


LAUDA

Operating Instructions

LAUDA High-temperature Thermostats

USH 400 and USH 400/6

03/93
YATE0009

<u>Table of Contents</u>		<u>Page</u>
1.	Technical Data	2
1.1	Technical data (thermostats)	2
1.2	Technical data (R 403/R 406)	3
2.	Basic design and technical description	11
2.1	Application	11
2.2	Construction	11
2.3	Controls and functional elements (Thermostat)	11
2.4	Controls and functional elements (R 403/R 406)	13
3.	Safety devices and warning notes 	15
4.	Thermostat liquids and hose connections	17
5.	Unpacking, assembly and setting up	19
6.	Starting up	20
7.	Multifunction output	26
8.	Maintenance	28
	Circuit Diagrams	
	Accessories	

1.	Technical data (to DIN 58966)	USH 400	USH 400/6
1.1	<u>Thermostat</u>		
	Ambient temperature range (°C)	5 ... 50	
	Operating temperature range (°C)	0 ... 400	
	Working temperature range (°C)	80 ... 250	
	with ext. equipment cooling (°C)	80 ... 400	
	with ext. equipment cooling and additional cooler (°C)	0 ... 400	
	Temperature probe	Pt 500 Class A to DIN IEC 751	
	Temperature control (<u>±</u> °C)	0.02...0.1	0.02...0.2
	Heater rating (kW)	3.0	5.6
	Heater surface loading (W/cm ²)	approx. 3	approx. 6
	Class to DIN 12879	3, additional level indication	
	Simplex pumps		
	Flow at zero head (pump output) (l/min)	22	
	max. discharge pressure (bar)	0.8	
	Liquid volume (l)	1.9	
	Expansion volume (l)	0.9	
	with extra expansion vessel		
	Liquid volume (l)	2.1	
	Expansion volume (l)	2.2	
	Heat carrier liquid 20 ... 350°C	Ultra-Therm 330 SCB Do <u>not</u> use water !	
	Base area (dia.) x height (thermostat only) (mm)	(180) x 540	
	Weight (without R 403/R 406) (kg)	17	
	Supply	230 V; 50 Hz 230 V; 60 Hz 3.2 kW	230/400 V; 3/N/PE 50 Hz 5.8 kW
	Interference suppression	Protection Class 1 to VDE 0100 to VDE 0875	
	Ref. No.	LTH 109 LTH 209	LTH 211

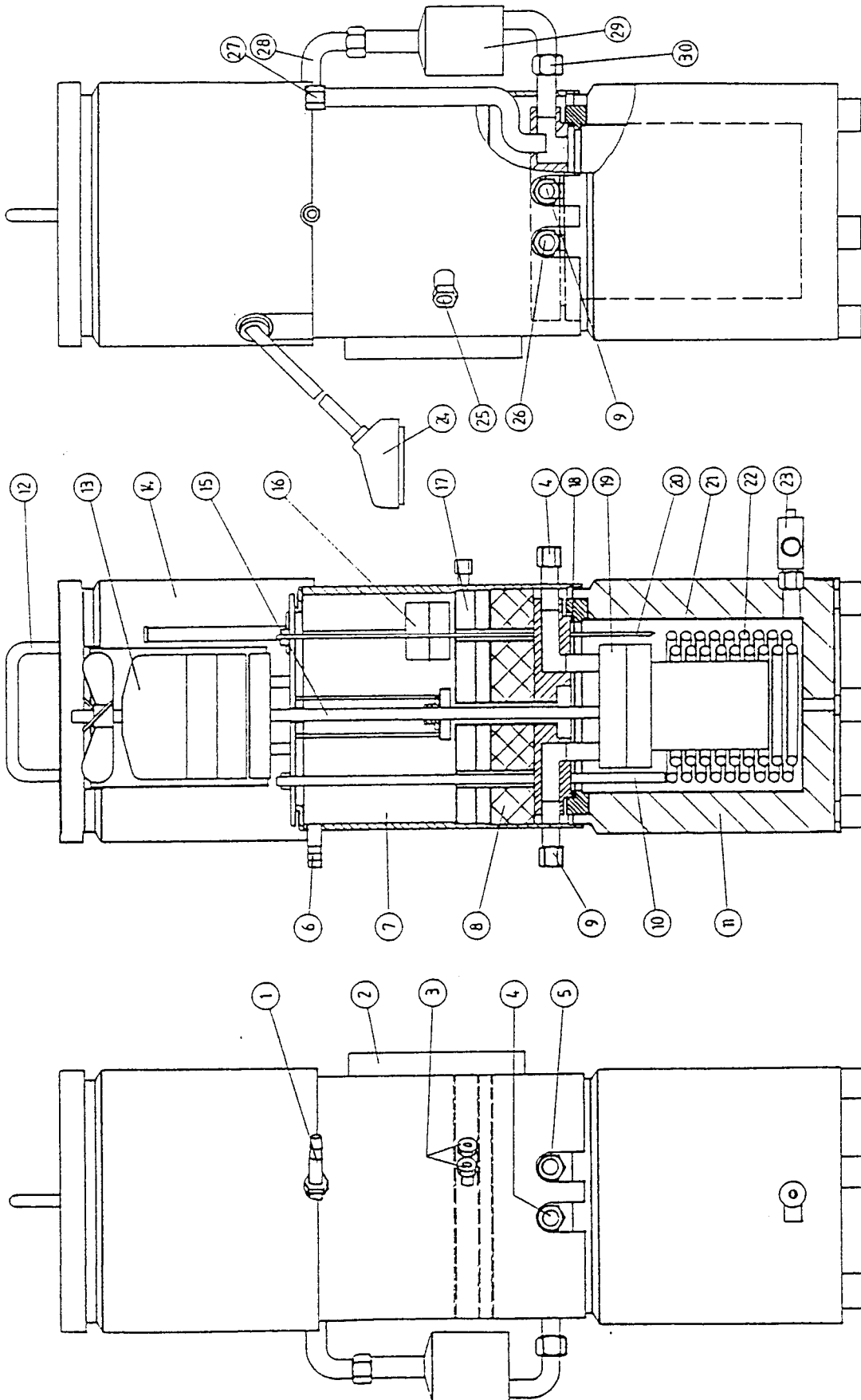
Safety devices	to Class 3 DIN 12879, adjustable overtemperature protection (switch-off point 0 ... 400°C), low level cut-out adjustable in 9 steps
Overtemperature measurement	thermocouple with open- circuit protection
Level indication	in 10 steps through LED bargraph floating contact "general alarm" (changeover)
Extra function	in-line warning circuit when temperature rises more than 5°C above setpoint, warning light and heater cut-out for motor chamber temperature, floating contact (changeover)
Multifunction output	Connection for - programmer with 10 mV/°K - computer connection via A/D converter or R 61 - recorder connection for actual temperature - remote transmission of alarm

LAUDA High-temperature Thermostats
 USH 400 and USH 400/6

- 5 -

<u>External controller EXT</u>		<u>R 403</u>	<u>R 406</u>
Temperature measurement Range	(°C)	-100 ... 500	
Instrumental accuracy (without probe)		0.1 % of reading \pm 0.1°C	
Indication		on display of R 403/R 406 (choice of internal or external temperature)	
Probe		Pt 100 to DIN IEC 751 in 4-wire circuit	
Master controller Setpoint		R 403/R 406 setpoint	
Control action		PID	
Tn	(sec)	40/220	
Tv	(sec)	20	
Amplification		0.2 ... 4	
Correction value limit	(°C)	\pm 5 ... 100	
Base area (W x D) x height	(mm)	300x170x150	500x170x150
Weight	(kg)	4.5	
Supply		230 V; 50/60 Hz	230/400 V; 3/N/PE 50Hz
Total power consumption	(kW)	3.2	6.2
		Protection Class I to VDE 0100	
Option MVH		automatic cooling can be installed	
Option ZP		Contactor, overcurrent protection and plug connection for extra pump can be installed	

LAUDA High-temperature Thermostat
USH 400 and USH 400/6



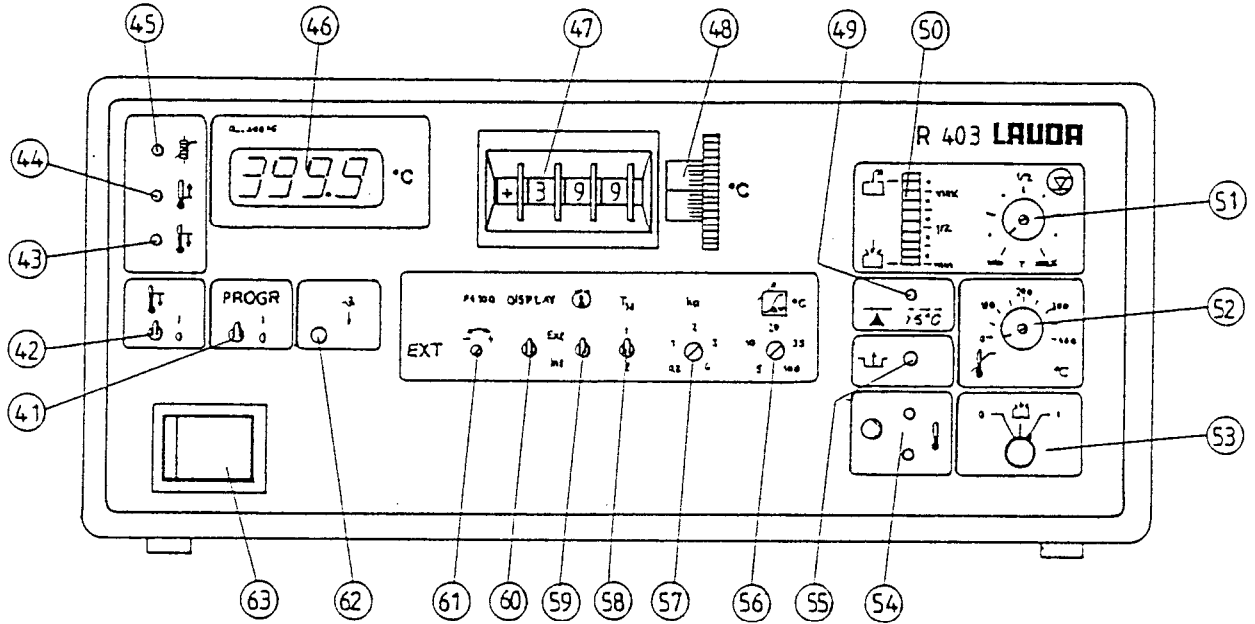
LAUDA High-temperature Thermostats
USH 400 and USH 400/6

