

Service Training



Commercial  
Vehicles

Self-study Programme 416

# Supplementary Heaters – Part 2 Volkswagen Commercial Vehicles

Design and Function



This self-study programme is the continuation of self-study programme 415.

The supplementary heaters available in the Transporter/Multivan and Caddy will be dealt with in this self-study programme, Supplementary Heaters Part 2. It must always be regarded in connection with the self-study programme entitled Supplementary Heaters Part 1.

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S416\_165

**NEW**









**Attention  
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.



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# Transporter – overview of supplementary heaters



## Overview of installation locations

The Transporter is available with one water-based pre-heater and one air- and one water-based auxiliary heater.

Pre-heater:

- Thermo Top Z supplementary coolant heater

Auxiliary heater:

- Air Top 3500 supplementary air heater
- Thermo Top C supplementary coolant heater



The second heat exchanger is integrated into the vehicle heating system and can only be operated during the vehicle's normal heating mode.

The heat exchanger does not generate any heat itself.

In the auxiliary heating function, the second heat exchanger's blower is not actuated, with the result that no hot air enters into the vehicle.



Supplementary coolant heater  
Thermo Top Z (pre-heater)  
or  
supplementary coolant heater  
Thermo Top C (auxiliary heater)





Second heat exchanger  
(optionally with integrated  
2nd evaporator)



S416\_046



Supplementary air heater  
Air Top 3500 (auxiliary heater)

# Transporter – overview of supplementary heaters



## Operation

### Controls

#### Auxiliary heater

Manual operation and programming of the switch-on times for the Thermo Top C supplementary coolant heater and the Air Top 3500 auxiliary heater can be carried out via the operating and display unit in the roof. In the California, the auxiliary heater is operated via the operating and display unit for camping equipment E153.

Model year 2004 to model year 2007:

- Blue display illumination
- Menu guidance with symbols
- Five switch-on times can be programmed
- Day display

As of model year 2008:

- Red display illumination
- More user-friendly menu guidance
- Menu guidance with plain text information
- Three switch-on times can be programmed
- Day and date display

#### Second heat exchanger

Depending on equipment, the second heat exchanger – auxiliary heat exchanger – is controlled using the controls in the instrument panel in the roof lining. When it is switched on, the auxiliary heat exchanger serves to heat the load and passenger compartment, and operates in recirculated air mode. No fresh air enters in this case.

The heat output depends on the coolant temperature – the full heat output is therefore only available when the engine is at operating temperature.



The second heat exchanger at the rear is also available with an evaporator as a rear air conditioning system.



S416\_020

Display for supplementary heater displays (illustration corresponds to Thermo Top C)



The individual auxiliary heater operating modes are set using the function buttons. The buttons' function is dependent on the relevant menu, and is shown as a symbol or text in the display depending on the model year. For more information, please refer to the owner's manual for the Transporter/Multivan.



S416\_150

Temperature regulator Blower regulator

(Illustration corresponds to actuation in the instrument panel)



## Radio remote control

The Thermo Top C supplementary coolant heater and the Air Top 3500 supplementary air heater can be either switched on and off using the radio remote control. The vehicle is only supplied with one radio remote control. A total of 3 radio remote controls can be coded in.

The radio receiver is installed under the left-hand dash panel beneath the light switch. The wire aerial is routed in the driver door's wiring harness.

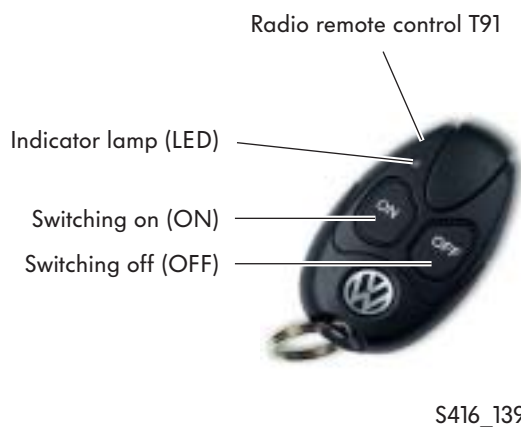


## New radio remote control

As of model year 2008, the new T91 radio remote control will be introduced for the Transporter. This is smaller and easier to handle than the previously available T90. Power is supplied via a 3 V lithium battery. The other technical features correspond to those of the T90 radio remote control.

## Technical features

- The distance between the radio remote control and the radio aerial must be at least 2 m to enable the auxiliary heater to be switched on and off with the radio remote control.
- With full battery capacity, the radio remote control has a range of up to 600 m – obstacles between the radio remote control and the vehicle, poor weather conditions and low battery capacity reduce the range.
- The indicator lamp (LED) provides feedback on whether the radio remote control signal has been received by the auxiliary heater and whether the batteries in the radio remote control are weak.



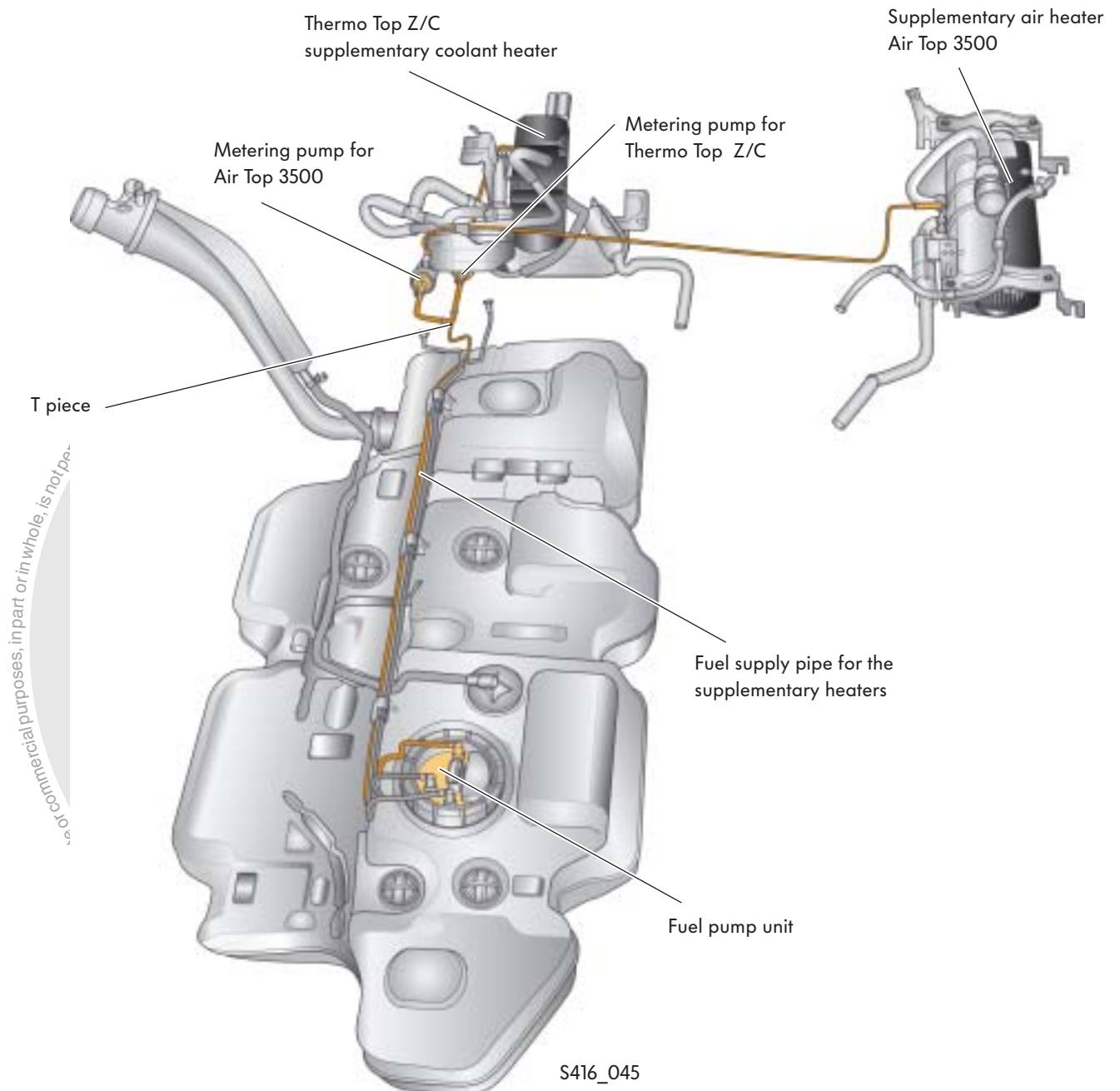
Information on the work sequence for teaching-in the radio remote control is available in ELSA. Battery renewal is described in the owner's manual for the vehicle.

# Transporter – overview of supplementary heaters



## Fuel supply

Fuel is pumped out via the connection at the fuel gauge sender.



## Cut-off

In the Thermo Top Z/C system, fuel cut-off takes place via the information CAN data bus on reaching the reserve fuel quantity.

The Air Top 3500 system cuts off when no further fuel can be taken via the supply line due to a lack of fuel (at approx. 3.1 litres of fuel).

# Transporter – Thermo Top Z/C

## Technical features

The Thermo Top Z supplementary coolant heater is fitted as standard in Transporter vehicles with TDI engines – in combination with certain equipment variants. The supplementary coolant heater is optionally available as an auxiliary heater in the form of the Thermo Top C variant.

The Thermo Top Z/C supplementary coolant heater is a coolant heater unit with evaporator burner. In auxiliary heating mode, its heating time is max. 120 minutes.

The Thermo Top Z/C supplementary coolant heater is integrated into the Transporter's vehicle diagnosis system.

The VAS 5051 B vehicle diagnosis, testing and information system and the VAS 5052 vehicle diagnosis and service information system are available for diagnosis.



S416\_044



## Technical data

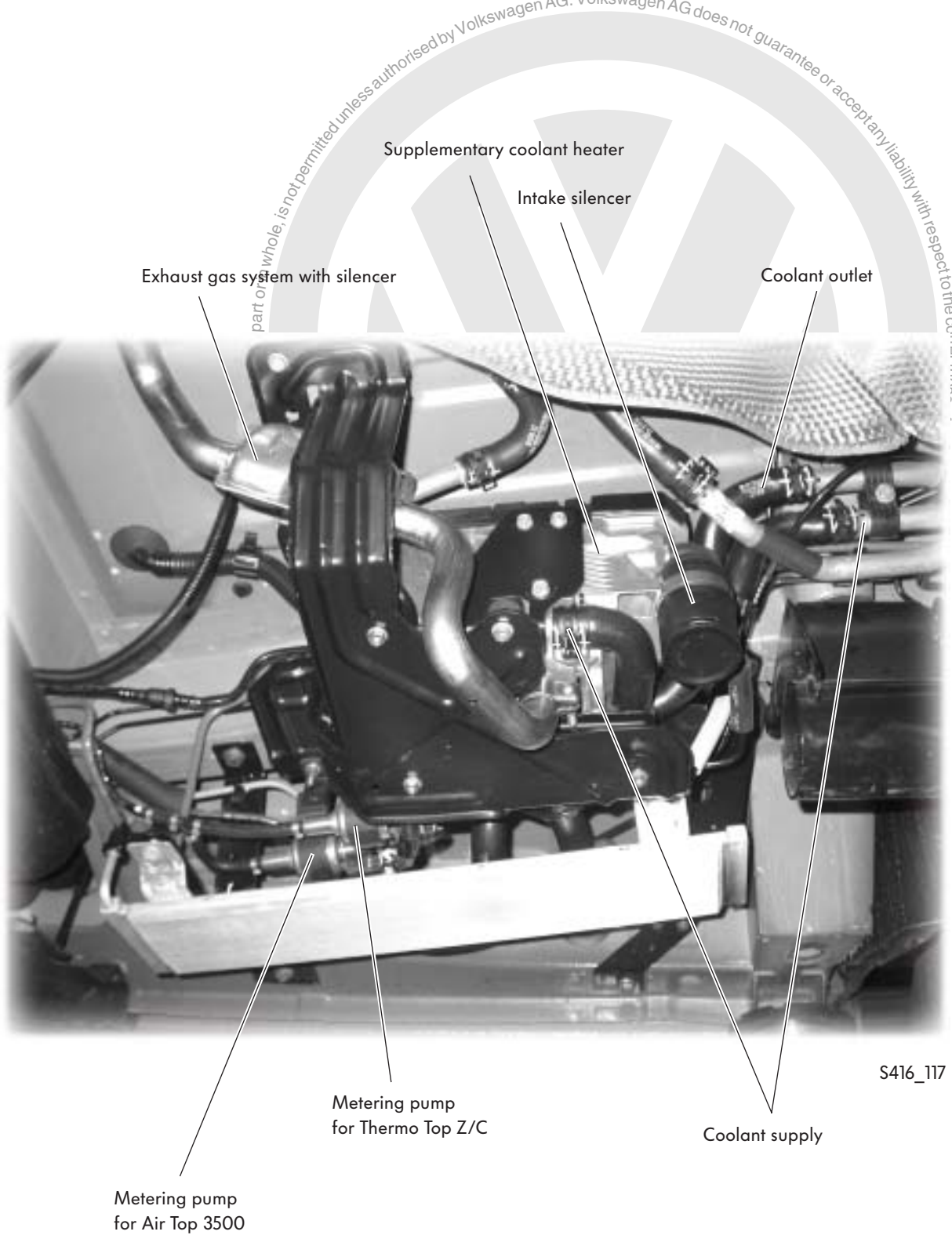
<b>Heat output:</b> Full load: Partial load:	5000 W 2500 W
<b>Fuel:</b>	Petrol, diesel (according to DIN EN 590) and RME* (according to DIN EN 14214)
<b>Current supply:</b>	Via second battery
<b>Rated voltage:</b>	12 V
<b>Operating voltage range:</b>	10.5 ... 15 V
<b>Electrical power consumption:</b> Without recirculation pump and vehicle blower – full load: Without recirculation pump and vehicle blower – partial load:	26 W 18 W
<b>Permissible operating pressure:</b>	0.4 ... 2.5 bar
<b>Fuel consumption:</b> Full load Partial load	Petrol: 0.67 l/h and diesel: 0.59 l/h Petrol: 0.34 l/h and diesel: 0.30 l/h
<b>Undervoltage shut-off:</b>	< 10.2 V
<b>CO<sub>2</sub> in the exhaust gas:</b>	8 ... 12 Vol.%
<b>Weight:</b>	2.9 kg
<b>Manufacturer:</b>	Webasto

\* RME approval is not available for vehicles with diesel particulate filter

# Transporter – Thermo Top Z/C

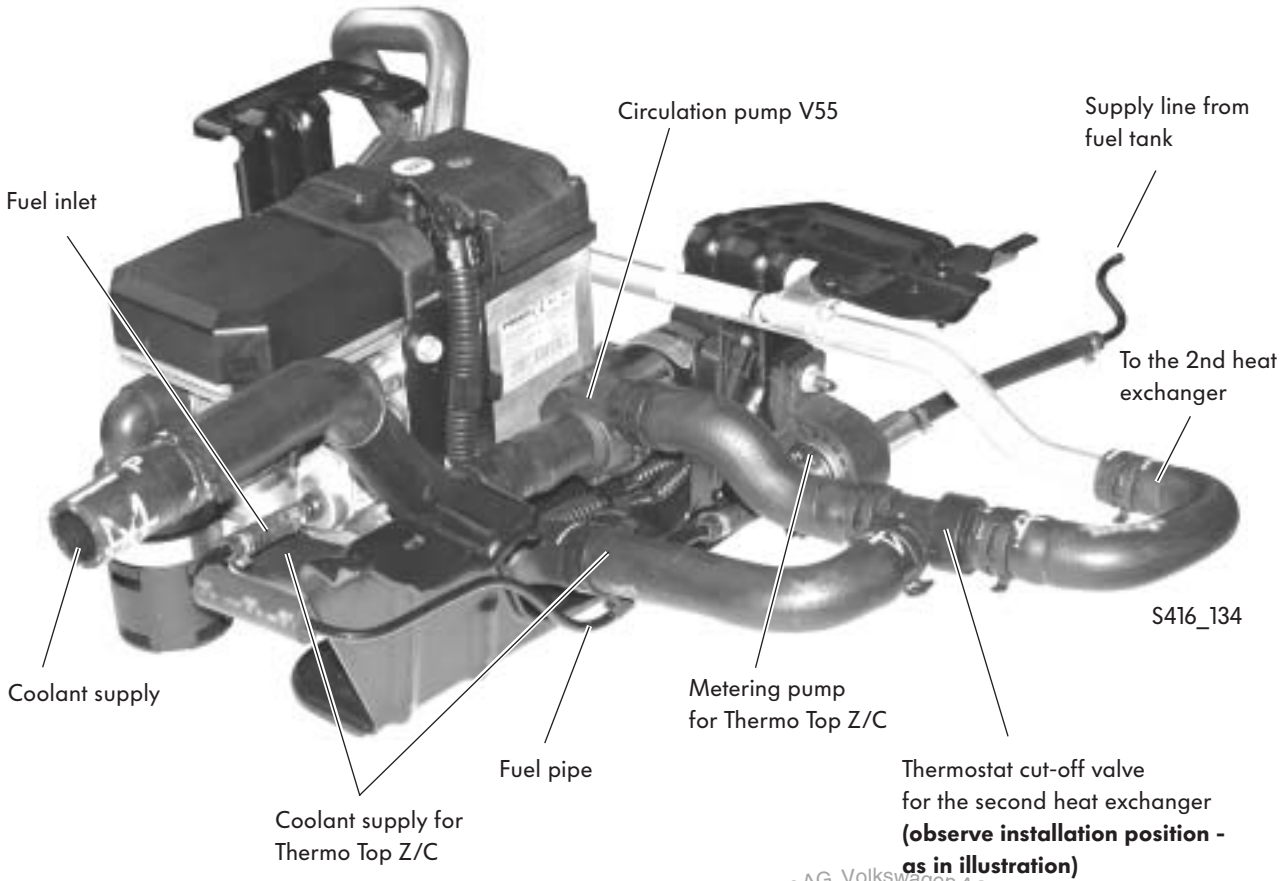
## Installation position

The supplementary heater is installed on the Transporter's left longitudinal member in the direction of travel.

