# USER-MANUAL
## TV2500

**Tamson Instruments bv**

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# 1 SAFETY AND WARNINGS

**Make sure before installing or operating the equipment to read and understand all instructions and safety precautions listed in this manual. If there are any questions concerning the operation of the equipment or about the information given in this manual please contact your local dealer or our sales department first.**

Performance of installation, operation, or maintenance other than those described in this manual may result in a hazardous situation and may void the manufacturer's warranty.

Never operate equipment that is not correctly installed. Unqualified personnel must not operate the equipment. Avoid damage to the equipment, or its accessories, caused by incorrect operation.

Important:
When performing service, maintenance or moving the apparatus, always disconnect the apparatus at the main's socket,
Proper skilled and trained personnel are only allowed to operate this equipment,
Take notice of warning labels and never remove them,
Refer service and repairs to qualified technician,
If a problem persists, call your supplier or Tamson Instruments b.v.

# 2 WARRANTY

Tamson Instruments b.v. warrants that all their manufactured equipment is free from defects in material and workmanship, preventing the machine from normal operation. Tamson Instruments b.v does not warranty that the equipment is fit for any other use than stated in this manual. The manufacturer can only be held responsible for the security, reliability and performance of the equipment, when operated in accordance with the operating instructions, extensions, adjustments, changes and/or if repair is performed by Tamson Instruments b.v. or authorized persons only. This warranty is limited to one year from the date of invoicing. All equipment and materials are subject to standard production tolerances and variations.

## 3 EC declaration of conformity

Manufacturer: Tamson Instruments b.v.
van 't Hoffstraat 12
2665 JL Bleiswijk
The Netherlands

Product: Thermostatic bath
Model: TV2500

We declare that the product mentioned above conforms to the essential's exigency of the directive 2006/42/EC relative to machinery, directives 2004/108/EC relatives to electromagnetic compatibility and directive 2006/95/EC relative to low voltage.

The products are in conformity with the following specifications:
EMC (2004/108/EG)

| | |
|---|---|
| Conducted emission | - EN55016-2-1 + EN61326+A1 |
| Radiated emission | - EN55016-2-3 + EN61326+A1+A2+A3 |
| Harmonics | - EN61000-3-2 |
| ESD | - EN61326 +A1+A2+A3 and EN61000-4-2 +A1+A2 |
| Radiated immunity | - EN61000-4-3 +A1 |
| Electrical Fast Transients | - EN61000-4-4+A1+A2 |
| Surges | - EN61000-4-5+A1 |
| Conducted immunity | - EN 61000-4-6+A1 |
| Voltage dips and Voltage variations | - EN61000-4-11 +A1 |

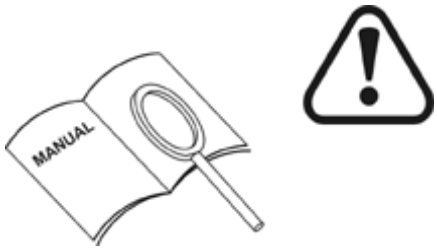
Low voltage (2006/95/EC):
Safety requirements for electrical equipment for measurement, control, and laboratory use Part 1, General requirements,
EN 61010-1-2010
Safety requirements for electrical equipment for measurement, control, and laboratory use Part 2, Particular requirements for laboratory equipment for the heating of material,
EN 61010-2-010-2003
Machinery directive (2006/42/EC)
2006-42-ec-2nd-2010

2010 Tamson Instruments b.v., The Netherlands,

Name : R.C. van Hall
Function : Director

# 4 PRECAUTIONS AND HAZARDS

**Before attempting to operate the bath read all parts of this manual carefully to insure smooth operation and avoid damage to the equipment or its accessories.**




**READ CAREFULLY**

If a malfunction occurs, consult section "TROUBLE SHOOTING" page 22 at the end of this manual.
If problem persists, call your supplier or Tamson Instruments b.v. Never operate the equipment if not correctly installed. The equipment must be operated only by qualified personnel. Avoid damage to the equipment or its accessories through incorrect operation.

# 5 INSTALLATION

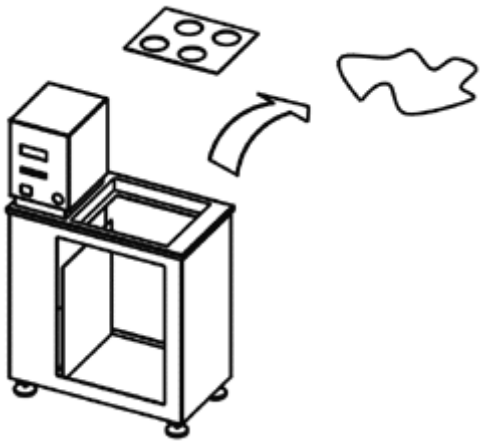
## 5.1 Important

Tamson Instruments b.v. is not responsible for any consequential damage or harm caused by using this bath. Repairs on the electrical system of the bath may only be carried out by well trained and authorized persons.

## 5.2 Unpacking

Before leaving the factory Tamson baths are adequately packed to prevent damage during normal transportation. Check the packing for external damage and make a note on the shipping documents if any damage is found. Always retain the cartons and packing material until the bath has been tested and found in good condition. (Transport companies generally will not honor a claim for damage if the respective packing material is not available for examination).

**REMOVE ALL PACKAGE MATERIAL**



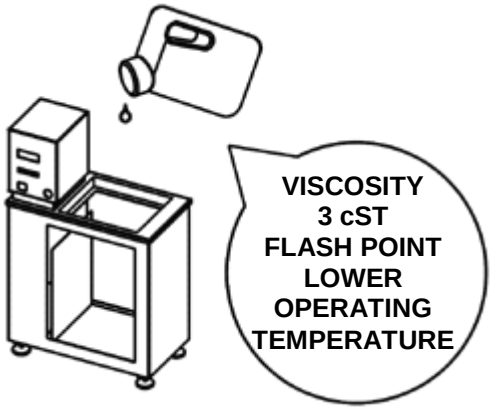
The shipment contains at least the bath as mentioned in the delivery checklist. Further the consignment might contain one or more viscometers, individually packed in small boxes with the calibration certificate included in the box, as well as ASTM thermometers, thermometer holders, etc. Please see packing list for details concerning total contents of consignment.

