

HEATING SYSTEMS

THERMO E 200/320

Installation instructions

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SPHEROS



Improper installation or repair of Spheros heating and cooling systems can cause fire or the leakage of deadly carbon monoxide leading to serious injury or death.

To install and repair Spheros heating and cooling systems you need to have completed a Spheros training course and have the appropriate technical documentation, special tools and special equipment.

NEVER try to install or repair Spheros heating or cooling systems if you have not completed a Spheros training course, you do not have the necessary technical skills and you do not have the technical documentation, tools and equipment available to ensure that you can complete the installation and repair work properly.

ALWAYS carefully follow Spheros installation and repair instructions and heed all **WARNINGS**.

Spheros rejects any liability for problems and damage caused by the system being installed by untrained personnel.

Highlighted words like Warning, Caution, ATTENTION and NOTE in these evacuation and charging instructions signify the following precautions:



Warning!

This caption is used to indicate possible severe injuries or fatal accidents if instructions or procedures are carried out incorrectly or entirely disregarded.



Caution!

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.

NOTE: Subject to modification. In multilingual versions the German language is binding. The latest version of this document you will find in the download center on www.spheros.com.



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1 Statutory regulations governing installation

1.1. Statutory regulations governing installation

For the heater exists a type approval according to the ECE Regulations

R10 (EMC)	No. 06 5742 and
R122 (Heater)	No. 000265 for Thermo E 200 No. 000266 for Thermo E 320.

Installation is governed above all by the provisions in Annex 7 of the ECE Regulation R122.

NOTE:

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

Extract from ECE Regulation R122, Annex 7:

“ ...

4. *The heater must have a manufacturer's label showing the manufacturer's name, the model number and type together with its rated output in kilowatts. The fuel type must also be stated and, where relevant, the operating voltage and gas pressure.*

(...)

7.1. *A clearly visible tell-tale in the operator's field of view shall inform when the combustion heater is switched on or off.*

... “

Extract from ECE Regulation R122, Part I:

“ ...

5.3 Vehicle Installation Requirements for Combustion Heaters

5.3.1 Scope

5.3.1.1 *Subject to paragraph 5.3.1.2., combustion heaters shall be installed according to the requirements of paragraph 5.3.*

5.3.1.2 *Vehicles of category O having liquid fuel heaters are deemed to comply with the requirements of paragraph 5.3.*

5.3.2 Positioning of combustion heater

5.3.2.1 *Body sections and any other components in the vicinity of the heater must be protected from excessive heat and the possibility of fuel or oil contamination.*

5.3.2.2 *The combustion heater shall not constitute a risk of fire, even in the case of overheating. This requirement shall be deemed to be met if the installation ensures an adequate distance to all parts and suitable ventilation, by the use of fire resistant materials or by the use of heat shields.*

5.3.2.3 *In the case of M2 and M3 vehicles, the combustion heater must not be positioned in the passenger compartment. However, an installation in an effectively sealed envelope which also complies with the conditions in paragraph 5.3.2.2. may be used.*

5.3.2.4 *The label referred to in Annex 7, paragraph 1.4., or a duplicate, must be positioned so that it can be easily read when the heater is installed in the vehicle.*

5.3.2.5 *Every reasonable precaution should be taken in positioning the heater to minimize the risk of injury and damage to personal property.*

5.3.3 Fuel supply

5.3.3.1 *The fuel filler must not be situated in the passenger compartment and must be provided with an effective cap to prevent fuel spillage.*

5.3.3.2 *In the case of liquid fuel heaters, where a supply separate from that of the vehicle is provided, the type of fuel and its filler point must be clearly labelled.*

5.3.3.3 *A notice, indicating that the heater must be shut down before refuelling, must be affixed to the fuelling point. In addition a suitable instruction must be included in the manufacturer's operating manual.*

5.3.4 Exhaust system

5.3.4.1 *The exhaust outlet must be located so as to prevent emissions from entering the vehicle through ventilators, heated air inlets or opening windows.*

5.3.5 Combustion air inlet

5.3.5.1 *The air for the combustion chamber of the heater must not be drawn from the passenger compartment of the vehicle.*

5.3.5.2 *The air inlet must be so positioned or guarded that blocking by rubbish or luggage is unlikely.*

(...)

5.3.8 Automatic control of the heating system

5.3.8.1 *The heating system must be switched off automatically and the supply of fuel must be stopped within five seconds when the vehicle's engine stops running. If a manual device is already activated, the heating system can stay in operation.*

... „

ATTENTION:

Failure to follow the installation instructions and the notes contained therein will lead to all liability being refused by Spheros. The same applies if repairs are carried out incorrectly or with the use of parts other than genuine spare parts. This will result in the invalidation of the type approval for the heater and therefore of its ECE Type Approval.



At petrol stations and other fuel filling facilities the heater must be switched off due to the explosion hazard. To advice to this requirement the self-adhesive label with the text "Switch off heater before refueling!", delivered with each heater, is to be affixed next to the filler neck.

2 Use / version

2.1. Use of the water heaters

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

- to heat the passenger cabin, and
- for pre-heating.

The heater may only be installed and operated in vehicles of the class **M2, M3**.

Any use beyond is not permitted.

The heaters operate independently of the engine and are connected to the cooling system, the fuel system and the electrical system of the vehicle.

 Warning!	Danger to life and health!
---	-----------------------------------

The heater is not approved for use in vehicles carrying dangerous goods according to Annex 9 of the UN/ECE Regulation R122.

 Warning!	Risk of fire, explosion, poisoning and asphyxiation!
---	---

The heater must not be operated:

- at filling stations and other refueling points.
- if the heater or its exhaust outlet is in locations where inflammable vapors or dust may form (e.g. close to fuel, plastic, coal, wood dust or cereal storage facilities or similar).
- if the heater or its exhaust outlet is located close to inflammable materials for example dry grass and leaves, cartons, paper etc.
- in enclosed areas (e.g. garages, hall without extraction system), not even if the pre-selection timer or Tele Start is used.
- if the exhaust outlet of the heater is partial or fully obstructed (e.g. by soil or snow, as it may occur while move the vehicle backwards).

The heater must:

- be shut down and the fuse shall be removed in the event of extensive smoke development, unusual combustion noises or fuel odors. The heater must not be used again until personnel trained by Spheros have examined it.

2.2. Versions

Thermo E 200 – 24V

Water heater for „diesel“
with 20 kW (17.200 kcal/h) heat current

Thermo E 320 – 24V

Water heater for „diesel“
with 32 kW (27.500 kcal/h) heat current

Depending on request and on the requirements of configuration, the heater may be equipped with a nozzle preheating system.

2.3. Use / Function

See Workshop Manual!

3 Installation

ATTENTION:

- **The statutory regulations governing the installation must be adhered.**
- **If the water heater is to be operated in a separately installed heating system, prior to installation an installation planning report must always be submitted to Spheros for approval. If this approval is not obtained, all warranty and liability claims will be void. The water heater has been designed, tested and approved for specific bus requirements.**
- **To the temperature sensor cable no mechanical load must be applied (e.g. carry the heater with it).**
- **Heaters and circulating pumps shall be always installed in such a way that a negative impact by road dirt, splashing water, exhaust gases or other harmful influences is excluded.**
- **The component disassembly (drive motor, fuel pump, solenoid valve, control device and temperature sensor) is not permitted and will lead to the loss of all liability claims.**

NOTE:

Consider the installation situation of the relevant vehicle type.

3.1. Installation location

The heater and the circulating pump are to be integrated into the cooling system (or in a separate heating system). The requirements regarding the combustion air supply (see Chapter 8) must be considered.

