ASTOTHERM®*plus*

Blood and Infusion Warmer

Models AP200, AP220 and AP260

Models AP200S, AP220S and AP260S with ASTOLINE

Repair Instructions

REVISION 6, 03/2010

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User information:

Test results which *must* be achieved to ensure safe operation are outlined by a frame.

The description for dismantling covers every possible assembly group and step. If a defective component or an assembly group are to be replaced, only the steps necessary for this should be performed.

1 Technical description

1.1 General

Applications

The ASTOTHERM PLUS allows fluids supplied to patients to be heated, either to avoid or reduce hypothermia or to increase well-being. Applications include transfusions, infusions, dialysis, haemofiltration and apheresis.

The warmer works in accordance with the principle of flow heating, i.e. the heat is transmitted by the heat exchanger via the sterile infusion extension to the fluid flowing within it.

If the full heating capacity is not required, two infusion extensions can also be inserted into the first and second halves of the heat exchanger. A check on heat exchanger temperature at the inlet and outlet avoids fluids being overheated, even if they have different inlet temperatures.

The patented heat protection sleeve insulates the heat exchanger cylinder and the infusion extension against the effects of ambient cold (e.g. air-conditioning systems) and thus increases the degree of efficiency. There is an opening in the centre of the heat protection sleeve for use of a second infusion extension. This is where extensions can be routed in and out and secured with the hand grips.

Overheating is reliably prevented by the following measures:

- 2 separate temperature sensors for temperature control, temperature display and excessive temperature cut-off,
- an additional independent temperature sensor for excessive temperature cut-off,
- optical and acoustic alarms.

On models 220(S) and 260(S), the temperature of the ASTOTHERM PLUS can be set alternatively at three fixed temperature steps up to 43 °C. On the model 200(S), the temperature is fixed at 40 °C. The temperature display always shows the current mean temperature of the **heat exchanger**.

Heating of the medium is based on flow speed and inlet temperature. For an optimum heat transfer we recommend the original infusion extension ASTOTUBE. (see outlet temperature diagrams in the operating instructions).
If on the models 220(S) and 260(S) the displayed temperature of the heat exchanger drops by more than 4 °C below the selected set temperature, the inadequate temperature alarm is activated. On the model 200(S), the inadequate temperature alarm is fixed at 32 °C.

There are ASTOTHERM PLUS in the following variations

Order no	Heat exchanger groove	Temperature	Power consumption	ASTOLINE actively-heated insulation up to the patient
AP 200*	4 mm	40°C (fixed)	250 W	-
AP 200 S*	4 mm	40°C (fixed)	250 W	✔
AP 220	4 mm	37°C, 39°C, 41°C (selectable) or 39°C, 41°C, 43°C (selectable)	450 W	-
AP 220 S	4 mm	37°C, 39°C, 41°C (selectable) or 39°C, 41°C, 43°C (selectable)	450 W	✔
AP 260	6,8 mm	37°C, 39°C, 41°C (selectable) oder 39°C, 41°C, 43°C (selectable)	450 W	-
AP 260 S	6,8 mm	37°C, 39°C, 41°C (selectable) oder 39°C, 41°C, 43°C (selectable)	450 W	✔

*no more in the actual sales program

Description of ASTOLINE (optional accessory)

Using the active ASTOLINE insulation, it is possible to limit cooling of the fluid en route from the warmer to the patient. The heated flexible silicone body surrounds the infusion extension over a distance of up to 130 cm, ensuring that the part of the infusion line which would otherwise be exposed to the cool ambient air is both insulated and heated. Its special shape also enables infusions and transfusions to be observed all the way to the patient.

1.2 Structure

In the top part of the housing underneath the front panel is the board with the components for electronic control, the keys for operation and the associated LEDs and LCD for actual and selected temperature displays. The board is operated exclusively with low-voltage power.

Depending on model type, the heat exchanger cylinder has either 11 (models 200(S) and 220(S)) or 9 windings (model 260(S)). Approximately 40 cm of infusion extension are required for one winding. The heating system is attached to the inner surface of the aluminium heat exchanger cylinder. The three temperature sensors for temperature control, display and safety cut-offs are located in the end faces of the cylinder.

The transformer board is inserted in the heat exchanger cylinder. On this board are the fuses, the connections for the mains cable and the heating and the heating control LED.
WARNING! This board is live (100 V AC to 240 V AC)!
The transformer board is secured in the heat exchanger cylinder by the intermediate ring and the fixing strip.

A universal mounting is fitted to the bottom part of the housing, allowing the device to be attached to an infusion stand (dia. 12 mm to dia. 35 mm) or to a standard medical rail. Warmers with ASTOLINE active insulation (models 200S, 220S and 260S) have the board and the device socket for the ASTOLINE fitted in the bottom part.

1.3 Description of the electronics

- **Temperature control:**

The temperature at the heat exchanger cylinder is controlled by a control unit consisting of a microprocessor, an A/D converter and a triac unit. The actual temperature is determined by two NTC sensors at the inlet (NTC1) and outlet (NTC2) (cf. Fig. 1, Block Diagram).

- **Temperature display:**

The actual temperature is displayed in the LCD as a mean value. At a temperature below 15 °C, only three bars at the bottom are shown and above 50 °C, only three bars at the top. The three small displays on the 220(S) and 260(S) models show the user-selectable temperatures. The frame outlines the current selection according to which the temperature of the heat exchanger is being controlled.
On the model 200(S), the temperature of the heat exchanger is fixed.

- **Safety cut-off at warmer inlet (heat exchanger rear side):**

The safety cut-off at the warmer inlet is a device independent of the microcontroller. It checks whether NTC1 is hotter than the alarm limit (temperature value of second excessive temperature cut-off, see Section 1.4) In the event of an alarm, the safety cut-off switches off relay K1. This interrupts the heating current and the power supply for K1 and K2. Drop-out of the relay is indicated by the flashing alarm LED and the alarm tone. If the heat exchanger cylinder cools to below the alarm limit, the device can be re-started manually. NTC1 cannot be affected by any conceivable defect of the safety cut-off at the warmer outlet or of NTC3.

- **Safety cut-off at warmer outlet (heat exchanger front side):**

The safety cut-off at the warmer outlet works according to the same principle as the safety cut-off at the inlet, though it checks NTC3 (temperature value of the first excessive temperature cut-off, see Section 1.4) located at the outlet and controls relay K2. NTC3 cannot be affected by any conceivable defect of the control system, the safety cut-off at the warmer inlet, NTC1 or NTC2. The drop-out of the relay is indicated by the flashing alarm LED and the alarm tone. If the heat exchanger cylinder cools to below the alarm limit, the device can be re-started manually.

- **Test devices:**

Pressing the Start key checks whether relays K1 and K2 reliably cut power if so required. A fault signal is sent to the safety cut-off at the warmer inlet followed by the safety cut-off at the warmer outlet. The safety cut-offs react with an audible click. Following a successful test, the device switches on the heating.
With alarm tests 1 and 2, the safety cut-offs at the warmer inlet and outlet can be tested individually (cf. operating instructions, Section “PERIODICALLY RECURRING TEST MEASURES”).

- **EEPROM memory:**

An EEPROM is provided to store constants and operating states. Calibration data are also stored here.

- **Watchdog device:**

The microprocessor is continuously monitored by a so-called watchdog circuit. If the microprocessor becomes defective due to a malfunction, the watchdog circuit emits a signal and the device goes to stand-by mode.

- **Mains power failure bridging:**

This is used to restart the device automatically in the previously selected state in the event of a brief power failure. Automatic start is effected in the event of a power failure lasting up to 5 seconds, 30 seconds at most.

- **ASTOLINE active insulation:**

ASTOLINE is an auxiliary heating system controlled by current and voltage. If voltage or current are above or below the permissible limit values, an alarm is activated. The board is operated with low-voltage power.

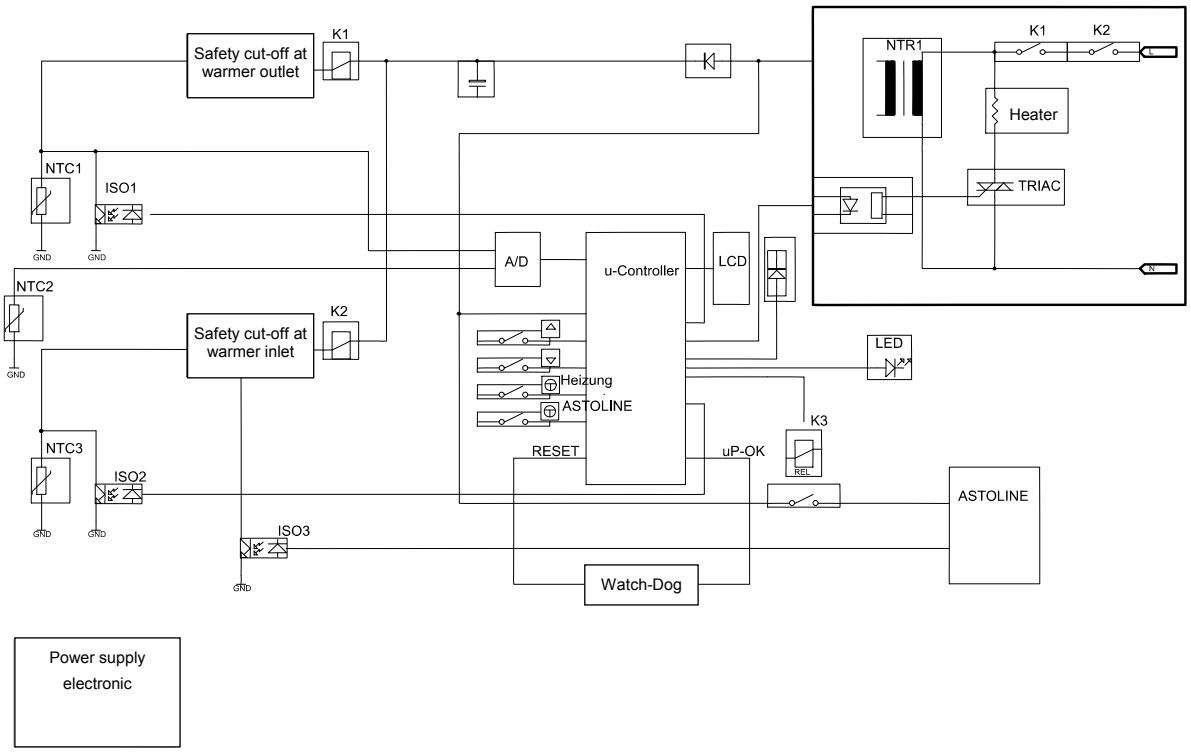


Fig. 1 Electronics block diagram

1.4 Technical Data

1.4.1 ASTOTHERM PLUS 200 and 200S

ASTOTHERM PLUS 200(S)	AP200(S) EU	AP200(S) UK	AP200(S) CH	AP200(S) DK	AP200(S) NA
Line voltage	230-240 VAC ±10% 47-63 Hz				100-115 VAC ±10% 47-63 Hz
Power supply cord	SCHUKO - plug H 05 VVF 3x0.75	BS - plug 13A Fuse H 05 VVF 3x1	Schweiz plug H 05 VVF 3x0,75	DK - plug DK2-Ia, DK2-5a H 05 VVF 3x0.75	Hospital Grade Plug NEMA 5-15P SJO, SJT 18/3
Impedance of protective earth	≤ 0.2 Ohm				≤ 0.2 Ohm
Insulation resistance	> 2 MOhm				> 2 MOhm
AC leakage current	≤ 0.2 mA				
Primary Fuses	2 x 4 A				
Secondary Fuses	2 x 0.63 A				
Power input	250 W				
Selfstart after mains power failure	5 to 30 sec.				
Protection class	I				
Protection level (IEC 601-1)	defibrillation-proof applied part of type B				
Humidity protection	IPX4				
Classification as per appendix IX	IIb (Rule 9)				
UMDNS Code	10-447				
Dimensions height width depth	 145 mm 135 mm 295 mm				
Weight	2.9 kg				
Warm- up time	approx. 1 min (20 °C to 35 °C)				
Operating mode	continous operation				
Permissible ambient temperature for operation for storage	 +16 °C to +30 °C -40 °C to +70 °C				
Ambient operating humidity	10 % to 90 %				
Operation temperature	40 °C (± 0.5 °C)				
1. safety cut-off 2. safety cut-off heater bimetal cut-off	42.5 °C (± 0.5 °C) 43.5 °C (± 0.5 °C) 65 °C (± 5 °C)				
inadequate temperature alarm	below 32 °C				

