OPERATING MANUAL

HD32.1

Thermal microclimate

EN

V3.0

senseca

Contents

1 General information

Read this document carefully and familiarize yourself with the operation of the device before using it. Keep this document ready to hand and in the immediate vicinity of the device so that it is always available to the personnel/user in case of doubt.

Only technically qualified persons are permitted to carry out commissioning, operation, maintenance and decommissioning. The personnel must have carefully read and understood the operating manual before starting any activity.

Legal notices

- For your safety, use only the manufacturer's original spare parts and accessories. We assume no responsibility for the use of other products and any resulting damage.
- The user must have adequate knowledge of the measuring process and use of the measurements. The user is liable in case of damage/danger due to misinterpretation of the measurements as a result of inadequate knowledge.
- The liability and warranty of the manufacturer for product damages and consequential damages are voided in the event of misuse, failure to comply with these operating instructions, failure to observe safety warnings, assignment to inadequately qualified technical personnel and arbitrary modifications of the device.
- No part of this document may be reproduced, modified or translated without prior written permission of the product manufacturer. In case of ambiguity between different language versions of this document, the English version applies.
- This document does not create any legally binding obligations for the product manufacturer. All legally binding obligations are included only in the General Terms and Conditions of Sale.

Correctness of content

- This document was checked for corrected contents and is subject to a continuous updating process. This does not rule out potential errors. In the event that errors are discovered or in case of suggestions to make this document more user-friendly, please inform us via the contact information given in this document.
- We reserve the right to change the product specifications and the contents of this document without prior notice.

Explanation of symbols used

Danger!

Warning of danger that could result in death, serious bodily injury, or serious property damage if not observed.

Caution!

Warning of potential danger or harmful situation that may cause damage to the device or the environment if not observed.

Attention!

Action that may have a direct effect on operation or may cause an unexpected behavior.

1.1 Product identification

Exact product name can be found on the plate on the back of the device.

1.2 Safety information

Fault-free operation and operational safety of the device can only be guaranteed if the general safety requirements and the specific safety requirements in this document are observed.

Do not use the device in climatic conditions other than those specified in this document. Do not use the device in places with:

- Rapid ambient temperature variations that may cause condensation.
- Direct vibrations / shocks to the device.
- High-intensity electromagnetic fields or static electricity.

Intended use

The device is a multi-parameter portable meter for microclimate analysis.

Foreseeable misuse

If the following notices are disregarded, personal injury or death, as well as property damage can occur.

Danger!

- Do not use in safety / emergency stop devices!
- Not suitable for use in hazardous areas (Ex-environments)!
- Not suitable for diagnostic or other medical purposes on patients!
- Not suitable for SIL (Safety Integrity Level)!
- Not suitable for contact with food!
- Not suitable for children!
- Do not use as PPE (Personal Protection Equipment).

Caution!

Do not use if:

- There is visible damage to the device.
- The device is not working as expected.
- The device has been stored under unsuitable conditions for an extended period.

On suspicion that the device can no longer be operated without danger, it must be decommissioned and prevented from recommissioning with appropriate labelling. In case of doubt, send the device to the manufacturer for repair or maintenance.

Attention!

Remove batteries to prevent leakage if the device is stored at a temperature above 50 °C or not used for an extended period of time.

1.3 Warnings on the usage of probes

Danger!

Some sensors are not isolated from the outer sheath; take great care not to come into contact with live parts (above 48 V): it could be dangerous for the instrument and for the operator who could be electrocute.

Caution!

The sensor of the hot-wire air speed probes is heated. In the presence of flammable vapors or gases, this could cause a fire or explosion. Make sure there are no flammable or explosive gases or vapors in the measurement area.

Caution!

The sensor in the omnidirectional hot-wire air speed probes is encased in glass and is very fragile, as it is completely exposed. Remove the protective cylinder carefully and straight. During measurements, use the metallic grid to protect the sensor. Replace the protective cylinder when the probe is not in use.

Caution!

- Do not touch the sensitive elements of the probes.
- Do not expose the probes to gas or liquids that could corrode the probe material. After the measurement, clean accurately the probes.
- Respect the correct probes polarity.
- When inserting the probes connector into the instrument, do not fold or force the contacts.
- Do not bend, deform or drop the probes: they can be irreparably damaged.

2 Introduction

HD32.1 is an instrument indicated for microclimate analysis in the workplace. The instrument measures the parameters needed to determine whether a given workplace is suitable for performing certain activities.

The instrument has **three operating programs**, depending on the parameters to be measured:

- **Operating program A: Microclimate analysis**
- **Operating program B: Discomfort analysis**
- **Operating program C: Physical quantities**

The **operating program A** (Microclimate analysis) detects the following quantities:

- Natural ventilation wet bulb temperature
- Globe thermometer temperature
- Dry bulb (ambient) temperature
- Barometric pressure
- Relative humidity
- Air speed

and calculates:

- **WBGT indoor** (Wet Bulb Globe Temperature) index in absence of solar irradiation
- **WBGT outdoor** (Wet Bulb Globe Temperature) index in presence of solar irradiation
- Mean radiant temperature **Tr**
- **TU** (Turbulence) index
- **WCI** (wind chill index)

Using the **DeltaLog10** software, it is possible to calculate the **DR** (Draft Rate) index based on the TU index value measured by the instrument.

The **operating program B** (Discomfort analysis) detects the quantities needed to calculate, using the **DeltaLog10** software, the local discomfort indices due to vertical temperature gradients or radiant asymmetry:

- Air temperature at head height
- Air temperature at abdomen height
- Air temperature at ankle height
- Temperature at floor level
- Temperature of the net radiometer
- Net radiation
- Radiant asymmetry temperature

The **operating program C** (Physical quantities) detects the following quantities:

- Temperature
- Relative humidity
- Illuminance, luminance, PAR, irradiance
- Air speed
- Carbon dioxide concentration (CO_2)
- Carbon monoxide concentration (CO)

Additional indices can be calculated using **DeltaLog10** software, for example:

- **PMV** (Predicted Mean Vote) index
- **PPD** (Predicted Percentage of Dissatisfied) index
- **HI** (Heat Index)
- **IREQ** (thermal insulation required)
- **DLE** (exposure time limit)
- **RT** (recovery time)
- **PHS** (predicted heat strain) method indices

The instrument is equipped with three inputs for probes with SICRAM module, which keeps memory of the probe calibration data. The probes can be inserted in any of the inputs (except the air speed vane probe, which must be connected to input 8): they are automatically recognized when the instrument is turned on.

The instrument has an internal barometric pressure sensor. The barometric pressure is displayed only with the operating program **A**.

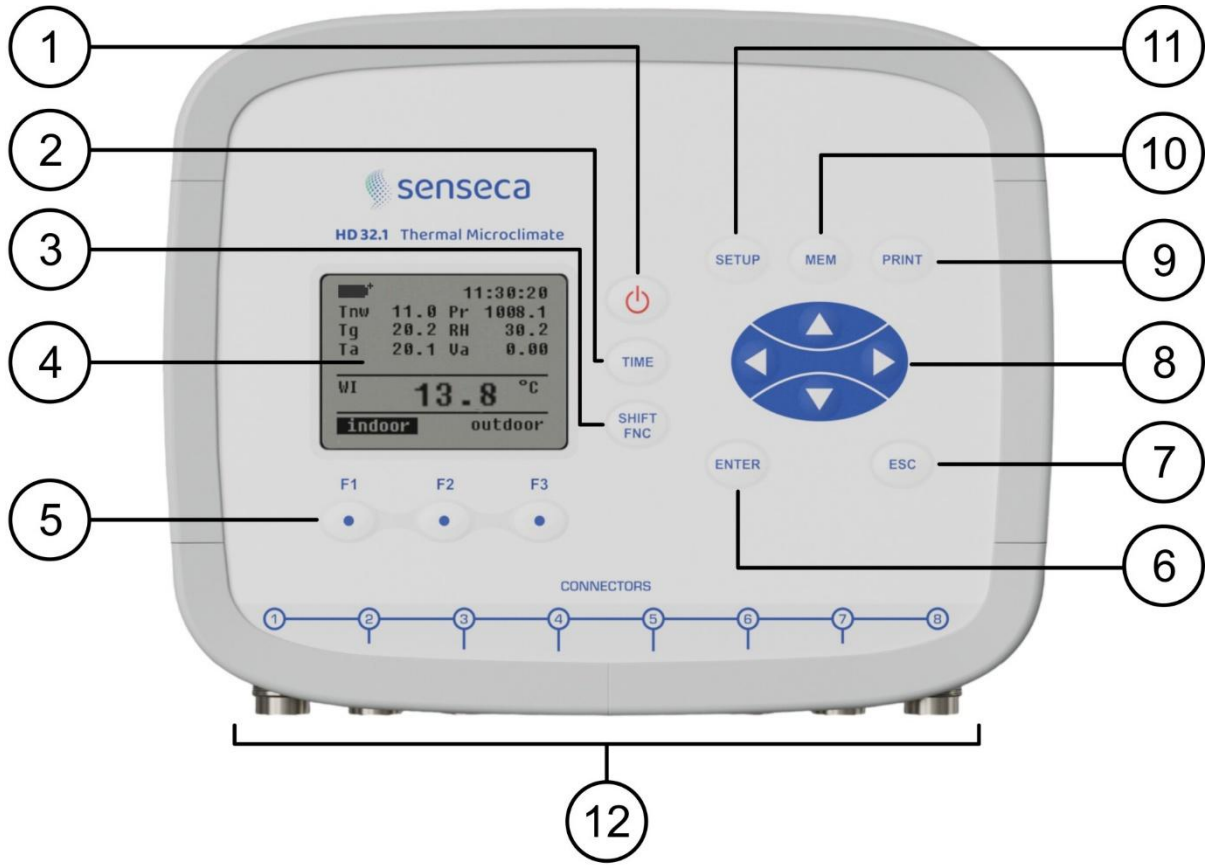
Instrument main features:

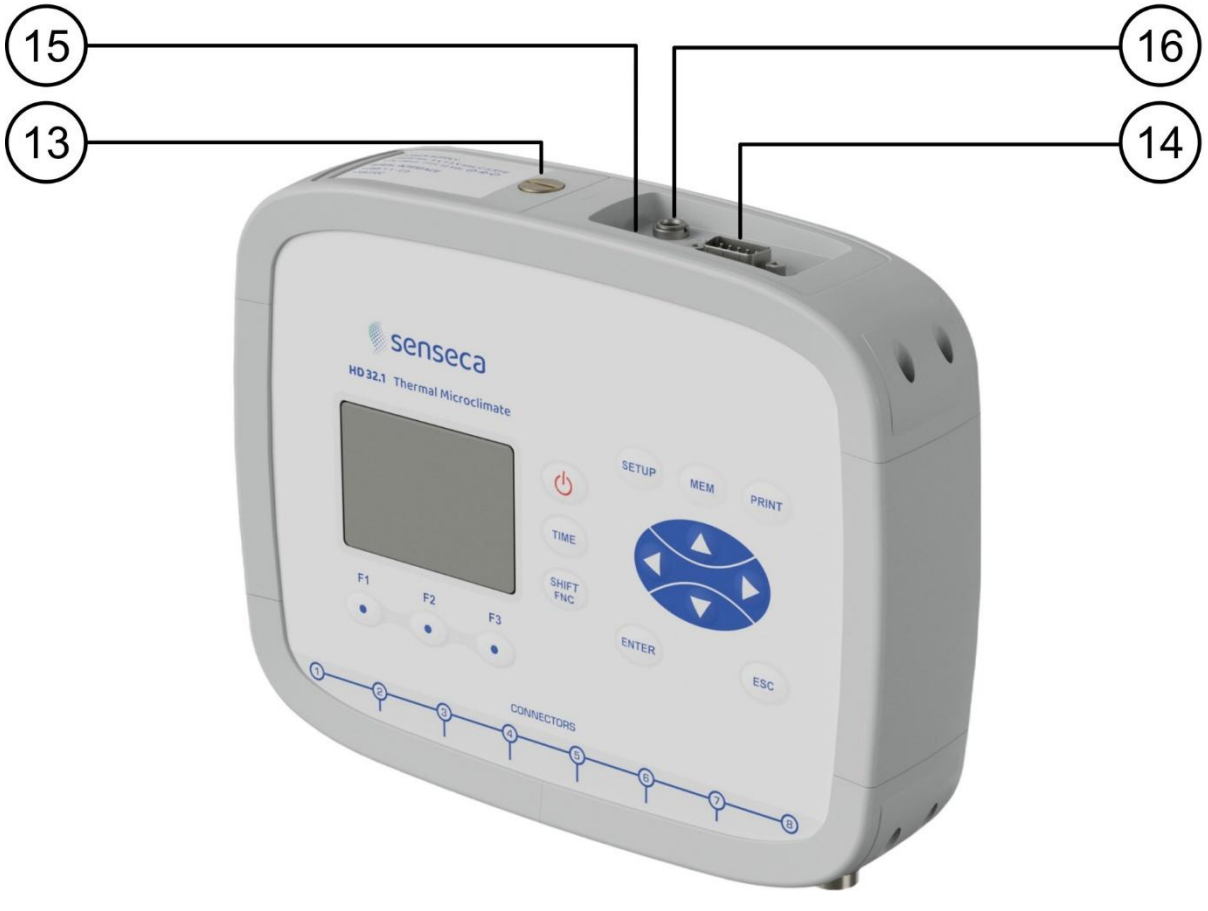
- Data logging. Memory capacity 64 different logging sessions, with possibility to set the logging interval. Logging duration can be set and, with **auto-start** function, it is possible to set the logging starting and ending date/time.
- Real-time clock.
- Display of maximum, minimum and average statistical parameters.
- Data transfer via RS232 serial port or USB port.
- Configurable temperature unit of measurement: °C, °F, K.
- Password-protected configuration.

Reference standards:

- **ISO 7726**: Ergonomics of the thermal environment - Instruments for measuring physical quantities.
- **ISO 7730**: Ergonomics of the thermal environment - Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria.
- **ISO 7243**: Ergonomics of the thermal environment - Assessment of heat stress using the WBGT (wet bulb globe temperature) index.
- **ISO 7933**: Ergonomics of the thermal environment – Analytical determination and interpretation of heat stress using calculation of the predicted heat strain.
- **ISO 11079**: Ergonomics of the thermal environment – Determination and interpretation of cold stress when using required clothing insulation (IREQ) and local cooling effect.

3 Description





1. **ON/OFF** key: switches the instrument on and off.
2. **TIME** key: displays the current date for about 8 seconds in the upper-left corner of the display, in place of the battery icon.
3. **SHIFT FNC** key: opens the Shortcut window.
4. Backlit LCD display.
5. **F1**, **F2** and **F3** function keys: activate the function shown on the bottom row of the display.
6. **ENTER** key: in menu, confirms the selection.
7. **ESC** key: exits the menu or, if in a submenu, returns to the upper level.
8. ▲▼◄► arrow keys: allow navigation within the menu.
9. **PRINT** key: prints the data via RS232 or USB communication port.
10. **MEM** key: starts and stops logging.
11. **SETUP** key: enters the menu (exists the menu if pressed inside the menu).
12. Inputs for **SICRAM** probes.
13. Battery compartment.
14. RS232 serial port.
15. USB port.
16. External power supply input.

4 Microclimate analysis (operating program A)

Microclimate refers to the environmental parameters that influence the thermal exchanges between an individual and the environment in confined places, and that determine the so-called "thermal well-being".

The micro-environmental climatic factors, together with the type of work done, condition the worker in a series of biologic responses linked to well-being situations (Comfort) or thermal uneasiness (Discomfort). In fact, the human body tries to keep the thermal balance in equilibrium conditions in order to keep the body temperature on optimal values.

The instrument detects the following quantities:

- $\mathbf{T_{nw}}$: natural ventilation wet bulb temperature probe
- $\mathbf{T_g}$: globe thermometer temperature
- $\mathbf{T_a}$: ambient temperature
- $\mathbf{P_r}$: barometric pressure
- **RH**: relative humidity
- $\mathbf{V_a}$: air speed

and calculates:

- **WBGT indoor** (Wet Bulb Globe Temperature) index in absence of solar irradiation
- **WBGT outdoor** (Wet Bulb Globe Temperature) index in presence of solar irradiation
- Mean radiant temperature **Tr**
- **TU** (Turbulence) index
- **WCI** (wind chill index)

Using the **DeltaLog10** software, it is possible to calculate the **DR** (Draft Rate) index based on the TU index value measured by the instrument.

4.1 WBGT index

WBGT (Wet Bulb Globe Temperature) is one of the indices used for determining the thermal stress to which is submitted an individual in a warm environment. It represents the value, with reference to the metabolic waste associated with a particular activity, beyond which the individual is in a thermal stress condition. WBGT index combines the natural ventilation wet bulb temperature measurement $\mathbf{T_{nw}}$ with the Globe thermometer temperature $\mathbf{T_g}$ and, in some situations, with the air temperature $\mathbf{T_a}$. The formula for the calculation is the following:

- inside and outside the buildings in **absence of solar irradiation**:

$$\mathbf{WBGT_{indoor} = 0.7\ T_{nw} + 0.3\ T_g}$$

- outside the building in **presence of solar irradiation**:

$$\mathbf{WBGT_{outdoor} = 0.7\ T_{nw} + 0.2\ T_g + 0.1\ T_a}$$

where:
$\mathbf{T_{nw}}$ = natural ventilation wet bulb temperature
$\mathbf{T_g}$ = globe thermometer temperature
$\mathbf{T_a}$ = air temperature

The detected data must be compared with the limit values established by the standard; if they are exceeded, it is necessary to:

- directly reduce the thermal stress in the workplace under consideration;
- proceed with a detailed analysis of the thermal stress.

Tab.3.1: limit values of the thermal stress WBGT indicated in the ISO 7243 standard

METABOLIC RATE CLASS	METABOLIC RATE, M		WBGT LIMIT VALUE			
	RELATIVE TO A UNIT AREA OF SKIN SURFACE (W/m^2)	TOTAL (FOR AN AVERAGE AREA OF SKIN SURFACE OF 1.8 m^2) (W)	INDIVIDUAL ACCLIMATED TO HEAT (°C)		INDIVIDUAL NON- ACCLIMATED TO HEAT (°C)	
0 (Resting)	M ≤ 65	M ≤ 117	33		32	
1	65 < M ≤ 130	117 < M ≤ 234	30		29	
2	130 < M ≤ 200	234 < M ≤ 360	28		26	
3	200 < M ≤ 260	360 < M ≤ 468	Stagnant air 25	Non-stagnant air 26	Stagnant air 22	Non-stagnant air 23
4	M > 260	M > 468	23	25	18	20
Note: the values have been established taking as a reference a maximum rectal temperature of 38 °C.						

