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Manual Kinematic Viscosity Bath

Tamson TV12

Rev 1.05

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Viscosity Business Today

- ✓ Testing kerosene
- ✓ Testing diesel
- ✓ Testing lubricants
- ✓ Testing fuel oils
- ✓ Testing residues
- ✓ Testing bituminous or asphalt samples
- ✓ Testing used oils
- ✓ Testing bio fuel

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Content of Presentation

- ✓ The Method
- ✓ Standards
- ✓ Manual Kinematic Viscosity baths
- ✓ TV12 (Main Characteristics)
- ✓ Unit Installation and Preparing

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The Method

- A manual bath is used for the measurement of transparent liquids and opaque liquids.
- Viscometer constant is independent to the temperature with a suspended-level viscometer (see ASTM D446).
- Therefore, we recommend to use suspended-level viscometers (e.g. Ubbelohde) for testing in combination with the TV12 when using the bath at different temperatures.

Standards

- Standards, ASTM D445, ASTM D446, ASTM D1655, ASTM D2270, IP71, EN ISO 3104, ISO 3105, and DIN 51562.
- The standard describes the manual measuring of determination of kinematic viscosity.
- Measure the time for a volume of liquid, transparent or opaque, to flow under gravity through a calibrated glass capillary viscometer (please see ASTM D445 & D446).

Manual Baths

Bath Temperature

- Use a bath with a constant temperature.
- Temperature tolerance max. ± 0.02°C between +15°C to +100°C. Outside this range ± 0.05°C.
- The temperature measuring device is a calibrated glass thermometer, accuracy ± 0.02°C or better. Or a Digital Contact Thermometer (DCT) is allowed. We recommend our E20 DCT thermometer with temp. range from 20°C to +120°C (P/N 19T4043). Other rangers are available.
- In October 2017, mercury in LIG thermometers will be forbidden and the market has to change to DCTs.

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Manual Baths

Bath Temperature

Tamson E20 Thermometers
Complies to IEC 751
✓Accuracy of ± 0.01°C
✓Calibrated of 0.015°C
✓Resolution of ± 0.001°C.
✓Substitute for the commonly known mercury thermometers
✓Free Tamcom software
✓Range from -40 .. +140°C
✓Protective blue suitcase
✓Conforms to new requirements of ASTM D445

- Sensor element PT100
- Display resolution 0.001°C
- Accuracy better than ±0.015°C
- Linearity ±0.01°C
- Fast response time 3 sec
- Annual drift <± 0.001°C

(Thermistor or PT100)
(0.01°C)
(±0.015°C)
(±0.01°C)
(<6 sec)
(<± 0.01°C)

Requirements ASTM D445

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Manual Baths

Capillaries

- The viscometer is a calibrated capillary, the size depends on the sample be tested.
- Flow times between 200 and 900 seconds are recommended.
- The viscometer has to be in a suspended vertical position This is possible with Tamson stainless steel viscometer holders. They are available for most of the ASTM D446 viscometers, see www.tamson.com for more information.

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Manual Baths

Timing Device

- The manual timing device must allow readings with a tolerance of 0.1 second or better. Accuracy ± 0.07%.
- Electrical timing devices can be used if an accuracy of ± 0.05 % or better is reached.

Manual Baths

Timing Device

- Tamson timer (reference number 10T6090) uses a crystal which has a maximum deviation of 20 ppm (parts per million).
- On one second that is (1 / 1000.000) * 20 = 0.00002 sec.
- One hour has 60*60*0.00002 = 0.072 seconds.
- Human reaction time is 0.2 second (200 mS).
- So, fault of Tamson timer when measuring one hour is three times less than human error.

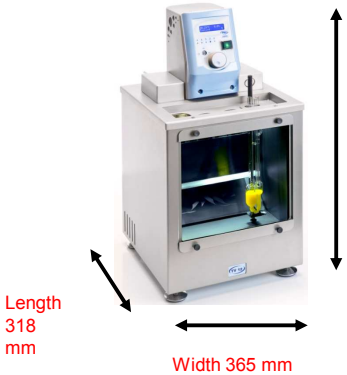
TV12

Main unique features:

- ✓ Very Small Footprint
- ✓ Temperature Range
- ✓ Ultra High Stability
- ✓ Ultra High Homogeneity
- ✓ Four Places, Small Bath Volume
- ✓ Internal LED Lights
- ✓ Detachable Front Window
- ✓ Bath Drain & Bath Overflow
- ✓ PID Digital Controller