1.4.2 ASTOTHERM PLUS 220, 220S and 260, 260S

ASTOTHERM PLUS 220(S) **ASTOTHERM PLUS 260(S)**	**AP220(S) EU** **AP260(S) EU**	**AP220(S) UK** **AP260(S) UK**	**AP220(S) CH** **AP260(S) CH**	**AP220(S) DK** **AP260(S) DK**	**AP220(S) NA** **AP260(S) NA**
Line voltage	230-240 VAC ±10% 47-63 Hz				100-115 VAC ±10% 47-63 Hz
Power supply cord	SCHUKO-plug H 05 VVF 3x0.75	BS - plug 13A Fuse H 05 VVF 3x1	Swiss plug H 05 VVF 3x0.75	DK-plug DK2-Ia, DK2-5a H 05 VVF 3x0.75	Hospital Grade Plug NEMA 5-15P SJO, SJT 18/3
Impedance of protective earth	≤ 0.2 Ohm				≤ 0.2 Ohm
Insulation resistance	> 2 MOhm				> 2 MOhm
AC leakage current	≤ 0.2 mA				
Primary Fuses	2 x 4 A				
Secondary Fuses	2 x 0.63 A				
Power input	450 W				
Selfstart after mains power failure	5 to 30 sec.				
Protection class	I				
Protection level (IEC 601-1)	defibrillation-proof applied part of type B				
Humidity protection	IPX4				
Classification as per appendix IX	IIb (Rule 9)				
UMDNS Code	10-447				
Dimensions height width depth	 145 mm 135 mm 295 mm				
Weight	2.9 kg				
Warm- up time	approx. 1 min (20 °C to 35 °C)				
Operating mode	continous operation				
Permissible ambient temperature for operation for storage	 +16 °C to +30 °C -40 °C to +60 °C				
Ambient operating humidity	10 % to 90 %				
Operation temperature	37 °C (± 0,5°C) / 39 °C (± 0,5 °C) / **41 °C** (± 0,5 °C) *up to SN ≤ 5000* or 39 °C (± 0.5°C) / 41 °C (± 0.5 °C) / **43 °C** (± 0.5 °C) *from SN ≥ 5001*				
1. safety cut-off 2. safety cut-off heater bimetal cut-off	**41°C-devices:** 42.5 °C (± 0.5 °C) **43°C-devices:** 45.5 °C (± 1°C) **41°C-devices:** 43.5 °C (± 0.5 °C) **43°C-devices:** 46.0 °C (± 1 °C) 65 °C (± 5 °C)				
inadequate temperature alarm	4 °C (± 0.5 °C) below operation temperature				