- 7 -

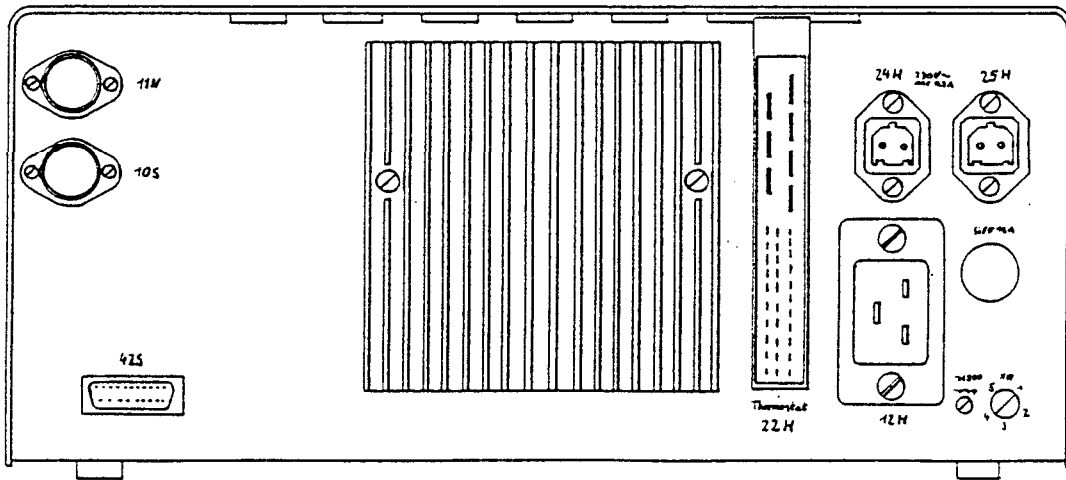
- 1 Overflow M 16 x 1 13 mm dia.
- 2 Fixing strap with two threads M 10
- 3 Connections for cooling chamber M 14 x 1.5
- 4 Pump connection "Outflow 1" M 16 x 1
- 5 Pump connection "Return 1" M 16 x 1
- 6 Inert gas connection 10 mm dia.
- 7 Expansion vessel
- 8 Insulation
- 9 Pump connection "Outflow 2" M 16 x 1
- 10 Temperature probe "safety circuit"
- 11 Insulation
- 12 Handle
- 13 Pump motor
- 14 Motor chamber
- 15 Pump shaft
- 16 Float for level sensor
- 17 Cooling chamber
- 18 Seal
- 19 Pump
- 20 Temperature probe "measurement"
- 21 Thermostating tank
- 22 Heater USH 400, 3 kW; USH 400/6, 5.6 kW
- 23 Drain cock
- 24 Control cable with special plug
- 25 Connection "extra expansion vessel" M 16 x 1
- 26 Pump connection "Return 2" M 16 x 1
- 27 Filler opening M 16 x 1
- 28 Connection "vent valve" M 16 x 1 (expansion vessel)
- 29 Vent valve
- 30 Connection "vent valve" (thermostating tank)

R 403

Front view

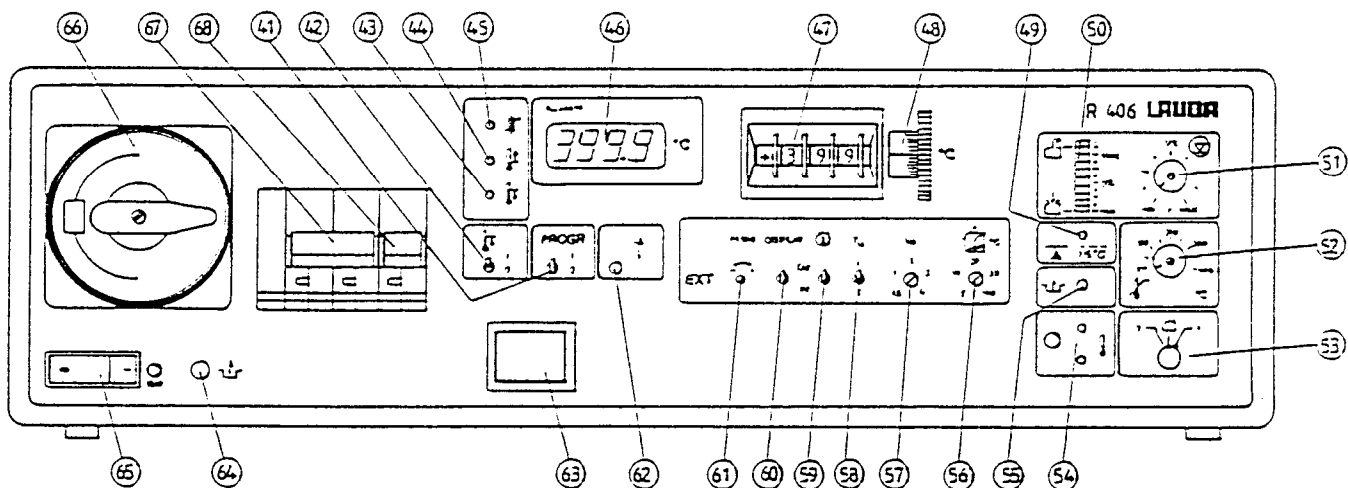


Rear view

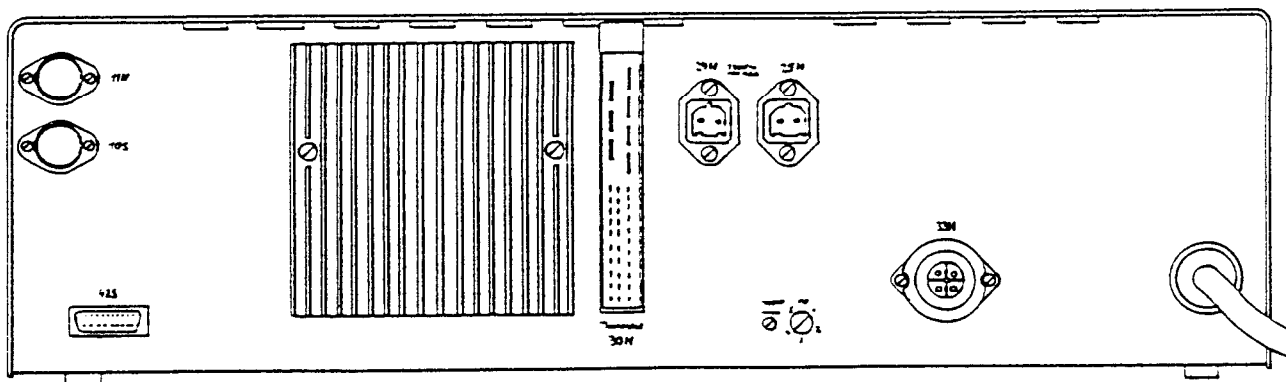


R 406

Front view



Rear view



- 41 Switch "program"
- 42 Switch "cooling"
- 43 LED indication "cooling"
- 44 LED indication "heating"
- 45 LED indication "heater output limit"
- 46 Temperature indication
- 47 Digit switch setpoint selection
- 48 Fine adjustment setpoint
- 49 LED indication "fault"
- 50 Level indication
- 51 Switch-off point adjustment for level limiter
- 52 Switch-off point adjustment for overtemperature limiter
- 53 Function switch "0 - fill - normal"
- 54 Indication "motor chamber alarm"
- 55 Key "reset"
- 56 Adjustment "correction value limit"
- 57 Adjustment "Kp control amplification EXT"
- 58 Switch "Tn reset time EXT"
- 59 Switch "EXT control ON"
- 60 Toggle switch "indication EXT"
- 61 Pt 100 EXT adjustment
- 62 Key "setpoint"
- 63 Mains switch (R 403) / Pilot lamp Mains (R 406)
- 64 Button "reset overcurrent protection extra pump"
- 65 Switch extra pump
- 66 Main switch
- 67 Fuse heater (2 poles)
- 68 Fuse control

2. Basic design and technical description

2.1 Application

The high-temperature thermostats USH 400 and USH 400/6 is intended for use as circulation thermostats for thermostating closed external systems. The design permits operation at outflow temperatures up to 400°C when using suitable liquids. Connecting a heat exchanger to cool the circulating liquid permits the abstraction of energy, and temperatures down to 20°C can be reached.

2.2 Construction

2.2.1 The unit consists of a thermostating tank (21) fitted with the functional elements such as heater (22), pump (19) and temperature probes (10) (20). The pump shaft (15) is introduced into this tank through a sleeve without guide. The gap between shaft and sleeve also serves as connection between thermostating tank and expansion vessel (7) for liquid interchange.

The thermal break between thermostating tank and expansion vessel is provided by thermal insulation, an air gap, and a cooling chamber (17) through which the floor of the expansion vessel can be cooled with compressed air, nitrogen, oil or water, if required.

The liquid level in the expansion vessel can be sensed through a float (16) with a digital transmitter and indicated on the R 403/R 406 control unit. The pump motor (13) and the electrical termination chamber (14) are arranged above the expansion vessel.

All parts in contact with the liquid are made of high-grade stainless steel or from a material well-suited to the used heat carrier liquid.

2.2.2 Most of the electrical and electronic units of the controller, the safety devices etc. are arranged in a separate control unit R 403/R 406 which also contains all electrical controls and indications.

2.3 Controls and functional elements (thermostat)

2.3.1 Thermostating tank

The thermostating tank (21) is completely filled with liquid during operation. Sealing against the top is provided by a flange with a special seal (18). The space between thermostatic tank and casing as well as above the flange is filled with mineral insulation as a thermal break (8) (11). The unit is charged directly into the thermostatic tank through a special filler tube (27) taken out at the top. A drain cock (23) is provided which can only be operated with a tool (SW 8 spanner).

