



## The Second Generation 3.0L V6 TDI Engine

Audi of America, LLC  
Service Training  
Printed in U.S.A.  
Printed 9/2012  
Course Number 920213

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Always check Technical Bulletins and the latest electronic service repair literature for information that may supersede any information included in this booklet.

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The Self-Study Program provides introductory information regarding the design and function of new models, automotive components, or technologies.

**The Self-Study Program is not a Repair Manual!**  
**All values given are intended as a guideline only.**

For maintenance and repair work, always refer to current technical literature.

**Reference**



**Note**



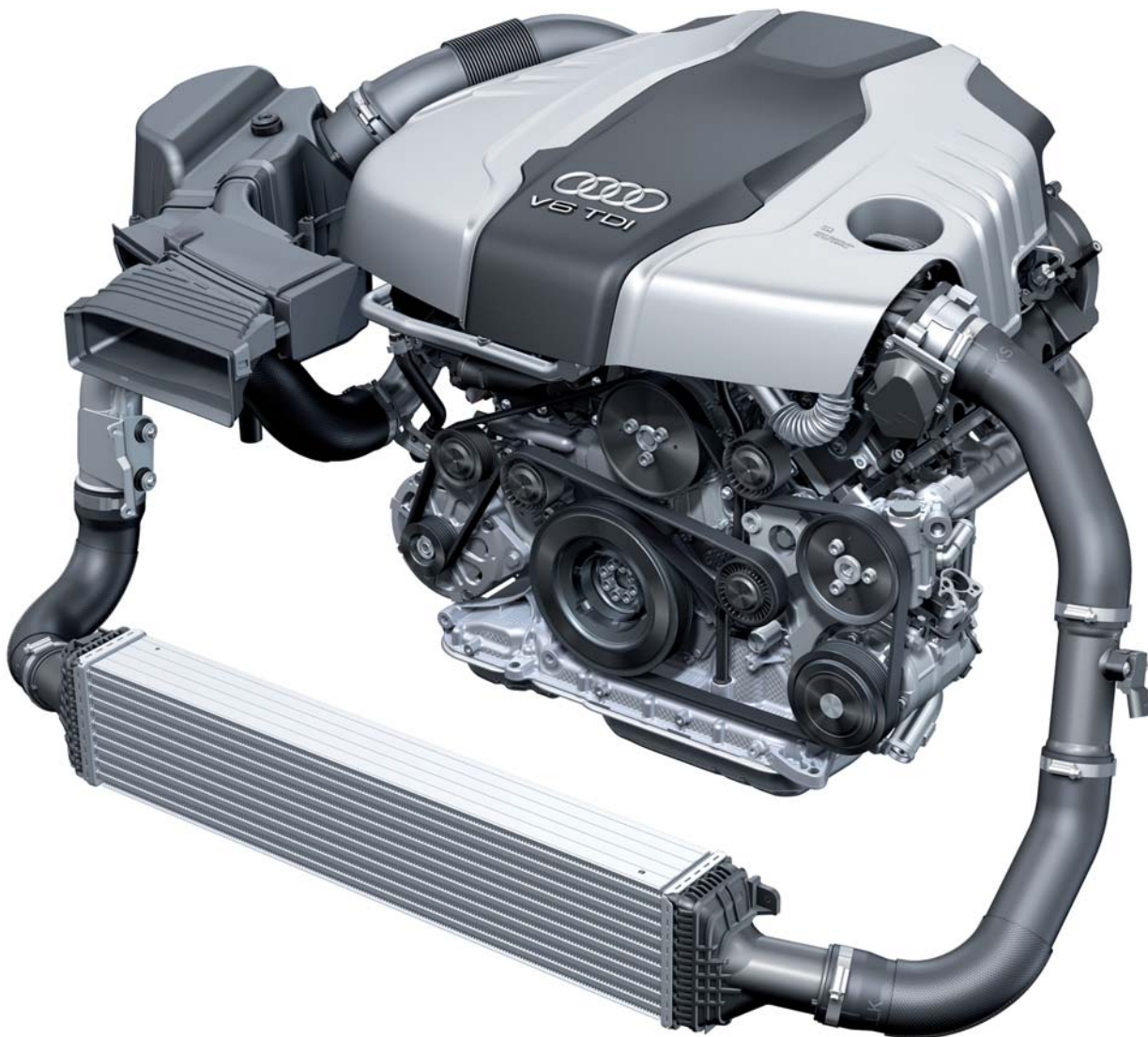
# Introduction

The success story for V6 TDI engines at Audi began in 1997 with the introduction of the world's first four-valve 2.5 liter V6 TDI with a distributor injection pump fuel system.

In late 2003, this engine was followed by a 3.0 liter V6 TDI with common rail fuel injection. A power reduced 2.7 liter version was introduced in 2004 but was not offered in the U.S. market.

V6 TDI engines have evolved with much success in various Audi and VW Group models.

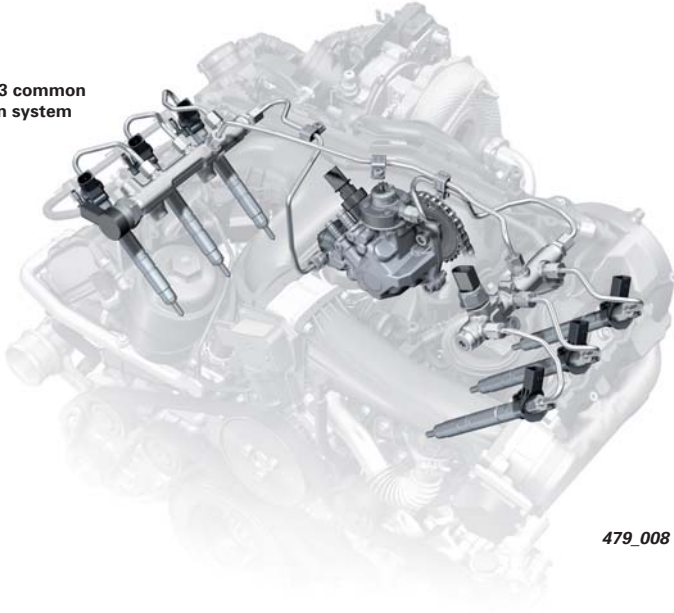
The second generation 3.0L V6 TDI engine features state-of-the-art diesel technology, such as a common rail fuel system with piezo fuel injectors, systematic thermal management, and extensive friction reducing improvements. This ensures that lower emissions and higher fuel economy are achieved.



