

# Thermo H plus

## Workshop Manual

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# 1 Introduction

## 1.1 Content and purpose

This workshop manual is used during maintenance and repair of water heaters (further referred to as heaters) Thermo H plus.

 <b>Warning!</b>	<b>Danger to life and health!</b>
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**Electrical work may only be performed by persons, which have the required qualification (see 1.6.1).**

**ATTENTION:**

**Work on the heater may only be performed by briefed and/or trained by Spheros personnel. Any changes to the heaters are strictly prohibited and will void both the warranty and, if applicable, the E1 approval.**

## 1.2 Effectivity of the workshop manual


The workshop manual applies to heaters listed on the title page of this document. It may be subjected to modifications and amendments. The respectively currently effectife version is binding. This version can be found in the downloadcenter on the Spheros homepage [www.spheros.com](http://www.spheros.com).

## 1.3 Meaning of highlighted content

Throughout this manual the emphasized words Warning!, Caution!, ATTENTION: and NOTE: used as follows:

 <b>Warning!</b>	<b>Danger to life and health!</b>
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**This caption is used to indicate possible severe injuries or fatal accidents if instructions or procedures are carried out incorrectly or entirely disregarded.**

 <b>Caution!</b>	<b>Hazardous to health!</b>
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**This caption is used to indicate possible minor injuries if instructions or procedures are carried out incorrectly or entirely disregarded.**

**ATTENTION:**

**This caption points to actions which may cause material damage.**

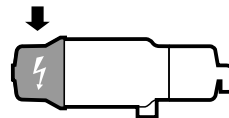
**NOTE:**

This caption is used to draw attention to an important feature.

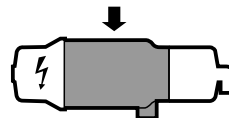
## 1.4 Symbols



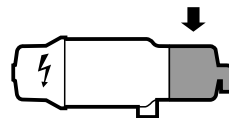
Symbol tightening torque value: Identifies in graphics parts (eg nuts, bolts) that are to be mounted with a specific tightening torque. The torque values are shown at the symbol and are binding.



Orientation help - next working step (s) on the HV control head.



Orientation help - next working step (s) on the heat exchanger.



Orientation help - next working step (s) on the Diesel burner head.

## 1.5 Further documentation to be used

The use of additional service literature is required. References are provided in the workshop manual at appropriate locations. Use the following documents during operation and maintenance of the heaters:

- Installation and operating instructions Thermo H plus
- Spare parts list Thermo H plus
- Technical Information (TI)
- Workshop Manual Thermo plus
- Maintenance plan Thermo AC/DC
- Maintenance plan Thermo

This service literature is also available in the download center on [www.spheros.com](http://www.spheros.com).

## 1.6 Safety information and regulations

Basically, general accident prevention provisions and the valid industrial safety directions must be adhered to. "General Safety Regulations" which exceed the frame-

work of these provisions are listed below. The specific safety regulations which affect the present manual are issued highlighted in the individual sections or procedures.

**1.6.1 Required qualifications**

 <b>Warning!</b>	<b>High voltage! Danger to life!</b>
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Electrical work may only be performed by a qualified electrician for HV systems in motor vehicles, craftsman, activity with repetitive character. Training acc. to DGUV 200-005 (previously BGI 8686)

**NOTE:**

The provisions of these Regulations are binding within the territory governed by DGUV Regulations and should similarly be observed in countries without specific regulations.

 <b>Warning!</b>	<b>High voltage! Danger to life!</b>
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Even before the start of non-electrical work, the voltage-freeness must be determined by a skilled electrician.

**1.6.2 Emergency stop / de-energizing**

The Thermo H plus heater itself does not have an emergency stop system. It's control and power supply is integrated into the vehicle's electrical system. It is therefore the responsibility of the user to inform himself before the commissioning of the heater in the vehicle how the heater can be successfully de-energized if necessary (maintenance, service work, abnormal behavior etc.).

**1.6.3 Work at the heater**

 <b>Warning!</b>	<b>High voltage! Danger to life!</b>
---	--

Installation, maintenance and repairs may only be carried out when the vehicle's engine is not running and the high voltage supply (AC/DC) / power supply is switched off.

**Before starting the work at the heater, it is to make voltageless acc. to DIN VDE 0105-100 and this state must be ensured for the duration of the work.**

**The following safety precautions must be observed:**

- switch off the power supply to the heater
- ensure it cannot be switched on again
- verify system is voltage-free, all poles
- ground and short circuit (the de-energized circuit)
- cover or block neighbouring parts under voltage

Electrical cables and operating elements of the heater must be arranged in the vehicle in such a way that their functioning is faultless under normal operating conditions and cannot be hampered.

Work at electrical equipment may only be started if protective measures against electric shock, short circuits and arcing faults have been carried out.

 <b>Warning!</b>	<b>Danger to life and health!</b>
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Familiarize yourself with the Thermo H plus Installation Instructions before you make any modifications to the existing heater installation.

**NOTE:**

The Installation and operating instructions contain the statutory regulations and other safety hints and regulations for the proper installation of the heater. Further they contain safety instructions and regulations to be followed for safe operation of the heater.

**1.6.4 Cleaning**

**ATTENTION:**

Cleaning with liquid media is to be avoided, as the insulation resistance can be reduced by water ingress.

**1.7 Suggestions for improvement and change**

Please direct any complaints, improvement or modification suggestions regarding this manual to:

[service@spheros.com](mailto:service@spheros.com)

## 2 Technical data

Except where limit values are specified, these technical data refer to the usual heater tolerances of  $\pm 10\%$  at an ambient temperature of  $+20^{\circ}\text{C}$  and at the rated voltage.

Technical data:

Heater (general)		
Kind of design		Hybrid heater
Ambient temperature during operation	$^{\circ}\text{C}$	-40 up to +85
Storage temperature	$^{\circ}\text{C}$	-40 up to +85
Operating overpressure max.	bar	2.0
Dimensions (tolerance +/- 3 mm)	mm	Length: 710 Width: 300 Height: 350
Weight	kg	32
Capacity of the heat exchanger	l	7
Minimum water flow	l/h	>1500 *
Minimum capacity of the water system	l	35
Antifreeze ratio in the cooling system	%	30 up to 60

\* Depending on the heat flow taken by the vehicle, a minimum burner operation of 120 seconds should be achieved.

Electrical part (high voltage)				
Device version		AC200	DC200	DC140
Nominal heating flow max.	kW	20	20	2x 7
Rated voltage	V	400	690	600
Rated control voltage	V	24		
Control voltage min.	V	20,4		16
Control voltage max.	V	26,4		32
Power consumption	kW	20	20	2x 7
Frequency	Hz	50 - 60	--	
Rated current	A	29.6	29.6	2x 11.8
Electrical protection	A	32	35	2x 16

Diesel part					
Thermo H plus		<b>160</b>	<b>230</b>	<b>300</b>	<b>350</b>
Heating flow (at ambient temperature of 20°C )	kW kcal/h	16 13800	23 20000	30 26000	35 30000
Fuel		Diesel			
Fuel consumption	kg/h	1.6	2.5	3.0	3.6
Rated voltage	V	24			
Operation voltage range	V	20 - 30			
Electrical power consumption at 24V	W	65	60	90	120
Max. permitted temperature of sucked combustion air	°C	+85			
CO <sub>2</sub> in exhaust gas at rated voltage	Vol %	9.5 + 1.0	9.0 ± 1.5	9.5 + 1.5	

## Optional Fuel Filter Heater

Filter heater		
Rated power consumption	W	240
Rated voltage	V	24
Switch-on point	C°	0.5 ± 2.5
Switch-off point	C°	5.5 ± 2.5

## 2.1 Fuel

Suitable fuel is the diesel fuel specified by the vehicle manufacturer. Only the one on the model plate of the heater specified fuel must be used.

The following table lists the by Spheros approved fuels and their specifications.

Fuel	Requirements acc.
Summer diesel	DIN EN 590
Winter diesel	DIN EN 590
Arctic diesel and Diesel for a strong winter climate	DIN EN 590
Bio diesel (FAME)*	DIN EN 12214
Paraffinic diesel fuel from synthesis or hydrogenation (HVO)*	DIN EN 15940

**NOTE:**

Circulating pumps must be assigned to the heaters according to the flow resistance in the coolant circulation system.

\* Further information on approved by Spheros fuels contains the TI (Technical Information) Fuels. It can be found in the download center on the Spheros homepage [www.spheros.com](http://www.spheros.com).

In case of air temperatures below 0°C a commercial available winter Diesel fuel must be used.

The usage of flow improvers respectively additives is permitted. There are no negative influences due to additives known.

**ATTENTION:**

**While using the fuels, their operating limits must be considered and if necessary, suitable measures (nozzle preheating, electrical heated filter) should be applied.**

**If fuel is supplied from the vehicle tank, follow the vehicle manufacturer's instructions on additives.**

### 3 Description of assemblies and components

The water heater, hereafter referred to as heater, is used in conjunction with the vehicle's own heating system

- to heat the passenger compartment,
- to defrost the vehicle windows and
- for pre-heating

The water heater operates independently from the vehicle engine and is connected to the cooling system, the fuel system and the electrical system of the vehicle. It is bolted down to the vehicle chassis or is secured using an additional cross beam.

The hybrid function of the heater includes the generation of heat

- a) by burning liquid fuel, and
- b) by electric current.

The diesel burner head (see Fig. 301) is responsible for heat generation by combustion - the control head AC / DC with the connected heating cartridges for the generation of heat by electric current.

Both systems for heat generation operate independently of one another and can be operated simultaneously or individually.

The heat is transferred to the coolant circuit of the vehicle via the heat exchanger of the heater. The adaptation to the changing heat demand is done by intermittent operation (intermittent mode).

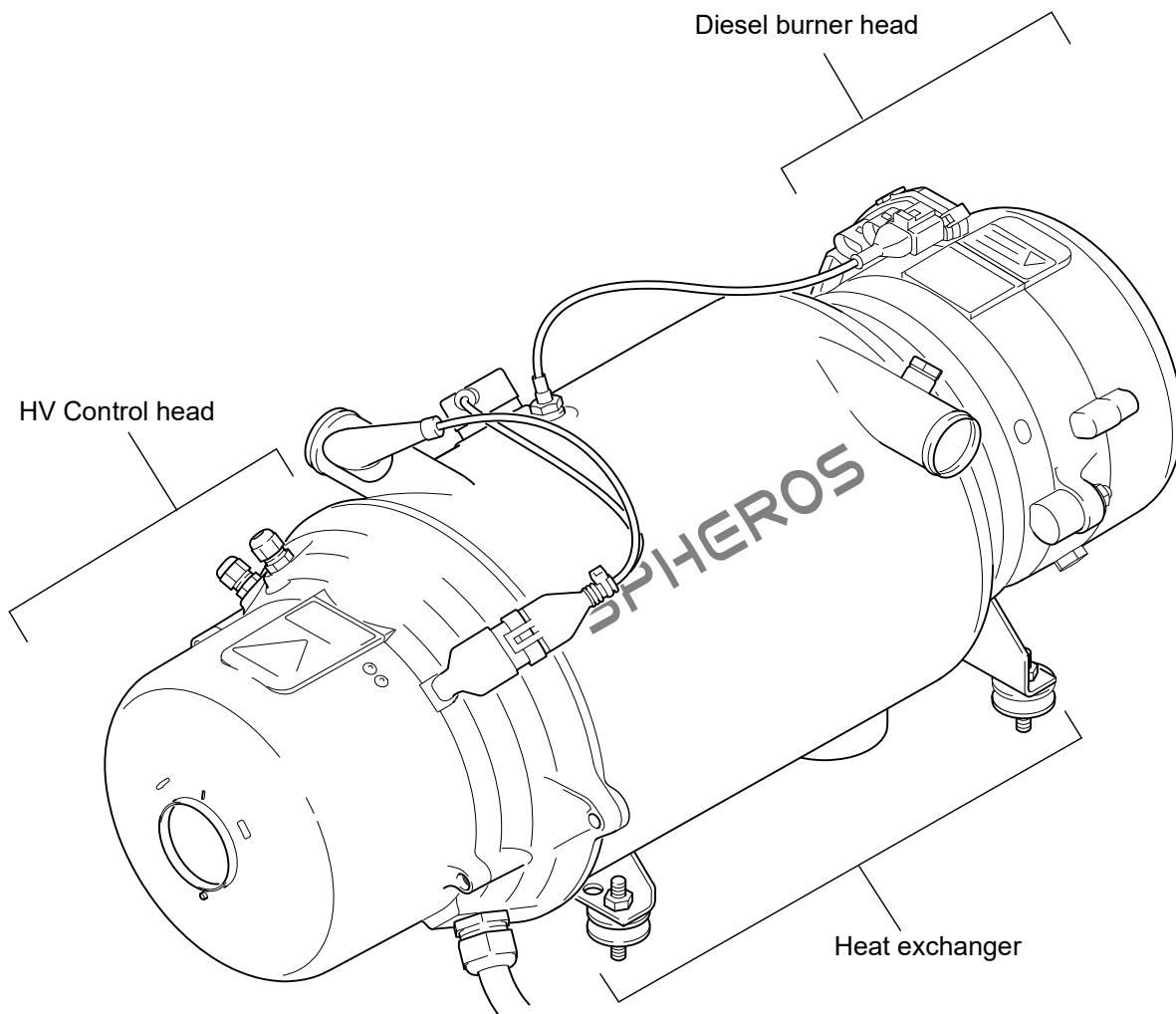


Fig. 301 Heater - Overview



3.1 HV control head

The AC/DC control head (see Fig. 302) consists of an aluminum die-cast ring as housing (4) and the hood (1). Inside is a small distribution board (3) behind a stabilizer (2). The housing (4) is screwed to the heat exchanger (8).

3.1.1 Small distribution board

The small distribution board (3, Fig. 302) includes the components required for the electrical part of the heater which are mounted on a 35mm top hat rail. The top hat rail is attached to the heat exchanger (8) via stud bolts.

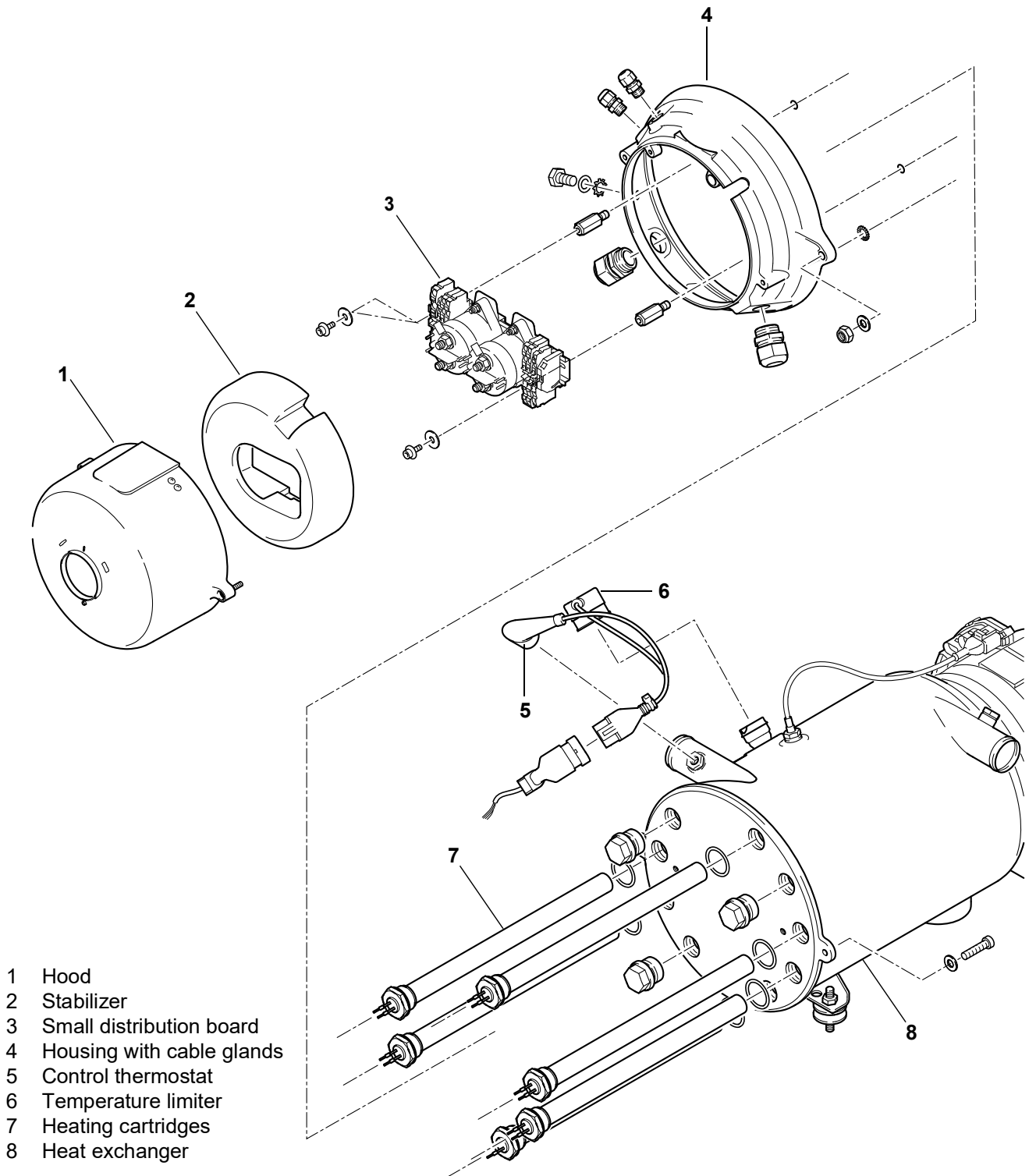


Fig. 302 HV control head / Small distributor board

### 3.2 Heat exchanger

In the heat exchanger (1, Fig. 303) the water flowing through is heated directly by heating cartridges (7) arranged in a ring shape.

