

MICROCLIMATE ANALYSIS

HD 32.1 THERMAL MICROCLIMATE instrument is manufactured by Delta Ohm Srl and it allows studying, measuring and controlling the Microclimate in the workplace, in compliance with the following standards:

UNI EN ISO 7726: Ergonomics of the thermal environment

- Instruments for measuring physical quantities.

UNI EN ISO 7730: Moderate Thermal Environments

- Determination of the PMV and PPD indices and specification of the condition for thermal comfort.

UNI EN ISO 27243: Hot environments. Estimation of the heat stress on working man, based on the WBGT Index (Wet bulb Globe temperature).

UNI EN ISO 7933: Ergonomics of the thermal environment

- Analytical determination and interpretation of heat stress using calculation of the predicted heat strain.

UNI ENV ISO 11079: Evaluation of cold environments

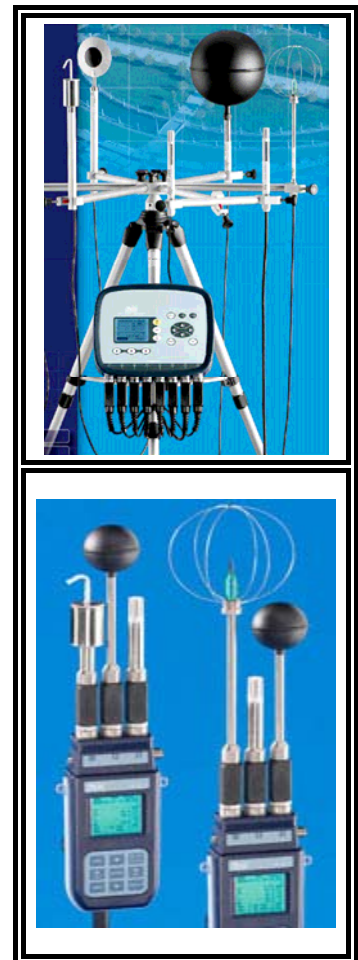
- Determination of required clothing insulation (IREQ).

UNI EN ISO 8996: Ergonomics of the thermal environment

- Determination of metabolic rate.

HD32.2 Datalogger for measuring the WBGT index in moderate environments.

HD32.3 Datalogger for measuring the WBGT index in very hot, and the PMV and PPD indices in moderate environments.





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HD 32.1 THERMAL MICROCLIMATE INSTRUMENT FOR STUDYING, MEASURING AND CONTROLLING THE MICROCLIMATE



The Thermal Microclimate **HD32.1** instrument is manufactured by Delta Ohm Srl and it allows studying, measuring and controlling the Microclimate in the workplace, in compliance with the following standards:

UNI EN ISO 7726: Ergonomics of the thermal environment
- Instruments for measuring physical quantities.

UNI EN ISO 7730: Moderate Thermal Environments - Determination of the PMV and PPD indices and specification of the condition for thermal comfort.

UNI EN ISO 27243: Hot environments. Estimation of the heat stress on working man, based on the WBGT Index (Wet bulb Globe temperature).

UNI EN ISO 7933: Ergonomics of the thermal environment
- Analytical determination and interpretation of heat stress using calculation of the predicted heat strain.

UNI ENV ISO 11079: Evaluation of cold environments - Determination of required clothing insulation (IREQ).

UNI EN ISO 8996: Ergonomics of the thermal environment
- Determination of metabolic rate.

Thanks to specific software:

**Moderate Environments,
Hot environments,**

Cold environments and Discomfort,

as well as specific probes, the instrument can perform the following measurements:

- Globe temperature
- Natural wet bulb temperature
- Ambient temperature
- Atmospheric pressure
- Relative Humidity
- Air velocity
- Air temperature at the height of the head (1,7m subject standing; 1,1m subject sitting).
- Air temperature at the height of the abdomen (1,1 m subject standing; 0,6m subject sitting).
- Air temperature at the height of the ankles (0,1 m).
- Temperature at the floor level.
- Net radiation temperature.
- Net radiation.
- Radiant temperature asymmetry.
- Illuminance, luminance, PAR, irradiance.

