C150

Multifunction Process Calibrator

User Manual

WD1027
4/29/08 Rev C
Revised 04/22/15

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LIMIT OF WARRANTY AND LIABILITY

Manufacturer warrants this product to be free from defects in material or workmanship under normal use and service for a period of 12 months from date of purchase. The Manufacturer agrees to repair or replace any product, which upon examination is revealed to have been defective due to faulty workmanship or material if returned to our factory, transportation charges prepaid, within the above stated warranty period. This warranty is in lieu of all other warranties, expressed or implied and of all obligations or liabilities on its part for damages including but not limited to consequential damages, following the use or misuse of instruments sold by the Manufacturer. No agent is authorized to assume for Manufacturer any liability except as set forth above.

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. 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

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A. GENERAL

Thank you for choosing this Wahl Instruments High Accuracy calibrator. Wahl has been providing high quality, high accuracy measuring instruments for over 50 years.

Because of this, we are able to continue our policy of continuous innovation, which has served our customers so well for the last 50 years. Wahl Instruments encourages your comments and would willingly accept any suggestions from you to help us to perfect our know-how and improve our future products.

A.1 Introduction

The C150 is hand-held, highly accurate multifunction calibrator used to measure and transmit simultaneously over 2 insulated channels or to measure over 2 input channels (differential measurements or comparative measurements). It is specially designed for calibration and maintenance and can measure and simulate physical and electrical quantities, either on site or in the laboratory.

It can perform all the following functions:

- Measure voltages, direct currents, resistance and pressure over 2 insulated channels.
- Measure temperatures by thermocouples, resistive probes, thermistors over 2 insulated channels.
- Supply power and measure a current loop which is compatible with the HART® protocol.
- Measure frequencies and counts (over one channel)
- Generate DC voltages and currents.
- Simulate resistance, thermocouples, resistive probes and thermistors.
- Recording of measurements and their display as a table or trend curve.
- Calibration and generation of the calibration report.
- Possibility of using calibrated sensors with memorization of the calibration factors

Measurement and transmission or measurements over 2 channels can be carried out simultaneously with double display.

The C150 has many associated functions that extend its range of application:

- Relative measurement.
- Results displayed based on a linear or other conversion law.
- Generation of increments and simple or cyclic ramps.
- 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 C150.

A.1.2 Unpacking

All C150 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
- A mains unit for charging the battery pack
- 6 measurement cables
- Mounting strap

A.1.3 Returning

Please use the Product Return Request form on our website, or contact Customer Service at (800) 421-2853, for a Return Merchandise Authorization number (RMA) before returning your instrument to the factory. You can find the Product Return Request form under the Service button at www.palmerwahl.com
You will be contacted with your RMA number and directions for returning your product.
If the unit is to be returned, it is preferable to use the original packaging.

Warning
The packaging supplied with the calibrator can withstand a maximum pressure of 20 bar at 21°C (290 psi at 70°F). Subjecting the package to a higher pressure risks damaging the unit.

A.2 Material

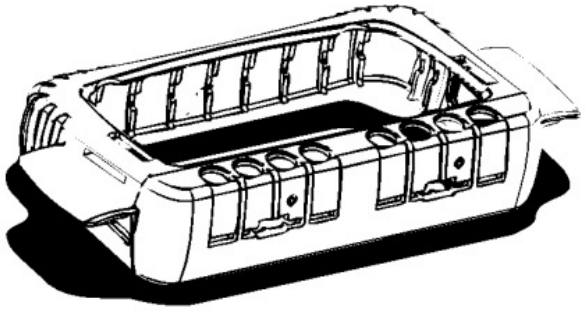
General characteristics:

- Portable unit powered by a pack of Ni-MH.
- Battery life: 4 to 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 or 115 V ± 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

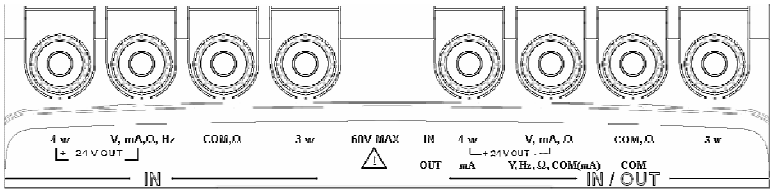
A.2.2 Boot

The C150 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.

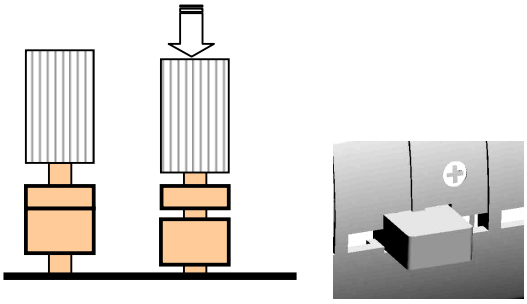


A.2.3 Connection terminals

Four terminals for the "measurement" function (IN) from channel 1 (V1) ; two of which are reserved for 3 or 4 wire connection when measuring resistance, temperature with a resistive probe and current for a passive transmitter. Refer to paragraph B.2.
Four terminals for connection when "transmit/simulate measurement" function (OUT/IN) from channel 2 (V2) is used. Refer to paragraph B.3.



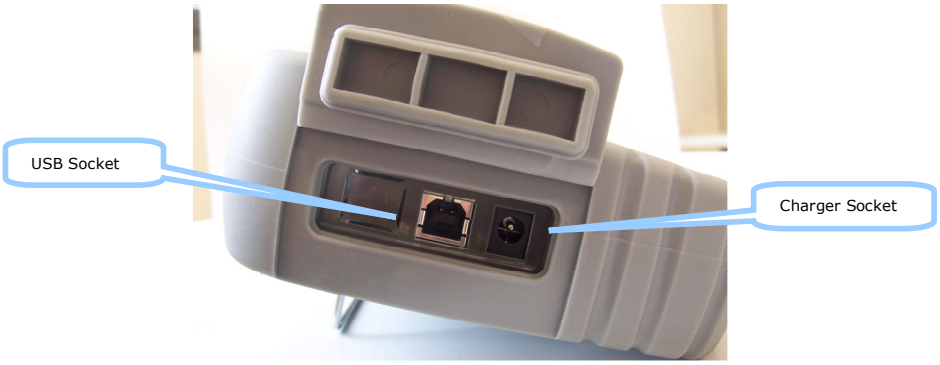
The 8 terminals of the C150 are of the "push & lock" type. They accept 4 mm banana plugs, bare wires, spade terminals and miniature connectors for thermocouples.



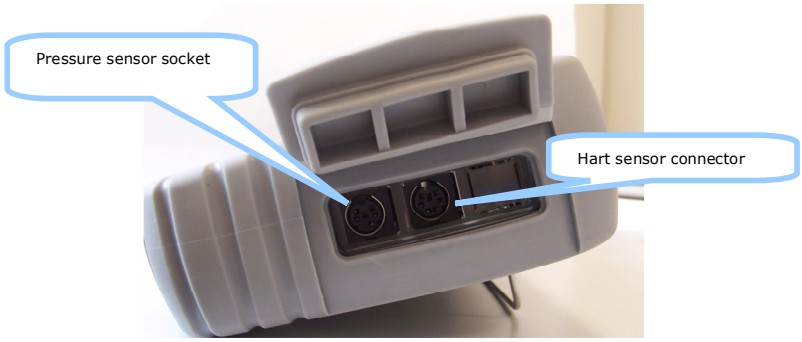
A.2.4 Side connectors

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.



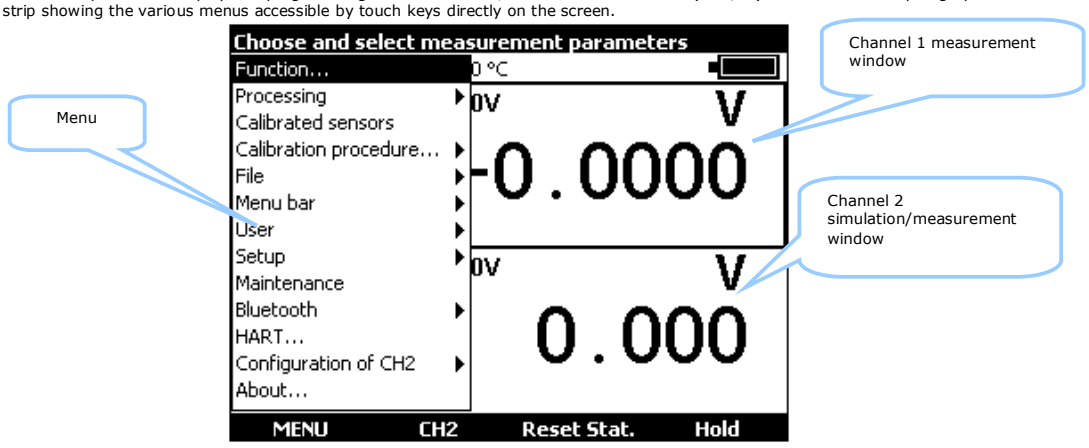
Connectors dedicated to sensors (pressure and HART®) are located on the right-hand side of the unit.



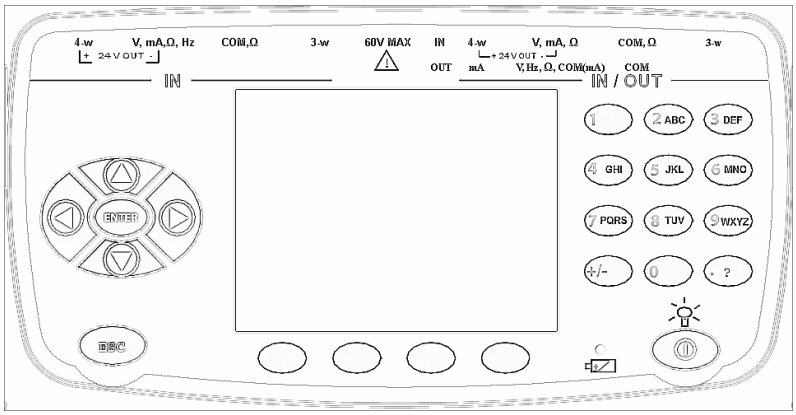
A.2.5 Screen

The C150 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:

- A window displaying the programming of the "measurement" function parameters (IN). Refer to paragraph B.2.
- A window for parameter display and programming for the "transmit/simulate measurement" (OUT/IN) function. Refer to paragraph B.3.
- A strip showing the various menus accessible by touch keys directly on the screen.

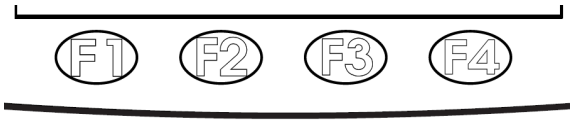


A.2.6 Keyboard

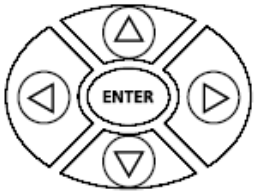


The keyboard contains:

- 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.



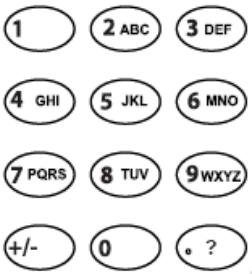
- A navigator:



- 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:
Upon receiving your C150 the batteries may not be 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 C150 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.

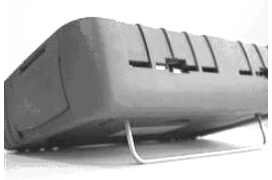
Warning
ONLY USE THE MAINS ADAPTOR SUPPLIED WITH THE CALIBRATOR.
The charger can be used with voltages of between 100 VAC and 250 VAC.
The charger is for indoor use only, at an ambient temperature not exceeding 40°C (104°F).

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

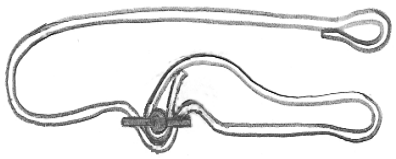
The stand provides a good view of the C150 when it is placed on a desk. Unfold the stand on the back of the unit and place the C150 on a desk as shown below.



A.2.10 Strap

The C150 is supplied with a durable nylon 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.

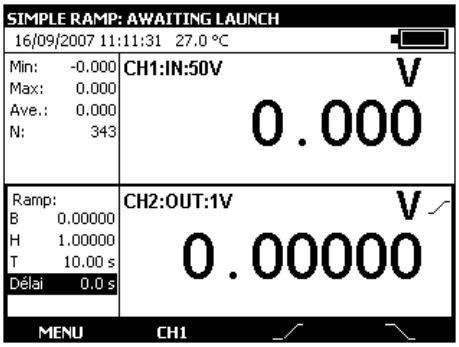


A.3 Software

The firmware of the C150 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:



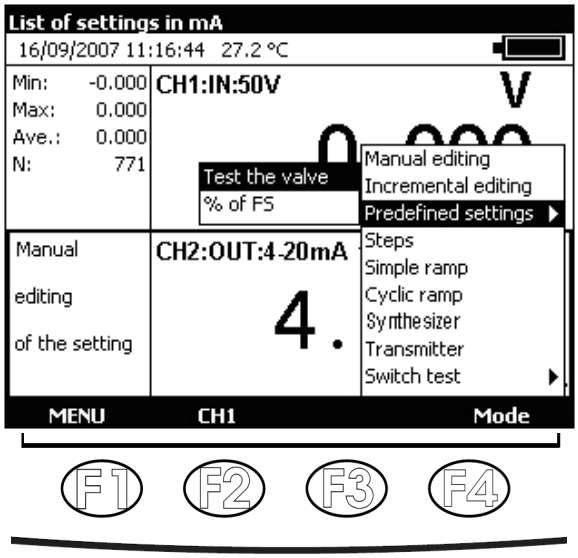
The "on-line help" function is not visible in the menu, but is accessible at any time by pressing the ? key. When active, a help window for the function in use appears. The ESC key closes the help window and all the dialog boxes displayed.

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 display the% **FS** menu in the example of the screen below, perform the following steps:

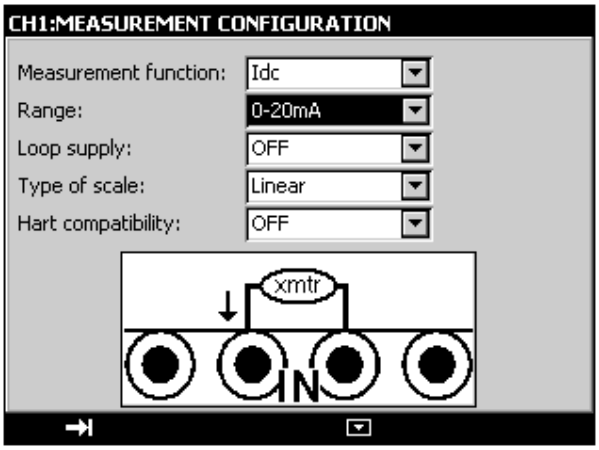
1) Press the F4 key associated with the proposed **Mode** from the main menu.
2) Press the Down ∇ navigation key twice to select the **Predefined settings** sub-menu and confirm with the ENTER key.
3) Press the Down navigation key ∇ once to select the% **FS** sub-menu and confirm with the ENTER key. A dialog box associated with this function appears and the four function keys change their function automatically to suit the dialog box.

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

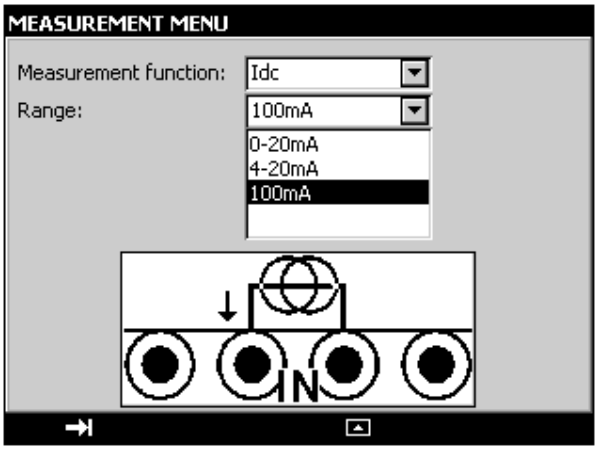


The dialog box interface is intuitive. It is managed by the function and navigation keys.

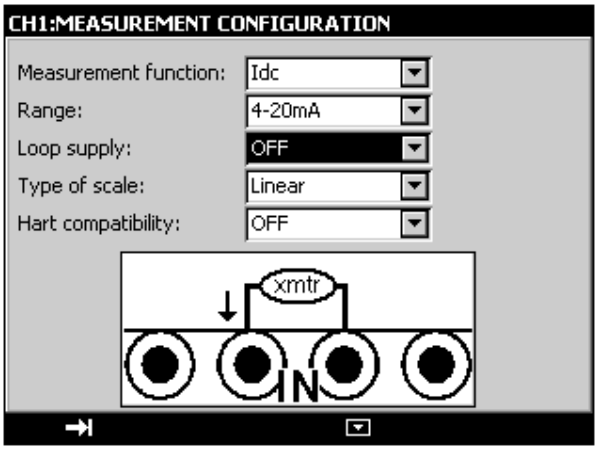
The tabulation key is used to select the next item from all the items in the dialog box. For example, to select the "Type of scale" field on the following screen, press the key once.



The tabulation key functions cyclically, so that the first item follows the last.
The Right ▷ navigation key can replace the tabulation key.
The function key is used to display a drop-down list. The key also closes an already open drop-down list. The Up △ and Down ∇ navigation keys are used to select an item from an open list. Confirm is by pressing the ENTER key.



There is a quicker way to select items from a drop-down list by using the Up/Down navigation keys to select the next/previous item from the list without displaying the contents of the list. For example, the state of the "Power supply loop" field can be changed from OFF to ON using the Down and Up navigation keys.



During operation of the C150, 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 résume transmission
	Launch transmission in the increasing direction
	Launch transmission in the decreasing direction
	Transmit synthesized points in the order entered
	Transmit synthesized points in the reverse order
	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
	HART compatibility is on
	Loop power supply is on
	Loop power supply is off
	Square law scale is on
	Warning: Out of Range or error
	2 wire cabling detected
	3 wire cabling detected
	4 wire cabling detected
	Transmission in incremental mode
	Transmission in staircase mode
	Transmission in simple ramp mode
	Transmission in cyclic ramp mode
	Transmission in synthesizer mode
	Transmission in% of Full Scale mode (% FS)
	Transmission in valve test mode
	Item already selected
	Measurement smoothing is active
	The Tare function is on
	Setting to scale is on
	Pulse transmission
1088	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 73/23/CE with standard EN611010-1
- Directive CEM 89/336/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 2,200 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 Worn devices

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 circuits available locally.

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 prejudice the safety of the operator and is therefore dangerous and forbidden.

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 overvoltages (standard CEI 664).

A.4.8.2 Table of symbols used

Symbol	Description
	Warning: see accompanying documents
	Earth point
	Complies with European Union directives
	Worn 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.

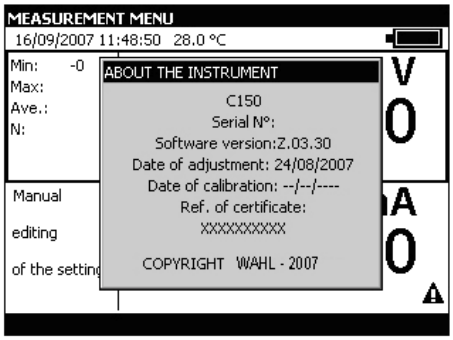
The responsible authority must ensure on a regular basis that factors affecting safety do not change with time and carry out any necessary preventive work.

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.

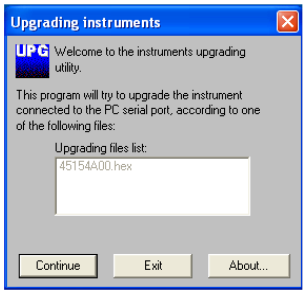
A.5.1 Software updates

The software is updated by a special program from Wahl Instruments available upon request. To find out which version of firmware is installed in your unit, use the **Menu** → **About** menu.

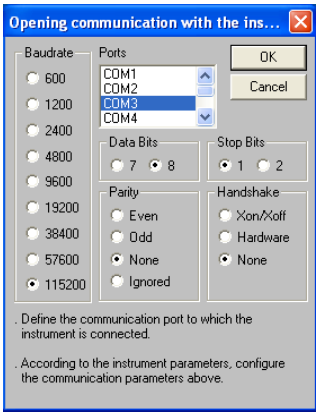


To find out if an update is available please contact Wahl Instruments Customer Service at 800-421-2853.
To update the firmware, proceed as follows:

1. Download a new version of the firmware.
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 C150. 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.

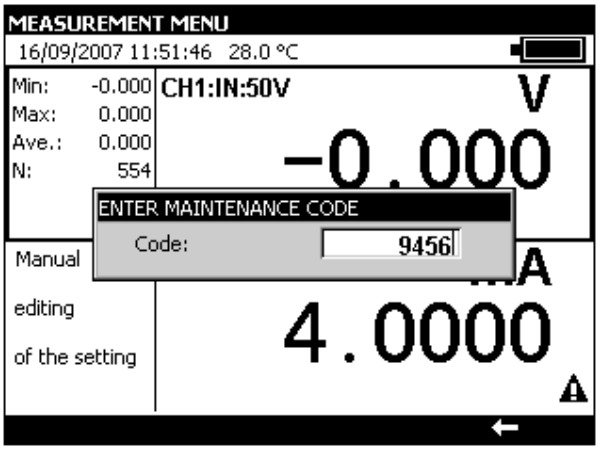
This check must take into account the metrological precautions for use. The following instructions must be followed.

The operations must be carried out under the reference conditions, namely:
- Ambient temperature: 23°C ± 1°C.
- Relative humidity: 45% to 75%.

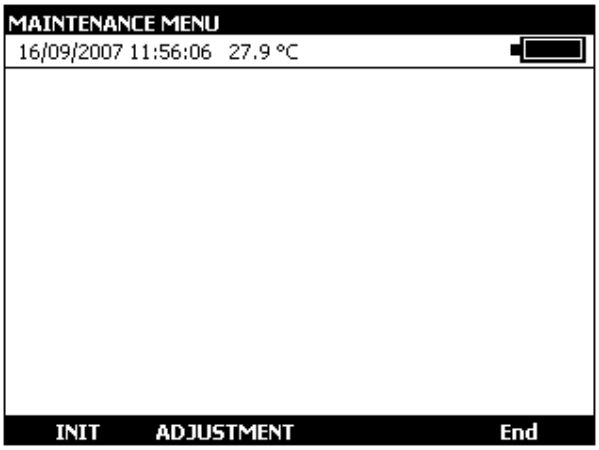
The standards used in the test process must be such that the errors at the test points are known and are less than or equal to ± 0.005%.

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.

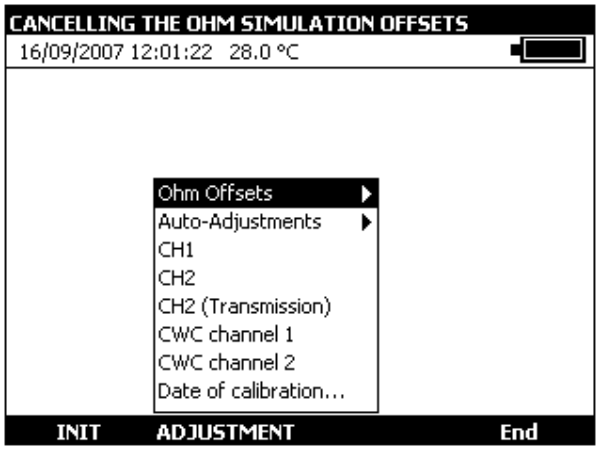
It is possible to adjust the C150 using an instrument whose accuracy is better than 50 ppm. To adjust the unit, select the **Menu → Maintenance** menu's, then enter the password 9456.

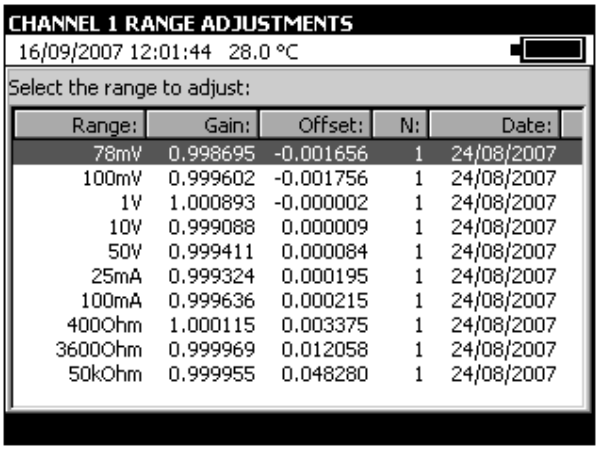


To exit the Maintenance mode, press the **End** function key.



To adjust the C150, use the **ADJUST** function key. Make adjustments in the following order:
- V1 measurement: run all calibration procedures
- V2 measurement: run all calibration procedures
- Ohms Offsets
- Auto-Adjust
- Transmission V2



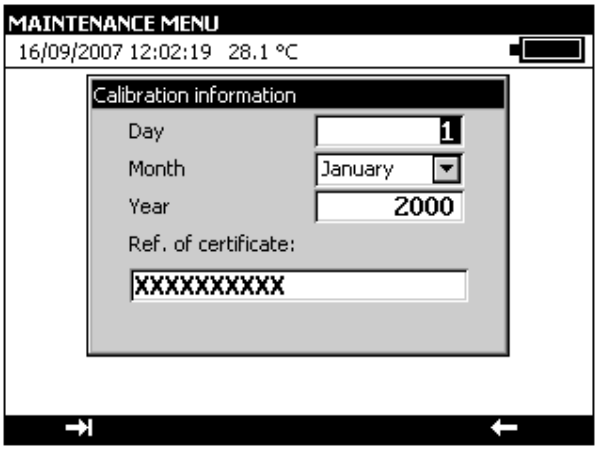


For each type of calibration, select the function to be calibrated with the Up and Down navigation keys and follow the instructions shown in the dialog boxes.

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 → Date of calibration** menus.



A.5.3 Cleaning

If the C150 needs cleaning, use a tissue soaked in a non-solvent cleaning solution. Switch off the unit and wipe the boot and keyboard if necessary. If any liquid enters the unit it may cause irreparable damage.

B. GETTING STARTED

In order to use the unit in complete safety, users must carefully read paragraph A.4 (page 14) which, among other things, deals with safety before handling. It is advisable also to read the following paragraphs:

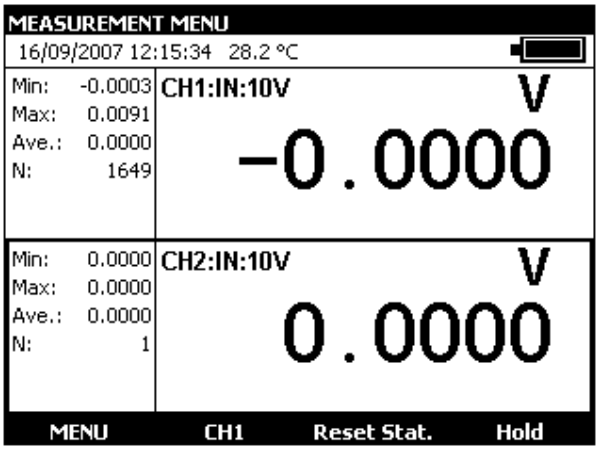
- ✓ A.1.2 Unpacking (page 6)
- ✓ A.2.7 Batteries and charger(page 9)
- ✓ A.5.3 Cleaning (page 18)

B.1 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.

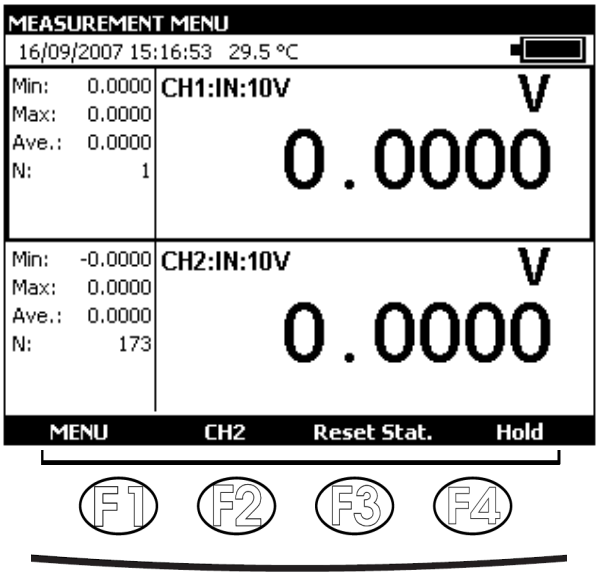
To start instrument, press On / Off key for one second.