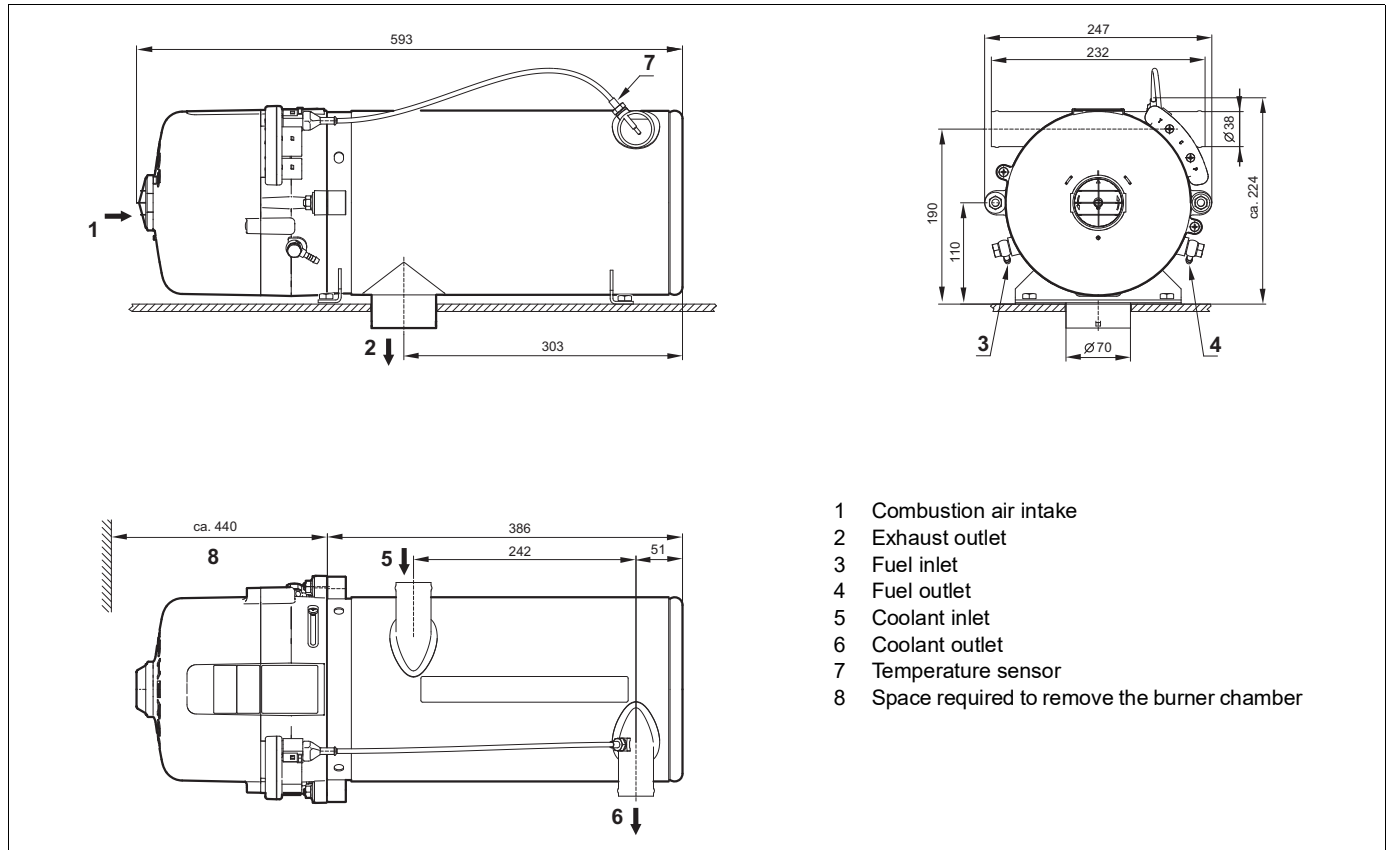
The heater should be installed as low as possible to allow the heater and circulating pump to be bled automatically. This is particularly important as the circulating pump is not self-priming.

If it is not possible to install the heater in the vehicle's engine bay it may be installed in a box. The installation box must have a sufficient external

ventilation to ensure that the maximum temperature of 100°C is not exceeded in the box.

This installation space is not a stowage compartment and must be kept clear. This prohibition applies in particular for fuel canisters, oil cans, fire extinguishers, cleaning rags, paper and all easily flammable materials. Water which has been ingressed or condensed must be able to run autonomously from the installation space.

Bear in mind the space required for servicing accessibility (for example for removing the combustion chamber) (see Figures 1 and 5) when installing the heater.



- 1 Combustion air intake
- 2 Exhaust outlet
- 3 Fuel inlet
- 4 Fuel outlet
- 5 Coolant inlet
- 6 Coolant outlet
- 7 Temperature sensor
- 8 Space required to remove the burner chamber

Fig. 1: Dimensions of the Thermo E 200/320 heater (horizontal installation)

3.2. Thermo E heater installation

NOTE:

The heaters are only licensed for horizontal installation (see Fig. 2).

The heater is secured with four screws M8 (see Figure 3).

Use washers acc. to DIN 125 if necessary.

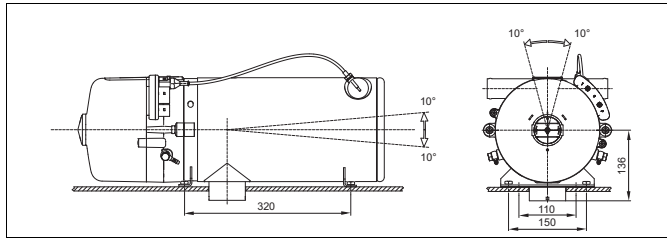


Fig. 2: Installation position

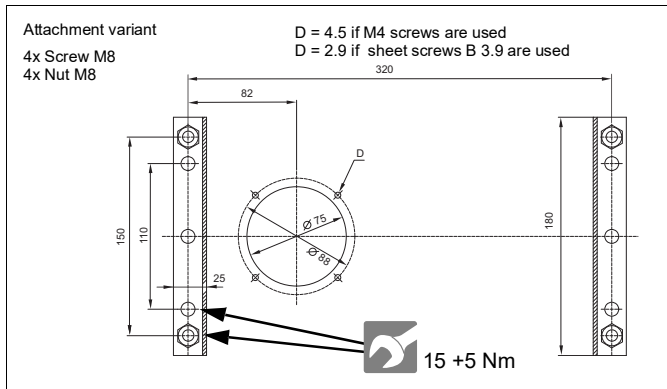


Fig. 3: Hole pattern

3.3. Model plate

The model plate must be protected from damage and must be clearly legible when the heater is installed (otherwise a duplicate model plate must be used).

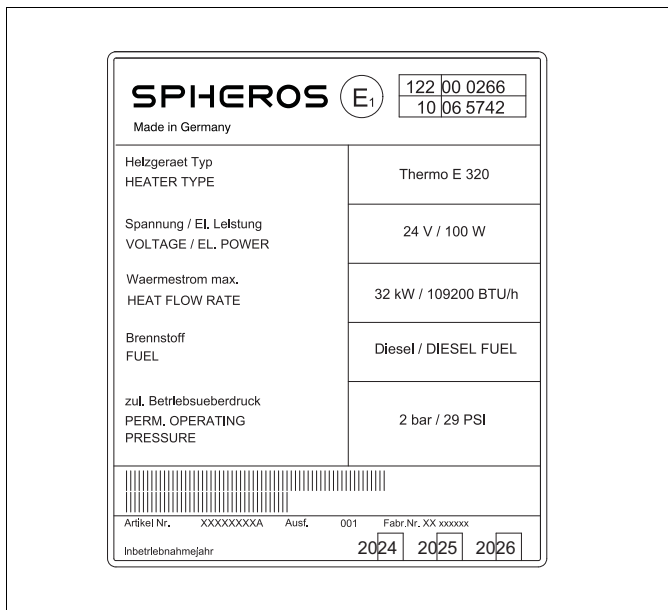


Fig. 4: Model plate (example)

NOTE:

The year of the initial operation must be durably marked by removing the year numbers that are not applicable.