1.5 Terminal connecting plan

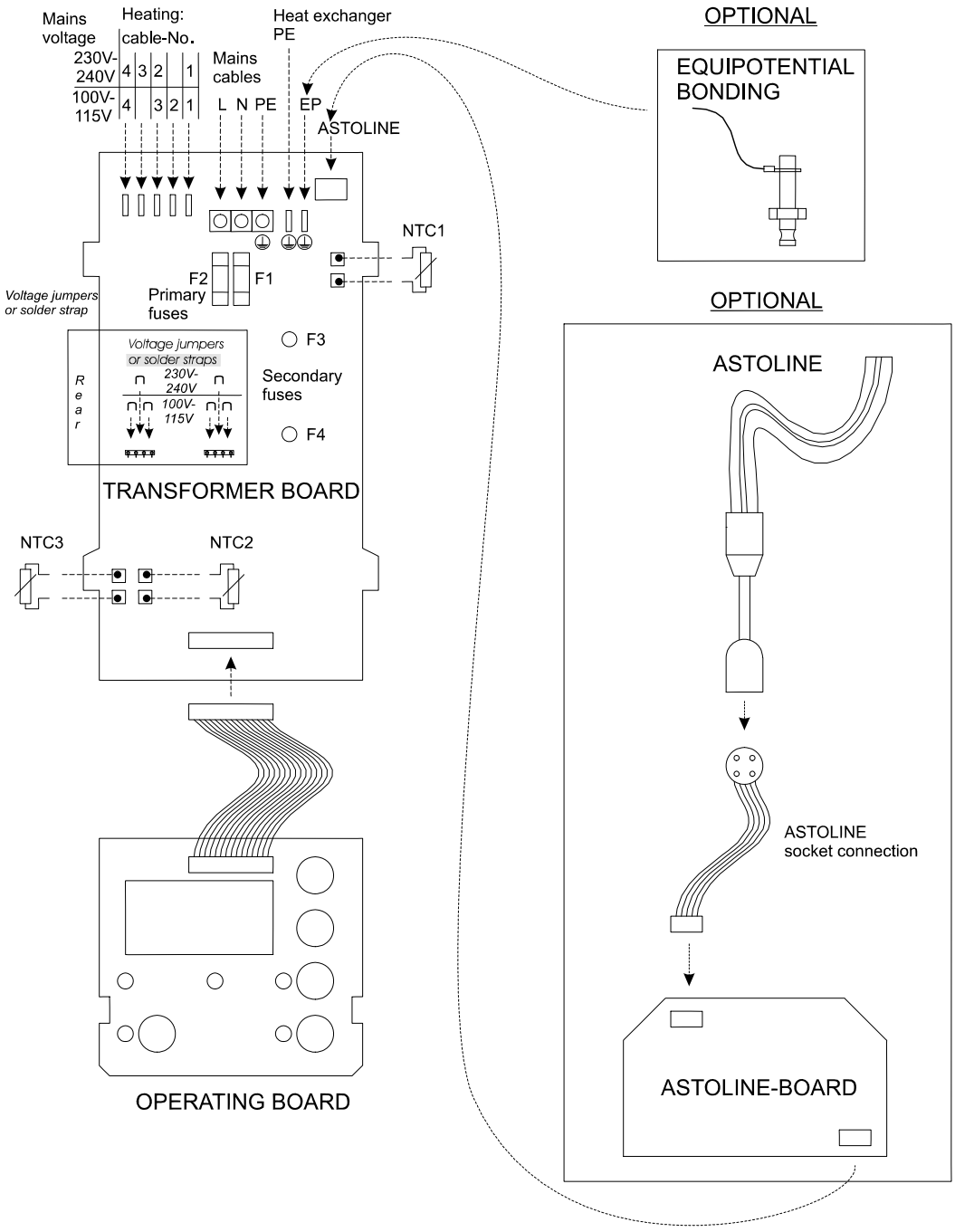


Fig. 2 Connections between electronic components

1.6 ASTOTHERM PLUS spare parts

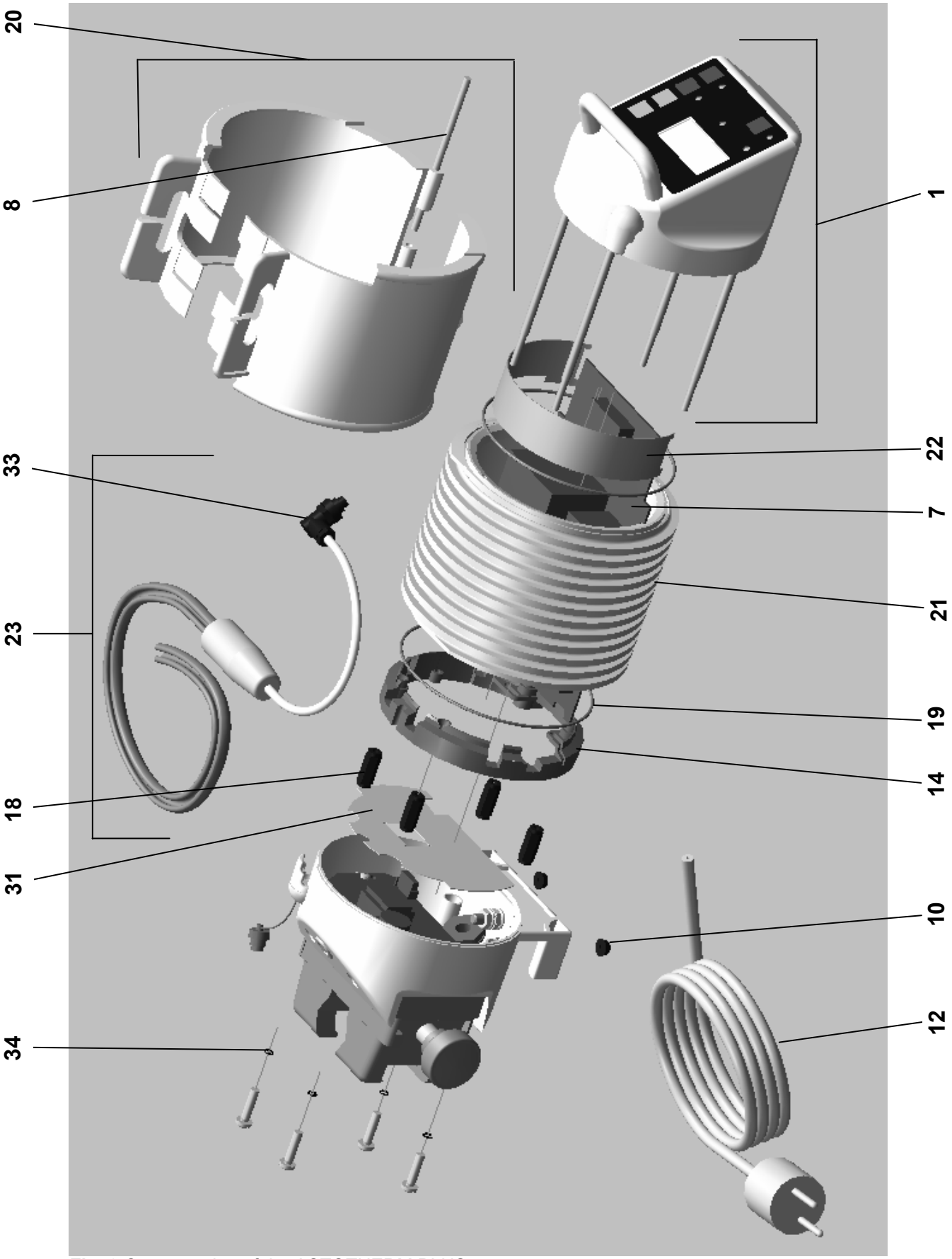


Fig. 3 Cross section of the ASTOTHERM PLUS

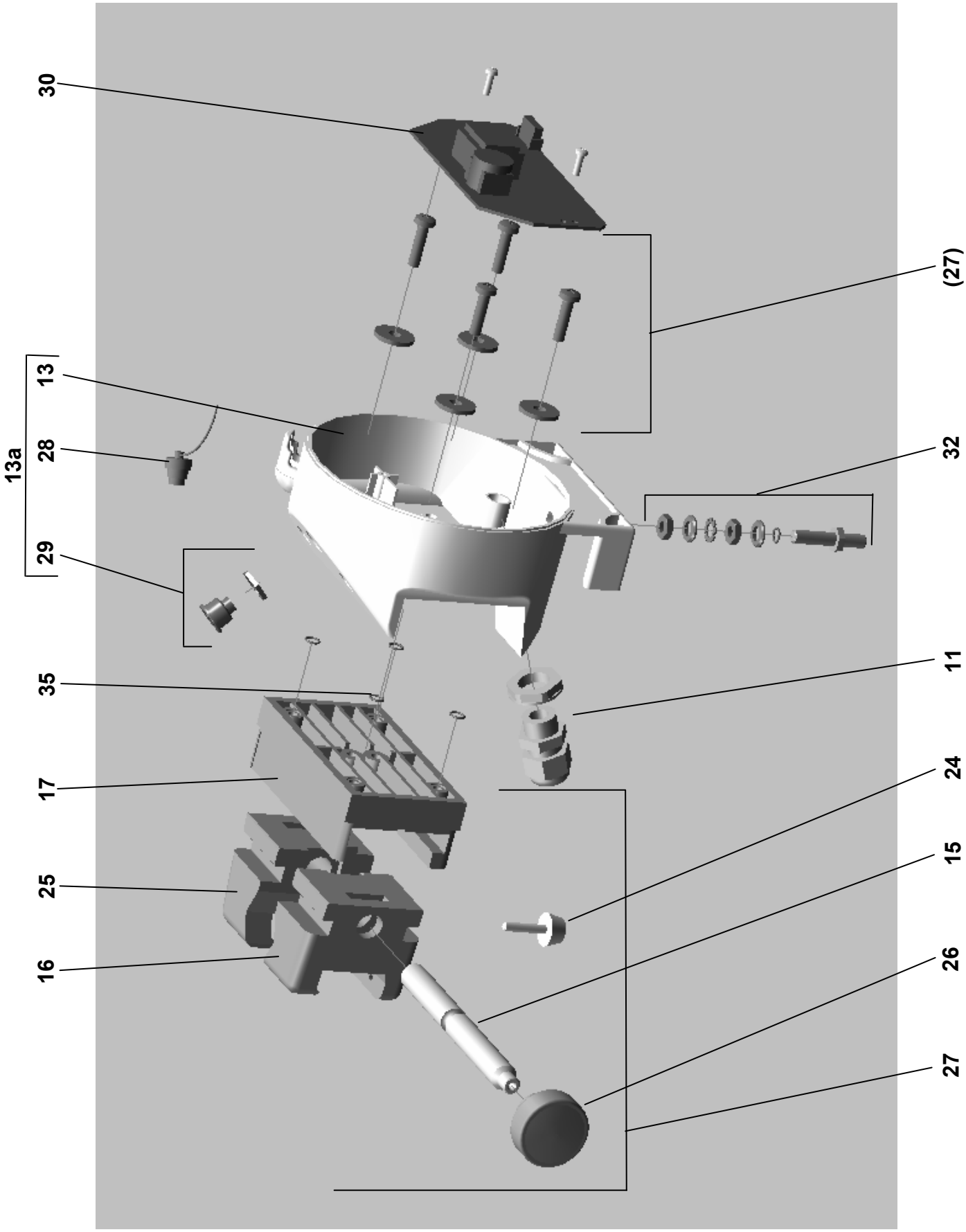


Fig. 4 Cross-section of bottom part assembly with optional components

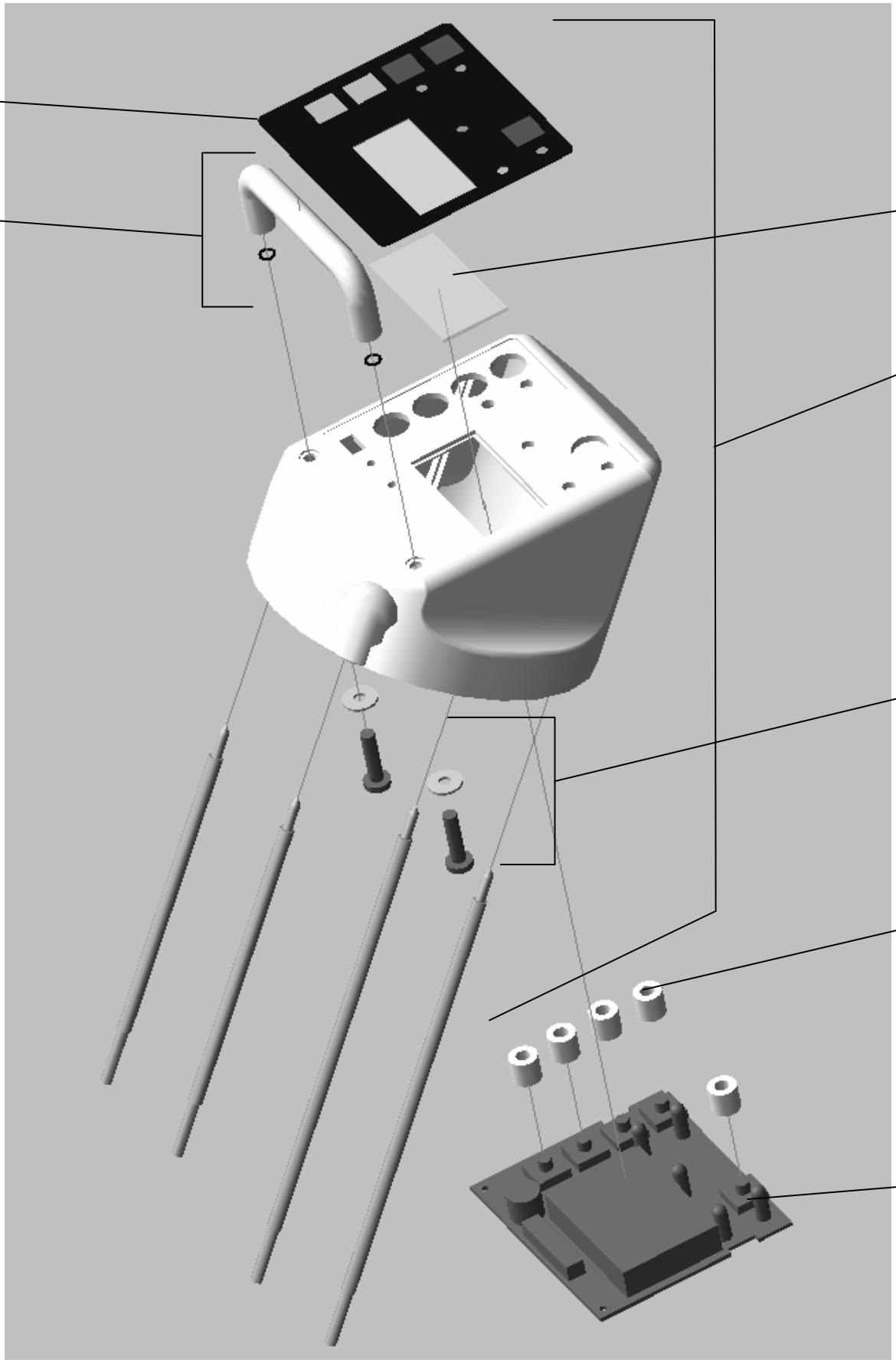


Fig. 5 Cross-section of top part assembly with optional components

ASTOTHERM PLUS spare parts

When ordering please indicate always model number and serial number!			
No.	**Order number**	**Name** consist of	
1	**9751.4205.00**	**TOP PART OF HOUSING AP 200** complete with handle, bolts and front panel	
	9750.4205.00	**TOP PART OF HOUSING AP 220/260** complete with handle, bolts and front panel	
	9751.4202.00	**TOP PART OF HOUSING AP 200S** complete with handle, bolts and front panel	
	9750.4202.00	**TOP PART OF HOUSING AP 220S** complete with handle, bolts and front panel	
	9770.4202.00	**TOP PART OF HOUSING AP 260S** complete with handle, bolts and front panel	
n.g.	**9750.8240.00**	**AL-Holder 4 mm** with fastening material	only from SN: BSEU1017, BSUK1021, BSCH1012, BSNA1001, DSEU1323, DSUK1043, DSCH1012, DSNA1054
n.g.	**9750.8241.00**	**AL-Holder 6,8 mm** with fastening material	only from SN: HSEU1015, HSUK1018, HSCH1001, HSNA1015
2	**9750.4202.14**	**HANDLE** with fastening material	
3	**9750.4200.13**	**DISPLAY COVER**	
4	**9751.4200.05**	**FRONT PANEL AP 200**	
	9751.4200.02	**FRONT PANEL AP 200S**	
	9750.4200.05	**FRONT PANEL AP 220/260**	
	9750.4200.02	**FRONT PANEL AP 220S/260S**	
5	**9750.2201.01-M841**	**OPERATING BOARD for M841 NTCs** 1) 2) 3) (**red** or **black** NTC wire insulation) tested and adjusted for Type	
	9750.2201.01-Glas	**OPERATING BOARD for glass NTCs** 1) 2) 3) (**white** NTC wire insulation) tested and adjusted for Type	
6	**9750.2200.14**	**KEY EXTENSION** (1 Piece)	
7	**9750.2101.01-M841**	**TRANSFORMER BOARD for M841 NTCs (41°C)** 1) 4) 5) (**red** or **black** NTC wire insulation) tested	
	9750.2101.01-Glas	**TRANSFORMER BOARD for glass NTCs (41°C)** 1) 4) 5) (**white** NTC wire insulation) tested	
	0450.2101.43	**TRANSFORMER BOARD (43°C)** 1) 4) 5) (**white** NTC wire insulation) tested	
8	**9750.8100.02**	**AXLE HEAT PROTECTION SLEEVE**	
10	**8510.0305.01**	**BUFFER** (2 Pieces)	
11	**9750.4100.09**	**CABLE GLAND PG9** 1Cable gland 1Counter nut	

When ordering please indicate always model number and serial number!		
12	**9750.4100.10**	**POWER SUPPLY CORD SCHUKO** 1Power supply cord SCHUKO 1Cable tie 90mm
	9750.4100.12	**POWER SUPPLY CORD GREAT BRITAIN** 1Power supply cord GREAT BRITAIN 1Cable tie 90mm
	9750.4100.16	**POWER SUPPLY CORD SWITZERLAND** 1Power supply cord SWITZERLAND 1Cable tie 90mm
	9750.4100.17	**POWER SUPPLY CORD USA** 1Power supply cord USA 1Sticker GROUNDING 1Cable tie 90mm
13	**9750.4100.00**	**BOTTOM PART OF HOUSING AP 200/220/260** 1Bottom part 1Sticker ASTO 2Buffer 2Cable tie 90mm
	9750.4101.00	**BOTTOM PART OF HOUSING AP 200/220/260 - PA** 1Bottom part with drill-hole for equipotential bonding 1Sticker ASTO 2Buffer 2Cable tie 90mm
13a	**9750.4102.10**	**BOTTOM PART OF HOUSING AP 200S/220S/260S WITH ASTOLINE DEVICE SOCKET** 1Bottom part with drill-hole for ASTOLINE socket connector 1AL-Device Socket 1AL arrow sticker 1Sticker ASTO 2Buffer 2Cable tie 90mm 1Protective cap 1Crimp connector
	9750.4103.10	**BOTTOM PART OF HOUSING AP 200S/220S/260S - PA WITH ASTOLINE DEVICE SOCKET** 1Bottom part with drill-hole for ASTOLINE socket connector and equipotential bonding 1AL-Device Socket 1AL arrow sticker 1Sticker ASTO 2Buffer 2Cable tie 90mm 1Protective cap 1Crimp connection
14	**9750.4300.01**	**INTERMEDIATE RING**
15	**9750.5100.04**	**THREADED SHAFT**
16	**9750.5102.00**	**CLAMP RIGHT** 1Clamp right 1Rectangular nut right 1Pad
17	**9750.5100.01**	**BASEPLATE** 1Base plate 1Identification label
18	**9750.4300.02**	**SPACING BOLT** (1 Piece)
19	**9720.3725.02**	**O-RING 114.02 x 1,78** (2 Pieces)
20	**9750.8100.00**	**HEAT PROTECTION SLEEVE AP** 2Half part Heat protection sleeve 1Axle 2Sticker ASTOTHERM PLUS 1Fixing cord

When ordering please indicate always model number and serial number!		
21	**9750.3132.00-41**	**HEAT EXCHANGER COMPLETE** **GROOVE 4 MM (AP200, 220) 40/41°C** 1) 6) 7) 1Earth conductor 200mm mounted 4Insulating cover 1Ferrit-Ring 2Cable tie 90mm
	9750.3132.00-43	**HEAT EXCHANGER COMPLETE** **GROOVE 4 MM (AP220) 43°C** 1) 6) 7) 1Earth conductor 200mm mounted 4Insulating cover 1Ferrit-Ring 2Cable tie 90mm
	9770.3132.00-41	**HEAT EXCHANGER COMPLETE** **GROOVE 6.7 MM (AP260) 41°C** 1) 6) 7) 1Earth conductor 200mm mounted 4Insulating cover 1Ferrit-Ring 2Cable tie 90mm
	9770.3132.00-43	**HEAT EXCHANGER COMPLETE** **GROOVE 6.7 MM (AP260) 43°C** 1) 6) 7) 1Earth conductor 200mm mounted 4Insulating cover 1Ferrit-Ring 2Cable tie 90mm
n.g.	**9750.8110.01**	**FIXING CORD HEAT PROTECTION SLEEVE**
n.g.	**9524.2620**	**FERRIT-RING**
22	**9950.2100.20**	**FIXING STRIP**
23	**9750.8230.00**	**ASTOLINE ACTIVE INSULATION 4 MM**
	9750.8231.00	**ASTOLINE ACTIVE INSULATION 6.8 MM**
24	**9850.5100.10**	**KNURLED SCREW**
25	**9750.5103.00**	**CLAMP LEFT** 1Clamp left 1Rectangular nut left 1Pad
26	**9750.5104.00**	**HAND WHEEL** 1Hand wheel with Nut M8 1Grip cover 1Head screw M4x8 1Washer A4,3
27	**9750.5101.00**	**DEVICE FIXING AP COMPLETE**
28	**9750.8230.17**	**PROTECTION CAP for ASTOLINE device socket** 1Protection cap 1Crimp connector
29	**9750.8230.02**	**ASTOLINE DEVICE SOCKET** 1AL device socket 1AL arrow sticker 1Counter nut
30	**9750.8220.03**	**ASTOLINE BOARD** 1AL-Board 2Pan head tapping screw
31	**9750.8240.04**	**AL-INSULATION PLATE**
32	**9750.4184.00**	**EQUIPOTENTIAL RETROFITTING SET** 1Earth conductor 150mm 1Connector dia. 6 mm 2Nut M6 2Washer R6,4 1Serrated lock washer V6,4 1O-ring 5x1 1Assembly plan 1Drilling gauge 1Sticker

When ordering please indicate always model number and serial number!		
33	**9750.8230.20**	**AL-PLUG (for soldering)** 1 AL arrow sticker
34	**9750.4201.14**	**SET O-RINGS 4x1 MM** 4 for housing screws 2 for handle 2Cable tie 90mm
35	**9750.5101.11**	**SET O-RINGS 5x1 MM** 4 for device fixing AP 1 for equipotential bonding plug 2Cable tie
n.g.	**9850.6001.00**	**PACKAGE AP COMPLETE** 1Internal carton 1EPS insert botton 1EPS insert top 1Outer carton 1Sticker package AP blank
n.g.	**9850.6003.01**	**OUTER CARTON SINGLE AP**
n.g.	**9850.6003.02**	**OUTER CARTON DOUBLE AP**
n.g.	**9850.6003.03**	**OUTER CARTON FOURFOLD AP**

TEST-EQUIPMENT		
n.g.	**9950.9000.02**	**POWER RESISTORS SET** 4Pieces 15 Ohm 10 W ±5 % 1Piece 100 Ohm 10 W ±5 %
n.g.	**9950.9000.03**	**CD-ROM AP Calibration Software** 1 Interface (230 VAC) 1 Instructions "AP Calibration Program" 1 Instructions "Eliminating microprocessor faults"
n.g.	**9950.9000.35**	**Test Thermistor tip 3.5 mm** to measure the temperature dependent on the resistance with multimeter and table

Important details

Because of the different variants and changes due to technical improvement it is absolutely necessary to indicate the model number (REF) and the serial number (SN). Only then it is ensured that the desired spare part is delivered in the right configuration.

