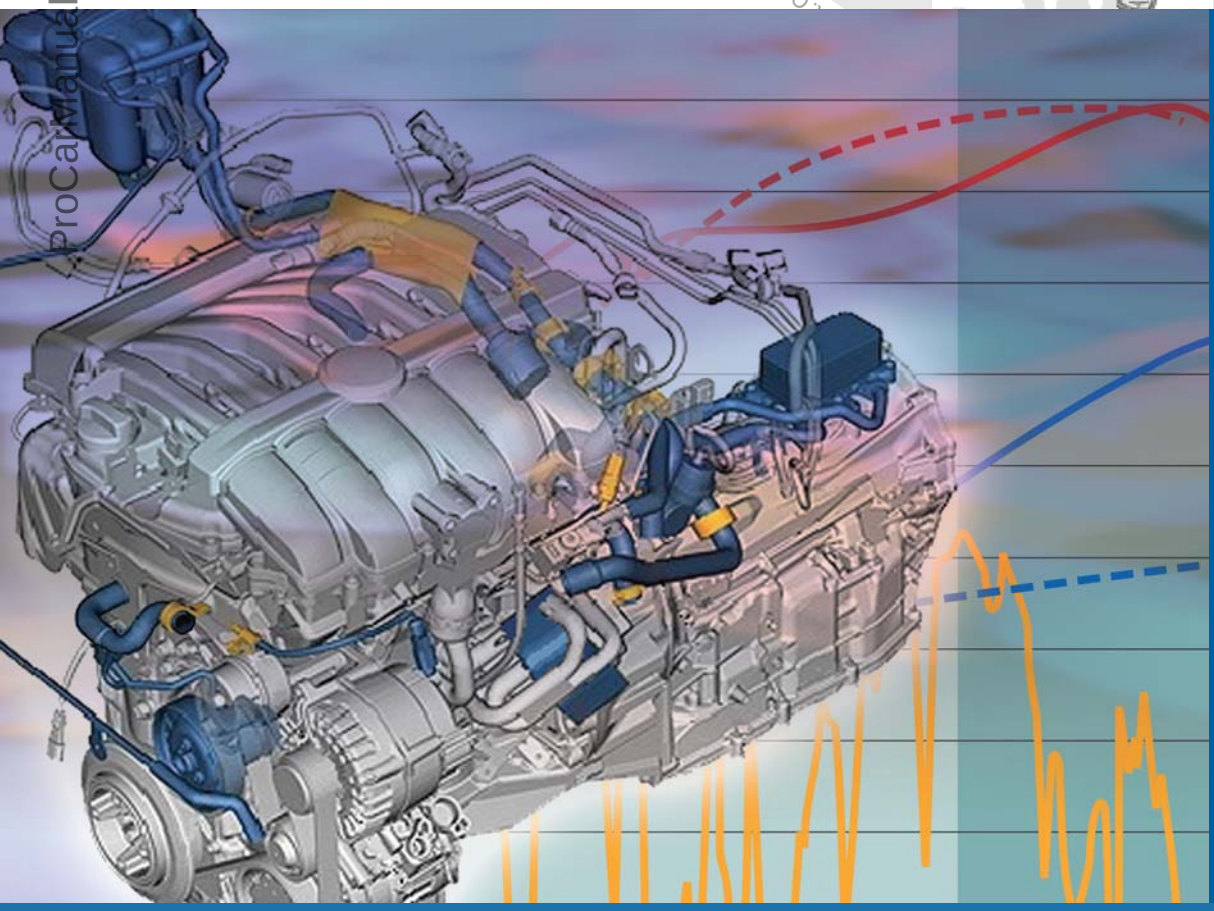
Service Training

Self-study programme 497

Innovative Thermal Management

Design and function



The thermal behaviour of combustion engines has been an issue since the invention of the motor vehicle. On the one hand, the engine together with its fluids needs to be brought up to operating temperature quickly and, on the other, it needs to be cooled once it reaches high operating temperatures. In addition to this, the vehicle occupants require heat. Vehicles need clever thermal management systems to meet these thermal requirements.

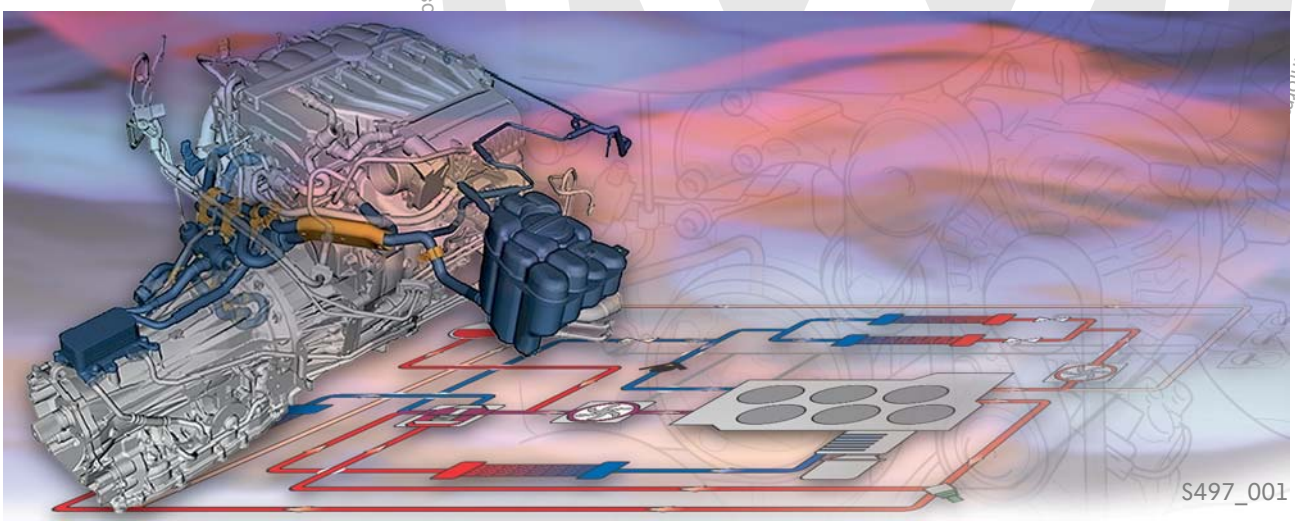
The innovative thermal management system (ITM) is an intelligent cold start and warm-up program for the engine and gearbox. Thanks to the specific control of the coolant flows, it allows the engine and the gearbox to reach their operating temperatures quicker for optimum fuel consumption and also the interior to be heated more quickly.

In brief, the following advantages are achieved thanks to the optimised thermal behaviour:

- fuel consumption reduced by up to 0.3l per 100km
- interior is heated more quickly
- engine warms up more quickly
- gearbox warms up more quickly

In the first development stage, the ITM was already used in the Touareg Hybrid and is described in self-study programme no. 452. It is also used in the 4.2l V8 TDI engine. Further information on the ITM in this engine can be found in self-study programme no. 467.

The ITM is used to its maximum in the 3.6l V6 FSI engine (engine code CGRA) and will be explained in more detail in this self-study programme.



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

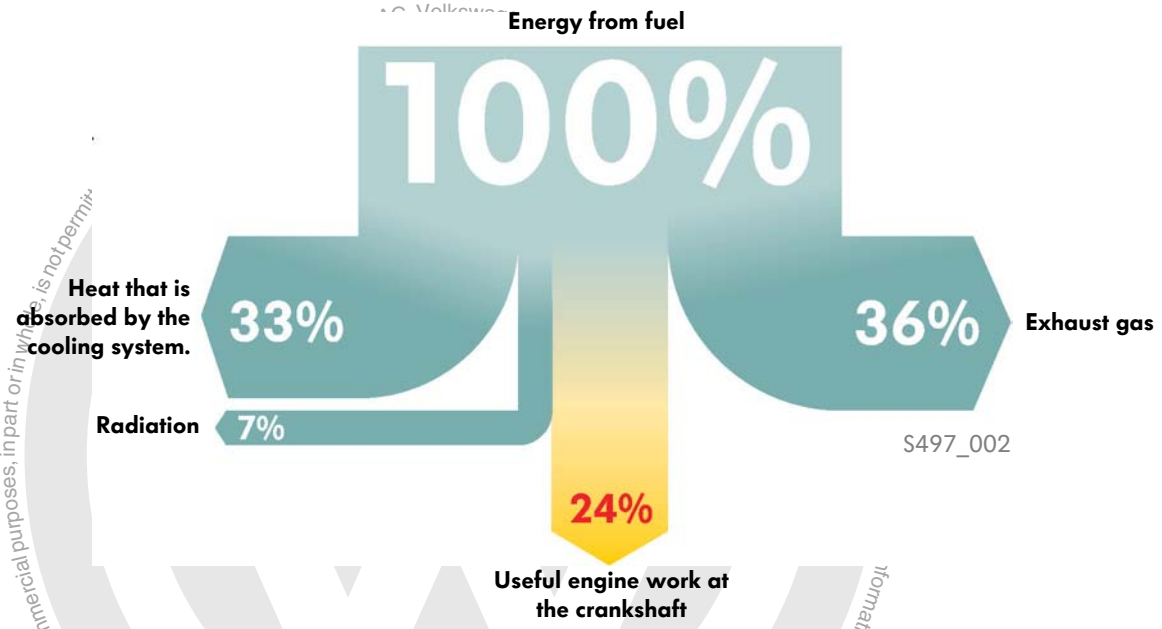
For current testing, adjustment and repair instructions, refer to the relevant

Important Note

Contents

Cooling system

While an internal combustion engine is running, only about one third of the energy released from the fuel is converted into mechanical energy for propelling the vehicle. The other two thirds are released in the form of heat. Of that, around half leaves the engine with the exhaust gases. The remainder (approx. 33%) is absorbed by the engine cooling system and dissipated.



The efficiency of an internal combustion engine is limited by the mechanical friction resistances of the moving parts. In addition, there are losses in the gearbox that make it impossible to use all of the energy provided by the fuel. The engine and gearbox oil reduce the friction considerably, but have the characteristic that they only provide the optimum viscosity for this once they are in a heated state. Also the properties of the materials used like cast and forged iron and aluminium require a certain temperature to reach the optimum operating point.
A cold engine that has just been started with a cold gearbox therefore requires more fuel for the same output than an engine and gearbox at operating temperature.
The cooling system of an internal combustion engine therefore has three tasks:

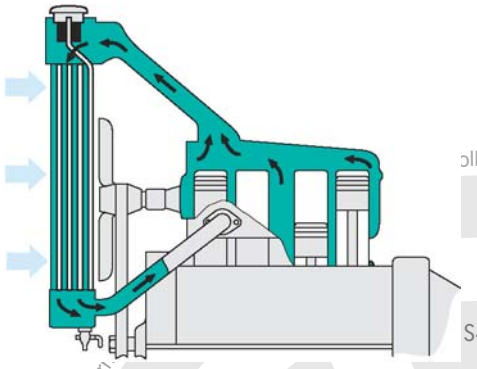
- to absorb the heat produced during combustion and dissipate it into the environment.
- to help the engine warm up.
- to heat the interior.