479\_001

# Technical Features

Bosch CRS 3.3 common rail injection system



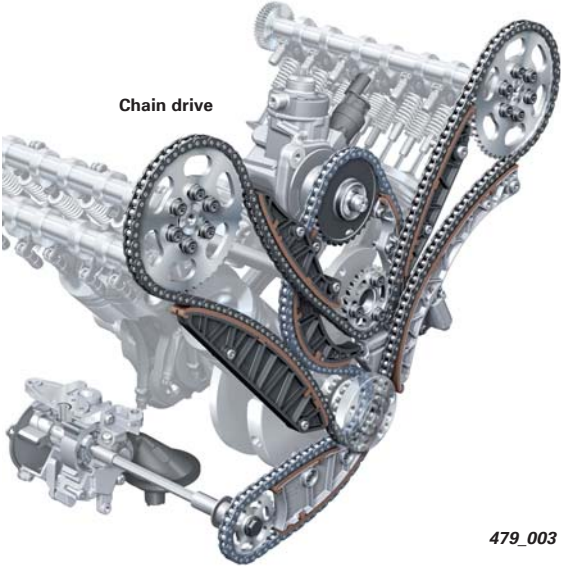
479\_008

Intake manifold with a single swirl flap

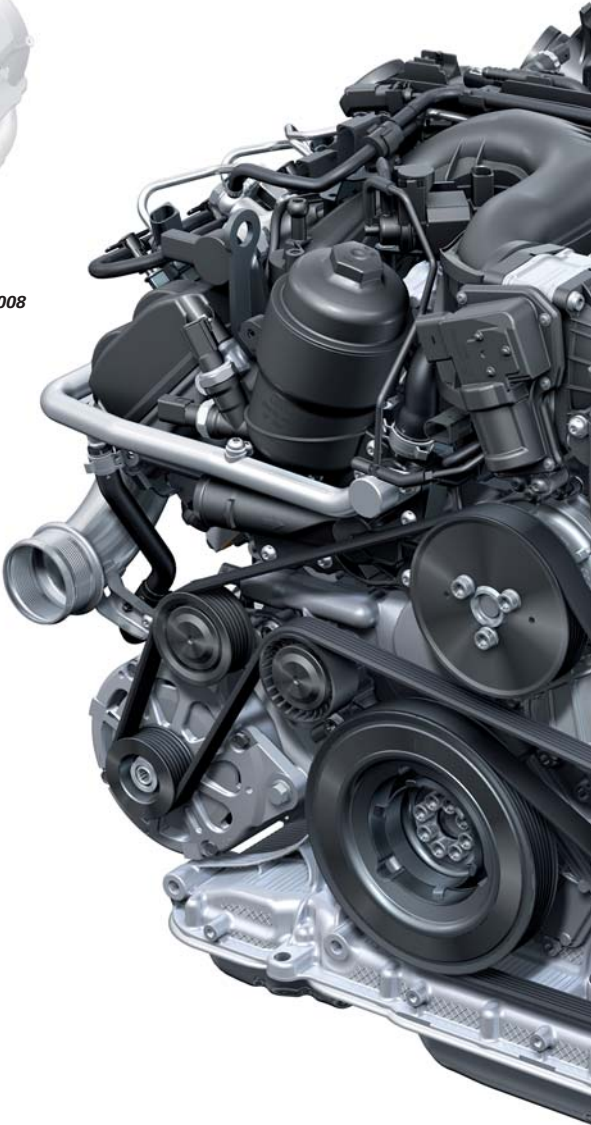


479\_012

Chain drive

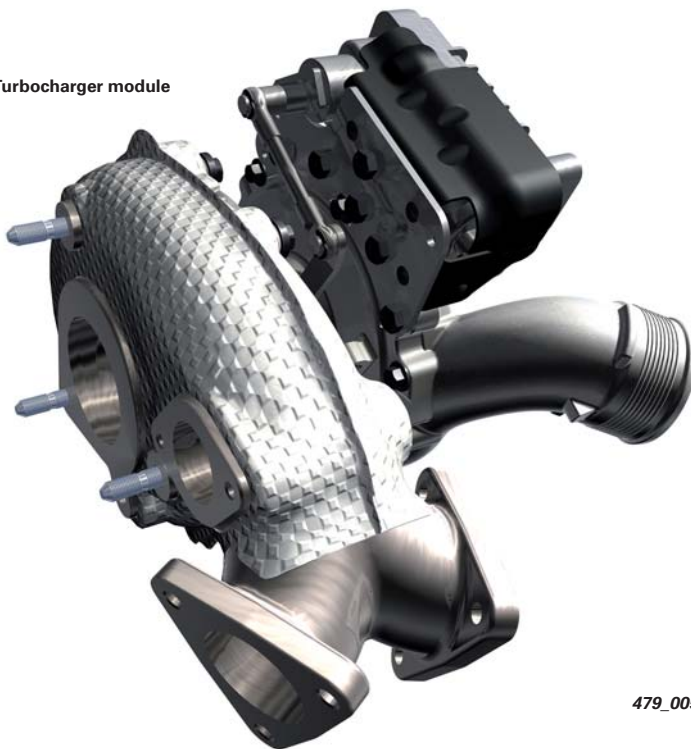


479\_003



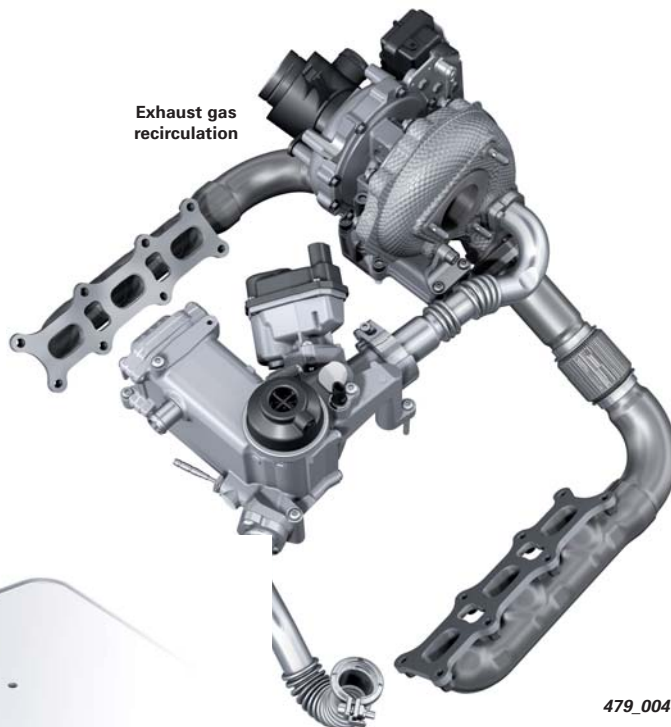


Turbocharger module



479\_005

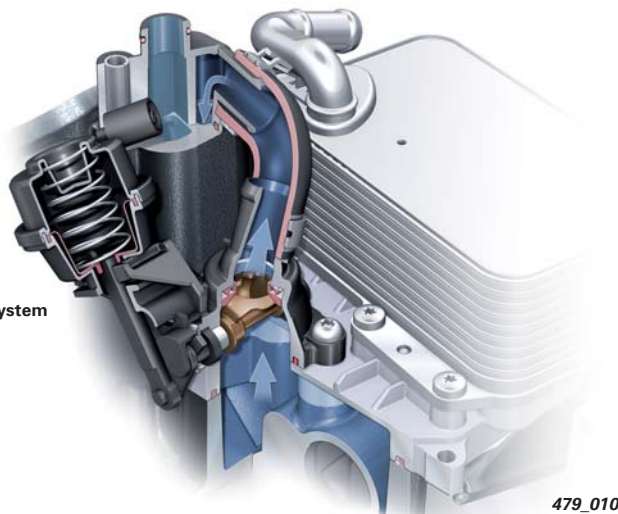
Exhaust gas recirculation



479\_004

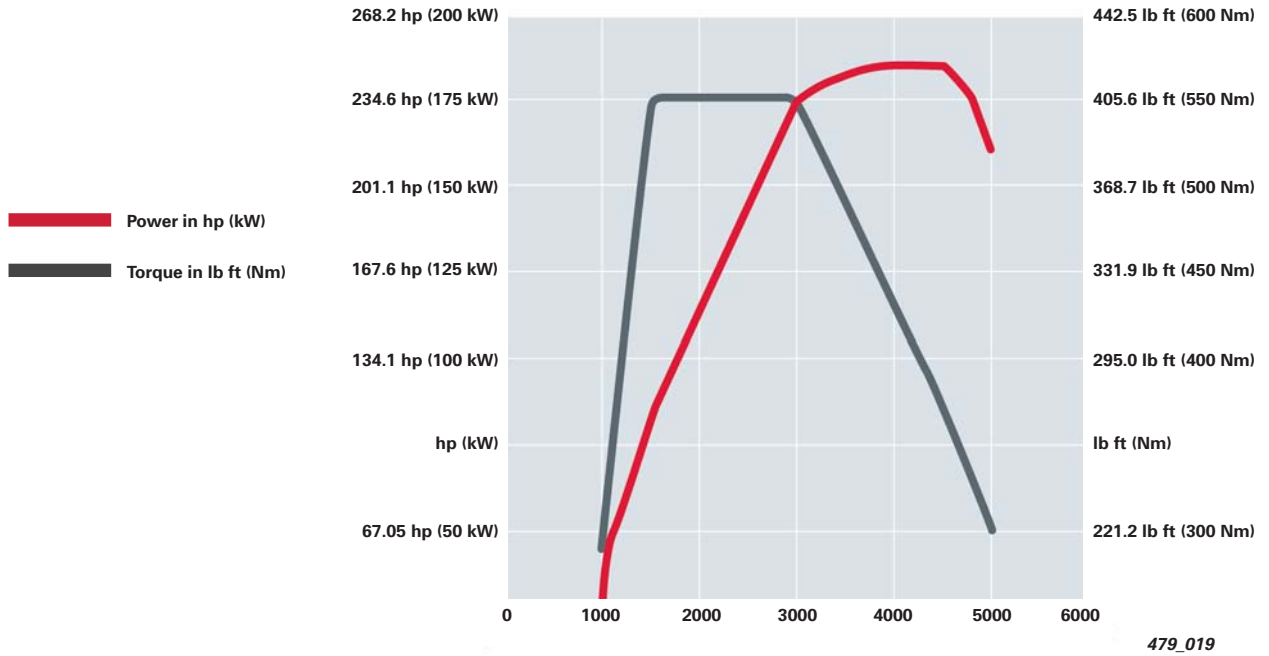
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Thermal management system



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# Specifications



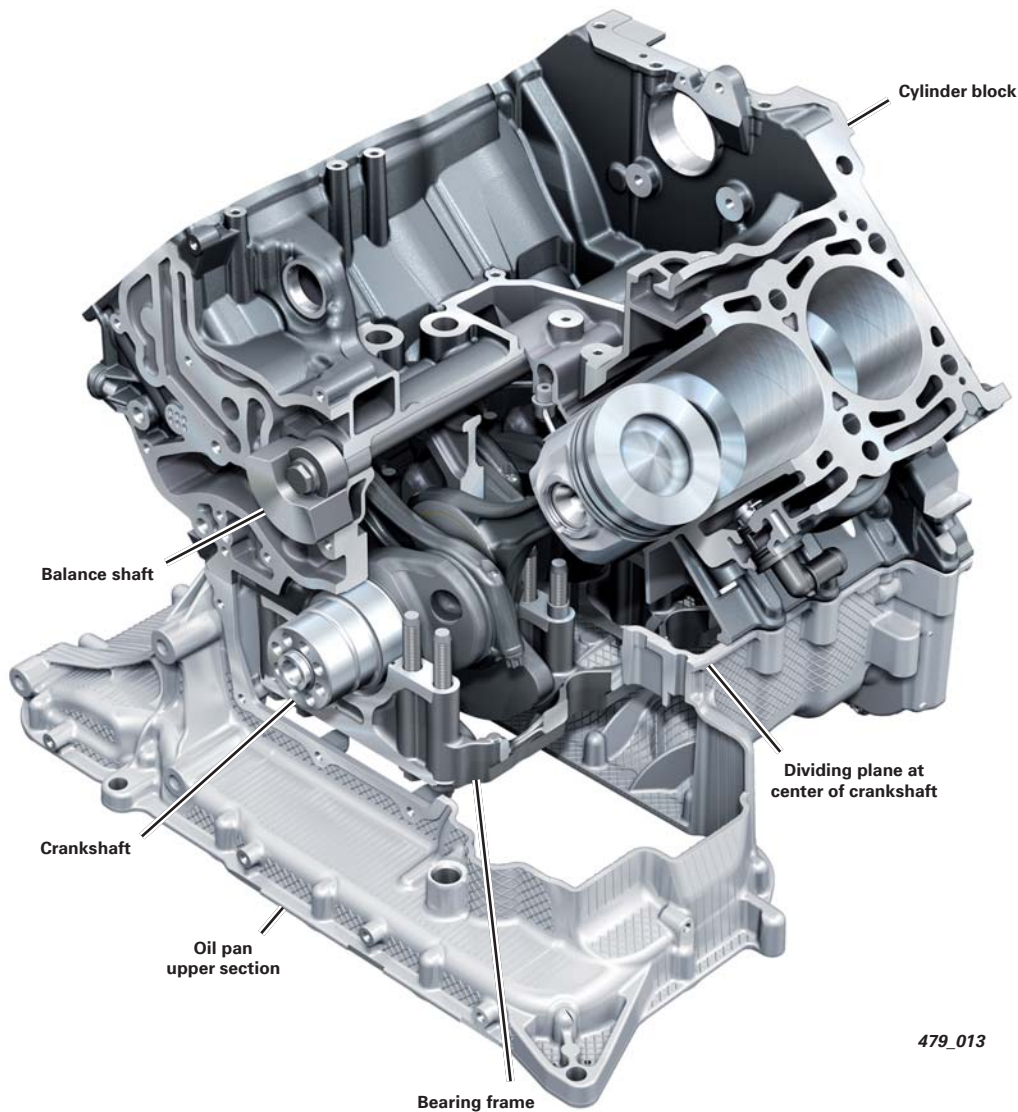
<b>Engine Code (model dependent)</b>	<b>Q7: CNRB, Q5: CPHA, A8: CPNA</b>
Engine type	Six-cylinder 90° V-engine
Displacement	181.0 cu in (2967 cm <sup>3</sup> )
Stroke	3.59 in (91.4 mm)
Bore	3.26 in (83 mm)
Cylinder spacing	3.54 (90 mm)
Number of valves per cylinder	4
Firing order	1-4-3-6-2-5
Compression ratio	16.8 : 1
Power output	246.7 hp (184 kW) @ 4000 rpm
Torque	405.6 lb ft (550 Nm) @ 1250–3000 rpm
Fuel	Diesel to EN 590
Engine management	Bosch CRS 3.3
Emissions standard	ULEV Tier II Bin5



## Cylinder Block

The cylinder block is made from vermicular graphite cast iron (CJV-450). This material provides high strength and load capacity. The proven bearing frame design principle from the previous generation V6 TDI engine has been adopted for the crankshaft bearings of this engine.

The weight of the cylinder block has been reduced by 17.6 lb (8.0 kg) when compared to the first generation V6 TDI engine. This was accomplished partly through systematic reductions in wall thickness.



479\_013

To ensure a perfectly round cylinder shape, the cylinder block is plate honed during the final machining processes. A special plate is mounted on the cylinder block to simulate the effect of an installed cylinder head.

A round bore ensures a substantial reduction in piston ring pre-stress which results in lower blow-by gases and less mechanical friction.

At the final stage of cylinder bore machining, the UV photon exposure process is applied. This ensures that a smooth cylinder bore surface is obtained without necessitating mechanical work (wear-in) by the piston.

## Crankshaft Assembly

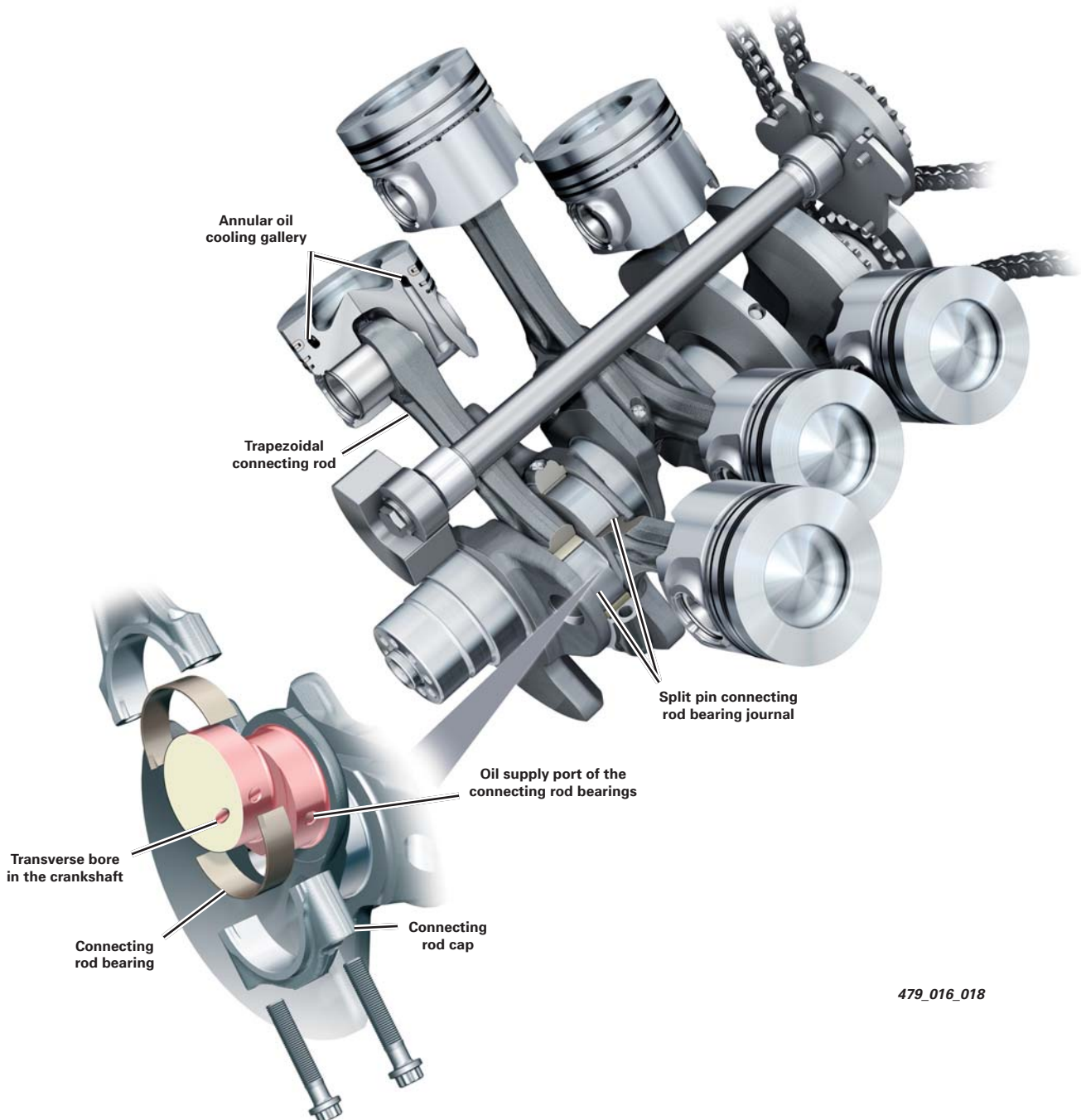
The forged 42 CrMo54 crankshaft has a split pin design to achieve identical firing intervals.

Due to the strong shear forces to which the crankshaft is subjected, both the main bearing journals and connecting rod journals are induction hardened.

Weight to the crankshaft assembly has been reduced by eliminating the center counterweights and machining relief bores in the main journals.

The forged connecting rods are diagonally split and cracked at the big end.

Approximately 2683.1 psi (185 bar) are generated during the combustion process. For optimal cooling of the piston ring assembly and recess rim, the aluminum pistons have an annular salt core cooling gallery and are sprayed from below by oil jets mounted on the cylinder block.