4 Installation example

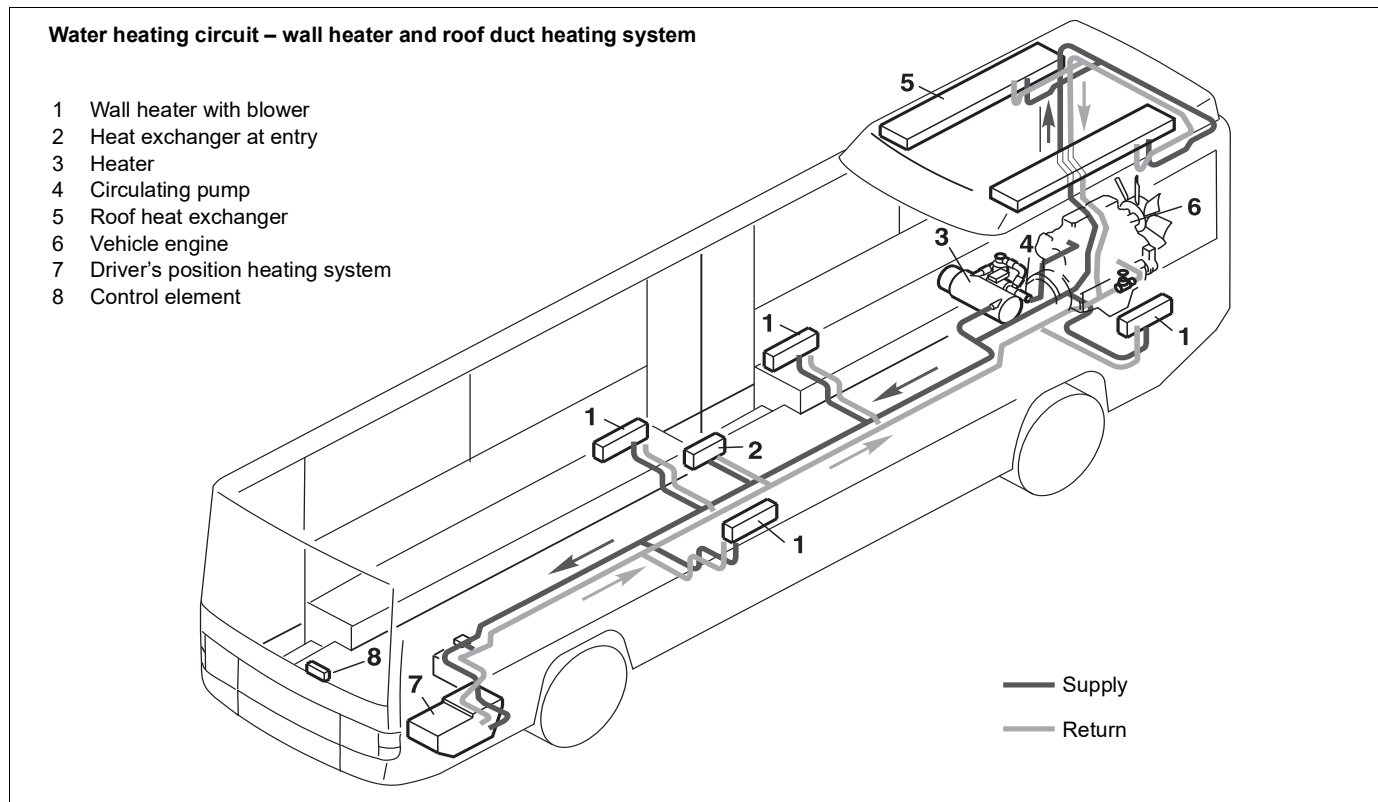


Fig. 5: Installation example for the heater

5 Installation of the circulating pump

ATTENTION:

**The heater should be equipped with a Spheros circulating pump.
Pumps of other manufacturers must be approved by Spheros.**

The following pumps are available:

- U4814 (Aquavent 5000)
- U4854 (Aquavent 5000S)
- U4855 (Aquavent 6000C)
- U4856 (Aquavent 6000SC)
- SPump



Information about these pumps and their installation you find in the download center under www.spheros.com.

NOTE:

- The annex of this Installation instructions contain the permitted installation positions of the pumps.
- The pump ports and connection lines from the water intake and water outlet must be flush (no stress).

ATTENTION:

When connecting the circulating pump U4856 it must be ensured that the volume flow does not drop below 2500 l/h for longer than a brief period only! Continuous operation at less than 2500 l/h will result in an undue wear of the wearing disc of the impeller!

6 Connection to the vehicle cooling system

The heater is to be connected to the vehicle cooling system in accordance with Figures 1 and 5. The system must contain at least 25 litres of coolant. A minimum of 30% of a good quality antifreeze should be maintained in the heating circuit of the heater at all times.

A current list of approved by Spheros antifreeze agents can be found on the Spheros website.

Basically the water hoses supplied by Spheros should be used. If this is not the case, the hoses must comply at least with DIN 73411 requirements. The hoses are to be routed without any kinks and - for proper venting of the heater - in an upward pitch, if possible. Hose connections must be secured against slipping off by means of hose clamps.

NOTE:

The tightening torques of the hose clamps used must be observed. After 2 hrs. / 100 km, the hose clamps should be retightened.

In the vehicle cooling system, or in a separate heating circuit, only pressure control valves with an opening pressure of min. 0.4 bar and max. 2.0 bar may be used.

Before the heater is started up for the first time, or after the coolant has been replaced, it must be ensured that the cooling system is properly bled. Heater and piping should be installed in such a way that static bleeding of the system is ensured.

Proper bleeding action can be recognised by the nearly silent operation of the circulating pump. Insufficient bleeding during heater operation can result to tripping of the temperature limiter.

If the circulating pump U 4855 / Aquavent 6000C is used it will be automatically deactivated approx. 10 seconds after its activation if coolant is

lacking or a blockage of the pump impeller has occurred, and can then be restarted after approx. 2 minutes.

If the circulating pump U 4856 / Aquavent 6000SC is used, it will be automatically deactivated approx. 45 minutes after its activation if coolant is lacking or a blockage of the pump impeller has occurred, and can then be restarted after approx. 2 minutes.

ATTENTION:

Before commissioning the heating system, the heating hoses, the pump and the heater must be completely filled.

Only by Spheros approved antifreeze agents may be used.

7 Fuel Supply

Fuel is extracted from the vehicle's fuel tank or from a separate fuel tank. Fuel lines and filters must be completely vented without using the fuel pump of the heater before commissioning. Thereby also during vehicle operation a safe fuel supply without air bubbles must be ensured continuously.

7.1. Fuel lines

When using fuel hoses, basically the hoses supplied or offered by Spheros are to be used. If this is not the case, the fuel hoses must at least comply with the requirements of DIN 73379. Fuel hoses must not be kinked, crushed or twisted and must be secured at intervals of about 25 cm with clamps.

Materials commonly used in the construction of vehicles may be also used for fuel hoses taking into account a suitable connection system in each case. The selection should be done considering the ambient temperature range and the fuel (Bio Diesel) used.

