AMETEK®
TEST & CALIBRATION INSTRUMENTS

Reference Manual

Reference Temperature Calibrator

JOFRA RTC-156/RTC-157/RTC-158/RTC-250/RTC-700 A/B/C

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...because calibration is a matter of confidence

Reference Manual

Reference Temperature Calibrator

JOFRA RTC-156/157/158/250/700 A/B/C

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About this manual….

- **The structure of the manual**

  This manual is divided into 9 chapters. These describe how to set up, operate, service and maintain the calibrator. The technical specifications are described and accessories may be ordered from the list of accessories.

  Along with the calibrator, you should have received a multi-lingual user manual, which sets out the operating instructions for the instrument. It is designed to provide a quick reference guide for use in the field.

- **Safety symbols**

  This manual contains a number of safety symbols designed to draw your attention to instructions that must be followed when using the instrument, as well as any risks involved.

Warning

Events that may compromise the safe use of the instrument and result in considerable personal or material damage.

Caution…

Events that may compromise the safe use of the instrument and result in slight personal or material damage.

Note…

Special situations, which demand the user's attention.

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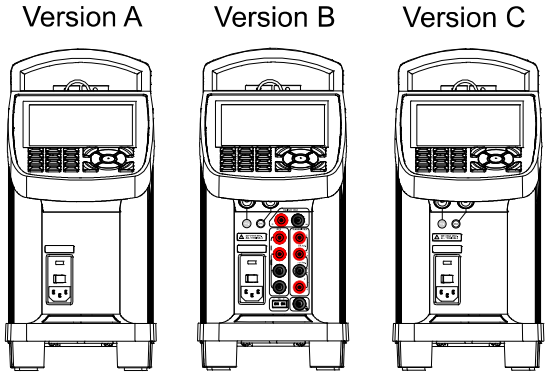
1.0 Introduction

Congratulations on your new AMETEK JOFRA RTC Calibrator!

With this AMETEK JOFRA calibrator, you have chosen an extremely effective instrument, which we hope will live up to all your expectations. Over the past many years, we have acquired extensive knowledge of industrial temperature calibration. This expertise is reflected in our products, which are all designed for daily use in an industrial environment. Please note that we are very interested in hearing from you, if you have any ideas or suggestions for changes to our products.

This reference manual applies to the following instruments:

- **JOFRA RTC-156 A - Temperature calibrator**
- **JOFRA RTC-156 B - Temperature calibrator with sensor and reference inputs**
- **JOFRA RTC-156 C - Temperature calibrator with reference input**
- **JOFRA RTC-157 A – Temperature calibrator**
- **JOFRA RTC-157 B – Temperature calibrator with sensor and reference inputs**
- **JOFRA RTC-157 C - Temperature calibrator with reference input**
- **JOFRA RTC-158 A – Temperature calibrator**
- **JOFRA RTC-158 B – Temperature calibrator with sensor and reference inputs**
- **JOFRA RTC-158 C - Temperature calibrator with reference input**
- **JOFRA RTC-250 A – Temperature calibrator**
- **JOFRA RTC-250 B – Temperature calibrator with sensor and reference inputs**
- **JOFRA RTC-250 C - Temperature calibrator with reference input**
- **JOFRA RTC-700 A - Temperature calibrator**
- **JOFRA RTC-700 B - Temperature calibrator with sensor and reference inputs**
- **JOFRA RTC-700 C - Temperature calibrator with reference input**



ISO-9001 certified

AMETEK Denmark A/S was ISO-9001 certified in September 1994 by Bureau Veritas Certification Denmark.

CE-label

Your new calibrator bears the CE label and conforms to the EMC Directive and the Low-voltage Directive.

Technical assistance

Please contact the dealer from whom you acquired the instrument if you require technical assistance.

Warranty

According to current terms of sale and delivery.

This warranty only covers defects in manufacture and becomes void if the instrument has been subject to unauthorized intervention and/or misuse.

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.

The screen menus shown in this manual represent the menus displayed when using a B-version.

Disposal – WEEE Directive

These calibrators contain Electrical and Electronic circuits and must be recycled or disposed of properly (in accordance with the WEEE Directive 2002/96/EC).

Warning……

About the use:

- The calibrator **must not** be used for any purposes other than those described in this manual.
- The calibrator has been designed for **interior use only** and should **not be used in hazardous areas**, where vapour or gas leaks, etc. may constitute a danger of explosion.
- The calibrator **must** be kept free within an area of 20 cm on all sides and 1 metre above the calibrator.
- **Never** use heat transfer fluids such as silicone, oil, paste, etc. in the dry-block calibrators. These fluids may penetrate the calibrator and cause damage or create poisonous fumes.
- The calibrator **must** be switched off before any attempt to service the instrument is made.
- When cleaning the well, **REMEMBER** to wear goggles when using compressed air in the dry-block calibrator and cleaning oil in the liquid bath calibrator.

- The calibrator **must not** be used in wet areas.
- Use protection shield when calibrating at high temperatures (RTC-700)

About the front panel:

- For B and C versions only, the sockets on the input module must **NEVER** be connected to voltages exceeding 30V with reference to ground. Thermostats must not be connected to any other voltage sources during test.

About insertion tubes, insulation plugs, well and sensor:

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

  If you intend to store the calibrator in the optional carrying case after use, you **must** ensure that the instrument has cooled down to a temperature **below 100°C/212°F** before placing it in the 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 be identical and correspond to the applied voltage and current.

About the liquid bath (RTC-158/250 A/B/C only):

- For liquid bath ensure that the sensor is absolutely clean and dry as a few drops of water in the well (liquid baths) might cause a steam explosion.
- **Do not pour** cold fluid into a hot well – it might cause an explosion.
- AMETEK Denmark A/S **does not** take any responsibility, if the well is filled with other fluids than those recommended.

- Liquid baths should **only** be operated by trained personal.
- Heat transfer fluids must **only** be used in calibrators prepared as a liquid bath. If these fluids are overheated they will create noxious or toxic fumes. Proper ventilation must be used.
- Product information on the fluid must be carefully investigated before use.
- **Do not** handle hot fluid.
- If the oil is heated beyond the flash point, it may constitute a fire hazard.
- **Do not pour** water or any other fluids into a bath filled with hot oil, because only a few drops of water might cause a steam explosion, if poured into 250°C hot oil.
- **Do not** under any circumstances pour water on burning oil. It might cause a dangerous steam explosion.

Caution – Hot surface

This symbol is engraved in the grid plate.

- **Do not touch** the grid plate, the well or the insertion tube when the calibrator is heating up – they may be very hot.
- **Do not touch** the lid or the spill tray when the calibrator is heating up – they may be very hot (RTC-158/250 A/B/C only).
- **Do not touch** the tip of the sensor when it is removed from the insertion tube/well – it may be very hot.
- **Do not touch** the handle of the calibrator during use – it may be very hot.
- **Over 100°C/212°F**

  If the calibrator has been heated up to temperatures above 100°C/212°F, you must wait until the instrument reaches a temperature **below 100°C/212°F** before you switch it off.

Caution – Cold surface

Below 0°C/32°F
(applies only to the RTC-156/157/158 A/B/C models)

- Do not touch the well or insertion tube when these are below 0°C/32°F - they might create frostbite.
- If the calibrator has reached a temperature below 0°C/32°F, ice crystals may form on the insertion tube and on the well. This, in turn, may cause the material surfaces to oxidize.
  To prevent this from happening, the insertion tube and the well must be dried. This is done by heating up the calibrator to min. 100°C/212°F and any water left will evaporate.
  Remove the insulation plug while heating up.
- It is very important that humidity in the well and insertion tube is removed to prevent corrosion and frost expansion damages.

Caution…

About the use:

- **Do not** use the instrument if the internal 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 liquid bath (RTC-158/250 A/B/C only):

- Be careful **not to overfill** the well with oil.
- Avoid getting silicone oil on the clothes. It is impossible to wash off.

  The oil level rises several centimetres when the temperature is rising. To stop overflow switch off the main power and the oil level will decrease.
- Carefully wipe off all silicone oil from the sensor under test to avoid spreading of the silicone oil.

- Be careful to select the right oil for the right task. Using other than the recommended oils might cause damage to the calibrator or degrade the performance.
- Remove excess hot fluid with the outmost care, as it might be very hot.
- Do not attempt to remove hot fluid with the liquid drainage tube, as it might melt.

About the well, insertion tube and sensor:

- The well and the insertion tube **must** be clean and dry before use.
- Do not use any alkali, acid or ionic fluids in the aluminium well as it might be damaged.
- 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 – 250°C (482°F) / 700°C (1292°F) - for a period of minimum 30 minutes (RTC-250/700 A/B/C only).
- 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.
- The tip of the sensor should rest at the bottom of the sensor basket for optimum results (liquid baths only).
- Be careful **not to** submerge the handle or wire inlet of the sensor-under-test in the fluid, as this might damage the sensor (liquid baths only).

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 unauthorized spare parts.

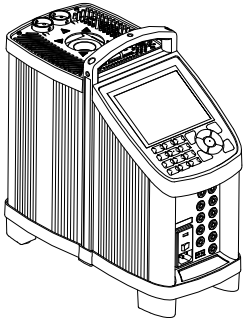
3.0 Setting up the calibrator

3.1 Receipt of the calibrator

When you receive the instrument…

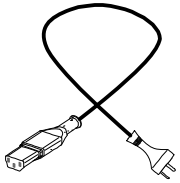
- Carefully unpack and check the calibrator and the accessories.
- Check the parts against the list shown below.

  If any of the parts are missing or damaged, please contact the dealer who sold the calibrator.

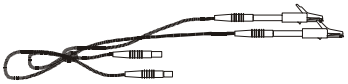


You should receive:

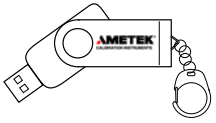
- 1 calibrator



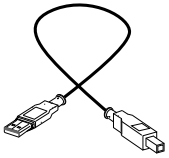
- 1 mains cable



- 2 sets of test cables (2 black, 2 red – B versions only)

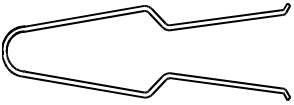


- 1 USB key containing software package “JOFRACAL” and reference manual

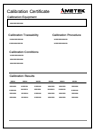


-
- 1 USB cable

- 1 tool for insertion tube



- 1 traceable certificate (A versions)

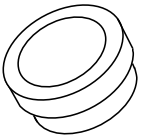


- 2 traceable certificates (C versions)

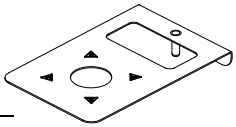
- 3 traceable certificates (B versions)

- 1 set of rubber cones for insulation plugs (RTC-156/157/158/250 only)

- 1 insulation collar (RTC-156 only)

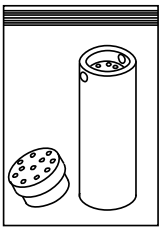


- 1 heat shield (RTC-700 only)



RTC-158/250 A/B/C only (dry-block)

- 1 dry block kit – metric consisting of :
  - 1 insertion tube, multi-hole, metric, with 12 bores (incl. DLC and reference bores)
  - 1 pcs. insulation plug for multi-hole, metric

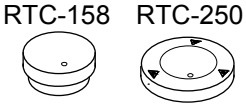


or

- 1 dry block kit – inch consisting of :
  - 1 insertion tube, multi-hole, inch, with 12 bores (incl. DLC and reference bores)
  - 1 pcs. insulation plug for multi-hole, inch

Caution

- **Do not use** the RTC-158 insulation plug with the RTC-250 instrument due to the risk of melting.



RTC-158/250 A/B/C only (liquid bath)

- 1 liquid bath kit consisting of :
  - 1 sensor basket
  - 2 lids for transportation / calibration
  - 1 stirring magnet
  - 1 stirring magnet remover
  - 1 liquid drainage syringe
  - 1 bottom shield
  - 1 silicone oil
  - 1 oil material safety data sheet

When reordering, please specify the part numbers found in the list of accessories, chapter 9.0.
Optional parts can also be found in the list of accessories.

3.2 Preparing the dry-block calibrator

Warning

- The calibrator **must not** be used for any purposes other than those described in this manual.
- The calibrator has been designed for **interior use only** and should **not be used in hazardous areas**, where vapour or gas leaks, etc. may constitute a danger of explosion.
- The calibrator **must** be kept free within an area of 20 cm on all sides and 1 metre above the calibrator.
- The calibrator **must not** be used in wet areas.

Note…

The instrument must **not** be exposed to draughts.

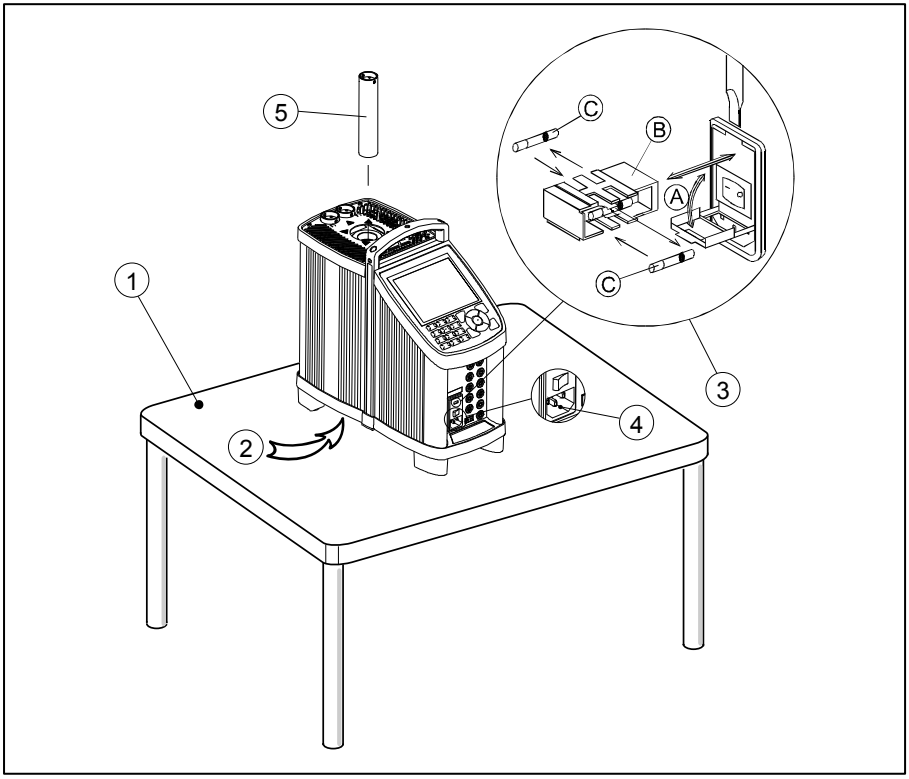


Fig. 1

3.2.1 When setting up the dry-block calibrator, you must…

① Place the calibrator on an even horizontal surface where you intend to use it.

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.
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 The fuse is contained in the power control switch (on/off switch To check do as follows (see fig. 1):

A. Open the fuse box lid using a screwdriver.

B. Take out the fuse box.

C. Remove both fuses replacing them with two new fuses. These must be identical and should correspond to the line voltage. See chapter 9.0.

B. Slide the fuse box back into place.

④ Check that the earth connection for the instrument is present and attach the cable.

⑤ Select an insertion tube with the correct bore diameter. See section 3.2.2 for information on how to select insertion tubes.

The calibrator is now ready for use.

3.2.2 Choice of insertion tube

Caution…

Before using new insertion tubes for calibration in the RTC-250/700 instruments, the insertion tubes **must** be heated up to maximum temperature 250°C (482°F) / 700°C (1292°F) - for a period of minimum 30 minutes.

Insertion tubes are selected on the basis of the diameter of the sensor to be calibrated.
Use the table for insertion tubes in chapter 9.0 to find the correct part number.

Alternatively, you may order an undrilled insertion tube and drill the required hole yourself. The finished dimensions should be as follows:

- Sensor diameter +0.2mm +0.05/-0
- DLC hole : Ø3.1mm +0.05/-0 (RTC-156/157/158/250 A/B/C)
  Ø4.2mm +0.05/-0 (RTC-700 A/B/C)
- Reference sensor holes : Ø4.2mm +0.05/-0 and Ø6.55mm +0.05/-0

For RTC-156/157/158 A/B/C only:

In order to get optimum results and prevent ice from building up in the well of the cooling calibrators, a proper sized insulation plug must be placed over the well during the calibration process.

The holes in the plug must have a tight fit and unused holes must be covered using e.g. EPDM plugs (spare part no. 126280).

3.2.3 Inserting the sensors

Before inserting the sensors and switching on the calibrator, please note the following important warning:

Warning

- **Never** use heat transfer fluids such as silicone, oil, paste, etc. in the dry-block calibrator.
  These fluids may penetrate the calibrator and cause damage or create poisonous fumes.

Insert the sensors as shown in fig. 2.

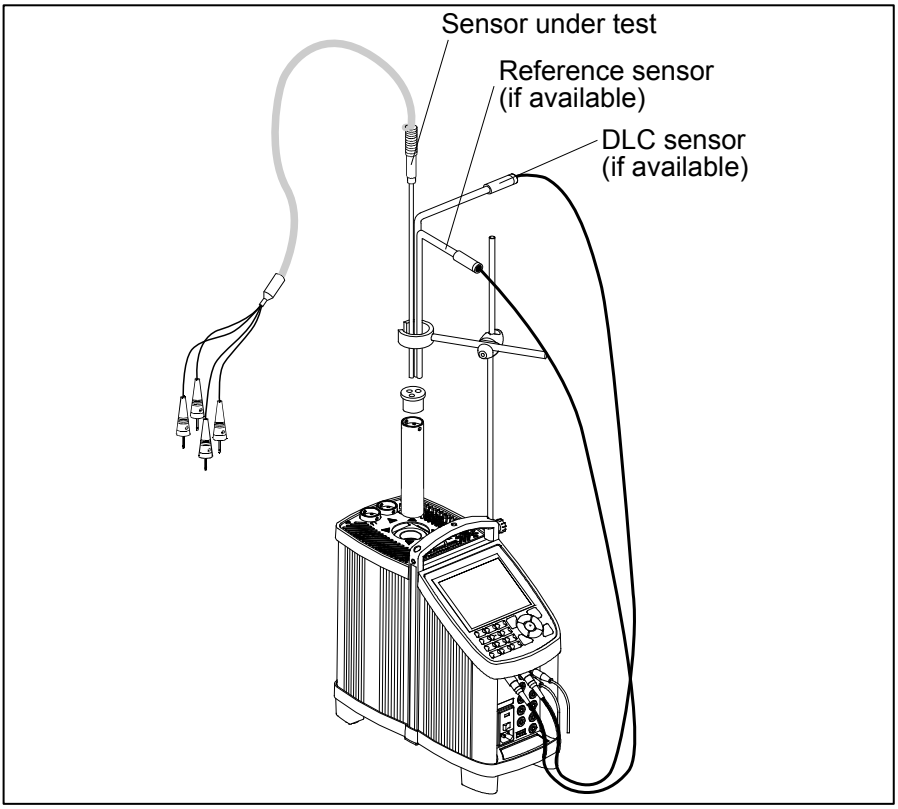


Fig. 2

The DLC sensor must be placed in the hole that is intended for the DLC sensor. Standard insertion tubes from AMETEK Denmark are marked with a dot on the rim to indicate the placement of the DLC hole, and the insulation plugs are marked with the letter D (RTC-156/157/158/250 A/B/C only). See fig. 3.

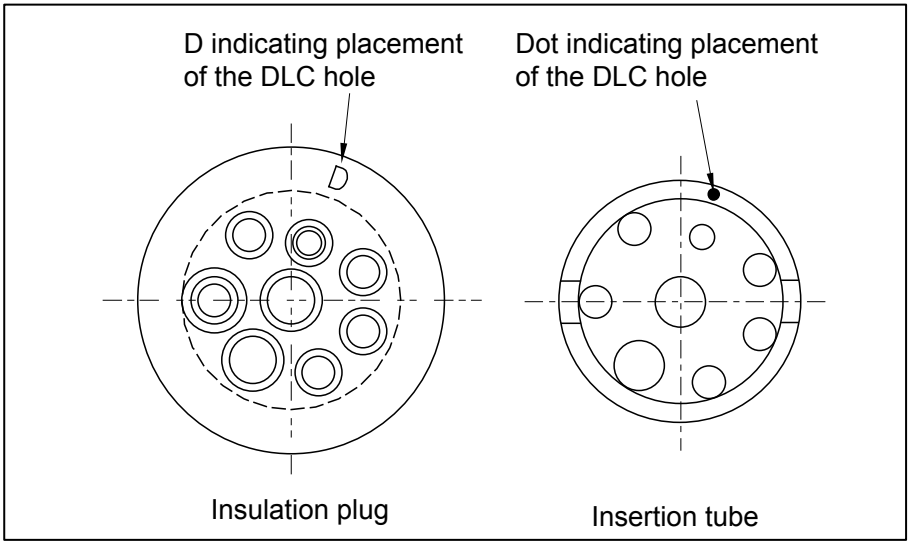


Fig. 3

Caution…

- The well and the insertion tube **must** be clean before use.
- 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.

Caution – Hot surface

- **Do not touch** the grid plate, the well or the insertion tube while the calibrator is heating up – they may be very hot.
- **Do not touch** the tip of the sensor when it is removed from the insertion tube – it may be very hot.
- **Do not touch** the handle of the calibrator during use – it may be very hot.

Caution – Cold surface

- If the calibrator has reached a temperature below 0°C/32°F, ice crystals may form on the insertion tube and on the well. This, in turn, may cause the material surfaces to oxidize.
  To prevent this from happening, the insertion tube and the well must be dried. This is done by heating up the calibrator to min. 100°C/212°F and any water left will evaporate.
  Remove the insulation plug while heating up.

  It is very important that humidity in the well and insertion tube is removed to prevent corrosion and frost expansion damages.
- Do not touch the well or insertion tube when these are below 0°C/32°F – they can create frostbite.

3.3 Preparing the liquid bath calibrator (RTC-158/250 A/B/C only)

Warning

- The calibrator **must not** be used for any purposes other than those described in this manual.
- The calibrator has been designed for **interior use only** and should **not be used in hazardous areas**, where vapour or gas leaks, etc. may constitute a danger of explosion.
- Liquid baths should **only** be operated by trained personal.
- AMETEK Denmark A/S **does not** take any responsibility, if the well is filled with other fluids than those recommended.
- Heat transfer fluids must **only** be used in calibrators with a liquid bath. If these fluids are overheated they will create noxious or toxic fumes. Proper ventilation must be used.

- Product information on the fluid must be carefully investigated before use.
- The calibrator **must** be kept free within an area of 20 cm on all sides and 1 metre above the calibrator.

Note…

The instrument must **not** be exposed to draughts.

