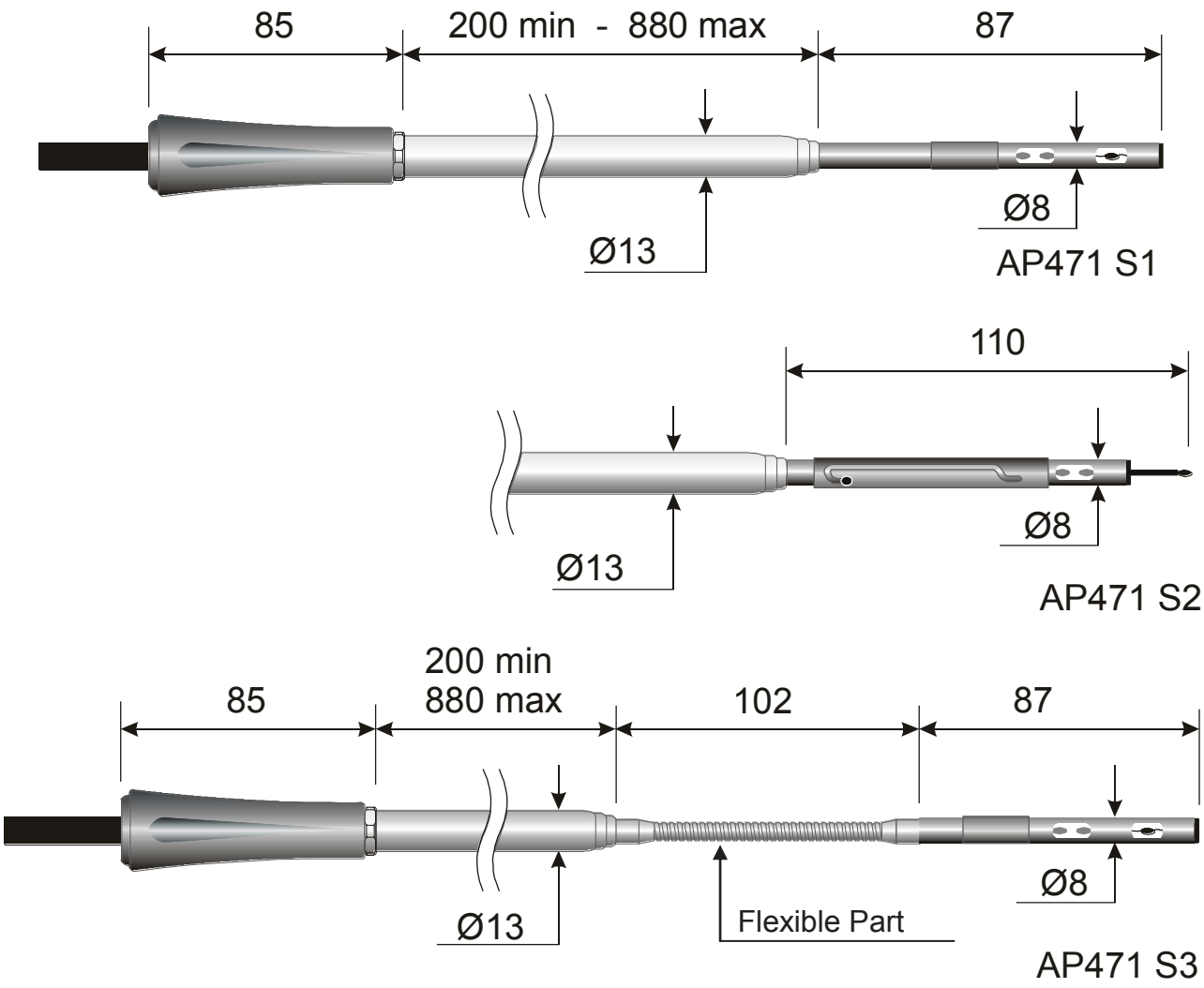
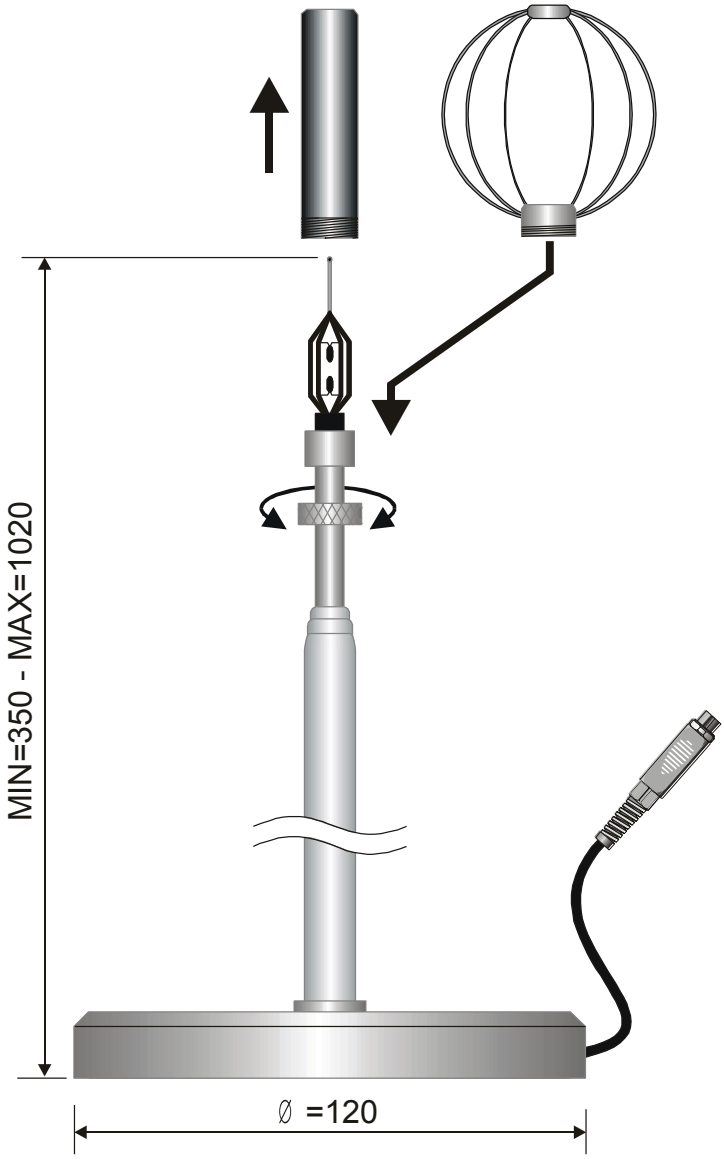
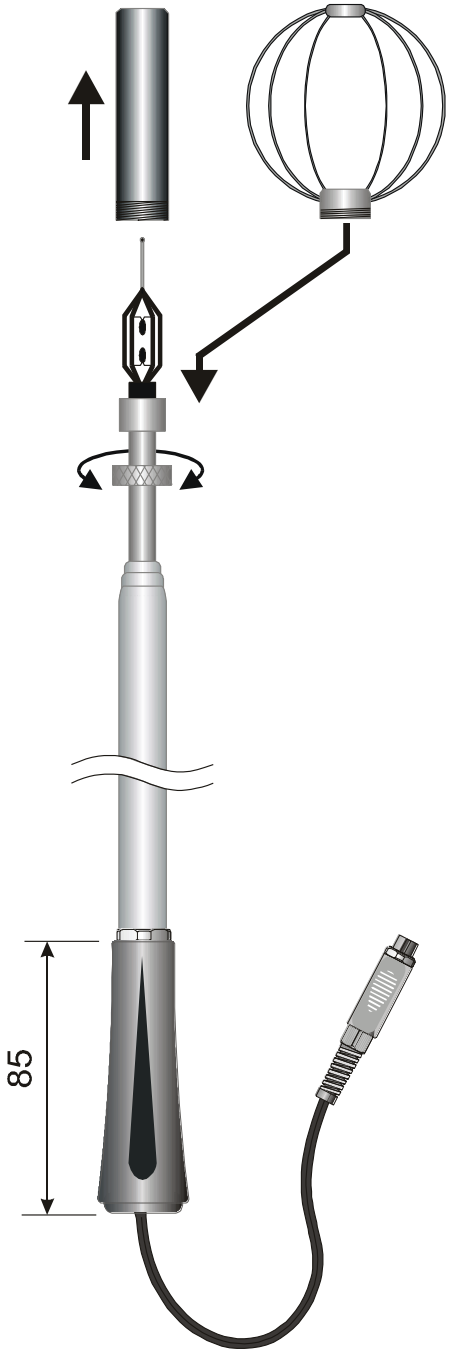
**Dimensions**


85
200 min - 880 max
87
Ø8
Ø13
AP471 S1
110
Ø8
Ø13
AP471 S2
200 min
880 max
85
102
87
Ø8
Ø13
Flexible Part
AP471 S3




AP471 S4




AP471 S5

### *6.2.8 AP472S… Vane wind speed measurement probes complete with SICRAM module*

The AP472 S1, S2 and S4 vane probes measure the incident wind speed and flow rate. The probes AP472 S1, AP472 S4LT and AP472 S4HT measure also the temperature using a thermocouple of type K. On request, they can be fitted with a telescopic rod that eases measurements in areas difficult to reach (for example vents). The probes' speed and temperature measurement ranges are outlined in the table below:

| | **Speed (m/s)** | **Temperature (°C)** | **Temperature sensor** | **Diameter (mm)** |
|---|---|---|---|---|
| **AP472 S1** | 0.6…25 | -25…+80 | Thermocouple K | 100 |
| **AP472 S2** | 0.3…20 | -25…+80 (functioning temperature) | ---- | 60 |
| **AP472 S4L** | 0.8…20 | -25…+80 (functioning temperature) | ---- | 16 |
| **AP472 S4LT (on request)** | 0.8…20 | -30…+120 (*) | Thermocouple K | 16 |
| **AP472 S4H** | 10…50 | -25…+80 (functioning temperature) | ---- | 16 |
| **AP472 S4HT (on request)** | 10…50 | -30…+120 (*) | Thermocouple K | 16 |

(*) The temperature limit refers to the probe head, where the vane and temperature sensors are located, and not to the handle, cable and telescopic rod that can be subjected to maximum temperatures of 80°C.

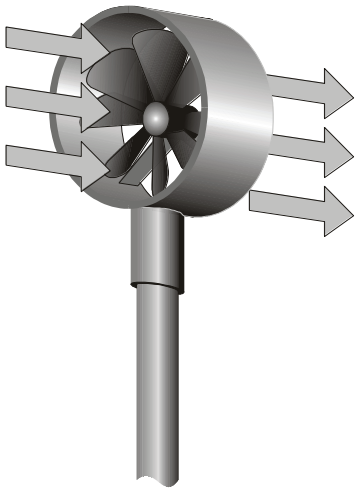
Greater diameters are suitable for flow measurements in the presence of turbulence with medium-low air speeds (i.e. at the exit of the ducts). Lower diameters are suitable in applications where the probe surface must be much slower than the duct cross section within which the measurement is carried out, i.e. ventilation ducts.

## Calibrations

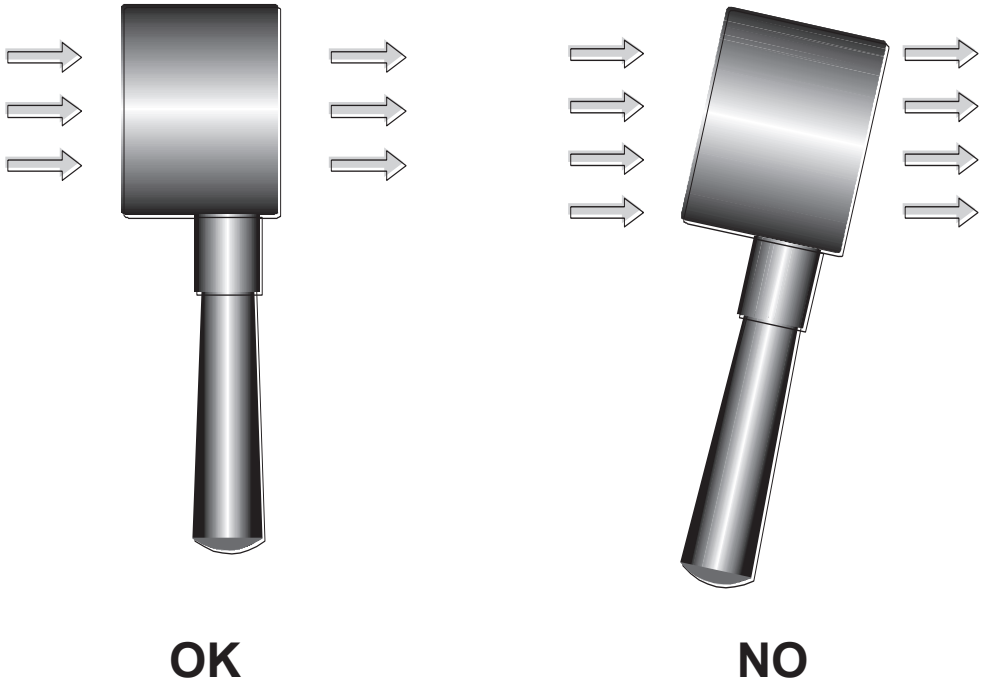
The AP472 S1, S2 and S4 probes are calibrated in the factory; no calibration is required by the user.

## Operation

Where present, extend the telescopic rod to the necessary length **paying attention to the cable so that it can slide freely and without strain**.
Introduce the probe in the air flow being measured, maintaining the arrow at the top of the probe parallel to the flow as indicated in the following figure.



The probe should be maintained orthogonal to the flow and not tilted in relation to it:

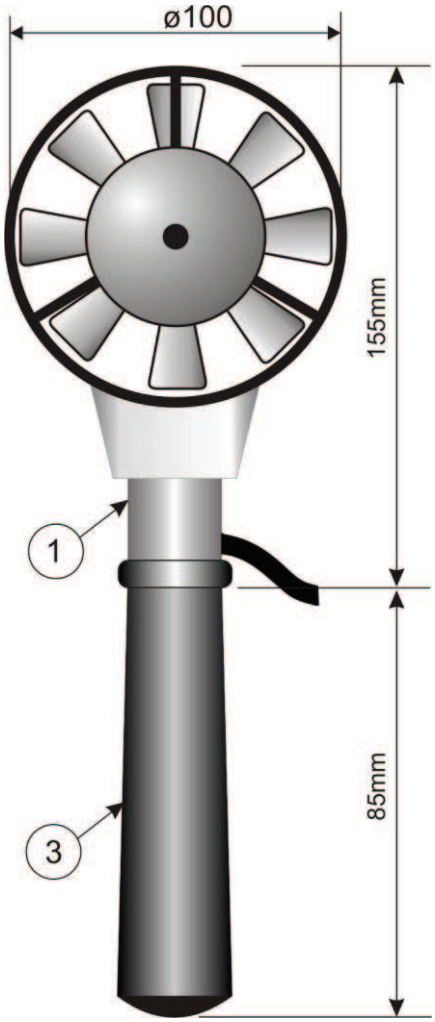



The probe is correctly positioned in relation to the air-flow when the value measured is the maximum possible.
Proceed with measurement following the instructions provided in this chapter.

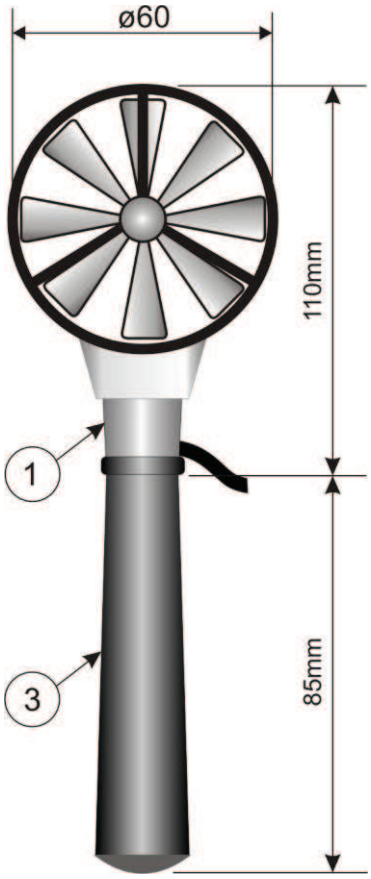
## Care and maintenance of the probes

The probe performance, mainly at low speeds, largely depends on the very slow friction of the vane on its own axis. In order not to compromise this characteristic, it is recommended that forcing is avoided, as well as blocking or rotating the vane with the fingers, and if possible, avoid inserting it in air flows that could soil the probe.

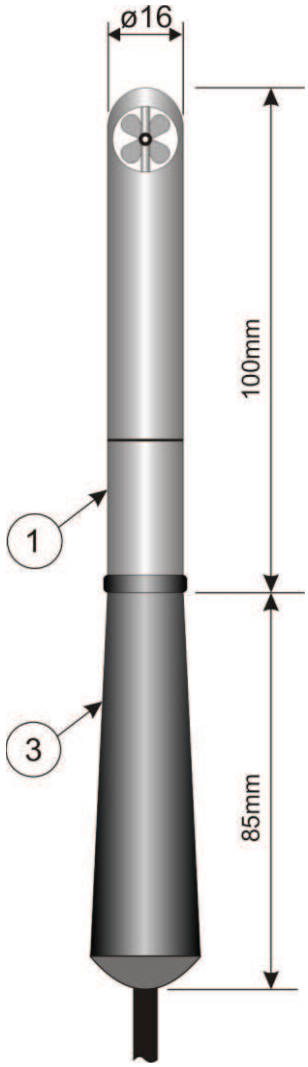
## Dimensions




**AP472 S1**

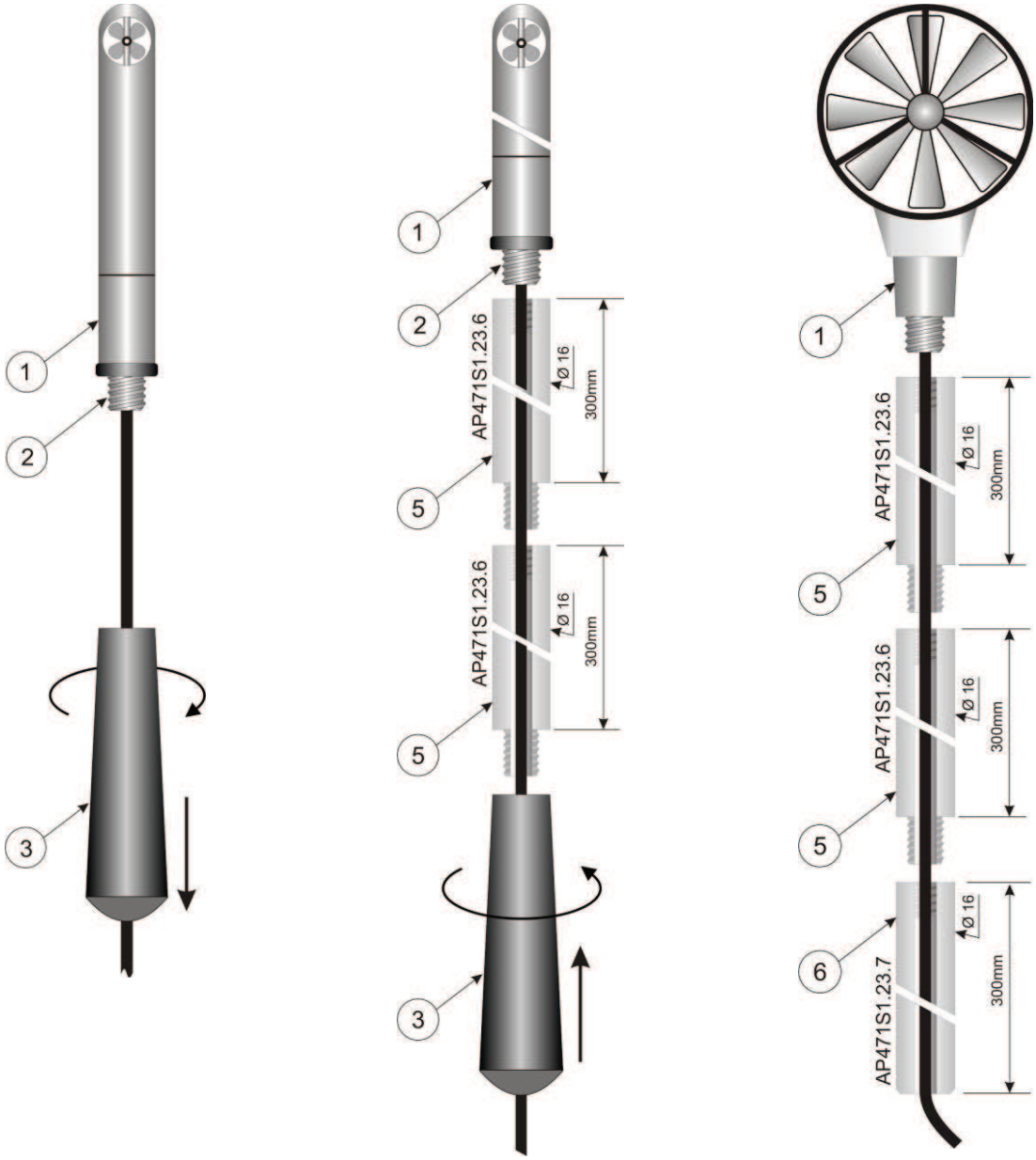



**AP472 S2**




**AP472 S4**

Unscrew the handle (3) holding the probe body still in the point (1).




The **AP472 S1 - AP472 S2** probes, in addition to the telescopic rod with swivel head can use the rigid telescopic rod ∅16 mm. Unscrew the handle (3) holding the probe body still in the point (1). Screw the rod end **AP471S1.23.6** (5) on the screw (2). You can add more telescopic rods **AP471S1.23.6**. The last element can be the handle (3) or the telescopic rod **AP471S1.23.7** (6).

The **AP472 S4** probe can be used with the rigid telescopic rods **AP471S1.23.6**.

### *6.2.9 Technical information on Vane wind speed measurement probes using SICRAM module*

| | **AP472 S1** | **AP472 S2** | **AP472 S4…** | | | |
|---|---|---|---|---|---|---|
| | | | **L** | **LT** | **H** | **HT** |
| *Type of Measurements* | Air velocity, calculated flow, air temperature | Air velocity, calculated flow | Air velocity, calculated flow | Air velocity, calculated flow, air temperature | Air velocity, calculated flow | Air velocity, calculated flow, air temperature |
| *Diameter* | 100 mm | 60 mm | 16 mm | | | |
| *Type of Measurement* | | | | | | |
| Velocity | Vane | Vane | Vane | | | |
| Temperature | Tc K | ---- | ---- | Tc K | ---- | Tc K |
| *Measuring Range* | | | | | | |
| Velocity (m/s) | 0.6…25 | 0.3…20 | 0.8…20 | | 10…50 | |
| Temperature | -25…+80 | -25…+80 (*) | -25...+80 (*) | -30..+120 (**) | -25...+80 (*) | -25…+80 |
| *Resolution* | | | | | | |
| Velocity | 0.01 m/s - 0.1 km/h - 1 ft/min - 0.1 mph - 0.1 knots | | | | | |
| Temperature | 0.1°C | ---- | ---- | 0.1°C | ---- | 0.1°C |
| *Accuracy* | | | | | | |
| Velocity | ±(0.2 m/s +1.5%f.s.) | ±(0.2m/s +1.5%f.s.) | ±(0.3 m/s +1.5%f.s.) | | | |
| Temperature | ±0.5°C | ---- | ---- | ±0.5°C | ---- | ±0.5°C |
| *Min. Velocity* | 0.6m/s | 0.3m/s | 0.8m/s | | 10m/s | |

(*) The indicated value refers to the working range of the fan.
(**) The temperature limit refers to the probe head where the fan and the temperature sensor are placed , and not to the grip, to the cable and the stretchable rod that must be undertaken at the maximum 80°C temperatures.