**Before filling the bath remove any remaining packing material from its interior. The interior of the bath can be accessed by taking off the lid on the top of the bath.**

## 5.3 Bath liquid

The bath must be filled with a liquid suitable for the minimum operating temperature.

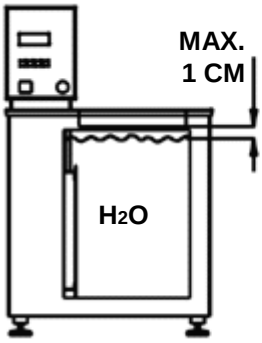
**It is very important to select a liquid with a viscosity of 3 cSt or less at the operating temperature and a flash point which is well above the operating temperature.**



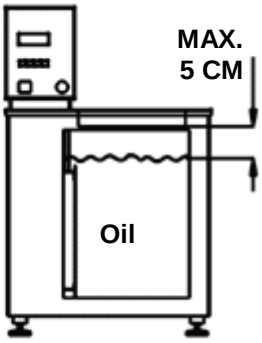

The use of other liquids is allowed as long as the viscosity of the fluid is low enough at the operating temperature. The viscosity must be approximately 3 cSt, but may definitively not exceed 10 cSt. High viscosity will result in poor stability as well as poor uniformity of the bath.

The fluid flashpoint must be well above the maximum operating temperature. Fluid must not be aggressive when in contact with stainless steel 304, 316, glass or PTFE and silicon sealing.

**When the bath has been installed it must be filled with an appropriate liquid. When working with water the bath should be filled to 1 cm below the lid. For oil the bath should be filled to not more than 5 cm below the lid. Depending on the operating temperature the liquid level in the bath should be observed and excessive fluid should be removed.**




**FILLED 1 CM BELOW THE LID**




**FILLED 5 CM BELOW THE LID**

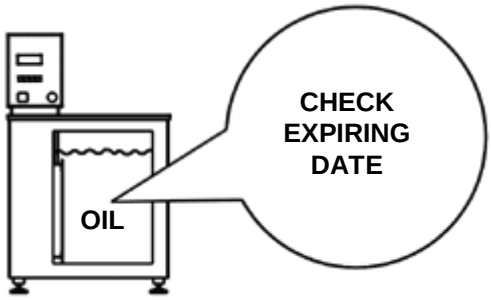
The liquid level should be maintained between 1 and 3 cm below the lid during normal operation.
A lower level than 5 cm below the lid will damage the heaters. A high bath level can cause overflow.

We recommend the use of the following liquids for the respective ranges:

| Recommended bath fluids | | |
|---|---|---|
| Range | Ordering code | Description |
| Ambient to 80°C/176°F | N.A. | Clean tap water<br>NOT DISTILLED |
| 80..150°C / 176..302°F | 00T0220 (20 litres) | Tamson mineral oil 150. Transparent, 10cSt @ 20°C/68°F; 3cSt @ 100°C/212°F; Flash point 200°C/392°F. |
| 20..150°C / 68..302°F | 08T0001 (gross 20 Kg = 20ltrs) | Silicon oil 200-10, transparent. 10 cSt @ 25°C/77°F;3 cSt @ 150°C/301°F. Flash point 211°C/411°F. Lifetime >2 years. |

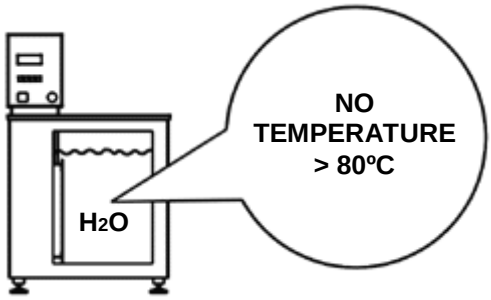
**The oil used has a limited lifetime.**

The type, brand and operating temperature mainly determines lifetime. Spilling of sample may also reduce lifetime, in some cases can start chemical reactions. Silicon oil has the tendency to form gel, for this reason silicon oil has to be replaced as soon as visible changes are noticed like string forming. Within a few hours silicon oil can transform itself into solid gel, which is very difficult to remove. When not totally cleaned, very small pieces of left over gel will catalyze new oil to form gel!

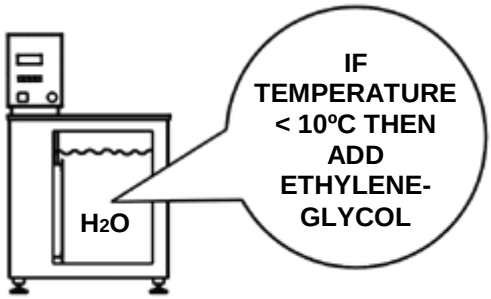



**Do not use distilled water. This can cause serious corrosion. Water filtered by reversed osmoses can be used.**

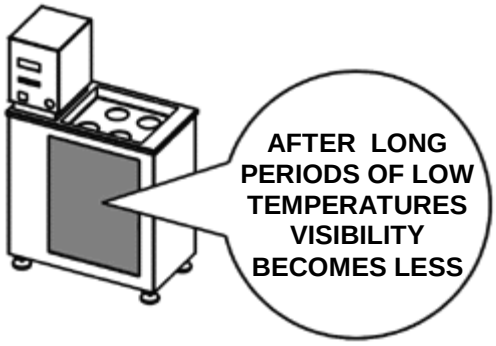
**Only use water as a bath fluid below 80°C/176°F. Working for a longer period with water at temperatures above 80°C will damage the stirrer bearings.**




**When working at temperatures below 10°C / 50°F ethylene-glycol should be added to the water. For example in the volume proportion of 50 / 50%.**