1) ***An exchange of this part requires an adjusting of temperature and display (see chapter 4 of the Repair Instructions). An exact adjustment can only be made by using the interface and the AP Calibration Software or by the manufacturer.***

2) ***Operating boards (only for Glass-NTCs, from Rev. 3.1) can be used alternatively for 40°C or for 41°C or for 43°C devices by uploading an corresponding data file (to do this the interface and the AP Calibration Software is necessary).***

3) ***Operating boards from Rev. 3.1 can be used alternatively for M841-NTC or Glass-NTC devices by switching a solder jumper.***

4) ***Because of the different characteristics of M841-NTCs and Glass-NTCs, transformer boards cannot be used alternatively. They must be ordered and built in for the specific NTC type.***

5) ***Because of the different excessive temperature cut-offs, transformer boards cannot be used alternatively for 40/41°C or for 43°C devices.***

6) ***Because of the different position of the NTCs, heat exchanger cannot be used alternatively for 40/41°C or for 43°C devices.***

7) ***Heat exchanger with M841-NTCs are no longer available.***

2 General guidelines and principles for the repair of ASTOTHERM PLUS blood and infusion warmers

2.1 Technical Service and Ordering Spare Parts

STIHLER ELECTRONIC GmbH
Julius-Hoelder-Str. 36
70597 Stuttgart
Germany

Tel: +49 (0) 711-720670
Fax: +49 (0) 711-7206757
www.stihlerelectronic.de
E-mail: info@stihlerelectronic.de

When making requests or ordering spare parts, please state the reference and serial number of the device in question. You can find them on the device rating plate:

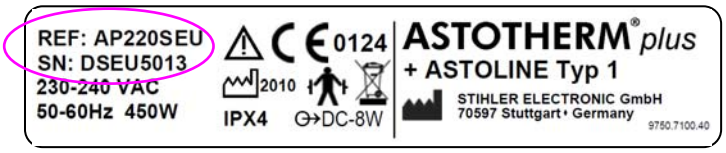


Fig. 6 Information on the rating plate

2.2 Guarantee repairs

A 12-month guarantee is granted. During the guarantee period, the manufacturer will remedy all defects due to material or manufacturing faults free of charge either by repair or replacement. This guarantee does not cover any other damage. Damage due to misuse or improper handling, excessive force or regular wear is not covered by this guarantee. This also applies to interventions by persons other than those authorised by the manufacturer or if the original condition is changed.
If damage occurs during the guarantee period, please clean the device and send it to a sales location near you or directly to STIHLER ELECTRONIC. The costs of transport and packaging are for the sender's account.

2.3 Liability

The manufacturer shall only be liable for the safety, reliability and performance of the device if all operating, maintenance and testing procedures comply with the procedures communicated by the manufacturer and are carried out by properly trained and qualified personnel; if -when necessary- only original spare parts are used to replace components; if assembly and repairs are only carried out by authorised personnel or an authorised service centre; if the electrical systems comply with the locally applicable instructions and regulations and the IEC requirements and if the device is used in keeping with the instructions of use for the intended purpose and at a suitable location.

CAUTION

The fact that technical documents or spare parts are made available does not imply any authorisation on the part of the manufacturer to open or repair the device.

2.4 Important instructions

- All tests must be carried out by properly qualified staff, i.e. staff who have the relevant expert professional training, knowledge and experience and are familiar with the relevant technologies, standards and local rules and regulations. Personnel who have to assess safety must be able to recognise any consequences and dangers caused by devices which do not comply with the requirements.
- The measuring equipment must comply with the relevant standards.
- All repair activities, all tests carried out and their results must be recorded.
- The pattern approval is invalidated if the device is no longer in its original state. You must therefore use only original spare parts.
- Due to the safety risks, electronic PWBs must only be repaired by the manufacturer. If they are faulty they must always be replaced in their entirety.
- Any heat exchanger cylinder is an individual item from a heat engineering point of view, due to its complex production and the large number of influencing variables (production tolerances in the manufacture of the heating system, NTCs etc.). For this reason, every electronic temperature control needs to be specifically matched to “its” heat exchanger cylinder in order to achieve sufficiently small control fluctuation later on.
- The NTCs form the core of the blood warmer. Their sensitivity means that it is **prohibited** to change their position or replace them. When dismantling or assembling the device, ensure that the NTCs/their connecting wires are not damaged.
  Defective NTCs may be replaced only by the manufacturer. The complete heat exchanger cylinder/transformer board/operating board unit needs to be returned for this purpose.
- For all thermal test work pay attention to room temperature and ambient effects!
  As the control temperature is set accurate to a few tenths of a °C, note the following points:
  - avoid external effects on the heat exchanger unit /electronics to be measured
  - no draughts
  - constant room temperature (20 to 26 °C)
  - keep out of direct sunlight
  - keep away from strong light sources

CAUTION

A functional check (see Section 4) and a continuous duty test (see Section 9) must be performed after any repair to the device.

2.5 Procedure for ASTOTHERM PLUS repairs

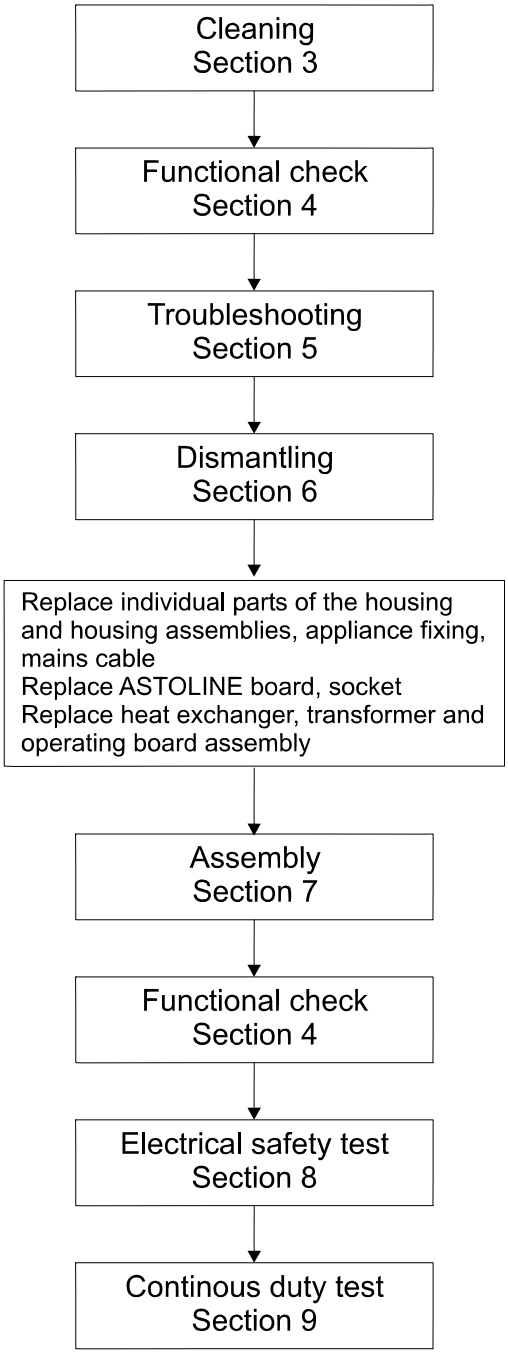


Fig. 7 Flow chart for repairs

3 Cleaning and disinfecting

CAUTION

Always disconnect from the mains before cleaning and disinfecting.

- **Cleaning**

To remove splashes of physiological saline or blood from the surface of the housing, use a soft cloth with a mild soap solution or a special plastic cleaner. Commercially-available cotton buds are suitable for cleaning the circumferential heat exchanger groove.
Never immerse device completely in fluid or bring into contact with steam!

- **Disinfecting**

For disinfecting, use ¼% sodium hypochlorite solution or alcohol-based disinfectants of the “ready-to-use spray disinfectant” type containing low quantities (< 0,2 %) of aldehydes. For disinfecting the ASTOTHERM PLUS and the ASTOLINE, we recommend **Bacillol plus** from Bode Chemie in Hamburg, **Meliseptol** from B. Braun in Melsungen and **Mikrozid Liquid** or **Mikrozid Pumpspray** from Schülke & Mayr in Hamburg.
The operator should not use any cleaning or decontamination methods other than those recommended. If using other methods, check with the manufacturer that these will not damage the device.

CAUTION

Under no circumstances sterilise with steam, hot air or thermo-chemically!

On the dismantled device, ensure that the NTCs/their connecting wires are not damaged or brought into contact with fluid.
If metal parts (connecting wires, printed circuits) of electronic components on the boards are contaminated or corroded, then replace the electronics for safety reasons.
Corroded metal parts inside the device suggest the use of non-approved cleaning agents and disinfectants and the destruction of seals.

4 Functional check

The functional check must be performed with the device assembled. Note the following ambient conditions:

- avoid external effects on the device
- no draughts
- constant room temperature (20 to 26 °C)
- keep out of direct sunlight
- keep away from strong light sources

CAUTION

All Tests must be passed. If any errors are found, the warmer must be repaired before using it on patients.

The results of the functional check can be entered in the repair report (template in appendix).

4.1 Check display devices (LCD and LED):

Connect the device to the mains at room temperature.

All the display devices should come on for a brief period (cf. Figs 8 and 9).

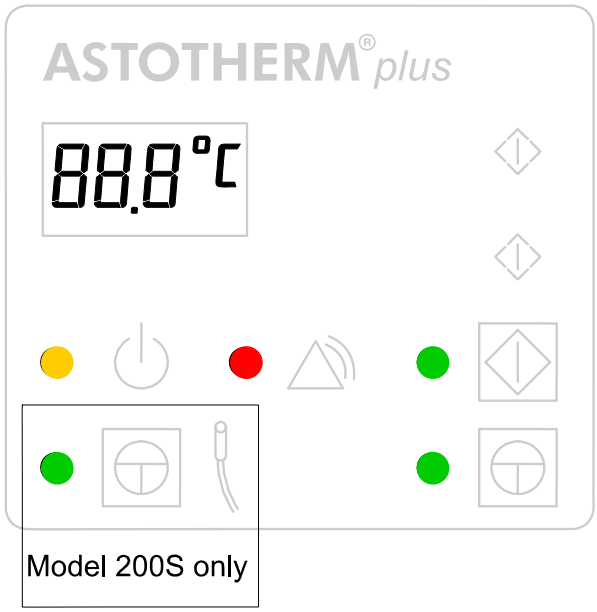


Fig. 8 Display elements of model 200(S)

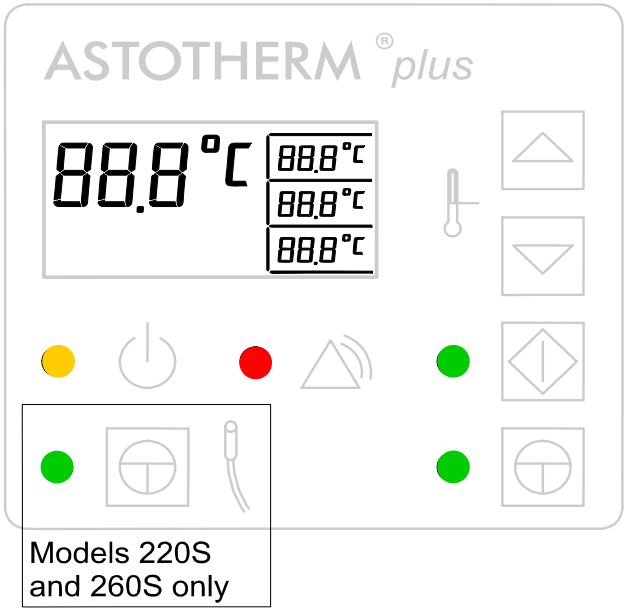


Fig. 9 Display elements of models 220(S) and 260(S)

4.2 Check heating-up time

Switch on the device and start the warmer (cf. operating instructions, Section “COMMISSIONING”) without selecting a temperature. Watch the temperature display during heating up. Temperature increases rapidly at first, then more slowly.

	AP 200	AP220/260
Heating-up time 20°C to 35°C	**max. 1.5 minutes**	**max. 1 minute**

4.3 Check display temperature fluctuation

(better with heat protection sleeve)

After a few minutes the displayed temperature is reaching the set temperature and is then deviating only marginally.

Fluctuation of the display temperature due to control may not exceed ± 0.2 °C in load-free mode.

4.4 Check temperature in control state

(better with heat protection sleeve)

The test thermistor (order-No. 9950.9000.35), a calibrated ohmmeter and the table of resistance/temperature in the appendix of these repair instructions are required for this purpose.
Insert the test thermistor into the rear measuring bore on the side of the heat exchanger (see Fig. 10) and connect it with the ohmmeter.
Wait until the indicated value is stable. Then read the indicated value and take the corresponding temperature out of the table.

Deviation of the control temperature measured with the test thermistor from the set control temperature may not exceed ± 0.4 °C. The displayed temperature of the warmer may not exceed more than 0.4°C from the selected and the measured temperature.

Example:

Set temperature	**41°C**	**41°C**	**41°C**
measured temperature	40.8°C **ok**	41.2°C **ok**	40.5°C **not ok**
displayed temperature of the warmer	40.6 – 41.2°C **ok**	40.7°C **not ok**	40.8°C **ok**

4.5 Test temperature overshoot on heating

(without heat protection sleeve)

The test thermistor (order-No. 9950.9000.35), a calibrated ohmmeter and the table of resistance/temperature in the appendix of these repair instructions are required for this purpose. Operate warmer with the highest set temperature (T_{Set}) and then switch off the device. Insert the test thermistor into the rear measuring bore on the side of the heat exchanger (see Fig. 10) and connect it with the ohmmeter. Allow heat exchanger cylinder to cool down by 1 °C ± 0.2 K. (If the device is switched back on, the temperature of the heat exchanger can be read off on the display. The alarm should sound continuously.)