Cooling the engine - basics

The temperatures (up to 2,000°C) produced when the fuel combusts are harmful for operation of the engine. It is therefore cooled to "operating temperature".

In **air cooling** (by means of airstream or fan), the excess heat is transferred directly to the surrounding air. The cylinders and the cylinder heads are mostly cast from light metal alloys and have cooling fins to improve their heat conductivity.

Thermosyphon cooling -
an automatic circulation cooling system



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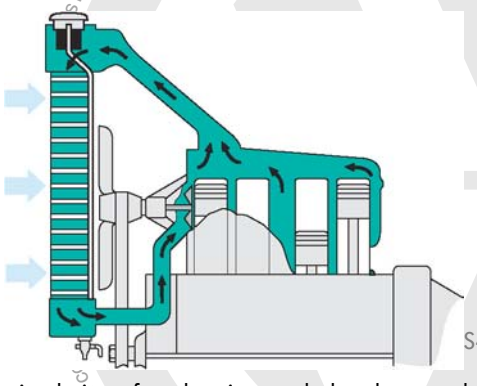
From 1910



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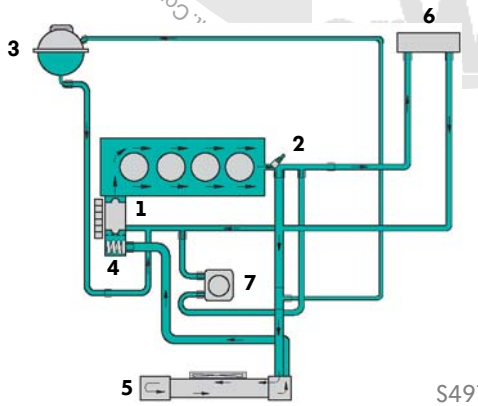
The circulation of coolant is speeded up by a coolant pump.

In **thermosyphon cooling**, the cylinders and cylinder head have double walls. The space between the walls is filled with a liquid, for example, water, and is configured so that a coolant circuit is formed. This thermal circulation cooling system is based on the fact that hot water has a lower density than cold water. The heated water therefore rises inside the cylinder water jacket and colder water flows from below out of the radiator. In later versions, the circulation of coolant was speeded up by a coolant pump. This solution has the following weaknesses:

- long warm-up time
- low engine temperature during the cold seasons
- higher CO_2 emissions

Closed system



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Today's cooling systems are closed systems with the following components:

- Coolant pump (1)
- Temperature sender (2)
- Coolant expansion tank (3)
- Thermostat (4)
- Radiator (5)
- Heat exchanger for heater (6)
- Engine oil cooler (7)

Innovative Thermal Management (ITM)

General information

Thermal management generally refers to the specific control of the flow of heat in the vehicle. Control of the coolant plays a central role. Due to its property as a heat carrier, it can be used not only to absorb heat at a source of heat ("cooling"), but also to dissipate heat again at a heat sink ("heating"). Heat exchangers allow the heat to be transferred.

ITM tasks

The innovative thermal management system has two tasks:

- controlling the flow of heat while the engine is warming up
- cooling the engine once it has reached operating temperature

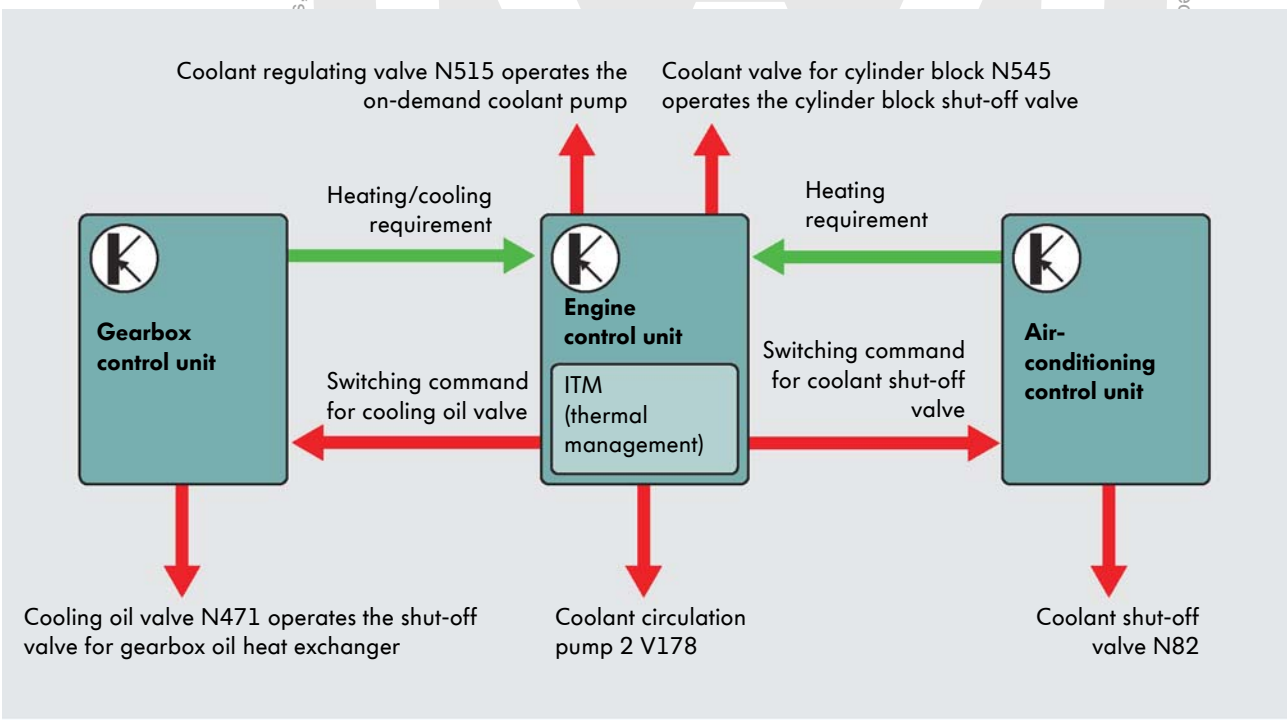
Controlling the flow of heat during warm-up	**Cooling once operating temperature has been reached**
Since many car journeys are shorter than 15 kilometres, an intelligent cold start and warm-up programme is very important. The ITM is intended, above all, to improve the cold start performance. At low outside temperatures in particular, the heat requirement for the engine and gearbox components have to compete with the heat requirement of the interior heating. The ITM takes care of the inadequate heat management. The heat produced during combustion is distributed optimally between the engine and gearbox oil as well as the interior. This allows the engine and gearbox to reach their ideal operating temperature more quickly. The comfort in the passenger cell, i.e. the interior heating output, needs to be balanced against this.	Once the engine has reached its operating temperature, cooling is necessary to prevent the maximum permitted component temperature being exceeded. Protection of components must be ensured. The surplus heat needs to be removed from the vehicle via the cooling components. In heating operation, the ITM supports distribution of the surplus heat.

The innovative thermal management system will be used in further engines.

Networking

The ITM system is a software application in the engine control unit that is also known as the ITM thermal manager. It forms a network between the engine, gearbox and air-conditioning control units along with their sensors and actuators. This newly developed software is used for optimum distribution of the available engine heat while taking the heating and cooling requirements of the interior, engine and gearbox into account.

The air-conditioning and gearbox control units signal their heating requirements to the ITM thermal manager in the engine control unit. The requirements are then weighted together with further input variables, for example, the coolant temperature in the cylinder head and the engine heat requirements calculated by the engine control unit. On the basis of this, the ITM thermal manager then sends commands to the corresponding control units, which then actuate the valves as required. The pumps are activated directly by the engine control unit.



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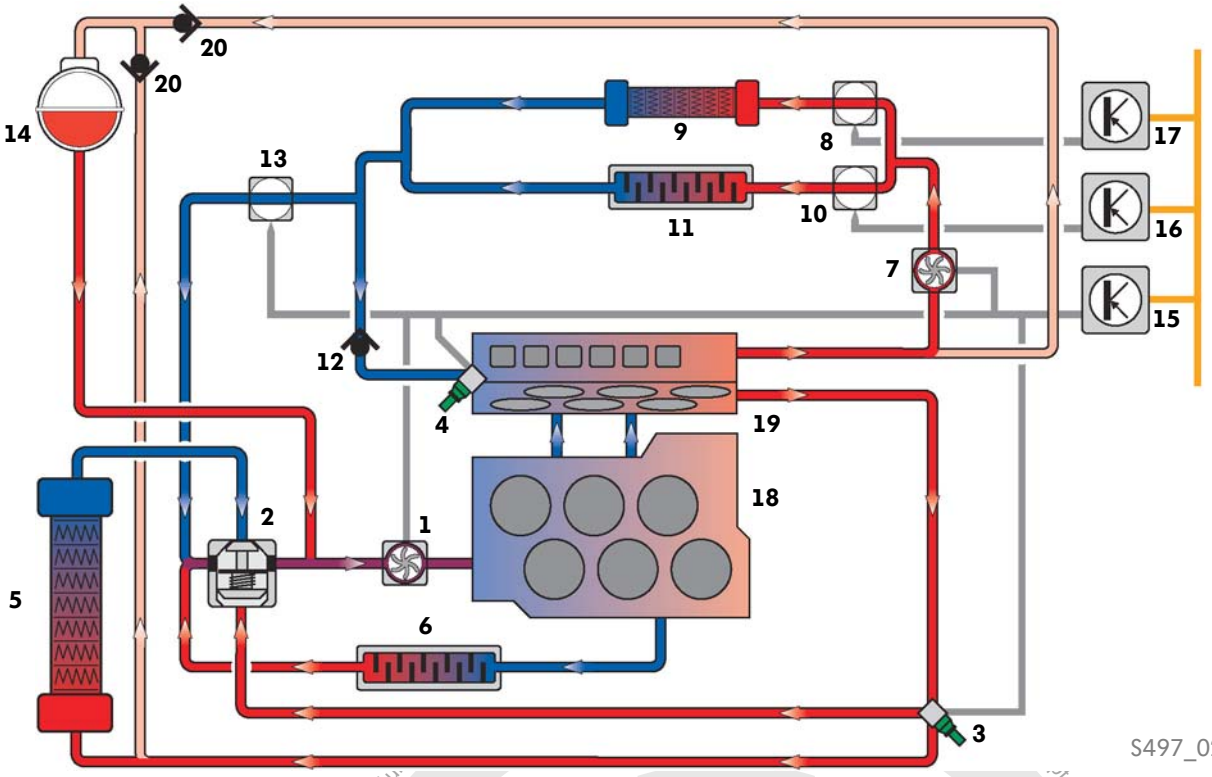
Cooling Circuit

Design

The following schematic diagram and the overview of locations show the coolant circuit for the 3.6l V6 FSI engine.