The water is also heated via the inner wall (15) of the heat exchanger when the diesel burner head is in operation.

The hot exhaust gases resulting from the combustion are conducted on the inner wall via lamellas (5) and thus give off heat to them.

The cylindrically welded construction has a water inlet (3) and a water outlet (11). The heater is integrated into the cooling water circuit via these two connection ports.

In the water inlet is the control thermostat (12) for the electrical part of the heater installed.

The temperature limiter (13) for the electrical part and the control thermostat (14) for the control of the diesel burner head are located in the wall of the heat exchanger. The plate at the front has receiving openings with threads for

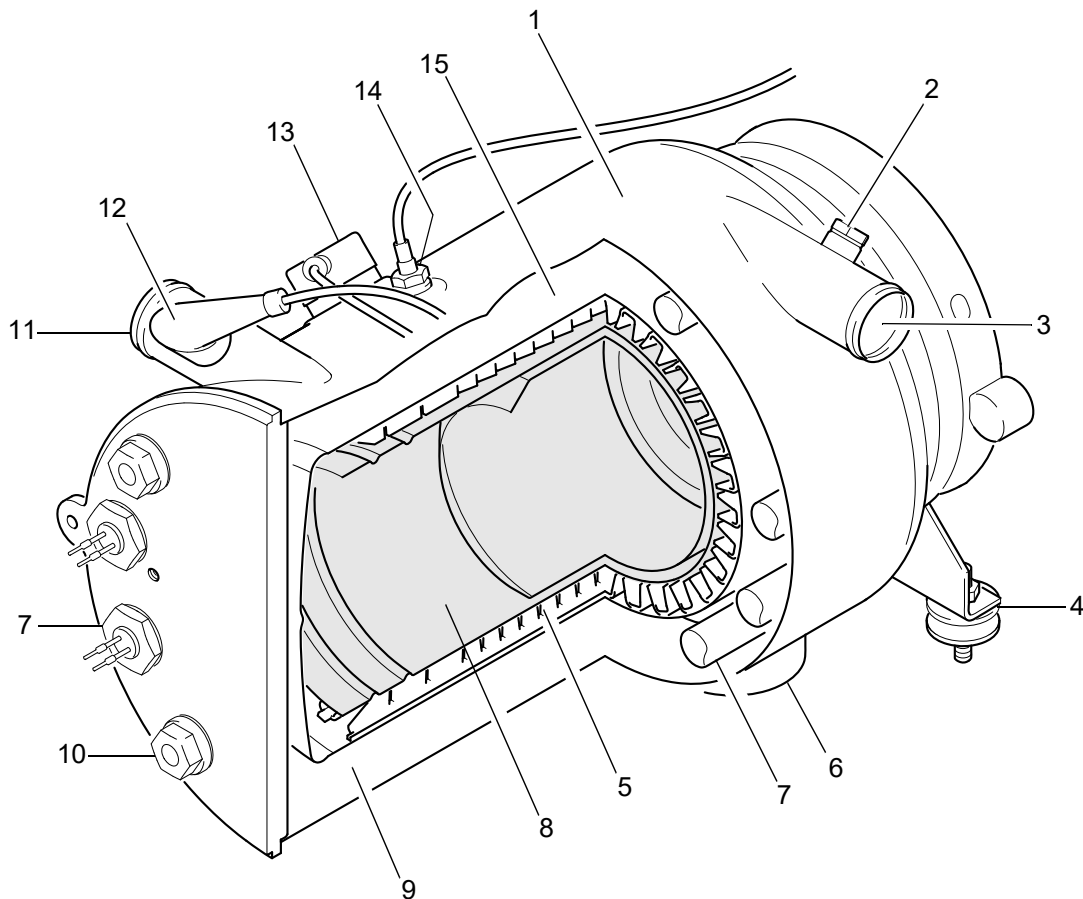
the heating cartridges. At the rear, the Diesel burner head is fixed.

#### 3.2.1 Combustion chamber

The combustion chamber (8, Fig. 303) is located inside the heat exchanger. In it the combustion of the diesel-air mixture produced by the diesel burner head takes place. After exiting the combustion chamber, the hot exhaust gases are deflected and passed through fins (5) which are located on the inner wall of the water-conducting part of the heat exchanger.

#### 3.2.2 Heating cartridges

At the end of the rod-shaped, water-proof heating cartridges (7, Fig. 303) there is an external thread with a hexagon for screwing in and the electrical cables are led out.



- |                             |                                   |                                    |
|-----------------------------|-----------------------------------|------------------------------------|
| 1 Heat exchanger outer wall | 7 Heating cartridge (6x)          | head)                              |
| 2 Bleed screw               | 8 Combustion chamber              | 13 Temperature limiter (HV control |
| 3 Water inlet               | 9 water-carrying area             | head)                              |
| 4 Device attachment         | 10 Blind plugs (3x)               | 14 Control thermostat (Diesel      |
| 5 Lamellae                  | 11 Water outlet                   | burner                             |
| 6 Exhaust gas outlet        | 12 Control thermostat (HV control | head)                              |
|                             |                                   | 15 Heat exchanger inner wall       |

Fig. 303 Heat exchanger

### 3.3 Diesel burner head

The diesel burner head is used to generate the diesel-air mixture, which is burned in the combustion chamber. Components for the control of the combustion process are integrated.

Further information can be found in Chapter 3 of the Workshop Manual for the Thermo plus series heaters.

See also [1.5](#).

## 4 Functions of the heater

### 4.1 General functional description of the heater

The Thermo H plus hybrid heater integrates two different and independent each other coolant heating systems:

1. Generation of heat by burning liquid fuel via the diesel burner head - further referred to as D heater.
2. Generation of heat by electrically operated heating cartridges via the HV control head - further referred to as HV heater.

Both transmit heat to the coolant circuit via the common heat exchanger.

Also the function and control of the two systems is independent of each other and is therefore also explained separately for the systems.

### 4.2 HV heater

#### NOTE:

The following functional sequence applies to the operation of the HV heater with AC or DC or both.

#### 4.2.1 Switching on

24V DC must be connected to the HV control wiring harness according to the valid wiring diagram for external control by an operating or control element (for example, switch, relay, pre-selection timer) installed on the vehicle in order to switch on the HV heater.

This power is fed to the load contactor(s), the control thermostat and the overheat protection (see 3.2). They constitute the control loop of the HV control head.

If all of the following three conditions are met:

1. 24V DC is applied to the external control input,
2. The control thermostat has not yet reached the upper switching threshold / has fallen below the lower switching threshold,
3. The overheating protection has not yet reached the upper switching threshold,

the respective contactor is activated, the moving core attracts and closes the main contacts.

In this way the heating cartridges connected to the contactor are powered.

The heating cartridges now convert the electrical energy into heat.

#### 4.2.2 Heating operation

The control thermostat opens its contact at 75°C and closes it again at 68°C. In this way, the heating operation

is regulated.

The overheat protection opens its contact at 125°C and must be mechanically reset by service personnel.

#### ATTENTION:

**After the overheating protection has been triggered, the cause of the overheating must first be removed before it is reset.**

#### 4.2.3 Switching off

When the 24V DC control voltage at the external control terminal is interrupted by a vehicle installed control element (e.g. switch, relay, pre-selection timer), the load contactor opens and the voltage supply of the heating cartridges is switched off.

The circulating pump in the coolant circuit continues its operation for approx. 120s.

**4.3 D heater**

The heater principle is based on a high-pressure atomizer burner and is monitored by an integrated control unit.

The burner motor powers the fan and the fuel pump. The fuel pump is coupled to the motor using a plastic coupling. The fan produces the required combustion air, the combustion air volume is impacted by the burner motor speed. The speed is read and monitored by a Hall sensor.

The speed required for the CO<sub>2</sub> content is determined during first calibration at Spheros and is stored in the control unit.

In a maintenance event the workshop can adjust the CO<sub>2</sub> setting using the DTT diagnosis (Diagnose Thermo Test) (siehe 4.4).

The fuel pressure is generated in the fuel pump and reduced to the required pressure using a pressure limiting valve.

A solenoid valve releases the fuel via the atomizer nozzle for combustion in the combustion chamber.

As an option, the fuel pump can be equipped with a nozzle block preheater. The nozzle block preheater heats the nozzle holder with the atomizer nozzle at low temperatures, and thus the fuel. The fuel air mixture is ignited in

the combustion chamber via a high-voltage ignition spark.

The flame is monitored by a flame detector integrated into the control device.

Depending on the equipment, the heater is switched on and off using a

- digital timer
- switch
- or climate control.

During heating operation the burner is automatically switched on and off. For control a temperature sensor is installed in the coolant outlet of the heat exchanger.

The heater is switched on, when the temperature falls short of a lower temperature threshold, and is switched off, if the upper temperature threshold is reached (see Table 401).

The switching thresholds depend on the operation mode of the heater and are programmed into the control device.

An operation indicator is available for monitoring the operation status of the heater. A flame indication can be optionally installed.

The operation indicator is also used to output error messages via flash code.

Table 401 Water Temperature Control Thresholds (standard data set)

Heater	Aux. heating (terminal 61)		Parking heating		Econ. setting	
	on	off (CI)	on	off (CI)	on	off (CI)
Thermo plus 160 Thermo plus 230 Thermo plus 300 Thermo plus 350	72	82	67	77	55	70

CI: Control idle  
on/off : lower/upper threshold

Aux. heating: Heater is operating, engine is operating

Parking heating: Heater is operating, engine is off

Economy setting: Control temperature is on a lower level

**NOTE:**

Auxiliary heating has priority over the economy setting!

Operational heater sequence

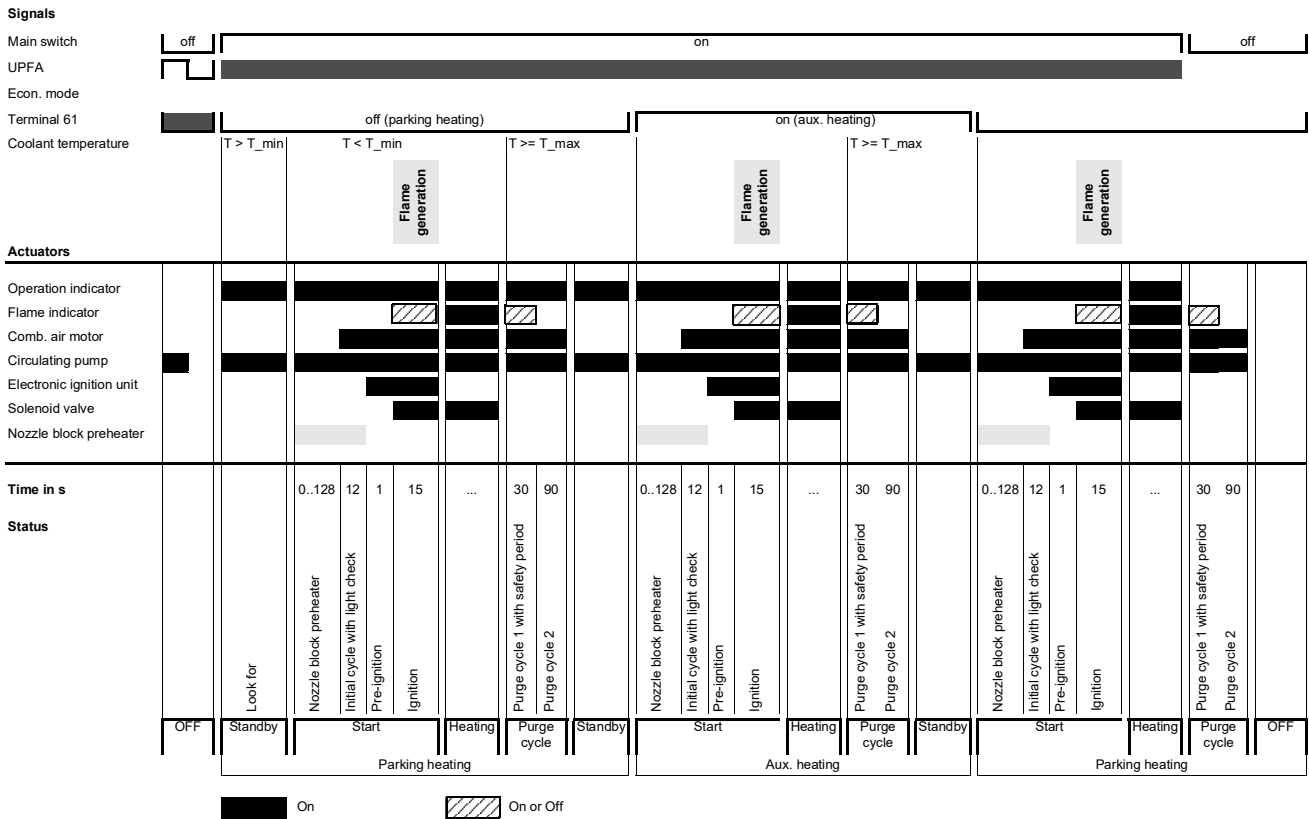


Fig. 401 Operational sequence

4.3.1 Switching on and start

When switched on, the operating display is illuminated, the control unit starts controlled operation and checks the coolant temperature.

If the coolant temperature is below the lower temperature threshold, the initial cycle starts. Combustion air fan and circulating pump are switched on. The initial cycle is used to flush the combustion chamber.

In the start phase until to the pre-ignition the in the control device integrated flameguard must continuously detect „dark“, otherwise it comes to a fault lock-out and the heater changes into the standby.

After approx. 12 seconds (initial cycle time) the high-voltage spark is ignited. Approx. 1 second later the solenoid valve in the fuel pump is opened.

The fuel injected via the atomizer nozzle and mixed with the air of the combustion air fan, is ignited by the ignition spark and burned in the combustion chamber.

The monitoring of the flame is done by the flame guard. A few seconds after a flame is detected, the control device switches the electronic ignition unit off. Until then the flame is stabilized and the heater is not yet in heating mode.

With optional nozzle block preheater:

With activated circulating pump the bimetal at the nozzle block preheater controls its operation. When the ambient temperature is less than 5 °C it is turned on. Not time-dependent and not limited.

Starting from a temperature <5 °C, the duration of the nozzle block preheating is prolonged, depending on the determined temperature. The burner motor does not run during the entire preheating time. It starts at the latest 12 seconds before the expiry of the determined preheating time with the initial cycle. The time of the initial cycle can thus be extended to a maximum of 140 seconds.

The further procedure is as described.

4.3.2 Heating operation

After the flame is stabilised, the heater is in controlled (normal) operation.

Depending on the coolant temperature, the coolant temperature is maintained at one level by switching the burner alternately on and off.

Once the upper switching threshold is exceeded, heating operation is finished and the purge cycle initiated.

The solenoid valve is closed, the flame expires, however the combustion air fan and the circulating pump continue running.

The purge cycle ends approx. after 120 seconds. The combustion air fan is switched off.  
The heater is in a controlled break.  
The operation indicator is on.  
Once the temperature falls short of the lower switching threshold, the heater restarts burner operation. It runs through the same sequence as the switching-on sequence.

#### 4.3.2.1 Auxiliary heating mode and parking heating mode

From the terminal D+ / +61 the control device receives the information either the vehicle engine is running or not. If the engine is running the heater is in the auxiliary heating mode.  
The switching thresholds are higher than in the parking mode with the engine not running.  
In the parking heating operation an economy mode may be activated.

#### 4.3.2.2 Economy circuit

If the economy circuit is activated (economy mode) the controlled temperatures in the heating system are maintained at a low temperature level. The lower and upper switching threshold are reduced.  
Due to lower radiation loss the fuel consumption can be reduced for a lower heat demand (e.g. warmer mode).  
The heater burner output is not reduced.  
In auxiliary heating mode (signal from terminal D+ / +61) saving mode is automatically deactivated.

#### 4.3.2.3 Gradient evaluation

In case of low coolant flow or poor coolant circuit venting the temperature quickly increases in heating operation. The control device recognises the quick temperature increase and automatically sets the upper switching threshold to a lower value.  
The quicker the temperature increases, the lower the switching threshold for starting the controlled break is set. In addition, the burner is also switched back on again after the controlled break at a lower switching threshold. This prevents residual heat triggering the overheating protection.

