M–301 *Precision Oil Bath*

Operation Manual

MEATEST

Content

1. Basic information

An oil thermostat is a device which is able to keep selected temperature of a work liquid of a total volume of 55 litres with a great accuracy. It is especially determined for tempering standards of electric quantities, for calibrating thermometers and temperature scanning sensors. All thermostat functions are operable on interface bus GPIB. Possibility of a system operation even enables an active control of a temperature rise slope. The thermostat is equipped with several protections, which automatically disconnect all power elements in a case of detection of any anomaly when running. It is equipped with STBY mode which enables holding of the working liquid temperature within a selected tolerance zone even when a proper thermostating is disconnected. A DAY mode switches over the thermostat function from a thermostating function into a STBY function at an in-advance programmed hour A controlling electronics contents hours of area) time.

Basic temperature range of the thermostat covers range from Tamb-5 ^{o} C to 55 ^{o} C at ambient temperature within the range 20 to 25 ^{o} C.

2. Content of delivery

Basic delivery packing contains following items.

Precision oil thermostat M301	1 pc
Operation manual	1 pc
Power line cable	1 pc
Spare fuse	1 pc

3. Specification

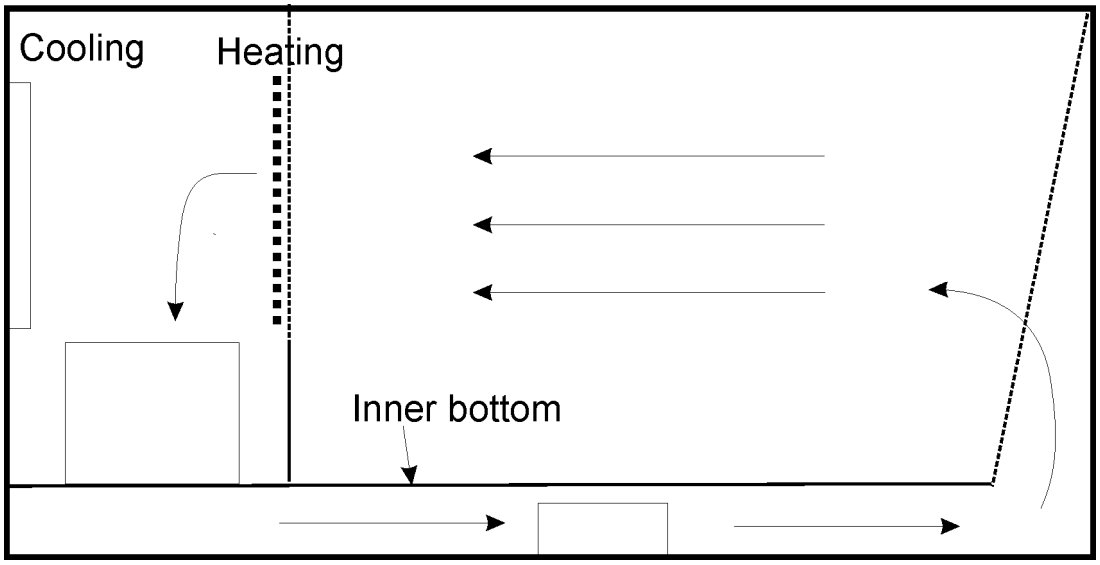
Range of reachable temperature	$T_{ambient}$ - 5 to +55^{o} C
Cooling slope at a difference of oil and ambient	approx. 1,5 ^{o} C / hour *

* Parameter can differ depending on type of working liquid

Non-homogeneity of a temperature field inside working space	0,01° C max.
Temperature stability after settling	+/- 0,002° C / 5 hours
Temperature adjustment accuracy of z;working liquid in range ± 5 ° C from calibration point	0,05° C
Working space dimensions	440 x 325 x 250 mm
Overall dimensions	1145x500x370mm
Power input of heating element	350 VA
Power input of cooling elements	150 VA
Power line:	220-230V / 50- 60 Hz
Range of working temperatures:	20 to 28° C
Recommended working liquid:	paraffinum liquidum
Fuse:	F4AL250V

4. Operating principles

Device can keep temperature of working liquid on pre-set value with high stability. According to pre-set working temperature value and ambient conditions, positive thermal energy (heating) or negative thermal energy is delivered into liquid. Heating is wire wound module directly heated working liquid. Cooling is solid state based on Peltier effect. Only positive thermal energy is continuously regulated to keep working temperature steady. Block diagram is shown on figure bellow.



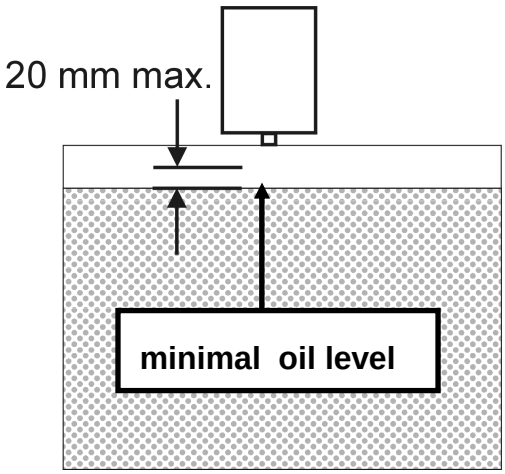
Working liquid streams from right side to left side to the space with motor unit. Motor propeller inducts liquid from working space across heating winding and pushes it under the inner bottom. Under this bottom liquid is transported back to the right side. Here it comes out back to the working space through side net. Temperature sensors of temperature control are located under inner bottom.