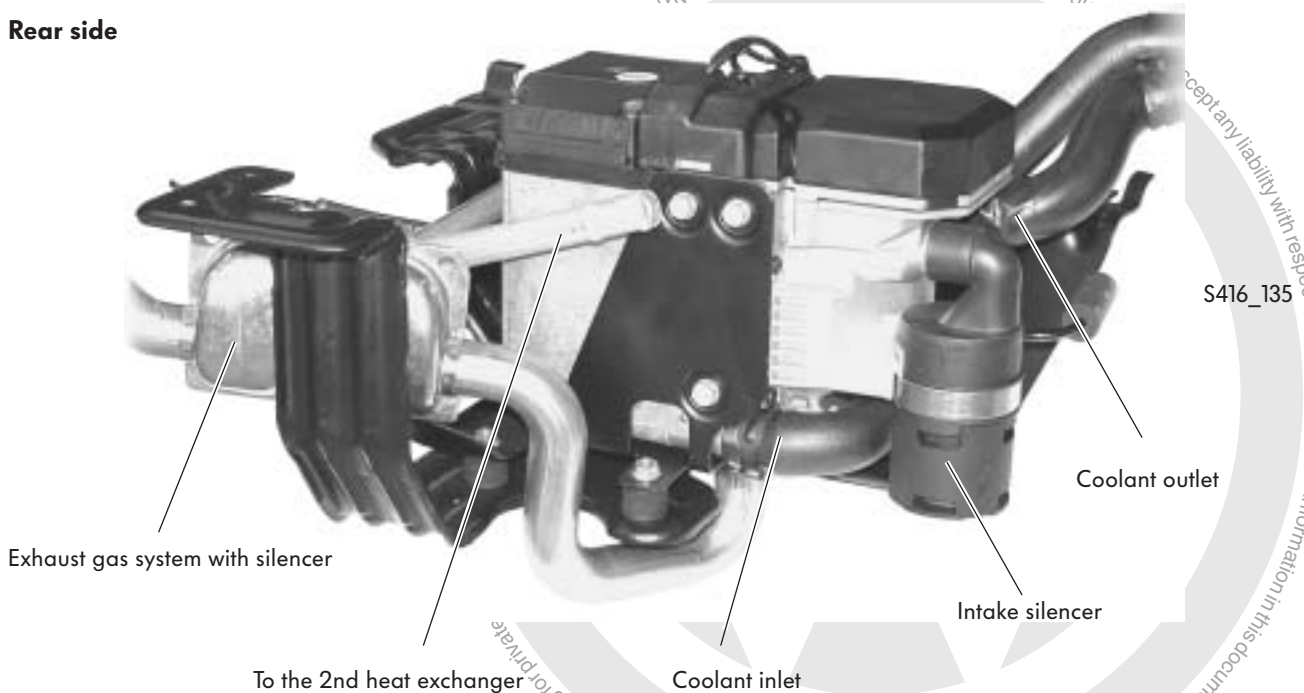


# Heating system with connections

## Front side



## Rear side



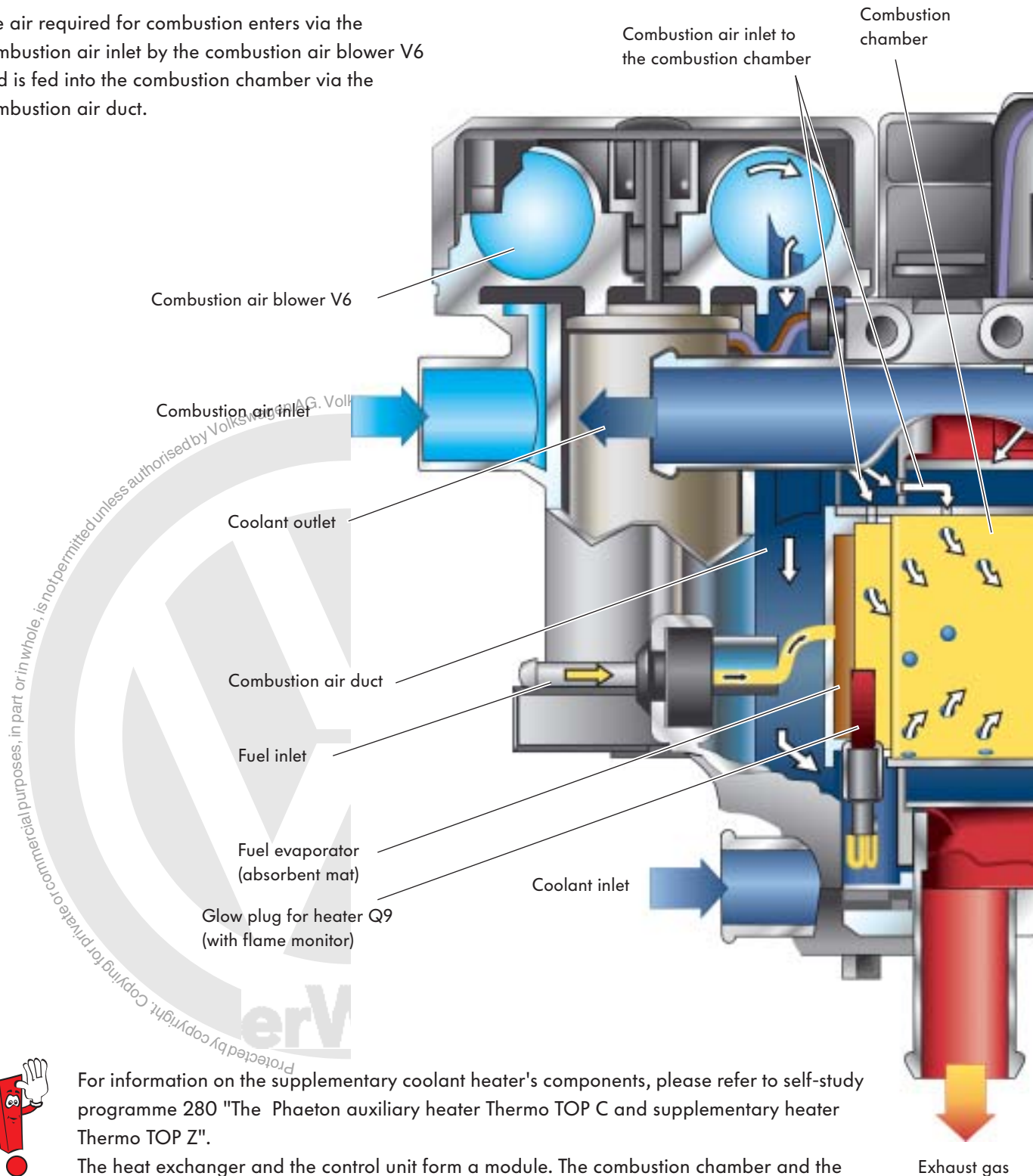
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# Transporter – Thermo Top Z/C

## Design – function overview

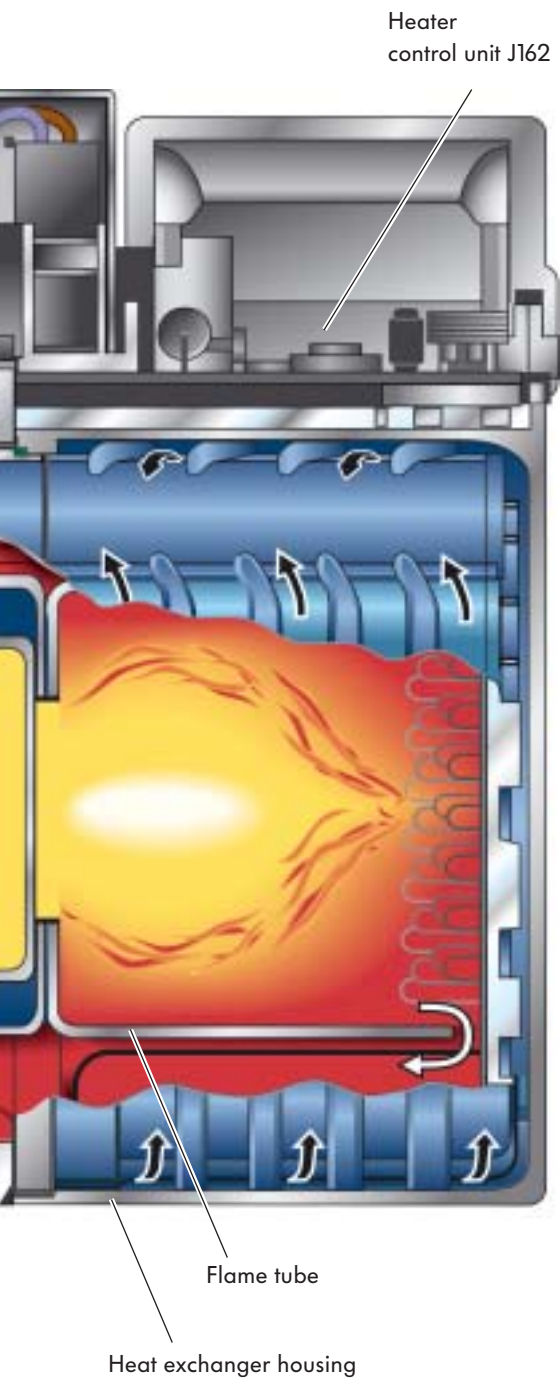
### Air supply for combustion

The air required for combustion enters via the combustion air inlet by the combustion air blower V6 and is fed into the combustion chamber via the combustion air duct.



For information on the supplementary coolant heater's components, please refer to self-study programme 280 "The Phaeton auxiliary heater Thermo TOP C and supplementary heater Thermo TOP Z".

The heat exchanger and the control unit form a module. The combustion chamber and the absorbent evaporator mat can only be renewed together. All of the other components which are shown can be renewed individually.



S416\_030

## Fuel supply and combustion

The supplementary coolant heater is supplied with fuel via the fuel inlet.

The fuel inlet stretches into the evaporator (absorbent mat). The combustion air enters the combustion chamber housing via the combustion air inlet and is then conducted via bores into the combustion chamber and also directly to the absorbent evaporator mat.

In the starting phase, the glow plug for heater Q9 heats the absorbent mat. The fuel which is supplied evaporates over the entire surface of the absorbent mat. A combustible fuel/air mixture is formed in combination with the combustion air which is supplied.

The mixture is ignited by the glow plug. During the heating phase, evaporation and ignition take place on the absorbent mat and the hot walls of the combustion chamber.

During the heating phase, only a small amount of current is applied to the glow plug by the control unit. The glow plug's electrical resistance is therefore used as a flame monitor.

## Coolant

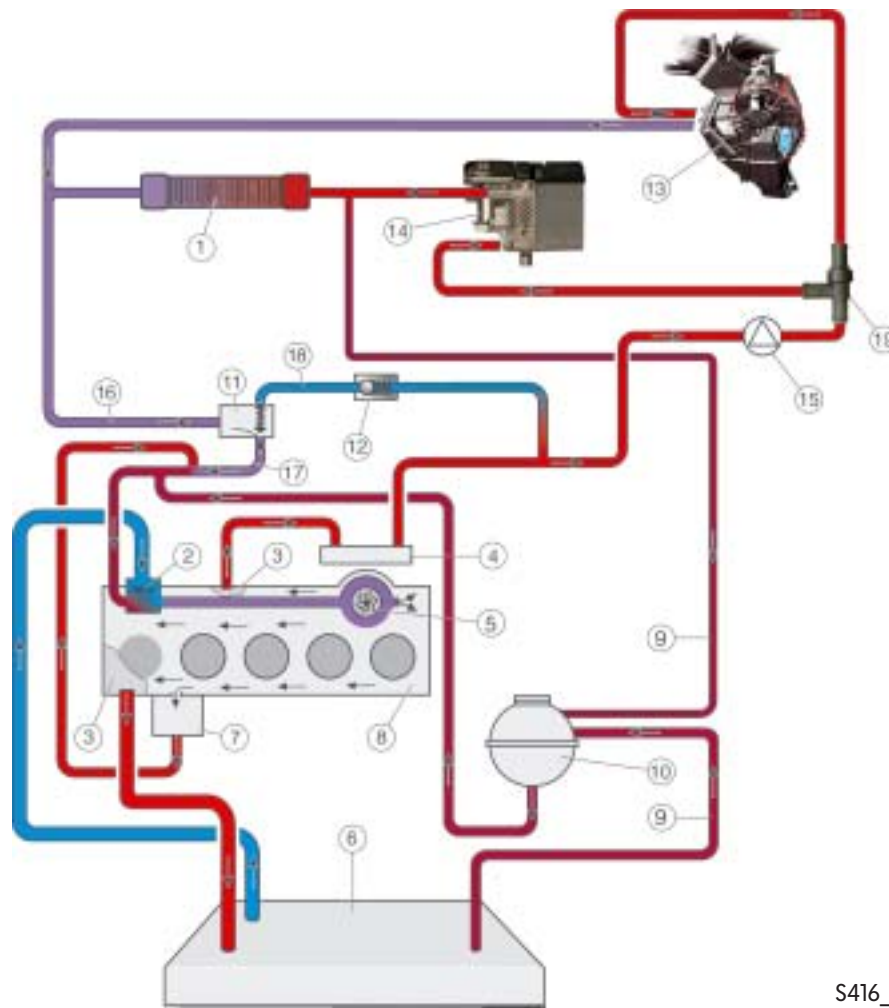
The coolant enters the supplementary coolant heater's water jacket via the coolant inlet aperture. It absorbs heat there. The heated coolant enters the coolant circuit via the coolant outlet aperture.



# Transporter – Thermo Top Z/C

## Coolant circuit

Integration of the Thermo Top Z/C supplementary coolant heater into the coolant circuit is shown using the example of the R5 TDI engine. The coolant circuit in other engines may deviate.



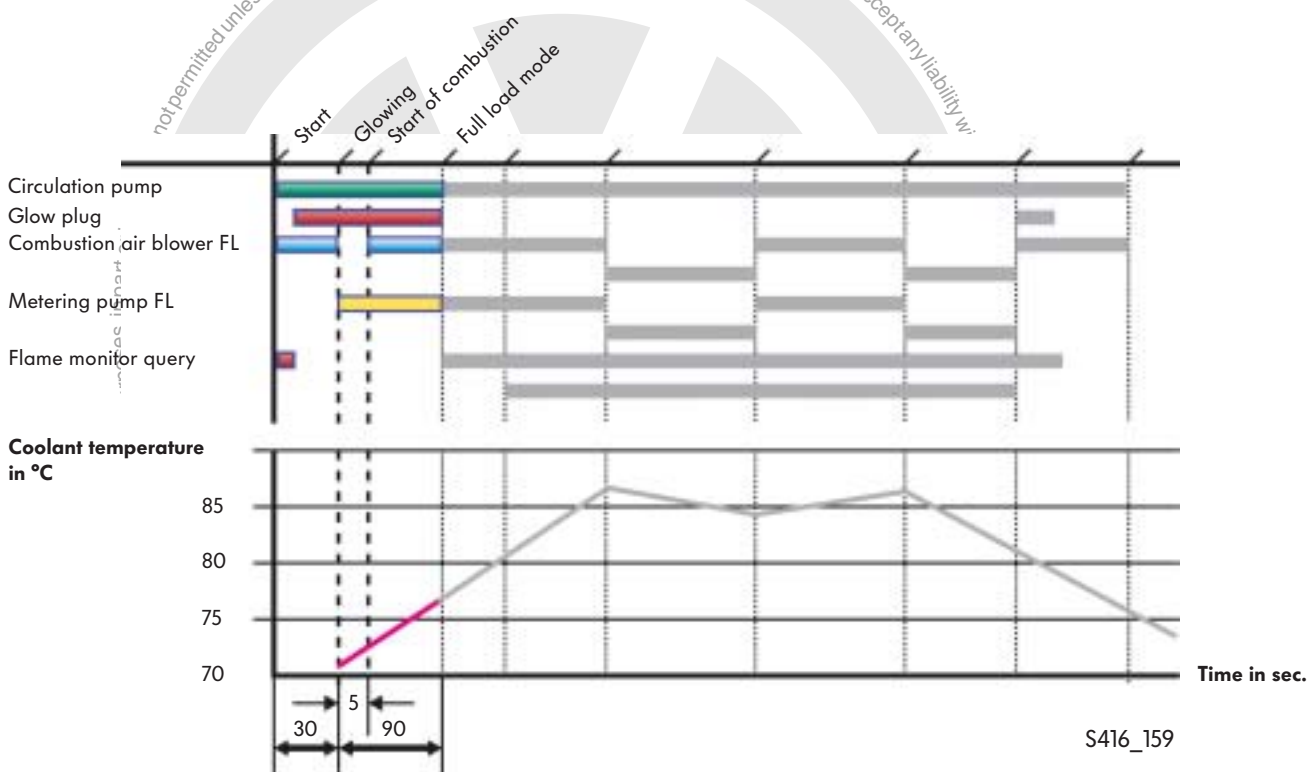
S416\_052

### Legend

- |    |                                      |    |   |
|----|--------------------------------------|----|---|
| 1  | Heat exchanger                       | 11 | Heater coolant shut-off valve N279 (3/2-way directional control valve) (in vehicles with auxiliary heating function only) |
| 2  | Thermostat                           | 12 | Non-return valve  |
| 3  | Cylinder head                        | 13 | Second heat exchanger (for rear area)   |
| 4  | Cooler for exhaust gas recirculation | 14 | Thermo Top C supplementary coolant heater   |
| 5  | Coolant pump                         | 15 | Circulation pump V51/V55  |
| 6  | Radiator                             | 16 | Return from the heater circuit  |
| 7  | Oil cooler                           | 17 | Return to the engine  |
| 8  | Cylinder block                       | 18 | Inlet to the heater circuit   |
| 9  | Breather pipe                        | 19 | Thermostat cut-off valve  |
| 10 | Expansion tank                       |    |   |

# Heating system management

## Auxiliary heating mode – starting phase



### Function

The supplementary coolant heater is switched on via

- The immediate starting function,
- Time pre-selection or
- The radio remote control.

The combustion air blower and the circulation pump are actuated.

The glow plug for heater Q9 begins to glow and the combustion air blower pumps air into the burner insert.

After approx. 30 seconds, the metering pump delivers fuel and the combustion air blower is switched off for approx. 5 seconds so that an adequately rich fuel/air mixture is available for starting.

The combustion air blower's output is gradually increased to full load and the fuel/air mixture is pumped into the combustion chamber. Combustion then commences.

If no flame is formed or if the flame goes out, starting is automatically repeated. After a total of 90 seconds without flame formation, the system is switched off until the ignition is next switched on (terminal 15).



The specified times and temperatures may deviate slightly depending on the model year and control unit software version (technical data correspond to model year 2008).

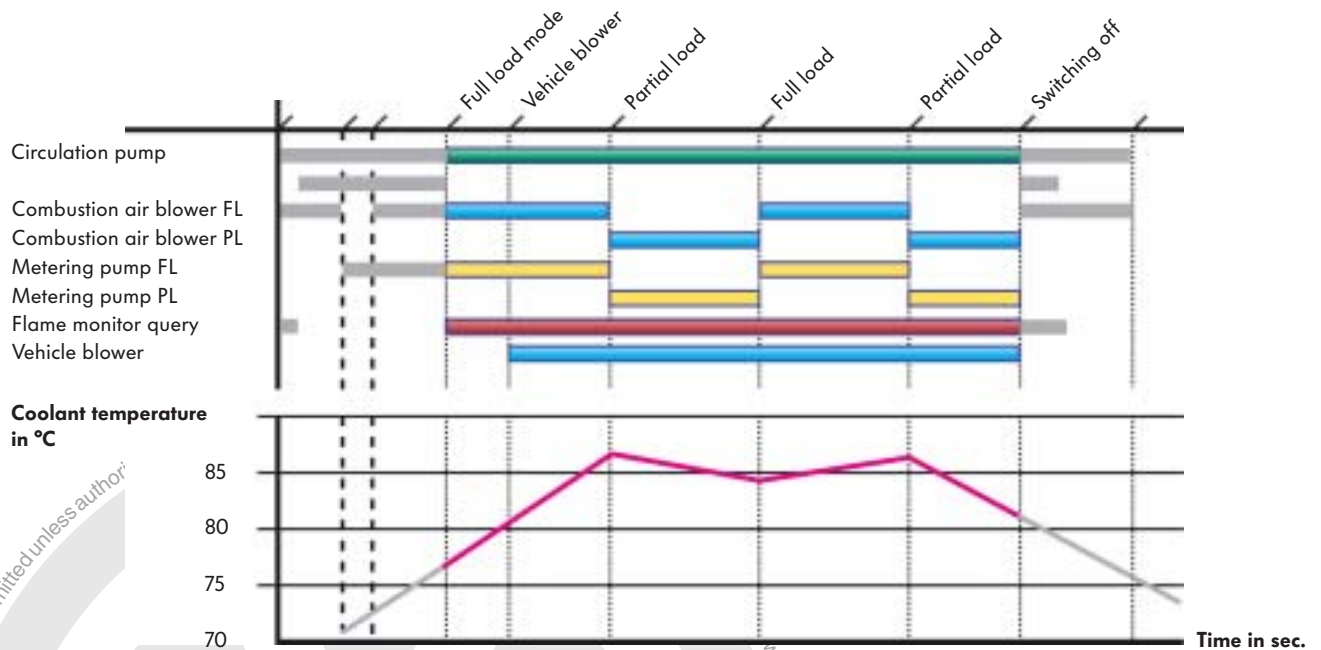
Further information is also available in ELSA, repair group 82.

