



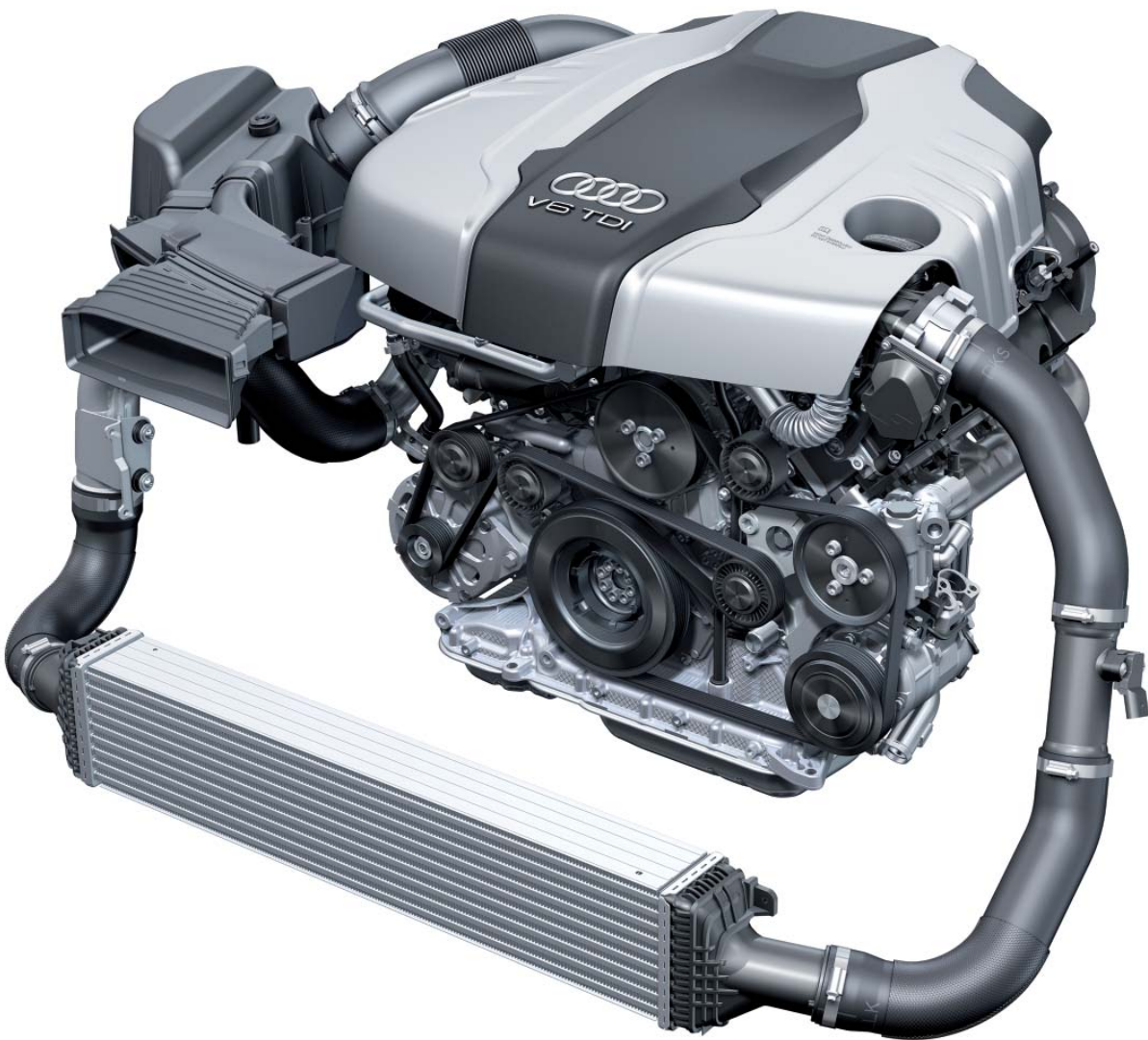
## Audi 3.0L V6 TDI engine (second generation)

## The second generation of the 3.0l V6 TDI engine

V6 TDI engines are already something of a tradition at Audi. The success story began in 1997 with the introduction of the world's first four-valve 2.5l V6 TDI engine with a distributor injection pump. In late 2003 it was followed by the first V6 TDI with common rail injection, a 3.0l engine with a chain-driven timing gear. A power-reduced 2.7l version derived from this model was rolled out in 2004.

Both engines have since undergone multiple stages of evolution and have been successfully introduced in various models, not only at Audi but also within the VW Group.

State-of-the-art diesel technology, such as the Piezo Inline Common Rail System with rail pressures of up to 2000 bar, systematic thermal management, extensive friction-reducing improvements and the start-stop system, ensures that the new engine achieves low emissions and better fuel economy in combination with new eight-speed automatic gearboxes.



479\_001

### Learning objectives of this Self Study Programme are:

This Self Study Programme describes the design and function of the second-generation 3.0l V6 TDI engine. When you have worked your way through this Self Study Programme, you will be able to answer the following questions:

- ▶ How has the chain drive changed?
- ▶ What is the task of the thermostat in the oil circuit?
- ▶ How does the thermal management system work?
- ▶ How many swirl flaps does the intake system have?

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► The Self Study Programme explains the basics of the design and function of new models, new automotive components or new technologies.

**It is not a Repair Manual! Figures given are for explanatory purposes only and refer to the data valid at the time of preparation of the SSP.**

For further information about maintenance and repair work, always refer to the current technical literature.



**Note**



**Reference**

# Introduction

## Brief technical description of the (second generation) 3.0l V6 TDI engine

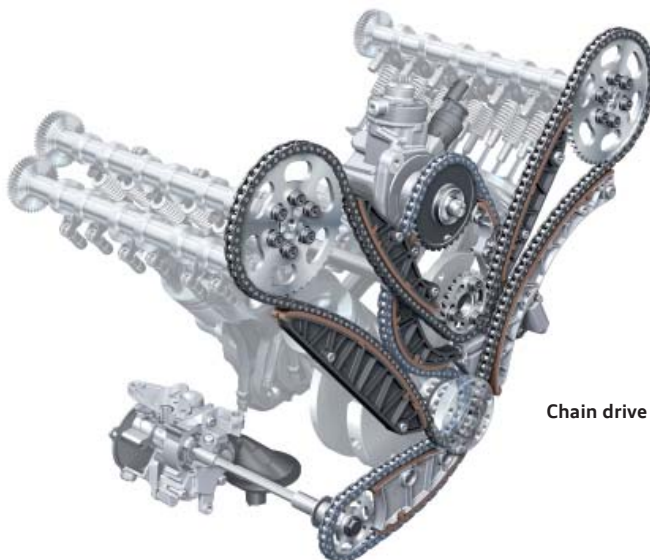
### Technical features



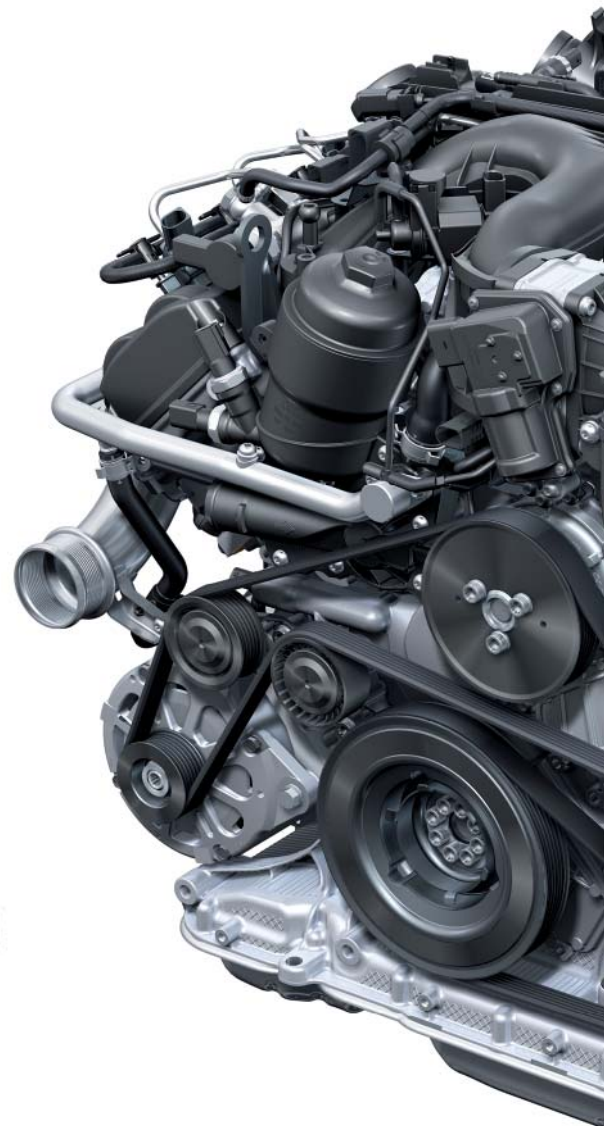
Intake manifold with a single swirl flap



Bosch CRS 3.3  
Common Rail Injection System



Chain drive





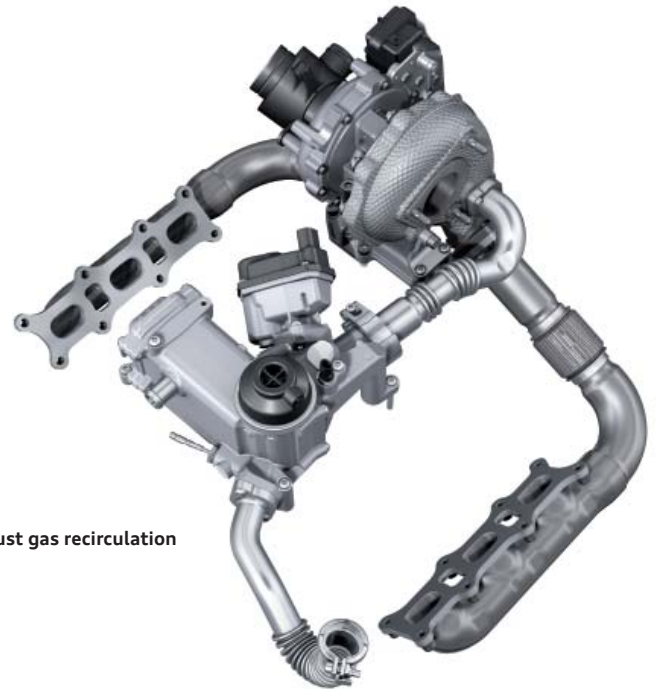
Start-stop system and recuperation



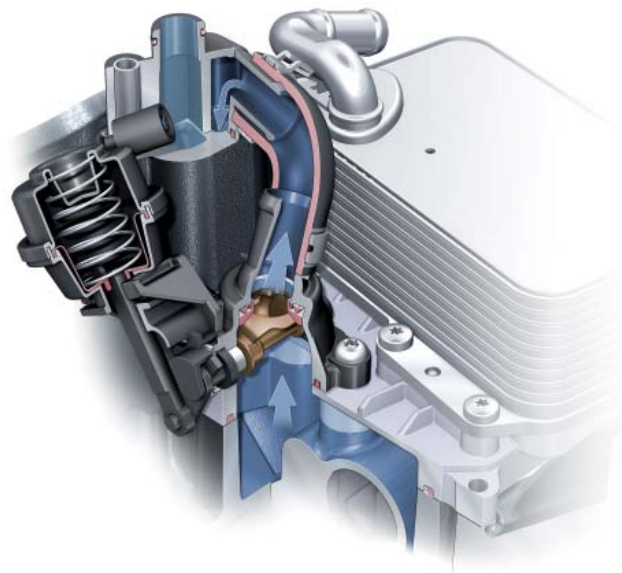
Turbocharger module



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Exhaust gas recirculation

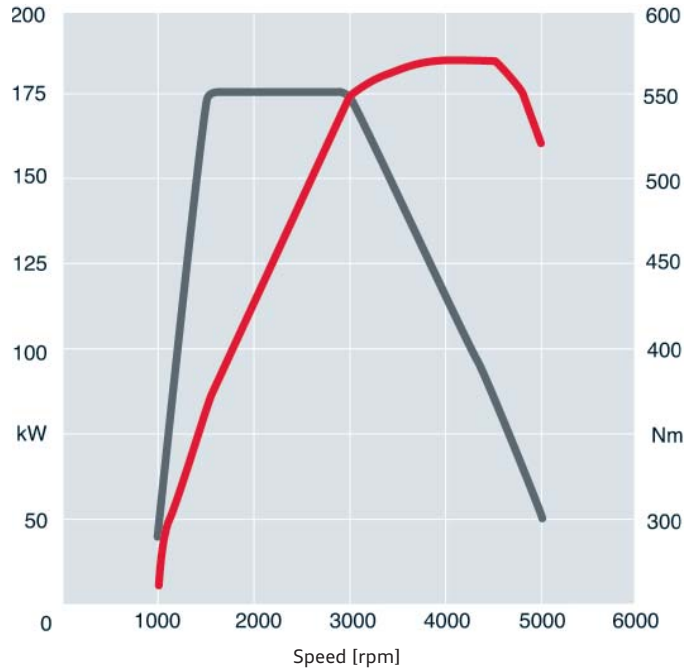


Thermal management system

# Specifications

## Torque-power curve

- Power output in kW
- Torque in Nm



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<b>Engine code</b>	<b>CDTA</b>
<b>Type</b>	Six cylinder V engine with 90° included angle
<b>Displacement</b> in cm <sup>3</sup>	2967
<b>Stroke</b> in mm	91,4
<b>Bore</b> in mm	83
<b>Cylinder spacing</b> in mm	90
<b>Number of valves per cylinder</b>	4
<b>Firing order</b>	1-4-3-6-2-5
<b>Compression ratio</b>	16,8 : 1
<b>Power output</b> in kW at rpm	184 at 4000
<b>Torque</b> in Nm at rpm	550 at 1250 – 3000
<b>Fuel</b>	Diesel to EN 590
<b>Engine management</b>	Bosch CRS 3.3
<b>Emissions standard</b>	EU5
<b>CO<sub>2</sub> emission</b> in g/km	174

The efficiency version of the 3.0l V6 TDI engine with a power output of 150 kW and 400 Nm of torque is described in Self Study Programme 478 "Audi A7 Sportback".



