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Service Information

2017 Technik Introduction

Macan (95B)

Porsche AfterSales Training

Student Name: _____

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Macan

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1 Engine

1.1 Macan

Features/development goals



Macan engine

1_01_13

When developing the engine of the Porsche Macan, the focus was on the aspects of power, efficiency and environmental friendliness. Thanks to the use of a host of new technical solutions, it was possible to realize outstanding performance characteristics in combination with an excellent environmental balance. The new power unit is characterized in particular by the following innovative solutions:

- Cylinder head with integrated exhaust manifold
- Camshaft control in combination with two-stage valve lift adjustment
- Dual fuel injection system (MPI/DFI), country-dependent
- Turbocharger with electric boost pressure adjuster
- Thermal management
- Controlled oil pump

Engine

1



Engine



Macan engine cover

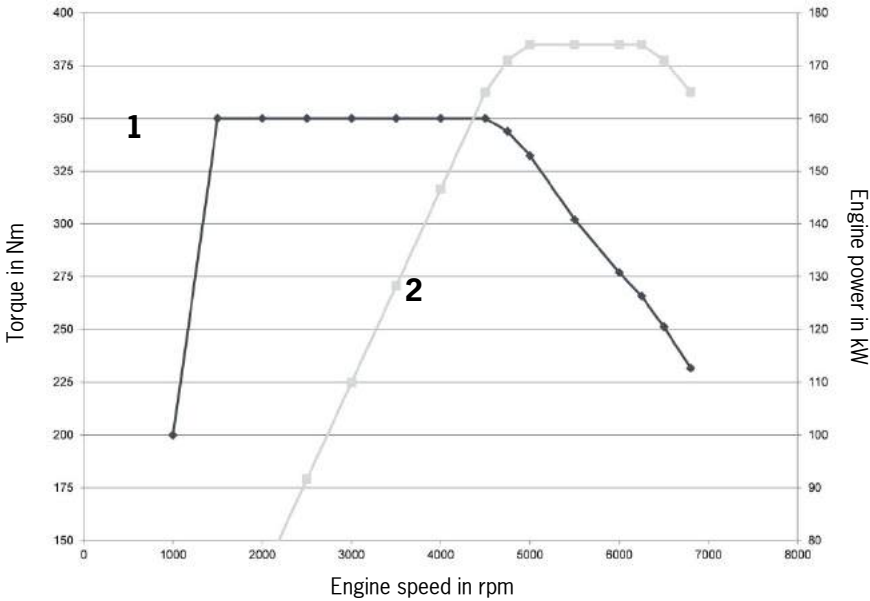
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- 1 Engine torque in Nm
- 2 Engine power in kW

Technical data

Engine type		CNC.C
Number of cylinders		4
Displacement	cm ³	1,984
Bore	mm	82.5
Stroke	mm	92.8
Compression ratio		9.6:1
Engine power at rpm	hp (kW) rpm	252 (188) 5,000 – 6,800
Max. torque	ft lbs (Nm)	273 (370)
Governed speed	rpm	6,800

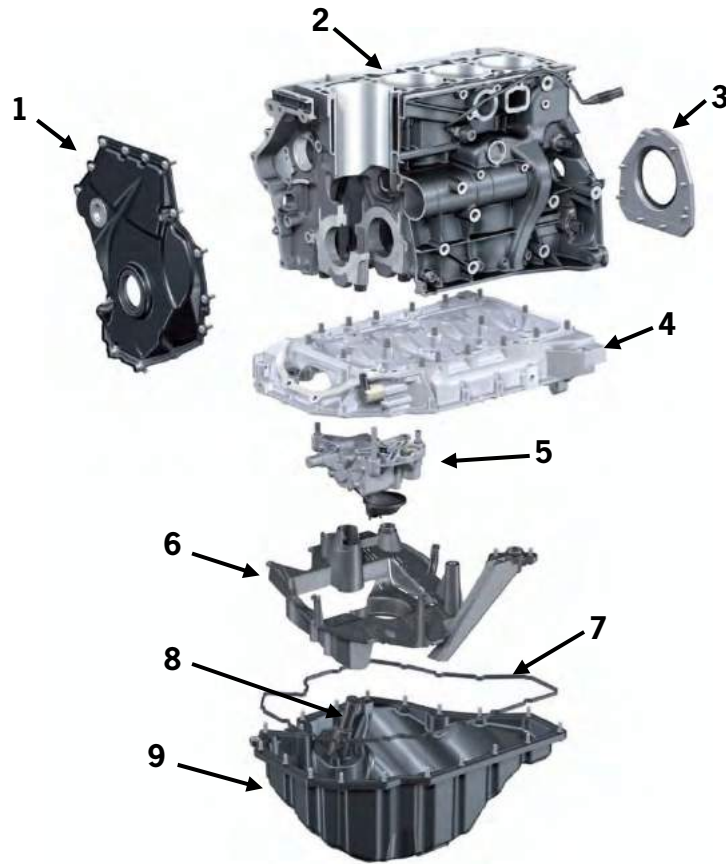
Full load curve



Power and torque

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Crankcase



Cylinder block

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The crankcase is made of gray cast iron GJL250 (wall thickness 3 mm) and features integrated cylinder sleeves (spiral slide-honed). The cylinder block contains the bearing locations for the two balance shafts and a pressure oil gallery for the switchable piston cooling nozzles. The upper part of the oil pan is made of die-cast aluminum. This accommodates the controlled oil pump with switching valve and the honeycomb insert for oil intake and return. Sealing with respect to the cylinder block is with liquid sealant. The bottom part of the oil pan is made of plastic. This accommodates the oil level and oil temperature sensor. It is sealed with respect to the upper part of the oil pan by way of a rubber profile seal. The oil drain is made of plastic (bayonet lock with O-ring).

Macan

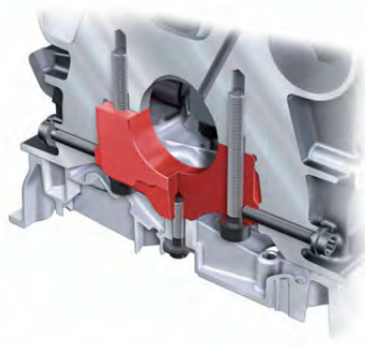


- 1 Timing case cover with front crankshaft rotating shaft seal
- 2 Crankcase
- 3 Sealing flange with rear crankshaft rotating shaft seal
- 4 Upper part of oil pan
- 5 Controlled oil pump
- 6 Honeycomb insert
- 7 Rubber profile seal
- 8 Oil level and oil temperature sensor
- 9 Bottom part of oil pan



The bayonet lock of the oil drain must be replaced at every oil change!

Bearing blocks

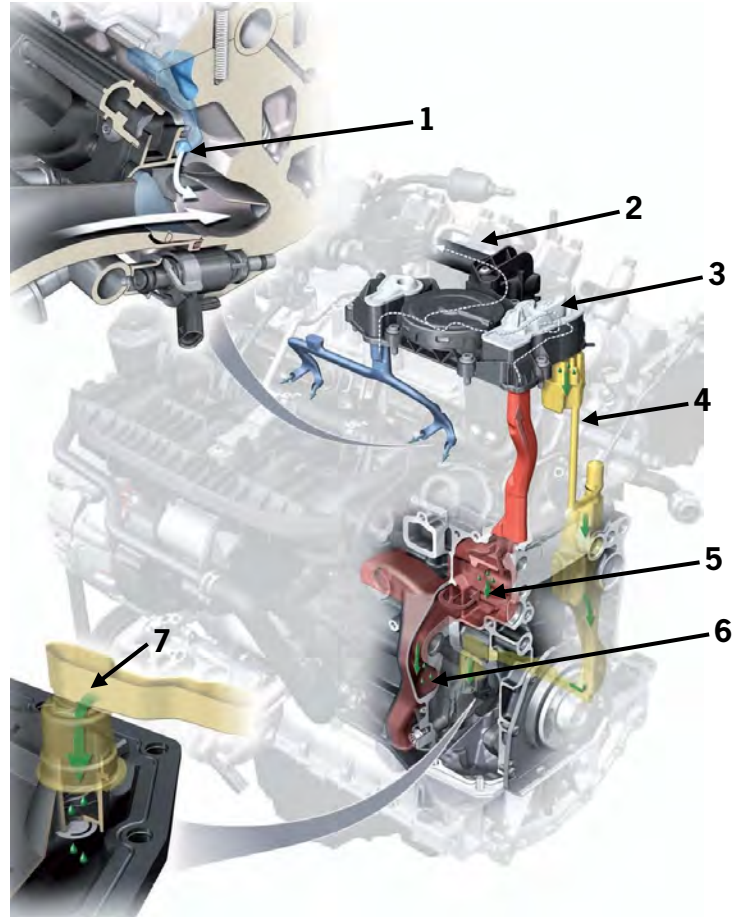


Bearing block screw connection

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The main bearing covers are screwed to the cylinder block and oil pan upper part. This fastening method positively influences the rigidity and vibration behavior of the unit. Screw connection with the cylinder block is done both vertically and horizontally.

Crankcase ventilation



Crankcase ventilation

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When developing the crankcase ventilation system, the goal was to achieve the most compact design possible with only few separate components as well as very good oil separation. There is only one pipe for discharge of the cleaned blow-by gases outside the engine. The system comprises the following components:

- Coarse oil separator in the cylinder block
- Fine oil separator module (screwed into the cylinder head cover)
- Hose for discharge of the cleaned blow-by gases
- Oil return in the crankcase with check valve in the honeycomb insert of the oil pan

Coarse oil separator

Coarse oil separation takes place in the crankcase. A large part of the engine oil is already separated by a change in direction in a labyrinth system. The separated oil runs back into the oil pan via a return channel in the crankcase. The return channel ends below the oil level.

Fine oil separation

After coarse cleaning, the blow-by gases are routed from the crankcase via a duct in the cylinder head into the fine oil separator module. Here, the gases are first routed via the cyclone separator. The separated oil from the cyclone separator is returned separately to the oil pan via a separate duct in the crankcase. The duct ends below the oil level. A check valve prevents oil from being sucked out of the sump under unfavorable pressure conditions and with strong transverse acceleration.

The blow-by gas that has been cleaned in this way is then supplied for combustion via the one-stage pressure-regulating valve. The intake/input point is determined by the pressure conditions in the intake system and is controlled by a valve. In intake operation, intake/input takes place directly into the intake pipe directly upstream of the intake valves. In boost operation, intake/input takes place into the turbocharger.



Crankshaft drive

Crankshaft drive

1_07_13

Crankshaft

The crankshaft is made of forged steel, is supported by 5 bearings and has eight balancing weights for optimum mass balancing. The stroke is 92.8 mm. Two-layer aluminum bearings with a diameter of 52 mm are used as the main bearings. The crankshaft is axially guided by thrust washers in the middle bearing. The crankshaft features spur toothing at the front to positively drive the vibration damper of the belt drive.

Connecting rods

The trapezoidal connecting rods are forged and designed as cracked connecting rods. Two-layer bronze bearings with a diameter of 47.8 mm are used in the bottom connecting rod big end. The piston pin is coated (DLC = Diamond-like Carbon) and is supported directly in the connecting rod material without a separate bearing bush.



Connecting rods, pistons

1_08_13

Pistons

The pistons are made of cast aluminum and have a cast-in ring carrier for the upper piston ring.

Upper piston ring	Plain compression ring, asymmetrically crowned
Middle piston ring	Stepped taper faced ring
Lower piston ring	Narrow-land spring-loaded oil ring (oil scraper ring)

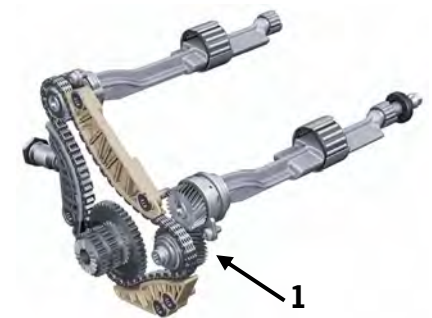
Timing drive with balance shafts



Chain drive

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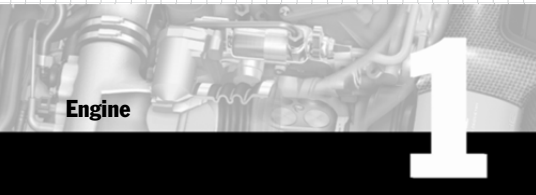
The camshafts, balance shafts and oil pumps are driven via three 1/4" toothed chains. The toothed chains for driving the camshafts and balance shafts are tensioned by means of a hydraulic chain tensioner and the toothed chain for driving the oil pumps by way of a mechanical spring. The balance shafts are driven so that they counter-rotate. There is a reversing gear between the sprocket and balance shaft for this purpose.



