High precision thermometer
PHP 602

instruction manual

HIGH PRECISION THERMOMETER

PHP 602

CE

Specifications indicated in the present instruction manual may be changed without prior notice.

Notes

1. OVERVIEW

Thank you for choosing this AOIP precision instrument which benefits from our century of experience designing and manufacturing accurate measurement tools.

We intend to continue with this policy of constant innovation which has served our customers so well during our first hundred years. AOIP encourages user comment and welcomes any suggestions you may have for future product enhancements.

1.1 Introduction

The PHP 602 is a high accurate instrument designed to measure signals delivered by temperature sensors, such as RTDs.
The unit has dual input channels which can be independently configured. It can be used with the channel scanner SHP 601.
It is driven by PC via an RS-232 or IEEE-488 interfaces and Windows' software is supplied in order to configure the unit, process the measurements and calibrate temperature sensors with edition of a report.
It comes in a rugged bench-type casing and is well adapted to site measurements thanks to its battery pack option.
AOIP Instrumentation has, in his works in Evry, a metrology department, entitled by the COFRAC, temperature section under no 2-1332, and electricity-magnetism under no 2-1216. This department supplies calibration certificates and checking official reports from the national calibration institute BNM-COFRAC.
A COFRAC calibration certificate warrants traceability to national standards.

1.2 Applications

Its main applications are as follows:
- Temperature measurements using RTDs sensors.
- Absolute or differential measurements over two channels.
- Calibration of temperature sensors.
- Checking temperature stability of baths.

1.3 Presentation

- Bench-type unit with tilt bail/handle for transport and mains supply; a version with built-in rechargeable battery pack is also available as option.
- Usable in rack with accessories.
- Backlit LCD display, graphic type, 240 x 64 pixels.
- Language available: English, French and German.
- Programming and processing the unit using a 22-key keypad, RS-232 link or optional IEEE-488 link.
- Connection of sensors using 4-mm plugs and connectors.
- Resistance measurement using 4-wire or 3-wire configuration.
- Selection of measurement current, range and current type (direct, pulse or alternate).
- Mains supply: 115 V or 230 V ± 10 %, 50 Hz to 400 Hz, 20 VA max.
- ABS bench-type casing.
- Dimensions: 225 x 88 x 310 mm.
- Weight: 2 kg (3 kg max. with battery pack and IEEE-488 option).

1.4 Safety provisions

1.4.1 In accordance with safety standards

The unit is constructed and tested according to the safety rules for electronic measuring instruments.
This instruction manual contains information and advice that users must follow to be protected against electrical shocks and to ensure the reliability of the unit in order to maintain it in a satisfactory state with regard to safety.
The unit may occasionally be exposed to temperatures between - 10°C and + 55°C without its safety features being compromised.

1.4.2 Following instructions supplied with the accompanying documents

The unit is constructed to operate under safety conditions if the instructions supplied in the accompanying documents are followed. Any usage, except those described, may reduce the safety of the user and then, becomes dangerous and prohibited.

1.4.3 Taking measurements

The test leads and measuring wires must be in good condition and should be changed if there is any evidence of deterioration (insulation split burnt, etc).
Never exceed the safety values indicated in the specifications. Refer to chapter 10.
When measuring voltages, remember that circuits may show dangerous voltage regarding the earth.
Never perform resistance measurements on a live circuit.

1.4.4 Faults and abnormal constraints

Should there be any indication that the protection has been compromised, it should be switched off and steps taken to prevent it being used inadvertently.
The protections may have been compromised in the following cases, for example:

- The unit is obviously damaged.
- The unit is no longer capable of taking accurate measurements.
- The unit has been stored under unfavorable conditions.
- The unit has been subject to severe stresses during transport.

1.4.5 Definitions

1.4.5.1 Definition of the installation category

This is also called overvoltage category.
It's the installation classification according to standardized limits for transient overvoltages (IEC Publication 664).

CAT III (IEC Publication 664): "Equipment of overvoltage category **III** is equipment in fixed installations and for cases where the reliability and the availability of the equipment is subject to special requirements. Examples of such equipment are switches in the fixed installation and equipment for industrial use with permanent connection to the fixed installation".

1.4.5.2 Table of the symbols used

Symbol	Description	Symbol	Description
~	Alternating current.	I	Power ON.
⎓	Direct current.	O	Power OFF.
≂	Direct and alternating current.	⧈	Double insulation.
⏚	Measurement earth terminal.	⚡	Risk of electric shock.
⏚	Protective conductor terminal.	⚠	Warning: see the accompanying document.

1.4.6 Maintenance

Refer to chapter 9.

Before the casing is opened, make sure that all the wires have been disconnected from the unit.

The unit should not be opened up for adjustment, maintenance or repair when live unless this is absolutely essential, in which case this work should be carried out **only by qualified personnel advised of the risk entailed**.

The unit should be reassembled as explained in the instruction manual. Any incomplete or bad reassemble may be dangerous for the safety of the operator.

The responsible body must check at regular time interval that all the components ensuring safety are not subject to wear and undertake all the necessary steps for preventive operations.

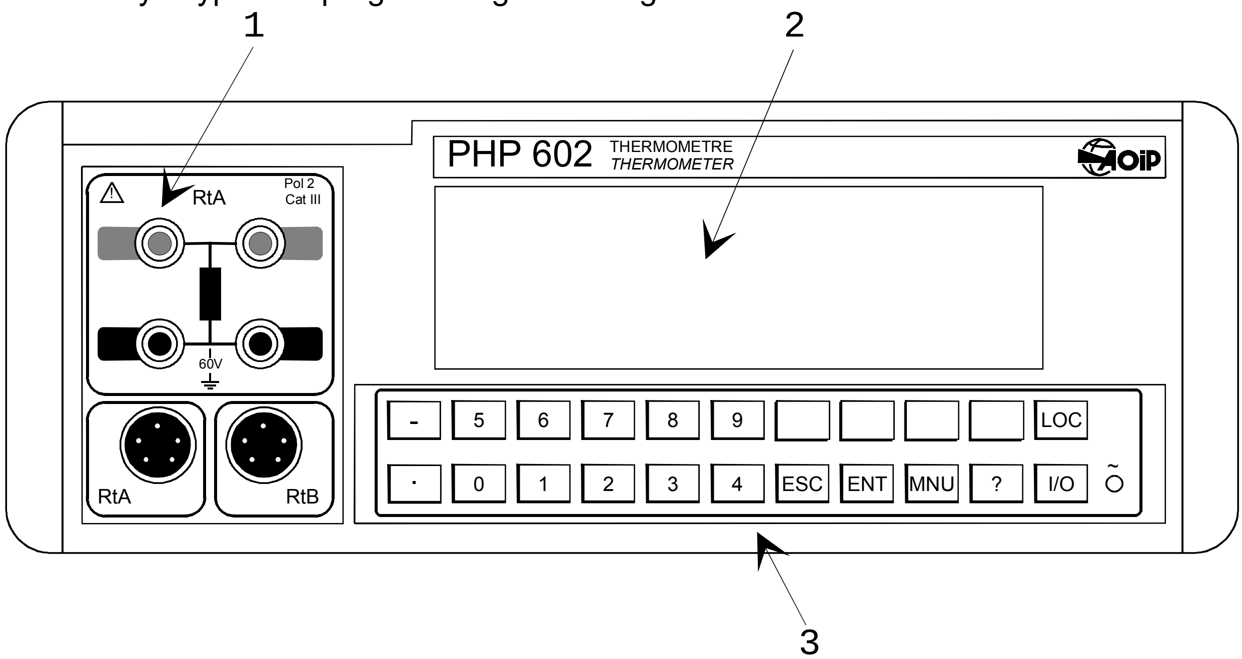
Notes

2. DESCRIPTION

Notes

2.1 Front panel

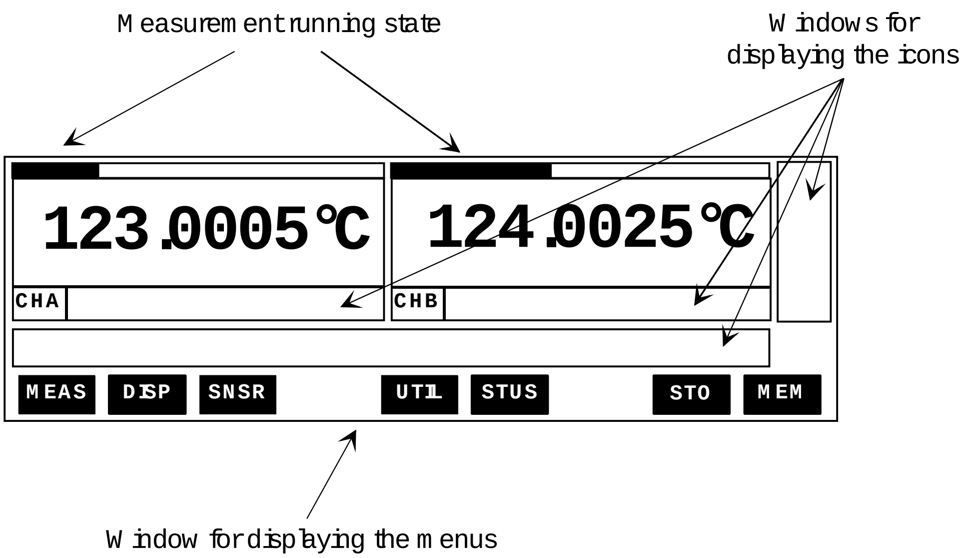
It is composed of:
1. A terminal block for sensor connection.
2. A graphic display for reading the measured values, configuration menus and icons particular to the functions used.
3. A 22-key keypad for programming and using the various functions.



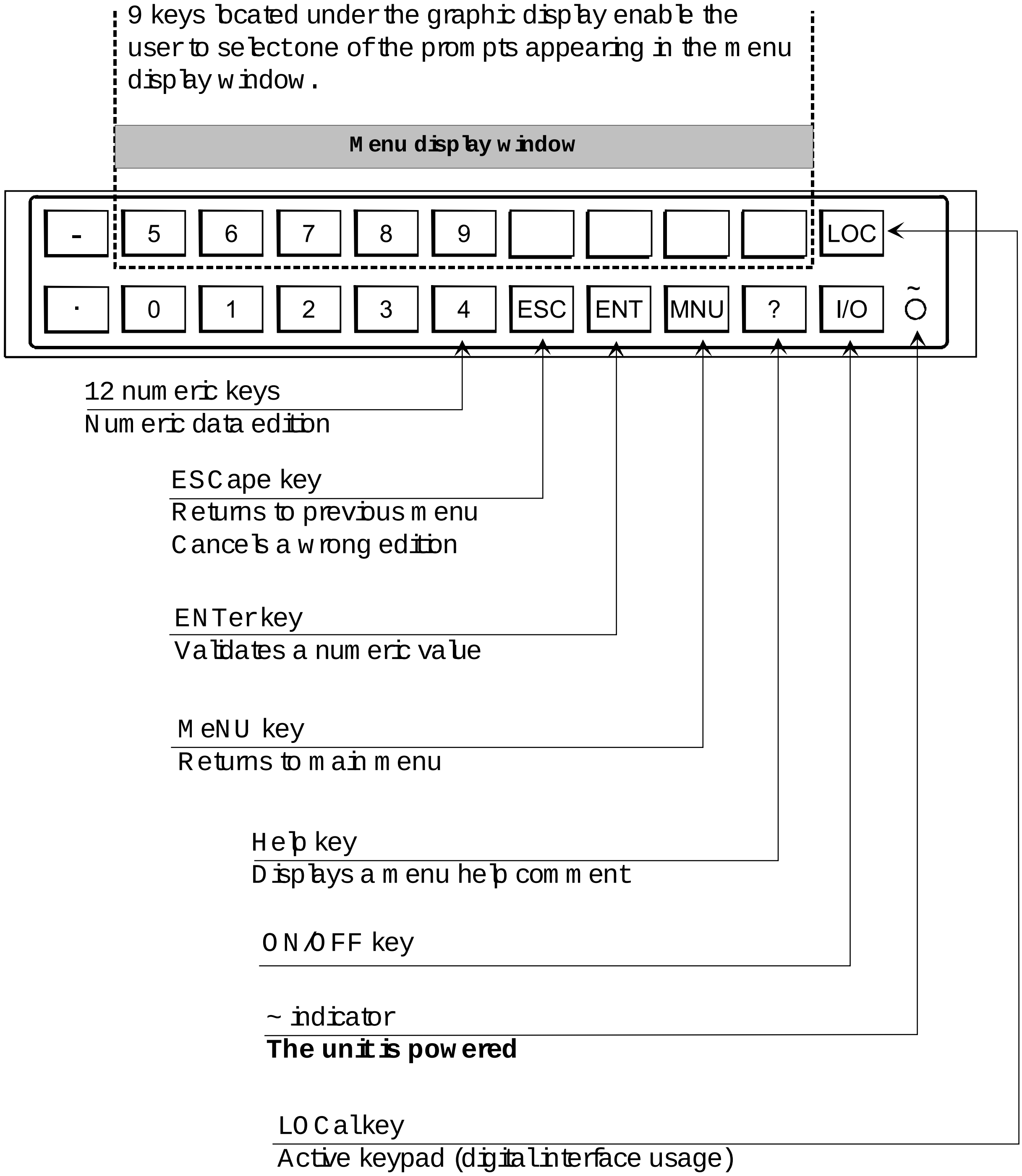
2.1.1 Terminal block

Used to connect the measurement sensors. It is composed of four terminals, 4-mm diameter, made of tellurium copper and two cylindrical connectors, 5 pins.
Refer to chapter 5 for the various possible connections.

2.1.2 Graphic display



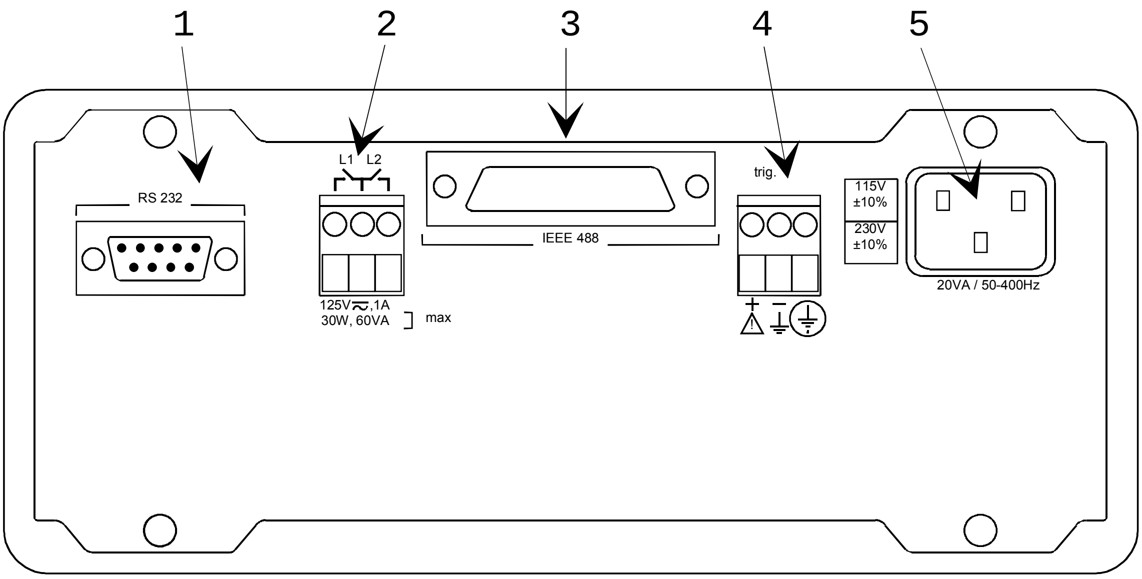
2.1.3 Keypad


9 keys located under the graphic display enable the user to select one of the prompts appearing in the menu display window.
Menu display window
-
5
6
7
8
9
LOC
.
0
1
2
3
4
ESC
ENT
MNU
?
I/O
12 numeric keys
Numeric data edition
ESCape key
Returns to previous menu
Cancels a wrong edition
ENTer key
Validates a numeric value
MeNU key
Returns to main menu
Help key
Displays a menu help comment
ON/OFF key
~ indicator
The unit is powered
LOCal key
Active keypad (digital interface usage)

2.2 Rear panel

It is composed of:

1. SUB-D connector, 9 female pins, for the RS 232 output.
2. Terminal blocks for alarm relay output.
3. Optional IEEE-488 connector.
4. Terminal block for "trigger" input and safety ground terminal.
5. Plug for mains connector compatible IEC Publication 320.



2.3 Tilt bail position

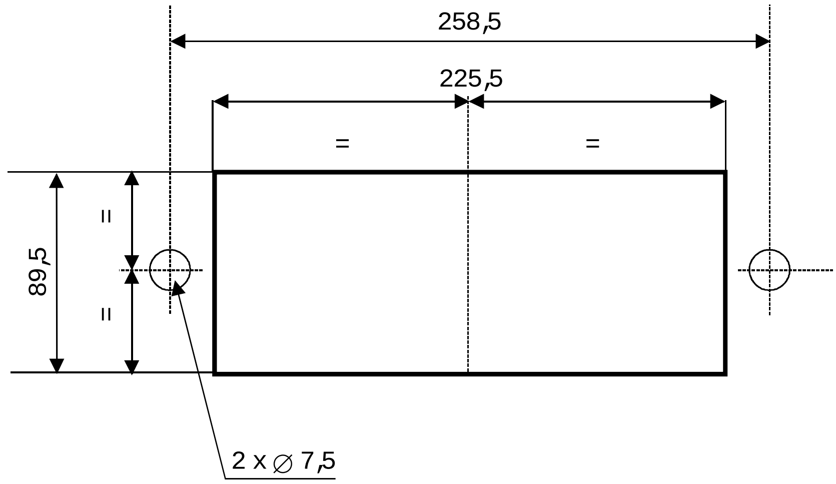
To change position of the tilt bail:

- Press the two yellow knobs and turn the bail.
- Release the knobs and turn the bail up to its automatic interlocking.
- The angle between each position is 30°.

2.4 Panel or rack mounting

The panel or rack mounting is made by means of the right-angle brackets delivered with the AN 5883 kit.
The accessory AN 5884 is used for the 3 U rack mounting and also includes the right-angle brackets above.

- Panel cutout should be done according to the dimensions in mm given below.



- Untighten the four fixing screws and remove the bail.
- Use the four holes to fix the two right-angle brackets by means of the 4 countersunk-head screws delivered with the kit.
- Insert the unit through the panel cutout and fix it by using the two M6 screws.
- Place a circuit breaker, clearly identified, close to the unit to power it down when necessary.

2.5 Accessories

2.5.1 Delivered with the unit

- A mains cord.
- An instruction manual.

2.5.2 Delivered in extra

Part number	Description
ER 48379-000	Plug for connector 5 pins LEMO type.
AN 5847 C	Pt 100 standard probe for connection to the 5-pin LEMO connector.
ACL 4601	Connection cable for measuring RTD or reference junction between the PHP 602 and SHP 101, 1 m long.
ACL 4603	Connection cable equipped with a plug for 5-pin LEMO connector and one free end, 2 m long.
AN 5836	IEEE-488 connection cable, 2 m long.
AN 5874	RS-232 connection cable, 2 m long, equipped with 25 pin male connector for connection to a microcomputer compatible PC.
AN 5875	RS-232 connection cable, 2 m long, equipped with 9 pin male connector for connection to a microcomputer compatible PC.
PEM40316	DIN-LEMO adapter.
AN 5883	Right-angle brackets for panel mounting.
AN 5884	3 U panel together with right-angle brackets for rack mounting.
AN 6901	Carrying case.
NTM47084-100A	Maintenance documents.

Notes

3. RAPID SET-UP GUIDE

Notes

3.1 Instructions before use

3.1.1 Unpacking

The PHP 602 is mechanically and electrically checked before dispatch. Every precaution has been taken to ensure that it reaches the user undamaged.
Nevertheless, it is advisable to carry out a quick check for any damage that may have occurred in transit. If any such damage is found, it should be reported to the shipper.

3.1.2 Return

If the unit is to be returned, the original packaging should be used and a note explaining as clearly as possible the reasons for returning it should be included.

3.2 Instructions before switching on

Before using the unit with all the necessary safety, the user must read **carefully** chapter 1, which deals with safety provisions.

3.3 Switching on

3.3.1 Mains operation

WARNING: Before any connection, make sure that the mains voltage suits to that of the unit.

Connection to the mains should be done by using the cord delivered with the unit. The mains plug should meet EEC 7 specifications (safety conductor connected to a protection ground).

When the unit is connected to the mains, the $\tilde{\mathrm{O}}$ LED located on front panel comes on indicating that the unit is powered.

3.3.2 Battery operation

The unit may be equipped with an optional lead battery pack, for an autonomous operation.

A special device indicates the state of the battery. The device works in two ways:

1. Blinking of symbol indicates that it remains approximately 10 minutes of autonomy.
2. Then, the unit automatically stops operating. It is then necessary to recharge the battery before to switch the unit on again.

NOTE: When the unit stops operating, all data are stored in a permanent memory.

