



T150 High Precision Temperature Multifunction Calibrator User Manual



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T150 High Precision Temperature Calibrator

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**WARRANTY & CALIBRATION
REGISTRATION at
www.palmerwahl.com/register**

Registration is fast and easy. In about a minute you can have your product automatically registered for Warranty Protection and our Calibration Reminder service. Let Palmer Wahl help you protect your investment, and maintain product accuracy and compliance with ISO and other quality standards. Questions? Call Customer Service at 1-800-421-2853 or 828-658-3131 Or email: register@palmerwahl.com

A. GENERAL

A.1 Introduction

The T150 is a very-high-precision portable thermometer, capable of simultaneous measurements on two separate channels (differential measurements or comparative measurements). It is intended more particularly for calibration and maintenance. It can measure physical and electrical quantities either on site or in the laboratory.

It can perform all the following functions:

- Measure temperatures by thermocouples, resistive probes, thermistors over 2 Insulated channels
- Recording of measurements and their display as a table or trend curve
- Simulate temperatures using thermocouples, resistive probes and thermistors on 1 isolated channel
- Calibration and generation of the calibration report
- Possibility of using calibrated sensors with memorization of the calibration factors

The T150 has many associated functions that extend its range of application:

- Relative measurement
- Results displayed based on a linear or other conversion law
- Synthesis of curves
- Compatibility with 21CFR Part 11 standard for electronic records

A number of improvements have provided it with:

- Rapid access to all its functions
- Intuitive user interface
- Bluetooth® Interface
- Advanced on-line help system
- Multi-functions keys defined step-by-step on the display
- Connections which can be made with 4 mm safety plugs
- Protection against overloads
- Powered by a rechargeable battery with rapid internal charger.

The unit is enclosed in an ABS case with rubber boot.

A.1.1 About this guide

This user guide consists of four parts: A, B, C and D.

Part A contains general information and a description of the hardware and software of the unit. It also contains a paragraph on safety and user precautions.

Part B contains brief handling information and a description of the various modes of operation.

Part C contains a description of the advanced functions.

Part D contains the technical specifications of the T150.

A.1.2 Unpacking

All T150 units are mechanically and electrically checked before delivery. The necessary precautions have been taken to ensure that they reach the user undamaged.

However, it is a good idea to make a brief check for any damage that may have occurred during transportation. If this is the case, make an immediate claim against the carrier.

The following accessories are standard:

- This user guide
- Unit for charging the battery pack
- 4 measurement cables and 4 crocodile
- clips
- Mounting strap

A.1.3 Returning

If the unit is to be returned, it is preferable to use the original packaging and state as clearly as possible, in a note attached to the unit, the reasons for its return.

**Palmer Wahl
Instrumentation Group
234 Old Weaverville Road
Asheville, NC, 28804-1228
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(828) 658-0728**



Warning

The packaging supplied with the calibrator can withstand a maximum pressure of 20 bar at 21°C (290 psi at 70°F).

A.2 Material

General characteristics:

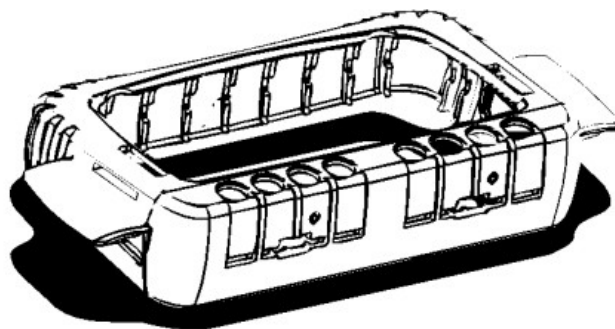
- Portable unit powered by a pack of Ni-MH
- Battery life: about 6 hours, depending on the functions used
- Stand for table mounting
- Strap for carrying and on-site use
- 240 x 320 pixel liquid crystal graphical display
- Choice of language for messages and programming the functions, settings and parameters using a keyboard with 22 keys
- Back-lit display controllable from a key on the keyboard, with automatic switch-off after a programmable time of inactivity
- Battery charging: mains adaptor supplied with the unit or from any 10 to 14 VDC power supply
- Adaptor characteristics: mains voltage 230 V \pm 10%, 50/60 Hz.
- Charging time: 4 h max
- Case: ABS case with rubber boot
- Dimensions: 210 mm x 110 mm x 50 mm. Weight: 900 g with boot and accessories
- Waterproof to IP 54 in accordance with standard EN 60529

A.2.1 General view of the unit



A.2.2 Boot

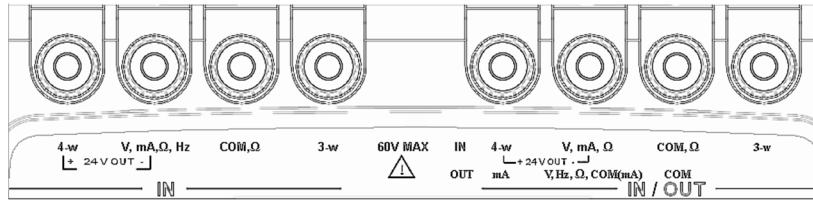
The T150 is delivered with a rubber boot fitted to the case. The boot protects the unit from mechanical shocks and makes the side openings for the USB interface connector and the charger connector waterproof to IP54.



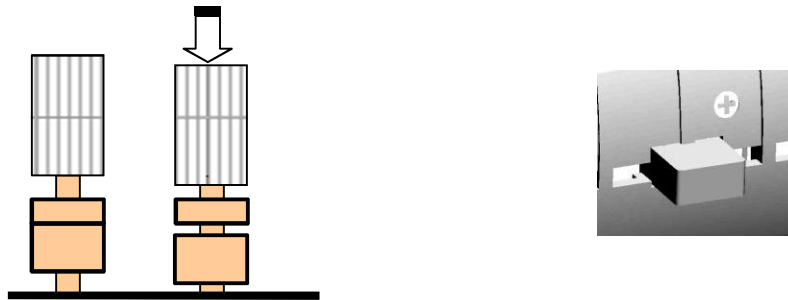
A.2.3 Connection terminals

Four terminals for channel 1 (C1) measurement function connection (IN); two of these terminals are reserved for 3-wire or 4-wire connection for resistance measurement and for temperature measurement with a resistive probe. Refer to paragraph B.2.

Four terminals for channel 2 (C2) measurement function connection (IN); two of these terminals are reserved for 3-wire or 4-wire connection for resistance measurement and for temperature measurement with a resistive probe. Refer to paragraph 2.



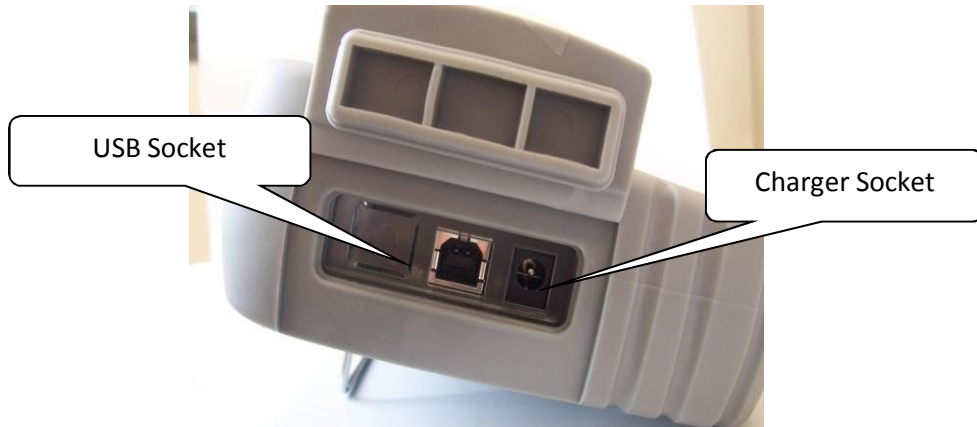
The 8 terminals of the T150 are of the “push & lock” type. They accept 4 mm banana plugs, bare wires, spade terminals and miniature connectors for thermocouples.



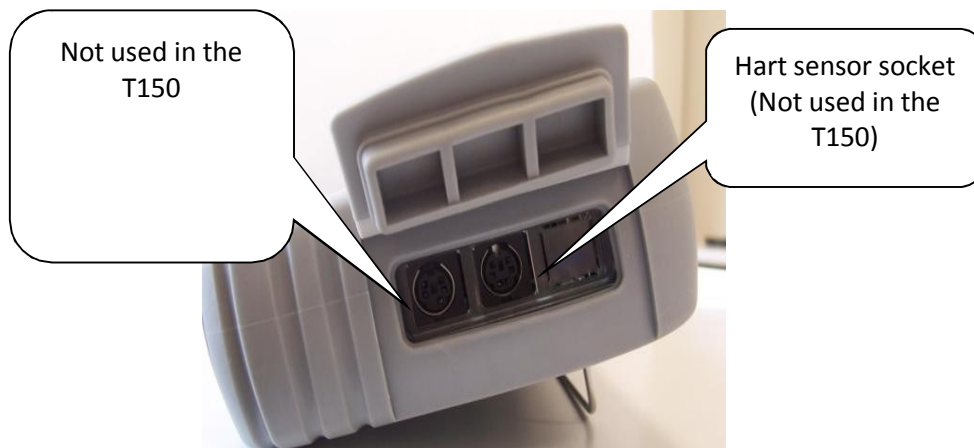
A.2.4 Side connectors

There are two connectors on the left hand side of the unit.

- The first is a mains unit connector for battery charging.
- The second is a type B USB socket for connection to a computer.



Connectors dedicated to sensors (pressure and HART®) are located on the right-hand side of the unit.

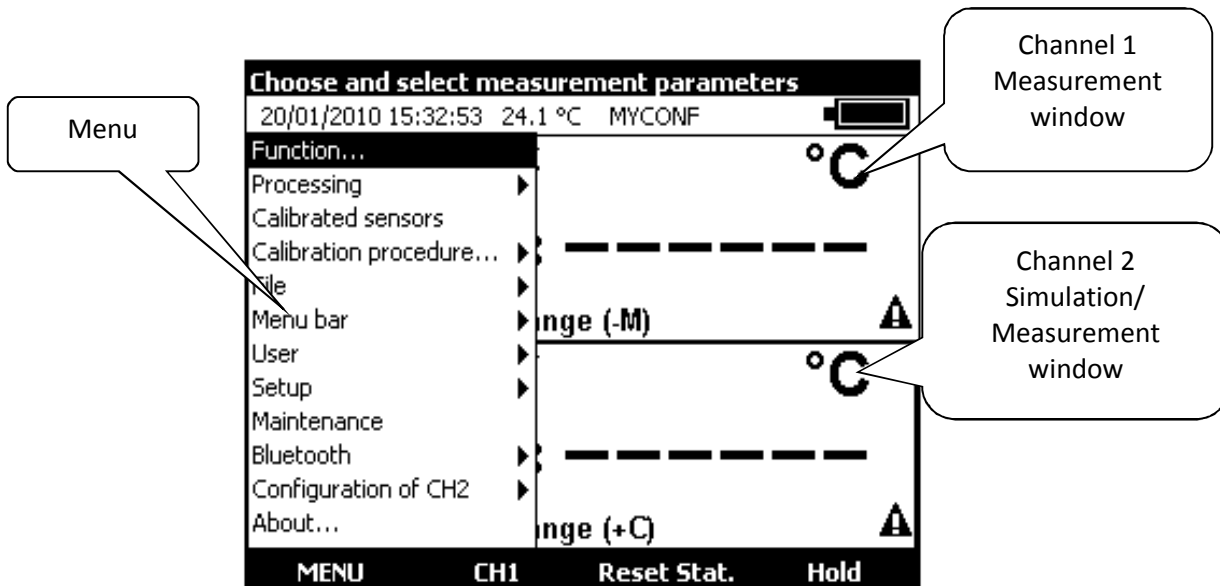


A.2.5 Screen

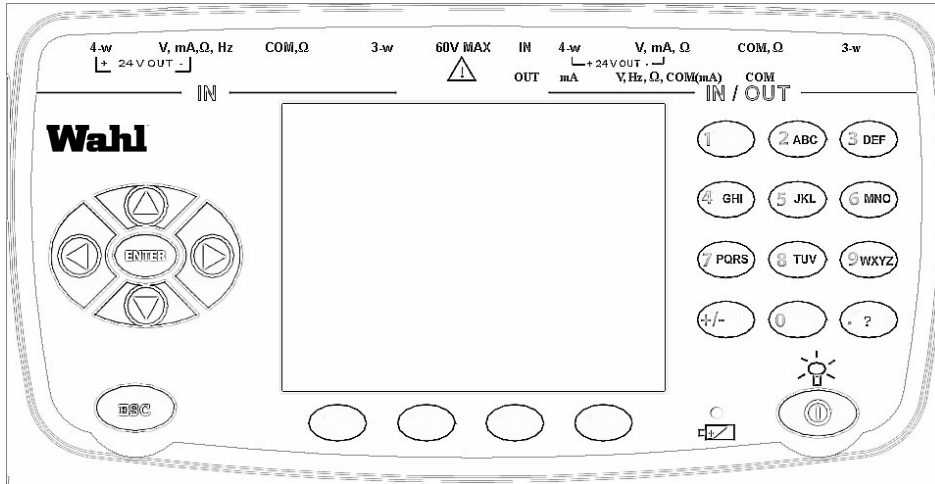
The T150 is fitted with an LCD graphical display which is backlit with white LEDs. The resolution of the display is 240 x 320 pixels.

When the unit is in use, the screen comprises:

- One window for displaying and programming the settings of the measurement function (IN/C1) (refer to paragraph B.2,
- A second window for displaying and programming the settings of the measurement function (IN/C2) (refer to paragraph B.2,
- A strip showing the various menus accessible by touch keys directly on the screen.

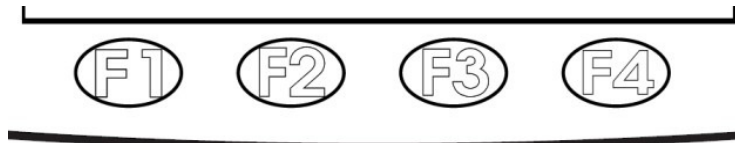


A.2.6 Keyboard

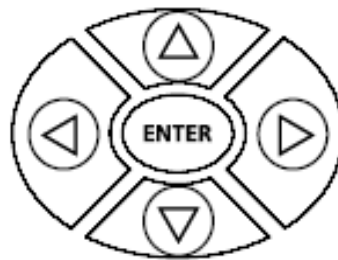


The keyboard contains:

- 4 blank function keys to select the various menus shown on the screen. Note: for the purposes of this manual, the buttons are referred to as F1, F2, F3 and F4 but are not labeled on the unit.



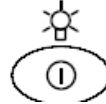
- A navigator:



- A cancel key:

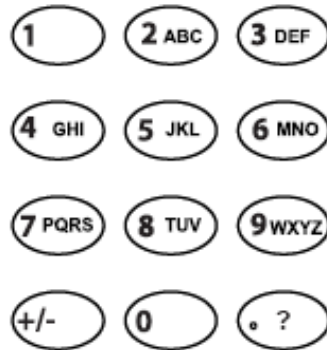


- A Start/stop key for the unit and back-lighting on/off key:



A short push switches the unit on. During operation, a short push switches the back-lighting on or off. A long push of 2 seconds switches the unit off.

- 12 alphanumeric keys for programming the parameters:



- An LED to indicate the state of charge of the battery:






A.2.7 Batteries and charger

Precautions to be taken if battery charge is low:

On reception of your T150 it is possible the batteries are not sufficiently charged for optimum operation or even for starting up the device.

It is therefore required to connect the device to the mains (see paragraph A.2.4) and to wait for a few minutes before starting it up (by pressing the On/Off button).

During normal operation:

When the  symbol is flashing, the battery should be recharged as soon as possible. Connect the charger to power system, the charge indicator (red LED)  on the front panel lights up. Leave the charger switched on for about 3 hours for a complete recharge and disconnect the charger when the charge indicator  goes off on the front panel.

Precautions to be taken to improve the service life of your batteries:

The battery technology (NiMH: nickel-metal hydride) used in your T150 provides greater autonomy, however this technology requires strict maintenance, requiring discharge cycles to avoid "memory effect". Any nickel-based battery should be fully discharged once a month. If such maintenance is not performed, a loss of capacity can be seen that can amount to a third of the capacity. Complete restoration then becomes more difficult if such regular maintenance is ignored.

The calibrator should be powered off for charging if not in use.

The internal charging circuit does not provide operating power for the unit. It is only for charging the battery. If the unit is left on, once the unit becomes fully charged it will stop the charging voltage and run off the battery until the battery again requires charging. Therefore, if the unit has been left on during the charging cycle, it is possible to have only a partial, or even a low charge, when it is disconnected for use.

The unit will still stop charging once the battery is fully charged, but if the unit is off it will not place a drain on the battery until it is turned on.

If the battery charge is too low, and the unit is being powered on, it may only flash the "Wahl" start-up screen, or even cause a system lock up. In either case plug the charger into the unit and allow a couple of minutes for normal operation to restore. If the unit is still locked up try depressing the "ESC" button and the Power button at the same time for about 15-20 seconds. This should cause a system reset and return to normal operation.

If the above symptoms continue after the battery has had a proper full charge cycle (minimum 3-4 hours while powered off) it may indicate a depleted battery pack requiring replacement.



Warning

ONLY USE THE ADAPTOR SUPPLIED WITH THE CALIBRATOR.

A.2.8 Replacing the battery pack

The battery pack should be changed once a year for optimal autonomy of instrument. To replace the battery pack, contact your dealer.

A.2.9 Stand

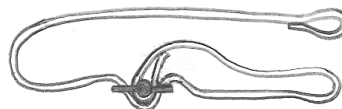
The stand gives a good angle of view when the T150 is placed on a desk. Unfold the stand on the back of the unit and place the T150 on a desk as shown below.



A.2.10 Strap

The T150 is supplied with an tear free strap and two pins to attach the strap to the case.

Before attaching the strap, pass the free end through the fixing loop as in the diagram. Feed the ends of the strap through the two slots on each side of the case. Insert the two pins into the strap and pull the strap to lock the pins in the case.

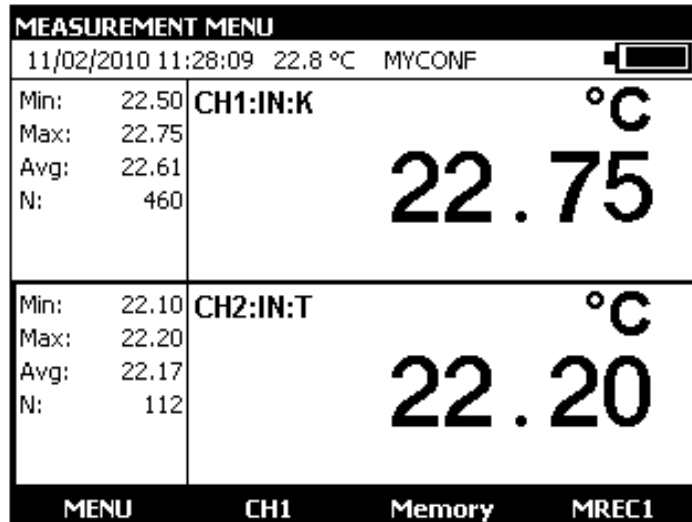


A.3 Software

The firmware of the T150 is stored in flash memory. It is therefore relatively easy to update the firmware when a new version is available. Refer to paragraph A.5.1 for detailed information on updating the firmware.