After WAHL logo is displayed followed by a window showing EEPROM testing, a screen similar to the one below should appear.



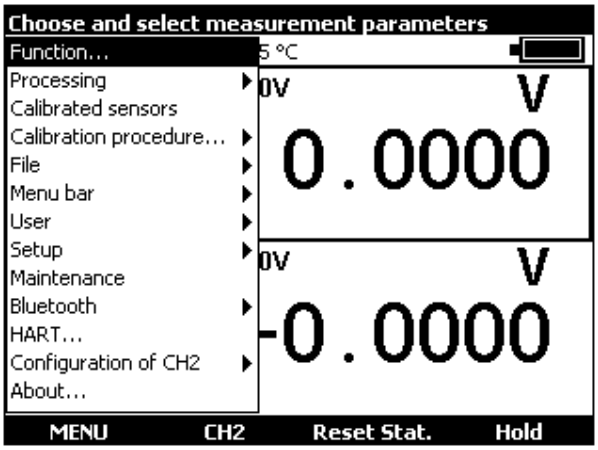
B.2 Measurement on channel V1

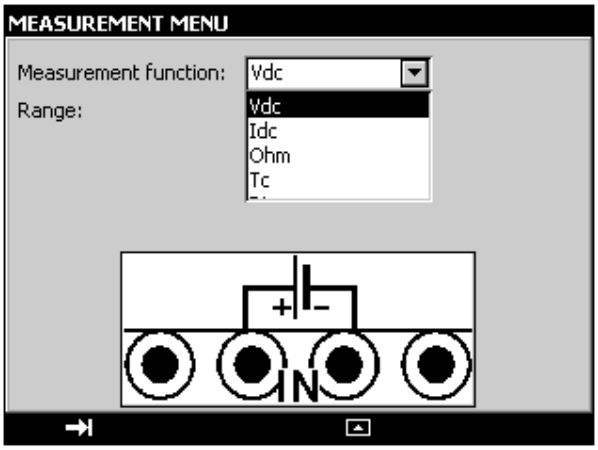
To change the Measurement functions from channel V1, a rectangle should surround the top window on the screen. If it is not the case, select channel by activating the measurement window with function key **F2** (V1).



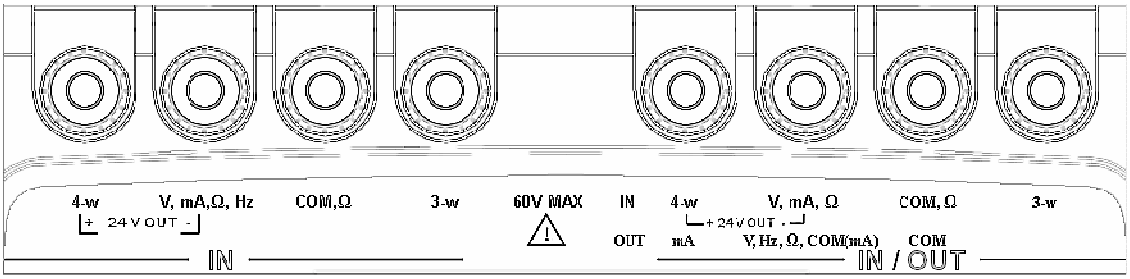
To choose a measurement function, press key **F1** (Menu).
Select the **Function ...** menu with the navigation keys and confirm with the ENTER key.

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



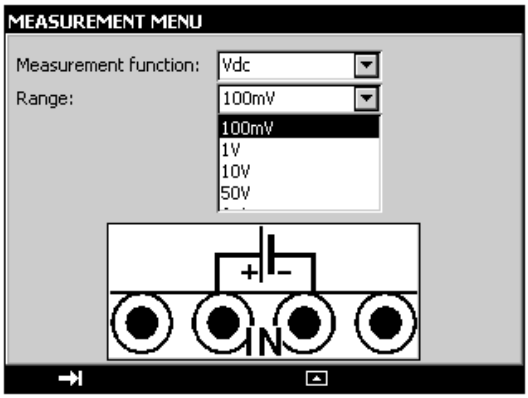


In measurement mode, channel V1 is connected to the four "IN" terminals located on the left half of the unit:



B.2.1 Measuring DC voltage

- Display the **MEASUREMENT MENU** dialog box:
- Select the **Vdc** measurement function then the correct measurement range using the function and navigation keys.
- Confirm with ENTER.



The following ranges are available:

Range	100 mV	1 V	10 V	50 V	Auto
Resolution	1 µV	10 µV	100 µV	1 mV	---
Input impedance	> 10 kΩ	> 10 kΩ	1 MΩ	1 MΩ	---

The DC voltage to be measured is connected between the V and COM terminals

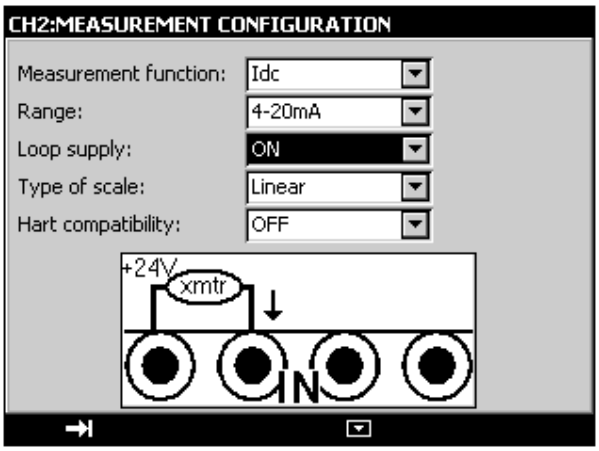
B.2.2 Measuring current

- Display the **MEASUREMENT MENU** dialog box:
- Select the **Idc** measurement function then the correct range of measurement using the function and navigation keys.
- Confirm with ENTER.

Depending on the range selected, several modes of measurement are available:

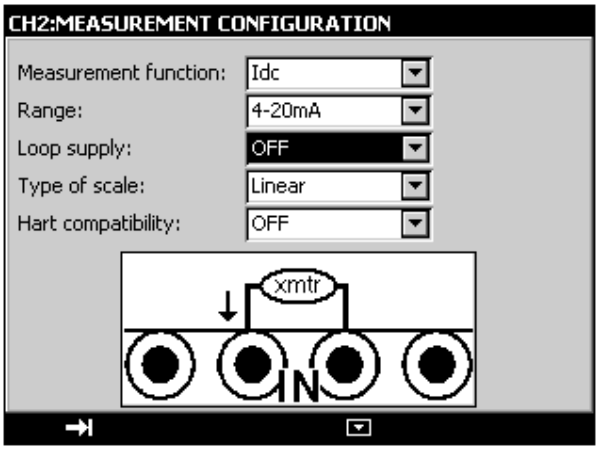
Range	100 mA	4-20 mA	0-20 mA
Resolution	0,1 µA	0,1 µA	0,1 µA
Input impedance	<30 Ω	<30 Ω <280 Ω if HART ON	<30 Ω <280 Ω if HART ON
Loop power supply	No	Possible	Possible
Set to scale	No	Linear or square law	Linear or square law

If loop power supply is on, the connection is made between terminals 4-w and mA.



In this case, the C150 supplies a passive transmitter with 24 V and at the same time measures the current established by the transmitter.

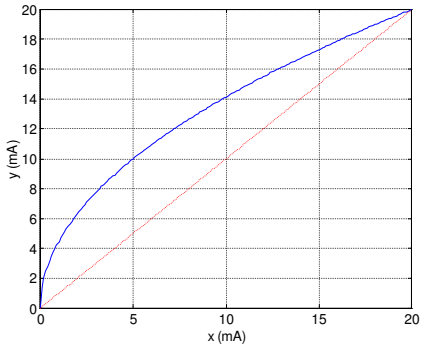
If the loop power supply is off, the connection is made between terminals mA and COM.



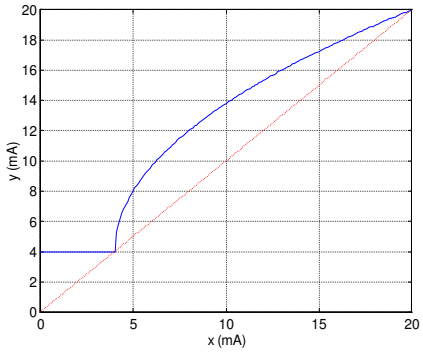
When set to the square law scale, the calibrator takes the square root of the input and displays the result as a percentage. For example, if the calibrator is connected to the output of a differential pressure transmitter, it displays a result proportional to the flow rate.
If the input current *x* varies between *a* and *b*, the scale is set according to the formula:

$$y = a + (b-a)\sqrt{\frac{(x-a)}{(b-a)}}$$

In the case of the 0-20 mA range, the scale curve is as follows:



In the case of the 4-20 mA range, the scale curve is as follows:



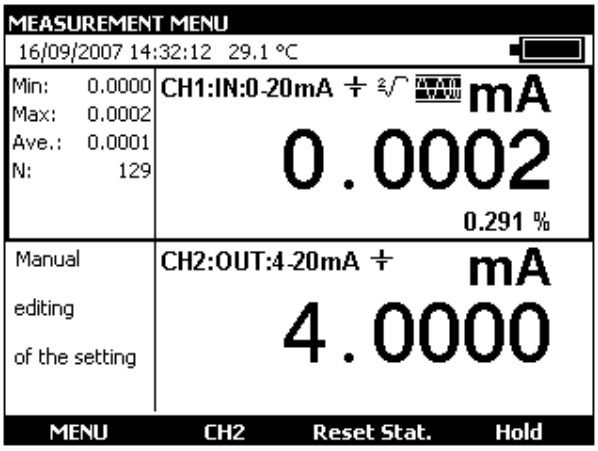
The C150 displays in the window details of the selected configuration using the following icons:

: to show loop power supply off

: to show loop power supply on

: to show square law scale

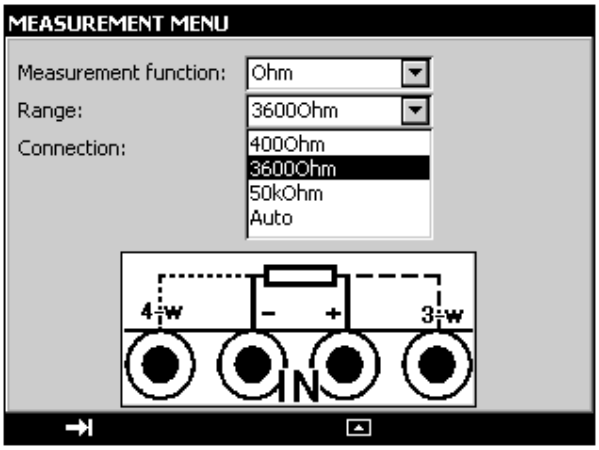
: to show HART compatibility.



When the values measured are near the lower limit of the range (0 mA or 4 mA) a small variation in the values measured translates into a more significant variation for the converted values (in %) because of the square law nature of the scaling.

B.2.3 Measuring resistance

- Display the **MEASUREMENT MENU** dialog box:
- Select the **Idc** measurement function then the correct measurement range using the function and navigation keys.
- Confirm with ENTER.



The following ranges are available:

Range	400 Ohm	3600 Ohm	50 kOhm	Auto
Resolution	1 mOhm	10 mOhm	0.1 Ohm	--
Measurement current	0.2 to 0.45 mA	0.2 to 0.45 mA	10µA to 25µA	

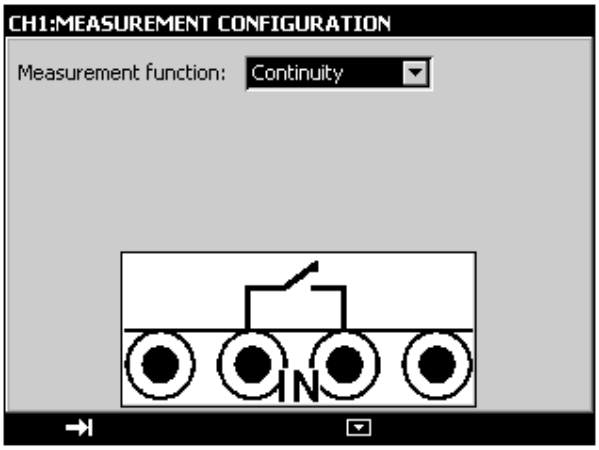
To carry out a correct resistance measurement with 3 wires, the 3 conductors used must be:

- ✓ of the same length,
- ✓ of the same diameter,
- ✓ of the same type of metal.

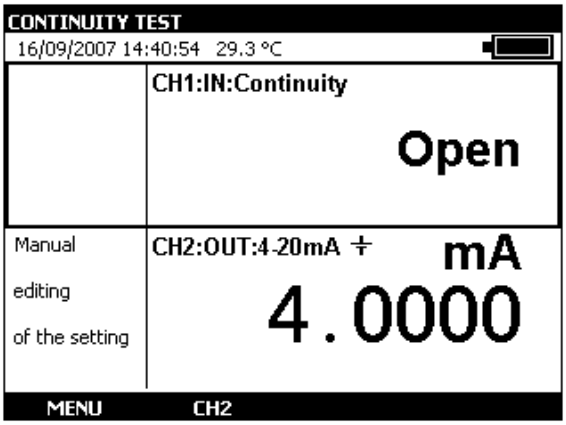
The C150 displays an icon showing the connections used (for 2 wire, for 3 wire or 4 wire) to make the measurement. The wiring arrangement is automatically detected by the calibrator.

B.2.4 Continuity test

- Display the **MEASUREMENT MENU** dialog box:
- Select the **Continuity** measurement function using the function and navigation keys.
- Confirm with ENTER.

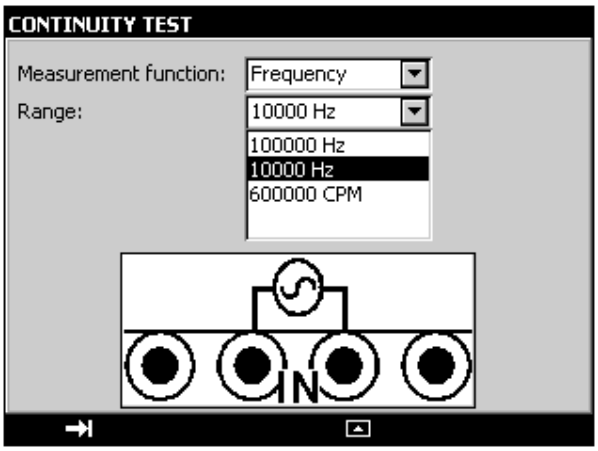


The C150 makes a resistance measurement in this mode and displays "open" if the resistance measured is greater than 1000 Ohm and "closed" if the resistance measured is less than 1000 Ohm.



B.2.5 Measuring frequency

- Display the **MEASUREMENT MENU** dialog box:
- Select the **Frequency** "measurement function", then the measurement range with function and navigation keys.
- Confirm with ENTER.



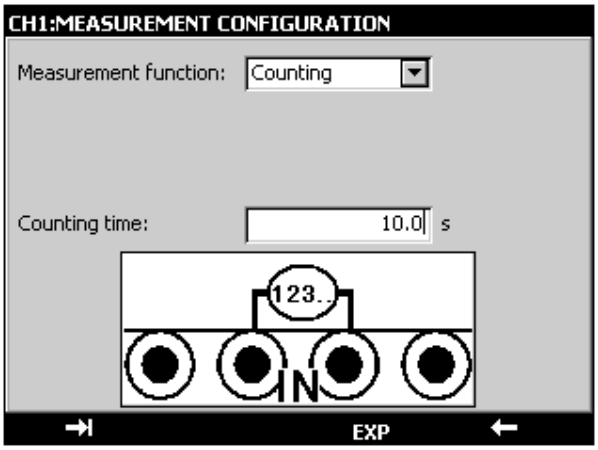
Connection is made between the Hz and COM terminals.
Units are displayed in Hertz (Hz) for 100000Hz and 10000Hz ranges or in beats per minute (BPM) for 600000CPM range.
The input voltage of periodic signals must not exceed 60 Volts peak to peak.

The following ranges are available:

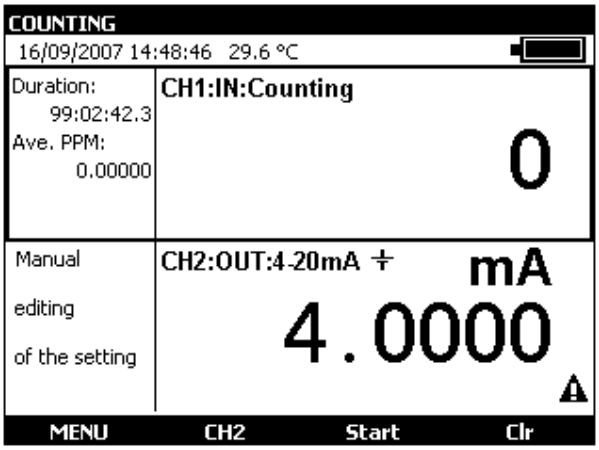
Range	10000 Hz	100000 Hz	600000 BPM
Resolution	10 mHz min	10 mHz min	0.1 BPM

B.2.6 Pulse counting

- Display the **MEASUREMENT MENU** dialog box:
- Select the **Counting** measurement function, then the "type of input" **Signal or Hard Contact** using the function and navigation keys.
- Enter the counting time using the alphanumeric keys.
- Confirm with ENTER.



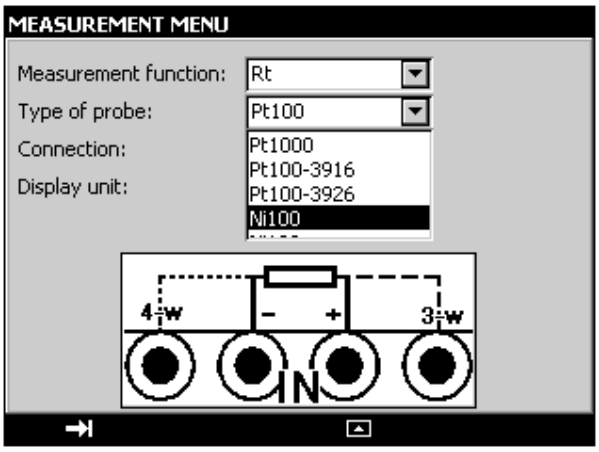
Connection is made between the Hz and COM terminals.
Input signals are converted into a logic signal.
If zero is entered for the counting time, counting is indefinite.



To initiate counting, confirm with the **Start** function key ("F3").
To stop counting without resetting the counter value, confirm with the **Stop** key (« F3 »).
To reset the counter to zero, press the **Clr** key (F4)
The counting period is displayed in the left part of the IN window. This period is reset whenever counting is stopped.

B.2.7 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(α = 3851)	Pt50
Pt 100 (α = 3851)	Pt100
Pt 100 (α = 3916)	Pt100-3916
Pt 100 (α = 3926)	Pt 100-3926
Pt 200 (α = 3851)	Pt200
Pt 500 (α = 3851)	Pt500
Pt 1 000 (α = 3851)	Pt1000
Ni 100 (α = 618)	Ni100
Ni 120 (α = 672)	Ni120
Ni 1 000 (α = 618)	Ni1000
Cu 10 (α = 427)	Cu10
Cu 50 (α = 428)	Cu50

α Being the temperature coefficient of the probe.

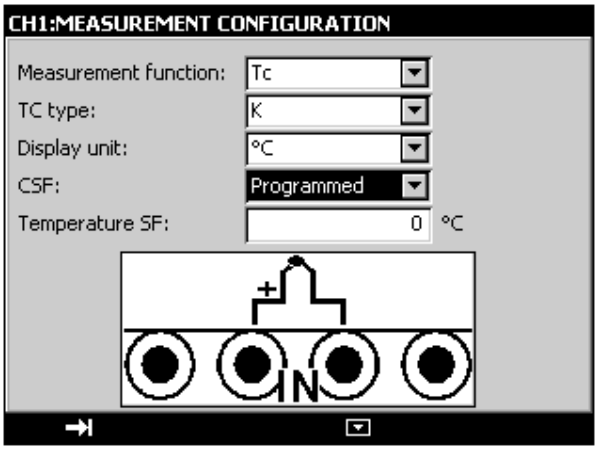
Wiring diagram is automatically detected by the calibrator. The C150 displays an icon showing the connections used (for 2 wires, for 3 wires or for 4 wires) to carry out the measurement. The wiring arrangement is automatically detected by the calibrator.

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 mΩ between two wires introduces an error of about 0.1°C).**
- **Take care with the connections to avoid the appearance of interfering contact potential differences.**

B.2.8 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.

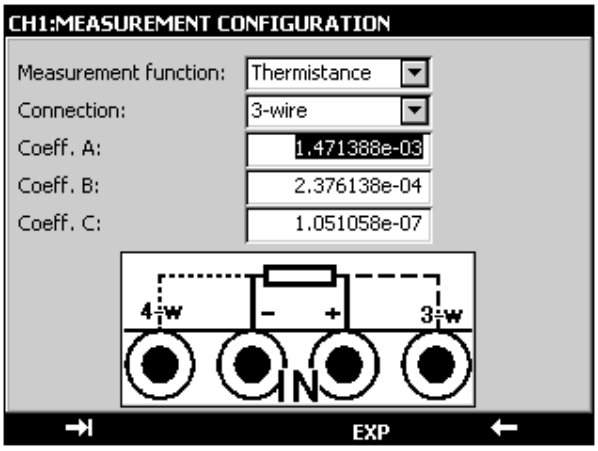


The thermocouples available are: K, T, J, E, N, U, L, S, R, B, C, PL, Mo, NiMo/NiCo.

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.

B.2.9 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.



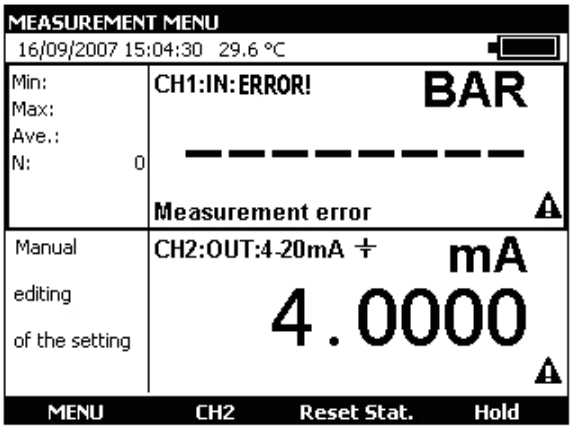
Wiring diagram is automatically detected by the calibrator. The C150 displays an icon showing the connection used to carry out measurement (for 2 wires, for 3 wires or for 4 wires).

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.**

B.2.10 Pressure measurement

Open the **MEASUREMENT MENU** dialog box,

- select the **Pressure** measurement function.
- select the unit (BAR, PSI, Pa, Atm, Kgcm2, cmHg, mmHg, inHgftH2O, in H2O).
- press ENTER.



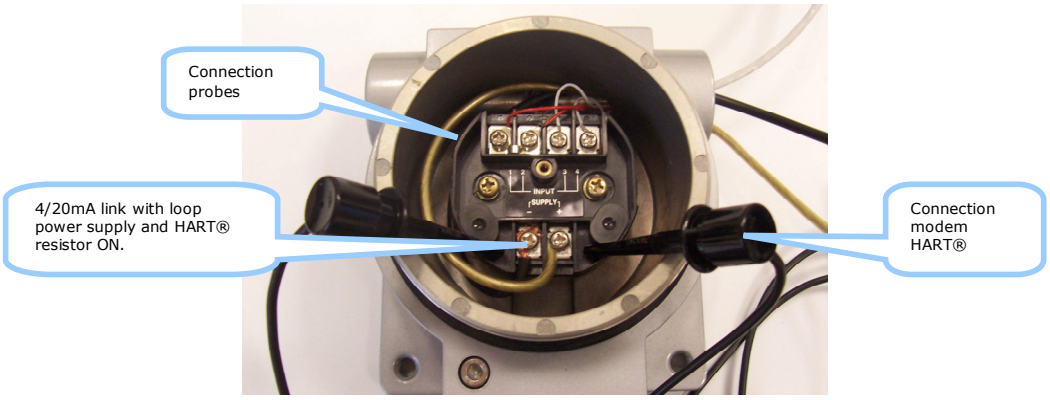
Connect the pressure sensor on the right-hand side of the unit (see chapter, side connectors). If this is not connected or is defective, an error message will be displayed.

B.2.11 Modules With HART® Protocol

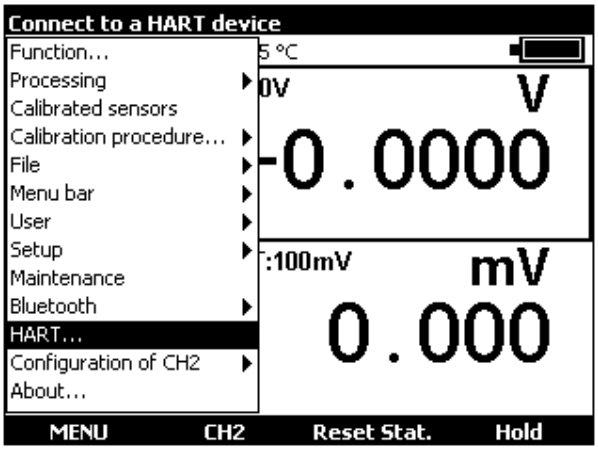
The HART® protocol (Highway-Addressable Remote Transducer) is a communications protocol over a direct current loop (0-20 or 4-20mA). This protocol is used without interfering with current measurement to both read measurements carried out by the HART® transmitter and transmitter-related information (brand, reference, etc..), and also to adjust it.
The C150 with related HART® module (ACL500) is used to carry out all of these operations.

To use the C150 in HART mode, the unit must be connected to the current loop (across 24V Out terminals from channel V1) and be provided with the specific ACL500 modem (connected to the unit's side).
The calibrator provides the loop power supply via an internal 250Ω series resistor.

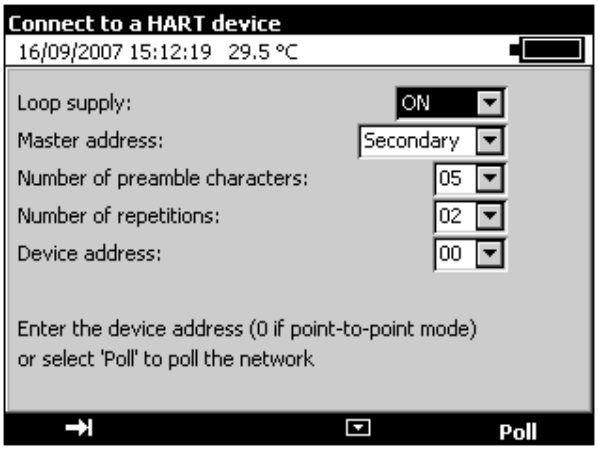
When an external loop power supply is used, a resistor from 230Ω to 270Ω must be series connected with the external loop power supply and transmitter.



To configure the C150 in this mode, "HART" function must be selected from "Menu":

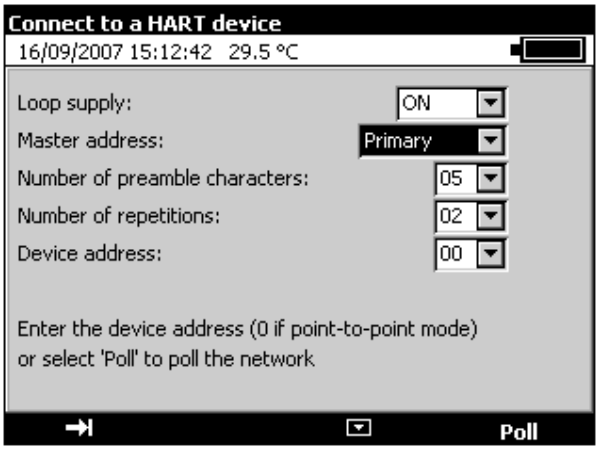


A configuration menu displays:



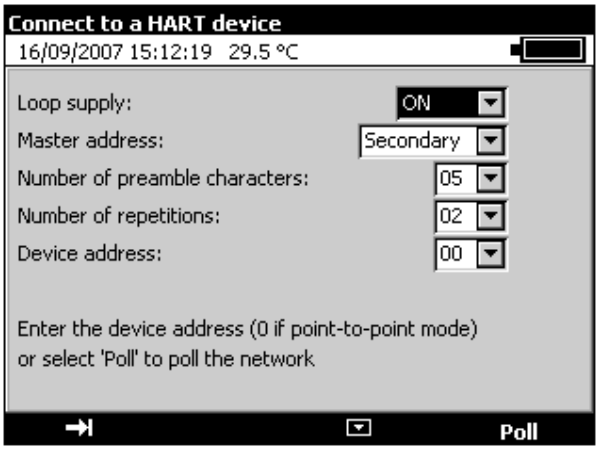
First, select whether the C150 supplies the HART loop (ON) or whether power supply is provided by another device (OFF).