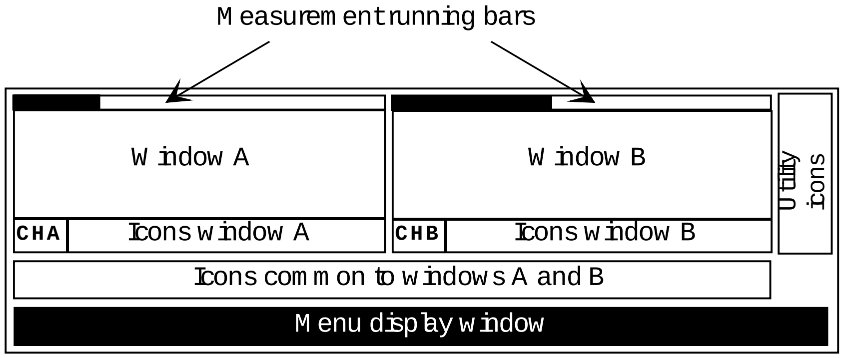
WARNING: Before any connection, make sure that the mains voltage suits to that of the unit.

To recharge the battery, connect the unit to the mains using the cord supplied. The Õ LED located on front panel comes on indicating that the unit is powered. The unit can be used during recharge.

For full details on battery pack, refer to chapter 9.

3.3.3 Getting started

- Make sure that the unit is disconnected from any external circuit.
- For a mains operation, connect the unit to the mains. The $\tilde{\bigcirc}$ LED comes on indicating that the unit is powered.
- Press the I/O key. After an initialization procedure, we get a screen divided into three main windows.



1. In window A, the unit reads the quantity measured over channel A or the difference {quantity measured over channel A – quantity measured over channel B} (value and unit).
2. In window B, the unit reads the quantity measured over channel B (value and unit).
3. In the menu display window is the main menu appearing in video inverted. This menu gives access to submenus used to configure the functions and processing conditions of the unit.

There are also icon windows and two measurement running bars.

Main menu

MEAS DISP SNSR UTIL STUS STO MEM

Press the ? key to read the meaning of the mnemonics for this menu. The display is as follows:

```
MEAS: Measurement channels
DISP : Units and display CHA-CHB
SNSR: Sensors memory
UTIL : General configuration
STUS: Display unit status
STO  : Store measurements
MEM  : Read stored measurements
```

Pressing a second time the ? key gives the following display:

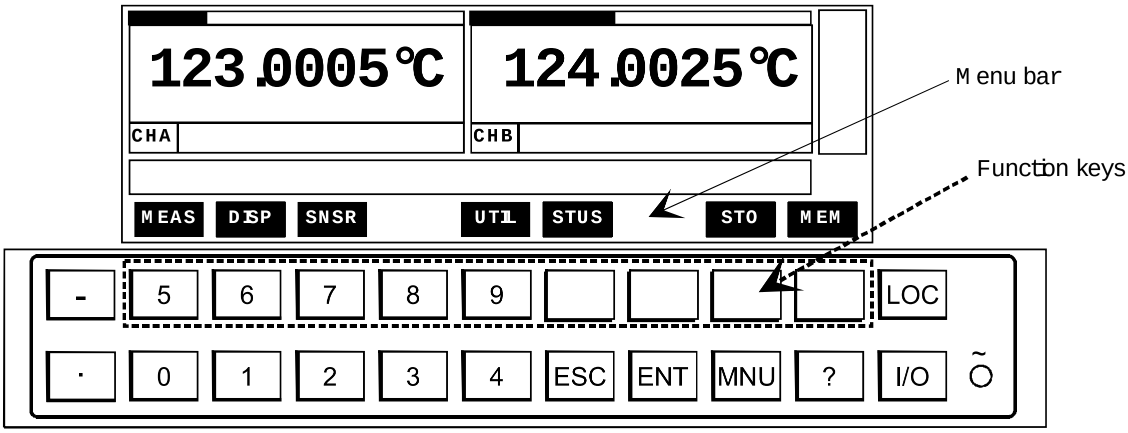
```
              SHORT OPERATING MODE

Return to main menu      :MNU
Return to previous menu  :ESC
Validate a number        :ENT
On-line help             :?
General help             :?-?
                          Pg↑          Pg↓
```

This is a short operating mode. Pressing the key located under one of the two arrows enables the user to scroll through the pages showing the various prompts to be selected in the successive menus in order to access the desired function.

Press the MNU key for returning to the main menu and initial display.

3.4 The function keys

The various processing and programming functions are available using menus. Selecting the various prompts is made by pressing the function key located under the screen.



Using the menus needs usage of the keypad keys following:

ESC	ESCape	In a menu, returns to the previous menu. In edition mode, clears the wrong value edited.
ENT	ENTer	In edition mode, validates and stores the data displayed.
MNU	MeNU	Immediate return to the main menu.
?	Help	Access to the on-line help. A second pressing displays the short operating mode.

3.5 Using the menus

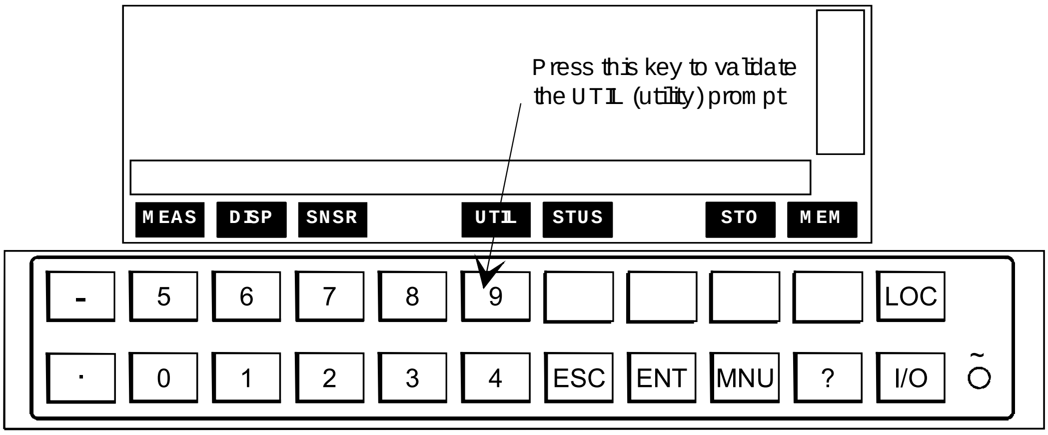
3.5.1 Validating a prompt

Configuring and programming the unit are made easier using successive menus. The menus are located at the bottom of the screen.

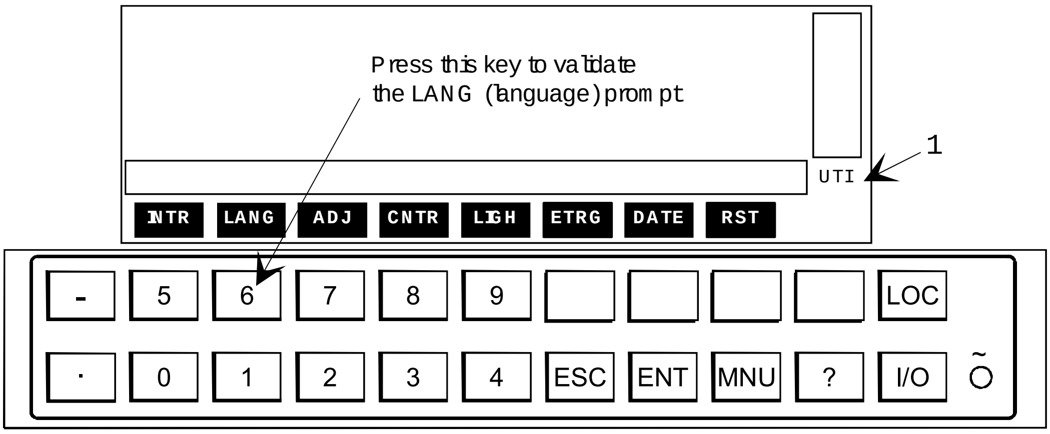
To validate a prompt in a menu, press the function key located under this prompt. If required, a new menu appears, validate again one of these prompts and so on until complete programming.

Example: Language configuration

- From the main menu:

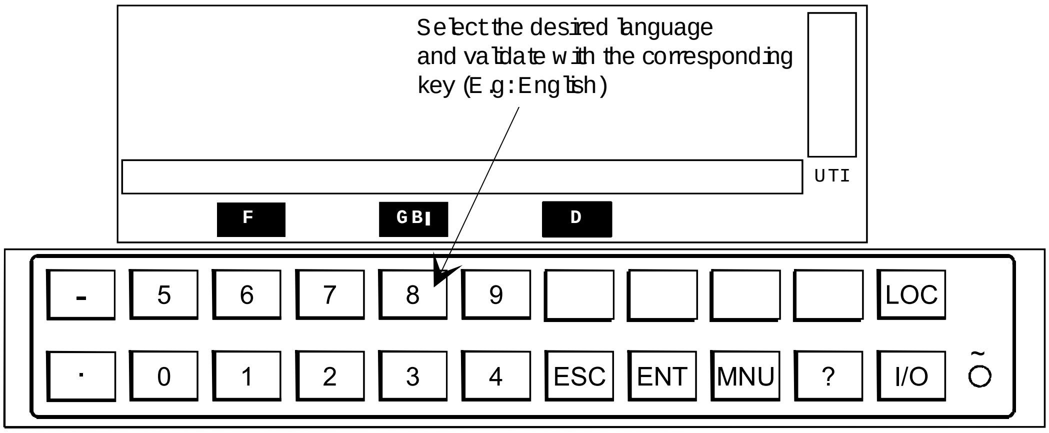


- From the UTILity menu:



NOTE 1: Selecting a prompt from the main menu shows, at right and above the menu, a wording indicating in which function the unit is operating (here, we read UTIlity).

- From the language menu:



F = French, GB = English, D = German

- Return to the main menu.

NOTE: The numeric keys from 5 to 9 are only active during edition (see paragraphs 3.5.5 and 3.5.6).

3.5.2 Typographic conventions

In order to help the operator, the different programming procedures are written in a simplified manner.
The menus are represented as they appear on the display by respecting the programming order.

By convention, in the examples following:

- Prompt shown as UTIL should be **validated**.
- Prompts shown as DISP should be **ignored**.
- Prompts shown as F indicate **the various prompts** to be chosen and validated by the operator depending on his/her application.

Example: Language configuration

MEAS	DISP	SNSR		UTIL	STUS		STO	MEM	1. Select UTIL prompt: utility.
INTR	LANG	ADJ	CNTR	LIGH	ETRG	DATE	RST		2. Select LANG prompt: language.
	F		GB		D				3. Prompt to be chosen by the operator.

Return to the main menu.

Parameters to be modified in the edition mode are described as follows:

Example: Programming the threshold value

T = _XXX.XXXe-3 °C

_XXX.XXXe-3 is the maximum format of the permissible numerical value.

3.5.3 The marker

When programming the unit and for some menus, a marker represented as ▌ and located at right of a prompt tells the operator the active range or function of the unit.

Validating another prompt moves the marker to the new active function.

Example: Setting OFF channel A

MEAS	DISP	SNSR		UTIL	STUS		STO	MEM	1. Select MEAS prompt: measurements.
AON▌	AOFF	BON	BOFF	CFG	RUN	HOLD	I/√2	PROC	2. Channel A is set to ON.
AON	AOFF▌	BON	BOFF	CFG	RUN	HOLD	I/√2	PROC	3. Channel A is set to OFF.

3.5.4 The data lists

When the unit displays a list of data, the user will have to select the information required by using the arrows ↑ and ↓ for moving the cursor (▸) in front of the selection. When the choice will be completed, use the OK prompt to validate it.

NOTE: When entering a data list, the cursor marks the choice previously selected.

3.5.5 Editing parameters

During a programming procedure for entering a number, the unit switches to edition mode and displays the parameter to be modified in video inverted.

Modification may be performed according two ways:
- Either, select the digit to be modified using the menu prompts **<** and **>** and correct using the keypad.
- Or, enter the new value using the keypad.

NOTE: To enter a value in exponential notation, activate EXP function from the menu.

Example: Enter value 2.5 x 10^{-3}

- Using keypad, enter 2 . 5
- Then validate EXP
- Then enter - 3

In case several variables are necessary, changing to the next parameter is done by validating the >> prompt from the menu.

When all the parameters are correctly entered, validate by pressing the ENT key from the keypad.

In case of error and to exit without modification, press the ESC key from the keypad.

3.5.6 Entering the names

When a name is prompted, the display and menu bars are as follows:

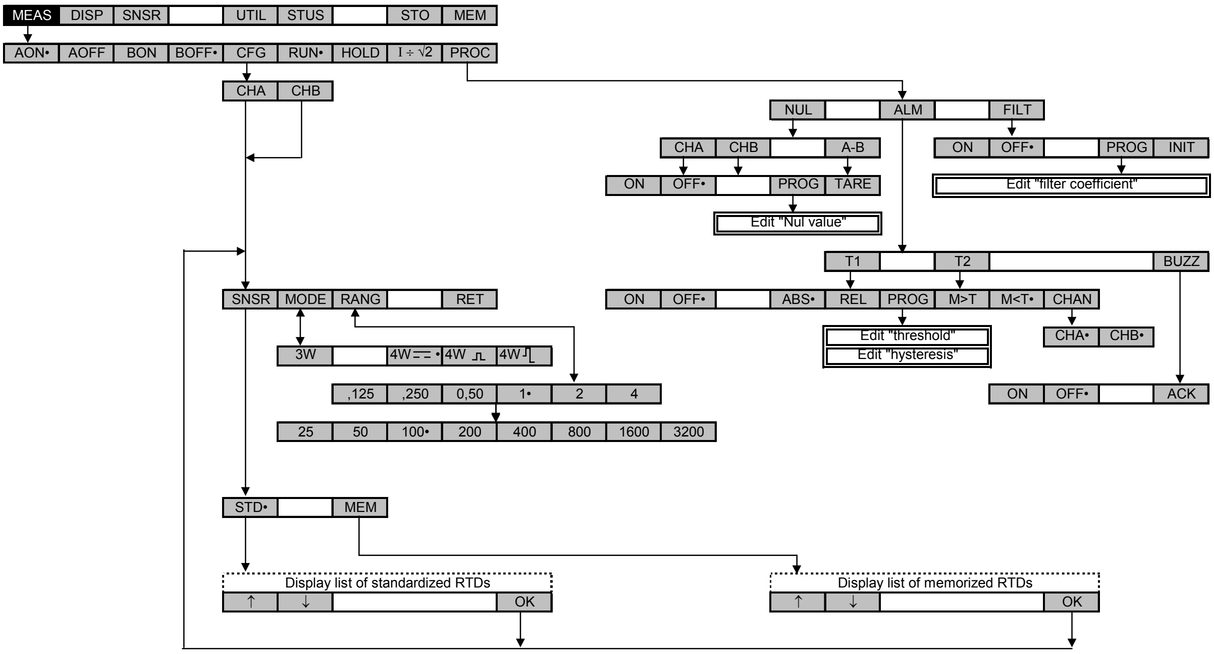
Name: _ A..G | H..N | O..U | V..Z | ( ).. | 0..4 | 5..9 | < | > A | B | C | D | E | F | G | CAPS	Example: entering F1: • Select the letter group from A to G. • Select the letter F **in capitals**.
A..G | H..N | O..U | V..Z | ( ).. | 0..4 | 5..9 | < | > 0 | 1 | 2 | 3 | 4	• Select the figure group from 0 to 4. See note. • Select figure 1. The name may be changed at any time by using prompts < or > which return you to the letter or figure to be modified. When the edition is completed, validate the name by pressing the ENT key.

NOTE: Selecting the ( ) .. prompt displays the symbols below to be chosen by the user. Black prompt is a "space" character.

