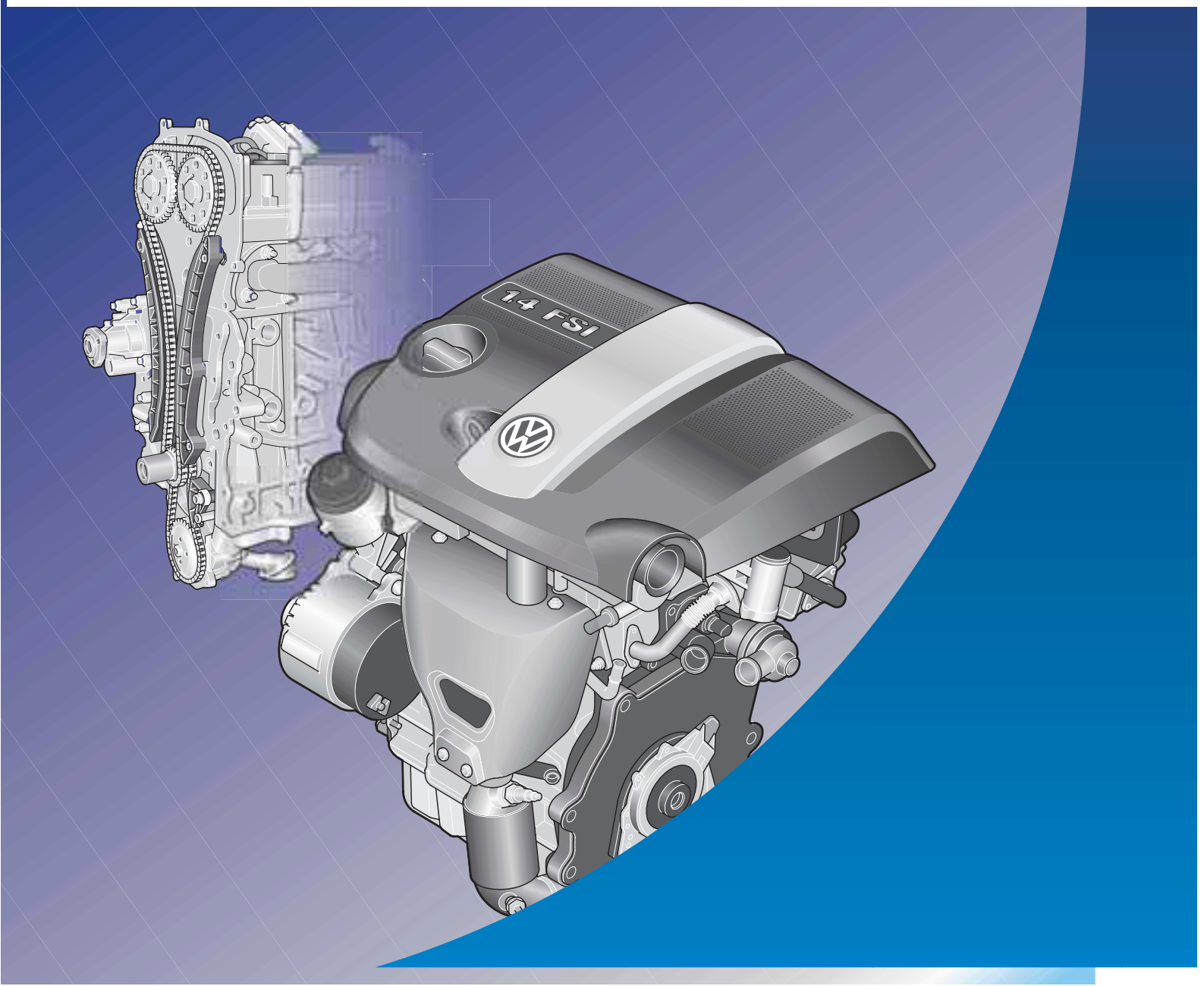
Service.

## Self study programme 296

# The 1.4 ltr. and 1.6 ltr. FSI engine with timing chain

Design and function



For Volkswagen, new and further development of engines with direct petrol injection is an important contribution towards environmental protection.
The frugal, environmentally-friendly and powerful FSI engines are offered in four derivatives for the following vehicles:

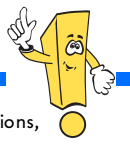
- 1.4 ltr./63 kW FSI engine in the Polo
- 1.4 ltr./77 kW FSI engine in the Lupo
- 1.6 ltr./81 kW FSI engine in the Golf/Bora
- 1.6 ltr./85 kW FSI engine in the Touran

S296_008

In this self-study programme you will be shown the design and function of the new engine mechanical and management systems.

Further information about engine management can be found in self-study programme 253 "The petrol direct injection system with Bosch Motronic MED 7".

**NEW**



**Important Note**

**The self-study programme shows the design and function of new developments!**
**The contents will not be updated.**

For current testing, adjustment and repair instructions, refer to the relevant service literature.

# Contents

# Introduction

Both engines are basically the same, in that they consist of cylinder block and cylinder head, camshaft drive, control housing, oil pump and ancillaries.

The significant differences of the 1.6 ltr. FSI engine are the greater stroke, variable valve timing and further developed operating condition "double injection".

S296_011

S296_051

## Technical properties

**Engine mechanics**

- Engine cover with air cleaner and hot air control
- Intake manifold upper part made of plastic
- Camshaft driven by chain
- Continually variable valve timing *)
- Oil cooler *)
- Regulated Duocentric oil pump
- Dual circuit cooling system
- Cross flow cooling in cylinder head
- Crankcase breather system

**Engine management**

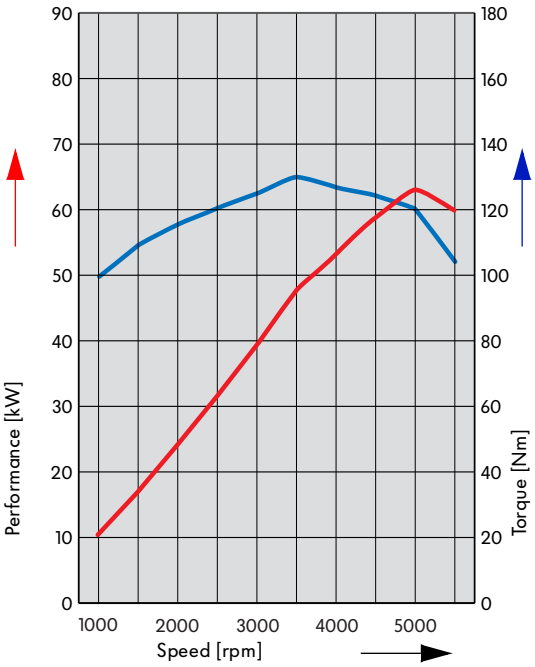
- Petrol direct injection with double injection
- Engine control unit with integrated ambient air pressure sender
- Intake air temperature sender in engine cover
- Supply on demand fuel system
- Single spark ignition coil
- Exhaust gas treatment with $NO_x$ storage catalyst and $NO_x$ sender
- Integrated radiator and fan control

*) 1.6 ltr./85 kW FSI engine only

The regulated Duocentric oil pump, the dual circuit cooling system and the supply on demand fuel system are new technologies that will also be used in other vehicles in the future.