### Note

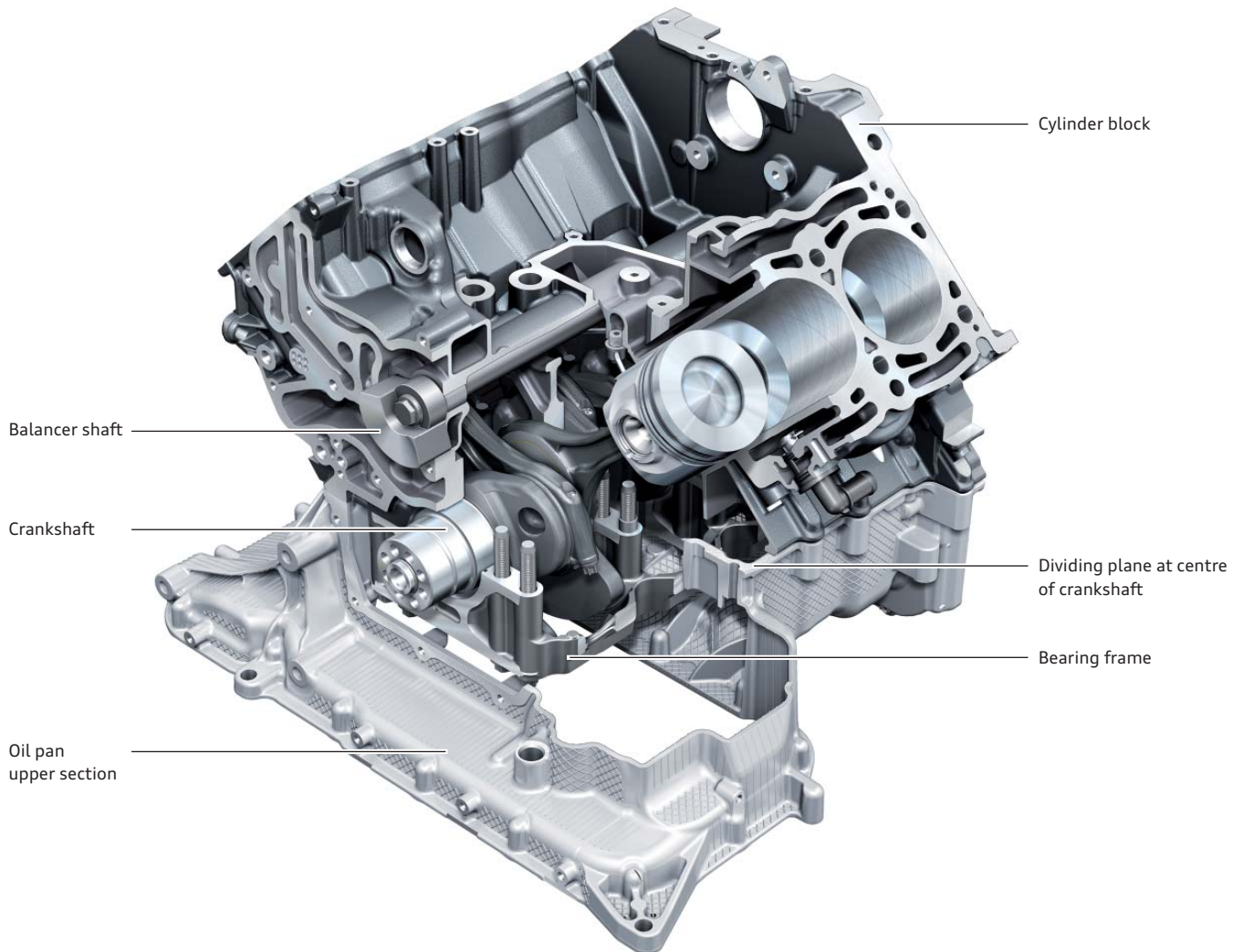
The 3.0l V6 TDI engine is available for various models in a variety of performance categories. The description given in this Self Study Programme refers by way of example to the engine used on the Audi A8 '10.

## Cylinder block

The proven design principle of the cylinder block has also been adopted into the new design. This means that use is made of vermicular graphite cast iron (CJV-450), with its high strength and load capacity.

For reasons of strength and rigidity, the proven bearing frame design principle has also been adopted for the crankshaft bearing.

The weight of the cylinder block has been reduced by 8 kilograms compared to the predecessor generation by systematically reducing wall thickness and by making improvements in terms of lightweight design.



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To obtain the best possible cylinder shape, the cylinder block is plate honed. For this purpose, the mounted cylinder head is simulated by plate honing during finish machining of the cylinder bores.

The near perfectly round bore allows a substantial reduction in piston ring prestress, resulting in low blow-by values and less mechanical friction.

As the final stage of machining the cylinder bore, use is made of the UV photon exposure process applied to the previous engine. Thus, a smooth cylinder race is achieved without mechanical work by the piston.

# Engine mechanicals

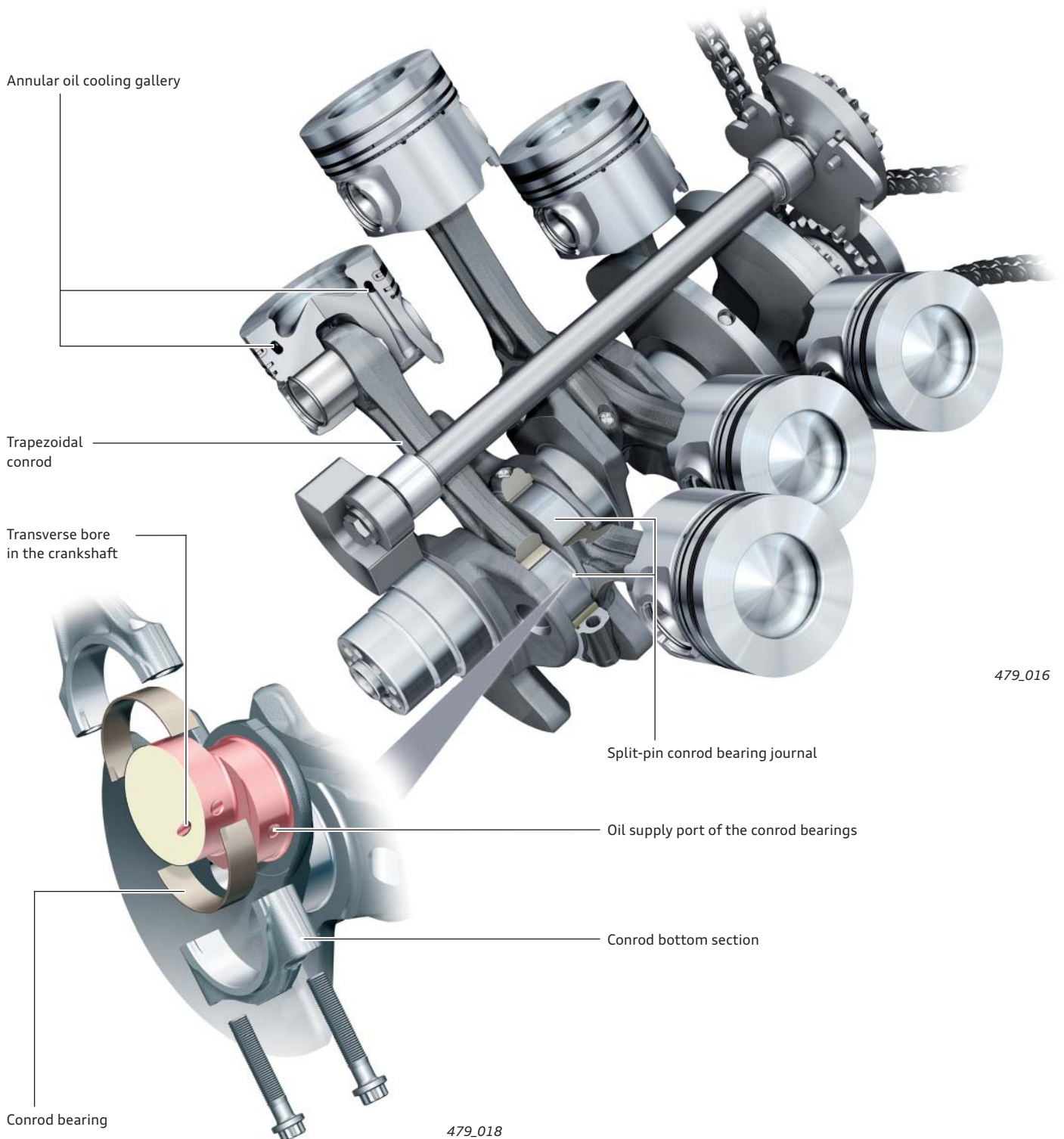
## Cranktrain

The forged 42 CrMoS4 crankshaft in the 90° V engine adopts a split-pin design to achieve identical firing intervals.

Both the main and conrod bearing journals are induction hardened to provide mechanical strength, a special challenge being the split pin itself on account of the strong shear forces to which it is subjected.

Weight has been reduced by eliminating the centre counterweights and by introducing main journal relief bores. The forged conrods are diagonally split and cracked.

For optimal cooling of the recess rim and piston ring assembly at ignition pressures of up to about 185 bar and, thus, higher thermal load, the aluminium pistons have a salt core cooling gallery and an oil spray cooling system.



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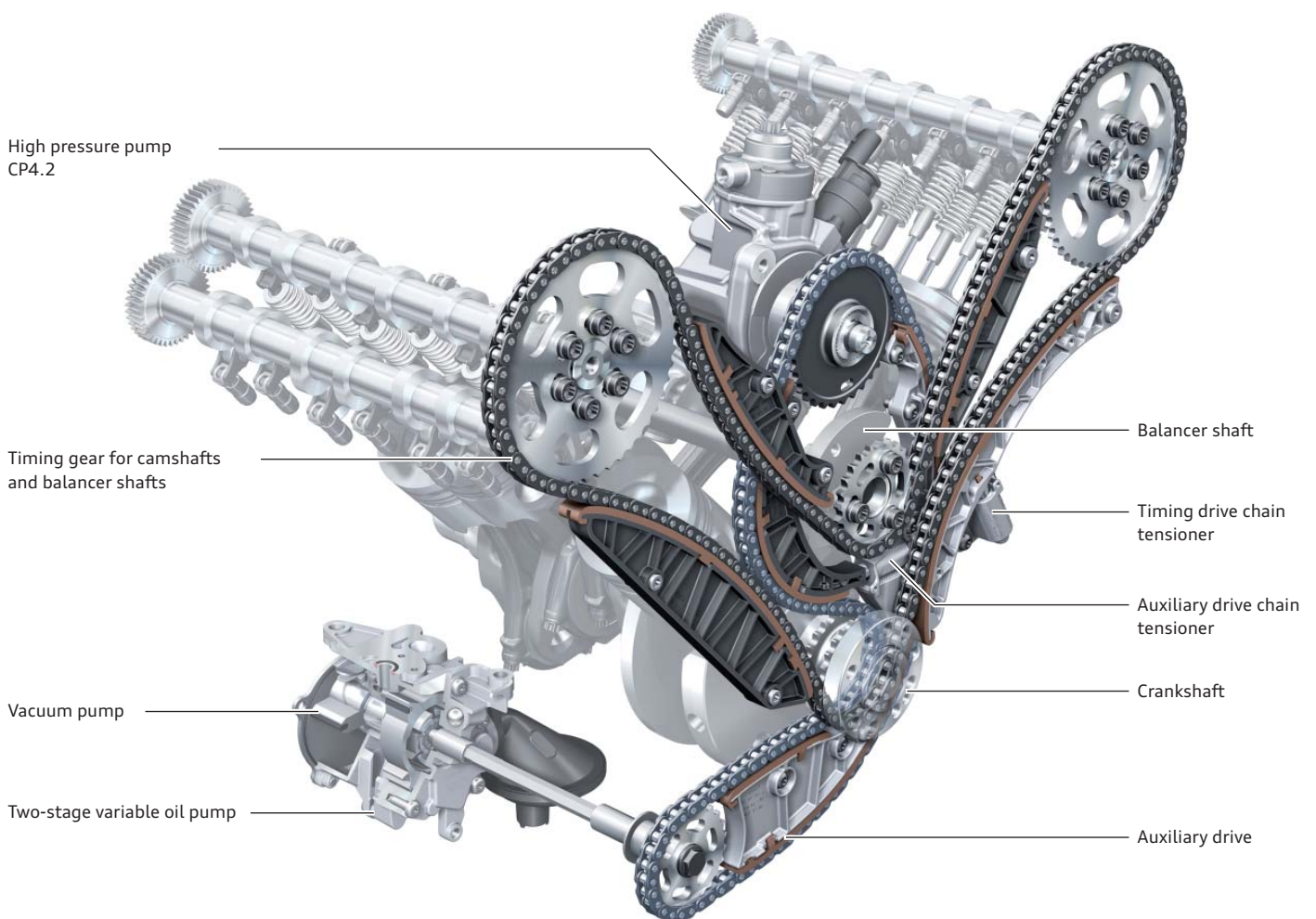
## Chain drive and valvetrain

One of the key features of the Audi V engine family – the double chain drive on the gearbox side – has been further refined for the V6 TDI. The chain drive has a new layout.

The new chain layout reduces the number of chains and chain tensioners from four to two and eliminates the need for idler sprockets. The timing gear uses a relatively long bush chain with 206 links to drive the twin intake camshafts and the balancer shaft.

To counteract chain elongation over time in use, the chain bolts have a wear-resistant coating. The auxiliary drive chain is also configured as a bush chain.

It drives the high pressure injection pump in the rear inner vee and a combined oil and vacuum pump in a common housing.



479\_003

## Cylinder head

The well-known Audi four-valve combustion system has been adopted from the predecessor generation, with a tangential port and a charging port on the intake side as well as two exhaust ports merging into a Y-branch pipe. The intake ports have been further refined for enhanced swirl and throughflow.

The head cooling concept has been revised to reduce the component temperatures around the combustion chamber despite the increased power output.

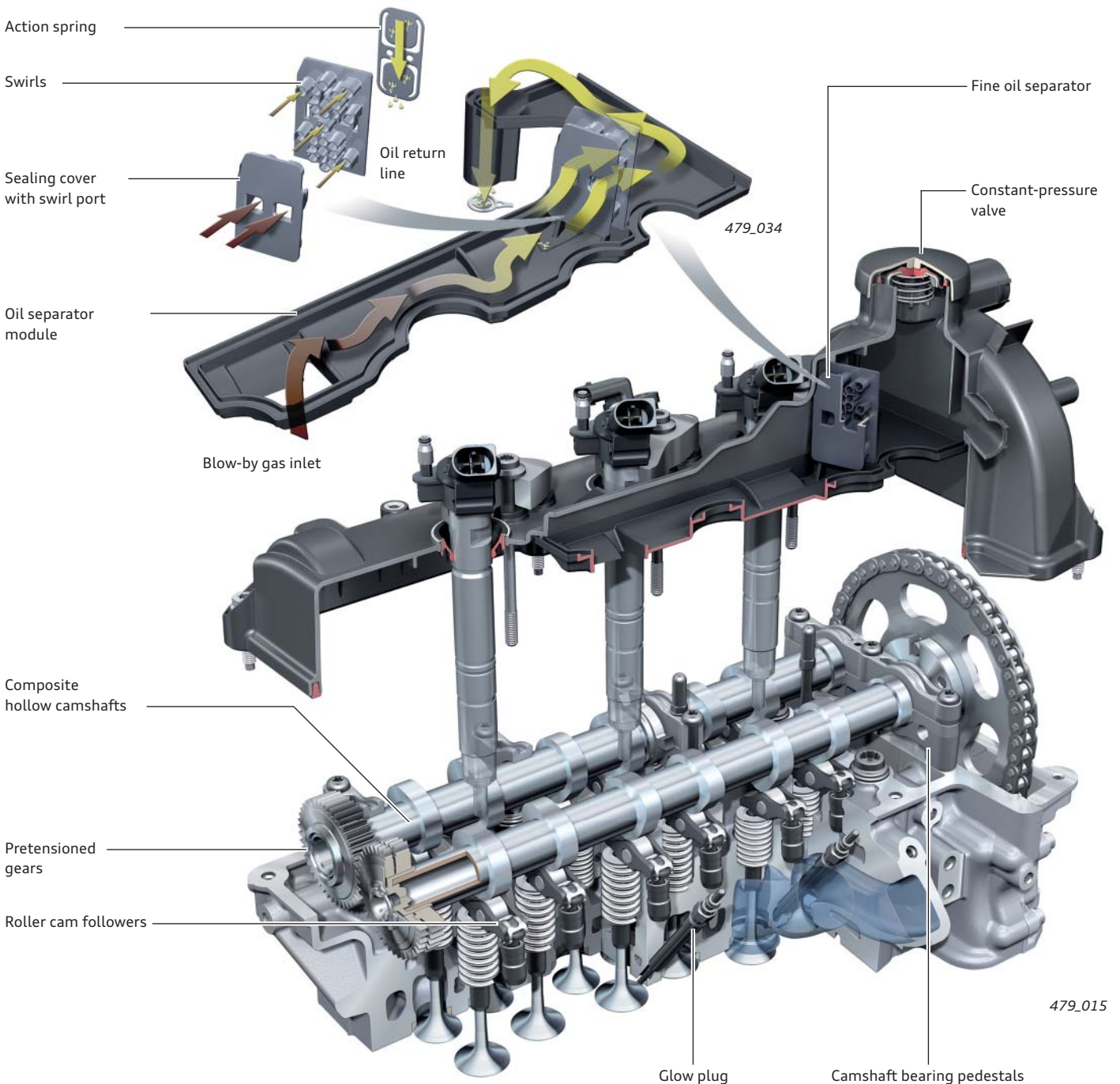
The exhaust valves have been moved further apart and downsized to reduce the coolant space. The cylinder head is designed for directional coolant flow with high flow rates and, thus, to ensure that optimal cooling is provided between the valves and the injector shaft in close proximity to the combustion chamber. Coolant is admitted on the exhaust side through three separate ports per cylinder.