2.3.2 Pump

The unit is equipped with a 2-stage centrifugal submerged pump (15) (19). It is driven by an induction motor (13) with external rotor. The pump can operate up to a liquid viscosity of 150 mm²/sec. The motor winding is fitted with an overtemperature cut-out. Part of the pump output always passes over the heater independently of the external circulation. Two outflow connections (4) (9) together with the corresponding return connections (5) (26) are available for external circulation. A connection (30) is provided for the automatic vent valve which is available as an accessory. The vented side of the valve leads through the connection (28) into the expansion vessel.

2.3.3 Heater

Two tubular heaters (22) are located in the lower part of the thermostatic tank in order to achieve the lowest possible heater surface loading. The heaters are arranged so as to achieve a directed uniform circulation around them.

Units type USH 400 are equipped with 3 kW heater rating. Units type USH 400/6 are equipped with 5.6 kW heater rating thus offering twice as much surface load.

2.3.4 Temperature probe

A temperature probe (20) for measurement and control, and also another probe (10) for the separate safety circuit which is also used to sense the heater surface temperature is immersed in the thermostatic tank.

2.3.5 Expansion vessel

The expansion vessel (7) is linked to the thermostatic tank through the annular gap around the pump shaft (15). The floor of the expansion vessel is arranged as a cooling chamber (17); a coolant can be passed through it through the connections (3) (M 14 x 1.5). There is a minimum liquid level in the expansion vessel so that the liquid in the thermostatic tank is always blanketed by cold oil which prevents contact between the hot liquid and atmospheric oxygen.

The liquid level in the expansion vessel is monitored by a float (16) and digitised through a magnetic probe with Hall sensors. If necessary, an additional expansion vessel of approx. 1 liter volume can be attached via the connection (25).

In addition there is a connector (10 mm ext. diameter) at the top of the expansion vessel as an inert gas connection (6), and a connection with connector (13 mm ext. diameter) as overflow (1).

The back of the unit carries a heavy strap (2) with two threaded holes (M 10) for mounting the unit on a laboratory wall.

2.3.6 Motor chamber


The motor chamber (14) takes the control cable connections and the level sensor electronics. It also contains the pump motor with fan which is separated from this area by the air guide; it draws air from below the noise cover and blows it out downwards above the expansion vessel. All functional elements are accessible after removing the housing. The connection terminals for the control cable are easily reached, e.g. for connection of a longer control cable.

2.4 Controls and functional elements (R 403 / R 406)

The entire electronics and the corresponding controls for temperature indication and setting as well as the safety functions are housed in a separate unit, the controller R 403/R 406. The connection with the thermostat is made through a special cable (24) which carries both power and instrument circuits. In addition a connector specially developed for this application is employed. In case of a repair it is essential to use only genuine cables and the genuine connector in order to ensure electrical safety. Thermostat USH 400 must only be operated with controller R 403. Thermostat USH 400/6 must only be operated with controller R 406. Any other combination will be non-operational, but does not lead to a dangerous situation.

The separation of thermostat and controller permits remote operation of the unit, e.g. the thermostat can be placed in a fume cupboard and the control unit outside.

2.4.1 Control

The unit operates with a Pt 500 to DIN IEC 751 (x 5) for monitoring the outflow temperature. It is digitally indicated on the control unit (46) with a resolution of 0.1°C. The display accuracy is optimised for the operating temperature range but also provides useful values outside this range. The indication is then limited by the probe temperature range. The setpoint is set on a digit switch (47) with 1°C steps and sign. Setting is possible up to 399°C; additionally it is limited to approx. 410°C by the internal electronics. In addition the range -0.2 ... 1.2°C can be adjusted in analog form on the fine adjustment knob (48) with 0.01°C scale division. The signal from the programmer input which is switched in with the toggle switch "PROGR" (41) is always added to the setpoint setting. The total value can be indicated on the display by pressing the key  (62).

The comparison between setpoint and actual value is followed by a PID controller which produces an output ranging from 100 % heating through 0 % heating and 0 % cooling to 100 % cooling with installed MVH option. The heating is controlled through a burst-firing triac switch with zero switching. The cycle time is approx. 1.5 sec.

2.4.2 External controller

The units are equipped as standard with an external controller. This offers the facility to monitor and indicate the temperature at an external point, e.g. in a reactor. The probe is a Pt 100 resistance thermometer to DIN IEC 751 in 4-wire circuit which can be connected through the multifunction output 42 S or through the socket 10 S. In addition a change to external control (59) realises a cascade control system which compares the actual temperature at the external point with the setpoint, and therefore not only simplifies operation but also improves the control action. The external master controller operates as PID controller with PD-PID structure change-over and adjustable correction value limitation. The actual external temperature can be indicated on the display (46) by operating the toggle switch (60).

2.4.3 Cooling with option MVH

By fitting the option MVH the controller R 403/R 406 can also operate a solenoid valve for controlled cooling (cooling water control). This automatically extends the output characteristic below 0 % heating into the cooling region so that cooling is automatically limited to the actual cooling requirement. Cooling indicator and switch (42) for cooling ON are not operational when option MVH is not fitted.

2.4.4 Heater power limitation


The LED (45) indicates operation of the automatic heater power limitation circuit. This is activated when the safety probe coupled thermally with the heater surface senses a temperature which is approx. 15°C above the outflow temperature. The circuit reduces the thermal loading of the liquid during the heating-up period.

2.4.5 Alarm circuit motor chamber temperature

The LEDs (54) indicate excessive motor chamber temperature. The yellow LED lights up from approx. 60°C and the red one from approx. 65°C. At the same time the heating is switched off through the signal of the red LED and a contact is operated which is accessible at the socket 11 N (6.5.4). The motor chamber temperature depends on ambient temperature, operating temperature of the liquid, pump loading and cooling of the expansion vessel !

2.4.6 Automatic filling

The switch automatic filling (53) is provided with positions:

- 0 = pump and heating OFF, only temperature indications ON
-  = "fill" → heating OFF, pump is only running, if sufficient level is given
- 1 = normal operation, all functions activated, safety circuit switched on completely.

The "overtemperature" safety function is always activated.

3. Safety devices and warning notes

3.1 The unit is fitted with safety devices to DIN 12879, although the complete system is not covered by this Standard, since the liquid is being operated at temperatures above the flashpoint as specified for industrial heat transfer systems to DIN 4754. However, the liquid at the operating temperature is not in contact with atmospheric oxygen as the expansion vessel ensures an intermediate stationary blanket of cold oil.

3.2 Why can a thermostat be dangerous?

1. Thermostats are equipped with heaters which supply the necessary heat to the thermostating liquid. If the temperature control fails or if the liquid level is too low, the heater can reach temperatures which may lead to a fire in the laboratory, especially in combination with inflammable liquids.
2. When using the thermostat as a circulation thermostat a hose may break, causing hot liquid to spill and endangering people and goods.

The classification of thermostats depends on whether

- o non-inflammable or inflammable liquids are used
- o they are being operated unattended or attended.

The thermostats described in these Operating Instructions incorporate safety devices to Class 3; they are protected against overtemperature and low level. Class 3 requires:


- o a temperature limiter as overtemperature protection which switches off the thermostat on all poles when an adjustable switch-off temperature is exceeded.

- o a level limiter as low-level protection, adjustable between minimum and maximum filling volume, which switches off the thermostat on all poles when the level falls below the switch-off point.

Important Note


Even with Class 3 units the user is only protected against hazards from excess temperature and low level. Further hazards may arise from the type of product being thermostated, e.g. a shift above or below certain temperature levels or fracture of the container followed by a reaction with the thermostatic liquid etc. It is impossible to provide protection against all possible causes and they remain largely within the decision and responsibility of the user.





3.3 Warning notes

- 3.3.1 The outer casing of the unit may reach temperatures above 60°C ! The outflow and return pipes of the pump reach the operating temperature. Danger of burns !!
- 3.3.2 The unit must only be filled through the filler pipe (27) using the funnel supplied. This is necessary to ensure preferential filling of the thermostatic tank. Then run the unit with switch (53) set to  until all air has been purged.
- 3.3.3 No water, nitrogen or compressed air must be connected to any of the connections with M 16 x 1 thread. Connect water or gas coolant only to the cooling chamber connections (3) with M 14 x 1.5 thread. Maximum permitted pressure in the cooling chamber 3 bar. Ensure that the outflow cannot be closed. Before starting up, check that all connections not in use which carry an M 16 x 1 thread (except the overflow) are closed with blind caps and ring nuts.
- 3.3.4 Mains cables and control cables must not come into contact with pump connections and hot surfaces ! In case of damaged cables or any extension of the control cable, the unit must only be opened by a qualified electrician ! Use only genuine control cables from the manufacturer.

3.4 Safety functions

- 3.4.1 The built-in overtemperature limiter can be adjusted on the controller between 0°C and 400°C with approx. 5°C overshoot. In accordance with DIN 12879 a tool (screwdriver) must be used. The outflow temperature is sensed by a separate thermocouple (10) and processed by a separate electronics. The circuit recognizes any break in the sensor.

When the switching point is exceeded the unit is permanently switched off on all poles (limiter function); the red LED  (49) lights up permanently, an audible signal is produced, an electrical signal is produced at the multifunction output 42 S at contact 12 (0 V) and 13 (12 V). A floating contact at socket 11 N also switches over (see 6.5.4).