Fig. 10 Measuring control temperature and temperature overshoot

Start the warmer when the T_{Set} -1°C cooling limit is reached. Look at the display of the ohmmeter and jot down the lowest measured resistance. Take the corresponding temperature out of the table and compare it with the following values:

max. set temperature	**AP200** **40°C**	**AP220/260** **41°C**	**AP220/260** **43°C**
Start at circa T_{Set} – 1 °C =	**38.8 – 39.2°C**	**39.8 – 40.2°C**	**41.8 – 42.2°C**
max. allowed temperature overshoot	**40.7 °C**	**42.2°C**	**43.5 °C**

4.6 Alarm test functions

The ASTOTHERM PLUS is fitted with alarm test functions. These simulate the failure of temperature sensors and thus lead to activation of alarm cut-offs. The description which follows relates to ASTOTHERM PLUS 220(S) and 260(S) models with adjustable selected temperature. For the ASTOTHERM PLUS 200(S) models, there are no keys for changing temperature. In this case, the key names in brackets apply (cf. Figs 8 and 9 and operating instructions, Section “CONTROL PANEL”).

Checking excessive temperature alarms:
Test 1: Start device at middle selected temperature. Keep "Start" key depressed for three seconds to start the internal test cycle.

LCD display alternately displays "t1" and actual temperature. After a brief time, the device should react with the excessive temperature alarm.

Re-start the device by pressing the "Start" key.

Test 2: Start device at upper selected temperature. Keep "Increase" key (top "Test function" key) depressed for three seconds to start the internal test cycle.

LCD display alternately displays "t2" and actual temperature. After a brief time, the device should react with the excessive temperature alarm.

Re-start the device by pressing the "Start" key.

Checking low temperature alarm:
Test 3: Start device at bottom selected temperature. Remove heat protection sleeve. Keep "Decrease" key (bottom "Test function" key) depressed for three seconds to start the internal test cycle.

LCD display alternately displays "t3" and actual temperature. Once the device has cooled down about approximately 4°C (AP220/260) respective to 32 °C (AP200) , the device should react with the low temperature alarm.

Switch off the device using the "Device On/Off" key. After this test, the device cannot be restarted by pressing the "Start" key.

4.7 Checking safety cut-offs

Note: the temperature display reflects the mean value of the temperature of the heat exchanger (between front and rear side).
By testing the safety cut-off of warmer rear side or warmer front side the heat exchanger is only heated up only at a small area. In this condition the display shows not the real temperature of the small heated area (it shows the mean value of the heated and unheated area). The formula below shows the background.

$$T_{Display} = (T_{inlet} + T_{Outlet}) / 2 \quad \text{or} \quad T_{Cut\text{-}off} = (T_{Display} \times 2) - T_{Set}$$

$T_{Display}$ actual temperature which is indicated on the display
T_{Inlet} actual temperature inside the heat exchanger in the area of the rear measuring bore
T_{Outlet} actual temperature inside the heat exchanger in the area of the front measuring bore
$T_{Cut\text{-}off}$ real temperature in the moment of switching off
T_{Set} selected temperature on the side which will not be warmed up from external

CAUTION

Please observe the following instructions:

1. **Warmer has to be calibrated and if necessary to be adjusted**
2. **Warmer needs to work in the control state for a few minutes to ensure that the heat exchanger is heated through evenly.**
3. **Immediately before testing the display of the warmer should indicate 40°C ± 0.1°C (AP200), 41°C or 43°C ± 0.1°C respectively (AP220/260).**
4. **Between the tests of "safety cut-off warmer inlet" (backside) and "safety cut-off warmer outlet" (frontside) you have wait until the temperature has dropped to the set temperature (see 3.).**

Safety cut-off at the warmer inlet

Using a hot-air blower or hairdryer on the lowest temperature setting, heat up the heat exchanger in the area below of the **rear** temperature measuring bore (bottom right on bottom part of housing, see mark in Fig. 11) until the device activates the alarm. Allow the device to cool down and keep pressing the Start key until it can be re-started. In the moment when the warmer can be re-started the temperature display should be within the range of values given in the table.

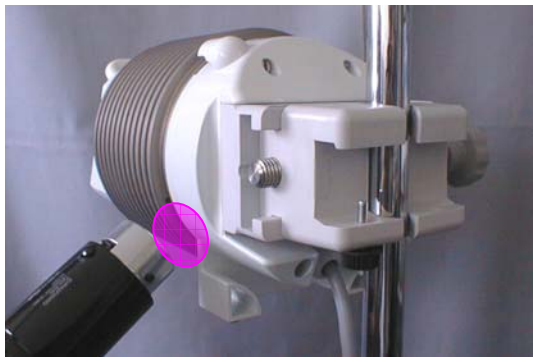


Fig. 11 Testing safety cut-off at warmer inlet

Safety cut-off temperature at warmer inlet (backside)	AP 200 (S) T_{Set} = 40°C	AP 220/260 (S) T_{Set} = 41°C	AP 220/260 (S) T_{Set} = 43°C
Nominal value warmer display $T_{Display}$	41.5 to 42.0°C	42.0 to 42.5°C	43.8 to 44.7°C
real value $T_{Cut-off}$	43.1 to 43.9°C	43.1 to 43.9°C	44.6 to 46.4°C

Safety cut-off at the warmer outlet

Allow the device to cool down to the set temperature and repeat the measurement as carried out above below the front temperature measuring bore (bottom left on top part of housing, see mark in Fig. 12).
The temperature in the moment when the warmer can be re-started should be within the range of values given in the table when the alarm occurs.

Fig. 12 Testing safety cut-off at warmer outlet

Safety cut-off temperature at warmer outlet (frontside)	AP 200 (S) T_{Set} = 40°C	AP 220/260 (S) T_{Set} = 41°C	AP 220/260 (S) T_{Set} = 43°C
Nominal value warmer display $T_{Display}$	41.0 to 41.7°C	41.5 to 42.2°C	44.0 to 45.0°C
real value $T_{Cut-off}$	42.1 to 42.9°C	42.1 to 42.9°C	45.1 to 46.9°C

Functional check of devices with ASTOLINE active insulation
(Models 200S, 220S, 260S only)

4.8 Measuring resistance of ASTOLINE active insulation

Using a resistance measuring device, measure the electrical resistance between Pin 1 and Pin 3 on the plug of the flexible silicone groove (see Fig. 13)
In cold condition ASTOLINE temperature = ambient temperature.

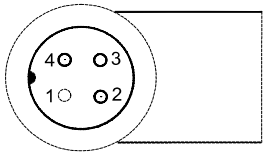


Fig. 13 Pin assignment on the ASTOLINE plug

The cold resistance of the ASTOLINE active insulation must be 54 ± 3.5 ohms at an ambient temperature of 20 °C*.

* add +0,26 ohms /1K higher ambient temperature

4.9 Testing ASTOLINE connection

For the test a set of power resistors is required (order no. 9950.9000.02).
The power resistors should have the following values:
- 4 pieces with 15 Ohm 10W ± 5%
- 1 piece with 100 Ohm 10W ± 5%

They should be connected to the circuit according to the table below (and Fig. 14), triggering the appropriate reaction on the device.

Resistance R_X [Ω]	Reaction required
30	Alarm
45	no Alarm
60	Measurement of voltage U = 20.8 – 21.4 VDC
100	no Alarm
∞	Alarm

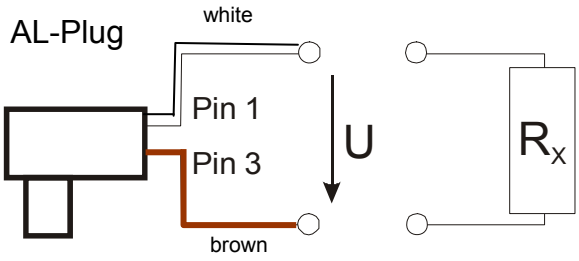


Fig. 14 Test circuit for devices with an ASTOLINE

After an alarm reaction, the device must be restarted before further tests can be performed.

5 Troubleshooting

If one or more items of the functional check are failed, then troubleshooting will be required.
Compare the activities of the display devices with the operating and alarm states also described in the operating instructions (Section “CONTROL PANEL”).

The table below is intended to assist in troubleshooting and help eliminate faults.
Renewal of individual components of the heat exchanger cylinder unit including transformer board and operating board requires calibration and if necessary adjusting of the calibration values with the interface. An exact adjustment can only carried out with the interface and the accompanying software or by the manufacturer!

A modified device may not be commissioned without calibration and testing. If a fault has been found on a component and there is no interface available, the complete device should be returned to the manufacturer with a brief description of the fault.

Fault	Possible causes	Remedy
Display devices (LED, LCD) do not light up after plugging in - device cannot be started	Lack of/incorrect power supply	⇒ Check socket/fuse, compare mains voltage with details on rating plate.
	Mains connection cable or mains plug defective	⇒ Change mains connection cable.
	Primary fuse defective (impact, short-circuit in heating system, in mains transformer or on board)	Measure resistance of heating system (see Section 6.4) If heating system OK: ⇒ change primary fuse; if device still not OK ⇒ transformer board; return complete electronics system with heat exchanger. If heating system not OK: ⇒ return complete electronics system with heat exchanger.
Device switched on - device cannot be started	Secondary fuses defective	⇒ Change secondary fuses on transformer board.
	Operating board defective	⇒ Change operating board and calibrate and adjust it if necessary.
	Transformer board defective	⇒ Change transformer board and calibrate the unit. Adjust it if necessary
	NTC 1, 2 or 3 defective	⇒ Change heat exchanger and calibrate the unit. Adjust it if necessary
	On models with ASTOLINE	Switch off ASTOLINE; if warmer can be started, check the following
	"ASTOLINE On/Off" key pressed but ASTOLINE not connected	⇒ Connect ASTOLINE
	ASTOLINE device socket defective	Check resistance. ⇒ Replace device socket.
	ASTOLINE board defective	⇒ Replace ASTOLINE board.
	ASTOLINE defective	Check resistance. ⇒ Replace ASTOLINE if necessary.
Device switched on - device cannot be started, bars only on temperature display	Control-NTC (NTC1) or Display-NTC (NTC2) defect.	⇒ Change heat exchanger and calibrate the unit. Adjust it if necessary
	Device is colder than 0°C	⇒place device in a warmer location.

Fault	Possible causes	Remedy
Device can be started, but heat exchanger cylinder does not get hot	Heating system defective	Measure resistance of heating system. In event of deviation from specified value (see Section 6.4): ⇒ Change heat exchanger and calibrate the unit. Adjust it if necessary
	Operating board defective	⇒ Change operating board and calibrate and adjust it if necessary.
	Defect on transformer board (relay, optocoupler, triac, control LED)	⇒ Change transformer board and calibrate the unit. Adjust it if necessary
Device activates alarm during heating up	Electronics defective (after fall, water damage or use of non-permitted disinfectants)	⇒ Change operating or transformer board and calibrate the unit. Adjust it if necessary
	NTC defect (NTC1, NTC2, NTC3)	⇒ Change heat exchanger and calibrate the unit. Adjust it if necessary
	External effect (sunlight, heating, air-conditioning, too hot a medical solution used)	⇒ Select a different location. ⇒ Do not use overheated medical solutions.
	Bimetal-thermal cut-off defective	⇒ Change heat exchanger and calibrate the unit. Adjust it if necessary
Device in alarm state, device cannot be started until display temperatures are below 30 °C	Bimetall-thermal cut-off has switched off	Check whether device got too hot (approx. 65 °C): - if due to external thermal effects: ⇒ thermal cut-off OK. - if not due to external effects, thermal cut-off defective: ⇒ Change heat exchanger and calibrate the unit. Adjust it if necessary
Display temperature above the tolerance of the control temperature set in the control state	External effect (sunlight, heating, air-conditioning, too hot a medical solution used)	⇒ Select a different location. ⇒ Do not use overheated medical solutions.
	Control NTC (NTC1) is	Check whether actual temperature of heat exchanger corresponds with display. If so, ⇒ Adjust control temperature (NTC1)
	incorrectly adjusted or defective	⇒ Change heat exchanger and calibrate the unit. Adjust it if necessary
		If not, see next line
	Display NTC (NTC2) is incorrectly adjusted or defective	⇒Adjust temperature display (NTC2) ⇒ Change heat exchanger and calibrate the unit. Adjust it if necessary
Display temperature above the tolerance of the control temperature set in the control state	Models with ASTOLINE: internal heating up due to heat from transformer with ASTOLINE switched on and not enough heat being taken away at the heat exchanger	⇒ Take off heat protection sleeve. ⇒ Switch off ASTOLINE (unless in sole use).
Software alarm (after connecting to the mains) alarm LED and alarm sound only	Program fault (microprocessor)	⇒ Unplug device, restart after approx. 1 minute. ⇒ Reset device: keep "Decrease" and "Increase" keys/ both test keys depressed for approx. 5 seconds. then disconnect from and connect to the mains ⇒ Transfer the original-data file* ⇒ Change operating board and calibrate the unit. Adjust it if necessary.

*available at manufacturer

6 Dismantling

Generally-applicable safety conditions and precautions apply to dismantling the ASTOTHERM PLUS. All electrical installations must comply with the applicable national standards and regulations in each case.

During dismantling, ensure that the device is reliably disconnected from the mains. Electronic components can contain a residual current even after the device is switched off. If a mains connection is required with the device dismantled (e.g. for test purposes), ensure that no conducting parts can be touched.

Procedure for dismantling:
The description follows the assembly structure of the device. Once the cause of the fault has been localised, the relevant assembly can be dismantled into smaller units. The section heading indicates the assembly in question. If potential dismantling is not described, then this is either because there is no point or because the unit should not be dismantled any further.

Once the device is dismantled, ensure that the electronics and the NTCs/their connecting wires are not damaged or brought into contact with fluid.
If metal parts (connecting wires, printed circuits) of the boards and the electronic components are contaminated or corroded, then the electronics should be replaced for safety reasons. Corroded metal parts inside the device suggest the use of non-approved cleaning agents and disinfectants or defective seals.