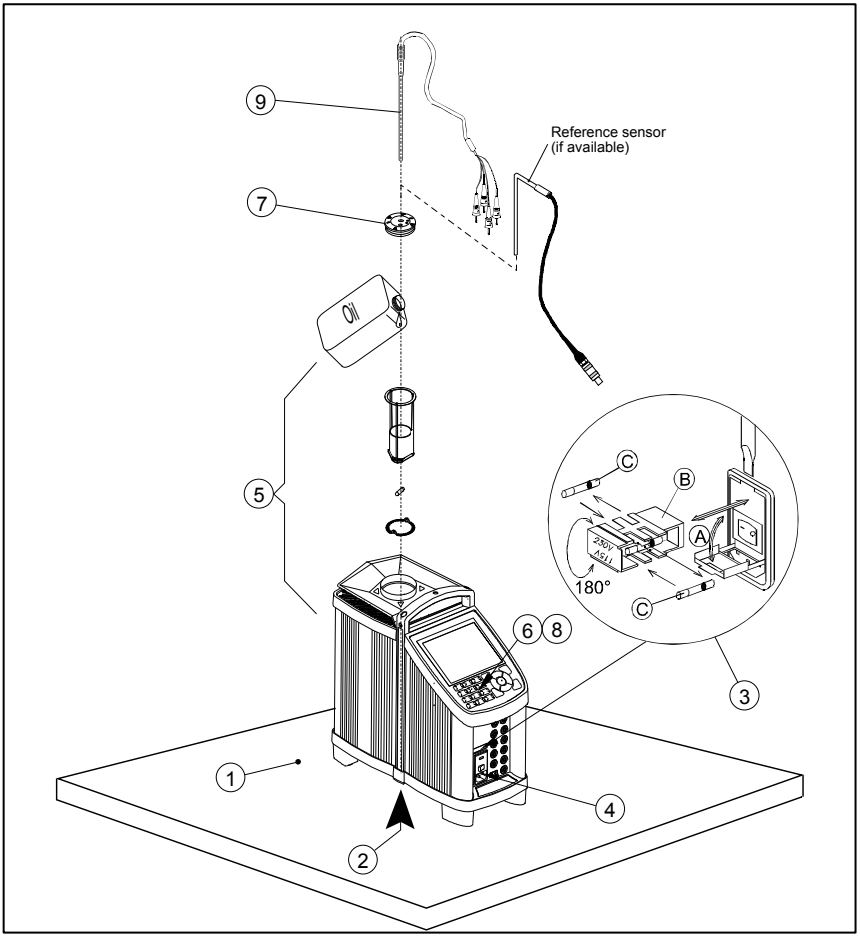


Fig. 4

3.3.1 When setting up the liquid bath calibrator, you must…

① Place the calibrator on an even horizontal surface where you intend to use it. Place it in a way that will minimize the risk of tilting.

Caution…

- **Do not** use the instrument if the internal fan is out of order.
- The well **must** be clean before use.

② Ensure a free supply of air to the internal fan located at the bottom of the instrument.
The area around the calibrator should be free of draught, dirt, flammable substances, etc.

③ 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 setting of the power control switch as follows (see fig. 4):

A. Open the fuse box lid using a screwdriver.

B. Take out the fuse box.

C. Remove both fuses and insert two new fuses. These must be identical and should correspond to the line voltage. See chapter 9.0.

B. Turn the fuse box 180° and slide it into place.

④ Check that the earth connection for the instrument is present and attach the cable.

⑤ Place the parts from the liquid bath kit in the well in the following order:

- **Bottom shield** – It is very important that the bottom shield is placed in the well before any calibration is attempted, as the bottom shield protects the well from being damaged during calibration.
- **Stirring magnet** – It is very important that the stirring magnet is in place and spinning before any calibration is attempted. The stirring magnet ensures minimum temperature gradient in the fluid. The magnets teflon cover will over time be worn down, leaving the magnet flat on one side. This will reduce the spinning ability. A magnet with a flat side must therefore be replaced.
- **Sensor basket** – It is very important to place the sensor basket in the well, as it ensures that the sensors encounter maximum temperature stability and ensures that the stirring magnet is not blocked.

- **Silicone oil** – Fill the well with oil according to the tables of recommended oil volume. The recommended volumes must be adjusted to the actual job.
  For oil tables and further oil information – see section 3.3.2.

  The sensor basket is marked with an optimum fluid level mark (100%). When filling the well with fluid and placing the sensors, this mark must **never** be exceeded.

Warning

- **Do not pour** cold fluid into a hot well – it might cause an explosion.
- **Do not pour** water or any other fluids into a bath filled with hot oil, because only a few drops of water might cause a steam explosion, if poured into e.g. 250°C hot oil.

Caution…

- Do not use any alkali, acid or ionic fluids in the aluminium well as it might be damaged.
- Be careful **not to overfill** the well with oil.

  The oil level rises several centimetres when the temperature is rising to maximum. To stop the overflow switch off the main power and the oil level will decent.
- Remove excess hot fluid with the outmost care, as it might be very hot.
- **Do not** attempt to remove hot fluid with the liquid drainage syringe, as it might melt.

⑥ Start the stirring magnet by following the procedure in section 4.12.

⑦ Place the calibration lid onto the well. See section 3.3.3 for drilling information.

⑧ Select a SET-temperature according to the tables of recommended oil volume by following the procedure in section 4.6.

Warning

Ensure that the sensor is absolutely clean and dry, as a few drops of water might cause a steam explosion.

⑨ Place the sensor to be calibrated vertically into the well. It is recommended to use the optional support rod set for a correct position during calibration. See fig. 5.

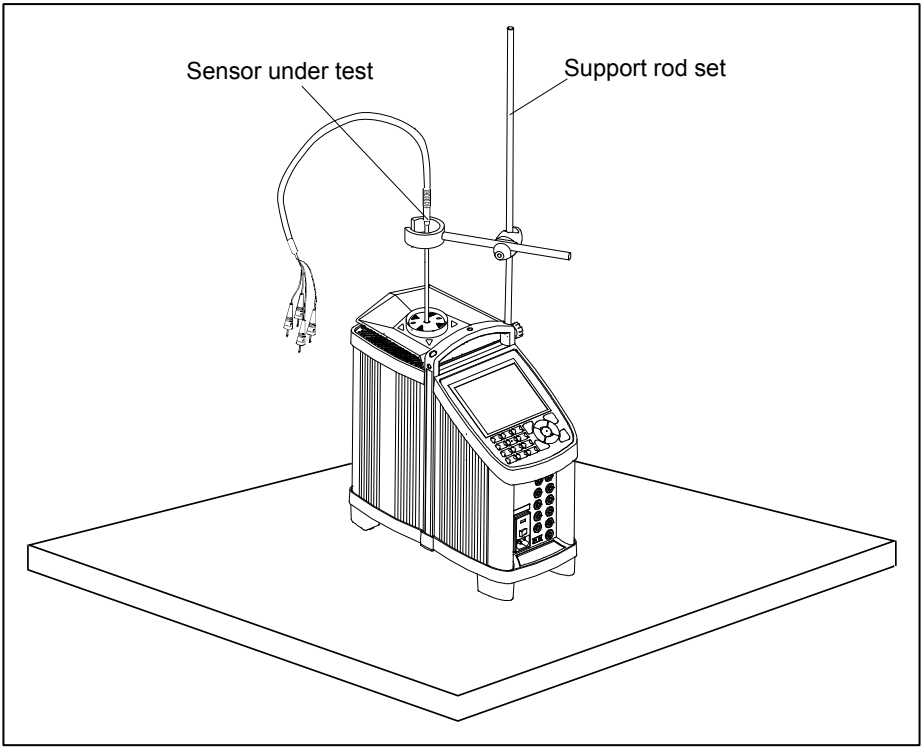


Fig. 5

Caution…

- The tip of the sensor should rest at the bottom of the sensor basket for optimum results.
- Be careful **not to** submerge the handle or wire inlet of the sensor-under-test in the fluid, as this might damage the sensor.

The calibrator is now ready for use.

3.3.2 Selection of fluids

Caution…

- Be careful to select the right fluid for the right task. Using other than the recommended fluids might cause damage to the calibrator or degrade the performance.

AMETEK Denmark A/S recommends DOW CORNING 200(R) oil 10cSt for sub zero temperatures to 158°C and DOW CORNING 200(R) oil 50cSt for ambient temperature to 250°C. Technical specifications for the liquid baths has been produced using the fluids mentioned above.

For proper handling, use and disposal of fluid – read fluid product information. When reading this information pay special attention to details regarding fume point, flash point, boiling point and point of decomposition.

When the fluid temperature approaches the fume point, it is necessary to use proper ventilation. An exhaust hood is recommended. When ventilation is applied take care not to expose the calibrator to alternating draft, as it might influent the temperature stability. If possible make the ventilation flow as constant as possible.

At low temperatures the viscosity of the fluid can constitute a problem. When the viscosity becomes to low, the stirring magnet can’t provide proper circulation in the well to maintain temperature uniformity. Therefore it is essential to investigate the physical property of the fluid before one is selected.

Tables of recommended oil level @23°C well temperature

RTC-250 A/B/C

For recommended 50 cSt oil

0°C - 50°C	100%
50°C - 100°C	95%
100°C - 150°C	90%
150°C - 200°C	85%
200°C - 250°C	80%

RTC-158 A/B/C

For recommended 10 cSt oil

-20°C - 50°C	100%
50°C - 100°C	95%
100°C - 120°C	90%
120°C - 155°C	85%

For the best result, the oil should be in good condition and free of foreign objects. If water is accumulated in the oil due to melted ice crystals – the oil must be dried out, by heating it up.

Warning

- **Do not** handle hot fluid.
- If the fluid is heated beyond the flash point, it may constitute a fire hazard.

If the fluid has caught fire, switch off the main power to prevent further heating of the fluid. Flames are best extinguished by cowering the well with a non-flammable lid.

Warning

Do not under any circumstances pour water on burning oil. It might cause a dangerous steam explosion.

3.3.3 Handling of lids

It is strongly recommended to leave the lid on during calibration. Calibration without the lid may affect the temperature stability and homogeneity.

To be able to use the lid for calibration, holes must be drilled in to it, in order to fit your calibration needs. If you use many different sizes of sensors more lids can be purchased at your JOFRA supplier.

It is advisable to drill the holes at the same size as the sensors plus 0,5mm and distribute the holes evenly over the lid.

3.3.4 Inserting the sensors

Be sure that the sensors can be calibrated in fluid. E.g. certain ceramic sensors might be destroyed.

Caution…

- The insertion tube **must** be clean before use.
- Scratches and other damage to the insertion tubes should be avoided by storing the insertion tubes carefully when not in use.
- Carefully wipe off all silicone oil from the sensor-under-test to avoid spreading of the silicone oil.

Caution – Hot surface

- **Do not touch** the lid or the spill tray when the calibrator is heating up – they may be very hot.
- **Do not touch** the tip of the sensor when it is removed from the well – it may be very hot.
- **Do not touch** the handle of the calibrator during use – it may be very hot.

3.4 Programming intelligent sensors

Use the configuration software CON050 supplied with RTC to program and to update calibration information in intelligent sensors.

For instructions read the software manual for CON050 installed on the USB key.

4.0 Operating the Calibrator

4.1 Standard connections

Communication connections (all versions)

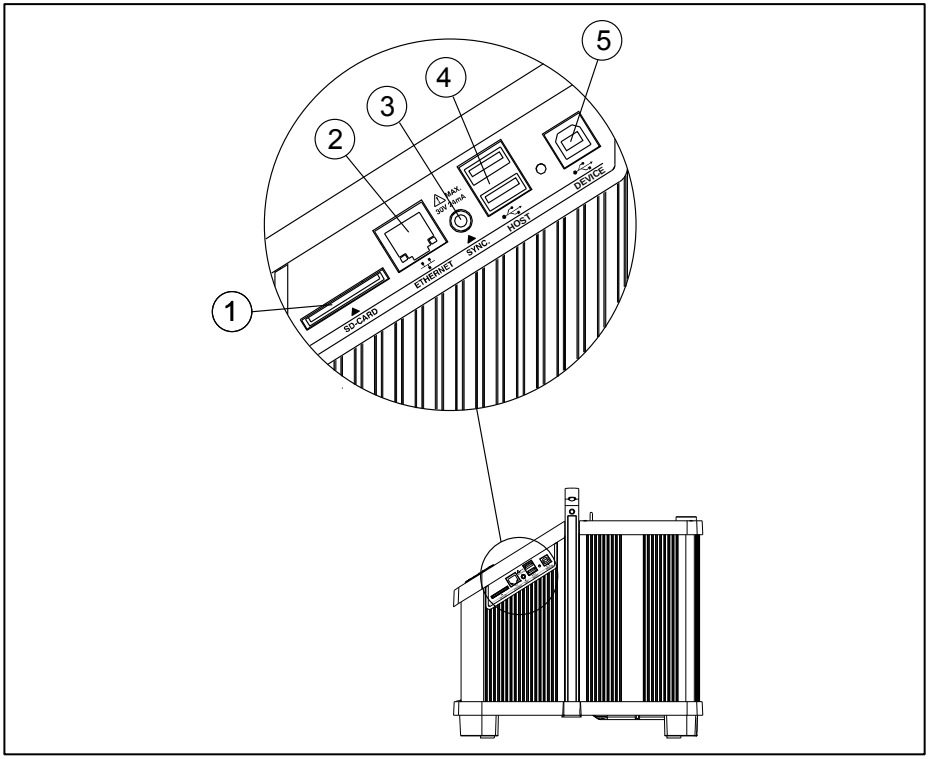


Fig. 6

Pos.	Description
1	**SD-card**: SD/MMC card slot
2	**Ethernet**: Ethernet MAC 10/100 base-T, RJ45
3	**Sync.**: Sync. Relay output, 3.5 mm Mini Jack
4	**Host**: USB 2.0 Double Host Port, 2 x USB A
5	**Device**: USB 2.0 Device Port, 1 x USB B

Standard connections (all versions)

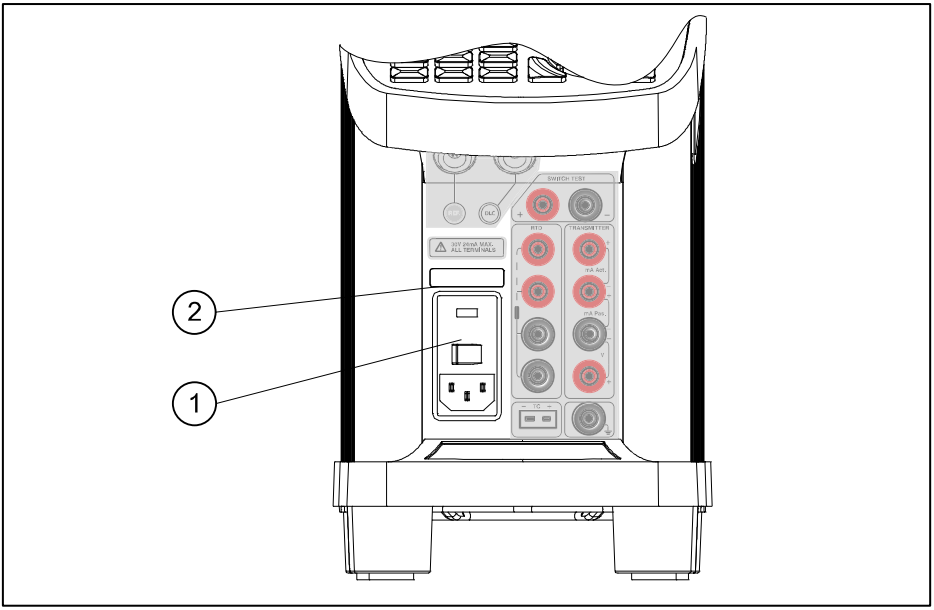


Fig. 7

Pos.	Description
1	Power control switch with a cable connection and on/off switch. It also contains the main fuse. See section 6.0 for information on how to change the fuses.
2	Label indicating fuse value

4.2 Input modules (B and C versions only)

Warning

- The input terminals must **NEVER** be connected to voltages exceeding 30V with reference to ground.

Description of sockets for external connections

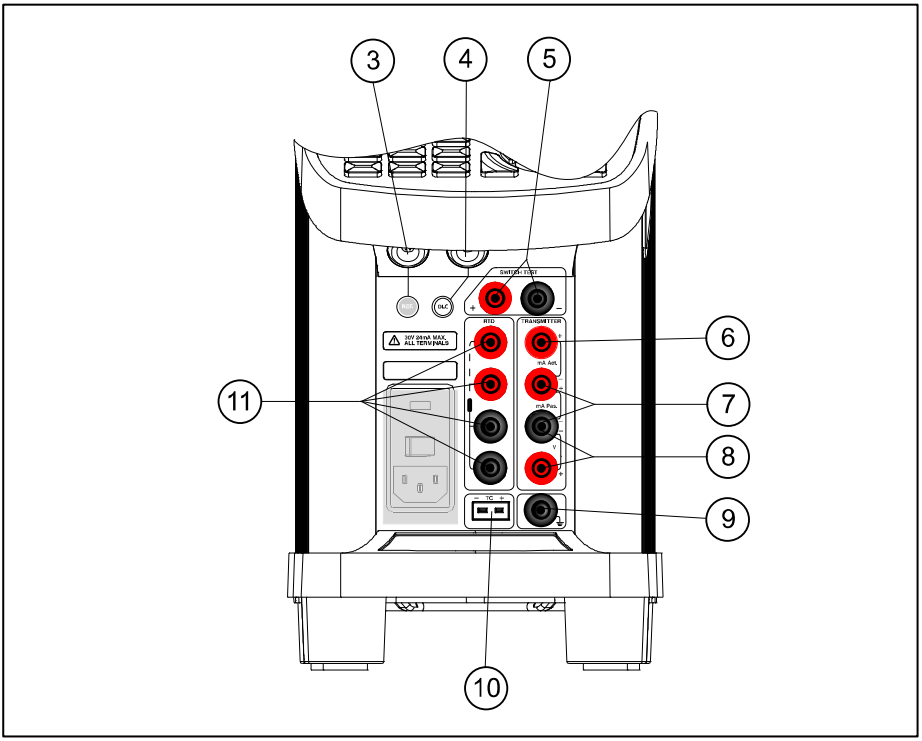


Fig. 8

Pos.	Description
3	Input for reference sensor (B and C versions)
4	Input for DLC sensor (B and C versions)
5	Connection for thermostat switch test (B-version) **Note** that this connection is for voltage free switches

6	24V supply for active mA input (B-version)
7	Passive mA input (B-version)
8	Voltage input (B-version)
9	Connection to chassis (earth/ground) (B-version)
10	TC connection for thermocouples (B-version)
11	Input for RTD sensor (2, 3 or 4 wire) (B-version)

One of the inputs either pos. **7**, **8**, **10** or **11** can be selected displaying the “SENSOR” temperature in the Setup and pos. **3** can be displayed as “TRUE” temperature.

Note: Only the sensor type, which is to be tested, should be connected to the input panel.

4.3 Keyboard and main screen display overview

Keyboard

Fig. 9

Keys	Description
	Full colour VGA display (main screen display information – see section 4.3.1)
0 - 9	NUMERIC KEYS to select menu options displayed in the horizontal and vertical menus and to type in values
↩	BACK KEY to cancel a selection/edit or return to previous menu.
☰	MENU KEY shows the vertical menu options listed. Can be displayed all through the process
←	DELETE KEY deletes previous character
↵	ENTER KEY accepts selected options or entered values. When a value is entered with the ENTER KEY the cursor selects the next value field in the list.
▲	ARROW KEYS have different functions depending on the mode of operation.

In navigation mode, they move the cursor in the desired direction.

In edit mode they roll in the list of options or if entering a number, the *ARROW left* and *ARROW right* move the cursor one character in the desired direction

ACTION KEY opens and closes edit fields or a menu button. The action key also accepts the selected option or entered value.

Main screen display

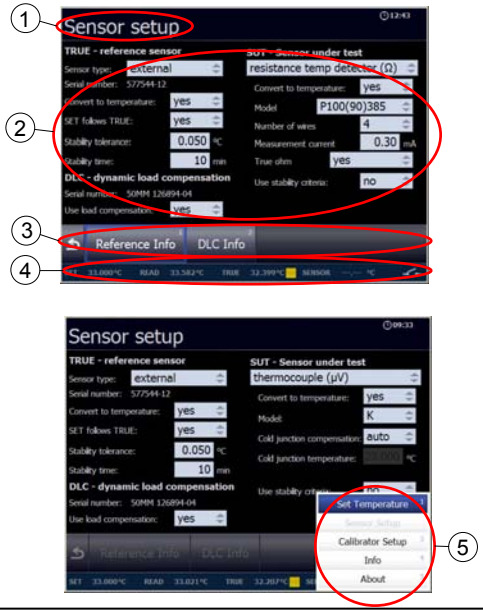


Fig. 10

The Main screen display is divided into four separate areas:

Pos.	Description
1	**Heading**: Informs you of the current menu selected.
2	**Setup field**: Provides the bulk of setup data in the menu. This data can be changed by moving the cursor to the various fields.
3	**Horizontal menu**: Provides you with the relevant menu options that can be selected at the present point. Each option can be activated either by selecting and activating the option – or simply by pressing the numeric key that corresponds to the option number.
4	**Readings**: This reading line is always visible and informs you of the current readings.
5	**Vertical menu**: This menu can be activated throughout the entire calibration. The menu can be switched on and of in all stages of operating the calibrator.

4.3.1 Main screen display information

The main screen gives an overview of the calibrator status and reads out the most relevant readings. In the Sensor Setup menu (see section 4.10) these readings can be changed.

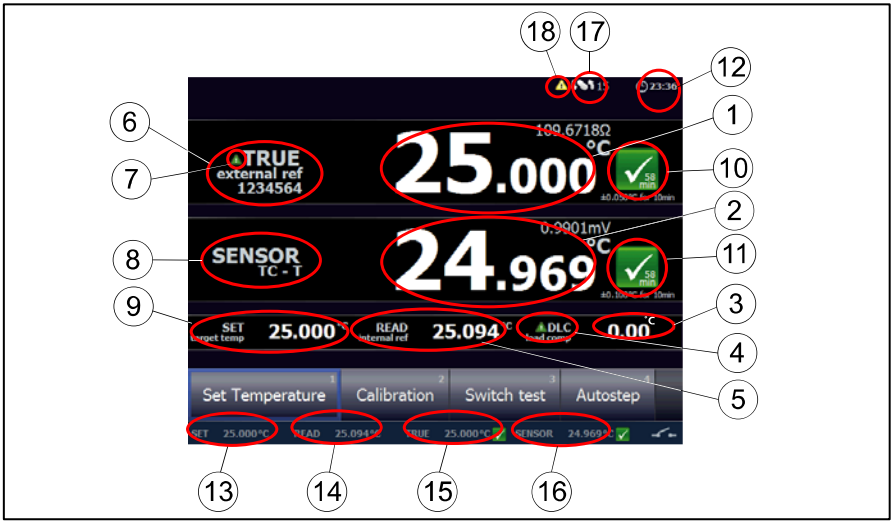


Fig. 11

Pos.	Description
1	True temperature reading. Can be either the internal reference sensor or an external reference sensor.
2	SENSOR. Sensor Under Test value.
3	DLC sensor reading. Displays the measured temperature load of the insert –if the load compensation is active, the DLC system will control this value towards 0.00°C.
4	DLC compensation activated. The icon indicates, that the Dynamic Load Compensation function is active
5	READ value. The internal reference is always displayed as READ value.
6	Reference Sensor Info. The serial number of the external reference sensor is read from the intelligent reference sensor and displayed in this field.

7	Set follows True activated. The icon indicates, that the Set follows True function is active and will control the Temperature of the external reference sensor to the SET temperature.
8	Sensor Under Test Type.
9	SET temperature.
10	Stability indicator displays the status of the True temperature stability. Yellow symbol indicates that stability is not yet obtained. A timer counts down. A green symbol indicates that the stability criteria are obtained and the time of stability is displayed. When time of stability is more than 99 min., the time is no longer displayed in the symbol, but only in the info screen (see section 4.13).
11	Sensor Under Test Stability indicator. If Sensor under Test stability criteria is selected, a symbol will indicate the stability of the sensor under test as well as the True sensor. When both Sensor Under Test and True sensor are stable, the calibrator is considered being stable.
12	Real Time Clock display.
13	SET reading always visible.
14	READ value always visible.
15	TRUE value always visible.
16	SENSOR value always visible.
17	WARNING/ERROR symbol. The yellow icon indicates a warning. The red icon indicates an error. When the error symbol is displayed the calibration results cannot be saved. See section 6.1 for details concerning warnings and errors.
18	Stirrer activated/speed indicator. The icon indicates that the stirrer is activated and how fast it is spinning.

4.3.2 Main screen temperature values

Two temperatures are always displayed:

- TRUE temperature: This is the reference temperature of the calibrator. In the A-version this is always the internal reference sensor. In B- and C-versions the TRUE temperature can either be the internal reference or the external reference.

- SET temperature: This is the target temperature for the well. SET temperature displays the last value entered. If no value has been entered previously, "---,---" is displayed.

Additional temperatures displayed (B versions only):

- SENSOR temperature: This is the temperature measured by the sensor under test (SUT).