To calculate the WBGT index, the following probes must be connected:

- **HP3201** or **TP3204S** natural ventilation wet bulb temperature probe.
- **TP3276** or **TP3275** globe thermometer probe.
- **TP3207** dry bulb temperature probe if the detection is made in presence of solar irradiation. Alternatively to the TP3207 temperature-only probe, a combined probe, e.g., HP3217R, can be used.

Instead of the two individual dry bulb and wet bulb probes, the **HP3217DM** combined probe can be used (which has priority over the individual probes, if installed).

Reference standards for WBGT index measurement are **ISO 7726** and **ISO 7243**.

4.2 Mean radiant temperature

The mean radiant temperature $\mathbf{T_r}$ is defined as the uniform temperature of a fictitious black cavity in which an individual would exchange the same amount of radiant thermal energy that it exchanges in the real non-uniform environment.

To evaluate the mean radiant temperature, the globe thermometer temperature, the air temperature and the air speed measured close to the globe thermometer must be detect.

The formula for calculating the mean radiant temperature is the following:

- In case of **natural convection**:

$$\mathbf{T_r} = \left[\left(\mathbf{T_g} + 273\right)^4 + \frac{0.25 \times 10^8}{\varepsilon_\mathbf{g}} \left(\frac{\left|\mathbf{T_g} - \mathbf{T_a}\right|}{\mathbf{D}} \right)^{1/4} \times \left(\mathbf{T_g} - \mathbf{T_a}\right) \right]^{1/4} - 273$$

- In case of **forced convection**:

$$\mathbf{T_r} = \left[\left(\mathbf{T_g} + 273\right)^4 + \frac{1.1 \times 10^8 \times \mathbf{V_a}^{0.6}}{\varepsilon_\mathbf{g} \times \mathbf{D}^{0.4}} \left(\mathbf{T_g} - \mathbf{T_a}\right) \right]^{1/4} - 273$$

where:
D = globe thermometer diameter
ε_g = 0.95 globe thermometer presumed emissivity
T_g = globe thermometer temperature
T_a = air temperature
V_a = air speed

The mean radiant temperature does not coincide with the air temperature: if within a room there are areas which have a temperature much higher than that of the air (think, for example, of the flame of a fireplace), the mean radiant temperature is an average significantly affected by the presence of this very hot area.

The mean radiant temperature is detected with the globe thermometer, which is a temperature probe consisting of a copper sphere painted with matt black, with emissivity ε_g equal to 0.95 (as required by ISO 7726), with a Pt100 sensor inside.

The temperature of globe thermometer may be significantly higher than the air temperature, as in the case of a mountain hut, where the air is 0 °C, but where the presence of a fireplace produces a medium radiant temperature of 40 °C, ensuring a comfort situation.

Under normal conditions, maintaining a mean radiant temperature significantly higher than the air temperature is an advantage in terms of environmental quality. In homes, where fireplaces or stoves no longer exist, usually the mean radiant temperature coincides with the air temperature, or it is even lower. These situations (the main case is represented by buildings with large glazed surfaces) are not particularly healthy as the warm and wet air facilitates the development of pathogens. From this point of view, the heating with lamps or radiant panels is much healthier. It is more hygienic to ensure the comfort conditions with a mean radiant temperature greater than the air temperature. The legislation erroneously establishes the air temperature rather than the mean radiant temperature as the evaluation parameter for heating systems.

To calculate the mean radiant temperature, the following probes must be connected:

- **TP3276** or **TP3275** globe thermometer probe.
- **HP3217R** combined relative humidity and temperature probe.
- **AP3203** or **AP3203F** hot wire air speed probe.

Reference standards for mean radiant temperature calculation is **ISO 7726**.

4.3 Turbulence intensity TU and draft rate DR

The local turbulence intensity, in percentage, is defined as the ratio between the local air speed standard deviation and the local average air speed (ISO 7726):

$$\mathbf{TU} = \frac{\mathbf{SD}}{\mathbf{V_a}} \times 100$$

where:
V_a = average local air speed
SD = local air speed standard deviation

$$\mathbf{SD} = \sqrt{\frac{1}{\mathbf{n}-1} \cdot \sum_{\mathbf{i}=1}^{\mathbf{n}} \left(\mathbf{V_{a_i}} - \mathbf{V_a}\right)^2}$$

From the turbulence calculation, knowing the average values of the local air speed and ambient temperature, the Draft Rate **DR** is obtained, according to ISO 7730:

$$\mathbf{DR} = (34 - \mathbf{T_a}) \cdot (\mathbf{V_a} - 0{,}05)^{0{,}62} \cdot (0{,}37 \cdot \mathbf{V_a} \cdot \mathbf{TU} + 3{,}14)$$

The air current discomfort is defined as an undesired local cooling of the body due to air motion. The Draft Rate DR indicates the percentage of people who are dissatisfied due to the air current.

The DR index is calculated when the temperature is between 20 and 26 °C and the average air speed is less than 0.5 m/s.

To calculate the turbulence intensity, the **AP3203** or **AP3203F** hot wire air speed probe must be connected.

Reference standards for turbulence intensity TU and the Draft Rate DR calculation are **ISO 7726** and **ISO 7730**.

4.4 WCI index

The Wind Chill Index (**WCI**) measures the degree of discomfort a person feels in conditions of low temperature and wind.

The index does not take into account either the type of protective clothing worn or the intensity of the activity being performed. The formula for the calculation is:

$$\mathbf{WCI = 13.12 + 0.6215\ T_a - 11.37\ V_a^{0.16} + 0.4275\ T_a\ V_a^{0.16}}$$

where:
- $\mathbf{T_a}$: air temperature (in °C);
- $\mathbf{V_a}$: air speed (in km/h) calculated at 10 m above the ground.

Since the instrument measures air speed at a height of 1.5 m above the ground, it applies a correction to calculate the index using the following formula:

$$\mathbf{WCI = 13.12 + 0.6215\ T_a - 11.37\ (1.5\ \ V_{1.5})^{0.16} + 0.4275\ T_a\ (1.5\ V_{1.5})^{0.16}}$$

where $\mathbf{V_{1.5}}$ is the air speed measured by the instrument at 1.5 m above the ground.

The index is calculated by the instrument if the air temperature is below 10 °C.

The following tables report the WCI index as a function of temperature and air speed, and the levels of frostbite risk (source: U.S. NOAA – National Weather Service).

		Air temperature Ta °C												
		10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50
Air speed v_a Km/h	10	8.6	2.7	-3.3	-9.3	-15.3	-21.1	-27.2	**-33.2**	**-39.2**	**-45.1**	**-51.1**	**-57.1**	**-63.0**
	15	7.9	1.7	-4.4	-10.6	-16.7	-22.9	**-29.1**	**-35.2**	**-41.4**	**-47.6**	**-51.1**	**-59.9**	**-66.1**
	20	7.4	1.1	-5.2	-11.6	-17.9	-24.2	**-30.5**	**-36.8**	**-43.1**	**-49.4**	**-55.7**	**-62.0**	**-68.3**
	25	6.9	0.5	-5.9	-12.3	-18.8	-25.2	**-31.6**	**-38.0**	**-44.5**	**-50.9**	**-57.3**	**-63.7**	**-70.2**
	30	6.6	0.1	-6.5	-13.0	-19.5	-26.0	**-32.6**	**-39.1**	**-45.6**	**-52.1**	**-58.7**	**-65.2**	**-71.7**
	35	6.3	-0.4	-7.0	-13.6	-20.2	-26.8	**-33.4**	**-40.0**	**-46.6**	**-53.2**	**-59.8**	**-66.4**	**-73.1**
	40	6.0	-0.7	-7.4	-14.1	-20.8	-27.4	**-34.1**	**-40.8**	**-47.5**	**-54.2**	**-60.3**	**-67.6**	**-74.2**
	45	5.7	-1.0	-7.8	-14.5	-21.3	-28.0	**-34.8**	**-41.5**	**-48.3**	**-55.1**	**-61.8**	**-68.6**	**-75.3**
	50	5.5	-1.3	-8.1	-15.0	-21.8	-28.6	**-35.4**	**-42.2**	**-49.0**	**-55.8**	**-62.7**	**-69.5**	**-76.3**
	55	5.3	-1.6	-8.5	-15.3	-22.2	**-29.1**	**-36.0**	**-42.8**	**-49.7**	**-56.6**	**-63.4**	**-70.3**	**-77.2**
	60	5.1	-1.8	-8.8	-15.7	-22.6	**-29.5**	**-36.5**	**-43.4**	**-50.3**	**-57.2**	**-64.2**	**-71.1**	**-78.0**

The values that can cause frostbite within ≤ 30 minutes are reported in bold.

WCI	Frostbite risk
> -28	Low
-28…-39	Medium: The exposed body parts can freeze in 10 to 30 minutes
-40…-44	High: The exposed body parts can freeze in 5 to 10 minutes (*)
-44…-47	High: The exposed body parts can freeze in 2 to 5 minutes (*)
< -48	High: The exposed body parts can freeze in less than 2 minutes (*)

(*) With $\mathbf{V_a}$ > 50 km/h the frostbite risk can be faster.

To calculate the WCI index, the following probes must be connected:

- **TP3207** dry bulb temperature probe.
  Alternatively to the TP3207 temperature-only probe, a combined probe, e.g., HP3217R, can be used.
- **AP3203** or **AP3203F** hot wire air speed probe.

Reference standards for WCI index calculation are **ISO 7726** and **U.S. NOAA - National Weather Service** specifications.

5 Discomfort analysis (operating program B)

The instrument detects the following quantities:

- **T_h**: air temperature at head height
- **T_b**: air temperature at abdomen height
- **T_k**: air temperature at ankle height
- **T_f**: temperature at floor level
- **T_n**: temperature of the net radiometer
- **P**: net radiation
- **DT**: radiant asymmetry temperature

Using the **DeltaLog10** software, it is possible to calculate, based on the values measured by the instrument, the following percentages of dissatisfied (**PD**) in accordance with **ISO 7730** standard:

- Percentage of dissatisfied with vertical temperature difference
- Percentage of dissatisfied with floor temperature
- Percentage of dissatisfied with radiant asymmetry

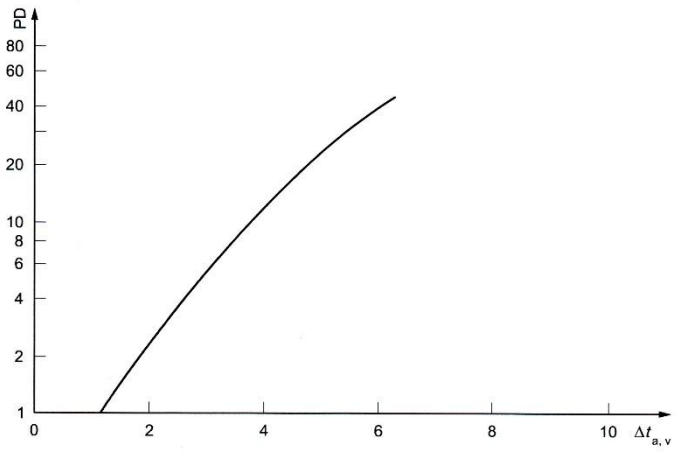
To perform temperature measurements in accordance with ISO 7726 and ISO 7730, the reference heights are:

- Head: 1.7 m standing person, 1.1 m seated person
- Abdomen: 1.1 m standing person, 0.6 m seated person
- Ankle: 0.1 m

5.1 Percentage of dissatisfied with vertical temperature difference

By measuring the temperature at various heights, it is possible to determine whether there is a vertical gradient in air temperature that could cause local discomfort.

The following graph shows the percentage of dissatisfied (PD) with vertical temperature difference as a function of the temperature gradient between the head (height 1.1 m) and the ankles (height 0.1 m) for a seated subject.

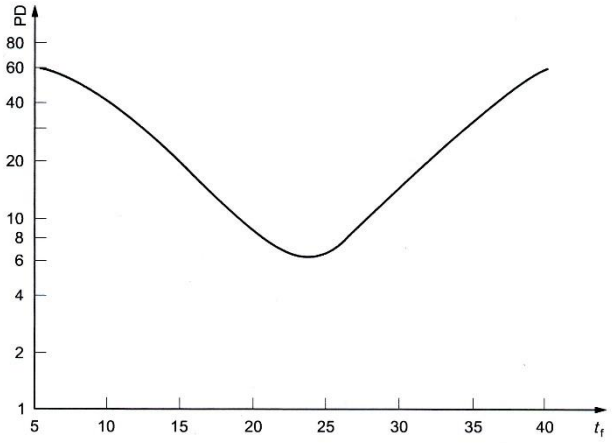


To calculate the percentage of dissatisfied with vertical temperature difference, the following probes must be connected:

- **TP3227K** temperature probe (for measurement at head and abdomen height).
- **TP3227PC** temperature probe (for measurement at ankle height).

5.2 Percentage of dissatisfied with floor temperature

The following graph shows the percentage of dissatisfied (PD) with floor temperature as a function of the floor temperature.

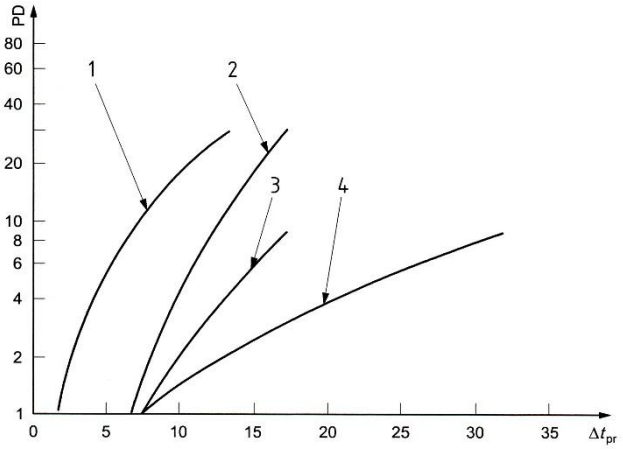


To calculate the percentage of dissatisfied with floor temperature, the **TP3207P** temperature probe or, alternatively, the **TP3227PC** dual temperature probe must be connected.

5.3 Percentage of dissatisfied with radiant asymmetry

The radiant asymmetry $\mathbf{\Delta t_{pr}}$ is the difference between the radiant temperatures measured with the net radiometer.

The percentage of dissatisfied (PD) with radiant asymmetry depends on whether the asymmetry is vertical (ceiling–floor) or horizontal (wall–wall), as shown in the following graph.



1 Hot ceiling
2 Cold wall
3 Cold ceiling
4 Hot wall

To calculate the percentage of dissatisfied with radiant asymmetry, the **TP3207P** temperature probe or, alternatively, the **TP3227PC** dual temperature probe must be connected.

6 Operation

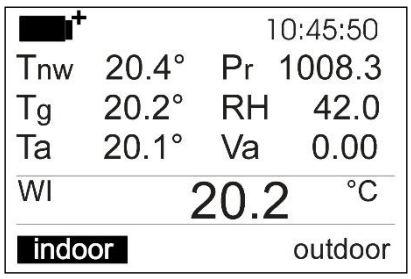
Before switching the instrument on, connect the probes to the inputs.

Notes:

- **The SICRAM probes must be connected when the instrument is off. If a probe is connected when the instrument is already on, it is not recognized: it is necessary to switch the instrument off and on again.**
- **The vane air speed probe can only be connected to input 8.** The other probes can be connected to any input.
- **The operating program C can manage up to 6 probes**, of which max. 2 of photo-radiometric type.
- Except for photo-radiometric probes, if more probes of the same type are connected, it will be considered only the first recognized probe: the scan of the probes, for their recognition, starts from input 1.
- If a probe is disconnected while the instrument is on, an audible alert (one beep per second) sounds, and "LOST" appears on display in the corresponding quantity row.

To switch the instrument on and off, press the **ON/OFF** key.

When the instrument is switched on, the instrument model and the selected operating program will be displayed for some seconds, then the measurements are displayed.



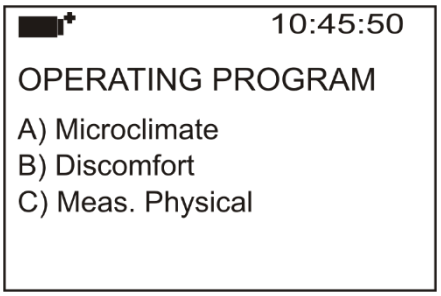
Note: if no probes are connected, the screen of the operating program **A** will display only the barometric pressure measured by the internal sensor.

The first row of the display shows the battery charge level, blinking, and the current time; if logging is in progress, the "LOG" indication also blinks.

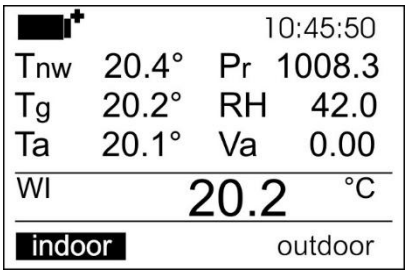
By pressing the **TIME** key, the current date is displayed for about 8 seconds in place of the battery icon.

6.1 Selecting the operating program

To change the operating program (A, B, or C), press **SETUP** to enter the menu, select **Firmware** using the ▲▼ keys, and press **ENTER**. Select the program using the ▲▼ keys, press **ENTER**, and wait for the instrument to activate the program..



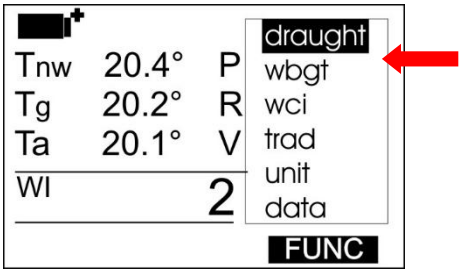
6.2 Operating program A (microclimate analysis)



The instrument detects the following quantities:

- **T_{nw}**: natural ventilation wet bulb temperature probe
- **T_g**: globe thermometer temperature
- **T_a**: ambient temperature
- **P_r**: barometric pressure
- **RH**: relative humidity
- **V_a**: air speed

The calculation of microclimatic indices is displayed below the measured values. To change the type of index displayed, press the **SHIFT FNC** key: a drop-down menu will open.



