

Operating manual

WBGT – PMV – PPD indices

HD32.3



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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 **T_g** with **TP3276.2** or **TP3275** probe.
- Wet bulb temperature with natural ventilation **T_n** with **HP3201.2**, **HP3201** or **TP3204S** probe.
- Ambient temperature **T** with **TP3207.2** or **TP3207** probe.
- Relative Humidity **RH** and ambient temperature **T** with **HP3217.2R** or **HP3217R** probe.
- Air speed **V_a** 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 **HP3217.2R** (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_r , 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 t_{nw} with the Glob thermometer t_g and, in some situations, with the air temperature 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 micro-climate 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/m²): 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 m² 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 neckline, 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

	clo	m ² K/W
Jerseys - blouses		
Short-sleeve shirt	0,15	0,023
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/m²)
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
Agriculture	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/m²
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

Activity	W/m²
Strain the concrete for foundations	275
Compact the concrete to vibrate	220
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 cm ² per double stroke	415
40 double strokes / min, 20 cm ² 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 – Agriculture	
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

Activity	W/m ²
Fertilizing a field	
Sowing by hand	280
Seeding with spreaders pulled by horses	250
Seeding with tractor	95
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.
- HP3217.2R 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 t_r

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**:

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

- In case of **forced convection**:

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

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 $\epsilon_g = 0.95$ (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**
- **HP3217.2R 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**:

■■■ WBGT Index	
2008/11/28 08:00:00	
Log 00	00:00:00
Tn	15.6 °C
Tg	20.2 °C
T	20.2 °C
WBGT(in) 17.0 °C	
WBGT(out) 17.0 °C	

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**:

■■■ PMV Index	
2008/11/28 08:00:00	
Log 00	00:00:00
Va	0.00 m/s
Tg	22.0 °C
T	22.0 °C
Tr	22.0 °C
RH	39.1 %
MET	1.20 CLO 1.00
PMV	0.1 PPD 5.1 %

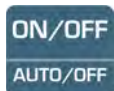
The visualized sizes are:

- 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.

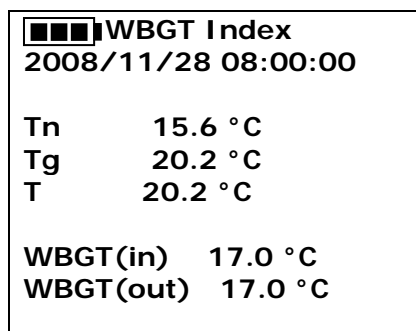
If you insert more probes of the same type, it will be only consider the first recognized probe: the scansion of the probes, for their recognition, happens from the inlet 1 up the inlet 3.

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:

■■■ PMV Index	
2008/11/28 08:00:00	
Va	0.00 m/s
Tg	22.0 °C
T	22.0 °C
Tr	22.0 °C
RH	39.1 %
MET	1.20 CLO 1.00
PMV	0.10 PPD 5.10%

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.*

	<i>NOTES</i>
=====	
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.

```

=====
      ISO 7730  PMV Index
=====
Model HD32.3 WBGT - PMV
Firm.Ver.=01.00
Firm.Date=2008/12/05
SN=12345678
ID=0000000000000000
-----
Probe ch.1 description
Type: Hot wire
Data cal.:2008/10/15
Serial N.:08109460
-----
Probe ch.2 description
Type: Pt100 Tg 50
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
Va          0.00 m/s
Tg          22.0 °C
Ta          22.0 °C
RH          39.1 %
MET         1.20
CLO         1.00
PMV         0.10
PPD         5.10 %

=====
Notes:

=====

```

NOTES

```

Reference regulation

Instrument model
Instrument firmware version
Instrument firmware date
Instrument serial number
Identification code

Description of the probe connected to the inlet 1

Description of the probe connected to the inlet 2

Date and Hour
Air speed
Globe thermometer Temperature
Wet bulb temperature
Relative Humidity
Metabolic rate
Cloth resistance
PMV - Predicted Mean Vote
PPD - Predicted Percentage of Dissatisfied

```

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:

```
■■■■
2008/11/10 08:00:00
MAIN MENU
Info
Logging
Serial
Reset
Contrast
Setup PMV
<ESC> exit/cancel
```

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**.

```
■■■■
2008/11/10 08:00:00
INFO
Info Instrument
Info Probe
Time/Date

<UP> <DOWN> select
<ENTER> confirm
<ESC> exit/cancel
```

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

```
■■■■
2008/11/10 08:00:00
INFO INSTRUMENT
Model HD32.3
Firm.Ver.=01.00
Firm.Date=2008/06/30
Ser. Number=08010000
Calib: 2008/11/10

ID: 0000000000000000
```

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 PROBE
Ch.1:Pt100Tg_50
Cal=2008/06/20
SN=08018422
Ch.2:Pt100
Cal=2008/06/21
SN=08018423
Ch.3:Pt100Tw
Cal=2008/06/20
SN=08018424
```

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 message will be visualized

```
■■■■
2008/11/10 08:00:00
enter date/time
<- arrows change ->
<ENTER> confirm
and set 00 seconds !
year/mm/dd hh:mm
2008/11/28 11:10:26
```

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.

```

■■■■ WBGT Index
2008/11/10 08:00:00
LOGGING MENU
Log interval
Self shut_off mode
Start/stop time
Cancel auto start
Log file manager
<ESC> exit/cancel
    
```

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 (previous paragraph), select **Log Interval** heading using **▲ ▼** arrow keys:

```

■■■■ WBGT Index
2008/11/10 08:00:00
LOGGING MENU
input LOG interval
as h:mm:ss (1h max)
arrows to correct
or <ESC> now set at:
0:00:15
    
```

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 you can 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:

```
■■■■ WBGT Index
2008/11/10 08:00:00
Log interval < 60 sec
During log session
the instrument
will STAY ON
between samples
```

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

```
■■■■ WBGT Index
2008/11/10 08:00:00
Log interval >= 60 sec
During log session
the instrument
will SHUT OFF
between samples
```

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 in-

creased 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" message will be visualized as indicated below:

```
■■■■ WBGT Index
2008/11/10 08:00:00
enter start time
arrows to correct
<ENTER> confirm
default = 5m > RealTime

2008/11/28 10:29:00
```

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:

```
■■■■ WBGT Index
2008/11/10 08:00:00
enter stop time
arrows to correct
<ENTER> confirm
default = 10m > RealTime

2008/11/28 10:39:00
```

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 acquisition 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.