#### 4.3.2.4 Minimum combustion period

**NOTE:**

Frequent burning time under 120 seconds may result in soot build and increased smoke formation.

A minimum burner combustion period of 120 seconds is targeted.

For ambient and operating conditions this target is not always achieved.  
In order to achieve the minimum combustion period, the lower switching threshold is variably adjusted by the control device.  
This process is also called hysteresis adaptation and is applied during each heating operation.

If the combustion period falls short of the minimum combustion period of 120 seconds, the lower switching value is lowered by 1K for the following combustion process. The upper switching threshold remains as is. This can be repeated until the minimum combustion period is reached or the lower switching threshold is reduced by 5K.

A further lowering is not possible.

Following a combustion process, where the required minimum combustion period was reached, the lower switching threshold is raised in steps of 1 K, max. up to the initial level.

#### 4.3.3 Switching off

Switching the heater off ends the combustion process. The operation indicator goes out and the purge cycle is initiated.

The solenoid valve closes, the flame expires, the combustion air fan and the circulating pump continue running. The purge cycle ends approx. after 120 seconds. The combustion air fan is switched off.

If a malfunction occurs during purge cycle (e.g. flame detection), the purge cycle may be shorter than 120 seconds.

During purge cycle it is permitted to switch the heater back on. The burner will restart after a purge cycle time of 30 seconds and subsequent initial cycle time.

### 4.4 Diagnosis interface and (Diagnose Thermo Test) DTT diagnosis

The D-heater supports diagnosis capabilities. Using the DTT diagnosis adapter, DTT diagnosis and a PC, the heaters in a vehicle can be checked.

Information on the hook-up of the heater to the DTT diagnosis and its usage can be found in the DTT Operation Instructions which are supplied with the device. The Operation Instructions are also available in the download center on [www.spheros.com](http://www.spheros.com).

**NOTE:**

For protection against moisture and contamination ensure that the diagnosis interface is sealed using a dummy plug, if not in use.

#### 4.5 Fault lock-out and heater lock-out

A distinction is made between fault lock-out and heater lock-out.

The lock-outs protect the heater and the surrounding vehicle assemblies against sequence errors after a failure or a malfunction of individual heater components.

In a heater lock-out safety-related components are affected by the failure or malfunction. It may only be released by Spheros trained personnel after eliminating the cause.

Each fault lock-out and heater lock-out is stored in the control device.

#### 4.6 Fault lock-out

If one of the malfunctions listed below occurs, the heater will initiate a fault shut-down, followed by a fault lock-out.

Depending on the error timing, no purge cycle or a 120 seconds purge cycle will be executed.

Flash impulses are outputted via the operation indicator. In case of several sequential fault lock-outs a heater lock-out is initiated.

**NOTE:**

If the circulating pump is externally actuated it will continue operating, if it is not affected itself.

In case of several sequential fault lock-outs a heater lock-out is initiated (see 4.7).

##### 4.6.1 Malfunctions during switching-on and start procedure

If malfunctions occur during switching-on or during the start process prior to ignition, the heater will be switched off without purge cycle.

The heater is in fault lock-out. The motor stops immediately or does not start.

**Malfunction criteria:**

- Short circuit and/or interruption of electrical components:
  - Circulating pump
  - Electronic ignition unit
  - Optional nozzle block preheater
- Flame or extraneous light detection by the flameguard prior to opening of the solenoid valve.
- No start: No flame detection within 15 seconds after opening the solenoid valve.

- Temperature sensor delivers unacceptable temperature values.
- Burner motor speed signal faulty.
- Voltage falls short of the low voltage threshold of approx. 20.5 V within a duration of 20 seconds after a heating request.
- Voltage exceeds the high voltage threshold of approx. 30 V within a duration of 6 seconds (purge cycle only, no fault lock-out).

##### 4.6.2 Malfunctions during heater operation

In case of malfunctions during heater operation, a 120 seconds purge cycle will be executed first. Subsequently the heater status is switched to fault lock-out.

**Malfunction criteria:**

- Circulating pump - short circuit and/or interruption
- Water temperature greater than the upper switching threshold
- Temperature sensor delivers unacceptable temperature values.
- Heater operation outside the permissible temperature range.
- Burner motor speed signal faulty.
- Flame interruption (combustion interruption for longer than 15 seconds).
- Voltage falls short of the low voltage threshold of approx. 20.5 V within a duration of 20 seconds after a heating request.
- Voltage exceeds the high voltage threshold of approx. 30 V within a duration of 6 seconds (purge cycle is applied only, but no fault lock-out).
- Control device malfunction

##### 4.6.3 Malfunctions during purge cycle

After the purge cycle the heater goes into the fault lock-out.

**Malfunction criteria:**

- Circulating pump - short circuit and/or interruption
- Heater operation outside the permissible temperature range.
- Burner motor speed signal faulty.
- Voltage falls short of the low voltage threshold of approx. 20.5 V within a duration of 20 seconds after a heating request.
- Voltage exceeds the high voltage threshold of approx. 30 V within a duration of 6 seconds (purge cycle is applied only, but no fault lock-out).
- Control device malfunction



#### 4.6.4 Fault lock-out release and error clearance

The fault lock-out is released when the heater is switched off.

After that it will be immediately ready for operation.

The detected error is stored in the error memory and can be read using DTT diagnosis. It is possible to delete the stored error using the DTT diagnosis

### 4.7 Heater lock-out

**The heater lock-out overrides the standard fault lock-out.**

If the heater lock-out is active, neither start nor purge cycle are executed after switching the heater back on. Prior to restarting the heater troubleshooting must be performed by personnel trained by Spheros in order to identify the root cause.

After that the heater interlock can be released (see 4.7.1).

**NOTE:**

If malfunctions occur during switching-on or during the start process prior to ignition, the heater will be switched off without purge cycle.

The heater is in the heater lock-out.

The burner motor stops immediately or does not start.

Besides that a purge cycle between 30 seconds and 60 seconds is performed depending on error type and timing. Subsequently the heater status is switched to heater lock-out.

If the circulating pump is externally actuated it will continue operating, if it is not affected itself.

**Heater lock-out causes:**

- Short circuit and/or interruption of electrical components:
  - Solenoid valve
  - Flameguard
  - Overheating protection
  - the temperature sensor (overheat protection/water temperature sensor) is unplugged.
- Flame is not expired within 30 seconds after purge cycle (burner motor stops).
- Overheating protection triggered.
- Control device error
- Repeated malfunctions
- Repeated flame interruptions

#### 4.7.1 Heater lock-out release

To release, the switched on heater must be disconnected from the vehicle electrical system as follows.

##### 4.7.1.1 Release a heater lock-out without DTT diagnosis

**NOTE:**

Disconnect the power supply for release, by pulling the plug C is not permissible.

1. Remedy the cause of the heater lock-out.
2. Disconnect the power supply (e.g. by pulling the fuse) for at least 10s.
3. Reconnect power supply.
4. Switch the locked-out heater off and then on again.
5. Repeat steps 2. and 3.
6. Heater is ready for service and starts, if necessary turn it off.

**NOTE:**

If the main switch remains in the on position when disconnecting the power supply, the heater automatically starts after connecting it to the vehicle electrical system. The heater can be switched off during initial cycle.

##### 4.7.1.2 Release the heater lock-out using the DTT diagnosis

1. Connect the heater with the DTT diagnosis and read out the error memory.
2. Remedy the cause of the heater lock-out.
3. Disconnect the power supply (e.g. by pulling the fuse) for at least 10s.
4. Reconnect the heater to the vehicle electrical system.
5. Using the DTT diagnosis, delete the error/error memory.

## 5 Troubleshooting and error correction

### 5.1 General

This section describes troubleshooting and error correction for Thermo H plus 160, H plus 230, H plus 300 and H plus 350 heaters.



The safety information and regulations (see 1.6) must be observed.

### 5.2 HV heater troubleshooting

The following table lists possible, general error symptoms.

Table 501: Error symptoms and possible causes

Error symptom	Possible cause
Heater can not be switched on.	<ul style="list-style-type: none"> <li>• Missing or insufficient supply voltage (24V)</li> <li>• 24V fuses defective or not active</li> <li>• Supply lead to the plug contacts of the HV control wiring harness (24V) defective or contact not established</li> <li>• Plug of the temperature sensors not connected</li> <li>• Temperature sensors defective</li> <li>• HV small distribution board defective</li> <li>• HVIL (Interloop) – failure (if existent)</li> </ul>
Temperature in the water circuit too low / too high	<ul style="list-style-type: none"> <li>• Control thermostat defective</li> <li>• Diodes in LV wiring harness defective (if applicable, heater may be connected incorrectly)</li> </ul>
Heater can not be switched off.	<ul style="list-style-type: none"> <li>• Supply voltage (24V) not switched off</li> <li>• HV small distribution board defective</li> <li>• Diodes in LV wiring harness defective (if applicable, heater may be connected incorrectly)</li> </ul>
Heater does not heat	<ul style="list-style-type: none"> <li>• No HV supply connected / active</li> <li>• HV fuses defective or not active</li> <li>• Ground fault interrupter or insulation monitoring device (IMD) defective or not active</li> <li>• HV small distribution board defective</li> <li>• Heating cartridge(s) defective</li> </ul>

Table 501: Error symptoms and possible causes

Error symptom	Possible cause
No HVIL (Interloop) signal (if existent)	<ul style="list-style-type: none"> <li>• SC600 respective the control unit does not transmit a HVIL signal</li> <li>• HVIL contact is not established</li> <li>• Hood not (correctly) mounted</li> <li>• HV cable not connected</li> <li>• HV control wiring harness (24V) not connected or cable defective</li> </ul>
Heating power too low	<ul style="list-style-type: none"> <li>• HV supply power too low</li> <li>• Heating cartridge(s) defective</li> </ul>
Heating power too high	<ul style="list-style-type: none"> <li>• HV supply power too high</li> </ul>
Overheating, temperature limiter has triggered	<ul style="list-style-type: none"> <li>• Control thermostat defective</li> </ul>

### 5.3 D heater troubleshooting

Refer to the workshop manual for the Thermo plus heater series, Chapter 5, for troubleshooting information. See also [1.5](#).

## 6 Wiring diagrams

### 6.1 General

The following figures show wiring diagrams/connecting schematics applicable for the Thermo H plus heater. Wiring diagrams/connecting schematics concerning the electrically operated part of the heater are designated with HV heater - such concerning the Diesel operated part are designated with D heater.

### 6.2 HV heater



**Electrical work may only be performed by persons, which have the required qualification (see 1.6.1).**

**NOTE:**

Consider also the information on the electrical installation given in the Thermo H Installation and operating instruction. The document is available for download in the download center on [www.spheros.com](http://www.spheros.com).

With the help of the following overview you will find the circuit diagrams for your heater based on the ident. no. on the type label.

Ident. no. Heater	Wiring diagram for housing removal	Hook-up overview for the small distribution board removal
11143458A und 11143457A	<a href="#">Fig. 601, page 602</a>	<a href="#">Fig. 606, page 607</a>
11139571A und 11143481A	<a href="#">Fig. 602, page 603</a>	<a href="#">Fig. 607, page 607</a>
11139574A und 11142595A	<a href="#">Fig. 603, page 604</a>	<a href="#">Fig. 608, page 608</a>
11142671A	<a href="#">Fig. 604, page 605</a>	<a href="#">Fig. 607, page 607</a>
11142686A	<a href="#">Fig. 605, page 606</a>	<a href="#">Fig. 609, page 608</a>

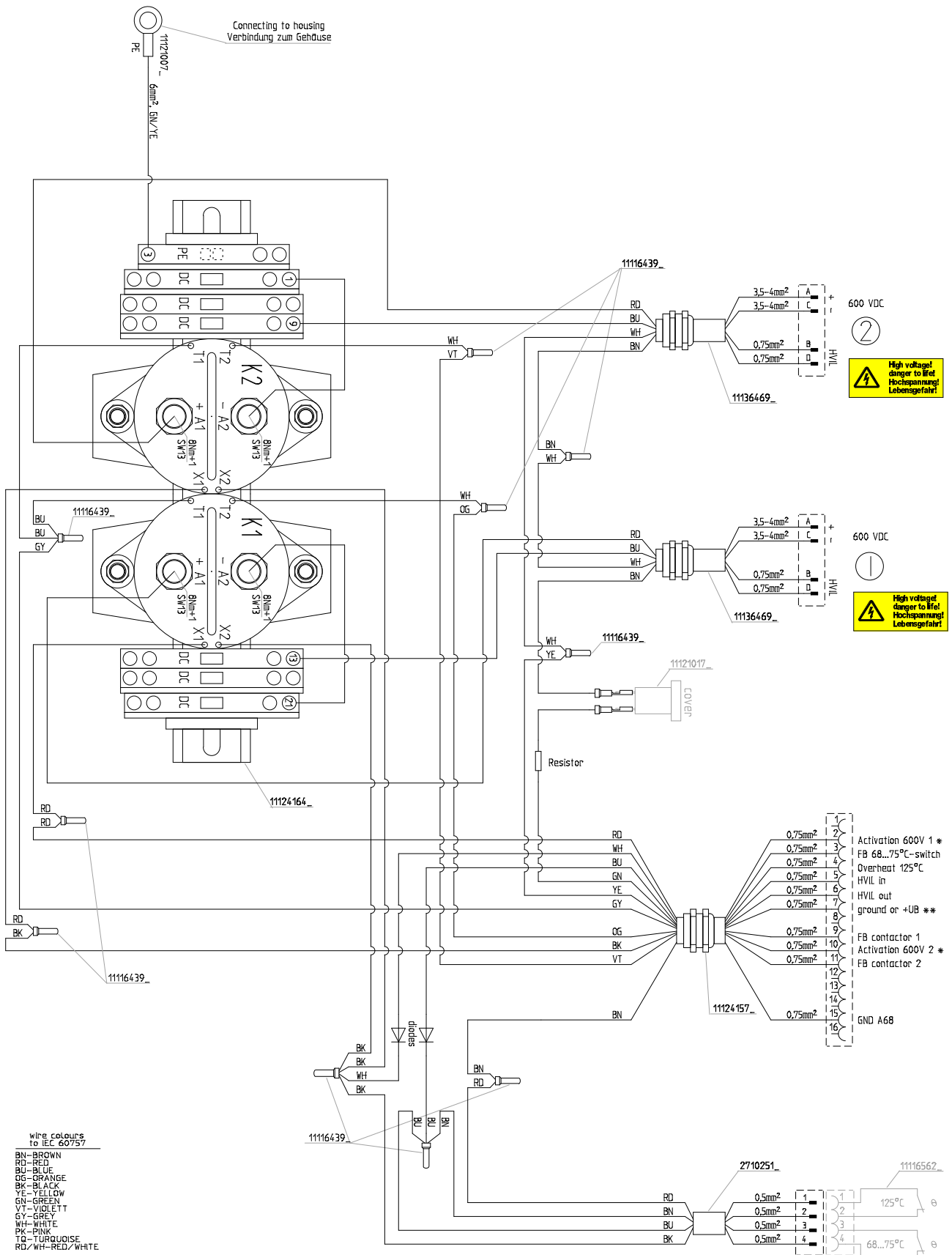


Fig. 601 Housing removal for devices Thermo H plus DC/DC 7.0/7.0 kW  
(heater ident no. acc. to model plate 11143458A/B, 11143457A/B, 11143484A and 11143485A)