**Using the bath for long periods at low temperatures will cause condensation on the glass window resulting in complete invisibility of material placed in the bath.**



**When operating at high temperatures the lid (of the bath), top plate and the window section of the bath become very hot. Always use heat protective gloves. Care must be taken when placing or removing material from the bath.**

**WEAR HEAT PROTECTIVE GLOVES**

**Hot surface or casing temperature**

| Bath [°C/°F] | Outher wall* [C/°F] | Top* [°C/°F] |
|---|---|---|
| 40/104 | 32/90 | 30/86 |
| 60/140 | 46/115 | 41/106 |
| 80/176 | 55/131 | 48/118 |
| 100/212 | 76/169 | 62/144 |
| 120/248 | 93/199 | 76/169 |

*** measured at 20°C ambient temperature**

**Pay attention when removing hot fluid:**

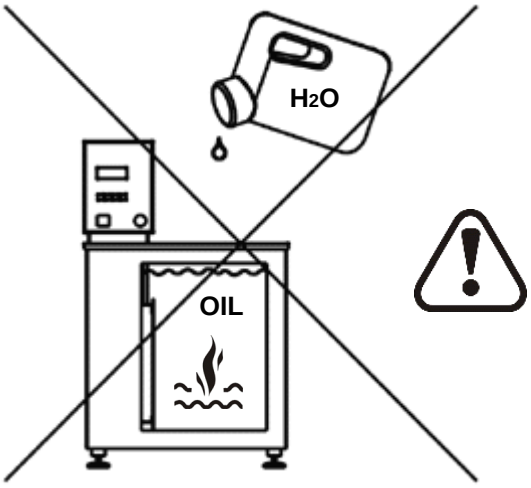
**Use heat protective clothing and wear gloves and safety glasses.**

**WEAR HEAT PROTECTIVE CLOTHES**

**When changing the bath fluid from water to oil for operating at temperatures above 80°C, completely remove all the water from the bath. Small drops of water may result in hazardous situations while reheating the bath with oil.**

Water and oil must at all times be kept separate within the bath. Never mix oil and water in or around the bath.

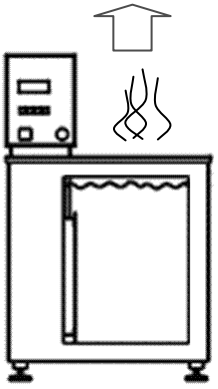
**Do not spill water in hot oil.**




**Never empty hot oil into a plastic container.**


**Use proper ventilation**
**Heated bath fluids can cause toxic fumes.**

**Remove fumes from hot oil or bath medium. Use fume cabinet or proper air ventilation**



Cooling

The bath is provided with an integral cooling coil. Because of the friction-heat generated by the stirrer mechanism the bath will heat-up slowly. The lowest operating temperature at which the bath can be controlled depends on the fluid used and the ambient temperature. When operating at temperatures around or below ambient it is necessary to pass a small amount of tap water through the cooling coil. Generally the temperature of the cooling coil water should be 5 °degrees (or more) below the operating temperature of the bath. To operate around ambient temperature a flow of 100 to 200 ml per minute is sufficient.

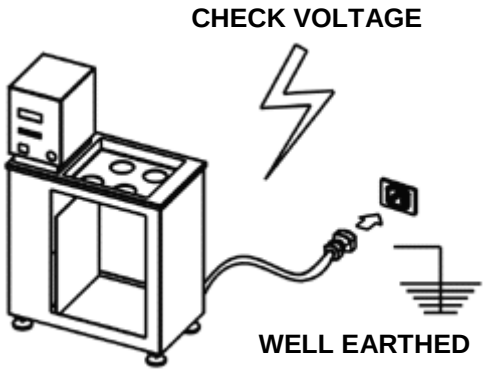
A cooling circulator can be connected to the cooling coil providing continuous cooling

**TLC10-3**
Small and compact continuous cooling circulator. Ultra low noise operation.

## 5.4 Connecting

Before plugging TV2500 into the mains socket, make sure the voltage of the bath corresponds to the local voltage.

**Use a mains supply that is well earthed, clean of interference and suitable for the acquired electrical load of the bath.**



# 6 INTRODUCTION

The TAMSON model TV-baths are designed to perform a variety of temperature control required for general laboratory use or as a constant temperature bath.

## 6.1 General

The heat input is controlled by a microprocessor system. A special optimized electronic temperature measurement circuit ensures reproducibility of operation conditions. The baths have an integrated cooling coil as standard, for rapidly reducing bath temperature alternatively for working at or slightly below ambient temperature.

## 6.2 Construction

The TAMSON baths are constructed entirely from corrosion-resistant materials – stainless steel and PTFE – entirely. The central microprocessor within the control module manages and controls the functions for temperature measuring regulation, program storage, safety control and error coding.

## 6.3 Stirrer

A circulation stirrer is built-in for uniform temperature distribution within the bath.

## 6.4 Temperature control and setting

The bath temperature is regulated using a Pt-100 temperature probe connected to a microprocessor module. The advanced electronic control system continually computes the energy input required for optimal temperature accuracy and stability. The controller will activate the heaters partially or in full, taking into account the difference between actual bath temperature and set point taking into account the type of bath fluid used and working conditions. This process does not interfere electrically with other equipment since all heating elements are switched in zero-cross mode. Through the application of an especially developed inlet circuit for the temperature probe, the sensitivity to external interference has been reduced to a minimum. The required temperature is set by means of membrane switches on the front panel. An absolute temperature offset is provided with a resolution of 0.1°C. This fine-tuning can be carried out at any time during operation of the bath.

## 6.5 Safety systems

In case of electronic failure the possibility exists that the heater element is continuously switched on. This will cause extreme temperature raise. To prevent high temperatures the bath is fitted with a mechanical over-temperature protection thermostat. This thermostat will switch-off the bath at a pre set temperature in the range from 50 to 270°C.