A.3.1 User Interface

The basic items forming the user interface are shown in the diagram below:



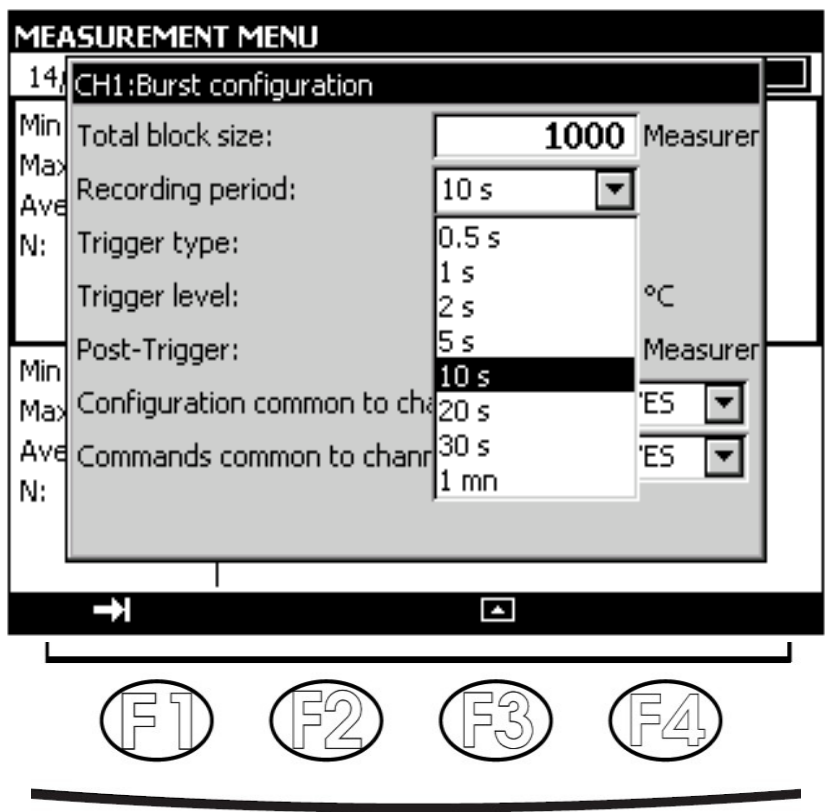
The “on-line help” function is not visible in the menu, but is accessible at any time by pressing the **?** key. When active, a help window for the function in use appears. The **ESC** key closes the help window and all the dialog boxes displayed.

The main menu is located at the bottom of the screen, opposite the four function keys (F1 to F4). To select an item from the menu, press the associated function key.

Navigation within menus and sub-menus is by means of the navigation keys and the ENTER key. For example, to open the **Memory** menu and configure the memory functions in the example shown in the screen below, perform the following steps:

- 1) Press the F3 key associated with the proposed **Memory** from the main menu.
- 2) Press the Down **V** navigation key twice to select the **Predefined settings** sub-menu and confirm with the ENTER key.
- 3) Use the numeric keypad to enter the block size.
- 4) To go to the next field, press function key F1 **→**.
- 5) To define the sampling period, press function key F3 **▾** to open the drop-down menu, then use the navigation keys (**^** or **V**) to select the time and press ENTER (or press function key F3 **▾**).
- 6) Repeat...

It is possible to cancel the selection at any time and return to the main menu by pressing the ESC key.



The dialog box interface is intuitive. It is managed by the function and navigation keys.

During operation of the T150, several symbols are displayed to simplify selection and indication of the current functions. These symbols are shown in the table below

Symbol	Description
Function Keys	
	Tabulation Key
	Open a drop down list
	Close a drop-down list
	Cancel the selected item
	Stop the current transmission
	Suspend the current transmission
	Commence or resume transmission
	Cancel the selection
	Add the item being edited
	Edit the selected item
	Open a file
Indication Symbols	
	Maintain transmission or display of measurements
	Indication of battery state
	Warning: Out of Range or error
	2 wire cabling detected
	3 wire cabling detected
	4wire cabling detected
	Item already selected
	Measurement smoothing is active
	The Tare function is on
	Setting to scale is on
	Acquisition in progress (the value to the right of the pictogram indicates the number of values logged)

A.4 Safety

A.4.1 Compliance with safety standards

The unit complies with applicable standards:

- Safety directive 2006/95/CE with standard EN611010-1
- Directive CEM 2004/108/CE with standard EN61326
- Radio directive 1999/5/CE with standards EN300-328 and EN301-489

These instructions for use contain information and warnings which must be observed by the user to protect the latter against the dangers of electricity, to ensure the safe operation of the device and to protect it against any mishandling which could damage or compromise the safety of use of the device.

A.4.2 Environmental conditions

As per publication EN 60359

Range of application of standards from 0 to 2,000 m.

Reference temperature range: 23°C ± 5°C, relative humidity: 45 % to 75 %.

Nominal operating range: -10°C to +50°C, relative humidity: 20 % to 80 % non-condensing.

Operating range limit: -15°C to +55°C, relative humidity: 10 % to 80 % (70 % at 55°C).

Storage and transport temperature range limit: - 30°C to + 60°C (without the batteries).

A.4.3 Disposal of device

Worn electrical devices can pollute the environment. We recommend you refrain from disposing of this device in an ordinary waste bin, but rather that you use the recycling centers available locally. If not, you can return the device to us, and we will take care of its disposal free of charge.

A.4.3.1 Waste generated by the device

A.4.4 Device destruction procedure

Open unit: unscrew screws from lower casing (after removing boot).

Separate both shells and disconnect battery pack

A.4.5 Instructions

The unit is designed to be used in complete safety if the instructions given in the accompanying documents are followed. Any use apart from those defined, may affect the safety of the operator and is therefore dangerous and not recommended.

A.4.6 Making measurements

Measuring wires and leads must be in good condition and must be replaced if their insulation appears defective (insulation cut, burned, etc.).

When the unit is connected to the measurement circuit, the terminals may be dangerous. Also, never place your hands near a terminal, whether in use or not. This advice also applies to the battery charger sockets and the USB link connected directly or indirectly to the terminals of the unit. Any work on these circuits must be carried out with the unit disconnected from any other external circuit.

Never exceed the limiting values of protection indicated in the specifications.

When the order of magnitude of the value to be measured is unknown, make sure that the starting measurement range is the highest possible, or choose the automatic range selection mode.

Before changing the function, disconnect the wires for measuring the external circuit. When measuring current and/or voltage, even if low, remember that the circuits may be live with respect to earth, at a voltage that is dangerous for the operator.

Never carry out resistance measurements on a live circuit.

A.4.7 Unusual faults and stresses

Whenever it is believed that the protection has been damaged, switch off the unit and ensure that it is not used prematurely. The protection may have been damaged if, for example:

- ✓ There is obvious damage to the unit.
- ✓ The unit is no longer able to make accurate measurements.
- ✓ The unit has been stored under unfavorable conditions.
- ✓ The unit has been subjected to severe stress during transportation.




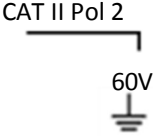


A.4.8 Definitions

A.4.8.1 Definition of the installation category

This is also known as the overvoltage category.

It is the classification of the installation according to standard limits for transient overvoltage's (standard CEI 664).

Table of symbols used

Symbol	Description
	Warning see accompanying documents
	Ground
	Complies with European Union directives
	Category II, pollution 2. Maximum common mode voltage compared with the ground = 60V
	Disposal of device: see chapter A.3.3
	Bluetooth® compatible unit

A.5 Service

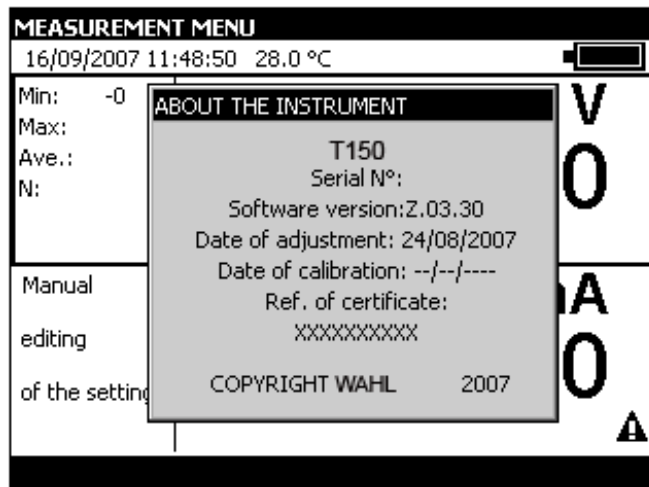
The unit must always be set up according to the instructions in this notice. Incomplete or poorly executed setting up may adversely affect the safety of the operator.

The responsible authority must ensure on a regular basis that factors affecting safety do not change with time and carry out any necessary preventive work.

Before opening the unit for any work, you must ensure that all wires are disconnected from the unit

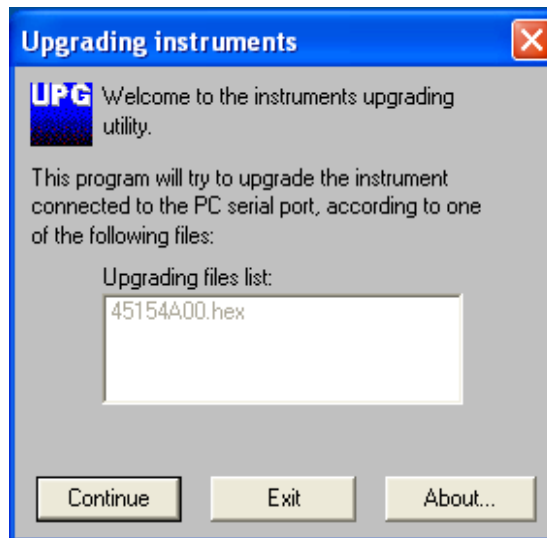
Any adjustment, maintenance or repair of an open unit must be avoided as far as possible and, if essential, must be carried out by qualified personnel who are familiar with the risks involved.

Menu  About menu.

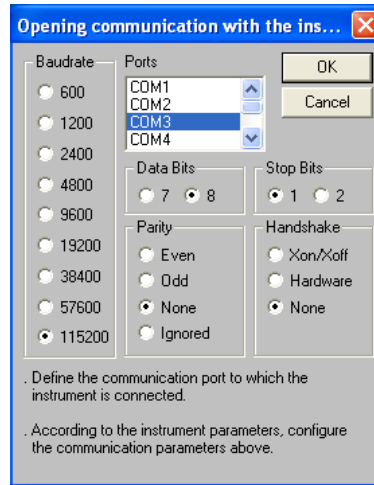


The quickest way to find out if an update is available is to contact Wahl Customer Service and look at the “Software” page. To update the firmware, proceed as follows:

1. If necessary, install on the PC the USB driver for communication with Wahl instruments. This driver can be downloaded from our site, along with an information page describing the installation procedure
2. Disconnect the leads connected to the measurement and simulation terminals
3. Connect the instrument to the PC using the USB lead supplied with the product.
4. Download and run the firmware update program.
5. Select the language then the file containing the firmware and download in the first stage.



6. Choose the communication parameters that match the parameters of the T150. The communication port used is a virtual port which does not correspond to a physical port on your computer. The other parameters to be selected are defined in the diagram below.



7. Confirm the update by pressing "OK" and wait for the firmware to load into the unit.

A.5.2 Recalibration

In order to maintain the quality of measurement, the user may wish to carry out a periodical performance check himself.

This check must take into account the metrological precautions for use. The following instructions must be followed.

The operations must be carried out under the reference conditions, namely:

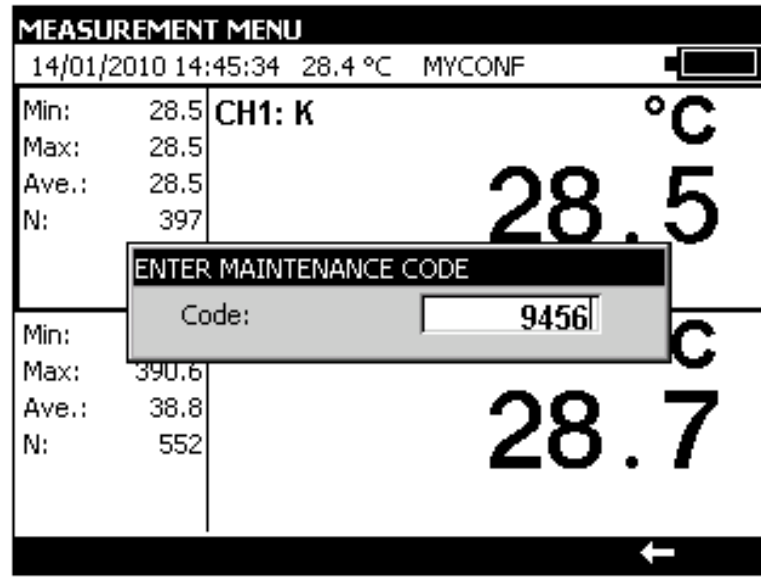
- Ambient temperature: $23^{\circ}\text{C} \pm 1^{\circ}\text{C}$
- Relative humidity: 45% to 75%

The standards used in the test process must be such that the errors at the test points are known and are less than or equal to $\pm 0.0005\%$.

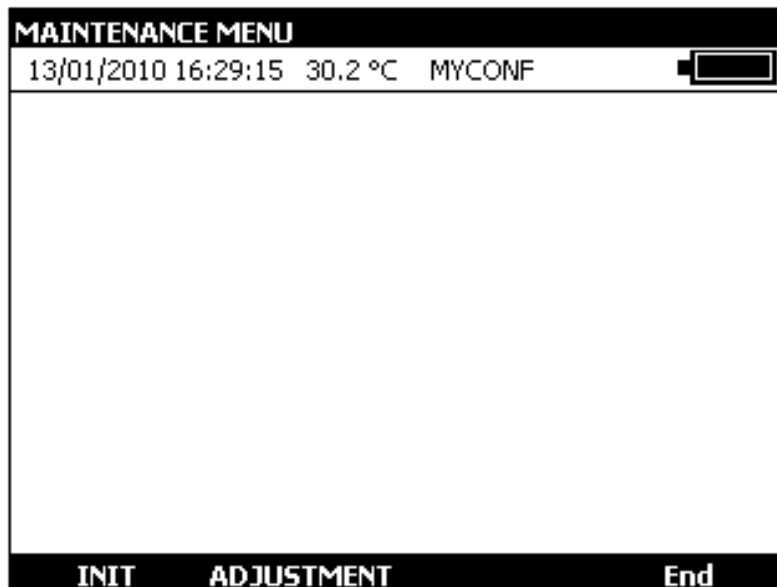
After these checks, if it is found that one or more of the characteristics of the unit are outside the tolerances given in chapter **D**, one may:

- Either make an adjustment in accordance with the procedure explained below, which requires equipment at least as accurate as that used for the test previously performed.
- Or return the unit to the address shown at the start of this guide for checking and adjustment.

It is possible to adjust the T150 using an instrument whose accuracy is better than 50 ppm. To adjust the unit, select the **Menu** \square **Maintenance** menus, then enter the password 9456.

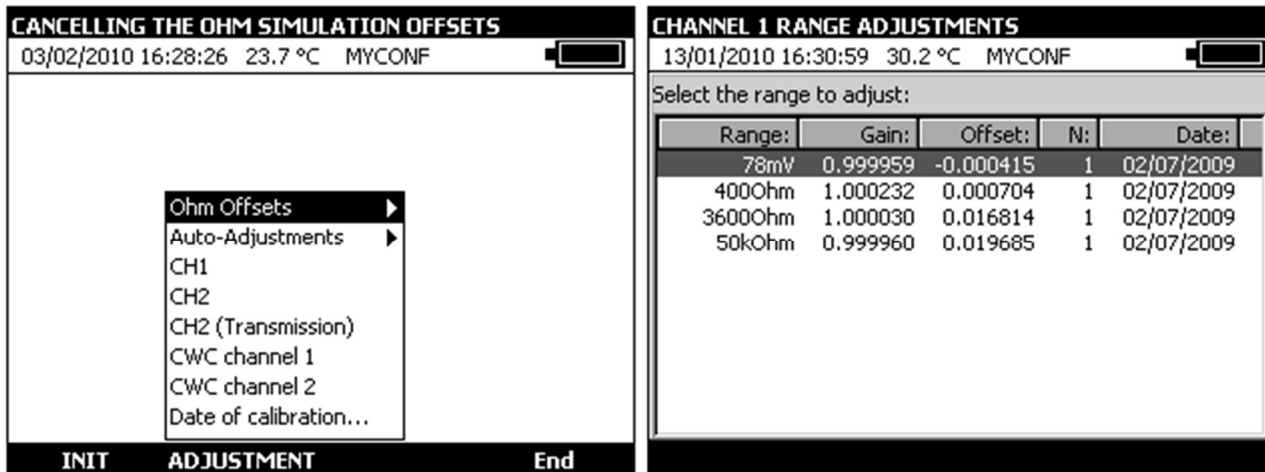


To exit the Maintenance mode, press the **End** function key.



To adjust the T150, use the **ADJUST** function key. Make adjustments in the following order:

- V1 measurement: run all calibration procedures
- V2 measurement: run all calibration procedures
- CWC channel 1
- CWC channel 2

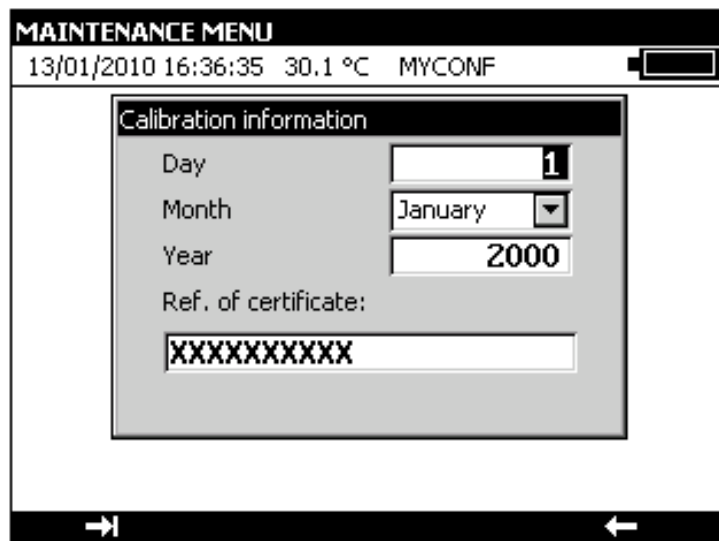


For each type of calibration, select the function to be calibrated with the Up \wedge or Down \vee navigation keys and follow the instructions shown in the dialog boxes.

When a unit is calibrated, data and certificate no. may be defined.

- Date of calibration

To change the date of calibration and enter the reference of any calibration certificate, use the **ADJUST** \boxtimes **Date of calibration** menus.