Select the index using the ▲▼ keys, and press **ENTER**.

- **draught**: calculation of the turbulence index **TU**; by entering the TU value in the DeltaLog10 software, the **DR** (Draft Rate) index can be obtained.
- **wbgt**: wet bulb globe temperature
- **wci**: wind chill index
- **trad**: mean radiant temperature

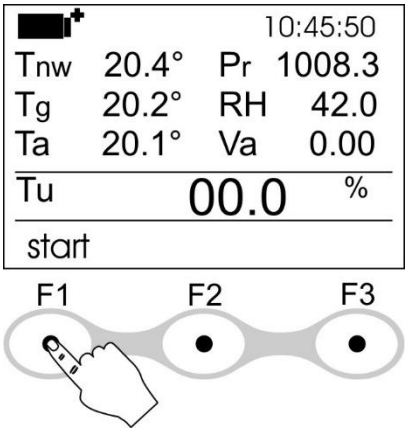
The **unit** option in the drop-down menu allows setting the temperature unit of measurement. Selecting the option, the available units (°C, °F, K) appear next to the **F1**, **F2**, and **F3** function keys; press the function key corresponding to the desired unit.

The **date** option in the drop-down menu allow displaying the statistical values of the measurements, see page 23.

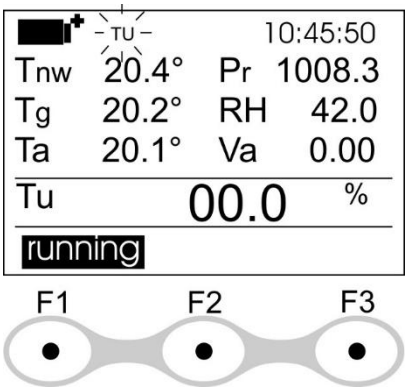
6.2.1 Calculation of the turbulence index

To calculate the turbulence index, it is necessary to manually initiate a procedure during which the instrument measures the air speed over a predetermined time interval.

After selecting the **draught** index from the drop-down menu, press the **F1** (**Start**) function key to start the calculation procedure.



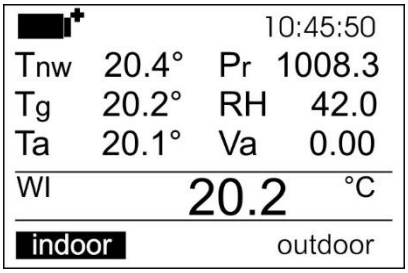
During the time required by the procedure, the **TU** symbol blinks on the first row of the display, and the label **start** above the function key is replaced by **running**.



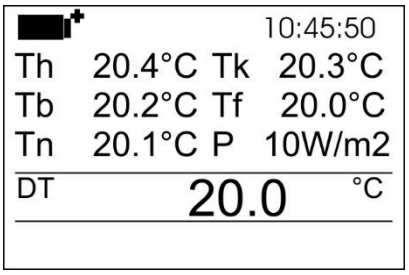
Once the procedure is complete, the **TU** symbol disappears, the word **running** is replaced by **start** and the turbulence index value is displayed.

6.2.2 WBGT indoor and outdoor

After selecting the **wbgt** index, the labels **indoor** and **outdoor** appear in correspondence with the **F1** and **F3** function keys. The WBGT value displayed refers to the option shown in white on a black background (indoor, in the figure below). If necessary, press the function key corresponding to the desired option.



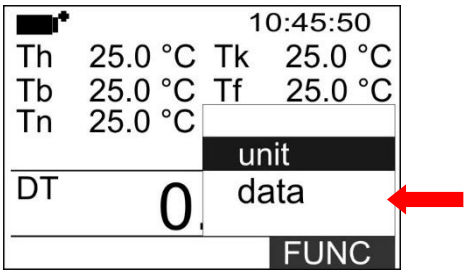
6.3 Operating program B (discomfort analysis)



The instrument detects the following quantities:

- **T_h**: air temperature at head height
- **T_b**: air temperature at abdomen height
- **T_k**: air temperature at ankle height
- **T_f**: temperature at floor level
- **T_n**: temperature of the net radiometer
- **P**: net radiation
- **DT**: radiant asymmetry temperature

Pressing the **SHIFT FNC** key opens a drop-down menu with the options **unit** and **data**, selectable using the ▲▼ keys and by pressing **ENTER**, which allow, respectively, setting the temperature unit of measurement and displaying the statistical values of the measurements.

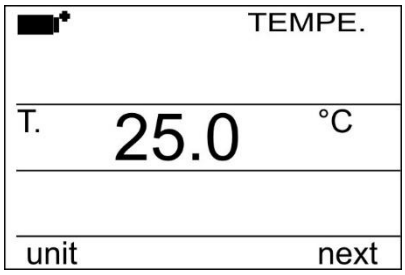


Selecting the **unit** option, the available units (°C, °F, K) appear next to the **F1**, **F2**, and **F3** function keys; press the function key corresponding to the desired unit.

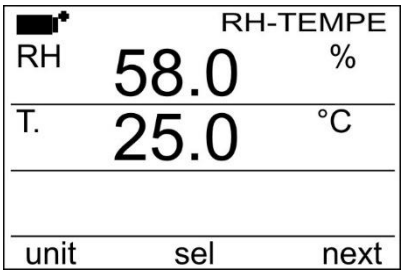
For displaying the statistical values of the measurements, see page 23.

6.4 Operating program C (physical quantity)

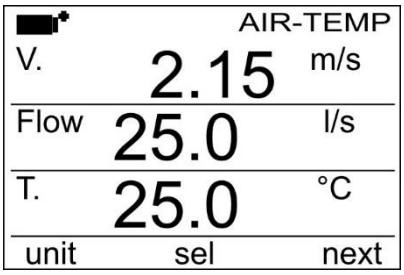
A measurement screen is displayed for each type of connected probe.



Pt100 temperature-only probe



Combined humidity and temperature probe



Combined air speed and temperature probe

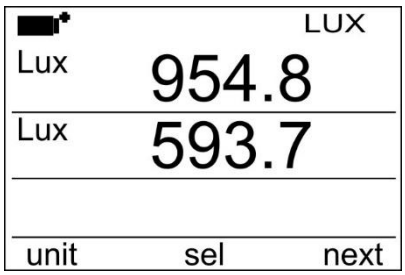
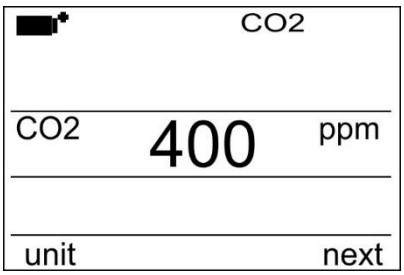
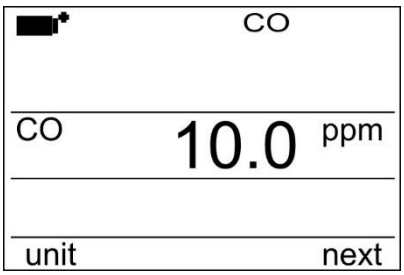


Photo-radiometric probes

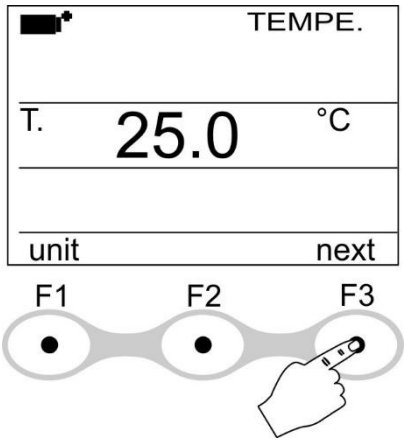


CO_2 probe

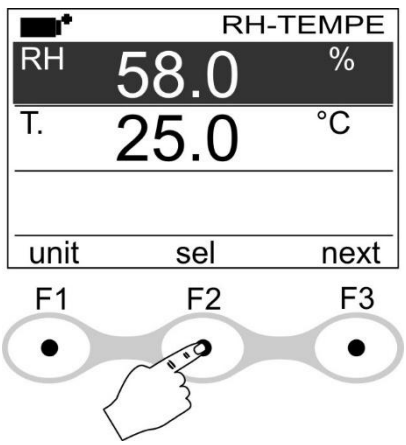


CO probe

To scroll through the various measurement screens, press the **F3** function key (**next**).



Using the **F1** (**unit**) function key, the unit of measurement of the quantities can be changed or, for the humidity, the calculated humidity quantities can be displayed. If multiple quantities are displayed, the F1 key affects the selected quantity. To select a quantity, press the **F2** (**sel**) function key until the quantity appears in white on a black background.



The available humidity quantities are the following (the relative humidity is measured; the other quantities are calculated):

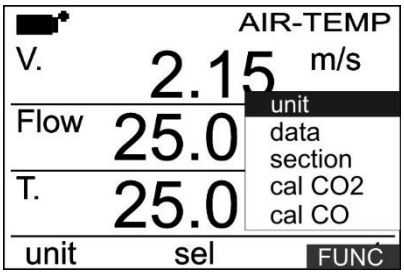
- **RH**: Relative humidity in %
- **SH**: Specific Humidity in g/Kg
- **AH**: Absolute Humidity in g/m^3
- **Pa:** Partial vapor pressure in hPa
- **H**: Enthalpy in J/g
- **Td**: Dew point in °C or °F
- **Tw:** Wet bulb temperature in °C or °F

Note: the calculation of the derived humidity quantities is made taking into consideration a fixed barometric pressure value equal to 1013.25 hPa.

For the other quantities, the following table lists the available units of measurement.

Quantity	**Unit of measurement**
Temperature	°C, °F
Air speed	m/s, km/h, ft/min, mph, knot
Flow	l/s (liters/s), m^3/s, m^3/min, m^3/h, ft^3/s, ft^3/min
Illuminance (PHOT)	Lux, fcd
Irradiance (RAD/UVA/UVB/UVC)	W/m^2, $\mu W/cm^2$
PAR	$\mu mol/m^2s$
Luminance (LUM2)	Cd/m^2
CO and CO_2	ppm

If the **unit** option does not appear in correspondence with the F1 function key (because other functions have been activated), press the **SHIFT FNC** key: a drop-down menu opens; select the option **unit** and press **ENTER**.



The other options in the drop-down menu allow:

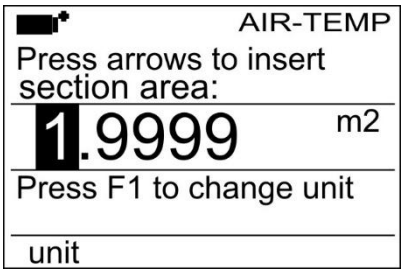
- **data:** displaying the statistical values of the measurements (page 23).
- **section:** setting the duct section for flow rate calculation (page 23).
- **cal CO2**: calibrating the CO_2 probe (page 40).
- **cal CO**: calibrating the CO probe (page 41).

Notes on CO_2 and CO measurements: when turned on, the instrument performs a probe "warm-up" for about 30 seconds before displaying the measurement. The "warm-up" indication remains on for another 30 seconds along with the reading to indicate that the values may not yet be within the specified accuracy. When the "warm-up" indication turns off, the reading is reliable.

6.4.1 Setting the duct section

To calculate the flow rate when connecting an air speed probe, the duct section must be set.

Press the **SHIFT FNC** key, select the option **section** in the drop-down menu that opens, and press **ENTER**. In the screen that appears, set the section by using the ◄► keys to select the digit to be changed and the ▲▼ keys to change the digit.



The value must be between 0.0001 m^2 (1 cm^2) and 1.9999 m^2.

Using the **F1** (**unit**) function key, the unit of measurement can be changed between m^2 and $inch^2$.

When finished, press **ENTER** to confirm and exit the section setting (or **ESC** to exit and discard the changes).

6.5 Statistical values

The maximum, minimum or average value of the detected measurements can be displayed.

Press the **SHIFT FNC** key, select the option **data** in the drop-down menu that opens, and press **ENTER**.

Use the **F1** or **F2** function key to select **max** (maximum), **min** (minimum) or **avg** (average). The setting applies to all displayed quantities.

Note: in the first five minutes, the average is calculated on the available samples; thereafter, the average is calculated on the samples of the last five minutes.

To reset the statistical values, press the **F3** (**Clr**) function key, select **yes** in the drop-down menu that opens, and press **ENTER**.

6.6 Printing the current measurements

The measurement values displayed can be printed by connecting the instrument RS232 serial port or USB port to, respectively:

- A PC RS232 serial port using the **9CPRS232** cable.
- A PC USB port using the **CP22** cable.

Note: the RS232 serial port and the USB port are alternatives; they do not operate simultaneously.

To receive measurements on the PC, use a standard serial communication program. In the program, set the COM port number to which the instrument is connected, the communication parameters to **8N1**, the flow control to **Xon/Xoff**, and the baud rate at which the instrument operates.

If the USB connection is used, the instrument operates with fixed **460800** baud rate, and the USB drivers included in DeltaLog10 software package must be installed on the PC.

If the RS232 connection is used, the instrument operates with the baud rate set in **Serial → Baudrate** menu (default 38400).

To start printing the measurements, press the **PRINT** key. Measurements are printed at regular intervals, according to the interval set in the **Serial → Print Interval** menu. If the interval is set to zero, only one printout is made. If the interval is greater than zero, printing can be stopped by pressing **PRINT** again.

During printing, the "PN" indication appears in the upper part of the display.

It is possible to print the measured values on a 80 column printer (*PRINT* key)

It is also possible to connect an external printer to the instrument RS232 serial port, provided it is capable of printing in 80-column mode.

6.7 Logging

The instrument can store up to 64 logging sessions, numbered sequentially from 00 to 63.

To start a logging session, press the **MEM** key, or schedule the automatic start in the **Logging → Start/stop time** menu.

The logging interval can be set in the **Logging → Log Interval** menu.

When logging is running, the **LOG** indication appears on display; a beep sounds each time a value is saved.

If the Self Shut-off option between two recordings is enabled (see **Logging → Self shut_off mode** menu item) and if the logging interval is greater than or equal to 1 minute, the instrument shuts down after a data acquisition and turns back on 15 seconds before the next acquisition. If the logging interval is less than one minute, the instrument remains always on during logging.

To manually stop the logging session, press the **MEM** key again. A time can be set after which logging stops automatically (see **Logging → Log file manager → Log time interval** menu item). For scheduled logging, the stop date and time can be set.

The stored data can be transferred to a PC using the **DeltaLog10** application software, downloadable from the website. While data transfer is in progress, the display shows "DUMP"; to stop the transfer, press the ESC key. Transferring data does not erase the memory: the transfer procedure can be repeated multiple times.

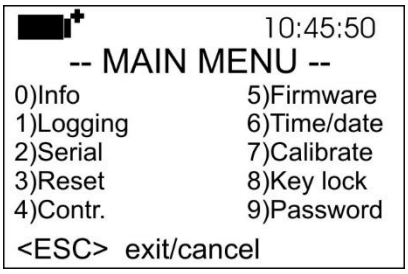
To erase the stored data, use the **DeltaLog10** application software or the **Logging → Log file manager → Erase ALL logs** menu item.

Notes:

- The stored data remains in memory regardless of the battery charge level.
- During logging, some keys are disabled; only **MEM**, **SETUP**, **ENTER** and **ESC** are active.
- Changing the logging settings has no effect if logging is already in progress.

7 Menu

Press the **SETUP** key to enter the main menu:



To select an item, use the ◄►▲▼ arrow keys and press **ENTER**.

To go back to the previous menu level, press **ESC**.

To exit the menu directly from any level, press **SETUP**.

f no key is pressed for 2 minutes, the instrument automatically exits the menu.

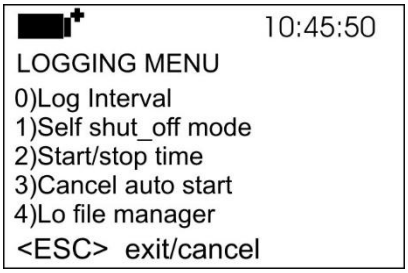
7.1 Info menu

The "Info" menu shows the instrument general information: model and operating program, firmware version and date, serial number, calibration date and user code (User ID).

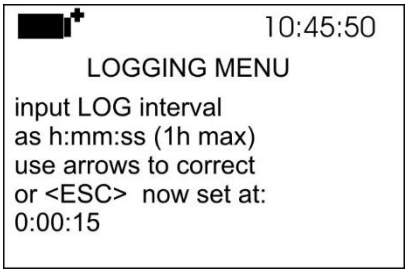
To change the user code, press ENTER, select the digits to be changed one by one using the ◄► arrows, and change them using the ▲▼ arrows. When finished, press **ENTER** to confirm.

7.2 Logging menu

The "Logging" menu allows setting the logging interval and duration. It also allows viewing the logging sessions stored in memory and erasing the memory.



7.2.1 Log Interval



Select the interval using the ▲▼ arrows and press **ENTER** to confirm. The available settings are 15/30 seconds, 1/2/5/10/15/20/30 minutes and 1 hour.

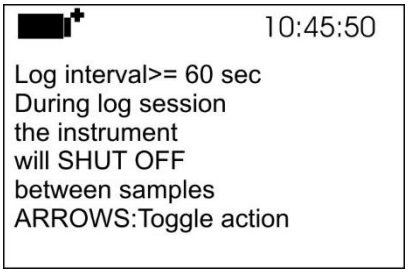
The following table shows approximately how long it takes for the memory to fill up,

depending on the logging interval.

Log interval	Memory capacity	Log interval	Memory capacity
15 seconds	11 days and 17 hours	10 minutes	1 year and 104 days
30 seconds	23 days and 11 hours	15 minutes	1 year and 339 days
1 minute	46 days and 22 hours	20 minutes	2 years and 208 days
2 minutes	93 days and 21 hours	30 minutes	3 years and 313 days
5 minutes	234 days and 17 hours	1 hour	7 years and 261 days

7.2.2 Self Shut-off mode (automatic shutdown during logging)

If the logging interval is greater than or equal to 1 minute, it is possible to choose whether the instrument should remain always on during logging or shut down between acquisitions, to extend the battery life.



Using the ▲▼ arrows, select "STAY ON" to keep the instrument always on during logging, or "SHUT OFF" to turn the instrument off between two consecutive acquisitions. Press **ENTER** to confirm.

