

User Manual
Marine Temperature Calibrator
Jofra MTC-650 A MKII



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1.0 Introduction

The MTC-calibrator is a fast, timesaving, and reliable true industrial temperature calibrator designed for on-site use calibrating temperature sensors and temperature switches.

Read this manual carefully before using the instrument and make sure that all safety instructions and warnings are observed.

1.1 List of equipment received

When you receive the instrument, the following should be enclosed:

- 1 MTC Calibrator
- 1 USB memory stick containing electronic Reference manual and software package JOFRACAL
- 1 mains cable
- 1 sets of test leads and test clips (black and red)
- Thermal protection shield
- 1 tool for insertion tube
- 1 USB cable
- 1 Calibration certificate (International traceable)

2.0 Safety instructions



Read this manual carefully before using the instrument!

In order to avoid any personal injuries and/or damage to the instrument all safety instructions and warnings must be observed.



Disposal – WEEE Directive

These calibrators contain Electrical and Electronic circuits and must be recycled or disposed of properly (in accordance with the WEEE Directive 2012/19/EU).



Warning

About the use:

- The calibrator **must not** be used for any purposes other than those described in this manual, as protection provided by the calibrator may be impaired and it might cause a hazard.
- The calibrator has been designed for **indoor use only** and is not to be used in wet locations.
- The calibrator is **not to be used in hazardous areas**, where vapour or gas leaks, etc. may constitute a danger of explosion.
- The calibrator is **not** designed for operation in altitudes above 2000 meters.
- The calibrator is a CLASS I product and must be connected to a mains outlet with a protective earth connection. Ensure the ground connection of the calibrator is properly connected to the protective earth before switching on the calibrator. Always use a mains power cable with a mains plug that connects to the protective earth.
- To ensure the connection to protective earth any extension cord used **must** also have a protective earth conductor.
- Only use a mains power cord with a current rating as specified by the calibrator and which is approved for the voltage and plug configuration in your area.
- **Always** make sure to position the power cord and other connected cables in a secure way to prevent the risk of personnel falling.
- To prevent the calibrator from tipping over and causing damage to equipment or systems, please avoid pulling the cables connected to the calibrator.
- Before switching on the calibrator make sure that it is set to the voltage of the mains electricity supply.
- **Always** position the calibrator to enable easy and quick disconnection of the power source (mains inlet socket).
- The calibrator **must** be kept clear within an area of 20 cm on all sides and 1 metre above the calibrator due to fire hazard.
- **Never** use heat transfer fluids such as silicone, oil, paste, etc. in the dry-block calibrators. These fluids may penetrate the calibrator and cause electrical hazard, damage or create poisonous fumes.
- The calibrator **must** be switched off before any attempt to service the instrument is made. There are no user serviceable parts inside the calibrator.
- When cleaning the well or the insertion tube, **REMEMBER** to wear goggles when using compressed air!

- Remember to use appropriate protective equipment or get help when carrying the calibrator (for a longer distance) in order to prevent injuries from dropping the calibrator.

About the front panel:

- The connectors, on the front panel of the calibrator, must **NEVER** be connected to a voltage source.
- Thermostats connected to the switch test input must **not** be connected to any other voltage source during a test.

About the insertion tubes and insulation plug:

- **Never** leave hot insertion tubes which have been removed from the calibrator unsupervised – they may constitute a fire hazard or personal injury.

If you intend to store the calibrator in the optional aluminium carrying case after use, you **must** ensure that the instrument has cooled down to a temperature **below 50°C/122°F** before placing it in the carrying case.


- **Never** place a hot insertion tube in the optional carrying case.

About the fuses:

- The fuse box must not be removed from the power control switch until the mains cable has been disconnected.
- The two main fuses must have the specified current and voltage rating and be of the specified type. The use of makeshift fuses and the short-circuiting of fuse holders are prohibited and may cause a hazard.



Caution – Hot surface

This symbol is visible on the grid plate. 

- **Do not touch** the grid plate, the well or the insertion tube as the calibrator is heating up – they may be very hot and cause burns.
- **Do not touch** the tip of the sensor when it is removed from the insertion tube/well – it may be very hot and cause burns.
- **Do not touch** the handle of the calibrator during use – it may be very hot and cause burns.
- **Over 50°C/122°F**
If the calibrator has been heated up to temperatures above 50°C/122°F, you must wait until the instrument reaches a temperature **below 50°C/122°F** before you switch it off.
- **Do not** remove the insert from the calibrator before the insert has cooled down to less than 50°C/122°F.



Caution...

About the use:

- **Do not** use the instrument if the fan is out of order.
- Before cleaning the calibrator, you **must** switch it off, allow it to cool down and remove all cables.