# Technical data

**1.4 ltr./63 kW FSI engine**

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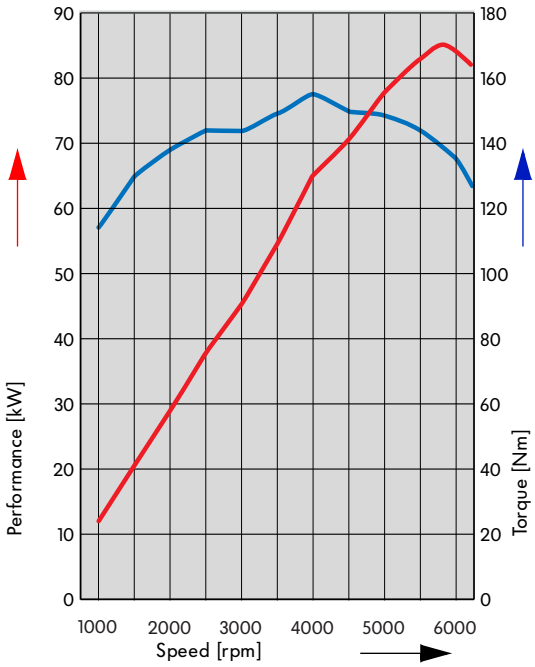
**1.6 ltr./85 kW FSI engine**

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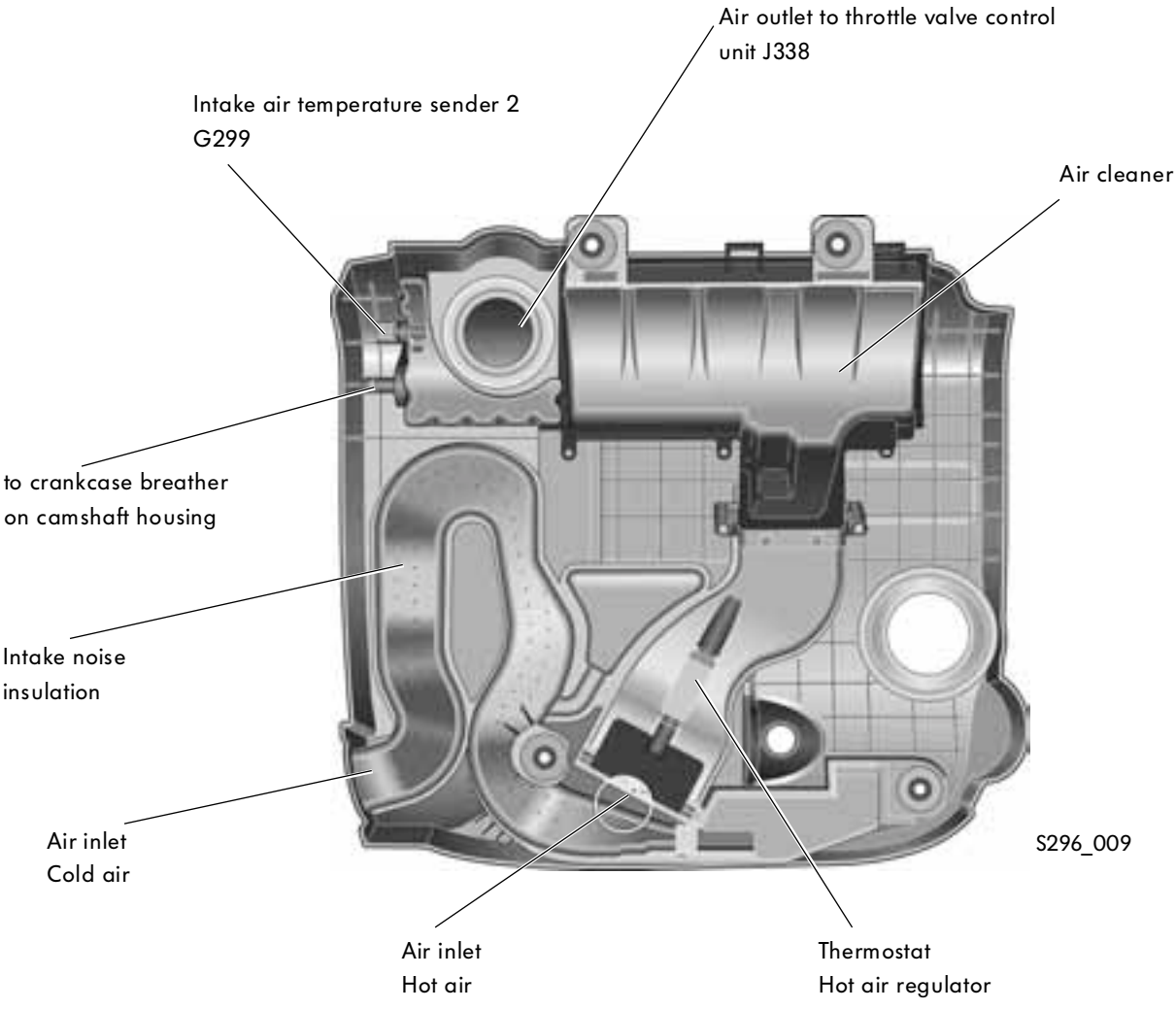
| Engine codes | AUX | BAG |
|---|---|---|
| Displacement | 1390 | 1598 |
| Type | 4-cylinder in-line engine | 4-cylinder in-line engine |
| Valves per cylinder | 4 | 4 |
| Bore | 76.5 mm | 76.5 mm |
| Stroke | 75.6 mm | 86.9 mm |
| Compression ratio | 12:1 | 12:1 |
| Maximum output | 63 kW at 5000 rpm | 85 kW at 5800 rpm |
| Maximum torque | 130 Nm at 3500 rpm | 155 Nm at 4000 rpm |
| Engine management | Bosch Motronic MED 7.5.11 | Bosch Motronic MED 9.5.10 |
| Fuel | Super unleaded at RON 98<br>(unleaded at RON 95 with reduction in performance) | |
| Exhaust gas treatment | Three-way catalyst with Lambda control, NOx storage catalytic converter | |
| Emissions standard | EU4 | |