### *6.2.10 Light measurement*

The instrument works with probes of the LP471… series: These are photometric and radiometric probes that measure **illumination** (LP471 PHOT), **irradiance** (LP471 RAD, LP471 UVA, LP471 UVB and LP471 UVC), **PAR** (LP471 PAR), **luminance** (LP471 LUM 2), and effective irradiance according to the UV action curve (LP471 ERY). All the probes, save the LUM 2, are provided with a diffuser for cosine correction.

**Upon turning on** the instrument automatically detects the probe connected to the input: It is sufficient to connect it. If the instrument is already on, turn it off and back on again in order for the probe to be detected. The unit of measurement is determined according to the probe connected to the input: In cases where more than one unit of measurement is provided for the same probe, use the UNIT key to select the one desired.

All probes are calibrated in the factory; no calibration is required by the user.

**The probe is detected during turn on, and this cannot be performed when the instrument is already on, therefore if a probe is connected and the instrument is on, it is necessary to turn it off and on**.

### *6.2.11 Technical characteristics of photometric and radiometric probes complete with SICRAM module to be connected with the instruments on line*

**ILLUMINANCE measurement probe LP 471 PHOT complete with SICRAM module and equipped with the instrument**

| | | | | |
|---|---|---|---|---|
| Measurement range (lux): | 0.01…199.99 | …1999.9 | …19999 | …$199.99 \cdot 10^3$ |
| Resolution (lux): | 0.01 | 0.1 | 1 | $0.01 \cdot 10^3$ |

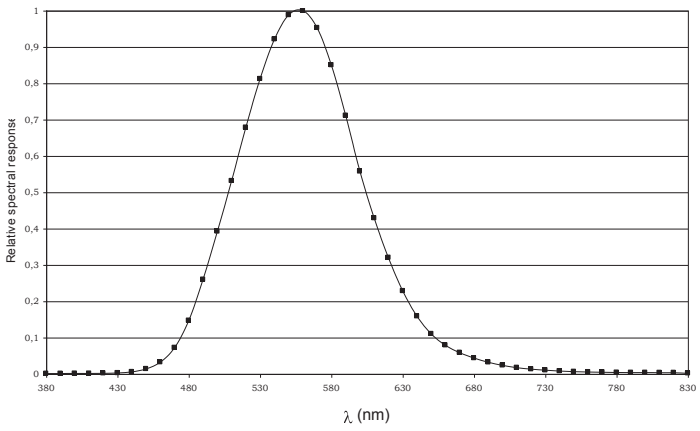
| | |
|---|---|
| Spectral range: | in agreement with standard photopic curve V(λ) |
| Class | C |
| Calibration uncertainty: | <4% |
| f'1 (in agreement with photonic response V(λ)): | <8% |
| $f_2$ (response according to the cosine law): | <3% |
| $f_3$ (linearity): | <1% |
| $f_4$ (instrument reading error): | <0.5% |
| $f_5$ (fatigue): | <0.5% |
| $f_6$ (T) (α temperature coefficient) | <0.05%/K |
| Drift after 1 year: | <1% |
| Working temperature: | 0…50°C |
| Reference Standard | CIE No. 69 |

**LUMINANCE measurement probe LP 471 LUM 2 complete with SICRAM module and equipped with the instrument**

| | | | | |
|---|---|---|---|---|
| Measurement range (cd/m$^2$): | 0.1…1999.9 | …19999 | …$199.99 \cdot 10^3$ | …$1999.9 \cdot 10^3$ |
| Resolution (cd/m$^2$): | 0.1 | 1 | $0.01 \cdot 10^3$ | $0.1 \cdot 10^3$ |

| | |
|---|---|
| Optical angle: | 2° |
| Spectral range: | in agreement with standard photonic curve V(λ) |
| Class | C |
| Calibration uncertainty: | <5% |
| f'1 (in agreement with photonic response V(λ)): | <8% |
| $f_3$ (linearity): | <1% |
| $f_4$ (instrument reading error): | <0.5% |
| $f_5$ (fatigue): | <0.5% |
| $f_6$ (T) (α temperature coefficient) | <0.05% K |
| Drift after 1 year: | <1% |
| Working temperature: | 0…50°C |
| Reference Standard | CIE No. 69 |

*Typical response curve*

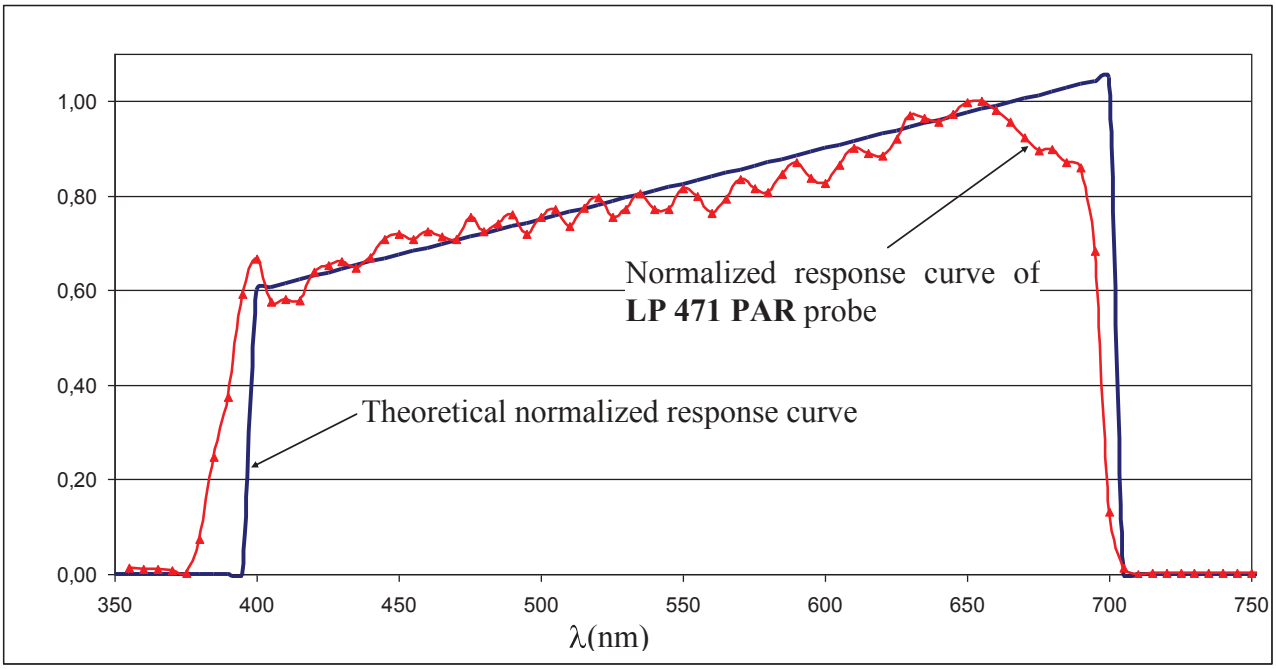


**Quantum radiometric probe for the measurement of the photon flow across the chlorophyll range PAR LP 471 PAR complete with SICRAM module and equipped with the instrument**

| | | | |
|---|---|---|---|
| Measurement range (µmol/m$^2$s): | 0.01… 199.99 | 200.0…1999.9 | 2000…10000 |
| Resolution (µmol/m$^2$s): | 0.01 | 0.1 | 1 |

| | |
|---|---|
| Spectral range: | 400nm…700nm |
| Calibration uncertainty: | <5% |
| $f_2$ (response according to the cosine law): | <6% |
| $f_3$ (linearity): | <1% |
| $f_4$ (instrument reading error): | ±1digit |
| $f_5$ (fatigue): | <0.5% |
| Drift after 1 year: | <1% |
| Working temperature: | 0…50°C |

*Typical normalized response curve*

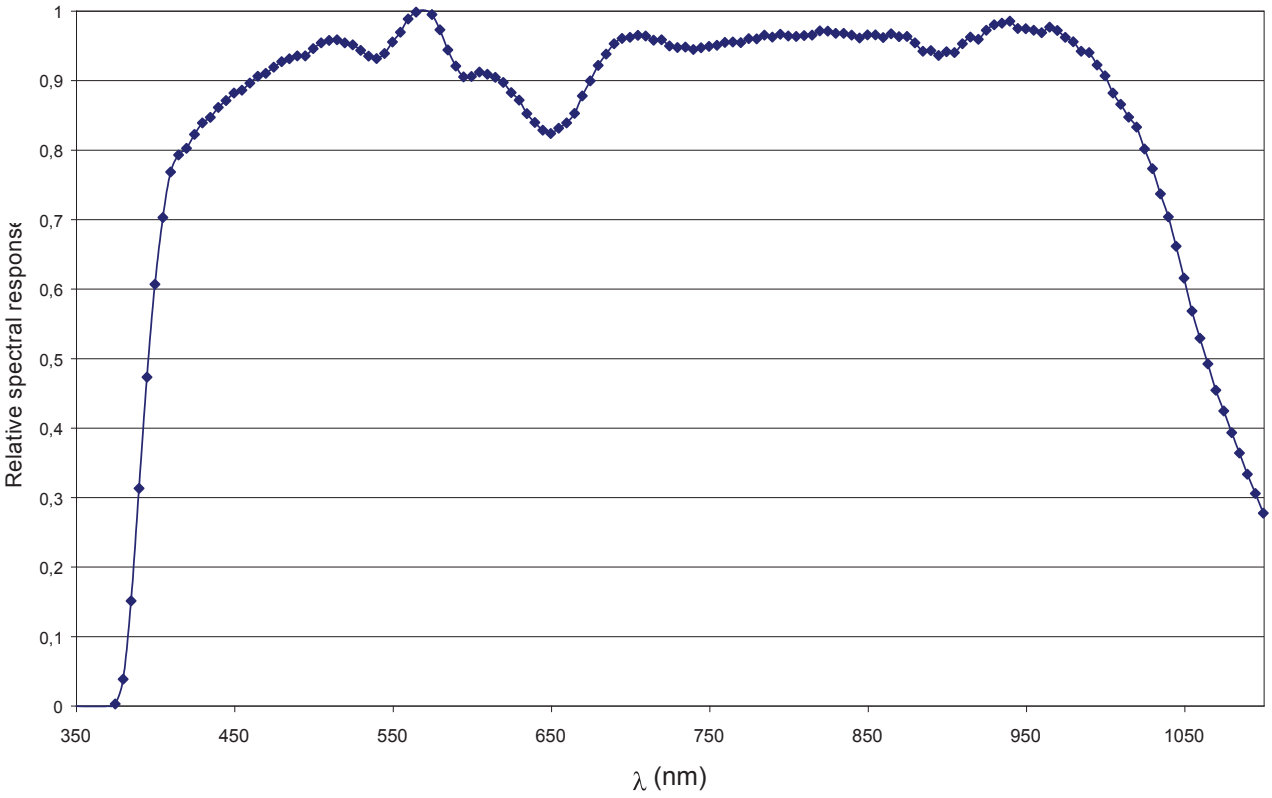


**IRRADIANCE measurement probe LP 471 RAD complete with SICRAM module and equipped with the instrument**

| | | | | |
|---|---|---|---|---|
| Measurement range ($W/m^2$): | $0.1 \cdot 10^{-3}$… $999.9 \cdot 10^{-3}$ | 1.000…19.999 | 20.00…199.99 | 200.0…1999.9 |
| Resolution ($W/m^2$): | $0.1 \cdot 10^{-3}$ | 0.001 | 0.01 | 0.1 |

| | |
|---|---|
| Spectral range: | 400nm…1050nm |
| Calibration uncertainty: | <5% |
| $f_2$ (response according to the cosine law): | <6% |
| $f_3$ (linearity): | <1% |
| $f_4$ (instrument reading error): | ±1digit |
| $f_5$ (fatigue): | <0.5% |
| Drift after 1 year: | <1% |
| Working temperature: | 0…50°C |

*Typical response curve*

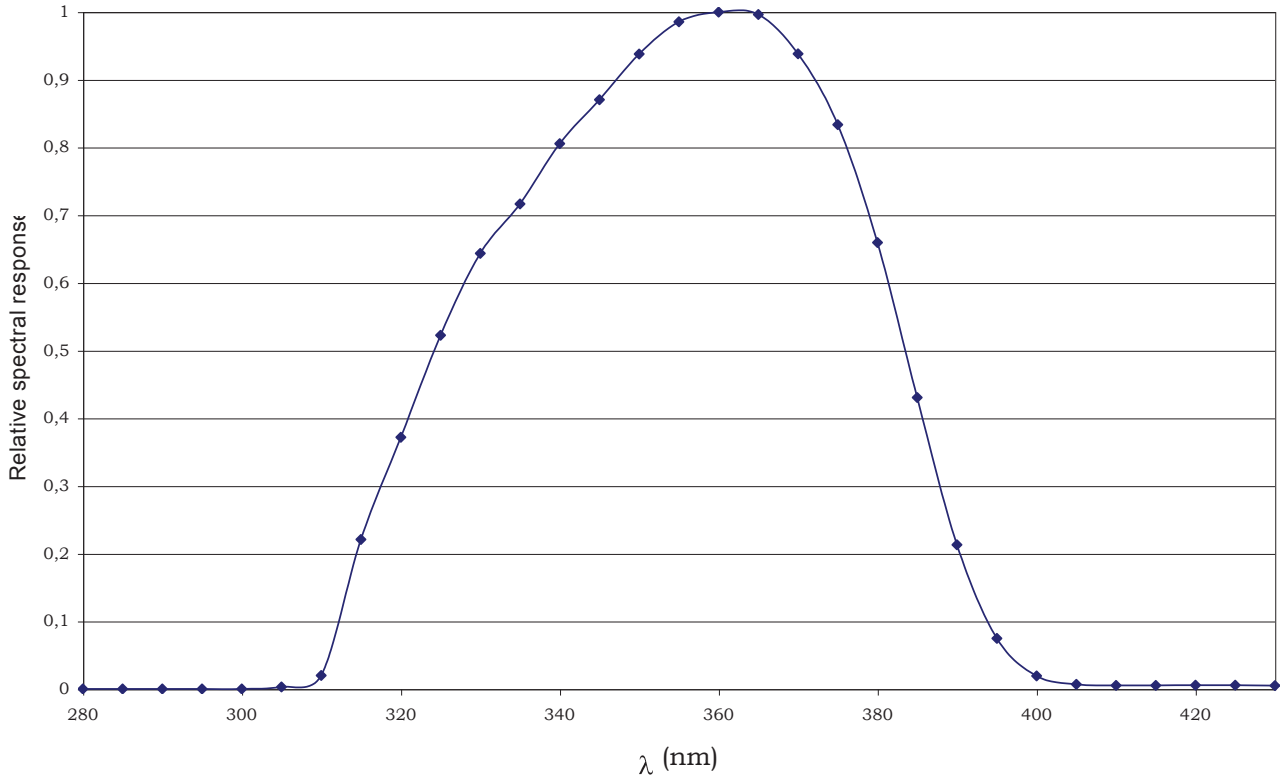


**IRRADIANCE measurement probe LP 471 UVA complete with SICRAM module and equipped with the instrument**

| | | | | |
|---|---|---|---|---|
| Measurement range ($W/m^2$): | $0.1 \cdot 10^{-3}$… $999.9 \cdot 10^{-3}$ | 1.000…19.999 | 20.00…199.99 | 200.0…1999.9 |
| Resolution ($W/m^2$): | $0.1 \cdot 10^{-3}$ | 0.001 | 0.01 | 0.1 |

| | |
|---|---|
| Spectral range: | 315nm…400nm (Peak 360nm) |
| Calibration uncertainty: | <5% |
| $f_2$ (response according to the cosine law): | <6% |
| $f_3$ (linearity): | <1% |
| $f_4$ (instrument reading error): | ±1digit |
| $f_5$ (fatigue): | <0.5% |
| Drift after 1 year: | <2% |
| Working temperature: | 0…50°C |

*Typical response curve*

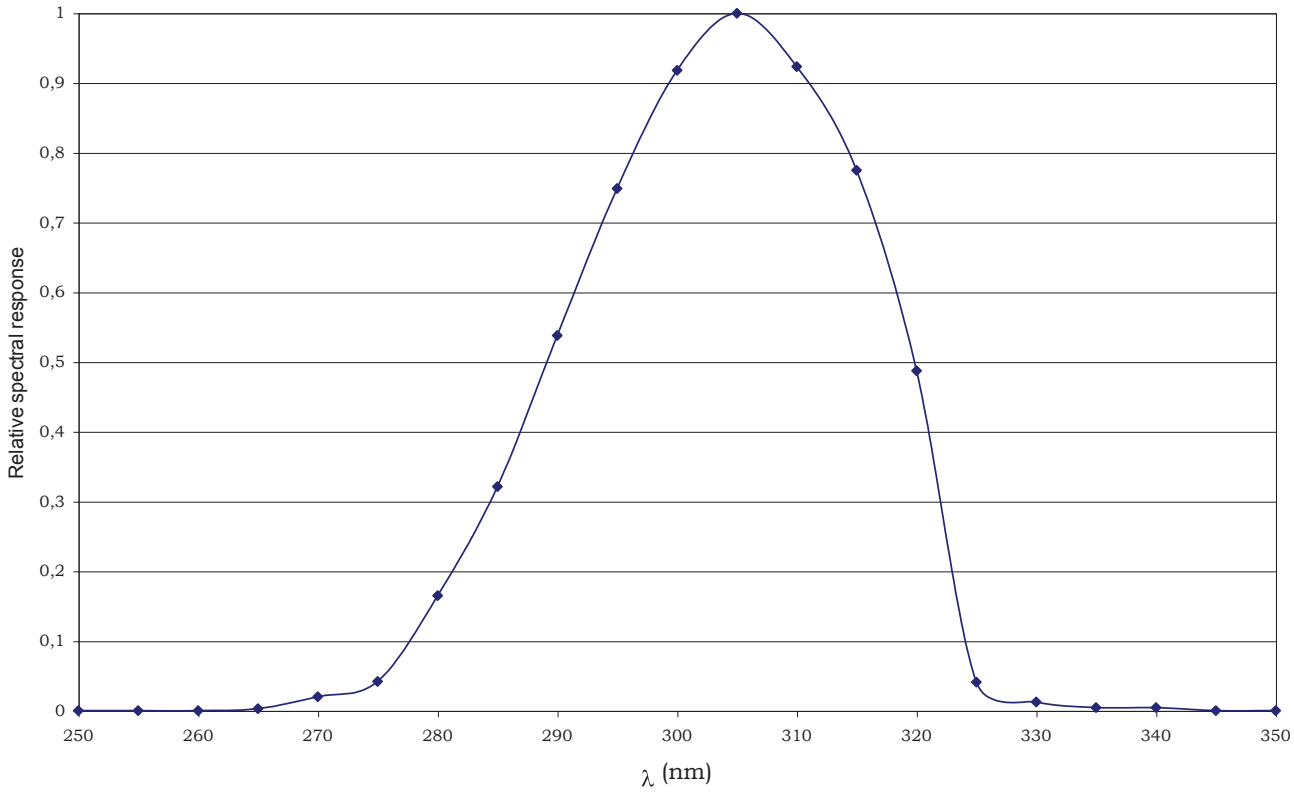


**IRRADIANCE measurement probe LP 471 UVB complete with SICRAM module and equipped with the instrument**

| | | | | |
|---|---|---|---|---|
| Measurement range ($W/m^2$): | $0.1 \cdot 10^{-3}$… $999.9 \cdot 10^{-3}$ | 1.000…19.999 | 20.00…199.99 | 200.0…1999.9 |
| Resolution ($W/m^2$): | $0.1 \cdot 10^{-3}$ | 0.001 | 0.01 | 0.1 |

| | |
|---|---|
| Spectral range: | 280nm…315nm (Peak 305nm) |
| Calibration uncertainty: | <5% |
| $f_2$ (response according to the cosine law): | <6% |
| $f_3$ (linearity): | <2% |
| $f_4$ (instrument reading error): | ±1digit |
| $f_5$ (fatigue): | <0.5% |
| Drift after 1 year: | <2% |
| Working temperature: | 0…50°C |

*Typical response curve*

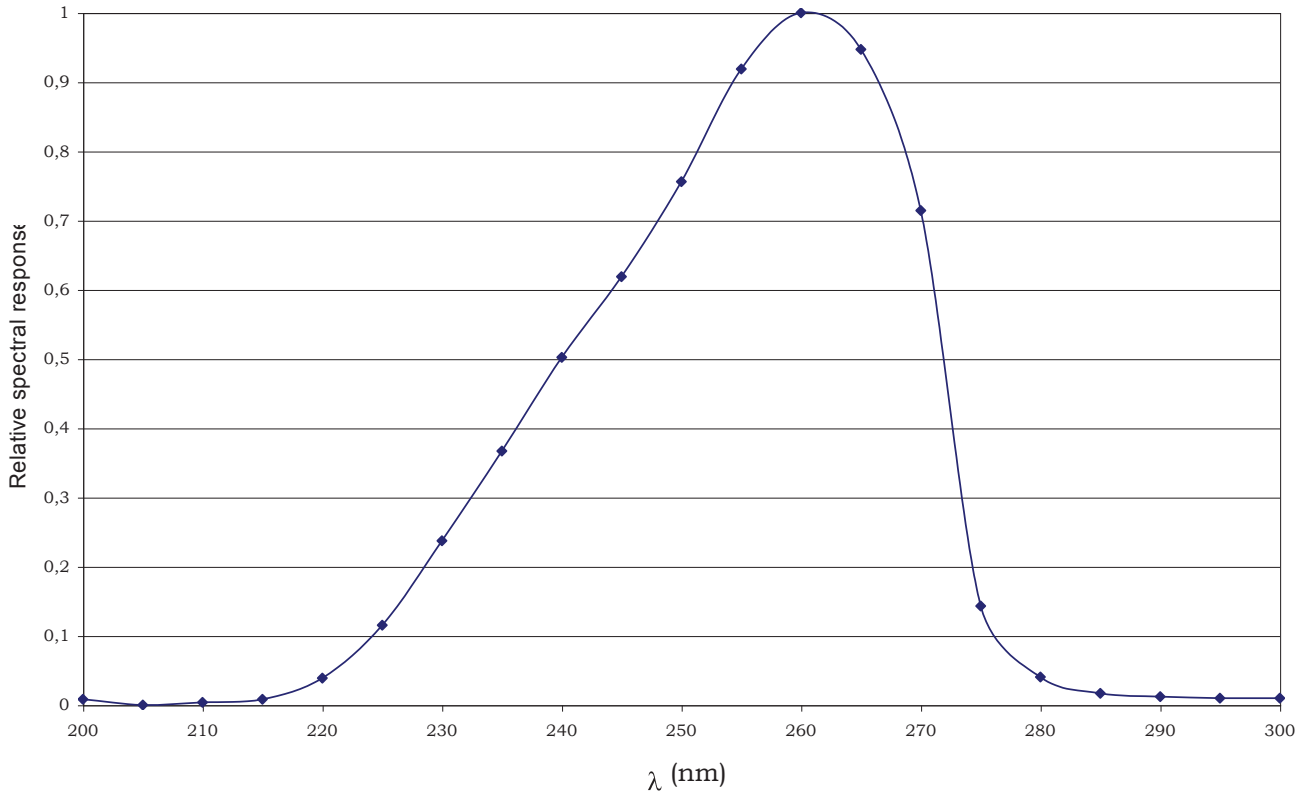


**IRRADIANCE measurement probe LP 471 UVC complete with SICRAM module and equipped with the instrument**

| | | | | |
|---|---|---|---|---|
| Measurement range ($W/m^2$): | $0.1 \cdot 10^{-3}$… $999.9 \cdot 10^{-3}$ | 1.000…19.999 | 20.00…199.99 | 200.0…1999.9 |
| Resolution ($W/m^2$): | 0.1·10-3 | 0.001 | 0.01 | 0.1 |