To control a HART network, there must be at least one master and only one known as "Primary", and the others are known as "Secondary". Select whether the unit is a "Primary" or "Secondary" master.

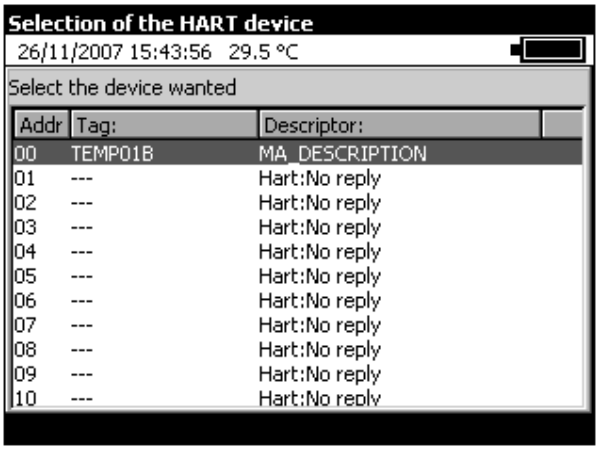


The "Number of preamble characters" parameter is specific to the HART protocol, it may be set to a value from 03 to 15. By default it is set to 05.

The "Number of repeats" parameter is also specific to this protocol, it may be set to a value from 00 to 05. By default it is set to 02.

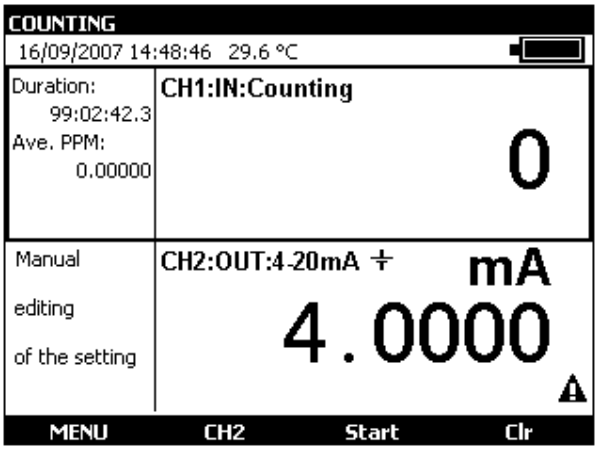


Enter device address from 00 to 15 or press F4 key (Scan) to scan for connected devices. The C150 will then pool the 15 network addresses to find out which replies and at which address.
For addresses 01 to 15, the unit sets to fixed current. For address 00, the units sets to point-to-point mode which uses the current loop over its full dynamic range and not as fixed current.
If only one device is available, enter 00 as "Device address" to use point-to-point mode. The sensor must also be configured at address 0. Otherwise, scan to find out sensor address and change using "Configure" and "HART output" menus (see details below).



Typical scan with only one device connected at address 00.

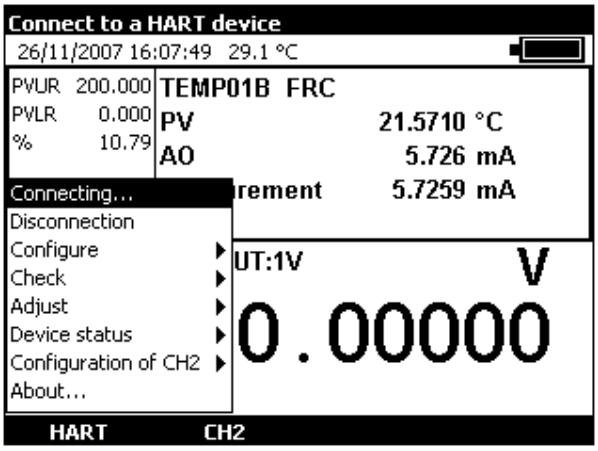
When selecting one of the addresses from a device having replied, display is the same as if a valid address had been directly entered:



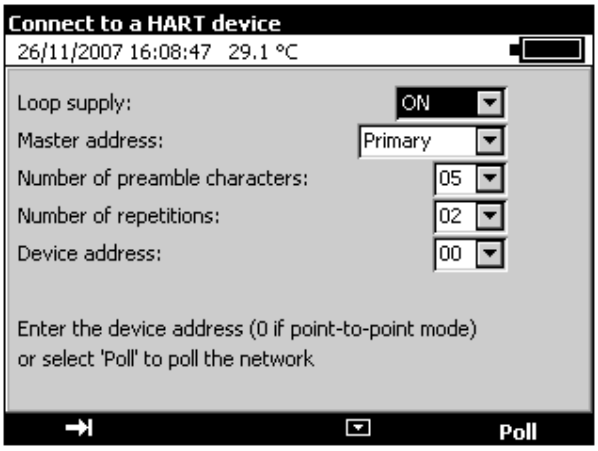
Display depends on the type of sensor, in this case, it is a temperature sensor in point-to-point mode at address 0.

Pressing F1 key ("HART") displays a specific menu:

B.2.11.1 Connection

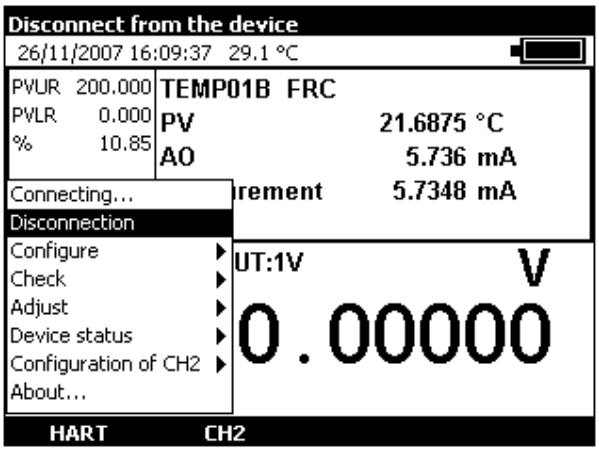


"Connection" is used to connect to a selected device. The same initial menu as when selecting the "HART" function is displayed, just select the address of the sensor to be used.

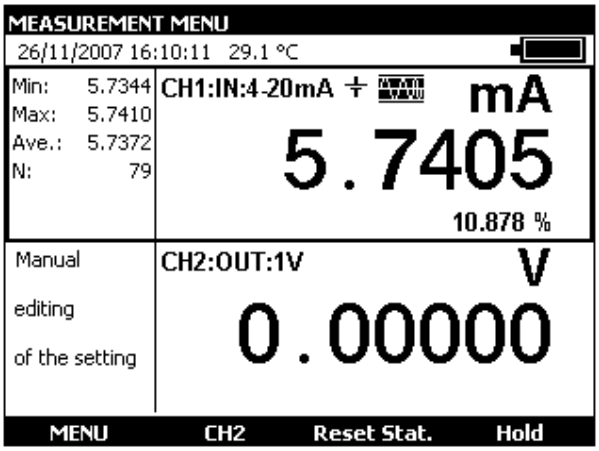


See details at the beginning of the chapter.

B.2.11.2 Disconnection

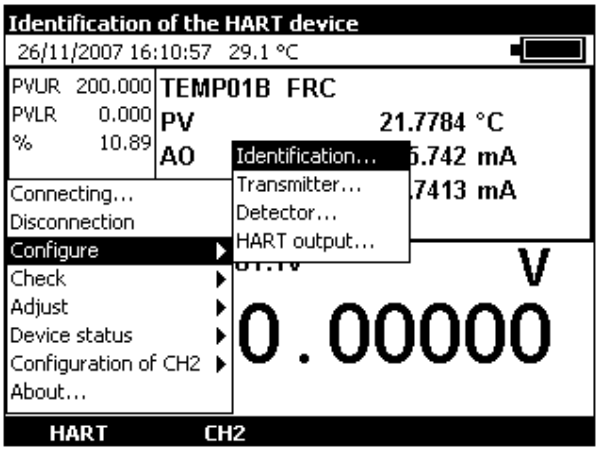


"Disconnection" is used to disconnect from HART sensor and return to initial menu.

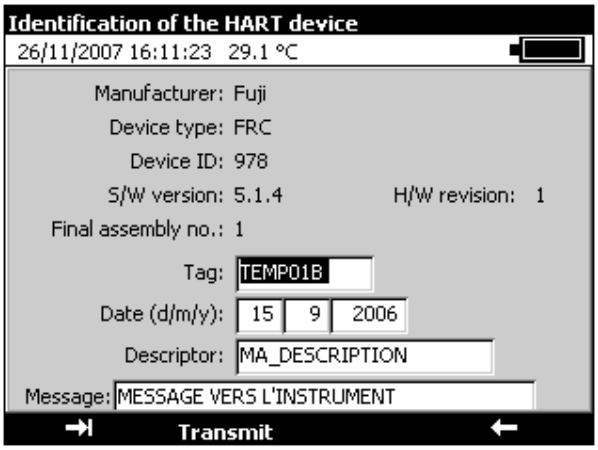


The C150 returns with channel V1 configured to the 4-20mA function, HART impedance enabled.

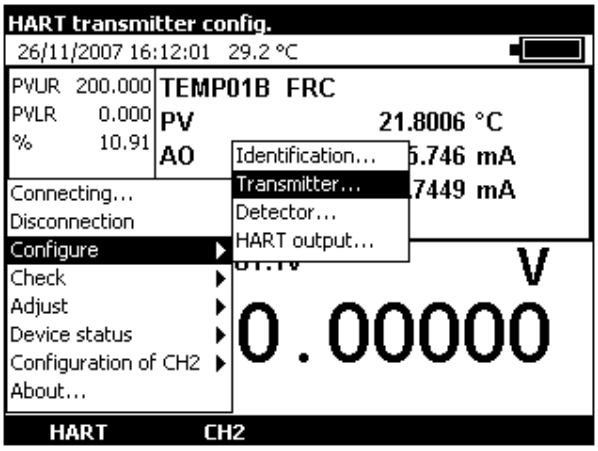
B.2.11.3 Configuration



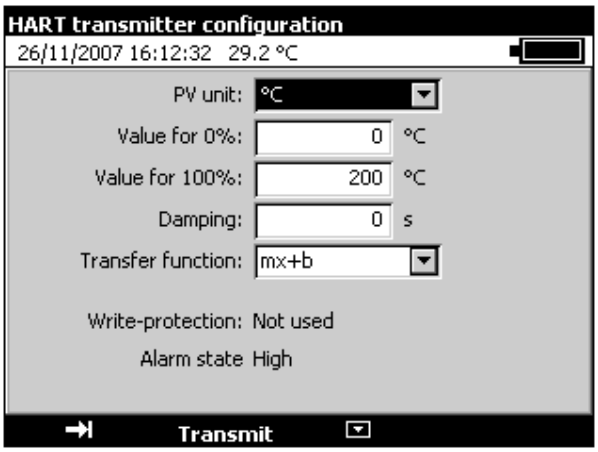
The "Configure" option from the HART menu is used to access the "Identification" screen from selected device.



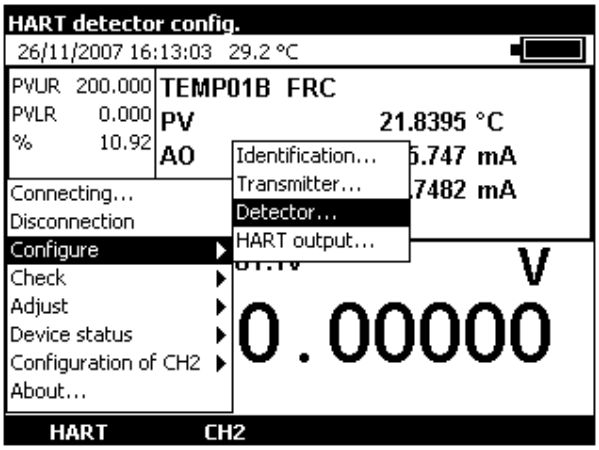
A screen displays sensor characteristics: Manufacturer, Type, Id and software version.
In the measurement window (Label), you may configure the name, change the date (in the form of dd mm yyyy) enter a descriptor (displayed in the list of devices when scanning), send a message to the sensor.
Once the fields edited, press F2 key (Transmit) to send this information to the device.



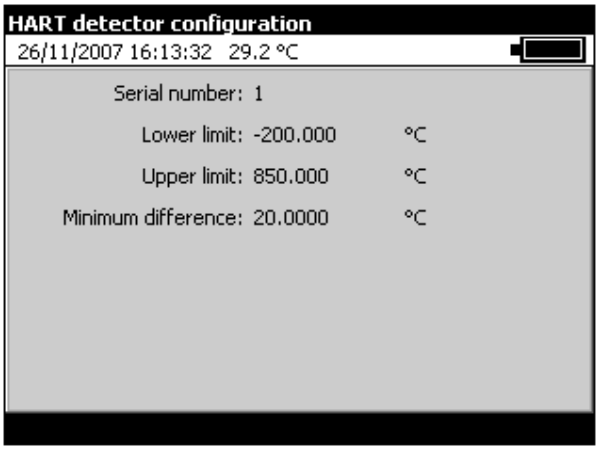
You can access the sensor configuration by selecting "Transmitter" in the "Configure" option from the HART menu.



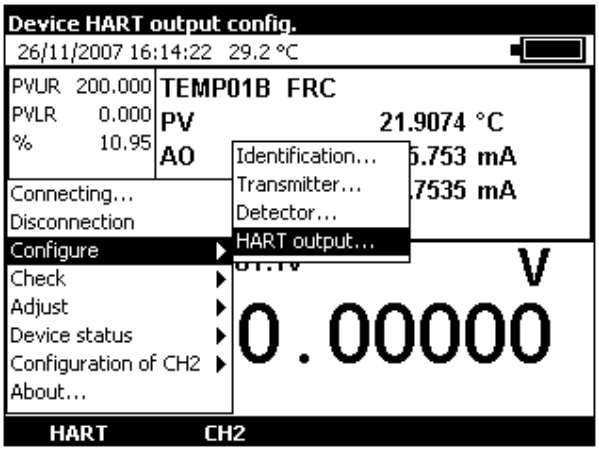
For this temperature sensor, you may change units "°C" or "°F", set display values for 0% and 100%, set a smoothing time (in s) or select a transfer function (linear or square root).
Press "Transmit" (F2 key) to send the new parameters to the device for them to be taken into account.



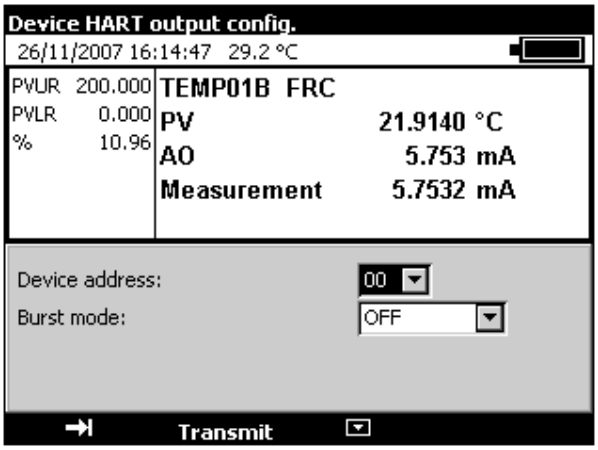
The detector configuration option is not supported by every sensor.



Press "Transmit" (F2 key) to send the new parameters to the device for them to be taken into account.

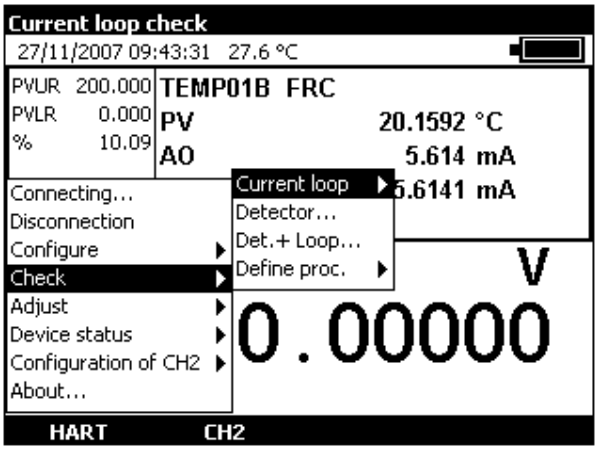


"Configuration" from "HART output" is used to access device addressing.

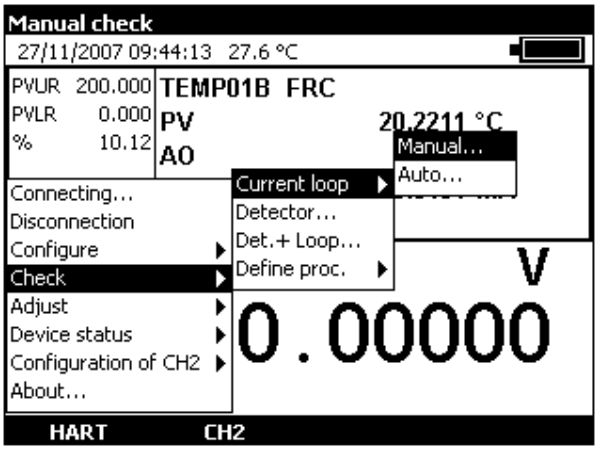


This configuration is used edit the connected device address (e.g., to switch to point-to-point mode in the event of a single sensor).

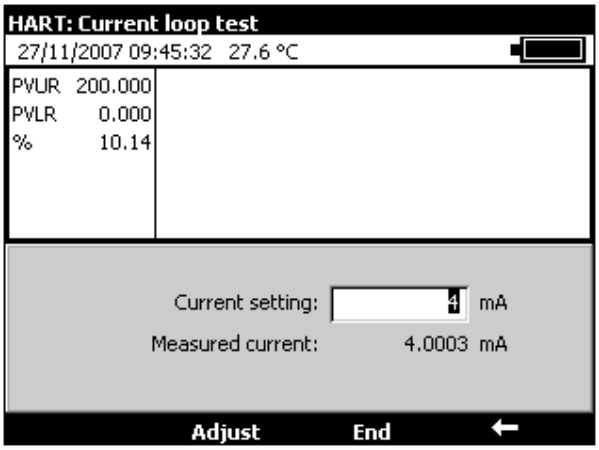
B.2.11.4 Verification



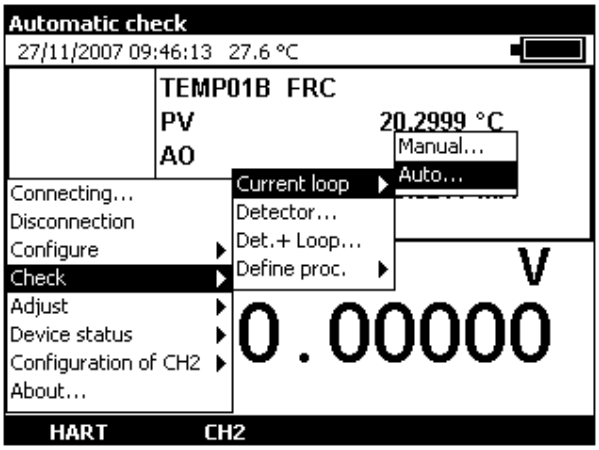
The "Verify" option from the Hart menu is used to access current loop, detector, detector and current loop checks.



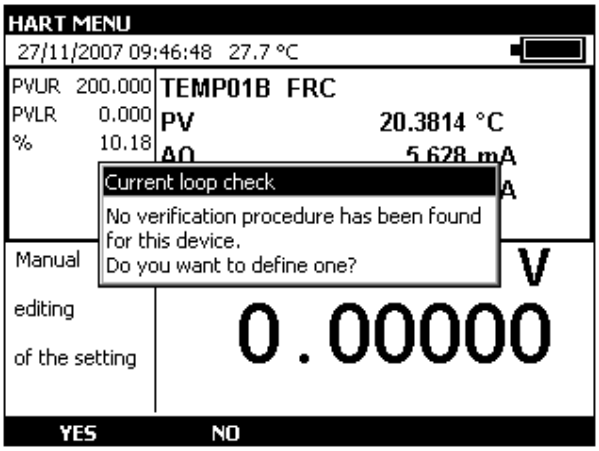
The current loop may be checked manually or automatically.



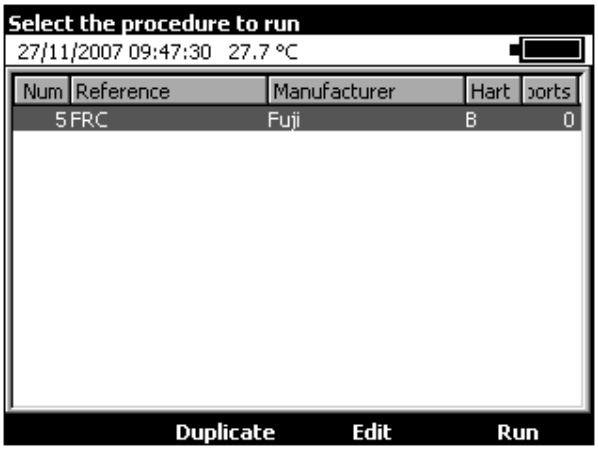
In "Manual" mode, a setpoint current is defined (4mA in the example above) and adjusted by pressing the F2 key ("Adjust").



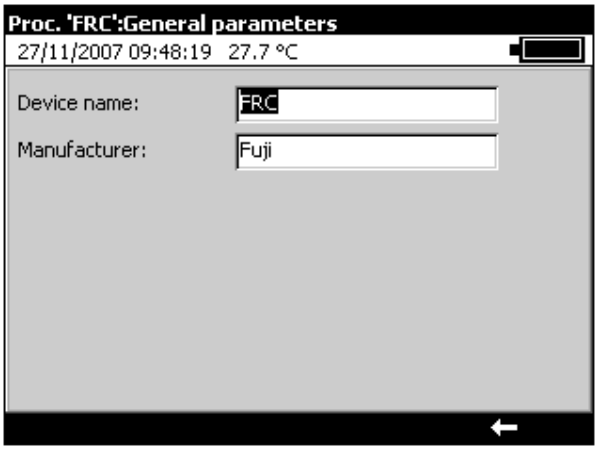
In automatic verify current loop mode, the C150 looks for a programmed procedure matching the device under test.



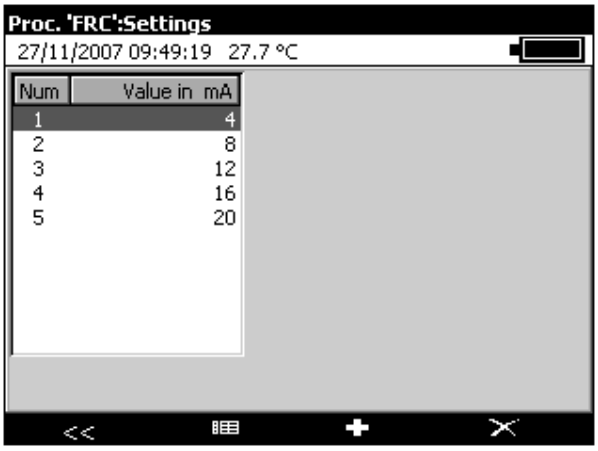
If no procedure is found, it prompts for creating one. Press keys F1 ("YES") or F2 ("NO").



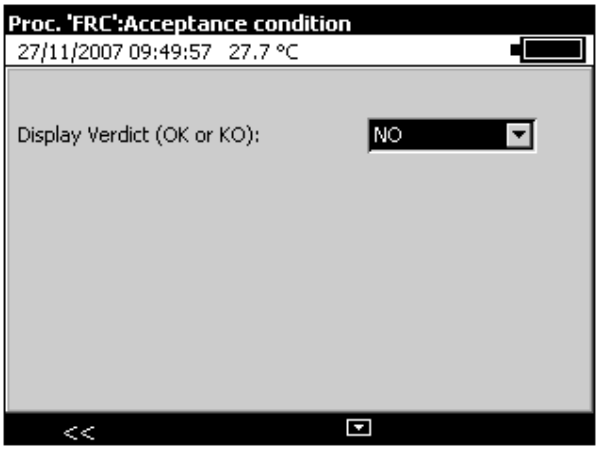
Once created, press the F3 key to "Edit" it.



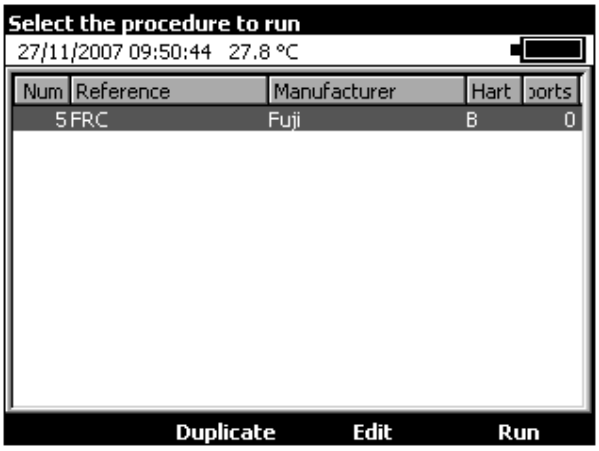
General parameters are those returned by the sensor, these may be edited.



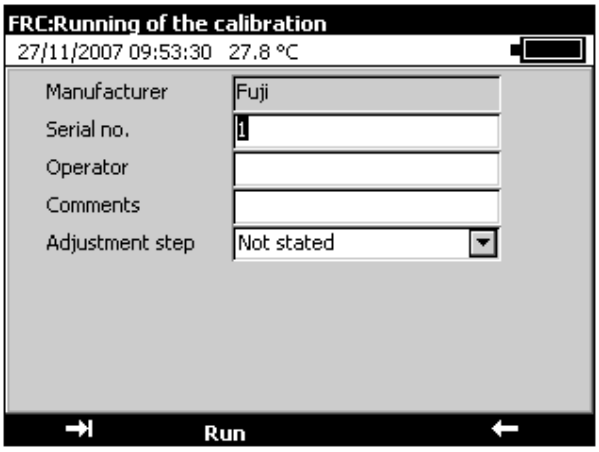
Setpoints may be edited. These may be removed or deleted with keys F2 to F4.
When complying with required procedure, confirm with "ENTER" key.



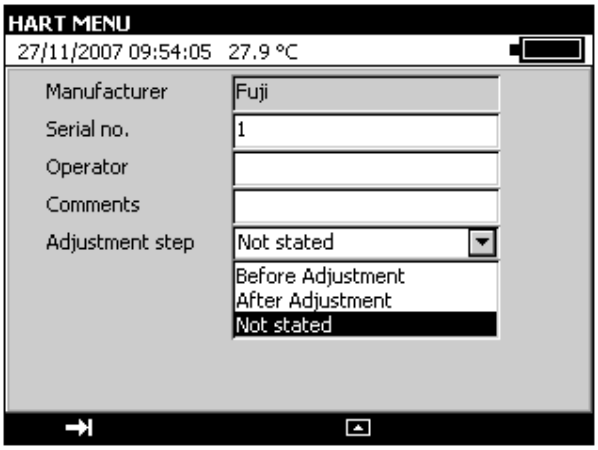
When verified, a verdict display may be added: "YES" for display "OK" or "KO", "NO" for report not to be displayed.