To prevent air inclusions from forming in the fuel, the fuel lines should be routed in an upward pitch, if possible. Connections within the fuel lines must be secured by means of hose clamps unless mechanical screwed connections are used.

To prevent the fuel lines from draining, the outlet of the return line in the tank should be below the fuel level.

ATTENTION:

If the heater is operated without coolant, the outer shell of the heater may reach a temperature equalling the ignition temperature of diesel fuel!

- The lines must be protected from thrown-up gravel
- any dripping or evaporating fuel must neither collect nor be

ignited by hot components or electrical equipment.

To prevent this, optionally a drip pan with defined drain holes is to be installed in the area below the interface burner housing/ fuel line connectors/heat exchanger.

ATTENTION:

The operation with a closed return line will cause damage to the fuel pump or fuel line. Fuel can leak out - fire hazard!

Fuel lines and filters must be protected against excessive heat.

The fuel pump must not run dry.

Unsupported fuel lines must be secured to prevent them from sagging.

The installation of an additional fuel pump is permissible only in consultation with Spheros.

For legal provisions refer to Chapter 1.

7.1.1. Permissible dimensions of the fuel lines

- Inside diameter for suction and return lines: 6 mm (other diameters on request).
 - Max. permissible length of each suction and return line: 15 m
 - Max. permissible suction height: 1 m
 - Max. permissible admission pressure: 0.3 bar
- Deviations are to be approved by Spheros.

7.2. Fuel Filter

A fuel filter supplied or approved by Spheros must be used (consider the

flow direction). To avoid malfunctions the filter or filter insert is to be replaced annually before the cold weather season starts.

If temperature limits of fuels have been reached, heated fuel filters are to be used. However, it is recommended to use them beforehand.

7.3. Operability of the heater depending on the negative pressure in the fuel system

The preferred range designed for the fuel supply system goes up to max. 350 mbar (at the heater).

For different fuel-side applications a separate approval by Spheros is required.

ATTENTION:

With increasing service life, the flow resistance in the fuel supply may be increased due to deposits (e.g. the filter clogs) and the heater is more susceptible for malfunctions.

8 Combustion air supply

Under no circumstances may the combustion air be taken from areas occupied by people. The combustion air intake opening **must not** point in the direction of travel. It must be located so that it cannot become clogged with dirt or snow and cannot suck in splashing water.

Permissible dimensions of the combustion air intake line Thermo E 200:

- Inside diameter: 55 mm
- Combustion air intake line: max. 1.5 m
- Combustion air intake line and exhaust gas line: max. 2.10 m
- Max. permissible bends: 270°

Permissible dimensions of the combustion air intake line Thermo E 320:

- Inside diameter: 55 mm
- Combustion air intake line: max. 5 m
- Combustion air intake line and exhaust gas line: max. 5 m
- Max. permissible bends: summarized 270°

Deviations must be approved by Spheros.

NOTE:

If the combustion air intake line cannot be installed so that it slopes downwards, a water drain hole with a diameter of 4 mm is to be made at its lowest point.

If the heater is installed in a general installation space near the vehicle's fuel tank, the combustion air must be taken in from the outside and the exhaust fumes discharged into the atmosphere. The openings must be made splash-proof.

An effective ventilation opening is required if the heater is installed in an enclosed box:

Thermo E 200	30 cm ²
Thermo E 320	40 cm ²

Verify by checking the CO₂ values whether the ventilation is effective and sufficient.

If the temperature in the installation housing exceeds the permissible ambient temperature of the heater (see Technical Data), the ventilation opening must be enlarged subject to prior consultation with Spheros.

9 Exhaust pipe

The opening of the exhaust pipe must be aligned against the direction of travel and must not become clogged with dirt or snow.

The outflowing exhaust gas must not be re-sucked in as combustion air.

The exhaust gas must be routed to the outside / into the atmosphere.

The exhaust pipe must be fixed at least once every 50 cm.

Rigid pipes made of unalloyed or alloyed steel with a minimum wall thickness of 1.0 mm, or flexible tubes of alloyed steel are to be used.

The exhaust pipe is to be secured to the heater, e.g. by means of a clamp.

Accumulations of condensate must be drained, if necessary, a condensation water drain hole Ø 4mm must be implemented.

Combustion air intake and exhaust gas outlet must be arranged to ensure that no air pressure difference (e.g. suction) will occur in any vehicle operating condition.

For further requirements see statutory regulations.

Permissible dimensions of the exhaust pipe Thermo E 200:

- Internal diameter: 70mm
- Max. permissible pipe length: 0.60 m without combustion air intake extension
- Total length of combustion air intake line and exhaust pipe max. 2.10 m

ATTENTION:

The exhaust pipe opening must be directed exclusively perpendicularly downwards. A sideways directed exhaust pipe opening is not permitted.

Permissible dimensions of the exhaust pipe Thermo E 320:

- Internal diameter: 70mm
- Max. permissible pipe length: 5 m without combustion air intake extension
- Total length of combustion air intake line and exhaust pipe max. 5 m
- Max. permissible bends: summarized 270° (kink-free)

Deviations only after approval by Spheros.

NOTE:

If the exhaust line is installed near heat-sensitive parts, it must be insulated.

ATTENTION:

- **The exhaust gas temperature may be up to max. 400 °C.**
- **The exhaust pipe must end in the open air.**
- **The exhaust pipe must be sloped down, arising condensate must be able to drain away.**
- **Because of the temperatures involved, sufficient distance from heat-sensitive or flammable materials must be ensured.**
- **Outflowing exhaust gas must not be re-sucked in as combustion air.**
- **The opening of the exhaust pipe must be aligned against the direction of travel and must not become clogged with dirt or snow.**
- **If the exhaust outlet is under the vehicle floor, blowing straight down, an exhaust gas deflection is absolutely necessary.**

10 Electrical connections

10.1. Heater hook-up

 Warning!	High Voltage! Danger to Life!
---	--

Before opening the heater, disconnect the connections at the control device (circulating pump, temperature sensor and the connection to the vehicle wiring harness).

The heater hook-up is to be accomplished according to the system wiring diagram (Fig. 6 or 7).

Before heater installation the **ripple voltage** level at the interface to the heater shall be checked. It must not be higher than 2 Vss. Otherwise a reduced service life of the electric and electronic components must be expected.

Plug designs that differ from the standard versions are primarily possible by using adapter cable harnesses. They are to be requested separately from Spheros.

ATTENTION:

The usage of an adapter cable harness is only permitted, if the heater is installed in an effective sealed installation box and reliable protected against moisture and dirt.

The wire cross-sections are minimum requirements and to be selected according to the following table:

Wire length <7.5 m	Wire length 7.5 - 15 m
0.75 mm ²	1.5 mm ²
2.5 mm ²	4.0 mm ²

For the heater a blade-type fuse is to be used according to DIN 72581, part 3. The power supply circuit of the heater (incl. circulating pump) is to be protected by F1 = 25A. The main switch wire is to be protected using a 5A fuse.

The required mating plug inclusive the required contacts and single wire seals can be ordered at Spheros using the material number 11114920 (Customer plug C Thermo E).

Due to the crimp suitability use FLR cable (sheathed cable with reduced outer diameter).

ATTENTION:

- **The water-proof electrical connection to the heater can only be achieved with the genuine plugs, contacts and single wire seals and by using the prescribed crimp tools.**
- **Its absolutely essential to consider the specified cable cross-section.**
- **The negative pole (terminal 31) and the positive pole (terminal 30) of the heater controller are to be directly connected to the battery without battery switch.**
- **Route the electrical wires so their insulation cannot be damaged (e.g. by jamming, thermal effects, bending, wearing through). Particularly close to the heater the wire harness is to be fixed to reduce the transfer of vehicle vibrations.**
- **Unused connectors must be protected by dummy plugs.**

10.2. Hook-up of the control elements

The heater can be switched on and off by the Spheros control elements switch or pre-selection timer. The control device is integrated in the heater.