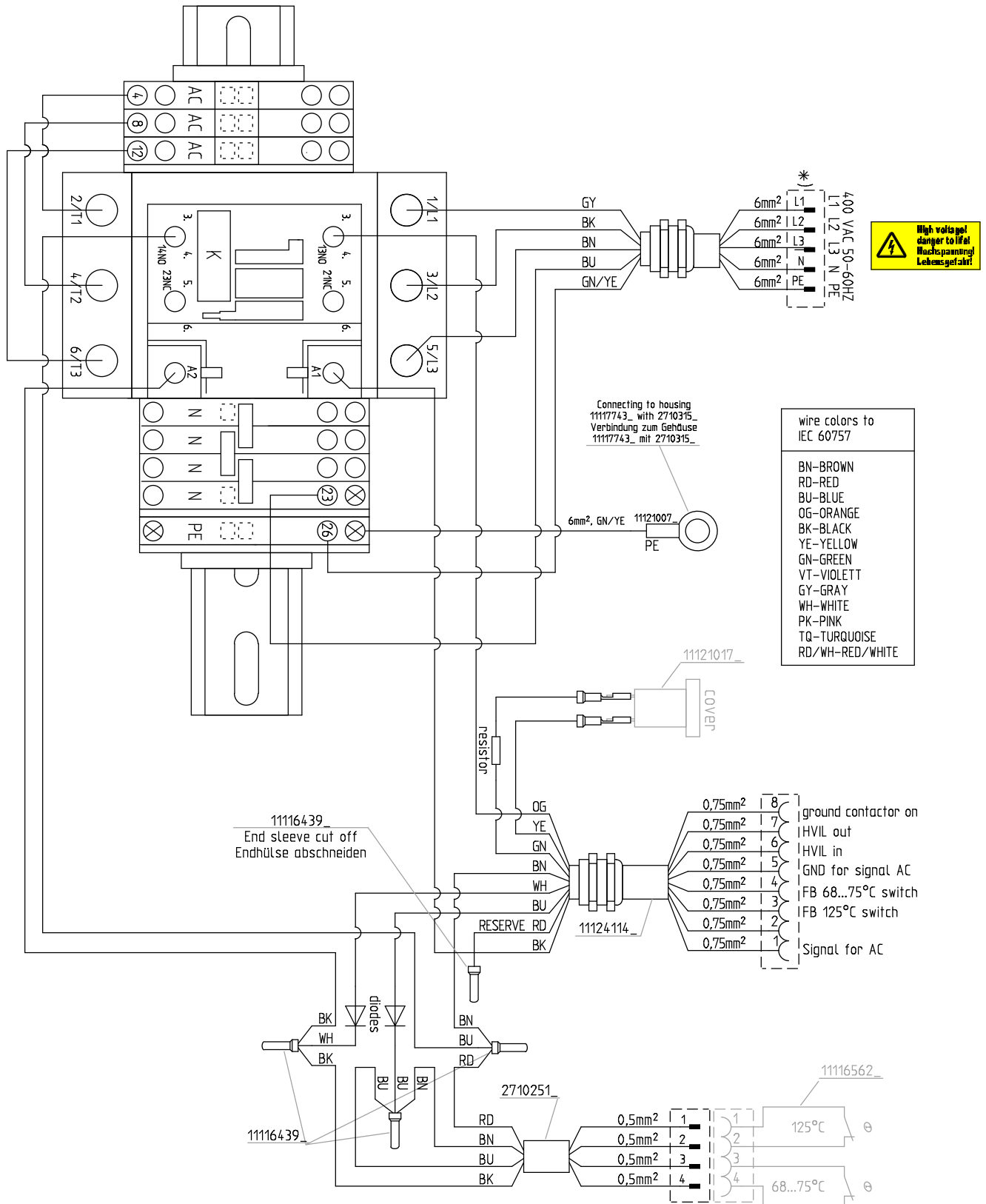


Fig. 602 Housing removal for devices Thermo H plus AC 20.0 kW (heater ident no. acc. to model plate 11139571A and 11143481A)

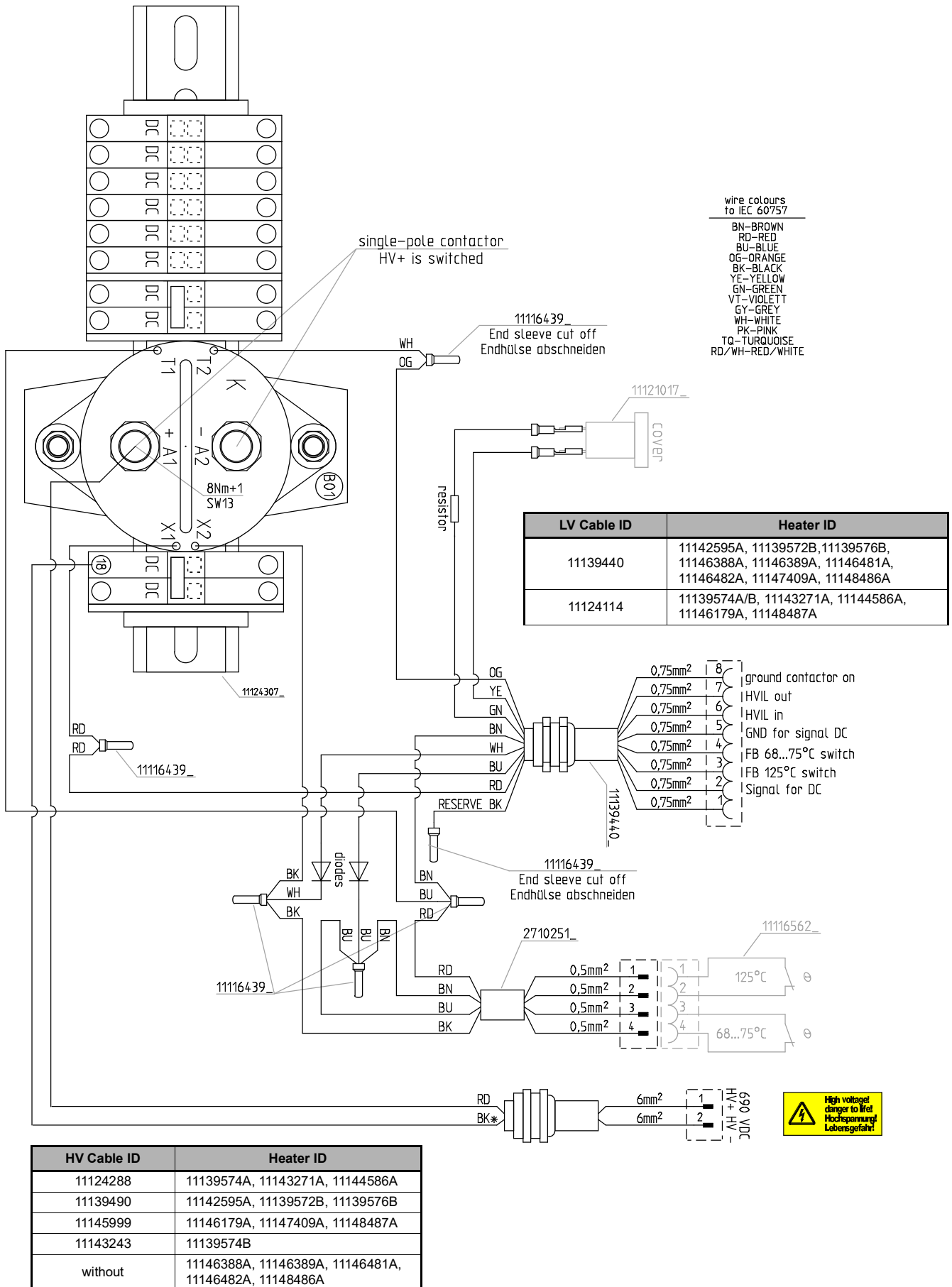


Fig. 603 Housing removal for devices Thermo H plus DC 20.0 kW (heater ident no. acc. to model plate 11139574A and 11142595A)

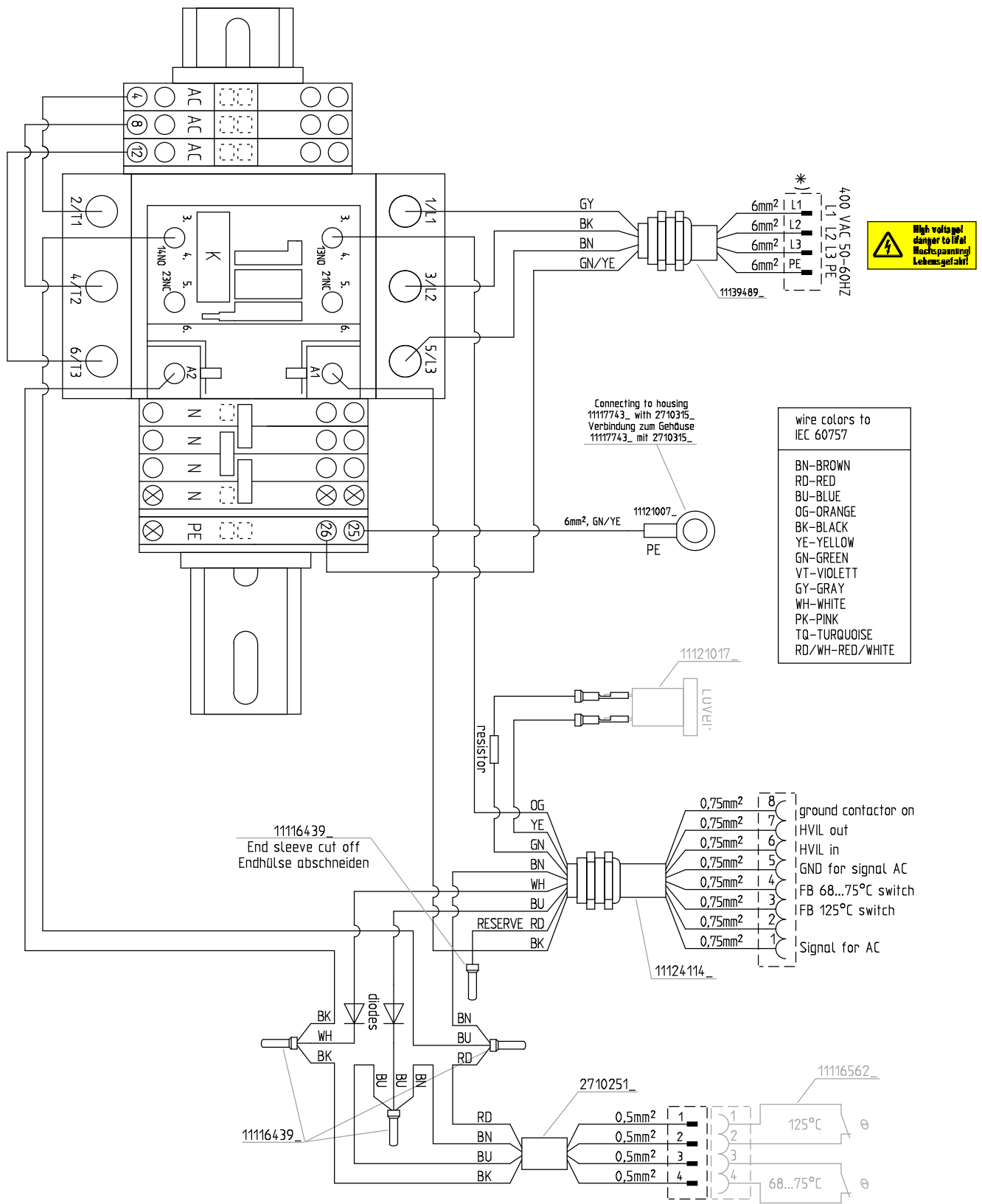


Fig. 604 Housing removal for devices Thermo H plus AC 20.0 kW  
(heater ident no. acc. to model plate 11142671A)



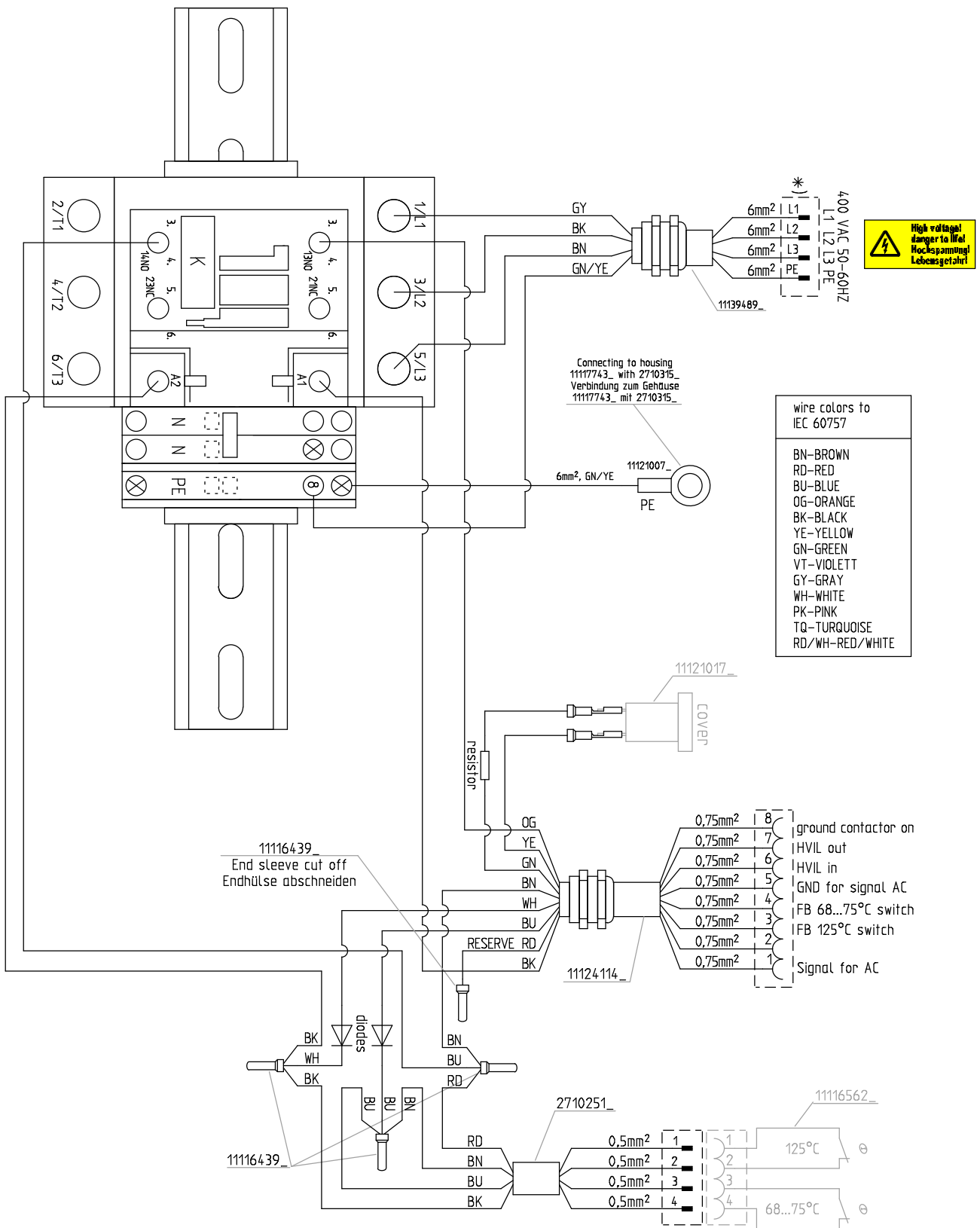


Fig. 605 Housing removal for devices Thermo H plus AC 7.0 kW (heater ident no. acc. to model plate 11142686A)

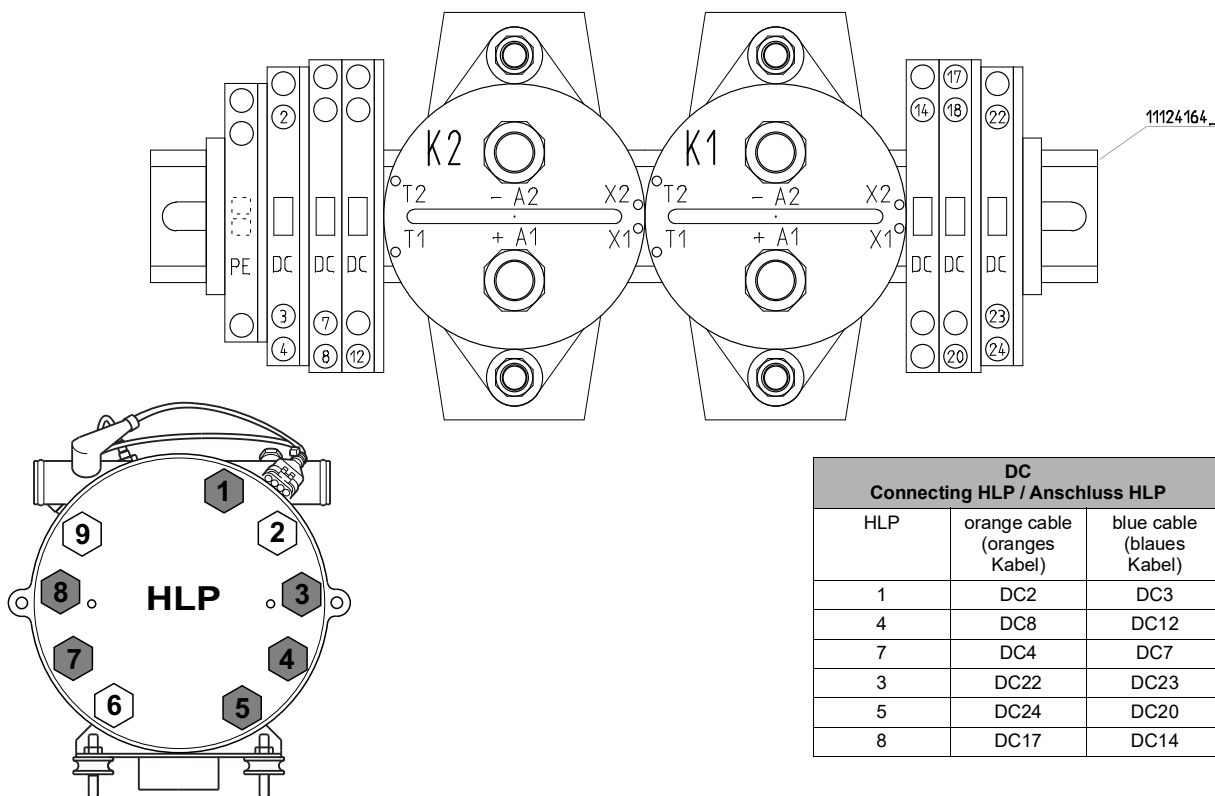


Fig. 606 Small distribution board removal for devices Thermo H plus DC/DC 7.0/7.0 kW (heater ident no. acc. to model plate 11143458A/B, 11143457A/B, 11143484A and 11143485A)