TV12

Very Small Footprint

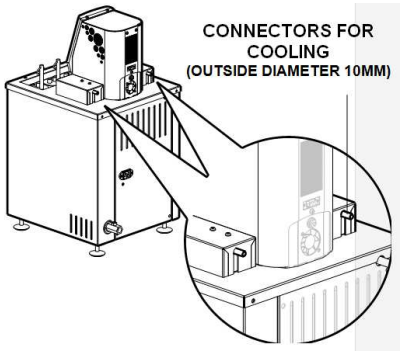


- Extremely small footprint.
- Saves important work bench space.
- Easy to place two baths next to each other e.g. @ 40ºC and @ 100ºC.

TV12

Temperature Range

- Standard range from ambient to +120ºC.
- TV12 is standard equipped with a cooling coil (to work below ambient).



TV12

Temperature Range

- When connecting with an external cooling circulator TLC15, +5ºC can be reached.
- When connecting with an external cooling circulator TLC10, +20ºC can be reached.

	TV12	TV12+TLC10-3	TV12+TLC15-5
Range	ambient.. +120°C	+20°C..+120°C	+5°C..+120°C
230V/50Hz	00T0400	00T0400+00T0050	00T0400+00T0565
115V/60Hz	00T0405	00T0405+00T0052	00T0405+00T0570
230V/60Hz	00T0400	00T0400+00T0051	00T0400+00T0567

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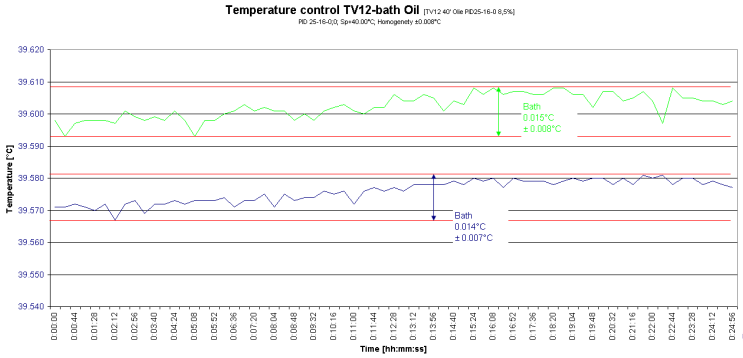
Ultra High Stability

ASTM D445 requirement: Temperature tolerance max. ± 0.02°C between 15°C to 100°C. Outside this range ± 0.05°C. Stability @ 40ºC.



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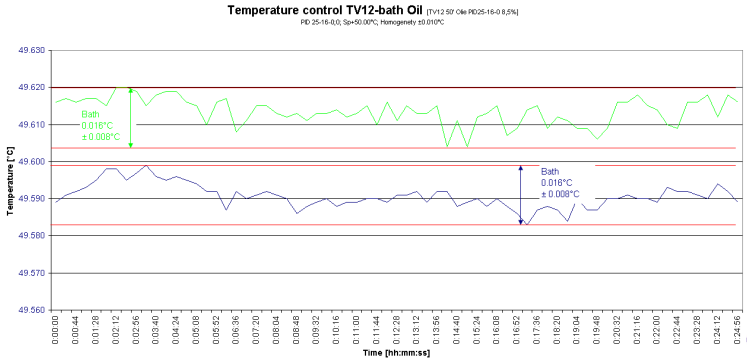
Ultra High Stability

ASTM D445 requirement: Temperature tolerance max. ± 0.02°C between 15°C to 100°C. Outside this range ± 0.05°C. Stability @ 50ºC.



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TV12

Ultra High Stability

ASTM D445 requirement: Temperature tolerance max. ± 0.02°C between 15°C to 100°C. Outside this range ± 0.05°C. Stability @ 60ºC.