- 3.4.2 In accordance with DIN 12879 Class 3 the switch-off point of the low-level limiter is also adjustable. This prevents pumping out an unnecessary large quantity of heat carrier liquid at the lowest setting. The level in the expansion vessel is monitored by a float whose position is digitised through a magnetic contact with Hall sensors. A series of LEDs on the controller acts as remote level indication (50) in 10 steps. The yellow LED  indicates that the liquid level in the expansion vessel is in the overflow range. The yellow LED acts as visual warning, as does the yellow re-fill LED  which is always alight when the set switch-off stage (51) coincides with the current level. Any further decrease in level then results in switch-off and alarm as for "overtemperature".
- 3.4.3 The switching-off of the safety circuit is also stored beyond a power failure or mains switch-off. It can only be reset by operation of the "reset" key  (55) after the fault has been rectified.
- 3.5 In-line warning circuit 5°C
The "fault" signal lamp  (49) flashes when the temperature of the heat carrier liquid is more than 5°C above the set temperature. This signal does not switch off the unit, it is only intended as a warning. When this safety circuit is activated a 12 V signal appears at contact 5 on the output 42 S.
On operation with external control it is possible that the lamp >5°C flashes during settling down without a fault being present.

4. Thermostat liquids and hose connections

- 4.1 For use with the high-temperature thermostat USH 400 / USH 400/6 we recommend our organic liquid

Ultra-Therm 330 SCB

Ref. No. LZB 007

This liquid can be used up to 350°C.
Do not use water !

Viscosity at 20°C	34 mm ² /sec
Flashpoint	190°C
Start of boiling	390°C

Fresh heat carrier liquid should be carefully heated up, also when the thermostat is re-filled. Operate the completely installed equipment initially for several hours at 100°C. Then raise to the required operating temperature in steps of about 50°C, pausing each time for about 30 minutes.

When hot, all suitable organic liquids must not come into contact with non-ferrous metals and oxygen, otherwise their life is greatly reduced. Therefore the USH 400/USH 400/6 has in the expansion vessel a quantity of cold oil whose temperature during continuous operation is between 30 and a maximum of 100°C. (If higher temperatures should be reached after a longer period, despite observing the instructions of Section 5.4, this is certainly caused by faulty condition of the complete system or the liquid.)

When changing the liquid the existing liquid must be removed as thoroughly as possible. The oil should be discharged at a tepid temperature. Remaining quantities up to 5 % usually cause no problems. If, however, there is special contamination, e.g. through solvents or other low-boiling or corrosive liquids, the system has to be rinsed. This can be done either with the liquid intended for the next operation, or using a special rinse oil, e.g. paraffin based, whose specification has to be obtained from the manufacturer of the particular liquid.

On no account must water be used for rinsing ! After rinsing, the system should, where appropriate, be blown down with dry air or nitrogen, especially when using low-boiling rinse liquids.

4.2 Hose connections

For safety reasons it is recommended to use only flexible metal hoses over the entire operating temperature range.

Metal hoses (single-layer insulation)

Application range 0...400°C

Metal hose MC 50	(50 cm long)	Ref. No. LZM 040
Metal hose MC 100	(100 cm long)	Ref. No. LZM 041
Metal hose MC 150	(150 cm long)	Ref. No. LZM 042
Metal hose MC 200	(200 cm long)	Ref. No. LZM 043

Metal hoses with special insulation (triple-layer insulation)

Application range 0...350°C

Metal hose MC 50 S	(50 cm long)	Ref. No. LZM 046
Metal hose MC 100 S	(100 cm long)	Ref. No. LZM 047
Metal hose MC 150 S	(150 cm long)	Ref. No. LZM 048
Metal hose MC 200 S	(200 cm long)	Ref. No. LZM 049

Metal hose connections to link
pump outlets together (insulated) MC 18
Application range 0 to 400°C

Ref. No. LZM 044

Highly flexible, thermally insulated stainless steel metal hoses with M 16 x 1 mm connecting threads. Internal dia. 10 mm. This hose offers maximum security.

5. Unpacking, assembly and setting up

- 5.1 Goods are packed carefully to prevent transport damage. If, however, the equipment should arrive damaged, the carrier, the post office, or the railway authorities have to be informed so that the damage can be inspected.

<u>Standard accessories:</u>	<u>Ref. No.</u>
1 Filler funnel	UD 259
8 Union nuts M 16 x 1	HKM 032
7 Blank caps	HKN 065
1 Connector 13 mm dia. (for overflow)	HKO 026
2 Connectors 11 mm dia. (for cooling chamber)(M 14x13)	HKO 009
1 Control and operating unit R 403 (USH 400)	LRK 009
1 Control and operating unit R 406 (USH 400/6)	LRK 211
1 Mains supply cable (USH 400)	UK 089
Operating Instructions	

5.2 USH 400 (3 kW Heater rating)

Place thermostat and controller R 403 next to each other. Make the connection to socket 22 H while the equipment is switched off. Ensure that the plug locks in.
Plug in the mains supply plug (12 H).

USH 400/6 (5.6 kW Heater rating)

Place thermostat and controller R 406 next to each other. Make the connection to socket 30 H while the equipment is switched off. Ensure that the plug locks in.
Only combine USH 400 with R 403 or USH 400/6 with R 406 respectively. Any other combination will not cause a hazardous situation, however, the equipment will not be operational.

Note: Mains cable and control cable must not come into contact with the pump connections or the outer casing ! Damaged cables must be replaced immediately by a qualified electrician, otherwise electrical safety is no longer ensured !

5.3 Connection to external systems

Only pressure-tight systems can be connected to the unit. Use only metal hoses to Section 4.2.

Note: When tightening the union nuts (SW 19) on the hose connections, hold the threaded nipple firmly with an SW 14 spanner ! With external systems at a high level it may happen even in closed circuits that the external volume drains down and the thermostat tank overflows if the pump is stopped and air enters the thermostated system !

Always ensure maximum possible flow area in the external circuit (connectors, tubing, system). This results in a larger flow and therefore improved thermostatic control.

- 5.4 Depending on the operating temperature it may be necessary to provide cooling for the bottom of the expansion vessel (3).
For keeping the temperature in the expansion vessel below 100°C there is no need for any cooling up to 250°C operating temperature; above this temperature, cooling with compressed air, nitrogen or water should be provided. It is important that the water flow should already be started at a liquid outlet temperature below 200°C, otherwise rapid temperature changes may cause problems.
In general water cooling is not necessary when working with compressed air or nitrogen.

Recommended flow rates:

compressed air, nitrogen	200 l/min approx.
water	1 l/min approx.

Note: Max. pressure in cooling chamber 3 bar !

- 5.5 Screw filler funnel on filler tube (27).
- 5.6 If necessary connect inert gas to connector (6) in order to blanket the thermostatic liquid in the expansion vessel.
- 5.7 With a larger expansion volume, connect tubing from overflow (1) to collecting vessel.
The use of an extra expansion vessel is recommended (optional; Ref. No. UD 260) which is mounted on connection (25).
- Note: Do not close the expansion vessel tightly !
- 5.8 With frequent changes of external systems at a high level, it is advisable to use the automatic vent valve Ref. No. UD 253, available as accessory. This speeds up and simplifies the purging of the system.
Connect the vent valve (29) at (30) and (28).

6. Starting up

6.1 Filling

- 6.1.1 Check the details on the labels on thermostat and the controller against the supply voltage and frequency !
Set operating switch (53) to position "0".
Set level switching point (51) to "min". Set the overtemperature cut-out point according to the required operating temperature. Switch toggle switch "Display" (60) and (59) to position "int". Set program switch (41) to position "0". Temperature setpoint at 100°C (heating up the thermostat liquid).

USH 400 (3 kW Heater rating)



A mains supply with shuttered socket, fused at 16 A, is required for units Protection Class 1 !

Plug in the mains supply plug. Switch on the unit with the mains switch (63). The green lamp in the mains switch lights up.



USH 400/6 (5.6 kW Heater rating)

A 230/400 V; 3/N/PE three-phase connection, fused at 16 A, is required.

Plug in the mains supply plug. Switch on the unit with the mains switch (64). The green lamp in the mains switch (65) lights up.

- 6.1.2 If the red fault LED is permanently on, this indicates a fault condition. Press the reset button  (55), operating mode switch (53) on  .
- 6.1.3 Check that all connections not required, except for overflow (1) and inert gas (6), are closed with blank caps. Pour in Ultra-Therm 330 SCB through the filler funnel. When the lower yellow LED (50) is alight, the pump starts up automatically and fills the external system until the yellow LED goes out again. Slowly pour in more liquid and the LED lights up again and the pump runs. When the thermostating circuit has been completely filled only the lower yellow LED should be on, or at most the lowest green LED on the level bargraph (50). This ensures that the maximum expansion volume is available. Let the unit run for a few minutes to ensure that the circuit is purged. Unscrew the funnel and close filler tube with blanking cap.