10.3. System wiring diagram

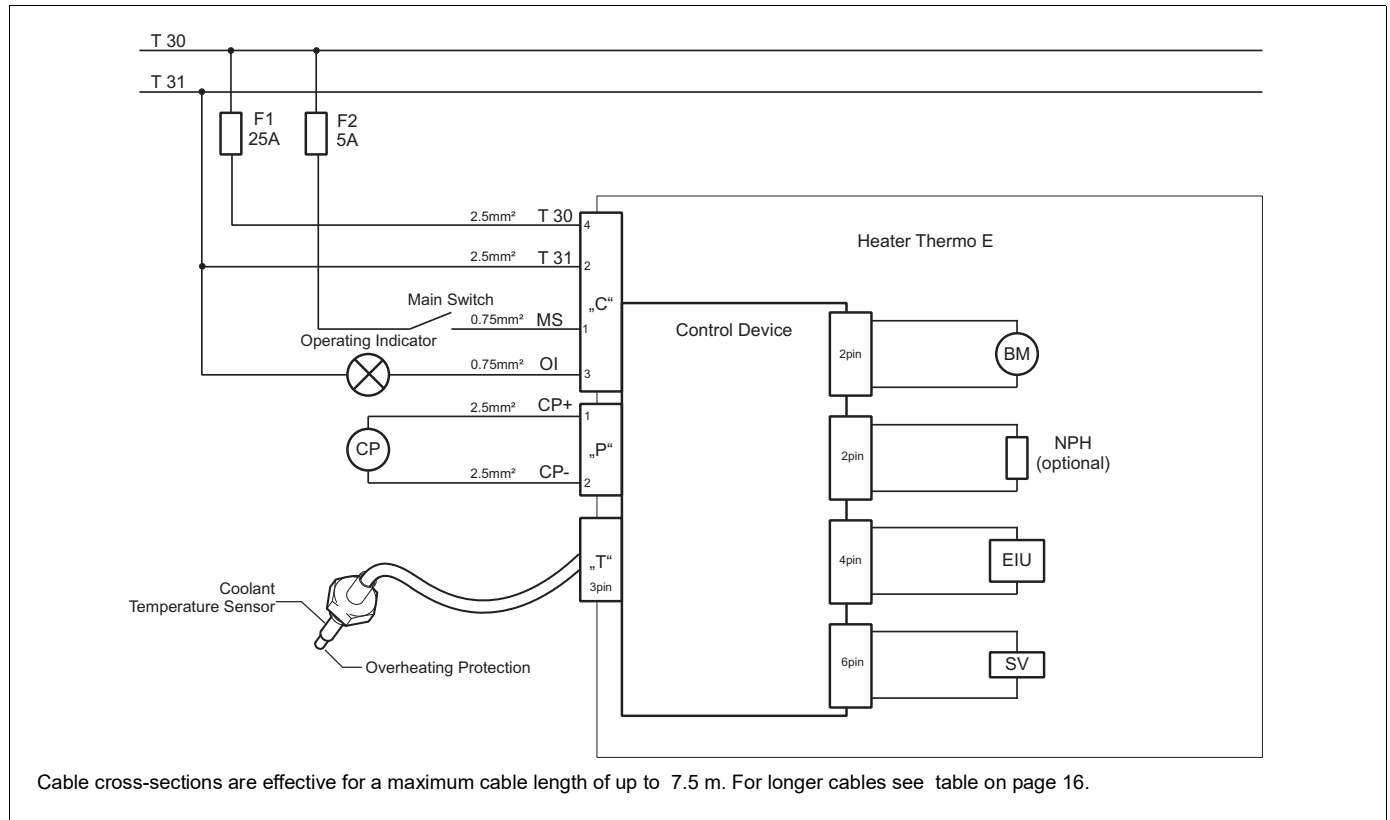
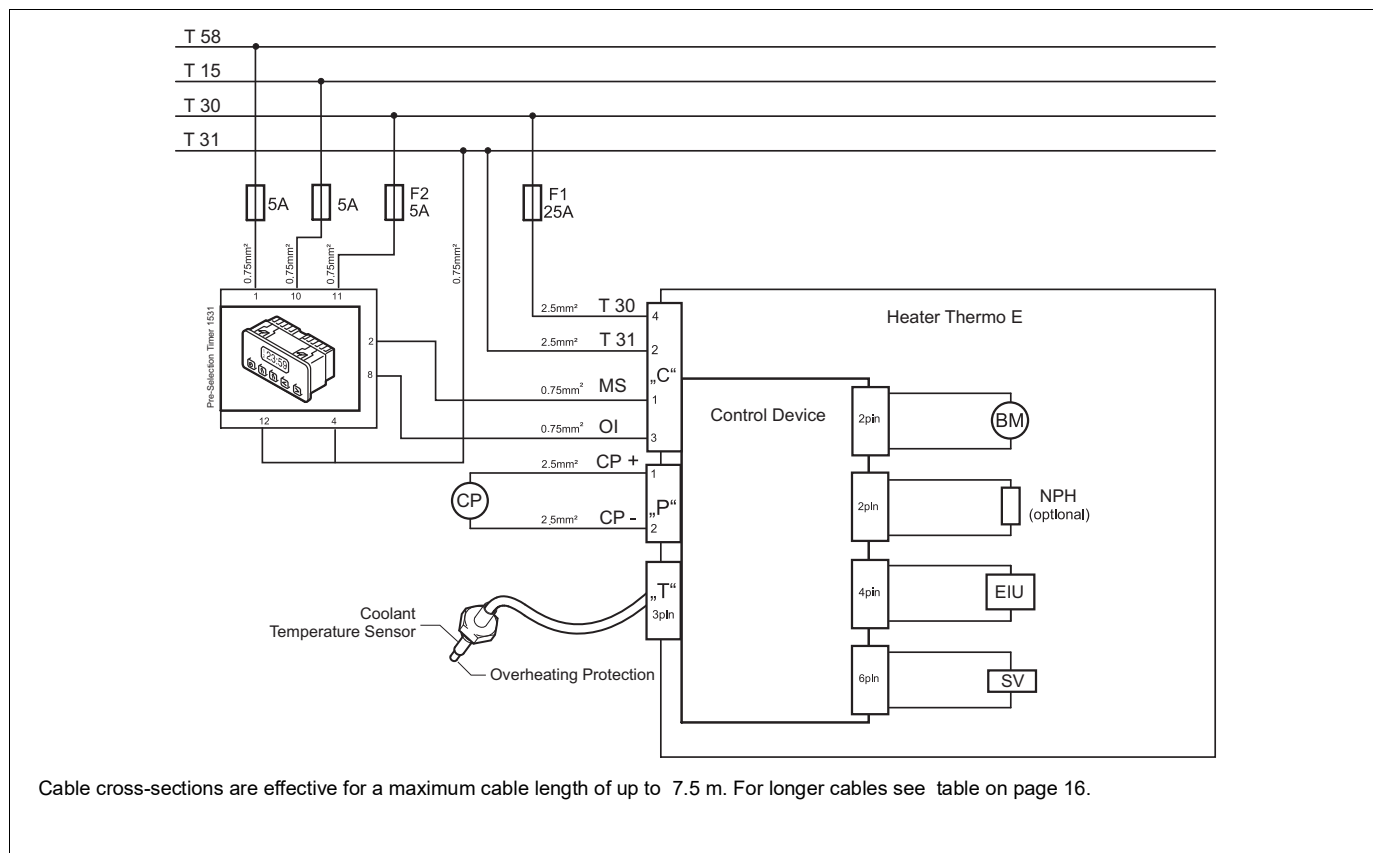


Fig. 6: System wiring diagram for heaters Thermo E, legend see page 19



Cable cross-sections are effective for a maximum cable length of up to 7.5 m. For longer cables see table on page 16.