A.5.3 Cleaning

In order to use the unit in complete safety, users must carefully read paragraph A.4 which, among other things, deals with safety before handling. It is advisable also to read the following paragraphs:

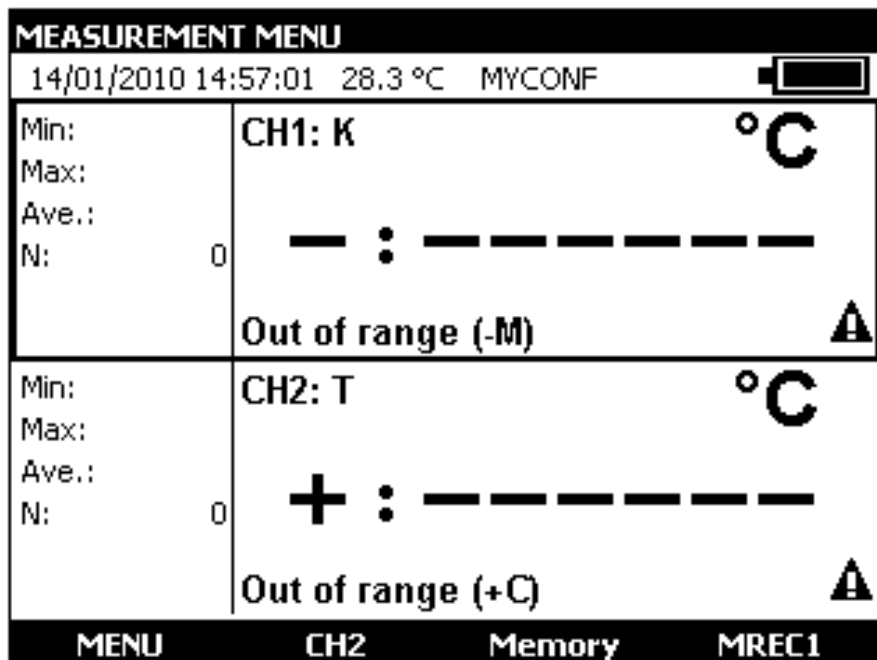
- ✓ A.1.2 Unpacking
- ✓ A.2.7 Batteries and charger
- ✓ A.5.3 Cleaning

A.6 Powering on

Connect the charger if this is the first time of use. The red LED  lights while the battery pack is charging. When batteries are fully charged, red LED goes off.

To start instrument, press On / Off  key for one second.

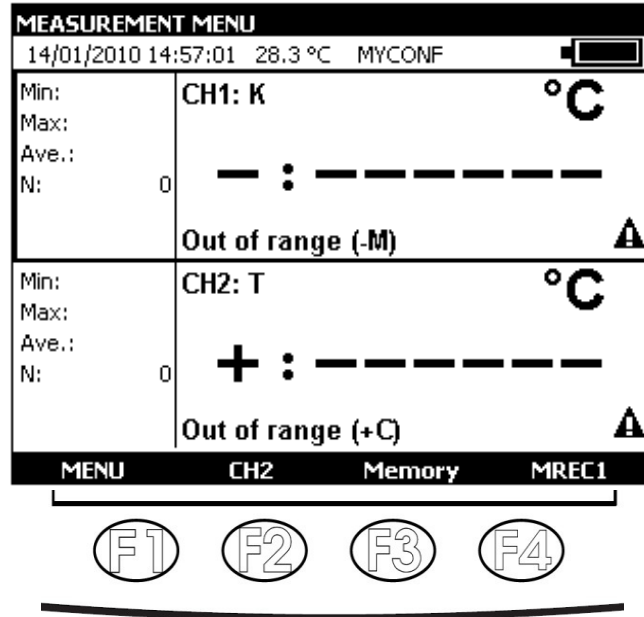
After a window showing EEPROM testing, a screen similar to the one below should appear.



A.7 Measurement on channel V1 or V2

To change the Measurement functions from channel V1, a rectangle should surround the top window on the screen. If it is not the case, select channel by activating the measurement window with function key **F2** (V1).

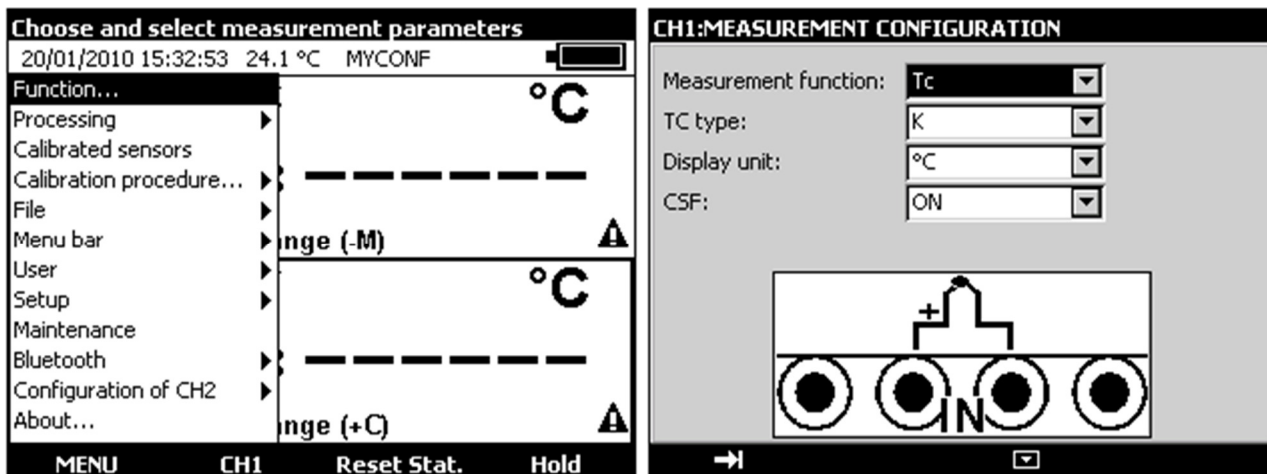
In order to be able to change the channel C2 measurement functions, there must be a rectangle around the lower window on the screen. If this is not the case, select the channel by pressing function key **F2** (C2) to activate the measurement window.



To choose a measurement function, press key **F1** (Menu).

Select the **Function ...** menu with the navigation keys and confirm with the ENTER key.

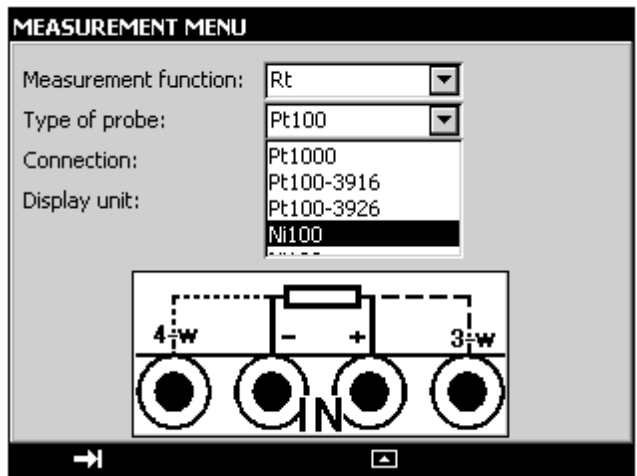
The **MEASUREMENT MENU** dialog box is displayed.



A.7.1 Resistive temperature probes (Temperature)

Display the **MEASUREMENT MENU** dialog box:

Select the **Rt** measurement function, then the appropriate “type of probe” using the function and navigation keys.






- Select **Auto, 2 -Wire, 3-Wire** or **4-Wire** connection with the function and navigation keys.
- Select display unit.
- Confirm with **ENTER**.

Connection is made according to the number of wires of the resistive probe.

The following probes are available:

Sensor	Probe Type Caption
Pt 50 ($\alpha = 3851$)	Pt50
Pt 100 ($\alpha = 3851$)	Pt100
Pt 100 ($\alpha = 3916$)	Pt100-3916
Pt 100 ($\alpha = 3926$)	Pt100-3926
Pt 200 ($\alpha = 3851$)	Pt200
Pt 500 ($\alpha = 3851$)	Pt500
Pt 1 000 ($\alpha = 3851$)	Pt1000
Ni 100 ($\alpha = 618$)	Ni100
Ni 120 ($\alpha = 672$)	Ni120
Ni 1 000 ($\alpha = 618$)	Ni1000
Cu 10 ($\alpha = 427$)	Cu10
Cu 50 ($\alpha = 428$)	Cu50

Being the temperature coefficient of the probe.

Wiring diagram is automatically detected by the calibrator. The T150 displays an icon showing the connections used ( for 2 wires,  for 3 wires or  for 4 wires) to carry out the measurement.

In order not to introduce an error when measuring with 3 wires, the following is recommended:

- Measure using conductors of the same length, the same diameter and the same type of metal (a difference of 40 m Ω between two wires introduces an error of about 0.1°C).
- Clean connections to avoid development of spurious electromotive force (emf).
- Take care with the connections to avoid the appearance of interfering contact potential differences.

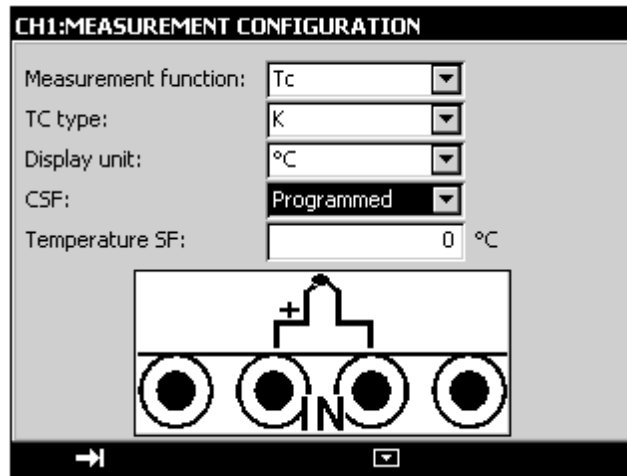
Note:

By changing the display unit, the ohmic value of the connected probe can be measured: The following ranges are available:

Range	400 ohms (probe type: PT100)	3600 ohms (probe type: PT1000)
Resolution	1 m ohm	10 m ohm
Automatic wire detection	2, 3 and 4 wires	2, 3 and 4 wires
Measuring current	0.2 to 0.45 mA	0.2 to 0.45 mA

A.7.2 Measurement by Thermocouple (Temperature)

- Display the **MEASUREMENT MENU** dialog box:
- Select the **Tc** measurement function, then the appropriate “type of thermocouple” using the function and navigation keys.
- Select the display unit
- Select the type of cold junction (CSF) used. Enter the temperature of the cold junction in the case of a programmed cold junction.
- Confirm with ENTER.



The thermocouples available are: K, T, J, E, N, U, L, S, R, B, C, PL, Mo, NiMo/NiCo.

After a significant thermal shock, it is recommended that the unit is left for the temperature to stabilize in order to use the internal cold junction (CSF) with maximum accuracy.

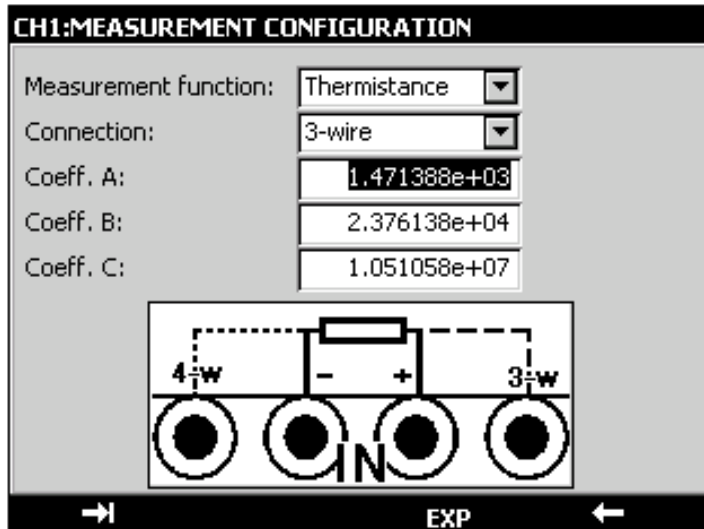
Note:




By changing the display unit to VOLT and programming CSF OFF, voltages between – 10 mV and + 75 mV can be measured.

Range	Max. 75 mV depending on the type of
Resolution	1 μ V
Input impedance	> 10 M Ω

A.7.3 Thermistor Measurement (Temperature)

- Display **MEASUREMENT MENU** dialog box:
- Select **Thermistor** measurement function, then select **Auto**, **2-Wire**, **3-Wire** or **4-Wire** connection with the function and navigation keys.
- Enter coefficients corresponding to thermistor **Coeff. A**, **Coeff. B** and **Coeff. C**.
- Confirm with ENTER.

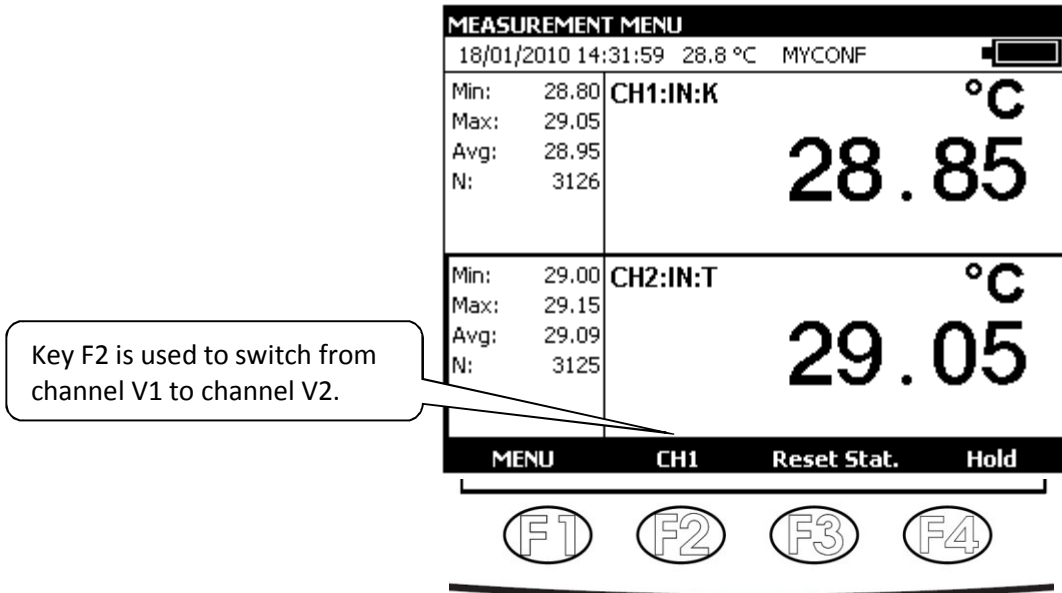


Wiring diagram is automatically detected by the calibrator. The T150 displays an icon showing the connection used to carry out measurement ( for 2 wires,  for 3 wires or  for 4 wires).

To avoid errors when measuring with 3 wires, the following is recommended: Measure using conductors with same length, same diameter and same type. Clean connections to avoid development of spurious electromotive force (emf). Use Y-shaped lugs to reduce connector resistance.

A.8 Simulation on Channel V2

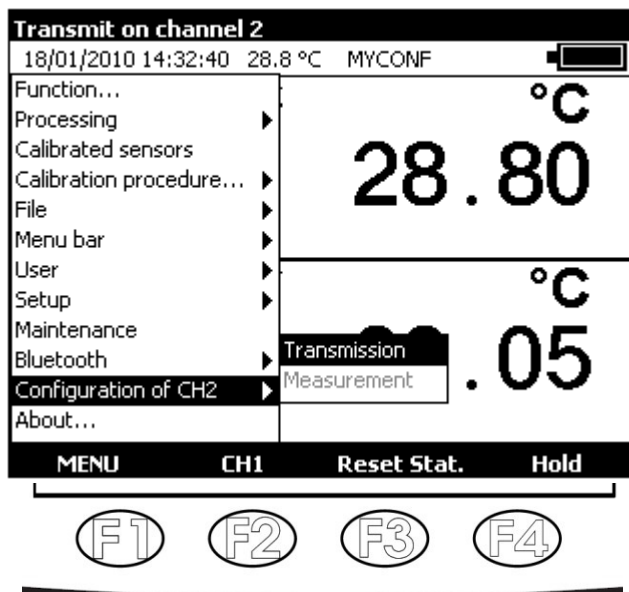
Channel V2 may be used as a Generation/Simulation or Measurement Channel. This channel is accessed with the **F2** function key (V2). Pressing this button activates the transmission/simulation window: the lower window in the display is then marked by a rectangular border.



A.8.1 Generation/Simulation Mode

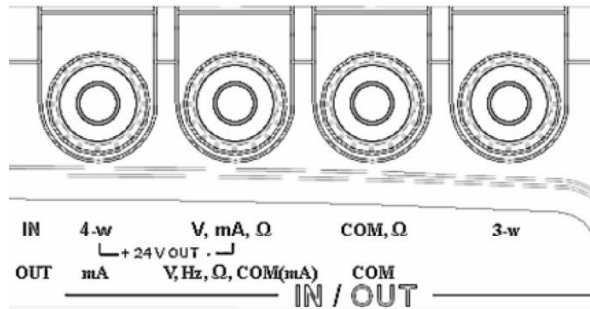
Generation/Simulation mode from channel V2 is accessed via the **F1** function key (Menu). When in measurement mode:

- Select **V2 Configuration** (near the bottom of the drop-down list) and **Transmit** with the function and navigation keys.
- Confirm with ENTER.



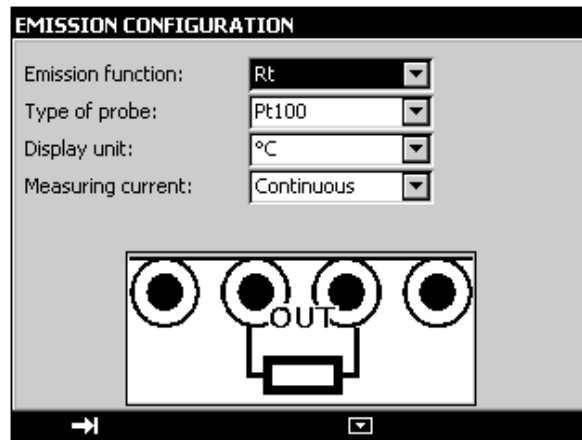
To select a simulation function, press the **F1** key (**Menu**).

In Transmit mode, connections are across the four "IN/OUT" terminals located on the right half of the unit:



A.8.1.1 Resistive probe simulation (temperature)

- Display the **TRANSMISSION CONFIGURATION** dialog box:
- Select the **Rt** transmission function, then the appropriate "type of probe", and range using the function and navigation keys.
- Select the display unit
- Select measurement current (direct or pulsed) Confirm with ENTER.



Connection is made between the two Ω terminals.

The following probes are available:

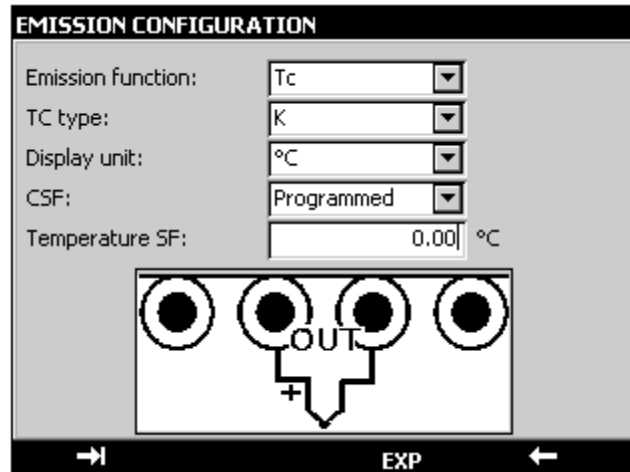
Sensor Probe Type Caption	Probe Type Caption
Pt 50 ($\alpha = 3851$)	Pt 50
Pt 100 ($\alpha = 3851$)	Pt 100
Pt 100 ($\alpha = 3916$)	Pt 100-3916
Pt 100 ($\alpha = 3926$)	Pt 100-3926
Pt 200 ($\alpha = 3851$)	Pt 200
Pt 500 ($\alpha = 3851$)	Pt 500
Pt 1 000 ($\alpha = 3851$)	Pt 1000
Ni 100 ($\alpha = 618$)	Ni 100
Ni 120 ($\alpha = 672$)	Ni 120
Ni 1 000 ($\alpha = 618$)	Ni 1000
Cu 10 ($\alpha = 427$)	Cu 10
Cu 50 ($\alpha = 428$)	Cu 50

The resistive temperature probe simulation function can be used with either 2, 3 or 4 wire connection.