Spectral range: 220nm…280nm (Peak 260nm)
Calibration uncertainty: <5%
$f_2$ (response according to the cosine law): <6%
$f_3$ (linearity): <1%
$f_4$ (instrument reading error): ±1digit
$f_5$ (fatigue): <0.5%
Drift after 1 year: <2%
Working temperature: 0…50°C

*Typical response curve*

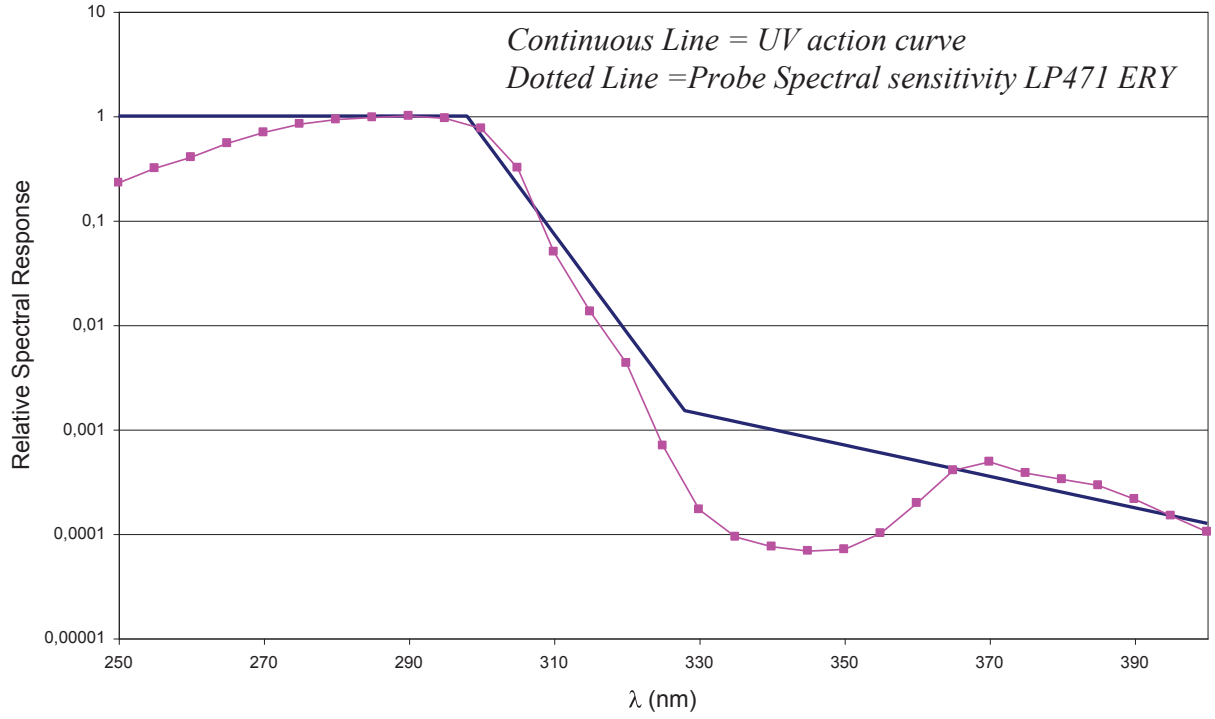


**Measurement probe LP 471ERY OF EFFECTIVE TOTAL IRRADIANCE ($W_{eff}/m^2$) weighted according to the UV action curve (CEI EN 60335-2-27) complete with SICRAM module and equipped with the instrument**

| | | | | |
|---|---|---|---|---|
| Measurement range ($W_{eff}/m^2$): | $0.1 \cdot 10^{-3}$… $999.9 \cdot 10^{-3}$ | 1.000…19.999 | 20.00…199.99 | 200.0…1999.9 |
| Resolution ($W_{eff}/m^2$): | $0.1 \cdot 10^{-3}$ | 0.001 | 0.01 | 0.1 |

| | |
|---|---|
| Spectral range: | UV action curve for erythema measurement (250 nm…400 nm) |
| Calibration uncertainty: | <15% |
| $f_3$ (linearity): | <3% |
| $f_4$ (instrument reading error): | ±1digit |
| $f_5$ (fatigue): | <0.5% |
| Drift after 1 year: | <2% |
| Working temperature: | 0…50°C |
| Reference Standard | CEI EN 60335-2-27 |

*Typical response curve*




The LP 471 ERY probe measures the total effective irradiance ($W_{eff}/m^2$) weighted according to the UV action curve (CEI EN 60335-2-27). The particular photodiode and a proper combination of filters, brings the probe's spectral curve close to the UV action curve.

The CEI EN 60335-2-27 norm prescribes that, during the first tanning treatment, the dosage of 100 $J/m^2$ cannot be exceeded, and that the maximum yearly dosage must not exceed 15000 $J/m^2$.

The typical spectral curve of the LP 471 ERY probe is illustrated in the figure together with the UV action curve:
The agreement between the two curves mean reliable measurements are obtained using the different types of lamps (and filters) used by the tanning machines currently on the market.

All probes are individually calibrated in the DeltaOhm photo-radiometry laboratory, using a dual-beam monochromator. **The calibration is performed at 295 nm, using a SIT calibration photodiode as reference.**

### *6.2.12 HD320A2 probe for the measurement of CO Carbon monoxide*

HD320A2 probe measures the carbon monoxide concentration in air. It's a colorless, odorless gas, lighter than the air and it can cause explosions or fires. It is poisonous even in low quantities: indeed, it's sufficient a concentration of 10-30ppm of carbon monoxide in air to produce symptoms of poisoning and about 2000ppm are fatal in less than 30 minutes.
Carbon monoxide is formed when substances containing carbon are burned in absence of oxygen, or when, although the amount of oxygen is sufficient, the combustion occurs at high temperature, e.g. in car engines.
Carbon monoxide is one of the major pollutant agents in urban areas. Moreover, being odorless, is an insidious poison.
Together with the HD320B2 probe, the HD320A2 probe allows analyzing and monitoring the air quality in internal environments and detecting any loss of CO.

The sensor for the measurement of CO consists of an electro - chemical cell with two electrodes.

**CO probe calibration**

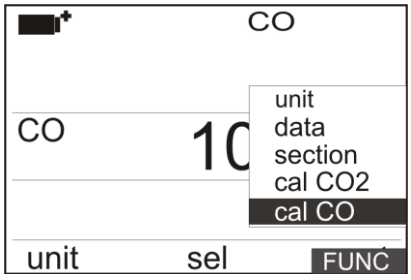
The probe is calibrated by the company and, usually, doesn't request any intervention by the user.

However, there is the possibility to make a new calibration that corrects the sensor zero:

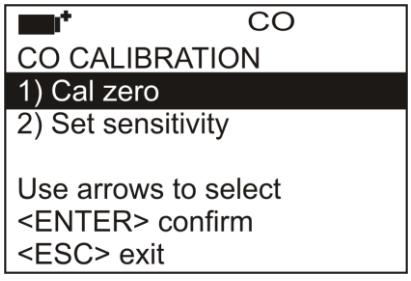
- in clean air (outside the CO concentration is less than 0,1ppm)
- With the help of nitrogen cylinders (code MINICAN.12A).

**CO zero calibration in clean air:**

1. Place the instrument in an environment with clean air (outside, far from the companies or the streets, the CO concentration is less than 0.1ppm), switch the instrument on and wait at least 15 minutes till the measurements becomes stable.
2. Press **SHIFT FNC** key: the shortcut window appears. With ▲▼ arrows select "cal CO" and confirm with ENTER.

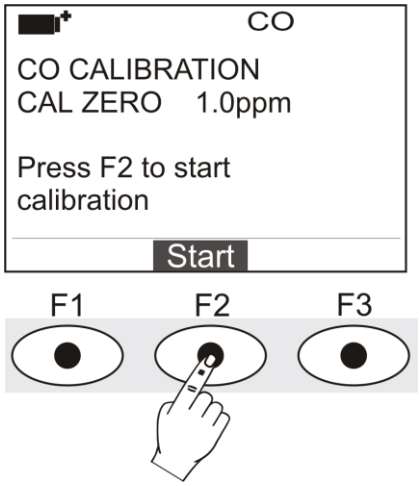



3. The screen for the operation to do on the sensor appears (calibration or replacement):




4. With Up and Down arrows, select "Cal zero" and confirm with ENTER. The screen for the calibration of CO sensor appears.

5. Press F2= START to start the calibration:

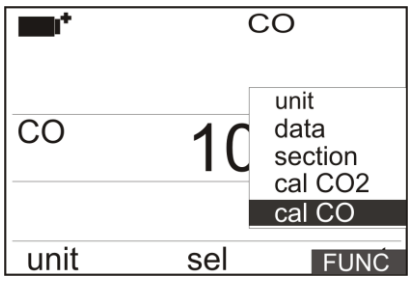



Next to "CAL ZERO" writing is indicated the CO concentration value measured by the instrument.

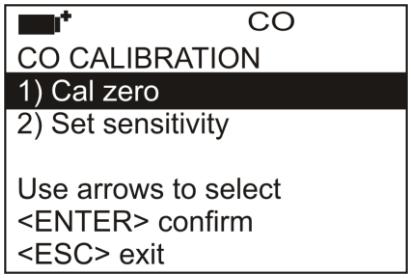
6. During the calibration "*Zero CO in progress*" message appears. Wait for some minutes to execute the process without modifying the working conditions.
7. At the end, the instrument gives an acoustic signal out and visualized "Calibration completed" message. Press F2=Exit for coming to the measurement.
8. The process is finished.

**Zero CO calibration with nitrogen cylinder (code MINICAN.12A):**

1. Switch the instrument on and wait at least 15 minutes till the measurements becomes stable.
2. Connect the pipe coming from MINICAN.12A cylinder with the rubber cowling on the CO sensor head.
3. Press **SHIFT FNC** key: the shortcut window appears. With ▲▼ arrows select "cal CO" and confirm with ENTER.

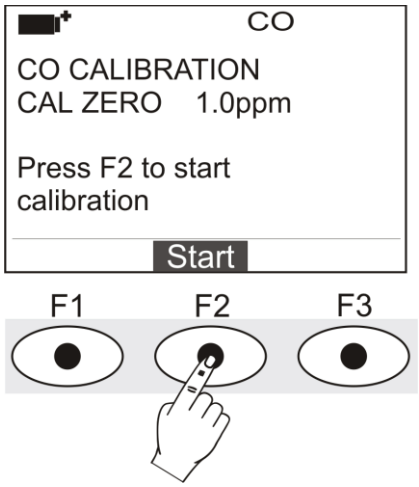



4. The screen for the operation to execute on the sensor appear (calibration or replacement):




5. With Up and Down arrows select "Cal zero" and confirm with ENTER. The screen for CO sensor calibration appears.

6. Supply the gas adjusting the fluxmeter of the cylinder in order to have a constant fluid between 0.1 and 0.2 l/min.
7. Press F2= START to start calibrating:



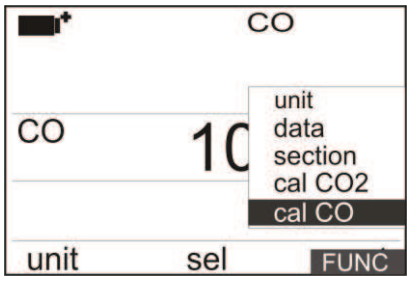

Next to "CAL ZERO" writing is indicated the CO concentration value measured by the instrument.

8. During the calibration "*Zero CO in progress*" message appears. Wait for some minutes to execute the process without modifying the working conditions.
9. At the end, the instrument gives an acoustic signal out and visualized "Calibration completed" message. Close the cylinder tap and remove the CO sensor cowling.
9. Press F2=Exit for coming back to calibrate.
10. Insert the protection.
11. The process is finished.

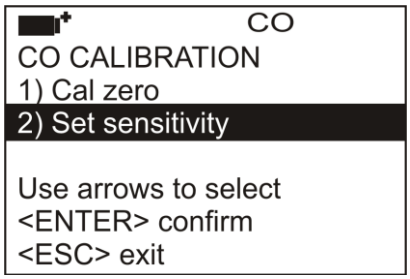
**Replacement of CO sensor:**

In normal conditions of use, CO sensor has an average expected life up to 5 years. If it's necessary to replace CO sensor, order a new sensor (code **ECO-SURE-2E CO**) and go on as indicated below:

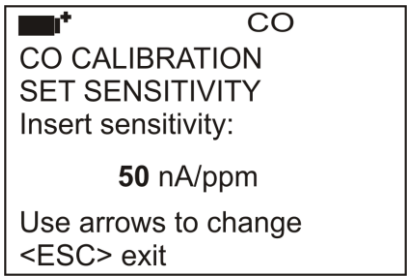
1. Disconnect the probe from the instrument.
2. Unscrew the head of the probe and extract the sensor of void CO.
3. Take note of the number written on the edge of the sensor that indicates the sensibility in nA/ppm.
4. Insert the new sensor electrodes into the contacts.
5. Screw the cap with the probe filter.
6. Connect the probe and switch the instrument on. Press Shift Fnc key: the shortcut window appears. With ▲▼ arrows select "Cal CO" and confirm with ENTER.




7. The screen for the operation to done on the sensor appears (calibration or replacement):




8. With Up and Down arrows select “Set sensitivity” and confirm with ENTER. The screen for the replacement of CO sensor appears.




9. With Up and Down arrows set the sensor sensibility value. Press ENTER to confirm: the instrument comes back to the previous screen.
10. If necessary, calibrate the zero of the CO new sensor.
11. Press ESC to come back in measurement.
12. The process is finished.

### *6.2.13 HD320B2 probe for the measurement of $CO_2$ carbon dioxide concentration*

HD320B2 probe measures the carbon dioxide concentration in air. It's indicated for checking and monitoring the air quality in external environments.

Typical applications are the check of the air quality in all the buildings where there is a crowd of people (schools, hospitals, auditoria, canteens, etc.), in the working places to optimize the comfort.

$CO_2$ measurement is obtained with an infrared special sensor (NDIR technology: Non-Dispersive Infrared Technology) that, thanks to the use of a double filter and a special measurement technique, warranties precise, stable and long-term measurements. The air to check is spread inside the measurement chamber through the protection membrane placed at the top of the probe.

**$CO_2$ probe calibration**

The probe is calibrated by the company and usually doesn't request any intervention by the user.

However, there is the possibility to execute a new calibration that corrects the sensor offset:

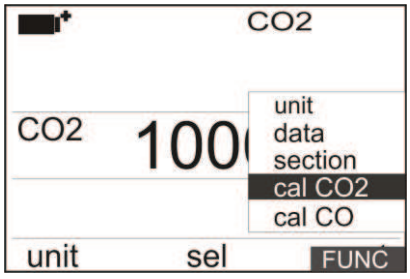
- at 400ppm in clean air
- at 0ppm with the help of nitrogen cylinder (code MINICAN.12A).

The instrument can automatically recognize the mode of the started calibration: if 400ppm or 0ppm. The calibration has to be done on one point: each new calibration cancels the previous one.

The concentration of carbon dioxide in air is influenced by different factors: the human activities (companies, pollution, combustion, etc.) cause an increase of this percentage in air. The calibration value is equal to 400ppm and it's in clean air, for example in the country far from the more polluted areas.

*Go on as indicated below:*

1. If you want to calibrate around 400ppm, make sure to apply clean air to the instrument through a membrane placed on the head of the probe.
2. For the calibration at 0ppm, remove the cap placed at the base of the probe in order to discover the plug of the calibration gas inlet and connect the tube coming from the nitrogen cylinder, Adjust the fluxmeter of the cylinder on the flow from 0.3 to 0.5l/min.
3. Switch the instrument on and wait for at least 15 minutes before going on.
4. Press **SHIFT FNC** key: the shortcut window appears. With ▲▼ arrows select "**cal CO2**" and confirm with ENTER.




5. Supply $CO_2$ for at least 2 minutes in order that the measurement becomes stable.
6. Going on supplying $CO_2$ to the probe, press **F2 = CAL CO2** function key: the calibration, **which lasts three minutes**, starts. In this phase the instrument measures $CO_2$ and calibrates itself to a value next to 0ppm if you are using the nitrogen cylinder, at 400ppm if you are calibrating it in clean air.

7. Wait for three minutes necessary for the calibration without modifying the working conditions.
8. If the timer reaches the zero, the instrument gives an acoustic signal out that confirms that the calibration is finished.

Note: the instrument rejects the calibration values that exceed ±150ppm from the theoretic value.

# 7. SERIAL INTERFACE AND USB

## 7.1 THE OPERATING PROGRAM A: MICROCLIMATE ANALYSIS

The **HD32.1** is fitted with an electrically isolated RS-232C serial interface, and an USB 2.0 interface. Optionally, they can be connected using a serial cable with sub D 9-pole female connectors (code **9CPRS232**) and a cable with USB 2.0 connectors (code **CP22**).
The USB connection requires the previous installation of a driver in the instrument software. **Install the driver before connecting the USB cable to the PC** (please see the details on chapter **8.2 Connection to the USB 2.0 port**).

Standard parameters of the instrument RS232 serial transmission are:

- Baud rate 38400 baud
- Parity None
- N. bit 8
- Stop bit 1
- Protocol Xon/Xoff

It is possible to change the RS232C serial port baud rate by setting the "*Selection of the serial transmission speed (Baud Rate)*" parameter in the menu (please see the menu on chapter ***5.3.1 The Baud Rate***). The possible values are: 38400, 19200, 9600, 4800, 2400, 1200. The other transmission parameters are fixed.
The USB 2.0 connection does not require the setting of parameters.

**The selection of the port is carried out directly by the instrument: If the USB port is connected to a PC, the RS232 serial port is automatically disabled, and vice versa.**

The instruments are provided with a complete set of commands and data queries to be sent via the PC.

All the commands transferred to the instrument must have the following structure:
**XXCR** where: **XX** is the command code and **CR** is the Carriage Return (ASCII 0D)
The XX command characters are exclusively upper case characters. Once a correct command is entered, the instrument responds with "&"; when any wrong combination of characters is entered, the instrument responds with "?".
The instrument response strings end with the sending of the CR command (Carriage Return) and LF (Line Feed).
Before sending commands to the instrument via the serial port, locking the keyboard to avoid functioning conflicts is recommended: Use the P0 command. When complete, restore the keyboard with the P1 command.

| Command | Response | Description |
|---|---|---|
| P0 | `&` | Ping (locks the instrument keyboard for 70 seconds) |
| P1 | `&` | Unlocks the instrument keyboard |
| S0 | | |
| G0 | `Model HD32.1 prog.A` | Instrument model |
| G1 | `M=THERMAL MICROCLIMATE` | Model description |
| G2 | `SN=12345678` | Instrument serial number |
| G3 | `Firm.Ver.=01.00` | Firmware version |
| G4 | `Firm.Date=2005/10/12` | Firmware date |
| G5 | `cal 0000/00/00 00:00:00` | Calibration date and time |
| C1 | | Probe 1 type, serial number, calibration date |
| C2 | | Probe 2 type, serial number, calibration date |
| C3 | | Probe 3 type, serial number, calibration date |

| Command | Response | Description |
|---|---|---|
| C4 | | Probe 4 type, serial number, calibration date |
| C5 | | Probe 5 type, serial number, calibration date |
| C6 | | Probe 6 type, serial number, calibration date |
| C7 | | Probe 7 type, serial number, calibration date |
| C8 | | Probe 8 type, serial number, calibration date |
| GC | | Print instrument's heading |
| GB | `User ID=0000000000000000` | User code (set with T2xxxxxxxxxxxxxxx) |
| H0 | `Tw= 19.5 øC` | Print wet bulb temperature |
| H1 | `Tg= 22.0 øC` | Print globe thermometer temperature |
| H2 | `Ta= 21.6 øC` | Print air temperature (dry bulb); |
| H3 | `Pr= 1018.1 hPa` | Print atmospheric pressure |
| H4 | `RH= 50.5 %RH` | Print relative humidity |
| H5 | `Va= 0.20 m/s` | Print wind speed |
| H6 | `Tr= 18.5 øC` | Print average radiation temperature |
| H7 | `WBGT(i)= 23.0 øC` | Print indoor WGBT (without solar radiation) |
| H8 | `WBGT(o)= 24.0 øC` | Print outdoor WGBT (with solar radiation) |
| H9 | `WCI=_ERROR_ øC` | Print WCI |
| HA | | Print date, time, Tw, Tg, Ta, Pr, RH, Va, Tr, WBGT(i), WBGT(o), WCI |
| LN | `A00 -A01 -B02 -B03 - .. - .. - .. - .. - .. - .. - .. - .. - .. - .. - .. -` | Print instrument memory map: If a section is allocated a number is displayed, if it is free 2 points (..) are displayed. |
| LFn | `!Log n.= 0!started on:!2006/01/01 00:37:32` | Print memory n section status. The number, the storage start date and time are displayed. (n= hexadecimal number 0-F). If the section is empty:"-->No Log Data<--" |
| LDn | | Print data stored in section n.<br>If the section is empty: "-->No Log Data<--" |
| LEn | & | Cancel data stored in section n. |
| LEX | & | Cancel data stored in all sections. |
| K1 | & | Immediate printing of data |
| K0 | & | Stop printing data |
| K4 | & | Start logging data |
| K5 | & | Stop logging data |
| KP | & | Auto-power-off function=ENABLE |
| KQ | & | Auto-power-off function=DISABLE |
| WC0 | & | Setting SELF off |
| WC1 | & | Setting SELF on |
| RA | `Sample print = 0sec` | Reading of PRINT interval set |
| RL | `Sample log = 30sec` | Reading of LOG interval set |
| WA# | & | Setting PRINT interval.<br># is a hexadecimal number 0…D that represents the position of the interval in the list 0, 1, 5, 10, …, 3600 seconds. |
| WL# | & | Setting LOG interval.<br># is a hexadecimal number 1…D that represents the position of the interval in the list 15, …, 3600 seconds. |

## 7.2 THE OPERATING PROGRAM B: DISCOMFORT ANALYSIS

The **HD32.1** is fitted with an electrically isolated RS-232C serial interface, and an USB 2.0 interface. Optionally, they can be connected using a serial cable with sub D 9-pole female connectors (code **9CPRS232**) and a cable with USB 2.0 connectors (code **CP22**).

The USB connection requires the previous installation of a driver in the instrument software. **Install the driver before connecting the USB cable to the PC** (please see the details on chapter **8.2 Connection to the USB 2.0 port**).

Standard parameters of the instrument RS232 serial transmission are:

- Baud rate 38400 baud
- Parity None
- N. bit 8
- Stop bit 1
- Protocol Xon/Xoff

It is possible to change the RS232C serial port baud rate by setting the "*Selection of the serial transmission speed (Baud Rate)*" parameter in the menu (please see the menu on chapter ***5.3.1 The Baud Rate***). The possible values are: 38400, 19200, 9600, 4800, 2400, 1200. The other transmission parameters are fixed.
The USB 2.0 connection does not require the setting of parameters.

**The selection of the port is carried out directly by the instrument: If the USB port is connected to a PC, the RS232 serial port is automatically disabled, and vice versa.**

The instruments are provided with a complete set of commands and data queries to be sent via the PC.