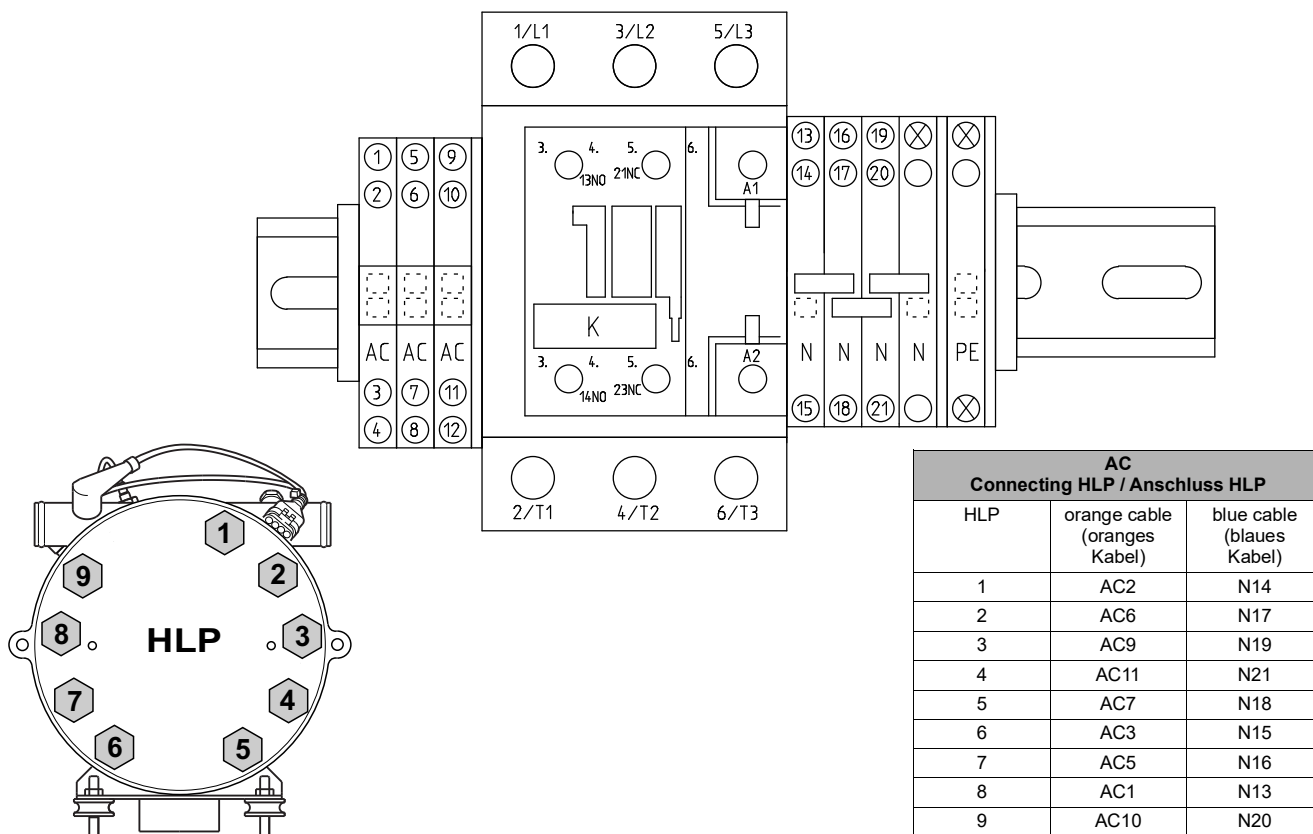


Fig. 607 Small distribution board removal for devices Thermo H plus AC 20.0 kW (heater ident no. acc. to model plate 11139571A, 11143481A and 11142671A)

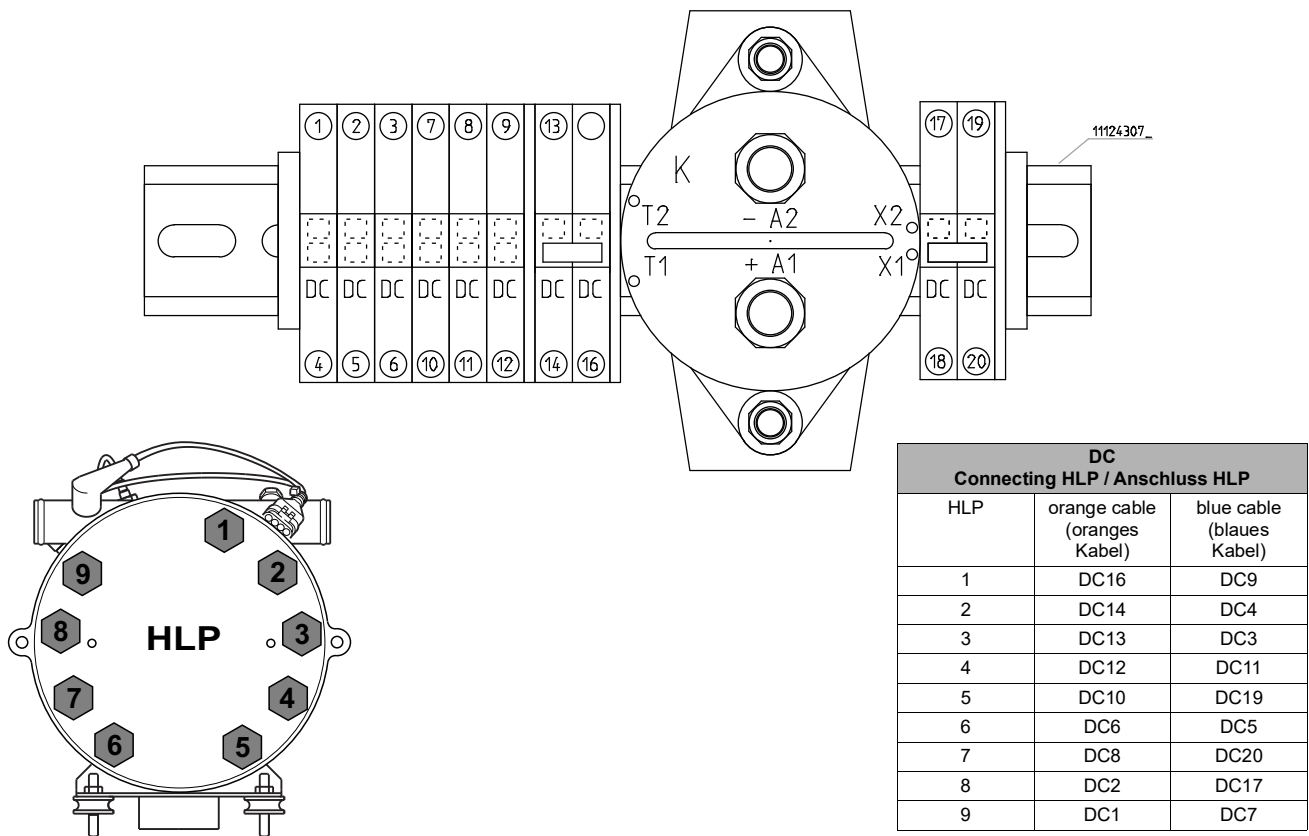


Fig. 608 Small distribution board removal for devices Thermo H plus DC 20.0 kW  
(heater ident no. acc. to model plate 11139574A/B, 11142595A, 11139572B, 11139576B, 11146388A, 11146389A, 11146481A, 11146482A, 11147409A, 11148486A, 11143271A, 11144586A, 11146179A, 11148487A)

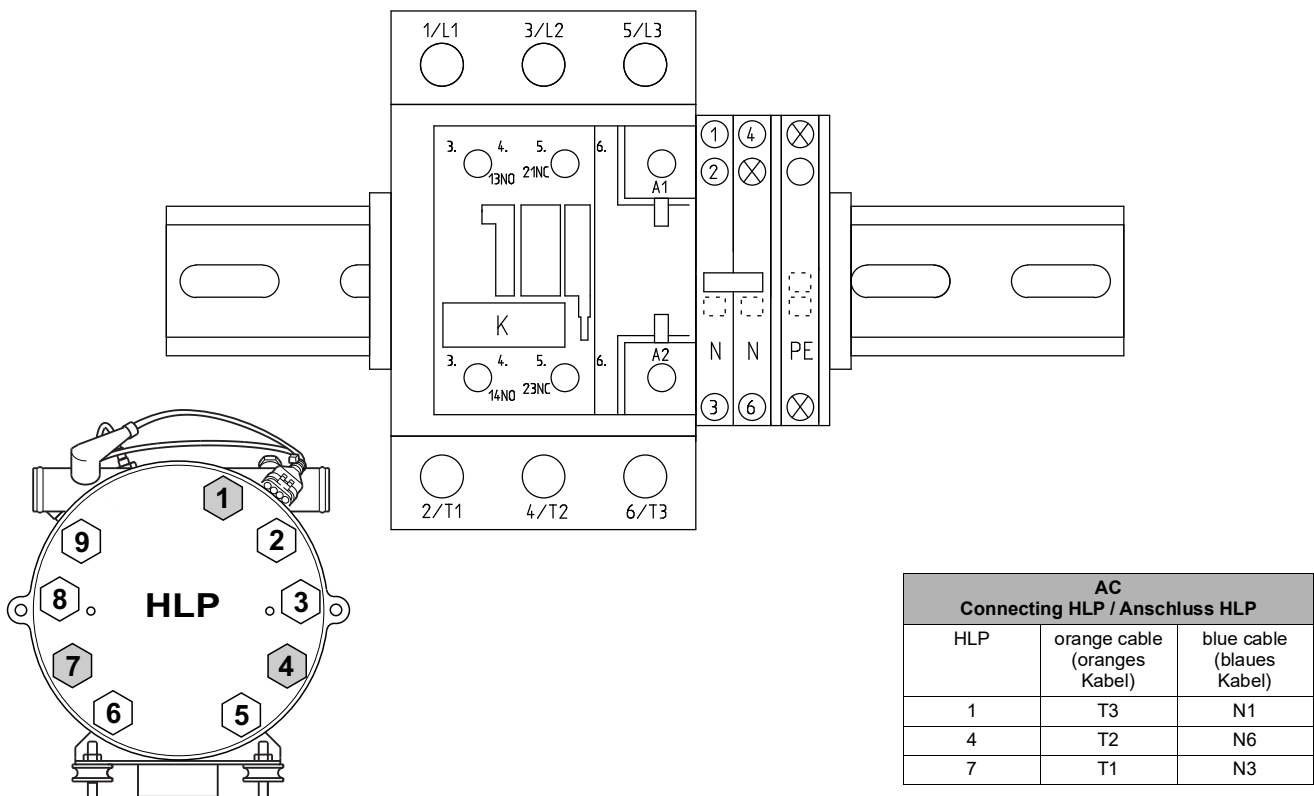


Fig. 609 Small distribution board removal for devices Thermo H plus AC 7.0 kW  
(heater ident no. acc. to model plate 11142686A)

### 6.3 D heater

The minimum cable cross-sections indicated in the table must be applied.

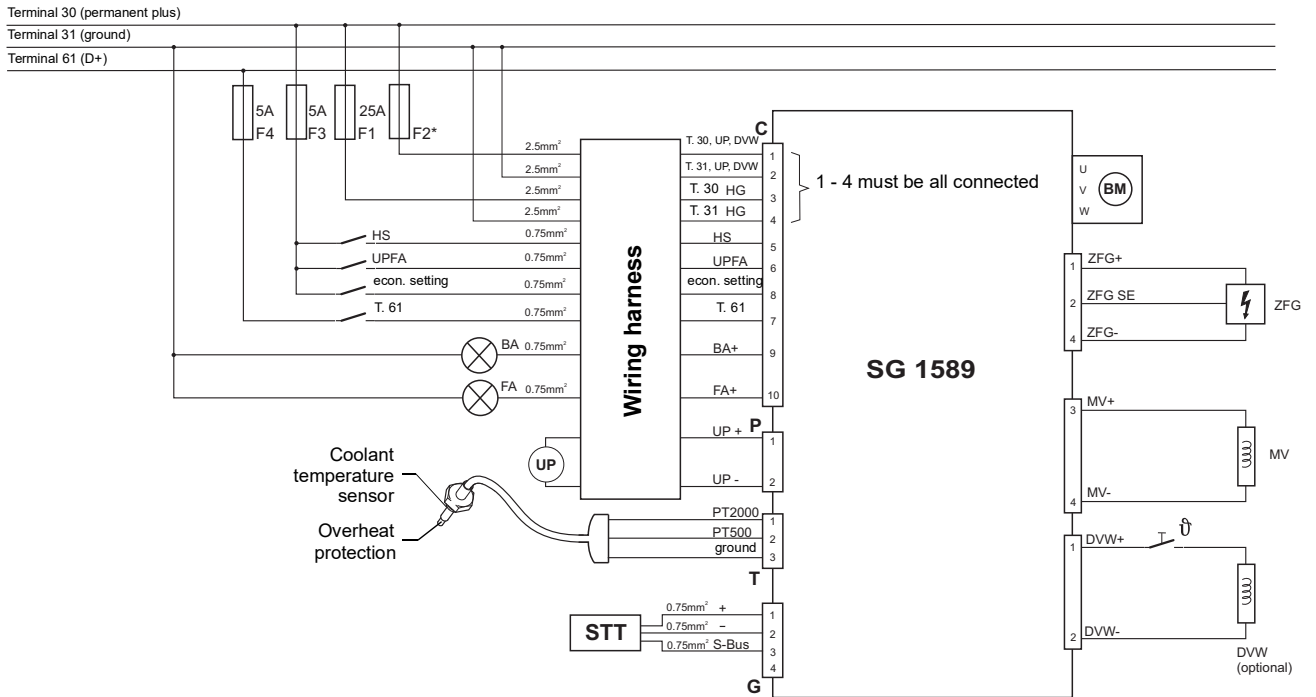
Cable length <7.5m	Cable length 7.5 - 15m
0.75 mm <sup>2</sup>	1.5 mm <sup>2</sup>
2.5 mm <sup>2</sup>	4.0 mm <sup>2</sup> *

\* The cable cross-section is to be reduced to 2.5 mm<sup>2</sup> in front of the heater

\* Note for F2: The max. possible for the design value is shown. The fuse is to be adapt under circumstances acc. to the smaller cable cross section of the connected circulating pump.

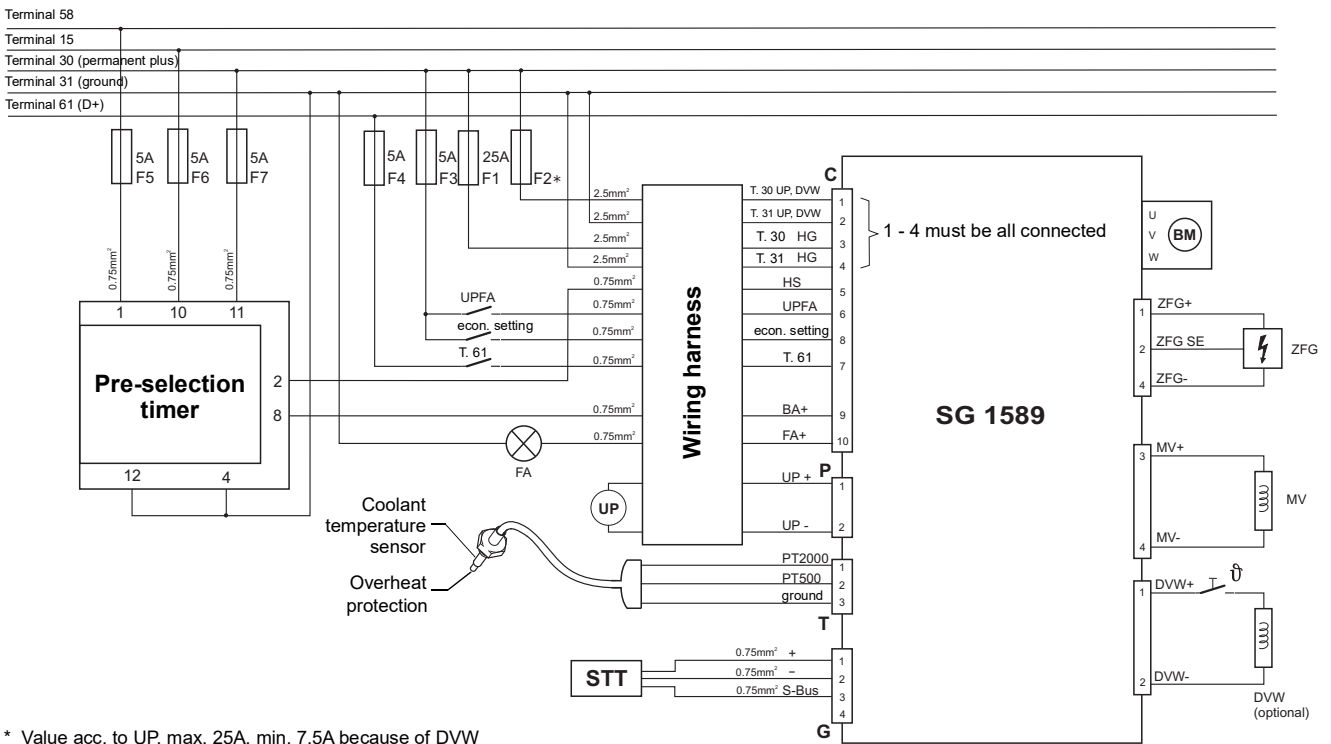
**NOTE:**

The vehicle fuses must be installed in such a way that their ambient temperature does not exceed 60 °C.