Balance shafts with drive

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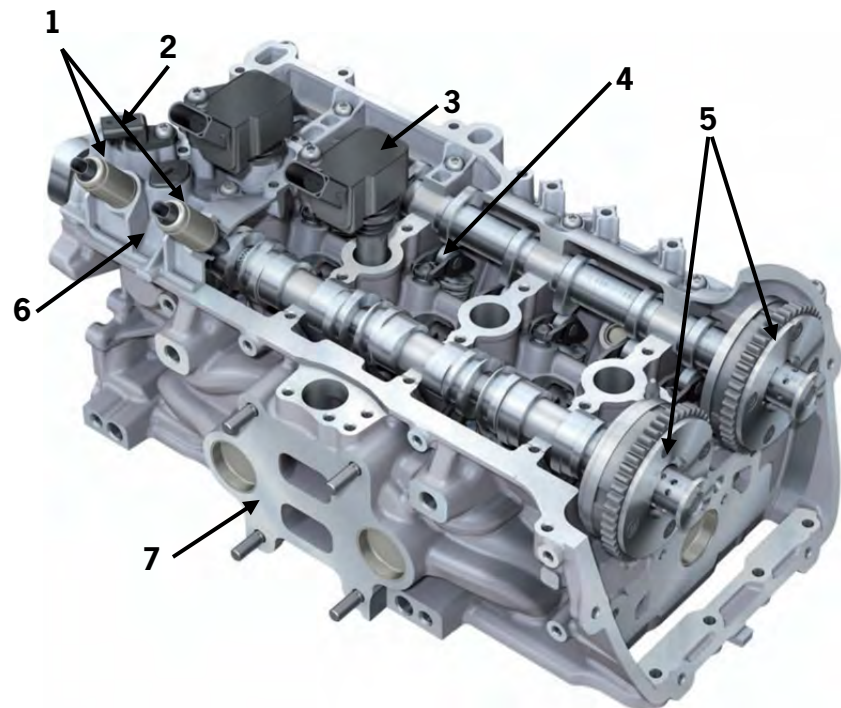
1 Reversing gear



Engine

- 1 Actuating elements for valve lift adjustment
- 2 Camshaft position sensor
- 3 Ignition coil
- 4 Rocker arm
- 5 Camshaft adjuster
- 6 Cylinder head cover
- 7 Flange for turbocharger

Cylinder head



Cylinder head

1_11_13

The cylinder head features an integrated exhaust manifold for the first time so that the turbocharger can be flanged on directly at the cylinder head. The camshafts are supported directly in the cylinder head and cylinder head cover. The exhaust camshaft has adjustable cam profiles for valve lift adjustment. (See "Valve lift adjustment" for further information.) The control valves for adjustment of the valve timing are located on the face ends of both camshafts. They are actuated by way of solenoid actuators fitted in the chain box cover. The valves are actuated by means of rocker arms with hydraulic valve-clearance compensation elements. Liquid sealant is used for sealing the cylinder head cover. Sealing on the control side is by way of the chain box cover made of plastic, in which the oil filler cap is integrated at the top. The cylinder head gasket comprises three layers and is made of metal.

Integrated exhaust manifold (IAGK)

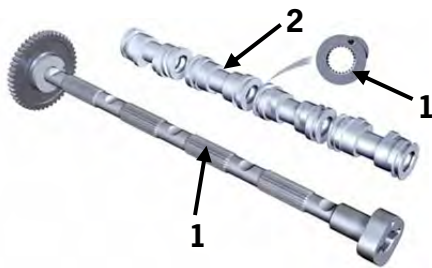


Cooling ducts of integrated exhaust manifold

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The integrated exhaust manifold lowers the temperature at the turbocharger. This means that it is largely possible to dispense with cooling full-load enrichment at high engine speeds. At the same time, the coolant is heated up faster, which means that the engine completely reaches its operating temperature more quickly. The integrated exhaust manifold is surrounded by coolant ducts in the cylinder head in order to ensure uniform and fast heat transfer to the coolant.

Camshafts



Exhaust camshaft

1_13_13

- 1 Tooth profile
- 2 Cam piece

Two assembled camshafts are used on the engine of the Porsche Macan. On the intake camshaft, the cam profiles are fixed in position on the shaft.

Axially adjustable cam pieces are fitted on a tooth profile on the exhaust camshaft for valve lift adjustment (also see "Valve lift adjustment").



- 1 Solenoid actuator
- 2 4/3-way central valve
- 3 Vane adjuster

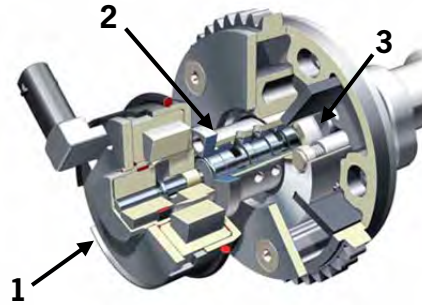


Valve lifting curves

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- 1 Intake valve lift
- 2 Exhaust valve lift, small
- 3 Exhaust valve lift, large

Camshaft adjuster



Camshaft adjuster

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A vane adjuster (INA system) is used in each case on the intake and exhaust camshafts. The 4/3-way central valves in the camshafts are actuated via solenoid actuators, which are installed in the chain box cover.

Intake camshaft adjustment range	° crank angle	30
Exhaust camshaft adjustment range	° crank angle	15

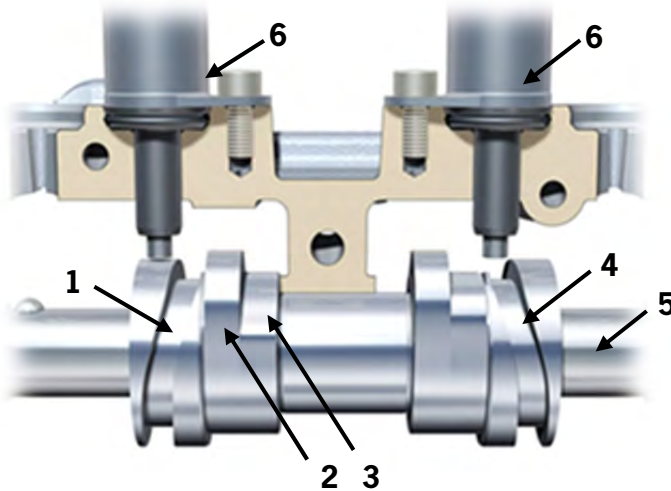
Valves

The intake valves have a stem made of solid material, are chrome-plated and have reinforced seats. The intake valve guides are made of brass. The exhaust valves have a hollow stem and are filled with sodium. They are quenched and tempered, are also chrome-plated and have reinforced seats. The exhaust valve guides are made of sintered metal.

Valve lift adjustment

Two-stage valve lift adjustment is used on the exhaust side. The adjustable valve opening cross-section means that it is possible to positively influence the flow rate of the exhaust gases and therefore the responsiveness of the turbocharger.

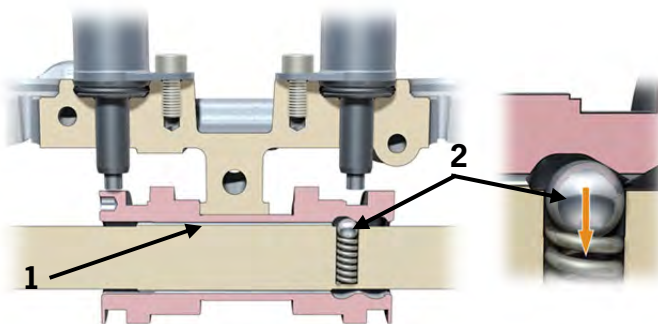
The exhaust valves are only partially opened at low engine speeds and with a correspondingly low flow rate. The exhaust gases are accelerated by the restricted valve opening cross-section and strike the turbine wheel of the turbocharger at higher speed. The turbine wheel is therefore accelerated more strongly. At high engine speeds, a narrower valve cross-section would lead to throttling losses, since the charge cycle in the combustion chamber then cannot take place quickly enough. The valves are therefore actuated with maximum lift at increasing engine speeds. Switchover is performed by the DME imperceptibly for the driver based on a map.



Side view of valve lift adjustment

1_16_13

The cam pieces have two different cam profiles for each exhaust valve. There is an adjusting groove on the left and right in each case next to the cam profiles. The cam pieces also serve as the bearing location for the camshaft. They are axially limited on both sides by the bearing blocks in the cylinder head.



Sectional view of camshaft

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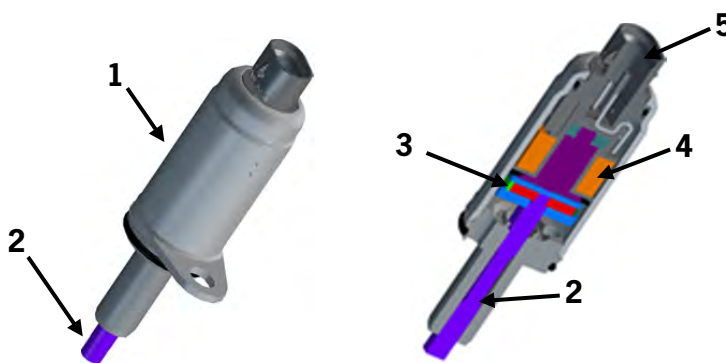
- 1 Adjusting groove
- 2 Cam profile for large valve lift
- 3 Cam profile for small valve lift
- 4 Cam piece
- 5 Camshaft
- 6 Actuating elements

- 1 Tooth profile
- 2 Spring-loaded ball



- 1 Actuating element housing
- 2 Adjusting tappet
- 3 Permanent magnet
- 4 Solenoid coil
- 5 Electrical connection

In order to prevent undesired movement of the cam pieces, they are additionally held in the end positions by spring-loaded balls, which are located in the camshafts.



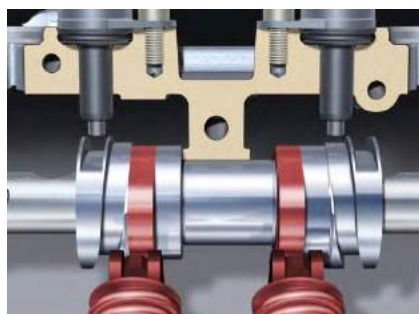
Actuating element

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Sectional view of actuating element

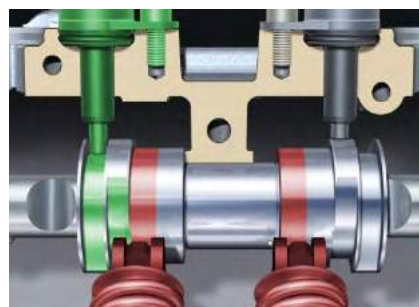
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Two electromagnetic actuating elements are located above the adjustable cam pieces in each case. These actuating elements are activated by the DME. They comprise a solenoid coil, the adjusting tappet with permanent magnet and the housing.



Large valve lift active

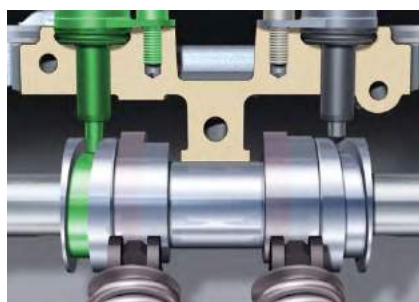
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Adjusting tappet extended

1_21_13

When the solenoid coil is energized, the adjusting tappet is extended from the actuating element and engages in the adjusting groove of the cam piece.