All the commands transferred to the instrument must have the following structure:
**XXCR** where: **XX** is the command code and **CR** is the Carriage Return (ASCII 0D)
The XX command characters are exclusively upper case characters. Once a correct command is entered, the instrument responds with "&"; when any wrong combination of characters is entered, the instrument responds with "?".
The instrument response strings end with the sending of the CR command (Carriage Return) and LF (Line Feed).
Before sending commands to the instrument via the serial port, locking the keyboard to avoid functioning conflicts is recommended: Use the P0 command. When complete, restore the keyboard with the P1 command.

| Command | Response | Description |
|---|---|---|
| P0 | `&` | Ping (locks the instrument keyboard for 70 seconds) |
| P1 | `&` | Unlocks the instrument keyboard |
| S0 | | |
| G0 | `Model HD32.1 prog.B` | Instrument model |
| G1 | `M=THERMAL MICROCLIMATE` | Model description |
| G2 | `SN=12345678` | Instrument serial number |
| G3 | `Firm.Ver.=01.00` | Firmware version |
| G4 | `Firm.Date=2005/10/12` | Firmware date |
| G5 | `cal 0000/00/00 00:00:00` | Calibration date and time |
| C1 | | Probe 1 type, serial number, calibration date |
| C2 | | Probe 2 type, serial number, calibration date |
| C3 | | Probe 3 type, serial number, calibration date |
| C4 | | Probe 4 type, serial number, calibration date |

| Command | Response | Description |
|---|---|---|
| C5 | | Probe 5 type, serial number, calibration date |
| C6 | | Probe 6 type, serial number, calibration date |
| C7 | | Probe 7 type, serial number, calibration date |
| C8 | | Probe 8 type, serial number, calibration date |
| GC | | Print instrument's heading |
| GB | User ID=0000000000000000 | User code (set with T2xxxxxxxxxxxxxxx) |
| H0 | Th= 19.5 øC | Print temperature at head height |
| H1 | Tb= 22.0 øC | Print temperature at body height |
| H2 | Tn= 21.6 øC | Print temperature of the net radiometer |
| H3 | Tk= 19.5 øC | Print temperature at ankles height |
| H4 | Tf= 19.5 øC | Print temperature of the floor |
| H5 | Pt= 0.0 W/m2 | Print power of net radiometer |
| H6 | Dt= 0.0 øC | Print asymmetrical radiant temperature of the net radiometer |
| HA | | Print date, time, Th, Tb, Tn,Tk, Tf, Pt, Dt |
| LN | A00 -A01 -B02 -B03 - .. - .. - .. - .. - .. - .. - .. - .. - .. - .. - .. - .. - .. - .. - .. - | Print instrument memory map: If a section is allocated a number is displayed, if it is free 2 points (..) are displayed. |
| LFn | !Log n.= 0!started on:!2006/01/01 00:37:32 | Print memory n section status. The number, and storage start date and time are displayed. (n= hexadecimal number 0-F). If the section is empty:"-->No Log Data<--" |
| LDn | | Print data stored in section n.<br>If the section is empty: "-->No Log Data<--" |
| LEn | & | Cancel data stored in section n. |
| LEX | & | Cancel data stored in all sections. |
| K1 | & | Immediate printing of data |
| K0 | & | Stop printing data |
| K4 | & | Start logging data |
| K5 | & | Stop logging data |
| KP | & | Auto-power-off function=ENABLE |
| KQ | & | Auto-power-off function=DISABLE |
| WC0 | & | Setting SELF off |
| WC1 | & | Setting SELF on |
| RA | Sample print = 0sec | Reading of PRINT interval set |
| RL | Sample log = 30sec | Reading of LOG interval set |
| WA# | & | Setting PRINT interval.<br># is a hexadecimal number 0…D that represents the position of the interval in the list 0, 1, 5, 10, …, 3600 seconds. |
| WL# | & | Setting LOG interval.<br># is a hexadecimal number 1…D that represents the position of the interval in the list 15, …, 3600 seconds. |

## 7.3 THE OPERATING PROGRAM C: PHYSICAL QUANTITIES

The **HD32.1** is fitted with an electrically isolated RS-232C serial interface, and an USB 2.0 interface. Optionally, they can be connected using a serial cable with sub D 9-pole female connectors (code **9CPRS232**) and a cable with USB 2.0 connectors (code **CP22**).

The USB connection requires the previous installation of a driver in the instrument software. **Install the driver before connecting the USB cable to the PC** (please see the details on chapter **8.2 Connection to the USB 2.0 port**).

Standard parameters of the instrument RS232 serial transmission are:

- Baud rate 38400 baud
- Parity None
- N. bit 8
- Stop bit 1
- Protocol Xon/Xoff

It is possible to change the RS232C serial port baud rate by setting the "*Selection of the serial transmission speed (Baud Rate)*" parameter in the menu (please see the menu on chapter ***5.3.1 The Baud Rate***). The possible values are: 38400, 19200, 9600, 4800, 2400, 1200. The other transmission parameters are fixed.
The USB 2.0 connection does not require the setting of parameters.

**The selection of the port is carried out directly by the instrument: If the USB port is connected to a PC, the RS232 serial port is automatically disabled, and vice versa.**

The instruments are provided with a complete set of commands and data queries to be sent via the PC.

All the commands transferred to the instrument must have the following structure:
**XXCR** where: **XX** is the command code and **CR** is the Carriage Return (ASCII 0D)
The XX command characters are exclusively upper case characters. Once a correct command is entered, the instrument responds with "&"; when any wrong combination of characters is entered, the instrument responds with "?".
The instrument response strings end with the sending of the CR command (Carriage Return) and LF (Line Feed).
Before sending commands to the instrument via the serial port, locking the keyboard to avoid functioning conflicts is recommended: Use the P0 command. When complete, restore the keyboard with the P1 command.

| Command | Response | Description |
|---|---|---|
| P0 | `&` | Ping (locks the instrument keyboard for 70 seconds) |
| P1 | `&` | Unlocks the instrument keyboard |
| S0 | | |
| G0 | `Model HD32.1 prog.C` | Instrument model |
| G1 | `M=THERMAL MICROCLIMATE` | Model description |
| G2 | `SN=12345678` | Instrument serial number |
| G3 | `Firm.Ver.=01.00` | Firmware version |
| G4 | `Firm.Date=2005/10/12` | Firmware date |
| G5 | `cal 0000/00/00 00:00:00` | Calibration date and time |
| C1 | | Probe 1 type, serial number, calibration date |
| C2 | | Probe 2 type, serial number, calibration date |
| C3 | | Probe 3 type, serial number, calibration date |
| C4 | | Probe 4 type, serial number, calibration date |

| Command | Response | Description |
|---|---|---|
| C5 | | Probe 5 type, serial number, calibration date |
| C6 | | Probe 6 type, serial number, calibration date |
| C7 | | Probe 7 type, serial number, calibration date |
| C8 | | Probe 8 type, serial number, calibration date |
| GC | | Print instrument's heading |
| GB | `User ID=0000000000000000` | User code (set with T2xxxxxxxxxxxxxxx) |
| H0 | `Tpt= 19.5 øC` | Print Pt100 temperature |
| H1 | `RH= 50.0 %` | Print %RH |
| H2 | `Trh= 21.6 øC` | Print temperature of the RH probe |
| H3 | `Va= 0.25 m/s` | Print air speed |
| H4 | `Fl= 1.5 l/s` | Print air flux of air speed probe |
| H5 | `Tv= 20.5 øC` | Print temperature of air speed probe |
| H6 | `Lux= 550.0 lux` | Print lux |
| HA | | Print date, time, Tpt, RH, Trh, Va, Fl, Tv, Lux1, Lux2, $CO_2$, CO |
| LN | `A00 -A01 -B02 -B03 - .. - .. - .. - .. - .. - .. - .. - .. - .. - .. - .. - .. -` | Print instrument memory map: If a section is allocated a number is displayed, if it is free 2 points (..) are displayed. |
| LFn | `!Log n.= 0!started on:!2006/01/01 00:37:32` | Print memory n section status. The number, and storage start date and time are displayed. (n= hexadecimal number 0-F). If the section is empty:"-->No Log Data<--" |
| LDn | | Print data stored in section n.<br>If the section is empty: "-->No Log Data<--" |
| LEn | & | Cancel data stored in section n. |
| LEX | & | Cancel data stored in all sections. |
| K1 | & | Immediate printing of data |
| K0 | & | Stop printing data |
| K4 | & | Start logging data |
| K5 | & | Stop logging data |
| KP | & | Auto-power-off function=ENABLE |
| KQ | & | Auto-power-off function=DISABLE |
| WC0 | & | Setting SELF off |
| WC1 | & | Setting SELF on |
| RA | `Sample print = 0sec` | Reading of PRINT interval set |
| RL | `Sample log = 30sec` | Reading of LOG interval set |
| WA# | & | Setting PRINT interval.<br># is a hexadecimal number 0…D that represents the position of the interval in the list 0, 1, 5, 10, …, 3600 seconds. |
| WL# | & | Setting LOG interval.<br># is a hexadecimal number 1…D that represents the position of the interval in the list 15, …, 3600 seconds. |

## 7.4 STORING AND TRANSFERRING DATA TO A PC

The **HD32.1** instrument can be connected to a personal computer via an RS232C serial port or USB port, and exchange data and information through the DeltaLog10 software running in a Windows operating environment. It is possible to print the measured values on a 80 column printer (*PRINT* key) or store them in the internal memory using the *Logging* function (MEM key). If necessary, the data stored in the memory can be transferred to a PC later.

### *7.4.1 The Logging Function*

The *Logging* function allows recording of the measurements registered by the probe connected to the inputs. The time interval between two consecutive measurements can be set from 15 seconds to 1 hour. The logging starts by pressing the **MEM** key and ends by pressing the same key again: The data memorized in this way form a continuous block of data.
See the description of the menu items on chapter "**5. MAIN MENU"**.
If the automatic turning off option between two recordings (see par. *5.2.2 Self Shut-off mode*) is enabled, upon pressing the **MEM** key the instrument logs the first data and turns off. 15 seconds before the next logging instant, it turns on again to capture the new sample, and then turns off.
The data stored in the memory can be transferred to a PC using a command (see par. 5.2.5 Log File Manager). During data transfer the display shows the message DUMP; to stop the data transfer press ESC on the instrument or on the PC.

### *7.4.2 The Erase Function: clearing the memory*

To clear the memory use the Erase Log function (see par. *5.2.5 Log File Manager*). The instrument starts clearing the internal memory; at the end of the operation, it goes back to normal display.

**NOTES:**

- Data transfer does not cause the memory to be erased: The operation can be repeated as many times as required.
- The stored data remain in the memory independently of battery charge conditions.
- In order to print the data to a parallel interface printer, you must use a parallel-serial adaptor (not supplied).
- **The direct connection between instrument and printer via a USB connector does not work.**
- Some keys are disabled during *logging*. The following keys are enabled: **MEM**, **SETUP**, **ENTER** and **ESC**.
- Pressing the **MEM** and **SETUP** keys has no effect on the logged data if these keys are pressed **after** starting the recording, otherwise the following is valid.

### *7.4.3 The Print Function*

Press **PRINT** to send the measured data directly to the RS232 or USB ports, in real time. Print data units of measurements are the same as those used on the display. The function is started by pressing **PRINT**. The time interval between two consecutive prints can be set from 15 second to 1 hour (please see the **Print interval** menu item at par. 5.3.2 The Print Interval). If the print interval is equal to 0, by pressing **PRINT** the single data is sent to the connected device. If the print interval is higher than 0, the data transfer continues until the operator stops it by pressing **PRINT** again. The "PN" message is displayed at the top of the display.

**NOTE: When setting the baud-rate, check the printer speed.**

# 8. CONNECTION TO A PC

The **HD32.1** is fitted with two ports for connecting the instrument to the PC:

- RS232C serial port with null modem cable code **9CPRS232**. The cable has two sub D 9-pole female connectors.
- USB 2.0 port with the cable code **CP22**. The cable has a USB type A connector for PC connection and a USB type B connector for connection to the instrument.

The instrument are supplied with the **DeltaLog10 software.** The software manages the connection, data transfer, graphic presentation, and printing operations of the captured or logged measurements. **The DeltaLog10 software is complete with "On-line Help" (also in PDF format) describing its characteristics and functions.**

The instruments are also compatible with the HyperTerminal communication program supplied with the Windows operating systems (from Windows 98 to Windows XP).

## 8.1 CONNECTION TO THE RS232-C SERIAL PORT

1. The measuring instrument has to be switched off.
2. Using the null-modem Delta Ohm 9CPRS232 cable, connect the measurement instrument to the first free serial port (COM) of the PC.
3. Turn on the instrument and set the baud rate to 38400 (SETUP key >> "*Serial*" >> "*Baud Rate* >> select 38400 using the arrow keys >> confirm with ENTER). The parameter remains in the memory.
4. Launch the DeltaLog10 application and press CONNECT. Wait for the connection to occur and follow the indications on the screen. **For a description of the DeltaLog10 application, please refer to its On-line Help.**

## 8.2 CONNECTION TO THE USB 2.0 PORT

*Proceed as follows:*

1. **Do not connect the instrument to the USB port until you are expressly requested to do it.**
2. Insert the DeltaLog10 CD-Rom and select the "*Install/Remove USB driver*" item.
3. The application checks the presence of the drivers on the PC: The installation starts if they are not present; if they are already installed, the drivers are removed by pressing the key.
4. The installation wizard prompts the software user license: To proceed, **the software usage terms must be accepted - click on YES**.
5. On the next page the folder where the drivers will be installed is indicated: Confirm without modifying.
6. Complete the installation by clicking on *Finish*. Wait few seconds until the DeltaLog10 page appears.
7. Close DeltaLog10.
8. Connect the instrument to the PC USB port. When Windows detects the new device, the "*New software installation wizard*" is started.
9. If you are asked for the authorization to search an updated driver, answer *NO* and continue.

10. In the installation window, select "*Install from a list or specific location*".
11. In the next window select "*Search for the best driver in these locations*" and "*Include this location in the search*".
12. Using *Browse*, indicate the installation folder provided at point 5:

    *C:\Program Files\Texas Instruments\USB-Serial Adapter*

    Confirm with *OK*.
13. If you get the message that the software did not pass the Windows Logo testing, select "*Continue*".
14. The USB driver are installed: At the end, click on "*Finish*".
15. **The installation wizard requests the files location once more**: Repeat the just described steps and provide the location of the same folder (see point 12).
16. **Wait**: The operation could take a few minutes.
17. The installation procedure is now complete: The device will be detected on each new connection automatically.

In order to check if the entire operation was successful, in CONTROL PANEL double click on SYSTEM. Select "Device Manager" and connect the instrument to the USB port.
The following items should appear:

- "*UMP Devices >> UMP3410 Unitary driver*" and "*Porte (COM and LPT) >> UMP3410 Serial Port (COM#)*" for Windows 98 and Windows Me,
- "*Schede seriali Multiport >> TUSB3410 Device*" and "*Porte (COM and LPT) >> USB-Serial Port (COM#)*" for Windows 2000, NT and XP.

When the USB cable is disconnected, these two items disappear and come back when it is connected again.

**Notes.**

1. If the instrument is connected to the USB port **before** installing the drivers, Windows signals the presence of an unknown device: In this case, cancel the operation and repeat the procedure illustrated at the beginning of this section.

2. **In the documentation supplied with the DeltaLog10 CD-Rom**, is included a detailed version of this chapter with pictures. Moreover, the necessary steps to remove the USB drivers are reported.

# 9. INSTRUMENT SIGNALS AND FAULTS

The following table lists all error indications and information displayed by the instrument and supplied to the user in different operating situations:

| Display indication | Explanation |
|---|---|
| **---.--** | This appears if the sensor relevant to the indicated physical quantity is not present or is faulty |
| **OVFL** | Overflow appears when the probe detects a value that exceeds the expected measurement range. |
| **UFL** | Underflow appears when the probe detects a lower value than the expected measurement range. |
| **WARNING: MEMORY FULL!!** | The instrument cannot store further data, the memory space is full. |
| **PN** | Blinking message. It appears on the first line of the display when the data transfer function is enabled (PRINT key). |
| **LOG** | Blinking message. It appears on the first line of the display and indicates a logging session. |

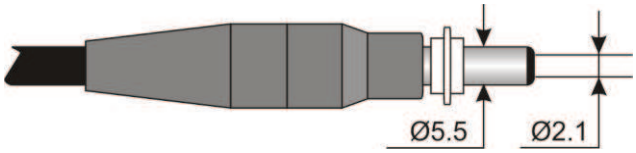
## 10. BATTERY SYMBOL AND BATTERY REPLACEMENT – MAINS POWER SUPPLY

The battery symbol 
on the 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.
**If you continue to use it, the instrument can no longer ensure correct measurement and turns off.** Data stored on memory will remain.
**The battery symbol becomes [~] when the external power supply is connected.**

To replace the batteries, proceed as follows:
1. Switch the instrument off;
2. Disconnect the external power supply, if connected;
3. Unscrew the battery cover counter clockwise and take out the battery holder. **Do not pull the battery connection wires as they could break;**
4. Replace the batteries (4 1.5V alkaline batteries - C - BABY). Check that the battery polarity matches the indication on the battery holder;
5. Replace the battery holder and screw the cover on clockwise.

The instrument can be powered by the mains using, for example, the stabilized power supply SWD10 input 100÷240Vac output 12Vdc – 1000mA (the positive is in the middle).




The external diameter of power supply connector is 5.5mm, the internal diameter is 2.1mm.
**Warning: The power supply cannot be used as battery charger.** If the instrument is connected to the external power supply, the **[~]** symbol is displayed instead the battery symbol.

**Malfunctioning upon turning on after battery replacement**
After replacing the batteries, the instrument may not restart correctly; in this case, repeat the operation.
After disconnecting the batteries, wait a few minutes in order to allow circuit condensers to discharge completely; then reinsert the batteries.

### 10.1 WARNING ABOUT BATTERY USE

- Batteries should be removed when the instrument is not used for an extended time.
- Flat batteries must be replaced immediately.
- Avoid loss of liquid from batteries.
- Use waterproof and good-quality batteries, if possible alkaline. Sometimes on the market, it is possible to find new batteries with an insufficient charge capacity.

## 11. INSTRUMENT STORAGE

Instrument storage conditions:

- Temperature: -25…+65°C.
- Humidity: less than 90% RH without condensation.
- During storage avoid locations where:
    - humidity is high;
    - the instrument may be exposed to direct sunlight;
    - the instrument may be exposed to a source of high temperature;
    - the instrument may be exposed to strong vibrations;
    - the instrument may be exposed to steam, salt or any corrosive gas.

Some parts of the instrument are made of ABS plastic, polycarbonate: do not use any incompatible solvent for cleaning.

# 12. MEASUREMENT REPORTS PRINTING

Please find below a few examples of reports created with DeltaLog10 software for the different environments.

## 12.1 MODERATE ENVIRONMENT

**Evaluation Report**

Moderate Environments: Determination of the thermal well-being by calculating PMV and PPD indices

Norm ISO 7730

**Delta OHM**
**Via Marconi, 5**
**35030 Caselle di Selvazzano**
**Padova**
**Italy**

### INTRODUCTION

Human's thermal sensation is connected to the thermal energy balance of the whole human body Such balance is influenced by physical activity and clothing, in addition to the following environment parameters: Air temperature, average radiation temperature, wind speed, and air humidity. When these parameters have been estimated or measured, the feeling of heat in the body as a whole can be predicted by calculating the index of PMV (Predicted Mean Vote). The PPD index (Predicted Percentage of Dissatisfied) provides information on thermal comfort, or thermal discomfort, predicting the percentage of people that could feel too hot or too cold in a certain environment.

### PURPOSE AND APPLICATION SCOPE

The purpose of this survey is the PMV and PPD indices evaluation on people exposed to moderate environments.

### REFERENCE STANDARDS

Norm ISO 7730

### NOTES

Space for notes

Moderate Environment

| | Evaluation Report<br>Moderate Environments: Determination of the thermal well-being by calculating PMV and PPD indices<br>Norm ISO 7730 | Mod. 001 rev.0<br>Page 2 of 7 |
|---|---|---|

**Measurement date:**

| | | | |
|---|---|---|---|
| **Start date:** | 2006/10/05 | **Start time:** | 10:30:00 |
| **End date:** | 2006/10/05 | **End time:** | 10:38:00 |

**Location of the survey:**

| | |
|---|---|
| **Company:** | Delta OHM |
| **Address:** | Via Marconi, 5 |
| **City:** | 35030 Caselle di Selvazzano |
| **Prov.:** | Padova |
| **Country:** | Italy |
| **Contact person:** | Paolo Bianchi |
| **Telephone/fax:** | 0039-0498977150 - Fax 0039-049635596 |
| **E-mail:** | deltaohm@tin.it |

**Report Author:**

| | |
|---|---|
| **Author:** | Mario Rossi |
| **Address:** | Via Marconi, 5 |
| **City:** | 35030 - Caselle di Selvazzano |
| **Prov.:** | Padova |
| **Country:** | Italy |
| **Contact person:** | Mario Rossi |
| **Telephone/fax:** | 0039-0498977150 - Fax 0039-049635596 |
| **E-mail:** | deltaohm@tin.it |

| Written | | Checked and Approved | |
|---|---|---|---|
| **Date** | **Signature** | **Date** | **Signature** |
| | | | |

Moderate Environment

| | Evaluation Report | |
|---|---|---|
| Delta OHM | Moderate Environments: Determination of the thermal well-being by calculating PMV and PPD indices<br>Norm ISO 7730 | Mod. 001 rev.0<br>Page 3 of 7 |

**Instrumentation used:**

| | |
|---|---|
| **Instrument Code:** | Model HD32.1 prog.A |
| **Firmware Version:** | Firm.Ver.=01.00 |
| **Firmware Date (yyyy/mm/dd):** | Firm.Date=2005/10/12 |
| **Instrument Serial Number:** | SN=12345678 |
| **User Code:** | User ID=0000000000000000 |

**Probes used:**

**Input description Ch.1**
Type of probe: Pt100
Cal. Date: 2004/09/13
Y/N: 87654321

**Input description Ch.2**
Type of probe: Pt100 Tg 50
Cal. Date: 2005/06/27
Y/N: 05013380

**Input description Ch.3**
Type of probe: RH
Cal. Date: 2002/01/02
Y/N: 04006422

**Input description Ch.4**
Type of probe: Hot wire
Cal. Date: 2002/07/05
Y/N: 04005175

**Input description Ch.5**
Type of probe: not present
Cal. Date: not present
Y/N: not present

**Input description Ch.6**
Type of probe: not present
Cal. Date: not present
Y/N: not present

**Input description Ch.7**
Type of probe: not present
Cal. Date: not present
Y/N: not present

**Input description Ch.8**
Type of probe: not present
Cal. Date: not present
Y/N: not present

| | Evaluation Report | |
|---|---|---|
| Delta OHM | Moderate Environments: Determination of the thermal well-being by calculating PMV and PPD indices<br>Norm ISO 7730 | Mod. 001 rev.0<br>Page 4 of 7 |

**Description of the observation location:**

Moderate Environment
Indoor
The worker being observed has an average size body (equivalent surface area 1.8 $m^2$)

**Description of clothing:**

Daily Clothing:
Intimate underwear and lingerie, short-sleeved vest/top, blouse, trousers, jacket, ankle socks, shoes — 1.5 clo