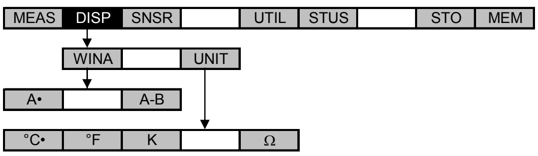
(	)		°	Ω	µ	%	.	/

3.6 Menu flowchart

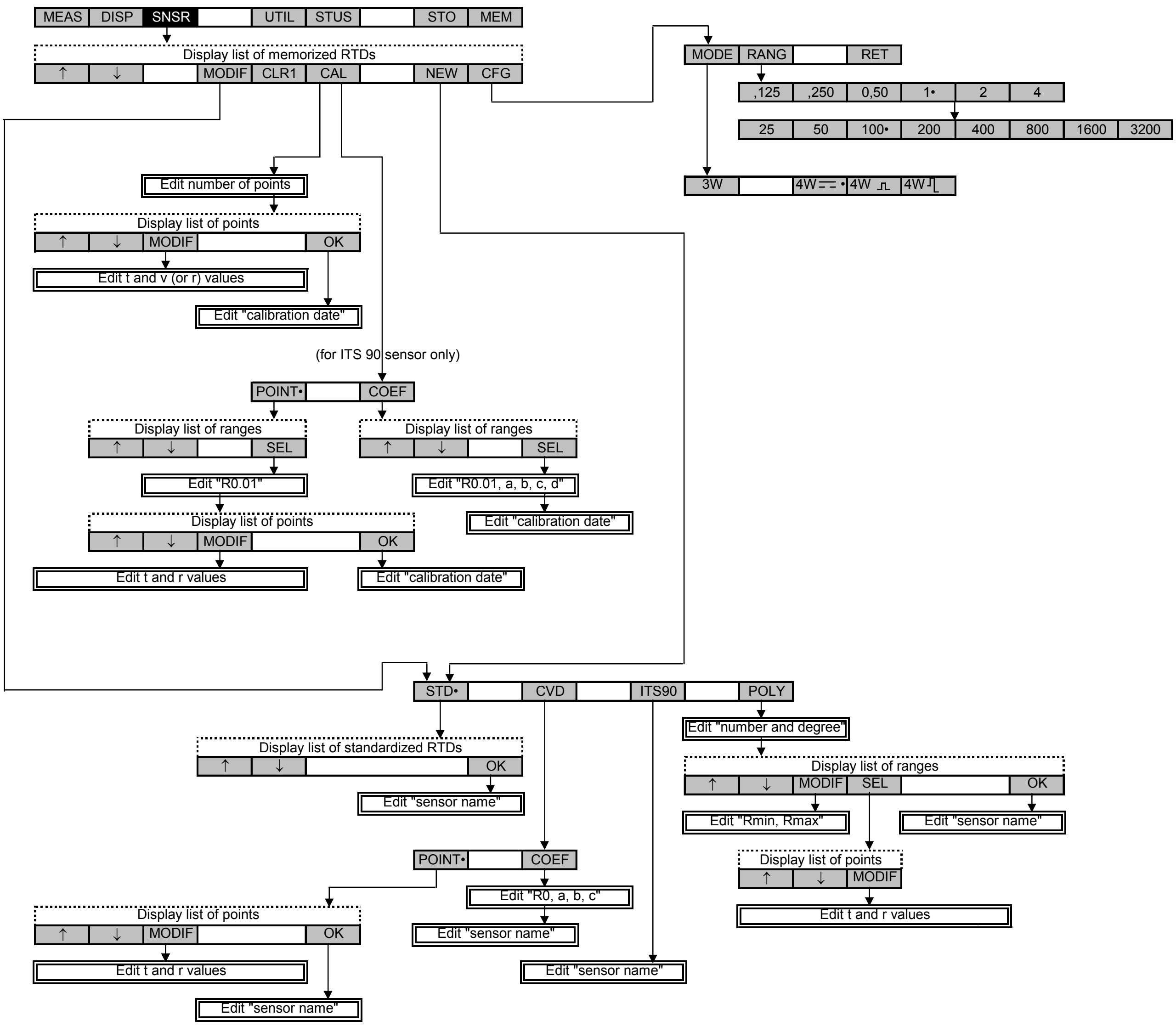
3.6.1 MEASUREMENT menu



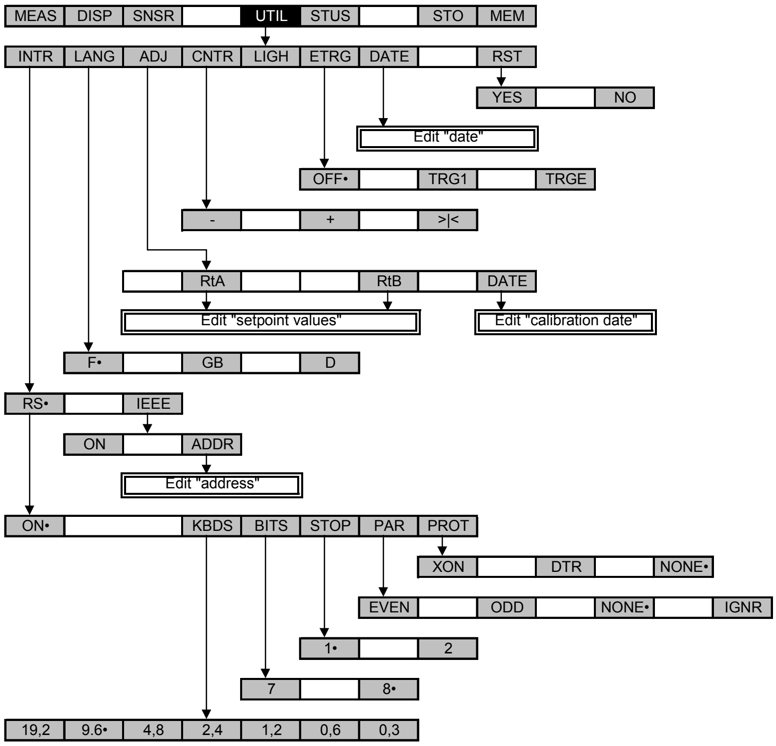
3.6.2 DISPLAY menu



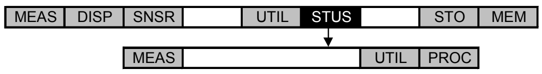
3.6.3 SENSOR menu



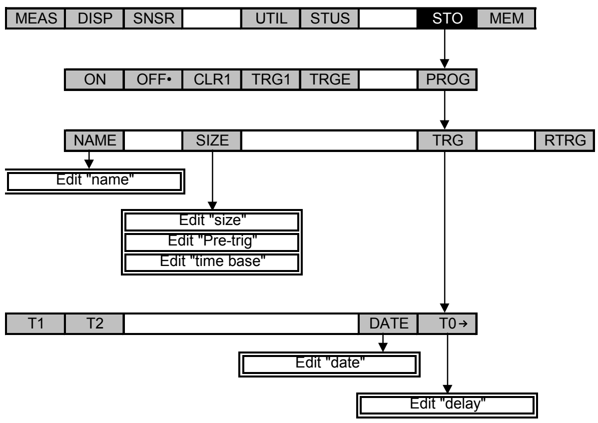
3.6.4 UTILITY menu



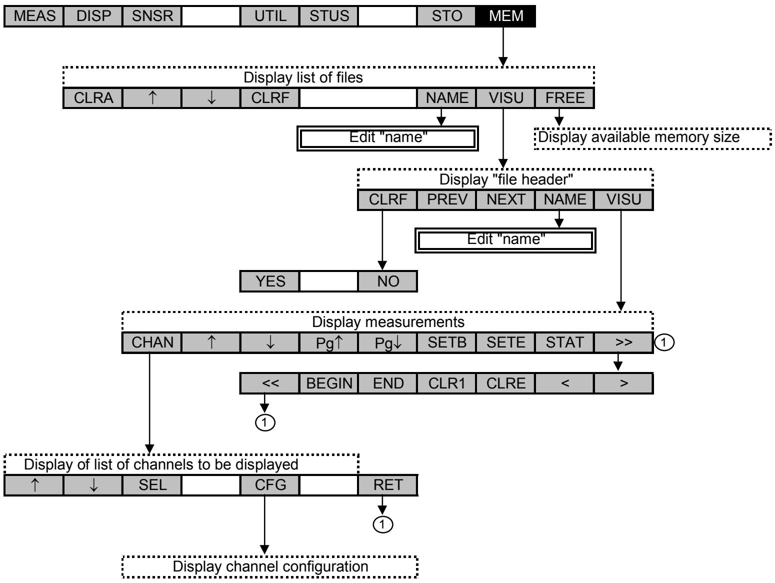
3.6.5 STATUS menu



3.6.6 STORAGE menu



3.6.7 MEMORY menu



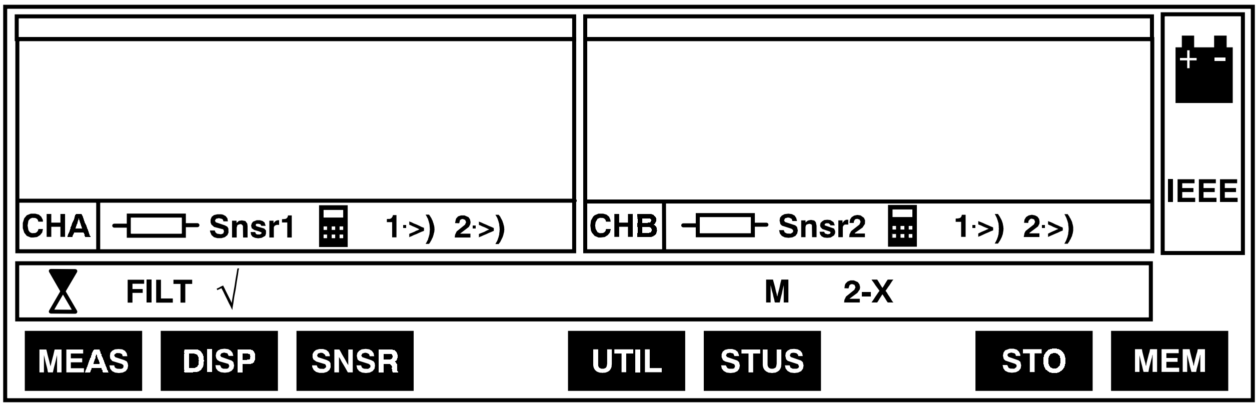
3.7 The error messages

Error messages	Meaning	What to do
GENERAL		
Value out of limits.	The value edited is outside the limits authorized for the parameter currently programmed.	• Read the permissible values using the help key (?).
Communication error with analog board.	Communication problem between the boards built-in the instrument.	• Switch the instrument OFF then ON (if this problem still occurs, return the instrument to our After-Sales service).
CHANNELS A AND B MEASUREMENT CONFIGURATION		
Measurement channel set to OFF.	It's not possible to set the NUL function in use over a channel set to OFF.	• Set the concerned channel to ON (MEAS-AON or MEAS-BON).
Illegal: Displaying (A-B).	It's not possible to set the NUL function in use over channels A or B if the unit reads (A-B) in window A.	• Display the channel A in window A (DISP-WINA-A).
Illegal: units A and B incompatible.	(A-B) may be displayed in window A with Ω unit only if the channels A and B are both configured with the same type of sensors.	• Display the channel A in window A (DISP-WINA-A). Or • Display temperature units (DISP-UNIT-°C or °F or K).
Illegal: NUL in use.	It's not possible to change the display unit if the NUL function is set in use over one of the channels. It's not possible to display (A-B) in window A if the NUL function is set in use over one of the channels.	• Set the NUL function to OFF over both channels (MEAS-PROC-NUL-CHA-OFF and MEAS-PROC-NUL-CHB-OFF). Or • Set the channels A or B to OFF (MEAS-AOFF or MEAS-BOFF).

MEASUREMENT MEMORIES		
No more memory available for burst !	The measurement storage memory is full.	• Clear one of the measurement files (MEM-↑-↓-CLRF).
Storing !	It's not possible to record a notepad file or clear a measurement file when a programmed recording is running.	• Stop the current programmed recording (STO-OFF).
Internal failure !	There is a problem with the storage memory.	• Clear the storage memory (MEM-CLRA).
Already triggered !	A programmed recording running cannot be triggered again.	• Stop the current programmed recording (STO-OFF).
No storage running !	A programmed recording cannot be triggered if it is not running.	• Set the programmed recording in use (STO-ON).
Size allocated to burst = 0 !	Zero cannot be allocated as a cycle number for a programmed recording.	• Enter a size above 0 (STO-PROG-SIZE).

Error messages	Meaning	What to do
SENSORS DATABASE		
Illegal parameters	The linearization parameters of the selected sensor are wrong.	• Select another sensor.
t value already assigned	It's not possible to enter the same temperature point twice.	• Edit a new point. Or • Search for the existing point and modify it.
Database full.	The sensors database is full.	• Select an existing sensor not used and clear it (SNSR-↑-↓-CLR1).
Database empty.	The sensors database is empty	• Create a new sensor (SNSR-NEW).
Sensor in use.	It's not possible to modify a sensor from the database which is used over a measurement channel set to ON. It's not possible to clear a sensor from the database which is used over a measurement channel even if it is set to OFF.	• To modify a sensor: set the concerned channel to OFF (MEAS-AOFF or MEAS-BOFF). • To clear a sensor: change the measurement configuration of the channel by selecting, for example, a standardized sensor (MEAS-CFG-CHA-SNSR-STD, or MEAS-CFG-CHB-SNSR-STD).
ADJUSTMENT		
Adjustment out of limits.	Computation of adjustment coefficient has not been performed.	• Repeat the adjustment and make sure that set points and measured values are close from each other.
INTERFACE		
Err: IEEE option or mains not available.	The interface cannot be programmed as IEEE mode if the instrument is not connected to the mains or not equipped with the optional IEEE board.	• Connect the instrument to the mains.

3.8 Icon meaning



Icons	Meaning
CHA, CHB	Name of the displayed channel.
	Sensor type: Rt (RTDs).
Snsr1, Snsr2	Sensor name.
	Nul function in use.
1.>)	Channel in alarm 1.
2.>)	Channel in alarm 2.
	Hold measurement.
FILT	Filter in use.
√	Current divider √2 in use.
M	Measurement file available.
2-X	Storage running: • 2: Number of measurements recorded. • X: Number of remaining measurements to be stored when using programmed recording.
	The battery must be recharged. See chapter 9.
IEEE or RS	Indicates the interface mode in use.

3.9 Selecting the language

From the main menu:

<table>
<tr><td>MEAS</td><td>DISP</td><td>SNSR</td><td></td><td>UTIL</td><td>STUS</td><td></td><td>STO</td><td>MEM</td><td>1. Select UTIL prompt (utility).</td></tr>
<tr><td>INTR</td><td>LANG</td><td>ADJ</td><td>CNTR</td><td>LIGH</td><td>ETRG</td><td>DATE</td><td>RST</td><td></td><td>2. Select LANG prompt (language).</td></tr>
<tr><td></td><td>F</td><td></td><td>GB</td><td></td><td>D</td><td></td><td></td><td></td><td>3. Prompt to be chosen by the user:
• F: French.
• GB: English.
• D: German.</td></tr>
</table>

3.10 Adjusting the unit

From the main menu:

<table>
<tr><td>MEAS</td><td>DISP</td><td>SNSR</td><td></td><td>UTIL</td><td>STUS</td><td></td><td>STO</td><td>MEM</td><td>1. Select UTIL prompt (utility).</td></tr>
<tr><td>INTR</td><td>LANG</td><td>ADJ</td><td>CNTR</td><td>LIGH</td><td>ETRG</td><td>DATE</td><td>RST</td><td></td><td>2. Select ADJ prompt (adjustment).</td></tr>
</table>

WARNING: This prompt should be used only for maintenance purposes. Refer to chapter 9.6.

Press the MNU key for returning to the main menu.

3.11 Adjusting the contrast

From the main menu:

<table>
<tr><td>MEAS</td><td>DISP</td><td>SNSR</td><td></td><td>UTIL</td><td>STUS</td><td></td><td>STO</td><td>MEM</td><td>1. Select UTIL prompt (utility).</td></tr>
<tr><td>INTR</td><td>LANG</td><td>AJST</td><td>CNTR</td><td>LUM</td><td>ETRG</td><td>DATE</td><td>RST</td><td></td><td>2. Select CNTR prompt : contrast.</td></tr>
<tr><td></td><td>-</td><td></td><td>+</td><td></td><td>>|<</td><td></td><td></td><td></td><td>3. Prompt to be chosen by the user:
• - : Decreases contrast.
• + : Increases contrast.
• >|< : Average contrast.</td></tr>
</table>

Press the MNU key for returning to the main menu.

3.12 Lighting the display

From the main menu:

<table>
<tr><td>MEAS</td><td>DISP</td><td>SNSR</td><td></td><td>UTIL</td><td>STUS</td><td></td><td>STO</td><td>MEM</td><td>1. Select UTIL prompt (utility).</td></tr>
<tr><td>INTR</td><td>LANG</td><td>ADJ</td><td>CNTR</td><td>LIGH</td><td>ETRG</td><td>DATE</td><td>RST</td><td></td><td>2. Select LIGH prompt (lighting). The display is lighted. A second pressing on this prompt switches the lighting off.</td></tr>
</table>

Press the MNU key for returning to the main menu.

3.13 Displaying the unit status

Validating the **STUS** prompt from the main menu enables the user to display all the information concerning the measurement, unit utilities and measurement processing.

From the main menu:

MEAS DISP SNSR UTIL **STUS** STO MEM	1. Select STUS prompt (status).
MEAS UTIL PROC	2. Select MEAS prompt (measurement).

Display example of the measurement status

```
CHA:Snsr1,T1,-T2
CHB:PT100,R100,MA1,WIRE4P,T1-T2
```

Press the MNU key for returning to the main menu (step 1).

MEAS **UTIL** PROC	3. Select UTIL prompt (utility).

Display example of the utility status

```
Interface:RS232,9600bauds,8bits,
          1stop-bit,no parity,
          no protocol
Software revision:
   logic:A09,analog.:A09,ADC:A04
Last adjustment date:98.14
Serial No:000107
```

Press the MNU key for returning to the main menu (step 1).

MEAS UTIL **PROC**	4. Select PROC prompt (processing).

Display example of the measurement processing

```
Filter:OFF (2)
Nul over CHA:ON ( 2.50000e-3)
Nul over CHB:OFF ( 000.000e-3)
Alarms:Buzzer ON
T1:ON,T= 1.00000,H= 1.00000e-3,M>T
   REL
T2:ON,T= 1.00000,H= 1.00000e-3,M>T
   ABS
```

Press the MNU key for returning to the main menu.

4. PROGRAMMING THE DISPLAY

Notes

4.1 Overview

Programming the display concerns:

- The value displayed in window A.
- The display units: °C, °F, K or Ω which will appear in windows A and B.

4.2 The display windows

As stated above, the graphic display is divided into two windows:

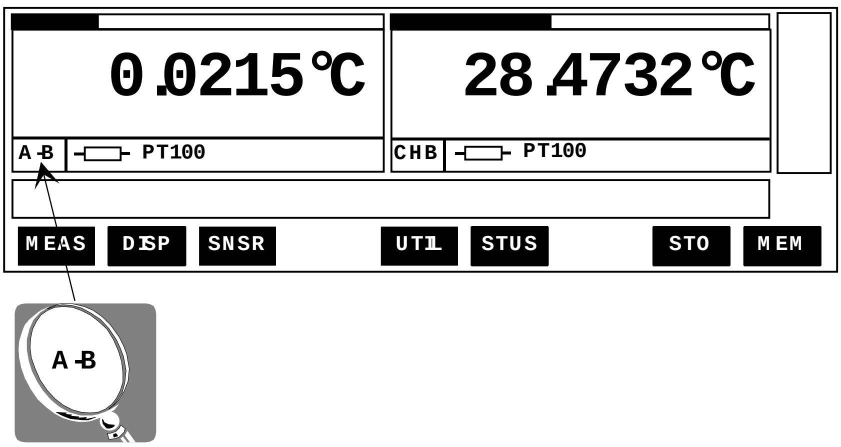
- The left window (window A) displays:
  - Either, the measurements performed over channel A together with unit.
  - Or, the difference between the measurements performed over channel A and the measurements performed over channel B together with units.
- The right window (window B) displays the measurements performed over channel B together with unit.

Then, the user will have to program the display window A.

From the main menu:

MEAS	DISP	SNSR	UTIL	STUS	STO	MEM	1. Select DISP prompt (display).
WINA		UNIT					2. Select WINA prompt (WINdow A).
A		A-B					3. Prompt to be chosen by the user: • Selection of channel A. • Selection of channel A – B.

A-B display example



4.3 The display units

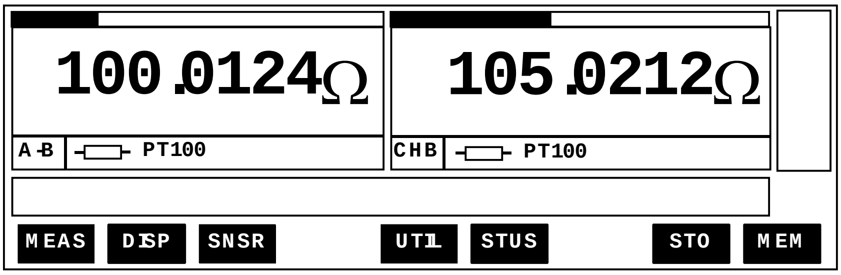
The user will have to select the desired display unit.

From the main menu:

MEAS · DISP · SNSR · UTIL · STUS · STO · MEM	1. Select DISP prompt (display).
WINA · UNIT	2. Select UNIT prompt (unit).
°C · °F · K · Ω	3. Prompt to be chosen by the user: • Degree Celsius unit. • Degree Fahrenheit unit. • Kelvin unit. • Ω unit.

NOTE: When using Ω unit, if the window A is configured as (A – B) display, both channels A and B should be configured with the same type of sensors.

Display example with unit Ω



5. MEASUREMENT FUNCTIONS

Notes

5.1 Measuring RTDs

5.1.1 Measurement principle

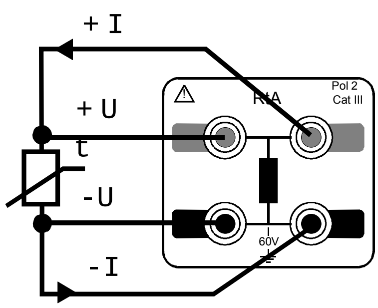
See chapter 10: Appendix.

5.1.2 Connections

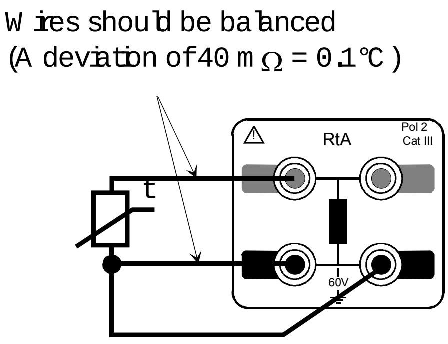
5.1.2.1 Measurement over channel A (RtA)

There are two alternatives:

1. Either by using copper wires tightened under the 4-mm terminals, or banana plugs inserted in the terminals as explained in diagram below (beware of spurious thermocouples with copper plugs).

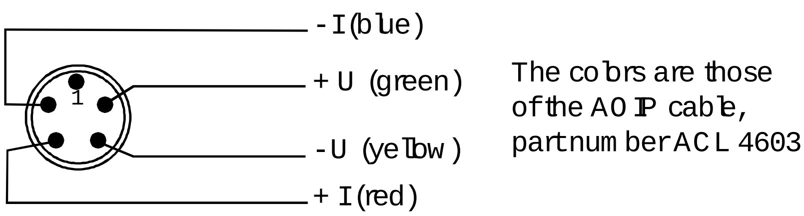


4-wire configuration



3-wire configuration

2. Or using cylindrical connector wired as indicated below.



Socket, front view

⚠ **Never wire sensors simultaneously over each input, as terminals RtA and socket RtA are set in parallel.**

5.1.2.2 Measurement over channel B (RtB)

Performed only by using the cylindrical connector wired in the same way as channel A explained above.

5.1.2.3 Measurements over channels A and B

As indicated above for each channel A and B.

5.1.3 Configuration

5.1.3.1 Configuring channel A

The user will have to program:

- The sensor type.
- The configuration type.
- The resistance range.
- The measurement current.

From the main menu:

MEAS DISP SNSR UTIL STUS STO MEM	1. Select MEAS prompt (measurement).
AON AOFF BON BOFF **CFG** RUN HOLD I/√2 PROC	2. Select CFG prompt (configuration).
CHA CHB	3. Example: configuring channel A.
SNSR MODE RANG RET	4. Select SNSR prompt (sensor type) See note 1.
STD MEM	5. Select STD prompt (standardized sensors). See note 2.
TYPE:PT100, R0=100, α=0.003850 (CEI751) TYPE:PT200, R0=200, α=0.003850 (CEI751) TYPE:PT500, R0=500, α=0.003850 (CEI751) ▸ TYPE:PT1K, R0=1000, α=0.003850 (CEI751) TYPE:NI100, R0=100, α=0.006180 (DIN43760) TYPE:NI120, R0=120, α=0.006720 (MILT24388C) TYPE:CU10, R0=10, α=0.004270 (MINCO 16/9) TYPE:A3916, R0=100, α=0.003916 (JISC1604) TYPE:A3926, R0=100, α=0.003926 (EIT90)	6. Data list: Type of sensor to be selected by the user. Refer to paragraph 3.5.4. Example: Selection of PT1K sensor.
SNSR **MODE** RANG RET	7. The PT1K sensor being selected, choose the measurement operating mode.
3W 4W⎓ 4W⎍ 4W∿	8. Prompt to be chosen by the user, i.e.: • 3-wire. • 4-wire, direct current mode. • 4-wire, pulse current mode. • 4-wire, alternate current mode.
3W **4W⎓** 4W⎍ 4W∿	9. Example: Selection of the 4-wire, direct current mode.

		SNSR	MODE	**RANG**		RET			10. Select RANG prompt (measurement current).
.125	.250	.50	1	2	4				11. Prompt to be chosen by the user.
.125	.250	.50	1	2	4				12. Example: Selection of 0.125 mA. See note 3.
					800	1600	3200		13. Selection of the resistance range compatible with the measurement current.
					800	**1600**	3200		14. Example: Selection of the 1 600 Ω range. See note 3.
		SNSR	MODE	RANG		**RET**			15. Select RET prompt (return) which returns you to step 3 in order to configure channel B in the same way as channel A, if required.

When channels A and B are programmed as desired, press the [ESC] key for returning to the menu below:

AON	AOFF	BON	BOFF	CFG	RUN	HOLD	I/√2	PROC	**Final steps**: • Set channels A and/or B to ON or OFF by selecting the adequate prompts. • If required, select prompt **I**/√2 in order to divide the current by square root of 2, thus authorizing a self-heating measurement. See paragraph 10.4.5.

Then, press the [MNU] key for returning to the main menu.

NOTES:

1. Order for programming sensor type (SNSR), measurement operating mode (MODE), as well as measurement current and resistance range (RANG) has no matter.