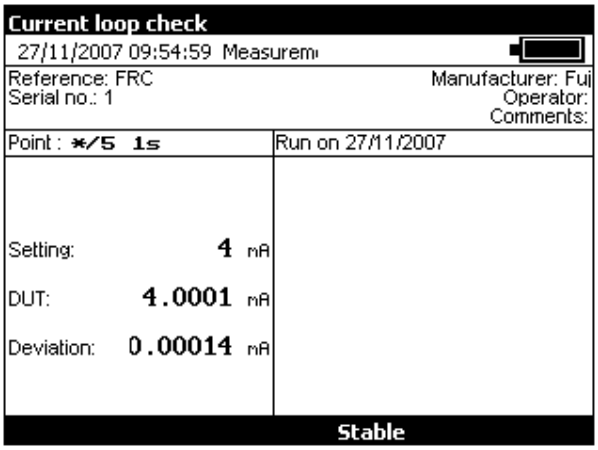
Once the procedure is defined, it may be "Run" with the F4 key, "Duplicated" with the F2 key or "Edited" with the F3 key. "B" in the HART column indicates that it is a verify loop procedure.



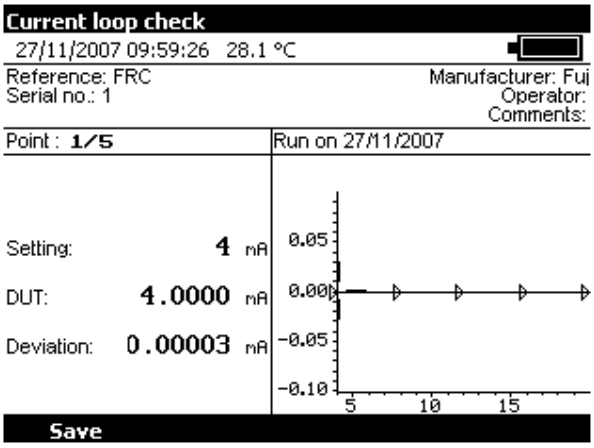
When run, you may enter the device serial number, name of the operator and a comment. This information will be shown in the verify report (PV).



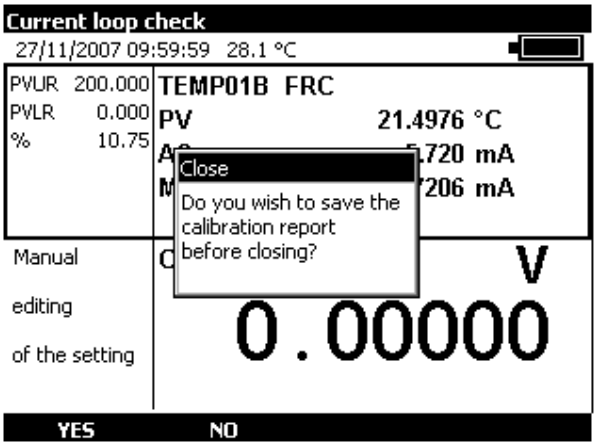
Select "Adjustment step": "Before adjustment", "After adjustment" or "Not specified".



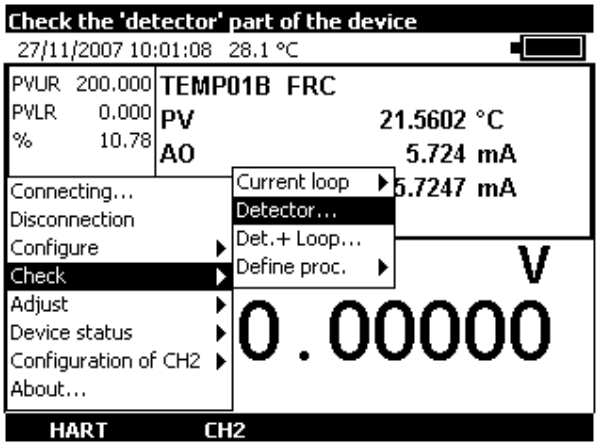
The C150 then runs the various steps defined for verification step-by-step. The procedure may be sped up by pressing the F3 key ("Stable") when stability is deemed satisfactory.

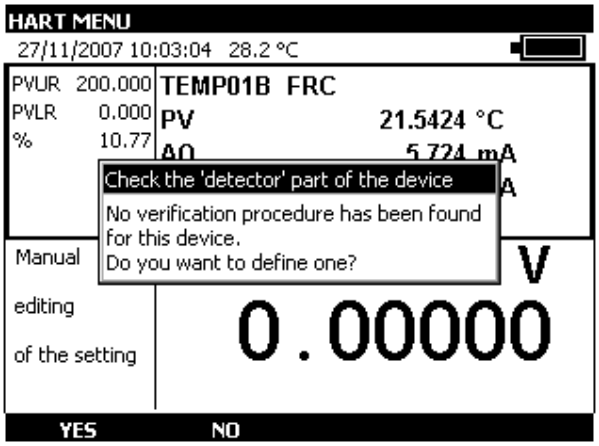


At the end of the verify procedure, the results may be "Saved" with the F1 key or exited with the "ENT" key.

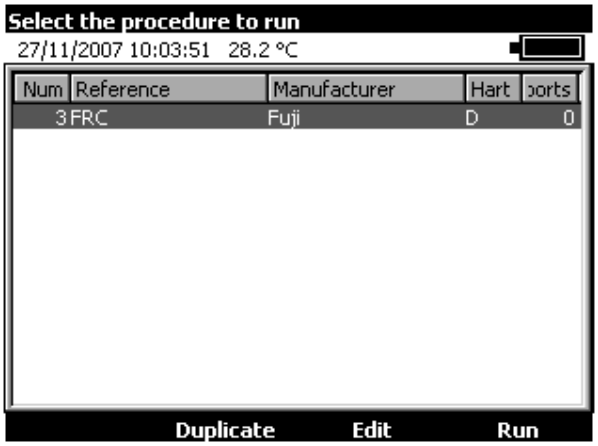


The unit displays the following prompt: "Save calibration report before closing?" Press keys F1 ("YES") or F2 ("NO").

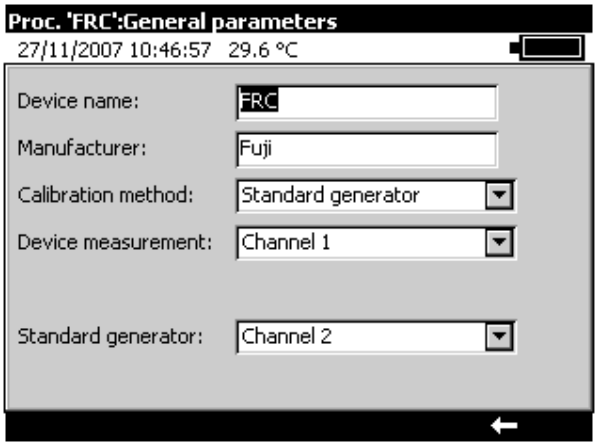


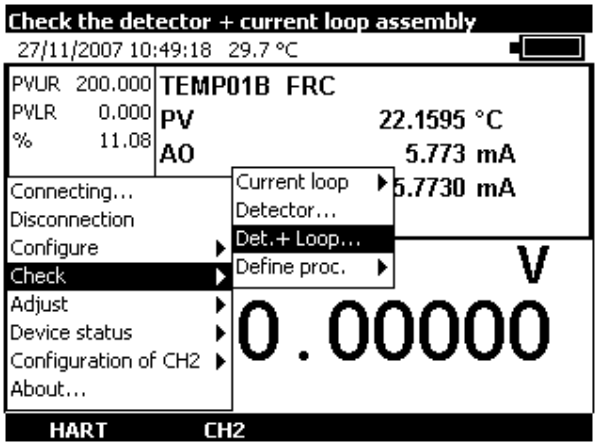


To create a verify procedure for the detector part, press the F1 key ("YES") or else cancel by pressing the F2 key ("NO").

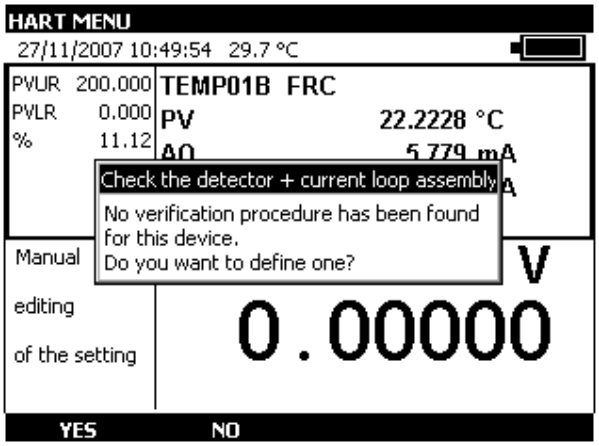


When a procedure is created, the letter "D" in the HART column indicates that it is a verify detector procedure. Edit procedure to complete creation.

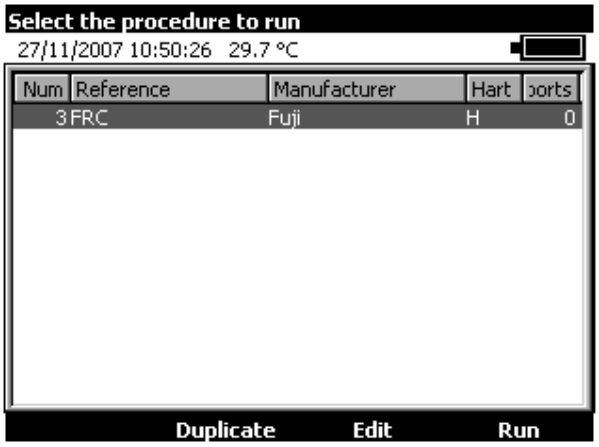




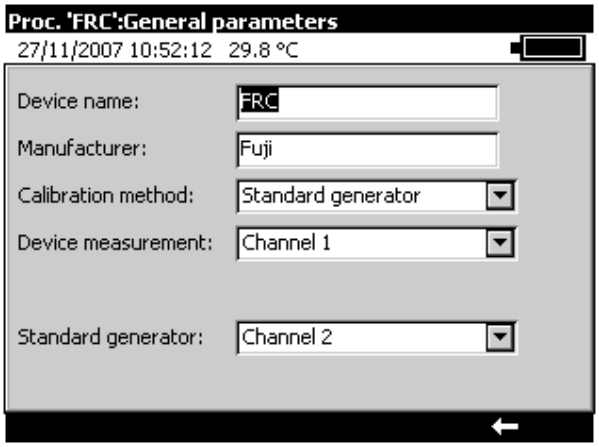
The detector and current loop may be verified at the same time.

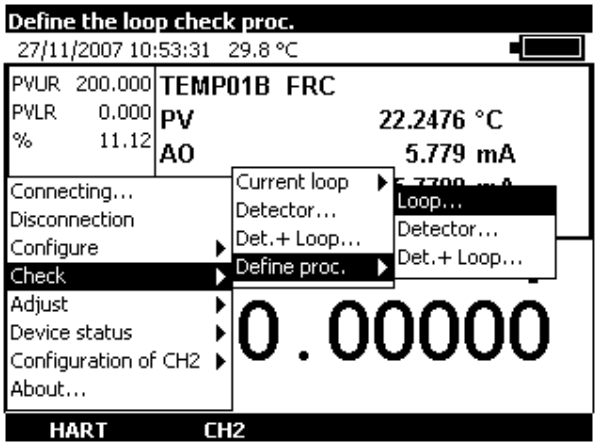


To create a verify procedure for the detector part, press the F1 key ("YES") or else cancel by pressing the F2 key ("NO").



When a procedure is created, the letter "H" in the HART column indicates that it is a verify detector procedure for the detector and current loop. Edit procedure to complete creation.

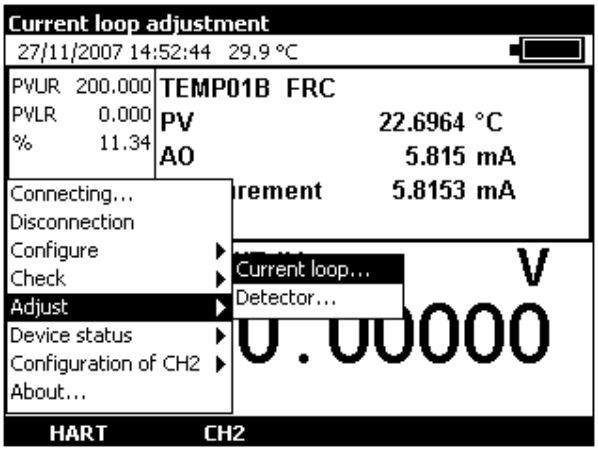




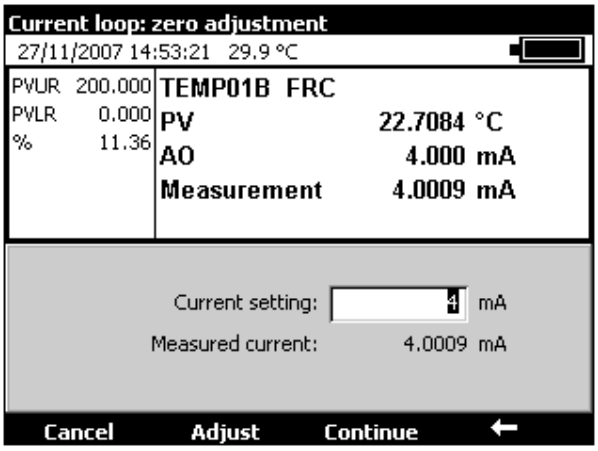
From the "HART" item, "Verify", "Define procedure", the three types of verify procedure may be directly edited: Loop, Detector, Detector + Loop. See relevant sections in the above explanations.

B.2.11.5 Adjustment

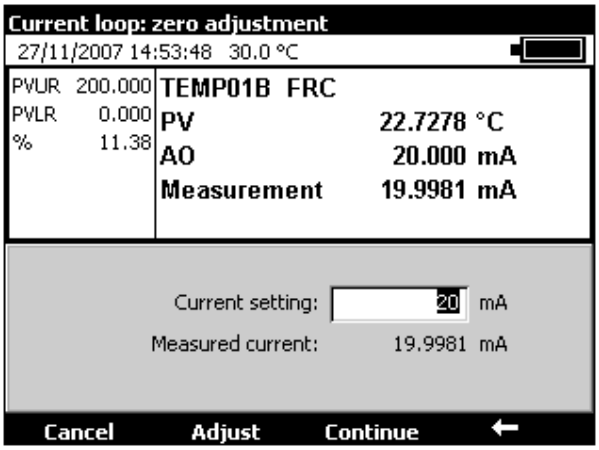
The current loop and/or detector may be adjusted.



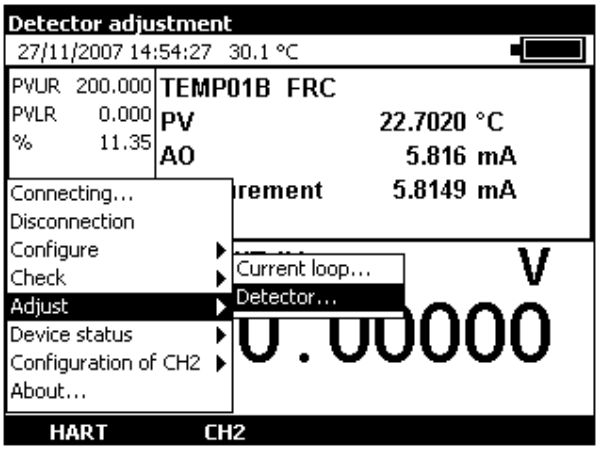
To adjust the current loop, select "Adjust", "Current loop" from the "HART" menu.



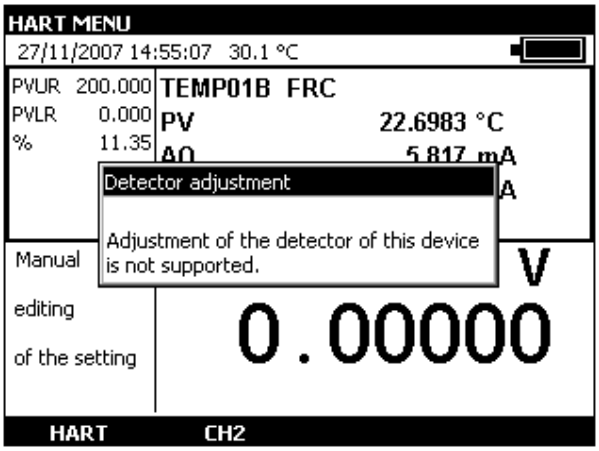
Edit current value according to required setpoint for zero setting. Press the F2 key ("Adjust" when device is ready. Then press the F3 key ("Continue") to move to the next point.



Edit current value according to required setpoint for gain adjustment. Press the F2 key ("Adjust") when device is ready. Then press the F3 key ("Done") to end adjustment operation.



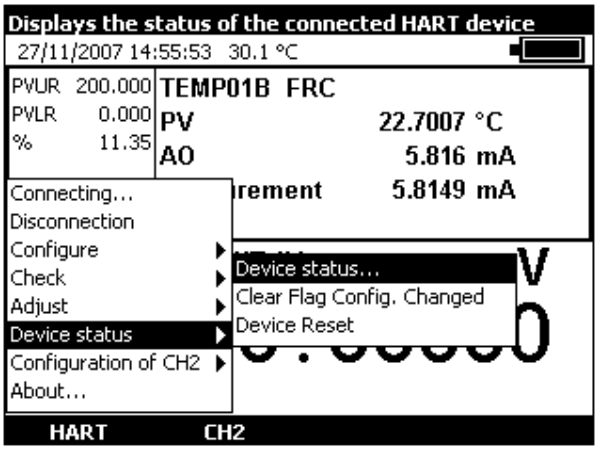
Detector adjustment is not supported by every HART device.



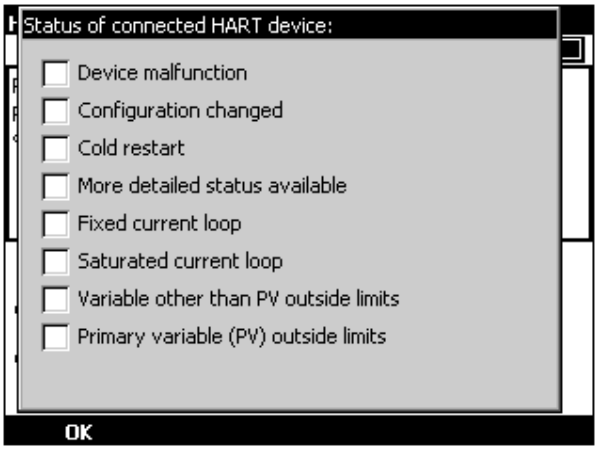
When a sensor supports this function, the screen is linked to the sensor.

B.2.11.6 Device status

The "Device status" item from the HART menu is used to access the following: Device status, Clear modified configuration indication and Reset device.



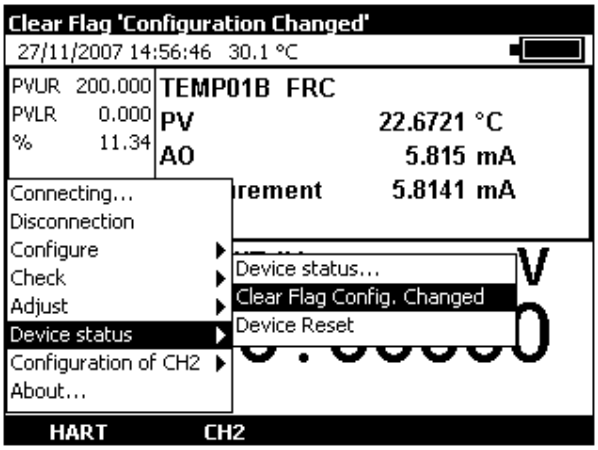
To access Device status, select "Device status", "Device status" items from the HART menu.



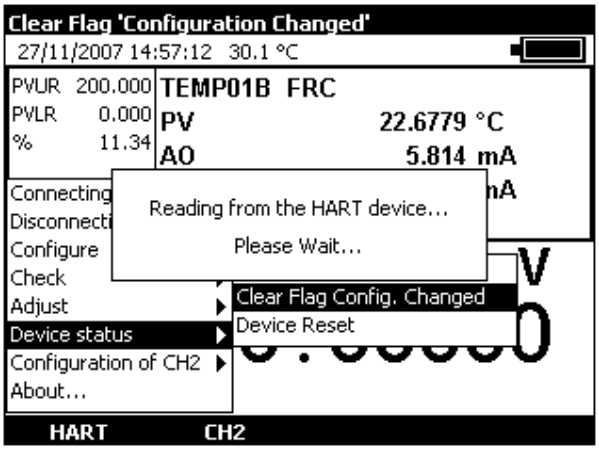
A table displays some device status registers:

- Device malfunction: indicates device malfunction. Refer to device user manual and check for compatibility with current operation.
- Modified configuration: this check box indicates that configuration has been modified. This information may be reset in the next chapter.
- Cold start: indicates a cold start???
- More detailed status available: indicates that a more detailed status is available???
- Fixed current loop: indicates that current is fixed, which is not the case in point-to-point-mode for instance.
- Saturated current loop: check connections in accordance with equipment manual.
- Variable other than PV out of range:
- Primary variable (PV) out of range:

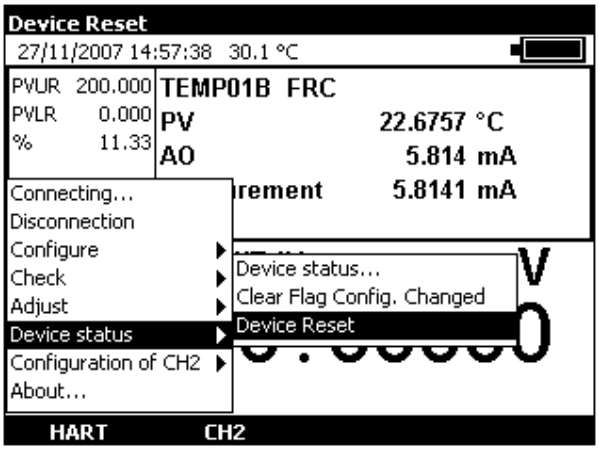
Once status assessed, press the F1 key ("OK") to switch back to normal operation.



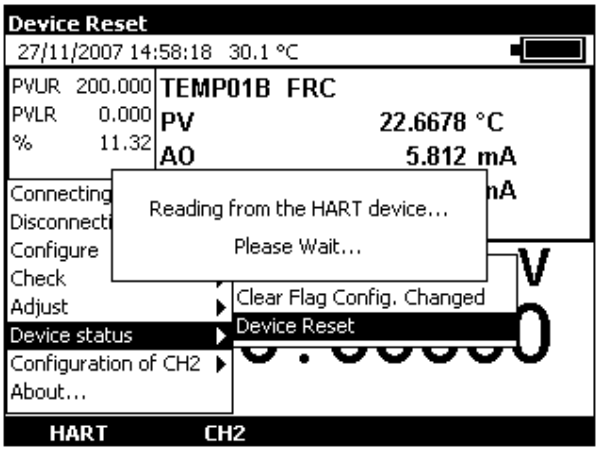
This item is used to clear the Modified configuration flag.



Confirm and wait for end of message to be displayed in dialog box.



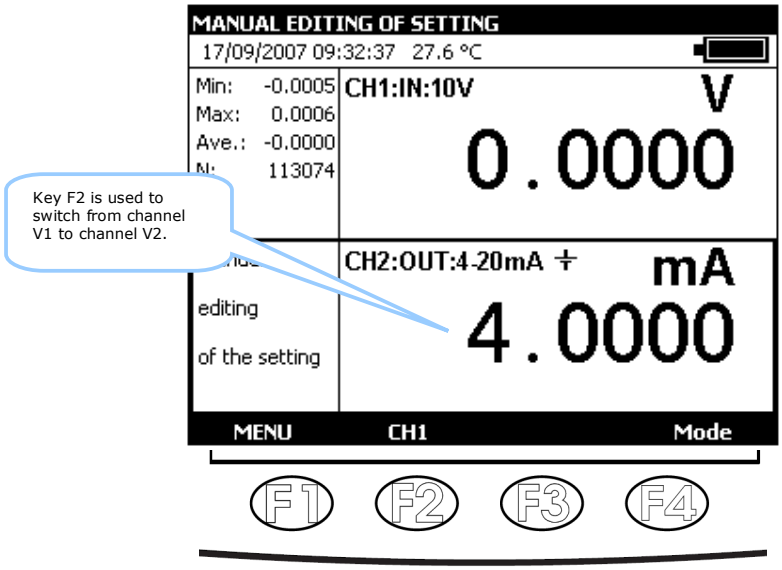
This item is self-explanatory; it is used to reset a device as after a modified power-up.



Confirm and wait for end of message to be displayed in dialog box.

B.3 Generation/Simulation or Measurement on Channel V2

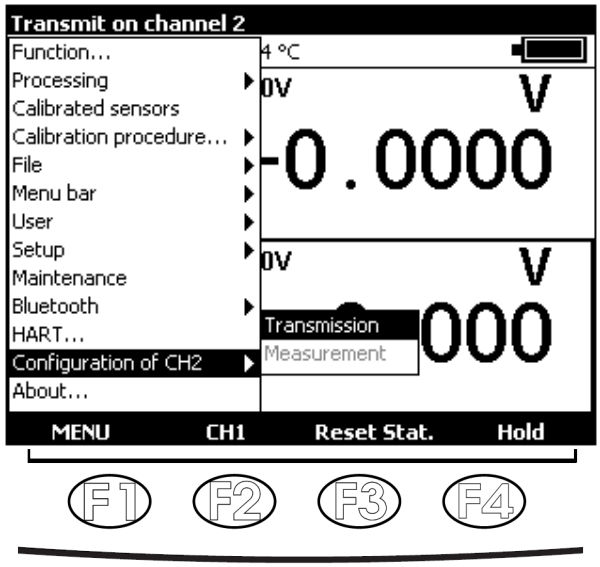
Channel V2 may be used as a Generation/Simulation or Measurement Channel. This channel is accessed with the **F2** function key (V2). Pressing this button activates the transmission/simulation window: the lower window in the display is then marked by a rectangular border.



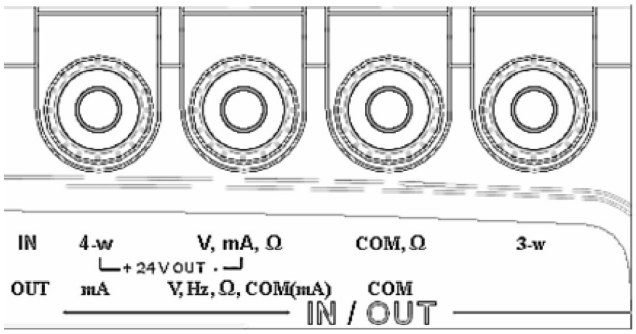
B.3.1 Generation/Simulation Mode

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.



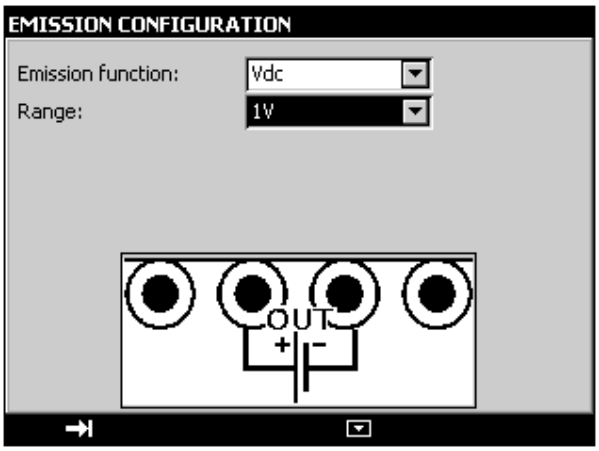
To select a simulation function, press the **F1** key (Menu).
In Transmit mode, connections are across the four "IN/OUT" terminals located on the right half of the unit:



B.3.1.1 Generating a DC voltage

- Display the **TRANSMISSION CONFIGURATION** dialog box:
- Select the **Vdc** transmission function, then the range suitable for measurement using the function and navigation keys.

- Confirm with ENTER.



The following ranges are available:

Range	100 mV	1 V	10 V	50V
Resolution	1 µV	10 µV	100 µV	1mV
Output impedance	< 1 Ω	<1 Ω	<1 Ω	<1 Ω
Output load	1 kOhm	2 kOhm	4 kOhm	4 kOhm

The DC source voltage to be generated is connected between terminals V and COM.