**We advise to adjust the mechanical over temperature to approximately + 25°C above the bath set point.**

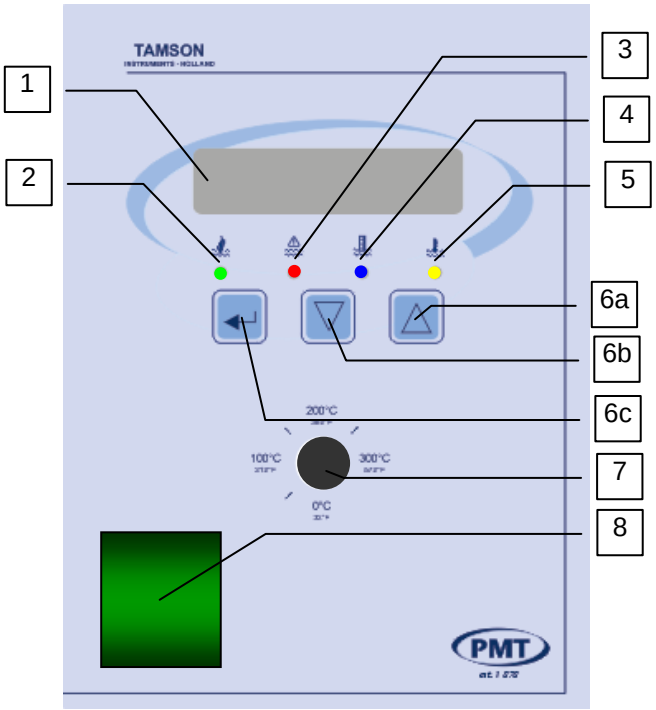
This safety construction prevents for example oil to be heated above flaming-point which will cause fire or prevent evaporation of bath fluid due to high temperatures.

The thermostat will automatically reset when the bath temperature drops approximately 10°C below the pre-set temperature. To continue normal operation the bath has to be switched off and on again.

## 6.6 Adjusting the mechanical over-temperature protection thermostat

Turn the thermostat clockwise (2, drawing 1) to its maximum. Be aware that the safety thermostat is now only functioning at 270 °C. Heat the bath to the appropriate set point. Gently turn the thermostat anti-clockwise, until the over-temperature protection is activated, and system switches off, Turn the thermostat approximately 30°...40° higher (turn clockwise). Switch the bath off and on again. The bath is ready to operate safely.

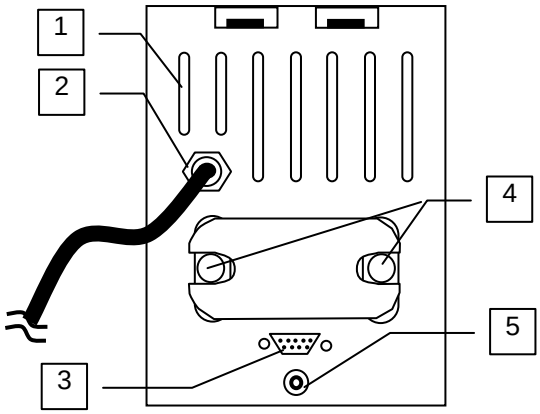
## 6.7 Control Panel




**1 LC Display**
**2 Heater indicator (Green)**
**3 Over temperature indicator (Red)**
**4 Level indicators (Blue)**
**5 Offset (Yellow)**
**6 Up(a), down(b), enter(c) buttons**
**7 Over-temperature protections**
**8 Mains switch**

## 6.8 Backside apparatus

1 Cooling sleeves,
2 Power cord,
3 RS232 communication port (Sub-D female 9-pole),
4 Inlet - outlet cooling coil (in- and outlet can be exchanged), outher diameter 8mm stainless steel tube,
5 Motor protection fuse.




## 6.9 Front panel keys

**The front panel layout shows the following 3 operating keys:**


**PAGE**


**DOWN**

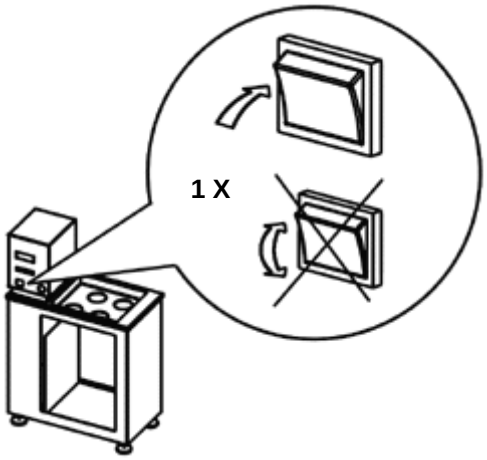

**UP**

The “Page” Key offers following:
- Temperature readout in °C,
- Temperature set point in °C,
- Changing the tuning (PID) parameters,

The “Up and Down” keys allow changing the listed value. All changed values like set point and PID parameters will be kept in memory even after switching of the power supply.

# 7 OPERATING THE SYSTEM

When the bath is ready for use it can be switched on by pressing the mains switch. Because the bath is equipped with an automatic calibration facility, the microprocessor controller first calibrates the analogous part of the controller. The display of the bath will indicate the text ”calibrating bath”.




**When switching off the apparatus, wait for 10 seconds before switching the system back on again.**

The electronics are suited for both 50 and 60 Hz.

Page 

Down 

Up 

The front panel layout shows the following 3 operating keys:

- Set point
- Offset**(press: <-5.00 .. +5.00°C step 0.01°C)
- Max Power (press: low, med, hi, max)
- Boost heater (press on / off)
- Time const (press: fast, medium slow, precise)
- Stirrer *
- Low alarm *
- High alarm *
- PID parameter:
  (PID set 1, PID set 2. PID set 3, PID set 4)
  - Proportional band (Pb=1/P where P is proportional value)
  - Integral value
  - Differential value
- Backlight
- Temp units
- Baudrate

* optional

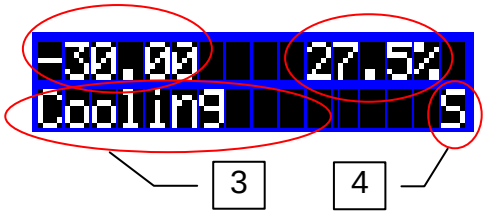
** This value is added to the measured temperature by the microcontroller. This way the temperature readout can be synchronized with an external calibrated measuring device like the TT3.

note: ☞ Display switches back automatically to temperature readout. Changed values are stored. Or Press  to confirm when settings are altered.
☞ Each time  is pressed another option is displayed.

