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English

Operating manual

WBGT – PMV – PPD indices

HD32.3

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INDEX

1. GENERAL FEATURES

HD32.3 is designed for:

- Analysis of hot environments through **WBGT** index (Wet Bulb Globe Temperature) in presence or absence of solar radiation.
- Analysis of moderate environments through PMV index (Predicted Mean Vote) and PPD index (Predicted Percentage of Dissatisfied).

The instrument is provided with three inputs for probes with SICRAM module: the probes have an electric circuit that communicates with the instrument; the sensor calibration data are saved in its permanent memory.

All the SICRAM probes can be inserted in one of the inputs: they are automatically recognized when you switch the instrument on.

The **main features of** the instrument are:

- **Logging:** acquisition and memorization of data inside the instrument. Memory capacity: **64** different **logging sections,** with the possibility to set the acquisition interval of the samples. You can set the **duration of the memorization** and, with **auto-start** function; it's possible to set the starting and finishing date and the hour of data memorization.
- The **measurement unit** of the temperature visualized sizes: °C, °F, °K.
- The system **date** and **hour**.
- The visualization of the **maximum, minimum and medium** statistic parameters and their cancellation.
- The transfer speed of the data through the serial port RS232.

NOTE: The set acquisition interval is the same for all the probes connected to the instrument.

HD32.3 instrument can contemporarily detect the following sizes:

- Globe thermometer temperature **Tg** with **TP3276.2** or **TP3275** probe.
- Wet bulb temperature with natural ventilation **Tn** with **HP3201.2**, **HP3201** or **TP3204S** probe.
- Ambient temperature **T** with **TP3207.2** or **TP3207** probe.
- Relative Humidity **RH** and ambient temperature **T** with **HP3217.2** or **HP3217R** probe.
- Air speed **Va** with **AP3203.2** or **AP3203** probe.

On the basis of the detected measurements, HD32.3 with **TP3207.2** (or **TP3207**)**, HP3276.2** (or **HP3275**) and **HP3201.2** (or **HP3201 / TP3204S**) can calculate:

- **WBGT(in)** index (Wet Bulb Glob Temperature: wet bulb and globe thermometer temperature) in absence of solar irradiation.
- **WBGT(out)** index (Wet Bulb Glob Temperature: wet bulb and globe thermometer temperature) in presence of solar irradiation.

On the basis of the detected measurements, HD32.3 with **HP3217.2** (or **HP3217R**)**, HP3276.2** (or **HP3275**) and **AP3203.2** (or **AP3203**) probes can calculate:

- Medium radiant temperature **Tr**.
- **PMV** index (Predicted Mean Vote).
- **PPD** index (Predicted Percentage of Dissatisfied).

HD32.3
WBGT – PMV – PPD indices

1. Inlets for **SICRAM** probes.
2. Inlet for power supply.
3. Back - enlightened graphic display.
4. Navigation key ▲: it allows the navigation through the menus. During the normal working it selects the reset of statistic data.
5. **ESC** key: it allows exiting from the menu or, in case of a submenu, exiting from the current level display.
6. Navigation key ◄: it allows the navigation through the menus. During a normal visualization, it allows to visualize the statistic data: maximum, minimum and medium.
7. **MEM** key: it starts and ends the recording of the data (logging).
8. Navigation key ▼: it allows the navigation through the menus. During the normal working it cancels the reset choice of statistic data.
9. **MENU** key: it allows entering or exiting from the instrument working parameters setting menu.
10. Navigation key ►: it allows the navigation through the menus.
11. **ENTER** key: it confirms the inserted data inside the menu. During the normal visualization, it allows resetting the statistic data and immediately printing the data on HD40.1 printer.
12. **ON/OFF** key**:** it switches the instrument on and off.
13. **RS232** and **USB** serial ports**.**

2. WORKING PRINCIPLE

Microclimate term means the environmental parameters that influence the thermal exchanges between the being and the environments inside limited places and that determinate the so-called "thermal well-being".

The micro-environmental weather factors together with your own job influences a series of your biologic responses connected to well-being situations (Comfort) or thermal uneasiness (Discomfort).

In fact, the human body tries to keep the thermal balance in equilibrium conditions in order to keep the body temperature on optimal values.

HD32.3 detects the following sizes:

During the visualization of **WBGT index**:

- t_{nw}**:** wet bulb with natural ventilation temperature probe
- t_g**:** globe thermometer temperature
- t_a**:** ambient temperature

During the visualization of **PMV index**:

- v_a**:** air speed
- t_g**:** globe thermometer temperature
- t_a**:** ambient temperature
- ***rh***: relative humidity

In addition to the direct measurements made with the probes connected to the instrument can directly calculate and visualize, in WBGT measurement, the **WBGT index in presence or absence of solar radiation**, in the PMV measurement, **the medium radiant temperature t, the Predicted Mean Vote (PMV) and Predicted Percentage of Dissatisfied (PPD).**

2.1.1 WBGT Index

WBGT (Wet Bulb Globe Temperature) - wet bulb and globe thermometer temperature - is one of the indexes used for determining the thermal stress to which is submitted a being in a warm environment. It represents the value, with reference to the metabolic waste connected to a special job, over which the being is in a thermal stress condition. WBGT index combines the temperature measurement of natural ventilation wet bulb $\mathbf{t_{nw}}$ with the Glob thermometer $\mathbf{t_g}$ and, in some situations, with the air temperature $\mathbf{t_a}$**.** The formula for the calculation is the following one:

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

$$WBGT_{close\ environments} = 0,7\ t_{nw} + 0,3\ t_g$$

- outside the building in presence of solar irradiation:

$$WBGT_{external\ environments} = 0,7\ t_{nw} + 0,2\ t_g + 0,1\ t_a$$

where:

t_{nw} = wet bulb temperature with natural ventilation
t_g = globe thermometer temperature;
t_a = air temperature.

The detected data must be compared with the limit values established by the regulation; if they are over passed, it's necessary to:

- directly decrease the thermal stress in the considered working place;
- go on with a detailed analysis of the thermal stress.

In the following table are indicated the limit values of the WBGT thermal stress index taken from ISO 7243 regulation:

LEVEL CLASS METABOLIC	METABOLIC LEVEL, M		WBGT LIMIT VALUE			
	RELATIVE TO A SINGLE SKIN SURFACE W/m^2	TOTAL (FOR A MEDIUM AREA OF 1,8 m^2 SKIN SURFACE) W	ACCLIMATIZED BEING TO HEAT °C		NON- ACCLIMATIZED BEING TO HEAT °C	
0 (RESTING)	M ≤ 65	M ≤ 117	33		32	
1	65 < M ≤ 130	117 < M ≤ 234	30		29	
2	130 < M ≤ 200	234 < M ≤ 360	28		26	
3	200 < M ≤ 260	360 < M ≤ 468	STAGNANT AIR 25	NO STAGNANT AIR 26	STAGNANT AIR 22	NO STAGNANT AIR 23
4	M > 260	M > 468	23	25	18	20
NOTE: THE VALUES ARE STABILIZED, CONSIDERING A MAXIMUM RECTAL TEMPERATURE OF 38° C FOR THE CONSIDERED BEINGS.						

To calculate WBGT index, it's necessary that to the instrument are connected:

- **HP3201.2, HP3201 or TP3204S wet bulb temperature probe with natural ventilation.**
- **TP3276.2 or TP3275 globe thermometer probe.**
- **TP3207.2 or TP3207 dry bulb temperature probe if the detection is made in presence of solar irradiation.**

To measure WBGT index consider the following regulations:

- **ISO 7726**
- **ISO 7243**

2.1.2 Predicted Mean Vote (PMV) and Predicted Percentage of Dissatisfied (PPD)

The thermal comfort is defined by ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers INC) as a condition of psycho-physical well being of the being with reference to the environment in which he lives and works.
The evaluation of such subjective state can be objectivities and calculates using the integrated indexes that consider the ambient microclimatic parameters (Ta, Tr, Va, rh), the energetic waste (metabolic waste MET) connected with the working activity and the clothing typology (thermal insulation CLO) usually used.
Between these indexes, the most precise one reflects the influence of the physical variables and physiological ones as mentioned above about the thermal comfort: it is **PMV** (Predicted Mean Vote).
Summary, it comes from the equation of thermal balance whose result is related with a psycho-physical well being scale and expresses the medium vote (predicted medium vote) on the thermal sensations of a sample of beings that are in the same environment.

From PMV comes a second index called **PPD** (Predicted Percentage of Dissatisfied) which calculates in percentage the "dissatisfied" beings in relation with precise microclimatic conditions.
ISO 7730 regulation suggests the PMV use in presence of the following environments with variables variations that influence the thermal balance:

- Energetic waste = 1 ÷ 4 met
- Thermal impedance by clothing = 0 ÷ 2 clo
- Wet bulb temperature = 10 ÷ 30°C
- Medium radiant temperature = 10 ÷ 40°C
- Air speed = 0 ÷ 1 m/sec
- Vapour pressure = 0 ÷ 2,7 kpa

So, PMV is an index suitable to the evaluation of working environments with moderate microclimate such as houses, schools, offices, laboratories, hospitals, etc.; it's useful in detecting limited degrees of thermal discomfort in the people in this environment.

ISO7730 regulation suggests PPM values between + 0,5 and - 0,5 for the thermal comfort state and to these values correspond a percentage of dissatisfied about the thermal conditions (PPD) less than 10% (see the following table).

Table 1: thermal environment evaluation scale

PMV	PPD %	THERMAL ENVIRONMENT EVALUATION
+3	100	Hot
+2	75,7	Warm
+1	26,4	A little bit warm
+0,85	**20**	**Acceptable thermal environment**
-0,5 < PMV < +0,5	**< 10**	**Thermal well-being**
-0,85	**20**	**Acceptable thermal environment**
-1	26,8	Cool
-2	76,4	Cold
-3	100	Very Cold

For the calculation of PMV and PPD indexes, it's necessary to know:

- The working charge (energetic waste);
- The thermal impedance of clothing.

The **working charge** can be calculated using the following measurement units:

kcal/h (1 kcal/h = 1.163 Watt): with this unit is expressed the medium power per hour supplied during the working activity;

MET (1 MET = 58.15 Watt/m^2): with this unit is expressed the total power per hour supplied by a being during the working activity divided for the body surface of the being.

Thermal impedance of the clothing is measured in CLO;

1 CLO = thermal gradient of 0.18 °C on a 1 m^2 area crossed by 1 kcal/h thermal flow

The following tables can help to establish the thermal impedance values of the clothing and the working rate (metabolism).

Table 2: Thermal resistance values, some typical combinations of clothes (*source* ISO 9920).

	clo	m^2 K/W
Work clothing		
Pants, overalls, socks, shoes	0,70	0,110
Pants, shirt, pants, socks, shoes	0,75	0,115
Pants, shirt, overalls, socks, shoes	0,80	0,125
Pants, shirt, pants, jacket, socks, shoes	0,85	0,135
Pants, shirt, pants, aprons, socks, shoes	0,90	0,140
Lingerie with short sleeves and legs, shirt, pants, jacket, socks, shoes	1,00	0,155
Lingerie with short sleeves and legs, shirt, pants, overalls, socks, shoes	1,10	0,170
Lingerie with long sleeves and legs, thermal jacket, socks, shoes	1,20	0,185
Lingerie with short sleeves and legs, shirt, pants, jacket, thermal jacket, socks, shoes	1,25	0,190
Lingerie with short sleeves and legs, overalls, thermal jacket and trousers, socks, shoes	1,40	0,220
Lingerie with short sleeves and legs, shirt, pants, jacket, thermal jacket and trousers, socks, shoes	1,55	0,225
Lingerie with short sleeves and legs, shirt, pants, jacket, padded jacket with heavy overalls, socks, shoes	1,85	0,285
Lingerie with short sleeves and legs, shirt, pants, jacket, heavy jacket and track suit, socks, shoes, cap, gloves	2,00	0,310
Lingerie with long sleeves and legs, thermal jacket and pants, thermal outer jacket and trousers, socks, shoes	2,20	0,340
Lingerie with long sleeves and legs, thermal jacket and pants, parka with heavy padding, padding with heavy overalls, socks, shoes, cap, gloves	2,55	0,395
Daily clothing		
Pants, shirt, shorts, light socks, sandals	0,30	0,050
Slip, slip, stockings, dress with light sleeves, sandals	0,45	0,070
Pants, shirt with short sleeves, light trousers, light socks, shoes	0,50	0,080
Panties, stockings, short-sleeve shirt, skirt, sandals	0,55	0,085
Pants, shirt, light trousers, socks, shoes	0,60	0,095
Slip, slip, stockings, dress, shoes	0,70	0,105
Underwear, shirts, trousers, socks, shoes	0,70	0,110
Underwear, complete racing (shirt and trousers), long socks, running shoes	0,75	0,115
Slip, slip, blouse, skirt, thick knee socks, shoes	0,80	0,120
Pants, shirt, skirt, a sweater necklace, thick knee socks, shoes	0,90	0,140
Pants, blouses with short sleeves, pants, sweater with a V-neck, socks, shoes	0,95	0,145
Pants, shirt, pants, jacket, socks, shoes	1,00	0,155
Panties, socks, shirt, skirt, vest, jacket	1,00	0,155
Panties, stockings, blouse, long skirt, jacket, shoes	1,10	0,170
Underwear, blouses with short sleeves, shirt, pants, jacket, socks, shoes	1,10	0,170
Underwear, short sleeve blouses, shirts, trousers, waistcoats, jackets, socks, shoes	1,15	0,180
Lingerie with long sleeves and legs, shirt, pants, sweater with a V-neck, jacket, socks, shoes	1,30	0,200
Lingerie with long sleeves and legs, shirt, pants, vest, jacket, coat, socks, shoes	1,50	0,230
Knitted underwear		
Panties	0,30	0,047
Long Panties	0,10	0,016
Blouse	0,04	0,006
Short-sleeve shirt	0,09	0,014
Long--sleeve shirt	0,12	0,019
Panties and bra	0,03	0,005
Jerseys - blouses		
Short-sleeve shirt	0,15	0,023

	clo	m^2 K/W
Light , with long sleeves and legs	0,20	0,031
Normal, with long sleeves and legs	0,25	0,039
In flannel, with long sleeves and legs	0,30	0,047
Weak blouse, with long sleeves and legs	0,15	0,023
Trousers		
Short	0,06	0,009
Light	0,20	0,031
Normal	0,25	0,039
In flannel	0,28	0,043
Clothes- skirts		
Light skirt (summer)	0,15	0,023
Heavy skirt (winter)	0,25	0,039
Light cloth with short sleeves and legs	0,20	0,031
Winter cloth with long sleeves and legs	0,40	0,062
Suit	0,55	0,085
Sweaters		
Gilet	0,12	0,019
Light sweater	0,20	0,031
Sweater	0,28	0,043
Heavy sweater	0,35	0,054
Jackets		
Light , summer jacket	0,25	0,039
Jacket	0,35	0,054
Apron	0,30	0,047
High thermal insulation, synthetic fur padding		
Suit	0,90	0,140
Trousers	0,35	0,054
Jacket	0,40	0,062
Waistcoat	0,20	0,031
Outdoor clothing		
Coat	0,60	0,093
Under-jacket	0,55	0,085
Parka	0,70	0,109
Suit	0,55	0,085
Accessories		
Socks	0,02	0,003
Heavy ankle socks	0,05	0,008
Heavy long socks	0,10	0,016
Nylon socks	0,03	0,005
Shoes (thin soles)	0,02	0,003
Shoes (thick soles)	0,04	0,006
Boots	0,10	0,016
Gloves	0,05	0,008