As for the resistance simulation function, if a polling acquisition system is used, ensure that the transmitter carries out the measurement at least 1 ms after the current is present.

A.8.1.2 Thermocouple simulation (temperature)

- Display the **TRANSMISSION CONFIGURATION** dialog box:
- Select the **Tc** transmission function, then the appropriate “type of thermocouple”, using the function and navigation keys.
- Select the display unit
- Select the type of cold junction compensation (CSF) used. Enter the temperature of the CSF in the case of a programmed CSF. Confirm with ENTER

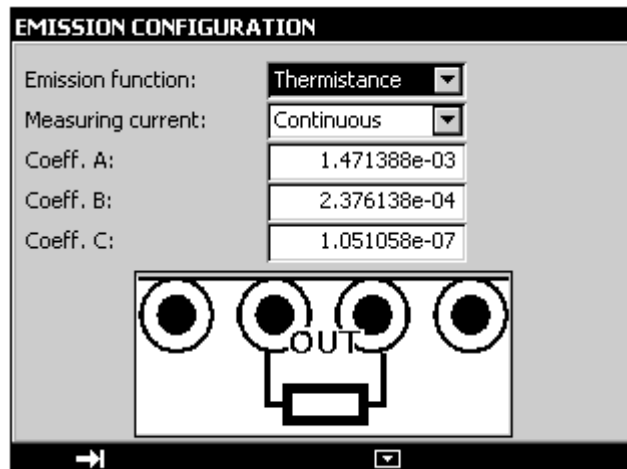


The thermocouples available are: K, T, J, E, N, U, L, S, R, B, C, PL, Mo, NiMo/NiCo.

After a significant thermal shock, it is recommended that the unit is left for the temperature to stabilize in order to use the internal cold junction (CSF) with maximum accuracy.

A.8.1.3 Thermistor simulation


- Display **TRANSMIT CONFIGURATION** dialog box:
- Select **Thermistor** "transmit function" with function and navigation keys.
- Select measurement current (direct or pulsed)
- Enter coefficients matching thermistor **Coeff. A**, **Coeff. B** and **Coeff. C**. Confirm with ENTER.



B. ADVANCED OPERATION

B.1 Simulation Modes

Several transmission modes are available in the T150 to facilitate rapid checking and calibration of instruments and transmitters. To change the transmission mode, open the transmission window using the **OUT** function key (F2).

Enter the setting on the digital keyboard		
18/01/2010 14:58:25 29.3 °C MYCONF 		
Min: 28.75 Max: 29.30 Avg: 28.93 N: 5965	CH1:IN:K	°C 29.30
Manual editing of the setting	CH2:OUT:K	Manual editing Incremental editing Steps Simple ramp Cyclic ramp Synthesiser
MENU	CH1	Mode

When the transmission window is open, the T150 is set by default to the **Manual edit** mode.

To access the other modes, select the **Mode** menu using function key F4. Select a transmission mode using the Up/Down keys of the navigator and confirm with ENTER.


To exit a transmission mode and return to the default mode, press the ESC key.

B.1.1 Manual Edit Mode

In this mode, the value to be transmitted may be entered directly using the alphanumeric keys.


The value entered appears at the bottom of the transmission window during entry.



To cancel the entry, press the ESC key. To transmit the value entered, confirm with the ENTER key.



MANUAL EDITING OF SETTING		
18/01/2010 15:02:08 29.4 °C MYCONF 		
Min: 28.75 Max: 29.45 Avg: 28.96 N: 6366	CH1:IN:K	°C 29.45
Manual editing of the setting	CH2:OUT:K	°C 0.00 123.45
CH1		

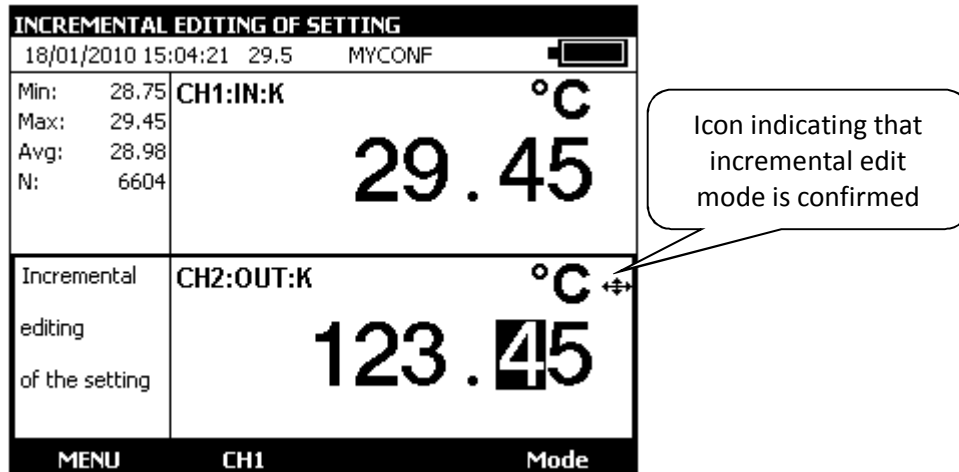
Setting entered manually

B.1.2 Incremental Edit Mode

When this mode is active, the  icon appears in the transmission window. Use the 4 navigator keys to edit the value to be transmitted.

To select a digit, use the Left  and Right  keys of the navigator. The editable digit appears reversed in the display (white on black).

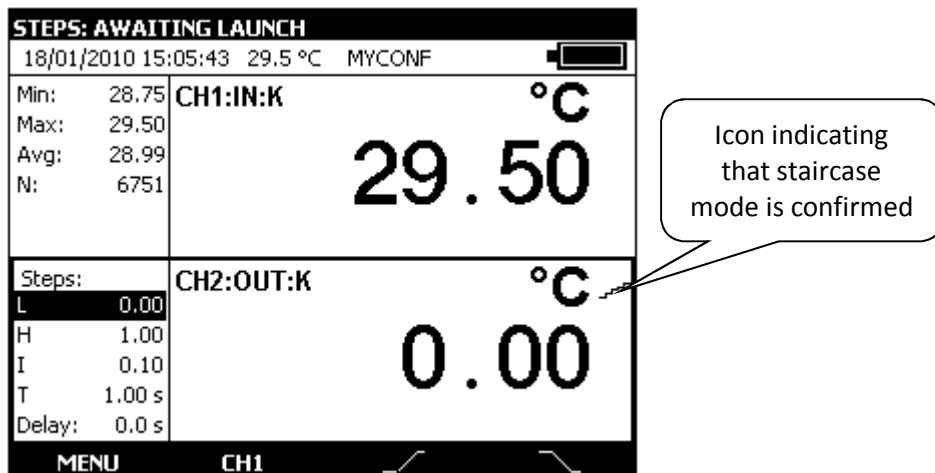
To increment/decrement the digit selected, use the Up  or Down  key of the navigator.






B.1.3 Staircase mode

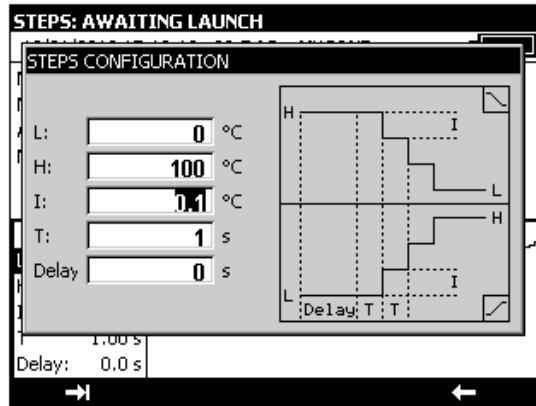
This mode is used to program an incremental progression of the active transmission function.

When this mode is active, the  icon appears in the transmission window.



The  function key launches a cycle of increasing increments and the  function key launches a cycle of decreasing increments.

The default parameters of this mode are displayed on the left hand side of the transmission window. To change these parameters, press ENTER or use the **Menu**  **Mode**.



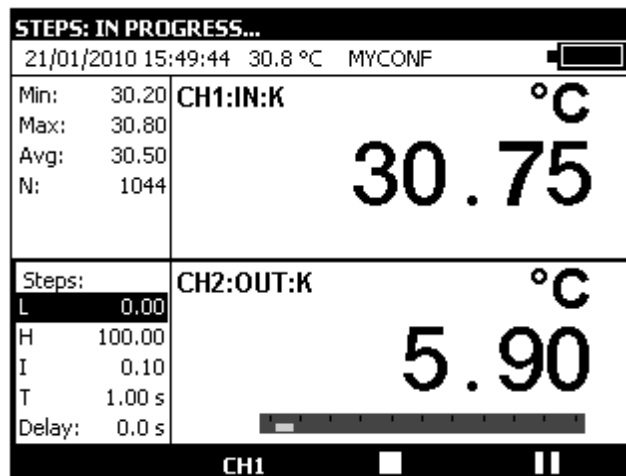
The parameters of a staircase are:

B: minimum amplitude of the signal.


H: maximum amplitude of the signal. I: amplitude of the increment

T: duration of the steps in seconds


Delay: delay in seconds between launching the staircase and transmission of the first increment.




During generation of a staircase, a progress bar indicates the state of progress. The function keys control generation:

The  key stops generation at any time


The  key suspends generation

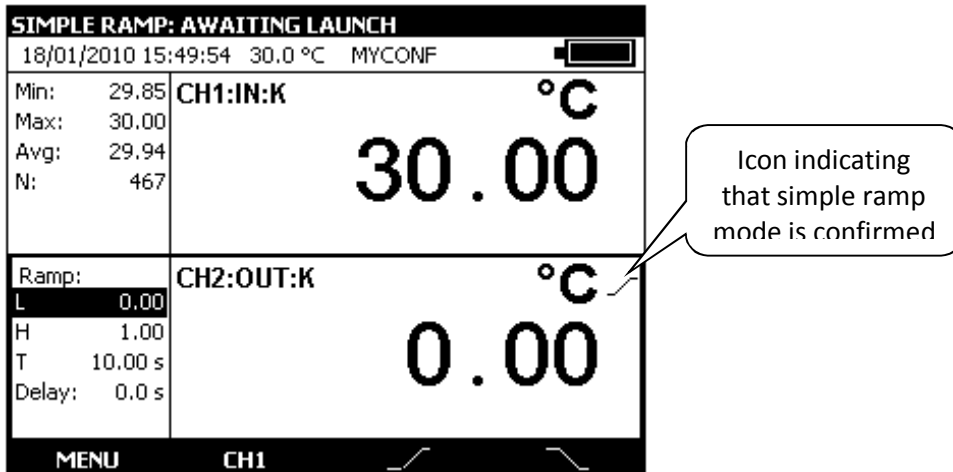
The  key commences or resumes generation



An  icon in the transmission window indicates suspended generation.

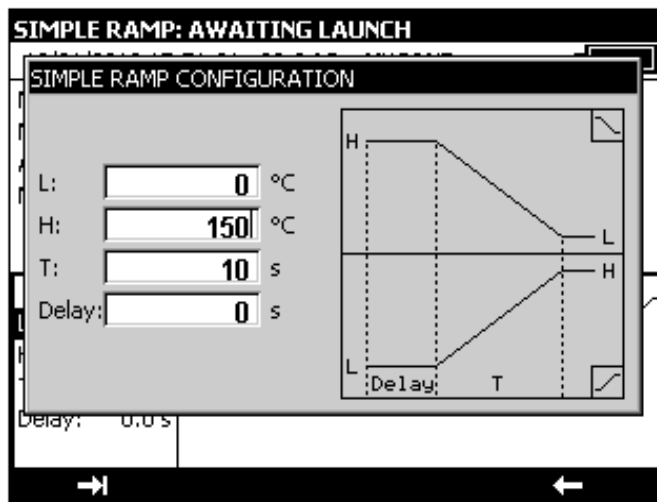
B.1.4 Simple Ramp Mode

The simple ramp generation function is used to program a linear variation in one direction (increasing or decreasing) of the active transmission function.

When this mode is active, the  icon appears on the transmission window.



The  key is used to launch an increasing ramp and the  function key is used to launch a decreasing ramp. The default parameters of this mode are displayed in the left hand side of the transmission window. To change these parameters, press ENTER or use the **Menu** **Mode....**



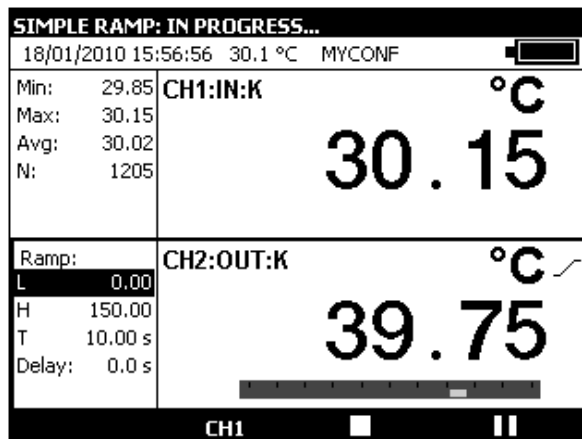
The parameters of a simple ramp are:

B: minimum amplitude of the signal.

H: maximum amplitude of the signal.


T: duration of the ramp in seconds.


Delay: delay in seconds between launching the ramp and the start of transmission.




During generation of a simple ramp, a progress bar indicates the state of progress. The function keys are used to control generation:


The  key stops generation at any time

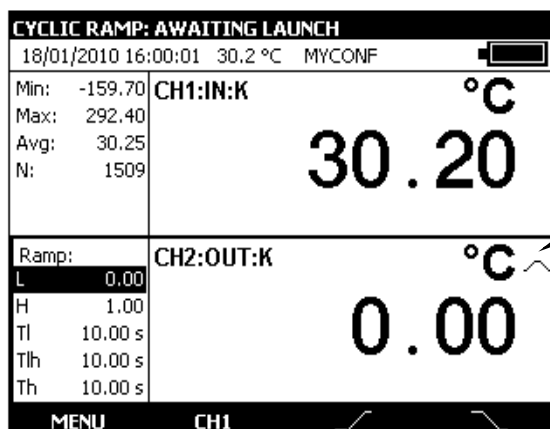
The  key suspends generation

The  key commences or resumes generation



An  icon in the transmission window indicates suspended generation.


B.1.5 Cyclic Ramp Mode

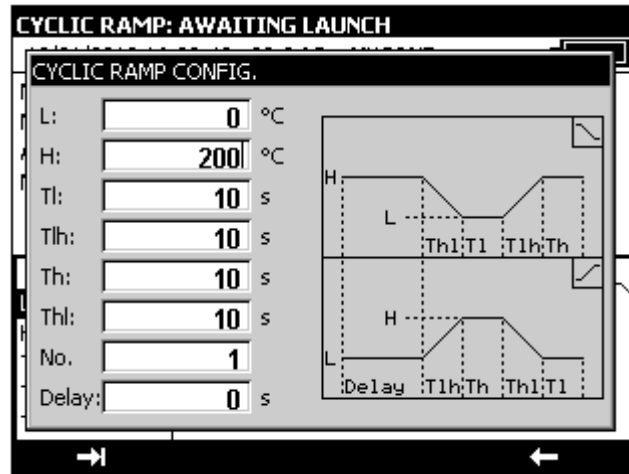
The cyclic ramp generation function is used to program a first linear variation in a direction (increasing or decreasing) followed by a first step and then a second linear variation in a direction opposite to the first variation followed by a second step. When this mode is active, the  icon appears in the transmission window.



Icon indicating that cyclic ramp mode is confirmed

The  function key is used to launch an increasing cyclic ramp and the  function key is used to launch a decreasing cyclic ramp.

The default parameters of this mode are displayed in the left hand side of the transmission window. To change these parameters, press ENTER or use the **Menu**  **Mode....**



The parameters of a cyclic ramp are: B: minimum amplitude of the signal.

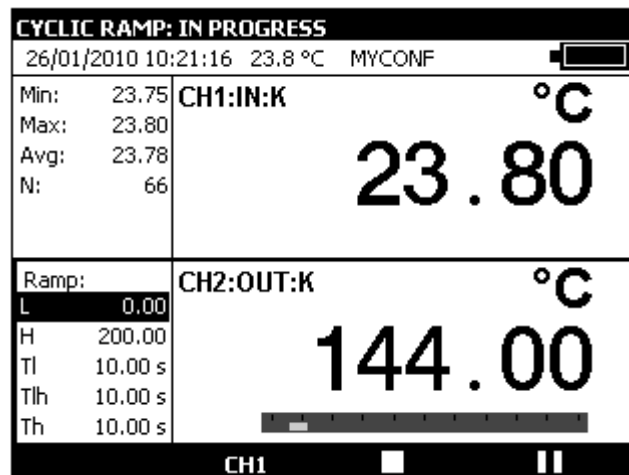
H: maximum amplitude of the signal. Thb: duration of a decreasing ramp. Tbh: duration of an increasing ramp.

Th: duration of the high step.

Tb: duration of the low step.

Nbr: number of cycles to be generated.


Delay: delay in seconds between launch of the cyclic ramp and the start of transmission.




During generation of a cyclic ramp, a progress bar indicates the state of progress. The function keys are used to control generation:

The  key stops generation at any time

The  key suspends generation


The  key commences or resumes generation

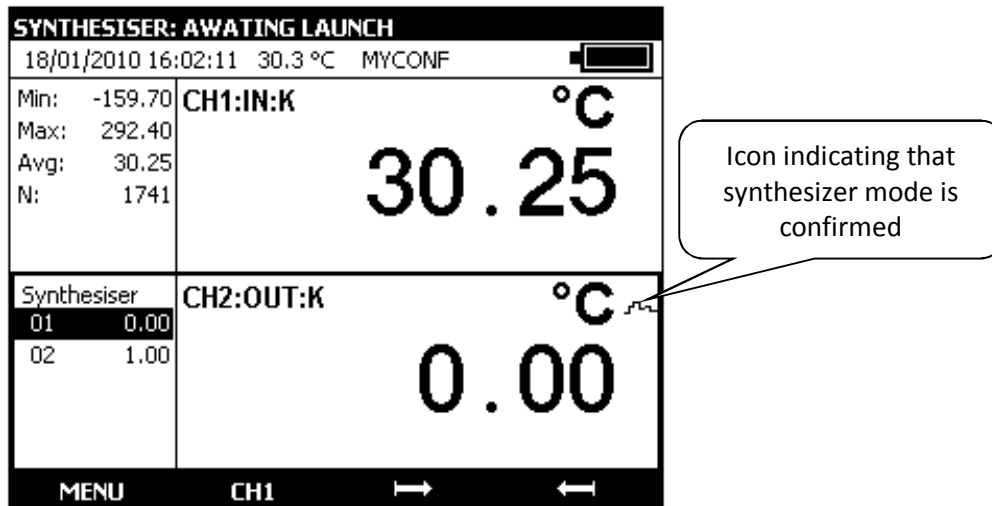
An  icon in the transmission window indicates suspended generation.



B.1.6 Synthesizer Mode

The synthesizer function is used:

- To store up to 100 transmission values in permanent memory,
- To recall and transmit the contents of these memories manually or automatically.

When this mode is active the  icon appears in the transmission window.



The  key is used to launch generation of values in increasing order and the  function key is used to launch generation of values in decreasing order.

The default parameters of this mode are displayed in the left hand side of the transmission window.