```

■■■■ WBGT Index
2008/11/10 08:00:00
<ENTER> confirm
Start time
2008/11/28 10:29:00
End time
2008/11/28 10:39:00

<ESC> exit/cancel

```

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 acquisition 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 avoid 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:

```

■■■■ WBGT Index
2008/11/10 08:00:00
Self-timer abort
Start scheduled at
2008/11/28 10:29:00
Stop scheduled at
2008/11/28 10:39:00
Press ARROW to
delete schedule

```

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

```

■■■■ WBGT Index
2008/11/10 08:00:00

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.

```

LOG FILE      0/3
00 - 01 - 02 - 03
04 - 05 - 06 - 07
08 - 09 - 10 - 11
12 - 13 - 14 - 15
Date:
2008/11/28 08:59:40
rec: 000039

<MEM> to charge Page
  
```

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

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

```

■■■■ WBGT Index
2008/11/10 08:00:00
LOG FILE MANAGER
Print selected log
Erase ALL logs
Log time
  
```

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.

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

WBGT Index

NOTES

```

Log number: 1
=====
  ISO 7243 WBGT Index
=====
Model HD32.3 WBGT – PMV
Firm.Ver.=01.00
Firm.Date=2008/12/05
SN=12345678
ID=0000000000000000
-----
Probe ch.1 description
Type: Pt100
Data cal.:2008/10/01
Serial N.:08109450
-----
Probe ch.2 description
Type: Pt100 Tg 50
Data cal.:2008/10/01
Serial N.:08109452
-----
Probe ch.3 description
Type: Pt100 Tw
Data cal.:2008/10/01
Serial N.:08109454
=====
From=2008/11/21 15:00:00
To =2008/11/21 16:30:00
Tot. rec.= 000360

**   max value   **
Tnw      21.2 °C

Tg       24.9 °C
Ta       31.3 °C
WBGT (i) 22.3 °C
WBGT (o) 23.0 °C

**   min value   **
Tnw      21.0 °C
Tg       24.9 °C
Ta       23.5 °C
WBGT (i) 22.2 °C
WBGT (o) 22.6 °C

**   avg value   **
Tnw      21.1 °C
Tg       24.9 °C
Ta       30.3 °C
WBGT (i) 22.3 °C
WBGT (o) 22.8 °C
=====
Notes:

=====
    
```

```

Number of logging sections

Reference rules

Instrument model
Version of the instrument firmware
Date of the instrument firmware
Instrument serial number
Identification code

Description of the probe connected to the inlet  1

Description of the probe connected to the inlet  2

Description of the probe connected to the inlet  3

Logging start day and hour
Logging end day and hour
Number of samples acquired by the instrument

Maximum value of the acquired data
Maximum temperature of wet bulb with natural ventilation
Maximum temperature of globe thermometer
Maximum temperature of wet bulb
Maximum WBGT in absence of direct solar irradiation
Maximum WBGT in presence of direct solar irradiation
Maximum value of the acquired data

Minimum value of the acquired data
Minimum temperature of wet bulb with natural ventilation
Minimum temperature of globe thermometer
Minimum temperature of wet bulb
Minimum WBGT in absence of direct solar irradiation
Minimum WBGT in presence of direct solar irradiation

Medium value of the acquired data
Medium temperature of wet bulb with natural ventilation
Medium temperature of globe thermometer
Medium temperature of wet bulb
Medium WBGT in absence of direct solar irradiation
Medium WBGT in presence of direct solar irradiation
    
```

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
=====
  ISO 7243 PMV Index
=====
Model HD32.3 WBGT - PMV
Firm.Ver.=01.00
Firm.Date=2008/12/05
SN=12345678
ID=0000000000000000
-----
Probe ch.1 description
Type: Hot wire
Data cal.:2008/10/01
Serial N.:08109450
-----
Probe ch.2 description
Type: Pt100 Tg 50
Data cal.:2008/10/01
Serial N.:08109452
-----
Probe ch.3 description
Type: RH
Data cal.:2008/10/01
Serial N.:08109454
=====
From=2008/11/21 15:00:00
To =2008/11/21 16:30:00
Tot. rec.= 000360

MET          1.20
CLO          1.00

**      max value      **
Va          0.00 m/s
Tg          22.0 °C
Ta          22.0 °C
RH          39.1 %
PMV         0.10
PPD         5.10 %

**      min value      **
Va          0.00 m/s
Tg          22.0 °C
Ta          22.0 °C
RH          39.1 %
PMV         0.10
PPD         5.10 %

**      avg value      **
Va          0.00 m/s
Tg          22.0 °C
Ta          22.0 °C
RH          39.1 %
PMV         0.10
PPD         5.10 %

=====
Notes:

=====

```

```

Number of logging sections

Reference rules

Instrument model
Version of the instrument firmware
Date of the instrument firmware
Instrument serial number
Identification code

Description of the probe connected to the inlet 1

Description of the probe connected to the inlet 2

Description of the probe connected to the inlet 3

Logging start day and hour
Logging end day and hour
Number of samples acquired by the instrument

Metabolic rate
Cloth resistance

Maximum value of the acquired data
Air speed
Globe Thermometer temperature
Wet bulb temperature
Relative humidity
PMV – Predicted Mean Vote
PPD – Predicted Percentage of Dissatisfied

Minimum value of the acquired data
Air speed
Globe Thermometer temperature
Wet bulb temperature
Relative humidity
PMV – Predicted Mean Vote
PPD – Predicted Percentage of Dissatisfied

Medium value of the acquired data
Air speed
Globe Thermometer temperature
Wet bulb temperature
Relative humidity
PMV – Predicted Mean Vote
PPD – Predicted Percentage of Dissatisfied

```

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:

```
LOG FILE      0/3
00 - 01 - 02 - 03
04 - 05 - 06 - 07
08 - 09 - 10 - 11
12 - 13 - 14 - 15
Date:
2008/11/28 08:59:40
rec: 000039

<MEM> to charge Page
```

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**" message will be visualized:

```
■■■■ WBGT Index
2008/11/10 08:00:00
ERASE ALL FILE

<MEM> confirm
<Esc> exit
```

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.