**Up** and **Down** keys allow changing the listed value. All changed values, like set point and PID parameters, will be kept in memory when pressing the page key to leave the menu. After switching off the power supply, changed values are kept in memory.

The Tamson Thermometer **"TT3"**. This can be used as an external calibrated temperature read out.

## 7.1 Display readout




1 Temperature readout
2 Applied percentage of power
3 Operating mode
4 Indicator, alarm high, alarm low, control stable

Ad 1: When the controller starts or is restarted, the displayed value increases to a stable readout appears after a few seconds.

Ad 2: The controller calculates every second the amount of power which should be applied for stable control. The value is displayed with a resolution of 0.1% and ranges from 0% to 99.9%.

Ad 3:

| | |
|---|---|
| Boost | Bath is heating to set point |
| Cooling | Bath is cooling down to set point |
| Tuning Ratio | Bath is tuning for power needed |
| Tuning SA | Bath is tuning, second step |
| PID SP=25.00 | Bath is controlling, set point is 25.00°C (example) |

Ad 4:

-  Bath control is stable
-  Alarm high, press button to reset
-  Alarm low, press button to reset

## 7.2 Quick start, adjust set point

To quickly start the bath:

Fill the bath with sufficient fluid to flood the heaters and cooling coil, However do not fill the bath fully to the maximum.
Place the power plug, switch the bath on using the mains switch,
Choose a working temperature (set point):
Press ↵ once. Display will indicate "set point".
Alter set point temperature by using up △ and down ▽ key to select the desired bath temperature. Press ↵ to confirm and display bath temperature again.

## 7.3 Tuning

Tuning can be done manually. The parameters mentioned in Table 1 will influence the control of the bath.

The PID parameters are set to

| P | I | D |
|---|---|---|
| 25 | 16 | 0 |

These parameters work fine for following bath contents:

- Water
- Water / Glycol
- Silicone oil, < 10cSt @ 25°C
- Mineral oil, < 10cSt @ 25°C

The temperature control of the bath is based on a digital PID system. When using different fluids in the bath each with their own heat capacity, the use of external cooling and external connected processes(circulation), or working at different set point temperatures requires new settings of the PID parameters. These parameters have to be optimized after changes to the system when optimal and accurate temperature control of the bath liquid is required.

Tuning of the bath results in:
Stable temperature control of the bath,
No over- or undershoot of the temperature set point,
Quick response to deviations from the set point caused by external disturbances.

| Parameter | Description | Display |
|---|---|---|
| Proportional band | The bandwidth in display-units over which the output power is proportional between minimum and maximum | Pb |
| Integration time | Determines the time taken by the controller to remove steady state error signals | Ti |
| Derivative time | Determines the time taken by the controller to react on error signals. | Td |

**Table 1 Parameters influencing the temperature control**

## 7.4 Manual tuning

The parameters for the PID control can also be changed manually. The control also allows to set the I and D values to zero. The bath will then function as a proportional system. The “P” parameter can than be varied to an optimal value by trial and error. A higher P will stabilize the system when I and D are off. The PID parameters can also be determined with the use of the Ziegler Nichols method described below.

Manual tuning by Ziegler-Nichols
With the process at its normal running temperature:

Set the integral time “Ti” and the derivative Time “Td” to off

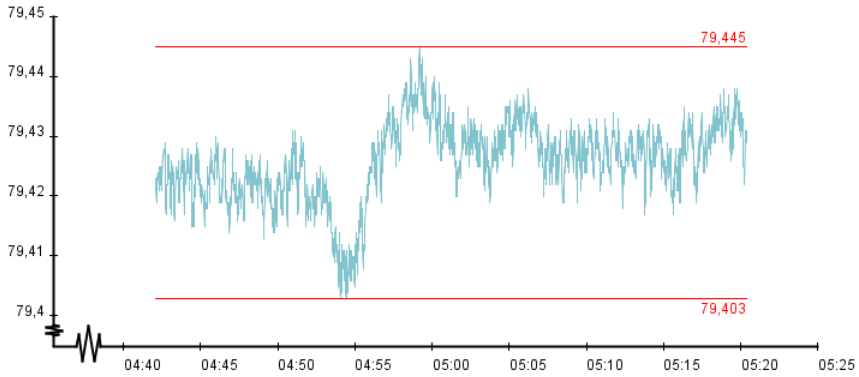
Ignore the fact that the temperature may not settle precisely at the set point
If the temperature is stable, reduce the proportional band Pb so that the temperature just starts to oscillate. If the temperature is already oscillating, increase the proportional band until it begins oscillating. Allow enough time between each adjustment for the loop to stabilize. Make a note of the proportional band value “B” and the period of oscillation “T” Set the Pb, Ti and Td parameter values according to the calculations given in the table below