Adjustment active

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Small valve lift active

1_23_13

Due to the contour form of the adjusting groove, the cam piece is displaced by the rotary movement of the camshaft. The adjusting groove tapers out at the end and thus pushes the adjusting tappet back into the housing of the actuating element. Adjustment takes place depending on the camshaft position and on a cylinder-specific basis, since displacement of the cam pieces can take place only without radial force, i.e. without actuation of the valve.

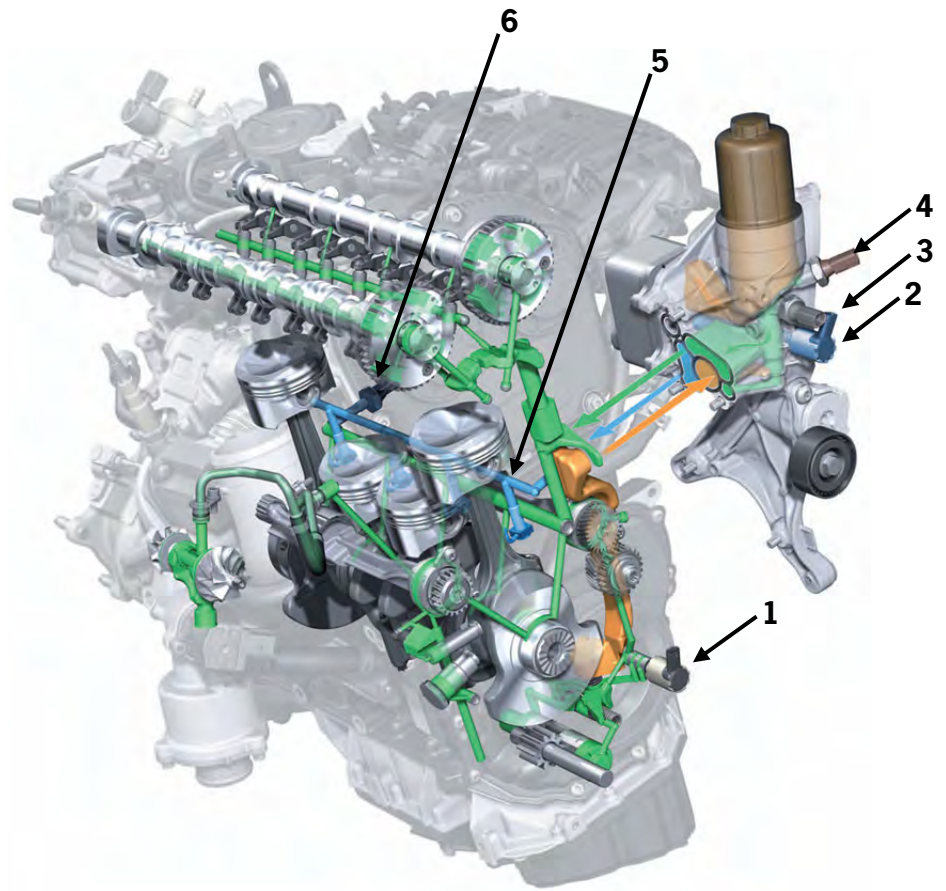
Exhaust valve lift, small	mm	6.35
Exhaust valve lift, large	mm	10
Intake valve lift	mm	10.7



1

- 1 Switching valve for controllable oil pump
- 2 Switching valve for piston cooling nozzles
- 3 Oil pressure switch, high pressure
- 4 Oil pressure switch, low pressure
- 5 Piston cooling nozzle
- 6 Oil pressure switch, piston cooling nozzles

Lubrication



Oil circuit

1_24_13

The oil circuit has been designed for maximum efficiency and minimum pressure losses. The goal was to reduce the energy requirement (fuel consumption) for lubrication as far as possible. For this reason, a controlled oil pump and switchable piston cooling nozzles are used. Activation takes place by the DME depending on the engine load. The function of the switchable piston cooling nozzles is monitored by means of an additional oil pressure switch for the piston cooling nozzles. The oil filter element is accessible from above in the engine compartment.

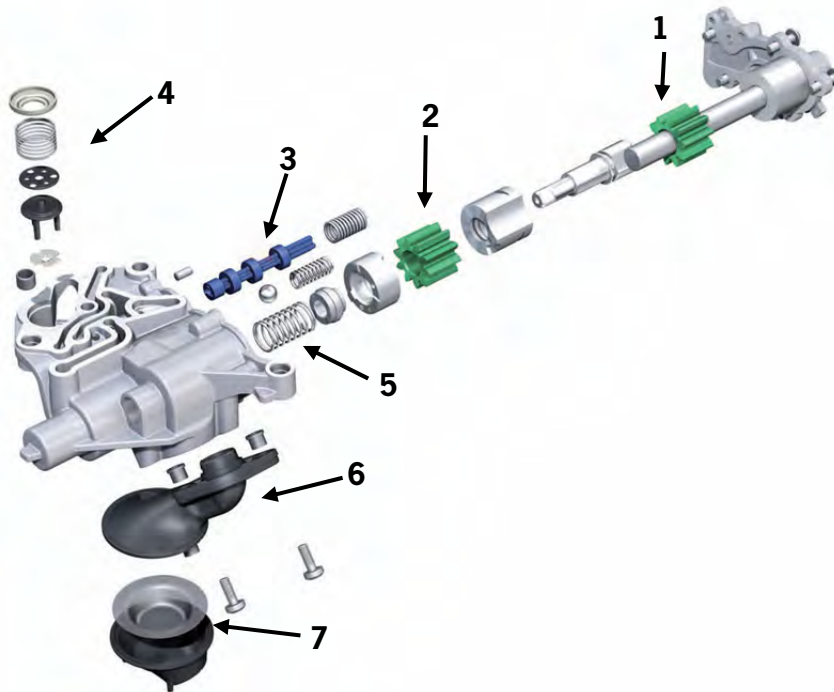
Controllable oil pump



Controllable oil pump

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The controllable oil pump is activated by the DME via the switching valve for the controllable oil pump. The goal of activation is to adapt the oil pressure to the lubrication requirement of the engine. The delivery rate and thus the oil pressure are reduced if there is a low requirement (low rpm/load). This reduces the drive output power of the oil pump (reduction in fuel consumption).



Exploded view of controllable oil pump

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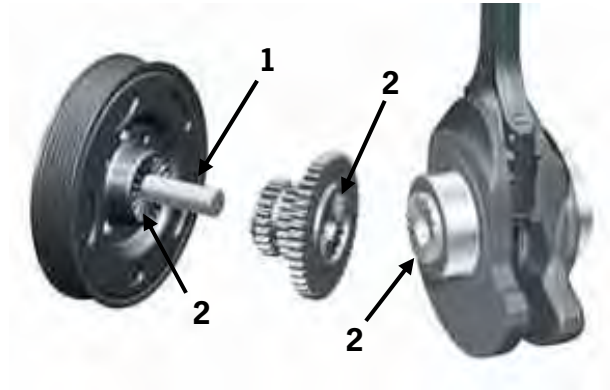
The delivery rate is controlled by axial displacement of the pump gear wheels with respect to each other.

- 1 Central screw
- 2 Spur toothing

Belt drive

The belt drive drives

- the three-phase generator and
- the air-conditioning compressor



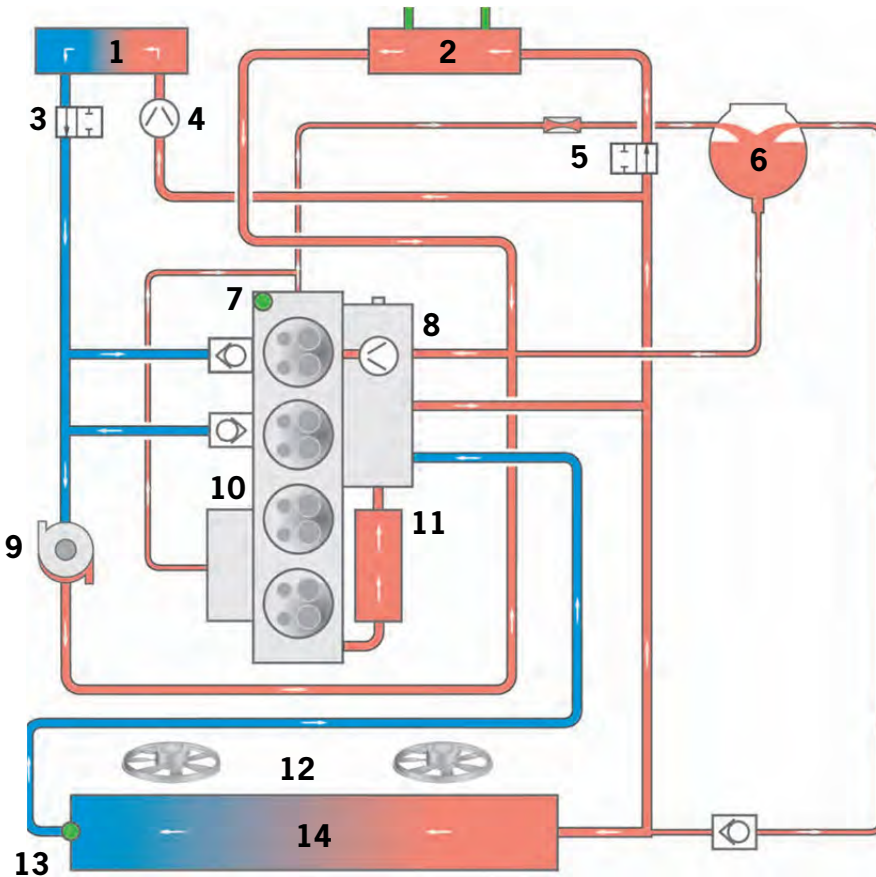
Pulley mounting

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The pulley is mounted on the crankshaft and the sprocket of the timing drive mechanism by means of a central screw.

Torque transmission from the crankshaft to the sprocket and belt pulley is by way of spur toothing.

Cooling



Cooling system

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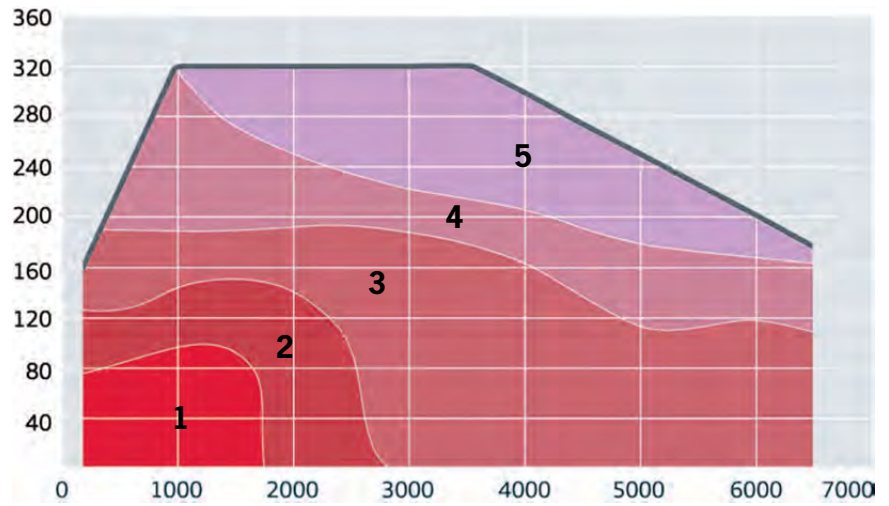
When developing the engine of the Porsche Macan, the focus was on reducing fuel consumption and emissions, while at the same time achieving high drive comfort. High specific efficiency is in combination with the possibility of heating the passenger compartment quickly if necessary through fast heating-up of the power unit, demand-controlled engine temperatures and intelligent distribution of the thermal energy.