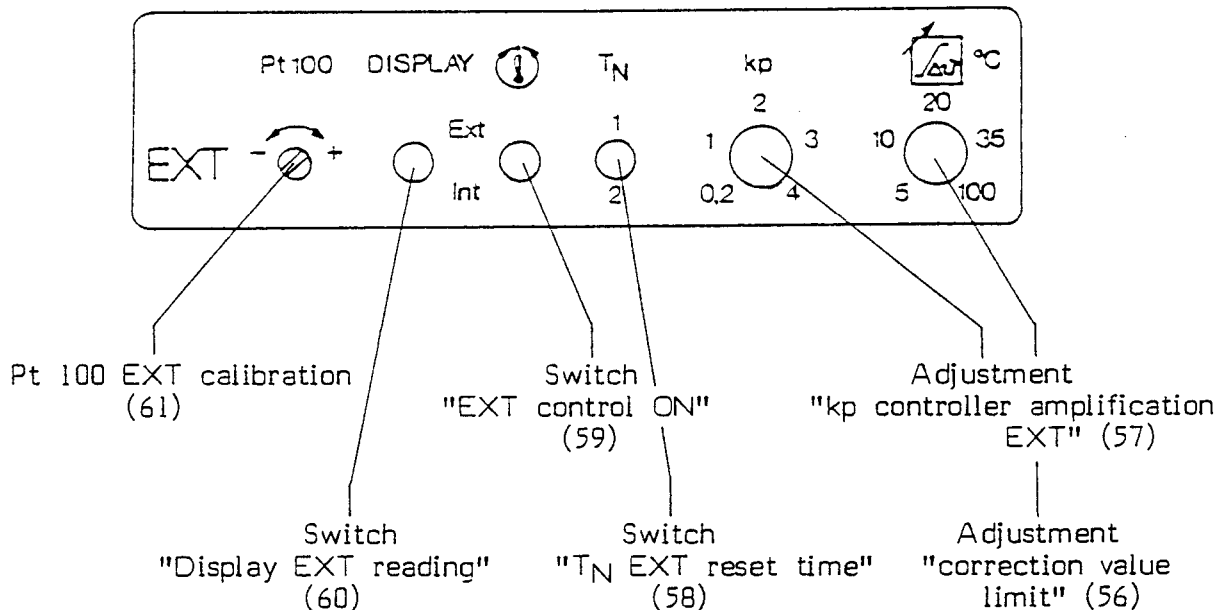
6.2 Heating up and operation

- 6.2.1 Set operating mode switch to "1": the unit is fully operational. During heating the automatic heater power limiter which monitors the heater surface temperature may be activated depending on viscosity and circulation. This can be recognized by the LED (45) lighting up. At the same time the LED (44) is flashing i.e. the heater power is reduced. After refilling, outgas or heat up the liquid according to Section 4.1.
- 6.2.2 When the set temperature has been reached, the yellow LED "heating"  (44) begins to flash (approx. 0.7 Hz), or with MVH cooling on, the green LED "cooling"  (43) (approx. 0.2 Hz). After the settling down period the digital thermometer should indicate the selected setpoint. At the back of the controller R 403 two adjusting potentiometers are located. The "Xp" potentiometer is used to adjust the controller to the control characteristics of the controlled system which may depend on external loads, thermostat liquid etc. The standard setting (with which the unit is shipped from the factory) is 4. The adjustment range extends from 1 to 5; position 1 corresponds to about 1°C proportional band, 5 to about 15°C proportional band. In particular cases the potentiometer Xp can be adjusted to optimise the control for the application concerned.

The adjusting potentiometer "Pt 500" provides additive calibration of the Pt 500 sensor to the electronics. This adjustment is made at the factory for the ideal case, i.e. 500 Ohm at 0°C. Since the sensors used meet Class A of DIN IEC 751 this may result in a maximum error of $\pm 0.2^\circ\text{C}$ at 0°C. This is considered appropriate in order to ensure easy replacement. Where improved accuracy is required and suitably accurate means of temperature measurement are available, the calibration of the sensor can be optimised at any temperature using the adjustment potentiometer "Pt 500".

6.3 Operation with external controller EXT

When using the external controller EXT the temperature in the external system (product, jacket etc.) can also be indicated on the digital display. The thermostat control can additionally be influenced from this external measurement point (Pt 100).



- 6.3.1 Connect Pt 100 resistance thermometer to multifunction output or separate 4-pin socket 10 S.
 Any Pt 100 to DIN IEC 751 can be used. The connection is made in a 4-wire circuit.

Pin connections at socket 42 S:



Pin	2:	- I	current path
	9:	- U	potential path
	11:	+ I	current path
	15:	+ U	potential path

Pin connections at socket 10 S:

Pin	1:	+ I	current path
	2:	+ U	potential path
	3:	- U	potential path
	4:	- I	current path

Mating plugs EQS 014 are available as accessory.

The time constant of the resistance thermometer should be as short as possible since it is included in the control loop parameters.


- 6.3.2 When used for external measurement the display can be changed over to the external reading with the switch "DISPLAY" (60). The resistance thermometer in the circuit can be recalibrated with the potentiometer (61).
- 6.3.3 The commutation to external control (cascade control) is performed by the toggle switch  (59). At the same time the internal (outflow) controller is switched from PID to PD action so that the integral portion alone is effective in the cascade.
- 6.3.4 The control parameters of the EXT master controller are adjusted to T_n 40 sec approx. (position 2) and the controller amplification K_p to 1. With slow control loops with e.g. viscous and poorly stirred products it is advisable to change the reset time T_n to 220 sec (position 1). It may also be useful to set the amplification K_p to smaller values, e.g. 0.5 or 0.2.
- 6.3.5 A special feature of the EXT controller is the adjustable double-acting (+) correction value limitation. The master controller operates by passing a correction value, corresponding to the temperature difference between outflow (int.) and system (ext.), to the outflow controller. With slow systems this correction may become very large during start-up, e.g. 200°C. Without correction limitation this may lead to several forms of thermal overload, e.g. the thermostatic liquid boils, its temperature falls below the solidification point, overtemperature switch-off point is exceeded, the product is thermally overloaded etc. In addition the start-up action is improved. The correction limitation can be adjusted on the potentiometer  (56). The basic setting is $\pm 20^\circ\text{C}$.
- When deciding on the setting, please keep in mind, that it includes the permanent deviation of the outflow controller which operates as PD controller when using the EXT controller.

- 6.3.6 Adjustment for a stirred jacketed 2 litre glass vessel
- | | |
|-----------------------|------------------------|
| Reset time | Tn 1 (220 sec approx.) |
| Amplification | Kp 4 |
| Correction limitation | 20°C |

Cable 42 S to LAUDA Pt 100-70, 72, 80, 82
Cable 10 S to LAUDA Pt 100-70, 72, 80, 82

Ref. No. UK 095
Ref. No. UK 047

6.4 Operation with programmer


In order to change the thermostat setpoint according to a program, a programmer Type PM 351 can be connected at the multifunction output 42 S. This requires that the energy balance (heating, cooling, load) of the thermostat is suitable for the program requirements (heating rate, cooling rate, operating temperatures). The push button "PROGR." is set to position "0", i.e. the programmer has no influence on the setpoint. Set the thermostat setpoint to the lowest temperature which occurs in the program, and this value is also entered as value A when programming the programmer. Now do not make any further changes of the setpoint and press the "PROGR." button. On operating the key  the digital display shows the current setpoint which is given by the programmer and according to which the unit is operating.


Further details see Operating Instructions for PM 351.

6.5 Safety circuit

The operation of the thermostat safety devices has already been described under 3.4.

After starting up it is advisable to check the correct operation of the safety devices to DIN 12879.

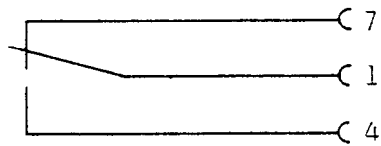
- 6.5.1 For the correct operation of the low-level cut-out it is essential that the level indication is operating correctly. Correct function of the level sensor can be checked by using the auto-fill system.
On setting the selector switch for the level cut-out to the same position as the level display, the yellow re-fill LED lights up. Set it higher, or in case of "max" filling level on "T" (test) - the red alarm lamp lights up and an audible alarm is produced. Pump and heating are switched off on all poles. For starting up again, set the level cut-off point below the level indication. Press reset key .

- 6.5.2 To check the overtemperature limiter slowly lower its switch-off point  .
When it falls below the value shown on the digital thermometer the unit must switch off as described in Section 6.5.1.
Set the switch-off point again above the outflow temperature and operate the reset button.

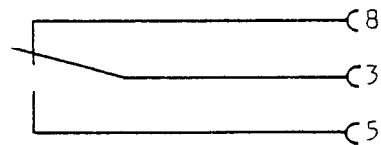
6.5.3 If any incorrect operation is noted under items 6.5.1 and 6.5.2 the unit should be shut down immediately and checked by a qualified electrician, otherwise safety is no longer ensured.

6.5.4 Connection of 7-pin socket 11 N

Floating contact "motor chamber temperature exceeded"



Floating contact general alarm




Data for contact loading:
24 V; 200 mA

Mating plug EQS 024 is available as accessory.

7. Multifunction output

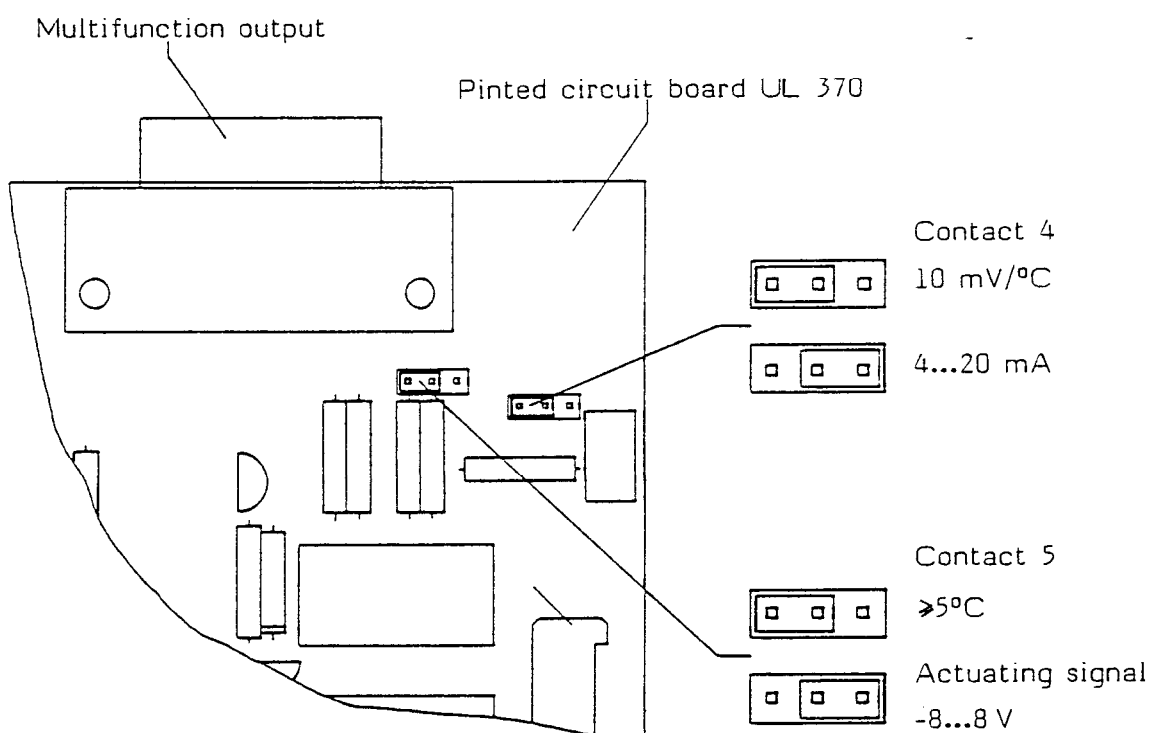
15-pin connector 42 S at the back of R 403/R 406 with several functions.