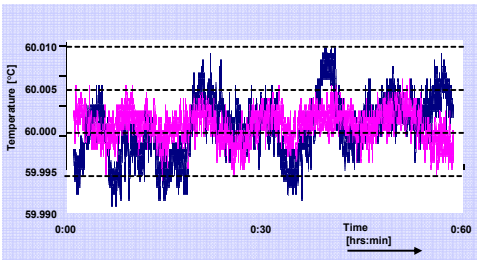
Accuracy

In water

standard deviation ± 0.002°C
min / max ± 0.008°C

In oil

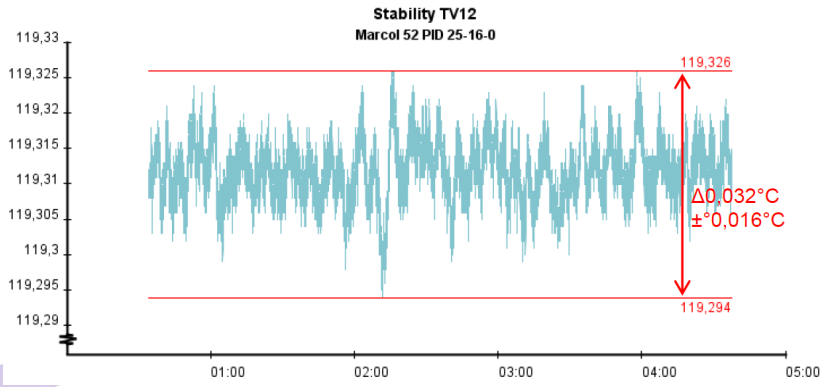
standard deviation ± 0.005°C
min / max ± 0.014°C



TV12

Ultra High Stability

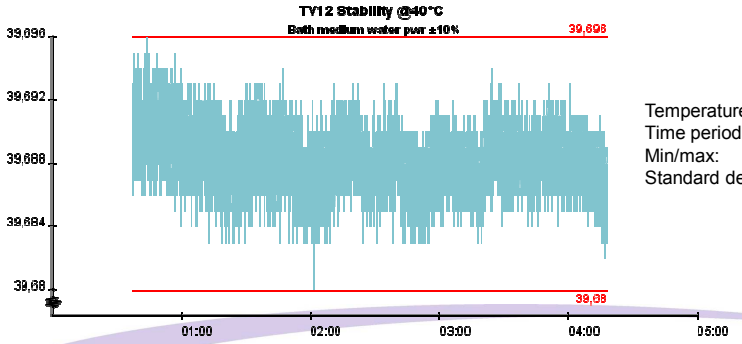
ASTM D445 requirement: Temperature tolerance max. ± 0.02°C between 15°C to 100°C. Outside this range ± 0.05°C. Stability @ 120ºC.



TV12

Ultra High Stability

ASTM D445 requirement: Temperature tolerance max. ± 0.02°C between 15°C to 100°C. Outside this range ± 0.05°C. Stability @ 40ºC for a duration test.



Temperature:	40°C
Time period:	4 hrs
Min/max:	± 0.008°C
Standard dev:	0.002°C

TV12

Ultra High Stability

As you can read in the paragraph 6.3.1 of ASTM D445, the ASTM committee allows quite a temperature instability.

But what is the consequence for the viscosity result if the bath temperature is varying by 0.02°C (± 0.01°C)?

	Sample	1	2	3	4	5	6
2	Time [sec.]	132.43	132.69	131.81	131.76	132.79	132.14
3	Min. Temp. °C	49.166	49.177	49.172	49.173	49.177	49.162
4	Max. Temp. °C	49.193	49.204	49.200	49.202	49.201	49.198
5	Delta (±)	-0.027	-0.027	-0.028	-0.029	-0.024	-0.036
6	Average temp. °C	49.178	49.185	49.190	49.184	49.192	49.171

We have tested 6 samples using a Ubbelohde viscometer with a constant of 0.009021. The results of the six tests are mentioned in the table.

Row 2 gives the duration of a measurement in seconds, where the time is measured via two optical infra red sensors.

Row 3 and 4 show the minimum and maximum temperature during a test.

Row 5 demonstrates the difference between the maximum and minimum temperature.

Row 6 gives the average temperature of the bath during a test.

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Ultra High Stability

	cSt	Deviation	Temp °C	Deviation
	1.188607	99.538%	49.184	100.002%
	1.194651	100.044%	49.178	99.990%
	1.196996	100.240%	49.185	100.003%
	1.189058	99.575%	49.190	100.014%
	1.197899	100.316%	49.192	100.017%
	1.192035	99.825%	49.171	99.976%
Average	1.194128		49.183	

The table shows the kinematic viscosity. For sample 1 it is calculated as follows:

v = C x t
v = 0.009021 x 132.43
v = 1.194651

You are allowed to delete one test result, so we have deleted the result of sample 4.