6.1 Dismantling for troubleshooting in assemblies

Disconnect device from the mains! Unplug the ASTOLINE active insulation!
Place the device on the front top and handle.

a) Undo the cable gland with a suitable tool until the mains cable can be moved.

b) Undo the four housing screws with a screwdriver and remove these and the O-rings.

c) Remove the lower part in an upward direction, pushing the mains cable after it.
Caution: the housing has a plastic pin to prevent twisting which reaches into the heat exchanger cylinder. Therefore never twist the bottom part against the heat exchanger.

d) *Models with ASTOLINE only:* remove insulating plate.

e) Undo mains cable connections on the transformer board and remove cable tie.
Models with equipotential bonding plug only: pull plug of earth wire cable off the transformer board and take out through the bore of the board.


c)

f) Unscrew the four spacing bolts of the bolts, undo the cable tie of the heating cable and take off the intermediate ring.

g) Take the heat exchanger cylinder off the top part.
Caution: the housing has a plastic pin to prevent twisting which rises up into the heat exchanger. Therefore take the top part in both hands and using your thumbs, push the heat exchanger cylinder upwards against the outlet side and remove. Never twist the top part and the heat exchanger.

h) Push the parts only far enough apart to allow the electrical connection between the transformer board and the operating board to be disconnected. Disconnect the connection between the transformer board and the operating board. Do **not** remove the fixing strip which retains the transformer board in the heat exchanger.

i) Prevent the heat exchanger/transformer board assembly from rolling away.

The device is now dismantled into individual groups.

Fig. 15 ASTOTHERM PLUS and ASTOLINE dismantled into assemblies

6.2 Dismantling bottom part assembly

- **Mains cable and screw connection:**

a) Undo the union nut of the cable gland until the mains cable can be pulled out. Place the bottom part on the fixing unit.

b) Should the cable gland have to be completely dismantled, the nut on the inside needs to be undone using a double cranked hex ring spanner (WAF 22).
(If an equipotential bonding plug is attached to the device, this must be removed beforehand).

- **ASTOLINE electronics:**

c) Undo the screws on the left and right of the ASTOLINE board. Take out the board far enough for the connection to the device socket to be accessible.

d) Disconnect the connecting cable of the device socket to the ASTOLINE board.

- **ASTOLINE active insulation:**

e) Note: only the plug can be dismantled. The described test (according chapter 4.8) should be performed before dismantling.

To dismantle the plug using an open-ended spanner (WAF 10), open the cable clamp completely. Using an open-ended spanner (WAF 12), open the hasp of the union nut and take it off. Carefully push the cable into the plug housing and evenly pull out the plug insert at the same time. Check the solder points for break.

- **Attaching device:**

f) Using a suitable cross-head screwdriver, undo the four screws of the device fixing and remove the washers. Lift off the bottom part and remove the O-rings. Replace the sealing rings before reassembling. Further procedure for dismantling is described in Section 6.5.
Caution: the two bolts are not secured and may easily fall out.

6.3 Dismantling the top part assembly

CAUTION

When handling the top part, ensure that the bolts are not put under lateral strain - this can lead to fracture of the bolts or of the housing domes.

- **Operating board:**

a) Place the top part on its front. Using a suitable cross-head screwdriver, remove the two top screws on the operating board. Slightly lift the operating board by the connecting cable until it slides out of the bottom screw retainer. Take the board out upwards without tilting. If necessary, loosen the two bottom mounting screws.
Defective operating boards can only be repaired by the manufacturer.

- **Handle:**

b) Using a suitable cross-head screwdriver, unscrew the screws of the handle and remove the washers. Remove the handle and the O-rings on the outside.

- **Front panel:**

c) Loosen the front panel with a knife or a needle and remove the display cover.

6.4 Dismantling the heat exchanger cylinder assembly

When handling this assembly ensure that:

- it is reliably disconnected from the mains,

- the fitted transformer board is prevented from moving by the fixing strip,

- the heat exchanger is prevented from rolling away.

a) Disconnect the electrical plug connections between the heat exchanger and the transformer board (heating and earth wire cable).

Measure heating system resistance between the numbered heating cables.

Specified values:	**1 - 2 → 125 to 145 ohm;**	**1 - 3 → 62.5 to 72.5 ohm;**
	1 - 4 → < 1 ohm;	**2 - 3 → 62.5 to 72.5 ohm.**

b) Turn the heat exchanger cylinder so that the secured transformer board is accessible from underneath.

c) Heat the soldering points of the NTC lines using a soldering iron and pull them out with tweezers. (One NTC is attached at the inlet side of the heat exchanger (mains side of the transformer board) and two NTCs at the outlet side (plug connection for the operating board)).

d) Turn the heat exchanger round again, take hold of the top centre of the fixing strip and pull it out.

e) Take hold of the transformer board in the area of the plug connector to the operating board and lift upwards. Push the board through the heat exchanger.

f) If polluted remove the sealing rings in both end faces of the heat exchanger using tweezers or another suitable tool and clean the groove.

6.5 Dismantling the device fixing assembly

- **Dismantling for cleaning purposes:**

a) Push the bolts out of the base plate using a drift.

b) Push the base plate off the clamps.

c) Unscrew the clamp on the right of the threaded shaft. Remove the rectangular nut on the right and unscrew the knurled screw.

Clean the fixing unit as dismantled thus far with the cleaning agents/ disinfectants mentioned in Section 3. To do so, turn the threaded shaft to and from in the clamp up to the ends.

- **Complete dismantling:**

Further assembly may lead to destruction of the grip cover.

d) Lever out the grip cover with a fine screwdriver.

e) Turn the hand wheel so that it is flush with the left-hand clamp. Using a suitable screw-driver, undo the cylinder bolt and unscrew it (it is secured with adhesive). Remove the washer.

f) Hold the threaded shaft with pliers in the cylindrical area and unscrew the hand wheel. Remove the big washer.

g) Unscrew the threaded shaft from the left-hand clamp and take out the rectangular nut on the left.

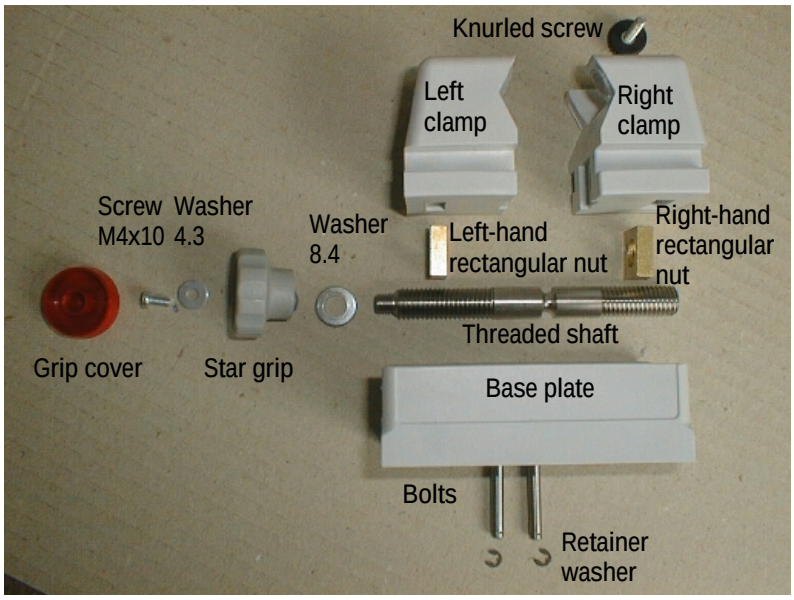


Fig. 16 Device fixing assembly disjointed completely

7 Assembling the device

The safety information in Section 6 applies to assembly of the ASTOTHERM PLUS device!

Procedure for assembly:
assembly steps are described in individual sections by assembly group.

7.1 Assembling the device fixing assembly

a) Prepare all the parts as shown in Fig. 16. Ensure that the base plate with the depression for the rating plate is facing upwards. Arrange the two clamps so that they can be suspended in a medical rail system. The lug needs to be on top of the clamp for this purpose.

b) Insert the left-hand rectangular nut (left-hand thread) into the opening on the underside of the left-hand clamp and the right-hand rectangular nut (right-hand thread) into the right-hand one.

c) Turn the two clamps on the threaded shaft and ensure that the two clamps meet in the centre of the threaded shaft at the same time. The groove of the threaded shaft must be precisely between the two clamps. If necessary, unscrew one clamp and turn the nut through 90 or 180°. Screw on again until the clamps are central in relation to the groove of the shaft.

d) Push the clamps and the shaft into the guide on the base plate.

e) Push the two bolts with the retaining washers into the bores of the base plate from underneath.

f) Screw the hand wheel and the washer very firmly onto the thin end of the thread of the shaft by hand and likewise screw very firmly to the cylindrical bolt and the washer. Secure the bolt with a drop of adhesive.

g) Press the grip cover flush onto the hand wheel.

h) Screw the knurled screw into the thread of the left-hand clamp.

7.2 Assembling the heat exchanger assembly

When handling this assembly ensure that:

- it is reliably disconnected from the mains,

- the fitted transformer board is prevented from moving by the fixing strip,

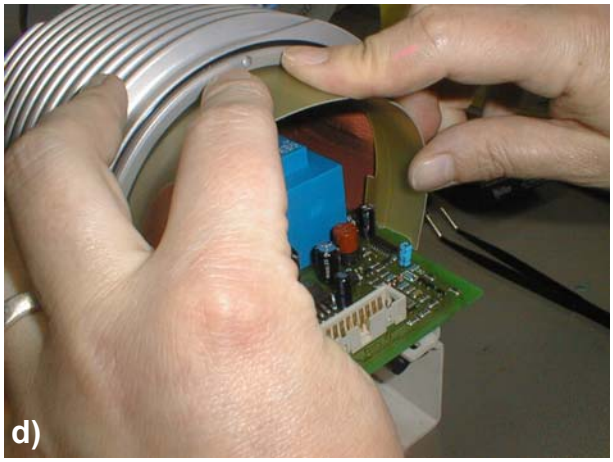
- the heat exchanger is prevented from rolling away,

a) Check whether the jumpers for voltage selection correspond to mains voltage and the details on the rating plate (cf. Fig. 2).

b) Check whether the solder bridges for NTC tolerance class selection (only glass type NTCs) are set correct.

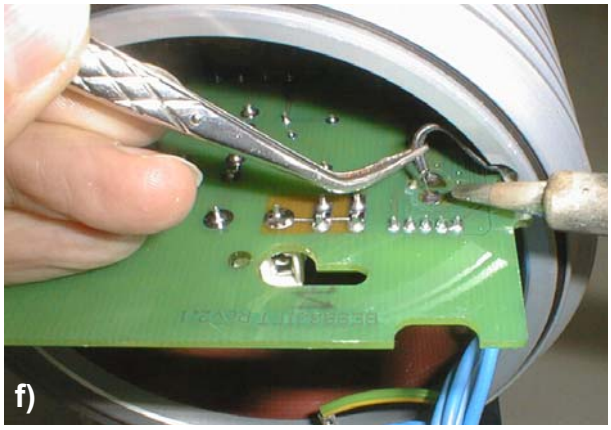
c) Push the heating cables and the NTC wires of the heat exchanger slightly outwards. When fitting the transformer board, ensure that they are not trapped or damaged.
Push the transformer board into the heat exchanger from the back (side with the heating system cables and one NTC) with the front (side with the plug connection to the operating board) tilted slightly upwards. Insert the rectangular flanks of the board into the two grooves of the heat exchanger and drop.

d) Clamp the fixing strip on the correct side on the front between the edge of the heat exchanger and the transformer board. The fixing strip has an opening for the bimetallic switch of the heating system.



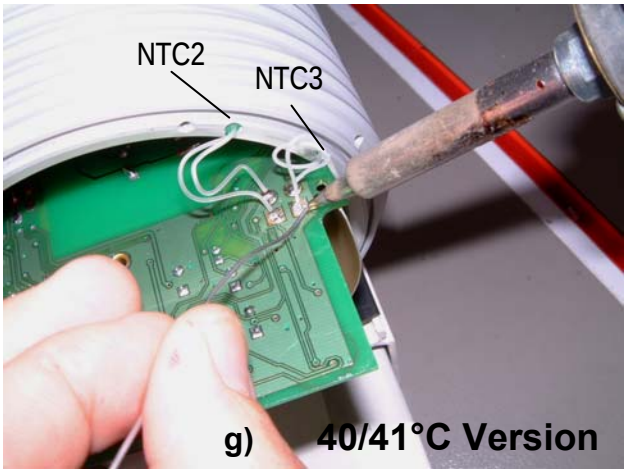
e) Turn round the heat exchanger cylinder so that the secured transformer board is accessible from underneath. Prevent the unit from rolling away.

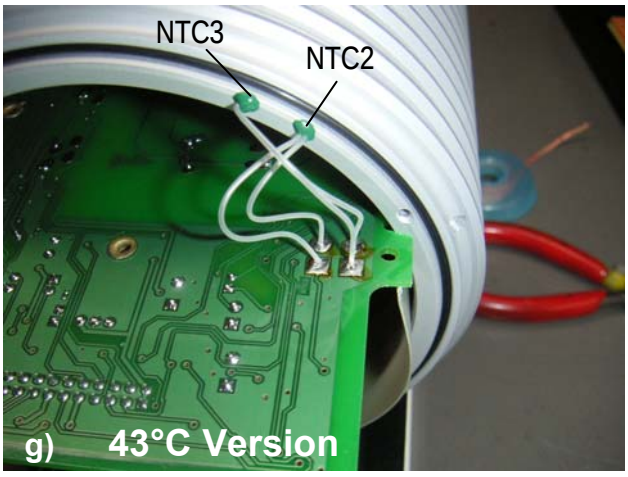
f) Push the connections of NTC1 into the designated solder eyes with tweezers and solder in place. The connecting wires must be bent close to the transformer board so that they are not subsequently damaged by the intermediate ring.