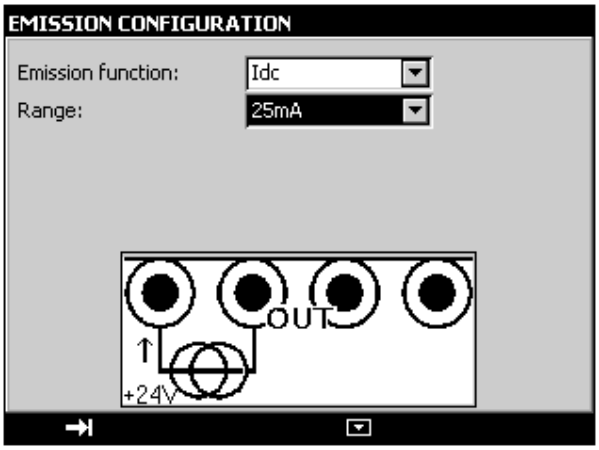
B.3.1.2 Current generation

- Display the **TRANSMISSION CONFIGURATION** dialog box:
- Select the **Idc** measurement function, then the range using the function and navigation keys.
- Confirm with ENTER.

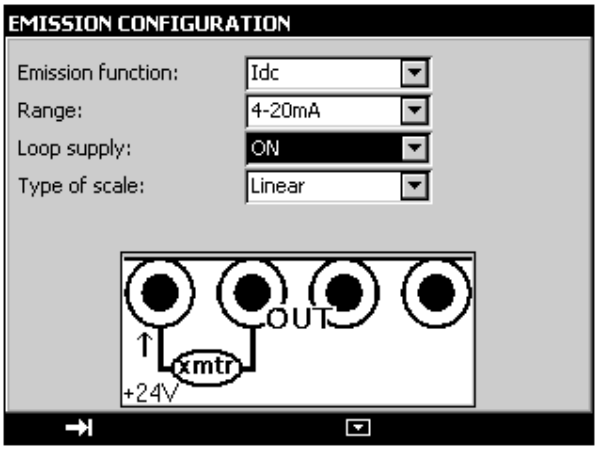
Depending on the range selected, several transmission modes are available:

Range	25 mA	4-20 mA	0-20 mA
Resolution	0.1 µA	0.1 µA	0.1 µA
Loop power supply	No	Possible	Possible
Set to scale	No	Linear or square law	Linear or square law

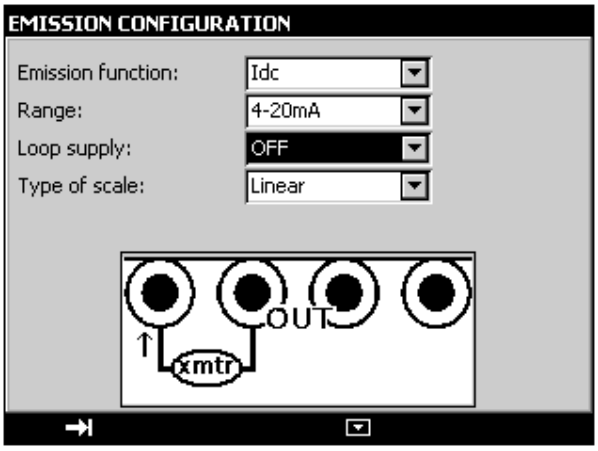
Connection is made between the mA and COM terminals.



If the loop power supply is on, the C150 simulates a passive transmitter supplied with 24 V externally.



If the loop power supply is off, the C150 simulates a passive transmitter supplied with 24 V externally.



When the square law scale is selected, it must be activated by using the **Menu → Set to scale** menus. Once "set to scale" is activated, the user enters the values to be simulated in a unit of the new scale.

The C150 indicates the configuration selected in the window, using the following icons:

: to show Loop power is off

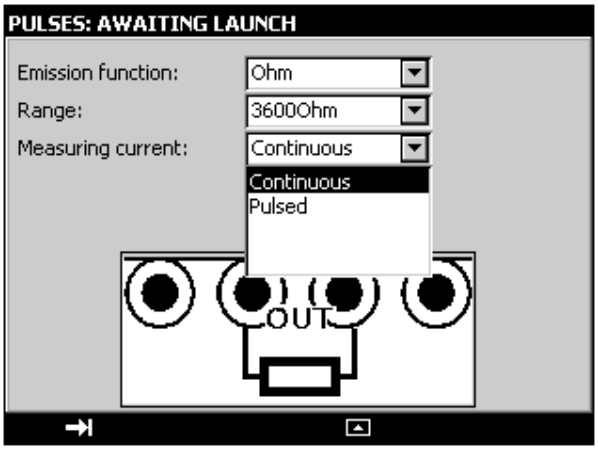
: to show Loop power is on

: to indicate a square law scale

Refer to paragraph **Error! Reference source not found.** (Measuring Current) for an explanation of the square law scale.

B.3.1.3 Resistance simulation

- Display the **TRANSMISSION CONFIGURATION** dialog box:
- Select the **Ohm** measurement function; Select the **Idc** measurement function, then the range using the function and navigation keys.
- Select measurement current (direct or pulsed)
- Confirm with ENTER.



The following ranges are available:

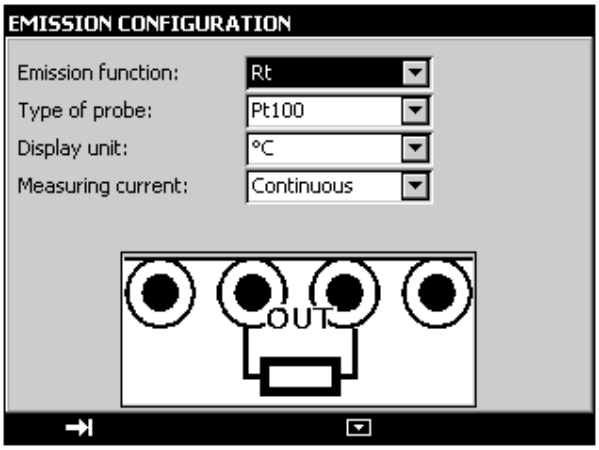
Range	400 Ohm	3600 Ohm	50 kOhm
Resolution	1 mOhm	10 mOhm	100 mOhm
Measurement current	0.1-1 mA	0.1-1 mA	5-50µA
Settling time	< 10 ms	< 10 ms	< 100 ms

If the measurement current is very high, the message "Out of Range" is displayed in the transmission window.
The resistance simulation function can be used with either 2, 3 or 4 wire connection.

If a polling acquisition system is used, ensure that the current is maintained for more than 1 ms to avoid measurement errors due to the response time of the resistance simulation function.

B.3.1.4 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:

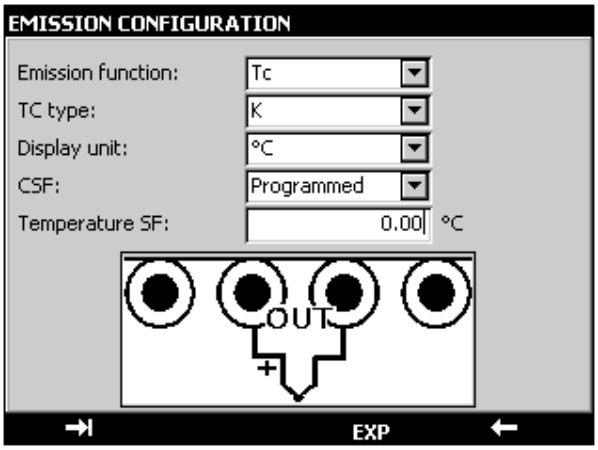
Sensor	Probe Type Caption
Pt 50(α = 3851)	Pt 50
Pt 100 (α = 3851)	Pt 100
Pt 100 (α = 3916)	Pt 100-3916
Pt 100 (α = 3926)	Pt 100-3926
Pt 200 (α = 3851)	Pt 200
Pt 500 (α = 3851)	Pt 500
Pt 1 000 (α = 3851)	Pt 1000
Ni 100 (α = 618)	Ni 100
Ni 120 (α = 672)	Ni 120
Ni 1 000 (α = 618)	Ni 1000
Cu 10 (α = 427)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

B.3.1.5 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.

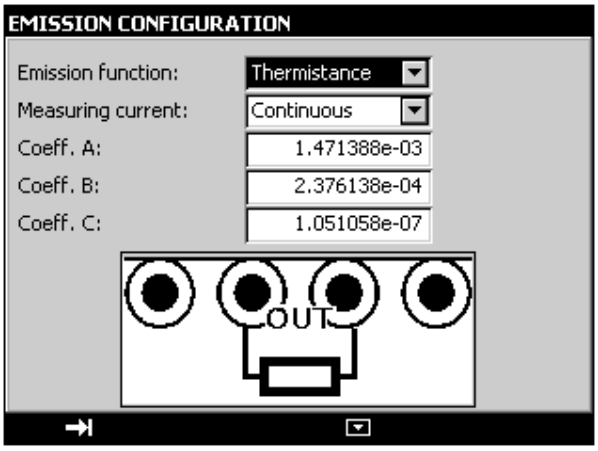


The thermocouples available are: K, T, J, E, N, U, L, S, R, B, C, PL, Mo, NiMo/NiCo.

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.

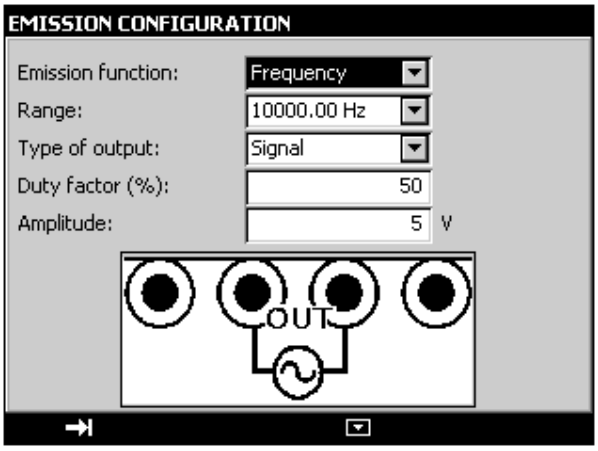
B.3.1.6 Thermistor simulation

- 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.3.1.7 Frequency generation

- Display the **TRANSMISSION CONFIGURATION** dialog box:
- Select the **Frequency** transmission function, then the range using the function and navigation keys.
- Select the **Signal** "Output type".
- Enter cyclic ratio between 20 and 80%
- Enter the amplitude of the signal between 0 and 20 V.
- Confirm with ENTER.



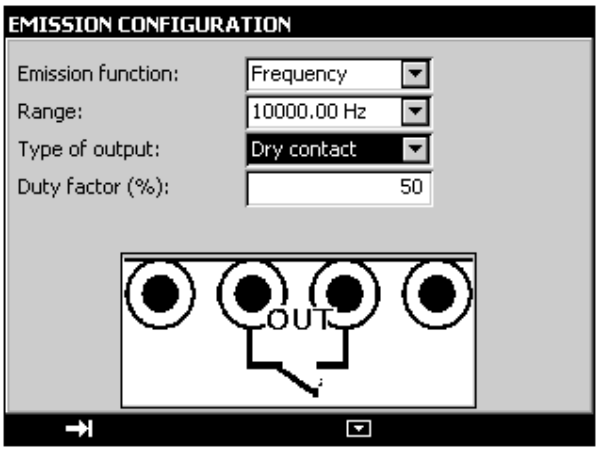
The following ranges are available:

Range	1,000 Hz	10,000 Hz
Resolution	0.01 Hz	0.1 Hz
Max. Amplitude	20 V	20 V

Depending on the range selected, display is in Hz or beats per minute (BPM).
Connection of the frequency source generated is between the Hz and COM terminals.

B.3.1.8 Frequency generation for hard contact

- Display the **TRANSMISSION CONFIGURATION** dialog box:
- Select the **Frequency** transmission function, then the range using the function and navigation keys.
- Select the "Type of Output" **Hard contact**.
- Enter cyclic ratio between 20 and 80%
- Confirm with ENTER.



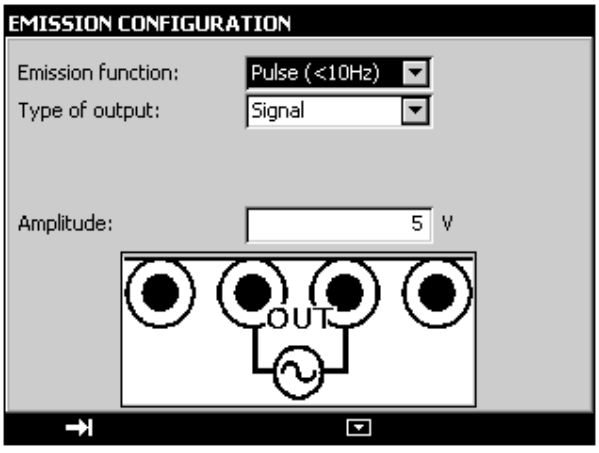
The following ranges are available:

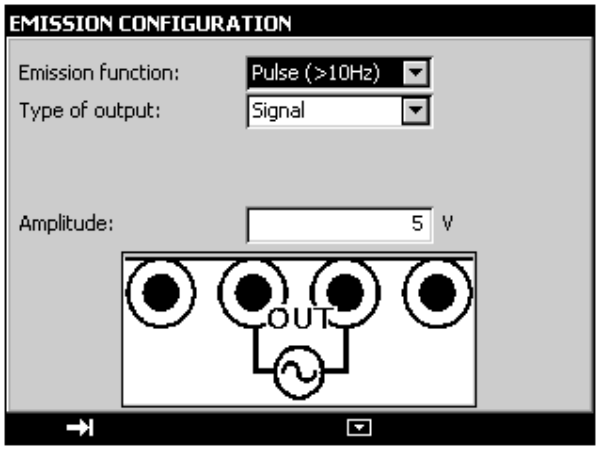
Range	1,000 Hz	10,000 Hz
Resolution	0.01 Hz	0.1 Hz
Max. Amplitude	20 V	20 V

Depending on the range selected, display is in Hz or beats per minute (BPM).
Connection of the frequency source generated is between the Hz and COM terminals.

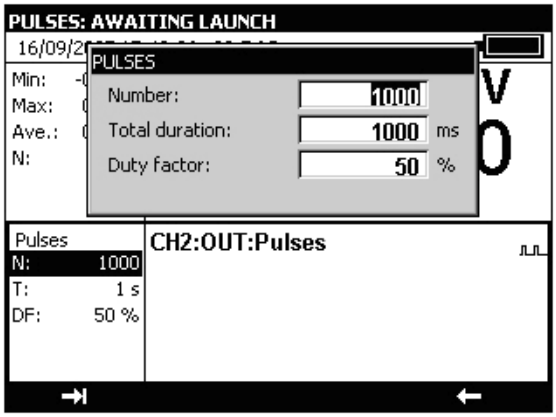
B.3.1.9 Pulse generation

- Display the **TRANSMISSION CONFIGURATION** dialog box:
- Select the **Pulse** transmission function, then the range using the function and navigation keys.
- Select the "Type of Output" **Signal**.
- Enter the amplitude of the signal between 0 and 20 V.
- Confirm with ENTER.





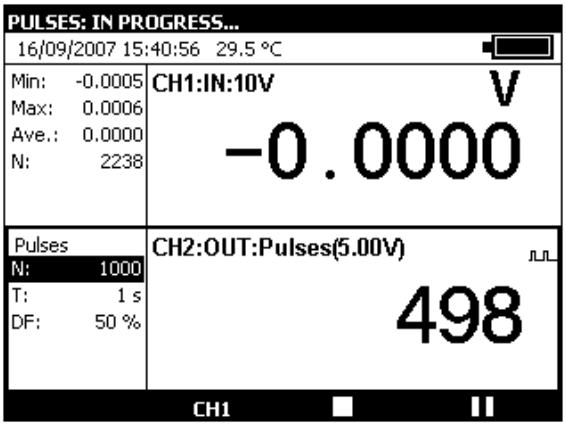
The icon appears in the Transmission window.
To change the default parameters, press ENTER or enter the **Configuration ...** menu then **Pulses ...**.



The parameters are:

- Number: Number of pulses to be generated between 1 and 8,000,000.
- Overall time: burst time in milliseconds (<10Hz) between 0.05 and 100 000 000 or in seconds (>10Hz) between 0.02 and 1 000 000
- Cyclic ratio: cyclic ratio between 20 and 80 %

To commence pulse generation, press **Start** (F3).



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

The ■ key stops generation at any time

The ▮▮ key suspends generation

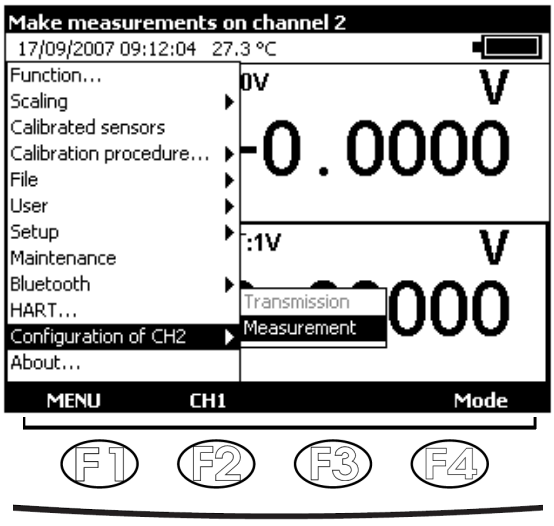
The ▶ key commences or resumes generation

The ⧗ icon in the transmission window indicates suspended generation.

B.3.2 Measurement Mode

Measurement mode from channel V2 is accessed with **F1** function key (Menu) and **V2 Configuration** item (near the bottom of the drop-down list)

- If in Transmit mode, select **Measurement** with the function and navigation keys.
- Confirm with ENTER.

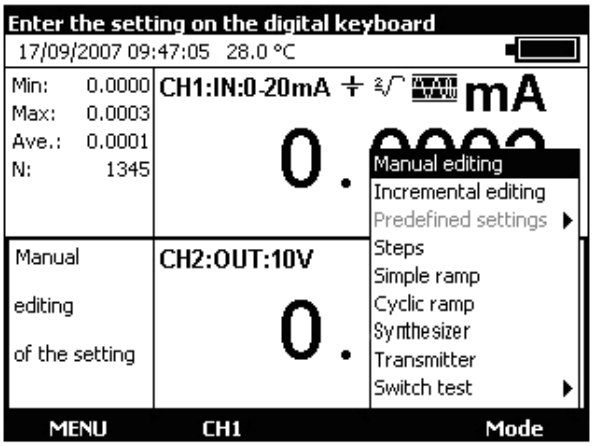


To select a Measurement function, press the **F1** key (Menu).
Select **Function ...** menu with navigation keys and confirm with ENTER key. As channel V2 Measurement mode is the same as channel V1 Measurement mode, refer to chapter B.2.
In Transmit mode (V2), connections are across the four "IN/OUT" terminals located on the right half of the unit.

C. ADVANCED OPERATION

C.1 *Simulation Modes*

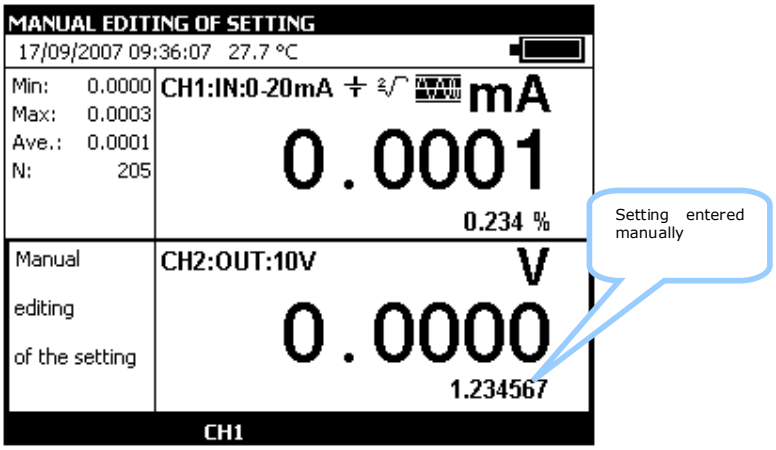
Several transmission modes are available in the C150 to facilitate rapid checking and calibration of instruments and transmitters.
To change the transmission mode, open the transmission window using the **OUT** function key (F2).



When the transmission window is open, the C150 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.

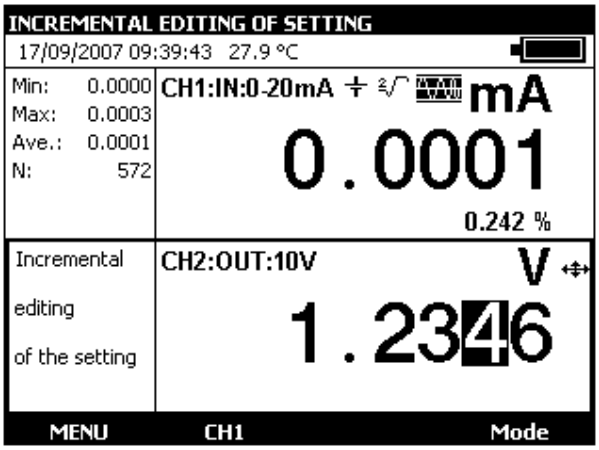
C.1.1 Manual Edit Mode

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.



C.1.2 Incremental Edit Mode

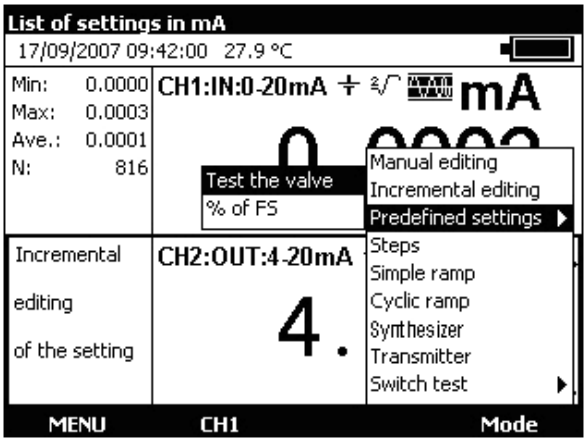
When this mode is active, the icon appears in the transmission window.
Use the 4 navigator keys to edit the value to be transmitted.
To select a digit, use the Left ◁ and Right ▷ keys of the navigator. The editable digit appears reversed in the display (white on black).
To increment/decrement the digit selected, use the Up △ or Down ▽ key of the navigator.



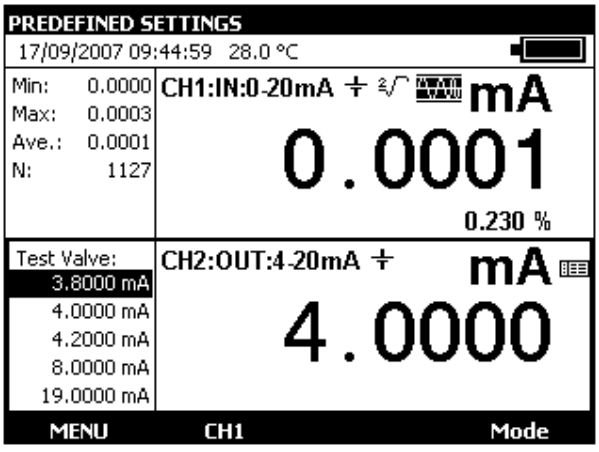
The value displayed is immediately active and it is not necessary to confirm it.

C.1.3 Predefined Settings Mode

This mode is available for the DC current transmission function for the 0-20 mA and 4-20 mA ranges only.
Two types of predefined settings are offered: Valve Test and Percentage of full scale (% of FS).

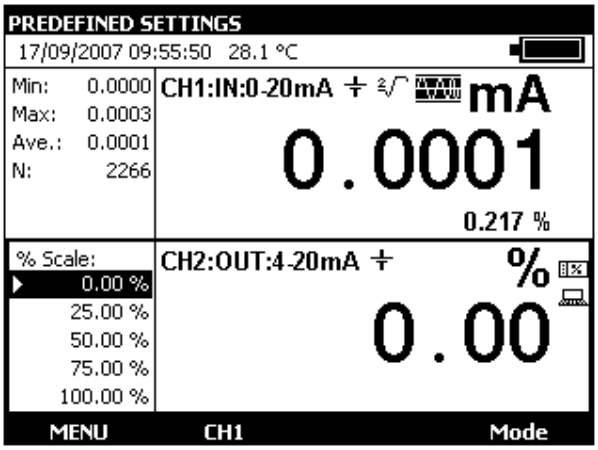


In the case of valve test, the predefined values are displayed in the left hand side of the transmission window. The  icon is displayed in the right hand side of the window.

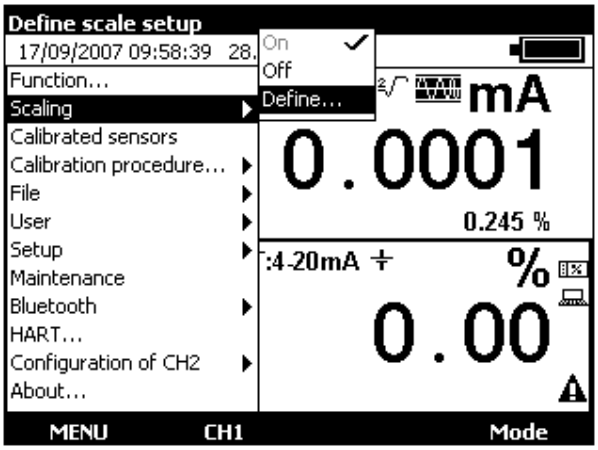


The Up/Down keys of the navigator can be used to select the setting from the list. The ENTER key transmits the selected setting. The Left/Right keys of the navigator are used to transmit the previous/next setting. The numerical keys 0 - 9 are used to enter the value to be transmitted on the keyboard.

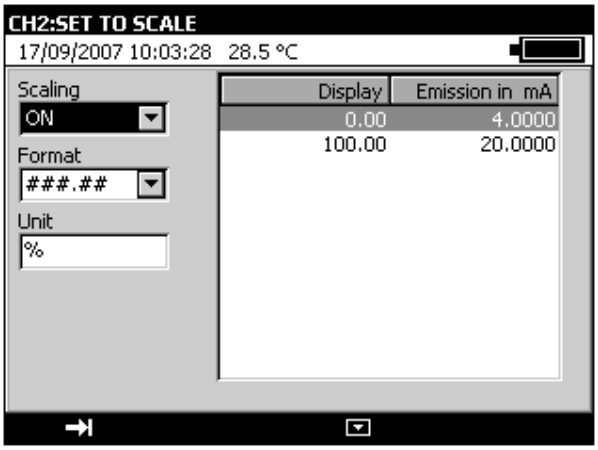
In the case of values predefined as a percentage of full scale, the  icon appears on the left hand side of the transmission window.



The icon indicates setting to scale. To view applied scaling, use **Scaling**, and **Define** items from **Menu**.



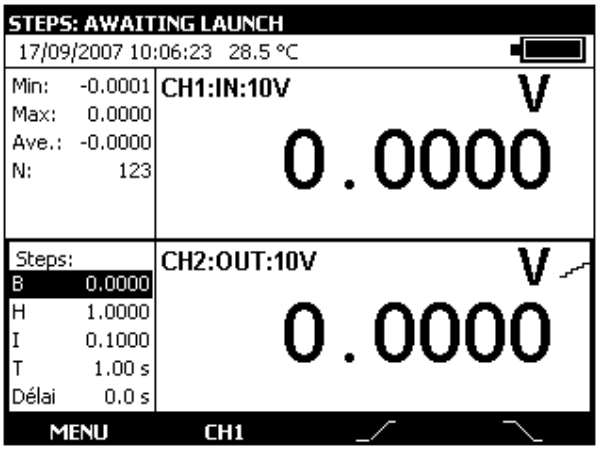
Value pairs may be edited.