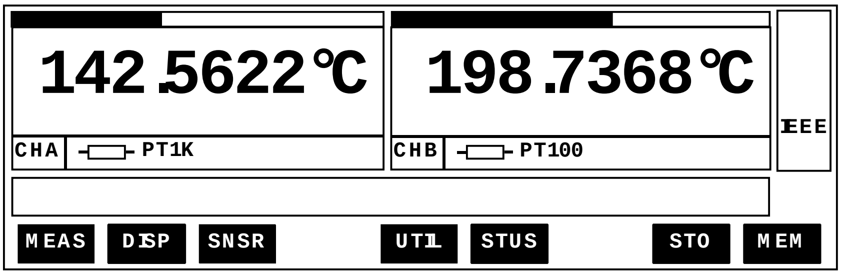
2. Prompt (MEM) enables the user to select a sensor memorized in the database. Refer to chapter 7 for full details.

3. Each time the user selects a measurement current, the unit prompts the resistance ranges to be selected as indicated in table below.

			Measurement current Ic peak ①					
Range	**Resolution**	**Span**	**0.125 mA**	**0.25 mA**	**0.5 mA**	**1.0 mA**	**2.0 mA**	**4.0 mA**
25 Ω	0.00001 Ω	29.37500 Ω						✓
50 Ω	0.00001 Ω	58.75000 Ω					✓	✓
100 Ω	0.00002 Ω	117.50000 Ω				✓	✓	✓
200 Ω	0.00005 Ω	235.00000 Ω			✓	✓	✓	
400 Ω	0.0001 Ω	470.0000 Ω		✓	✓	✓		
800 Ω	0.0002 Ω	940.0000 Ω	✓	✓	✓			
1 600 Ω	0.0005 Ω	1 880.0000 Ω	✓	✓				
3 200 Ω	0.001 Ω	3 760.000 Ω	✓					

① RMS measurement current:
- Pulse mode $I_{RMS} = Ic/\sqrt{2}$.
- Direct mode $I_{RMS} = Ic$.
- Alternate mode $I_{RMS} = Ic$.

5.1.4 Display example



5.2 Processing procedures over the measurement

5.2.1 Relative measurements (NUL)

- The aim is to apply a constant shift to the measurement (i.e.: to cancel the measurement by a given value).
  If N is the Nul value and M the value Measured, the unit will read: A = M – N.
  The Nul value may either be a value entered using the keypad, or a value measured at a given time.

- This processing procedure may be applied either on channels A or B or on (A – B) with different Nul values for A, B and (A – B).

5.2.1.1 Configuration

From the main menu:

MEAS	DISP	SNSR		UTIL	STUS		STO	MEM	1. Select MEAS prompt (measurement).
AON	AOFF	BON	BOFF	CFG	RUN	HOLD	I/√2	**PROC**	2. Select PROC prompt (processing procedure).
NUL		ALM		FILT					3. Select NUL prompt.
CHA	CHB		A-B						4. Example: selection of channel A.
ON	OFF		**PROG**	TARE					5. Selection of PROG prompt or go to step 8.
		N= _XXX.XXXe-3 °C							6. Enter the Nul value using the keypad (from $-1e^{12}$ to $1e^{12}$) and validate it with the ENT key.
	Digital keys				<	>		EXP	
ON	OFF		PROG	TARE					7. Set the processing procedure in use by validating the ON prompt. See notes 1 and 2.
ON	OFF		PROG	**TARE**					8. The displayed measurement will be memorized as Nul value. This prompt automatically sets the processing procedure in use.
CHA	CHB		A-B						9. Return to step 4 in order to configure channel B and/or A – B.

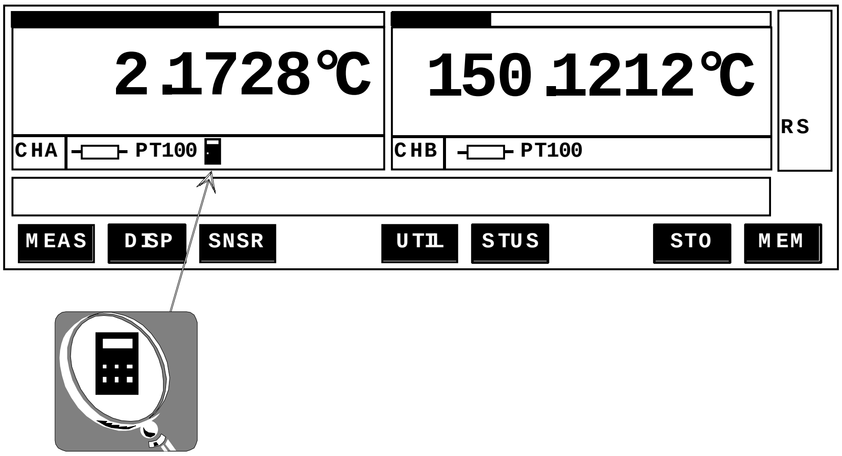
Then, press the MNU key for returning to the main menu.

NOTES:

1. The processing procedure is disabled:
   - When a channel is not set to ON.
   - Over A – B if the unit reads CHA in window A.
   - Over CHA or CHB if the unit reads A – B in window A.

2. The processing procedure can be set in use without reprogramming the Nul value. But, if the unit of the Nul value is different from the current unit displayed, the instrument will ask for confirmation of the value when setting the processing procedure in use.

5.2.1.2 Display example



5.2.2 Filter

This is an exponential smoothing type filter equivalent to a 1st order filter.
If C is a whole number corresponding to the filter coefficient, at the nth measurement, the unit reads:

$$A_n = \frac{(2^c - 1)\,A_{n-1} + M_n}{2^c}$$

with:
M_n = Current measurement.
A_{n-1} = Previous display.

This filter is similar to an electronic filter (RC) whose time constant could be $2^c.\Delta t$, with Δt the time interval between two successive measurements.

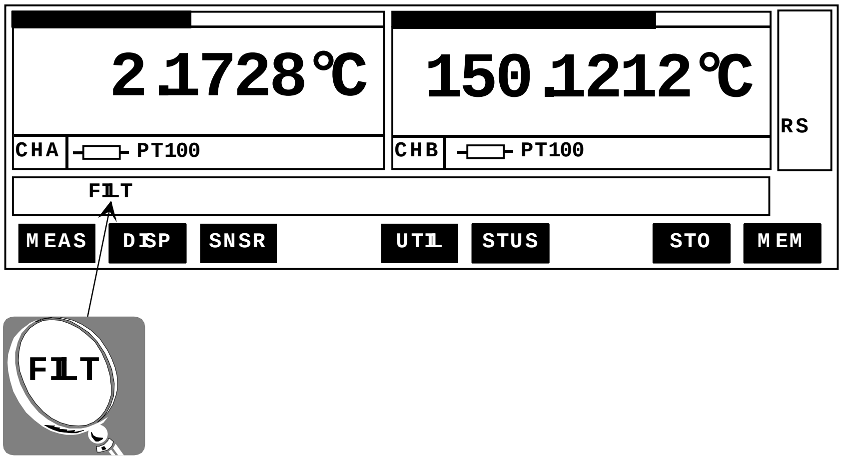
5.2.2.1 Configuration

MEAS DISP SNSR UTIL STUS STO MEM	1. Select MEAS prompt (measurement).
AON AOFF BON BOFF CFG RUN HOLD I/√2 PROC	2. Select PROC prompt (processing procedure).
NUL ALM FILT	3. Select FILT prompt (filter).
ON OFF PROG INIT	4. Select PROG prompt (programming).
N= X Digital keys < >	5. Enter the filter coefficient using keypad (from 1 to 8) and validate it with the ENT key.
ON OFF PROG INIT	6. If desired, set the filter in use by validating the ON prompt.
ON OFF PROG INIT	7. If desired, reinitialize the filter (A_{n-1} = 0).
ON OFF PROG INIT	8. If desired, deactivate the filter by validating the OFF prompt.

Then, press the MNU key for returning to the main menu.

NOTE: Setting the filter in use initializes it (A_{n-1} = 0).

5.2.2.2 Display example



5.2.3 Alarms

5.2.3.1 Operating mode

There are two programmable alarms T1 and T2.

An alarm is defined by:
- A threshold value.
- An hysteresis value.
- A comparison direction (high or low regarding the threshold).
- A comparison mode (relative or absolute).
- The channels to which it is assigned.

Comparison direction

The alarm is activated when the measurement is above the threshold (M > T) or below the threshold (M < T).

Comparison mode

Two comparison modes are available:

- The absolute mode: the unit compares the threshold value to the value measured over the channels concerned by the alarm (Ex. 1).

- The relative mode: the unit compares the threshold value and the difference between the measurement over the channel concerned by the alarm and the measurement of the reference channel. (Ex. 2).

Example 1 : Alarm 1 is programmed in absolute mode over channel B. The unit compares the value of the threshold 1 to the value measured over channel B.

Example 2 : Alarm 2 is programmed in relative mode over channel A. The unit compares the value of the threshold 2 to the difference {Value measured over channel A – Value measured over channel B}.

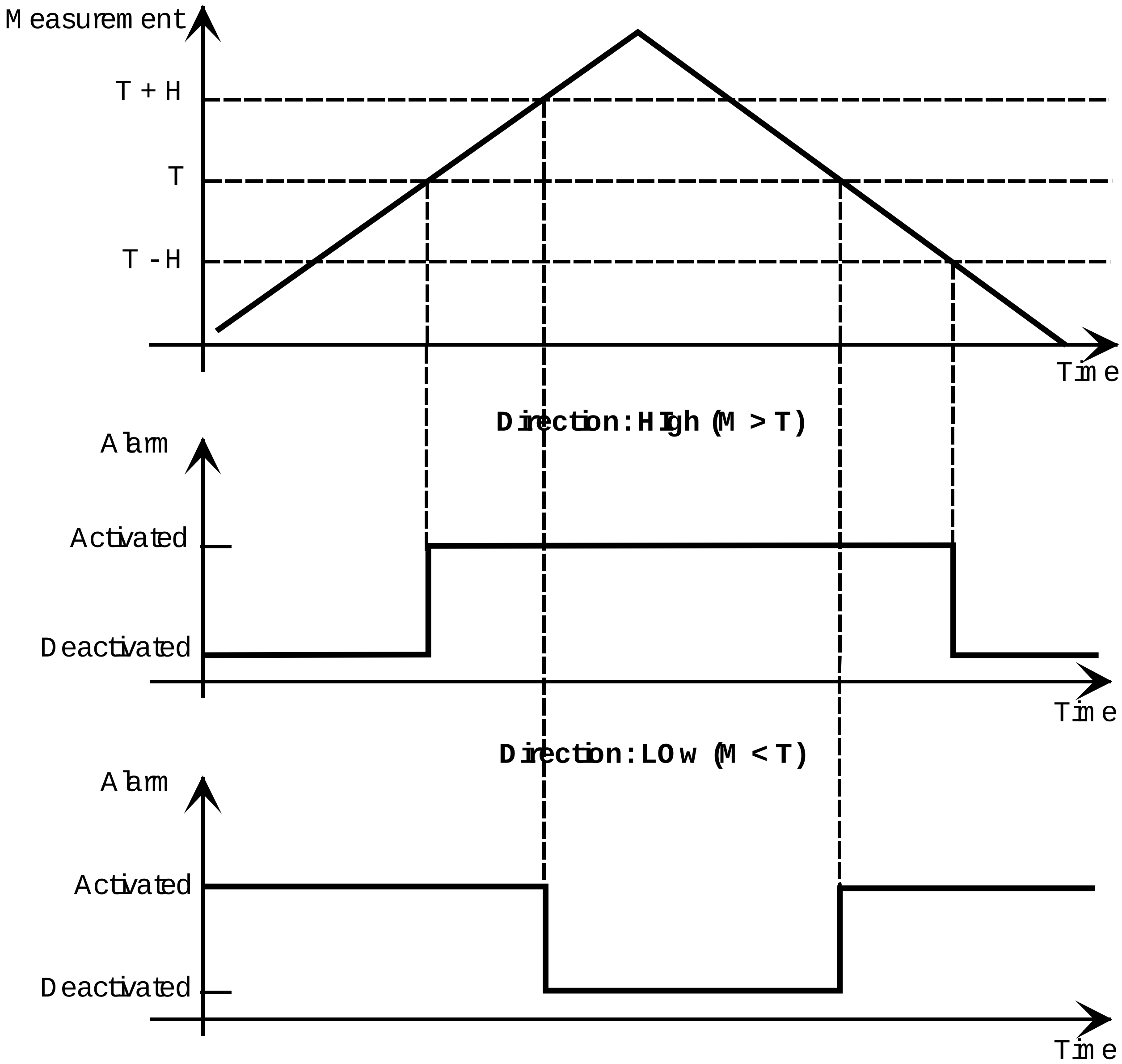
Activating one of the alarms can trigger an audible warning.

Alarm hysteresis

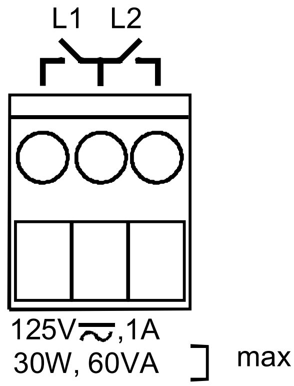
In any state-changing device, an alarm system may lead to some fluctuations. The hysteresis is made to be free from these fluctuations.

Let be:

M = The value Measured.
T = The value of the programmed Threshold.
H = The value of the programmed Hysteresis.



5.2.3.2 Connection



A NO contact is assigned to each alarm available at rear of the unit.

When the alarm is activated, closing of the contact assigned to this alarm triggers any external device.
(125 V~, 1 A~, 30 W, 60 VA maximum permissible).

5.2.3.3 Configuration

Parameters to be programmed for each threshold:
- Comparison mode.
- Comparison direction.
- Threshold and hysteresis values.
- Channels assigned.
- Buzzer ON or OFF (audible warning).

MEAS	DISP	SNSR		UTIL	STUS		STO	MEM	1. Select MEAS prompt (measurement).
AON	AOFF	BON	BOFF	CFG	RUN	HOLD	I/√2	PROC	2. Select PROC prompt (processing procedure).
NUL		ALM		FILT					3. Select ALM prompt (alarm).
	T1		T2				BUZZ		4. Example: Programming threshold T1.
ON	OFF		ABS	REL	PROG	M>T	M<T	CHAN	5. Comparison mode to be selected by the user: absolute or relative.
ON	OFF		ABS	REL	PROG	M>T	M<T	CHAN	6. High or Low overrun to be selected by the user.
ON	OFF		ABS	REL	PROG	M>T	M<T	CHAN	7. Select PROG prompt (programming).
	T=	_XXX.XXXe-3		°C					8. Edit the threshold value and
	H=	_XXX.XXXe-3		°C					the hysteresis value.
	Digital keys				<	>	>>	EXP	Prompt >> moves you to the next or previous field or vice versa. Validate the values with the ENT key.
ON	OFF		ABS	REL	PROG	M>T	M<T	CHAN	9. Select CHAN prompt (channels) for assignment.
CHA	CHB								10. Prompt CHA and/or CHB to be selected by the user.

Press the [ESC] key twice for returning to the menu below:

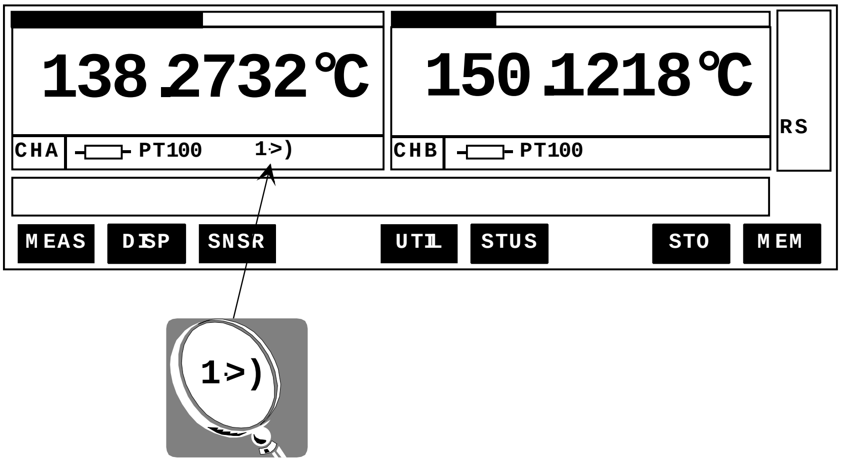
T1 T2 BUZZ	11. Return to step 4 in order to program threshold T2 if required.

T1 T2 **BUZZ** ON OFF ACK	**Final step:** • If required, validate BUZZ prompt (buzzer). To be selected by the user: • Buzzer ON. • Buzzer OFF. See note.

Then, press the [MNU] key for returning to the main menu.

NOTE: When the buzzer is activated, the **ACK** prompt acknowledges and switches the audible warning OFF.

5.2.3.4 Display example



Alarm 1 is activated over channel A.

6. MEASUREMENT MEMORIES

Notes

6.1 Operating mode

The instrument memory has a capacity of 50 kbytes for recording the measurement results (i.e.: 5 545 cycles for one channel set in use).
Recordings can either be programmed to start at the appearance of a trigger event, or triggered at any time according to the user's requirements.

6.1.1 Records triggered by the user: "notepad function"

The measurement cycles are recorded either one by one at each trigger validated by the user (command **TRG1** from the **STO**rage menu) or at each detection of a valid external trigger[1] command (on condition that it remains enough place in memory and that the unit is not storing *programmed records*, see below).

For each cycle, the following data are recorded in a "notepad" file type:
- date and time of the end of cycle,
- measurement results of all cycle channels.

If the unit is measuring (RUN) at the time of the command, the results recorded are those of the current cycle. Recording is performed when the unit has completed the measurement of the last channel of the cycle[2]. If the unit is waiting for trigger (HOLD), it performs the measurement cycle, records it and returns to hold.

In addition to the dated measurement results, such a file also contains a header in which are recorded the measurement configurations of the channels set in use.

A "notepad" type file may contain several dated result lines corresponding to several successive TRG1 commands: As a matter a fact, in order to save the memory space used for recording the configuration information, the unit records the results in the same file as long as the channel list in use together with their configuration are not changed.

[1] *External trigger:*
The closing of the external trigger contact, the interface *TRG command as well as the IEEE-488 GET command can also trigger a notepad record if they are assigned to this function. For that, use command ETRG from the UTIL menu and select TRG1 option.

[2] *Measurement cycle:*
Executing a cycle is the measurement of all channels set in use in the following order: channel B, channel A.

So, when the TRG1 command is executed, the unit tests if a notepad file is opened. If yes, it compares the measurement configuration recorded in this file header to the current configuration and, if they are similar, the new cycle is recorded in the same file. If not, a new file is created.
Then, the file is maintained opened in order to be filled at the next TRG1 command.

The current notepad is closed when:
- Executing TRG1 command after one configuration parameter has been modified.
- Setting the "programmed" records in use.
- Entering the menu **MEM** to read the records performed.
- Stopping the unit.

6.1.2 Programmed records

The unit automatically records the measurement results of all channels set in use within the interval defined by the user, and also monitors occurrence of a trigger event. After this event is detected, it continues recording during a programmable time, then closes the file.

A "programmed" record can be triggered:

- by selecting the **TRGE** prompt,
- at detection of an external trigger[3],
- when an alarm is activated,
- from a given date and time,
- after the delay since the beginning of storage has elapsed.

The user can combine one or more trigger events (called "TRIGGERS").

As long as the storage is set in use, the unit records the measurement cycles within the specified rate by respecting the size allocated to the file. When this size is reached, the results of the oldest cycle are erased and replaced by the most recent.

When one of the validated TRIGGERS[4] is detected, the unit uses the PRE-TRIGGER value programmed to compute the number of cycles it has to record before to stop storage. Then, it counts down this number of cycles at each record and, when it reaches zero, the file is closed and the storage stops.

[3] *External trigger:*
The closing of the external trigger contact, the interface *TRG command as well as the IEEE-488 GET command can also trigger a notepad record if they are assigned to this function. For that, use command ETRG from the UTIL menu and select TRG1 option.

[4] *TRIGGER*
Means a programmed record trigger event.

If the automatic reset is selected, the storage is immediately reset in use, a new file is created and the unit returns to TRIGGER[5] waiting phase.

It is always possible to stop acquisition and close the file using the command **OFF** from the **STO**rage menu.

It is impossible to change recording parameters for the current file. If modifications occur in the programming (Size, TRIGGER,…) they apply only when a new file is created.

6.2 Programming

The user must specify:

- The **maximum size of the result file** by entering the number of measurement cycles to be kept.

- The **recording time base** in seconds.
  Time interval between record of two successive cycles.

- The **TRIGGER**[5], together with a **PRE-TRIGGER** value between 0 and 100 %.
  The TRIGGER defines the moment from which the unit will begin to count down the number of cycles it has to record, then will close the file when it reaches zero.

  Number of cycles to be recorded after TRIGGER = Programmed file size * (100 - PRETRIG)/100.

  The TRIGGER can be selected through the menu from the following events:
  - **Date** and time.
  - **Delay** in seconds after the beginning of storage.
  - Alarm appearance **T1** or **T2** (changing from "normal" state to "alarm" state over one of the channels set in use).

  The user can select more than one event. In that case, the first occurring will activate the trigger.

Moreover, the user can select the "**automatic reset**". In that case, the unit, when closing the file, automatically creates a new one as long as there is enough place in memory.

[5] *TRIGGER*
Means a programmed record trigger event.

- **Programming "programmed records"**

Programming order has no matter.