- Contact 1: outflow temperature recorder connection, correct sign;
10 mV/°C; $R_i \approx 100$ Ohm; internal recorder resistance
 ≥ 1 MOhm min. (0 V contact 3)
- Contact 2: Pt 100 EXT; 4-wire circuit, - current path
- Contact 3: 0 V reference potential for signals
- Contact 4: program or ext. setpoint input 10 mV/°C added to internally
set setpoint. Total indicated with key , $R_i = 24.6$ kOhm
(0 V contact 3)
- Contact 5: 12 V when alarm light is flashing, i.e. operating temperature
more than 5°C above setpoint. $R_i \approx 10$ kOhm approx.,
 $I_{max} = 1$ mA (0 V contact 12)
- Contact 6: Setpoint output 10 mV/°C, $R_i \approx 100$ Ohm approx., load
resistance 10 kOhm min. (0 V contact 3)
- Contact 7: +12 V supply, max. additional load 20 mA
- Contact 8: reference voltage 10 V \pm 0.1 %, load resistance \geq
10 kOhm min. (0 V contact 3)
- Contact 9: Pt 100 EXT; 4-wire circuit, - potential path
- Contact 10: -12 V supply, max. extra load 20 mA (0 V contact 12)
- Contact 11: Pt 100 EXT; 4-wire circuit, + current path
- Contact 12: 0 V load reference potential
- Contact 13: 12 V if red alarm light is on continuously, i.e. safety circuit
to DIN 12879 is activated. $R_i \approx 10$ kOhm approx;
 $I_{max} = 1$ mA (0 V contact 12)
- Contact 14: recorder connection for external temperature, correct sign,
10 mV/°C; $R_i \approx 100$ Ohm approx; internal recorder resistance
 ≥ 1 MOhm min. (0 V contact 3)
Signal available only when EXT board is fitted !
- Contact 15: Pt 100 EXT; 4-wire circuit, + potential path

Remark regarding Contact 4:

By changing the plug connection of a code plug on the printed circuit board UL 370 in the R 403/R 406 the scaling of the setpoint input can be changed to 4...20 mA $\hat{=}$ -100...400°C

At the same time the digit switch has to be set to -225°C.



Remark to Contact 5:

For tests or special supplementary apparatus the function of contact 5 can be changed into an output for an actuating signal.

Note: Before opening up the thermostat or the controller always pull out the mains supply plug! Only a qualified electrician is authorized to do these repairs.

In case of a fault the signal at these plug connections can very usefully be employed for initial diagnosis.

15-pin mating plug
Case for above

Ref. No. EQM 030
Ref. No. EQG 017

8. Maintenance

- 8.1 LAUDA Ultra Thermostats operate largely without maintenance. Contaminated thermostatic liquid should be removed through the drain cock and replaced.
- 8.2 In case of faults on the thermostat or R 403/R 406 controller return the corresponding parts only.
- 8.3 For cleaning the thermostatic tank it can be split at the cover flange. First remove the outer casing and the insulation and then unscrew the eight Allen screws M 8 x 35.
The special seal (18) is available as spare part (Ref.No.: EDF 106).

Note: Before opening up the thermostat or the controller, always pull out the mains supply plug!

We shall always be happy to deal with queries, suggestions and complaints.

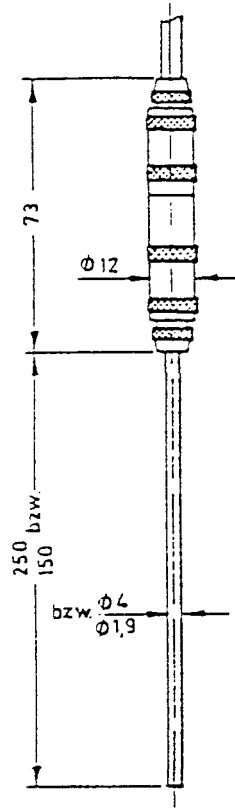
LAUDA DR. R. WOBSEK
GMBH & CO. KG

LAUDA High-temperature Thermostat
USH 400 and USH 400/6

Accessories

Type	Ref.No.
Controlled Cooler MVH already installed	LTZ 035
for subsequent installation	LTZ 034
Automatic purging valve	UD 253
Additional expansion vessel (approx. 1 liter)	UD 260
Programmer PM 351-1 with max. 50 program segments feely programmabel in a range up to 350°C. Programmable deviation control. Externally controllable START, STOP, and RESET function.	LRP 012
RS 232 C serial interface R 6 for transfer and triggering of temperatures and conditions via a computer.	LRT 013

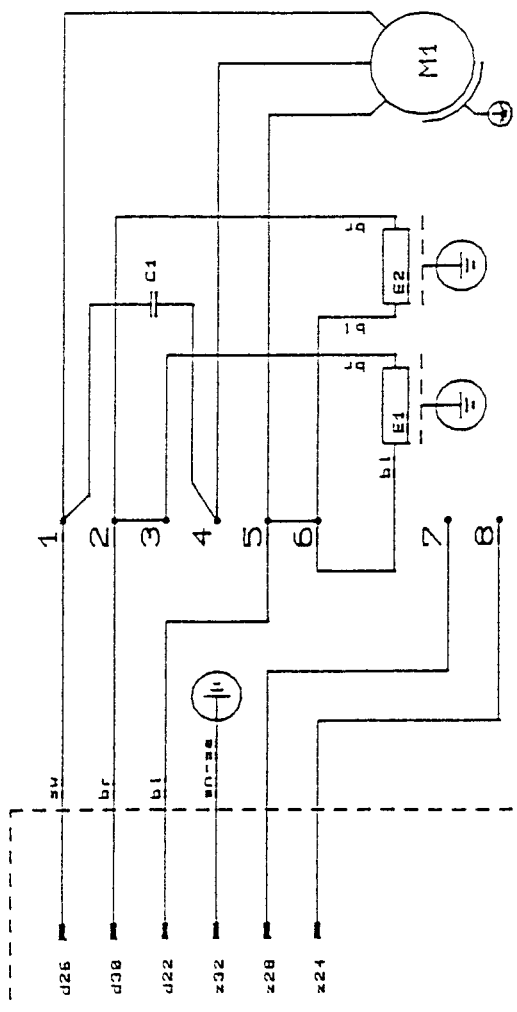
LAUDA High-temperature Thermostat
 USH 400 and USH 400/6



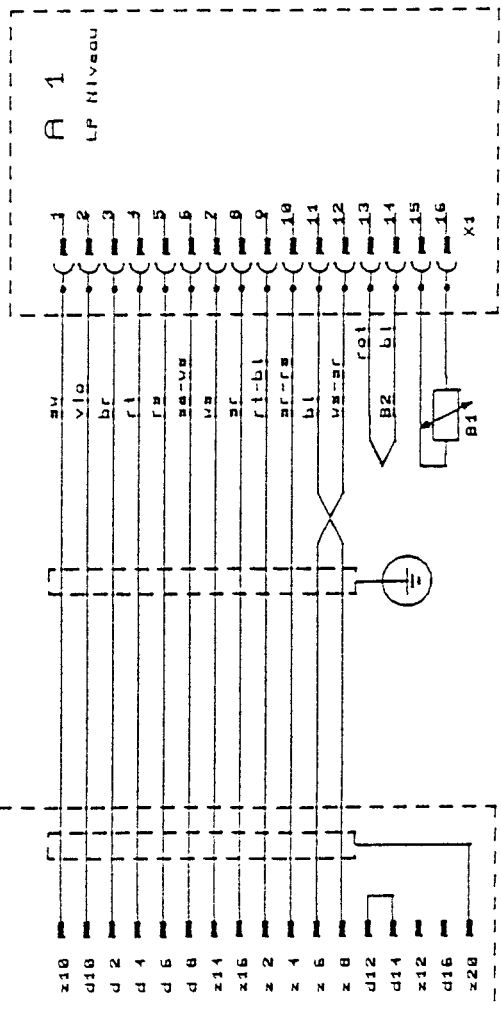
Stainless-steel Resistance thermometer Pt 100

Pt 100-70 diam. 4 mm Length 250 mm, Temperature range -200...300°C Half-life time 1.5 sec	ETP	009
Pt 100-72 diam. 4 mm Length 250 mm, Temperature range -200...800°C Half-life time 7.5 sec	ETP	011
Pt 100-80 diam. 1.9 mm Length 150 mm, Temperature range -200...300°C Half-life time below 1.5 sec	ETP	012
Connecting cable Socket 42 S to Pt 100-70, 72, 80	UK	095
Connecting cable Socket 10 S to Pt 100-70, 72, 80	UK	047
Longer control cable for connection of thermostat and controller; max. length: 20 m, indicate desired length in your order	UK	186