About the well, insertion tube and grid plate:

- The well and the insertion tube **must** be clean and dry before use.
- **Do not** pour any form of liquids into the well. It might damage the well or cause a hazard.
- Scratches and other damage to the insertion tubes should be avoided by storing the insertion tubes carefully when not in use.
- The insertion tube must **never** be forced into the well. The well could be damaged as a result, and the insertion tube may get stuck.
- **Before** using new insertion tubes for the calibration, the insertion tubes **must** be heated up to maximum temperature 650°C (1202°F) for a period of minimum 30 minutes.
- The insertion tube must **always** be removed from the calibrator after use. The humidity in the air may cause corrosion oxidation on the insertion tube inside the instrument. There is a risk that the insertion tube may get stuck if this is allowed to happen.
- If the calibrator is to be transported, the insertion tube **must** be removed from the well to avoid damage to the instrument.



Note...

The product liability **only** applies if the instrument is subject to a manufacturing defect. This liability becomes void if the user fails to follow the instructions set out in this manual or uses unauthorised spare parts.

3.0 Setting up the calibrator

ENVIRONMENTAL SPECIFICATIONS

Ambient operating temperature range:	0-50°C / 32-122°F
Storage temperature range:	-20-50°C / -4-122°F
Humidity range:	5-90% RH, non-condensing
IP protection class:	IP10
Altitude:	0-2000 m
Electromagnetic Compatibility:	Tested for use in domestic establishment and in establishments directly connected to low voltage power supply network which supplies buildings used for domestic purposes as well as in an industrial electromagnetic environment as described in EN61326-1:2013.

POWER SUPPLY SPECIFICATIONS

Line voltage/frequency:	90-127VAC / 180-254VAC 47-63 Hz
IEC protection class:	Class I
Power consumption:	1150 VA max.

3.1 Before use




Warning

- The calibrator has been designed for **indoor use only** and is not to be used in wet locations.
- The calibrator is **not to be used in hazardous areas**, where vapour or gas leaks, etc. may constitute a danger of explosion.
- The calibrator is **not** designed for operation in altitudes above 2000 meters.
- The calibrator is a CLASS I product and must be connected to a mains outlet with a protective earth connection. Ensure the ground connection of the calibrator is properly connected to the protective earth before switching on the calibrator. Always use a mains power cable with a mains plug that connects to the protective earth.
- To ensure the connection to protective earth any extension cord used **must** also have a protective earth conductor.
- Only use a mains power cord with a current rating as specified by the calibrator and which is approved for the voltage and plug configuration in your area.
- **Always** make sure to position the power cord and other connected cables in a secure way to prevent the risk of personnel falling.
- To prevent the calibrator from tipping over and causing damage to equipment or systems, please avoid pulling the cables connected to the calibrator.
- Before switching on the calibrator make sure that it is set to the voltage of the mains electricity supply.

- **Always** position the calibrator to enable easy and quick disconnection of the power source (mains inlet socket).
- The calibrator **must** be kept clear within an area of 20 cm on all sides and 1 metre above the calibrator due to fire hazard.



Caution – Hot surface

This symbol is visible on the grid plate. 

- **Do not touch** the grid plate, the well or the insertion tube as the calibrator is heating up – they may be very hot and cause burns.
- **Do not touch** the handle of the calibrator during use – it may be very hot and cause burns.

When setting up the calibrator, you must... (cf. the figure this page):

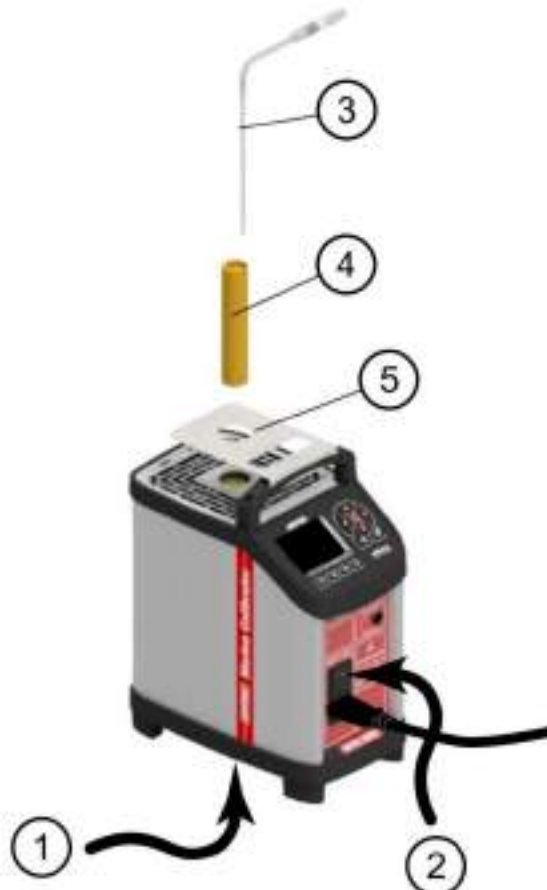
1. Place the calibrator on an even horizontal surface where you intend to use it and away from all draughts. The calibrator **must** be kept clear within an area of 20 cm on all sides and 1 metre above the calibrator due to fire hazard.