## Engine cover

Integrated in the engine cover:

- Air guide to throttle valve control unit
- Hot air regulator
- Intake noise insulation
- Air cleaner
- Intake air temperature sender 2 G299

**Engine cover, underside**



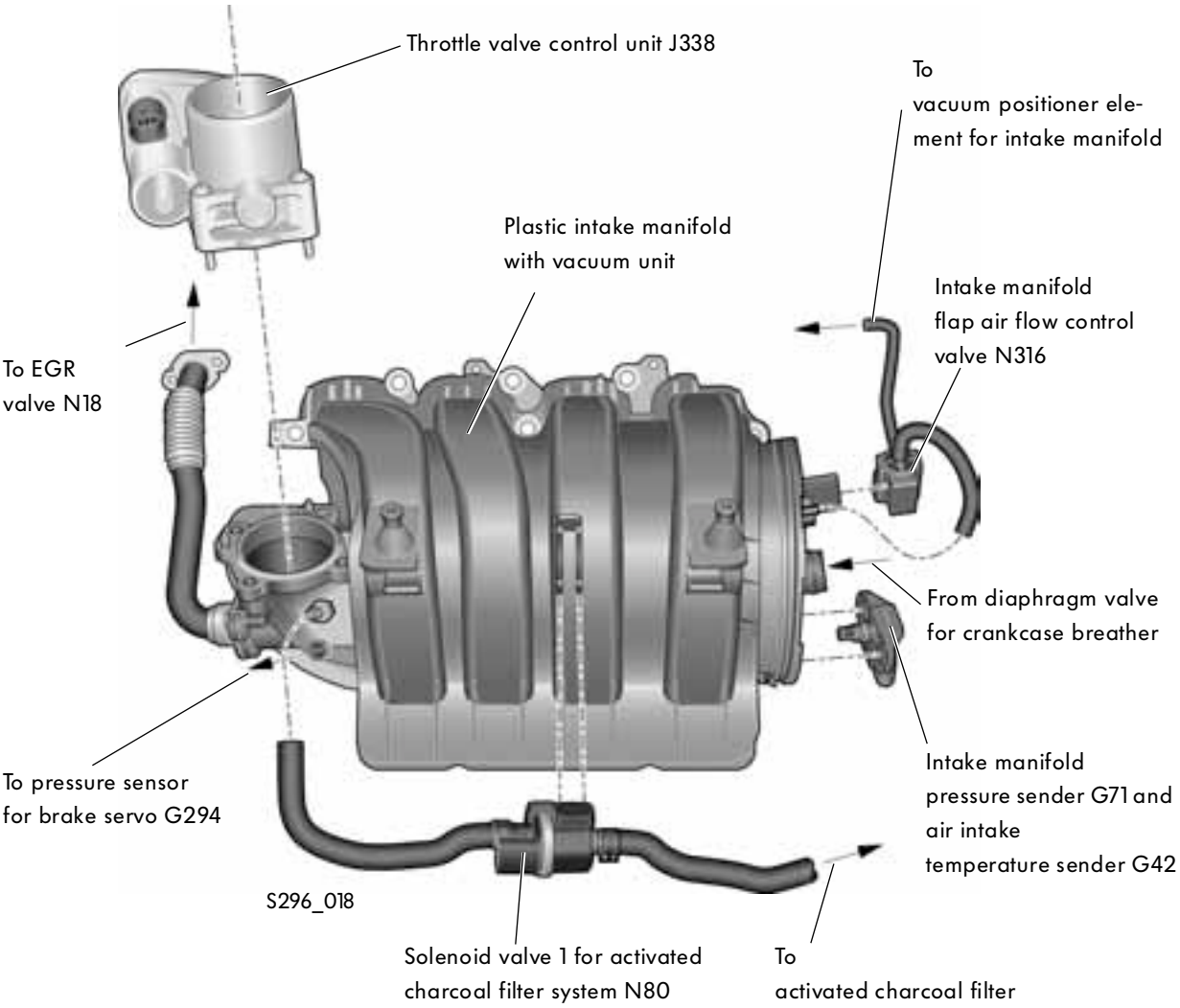
## Intake manifold upper part

The intake manifold upper part is made of plastic.

This has the following advantages:

- Reduction in weight
- Air flow improvement thanks to smoother intake walls

In the intake manifold upper part there is a vacuum unit that assures actuation of the intake manifold flaps even when vacuum pressure is low.

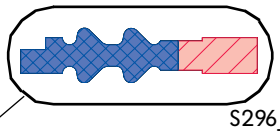


## Control housing seal

The control housing is sealed to the cylinder head and the cylinder block by a bonded rubber gasket. Between the control housing and the oil sump there is a fluid gasket.

**Oil filter housing**
The oil filter housing is integrated in the control housing. This means that there is no requirement for a sealing surface between the cylinder block and the oil filter housing.