Fig. 7: System wiring diagram for heaters Thermo E with pre-selection timer 1531, legend see page 19

Position	Designation
OI	Operation indicator max. 1x5W or 2x2W
BM	Burner motor
NPH	Nozzle block pre-heater
F1	Car flat-type fuse 25A acc. DIN 72581 part 3
F2	Car flat-type fuse 5A acc. DIN 72581 part 3
MS	Main switch
SV	Solenoid valve
CP	Circulating pump
EIU	Electronic ignition unit

Legend to the system wiring diagram

C	To vehicle (Power)	T	Temperature sensors
C1	Main switch	T1	Temperature sensor)
C2	Terminal 31 (-)	T2	Overheating protection
C3	Operation indicator +	T3	Ground
C4	Terminal 30 (+)	V	Nozzle block pre-heating
P	Circulation pump	V1	Nozzle block pre-heating +
P1	Circulation pump +	V2	Nozzle block pre-heating -
P2	Circulation pump -	Z	electronic ignition unit
B	Burner motor	Z1	electronic ignition unit +
B1	Burner motor +	Z2	electronic ignition unit +
B2	Burner motor -	Z4	electronic ignition unit -
M	Solenoid valve		
M3	Solenoid valve +		
M4	Solenoid valve -		

Connector pin assignment

10.4. Operation indication

To monitor the operating status an operating indication is provided. The operation indication has two display modes. First the pure switching mode and further a flashing mode. In the flashing mode this output displays the error flash codes by the operation indication.

Two functions are indicated:

- the device is switched on or off
- error indication by a special flash code

The output is designed for the control of up to two lamps 24V/2W or a single lamp 24V/5W.

11 Initial start-up

NOTE:

It is mandatory to read through the operating and maintenance instructions as well as the installation instructions before starting the heater.

The safety precautions given in the above mentioned documents must be considered!

The heaters are adjusted in the factory and can be used unlimited without a change of the CO₂ adjustment up to an altitude of 1500 m above MSL and up to 2000 m above MSL if that is a short stay in such conditions (pass crossing, break).

In case of a permanent heater operation above 1500 m the CO₂ setting should be readjusted, due to a negative change of the exhaust gas values in result of the decreased air density.

It is also recommended to adjust the CO₂ content according to the technical data if combustion air supply or exhaust gas applications are used.

After heater installation, bleed the water system and the fuel supply system carefully. In this process it is mandatory to fill the suction line and the fuel filter of the heater completely. Spheros recommends the usage of a separate bleeding unit. Follow the appropriate instructions provided by the vehicle manufacturer. Verify the fuel supplied to the heater is bubble-free.

ATTENTION:

Do not use the fuel pump to fill / bleed the fuel system!

Generally, the hook-up of the heater to the vehicle power grid must be done only after filling / bleeding of the fuel system in order to prevent a premature start of the fan motor/fuel pump.

Conduct a test run of the heater to check all the water and fuel connections for leaks and to ensure that they are secure. If the heater suffers a fault during operation, the fault must be located and remedied according

to given in the shop manual instructions.

ATTENTION:

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

If the heater functions normally the different operating states are passing according to the following functional diagram:

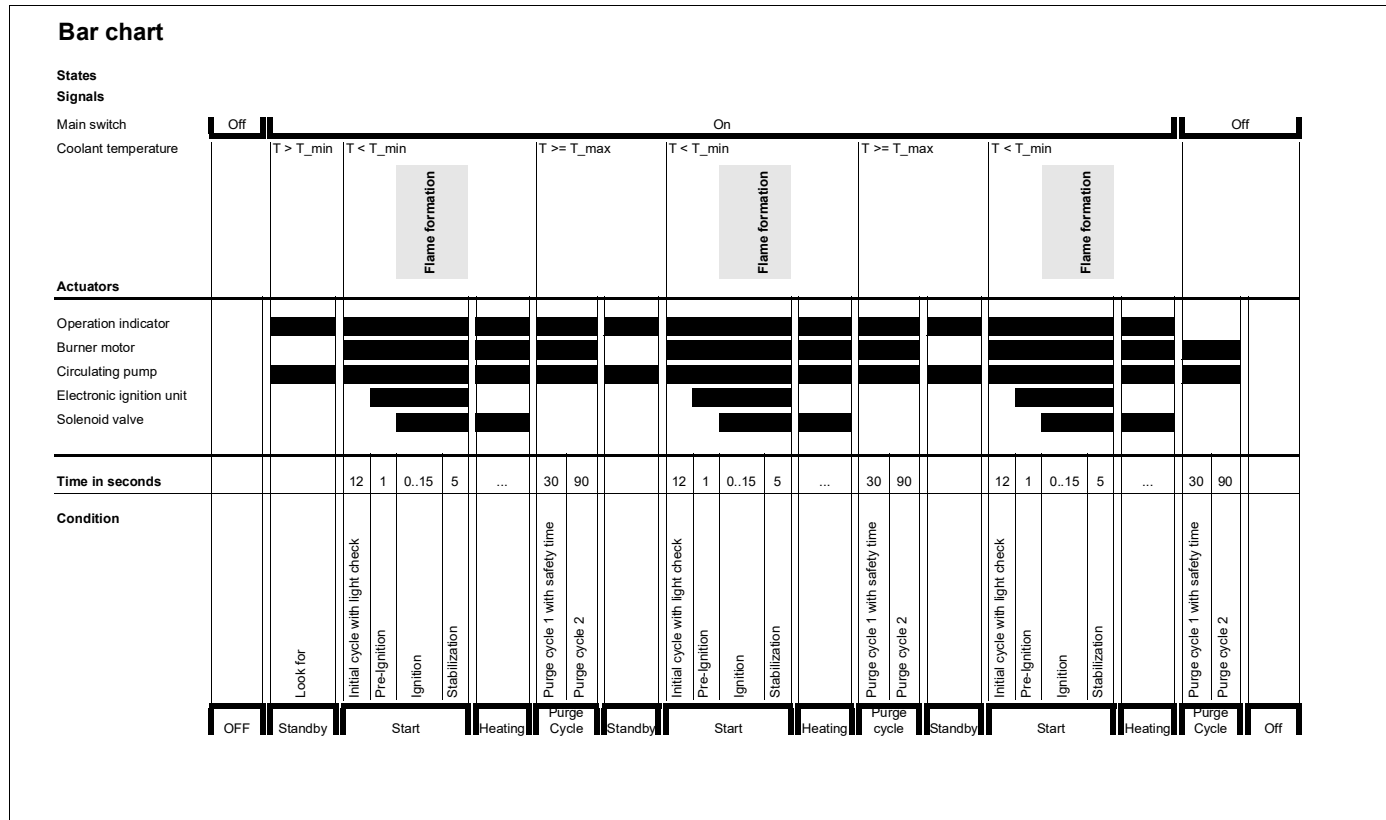


Bild 8: Functional diagram

12 Maintenance

Periodic maintenance is to be performed in accordance to the instructions contained in the Workshop Manual.

NOTE:

The receptacles can be detached easier from the control device by pressing them first firmer onto the control device, and then lifting the latching lug.