Caution...

Do not use the instrument if the internal fan is out of order.

2. Ensure a free supply of air to the internal fan located at the bottom of the instrument (pos. 1). The area around the calibrator should be free of draught, dirt, flammable substances etc.
3. Check that the fuse size corresponds to the applied voltage on (pos. 2). The fuse is contained in the power control switch (on/off switch (230V/115V)).





Warning

The two main fuses must have the specified current and voltage rating and be of the specified type. The use of makeshift fuses and the short-circuiting of fuse holders are prohibited and may cause a hazard.

4. Check that the earth connection for the instrument is present and attach the cable.
5. Place the sensor (pos. 3) in the insertion tube (pos. 4) as shown in the figure.



Caution...

Before using new insertion tubes for the calibration in the MTC-650 instrument the insertion tubes **must** be heated up to maximum temperature 650°C (1202°F) for a period of minimum 30 minutes.

6. In order to protect the sensor and its connections use the thermal protection shield (129264 – pos. 5) at high temperatures.

3.2 Keypad - Functions



Function keys - F1, F2, F3, F4
For operating the horizontal menu.



Arrow Keys

Navigation mode: Use the four keys to move the cursor in the desired direction.

Edit mode: The Up and Down Arrow keys scroll through the lists of options. If entering a number, the Left and Right Arrow keys move the cursor one character in the desired direction.

Action key / Enter key

Action function: Open and close edit fields or a menu button. The action key also accepts the selected option or entered value.

Enter function: Accept selected options or entered values. When a value is entered with the Enter Key the cursor selects the next configurable field in the list.

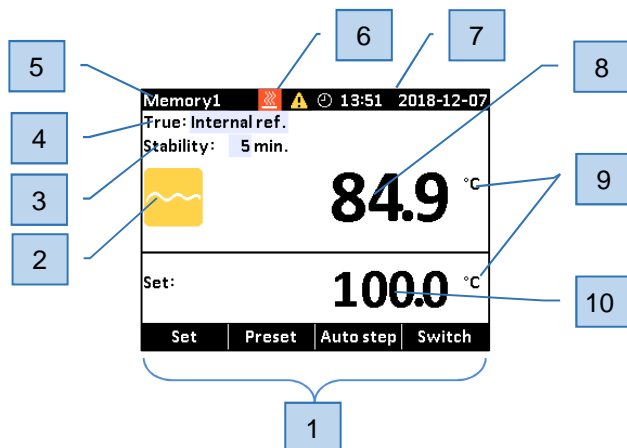
System menu key

Enter the System menu.

Back key

Cancel a selection or return to previous menu.

3.3 Display



1) Horizontal menu bar

Provides you with the relevant menu options that can be selected at the present point. Each option can be selected and activated by pressing the function keys (F1, F2, F3 and F4).

2) Process Indicator

Indicates the status of the current process.

3) "Time to stable" Selection

Shows the selected specified stability criteria and states a time when the stable situation can be achieved.



4) Reference sensor info

Shows the reference sensor selected.

5) Memory reading

Shows the current memory selected from the System menu.

6) Warning/Error symbols.

If a warning  or an error symbol  occurs during operation, action needs to be taken.

7) Real Time Clock and date display.

8) True temperature reading

Shows the numeric value of the temperature being measured.

9) Units

Shows the unit of the current measurement.

10) Set temperature reading

Shows the numeric value of the current set temperature selected.

3.4 Connections



Device

USB 2.0 Device Port, 1 x USB.

Switch Test



Connection for thermostat switch test. **Note** that this connection is for voltage free switches.


Power Control Switch

With a cable connection and On/Off switch. It also contains the main fuse. See section 3.1 in the reference manual for information on how to change the fuse. The text above the Power Control Switch indicates the fuse value.



3.5 Stability of temperature values

The stability of the TRUE temperature is indicated by the following messages:



-  "Not stable": Indicates that the measured temperature is not yet within the specified stability criteria.
-  Indicates "Time to stable": The temperature changes are within the specified stability criteria and states a time (in minutes and seconds) when the stable situation can be achieved.

-  Indicates that the “stable” situation is achieved and for how long the calibrator has been stable. When the calibrator has been stable for more than 99 minutes, only the stable sign is displayed (time is no longer displayed).

When the instrument is heating up and cooling down indication of this will be shown as following symbols:

-  The instrument is heating up.
-  The instrument is cooling down.

Hot and cold symbols will be displayed in the upper black info bar when:

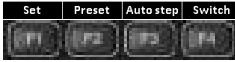
-  the well temperature is below 5°C.
-  the well temperature is above 45°C.









4.0 Operating the calibrator

4.1 Operating principle

The calibrator is operated using the Functions keys, the Arrow keys and the Action/Enter key.