**Cross section of bonded rubber gasket**



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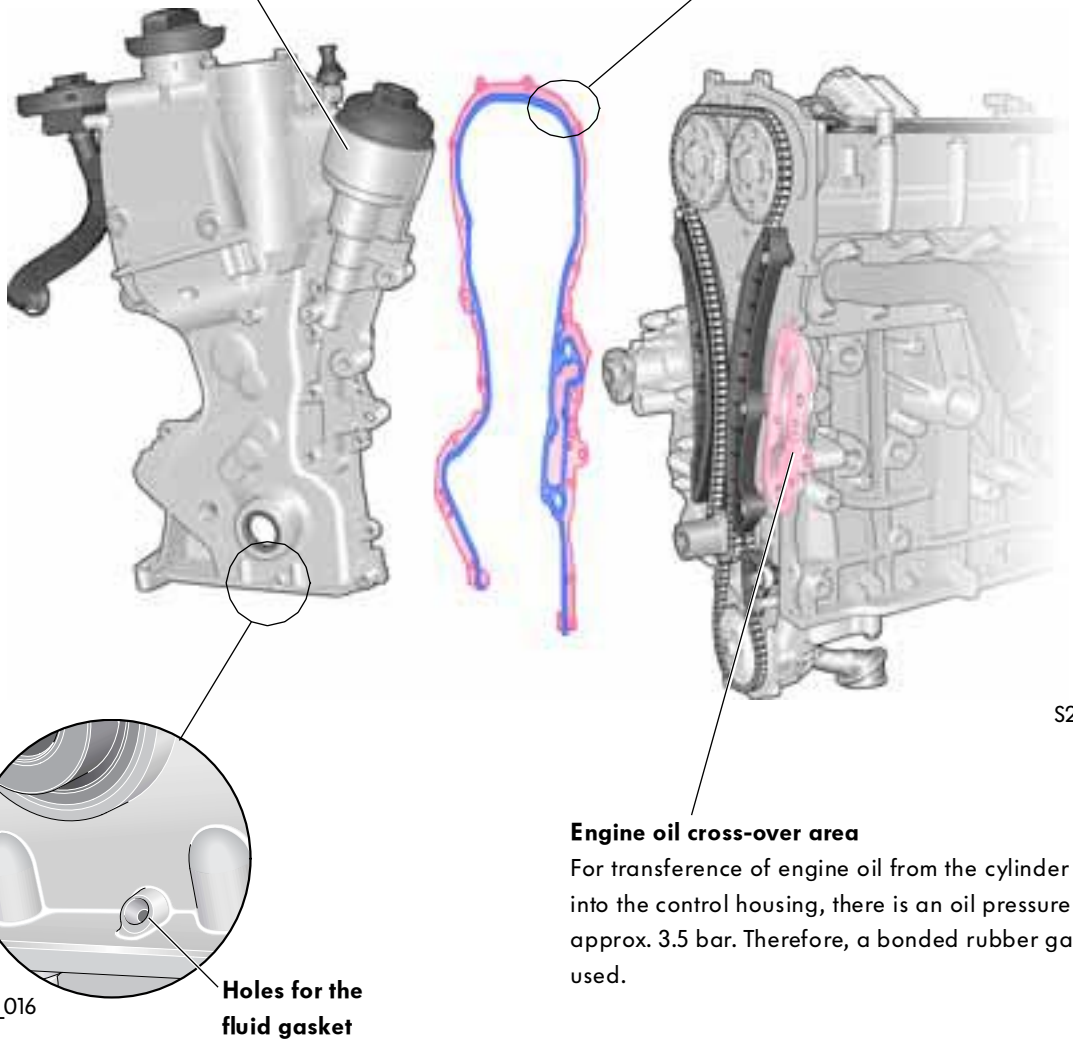

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S296_016

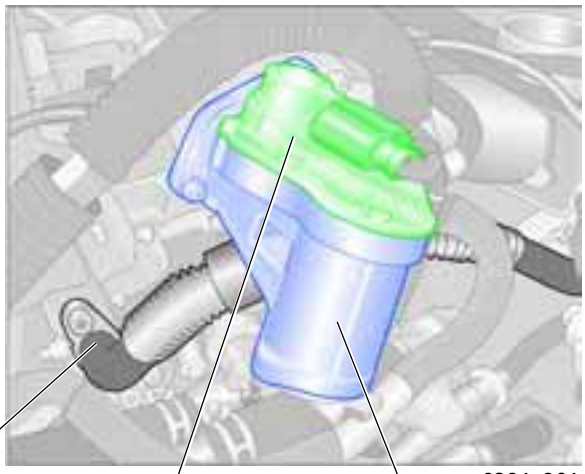
**Holes for the fluid gasket**

**Engine oil cross-over area**
For transference of engine oil from the cylinder block into the control housing, there is an oil pressure of approx. 3.5 bar. Therefore, a bonded rubber gasket is used.

**Fluid gasket**
The seal between the control housing and the oil sump is made by a fluid gasket. This is pressed between the sealing surfaces by means of a special drilling in the control housing.

## Electric exhaust gas recirculation valve

The electric exhaust gas recirculation valve with EGR valve N18 and the potentiometer for exhaust gas recirculation G212 are bolted to the cylinder head.
The valve is designed for treatment of high levels of exhaust gas and draws the exhaust gas directly from the 4th cylinder of the cylinder head.



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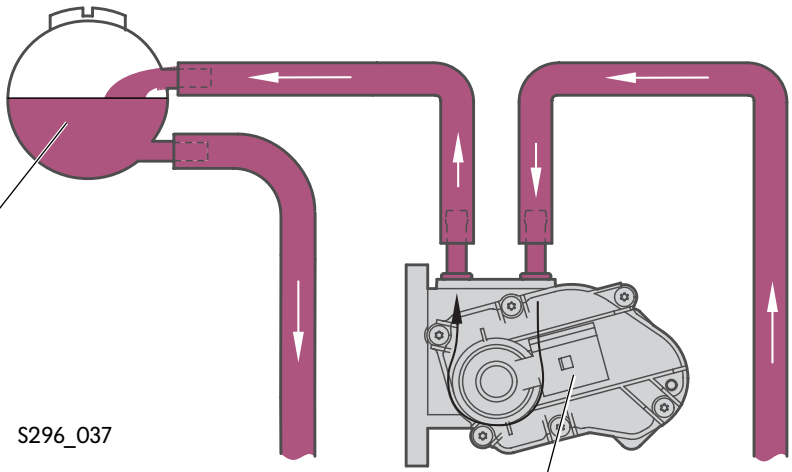
Withdrawal at cylinder no. 4

Potentiometer for exhaust gas recirculation G212

Exhaust gas recirculation valve N18

### Electric exhaust gas recirculation valve in the coolant circuit

Due to the vicinity of the exhaust gas withdrawal point, the exhaust gas recirculation valve is integrated in the coolant circuit of the engine. This allows the exhaust gas recirculation valve to be cooled and protected from excessively high temperatures.