Schematic diagram



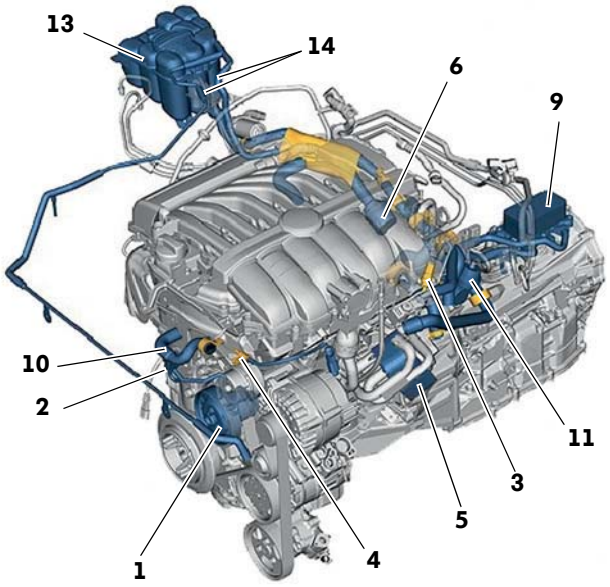
S497_022

Key

1 On-demand coolant pump + coolant regulating valve N515
2 Thermostat
3 Coolant temperature sender G62
4 Temperature sender for engine temperature regulation G694
5 Main radiator
6 Engine oil cooler
7 Coolant circulation pump 2 V178
8 Coolant shut-off valve? N82
9 Heat exchanger for heater
10 Shut-off valve for gearbox oil heat exchanger + cooling oil valve N471
11 Gearbox oil heat exchanger
12 Non-return valve for cylinder head circuit
13 Shut-off valve for cylinder block + coolant valve for cylinder block N545
14 Coolant expansion tank
15 Engine control unit J623
16 Automatic gearbox control unit J217
17 Climatronic control unit J255
18 Cylinder block
19 Cylinder head
20 Non-return valve for coolant return

Numbers 6 and 11 are coolers that exchange the heat between oil and water. Numbers 5 and 9 are coolers that exchange heat between air and water.

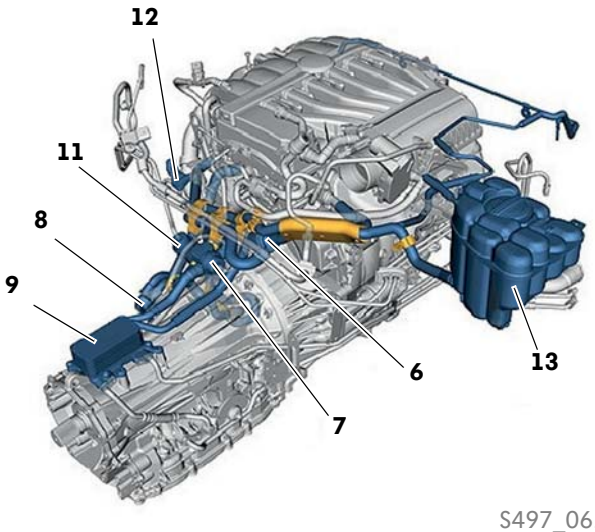
Locations



S497_063

Key

1 On-demand coolant pump
2 Coolant regulating valve N515
3 Coolant temperature sender G62
4 Temperature sender for engine temperature regulation G694
5 Engine oil cooler
6 Coolant circulation pump 2 V178
7 Shut-off valve for gearbox oil heat exchanger
8 Cooling oil valve N471
9 Gearbox oil heat exchanger
10 Non-return valve for cylinder head circuit
11 Shut-off valve for cylinder block
12 Coolant valve for cylinder block N545
13 Coolant expansion tank
14 Non-return valve for coolant return



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Cooling Circuit

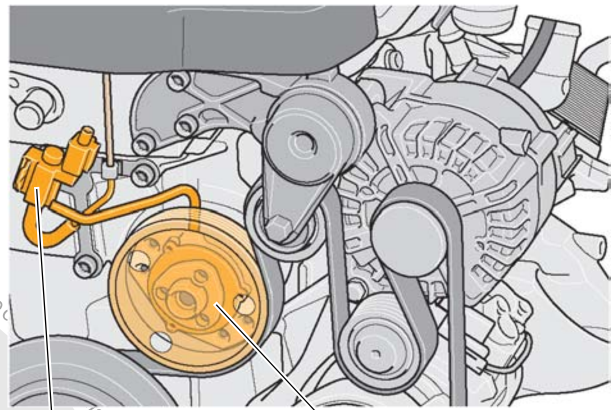
Components

On-demand coolant pump

Task

The coolant pump is constantly driven by the belt drive. As a result, it pumps coolant through the coolant circuit ensuring a sufficient movement of heat to the heat exchangers.

The engine should reach its operating temperature as quickly as possible during cold start and warm-up. Therefore the coolant pump is switched off by a shutter that is operated by the vacuum system. The coolant in the engine is then stationary and is heated faster.



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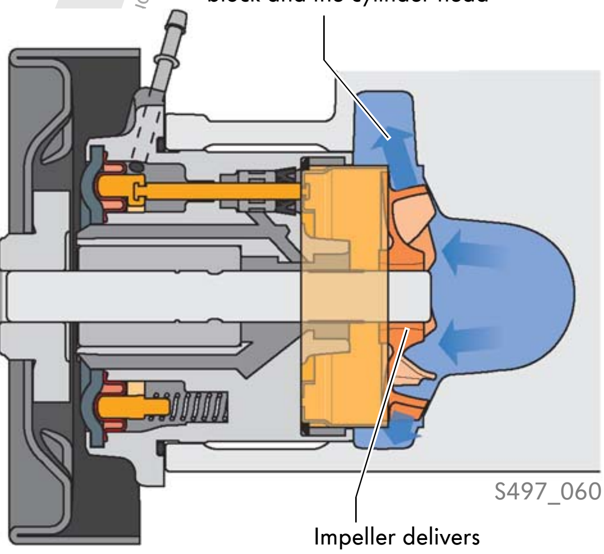
How it works

Coolant pump is "switched on":

If the coolant temperature is less than -15°C or greater than 75°C, the coolant pump is "switched on". As in the case of a conventional coolant pump, the coolant is pumped to the cylinder block and the cylinder head.



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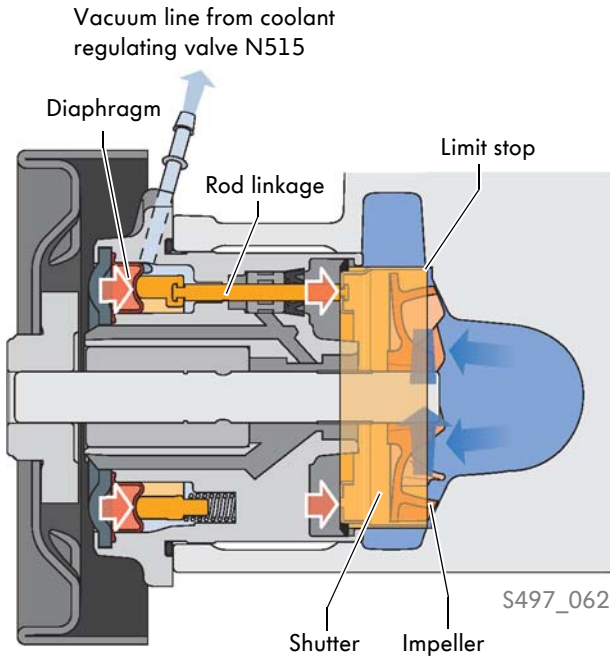
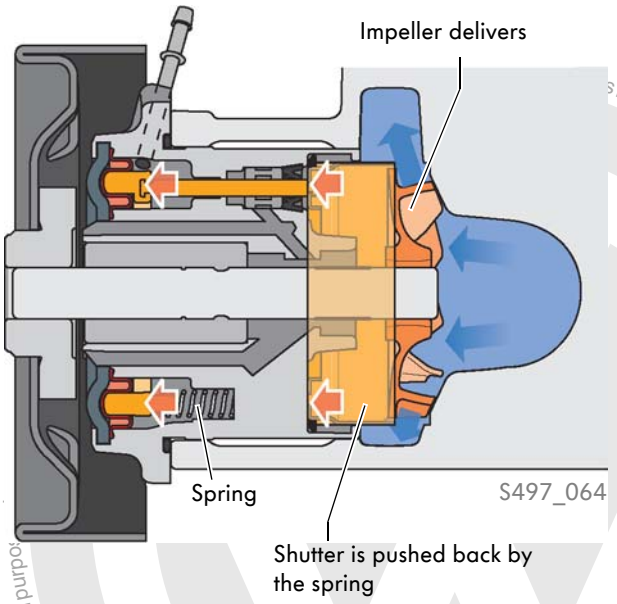
The coolant pump is "switched on and off" not just depending on the temperature. The engine torque and speed also play a part.



Coolant pump is "switched off":

If the coolant temperature is between -15°C and 75°C when the engine is started, the coolant pump is "switched off" conditionally. The coolant regulating valve is actuated by the engine control unit and opens the path for the vacuum. The diaphragm is pulled to the right by the vacuum. As the shutter and the diaphragm are linked together via a rod, the shutter is pushed over the impeller until it reaches the stop limit. The flow of coolant is stopped by the shutter. Coolant is no longer delivered (see also subsection "Stationary coolant").



Coolant pump is "pulsed":

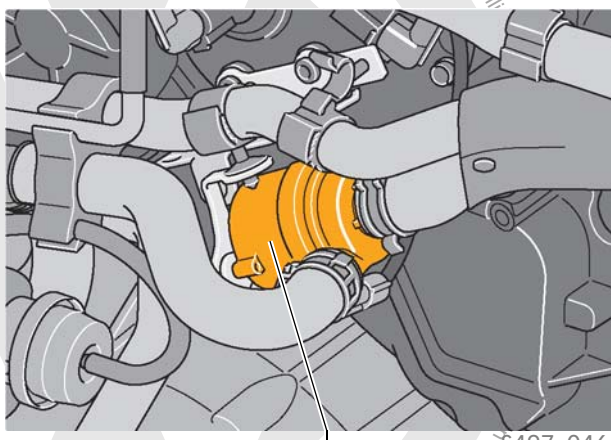
The coolant pump is activated at a cylinder head temperature of approx. 75°C. The coolant regulating valve is activated several times (mixed phase) to reactivate the coolant pump. This opens and closes the coolant pump shutter intermittently. This ensures that the cold coolant from the cylinder block is mixed slowly with the hot coolant from the cylinder head.