1. Press the Functions keys to operate the horizontal menu bar.





2. Press any of the  (Arrow) keys to enter Navigation Mode. Editable fields will be highlighted in blue.
3. Use the  (Arrow) keys to move between the configurable fields within the display. Selected fields will be highlighted in dark blue.
4. Press the  (Enter) key to access the selected field for editing.
5. Use the  (Up) and  (Down) Arrow keys to select a new value.
6. Press the  (Enter) key to accept the new value
7. To exit the Navigation Mode press the  (Back) key. The  (Back) key is also used to cancel a selection or to return to a previous menu.

4.2 System menu

The System menu can be accessed at any stage of operation:




1. Press the  (System) key to display the System menu.



2. Use the  (Up) and  (Down) Arrow keys to scroll in the list.


- **System Settings menu**

System Settings	
Min. SET Temp:	0.0 °C
Max. SET Temp:	650.0 °C
Resolution:	0.1 °C
Temperature unit:	°C
Silent mode:	<input checked="" type="checkbox"/>
Date	2018-12-07
Time	13:54
Calibration interval:	12 Months

1. Use the  (Enter) key and the  (Up) and  (Down) Arrow keys to access editable fields, select new values and accept new values.



Note...

- If the current set-temperature is higher than the new max-temperature, you will need to adjust the set-temperature. The instrument will immediately begin to cool (if required) as soon as the new max-temperature is accepted.
- The calibration interval can be set between 1 and 99 months. When the calibration interval is exceeded, a yellow warning symbol  will appear in the upper part of the display.
- If Silent mode is selected, the cooling speed will be reduced.

- **Presets menu**

Preset Temperature Settings	
Preset temperature F1:	50.0 °C
Preset temperature F2:	75.0 °C
Preset temperature F3:	100.0 °C
Preset temperature F4:	150.0 °C

1. The preset temperatures can be changed manually using the  (Arrows) keys.



Note...

Temperature range is limited by Min. SET Temp. and Max. SET Temp. settings editable in the System Settings menu.

- **System Info menu**

System Info - MTC-650A MKII	
S/N:	641488-00002
Version:	1.27.0
Calibrator calibrated:	2018-10-03

1. In the System Info menu important information such as serial numbers and calibration dates of the instrument are given.
It is not possible to edit any fields in this menu.

- **Store menu (Save Settings)**

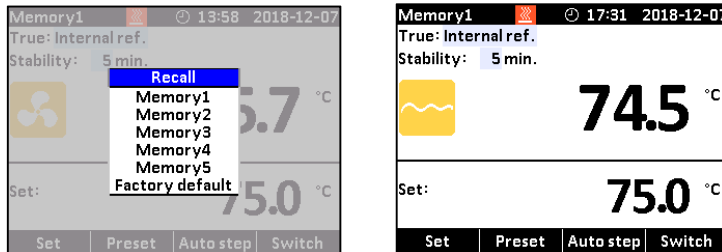
Save Settings	
1- Memory1	
2- Memory2	
3- Memory3	
4- Memory4	
5- Memory5	

Back Save

After you have configured the instrument, you can save the setup for future use using the Store function.

1. Use the ▲ (Up) and ▼ (Down) Arrow keys to select the Memory-setup you want to modify, and press **F3** (Save). The new configuration is now saved.
2. You can change the name of the highlighted saved setup by pressing **Enter**, and then using the ▲ (Up) and ▼ (Down) Arrow keys to change the characters.
The name is limited to seven (7) characters.
3. Press **F3** to save the new name.

- **Recall menu**



To recall your memory setups select the Recall function.

1. Use the ▲ (Up) and ▼ (Down) Arrow keys to scroll in the setup-list.
2. Select the requested setup, and press **Enter**.

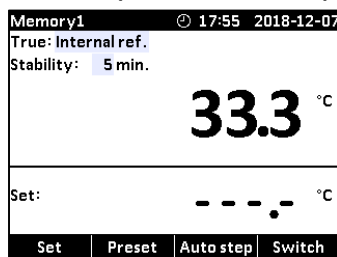
The name of the setup will appear in the upper-left corner of the display.

If selecting the Factory default function the active setup will be reset and change to the initial setting.

4.3 Starting the calibrator

Switch on the calibrator using the power control switch.

A start up screen is displayed and then replaced with the main menu screen:



The functions in the horizontal menu bar are available using the Functions soft keys F1–F4. For Operating principle – See section 4.1.

4.4 Stability setting

When internal reference is selected the calibrator uses a set of minimum internal stability criteria that shall be met before stability is indicated.



The stability time can be adjusted from the minimum internal stability time (typical 5 min) up to 99 min.

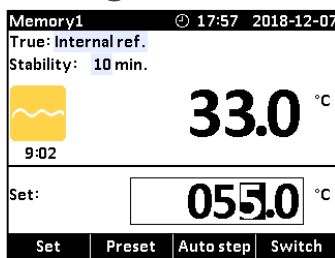
4.5 Selecting the set-temperature

Note...