**This note applies to pages 15 - 18.**



# Transporter – Thermo Top Z/C

## Auxiliary heating mode – heating phase



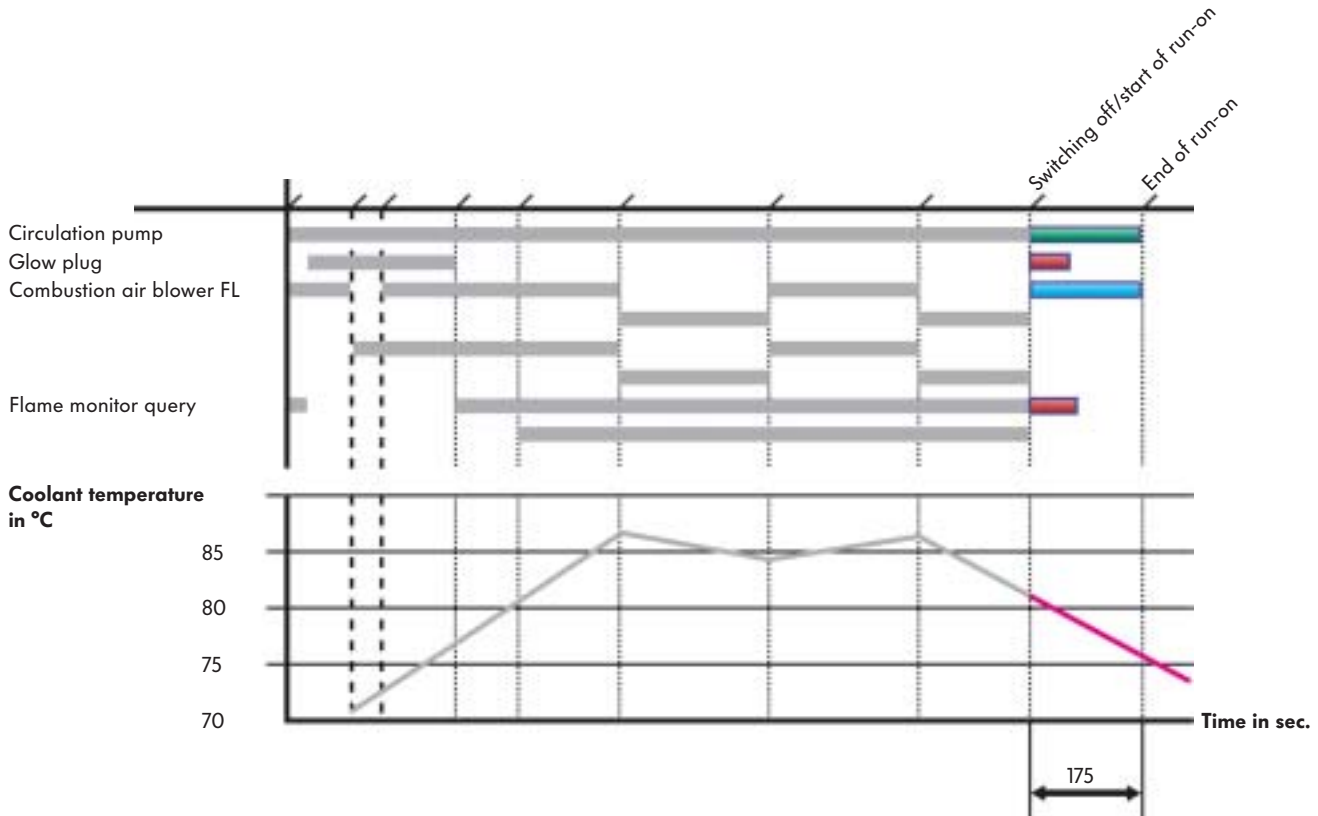
S416\_160

### Function

If the coolant reaches a temperature of 77 °C, the supplementary coolant heater is switched from full load to partial load mode. The combustion air blower's output is therefore reduced. The metering pump delivers less fuel. If the coolant temperature falls to approx. 67 °C, the system switches to full load mode again.

A regulation pause takes place at a coolant temperature of approx. 81 °C. If the coolant temperature falls to approx. 69 °C, a heating phase is started again.

## Auxiliary heating mode – run-on phase



S416\_161

### Function

Supplementary coolant heater shut-off is initiated by

- Switching off the engine,
- Switching off the supplementary coolant heater or
- Expiry of the max. heating duration (120 minutes).

At the end of the heating phase, the metering pump is shut off and combustion is ended.

The circulation pump and the combustion air blower continue to run for cooling purposes and are shut off automatically.

The glow plug for heater Q9 is actuated briefly to burn off residues.

The run-on time is variant-dependent and may be between 100 and 175 seconds.

Run-on time for petrol-driven supplementary coolant heaters:

- 168 seconds on switching off from full load mode
- 157 seconds on switching off from partial load mode

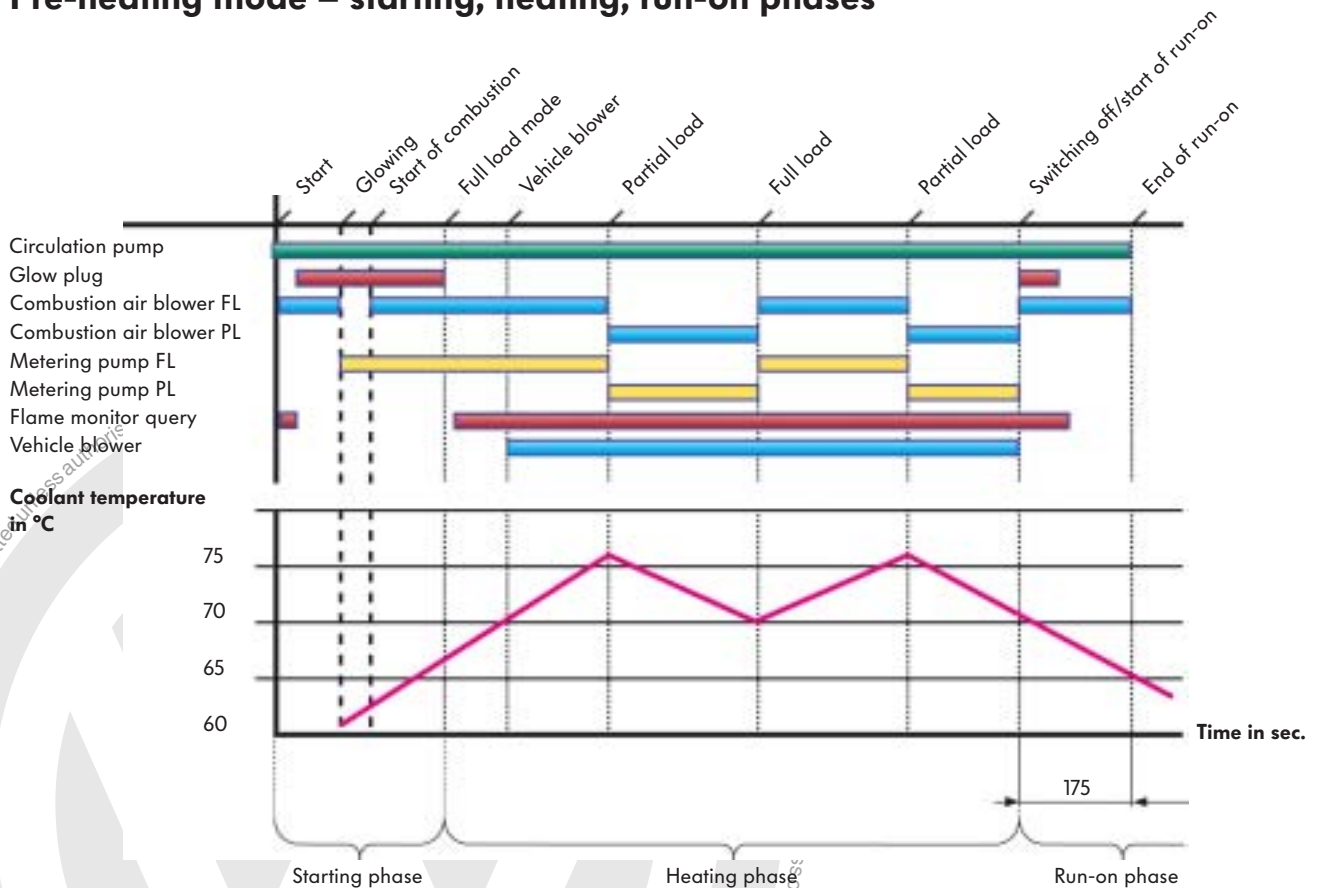
Run-on time for diesel-driven supplementary coolant heaters:

- 175 seconds on switching off from full load mode
- 100 seconds on switching off from partial load mode



# Transporter – Thermo Top Z/C

## Pre-heating mode – starting, heating, run-on phases



### Function

#### Starting phase

At a coolant temperature of less than +69 °C, an exterior temperature of less than +10 °C and when the engine speed signal is present at the control unit, the operating conditions are given and the starting process begins.

#### Heating phase

A regulation pause takes place when the coolant reaches a temperature of +81 °C. At a coolant temperature of +77 °C, the system switches from full load to partial load mode. If the coolant temperature falls below +69 °C during the regulation pause, the heating system starts up in partial load mode with the regular starting process.

#### Run-on phase

After reaching the engine's operating temperature, the pre-heater is shut off. Combustion is ended and run-on commences.

Run-on time for pre-heater:

- 175 seconds on switching off from full load mode
- 100 seconds on switching off from partial load mode

## Switching on conditions

### Pre-heater

- Coolant temperature:  $t < 69\text{ °C}$   
(measured at the coolant temperature sender for heater G241)
- Exterior temperature:  $t < 10\text{ °C}$
- Terminal 15 (ignition): On
- Engine speed signal:  $n > 300\text{ rpm}$

### Auxiliary heater

- Switch-on request via roof display module
- Switch-on request via radio remote control
- Running time:
  - 30 minutes (installation up to week 30/2004)
  - 120 minutes (installation as of week 30/2004)



Regardless of engine operation, the supplementary coolant heater runs in auxiliary heating mode until the pre-selection time has expired. In vehicles with TDI engine and pre-heater, the system automatically switches to pre-heating mode on expiry of the pre-selection time when the engine is running.

## Switching off conditions

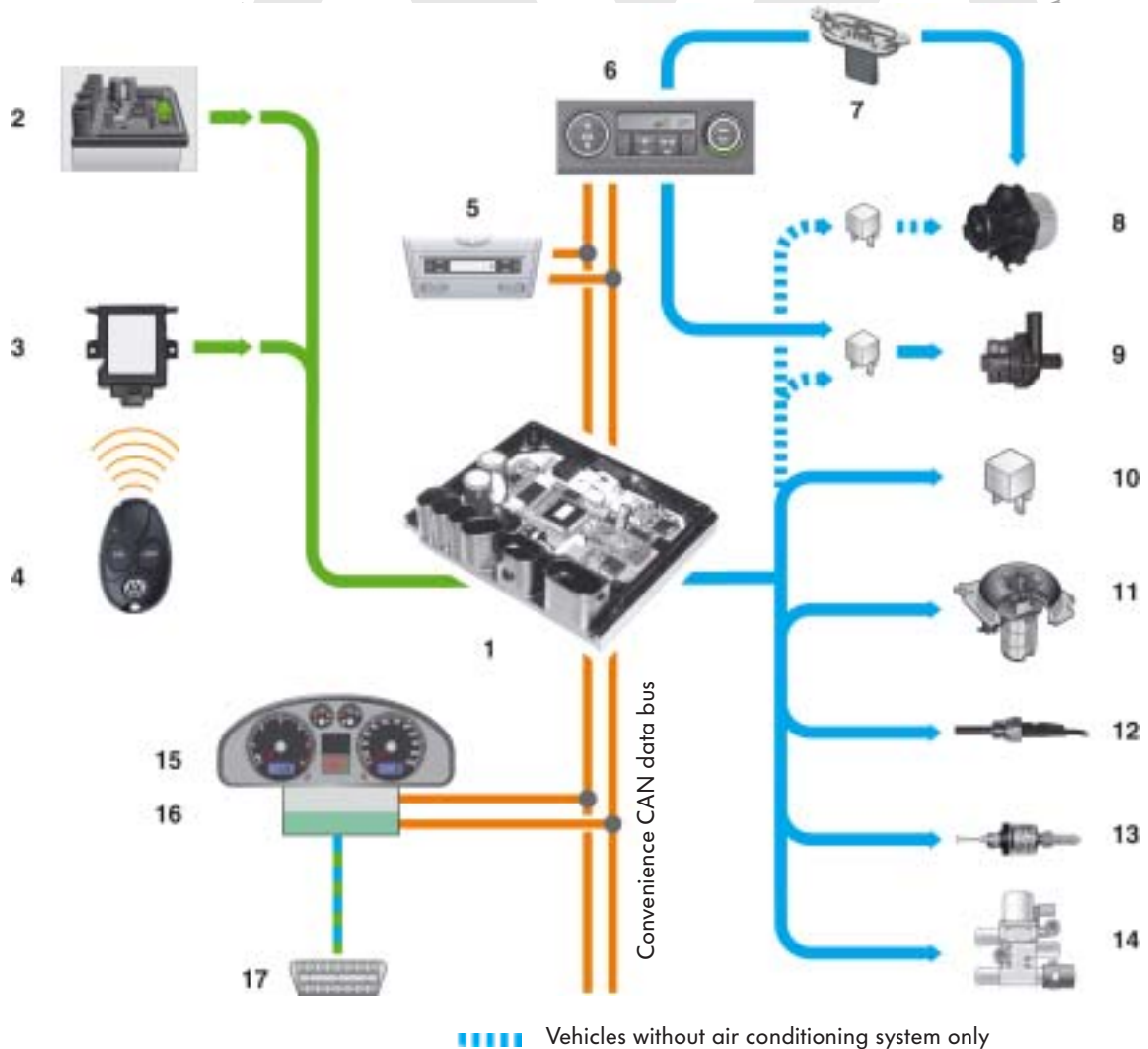
### Pre-heater/auxiliary heater

- Pre-heater: Coolant temperature  $t > 85\text{ °C}$
- Pre-heater: Engine speed  $n < 300\text{ rpm}$
- Auxiliary heater: Pre-selection time expired, switched off manually
- Fuel: Reserve mode
- Undervoltage shut-off:  $U < 10.5\text{ V}$  for more than 20 seconds
- Internal overheating shut-off: Temperature in the heater unit  $> 125\text{ °C}$
- Crash signal: Via airbag deployment



# Transporter – Thermo Top Z/C

## Overview of the system



S416\_146

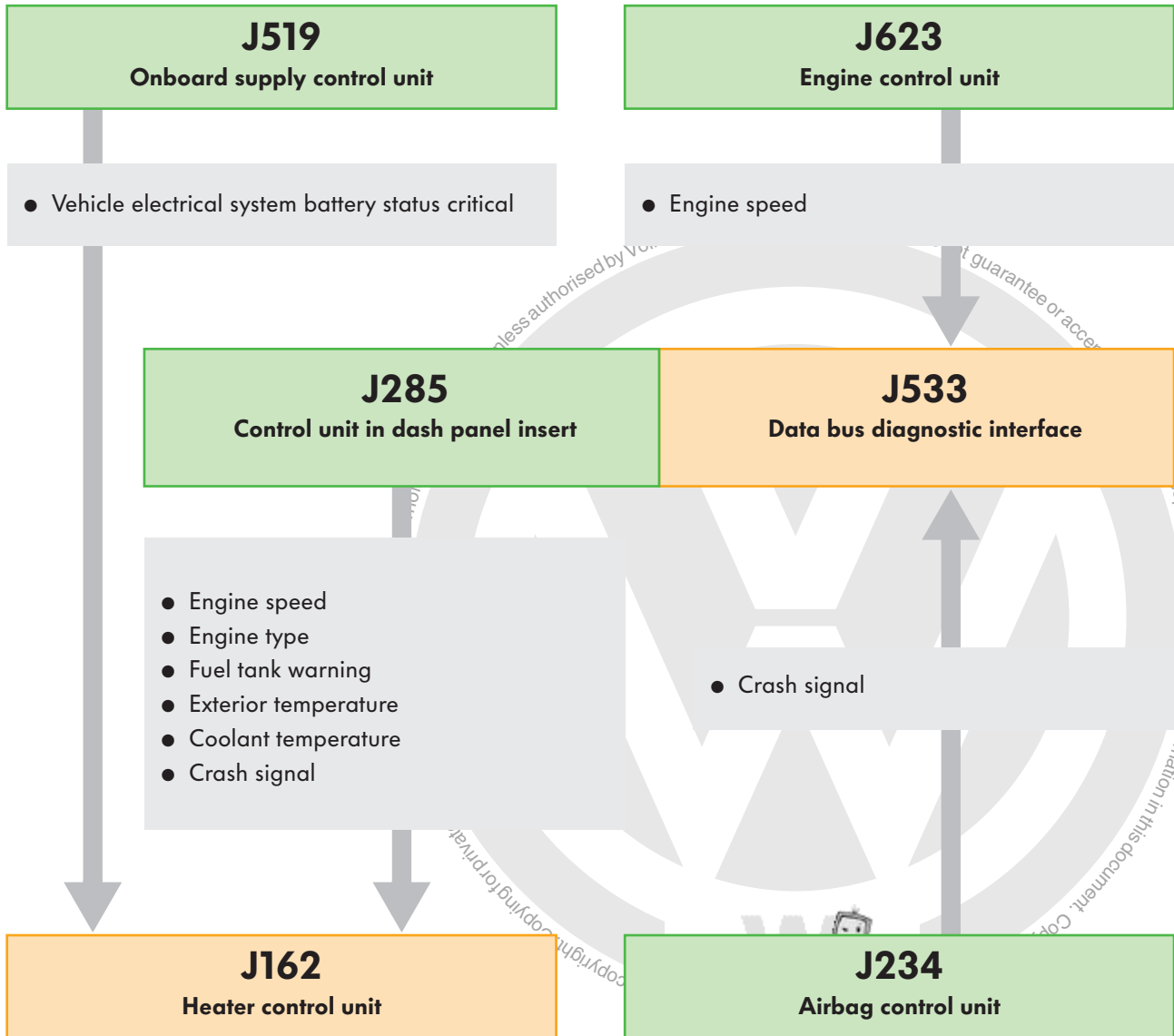
### Legend

- |   |   |
|---|---|
| 1 - Heater control unit J162  | 9 - Coolant pump relay J708*,<br>coolant circulation pump V51/V55                         |
| 2 - Coolant temperature sender for heater G241  | 10 - Battery isolation relay J7   |
| 3 - Remote control receiver for auxiliary coolant heater R149   | 11 - Combustion air blower V6   |
| 4 - Radio remote control T91  | 12 - Glow plug for heater Q9  |
| 5 - Auxiliary heater operating and display unit E407  | 13 - Metering pump V54  |
| 6 - Link to ambient air for interior temperature sensor under "ECON" button, in the Climatronic control unit J255 | 14 - Heater coolant shut-off valve N279, in vehicles with auxiliary heating function only |
| 7 - Sender (control unit) for Climatronic blower regulation G462  | 15 - Control unit in dash panel insert J285   |
| 8 - Blower motor V305, auxiliary heater relay J8*, fresh air blower V2*   | 16 - Data bus diagnostic interface J533   |
|   | 17 - Diagnostic connection  |
- \* Vehicles without air conditioning system only

# Networking

## Data bus messages

List of the most important CAN messages for the Thermo Top Z (pre-heater) system function.