13 Malfunctions

Malfunctions are signalled by the operation indicator. During all active operating phases of the heater, all components, the operating voltage and functional irregularities are monitored and recorded. A malfunction causes the heater to terminate its operation by a fault shut-off and to go into the fault lock-out mode to prevent the heater from an automatic combustion restart. At the same time the operation indicator begins immediately to flash after detection of the malfunction with a specific code depending on the kind of malfunction. If the heater remains energized, the operation indicator keeps flashing until the heater is freed.

The flash code comprises of a sequence of 5 short flashes depicting the break and a defined number of long pulses corresponding to the malfunction number, which are to be counted. After that the cycle starts with 5 short flashes again and so on.

The meaning of the number of long pulses is shown in the table below.

The **fault lock-out** occurs:

- if combustion was not established during start-up
- Flame interruption
- if the control device itself has failed or peripheral components are defective
- undervoltage within a defined time period
- extrinsic light

Variants to reset the heater after a fault lock-out:

1. Switch off the main switch (MS) and then turn it on again.
2. Reset the control device, e.g. through disconnecting it from the power supply.

Additional to the fault lock-out a heater lock-out occurs if safety related components such as the flame guard and the overheating protection are affected as well after reaching a counter threshold of repeated malfunctions and flame interruptions. The heater lock-out is saved by the control device.

Under the following conditions a **heater lock-out** occurs:

- overheat protection/ function has been activated or is defective
- water temperature sensor is defective
- solenoid valve is defective
- flame guard is defective
- repeated malfunctions
- repeated flame interruptions
- flame within the purge cycle 2
- malfunction of the control device

In case of a heater lock-out, the heater is to be maintained and released by Spheros trained personnel

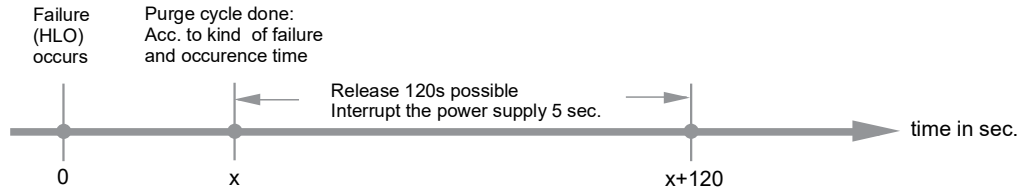
Before deleting the fault or heater lock-out the failure cause must be remedied!

Variants to reset the heater after a heater lock-out:

1. Immediately after the malfunction occurs (within 2 min)

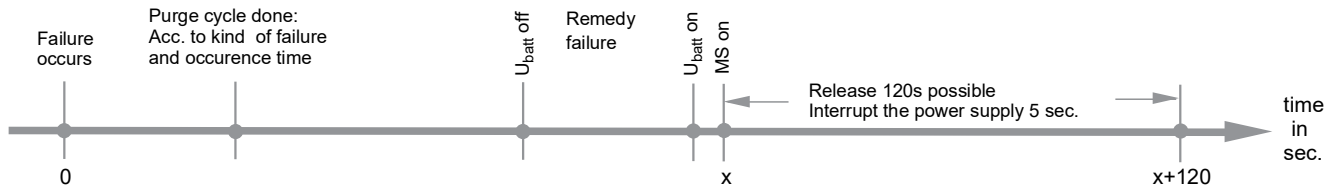
- Keep the heater energized.
- If no purge cycle took place, when for example the malfunction did occur within the initial cycle, skip the next point.
- Await the purge cycle (Attention: Reading the flash code 8, the purge cycle takes place without burner motor).

- Remedy the failure cause and then interrupt the power supply for at least 5 sec. within the next 2 min.



2. Generally

- purge cycle 120s (Attention: Reading the flash code 8, the purge cycle takes place without burner motor)
- interruption of the power supply
- remedy the failure cause
- return the power supply
- switch the heater on
- Now the heater lock-out can be released if the power supply for at least 5 sec. within the next 2 min is interrupted again.



Power supply interruption for example by

- remove the fuse
- disconnect the connector "C" at heater

Table: Flash codes

No. of pulses	Malfunction	Description
0	CD malfunction	Control device malfunction
1	No start within safety time	No start within safety time
2	Flame interruption	Flame interruption during burner operation, restart unsuccessful
3	Overvoltage / undervoltage	Overvoltage
		Undervoltage
4	Unexpected light detection in initial or purge cycle	Unexpected light (flame guard bright in purge cycle 2)
		Unexpected light (flame guard bright before ignition)
5	Flame guard defective	Flame guard short-circuited
		Flame guard disconnected
6	Temperature sensor / overheating protection defective	Temperature sensor short-circuited
		Temperature sensor disconnected
		Temperature sensor / overheating protection implausible
		Overheating protection short-circuited
		Overheating protection disconnected
7	Solenoid valve defective	Solenoid valve short-circuited
		Solenoid valve disconnected
8	Burner Motor / Nozzle block pre-heater defective	Burner Motor short-circuited
9	Circulating pump defective	Circulating pump short-circuited
10	Overheating protection has tripped	Overheating T>125°C
11	Electronic ignition unit defective	Electronic ignition unit short-circuited
		Electronic ignition unit disconnected
12	Heater lock-out	Flame interruption counter threshold reached
		Heater lock-out - release required
		Malfunction counter threshold reached

14 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.

NOTE:

The assignment of circulating pumps to heaters must be made considering the water-side resistances.

14.1. Fuel

Suitable fuel is the diesel fuel specified by the vehicle manufacturer.

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

Fuel	Requirements acc.	Remarks
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 14214	max. 20% see TI Fuels
Paraffinic diesel fuel from synthesis or hydro-genation (HVO)*	DIN EN 15940	only selected fuels see TI Fuels

* Further information on approved fuels contains the TI (Technical Information) Fuels.

It can be found in the download center on www.spheros.com.



In case of air temperatures below 0°C a commercially available winter Diesel fuel, at temperatures below -18°C a Diesel for arctic climate conditions 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.

Heater		Thermo E 200	Thermo E 320
Kind of construction		High pressure atomizer	
Rated heating flow	kW	20	32
Fuel		Diesel / Heating oil	
Fuel consumption	kg/h	2,0	3,2
Rated voltage	V =	24	
Operating voltage range	V =	20.5...30.0	
Rated power consumption at 24V	W	55	100
Temperature of sucked com-bustion air	°C	-40...+ 85	
Ambient temperature during operation	°C	-40...+ 85	
Storage temperature	°C	-40...+ 90	
Operating overpressure	bar	max. 2.0	
Capacity of the heat exchanger	l	1.8	
Minimum water flow	± ...l/h	2400 ± 200	2700 ± 200
Minimum capacity of the water system	l	min. 25.0	
CO ₂ in exhaust gas at rated voltage	Vol %	9.5 ± 0.5	10.0 -0.5 / +0.8
CO ₂ in exhaust gas with application at rated voltage	Vol %	9.5 ± 0.5	10.0 -0.5 / +0.8
		9.5 -0.5 / +0.8*	10.0 -0.5 / +2.0**
Heater dimensions (tolerance ± 3 mm)	mm	Length 593 / Width 247 / Height 224	
Weight	kg	16.5	17.3

* If at voltages less the rated voltage the smoke spot number acc. Bacharach keeps ≤ 4.
Reference value: Possibly increased soot at CO ≥ 60 ppm resp. CO ≥ 0,006 Vol %.

** If at voltages less the rated voltage the smoke spot number acc. Bacharach keeps ≤ 4.
Reference value: Possibly increased soot at CO ≥ 100 ppm resp. CO ≥ 0,01 Vol %.