The parameters of the synthesizer mode are:

First point no.: number of the first point in a cycle

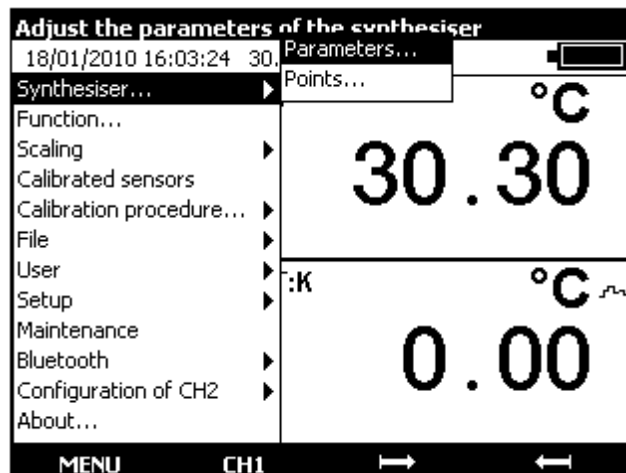
Last point no.: number of the last point in a cycle

T: the duration for which a point is transmitted.

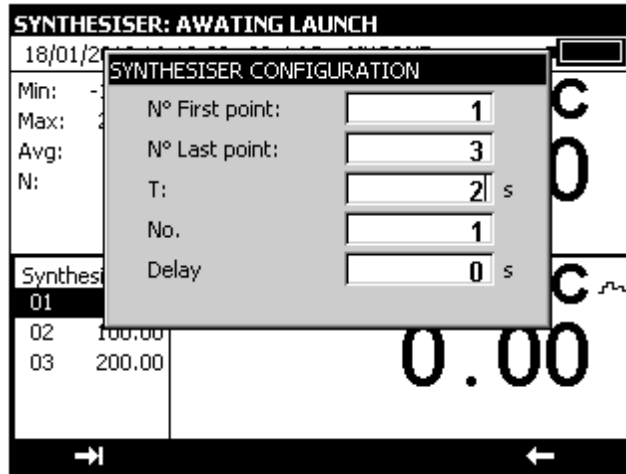
Nbr: the number of polling cycles

Delay: delay between launch and transmission of the first point.

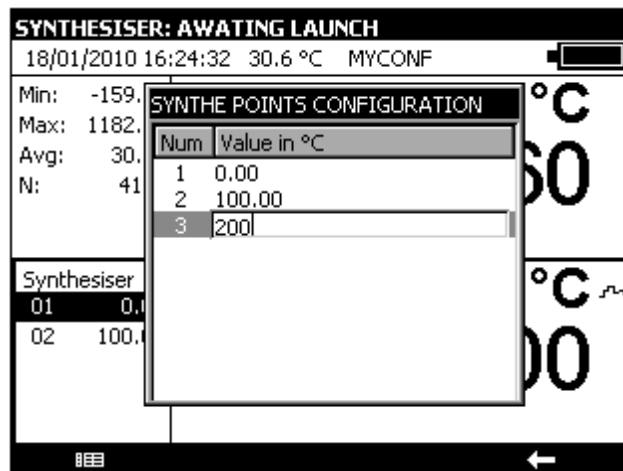
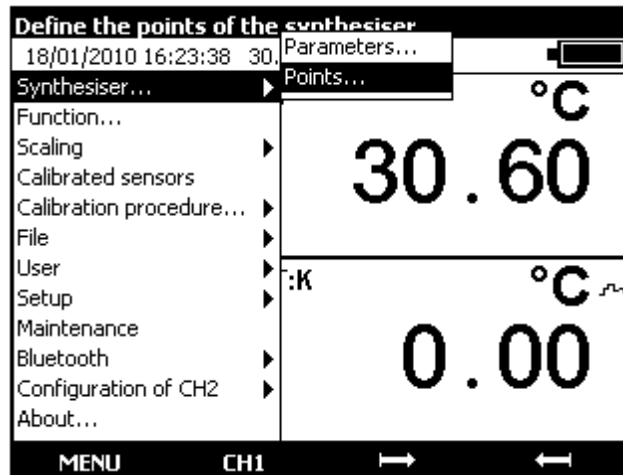
To change these parameters, use the **Menu**  **Synthesizer...**  **Parameters...**




The number of the first point may be higher than that of the last point. All points between the first and last are generated.





To edit the points to be synthesized, use the **Menu** → **Synthesizer...** → **Points....**





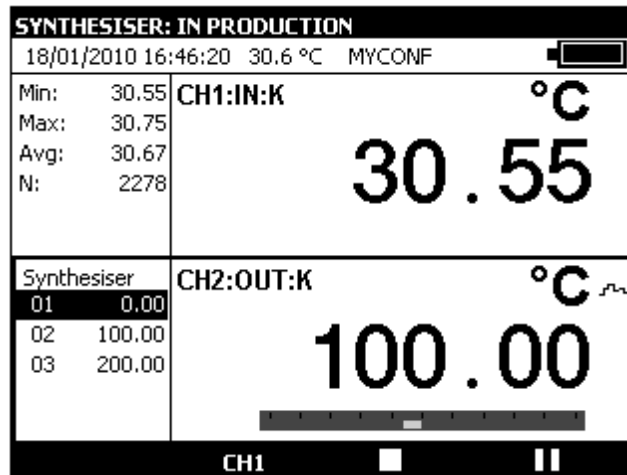
Use the function keys:

 to cancel a point


 to add a point


 to edit a point


use the  and  keys to transmit points according to the parameters defined.




During generation, a progress bar indicates the state of progress. The function keys are used to control generation:

The  key stops generation at any time

The  key suspends generation

The  key commences or resumes generation

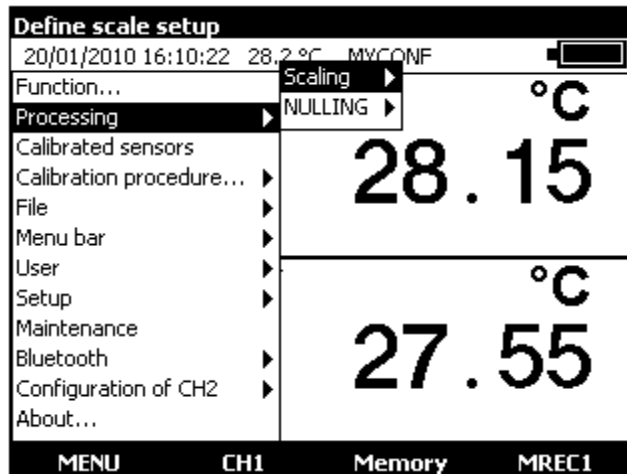
An  icon in the transmission window indicates suspended generation.


B.2 Scaling

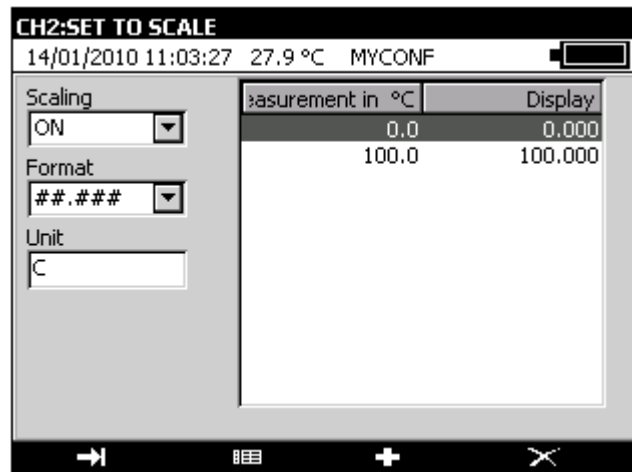
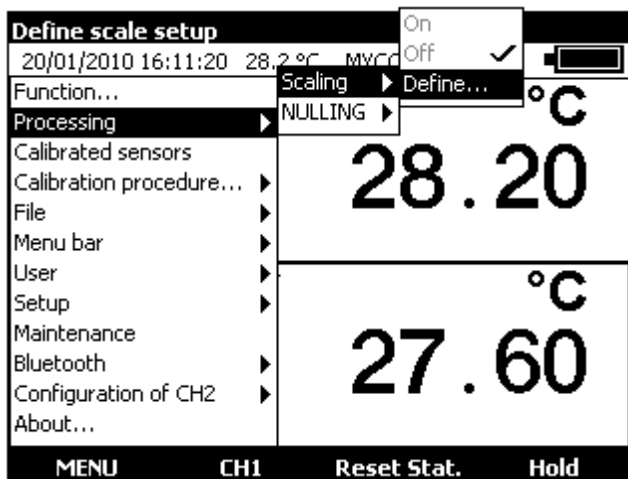
The scale correction function performs a conversion between the electrical quantities measured and the physical quantities converted.

This linearization is used partially to correct errors induced by nonlinear sensor/converter systems.

The Set to scale function is used to define up to 10 segments of a straight line, or 10 points, in order to approach a nonlinear response curve as closely as possible and to perform scale corrections for each segment.



The  symbol is displayed on the screen in the active window when Set to scale is active.




The **Define...** menu is used to program up to 10 lines of 2 values: X and Y= f(X).

In measurement: X = The value measured and Y = The value displayed.


In transmission: X = The Setting displayed and Y = The value transmitted.

The lines entered are sorted according to increasing X to set to scale a value X, the unit searches for the 2 lines n and m=n+1 that enclose it and extrapolates linearly: $Y = Y_n + (X - X_n) \times (Y_m - Y_n) / (X_m - X_n)$

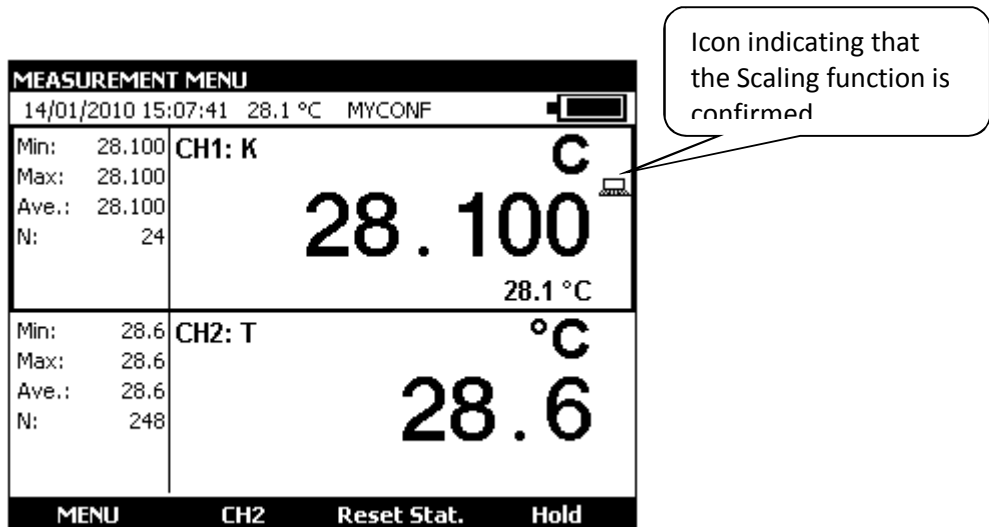
Use the function keys to edit the points:

To Add a line: enter X and Y, then press the  function key.

To select a line from the list, use the Up and Down navigation keys.

To cancel a selected line, use the  key.

The Format and Units zones are used to select the number of decimal places and the display units.

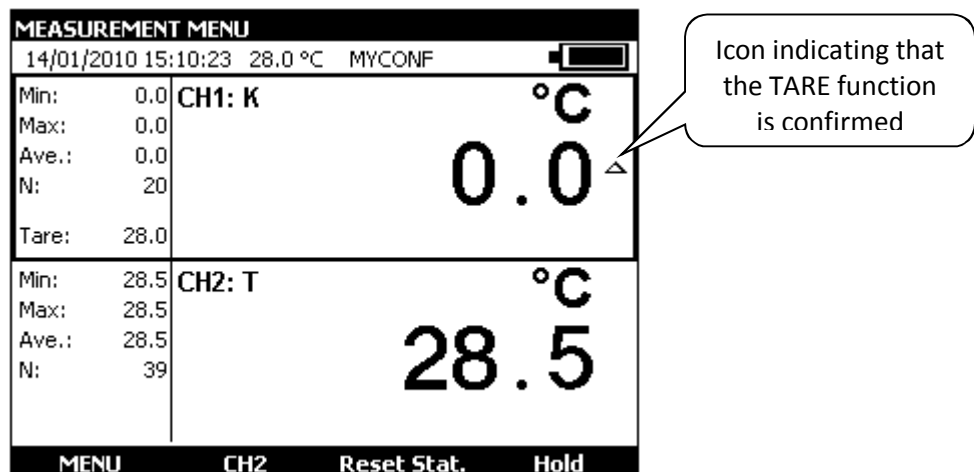
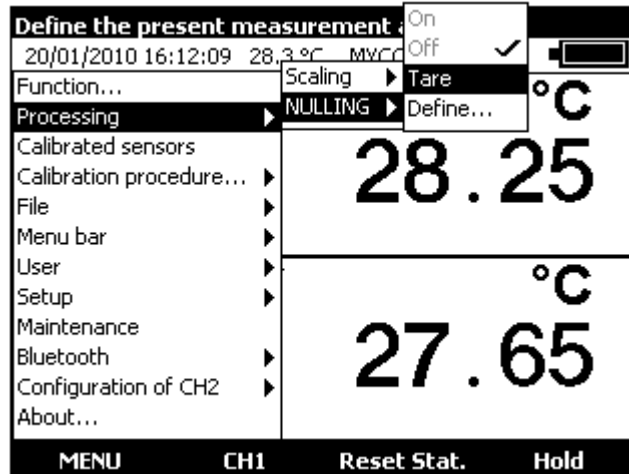


B.3 Differential Measurements

The relative measurement function of the unit is used:

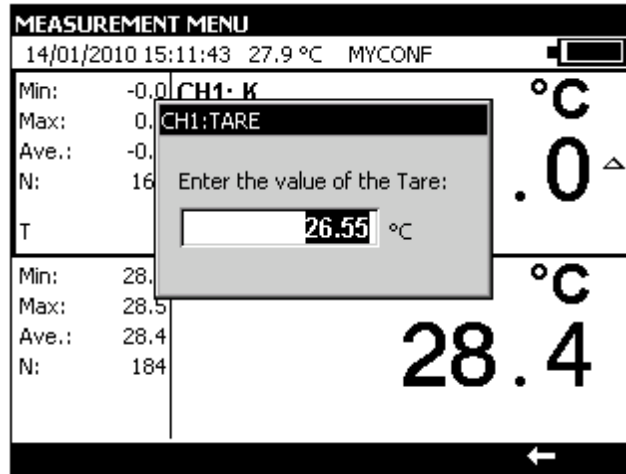
- ✓ to program a reference value other than that of the unit (ZERO function),
- ✓ to cancel by measurement or programming a constant or interfering value (TARE function).

When one of the relative measurement functions is active, the Δ symbol is displayed on the screen in the measurement window.



The **ZERO** → **Define...** menu is used to program the Tare value (positive or negative). This value is subtracted from the measurements:

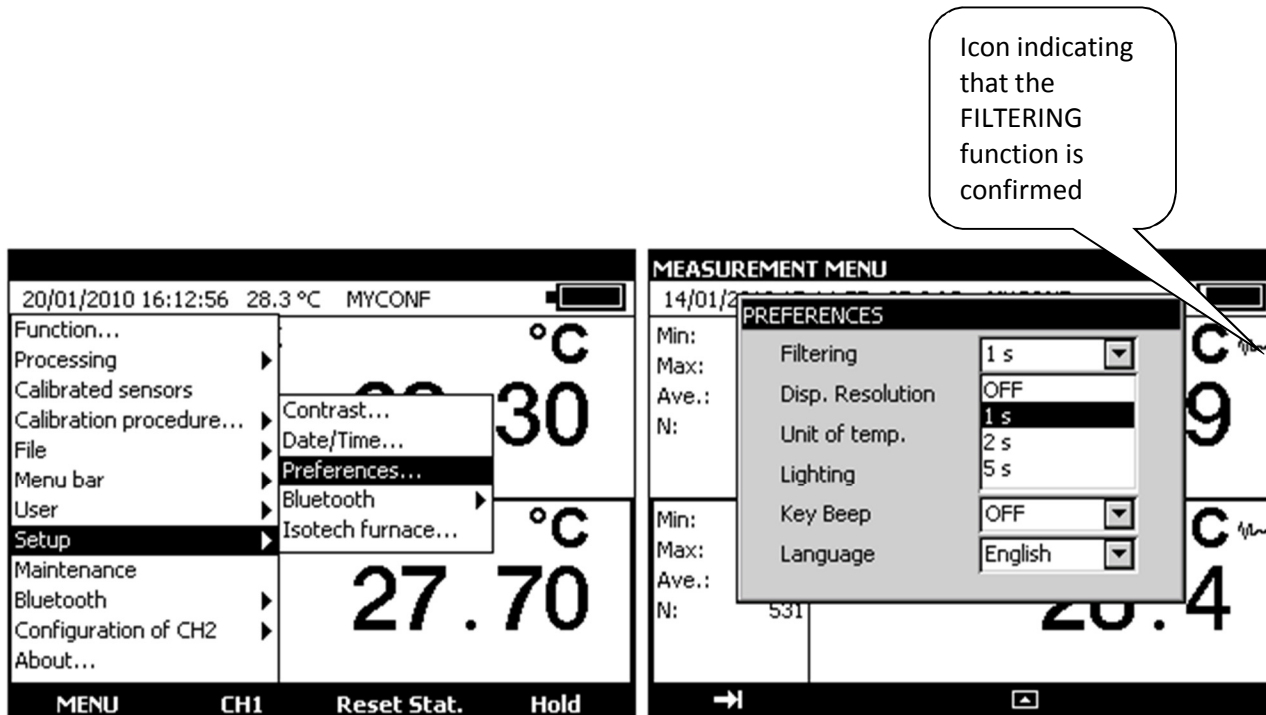
$$\text{Value Displayed} = \text{Value measured} - \text{Tare Value}$$



B.4 Filtering

The Filtering function averages (filters) the measurements over predefined periods (1 s, 2 s and 5 s) in order to avoid excessively wide fluctuations (noise) of the measured signal.

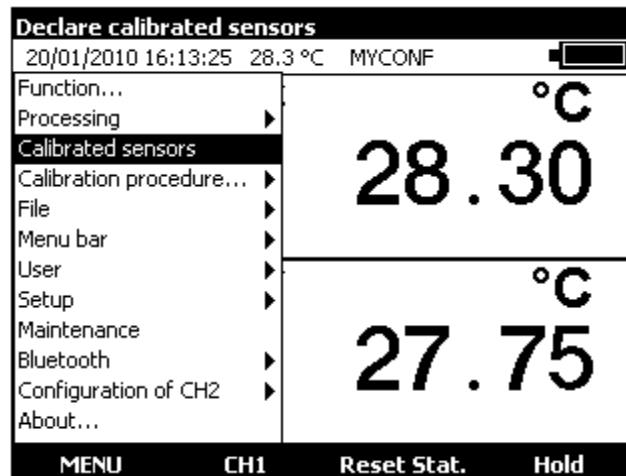
This function is accessible from the **SETUP/PREFERENCE** menu. **



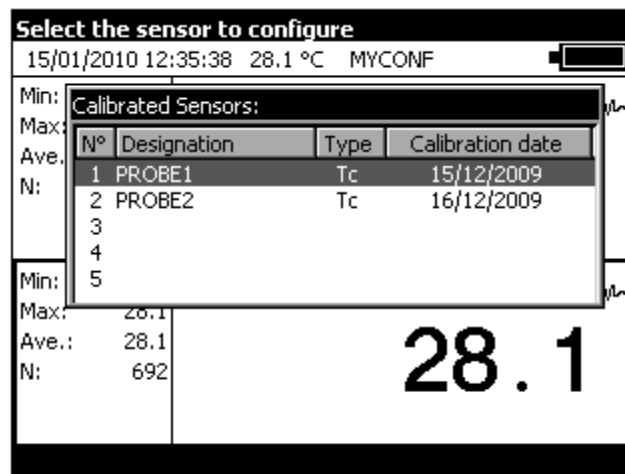
B.5 Calibrated sensors

The unit's calibrated sensors function makes it possible to use sensors of which the calibration (correction) factors can be taken into account by the unit at the time of measurement.