Table 3: Metabolic rate – classification considering the job

Job		**Metabolism** (W/m^2)
Craftsman	Bricklayer	110 ÷ 160
	Carpenter	110 ÷ 175
	Glazier	90 ÷ 125
	Painter	100 ÷ 130
	Baker	110 ÷ 140
	Butcher	105 ÷ 140
	Watchmaker	55 ÷ 70
Mining	Trasporter worker	70 ÷ 85
	Coal miner	110
	Coke oven worker	115 ÷ 175
Steel industry	Blastfurnace worker	170 ÷ 220
	Electrical oven worker	125 ÷ 145
	Trainer by hand	140 ÷ 240
	Trainer by machine	105 ÷ 165
	Melter	140 ÷ 240
Metallurgical industry	Blacksmith	90 ÷ 200
	Welder	75 ÷ 125
	Turner	75 ÷ 125
	Milled operator	80 ÷ 140
	Precision mechanic	70 ÷ 110
Graphical jobs	Composer by hand	70 ÷ 95
	Bookbinder	75 ÷ 100
Agricolture	Gardener	115 ÷ 190
	Tractor Conducer	85 ÷ 110
Traffic	Car Conducer	70 ÷ 100
	Bus Conducer	75 ÷ 125
	Tram Conducer	80 ÷ 115
	Crane Conducer	65 ÷ 145
Different jobs	Laboratory assistant	85 ÷ 100
	Teacher	85 ÷ 100
	Sales assistance	100 ÷ 120
	Secretary	70 ÷ 85

Table 4: Metabolic rate – classification per category

Class	M variation range		Examples
	W/m^2	W	
0 In rest condition	65 (55 ÷ 70)	115 (100 ÷ 125)	In rest condition
1 Low metabolic rate	100 (70 ÷ 130)	180 (125 ÷ 235)	**Comfortable seated**: light manual work (writing, typing, drawing, cutting, accounting), working with hands and arms (small tools, inspection, assembly or sorting of material), with arms and legs (driving a vehicle under normal conditions, operation of a pedal or a switch with their feet). **Standing**: work with drill (small pieces), router (small pieces), winding bobbins, armature winding small, with low power machines, walk (speed up to 3.5 km / h).
2 Moderate metabolic rate	165 (130 ÷ 200)	295 (235 ÷ 360)	High work supported by the hands and arms: (hammering nails, polish), work with arms and legs (driving off-road trucks, tractors or building machinery), work with arms and trunk (with jackhammer, tractor assembly, plastering, handling intermittent to moderately heavy materials, hoeing, harvest fruits and vegetables), push or pull carts or wheelbarrows light, walk at speeds between 3.5 and 5.5 km / h; forging.
3 High metabolic rate	230 (200 ÷ 260)	415 (360 ÷ 465)	Intensive work with arms and bust, bringing heavy equipment, digging with shovel; working with hammer, saw, chisel or plane hardwood; shearing the grass by hand, digging, walking at a speed between 5.5 and 7 km / h. Pushing or pulling carts and wheelbarrows with heavy loads; debarring castings; placing cement blocks.
4 Very high metabolic rate	290 (> 260)	520 (>465)	A very intense work from fast to maximum; working with the dark, digging so intense, climbing the stairs, ramps, walking quickly in small steps, running, walking at speeds greater than 7 km / h.

Table 5: Metabolic rate – classification per specific activity

Activity		W/m^2
Flat walk along the path		
	at 2 km/h	110
	at 3 km/h	140
	at 4 km/h	165
	at 5 km/h	200
Walking up to 3 km / h		
	slope of 5°	195
	slope of 10°	275
	slope of 15°	390
Walking downhill, 5 km / h		
	slope of 5°	130
	slope of 10°	115
	slope of 15°	120
Climb a ladder (0.172 m / step)		
	80 steps per minute	440
Down a scale (0.172 m / step)		
	80 steps per minute	155
Carry a cargo, 4 km / h		
	mass 10 kg	185
	mass 30 kg	250
	mass 50 kg	360
Relaxing		
	Sleeping	41
	Standing	46
	Seat in a rest condition	58
	Relaxing	65
	Standing in a relaxing condition	79
Various		
	sedentary activities (work, home, lab, light ind.)	70
	light standing activities (shop, lab, light ind.)	93
	media activities in a standing condition (committed, housework, work on the machine)	116
Jobs – Building industry		
Laying bricks (building a wall with the same area)		
	Full brick (mass 3.8 kg)	150
	Hollow brick (mass 4.2 kg)	140
	Hollow brick (mass 15,3 kg)	125
	Hollow brick (mass 23,4 kg)	135
Prefabrication of concrete elements		
	Mounting and unmounting shuttering (compressed concrete)	180
	Insert steel rods	130
	Strain the concrete (compressed concrete)	180
Construction of houses		
	Mix cement	155
	Strain the concrete for foundations	275
	Compact the concrete to vibrate	220

Activity		W/m^2
	Mount formworks	180
	Load the wheelbarrow with stone and lime	275
Jobs – Steel industry		
Blastfurnace		
	Prepare the casting channel	340
	Tapping	430
Forming (by hand)		
	Forming medium size pieces	285
	Hammering with jackhammer	175
	Forming small pieces	140
Forming (by machine)		
	Strain castings	125
	Forming ladle with one operator	220
	Forming ladle with two operators	210
	Forming from a ladle suspended to a crane	190
Finishing		
	Working with jackhammer	175
	Grinding. Cutting.	175
Jobs – Forestry industry		
Transportation and working with ax		
	Walking and carrying (7 kg) in a forest, 4 km / h	285
	Carrying a power saw (18 kg) by hand, 4 km /h	385
	Working with an ax (2 kg, 33 strokes / min)	500
	Cutting roots with an ax	375
	Chopping down (fir)	415
Sawing - cutting with circular saw operated by two people		
	60 double strokes / min, 20 cm2 per double stroke	415
	40 double strokes / min, 20 cm2 per double stroke	240
Sawing - cutting with power saw		
	Saw operated by a person	235
	Saw operated by two people	205
Sawing – cutting in the opposite direction		
	Saw operated by a person	205
	Saw operated by two people	190
Sawing - removing the bark		
	Summer average	225
	Winter average	390
Job – Agricolture		
Different jobs		
	Digging (24 strokes / min)	380
	Plowing with horse	235
	Plowing with a tractor	170
	Hoeing (mass of the hoe 1.25 kg)	170
Fertilizing a field		
	Sowing by hand	280
	Seeding with spreaders pulled by horses	250
	Seeding with tractor	95

Activity	W/m²
Jobs - Sport	
Running	
9 km/h	435
12 km/h	485
15 km/h	550
Skiing - in good snow plan	
7 km/h	350
9 km/h	405
12 km/h	510
Ice Skating	
12 km/h	225
15 km/h	285
18 km/h	360
Jobs – Home jobs	
Different jobs	
Cleaning	100 ÷ 200
Cooking	100 ÷ 200
Cleaning dishes, standing	145
Hand washing and ironing	120 ÷ 220
Shaving, washing and dressing	100

To calculate the *Predicted Mean Vote (PMV)* **and** *Predicted Percentage of Dissatisfied (PPD)* **it is necessary that are connected the following probes:**

- **TP3276.2 or TP3275 globe thermometer probe.**
- **HP3217.2 or HP3217R combined probe for the measurement of relative humidity and the air temperature.**
- **AP3203.2 or AP3203 probe with warm wire for the measurement of the air speed.**

To calculate the *Predicted Mean Vote (PMV)* **and** *Predicted Percentage of Dissatisfied (PPD)* **consider the regulations:**

- **ISO 7726**
- **ISO 7730:2005**

2.1.3 Medium radiant temperature tr

The medium radiant temperature is defined as a temperature involving a fictitious thermal uniform environment that would exchange with the beings the same thermal radiant power exchanged with the real environment.
To check the medium radiant temperature we must detect: **the globe thermometer temperature, air temperature and air speed measured close to the globe thermometer**.
The formula for calculating the medium radiant temperature is the following one:

- In case of **natural convection**:

$$t_r = \left[\left(t_g + 273\right)^4 + \frac{0.25 \times 10^8}{\varepsilon_g} \left(\frac{\left|t_g - t_a\right|}{D} \right)^{1/4} \times \left(t_g - t_a\right) \right]^{1/4} - 273$$

- In case of **forced convection:**

$$t_r = \left[\left(t_g + 273 \right)^4 + \frac{1.1 \times 10^8 \times v_a^{0.6}}{\varepsilon_g \times D^{0.4}} \left(t_g - t_a \right) \right]^{1/4} - 273$$

where:

D = globe thermometer diameter
ε_g = 0.95 globe thermometer predicted emissivity
t_g = globe thermometer temperature
t_a = air temperature
v_a = air speed

The medium radiant temperature does not coincide with the temperature: if within a room, there are areas which have a temperature much higher than the one belonging to the air (think, for example, about the flame of a fireplace); the medium radiant temperature is an average in which the presence of this very hot area is significant.

The medium radiant temperature is detected by the globe thermometer, it's a temperature probe consists of a copper sphere with 50 mm diameter, painted with matt black, with emissivity equal to εg = 0.95 (as required by **ISO 7726**), with inside a Pt100sensor. The temperature of globe thermometer may be significantly higher than the air temperature, as in the case of a little cabin in the mountains, where the air is 0 ° C, but where the presence of a fireplace produces medium radiant temperature of 40 ° C, ensuring a situation of comfort. Under normal conditions, maintaining a certain difference between the medium radiant temperature and the air temperature (where T_{MR} is significantly higher than T_A) is a merit in terms of ambient quality. In homes where there are no more fireplaces or stoves, usually the medium radiant temperature coincides with the air temperature, or even it's inferior. These situations (the main case is represented by buildings with large glazed surfaces) are not particularly healthy as the warm and wet air facilitates the development of pathogens. From this point of view, the heating with lamps or radiant panels is much healthier. It's more hygienic to ensure the comfort conditions with a medium radiant temperature greater than the air temperature. The laws erroneously stipulate as an evaluation parameter for heating plants the air temperature and not the medium radiant temperature.

To calculate the medium radiant temperature it's necessary that are connected the following probes:

- **TP3276.2 or TP3275 globe thermometer probe**
- **HP3217.2 or HP3217R combined probe for the measurement of relative humidity and the air temperature.**
- **AP3203.2 or AP3203 probe with warm wire for the measurement of the air speed.**

To calculate the medium radiant temperature you can see the regulation:

- **ISO 7726**

3. USER INTERFACE

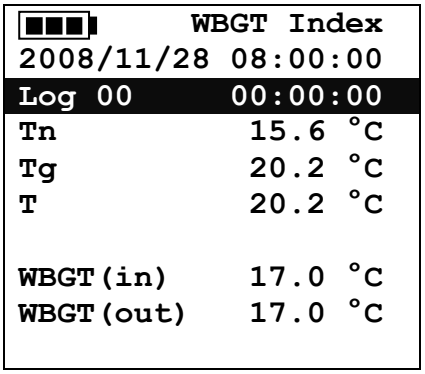
The user interface is composed of an **LCD graphic back - enlighten display** and start and set keys of the instrument. With a battery power supplying without pressing any key, the back- lighting switches off after 1 minute. To activate it again, press one key. With external power supply, the back-lighting is always activated.

To switch the instrument on and off, press **ON/OFF** key. When you switch it on, the logo and the model of the instrument will be visualized, for some seconds, then you can go to the main visualization.

3.1 THE DISPLAY

HD32.3 visualizes the parameters for the calculation of **WBGT** index and for the calculation of **PMV-PPD** indexes. During the normal working, pressing the key ▼ you can go from the visualization of **WBGT** index parameters to the **PMV – PPD** index parameters visualization.

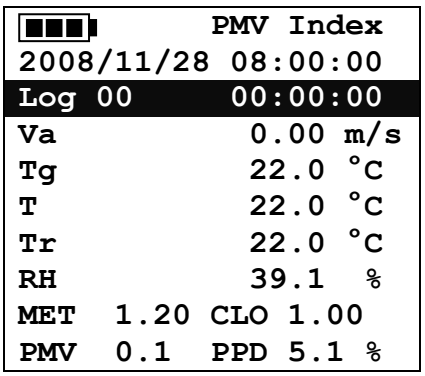
Visualization of **WBGT Index:**



The first line visualizes the **charge condition of the battery**, the **second line indicates the current date and the current hour**. If logging function is activated, the third line indicates the current logging number and the spent time from the logging start.
The **detected sizes** are:

Tn: wet bulb temperature with natural ventilation
Tg: globe thermometer temperature
T: ambient temperature
WBGT (in): WBGT index in absence of direct solar irradiation
WBGT (out): WBGT index in presence of direct solar irradiation

Pressing the key ▼ you can visualize the **PMV-PPD index**:



The visualized sizes are:

Va:	air speed
Tg:	**globe thermometer temperature**
T:	ambient temperature
Tr:	radiant medium temperature
RH:	relative humidity
Act:	metabolic rate expressed in MET, set by the user
Clo:	thermal resistance of the cloths set by the user
PMV:	PMV index, Predicted Mean Vote
PPD:	PPD index, Predicted Percentage of Dissatisfied

3.2 THE KEYBOARD

The instrument keys have the following functions:

ON-OFF / AUTO-OFF key

ON-OFF: It allows switching the instrument on and off.
When you switch the instrument on, the first screen will be visualized and, after some seconds, the detected measurements will be visualized.
AUTO-OFF: The instrument switches off after 8 minutes from the switching on. When you switch the instrument on, the AUTO-OFF function can be disabled pressing together ESC and ON/OFF keys.

MENU key

It allows entering and exiting from the setting menu of the instrument working parameters.

ENTER key

Inside the menu for confirming the inserted data.
During a normal working:

- it confirms the choice to reset the statistic data.
- it prints the immediate data on HD40.1 printer.

ESC key

You exit from the menu or, if there is a submenu, you exit from the current level visualization.

MEM key

It allows starting and stopping a "logging" section (data memorization); the interval for sending data must be set from the menu.

◄/FUNC key

◄ it allows going through the menu.

FUNC: during a normal visualization, it allows to select the statistic data: maximum, minimum and medium.

▲ key

▲it allows going through the menu. During the normal working, it selects the reset of statistic data.

▼ key

▼ it allows going through the menu.
During the normal working:

- it cancels the choice to reset the statistic data
- it commutates the display visualization between WBGT index and PMV index

►/UNIT key

► it allows going through the menu.

UNIT: it allows the temperature measurement unit selection: °C, °F, °K.

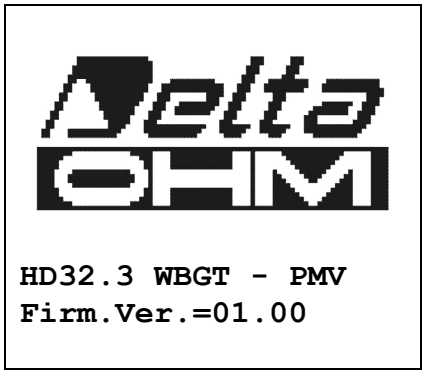
4. WORKING

Before switching the instrument on, connect the SICRAM probes to the inlets: 8 pin male connector DIN 45326 that is on the bottom of the instrument.