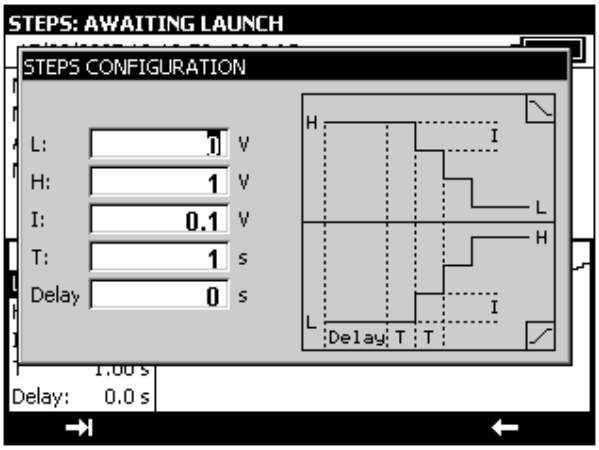
C.1.4 Staircase mode

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

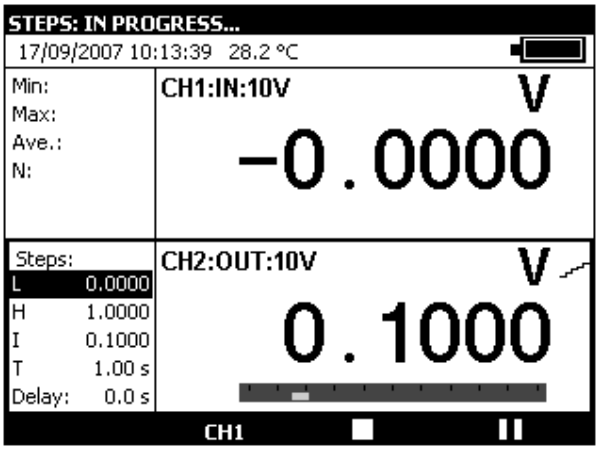
When this mode is active, the icon appears in the transmission window.



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

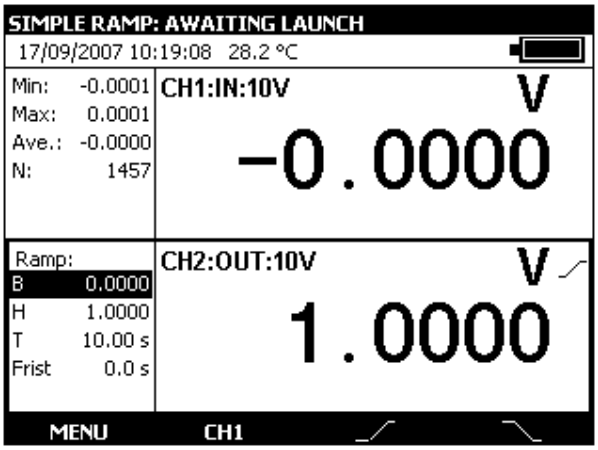
The  key suspends generation

The  key commences or resumes generation

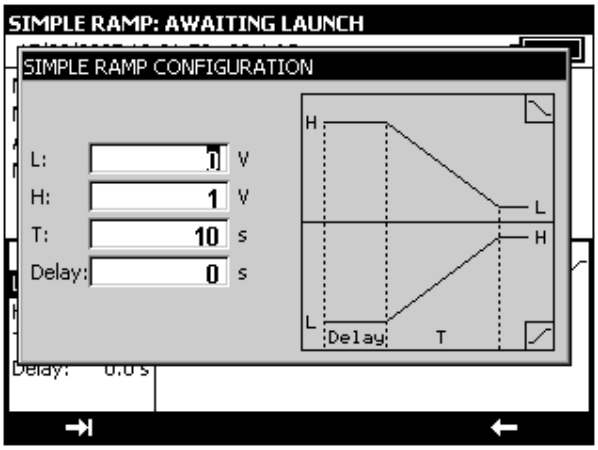
An icon in the transmission window indicates suspended generation.

C.1.5 Simple Ramp Mode

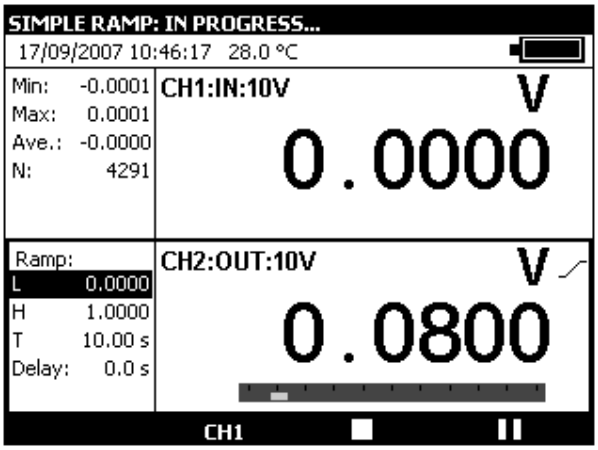
The simple ramp generation function is used to program a linear variation in one direction (increasing or decreasing) of the active transmission function.
When this mode is active, the icon appears ion the transmission window.



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

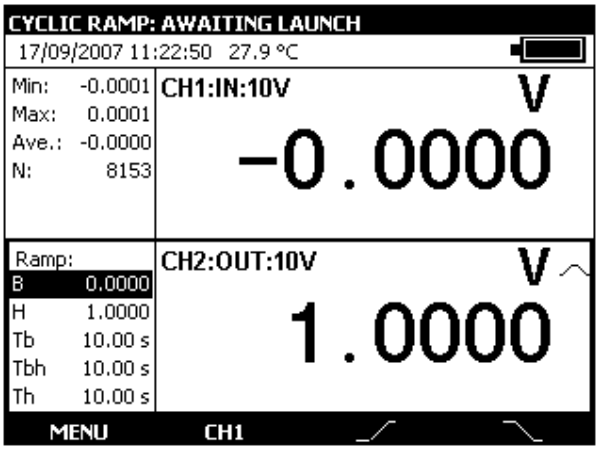
The key commences or resumes generation

An icon in the transmission window indicates suspended generation.

C.1.6 Cyclic Ramp Mode

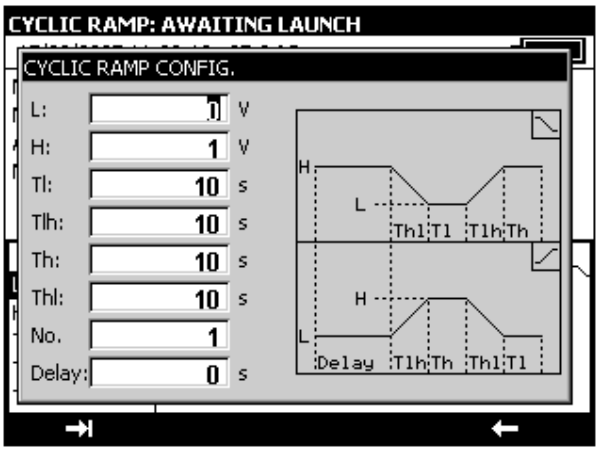
The cyclic ramp generation function is used to program a first linear variation in a direction (increasing or decreasing) followed by a first step and then a second linear variation in a direction opposite to the first variation followed by a second step.

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

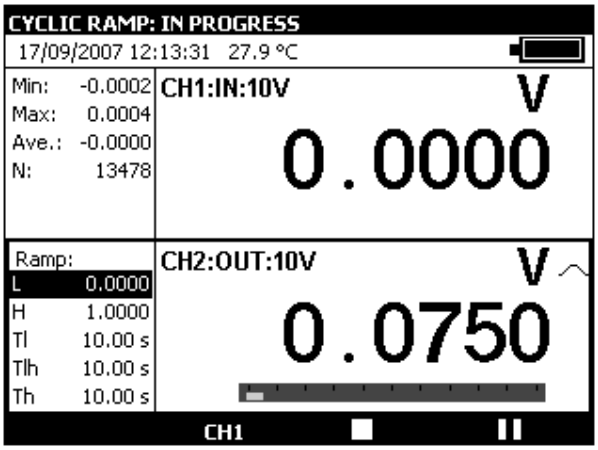


The function key is used to launch an increasing cyclic ramp and the function key is used to launch an decreasing cyclic ramp.

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

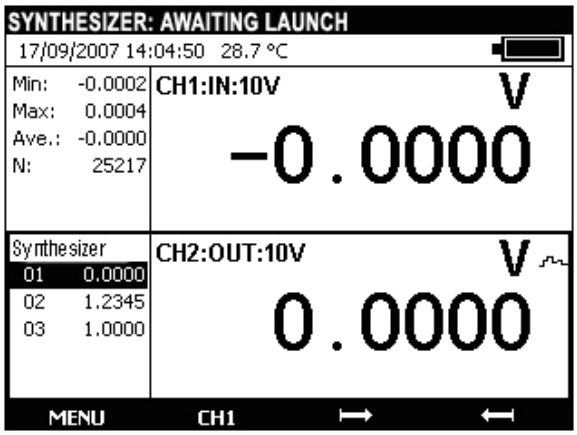
An ⧗ icon in the transmission window indicates suspended generation.

C.1.7 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.

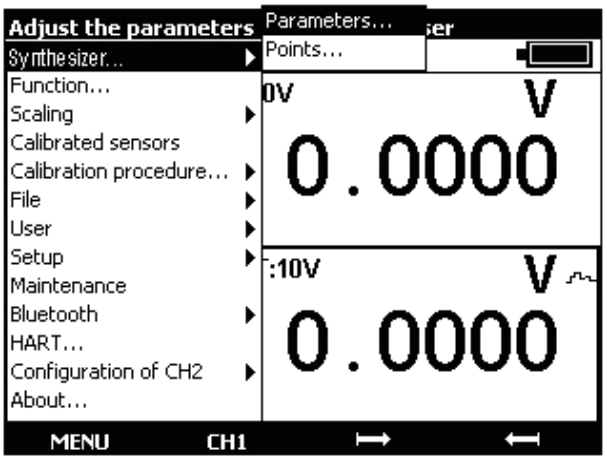
When this mode is active the ⎍ icon appears in the transmission window.



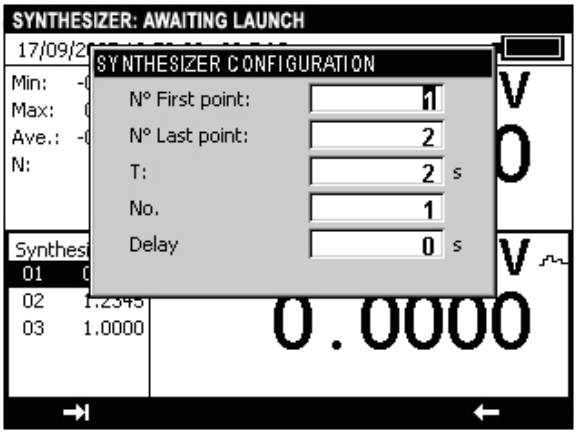
The ⟼ key is used to launch generation of values in increasing order and the ⟻ function key is used to launch generation of values in decreasing order. The default parameters of this mode are displayed in the left hand side of the transmission window.

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.

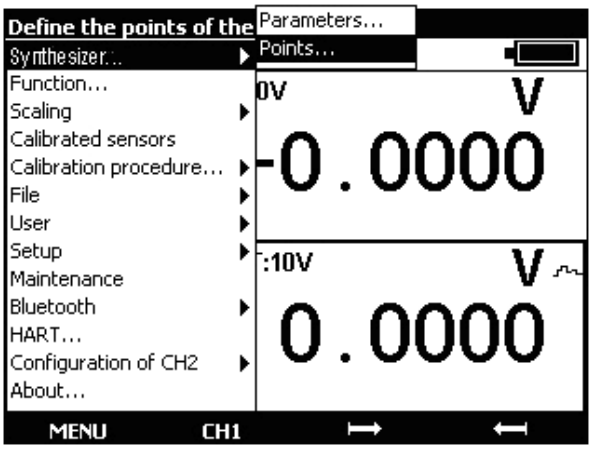
To change these parameters, use the **Menu → Synthesizer... → Parameters...**

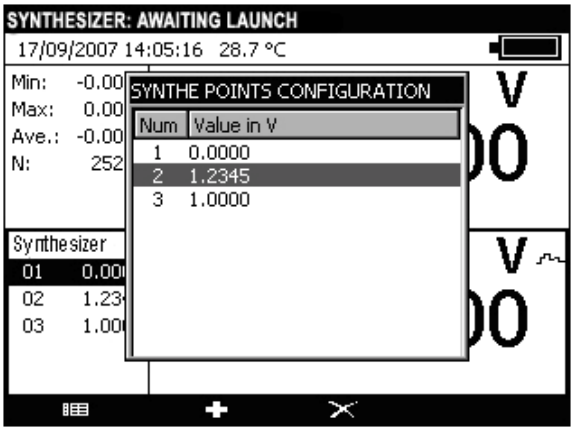


The number of the first point may be higher than that of the last point. All points between the first and last are generated.



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





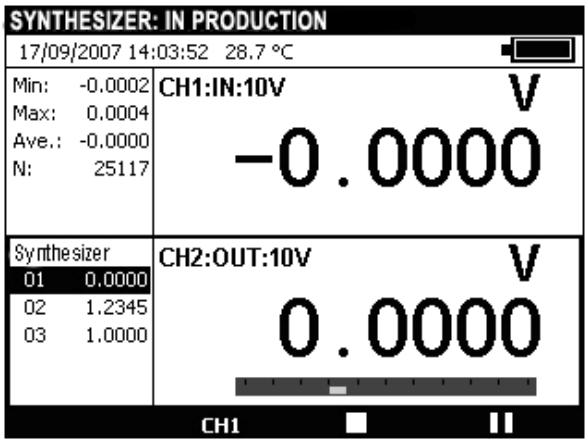
Use the function keys:

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

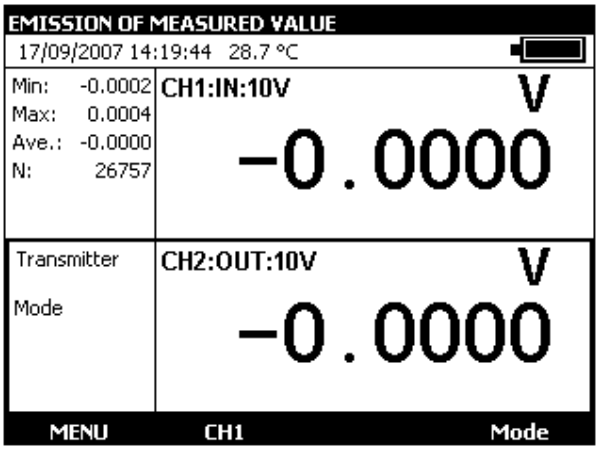
The key commences or resumes generation

An icon in the transmission window indicates suspended generation.

It is possible to transmit points manually one by one using the navigation keys. Use the Up and Down keys to select a point. ENTER transmits the selected point and Left/Right select and transmit the previous/next point in the list immediately.

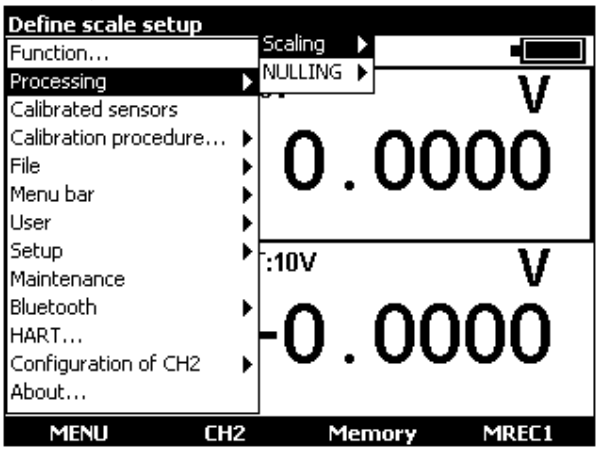
C.1.8 Transmitter Mode

This mode is used to transmit a value identical to the measured value.

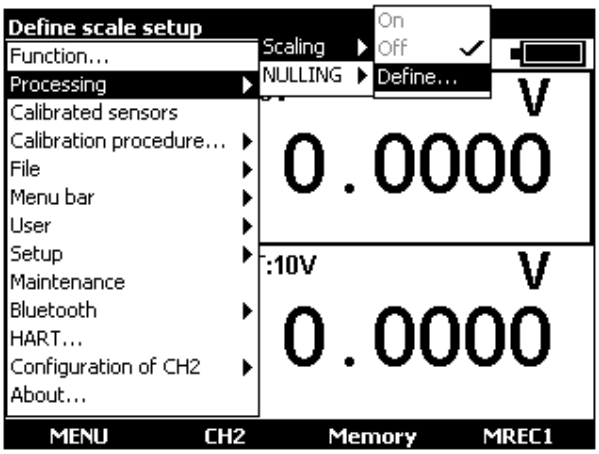


C.2 Scaling

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 non linear 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 non linear 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.

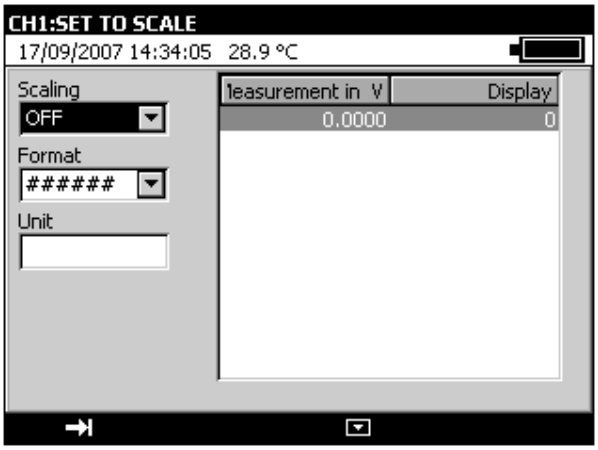


The **Define...** menu is used to program up to 10 lines of 2 values: X and Y= f(X).
In measurement: X = The value measured and Y = The value displayed.
In transmission: X = The Setting displayed and Y = The value transmitted.
The lines entered are sorted according to increasing X to set to scale a value X, the unit searches for the 2 lines n and m=n+1 that enclose it and extrapolates linearly: Y = Yn + (X-Xn) x (Ym-Yn)/(Xm-Xn)
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.

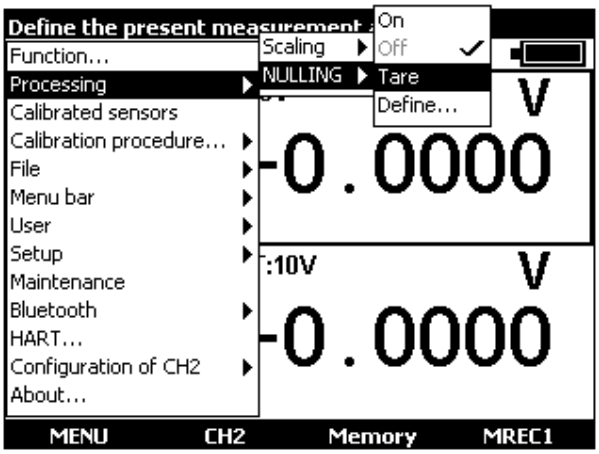
The Format and Units zones are used to select the number of decimal places and the display units.

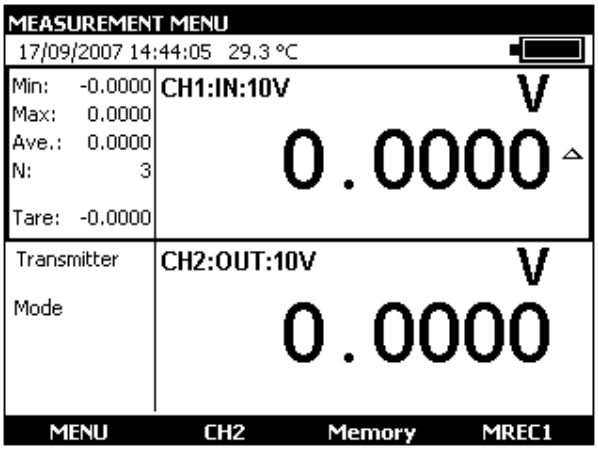


C.3 Differential Measurements

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).

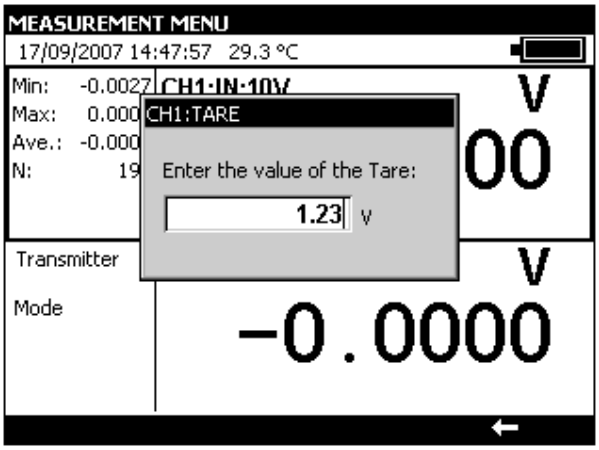
When one of the relative measurement functions is active, the △ symbol is displayed on the screen in the measurement window.





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

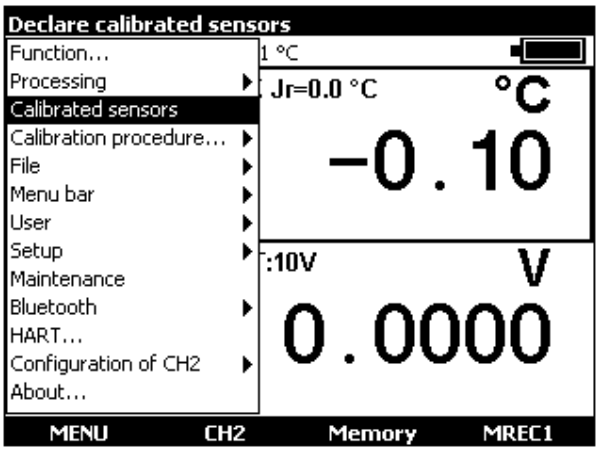
Value Displayed = Value measured – Tare Value



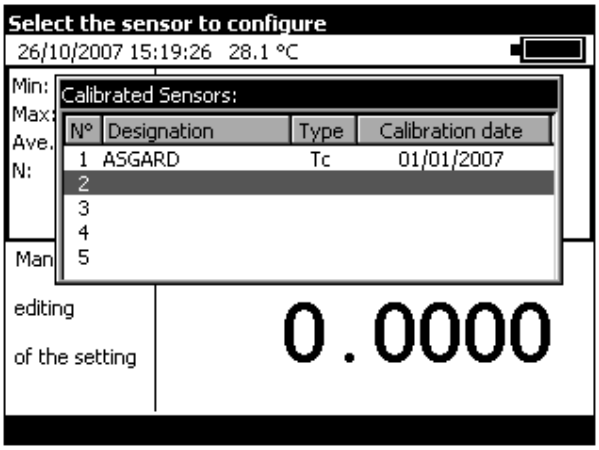
C.4 Calibrated sensors

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.

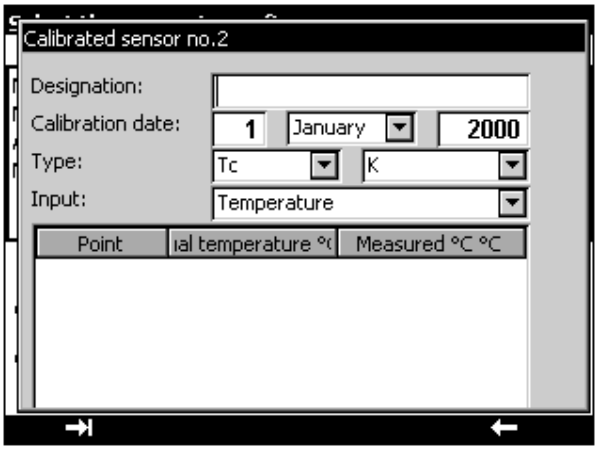
- Open the **MEASUREMENT MENU** dialog box,
- select the **Calibrated Sensors** function.



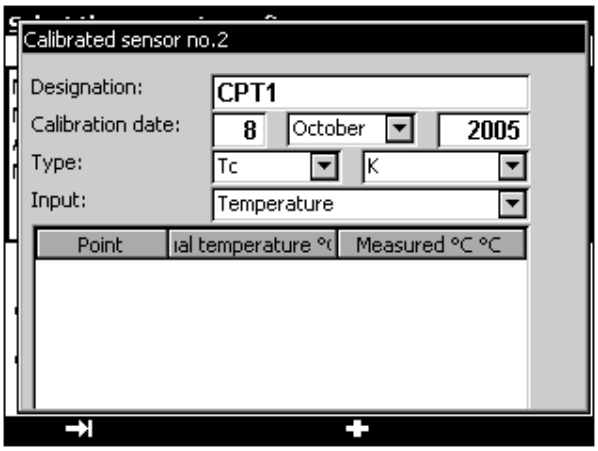
- press ENTER.



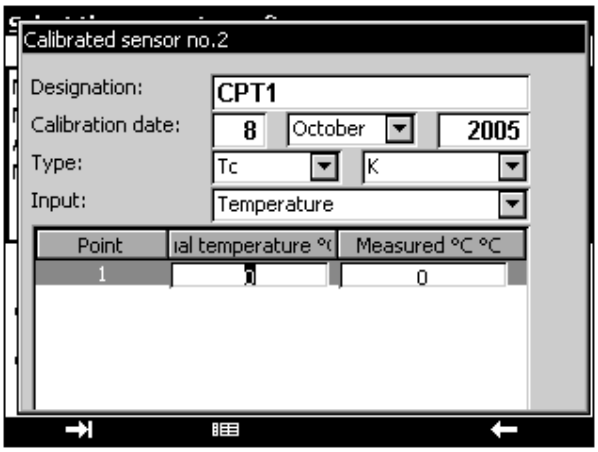
- Use the Up △ / Down ▽ arrow buttons to adjust the parameters or select a new line to define a new sensor.
- press ENTER.



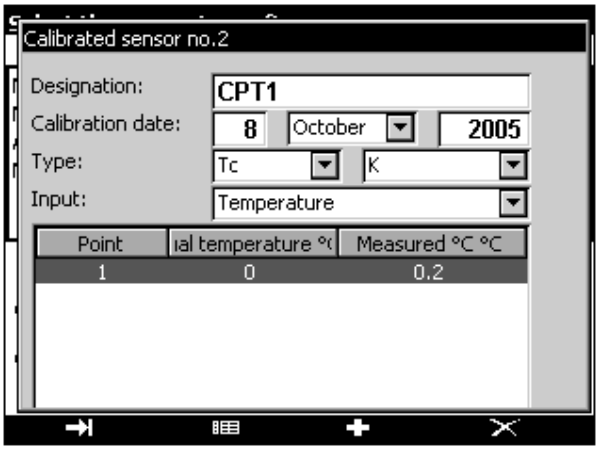
- Fill in the information fields for the sensor. To move from field to field, use the function button, **F1** ( ).



- To enter calibration points in the table, use the button.



- Enter the values and press ENTER.



- 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.

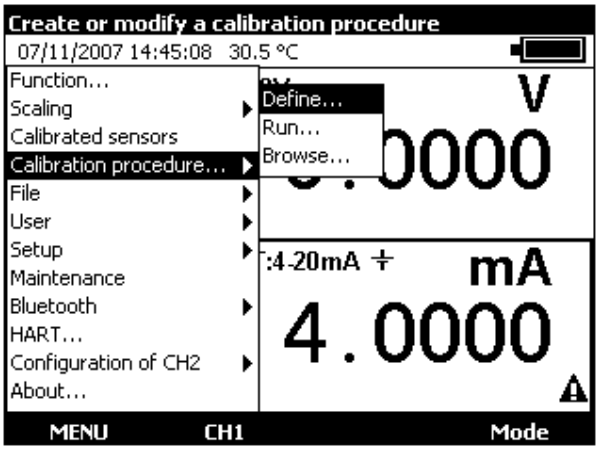
In the specific case where a single calibration point is given, the behavior will differ according to whether the sensor is a thermocouple or a thermometric resistance:
. In the case of a thermocouple, the correction is a fixed voltage deviation.
. In the case of a resistive probe, the correction made is an R0 correction.

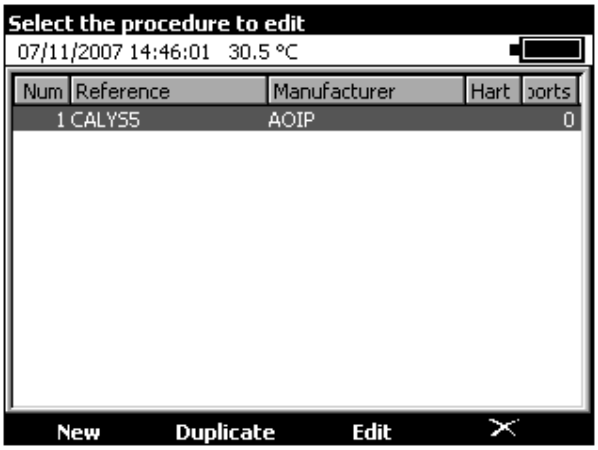
Sensors declared in this manner are added to the list of couple types (or of probe types) proposed in the measurement function settings dialog box. They appear at the top of the list, in front of the standard sensors. Their name is preceded by the '*' character, indicating that these are calibrated sensors.