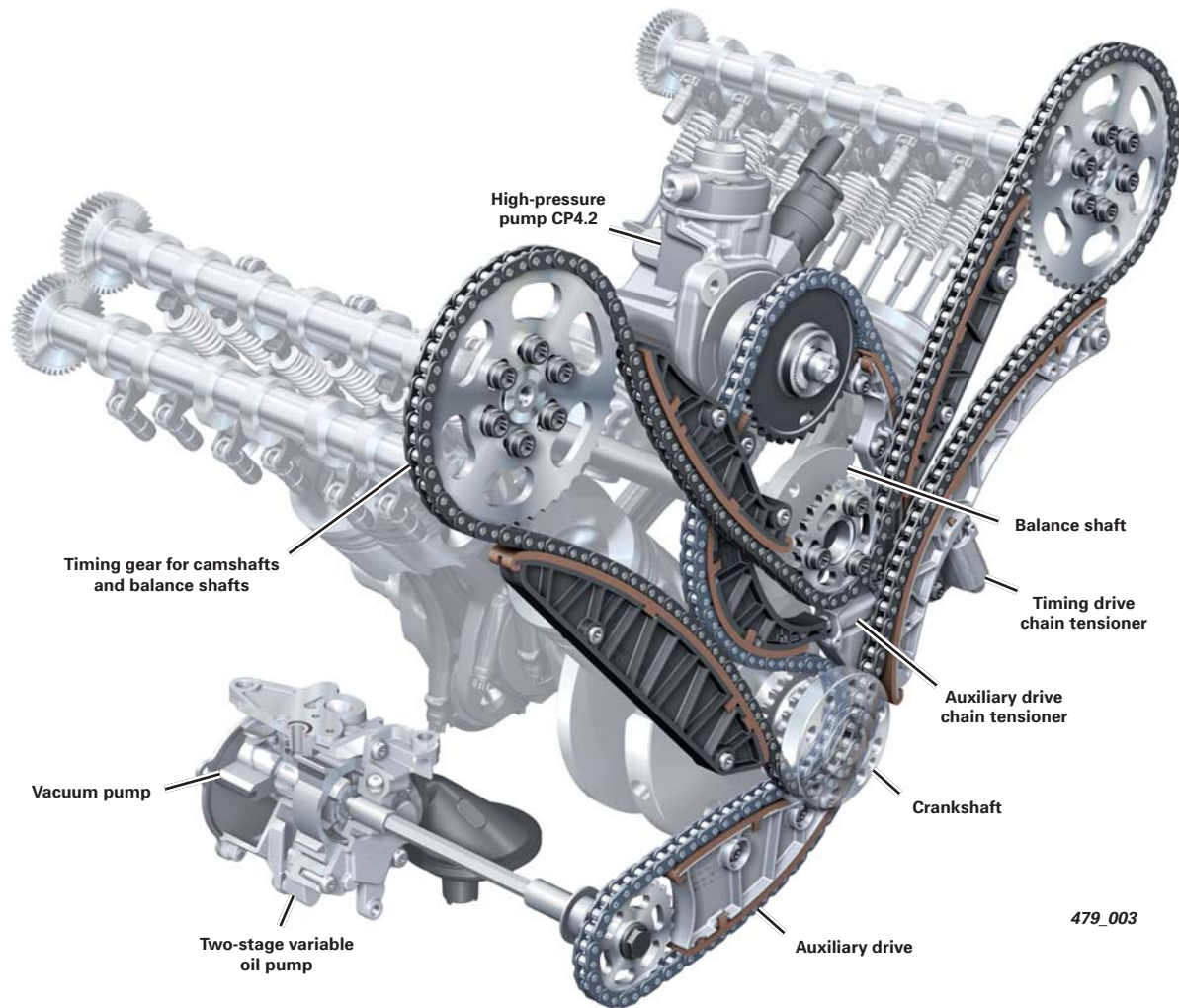
479\_016\_018

## Chain Drive System

The second generation V6 TDI engine has a new chain drive layout compared to the first generation V6 TDI.

The new chain layout reduces the number of chains and chain tensioners from four to two and eliminates the need for idler sprockets. A relatively long roller chain (206 links) is used to drive the intake camshafts and balance shaft. To counteract chain elongation, the chain pins have a wear-resistant coating.

The auxiliary drive chain is also a roller-type. It drives the high-pressure fuel injection pump in the rear inner Vee of the engine, and the combined oil pump/vacuum pump.



## Cylinder Head

The proven first generation V6 TDI four-valve cylinder head design has been adapted for the second generation engine.

This new engine features swirl ports and charging ports in the intake, both of which have been redesigned to enhance swirl and through-flow, while the exhaust side has two exhaust ports merging into a Y-branch pipe.

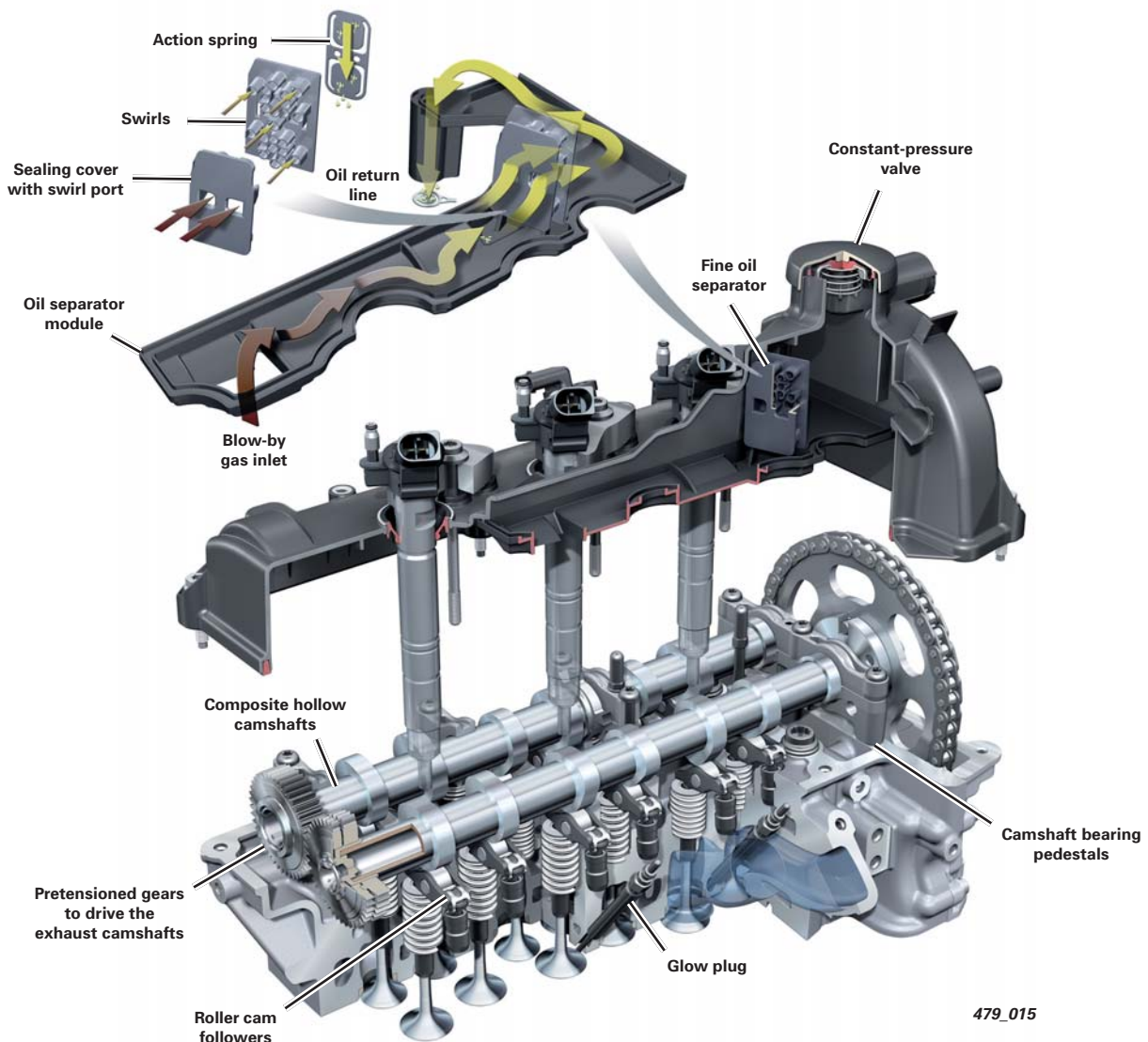
The cylinder head cooling concept has been revised to reduce component temperatures around the combustion chamber despite increased engine power output.

The exhaust valves have been reduced in size and moved further apart. This reduces the area needed to be cooled. The cylinder head is designed for directional coolant flow with high flow rates. This ensures that optimal cooling is provided between the valves and the fuel injector bore, which are in close proximity to the combustion chamber.

The Hydro-formed hollow camshafts are mounted on the cylinder heads on split twin bearing pedestals rather than a ladder frame. The camshafts have been repositioned inward (or closer to each other) allowing them to be designed without additional clearances to access the head bolts.

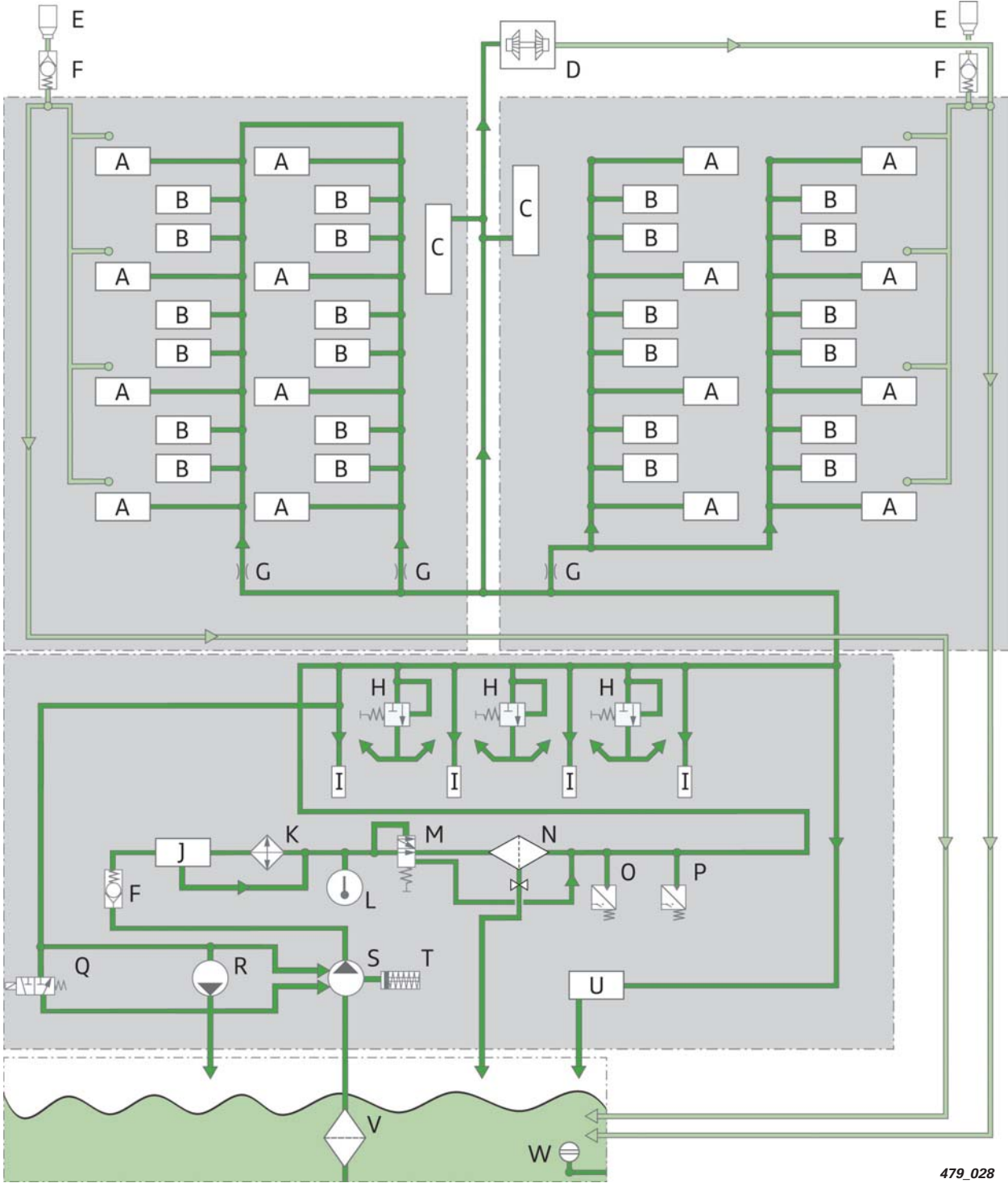
To minimize friction in the valve train, the diameter of the camshaft bearings has been reduced to 0.9 in (24.0 mm) from 1.25 in (32.0 mm).

The crankcase ventilation system (both coarse and fine oil separators) has been moved from the Vee of the engine into the cylinder head covers. Both crankcase vents lead to the pressure control valve and from there to the intake side of the turbocharger.



479\_015

## Oil Circuit Schematic



479\_028

**Legend:**

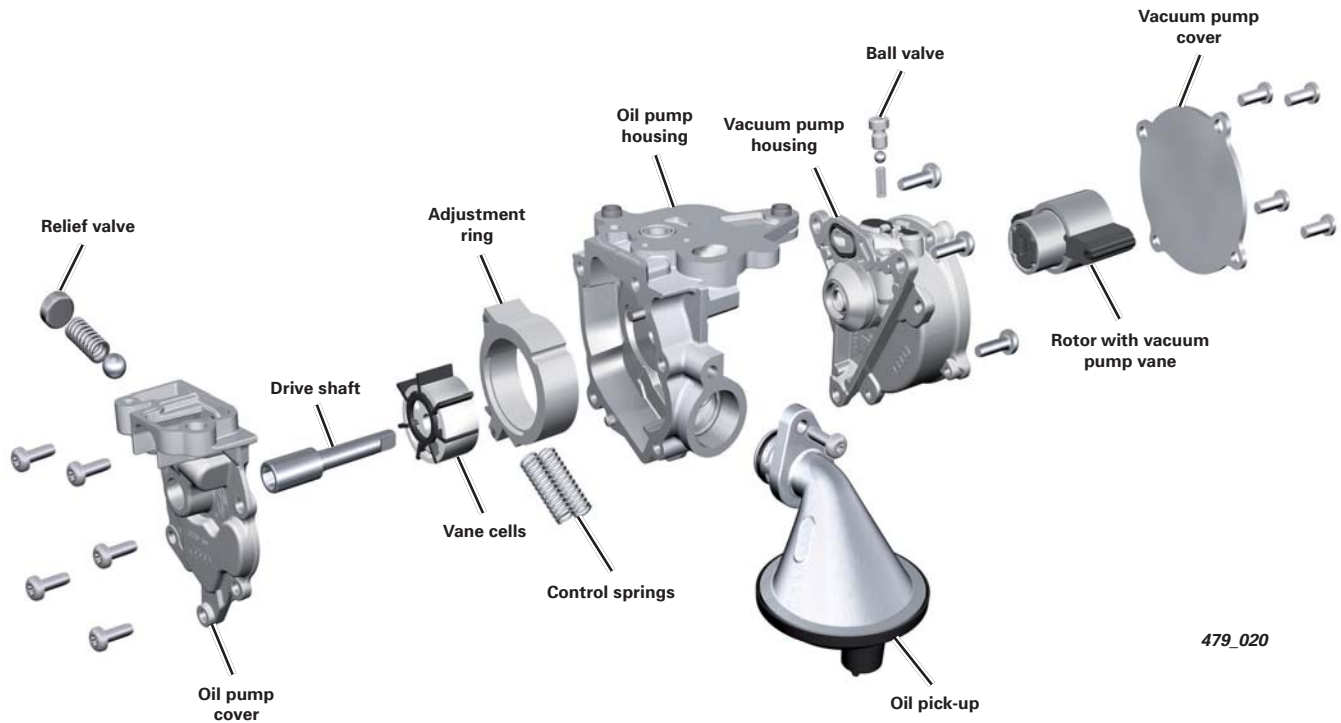
- |  |                                    |                                      |
|--|------------------------------------|--------------------------------------|
| A Camshaft bearing                           | I Main bearing                     | P Oil Pressure Switch F22            |
| B Balancer elements                          | J Thermostat                       | Q Oil Pressure Regulation Valve N428 |
| C Chain tensioner                            | K Water-oil heat exchanger         | R Vacuum pump                        |
| D Exhaust turbocharger                       | L Oil Temperature Sensor G8        | S Oil pump                           |
| E Crankcase ventilation fine oil separator   | M Filter bypass valve              | T Relief valve                       |
| F Non-return valve                           | N Oil filter                       | U Oil pump drive gear bearing        |
| G Flow restrictor                            | O Reduced Oil Pressure Switch F378 | V Intake sieve                       |
| H Piston cooling jets with integrated valves |                                    | W Oil Level Thermal Sensor G266      |

## Engine Oil Pump with Integral Vacuum Pump

Engine oil is circulated by a flow rate controlled vane cell pump. A rotating adjustment ring regulates the volumetric engine oil flow which results in reducing the amount of drive power required to operate the pump. The amount of oil flow required is mainly based on engine load.