NOTE: The probes must be connected to the instrument off. If you connect a new probe to the instrument already switched on, it isn't recognized, so it's necessary to switch the instrument off and switch it on again.

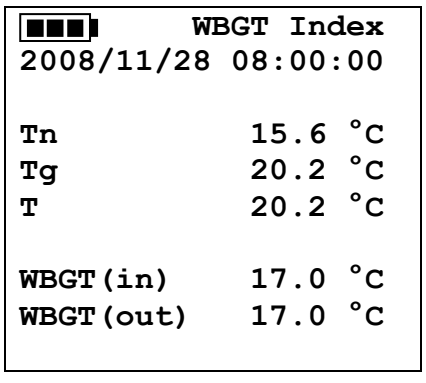
If you disconnect a probe with the instrument switched on, you have an acoustic alarm (a beep per second) and you can visualize it on the display in correspondence of a disconnected physical size, the "LOST" message will be visualized.
If you insert more probes of the same type, it will be only consider the first recognized probe: the scansion of the probes, for their recognition, happens from the inlet 1 up the inlet 3.

When you switch the instrument on, on the display appears the following writing for at least 10 seconds:



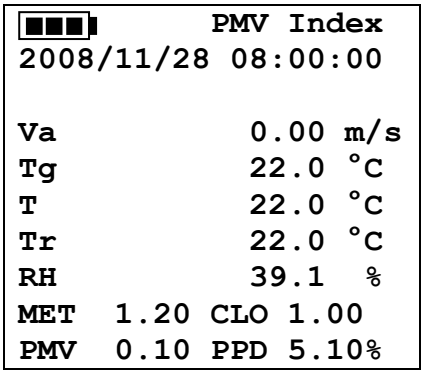
In addition to Delta **Ohm logo are** indicated the **instrument code and the firmware version.**

After connecting the probes, switch the instrument on: the display, after 10 seconds, will appear in the measurement visualization mode that refers to WBGT and PMV indexes.



Tn: wet bulb temperature with natural ventilation
Tg: globe thermometer temperature, detected by the globe thermometer probe
T: ambient temperature, detected by Pt100 probe
WBGT (in): WBGT index calculated in absence of solar irradiation
WBGT (out): WBGT index calculated in presence of solar irradiation

Pressing the key ▼, you can visualize:



The sizes detected are:

Va: air speed
Tg: globe thermometer temperature
T: ambient temperature
Tr: radiant medium temperature
RH: relative humidity
Act: metabolic rate expressed in MET, set by the user
Clo: thermal resistance of the cloths, set by the user
PMV: PMV index (Predicted Mean Vote)
PPD: PPD index (Predicted Percentage of Dissatisfied).

4.1.1 The measurement "Unit"

Pressing ►/ **UNIT** key, it's possible to visualize the temperature in degrees °C (Celsius), °F (Fahrenheit) or °K (Kelvin).

4.1.2 The maximum, minimum and medium values of the detected sizes

Pressing ◄/**FUNC** key, it's possible to visualize the maximum, minimum and medium value of the detected sizes.
To reset the statistic data, press ◄/**FUNC** key till "Clear Func? Yes No" writing doesn't appear.
Select Yes with ▲▼ keys and confirm with ENTER key.

NOTE: Once selected, for example, ***max***, all the visualized sizes indicate the maximum value. **The average is calculated on the number of samples belonging to the first five minutes and then, considering the current average.**

4.1.3 Instrument setting

To set the instrument up, you must enter to the main menu, pressing **MENU** key. For more details, see the chapter 5.

4.1.4 The immediate printing of the data

Pressing **Enter** key, it's possible to print the immediate data on **HD40.1** printer.

*Example of immediate printing of the WBGT data, obtained using **HD40.1** printer.*

	NOTES
==========	
ISO 7243 WBGT Index	Reference regulation
==========	
Model HD32.3 WBGT - PMV	Instrument model
Firm.Ver.=01.00	Instrument firmware version
Firm.Date=2008/12/05	Instrument firmware date
SN=12345678	Instrument serial number
ID=0000000000000000	Identification code

Probe ch.1 description	Description of the probe connected to the inlet 1
Type: Pt100	
Data cal.:2008/10/01	
Serial N.:08109450	

Probe ch.2 description	Description of the probe connected to the inlet 2
Type: Pt100 Tg 50	
Data cal.:2008/10/01	
Serial N.:08109452	

Probe ch.3 description	Description of the probe connected to the inlet 3
Type: Pt100 Tw	
Data cal.:2008/10/01	
Serial N.:08109454	
==========	
Date=2008/11/21 15:00:00	Date and hour
Tnw 21.2 °C	Wet bulb temperature with natural ventilation
	Globe thermometer temperature
Tg 24.9 °C	Wet bulb temperature
Ta 31.3 °C	WBGT in absence of direct solar irradiation
WBGT (i) 22.3 °C	WBGT in presence of direct solar irradiation
WBGT (o) 23.0 °C	Date and hour
==========	
Notes:	
==========	

*Example of immediate printing of the PMV data, obtained using **HD40.1** printer.*

	NOTES
==========	
ISO 7730 PMV Index	
==========	Reference regulation
Model HD32.3 WBGT - PMV	
Firm.Ver.=01.00	Instrument model
Firm.Date=2008/12/05	Instrument firmware version
SN=12345678	Instrument firmware date
ID=0000000000000000	Instrument serial number
----------	Identification code
Probe ch.1 description	
Type: Hot wire	Description of the probe connected to the inlet 1
Data cal.:2008/10/15	
Serial N.:08109460	

Probe ch.2 description	
Type: Pt100 Tg 50	Description of the probe connected to the inlet 2
Data cal.:2008/10/01	
Serial N.:08109452	

Probe ch.3 description	
Type: RH	
Data cal.:2008/10/15	
Serial N.:08109464	
==========	
Date=2008/11/21 15:00:00	Date and Hour
Va 0.00 m/s	Air speed
Tg 22.0 °C	Globe thermometer Temperature
Ta 22.0 °C	Wet bulb temperature
RH 39.1 %	Relative Humidity
MET 1.20	Metabolic rate
CLO 1.00	Cloth resistance
PMV 0.10	PMV – Predicted Mean Vote
PPD 5.10 %	PPD – Predicted Percentage of Dissatisfied
==========	
Notes:	
==========	

4.1.5 Start a memorization section (Logging)

To start a **Logging** section, press **MEM** key: the key starts and stops the memorization (Logging) of a data block that will be kept into the instrument internal memory. The frequency with which the data are memorized is set with "**Log interval"** menu parameter. The memorized data between a start and a following stop represent a measurement block.

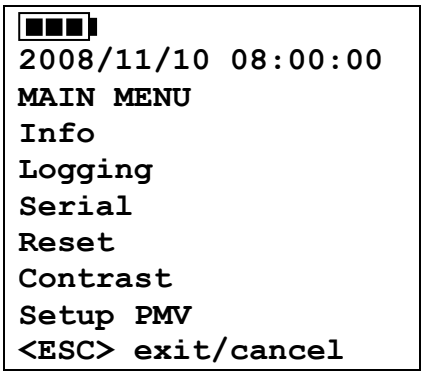
With the memorization function on, ***LOG and number of logging section*** appears on the display; a beep is given out during each memorization.

To finish the logging, press **MEM** key again.

The instrument can switch off during the logging between an acquisition and the following one: the function is controlled by ***Auto_shut_off_Mode*** parameter. With a memorization interval less than one minute, the instrument remains always on during the logging; with an interval of at least one minute, it switches off between an acquisition and the following one.

5. THE MAIN MENU

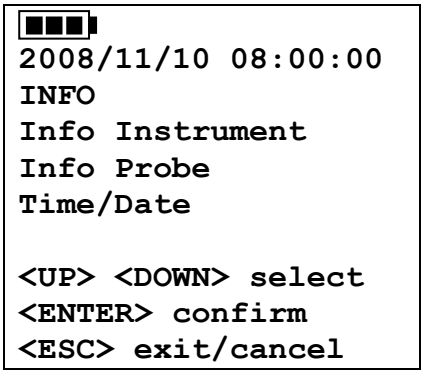
To visualize the programming menu, press **MENU** key:



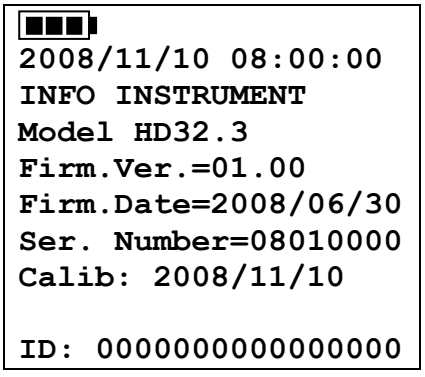
If you don't press any key for at least 2 minutes, the instrument will be back to the main visualization.
To select a heading, use ▲▼ arrow keys and press **ENTER**.
To exit from the selected heading and be back to the previous menu level, press **ESC**.
To exit directly from the main menu, press **MENU** again.

5.1 MENU INFO

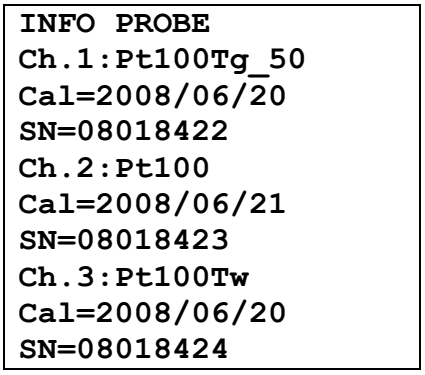
Pressing **MENU** key, you enter into the main menu. To enter to Info menu, select **Info** heading with ▲▼ keys and press **ENTER**.



Selecting **Info Instrument**, you can visualize the information involving the instrument: instrument code and operative programm, firmware version and date, serial number, instrument calibration date and identification code.



To modify the **ID**, press ENTER. Select the heading that you want to change with ◄► arrows and modify it with ▲▼ arrows. Go on with the other headings and, at the end, confirm with **ENTER** key.
Selecting **Info Probe** you can visualize the information involving the probes connected to the inlets:

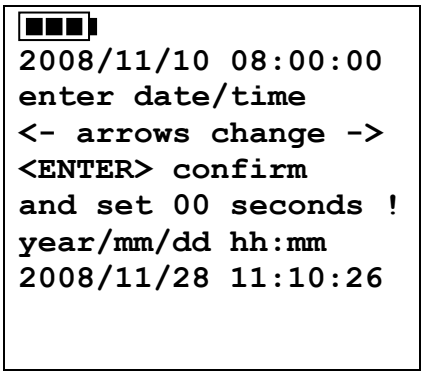


INFO ABOUT PROBE:
Description of the probe connected to the inlet 1.
Calibration data of the probe connected to the inlet 1.
Serial number of the probe connected to the inlet 1.

Description of the probe connected to the inlet 2.
Calibration data of the probe connected to the inlet 2.
Serial number of the probe connected to the inlet 2.

Description of the probe connected to the inlet 3.
Calibration data of the probe connected to the inlet 3.
Serial number of the probe connected to the inlet 3.
To go back to the main menu, press **ESC**. To exit from the menu, press **MENU**.

Time/Date allows to set the date and the hour that will appear on the upper part of the display.
To enter into ***Time/date***, go on as indicated below:
1. using ▼▲ arrow keys, select ***Time/date*** heading
2. press **ENTER**
3. the messagge will be visualized



4. use ◄► arrows to select the data to set (year/month/day – hour : minutes)
5. once selected, the data will start flashing;
6. using ▼▲ arrows, insert the right value;
7. press **ENTER** to confirm and go back to the main menu;

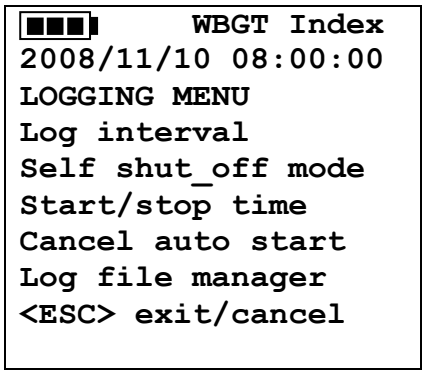
8. or press **ESC** to go back to the menu, without modifying anything;
9. press **MENU** to exit directly from the main menu.

NOTE: With reference to the time, you can set hour and minuted, the seconds are always set at 00 (set 00 seconds!).

5.2 LOGGING MENU

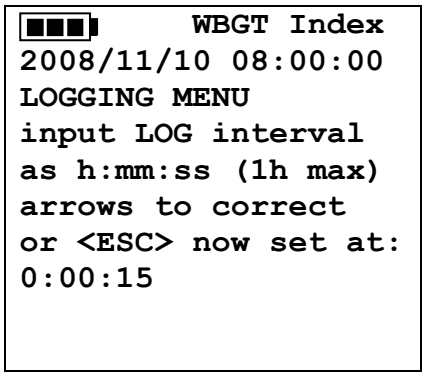
Press **MENU** key to enter into the main menu;

- Select **Logging** heading using ▲ ▼ keys;
- press **ENTER**: the submenu for the parameters setting involving the Logging section (to aquired) is visualized.



5.2.1 Log Interval

Through this heading, it's possible to set the LOG interval (interval between two acquisition following samples): to set, go on as indicated below:
enter into ***LOGGING*** submenu (previus paragraph), select ***Log Interval*** heading using ▲ ▼ arrow keys:



1. Using ▲ ▼ arrow keys select the interval duration that is between a minimum of 15 seconds and a maximum of one hour.
2. Press **ENTER** to confirm and go back to Logging menu.
3. To go back to **Logging** menu without modifying anything, press **ESC**.
4. To go back to the main menu, press **ESC** again.
5. To exit directly from the menu, press **MENU**.

The values that youc an set are the following ones: 15 seconds - 30 seconds - 1 minute - 2 minutes - 5 minutes- 10 minutes - 15 minutes -20 minutes - 30 minutes – 1 hour

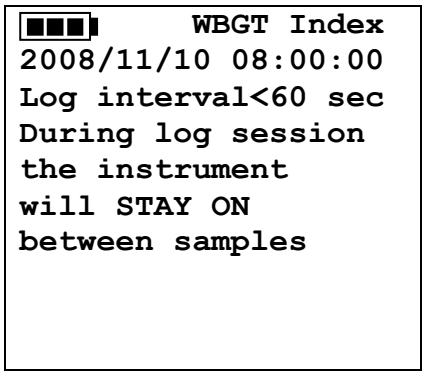
Memorization interval	Memory capacity	Memorization interval	Memory capacity
15 seconds	About 11 days and 17 hours	10 minutes	About 1 year and 104 days
30 seconds	About 23 days and 11 hours	15 minutes	About 1 year and 339 days
1 minute	About 46 days and 22 hours	20 minutes	About 2 years and 208 days
2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

5.2.2 Self Shut-off mode – The automatic switching off

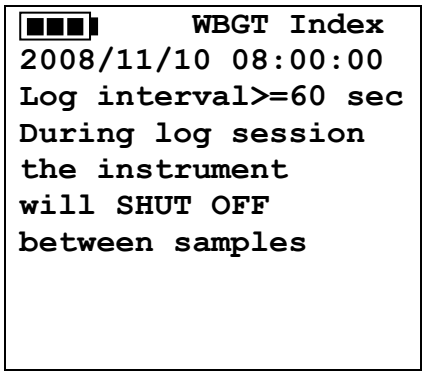
Self shut-off mode heading controls the instrument automatic switching off mode during the logging between the acquisition of a sample and the following one. **With an interval less than 60 seconds, the instrument will always remain on.** With intervals upper or equal to 60 seconds, it's possible to choose switching the instrument off between the memorizations: it will switch on in correspondence of the sampling time and it will switch off after some seconds, so extending the life of the batteries.