C.5 Calibration procedure

The C150 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).

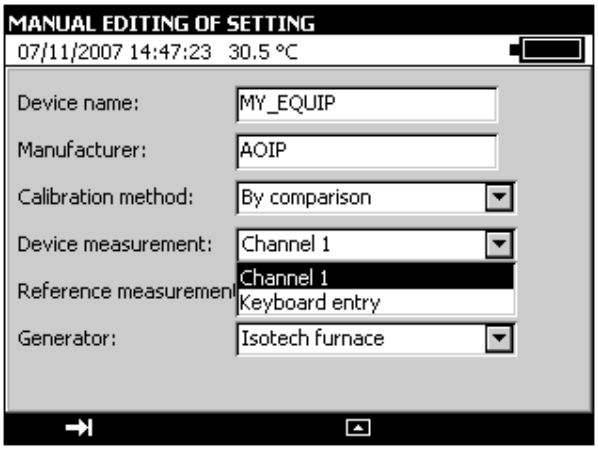
- Open the **MEASUREMENT MENU** dialog box,
- select the **Calibration procedure** function,
- press ENTER.



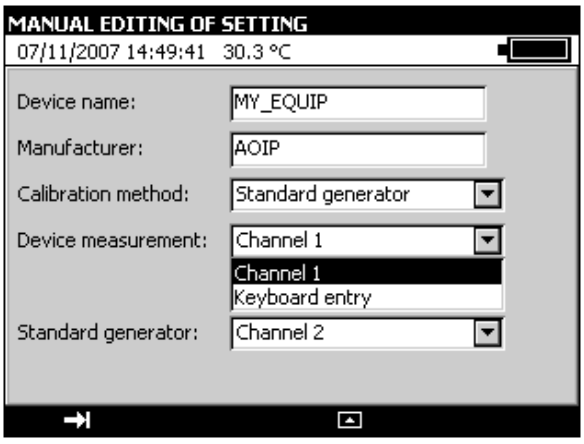


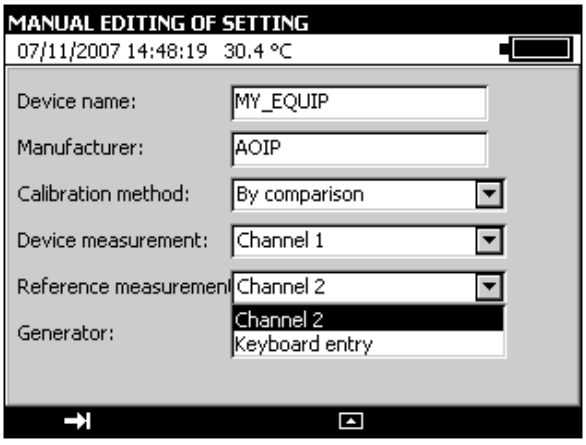
- Use the Up ∇ / Down Δ arrow buttons to adjust the parameters or press the function button **F1** (new) to define a new procedure. A procedure may be duplicated with the F2 key (Duplicate). The F4 key is used to delete a selected procedure.
- press ENTER.

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.

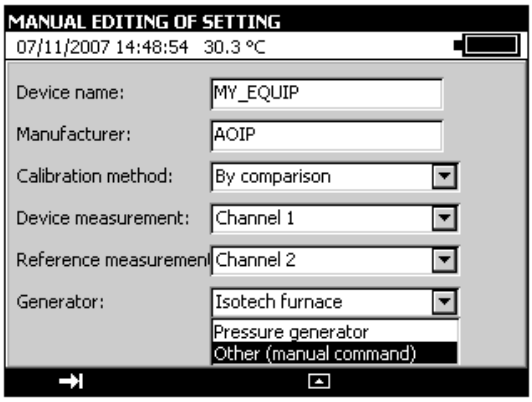


The instrument features 2 calibration methods: "By comparison" or "Standard generator". Select from drop-down list.

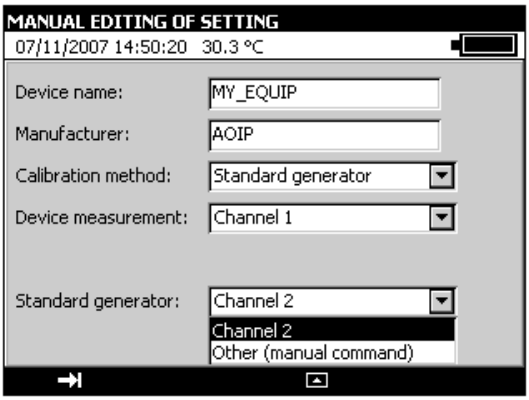




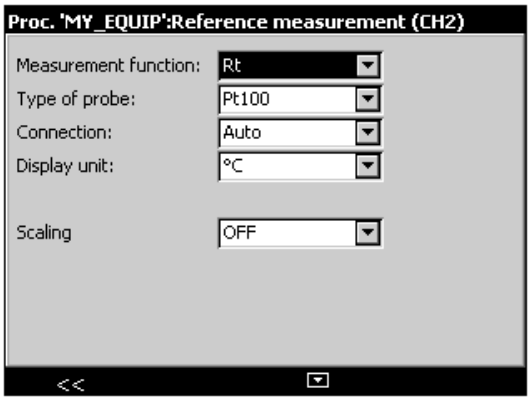
In both methods, select "Device measurement": "Channel 1" or "Keyboard entry".



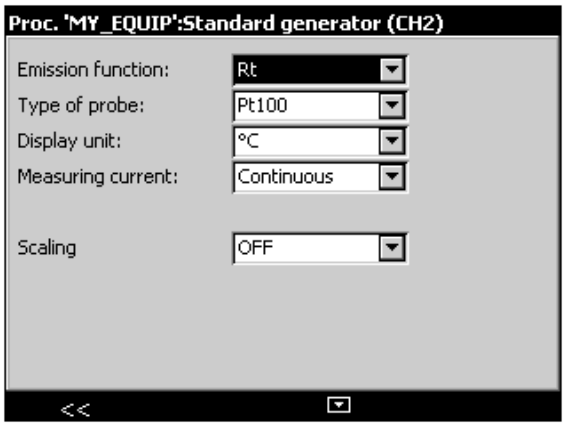
In the "By comparison" method, select "Reference measurement" method: "Channel 2 " or "Keyboard entry"



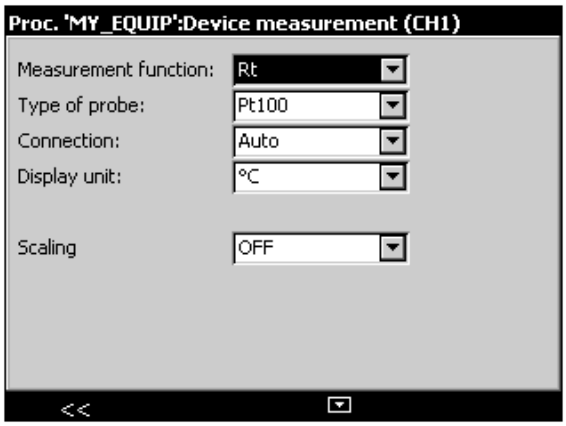
For the "By comparison" calibration method, in the drop-down list, select: "Four Isotech", "Pressure generator" or "Other (manual control)"



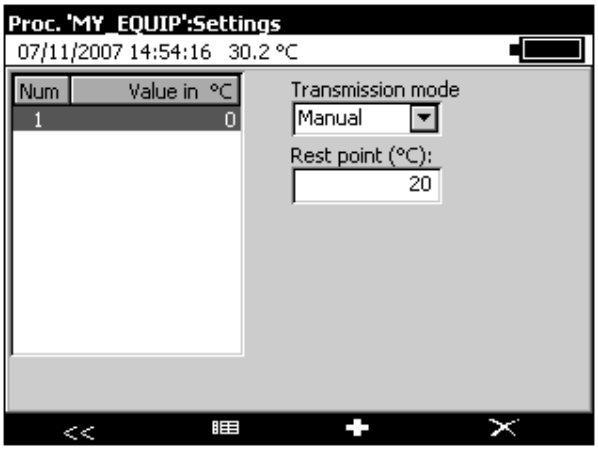
For the "Standard generator" calibration method, in the drop-down list, select: "Channel 2" or "Other (manual control".



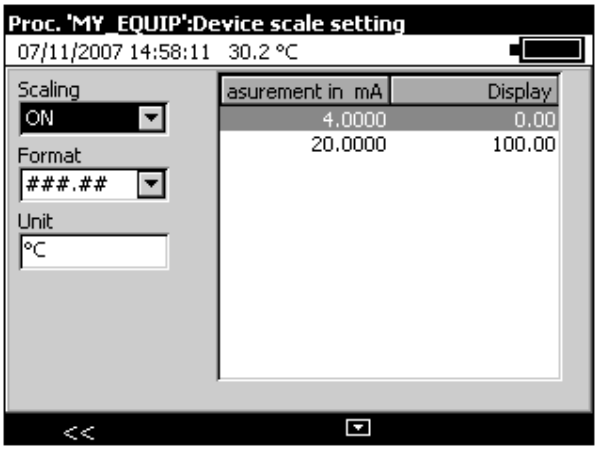
If "Reference measurement" via channel 2 is selected, select "Measurement function" and confirm with Enter.



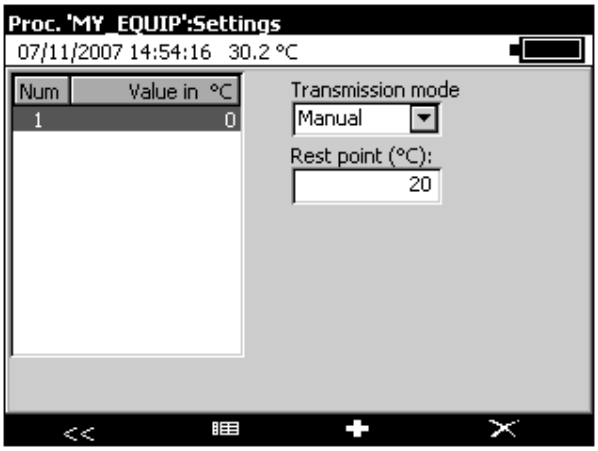
If "Standard generator" via channel 2 is selected, select "Measurement function" and confirm with Enter.



If "Device measurement" via channel 1 is selected, select "Measurement function" and confirm with Enter.



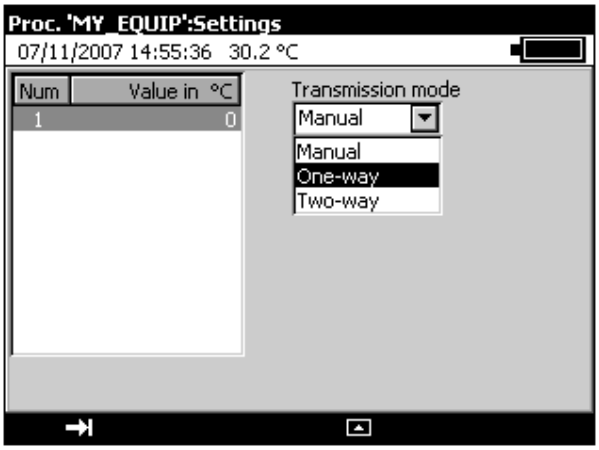
You may apply scaling to a device: select "ON" and set parameters.



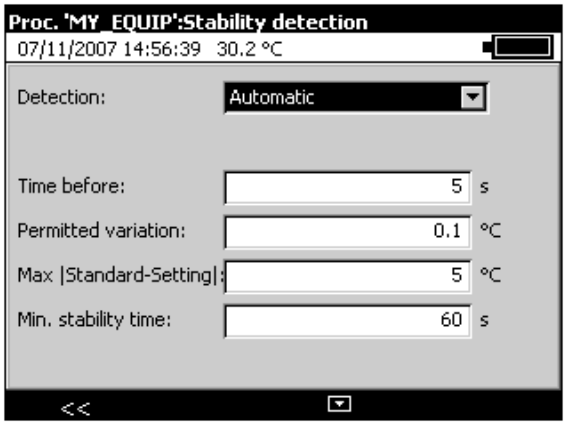
- Press key **F2** (Points) to set calibration points.
- Use the following buttons to define the points.

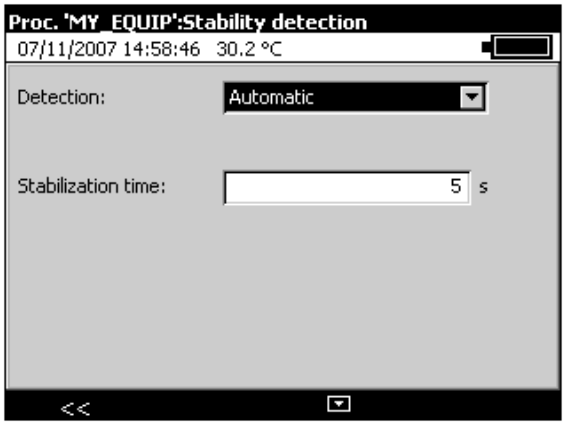
  to edit an existing calibration point,
  to add a calibration point,
  to delete a calibration point.

- Use the F1 ( ) button to select the transmission mode field, press the function button, F4 ( ) to drop down the menu and use the Up △ / Down ▽ arrow buttons to choose the transmission mode.

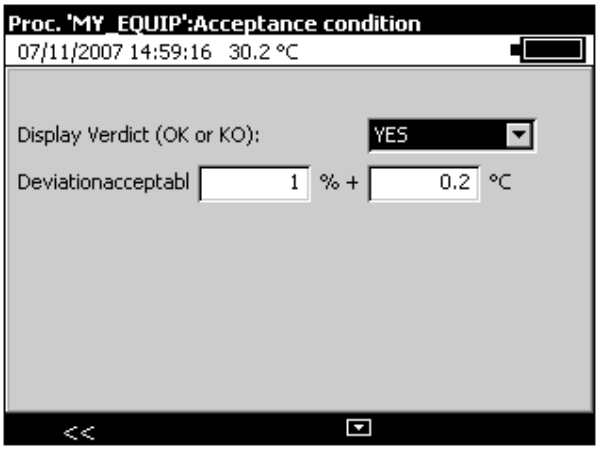


Definitions of transmission modes:
Manual: the settings are generated under manual control with the user accepting each point,
One-Way: the settings are generated automatically in the order in which the points (Point 1, Point 2, Point 3 etc.) are defined,
Two-Way: the settings are generated automatically in the order in which the points (Point 1, Point 2, Point 3 etc.) are defined and then in reverse order (Point n, Point (n-1) etc.).



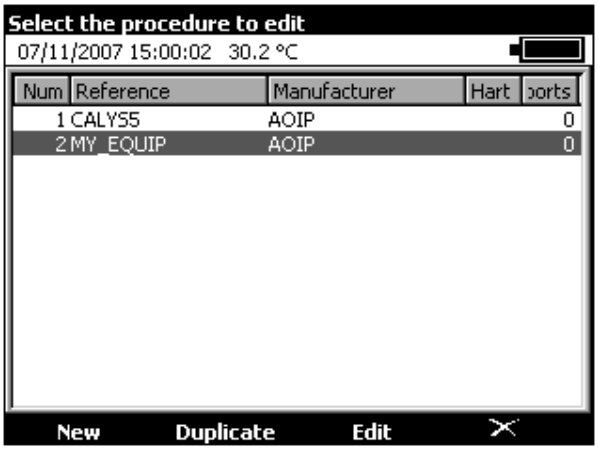


The settling time field can be used to define the time, in seconds, between sending the setting from the output of the C150 and making the measurement at its input.



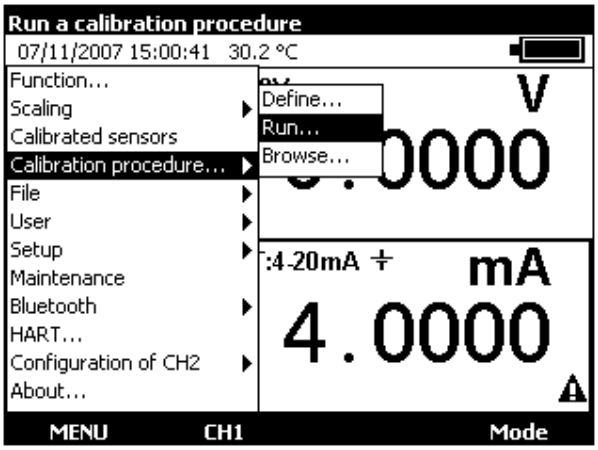
The unit may be set to display a "Verdict": "OK" or "KO" at the end of the procedure. In this case, set permissible deviation in percent and units (according to the type of measurement).

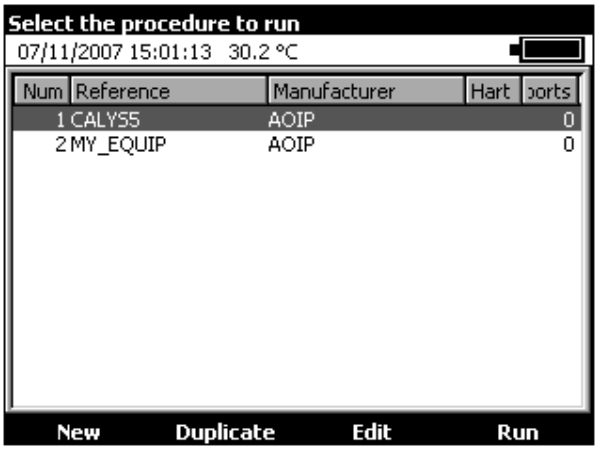
- When all fields have been completed, press ENTER.



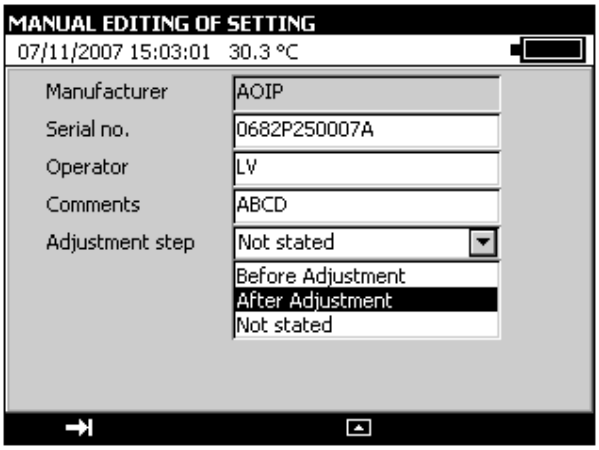
When editing is completed, exit Menu with ESC key.

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



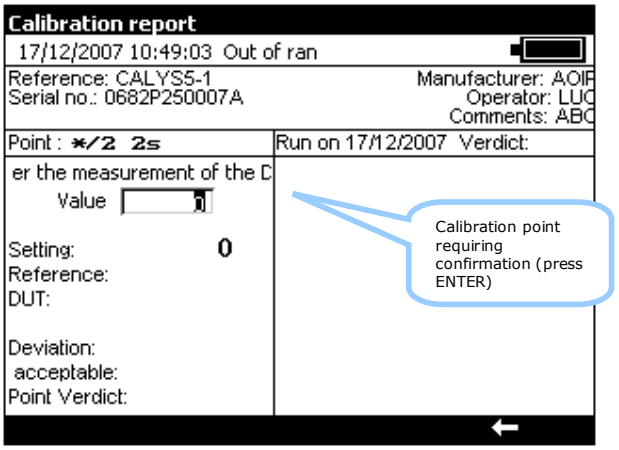


- To run a procedure, select it and press the **F4** key (Run) or **Enter** key.

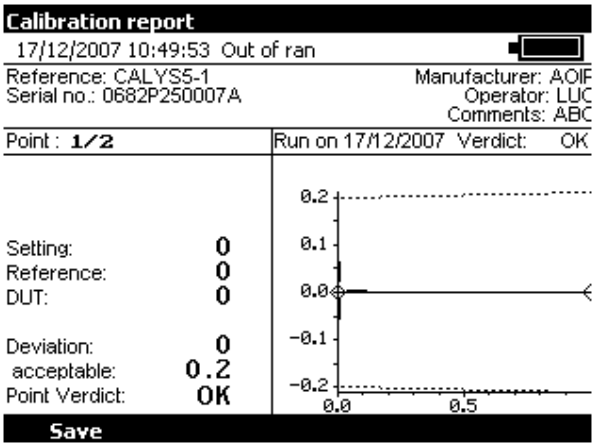


- After completing the fields, start execution by pressing **F3** (Execute).

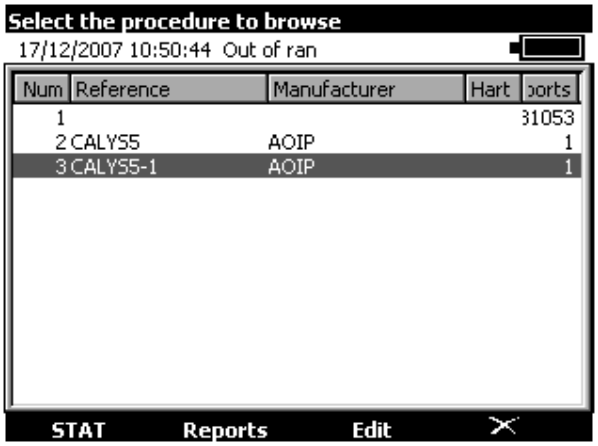
Where the procedure is executed manually, the user will have to confirm the calibration points one by one.



If the transmission mode has been defined as One-Way or Two-Way, the procedure is executed automatically.



- Press the function button, **F1**, to store the calibration report.

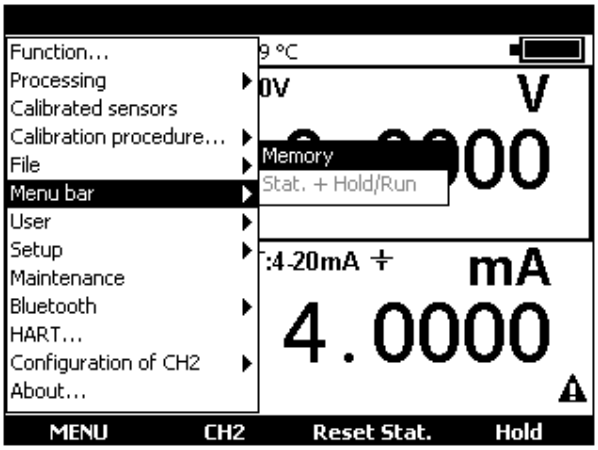


- To display the calibration reports, select the desired procedure and press the function button, **F2** (Reports).
- From the list, select the report to be viewed and press the function button, F1 (View).

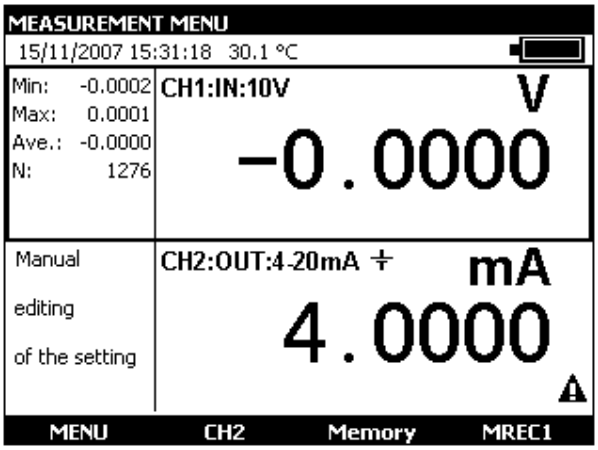
C.6 Storing the current acquisitions

The C150 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**.



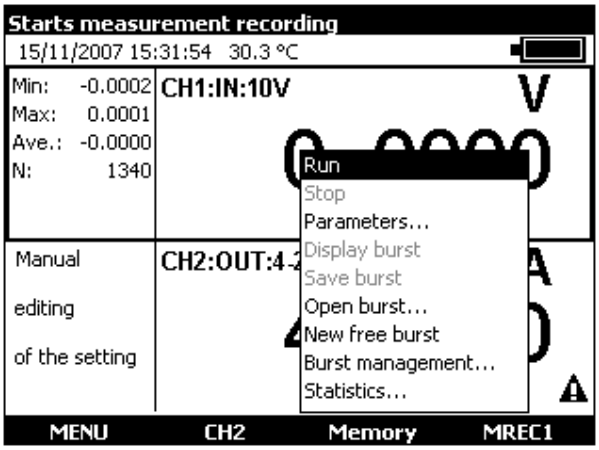
- Press ENTER.



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.

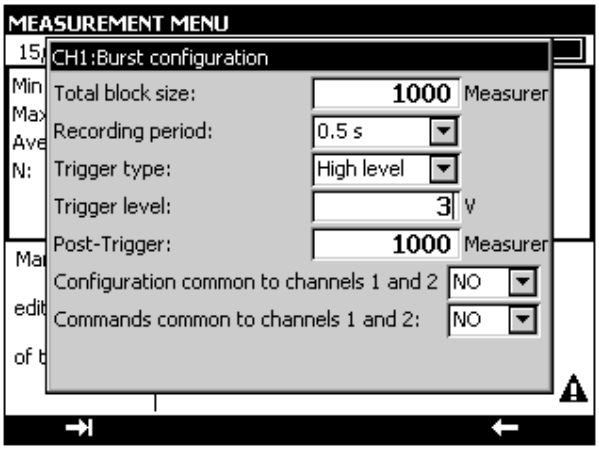
Pressing **F3** (Memory) gives access to all the memory functions.

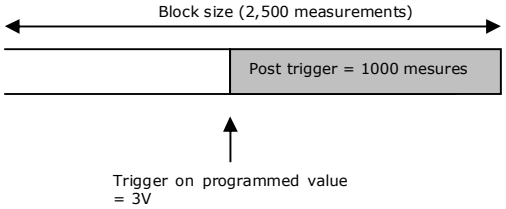


RUN:
starts the storage of data as configured using the **Parameters** function. The icon is shown in the Measurements window.

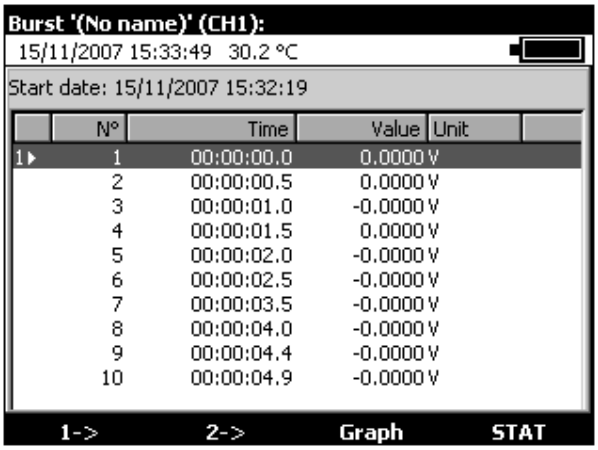
STOP:
stops the current storage operation.

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



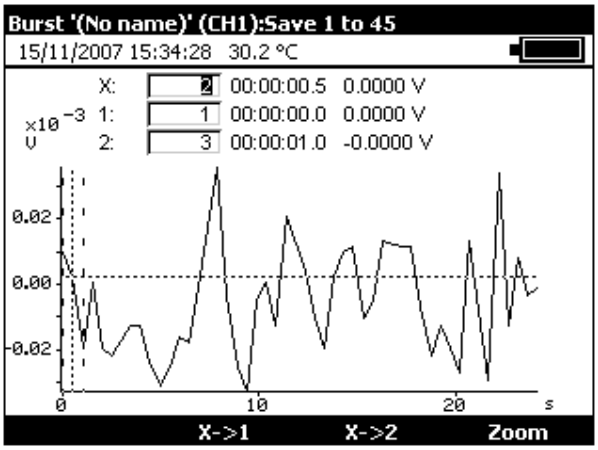


Burst display:
The burst can be displayed as a table of values or a trend curve.



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.