From the main menu:

MEAS DISP SNSR UTIL STUS **STO** MEM	1. Select STO prompt (storage).
ON OFF CLR1 TRG1 TRGE **PROG**	2. Select PROG prompt (programming the "programmed records").
NAME SIZE TRG RTRG **Name:** _	3. Edit the name of the next file created by the unit. See paragraph 3.5.6.
NAME **SIZE** TRG RTRG **File max. size =** 00000 cycles **Pre-Trigger =** 000 % **Time base =** 00000 s **Digital keys** < > >>	4. Selection of SIZE prompt: edition of parameters of the next created file. Enter: • Maximum size for the next file (number of measurement cycles kept in memory). • Pre-trigger value between 0 and 100 %. • Record time base (time in seconds between recording of two consecutive cycles). See paragraph 3.5.5.
NAME SIZE TRG **RTRG**	5. Select RTRG prompt (automatic reset mode).

Then, press the MNU key for returning to the main menu.

- **Programming the TRIGGER**

From the main menu:

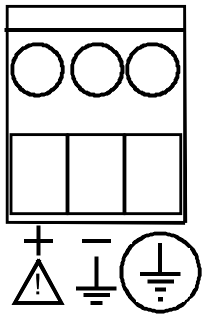
MEAS DISP SNSR UTIL STUS **STO** MEM	1. Select STO prompt (storage).
ON OFF CLR1 TRG1 TRGE **PROG**	2. Select PROG prompt (programming).
NOM SIZE **TRG** RTRG	3. Select TRG prompt (TRIGGER programming).
T1 T2 DATE TO →	4. Prompt T1 and/or T2 to be chosen by the user: • T1: appearance of alarm 1 over one of the channels set in use. • T2: appearance of alarm 2 over one of the channels set in use.
T1 T2 **DATE** TO →	5. Validate DATE prompt (programmed date). See note
TRIGGER date **Date = 1998/ 03/ 18 12: 57: 46** Digital keys < > >>	6. Edit the date and time. See paragraph 3.5.5.
T1 T2 DATE **TO →**	7. Select TO → prompt (delay after beginning of storage). See note.
TRIGGER delay **T0= 00000 s** Digital keys < >	8. Edit the delay in seconds. See paragraph 3.5.5.

NOTE: Validating DATE prompt cancels TO → prompt and vice versa.

Then, press the MNU key for returning to the main menu.

6.3 Assigning an external trigger

trig.



Triggering a record may be performed by closing of an external contact connected to the "trig" terminals at back of the unit.

A NO contact free from potential should be connected to these terminals. With a semiconductor, follow the indicated polarities (internal source 5 V, 47 kΩ). The minus terminal (-) is connected to the low point of the logic circuits.

The user must determine if closing of this contact:

- will trigger a "notepad" record,
- will trigger a "programmed" record,
- will have no effect.

From the main menu:

MEAS	DISP	SNSR		**UTIL**	STUS		STO	MEM	1. Select UTIL prompt (utility).
INTR	LANG	ADJ	CNTR	LIGH	**ETRG**	DATE	RST		2. Select ETRG prompt (external trigger).
	OFF		TRG1		TRGE				3. Prompt to be selected by the user: • OFF: no effect. • TRG1: "notepad" record trigger. • TRGE: "programmed" record trigger.

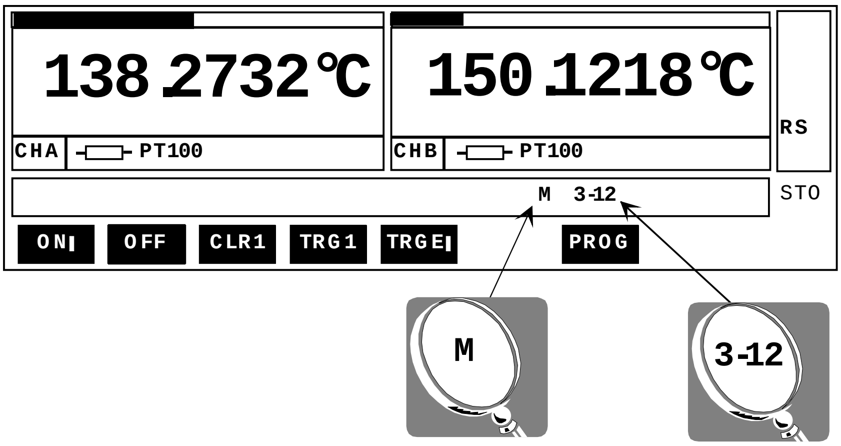
Then, press the MNU key for returning to the main menu.

6.4 Setting in use

From the main menu:

MEAS DISP SNSR UTIL STUS STO MEM	1. Select STO prompt (storage).
ON OFF CLR1 TRG1 TRGE PROG	2. Prompt to be selected by the user: • ON: starting the programmed storage. • OFF: stopping the programmed storage. • CLR1: clearing the last cycle recorded from the current notepad file. • TRG1: Immediate recording of the current cycle results in the notepad file (only when the programmed storage is set to OFF). • TRGE: Triggers the count-down of cycles before the storage stops (only if the programmed storage is set to ON).

Display example



M : appears as soon as there is a measurement file available.

3 : number of cycles recorded.
12 : number of cycles to be recorded according to the max. size allocated to the file.

6.5 Reading the measurement files

The command **MEM** from the menu enables the user to display the list of the result files. The files are displayed from the most recent (number – 1) to the oldest.

From the main menu:

MEAS	DISP	SNSR		UTIL	STUS		STO	MEM	1. Select MEM prompt (memory).

File list display example

```
 NAME:   BEGIN:              END:
▸-1TEST1 98/03/18 15:20:20   98/03/18 15:25:30
 -2      98/03/18 14:20:20   98/03/18 14:25:30
 -3      98/03/18 13:20:20   98/03/18 13:25:30      RS
                    M                               MEM
CLRA  ↑  ↓  CLRF            NAME  VISU  FREE
```

Menu commands

CLRA Clears all the recorded files.

↑ **↓** Selects one file by means of the cursor ▸.

CLRF Clears the file pointed by the cursor.

NAME Changes the file name pointed by the cursor.

FREE Displays the available memory for storage.

VISU Displays the file header pointed by the cursor.

File header display example

```
FILE:    -1        NAME:      TEST1
SIZE:    3         RUN:       98/03/18 15:20:20
TB (s):  NOTEPAD   BEGIN:     98/03/18 15:20:20
TRIG:    NONE      TRIG DATE:                        RS
UNIT:    °C        END:       98/03/18 15:25:30
                    M                                MEM
          CLRF  PREV  NEXT  NAME  VISU
```

Details of the displayed information

FILE	File number.
NAME	File name.
SIZE	Number of lines (= number of recorded cycles).
RUN	Date and time of recording in this file. This date may be earlier to the date of the oldest result if the TRIGGER event has not occurred immediately.
TB	Record time base of the consecutive cycles in case of programmed records. A notepad file is indicated by NOTEPAD in this field.
BEGIN	Date and time of the oldest cycle.
TRIG	TRIGGER detected.
TRIG DATE	Date and time of the TRIGGER detection.
UNIT	Recorded measurement unit.
END	Date and time of the most recent cycle.

Menu commands

CLRF Clears the displayed file.

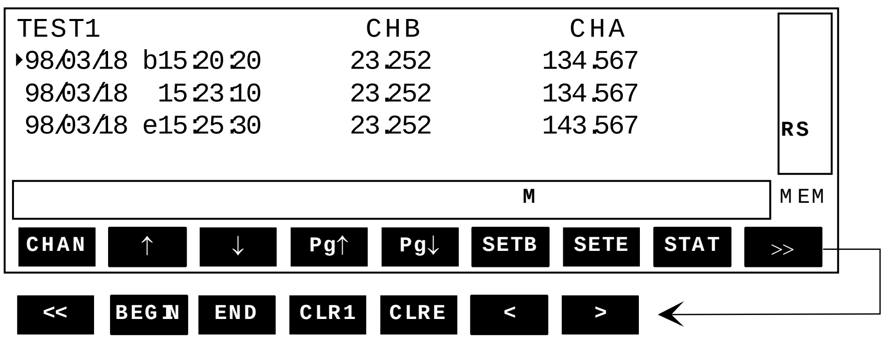
PREV Displays the previous file header.

NEXT Displays the next file header.

NAME Changes the file name.

VISU Displays the measurement results.

Measurement result display example



The screen displays 4 lines including each the date and time of the recorded cycle as well as 3 columns of measurement results, i.e. 3 channels.

When the file includes more than 3 channels, prompts < and > enable the user to shift one column to the right or to the left in order to visualize all the channels.

Three markers may appear in the column separating the date and time:

- Markers "**b**" and "**e**" defining the beginning and the end of a span of results. Some menu commands refer to this span. The user may move both markers.

- Marker "**t**" indicating the line corresponding to the occurrence of the TRIGGER detected.

Menu commands

CHAN Displays the list of the recorded channels and enables the user to select those to be displayed.

↑ **↓** Move the current line cursor ▸.

Pg↑ Displays the previous page.

Pg↓ Displays the next page.

SETB Sets the selection beginning marker "**b**" on the current line. (By default, the marker "**b**" is set on the first line).

SETE Sets the selection end marker "**e**" on the current line. (By default, the marker "**e**" is set to the last line).

STAT Displays the statistics of the channels inside the span marked by the two markers "**b**" and "**e**". (Minimum, Maximum, Average and Standard Deviation).

>> Cont'd.

<< Cont'd.

BEGIN Displays the file beginning (first result page).

END Displays the file end (last result page).

CLR1 Clears the current line from the file (line marked by the cursor ▸).

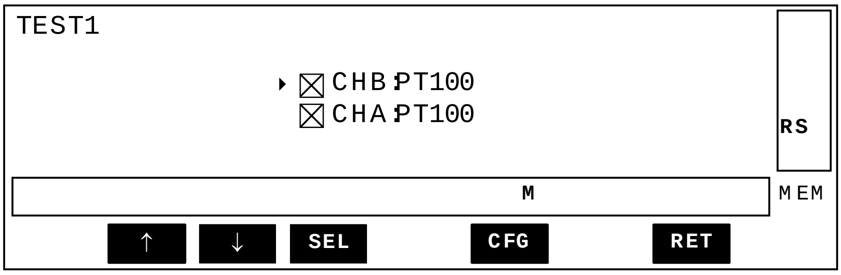
CLRE Clears, from the file, the lines outside the span selected (i.e.: lines preceding the marker "**b**" or following the marker "**e**").

< Shifts the display one column to the left.

> Shifts the display one column to the right.

Example for selecting the channels to be displayed

Validating prompt **CHAN** displays the following screen:



↑ **↓** Moves the channel cursor ▸.

SEL Selects/deselects the marked channel.

CFG Displays the configuration of the marked channel:

- For an RTD: Configuration, measurement current and NUL status.

RET Returns to the measurement result display.

Notes

7. SENSORS DATABASE

Notes

In addition to the standardized sensors described before, the unit offers usage of sensors whose linearization curve is defined by the user.

Moreover, for any kind of sensor (standardized or defined by the user) calibration points may be entered.

The unit memorizes up to 32 sensors together with associated measurement configuration.

7.1 Data structure

Each sensor from the database is structured as follows:

- name enabling to identify the sensor,
- linearization curve (standardized or defined by the user),
- calibration points and date,
- measurement configuration.

When the user selects one sensor from the database over one of the measurement channels, the unit operates as follows:

- It prompts the measurement configuration stored for the selected sensor.
- When a resistance measurement is available (if the display unit is a temperature unit), it applies the linearization curve for the selected sensor in order to infer a temperature.
- Then, it applies the correction coefficients computed from the calibration points stored for the sensor and displays the corrected temperature.

7.2 Sensor linearization

7.2.1 Standardized RTD sensor

7.2.1.1 Linearization curve

The linearization curve used if the one defined by the selected standard.

7.2.1.2 Definition

The sensor is defined by the referenced standard.

7.2.1.3 Programming

The user must select the standard corresponding to his sensor.

From the main menu:

MEAS DISP **SNSR** UTIL STUS STO MEM	1. Select SNSR prompt (sensors). If the database is empty, the unit reads: **"Database empty"**.
↑ ↓ MODIF CLR1 CAL **NEW** CFG	2. Create a sensor in the database by selecting the NEW prompt. See notes 1, 2.
STD CVD ITS90 POLY	3. Select a **standardized** RTD sensor. See note 3.
↑ ↓ **OK**	4. The unit displays the list of **standardized** RTDs Select the standard by means of prompts ↑ or ↓ and validate with OK prompt.
Name: Snsr1	5. Enter the sensor name. See paragraph 3.5.6. Validate it with the ENT key.
↑ ↓ MODIF CLR1 CAL NEW CFG	6. Return to step 2.

NOTES:

1. If the unit reads "database full", first clear one of the stored sensors by using prompt (CLR1) before creating a new one.

2. To change parameters of a stored sensor, select prompt (MODIF) instead of (NEW) prompt.

3. The list of the standardized RTD sensors is that indicated in paragraph 5.1.3.

7.2.2 RTD sensor according to Callendar and Van Dusen equations and defined with coefficients

7.2.2.1 Linearization curve

Callendar and Van Dusen equations are defined as follows:

$$\text{for } t \geq 0°C: R(t) = R_0 \cdot (1 + A \cdot t + B \cdot t^2)$$

$$\text{for } t < 0°C: R(t) = R_0 \cdot (1 + A \cdot t + B \cdot t^2 + C \cdot (t - 100) \cdot t^3)$$

$$\text{where } R_0 = \text{resistance value at } 0°C$$

To determine the linearization curve of a sensor such defined, the inverse functions of Callendar and Van Dusen equations are approximated by five polynomials of fourth degree, whose coefficients are determined by the method of the least squares.

To determine the corresponding temperature (t) when a resistance measurement (R) is available, we apply the appropriate polynomial: $t = P_j(R)$

7.2.2.2 Definition

The sensor is defined by the coefficients R_0, A, B and C.

7.2.2.3 Programming

The user must determine the coefficients R_0, A, B and C corresponding to his sensor.

From the main menu:

MEAS	DISP	**SNSR**		UTIL	STUS		STO	MEM	1. Select SNSR prompt (sensors). If the database is empty, the unit reads: **"Database empty"**.
↑	↓		MODIF	CLR1	CAL		**NEW**	CFG	2. Create a sensor in the database by selecting the NEW prompt. See notes 1, 2.
STD		**CVD**		ITS90		POLY			3. Select CVD prompt (Callendar and Van Dusen).

POINT	COEF	With coefficient:
R0= 0100.0000 B= -577.5000e-9 A= 3.908300e-3 C= -4.18300e-12		4. Edit the linearization equation coefficients See paragraph 3.5.5. Validate with the ENT key.
Name: Snsr2		5. Enter the sensor name. See paragraph 3.5.6. Validate it with the ENT key.
↑ ↓ MODIF CLR1 CAL NEW CFG		6. Return to step 2.

NOTES:

1. If the unit reads "database full", first clear one of the stored sensors by using prompt (CLR1) before creating a new one.

2. To change parameters of a stored sensor, select prompt (MODIF) instead of (NEW) prompt.

7.2.3 RTD sensor according to Callendar and Van Dusen equations and defined with points

7.2.3.1 Linearization curve

Callendar and Van Dusen equations are defined as follows:

$$\text{for } t \geq 0°C: R(t) = R_0 \cdot (1 + A \cdot t + B \cdot t^2)$$

$$\text{for } t < 0°C: R(t) = R_0 \cdot (1 + A \cdot t + B \cdot t^2 + C \cdot (t - 100) \cdot t^3)$$

$$\text{where } R_0 = \text{resistance value at } 0°C$$

Knowing, for four given temperatures, the sensor resistance values, one can compute the coefficients R_0, A, B and C from the previous equations. To determine the linearization curve of a sensor such defined, the inverse functions of Callendar and Van Dusen equations are approximated by five polynomials of fourth degree, whose coefficients are determined by the method of the least squares.

To determine the corresponding temperature (t) when a resistance measurement (R) is available, we apply the appropriate polynomial: $t = P_j(R)$.

7.2.3.2 Definition

The sensor is defined by the resistance values for four given temperatures. These temperatures must be well distributed according to the sensor operating range. One of the temperatures must be negative.

7.2.3.3 Programming

The user must determine points (r_0, t_0), (r_1, t_1), (r_2, t_2), (r_3, t_3)), where r_i is the sensor resistance at the temperature t_i, corresponding to his sensor.

From the main menu:

MEAS DISP **SNSR** UTIL STUS STO MEM	1. Select SNSR prompt (sensors). If the database is empty, the unit reads: **"Database empty"**.
↑ ↓ MODIF CLR1 CAL **NEW** CFG	2. Create a sensor in the database by selecting the NEW prompt. See notes 1, 2.
STD **CVD** ITS90 POLY	3. Select CVD prompt (Callendar and Van Dusen).
POINT COEF	**With point:**
t0 = -200.000°C r0 = 18.52000 Ω t1 = 0.000°C r1 = 100.0000 Ω t2 = 400.000°C r2 = 247.092 Ω t3 = 850.000°C r3 = 390.481 Ω	4. Display of the list of points: • Select and modify one of the points with the MODIF prompt. • Enter the point values. See paragraph 3.5.5. • Validate with the ENT key. • Validate the list of points with the OK prompt.
Name: Snsr3	5. Enter the sensor name. See paragraph 3.5.6. Validate it with the ENT key.
↑ ↓ MODIF CLR1 CAL NEW CFG	6. Return to step 2.

NOTES:

1. If the unit reads "database full", first clear one of the stored sensors by using prompt (CLR1) before creating a new one.

2. To change parameters of a stored sensor, select prompt (MODIF) instead of (NEW) prompt.

7.2.4 RTD sensors according to ITS90 equations

7.2.4.1 Linearization curve

We simply use the ITS90 computation method.

Put:

$R_{0.01}$ = resistance value at 0.01°C

$Wr = R/R_{0.01}$

T = temperature in Kelvin

The reference function is given by the relations:

$$\text{for } T \le 273.16\,K : Ln[Wr(T)] = A_0 + \sum_{i=1}^{12} A_i \cdot \left\{ \frac{[Ln(T/273.16) + 1.5]}{1.5} \right\}^i$$

$$\text{for } T \ge 273.15\,K : Wr(T) = C_0 + \sum_{i=1}^{9} C_i \cdot \left(\frac{T - 754.15}{481} \right)^i$$

The inverse reference function is approximated (better than 0.13 mK) by the relations:

$$\text{for } T \le 273.16\,K : T/273.16 = B_0 + \sum_{i=1}^{15} B_i \cdot \left(\frac{Wr^{1/6} - 0.65}{0.35} \right)^i$$

$$\text{for } T \ge 273.15\,K : T - 273.15 = D_0 + \sum_{i=1}^{9} D_i \cdot \left(\frac{Wr - 2.64}{1.64} \right)^i$$

with the coefficients defined by the ITS 90:

A		B		C		D	
0	-2.13534729	**0**	0.183324722	**0**	2.78157254	**0**	439.932854
1	3.18324720	**1**	0.240975303	**1**	1.64650916	**1**	472.418020
2	-1.80143597	**2**	0.209108771	**2**	-0.13714390	**2**	37.684494
3	0.71727204	**3**	0.190439972	**3**	-0.00649767	**3**	7.742018
4	0.50344027	**4**	0.142648498	**4**	-0.00234444	**4**	2.920828
5	-0.61899395	**5**	0.077993465	**5**	0.00511868	**5**	0.005184
6	-0.05332322	**6**	0.012475611	**6**	0.00187982	**6**	-0.963864
7	0.28021362	**7**	-0.032267127	**7**	-0.00204472	**7**	-0.188732
8	0.10715224	**8**	-0.075291522	**8**	-0.00046122	**8**	0.191203
9	0.29302865	**9**	-0.075470670	**9**	0.00045724	**9**	0.049025
10	0.04459872	**10**	0.076201285				
11	0.11868632	**11**	0.123893204				
12	-0.05248134	**12**	-0.029201193				
		13	-0.091173542				
		14	0.001317696				
		15	0.026025526				

When a resistance measurement (R) is available, we apply the appropriate inverse reference function to determine the corresponding temperature (t).

7.2.4.2 *Programming*

From the main menu:

MEAS DISP **SNSR** UTIL STUS STO MEM	1. Select SNSR prompt (sensors). If the database is empty, the unit reads **"Database empty"**.
↑ ↓ MODIF CLR1 CAL **NEW** CFG	3. Create a sensor in the database by selecting the NEW prompt. See notes 1, 2.
STD CVD **ITS90** POLY	4. Select ITS90 prompt.
Name: Snsr4	5. Enter the sensor name. See paragraph 3.5.6. Validate it with the ENT key.
↑ ↓ MODIF CLR1 CAL NEW CFG	6. Return to step 2.

NOTES:

1. If the unit reads "database full", first clear one of the stored sensors by using prompt (CLR1) before creating a new one.

2. To change parameters of a stored sensor, select prompt (MODIF) instead of (NEW) prompt.

7.2.5 RTD sensor according to polynomial equations and defined with points

7.2.5.1 Linearization curve

The linearization equations are polynomials whose degree, number, temperature range and coefficients depend on the sensor.

To determine the corresponding temperature (t) when a resistance measurement (R) is available, we apply the appropriate polynomial.

7.2.5.2 Definition

The sensor is defined by the polynomial number and degree, the application span of each polynomial together with the resistance values at given temperatures.

The number of polynomials is 5, the number of points is 25 and the polynomial degree is 10.

7.2.5.3 Programming

The user must determine the number and degree of the polynomials, their application spans and, at least, the points (r_0, t_0)... (r_{11}, t_{11}), (r_{12}, t_{12}), (r_{13}, t_{13})... where r_i is the sensor resistance at the temperature t_i, for each span.