The main flow is directed between the exhaust valves and then distributed to the other valve lands. After in-process assembly of the cylinder head, the composite hollow camshafts are mounted on the cylinder heads with split twin bearing pedestals in place of a ladder frame. This assembly sequence enables the camshafts to be designed without special clearances for fitting the cylinder head bolts while allowing the camshafts to be positioned very close together.

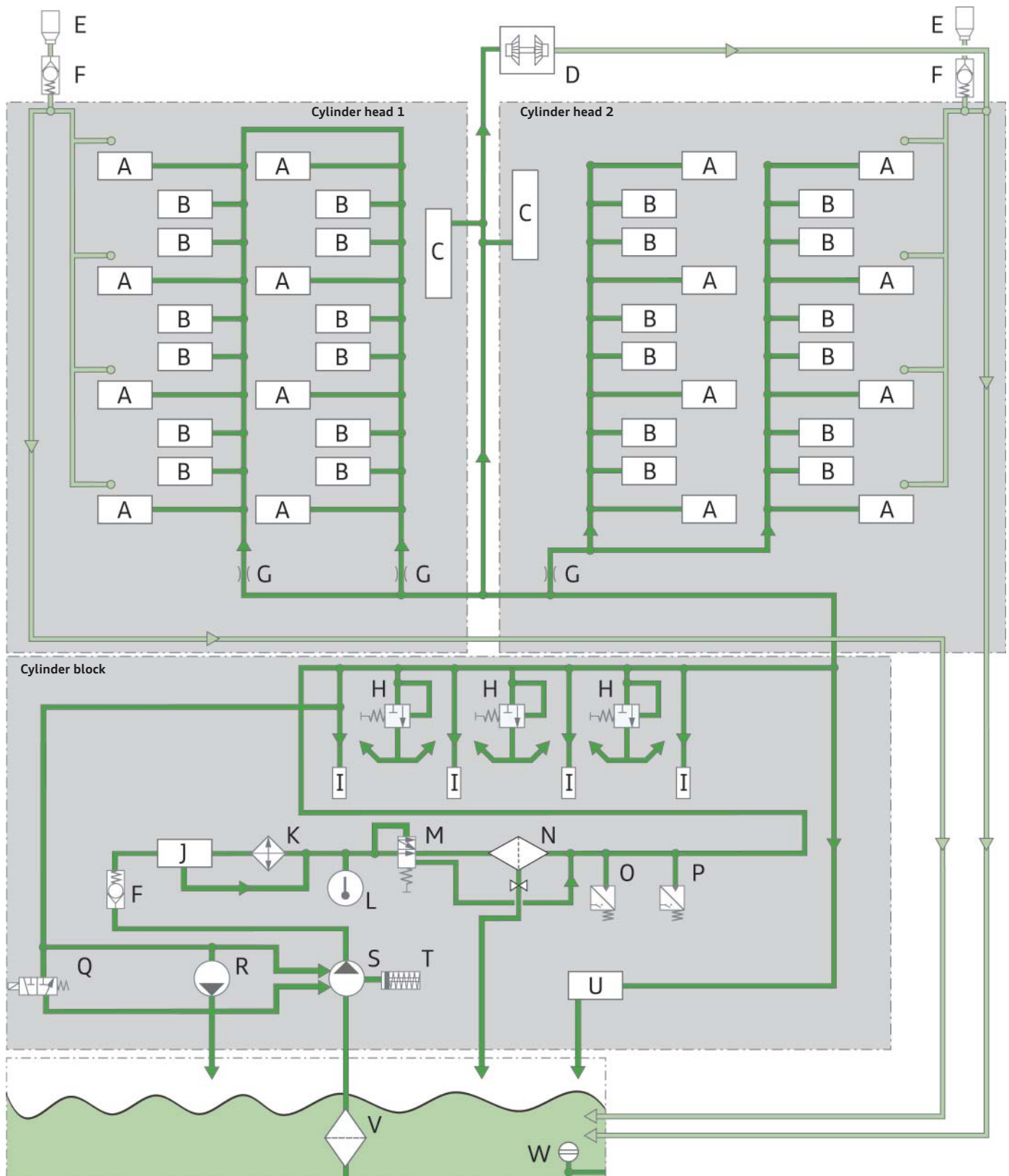
To minimise friction in the valve gear, the diameter of the camshaft bearings has been reduced to 24 mm from 32 mm.

The engine management system has been moved from the inner vee of the cylinder heads into the cylinder head covers together with the coarse and fine oil separators. Both crankcase vents lead to the pressure control valve and from there to the intake side of the turbocharger.

### Design



## Overview



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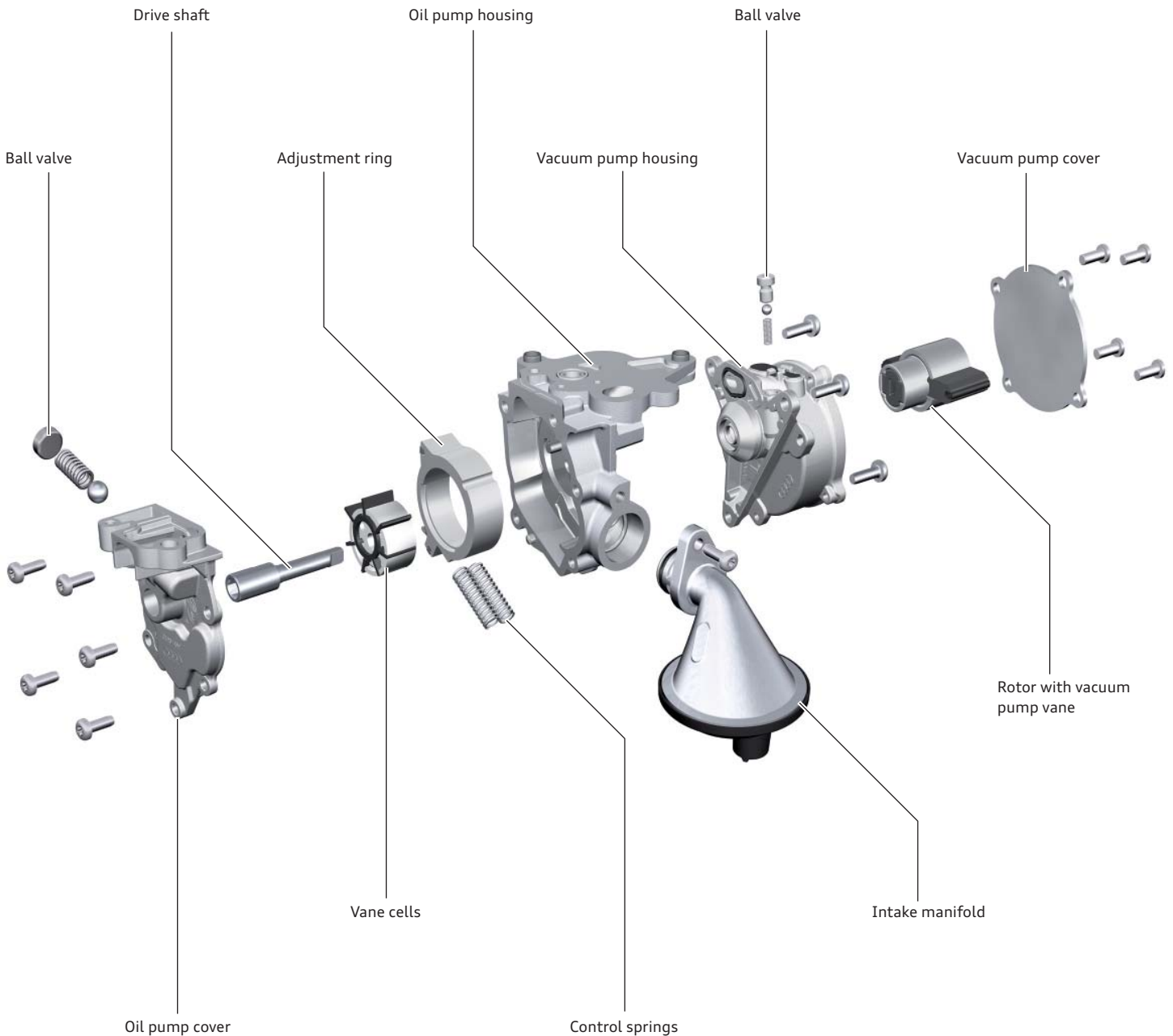
A	Camshaft bearing	I	Main bearing	P	Oil pressure switch F22
B	Balancer elements	J	Thermostat	Q	Solenoid valve N428
C	Chain tensioner	K	Water-oil heat exchanger	R	Vacuum pump
D	Exhaust turbocharger	L	Oil temperature sender G8	S	Oil pump
E	Oil spray separator	M	Filter bypass valve	T	Panic valve
F	Non-return valve	N	Oil filter	U	Oil pump drive gear bearing bolt
G	Flow restrictor	O	Oil pressure switch for reduced oil pressure F378	V	Intake sieve
H	Injection nozzles with integrated valves			W	Oil level sensor G266

## Oil pump with integral vacuum pump

Oil is pumped by a vane-cell pump; its delivery characteristic can be adjusted via a rotatably mounted adjustment ring. The result is a volumetric flow control system which helps to reduce the amount of drive power required depending on engine load.

The lower pressure level is activated up to a maximum engine speed of 2500 rpm, depending on engine load, oil temperature and other operating parameters. In the vacuum pump, vacuum is delivered by a rotor with flexible vanes.

### Design



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#### Reference

For more detailed information about the function of the variable oil pump, please refer to Self-Study Programme 428 "Audi 3.0l V6 TDI engine with ultra low emission system (EU6, LEV II, BIN5)".

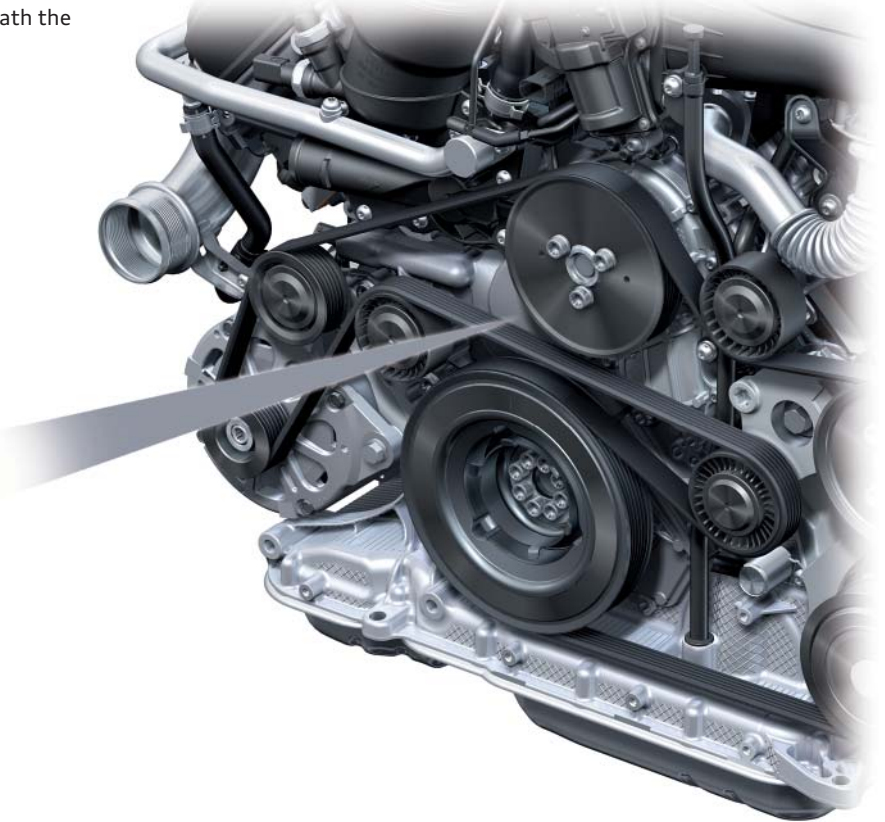
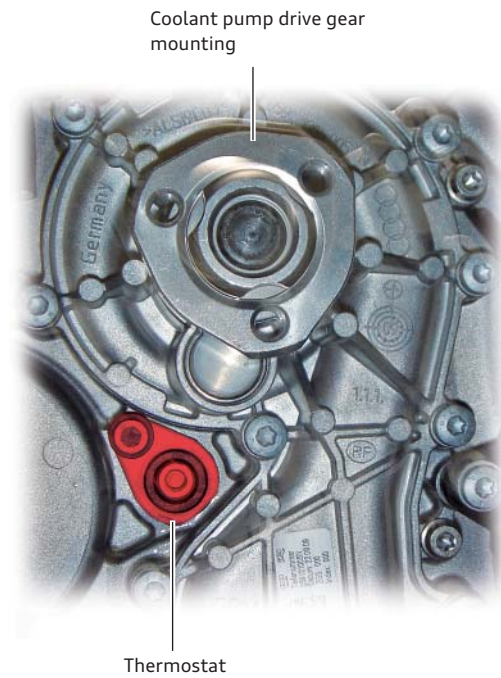
## Engine oil cooler with thermostat-controlled bypass port

To assist the Innovative Thermal Management system, an oil cooler bypass is integrated in engine oil cooler on the oil side. A wax expansion element opens a bypass port at oil temperatures of below 103 °C.

The main volumetric flow oil bypasses the engine oil cooler.