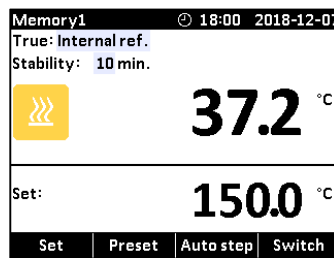
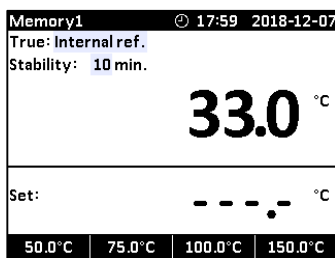
Temperature range is limited by Min. SET Temp. and Max. SET Temp. settings editable in the System Settings menu.

The set-temperature can be entered both manually and by selecting a preset temperature.

1. For manually use press **F1** (Set)
2. Use the  (Arrow) keys to enter the temperature requested.
3. Press  (Enter) to accept the entered temperature.



1. For selecting the preset temperature press **F2** (Preset).
2. Select one of the 4 temperature options available from the menu bar by pressing the correspondent Function key (F1 – F4).
3. The set-temperature is selected, once the Function key has been pressed.

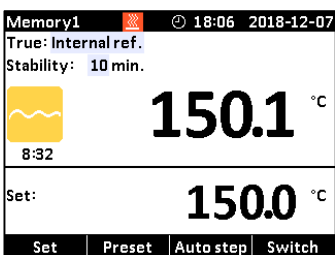



The calibrator will now heat up / cool down.

The starting point is the last chosen set-temperature (even if the instrument has been switched off).

The top display continuously shows the read-temperature and the lower display shows the set-temperature.


In the top display the calibrator will indicate the estimated time in whole minutes until the calibrator will be stable.

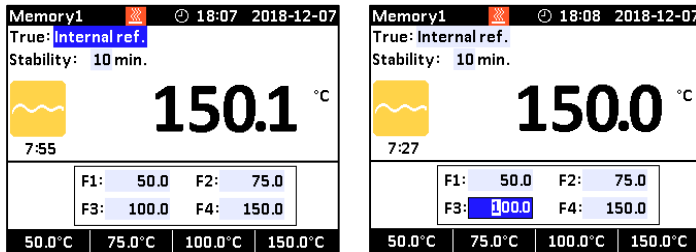







When the calibrator is stable the display will show a green  checkmark symbol and the instrument will emit an audible alarm. The instrument will indicate in minutes and seconds for how long the instrument has been stable.

4.5.1 Editing the preset set-temperature

It is possible to change the preset set temperature to whatever value desired.

1. Press **F2** (Preset).
2. Press one of the  (Arrow) keys and an editable field displaying the preset set temperatures appears.
3. Navigate to the set temperature field using the arrows.



4. Press  (Enter) to access the editable field and use the arrows  (Up) and  (Down) to select a new set value.
5. Press  (Enter) to accept the new set value.
6. Press  (Back) to return to the previous menu.

4.6 Auto Step function

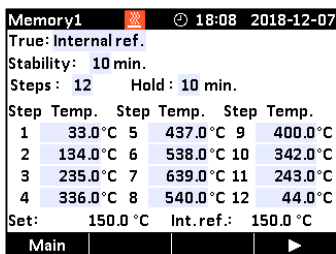
Auto Step is used to step automatically between a range of different calibration temperatures. This is useful when calibrating sensors in places which are hard to reach, and when calibrating sensors for which the output is displayed in a different location.


Note...

Temperature range is limited by Min. SET Temp. and Max. SET Temp. settings editable in the System Settings menu.


4.6.1 Running an Auto Step test

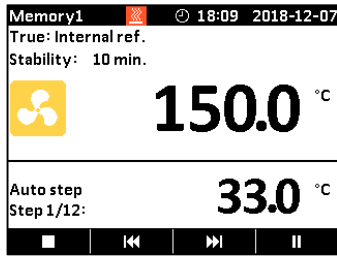
1. Press **F3** (Auto Step) to access the Auto Step setup. If you wish to return to the Main screen press **F1** (Main).



2. Press one of the  (Arrow) keys to access the editable fields for new values:
 - **No of steps:** the number of temperature steps per direction ($T_1 \rightarrow T_x$) can be set using integers from 2 to 12. You must select minimum 2 steps, maximum 12 steps.
 - **Hold time:** defines the time (in minutes) the temperature is maintained (after it is stable) for each step.







- **Step values:** must be set within the sensors permitted range.

3. Press  (F4) to start the Auto Step test.



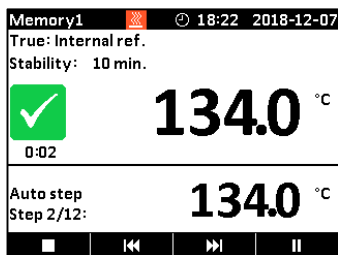
The Auto Step test is now in progress.