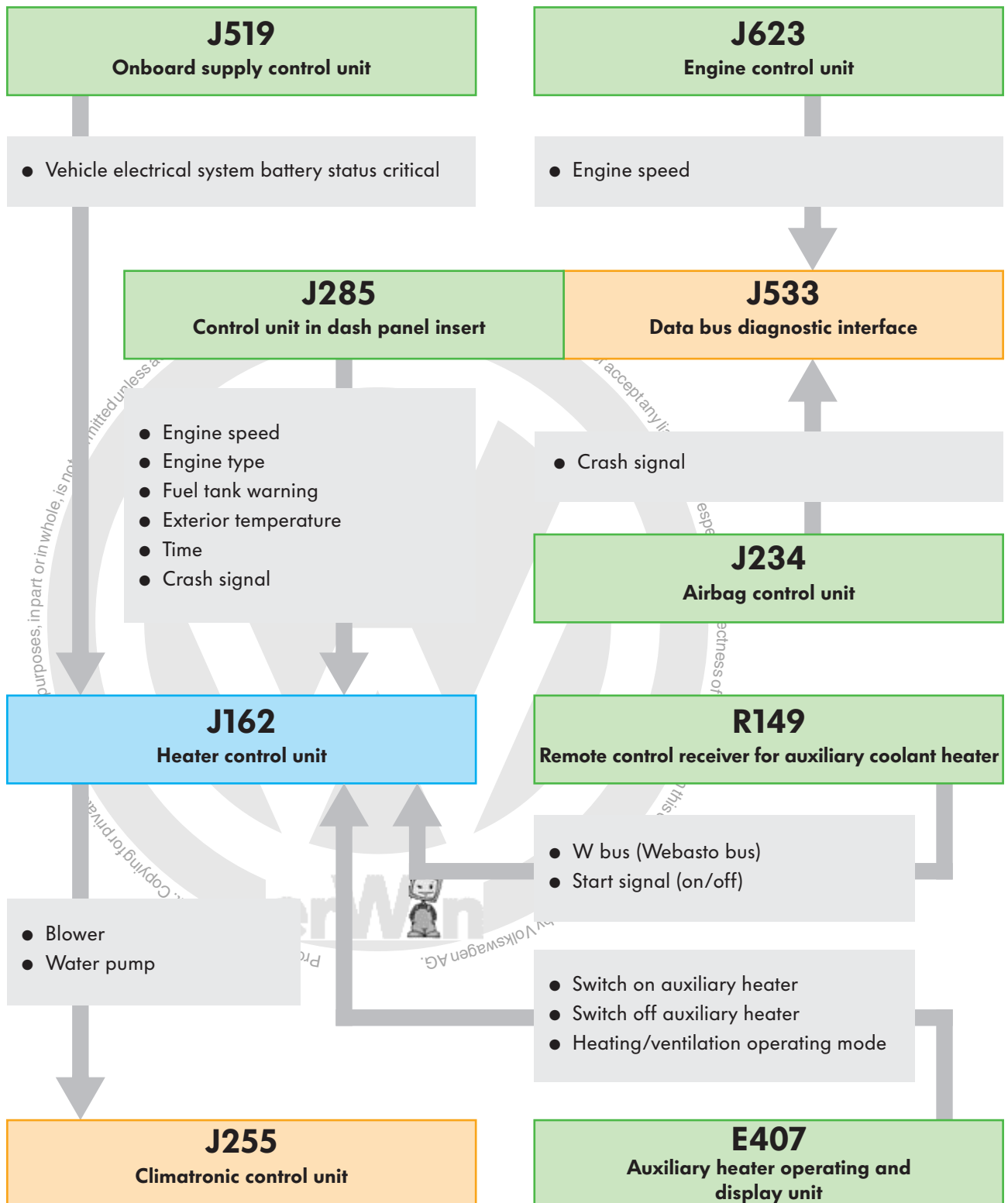
-  Transmitter
-  Receiver

# Transporter – Thermo Top Z/C

## Networking

### Data bus messages

List of the most important CAN messages for the Thermo Top C (auxiliary heater) system function.



# Transporter – Air Top 3500

## Technical features

The Air Top 3500 supplementary heater is an air-based auxiliary heater. It has a pre-selection function for programming the switch-on time and the desired temperature.

The Air Top 3500 is integrated into the Transporter's vehicle diagnosis system.

The vehicle diagnosis, testing and information system VAS 5051 B and the vehicle diagnosis and service information system VAS 5052 are available for diagnosis.



S416\_066



## Technical data

<b>Max. heat output:</b>	3000 W (high) and 1500 W (low)
<b>Fuel:</b>	Petrol, diesel (according to DIN EN 590) and RME* (according to DIN EN 14214)
<b>Current supply:</b>	Via second battery
<b>Operating voltage:</b>	12 V
<b>Electrical power consumption in the regulation range:</b>	15 W (low) 33 W (high)
<b>Fuel consumption:</b>	0.19 l/h ... 0.46 l/h (petrol) 0.15 l/h ... 0.42 l/h (diesel)
<b>Undervoltage shut-off:</b>	10.5 V
<b>Overvoltage shut-off:</b>	16 V
<b>Permissible combustion air intake temperature:</b>	-40 to +20 °C
<b>Interior temperature setting range:</b>	+5 to +35 °C
<b>CO<sub>2</sub> in the exhaust gas:</b>	
Low stage:	5 ... 8 Vol.%
High stage:	9 ... 12.5 Vol.%
<b>Heater unit weight:</b>	5.9 kg
<b>Manufacturer:</b>	Webasto

\* RME approval is not available for vehicles with diesel particulate filter

## Colour legend for page 22



Transmitter



Receiver



Transmitter and receiver

# Transporter – Air Top 3500

## Installation position

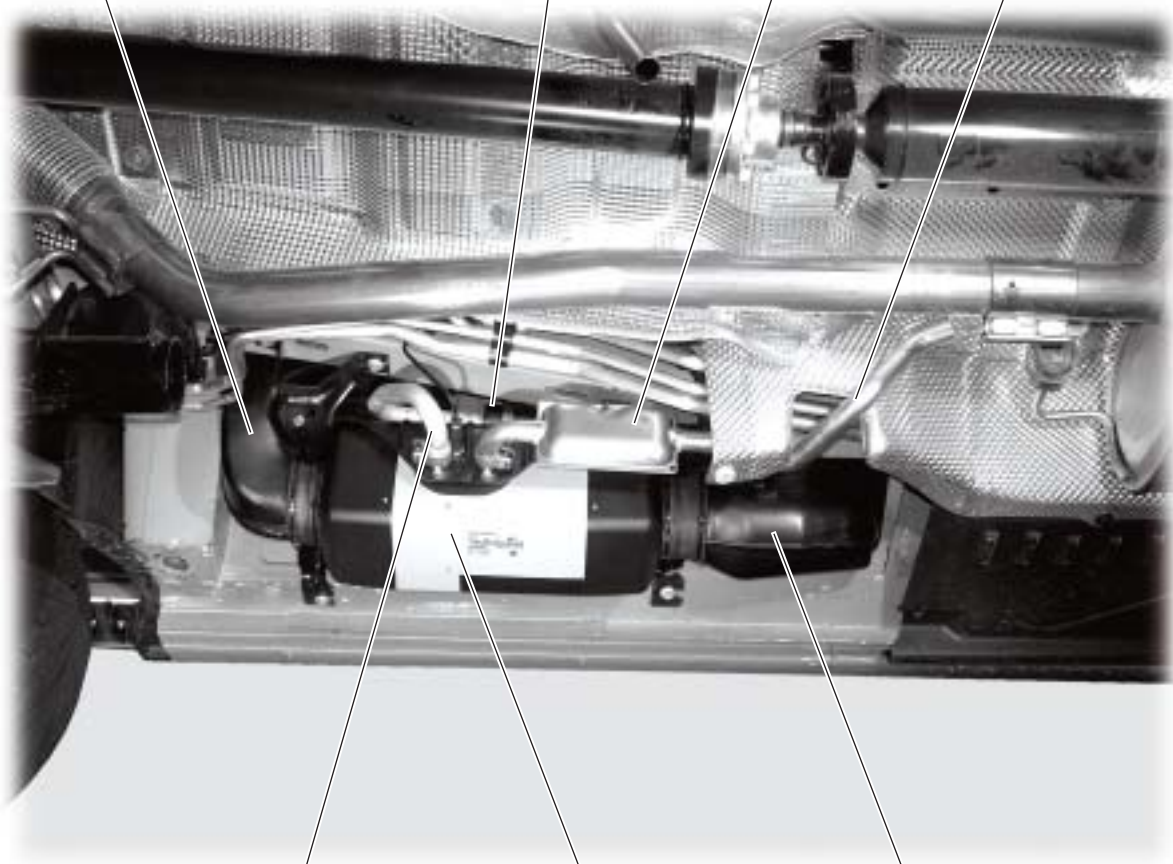
The Air Top 3500 auxiliary heater is installed underneath the Transporter on the right-hand side of the vehicle.

Intake air supply from the vehicle interior (recirculated air)

Intake silencer

Exhaust gas system with silencer

Exhaust pipe



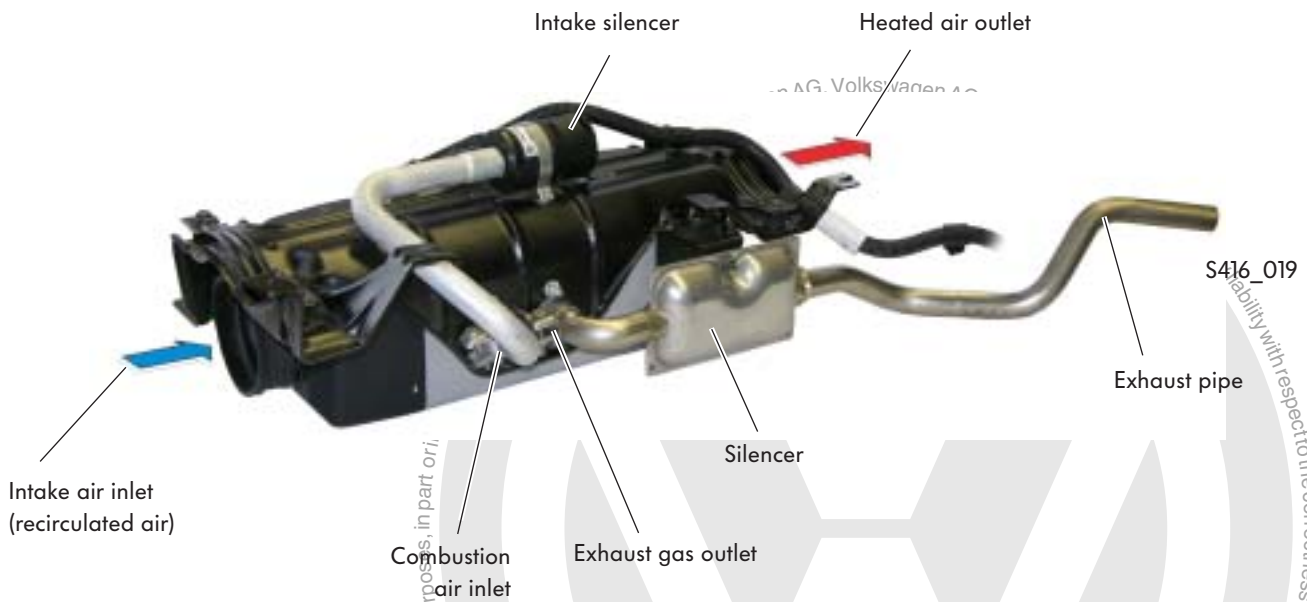
S416\_112

Combustion air supply

Air Top 3500 auxiliary heater

Heated air supply into the vehicle interior

## Heating system and connections



## Air ducting

### Intake air inlet

The intake air (recirculated air) enters via an air slot in the area of the front passenger door entrance.



S416\_021

### Heated air outlet

The heated air is conducted from two air slots in the lower area of the B-pillar, behind the front passenger seat, and into the load and passenger compartment.



S416\_022

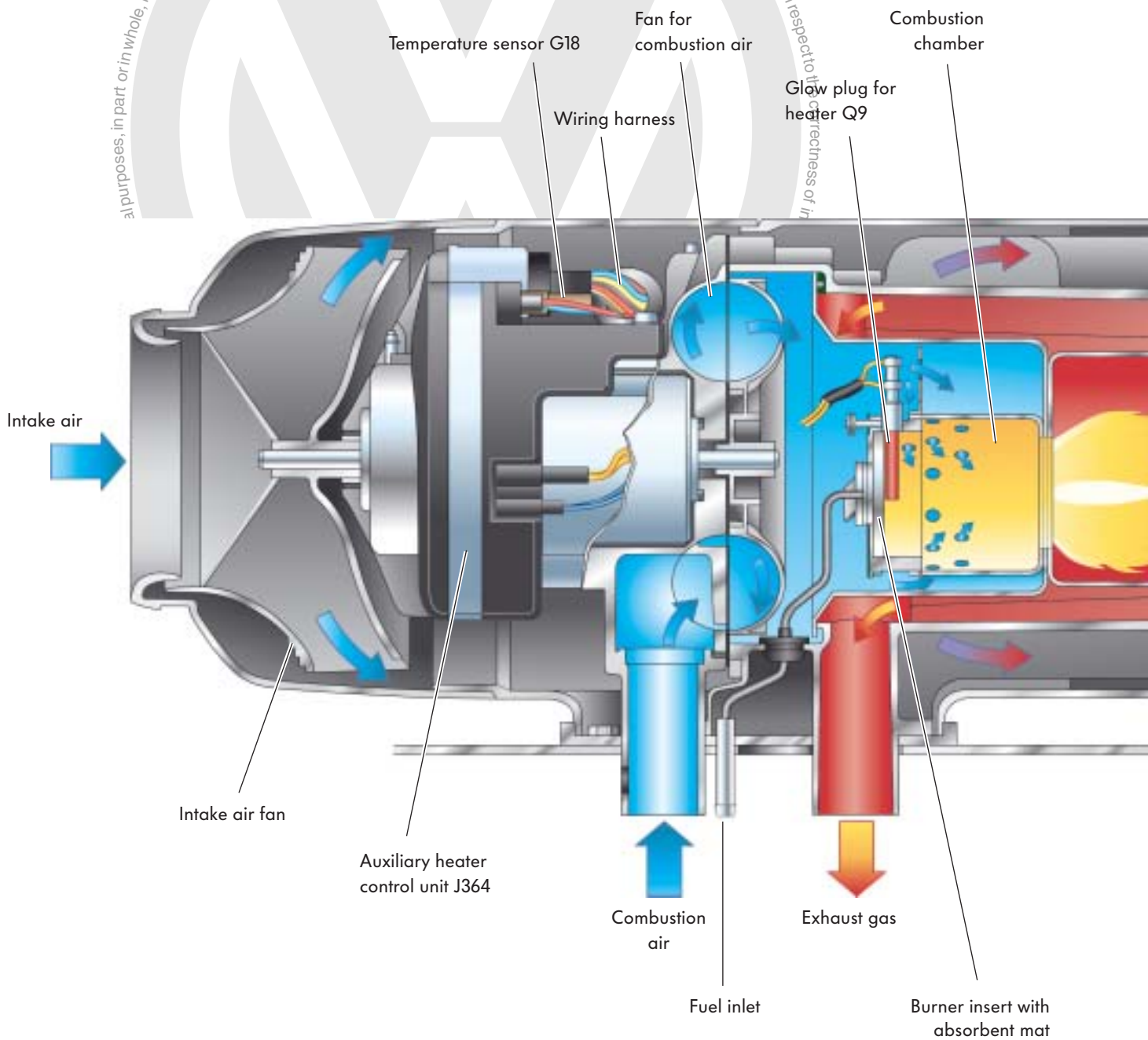


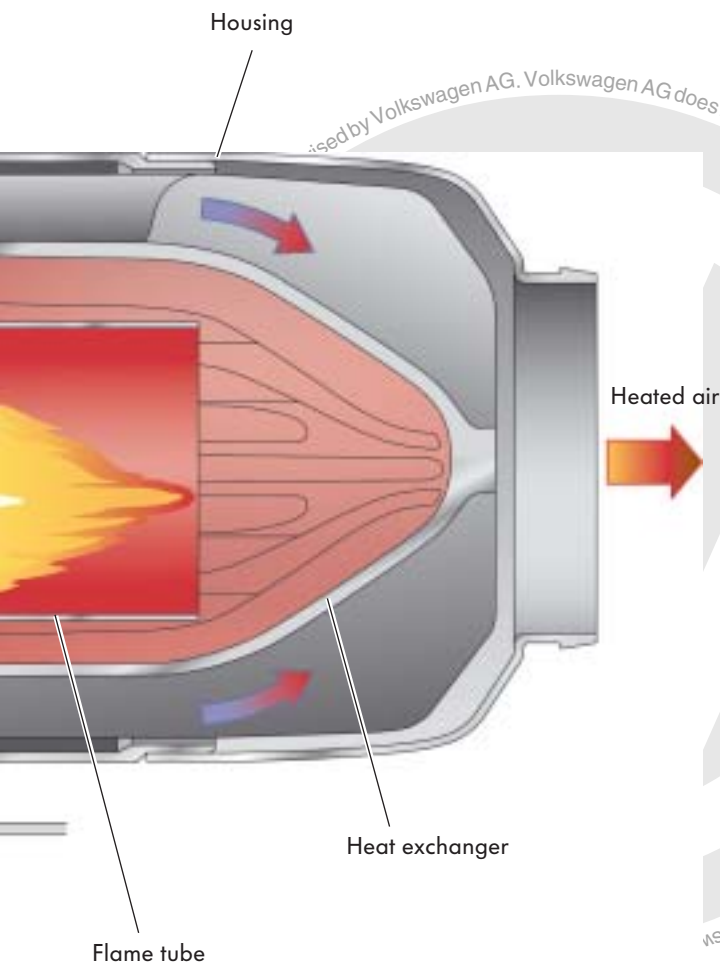
# Transporter – Air Top 3500

## Design – function overview

### Air supply for combustion

The air required for combustion enters into the combustion air housing by the combustion air blower V6 fan for combustion air via the combustion air hose; from there, it is conducted into the combustion chamber.





S416\_048

## Fuel supply and combustion

The supplementary heater is supplied with fuel via the fuel inlet. The fuel inlet stretches into the evaporator (absorbent mat). The combustion air enters the combustion chamber housing via the combustion air inlet and is then conducted via bores into the combustion chamber and also directly to the absorbent evaporator mat.

In the starting phase, the glow plug for heater Q9 heats the absorbent mat. The fuel which is supplied evaporates over the entire surface of the absorbent mat. A combustible fuel/air mixture is formed in combination with the combustion air which is supplied. The glow plug ignites the mixture in its vicinity and in the adjacent combustion chamber.

Subsequently, during the heating phase, after the glow plug has been switched off, evaporation and ignition take place on the absorbent mat and the hot walls of the combustion chamber. The flame front continues into the flame tube.

During the heating phase, only a small amount of current is applied to the glow plug by the control unit. The glow plug's electrical resistance is therefore used as a flame monitor.

## Intake and heated air

The intake air enters via an aperture in the face end of the heating system by the combustion air blower's intake air fan and is guided past the heat exchanger at the outer side.

The air absorbs heat whilst doing so, and emerges from the heating system as heated air via the outlet aperture at the other face end.