From the main menu:

MEAS DISP **SNSR** UTIL STUS STO MEM	1. Select SNSR prompt (sensors). If the database is empty, the unit reads **"Database empty"**.
↑ ↓ MODIF CLR1 CAL **NEW** CFG	2. Create a sensor in the database by selecting the NEW prompt. See notes 1, 2.
STD CVD ITS90 **POLY**	3. Select POLY prompt (polynomial).
Number= **5** Degree= 4	4. Enter the number and degree of polynomials. See paragraph 3.5.5. Validate with the ENT key.

‣ 18.5200 Ω ≤ r ≤ 100.0000 Ω 100.0000 Ω ≤ r ≤ 247.0900 Ω 247.0900 Ω ≤ r ≤ 375.7000 Ω	5. The unit displays the list of application spans of each polynomial: Modify the span limits with the MODIF prompt.
MinR= **0100.000** MaxR= 247.0900	6. Enter the limit values. See paragraph 3.5.5. Validate with the ENT key.
‣ 18.5200 Ω ≤ r ≤ 100.0000 Ω 100.0000 Ω ≤ r ≤ 247.0900 Ω 247.0900 Ω ≤ r ≤ 375.7000 Ω	7. Select the span with the SEL prompt.
‣ t0 = -200.000 °C r0 = 18.52000 Ω t1 = -150.000 °C r1 = 39.7200 Ω t2 = -100.000 °C r2 = 60.2600 Ω t3 = -50.000 °C r3 = 80.3100 Ω t4 = 0.000 °C r4 = 100.0000 Ω	8. The unit displays the list of points: Select and modify one of the points with the MODIF prompt.
t= **-200.000** °C r= 18.52000 Ω	9. Enter the point values. See paragraph 3.5.5. Validate with the ENT key.
‣ t0 = -200.000 °C r0 = 18.52000 Ω t1 = -150.000 °C r1 = 39.7200 Ω t2 = -100.000 °C r2 = 60.2600 Ω t3 = -50.000 °C r3 = 80.3100 Ω t4 = 0.000 °C r4 = 100.0000 Ω	10. Validate the list of points with the ESC key.
‣ 18.5200 Ω ≤ r ≤ 100.0000 Ω 100.0000 Ω ≤ r ≤ 247.0900 Ω 247.0900 Ω ≤ r ≤ 375.7000 Ω	11. Validate the programming (spans and points) with the OK prompt.
Name: **Snsr6**	12. Enter the sensor name. See paragraph 3.5.6. Validate it with the ENT key.
↑ ↓ MODIF CLR1 CAL NEW CFG	13. Return to step 2.

NOTES:

1. If the unit reads "database full", first clear one of the stored sensors by using prompt (CLR1) before creating a new one.

2. To change parameters of a stored sensor, select prompt (MODIF) instead of (NEW) prompt.

Summary of the different linearization types

Sensor type		Sensor definition	Linearization computation
RTDs	**Standardized**	Standard.	Tables.
	Callendar and Van Dusen with coefficients	R_0, A, B, C.	Inverse functions of Callendar and Van Dusen equations.
	Callendar and Van Dusen with points	(r_0, t_0), (r_1, t_1), (r_2, t_2), (r_3, t_3).	Inverse functions of Callendar and Van Dusen equations.
	ITS 90		Inverse relations of reference functions.
	Polynomial	Number of polynomials: *(1 to 5)* Degree of polynomials: *(1 to 10)* Limits of polynomials: (R0, R1, R2, R3, R4) *(2 limits as a minimum)* (r_0, t_0),(r_1, t_1), (r_2, t_2), (r_3, t_3), (r_4, t_4), (r_5, t_5), (r_6, t_6), (r_7, t_7), (r_8, t_8), (r_9, t_9), (r_{10}, t_{10}), (r_{11}, t_{11}), (r_{12}, t_{12}), (r_{13}, t_{13}), (r_{14}, t_{14}) *(2 points as a minimum)*	Polynomial function per segment.

7.3 Calibrating sensors other than ITS 90 sensors

7.3.1 Definition

For all sensor types described above, the user may enter from 0 to 4 calibration points (0 to suppress the calibration).

From these calibration points, we compute a correction polynomial of degree 1 to 3 which is applied as follows:

- To determine the corresponding temperature (t) when a resistance measurement (M) is available, we compute the theoretical temperature (T_{th}) from the linearization function corresponding to the sensor. Then, we evaluate the sensor correction, c(M) = Δt, and at least, we compute t = T_{th} - Δt.

NOTE: For an RTD sensor, if only one calibration point is entered, the correction performed is called a slope correction (c(M) = α . M); in the other cases, the correction polynomial degree of correction is equal to the number of points minus one.

7.3.2 Programming

The user must define the number of calibration points, their values together with the calibration date.

From the main menu:

MEAS DISP **SNSR** UTIL STUS STO MEM	1. Select SNSR prompt (sensors). If the database is empty, the unit reads: **"Database empty"**.
↑ ↓ MODIF CLR1 **CAL** NEW CFG	2. Select CAL prompt (calibration).
Number= 2	3. Enter the number of calibration points. See paragraph 3.5.5. Validate it with the ENT key.
‣ t0 = 0.000 °C r0 = 0.0000 Ω t1 = 0.000 °C r1 = 0.0000 Ω	4. The unit displays the list of points. Select and modify one of the points with the MODIF prompt.
t= 0000.000 °C r= 0.0000 Ω	5. Enter the point values. See paragraph 3.5.5. Validate with the ENT key.
‣ t0 = 0.000 °C r0 = 0.0000 Ω t1 = 0.000 °C r1 = 0.0000 Ω	6. Validate the list of points with the OK prompt.
Date= 00.00	7. Enter the calibration date in the form YY.WW (Year, Week). See paragraph 3.5.5. Validate it with the ENT key.
↑ ↓ MODIF CLR1 CAL NEW CFG	8. Return to step 2.

7.4 Calibrating ITS 90 sensors

7.4.1 With coefficients

7.4.1.1 Definition

For an ITS 90 sensor, the deviation function $\varepsilon(W) = W - Wr$ is defined by:

$$\text{for } T \geq 0°C : \varepsilon(W) = W - Wr = a \cdot (W - 1) + b \cdot (W - 1)^2 + c \cdot (W - 1)^3 + d \cdot (W - W(660.23°C))^2$$

$$\text{for } T \leq 0.01°C : \varepsilon(W) = W - Wr = a \cdot (W - 1) + b \cdot (W - 1) \cdot Ln(W)$$

Depending on the considered temperature range, some coefficients of the previous relations may be zero:

Temperature range	Zero coefficients
from -189.3442 °C to 0.0100 °C	c = d = 0
from -38.8344 °C to 29.7646 °C	c = d = 0
from 0.0000 °C to 29.7646 °C	b = c = d = 0
from 0.0000 °C to 156.5985 °C	b = c = d = 0
from 0.0000 °C to 231.9280 °C	c = d = 0
from 0.0000 °C to 419.5270 °C	c = d = 0
from 0.0000 °C to 660.3230 °C	d = 0
from 0.0000 °C to 961.7800 °C	none

To determine the corresponding temperature (t) when a resistance measurement (R) is available, we compute $\varepsilon(W)$, then we infer $Wr = W - \varepsilon(W)$, and at least we use the relations of the inverse reference function to compute (t).

7.4.1.2 Programming

From the main menu:

MEAS	DISP	**SNSR**		UTIL	STUS		STO	MEM	1. Select SNSR prompt (sensors). If the database is empty, the unit reads: **"Database empty"**.
↑	↓		MODIF	CLR1	**CAL**		NEW	CFG	2. Select CAL prompt (calibration).

POINT COEF	With coefficient:
▸ -189.3442 °C ≤ t ≤ 0.0100 °C -38.8344 °C ≤ t ≤ 29.7646 °C 0.0000 °C ≤ t ≤ 29.7646 °C 0.0000 °C ≤ t ≤ 156.5985 °C 0.0000 °C ≤ t ≤ 231.9280 °C	3. The unit displays the list of spans: • Select a temperature span with the SEL prompt. • Enter the value of the resistance at 0.01°C (R0.01), as well as the coefficient values. See paragraph 3.5.5. • Validate with the ENT key.
Date= **00.00**	4. Enter the calibration date in the form YY.WW (Year, Week). See paragraph 3.5.5. Validate it with the ENT key.
↑ ↓ MODIF CLR1 CAL NEW CFG	5. Return to step 2.

7.4.2 With points

7.4.2.1 Definition

The sensor is determined by an operating span, its resistance value at 0.01°C, and its resistance values for given temperatures.
NOTE: These temperatures may be different from those of the ITS 90 fixed points.
To determine the measured temperature, we apply the same computation as explained in paragraph 7.4.1.

7.4.2.2 Programming

The user must determine the temperature span to be considered, the resistance value at 0.01°C ($R_{0.01}$) and points (r_0, t_0), (r_1, t_1), (r_2, t_2), (r_3, t_3), where r_i is the sensor resistance at the temperature $t_{i,}$, corresponding to his sensor.

From the main menu:

MEAS DISP **SNSR** UTIL STUS STO MEM	1. Select SNSR prompt (sensor). If the database is empty, the unit reads: **"Database empty"**.
↑ ↓ MODIF CLR1 **CAL** NEW CFG	2. Select CAL prompt (calibration).
POINT COEF	**With points:**
▸ -189.3442 °C ≤ t ≤ 0.0100 °C -38.8344 °C ≤ t ≤ 29.7646 °C 0.0000 °C ≤ t ≤ 29.7646 °C 0.0000 °C ≤ t ≤ 156.5985 °C 0.0000 °C ≤ t ≤ 231.9280 °C	3. The unit displays the list of spans: • Select a temperature span with the SEL prompt. • Enter the resistance value at 0.01°C (R0.01). See paragraph 3.5.5. • Validate it with the ENT key.
▸ t0 = -200.000°C r0 = 18.52000 Ω t1 = 0.000°C r1 = 100.0000 Ω t2 = 400.000°C r2 = 247.092 Ω t3 = 850.000°C r3 = 390.481 Ω	4. The unit displays the list of points: • Select and modify one of the points with the MODIF prompt. • Enter the point values. See paragraph 3.5.5. • Validate with the ENT key. • Validate the list of points with the OK prompt.
Date= 00.00	5. Enter the calibration date in the form YY.WW (Year, Week). See paragraph 3.5.5. Validate it with the ENT key.
↑ ↓ MODIF CLR1 CAL NEW CFG	6. Return to step 2.

7.5 Measurement configuration

7.5.1 Definition

A measurement configuration can be associated and stored with an RTD sensor.

The unit will automatically prompt this configuration when the sensor will be selected over one of the measurement channel.

7.5.2 Programming

The user must define the configuration used, the resistance range together with the measurement current.

From the main menu:

MEAS	DISP	**SNSR**		UTIL	STUS		STO	MEM	1. Select SNSR prompt (sensors).
↑	↓		MODIF	CLR1	CAL		NEW	**CFG**	2. Validate CFG prompt (configuration).
			MODE	RANG		RET			3. Select the measurement operating mode.
3W		**4W**	4W	4W					4. Prompt to be selected by the user, i.e.: • 3-wire. • 4-wire, direct current mode. • 4-wire, pulse current mode. • 4-wire, alternate current mode. Example: 4-wire, direct current mode.
			MODE	**RANG**		RET			5. Select RANG prompt (measurement current).
.125I	.250	0.50	1	2	4				6. Prompt to be chosen by the user. Example: 0.125 mA.
					800	**1600I**	3200		7. Select the resistance range compatible with the measurement current. Example: 1 600 Ω.
			MODE	CAL		**RET**			8. Select the RET prompt (return) which returns you to step 2.

Notes

8. OPERATION WITH THE IEEE-488 OR RS-232 INTERFACES

Notes

8.1 Overview

The PHP 602 can be remote controlled by an IEEE-488 controller, a computer or a terminal, either via the asynchronous serial interface included as standard equipment on all instruments (RS-232), or by an optional IEEE-488 bus, if installed.

The PHP 602's IEEE-488 interface has been implemented with the following functions:

AH1, SH1, T6, L4, SR1, RL1, PP0, DC1, DT0, C0, E2

The remote control mode and parameters must be set from the instrument's keypad (see below).

Most remote commands and parameters are the same for both modes, with the exception of the following differences:
- The IEEE-488 mode will only work when the PHP 602 is powered by mains.
- In RS-232 mode:
  - Remote command is possible during battery-powered operation.
  - The REM, LLO and LOC commands replace the corresponding messages of the IEEE-488 mode.
  - There is no service request facility (SRQ).
  - The IEEE-488 handshake is replaced by a protocol.

⚠ **All remote command syntax together with the list of the instrument's remote commands are placed in a file README.TXT that you will find on the diskette supplied with the instrument.**

8.2 Remote state (REM)

When the unit is set to "Remote state", only the keypad keys LOC and I/O are active. The instrument can then be driven via the remote command interface.
The message "Unit to remote " is displayed in the menu window.

To reactivate the keypad, the user must press the LOC key or send "LOC" command via the interface.

When the unit is set to "LLO" mode, only the keypad key I/O is active. The message "Unit to locked remote" is displayed in the menu window.
To reactivate the keypad, the user must send the "LOC" command via the interface.

8.3 "LOCal" key

Pressing the LOC key activates the keypad when the instrument operates with one of both interfaces.

8.4 Selecting the remote command interface

The user has to select the parameters of the RS-232 interface (transmission rate, parity, etc.) as well as the parameters of the IEEE-488 if installed. Then, he will have to validate one of the interfaces.

8.4.1 Parameters over the RS-232 serial link

From the main menu:

MEAS	DISP	SNSR		**UTIL**	STUS		STO	MEM	1. Select UTIL prompt (utility).
INTR	LANG	ADJ	CNTR	LIGH	ETRG	DATE	RST		2. Select INTR prompt (interface).
RS		IEEE							3. Select RS-232 prompt.
ON			**KBDS**	BITS	STOP	PAR	PROT		4. Select the transmission rate.
19.2	9.6	4.8	2.4	1.2	0.6	0.3			• Rate in Kbauds to be selected by the user. See note.
ON			KBDS	**BITS**	STOP	PAR	PROT		5. Select the word length.
		7		8					• Number of bits to be selected from the prompted values.
ON			KBDS	BITS	**STOP**	PAR	PROT		6. Select the number of stop bits.
		1		2					• Number of stop bits to be selected from the prompted values.
ON			KBDS	BITS	STOP	**PAR**	PROT		7. Select the parity.
		EVEN		ODD		NONE		IGNR	Parity to be selected from the prompted possibilities: • EVEN: Even parity. • ODD: Odd parity. • NONE: No parity. • IGNR: Ignore parity.
ON			KBDS	BITS	STOP	PAR	**PROT**		8. Select the RS-232 communication protocol. Prompt to be chosen by the user:
		XON		DTR		NONE			• XON: XON/XOFF protocol. • DTR: CTS/DTR protocol. • NONE: No protocol.
ON			KBDS	BITS	STOP	PAR	PROT		9. Validate the RS-232 communication.
MEAS	DISP	SNSR		UTIL	STUS		STO	MEM	10. Return to main menu.

NOTE: The order of programming has no matter.

8.4.2 Parameters over the IEEE-488 bus (option)

From the main menu:

MEAS	DISP	SNSR		UTIL	STUS		STO	MEM	1. Select UTIL prompt (utility).
INTR	LANG	ADJ	CNTR	LIGH	ETRG	DATE	RST		2. Select INTR prompt (interface).
RS		IEEE							3. Select IEEE-488 prompt.
ON		ADDR							4. Select the instrument address over the IEEE-488 bus.
		Address = XX Digital keys		<	>				5. Enter the address (from 0 to 30) and validate it with the ENT key.
ON		ADDR							6. Validate the IEEE-488 interface.
MEAS	DISP	SNSR		UTIL	STUS		STO	MEM	7. Return to main menu.

Notes

9. MAINTENANCE

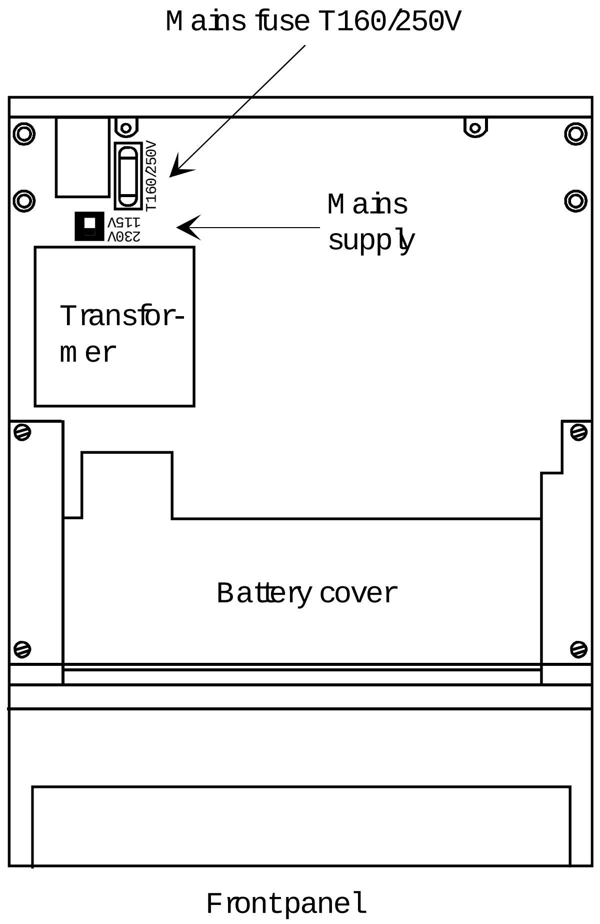
Notes

In view of the necessary precautions and the risks involved, any maintenance operations apart from those relating to battery and fuse changing should be left to **qualified personnel**. All maintenance operations, such as adjustment, are described in another manual called "Maintenance documents", see chapter 2, paragraph 2.5.2.

9.1 Opening/closing the unit

WARNING: When a maintenance procedure needs opening of the unit cover, remove all the connections from the external circuits as well as the mains cord if the unit is powered. Make sure that the unit is switched off.

- Untighten the four fixing screws from the upper cover.
- Remove the upper cover.
- If the unit is equipped with the optional IEEE-488 board, remove its four fixing screws, slide it towards the front and turn it over. The board remains attached to the instrument by the braid.
- The unit appears as shown below:



- To remantle the unit, perform the operations above in reverse way.

NOTE: For safety reasons, make sure that all the screws are well tightened.

9.2 Battery pack (option)

This paragraph concerns the units equipped with a tight lead battery. The battery does not required maintenance and checking charge state is only essential.

9.2.1 Usual operation

9.2.1.1 Battery discharge

During battery operation the icon advises the user to recharge the battery. In that state, the remaining life is approximately 10 minutes depending on usage. Above that time, the unit stops operating and it cannot be switched on again. **It is then necessary to recharge the battery**.

9.2.1.2 Recharging the battery

- Connect the unit to the power supply. The LED indicates that the battery is charging.
- Leave the battery on charge for 12 to 14 hours; **unit switched off** (blank display). The unit may remain in that state for a long period with no damage for the battery.

9.2.2 Storage

WARNING: To preserve battery life, never store the unit with a discharged battery.

If the unit is to be stored for a few days with a discharged battery, note that the unit may lose a part of its operating autonomy.
If the unit is to be stored for a few weeks with a discharged battery, note that the unit cannot be used longer.

If the unit is to be stored for a long period, note that the self discharging current of a lead battery changes with the temperature.
Before storage, a complete recharge is necessary, then, depending on the storage temperature, refer to table below.

	Recharge when storing the unit		
Storage temperature	- 15°C to + 25°C	+ 25°C to + 40°C	+ 40°C to + 50°C
Complete recharge	Every year	Every 6 months	Every month

For a storage temperature ranging about 25°C, it is advisable to recharge the unit for 12 h every 6 months. At 50°C, which is the limit storage temperature, the unit may remain on charge permanently (blank display).

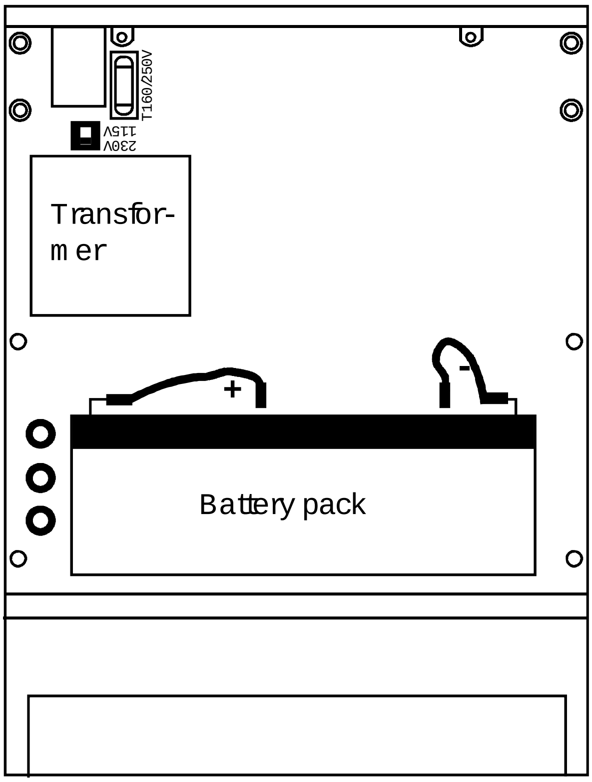
9.2.3 Replacing the battery pack

In case of battery abnormal operation or if the life is highly reduced regarding that indicated in the technical specifications, the user may replace the battery with an identical part (tight lead battery pack, 12 V, 1.8 to 2.0 Ah), AOIP part number: ER 41206-003.