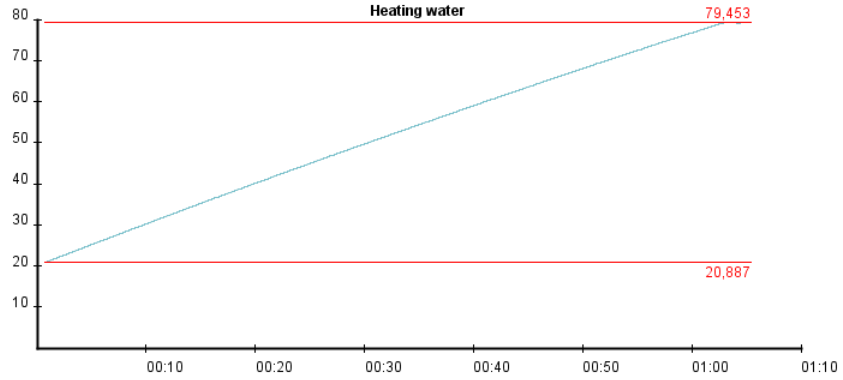
| Type of control | Proportional band | Integral time "**ti**" | Derivative Time "**td**" |
|---|---|---|---|
| Proportional only | 2xB | Off | Off |
| P + I control | 2,2xB | 0,8xT | Off |
| P + I + D control | 1,7xB | 0,5xT | 0,12xT |

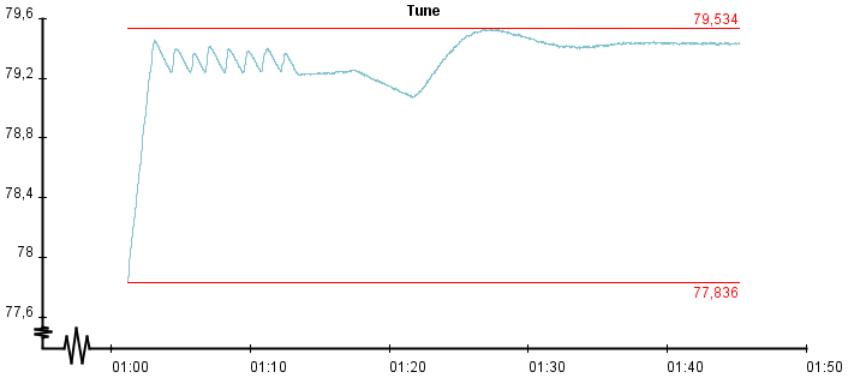
# 8 Technical specifications

## 8.1 Using water as a bath fluid

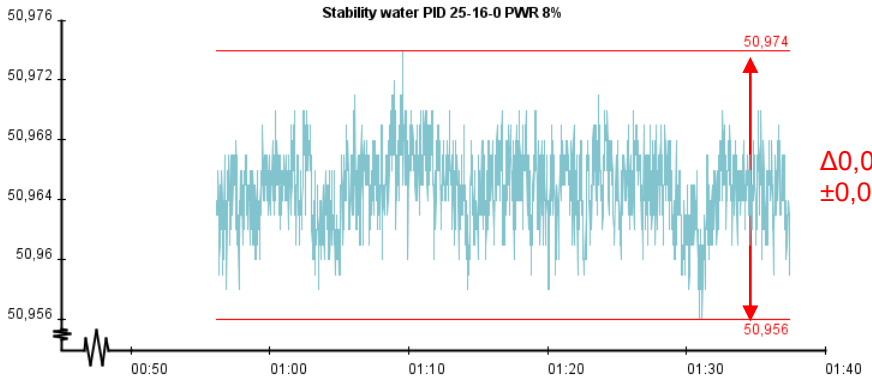
### 8.1.1 General results



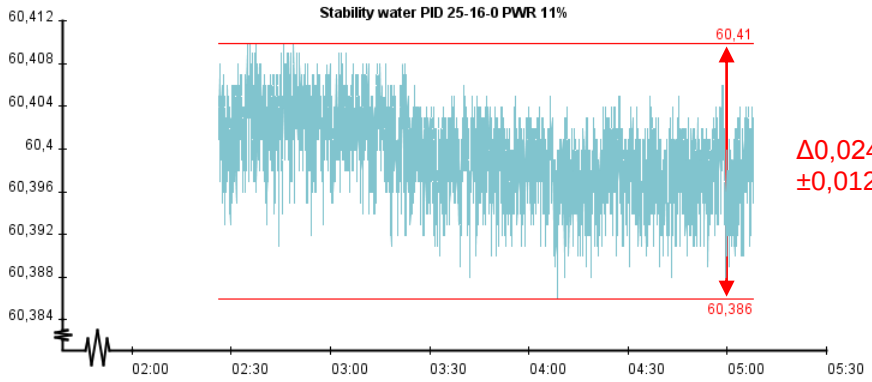



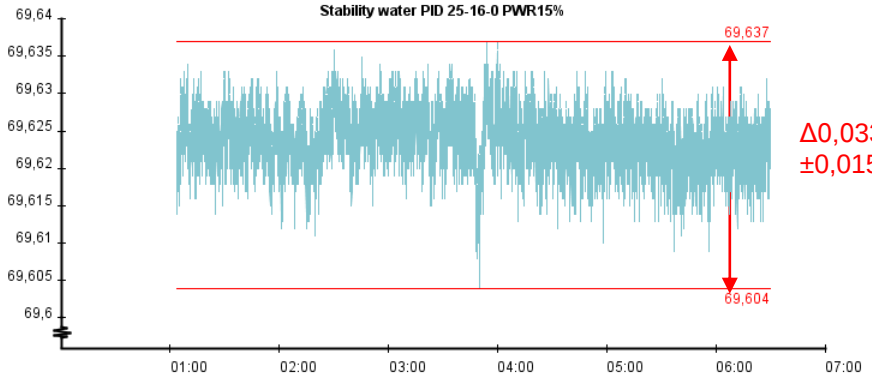
### 8.1.2 Stability using water as bath a fluid