# Transporter – Air Top 3500

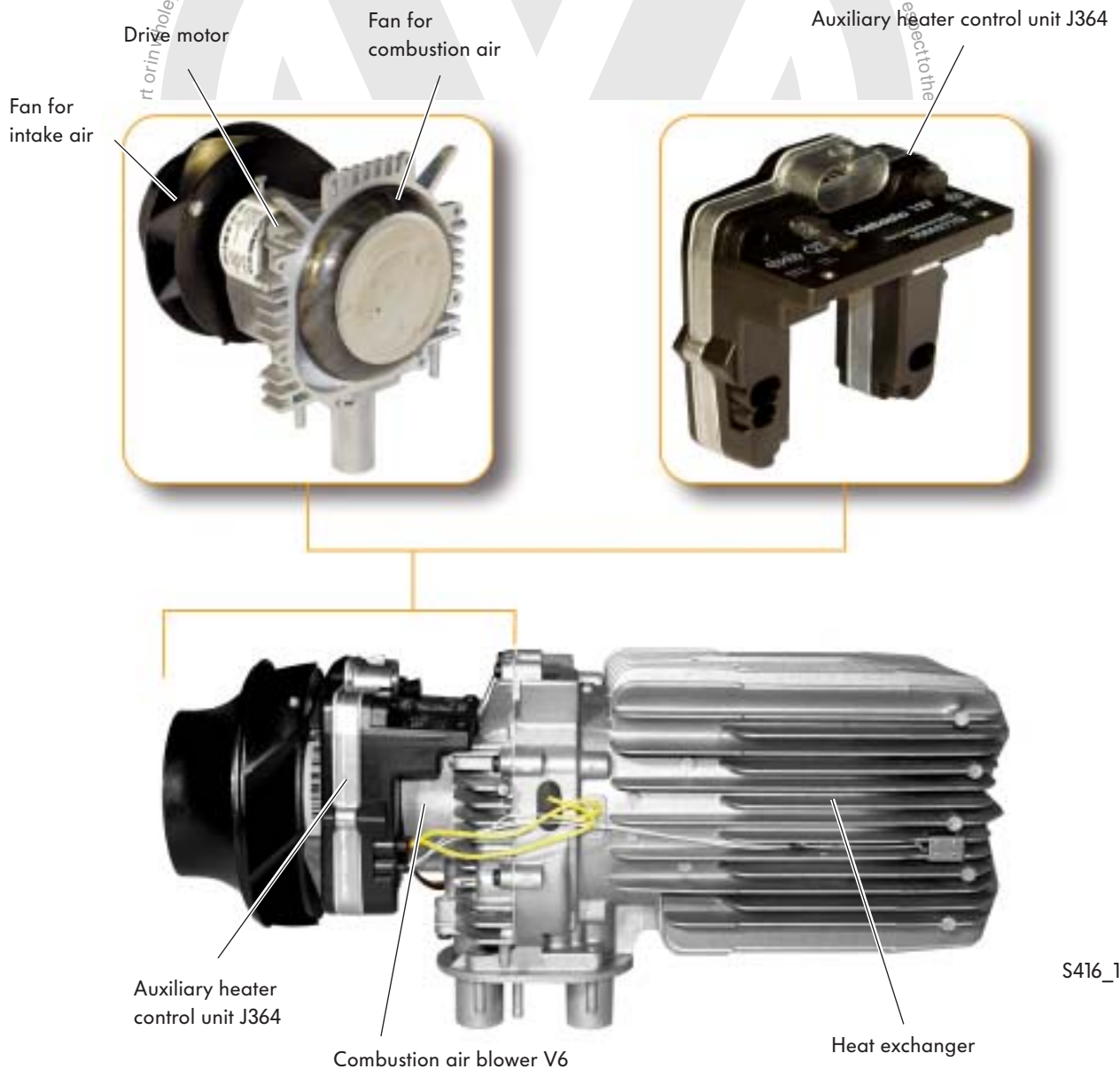
## Combustion air blower V6 and auxiliary heater control unit J364

The combustion air blower is a combined component. It has both a fan for the intake air and the combustion air. Both fans have a common drive motor. The fan for intake air and the fan for combustion air are driven via the motor's armature shaft. The blower operates in 2 speed stages to dissipate the heat.

The auxiliary heater control unit J364 is positioned between the fan for heated air and the fan for combustion air at the top of the common combustion air housing shaft.

### Combustion air blower V6

### Auxiliary heater control unit J364



S416\_126

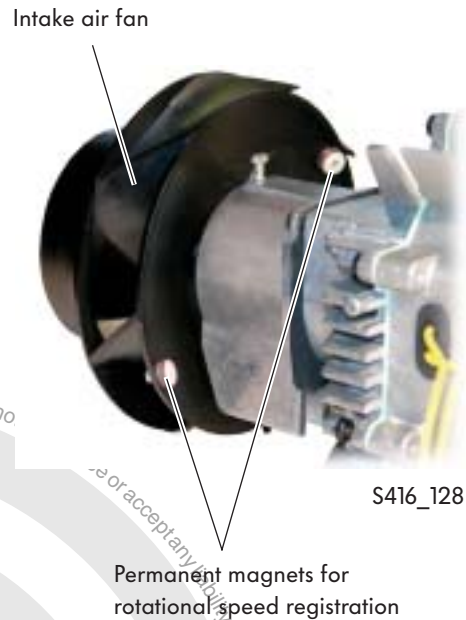
## Speed sensor

An even and correct blower speed is important for optimal mixture formation.

The blower speed is measured by a Hall sender in combination with two permanent magnets for rotational speed measurement.

The Hall sender is installed within the control unit housing – invisible from the outside.

The two permanent magnets for rotational speed measurement are secured, offset by 180° around the circumference, at the rear of the fan for heated air.

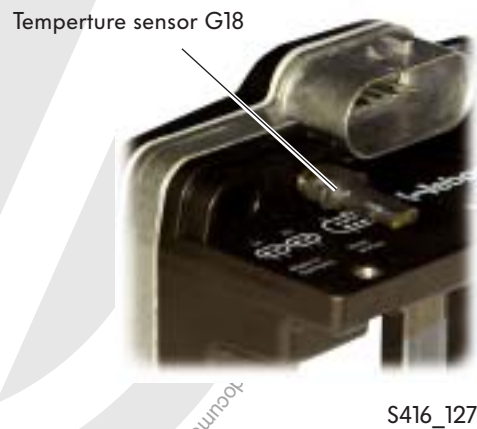


## Temperature sensor G18

The temperature sensor G18 for measuring the temperature of the recirculated air intaken from the interior of the vehicle is located at the top rear of the control unit.

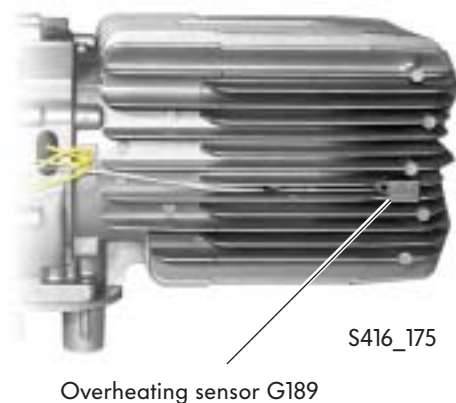
The temperature sensor consists of an NTC resistor.

The auxiliary heater control unit J364 evaluates the recorded temperature value as the actual interior temperature value and regulates the heat output stage according to the desired temperature set by the driver (nominal value).



## Overheating sensor G189

The overheating sensor G189, which is located between the fins of the heat exchanger, is a PTC resistor and measures the temperature at the heat exchanger. It serves to monitor the combustion temperatures and therefore to avoid positive temperature deviations in the supplementary heater.



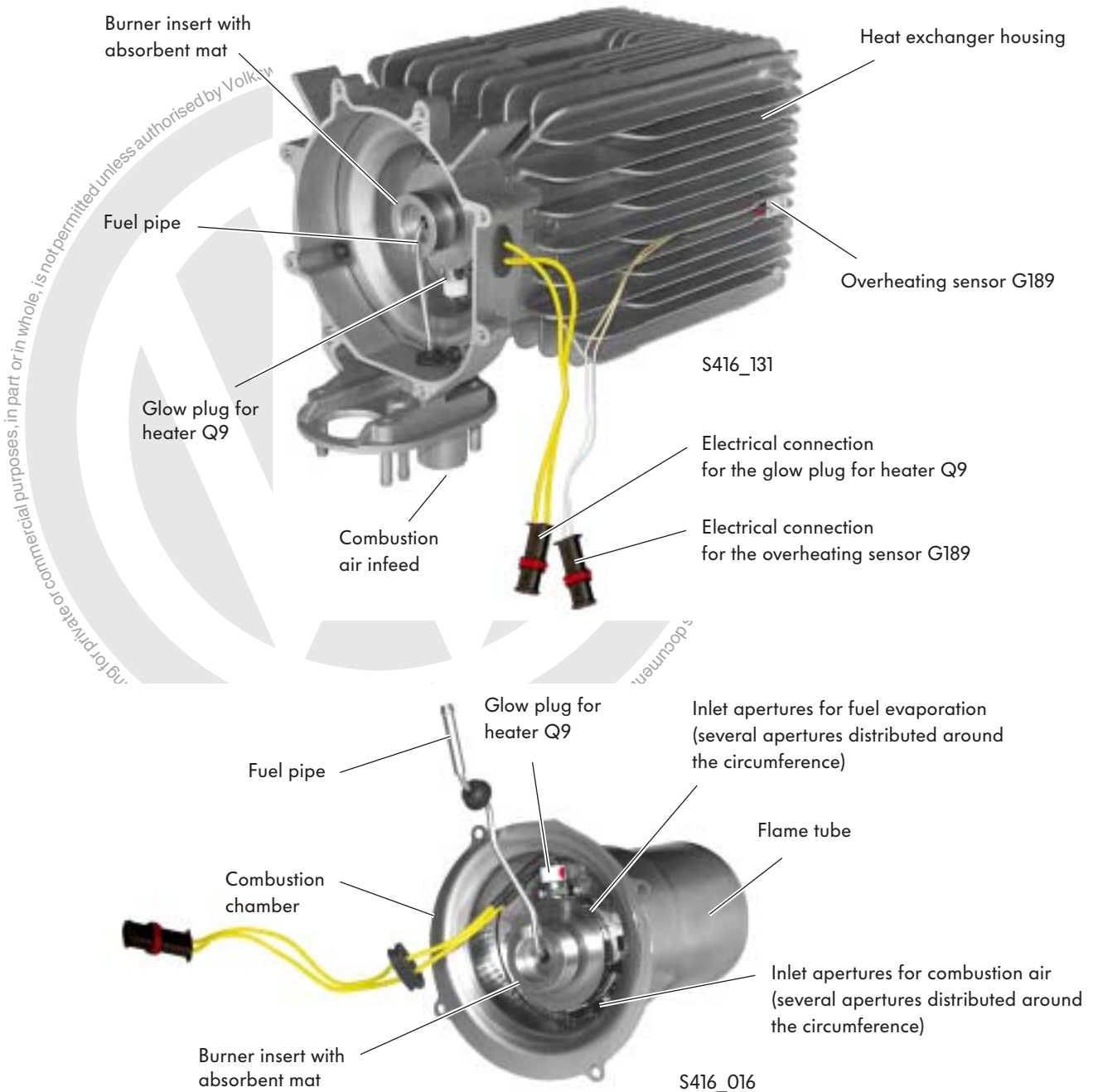
# Transporter – Air Top 3500

## Heat exchanger and combustion chamber with flame tube

The combustion chamber with flame tube, the burner insert with absorbent mat and the glow plug for heater Q9 are installed in the heat exchanger.

The air supplied by the combustion air blower's fan is delivered to the burner via the combustion chamber's inlet apertures and is therefore made available for mixture formation.

The heat exchanger, the combustion chamber with flame tube and the burner insert with absorbent mat can be renewed individually.



## Glow plug for heater Q9

The glow plug for heater Q9 is activated immediately after switching on the heater unit. After approx. 116 seconds, the glow plug is switched off and the flame monitor function is activated.

When switching off the heater unit, the glow plug is switched on for approx. 20 seconds within the run-on time of 3 minutes, in order to remove combustion residues from it.

## Mixture formation and combustion

Mixture formation and combustion can be broken down into the starting phase and the heating phase.

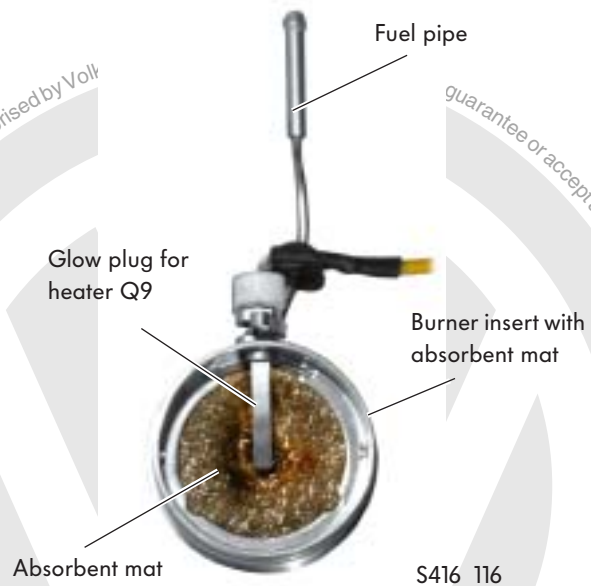
### Starting phase

- The glow plug heats the absorbent mat in the burner.
- Via the lateral inlet apertures for fuel evaporation, a small quantity of combustion air is conducted to the combustion chamber, the bottom of which is lined with a mesh-like absorbent mat.
- The fuel, the combustion air (enters via the lateral inlet apertures for fuel evaporation) and the high temperature of the glow plug result in a combustible fuel/air mixture at the absorbent mat.
- The fuel/air mixture ignites in the combustion chamber.

### Heating phase

- After the starting phase, the glow plug is switched off. The fuel continues to be conducted via the absorbent mat, which is still very hot, and mixture formation continues.
- Due to the combustion chamber, which is now very hot, the fuel/air mixture is consequently able to ignite on the hot walls of the combustion chamber and form a constant flame.
- The corresponding necessary intake of combustion air is ensured by the axially positioned inlet apertures for combustion air.

The glow plug with flame monitor, which is designed as an electrical resistor, monitors the temperature of the flame during heating mode.



# Transporter – Air Top 3500

## Heating system management

### Switching off conditions

Individual heater unit component faults and disturbances during the starting procedure and heating mode are detected in the control unit. The Air Top 3500 auxiliary heater is not started or is switched off and set to fault locking under the following conditions:

- No starting or faulty starting
- Temperature sensor is defective
- Overheating sensor – interruption or short-circuit are present
- Overheating sensor has been incorrectly installed
- Heater element/flame monitor – interruption or short-circuit are present
- Blower motor is overloaded, blocked or short-circuit or interruption are present
- Fault in the metering pump current circuit
- Lower or upper voltage limit reached – shut-off after 20 seconds:  
Undervoltage shut-off at 11.3 V
- Control unit defective
- Overheating present:  
The fuel supply is interrupted and run-on is carried out as on switching off manually; after run-on, the control unit switches to fault locking
- Fuel supply not guaranteed:  
Fuel reserve reached
- Max. operating duration reached:  
After a programmed running time of 120 minutes (constant operation possible via manual operation – see owner's manual)



### Rectification of the cause of the fault

Several fault locking variants are stored in the control unit. Fault locking can be rectified either by

- Switching off and on again,
- Removing terminal 30 or
- Via the vehicle diagnosis, testing and information system VAS 5051 B and the vehicle diagnosis and service information system VAS 5052

depending on the type of fault which is present.

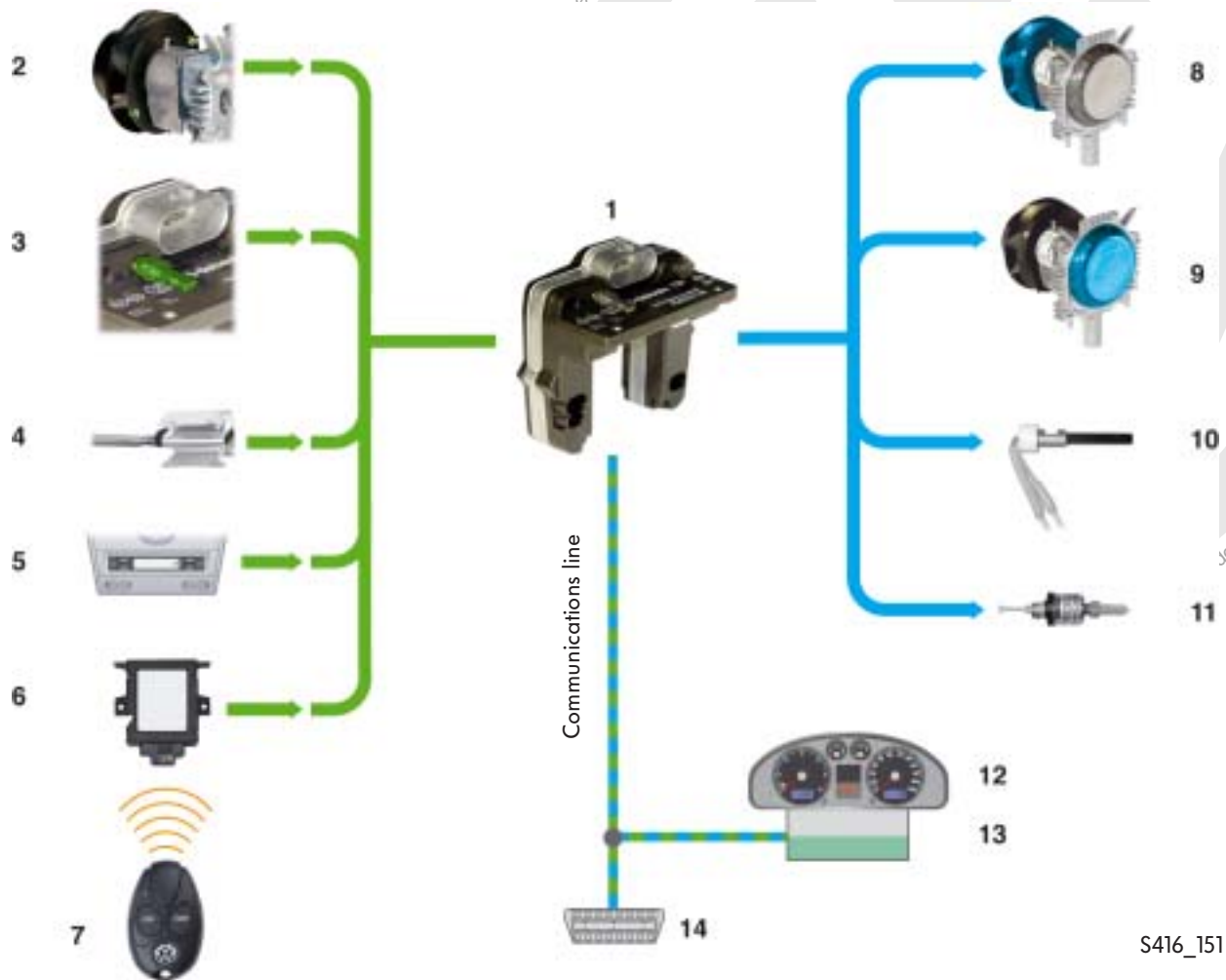


The specified times and temperatures may deviate slightly depending on the model year and control unit software version (technical data correspond to model year 2008).

Further information is also available in ELSA, repair group 82.



## Overview of the system



### Legend

- |   |   |
|---|---|
| 1 - Auxiliary heater control unit J364  | 8 - Combustion air blower V6 fan for heated air     |
| 2 - Permanent magnets for speed sensor at combustion air blower V6 (speed sensor not visible) | 9 - Combustion air blower V6 fan for combustion air |
| 3 - Temperature sensor G18  | 10 - Glow plug for heater Q9                        |
| 4 - Overheating sensor G189   | 11 - Metering pump V54                              |
| 5 - Auxiliary heater operating and display unit E407  | 12 - Control unit in dash panel insert J285         |
| 6 - Remote control receiver for auxiliary heating R64   | 13 - Data bus diagnostic interface J533             |
| 7 - Radio remote control T91  | 14 - Diagnostic connection                          |

S416\_151

# Caddy – overview of supplementary heaters

## Overview of installation locations

The Thermo Top V supplementary coolant heater is an option available for the Caddy and the Caddy Maxi.

The PTC supplementary air heater is an option available for the Caddy MAXI only (country-specific). It is installed downstream of the heat exchanger in the heater/air conditioner unit.

The Thermo Top V supplementary coolant heater is installed behind the front bumper, on the right hand side, beneath the headlight.



The PTC supplementary air heater will not be described in greater detail for the Caddy. For information, please refer to self-study programme part 1, chapter entitled "Crafter – PTC supplementary air heater".