Coolant pump delivers:

When the coolant regulating valve is no longer actuated, the vacuum is dissipated and the spring pushes the shutter back to its initial position. The impeller is released again and delivers the coolant in the direction of the engine.

Coolant circulation pump 2 V178

Coolant circultation pump 2 V178 is electronically regulated by means of pulse-width modulation (PWM).



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Coolant circulation pump 2 V178

Design

The design of coolant circulation pump 2 corresponds with a centrifugal pump. The following components are integrated into the pump module:

- Centrifugal pump
- Electric motor
- Electronic control

The electrical connection for the coolant circulation pump 2 has three pins:

- Terminal 31
- Battery voltage from terminal 87a
- PWM signal from engine control unit

How it works

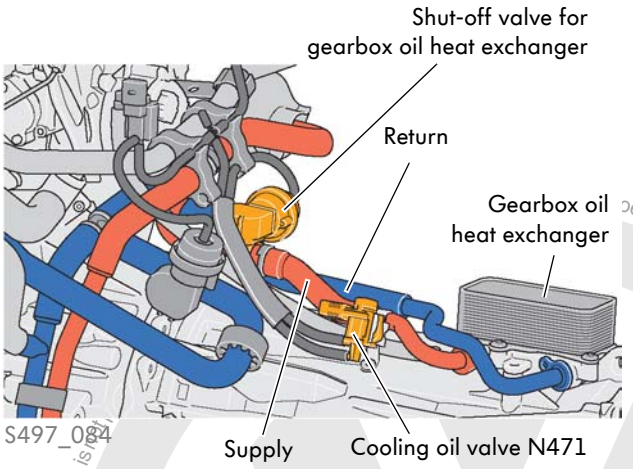
If the coolant in the cylinder block is stationary (see "Stationary coolant" sub-function), the coolant circulation pump 2 allows hot coolant to be pumped from the cylinder head to the heat exchanger for the heater. This means that the cylinder head cooling circuit forms a separate circuit with its own pump when the main circuit is deactivated. The cylinder head can therefore be cooled and the heat exchanger for the heater supplied with warm coolant without the cylinder block being cooled.

If the coolant pump is delivering, but the shut-off valve for cylinder block is still closed, the coolant circulation pump 2 allows hot coolant to be delivered to the gearbox oil heat exchanger and, depending on the heating requirement, to the heat exchanger for the heater (see sub-function "Gearbox oil heating").

Furthermore the coolant circulation pump 2 supports the coolant pump for the interior heating when the engine is warm and running below 1,240rpm.

The valves and their functions

Shut-off valve for gearbox oil heat exchanger and cooling oil valve N471



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The cooling oil valve N471 is a solenoid changeover valve. It controls the vacuum supply to the shut-off valve for the gearbox oil heat exchanger, which is a pneumatic valve.

These two valves interrupt the flow of coolant or allow coolant to flow through the gearbox oil heat exchanger.

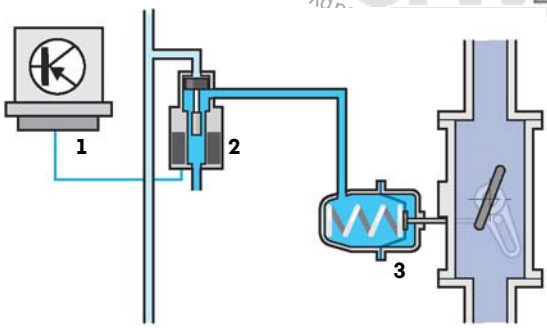
How it works

De-energised

When no current is supplied, the cooling oil valve N471 closes the vacuum line to the shut-off valve for the gearbox oil heat exchanger. The coolant line to the gearbox oil heat exchanger is opened by the shut-off valve for the gearbox oil heat exchanger.

Energised

If the coolant valve for gearbox N488 is energised, it opens the vacuum line to the shut-off valve for the gearbox oil heat exchanger. The vacuum then causes the shut-off valve for the gearbox oil heat exchanger to close the coolant line to the gearbox oil heat exchanger.



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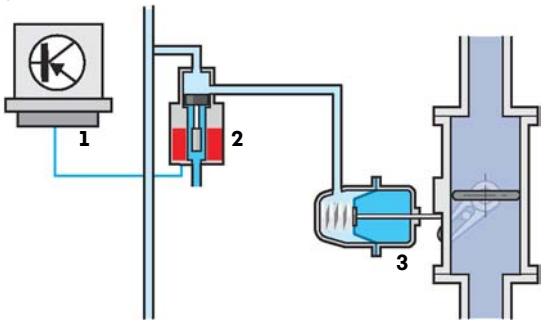

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Key

1 Engine control unit J623
2 Cooling oil valve N471
3 Shut-off valve for gearbox oil heat exchanger

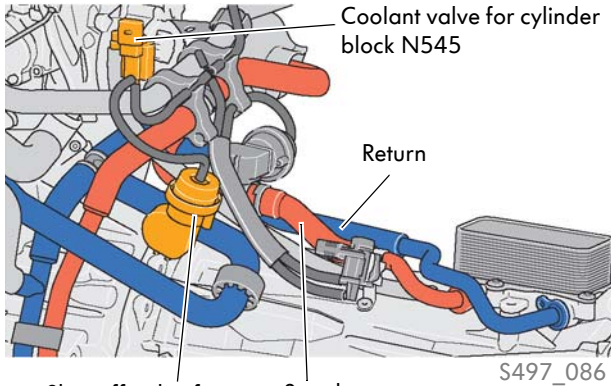
Cooling Circuit

Shut-off valve for cylinder block and coolant valve for cylinder block N545

The coolant valve for cylinder block N545 is a solenoid changeover valve. It controls the vacuum supply to the shut-off valve for cylinder block, which is a pneumatic valve. These two valves are used to interrupt the flow of coolant from the coolant circulation pump 2 V178 to the cylinder block and thus stop the supply of cold coolant to the cylinder block during the warm-up phase.

How it works

These valves work in exactly the same way as the coolant valve for gearbox N488 and the shut-off valve for gearbox oil heat exchanger.



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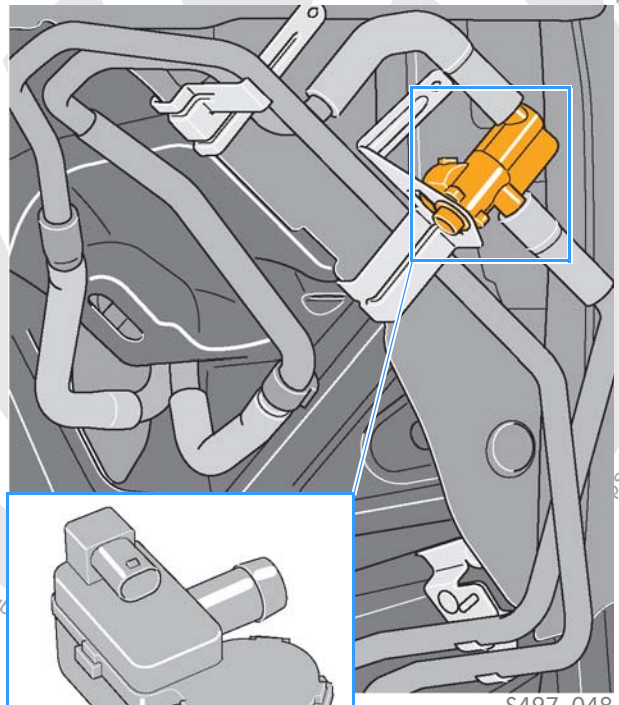
Coolant shut-off valve N82

The coolant shut-off valve N82 is fitted in the wheel housing on the left in the direction of travel.

This valve is operated by an electric motor. It contains a small electric motor that moves the shut-off plunger via a worm gear.

This valve allows or interrupts the flow of coolant through the heat exchanger for heater.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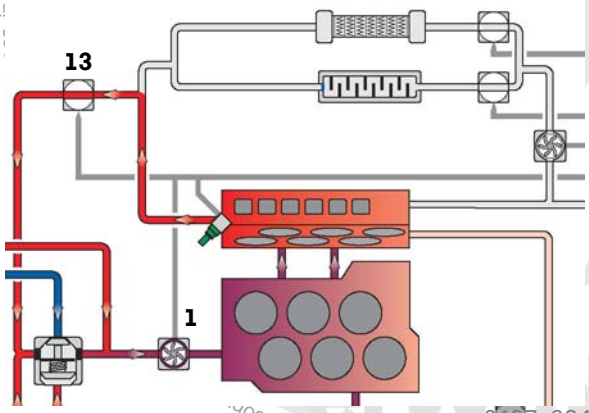
Cylinder head circuit non-return valve

During normal operation, i.e. when the engine has reached operating temperature and the shut-off valve for cylinder block (13) is open, the non-return valve in the cylinder head circuit (12) prevents coolant flowing directly from the cylinder head connection at the front to the on-demand coolant pump (1). This ensures that coolant flows through the cylinder head circuit.

Impermissible coolant flow (without non-return valve)



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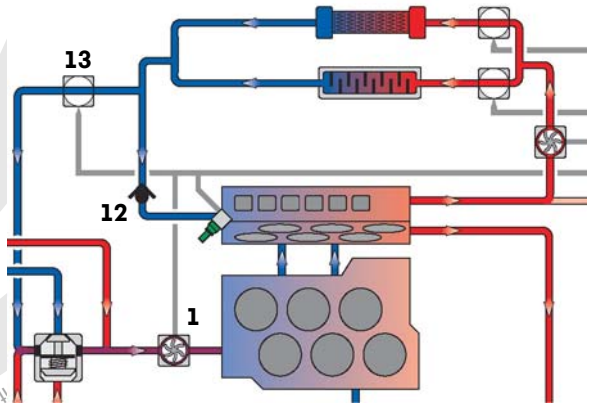
Permissible coolant flow (with non-return valve)



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Non-return valve for coolant return

The non-return valves in the coolant return to the coolant expansion tank prevent the coolant circulation pump 2 V178 drawing air from the coolant expansion tank into the cooling system.

Coolant temperature sender G62

This temperature sender measures the coolant temperature at the engine coolant outlet.
The temperature information is used to regulate the coolant temperature in the coolant circuit (i.e. activation of the radiator fan).

Temperature sender for engine temperature regulation G694

This temperature sender is fitted in the cylinder head close to the combustion chamber and measures the coolant temperature.
The temperature information is used to control the heating phase of the engine and to prevent the coolant boiling during the "Stationary coolant" sub-function.

Function

This chapter is divided into two sections in order to explain the innovative thermal management functions better.
The section "ITM sub-functions" explains the four basic functions.
The section "Warm-up strategy" describes the procedure for the warm-up program as well as the interaction of the sub-functions during this process.