- 1 Heating heat exchanger
- 2 Oil-water heat exchanger PDK
- 3 Heating system coolant shut-off valve
- 4 Pump for coolant circulation
- 5 Coolant shut-off valve PDK
- 6 Coolant expansion tank
- 7 Engine coolant temperature sensor
- 8 Coolant pump with actuating element for engine temperature control
- 9 Turbocharger
- 10 Integrated exhaust manifold
- 11 Engine oil-water heat exchanger
- 12 Radiator fan (2)
- 13 Coolant temperature sensor, radiator outlet
- 14 Radiator



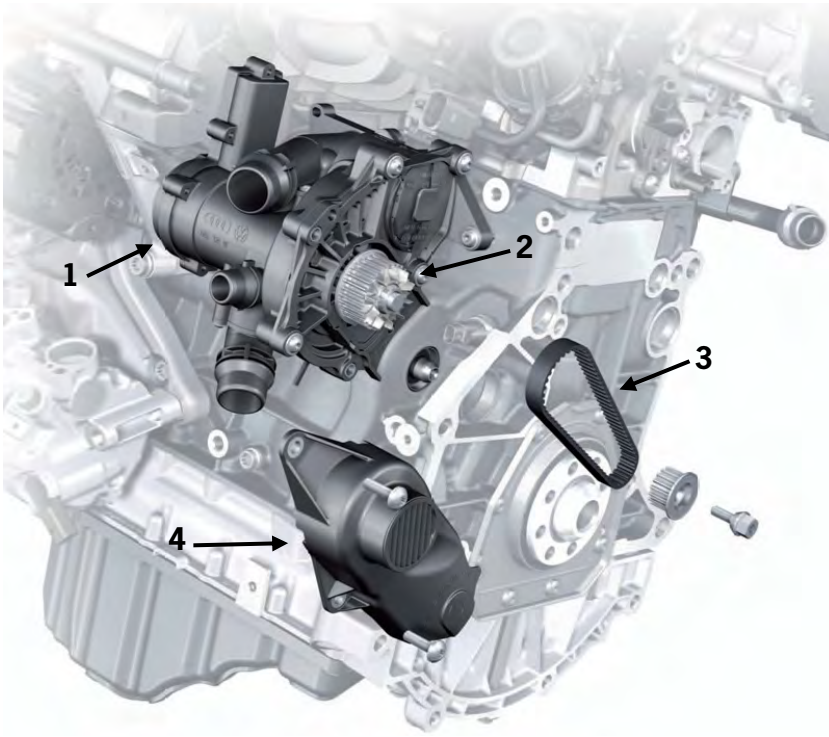
- 1 221° F (105° C)
- 2 212° F (100° C)
- 3 203° F (95° C)
- 4 194° F (90° C)
- 5 185° F (85° C)



Engine temperature as a function of engine speed and load

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As a result of higher engine temperatures at low engine speeds and loads, it is possible to reduce the friction in the power unit and thus increase the efficiency. In contrast, the volumetric efficiency and therefore the peak power can be improved by low temperatures in the upper engine speed and load range. The two most important thermal management components are the exhaust manifold integrated in the cylinder head and the actuating element for engine temperature control.

Actuating element for engine temperature control

Actuating element for engine temperature control

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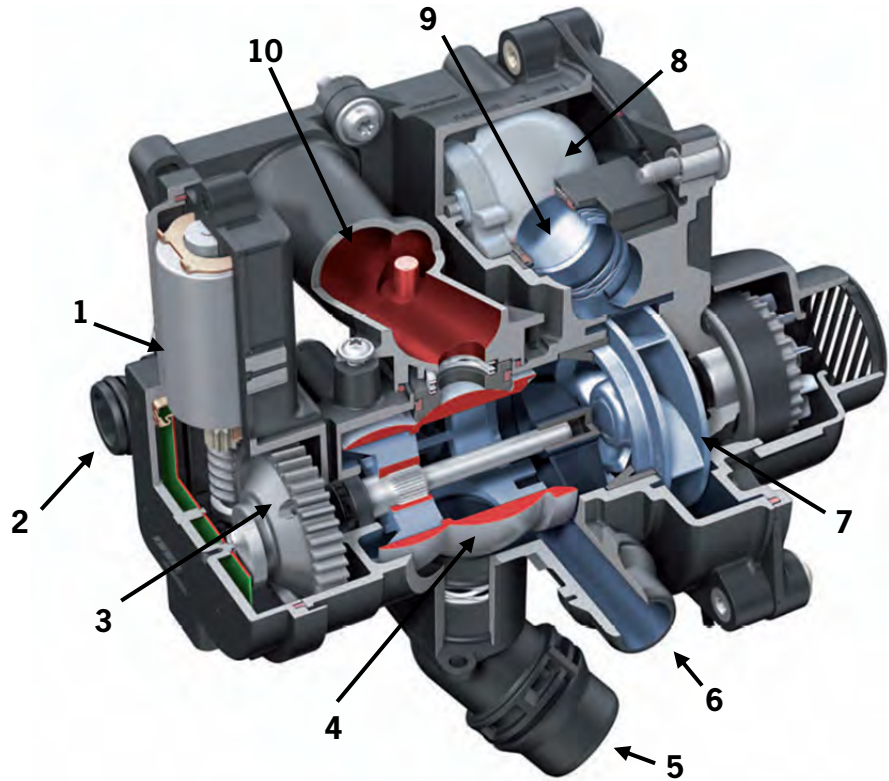
The actuating element for engine temperature control forms one unit together with the water pump. It regulates the coolant flow between the engine, radiator, oil-water heat exchanger and passenger compartment heater by way of two mechanically coupled rotary slides. The angular position of the rotary slides is controlled by the DME control unit based on a map.



- 1 Actuating element for engine temperature control
- 2 Water pump
- 3 Toothed belt for water pump
- 4 Toothed belt cover



- 1 Servo motor
- 2 Oil-water heat exchanger return line
- 3 Worm gear
- 4 Rotary slide 1
- 5 Return line from radiator
- 6 Return line from heater, turbocharger
- 7 Water pump
- 8 Rotary slide 2
- 9 Engine water inlet
- 10 Engine water outlet



Actuating element for engine temperature control

1_31_13



* SENT=Single Edge Nibble Transmission
Digital interface between control units and sensors (SAE J2716).

The rotary slides are driven via a DC motor, which is activated directly by the DME control unit via a PWM signal (amplitude voltage 12 V, carrier frequency 1,000 Hz). The electric motor drives rotary slide 1 via a worm gear. Rotary slide 2 is connected with rotary slide 1 by way of a pin wheel gear. The pin wheel gear is designed so that rotary slide 2 is engaged and disengaged at certain angular positions of rotary slide 1. The rotary movement of rotary slide 2 (opening of the coolant flow through the cylinder block) starts at an angular position of rotary slide 1 of approx. 145° and ends at an angular position of rotary slide 1 of approx. 85°. Rotary slide 2 is then opened to the maximum amount. The movements of both rotary slides are limited by mechanical stops. A rotary angle sensor is fitted on the worm gear in order to detect the position of the rotary slides and possible malfunctions. This sensor supplies a unidirectional, asynchronous voltage signal (SENT*) to the DME.

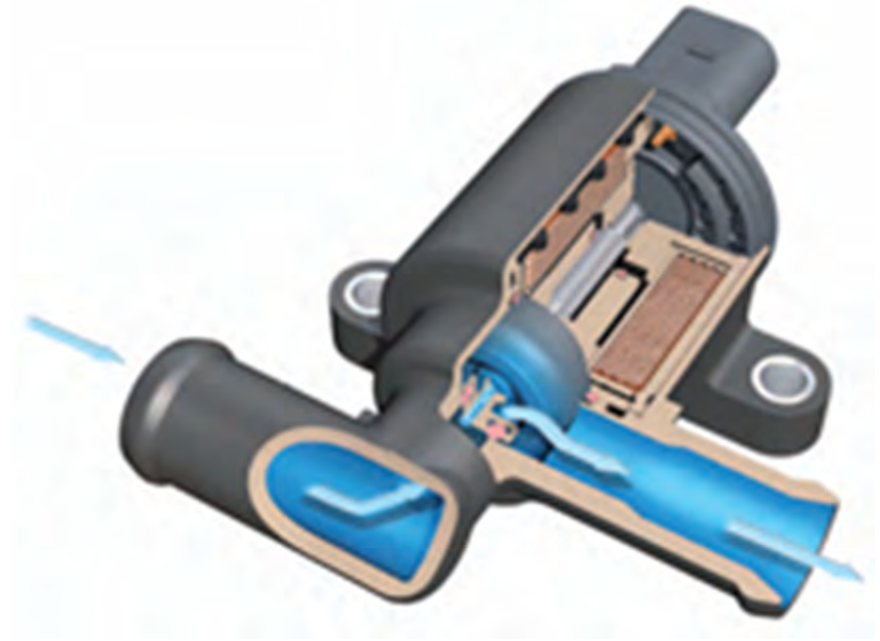
Pump for coolant circulation

Pump for coolant circulation

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The pump for coolant circulation improves the coolant output in the heat exchanger of the passenger compartment heating system. It is activated by the A/C control unit by means of a PWM signal and is diagnosable.



Heating system coolant shut-off valve

Heating system coolant shut-off valve

1_33_13

The coolant flow to the heat exchanger of the passenger compartment heating system can be controlled by way of the heating system coolant shut-off valve. This is a solenoid valve which is held open by spring force in de-energized state. Activation takes place by the A/C control unit. The heating system coolant shut-off valve is closed when the engine is started. It is opened after a heating request, for coolant after-run when the engine is switched off and during a start-stop request.

PDK coolant shut-off valves

The PDK coolant shut-off valve has an identical design to the heating system coolant shut-off valve and controls the coolant flow to the oil-water heat exchanger of the PDK. It is activated by the DME.



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2 DME engine electronics

2.1 Macan

The DME system of the Macan 2.0 I includes the following technical highlights, which are described in this section:

- Direct fuel injection combined with intake manifold injection (country-specific)
- Valvelift system
- Turbocharger with electric wastegate
- Integrated exhaust manifold
- Rotary slide module for thermal management

DME control unit

The Continental SIMOS 18 engine management system is used in the Porsche Macan 2.0 I.