1 2 3 4 5 6 7 8



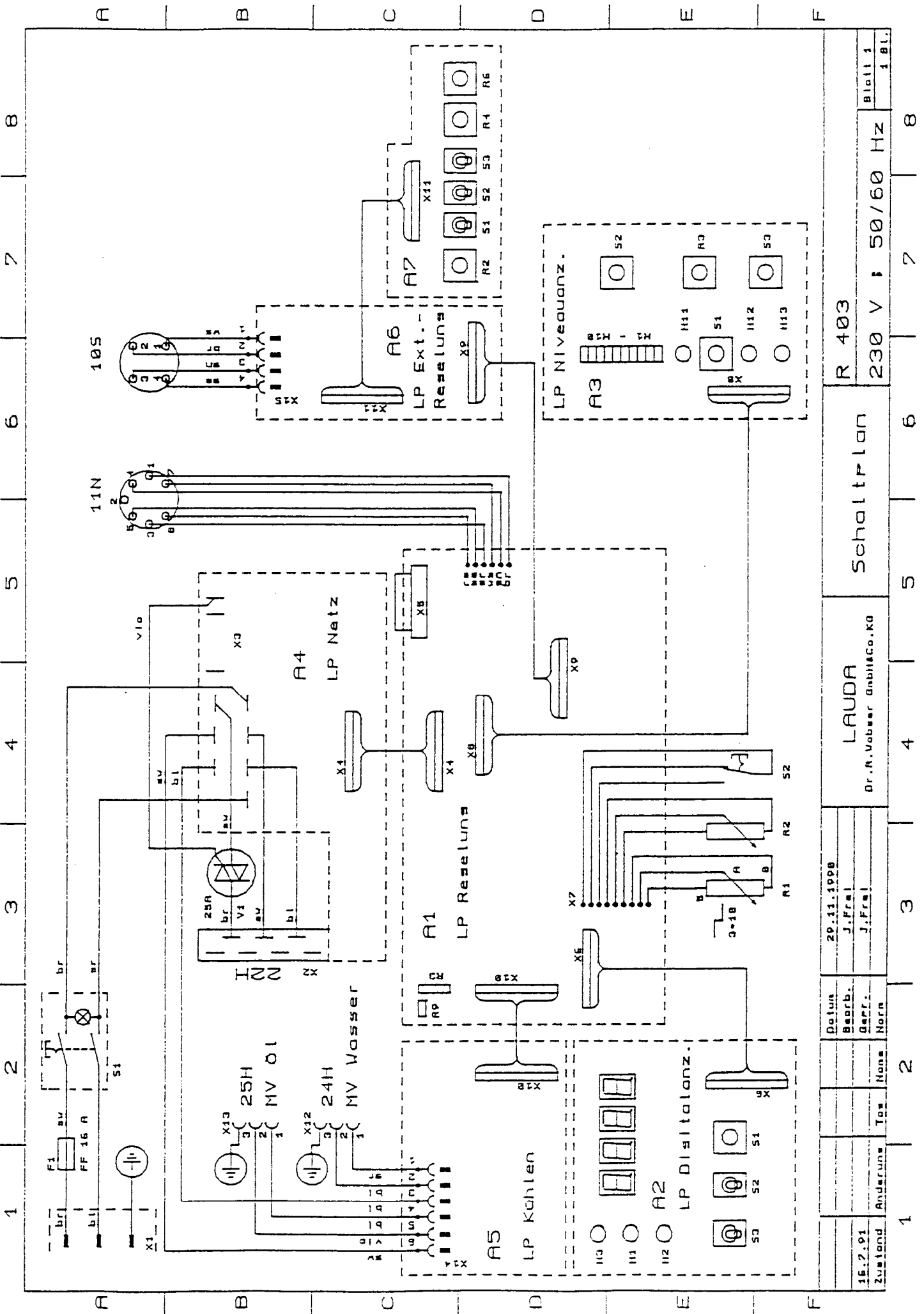
X2



A B C D E F

- A 1 Lettierplatte Niveau
Circuit Imprimé Niveau
Printed circuit Level UL 372
- B 1 Pt 500 Messfühler
PT 500 Sonde de mesure
PT 500 Measuring probe ETP 001
- B 2 Thermoelement Oberflächenschutzf. ETP 013
Element de chauffe Protect. pour surface.
Thermoeal. for protection against overheating
- C 1 Motorkondensator 7µF
Condensateur
Capacitor ECA 004
- E 1 Heizkörper
Corps de chauffe
Heaters UH 139
- E 2 Heizkörper
Corps de chauffe
Heaters UH 140
- X 1 Steckleiste
Stripe terminal
Borne plate EZK 064
- X 2 Verbindungskabel zum R 403
Cable de connexion R 403
Connection cable to R 403 UK 186

22.2.92		20.11.1990		USH 400		Blatt 1	
Zustand	Anderung	Datum	Bearb.	Schaltplan		R	
			J.Frel			7	
			J.Frel			6	
			Norm			5	
						4	
						3	
						2	
						1	
LAUDA				Dr.-R.Vobser GmbH&Co.KG			
230 V 50 Hz				1 Bl.			
230 V 50 Hz							



Zustand		15.2.01		20.11.1998		Dr. R. Vobser GmbH & Co. KG		Schaltplan		R 403		230 V ; 50/60 Hz		Blatt 1		1 Bl.	
Anderrung	Tag	Nam	Nam	Gepr.	J.Fr	Gepr.	J.Fr										

Teil Nr. Pièces No. Part No.	Bezeichnung Désignation Designation	Typ Type Type	Ersatzteilbestell-Nr. No. Ref. pièces détachées Order No. for spares
A 1	Leiterplatte Regelung / Circuit imprimé Réglage / Printed circuit board Control	200 Ohm	UL 370
A 1-R 16	Pt 500 Abgleich / Pt 500 Ajustage / Pt 500 Adjustment	10 kOhm	
A 1-R 45	XP-Einstellung / XP-Valeur de consigne / XP-Adjustment	42 S	
A 1-X 5	Multifunktionsausgang / Sortie à multifonction / Multifunction output		
A 2	Leiterplatte LED-Anzeige / Circuit imprimé Indication LED / PCB LED Indication		UL 368
A 2-H 1	LED-Anzeige Heizen / Indication LED Chauffage / LED Indication Heating		
A 2-H 2	LED-Anzeige Kühlen / Indication LED Refroidissement / LED Indication cooling		
A 2-H 3	LED-Anzeige Heizleistungsbegrenzung / Indication LED limiteur de la capacité de chauffe / LED indication Heat capacity limiter		
A 2-S 1	Taster Istwert/Setpoint / Touche Valeur réelle/Valeur de consigne / Push button Actual value/Setpoint		
A 2-S 2	Schalter Programmtrieb Ein/Aus / Sélecteur Programmation March/Arrêt / Switch Programmer operation On/Off		
A 2-S 3	Schalter Kühlen / Commutateur Refroidissement / Push button switch cooling		
A 3	Leiterplatte Niveauanzeige / Circuit imprimé Indication Niveau / PCB level Indication		UL 371
A 3-H 1-10	LED-Anzeige Niveau / Indication LED Niveau / LED Indication Level		
A 3-H 11	LED-Anzeige Störung / Indication LED Perturbation / LED Indication Fault		
A 3-H 12,13	LED-Anzeige Motorraumtemperaturwarnung / Indication LED Signal avertisseur surveillant la température dans la chambre de moteur / Warning signal for engine room temperature		
A 3-R 3	Einstellung Übertemperaturschutz / Ajustage Protection de surtempérature / Adjustment Overtemperature protection		
A 3-S 1	Taster Entisperren / Touche Déblocage / Push button Reset		
A 3-S 2	Einstellung Niveauschutz / Ajustage Protection de niveau / Adjustment Level protection		
A 4	Leiterplatte Netz / Circuit imprimé Secteur / PCB mains		UL 369
A 4-X 2	Ausgang für LAUDA Thermostat / Sortie pour LAUDA Thermostat / Output for LAUDA Thermostat	22 H	
A 6	Leiterplatte Externregelung / Circuit imprimé Régulateur externe / PCB External control		UL 346
A 7	Leiterplatte Bedlenung Extern / Circuit imprimé Opération externe / PCB Front panel-external controller	200 Ohm	UL 347
A 7-R 1	Pt 100 Abgleich / Pt 100 Ajustage / Pt 100 Adjustment		
A 7-S 1	Schalter Anzeige Extern/Intern / Commutateur Affichage Externe/Interne / Push button switch External/Internal display		
A 7-S 2	Schalter Regelung Extern/Intern / Commutateur Réglage Externe/Interne / Push button switch External/Internal Control		
A 7-S 3	Schalter Regelparameter 1/2 / Commutateur Paramètres de régulation / Push button switch Parameters of controller		
A 7-R 4	Einstellung Regelverstärkung Kp / Ajustage Amplification / Adjustment Amplification		
A 7-R 6	Einstellung Korrekturgrößenbegrenzung / Ajustage Sélecteur de correction d'écart / Adjustment correction limitation		

Geräteliste Schaltplan
 Liste de pièces Schéma de connexions
 List of parts Circuit diagram