Additional temperatures displayed (B and C versions only):

- Ext. TRUE temperature: This is the temperature measured by an external reference sensor. This is only displayed when an external reference sensor is used and replaces the internal reference.

4.3.3 Stability of temperature values

The stability of the TRUE and SENSOR temperatures are indicated by the following messages:

- "Not stable": Indicates that the measured temperature is not yet within the specified stability criteria.
- 4:32 Indicates "Time to stable": The temperature changes are within the specified stability criteria (see chapter 8.0) and states a time (in minutes and seconds) when the stable situation can be achieved.
- : Indicates that the “stable” situation is achieved.

- If External reference is selected as TRUE, the stability criteria will refer to this.

The criteria can be changed, however, if the temperature stability criteria is set wider or the stability time is set shorter, the calibrator may not reach the SET temperature.

- If “Use stability criteria” is set to “Yes” for the SENSOR, the automatic calibration function will continue to next temperature step only when both TRUE and SENSOR indicate stability.

4.4 Operating principle

The calibrator is operated using the horizontal and the vertical menu list.

The NUMERIC keys are used for selecting and activating the various menus and functions from both the horizontal and vertical menu lists.

The ◉ (ACTION key) and ↵ (ENTER key) are also used for selecting and activating the menus and functions and for accessing various parameters in setup fields.

The ▲ (ARROW keys) are used to move from menu item to menu item in the menu lists, to access various result lists, to scroll through various lists and to access setup fields.

4.4.1 Horizontal Menu

The horizontal menu options apply to the displayed screen. It is dynamically giving the relevant choices during operation. Each menu function can be activated in 2 ways:

☞ 1. Move the blue cursor with the ARROW key ▶ to mark the menu button on the screen. Then press ◉ or ↵ to activate the selection.

☞ 2. Whenever the menu is visible simply press the NUMERIC key.

4.4.2 Vertical Menu

The vertical menu list can be called at any stage of operation making it possible to jump to the desired menu.

This allows you to jump to the most used menu easily - no matter where you are.

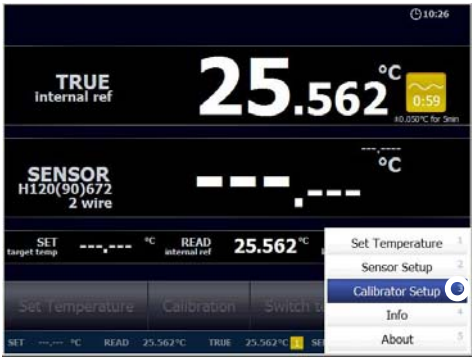
☞ Press the button to access the menu. To exit the menu, press the button again or (BACK).

This menu always gives the same options, however at some points some choices are not relevant and will therefore be shaded, i.e. you can not set a temperature, when an Auto step procedure is running.

Each menu function can be activated in 2 ways.

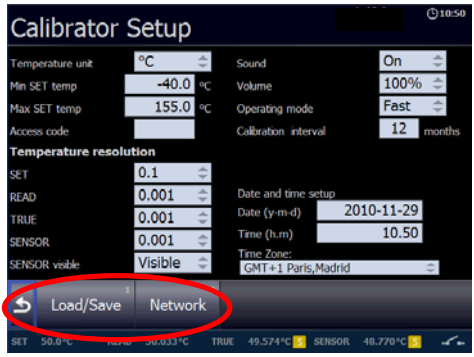
☞ 1. Move the cursor with the ARROW keys ▼ or ▲ to mark the menu field on the screen. Then press ◎ or ↵ to activate the selection.

☞ 2. When the menu is visible simply press the NUMERIC key.



4.4.3 Parameter Fields

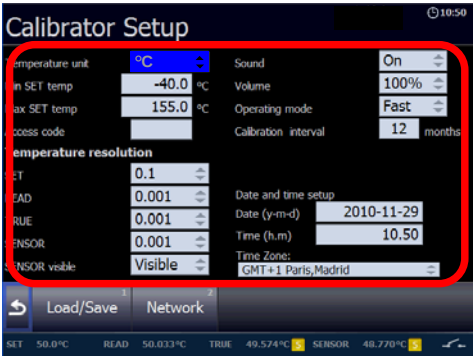
The setup menus have fields for parameter entries. When the setup is entered, then focus will be on the horizontal menu, and the function here can be activated.



☞ By pressing the ARROW UP key ▲ focus will move from the horizontal menu to the parameter field area.

The parameter field area focus is indicated by

- The horizontal menu is now shaded
- The parameter field area has a blue frame
- The selected parameter field highlighted with a dark blue color



Use the 4 ARROW keys to move between the parameter fields.

A parameter value is changed by:

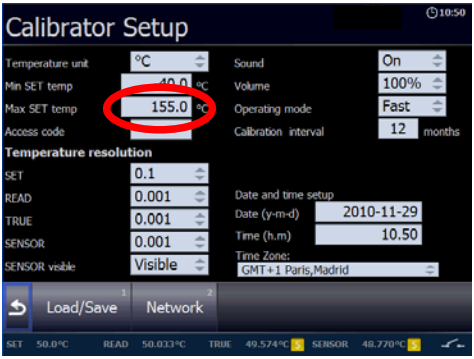
☞ • Pressing ◉ or ↵ to open the field for editing.

☞ • A numeric field can be entered directly without opening it first – simply enter the number.

When the parameter is entered press one of the keys:

☞ ◉ This enters the value and leaves the cursor on the parameter field.

☞ ↵ This enters the value and moves the cursor to the next parameter field.

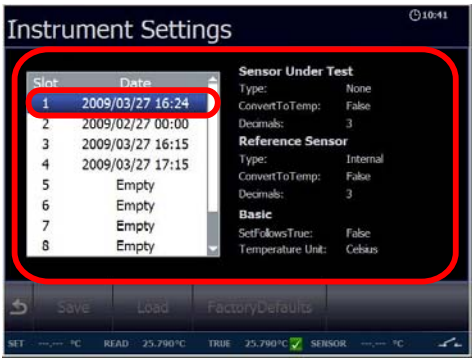


4.4.4 Working with lists

When it is possible to choose between a number of data sets, the data sets are presented in lists.

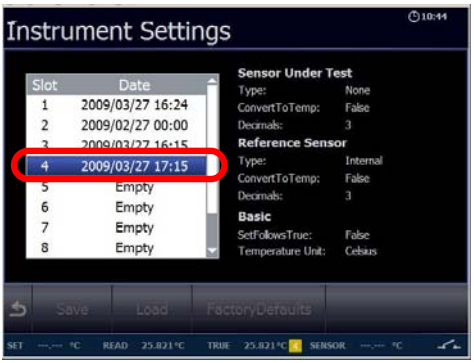
☞ As an example access the Calibrator Setup menu from the vertical menu and activate “Load/Save [1]”
A list of instruments settings will be displayed.

☞ Press ARROW UP ▲ to move the focus from the horizontal menu to the list.

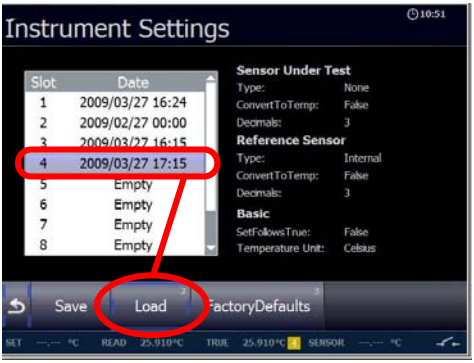


The selected data set in the list is now highlighted with a dark blue color.

☞ Scrolling in the list is done using the ARROW UP key ▲ and the ARROW DOWN key ▼.



☞ When the desired dataset in the list is highlighted press ◎ or ↵ .

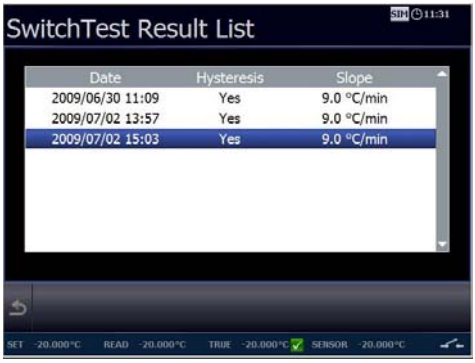


Now the horizontal menu will be in focus again and here you are able to decide what to do with the chosen dataset.

Activate the desired function in the horizontal menu. In this example the Instrument Settings from 2009/03/27 17:15 will be loaded from the memory into the active setup.

Some lists have no horizontal menus and only one option available.

☞ As an example access the Switch test menu by selecting “Switch test [3]” from the main menu and then activate “Results[2]”.



Scroll through the list using the ARROW UP key ▲ and the ARROW DOWN key ▼ and just press ◎ or ↵ to display the result of the highlighted dataset.

4.5 Starting the calibrator

Switch on the calibrator using the power control switch (pos. 1, fig. 7). A start up screen is displayed and then replaced with the main menu screen:

The functions in the horizontal menu are available using the soft keys or the arrow keys on the keyboard (see description in section 4.3).

4.6 Setting the temperature

☞ Access the Set Temperature function by selecting “Set Temperature [1] “.

☞ Use the NUMERIC keys to enter a new value, or ⊙ or ↵ to accept the value. When pressing the ACTION key or the ENTER key the calibrator returns to the main menu screen.

The Set temperature function can also be accessed using the vertical menu (press ☰). Through this menu a new set point value can be entered at any stage of the operation **except when one of the automatic functions are active.**

4.7 Calibration

Note…

This Calibration function is for B versions only.

This function enables you to perform automatic calibrations of different temperature sensors. The calibration procedure is semi-automatic, using parameters and settings, which are defined in workorders. These workorders are created and edited using the "JOFRACAL" PC program. Multiple calibrations can be performed using the same workorder settings.

☞ Access the Calibration menu by selecting “Calibration [2]” from the main menu.

A Workorder List is displayed.

☞ Run the selected workorder by activating “Run [1] “. A new calibration is started.

You can also chose to activate:

“View [2]” – shows the setting of the workorder.

“Results [3]” – shows the previous calibration results from this workorder.

“Delete [4]” – deletes the workorder setting and the results.

For operating the Results menu see section 4.7.2.
For operating the View menu see section 4.7.3.
For operating the Delete function see section 4.7.4.

Note…

Calibration information is available in several places throughout the calibration menus. The content of this information is described in section 4.7.3.

4.7.1 Running a calibration

☞ To run the calibration, select “Run [1] “ from the Workorder List menu.

If the serial number of the reference sensor used for calibration does not match the one specified in the workorder the following message is displayed :

If you proceed, the connected reference sensor will be documented along with the results.

If you do not wish this message to appear, the correct reference sensor must be specified when the workorder is edited using the “JOFRACAL” PC program.

☞ Choose “YES” and press ◉ or ↵ if you want to proceed with the calibration.

The Parameter setup menu is displayed.

Note…

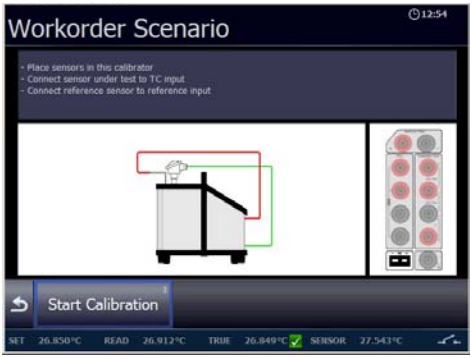
If the sensor under test is a thermocouple sensor and the manual compensation mode is selected in work orders, a cold junction temperature must be defined.

The parameters in the workorder can be edited.

Note…

- Only numeric data can be entered.
- The BACK key ↩ cancels a selection/edit or returning to previous menu. The ESC key can be used throughout the process.

☞ Select “Next [1] “ to proceed with the operation.



A workorder Scenario is displayed, giving a graphical display of the setup and sensor connections.

☞ Start the calibration by selecting “Start Calibration [1]”.

The Calibration Running step 1 of 2 is started and the temperature is heading towards step 1.

The following screen is displayed :

When the temperature has reached the stable criteria, the calibration data will be stored and the temperature goes towards the next set temperature.

If the workorder contains manual reading during calibration, you will be asked to enter the Sensor Under Test temperature before that.

The following screen is displayed :

If manual readings are specified these will have to be entered before next step starts.

Note…

The calibration can be stopped at any time by activating “Stop [2]”, but this will erase the calibration results.

During calibration several other functions are available:

“Result [1]” - To view the calibration results (no editing is possible).

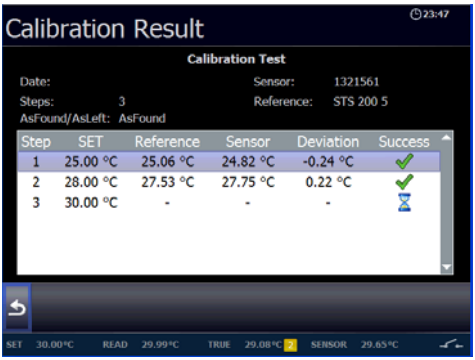
“Pause [3]” - To pause the calibration.

“Prev [4]” - Force the calibration to jump a step backwards to the previous calibration screen regardless of the calibration stability.

“Next [5]” - Force the calibration to jump a step forwards to the next calibration screen regardless of the calibration stability. This will leave the current step without saving calibration results.

“View [6]” - To view the workorder settings.

When the calibration has completed a green check ✓ is shown on the screen and the Calibration Result follows quickly hereafter.



☞ Select “Save [1]” to store the results in the calibrator

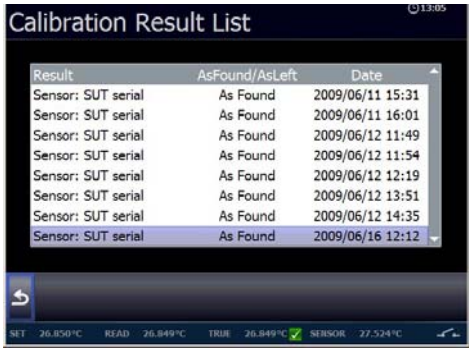
or

☞ select “Discard [2]” and press “Yes” to delete the calibration results or “No” to return to the Calibration Result screen.

A full Calibration Result List can be viewed using the instructions in section 4.7.2.

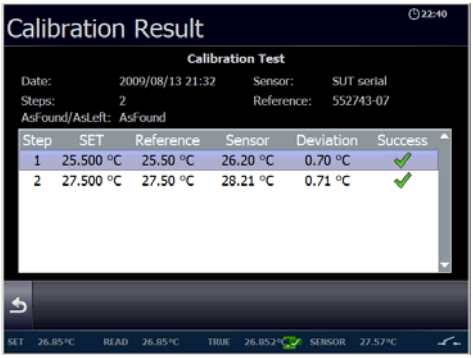
4.7.2 Viewing calibration results

☞ Access the Calibration Result function by selecting “Results [3]” from the Workorder List menu.



A full Calibration Result List is displayed.

☞ Select a workorder to be displayed showing the calibration details for the specific workorder.



☞ The calibration results can be uploaded with the “JOFRACAL” PC program. This enables you to print out the results on a certificate.

☞ Press ⮌ to exit the Calibration Result List and return to the Workorder List menu.

4.7.3 Displaying calibration information

Calibration information is defined within the work orders created on the PC using "JOFRACAL".

☞ Access the Workorder Sensors menu by selecting “View [2]” from the Workorder List menu,

The Workorder Sensors menu is displayed.

This screen gives you an overview of the workorder sensor setup including a summary of Notes, Scenario and Steps. Each of these can be displayed in details

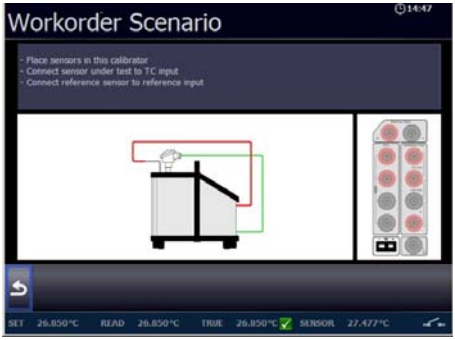
☞ Select “Notes [1]” to access the Notes function.

A list of Workorder Notes is displayed.

The notes are information entered via the PC program, when the workorder is created.

☞ Press ⮌ to exit the Workorder Notes screen.

☞ Select “Scenario [2]” to access the Scenario function.



A Workorder Scenario is displayed.

The calibration set up is shown in a graphic format, and the active sensor input is marked. The parameters for this setup are defined in the work order created using the PC program.

☞ Press ⮌ to exit the Workorder Scenario screen.

☞ Select “Steps [3]” to access the Step function.

A list of Temperature Steps is displayed.

This function shows the pre-defined temperature steps for the calibration.

☞ Press ⮌ to exit the Step function and return to the Workorder Sensors menu.

4.7.4 Deleting workorders

It is possible to delete a workorder using the Delete function from the Workorder List menu.

☞ Select “Delete [4]” to access the Delete function.

☞ Press “Yes” if you want to delete your workorders and “No” if you want to exit the Delete function without deleting anything.

Warning

If you choose to delete a workorder, the whole workorder including the calibration results will be deleted.

☞ Press ↩ to exit the Workorder List menu and return to the main menu.

4.8 Switch test menu

Note…

This Switch test function is for B versions only.

Switch test automatically locates the switch temperatures of a thermostat.

Three parameters are required:

- Start temperature (T_1)
- End temperature (T_2)
- Rate of change in temperature (slope rate).

Hysteresis of a thermostat can also be determined here. Where the hysteresis determines the tolerence between the upper switch temperature and the lower switch temperature of the thermostat.

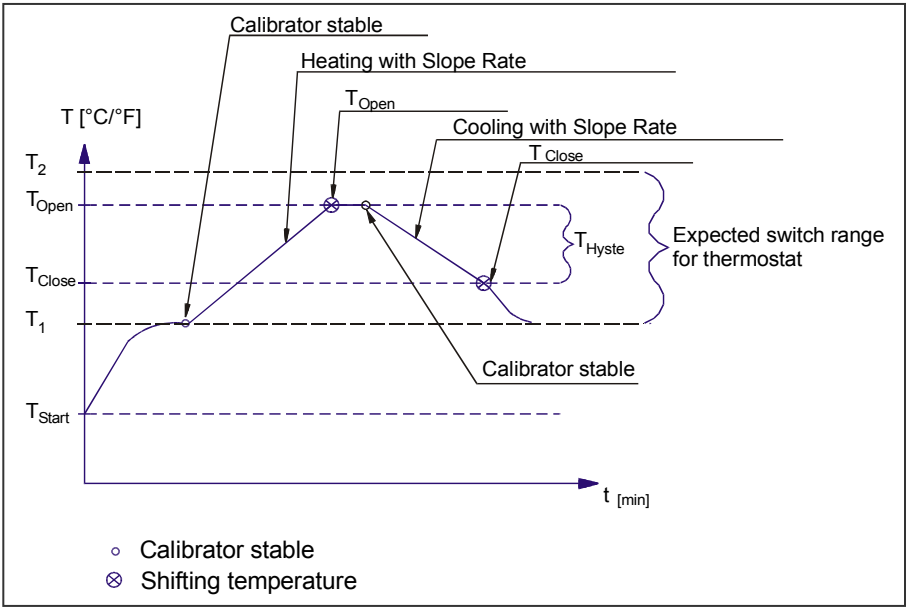


Fig. 12

4.8.1 Running a switch test

☞ Access the Switch test menu by selecting “Switch test [3]” from the main menu.

A Switch test setup menu is displayed.

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

☞ Access the setup field to edit the parameters:

- T_1 - first set temperature
- T_2 - second set temperature
- Hysteresis - to determine hysteresis, toggle between "Yes" (a two-way-temperature measurement) and "No" (a one-way-temperature measurement).
- Slope rate - The permitted range is 0.1 - 9.9°C/min. / 0.2 - 17.8°F/min.

Note…

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

☞ Press ⮌ to exit the setup function and return to the Switch test setup menu.

Before starting the switch test ensure that the switch is connected to the switch input (see page 34, pos. 6).

☞ Select “Start [1]” to start the switch test.

The Switch Test is now in progress.

While the switch test is in progress, 2 options are available:

“Result [1]” – displaying the current switch test results.
“Stop [3]” – stopping the switch test. Press “Yes” to stop the switch test and “No” to return to the Switch Test screen.

The calibrator's switch test procedure

1. Once the switch test is started, the calibrator starts working towards T_1 as quickly as possible. The calibrator's temperature changes (heating or cooling) and switch status are shown in the display.

2. When T_1 is achieved and the temperature is stable, the text and the graphic in the middle of the screen will change accordingly.

3. The calibrator now starts working towards T_2 at the specified slope rate.

4. In a normal situation, the thermostat changes state before T_2 is achieved. If T_2 is achieved and the temperature is stable, a red cross will be displayed instead of a green check ✓.

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

   When hysteresis is selected (two switch changes), the calibrator starts working towards T_1 at the specified slope rate.

6. Normally, the thermostat changes state before T_1 is achieved. If T_1 is reached and the temperature is stable, a red cross will be displayed instead of a green check ✓.

7. The finished switch test results are displayed.

4.8.2 Showing switch test results

Two types of switch test results are available:

- Results during a switch test.
- Results of a finished switch test.

Results during a switch test

☞ Access the Switch Test Result List by selecting “Result [1]” from the Switch Test menu.

This shows the results that are currently available. These results change as the test progresses.

☞ Press ⮌ to return to the switch test.

Finished switch test results

At the end of a switch test the results are displayed. These 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 hysteresis.

☞ Select “Save [1]” to save the results storing them in the calibrator’s memory.

☞ Select “Discard [2]” to delete the results from the screen.

Note…

A hysteresis result is only measured when hysteresis is set to “Yes”.

You will then automatically return to the Switchtest setup menu.

If no change in the switch position is registered during the test a red cross will be displayed in the Result list instead of a green check ✓.

☞ Delete the result by selecting “Discard [2]” or save the result by selecting “Save [1]”.

To view stored switch test results

☞ Access the Switch Test Result List by selecting “Results [2]” from the Switch test setup menu.

☞ Select a test result to be displayed.

☞ Press ↩ twice to return to the Switch test setup menu.

4.9 Auto step menu

Auto step is used to step automatically between a range of different calibration temperatures. This is useful when calibrating sensors in places that are difficult to reach and sensors where the output is displayed in a different location.

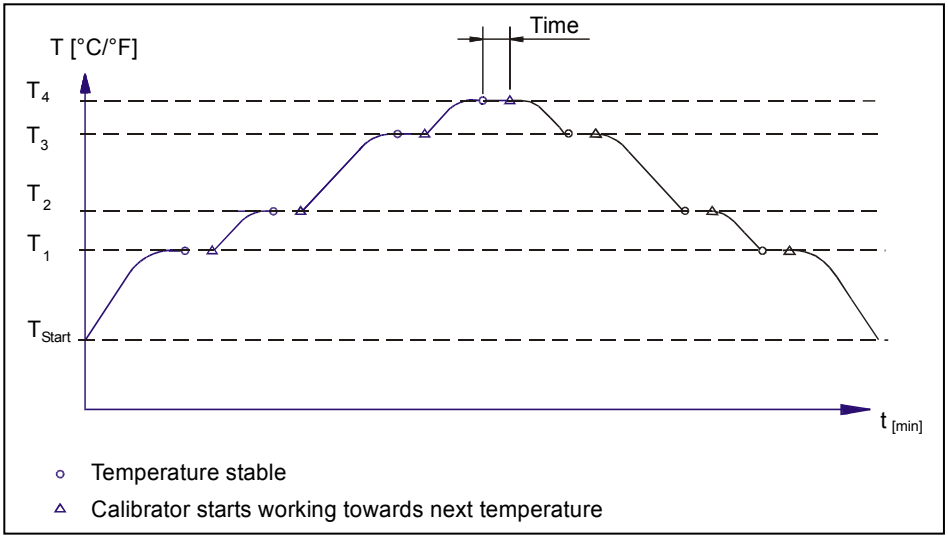


Fig. 13

4.9.1 Running an Auto step calibration

☞ Access the Auto Step Setup menu by selecting “Autostep [4]” from the main menu.