- Open the **MEASUREMENT MENU** dialog box
- select the **Calibrated Sensors** function



- press ENTER.



- Use the Up \wedge or Down \vee arrow buttons to adjust the parameters or select a new line to define a new sensor.
- Press ENTER.

Calibrated sensor no.1

Designation: **PROBE1**

Calibration date: **15** December **2009**

Type: Tc K

Input: Temperature

Point	Ideal temperature °C	Measured °C °C
1	0	1
2	10	10.02
3	100	100.05
4	1000	999.09

Calibrated sensor no.2

Designation:

Calibration date: **1** December **2000**

Type: Tc K

Input: Temperature

Point	Ideal temperature °C	Measured °C °C
-------	----------------------	----------------

- Fill in the information fields for the sensor. To move from field to field, use the function button, F1 (\rightarrow).
- To enter calibration points in the table, use the \oplus button.

Calibrated sensor no.2

Designation: **PROBE2**

Calibration date: **16** December **2009**

Type: Tc K

Input: Temperature

Point	Ideal temperature °C	Measured °C °C
1		0

- Enter the values and press ENTER.

Calibrated sensor no.2

Designation: **PROBE2**

Calibration date: **16** December **2009**

Type: Tc K

Input: Temperature

Point	Ideal temperature °C	Measured °C °C
1	0	0.2

- Use the following buttons to continue configuring a sensor.



to edit an existing calibration point,



to add a calibration point,



to delete a calibration point.

Between 1 and 4 calibration points can be entered per sensor.

These calibration points are used to calculate a polynomial $c(T)$ of degree 0 to 3, giving the sensor's voltage (or resistance) correction at temperature T .

In the specific case where a single calibration point is given, the behavior will differ according to whether the sensor is a thermocouple or a thermometric resistance:

- . In the case of a thermocouple, the correction is a fixed voltage deviation.
- . In the case of a resistive probe, the correction made is an R_0 correction.

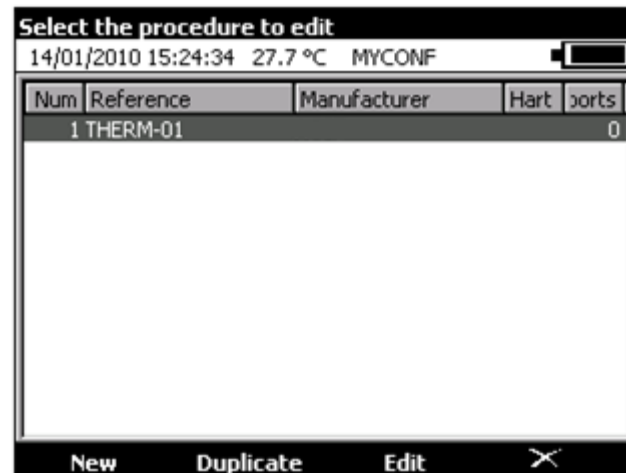
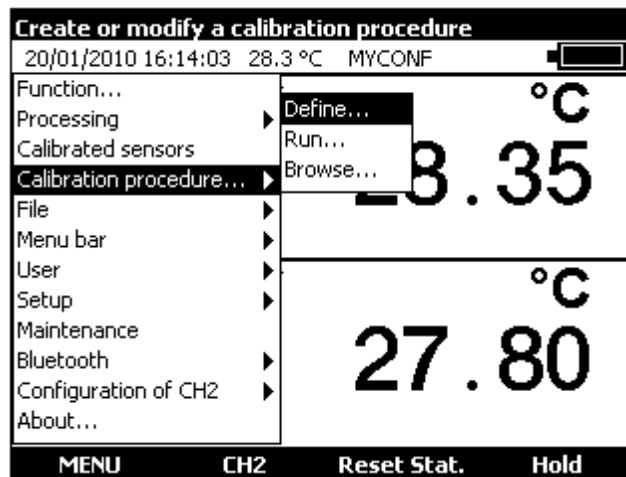
Sensors declared in this manner are added to the list of couple types (or of probe types) proposed in the measurement function settings dialog box. They appear at the top of the list, in front of the standard sensors. Their name is preceded by the '*' character, indicating that these are calibrated sensors.

B.6 Calibration procedure

The T150 is capable of creating a calibration report from a pre-defined procedure.

The number of procedures that can be recorded depends on the size of the available memory and the size of each procedure (number of test points). If the memory is not being used by other functions, it is possible to record several tens of procedures. To find the available memory size, refer to the chapter, Storage of current acquisitions (chapter 6).

- Open the **MEASUREMENT MENU** dialog box,
- Select the **Calibration procedure** function,
- Press ENTER.



- Use the Up \wedge or Down \vee arrow buttons to adjust the parameters or press the function button **F1** (new) to define a new procedure. A procedure may be duplicated with the F2 key (Duplicate). The F4 key is used to delete a selected procedure.
- Press ENTER.

The screenshot shows a handheld device screen with the following fields and values:

Field	Value
Device name:	THERM-01
Manufacturer:	Wahl
Calibration method:	By comparison
Device measurement:	Channel 1
Reference measurement:	Keyboard entry
Generator:	Channel 2 Keyboard entry

- With edit keys, enter "Device name" which is displayed in the "Reference" field in the above list.
- Enter "Manufacturer" name which is displayed in the "Manufacturer" field in the above list.

The device is designed to operate using the “by comparison” calibration method only:

- Select the Device Measurement mode: Channel 1 or Keypad entry.

The screenshot shows a handheld device screen with the following fields and values:

Field	Value
Device name:	THERM-01
Manufacturer:	Wahl
Calibration method:	By comparison
Device measurement:	Channel 1
Reference measurement:	Channel 1 Keyboard entry
Generator:	Isotech furnace

- Select the Reference Measurement mode: Channel 2 or Keypad entry.
- Select the Generator: Isotech oven or Other (manual control).

Proc. 'THERM-01':General parameters
 11/02/2010 13:10:50 26.2 °C MYCONF

Device name: THERM-01

Manufacturer: Wahl

Calibration method: By comparison

Device measurement: Channel 1

Reference measurement: Channel 2

Generator: Isotech furnace

Isotech furnace

Other (manual command)

Press ENTER to confirm the options in this screen, then select the probe type for channel C2 then channel C1.

Proc. 'THERM-01':Reference measurement (CH2)

Measurement function: Rt

Type of probe: Pt100

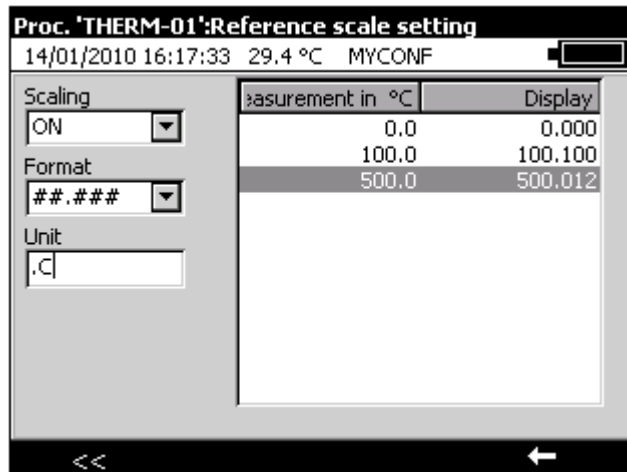
Connection: Auto

Display unit: °C




Scaling: OFF

You have the option of applying scaling to the device:

- Select ON and configure the settings.





- Press key **F2** (Points) to set calibration points.
- Use the following buttons to define the points.


-  to edit an existing calibration point,
-  to add a calibration point,
-  to delete a calibration point.



To define the calibration sequence:

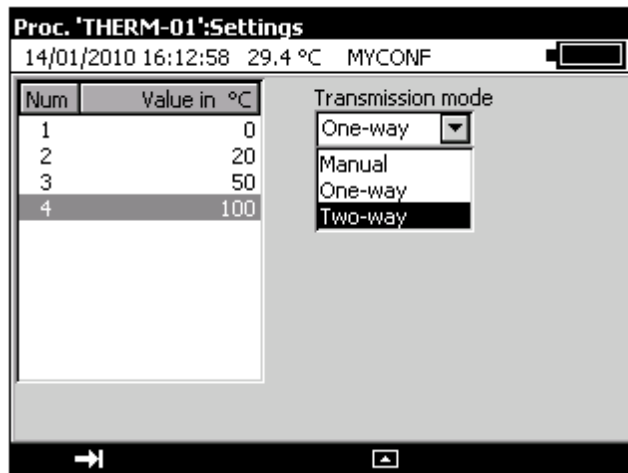
- Use the following keys to define the points: to change a calibration point

 To edit an item already published

 To add a point

 To remove a point

Press function key F1 () , select the **Transmission mode** field, press function key F4 () to open the drop-down menu, and use the Up \wedge or Down \vee navigation keys to select the transmission mode.



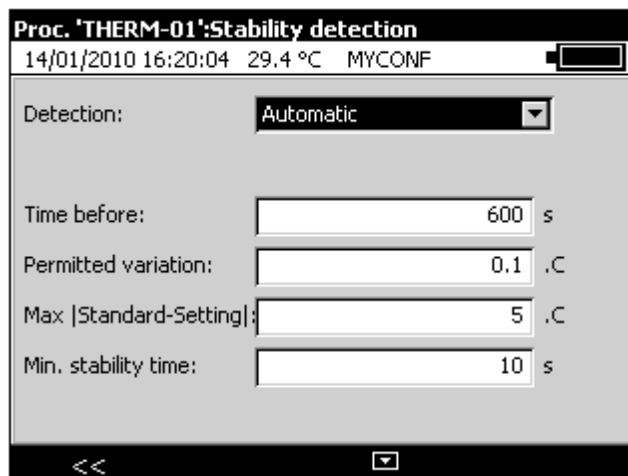
Definitions of transmission modes:

Manual: the settings are generated under manual control with the user accepting each point,

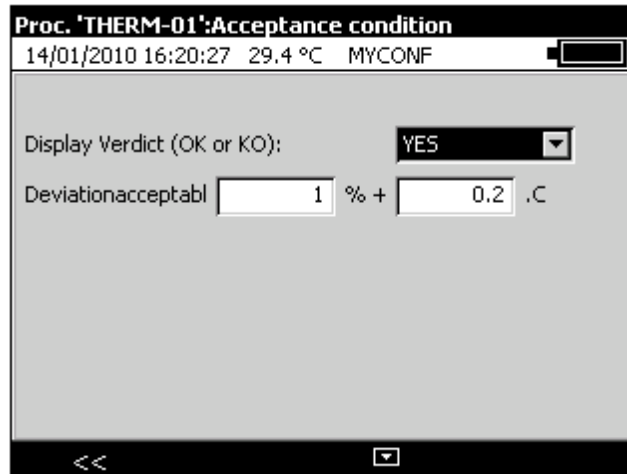
One-Way: the settings are generated automatically in the order in which the points (Point 1, Point 2, Point3 etc.) are defined,

Two-Way: the settings are generated automatically in the order in which the points (Point 1, Point 2, Point3 etc.) are defined and then in reverse order (Point n, Point (n-1) etc.).

- Define the quiescent point and press ENTER.
- Define the stability detection.



To define the acceptance conditions:

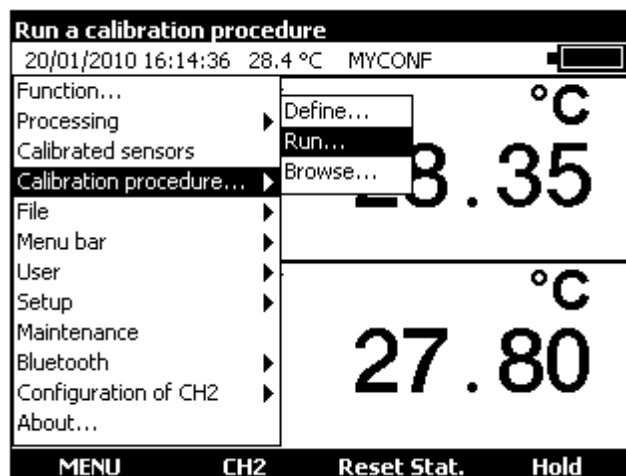


The unit may be set to display a "Verdict": "OK" or "KO" at the end of the procedure. In this case, set permissible deviation in percent and units (according to the type of measurement).



When editing is completed, exit Menu with ESC key.

To run a calibration procedure, return to "Calibration procedure" menu and select "Run".



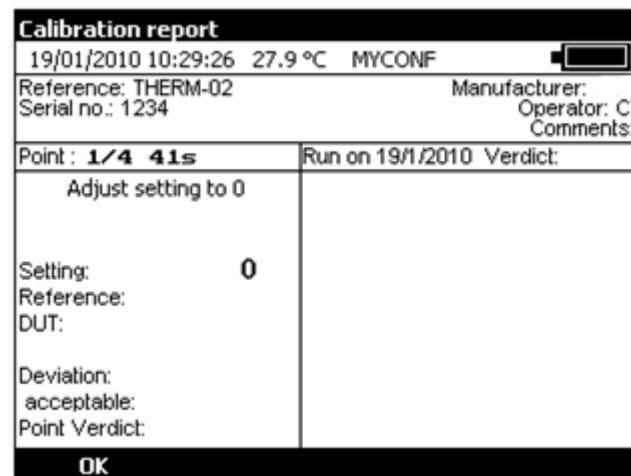
- To run a procedure, select it and press the **F4** key (Run) or **Enter** key.



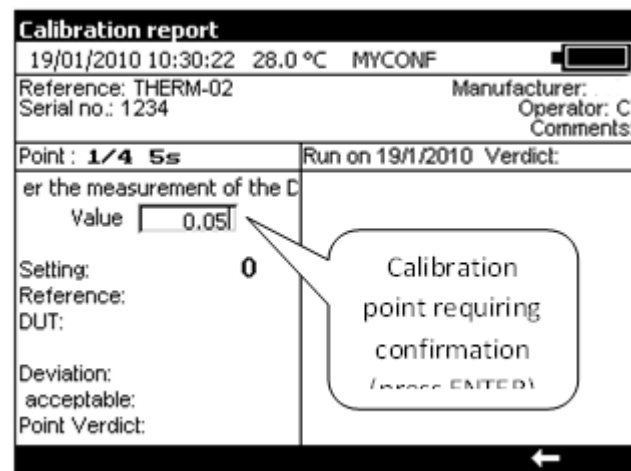
- After completing the fields, start execution by pressing **F3** (Execute).

Example of a procedure run manually (device and reference) with Isotech oven:

The first screen requests definition of the Isotech oven setting (first point at 0 °C):

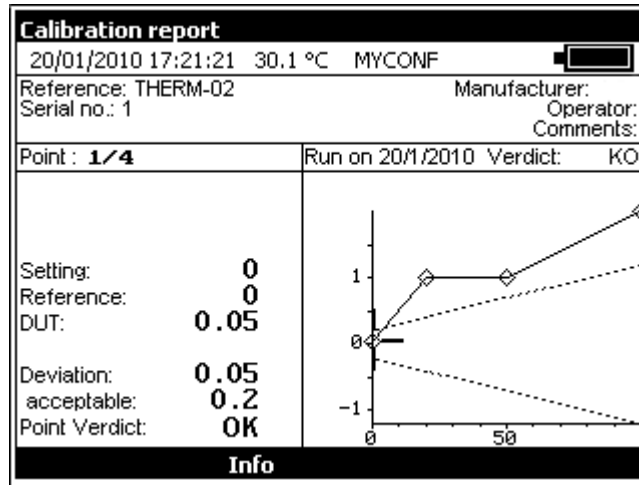


- Press key **F1** (OK) the key **F3** (Stable) when the temperature is stable.
- Enter the value of the product under test (C1).



Enter the value of the reference (C2).

Repeat for each point defined in the procedure.



- Press function key **F1** to save the report (the report number is displayed in the Reports column).

Select the procedure to run
 20/01/2010 17:06:58 29.6 °C MYCONF

Num	Reference	Manufacturer	Hart	ports
1	THERM-01	Wahl		0
2	THERM-02	Wahl		1

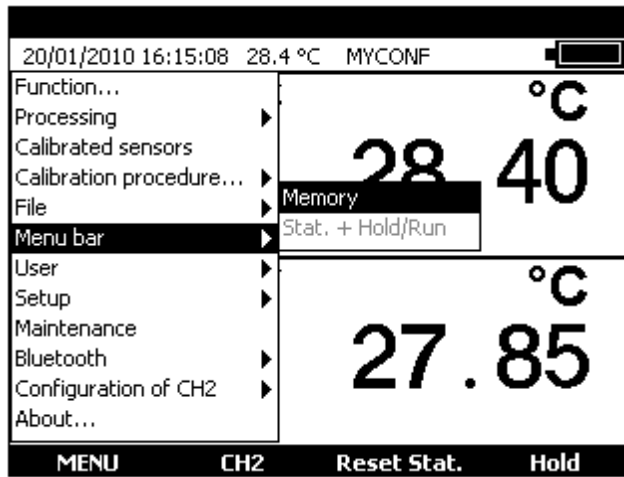
New Duplicate Edit Run

- To display the reports, select the procedure: MENU/CALIBRATION PROC./BROWSE then ENTER.
- Select the procedure and press function key **F2** (Reports).
- Select the report to be displayed from the list, then press function key **F1** (Display) to confirm.

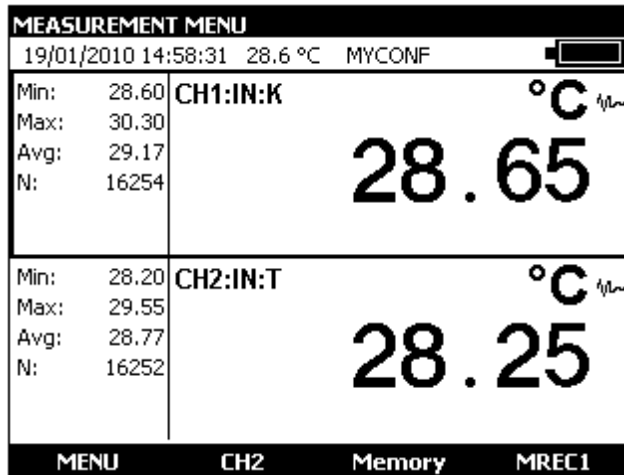
B.7 Storing the current acquisitions

The T150 is capable of storing 10,000 values in one or more acquisition bursts.

- If necessary, use the F2 button to open the „IN“ window and display the **Measurement** menu bar.
- Press F1 key to open Menu
- Select the **Menu** function then **Memory**.