**Description of activity:**

Type of Job: Sedentary activity (office, home, school, laboratory) — 70 W/m2

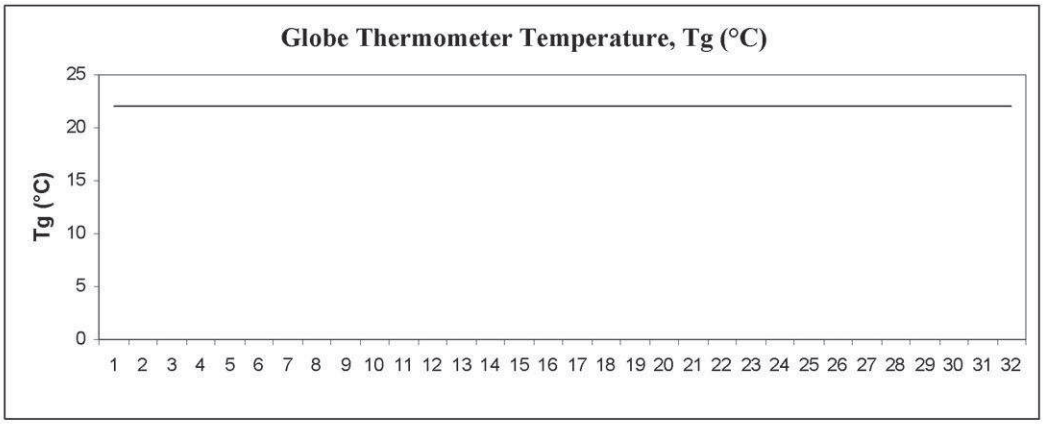
Moderate Environment

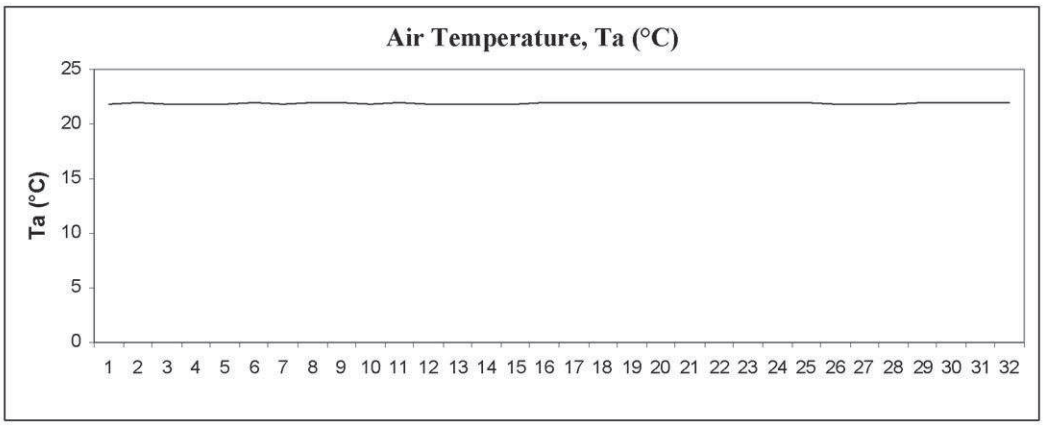
| | Evaluation Report | |
|---|---|---|
| Delta OHM | Moderate Environments: Determination of the thermal well-being by calculating PMV and PPD indices<br>Norm ISO 7730 | Mod. 001 rev.0<br>Page 5 of 7 |

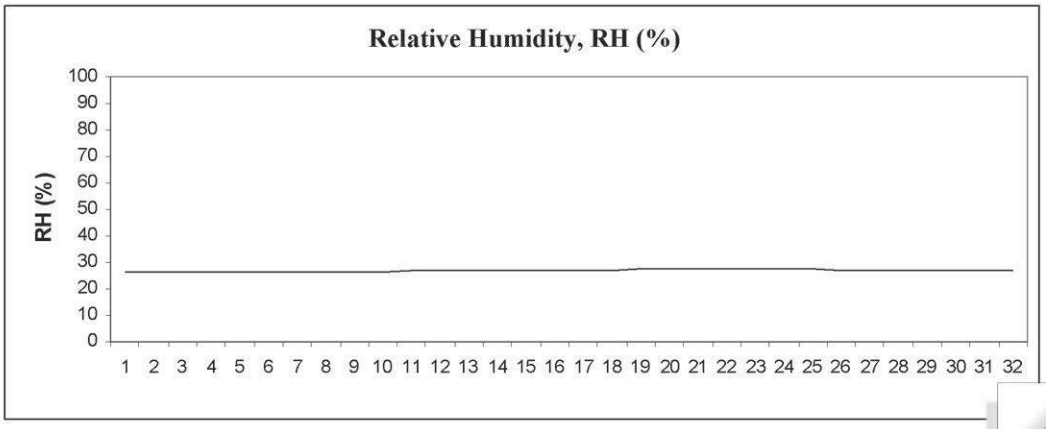
**Graph Trend:**

| | | | |
|---|---|---|---|
| **Start date:** | 2006/10/05 | **Start time:** | 10:30:00 |
| **End date:** | 2006/10/05 | **End time:** | 10:38:00 |

**Acquisition frequency: 15 sec**

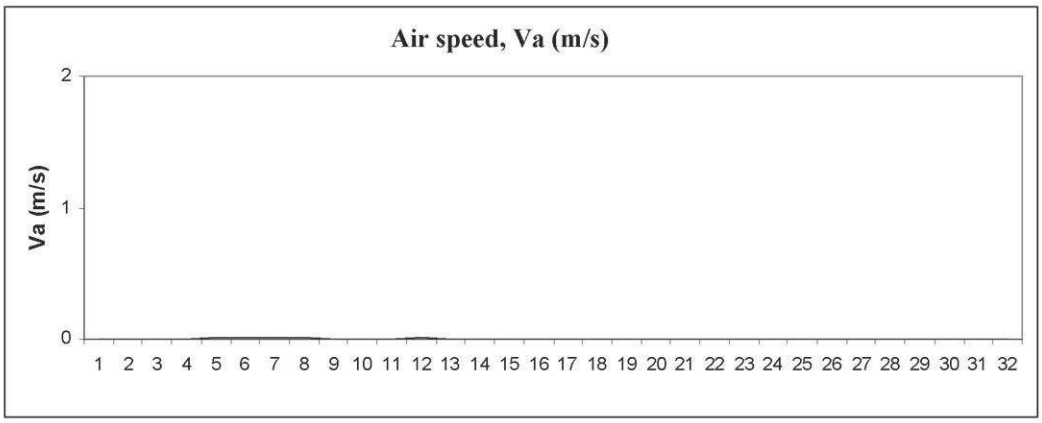


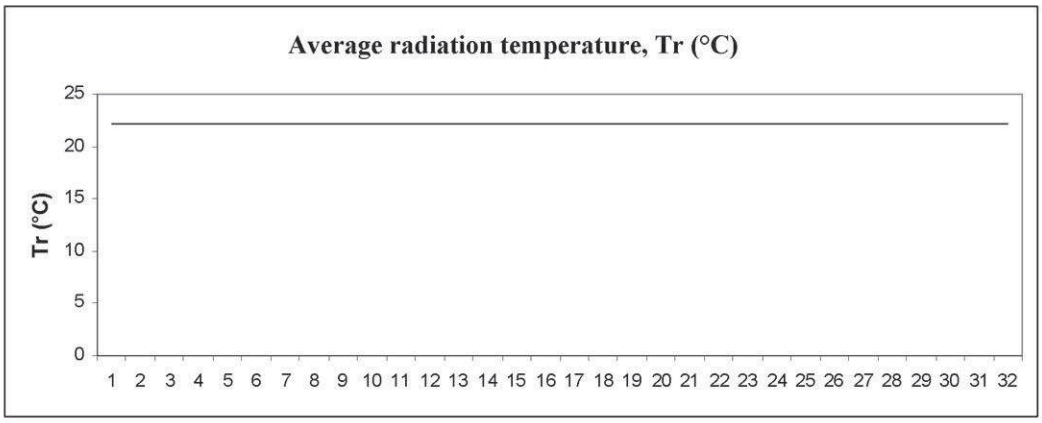



Moderate Environment

| | Evaluation Report | |
|---|---|---|
| Delta OHM | Moderate Environments: Determination of the thermal well-being by calculating PMV and PPD indices<br>Norm ISO 7730 | Mod. 001 rev.0<br>Page 6 of 7 |



Moderate Environment

| | | |
|---|---|---|
| Delta OHM | **Evaluation Report**<br>Moderate Environments: Determination of the thermal well-being by calculating PMV and PPD indices<br><br>Norm ISO 7730 | Mod. 001 rev.0<br>Page 7 of 7 |

**Measurements:**

| | |
|---|---|
| Globe Thermometer Temperature, Tg (°C) | 22 |
| Wet Bulb Temperature, Tw (°C) | 21.8 |
| Air Temperature, Ta (°C) | 22 |

**Overall result:**

| | |
|---|---|
| Predicted Mean Vote PMV | -0.7 |
| Predicted Percentage of Dissatisfied - PPD | 14.7 |

## 12.2 WARM ENVIRONMENT

# Evaluation Report

Hot Environments: Determination of WBGT heat stress index

Norm ISO 7243

**Delta OHM**
**Via Marconi, 5**
**35030 Caselle di Selvazzano**
**Padova**
**Italy**

### INTRODUCTION

The WBGT (*Wet Bulb Globe Temperature*) (UNI, 1996) is an empirical temperature index used to evaluate very hot thermal environments, from the experimental correlations between microclimatic parameters and physiologic reactions of a large sample of subjects.
In order to determine the conditions of thermal stress within an environment, you should know the air temperature, wind speed, and air humidity, as well as the average radiation temperature. The WBGT index uses some derived quantities to characterise the environment under consideration from a thermal point of view.

### PURPOSE AND APPLICATION SCOPE

The purpose of this survey is the WBGT index evaluation in a hot environment.

### REFERENCE STANDARDS

Norm ISO 7243

### NOTES

Space for notes

| | Evaluation Report<br>Hot Environments: Determination of WBGT heat stress index<br>Norm ISO 7243 | Mod. 002 rev.0<br>Page 2 of 6 |
|---|---|---|

**Measurement date:**

| | | | |
|---|---|---|---|
| **Start date:** | 2006/10/05 | **Start time:** | 10:30:00 |
| **End date:** | 2006/10/05 | **End time:** | 10:38:00 |

**Location of the survey:**

| | |
|---|---|
| **Company:** | Delta OHM |
| **Address:** | Via Marconi, 5 |
| **City:** | 35030 Caselle di Selvazzano |
| **Prov.:** | Padova |
| **Country:** | Italy |
| **Contact person:** | Paolo Bianchi |
| **Telephone/fax:** | 0039-0498977150 - Fax 0039-049635596 |
| **E-mail:** | deltaohm@tin.it |

**Report Author:**

| | |
|---|---|
| **Author:** | Mario Rossi |
| **Address:** | Via Marconi, 5 |
| **City:** | 35030 - Caselle di Selvazzano |
| **Prov.:** | Padova |
| **Country:** | Italy |
| **Contact person:** | Mario Rossi |
| **Telephone/fax:** | 0039-0498977150 - Fax 0039-049635596 |
| **E-mail:** | deltaohm@tin.it |

| Written | | Checked and Approved | |
|---|---|---|---|
| **Date** | **Signature** | **Date** | **Signature** |
| | | | |

| | Evaluation Report<br>Hot Environments: Determination of WBGT heat stress index<br>Norm ISO 7243 | Mod. 001 rev.0<br>Page 3 of 6 |
|---|---|---|

**Instrumentation used:**

| | |
|---|---|
| **Instrument Code:** | Model HD32.1 prog.A |
| **Firmware Version:** | Firm.Ver.=01.00 |
| **Firmware Date (yyyy/mm/dd):** | Firm.Date=2005/10/12 |
| **Instrument Serial Number:** | SN=12345678 |
| **User Code:** | User ID=0000000000000000 |

**Probes used:**

**Input description Ch.1**
Type of probe: Pt100
Cal. Date: 2004/09/13
Y/N: 87654321

**Input description Ch.2**
Type of probe: Pt100 Tg 50
Cal. Date: 2005/06/27
Y/N: 05013380

**Input description Ch.3**
Type of probe: Pt100 Tw
Cal. Date: 2002/01/02
Y/N: 04006422

**Input description Ch.4**
Type of probe: not present
Cal. Date: not present
Y/N: not present

**Input description Ch.5**
Type of probe: not present
Cal. Date: not present
Y/N: not present

**Input description Ch.6**
Type of probe: not present
Cal. Date: not present
Y/N: not present

**Input description Ch.7**
Type of probe: not present
Cal. Date: not present
Y/N: not present

**Input description Ch.8**
Type of probe: not present
Cal. Date: not present
Y/N: not present

| | Evaluation Report<br>Hot Environments: Determination of WBGT heat stress index<br>Norm ISO 7243 | Mod. 001 rev.0<br>Page 4 of 6 |
|---|---|---|

**Description of the observation location:**

Very Hot Environment
Indoor, without solar radiation
Person acclimatized to heat
The worker being observed has an average size body

**Description of clothing:**

Daily Clothing:
Intimate underwear and lingerie, short-sleeved vest/top, blouse, trousers, jacket, ankle socks, shoes — 1.5 clo

**Description of activity:**

Type of Job: Sedentary activity (office, home, school, laboratory) — 70 W/m2

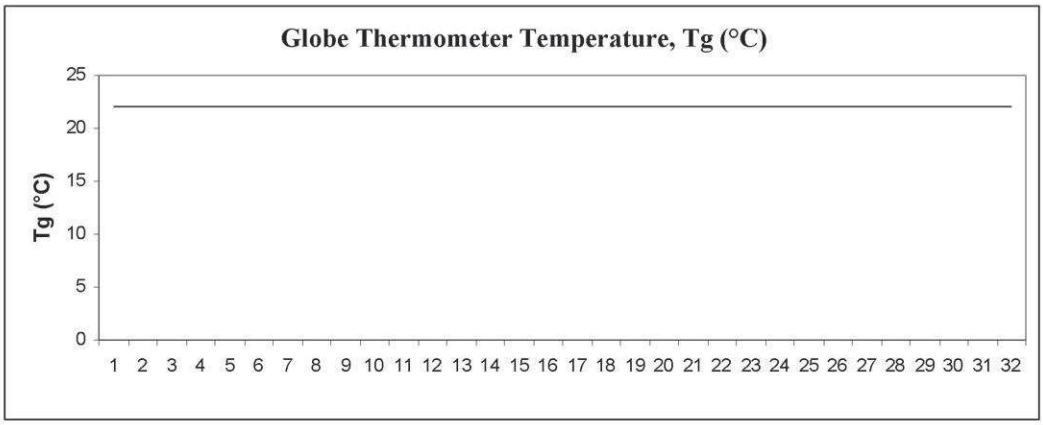
Warm Environment

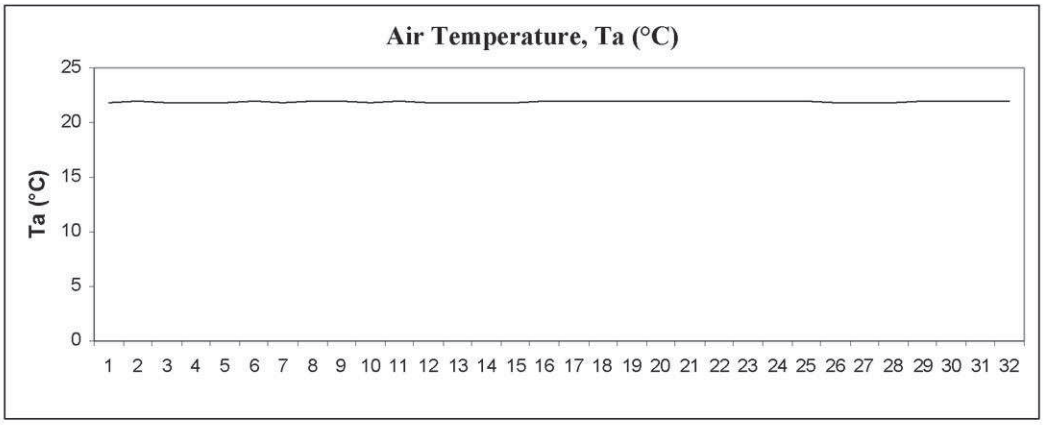
| | Evaluation Report<br>Hot Environments: Determination of WBGT heat stress index<br>Norm ISO 7243 | Mod. 001 rev.0<br>Page 5 of 6 |
|---|---|---|

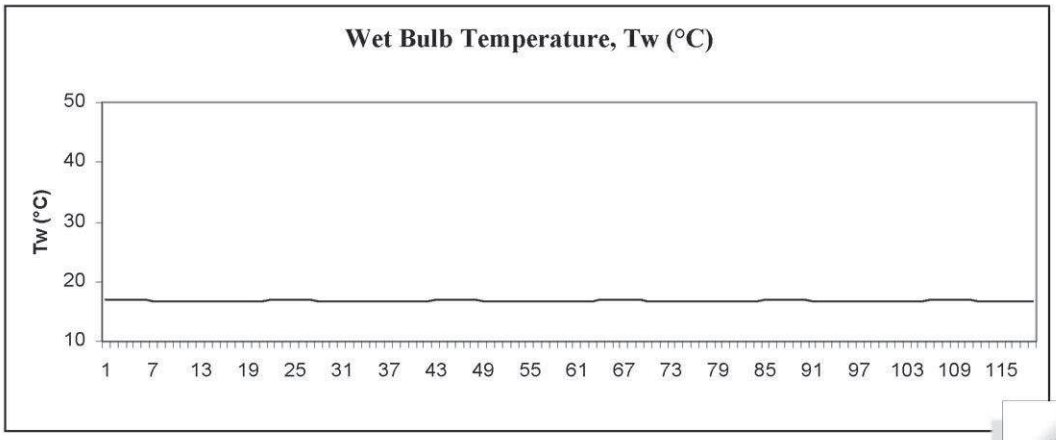
**Graph Trend:**

| | | | |
|---|---|---|---|
| **Start date:** | 2006/10/05 | **Start time:** | 10:30:00 |
| **End date:** | 2006/10/05 | **End time:** | 10:38:00 |

**Acquisition frequency: 15 sec**



Warm Environment

| | | |
|---|---|---|
| Delta OHM | **Evaluation Report**<br>Hot Environments: Determination of WBGT heat stress index<br><br>Norm ISO 7243 | Mod. 001 rev.0<br>Page 6 of 6 |

**Measurements:**

| | |
|---|---|
| Globe Thermometer Temperature, Tg (°C) | 22.7 |
| Wet Bulb Temperature, Tw (°C) | 16.8 |
| Air Temperature, Ta (°C) | 22.7 |

**Overall result:**

| | |
|---|---|
| WBGT heat stress index (°C) | 18.6 |
| WBGT value limit (°C) | 28.0 |

## 12.3 DISCOMFORT ANALYSIS

# Evaluation Report

Moderate Environments: Local Discomfort Analysis

Norm ISO 7730

**Delta OHM**
**Via Marconi, 5**
**35030 Caselle di Selvazzano**
**Padova**
**Italy**

### INTRODUCTION

Human's thermal sensation is connected to the thermal energy balance of the whole human body. Such balance is influenced by physical activity and clothing, in addition to the following environment parameters:
Air temperature, average radiation temperature, wind speed, and air humidity.
Even when the quantities involved could guarantee an average thermal well-being, the person could experience a sensation of discomfort in some parts of the body, due to local inequality.
Therefore, the conditions in which the subject perceives a feeling of well-being in all parts of the body need to be verified locally; thermal discomfort could be due to an undesired local cooling or heating of the body.
This survey is going to analyze:
Local wind speed variations.
Presence of vertical temperature gradients.
Too hot or cold floor.

### PURPOSE AND APPLICATION SCOPE

The purpose of this survey is the local discomfort indices evaluation.

### REFERENCE STANDARDS

Norm ISO 7730

### NOTES

Space for notes

| | Evaluation Report<br>Moderate Environments: Local Discomfort Analysis<br>Norm ISO 7730 | Mod. 001 rev.0<br>Page 2 of 7 |
|---|---|---|

**Measurement date:**

| | | | |
|---|---|---|---|
| **Start date:** | 2006/10/05 | **Start time:** | 10:30:00 |
| **End date:** | 2006/10/05 | **End time:** | 10:38:00 |

**Location of the survey:**

| | |
|---|---|
| **Company:** | Delta OHM |
| **Address:** | Via Marconi, 5 |
| **City:** | 35030 Caselle di Selvazzano |
| **Prov.:** | Padova |
| **Country:** | Italy |
| **Contact person:** | Paolo Bianchi |
| **Telephone/fax:** | 0039-0498977150 - Fax 0039-049635596 |
| **E-mail:** | deltaohm@tin.it |

**Report Author:**

| | |
|---|---|
| **Author:** | Mario Rossi |
| **Address:** | Via Marconi, 5 |
| **City:** | 35030 - Caselle di Selvazzano |
| **Prov.:** | Padova |
| **Country:** | Italy |
| **Contact person:** | Mario Rossi |
| **Telephone/fax:** | 0039-0498977150 - Fax 0039-049635596 |
| **E-mail:** | deltaohm@tin.it |

| Written | | Checked and Approved | |
|---|---|---|---|
| **Date** | **Signature** | **Date** | **Signature** |
| | | | |

Discomfort Analysis

| | Evaluation Report<br>Moderate Environments: Local Discomfort Analysis<br>Norm ISO 7730 | Mod. 001 rev.0<br>Page 3 of 7 |
|---|---|---|

**Instrumentation used:**

| | |
|---|---|
| **Instrument Code:** | Model HD32.1 prog.A |
| **Firmware Version:** | Firm.Ver.=01.00 |
| **Firmware Date (yyyy/mm/dd):** | Firm.Date=2005/10/12 |
| **Instrument Serial Number:** | SN=12345678 |
| **User Code:** | User ID=0000000000000000 |

**Probes used:**

**Input description Ch.1**

| | |
|---|---|
| Type of probe: | Pt100 h-b |
| Cal. Date: | 2004/09/13 |
| Y/N: | 87654321 |

**Input description Ch.2**

| | |
|---|---|
| Type of probe: | Pt100 k-f |
| Cal. Date: | 2005/06/27 |
| Y/N: | 05013380 |

**Input description Ch.3**

| | |
|---|---|
| Type of probe: | NR |
| Cal. Date: | 2002/01/02 |
| Y/N: | 04006422 |

**Input description Ch.4**

| | |
|---|---|
| Type of probe: | not present |
| Cal. Date: | not present |
| Y/N: | not present |

**Input description Ch.5**

| | |
|---|---|
| Type of probe: | not present |
| Cal. Date: | not present |
| Y/N: | not present |

**Input description Ch.6**

| | |
|---|---|
| Type of probe: | not present |
| Cal. Date: | not present |
| Y/N: | not present |

**Input description Ch.7**

| | |
|---|---|
| Type of probe: | not present |
| Cal. Date: | not present |
| Y/N: | not present |

**Input description Ch.8**

| | |
|---|---|
| Type of probe: | not present |
| Cal. Date: | not present |
| Y/N: | not present |

Discomfort Analysis

| | Evaluation Report<br>Moderate Environments: Local Discomfort Analysis<br>Norm ISO 7730 | Mod. 001 rev.0<br>Page 4 of 7 |
|---|---|---|