The Auto Step Setup menu is displayed.

☞ Access the Auto Step Setup to edit the parameters:

- **No of steps**: the number of temperature steps per direction ($T_1 \rightarrow T_x$) can be set using integers from 1 – 20. When a Two-way mode is selected, the same number of steps are used for the second direction ($T_x \rightarrow T_1$).
- **Mode**: toggle between “One-way” and “Two-way”.
- **Hold time**: defines the time (in minutes) the temperature is maintained (after it is stable) for each step.
- **T** step values: must be set within the sensors permitted range.

☞ Press ⮌ to exit the editor and return to the Auto Step setup menu.

☞ Access the Sensor setup menu by selecting “Next [1]” from the Auto Step Setup menu.

The Sensor setup menu is displayed. In this menu you have the opportunity to check and if necessary change the settings as described in section 4.10 – Sensor Setup menu.

☞ Select “Start [3]” to start the Auto Step calibration.

An Auto Step Running step screen is displayed.

While the step test is in progress, several functions are available:

“Result [1]” - To review the Auto Step results (no editing is possible).

“Stop [2]” - To stop the Auto Step test.

“Pause [3]” - To pause the test.

“Prev [4]” - Force the test to jump a step backwards to the previous running step regardless of the step’s stability.

“Next [5]” - Force the test to jump a step forwards to the next running step regardless of the step’s stability.

When the Auto Step test is complete the results are displayed.

☞ Select “Save [1]” to save the results storing them in the calibrator’s memory.

☞ Select “Discard [2]” to delete the results from the screen. The calibrator then returns to the Auto Step Setup menu.

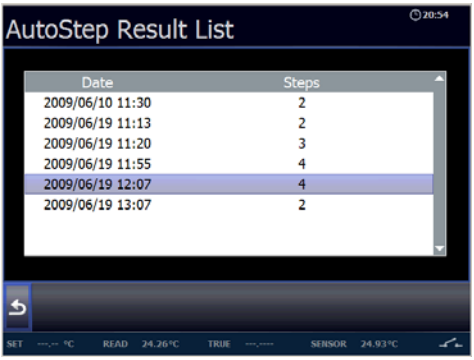
4.9.2 Auto Step test results

At the end of an Auto Step test the results are displayed and stored in the calibrators memory.

The measured TRUE and SENSOR temperatures for each step are displayed.

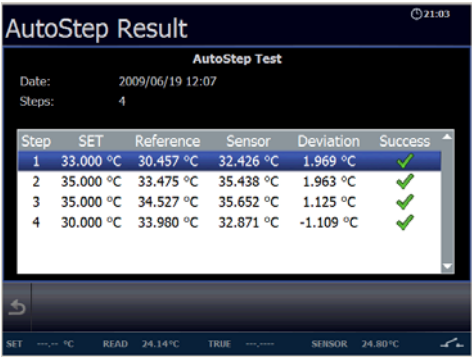
To view stored Auto step test results

☞ Access the Auto Step Result List by selecting “Results [2]” from the Auto Step Setup menu.



The Auto Step Result List is displayed.

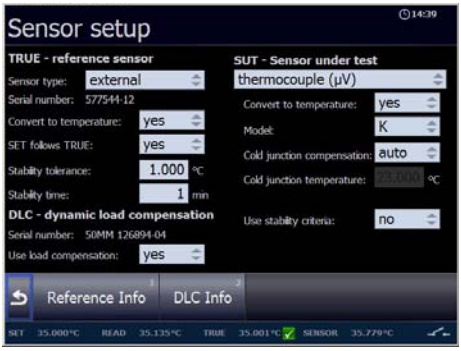
☞ Select an auto step result to be displayed.



☞ Press twice to return to the Auto Step Setup menu.

4.10 Sensor Setup menu

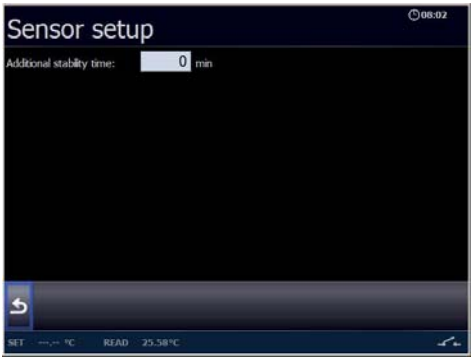
☞ The Sensor Setup can be entered through the vertical menu (press ☰)
The Sensor Setup can also be edited immediately before running the Auto step (section 4.9.1) or when starting a switch test.



☞ Activate “Sensor Setup[2]”.

4.10.1 Setting the additional stability time (A version)

☞ Set the additional stability time by pressing ⊙ and the NUMERIC keys. Stability time can be set (in minutes) using integers from 0 – 99.



4.10.2 Setting the parameters for TRUE – reference sensor (B and C versions only)

Sensor type:

Internal reference source.

The internal reference sensor will be displayed as the TRUE value on the main screen.

The calibrator has a set of internal stability criteria it shall meet before stability is indicated. Additional stability time may be set beyond the internal stability criteria.

☞ Set the additional stability time by pressing ◎ and the NUMERIC keys. Stability time can be set (in minutes) using integers from 0 – 99.

External reference source

The TRUE value on the main screen will be read from the Intelligent Reference Sensor connected to the REF. INPUT on the front panel (see section 4.2 fig. 6). The calibrator automatically reads the calibration data and serial number of the Sensor.

Convert to temperature:

- “yes” sets the readout of the External reference as a temperature.
- “no” sets the readout of the External reference in Ω values.

SET follows TRUE:

This function enables you to reach the TRUE temperature measured by the External reference sensor.

Note…

that when “yes” is selected, the calibrator will control the temperature to the TRUE temperature. This means that it could take longer time before the calibrator indicates stability.

The “SET follows TRUE” function is indicated with the symbol ⚠ at the TRUE reading in the main display.

Note…

SET follows TRUE is only relevant when the External reference sensor is displayed in temperature units.

Stability tolerance:

The Stability tolerance can be set down to ±0.001°. The tolerance should be set low enough to utilize the good temperature stability of the calibrator – however a low value also gives a longer time to be stable.

Stability time:

Stability time can be set from 1 – 99 minutes.

When the TRUE temperature has reached the specified Stability tolerance during the specified Stability time, then the stability indicator in the main screen will turn green.

☞ Press ↩ to accept the new setting(s) and return to the Sensor setup menu or continue to edit the DLC sensor parameters or the Sensor under test parameters.

4.10.3 Setting the parameters for DLC– dynamic load compensation (B and C versions only)

The DLC value on the main screen will be read from the Intelligent Load Sensor as soon as it is connected to the DLC INPUT on the front panel (see section 4.2 fig. 6). The calibrator automatically reads the calibration data and serial number of the Sensor.

However if the Dynamic Load Compensation shall be active, it must be enabled.

Use load compensation:

The active “DLC” function is indicated with the symbol at the DLC reading in the main display.

Note…

always use external reference sensor when calibrating with the DLC-function activated for specified accuracy.

☞ Press to accept the new setting(s) and return to the Sensor setup menu or continue to edit the reference sensor parameters or the Sensor under test parameters.

4.10.4 Setting the parameters for SUT– Sensor under test (B versions only)

Sensor type:

☞ Choose between :

- thermocouple sensors (μV)
- voltage sensors (V)
- current (ma) sensors
- RTD sensors (resistance temp. detector (Ω))
- None (no sensor connected)

☞ Select a sensor.

The selected sensor and its list of parameters are now displayed. The various settings can be edited as described in the following :

Convert to temperature:

(using thermocouple, voltage, current and RTD)

- "yes" – the inputs are converted to temperatures.
- "no" – no conversion is made.
  When "no" has been selected the type of model is the only other parameter which can be altered.

Model:

(using thermocouple and RTD)

☞ Toggle between the models; K, N, R, S, T, U, B, E and J (thermocouple) or P10(90)385, P100(90)385, P100(90)392, P1000(90)385, P200(90)385, P50(90)385, P500(90)385, Pt-100 MILL, P100(90)391, P50(90)391, YSI-400, H120(90)672, M100(90)428, M50(90)428-06, M100(90)428… and M50(90)428 (RTD).

Cold junction compensation:

(using thermocouple)

- "auto" – when the automatic mode is selected, the calibrator measures the temperature in the T/C connector and uses this for the cold junction compensation of the thermocouple.
- "manual" – to define a manual temperature for cold junction compensation. Can be used when an external cold junction temperature can be established.

Cold junction temperature:

(using thermocouple)

☞ When "manual" Cold junction compensation has been selected the temperature for cold junction can be set using the NUMERIC keys.

Voltage(V) and temperature(T) span:
(using voltage)

The minimum and the maximum of the voltage and the corresponding temperature span can be set here.

☞ Use the NUMERIC keys to set the value of the voltage and/or the temperature.

Current(C) and temperature(T) span:
(using current)

The minimum and the maximum of the current and the corresponding temperature span can be set here.

☞ Use the NUMERIC keys to set the value of the current and/or the temperature.

Number of wires:
(using RTD)

The number of wires used for the sensor under test can be selected here.

☞ Choose between 2, 3 or 4 wires.

Use stability criteria:
(using thermocouple, voltage, current and RTD)

Beside the stability check on the Reference sensor, it is also possible to ensure that the Sensor Under Test (SENSOR) is stable before the temperature is indicated as stable.

- "yes" – Stability will be checked on both Reference sensor (TRUE) temperature and Sensor Under Test (SENSOR) temperature.
- "no" – Stability will be checked on Reference sensor (TRUE) temperature only.

Stability tolerance:
(using thermocouple, voltage, current and RTD)

☞ Enter the Stability tolerance (temperature) by pressing the NUMERIC keys.

The Stability tolerance can be set down to ±0.001° however the expected performance of the Sensor Under Test should be considered before setting the tolerance.

Stability time:

(using thermocouple, voltage, current and RTD)

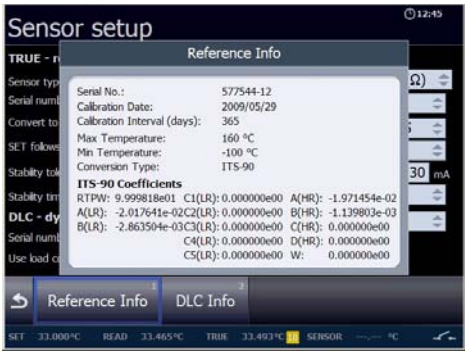
☞ Set the Stability time by pressing the NUMERIC keys. Stability time can be set from 1 – 99 minutes.

When the SENSOR temperature has reached the specified Stability tolerance during the specified Stability time, then the stability indicator in the main screen will turn green.

4.10.5 Viewing the Reference and DLC data (B and C versions only)

The calibration data of the Intelligent Reference sensor and the intelligent DLC sensor can be viewed using the Reference Info function or the DLC Info function from the Sensor setup menu.

☞ View the Reference Info box by selecting “Reference Info [1]”.



The Reference Info box is displayed.

☞ Press ⮌ to return to the Sensor setup menu.

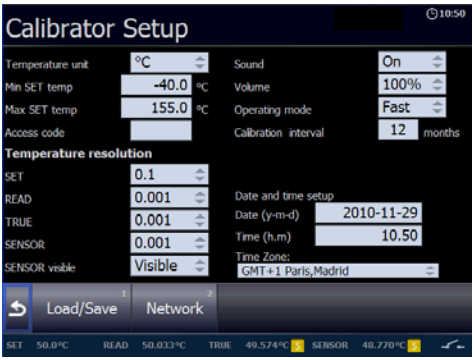
☞ View the DLC Info box by selecting “DLC Info [2]”.

The DLC Info box is displayed.

☞ Press ⮌ to return to the Sensor setup menu.

4.11 Calibrator Setup menu

☞ The Calibration Setup can be edited through the vertical menu (press ☰).



☞ Activate “Calibrator Setup[3]”.

4.11.1 Setting the temperature parameters

Temperature unit:

☞ Choose between:

- °C (Celsius)
- °F (Fahrenheit)
- K (Kelvin)

Min SET temp / Max SET temp:

☞ Enter the access code to get access to the editor.

☞ Use the NUMERIC keys to set the Min/Max SET temperature in Celsius, Fahrenheit or Kelvin.

Note…

The Enter Access Code box is displayed every time you try to access the Min/Max SET temp parameters. Type in your access code and continue.

Access code:

The following features can be protected by an access code:

- Resetting the calibrator to Factory default settings.
- Setting the Min/Max SET Temperature.
- Editing the Access code while it is enabled.

☞ Press ⊙ or ↵ to access the Access code function.

☞ Use the NUMERIC keys to type in a value from 0000 to 9999. Use all 4 digits.
Typing 0000 disables the Access code function.

The access code is accepted showing a green check ✓ for a few seconds allowing you to continue.

Caution…

If you choose to let your access code consist of only 1, 2 or 3 digits you must enter the access code with 0 followed by the chosen value.

Example:

☞ The access code 12 is selected.

☞ Type in 0012 in the Enter Access Code box

Note…

The access code can be deleted allowing you to change the Min/Max SET temperature without having to enter the access code.

☞ Press ◎ or ↵ to access the Access code function.

☞ Type in your access code.

No new value is entered.

☞ Accept the new setting (empty box).

It is now possible to enter the editor without using the access code.

4.11.2 Setting the temperature resolution

☞ Choose between :

- SET
- READ
- TRUE
- SENSOR

☞ Choose between the resolutions:

- 0.001
- 0.01
- 0.1
- 1

SENSOR visible:

☞ Choose between :

- Visible
- Hidden

If the Hidden option is chosen the Sensor Under Test reading will not be displayed on the main screen.

4.11.3 Setting the sound, volume and operating mode

Sound:

☞ Choose between :

- On
- Off

Enables the calibrator to make a sound during operation. Sound responses are given at the following conditions:

- Stability
- Warnings
- Accept of data entry
- Reject of data entry

Volume:

☞ The volume of the sound can be adjusted from 0 – 100%.

Operating mode:

☞ Choose between :

- Fast
- Silent

"Fast" – the fan operates in a fast mode giving the best performance of cooling.

"Silent" – the fan operates in a silent mode reducing the noise. Using this option the cooling process is made a little slower and the calibrator might not be able to reach the specified minimum temperature.

4.11.4 Setting calibration interval

Sets the required recalibration interval for the calibrator.

☞ Choose a value between 1 month and 99 months.

When the recalibration interval is exceeded, the warning symbol will appear in the display.

Note…

The recalibration interval is not used for the external reference sensor and the DLC. The interval for these sensors are stored in the intelligent sensor.

4.11.5 Changing the date and time

Date:

☞ Use the NUMERIC keys to enter a new date.

The date can only be entered using the format yyyy-mm-dd. When entering the date with different format, the text will disappear when you try to accept the setting.

Time:

The calibrator is set up with a default time (present time).

☞ Use the NUMERIC keys to enter a new time using the format hh.mm.

Time Zone:

☞ The relevant time zone is selected from a list of various zones.

4.11.6 Saving a setup

Saving a setup saves parameters in the Setup menu.

☞ Access the Instrument Settings menu by selecting “Load/Save [1]” from the Calibrator Setup menu.

The Instrument Settings are displayed.

☞ Select a register number to be used for saving.

The setup will be saved with the selected register number.

Note…

In the Calibrator Setup the following parameters will not be saved:

- Min SET temp
- Max SET temp
- SENSOR visible

You can save up to 10 setups.

When the setup is saved the parameters are visible in the right side of the screen.

4.11.7 Loading a setup

Loading a setup causes the setup parameters to be overwritten.

☞ Select a setup from the list to be loaded.

The selected setup will be loaded into the calibrator's memory.

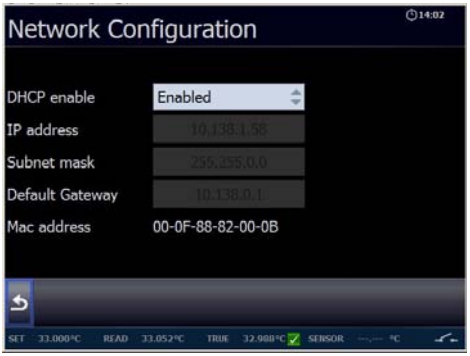
☞ Press ↩ to return to the Calibrator setup menu.

4.11.8 Resetting the instrument setup to factory defaults

Resetting to the factory default settings changes the active setup to the initial settings.

4.11.9 Network Configuration (for service use only)

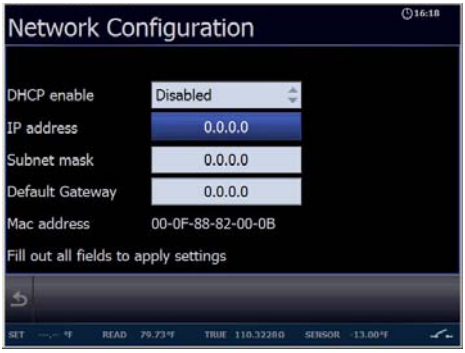
☞ Access the Network Configuration function by selecting “Network [2]” from the Calibration Setup menu.



The Network Configuration screen is displayed.

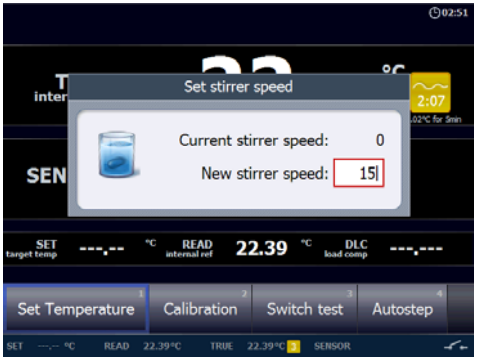
When DHCP is set to Enabled, the IP address will be updated when leaving the network menu.

When DHCP is disabled, you can configure the IP-settings manually using the NUMERIC keys.



4.12 Selecting the stirrer speed (RTC-158/250 A/B/C only)

☞ The Sensor Setup can be entered through the vertical menu (press ☰)
Use the ARROW keys to select “Stirrer Speed”.



☞ Use the NUMERIC keys to enter a value, or ⊙ or ↵ to accept the value. When pressing the ACTION key or the ENTER key the calibrator returns to the main menu screen.

☞ Select a speed setting between 0 and 100.
The normal setting is between 30 and 40.

When using the RTC-158/250 A/B/C with a dry block kit the stirrer speed must be set to 0.

The DLC will be disabled when the stirrer is started

Caution…

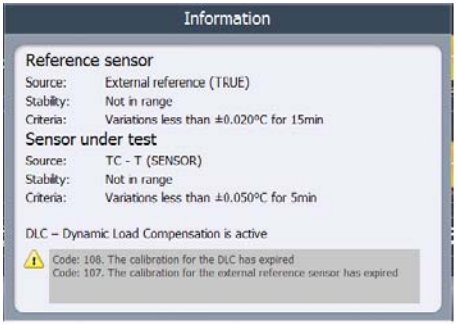
If the speed level chosen is too high, the magnet will fall off making a rattling sound and there will be no stirring in the fluid. With no stirring of the fluid, temperature gradients will emerge in the bath, which will again affect the result of the calibration.

To reconnect the magnet, set the speed level to 0 and select a speed setting lower than the previous.

☞ Press ◎ or ↵ to accept the value and return to the setup menu.

4.13 Information Screen

☞ Information about the status can be viewed using the Info function from the vertical menu (press ☰).



A status summary of the sensors setting and stability information is displayed.

If a warning or an error has occurred, it will be listed on the information screen.

Note…

The list will be cleared, when the calibrator is turned off.

☞ Press ⮌ to exit the Info function.

4.14 About the calibrator

☞ Information about the calibrator can be viewed using the About function from the vertical menu (press ☰).

This informs you about the calibrator type, the software version installed, the serial number, the date when it was last calibrated, the build date and the build description.

☞ Press ⮌ to exit the About function.

4.15 Simulation or training

☞ Switch off the calibrator and switch it on again using the power control switch.
The start up screen is displayed.

☞ Shortly after a black screen is displayed for a few seconds and then the start up screen is displayed again.

Now press and hold ⮌ down for a minimum of 5 seconds while the start screen is displayed.

The calibrator will start in the simulation mode.

This mode is used to train personnel. The simulation differs from the standard setting in the following ways:

- The instrument does not actually heat up or cool down the well.
- The heating and cooling processes are simulated at exaggerated speeds.
- Data are not stored in the calibrator’s memory.

The calibrator will remain in simulation mode until it is switched off.

5.0 After use

5.1 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 (all versions).

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. Turning off the calibrator during the calibration process will not damage either the instrument or the sensor.

Dry-block calibrators only
The following routine must be observed **before the insertion tube is** removed and the instrument switched off:

Over 100°C/212°F

If the calibrator has been heated up to temperatures above 100°C/212°F, you must wait until the instrument reaches a temperature **below 100°C/212°F** before you switch it off.

Below 0°C/32°F
(applies only to the RTC-156/157/158 A/B/C models)

- If the calibrator has reached a temperature below 0°C/32°F, ice crystals may form on the insertion tube and on the well. This, in turn, may cause the material surfaces to oxidize.
  To prevent this from happening, the insertion tube and the well must be dried. This is done by heating up the calibrator to min. 100°C/212°F and any water left will evaporate.
  Remove the insulation plug while heating up.

It is very important that humidity in the well and insertion tube is removed to prevent corrosion and frost expansion damages.

Remove the insertion tube from the calibrator using the tool for insertion tube supplied with the instrument (see fig. 14).

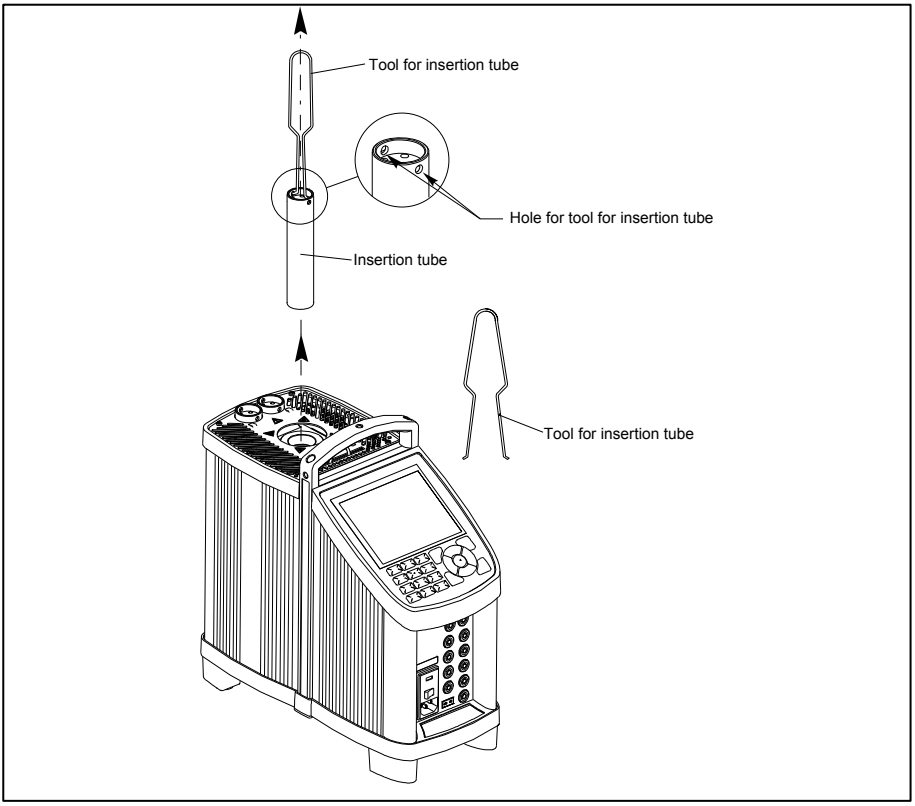


Fig. 14

Caution…

The insertion tube must **always** be removed from the calibrator after use.
The humidity in the air may cause oxidation on the insertion tube inside the instrument. There is a risk that the insertion tube may become stuck if this is allowed to happen.