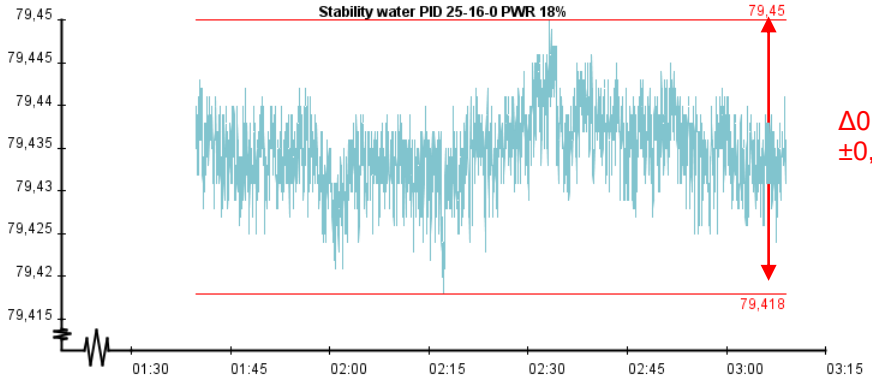

Δ0,018˚C
±0,009°C




Δ0,024˚C
±0,012°C




Δ0,033˚C
±0,015°C



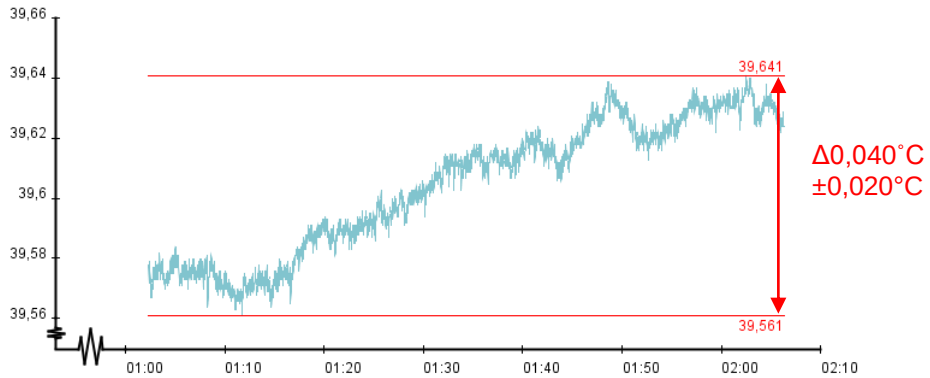

Δ0,032˚C
±0,016°C

## 8.2 Using mineral oil as a bath fluid

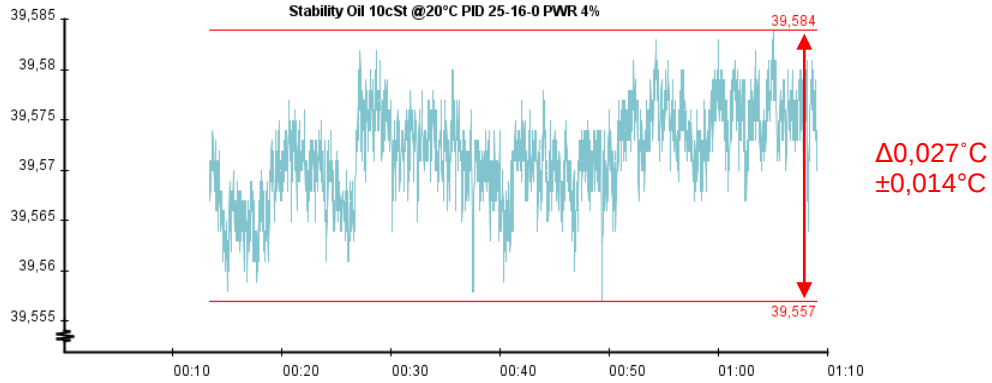
Using mineral oil with viscosity of 10 cSt @ 20°C as a bath fluid

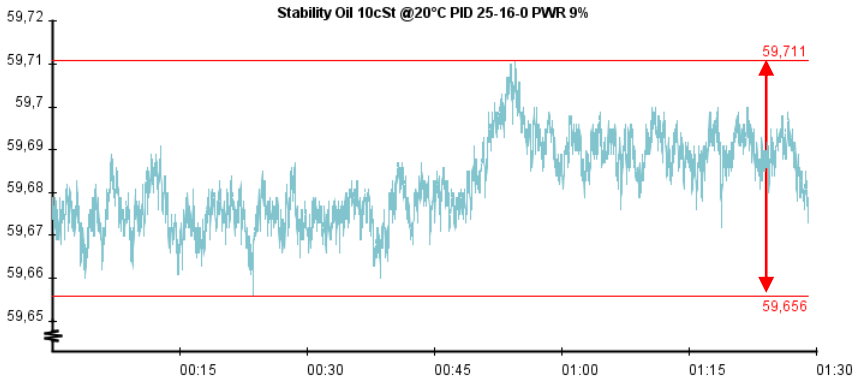
### 8.2.1 General results

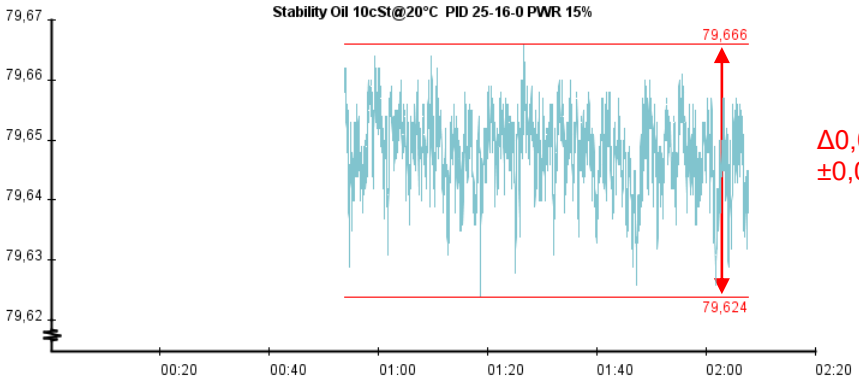
Fluctuation when ambient varying from 18,0.. 20,0 (Δ 2,0°C)