\* Value acc. to UP, max. 25A, min. 7.5A because of DVW

Fig. 610 System wiring diagram for the D heater, legend see page 611



\* Value acc. to UP, max. 25A, min. 7.5A because of DVW

Fig. 611 System wiring diagram for the D heater with pre-selection timer, legend see page 611

Position	Designation
BA	Operation indicator 3W (max. 5W)
FA	Flame indicator 3W (max. 5W)
UP	Circulation pump
STT	Spheros Thermo Test (diagnostic tool)
F1, F2*	Car flat-type fuse 25A acc. to DIN 72581 part 3 or ISO 8820-3
F3 - F7	Car flat-type fuse 5A acc. to DIN 72581 part 3 or ISO 8820-3
HS	Main switch
UPFA	Circulating pump external control
Spar	Economic setting
DVW	Nozzle preheater (in the heater)
ZFG	Electronic ignition unit (in the heater)
MV	Solenoid valve (in the heater)
BM	Combustion air motor (in the heater)

Legend for wiring diagrams

Connector	Description	
<b>C</b>	<b>To vehicle (Power)</b>	
C1	Terminal 30 (+), UP (DVW)	
C2	Terminal 31 (-), UP (DVW)	
C3	Terminal 30 (+), HG	
C4	Terminal 31 (-), HG	
C5	Main switch	
C6	UPFA	
C7	Terminal 61 (D+)	
C8	Economic setting (Spar)	
C9	Operation indicator +	
C10	Flame indicator +	
<b>T</b>	<b>Temperature sensors</b>	
T1	Temp. sensor PT2000 +	
T2	Overheat protection PT500 +	
T3	Ground	
<b>P</b>	<b>Circulating pump</b>	
P1	Circulating pump +	
P2	Circulating pump -	
<b>G</b>	<b>Diagnosis STT</b>	
G1	Terminal 30	
G2	Ground	
G3	S Bus	
G4	--	

Connector pin assignment

## 7 Servicing

### 7.1 General



The safety information and regulations (see [1.6](#)) must be observed.

#### 7.1.1 Heater servicing

For risk of overheating, the battery main current may not be disconnected, while the heater is operating or in run-down. Make sure that the circulating pump is running while the heater is switched on for tests/inspections.

### 7.2 HV heater servicing

The necessary service work can be found in the maintenance plan for the Thermo AC/DC heater series. It can be found in the download center on [www.spheros.com](http://www.spheros.com).

### 7.3 D heater servicing

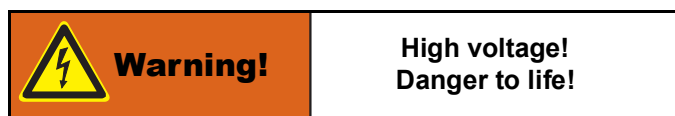
Information on necessary service work for the D heater is contained in the Workshop Manual for the Thermo plus heater series, Chapter 7. See also [1.5](#).

## 8 Components and heater removal and installation

### 8.1 General



The safety hints and regulations in Chapter 1 (see 1.6) must be adhered.



Before starting the work at the heater, it is to make voltageless and this state must be ensured for the duration of the work. (consider 1.6.3 !).

#### ATTENTION:

Sealing elements between disassembled components must be principally discarded and replaced. This does not apply to the temperature sensor gasket ring, as it is permanently attached. Screws with coated threads must be discarded and replaced.

It is permitted to remove components from the heater, while the heater is installed in the vehicle, assuming that sufficient space is available and no components will be damaged.

#### NOTE:

If components are disassembled to a degree not covered in this workshop manual, any warranty claim shall be voided.  
Only genuine Spheros spare parts should be used.

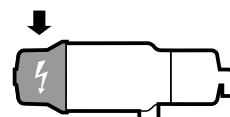
In the figures of the procedures following icon is used:



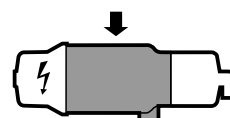
Symbol tightening torque:  
Features in graphics parts (e.g. nuts, bolts) that are to be mounted with a specific tightening torque. The values for the tightening torque are at the symbol and are binding.

The following symbols give you an orientation during the procedures, where the next step(s) will be performed on the heater:

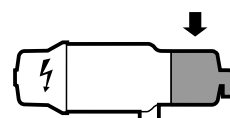
- at the HV control head



- at the heat exchanger

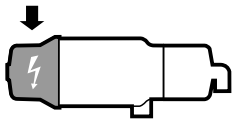


- at the Diesel burner head





8.2 HV control head



8.2.1 Temperature guards (temperature limiter, control thermostat) removal/installation.

<p><b>Caution!</b></p>	<p><b>Scalding hazard!</b></p>
------------------------	--------------------------------

Risk of injuries if coolant temperature is increased.

Removal

1. Establish voltage-free state of the heater and secure it for duration of the work (**Observe 1.6.3 !**).
2. Disconnect temperature guards plug (1, Fig. 801).
3. Remove the rubber cap of the temperature limiter (4).
4. Using a screw driver, lever off retaining spring (3) and remove the temperature limiter (2).
5. Remove the protection cap of the control thermostat (6).
6. Screw out by hand the control thermostat (7).

**NOTE:**

The control thermostat is screwed into the screw-in socket, which should not be loosened.

Installation

1. Screw the control thermostat (7, Fig. 801) by hand into the coolant inlet.
2. Install protection cap (6).
3. Slide rubber cap (4) of the temperature limiter (2) back until it can be put in its installation position.
4. Position temperature limiter (2) in the reception neck (5) and push in the retaining clip (3).

**ATTENTION:**

**The retaining spring must be located in the groove of the reception neck and must be latched in position both perceptibly and audibly (twice) at the collar of the reception neck. Only then will the temperature limiter be in proper contact with the heat exchanger jacket.**

5. Install the rubber cap. After the rubber cap has been installed, the cable must be aligned in the cable sleeve so it is tension-free. Connection cables must not be routed over the reset button.
6. Reconnect the temperature guards plug (1).
7. Restore the power supply as required.

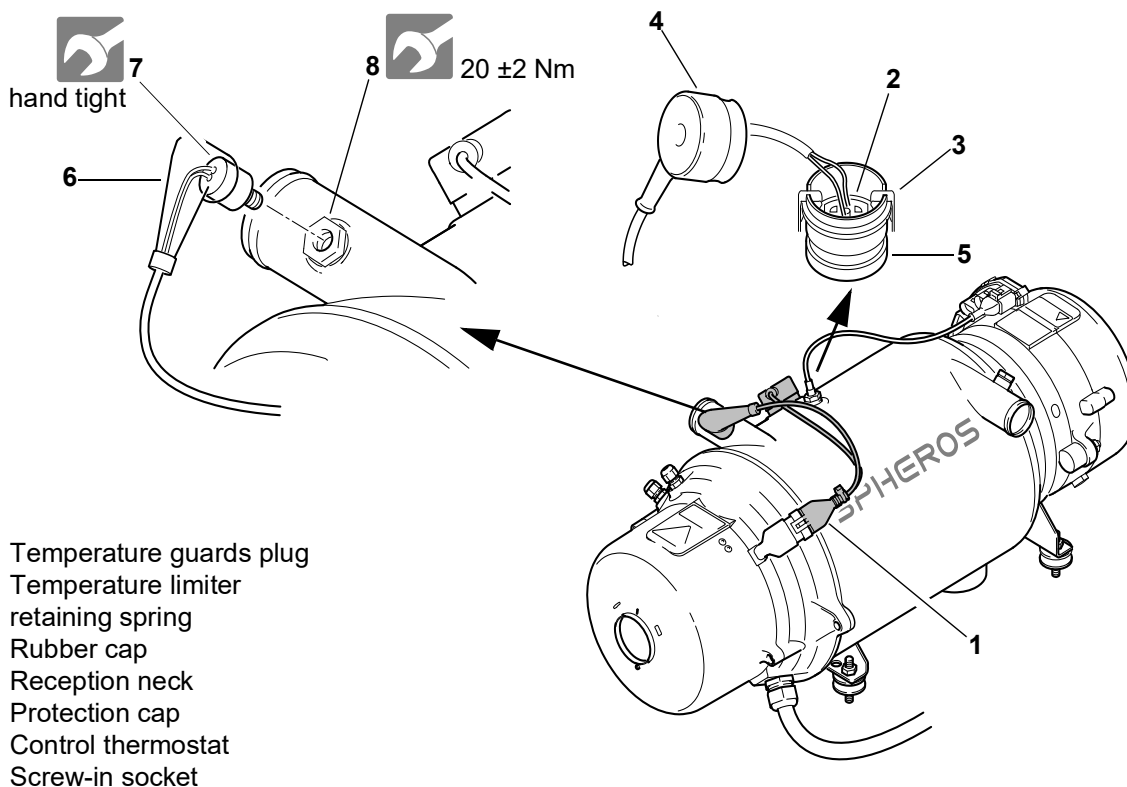


Fig. 801 Removal and installation of the temperature guards

### 8.2.2 Hood removal/installation

Removing the hood provides access to the following components for maintenance, inspection and repair purposes:

- Small distribution board (load contactor AC/DC)
- Heating cartridges
- HVIL contact

#### Removal

1. Establish voltage-free state of the heater and secure it for duration of the work (**Observe 1.6.3 !**).
2. Loosen screws (19, Fig. 805).

#### NOTE:

The screws remain in the hood.

3. Remove hood (1) with stabilizer (2) from heater.

#### Installation

1. Place stabilizer (2, Fig. 805) onto the small distribution board (7).
2. Place hood (1) in assembly position, turn in the screws (19) and tighten them.
3. Restore power supply.
4. Perform functional test.

### 8.2.3 Housing removal/installation (incl. cable connections)

#### Removal

1. Disconnect all cables from the vehicle electrical system to the heater.
2. Remove hood (see 8.2.2).
3. Disconnect cables connected to the small distribution board (7, Fig. 805) by loosening the appropriate connections.

#### NOTE:

For connections to be disconnected, refer to wiring diagrams in Chapter 6, depending on the heater version. Compare the heater ident. number under the wiring diagram with that on the model plate of your heater.

4. Remove the cable ties that bundle the single cables.
5. Disconnect temperature guards plug (23) from connection piece (22) of temperature guards.
6. Loosen grounding screw (8) and remove it with washer (9), serrated washer (10) and vehicle grounding cable lug.
7. Remove nuts (16) and washers (15).

#### NOTE:

During the next step pay attention that the cables are not jammed or are still connected. "Danger of damage".

8. Remove housing (12) from heater.

#### Installation

1. Position housing (12) over the small distribution board onto the heater and then secure it using screws (24, Fig. 805), washers (15), serrated washers (14) and nuts (16).
2. Screw grounding screw (8) with washer (9), serrated washer (10) and vehicle grounding cable lug into the housing (12) and tighten as required.
3. Install connection piece (22) of temperature guards onto the housing (12) if necessary.
4. Plug the temperature guards plug (23) into the connection piece (22) of temperature guards (note the snap-in noise).
5. Hook-up the supply cables to the corresponding terminals of the small distribution board (7) and tighten screws as required.

#### NOTE:

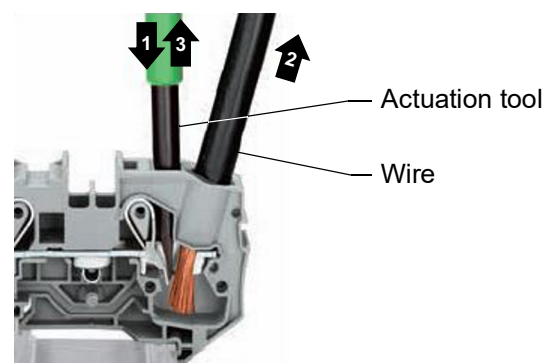
For connections to be established, refer to wiring diagrams in Chapter 6, depending on the heater version. Compare the heater ident. number under the wiring diagram with that on the model plate of your heater.

6. Check the wiring again using the wiring diagram (see chapter 6).
7. Bundle single wires using cable ties.
8. Install hood (see 8.2.2).
9. Connect all supply cables to the vehicle electrical system, fix them if required.

### 8.2.4 Small distribution board removal/installation

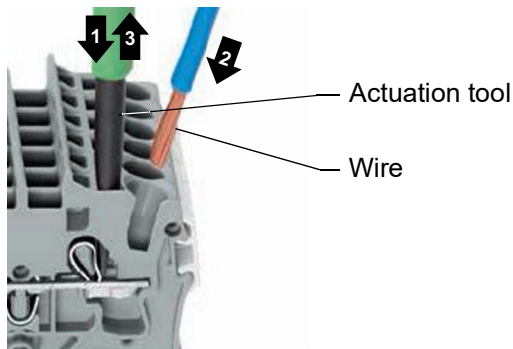
#### NOTE:

For loosening and connecting of cables to WAGO® terminals a special actuation tool is required. Learn more on the manufacturer's website regarding its proper handling.



Loosen wire: 1 - 2 - 3

Fig. 802



**Connect wire:** 1 - 2 - 3

Fig. 803

### Removal

1. Establish voltage-free state of the heater and secure it for duration of the work (**Observe 1.6.3 !**).
2. Remove housing (see 8.2.3).
3. Disconnect cable connections to heating cartridges.

### NOTE:

For connections to be disconnected, refer to wiring diagrams in Chapter 6, depending on the heater version. Compare the heater ident. number under the wiring diagram with that on the model plate of your heater.

4. If necessary remove the end clamps from the top hat rail.
5. Remove screws (3, Fig. 805) and washers (4).
6. Remove small distribution board (7) from heater.

### Installation

1. Position small distribution board (7, Fig. 805) to the stud bolts (18) and secure using washers (4) and screws (3).
2. Ensure all electrical components are installed and aligned on the top hat rail.
3. If necessary install the end clamps to the top hat rail.
4. Hook-up heating cartridges to the WAGO® clamps.

### NOTE:

For connections to be established, refer to wiring diagrams in Chapter 6, depending on the heater version. Compare the heater ident. number under the wiring diagram with that on the model plate of your heater.

5. Install housing (see 8.2.3).
6. Install hood (see 8.2.2).

## 8.2.5 Heating cartridges/screw plugs removal/ installation

### Removal

1. Establish voltage-free state of the heater and secure it for duration of the work (**Observe 1.6.3 !**).

### NOTE:

To ensure the safe removal and installation of the heating cartridges, the heat exchanger is to be removed and placed in a vertical mounting position. To do this, the heater must be removed.

2. Remove heat exchanger (see 8.4).
3. Place heat exchanger into a vertical mounting position (see Fig. 804).

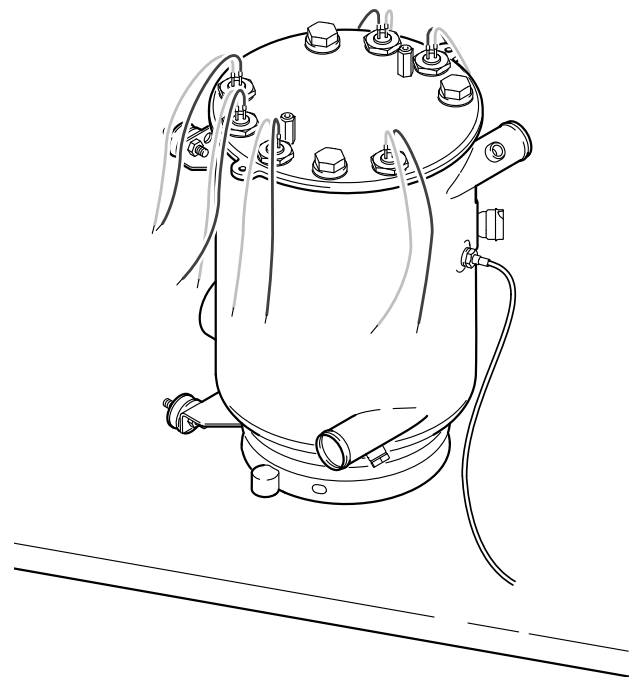


Fig. 804

4. Using a wrench loosen the heating cartridges (20, Fig. 805) or the screw plugs (21), screw them out and remove them from heat exchanger. Discard gasket rings (25).