Warning (all versions)

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

  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 100°C/212°F** before placing it in the carrying case.

- Do not touch the well or insertion tube when these are deep frozen – they can create frostbite.

5.1.1 Transporting the dry-block calibrator

Caution…

The insertion tube **must** be removed to avoid damage to the instrument if the calibrator is to be transported long distances.

5.1.2 Transporting the liquid bath calibrator

Before transporting the fluid it must be cooled down to a temperature near ambient.

It is possible to move the liquid bath calibrator, when it is filled with fluids.
The transportation lid is used to reduce the risk of spilling.
As the lid is not completely fluid tight it is advisable to emptying the well completely before any transportation is attempted (see section 5.2).

5.2 Emptying the well (liquid baths only)

It is not recommendable to leave the fluid in the well for long-term storage. The best way to store the fluid is in its original airtight container.

Warning

- **Do not** handle hot fluid.
- **Do not** attempt to remove hot fluid with the liquid drainage tube, as it might melt.
- **Do not** leave any fluid (silicone oil) in the spill tray.
- **Do not** touch the items removed from the well – they may be very hot.
- **Never** leave hot items, which have been removed from the well, unsupervised – they may constitute a fire hazard.

The following guidelines must be observed before emptying the well :

1. Switch off the calibrator using the power control switch.
2. Before handling the fluid, it must be cooled down to a temperature close to ambient.
3. Remove the sensor basket and clean it with disposable paper towels.
4. Remove the stirring magnet using the stirring magnet remover supplied and clean it with disposable paper towels.
5. Empty the well using the liquid drainage tube supplied. Tilting the calibrator is not recommendable, as it increases the risk of splashing oil all over the test area.

6.0 Replacing the main fuses

Warning

- The calibrator **must** be switched off before any attempt to service the instrument is made.
- The fuse box must not be removed from the power control switch until the mains cable has been disconnected.
- The two main fuses must be identical and correspond to the applied voltage.

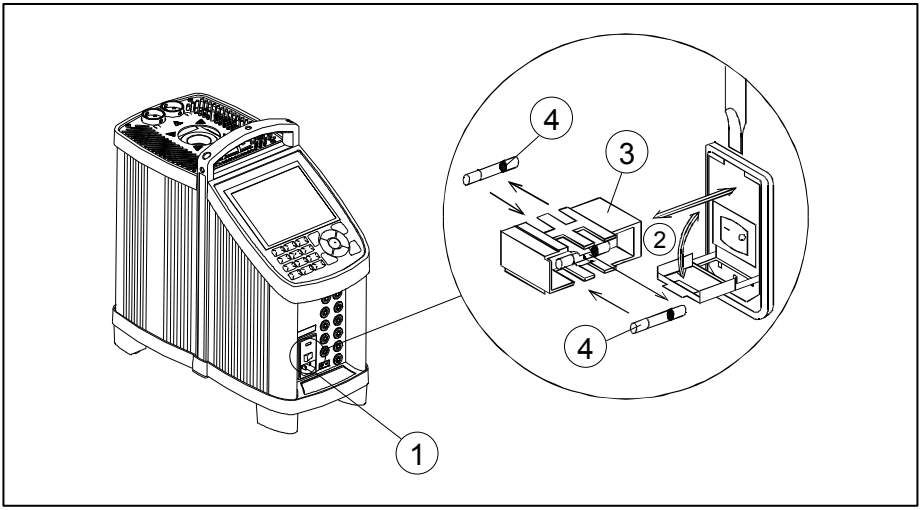


Fig. 15

① Locate the main fuses in the fuse box in the power control switch.

② Open the lid of the fuse box using a screwdriver.

③ Remove the fuse box.

④ Replace the fuses.

- RTC-156/157/158: 115V 8AT = 127211 / 230V, 4AT = 127210
- RTC-250/700: 115V, 10AF = 60B302 / 230V, 5AF = 127573

If the fuses blow immediately after you have replaced them, the calibrator should be returned to the manufacturer for service.

6.1 Error messages

Error messages are displayed in a dialog box with the following text:

Internal Error # xxx
Please read the manual for further information

Error #	Error text	Category	Solution
0	**Read temperature lower than calibrator minimum temperature.**	Warning	Please report the error to your local distributor or to AMETEK Denmark's service department.
1	**Read temperature higher than calibrator maximum temperature.**	Warning	Please report the error to your local distributor or to AMETEK Denmark's service department.
2	**Read temperature higher than current SET-temperature.**	Warning	Please report the error to your local distributor or to AMETEK Denmark's service department.
3	**Zone 1 or zone 2 temperature deviation.**	Warning	The calibrator could be stressed due to the insertion of too many sensors. Remove some of the sensors. If the error still occurs please report the error to your local distributor or to AMETEK Denmark's service department.
4	**Internal reference measuring circuit error.**	Warning	Please report the error to your local distributor or to AMETEK Denmark's service department.
5	**Internal reference sensor error.**	Warning	Please report the error to your local distributor or to AMETEK Denmark's service department.
6	**Zone 2 sensor error.**	Warning	Please report the error to your local distributor or to AMETEK Denmark's service department.
7	**Zone 1 sensor error.**	Warning	Please report the error to your local distributor or to AMETEK Denmark's service department.

Error #	Error text	Category	Solution
8	**Heater 1 error.**	Warning	Please report the error to your local distributor or to AMETEK Denmark's service department.
9	**Heater 2 error.**	Warning	Please report the error to your local distributor or to AMETEK Denmark's service department.
10	**Heater 3 error.**	Warning	Please report the error to your local distributor or to AMETEK Denmark's service department.
11	**Heater 4 error.**	Warning	Please report the error to your local distributor or to AMETEK Denmark's service department.
100	**Sensor input board error.**	Error	Please report the error to your local distributor or to AMETEK Denmark's service department.
101	**The sensor input board has not been calibrated.**	Error	The sensor input board has not been calibrated
102	**Reference input board error.**	Error	Please report the error to your local distributor or to AMETEK Denmark's service department.
103	**The reference input board has not been calibrated**	Error	The reference input board has not been calibrated
104	**The calibration for the heat source has expired.**	Warning	The calibration for the heat source has expired.
105	**The calibration for the sensor input board has expired.**	Warning	The calibration for the sensor input board has expired.
106	**The calibration for the reference input board has expired.**	Warning	The calibration for the reference input board has expired.
107	**The calibration for the external reference sensor has expired.**	Warning	The calibration for the external reference sensor has expired.
108	**The calibration for the DLC has expired.**	Warning	The calibration for the DLC has expired.
109	**Heat source not calibrated**	Error	The instrument needs to be recalibrated.

6.2 Returning the calibrator for service

When returning the calibrator to the manufacturer for service, please enclose a fully completed service information form. Simply copy the form on the following page and fill in the required information.
The calibrator should be returned in the original packing.

Note…

If the software detects an error during operation, the error will be shown in the display.

Make a note of the error message and contact your distributor or AMETEK Denmark's service department.

AMETEK Denmark's liability ceases if:

- parts are replaced/repaired using spare parts which are not identical to those recommended by the manufacturer.
- non-original parts are used in any way when operating the instrument.

AMETEK Denmark's liability is restricted to errors that originated from the factory.

Service info

Customer data: **Date:**

Customer name and address:_____

Attention and Dept.:_____

Fax no./Phone no.:_____

Your order no.:_____

Delivery address:_____

Distributor name:_____

Instrument data:

Model and Serial no.:_____

Warranty claimed Yes:____ No:_____ Original invoice no.:_____

Temp. calibration	Sensor input	**Service request:**	**This instrument is sent for (please check off):**
☐	☐	___ Calibration as left	___ Check
☐	☐	___ Calibration as found and as left	___ Service
☐	☐	___ Accredited calibration as left	___ Repair
☐	☐	___ Accredited calibration as found and as left.	

Diagnosis data/cause for return:

Diagnosis/Fault description:_____

_____

Special requests:_____

_____

Safety precautions: if the product has been exposed to any hazardous substances, it must be thoroughly decontaminated before it is returned to AMETEK. Details of the hazardous substances and any precautions to be taken must be enclosed.

7.0 Maintenance

7.1 Cleaning

Caution…

Before cleaning the calibrator, you **must** switch it off, allow it to cool down and remove all cables.

Users should/must carry out the following cleaning procedures as and when required:

- **The exterior of the instrument –** Clean using water or isopropyl alcohol and a soft cloth.
  The cloth should be wrung out hard to avoid any water penetrating the calibrator and causing damage.
  The keyboard may be cleaned using isopropyl alcohol when heavily soiled.

- **The insertion tube –** must **always** be clean and should be regularly wiped using a soft, lint-free, dry cloth.
  You must ensure there are no textile fibres on the insertion tube when it is inserted in the well. The fibres may adhere to the well and damage it.
  If the calibrator has reached a temperature below 0°C/32°F, ice crystals may form on the insertion tube. This, in turn, may cause the material surfaces to oxidize.
  To prevent this from happening, the insertion tube must be dried. This is done by heating up the calibrator to min. 100°C/212°F and any water left will evaporate.
  Remove the insulation plug while heating up.

  It is very important that humidity in the insertion tube is removed to prevent corrosion and frost expansion damages.

- **The well –** must **always** be clean.
  Dust and textile fibres in the well should be removed from the dry-block calibrator using e.g. compressed air.
  Remains of silicone oil in the well should be removed from the liquid bath calibrator by using special cleaning oil.

Warning

REMEMBER to wear goggles when using compressed air and cleaning oil.

If the calibrator has reached a temperature below 0°C/32°F, ice crystals may form on the well. This, in turn, may cause the material surfaces to oxidize.
To prevent this from happening, the well must be dried. This is done by heating up the calibrator to min. 100°C/212°F and any water left will evaporate.
Remove the insulation plug while heating up.

It is very important that humidity in the well is removed to prevent corrosion and frost expansion damages.

- **The stirring magnet and sensor basket (RTC-158/250 A/B/C only) –** When removed from the calibrator the items must be cleaned thoroughly with dry disposable paper towels to avoid spilling of fluid. Drops of silicone oil can be removed by using special cleaning oil.

- **The sensor-under-test (RTC-158/250 A/B/C only) –** When removed from the calibrator the sensor must be cleaned thoroughly with dry disposable paper towels to avoid spilling of fluid. Drops of silicone oil can be removed by using special cleaning oil.

Caution…

Avoid getting silicone oil on the clothes. It is impossible to wash off.

7.2 Adjusting and calibrating the instrument

You are advised to return the calibrator to AMETEK Denmark A/S or another accredited laboratory at least once a year for calibration.

Alternatively, you can calibrate/adjust the calibrator yourself using the AmeTrim Adjust and Calibration Software.

Please refer to the Ametrim User Manual also found on the installation USB memory stick.

7.3 Maintenance of STS-reference sensor

Use the configuration software CON050 supplied with the RTC to update calibration information in the intelligent reference sensor.

Read the STS- and CON050 manuals for instruction about calibration and up-/download procedure.

The following information in the sensor is used by the RTC and must be filled in correctly:

- Serial number
- Model number
- Sensor type
- Temperature range Min/Max
- Electrical output Min/Max
- RTD type (CvD or ITS-90)
- Calibration date
- Calibration initials
- Calibration period
- R0, A, B and C (RTD type = CvD)
- RTPW, A(LR), B(LR)C(LR)/C1(LR), C2(LR), C3(LR), C4(LR), C5(LR) A(HR), B(HR), C(HR), D(HR) and W(HR) (RTD type = ITS-90)

All other data are not used by the RTC.

On the sensor calibration certificates, the coefficients can be listed using the ITS-90 names for coefficients. The table below can be used

to convert the ITS-90 coefficient names to RTC-coefficient names for the ITS-90 subranges used in the RTC-calibrator temperature range.

		ITS90 Subrange								
		3	4	5	6	7	8	9	10	11
RTC coefficient	A(LR)	a3	a4	0						
	B(LR)	b3	b4	0						
	C(LR)/C1(LR)	c3	0	0						
	A(HR)			a5	a6	a7	a8	a9	a10	a11
	B(HR)			b5	b6	b7	b8	b9	0	0
	C(HR)			0	c6	c7	0	0	0	0
	D(HR)			0	d	0	0	0	0	0
	W				w					

7.4 Maintenance of DLC-sensor

Use the configuration software CON050 supplied with the RTC to update calibration information in the intelligent reference sensor.

Read the DLC- and CON050 manuals for instruction about calibration and up-/download procedure.

The following information in the sensor is used by the RTC and must be filled in correctly:

- Serial number
- Model number
- Sensor type
- Temperature range Min/Max
- Electrical output Min/Max
- TC-type (DLC-155/158/250 = T, DLC-700 = N)
- CJC (Must be set to "No compensation")
- Calibration date
- Calibration initials
- Calibration period
- Correction coefficients A, B and C

All other data are not used by the RTC.

8.0 Technical specifications

The illustration below shows the setup that forms the basis for the technical specifications for dry-block calibrators.

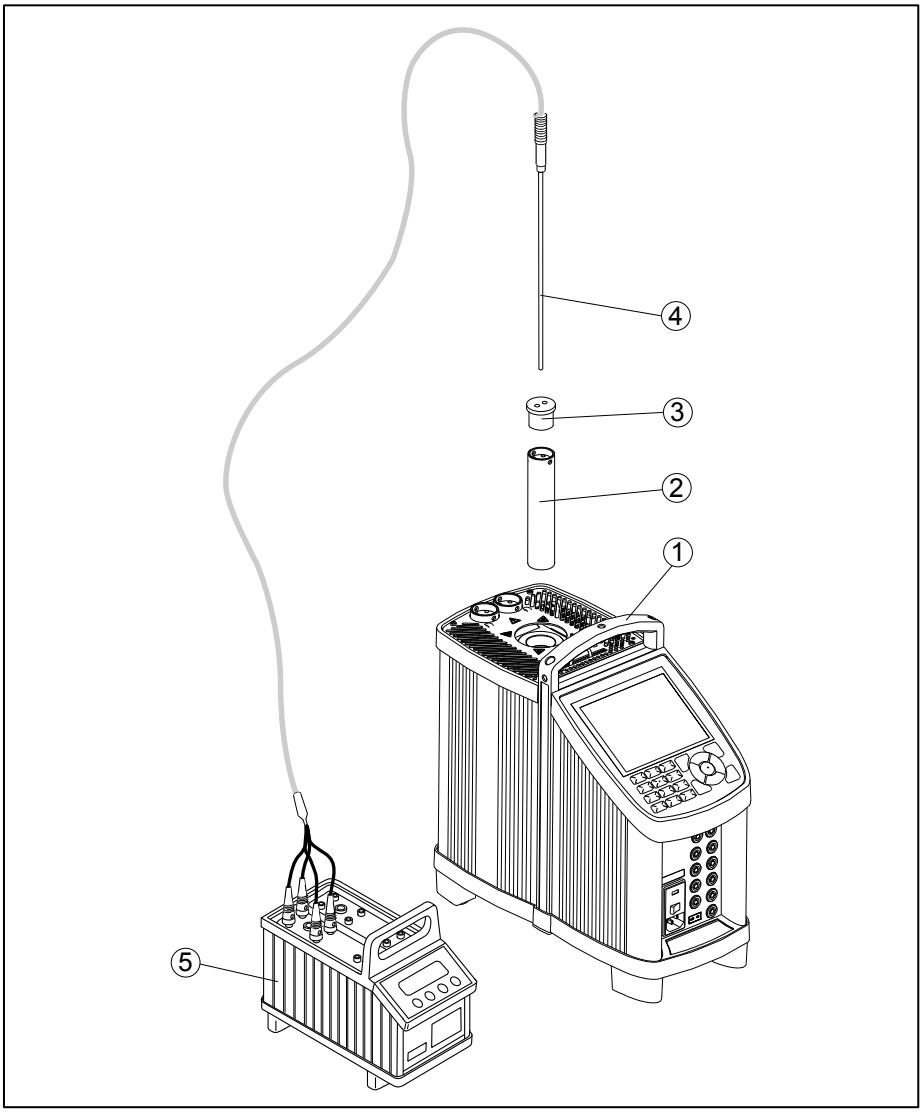


Fig. 18

Pos.	Description – dry-block calibrators (fig. 18)
1	Calibrator
2	Ø1/4“ insertion tube
3	Insulation plug (RTC-156/157/158/250 only)
4	1/4” STS-200 sensor
5	DTI-1000 reference precision thermometer

The illustration below shows the setup that forms the basis for the technical specifications for liquid bath calibrators.

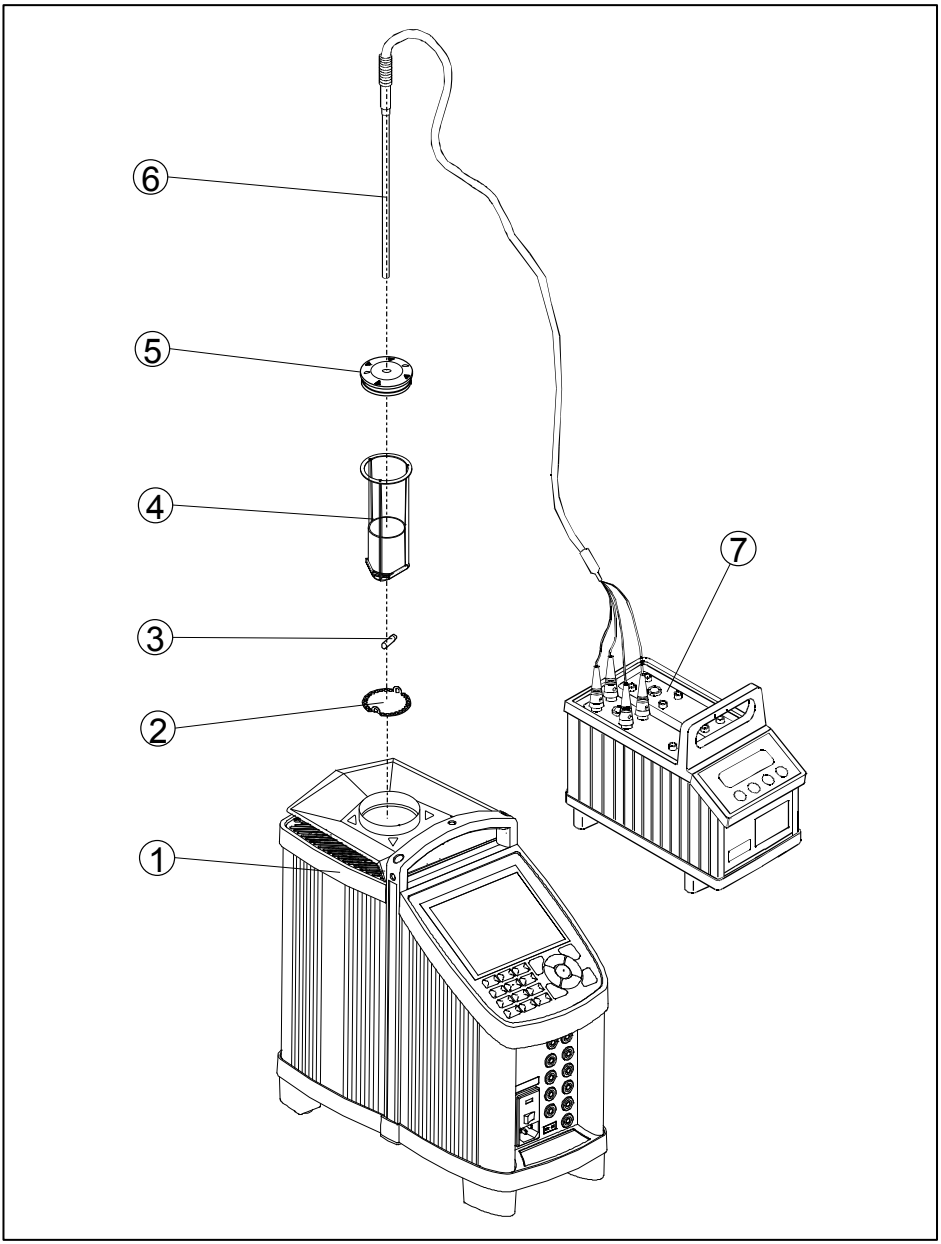


Fig. 19

Pos.	Description – liquid bath calibrators (fig. 19)
①	Calibrator
②	Bottom shield
③	Stirring magnet
④	Sensor basket
⑤	Lid for calibration
⑥	1/4” STS-200 sensor
⑦	DTI-1000 reference precision thermometer

TECHNICAL SPECIFICATIONS

All specifications are given with an ambient temperature of 23°C/73.4°F ± 3°C/5.4°F

MECHANICAL SPECIFICATIONS	RTC-156 A/B/C
Dimensions l × w × h	362 × 171 × 363 mm / 14.2 x 6.7 x 14.3 inch
Weight	RTC-156 A : 10.4 kg / 23.0 lb RTC-156 B/C : 10.5 kg / 23.1 lb
Shipping dimensions	580 x 250 x 500mm / 22.8 x 9.8 x 19.7 inch (Cardboard box) 550 x 440 x 610mm / 21.7 x 17.3 x 24.0 inch (Carrying case in cardboard box)
Shipping weight	14.8 kg / 32.6 lb (in cardboard box) 20.5 kg / 45.2 lb (in carrying case in cardboard box)
Bore diameter/depth of well	ø30 mm / 150 mm – ø1.18 inch / 5.91 inch
Weight non-drilled insert	290 g / 10.2 oz
POWER SUPPLY	
Line voltage/frequency	90-127VAC / 180-254VAC 45-65 Hz
Power consumption	400 W
Type of connection	IEC320
COMMUNICATION INTERFACES	
Type of connections	USB A, USB B, SD card slot, RJ45
OTHER CONNECTIONS	
Syncronisation relay output	3,5 mm mini jack.
ENVIRONMENT	
Ambient operating temperature range	0-40°C / 32-104°F
Storage temperature range	-20-50°C / -4-122°F
Humidity range	0-90% RH.
Protection class	IP10
READOUT SPECIFICATIONS	
Resolution	0.001°C / 0.001°F / 0.001 K
Temperature units	°C / °F / K

THERMAL SPECIFICATIONS	RTC-156 A/B/C
Maximum temperature	155°C / 311°F
Minimum temperature *	-46°C / -50.8°F @ ambient temperature 0°C / 32°F -30°C / -22.0°F @ ambient temperature 23°C / 73.4°F -15°C / -5.0°F @ ambient temperature 40°C / 104°F

* The minimum temperature will be affected by the number of sensors and the dimensions of the sensors being calibrated.