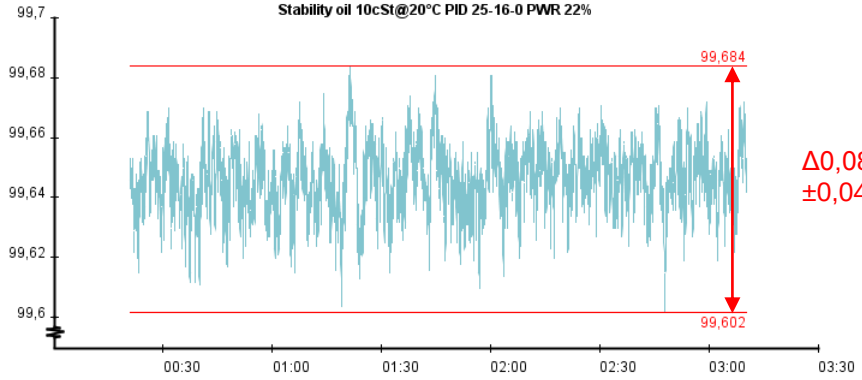

### 8.2.2 Temperature stability using mineral oil as a bath fluid



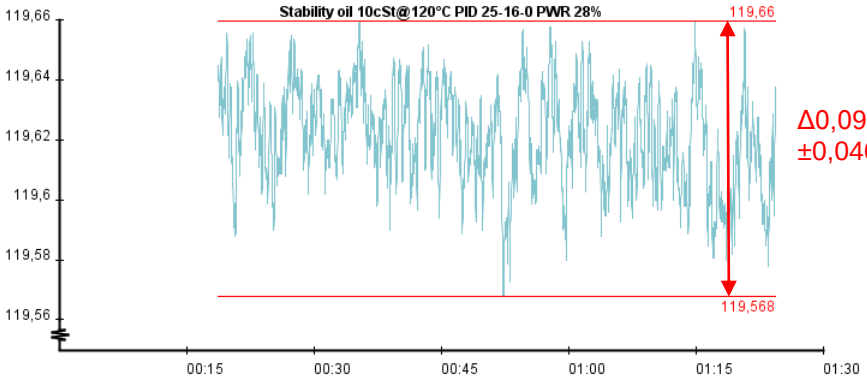






Δ0,042˚C
±0,021°C




Δ0,082˚C
±0,041°C




Δ0,092˚C
±0,046°C

# 9 TROUBLE SHOOTING

## 9.1 Application errors

All Tamson products are well designed and thoroughly tested before shipping. This will not fully prevent small problems in the field. Following will help you to locate commonly known problems and how to fix them. In case of doubt please check your local dealer or Tamson instruments b.v.

## 9.2 Bath malfunction

- The pump motor is not running and electronics do not function.

Check mains and main fuse.
Check over-temperature protection see "**Temperature control and setting**" page 12.

- Motor is not turning

The motor fuse is activated. *Restart the motor by pressing the motor fuse. This fuse is located at the backside of the top casing*. *Also check viscosity of the bath fluid. High viscosity will activate the motor fuse.*
Electrical defect
*Motor capacitor defective, replace capacitor or contact local dealer or Tamson instruments b.v.*

## 9.3 Problems with set point

- Heater LED is not burning, motor is turning and temperature rises above set point.

Set point too near to room temperature*. Cooling of the bath is needed*

- Temperature doesn't reach set point, motor turns fast.

Bath fluid evaporates too quickly. Use other fluid
Heater malfunctions. *Measure mains electrical current output. Low power consumption indicates a problem with the heating element.*
Cooling capacity is too high*. Reduce cooling.*

- Temperature not stable

*See explanation "***Bath temperature does not become stable***" page 23.*

## 9.4 Faulty temperature reading or temperature offset

- The temperature readout on the display does not correspond to the temperature measured.

PT100 is defective,

## 9.5 Bath temperature does not become stable

If the bath temperature does not stabilize after 45 minutes after set point has been is reached the following points might cause this problem:
The operating temperature is around or below 30°C. To stabilize the bath at set points just above the ambient temperature it is necessary to apply cooling water to the cooling coil or to increase or decrease the flow of cooling water through the cooling coil.

If the operating temperature is far above the ambient temperature it is most likely that the viscosity of the bath fluid used is too high. The maximum viscosity of the bath fluid lies below 10 cSt at the operating temperature but is preferably less than 3 cSt. If the viscosity of the bath fluid used is too high the circulating system is incapable to mix it thoroughly resulting in poor stability.

Check PID constant of the bath.
P) 25
I) 16
D) 0

Position of the stirrer fan must be exactly in the center of the hole in the baffle plate (both in horizontal and vertical position).

Check possible heat transfer from additional apparatus close to the bath i.e. oven or central heating.

Check any possible strong magnetic field from other apparatus.

Check overheating of electronics inside apparatus.

## 9.6 Offset display readout

If there remains an offset in the display readout:

- Try the menu option restart. The bath will retune itself around the set point.
- Try to set the precision to the maximal value i.e. 300 sec.
- Decrease the P parameter. The P stands for proportional band which is 1/P (one divided by the proportional value). When P decreases the system will amplify the measured error more thus reducing the offset.

- Bath fluid is too viscous. When using oil try a less viscous bath fluid. In general viscosity should be less than 3 cSt around process value.

## Spare parts list

| 230 Volt 50HZ | 230V 60HZ | 115 Volt 60Hz | Description |
|---|---|---|---|
| 25T1295 | | 25T1301 | Motor for stirrer |
| 25T1343 | | n.a. | Capacitor 2uF |
| n.a. | | 25T1344 | Capacitor 7uF |
| 25T0360 | | 25T0355 | Heater 1800 (1400W 115V) Watts |
| 24T8081 | | n.a. | Motor fuse 0.3 Amp. |
| n.a. | | 24T8080 | Motor fuse 0,6 Amp. |
| 06T0514 | | 06T0524 | PCB power board TLC-TMC70 |
| 24T8581 | | | Over-temperature protection thermostat |
| 24T8545 | | | Mains switch |
| 28T4023 | | | Front keypad |
| 25T2310 | | | PT-100 sensor |
| 06T0518 | | | PCB with micro controller |

## 10 DISCLAIMER

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