If the logging interval is less than one minute, this parameter has no effect, and the instrument remains always on during logging.

7.2.3 Start/stop time (scheduled logging)

The logging automatic start and stop date/time can be set.

The current time plus 5 minutes is proposed as the start time. It can be accepted by pressing **ENTER**, or a different time can be set by selecting the parameters to be changed (year/month/day, hour:minutes:seconds) one by one using the ◄► arrows, and changing them using the ▲▼ arrows; when finished, press **ENTER** to confirm.

After confirming the start date/time, the screen for setting the stop date/time (by default, the start time plus 10 minutes) will appear. Set the stop date/time using the same procedure as for the start date/time.

After confirming the stop date/time, a summary screen appears showing the logging start and stop date/time; press **ENTER** to confirm or **ESC** to exit without enabling the autoamtic start.

The scheduled logging starts even if the instrument is off; the instrument turns on automatically a few seconds before the start time, and remains on after logging is

complete, turning off after the auto-off time has elapsed if it is battery-powered.

7.2.4 Cancel auto start

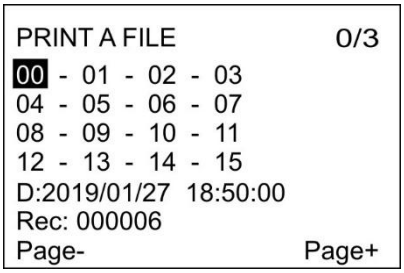
This submenu allows canceling any scheduled logging.

Selecting the item displays a screen showing the scheduled logging start and stop date/time. Press the ▲ key, the message "Self-timer not active" is displayed; press **ENTER** to confirm cancellation or **ESC** to exit without canceling the schedule.

7.2.5 Log file manager

This submenu allows printing the statiscal values of the logging sessions in memory (Print selected log), erasing the whole memory (Erase ALL logs), and setting the duration of the logging sessions (Log time interval).

Selecting "Print selected log" displays the list of the sessions in memory:



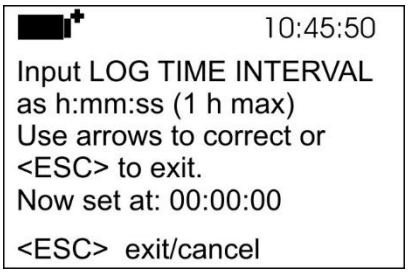
The list of sessions is arranged in 4 rows and 4 columns. If there are more than 16 sessions, press the **F3** (**Page+**) function key key to move to the next screen. The **F1** (**Page-**) function key allows returning to the previous screen. The current page and the total number of pages with stored data are displayed in the upper-right corner.

To select a session on the screen displayed, use the ▲▼◄► arrows. Below the list of sessions, the start date and time and the number of records of the selected session are shown. After confirming the selected session with the **ENTER** key, the data of that session are printed; during printing, a data transfer message appears on the display.

Note: only the data logged with the same operating program currently active in the instrument can be printed.

To delete all data in memory, select "Erase ALL logs" from the "Log file manager" submenu. It is not possible to delete individual sessions.

To set the duration of the logging sessions, select "Log time interval" from the "Log file manager" submenu.

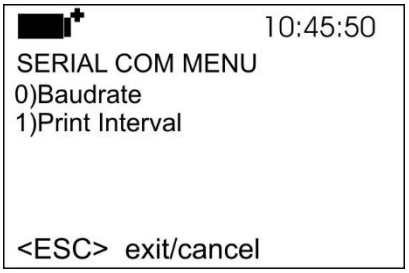


Set the duration (hours:minutes:seconds) using the ▲▼◄► arrows and confirm with **ENTER**.

The maximum duration that can be set is 1 hour. If 00:00:00 is set, the function is disabled and the logging stops only when the MEM key is pressed or when the memory is full.

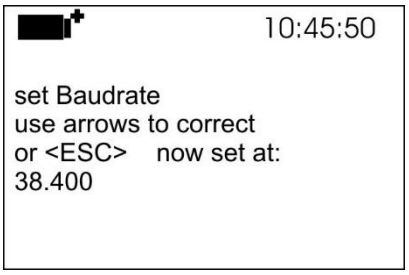
7.3 Serial menu

The "Serial" menu allows setting the RS232 serial communication baud rate and the measurements printing interval.



7.3.1 Baud rate

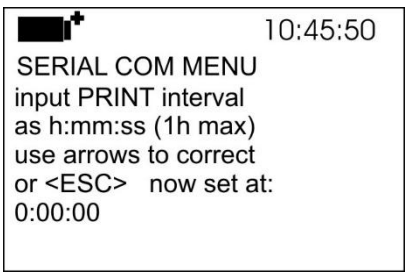
Set the value using the ▲▼ arrows and confirm with **ENTER**. The baud rate can be set to 1200, 2400, 4800, 9600, 19200 or 38400 (default).



Note: for the USB connection, the baud rate cannot be set, but is fixed at 460800.

7.3.2 Print Interval

Set the value using the ▲▼ arrows and confirm with **ENTER**. The available settings are 0, 15/30 seconds, 1/2/5/10/15/20/30 minutes and 1 hour.



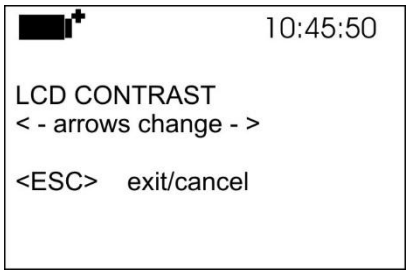
If zero is set (default), measurements are not printed automatically at regular intervals, but a single printout is generated when pressing the ENTER key.

7.4 Reset menu

The "Reset" menu allows resetting the instrument. After selecting "Reset" in the main menu, select "Reset" again using the ▲▼ arrows and confirm with **ENTER**.

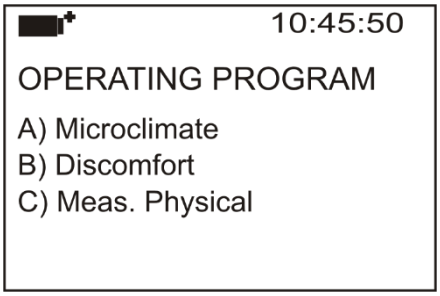
7.5 Contrast menu

The "Contrast" menu allows adjusting the display contrast. Use the ◄► arrows to decrease or increase the contrast, and confirm with **ENTER**.



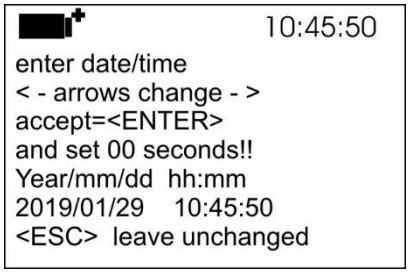
7.6 Firmware menu

The "Firmware" menu allows changing the operating program of the instrument. Select the program using the ▲▼ keys, press **ENTER**, and wait for the instrument to activate the program.



7.7 Time/date menu

The "Time/date" menu allows setting the clock of the instrument.



Select the parameters to be changed (year/month/day, hour:minutes) one by one with the ◄► arrows, and change them with the ▲▼ arrows; when finished, press **ENTER** to confirm.

The seconds cannot be set: they are automatically set to zero when ENTER is pressd.

7.8 Calibrate menu

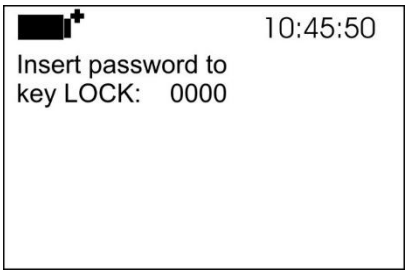
The "Calibrate" menu displays the date of the last calibration.

No settings are allowed; press ENTER or ESC to close the screen.

7.9 Key lock menu

The "Key lock" menu allows enabling/disabling the password protection (which can be set in the **Password** menu) of the instrument configuration.

After selecting "Key lock" in the main menu, enter the password (default 0000) using the ▲▼ arrows and confirm with **ENTER**.



This is a "toggle" operation: if the instrument was unlocked, it is locked; if the instrument was locked, it is unlocked.

When the protection is enabled, the key icon appears at the top of the display.

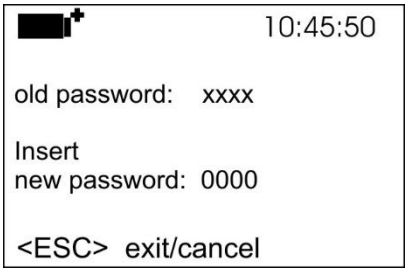
In protected mode, the MEM button is active to start and stop logging. The SETUP, ENTER, and ESC buttons are also active to access the "Key Lock" menu to unlock the instrument.

Note: if an incorrect password is entered, the message "Wrong password" appears.

7.10 Password menu

The "Password" menu allows setting the password to lock/unlock the instrument with the "Key lock" menu. The default password is 0000.

You will first be prompted to enter the current password ("Insert old password"); enter the password using the ▲▼ arrows and confirm with **ENTER**. You will then be prompted to enter the new password ("Insert new password"); enter the password using the ▲▼ arrows and confirm with **ENTER**.



8 Preparation and maintenance of the probes

The probes are already factory calibrated. The calibration data are stored in the SICRAM module memory.

8.1 Probes for microclimate and discomfort analysis

TP3575 and TP3276 globe thermometer probes:

Screw the globe to probe stem.

HP3201 and combined HP3217DM natural ventilation wet bulb probe:

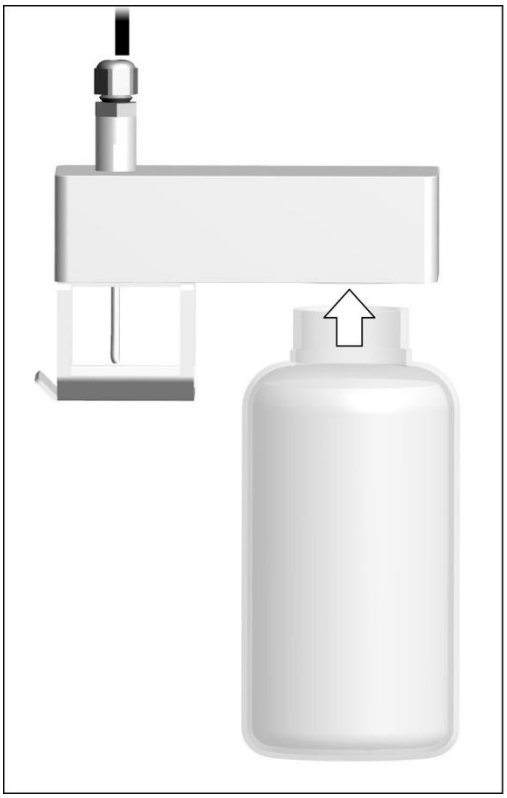
- Remove the reservoir cap (the cap is not screwed).
- Insert the cotton wick, previously dipped with distilled water, into the temperature probe. The cotton wick must protrude from the probe for about 20 mm.
- Fill the reservoir up till ¾ with **distilled water**.
- Replace the cap.

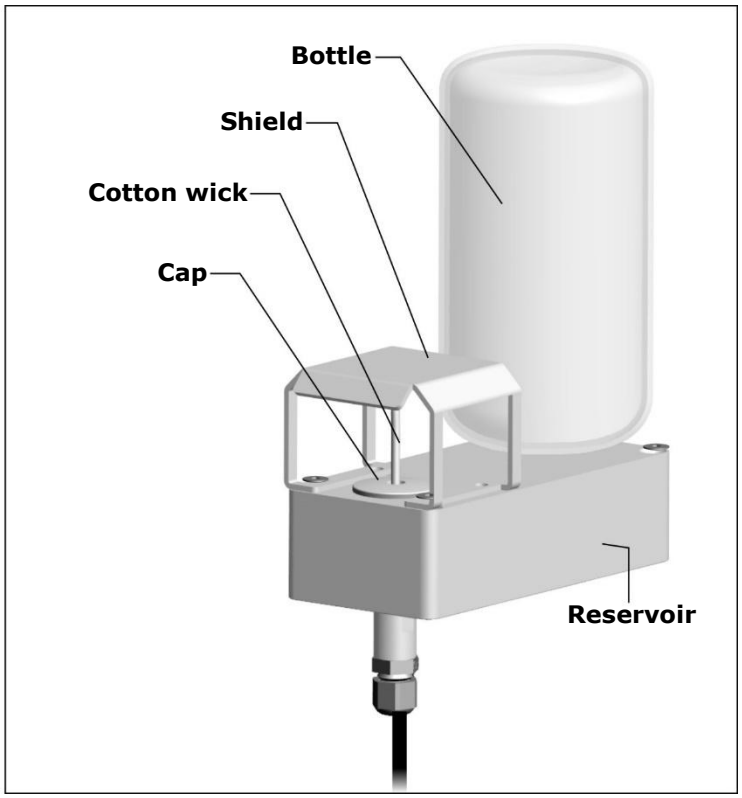
Warning: keep the probe vertical to prevent water from leaking.

Note: over time the cotton wick tends to calcify (harden): it must be replaced periodically.

TP3204S natural ventilation wet bulb probe:

- Remove the sensor cap (the cap is not screwed).
- Insert the cotton wick, previously dipped with distilled water, into the temperature probe. The cotton wick must protrude from the probe for about 20 mm.
- Replace the cap.
- Fill the bottle with 500 cc of **distilled water**.
- Turn the probe over and firmly screw the bottle to the probe reservoir.
- Turn the probe quickly (to avoid water spillage).





For measurements in presence of solar irradiation, use the protection shield from solar radiations.

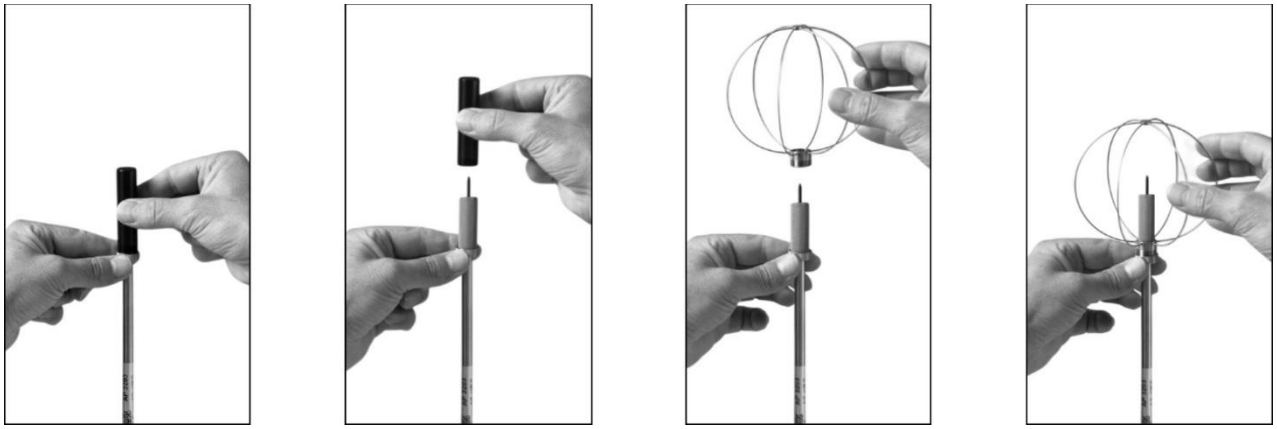
Note: over time the cotton wick tends to calcify (harden): it must be replaced periodically.

HP3217R combined relative humidity and temperature probe:

- Do not touch the sensors with the hands; avoid dirtying them with oils, greases or resins.
- The sensors can be cleaned by the dust and pollution by using a very soft brush (e.g. badger) soaked in distilled water.
- To **check** the appropriateness of the relative humidity measurement, the saturated salt solutions **HD75** (75 %RH) and **HD33** (33 %RH) can be used.
- If the measurements are not appropriate, check that the sensors are not dirty, corroded, chipped or broken.

AP3203 and AP3203F omnidirectional hot wire air speed probes:

Unscrew the sensor protection cylinder and screw the spherical metal grid.



Danger!

The sensor of AP3203 and AP3203F probes is heated. **In case of vapours or gases, a fire or an explosion could be triggered. Do not use the probe in the presence of flammable gases. Make sure that in the environment where the measurement are made there are no gas leaks or potentially explosive vapours.**

Caution!

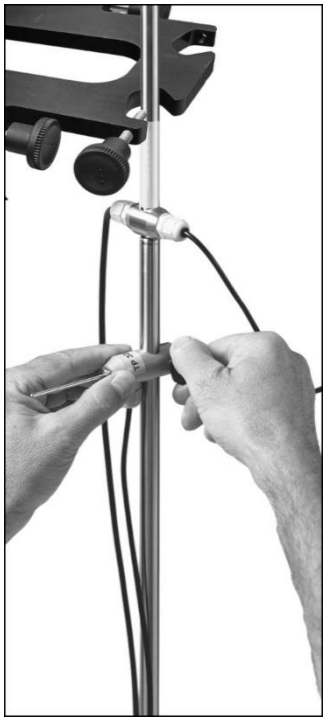
- **The probe is fragile and must be handled with extreme care**. A simple shock can make the probe unusable.
- After finishing the measurement, the sensor placed on the probe head must be protected with the provided threaded protection cylinder.
- During the use, the probe must be protected with the proper spherical metal grid.
- Do not touch the sensor.

Attention!

For cleaning the probe use only distilled water.

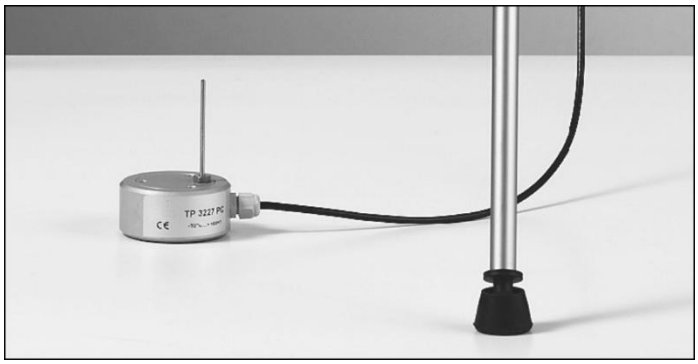
TP3227K dual temperature probe:

- Screw the L = 450 mm extension rod.
- Secure the rod to a clamp on the SP32TC.8 bracket so that the fixed sensor is 1.7 m (for standing subjects) or 1.1 m (for seated subjects) above the floor.
- Adjust the sliding probe to a height of 1.1 m (for standing subjects) or 0.6 m (for seated subjects) above the floor.