THERMAL SPECIFICATIONS	RTC-156 A/B/C
Well specifications	<u>Loaded with 2 x 3mm sensors:</u> 40 mm / 1.57 inch axial homogeneity: ±0.025°C/0.045°F @ -30°C/-22°F to 0°C/32°F 40 mm / 1.57 inch axial homogeneity: ±0.020°C/0.036°F @ 0°C/32°F to 50°C/122°F 40 mm / 1.57 inch axial homogeneity: ±0.025°C/0.045°F @ 50°C/122°F to 155°C/311°F 50 mm / 1.97 inch axial homogeneity: ±0.025°C/0.045°F @ -30°C/-22°F to 0°C/32°F 50 mm / 1.97 inch axial homogeneity: ±0.020°C/0.036°F @ 0°C/32°F to 50°C/122°F 50 mm / 1.97 inch axial homogeneity: ±0.025°C/0.045°F @ 50°C/122°F to 155°C/311°F 60 mm / 2.36 inch axial homogeneity: ±0.025°C/0.045°F @ -30°C/-22°F to 0°C/32°F 60 mm / 2.36 inch axial homogeneity: ±0.020°C/0.036°F @ 0°C/32°F to 50°C/122°F 60 mm / 2.36 inch axial homogeneity: ±0.025°C/0.045°F @ 50°C/122°F to 155°C/311°F 70 mm / 2.76 inch axial homogeneity: ±0.035°C/0.063°F @ -30°C/-22°F to 0°C/32°F 70 mm / 2.76 inch axial homogeneity: ±0.030°C/0.054°F @ 0°C/32°F to 50°C/122°F 70 mm / 2.76 inch axial homogeneity: ±0.035°C/0.063°F @ 50°C/122°F to 155°C/311°F 80 mm / 3.15 inch axial homogeneity: ±0.050°C/0.09°F @ -30°C/-22°F to 0°C/32°F 80 mm / 3.15 inch axial homogeneity: ±0.040°C/0.072°F @ 0°C/32°F to 50°C/122°F 80 mm / 3.15 inch axial homogeneity: ±0.050°C/0.09°F @ 50°C/122°F to 155°C/311°F <u>Loaded with 3 x 3mm sensors + 1 x 4mm sensors:</u> 40 mm / 1.57 inch axial homogeneity: ±0.025°C/0.045°F @ -30°C/-22°F to 0°C/32°F 40 mm / 1.57 inch axial homogeneity: ±0.020°C/0.036°F @ 0°C/32°F to 50°C/122°F 40 mm / 1.57 inch axial homogeneity: ±0.025°C/0.045°F @ 50°C/122°F to 155°C/311°F

50 mm / 1.97 inch axial homogeneity:
±0.025°C/0.045°F @ -30°C/-22°F to 0°C/32°F

50 mm / 1.97 inch axial homogeneity:
±0.020°C/0.036°F @ 0°C/32°F to 50°C/122°F

50 mm / 1.97 inch axial homogeneity:
±0.025°C/0.045°F @ 50°C/122°F to 155°C/311°F

60 mm / 2.36 inch axial homogeneity:
±0.030°C/0.054°F @ -30°C/-22°F to 0°C/32°F

60 mm / 2.36 inch axial homogeneity:
±0.020°C/0.036°F @ 0°C/32°F to 50°C/122°F

60 mm / 2.36 inch axial homogeneity:
±0.035°C/0.063°F @ 50°C/122°F to 155°C/311°F

70 mm / 2.76 inch axial homogeneity:
±0.040°C/0.072°F @ -30°C/-22°F to 0°C/32°F

70 mm / 2.76 inch axial homogeneity:
±0.030°C/0.054°F @ 0°C/32°F to 50°C/122°F

70 mm / 2.76 inch axial homogeneity:
±0.050°C/0.09°F @ 50°C/122°F to 155°C/311°F

80 mm / 3.15 inch axial homogeneity:
±0.060°C/0.11°F @ -30°C/-22°F to 0°C/32°F

80 mm / 3.15 inch axial homogeneity:
±0.040°C/0.072°F @ 0°C/32°F to 50°C/122°F

80 mm / 3.15 inch axial homogeneity:
±0.070°C/0.13°F @ 50°C/122°F to 155°C/311°F

Loaded with 3 x 3mm sensors + 1 x 4mm sensor and 1 x 6 mm sensor

DLC active:

40 mm / 1.57 inch axial homogeneity:
±0.035°C/0.063°F @ -30°C/-22°F to 0°C/32°F

40 mm / 1.57 inch axial homogeneity:
±0.025°C/0.045°F @ 0°C/32°F to 50°C/122°F

40 mm / 1.57 inch axial homogeneity:
±0.035°C/0.063°F @ 50°C/122°F to 155°C/311°F

50 mm / 1.97 inch axial homogeneity:
±0.035°C/0.063°F @ -30°C/-22°F to 0°C/32°F

50 mm / 1.97 inch axial homogeneity:
±0.025°C/0.045°F @ 0°C/32°F to 50°C/122°F

50 mm / 1.97 inch axial homogeneity:
±0.035°C/0.063°F @ 50°C/122°F to 155°C/311°F

THERMAL SPECIFICATIONS	RTC-156 A/B/C
	60 mm / 2.36 inch axial homogeneity: ±0.035°C/0.063°F @ -30°C/-22°F to 0°C/32°F
	60 mm / 2.36 inch axial homogeneity: ±0.030°C/0.054°F @ 0°C/32°F to 50°C/122°F
	60 mm / 2.36 inch axial homogeneity: ±0.035°C/0.063°F @ 50°C/122°F to 155°C/311°F
	70 mm / 2.76 inch axial homogeneity: ±0.045°C/0.081°F @ -30°C/-22°F to 0°C/32°F
	70 mm / 2.76 inch axial homogeneity: ±0.040°C/0.072°F @ 0°C/32°F to 50°C/122°F
	70 mm / 2.76 inch axial homogeneity: ±0.045°C/0.081°F @ 50°C/122°F to 155°C/311°F
	80 mm / 3.15 inch axial homogeneity: ±0.060°C/0.11°F @ -30°C/-22°F to 0°C/32°F
	80 mm / 3.15 inch axial homogeneity: ±0.050°C/0.09°F @ 0°C/32°F to 50°C/122°F
	80 mm / 3.15 inch axial homogeneity: ±0.060°C/0.11°F @ 50°C/122°F to 155°C/311°F
	Difference between borings : 0.01°C/0.02°F
	Influence from load : 0.10°C/0.18°F
	Influence from load with Ext. Reference : 0.01°C/0.02°F
	Long term drift (1 year) : ±0.04°C/±0.07°F
Temperature coefficient	±0.005°C/°C (0-20°C and 26-40°C) / ±0.009°F/°F (32-68°F and 79-104°F)
Stability	±0.005°C/ ±0.009°F
Accuracy	±0.10°C/±0.18°F
Heating time incl. insert	-30°C / -22.0°F to 23°C / 73.4°F : 4 min.
	23°C / 73.4°F to 155°C / 311°F : 15 min.
	-30°C / -22.0°F to 155°C / 311°F : 19 min.
Time to stability	10 min.
Cooling time incl. insert	155°C / 311°F to 100°C / 212°F: 4 min.
	100°C / 212°F to 23°C / 73.4°F: 8 min.

THERMAL SPECIFICATIONS	RTC-156 A/B/C
	23°C / 73.4°F to –24°C / -11.2°F : 15 min.
	-24°C / -11.2°F to –30°C / -22.0°F: 10 min.
	155°C / 311°F to –30°C / -22.0°F : 37 min.

MECHANICAL SPECIFICATIONS	RTC-157 A/B/C
Dimensions l × w × h	362 × 171 × 363 mm / 14.2 x 6.7 x 14.3 inch
Weight	RTC-157 A : 10.4 kg / 23.0 lb RTC-157 B/C : 10.5 kg / 23.1 lb
Shipping dimensions	580 x 250 x 500mm / 22.8 x 9.8 x 19.7 inch (Cardboard box) 550 x 440 x 610mm / 21.7 x 17.3 x 24.0 inch (Carrying case in cardboard box)
Shipping weight	14.8 kg / 32.6 lb (in cardboard box) 20.5 kg / 45.2 lb (in carrying case in cardboard box)
Bore diameter/depth of well	ø30 mm / 150 mm – ø1.18 inch / 5.91 inch
Weight non-drilled insert	290 g / 10.2 oz
POWER SUPPLY	
Line voltage/frequency	90-127VAC / 180-254VAC 45-65 Hz
Power consumption	400 W
Type of connection	IEC320
COMMUNICATION INTERFACES	
Type of connections	USB A, USB B, SD card slot, RJ45
OTHER CONNECTIONS	
Syncronisation relay output	3,5 mm mini jack.
ENVIRONMENT	
Ambient operating temperature range	0-40°C / 32-104°F
Storage temperature range	-20-50°C / -4-122°F
Humidity range	0-90% RH.
Protection class	IP10

MECHANICAL SPECIFICATIONS	RTC-157 A/B/C
READOUT SPECIFICATIONS	
Resolution	0.001°C / 0.001°F / 0.001 K
Temperature units	°C / °F / K

THERMAL SPECIFICATIONS	RTC-157 A/B/C
Maximum temperature	155°C / 311°F
Minimum temperature *	-57°C / -70.6°F @ ambient temperature 0°C / 32°F -45°C / -49°F @ ambient temperature 23°C / 73.4°F -31°C / -23.8°F@ ambient temperature 40°C / 104°F

* The minimum temperature will be affected by the number of sensors and the dimensions of the sensors being calibrated.

THERMAL SPECIFICATIONS	RTC-157 A/B/C
Well specifications	<u>Loaded with 2 x 3mm sensors:</u> 40 mm / 1.57 inch axial homogeneity: ±0.030°C/0.054°F @ -45°C/-49°F to 0°C/32°F 40 mm / 1.57 inch axial homogeneity: ±0.020°C/0.036°F @ 0°C/32°F to 50°C/122°F 40 mm / 1.57 inch axial homogeneity: ±0.030°C/0.054°F @ 50°C/122°F to 155°C/311°F 50 mm / 1.97 inch axial homogeneity: ±0.035°C/0.063°F @ -45°C/-49°F to 0°C/32°F 50 mm / 1.97 inch axial homogeneity: ±0.020°C/0.036°F @ 0°C/32°F to 50°C/122°F 50 mm / 1.97 inch axial homogeneity: ±0.035°C/0.063°F @ 50°C/122°F to 155°C/311°F 60 mm / 2.36 inch axial homogeneity: ±0.035°C/0.063°F @ -45°C/-49°F to 0°C/32°F 60 mm / 2.36 inch axial homogeneity: ±0.020°C/0.036°F @ 0°C/32°F to 50°C/122°F 60 mm / 2.36 inch axial homogeneity: ±0.035°C/0.063°F @ 50°C/122°F to 155°C/311°F 70 mm / 2.76 inch axial homogeneity: ±0.050°C/0.09°F @ -45°C/-49°F to 0°C/32°F 70 mm / 2.76 inch axial homogeneity: ±0.030°C/0.054°F @ 0°C/32°F to 50°C/122°F 70 mm / 2.76 inch axial homogeneity: ±0.050°C/0.09°F @ 50°C/122°F to 155°C/311°F 80 mm / 3.15 inch axial homogeneity: ±0.070°C/1.26°F @ -45°C/-49°F to 0°C/32°F 80 mm / 3.15 inch axial homogeneity: ±0.040°C/0.072°F @ 0°C/32°F to 50°C/122°F 80 mm / 3.15 inch axial homogeneity: ±0.070°C/1.26°F @ 50°C/122°F to 155°C/311°F <u>Loaded with 3 x 3mm sensors + 1 x 4mm sensors:</u> 40 mm / 1.57 inch axial homogeneity: ±0.030°C/0.054°F @ -45°C/-49°F to 0°C/32°F 40 mm / 1.57 inch axial homogeneity: ±0.020°C/0.036°F @ 0°C/32°F to 50°C/122°F 40 mm / 1.57 inch axial homogeneity: ±0.030°C/0.054°F @ 50°C/122°F to 155°C/311°F

50 mm / 1.97 inch axial homogeneity:
±0.035°C/0.063°F @ -45°C/-49°F to 0°C/32°F

50 mm / 1.97 inch axial homogeneity:
±0.020°C/0.036°F @ 0°C/32°F to 50°C/122°F

50 mm / 1.97 inch axial homogeneity:
±0.035°C/0.063°F @ 50°C/122°F to 155°C/311°F

60 mm / 2.36 inch axial homogeneity
±0.050°C/0.09°F @ -45°C/-49°F to 0°C/32°F

60 mm / 2.36 inch axial homogeneity:
±0.020°C/0.036°F @ 0°C/32°F to 50°C/122°F

60 mm / 2.36 inch axial homogeneity
±0.050°C/0.09°F @ 50°C/122°F to 155°C/311°F

70 mm / 2.76 inch axial homogeneity:
±0.070°C/1.26°F @ -45°C/-49°F to 0°C/32°F

70 mm / 2.76 inch axial homogeneity:
±0.030°C/0.054°F @ 0°C/32°F to 50°C/122°F

70 mm / 2.76 inch axial homogeneity:
±0.070°C/1.26°F @ 50°C/122°F to 155°C/311°F

80 mm / 3.15 inch axial homogeneity:
±0.120°C/0.216°F @ -45°C/-49°F to 0°C/32°F

80 mm / 3.15 inch axial homogeneity:
±0.050°C/0.09°F @ 0°C/32°F to 50°C/122°F

80 mm / 3.15 inch axial homogeneity:
±0.120°C/0.216°F @ 50°C/122°F to 155°C/311°F

Loaded with 3 x 3mm sensors + 1 x 4mm sensor and 1 x 6 mm sensor

DLC active:

40 mm / 1.57 inch axial homogeneity:
±0.035°C/0.063°F @ -45°C/-49°F to 0°C/32°F

40 mm / 1.57 inch axial homogeneity:
±0.025°C/0.045°F @ 0°C/32°F to 50°C/122°F

40 mm / 1.57 inch axial homogeneity:
±0.035°C/0.063°F @ 50°C/122°F to 155°C/311°F

50 mm / 1.97 inch axial homogeneity:
±0.035°C/0.063°F @ -45°C/-49°F to 0°C/32°F

50 mm / 1.97 inch axial homogeneity:
±0.025°C/0.045°F @ 0°C/32°F to 50°C/122°F

50 mm / 1.97 inch axial homogeneity:
±0.035°C/0.063°F @ 50°C/122°F to 155°C/311°F

THERMAL SPECIFICATIONS	RTC-157 A/B/C
	60 mm / 2.36 inch axial homogeneity: ±0.045°C/0.081°F @ -45°C/-49°F to 0°C/32°F
	60 mm / 2.36 inch axial homogeneity: ±0.030°C/0.054°F @ 0°C/32°F to 50°C/122°F
	60 mm / 2.36 inch axial homogeneity: ±0.045°C/0.081°F @ 50°C/122°F to 155°C/311°F
	70 mm / 2.76 inch axial homogeneity: ±0.060°C/0.11°F @ -45°C/-49°F to 0°C/32°F
	70 mm / 2.76 inch axial homogeneity: ±0.040°C/0.072°F @ 0°C/32°F to 50°C/122°F
	70 mm / 2.76 inch axial homogeneity: ±0.060°C/0.11°F @ 50°C/122°F to 155°C/311°F
	80 mm / 3.15 inch axial homogeneity: ±0.100°C/0.18°F @ -45°C/-49°F to 0°C/32°F
	80 mm / 3.15 inch axial homogeneity: ±0.050°C/0.09°F @ 0°C/32°F to 50°C/122°F
	80 mm / 3.15 inch axial homogeneity: ±0.100°C/0.18°F @ 50°C/122°F to 155°C/311°F
	Difference between borings : 0.01°C (0.02°F)
	Influence from load : 0.10°C (0.18°F)
	Influence from load with Ext. Reference : 0.01°C / 0.02°F
	Long term drift (1 year) : ±0.04°C / ±0.07°F
Calibration accuracy (test limit)	±0.04°C / ±0.07°F
Temperature coefficient	±0.005°C/°C (0-20°C and 26-40°C) / ±0.009°F/°F (32-68°F and 79-104°F)
Stability	±0.005°C / ±0.009°F
Accuracy	±0.10°C / ±0.18°F
Heating time incl. insert	-45°C / -49.0°F to 23°C / 73.4°F : 7 min.
	23°C / 73.4°F to 100°C / 212°F : 8 min.
	100°C / 212°F to 155°C / 311°F 9 min.

THERMAL SPECIFICATIONS	RTC-157 A/B/C	
	-45°C / -49.0°F to 155°C / 311°F :	24 min.
Time to stability	10 min.	
Cooling time incl. insert	155°C / 311°F to 100°C / 212°F:	5 min.
	100°C / 212°F to 23°C / 73.4°F:	10 min.
	23°C / 73.4°F to –0°C / 32°F :	5 min.
	0°C / 32°F to –30°C / -22.0°F	12 min.
	-30°C / -22.0°F to –45°C / -49.0°F:	25 min.
	155°C / 311°F to –45°C / -49.0°F :	57 min.

MECHANICAL SPECIFICATIONS	RTC-158 A/B/C
Dimensions l × w × h	366 × 171 × 363 mm / 14.4 x 6.7 x 14.3 inch
Weight	RTC-158 A : 10.9 kg / 24.0 lb RTC-158 B/C : 11.0 kg / 24.3 lb
Shipping dimensions	580 x 250 x 500mm / 22.8 x 9.8 x 19.7 inch (Cardboard box) 550 x 430 x 660mm / 21.7 x 16.9 x 26.0 inch (Carrying case in cardboard box)
Shipping weight	RTC-158 A : 16.9 kg / 37.2 lb (in cardboard box) RTC-158 B/C : 17.0 kg / 37.5 lb (in cardboard box) RTC-158 A : 27.9 kg / 61.5 lb (in carrying case in cardboard box) RTC-158 B/C : 28.0 kg / 61.7 lb (in carrying case in cardboard box)
Bore diameter/depth of well	Ø63.8 mm / 160 mm – ø2.5 inch / 6.3 inch
Weight non-drilled insert	1200 g / 42.3 oz
POWER SUPPLY	
Line voltage/frequency	90-127VAC / 180-254VAC 45-65 Hz
Power consumption	400 W
Type of connection	IEC320
COMMUNICATION INTERFACES	
Type of connections	USB A, USB B, SD card slot, RJ45

MECHANICAL SPECIFICATIONS	RTC-158 A/B/C
OTHER CONNECTIONS	
Syncronisation relay output	3,5 mm mini jack.
ENVIRONMENT	
Ambient operating temperature range	0-40°C / 32-104°F
Storage temperature range	-20-50°C / -4-122°F
Humidity range	0-90% RH.
Protection class	IP10
READOUT SPECIFICATIONS	
Resolution	0.001°C / 0.001°F / 0.001 K
Temperature units	°C / °F / K

THERMAL SPECIFICATIONS – DRY BLOCK	RTC-158 A/B/C
Maximum temperature	155°C / 311°F
Minimum temperature	-37°C / -34.6°F @ ambient temperature 0°C / 32°F -22°C / -7.6°F @ ambient temperature 23°C / 73.4°F -9°C / -15.8°F @ ambient temperature 40°C / 104°F

THERMAL SPECIFICATIONS – DRY BLOCK	RTC-158 A/B/C
Well specifications	Loaded with 2 x 3mm sensors: 40 mm / 1.57 inch axial homogeneity: ±0.025°C/0.045°F@ -22°C/-7.6°F to 0°C/32°F 40 mm / 1.57 inch axial homogeneity: ±0.020°C/0.036°F @ 0°C/32°F to 50°C/122°F 40 mm / 1.57 inch axial homogeneity: ±0.030°C/0.054°F @ 50°C/122°F to 155°C/311°F 50 mm / 1.97 inch axial homogeneity: ±0.025°C/0.045°F @ -22°C/-7.6°F to 0°C/32°F 50 mm / 1.97 inch axial homogeneity: ±0.020°C/0.036°F @ 0°C/32°F to 50°C/122°F 50 mm / 1.97 inch axial homogeneity: ±0.030°C/0.054°F @ 50°C/122°F to 155°C/311°F 60 mm / 2.36 inch axial homogeneity: ±0.025°C/0.045°F@ -22°C/-7.6°F to 0°C/32°F 60 mm / 2.36 inch axial homogeneity: ±0.020°C/0.036°F @ 0°C/32°F to 50°C/122°F 60 mm /2.36 inch axial homogeneity: ±0.030°C/0.054°F @ 50°C/122°F to 155°C/311°F 70 mm / 2.76 inch axial homogeneity: ±0.025°C/0.045°F@ -22°C/-7.6°F to 0°C/32°F 70 mm / 2.76 inch axial homogeneity: ±0.025°C/0.045°F @ 0°C/32°F to 50°C/122°F 70 mm / 2.76 inch axial homogeneity: ±0.050°C/0.09°F @ 50°C/122°F to 155°C/311°F 80 mm / 3.15 inch axial homogeneity: ±0.050°C/0.09°F @ -22°C/-7.6°F to 0°C/32°F 80 mm / 3.15 inch axial homogeneity: ±0.040°C/0.072°F @ 0°C/32°F to 50°C/122°F 80 mm / 3.15 inch axial homogeneity: ±0.075°C/0.135°F @ 50°C/122°F to 155°C/311°F

THERMAL SPECIFICATIONS – DRY BLOCK	RTC-158 A/B/C
Well specifications	Loaded with 3 x 3mm sensors + 1 x 4mm sensor and 1 x 6 mm sensor DLC active: 40 mm / 1.57 inch axial homogeneity: ±0.035°C/0.063°F @ -22°C/-7.6°F to 0°C/32°F 40 mm / 1.57 inch axial homogeneity: ±0.025°C/0.045°F @ 0°C/32°F to 50°C/122°F 40 mm / 1.57 inch axial homogeneity: ±0.035°C/0.063°F @ 50°C/122°F to 155°C/311°F 50 mm / 1.97 inch axial homogeneity: ±0.035°C/0.063°F @ -22°C/-7.6°F to 0°C/32°F 50 mm / 1.97 inch axial homogeneity: ±0.025°C/0.045°F @ 0°C/32°F to 50°C/122°F 50 mm / 1.97 inch axial homogeneity: ±0.035°C/0.063°F @ 50°C/122°F to 155°C/311°F 60 mm / 2.36 inch axial homogeneity: ±0.035°C/0.063°F @ -22°C/-7.6°F to 0°C/32°F 60 mm / 2.36 inch axial homogeneity: ±0.030°C/0.054°F @ 0°C/32°F to 50°C/122°F 60 mm / 2.36 inch axial homogeneity: ±0.035°C/0.063°F @ 50°C/122°F to 155°C/311°F 70 mm / 2.76 inch axial homogeneity: ±0.045°C/0.081°F @ -22°C/-7.6°F to 0°C/32°F 70 mm / 2.76 inch axial homogeneity: ±0.040°C/0.072°F @ 0°C/32°F to 50°C/122°F 70 mm / 2.76 inch axial homogeneity: ±0.045°C/0.081°F @ 50°C/122°F to 155°C/311°F 80 mm / 3.15 inch axial homogeneity: ±0.060°C/0.11°F @ -22°C/-7.6°F to 0°C/32°F 80 mm / 3.15 inch axial homogeneity: ±0.050°C/0.09°F @ 0°C/32°F to 50°C/122°F 80 mm / 3.15 inch axial homogeneity: ±0.060°C/0.11°F @ 50°C/122°F to 155°C/311°F

THERMAL SPECIFICATIONS – DRY BLOCK	RTC-158 A/B/C	
	Difference between borings:	
	0.05°C / 0.09°F@155°C / 311°F 0.03°C / 0.054°F @-22°C / -8°F	
	Influence from load:	
	0.15°C / 0.27°F @155°C / 311°F 0.07°C / 0.13°F @-22°C / -8°F	
	Influence from load with Ext. Reference :	
	0.04°C / 0.07°F @155°C / 311°F 0.04°C / 0.07°F @-22°C / -8°F	
	Long term drift (1 year): ±0.05°C / ±0.09°F	
Calibration accuracy (test limit)	±0.05°C / ±0.09°F	
Temperature coefficient	±0.010°C/°C (0-20°C and 26-40°C) / ±0.010°F/°F (32-68°F and 79-104°F)	
Stability	±0.01°C / ±0.02°F	
Reference accuracy	±0.02°C / ±0.04°F	
Total accuracy	±0.18°C / ±0.32°F	
Heating time incl. insert	-22°C / -7.6°F to 23°C / 73.4°F :	9 min.
	23°C / 73.4°F to 100°C / 212°F:	23 min.
	100°C / 212°F to 155°C / 311°F:	28 min.
	-22°C / -7.6°F to 155°C / 311°F :	60 min.
Time to stability	30 min.	
Cooling time incl. insert	155°C / 311°F to 100°C / 212°F :	9 min
	100°C / 212°F to 23°C / 73.4°F:	24 min.
	23°C / 73.4°F to 0°C / 32°F:	15 min.
	0°C / 32°F to –15°C / 5°F:	21 min.
	-15°C / -5°F to –22°C / -7.6°F :	25 min.
	155°C / 311°F to –22°C / -7.6°F :	94 min.