ITM sub-functions

The innovative thermal management (ITM) can be sub-divided into four sub-functions:

Sub-function 1 - Stationary coolant
Sub-function 2 - Autarkic heating
Sub-function 3 - Gearbox oil heating
Sub-function 4 - Separation of interior heating circuit

These four basic functions each relate to a separate sub-system of the complete vehicle.
Therefore you can assign
- "gearbox oil heating" to the gearbox,
- the "separation of interior heating" as well as "autarkic heating" to the heating/air-conditioning system and
- "stationary coolant" to the engine.

The sub-functions can also be active independently of each other.

All four sub-functions are implemented in the 3.6l V6 FSI engine. Therefore, in the following section, the sub-functions will be explained in more detail using the coolant circuit of that engine as an example.

If the engine is started with a coolant temperature less than -15°C, the ITM will work with limitations. The sub-functions 1 and 2 will be deactivated and the shut-off valve for cylinder block will not be closed.

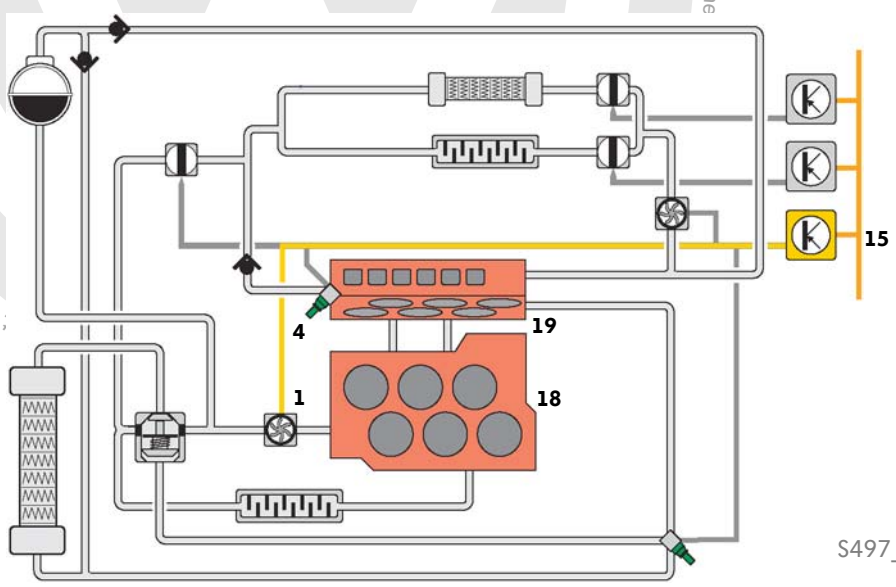
Sub-function 1 - Stationary coolant

Task

This function serves to warm-up the engine quickly. Deactivating the coolant circuit prevents circulation of coolant through the whole engine. The stationary coolant is achieved with the on-demand coolant pump.

How it works

If the coolant temperature is between -15°C and 75°C when the engine is started, the engine control unit activates the coolant pump. The shutter is pushed over the impeller and the flow of coolant is interrupted by the shutter. This stops the flow of coolant and shortens the warm-up time of the whole engine (see also description of how the on-demand coolant pump works on page 11).



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Key

1 On-demand coolant pump
4 Temperature sender for engine temperature regulation G694
15 Engine control unit J623
18 Cylinder block
19 Cylinder head

Sub-function 2 - Autarkic heating

Task

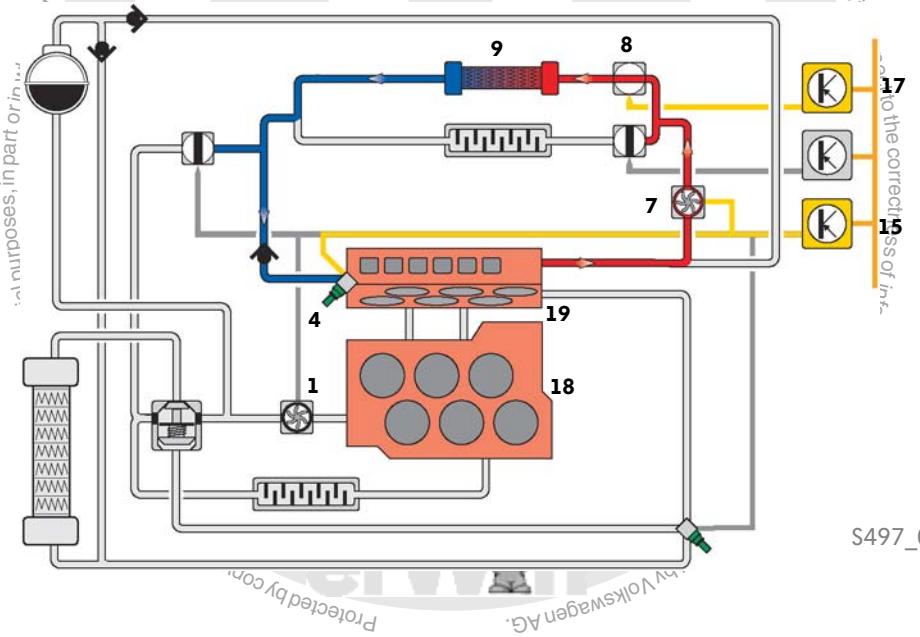
This function serves to quickly heat the vehicle interior according to the occupants' heating requirements. The heat from the cylinder head is used for the heat exchanger in this case.

How it works

A vehicle occupant sets the heating requirement via the air-conditioning controls. The Climatronic control unit assigns this heating requirement to one of the following four stages:

- Stage 0 = maximum heating requirement or defrost request
- Stage 1 = medium heating requirement
- Stage 2 = low heating requirement
- Stage 3 = no heating requirement

Sub-function 2 - Autarkic heating is implemented for interior heating requirement stages 0 to 2. Coolant circulation pump 2 is activated by the engine control unit once a set temperature threshold has been reached in the cylinder head. At the same time, the Climatronic control unit opens the coolant shut-off valve N82 after a switching command from the engine control unit. This enables an autarkic flow of coolant through the cylinder head and the heat exchanger for heater while the coolant in the cylinder block continues to be stationary.



Key

1 On-demand coolant pump
4 Temperature sender for engine temperature regulation G694
7 Coolant circulation pump 2 V178
8 Coolant shut-off valve N82
9 Heat exchanger for heater
15 Engine control unit J623
17 Climatronic control unit J255
18 Cylinder block
19 Cylinder head

Sub-function 3 - Gearbox oil heating

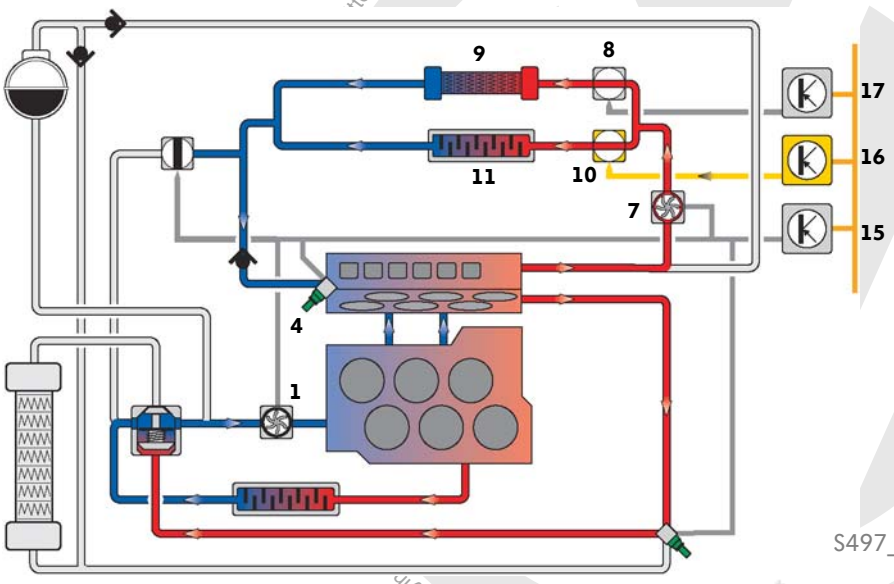
Task

This function ensures that the gearbox is warmed up quickly by activating the gearbox oil heat exchanger. This means that the gear oil can be specifically heated up by the hotter coolant.

How it works

If the coolant is in a suitable temperature range (from approx. 82°C cylinder head temperature) and the coolant is warmer than the gearbox oil, sub-function 3 - Gearbox oil heating is possible.
Depending on the gearbox heating requirement, the gearbox control unit opens the shut-off valve for the gearbox oil heat exchanger upon receiving the switching command from the engine control unit. Coolant can then flow through the gearbox oil heat exchanger. In this way, the coolant heated in the cylinder head is sent to the gearbox.

The Climatronic control unit also has an influence on this sub-function. "Gearbox oil heating" (as described above) is possible for an interior heating requirement in stages 1 to 3.
However, at maximum interior heating requirement in stage 0, the shut-off valve for the gearbox oil heat exchanger must be closed. This requirement is forwarded from the air-conditioning control unit via the engine control unit to the gearbox control unit. All of the hot coolant then flows through the heat exchanger for the heater.



Key

1 On-demand coolant pump
4 Temperature sender for engine temperature regulation G694
7 Coolant circulation pump 2 V178
8 Coolant shut-off valve N82
9 Heat exchanger for heater
10 Shut-off valve for gearbox oil heat exchanger
11 Gearbox oil heat exchanger
15 Engine control unit J623
16 Automatic gearbox control unit J217
17 Climatronic control unit J255

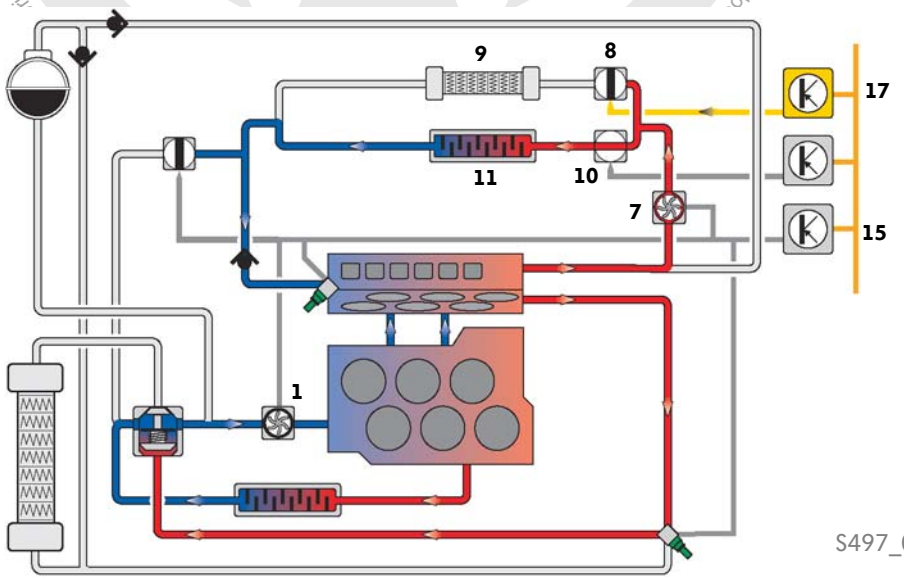
Sub-function 4 - Separation of interior heating circuit

Task

If no heating requirement is signalled by the Climatronic control unit (i.e. stage 3), the warm-up phase of the engine can be reduced further by disconnecting the heat exchanger for the heater.