Expansion tank

S296_037

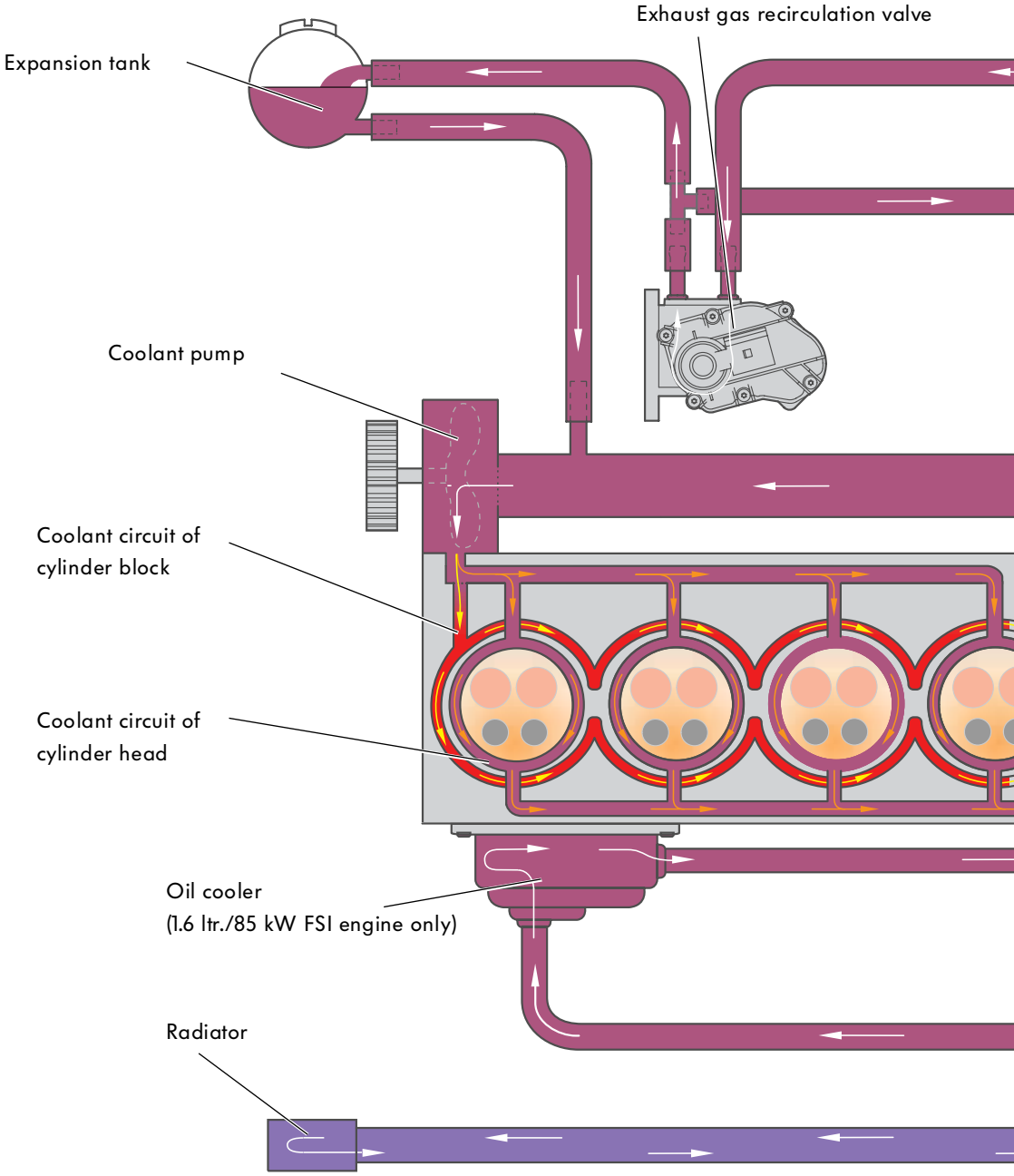
**To coolant pump**

**From radiator**

Exhaust gas recirculation valve

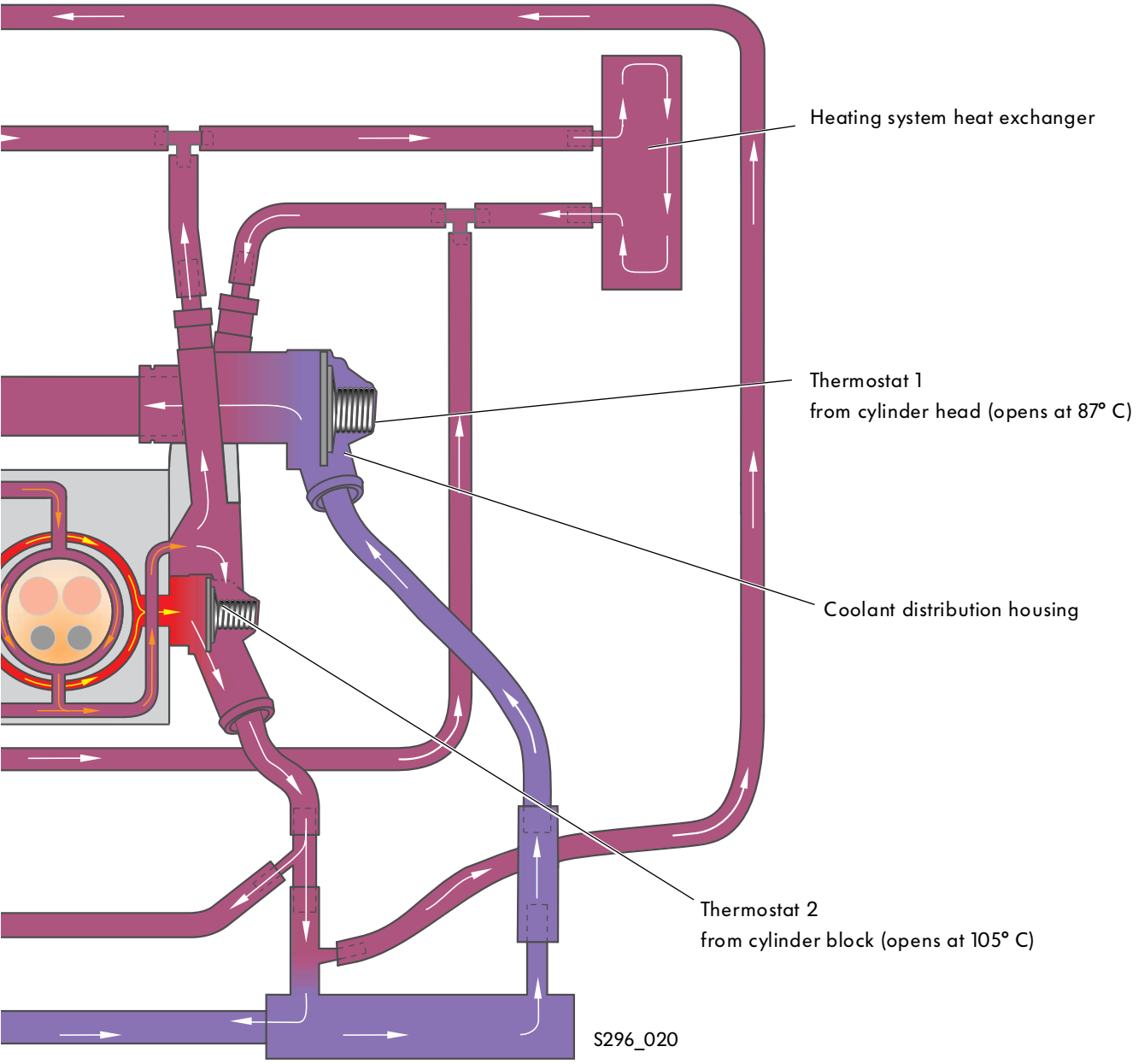
## Cooling system

The cooling system is of a dual circuit design. This system features a separate coolant path, with different temperatures, through the cylinder block and the cylinder head. The coolant flow is controlled by two thermostats in the coolant distribution housing. One for the cylinder block and one for the cylinder head. Furthermore, both engines feature cross flow cooling of the cylinder head.