**Description of the observation location:**

Moderate Environment
Indoor
The worker being observed has an average size body

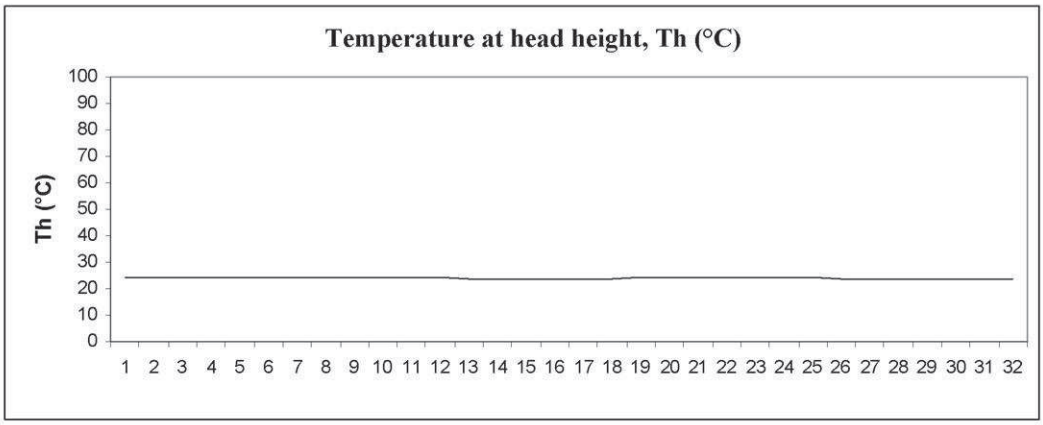
Discomfort Analysis

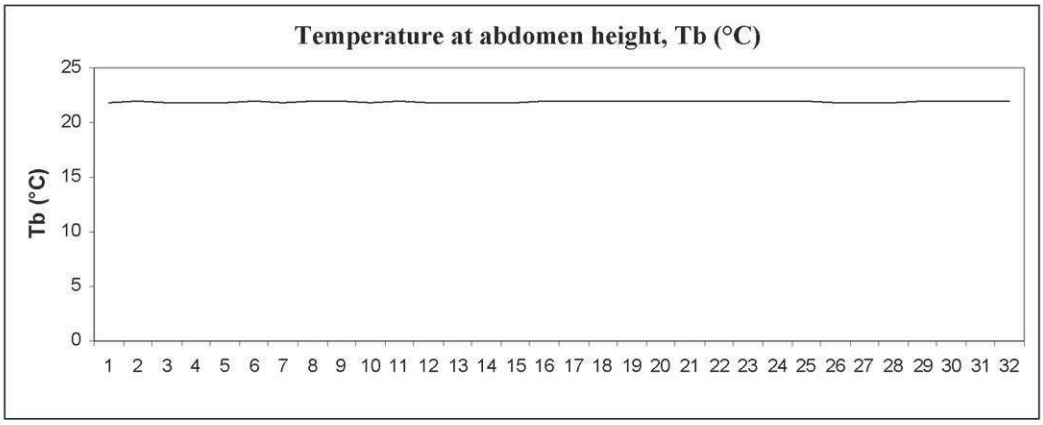
| | Evaluation Report<br>Moderate Environments: Local Discomfort Analysis<br>Norm ISO 7730 | Mod. 001 rev.0<br>Page 5 of 7 |
|---|---|---|

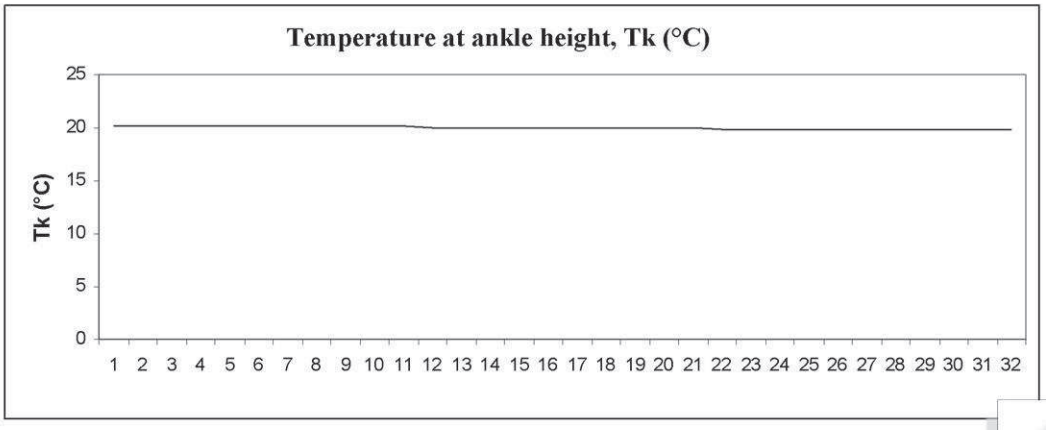
**Graph Trend:**

| | | | |
|---|---|---|---|
| **Start date:** | 2006/10/05 | **Start time:** | 10:30:00 |
| **End date:** | 2006/10/05 | **End time:** | 10:38:00 |

**Acquisition frequency: 15 sec**

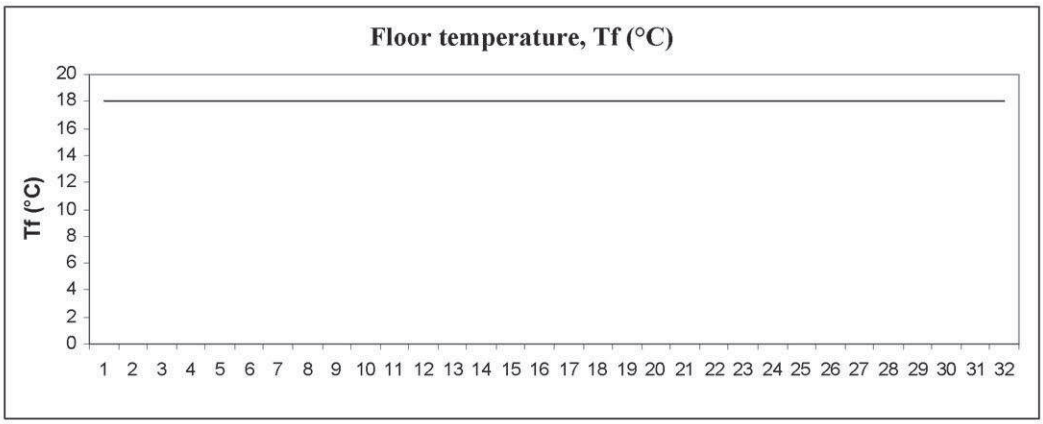


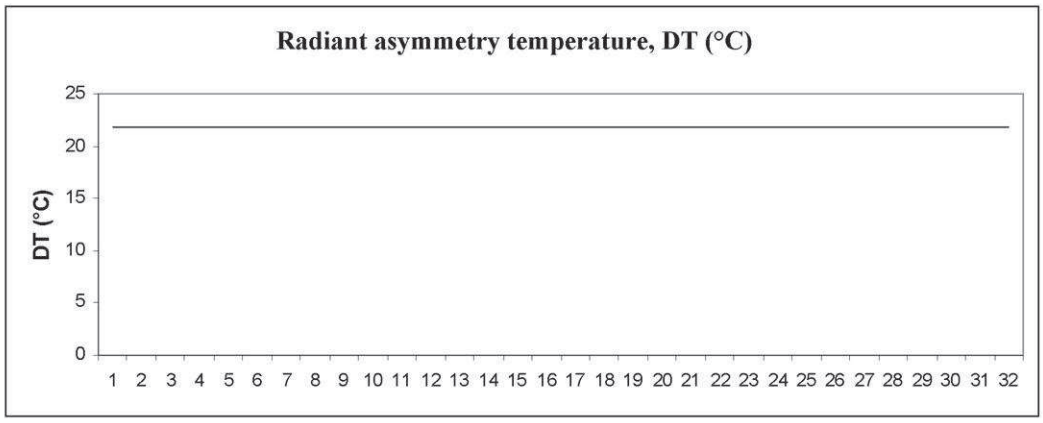



Discomfort Analysis

| | Evaluation Report<br>Moderate Environments: Local Discomfort Analysis<br>Norm ISO 7730 | Mod. 001 rev.0<br>Page 6 of 7 |
|---|---|---|



Discomfort Analysis

| | | |
|---|---|---|
| Delta OHM | **Evaluation Report**<br>Moderate Environments: Local Discomfort Analysis<br><br>Norm ISO 7730 | Mod. 001 rev.0<br>Page 7 of 7 |

**Measurements:**

| | |
|---|---|
| Temperature at head height, Th (°C) | 24 |
| Temperature at abdomen height, Tb (°C) | 22.1 |
| Temperature at ankle height, Tk (°C) | 20 |
| Floor temperature, Tf (°C) | 18 |
| Radiant asymmetry temperature, DT (°C) | 21.9 |

**Overall result:**

| | |
|---|---|
| PD: Dissatisfied with the difference of temperature (head-ankles). | 9 % |
| PD: Dissatisfied with a cold and hot floor | 13 % |
| Vertical Radiant Asymmetry: PD hot ceiling | 64 % |

**Description of clothing:**

| | |
|---|---|
| Daily Clothing:<br>Intimate underwear and lingerie, short-sleeved vest/top, blouse, trousers, jacket, ankle socks, shoes | 1.5 clo |

**Description of activity:**

| | |
|---|---|
| Type of Job: Sedentary activity (office, home, school, laboratory) | 70 W/m2 |

## 12.4 HOT ENVIRONMENT

**Evaluation Report**

Very Hot Environments: Determination of thermal stress by calculating the predicted heat strain

Norm ISO 7933

**Delta OHM**
**Via Marconi, 5**
**35030 Caselle di Selvazzano**
**Padova**
**Italy**

### INTRODUCTION

The problems arising in very hot environments are essentially the result of the fact that thermoregulation mechanisms are not sufficient to guarantee homeothermy of the body's core. This results in an accumulation of thermal energy and consequent rise in body temperature that may reach unacceptable levels. Furthermore, the continuous activation of the sweating mechanism of can lead to a hydromineral unbalance.
Studies of very hot environments distinguish between acclimatized and non acclimatized people.
A non acclimatized person reacts to hot environments much worse than those who are acclimatized since, for physiological reasons, the latter activate sweating more rapidly.
The method adopted here quantifies the heat strain by relating it to the heat quantity that the human body is capable of dissipating through sweating.

### PURPOSE AND APPLICATION SCOPE

The purpose of this survey is the determination of thermal stress by calculating the predicted heat strain.

### REFERENCE STANDARDS

Norm ISO 7933

### NOTES

Space for notes

| | Evaluation Report<br>Very Hot Environments: Determination of thermal stress by calculating the predicted heat strain<br>Norm ISO 7933 | Mod. 001 rev.0<br>Page 2 of 7 |
|---|---|---|

**Measurement date:**

| | | | |
|---|---|---|---|
| **Start date:** | 2006/10/05 | **Start time:** | 10:30:00 |
| **End date:** | 2006/10/05 | **End time:** | 10:38:00 |

**Location of the survey:**

| | |
|---|---|
| **Company:** | Delta OHM |
| **Address:** | Via Marconi, 5 |
| **City:** | 35030 Caselle di Selvazzano |
| **Prov.:** | Padova |
| **Country:** | Italy |
| **Contact person:** | Paolo Bianchi |
| **Telephone/fax:** | 0039-0498977150 - Fax 0039-049635596 |
| **E-mail:** | deltaohm@tin.it |

**Report Author:**

| | |
|---|---|
| **Author:** | Mario Rossi |
| **Address:** | Via Marconi, 5 |
| **City:** | 35030 - Caselle di Selvazzano |
| **Prov.:** | Padova |
| **Country:** | Italy |
| **Contact person:** | Mario Rossi |
| **Telephone/fax:** | 0039-0498977150 - Fax 0039-049635596 |
| **E-mail:** | deltaohm@tin.it |

| Written | | Checked and Approved | |
|---|---|---|---|
| **Date** | **Signature** | **Date** | **Signature** |
| | | | |

| | Evaluation Report<br>Very Hot Environments: Determination of thermal stress by calculating the predicted heat strain<br>Norm ISO 7933 | Mod. 001 rev.0<br>Page 3 of 7 |
|---|---|---|

**Instrumentation used:**

| | |
|---|---|
| **Instrument Code:** | Model HD32.1 prog.A |
| **Firmware Version:** | Firm.Ver.=01.00 |
| **Firmware Date (yyyy/mm/dd):** | Firm.Date=2005/10/12 |
| **Instrument Serial Number:** | SN=12345678 |
| **User Code:** | User ID=0000000000000000 |

**Probes used:**

**Input description Ch.1**
Type of probe: Pt100
Cal. Date: 2004/09/13
Y/N: 87654321

**Input description Ch.2**
Type of probe: Pt100 Tg 50
Cal. Date: 2005/06/27
Y/N: 05013380

**Input description Ch.3**
Type of probe: RH
Cal. Date: 2002/01/02
Y/N: 04006422

**Input description Ch.4**
Type of probe: Hot wire
Cal. Date: 2002/07/05
Y/N: 04005175

**Input description Ch.5**
Type of probe: not present
Cal. Date: not present
Y/N: not present

**Input description Ch.6**
Type of probe: not present
Cal. Date: not present
Y/N: not present

**Input description Ch.7**
Type of probe: not present
Cal. Date: not present
Y/N: not present

**Input description Ch.8**
Type of probe: not present
Cal. Date: not present
Y/N: not present

| | Evaluation Report<br>Very Hot Environments: Determination of thermal stress by calculating the predicted heat strain<br>Norm ISO 7933 | Mod. 001 rev.0<br>Page 4 of 7 |
|---|---|---|

**Description of the observation location:**

Very Hot Environment
Indoor
The worker being observed has an average size body

**Description of clothing:**

Daily Clothing:
Intimate underwear and lingerie, short-sleeved vest/top, blouse, trousers, jacket, ankle 1.5 clo

**Worker Parameters:**

| | | | |
|---|---|---|---|
| Body mass | massa | 75,0 | kg |
| Height | a | 1,8 | m |
| Can the person drink freely? | D | sì | |
| Mechanical flow | W | 0 | W/m2 |
| Posture | Posture | 2 | |
| Static Vapour Permeability Index | imst | 0,38 | |
| Fraction of body surface covered by reflective clothing | Ap | 0,55 | |
| Emissivity of reflective clothing | Fr | 0,12 | |
| Is the person walking? | defspeed | no | |
| Speed of the person | Walkspd | 0,0 | m/s |
| Is there a defined direction of walk? | defdir | no | |
| Angle between direction of movement and wind direction | THETA | 0,0 | ° |
| Acclimatization percentage | accl | 100 | |

**Description of activity:**

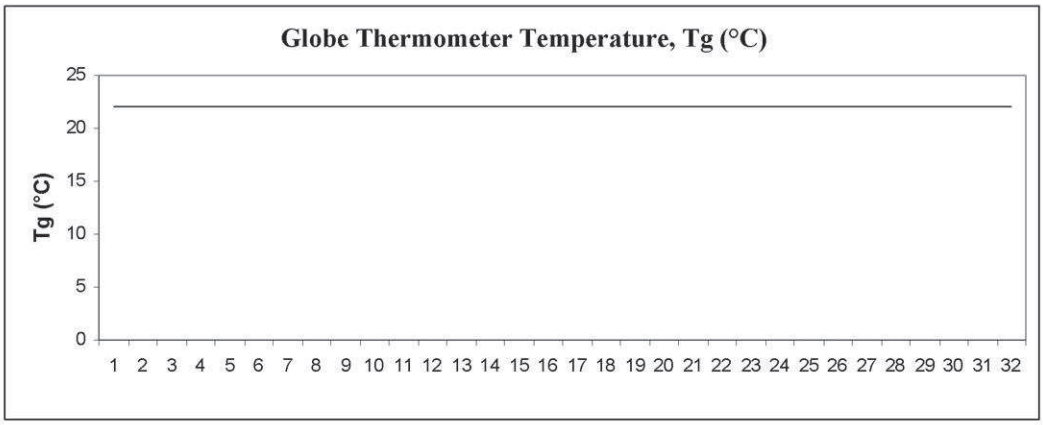
Type of Job: Sedentary activity (office, home, school, laboratory) 70 W/m2

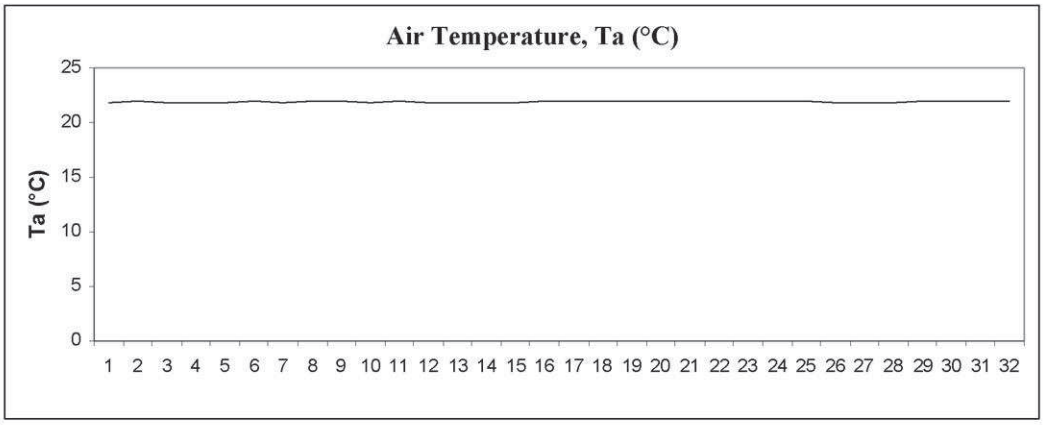
| | Evaluation Report | |
|---|---|---|
| Delta OHM | Very Hot Environments: Determination of thermal stress by calculating the predicted heat strain<br>Norm ISO 7933 | Mod. 001 rev.0<br>Page 5 of 7 |

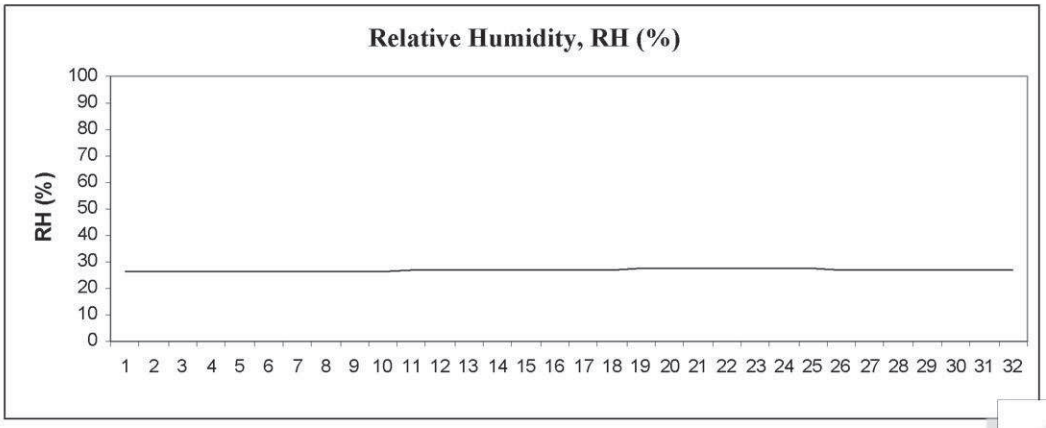
**Graph Trend:**

| | | | |
|---|---|---|---|
| **Start date:** | 2006/10/05 | **Start time:** | 10:30:00 |
| **End date:** | 2006/10/05 | **End time:** | 10:38:00 |

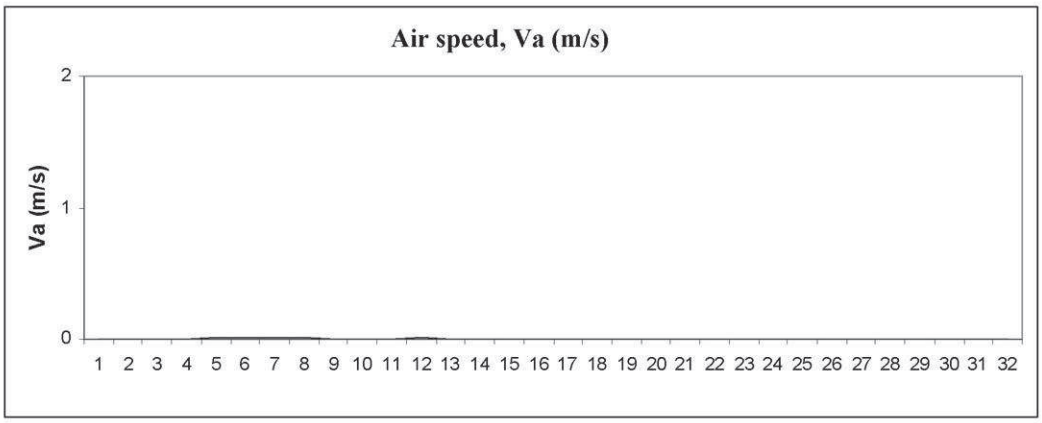
**Acquisition frequency: 15 sec**

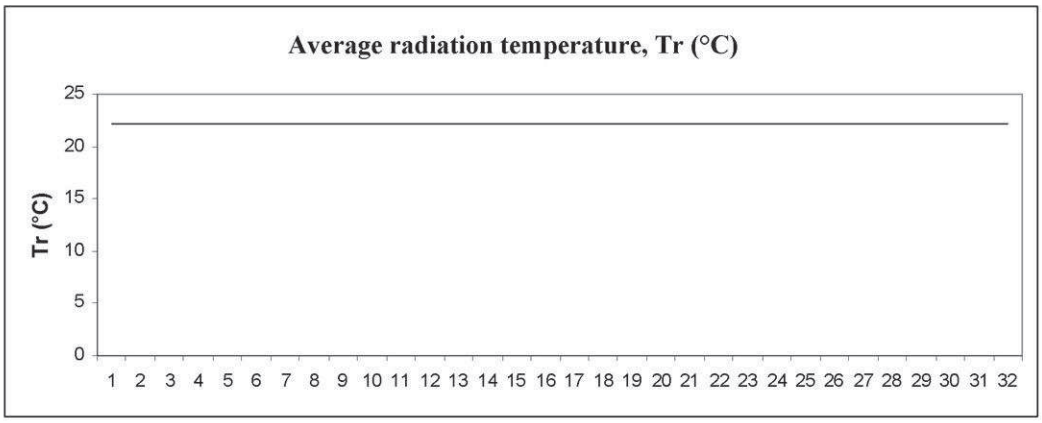


| | Evaluation Report<br>Very Hot Environments: Determination of thermal stress by calculating the predicted heat strain<br>Norm ISO 7933 | Mod. 001 rev.0<br>Page 6 of 7 |
|---|---|---|



| | | |
|---|---|---|
| Delta OHM | **Evaluation Report**<br>Very Hot Environments: Determination of thermal stress by calculating the predicted heat strain<br>Norm ISO 7933 | Mod. 001 rev.0<br>Page 7 of 7 |

**Measurements:**

| | |
|---|---|
| Air Temperature, Ta (°C) | 35 |
| Relative Humidity (%) | 65 |
| Wind Speed (m/s) | 1 |
| Average Radiation Temperature (°C) | 28 |

**Overall result:**

| | | | |
|---|---|---|---|
| Rectal Temperature | Tre | 37.1 | °C |
| Water Loss | Water loss | 2118 | g |
| Maximum Exposure Time Allowed for Thermal Accumulation | DlimTre | 480 | min |
| Maximum Exposure Time Allowed for Water Loss, Average Person | Dlimloss50 | 480 | min |
| Maximum Exposure Time Allowed for Water Loss, 95% of the Working Population | Dlimloss95 | 480 | min |

## 12.5 COLD ENVIRONMENT

# Evaluation Report

Very Cold Environments: Determination of the IREQ, WCI, DLE, RT cold stress indices

Norm ISO 11079

**Delta OHM**
**Via Marconi, 5**
**35030 Caselle di Selvazzano**
**Padova**
**Italy**

### INTRODUCTION

In order to prevent the cooling of the body's core when exposed to extremely cold environments for long periods, the organism of an individual reacts by initially activating the vasomotor mechanisms and then the behavioral ones.
Due to vasometric regulation and in order to reduce blood circulation in peripheral areas of the body the sphincters are shrinked in peripheral capillaries. When this mechanism is no longer sufficient to guarantee homeothermy and the core of the body cools under 35°C (hypothermia), shivering is triggered activating muscle groups that in turn generate thermal energy but without producing mechanical work towards the external environment.
The thermal stress conditions affecting individuals in extremely cold environments are evaluated by the procedures of the UNI ENV ISO 11079:2001 standard, by using the IREQ index. In addition, the WCI index is used to compare the effects of exposure on unprotected parts of the body.

### PURPOSE AND APPLICATION SCOPE

The purpose of this survey is the determination of the IREQ, WCI, DLE, RT indices.