Depending on engine load, oil temperature, and other operating parameters, a lower oil pressure is used at engine speeds less than 2500 rpm.

The vacuum pump uses a rotor to generate necessary vacuum.



479\_020



### Reference

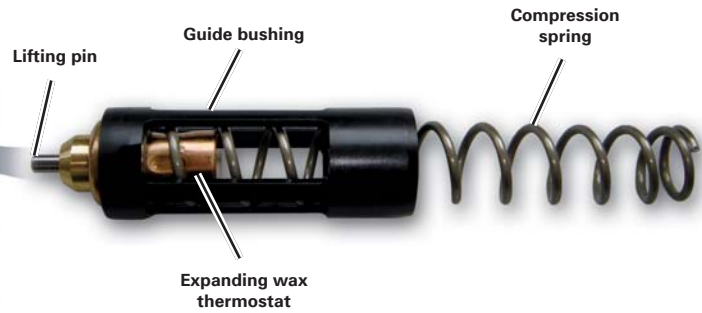
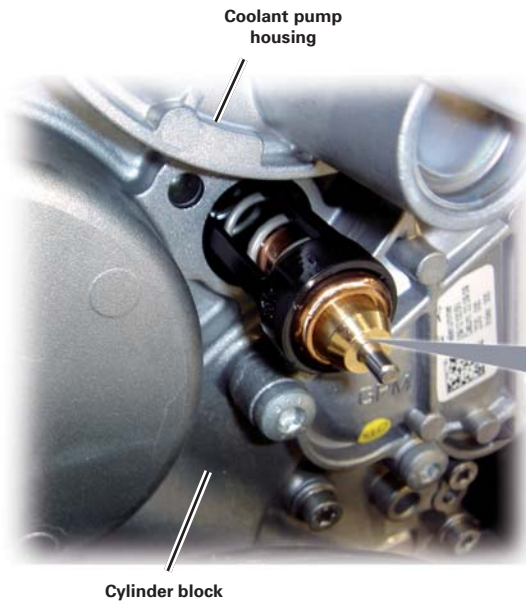
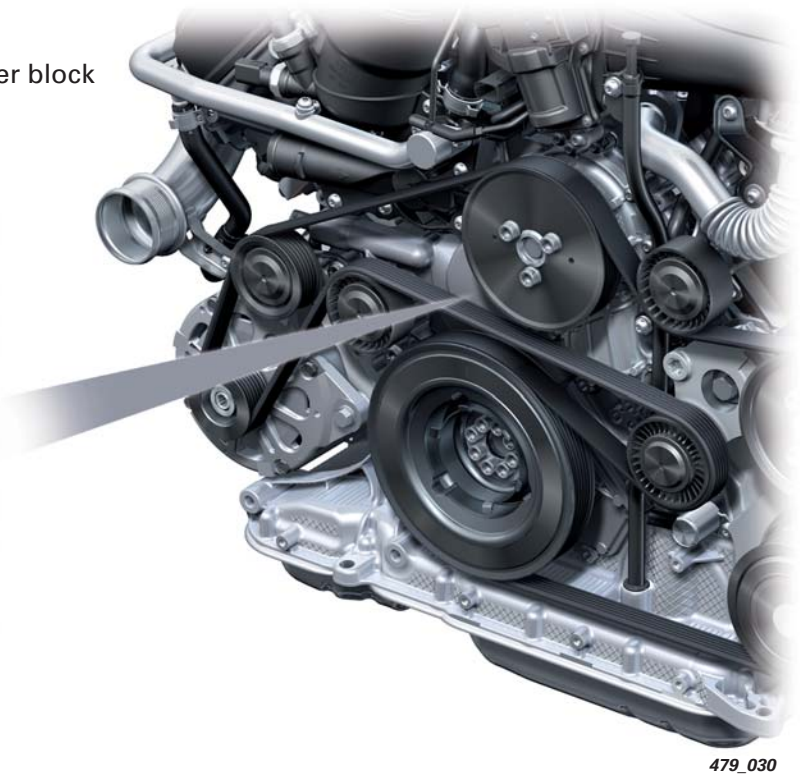
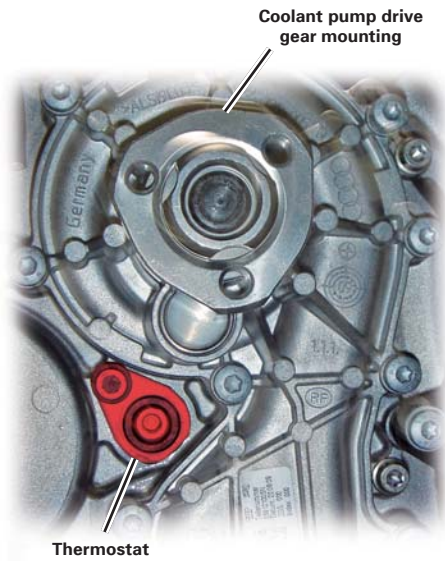
For more detailed information about the flow rate controlled oil pump, refer to Self-Study Program 941803, *Audi 3.0-liter V6 TDI With Clean Diesel System*.

## Engine Oil Cooler with Thermostat Controlled Bypass Port

To assist thermal management of the engine, a thermostatically controlled oil bypass is integrated in the engine oil cooler. At temperatures below 217.4°F (103°C), the bypass port is open and the main volume of oil bypasses the engine oil cooler. At temperatures above 217.4°F (103°C), the wax expansion element moves a lifting pin and the oil thermostat opens. The main volume of oil is then directed through the engine oil cooler.

### Installation Location

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

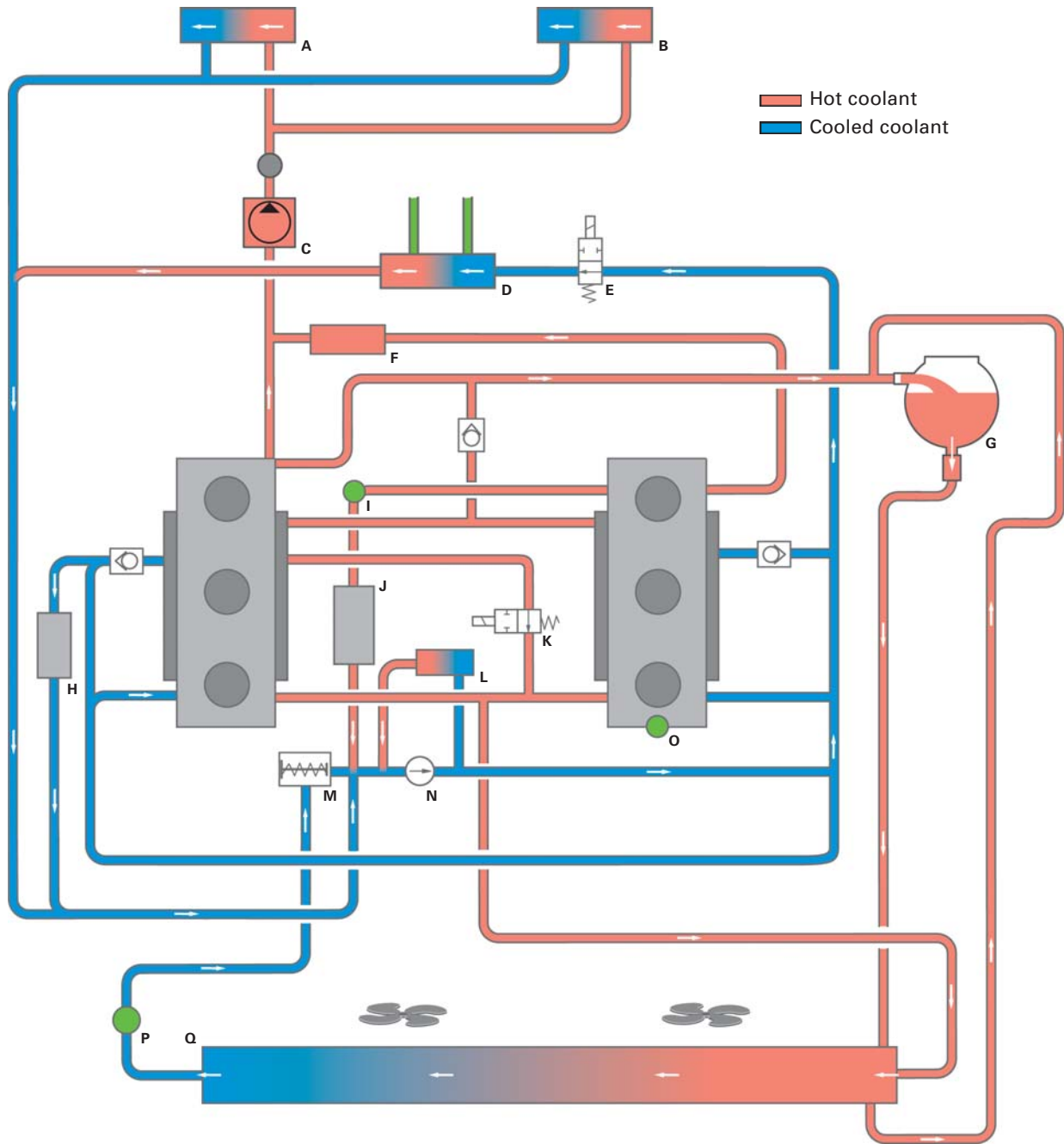


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# Cooling System

## Overview

Example: 2013 Audi A8



479\_021

### Legend:

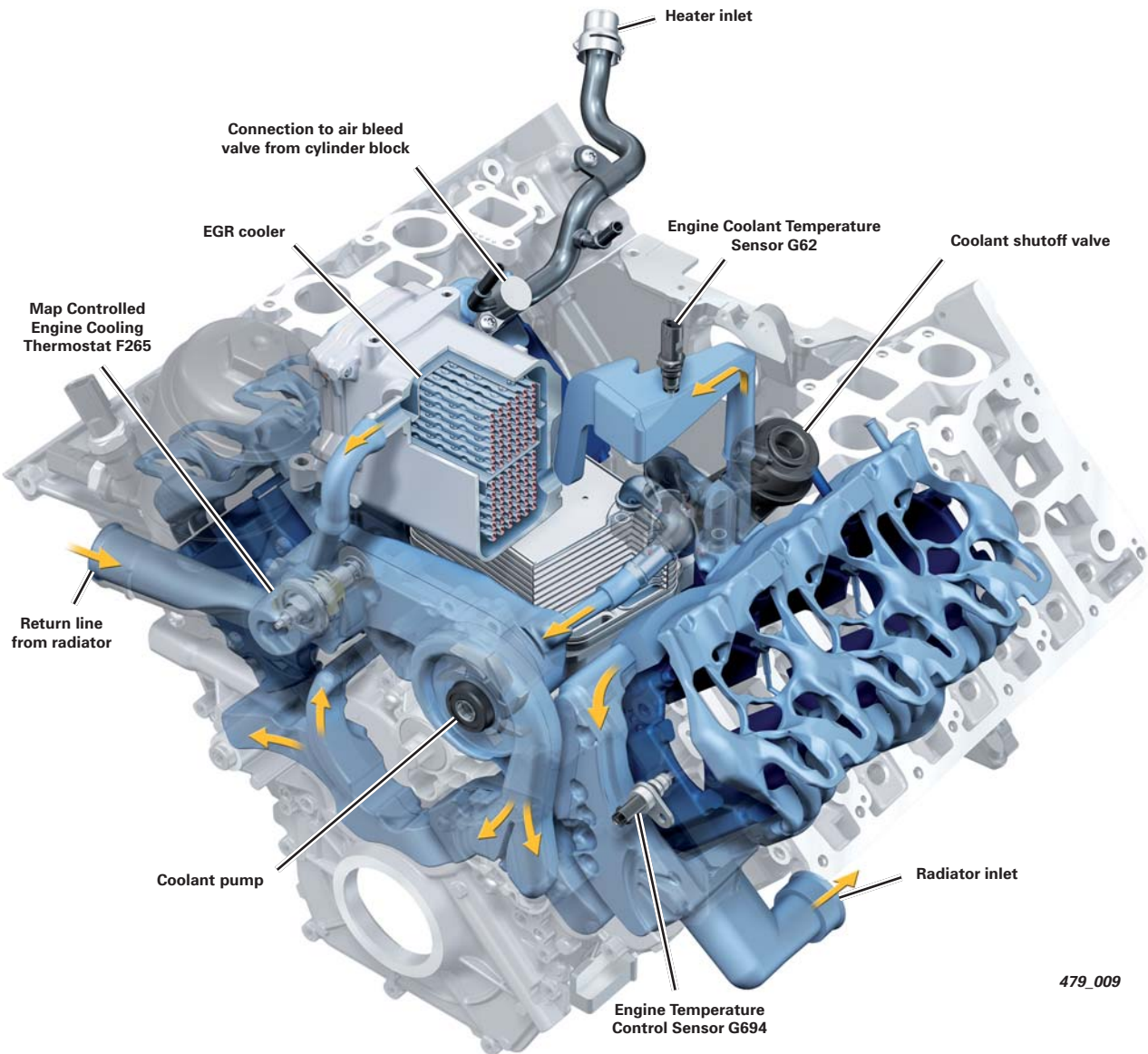
- |   |   |
|---|---|
| A Front heater heat exchanger           | J EGR cooler  |
| B Rear heater heat exchanger            | K Coolant shutoff valve                             |
| C Coolant Recirculation Pump V50        | L Engine oil cooler                                 |
| D ATF cooler                            | M Coolant thermostat                                |
| E Transmission Coolant Valve N488       | N Coolant pump                                      |
| F Exhaust turbocharger                  | O Engine Temperature Control Sensor G694            |
| G Coolant expansion tank                | P Engine Coolant Temperature Sensor on Radiator G83 |
| H Alternator                            | Q Radiator  |
| I Engine Coolant Temperature Sensor G62 |   |



## Coolant Circuit and Thermal Management System

To increase efficiency, it is best to heat up the engine as quickly as possible. This is accomplished on the V6 TDI engine by using a split cooling system concept. Engine coolant flows through the cylinder block and cylinder heads in two separate but parallel cooling circuits.