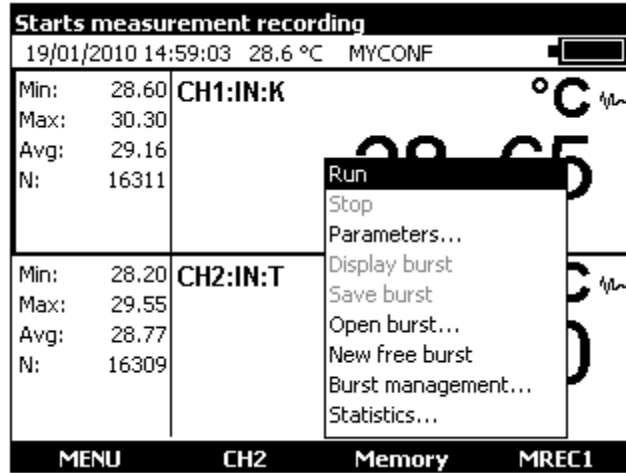
- Press ENTER.



Two new functions, Memory and MREC1, then appear in the bottom bar (replacing the functions Rest stat. And Hold). The left < and right > arrow buttons can be used to switch from one mode to the other.

Pressing the function button, **F4** (MREC1), stores the current acquisition.

Pressing **F3** (Memory) gives access to all the memory functions.



RUN:

Starts the storage of data as configured using the **Parameters** function. The icon is shown in the Measurements window.

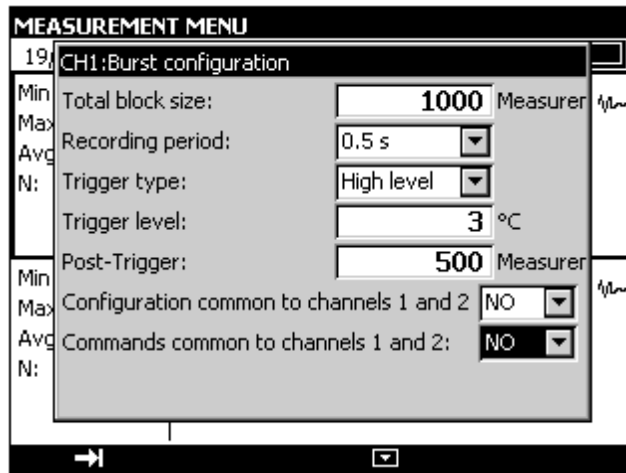
STOP:

Stops the current storage operation.

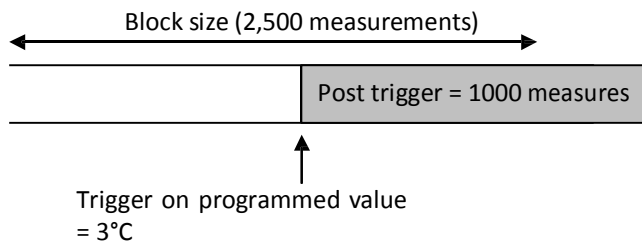
PARAMETERS

This can be used to define:

- the burst size (10,000 values max.),
- the sampling period, from 0.5 sec. to 30 min,
- and the type of trigger (none, low level, high level).
- the same parameters may be selected for both channels (V1 and V2),
- the same commands common to both channels (V1 and V2) may be selected



If high-level or low-level trigger is selected, the trigger level and number of data points to be stored after this trigger must be defined.



Burst display: The burst can be displayed as a table of values or a trend curve.

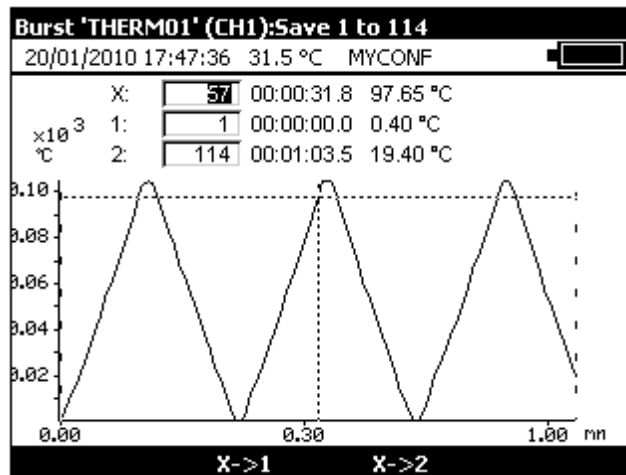
Burst 'THERM01' (CH1):
 20/01/2010 17:46:59 31.5 °C MYCONF

Start date: 20/01/2010 14:42:10

N°	Time	Value	Unit
1	00:00:00.0	0.40	°C
2	00:00:01.0	8.75	°C
3	00:00:02.0	16.00	°C
4	00:00:02.5	21.00	°C
5	00:00:03.0	26.05	°C
6	00:00:03.5	31.05	°C
7	00:00:04.0	36.15	°C
8	00:00:04.5	41.25	°C
9	00:00:05.0	46.40	°C
10	00:00:05.5	53.80	°C

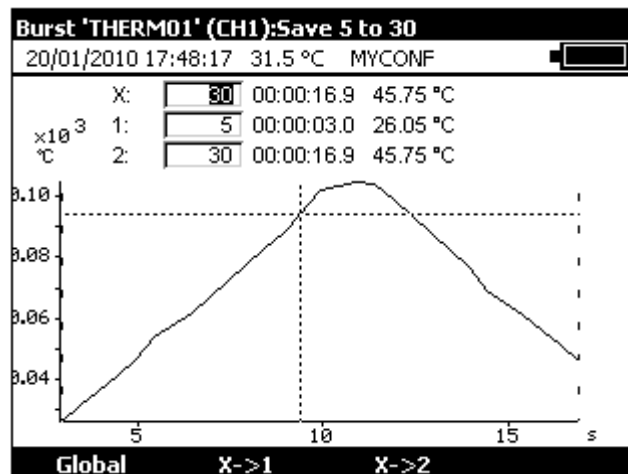
1-> 2-> Graph STAT

At this level, markers can be set (F1 and F2 function keys) and all values falling between these 2 markers can be displayed in graphical form. To display all the values in memory, press the function button, **F1** (Global).

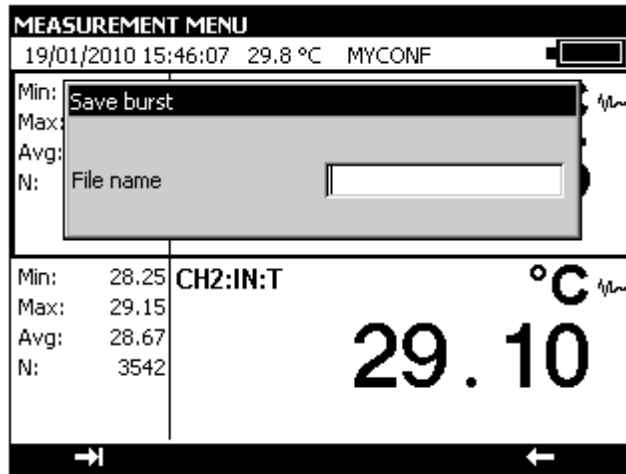


The left < and right > arrow buttons can be pressed to move the cursor and read off the abscissa and ordinate values. At this level, the markers can be redefined in order to zoom in between these two new points:

- in the X field, enter a low value for the marker (X1), press ENTER and then press the function button, F2 (X1),
- in the X field, enter a high value for the marker (X2), press ENTER and then press the function button, F3 (X2).

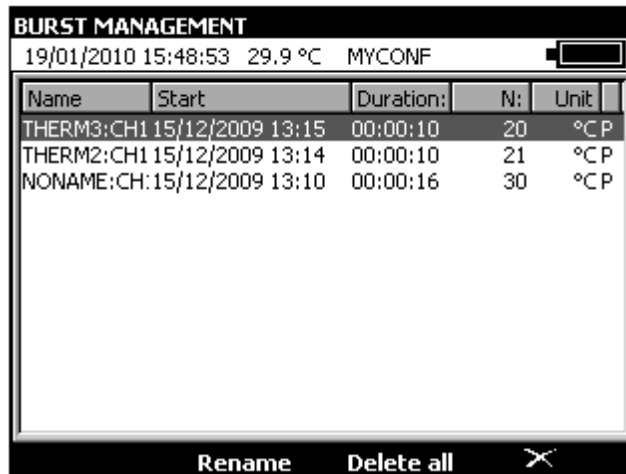


Burst save: stores the current burst.



Burst open:

Allows a burst to be selected for opening in order to view the data. At this level, a burst can be renamed or one or more bursts can be deleted.



New burst:

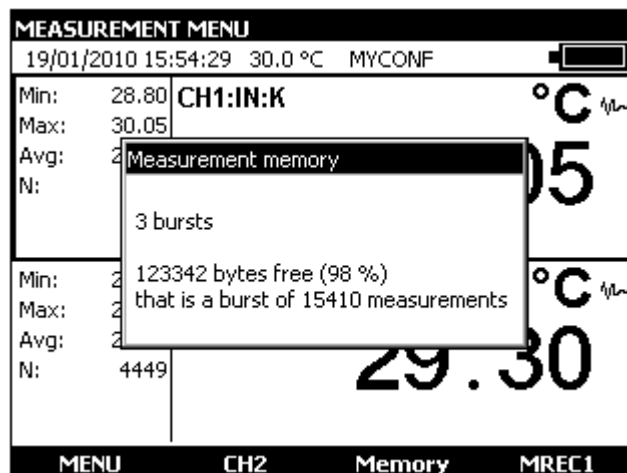
Starts a new burst. If a burst is running, the user will be asked if this should be saved.

Burst management:

Can be used to view all bursts in memory. At this level, a burst can be renamed or one or more bursts can be deleted.

Statistics:

Shows the number of bursts in memory, the number of free bytes and the number of measurements that can be saved.

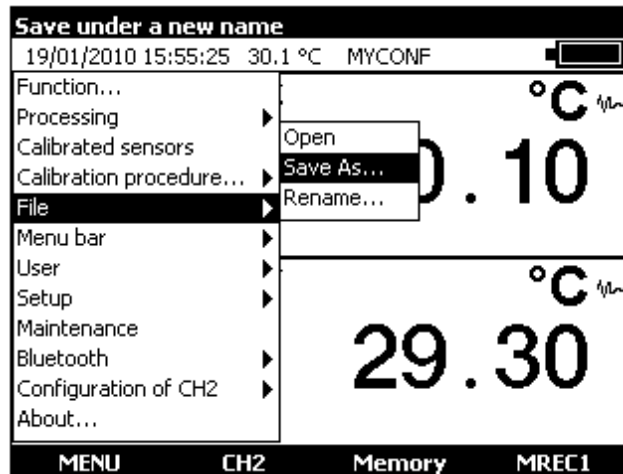


B.8 Configurations

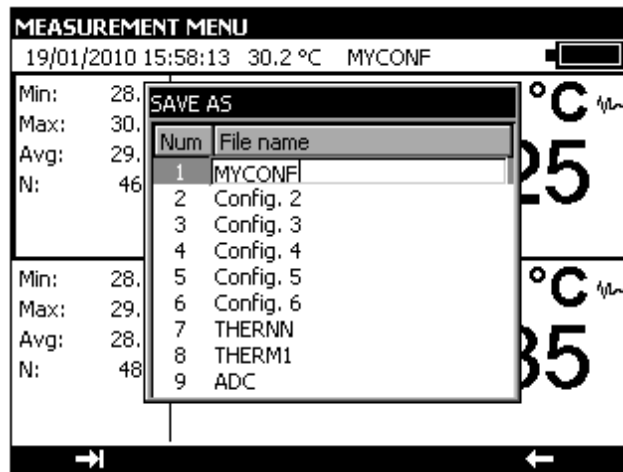
A configuration is the state of the T150 at a given moment. The state of the unit includes:

- The current functions and ranges for measurement and simulation,
- The parameters of all the transmission modes (staircase, ramp, synthesizer, etc.),
- The scale corrections applied,
- All the preferences defined in paragraph C.9.3.

To save the state of the unit, use the **Menu** \rightarrow **File** \rightarrow **Record under...**



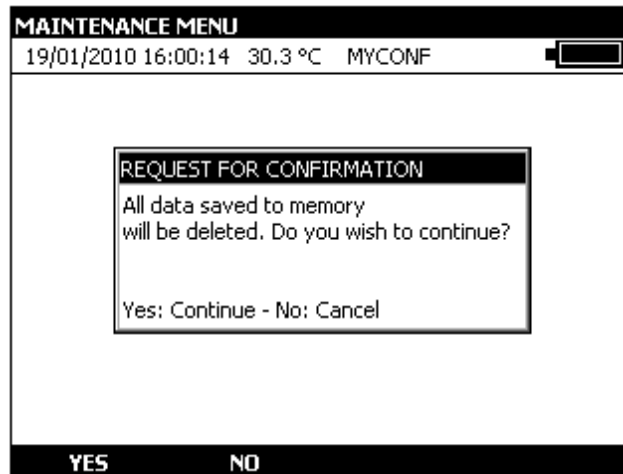
Use the navigation keys to select a configuration. Edit the name of the configuration to be saved with the alphanumeric keys and confirm with ENTER.



To recall a configuration from memory, use the **Menu** → **File** → **Open...**

Use the navigation keys to select a configuration. Confirm with ENTER.

To erase the configurations of the T150, refer to paragraph **A.5.2** to enter the Maintenance mode. Use the **Init EEP** function key to reset the configurations of the unit to zero.



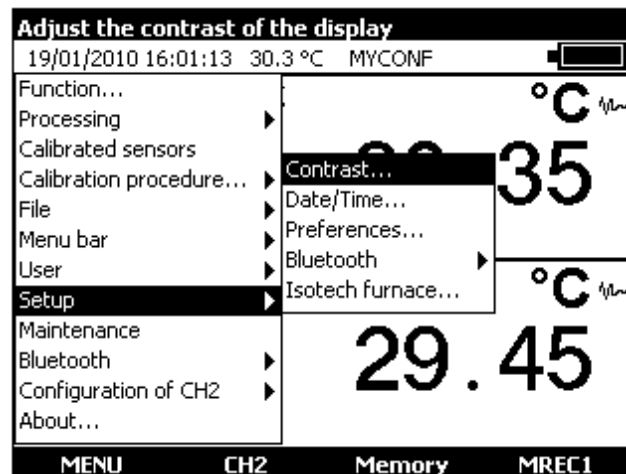
B.9 Setting parameters

The parameters of the T150 can be set using the **Configuration** → **Setup** menus.

The **Contrast...** sub menu is used to adjust the contrast of the display.

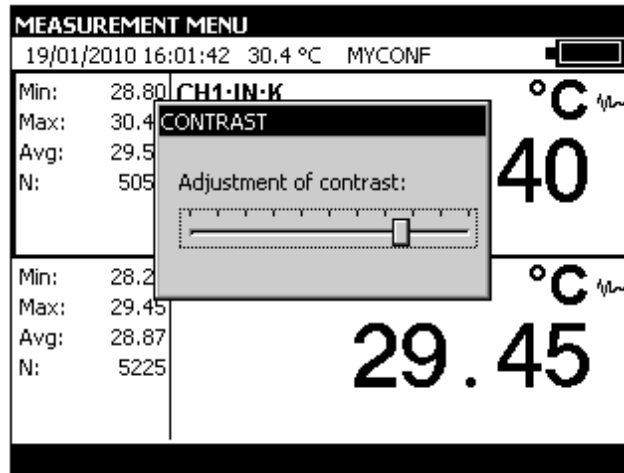
The **Date/Time...** sub menu is used to set the date and time of the unit.

The **Preferences...** sub menu is used to set the generic parameters which apply to all the functions performed by the T150.



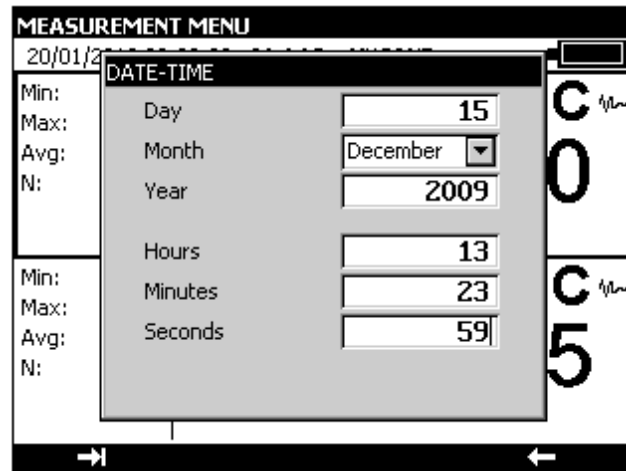
B.9.1 Adjustment of contrast

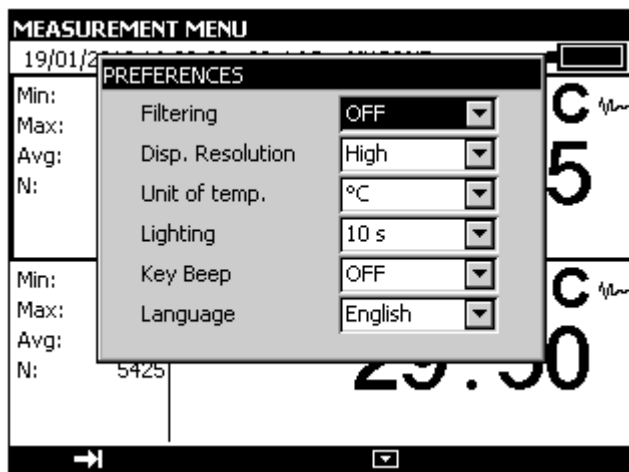
Use the Right and Left navigation keys to adjust the contrast of the display. The T150 saves the setting made in its nonvolatile memory and uses it each time the unit is switched on.



B.9.2 Date and Time

To set the date and time, use the **Configuration** → **Setup** → **Date/Time...** menus.





To display the Preferences dialog box, use the **Configuration** → **Setup** → **Preferences...** menus.

The adjustable parameters are:

Filtering: Used to average measurements before display. When filtering is switched off, the integration time for measurements is 0.5 seconds.

Resolution: Used to adjust the resolution of the measurements when displayed. There are three possible choices:

- HIGH: displays measurements with the highest possible resolution.
- AVERAGE: displays one digit fewer compared with the HIGH resolution mode.
- LOW: displays two digits fewer compared with the HIGH resolution mode.

Temperature units: used to select the temperature units, either °C, °F or K, for measurements and simulation.

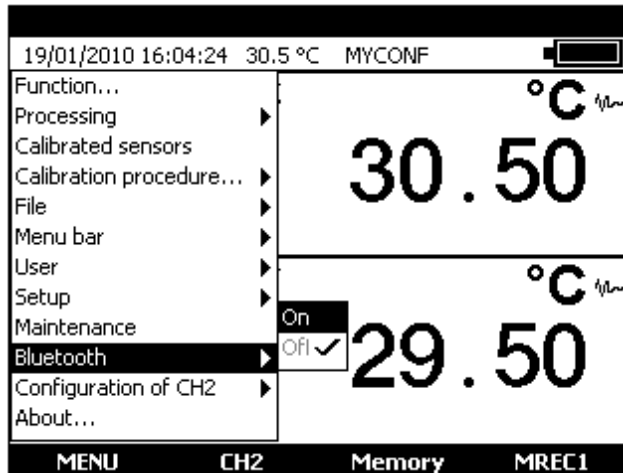
Lighting: used to set the on time of the lighting before it is switched off to save the batteries.

Beep keys: used to switch on or off the transmission of an audible signal when pressing keys on the keyboard.

Language: used to select the language of the display in menus, dialog boxes and on-line help.