```
■■■■ WBGT Index
2008/11/10 08:00:00
LOG TIME
as h:mm:ss (1h max)
arrows to correct
or <ESC> now set at:
00:00:00
```

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.

```
■■■■ WBGT Index
2008/11/10 08:00:00
SERIAL COM MENU
Baudrate
Print Interval

<UP> <DOWN> select
<ENTER> confirm
<ESC> exit/cancel
```

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:

```
■■■■ WBGT Index
2008/11/10 08:00:00

set Baudrate
arrows to correct
Or <ESC> now set at:
38.400
```

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;

```
■■■■ WBGT Index
2008/11/10 08:00:00
SERIAL COM MENU
input PRINT interval
as h:mm:ss (1h max)
arrows to correct
or <ESC> now set at:
0:00:00
```

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 message will be visualized:

```
■■■■ WBGT Index
2008/11/10 08:00:00

0)Reset

<Up-Down>: select
<Enter>: confirm
```

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:

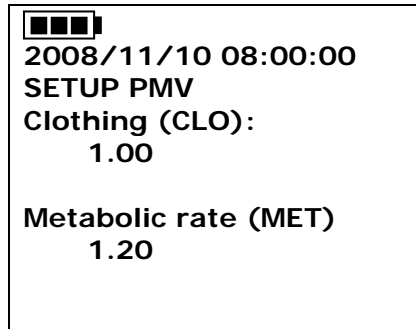
1. Press **MENU** key of the instrument;
2. Use ▲▼ arrow keys to select **Contrast.**;
3. Press **ENTER**;
4. The following message will be visualized.