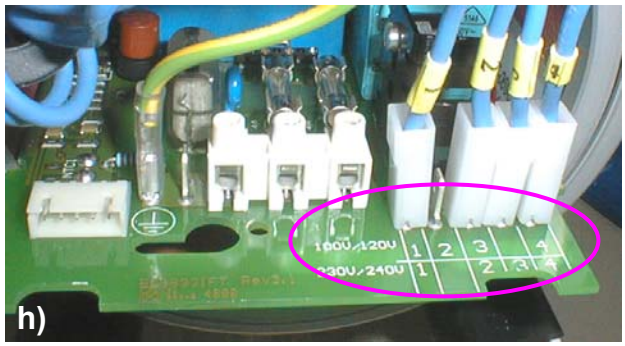
<u>Note:</u> NTC3 is positioned differently in 40°C/41°C devices and in 43°C devices!

g) Route the connecting wires of NTCs 2 and 3 in a slight inward curve, push through the soldering eyes and solder in place.





h) Turn the unit round. **Connect** the earth wire and **the heating cable to the transformer board in accordance with mains voltage** (see printed information on the transformer board).



7.3 Assembly of the top part assembly

CAUTION

When handling the top part, ensure that the bolts are not put under lateral strain. This can lead to the bolts or the housing domes fracturing.

Steps a) to i) can also be performed with the front panel glued in place.

- **Handle:**

a) Put washers on the screws of the handle and push them through the relevant top bores in the housing.

b) Secure the screws against falling out with the o-ring seals.

c) The handle should not have any burr on the end faces. If necessary, remove burr with a knife. Carefully place the handle on the screws. Tighten up the screws loosely with a suitable cross-head screwdriver to a gap of approx. 5 mm. Ensure that the O-rings are not damaged by the screw thread.

d) Turn the housing so that the handle points downwards. Align the O-rings on the handle. Push the handle against the housing. The seals must lie cleanly inside the depressions. Tighten up screws evenly.

e) Put the pre-assembled top part down with the front facing downwards.

- **Operating board:**

f) Fit the key extensions to the keys of the operating board. The key extensions must lie level on the keys.

g) Push operating board into the lateral guide rails of the housing at an angle and suspend behind the bottom mounting screws. If necessary, undo the bottom mounting screws slightly and suspend the operating board. Move the washers towards the operating board using a fine screwdriver and tighten back up.

h) Screw the operating board firmly in the housing.

i) Place the top part on the bolts and check that the key extensions do not project beyond or drop behind the openings in the surface of the front panel.
Adjusting the height of keys: The distance from the surface of the front panel can be slightly altered by moving the washers of the bottom mounting screws. To do so, undo the screws and push the washers towards the operating board with a fine screwdriver. This leads to the key extensions projecting out of the surface of the front panel.
Be sure that the front panel does not keep a key permanently depressed!

- **Front panel:**

Do not stick a front panel back on once it has been removed, as this does not guarantee permanently leak tight adhesion!

j) Remove old parts of adhesive. Clean and degrease carefully the opening in the top part for the front panel with alcohol. **Do not use agents which attack plastic for degreasing!** Ensure that no fluid gets through the openings onto the board.
Blow off dust particles on the LCD display or remove with a soft lint-free cloth.

k) If using a new display cover, remove the protective film. Clean the display cover with alcohol. Blow off dust particles or remove with a soft lint-free cloth.

l) Insert the display cover in the opening (satin side to front panel). Ensure that it does not project beyond the front panel opening.

m) Experimentally position the front panel (plus protective film) onto the top part and align in accordance with the LEDs. Observe the intervals from the edge of the front panel opening.

n) Pull the protective film off the adhesive back of the front panel. Stick the front panel down on one side according to the previous alignment. Slowly unroll the front panel and smooth onto the housing without trapping any air. Do not take the front panel off again!

7.4 Assembling the bottom part assembly

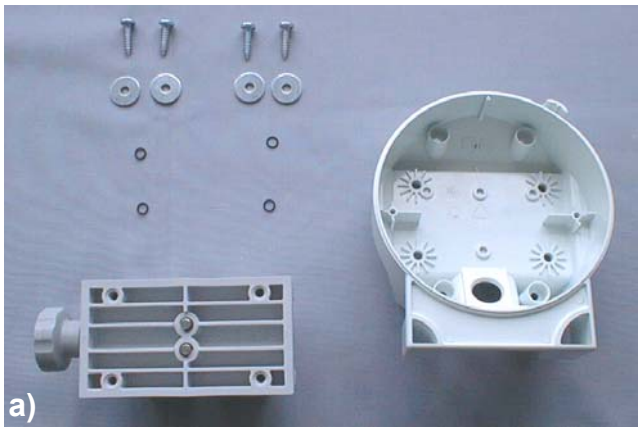
- **Device fixing:**

a) Place the preassembled device fixing (as per Section 7.1) on the clamps so that the handwheel points to the left.

b) Insert o-ring seals in the depressions of the base plate at the screw bores.

c) Place the bottom part on the device fixing and align in accordance with the bores.
Note: the rating plate must point in the direction of the inlet retainer (towards the top of the device).

d) Put the screws (plus washers) in the bores and tighten up using a suitable cross-head screwdriver.



- **Cable gland:**

e) Push the cable gland into the bore of the bottom part from the outside. The hexagon of the cable gland must engage in the flanks of the bottom part (prevents twisting).

f) Place the nut on the cable gland from inside and tighten up using a suitable tool.

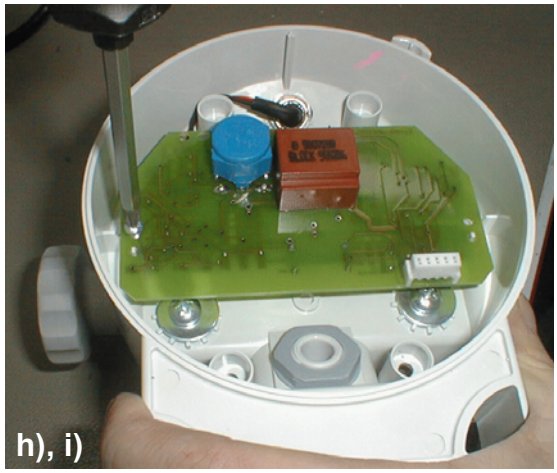
For devices with ASTOLINE:

- **ASTOLINE Board:**

g) Connect the board plug of the device socket to the ASTOLINE board.

h) Route the cable of the device socket around the top left screw dome.
Warning: correct routing of the cables is essential for EMC and safety reasons!
(heating the shrink tube makes the cable more flexible)!

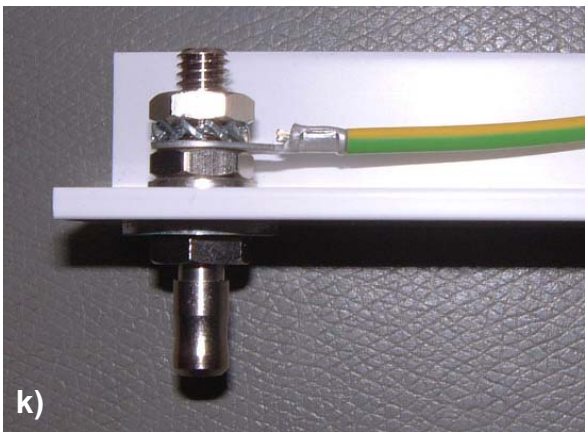
i) Insert board in the guide journals and align to suit the bores. The cables may not be damaged in the process. The board must lie level. Tighten up the mounting screws and check that the board is firmly seated.



- **Devices with equipotential bonding plug:**

j) Push the O-ring seal over the thread of the equi-potential bonding plug and insert this in the housing bore from the outside.

k) Put on the washer and tighten the nut with an open-ended spanner (WAF 10). The plug must be held steady with an identical open-ended spanner. The o-ring may not be forced out in the process.



l) Put on the serrated lock washer and the cable eye of the EP cable and tighten the second nut up slightly. Align the cable eye front right at 45 °, hold steady and tighten up the nut.

7.5 Final assembly of assemblies

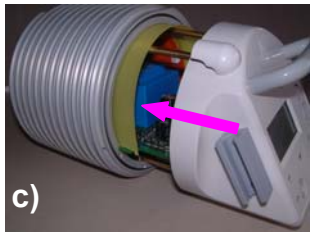
Once the individual assemblies are prepared, they can be joined to form a complete ASTOTHERM PLUS device.

- **Heat exchanger assembly and top part assembly:**

a) If necessary insert new sealing rings in the end-face grooves of the heat exchanger.

b) Check whether the connecting wires of the NTCs are correctly located (inside the heat exchanger) so they are not damaged.

c) Insert the top part with the bolts ahead into the heat exchanger.



d) Plug the operating board plug onto the transformer board.

e) Guide the transformer board into the lateral guide rails in the top part. Be careful with the connecting wires.

f) Align the heat exchanger with the device to prevent twisting and carefully press onto the housing.

g) Push the intermediate ring plus lateral guide grooves onto the transformer board and bolts.
Be careful with the NTC connecting wires.

h) Screw the four spacing bolts onto the bolts. Align the intermediate ring with the top groove to match the bore in the heat exchanger. Hand-tighten the spacing bolts!

i) Push the cable tie through the top bore in the intermediate ring and place loosely around the heating cable and earth wire. **Align the cables exactly as shown in Fig. "h"**, slightly tighten the cable tie and cut off the excess.

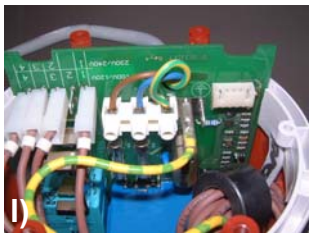
Warning: correct routing of cables is essential for EMC and safety reasons!

j) Check whether the sealing ring is properly seated in the groove of the heat exchanger and whether the heating cables are connected in accordance with mains voltage.

- **Bottom part assembly**

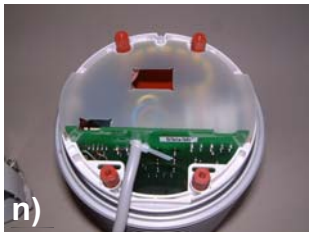
k) Push mains cable through the cable gland in the prepared bottom part from the outside.

l) Push mains cable (and, if necessary, the equipotential bonding cable (EP cable)) through the opening of the transformer board from underneath. Connect mains cable to the mains terminals according to the printed information (cf. Fig. 2).



m) Guide cable tie through the small bore next to the opening around the mains cable from underneath and tighten. (If appropriate, plug EP cable onto free earth wire connection (cf. Fig. 2). Do not secure this cable with the cable tie.)

n) *Models with ASTOLINE only*: place insulating plate on heating cables and intermediate ring.
Note: to make it easier to assemble the bottom part, one corner of the cut-away of the insulating plate can be engaged in the mains cable opening of the transformer board.



o) Carefully align the bottom part on the spacing bolts, pulling the mains cable out of the cable gland (and pushing the EP cable through the transformer board after it). On bottom parts of housings with an ASTOLINE board, ensure that the plug connection of the boards is not damaged when putting on the bottom part.

Warning: correct routing of the cables is essential for EMC and safety reasons.

p) Place the bottom part on the heat exchanger, exerting slight pressure. The bottom part must be in place, all but a small gap, without the use of great force.

q) Fit the four housing screws with new O-rings and place in the bores. Tighten up screws evenly with minimum force until the gap closes.

r) Push the mains cable back into the bottom part a little way. Tighten up the cable gland by hand until the sealing grommet abuts on all sides. Using a suitable tool, turn another half turn. It should now only be possible to move the mains cable using considerable force.

Once the device has been assembled, a complete functional check as described in Section 4 must be performed!

The results of the functional check must be entered in a repair report (template in appendix).

8 Electrical safety test

The following checks are to be performed and recorded after any repair or modification to electrical medical equipment. (For exact testing guidelines, see EN 62353.)

All checks must be passed according to the limit values!
Before conducting the tests, ensure that test equipment is calibrated and in perfect condition.

Limit values according to EN 62353	
Protective earth resistance *	**≤ 0.3 Ohm**
Insulation resistance	**> 2** MOhm**
Equipment leakage current (Alternative method)	**≤ 1 mA**

* *On the top of the back of the heat exchanger cylinder is a small point for contacting with the test probe when measuring protective earth resistance. At this point, the anodised aluminium coating of the heat exchanger has already been penetrated by the manufacturer's test.*
** *The standard EN 62353 regulates no limit value; the stated value is given by the manufacturer.*

Fig. 17 Contact point for protective earth resistance test

On devices with equipotential bonding plugs, earth wire resistance must likewise be measured with the test probe at the plug.

No electrical tests are carried out on ASTOLINE and the ASTOLINE device socket (these parts are double insulated).

The results of the test for electrical safety must be entered in a repair report (template in appendix).

9 Continous duty test

Once the functional check of the ASTOTHERM PLUS blood and infusion warmer is complete, a continuous duty test needs to be carried out in conclusion.

In this test, note room temperature and ambient effects!