How it works

If there is no heating requirement, the Climatronic control unit closes the coolant shut-off valve upon receiving the command from the engine control unit. As a result, no heated coolant reaches the heat exchanger for heater. All of the heated coolant (from approx. 82°C cylinder head temperature) then flows through the gearbox oil heat exchanger.



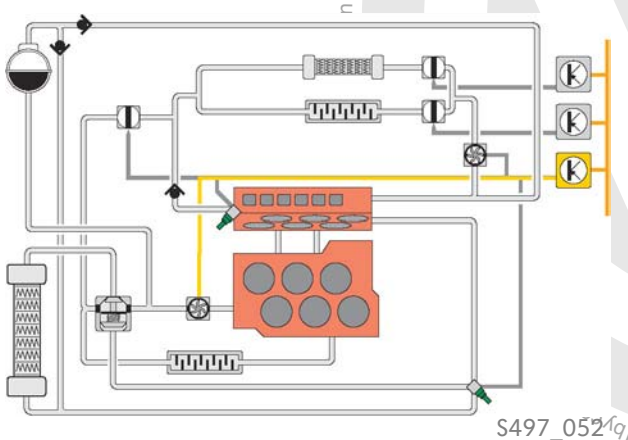
Key

1 On-demand coolant pump
7 Coolant circulation pump 2 V178
8 Coolant shut-off valve N82
9 Heat exchanger for heater
10 Shut-off valve for gearbox oil heat exchanger
11 Gearbox oil heat exchanger
15 Engine control unit J623
17 Climatronic control unit J255

Warm-up strategy

The warm-up strategy depends on many factors (for example, heating requirement, engine speed, torque, summer or winter operation).

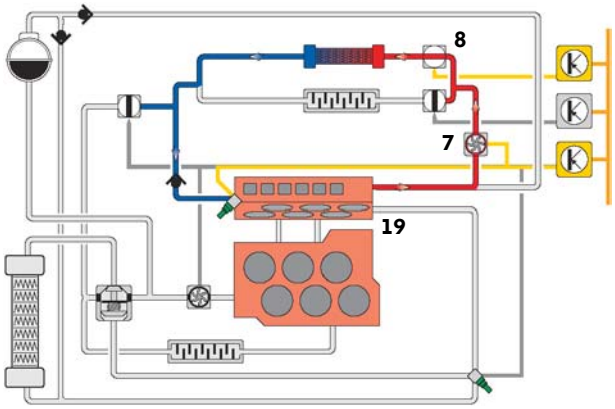
Basic strategy (winter operation)



S497_052

Phase 1

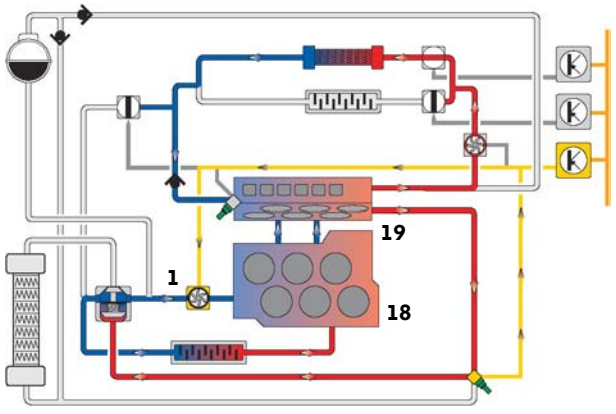
The "Stationary coolant" sub-function initially ensures that the cylinder block warms up quickly after engine start.



S497_054

Phase 2

When a heating requirement is set on the air-conditioning system, the heat output from the cylinder head (19) is initially activated with coolant circulation pump 2 (7) (cylinder head circuit). At the same time, the "Autarkic heating" sub-function becomes active due to the coolant shut-off valve (8) being opened. The flow of coolant in the cylinder block is then switched off by the "Stationary coolant" sub-function.



S497_056

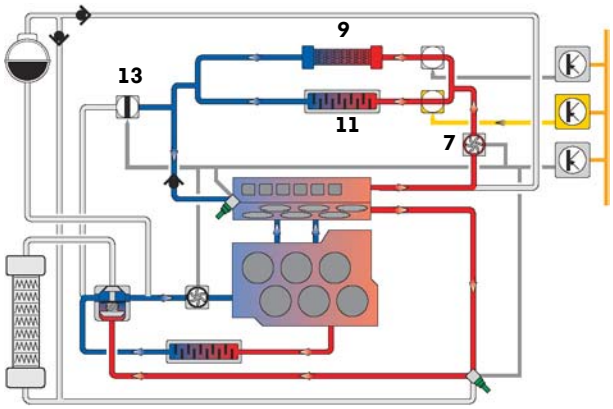
Phase 3

The coolant pump (1) is activated at a cylinder head temperature of approx. 75 °C. During the transition phase, the coolant pump is pulsed, i.e. the shutter in the coolant pump is opened and closed intermittently, to balance the coolant temperatures in the cylinder block (18) and in the cylinder head (19). After that, the coolant pump delivers constantly.

Function

Phase 4

Next, the gearbox oil is heated via the gearbox oil heat exchanger (11) ("Gearbox oil heating" sub-function). Since the shut-off valve for cylinder block (13) is still closed, the coolant circulation pump 2 (7) enables the hot coolant to be delivered to the gearbox oil heat exchanger (11) as well as to the heat exchanger for the heater (9) depending on the interior heating requirement.



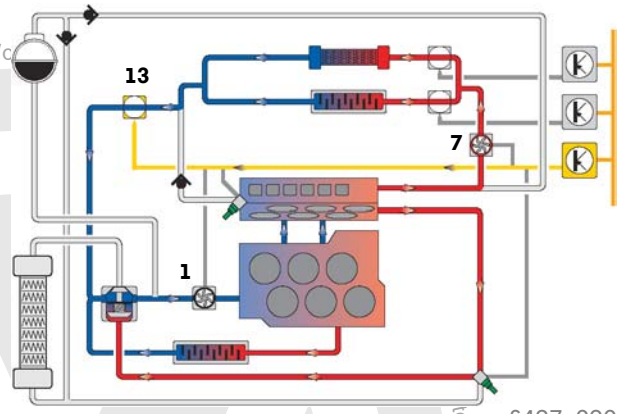
S497_088

Phase 5

The shut-off valve for cylinder block (13) is opened once the engine reaches operating temperature (approx. 87°C).

Warm-up is completed.

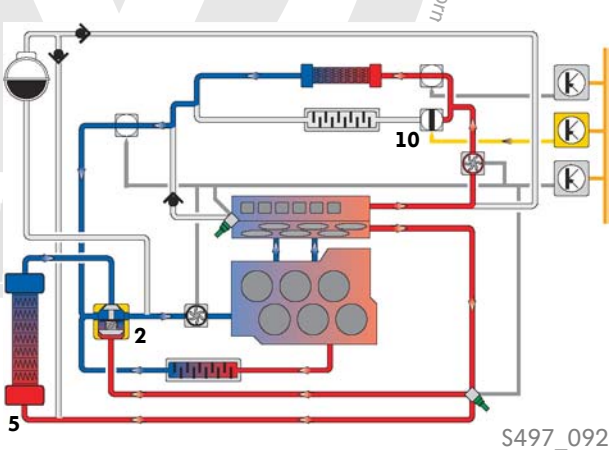
In this operating mode, the output of the coolant pump (1) is normally sufficient to meet the heating requirements without the support of the coolant circulation pump 2 (7). Support is only provided by the coolant circulation pump 2 while the coolant pump is running at engine speeds below 1,240rpm.



S497_090

Phase 6

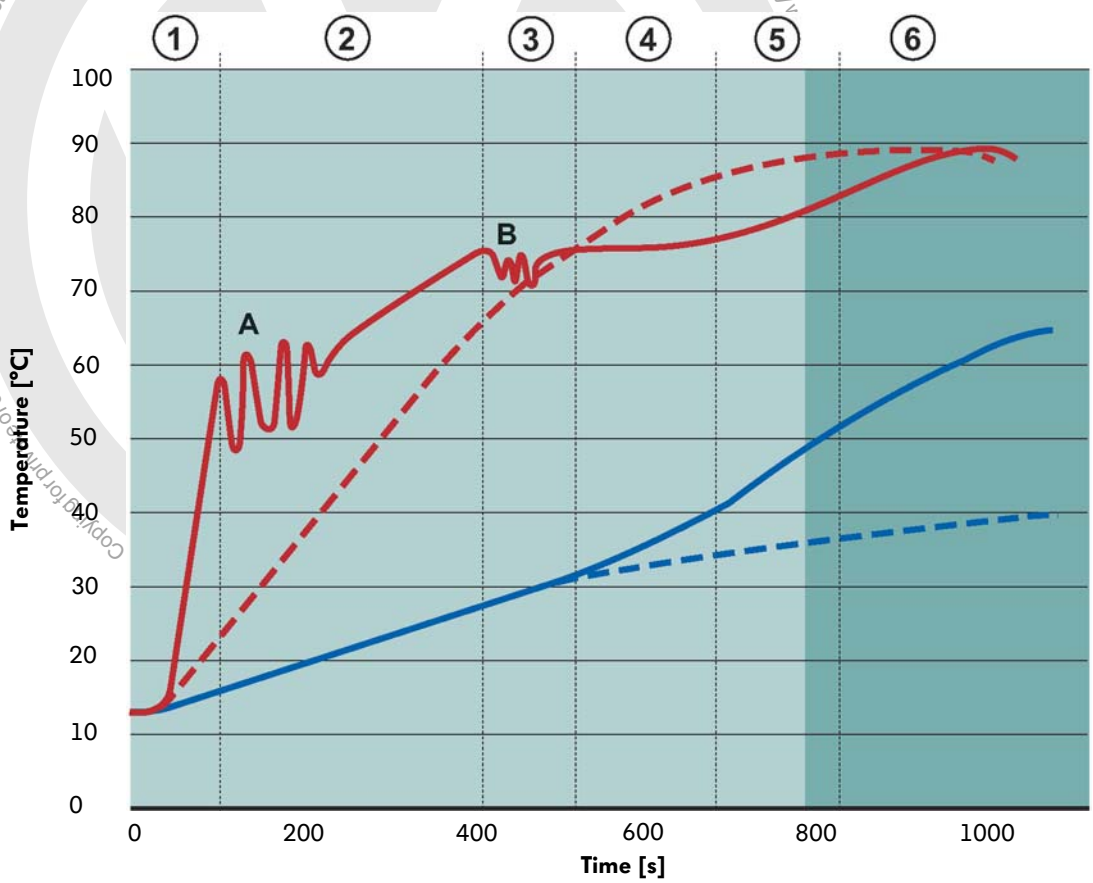
Over the further course of the engine warm-up, the thermostat (2) opens the large coolant circuit with the main radiator (5) at a temperature of 89°C. This prevents components overheating. Once the gearbox has reached operating temperature, gearbox oil heating is ended again by closing the shut-off valve for the gearbox oil heat exchanger (10).