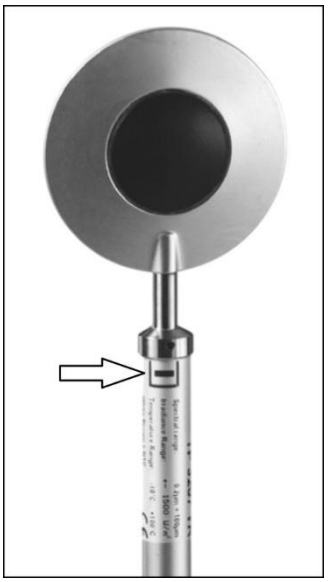
TP3207P and TP3227PC temperature probes:

Place the probe on the floor. In the TP3227PC dual probe, the ankle-height sensor rod must be facing upward.



TP3207TR combined probe for the measurement of radiant temperature:

The side of the probe marked with the "—" symbol, indicated by the arrow in the figure below, should be pointed toward the heat source.



8.2 Probes for operating program C "Physical quantities"

8.2.1 Temperature probes

Pt100 probes with SICRAM module can be connected. The probes have a 4-wire connection and the excitation current is designed to minimize the sensor self-heating effect.

The sensor is located at the end of the probe.

Immersion or penetration measurement: immerse the probe stem for at least 60 mm; when measuring in liquids, stir the liquid if possible.

Attention!

The measurement may be inaccurate if the probe stem is not sufficiently immersed, due to heat loss from the metal stem.

Measurement in air/gases: immerse the stem as much as possible in the fluid to be measured. The response time is shorter in the presence of flow; in the absence of flow, you can speed up the measurement by moving the probe, if possible.

Attention!

The probe stem must be dry, otherwise a temperature lower than the actual temperature will be detected.

Measurement of solid materials by contact: the measuring surface should be flat and smooth; the probe should be perpendicular to the measuring plane. Probes with tip specially designed for contact measurements must be used. The ambient temperature and heat dissipation of the probe metal stem can affect the accuracy of the measurement.

Attention!

For a more accurate and faster contact measurement, interpose thermally conductive paste between the measuring surface and the probe tip.
Measurement on non-metallic surfaces takes longer because of the poor thermal conductivity.

8.2.2 Combined relative humidity and temperature probes

The relative humidity and temperature combined probes use a capacitive sensor for the measurement of relative humidity and a Pt100 sensor for the measurement of temperature.

For measuring, place the probe avoiding areas where fast temperature variations may occur creating condensation. The measurement in no condition of fast temperature variations is almost immediate. On the contrary, if fast temperature variations occur, you have to wait the sensors and the probe body to reach thermal balance in order to obtain accurate measurements.

Attention!

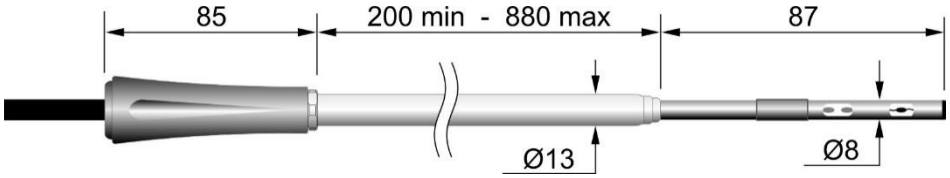
Avoid any contact of the sensitive element with hands or any other object or liquids.

The user calibration of relative humidity and temperature combined probes is not available.

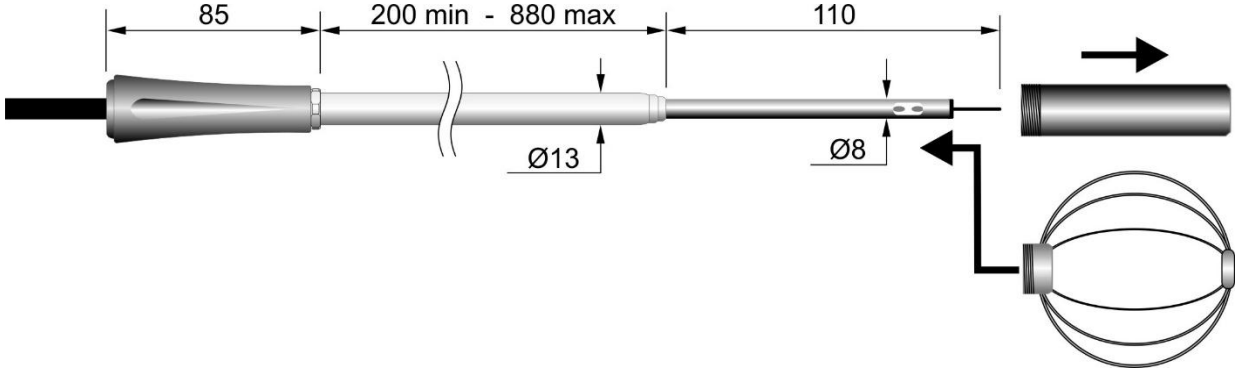
8.2.3 Hot-wire air speed probes

The probes of the AP471Sx series can be connected. AP471S1 and AP471S3 probes measure incident air flows up to 40 m/s; AP471S2 and AP471S4 probes, equipped with omnidirectional sensor, measure air speed up to 5 m/s in any direction of the air flow incident on the probe. Air speed measurement temperature is compensated in the range 0…+80 °C.

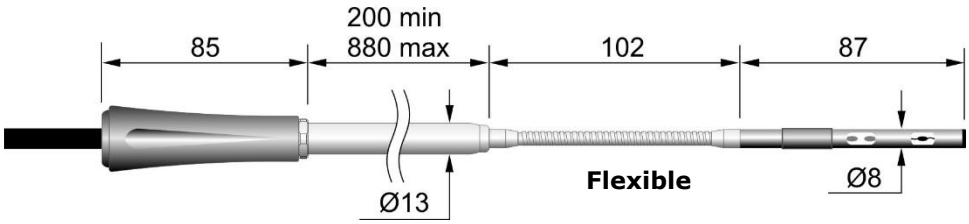
AP471S1



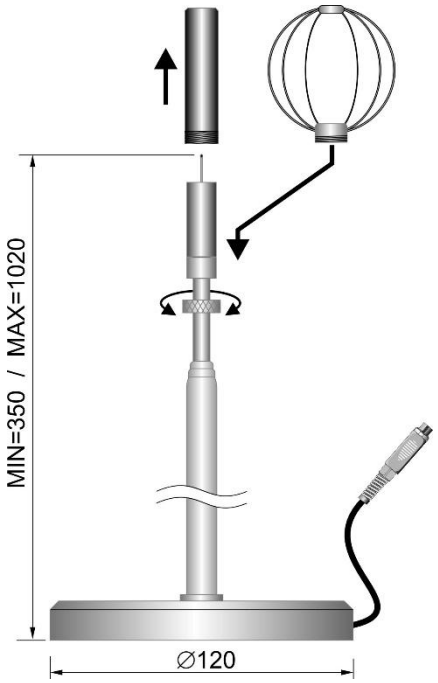
AP471S2



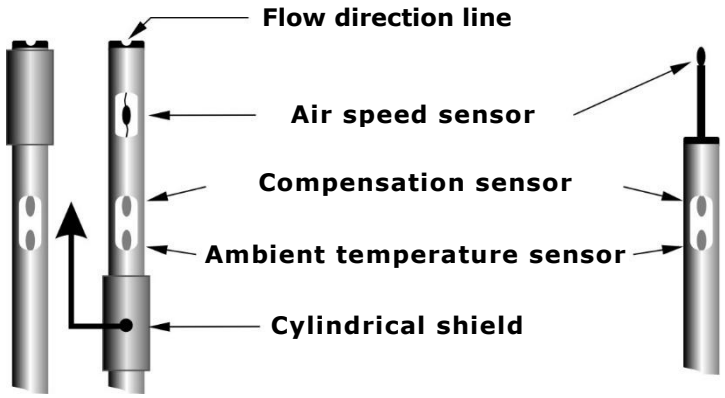
AP471S3



AP471S4

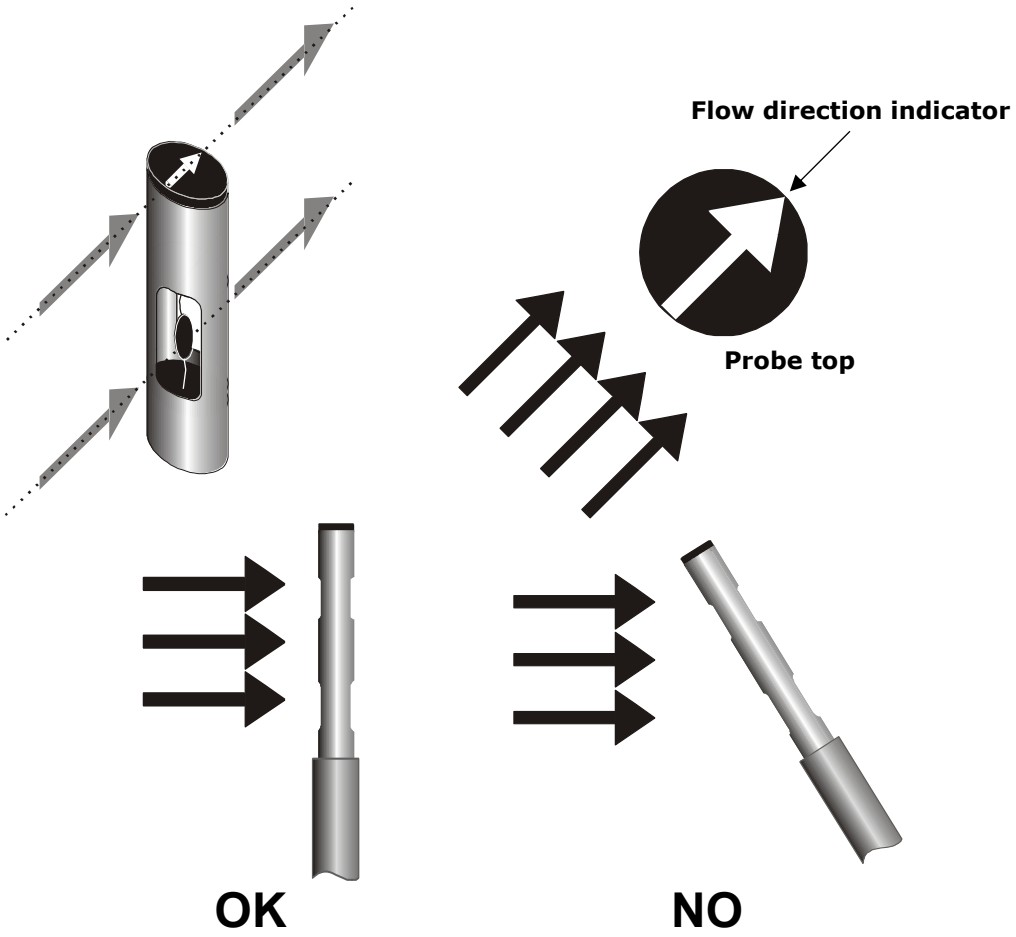


AP471S1 and AP471S3 probes are equipped with a cylindrical shield that can slide longitudinally along a guide. The shield has two end positions that lock it in the measurement position (all the way down) or the rest position (all the way up).



To save space when they are not in use, AP471S2 and AP471S4 probes are equipped with a protection cylinder to be screwed onto the probe tip (see the figures on the previous page).

To perform the measurement, extend the telescopic rod for the necessary length ensuring that the cable may slide freely and without efforts. Uncover the sensor and insert the probe in the air flow to be measured, keeping the arrow on top of the probe parallel to the flow, as indicated in the figures below. The probe must be kept orthogonal to the flow and not inclined.

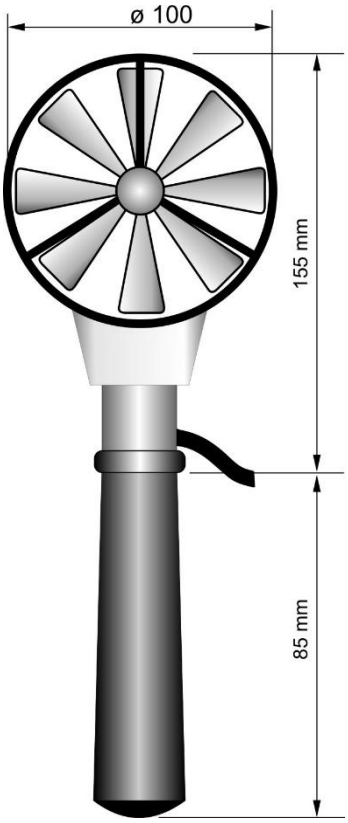


8.2.4 Vane air speed probes

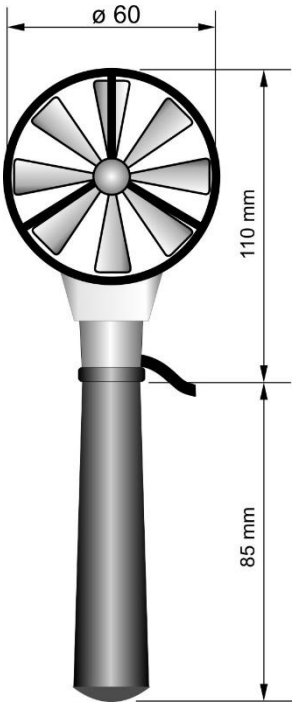
The probes AP472S1 and AP472S2 can be connected. AP472S1 probe measures also the temperature through a type K thermocouple. They are equipped, upon request, with an extensible telescopic rod (**AST.1**) which facilitates measurements in hard-to-reach areas (e.g. air-vents).

The bigger diameters are suitable for flow measurements in the presence of low-to-medium air speed turbulence (e.g. duct outlets). Lower diameters are suitable for applications where the probe surface must be much smaller than the transversal section of the duct, inside which the measurement is performed, e.g. aeration channels.

AP472 S1

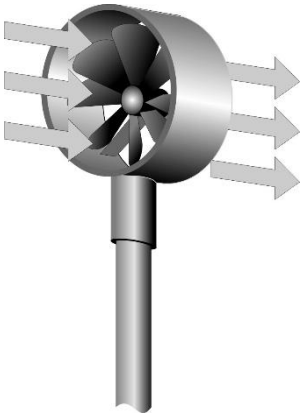


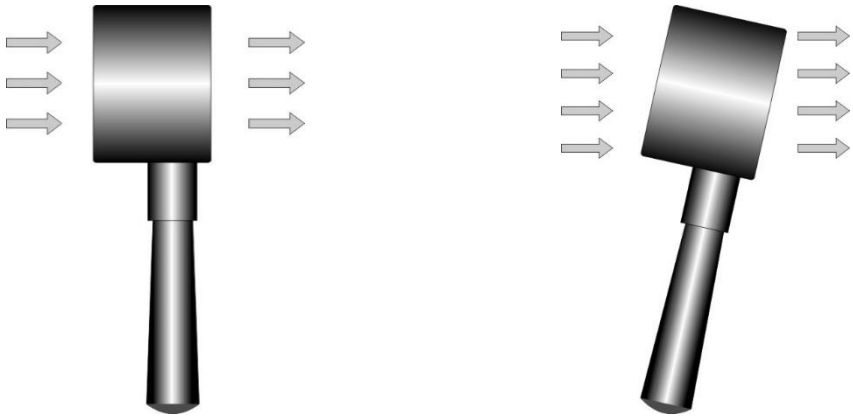
AP472 S2



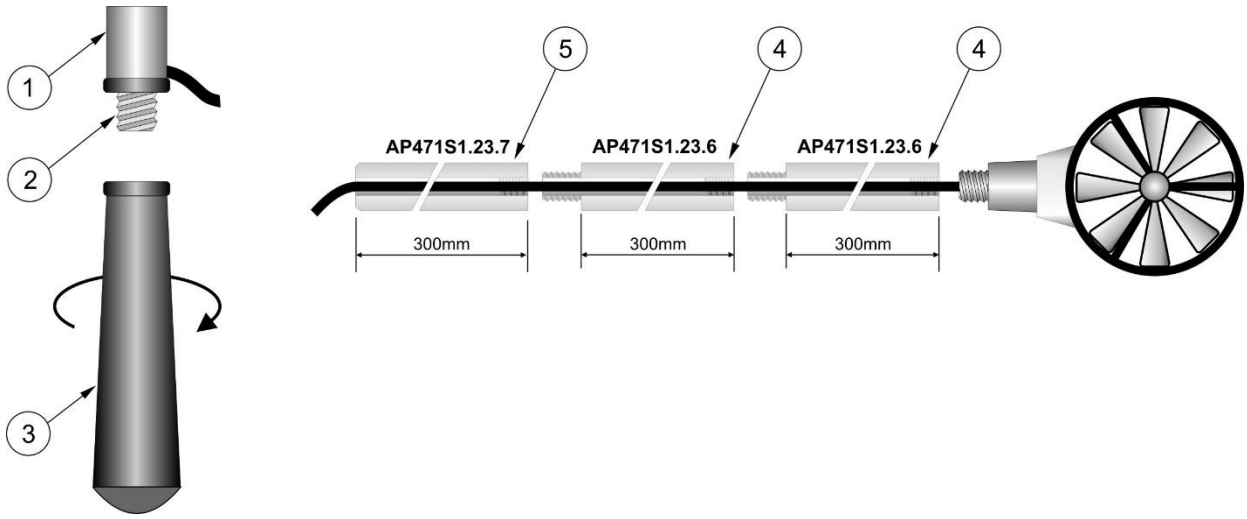
ATTENTION: vane probes can be connected only to input number 8.

To perform the measurement, extend the telescopic rod for the necessary length making sure that the cable slides freely and without efforts. Insert the probe in the air flow to be measured, keeping the propeller axis parallel to the flow, as indicated in the figures below. The probe should be kept orthogonal to the flow and not inclined. The probe is correctly positioned in the air flow when the maximum value is detected.





The probes AP472S1 and AP472S2 , plus auction telescoping AST.1 with swivel head, can use a ∅ 16 mm rigid extension rod. To unscrew the handle (3) hold the probe body at the point (1). Screw the rod top **AP471S1.23.6** (4) on the screw (2). Other extension rods **AP471S1.23.6** can be added. The last element can be the handle (3) or the extension rod **AP471S1.23.7** (5).