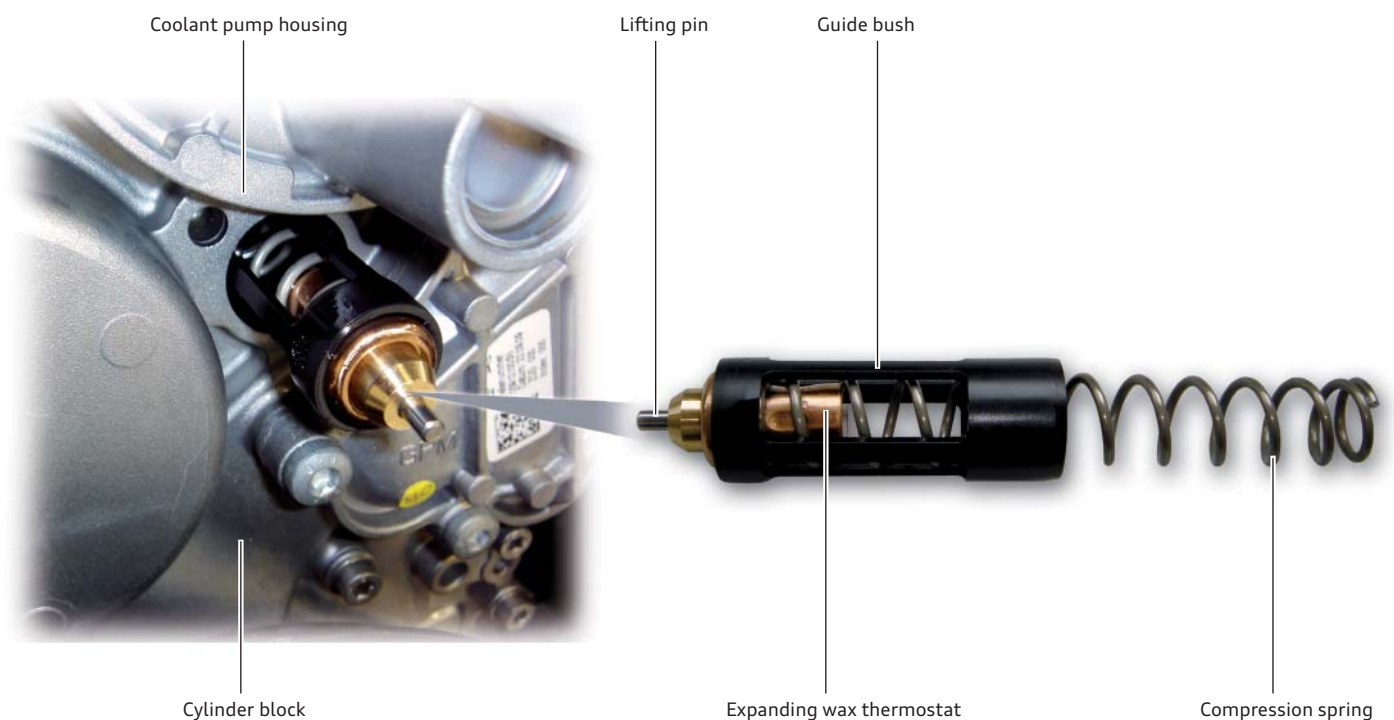
### Installation location

The thermostat is located in the cylinder block beneath the coolant pump.



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### Design



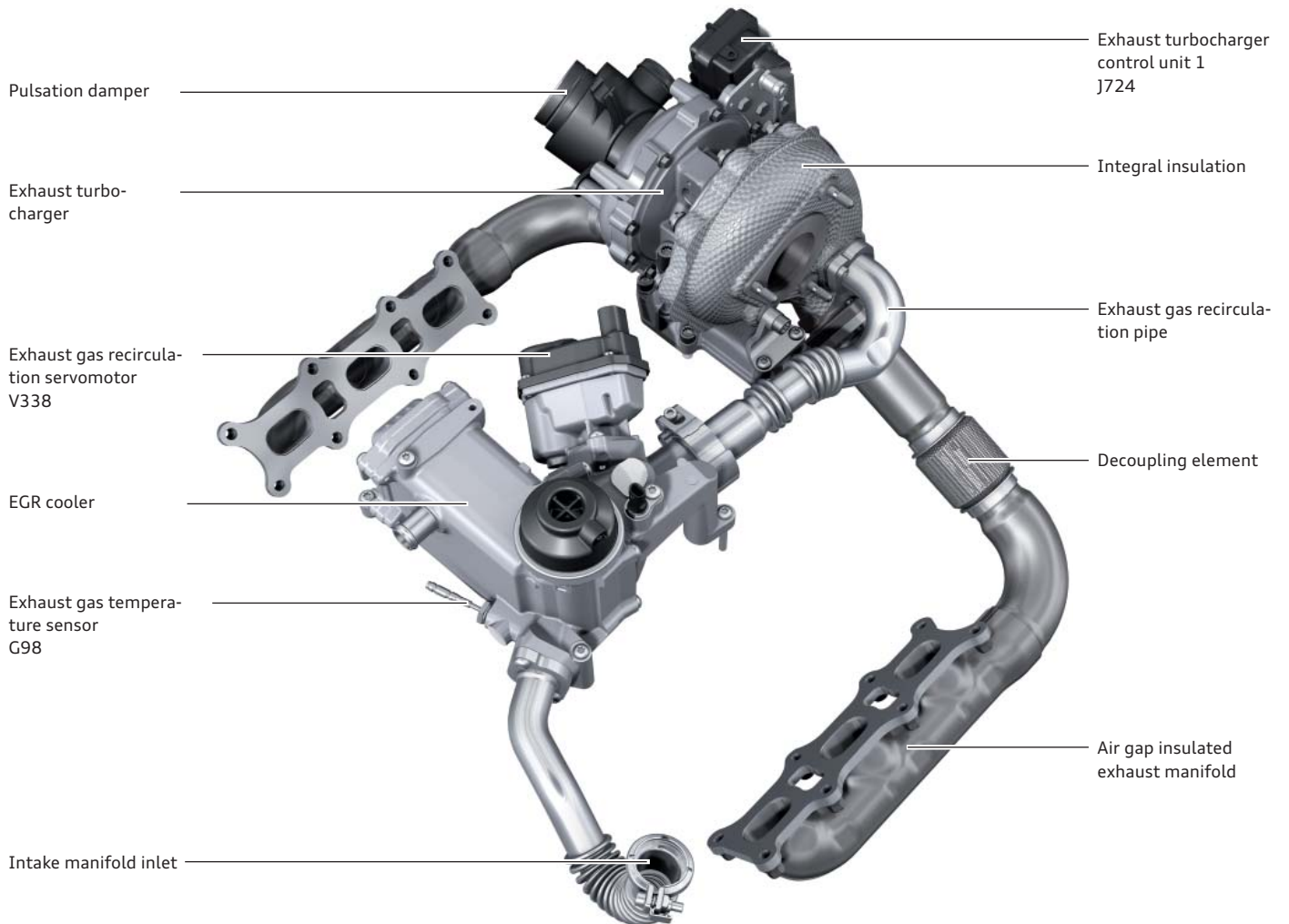
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# Exhaust gas recirculation

## Overview

The exhaust gas recirculation system has a key role to play in meeting the applicable emission standards. The EGR system, which is optimised for pressure loss to achieve high recirculation rates, extracts the exhaust gas from the turbocharger housing upstream of the turbine.

All functional elements of the exhaust gas recirculation system are integrated in the EGR module, which consists of the EGR valve, EGR cooler and bypass valve.



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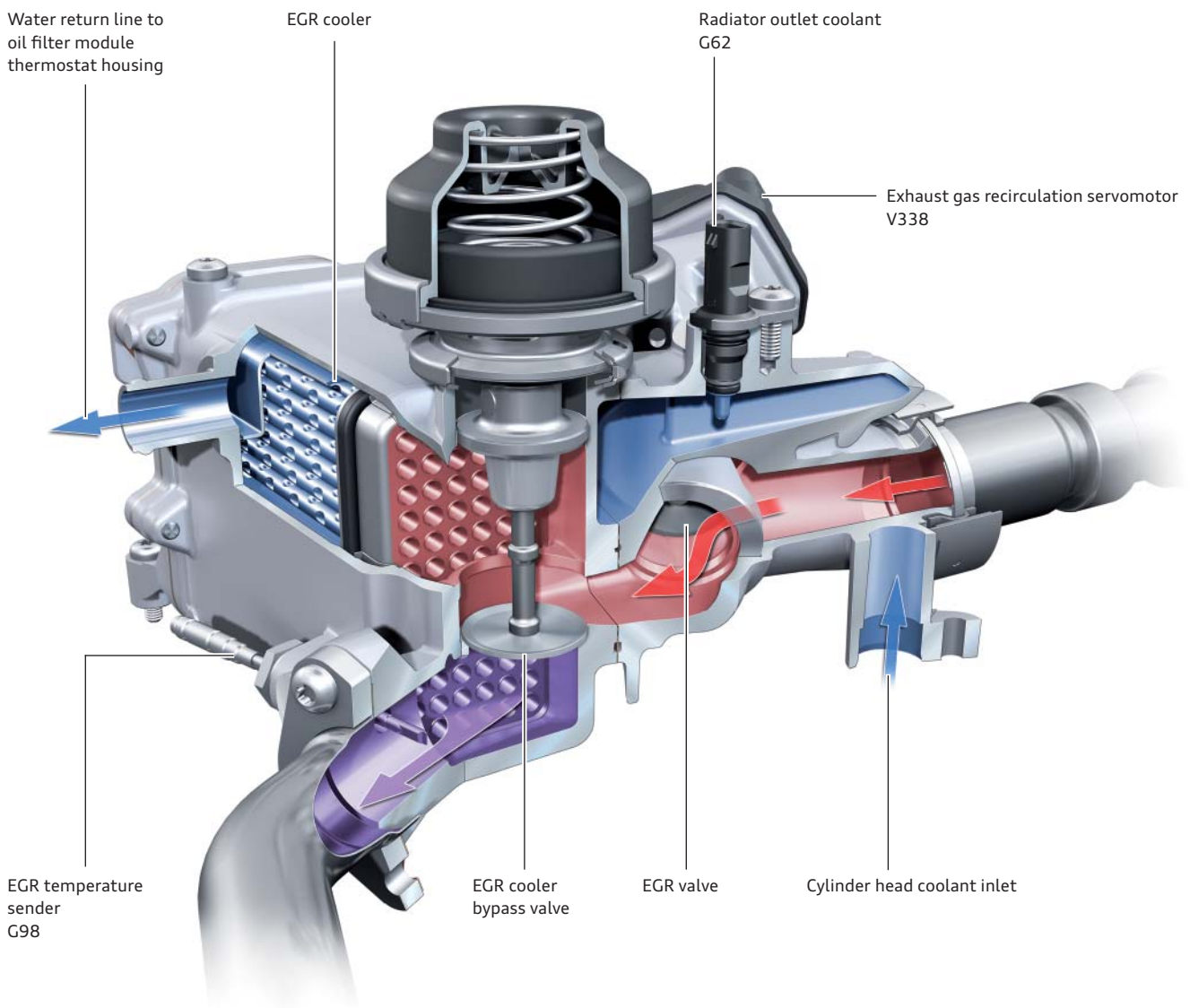
## Active EGR cooler

The drive motor of the electrically actuated, continuously adjustable EGR valve located on the "hot side" has been optimised with a view to achieving higher adjustment forces.

To reduce pressure loss, the seat diameter of the valve has been increased to 30 mm from the 27 mm of the predecessor generation.

The tubular stainless steel EGR cooler has enhanced cooling capacity and is integrated in the module's aluminium housing. A pneumatically actuated lift valve is used in lieu of a flap to bypass the EGR valve.

Compared to a flap, which inevitably comes with a gap, the lift valve has a major advantage in that its seat guarantees a vacuum-tight seal during cooling operation and hence high cooling capacity.



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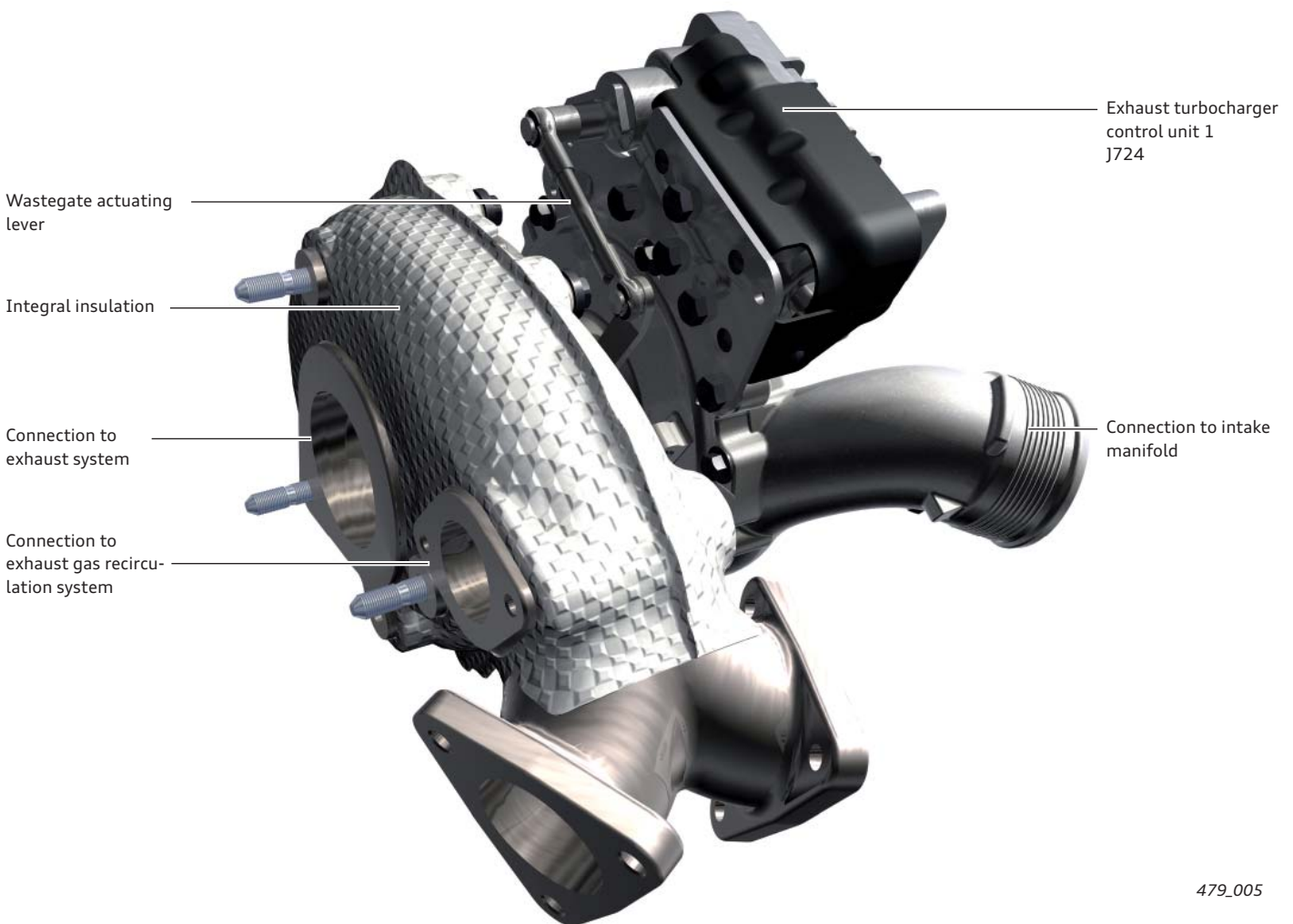
# Charging

## Exhaust turbocharger

Compared to the first generation of the V6 TDI engine, the turbocharger has been adapted to meet the increased power demand. A GT 2260 exhaust turbocharger from Honeywell Turbo Technologies (HTT) is now used for the version with an engine output of 184 kW. The GT 2256 turbocharger is fitted in other versions of the 3.0l V6 TDI engine with less power output.

Many aspects of the turbocharger have been improved. Both the compressor and turbine wheels have been further optimised and the rotating assembly bearing has been significantly enhanced in respect of friction losses.

In combination with the clearly de-restricted intake manifold and the swirl and flow enhanced inlet ports, this results in good internal chargeability combined with enhanced cylinder charging and reduced charge cycle losses.



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## Overboost function

When the accelerator pedal angle exceeds 70 % under acceleration, the overboost function increases nominal capacity by approx. 10 kW. The overboost function is active for up to 10 seconds at driving speeds of between 10 and 120 kph.