S497_092

Warm-up graphs (winter operation)

The following graphs show the influence of the ITM on the coolant temperature and on the gearbox oil temperature while the engine warms up.



S497_010

Key

- = Coolant temperature with ITM
- = Coolant temperature without ITM
- = Gearbox oil temperature with ITM
- = Gearbox oil temperature without ITM
- = Cold start with ITM
- = Engine warm

(1) = Phase 1
(2) = Phase 2
(3) = Phase 3
(4) = Phase 4
(5) = Phase 5
(6) = Phase 6

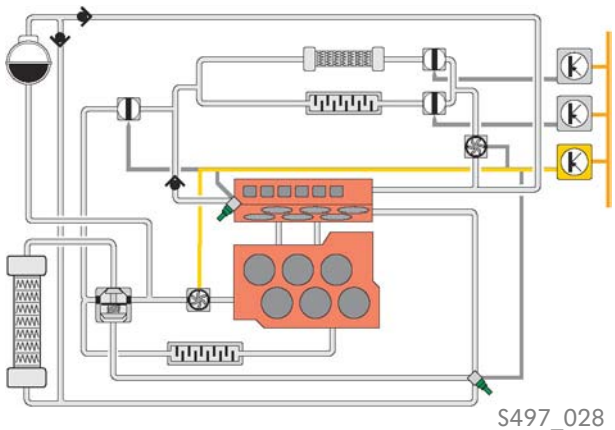
A = Coolant circulation pump 2 is activated as required with pulse-width modulation.

B = The coolant pump is pulsed.

Basic strategy (summer operation)

Phase 1

The "Stationary coolant" sub-function initially ensures that the cylinder block warms up quickly after engine start.



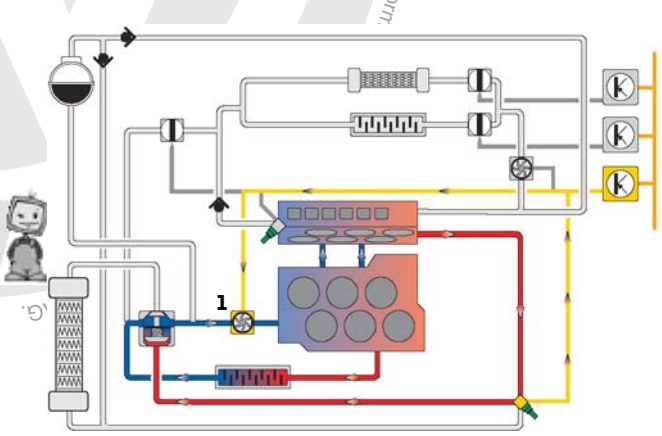
S497_028

Phase 2

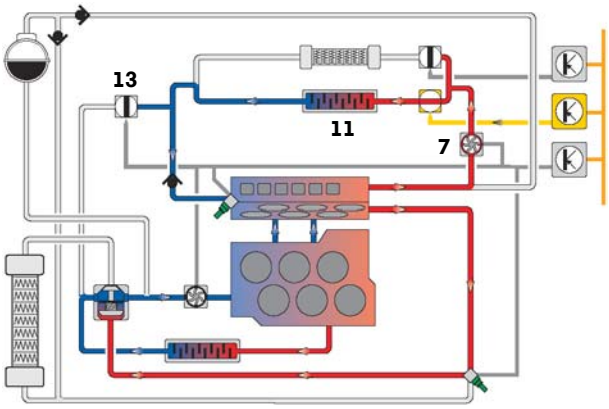
Since there is no heating requirement, the "Autarkic heating" sub-function is not active.

Phase 3

The coolant pump (1) is activated at a cylinder head temperature of approx. 75°C. During the transition phase, the coolant pump is pulsed, i.e. the shutter in the coolant pump is opened and closed intermittently, to balance the coolant temperatures in the cylinder block (18) and in the cylinder head (19). After that, the coolant pump delivers constantly.



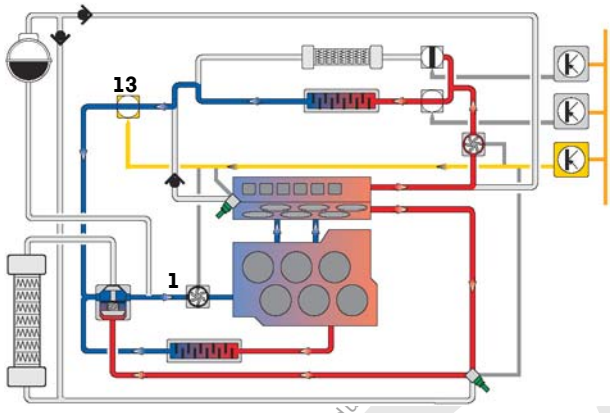
S497_076



S497_078

Phase 4

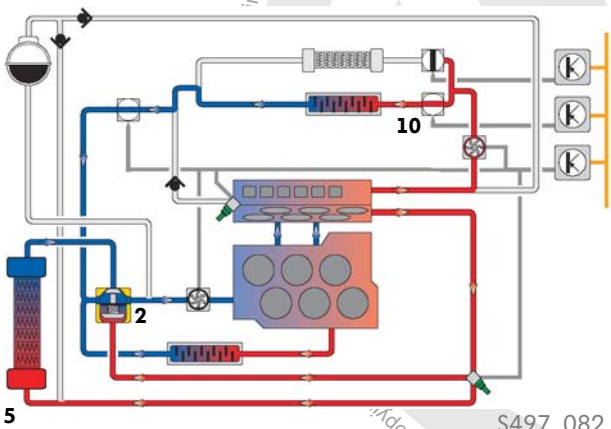
Next, the gearbox oil is heated via the gearbox oil heat exchanger (11) ("Gearbox oil heating" sub-function). Since the shut-off valve for cylinder block (13) is still closed, the coolant circulation pump 2 (7) enables the hot coolant to be delivered to the gearbox oil heat exchanger.



S497_080

Phase 5

The shut-off valve for cylinder block (13) is opened once the engine reaches operating temperature (approx. 87°C).
Warm-up is completed.



S497_082

Phase 6

Over the further course of the engine warm-up, the thermostat (2) opens the large coolant circuit with the main radiator (5) at a temperature of 89°C. This prevents components overheating. Since there is no heating requirement, the shut-off valve for the gearbox oil heat exchanger (10) also remains open after the gearbox reaches operating temperature to ensure that coolant flows through the cylinder head.

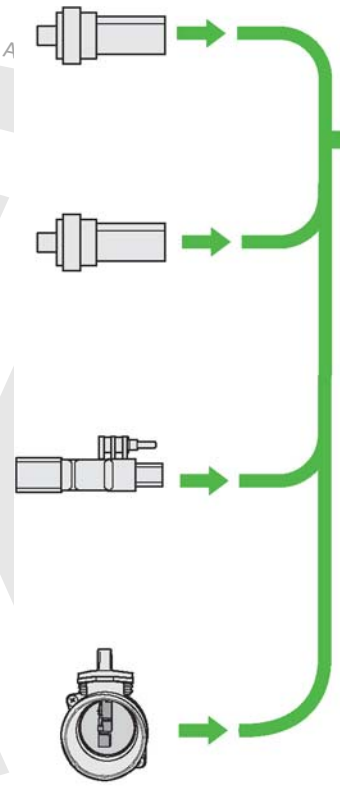
Sensors

Coolant temperature sender **G62**

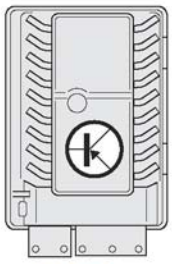
Temperature sender for engine temperature regulation **G694**

Engine speed sender **G28**

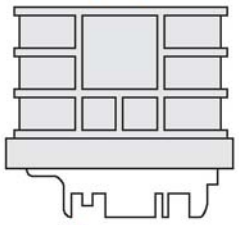
Air mass meter **G70** with intake air temperature sender **G42**



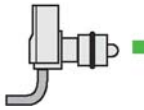
Engine control unit **J623**



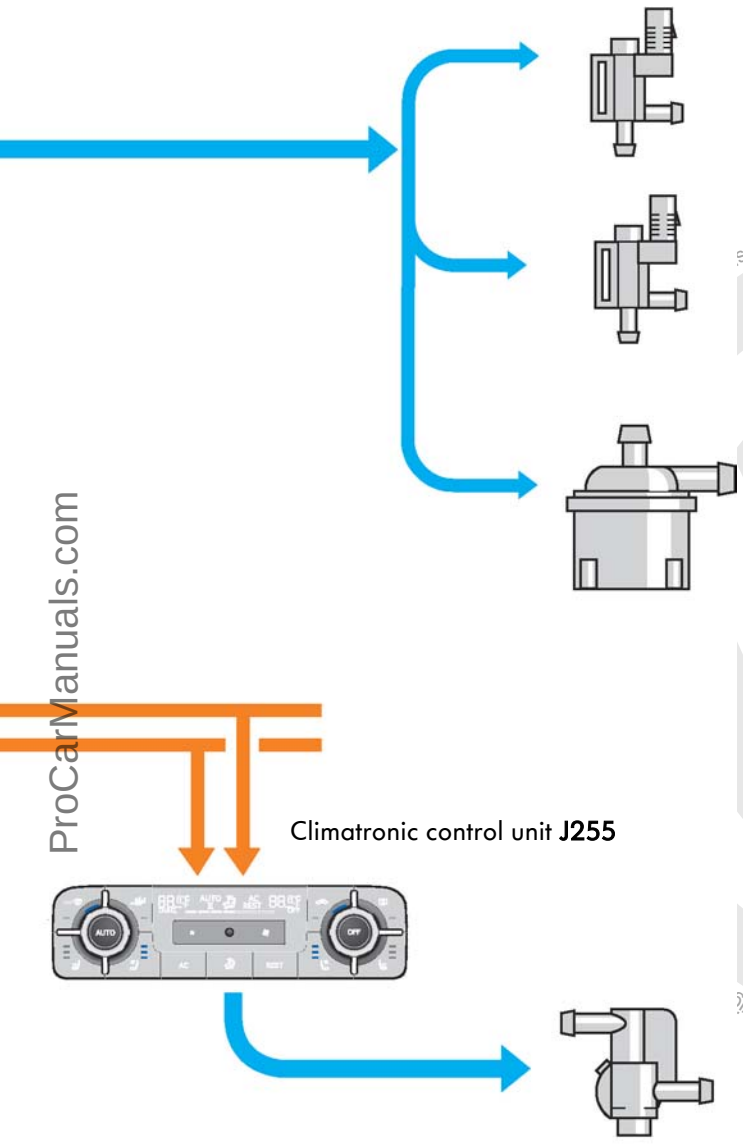
Automatic gearbox control unit **J217**



Gearbox oil temperature sender **G93**



Actuators



Function Matrix

The ITM functions have different characteristics depending on the engine in question. The following the table shows which of the four sub-functions are implemented in the engines featuring ITM.