To replace the battery, operate as follows:

- **Switch the unit off.**
- **Disconnect the mains cord as well as all the electrical links.**
- Dismantle the unit as explained in paragraph 9.1.
- Remove the four fixing screws from the battery cover.
- Remove the battery cover together with the wedge retaining the battery.

The battery is as follows:



Frontpanel

- Remove the battery and disconnect the lugs.
- Place a new battery and reconnect the lugs. **WARNING**: Follow the polarities indicated on the board.
- Replace the wedge as well as the cover and tighten the whole set using the four fixing screws.
- Remantle the unit as indicated in paragraph 9.1.
- Then, charge the battery fully as explained in paragraph 9.2.1.2.

9.2.4 Used battery pack

The user must follow the whole set of legislative, regulation and administrative texts relating to safety and protection of the human health and environment.

9.3 Mains fuse

If the $\tilde{\bigcirc}$ LED does not light up when the unit is connected to the mains, replace the fuse. Replacing the fuse needs opening of the upper cover and **call all the precautions linked to this operation**.

To change the mains fuse, operate as follows:

- **Switch the unit off.**
- **Disconnect the mains cord as well as all the electrical links.**
- Dismantle the cover as explained in paragraph 9.1.
- If the unit is equipped with the optional IEEE-488 board, remove the two lateral screws and pull it towards the front.
- Remove the protection cover of the fuse. For that, insert blade of a small screwdriver between the fuse and support and press gently upwards to remove it.
- Check that the fuse has blown and identify the reason.
- Replace the fuse with same type, time-lag 5 x 20 mm, 160 mA, 250 V~, AOIP part number: ER 48124-161.
- Replace the protection cover of the fuse.
- Replace the optional IEEE-488 board if required.
- Close the cover as indicated in paragraph 9.1.

9.4 Changing the power supply

The unit may be powered from the 115 V or 230 V mains. Changing the power supply needs opening of the upper cover and **call all the precautions linked to this operation**.

To change the power supply, operate as follows:
- **Switch the unit off.**
- **Disconnect the mains cord as well as all the electrical links.**
- Dismantle the cover as explained in paragraph 9.1.
- Set the mains voltage selector to the desired position as indicated on the figure in paragraph 9.1.
- Remantle the upper cover as explained in paragraph 9.1.
- Below the mains plug, set a label indicating the new voltage value.

9.5 Checking of performances

The user may require cyclic checking of the performances in order to keep track of the quality.

This operation implies as follows:
- The handling should be performed according to the reference conditions, i.e.:
  - Room temperature: 23°C ± 1°C.
  - Relative humidity: 45 % à 75 %.

- Known accuracy for the instruments used for checking below or equal to ± 0.0010 %.

The unit should only be adjusted if one or more characteristics are really outside the tolerances specified in chapter 10. The user may:
- Adjust the unit according to the procedure described in the maintenance manual (AOIP part number: NTM47084-100A)
- Adjust the unit according to the procedure explained in paragraph 9.6. This implies equipment with performances equal to the one used for verification above.
- Return the unit to the address indicated in paragraph 9.7 for checking and adjustment in our works.

9.6 Adjusting the unit

9.6.1 Principle

An adjustment is made to compute and store the correction coefficients enabling to compare the measured values to those of the standards used.

Each of the measurement channels A and B has their own coefficients and can be adjusted independently.

A complete adjustment program is composed of two steps:

1. **The primary step** for adjusting the internal reference resistance when measuring RTDs.

2. **The secondary step** for adjusting all the ranges.

For a keypad readjustment, only the primary phase may be performed as it only needs a minimum of material (see paragraph 9.6.2) and is quite sufficient in most cases as it cancels 90 % of the drift for each range.

If this primary readjustment is not sufficient, it is advisable to return the unit to AOIP for a complete adjustment. This adjustment is described in the maintenance manual, AOIP part number: NTM47084-100A.

9.6.2 Material required

The handling should be performed in accordance with the reference conditions, i.e.:
- Room temperature: 23°C ± 1°C.
- Relative humidity: 45 % à 75 %.

Adjusting the internal reference resistance needs the use of a 100 Ω standard resistor with an uncertainty below or equal to à 1.10^{-5} (temperature coefficient ≤ 1 ppm/°C).

WARNING: If this equipment is not at the user's disposal, we suggest him not to readjust the unit and to send the unit back to us for a complete readjustment procedure.

9.6.3 Preparation

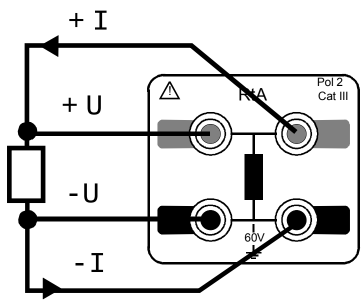
- Power on the unit to be adjusted and the material required 24 h in advance in the room at 23°C ± 1°C.

9.6.4 Adjusting the reference resistances (channel A, channel B)

9.6.4.1 Connecting channel A

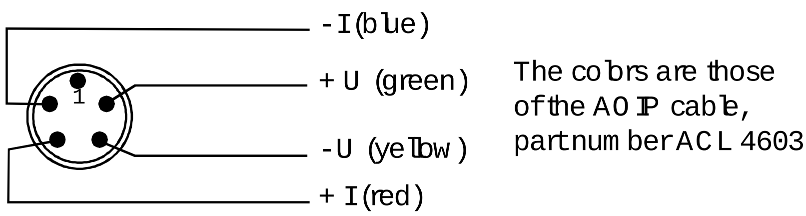
There are two alternatives:

1. Either by using copper wires tightened under the 4-mm terminals, or banana plugs inserted in the terminals as explained in diagram below (beware of spurious thermocouples with copper plugs).



4 wire configuration

2. Or by using cylindrical connector wired as indicated below.



Socket, front view

9.6.4.2 *Connecting channel B*

Performed only by using the cylindrical connector wired in the same way as channel A explained above.

9.6.4.3 *Procedure for adjusting the reference resistances*

The adjustment is carried out in a single point, close to 100 Ω, and over each channel.

From the main menu:

MEAS DISP SNSR **UTIL** STUS STO MEM	1. Select UTIL prompt (utility).
INTR LANG **ADJ** CNTR LIGH ETRG DATE RST	2. Select ADJ prompt (adjustment).
Code= 00000 Digital keys < >	3. Enter the access code: **9456**, using the keypad. Validate it with the ENT key.
RtA RtB DATE	4. Select RtA prompt (adjusting channel A).
C2= 100.00000 Ω Digital keys < >	5. Enter the value that the unit is going to measure over its measurement input (high value) and validate it with the ENT key.
The unit reads: **Press ENT…**	6. When the resistor is connected to the RtA input, press the ENT key.
The unit reads: **Wait…**	7. Wait until the unit has completed its series of measurements.
RtA RtB DATE	8. From this moment, if there is no error message displayed, the adjustment of channel A has been successfully completed.
RtA **RtB** DATE	9. Return to step 4. Select RtB prompt in order to adjust channel B.

From this moment, it is possible to enter the adjustment date, for that refer to paragraph 9.6.5.

9.6.5 Programming the date of the last adjustment

From the main menu or directly from the previous steps:

MEAS DISP SNSR UTIL STUS STO MEM	1. Select UTIL prompt (utility).
INTR LANG ADJ CNTR LIGH ETRG DATE RST	2. Select ADJ prompt (adjustment).
Code= 00000 Digital keys < >	3. Enter the access code: **9456**, using the keypad Validate it with the ENT key.
RtA RtB DATE	4. Select DATE prompt (adjustment date).
Date= 00.00 Digital keys < >	5. Enter the adjustment date in the form YY.WW (Year, Week). Validate it with the ENT key.
RtA RtB DATE	

Then, press the MNU key for returning to the main menu.

9.7 Customer Service

AOIP can be contacted either by writing to:

AOIP
ZAE de SAINT GUENAULT
6, rue Maryse Bastié
BP 182 – Courcouronnes
91006 EVRY CEDEX – FRANCE

or by telephoning or faxing to the following numbers:

Telephone Measurement Service: +33 1 69 36 50 68
Fax: +33 1 69 36 50 82

or by e-mail to: sav@aoip.com

Our Web site is as follows: http://www.aoip.fr

9.8 AOIP agencies

U.K
AOIP – 10 Lanesfield Drive
Spring Road Industrial Estate
Ettingshall, Wolverhampton
West Midlands WV4 6UA
Phone: 01 902 494495
Fax: 01 902 494607
e-mail: sales@aoip.co.uk

Germany
AOIP Verbindungsbüro Deutschland
Lebacher Straβe 4
D 66113 Saarbrücken
Phone: 06 81/99 63 306
Fax: 06 81/99 63 409
e-mail: vertrieb@aoip.com

AOIP is present in over 60 continents. Call our Export department for our distributor's addresses:
Phone: +33 1 69 36 50 60
Fax: +33 1 60 77 82 97
e-mail: export@aoip.com

9.9 Warranty

The PHP 602 is fully warranted for one year in respect of defects which under proper use may appear in any parts and which are due to faulty manufacturing materials or workmanship provided that no unauthorized modifications have been made on the unit.

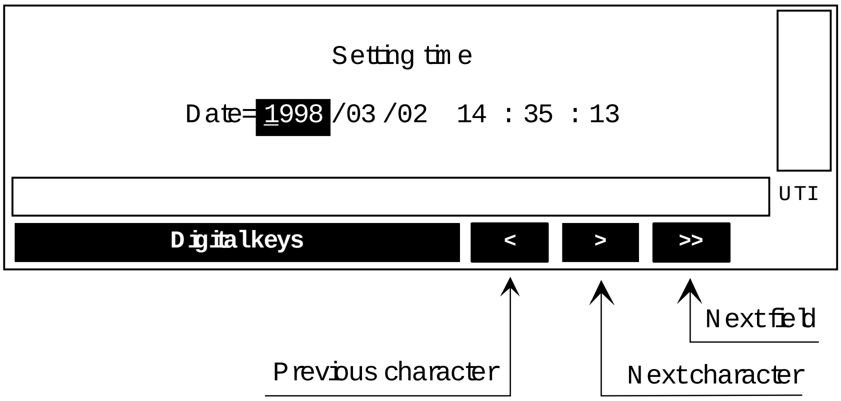
It the unit is not operating correctly, it must be returned to the address above or to your local approved agency by using the original packaging and explaining as clearly as possible the reasons for returning it.

9.10 Adjusting date and time

From the main menu:

MEAS	DISP	SNSR		UTIL	STUS		STO	MEM	1. Select UTIL prompt (utility).
INTR	LANG	ADJ	CNTR	LIGH	ETRG	DATE	RST		2. Select DATE prompt.

The unit reads for example:



Enter the date and time using the <, > and >> prompts, then press the ENT key to validate the information.

9.11 Resetting to zero

From the main menu:

MEAS DISP SNSR UTIL STUS STO MEM	1. Select UTIL prompt (utility).
INTR LANG ADJ CNTR LIGH ETRG DATE RST	2. Select the RST prompt (resetting to zero).
YES NO	3. Prompt to be selected by the user. If yes: • All the channels are set to OFF. • Display unit: °C. • RTD function: Pt 100, 4 wires pulse mode, 100 Ω range, 1 mA. • All the values are reinitialized. • All the processing procedures are set to OFF. • Interface default values: - RS-232: 9 600 bauds, 8 bits, 1 stop bit, no parity, no protocol. - IEEE-488: address 12. See note.

NOTE: Are kept in memory:

- The measurement memories.
- The sensors database.

10. APPENDIX

Notes

10.1 Applicable standards

10.1.1 Safety class

In accordance with European Norm EN 61010-1.
Category III, pollution 2.
Rated voltage: 60 V.
The unit should not be used at altitude above 2 500 m.
Note 1: Safety provisions for the unit are given in chapter 1.

10.1.2 EMC conformity

The performances of the unit meet the following standards:
Conducted and radiated disturbances: EN 55022/1994, class B.
Immunity:
 Radiated: IEC 61000-4-3. Conducted: IEC 61000-4-4.
 Electrostatic discharges: IEC 61000-4-2.
 Conducted RF disturbances: IEC 61000-4-6.

10.1.3 Ambient conditions

In accordance with IEC Publication 359: Operating category I.
Reference range: 23°C ± 1°C, relative humidity: 45 % to 75 %.
Normal operating range: 0°C to + 50°C, relative humidity: 20 % to 75 % non-condensing.
Operating range limits: - 10°C to + 55°C, relative humidity: 10 % to 80 % non-condensing.
Storage and transport range: - 30°C to + 60°C (- 15°C to + 50°C with battery charged).

10.1.4 Mechanical conditions

Protection according to IEC Publication 529: IP 40.
Vibrations: according to IEC Publication 68-2-6.
Shocks: according to European Norm EN 61010-1.

10.1.5 Measurements at reference conditions

According to IEC Publication 485.

10.1.6 RTDs

Pt 100 Ω, 200 Ω, 500 Ω, 1000 Ω (α = 3851) according to IEC Publication 751/1995.
JPt 100 Ω (α = 3916) according to Publication JIS C 1604/1989.
Pt 100 Ω ITS90 sensors (α = 3926).
Ni 100 Ω (α = 618) according to Publication DIN 43760.
Ni 120 Ω (α = 672) according to Publication MIL-T-24388C.
Cu 10 Ω (α = 427) according to Publication MINGO 16/9.

- International Temperature Scale ITS 90.
- For linearizations non-conforming to this scale, the correction ITS 90 – IPTS 68/1993 is applied.

10.1.7 IEEE-488 bus

In accordance with IEC Publications 625-1 and 625-2 (American standards IEEE-488.1 and 488.2).

10.1.8 RS-232 transmission

In accordance with standard ANSI EIA/TIA-232-E-1991.

10.2 Particular specifications

10.2.1 General

- Stated accuracies applied to a unit situated in the reference conditions defined elsewhere in the manual after warming-up for one hour.
- Input protection: ± 15 V, ± 100 mA max.

10.2.2 Resistance measurements

			Measurement current Ic peak ①					
Range	**Resolution**	**Span**	**0.125 mA**	**0.25 mA**	**0.5 mA**	**1.0 mA**	**2.0 mA**	**4.0 mA**
25 Ω	0.00001 Ω	29.37500 Ω						✓
50 Ω	0.00001 Ω	58.75000 Ω					✓	✓
100 Ω	0.00002 Ω	117.50000 Ω				✓	✓	✓
200 Ω	0.00005 Ω	235.00000 Ω			✓	✓	✓	
400 Ω	0.0001 Ω	470.0000 Ω		✓	✓	✓		
800 Ω	0.0002 Ω	940.0000 Ω	✓	✓	✓			
1 600 Ω	0.0005 Ω	1 880.0000 Ω	✓	✓				
3 200 Ω	0.001 Ω	3 760.000 Ω	✓					

① RMS measurement current:
- Pulse mode $I_{RMS} = Ic/\sqrt{2}$.
- Direct mode I_{RMS} = Ic.
- Alternate mode I_{RMS} = Ic.

All ranges	Stability over 24 h	Accuracy ① 90 days	1 year
25 Ω to 3 200 Ω	0.0005 % Ran	0.0030 % rdg + 0.0005 % Ran	0.0045 % rdg + 0.0005 % Ran

rdg = Reading. Ran = Range used.
Temperature coefficient: ≤ 10 % of accuracy over 90 days/°C.
① In direct current mode and for a cycle reinitialized since 24 hours as a maximum. With the 3-wire configuration, add 1 mΩ.

10.2.3 Temperature measurements with RTDs

Measurement range and resolution automatically adapt to the sensor, measurement current and range selected.

Examples given are for standardized sensors (4-wire configuration):

Pt 100 Ω at 0 °C (α = 3851)					
Measurement range	**Range**	**Resolution**	**Stability over 24 h**	**Accuracy 90 days**	**1 year**
- 210°C to + 45°C	100 Ω	0.0001°C	0.002°C	0.003 % rdg + 0.009°C	0.004 % rdg + 0.013°C
- 210°C to + 365°C	200 Ω	0.0002°C	0.004°C	0.003 % rdg + 0.010°C	0.004 % rdg + 0.014°C
- 210°C to + 1 100°C	400 Ω	0.0005°C	0.010°C	0.003 % rdg + 0.012°C	0.004 % rdg + 0.016°C

JPt 100 Ω at 0 °C (α = 3916)					
Measurement range	**Range**	**Resolution**	**Stability over 24 h**	**Accuracy**	
				90 days	**1 year**
- 200°C to + 44°C	100 Ω	0.0001°C	0.002°C	0.003 % rdg + 0.009°C	0.004 % rdg + 0.013°C
- 200°C to + 358°C	200 Ω	0.0002°C	0.004°C	0.003 % rdg + 0.010°C	0.004 % rdg + 0.014°C
- 200°C to + 510°C	400 Ω	0.0005°C	0.010°C	0.003 % rdg + 0.012°C	0.004 % rdg + 0.016°C

Pt 100 Ω at 0 °C (α = 3926)					
Measurement range	**Range**	**Resolution**	**Stability over 24 h**	**Accuracy**	
				90 days	**1 year**
- 210°C to + 44°C	100 Ω	0.0001°C	0.002°C	0.003 % rdg + 0.009°C	0.004 % rdg + 0.013°C
- 210°C to + 357°C	200Ω	0.0002°C	0.004°C	0.003 % rdg + 0.010°C	0.004 % rdg + 0.014°C
- 210°C to + 850°C	400 Ω	0.0005°C	0.010°C	0.003 % rdg + 0.012°C	0.004 % rdg + 0.016°C

Pt 200 Ω at 0 °C (α = 3851)					
Measurement range	**Range**	**Resolution**	**Stability over 24 h**	**Accuracy**	
				90 days	**1 year**
- 210°C to + 45°C	200 Ω	0.0001°C	0.002°C	0.003 % rdg + 0.009°C	0.004 % rdg + 0.013°C
- 210°C to + 365°C	400 Ω	0.0002°C	0.004°C	0.003 % rdg + 0.010°C	0.004 % rdg + 0.014°C
- 210°C to + 1 100°C	800 Ω	0.0005°C	0.010°C	0.003 % rdg + 0.012°C	0.004 % rdg + 0.016°C

Pt 500 Ω at 0 °C (α = 3851)					
Measurement range	**Range**	**Resolution**	**Stability over 24 h**	**Accuracy**	
				90 days	**1 year**
- 210°C to + 233°C	800 Ω	0.0001°C	0.002°C	0.003 % rdg + 0.009°C	0.004 % rdg + 0.013°C
- 210°C to + 800°C	1600 Ω	0.0002°C	0.004°C	0.003 % rdg + 0.010°C	0.004 % rdg + 0.014°C
- 210°C to + 1 200°C	3 200 Ω	0.001°C	0.010°C	0.003 % rdg + 0.012°C	0.004 % rdg + 0.016°C

Pt 1000 Ω at 0 °C (α = 3851)					
Measurement range	**Range**	**Resolution**	**Stability over 24 h**	**Accuracy**	
				90 days	**1 year**
- 210°C to + 230°C	1 600 Ω	0.0002°C	0.002°C	0.003 % rdg + 0.009°C	0.004 % rdg + 0.013°C
- 210°C to + 800°C	3 200 Ω	0.0005°C	0.004°C	0.003 % rdg + 0.010°C	0.004 % rdg + 0.014°C

Ni 100 Ω at 0 °C (α = 618)					
Measurement range	**Range**	**Resolution**	**Stability over 24 h**	**Accuracy**	
				90 days	**1 year**
- 60°C to + 30°C	100 Ω	0.0001°C	0.002°C	0.007°C	0.010°C
- 60°C to + 180°C	200 Ω	0.0001°C	0.002°C	0.009°C	0.013°C

Ni 120 Ω at 0 °C (α = 672)					
Measurement range	**Range**	**Resolution**	**Stability over 24 h**	**Accuracy**	
				90 days	**1 year**
- 40°C to + 136°C	200 Ω	0.0001°C	0.002°C	0.008°C	0.012°C
- 40°C to + 205°C	400 Ω	0.0002°C	0.004°C	0.010°C	0.014°C

Cu 10 Ω at 25 °C (α = 427)					
Measurement range	**Range**	**Resolution**	**Stability over 24 h**	**Accuracy**	
				90 days	**1 year**
- 200°C to + 260°C	25 Ω	0.0002°C	0.004°C	0.003 % rdg + 0.010°C	0.0045 % rdg + 0.013°C

Temperature coefficient: ≤ 10 % of accuracy over 90 days/°C.

10.3 Other specifications

10.3.1 RS-232 link

The PHP 602 is equipped with an RS-232 output via a female SUB-D connector, 9 pins. A keypad key enables the user to take control of the unit in local.

Link specifications:

- Transmission rate: 300, 600, 1 200, 2 400, 4 800, 9 600 and 19 200 bauds.
- Character format: 7 or 8 bits with 1 or 2 stop bits.
- Parity: even, odd, ignore or no parity.
- Receiver management protocol: XON/OFF, DTR/CTS or no protocol.

These parameters are programmed from the unit keypad and stored in permanent memory.

10.3.2 IEEE-488 link (Option)

Connection to the bus is performed via a standardized connector, 24 pins.
The unit address is entered using the keypad and stored in permanent memory (31 addresses available).
A keypad key enables the user to take control of the unit in local.
Circuits of the IEEE network are set to the same potential as the RS-232 and trigger command.