5. Installation

1) Place oil bath on working table in horizontal position with maximal rake 3 °. Leave area around side cover with ventilation holes and fans free to enable sufficient cooling of power electronic parts inside.
2) Install upper unit with motor and propeller, if it is not installed yet. Take unit and insert it into the bath so that rotor with propeller lays in circular hole in inner bottom. Fix cover plate with four screws.
3) Connect cable to the connector on topside of the unit on one side and to the connector on topside of wooden box on the other side.
4) Ensure, that outlet hose is closed. End of outlet hose is located inside in space with power electronic. To make access to the hose, side cover with ventilation fans must be removed. Dismount 6 screws from the side net and open remove it. End of hose is located on the top right side. Outlet hose is closed with rubber plug.

Note: When oil bath is delivered, output hose is closed. It is not necessary to remove side cover and check it.

5) Fill bath with working liquid from the topside. After filling oil level must be above side net of motor unit and must not exceed level 2 cm above margin of the net, see picture.



Note: It is prohibited to run oil bath with insufficient amount of working liquid. Heating inside motor unit can be damaged.

6) Connect power line cable to the power line socket. Use 230V/50-60 Hz power line voltage.

WARNING

Thermal energy is delivered to the working liquid via wire heating connected directly to the power line voltage. Wire heating is located on the motor unit, from its inner side and it is mounted on side net wall.

Use of dirty liquids or liquids with flowing solid pieces of a material is dangerous.

It is strictly recommended to use oil with high isolation resistance as working liquid. It is prohibited to use liquids with low isolation resistance like water, alcohol, etc.

It is prohibited to manipulate with conductive objects in space behind net wall of motor unit.

WARNING DANGEROUS

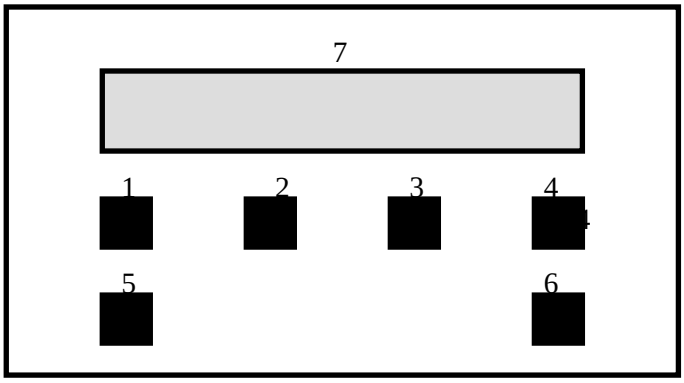
It is prohibited to switch on thermostat without appropriate liquid charge inside.

Steel bath and all metal part as well are galvanically connected to the power line ground terminal. It is recommended to isolate objects to be tempered inside bath from metal bath to avoid electrical noise during precise measurements.

6. Operation

6.1 Control and indication elements

Oil bath contains two panels with buttons, connectors and display. Main panel is located on top side of electronic unit. On the panel there is display and six buttons with following meaning:



1 cursor button lefts

2 cursor button up

3 cursor button down

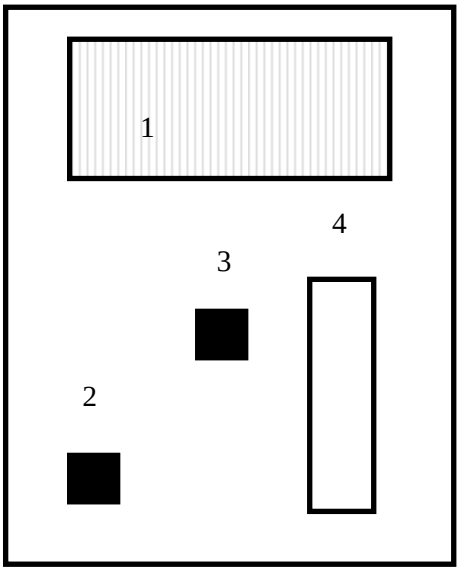
4 cursor button rights

5 MENU button

6 ENTER button

7 Two-rows LCD display

Second panel is located on the side wall of wooden box and it contains power line switch, GPIB connector and LOCAL button.



1. ventilation holes
2. power line switch
3. LOCAL button (used to return to manual mode from remote mode)
4. GPIB connector

6.2 First start

1. Connect power line cable to the socket.

2. Push power line button on the side wall to switch oil bath on.

3. After switching instrument on power line button is lit, bath beeps and electronic unit display is illuminated. Following information is displayed for approximately 3 seconds:

Oil Thermostat M-301 ***** MEATEST *****

During this period, microcontroller is checking internal memory.

4. When electronic unit is ready for operation, display starts to indicate basic status of last used function mode. New instrument is delivered from manufacturer with last used mode “OFF”. Display indicates status of power electronic modules (motor, heating, cooling) in this case:

MOTOR OFF HEAT OFF **COOL OFF**

6.3 Thermostat control

All functions are controlled by internal microcomputer. Information about status, pre-set values, set-up configuration, etc. can be recalled and displayed on two-rows LCD front panel display. Manual control is accessible via six front panel buttons and system of Menus. Buttons 1, 2, 3, 4 are determined for moving the cursor in MENU display and increasing or decreasing values. Active position of cursor is signalised with blinking quadrate.