```
■■■■ WBGT Index
2008/11/10 08:00:00
LCD CONTRAST
<- arrows change ->
<ESC> exit/cancel
Contrast Adjust: 012
```

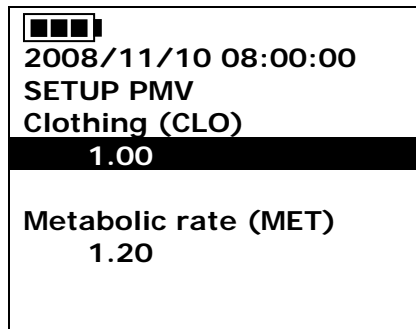
5. use ◀▶ arrow key to decrease or increase the contrast;
6. press **ENTER** or **ESC** to go back to the main menu;
7. press **MENU** to exit immediately from the main menu.

5.6 SETUP PMV

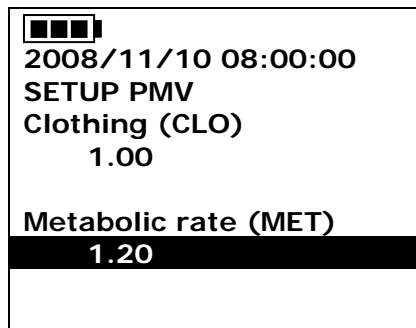
Setup PMV allows setting the Thermal Resistance of the clothing, expressed in CLO and the metabolic rate, expressed in MET. For values to set, see the paragraph 2.1.2. *Predicted Mean Vote PMV and Predicted Percentage of Dissatisfied PPD.*



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 ▼▲ change the value and confirm with ENTER key.

6. PROBES PREPARATION AND MAINTENANCE

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



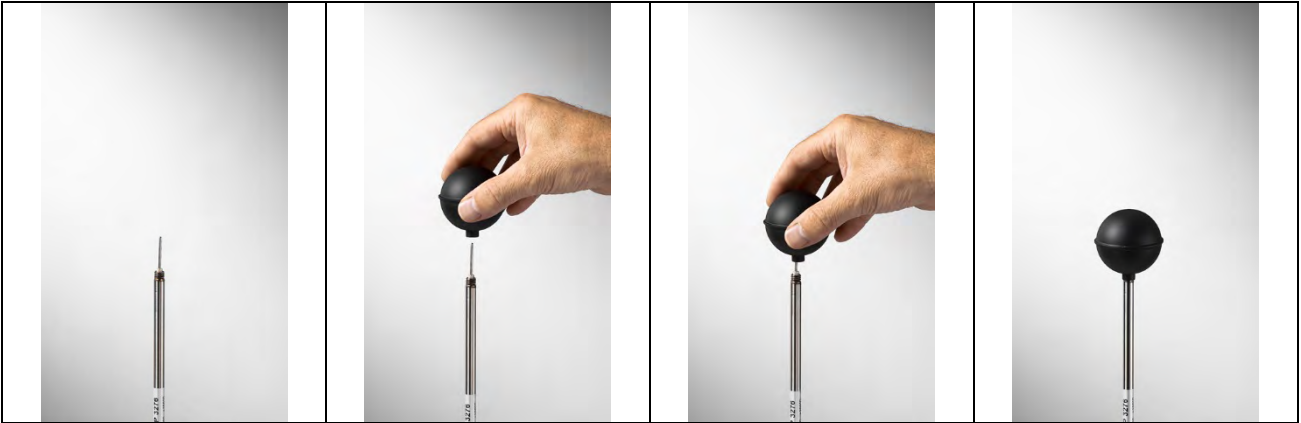
Necessary **probes** for **PMV** measurement are:



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

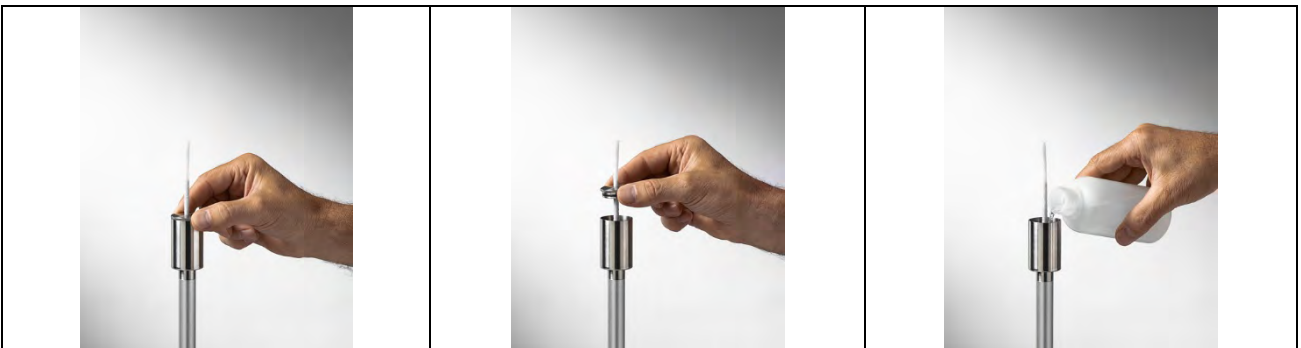
TP3575 and TP3276.2 globe thermometer probes

Screw the globe to probe stem.



HP3201.2 and HP3201 natural ventilation wet bulb probes

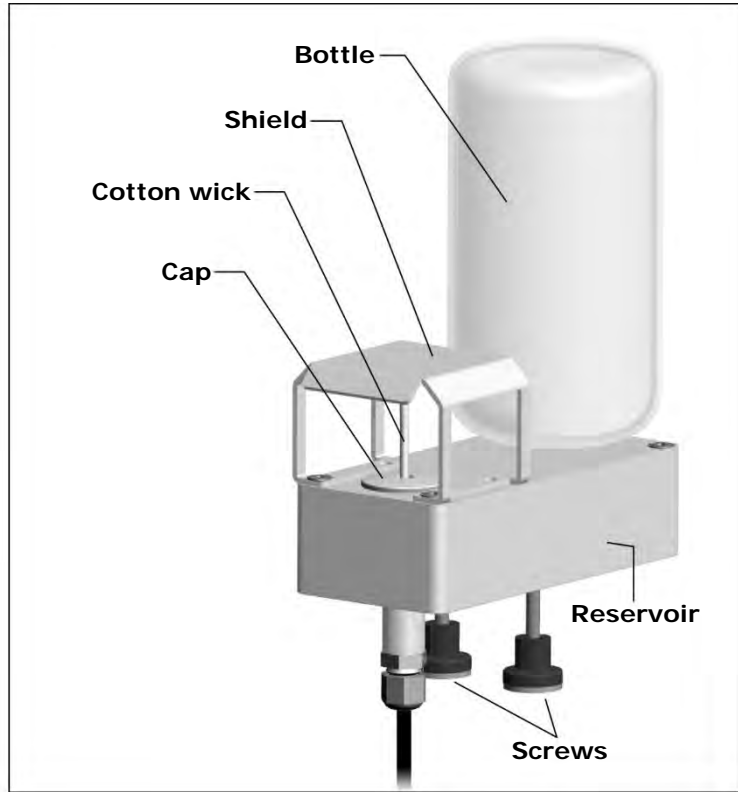
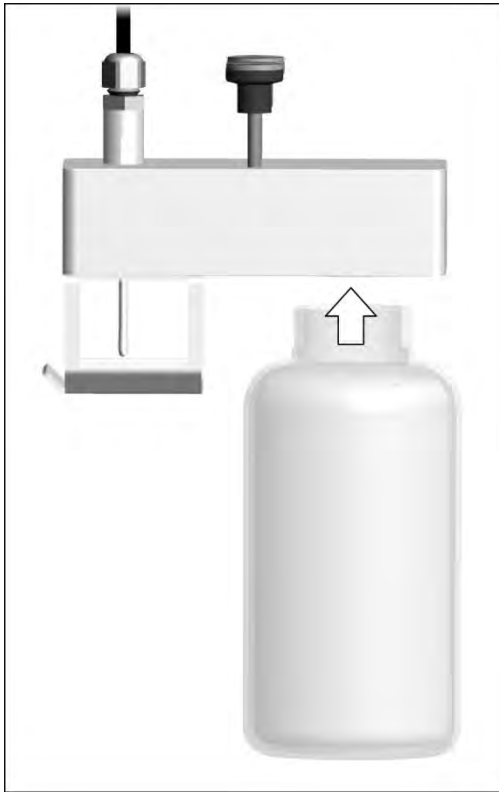
- Remove the sensor cap (the cap is not screwed).
- Insert the cotton wick, previously dipped with distilled water, into the temperature probe. The cotton wick must protrude from the probe for about 20 mm.
- Fill the reservoir up till $\frac{3}{4}$ with **distilled water**.
- Replace the cap.
- **Warning:** keep the probe vertical to prevent water from leaking.



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

TP3204S natural ventilation wet bulb probe

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



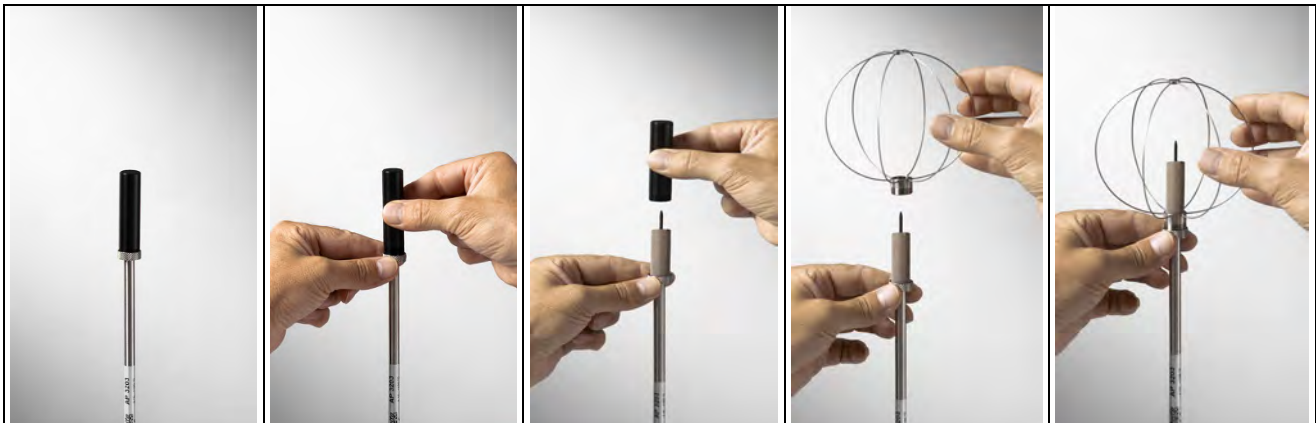
For measurements in presence of solar irradiation, use the protection shield from solar radiations.
 Note: over time the cotton wick tends to calcify (harden): it must be replaced periodically.

HP3217R and HP3217.2R combined relative humidity and temperature probes

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

AP3203 and AP3203.2 omnidirectional hot wire air speed probes

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





- The sensor of AP3203 and AP3203.2 probes is heated. **In case of vapours or gases, a fire or an explosion could be triggered. Do not use the probe in the presence of flammable gases. Make sure that in the environment where the measurement are made there are no gas leaks or potentially explosive vapours.**