A continuous-duty coolant pump mounted in the Vee at the front of the engine delivers coolant to the cylinder block at the exhaust sides of the engine. The coolant flow then divides into two streams to the cylinder heads and the cylinder block, returning to the intake side of the pump after flowing through both sub-circuits.



479\_009

- Cylinder head cooling circuit
- Cylinder block cooling circuit

## Cylinder Head Cooling Circuit

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

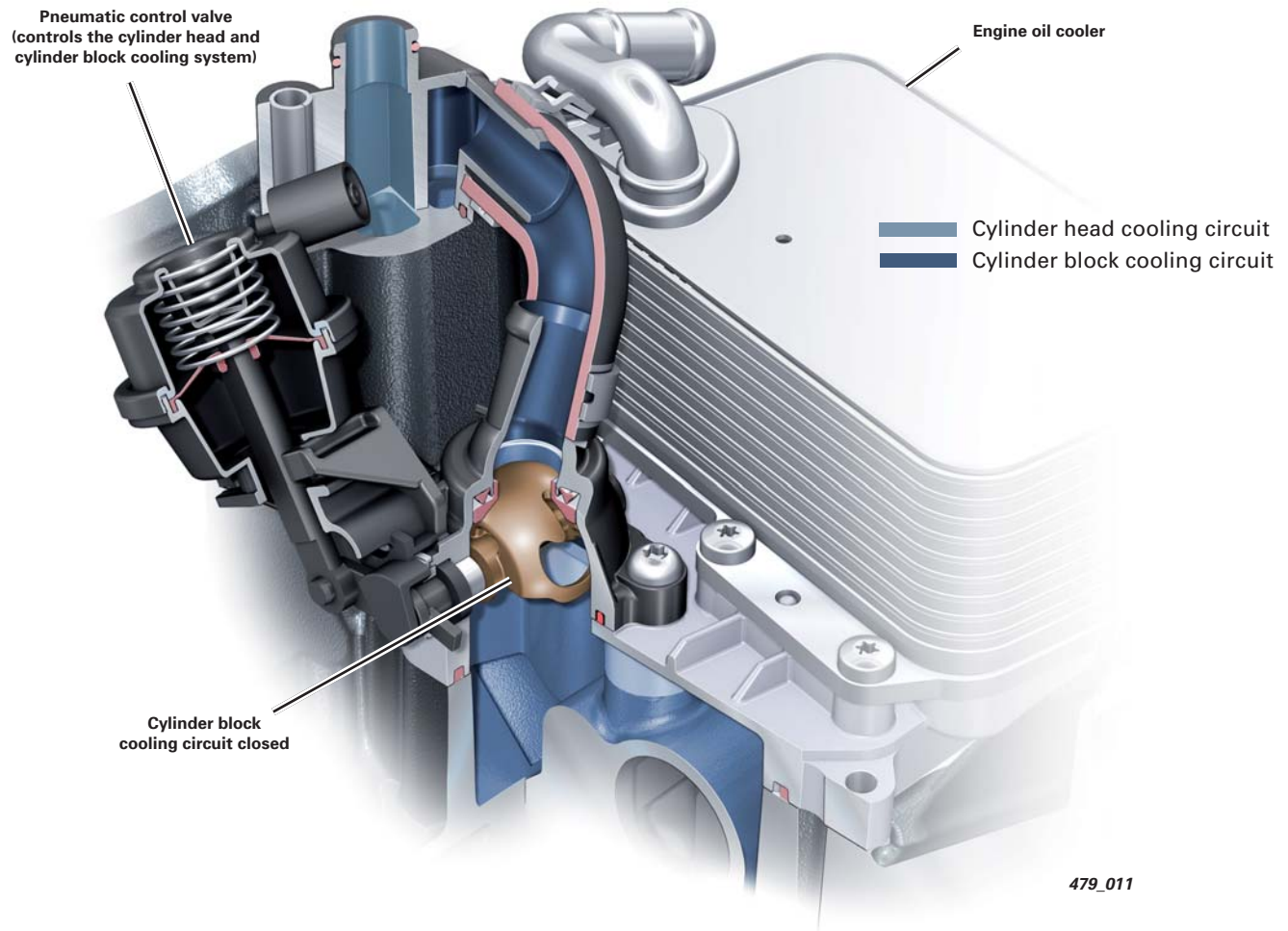
- ▶ Coolant chambers in both cylinder heads
- ▶ Engine oil and EGR cooler
- ▶ Passenger compartment heat exchanger and transmission heat exchanger
- ▶ Coolant radiator

The temperature level of the cylinder head cooling circuit is controlled via a mapped thermostat with a heated wax expansion element. The thermostat is de-energized during the warm-up phase and opens at 194°F (90°C). This means that no thermal energy is dissipated to the main coolant radiator until the opening temperature is reached.

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

The limiting conditions for this function are:

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



### Note

The cooling system is equipped with a control valve and can only be filled using VAS 6096 (vacuum filling). Follow all instructions outlined in current technical literature.

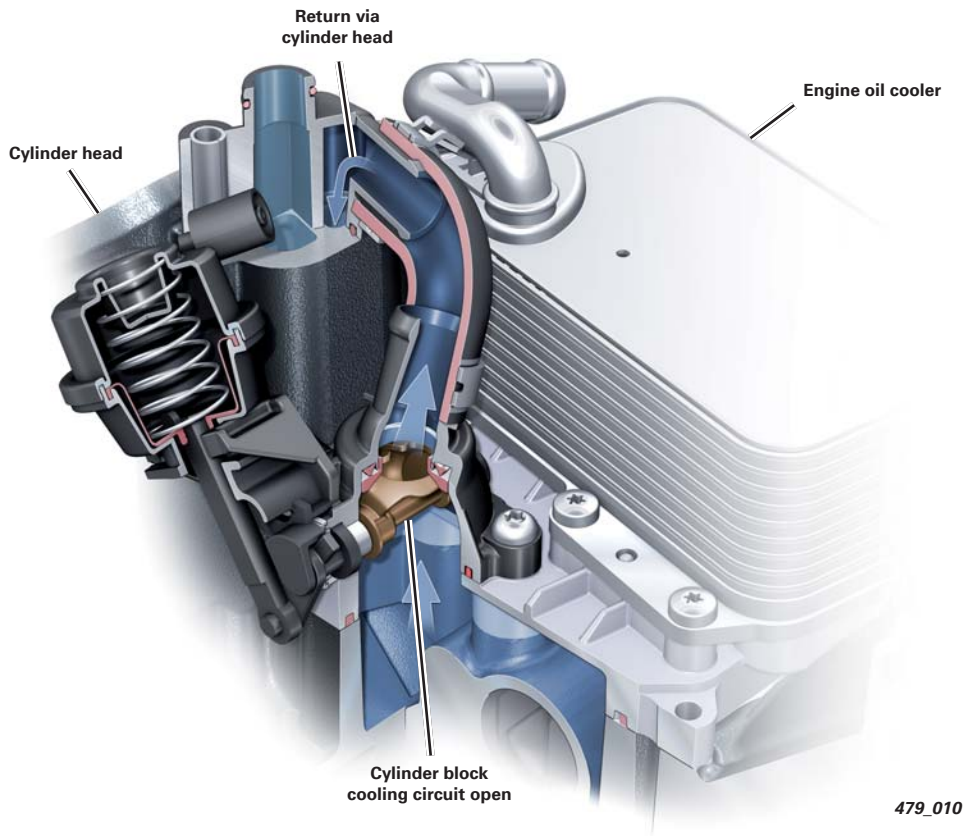
## Cylinder Block Cooling Circuit

Coolant is admitted to the cylinder head cooling circuit on the exhaust sides of the cylinder banks via a non-return valve. Non-return valves serve to prevent coolant back flow between the two cylinder banks, while eliminating unwanted heat dissipation from the cylinder block.

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

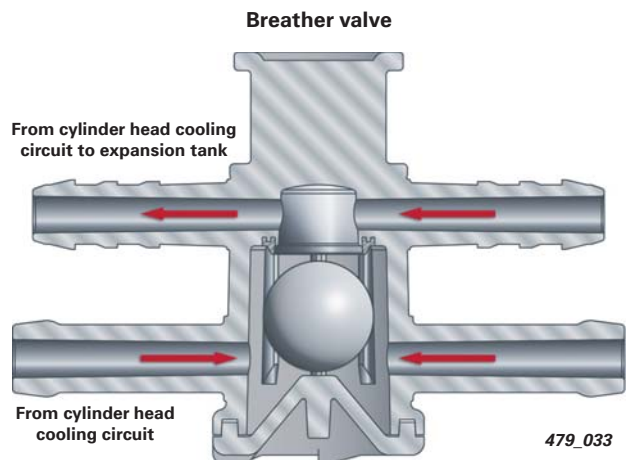
After the engine has heated up, the temperature level in the cylinder block cooling circuit is adjusted to approximately 221°F (105°C) via the ball valve.

The ball valve is activated by a pulse width modulated (PWM) signal by Cylinder Head Coolant Valve N489. To promote rapid heating, an oil-side oil cooler bypass is utilized.



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 block circuit. The breather valve seals both sub-circuits off from one another via a floating ball valve. Therefore, when the cylinder head circuit is ventilated, no heat energy can dissipate from the cooling circuit via the permanent ventilation system.



# Exhaust Gas Recirculation

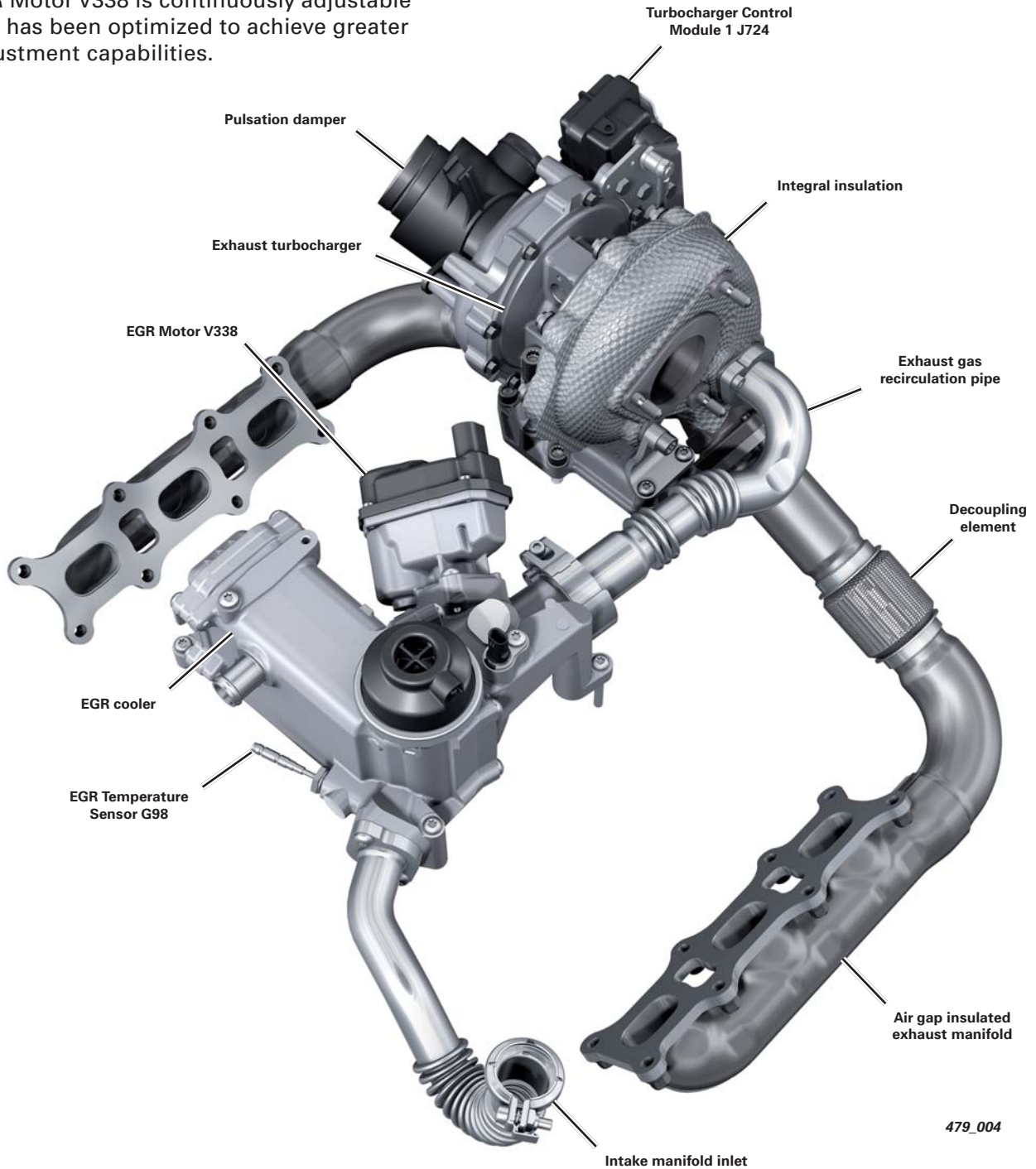
## Overview

The exhaust gas recirculation system plays a key role in meeting applicable emission standards.

All functional elements of the EGR system are integrated into an EGR module consisting of an EGR valve, EGR cooler, and a bypass valve.