ENTER button serves for confirmation and saving actually displayed values. MENU button is used for recalling system of MENU.

6.3.1 Main MENU

Basic MENU can be recall by pushing the button MENU. After pushing the button following form will appear:

OFF TERM STBY DAY **SET CAL TEST RET**

Cursor sign is blinking on letter “O” of OFF item. With cursor buttons any of items can be selected. After selecting requested item confirmation must be performed by pushing the button ENTER.

On the upper row MENU offers following basic modes of operation:

- OFF all power devices (motor, heating, cooling) are switched off
- TERM thermostating
- STBY standby mode
- DAY day mode

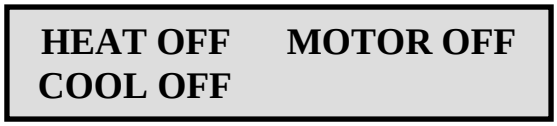
And following set-up items:

- SET pre-set of parameters
- CAL one-point calibration
- TEST auxiliary test procedures
- RET return to basic MENU

If there is no handle with button in any MENU mode for more than 20 s, control of instrument returns back to indication of last selected operation mode. Even if changes of parameters are currently done in a MENU mode, thermostat is keeping last selected operation mode.

6.3.2 OFF operation mode

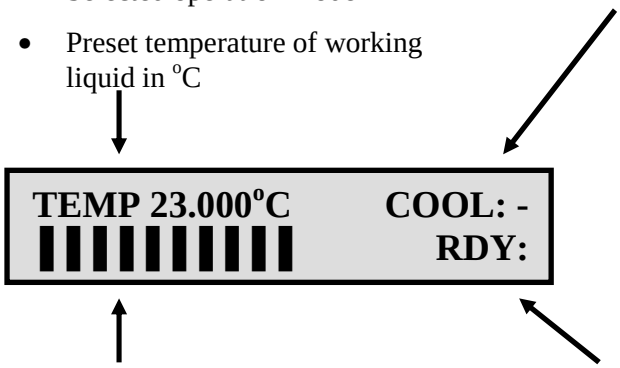
In operation mode OFF all power devices, i.e. motor, heating and cooling are switched off. All other electronic is activated. OFF mode serves for handling with thermostat like setting parameters, changing configuration while all power equipment are disconnected. Display is showing following form:



6.3.3 TERM operation mode

TERM operation mode is basic mode of the instrument. Thermostat is tempering working liquid inside bath and keep it on pre-set temperature Toil . Display shows information similar to following picture:

- Selected operation mode
- Preset temperature of working liquid in °C



Label COOL with indicator „-„ or „+“. It expresses if cooling is on or off.

„+“ indicator means that cooling is actually ON, „-„ indicator means, that cooling is OFF.

Semianalogue indiactor of heating status.

Indicator is created with line of squares. The longer line is displayed, the higher power is transfered into working liquid. 7

Information, if thermostat has reached already preset working temperature.

„-“ means „not ready“.

„+“ indicator means „ready for use“. Preset temperature has been reached. Temperature inside the bath is stable.

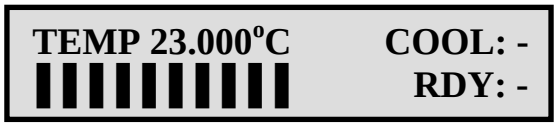
Normally „+“ indicator will appear in 10 minutes after the the first achieving the preset working temperature.

Note: Heating indicator indicates thermal power, which is delivered via heat wir into working liquid. Length of bar relates to the quantity of thermal power. For values Toil bellow 30 ºC maximal length is 4 squares, for Toil above 30 ºC length is maximal 9 squares. For Toil above 40 ºC cooling is always switched off.

They can occur three basic statuses in TERM mode:

- **T_{oil} > T_{real}**

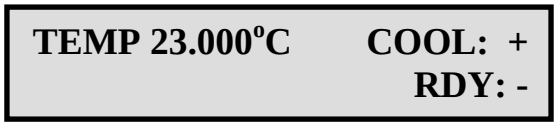
  Temperature is not steady. Thermostat is heating to increase temperature of working liquid. On display following information is displayed:



COOL: -	Cooling is switched off.
▌▌▌	Heating is on with highest power.
RDY: -	Thermostat is not ready.

- **T_{oil} < T_{rael}**

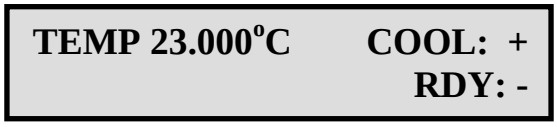
Temperature is not steady. Thermostat is cooling to decrease temperature of working liquid. On display following information is displayed:



COOL: +	Cooling is switched on.
▌▌▌	Heating is switched off.
RDY: -	Thermostat is not ready.

- **T_{oil} = T_{real}**

  Temperature is steady. Thermostat is tempering working liquid. On display following information is displayed:



COOL: + or -	Cooling is switched on or off depending on actual need.
▌▌▌	Heating is switched on or off depending on actual need.
RDY: +	Thermostat is ready.