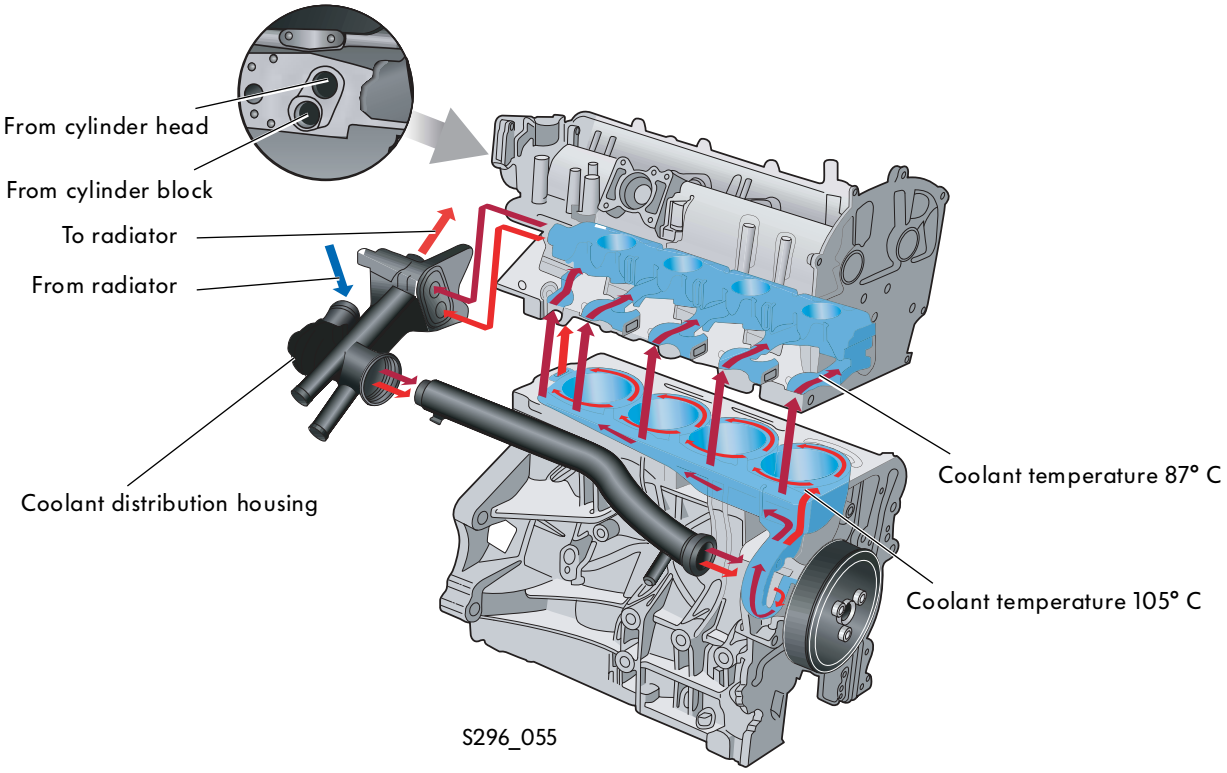
The dual circuit cooling system has the following advantages:

- The cylinder block is heated up faster because the coolant stays in the cylinder block until it reaches 105° C.
- There is less friction in the crankcase drive system due to higher temperatures in the cylinder block.
- There is improved cooling in the combustion chambers thanks to lower temperatures in the cylinder head. This leads to improved filling with less risk of knocking.



## Dual circuit cooling system

The cooling system is split into two circuits in the engine. A third of the coolant in the engine flows to the cylinders and two thirds to the combustion chambers in the cylinder head.

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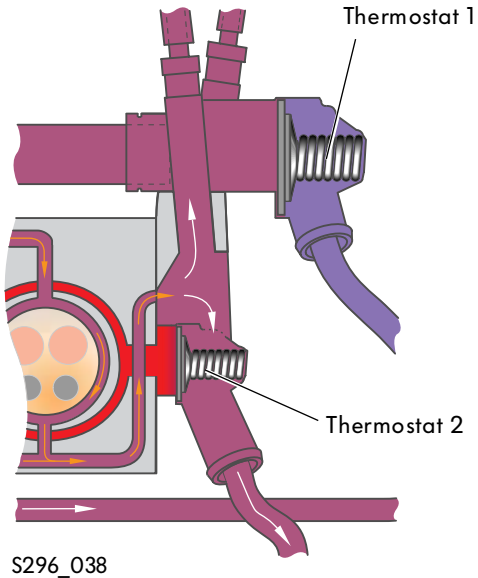
**Position of thermostats up to 87° C:**

Both thermostats are closed, which means the engine is heated up faster.

The coolant flows through the following components:

- **Coolant pump**
- **Cylinder head**
- **Coolant distribution housing**
- **Heating system heat exchanger**
- **Oil cooler (1.6 ltr./85 kW FSI engine only)**
- **Exhaust gas recirculation valve**
- **Expansion tank**

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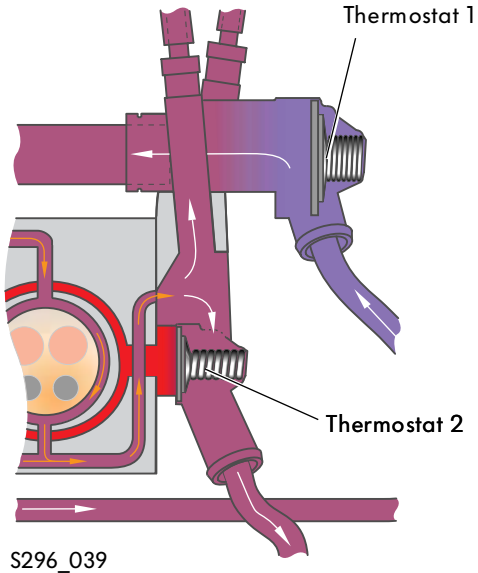
**Position of thermostats from 87° C to 105° C:**

Thermostat 1 is open and thermostat 2 is closed. This regulates the temperature in the cylinder head to 87° C and increases the temperature in the cylinder block further.