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

General warnings



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

- Do not expose the probes to gas or liquids that could corrode the probe material. After the measurement, clean accurately the probes.
- Respect the correct probes polarity.
- When inserting the probes connector into the instrument, do not fold or force the contacts.
- Do not bend, deform or drop the probes: they can be irreparably damaged.
- Use the probes suitable for the type of measurement to be performed.
- For a reliable measurement, avoid too rapid temperature variations.
- Avoid measuring in presence of high-frequency sources, microwave or high magnetic fields,

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=WBG 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
C2		Probe 2 type, serial number, calibration date

Command	Response	Description
C3		Probe 3 type, serial number, calibration date
GC		Print instrument's heading
GB	ID=0000000000000000	User code (set with T2xxxxxxxxxxxxxxxxxx)
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 WBGT (without solar radiation)
H8	WBGT(o)= 24.0 øC	Print outdoor WBGT (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 (just one print), 15, 30 seconds, 1, 2, 5, 10, 15, 20, 30 minutes and 1 hour.
WL#	&	Setting LOG interval. # is a hexadecimal number 1..D that represents the position of the interval in the list 15, 30 seconds, 1,2, 5, 10, 15, 20, 30 minutes and 1 hour.

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 instant, 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.

8. 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.

9. 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.

9.1 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.

10. 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

Warm environments

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

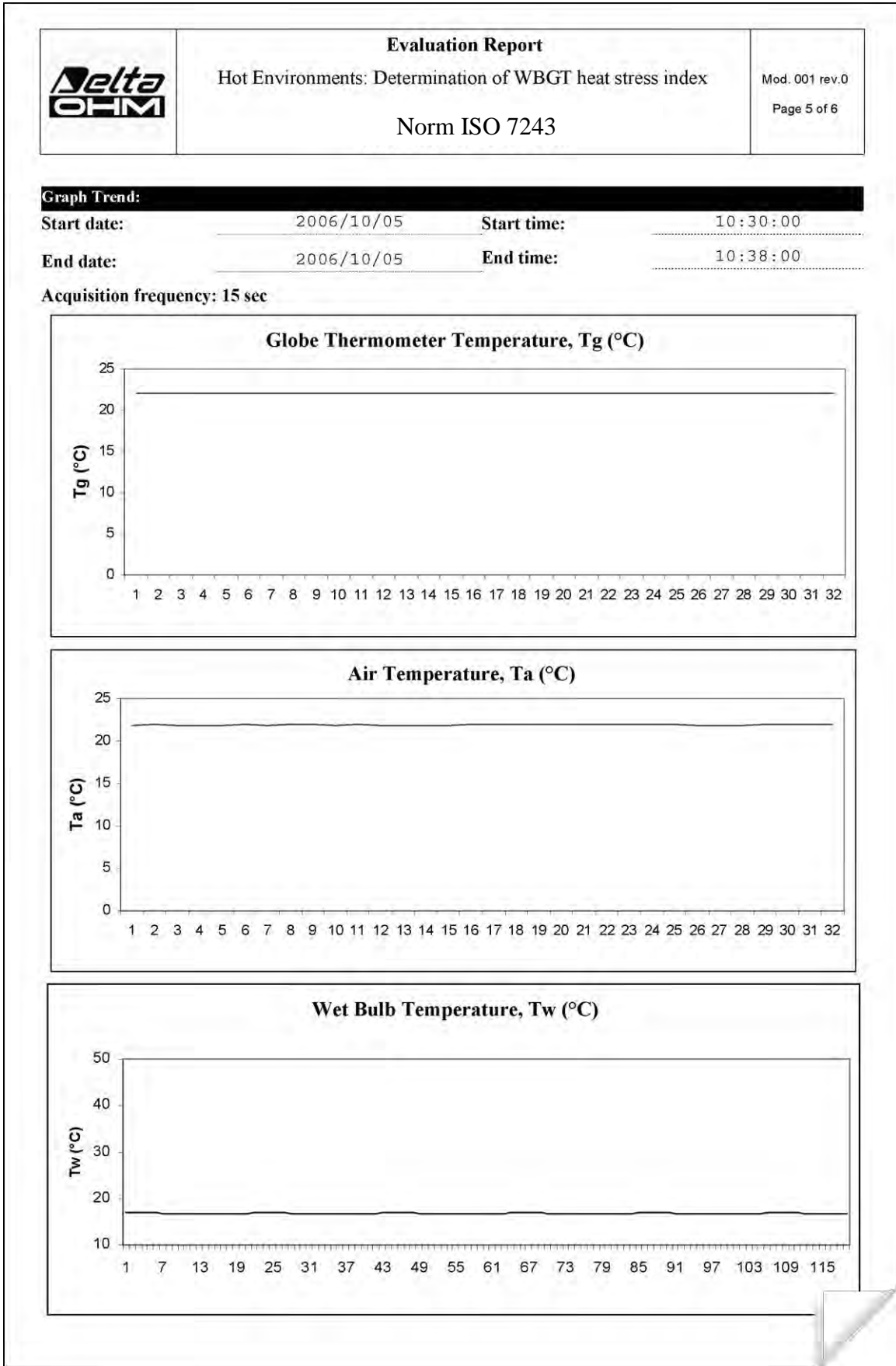
Written		Checked and Approved	
Date	Signature	Date	Signature

	<p style="text-align: center;">Evaluation Report Hot Environments: Determination of WBGT heat stress index Norm ISO 7243</p>	<p style="text-align: right;">Mod. 001 rev.0 Page 3 of 6</p>
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

	<p style="text-align: center;">Evaluation Report Hot Environments: Determination of WBGT heat stress index Norm ISO 7243</p>	<p style="text-align: right;">Mod. 001 rev.0 Page 4 of 6</p>
Description of the observation location:		
<p>Very Hot Environment Indoor, without solar radiation Person acclimatized to heat The worker being observed has an average size body</p>		