DME control unit



2_01_13 Porsche Macan engine cover

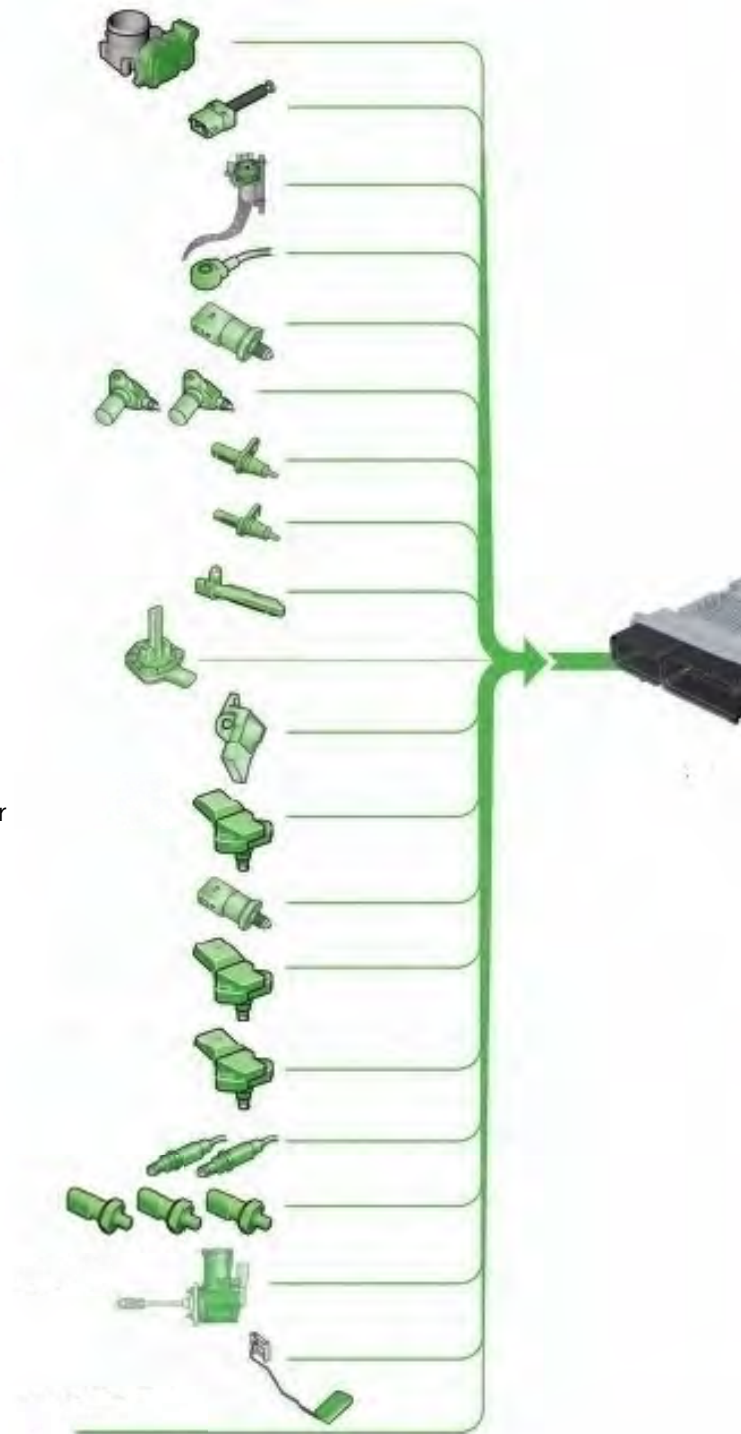
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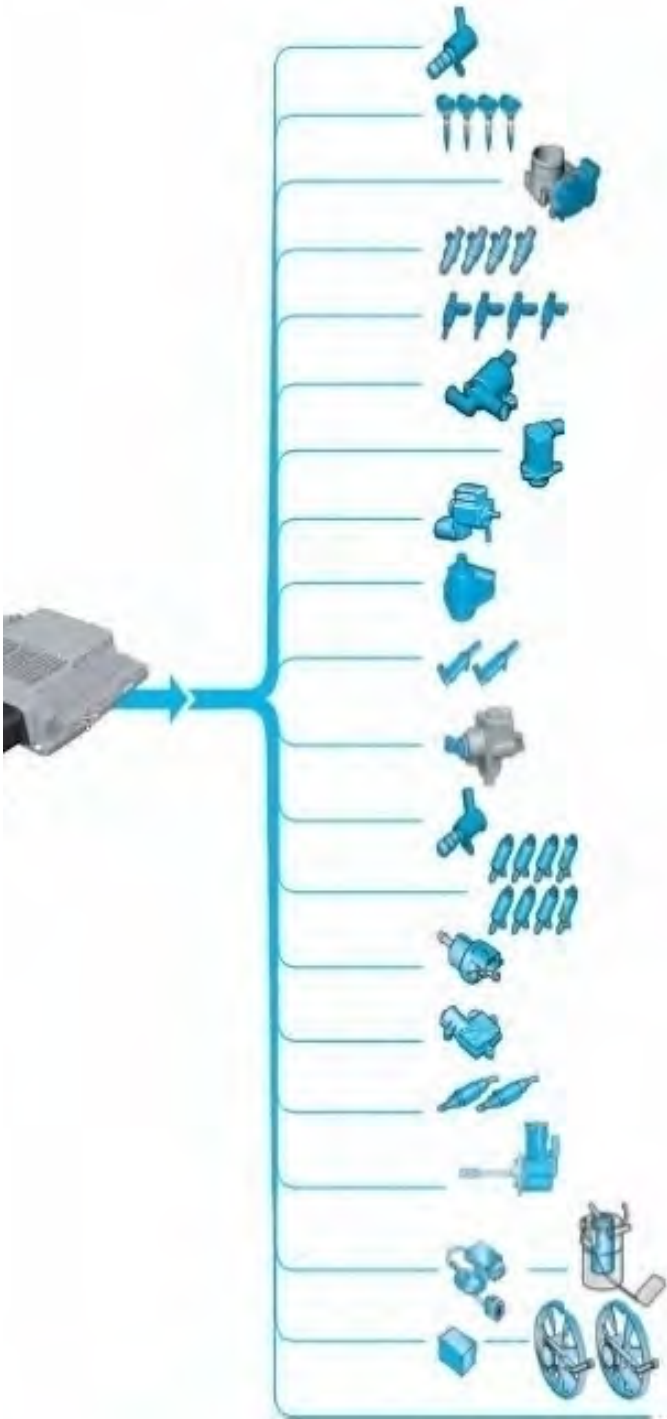
Similar to the other Macan engine versions, the control unit is installed in the E-box plenum panel. It projects into the interior under the dashboard.

DME engine electronics

2

- Sensor for throttle valve position (redundant)
- Brake light switch
- Sensor for accelerator pedal position (redundant)
- Knock sensor
- Fuel low-pressure sensor
- Sensor for camshaft position 1
- Sensor for camshaft position 2
- Coolant temperature sensor
- Radiator outlet coolant temperature sensor
- Engine speed sensor
- Oil level and oil temperature sensor
- Sensor for intake manifold flap position
- Intake air temperature and intake manifold pressure sensor
- Fuel high-pressure sensor
- Boost pressure sensor
- Brake booster pressure sensor
- Oxygen sensor/monitor oxygen sensor
- Oil pressure switch for high pressure,
Oil pressure switch for low pressure,
Oil pressure switch for piston cooling nozzles
- Position sensor for boost pressure adjuster
- Fuel tank sensor
- Additional signals from: Cruise control, speed signal,
Start request,
Terminal 50,
Crash signal





Switching valve for piston cooling nozzles

Ignition coils 1-4 (each with integrated output final stage)

Drive link for throttle valve

Injectors 1-4, low pressure

Injectors 1-4, high pressure

Coolant shut-off valve PDK

Recirculating air valve for turbocharger

Control valve for intake manifold flaps

Pump for coolant circulation

Solenoid actuator for intake camshaft adjustment,
Solenoid actuator for exhaust camshaft adjustment

Quantity control valve

Switching valve for controllable oil pump

Actuating elements 1-8 for valve lift adjustment

Solenoid valve for carbon canister

Actuating element for engine temperature control

Oxygen sensor heater, monitor oxygen sensor heater

Boost pressure adjuster

Control unit for in-tank fuel pump

Radiator fan control unit

Additional signals to: PDK,
PSM,
Air conditioning system,
Starter control

- 1 Control unit for in-tank fuel pump
- 2 In-tank fuel pump with filter
- 3 Quantity control valve
- 4 Single-piston fuel high-pressure pump
- 5 Fuel low-pressure rail (not USA)
- 6 Fuel low-pressure sensor (not USA)
- 7 Low-pressure injectors (not USA)
- 8 Fuel high-pressure rail
- 9 Fuel high-pressure sensor
- 10 High-pressure injectors

 Not for USA

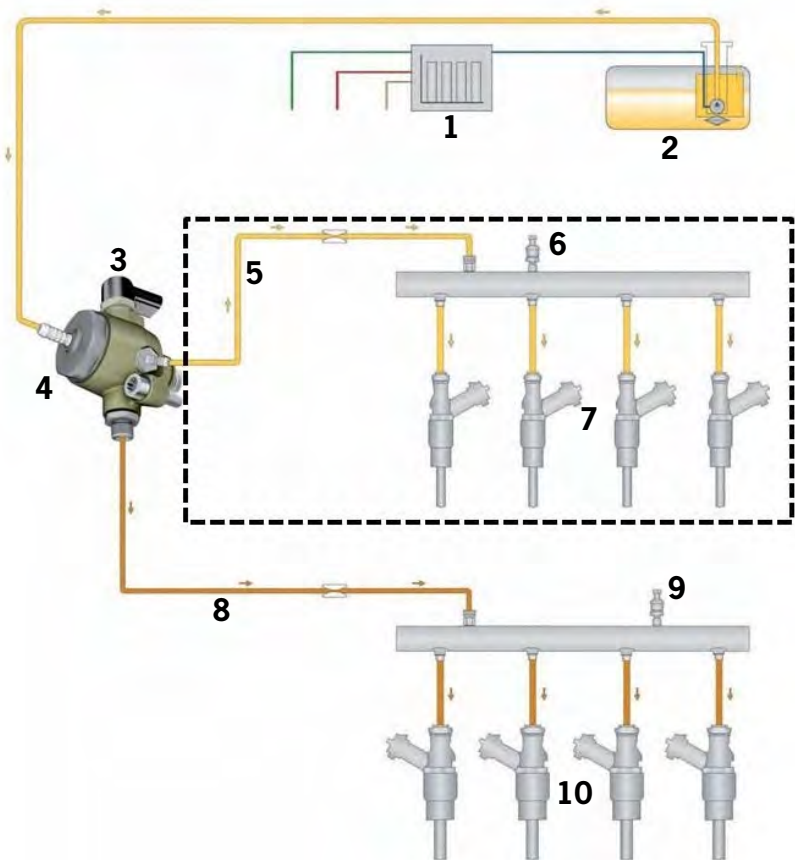
Fuel system

The fuel low-pressure system corresponds to that of the V6 biturbo engines of the Porsche Macan S and Macan Turbo.

A combination of direct fuel injection (DFI) and multi-port injection (MPI) is used for the Porsche Macan engine (USA: only direct fuel injection). This made it possible to achieve the following improvements in particular:

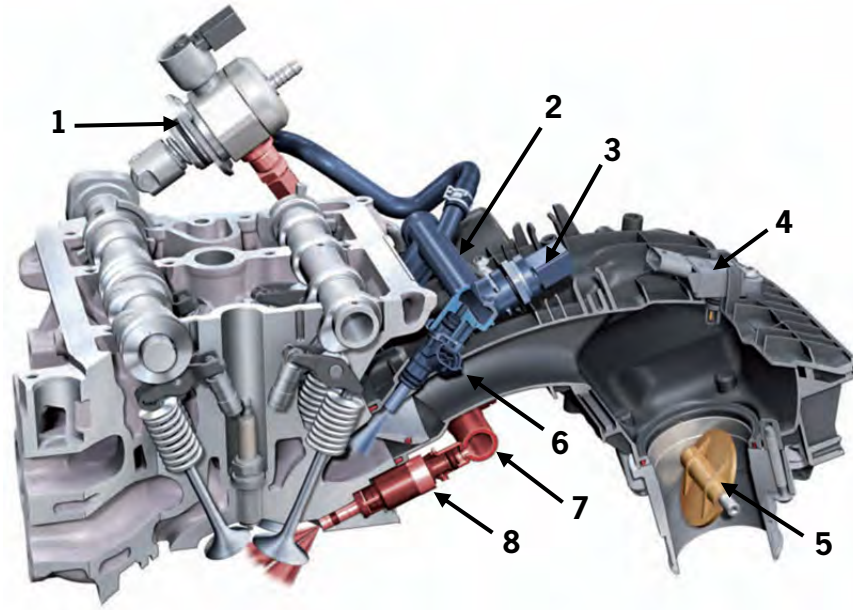
- Improved engine acoustics
- Reduced particulate emissions
- Reduced fuel consumption and thus lower CO₂ emissions, particularly in the part-load range

Overview of fuel system



Fuel system

2_05_13



Cylinder head with injection system

2_06_13

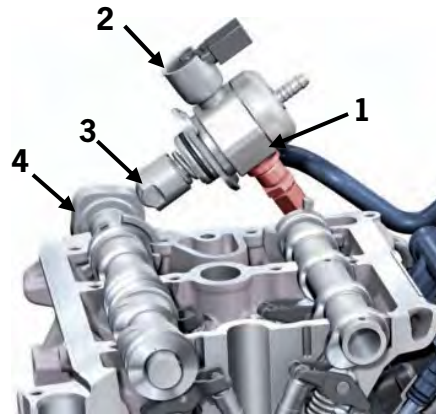
DFI fuel injection system

The DFI fuel injection system operates with an injection pressure of up to 2900 psi (200 bar). In order to minimize noise, the high-pressure injectors are acoustically isolated from the cylinder head by way of steel spring washers and the fuel high-pressure rail is screwed directly onto the cylinder head.