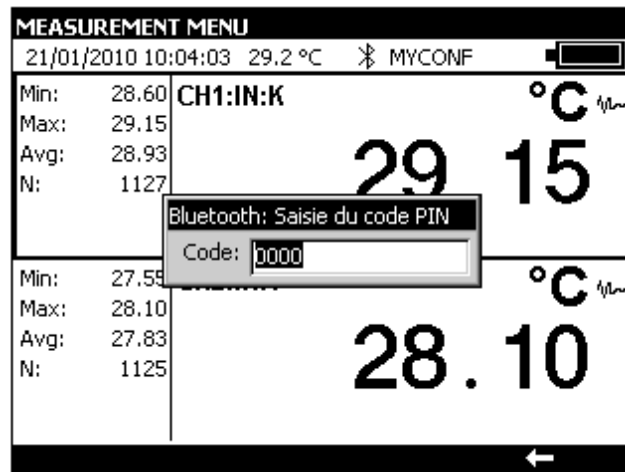
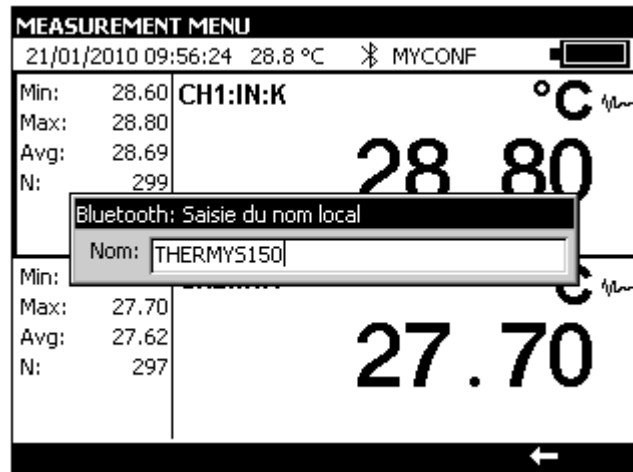
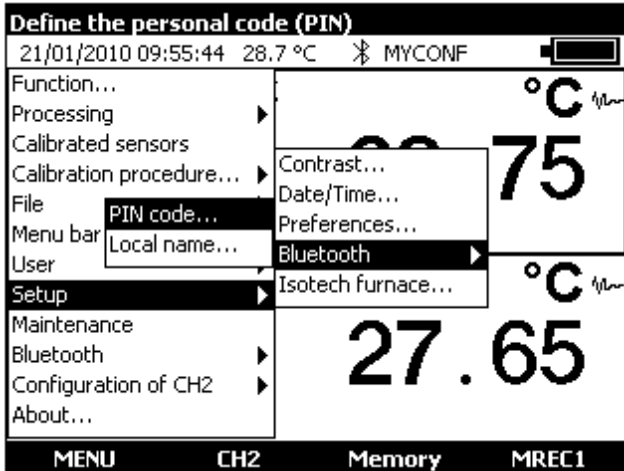
B.10 Bluetooth® Interface Configuration

The Bluetooth® module is enabled with the F1 key **MENU**→ **Bluetooth** → **ON**



A name may be assigned to a unit connected to a Bluetooth® network with the F1 key **MENU**→ **Setup**→ **Bluetooth** → **Name local**.

An access code (PIN code) may be defined which will be requested when connecting to the network. By default, this PIN code is 0000.



c. TECHNICAL SPECIFICATIONS

The accuracies quoted apply at + 18°C to + 28°C unless otherwise stated, and are expressed as $\pm (n \% L + C)$ where L = The reading and C = a Constant expressed in practical units. The specifications are given for a confidence level of 95%.

They apply to a product placed under reference conditions of measurement defined hereafter:

- Power up unit and warm up for 30 minutes.
- Using instrument not connected to mains (230V or 110V).
- Wait for thirty minutes after disconnecting AC/DC power adaptor.
- For weak signals (temperature measurement by thermocouple probes) use connections with spade terminals or bare wires.
- Acquisition in filtered mode (averaged)

The accuracy includes the accuracy of the reference standards, non-linearity, hysteresis, repeatability and long term stability over the period quoted.

c.1 Measurement Function (Channel 1 and channel 2)

c.1.1 DC voltage (Cal TC 75mV)

Range	Specified measurement	Resolution	Accuracy/1 year	Notes
+75mV	- 10mV + 75mV	1 μ V	0,005% + 2 μ V	Rin > 10 Ω M

Temperature coefficient <5 ppm/°C from 0°C to 18°C and from 28°C to 50 °C. Use the absolute value of the value measured (|L|) to calculate the accuracy.

c.1.2 Resistance (Cal PT100/PT1000)

Range	Specified measurement range	Resolution	Accuracy/1 year	Notes
400 Ω	0 Ω à 400 Ω	1 m Ω	0,006% L + 8 m Ω	4-wire measurement
3600 Ω	0 Ω à 3600 Ω	10 m Ω	0,006% L + 50 m Ω	4-wire measurement

Temperature coefficient < 5 ppm/°C from 0°C to 18°C and from 28°C to 50 °C. Automatic detection of connection scheme: 2 wire, 3 wire or 4 wire.

For 2 wire connection, the measurement includes the resistance of the line.

For 3 wire connection, add the out-of-balance of the line resistances.

c.1.3 **Temperature by thermocouples**

Sensor types:

- in accordance with CEI 584-1/1995 (couples K, T, J, E, S, B, N),
- in accordance with Din 43710 (couples U and L),
- in accordance with the ENGELHARD table (platinum couple).
- As per standard ASTM E 1751-00 (G couple)
- As per standard ASTM E 988-96 (D W3Re/W25Re couple; C W5Re/W26Re couple)

Sensor	Measuring range	Resolution	T150 Drift / year
K	- 250° to - 200°C - 200° to - 120°C -120° to + 1 372°C	0.2°C 0.05°C 0.05°C	0.50°C 0.15°C 0.0050 % L + 0.08°C
T	- 250° to - 200°C - 200° to - 100°C - 100° to + 80°C + 80° to + 400°C	0.2°C 0.05°C 0.05°C 0.05°C	0.50°C 0.05% L + 0.06°C 0.015% L + 0.07°C
J	- 210° to - 120°C - 120° to + 60°C + 60° to + 1 200°C	0.05°C 0.05°C 0.05°C	0.15°C 0.005% L + 0.07°C 0.0025 % L + 0.06°C
E	- 250° to - 200°C - 200° to + 100°C + 100° to + 1 000°C	0.1°C 0.05°C 0.05°C	+ 0.30°C + 0.06°C 0.005 % L + 0.05°C
R	- 50° to + 0°C + 0° to + 150°C + 150° to + 1 768°C	0.5°C 0.2°C 0.1°C	+ 0.60°C + 0.60°C + 0.3°C
S	- 50° to + 150°C + 150° to +1450°C + 1450° to + 1 768°C	0.5°C 0.2°C 0.1°C	0.80°C 0.30°C 0.35°C
B	+ 400° + 900°C + 900° + 1 820°C	0.2°C 0.1°C	0.005 % L + 0.4°C 0.005 % L + 0.2°C
U	- 200° to - 100°C - 100° to + 660°C	0.05°C 0.05°C	+ 0.13°C + 0.09°C
L	- 200° to + 900°C	0.05°C	+ 0.10°C
C	- 20° to + 900°C + 900° to + 1 730°C + 1 730° to + 2 310°C	0.1°C 0.1°C 0.1°C	0.15°C 0.008 % L+ 0.12°C 0.015 % L+ 0.12°C
N	- 240° to - 190°C - 190° to - 110°C - 110° to + 0°C + 0° to - 400°C + 400° to + 1 300°C	0.2°C 0.1°C 0.05°C 0.05°C 0.05°C	0.25% L 0.1% L % L + 0.06°C 0.08°C % L + 0.06°C
PlatineL	- 100° to + 100°C + 100° to + 1 400°C	0.05°C 0.05°C	0.15°C 0.005% L + 0.06°C
Mo	0° + 1 375°C	0.05°C	0.005 %L + 0.06°C
NiMo/NiCo	- 50° to + 1 410°C	0.05°C	0.005 %L + 0.30°C
G	0° to + 100°C 100° to + 200°C 200° to + 1 800°C	0.05°C 0.05°C 0.05°C	1.5°C 0.40° C
D	0° to + 1 000°C 1 000° to + 2 000°C 1 800° to + 2 315°C	0.05°C 0.05°C 0.05°C	0.20°C 0.015% L 0.02% L

The precision is guaranteed for a reference junction temperature of 0 °C.

When using the internal reference junction (except couple B) add an additional uncertainty of 0.2 °C at 0 °C. For other temperatures, account must be taken of the sensitivity of the thermocouple to the temperature (T) in question, giving an additional uncertainty of $0.2^{\circ}\text{C} * S(0^{\circ}\text{C})/S(T)$.

- Temperature coefficient: < 10 % of the accuracy/°C.
- Display in °C, °F and K.
- It is possible, thermocouple B excepted, to choose the location of the cold junction by programming from the keyboard:
 - external at 0°C,
 - internal (compensation for the temperature of the terminals of the unit).
 - by programming the temperature.

c.1.4 Temperature using resistive probes

Type of sensors:

- Pt 10ohm, 50ohm, 100ohm, 200ohm, 500ohm, 1,000ohm with $\alpha = 3851$ as per CEI 751/1995
- Pt 100ohm with $\alpha = 3916$ as per JIS C 1604/1989
- Pt 100ohm with $\alpha = 3926$ as per EIT90
- Ni 100ohm, 1,000 ohm with $\alpha = 618$ as per DIN 43760
- Ni 120ohm with $\alpha = 672$ as per MIL-T-24388
- Cu 10ohm with $\alpha = 427$ as per MINCO 16/9
- Cu 50ohm with $\alpha = 428$ as per OIML R 84

Sensor	Specified	Resolution	Accuracy/1 year
Pt 50 ($\alpha = 3851$)	- 220°C + 850°C	0.01°C	0.006% L + 0.04°C
Pt 100 ($\alpha = 3851$)	- 220°C + 850°C	0.01°C	0.006% L + 0.03°C
Pt 100 ($\alpha = 3916$)	- 200°C + 510°C	0.01°C	0.006% L + 0.03°C
Pt 100 ($\alpha = 3926$)	- 210°C + 850°C	0.01°C	0.006% L + 0.03°C
Pt 200 ($\alpha = 3851$)	- 220°C + 850°C	0.01°C	0.006% L + 0.04°C
Pt 500 ($\alpha = 3851$)	- 220°C + 850°C	0.01°C	0.006% L + 0.03°C
Pt 1 000 ($\alpha = 3851$)	- 220°C + 850°C	0.01°C	0.006% L + 0.03°C
Ni 100 ($\alpha = 618$)	- 60°C + 180°C	0.01°C	0.006% L + 0.05°C
Ni 120 ($\alpha = 672$)	- 40°C + 205°C	0.01°C	0.006% L + 0.05°C
Ni 1 000 ($\alpha = 618$)	- 60°C + 180°C	0.01°C	0.006% L + 0.05°C
Cu 10 ($\alpha = 427$)	- 50°C + 150°C	0.10°C	0.006% L + 0.18°C
Cu 50 ($\alpha = 428$)	- 50°C + 150°C	0.01°C	0.006% L + 0.05°C

For negative temperatures, use the displayed value L and not its absolute value.

Temperature coefficient: < 10 % of the accuracy/°C.

The above accuracy is given for 4 wire connection of the temperature sensor ("Y shaped lug" connection).

Taking into account, also, the intrinsic error of the temperature sensor used and its conditions of use

C.2 "Transmission/simulation" function

Maximum rated voltage in common mode: 60 VDC or VAC.

C.2.1 DC Voltage (Cal TC 75mV)

Range	Resolution	Specified measurement range	Accuracy/1 year	Notes
+75mV	- 5mV + 75mV	1 μ V	0.005% + 2 μ V	Output load min = 1 k Ohm

Temperature coefficient < 5 ppm/°C from 0°C to 18°C and from 28°C to 50 °C.

C.2.2 Resistance (Cal PT100 \approx 400 Ohm ; Cal PT1000 \approx 3600 Ohm)

Range	Specified measurement	Resolution	Accuracy/1 year	Notes
400 (direct current)	1 Ω to 400	10 m Ω	0.006% L + 20 m Ω	Test at 0.1 mA / 1 mA
400 (Pulsed)	1 Ω to 400	10 m Ω	0.006% L + 30 m Ω	Test at 0.1 mA / 1 mA
3600 (direct current)	10 Ω to 3600	100 m Ω	0.006% L + 100 m Ω	Test at 0.1 mA / 1 mA
3600 (Pulsed current)	10 Ω to 3600	100 m Ω	0.006% L + 200 m Ω	Test at 0.1 mA / 1 mA

Accuracy applies to a 4-wire connection with Y-shaped lugs, add 20mOhm of uncertainty when banana plugs are used. Temperature coefficient < 5 ppm/°C from 0°C to 18°C and from 28°C to 50 °C.

C.2.3 Temperature by thermocouples

Sensor types:

- in accordance with CEI 584-1/1995 (couples K, T, J, E, S, B, N),
- in accordance with Din 43710 (couples U and L),
- in accordance with the ENGELHARD table (platinum couple).
- As per standard ASTM E 1751-00 (G couple)
- As per standard ASTM E 988-96 (D W3Re/W25Re couple; C W5Re/W26Re couple)

Type	Temperature Range	Resolutio	Precision
K	- 250 to - 50°C	0.2°C	0.15% Rdg
	- 50 to + 120°C	0.1°C	0.06°C
	+ 120 to + 1020°C	0.05°C	0.005% Rdg + 0.05°C
	+ 1020°C to + 1370°C	0.05°C	0.007% Rdg + 0.05°C
T	- 250 to - 100°C	0.2°C	0.1% Rdg + 0.05°C
	- 100 to + 0°C	0.05°C	0.02% Rdg + 0.06°C
	+ 0 to + 400°C	0.05°C	0.055°C
J	- 210 to + 0°C	0.05°C	0.03% Rdg + 0.08°C
	+ 0 to + 50°C	0.05°C	0.05% Rdg + 0.07°C
	+ 50 to + 1 200°C	0.05°C	0.005 % Rdg + 0.04°C
E	- 250 to + 40°C	0.1°C	0.15°C
	+ 40 °C to + 550°C	0.05°C	0.005% Rdg + 0.12°C
	+ 550 to + 1 000°C	0.05°C	0.005% Rdg + 0.13°C
R	- 50 to + 0°C	0.5°C	0.35% Rdg + 0.4°C
	+ 0 to + 350°C	0.2°C	+ 0.4°C
	+ 350 to + 1 768°C	0.1°C	+ 0.25°C
S	- 50 to + 0°C	0.5°C	0.25% Rdg + 0.4°C
	+ 0 to + 350°C	0.2°C	0.30°C
	+ 350 to + 1 768°C	0.1°C	0.25°C
B	+ 400 to + 900°C	0.2°C	0.005 % Rdg + 0.4°C
	+ 900 to + 1 820°C	0.1°C	0.005 % Rdg + 0.2°C
U	- 200 to + 400°C	0.05°C	+ 0.09°C
	+ 400° to + 600°C	0.05°C	+ 0.11°C
L	- 200 to + 900°C	0.05°C	+ 0.15°C
C	- 20 to + 1 540°C	0.1°C	+ 0.25°C
	+ 1 540 to + 2 310°C	0.1°C	0.012 % Rdg + 0.1°C
N	- 240 to - 200°C	0.2°C	0.15 % Rdg
	- 200 to + 10°C	0.1°C	+ 0,10°C
	+ 10 to + 250°C	0.05°C	+ 0,08°C
	+ 250 to + 1300°	0.05°C	0.008 % Rdg + 0.05°C
PlatineL	- 100 to + 1 400°C	0.05°C	+0.10°C
Mo	0 to + 1 375°C	0.05°C	0.005 % Rdg + 0.06°C
NiMo/NiCo	- 50 to + 1 410°C	0.05°C	0.005 % Rdg + 0.30°C
G	0 to + 100°C	0.05°C	1.5°C
	100 to + 200°C	0.05°C	0.40°C
	200 to + 1 800°C	0.05°C	0.20°C
	1 800 to + 2 315°C	0.05°C	0.35°C
D	0 to + 1 000°C	0.05°C	0.20°C
	1 000 to + 2 000°C	0.05°C	0.015% Rdg
	1 800 to + 2 315°C	0.05°C	0.02% Rdg

The precision is guaranteed for a reference junction temperature of 0 °C. When using the internal reference junction (except couple B) add an additional uncertainty of 0.2 °C at 0 °C. For other temperatures, account must be taken of the sensitivity of the thermocouple to the temperature (T) in question, giving an additional uncertainty of 0.2 °C * S(0 °C)/S(T).

- Temperature coefficient: < 10 % of the accuracy/°C.
- Display in °C, °F and K.
- It is possible, thermocouple B excepted, to choose by programming the position of the cold junction with the keyboard:
 - external at 0°C,
 - internal (compensation for the temperature of the terminals of the unit).
 - by programming the temperature.

"Transmission/simulation" function

C

C.2.4 Temperature by resistive probes

Type of sensors:

- Pt 10ohm, 50ohm, 100ohm, 200ohm, 500ohm, 1,000ohm with $\alpha = 3851$ as per CEI 751/1995
- Pt 100ohm with $\alpha = 3916$ as per JIS C 1604/1989
- Pt 100ohm with $\alpha = 3926$ as per EIT90
- Ni 100ohm, 1,000ohm with $\alpha = 618$ as per DIN 43760
- Ni 120ohm with $\alpha = 672$ as per MIL-T-24388
- Cu 10ohm with $\alpha = 427$ as per MINCO 16/9
- Cu 50ohm with $\alpha = 428$ as per OIML R 84

Sensor	Specified	Resolution	Accuracy/1 year
Pt 50 ($\alpha = 3851$)	- 220°C to + 850°C	0.01°C	0.006% Rdg + 0.04°C
Pt 100 ($\alpha = 3851$)	- 220°C to + 850°C	0.01°C	0.006% Rdg + 0.035°C
Pt 100 ($\alpha = 3916$)	- 200°C to + 510°C	0.01°C	0.006% Rdg + 0.035°C
Pt 100 ($\alpha = 3926$)	- 210°C to + 850°C	0.01°C	0.006% Rdg + 0.035°C
Pt 200 ($\alpha = 3851$)	- 220°C to + 850°C	0.01°C	0.006% Rdg + 0.04°C
Pt 500 ($\alpha = 3851$)	- 220°C to + 850°C	0.01°C	0.006% Rdg + 0.04°C
Pt 1 000 ($\alpha = 3851$)	- 220°C to + 850°C	0.01°C	0.006% Rdg + 0.035°C
Ni 100 ($\alpha = 618$)	- 60°C to + 180°C	0.01°C	0.006% Rdg + 0.04°C
Ni 120 ($\alpha = 672$)	- 40°C to + 205°C	0.01°C	0.006% Rdg + 0.04°C
Ni 1 000 ($\alpha = 618$)	- 60°C to + 180°C	0.01°C	0.006% Rdg + 0.04°C
Cu 10 ($\alpha = 427$)	- 70°C to + 150°C	0.01°C	0.006% Rdg + 0.1°C
Cu 50 ($\alpha = 428$)	- 50°C to + 150°C	0.01°C	0.006% Rdg + 0.05°C

- For negative temperatures, use the value displayed L and not its absolute value.
- Temperature coefficient: < 10 % of the accuracy/°C.
- The above accuracy is given for a 4-wire connection to the temperature measurer in continuous mode ("Y-shaped lug" connection) and for a 1mA measurement current for PT50, PT100, NI100, NI120, CU10 and CU50 probes and 0.1mA for PT200, PT500 and PT1000 probes. For measurement currents included in the measurement range (0.1mA-1mA), the constant accuracy term for 1 year has to be multiplied by 2 (e.g., PT100 at 0.1mA, accuracy is 0.006% + 0.07°C).
- Taking into account, also, the intrinsic error of the temperature sensor used and its conditions of use.



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