The average in table 2 is taken from the five other samples.

The deviation is calculated by dividing the *v* by the average of the five samples. This result has been multiplied by 100%.

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Ultra High Stability

cSt	Deviation	Temp °C	Deviation
1.192035	100.316%	49.171	100.017%
1.197899	99.825%	49.192	99.976%

Table 3 is a part of previous table. The delta in temperature is 49.192°C – 49.171°C = 0.021°C. And the deviation in the measuring result is 100.316% – 99.825% = 0.491%!
Based on this experiment, we can conclude that a slight temperature variation by only 0.02°C - thus conform ASTM D445 - can cause a 0.5% deviation in the viscosity result.

Conclusion: It is not only important that the TV12 is conform the ASTM D445 method. It is also very important that the bath is stable as possible for the best results.

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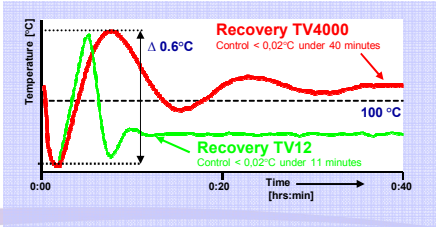
TV12

Ultra High Stability

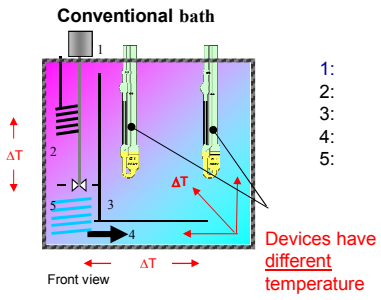
- When the bath temperature is disturbed i.e. when viscometers in viscometer holders are placed, the electronic regulation will establish new control over 3 times faster than conventional systems.
- The graph shows the temperature of a conventional bath (blue) and the temperature measured in the glass capilary of a viscometer (pink).
- The green curve shows the TV12 behaviour. This is strictly conform the method ASTM D445 as it states that you should wait for 30 minutes before starting the measurement.



TV12

Ultra High Homogeneity

All thermostatic baths contain heating. Simple bath constructions have a single heater and stirrer for circulation. This causes random energy distribution and poor homogeneity. The heating energy is distributed randomly.



More sophisticated systems have controlled flow by using a baffle plate. The heat distribution however is still diagonal in the bath as shown in the diagram.

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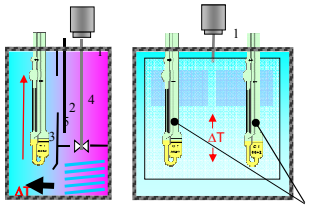
Ultra High Homogeneity



Devices have same temperature

Temperature gradient TV12 versus conventional system

The TV12 construction is such that it only knows vertical offset. When outlining viscometers or other measuring devices for measuring or calibration, they will all have the same temperature.

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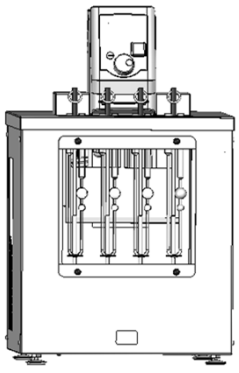
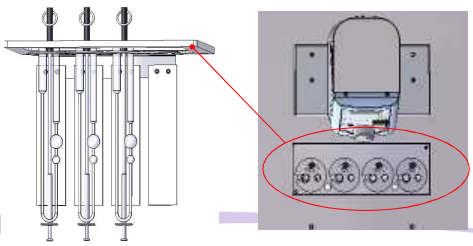
TV12

Four Places, Small Bath Volume



- The cover of the bath has 4 round 51 mm holes with lids, for suspending glass capillary viscometers in holders.
- Bath volume is only 12..15 litres.



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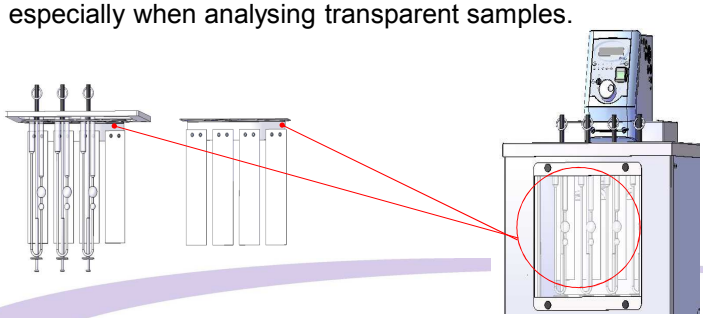
Internal LED lights

- A permanent LED light is located below the top plate to supply clear light and to guarantee optimal visibility inside the bath.
- **Levelling platform (P/N 13T6220)** White background plate are mounted under the top lid. The semi transparent white plate realises uniform background and optimizes contrast and readout of the viscometer, especially when analysing transparent samples.