EGR Motor V338 is continuously adjustable and has been optimized to achieve greater adjustment capabilities.

To reduce pressure loss in the EGR system, the seat diameter of the EGR valve has been increased to 1.18 in (30 mm) from 1.06 in (27 mm), compared to the first generation V6 TDI engine.

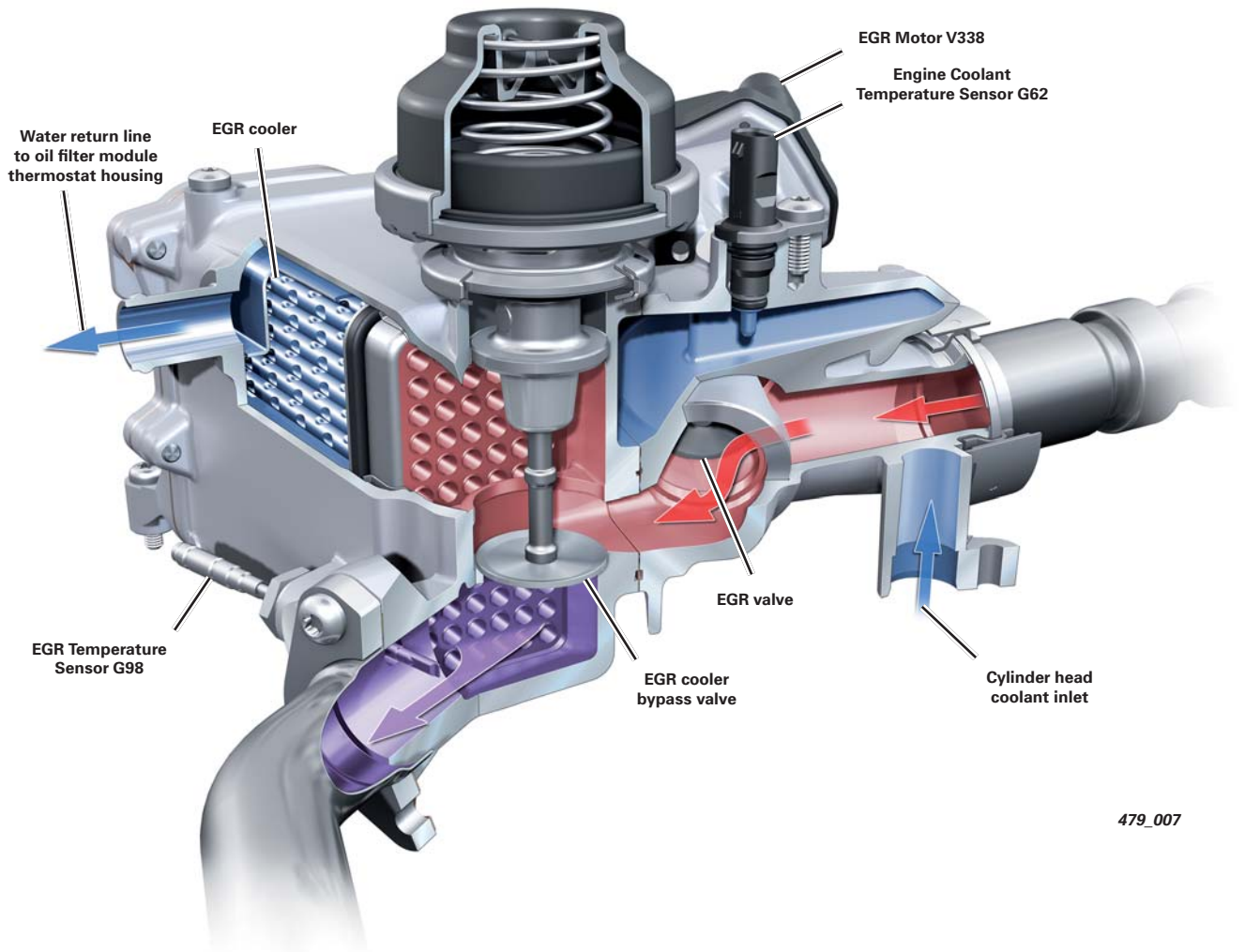


479\_004

## Active EGR Cooler

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

The major advantage of the lift valve is that its seat guarantees a vacuum-tight seal during cooling operation and therefore ensures a higher cooling capacity.



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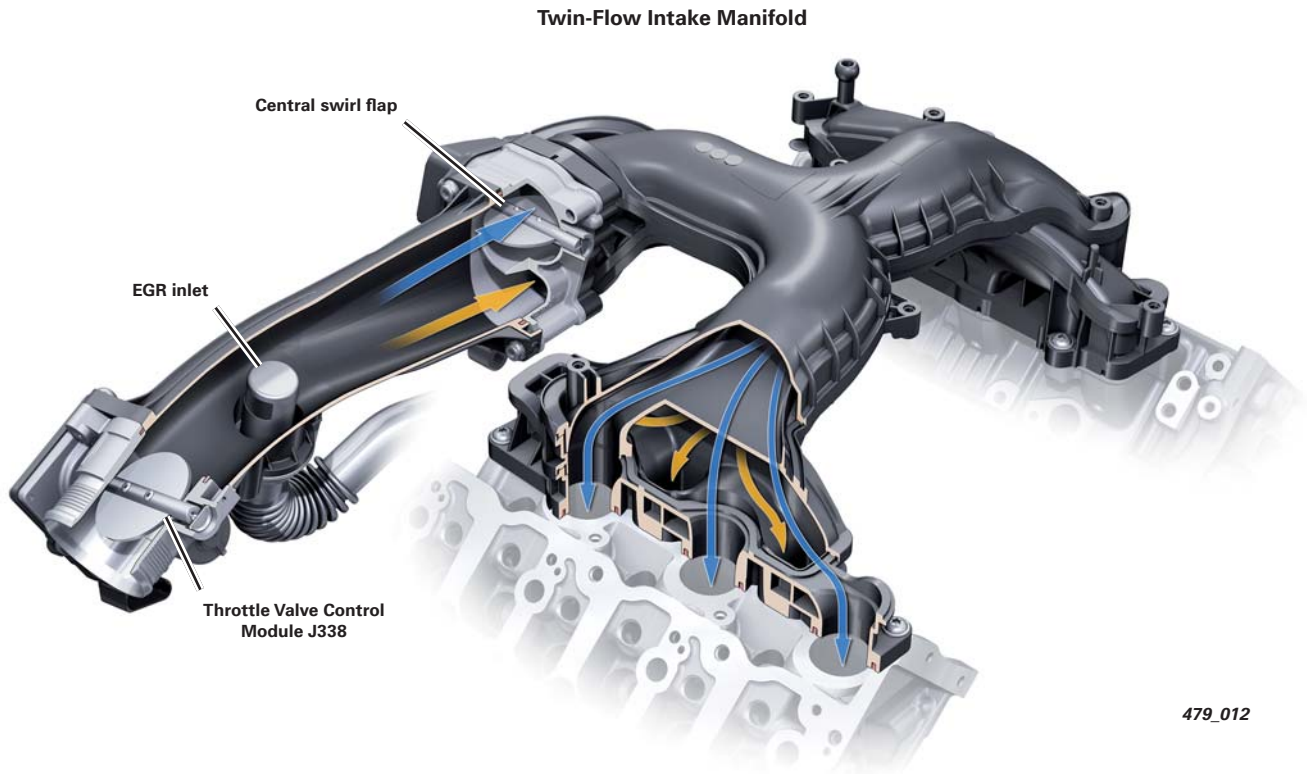
# Intake Air Ducting

Intake air is inducted from the front of the vehicle and directed through the filter housing to the throttle valve. Just past the throttle valve, recirculated exhaust gas is admitted to the intake path through a thermally de-coupled stainless steel intake.

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.

A single, central swirl flap is used on the second generation TDI engine instead of the six swirl flaps used on the first generation 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.

Intake manifold geometry was also enhanced to better control pressure loss and ensure uniform airflow distribution to the individual cylinders.



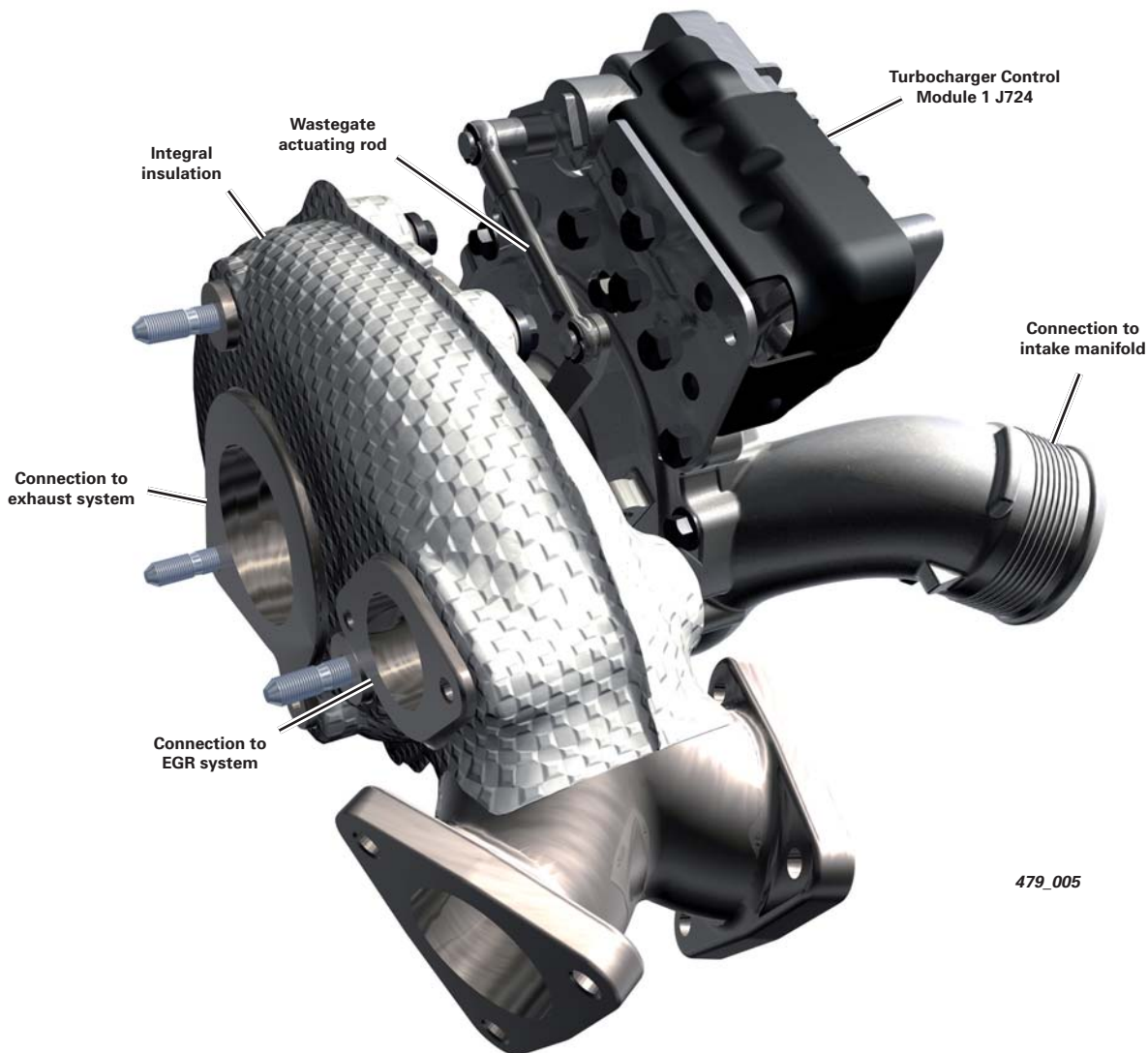
479\_012

# Turbocharging

The turbocharger for the V6 TDI engine is manufactured by Honeywell Turbo Technologies.

The compressor and turbine wheel design has been optimized for flow and the bearing assemblies have been enhanced to reduce frictional losses.

Optimized cylinder charging and a reduction in charge cycle losses has been accomplished through minimizing flow restrictions in the intake manifold, and redesigning the swirl and inlet ports.



479\_005

## Over-Boost Function

When driving between speeds of 6.2–74.5 mph (10–120 km/h), with the accelerator pedal angle exceeding 70% under acceleration, the over-boost function increases nominal engine output by approximately 13.4 hp (10 kW) for a period of 10 seconds.