Attention!

Probe performances, especially at low speed, depend widely on the very low friction with which the propeller rotates around its axis. So as not to compromising this feature, it is recommended not to force, lock or rotate the propeller with your fingers and not to introduce it in air flows which could soil it, as far as possible.

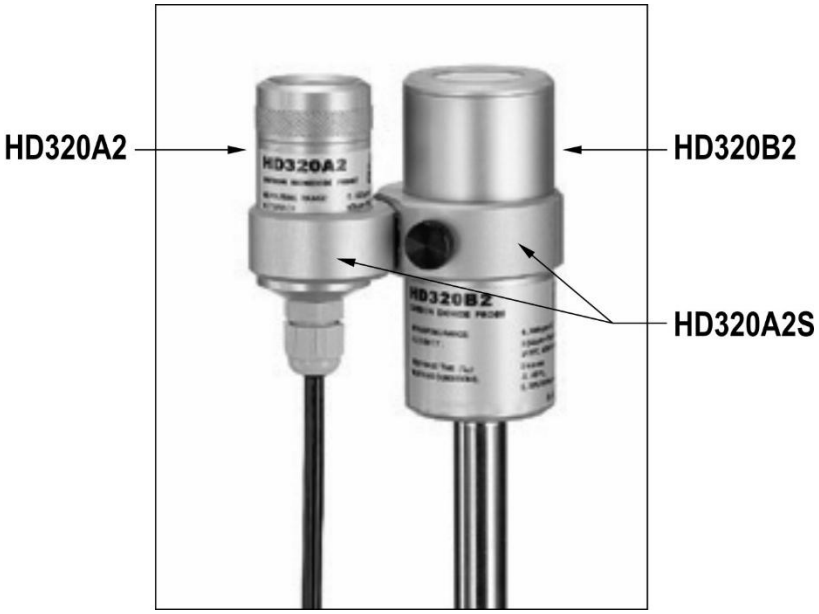
8.2.5 Photo-radiometric probes

The photometric and radiometric probes of LP471... series can be connected.

The measurement unit is chosen by the instrument depending on the probe connected. If several measurement units are provided for the same probe, press the **F1** (**unit**) function key for the selection of the desired unit.

8.2.6 CO_2 and CO probes

The HD320B2 CO_2 probe can be secured to a clamp on the SP32TC.8 bracket. The HD320A2 CO probe can be attached to the HD320B2 using the HD320A2S magnetic holder.



The probes are factory-calibrated and normally do not require any intervention by the user. However, it is possible to perform a recalibration to correct the sensor offset.

CO_2 probe calibration

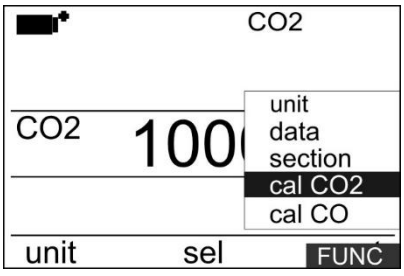
The probe can be calibrated:

- at 400 ppm in clean air
- at 0 ppm with the help of nitrogen cylinder.

The instrument can automatically detect the calibration method used: whether 400 ppm or 0 ppm. The calibration should be performed at one point only: each new calibration cancels the previous one.

Proceed as follows:

1. a) To calibrate at 400 ppm, simply place the probe in clean air.
   b) To calibrate at 0 ppm, remove the cap at the base of the probe to expose the calibration gas inlet, and connect the tubing from the nitrogen cylinder to it. Adjust the cylinder flow meter to get a constant flow from 0.3 to 0.5 l/min.
2. Switch the instrument on and wait at least 15 minutes before proceeding.
3. Press the **SHIFT FNC** key, select the option **cal CO2** in the drop-down menu that opens, and press **ENTER**.



4. Wait for at least 2 minutes to stabilize the measure.

5. Press the **F2** (**cal CO2**) function key to start calibration, which lasts some minutes.
6. Wait for the time necessary for the calibration without changing the operating conditions.
7. When the timer reaches zero, the instrument emits an audible signal confirming that the calibration is complete.
8. If the nitrogen cylinder was used, close the cylinder spigot and remove the tube from the sensor.

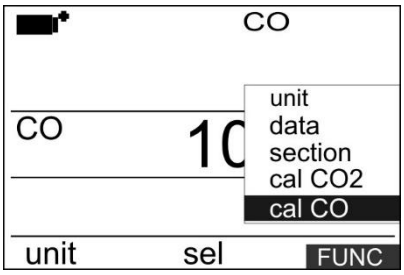
Note: the instrument rejects calibration values exceeding ±150 ppm from the nominal value.

CO probe calibration

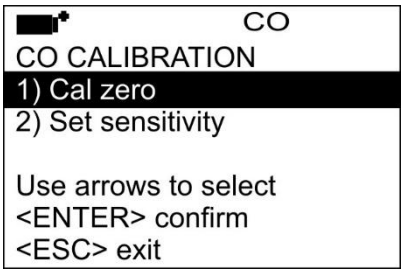
The probe can be calibrated at 0 ppm in clean air (outdoor the CO concentration is less than 0.1 ppm) or with the help of nitrogen cylinders.

Proceed as follows:

1. If the nitrogen cylinder is used, connect the tube with the rubber cap from the nitrogen cylinder on the CO sensor head. Adjust the cylinder flow meter to get a constant flow from 0.1 to 0.2 l/min.
2. Switch the instrument on and wait at least 15 minutes before proceeding.
3. Press the **SHIFT FNC** key, select the option **cal CO** in the drop-down menu that opens, and press **ENTER**.



4. Select **Cal zero** using the ▲▼ keys and press **ENTER**.



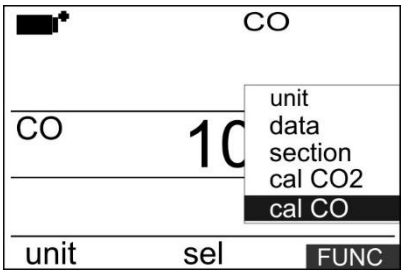
5. Press the **F2** (**Start**) function key to start calibration, which lasts some minutes (the value displayed during the process is the current CO reading).
6. Wait for the time necessary for the calibration without changing the operating conditions.
7. When finished, the instrument displays "Calibration completed" and emits an audible signal confirming that the calibration is complete. Press the **F2** (**Exit**) function key to return to measurement mode.

8. If the nitrogen cylinder was used, close the cylinder spigot and remove the cap from the sensor.

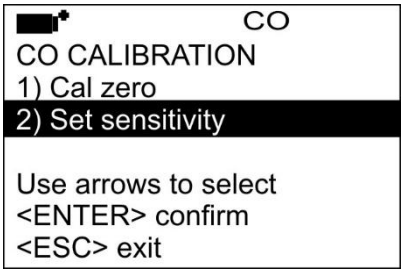
Replacement of CO sensor

In normal usage conditions, the CO sensor has an average life longer than 5 years. To replace the CO sensor, proceed as follows:

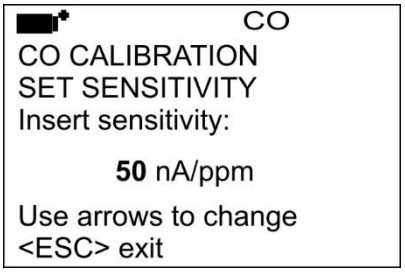
1. Disconnect the probe from the instrument.
2. Unscrew the head of the probe and remove the CO sensor.
3. Take a new CO sensor and note down the number printed on the edge that indicates its nA/ppm sensitivity.
4. Insert the new sensor electrodes in the terminals.
5. Screw the cap with the filter of the probe.
6. Connect the probe and switch the instrument on.
7. Press the **SHIFT FNC** key, select the option **cal CO** in the drop-down menu that opens, and press **ENTER**.



8. Select **Cal zero** using the ▲▼ keys and press **ENTER**.



9. Set the sensor sensitivity using the ▲▼ keys and press **ENTER**.



10. The instrument returns to the previous screen. If necessary, calibrate the zero of the new sensor or press **ESC** to return to measurement mode.

9 RS232 and USB interface

The instrument is equipped with a galvanically isolated RS-232C serial interface and a USB 2.0 interface. The instrument can be connected:

- To a PC RS232 serial port using the **9CPRS232** cable.
- To a PC USB port using the **CP22** cable.

To interact with the instrument from a PC, use a standard serial communication program. In the program, set the COM port number to which the instrument is connected, the communication parameters to **8N1**, the flow control to **Xon/Xoff**, and the baud rate at which the instrument operates.

If the USB connection is used, the instrument operates with fixed **460800** baud rate, and the USB drivers included in DeltaLog10 software package must be installed on the PC.

If the RS232 connection is used, the instrument operates with the baud rate set in **Serial → Baudrate** menu (default 38400).

Serial commands:

The table below lists all the serial commands that can be sent to the instrument.

Command characters must be in uppercase only. Commands must end with a carriage return character (CR, ASCII 0D).

The instrument replies with "&" if the command is correct, or with "?" if the command is not recognized. The instrument reply strings are terminated with Carriage Return (CR, ASCII 0D) and Line Feed (LF, ASCII 0A) characters.

Before sending serial commands to the instrument, it is recommended to lock the keyboard using the P0 command to prevent operational conflicts. When finished, restore keyboard operation using the P1 command..

Command	Reply	Description
P0	&	Blocks the instrument keyboard for 70 seconds
P1	&	Unlocks the instrument keyboard
G0	Model HD32.1 prog.A	Instrument model
G1	M=THERMAL MICROCLIMATE	Model description
G2	SN=12345678	Instrument serial number
G3	Firm.Ver.=xx.yy	Firmware version
G4	Firm.Date=yyyy/mm/dd	Firmware date
G5	cal yyyy/mm/dd hh:mm:ss	Calibration date and time
C1		Input 1 probe type, serial number, calibration date
C2		Input 2 probe type, serial number, calibration date
C3		Input 3 probe type, serial number, calibration date
C4		Input 4 probe type, serial number, calibration date
C5		Input 5 probe type, serial number, calibration date
C6		Input 6 probe type, serial number, calibration date
C7		Input 7 probe type, serial number, calibration date
C8		Input 8 probe type, serial number, calibration date
GC		Print instrument heading
GB	ID=0000000000000000	User code (set with T2xxxxxxxxxxxxxxx)

Command	Reply	Description
H0	Tw= 19.5 °C (prog.A) Th= 19.5 °C (prog.B) Tpt= 19.5 °C (prog.C)	Prints wet bulb temperature (prog.A) Prints temperature at head height (prog.B) Prints Pt100 probe temperature (prog.C)
H1	Tg= 22.0 °C (prog.A) Tb= 22.0 °C (prog.B) RH= 50.0 % (prog.C)	Prints globe thermometer temperature (prog.A) Prints temperature at body height (prog.B) Prints relative humidity (prog.C)
H2	Ta= 21.6 °C (prog.A) Tn= 21.6 °C (prog.B) Trh= 21.6 °C (prog.C)	Prints air temperature (dry bulb, prog.A) Prints net radiometer temperature (prog.B) Prints RH probe temperature (prog.C)
H3	Pr= 1018.1 hPa (prog.A) Tk= 19.5 °C (prog.B) Va= 0.25 m/s (prog.C)	Prints barometric pressure (prog.A) Prints temperature at ankles height (prog.B) Prints air speed (prog.C)
H4	RH= 50.5 % (prog.A) Tf= 19.5 °C (prog.B) Fl= 1.5 l/s (prog.C)	Prints relative humidity (prog.A) Prints floor temperature (prog.B) Prints calculated flow rate (prog.C)
H5	Va= 0.20 m/s (prog.A) Pt= 0.0 W/m^2 (prog.B) Tv= 20.5 °C (prog.C)	Prints air speed (prog.A) Prints net radiation (prog.B) Prints air speed probe temperature (prog.C)
H6	Tr= 18.5 °C (prog.A) Dt= 0.0 °C (prog.B) Lux= 550.0 lux (prog.C)	Prints mean radiant temperature (prog.A) Prints radiant asymmetry temperature (prog.B) Prints photo-radiometric measurement 1 (prog.C)
H7	WBGT(i)= 23.0 °C (prog.A) -- (prog.B) Lux= 550.0 lux (prog.C)	Prints indoor WGBT (prog.A) *Measurement not available in prog.B* Prints photo-radiometric measurement 2 (prog.C)
H8	WBGT(o)= 24.0 °C (prog.A) -- (prog.B) CO2= 842 ppm (prog.C)	Prints outdoor WGBT (prog.A) *Measurement not available in prog.B* Prints CO_2 (prog.C)
H9	WCI= 8.2 °C (prog.A) -- (prog.B) CO= 0 ppm (prog.C)	Prints Wind Chill Index (prog.A) *Measurement not available in prog.B* Prints CO (prog.C)
HA		Prints date, time and measurements of current program (all the measurements obtainable individually with H0…H9)
LN	A00 - A01 - B02 - B03 .. - .. - .. - .. - ……	Prints the memory map: if a session contains data, a number is displayed; if it is empty, 2 points (..) are displayed.
LFn	!Log n.= 0!started on:!2006/01/01 00:37:32	Prints start date and time of logging session n (hexadecimal number 0…F). If the session is empty, "-->No Log Data<--" is printed.
LDn		Prints data stored in logging session n (hexadecimal number 0…F). If the session is empty, "-->No Log Data<--" is printed.
LEn	&	Erases data of logging session n (hexadecimal number 0…F)
LEX	&	Erases all stored data
K1	&	Prints measurements
K0	&	Stops printing measurements
K4	&	Starts logging
K5	&	Stops logging
KP	&	Enables auto-off

Command	Reply	Description
KQ	&	Disables auto-off
WC0	&	Disables self shut-off during logging
WC1	&	Enables self shut-off during logging
RA	Sample print = 0sec	Reads the set print interval
RL	Sample log = 30sec	Reads the set logging interval
WA#	&	Sets the print interval of index # (hexadecimal number 0…D representing the position of the interval in the list 0, 1, 5, 10, …, 3600 seconds.
WL#	&	Sets the logging interval of index # (hexadecimal number 1…D representing the position of the interval in the list 15, …, 3600 seconds.

10 Error indications

Displayed indication	Description
- - -.- -	Probe not connected or faulty.
OVFL	Overflow, the detected measurement value is greater than the upper limit of the measuring range.
UFL	Underflow, the detected measurement value is less than the lower limit of the measuring range.
WARNING: MEMORY FULL!!	Memory is full; no more data can be stored.

11 Power supply

The meter is supplied with 4 x 1.5 V C size **alkaline** batteries.

The battery symbol on display constantly shows the battery charge status. To the extent that batteries have discharged, the symbol "empties". When the charge decreases still further it starts blinking.

In this case, batteries should be replaced as soon as possible.

When the battery charge is too low to ensure accurate measurements, the instrument turns off. The data in memory are retained.

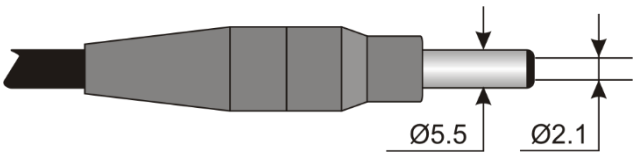
To replace the batteries, proceed as follows:

1) Switch the instrument off.
2) Disconnect the external power supply, if connected.
3) Unscrew the battery compartment cover screw counterclockwise and remove the battery holder. **Do not pull the battery holder wires, as they may break.**
4) Replace the batteries (4 x 1,5 V C alkaline) making sure to observe the correct polarity indicated on the battery compartment.
5) Reinsert the battery holder and replace the cover by tightening the screw clockwise.

Note: the instrument may not restart properly after replacing the batteries. If this happens, remove the batteries and wait a few minutes to allow the circuit capacitors to discharge completely, then reinsert the batteries.

The instrument can be powered from mains by using an external power supply, for example the optional **SWD10** power supply (input 100…240 Vac, output 12 Vdc – 1A).

The power supply connector has the positive terminal in the center.



The battery symbol is replaced by **[≈]** when the external power supply is connected.

Note: the display backlight is always on and the instrument does not turns itself off automatically after a period on inactivity. If the device is battery-powered only, turn it off when not in use to extend battery life.

Warnings on battery usage:

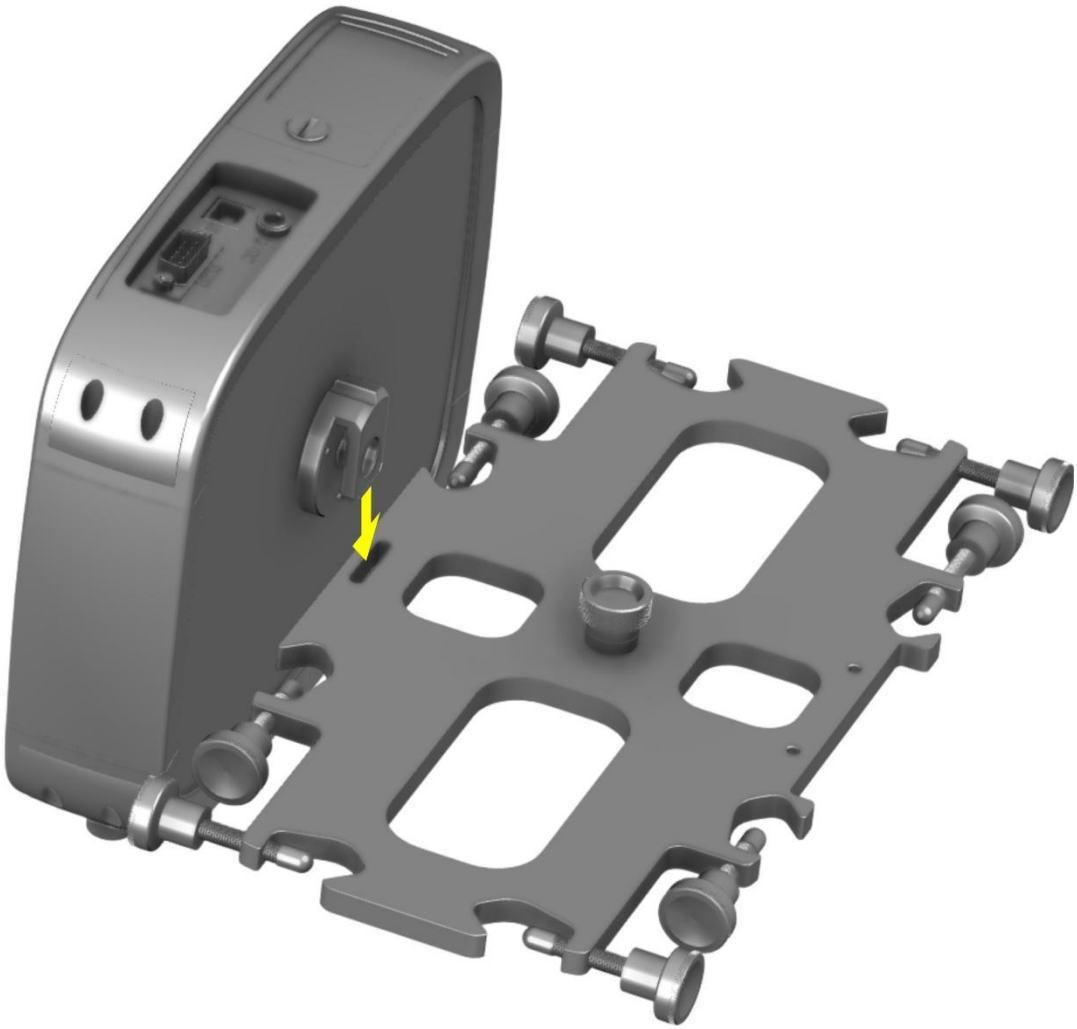
- If the instrument is not used for a long period of time, remove the batteries.
- If the batteries are low, replace them as soon as possible.
- If the batteries leak, replace them immediately.
- Use high-quality, sealed alkaline batteries with sufficient capacity.