For slight short time stabilization of working liquid thermostat regulates heating only. Under normal condition heating indicator on the display is appearing with period from 5 s to 30 s depending on actual Toil, T_{amb} temperatures. During temperature stabilization cooling is always only on or only off. If cooling is on or off depends on absolute difference between pre-set values Toil, $T_{amb.}$ Both values Toil, T_{amb} must be pre-set in MENU (see later).

6.3.4 STBY operation mode

In this operation mode thermostat does not stabilize temperature of working liquid with the highest precision. Power devices are normally in off status. But thermostat looks about temperature inside. If measured temperature overcrosses pre-set limits, thermostat is switched to the TERM operation mode for a period necessary to reach Toil temperature. When Toil temperature is reached, thermostat comes back to OFF (sleepy) mode. All power devices are switched off again. Limits of the temperature band can be set up in MENU.

Temperature inside is measured via auxiliary diode thermometer during OFF period. Measurements are taken every 30 minutes. Before this measurement motor is started for 1 minute to homogenize temperature field inside the bath.

Operation mode is suitable for long term use, especially in time, when measurements of tempering objects inside is not performed. STBY mode enables to reduce power consumption of the thermostat and hereto to avoid temperature “cycling” of objects inside. It is suitable to use STBY mode, if course temperature cycling is supposed during switching off the thermostat. It can occur especially, when

difference between Toil and T_{amb} temperatures higher than 1.5 ^{o}C is and thermostat is to be used in working ours only and not used out of working ours.

Display looks as follows in STBY mode:

STBY 23.000^{o}C	**COOL: -**
Ttol=1.5^{o}C	**RDY: -**

It displays:

STBY T_{oil}	pre-set working temperature
T_{tol} = xx.x ^{o}C	tolerance band around T_{oil} temperature which must not be exceeded
COOL: -(+)	status of cooling
RDY: -	not ready for use

6.3.5 DAY operation mode

DAY operation mode combines STBY and TERM modes. Two clock values must be entered in appropriate MENU/SET item. In these pre-set time points thermostat is switched from STBY to TERM mode and back to STBY mode. DAY mode is suitable for non-interrupted operation. It can be programmed so that, during day thermostat is in TERM mode and it is ready for use and during night it is in STBY mode.

Form of display is similar to the STBY and TERM mode, but instead of label TERM/STBY DAY symbol is shown.

6.4. Parameters setting

For parameters setting item SET in main MENU is determined. Recall main MENU by pushing MENU button and place cursor on symbol SET. Confirm by pushing ENTER button.

Following form will display:

Toil	**Tamb**	**Ttol**	**DAY**
RTC	**GPIB**	**RET**	**RET**

One of following parameters can be set-up:

- Toil working temperature of liquid.
- Tamb ambient temperature in the laboratory. It is setting-up manually.
- Ttol width of tolerance band, which temperature of liquid should not come over.
- DAY setting-up of time points of DAY mode

- RTC setting-up of real time clock
- GPIB GPIB address of the thermostat
- RET return to previous MENU

To select a required parameter place cursor in its symbol and confirm by ENTER button.

Here set parameters are saved in backup memory. Switching off the thermostat does not influence their setting.

Note: During setting the parameters, last time selected operation mode with old parameters is in process until new entered parameters are not confirmed.

6.4.1 Working temperature

When selected item Toil, following display is shown:

Set oil temperature:
Toil (^{o}C) = x x . x x x

Working temperature can be used with resolution 0.001^{o}C. Use left/right cursor buttons to place cursor on required position and up/down buttons to change value. After setting new value, push ENTER to confirm validity of new data. Thermostat comes back to main MENU.

Range of allowed values is from 15 to 55 ^{o}C.

6.4.2 Ambient temperature

When selected item Tamb, following display is shown:

Set amb. temperature:
Tamb (^{o}C) = x x

Use left/right cursor buttons to place cursor on required position and up/down buttons to change value. After setting new value, push ENTER to confirm validity of new data. Thermostat comes over back to main MENU.

Range of allowed values is limited from 20 to 29 ^{o}C. Setting is not critical. Accuracy about +/-2^{o}C is enough for proper function.

Note: Ambient temperature value is used by internal microcontroller to guess, if cooling have to be switched on or off. Status of cooling depends on difference between Toil and Tamb. If the difference Toil – Tamb is higher than about 7 ^{o}C, cooling is not switched on at all. Physical thermal lost of the bath with oil is high enough due to non-ideal thermal isolation to keep working temperature on the pre-set value.

6.4.3 Tolerance temperature

When selected item Ttol, following display is shown:

Set tol. temperature:
Ttol (^{o}C) = x . x

Use left/right cursor buttons to place cursor on required position and up/down buttons to change value. After setting new value, push ENTER to confirm validity of new data. Thermostat comes back to main MENU.

Tolerance temperature is used in STBY mode only. Its value creates temperature band around Toil, which are not to be exceeded in STBY mode. Range of allowed values is limited from 0.5 to 5.0 ^{o}C.

6.4.4 DAY time

When selected item DAY, following display is shown:

xx : xx	**A**
yy : yy	**B**

Use left/right cursor buttons to place cursor on required position and up/down buttons to change value. After setting new value, push ENTER to confirm validity of new data. Thermostat comes back to main MENU.

"xx.xx" presents time data in 24 hours format, which thermostat come over from operation mode B to operation mode A.