PTC supplementary air heater



S416\_050



Thermo Top V supplementary coolant heater



## Operation

The supplementary coolant heater can be operated in three different ways:

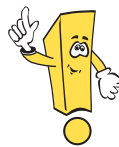
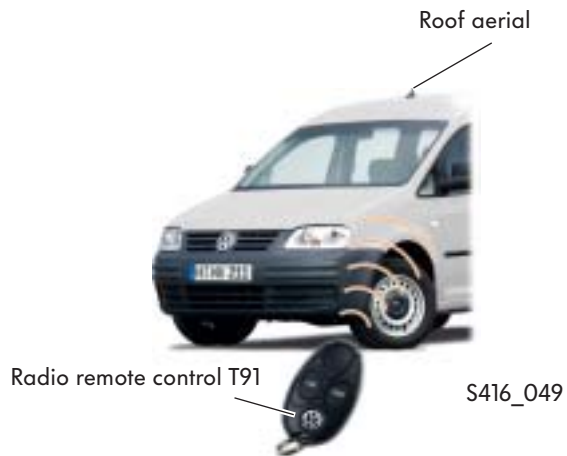
- Via the radio remote control
- Via the display in the dash panel insert
- Via the instant heat button in the operating unit for heating and ventilation

### Radio remote control

The supplementary coolant heater can be switched on and off using the radio remote control.

### Radio receiver installation location

The remote control receiver R149 is installed under the dash panel on the left of the centre console. The auxiliary heater aerial R182 is integrated into the roof aerial.



A Climatronic system and a multi-function steering wheel are optionally available for the Caddy as of model year 2008; the supplementary coolant heater can also be operated via these. The modified radio remote control T91 will also be launched at this point in time.

### Display in the dash panel insert

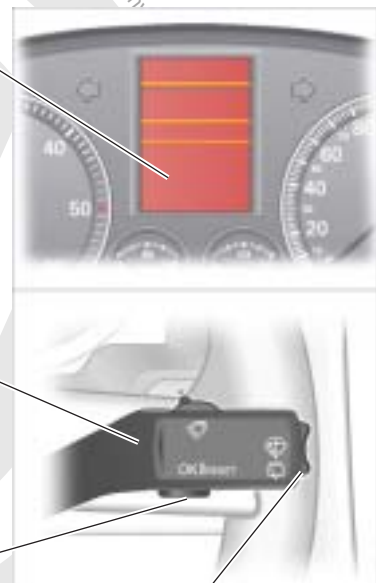
Select the settings menu option in the main menu. Then select the auxiliary heater menu option in the settings sub-menu. The following pre-settings can be selected here: Activation, pre-selection time 1 ... 3, running time and operating mode.

Within a menu, switching between the sub-menu options is carried out by pressing the rocker switch on the windscreen wiper arm up or down. The sub-menu options are confirmed with OK/RESET. If the vehicle is equipped with a multi-function steering wheel, the menus can be called up and switched in the dash panel insert display via the relevant buttons.

Display in the dash panel insert

Windscreen wiper arm

Button for confirming menu options



### Instant heat button

The supplementary coolant heater can also be switched on and off via the instant heat button in the operating unit for heating and ventilation/Climatic.

Operating unit for heating and ventilation/Climatic

Instant heat button



S416\_148

S416\_149



# Caddy – Thermo Top V

## Technical features

The Thermo Top V supplementary coolant heater can be operated as either a pre-heater or an auxiliary heater.

In vehicles with diesel engines, the supplementary coolant heater is automatically operated as a pre-heater at exterior temperatures below 5 °C.

The Thermo Top V is integrated into the Caddy's vehicle diagnosis system.

The vehicle diagnosis, testing and information system VAS 5051 B and the vehicle diagnosis and service information system VAS 5052 are available for diagnosis.



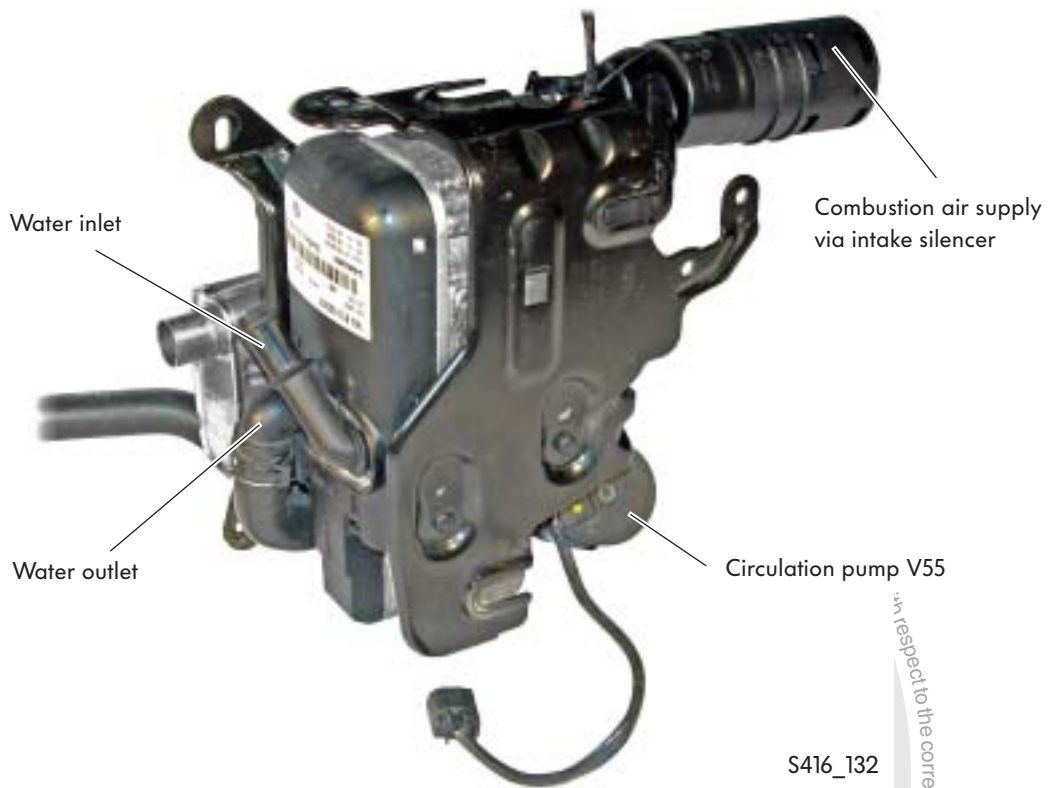
S416\_069

## Technical data

<b>Heat output:</b> Full load: Partial load:	5000 W 2500 W
<b>Fuel:</b>	Petrol, diesel (according to DIN EN 590) and RME* (according to DIN EN 14214)
<b>Current supply:</b>	Via starter battery
<b>Rated voltage:</b>	12 V
<b>Operating voltage range:</b>	10.5 ... 15 V
<b>Electrical power consumption:</b> Without recirculation pump and vehicle blower – full load: Without recirculation pump and vehicle blower – partial load:	26 W 18 W
<b>Permissible operating pressure:</b>	0.4 ... 2.5 bar
<b>Fuel consumption:</b> Full load Partial load	Petrol: 0.67 l/h and diesel: 0.59 l/h Petrol: 0.34 l/h and diesel: 0.30 l/h
<b>Undervoltage shut-off:</b>	< 11.3 V
<b>CO<sub>2</sub> in the exhaust gas:</b>	8 ... 12 Vol.%
<b>Weight:</b>	2.9 kg
<b>Manufacturer:</b>	Webasto

\* RME approval is not available for vehicles with diesel particulate filter

## Heating system with connections



\*in respect to the correctness of information in...



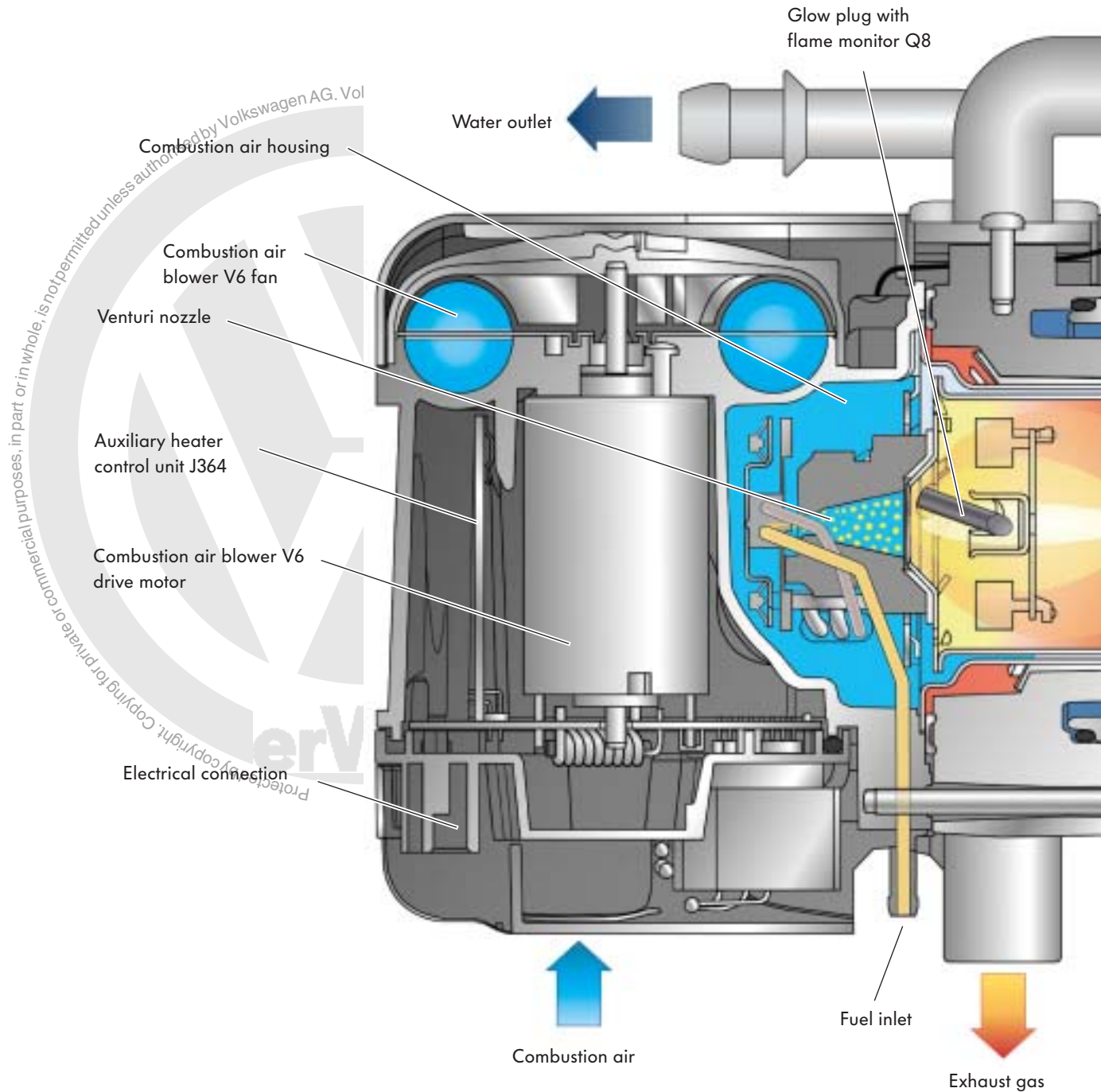
The initial versions of the Thermo Top V were fitted with electrical cable adapters. Subsequently, the control unit was adapted by Webasto in such a way that the Volkswagen connectors fit onto the control unit. On possible renewal of the supplementary coolant heater, these adapters are superfluous.

# Caddy – Thermo Top V

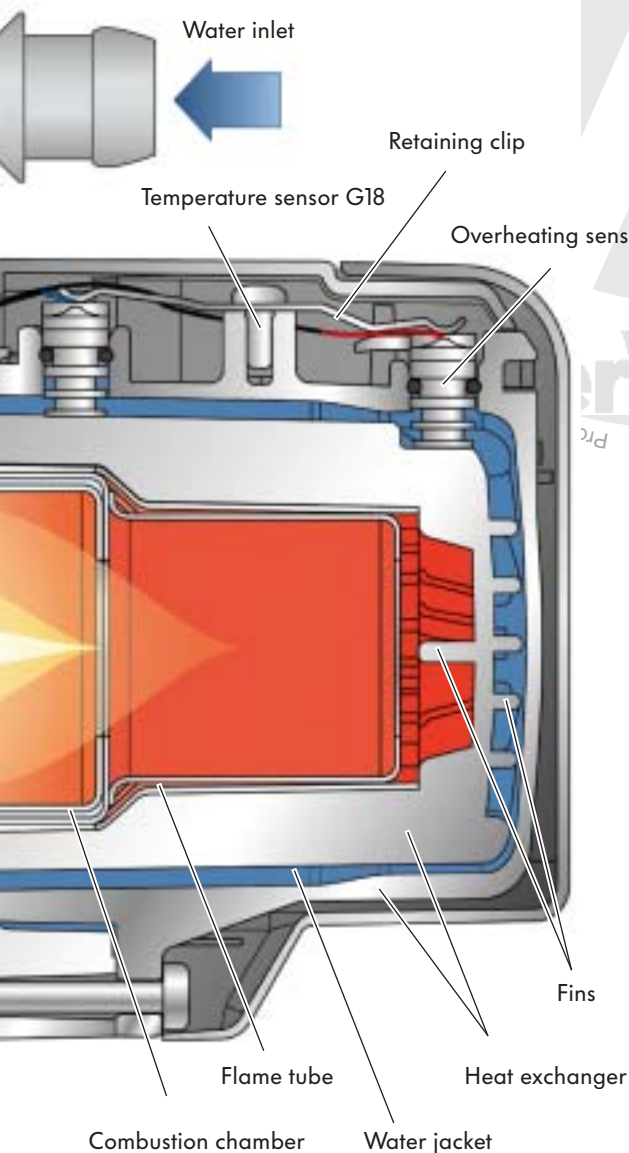
## Design – function overview

### Air supply for combustion

The air required for combustion enters into the combustion air housing by the combustion air blower V6 fan and is conducted to the venturi nozzle.



For information on the design and function of the supplementary heater, please refer to self-study programme 318 "The 2004 Golf" and self-study programme 328 "The Caddy 2004".



## Fuel supply and combustion

The supplementary heater is supplied with fuel via the fuel inlet. The fuel inlet stretches to the venturi nozzle. The intaken air is conducted via the venturi nozzle (ceramic housing). The differential pressure which occurs supports fuel injection – mixture formation commences.

The glow plug with flame monitor Q8 projects from the side into the combustion chamber in such a way that the end of the plug is positioned centrally in front of the venturi nozzle outlet in the combustion chamber.

In the starting phase, the glow plug ignites the mixture in the area around the glow plug and in the adjacent combustion chamber.

Later, during the heating phase, after the glow plug has been switched off, the mixture is ignited at the flame front in the combustion chamber.

## Coolant

The coolant enters the water jacket via the coolant inlet aperture. There, it absorbs heat via the outer wall of the heat exchanger.

The heated coolant enters the coolant circuit via the coolant outlet aperture.



S416\_099



Together, the combustion air blower and the control unit form a module. The glow plug is only individually available in the case of supplementary heaters without fuel pre-heating. In supplementary heaters with fuel pre-heating, the glow plug and burner are renewed together.

# Caddy – Thermo Top V

## Combustion air blower V6, auxiliary heater control unit J364

The combustion air blower V6 is integrated into a housing which is flanged onto the heat exchanger.

It has a fan for drawing in the air which is required for combustion.

The fan is driven by a motor, which is mounted immediately beneath the fan and is installed in the housing, where it is protected.



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The auxiliary heater control unit J364 consists of a cover with connections and a printed circuit board, which is integrated into the housing next to the blower motor, where it is protected against moisture.

The control unit and combustion air fan are matched and can therefore only be renewed together as a single part.



Auxiliary heater control unit J364

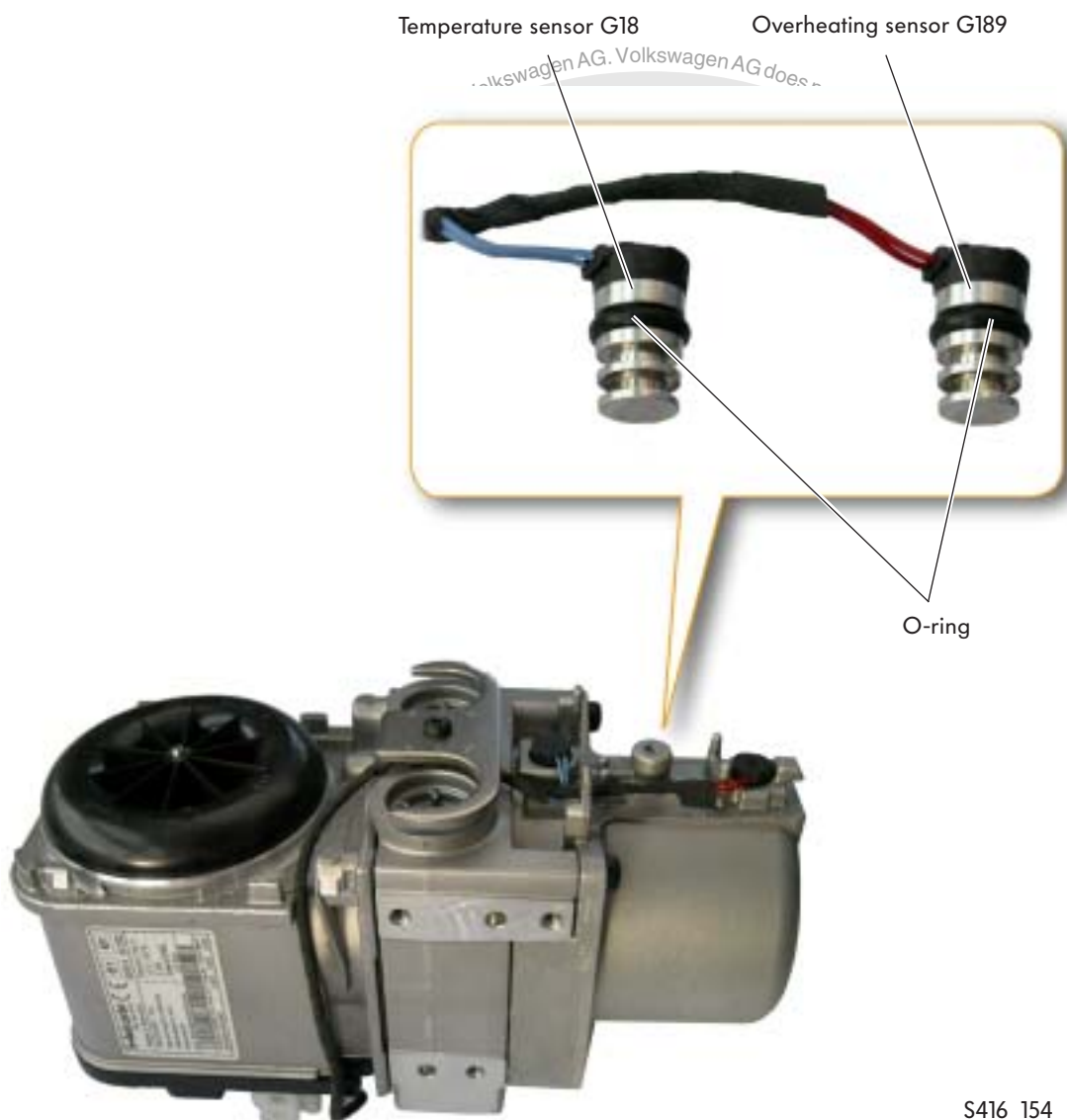
## Temperature sensor G18 and overheating sensor G189

The temperature sensor G18 and the overheating sensor G189 are located in the outer wall of the heat exchanger, each with an O-ring, and are secured with a retaining clip (see illustration S416\_166 on page 40; to show the installation of the two temperature sensors more clearly, no retaining clips are shown in illustration S416\_154 below). They register the current coolant temperature in the heater unit and the temperature conditions at the heat exchanger.