The function is deactivated:

- ▶ when towing a trailer
- ▶ at a charge air temperature of greater than 55 °C

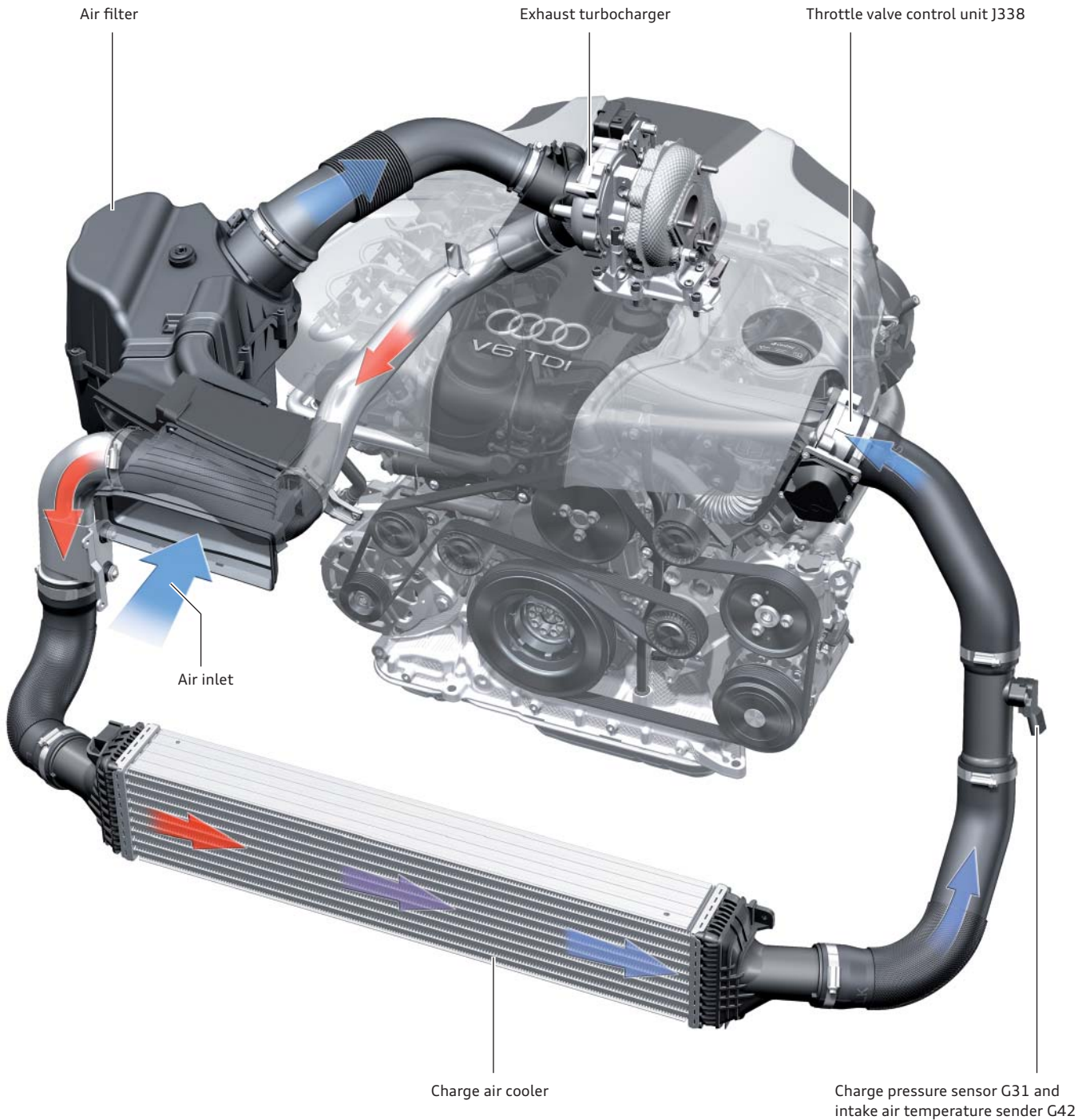
To avoid sudden changes in torque, the overboost function is activated and deactivated on the basis of a mapped ramp.



## Charge air cooling

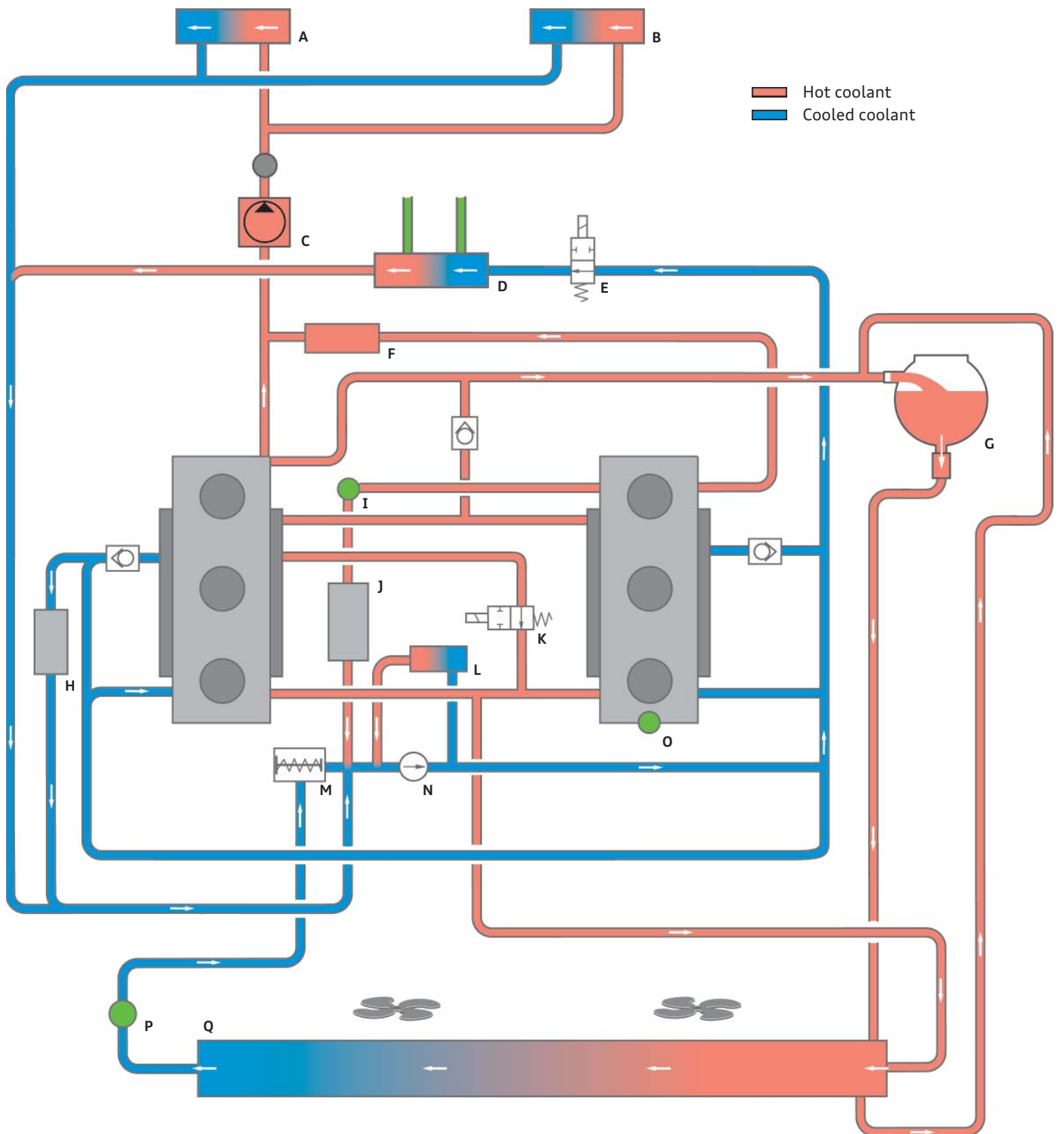
The complete air circulation system from the air filter to the turbocharger has been revised and designed for minimum pressure loss. The pressure-side air circulation system with only one charge air cooler has also been optimised by using low-swirl transitions between the hose connections.

This has resulted in improved engine response as well as having a beneficial effect on emissions and fuel economy.



# Cooling system

## Overview (installation of A8 '10)



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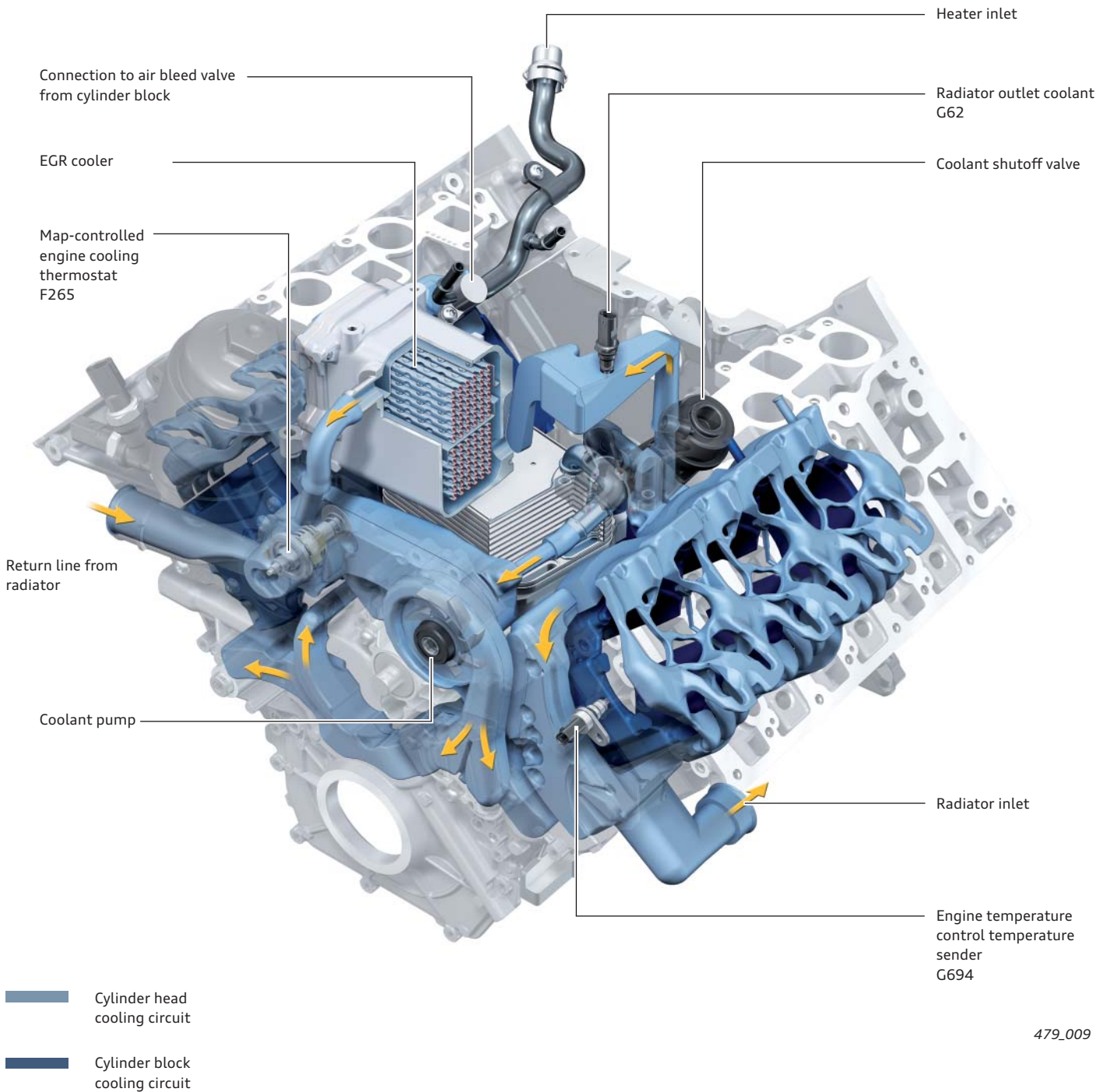
### Legend:

- |          |                                |          |  |
|----------|--------------------------------|----------|--|
| <b>A</b> | Front heater heat exchanger    | <b>J</b> | EGR cooler   |
| <b>B</b> | Rear heater heat exchanger     | <b>K</b> | Coolant shutoff valve                              |
| <b>C</b> | Coolant circulation pump V50   | <b>L</b> | Engine oil cooler                                  |
| <b>D</b> | ATF cooler                     | <b>M</b> | Coolant thermostat                                 |
| <b>E</b> | Gearbox coolant valve N488     | <b>N</b> | Coolant pump                                       |
| <b>F</b> | Exhaust turbocharger           | <b>O</b> | Engine temperature control temperature sender G694 |
| <b>G</b> | Coolant expansion tank         | <b>P</b> | Radiator outlet coolant temperature sender G83     |
| <b>H</b> | Alternator                     | <b>Q</b> | Coolant radiator                                   |
| <b>I</b> | Coolant temperature sender G62 |          |  |

## Coolant circuit and thermal management system

To increase efficiency, special emphasis was placed on heating up the engine as quickly as possible. The cooling system of the new Audi V6 TDI engine therefore employs a split cooling concept, i.e. coolant flows through the cylinder block and cylinder heads in two separate, parallel cooling circuits.

The continuous-duty coolant pump in the inner vee at the front end delivers the coolant in the cylinder block to the exhaust sides of the engine. The coolant flow divides here into two streams to the cylinder heads and to the cylinder block, returning to the intake side of the coolant pump and after flowing through both subcircuits.



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## Cylinder head cooling circuit

The continuous-flow cylinder head cooling circuit primarily consists of:

- ▶ Coolant chambers in both cylinder heads
- ▶ Engine oil and EGR cooler
- ▶ On-board heater and gearbox oil heat exchangers
- ▶ Coolant radiator

The temperature level of the cylinder head cooling circuit is controlled via a mapped thermostat with a heated wax expansion element. The thermostat is deenergised during the warm-up phase and opens at 90 °C. Thus, no thermal energy is dissipated to the main radiator in order to achieve this temperature.

Hot coolant is provided for heating the ATF oil and for heating as necessary. The temperature level of the cylinder head cooling circuit can be reduced – within the physical bounds of the radiator – by energising the map-controlled engine cooling thermostat.