Circulating pump		U 4814 Aquavent 5000	U 4854 Aquavent 5000S	U 4855 Aquavent 6000C	U4856 Aquavent 6000SC
Delivery rate	l/h	5000 (against 0.2 bar)	5000 (against 0.2 bar)	6000 (against 0.4 bar)	6000 (against 0.4 bar)
Rated voltage	V =	24	24	24	24
Operating voltage range	V =	20...28	20...28	20...28	20...28
Rated power consumption	W	104	104	210	210

Note: For further technical data e.g. dimensions, refer to the pumps documentation.

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

15 Environment

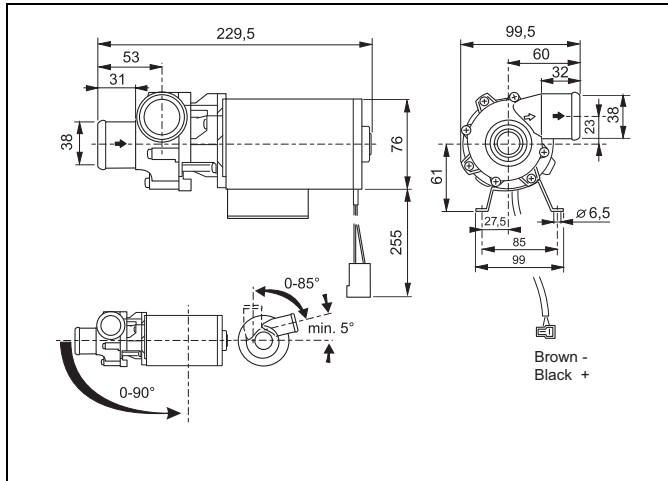
Recycling of heater parts

The correct disposal of the heater components determined by material groups for old appliances, damaged or defective parts and packaging material can be realized without problems. In the process the materials as steel, non-ferrous metals, plastics and electrical scrap (as motors, control devices, harnesses and sensors) are to be professionally and environmentally friendly disposed by the recycling plant.

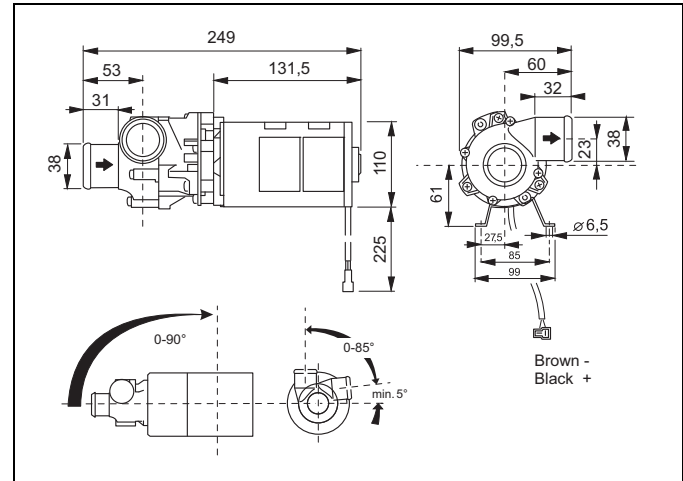
The heater disassembly is precisely described in the workshop manual. For the package the same recycling conditions applies as for paper and paperboard. Keep the package a defined period for a possible return shipment.

Annex

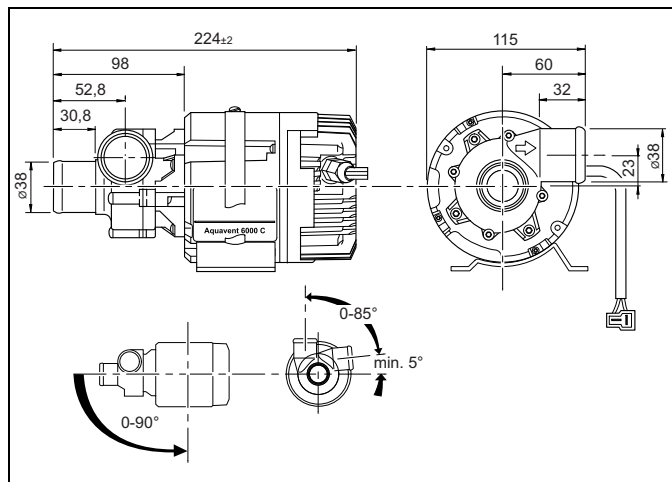
Circulating pumps installation position



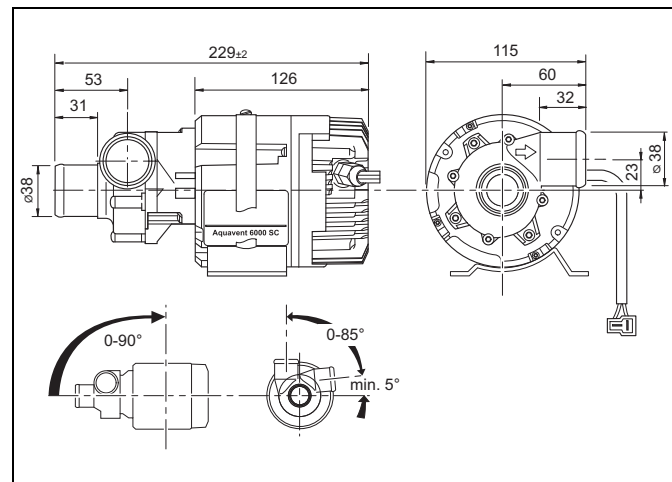
U 4814 Installation position



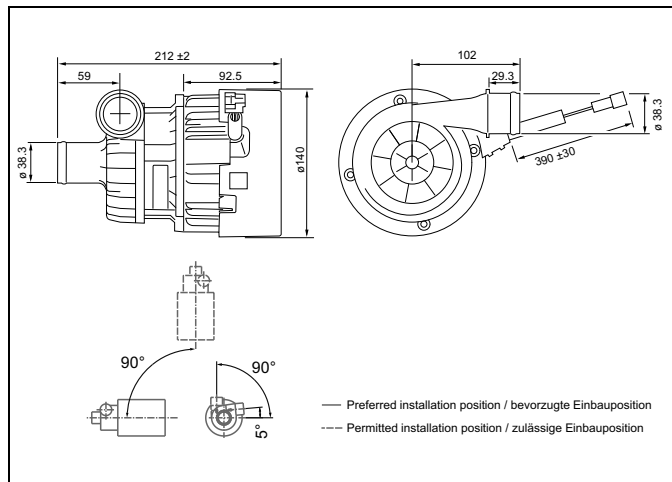
U 4854 Installation position



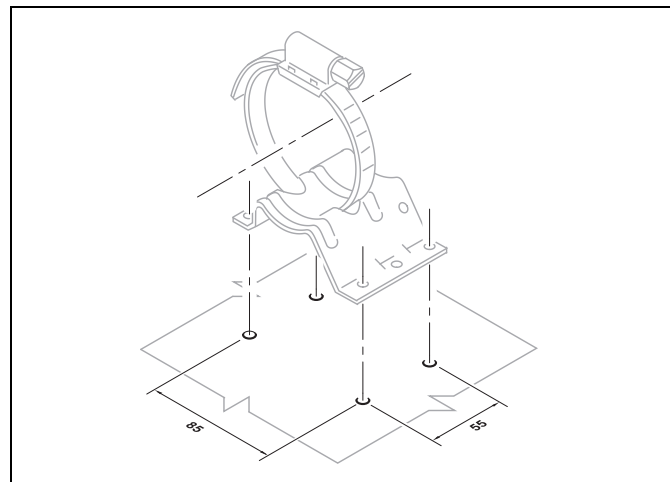
U 4855 Installation position



U 4856 Installation position



SPump Installation position



Hole pattern for stand



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