### REFERENCE STANDARDS

Norm ISO 11079

### NOTES

Space for notes

| | Evaluation Report<br>Very Cold Environments: Determination of the IREQ, WCI, DLE, RT cold stress indices<br>Norm ISO 11079 | Mod. 001 rev.0<br>Page 2 of 8 |
|---|---|---|

**Measurement date:**

| | | | |
|---|---|---|---|
| **Start date:** | 2006/10/05 | **Start time:** | 10:30:00 |
| **End date:** | 2006/10/05 | **End time:** | 10:38:00 |

**Location of the survey:**

| | |
|---|---|
| **Company:** | Delta OHM |
| **Address:** | Via Marconi, 5 |
| **City:** | 35030 Caselle di Selvazzano |
| **Prov.:** | Padova |
| **Country:** | Italy |
| **Contact person:** | Paolo Bianchi |
| **Telephone/fax:** | 0039-0498977150 - Fax 0039-049635596 |
| **E-mail:** | deltaohm@tin.it |

**Report Author:**

| | |
|---|---|
| **Author:** | Mario Rossi |
| **Address:** | Via Marconi, 5 |
| **City:** | 35030 - Caselle di Selvazzano |
| **Prov.:** | Padova |
| **Country:** | Italy |
| **Contact person:** | Mario Rossi |
| **Telephone/fax:** | 0039-0498977150 - Fax 0039-049635596 |
| **E-mail:** | deltaohm@tin.it |

| Written | | Checked and Approved | |
|---|---|---|---|
| **Date** | **Signature** | **Date** | **Signature** |
| | | | |

| | Evaluation Report<br>Very Cold Environments: Determination of the IREQ, WCI, DLE, RT cold stress indices<br>Norm ISO 11079 | Mod. 001 rev.0<br>Page 3 of 8 |
|---|---|---|

**Instrumentation used:**

| | |
|---|---|
| **Instrument Code:** | Model HD32.1 prog.A |
| **Firmware Version:** | Firm.Ver.=01.00 |
| **Firmware Date (yyyy/mm/dd):** | Firm.Date=2005/10/12 |
| **Instrument Serial Number:** | SN=12345678 |
| **User Code:** | User ID=0000000000000000 |

**Probes used:**

**Input description Ch.1**
Type of probe: Pt100
Cal. Date: 2004/09/13
Y/N: 87654321

**Input description Ch.2**
Type of probe: RH
Cal. Date: 2005/06/27
Y/N: 05013380

**Input description Ch.3**
Type of probe: Tg
Cal. Date: 2002/01/02
Y/N: 04006422

**Input description Ch.4**
Type of probe: Hot wire
Cal. Date: 2002/01/02
Y/N: 04006420

**Input description Ch.5**
Type of probe: not present
Cal. Date: not present
Y/N: not present

**Input description Ch.6**
Type of probe: not present
Cal. Date: not present
Y/N: not present

**Input description Ch.7**
Type of probe: not present
Cal. Date: not present
Y/N: not present

**Input description Ch.8**
Type of probe: not present
Cal. Date: not present
Y/N: not present

| | Evaluation Report | |
|---|---|---|
| Delta OHM | Very Cold Environments: Determination of the IREQ, WCI, DLE, RT cold stress indices<br>Norm ISO 11079 | Mod. 001 rev.0<br>Page 4 of 8 |

**Description of the observation location:**

Very Cold Environment
Indoor
The worker being observed has an average size body

**Description of clothing:**

Daily Clothing:
Intimate underwear and lingerie, short-sleeved vest/top, blouse, trousers, jacket, ankle socks, shoes — 1.5 clo

**Description of activity:**

Type of Job: Sedentary activity (office, home, school, laboratory) — 70 W/m2

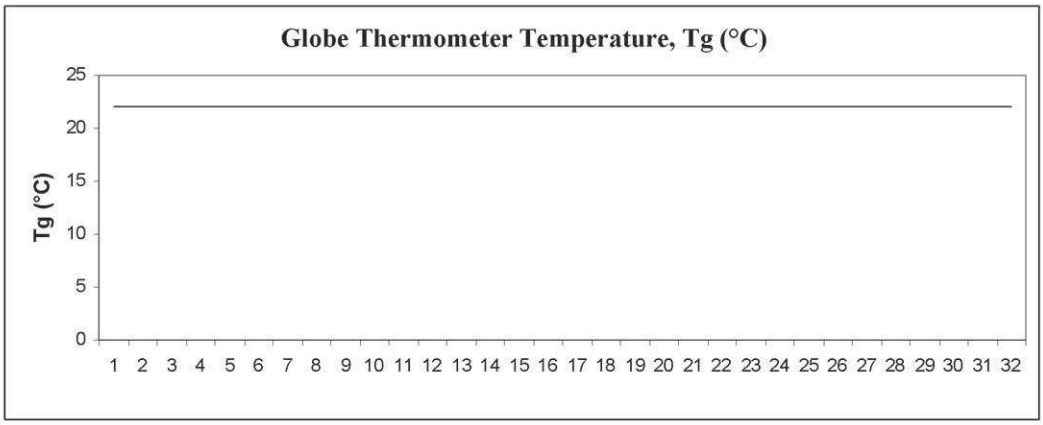
Cold Environment

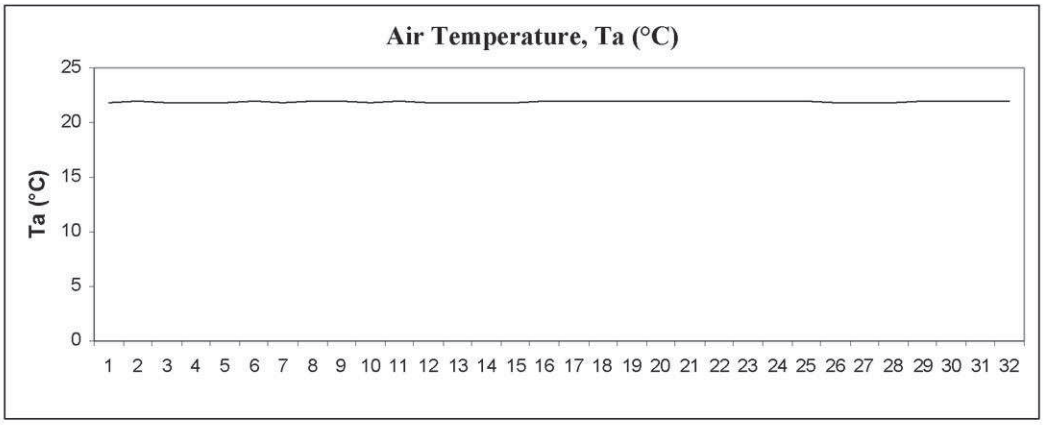
| | Evaluation Report<br>Very Cold Environments: Determination of the IREQ, WCI, DLE, RT cold stress indices<br>Norm ISO 11079 | Mod. 001 rev.0<br>Page 5 of 8 |
|---|---|---|

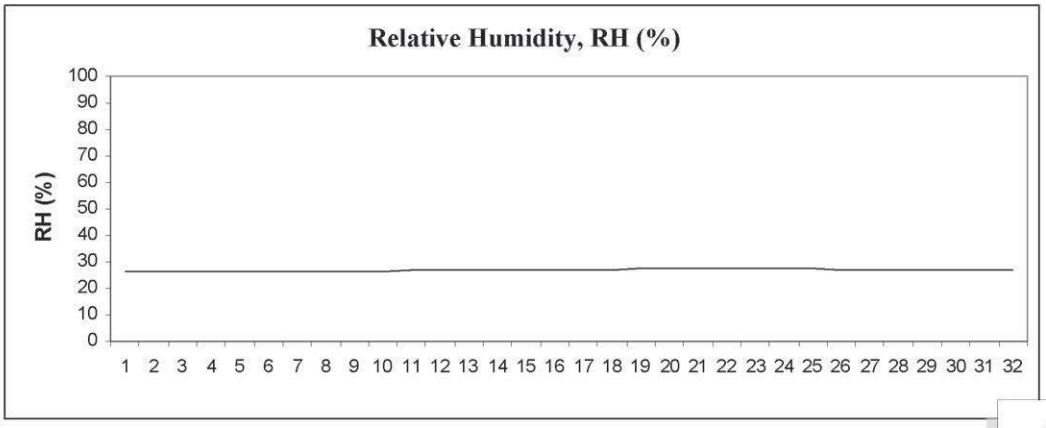
**Graph Trend:**

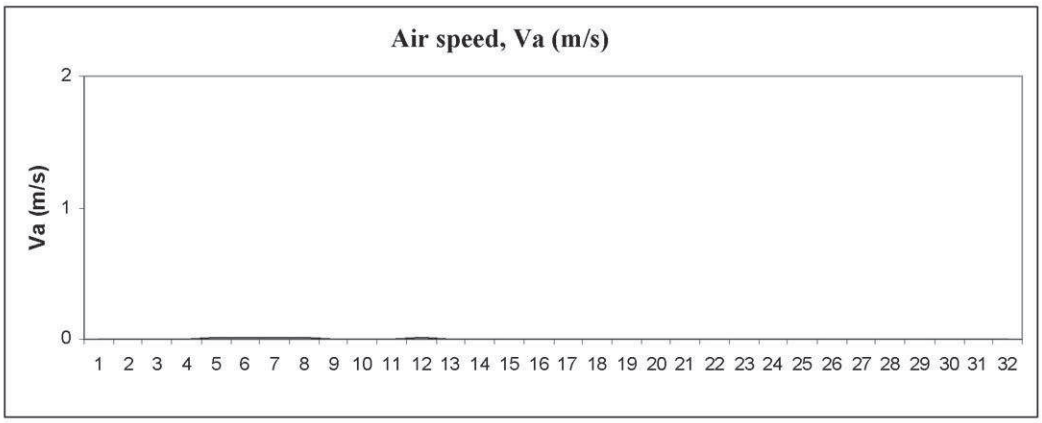
| | | | |
|---|---|---|---|
| **Start date:** | 2006/10/05 | **Start time:** | 10:30:00 |
| **End date:** | 2006/10/05 | **End time:** | 10:38:00 |

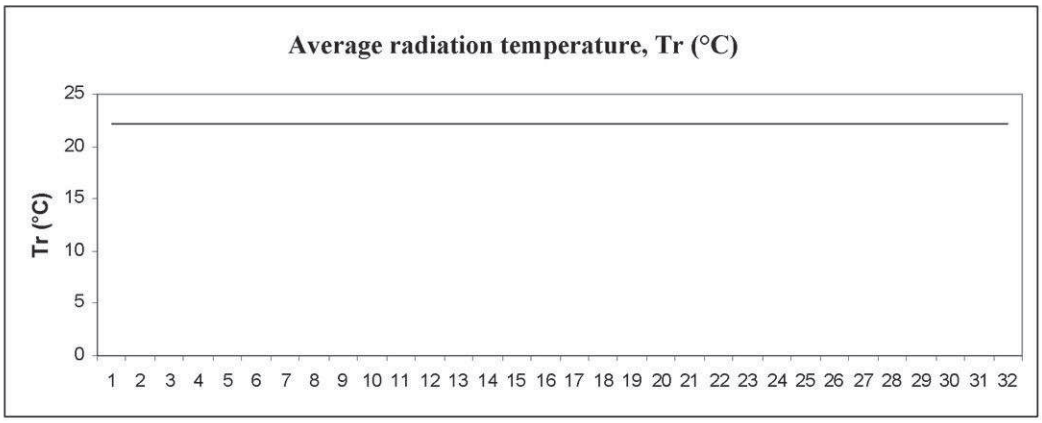
**Acquisition frequency: 15 sec**




Air speed, Va (m/s)
Va (m/s)
2
1
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32


Average radiation temperature, Tr (°C)
Tr (°C)
25
20
15
10
5
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32

| | Evaluation Report<br>Very Cold Environments: Determination of the IREQ, WCI, DLE, RT cold stress indices<br>Norm ISO 11079 | Mod. 001 rev.0<br>Page 7 of 8 |
|---|---|---|

**Measurements:**

| | |
|---|---|
| Air Temperature, Ta (°C) | -20 |
| Relative Humidity (%) | -20 |
| Wind Speed (m/s) | 1.5 |
| Average Radiation Temperature (°C) | -20 |

**Overall result:**

**IREQ Calculation**

| | | | |
|---|---|---|---|
| Ratio between the dressed human body surface and the naked human body surface | fcl | 2.02 | |
| Skin average temperature | Tsk | 32.42 | °C |
| Wet skin fraction | wetness | 0.12 | % |
| Unit convective thermal conductivity | hc | 12.36 | W/(m$^2$ K) |
| Unit radiation thermal conductivity | hr | 2.74 | W/(m$^2$ K) |
| Water partial pressure at environment temperature | Pa | 0.04 | kPa |
| Cloth surface temperature | Tcl | -16.88 | °C |
| Evaporation insulation resulting from clothing and limit stratum | Rt | 0.09 | (m$^2$ kPa)/W |
| Exchanged thermal flow due to sweat evaporation | E | 6.39 | W/m$^2$ |
| Exchanged thermal flow due to convection and evaporation in breathing | Hres | 13.47 | W/m$^2$ |
| Exchanged thermal flow due to radiation | R | 17.23 | W/m$^2$ |
| Exchanged thermal flow due to convection | C | 77.86 | W/m$^2$ |
| Thermal insulation of the required clothing | IREQ | 0.52 | (m$^2$ K)/W |
| Thermal insulation of the required clothing | IREQ | 3.35 | clo |
| Intrinsic thermal insulation of the clothing | Icl | 4.2 | clo |
| Thermal insulation of the clothing | Iclr da input | 1.6 | clo |

| | | |
|---|---|---|
| Delta OHM | **Evaluation Report**<br>Very Cold Environments: Determination of the IREQ, WCI, DLE, RT cold stress indices<br>Norm ISO 11079 | Mod. 001 rev.0<br>Page 8 of 8 |

**DLE Calculation**

| | | | |
|---|---|---|---|
| Ratio between the dressed human body surface and the naked human body surface | fcl | 2.02 | |
| Skin average temperature | Tsk | 32.42 | °C |
| Wet skin fraction | wetness | 0.12 | % |
| Unit convective thermal conductivity | hc | 12.36 | W/(m$^2$ K) |
| Unit radiation thermal conductivity | hr | 2.74 | W/(m$^2$ K) |
| Water partial pressure at environment temperature | Pa | 0.04 | kPa |
| Cloth surface temperature | Tcl | -16.88 | °C |
| Evaporation insulation resulting from clothing and limit stratum | Rt | 0.09 | (m$^2$ kPa)/W |
| Exchanged thermal flow due to sweat evaporation | E | 6.39 | W/m$^2$ |
| Exchanged thermal flow due to convection and evaporation in breathing | Hres | 13.47 | W/m$^2$ |
| Exchanged thermal flow due to radiation | R | 17.23 | W/m$^2$ |
| Exchanged thermal flow due to convection | C | 77.86 | W/m$^2$ |
| Thermal insulation of the required clothing | IREQ | 0.52 | (m$^2$ K)/W |
| Thermal insulation of the required clothing | IREQ | 3.35 | clo |
| Intrinsic thermal insulation of the clothing | Icl | 4.2 | clo |
| Thermal insulation of the clothing | Iclr da input | 1.6 | clo |

**WCI Calculation**

| | | | |
|---|---|---|---|
| Wind Cooling Index | WCI | 1356 | W/m2 |
| Cooling temperature | Tch | -20.2 | °C |
| Relative wind speed | var | 1.8 | m/s |

**RT Calculation**

| | | | |
|---|---|---|---|
| Ratio between the dressed human body surface and the naked human body surface | fcl | 1.31 | |
| Skin average temperature | Tsk | 34.42 | °C |
| Wet skin fraction | wetness | 0.05 | % |
| Unit convective thermal conductivity | hc | 12.92 | W/(m2 K) |
| Unit radiation thermal conductivity | hr | 4.24 | W/(m2 K) |
| Water partial pressure at environment temperature | Pa | 1.17 | kPa |
| Cloth surface temperature | Tcl | 23.22 | °C |
| Evaporation insulation resulting from clothing and limit stratum | Rt | 0.03 | (m2 kPa)/W |
| Exchanged thermal flow due to sweat evaporation | E | 6.10 | W/m2 |
| Exchanged thermal flow due to convection and evaporation in breathing | Hres | 3.83 | W/m2 |
| Exchanged thermal flow due to radiation | R | 17.85 | W/m2 |
| Exchanged thermal flow due to convection | C | 54.36 | W/m2 |
| Limit exposure time | RT | 1.08 | h |

## 12.6 PHYSICAL QUANTITIES

```
Model HD32.1 prog.C
/*
THERMAL MICROCLIMATE
Firm.Ver.=01.00
Firm.Date=2005/10/12
SN=12345678
User ID=0000000000000000
Cal.=Factory
Description Channel 1     Probe = Pt100          Probe cal.=2004/09/13     Probe SN=87654321
Description Channel 2     Probe = RAD            Probe cal.=2005/06/27     Probe SN=05013380
Description Channel 3     Probe = RH             Probe cal.=2002/01/02     Probe SN=04006422
Description Channel 4     Probe = Hot wire       Probe cal.=2002/07/05     Probe SN=04005175
Description Channel 5     Probe = not present    Probe cal.=not present    Probe SN=not present
Description Channel 6     Probe = not present    Probe cal.=not present    Probe SN=not present
Description Channel 7     Probe = not present    Probe cal.=not present    Probe SN=not present
Description Channel 8     Probe = not present    Probe cal.=not present    Probe SN=not present
*/
Sample interval=   1sec        Tpt       V        Fv        Tv        RH        Trh       Lux
Unit measure:                   øC      m/s       l/s       øC         %        øC       lux
Date=2006/01/01 01:27:17      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:18      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:19      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:20      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:21      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:22      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:23      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:24      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:25      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:26      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:27      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:28      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:29      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:30      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:31      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:32      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:33      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:34      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:35      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:36      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:37      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:38      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:39      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:40      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:41      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:42      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:43      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:44      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:45      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:46      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:47      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:48      21.9      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:49      21.8      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:50      21.8      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:51      21.8      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:52      21.8      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:53      21.8      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:54      21.8      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:55      21.8      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:56      21.8      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:57      21.8      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:58      21.8      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:27:59      21.8      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:28:00      21.8      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:28:01      21.8      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:28:02      21.8      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:28:03      21.8      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:28:04      21.8      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:28:05      21.8      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:28:06      21.8      0.00      0.0      21.8      50.0      21.8     522.1
Date=2006/01/01 01:28:07      21.8      0.00      0.0      21.8      50.0      21.8     522.1
-->End of Log Session<--
```

## 13. TECHNICAL CHARACTERISTICS

| | |
|---|---|
| *Instrument* | |
| Dimensions (Length x Width x Height) | 220x180x50 mm |
| Weight | 1,100 g (batteries included) |
| Materials | ABS, polycarbonate and aluminum |
| Display | Backlit, Dot Matrix<br>128x64 points, visible area 56x38mm |
| *Operating conditions* | |
| Operating temperature | -5 … 50°C |
| Warehouse temperature | -25 … 65°C |
| Working relative humidity | 0 … 90% RH without condensation |
| **Protection degree** | **IP64** |
| *Instrument uncertainty* | ± 1 digit @ 20°C |
| *Barometric pressure measurement with internal sensor* | |
| Measuring range | 600…1100hPa |
| Resolution | 0.1hPa |
| Accuracy | ±0.5hPa |
| Response time | 1s |
| *Instrument temperature measurement with Pt100 probe* | |
| Pt100 measuring range | -200…+650°C |
| Resolution | 0.01°C in the range ±199.99°C,<br>0.1°C in the remaining range |
| Accuracy | ±0.01°C in the range ±199.99°C,<br>±0.1°C in the remaining range |
| Temperature drift @20°C | 0.003%/°C |
| Drift after 1 year | 0.1°C/year |
| *Instrument relative humidity measurement (capacitive sensor)* | |
| Measuring range | 0…100%RH |
| Resolution | 0.1%RH |
| Accuracy | ±0.1%RH |
| Temperature drift @20°C | 0.02%RH/°C |
| Drift after 1 year | 0.1%RH/year |
| *Power* | |
| Mains adapter (code SWD10) | 12Vdc/1A |
| Batteries | 4 1.5V type C-BABY batteries |
| Autonomy | RH and temperature probes:<br>200 hours with 7800mAh alkaline batteries<br>Hot-wire probe @ 5m/s:<br>100 hours with 7800mAh alkaline batteries |
| Power absorbed with instrument off | < 45µA |
| *Security of stored data* | Unlimited |

| | |
|---|---|
| *Connections* | |
| Input for probes with SICRAM module | 8x 8-pole male DIN45326 connector |
| *RS232C serial interface* | |
| Type | RS232C electrically isolated |
| Baud rate | Can be set from 1200 to 38400 baud |
| Data bit | 8 |
| Parity | None |
| Stop bit | 1 |
| Flow Control | Xon/Xoff |
| Serial cable length | Max. 15 m |
| *USB interface* | |
| Type | 1.1 – 2.0 electrically isolated |
| *Memory* | divided into 64 blocks. |
| *Memory capacity* | 67600 recordings for 8 inputs each. |
| *Storage interval* | selectable among: 15, 30 seconds, 1, 2, 5, 10, 15, 20, 30 minutes and 1 hour. |
| *Print interval* | selectable among: 15, 30 seconds, 1, 2, 5, 10, 15, 20, 30 minutes and 1 hour. |
| *EMC Standard Regulations* | |
| Safety | EN61000-4-2, EN61010-1 level 3 |
| Electrostatic discharges | EN61000-4-2 level 3 |
| Fast electric transients | EN61000-4-4 level 3, EN61000-4-5 level 3 |
| Voltage variations | EN61000-4-11 |
| Electromagnetic interference susceptibility | IEC1000-4-3 |
| Electromagnetic interference emission | EN55020 class B |

# 14. EXPLANATORY TABLES ON THE MICROCLIMATE PROBES USAGE

| DeltaLog10 Software | Operating Program | Main Calculated Indexes | Environments | Reference Standard |
|---|---|---|---|---|
| **DeltaLog10BASIC** | **Prog.A** | **$t_a$:** Air Temperature<br>**$t_r$:** Average Radiation Temperature<br>**PMV:** Expected Average Rating<br>**PPD:** Unsatisfied Percentage<br>**DR:** Draught Risk<br>**$t_o$:** Operating temperature<br>**$t_{eq}$:** Equivalent temperature | Moderate | ISO 7730 |
| **DeltaLog10 Hot Environments** | **Prog.A** | **WBGT:** Wet Bulb Globe Temperature<br>**$SW_p$:** Sweat Rate<br>**$E_p$:** Predicted Evaporative Heat Flow<br>**PHS:** Predicted Heat Strain Model | Severe Hot | ISO 7243 |
| **DeltaLog10 Cold Environments** | **Prog.A** | **IREQ:** Required Insulation<br>**DLE:** Limit Exposure Time<br>**RT:** Limit Exposure Time<br>**WCI:** Wind Chill Index | Severe Cold | ISO 11079 |
| **DeltaLog10 Discomfort Analysis** | **Prog.B** | **$PD_v$:** Unsatisfied with the vertical difference of temperature (head-ankles)<br>**$PD_f$:** Unsatisfied with the floor temperature<br>**$PD_\Lambda$:** Unsatisfied with the radiant asymmetry | Moderate | ISO 7730 |
| **DeltaLog10BASIC** | **Prog.C** | **$t_a$:** Air Temperature<br>**RH-t:** Humidity-temperature<br>**$V_a$-t:** Wind speed-temperature<br>**Lux:** Illuminance<br>**cd/$m^2$:** Luminance<br>**µW/$m^2$:** Irradiance<br>**W/$m^2$:** Irradiance<br>**µmol/$m^2$s:** PAR<br>**$CO_2$:** Bioxide carbonic concentration (ppm)<br>**CO:** Monoxide carbonic concentration (ppm) | General use | |

## *14.1 Diagram of the probes for HD32.1 Operating Program A: Microclimate Analysis*

**TP3207** Dry bulb temperature probe.
**TP3275** Globe thermometer probe Ø 150 mm. (instead of TP3276)
**TP3276** Globe thermometer probe Ø 50mm. (instead of TP3275)
**AP3203** Omni directional hot-wire probe (0…+80°C).
**AP3203-F** Omni directional hot-wire probe (-30…+30°C).
**HP3201** Natural ventilation wet bulb probe.
**HP3217** Relative humidity and temperature combined probe.
**HP3217DM** Two-sensor probe for natural ventilation wet bulb temperature and dry bulb temperature measurement (instead of: HP3201 and TP3207).