Description of clothing:		
<p>Daily Clothing: Intimate underwear and lingerie, short-sleeved vest/top, blouse, trousers, jacket, ankle socks, shoes</p>		
<u>1.5 clo</u>		
Description of activity:		
<p>Type of Job: Sedentary activity (office, home, school, laboratory)</p>		
<u>70 W/m2</u>		

Warm environments



Warm environments

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

	<p>Evaluation Report</p> <p>Moderate Environments: Determination of the thermal well-being by calculating PMV and PPD indices</p> <p>Norm ISO 7730</p>	<p>Mod. 001 rev.0</p> <p>Page 2 of 7</p>													
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														
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E-mail:	deltaohm@tin.it														
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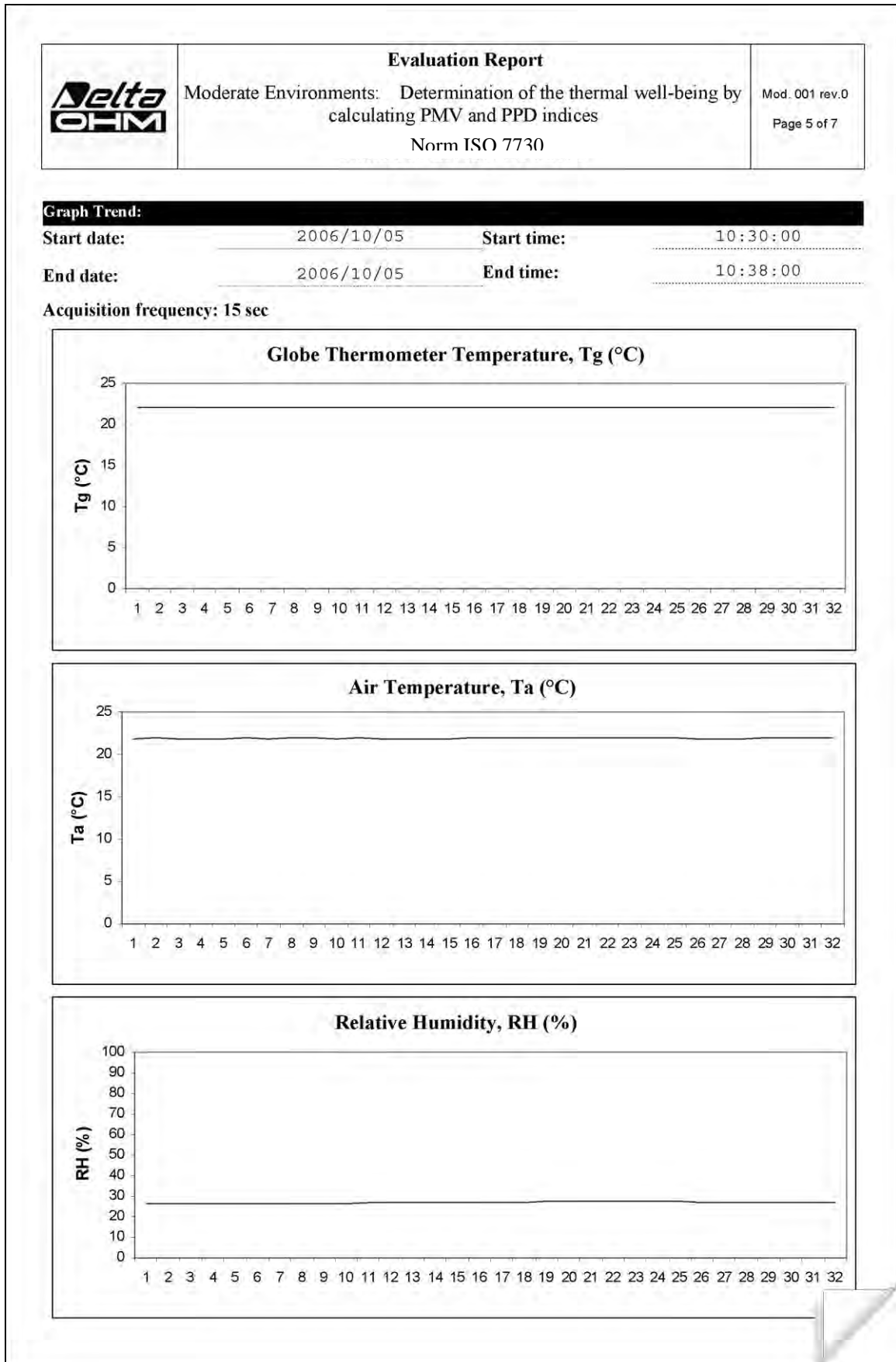
Moderate environments

	Evaluation Report 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	

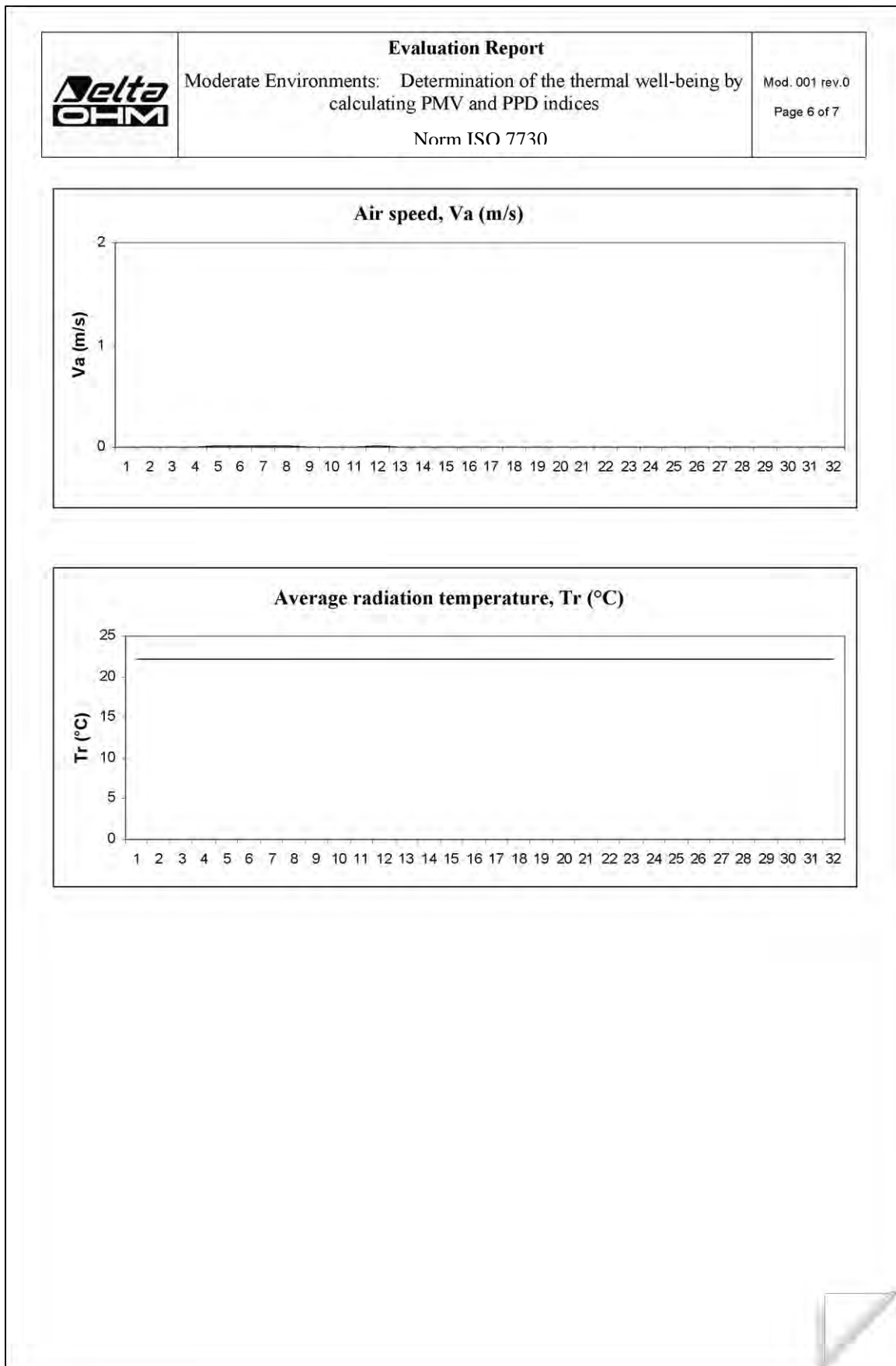
Moderate environments

	Evaluation Report 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



Moderate environments



Moderate environments

	Evaluation Report Moderate Environments: Determination of the thermal well-being by calculating PMV and PPD indices	Mod. 001 rev.0 Page 7 of 7
	Norm ISO 7730	
Measurements:		
Globe Thermometer Temperature, T _g (°C)	22	
Wet Bulb Temperature, T _w (°C)	21.8	
Air Temperature, T _a (°C)	22	
Overall result:		
Predicted Mean Vote PMV	-0.7	
Predicted Percentage of Dissatisfied - PPD	14.7	

11. 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

12. 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.

13. TECHNICAL CHARACTERISTICS

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
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 15 m
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
Safety of the memorized data	unlimited
Logging interval	Configurable from 1 second to 1 hour
Storage capacity	8 GB
Display	Dot matrix with backlight 160x160 points, visible area 52x42mm
Uncertainty	± 1 digit @ 20 °C
Operating conditions	-5...50 °C, 0...90 %RH no condensation
Storage Temperature	-25...65 °C
Materials	ABS, rubber
Dimensions	185 x 90 x 40 mm (Length x Width x Height)
Weight	470 g (complete of batteries)
Degree of protection	IP 64

TP3275 AND TP3276.2 TEMPERATURE PROBES

Sensor	Pt100
Measuring range:	-30...120 °C
Resolution:	0.1 °C
Accuracy:	1/3 DIN
Temperature drift @ 20 °C	0.003 %/°C
Long term stability	0.1 °C/year
Connection	8-pole female DIN45326 connector Cable L=2 m (only TP3275)