The coolant flows through the following components:

- Coolant pump
- Cylinder head
- Coolant distribution housing
- Heating system heat exchanger
- Oil cooler
  (1.6 ltr./85 kW FSI engine only)
- Exhaust gas recirculation valve
- Expansion tank
- **Radiator**



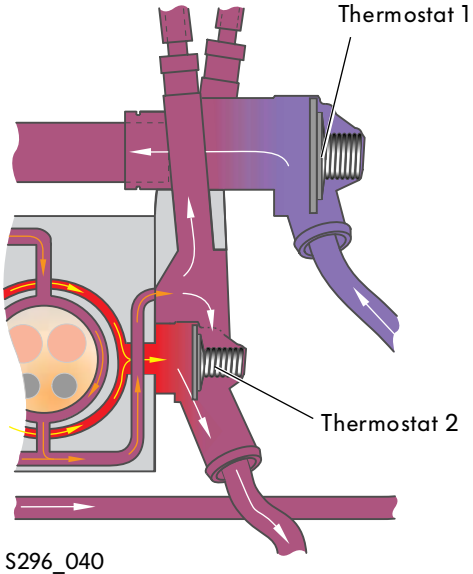
S296_039

**Position of thermostats above 105° C:**

Both thermostats are open. This regulates the temperature in the cylinder head to 87° C and in the cylinder block to 105° C.

The coolant flows through the following components:

- Coolant pump
- Cylinder head
- Coolant distributor
- Heating system heat exchanger
- Oil cooler
  (1.6 ltr./85 kW FSI engine only)
- Exhaust gas recirculation valve
- Expansion tank
- Radiator
- **Cylinder block**



S296_040

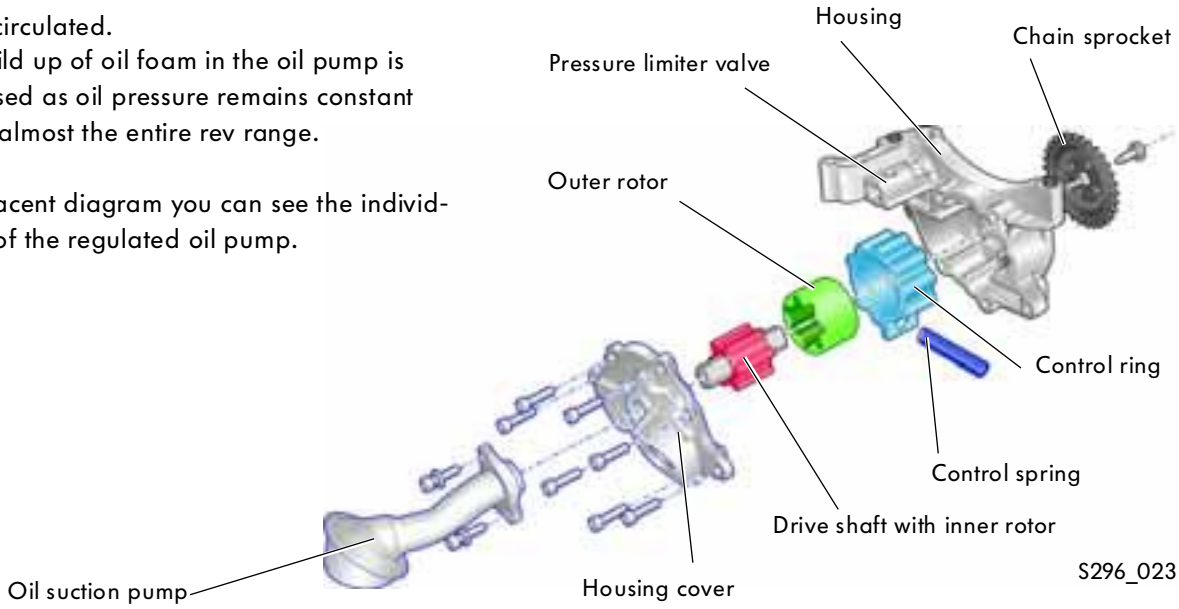
## Regulated Duocentric oil pump

A regulated Duocentric oil pump is installed for the first time. Thanks to this equipment, oil pressure is regulated to approx. 3.5 bar across almost the entire rev range. Regulation is by means of a control ring and control spring.

This provides the following advantages:

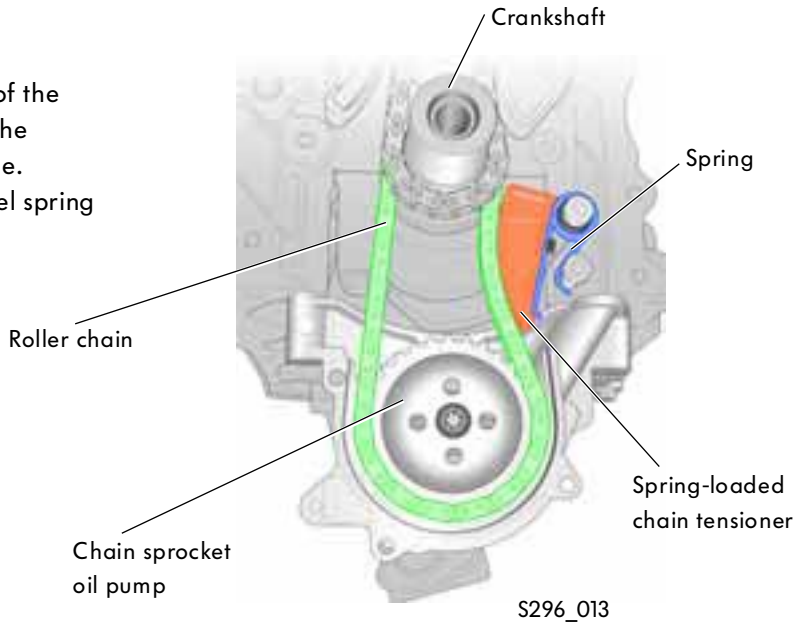
- The drive performance of the oil pump is reduced by up to 30 %.
- Wear in the oil is reduced because less oil is being circulated.
- The build up of oil foam in the oil pump is minimised as oil pressure remains constant across almost the entire rev range.

In the adjacent diagram you can see the individual parts of the regulated oil pump.




### Drive of regulated oil pump

The oil pump is bolted to the underside of the cylinder block and is chain driven from the crankshaft. The chain is maintenance-free.
The chain is tensioned by means of a steel spring on the chain tensioner.