While the Auto Step test is in progress, 4 options are available:

- **Stop :** Press  (F1) to stop the Auto Step test. The process will end. Pressing the  (F4) key the process will start again running step 1.
- **Previous :** Press  (F2) to force the test to jump a step backwards to the previous running step regardless of the step's stability.
- **Next :** Press  (F3) to force the test to jump a step forwards to the next running step regardless of the step's stability.
- **Pause :** Press  (F4) to pause the test. Pressing start  (F4) again, the process will continue running from the current step.

4.6.2 The calibrator's Auto Step procedure

- 1) Once the Auto Step test is started, the calibrator starts working towards the given set-temperature. An audible alarm will be emitted once the calibrator is stable.
- 2) The calibrator will wait the specified amount of hold time. The instrument indicates this by counting down the amount of time remaining.
- 3) The calibrator will then go to the next step. The procedure is the same as for the first step. This process will be repeated until the last step has been executed and the function has been completed.
- 4) The measured TRUE temperatures for each step are displayed during operation.



4.7 Switch Test function

Switch Test automatically locates the switch temperature of a thermostat.

Three parameters are required:

- Start temperature (T_1)
- End temperature (T_2)
- Rate of change in temperature pr. minute (Rate).

Dead band of a thermostat can also be determined here. Where the dead band determines the tolerance between the upper switch temperature and the lower switch temperature of the thermostat.

4.7.1 Running a Switch Test



Warning

Thermostats connected to the switch test input **must not** be connected to any other source during test.



Note...

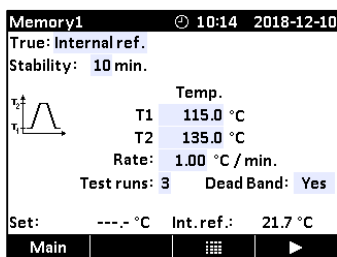
Before running the Switch Test, make sure that the switch is connected to the Switch Test input.




Note...

Temperature range is limited by Min. SET Temp. and Max. SET Temp. settings editable in the System Settings menu.

1. Press **F4** (Switch) to access the Switch Test setup. If you wish to return to the Main screen press **F1** (Main).



The small graph illustrates the current T_1 , T_2 and dead band selections. Note that T_1 can be greater than T_2 .


2. Press one of the  (Arrow) keys to access the editable fields for new values:

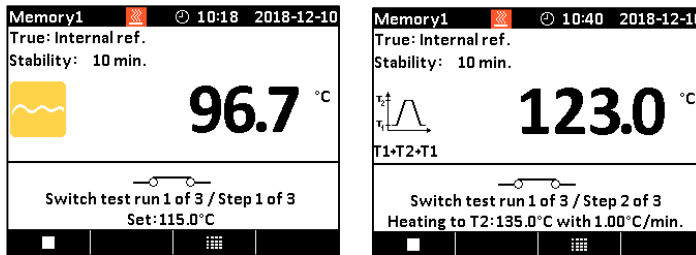
- T_1 : First set temperature
- T_2 : Second set temperature

- **Dead band** : To determine dead band, toggle between "Yes" (a two-way-temperature measurement) and "No" (a one-way-temperature measurement). A dead band result is only measured when dead band is set to "Yes".
- **Rate** : The permitted range is 0.01 - 10.0°C/min. / 0.02 - 18.0°F/min.
- **Test runs**: Can be set from 1 to 3 making it possible to run the test more than once.

➔ **Note...**




the Rate should be set so that the thermostat sensor can follow the temperature in the calibrator's well.

3. Press  (F4) to start the Switch Test.



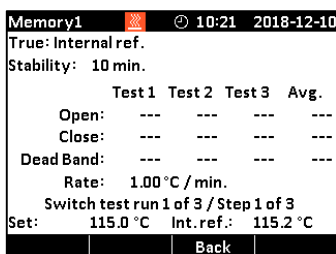
The Switch test is now in progress.

While the Switch Test is in progress, 2 options are available:

- **Stop** : Press  (F1) to stop the Switch Test. The process will end and the results will be deleted from the results list. Pressing the  (F4) key the process will start from the beginning heating towards T₁.
- **Results** : Press  (F3) to display the current Switch Test result. The results change as the test progresses. The results list is also accessible from the Switch Test menu screen.


4.7.2 The calibrator's Switch Test procedure

- 1) Once the Switch Test is started, the calibrator starts working towards T₁ as quickly as possible. The calibrator's temperature changes (heating or cooling) and switch status are shown in the display.
- 2) When T₁ is achieved and the temperature is stable, the text and the graphic in the bottom of the screen will change accordingly.
- 3) The calibrator now starts working towards T₂ at the specified Rate.
- 4) In a normal situation, the thermostat changes state before T₂ is achieved. If T₂ is achieved and the temperature is stable, no results will be displayed.