"yy.yy" presents time data in 24 hours format, which thermostat come over from operation mode A to operation mode B.

Following operation modes can be selected for A and B: TERM, STBY, OFF

Clock values are used in DAY operation mode only. If more complicated control of thermostat is required, remote control via BPIB bus can be used.

6.4.5 Real time clock

Real time clock and actual date can be set here in 24 hour format.

When selected item RTD, following display is shown:

SET REAL TIME CLOCK :
(HH:MM:SS) xx:yy:zz

Use left/right cursor buttons to place cursor on required position and up/down buttons to change value. After setting new value, push ENTER to confirm validity of new data. Date display is shown:

SET DATE :
(YY:MM:DD) xx/yy/zz

Set actual date and confirm by pushing ENTER. Thermostat comes back to main MENU.

6.4.5 GPIB address

When selected item GPIB, following display is shown:

SET GPIB ADDRESS :
VALUE (dec) : xx

Use left/right cursor buttons to place cursor on required position and up/down buttons to change value. After setting new value, push ENTER to confirm validity of new data. Thermostat comes back to main MENU.

GPIB address is in decimal format. Range of values is limited from 00 to 31. GPIB address is important, if the thermostat is use in remote mode with computer control. Pre-set value is 02.

Note: GPIB is standardized communication bus for connection among measuring instruments and computer.

6.5. Calibration

Thermostat enables to perform one-point calibration. One-point calibration means that thermostat temperature scale can be adjusted in one temperature point, usually working temperature.

Note: Main temperature sensor consists of pair of precise and long-term stable thermistors. Termistors are located in space under inner bottom. Non-linearity of thermistors temperature dependency is saved in internal memory and is compensated.

Calibration data is protected with password. Without entering correct password new calibration cannot be performed. Calibration code can be changed in item MENU/TEST.

Calibration procedure:

Required instruments: standard thermometer with accuracy better than 0.01 %

Procedure:

- Place sensor of standard thermometer into the bath. Keep sensor at minimum 10 cm bellow liquid level
- Set Toil to the value, where calibration is to be done, select TERM operation mode and leave thermostat to stabilize temperature. Calibration is recommended to be performed min. 30 minutes after reaching working temperature.

- Recall main MENU by pushing the button MENU.
- Select item CAL and confirm by button ENTER.
- Calibration password is requested:

CALIBRATION
CODE : x x x x x x

Note: Pre-set password after manufacturing is "000000".

- Enter correct password and confirm by pushing the button ENTER. If password is not correct, message "Wrong calibration code" is displayed and thermostat returns back to main MENU.
- If password is correct display form with calibration value is shown:

CALIBRATION POINT:
Toil = x x. x x x ^{o}C

- Read value on standard thermometer. Write this value to the window "Calibration point". Confirm by pushing the button ENTER.
- New calibration value is saved into memory. Message "Write to memory. Please wait …" is displayed during saving. After successful saving thermostat returns back to the main MENU.

Calibration can be performed only, if thermostat is in operation mode TERM or DAY/TERM. Calibration cannot be performed, if temperature of liquid inside bath is unstable, i.e. READY indicator on display indicates "-".

6.6. Test function

In TEST features, there is available auxiliary function. TEST menu can be recall by pushing the button MENU and selecting item TEST. Following form will appear:

DNr	**CODE**	**Tinf**	**SERV**
CAL	**KBD**	**INFO**	**RET**

On the upper row following features are accessible:

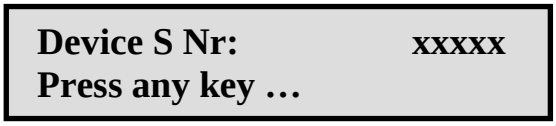
- DNr displays device serial number.
- CODE calibration code modification
- Tinf temperature of auxiliary thermometer
- SERV service function
- CAL date of last calibration

- KBD beeper setting
- INFO displays model name
- RET return to the main MENU

To recall function place cursor on the appropriate label and push the button ENTER.

6.6.1 Device serial number

Device serial number can be displayed here. It cannot be changed. To return back to the main MENU press any key.



6.6.2 Calibration code

Users defined calibration code can be entered here. After manufacturing calibration code in form "000000" is saved in memory. Once non-zero calibration code is entered, this function is not accessible further. It is recommended to make a note of non-zero calibration code. In case of calibration code loss initialization must be performed to refresh calibration code "000000".

Note: Calibration code serves as protection against changing of calibration data by non-competent person.

Procedure:

- Recall main MENY, place cursor on item TEST and push the button ENTER.
- Select item CODE, push the button ENTER.
- Change 6 digit number "000000" to a new users defined number. Use down/up, right/left buttons. Confirm new calibration code by pushing the button ENTER.
- Thermostat returns back to main MENU. New calibration code is valid to access into calibration function.

6.6.3 Auxiliary thermometer

This function enables to measure temperature inside the bath with auxiliary thermometer. Diode sensor of this thermometer is located under inner bottom. Measured values are used by microcontroller to evaluate thermal condition in thermostat. As result of it, microcontroler decide whether to switch cooling on or off.

Tinf = xx.x °C
Press any key …

Next function is of the auxiliary thermometer is additional thermal protection of the working liquid against non-required overheating in case of any failure.

Recall function from main MENU by placing cursor on name Tinf and confirm by ENTER. After recalling the function, one reading of temperature is performed and result is displayed on display. Press any key to return to main MENU.