Batteries disposal:

- Dispose of dead batteries in the dedicated bins or deliver them to authorized collection centers. Follow the relevant regulation.
- Do not dispose as household waste.
- Do not throw batteries into fire.

12 Fixing the instrument to the SP32TC.8 holder

Insert the hook on the back of the instrument into the rectangular slot on the SP32TC.8 holder.



13 Maintenance

Do not use aggressive cleaning agents or incompatible with the materials indicated in the technical specifications. For cleaning, use a soft dry cloth or slightly dampened with clean water.

14 Safety instructions

The instrument proper operation and operating safety can be ensured only in the climatic conditions specified in this manual and if all standard safety measures as well as the specific measures described in this manual are followed.
Do not use the instruments in places where there are:

- Corrosive or flammable gases.
- Direct vibrations or shocks to the instrument.
- High-intensity electromagnetic fields, static electricity.

User obligations

The instrument operator shall follow the directives and regulations below that refer to the treatment of dangerous materials:

- EU directives on workplace safety.
- National law regulations on workplace safety.
- Accident prevention regulations.

15 Technical specifications

Power supply	4 x 1.5 V C size alkaline batteries 12 Vdc/1 A external power supply unit (**SWD10**)
Battery life	200 hours of continuous operation with 7800 mAh batteries and temperature and RH probes 100 hours of continuous operation with 7800 mAh batteries and hot-wire air speed probe @ 5 m/s Current consumption when the instrument is off <45 μA
Logging interval	Configurable 15/30 seconds, 1/2/5/10/15/20/30 minutes, 1 hour
Storage capacity	67,600 entries for each of the 8 inputs The memory is divided in 64 blocks
Inputs	8 inputs with 8-pole DIN45326 connector for probes with SICRAM module
Display	Backlit dot matrix LCD Visible area 56x38 mm, 128x64 pixels
Connectivity	RS232C or USB 2.0, 8-pole M12 connector
Uncertainty	± 1 digit @ 20 °C (only the instrument)
Operating conditions	-5…50 °C, 0…90 %RH no condensation
Storage Temperature	-25…65 °C
Materials	ABS and aluminum
Dimensions	220x180x50 mm
Weight	1100 g (with batteries)
Degree of protection	IP 64

Measurement specifications

The measurement specifications for external probes apply to the instrument in line with the probe.

BAROMETRIC PRESSURE (internal sensor)

Sensor	Piezoresistive
Measuring range	600…1100 hPa
Resolution	0.1 hPa
Accuracy	± 0.5 hPa @ T=20°C
Long term stability	1 hPa / year
Response time	1 s

TP3275 AND **TP3276** TEMPERATURE PROBES

Sensor	Pt100
Measuring range	-30…120 °C
Resolution	0.1 °C
Accuracy	1/3 DIN
Temperature drift @ 20 °C	0.003 %/°C
Long term stability	0.1 °C/year
Connection	8-pole female DIN45326 connector, cable L=2 m
Globe dimensions	Ø=150 mm (TP3275), Ø=50 mm (TP3276)
Stem dimensions	Ø=14 mm, L=110 mm (TP3275) Ø=8 mm, L=170 mm (TP3276)
Response time T_{95} (1)	15 minutes

TP3207 TEMPERATURE PROBE

Sensor	Pt100
Measuring range	-40…100 °C
Resolution	0.1 °C
Accuracy	1/3 DIN
Temperature drift @ 20 °C	0.003 %/°C
Long term stability	0.1 °C/year
Connection	8-pole female DIN45326 connector, cable L=2 m
Dimensions	Ø=14 mm, L=140 mm
Response time T_{95} (1)	15 minutes

HP3201 NATURAL VENTILATION WET BULB PROBE

Sensor	Pt100
Measuring range	4…80 °C
Resolution	0.1 °C
Accuracy	Class A
Temperature drift @ 20 °C	0.003 %/°C
Long term stability	0.1 °C/year
Connection	8-pole female DIN45326 connector, cable L=2 m
Dimensions	Shaft: Ø=14 mm, L=110 mm Reservoir: Ø=30 mm, L=35 mm
Cotton wick length	10 cm approx.
Reservoir capacity	15 cc, autonomy 96 hours @ RH=50% and t=23 °C
Response time T_{95} (1)	15 minutes

TP3204S NATURAL VENTILATION WET BULB PROBE

Sensor	Pt100
Measuring range	4…80 °C
Resolution	0.1 °C
Accuracy	Class A
Temperature drift @ 20 °C	0.003 %/°C
Long term stability	0.1 °C/year
Connection	8-pole female DIN45326 connector, cable L=2 m
Dimensions	L x W x H = 140 x 65 x 178,5 mm (reservoir + bottle)
Cotton wick length	10 cm approx.
Reservoir capacity	500 cc, autonomy 15 days @ t=40 °C
Response time T_{95} (1)	15 minutes

HP3217DM COMBINED DRY BULB AND NATURAL VENTILATION WET BULB PROBE

Sensor	Pt100
Measuring range	-30…100 °C (dry bulb) / 4…80 °C (wet bulb)
Resolution	0.1 °C
Accuracy	Class A
Temperature drift @ 20 °C	0.003 %/°C
Long term stability	0.1 °C/year
Connection	8-pole female DIN45326 connector, cable L=2 m
Dimensions	Shaft: Ø=14 mm, L=170 mm Sensors support disk: Ø=59 mm, L=30 mm
Cotton wick length	10 cm approx.
Reservoir	Capacity 15 cc, autonomy 96 hours @ RH=50% and t=23 °C
Response time T_{95} (1)	4 minutes (dry bulb) / 30 minutes (wet bulb)

HP3217R TEMPERATURE AND RELATIVE HUMIDITY COMBINED PROBE

Sensor	Temperature: Pt100 R.H.: capacitive
Measuring range	Temperature: -40…100 °C R.H.: 0…100%
Resolution	0.1 °C / 0.1 %RH
Accuracy	Temperature: 1/3 DIN R.H.: ±1.5% (0…90%RH) / ±2% (90…100%RH) @ T=15…35 °C (1.5 + 1.5% measure)% @ T= remaining range
Temperature drift @ 20 °C	0.02 %RH/°C
Long term stability	0.1 %RH/year
Connection	8-pole female DIN45326 connector, cable L=2 m
Dimensions	Ø=14 mm, L=150 mm
Response time T_{95} (1)	15 minutes

AP3203 AND **AP3203F** OMNIDIRECTIONAL HOT WIRE AIR SPEED PROBES

Sensor	NTC 10 kΩ
Measuring range	0.02…5 m/s 0…80 °C (AP3203) / -30…30 °C (AP3203F)
Resolution	0.01 m/s
Accuracy	± (0,05 + 5% measure) m/s
Temperature drift @ 20 °C	0.06 %/°C
Long term stability	0.12 °C/year
Connection	8-pole female DIN45326 connector, cable L=2 m
Stem dimensions	Ø=8 mm, L=230 mm
Protection dimensions	Ø=100 mm

TP3227K DUAL TEMPERATURE PROBE

Sensor	Pt100
Measuring range	-10…100 °C
Resolution	0.1 °C
Accuracy	1/3 DIN
Temperature drift @ 20 °C	0.003 %/°C
Long term stability	0.1 °C/year
Connection	8-pole female DIN45326 connector, cable L=2 m
Dimensions	Ø=14 mm, L=490 mm (probe rod) + 450 mm (extension rod) Adjustable lower sensor height
Response time T_{95} (1)	15 minutes (upper sensor) / 4 minutes (lower sensor)

TP3207P AND **TP3227PC** TEMPERATURE PROBES

Sensor	Pt100
Measuring range	-10…100 °C
Resolution	0.1 °C
Accuracy	1/3 DIN
Temperature drift @ 20 °C	0.003 %/°C
Long term stability	0.1 °C/year
Connection	8-pole female DIN45326 connector, cable L=2 m
Dimensions	Ø=70 mm, H=32 mm (TP3207P) / 100 mm (TP3227PC)
Response time T_{95} (1)	20 minutes (floor) / 4 minutes (ankles, only TP3227PC)

TP3207TR COMBINED PROBE FOR THE MEASUREMENT OF RADIANT TEMPERATURE

Sensor	Thermopile / NTC
Thermopile typical sensitivity	10 μV/(Wm^{-2})
Temperature measuring range	0…60 °C
Resolution	0.1 °C / 1 Wm^{-2}
Temperature accuracy	±0,15 °C
Connection	8-pole female DIN45326 connector, cable L=2 m
Dimensions	Shaft: Ø=16 mm / Head: Ø=80 mm
Response time T_{95} (1)	20 minutes (temperature) / 90 seconds (net radiation)

HD320B2 CO_2 PROBE

Sensor	Non-dispersive infrared rays (NDIR)
Measuring range	0…5000 ppm
Resolution	1 ppm
Accuracy	±(50 ppm + 3% of measure) @ 20 °C, 50 %RH and 1013 hPa
Temperature drift @ 20 °C	0.2 %/°C typical
Long term stability	5% of measuring range / 5 years typical
Connection	8-pole female DIN45326 connector, cable L=2 m
Dimensions	Shaft: Ø=14 mm, L=110 mm / Head: Ø=40 mm, L=90 mm
Response time T_{63} (2)	2 minutes
Operating conditions	-5…50 °C / 0…95 %RH non condensing The effect of atmospheric pressure is compensated with the sensor integrated in the instrument

HD320A2 CO PROBE

Sensor	Electrochemical cell
Measuring range	0…500 ppm
Resolution	0.1 ppm
Accuracy	±(3 ppm + 3% of measure) @ 20 °C, 50 %RH and 1013 hPa
Long term stability	5% of measure / year typical
Connection	8-pole female DIN45326 connector, cable L=2 m
Dimensions	Ø=30 mm, L=57 mm
Response time T_{63} (2)	1 minute
Operating conditions	-5…50 °C / 0…95 %RH non condensing
Expected sensor life	5 years typical under normal environmental conditions

(1) The response time T_{95} is the time needed to reach 95% of the final value.

(2) The response time T_{63} is the time needed to reach 63% of the final value.

4-WIRE Pt100 TEMPERATURE PROBES FOR GENERAL USE

Model	Type	Measuring range	Accuracy
TP472I	Immersion	-196…500 °C	±0.1°C (@ 0 °C) ±0.2°C (-50 °C ≤ t ≤ 250 °C) ±0.3°C (t < -50 °C; t > 250 °C)
TP472I.O	Immersion	-50…300 °C	
TP473P.I	Penetration	-50…400 °C	
TP473P.O	Penetration	-50…300 °C	
TP474C.O	Contact	-50…300 °C	
TP475A.O	Air	-50…250 °C	
TP472I.5	Penetration	-50…400 °C	
TP472I.10	Penetration	-50…400 °C	

Common specifications

Resolution	0.01 °C in the range ±199.99 °C / 0.1 °C outside
Temperature drift @ 20 °C	0.003 %/°C

Note: the instrument measuring range is -200…650 °C; the actual measurement range may be limited by the probe operating temperature.

COMBINED RELATIVE HUMIDITY AND TEMPERATURE PROBES

Model	Temperature sensor	Measuring range		Accuracy	
		R.H.	Temperature	R.H.	Temp.
HP472ACR	Pt100	0…100%	-20…80 °C	±1.5% (0…85%RH) ±2.5% (85…100%RH) @ T=15…35 °C (2 + 1.5% measure)% @ T=remaining range	±0.3 °C
HP473ACR			-20…80 °C		±0.3 °C
HP474ACR			-40…150 °C		±0.3 °C
HP475ACR			-40…150 °C		±0.3 °C
HP475AC1R			-40…170 °C		±0.3 °C
HP477DCR			-40…100 °C		±0.3 °C
HP478ACR			-40…150 °C		±0.3 °C

Common features

Relative humidity

Sensor	Capacitive
Resolution	0.1 %RH
Temperature drift @ 20 °C	0.02 %RH/°C
Response time at constant temperature	10 s (10→80 %RH; air speed=2 m/s)

Temperature

Sensor	Pt100
Resolution	0.01 °C
Temperature drift@ 20 °C	0.003 %/°C

HOT-WIRE AIR SPEED PROBES

	AP471S1 AP471S3	AP471S2	AP471S4
Sensor Speed Temperature	 NTC Thermistor NTC Thermistor	 Omnidirectional NTC thermistor NTC thermistor	
Measuring range Speed Temperature	 0.02…40 m/s -25…80 °C	 0.02…5 m/s -25…80 °C	 0…80 °C
Air temperature compensation	0…80 °C		
Resolution Speed Temperature	 0.01 m/s - 0.1 km/h - 1 ft/min - 0.1 mph - 0.1 knot 0.1°C		
Accuracy Speed Temperature	 ±0.2 m/s (0.10…0.99 m/s) ±0.4 m/s (1.00…9.99 m/s) ±0.8 m/s (10.00…40.00 m/s) ±0.8 °C (-10…80°C)	 ±0.05 m/s (0.10…0.99 m/s) ±0.15 m/s (1.00…5.00 m/s) ±0.8 °C (-10…80 °C)	
Minimum speed	0.02 m/s		
Cable length	~2 m		

VANE AIR SPEED PROBES

	AP472S1	AP472S2
Sensor Speed Temperature	 Propeller ∅100 mm Tc K	 Propeller ∅60 mm ----
Measuring range Speed Temperature	 0.6…25 m/s -25…80 °C	 0.5…20 m/s ----
Resolution Speed Temperature	 0.01 m/s - 0.1 km/h - 1 ft/min - 0.1 mph - 0.1 knot 0.1 °C	 ----
Accuracy Speed Temperature	 ±(0.4 m/s + 1.5% f.s.) ±0.8 °C	 ±(0.4 m/s + 1.5% f.s.) ----
Minimum speed	0.6 m/s	0.5 m/s
Operating temperature	-25…80 °C	
Length del cable	~2 m	

PROBE FOR THE MEASUREMENT OF ILLUMINANCE **LP471PHOT**

Measuring range (lux)	0.10…199.99	…1999.9	…19999	…199.99x10^3
Resolution(lux)	0.01	0.1	1	0.01 x 10^3
Spectral range	in accordance with standard photopic curve V(λ)			
α (temperature coefficient) f_6(T)	<0.05% K			
Calibration uncertainty	<4%			
f'_1 (accordance with photopic response V(λ))	<6%			
f_2 (response as law of cosines)	<3%			
f_3 (linearity)	<1%			
f_4 (error in instrument reading)	<0.5%			
f_5 (fatigue)	<0.5%			
Class	B			
1 year drift	<1%			
Operating temperature	0…50 °C			
Reference standard	CIE n°69 – UNI 11142			

PROBE FOR THE MEASUREMENT OF LUMINANCE **LP471LUM2**

Measuring range (cd/m^2)	1…1999.9	…19999	…199.99x10^3	…1999.9x10^3
Resolution(cd/m^2)	0.1	1	0.01 x 10^3	0.1 x 10^3
Angle of view	2°			
Spectral range	in accordance with standard photopic curve V(λ)			
α (temperature coefficient) f_6(T)	<0.05% K			
Calibration uncertainty	<5%			
f'_1 (accordance with photopic response V(λ)	<8%			
f_3 (linearity)	<1%			
f_4 (error in instrument reading)	<0.5%			
f_5 (fatigue)	<0.5%			
Class	C			
1 year drift	<1%			
Operating temperature	0…50 °C			
Reference standard	CIE n°69 – UNI 11142			

QUANTUM-RADIOMETRIC PROBES FOR THE MEASUREMENT OF PHOTON FLUX IN THE PAR CHLOROPHYLL FIELD **LP471PAR** / **LP471PAR02**

Measuring range (μmol/m^2s)	0.1… 199.99	200.0…1999.9	2000…10000
Resolution(μmol/m^2s)	0.01	0.1	1
Spectral range	400…700 nm		
Calibration uncertainty	<5%		
f_2 (response as law of cosines)	<6%		
f_3 (linearity)	<1%		
f_4 (error in instrument reading)	±1digit		
f_5 (fatigue)	<0.5%		
1 year drift	<1%		
Operating temperature	0…50 °C		

PROBE FOR THE MEASUREMENT OF IRRADIANCE **LP471RAD**

Measuring range (W/m^2)	$1x10^{-3}$…$999.9x10^{-3}$	1.000…19.999	20.00…199.99	200.0…1999.9
Resolution(W/m^2)	$0.1x10^{-3}$	0.001	0.01	0.1
Spectral range	400…1050 nm			
Calibration uncertainty	<5%			
f_2 (response as law of cosines)	<6%			
f_3 (linearity)	<1%			
f_4 (error in instrument reading)	±1digit			
f_5 (fatigue)	<0.5%			
1 year drift	<1%			
Operating temperature	0…50 °C			