	Stationary coolant	**Autarkic heating**	**Gearbox oil heating**	**Separation of interior heating circuit**
1.2l 77kW TSI engine	Yes	No	No	No
3.6l 206kW V6 FSI engine	Yes	Yes	Yes	Yes
4.2l 265kW V8 FSI engine	Yes	No	Yes	Yes
3.0l 176kW V6 TDI engine	No	No	Yes	Yes
4.2l 250kW V8 TDI engine	Yes	No	Yes	Yes
3.0l 245kW V6 TSI engine (hybrid)	Yes	No	Yes	Yes
3.0l 180kW V6 TDI engine (W36 - generation 2)	Yes	Yes	Yes	Yes

Please note that there may be different, country-specific ITM systems for the engines.

Which answers are correct?

One or several of the given answers may be correct.

1. What do you understand by innovative thermal management (ITM)?

❒ a) The airstream is directed at hot engine components.

❒ b) The specific control of the flow of heat in the vehicle.

❒ c) The ITM is a thermal management system similar to an auxiliary heater.

2. Where is the ITM thermal manager fitted?

❒ a) The ITM thermal manager is a separate control unit that is networked with the engine control unit on the CAN data bus.

❒ b) The ITM thermal manager is a software application that is installed in the gearbox, air-conditioning and engine control unit.

❒ c) The ITM thermal manager is a software application in the engine control unit.

3. Which phase of the warm-up strategy in winter operation is identical to an ITM sub-function?

❒ a) Sub-function 1 - Stationary coolant is identical to phase 1 of the warm-up strategy.

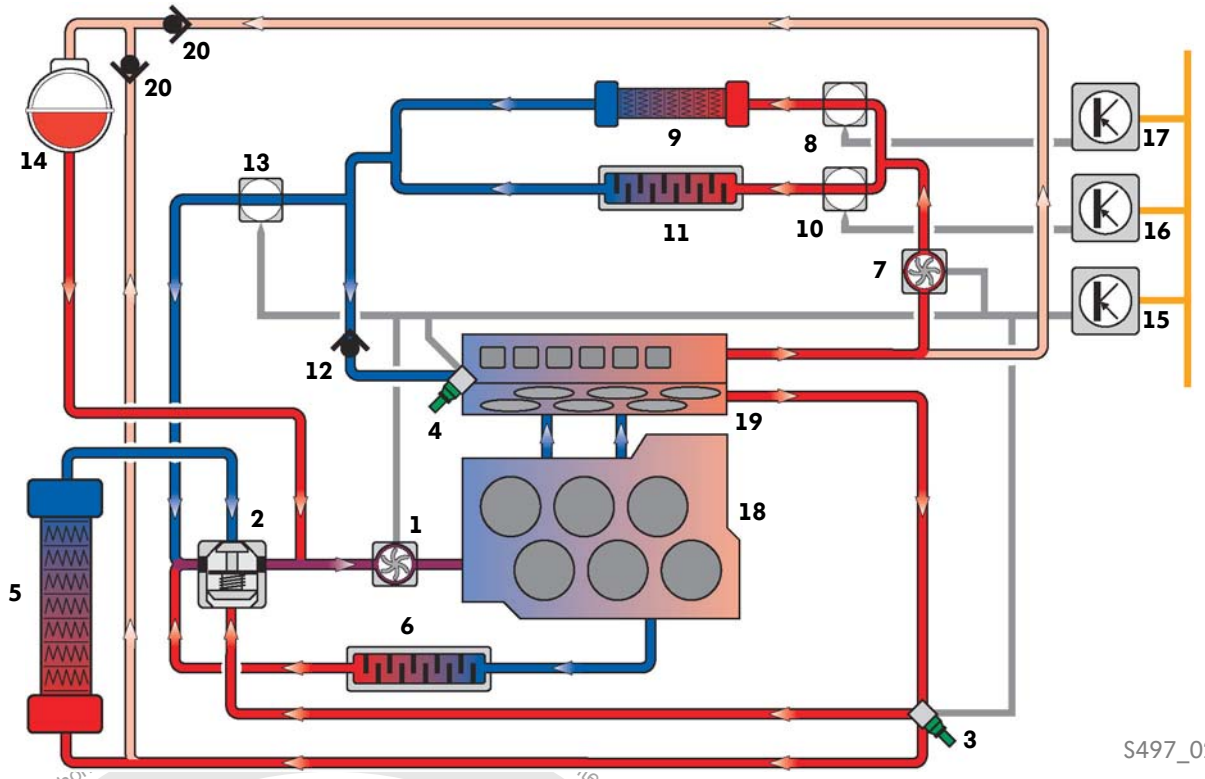
❒ b) Sub-function 1 - Stationary coolant is identical to phase 2 of the warm-up strategy.

❒ c) Sub-function 3 - Gearbox oil heating is identical to phase 5 of the warm-up strategy.

❒ d) Phase 2 of the warm-up strategy is identical to sub-function 2 - Autarkic heating.

Test Yourself

4. Name the components.



S497_026

Key

1 _____
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16 _____
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18 _____
19 _____
20 _____

5. What function do the four sub-functions of the ITM have in winter operation?

❒ a) The four sub-functions are used to warm up the engine, the interior and the gearbox more quickly.

❒ b) The four sub-functions are identical to the 4 stages of the interior heating requirement.

❒ c) The sub-functions can only ever be active together and not independently.

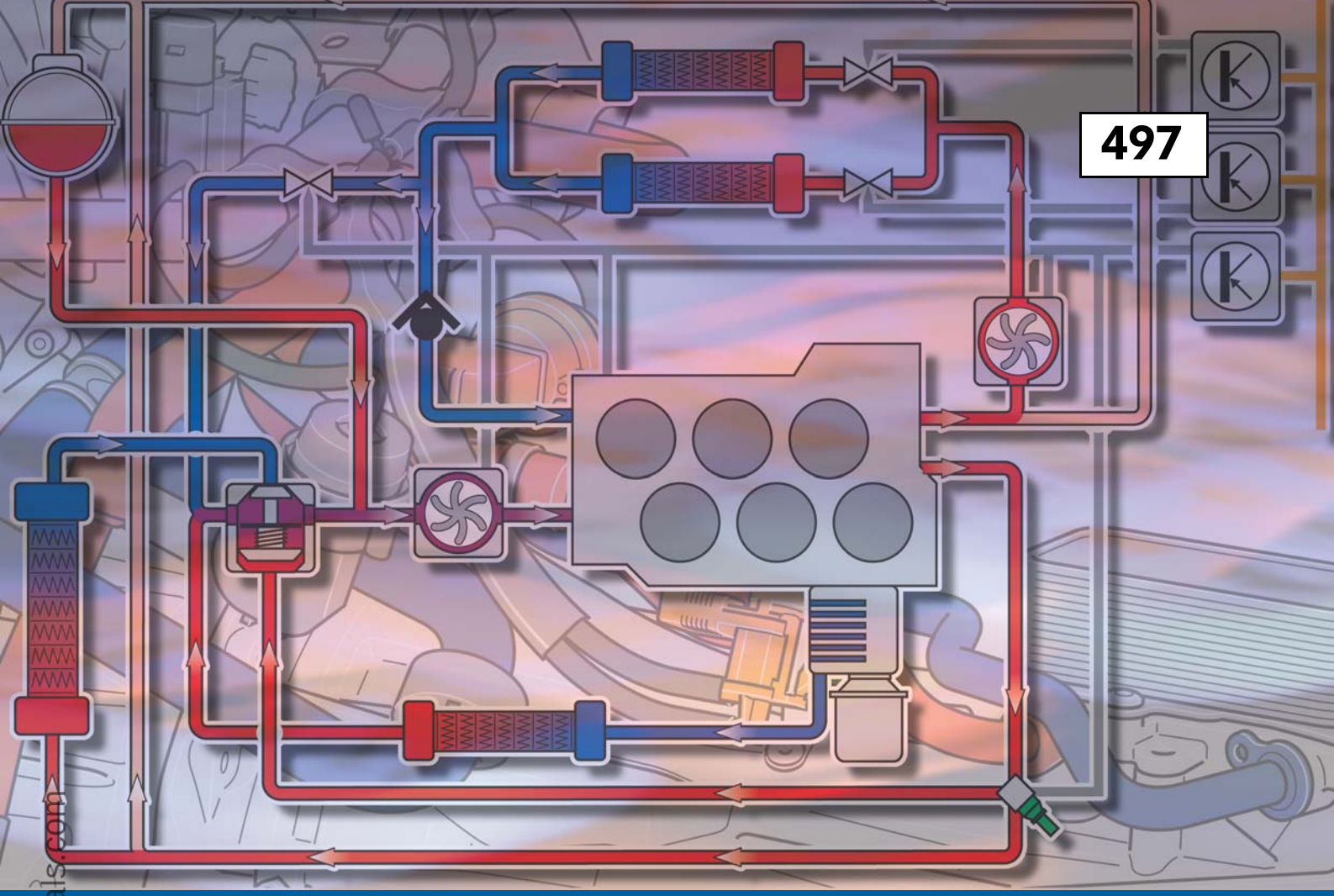
6. Why is the coolant pump pulsed when switched on?

❒ a) So that the components are not subjected to any high temperature fluctuations (protection of engine components).

❒ b) The pump is protected from freezing.

❒ c) It is a function check for the pump and its components.

Answers:
1. b)
2. c)
3. a), d)
4.
1 On-demand coolant pump + coolant regulating valve N515
2 Thermostat
3 Coolant temperature sender G62
4 Temperature sender for engine temperature regulation G694
5 Main radiator
6 Engine oil cooler
7 Coolant circulation pump 2 V178
8 Coolant shut-off valve N82
9 Heat exchanger for heater
10 Shut-off valve for gearbox oil heat exchanger + cooling oil valve N471
11 Gearbox oil heat exchanger
12 Non-return valve for cylinder head circuit
13 Shut-off valve for cylinder block + coolant valve for cylinder block N545
14 Coolant expansion tank
15 Engine control unit J623
16 Automatic gearbox control unit J217
17 Climatronic control unit J255
18 Cylinder block
19 Cylinder head
20 Coolant return non-return valve
5. a)
6. a)



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