Globe dimensions	Ø=150 mm (TP3275), Ø=50 mm (TP3276.2)
Stem dimensions	Ø=14 mm, L=110 mm (TP3275) Ø=8 mm, L=170 mm (TP3276.2)
Response time T₉₅ (*)	15 minutes

TP3207 AND TP3207.2 TEMPERATURE PROBES

Sensor	Pt100
Measuring range:	-40...100 °C
Resolution:	0.1 °C
Accuracy:	1/3 DIN
Temperature drift @ 20 °C	0.003 %/°C
Long term stability	0.1 °C/year
Connection	8-pole female DIN45326 connector Cable L=2 m (only TP3207)
Dimensions	Ø=14 mm, L=140 mm (TP3207), L=150 mm (TP3207.2)
Response time T₉₅ (*)	15 minutes

HP3201 AND HP3201.2 NATURAL VENTILATION WET BULB PROBES

Sensor	Pt100
Measuring range:	4...80 °C
Resolution:	0.1 °C
Accuracy:	Class A
Temperature drift @ 20 °C	0.003 %/°C
Long term stability	0.1 °C/year
Connection	8-pole female DIN45326 connector Cable L=2 m (only HP3201)
Stem dimensions	Ø=14 mm, L=110 mm (HP3201), L=170 mm (HP3201.2)
Cotton wick length	10 cm approx.
Reservoir	Capacity 15 cc, autonomy 96 hours @ RH=50% and t=23 °C
Response time T₉₅ (*)	15 minutes

TP3204S NATURAL VENTILATION WET BULB PROBE

Sensor	Pt100
Measuring range:	4...80 °C
Resolution:	0.1 °C
Accuracy:	Class A
Temperature drift @ 20 °C	0.003 %/°C
Long term stability	0.1 °C/year
Connection	8-pole female DIN45326 connector, cable L=2 m
Dimensions	L x W x H = 140 x 65 x 178,5 mm (reservoir + bottle)
Cotton wick length	10 cm approx.
Reservoir	Capacity 500 cc, autonomy 15 days @ t=40 °C
Response time T₉₅ (*)	15 minutes

HP3217R AND **HP3217.2R** TEMPERATURE AND RELATIVE HUMIDITY COMBINED PROBES

Sensor	Temperature: Pt100 - R.H.: capacitive
Measuring range:	Temperature: -40...100 °C - R.H.: 0...100%
Resolution:	0.1 °C / 0.1 %RH
Accuracy:	Temperature: 1/3 DIN R.H.: ±1.5% (0...90%RH) / ±2% (90...100%RH) @ T=15...35 °C (1.5 + 1.5% measure)% @ T= remaining range
Temperature drift @ 20 °C	0.02 %RH/°C
Long term stability	0.1 %RH/year
Connection	8-pole female DIN45326 connector Cable L=2 m (only HP3217R)
Dimensions	Ø=14 mm, L=150 mm
Response time T₉₅ (*)	15 minutes

AP3203 AND **AP3203.2** OMNIDIRECTIONAL HOT WIRE AIR SPEED PROBES

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

(*) The response time T₉₅ is the time needed to reach 95% of the final value. The measurement of the response time is done with a negligible air speed (motionless air).

15. ORDERING CODES

- HD32.3** Thermal microclimate to measure the WBGT Index, PMV Index and PPD. 3 inputs for probes with SICRAM module, graphic display. Includes DeltaLog 10 software (with analysis of WBGT, PMV and PPD indices) downloadable from Delta OHM website. The kit is composed of instrument, four AA 1.5 V batteries, instruction manual. **The probes and cables have to be ordered separately.**