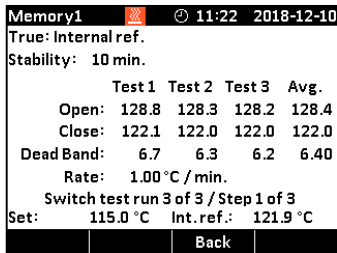


- 5) When dead band is not selected (single temperature change) (the graphic indicates the choice), the finished switch test result is displayed.

When dead band is selected (two switch changes), the calibrator starts working towards T_1 at the specified Rate.

- 6) Normally, the thermostat changes state before T_1 is achieved. If T_1 is reached and the temperature is stable, no results will be displayed.
- 7) The finished switch test results are displayed in the results list by pressing  (F3).

The results show the temperature when the thermostat has closed and the temperature when it has opened – whichever comes first. The difference between these 2 temperatures is calculated as the dead band.



	Test 1	Test 2	Test 3	Avg.
Open:	128.8	128.3	128.2	128.4
Close:	122.1	122.0	122.0	122.0
Dead Band:	6.7	6.3	6.2	6.40

Rate: 1.00 °C / min.
Switch test run 3 of 3 / Step 1 of 3
Set: 115.0 °C Int.ref.: 121.9 °C

Back

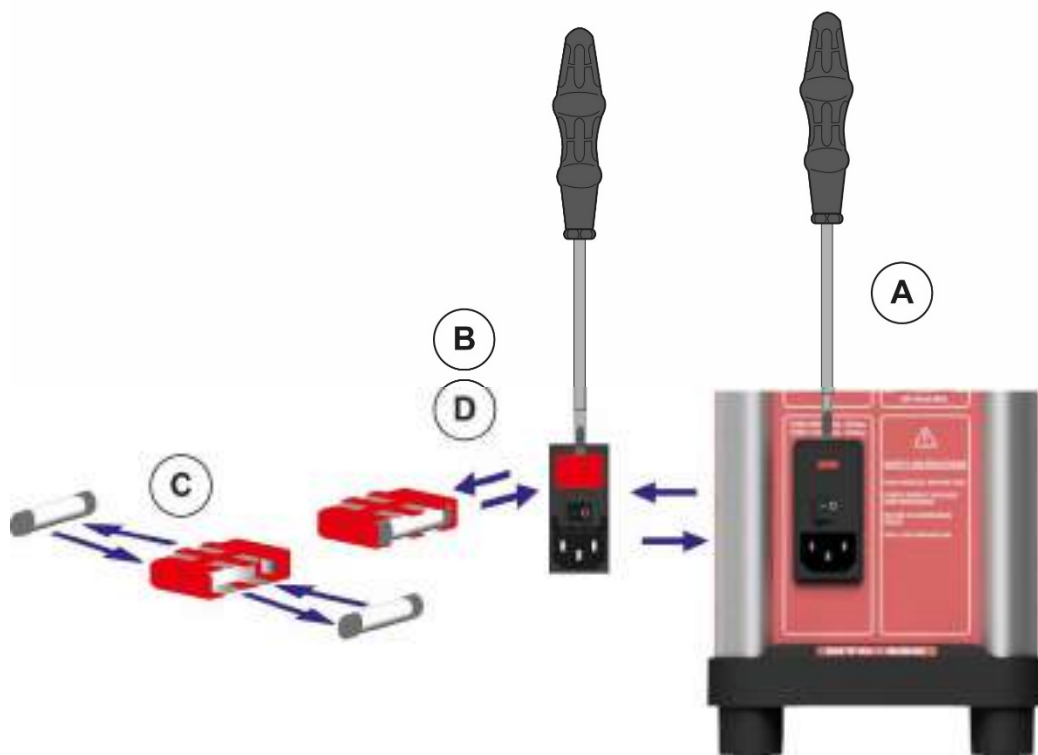
5.0 Setting the mains voltage and replacing the main fuses

5.1 Replacing the main fuses



Warning

- The calibrator **must** be switched off before any attempt to service the instrument is made. There are no user serviceable parts inside the calibrator.
- The fuse box **must not** be removed from the power control switch until the mains cable has been disconnected.
- The two main fuses must have the specified current and voltage rating and be of the specified type. The use of makeshift fuses and the short-circuiting of fuse holders are prohibited and may cause a hazard.



- Locate the main fuses in the fuse box in the power control switch and check the voltage of the power control switch (on/off switch (230V/115V)). If the voltage of the power control switch differs from the line voltage, you must adjust the voltage of the power control switch.
- Open the lid of the fuse box using a screwdriver and remove the fuse box.
- Replace the fuses. The fuses must be identical and should correspond to the line voltage.
 - 115V: 10AF/250V = 60B302
 - 230V: 5AF/250V = 127573If the fuses blow immediately after you have replaced them, the calibrator should be returned to the manufacturer for service.
- Slide the fuse box into place with the correct voltage turning upwards.

6.0 After use

6.1 Storing and transporting the calibrator



Caution...

The following guidelines should always be observed when storing and transporting the calibrator. This will ensure that the instrument and the sensor remain in good working order.