The following table shows the required probes for microclimate indexes measurement.

The following indexes are calculated using the **DeltaLog10BASIC** software:

**Each line indicates the combination of probes to be used for the different indexes calculation**

| | TP3207 | TP3275 | TP3276 | AP3203 AP3203-F | HP3201 | HP3217 | HP3217DM |
|---|---|---|---|---|---|---|---|
| $t_a$: Air Temperature. | ● | | | | | | |
| | | | | | | | ● |
| | | | | | | ● | |
| $t_r$: Average Radiation Temperature. | ● | ● | | ● | | | |
| | ● | | ● | ● | | | |
| | | ● | | ● | | | ● |
| | | | ● | ● | | | ● |
| | | ● | | ● | | ● | |
| | | | ● | ● | | ● | |
| **PMV**: Expected Average Rating. **PPD**: Unsatisfied Percentage | ● | ● | | ● | | ● | |
| | ● | | ● | ● | | ● | |
| | | ● | | ● | | ● | ● |
| | | | ● | ● | | ● | ● |
| | | ● | | ● | | ● | |
| | | | ● | ● | | ● | |
| **DR**: Draught Risk. | ● | | | ● | | | |
| | | | | ● | | | ● |
| | | | | ● | | ● | |
| $t_o$: Operating temperature. | ● | ● | | ● | | | |
| | ● | | ● | ● | | | |
| | | ● | | ● | | | ● |
| | | | ● | ● | | | ● |
| | | ● | | ● | | ● | |
| | | | ● | ● | | ● | |
| $t_{eq}$: Equivalent Temperature. | ● | | | | | ● | |
| | | | | | | ● | |
| | | | | | | ● | ● |

The following indexes are calculated using the **DeltaLog10 Hot Environments** software:

**Each line indicates the combination of probes to be used for the different indexes calculation**

| | | TP3207 | TP3275 | TP3276 | AP3203 | HP3201 | HP3217 | HP3217DM |
|---|---|---|---|---|---|---|---|---|
| **WBGT Indoor:** Wet Bulb Globe Temperature | | | ● | | | ● | | |
| | | | | ● | | ● | | |
| **WBGT Outdoor:** Wet Bulb and Globe Thermometer Temperature with solar radiation | | ● | ● | | | ● | | |
| | | ● | | ● | | ● | | |
| | | | ● | | | ● | | ● |
| | | | | ● | | ● | | ● |
| | | | ● | | | ● | ● | |
| | | | | ● | | ● | ● | |
| **$SW_p$:** Sweat Rate | | ● | ● | | ● | | ● | |
| | | ● | | ● | ● | | ● | |
| **$E_p$:** Predicted Evaporative Heat Flow | | | ● | | ● | | ● | ● |
| | | | | ● | ● | | ● | ● |
| | | | ● | | ● | | ● | |
| | | | | ● | ● | | ● | |
| **PHS** | (1) $T_{re}$ | ● | ● | | ● | | ● | |
| | Water Loss | ● | | ● | ● | | ● | |
| | $D_{lim\ tre}$ | | ● | | ● | | ● | ● |
| | $D_{limloss50}$ | | | ● | ● | | ● | ● |
| | $D_{limloss95}$ | | ● | | ● | | ● | |
| | | | | ● | ● | | ● | |

(1) $T_{re}$: Expected Rectal Temperature
Water Loss: Water Loss
$D_{lim\ tre}$: Maximum Exposure Time Allowed for Thermal Accumulation
$D_{limloss50}$: Maximum Exposure Time Allowed for Water Loss, Average Person
$D_{limloss95}$: Maximum Exposure Time Allowed for Water Loss, 95% of the Working Population

The following indexes are calculated using the **DeltaLog10 Cold Environments** software:

**Each line indicates the combination of probes to be used for the different indexes calculation**

| | | TP3207 | TP3275 | TP3276 | AP3203 AP3203-F (3) | HP3201 | HP3217 | HP3217DM |
|---|---|---|---|---|---|---|---|---|
| (2) | **IREQ:** Required Insulation | ● | ● | | ● | | ● | |
| | **DLE:** Limit Exposure Time | ● | | ● | ● | | ● | |
| | | | ● | | ● | | ● | ● |
| | **RT:** Limit Exposure Time | | | ● | ● | | ● | ● |
| | | | ● | | ● | | ● | |
| | **WCI:** Wind Chill Index | | | | ● | | ● | |
| | | ● | | | ● | | | |
| | | | | | ● | | | ● |

(2) With IREQ, DLE, RT, WCI you can calculate:
Ratio between the dressed human body surface and the naked human body surface
Skin average temperature
Wet skin fraction
Unit convective thermal conductivity
Unit radiation thermal conductivity
Water partial pressure at environment temperature
Cloth surface temperature
Evaporation insulation resulting from clothing and limit stratum
Exchanged thermal flow due to sweat evaporation
Exchanged thermal flow due to convection and evaporation in breathing
Exchanged thermal flow due to radiation
Exchanged thermal flow due to convection
Limit exposure time
Thermal insulation of the required clothing
Intrinsic thermal insulation of the clothing

(3) AP3203: 0°C … +80°C
AP3203-F: -30°C … +30°C

### *14.2 Diagram of the probes for HD32.1 Operating Program B: Discomfort Analysis*

**TP3227K** Temperature probe composed of 2 standalone probes, head and abdomen temperature.
**TP3227PC** Temperature probe composed of 2 standalone probes, ankles and floor temperature.
**TP3207P** Pt100 sensor temperature probe, floor temperature
**TP3207TR** Probe for radiant temperature measurement (net radiometer)

In the following table are reported the required probes for microclimate indexes measurement.

The following indexes are calculated using the **DeltaLog10 Discomfort Analysis** software:

**Each line indicates the combination of probes to be used for the different indexes calculation**

| | | TP3227K | TP3227PC | TP3207P | TP3207TR | LP 471 Phot |
|---|---|---|---|---|---|---|
| **$PD_v$:** | Unsatisfied with the vertical difference of temperature (head-ankles). | • | • | | | |
| **$PD_f$:** | Unsatisfied with the floor temperature. | | • | | | |
| | | | | • | | |
| **$PD_\Delta$:** | Unsatisfied with the radiant asymmetry. | | | | • | |
| **FLD** | Daylight medium factor (It requires HD32.1 program C) | | | | | • |

## 15. ORDERING CODES

**HD32.1 Basic Kit:** The kit is composed of the **HD32.1 instrument, Operating Program A: Microclimate Analysis**, 4 1.5V alkaline C/Baby type batteries, operating manual.
**DeltaLog10 Basic Moderate Environments Software** (Windows 98 to Windows XP).

**DeltaLog10 Hot Environments Software:**
This software requires the **complete HD32.1 Basic Kit.**

**DeltaLog10 Cold Environments Software:**
This software requires the **complete HD32.1 Basic Kit.**

**DeltaLog10 Discomfort Analysis Software:**
This software requires the **Operating Program B: Discomfort Analysis** and the **complete HD32.1 Basic Kit.**

**HD32.1 Program B – Discomfort Analysis:**
Program for HD32.1 to carry out discomfort measurements in moderate environments. The DeltaLog10 Discomfort Analysis software is required.

**HD32.1 Program C – Physical Quantities:**
Program for HD32.1 to carry out temperature, relative humidity, light, air speed, CO and $CO_2$ measurements.

**Probes, support, carrying case and cables must be ordered separately.**

**Accessories:**

| | |
|---|---|
| **VTRAP32** | Tripod complete with 6 input head and 4 probe holders code **HD3218K** |
| **9CPRS232** | Connection cable with sub D 9-pole female connectors for RS232C. |
| **CP22** | Connection cable USB 2.0 connector type A - connector type B. |
| **BAG32** | Carrying case for the HD32 instrument and accessories. |
| **SWD10** | Stabilized power supply at 100-240Vac/12Vdc-1A mains voltage. |
| **HD3218K** | Rod for probes |
| **AM32** | Two clamp rod for two probes |
| **AQC** | 200 cc distilled water and no. 3 braids for probes HP3201 or HP3217DM |

**The Delta Ohm Metrological Laboratories are accredited by SIT in regards to Temperature, Humidity, Pressure, Photometry/Radiometry, Acoustics and Wind speed. On request, the probes can be supplied with calibration certificate.**

## 15.1 A AND B OPERATING PROGRAMS PROBES
### A: MICROCLIMATE ANALYSIS
### B: DISCOMFORT ANALYSIS

**TP3207** Pt100 sensor temperature probe. Probe's stem Ø 14mm, length 140 mm. Cable length 2 meters. Complete with SICRAM module.
Used for the following indexes calculation: **IREQ, WCI, DLE, RT, PMV, PPD, WBGT, SR**. Used for the average radiation temperature calculation.

**TP3275** Pt100 sensor globe thermometer probe, globe Ø 150 mm.
Stem Ø 14 mm, length 110 mm. Cable length 2 meters. Complete with SICRAM module.
Used for the measurement of: **Average radiation temperature, WBGT**.

**TP3276** Pt100 sensor globe thermometer probe, globe Ø 50 mm.
Stem Ø 8 mm, length 110 mm. Cable length 2 meters. Complete with SICRAM module.
Used for the measurement of: **Average radiation temperature, WBGT**.

**TP3227K** Temperature probe composed of 2 standalone temperature probes, Pt100 sensor. Stem Ø 14 mm, length 500 mm. Cable length 2 meters. Complete with dual SICRAM module and telescopic rod Ø 14 mm, length 450 mm TP3227.2.
Used for the measurement of **local discomfort due to vertical temperature gradient**. It can be used to study standing or seated persons. The probe's height can be adjusted.

**TP3227PC** Temperature probe is composed of 2 standalone temperature probes, Pt100 sensor, one for floor level temperature measurement (Ø 70 mm, height 30 mm), the other for temperature measurement at ankle height (Ø 3 mm, height 100 mm). Cable length 2 meters. Complete with dual SICRAM module.
Used for the measurement of **local discomfort due to vertical temperature gradient**.

**TP3207P** Pt100 sensor temperature probe for floor level temperature measurement (Ø 70 mm, height 30 mm). Cable length 2 meters. Complete with SICRAM module.
Used for the measurement of **local discomfort due to vertical temperature gradient**.

**TP3207TR** Probe for radiant temperature measurement. Probe's stem Ø 16 mm, length 250 mm. Cable length 2 meters. Complete with SICRAM module.
Used to **assess the unsatisfied with the radiant asymmetry percentage**.

**AP3203** Omni directional hot-wire probe. Measurement range: Wind speed 0÷5 m/s, temperature **0°C…+80°C**. Probe's stem Ø 14 mm, length 110 mm. Cable length 2 meters. Complete with SICRAM module.
Used for the following indexes calculation: **IREQ, WCI, DLE, RT, PMV, PPD, SR**. Used for the average radiation temperature calculation.

**AP3203-F** Omni directional hot-wire probe. Measurement range: Wind speed 0÷5 m/s, temperature **-30°C…+30°C**. Probe's stem Ø 14 mm, length 110 mm. Cable length 2 meters. Complete with SICRAM module.
Used for the following indexes calculation: **IREQ, WCI, DLE, RT, PMV, PPD, SR**. Used for the average radiation temperature calculation.

**HP3201** Natural ventilation wet bulb probe. Pt100 sensor Probe's stem Ø 14 mm, length 110 mm. Cable length 2 meters. Complete with SICRAM module, braid spare and container with 50 cc of distilled water.
Used for the measurement of: **WBGT**.

**HP3217** Relative humidity and temperature combined probe. Capacity sensor for relative humidity, Pt100 temperature sensor. Probe's stem Ø 14 mm, length 110 mm. Cable length 2 meters. Complete with SICRAM module.
Used for the following indexes calculation: **IREQ, WCI, DLE, RT, PMV, PPD, SR**.

**HP3217DM** Dual natural ventilation wet bulb and temperature probe (dry bulb). Probe's stem Ø 14 mm, length 110 mm. Cable length 2 meters. Complete with dual SICRAM module, braid spare and container with 50 cc of distilled water.

## 15.2 PROBES FOR THE OPERATING PROGRAM C: PHYSICAL QUANTITIES

### *15.2.1 Temperature probes complete with SICRAM module*

**TP472I** Pt100 sensor immersion probe. Stem Ø 3 mm, length 300 mm. Cable length 2 meters.

**TP472I.0** Pt100 sensor immersion probe. Stem Ø 3 mm, length 230 mm. Cable length 2 meters.

**TP473P.0** Pt100 sensor penetration probe. Stem Ø 4 mm, length 150 mm. Cable length 2 meters.

**TP474C.0** Pt100 sensor contact probe. Stem Ø 4 mm, length 230 mm, contact surface Ø 5 mm. Cable length 2 meters.

**TP475A.0** Pt100 sensor air probe. Stem Ø 4 mm, length 230 mm. Cable length 2 meters.

**TP472I.5** Pt100 sensor immersion probe. Stem Ø 6 mm, length 500 mm. Cable length 2 meters.

**TP472I.10** Pt100 sensor immersion probe. Stem Ø 6 mm, length 1000 mm. Cable length 2 meters.

### *15.2.2 Relative Humidity and Temperature combined probes complete with SICRAM module*

**HP472AC** Combined probe %RH and temperature, dimensions Ø 26x170 mm. Connection cable length 2 meters.

**HP473AC** Combined probe %RH and temperature. Handle size Ø 26x130 mm, probe Ø 14x110 mm. Connection cable length 2 meters.

**HP474AC** Combined probe %RH and temperature. Handle size Ø 26x130 mm, probe Ø 14x210 mm. Connection cable length 2 meters.

**HP475AC** Combined probe %RH and temperature. Connection cable length 2 meters. Handle Ø 26x110mm. Stainless steel stem Ø 12x560mm. Point Ø 13.5x75mm.

**HP475AC.1** Combined probe %RH and temperature. Stainless steel probe Ø 14x500 mm with sintered stainless steel filter 20μm. Handle 80 mm. Connection cable length 2 meters.

**HP477DC** Combined sword probe %RH and temperature. Connection cable length 2 meters. Handle Ø 26x110mm. Probe's stem 18x4mm, length 520 mm.

### *15.2.3 Wind Speed and Temperature combined probes complete with SICRAM module*

#### *HOT-WIRE PROBES*

**AP471 S1** Hot-wire telescopic probe, measuring range: 0.05…40m/s. Cable length 2 meters.

**AP471 S2** Omni directional hot-wire telescopic probe, measuring range: 0.05…5m/s. Cable length 2 meters.

**AP471 S3** Hot-wire telescopic probe with terminal tip for easy position, measuring range: 0.05…40m/s. Cable length 2 meters.

**AP471 S4** Omni directional hot-wire telescopic probe with base, measuring range: 0.05…5m/s. Cable length 2 meters.

**AP471 S5** Omni directional hot-wire telescopic probe, measuring range: 0.05…5m/s. Cable length 2 meters.

#### *VANE PROBES*

**AP472 S1** Vane probe with thermocouple K, Ø 100 mm. Speed from 0.6 to 25 m/s; temperature from -25 to 80°C. Cable length 2 meters.

**AP472 S2** Vane probe, Ø 60 mm. Measurement range: 0.3…20m/s. Cable length 2 meters.

**AP472 S4L** Vane probe, Ø 16 mm. Speed from 0.8 to 20 m/s. Cable length 2 meters.

**AP472 S4LT** Vane probe, Ø 16 mm. Speed from 0.8 to 20 m/s. Temperature from -30 to 120°C with thermocouple K sensor(*). Cable length 2 meters.

**AP472 S4H** Vane probe, Ø 16 mm. Speed from 10 to 50 m/s. Cable length 2 meters.

**AP472 S4HT** Vane probe, Ø 16 mm. Speed from 10 to 50 m/s. Temperature from -30 to 120°C with thermocouple K sensor(*). Cable length 2 meters.

### *15.2.4 Photometric/Radiometric probes for Light measurement complete with SICRAM module*

**LP 471 PHOT** Photometric probe for **ILLUMINANCE** measurement complete with SICRAM module, spectral response in agreement with standard photopic vision, diffuser for cosine correction. Measurement range: 0.01 lux…$200 \cdot 10^3$ lux.

**LP 471 LUM 2** Photometric probe for **LUMINANCE** measurement complete with SICRAM module, spectral response in agreement with standard photonic vision, vision angle 2°. Measurement range: 0.1 cd/$m^2$…$2000 \cdot 10^3$ cd/$m^2$.

**LP 471 PAR** Quantum radiometric probe for the measurement of the photon flow across the chlorophyll range **PAR** (Photosynthetically Active Radiation 400 nm…700 nm) complete with SICRAM, measurement in μmol/$m^2$s, diffuser for cosine correction. Measurement range: 0.01μmol/$m^2$s…$10\mu 10^3$μmol/$m^2$s

**LP 471 RAD** Radiometric probe for **IRRADIANCE** measurement complete with SICRAM module; in the 400 nm…1050 nm spectral range, diffuser for cosine correction. Measurement range: $0.1 \cdot 10^{-3}$W/$m^2$ …2000 W/$m^2$.

---

(*) Temperature limit refers to the probe where the vane and temperature sensor are located and not to the handle, the cable and telescopic shaft which maximum working temperature is 80°C.

**LP 471 UVA** Radiometric probe for **IRRADIANCE** measurement complete with SICRAM module; in the 315 nm…400 nm, peak 360 nm, **UVA** spectral range, quartz diffuser for cosine correction. Measurement range: $0.1 \cdot 10^{-3} W/m^2$…2000 $W/m^2$.

**LP 471 UVB** Radiometric probe for **IRRADIANCE** measurement complete with SICRAM module, in the 280 nm…315 nm, peak 305 nm, **UVB** spectral range, quartz diffuser for cosine correction.
Measurement range: $0.1 \cdot 10^{-3} W/m^2$…2000 $W/m^2$.

**LP 471 UVC** Radiometric probe for **IRRADIANCE** measurement complete with SICRAM module, in the 220 nm…280 nm, peak 260 nm, **UVC** spectral range, quartz diffuser for cosine correction. Measurement range: $0.1 \cdot 10^{-3} W/m^2$…2000 $W/m^2$.

**LP 471 ERY** Radiometric probe for **EFFECTIVE TOTAL IRRADIANCE** measurement ($W_{eff}/m^2$) weighted according to the UV action curve (CEI EN 60335-2-27) complete with SICRAM module. Spectral range: 250 nm…400 nm, quartz diffuser for cosine correction.
Measurement range: $0.1 \cdot 10^{-3} W_{eff}/m^2$…2000 $W_{eff}/m^2$.

**LP 32 F/R** Support bracket for photometric-radiometric probes for Light measurement LP471...

### *15.2.5 Probes for $CO_2$ carbon dioxide measurement complete with SICRAM module*

**HD320B2** Probe for the measurement of $CO_2$ carbon dioxide complete with SICRAM module, with double source infrared sensor. Measurement range: 0…5000ppm. Cable L=2m.

**MINICAN.12A** Nitrogen cylinder for $CO_2$ calibration at 0ppm. Volume 12 litres. **With adjusting valve.**

**MINICAN.12A1** Nitrogen cylinder for $CO_2$ calibration at 0ppm. Volume 12 litres. **Without adjusting valve.**

**HD37.37** Kit for connection tube between the probe and MINICAN.12A for $CO_2$ calibration.

### *15.2.6 Probes for the measurement of CO carbon monoxide complete with SICRAM module*

**HD320A2** Probe for the measurement of $CO_2$ carbon monoxide complete with SICRAM module, with electro chemical sensor endowed with two electrodes. Measurement range: 0…5000ppm. Cable L=2m.

**HD320AS2** Magnetic support for fixing the probe to HD320B2 probe body.

**MINICAN.12A** Nitrogen cylinder to calibrate CO at 0ppm. **With adjusting valve.**

**MINICAN.12A1** Nitrogen cylinder to calibrate CO at 0ppm. **Without adjusting valve.**

**ECO-SURE-2E CO** CO spare sensor.

**HD37.36** Kit for connection tube between the sensor and MINICAN.12A for the calibration of CO.

# CERTIFICATO DI CONFORMITÀ DEL COSTRUTTORE

*MANUFACTURER'S CERTIFICATE OF CONFORMITY*

**rilasciato da**
*issued by*

## DELTA OHM SRL STRUMENTI DI MISURA

**DATA**
*DATE* 2009/02/12

Si certifica che gli strumenti sotto riportati hanno superato positivamente tutti i test di produzione e sono conformi alle specifiche, valide alla data del test, riportate nella documentazione tecnica.

*We certify that below mentioned instruments have been tested and passed all production tests, confirming compliance with the manufacturer's published specification at the date of the test.*

La riferibilità delle misure ai campioni internazionali e nazionali delle unità del SIT è garantita da una catena di riferibilità ininterrotta che ha origine dalla taratura dei campioni di laboratorio presso l'Istituto Primario Nazionale di Ricerca Metrologica.

*The traceability of measures assigned to international and national reference samples of SIT units is guaranteed by a uninterrupted reference chain which source is the calibration of laboratories samples at the Primary National Metrological Research Institute.*

**Tipo Prodotto:** **Thermal Microclimate**
*Product Type:*

**Nome Prodotto:** **HD32.1**
*Product Name:*

***Responsabile Qualità***
*Head of Quality*

**DELTA OHM SRL**
**35030 Caselle di Selvazzano (PD) Italy**
**Via Marconi, 5**
Tel. +39.0498977150 r.a. - Telefax +39.049635596
Cod. Fisc./P.Iva IT03363960281 - N.Mecc. PD044279
R.E.A. 306030 - ISC. Reg. Soc. 68037/1998

# GUARANTEE

**GUARANTEE CONDITIONS**

All DELTA OHM instruments have been subjected to strict tests and are guaranteed for 24 months from date of purchase. DELTA OHM will repair or replace free of charge any parts which it considers to be inefficient within the guarantee period. Complete replacement is excluded and no request of damage is recognized. The guarantee does not include accidental breakages due to transport, neglect, incorrect use, incorrect connection to different voltage. Furthermore the guarantee is not valid if the instrument has been repaired or tampered by unauthorized third parties. The instrument has to be sent to the retailer without transport charge. For all disputes the competent court is the Court of Padua.

The electric and electronic devices with the following symbol cannot be disposed in the public dumps. According to the Directive UE 2002/96/EC, the European users of electric and electronic devices are allowed to give back to the Distributor or Manufacturer the used device at the time of purchasing a new one. The illegal disposing of electric and electronic devices is punished by a pecuniary administrative penalty.

This guarantee must be sent together with the instrument to our service centre.

N.B.: Guarantee is valid only if coupon has been correctly filled in all details.

**Instrument type** ❑ **HD32.1**

Serial number _____

## RENEWALS

| | |
|---|---|
| Date _____ | Date _____ |
| Inspector _____ | Inspector _____ |
| Date _____ | Date _____ |
| Inspector _____ | Inspector _____ |
| Date _____ | Date _____ |
| Inspector _____ | Inspector _____ |

| CE CONFORMITY | |
|---|---|
| Safety | EN61000-4-2, EN61010-1 LEVEL 3 |
| Electrostatic discharge | EN61000-4-2 LEVEL 3 |
| Electric fast transients | EN61000-4-4 LEVEL 3 |
| Voltage variations | EN61000-4-11 |
| Electromagnetic interference susceptibility | IEC1000-4-3 |
| Electromagnetic interference emission | EN55020 class B |