The temperature sensor G18 monitors the coolant temperature during heating mode.

The overheating sensor G189 protects the heater unit from overheating and monitors the temperature sensor.

The signals from the temperature sensor G18 and the overheating sensor G189 are used by the control unit J364 to regulate the heat output stages. Both sensors are identically designed NTC resistors.



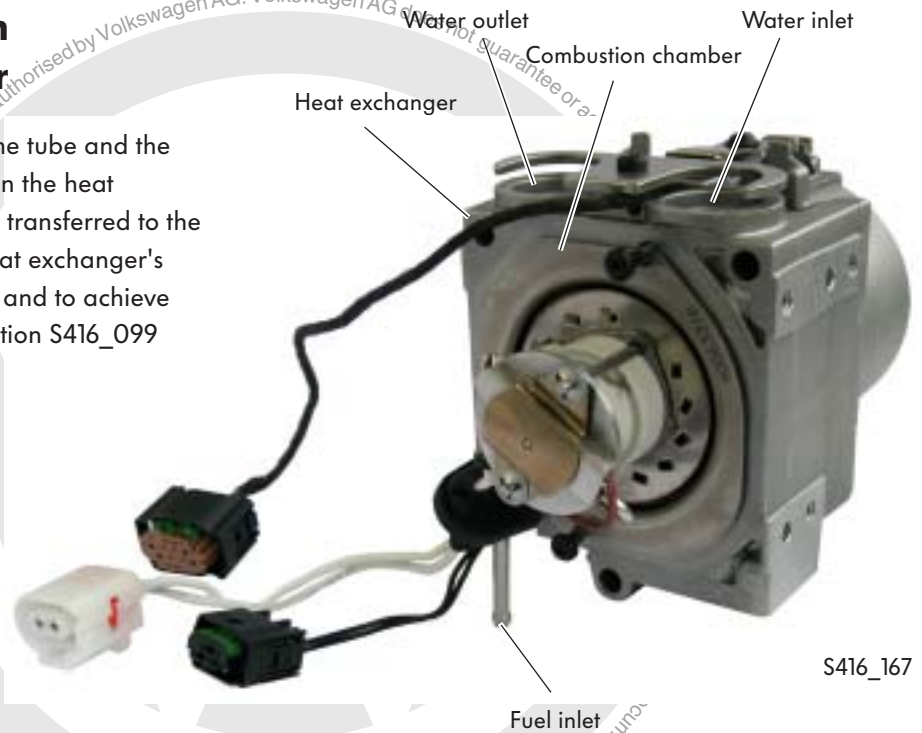
S416\_154



# Caddy – Thermo Top V

## Heat exchanger with combustion chamber

The combustion chamber with flame tube and the temperature sensors are installed in the heat exchanger. The combustion heat is transferred to the coolant in the water jacket. The heat exchanger's internal fins serve to optimise flow and to achieve even heat absorption – see illustration S416\_099 on pages 38/39.



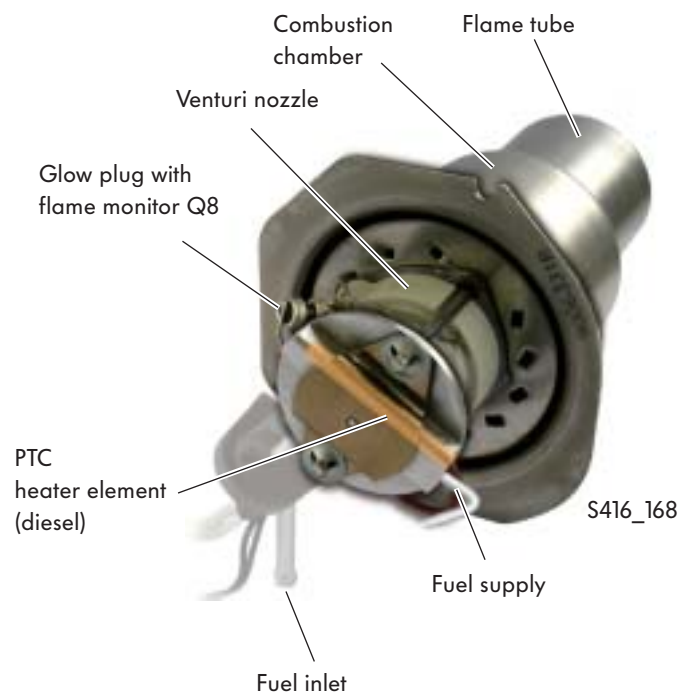
## Combustion chamber with venturi insert

The combustion chamber consists of the combustion chamber with flame tube, the venturi nozzle with laterally installed glow plug with flame monitor Q8 and a PTC heater element in diesel-driven heater units.

A venturi nozzle is installed in the air inlet duct to the combustion chamber. Via fuel evaporation, this ensures subsequent combustion.

To improve the diesel fuel's flow capability and to avoid severe smoke development, the fuel is heated during the starting phase.

To achieve this, a PTC heater element is installed parallel to the fuel inlet above the venturi nozzle. During the starting phase, the PTC heater element is actuated by the control unit J364 for approx. 1 minute at exterior temperatures of  $<5^{\circ}\text{C}$ .



## Fuel shut-off valve N109

During the current model year 2007, fuel shut-off via solenoid valve – fuel shut-off valve N109 – was introduced for the Caddy. This measure helps to reduce smoke formation caused by subsequently dripping fuel.

In these vehicles, fuel for the heater unit is not taken directly from the fuel tank, but from the swirl pot.

The solenoid valve is located in the fuel inlet to the supplementary heater. So that as little fuel as possible is able to subsequently drip, it is positioned directly in the heater unit in the vicinity of the valve insert.

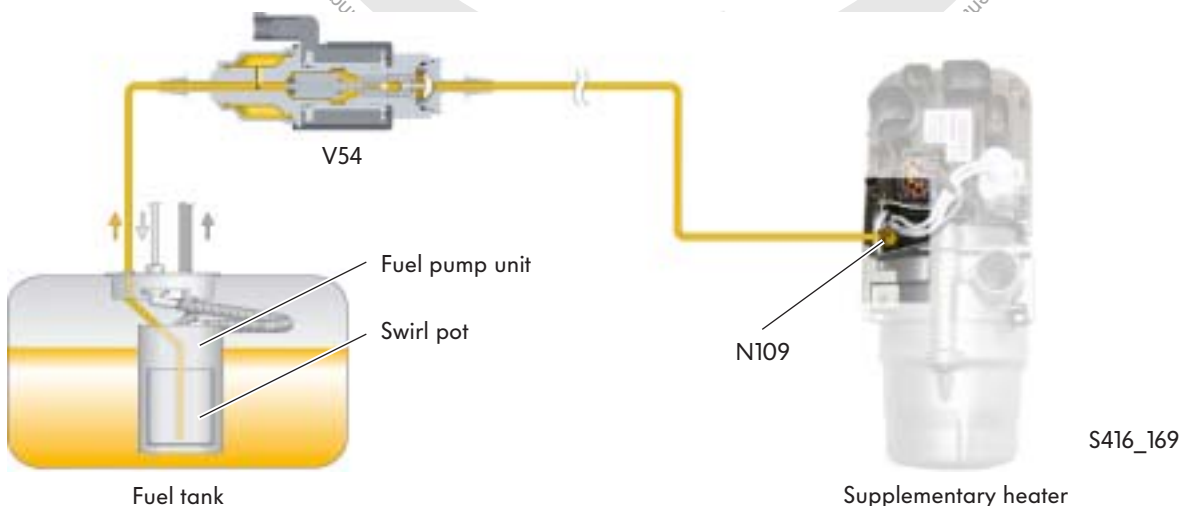
During supplementary heater operation, the N109 is supplied with current and releases the fuel inlet to the valve insert. Following shut-off, the N109 is no longer supplied with current and closes the inlet tightly. This means that no further fuel is able to subsequently drip and collect in the combustion chamber.

To prevent an impermissibly high pressure from building up in the fuel pipe between the metering pump and the supplementary heater when the supplementary heater is switched off, a modified metering pump V54 with internal pressure compensation has been introduced at the same time. This internal pressure compensation enables fuel pressure which is building up – as a result of pressure increase – to be released back into the fuel tank via a drain in the metering pump.

The fuel shut-off valve N109 is monitored via self-diagnosis. In the event of failure, the supplementary heater is unable to start due to a lack of fuel.



When renewing the metering pump, attention must be paid to the use of the correct pump variant. Different metering pumps are available for diesel and petrol engines and for systems with and without fuel shut-off valve N109.

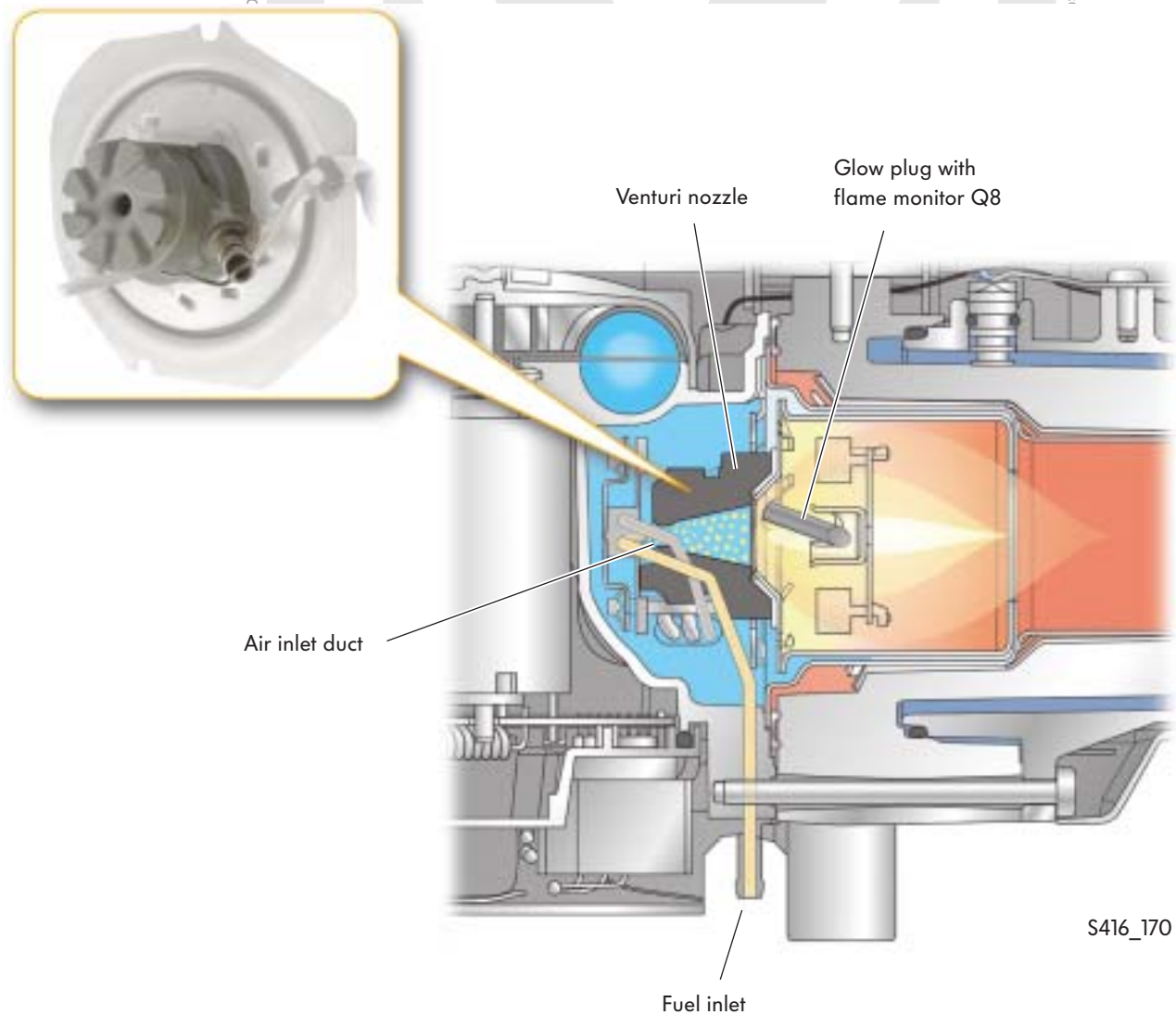


# Caddy – Thermo Top V

## Venturi principle

In the Thermo Top V, mixture formation is carried out via a venturi nozzle.

The letter **V** in the designation is derived from the word venturi.



The fuel is fed to the venturi nozzle's air inlet duct via the fuel inlet.

Due to the venturi nozzle, the entering combustion air is accelerated to a speed of 50 m/s. There is no absorbent mat or strainer which first has to be coated.

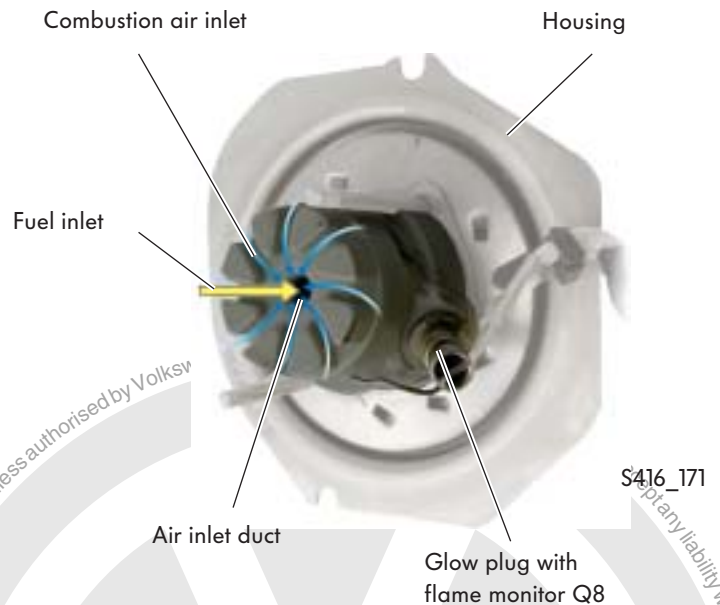
The supplementary heater reaches its operating temperature faster.

The intake air is guided through a ceramic housing, which is shaped as a venturi nozzle.

The resulting differential pressure and air rotation helps atomisation of the fuel.

To optimise mixture formation, the combustion air is caused to rotate.

The constriction in the combustion air and fuel inlet generates a vacuum, which supports mixture formation (carburettor principle).



## Glow plug with flame monitor Q8

The glow plug with flame monitor Q8 is activated immediately after switching on the heater unit and is supplied with current for approx. 90 seconds for glowing; after this, it is switched off. After the starting phase, the glow plug functions as a flame monitor.

When switching off the heater unit, the glow plug is switched on briefly within the run-on time, in order to remove combustion residues from it.

The glow plug cannot be renewed individually in diesel heater units.

## Mixture formation and combustion

Mixture formation and combustion can be broken down into a starting phase and a heating phase.

### Starting phase

In the starting phase, the glow plug ignites the mixture formed in the venturi nozzle in the area around the glow plug and in the adjacent combustion chamber.

### Heating phase

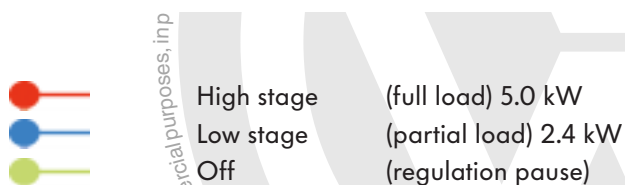
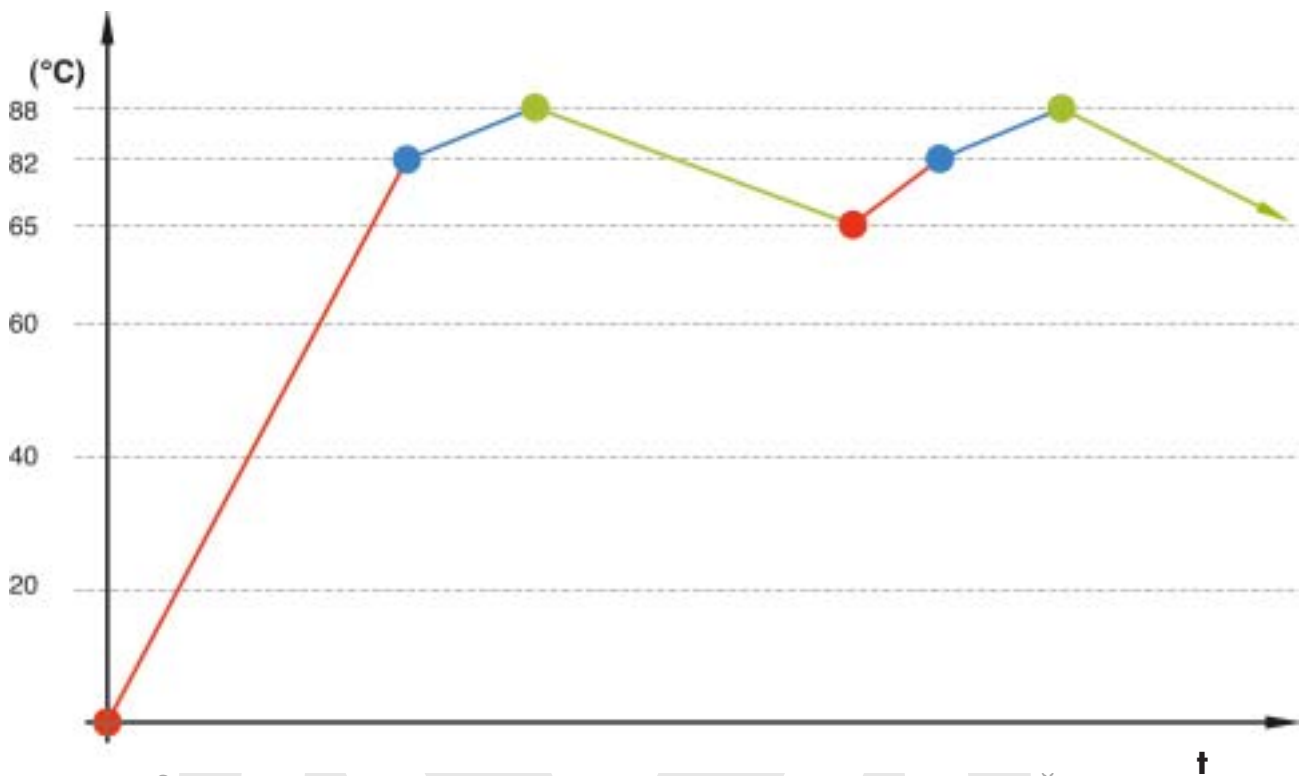
Later, during the heating phase, after the glow plug has been switched off, the mixture is ignited at the flame front in the combustion chamber.



# Caddy – Thermo Top V

## Heating system management

### Auxiliary heating mode



S416\_173

If the regulation pause exceeds a duration of 15 minutes and the coolant temperature has fallen below 70 °C during this time, the heater unit starts in full load mode as of a temperature of less than 65 °C with a regular starting procedure (glowing, etc.).