6.6.4 Service function

This function is for service use only. It can be entered after code “999999”. In service menu there is information about internal circuits.

Note: *It is strongly recommended not to enter to the items in service menu. Un-appropriate control can damage electronic circuits.*

The only item which can be used without danger of damage is CODE function, where actually valid calibration code is written to read calibration code

6.6.5 Date of last calibration

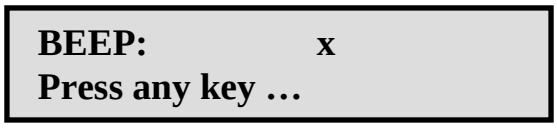
In this function date and nominal calibration point of last calibration can be displayed. Value is for information only and it cannot be changed.

Date (YY/MM/DD) xx/yy/zz
Point: xx.xxx °C

Recall function from main MENU by placing cursor on name CAL and confirm by ENTER. After recalling the function, above shown display will appear. Press any key to return to main MENU.

6.6.6 Beeper

In this function beeper sound when pushing any button can be switched on or off. It does not effect alarm acoustic signalization.



Recall function from main MENU by placing cursor on name KBD and confirm by ENTER. After recalling the function, above shown display will appear. Change status by up/down buttons and confirm by ENTER.

6.7. Initialisation

Anytime, configuration of parameters in thermostat can be refreshed to the status, which is pre-set in manufacturer facility. This feature can be of good use, if parameters were changed and original setting is required.

Initialization can be started only when thermostat is switched off.

Procedure:

- Switch off thermostat
- Push both buttons ENTER, MENU, hold them pushed and switch on thermostat with power line switch on the side panel.
- Display will show following form for about 10 seconds:

After initialization following parameters are set:

Operation mode:	OFF
Toil:	20.000 °C
Tamb:	23 °C
Ttol:	0.5 °C
Time DAY 1:	6:00 TERM
Time DAY2:	14:30 OFF
GPIB address:	02
Calibration code:	000000

Initialization does not influence real time clock setting (RTC parameter).

WARNING

During initialization users entered calibration data are lost and replaced with original calibration data.

6.8. Error messages

Thermostat can display error messages, when non-proper operation is observed or if wrong commands are used on GPIB bus when it is in remote mode.

Cal. code wrong RTC **Press any key …**	Not correct password was entered in access to calibration function
Temp out of range ! **Press any key …**	User's error. Attempt to set Toil temperature out of allowed interval. Enter correct value.
No TERM Mode **Press any key …**	Users error. Attempt to start calibration while thermostat is not in TERM operation mode. Set TERM operation mode.
Temp. Is not stable ! **Press any key …**	Attempt to start calibration while working liquid temperature is not stable. Thermostat is not ready. Wait for ready status (RDY: +).
Temp. over range ! **System halted.**	Thermostat error. Auxiliary diode thermometer indicates at minimum 5 ºC temperature of working liquid higher that Toil pre-set value is. Thermostat is showing above message and it is beeping. It is switched to operation mode OFF at the same time automatically. The only possible control is to switch it off. Wait 5 second and switch it on again. If the same error will occur again, contact manufacturer.

Note: *This error message indicates suspicious differences between Toil set value and real measured. The reason of this function is to protect objects inside the bath against overheating in case of course failure in thermostat control.*

Bad route to analog. board	Thermostat internal error. Switch it off and on again.
Status delay 7109. System halted.	Thermostat internal error. Switch it off and on again.
ADC 7109 over range System halted.	Thermostat internal error. Switch it off and on again.
Negative Tinf. System halted.	Thermostat internal error. Switch it off and on again.

When any of internal error will occur, thermostat is showing error message, it is beeping and it switches over to operation mode OFF. The only possible control is to switch it off. Wait 5 second and switch it on again. If the same error will occur again, contact manufacturer.

7. GPIB interface

Thermostat can be controlled in remote mode via standard GPIB bus (IEEE 488). Interface connector is located on side wall near power line switch.

According to IEEE 488 standard, thermostat can execute following functions:

SH1, AH1, T5, RL1, DC1

In table bellow there is shown list of commands.

Code	*meaning*	*parameter/mode*	*string*
A	Tamb ambient temperature	A ambient temperature in ºC	A xx
B	Ttol temperature tolerance	B temperature tolerance in ºC	B x.x
M	Operation mode	Operation mode OFF	M0
		Operation mode TERM	M1
		Operation mode STBY	M2

		Operation mode DAY	M3
T	Toil, working temperature	T working temperature in ºC	T xx.xxx
V	Status checking	Toil, working temperature	V0
		Tamb, ambient temperature	V1
		Ttol, temperature tolerance	V2
		Device serial number	V3
		Active operation mode	V4
		Time	V5
		Date	V6

Thermostat is controlled with string of commands and parameters in format A X A X A X, where A is code of function and X is parameter/status.

Output string format:

Function	*Output format*
V0	_T XX.XXX CR LF
V1	_A XX.XXX CR LF
V2	_B XX.XXX CR LF
V3	_V XXXXX CR LF
V4	_M (0/1/2/3) CR LF
V5	_R HH:MM:SS CR LF
V6	_D YYYY.MM.DD CR LF

Input string format:

Format for set-up commands is as follows:

A xxx CR (B xxx CR) (T xxx CR)

where xxx is set value in decimal or exponential format.