Once you entered into ***LOGGING*** sub menu (previous paragraph), select ***Self shut_off mode*** heading using ▲ ▼ arrow keys:

if the set ***Log Interval*** (see the previous paragraph) is less than 60 seconds, there will be visualized:



- if the set ***Log Interval*** (see the previous paragraph) is upper or equal to 60 seconds, there will be visualixed:



1. Pressing ▲ ▼arrows, you can select:

   STAY ON (the instrument remains on)
   SHUT OFF (the instrument remains off)

2. To go back to ***Logging*** menu, press **ESC**.
3. To go back to the main menu, press **ESC** again**.**
4. To exit directly from the menu press **MENU**.

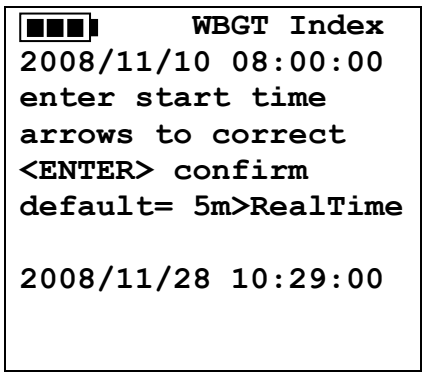
5.2.3 Start/stop time – The automatic start

The start and the end of the memorization can be programmed inserting the date and the hour.
The function offers, as start hour, the current hour increased by 5 minutes: to confirm, press <ENTER>, vice versa set the date and the hour using the arrows. So it's requested to set the data for ending the memorization: in a default mode, the instrument offers the start hour increased of 10 minutes. The values offered in default mode are such to allow the user arranging the instrument for the measurement.

NOTE: in a default mode, the set time is more than 5 minutes with reference to the current hour.

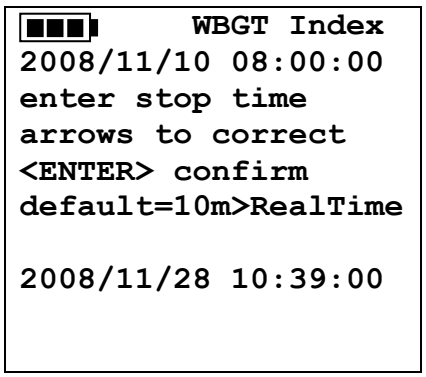
For the setting, go on as indicated below.

Once entered into ***LOGGING*** submenu, select ***Start/Stop time heading using*** ▲ ▼ arrow keys: "Enter start time" messagge will be visualized as indicated below:



1. using ◄ ► arrow key select the data to modify (year/month/day and hour/minutes/seconds);
2. once selected, the data will start flashing;
3. change the valued with ▼▲ keys;
4. confirm pressing **ENTER**;
5. to be back to ***Logging*** menu without modifying anything, press **ESC**;
6. to be back to the main menu, press **ESC** again;
7. to exit directly from the main menu, press **MENU**.

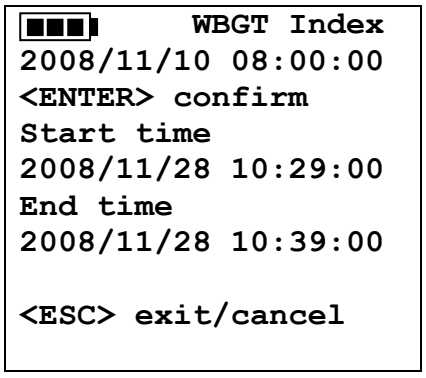
After setting the start hour of initialization, the screen that requests to insert the end memorization hour (enter stop time) will be visualized:



1. using ◄ ► arrow key select the data to modify (year/month/day and hour/minutes/seconds);
2. once selected, the data will start flashing;
3. change the value with ▼▲ keys;
4. confirm pressing **ENTER**;
5. to be back to ***Logging*** menu without modifying anything, press **ESC**;
6. to be back to the main menu, press **ESC** again;
7. to exit directly from the main menu, press **MENU**.

NOTE: by default the hour of set adquisition end hour is more than 10 minutes with reference to the start hour of Logging Section.

Once set both the values, you can visualize the hours summary: date and hour of start and end of LOG section.



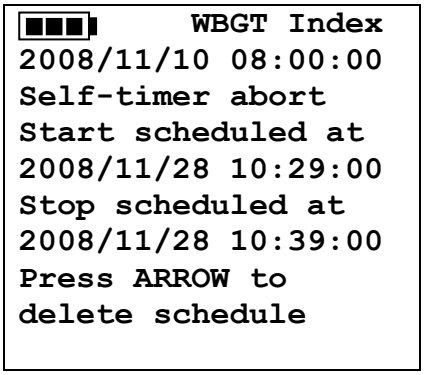
8. Press **ENTER** to confirm or **ESC** to exit without activating the automatic start: in both cases, you'll go back to ***LOGGING*** menu.
9. Press MENU to exit directly from the main menu.

When the instrument starts automatically the LOG section, a beep is given out for each adquisition and, in the upper part of the display, the flashing writing **LOG** appears,
To block the section before the set stop time, press the key **MEM**.
To cancel the settings of automatic start, use the function **Cancel auto start**, described in the following paragraph.

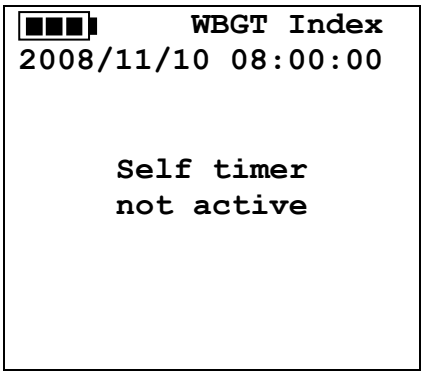
NOTE: the automatic logging section starts also if the instrument is off. If, when you start the section of automatic logging, the instrument is off, it switches on some seconds before the start time and, at the end of the logging, remains on. If it's supplied by batteries, it switches off after some minutes of inactivity at the end of logging section.
To set the auto- switching off, see the paragraph 5.2.2.

5.2.4 Cancel auto start

Once set the start and end times of LOG section, you can avoit the auto start of the section through ***Cancel auto start*** heading.
Once entered into ***LOGGING*** submenu:
1. select, using ▲ ▼ arrow keys, ***Cancel auto start*** heading
2. a message containing the start and end time of LOG section will be visualized:



3. pressing ▲ key the following message will be visualized: ”Self timer not active”;

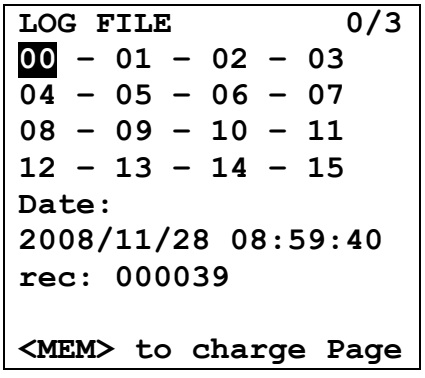


4. press **ENTER** to cancel the auto start;
5. press **ESC** to exit without cancelling the auto start;
6. press **ESC** again to go out from the different submenus;
7. or press **MENU** to exit directly from the main menu.

After cancelling the auto start time, to set a new one, see the previous paragraph.

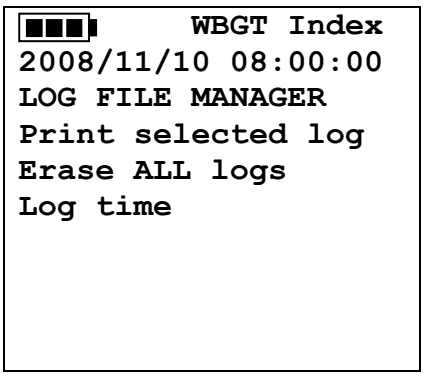
5.2.5 Log File Manager

Through this heading, it’s possible to manage the acquired log sections: the instrument allows printing the acquired data files (***Print selected log***) and cancelling the whole memory (***Erase ALL logs***).
The instrument can memorize up to 64 sections of LOG numbered progressively from 00 to 63: the list of the sections is placed on 4 lines and 4 columns. If there are more than 16 sections, using **MEM** key you can visualize the following screen. Downwards, at the right, is indicated the current page (0, 1, 2 or 3) and the total number of pages with the memorized data: in the example, “0/3” means that you must print the page 0 on the three pages with memorized data.



Once you enter into the submenu ***LOGGING***:

1. select **Log File manager** heading through ▲▼ arrow keys: the following submenu will be visualized:



2. to select a menu heading, use ▲ ▼ arrow keys;
3. press **ENTER** to confirm;
4. press **ESC** to go back to the menu;
5. press **MENU** to exit immediately from the main menu.

NOTE: you can connect a PC to the serial port RS232C of the instrument or the **HD40.1 printer**. Before starting to print through the port RS232C, you must set the baud rate. To do this, select ***Baud Rate*** heading from ***Serial*** menu (see the paragraph 5.3.1 The Baud Rate) and select the maximum value equal to **38400 baud**. For the connection to a printer, use the maximum value tolerated by the printer.

The communication between the instrument and the PC or between the instrument and the printer works only if the baud rate of the instrument and the one belonging to the connected device (computer or printer) are the same.

HD40.1

*Example of printing of a logging section, obtained with **HD40.1** printer*

WBGT Index

	NOTES
`Log number: 1`	Number of logging sections
`========================`	
`  ISO 7243 WBGT Index`	Reference rules
`========================`	
`Model HD32.3 WBGT - PMV`	Instrument model
`Firm.Ver.=01.00`	Version of the instrument firmware
`Firm.Date=2008/12/05`	Date of the instrument firmware
`SN=12345678`	Instrument serial number
`ID=0000000000000000`	Identification code
`------------------------`	
`Probe ch.1 description`	Description of the probe connected to the inlet 1
`Type: Pt100`	
`Data cal.:2008/10/01`	
`Serial N.:08109450`	
`------------------------`	
`Probe ch.2 description`	Description of the probe connected to the inlet 2
`Type: Pt100 Tg 50`	
`Data cal.:2008/10/01`	
`Serial N.:08109452`	
`------------------------`	
`Probe ch.3 description`	Description of the probe connected to the inlet 3
`Type: Pt100 Tw`	
`Data cal.:2008/10/01`	
`Serial N.:08109454`	
`========================`	
`From=2008/11/21 15:00:00`	Logging start day and hour
`To  =2008/11/21 16:30:00`	Logging end day and hour
`Tot. rec.= 000360`	Number of samples acquired by the instrument
`**     max value      **`	Maximum value of the acquired data
`Tnw            21.2 °C`	Maximum temperature of wet bulb with natural ventilation
	Maximum temperature of globe thermometer
`Tg             24.9 °C`	Maximum temperature of wet bulb
`Ta             31.3 °C`	Maximum WBGT in absence of direct solar irradiation
`WBGT (i)       22.3 °C`	Maximum WBGT in presence of direct solar irradiation
`WBGT (o)       23.0 °C`	Maximum value of the acquired data
`**     min value      **`	Minimum value of the acquired data
`Tnw            21.0 °C`	Minimum temperature of wet bulb with natural ventilation
`Tg             24.9 °C`	Minimum temperature of globe thermometer
`Ta             23.5 °C`	Minimum temperature of wet bulb
`WBGT (i)       22.2 °C`	Minimum WBGT in absence of direct solar irradiation
`WBGT (o)       22.6 °C`	Minimum WBGT in presence of direct solar irradiation
`**     avg value      **`	Medium value of the acquired data
`Tnw            21.1 °C`	Medium temperature of wet bulb with natural ventilation
`Tg             24.9 °C`	Medium temperature of globe thermometer
`Ta             30.3 °C`	Medium temperature of wet bulb
`WBGT (i)       22.3 °C`	Medium WBGT in absence of direct solar irradiation
`WBGT (o)       22.8 °C`	Medium WBGT in presence of direct solar irradiation
`========================`	
`Notes:`	
`========================`	

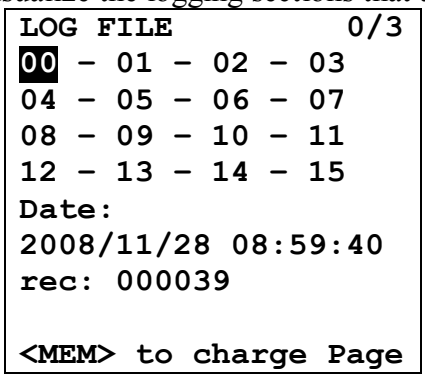
NOTE: The printing of a logging section on HD40.1 printer contains only the statistic data. To visualize all the acquired data, it's necessary to download the data using DeltaLog10 software.

PMV Index

	NOTES
`Log number: 1`	Number of logging sections
`========================`	
`  ISO 7243 PMV Index`	Reference rules
`========================`	
`Model HD32.3 WBGT - PMV`	Instrument model
`Firm.Ver.=01.00`	Version of the instrument firmware
`Firm.Date=2008/12/05`	Date of the instrument firmware
`SN=12345678`	Instrument serial number
`ID=0000000000000000`	Identification code
`------------------------`	
`Probe ch.1 description`	Description of the probe connected to the inlet 1
`Type: Hot wire`	
`Data cal.:2008/10/01`	
`Serial N.:08109450`	
`------------------------`	
`Probe ch.2 description`	Description of the probe connected to the inlet 2
`Type: Pt100 Tg 50`	
`Data cal.:2008/10/01`	
`Serial N.:08109452`	
`------------------------`	
`Probe ch.3 description`	Description of the probe connected to the inlet 3
`Type: RH`	
`Data cal.:2008/10/01`	
`Serial N.:08109454`	
`========================`	
`From=2008/11/21 15:00:00`	Logging start day and hour
`To  =2008/11/21 16:30:00`	Logging end day and hour
`Tot. rec.= 000360`	Number of samples acquired by the instrument
`MET  1.20`	Metabolic rate
`CLO  1.00`	Cloth resistance
`**  max value  **`	Maximum value of the acquired data
`Va  0.00 m/s`	Air speed
`Tg  22.0 °C`	Globe Thermometer temperature
`Ta  22.0 °C`	Wet bulb temperature
`RH  39.1  %`	Relative humidity
`PMV  0.10`	PMV – Predicted Mean Vote
`PPD  5.10  %`	PPD – Predicted Percentage of Dissatisfied
`**  min value  **`	Minimum value of the acquired data
`Va  0.00 m/s`	Air speed
`Tg  22.0 °C`	Globe Thermometer temperature
`Ta  22.0 °C`	Wet bulb temperature
`RH  39.1  %`	Relative humidity
`PMV  0.10`	PMV – Predicted Mean Vote
`PPD  5.10  %`	PPD – Predicted Percentage of Dissatisfied
`**  avg value  **`	Medium value of the acquired data
`Va  0.00 m/s`	Air speed
`Tg  22.0 °C`	Globe Thermometer temperature
`Ta  22.0 °C`	Wet bulb temperature
`RH  39.1  %`	Relative humidity
`PMV  0.10`	PMV – Predicted Mean Vote
`PPD  5.10  %`	PPD – Predicted Percentage of Dissatisfied
`========================`	
`Notes:`	
`========================`	

NOTE: The printing of a logging section on HD40.1 printer contains only the statistic data. To visualize all the acquired data, it's necessary to download the data using DeltaLog10 software.