THERMAL SPECIFICATIONS – LIQUID BATHS	RTC-158 A/B/C
Maximum temperature	155°C / 311°F
Minimum temperature	-37°C / -35°F @ ambient temperature 0°C / 32°F -22°C / -7.6°F @ ambient temperature 23°C / 73.4°F -9°C / -15.8°F @ ambient temperature 40°C / 104°F
Well specifications	40 mm / 1.57 inch axial homogeneity: ±0,01°C/0.02°F @ 155°C/311°F ±0,01°C/0.02°F @ -22°C/-7.6°F 50 mm / 1.97 inch axial homogeneity: ±0,01°C/0.02°F @ 155°C/311°F ±0,01°C/0.02°F @ -22°C/-7.6°F 60 mm / 2.36 inch axial homogeneity: ±0,01°C/0.02°F @ 155°C/311°F ±0,02°C/0.02°F @ -22°C/-7.6°F 70 mm / 2.76 inch axial homogeneity: ±0,03°C/0.02°F @ 155°C/311°F ±0,02°C/0.02°F @ -22°C/-7.6°F 80 mm / 3.15 inch axial homogeneity: ±0,05°C/0.02°F @ 155°C/311°F ±0,03°C/0.02°F @ -22°C/-7.6°F Radial homogeneity: 0.015°C/0.027°F Influence from load: 0.10°C/0.18°F @ 155°C/311°F 0.04°C/0.07°F @ -22°C/-7.6°F Influence from load with ext. reference: 0.02°C/0.04°F @ 155°C/311°F 0.02°C/0.04°F @ -22°C/-7.6°F Difference between insert/oil: 0.20°C/0.36°F Long term drift (1 year) : ±0.05°C/0.09°F
Calibration accuracy (test limit)	±0.05°C / ±0.20°F
Temperature coefficient	0.010°C/°C (0-40°C) / 0.010°F/°F(32-104°F)
Stability	±0.01°C / ±0.02°F
Reference accuracy	±0.02°C / ±0.04°F
Total accuracy (std. cal. with insert)	±0.30°C / ±0.54°F
Time to stability	15 min.

MECHANICAL SPECIFICATIONS	RTC-250 A/B/C
Dimensions l × w × h	366 × 171 × 363 mm / 14.4 x 6.7 x 14.3 inch
Weight	RTC-250 A : 9.8 kg / 21.6 lb RTC-250 B/C : 9.9 kg / 21.8 lb
Shipping dimensions	580 x 250 x 500mm / 22.8 x 9.8 x 19.7 inch (Cardboard box) 550 x 430 x 660mm / 21.7 x 16.9 x 26.0 inch (Carrying case in cardboard box)
Shipping weight	RTC-250 A : 15.8 kg / 34.8 lb (in cardboard box) RTC-250 B/C : 15.9 kg / 35.1 lb (in cardboard box) RTC-250 A : 26.8 kg / 59.1 lb (in carrying case in cardboard box) RTC-250 B/C : 26.9 kg / 59.3 lb (in carrying case in cardboard box)
Bore diameter/depth of well	Ø63.8 mm / 160 mm – ø2.5 inch / 6.3 inch
Weight non-drilled insert	1200 g / 42.3 oz
POWER SUPPLY	
Line voltage/frequency	90-127VAC / 180-254VAC 45-65 Hz, 8A/4A
Power consumption	1150 W
Type of connection	IEC320
COMMUNICATION INTERFACES	
Type of connections	USB A, USB B, SD card slot, RJ45
OTHER CONNECTIONS	
Syncronisation relay output	3,5 mm mini jack.
ENVIRONMENT	
Ambient operating temperature range	0-40°C / 32-104°F
Storage temperature range	-20-50°C / -4-122°F
Humidity range	0-90% RH.
Protection class	IP10
READOUT SPECIFICATIONS	
Resolution	0.001°C / 0.001°F / 0.001 K
Temperature units	°C / °F / K

THERMAL SPECIFICATIONS – DRY – BLOCK	RTC-250 A/B
Maximum temperature	250°C / 482°F
Minimum temperature	5°C / 41°F @ ambient temperature 0°C / 32°F
	28°C / 82°F @ ambient temperature 23°C / 73.4°F
	45°C / 113°F@ ambient temperature 40°C / 104°F

THERMAL SPECIFICATIONS – DRY – BLOCK	RTC-250 A/B
Well specifications	Loaded with 2 x 3mm sensors: 40 mm / 1.57 inch axial homogeneity: ±0.030°C/0.054°F@ 28°C/82.4°F to 150°C/302°F 40 mm / 1.57 inch axial homogeneity: ±0.050°C/0.09°F @ 150°C/302°F to 250°C/482°F 50 mm / 1.97 inch axial homogeneity: ±0.050°C/0.09°F @ 28°C/82.4°F to 150°C/302°F 50 mm / 1.97 inch axial homogeneity: ±0.100°C/0.18°F @ 150°C/302°F to 250°C/482°F 60 mm / 2.36 inch axial homogeneity: ±0.060°C/0.11°F@ 28°C/82.4°F to 150°C/302°F 60 mm / 2.36 inch axial homogeneity: ±0.120°C/0.22°F @ 150°C/302°F to 250°C/482°F 70 mm / 2.76 inch axial homogeneity: ±0.100°C/0.18°F@ 28°C/82.4°F to 150°C/302°F 70 mm / 2.76 inch axial homogeneity: ±0.200°C/0.36°F @ 150°C/302°F to 250°C/482°F 80 mm / 3.15 inch axial homogeneity: ±0.120°C/0.22°F @ 28°C/82.4°F to 150°C/302°F 80 mm / 3.15 inch axial homogeneity: ±0.250°C/0.45°F @ 150°C/302°F to 250°C/482°F Loaded with 3 x 3mm sensors + 1 x 4mm sensor and 1 x 6 mm sensor DLC active: 40 mm / 1.57 inch axial homogeneity: ±0.040°C/0.072°F@ 28°C/82.4°F to 150°C/302°F 40 mm / 1.57 inch axial homogeneity: ±0.060°C/0.11°F @ 150°C/302°F to 250°C/482°F 50 mm / 1.97 inch axial homogeneity: ±0.050°C/0.09°F @ 28°C/82.4°F to 150°C/302°F 50 mm / 1.97 inch axial homogeneity: ±0.070°C/0.13°F @ 150°C/302°F to 250°C/482°F 60 mm / 2.36 inch axial homogeneity: ±0.060°C/0.11°F @ 28°C/82.4°F to 150°C/302°F 60 mm / 2.36 inch axial homogeneity: ±0.100°C/0.18°F @ 150°C/302°F to 250°C/482°F

THERMAL SPECIFICATIONS – DRY – BLOCK	RTC-250 A/B
Well specifications	70 mm / 2.76 inch axial homogeneity: ±0.070°C/0.13°F @ 28°C/82.4°F to 150°C/302°F 70 mm / 2.76 inch axial homogeneity: ±0.120°C/0.22°F@150°C/302°F to 250°C/482°F 80 mm / 3.15 inch axial homogeneity: ±0.080°C/0.14°F @ 28°C/82.4°F to 150°C/302°F 80 mm / 3.15 inch axial homogeneity: ±0.150°C/0.27°F @ 150°C/302°F to 250°C/482°F Difference between borings : 0.05°C / 0.09°F Influence from load : 0.10°C / 0.18°F @250°C / 482°F Influence from load with Ext. Reference : 0.03°C / 0.05°F @250°C / 482°F Long term drift (1 year) : ±0.05°C / ±0.09°F
Calibration accuracy (test limit)	±0.08°C / ±0.14°F
Temperature coefficient	±0.020°C/°C (0-20°C and 26-40°C) (32-68°F and 79-104°F)
Stability	±0.02°C / ±0.04°F
Reference accuracy	±0.06°C (±0.11°F)
Total accuracy	±0.28°C (±0.50°F)
Heating time incl. insert	28°C / 82°F to 100°C / 212°F : 3 min. 50°C / 122°F to 100°C / 212°F : 2 min. 100°C / 212°F to 250°C / 482°F : 9 min.
Time to stability	15 min.
Cooling time incl. insert	250°C / 482°F to 100°C / 212°F : 24 min. 100°C / 212°F to 50°C / 122°F : 24 min. 100°C / 212°F to 28°C / 82°F : 65 min.

THERMAL SPECIFICATIONS – LIQUID BATHS	RTC-250 A/B
Maximum temperature	250°C / 482°F
Minimum temperature	45°C / 113°F@ambient temperature 40°C / 104°F
	28°C / 82°F@ambient temperature 23°C / 73.4°F
	5°C / 4°F@ ambient temperature 0°C / 32°F

THERMAL SPECIFICATIONS – LIQUID BATHS	RTC-250 A/B
Well specifications	40 mm / 1.57 inch axial homogeneity: ±0.010°C/0.018°F@ 28°C/82.4°F to 150°C/302°F 40 mm / 1.57 inch axial homogeneity: ±0.020°C/0.036°F@150°C/302°F to 250°C/482°F 50 mm / 1.97 inch axial homogeneity: ±0.010°C/0.018°F@ 28°C/82.4°F to 150°C/302°F 50 mm / 1.97 inch axial homogeneity: ±0.020°C/0.036°F@150°C/302°F to 250°C/482°F 60 mm / 2.36 inch axial homogeneity: ±0.010°C/0.018°F@ 28°C/82.4°F to 150°C/302°F 60 mm / 2.36 inch axial homogeneity: ±0.020°C/0.036°F@150°C/302°F to 250°C/482°F 70 mm / 2.76 inch axial homogeneity: ±0.025°C/0.045°F@ 28°C/82.4°F to 150°C/302°F 70 mm / 2.76 inch axial homogeneity: ±0.025°C/0.045°F@150°C/302°F to 250°C/482°F 80 mm / 3.15 inch axial homogeneity: ±0.025°C/0.045°F@ 28°C/82.4°F to 150°C/302°F 80 mm / 3.15 inch axial homogeneity: ±0.050°C/0.09°F @ 150°C/302°F to 250°C/482°F Radial homogeneity: 0.015°C / 0.027°F Influence from load : 0.10°C / 0.18°F @250°C / 482°F Influence from load with Ext. Reference : 0.02°C / 0.04°F @250°C / 482°F Difference between insert/oil : 0.30°C / 0.54°F Long term drift (1 year) : ±0.05°C / ±0.09°F

THERMAL SPECIFICATIONS – LIQUID BATHS	RTC-250 A/B
Calibration accuracy (test limit)	±0.06°C / ±0.20°F
Temperature coefficient	±0.020°C/°C (0-20°C and 26-40°C) (32-68°F and 79-104°F)
Stability	±0.02°C / ±0.04°F
Reference accuracy	±0.06°C / ±0.11°F
Total accuracy (std. cal. with insert)	±0.50°C / ±0.90°F
Heating time incl. insert	Not specified
Time to stability	15 min.
Cooling time incl. insert	Not specified

MECHANICAL SPECIFICATIONS	RTC-700 A/B/C
Dimensions l × w × h	362 × 171 × 421 mm (14.3 x 6.7 x 16.6 inch)
Weight	11.3 kg / 24.9 lb
Shipping dimensions	580 x 250 x 500mm / 22.8 x 9.8 x 19.7 inch (Cardboard box)
	550 x 430 x 660mm / 21.7 x 16.9 x 26.0 inch (Carrying case in cardboard box)
Shipping weight	16.3 kg / 36.0 lb (in cardboard box)
	27.3 kg / 60.2 lb (in carrying case in cardboard box)
Bore diameter/depth of well	ø30 mm / 210 mm – ø1.18 inch / 8.3 inch
Weight non-drilled insert	1060 g / 37.3 oz
POWER SUPPLY	
Line voltage/frequency	90-127VAC / 180-254VAC 45-65 Hz
Power consumption	1150 W
Type of connection	IEC320
COMMUNICATION INTERFACES	
Type of connection	USB A, USB B, SD card slot, RJ45
OTHER CONNECTIONS	
Syncronisation relay output	3,5 mm mini jack.

MECHANICAL SPECIFICATIONS	RTC-700 A/B/C
ENVIRONMENT	
Ambient operating temperature range	0-40°C / 32-104°F
Storage temperature range	-20-50°C / -4-122°F
Humidity range	0-90% RH.
Protection class	IP10
READOUT SPECIFICATIONS	
Resolution	0.001°C / 0.001°F / 0.001 K
Temperature units	°C / °F / K

THERMAL SPECIFICATIONS	RTC-700 A/B/C
Maximum temperature	700°C / 1292°F
Minimum temperature*	10°C / 50°F @ ambient temperature 0°C / 32°F
	33°C / 91°F @ ambient temperature 23°C / 73.4°F
	50°C / 122°F@ ambient temperature 40°C / 104°F

* The minimum temperature will be affected by the number of sensors and the dimensions of the sensors being calibrated.

THERMAL SPECIFICATIONS	RTC-700 A/B/C
Well specifications	Loaded with 4 x 4mm sensors: 40 mm / 1.57 inch axial homogeneity: ±0.100°C/0.18°F @ 33°C/91°F to 100°C/212°F 40 mm / 1.57 inch axial homogeneity: ±0.200°C/0.36°F @ 100°C/212°F to 420°C/788°F 40 mm / 1.57 inch axial homogeneity: ±0.300°C/0.54°F@420°C/788°F to 700°C/1292°F 50 mm / 1.97 inch axial homogeneity: ±0.100°C/0.18°F @ 33°C/91°F to 100°C/212°F 50 mm / 1.97 inch axial homogeneity: ±0.200°C/0.36°F @ 100°C/212°F to 420°C/788°F 50 mm / 1.97 inch axial homogeneity: ±0.300°C/0.54°F@420°C/788°F to 700°C/1292°F 60 mm / 2.36 inch axial homogeneity: ±0.100°C/0.18°F @ 33°C/91°F to 100°C/212°F 60 mm / 2.36 inch axial homogeneity: ±0.250°C/0.45°F @ 100°C/212°F to 420°C/788°F 60 mm / 2.36 inch axial homogeneity: ±0.400°C/0.72°F@420°C/788°F to 700°C/1292°F 70 mm / 2.76 inch axial homogeneity: ±0.100°C/0.18°F @ 33°C/91°F to 100°C/212°F 70 mm / 2.76 inch axial homogeneity: ±0.250°C/0.45°F @ 100°C/212°F to 420°C/788°F 70 mm / 2.76 inch axial homogeneity: ±0.500°C/0.9°F @ 420°C/788°F to 700°C/1292°F 80 mm / 3.15 inch axial homogeneity: ±0.150°C/0.27°F @ 33°C/91°F to 100°C/212°F 80 mm / 3.15 inch axial homogeneity: ±0.300°C/0.54°F @ 100°C/212°F to 420°C/788°F 80 mm / 3.15 inch axial homogeneity: ±0.600°C/1.08°F@420°C/788°F to 700°C/1292°F Loaded with 4 x 4mm sensor and 1 x 6 mm sensor DLC active: 40 mm / 1.57 inch axial homogeneity: ±0.120°C/0.22°F @ 33°C/91°F to 100°C/212°F

THERMAL SPECIFICATIONS	RTC-700 A/B/C
Well specifications	40 mm / 1.57 inch axial homogeneity: ±0.200°C/0.36°F @ 100°C/212°F to 420°C/788°F
	40 mm / 1.57 inch axial homogeneity: ±0.300°C/0.54°F@420°C/788°F to 700°C/1292°F
	50 mm / 1.97 inch axial homogeneity: ±0.120°C/0.22°F @ 33°C/91°F to 100°C/212°F
	50 mm / 1.97 inch axial homogeneity: ±0.200°C/0.36°F @ 100°C/212°F to 420°C/788°F
	50 mm / 1.97 inch axial homogeneity: ±0.350°C/0.63°F@420°C/788°F to 700°C/1292°F
	60 mm / 2.36 inch axial homogeneity: ±0.150°C/0.27°F @ 33°C/91°F to 100°C/212°F
	60 mm / 2.36 inch axial homogeneity: ±0.250°C/0.45°F @ 100°C/212°F to 420°C/788°F
	60 mm / 2.36 inch axial homogeneity: ±0.400°C/0.72°F@420°C/788°F to 700°C/1292°F
	70 mm / 2.76 inch axial homogeneity: ±0.150°C/0.27°F @ 33°C/91°F to 100°C/212°F
	70 mm / 2.76 inch axial homogeneity: ±0.250°C/0.45°F @ 100°C/212°F to 420°C/788°F
	70 mm / 2.76 inch axial homogeneity: ±0.400°C/0.72°F@420°C/788°F to 700°C/1292°F
	80 mm / 3.15 inch axial homogeneity: ±0.200°C/0.36°F @ 33°C/91°F to 100°C/212°F
	80 mm / 3.15 inch axial homogeneity: ±0.250°C/0.45°F @ 100°C/212°F to 420°C/788°F
	80 mm / 3.15 inch axial homogeneity: ±0.400°C/0.72°F@420°C/788°F to 700°C/1292°F

THERMAL SPECIFICATIONS	RTC-700 A/B/C
	Difference between borings :
	±0.01°C/0.02°F @ 33°C/91.4°F to 100°C/212°F
	±0.025°C/0.045°F @ 100°C/212°F to 420°C/788°F
	±0.040°C/0.072°F @ 420°C/788°F to 600°C/1112°F
	±0.050°C/0.09°F @ 600°C/1112°F to 660°C/1220°F
	±0.060°C/0.108°F @ 660°C/1220°F to 700°C/1292°F
	Influence from load :
	0.01°C/0.02°F @ 33°C/91.4°F to 100°C/212°F
	0.05°C/0.09°F @ 100°C/212°F to 420°C/788°F
	0.15°C/0.27°F @ 420°C/788°F to 700°C/1292°F
	Influence from load with ext. reference :
	0.01°C/0.02°F @ 33°C/91.4°F to 100°C/212°F
	0.02°C/0.04°F @ 100°C/212°F to 420°C/788°F
	0.03°C/0.05°F @ 420°C/788°F to 700°C/1292°F
	Difference between inserts :
	0.05°C/0.09°F @ 420°C/788°F
	0.10°C/0.18°F @ 700°C/1292°F
	Long term drift (1 year): ±0.11°C/±0.20°F
Calibration accuracy (test limit)	±0.10°C (±0.18°F)
Temperature coefficient	±0.005°C/°C (0-20°C and 26-40°C) / ±0.009°F/°F (32-68°F and 79-104°F)
Stability	±0.008°C/0.014°F@33°C/91.4°F to 125°C/257°F
	±0.015°C/0.027°F@125°C/257°F to 425°C/797°F
	±0.020°C/0.36°F@425°C/797°F to 700°C/1292°F
Accuracy	±0.30°C/0.54°F @ 33°C/91.4°F to 660°C/1220°F
	±1.69°C/3.04°F@660°C/1220°F to 700°C/1292°F
Heating time incl. insert	33°C/91.4°F to 700°C/1292°F : 45 min.

THERMAL SPECIFICATIONS	RTC-700 A/B/C	
Time to stability	10 min.	
Cooling time incl. insert	700°C / 1292°F to 100°C / 212°F :	43 min.
	100°C / 212°F to 50°C / 122°F :	17 min.
	50°C / 122°F to 33°C / 91.4°F :	20 min.

STANDARDS

The following standards are observed according to the EMC-Directive 2004/108/EC	EN 61326-1: 2006: Electrical equipment for measurement, control and laboratory use – EMC requirements in standard environment and industrial location. The EM field immunity according to IEC 61000-4-3 is reduced from 10V/m to 3V/m at some frequencies
The following standards are observed according to the low voltage-directive (2006/95/EC)	EN61010-1:2001 : Safety requirements for electrical equipment for measurement, control and laboratory use, part 1: general requirement

TECHNICAL SPECIFICATIONS – B VERSIONS ONLY

INPUT SPECIFICATIONS

mA input

Signal range	0 – 24 mA
Internal power supply	24 V, max. 28 mA
Resolution	0.0001mA / 0.001°C / 0.001°F
Accuracy	±(0.005% of rdg. + 0.010% of F.S.)
Temperature coefficient	±7 ppm F.S./°C (0-20°C and 26-40°C) / (32-68°F and 79-104°F)
Input impedance	< 10 Ω
Type of connection	4 mm safety sockets

INPUT SPECIFICATIONS

Voltage input	
Signal range	0 – 12 V
Resolution	0.0001V / 0.001°C / 0.001°F
Accuracy	±(0.005% of rdg. + 0.010% of F.S.)
Temperature coefficient	±5 ppm F.S./°C (0-20°C and 26-40°C) / (32-68°F and 79-104°F)
Input impedance	> 1 MΩ
Type of connection	4 mm safety sockets
Thermocouple input	
Signal range	-78mV – 78 mV (E, J, K, N, R, S, T, U, B)
Resolution	0.0001mV / 0.001°C / 0.001°F (E, J, K, N, R, S, T, U, B)
Accuracy	±(0.005% of rdg. + 0.005% of F.S.), see page 141 – 143 for accuracy in °C/°F
Temperature coefficient	±5 ppm F.S./°C (0-20°C and 26-40°C) / (32-68°F and 79-104°F)
Input impedance	> 1 MΩ
Type of connection	Mini TC-connector
RTD-input (2-, 3- or 4-wire)	
Signal range	0-400 Ω (P10(90)386/P50(90)385/P100(90)385/P50(90)391/P100(90)391/P100(90)392/ M50(90)428/M100(90)428/H100(90)617/H120(90)672/Pt-100 MILL) 0-4000 Ω (P200(90)385/P500(90)385/P1000(90)385/YSI-400)
Internal power supply	Excitation current 0.3 mA
Resolution	0.0001Ω / 0.001°C / 0.001°F (P10(90)386/P50(90)385/P100(90)385/P50(90)391/P100(90)391/P100(90)392/ M50(90)428/M100(90)428/H100(90)617/H120(90)672/Pt-100 MILL) 0.001Ω / 0.001°C / 0.001°F (P200(90)385/P500(90)385/P1000(90)385/YSI-400)

INPUT SPECIFICATIONS

Accuracy	±(0.002% of rdg. + 0.002% of F.S.), (0-400Ω range), see page 146 - 150 for accuracy in °C/°F ±(0.005% of rdg. + 0.005% of F.S.), (0-4000Ω range), see page 144 - 145 + 150 for accuracy in °C/°F
Temperature coefficient	±2 ppm F.S./°C (0-20°C and 26-40°C) / (32-68°F and 79-104°F)
Type of connection	4 mm safety sockets
Switch test input	
Signal range	on : 0-10kΩ / off : >100kΩ
Internal power supply	5 V (open)
Type of connection	4 mm safety sockets
Reference input (4 wire true ohm Pt100)	**B and C versions only**
Signal range	0Ω – 400Ω
Internal power supply	Measuring current 0.8 mA
Resolution	0.0001Ω / 0.001°C / 0.001°F
Accuracy	±(0.0012% of rdg. + 0.0005% of F.S.), see page 150 for accuracy in °C/°F
Temperature coefficient	±2 ppm F.S./°C (0-20°C and 26-40°C) / (32-68°F and 79-104°F)
Type of connection	LEMO Redell 6-pole-connector
DLC (TC input)	**B and C versions only**
Signal range	-78mV – 78mV
Resolution	0.01°C / 0.01°F
Accuracy	0.39μV / 0.014°C @ 0mV
Temperature coefficient	±5 ppm F.S./°C (0-20°C and 26-40°C) / (32-68°F and 79-104°F)
Type of connection	LEMO Redell 4-pole-connector