- 1 Fuel high-pressure pump
- 2 Fuel low-pressure rail (not USA)
- 3 Fuel low-pressure sensor (not USA)
- 4 Intake manifold pressure sensor/intake air temperature sensor
- 5 Throttle valve
- 6 Low-pressure injector (not USA)
- 7 Fuel high-pressure rail
- 8 High-pressure injector

- 1 Fuel high-pressure pump
- 2 Quantity control valve
- 3 Roller tappet
- 4 Multiple cam on exhaust camshaft

Fuel high-pressure pump



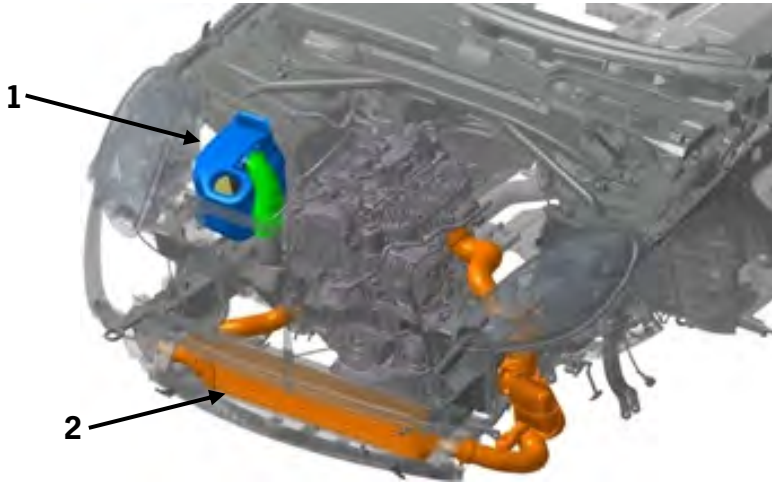
Fuel high-pressure pump

2_07_13

A single-piston pump is used as the fuel high-pressure pump. This is driven via a roller tappet by a separate multiple cam of the exhaust camshaft. The quantity control valve is located on the fuel pump. There is no pressure build-up in the fuel high-pressure rail if the quantity control valve is not functioning.

Intake system and turbocharging

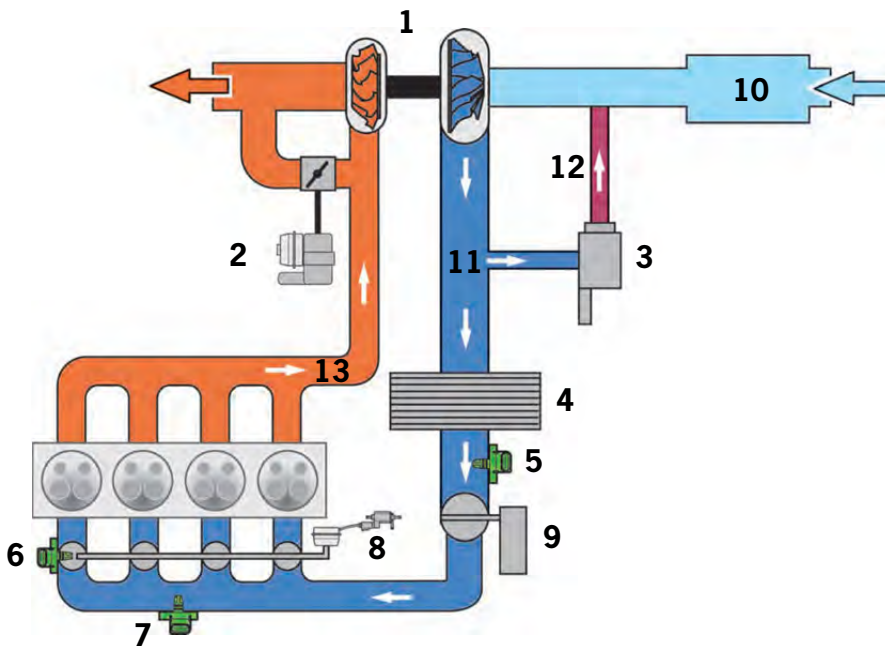
The intake air is filtered similar to the arrangement in the Porsche Macan S Diesel by way of an air cleaner at the front right of the engine compartment, which is supplied with air just under the hood. The charge air cooler is positioned transversely in front of the radiator.



Charge air routing

2_09_13

In order to ensure an optimum gas cycle, an intake manifold flap system is used in combination with a new mono-scroll turbocharger with integrated overrun air control.



Overview of intake system

2_10_13

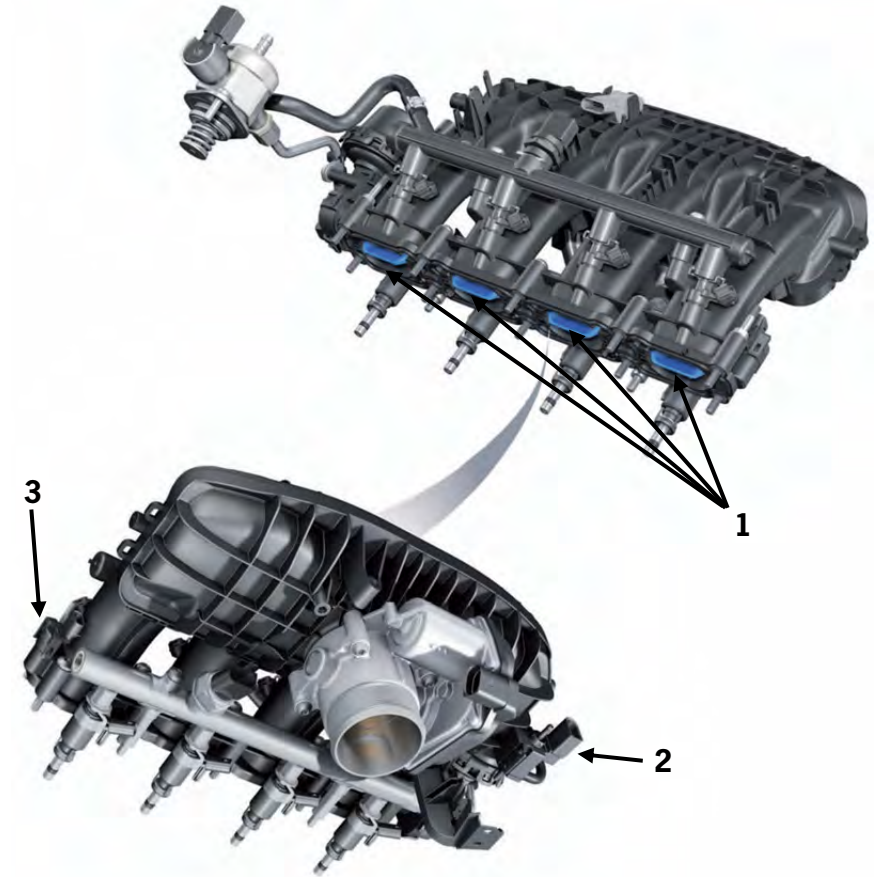
DME engine electronics

2

- 1 Air cleaner
- 2 Charge air cooler

- 1 Turbocharger
- 2 Boost pressure adjuster
- 3 Diverter valve for turbocharger
- 4 Charge air cooler
- 5 Boost pressure sensor
- 6 Position sensor for intake manifold flaps
- 7 Pressure/temperature sensor for intake air
- 8 Switching valve for intake manifold flaps
- 9 Throttle valve (electronic throttle)
- 10 Intake side
- 11 Boost pressure
- 12 Deceleration air
- 13 Exhaust gas

- 1 Intake manifold flaps
- 2 Control valve for intake manifold flaps
- 3 Sensor for intake manifold flap position

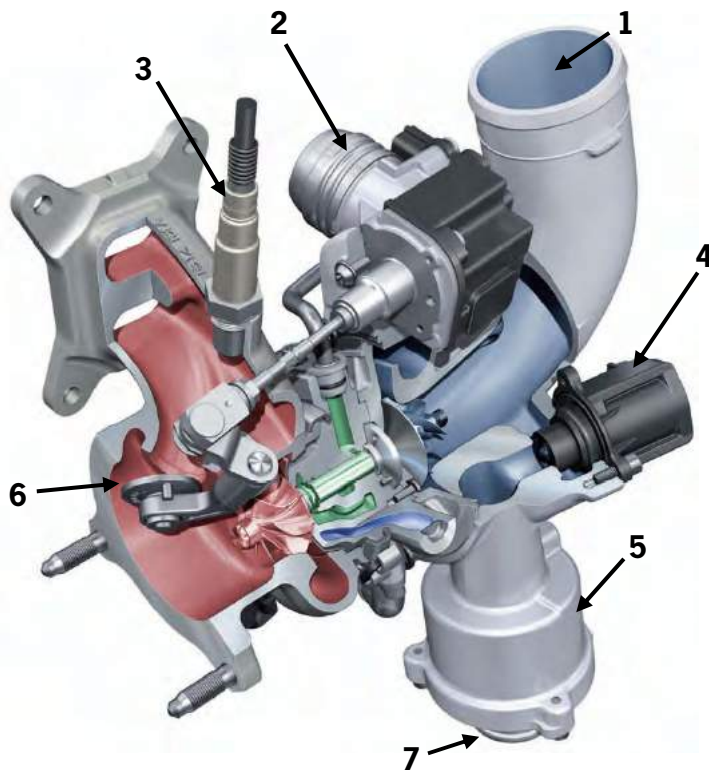


Intake manifold

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The position of the intake manifold flaps is detected by the position sensor for the intake manifold flaps and is checked by the DME.

Turbocharger



Turbocharger

2_12_13

The mono-scroll* turbocharger was newly developed for optimized behavior at full throttle. It has the following features:

- Cast-steel turbine housing with twin-branch intake duct (mounted directly on the cylinder head)
- Aluminum compressor housing with integrated pulsation silencer and electric diverter valve
- Inconel** turbine wheel
- Milled compressor wheel
- Electric boost pressure adjuster (wastegate)
- Broadband oxygen sensor integrated in the turbine housing

Macan



DME engine electronics

- 1 Air inlet
- 2 Electric boost pressure adjuster
- 3 Oxygen sensor (broadband)
- 4 Electric diverter valve
- 5 Pulsation silencer
- 6 Wastegate valve
- 7 Air outlet



Cylinder head

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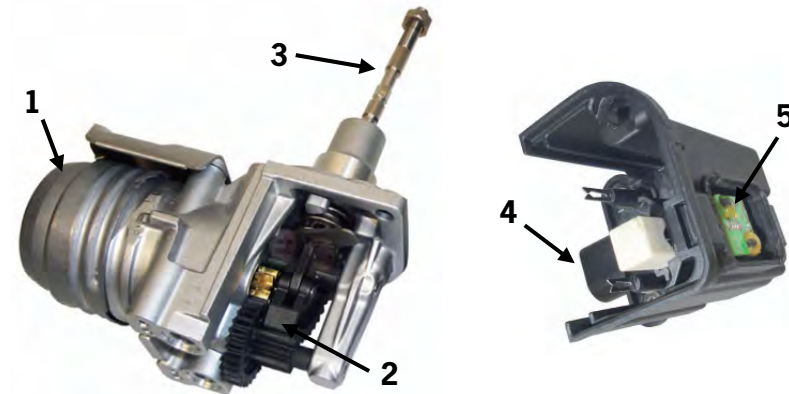
- 1 Assembly flange for turbocharger



* Mono-scroll: A single channel or pathway through the turbine housing for exhaust gasses. This is the standard turbine housing design on most turbos.

** Inconel: A proprietary name for any nickel-based alloys developed by Special Metals Corporation that are resistant to the effects of large amounts of heat.'

- 1 DC motor
- 2 Gear unit
- 3 Wastegate actuating lever with tolerance compensation element
- 4 Electrical connection (DME)
- 5 Position sensor for boost pressure adjuster



Electric boost pressure adjuster

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Cover of electric boost pressure adjuster

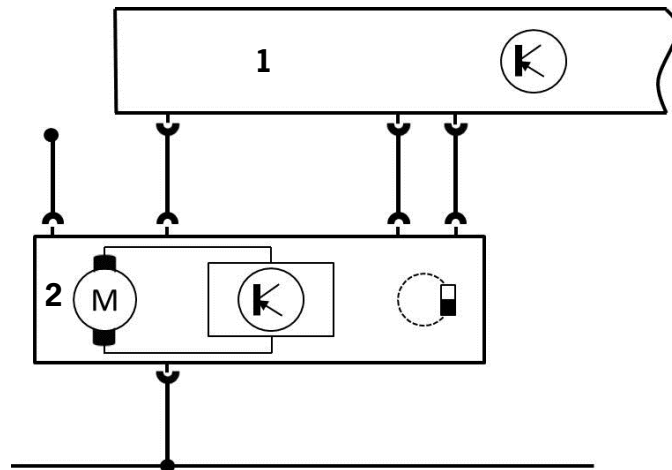
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The electric boost pressure adjuster consists of a DC motor, the gear unit, the actuating lever with tolerance compensation element and the integrated, proximity position sensor for the boost pressure adjuster.