### Switching off

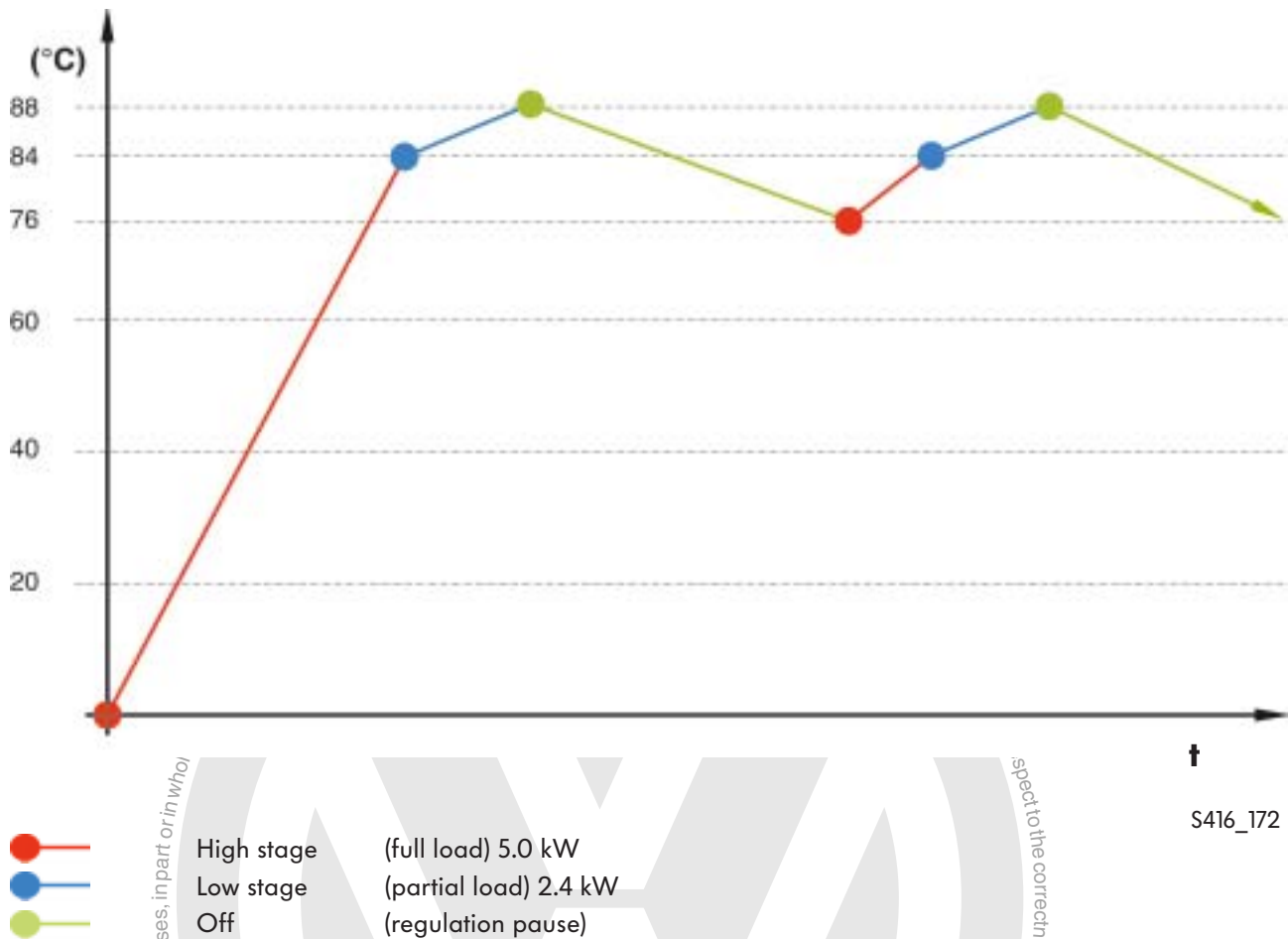
The run-on phase starts after switching off manually or following the expiry of the maximum running time.

During the run-on phase, post-glowing is briefly carried out and the combustion air blower and the circulation pump continue to run in order to cool the heater unit.

The duration of the run-on phase is operating phase-related and may vary depending on the heater unit's software version:

- 175 seconds on switching off from full load mode,
- 110 seconds on switching off from partial load mode.

## Pre-heating mode



t  
S416\_172

If the regulation pause exceeds a duration of 15 minutes and the coolant temperature has fallen below 76 °C during this time, the heater unit starts in full load mode with a regular starting procedure (glowing, etc.).



The specified times and temperatures may deviate slightly depending on the model year and control unit software version.  
Further information is also available in ELSA, repair group 82.

**This note applies to pages 46 - 47.**



# Caddy – Thermo Top V

## Switching on conditions

### Pre-heater

- Coolant temperature:  $t < 69\text{ }^{\circ}\text{C}$
- Exterior temperature:  $t < 5\text{ }^{\circ}\text{C}$
- Terminal 15 (ignition): On
- Engine speed:  $n > 300\text{ rpm}$
- Temperature pre-selection: Not set to "cold" and ECON button not actuated
- Reserve fuel mode: No
- Vehicle electrical system: Load management not activated
- Crash shut-off: No crash signal present from the airbag control unit
- Fault memory entries: No entries which prevent starting present, e.g. electronic control unit locking

### Auxiliary heater

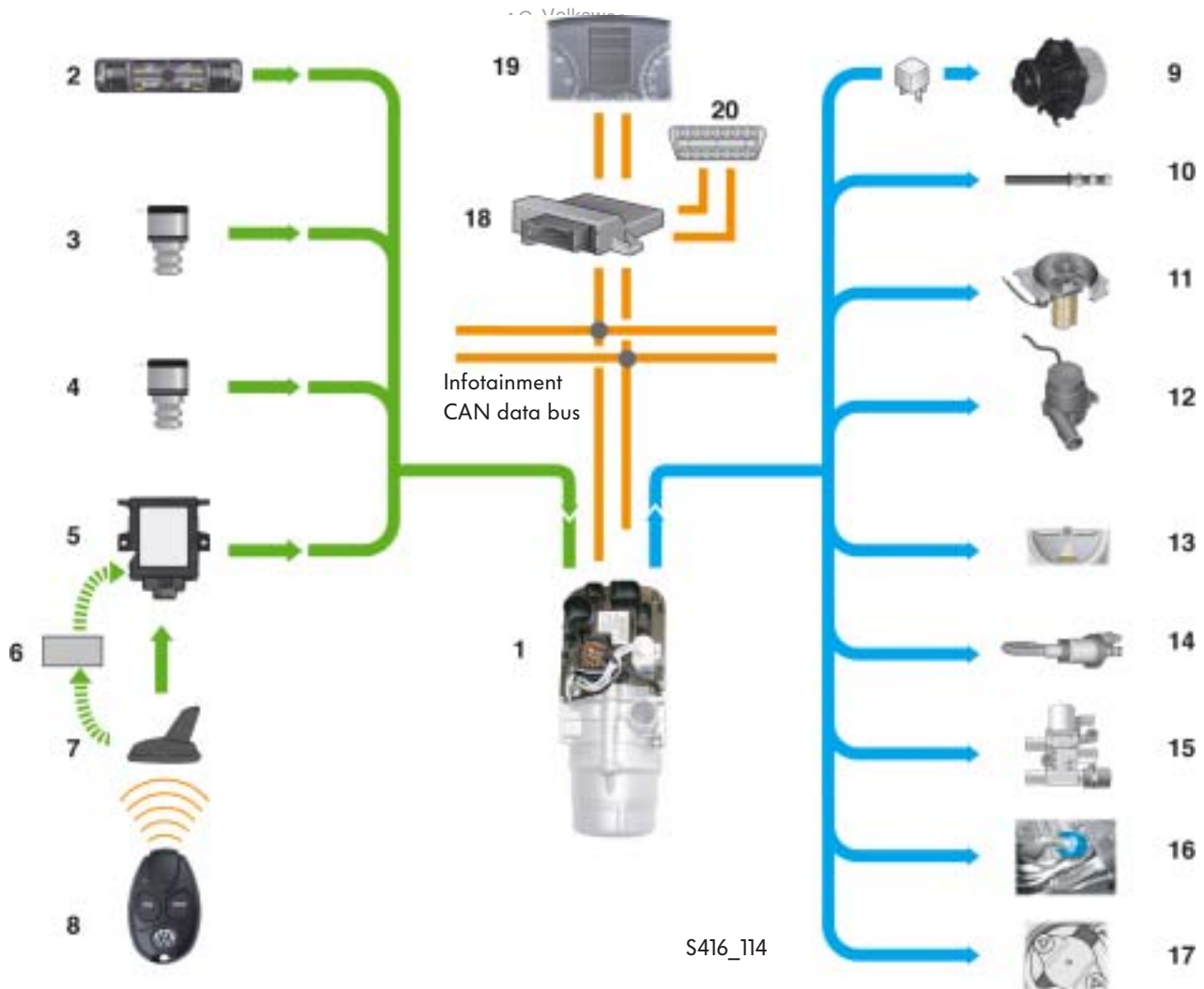
- Reserve fuel mode: No
- Undervoltage shut-off: No undervoltage present
- Crash shut-off: No crash signal present from the airbag control unit
- Fault memory entries: No entries which prevent starting present, e.g. electronic control unit locking

## Switching off conditions

- Pre-heater: Engine speed  $n < 300\text{ rpm}$
- Fault memory entries: Entries which prevent starting present, e.g. electronic control unit locking
- Undervoltage shut-off:  $U < 11.3\text{ V}$  for more than 250 seconds
- Vehicle electrical system: Load management activated
- Crash shut-off: Crash signal present from the airbag control unit
- Reserve fuel mode: Only taken into consideration prior to starting (residual fuel quantity less than 7 litres)
- Pre-heater: Temperature pre-selection set to "cold" or ECON button actuated
- Auxiliary heater: Pre-selection time expired, switched off manually or max. operating time reached – after a running time of 60 minutes



## Overview of the system



S416\_114

### Legend

- 1 - Auxiliary heater control unit J364
- 2 - Instant heat button
- 3 - Temperature sensor G18
- 4 - Overheating sensor G189
- 5 - Remote control receiver for auxiliary coolant heater R149
- 6 - Aerial filter R87\*
- 7 - Aerial (roof aerial) R182
- 8 - Radio remote control T91
- 9 - Fresh air blower relay J13\*\* and fresh air blower V2
- 10 - Glow plug with flame monitor Q8
- 11 - Combustion air blower V6
- 12 - Circulation pump V55
- 13 - Instant heat button LED\*\*\*
- 14 - Metering pump V54

- 15 - Heater coolant shut-off valve N279\*\*\*\*
- 16 - Fuel shut-off valve N109
- 17 - Fuel pre-heating heater element Z66 (with diesel only)
- 18 - Data bus diagnostic interface J533
- 19 - Control unit in dash panel insert J285
- 20 - Diagnostic connection

\* Vehicles with telephone/preparation for telephone only

\*\* With Climatic and heating system only

\*\*\* As analogue signal with heating only, otherwise via CAN data bus line

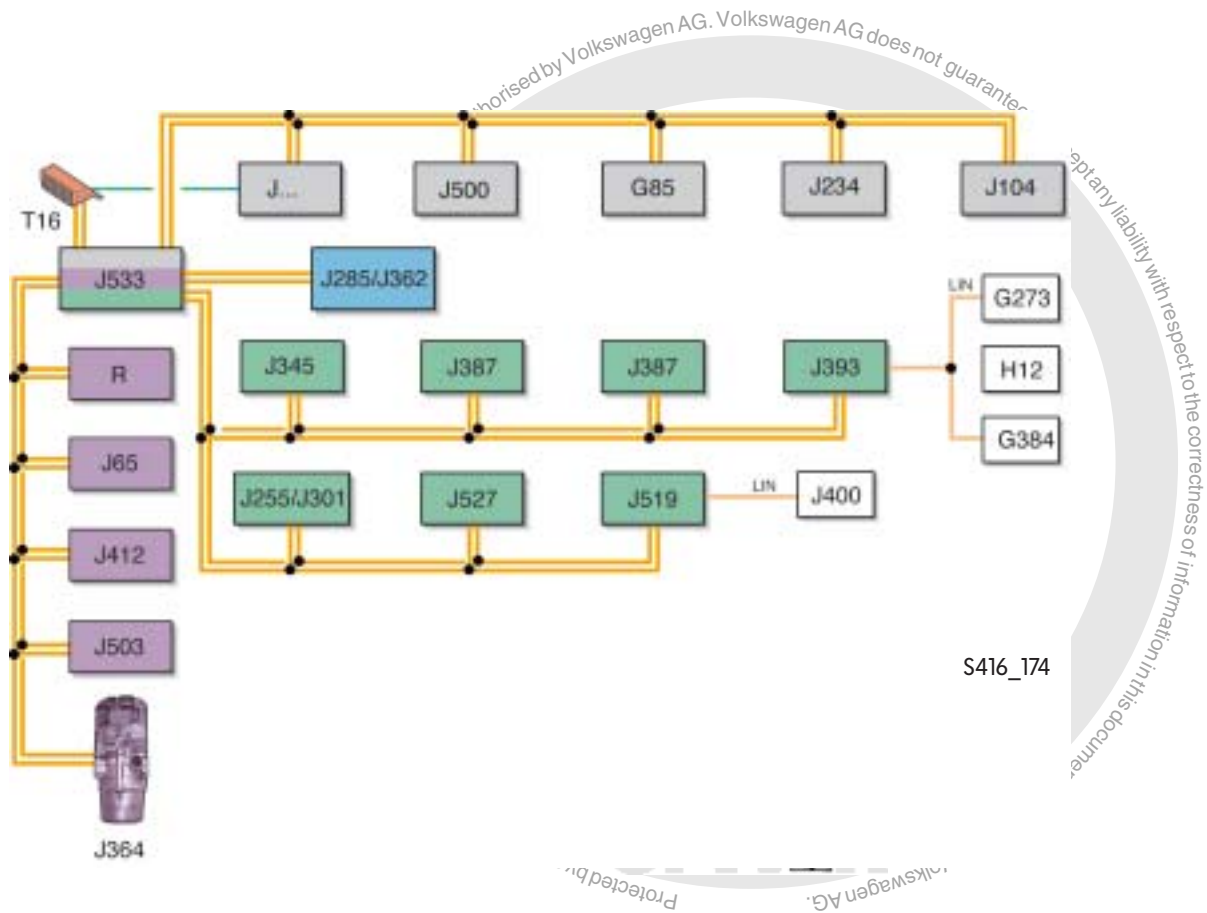
\*\*\*\* Installed depending on engine variant



# Caddy – Thermo Top V

## Data bus messages

The Thermo Top V is integrated into the infotainment CAN data bus.



The auxiliary heater control unit J364 exchanges information with the following control units.

Engine control unit J...	Speed signal greater than 500 rpm for engine operation detection
Airbag control unit J234	Heater system shut-off with crash signal
Control unit in dash panel insert J285	Display for settings, reference clock and synchronisation for clock in the heater system control unit, fuel tank fill level
Steering column electronics control unit J527	Switch commands from multi-function operation buttons
Onboard supply control unit J519	Heater system shut-off via load management in the event of overvoltage and undervoltage in pre-heating mode. In auxiliary heating mode, the heater system control unit checks the operating voltage itself and shuts off in the event of a voltage of less than approx. 11.3 V and undervoltage lasting for 250 seconds with fault entry.  In vehicles with fuel shut-off valve N109: The fuel pump G6 is briefly actuated after starting the heating system and then every 20 minutes during heater system operation. As a result of this, the swirl pot in the fuel pump unit is constantly filled and emptied and the auxiliary heating mode is prevented.
Climatronic control unit J255, air conditioning system control unit J301	Switch-on command from the instant heat button
Auxiliary heater control unit J364	Outputs: LED actuation in the instant heat button, wake-up signal for network, heater blower actuation, fault status, fuel consumption, heat output, temperature/heater circuit
Data bus diagnostic interface J533	Status memory for diagnosis, interface for CAN diagnosis, high-speed and low-speed CAN data implementation

# Test yourself

Which are the correct answers?

1. When does the Hydronic D5WS supplementary coolant heater shut off?

- a) When the supplementary coolant heater's fuel supply pipe intakes air.
- b) When the fuel tank sender on the fuel pump unit registers a fuel quantity of less than 16 litres.
- c) When the supplementary coolant heater has completely drained the fuel tank.

2. What is the task of the plug mantle in the Crafter's Hydronic D5WS supplementary coolant heater?

- a) The fuel evaporates at the hot plug mantle.
- b) The plug mantle serves as an air filter for the combustion air.
- c) The plug mantle filters particles of dirt out from the fuel.

3. Which statement on the Crafter's Airtronic D2 supplementary air heater is correct?

- a) Following the end of the glow phase, the glow plug functions as a flame monitor.
- b) The Airtronic system does not require any flame monitoring.
- c) The flame sensor integrated into the combination sensor functions as the flame monitor.

4. At what speed does the fan for intake air run in the Crafter's D2/D4S supplementary air heater?

- a) The fan for intake air runs at precisely the same speed as the fan for combustion air.
- b) The fan for intake air runs at a fixed speed.
- c) The speed of the fan for intake air can be set by the driver via the potentiometer in the pre-selection clock.

5. **By which battery is the Airtronic D4S supplementary air heater driven in the Crafter?**

- a) By an additional battery.
- b) By the starter battery.
- c) By the second battery.

6. **How does mixture formation take place in the Transporter's Thermo Top C supplementary coolant heater?**

- a) Via an absorbent evaporator mat.
- b) Via an evaporator with plug mantle.
- c) Via a venturi nozzle.

7. **By which battery is the Air Top 3500 supplementary air heater driven in the Transporter?**

- a) By an additional battery integrated into the supplementary air heater.
- b) By the starter battery.
- c) By the second battery.

8. **Which statement on the operating duration of the Air Top 3500 supplementary air heater in the Transporter/Multivan is correct?**

- a) The maximum operating duration is 120 minutes.
- b) The maximum operating duration is 60 minutes.
- c) The heating system can be operated continuously via manual actuation.



# Test yourself

9. What does the letter "V" in the designation Thermo Top V mean?

- a) Heat output of 50 kW
- b) Venturi nozzle
- c) Vertical burner
- d) Variable burner insert

10. What is the task of the solenoid valve N109 in the Thermo Top V supplementary coolant heater?

- a) After switching off the heater unit, it shuts off the fuel inlet in the heater unit and therefore prevents subsequent dripping into the combustion chamber.
- b) It is actuated directly by the airbag control unit when the crash signal is triggered, and shuts off the heater unit.
- c) During heating mode, it electronically controls the fuel supply and therefore reduces CO<sub>2</sub> emissions.

11. Into which CAN databus system is the Hydronic D5WS supplementary coolant heater in the Crafter integrated?

- a) Powertrain CAN data bus
- b) Convenience CAN data bus
- c) Infotainment CAN data bus
- d) The Hydronic D5WS system in the Crafter operates without CAN connection.

12. Which heater unit variants of the Thermo Top V supplementary coolant heater are fitted with fuel pre-heating?

- a) Pre-heating is fitted in all heater unit variants.
- b) Pre-heating is only fitted in petrol-driven Thermo Top V heater units.
- c) Pre-heating is fitted in diesel-driven Thermo Top V heater units in order to improve the fuel's flow capability.
- d) Fuel pre-heating is only fitted in the Nordic countries of Norway, Finland and Sweden.

13. Where in the Transporter/Multivan is the aerial for the Thermo Top C supplementary coolant heater's radio remote control installed?

- a) In the rear left side window.
- b) In the driver door wiring harness.
- c) In the vicinity of the front right headlight.
- d) On the roof.

14. How can the driver of a Caddy switch off the Thermo Top V pre-heater manually?

- a) He cannot.
- b) Switch off the blower.
- c) In the pre-heater menu in the dash panel insert.
- d) With the "ECON" button.

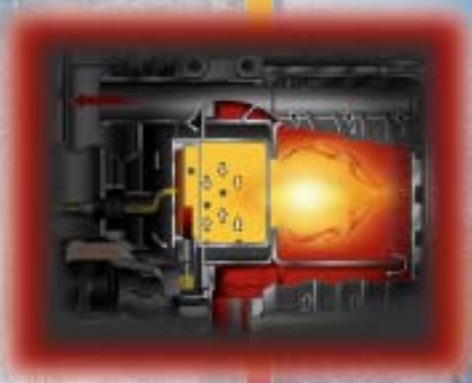
15. Which of the following components runs constantly throughout all water-based auxiliary heater operation?

- a) Glow plug
- b) Circulation pump
- c) Metering pump

Answers: 1. b; 2. a; 3. c; 4. a; 5. b; 6. a; 7. c; 8. c; 9. b; 10. a; 11. b; 12. c; 13. b; 14. d; 15. b



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