### Installation

1. Remove remains of the heating cartridge sealing from the heat exchanger.
2. Preassemble heating cartridge (20, Fig. 805) or screw plug (21) with a new gasket ring (25).

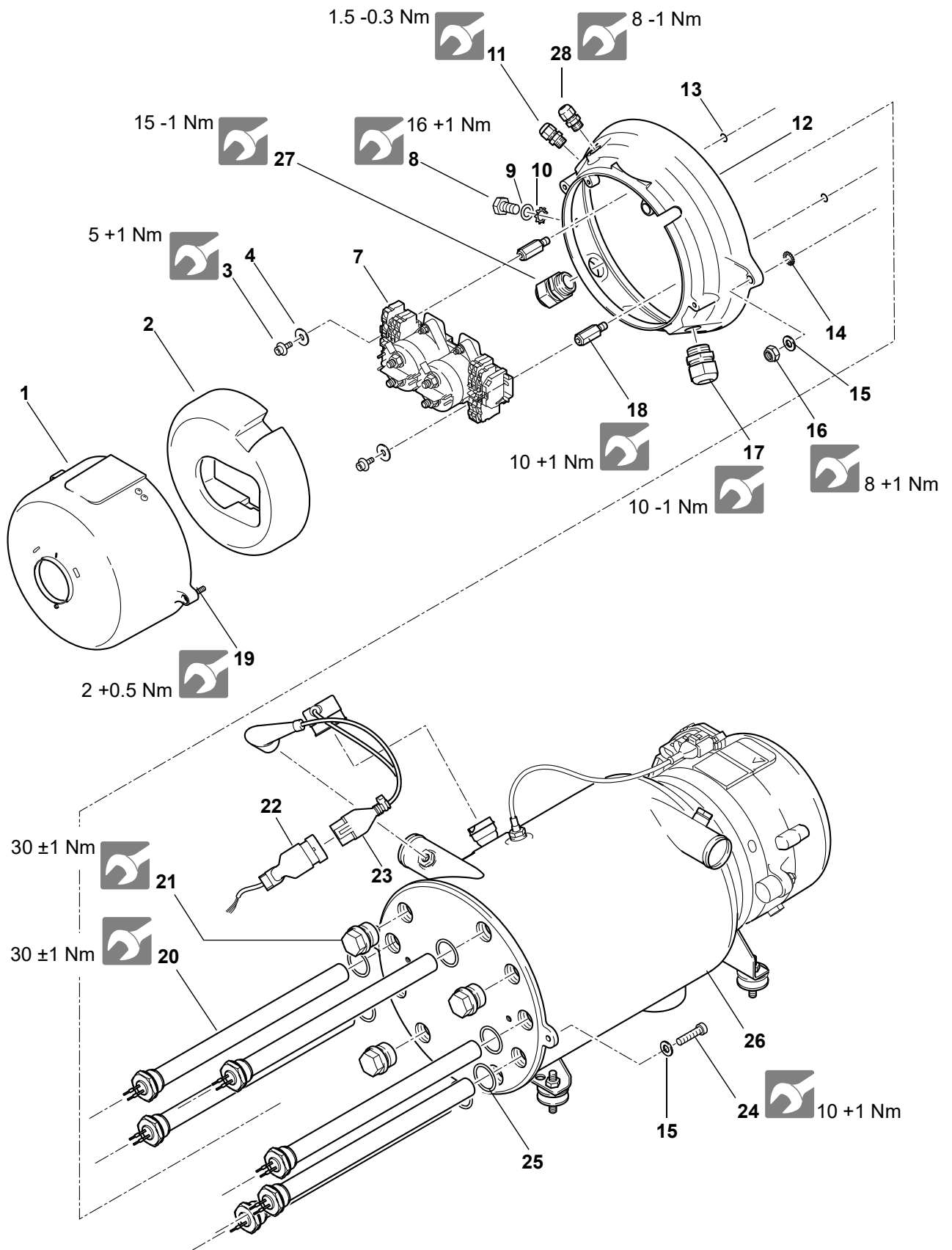


Fig. 805 HV Control head - Removal and Installation of components

**NOTE:**

The groove of the gasket ring must in installed position rest on the heat exchanger.

3. Apply thread sealant according to the manufacturer's instructions onto the thread, see Fig. 806, of the heating cartridge (20, Fig. 805) or screw plug (21).

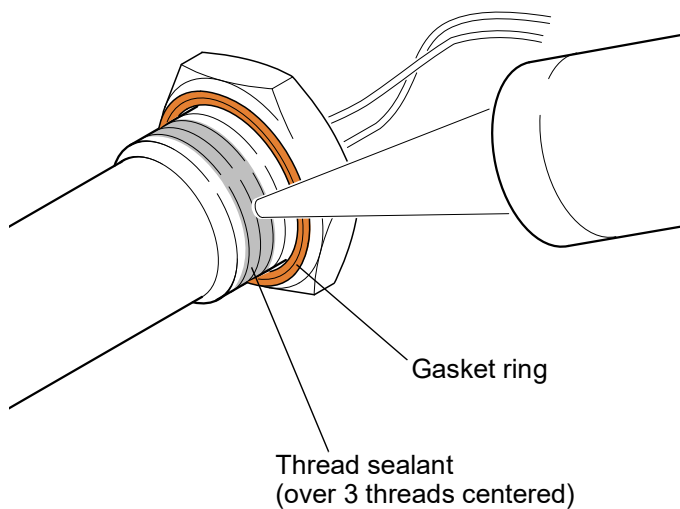


Fig. 806

4. Screw the heating cartridge (20) or screw plug (21) into the heat exchanger (26).
5. Tighten heating cartridge (20) or screw plug (21) as required.
6. Install heat exchanger (see 8.4).
7. Install heater (see 8.5).

### 8.2.6 HV DC wiring harness removal/ installation

**Removal**

1. Establish voltage-free state of the heater and secure it for duration of the work (**Observe 1.6.3 !**).
2. Disconnect all supply cables from vehicle electrical system.
3. Remove hood (see 8.2.2).
4. Remove housing (see 8.2.3).
5. If necessary disconnect connectors from the HVIL socket (Fig. 808).
6. Remove ties with bundle disconnected wires.
7. Separate single wires at the end connectors (see appropriate wiring diagram in Cha.6).

**NOTE:**

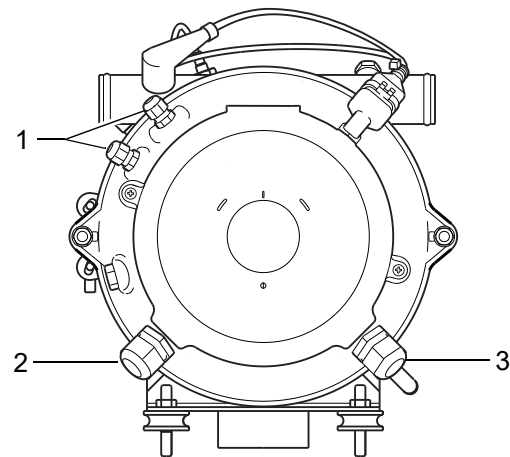
During the next step pay attention that the cables are not jammed or are still connected. "Danger of damage".

8. Loosen cable gland (17, Fig. 805) and screw it with the appropriate cable harness from out the housing (12).

**Installation****NOTE:**

During the next step pay attention that the cables are not jammed. "Danger of damage".

1. Route the single wires of the HV DC wiring harness through the appropriate hole (see Fig. 807) into the housing (12, Fig. 805) and screw the cable gland (17) into the housing and tighten it.



- 1 24V Control voltage and HVIL (Cable gland usage acc. to LV wiring harness version)
- 2 HV AC (DC)
- 3 HV DC

Fig. 807 Cable glands

2. Connect single wires with endconnectors (see appropriate wiring diagram in Cha.6).
3. Install housing (see 8.2.3).
4. If necessary reconnect connectors to the HVIL socket (Fig. 808).
5. Check the wiring again using the wiring diagram.
6. Bundle single wires using cable ties.
7. Install hood (see 8.2.2).
8. Connect all supply cables to the vehicle electrical system, fix them if required.
9. Perform a function check.

### 8.2.7 HV AC wiring harness removal/ installation

**Removal**

1. Establish voltage-free state of the heater and secure it for duration of the work (**Observe 1.6.3 !**).
2. Disconnect all supply cables from vehicle electrical system.

3. Remove hood (see 8.2.2).
4. Remove housing (see 8.2.3).
5. Remove ties with bundle disconnected wires.

**NOTE:**

During the next step pay attention that the cables are not jammed or are still connected. "Danger of damage".

6. Loosen cable gland (27, Fig. 805) and screw it with the appropriate cable harness from out the housing (12).

**Installation****NOTE:**

During the next step pay attention that the cables are not jammed. "Danger of damage".

1. Route the single wires of the HV AC wiring harness through the appropriate hole (see Fig. 807) into the housing (12, Fig. 805) and screw the cable gland (27) into the housing and tighten it.
2. Install housing (see 8.2.3).
3. Check the wiring again using the wiring diagram.
4. Bundle single wires using cable ties.
5. Install hood (see 8.2.2).
6. Connect all supply cables to the vehicle electrical system, fix them if required.
7. Perform a function check.

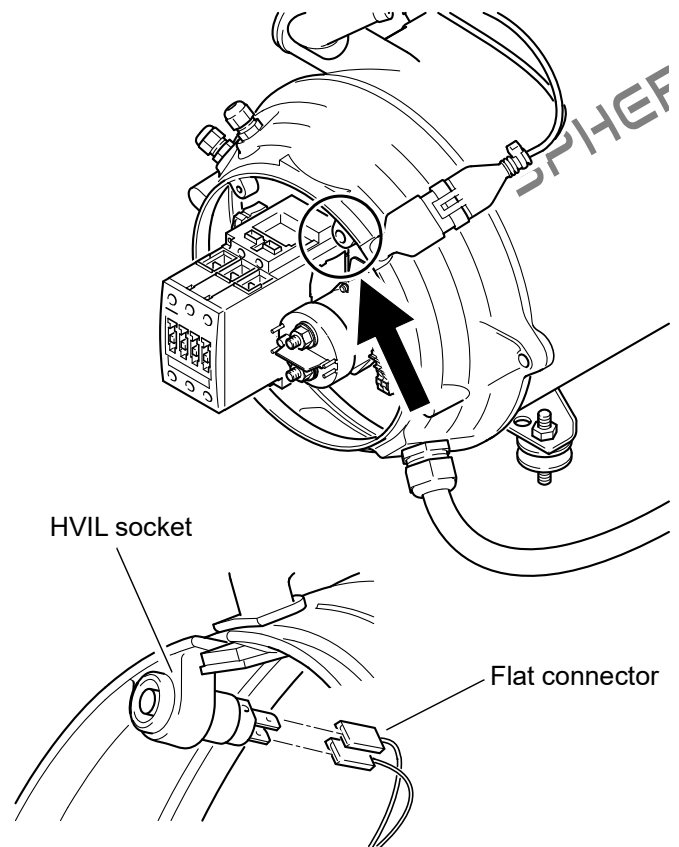


Fig. 808 HVIL Socket

**8.2.8 LV DC control wiring harness removal/ installation****Removal**

1. Establish voltage-free state of the heater and secure it for duration of the work (**Observe 1.6.3 !**).
2. Disconnect all supply cables from vehicle electrical system.
3. Remove hood (see 8.2.2).
4. Remove housing (see 8.2.3).
5. If necessary disconnect connectors from the HVIL socket (Fig. 808).
6. Remove ties with bundle disconnected wires.
7. Separate single wires at the end connectors (see appropriate wiring diagram in Cha.6).

**NOTE:**

During the next step pay attention that the cables are not jammed or are still connected. "Danger of damage".

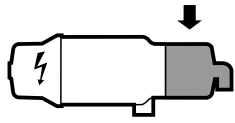
8. Loosen cable gland (11, Fig. 805) and screw it with the appropriate cable harness from out the housing (12).

**Installation****NOTE:**

During the next step pay attention that the cables are not jammed. "Danger of damage".

1. Route the single wires of the LV DC control wiring harness through the appropriate hole (see Fig. 807) into the housing (12, Fig. 805) and screw the cable gland (11) into the housing and tighten it.
2. Connect 4 single wires with endconnectors (see appropriate wiring diagram in Cha.6).
3. Install housing (see 8.2.3).
4. If necessary reconnect connectors to the HVIL socket (Fig. 808).
5. Check the wiring again using the wiring diagram.
6. Bundle single wires using cable ties.
7. Install hood (see 8.2.2).
8. Connect all supply cables to the vehicle electrical system, fix them if required.
9. Perform a function check.

8.3 Diesel burner head



Removing the Diesel burner head, in the following referred to as burner, provides access to the combustion chamber.

It is further removed when removing the heat exchanger (see 8.4).

Procedures for the maintenance and/ or removal and installation of components of the burner can be found in the workshop manual for the Thermo plus heaters, chapter 8. See also 1.5.

8.3.1 Burner removal/installation

Removal

1. Establish voltage-free state of the heater and secure it for duration of the work (**Observe 1.6.3 !**).
2. If necessary, disconnect the combustion air intake line from the heater.
3. If required, disconnect heater wiring harness plug from control device.
4. Disconnect temperature sensor plug (5, Fig. 809) from control device.

**NOTE**

Make sure that any fuel leaking during the following work step is immediately bound and professionally disposed of.

5. Unscrew fuel lines and seal with blank plugs.
6. Unscrew nuts (2).
7. Remove burner (1).

- 1 Burner
- 2 Nuts (2)
- 3 Screws (2)
- 4 Hood
- 5 Temperature sensor plug
- 6 Hollow screws (2) fuel lines connection
- 7 Plug screw

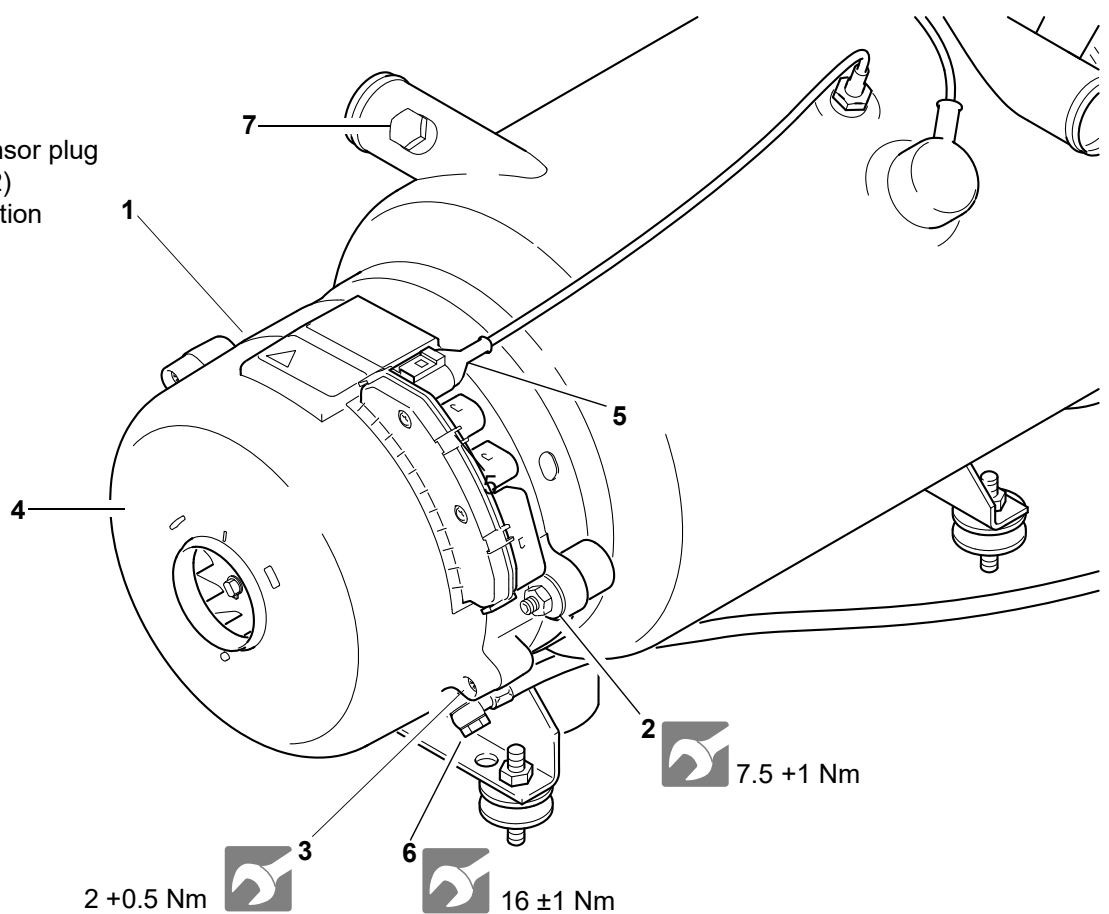


Fig. 809 Burner head / hood removal and installation

**Installation**

1. Bring burner (1, Fig. 809) in assembly position and ensure center alignment and correct fit.
2. Place nuts (2) and alternately tighten them slightly.
3. Tighten nuts (2).
4. If applicable, bolt fuel lines down using hollow screws (6) and new gaskets, or slide on fuel lines and secure with hose clamps.
5. Connect the temperature sensor plug.
6. Connect the heater wiring harness plug.
7. If applicable, secure the combustion air intake line to the heater.