- 1 DME control unit
- 2 Electric boost pressure adjuster with integrated position sensor for the boost pressure adjuster



After replacement of the electric boost pressure adjuster, the wastegate valve can be adjusted by means of the length-adjustable actuating lever.



Wiring diagram of electric boost pressure adjuster

2_16_13

The electric boost pressure adjuster is activated directly by the DME control unit.

Mixture formation

Camshaft adjuster

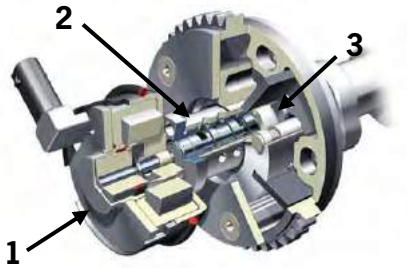
In the Porsche Macan engine, camshaft adjusters are used on both the intake and exhaust camshafts.



Camshaft adjuster

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Vane adjusters (INA system) are used which are activated via 4/3-way central valves in the camshafts.

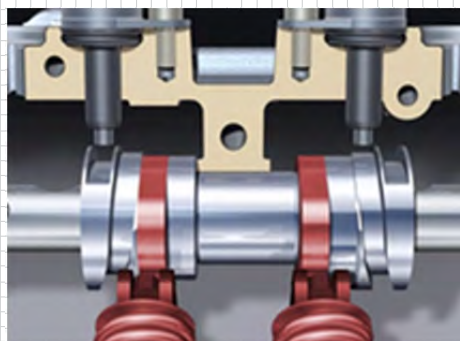


Camshaft adjuster, sectional view

2_18_13

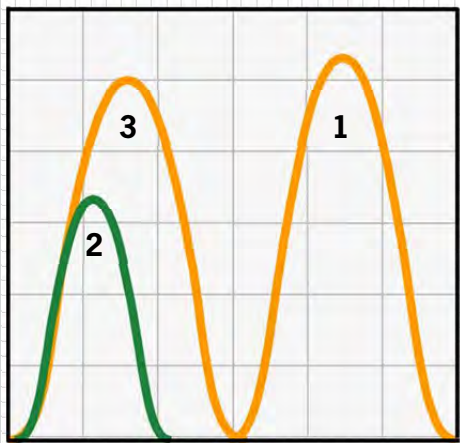
- 1 Camshaft adjuster for intake camshaft
- 2 Camshaft adjuster for exhaust camshaft

- 1 Solenoid actuator
- 2 4/3-way central valve
- 3 Vane adjuster



Valve lift adjustment

2_19_13



Valve lifting curves

2_20_13

- 1 Intake valve lift
- 2 Exhaust valve lift, small
- 3 Exhaust valve lift, large



Camshaft adjuster, sectional view

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The central valves are actuated by way of solenoid actuators fitted in the chain box cover.

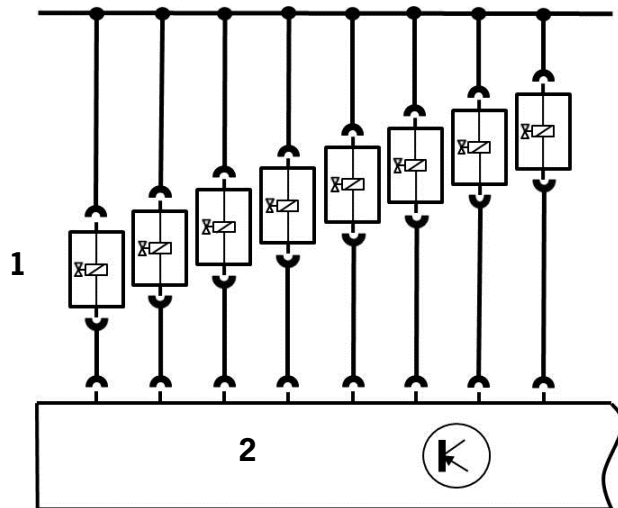
Adjustment ranges

Intake camshaft adjustment range	° crank angle	30
Exhaust camshaft adjustment range	° crank angle	15

Valve lift adjustment

Two-stage valve lift adjustment is used on the exhaust side. The adjustable valve opening cross-section means that it is possible to positively influence the flow rate of the exhaust gases and therefore also the responsiveness of the turbocharger. The exhaust valves are only partially opened at low engine speeds and with a correspondingly low flow rate. The exhaust gases are accelerated by the restricted valve opening cross-section and strike the turbine wheel of the turbocharger at higher speed. The turbine wheel is thus accelerated more strongly. At high engine speeds, a narrower valve cross-section would lead to throttling losses, since the charge cycle in the combustion chamber then cannot take place quickly enough. The valves are therefore actuated with maximum lift at increasing engine speeds. Switchover is performed by the DME imperceptibly for the driver based on a map. Further information on the valve lift adjustment function can be found in Chapter 1 "Porsche Macan engine, cylinder head, valves, valve lift adjustment".

Activation/position detection for valve lift adjustment

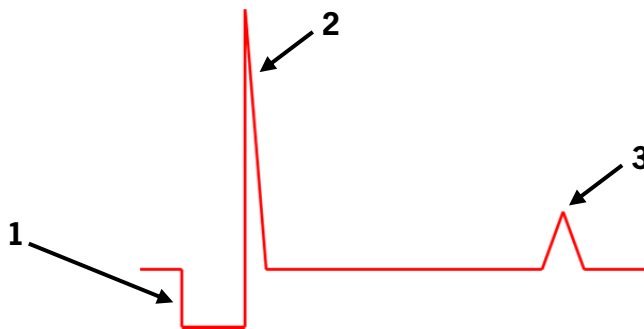


Wiring diagram for valve lift adjustment

2_21_13

The DME control unit directly controls the solenoid actuating elements for valve lift adjustment. Since valve lift adjustment influences the resultant emission values, it is necessary to monitor the adjustment position and successful adjustment in accordance with the emissions legislation that applies in many of the target markets.

The DME uses the voltage characteristic at the solenoid actuating element for position detection, since an induced voltage is produced at the solenoid coil by mechanical resetting.



Voltage characteristic at the actuating element

2_22_13

Activation is repeated if no mechanical resetting is detected. If there is again no feedback, all valve lift adjustments that have been performed up to this point are reset. An entry is made in the fault memory and a warning is displayed in the instrument cluster.

DME engine electronics

2

- 1 Actuating elements for valve lift adjustment 1-8
- 2 DME control unit

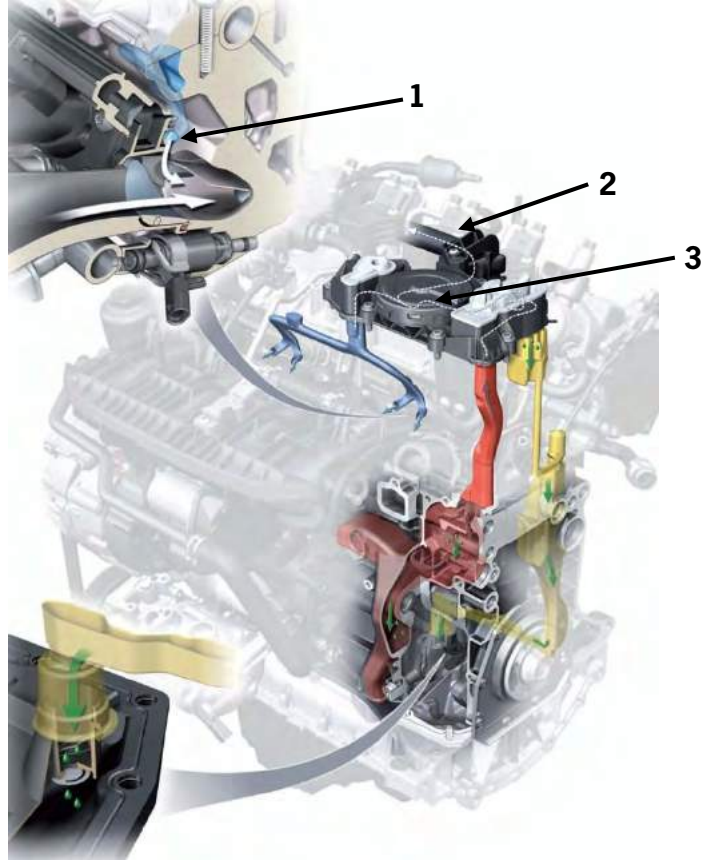
- 1 Activation by the DME control unit
- 2 Induced voltage during activation
- 3 Induced voltage during resetting



Fault diagnosis of valve lift adjustment is performed using the PIWIS II Tester.

cardiagn.com

- 1 Input/intake of cleaned blow-by gases in intake operation
- 2 Input/intake of cleaned blow-by gases in boost operation
- 3 One-stage pressure-regulating valve



Crankcase ventilation

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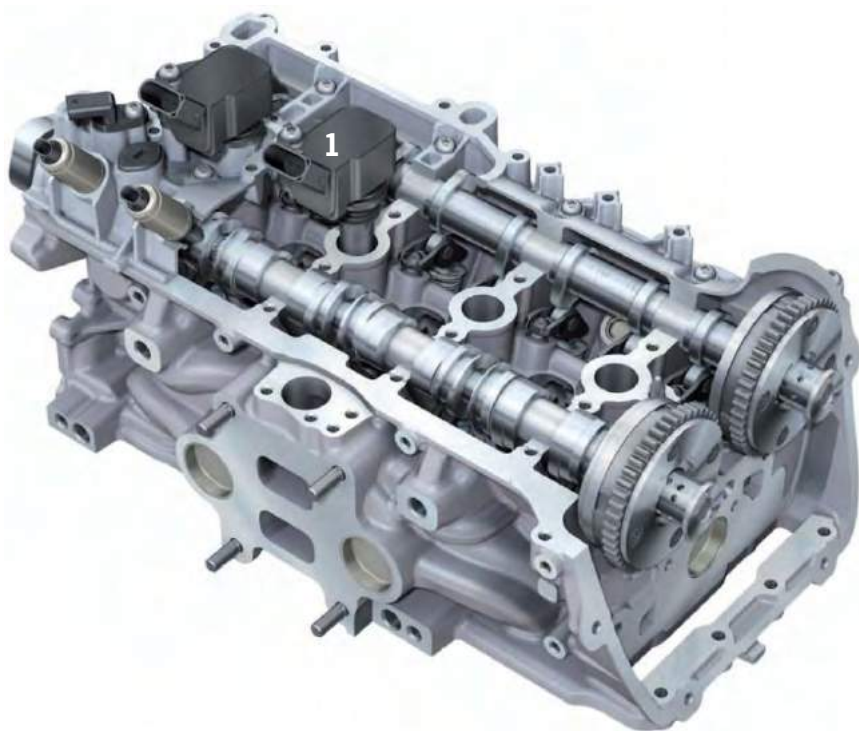
The fine oil separator module contains the one-stage pressure-regulating valve, which controls the blow-by gas flow. In suction operation, the gases are supplied directly into the intake manifold immediately in front of the intake valves. In boost operation, the blow-by gases are routed into the turbocharger via a separate hose line.

Further information on crankcase ventilation can be found in Chapter 1, "Porsche Macan engine, crankcase, crankcase ventilation".

Ignition system

Single-spark ignition coils

The Macan 2.0 I engine has 4 individual ignition coils with integrated driver (1).



Position of the ignition coil

2_13_13

Spark plugs

The country-specific change intervals for the spark plugs, plug type, heat rating and tightening torques can be found in the PIWIS information system/maintenance schedule.

Knock sensor

The knock sensor for detection of combustion knocking is located on the engine block.

