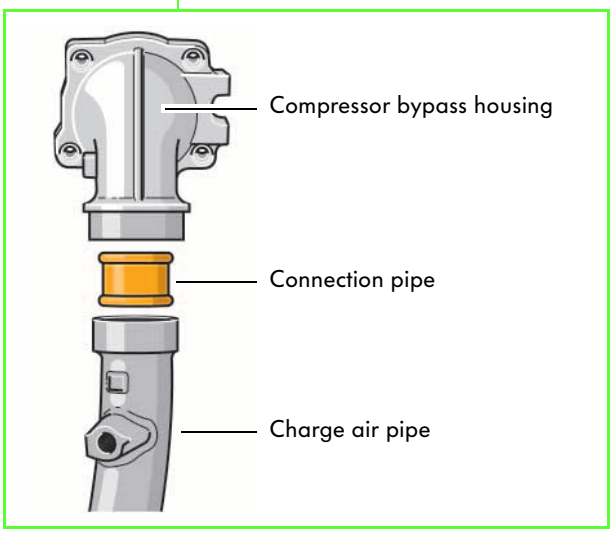
Separating point of connecting pipe to compressor bypass

S455_086

When working on an engine in which the bi-turbo unit has to be separated from the engine, follow the instructions in ELSA.



S455_070



S455_073

The connecting pipe

There is a branch in the charge air line before the inlet opening of the high-pressure turbocharger.
One branch leads to the compressor turbine of the high-pressure turbocharger, the other to the compressor bypass. The pipe to the compressor bypass is divided and is connected together with a connecting pipe as a compensating element.
For one thing, this functions as a flexible connection to cushion vibration as well as to compensate for stresses, and for another thing it provides a separating point in the charge air line between the low-pressure and high-pressure turbochargers.

Test your knowledge

What is the correct answer?

These questions may have one or more correct answers.

1. How is the turbocharging performed in the 2.0l TDI engine with 132kW, engine code: CFCA?

☐ a) Turbocharging is performed by a VTG turbocharger.

☐ b) Turbocharging is performed by a wastegate turbocharger.

☐ c) Turbocharging is provided by a bi-turbo unit.

2. What special feature exists in the cooling system of the 2.0l TDI engine in the T5 2010?

☐ a) The 2.0l TDI engines in the T5 2010 do not have a coolant regulator.

☐ b) The 2.0l TDI engines in the T5 2010 do not have any new features in their cooling system.

☐ c) The 2.0l TDI engines use a new ball thermostat (4/2-way valve) in the cooling system.

3. What component of the bi-turbo unit controls the air supply to the high-pressure turbocharger?

☐ a) A mechanical compressor bypass.

☐ b) An electric charge pressure positioner.

☐ c) A hydraulic charge pressure positioner.

4. What is the special feature of the cylinder block of the 2.0l TDI engine with 132kW in terms of the cylinder bores?

☐ a) There are no special features.

☐ b) The 2.0l TDI engine with 132kW has reinforced cylinder walls.

☐ c) There is an additional cooling bore running between the cylinder bores.

5. What is the structure of the 2.0l TDI engine with 132kW?

☐ a) The oil filter is screwed onto the engine block separately.

☐ b) Oil filter, oil cooler, EGR cooler and EGR valve are combined in one module.

☐ c) The oil filter is integrated in the oil cooler as a filter insert.

6. What needs to be considered when working on the bi-turbo unit?

☐ a) The bi-turbo unit can only be removed in individual parts.

☐ b) The bi-turbo unit is not allowed to be separated.

☐ c) The bi-turbo unit is only allowed to be separated at two defined separating points.

Notes

Answers

1. c); 2. c); 3. a) ; 4. c); 5. b); 6. c)

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