Probes with SICRAM module for the measurement of microclimatic indices

The probes necessary for **WBGT** index measurement are:

- Dry bulb temperature probe, one of the following:
 - **TP3207.2** Ø 14mm, L=150 mm.
 - **TP3207** Ø 14mm, L=140 mm. Cable 2 m.
- Globe thermometer probe, one of the following:
 - **TP3276.2** Globe Ø 50 mm. Stem Ø 8 mm, L=170 mm.
 - **TP3275** Globe Ø 150 mm. Stem Ø 14 mm, L=110 mm. Cable 2 m.
- Natural ventilation wet bulb temperature probe, one of the following:
 - **HP3201.2** Stem Ø 14 mm, L=170 mm.
 - **HP3201** Stem Ø 14 mm, L=110 mm. Cable 2 m.
 - **TP3204S** For long-lasting measurements. 500 cc distilled water capacity. Cable 2 m.

The probes necessary for **PMV/PPD** indices measurement are:

- Temperature and relative humidity combined probe, one of the following:
 - **HP3217.2R** Stem Ø 14 mm, L=150mm.
 - **HP3217R** Stem Ø 14 mm, L=110mm. Cable 2 m.
- Omnidirectional hot wire air speed probe, one of the following:
 - **AP3203.2** Stem Ø 8 mm, L=230 mm.
 - **AP3203** Stem Ø 8 mm, L=230 mm. Cable 2 m.
- Globe thermometer probe, one of the following:
 - **TP3276.2** Globe Ø 50 mm. Stem Ø 8 mm, L=170 mm.
 - **TP3275** Globe Ø 150 mm. Stem Ø 14 mm, L=110 mm. Cable 2 m.

Accessories

VTRAP30	Tripod, maximum height 280 mm.
VTRAP32.2A.3A	Tripod for measurements with probes with cable.
HD32.2.7.1	Probes support to be fixed to the VTRAP32.2A.3A tripod.
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	100-240 Vac/12 Vdc-1 A stabilized mains power supply.
AQC	200 cc 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.

NOTES

WARRANTY

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

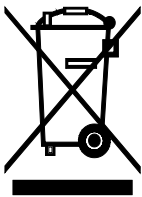
The manufacturer repairs the products that show defects of construction in accordance with the terms and conditions of warranty included in the manual of the product. For any dispute, the competent court is the Court of Padua. The Italian law and the "Convention on Contracts for the International Sales of Goods" apply.

TECHNICAL INFORMATION

The quality level of our instruments is the result of the continuous product development. This may lead to differences between the information reported in the manual and the instrument you have purchased.

We reserves the right to change technical specifications and dimensions to fit the product requirements without prior notice.

DISPOSAL INFORMATION



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

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

CE RoHS