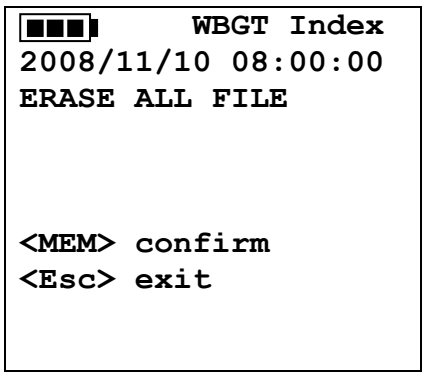
Print selected log (stampa il log selezionato):
Selecting this heading you can visualize the logging sections that are into the instrument:



1. select the log to print, using ▲▼◄►arrows and **MEM** key to go to the following page.
2. once selected a file, in the lower part of the display, are indicated the date and the hour of acquisition start and the number of samples contained into the file (Rec). **The files are memorized in a growing order.** Each file is only identified by the date and the hour **indicated on the display.** In the example above, the file 00 is selected: the memorization started at 08:50:40 on 11/28/2008. The file contains 39 samples.
3. the data transfer message is visualized for some seconds, then the instrument go back to **Print selected log** screen to select another log to print.
4. repeat the process to print the sections you are interested in or press **ESC** to exit from this menu level.
5. press **MENU** to exit immediately from the main menu.

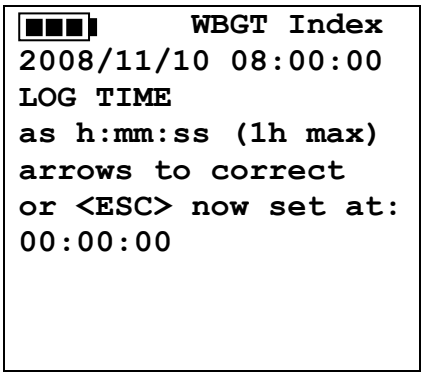
Erase all memory

Selecting this heading, **"ERASE ALL FILES"** messagge will be visualized:



1. press **MEM** to erase all the files;
2. press **ESC** to erase the operation and go back to the upper menu level;
3. press **MENU** to exit immediately from the main menu.

Log time (Set time for the memorization)
It represents the duration of the memorization: after the set time, the memorization stops. The memorization can be finished before the expiration of the set time, pressing **MEM** key.
To disable the function, set the time at 0:00:00. In this case, the memorization stops pressing MEM key or when the memory is full.



With the arrows modify the set time, the maximum value admitted is 1 hour.
Confirm with **ENTER** key.
Press **ESC** to exit from this menu level without modifying anything.
Press **MENU** to exit immediately from the main menu.

5.3 SERIAL MENU (SERIAL COMMUNICATION)

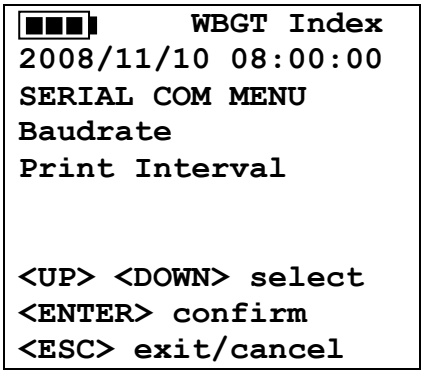
Serial sub menu allows setting the data transfer speed by serial means (***Baud rate***) and the record printing interval (***Print Interval***).

LOG sections can be downloaded to a PC by **RS232** serial connection or **USB** connection.
In case of serial connection, the transmission speed is set by the user (see the following paragraphs) and, however, can't be more than 38400 bps.
In case of USB connection, the transmission speed is fixed at 460800 bps.

After downloading the data on your PC, by the relative software, the data are elaborated by the software for the graphical visualization and for the calculation of the comfort/stress indexes.

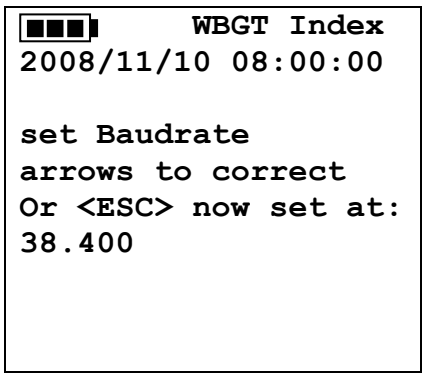
The instrument can be directly connected to **HD40.1 printer.**

To enter into ***Serial*** submenu, go on as indicated below:
1. Press **MENU** key of the instrument;
2. Select, using ▼▲ arrow keys, ***Serial*** heading;
3. press **ENTER;**
4. ***Serial*** submenu will be visualized.



5.3.1 Baud Rate

Baud Rate represents the speed used for the serial communication with the PC.
To set ***Baud rate***, go on as indicated below:
1. select the heading with ▼▲ arrow keys;
2. press **ENTER**: the following message will be visualized:



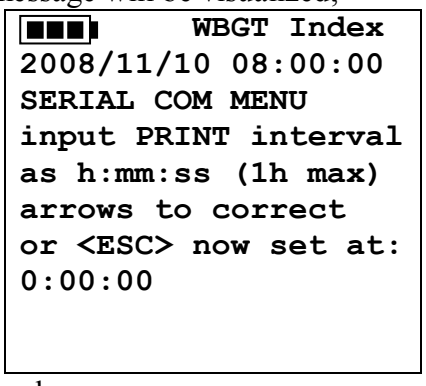
3. set the value through ▼▲ arrow keys;
4. press **ENTER** to confirm and go back to the previous screen or press **ESC** not to modify the value and exit for the menu heading;
5. press **ESC** over and over to exit from the menu different levels;
6. press **MENU** to exit immediately from the main menu.

WARNING
The communication between the instrument and the PC (or serial port printer) works only if the instrument and PC Baud rates are the same. If USB connection is used, this parameter value is automatically set.

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

5.3.2 Print Interval

To set ***Print Interval***, go on as indicated below:
1. use ▲▼ arrow keys to select the heading;
2. press **ENTER**: the following message will be visualized;



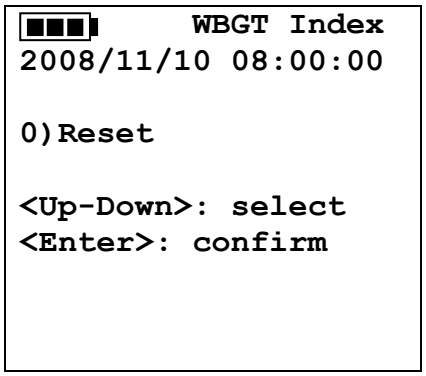
3. using ▼▲ arrow keys, set the value;
4. press **ENTER** to confirm and go back to the previous screen or press **ESC** not to modify the value and exit from the menu heading;
5. press **ESC** over and over to exit from menu different levels;

6. press **MENU** to exit immediately from the main menu.

The print interval can be set from 0 seconds to one hour:
0 s - 15 s - 30 s - 1 min. - 2 min. - 5 min. - 10 min. - 15 min. - 20 min. - 30 min. - 1 hour.

5.4 RESET

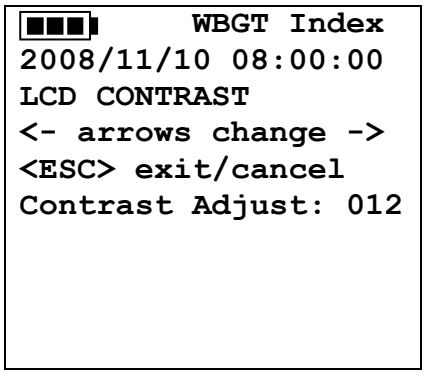
To enter into ***Reset*** submenu in order to carry out a complete reset of the instrument, go on as indicated below:
1. press **MENU** key of the instrument;
2. select ***Reset*** heading, using ▼▲ arrow keys;
3. press **ENTER**: the messagge will be visualized:



4. press ▼▲ arrow key to select ***Reset*** heading;
5. press **ENTER** to confirm or press **ESC** over and over to exit from the menu different levels;
6. press **MENU** to exit immediately from the main menu.

5.5 CONTRAST

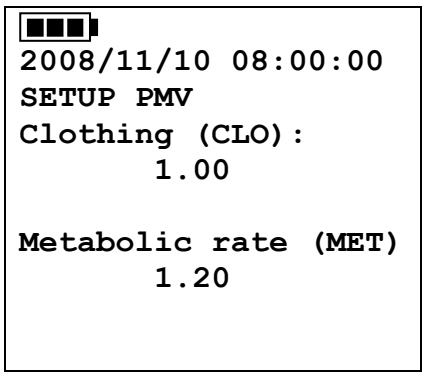
This menu heading allows increasing or decreasing the contrast on the display:
To enter into ***Contrast*** submenu, go on as indicated below:
1. Press **MENU** key of the instrument;
2. Use ▲▼ arrow keys to select ***Contrast.;***
3. Press **ENTER**;
4. The following message will be visualized.



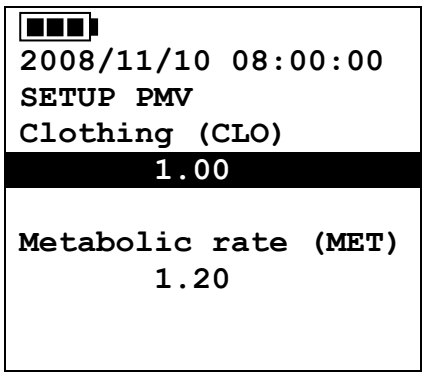
5. use ◄►arrow key to decrease or increase the contrast;
6. press **ENTER** or **ESC** to go back to the main menu;
7. press **MENU** to exit immediately from the main menu.

5.6 SETUP PMV

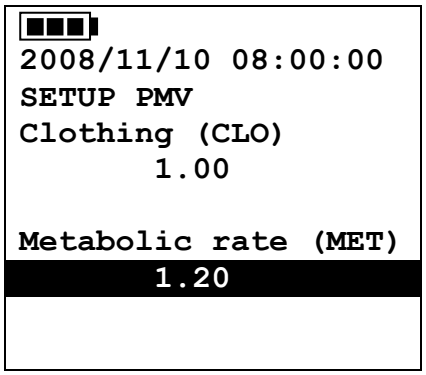
Setup PMV allows setting the Thermal Resistance of the clothing, expressed in CLO and the metabolic rate, expressed in MET. For values to set, see the paragraph *2.1.2. Predicted Mean Vote PMV and Predicted Percentage of Dissatisfied PPD.*



To modify the parameter **clothing,** press **ENTER** key till by reverse the current clothing value appears:



With arrows key ▼▲ change the value and confirm with ENTER key.
To modify the parameter **metabolic rate**, press **ENTER** key till by reverse the current clothing value appears:



With arrows keys ▼▲ chenge the value and confirm with ENTER key.

6. PROBES AND MEASUREMENTS

Necessary **probes** for **WBGT** measurement are:

Necessary **probes** for **PMV** measurement are:

TP3207.2, TP3207

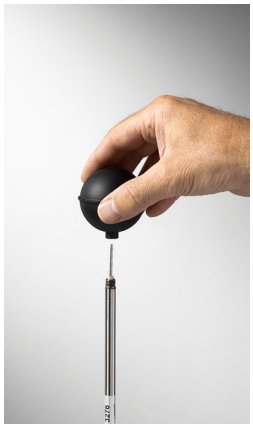
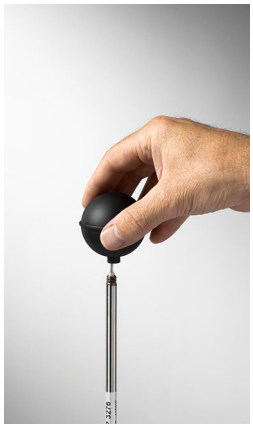
Temperature probe

	Sensor type:	Thin film Pt100
(*)	Accuracy:	Class 1/3 DIN
	Measurement range:	-40 ÷ 100 °C
	Connection:	4 wires plus SICRAM module
	Connector:	8-pole female DIN45326
	Cable:	Only TP3207 (2m)
	Dimensions:	Ø=14 mm L= 150 mm (TP3207.2), L= 140 mm (TP3207)
(**)	Response time T_{95}	15 minutes

TP3276.2, TP3275

Globe thermometer probe Ø=50 mm (TP3276.2), Ø=150 mm (TP3275)

	Sensor type:	Pt100
(*)	Accuracy:	Class 1/3 DIN
	Measurement range	-10 ÷ 100 °C
	Connection:	4 wires plus SICRAM module
	Connector:	8-pole female DIN45326
	Cable:	Only TP3275 (2m)
	Stem dimension:	Ø=8 mm L= 170 mm (TP3276.2), Ø=14 mm L= 110 mm (TP3275)
(**)	Response time T_{95}	15 minutes


(*) The probe is calibrated, the calibration data are kept into the SICRAM module memory.

(**) T_{95} response time is the time spent to reach the 95% of the final value. The measurement of the response time is done with a negligible air speed (motionless air).

HP3201.2, HP3201

Wet bulb probe with natural ventilation

	Sensor type:	Pt100
(*)	Accuracy:	Class A
	Measurement range:	4 °C ÷ 80 °C
	Connection:	4 wires plus SICRAM module
	Connector:	8-pole female DIN45326
	Cable:	Only HP3201 (2m)
	Stem dimension:	Ø=14 mm L= 170 mm (HP3201.2), L= 110 mm (HP3201)
	Cotton wick length:	about 10 cm
	Tank capacity:	15 cc
	Tank autonomy:	96 hours con RH=50%, t = 23°C
(**)	Response time T_{95}	Pt100

HP3201.2, HP3201 wet bulb probe with natural ventilation

For the start up go on as indicated below:

- Remove the cover, **the cover isn't screwed**.
- Insert the cotton wick into the temperature probe, the cotton wick was previously dipped with distilled water.
- Fill the case up till ¾ with **distilled water**.
- Close the case cover.
- **Warning**: don't turn the probe in the vertical direction because the distilled water can exit.
- The cotton wick must project from the temperature probe for about 20mm.
- During the time, the cotton wick is going to calcify (to become hard) and so it's necessary to replace periodically it.

(*) The probe is calibrated, the calibration data are kept into the SICRAM module memory.

(**) T_{95} response time is the time spent to reach the 95% of the final value. The measurement of the response time is done with a negligible air speed (motionless air).