This function is deactivated:

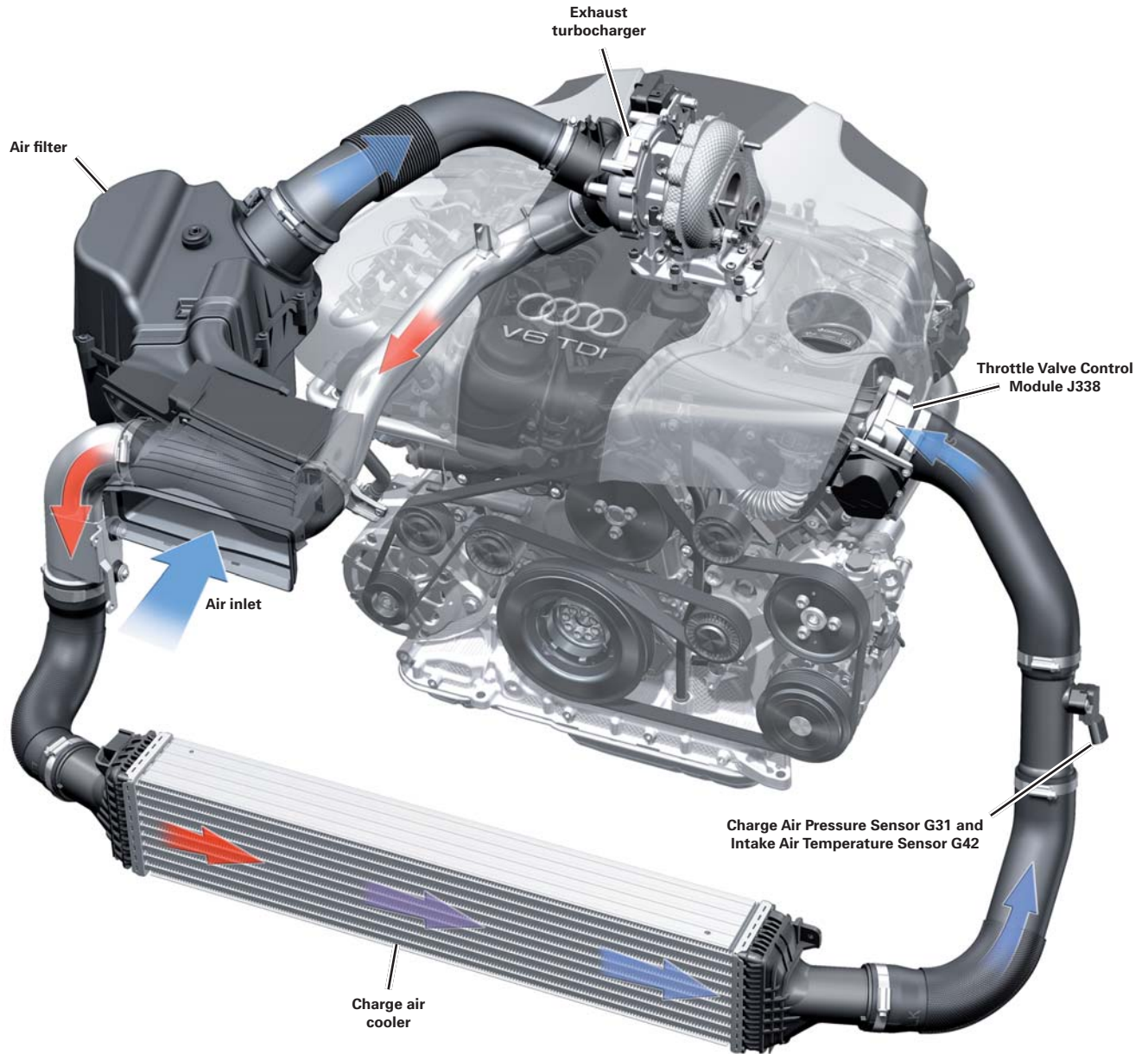
- ▶ When towing a trailer
- ▶ When the charge air temperature exceeds 131°F (55°C)

To avoid sudden changes in torque, the over-boost function is activated and deactivated by a map-controlled program.

## Charge Air Cooling

The complete air circulation system, from the air filter to the turbocharger, has been redesigned for minimum pressure loss. The pressure-side air circulation system, with only one charge air cooler, has also been optimized via low-swirl transitions between the hose connections.

This has resulted in improved engine response, as well as lower emissions and greater fuel economy.



479\_006



# Common Rail Injection System

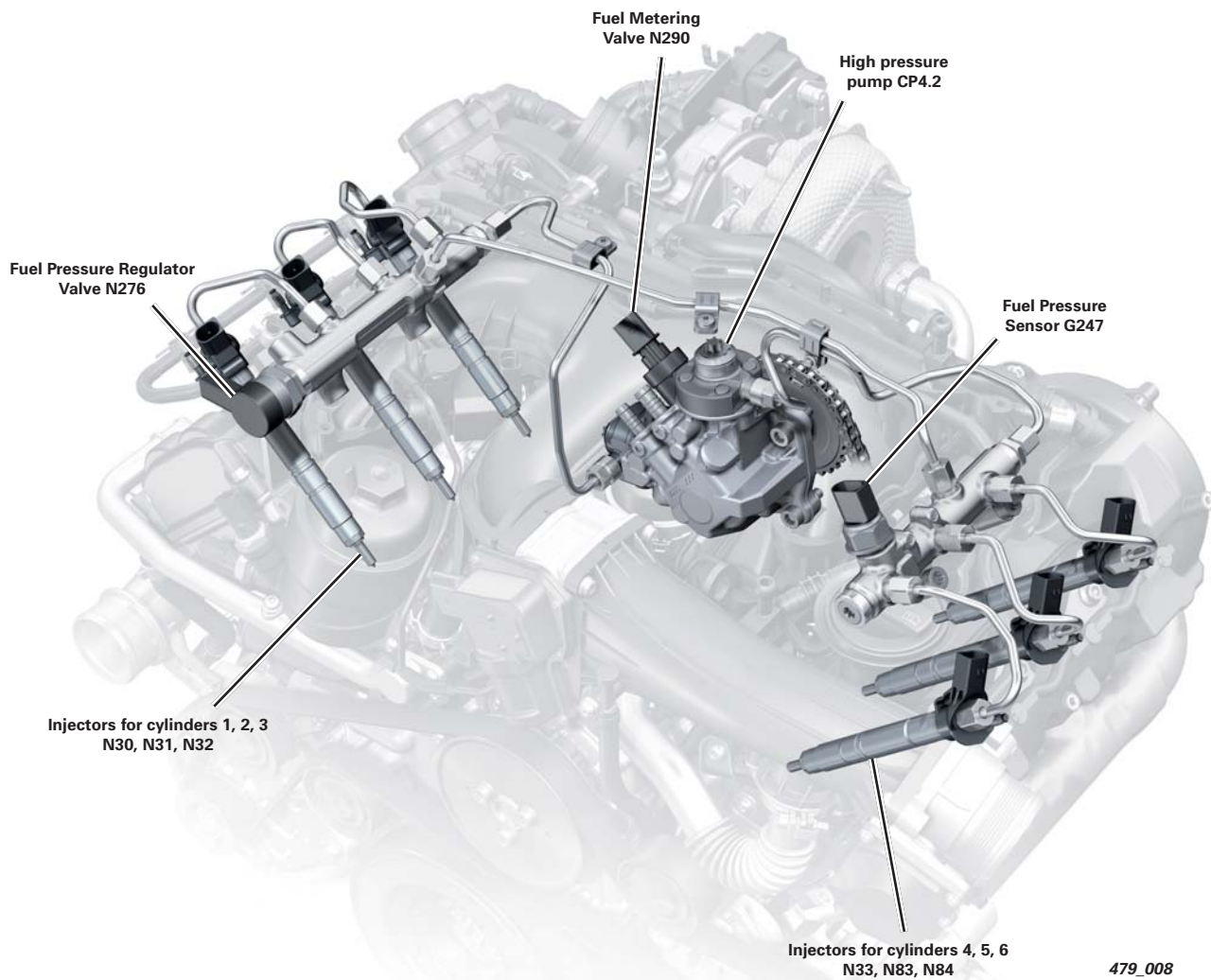
## Chain-Driven Injection System

The second generation V6 TDI engine uses the latest Bosch common rail fuel injection system.

Fuel pressure is produced by a CP4.2 dual plunger high-pressure pump housed in a single aluminum casting. The piezo injectors are connected to the short forged rails by stainless steel lines and are capable of withstanding pressures of over 29,000 psi (2000 bar).

The high-pressure pump housing is located in the Vee on the transmission side of the cylinder block below the turbocharger. It is driven directly by the crankshaft via a secondary drive chain.

It is critical that fuel delivery is synchronized with the injection phase. To help achieve this, a pump pulley to crankshaft ratio of 1:0.75 is used. The chain forces on the pump must be kept to a minimum. This is accomplished through the chain drive and pump mount design. These modifications minimize differences in the amount of fuel injected into each of the cylinders across the entire operating range. This is very important with regard to achieving lower emissions.

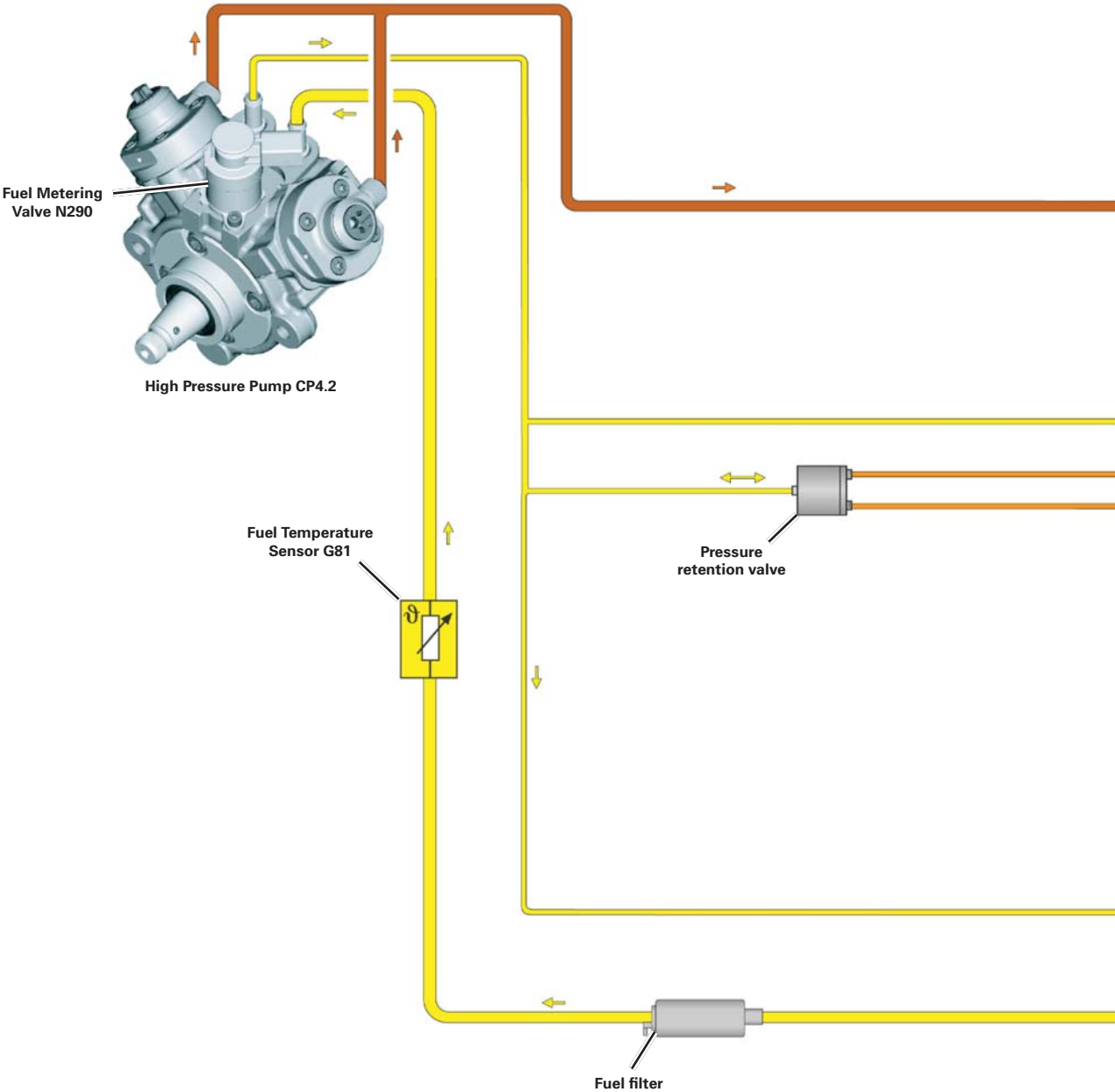


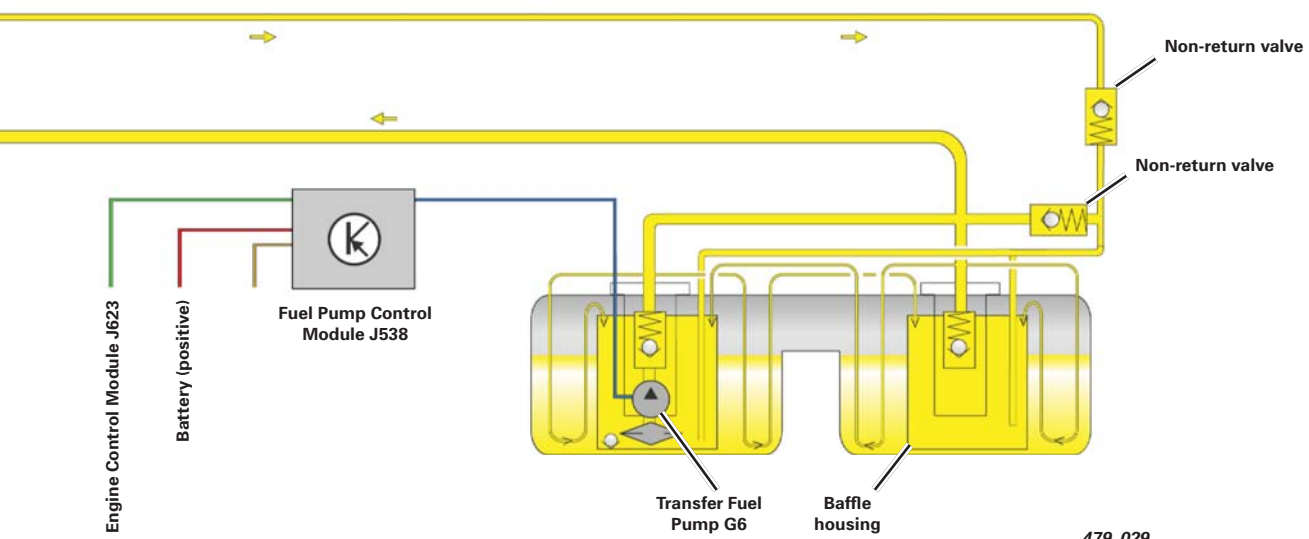
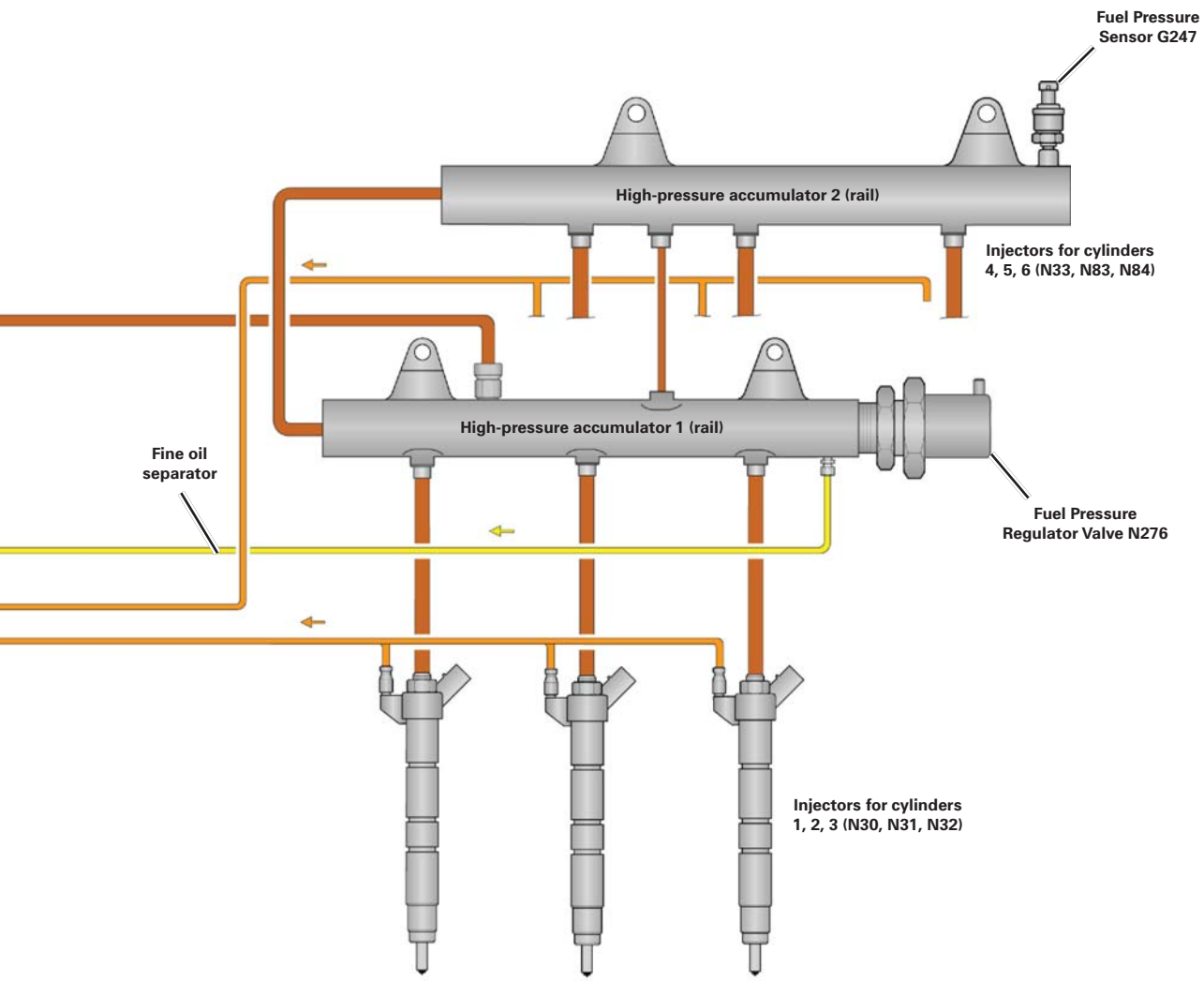
### Note