Warning

- The calibrator **must** be switched off before any attempt to service the instrument is made. There are no user serviceable parts inside the calibrator.
- Remember to use appropriate protective equipment or get help when carrying the calibrator (for a longer distance) in order to prevent injuries from dropping the calibrator.

The following routine must be observed **before the insertion tube is** removed and the instrument switched off:



Over 50°C/122°F

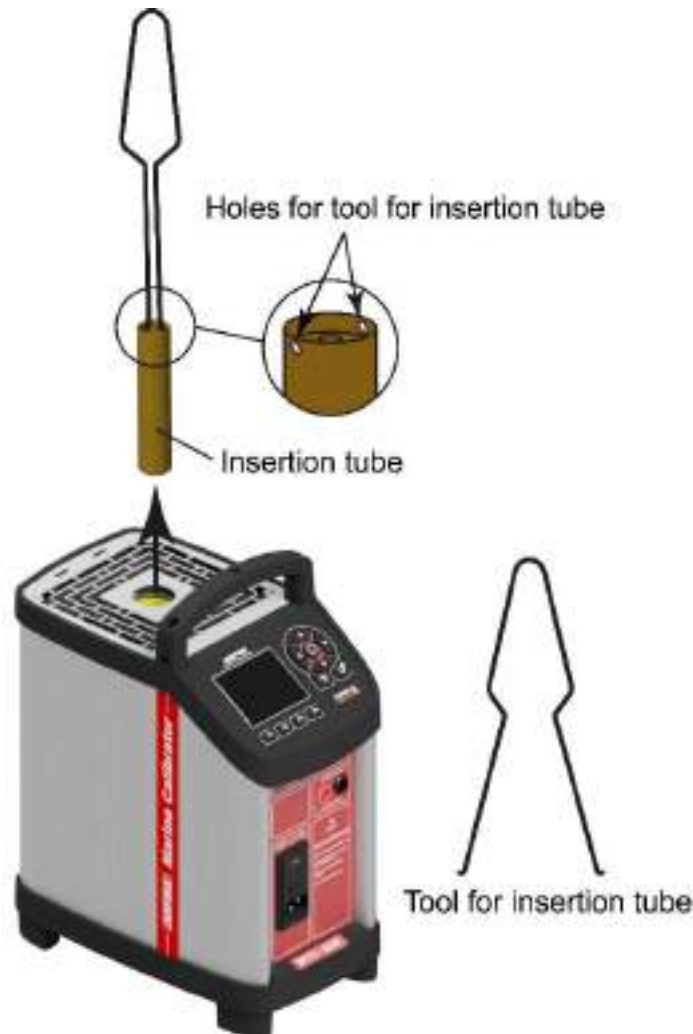
If the calibrator has been heated up to temperatures above 50°C/122°F, you must wait until the instrument reaches a temperature **below 50°C/122°F** before you switch it off.

6.2 Switching off the calibrator

1. Switch off the calibrator using the power control switch.

Note that the calibration procedure may be interrupted at any time using the power control switch. Switching off the calibrator during the calibration process will not damage either the instrument or the sensor.

2. Remove the insertion tube from the calibrator using the tool for insertion tube supplied with the instrument as shown in the figure.



Caution – Hot surface

Do not remove the insert from the calibrator before the insert has cooled down to less than 50°C/122°F



Caution...

- The insertion tube must **always** be removed from the calibrator after use.

The humidity in the air may cause corrosion oxidation on the insertion tube inside the instrument. There is a risk that the insertion tube may get stuck if this is allowed to happen.

- If the calibrator is to be transported long distances, the insertion tube **must** be removed from the well to avoid damage to the instrument.



Warning

- **Never** leave hot insertion tubes which have been removed from the calibrator unsupervised – they may constitute a fire hazard or personal injury.

If you intend to store the calibrator in the optional aluminium carrying case after use, you **must** ensure that the instrument has cooled to a temperature **below 50°C/122°F** before placing it in the carrying case.

- **Never** place a hot insertion tube in the optional carrying case.
- **Do not** touch the well or insertion tube when these are deep frozen – they might create frostbite.



www.ametekcalibration.com

UK

Tel +44 (0)1243 833 302
stc.uk@ametek.com

France

Tel +33 (0)1 30 68 89 40
general.lloyd-instruments@ametek.fr

Germany

Tel +49 (0)2159 9136 510
info.mct-de@ametek.de

Denmark

Tel +45 4816 8000
jofra@ametek.com

USA - California

Tel +1 (800) 444 1850
crystal@ametek.com

USA - Florida

Tel +1 (800) 527 9999
cal.info@ametek.com

India

Tel +91 22 2836 4750
jofra@ametek.com

Singapore

Tel +65 6484 2388
jofra@ametek.com

China - Shanghai

Tel +86 21 5868 5111
stc.china@ametek.com

China - Beijing

Tel +86 10 8526 2111 ext. 19
stc.china@ametek.com