Exhaust system/emission control

Integrated exhaust manifold

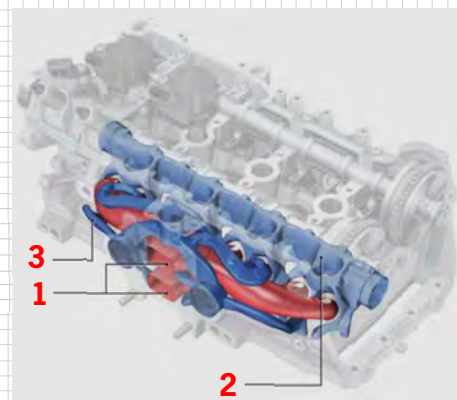
The exhaust manifold (1) integrated in the cylinder head lowers the temperature at the turbocharger. This way that it is largely possible to dispense with cooling full-load enrichment at high engine speeds. At the same time, the coolant (2) is heated up faster, which means that the engine reaches its operating temperature more quickly. The exhaust manifold is surrounded by coolant ducts (3) in the cylinder head in order to ensure uniform and fast heat transfer to the coolant.

Macan

DME engine electronics



The safety instructions and specifications in the PIWIS information system, Group 2, must be observed when working on the ignition system.



Integrated exhaust manifold

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Tailpipe cover for Macan 2.0 I

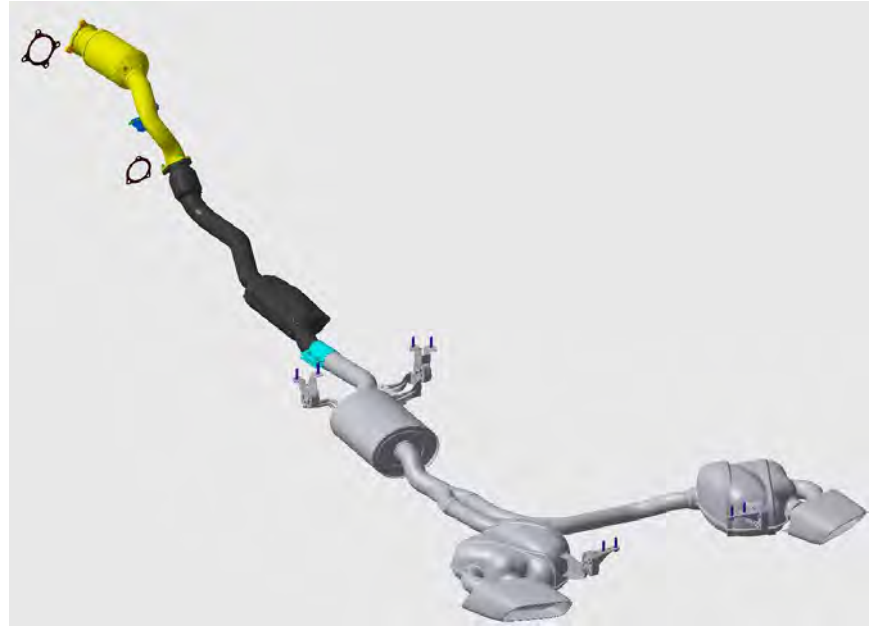
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Catalytic converter for emission control

The catalytic converter is flanged on downstream of the turbocharger mounted on the cylinder head. The broadband oxygen sensor (LSU) for mixture control is installed upstream of the catalytic converter in the exhaust duct of the turbocharger. The step-change oxygen sensor (LSF) for catalytic converter monitoring is located downstream of the catalytic converter.

Exhaust system

The figures shows exhaust gas routing in the 2.0 I Macan from the catalytic converter up to the rear mufflers.



Exhaust system of Macan 2.0 I

2_26_13

The exhaust system is realized with a single-branch design in the front area and has two branches ahead of the rear mufflers. The exhaust tailpipe covers of the Macan 2.0 I have a unique design.

Thermal management

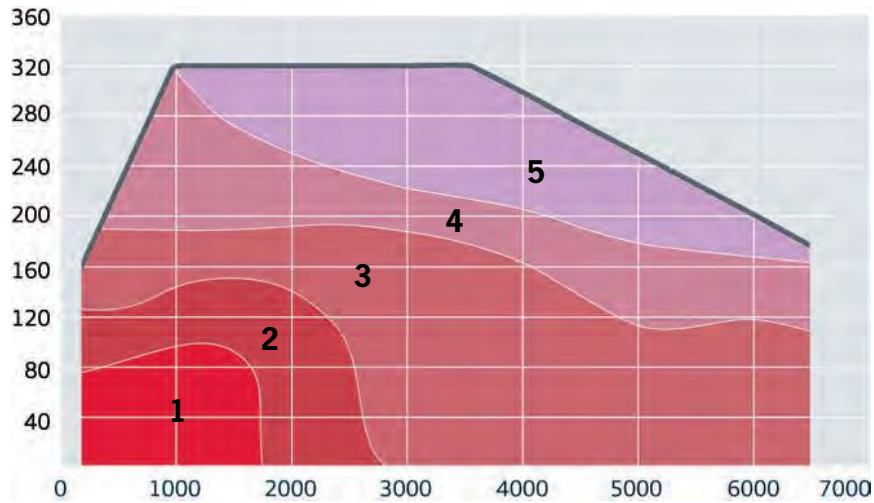
Thermal management plays a major part in improving the efficiency of combustion engines. It is necessary to distinguish here between:

- a demand-optimized operating temperature and
- a sensible distribution of the thermal energy.

The thermal management system of the Porsche Macan performs both of these tasks. A demand-optimized operating temperature makes it possible to reduce internal friction by increasing the operating temperature in the lower and middle engine speed and load ranges.

In addition, the limited thermal energy that is available during the warm-up phase in particular is sensibly distributed, i.e. to the locations with the highest need. Further information on the design of the individual components of the thermal management system can be found in Chapter 1 "Porsche Macan engine, cooling".

Overview of engine operating temperatures



Engine temperature as a function of engine speed and load

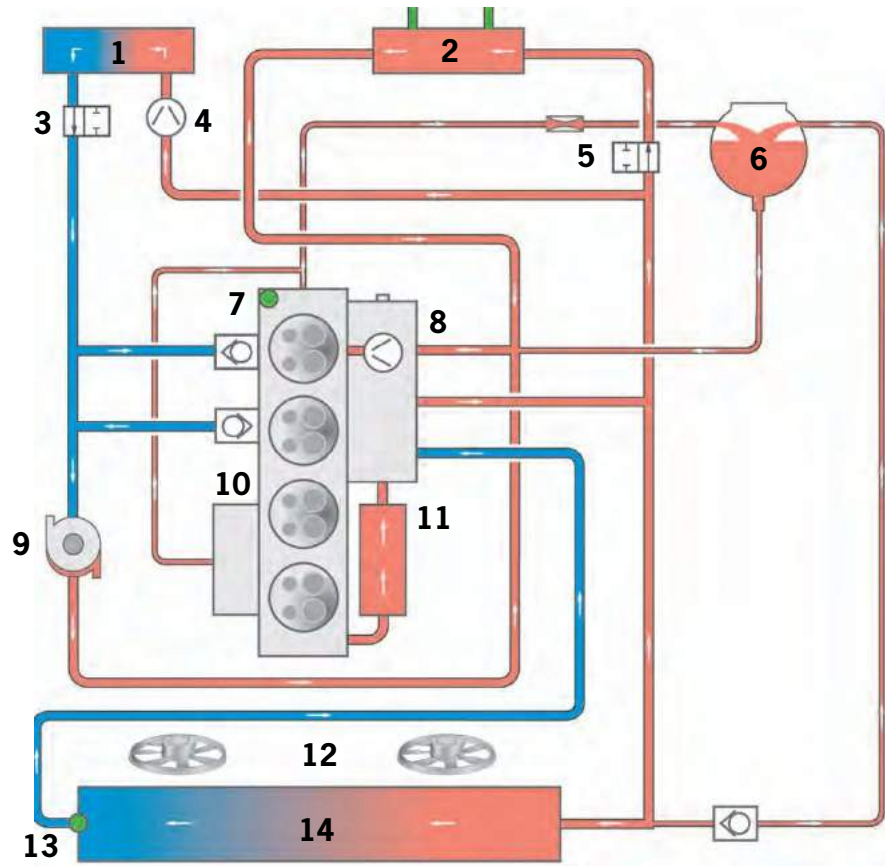
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DME engine electronics

2

- 1 Heating heat exchanger
- 2 Oil-water heat exchanger PDK
- 3 Heating system coolant shut-off valve
- 4 Pump for coolant circulation
- 5 Coolant shut-off valve PDK
- 6 Coolant expansion tank
- 7 Engine coolant temperature sensor
- 8 Coolant pump with actuating element for engine temperature control
- 9 Turbocharger
- 10 Integrated exhaust manifold
- 11 Engine oil-water heat exchanger
- 12 Radiator fan (2)
- 13 Coolant temperature sensor, radiator outlet
- 14 Radiator

Overview of thermal management



Cooling system

2_28_13

The DME control unit monitors thermal management of the cooling system. For this purpose, it activates the following components of the cooling system directly:

- actuating element for engine temperature control
- coolant shut-off valve PDK

In addition, it communicates via CAN bus with the A/C control unit in order to initiate activation of the:

- heating system coolant shut-off valve and the
- pump for coolant circulation

Operating phases

The actuating element for engine temperature control is the central component for temperature control and energy distribution.

Warm-up



Heating

2_29_13

Installation position of actuating element
for engine temperature control

2_30_13

For engine warm-up, rotary slide 1 closes the connections of the oil-water heat exchanger and radiator return line. Rotary slide 2 closes the engine water inlet. The heating coolant shut-off valve is closed and the pump for coolant circulation is not activated. No coolant circulation takes place through the cylinder block "standing coolant"). A coolant temperature of up to 194° F (90° C) is achieved depending on the engine load and speed.

Heating request

If there is a heating request, the heating coolant shut-off valve and the pump for coolant circulation are activated. Coolant flows through the cylinder head, turbocharger and heating heat exchanger.



Heating system

2_31_13

Low coolant volume flow

Low coolant flow

2_31_13



Pump for coolant circulation

2_33_13



Connected oil-water heat exchanger

2_32_13

Rotary slide 2 is opened slightly in order to protect the cylinder head with integrated exhaust manifold and the turbocharger from overheating when the coolant in the engine is stationary. As a result, a quantity of coolant flows through the cylinder block into the cylinder head, through the turbocharger and back via the rotary slide module to the water pump. If required, coolant flows to the heating heat exchanger via the heating coolant shut-off valve. The pump for coolant circulation is activated only in the event of a "heating request".

Connection of oil-water heat exchanger

The coolant supply to the oil-water heating exchanger is opened during the further course of the engine warm-up phase. Parallel to this, rotary slide 2 gradually opens further and the coolant flow through the cylinder block increases. The engine oil is additionally heated up by targeted connection of the engine oil cooler.

Temperature control via radiator

Part-load range

2_34_13

Full-load range

2_32_13

In order to control the coolant temperature as a function of engine speed and load when the engine is warm, the coolant return line from the radiator is steplessly opened and closed via rotary slide 1. This makes it possible to regulate coolant temperatures between 185° F (85° C) in the full-load range and 225° F (107° C) in the lower part-load range.

After-run function with engine switched off

After-run function

2_35_13

Pump for coolant circulation

2_33_13

In order to avoid boiling of the coolant at the cylinder head or turbocharger when the engine is switched off, the after-run function is started after a map request. This function is active for up to 15 minutes after the engine is switched off. The after-run function includes coolant temperature control. In the case of a low coolant setpoint temperature, the coolant return line is opened fully and the connection to the crankcase is closed by means of rotary slide 2. The pump for coolant circulation and the heating coolant shut-off valve are activated.

The coolant flows via the cylinder head to the pump for coolant circulation and a second partial flow flows via the turbocharger through the rotary slide and then through the radiator back to the pump for coolant circulation. There is no flow through the cylinder crankcase in the after-run setting, therefore avoiding excessive heat loss and fast cooling down of the engine.

Effects in the event of a fault

In the event of failure of the rotary angle sensor, the rotary slides are opened to maximum position. In the event of a faulty DC motor or jammed rotary slides, engine speed and torque limitation is activated, the pump for coolant circulation is activated and the heating coolant shut-off valve is opened. If a temperature of 235° F (113° C) is reached in the actuating element for engine temperature control, an expansion element in the rotary slide opens a bypass to the radiator.

A warning appears in the instrument cluster. It is possible to drive on subject to restrictions.