Always observe all Cautions and Warnings in current technical literature when removing and installing the high pressure pump.

# Fuel Delivery System

3.0L V6 TDI Engine (Example: 2013 Audi A8)





479\_029

# Engine Management

## System Overview

### Sensors

Mass Airflow Sensor G70

Engine Speed Sensor G28

Camshaft Position Sensor G40

Engine Coolant Temperature Sensor G62

Engine Coolant Temperature Sensor on Radiator G83

Fuel Temperature Sensor G81

Engine Temperature Control Sensor G694

Oil Level Thermal Sensor G266

Fuel Pressure Sensor G247

Accelerator Pedal Position Sensor G79  
Accelerator Pedal Position Sensor 2 G185

EGR Potentiometer G212

Brake Light Switch F

Charge Air Pressure Sensor G31  
Intake Air Temperature Sensor G42

Heated Oxygen Sensor G39

Oil Temperature Sensor 2 G664

Oil Pressure Switch F22

Reduced Oil Pressure Switch F378

Exhaust Gas Temperature Sensor 3 G495

EGR Temperature Sensor G98

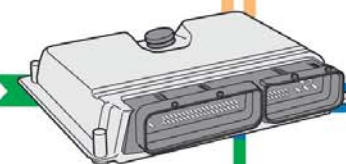
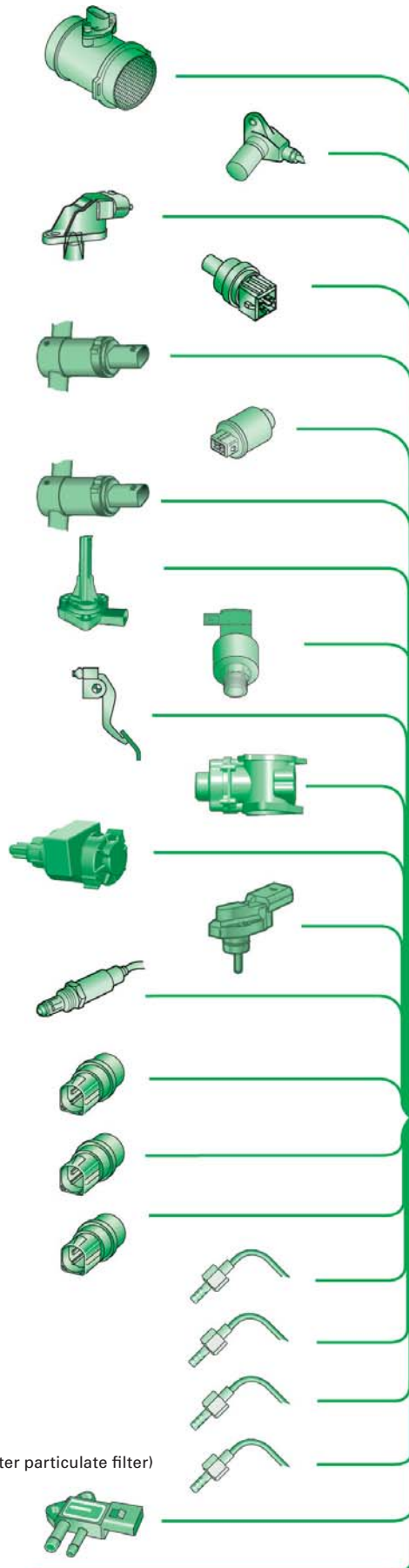
Exhaust Gas Temperature Sensor 1 G235

Exhaust Gas Temperature Sensor 4 G648 (after particulate filter)

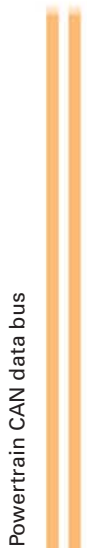
Differential Pressure Sensor G505

Additional signals:

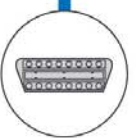
- ▶ Cruise control system
- ▶ Speed signal
- ▶ Start request to ECM (Kessy 1 + 2)
- ▶ Terminal 50
- ▶ Crash signal from Airbag Control Module



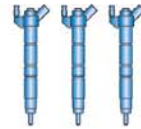
Engine Control Module J623



Powertrain CAN data bus

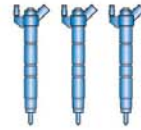


Data Link Connector



### Actuators

Piezoelectric Fuel Injectors for Cylinders 1-3  
N30, N31, N32



Piezoelectric Fuel Injectors for Cylinders 4-6  
N33, N83, N84



Glow plugs Q10, Q11, Q12  
Automatic Glow Time Control Module J179

Glow plugs Q13, Q14, Q15



Oil Pressure Regulation Valve N428



Throttle Valve Control Module J338



Fuel Metering Valve N290



Fuel Pressure Regulator Valve N276



EGR Motor V338



EGR Cooler Switch-Over Valve N345



Cylinder Head Coolant Valve N489



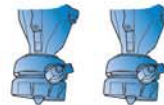
Turbocharger Control Module 1 J724



Map Controlled Engine Cooling Thermostat F265



Fuel Pump Control Module J538



Left Electro-Hydraulic Engine  
Mount Solenoid Valve N144  
Right Electro-Hydraulic Engine  
Mount Solenoid Valve N145



Oxygen Sensor Heater Z19



Fuel Pump Relay J17

Transfer Fuel Pump G6

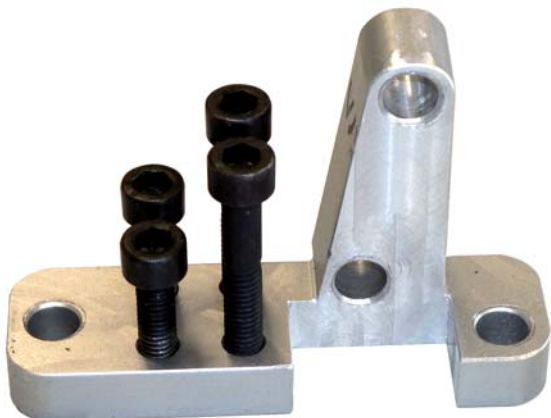
Additional signals:

- ▶ A/C compressor
- ▶ Auxiliary coolant heater
- ▶ Fan setting 1 + 2

- ▶ Auxiliary Heater Heating Element Z35

# Special Tools and Workshop Equipment

Detent T40246



479\_040

Used to hold the chain guide when removing the camshaft timing chain.

Installing tool T40048/7



479\_041

Used for pressing in crankshaft seal.

Retainer VAS 6395/6



479\_042

Used when replacing Turbocharger Control Module 1 J724.

Counter-hold tool T40248



479\_043

Used to hold the high pressure pump shaft when replacing the high-pressure pump.

Guide plate VAS 5161-29



479\_045

For replacing valve keepers on the V6 TDI engine.

Sealing pin VAS 5161-29-1



479\_047

Engine support VAS 6095-1-11



479\_046

Used with engine/transmission stand VAS 6095.

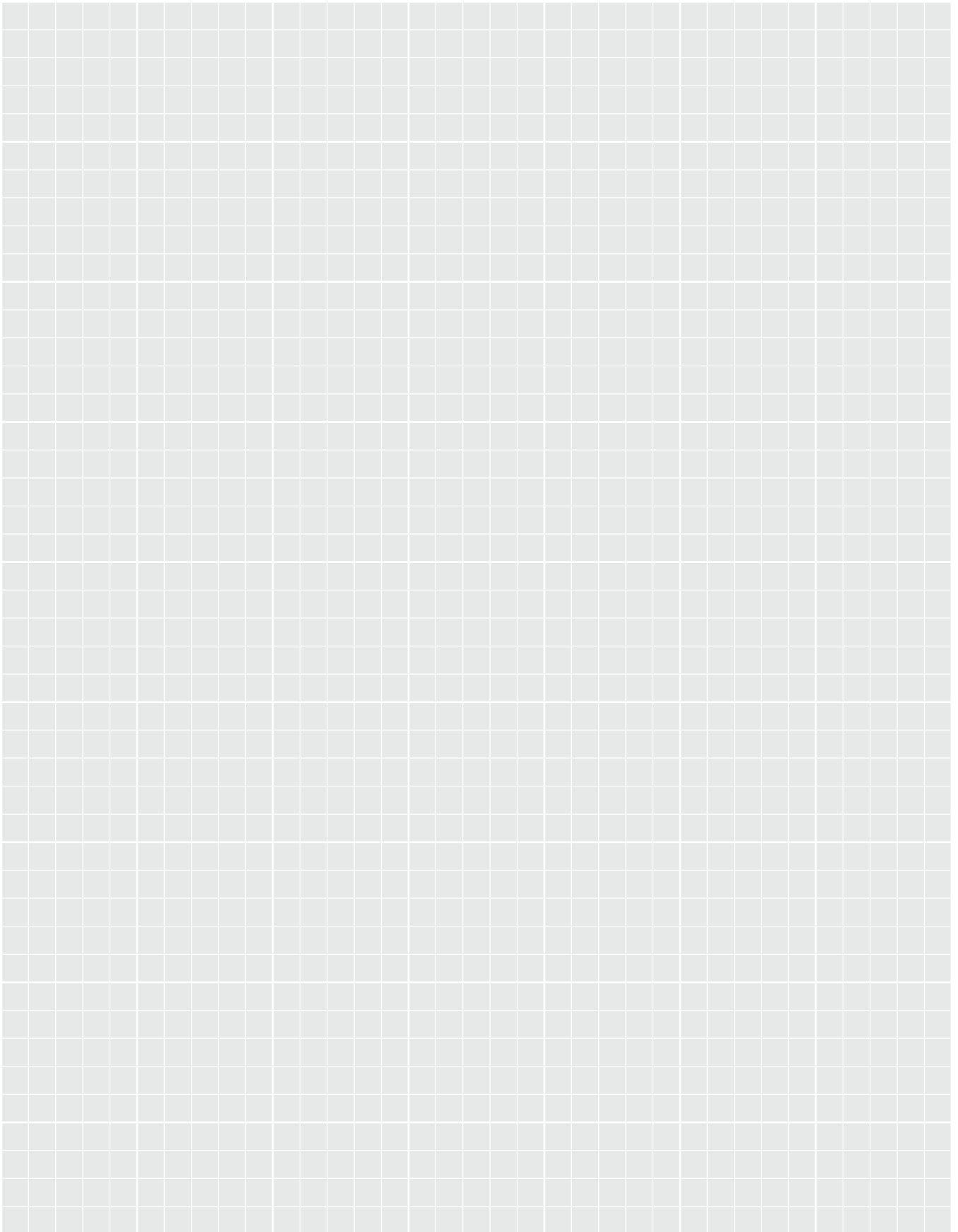
Locking pin T40245



479\_044

Used to lock the high-pressure pump sprocket in place when removing pump.

# Notes





# Knowledge Assessment

An on-line Knowledge Assessment (exam) is available for this Self-Study Program.

The Knowledge Assessment is required for Certification.

You can find this Knowledge Assessment at:

**[www.accessaudi.com](http://www.accessaudi.com)**

From the [accessaudi.com](http://accessaudi.com) Homepage:

- ▶ Click on the "ACADEMY" tab
- ▶ Click on the "Academy Site" link
- ▶ Click on Course Catalog Search and select "920213B — The Audi 3.0L V6 TDI Engine (second generation)"

Please submit any questions or inquiries via the Academy CRC Online Support Form which is located under the "Support" tab or the "Contact Us" tab of the Academy CRC.

*Thank you for reading this Self-Study Program and taking the assessment.*

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