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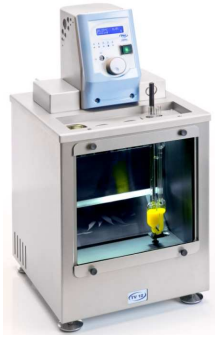
Detachable Front Window

The bath is fitted with a double window of which the front pane is detachable for cleaning purposes.



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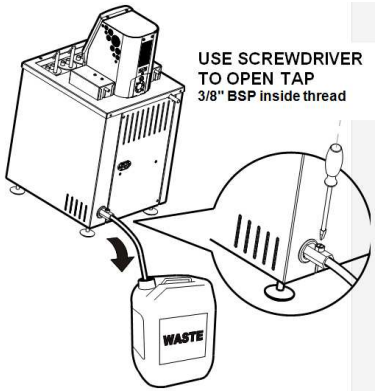
TV12

Bath Drain & Overflow Outlet



- The TV12 can be emptied via the drain tap located at the backside of the apparatus.
- For safety reasons the tap can only be opened by using a screwdriver.
- The thread inside the tap is 3/8".

TV12

Digital Controller

One of the reasons for the unique bath stability is that we use our own Tamson Microprocessor controller (TMC70) board. This circuit board offers several nice features:

- ✓ Two decimal readout
- ✓ Offset
- ✓ Percentage heating is shown in display, maximum percentage can be programmed
- ✓ PID settings (automatic and manually)
- ✓ RS232 communication

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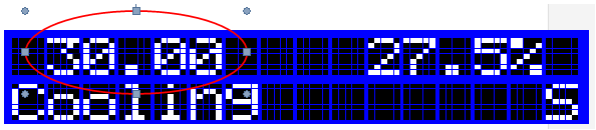
TV12

Digital Controller

Two decimal readout



Temperature stability is very important for ASTM D445. Therefore, we show a two decimal readout in the display. Optional is a three decimal readout.

It is doubtful to use a viscosity bath with an analog controller or a digital controller offering 1 decimal readout for ASTM D445 tests.

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TV12

Digital Controller

Offset

The temperature displayed can be increased or decreased with an offset ranging from +5.00°C down to -5.00°C in steps of 0.01°C. This way the temperature reading on the display can be synchronised with an independent separate thermometer.

N.B. an offset is essential for your viscosity bath.

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TV12

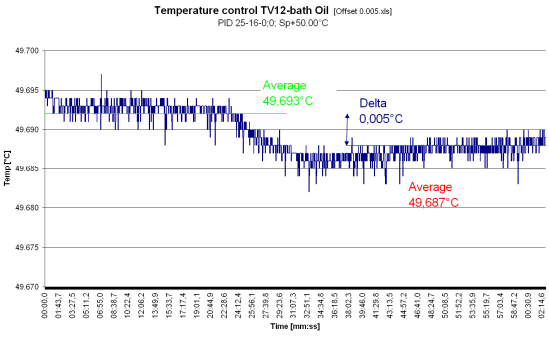
Digital Controller

Offset

Also, we offer standard an additional 0.005°C offset.

This is very important e.g. when temp is 39.995°C you can only go to 40.005°C, with a 0.01°C offset

With the 0.005°C offset you can go to 40.000°C.



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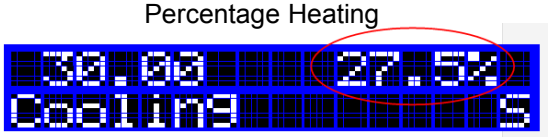
Digital Controller

Percentage Heating



- Maximum percentage of heating can be selected in the menu. This maximum power can be selected to prevent overshoot or burning of bath media. Four stages are available: 25%, 50%, 75% and 100%
- The controller continually calculates 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%.
- If this percentage is lower than 10%, additional cooling is needed to get good stability. This is a good explanation as to why the bath temperature is not stable. Other brands don't give you this information.