**Principle of oil delivery**

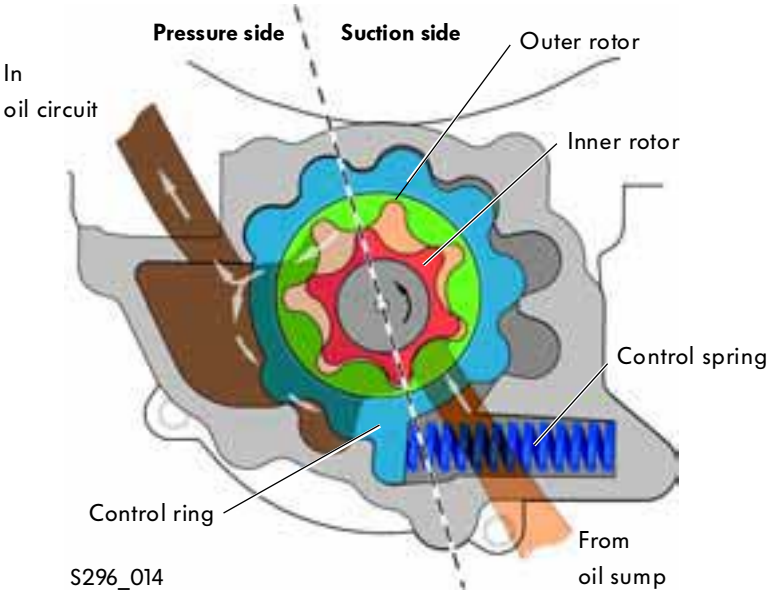
The inner rotor sits on the drive shaft and drives the outer rotor. Due to the different rotating axes of the inner and outer rotors, a larger space is created on the suction side due to the rotating motion. The oil is drawn in and transported to the pressure side. On the pressure side, the space between the teeth becomes smaller again and oil is forced into the oil circuit.

**Regulation of oil pressure**

On the regulated Duocentric oil pump, oil pressure is regulated at 3.5 bar in the amount of oil delivered.

**Oil pressure below 3.5 bar**

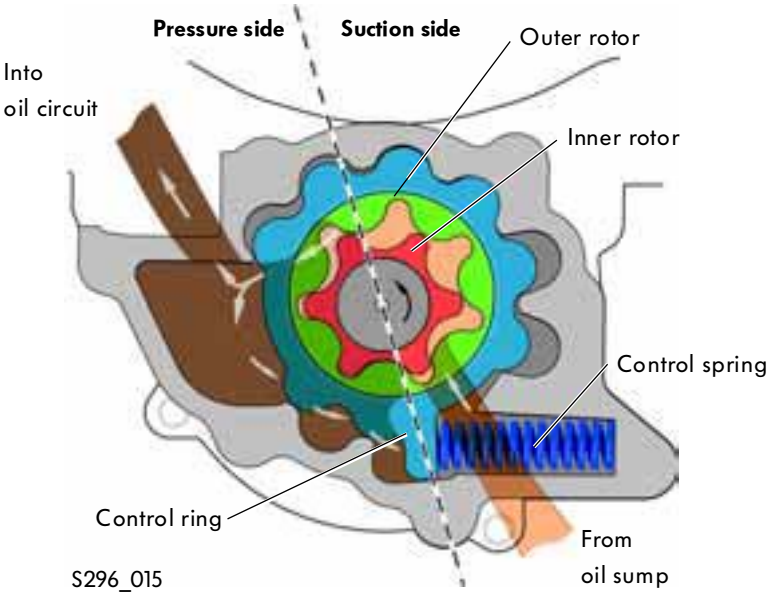
The control spring forces the control ring against the oil pressure (arrows). The control ring also causes the outer rotor to turn and an increase in space between inner and outer rotors is the result. This means that more oil is transported from the suction side to the pressure side and forced into the oil circuit. With a greater amount of oil, there is also greater oil pressure.



S296_014

**Oil pressure above 3.5 bar**

The oil pressure (arrows) forces the control ring against the control spring.
The outer rotor is also turned in the direction of the arrow and a decrease in space between the inner and outer rotors is the result. This means that less oil is transported from the suction side to the pressure side and forced into the oil circuit. With a reduced amount of oil, there is less oil pressure.



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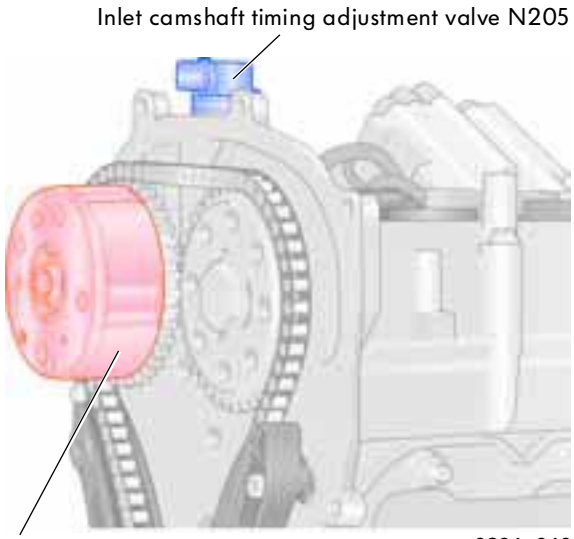
## Variable valve timing (1.6 ltr./85 kW FSI engine)

The 1.6 ltr./85 kW FSI engine has variable inlet valve timing. Adjustment of the camshaft is load and speed dependent and comes from a vane cell adjuster attached directly to the inlet camshaft.

Variable valve timing leads to:

- very effective inner exhaust gas recirculation, whereby combustion temperature and nitrogen oxides are reduced, and
- also improved torque development.




The central securing bolt of the vane cell adjuster has a left-handed thread.

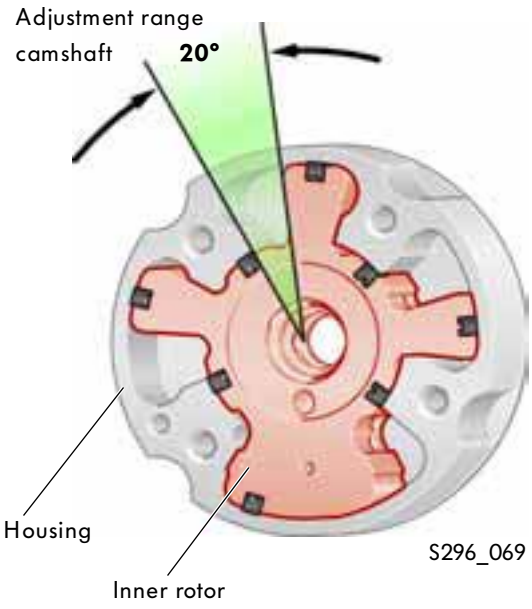
### Vane cell adjuster

The vane cell adjuster is bolted to the timing control side of the inlet camshaft.

The adjustment range covers a maximum 40° crankshaft angle and a 20° camshaft angle, starting from the basic position towards "advanced".

The advantages of the vane cell adjuster as opposed to the camshaft adjuster of the 1.4 ltr./77 kW FSI are:

- Adjustment is possible even at low oil pressures
- It is easier
- It is cheaper




Further information about this principle of variable valve timing can be found in self-study programme number 246 "Variable valve timing with the vane cell adjuster".