TP3204S

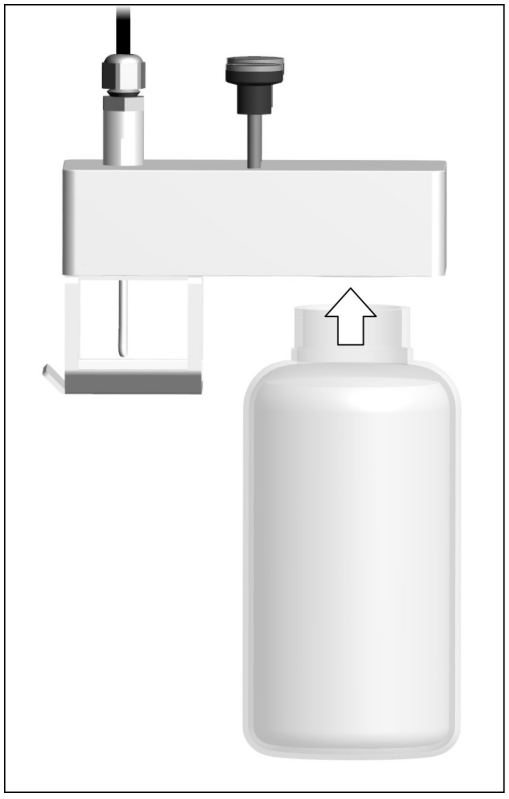
Natural ventilation wet bulb probe for long-lasting measurements

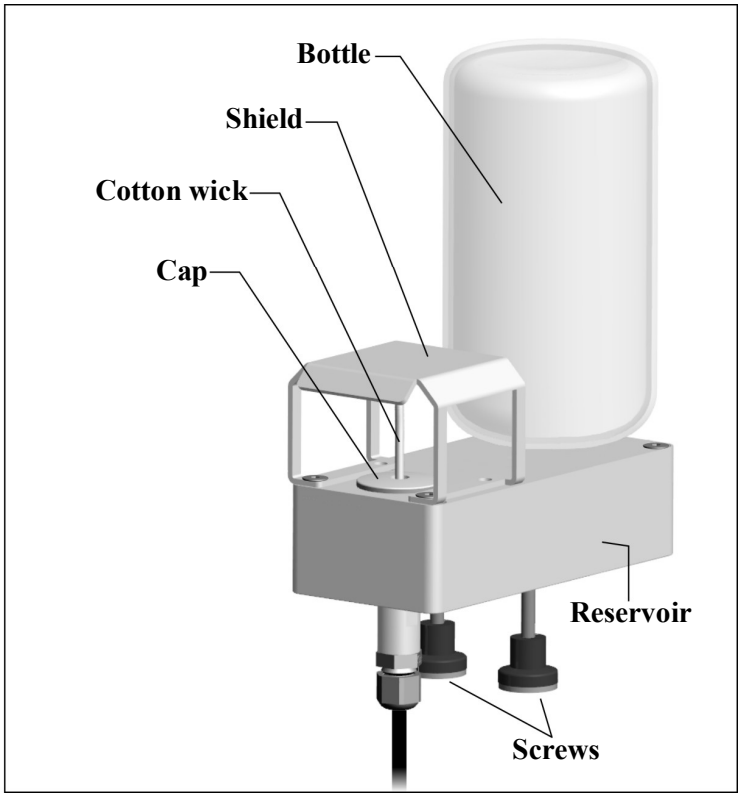
	Sensor type:	Pt100
(*)	Accuracy:	Class A
	Measurement range:	4 °C ÷ 80 °C
	Connection:	4 wires plus SICRAM module
	Connector:	8-pole female DIN45326
	Cable:	2 m
	Dimensions:	L x W x H=140 x 65 x 178.5 mm (reservoir + bottle)
	Cotton wick length:	about 10 cm
	Tank capacity:	500 cc
	Tank autonomy:	15 days @ t = 40 °C
(**)	Response time T_{95}	15 minutes

TP3204S wet bulb probe with natural ventilation

For the start up go on as indicated below:

- Remove the sensor cap (**the cap is not screwed**).
- Insert the cotton wick, previously dipped with distilled water, into the temperature probe. The cotton wick must protrude from the probe for about 20 mm.
- Replace the cap.
- Fill the bottle with 500 cc of **distilled water**.
- Turn the probe over and firmly screw the bottle to the probe reservoir.
- Turn the probe quickly (to avoid water spillage).
- Secure the probe to the **HD32.2.7.1** support by using the two screws at the bottom of the probe.





For measurements in presence of solar irradiation, use the protection shield from solar radiations.
The cotton wick calcifies (becomes hard) with time: replace it periodically.

(*) The probe is calibrated, the calibration data are kept into the SICRAM module memory.

(**) T_{95} response time is the time spent to reach the 95% of the final value. The measurement of the response time is done with a negligible air speed (motionless air).

HP3217, HP3217R
Combined probe for temperature and relative humidity.
Used in the measurement of ambient comfort indexes.

	Sensor types:	- Thin film Pt100 for temperature - Capacitive sensor for relative humidity.
(*)	Accuracy :	temperature: 1/3 DIN relative humidity: ± 2.5%
	Connection:	temperature: -10 °C ÷ 80 °C relative humidity: 5% RH ÷ 98% RH
	Connection:	7 wires plus SICRAM module
	Connector:	8 -pole female DIN45326
	Cable:	Only HP3217R (2m)
	Dimensions:	Ø=14 mm L= 150 mm
(**)	Response time T_{95}	15 minutes

Combined probe of relative humidity (RH) and temperature HD3217.2, HP3217R
- Don't use your hands for touching the sensors with your hands, avoid dirtying them with oils, greases or resins.
- The sensor support is in aluminium so they can break easily with shocks, blows, falls.
- The sensors can be cleaned by the dust, the pollution with distilled water and a brush very soft (i.e. by yew).
- If the measurements are not adequate, check that the sensors are not dirty, corroded, chipped or broken.
- To **check** the appropriateness of the RH measurement you can use the standard satured salt solutions: **HD75** (75% RH) and **HD33** (33% RH).

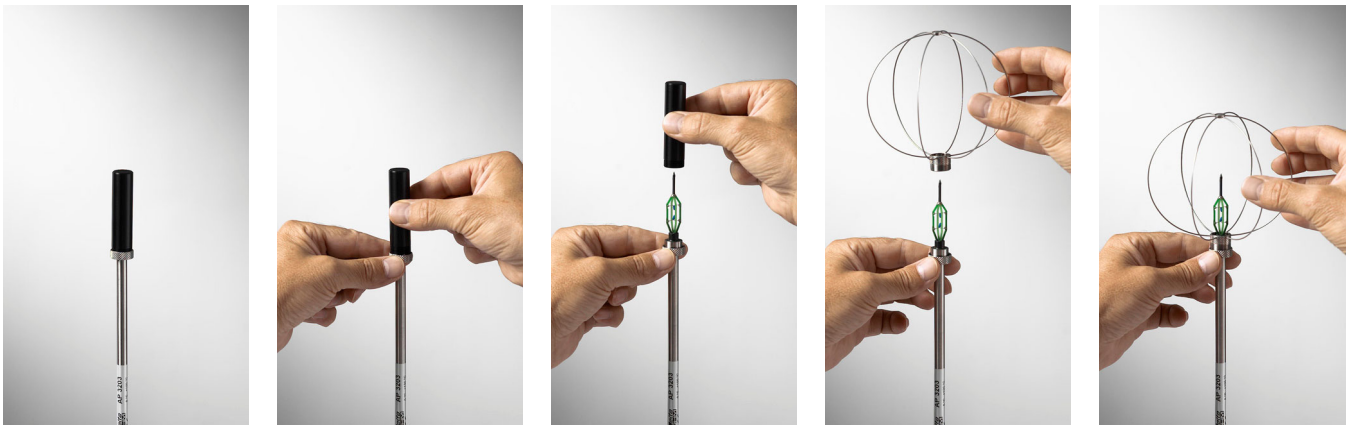
(*) The probe is calibrated, the calibration data are kept into the SICRAM module memory.

(**) T_{95} response time is the time spent to reach the 95% of the final value. The measurement of the response time is done with a negligible air speed (motionless air).

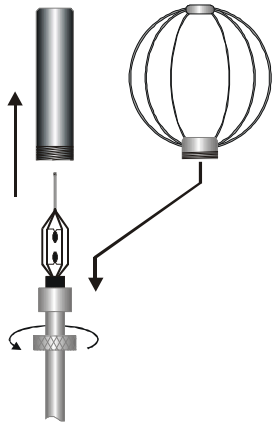
AP3203.2, AP3203

Probe with hot omnidirectional wire

	Sensor type:	NTC 10kohm
(*)	Accuracy:	± 0.05 m/s (0.05÷1 m/s)
		± 0.15 m/s (1÷5 m/s)
	Measurement range:	0.05÷5 m/s
		0 °C ÷ 80 °C
	Connection:	7 wires plus SICRAM module
	Connector	8- pole female DIN45326
	Cable:	Only AP3203 (2m)
	Stem dimension:	Ø=8 mm L= 230 mm
	Protection dimension:	Ø=80 mm



- The hot wire air speed sensor of the AP3203.2 and AP3203 probes is heated and, **in case of vapours or gases, could trigger a fire or an explosion. Do not use the probe in the presence of flammable gases. Make sure that in the environment where you measure, there are no gas leaks or potentially explosive vapours.**
- **The probe is fragile and you have to handle it with attention**. A simple shock, given that the sensor is partially protected during its use, make the probe unusable.
- After finishing the measurement, the sensor placed on the probe head must be protected with the provided threaded protection barrel.
- During the use, AP3203.2 or AP3203 omnidirectional probe has to be protected with the relative sphere of metal circles.
- Don't touch the sensors with your fingers.
- For **cleaning** the probe use only distilled water.



AP3203.2 or **AP3203** probe has a spherical protection scheme. To reduce the encumbrance when it's not use, **AP3203.2** or **AP3203** probe is supplied with a cylindrical case to screw on the probe head.

Measurement

In the place where you want to measure, you must assembly the tripod and the probes necessary for the measurement. You set the instrument up and then you start measuring. If the measurement has to be done in other places, you have to move all the equipment in the new measurement position.

At the end of the measurement or after some times, the acquired data are transferred to the PC for the elaboration and to allow writing the measurement report/s.

6.1.1 Instruction, accuracy and maintenance of the probes

- Don’t expose the probes to gas or liquids that could corrode the probe material. After the measurement clean accurately the probes.
- Don’t fold the connector, using force upwards or downwards.
- Respect the correct probe polarity.
- During the insertion of the probe’s connector into the instrument, don’t fold or use force against the contacts.
- Don’t fold the probes and don’t distort them or let them fall: they can damage in an irreparable manner.
- Use a probe suitable to the measurement type that you want to realize.
- For a reliable measurement, avoid too speed temperature variations.

- Some sensors aren’t isolated with reference to the external sheathing, pay attention not to be in contact with items under tension (up to 48V): it could be dangerous for the instrument and for the operator who can be electrocute.

- Avoid measuring in presence of high-frequency sources, microwave or great magnetic fields, because they will be not so reliable.
- The instrument is water-proof, don't dip it into the water. If it falls into the water, check that there isn't any infiltration.

7. SERIAL AND USB INTERFACES

HD32.3 has a RS-232C serial interface, galvanically isolated and it has a USB 2.0 interface. As an optional, we can supply, under request:

- RS-232C serial connection cable (code **HD2110/RS**) with M12 connector from instrument side and 9-pole female connector sub D from the PC side.
- USB 2.0 connection cable (code **HD2110/USB**) with M12 connector from instrument side and USB 2.0 connector from the PC side.

The USB connection requires the previous installation of a driver included in the DeltaLog10 software package. **Install the driver before connecting the USB cable to the PC** (follow the instructions included in the software package).

The instrument standard RS232 serial transmission parameters are:

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

It's possible to change the speed of RS232C serial data transmission acting on "*Selection of serial transfer speed (Baud Rate)*" inside the menu (see the menu of the chapter **5.3.1 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 (Baud rate = 460800 fixed).

The port selection is directly done by the instrument: if USB port is connected to a PC, RS232 serial port is automatically excluded and vice versa.

The instruments are provided with a complete set of commands and data request to send by PC.

All the commands transmitted to the instrument must have the following structure:
XXCR where: **XX is the command code and CR is the** Carriage Return (ASCII 0D).
The command characters XX are only capital, the instrument responses with "&" if the command is correct, with "?" for each characters combination that is wrong.
The response string of the instrument is finished, entering CR (Carriage Return) and LF (Line Feed) commands.
Before entering the commands to the instrument through the serial port, we suggest you to block the keyboard to avoid working conflicts: use P0 command. At the end of the process, restore the keyboard use with P1 command.

Command	Response	Description
P0	&	Ping (locks the instrument keyboard for 70 seconds)
P1	&	Unlocks the instrument keyboard
S0		
G0	Model HD32.3	Instrument model
G1	M=WBGT Index	Model description
G2	SN=12345678	Instrument serial number
G3	Firm.Ver.=01.00	Firmware version
G4	Firm.Date=2008/10/12	Firmware date
G5	cal 2008/11/10 10:30:00	Calibration date and time
C1		Probe 1 type, serial number, calibration date

Command	Response	Description
C2		Probe 2 type, serial number, calibration date
C3		Probe 3 type, serial number, calibration date
GC		Print instrument's heading
GB	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);
H7	WBGT(i)= 23.0 øC	Print indoor WGBT (without solar radiation)
H8	WBGT(o)= 24.0 øC	Print outdoor WGBT (with solar radiation)
LN	A00 -A01 -A02 -A03 - .. - .. - .. - .. - .. - .. - .. - .. - .. - .. - .. - .. - .. - .. - .. -	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. If the section is empty: "-->No Log Data<--"
LE	&	Cancel stored data
K1	&	Immediate data printing
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. # 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. # is a hexadecimal number 1…D that represents the position of the interval in the list 15, …, 3600 seconds.

7.1 THE DATA MEMORIZATION AND THE DATA TRANSFER TO A PC

HD32.3 can be connected to RS232C serial port or USB port of a PC and can exchange data and information through DeltaLog10 software that works with Windows. The values measured can be printed (ENTER key) or stored in the memory of the instrument by using the *Logging* function (MEM key). The memorized data can be transferred to the PC in a second time.

*7.1.1 **Logging** function*

Logging function allows memorizing the measurements detected by the probes connected to the inlets. The interval between two following measurements can be set between 15 seconds and 1 hour. The memorization start is obtained pressing **MEM** key; the stop is obtained pressing the same key: so, the memorized data are a continuous block of data.
See the menu headings description in the chapter 5. MEIN MENU".
If the *Self Shut-off* option is activated between two memorizations (see the paragraph *5.22 Self Shut-off mode*), pressing **MEM** key, the instrument memorizes the first data and the switches off, 15 seconds before the following memorization istant, the instrument switches on to acquired the new sample and then it switches off.
The memorized data can be transferred to the PC (see the paragraph *5.22 Log File Manager*). During the data transfer, the display visualizes DUMP writing; to stop the data transfer, press ESC key on the instrument or on the PC.

7.1.2 Erase function: cancellation of the memorized data

To cancel the content of the memory, you must use Erase Log function (see the paragraph *5.2.5 Log file Manager*). The instrument cancels the internal memory and, at the end of the operation, goes back to the normal visualization.