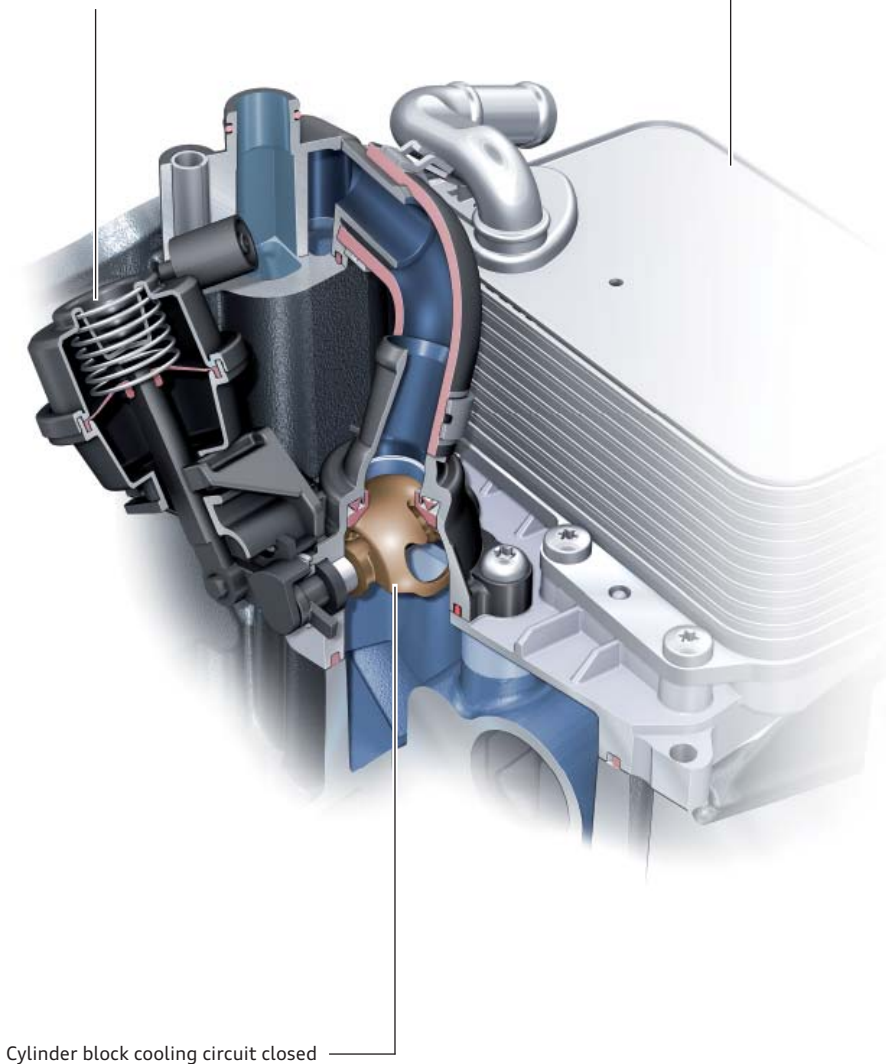
The boundary conditions for this are:

- ▶ Maximum EGR cooling capacity is required
- ▶ Component protection of the cylinder head under high component load
- ▶ Gearbox cooling is required

Pneumatic control valve  
(controls the cylinder head and cylinder block cooling system)

Engine oil cooler

— Cylinder head cooling circuit  
— Cylinder block cooling circuit



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### Note

Follow the instructions given in the Workshop Manual for filling the cooling system. The cooling system is equipped with control valves and may only be filled using the CAS 6096 filling system (vacuum filling).

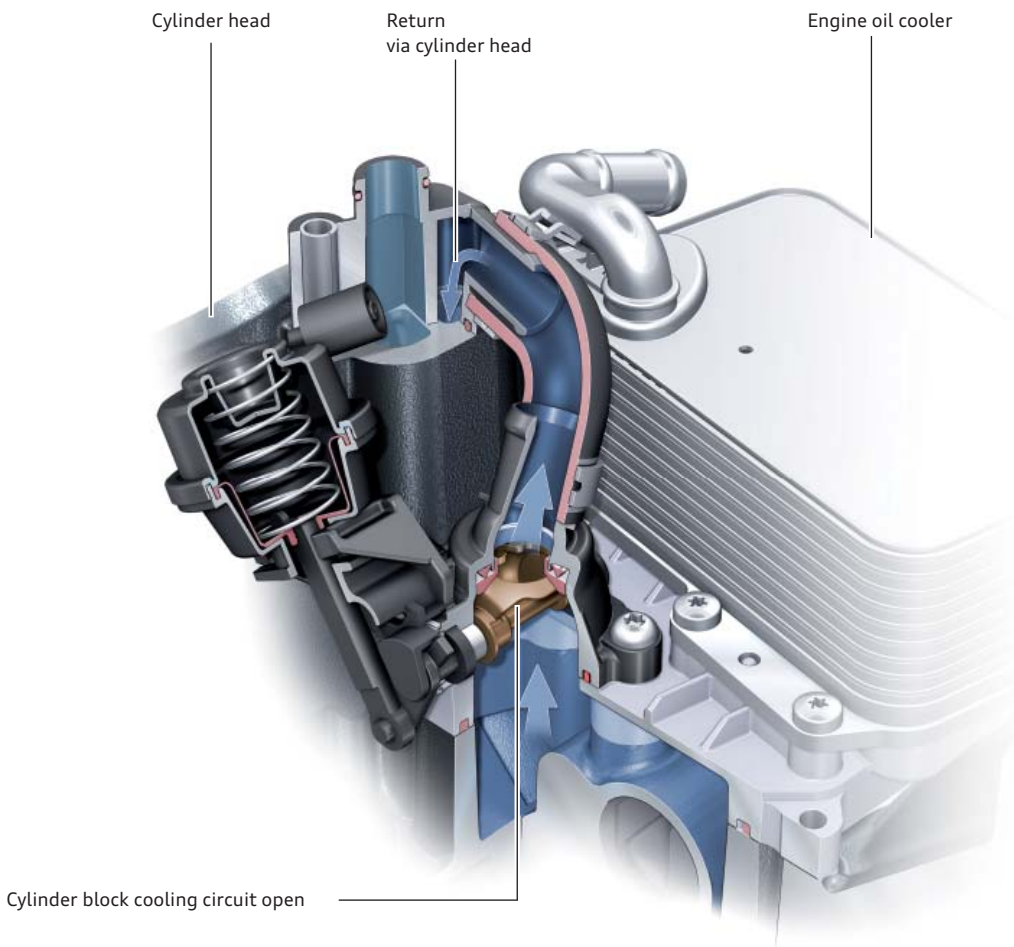
## Cylinder block cooling circuit

Coolant is admitted to the cylinder head cooling circuit on the exhaust sides of the cylinder banks via a nonreturn valve. The nonreturn valves serve to avoid coolant backflow between the two cylinder banks and eliminate unwanted heat dissipation from the cylinder block.

Firstly, the cylinder block cooling circuit is positioned above the coolant outlet, the vacuum-controlled ball valve is shut off and operated with stationary coolant to shorten the warm-up phase of the engine and reduce friction.

After the engine has heated up, the temperature level in the cylinder block cooling circuit is adjusted to approx. 105 °C via the ball valve. The crankgear can, thus, be operated in the ideal temperature range in frictional terms.

For this purpose, the ball valve is activated in a pulse width modulated (PWM) manner by the cylinder head coolant valve N489. To promote rapid heating, the concept includes an oil-side oil cooler bypass.

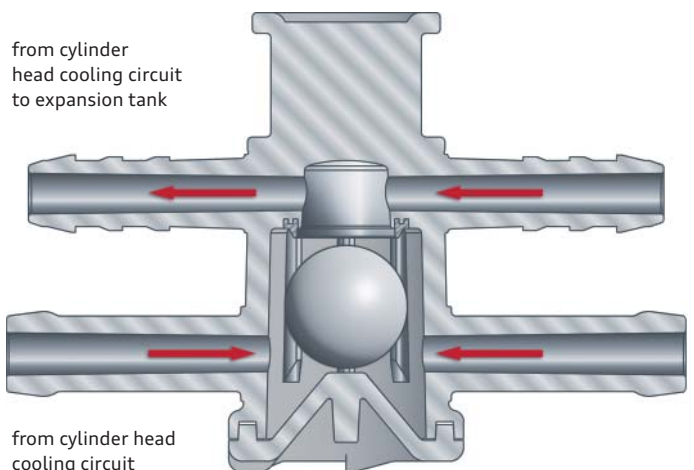


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This cylinder block cooling circuit has a separate vent. The water jackets of the cylinder banks are connected to a header rail in the cylinder heads via the cylinder head gaskets. This ensures that air bubbles are able to leave the cylinder block circuit at the highest point in the system – even when the coolant is stationary.

The ventilation lines lead from the header rails to a breather valve which interconnects the permanent ventilation system of the cylinder head circuit and the ventilation system of the cylinder head circuit. The breather valve seals both subcircuits off from one another via a floating ball valve. When the cylinder head circuit is ventilated, therefore, no heat energy can dissipate from the cooling circuit via the permanent ventilation system.

### Breather valve



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# Intake air ducting

## Overview

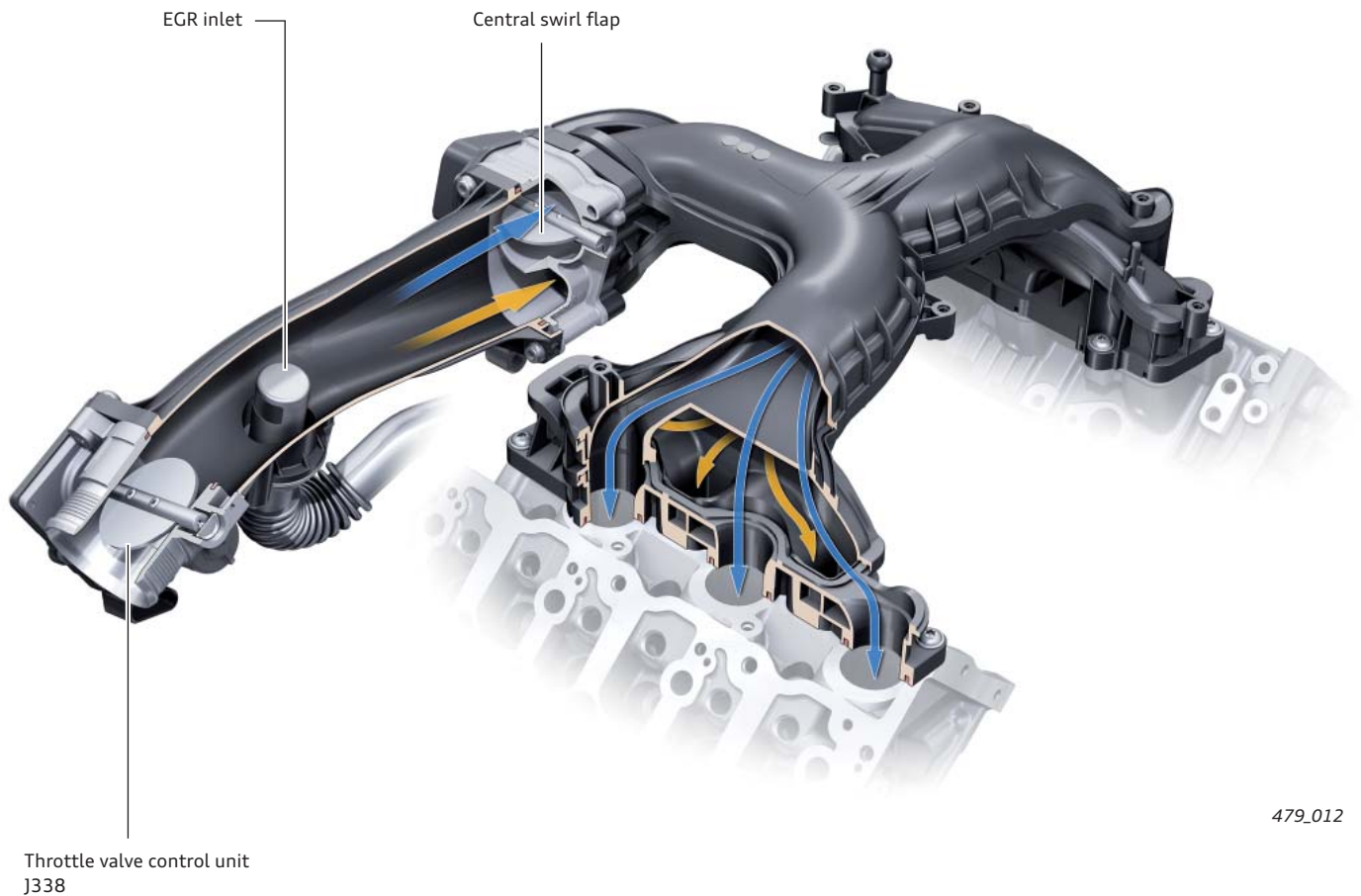
The air induced via the front end flows along a plastic air line to the throttle valve. After leaving the throttle valve, the recirculated exhaust gas is admitted to the intake line in a flow-optimised fashion via a thermally decoupled sheet-metal intake made of stainless steel.

The geometric design of the exhaust gas intake helps to avoid build-up on the inner wall of the plastic tube at all operating points while ensuring a good degree of mixing.

In the new TDI engine swirl is controlled by a single swirl flap, as compared to the six swirl flaps used previously in the (first generation) 3.0l V6 TDI engine. After the central swirl flap, the intake manifold has a twin-flow configuration up to both cylinder banks. The upper half channels air into the swirl ports and the lower half into the charging ports.

For this purpose, plastic intake manifold comprises three friction-welded shells. The intake manifold geometry was enhanced over the course of several calculation loops with respect to pressure loss and uniform distribution of the air flows to the individual cylinders.

## Twin-flow intake manifold



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# Common rail injection system

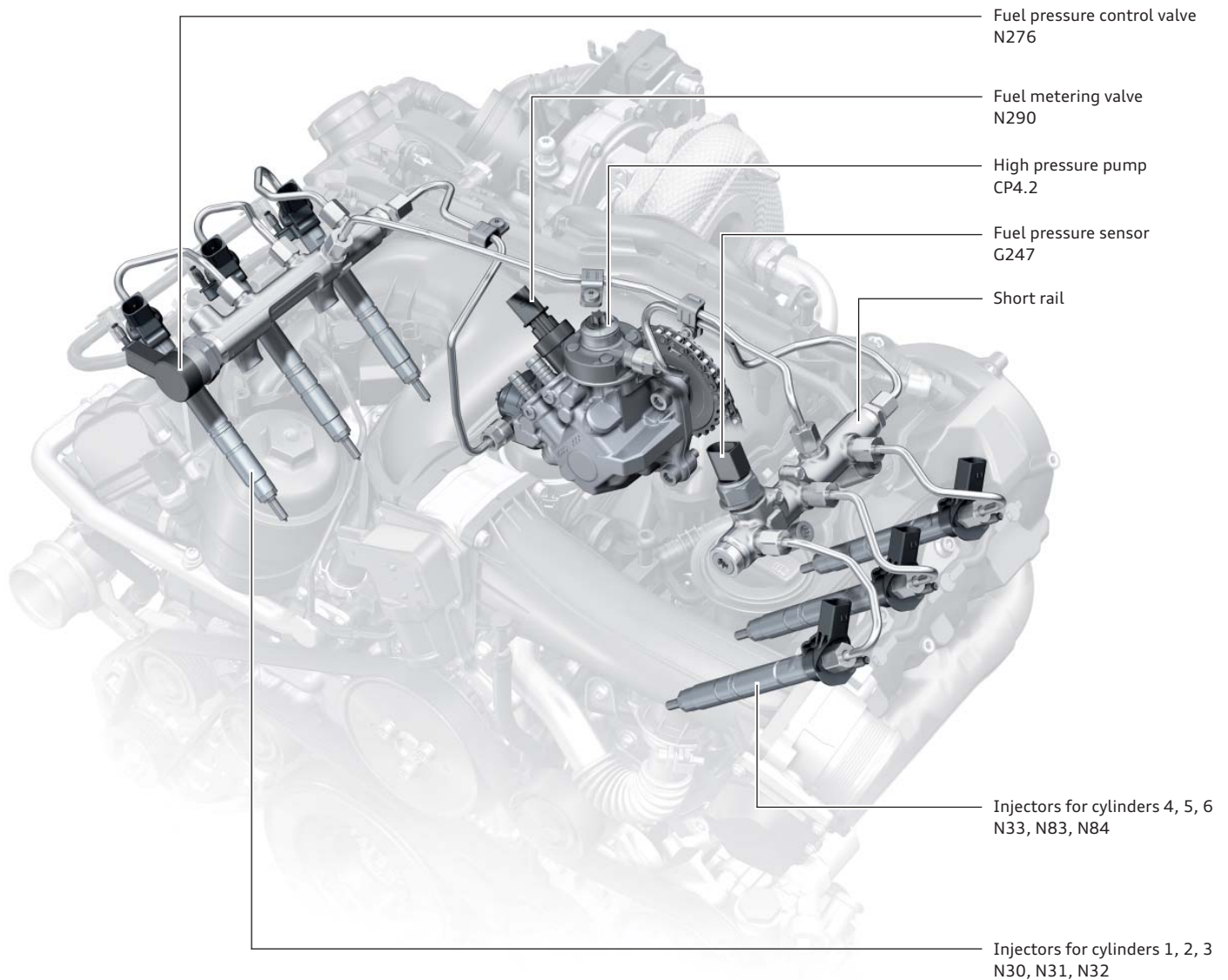
## Chain-driven injection system

The latest Bosch Common Rail System designed for injection pressures of up to 2000 bar and piezoelectric injectors is used as the high-pressure injection system. Depending on the power and installation scenario, a maximum rail pressure is 1800 or 2000 bar and is combined with a matching injector port configuration.