INPUT SPECIFICATIONS	ACCURACY IN °C/°F
Accuracy thermocouple type E input	±0.74°C(±1.34°F) @ -270°C(-454°F)
-270°C to 1000°C	±0.18°C(±0.32°F) @ -200°C(-328°F)
(excluding sensor accuracy)	±0.09°C(±0.17°F) @ -50°C(-58°F)
	±0.06°C(±0.11°F) @ 0°C(32°F)
	±0.06°C(±0.11°F) @ 155°C(311°F)
	±0.07°C(±0.12°F) @ 320°C(608°F)
	±0.08°C(±0.14°F) @ 650°C(1202°F)
	±0.10°C(±0.29°F) @ 1000°C(1832°F)
Accuracy thermocouple type J input	±0.23°C(±0.41°F) @ -210°C(-346°F)
-210°C to 1200°C	±0.10°C(±0.18°F) @ -100°C(-148°F)
(excluding sensor accuracy)	±0.08°C(±0.14°F) @ 0°C(32°F)
	±0.09°C(±0.16°F) @ 155°C(311°F)
	±0.09°C(±0.16°F) @ 320°C(608°F)
	±0.09°C(±0.17°F) @ 650°C(1202°F)
	±0.13°C(±0.23°F) @ 1200°C(2192°F)
Accuracy thermocouple type K input	±0.94°C(±1.69°F) @ -270°C(-454°F)
-270°C to 1372°C	±0.27°C(±0.49°F) @ -200°C(-328°F)
(excluding sensor accuracy)	±0.14°C(±0.24°F) @ -100°C(-148°F)
	±0.10°C(±0.19°F) @ 0°C(32°F)
	±0.11°C(±0.20°F) @ 155°C(311°F)
	±0.11°C(±0.20°F) @ 320°C(608°F)
	±0.13°C(±0.23°F) @ 650°C(1202°F)
	±0.20°C(±0.36°F) @ 1372°C(2502°F)

INPUT SPECIFICATIONS	ACCURACY IN °C/°F
Accuracy thermocouple type T input	±0.65°C(±1.17°F) @ -270°C(-454°F)
-270°C to 400°C	±0.27°C(±0.49°F) @ -200°C(-328°F)
(excluding sensor accuracy)	±0.15°C(±0.26°F) @ -100°C(-148°F)
	±0.10°C(±0.18°F) @ 0°C(32°F)
	±0.08°C(±0.15°F) @ 155°C(311°F)
	±0.08°C(±0.15°F) @ 320°C(608°F)
	±0.08°C(±0.14°F) @ 400°C(752°F)
Accuracy thermocouple type R input	±1.30°C(±2.35°F) @ -50°C(-58°F)
-50°C to 1768°C	±0.78°C(±1.40°F) @ 0°C(32°F)
(excluding sensor accuracy)	±0.47°C(±0.84°F) @ 155°C(311°F)
	±0.40°C(±0.73°F) @ 320°C(608°F)
	±0.39°C(±0.70°F) @ 650°C(1202°F)
	±0.41°C(±0.74°F) @ 1768°C(3214°F)
Accuracy thermocouple type S input	±0.98°C(±1.76°F) @ -50°C(-58°F)
-50°C to 1768°C	±0.78°C(±1.40°F) @ 0°C(32°F)
(excluding sensor accuracy)	±0.49°C(±0.89°F) @ 155°C(311°F)
	±0.45°C(±0.81°F) @ 320°C(608°F)
	±0.41°C(±0.73°F) @ 650°C(1202°F)
	±0.46°C(±0.83°F) @ 1768°C(3214°F)
Accuracy thermocouple type B	±1.57°C(±2.83°F) @ 250°C(482°F)
250°C to 1820°C	±1.19°C(±2.14°F) @ 320°C(608°F)
(excluding sensor accuracy)	±0.67°C(±1.21°F) @ 650°C(1202°F)
	±0.48°C(±0.86°F) @ 1820°C(3308°F)

INPUT SPECIFICATIONS	ACCURACY IN °C/°F
Accuracy thermocouple type N	±1.37°C(±2.47°F) @ -270°C(-454°F)
-270°C to 1300°C	±0.41°C(±0.74°F) @ -200°C(-328°F)
(excluding sensor accuracy)	±0.20°C(±0.35°F) @ -100°C(-148°F)
	±0.15°C(±0.27°F) @ 0°C(32°F)
	±0.13°C(±0.23°F) @ 155°C(311°F)
	±0.13°C(±0.23°F) @ 320°C(608°F)
	±0.13°C(±0.23°F) @ 650°C(1202°F)
	±0.14°C(±0.25°F) @ 800°C(1472°F)
	±0.15°C(±0.27°F) @ 1000°C(1832°F)
	±0.16°C(±0.29°F) @ 1200°C(2192°F)
	±0.17°C(±0.31°F) @ 1300°C(2372°F)
Accuracy thermocouple type L	±0.14°C(±0.25°F) @ -200°C(-328°F)
* -200°C to 900°C	±0.09°C(±0.17°F) @ -100°C(-148°F)
(excluding sensor accuracy)	±0.08°C(±0.14°F) @ 0°C(32°F)
	±0.08°C(±0.14°F) @ 155°C(311°F)
	±0.09°C(±0.15°F) @ 320°C(608°F)
	±0.09°C(±0.15°F) @ 650°C(1202°F)
	±0.09°C(±0.15°F) @ 900°C(1652°F)
Accuracy thermocouple type U	±0.13°C(±0.24°F) @ -80°C(-112°F)
-80°C to 600°C	±0.10°C(±0.18°F) @ 0°C(32°F)
(excluding sensor accuracy)	±0.08°C(±0.14°F) @ 155°C(311°F)
	±0.08°C(±0.14°F) @ 320°C(608°F)
	±0.08°C(±0.14°F) @ 600°C(1112°F)
Accuracy automatic cold junction compensation	±0.30°C (±0.54°F) @ ambient temperature 0°C to 40°C (32°F to 104°F).

INPUT SPECIFICATIONS	ACCURACY IN °C/°F
Accuracy RTD Pt1000 385	±0.049°C(±0.088°F) @ -200°C(-328°F)
Pt1000(90)385: -200°C to 850°C	±0.058°C(±0.104°F) @ -90°C(-130°F)
* Pt1000(68)385: -200°C to 850°C	±0.061°C(±0.109°F) @ -50°C(-58°F)
(excluding sensor accuracy)	±0.064°C(±0.116°F) @ 0°C(32°F)
	±0.075°C(±0.135°F) @ 155°C(311°F)
	±0.088°C(±0.158°F) @ 320°C(608°F)
	±0.096°C(±0.172°F) @ 420°C(788°F)
	±0.117°C(±0.210°F) @ 660°C(1220°F)
	±0.121°C(±0.217°F) @ 700°C(1292°F)
	±0.136°C(±0.244°F) @ 850°C(1562°F)
Accuracy RTD	±0.095°C(±0.171°F) @ -200°C(-328°F)
Pt500(90)385: -200°C to 850°C	±0.108°C(±0.193°F) @ -90°C(-130°F)
(excluding sensor accuracy)	±0.111°C(±0.200°F) @ -50°C(-58°F)
	±0.116°C(±0.208°F) @ 0°C(32°F)
	±0.129°C(±0.232°F) @ 155°C(311°F)
	±0.145°C(±0.260°F) @ 320°C(608°F)
	±0.154°C(±0.278°F) @ 420°C(788°F)
	±0.181°C(±0.325°F) @ 660°C(1220°F)
	±0.185°C(±0.333°F) @ 700°C(1292°F)
	±0.204°C(±0.367°F) @ 850°C(1562°F)

INPUT SPECIFICATIONS	ACCURACY IN °C/°F
Accuracy RTD	±0.118°C(±0.213°F) @ -200°C(-328°F)
* Pt400(90)385: -200°C to 850°C	±0.132°C(±0.238°F) @ -90°C(-130°F)
(excluding sensor accuracy)	±0.137°C(±0.245°F) @ -50°C(-58°F)
	±0.141°C(±0.254°F) @ 0°C(32°F)
	±0.156°C(±0.280°F) @ 155°C(311°F)
	±0.173°C(±0.311°F) @ 320°C(608°F)
	±0.184°C(±0.330°F) @ 420°C(788°F)
	±0.212°C(±0.382°F) @ 660°C(1220°F)
	±0.218°C(±0.391°F) @ 700°C(1292°F)
	±0.238°C(±0.428°F) @ 850°C(1562°F)
Accuracy RTD	±0.234°C(±0.421°F) @ -200°C(-328°F)
Pt200(90)385: -200°C to 850°C	±0.256°C(±0.461°F) @ -90°C(-130°F)
(excluding sensor accuracy)	±0.262°C(±0.472°F) @ -50°C(-58°F)
	±0.269°C(±0.484°F) @ 0°C(32°F)
	±0.290°C(±0.522°F) @ 155°C(311°F)
	±0.314°C(±0.565°F) @ 320°C(608°F)
	±0.330°C(±0.593°F) @ 420°C(788°F)
	±0.371°C(±0.668°F) @ 660°C(1220°F)
	±0.379°C(±0.682°F) @ 700°C(1292°F)
	±0.409°C(±0.736°F) @ 850°C(1562°F)

INPUT SPECIFICATIONS	ACCURACY IN °C/°F
Accuracy RTD	±0.020°C(±0.035°F) @ -200°C(-328°F)
Pt100(90)385: -200°C to 850°C	±0.024°C(±0.042°F) @ -90°C(-130°F)
* Pt100(68)385: -200°C to 850°C	±0.025°C(±0.044°F) @ -50°C(-58°F)
(excluding sensor accuracy)	±0.026°C(±0.047°F) @ 0°C(32°F)
	±0.030°C(±0.054°F) @ 155°C(311°F)
	±0.035°C(±0.063°F) @ 320°C(608°F)
	±0.039°C(±0.069°F) @ 420°C(788°F)
	±0.047°C(±0.084°F) @ 660°C(1220°F)
	±0.049°C(±0.087°F) @ 700°C(1292°F)
	±0.055°C(±0.098°F) @ 850°C(1562°F)
Accuracy RTD	±0.038°C(±0.069°F) @ -200°C(-328°F)
Pt50(90)385: -200°C to 850°C	±0.043°C(±0.078°F) @ -90°C(-130°F)
* Pt50(68)385: -200°C to 850°C	±0.045°C(±0.080°F) @ -50°C(-58°F)
(excluding sensor accuracy)	±0.047°C(±0.083°F) @ 0°C(32°F)
	±0.052°C(±0.093°F) @ 155°C(311°F)
	±0.058°C(±0.104°F) @ 320°C(608°F)
	±0.062°C(±0.111°F) @ 420°C(788°F)
	±0.073°C(±0.130°F) @ 660°C(1220°F)
	±0.074°C(±0.134°F) @ 700°C(1292°F)
	±0.082°C(±0.147°F) @ 850°C(1562°F)

INPUT SPECIFICATIONS	ACCURACY IN °C/°F
Accuracy RTD	±0.186°C(±0.335°F) @ -200°C(-328°F)
Pt10(90)385: -200°C to 850°C	±0.202°C(±0.363°F) @ -90°C(-130°F)
(excluding sensor accuracy)	±0.206°C(±0.370°F) @ -50°C(-58°F)
	±0.210°C(±0.378°F) @ 0°C(32°F)
	±0.224°C(±0.402°F) @ 155°C(311°F)
	±0.239°C(±0.430°F) @ 320°C(608°F)
	±0.249°C(±0.448°F) @ 420°C(788°F)
	±0.276°C(±0.496°F) @ 660°C(1220°F)
	±0.281°C(±0.505°F) @ 700°C(1292°F)
	±0.301°C(±0.541°F) @ 850°C(1562°F)
Accuracy RTD	±0.019°C(±0.034°F) @ -200°C(-328°F)
Pt100(90)391: -200°C to 1100°C	±0.023°C(±0.041°F) @ -90°C(-130°F)
* Pt100(68)391: -200°C to 1100°C	±0.024°C(±0.043°F) @ -50°C(-58°F)
(excluding sensor accuracy)	±0.025°C(±0.045°F) @ 0°C(32°F)
	±0.030°C(±0.054°F) @ 155°C(311°F)
	±0.035°C(±0.062°F) @ 320°C(608°F)
	±0.038°C(±0.067°F) @ 420°C(788°F)
	±0.046°C(±0.083°F) @ 660°C(1220°F)
	±0.048°C(±0.086°F) @ 700°C(1292°F)
	±0.054°C(±0.096°F) @ 850°C(1562°F)
	±0.065°C(±0.116°F) @ 1100°C(2012°F)

INPUT SPECIFICATIONS	ACCURACY IN °C/°F
Accuracy RTD	±0.038°C(±0.067°F) @ -200°C(-328°F)
Pt50(90)391: -200°C to 1100°C	±0.042°C(±0.076°F) @ -90°C(-130°F)
* Pt50(68)391: -200°C to 1100°C	±0.044°C(±0.079°F) @ -50°C(-58°F)
(excluding sensor accuracy)	±0.046°C(±0.082°F) @ 0°C(32°F)
	±0.051°C(±0.092°F) @ 155°C(311°F)
	±0.057°C(±0.102°F) @ 320°C(608°F)
	±0.061°C(±0.109°F) @ 420°C(788°F)
	±0.071°C(±0.128°F) @ 660°C(1220°F)
	±0.073°C(±0.132°F) @ 700°C(1292°F)
	±0.081°C(±0.145°F) @ 850°C(1562°F)
	±0.095°C(±0.170°F) @ 1100°C(2012°F)
Accuracy RTD	±0.020°C(±0.036°F) @ -200°C(-328°F)
Pt100(90)392: -200°C to 630°C	±0.023°C(±0.042°F) @ -90°C(-130°F)
(excluding sensor accuracy)	±0.024°C(±0.042°F) @ -50°C(-58°F)
	±0.024°C(±0.046°F) @ 0°C(32°F)
	±0.030°C(±0.054°F) @ 155°C(311°F)
	±0.035°C(±0.062°F) @ 320°C(608°F)
	±0.038°C(±0.068°F) @ 420°C(788°F)
	±0.045°C(±0.081°F) @ 630°C(1166°F)
Accuracy RTD	±0.020°C(±0.035°F) @ -200°C(-328°F)
M100(90)428: -200°C to 200°C	±0.021°C(±0.038°F) @ -90°C(-130°F)
* M100(68)428: -200°C to 200°C	±0.022°C(±0.040°F) @ -50°C(-58°F)
(excluding sensor accuracy)	±0.024°C(±0.043°F) @ 0°C(32°F)
	±0.027°C(±0.048°F) @ 155°C(311°F)
	±0.028°C(±0.050°F) @ 200°C(392°F)

INPUT SPECIFICATIONS	ACCURACY IN °C/°F
Accuracy RTD	±0.038°C(±0.069°F) @ -200°C(-328°F)
M50(90)428 : -200°C to 200°C	±0.040°C(±0.071°F) @ -90°C(-130°F)
* M50(68)428 : -200°C to 200°C	±0.041°C(±0.073°F) @ -50°C(-58°F)
(excluding sensor accuracy)	±0.043°C(±0.076°F) @ 0°C(32°F)
	±0.046°C(±0.082°F) @ 155°C(311°F)
	±0.047°C(±0.083°F) @ 200°C(392°F)
Accuracy RTD	±0.023°C(±0.041°F) @ -50°C(-58°F)
* M100(90)426: -50°C to 200°C	±0.024°C(±0.043°F) @ 0°C(32°F)
(excluding sensor accuracy)	±0.027°C(±0.048°F) @ 155°C(311°F)
	±0.028°C(±0.050°F) @ 200°C(392°F)
Accuracy RTD	±0.040°C(±0.071°F) @ -50°C(-58°F)
* M53(68)426: -50°C to 200°C	±0.041°C(±0.073°F) @ 0°C(32°F)
(excluding sensor accuracy)	±0.044°C(±0.078°F) @ 155°C(311°F)
	±0.045°C(±0.080°F) @ 200°C(392°F)
Accuracy RTD	±0.042°C(±0.075°F) @ -50°C(-58°F)
* M50(90)426: -50°C to 200°C	±0.043°C(±0.077°F) @ 0°C(32°F)
(excluding sensor accuracy)	±0.046°C(±0.082°F) @ 155°C(311°F)
	±0.047°C(±0.084°F) @ 200°C(392°F)
Accuracy RTD	±0.021°C(±0.037°F) @ -60°C(-76°F)
* H100(90)617: -60°C to 180°C	±0.019°C(±0.033°F) @ 0°C(32°F)
(excluding sensor accuracy)	±0.017°C(±0.030°F) @ 100°C(212°F)
	±0.015°C(±0.027°F) @ 180°C(392°F)
Accuracy RTD	±0.016°C(±0.029°F) @ -80°C(--112°F)
H120(90)672: -80°C to 260°C	±0.015°C(±0.027°F) @ 0°C(32°F)
(excluding sensor accuracy)	±0.014°C(±0.025°F) @ 100°C(212°F)
	±0.012°C(±0.021°F) @ 260°C(500°F)

INPUT SPECIFICATIONS	ACCURACY IN °C/°F
Accuracy RTD	±0.020°C(±0.036°F) @ -200°C(-328°F)
Pt100 MILL: -200°C to 850°C	±0.023°C(±0.041°F) @ -90°C(-130°F)
(excluding sensor accuracy)	±0.024°C(±0.043°F) @ -50°C(-58°F)
	±0.026°C(±0.046°F) @ 0°C(32°F)
	±0.030°C(±0.054°F) @ 155°C(311°F)
	±0.035°C(±0.063°F) @ 320°C(608°F)
	±0.038°C(±0.068°F) @ 420°C(788°F)
	±0.046°C(±0.083°F) @ 660°C(1220°F)
	±0.048°C(±0.086°F) @ 700°C(1292°F)
	±0.054°C(±0.097°F) @ 850°C(1562°F)
Accuracy RTD YSI-400 15°C to 50°C (excluding sensor accuracy)	±0.002°C(±0.004°F) @ 15°C(59°F) ±0.008°C(±0.013°F) @ 50°C(122°F)
Accuracy Pt100 reference input	±0.006°C(±0.010°F) @ -200°C(-328°F)
(excluding sensor accuracy)	±0.007°C(±0.013°F) @ -90°C(-130°F)
	±0.008°C(±0.015°F) @ -50°C(-58°F)
	±0.008°C(±0.015°F) @ 0°C(32°F)
	±0.011°C(±0.019°F) @ 155°C(311°F)
	±0.014°C(±0.024°F) @ 320°C(608°F)
	±0.015°C(±0.027°F) @ 420°C(788°F)
	±0.020°C(±0.035°F) @ 660°C(1220°F)
	±0.020°C(±0.036°F) @ 700°C(1292°F)
	±0.023°C(±0.042°F) @ 850°C(1562°F)

* Available upon request on selected markets.

9.0 List of accessories

All parts listed in the list of accessories can be obtained from the factory through our dealers.

Please contact your dealer for assistance if you require parts, which do not appear on the list.

List of accessories

Accessories	Parts no.
Fuse 115V, 10AF (RTC-250/700)	60B302
Fuse 230V, 5AF (RTC-250/700)	127573
Fuse 250V, 8AT (RTC-156/157/158)	127211
Fuse 250V, 4AT (RTC-156/157/158)	127210
Tool for insertion tube	60F170
Insulation collar (RTC-156 only)	123652
Set of EPDM plugs (RTC-156/157/158/250 only)	126280
Heat shield (RTC-700 only)	127375
Carrying case (RTC-156/157)	127292
Carrying case (RTC-158/250)	127782
Carrying case (RTC-700)	127552
Mains cable, 115V, US, type B	60F135
Mains cable, 240V, UK, type C	60F136
Mains cable, 220V, South Africa, type D	60F137
Mains cable, 220V, Italy, type E	60F138
Mains cable, 240V, Australia, type F	60F139
Mains cable, 230V, Europe, type A	60F140
Mains cable, 230V, Denmark, type G	60F141
Mains cable, 220V, Switzerland, type H	60F142
Mains cable, 230V, Israel, type I	60F143
Thermocouple male plug type K	120517
Thermocouple male plug type N	120514
Thermocouple male plug type T	120515
Thermocouple male plug type Cu-Cu	120519

List of accessories

Accessories	Parts no.
Thermocouple male plug type J	120516
Thermocouple male plug type R/S	120518
USB cable	127278
Electronical ref. manual +JOFRACAL PC software	127429
Mini Jack connector	122771
Cleaning brush ø4mm	122832
Cleaning brush ø6mm	60F174
Cleaning brush ø8mm	122822
Application kit for calibration of sanitary sensors	127279
Liquid bath kit (RTC-158)	125022
Liquid bath kit (RTC-250)	125035
Dry-block kit – metric (RTC-158)	125023
Dry-block kit – inch (RTC-158)	125024
Dry-block kit – metric (RTC-250)	127871
Dry-block kit – inch (RTC-250)	127872
Silicone oil for RTC-158 (0.75 l.)	125033
Silicone oil for RTC-250 (0.75 l.)	124885
Support rod set for sensors	127277
Extra fixture for sensor grip	125066
Extra sensor grip	125067
Set of test cables	104203
Cable for STS-200, LEMO/LEMO 6-pol, 650 mm.	127131
Reference probe STS-200 90°, with accredited certificate, diameter 4mm, (-45°C to 155°C)	STS200A915EH
Reference probe STS-200 90°, with accredited certificate, diameter ¼”, (-45°C to 155°C)	STS200B915EH

PARTS NO. FOR STANDARD INSERTION TUBES WITH 4 MM + 1/4” REF. HOLES AND DLC HOLE - UNDRILLED				
Sensor size	**RTC-156/157 A/B/C (Aluminium tubes)**	**RTC-700 A/B/C (Alu. Bronze tubes)**	**RTC-158 A/B/C (Aluminium tubes)**	**RTC-250 A/B/C (Aluminium tubes)**
Undrilled	127299	127197	124899	127758
Undrilled with DLC hole	127300	127198	127829	127834
Undrilled with DLC and ref. holes	127301	127199	127831	127835

PART NO. FOR STANDARD INSERTION TUBES – MULTI-HOLE - METRIC		
Insert type	**RTC-156/157 A/B/C (Aluminium tubes)**	**RTC-700 A/B/C (Alu. Bronze tubes)**
Type M01	127329	127200
Type M02	127330	127201
Type M03	127331	127202
Type M04	127332	127203
Type M07	127241	127244
Type M08	127242	127245
Type M09	127243	127246
Set of 4 pcs. Inserts, 3mm to 13mm.	127326	127252

PART NO. FOR STANDARD INSERTION TUBES – MULTI-HOLE - IMPERIAL		
Insert type	**RTC-156/157 A/B/C (Aluminium tubes)**	**RTC-700 A/B/C (Alu. Bronze tubes)**
Type M05	127327	127204
Type M06	127328	127205
Type M10	127247	127249
Set of 3 pcs. Inserts, 1/8” to 1/2”	127311	127254

PART NO. FOR STANDARD INSERTION TUBES – MULTI-HOLE - METRIC		
Insert type	**RTC-158 A/B/C (Aluminium tubes)**	**RTC-250 A/B/C (Aluminium tubes)**
Type M01	124897	127759

PART NO. FOR STANDARD INSERTION TUBES – MULTI-HOLE - IMPERIAL		
Insert type	**RTC-158 A/B/C (Aluminium tubes)**	**RTC-250 A/B/C (Aluminium tubes)**
Type M02	124898	127760

PARTS NO. FOR STANDARD INSERTION TUBES WITH 4 MM + 1/4” REF. HOLES AND DLC HOLE - IMPERIAL		
Sensor size	**RTC-156/157 A/B/C (Aluminium tubes)**	**RTC-700 A/B/C (Alu. Bronze tubes)**
1/8”	127302	127164
3/16”	127303	127165
1/4”	127304	127166
5/16”	127305	127167
3/8”	127306	127168
7/16”	127307	127169
1/2”	127308	127170
9/16”	127309	127171
5/8”	127310	127172
Set of 9 pcs. Imperial inserts	127335	127173

PARTS NO. FOR STANDARD INSERTION TUBES WITH 4 MM + 1/4" REF. HOLES AND DLC HOLE - METRIC		
Sensor size	**RTC-156/157 A/B/C (Aluminium tubes)**	**RTC-700 A/B/C (Alu. Bronze tubes)**
3 mm	127212	127148
4 mm	127313	127149
5 mm	127314	127150
6 mm	127315	127151
7 mm	127316	127152
8 mm	127317	127153
9 mm	127318	127154
10 mm	127319	127155
11 mm	127320	127156
12 mm	127321	127157
13 mm	127322	127158
14 mm	127323	127159
15 mm	127324	127160
16 mm	127325	127161
Set of 14 pcs. Metric inserts	127336	127162

NOTE: All multi-hole insertion tubes (metric and imperial) for RTC-156 /157/158/250 are supplied with a matching insulation plug.

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