8. Termostat description

Electronic parts are divided between power part with power devices and control circuits. Power part is located in left side beside bath, control unit is located on upper panel.

8.1 Temperature regulator

Temperature regulator is located one PCB and is mounted from rear side of electronic unit with display. Regulator senses actual temperature in bath. Couple of thermistors located under inner bottom is used.

Main part of regulator is created with low-frequency oscillator. Its point of stability is controlled via feedback chain consisting of voltage amplifier with temperature dependent gain, digitally controlled high precise 20-bit divider and autotransformer with ratio 1:2. Oscillation are detected and information is led into microcontroller unit. This unit located on next PCB collects all information and control switching of power devices, ensure communication on GOIB bus, control front panel display and senses status of buttons. To the processor unit auxiliary diode thermometer is connected too.

8.2 Power devices

Supplying of power devices. i.e. motor, heating and cooling is located in separated space left side. Also main power switch formed by electromagnetic relay is here. On PCB there are located power rectifiers, transformers and opto-triac switching system. As source of cooling serves block of Peltier cells, integrated with fan and radiator. Peltier cells are mechanically mounted directly on side wall of the bath. Heating is located on motor unit. It is wired from Kanthal flat wire. Heating and motor are supplied over short cable on the upper side of thermostat.

Electronic circuits are protected with fuse, which holder is integrated with power line socket.

8.3 Mechanical construction

Basic mechanical component is inner oven made from non-corrosive steel. On one side wall Peltier cells are fixed. In the oven next inner bottom and inner hips are placed. On left side motor unit connected with other electronic is installed. Temperature sensors are located under inner bottom in the centre. Cables from sensors are led under the bottom and through hole in upper side of oven to the space with control unit.

Steel oven is thermally isolated with polystyrene sheets and polyurethane foam and it is mounted into wooden box. Wooden box cannot be dismounted.

In left side separated space for power electronic supplying is located. This space is covered by steel net. On the net two auxiliary fans are mounted. In the space with power electronic also end of output hose is fixed.

9. Maintenance

Thermostat is device which should be periodically revised. Especially cleanness of working liquid must be observed periodically. During operation working liquid become partially polluted usually from dust and fine contamination. It is necessary time to time clean inner oven and exchange working liquid. Exact interval depends on frequency of use and cleanness of ambient air in laboratory. At minimum it is recommended to check liquid cleanness ones per two years.

9.1 Motor unit removing

To remove motor unit follow the instruction:

- Switch thermostat off, remove power line cable from socket.
- Disconnect cable between power electronic unit and motor unit. To release it push small knob on connector body.
- Remove 4 screws on motor unit upper side. Use screwdriver.
- Pull slightly motor unit up, keep vertical direction during moving up.
- Place unit on a table with steel net face down.

Access to heating and rotor with propeller is possible now.

9.2 Fuse exchanging

Fuse is located in power socket . To exchange fuse use following procedure:

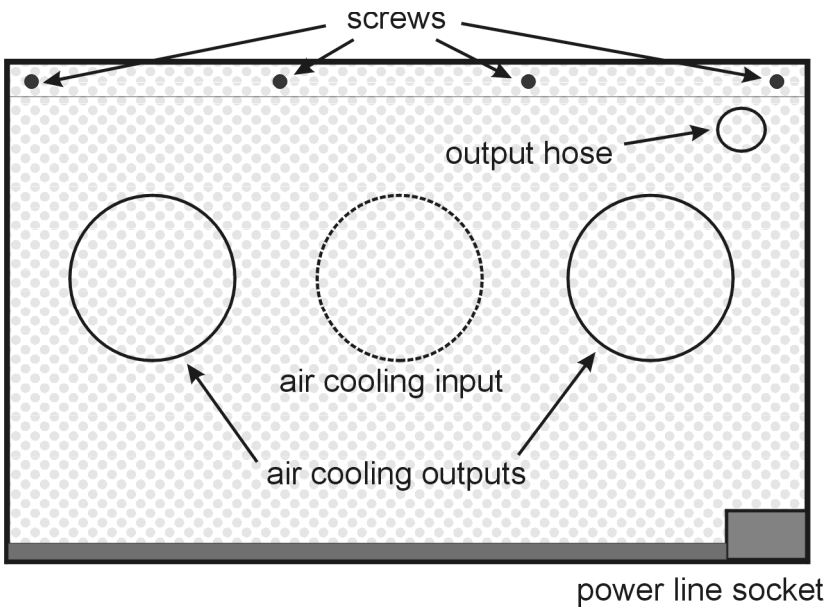
- Switch thermostat off, remove power line cable from socket.
- Pull out fuse holder, which is placed from outside on bottom of the socket. Use screwdriver for easier removing.
- Throw up fail fuse and insert new one with the same nominal current/voltage parameters.