The piezo injectors are connected to the extremely short, forged rails by stainless steel lines designed to withstand injection pressures of up to 2000 bar. Rail pressure is produced by two CP4.2 dual-plunger high pressure pumps with an aluminium casing.

The high pressure pump is seated on the gearbox side in the inner vee of the cylinder block below the turbocharger. It is driven directly by the crankshaft via the secondary drive chain.

To ensure that fuel delivery is in sync with the injection phase, a pulley to crankshaft ratio of 1 : 0.75 is employed. To keep chain forces to a minimum, the pump is mounted to the engine in a phase-oriented fashion. These modifications ensure extremely small differences in the amount of fuel injected into each of the cylinders across the entire mapped range, these differences being particularly important with regard to low emissions.



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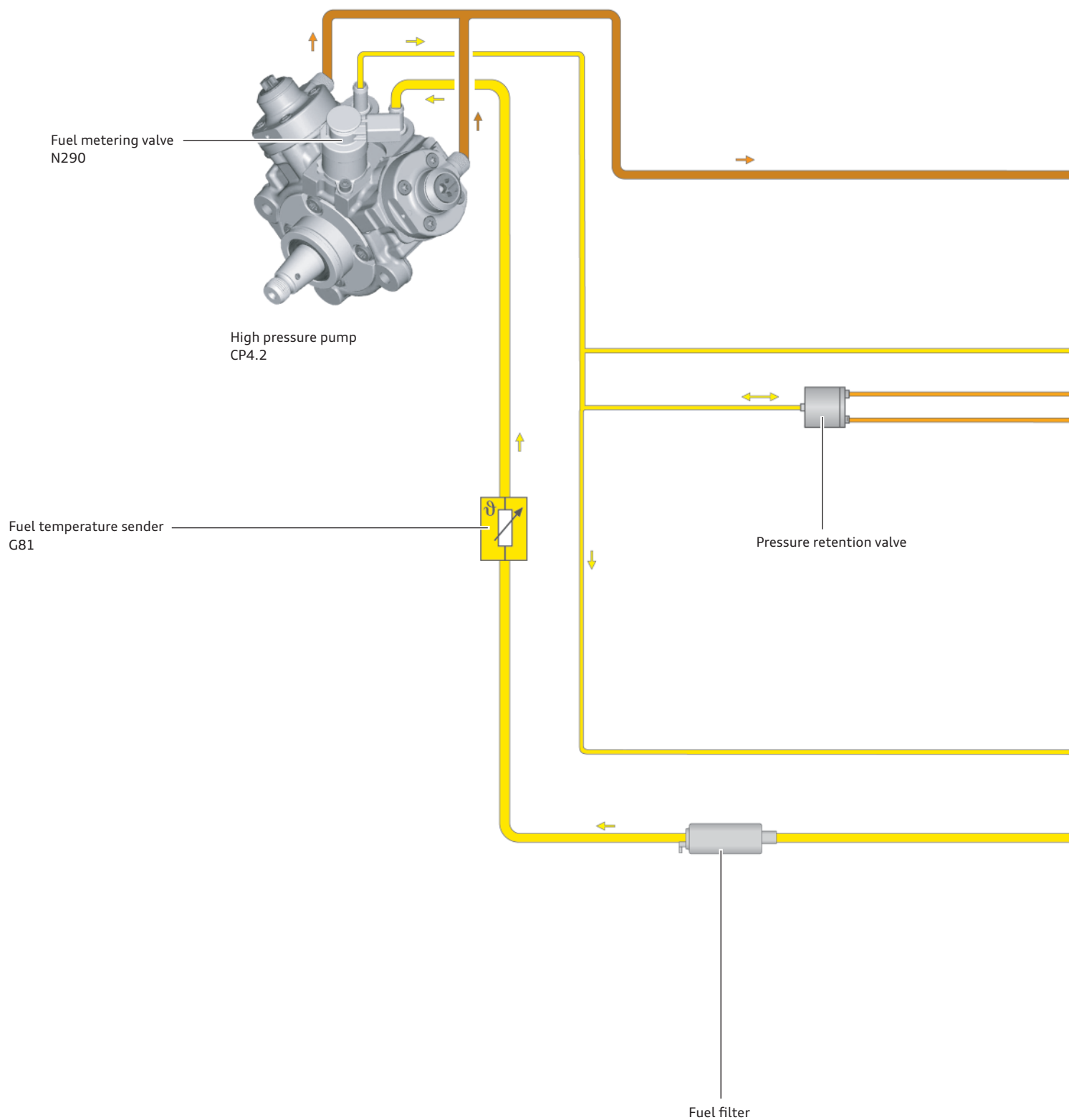


### Note

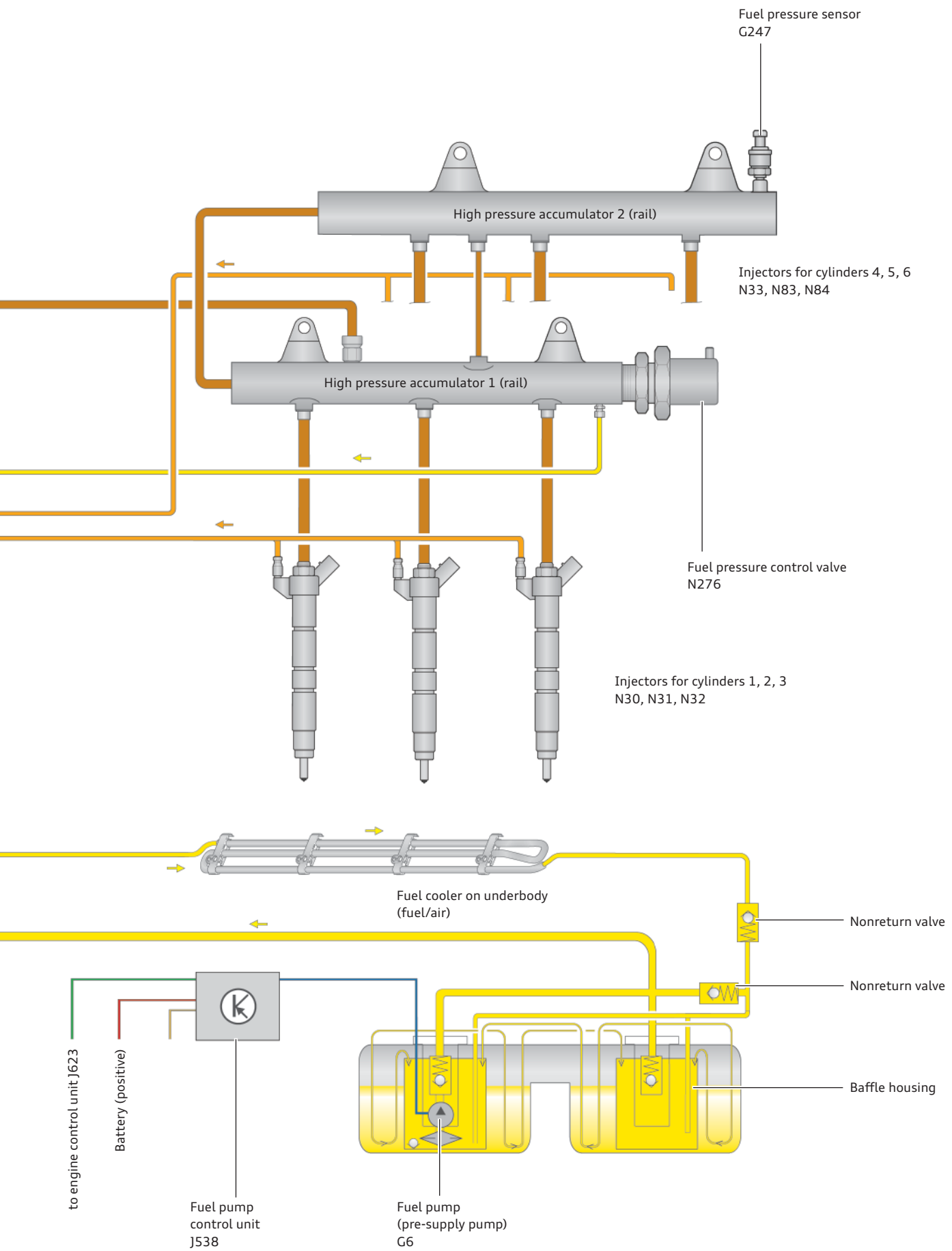
The instructions given in the current Workshop Manual must be observed when removing and installing the high pressure pump.

# Fuel system

## 3.0l V6 TDI engine (second generation) on the Audi A8 '10







479\_029

# Engine management

## System overview

### Sensors

Air mass meter G70

Engine speed sender G28

Hall sender G40

Coolant temperature sender G62

Radiator outlet coolant temperature sender G83

Fuel temperature sender G81

Temperature sender for engine temperature control G694

Oil level/oil temperature sensor G266

Fuel pressure sender G247

Accelerator pedal sensor and accelerator pedal position sender G79 and G185

Exhaust gas recirculation potentiometer G212

Brake light switch F

Charge pressure sender G31 and intake air temperature sender G42

Oxygen sensor G39

Oil temperature sender 2 G664

Oil pressure switch F22

Oil pressure switch for reduced oil pressure F378

Exhaust gas temperature sender 3 (after cat) G495

EGR temperature sensor G98

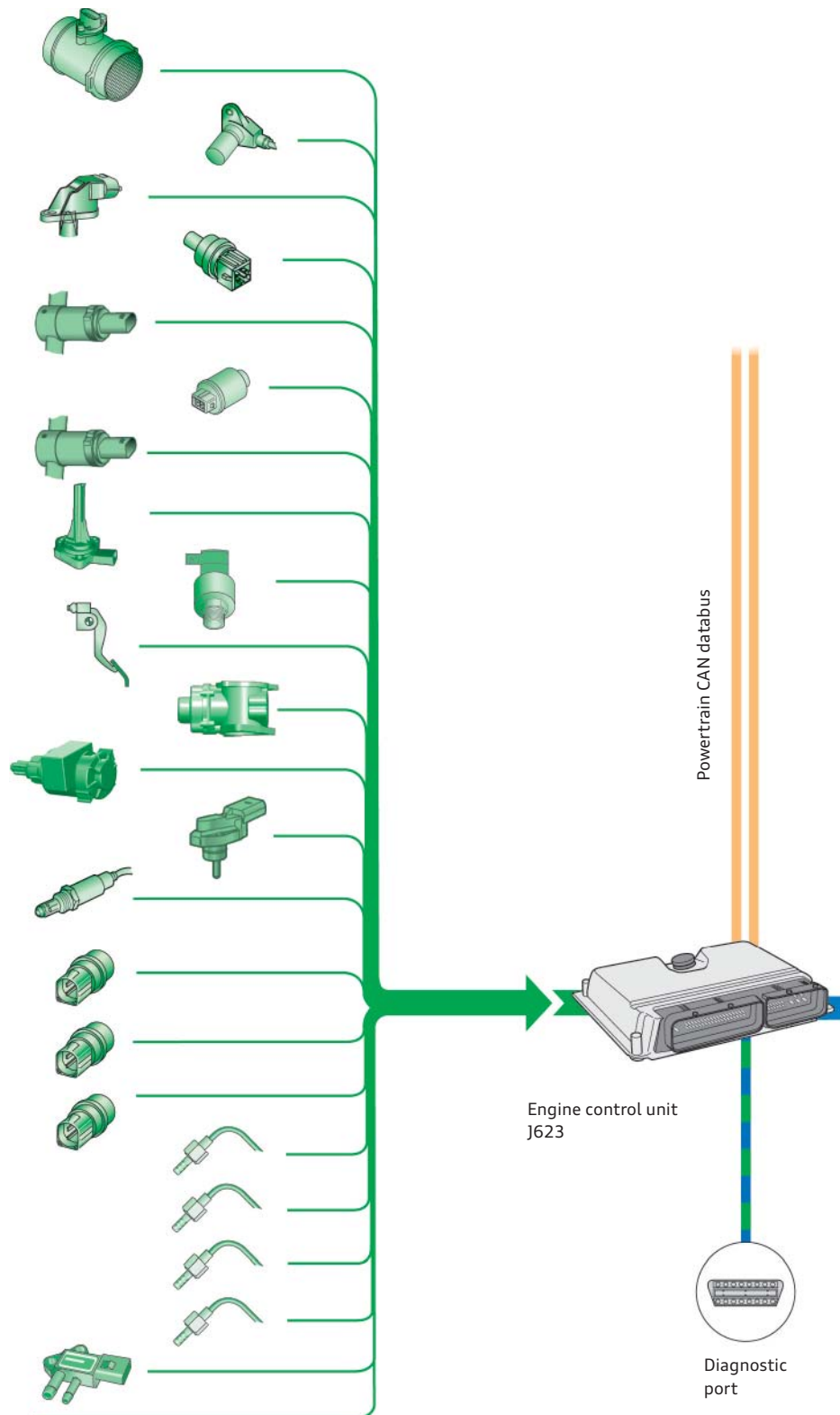
Exhaust gas temperature sender 1 G235

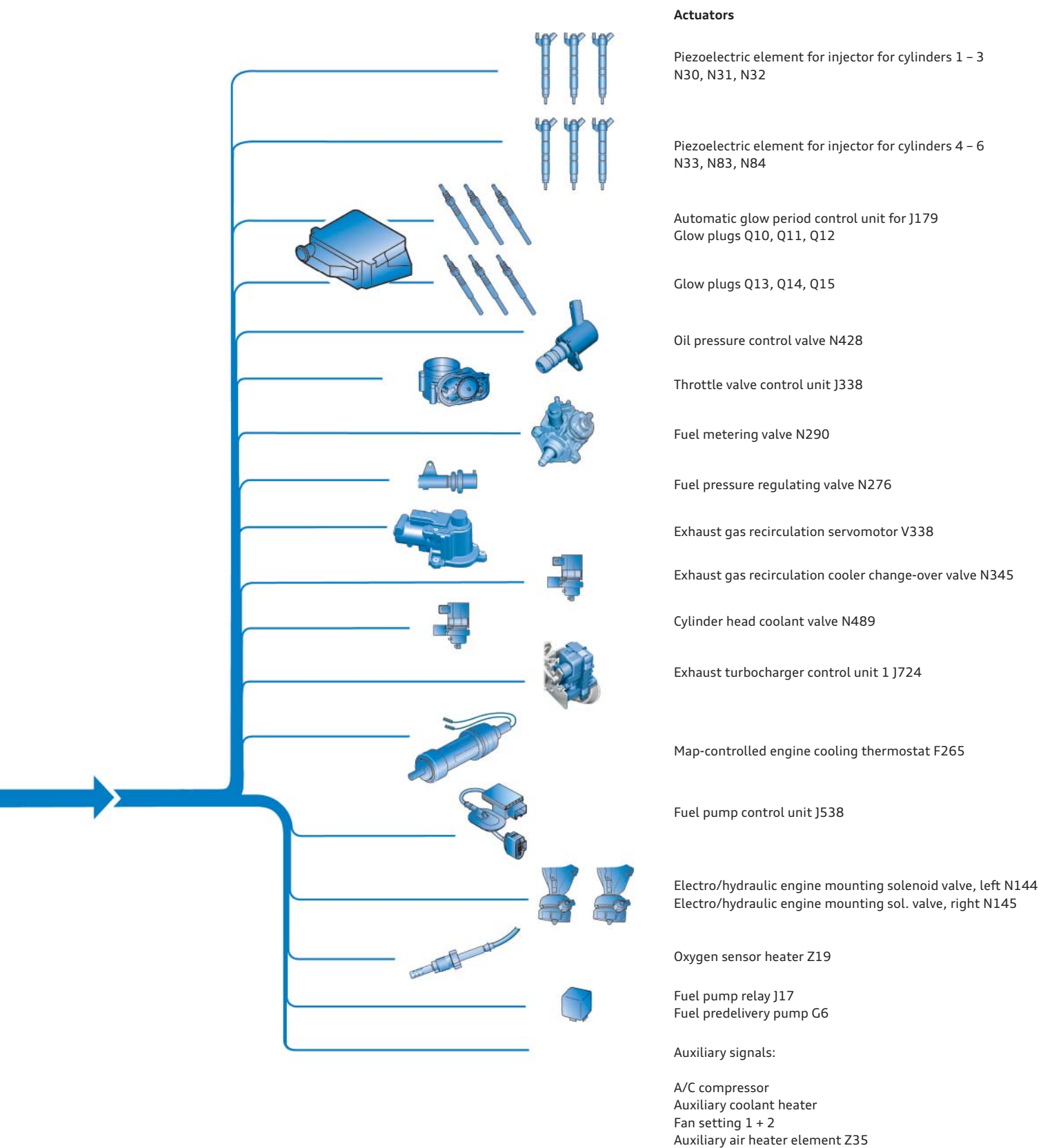
Exhaust gas temperature sender 4 (after particulate filter) G648