NOTES:

- The data transfer doesn't involve the memory cancellation: it's possible to repeat over and over the transfer process.
- The memorized data independently remain in memory from the batteries charge condition.
- To print the data using a printer provided with a parallel interface, it's necessary to use a serial- parallel converter (usually, not supplied).
- **The direct connection between the instrument and the printer with USB connection doesn't work.**
- During *logging*, some keys are disabled, **MEM**, **MENU**, **ENTER** and ESC are enabled.
- Pressing **MEM** and **MENU** keys, doesn't involve the memorized data if these keys are pressed **after** starting the memorization, vice versa it's valid what indicated below.

*7.1.3 **Print** function*

Pressing **ENTER** key, in real time, you can immediately send the detected data by the instrument to RS232C or USB ports. The measurement units of the printed data are the ones visualized on the display. The function starts, pressing **ENTER** key. The interval between the two following printings can be set between 15 seconds and 1 hour (see **Print interval** menu heading at the paragraph 5.3.2. Print Interval). If the printing interval is equal to 0, pressing **ENTER**, key you send only a data to the device. If the printing interval is more than 0, the data sending goes on till the operator doesn't stop it, pressing **ENTER** key again.

NOTE: During baud-rate setting, check the printing speed capacity of the used printer.

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.
LOG	Blinking message. It appears on the first line of the display and indicates a logging session.

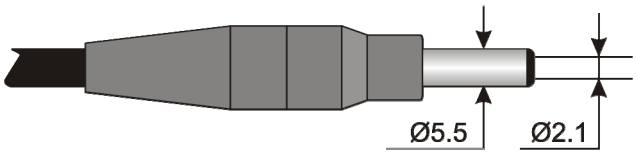
10. BATTERY SYMBOL AND BATTERY REPLACEMENT – MAIN POWER SUPPLY

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, go on as indicated below:
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.
4. replace the batteries (4 1.5V alkaline batteries – 1.5 V AA type). 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 main using, for example, the stabilized power supply SWD10 input 100÷240Vac output 12Vdc – 1000mA. The positive connector 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 THE BATTERIES 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;
    - there are strong vibrations;
    - there are steams, 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. PRINTING OF THE MEASUREMENT REPORT

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 Hot Environments: Determination of WBGT heat stress index Norm ISO 7243	Mod. 002 rev.0 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**

Warm environments

Delta OHM	**Evaluation Report** Hot Environments: Determination of WBGT heat stress index Norm ISO 7243	Mod. 001 rev.0 Page 3 of 6

Instrumentation used:

Instrument Code:	Model HD32
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

Warm environments

	Evaluation Report Hot Environments: Determination of WBGT heat stress index Norm ISO 7243	Mod. 001 rev.0 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

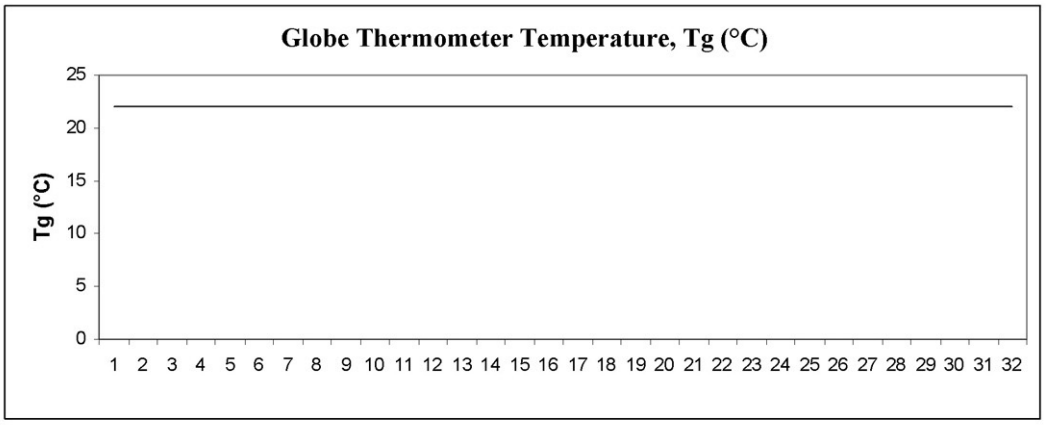
Warm environments

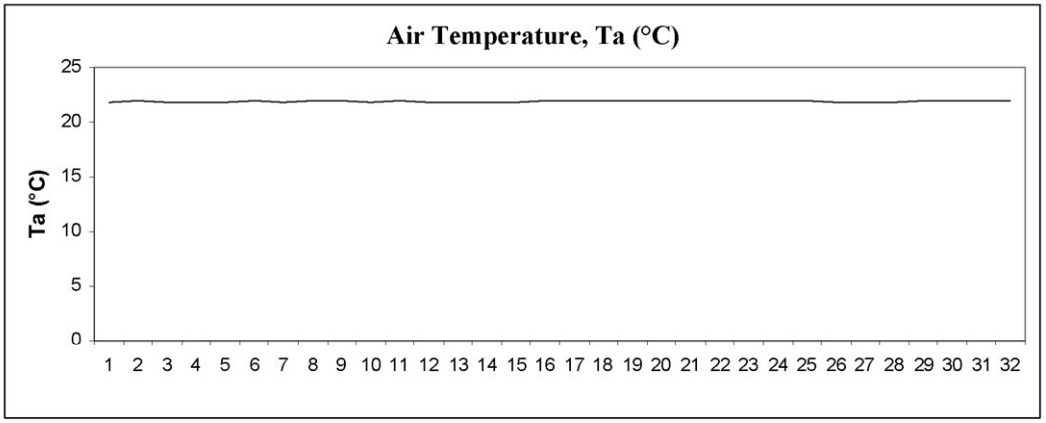
	Evaluation Report Hot Environments: Determination of WBGT heat stress index Norm ISO 7243	Mod. 001 rev.0 Page 5 of 6

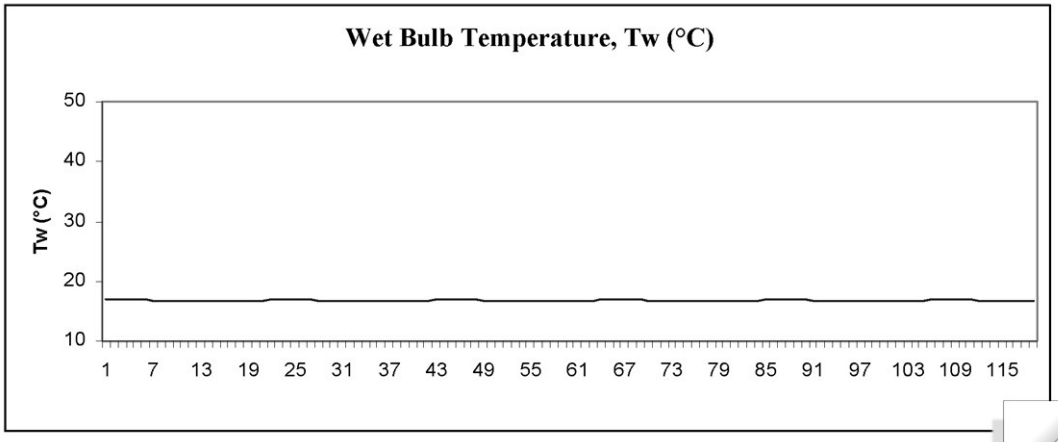
Graph Trend:

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 environments

Delta OHM	**Evaluation Report** Hot Environments: Determination of WBGT heat stress index Norm ISO 7243	Mod. 001 rev.0 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

Moderate environments

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 environments

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

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

Instrumentation used:

Instrument Code:	Model HD32
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

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

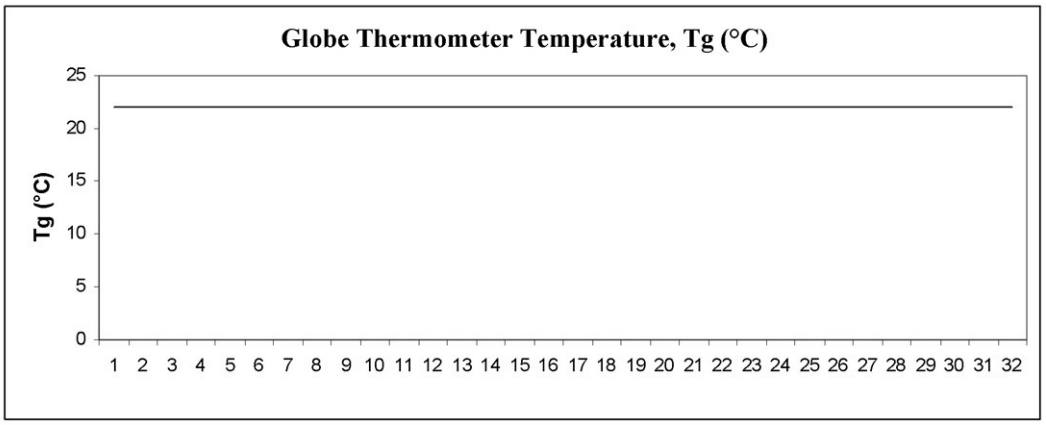
Moderate environments

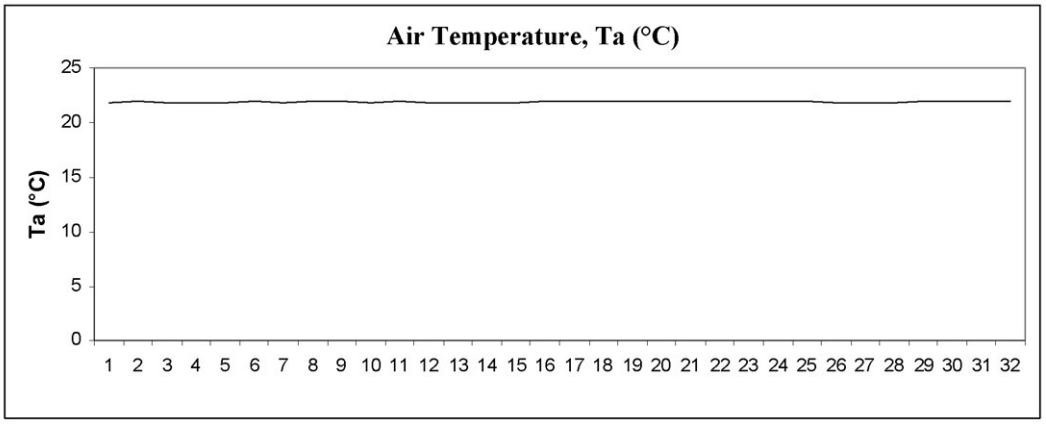
	Evaluation Report	
Delta OHM	Moderate Environments: Determination of the thermal well-being by calculating PMV and PPD indices Norm ISO 7730	Mod. 001 rev.0 Page 5 of 7

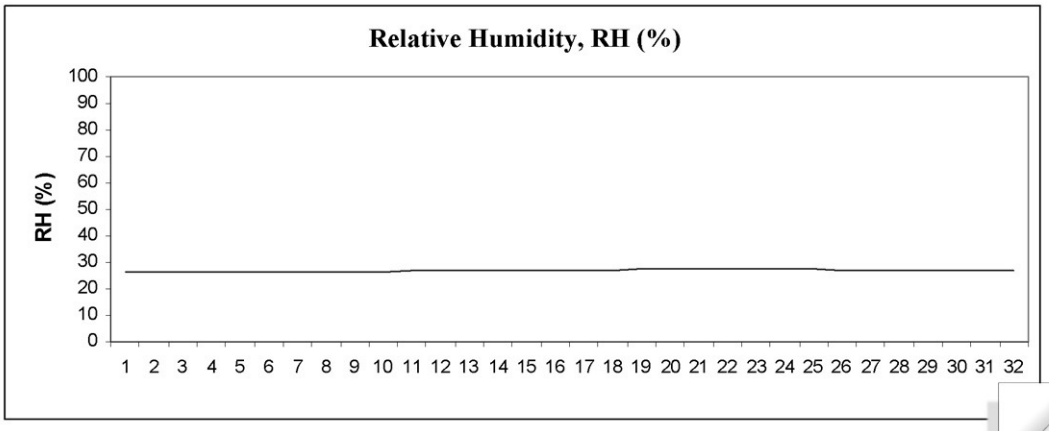
Graph Trend:

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

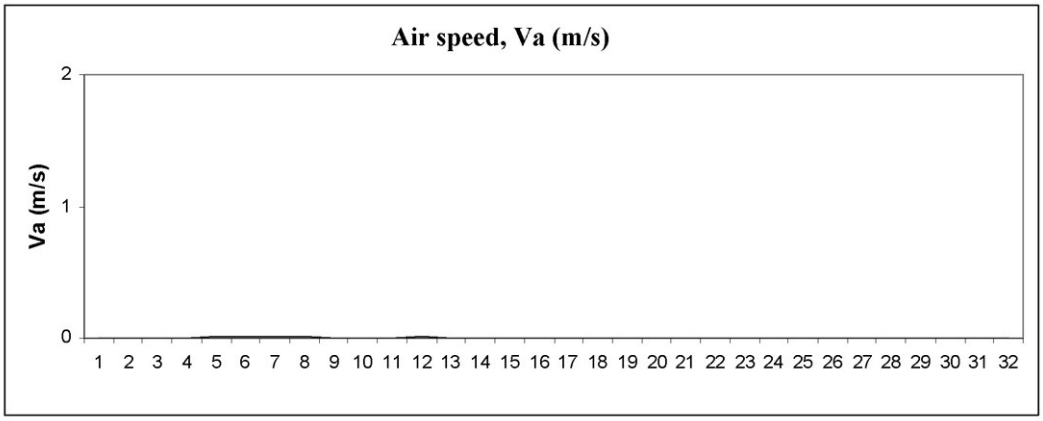
Acquisition frequency: 15 sec

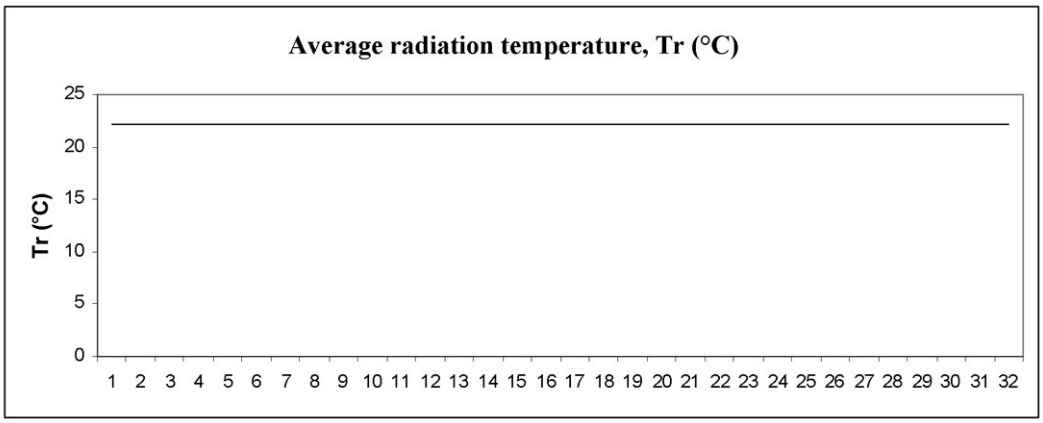






	Evaluation Report	
Delta OHM	Moderate Environments: Determination of the thermal well-being by calculating PMV and PPD indices Norm ISO 7730	Mod. 001 rev.0 Page 6 of 7





Moderate environments

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

13. NOTES ON WORKING AND OPERATING SAFETY

Authorized use

Comply with the technical specifications outlined in the chapter "TECHNICAL CHARACTERISTICS". Its use is authorized only in conformity with the instructions written in this manual. Any different use is considered improper.