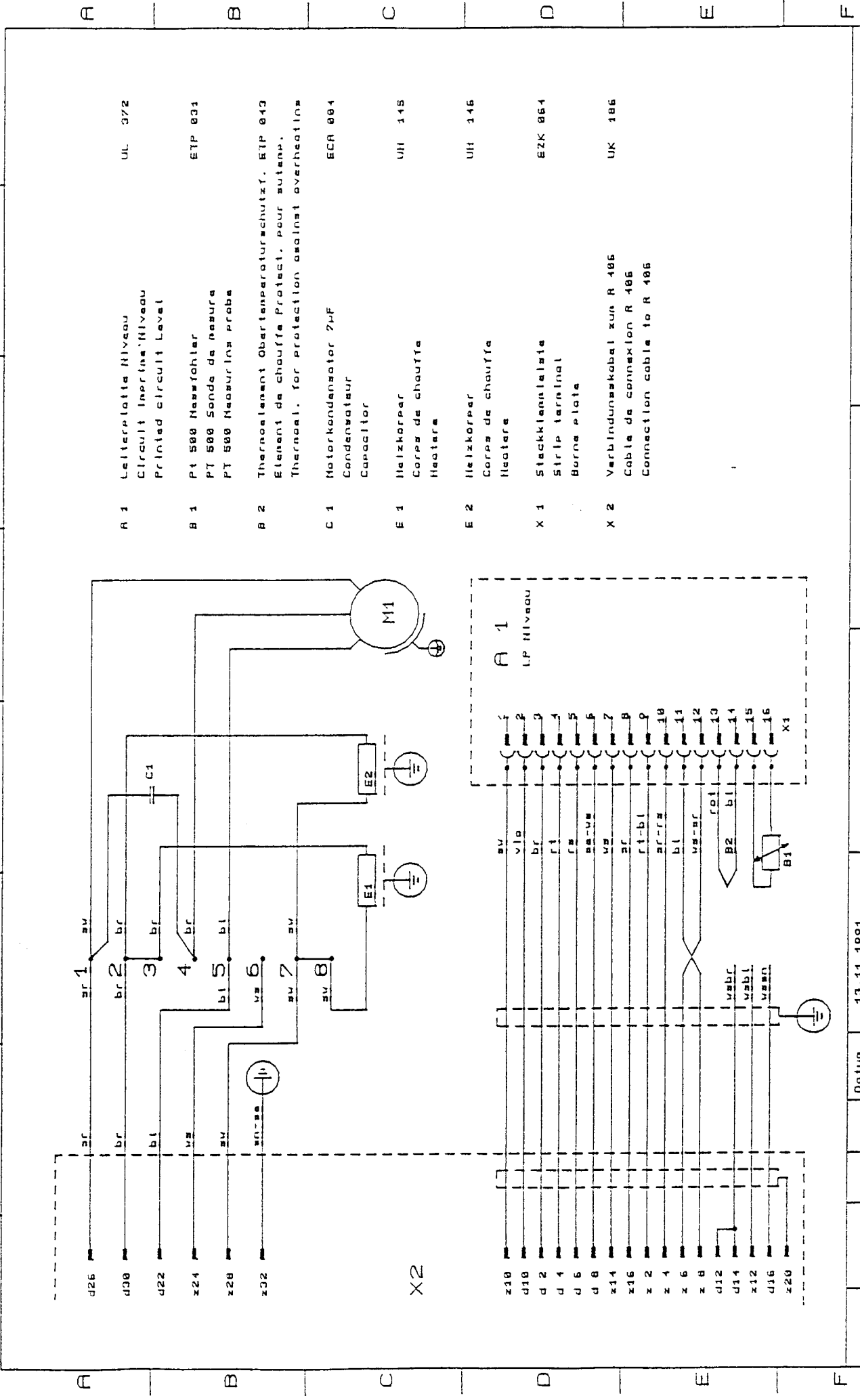
R 403

230 V; 50/60 Hz

Blatt 2

Teil Nr. Pièces No. Part No.	Bezeichnung Designation Designation	Typ Type Type	Ersatzteilbestell-Nr. No. Ref. pièces détachées Order No. for spares
F 1	Sicherung Netz / Fusible Secteur / Fuse Mains	FF 16 A	
H 1	Kontrolllampe Netz / Lampe témoin Secteur / Pilot lamp Mains		
R 1	Digitalschaltwerk-Sollwert / Sélecteur digital-Valeur de consigne / Digit switch-Setpoint	10 kOhm	
R 2	Sollwert Feinstellung / Réglage précis de la valeur de consigne / Fine adjustment of setpoint	10 kOhm	
S 1	Netzschalter / Interrupteur secteur / Mains switch	25 A 600 V	
S 2	Sollwert-einstellung +/- / Valeur de consigne +/- / Setpoint +/-		
V 1	Triac / Triac / Triac		
X 1	Netzeingang / Entrée Secteur / Mains Input	12 H	

1 2 3 4 5 6 7 8



- A 1 Leiterplatte Niveau
Circuit Imprime Niveau
Printed circuit Level
UL 372
- B 1 Pt 500 Messschalter
PT 500 Sonda de masura
PT 500 Measuring probe
ETP 831
- B 2 Thermolement Oberstromschutzf. BTP 013
Element de chauffe Protect. pour surtemp.
Thermoel. for protection against overheating
- C 1 Motorkondensator 7µF
Condensator
Capacitor
ECA 004
- E 1 Heizkörper
Corps de chauffe
Heater
UH 145
- E 2 Heizkörper
Corps de chauffe
Heater
UH 145
- X 1 Steckleiste
Strip terminal
Borne plate
EZK 864
- X 2 Verbindungskabel zum R 405
Cable de connexion R 405
Connection cable to R 405
UK 186

22.7.92
Zustand

Dr. R. Moberger GmbH & Co. KG

13.11.1991
Bearb. J. Freil
Gepr. J. Freil

Schaltplan

USH 400 / 6
230/400V; 3/N/PE 50Hz

Blatt 1
1 Bl.

1 2 3 4 5 6 7 8

Teil Nr. Pièces No. Part No.	Bezeichnung Désignation Designation	Typ Type Type	Ersatzteilbestell-Nr. No. Ref. pièces détachées Order No. for spares
A 1	Leiterplatte Regelung / Circuit imprimé Réglage / Printed circuit board Control		UL 370
A 1-R 16	Pt 500 Abgleich / Pt 500 Ajustage / Pt 500 Adjustment	200 Ohm	
A 1-R 45	XP-Einstellung / XP-Valeur de consigne / XP-Adjustment	10 kOhm	
A 1-X 5	Multifunktionsausgang / Sortie à multifonction / Multifunction output	42 S	UL 368
A 2	Leiterplatte LED-Anzeige / Circuit imprimé Indication LED / PCB LED Indication		
A 2-H 1	LED-Anzeige Heizen / Indication LED Chauffage / LED Indication Heating		
A 2-H 2	LED-Anzeige Kühlen / Indication LED Refroidissement / LED Indication cooling		
A 2-H 3	LED-Anzeige Heizleistungsbegrenzung / Indication LED limiteur de la capacité de chauffe / LED Indication Heat capacity limiter		
A 2-S 1	Taster Istwert/Sollwert / Touche Valeur réelle/Valeur de consigne / Push button Actual value/Setpoint		
A 2-S 2	Schalter Programmbetrieb Ein/Aus / Sélecteur Programmation March/Arrêt / Switch Programmer operation On/Off		
A 2-S 3	Schalter Kühlen / Commutateur Refroidissement / Push button switch cooling		
A 3	Leiterplatte Niveauanzeige / Circuit imprimé Indication Niveau / PCB level Indication		UL 371
A 3-H 1-10	LED-Anzeige Niveau / Indication LED Niveau / LED Indication Level		
A 3-H 11	LED-Anzeige Störung / Indication LED Perturbation / LED Indication Fault		
A 3-H 12,13	LED-Anzeige Motorraumtemperaturwarnung / Indication LED Signal avertisseur surveillant la température dans la chambre de moteur / Warning signal for engine room temperature		
A 3-R 3	Einstellung Übertemperaturschutz / Ajustage Protection de surtempérature / Adjustment Overtemperature protection		
A 3-S 1	Taster Entsperrn / Touche Déblocage / Push button Reset		UL 407
A 3-S 2	Einstellung Niveauschutz / Ajustage Protection de niveau / Adjustment Level protection		
A 4	Leiterplatte Netz / Circuit imprimé Secteur / PCB mains	30 H	UL 373 UL 346
A 4-X 2	Ausgang für LAUDA Thermostat / Sortie pour LAUDA Thermostat / Output for LAUDA Thermostat		UL 347
A 5 *	Leiterplatte Kühlen / Circuit imprimé Refroidir / PCB Cooling		
A 6	Leiterplatte Extremregelung / Circuit imprimé Régulateur externe / PCB External control		
A 7	Leiterplatte Bedienung Extern / Circuit imprimé Opération externe / PCB Front panel-external controller	200 Ohm	
A 7-R 1	Pt 100 Abgleich / Pt 100 Ajustage / Pt 100 Adjustment		
A 7-S 1	Schalter Anzeige Extern/Intern / Commutateur Affichage Externe/Interne / Push button switch External/Internal display		
A 7-S 2	Schalter Regelung Extern/Intern / Commutateur Réglage Externe/Interne / Push button switch External/Internal Control		
A 7-S 3	Schalter Regelparameter 1/2 / Commutateur Paramètres de régulation / Push button switch Parameters of controller		
A 7-R 4	Einstellung Regelverstärkung Kp / Ajustage Amplification / Adjustment Amplification		
A 7-R 6	Einstellung Korrekturgrößenbegrenzung / Ajustage Sélecteur de correction d'écarts / Adjustment correction limitation		

R 406

Geräteliste Schaltplan
 Liste de pièces Schéma de connexions
 List of parts Circuit diagram

230/400 V; 3/N/PE 50 Hz

Blatt 2

Teil Nr. Pièces No. Part No.	Bezeichnung Désignation Designation	Typ Type Type	Ersatzteilbestell-Nr. No. Ref. pièces détachées Order No. for spares
F 1 F 2 F 3 **	Sicherung Heizung / Fusible Chauffage / Fuse Heating Sicherung Pumpe und Steuerung / Fusible pompe et controle / Fuse pump and control Überstromauslöser Zusatzpumpe / Relais de surintensité pompe additionnel / Overcurrent relay additional pump	B 16 A K 2 A 1,3-1,8 A	EEA 059 EEA 010 ERU 039
H 1	Kontrolllampe Netz / Lampe témoin Secteur / Pilot lamp Mains		
K 1 K 2 **	Schütz Heizung und Pumpe / Contacteur Chauffage et pompe / Contactor heating and pump Schütz Zusatzpumpe / Contacteur pompe additionnel / Contactor additional pump		ERL 014 ERL 014
Q 1	Hauptschalter / Interrupteur général / Main switch		ESP 009
R 1 R 2	Digitalschaltwerk-Sollwert / Sélecteur digital-Valeur de consigne / Digit switch-Setpoint Sollwert Feineinstellung / Réglage précis de la valeur de consigne / Fine adjustment of setpoint	10 kOhm 10 kOhm	EST 056
S 1 S 2	Schalter Umwälzpumpe / Commutateur pompe circulation / Switch circulating pump SollwertEinstellung +/- / Valeur de consigne +/- / Setpoint +/-	25 A 600 V	
V 1	Triac / Triac / Triac	16 A Stakel 2 Stakel 200	EQK 004 EQD 037 EQD 032
X 1 X 12 • X 13 • X 16 **	Netzleitung / Entrée Secteur / Mains Input Ausgang 24 Hz; MV Wasser / Sortie 24 Hz; MV Eau / Output 24 Hz; MV Water Ausgang 25 Hz; MV Öl / Sortie 25 Hz; MV Huile / Output 25 Hz; MV Oil Ausgang Zusatzpumpe / Sortie Pompe additionnel / Output additional pump		
•	Option MVH / Option MVH / Option MVH		
**	Option Zusatzpumpe / Option Pompe additionnel / Option additional pump		