**CAUTION**

The two combination nuts M8, connecting the burner and the heat exchanger, must be tightened to  $7.5 \pm 1$  Nm each and additional are to be secured using thread lock (Spheros ident. no.: 154245Z).

### 8.3.2 Removal/installation of the temperature sensor with integrated overheating protection



Risk of injuries if coolant temperature is increased.

**Removal**

1. Establish voltage-free state of the heater and secure it for duration of the work (**Observe 1.6.3 !**).
2. Disconnect the temperature sensor plug from control device.
3. Unscrew and remove temperature sensor (1, Fig. 810).

**Installation**

1. Manually screw temperature sensor (1, Fig. 810) into the heat exchanger.
2. Tighten temperature sensor (1).
3. Connect the temperature sensor plug to the control device.

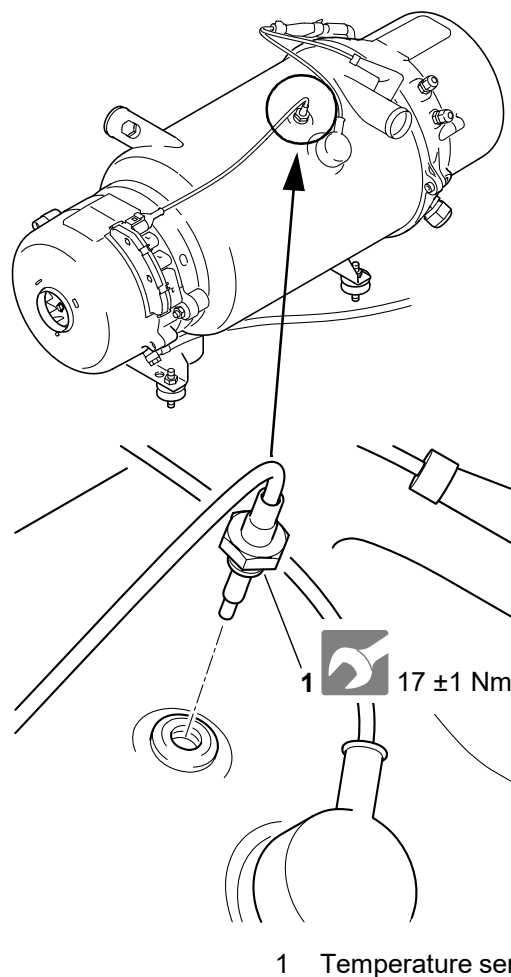


Fig. 810 Temperature sensor removal and installation

**8.3.3 Hood removal/installation****Removal**

1. Establish voltage-free state of the heater and secure it for duration of the work (**Observe 1.6.3 !**).
2. Loosen screws (3, Fig. 809).
3. Remove hood (4).

**Installation**

1. Position hood (4, Fig. 809) in assembly position. Ensure center alignment, proper fit and seal towards heater wiring harness and cable grommet of the temperature sensor.
2. Screw in screws (3) and tighten.



**8.3.4 Combustion air fan removal/installation**

**Removal**

1. Remove burner (see 8.3.1).
2. Withdraw combustion chamber (1, Fig. 811) from out the heat exchanger (2).

**Installation**

**ATTENTION:**

**When replacing the combustion chamber, ensure that the new combustion chamber corresponds to the heating capacity class of your heater.**

1. Slide combustion chamber (1, Fig. 811) fully into the heat exchanger (2) against stop. Pay attention to a) the welding seam position, and

b) the position of cut-outs in the combustion chamber head.

**NOTE:**

- The combustion chamber should be inserted into the heat exchanger in such a way that its welding seam is positioned between 2 and 10 o'clock (not upwards!) (Fig. 811).
  - A position change during maintenance is permissible and affects the expected service life of the combustion chamber positively.
  - Position the cut-outs in the combustion chamber head as shown in Fig. 811.
- Dripping from nozzle fuel is so collected in a reservoir between disc and burner head and will be burned at the next burner operation instead to soil the heater.

2. Install burner (see 8.3.1).

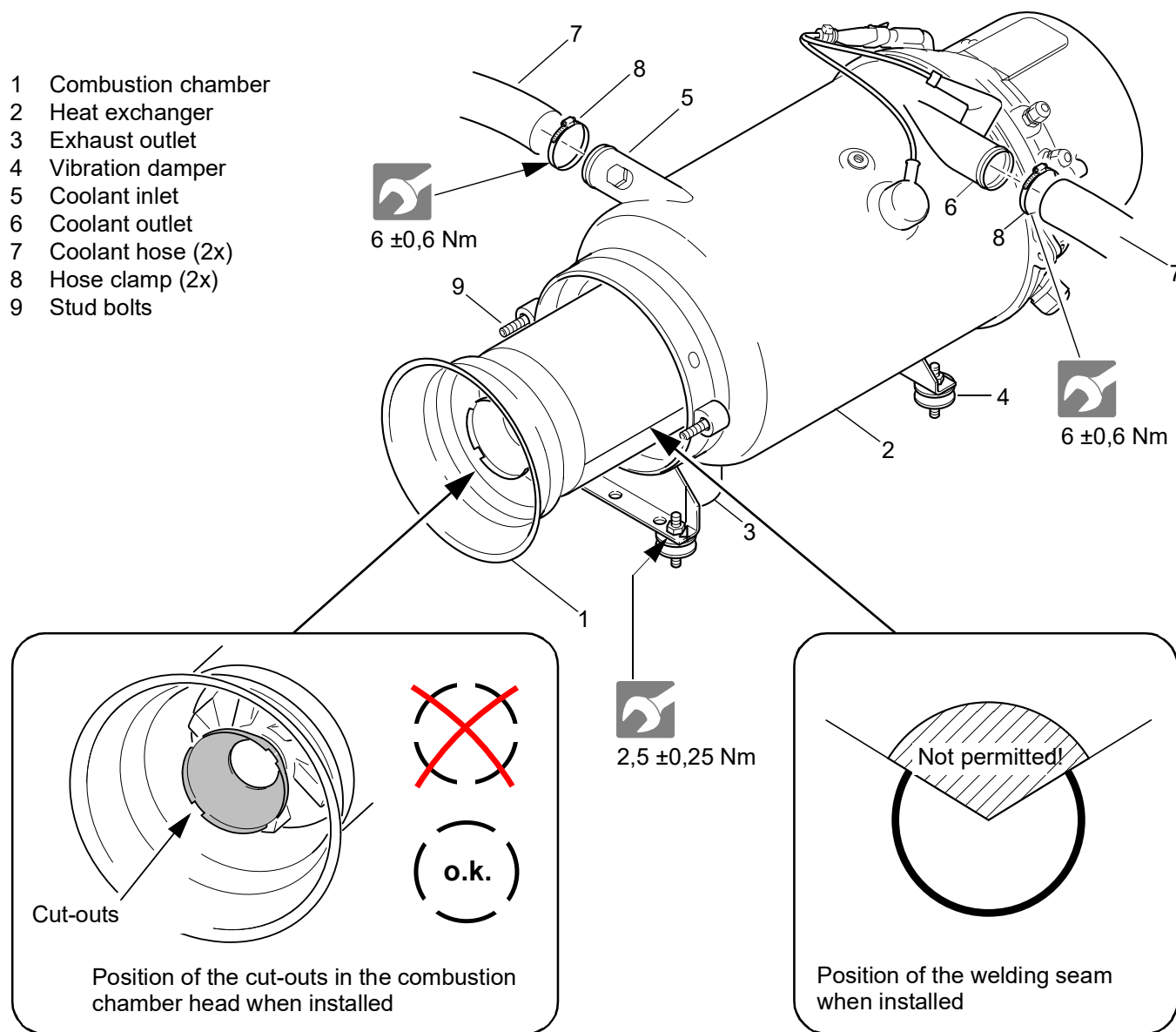
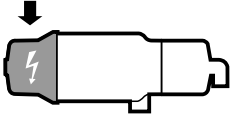


Fig. 811 Combustion chamber / heat exchanger removal/installation

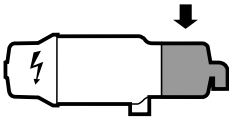
## 8.4 Heat exchanger removal/installation

### Removal

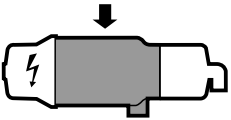
1. Establish voltage-free state of the heater and secure it for duration of the work (**Observe 1.6.3 !**).
2. Remove heater (see 8.5).



3. Remove small distribution board (see 8.2.4).



4. Remove burner (see 8.3.1).
5. Remove combustion chamber (see 8.3.4).



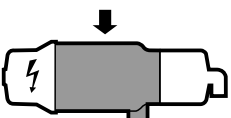
For the removal of heating cartridges (20, Fig. 805) or screw plugs (21):

6. Screw the threaded pins (9, Fig. 811) out.
- For the replacement of the heat exchanger:
7. Remove the temperature guards (HV heater), refer to 8.2.1.
  8. Remove the temperature sensor (D heater), refer to 8.3.2.
  9. Remove the screws (24, Fig. 805).
  10. Remove the stud bolts (18), discard gasket rings (13).
  11. Remove the screw-in socket (8, Fig. 801).
  12. Remove the screw plug (7, Fig. 809).
  13. Remove the heating cartridges (20, Fig. 805) and screw plugs (21), refer to 8.2.5.
  14. Remove the vibration damper (4, Fig. 811).

### Installation

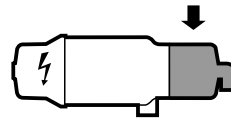
#### NOTE:

After installation of the heating cartridges (20, Fig. 805) or screw plugs (21) proceed with step 9.

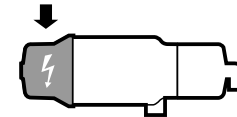


1. Install vibration damper (4, Fig. 811) and tighten nuts.
2. Install heating cartridges (20, Fig. 805) or screw plugs (21), refer to 8.2.5.
3. Screw the plug screw (7, Fig. 809) in and tighten it.
4. Install the screw-in socket (8, Fig. 801) and tighten it.
5. Install the stud bolts (18) using new gasket rings (13) and tighten them.

6. Install screws (24, Fig. 805) with washers (15).
7. Install temperature sensor (D heater), refer to 8.3.2.
8. Install temperature guards (HV heater), refer to 8.2.1.
9. Install threaded pins (9, Fig. 811).



10. Install combustion chamber (see 8.3.4).



11. Install small distribution board (see 8.2.4).
12. Install heater (see 8.5).

## 8.5 Heater removal/installation



The heat exchanger of the heater can be very hot. If necessary, let it cool down.



Risk of injuries if coolant temperature is increased.

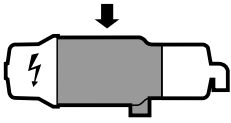
#### ATTENTION:

The fuel supply system must be subsequently bled (see 8.6.1).

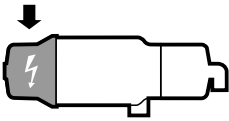
The coolant circuit must be subsequently bled (see 8.6.2).

### Removal

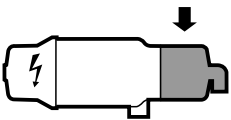
1. Establish voltage-free state of the heater and secure it for duration of the work (**Observe 1.6.3 !**).
2. Disconnect all supply cables from vehicle electrical system.
  - If necessary disconnect HV DC wiring harness from HV heater, see 8.2.6.
  - If necessary disconnect HV AC wiring harness from HV heater, see 8.2.7.
  - If necessary disconnect LV DC control wiring harness from HV heater, see 8.2.8.
  - Disconnect heater wiring harness from D heater.



3. Close coolant hoses (7, Fig. 811) using suitable pinch-off pliers.
4. Loosen hose clamps (8) and pull the coolant hoses (7) from the coolant inlet (6) and the coolant outlet (5).
5. If necessary, loosen the exhaust line clamp on the exhaust outlet (3) and remove extension/deflection.



6. Disconnect grounding cable from the housing (12, Fig. 805).



7. If necessary disconnect the combustion air suction line from the heater.

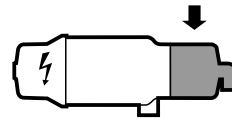
#### NOTE:

Make sure that any fuel leaking during the following work step is immediately bound and professionally disposed of.

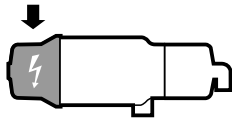
8. Unscrew the fuel lines and seal with blank plugs.
9. Seal the fuel supply and return openings on the heater with blank plugs.
10. Remove the 4 nuts (each with washer), securing the heater to the vehicle structure and remove the heater from the vehicle.

#### Installation

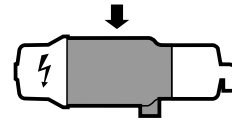
1. Check the voltage-free state at all supply lines to the heater (**Observe 1.6.3!**).
2. Place the heater into the installation position and secure with 4 nuts and 4 washers via the vibration damper (4, Fig. 811) to the vehicle. Tighten nuts as required.



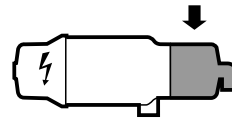
3. Reconnect the fuel lines for fuel supply and fuel return to the heater, using for each a hollow screw and two gasket rings.



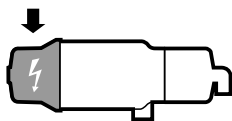
4. Connect the grounding cable to the housing (12, Fig. 805).



5. If necessary, install the extension/deflection onto the exhaust outlet (3, Fig. 811) using a hose clamp.
6. Fit coolant hoses (7) onto the coolant inlet (6) and coolant outlet (5) and secure with hose clamps (8).
7. Remove pinch-off pliers from the coolant hoses (7).



8. Connect the D heater with the vehicle electrical system.
  - Connect the heater wiring harness to the D heater.
9. Bleed fuel system (see 8.6.1).
10. Bleed coolant circuit (see 8.6.2).



11. Restore all supply cable connections from vehicle electrical system.
  - If necessary reconnect LV DC control wiring harness to HV heater, see 8.2.8.
  - If necessary reconnect HV AC wiring harness to HV heater, see 8.2.7.
  - If necessary reconnect HV DC wiring harness to HV heater, see 8.2.6.
12. Perform function test of the HV heater.

## 8.6 Start-up after burner or heater installation

The fuel system must be bled after burner installation. The coolant circuit and the fuel system must be bled after heater installation.

The vehicle manufacturer specifications must be observed.

Coolant and fuel connections must be checked for leak-tightness and tight fit during the test run.

If a malfunction occurs during heater operation, troubleshooting must be performed (see chapter 5).

### 8.6.1 Bleeding the fuel system

The whole fuel supply system including the fuel filter must be completely filled with fuel before initial start-up.

**ATTENTION:**

**Never use the fuel pump to fill / bleed the fuel system!**

**ATTENTION:**

**In the event no fuel comes to the fuel pump during initial start-up (dry run), there is a risk that the fuel pump will be damaged!**

### 8.6.2 Bleeding of the coolant circuit

**NOTE:**

The coolant circuit must be principally bled according to the manufacturer specification.



**Risk of scalds if coolant temperature is increased.**

The Aquavent 5000 (U4814) and Aquavent 6000S (U4855) circulating pumps may only be switched on for bleeding, after dry operation can be excluded.

The Aquavent 5000S (U4854) and Aquavent 6000SC (U4856) circulating pumps may even in dry operation be switched on for bleeding.

Adjust the vehicle heating system to "warm" and refill coolant.

As soon as it is confirmed that the vehicle engine is filled with coolant, run vehicle engine with increased idle speed. Once the cooler thermostat opens, switch the vehicle engine off and check the coolant level. Refill coolant as needed.

While the vehicle engine is switched off, switch on the heater with the circulating pump and the vehicle heating fan.

After the engine motor cooled down, the heater must automatically start and stop as soon as the upper switching threshold is reached.

If the heater does not start automatically, it must be verified, whether the heater overheating protection is triggered and the heater is in fault-lockout state.

Release the heater (see 4.7.1) and repeat the bleeding process.

## 9 Modifications and retrofits

### 9.1 General

For further optimization the heaters are continuously improved. Units in the field can usually be upgraded or retrofitted. For this purpose respective modification kits will be available.

## 10 Packing/storage/shipping

### 10.1 General

The heater or its components, which are sent to Spheros for inspection or repair, must be cleaned and packaged to ensure that handling, transport and storage will not damage them.

**ATTENTION:**

**If a complete heater is sent back, it must be completely drained. While packaging and/or shipping it must be ensured that no fuel or coolant can leak.**

Coolant inlet and outlet fittings as well as the fuel lines must be plugged and sealed using blank plugs.

The temperatures described in Chapter 2 may not be exceeded during storage.

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