As the control temperature is set accurate to a few tenths of a °C, note the following points:

- avoid external effects on the heat exchanger unit/electronics to be measured
- no draughts
- constant room temperature (20 to 26 °C)
- keep out of direct sunlight
- keep away from strong light sources

The continuous duty test corresponds to the “Check temperature in control state” as described in Section 4. This test is carried out 3 times over a period of 24 hours. The measured value of the thermometer and the temperature display must be entered in a repair report (template in appendix).

10 Return and/or disposal of devices or assemblies

If the device or an assembly has been in contact with blood or bodily fluids, it needs to be carefully cleaned and disinfected.

In view of the risk of contamination with viruses and other pathogens, adequate precautions should always be taken to prevent contact with such pathogens. We recommend placing the device in a plastic bag and sealing this tightly before returning it.

The device should be packed in either the original packaging or equivalent to avoid transport damage. This likewise applies to individual assemblies. It is the customer’s responsibility to pack and mark correctly the product for return.

STIHLER ELECTRONIC can dispose of your old device cheaply and properly. To make use of this service, return the cleaned and disinfected device with a note to this effect.

11 Appendix

a) Form „Repair Report“ Rev 2, 02/05

b) Table Resistance – Temperature of Test-Thermistor (order no. 9950.9000.35)

Reparaturbericht
Repair report

Seite 1 von
Page 1 /

PRODUKT / PRODUCT **ASTOTHERM PLUS**

KUNDE / CUSTOMER

AUSFÜHRUNG / MODEL
☐ AP200 ☐AP220 ☐AP260
☐ "S" (ASTOLINE) ☐40°C ☐41°C ☐43°C

SN:

FEHLERBESCHREIBUNG KUNDE / DEFECT DESCRIPTION CUSTOMER	**TATSÄCHLICHE FEHLER / REALLY DEFECTS**

AUSGEFÜHRTE ARBEITEN / WORK PERFORMED

SICHTPRÜFUNG / VISUAL CHECK — Ok — defekt/defective

	Ok	defekt/defective
Gehäuse / Housing:	☐	☐
Aufschriften / Labeling:	☐	☐
Frontplatte / Front panel:	☐	☐
Netzanschlußleitung / power supply cord:	☐	☐
ASTOLINE / ASTOLINE	☐	☐

FUNKTIONSPRÜFUNG / FUNCTIONAL TEST

Anzeigeeinrichtungen / Indicators	☐ o.k.
Funktion / Function	☐ o.k.
Alarmtest t1, t2 / Temperature alarms t1, t2	☐ o.k.
Temperaturüberschwinger / Thermal overshoot:	.....°C
Temperaturregelung / Temperature control	
Thermometer / Thermometer:	.....°C
Temperaturanzeige / Displayed temperature:	.....°C
Abschaltung Wärmereintritt / Safety cutoff warmer inlet:	.....°C
Abschaltung Wärmeraustritt / Safety cutoff warmer outlet:	.....°C
ASTOLINE-Test / ASTOLINE-Test	☐ o.k.

DEMONTAGE / DISMANTLING

REPARATUR / REPAIR

MONTAGE / ASSEMBLY

SONSTIGES / OTHER

AUSGEWECHSELTE TEILE / REPLACED PARTS			

ENDPRÜFUNG/ FINAL TESTING

ANZEIGEEINRICHTUNGEN / INDICATORS	☐ o.k.
FUNKTION / FUNCTION	☐ o.k.
ALARMTEST t1, t2 / TEMPERATURE ALARMS t1, t2	☐ o.k.
TEMP. ÜBERSCHWINGER/THERMAL OVERSHOOT:	°C
THERMOMETER/THERMOMETER:	*siehe rechts / see right side*
ANZEIGETEMPERATUR / DISPLAYED TEMPERATURE	
ABSCHALTUNG W-EINTRITT / SAFETY CUTOFF W-INLET	°C
ABSCHALTUNG W-EINTRITT / SAFETY CUTOFF W-OUTLET	°C
ASTOLINE-TEST	☐ o.k.
SCHUTZLEITERWIDERSTAND / PROTECTIVE EARTH RES.:	Ohm
ISOLATIONSWIDERSTAND / INSULATION RESISTANCE:	MOhm
ABLEITSTROM / LEAKAGE CURRENT:	mA

GETESTED VON, DATUM / TESTED BY, DATE

☐ das geprüfte Gerät hat alle geforderten Prüfungen bestanden
the tested unit has fulfilled all required tests

DAUERTEST / ENDURANCE TEST

		ANZEIGE / DISPLAY	THERMOMETER
1.	0h	°C	°C
2.		°C	°C
3.	24h	°C	°C

ABWICKLUNG / TRANSACTION

GARANTIE / GUARANTEE ☐
KULANZ / FAIR DEAL ☐
KUNDE / CUSTOMER ☐

AUSFÜHRENDE STELLE / REPAIR OFFICE

BEMERKUNGEN / NOTES

b) Table Resistance – Temperature of Test-Thermistor

[°C]	[kΩ]	[°C]	[kΩ]	[°C]	[kΩ]
15	7.40155109	21	5.83372682	27	4.63624353
15.1	7.37172128	21.1	5.81104614	27.1	4.61883346
15.2	7.34202981	21.2	5.78846694	27.2	4.60149863
15.3	7.31247595	21.3	5.76598869	27.3	4.58423866
15.4	7.28305898	21.4	5.74361089	27.4	4.56705319
15.5	7.2537782	21.5	5.72133303	27.5	4.54994187
15.6	7.22463287	21.6	5.69915461	27.6	4.53290432
15.7	7.1956223	21.7	5.67707512	27.7	4.51594019
15.8	7.16674578	21.8	5.65509406	27.8	4.49904911
15.9	7.13800261	21.9	5.63321094	27.9	4.48223074
16	7.1093921	22	5.61142527	28	4.46548472
16.1	7.08091354	22.1	5.58973655	28.1	4.4488107
16.2	7.05256626	22.2	5.5681443	28.2	4.43220832
16.3	7.02434956	22.3	5.54664803	28.3	4.41567725
16.4	6.99626278	22.4	5.52524726	28.4	4.39921712
16.5	6.96830522	22.5	5.5039415	28.5	4.38282761
16.6	6.94047623	22.6	5.48273029	28.6	4.36650836
16.7	6.91277513	22.7	5.46161314	28.7	4.35025904
16.8	6.88520125	22.8	5.4405896	28.8	4.3340793
16.9	6.85775394	22.9	5.41965917	28.9	4.31796882
17	6.83043253	23	5.39882141	29	4.30192725
17.1	6.80323639	23.1	5.37807584	29.1	4.28595426
17.2	6.77616485	23.2	5.35742201	29.2	4.27004951
17.3	6.74921726	23.3	5.33685945	29.3	4.25421269
17.4	6.722393	23.4	5.31638772	29.4	4.23844346
17.5	6.69569142	23.5	5.29600635	29.5	4.2227415
17.6	6.66911189	23.6	5.27571489	29.6	4.20710648
17.7	6.64265377	23.7	5.2555129	29.7	4.19153807
17.8	6.61631643	23.8	5.23539993	29.8	4.17603597
17.9	6.59009927	23.9	5.21537554	29.9	4.16059984
18	6.56400164	24	5.19543929	30	4.14522937
18.1	6.53802295	24.1	5.17559073	30.1	4.12992425
18.2	6.51216257	24.2	5.15582943	30.2	4.11468415
18.3	6.48641989	24.3	5.13615496	30.3	4.09950878
18.4	6.46079432	24.4	5.11656688	30.4	4.08439781
18.5	6.43528524	24.5	5.09706477	30.5	4.06935094
18.6	6.40989206	24.6	5.07764821	30.6	4.05436786
18.7	6.38461419	24.7	5.05831675	30.7	4.03944827
18.8	6.35945102	24.8	5.03906999	30.8	4.02459185
18.9	6.33440198	24.9	5.01990751	30.9	4.00979832
19	6.30946648	25	5.00082888	31	3.99506736
19.1	6.28464393	25.1	4.98183369	31.1	3.98039868
19.2	6.25993376	25.2	4.96292153	31.2	3.96579198
19.3	6.23533539	25.3	4.94409199	31.3	3.95124696
19.4	6.21084825	25.4	4.92534466	31.4	3.93676333
19.5	6.18647177	25.5	4.90667914	31.5	3.9223408
19.6	6.16220538	25.6	4.88809501	31.6	3.90797907
19.7	6.13804853	25.7	4.86959189	31.7	3.89367786
19.8	6.11400065	25.8	4.85116937	31.8	3.87943687
19.9	6.09006119	25.9	4.83282705	31.9	3.86525583
20	6.06622959	26	4.81456453	32	3.85113443
20.1	6.04250531	26.1	4.79638144	32.1	3.83707241
20.2	6.0188878	26.2	4.77827737	32.2	3.82306948
20.3	5.99537651	26.3	4.76025193	32.3	3.80912535
20.4	5.97197091	26.4	4.74230475	32.4	3.79523976
20.5	5.94867046	26.5	4.72443543	32.5	3.78141241
20.6	5.92547462	26.6	4.70664359	32.6	3.76764304
20.7	5.90238286	26.7	4.68892886	32.7	3.75393136
20.8	5.87939466	26.8	4.67129086	32.8	3.74027712
20.9	5.85650949	26.9	4.65372921	32.9	3.72668002

[°C]	[kΩ]	[°C]	[kΩ]	[°C]	[kΩ]
33	3.71313981	39	2.99538732	45	2.43278453
33.1	3.69965621	39.1	2.98485751	45.1	2.42449714
33.2	3.68622896	39.2	2.9743703	45.2	2.41624225
33.3	3.67285779	39.3	2.96392549	45.3	2.4080197
33.4	3.65954244	39.4	2.95352289	45.4	2.39982935
33.5	3.64628264	39.5	2.94316231	45.5	2.39167106
33.6	3.63307812	39.6	2.93284355	45.6	2.38354468
33.7	3.61992864	39.7	2.92256642	45.7	2.37545009
33.8	3.60683392	39.8	2.91233074	45.8	2.36738713
33.9	3.59379372	39.9	2.90213632	45.9	2.35935566
34	3.58080777	40	2.89198296	46	2.35135555
34.1	3.56787582	40.1	2.88187047	46.1	2.34338667
34.2	3.55499762	40.2	2.87179869	46.2	2.33544886
34.3	3.54217291	40.3	2.86176741	46.3	2.32754199
34.4	3.52940144	40.4	2.85177645	46.4	2.31966593
34.5	3.51668296	40.5	2.84182564	46.5	2.31182055
34.6	3.50401723	40.6	2.83191478	46.6	2.3040057
34.7	3.49140399	40.7	2.82204371	46.7	2.29622125
34.8	3.47884301	40.8	2.81221222	46.8	2.28846707
34.9	3.46633402	40.9	2.80242016	46.9	2.28074302
35	3.4538768	41	2.79266733	47	2.27304898
35.1	3.4414711	41.1	2.78295356	47.1	2.2653848
35.2	3.42911668	41.2	2.77327868	47.2	2.25775037
35.3	3.41681329	41.3	2.7636425	47.3	2.25014555
35.4	3.40456071	41.4	2.75404485	47.4	2.2425702
35.5	3.39235869	41.5	2.74448557	47.5	2.23502421
35.6	3.380207	41.6	2.73496446	47.6	2.22750743
35.7	3.36810539	41.7	2.72548137	47.7	2.22001975
35.8	3.35605365	41.8	2.71603612	47.8	2.21256104
35.9	3.34405154	41.9	2.70662854	47.9	2.20513117
36	3.33209881	42	2.69725846	48	2.19773
36.1	3.32019526	42.1	2.68792571	48.1	2.19035743
36.2	3.30834064	42.2	2.67863012	48.2	2.18301332
36.3	3.29653473	42.3	2.66937153	48.3	2.17569755
36.4	3.2847773	42.4	2.66014976	48.4	2.16840999
36.5	3.27306814	42.5	2.65096466	48.5	2.16115052
36.6	3.261407	42.6	2.64181606	48.6	2.15391903
36.7	3.24979368	42.7	2.63270379	48.7	2.14671538
36.8	3.23822794	42.8	2.62362769	48.8	2.13953946
36.9	3.22670958	42.9	2.6145876	48.9	2.13239114
37	3.21523836	43	2.60558335	49	2.12527031
37.1	3.20381407	43.1	2.59661479	49.1	2.11817684
37.2	3.1924365	43.2	2.58768176	49.2	2.11111062
37.3	3.18110543	43.3	2.5787841	49.3	2.10407153
37.4	3.16982064	43.4	2.56992164	49.4	2.09705945
37.5	3.15858191	43.5	2.56109424	49.5	2.09007427
37.6	3.14738905	43.6	2.55230173	49.6	2.08311586
37.7	3.13624183	43.7	2.54354396	49.7	2.07618411
37.8	3.12514004	43.8	2.53482077	49.8	2.06927891
37.9	3.11408348	43.9	2.52613201	49.9	2.06240014
38	3.10307194	44	2.51747752	50	2.05554768
38.1	3.0921052	44.1	2.50885716		
38.2	3.08118307	44.2	2.50027077		
38.3	3.07030533	44.3	2.49171819		
38.4	3.05947179	44.4	2.48319929		
38.5	3.04868224	44.5	2.4747139		
38.6	3.03793648	44.6	2.46626188		
38.7	3.02723431	44.7	2.45784308		
38.8	3.01657552	44.8	2.44945735		
38.9	3.00595993	44.9	2.44110455		