PROBE FOR THE MEASUREMENT OF UVA IRRADIANCE **LP471UVA**

Measuring range (W/m^2)	$1x10^{-3}$… $999.9x10^{-3}$	1.000…19.999	20.00…199.99	200.0…1999.9
Resolution(W/m^2)	$0.1x10^{-3}$	0.001	0.01	0.1
Spectral range	315…400 nm (Peak 365 nm)			
Calibration uncertainty	<5%			
f_3 (linearity)	<1%			
f_4 (error in instrument reading)	±1digit			
f_5 (fatigue)	<0.5%			
1 year drift	<2%			
Operating temperature	0…50 °C			

PROBE FOR THE MEASUREMENT OF UVB IRRADIANCE **LP471UVB**

Measuring range (W/m^2)	$1x10^{-3}$…$999.9x10^{-3}$	1.000…19.999	20.00…199.99	200.0…1999.9
Resolution(W/m^2)	$0.1x10^{-3}$	0.001	0.01	0.1
Spectral range	280…315 nm (Peak 305 nm)			
Calibration uncertainty	<5%			
f_3 (linearity)	<2%			
f_4 (error in instrument reading)	±1digit			
f_5 (fatigue)	<0.5%			
1 year drift	<2%			
Operating temperature	0…50 °C			

PROBE FOR THE MEASUREMENT OF UVC IRRADIANCE **LP471UVC**

Measuring range (W/m^2)	$1x10^{-3}$…$999.9x10^{-3}$	1.000…19.999	20.00…199.99	200.0…1999.9
Resolution(W/m^2)	$0.1x10^{-3}$	0.001	0.01	0.1
Spectral range	220…280 nm (Peak 260 nm)			
Calibration uncertainty	<5%			
f_3 (linearity)	<1%			
f_4 (error in instrument reading)	±1digit			
f_5 (fatigue)	<0.5%			
1 year drift	<2%			
Operating temperature	0…50 °C			

PROBE FOR THE MEASUREMENT OF UVBC IRRADIANCE **LP471UVBC**

Measuring range (W/m^2)	$1x10^{-3}$…$999.9x10^{-3}$	1.000…19.999	20.00…199.99	200.0…1999.9
Resolution(W/m^2)	$0.1x10^{-3}$	0.001	0.01	0.1
Spectral range	210…355 nm (Peak 265 nm)			
Calibration uncertainty	<7% (calibration @ 254 nm)			
f_3 (linearity)	<2%			
f_4 (error in instrument reading)	±1digit			
f_5 (fatigue)	<0.5%			
1 year drift	<2%			
Operating temperature	0…50 °C			

PROBE FOR THE MEASUREMENT OF EFFECTIVE IRRADIANCE IN BLUE LIGHT SPECTRAL BAND **LP471BLUE**

Measuring range (W/m^2)	$1x10^{-3}$…$999.9x10^{-3}$	1.000…19.999	20.00…199.99	200.0…1999.9
Resolution(W/m^2)	$0.1x10^{-3}$	0.001	0.01	0.1
Spectral range	380…550 nm, action curve for blue-light induced damage B(λ)			
Calibration uncertainty	<10%			
f_2 (response as law of cosines)	<6%			
f_3 (linearity)	<3%			
f_4 (error in instrument reading)	±1digit			
f_5 (fatigue)	<0.5%			
1 year drift	<2%			
Operating temperature	0…50 °C			

Note: for the spectral response curves of the LP471… probes, see the probes datasheet available on the website.

16 Summary of measured parameters and calculated indices

The following table shows which indices require calculation using the DeltaLog10 software and in which section of the software they can be calculated. When the software section is not specified, the indices are calculated directly by the instrument.

OPERATING PROGRAM **A**

Measured parameters	Main indices calculated	DeltaLog10
T_{nw}: wet bulb temperature **T_g**: globe thermometer temperature **T_a**: ambient temperature **P_r**: barometric pressure **RH**: relative humidity **V_a**: air speed	**WBGT indoor** **WBGT outdoor** **Tr**: mean radiant temperature **TU**: turbulence **WCI**: wind chill index	
	DR: draft rate	Local discomfort
	PMV: predicted mean vote **PPD**: predicted percentage of dissatisfied	Moderate environments
	IREQ: required insulation **Dlim**: limit exposure time **RT**: recovery time	Cold environments
	PHS: predicted heat strain	Very hot environments
	IS: Scharlau index **DI**: Thom index **THI**: thermo-hygrometric index **RSI**: relative strain index **SSI**: new summer simmer index **HI**: heat index **H**: humidex index **T_{eq}**: equivalent temp. index	Discomfort indices

OPERATING PROGRAM **B**

Measured parameters	Main indices calculated	DeltaLog10
T_h: air temperature at head height **T_b**: air temperature at abdomen height **T_k**: air temperature at ankle height **T_f**: temperature at floor level **T_n**: temperature of the net radiometer **P**: net radiation **DT**: radiant asymmetry temperature	**PD_v**: percentage of dissatisfied with vertical temperature difference **PD_f**: percentage of dissatisfied with floor temperature **PD_Δ**: percentage of dissatisfied with radiant asymmetry	Local discomfort

OPERATING PROGRAM **C**

Measured parameters	Main indices calculated	DeltaLog10
T_a: temperature **RH**: relative humidity **V_a**: air speed **CO_2**: carbon dioxide **CO**: carbon monoxide Photo-radiometric parameters: illuminance luminance PAR UVA, UVB, UVC, UVBC, blue light irradiance	**FLD**: daylight factor	Discomfort indices

16.1 Probes required for the calculation of microclimate indices

In the following tables, each row represents a possible combination of probes that allows for the calculation of the corresponding indices. The probes are grouped by type; probes that measure the same parameters are alternatives.

The parameters required to calculate the indices are indicated in square brackets.

OPERATING PROGRAM **A**

Measured parameters	T_a	T_g	T_{nw}	T_a+T_{nw}	V_a	T_a+UR
Probes / Calculated indices	TP3207	TP3275 or TP3276	HP3201 or TP3204S	HP3217DM	AP3203 or AP3203F	HP3217R
WBGT indoor [▶ T_g, T_{nw}]		•	•			
WBGT outdoor	•	•	•			
[▶ T_a, T_g, T_{nw}]		•		•		
		•	•			•
Tr: mean radiant temperature	•	•			•	
[▶ T_a, T_g, V_a]		•		•	•	
		•			•	•
TU: turbulence [▶ V_a]					•	
DR: draft rate	•				•	
WCI: wind chill index				•	•	
[▶ T_a, V_a]					•	•
PMV: predicted mean vote **PPD**: predicted percentage of dissatisfied **IREQ**: required insulation **Dlim**: limit exposure time **RT**: recovery time **PHS**: predicted heat strain [▶ T_a, T_g, V_a, RH]		•			•	•

Measured parameters / Probes / Calculated indices	T_a TP3207	T_g TP3275 or TP3276	T_{nw} HP3201 or TP3204S	T_a+T_{nw} HP3217DM	V_a AP3203 or AP3203F	T_a+UR HP3217R
IS: Scharlau index **DI**: Thom index **THI**: thermo-hygrometric index **RSI**: relative strain index **SSI**: new summer simmer index **HI**: heat index **H**: humidex index **T_{eq}**: equivalent temp. index [▶ **T_a, RH**]						•

OPERATING PROGRAM **B**

Measured parameters / Probes / Calculated indices	T_h+T_b TP3227K	T_k+T_f TP3227PC	T_f TP3207P	T_n+P TP3207R
PD_v: percentage of dissatisfied with vertical temperature difference [▶ **T_h, T_k**]	•	•		
PD_f: percentage of dissatisfied with floor temperature		•		
[▶ **T_f**]			•	
PD_Δ: percentage of dissatisfied with radiant asymmetry [▶ **P**]				•

OPERATING PROGRAM **C**

Measured parameters / Probes / Calculated indices	Lux LP471PHOT
FLD: daylight factor [▶ **Lux**]	•

17 Probes and accessories ordering codes

The instrument is supplied with 4 x 1.5 V C size alkaline batteries.

DeltaLog10 software is downloadable from website.

Probes, SWD10 external power supply, cables for connection to PC and carrying case must be ordered separately.

Probes with SICRAM module for operating program A

TP3207 Dry bulb temperature probe, Pt100 sensor. Ø14 mm, L=140 mm. Cable 2 m.

TP3275 Globe thermometer probe, Pt100 sensor. Globe Ø150 mm. Stem Ø14 mm, L=110 mm. Cable 2 m.

TP3276 Globe thermometer probe, Pt100 sensor. Globe Ø50 mm. Stem Ø8 mm, L=170 mm. Cable 2 m.

HP3201 Natural ventilation wet bulb temperature probe, Pt100 sensor. Stem Ø14 mm, L=110 mm. Cable 2 m. Supplied with spare cotton wick and 50 cc of distilled water.

TP3204S Natural ventilation wet bulb temperature probe for long-lasting measurements, Pt100 sensor. Stem Ø14 mm. Cable 2 m. Supplied with spare cotton wick and 500 cc bottle.

HP3217DM Combined dry bulb and natural ventilation wet bulb temperature probe, Pt100 sensors. Stem Ø14 mm, L=170 mm. Cable 2 m. Supplied with spare cotton wick and 50 cc of distilled water.

HP3217R Relative humidity and temperature combined probe. Capacitive RH sensor and Pt100 temperature sensor. Stem Ø14 mm, L=150 mm. Cable 2 m.

AP3203 Omnidirectional hot-wire air speed probe. Measuring range 0.02…5 m/s, 0…80 °C. Stem Ø8 mm, L=230 mm. Cable 2 m.

AP3203F Omnidirectional hot-wire air speed probe. Measuring range 0.02…5 m/s, -30…30 °C. Stem Ø8 mm, L=230 mm. Cable 2 m.

Probes with SICRAM module for operating program B

TP3227K Probe consisting of two independent temperature probes, Pt100 sensors. Adjustable lower sensor height. It can be used for the discomfort analysis of standing or seated subjects. Stem Ø14 mm, L=490 mm + extension L=450 mm. Cable 2 m.

TP3227PC Probe consisting of two independent probes for the measurement of the temperature at floor level and ankle height, Pt100 sensors. Ø=70 mm, H=100 mm. Cable 2 m.

TP3207P Probe for the measurement of floor temperature, Pt100 sensor. Ø=70 mm, H=32 mm. Cable 2 m.

TP3207TR Net radiometer. Stem Ø16 mm, head Ø80 mm. Cable 2 m.

Probes with SICRAM module for operating program C

TEMPERATURE PROBES

TP472I Pt100 immersion probe. Stem Ø3 mm, L=300 mm. Cable 2 m.

TP472I.O Pt100 immersion probe. Stem Ø3 mm, L=230 mm. Cable 2 m.

TP473P.I Pt100 penetration probe. Stem Ø4 mm, L=150 mm. Cable 2 m.

TP473P.O Pt100 penetration probe. Stem Ø4 mm, L=150 mm. Cable 2 m.

TP474C.O Pt100 contact probe. Stem Ø4 mm, L=230 mm, contact surface Ø5 mm. Cable 2 m.

TP475A.O Pt100 air probe. Stem Ø4 mm, L=230 mm. Cable length 2 m.

TP472I.5 Pt100 penetration probe. Stem Ø6 mm, L=500 mm. Cable 2 m.

TP472I.10 Pt100 penetration probe. Stem Ø6 mm, L=1000 mm. Cable 2 m.

RELATIVE HUMIDITY AND TEMPERATURE COMBINED PROBES

HP472ACR %RH and temperature combined probe. Ø26x170 mm. Cable 2 m.

HP473ACR %RH and temperature combined probe. Handle Ø26x130 mm, stem Ø14x120 mm. Cable 2 m.

HP474ACR %RH and temperature combined probe. Handle Ø26x130 mm, stem Ø14x215 mm. Cable 2 m.

HP475ACR %RH and temperature combined probe. Handle Ø26x110 mm. Stainless steel stem Ø12x560 mm. Tip Ø13,5x75 mm. Cable 2 m.

HP475AC1R %RH and temperature combined probe. Handle 80mm. Stainless steel stem Ø14x480 mm. Cable 2 m.

HP477DCR %RH and temperature combined sword probe. Handle Ø26x110 mm. Probe stem 18x4 mm, length 520 mm. Cable 2 m.

HP478ACR %RH and temperature combined probe. Stainless steel stem Ø14x130 mm. Cable 5 m.

HOT-WIRE AIR SPEED PROBES

AP471S1 Extensible hot-wire probe. Measuring range 0.02…40 m/s. Cable 2 m.

AP471S2 Omnidirectional extensible hot-wire probe. Measuring range 0.02…5 m/s. Cable 2 m.

AP471S3 Extensible hot-wire probe with shapeable end. Measuring range 0.02…40 m/s. Cable 2 m.

AP471S4 Omnidirectional extensible hot-wire probe with base. Measuring range 0.02…5 m/s. Cable 2 m.

VANE AIR SPEED PROBES

AP472 S1 Vane probe with thermocouple K, Ø100 mm. Measuring range 0.6…25 m/s, -25…80 °C. Cable 2 m.

AP472 S2 Vane probe, Ø60 mm. Measuring range 0.5…20 m/s. Cable 2 m.

PHOTO-RADIOMETRIC PROBES

LP471PHOT Photometric probe for the measurement of **illuminance**. Spectral response according to standard photopic vision, diffuser for cosine correction. Measuring range 0.1…200x10^3 lux. Cable 1.5 m.

LP471RAD Radiometric probe for the measurement of **irradiance** in the spectral range 400…1050 nm. Diffuser for cosine correction. Measuring range 1x10^{-3}…2000 W/m^2. Cable 1.5 m.

LP471PAR Quantum-radiometric probe for the measurement of photon flux in the **PAR** chlorophyll field (photosynthetically Active Radiation 400…700 nm). Diffuser for cosine correction. Measuring range 0.1…10x10^3 μmol/m^2s. Cable 1.5 m.

LP471PAR02 Quantum-radiometric probe for the measurement of photon flux in the **PAR** chlorophyll field (photosynthetically Active Radiation 400…700 nm). **Quartz** diffuser for cosine correction. Measuring range 0.1…10x10^3 μmol/m^2s. Cable 1.5 m.

LP471UVA Radiometric probe for the measurement of **irradiance** in the 315…400 nm **UVA** spectral range, peak at 365 nm. Quartz diffuser for cosine correction. Measuring range 1x10^{-3}…2000 W/m^2. Cable 1.5 m.

LP471UVB Radiometric probe for the measurement of **irradiance** in the 280…315 nm **UVB** spectral range, peak at 305 nm. Quartz diffuser for cosine correction. Measuring range 1x10^{-3}…2000 W/m^2. Cable 1.5 m.

LP471UVC Radiometric probe for the measurement of **irradiance** in the 220…280 nm **UVC** spectral range, peak at 260 nm. Quartz diffuser for cosine correction. Measuring range 1x10^{-3}…2000 W/m^2. Cable 1.5 m.

LP471UVBC Radiometric probe for the measurement of **irradiance** in the 210…355 nm **UVBC** spectral range, peak at 265 nm. Quartz diffuser for cosine correction. Measuring range 1x10^{-3}…2000 W/m^2. Cable 1.5 m.

LP471LUM2 Radiometric probe for the measurement of **effective irradiance** in the **Blue** light spectral band. Spectral range 380…550 nm, diffuser for cosine correction. Measuring range 1x10^{-3}…2000 W/m^2. Cable 1.5 m.

LP471BLUE Radiometric probe for the measurement of effective irradiance in the Blue light spectral band. Spectral range 380…550 nm, diffuser for cosine correction. Measuring range 1x10^{-3}…2000 W/m^2. Cable 1.5 m.

LP32F/R Support for fixing LP471... a photo-radiometric probe to SP32TC.8.

CO_2 AND CO PROBES

HD320B2 CO_2 probe. Double source infrared sensor. Measuring range 0…5000 ppm. Cable 2 m.

HD320A2 CO probe. 2-electrode electrochemical sensor. Measuring range 0…500 ppm. Cable 2 m.

HD320AS2 Magnetic support for fixing the probe HD320A2 to the probe HD320B2.

HD37.37 Connection tube kit between probe and nitrogen cylinder for CO_2 calibration.

HD37.36 Connection tube kit between probe and nitrogen cylinder for CO calibration.

Accessories

VTRAP	Tripod, max. height 1310 mm (SP32TC.8 support not included).
SP32TC.8	Holder for instrument and 8 probes with cable. To be fixed to VTRAP tripod.
9CPRS232	RS232C null-modem cable, Sub-D 9-pole female connector on both sides.
CP22	USB 2.0 cable, connector type A on one side, type B on the other side.
BAG32	Aluminum carrying case for the instrument and its accessories.
SWD10	100-240 Vac/12 Vdc-1 A stabilized mains power supply.
AQC	200 cc distilled water.

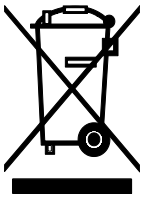
WARRANTY

The manufacturer is required to respond to the "factory warranty" only in those cases provided by Legislative Decree 6 September 2005 - n. 206. Each instrument is sold after rigorous inspections; if any manufacturing defect is found, it is necessary to contact the distributor where the instrument was purchased from. During the warranty period (24 months from the date of invoice) any manufacturing defects found will be repaired free of charge. Misuse, wear, neglect, lack or inefficient maintenance as well as theft and damage during transport are excluded. Warranty does not apply if changes, tampering or unauthorized repairs are made on the product. Solutions, probes, electrodes and microphones are not guaranteed as the improper use, even for a few minutes, may cause irreparable damages.
The manufacturer repairs the products that show defects of construction in accordance with the terms and conditions of warranty included in the manual of the product. For any dispute, the competent court is the Court of Padua. The Italian law and the "Convention on Contracts for the International Sales of Goods" apply.

TECHNICAL INFORMATION

The quality level of our instruments is the result of the continuous product development. This may lead to differences between the information reported in the manual and the instrument you have purchased.
We reserve the right to change technical specifications and dimensions to fit the product requirements without prior notice.

DISPOSAL INFORMATION



Electrical and electronic equipment marked with specific symbol in compliance with 2012/19/EU Directive must be disposed of separately from household waste. European users can hand them over to the dealer or to the manufacturer when purchasing a new electrical and electronic equipment, or to a WEEE collection point designated by local authorities. Illegal disposal is punished by law.

Disposing of electrical and electronic equipment separately from normal waste helps to preserve natural resources and allows materials to be recycled in an environmentally friendly way without risks to human health.

CE RoHS

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