General instructions on security

This instrument has been manufactured and tested according to safety regulation EN 61010-1:2010 concerning electronic measurement instruments and was delivered ex factory in perfect security conditions.
Its regular functioning and operating security can be ensured only if all the normal safety measures as well as the specifications described in this manual are complied with.
Its regular functioning and operating security can be ensured only within the climatic conditions specified in the chapter "TECHNICAL CHARACTERISTICS".

Do not use or store the instrument in ways and/or places in which there are:

- Quick environment temperature changes that could cause condensation.
- Corrosive or inflammable gases.
- Direct vibrations or shocks against the instrument.
- High intensity electromagnetic fields, static electricity.

If the instrument is moved from a cold to a hot environment, the condensation can disturb its functioning. In this case, you need to wait for the instrument to reach the environment temperature before using it.

User obligations

The user of the instrument must ensure that the following regulations and directives concerning the handling of hazardous materials are complied with:

- CEE directives on job safety
- National laws on job safety
- Accident prevention regulations

14. TECHNICAL CHARACTERISTICS

Instrument

Dimensions (Length x Width x Height)	185x90x40 mm
Weight	470 g (complete of batteries)
Materials	ABS, rubber
Display	Dot matrix with backlight 160x160 points, visible area 52x42mm

Working conditions

Operative temperature	-5 … 50°C
Storage temperature	-25 … 65°C
Humidity relative to work	0 … 90% HR no condensation
Protection degree	**IP67**
Instrument uncertainty	± 1 digit @ 20°C

Power supply

Net power supply (code SWD10)	12Vdc/1A
Batteries	4 batteries 1.5V AA type
Autonomy	200 hours with 1800mAh alkaline batteries
Absorbed current with switched instrument off	< 45μA
Safety of the memorized data	unlimited

***TP3207.2, TP3207** temperature probe*

Sensor type:	Thin film Pt100
Accuracy:	Class 1/3 DIN
Measurement range:	-40 ÷ 100 °C
Resolution:	0.1°C
Drifting in temperature @20°C:	0.003%/°C
Drifting after 1 year:	0.1°C/year
Connection:	4 wires plus SICRAM module
Connector:	8 – poles female DIN45326
Cable:	Only TP3207 (2m)
Dimensions:	Ø=14 mm L= 150 mm (TP3207.2), L= 140 mm (TP3207)
Response time T_{95}:	15 minutes

*Globe thermometer probe Ø=50 mm **TP3276.2**, Ø=150 mm **TP3275***

Sensor type:	Pt100
Accuracy:	Class 1/3 DIN
Measurement range:	-10 ÷ 100 °C
Resolution:	0.1°C
Drifting in temperature @20°C:	0.003%/°C
Drifting after 1 year:	0.1°C/year
Connection:	4 wires plus SICRAM module
Connector:	8 – poles female DIN45326
Cable:	Only TP3275 (2m)
Stem dimensions:	Ø=8 mm L= 170 mm (TP3276.2), Ø=14 mm L= 110 mm (TP3275)
Response time T_{95}:	15 minutes

HP3201.2, HP3201 *Natural ventilation wet bulb probe*

Sensor type:	Pt100
Accuracy:	Class A
Measurement range:	4 °C ÷ 80 °C
Resolution:	0.1°C
Drifting in temperature @20°C:	0.003%/°C
Drifting after 1 year:	0.1°C/year
Connection:	4 wires plus SICRAM module
Connector:	8 – poles female DIN45326
Cable:	Only HP3201 (2m)
Stem dimensions:	Ø=14 mm L= 170 mm (HP3201.2), L= 110 mm (HP3201)
Cotton wick length:	about 10 cm.
Tank capacity:	15 cc.
Tank autonomy:	96 hours with RH=50%, t = 23°C
Response time T_{95}:	15 minutes

TP3204S *Natural ventilation wet bulb probe*

Sensor type:	Pt100
Accuracy:	Class A
Measurement range:	4 °C ÷ 80 °C
Resolution:	0.1°C
Drifting in temperature @20°C:	0.003%/°C
Drifting after 1 year:	0.1°C/year
Connection:	4 wires plus SICRAM module
Connector:	8 – poles female DIN45326
Cable:	2 m
Dimensions:	L x W x H=140 x 65 x 178.5 mm (reservoir + bottle)
Scotch length:	about 10 cm
Tank capacity:	500 cc
Tank autonomy:	15 days @ t = 40 °C
Response time T_{95}:	15 minutes

Combined probe and relative humidity ***HP3217.2, HP3217R***

Sensor types:	Thin film Pt100 for temperature Capacitive sensor for relative humidity
Accuracy:	temperature: 1/3 DIN Relative humidity: ± 2.5%
Measurement range:	temperature: -10 °C ÷ 80 °C Relative humidity: 5% ÷ 98% UR
Connection:	4 wires plus SICRAM module
Connector:	8 – poles female DIN45326
Cable:	Only HP3217R (2m)
Dimensions:	Ø=14 mm L= 150 mm
Response time T_{95}:	15 minutes
Resolution:	0.1%RH
Drifting in temperature @20°C:	0.02%RH/°C
Drifting after 1 year:	0.1% C/year

Probe with omnidirectional hot wire ***AP3203.2, AP3203***

Sensor type:	NTC 10Kohm
Accuracy:	± 0.05 m/s (0.05÷1 m/s) ± 0.15 m/s (1÷5 m/s)
Measurement range:	0.05÷5 m/s 0 °C ÷ 80 °C
Connection:	7 wires plus SICRAM module
Connector:	8 – poles female DIN45326
Cable:	Only AP3203 (2m)
Stem dimensions:	Ø=8 mm L= 230 mm
Protection dimension:	Ø=80 mm
Resolution:	0.01 m/s
Drifting in temperature @20°C:	0.06% /°C
Drifting after 1 year:	0.12 °C/year

Connections

Inputs for probes with SICRAM module	3 male 8-pole DIN 45326 connectors

Serial interface:

Pin:	M12-8 poles.
Type:	RS232C (EIA/TIA574) or USB 1.1 or 2.0 no-isolated
Baud rate:	from 1200 to 38400 baud. with USB baud=460800
Data Bit:	8
Parity:	None
Stop bit:	1
Flow control:	Xon-Xoff
Cable length:	max 15m

Memory	divided in 64 blocks.
Memory capacity	67600 memorizations for each of 3 inputs
Memorization interval	selectable between: 15, 30 seconds, 1, 2, 5, 10, 15, 20, 30 minutes and 1 hour

15. ORDERING CODES

The **kit** for WBGT and PMV indexes analysis consists of:

- **HD32.3 instrument**, 4 alkaline batteries 1.5V AA type, instruction manual, case. **The probes and the cables are not included.**
- **DeltaLog10 Software WBGT and PMV indexes analysis.**
  The DeltaLog10 software is downloadable from Delta OHM website.

Necessary **probes** for **WBGT** measurement are:

- **TP3207.2** Dry bulb temperature probe**.**
- **TP3276.2** Globe thermometer probe.
- **HP3201.2** Wet bulb temperature probe with natural ventilation.

Necessary **probes** for **WBGT version A** measurement are:

- **TP3207** Dry bulb temperature probe**.**
- **TP3275** Globe thermometer probe.
- **HP3201** or **TP3204S** Wet bulb temperature probe with natural ventilation.

Necessary **probes** for **PMV** measurement are:

- **HP3217.2** combined probe for temperature and relative humidity
- **AP3203.2** Probe with omnidirectional hot wire.
- **TP3276.2** Globe thermometer probe.

Necessary **probes** for **PMV version A** measurement are:

- **HP3217R** combined probe for temperature and relative humidity
- **AP3203** Probe with omnidirectional hot wire.
- **TP3275** Globe thermometer probe.

15.1 PROBES FOR HD32.3

TP3207.2 Temperature probe for Pt100 sensor. Shank probe Ø 14mm, length 150mm. complete with SICRAM module. **Used for WBGT measurement.**

TP3276.2 Globe thermometer probe for Pt100 sensor, globe Ø 50 mm. Shank Ø 8 mm, length 170 mm, complete with SICRAM module. **Used for WBGT and PMV measurement.**

HP3201.2 Wet bulb probe with natural ventilation. Pt100 sensor. Shank probe Ø 14 mm, length 170 mm complete with SICRAM module, spare parts of the cotton wick and case of 50cc. distilled water. **Used for WBGT measurement.**

TP3207 Temperature probe for Pt100 sensor. Shank probe Ø 14mm, length 140mm. Cable length 2 m. Complete with SICRAM module. **Used for WBGT measurement.**

TP3275 Globe thermometer probe for Pt100 sensor, globe Ø 150 mm. Shank Ø 14 mm, length 110 mm. Cable length 2 m. Complete with SICRAM module. **Used for WBGT and PMV measurement.**

HP3201 Wet bulb probe with natural ventilation. Pt100 sensor. Shank probe Ø 14 mm, length 110 mm. Cable length 2 m. Complete with SICRAM module, spare parts of the cotton wick and and case of 50cc. distilled water. **Used for WBGT measurement.**

TP3204S	Natural ventilation wet bulb probe for long-lasting measurements. Capacity: 500 cc of distilled water. Pt100 sensor. Cable length 2 m. Complete with SICRAM module, 500 cc bottle and two spare cotton wicks. **Used for WBGT measurement.**
HP3217.2	Combined probe for temperature and relative humidity. Capacitive RH sensor, Pt100 temperature sensor. Shank probe Ø 14mm, length 150mm. complete with SICRAM module. **Used for PMV measurement.**
AP3203.2	Probe with omnidirectional hot wire. Measurement range: air speed 0.05÷5 m/s, temperature 0÷80 °C. Shank Ø 8 mm, length 230 mm, complete with SICRAM module. **Used for PMV measurement**.
HP3217R	Combined probe for temperature and relative humidity. Capacitive RH sensor, Pt100 temperature sensor. Shank probe Ø 14mm, length 110mm. Cable length 2 m. Complete with SICRAM module. **Used for PMV measurement.**
AP3203	Probe with omnidirectional hot wire. Measurement range: air speed 0.05÷5 m/s, temperature 0÷80 °C. Shank Ø 14 mm, length 110 mm. Cable length 2 m. Complete with SICRAM module. **Used for PMV measurement**.

Accessories:

VTRAP30	Tripod to be fixed to the instrument with a maximum height of 280 mm
VTRAP32.2A.3A	Tripod for HD32.3A
HD32.2.7.1	Support for probes, to be fixed on standard tripod for version **HD32.3A**
HD2110/RS	Connection cable with M12 connector on the instrument side and with 9-pole SubD female connector for RS232C on PC side.
HD2110/USB	Connection cable with M12 connector on the instrument, USB 2.0 connector on PC side.
SWD10	Stabilized power supply with 100-240Vac/12Vdc-1A main tension
AQC	200cc of distilled water
HD40.1	Printer (it uses **HD2110/RS** cable)

DELTA OHM metrology laboratories LAT N° 124 are ISO/IEC 17025 accredited by ACCREDIA for Temperature, Humidity, Pressure, Photometry / Radiometry, Acoustics and Air Velocity. They can supply calibration certificates for the accredited quantities.

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DICHIARAZIONE DI CONFORMITÀ UE
EU DECLARATION OF CONFORMITY

Delta Ohm S.r.L. a socio unico – Via Marconi 5 – 35030 Caselle di Selvazzano – Padova – ITALY

Documento Nr. / Mese.Anno:
Document-No. / Month.Year : **5040 / 05.2017**

Si dichiara con la presente, in qualità di produttore e sotto la propria responsabilità esclusiva, che i seguenti prodotti sono conformi ai requisiti di protezione definiti nelle direttive del Consiglio Europeo:
We declare as manufacturer herewith under our sole responsibility that the following products are in compliance with the protection requirements defined in the European Council directives:

Codice prodotto:
Product identifier : **HD32.3**

Descrizione prodotto:
Product description : **Analizzatore degli indici microclimatici WBGT, PMV e PPD**
WBGT, PMV and PPD microclimatic indices analyzer

I prodotti sono conformi alle seguenti Direttive Europee:
The products conform to following European Directives:

Direttive / *Directives*	
2014/30/EU	Direttiva EMC / *EMC Directive*
2014/35/EU	Direttiva bassa tensione / *Low Voltage Directive*
2011/65/EU	RoHS / *RoHS*

Norme armonizzate applicate o riferimento a specifiche tecniche:
Applied harmonized standards or mentioned technical specifications:

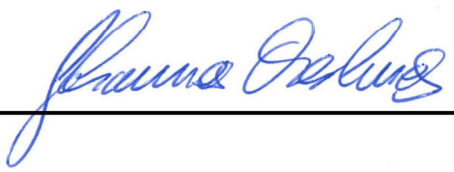
Norme armonizzate / *Harmonized standards*	
EN 61010-1:2010	Requisiti di sicurezza elettrica / *Electrical safety requirements*
EN 61326-1:2013	Requisiti EMC / *EMC requirements*
EN 50581:2012	RoHS / *RoHS*

Il produttore è responsabile per la dichiarazione rilasciata da:
The manufacturer is responsible for the declaration released by:

Johannes Overhues

Amministratore delegato
Chief Executive Officer

Caselle di Selvazzano, 23/05/2017



Questa dichiarazione certifica l'accordo con la legislazione armonizzata menzionata, non costituisce tuttavia garanzia delle caratteristiche.
This declaration certifies the agreement with the harmonization legislation mentioned, contained however no warranty of characteristics.

GUARANTEE

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TERMS OF GUARANTEE

All DELTA OHM instruments are subject to accurate testing, and are guaranteed for 24 months from the date of purchase. DELTA OHM will repair or replace free of charge the parts that, within the warranty period, shall be deemed non efficient according to its own judgement. Complete replacement is excluded and no damage claims are accepted. The DELTA OHM guarantee only covers instrument repair. The guarantee is void in case of incidental breakage during transport, negligence, misuse, connection to a different voltage than that required for the appliance by the operator. Finally, a product repaired or tampered by unauthorized third parties is excluded from the guarantee. The instrument shall be returned FREE OF SHIPMENT CHARGES to your dealer. The jurisdiction of Padua applies in any dispute.

The electrical and electronic equipment marked with this symbol cannot be disposed of in public landfills. According to the Directive 2011/65/EU, the european users of electrical and electronic equipment can return it to the dealer or manufacturer upon purchase of a new one. The illegal disposal of electrical and electronic equipment is punished with an administrative fine.

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

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

Instrument Code: HD32.3

Serial Number _____

RENEWALS

Date _____	Date _____
Inspector _____	Inspector _____
Date _____	Date _____
Inspector _____	Inspector _____
Date _____	Date _____
Inspector _____	Inspector _____

CE

RoHS 2011/65/EU

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