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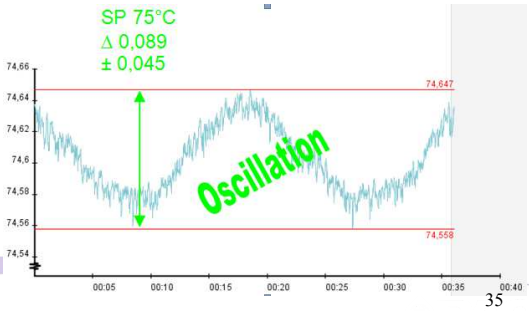
TV12

Digital Controller

PID Settings

Controller is equipped with PID settings
If necessary, the PID settings can be manually adjusted to get the best optimum.
For example, below a graph off an unstable bath.

Temperature:	75°C
Proportional band (Pb):	100
Integrator:	16
Differentiator:	0
Min/max:	± 0.045



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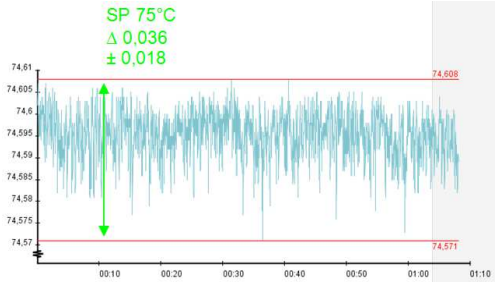
Digital Controller

PID Settings

By changing the P from '100' to '50', stability is becoming better. All other variables are the same.

Temperature:	75°C
Proportional band (Pb):	50
Integrator:	16
Differentiator:	0
Min/max:	± 0.018



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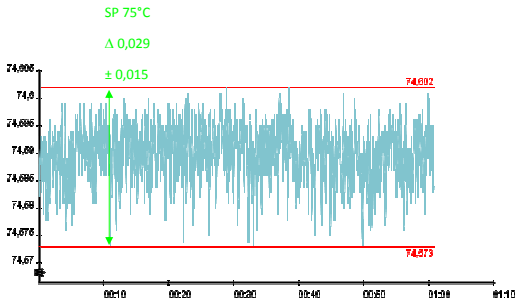
Digital Controller

PID Settings

By changing the P from ’50’ to ’25’ the temperature stability even improves further.

Temperature:	75°C
Proportional band (Pb):	25
Integrator:	16
Differentiator:	0
Min/max:	± 0.015



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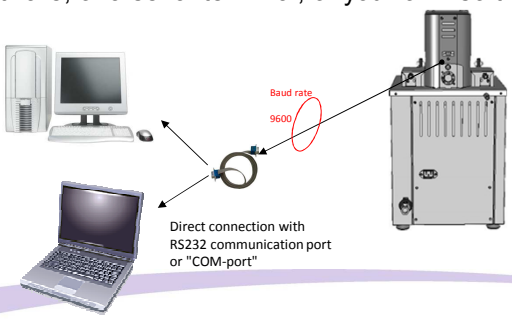
Digital Controller

RS232 Communication

- ✓ Equipment is standard equipped with RS232 communication.
- ✓ Using RS232 the controller can be controlled remotely using the Tamson software, or a serial terminal, or your own software.



TV12

Digital Controller

RS232 Communication

The Tamcom software can do following:

- ✓ Logging data into a file, (CSV)
- ✓ Programming a Set Point curve via simple data in a file
- ✓ Display process value and set point temperature in a graph
- ✓ Actual values
- ✓ Change set point temperature
- ✓ Show Process value
- ✓ Set Offset
- ✓ Set PID values

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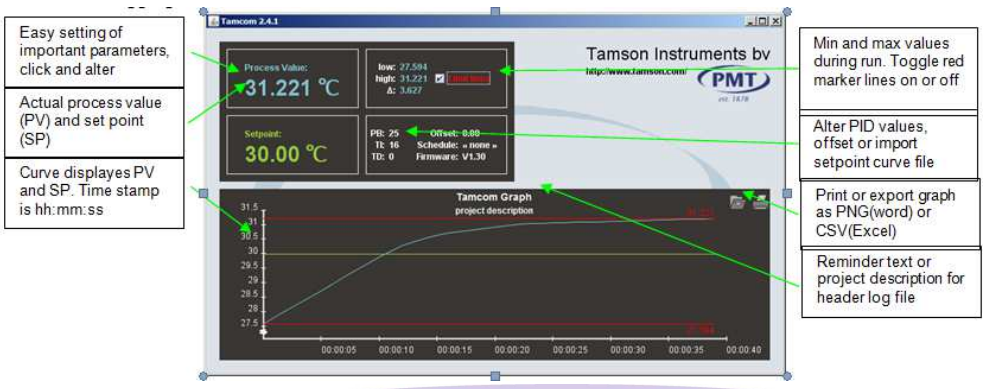
Digital Controller