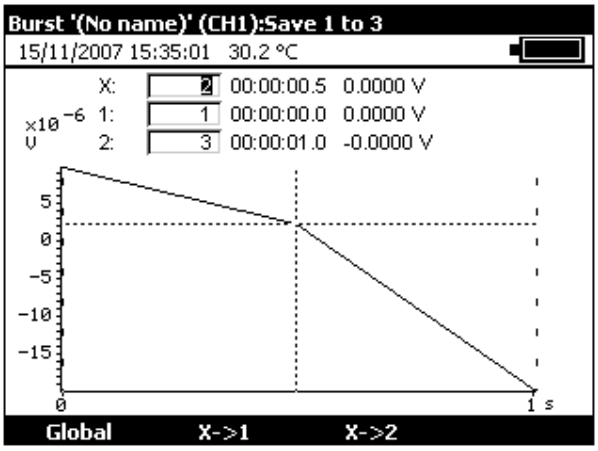
To display all the values in memory, press the function button, **F1** (Global).



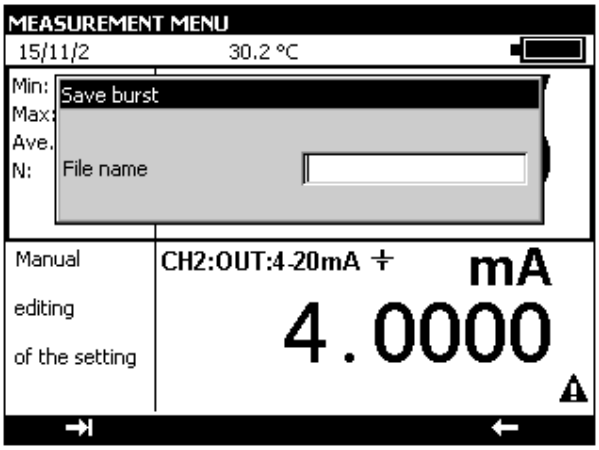
The left ◁ and right ▷ arrow buttons can be pressed to move the cursor and read off the abscissa and ordinate values.

At this level, the markers can be redefined in order to zoom in between these two new points:

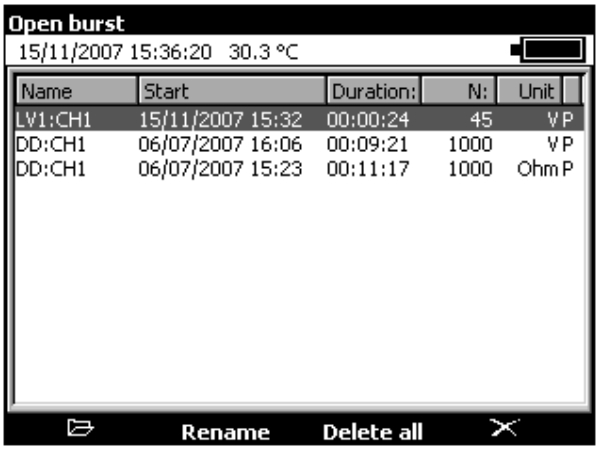
- in the X field, enter a low value for the marker (X1), press ENTER and then press the function button, F2 (X→1),
- in the X field, enter a high value for the marker (X2), press ENTER and then press the function button, F3 (X→2).



Burst save:
stores the current burst.



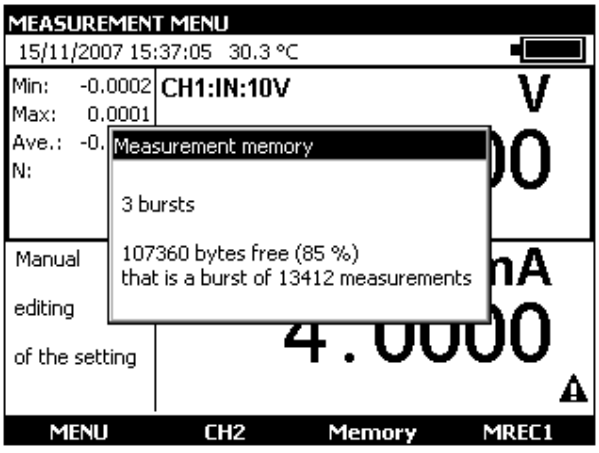
Burst open:
allows a burst to be selected for opening in order to view the data. At this level, a burst can be renamed or one or more bursts can be deleted.



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.

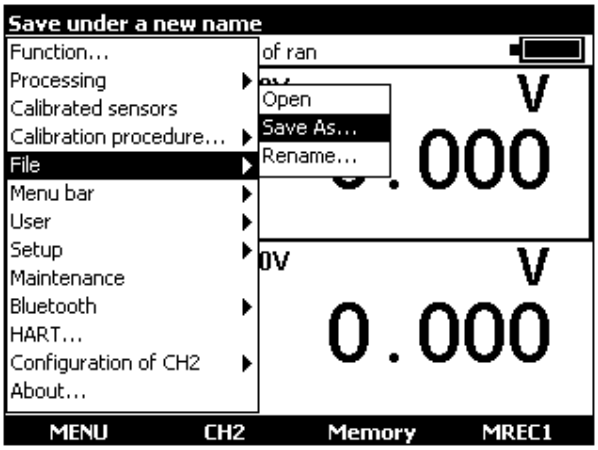


C.7 Configurations

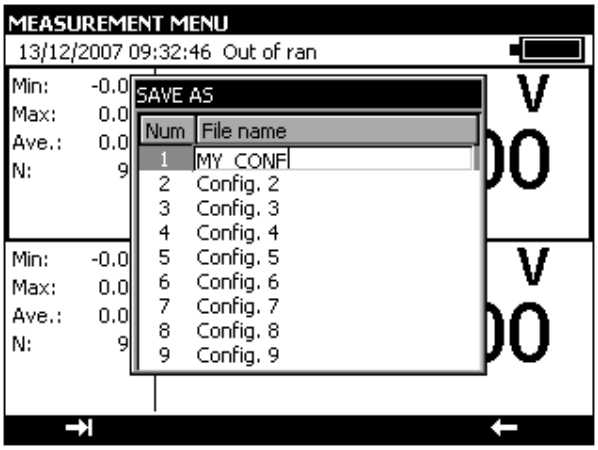
A configuration is the state of the C150 at a given moment. The state of the unit includes:

- 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.8.3.

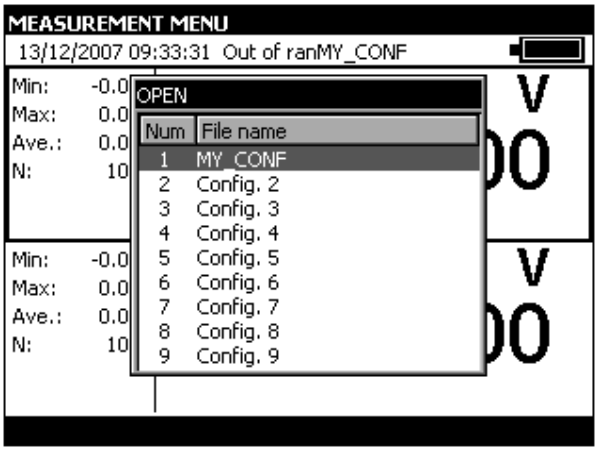
To save the state of the unit, use the **Menu → File → Record under...**



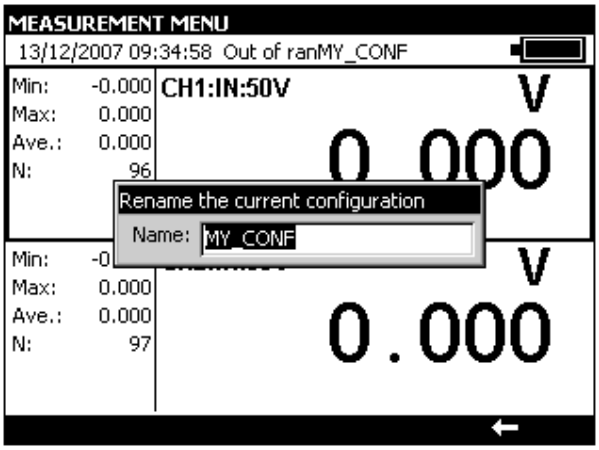
Use the navigation keys to select a configuration. Edit the name of the configuration to be saved with the alphanumeric keys and confirm with ENTER.



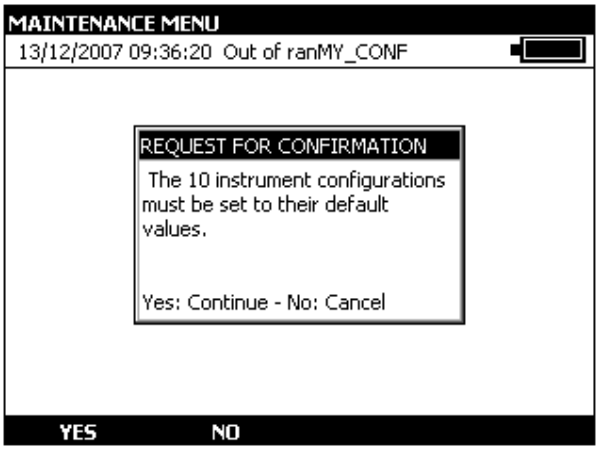
To recall a configuration from memory, use the **Menu → File → Open...**



Use the navigation keys to select a configuration. Confirm with ENTER.
When loading a saved configuration, the C150 enters the manual Edit mode in transmission.

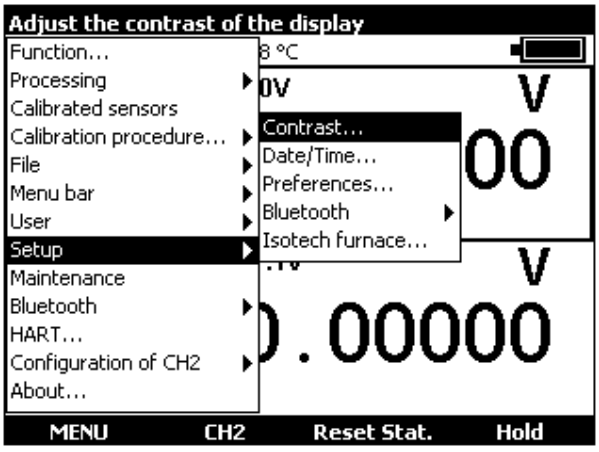


To erase the configurations of the C150, refer to paragraph A.5.2 to enter the Maintenance mode. Use the **Init EEP** function key to reset the configurations of the unit to zero.



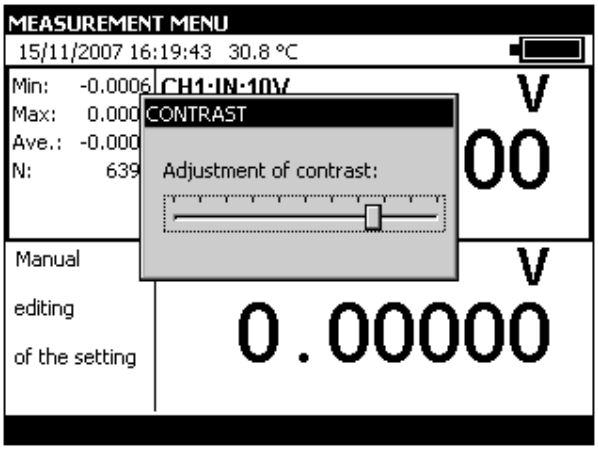
C.8 Setting parameters

The parameters of the C150 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 C150.



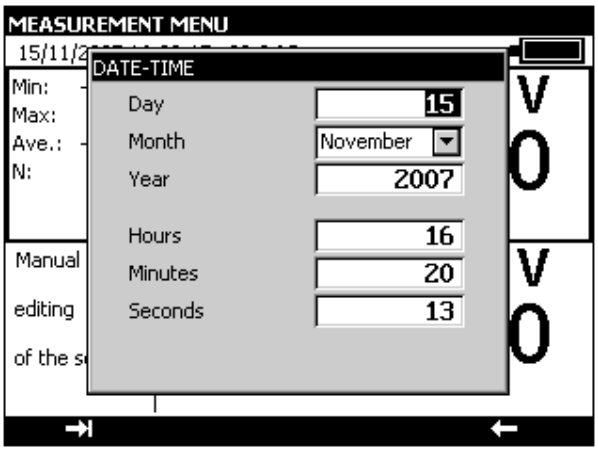
C.8.1 Adjustment of contrast

Use the Right and Left navigation keys to adjust the contrast of the display. The C150 saves the setting made in its non volatile memory and uses it each time the unit is switched on.

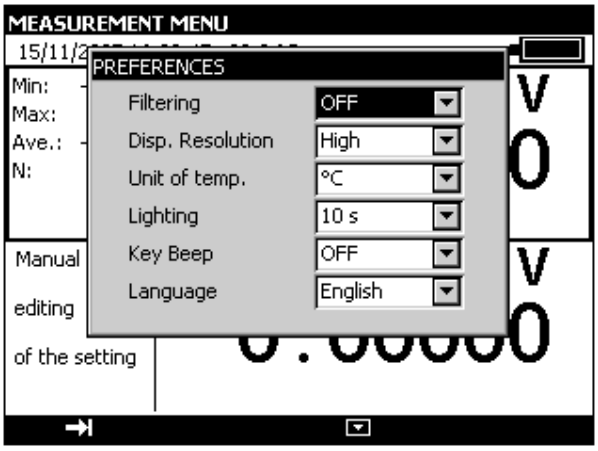


C.8.2 Date and Time

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



C.8.3 Preferences



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.

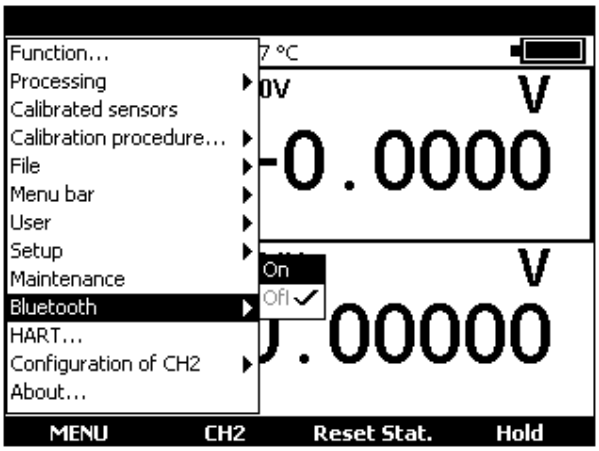
Lighting: used to set the on time of the lighting before it is switched off to save the batteries.

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

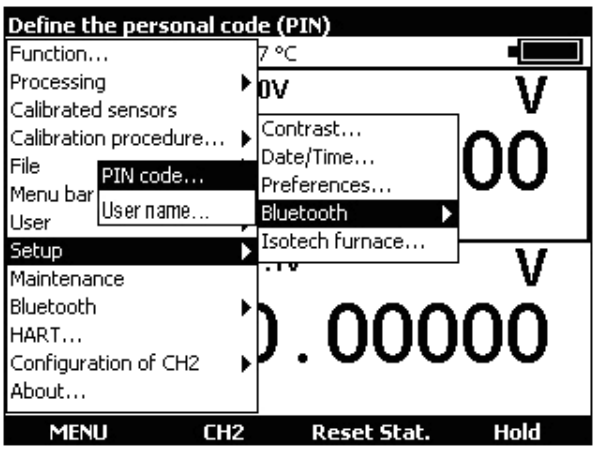
Language: used to select the language of the display in menus, dialog boxes and on-line help.

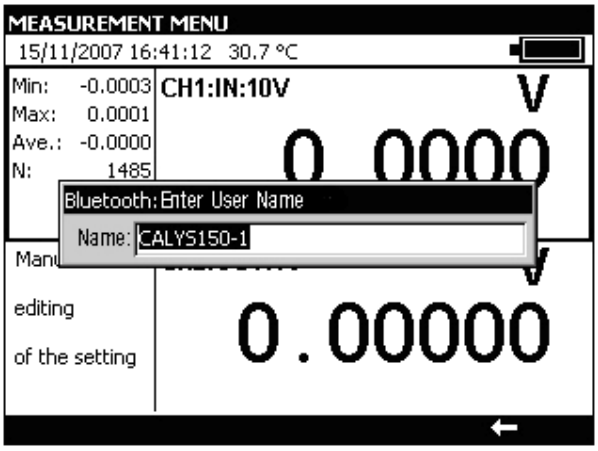
C.9 Bluetooth® Interface Configuration

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

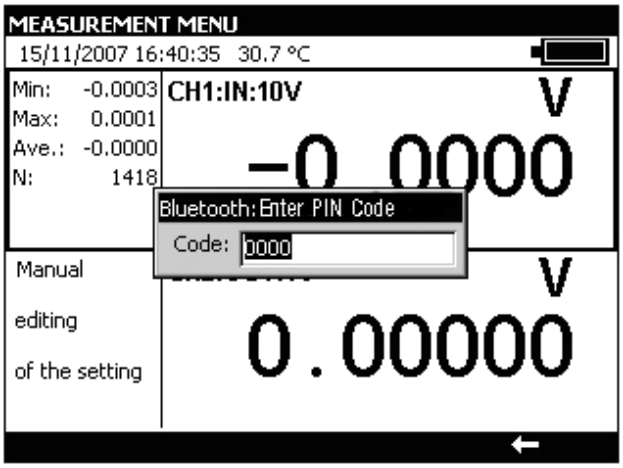


A name may be assigned to a unit connected to a Bluetooth® network with the F1 key **MENU→ Setup→ Bluetooth → User Name.**





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



D. TECHNICAL SPECIFICATIONS

The accuracies quoted apply at + 18°C to + 28°C unless otherwise stated, and are expressed as ± (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 (100mV/1V cal voltage measurement and simulation and Ohm measurement and simulation) using connections with Y-shaped lugs 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.

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

D.1.1 DC Voltage

Range	Specified measurement range	Resolution	Accuracy/1 year	Notes
+100 mV	- 10mV + 100mV	1 µV	0.005% + 2 µV	Rin > 10 MΩ
+1V	- 100mV + 1V	10 µV	0.005% + 8 µV	Rin > 10 MΩ
+10V	- 1V + 10V	100 µV	0.007% + 80 µV	Rin = 1 MΩ
+50V	- 5V + 50V	1 mV	0.007% + 0,5 mV	Rin = 1 MΩ

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.

D.1.2 DC Current

Range	Specified measurement range	Resolution	Accuracy/1 year	Notes
0-20 mA	0 mA to 24 mA	0.1 µA	0.007% + 0.8 µA	Rin < 30 Ω
4-20 mA	3 mA to 24 mA	0.1 µA	0.007% + 0.8 µA	Rin < 30 Ω
100 mA	0 mA to 100 mA	0.1 µA	0.009% + 2 µA	Rin < 30 Ω

Temperature coefficient < 7 ppm/°C from 0°C to 18°C and from 28°C to 50 °C.
- Loop power supply = 24 V ± 10%.
- HART compatibility: input impedance Rin = 280 Ω.
- Linear or square law display scale.

These specifications are provided for the following configurations:-
- C150 active mode (+24V ON) ←→ Measurer passive mode (+ 24V OFF).
- C150 passive mode (+24V OFF) ←→ Measurer active mode (+ 24V ON)

Use the absolute value of the value measured (|L|) to calculate the accuracy.

D.1.3 Resistance

Range	Specified measurement range	Resolution	Accuracy/1 year	Notes
400 Ω	0 Ω to 400 Ω	1 mΩ	0.006% R + 8 mΩ	4-wire measurement
3600 Ω	0 Ω to 3600 Ω	10 mΩ	0.006% R + 50 mΩ	4-wire measurement
50 KΩ	0 Ω to 100 KΩ	100 mΩ	0.008% R + 1 Ω	4-wire measurement

Accuracy applies to a 4-wire connection with Y-shaped lugs, add 10 mOhm of uncertainty when connecting with banana plugs
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.
- Open circuit terminal voltage < 10V.
- Continuity test:
  - Open circuit for R > 1000 Ω.
  - Closed circuit for R < 1000 Ω.

D.1.4 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	C150 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 % R + 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% R + 0.06°C 0.015% R + 0.07°C 0.06°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% R + 0.07°C 0.0025 % R + 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 % R + 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 to + 900°C + 900 to + 1 820°C	0.2°C 0.1°C	0.005 % R + 0,4°C 0.005 % R + 0,2°C
U	- 200 to - 100°C - 100 to + 660°	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 + 1730°C + 1730 to + 2 310°C	0.1°C 0.1°C 0.1°C	0.15°C 0.008 % R+ 0.12°C 0.015 % R+ 0.12°C
N	- 240 to - 190°C - 190 to - 110°C - 110°C to + 0°C + 0 to – 400°C + 400°C to + 1 300°C	0.2°C 0.1°C 0.05°C 0.05°C 0.05°C	0.25% R 0.1% R 0.04% R + 0.06°C 0.08°C 0.005% R + 0.06°C
PlatineL	- 100 to + 100°C + 100 to + 1 400°C	0.05°C 0.05°C	0.15°C 0.005% R + 0.06°C
Mo	0 to + 1 375°C	0.05°C	0.005 %R + 0.06°C
NiMo/NiCo	- 50 to + 1 410°C	0.05°C	0.005 %R + 0.30°C
G	0 to + 100°C 100 to + 200°C 200 to + 1 800°C 1 800 to + 2 315°C	0.05°C 0.05°C 0.05°C 0.05°C	1.5°C 0.40°C 0.20°C 0.35°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% R 0.02% R

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 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.

D.1.5 Temperature using resistive probes

Type of sensors:

- Pt 10ohm, 50ohm, 100ohm, 200ohm, 500ohm, 1,000ohm with α = 3851 as per CEI 751/1995
- Pt 100ohm with α = 3916 as per JIS C 1604/1989
- Pt 100ohm with α = 3926 as per EIT90
- Ni 100ohm, 1,000 ohm with α =618 as per DIN 43760
- Ni 120ohm with α = 672 as per MIL-T-34388C
- Cu 10ohm with α = 427 as per MINCO 16/9
- Cu 50ohm with α = 428 as per OIML R 84

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

For negative temperatures, use the displayed value R 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.

D.1.6 Frequency and counting

Range	Resolution	Specified measurement range	Accuracy/1 year	Notes
10 kHz	0.01 Hz	1 Hz to 10 KHz	0.005%	Vin min = 1V
100 kHz	0.1 Hz	10 Hz to 100 KHz	0.005%	Vin min = 1V

- Temperature coefficient < 5 ppm/°C from 0°C to 18°C and from 28°C to 50°C.
- Triggering level 1V
- Scale in beats/min and Hz
- Measurement for frequency output and dry contact
- In the case of counting, this measurement may be made for a defined time or an infinite time.

D.1.7 Additional characteristics in "measurement"

D.1.7.1 Manual or automatic range selection

For the mV, V and Ω functions, with automatic range selection, the unit selects a higher or lower range.

D.1.7.2 Relative measurement

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

D.1.7.3 Scale correction

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

D.1.7.4 Linearization

Linearization is used partially to correct errors induced by non linear sensor/converter systems.

D.1.7.5 Statistics

Display of the minimum, maximum and average value and the number of measurement points.
The statistics may be reset to zero.

D.2 "Transmission/simulation" function

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

D.2.1 DC Voltage

Range	Resolution	Specified measurement range	Accuracy/1 year	Notes
+100mV	- 5mV + 100mV	1 µV	0.005% + 2 µV	Output load min = 1 kOhm
+1V	- 5mV + 1V	10 µV	0.005% + 8 µV	Output load min = 2 kOhm
+10V	- 100mV + 10V	100 µV	0.007% + 80 µV	Output load min = 4 kOhm
+50V	- 100mV + 50V	1 mV	0.007% + 0.5 mV	Output load min = 4 kOhm

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

D.2.2 DC Current

Range	Resolution	Accuracy/1 year	Notes
24 mA	1 µA	0.007% + 0.8µA	
4-20 mA	1 µA	0.007% + 0.8µA	
0-20 mA	1 µA	0.007% + 0.8µA	

Temperature coefficient < 7 ppm/°C from 0°C to 18°C and from 28°C to 50 °C.

The above specifications are given for the following configurations:-
- C150 active mode (+24V ON) ←→ Passive mode measurer (+24V OFF).
- C150 passive mode (+24V OFF) ←→ Active mode measurer (+24V ON).

D.2.3 Resistance

Range	Specified measurement range	Resolution	Accuracy/1 year	Notes
400 Ω (direct current)	1 Ω to 400 Ω	10 mΩ	0.006% R + 20 mΩ	Iext of 0.1 mA / 1 mA
400 Ω (Pulsed current)	1 Ω to 400 Ω	10 mΩ	0.006% R + 30 mΩ	Iext of 0.1 mA / 1 mA
3600 Ω (direct current)	10 Ω to 3600 Ω	100 mΩ	0.006% R + 100 mΩ	Iext of 0.1 mA / 1 mA
3600 Ω (Pulsed current)	10 Ω to 3600 Ω	100 mΩ	0.006% R + 200 mΩ	Iext of 0.1 mA / 1 mA
50 KΩ (direct current)	10 Ω to 50 KΩ	1 Ω	0.008% R + 3 Ω	Iext of 5 µA / 50µA
50 KΩ (Pulsed current)	10 Ω to 50 KΩ	1 Ω	0.008% R + 5 Ω	Iext of 5 µA / 50µA

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.

D.2.4 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	Drift / year
K	- 250 to - 50°C - 50 to + 120°C + 120 to + 1020°C + 1020°C + 1370°C	0.2°C 0.1°C 0.05°C 0.05°C	0.15% R 0.06°C 0.005% R + 0.05°C 0.007% R + 0.05°C
T	- 250 to - 100°C - 100 to + 0°C + 0 to + 400°C	0.2°C 0.05°C 0.05°C	0.1% R + 0.05°C 0.02% R + 0.06°C 0.055°C
J	- 210 to + 0°C + 0 to + 50°C + 50 to + 1 200°C	0.05°C 0.05°C 0.05°C	0.03% R + 0.08°C 0.05% R + 0.07°C 0.005 % R + 0.04°C
E	- 250 to + 40°C + 40 °C to + 550°C + 550 to + 1 000°C	0.1°C 0.05°C 0.05°C	0.15°C 0.005% R + 0.12°C 0.005% R + 0.13°C
R	- 50 to + 0°C + 0 to + 350°C + 350 to + 1 768°C	0.5°C 0.2°C 0.1°C	0.35% R + 0.4°C + 0.4°C + 0.25°C
S	- 50 to + 0°C + 0 to + 350°C + 350 to + 1 768°C	0.5°C 0.2°C 0.1°C	0.25% R + 0.4°C 0.30°C 0.25°C
B	+ 400 to + 900°C + 900 to + 1 820°C	0.2°C 0.1°C	0.005 % R + 0.4°C 0.005 % R+ 0.2°C
U	- 200 to + 400°C + 400°C to + 600°C	0.05°C 0.05°C	+ 0.09°C + 0.11°C
L	- 200 to + 900°C	0.05°C	+ 0.15°C
C	- 20 to + 1 540°C + 1 540 to + 2 310°C	0.1°C 0.1°C	+ 0.25°C 0.012 % R+ 0.1°C
N	- 240 to - 200°C - 200 to + 10°C + 10 to + 250°C + 250 to + 1300°	0.2°C 0.1°C 0.05°C 0.05°C	0.15 % R + 0,10°C + 0,08°C 0.008 % R + 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 % R + 0.06°C
NiMo/NiCo	- 50 to + 1 410°C	0.05°C	0.005 % R + 0.30°C
G	0 to + 100°C 100 to + 200°C 200 to + 1 800°C 1 800 to + 2 315°C	0.05°C 0.05°C 0.05°C 0.05°C	1.5°C 0.40°C 0.20°C 0.35°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% R 0.02% R

The precision is guaranteed for a reference junction temperature of 0 °C.
When using the internal reference junction (except thermocouple 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.

D.2.5 Temperature by resistive probes

Type of sensors:

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

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

For negative temperatures, use the value displayed R 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.

D.2.6 Frequency and pulses

Range	Resolution	Range	Accuracy / 1 year	Notes
1 000 Hz	0.01 Hz	0.01 Hz to 1 000 KHz	0.005%	
100 kHz	1 Hz	1 Hz to 100 KHz	0.005%	

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

D.2.7 Additional characteristics in simulation

D.2.7.1 Generation of increments

The increment generation function is used to program an incremental progression of the active transmission function.

D.2.7.2 Generation of ramps

The ramp generation function is used to program a linear variation of the active transmission function.

D.2.7.3 Synthesizer

The Synthesizer function is used:
- to store up to 100 transmission values in permanent memory,
- to recall and transmit manually or automatically the contents of these memories.

D.2.7.4 Scale correction

The scale correction function performs a conversion between the physical quantities displayed and the electrical quantities simulated.

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