Differential pressure sensor G505

Auxiliary signals:

- Cruise control system
- Speed signal
- Start request to engine control unit (Kessy 1 + 2)
- Terminal 50
- Crash signal from airbag control unit



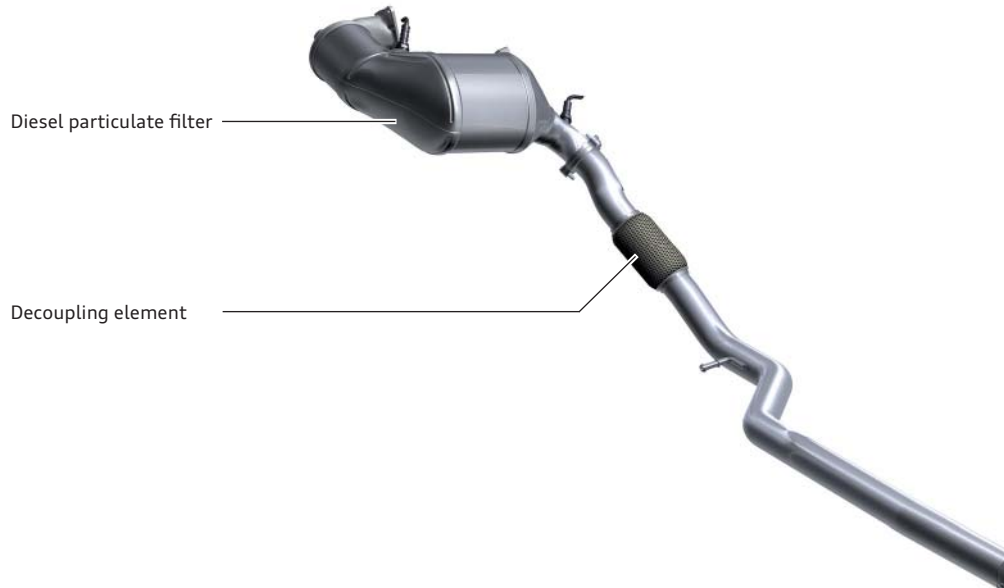


# Exhaust system

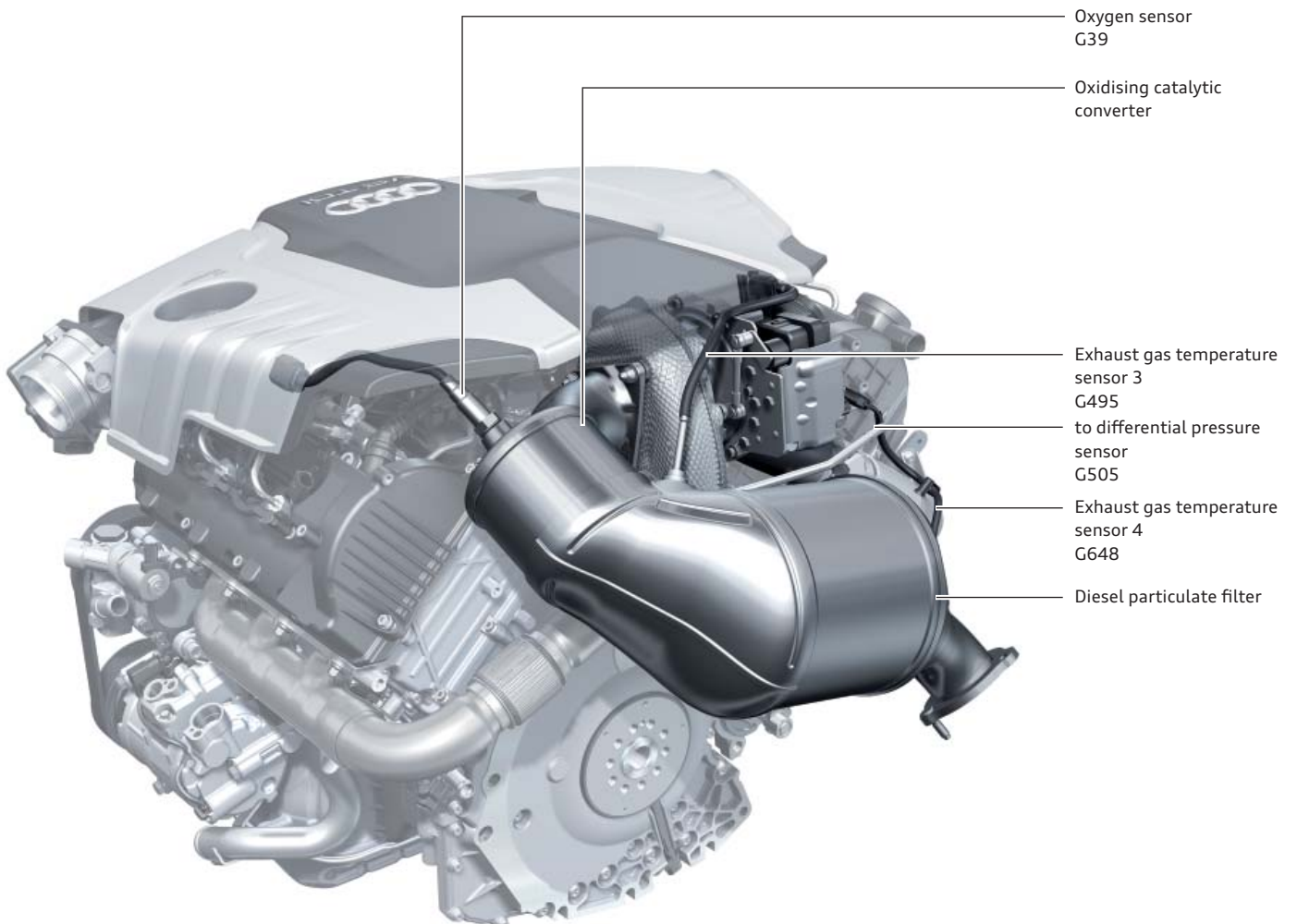
## Oxidising catalytic converter and diesel particulate filter

The oxidising catalytic converters used on all Audi V6 TDI engines and the catalysed soot filter have been further enhanced for the new generation of engines. The oxidising catalytic converter has a capacity of 1.0 litres, the catalysed soot filter 3.7 litres.

Aluminium titanate has been developed in extensive tests as a new diesel particulate filter substrate providing significantly longer regeneration intervals.



## Overview



## Diesel particulate filter regeneration

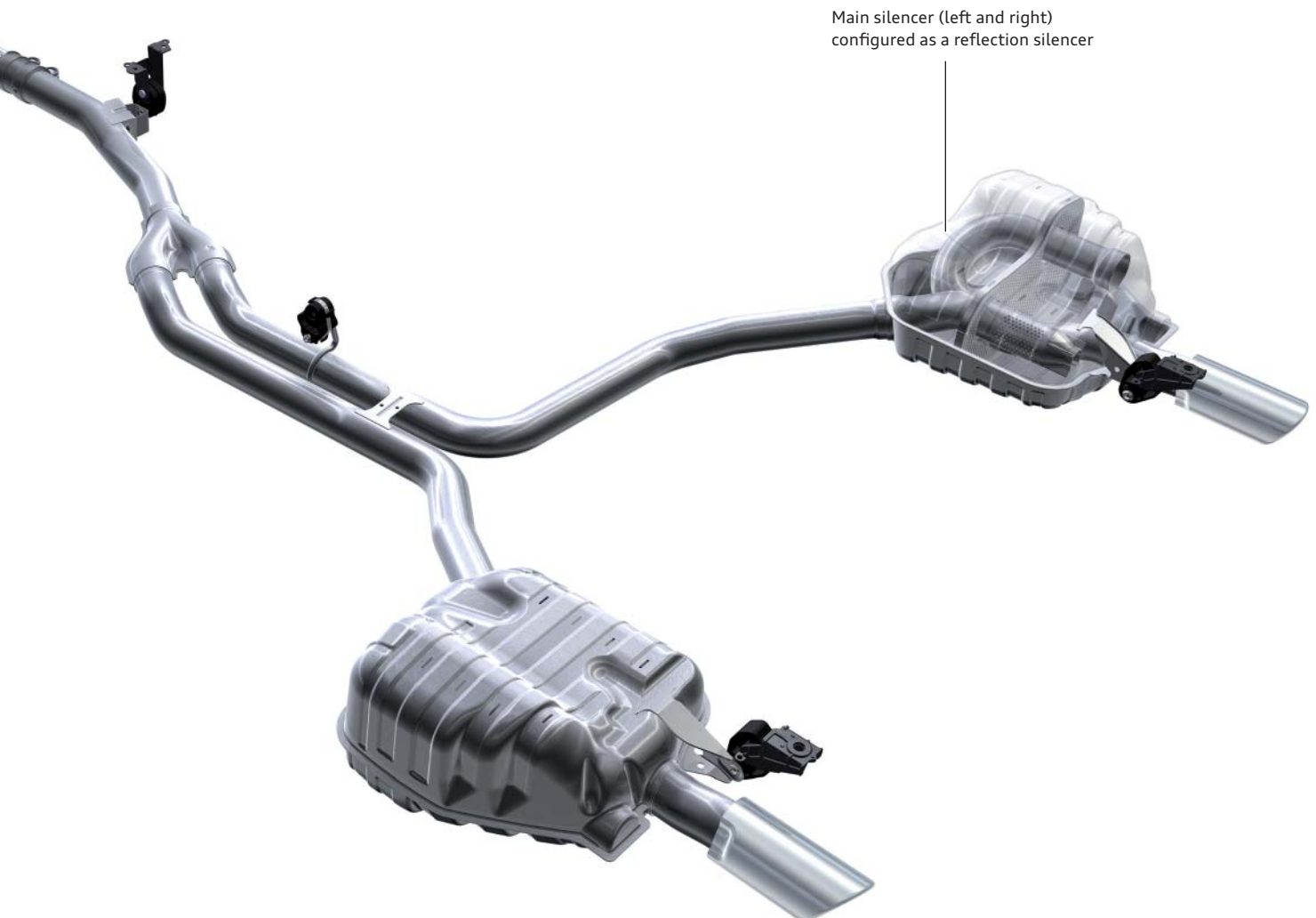
For the first time in a new V6 TDI engine, a triple post-injection is used during the diesel particulate filter regeneration phase to increase temperature at low engine load. This ensures reliable and rapid soot burnoff in all operating conditions, particularly in stop-and-go traffic.

Most of the thermal energy is produced by two closely sequenced, i.e. combusting, post-injections subsequent to the main injection.

The third, retarded post-injection, designed to produce exothermy<sup>1)</sup> via the oxidising catalytic converter, uses very small injection quantities.

This third post-injection allows diesel particulate filter to regenerate at lower exhaust gas temperatures as a result of the lower fuel consumption. This also minimises oil thinning and enhances the resistance of oxidising catalytic converters to ageing.

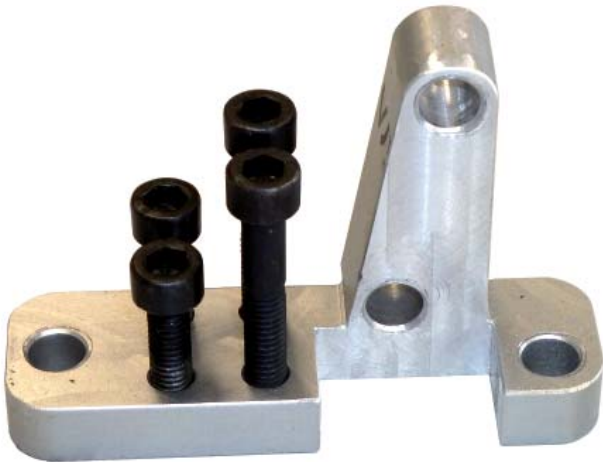
<sup>1)</sup> The term "exothermic" describes a chemical process, usually a chemical reaction where energy is released into the atmosphere as heat.



# Annex

## Special tools and workshop equipment

Detent T40246



479\_040

Installing tool T40048/7



479\_041

Retainer VAS 6395/6



479\_042

Counter-hold tool T40248



479\_043

Guide plate VAS 5161-29



479\_045

Sealing pin VAS 5161-29-1



479\_047

## Engine support VAS 6095-1-11



479\_046

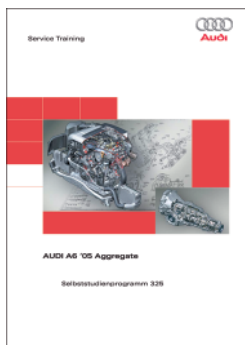
## Locking pin T40245



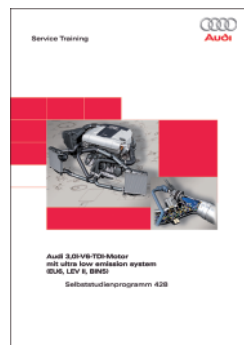
479\_044

## Self Study Programmes

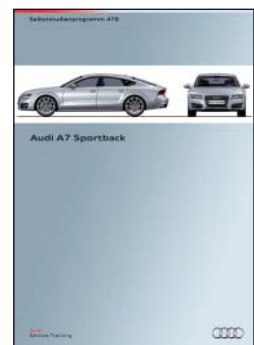
You will find further information on the technology of the 3.0l V6 TDI engine in the following Self Study Programmes.



479\_037



479\_038



479\_039

### SSP 325 Audi A6 '05 engines, order number: A04.5S00.08.20

- ▶ Piezoelectric injectors
- ▶ Engine mechanicals
- ▶ EGR cooling system
- ▶ Common rail injection system

### SSP 428 Audi 3.0l V6 TDI engine with ultra low emission system (EU6, LEV II, BIN5), order number: A08.5S00.56.20

- ▶ Function of the oil pump
- ▶ Exhaust gas after-treatment with ultra low emission system

### SSP 478 Audi A7 Sportback, order number: A10.5S00.71.20

- ▶ Efficiency version of the (second generation) 3.0l V6 TDI engine

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