Functions managed by the unit are as follows:

AH1, SH1, T6, L4, SR1, RL1, PP0, DC1, DT0, C0, E2

10.3.3 Power requirements

- Mains supply: 115 V or 230 V ± 10 %, 50 to 400 Hz, 20 VA max.
- Option : Tight lead battery pack, 12 V.
  Life: approx. 5 hours.
  Supply is automatically cut down at the end of discharge.
  Recharge time: 12 to 14 hours.

10.3.4 Measurement period

Table indicating the measurement refreshment stage (in number of stages) depending on the configuration of channels A and B

1 Stage = 700 ms 1 preliminary Stage = 700 ms (only performed when the channel is set in use <ON>)

CHA \ CHB	OFF	Rt, 3 wire	Rt, 4 wire, direct current mode	Rt, 4 wire, pulse current mode	Rt, 4 wire, alternate current mode
OFF	0 Stage	2 Stages + 1 preliminary Stage	1 Stage + 2 preliminary Stages	2 Stages + 1 preliminary Stage	2 Stages + 1 preliminary Stage
Rt, 3 wire	2 Stages + 1 preliminary Stage	4 Stages + 1 preliminary Stage	4 Stages + 2 preliiminary Stages	4 Stages + 1 preliminary Stage	4 Stages + 1 preliminary Stage
Rt, 4 wire, direct current mode	1 Stage + 2 preliminary Stages	4 Stages + 2 preliminary Stages	4 Stages + 3 preliminary Stages	4 Stages + 2 preliminary Stages	4 Stages + 2 preliminary Stages
Rt, 4 wire, pulse current mode	2 Stages + 1 preliminary Stage	4 Stages + 1 preliminary Stage	4 Stages + 2 preliminary Stages	4 Stages + 1 preliminary Stage	4 Stages + 1 preliminary Stage
Rt, 4 wires, alternate current mode	2 Stages + 1 preliminary Stage	4 Stages + 1 preliminary Stage	4 Stages + 2 preliminary Stages	4 Stages + 1 preliminary Stage	4 Stages + 1 preliminary Stage

10.4 RTD measurement principle

The unit offers four measurement types to correct the different errors due to that type of measurement:

- 3 wire configuration, pulse current mode,
- 4 wire configuration, direct current mode,
- 4 wire configuration, pulse current mode,
- 4 wire configuration, alternate current mode.

The main errors are as follows:

- resistances of the connection wires,
- offset voltage of the measurement configuration.

10.4.1 Three-wire measurement, pulse current mode

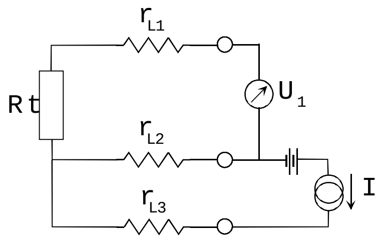
(It enables to be free from resistances of the connection wires only if those ones are well balanced).

The measurement is carried out in two stages:

- **Stage 1**

(measuring resistance of one of the connection wires).

We measure: $U_1 = r_{L2} \cdot I + \mathrm{Offset}$.



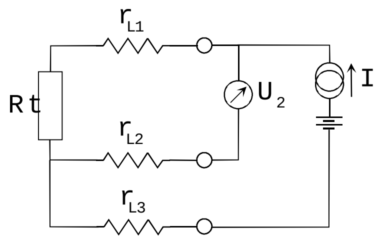
r_{L1}, r_{L2}, and r_{L3} : Resistances of the connection wires.
Rt : Resistor to be measured.
I : Measurement current.
U_1 : Measured voltage.
Offset : Offset voltage of the measurement configuration.

- **Stage 2**

We measure:
$U_2 = (Rt + r_{L1}) \cdot I + \mathrm{Offset}$

Then, we display: $R = \dfrac{U_2 - U_1}{I}$.

If the connection wires are well balanced ($r_{L1} = r_{L2}$) we have $R = Rt$.



r_{L1}, r_{L2}, and r_{L3} : Resistances of the connection wires.
Rt : Resistor to be measured.
I : Measurement current.
U_2 : Measured voltage.
Offset : Offset voltage of the measurement configuration.

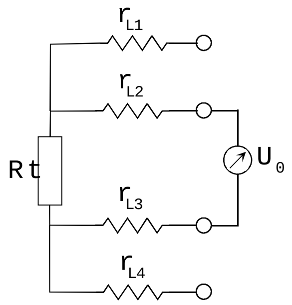
10.4.2 Four-wire measurement, direct current mode

(It enables to be free from the offset voltages inside a stable temperature environment and over a reduced time period).

The measurement is carried out in one stage, with, each time the measurement is set in use, a preliminary stage which is executed only one time.

- **Preliminary stage**

Zero current measurement for evaluation of the offset errors from the measurement circuit.
We measure: $U_0 = \mathrm{Offse}$.



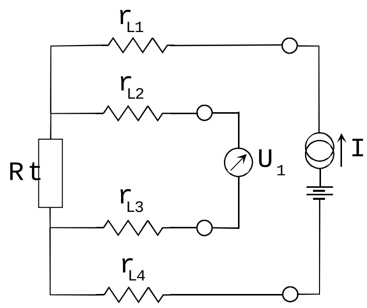
r_{L1}, r_{L2}, r_{L3} and r_{L4} : Resistances of the connection wires.
Rt: Resistor to be measured.
I: Measurement current.
U_0 : Measured voltage.
Offset: Offset voltage of the measurement configuration.

- **Stage 1**

We measure: $U_1 = Rt \cdot I + \mathrm{Offse}$.

Then, we display: $R = \dfrac{U_1 - U_0}{I}$.

If the offset remains constant, we have $R = Rt$.



r_{L1}, r_{L2}, r_{L3} and r_{L4} : Resistances of the connection wires.
Rt: Resistor to be measured.
I: Measurement current.
U_1 : Measured voltage.
Offset: Offset voltage of the measurement configuration.

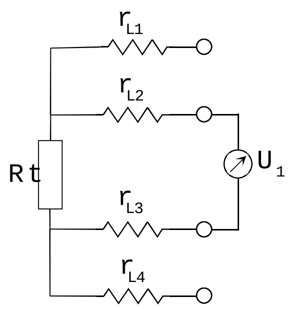
10.4.3 Four-wire measurement, pulse current mode

The measurement is carried out in two stages:

- **Stage 1**

Zero current measurement for evaluation of the offset voltages of the unit (contrary to previous case, this stage is performed at each measurement).

We measure: $U_1 = \mathrm{Offse}$.



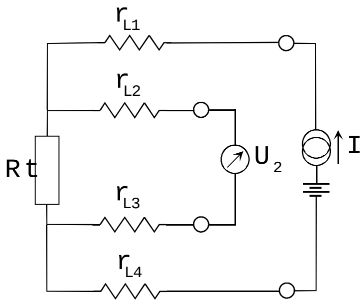
r_{L1}, r_{L2}, r_{L3} and r_{L4} : Resistances of the connection wires.
Rt: Resistor to be measured.
I: Measurement current.
U_1 : Measured voltage.
Offset: Offset voltage of the measurement configuration.

- **Stage 2**

We measure: $U_2 = Rt \cdot I + Offset$.

Then, we display: $R = \dfrac{U_2 - U_1}{I}$.

We really have $R = Rt$.



r_{L1}, r_{L2}, r_{L3} and r_{L4} : Resistances of the connection wires.
Rt: Resistor to be measured.
I: Measurement current.
U_2 : Measured voltage.
Offset: Offset voltage of the measurement configuration.

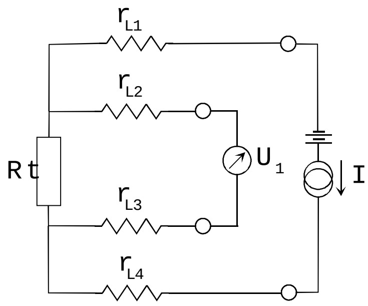
10.4.4 Four-wire measurement, alternate current mode

The measurement is carried out in two stages (the current is inverted between the two stages).

- **Stage 1**

Negative current measurement.

We measure: $U_1 = -(Rt \cdot I) + Offset$.



r_{L1}, r_{L2}, r_{L3} and r_{L4} : Resistances of the connection wires.
Rt: Resistor to be measured.
I: Measurement current.
U_1 : Measured voltage.
Offset: Offset voltage of the measurement configuration.

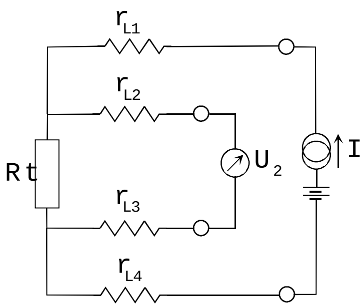
- **Stage 2**

Positive current measurement.

We measure: $U_2 = Rt \cdot I + Offset$.

Then, we display: $R = \dfrac{U_2 - U_1}{2 \cdot I}$.

We really have $R = Rt$.



r_{L1}, r_{L2}, r_{L3} and r_{L4} : Resistances of the connection wires.
Rt: Resistor to be measured.
I: Measurement current.
U_2 : Measured voltage.
Offset: Offset voltage of the measurement configuration.

10.4.5 Self-heating correction

Current flowing through the RTD heats the sensor by the Joule effect (RI^2) and changes its temperature. This self-heating being proportional to the power dissipated in the resistor, we can correct the error as follows :

- First, we apply a current i.
- We measure $t_i = t + \alpha i^2$ (where t is the sensor temperature without self-heating).
- Then, we apply a current $i/\sqrt{2}$.
- We measure: $t_{i/\sqrt{2}} = t + \alpha \left(\frac{i}{\sqrt{2}} \right)^2$.
- The difference between both measurements enables us to compute the error due to the self-heating: $\varepsilon t = 2(t_i - t_{i/\sqrt{2}})$.
- The real temperature of the sensor can then be inferred: $t = t_i - \varepsilon t$.

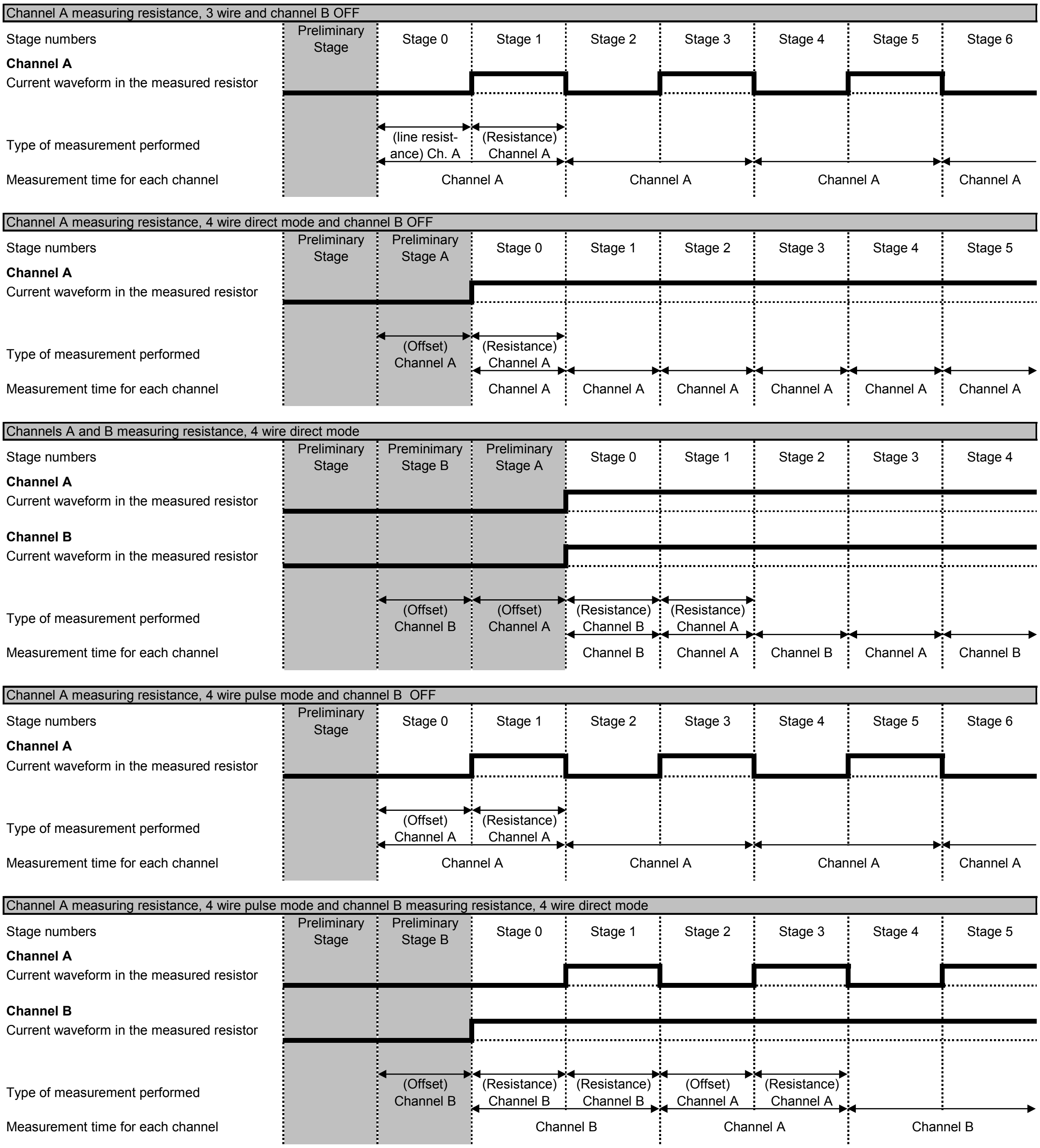
NOTES:

1. Coefficient α depends on the environment in which the sensor is plunged. The error computed previously is valid only for a given experiment.

2. The error depends on the initial measurement current i. If the current is changed, it should be recomputed.

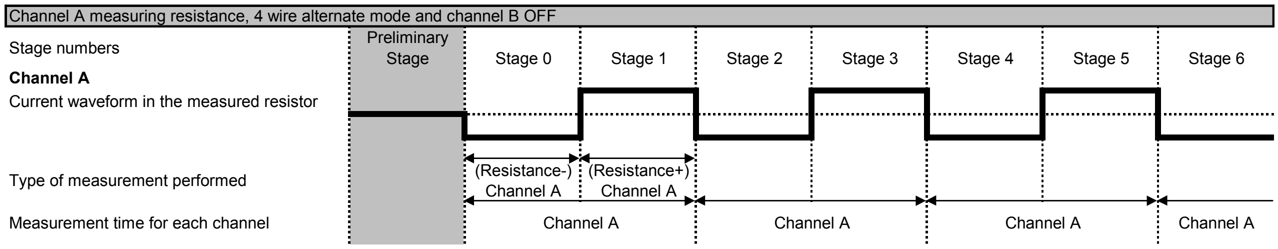
3. The pulse current mode, which divides by two the power dissipated in the sensor, should be chosen to reduce the error due to the self-heating.

Examples showing resistance measurements depending on the measurement configuration of channels A and B

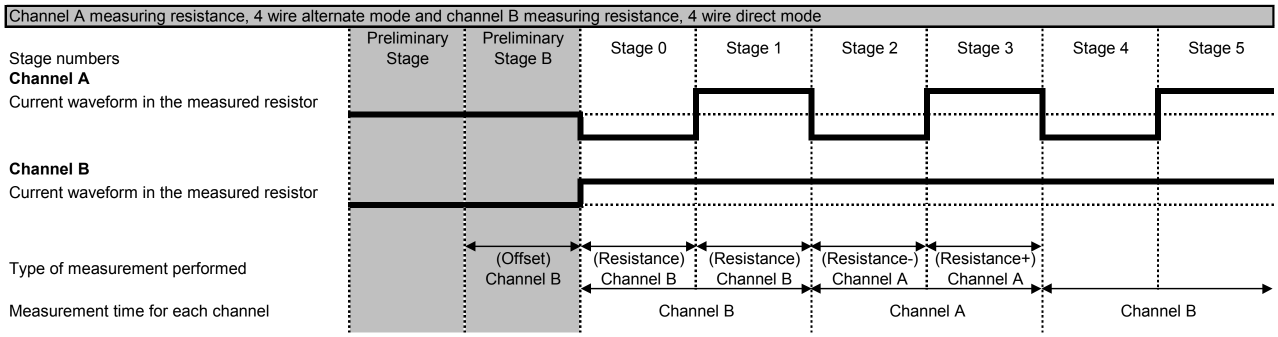


Examples showing resistance measurements depending on the measurement configuration of channels A and B (Cont'd)

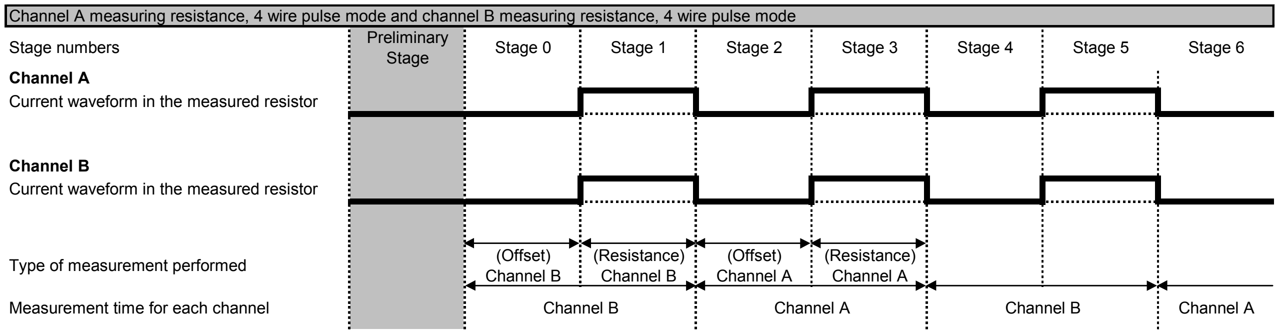
Channel A measuring resistance, 4 wire alternate mode and channel B OFF



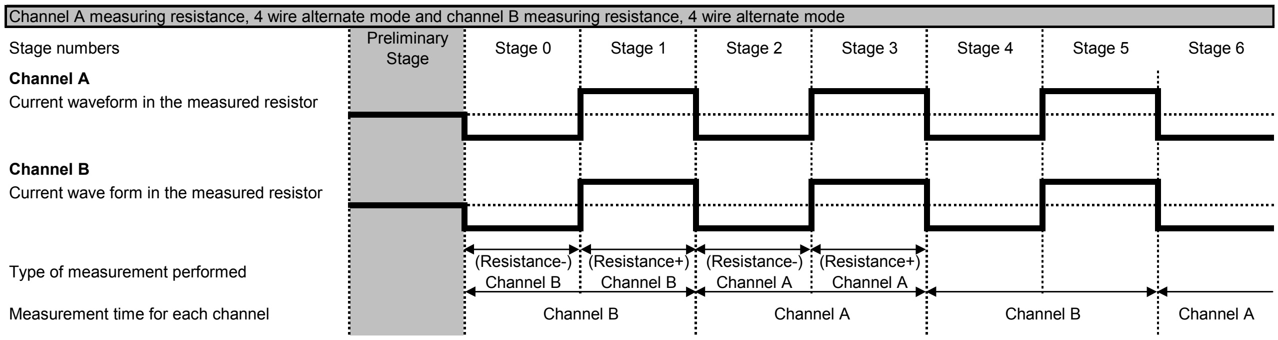
Channel A measuring resistance, 4 wire alternate mode and channel B measuring resistance, 4 wire direct mode



Channel A measuring resistance, 4 wire pulse mode and channel B measuring resistance, 4 wire pulse mode



Channel A measuring resistance, 4 wire alternate mode and channel B measuring resistance, 4 wire alternate mode



Déclaration de conformité

suivant le guide 22 ISO/CEI et la norme EN 45014

Declaration of conformity

according to ISO/IEC guide 22 and EN 45014

Nom du fabricant :
Manufacturer's name :

Adresse du fabricant : Z.I. de Saint-Guénault - Rue Maryse Bastié
Manufacturer's address : BP 182 - 91006 EVRY CEDEX - FRANCE

Déclare que le produit
Declares, that the product

Désignation : Thermomètre de haute précision
Designation : *High precision thermometer*

Référence : PHP 602
Model number :

Date : 14.02.01

a été fabriqué conformément aux spécifications techniques du produit et sous tous ses aspects, est conforme aux normes et réglementations en vigueur s'y rapportant et en particulier à la :

Sécurité

EN 61010-1 + amend. 1 (1995)
Catégorie de surtension : CAT III, 60 V.
Degré de pollution : 2

Compatibilité électromagnétique

CISPR 22 : EN 55022, classe B
CEI 61000-4-2, niveau 3
CEI 61000-4-3, niveau 2
CEI 61000-4-4, niveau 2
CEI 61000-4-6, niveau 2

Le produit nommé ci-dessus est conforme aux prescriptions de la directive européenne basse tension 73/23/CEE et à la directive CEM 89/336/CEE amendées par 93/68/CEE.

has been manufactured according to the technical specifications of the product and conforms in all respects to the relevant standards and regulations in force and especially to :

Safety

EN 61010-1 + amend. 1 (1995)
Overvoltage category: CAT III, 60 V.
Degree of pollution: 2

Electromagnetic compatibility

CISPR 22 : EN 55022, class B
IEC 61000-4-2, level 3
IEC 61000-4-3, level 2
IEC 61000-4-4, level 2
IEC 61000-4-6, level 2

The product herewith complies with the requirements of the low voltage directive 73/23/EEC and the EMC directive 89/336/EEC amended by 93/68/EEC.

R. SOUCEK
Directeur Assurance Qualité
Quality Assurance Manager