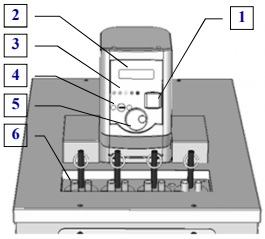
RS232 Communication



Installation

- ✓ Bath is completely assembled and tested at factory.
- ✓ Remove bath from packaging material.
- ✓ Clean inner bath thoroughly of any loose packing materials, etc.
- ✓ Place the bath spirit level. The four supporting feet can be turned in and outwards for exact adjustment.
- ✓ Use a mains supply that is well earthed and clean of interference and can carry the load of the bath. Be sure to check the power requirements (230V/50-60Hz, 115V/60Hz) marked on the tag plate at the back side of the bath.
- ✓ Check operating voltage (230V/50-60Hz, 115V/60Hz) and connect the bath to appropriate mains supply. The bath has to be filled with a liquid suitable for operating temperature.

Preparing



1: On/off switch
2: Display (two decimals)
3: Indicator lights
4: Over-temperature cut-out
5: Encoder switch
6: Viscometer holders

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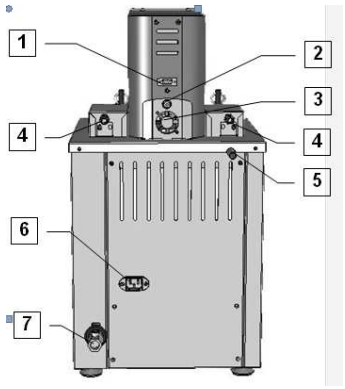
Preparing



1: RS232 connector (Sub D - female)
2: Motor fuse
3: Fan
4: Cooling coil
5: Overflow outlet (10mm outer diameter)
6: Mains connector (IEC60320) (use well protected earth!)
7: Bath drain (3/8" inner thread)

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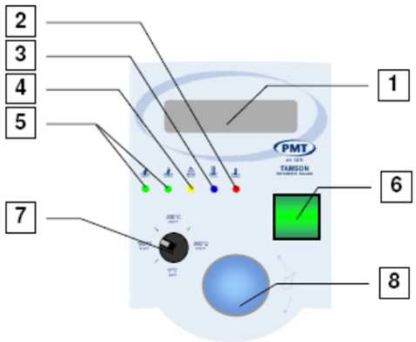
Preparing



1 LC Display
2 Over-temperature indicator (Red)
3 Level indicator, optional (Blue)
4 Error (Yellow)
5 Heater indicators (Green)
6 Mains switch
7 Safety thermostat
8 Turn-push button

Preparing

Overview menu items

- ✓ Set point
- ✓ Offset (press: <-5.00 .. +5.00°C resolution 0.01°C)
- ✓ Max Power (press: low 25, med, hi, max)
- ✓ Boost heater (press on / off)
- ✓ Time const (press: fast, medium slow, precise)
- ✓ Stirrer
- ✓ Low alarm
- ✓ High alarm
- ✓ PID parameter :
- ✓ Backlight
- ✓ Temp units
- ✓ Baudrate
- ✓ SP Offset
- ✓ Restart

The front panel layout shows the turn-push button:

Next / increase:	Turn right
Previous / decrease:	Turn left
Select:	Press

Preparing

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

2 **Applied percentage of power**
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%.
To have a stable bath heating percentage should be higher than 10% at working temperature.

3 **Operating mode**

Boost	Bath is heating to set point using boost heater
Heating	Bath is heating to set point, boost heater is off
Cooling	Bath is cooling down to set point
Tuning Ratio	Bath is tuning for power needed at set point, first step
Tuning SA	Bath is tuning, second step
PID SP=25.00	Bath is controlling, set point is 25.00°C

4 **Indicator, alarm high, alarm low, control stable**
Bath control is stable