9.3 Cleaning

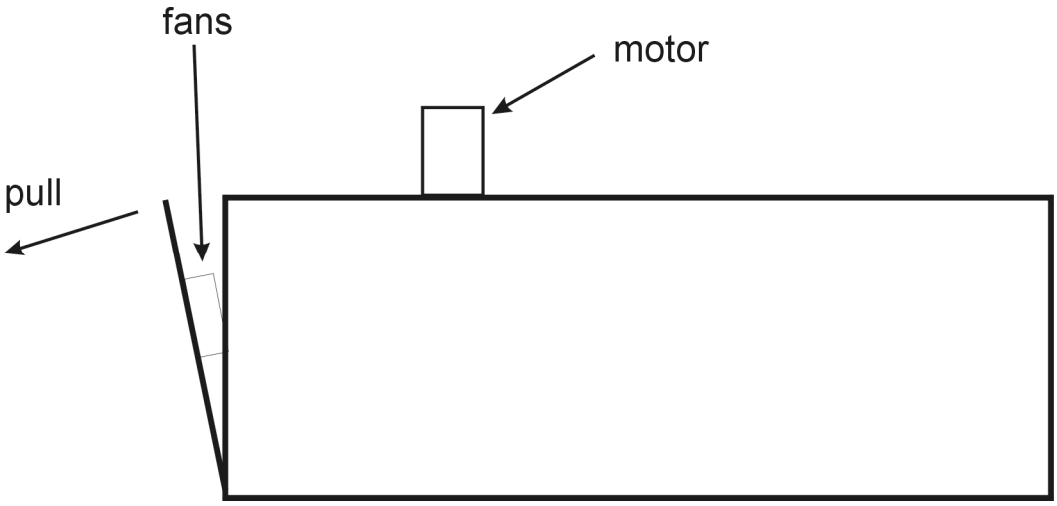
Cleaning of oil bath, including exchanging working liquid is recommended to perform at minimum one per two years. Before cleaning liquid must be sewed and motor unit removed.

1. Working liquid sewing

- The first dismount 4 screws from the cover of power electronic. It creates one side wall.

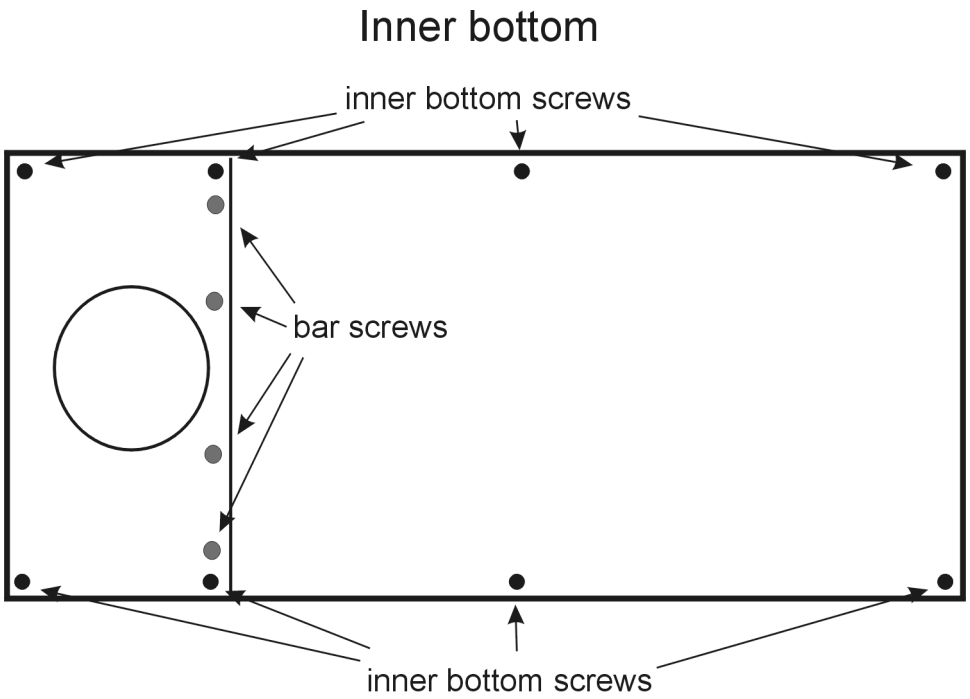


- When screws are removed, pull the net wall on upper side out.



- Put the cover on the table. Cover is connected with power electronic with several cables. Also auxiliary fans are connected with cables. All these cables are not necessary to disconnect.
- Take hose out, remove plug from its end and place end of hose to a barrel to collect liquid. Barrel has to be placed in horizontal position under thermostat level to sew liquid. Total amount of liquid is about 55 l. Barrel must be of appropriate larger size to avoid break liquid away.

2. Motor unit removal
   - Disconnect cable between power electronic unit and motor unit. To release it push small knob on connector body.
   - Remove 4 screws on motor unit upper side. Use screwdriver.
   - Pull slightly motor unit up, keep vertical direction during moving up.
   - Place unit on a table with steel net face down.
3. Inner bottom removing
   - Dismount 4 screws which fix bar sheet. Remove it out.
   - Dismount 8 screws in the inner bottom.



- Now inner bottom can be easily removed. Throw it up in direction to electronic control panel.

Now thermostat is ready for cleaning. It is recommended to use dry cotton suite and wipe out whole oven until is clean and dry. If there is small solid dirt like fibers on steel net either in oven or on

motor unit, they must be put away carefully. Heating can be cleaned also with dry suite and if it is hardly polluted, spirit can be used too.

Note: Cleaning around temperature sensors must be done carefully to damage them. Temperature sensors are located under steel tin holder in the centre of bottom.

After cleaning thermostat can be completed in the same way. Do not forget to insert plug into output hose and fix it in original position, i.e. end of the hose must be higher than maximal liquid level in the bath is.