According to measurements performed, HD32.1, together with its software, calculates the following parameters:

- t_r : Mean radiant temperature
- **PMV** : Predicted Mean Vote
- **PPD** : Predicted Percentage Dissatisfied
- **DR** : Draught Rating
- t_o : Operative temperature
- t_{eq} : Equivalent temperature
- **WBGT_{Indoor}** : Wet bulb Globe temperature
- **WBGT_{Outdoor}** : Wet bulb Globe temperature in the presence of radiation
- **SW_p** : Sweat rate
- E_p : Predicted evaporative heat flow
- **PHS** : Tre - Water loss - Dlimtre - Dlimloss95
- **IREQ** : Required clothing insulation
- **DLE** : Duration Limit Exposure
- **RT** : Recovery time
- **WCI** : Wind chill index

- **PD_v** : Percentage Dissatisfied due to vertical temperature difference (head-ankles)
- **PD_f** : Percentage Dissatisfied due to floor temperature
- **PD_Δ** : Percentage Dissatisfied due to radiant asymmetry

To calculate the following indices is necessary to measure RH and air temperature and insert the measured values of the tables "Index of discomfort"

- **IS** : Scharlau index
- **DI** : Tom index
- **THI** : Thermohygrometric Index
- **RSI** : Relative Strain Index
- **SSI** : New Summer Simmer Index
- **HI** : Hot index
- **H** : Humidex index
- **Teq** : Equivalent Temperature index

For the calculation of the FLD is necessary to measure light (luxmeter Sonda LP PHOT 471).

You need the program "HD32.1 prog.C"

- **FLD** : Average daylight factor



Three operating programs are already uploaded on the instrument and they can be used according to the analysis:

HD32.1 A operating program: Analysis of the Microclimate in moderate, hot and cold environments.

HD32.1 B operating program: Analysis of Discomfort in moderate environments.

HD32.1 C operating program: Measurement of Physical Quantities for general purposes.

The HD32.1 together with C operating program turns into a multifunction datalogger instrument displaying maximum, minimum and average values. By connecting SICRAM probes, the instrument allows measuring temperature, temperature and relative humidity, air velocity, flow, light (with photometric/radiometric probes).

TECHNICAL SPECIFICATIONS

Instrument

Dimensions (Length x Width x Height) 220x180x50 mm
Weight 1100 g (with batteries)
Materials ABS, Polycarbonate and Aluminium
Display Backlit, dot matrix 128x64 dots, visible area 56x38mm

Operative conditions

Operative temperature -5 ... 50°C
Storage temperature -25 ... 65°C
Operative Relative Humidity 0 ... 90% RH non condensing

Protection class IP64

Instrument uncertainty

± 1 digit @ 20°C

Power supply

Mains adapter (code SWD10) 12Vdc/1A
Batteries Four 1.5V batteries size C-BABY
Autonomy With temperature and RH probes
200 hours with 7800mAh alkaline batteries
With hotwire probe @ 5m/s:
100 hours with 7800mAh alkaline batteries
Power absorbed (instrument off) < 20μA

Security of stored data

Unlimited

Connections

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

RS232C Serial interface

Type Galvanically isolated RS232C
Baud rate Configurable between 1200 and 38400 baud
Data Bit 8
Parity None
Stop Bit 1
Flow control Xon/Xoff
Serial cable length Max 15m

USB Interface

Type 1.1 - 2.0 galvanically isolated

EMC standards

Safety EN61000-4-2, EN61010-1 level 3
Electrostatic discharge EN61000-4-2 level 3
Electrical Fast Transients EN61000-4-4 level 3, EN61000-4-5 level 3
Voltage variations EN61000-4-11
Electromagnetic interference susceptibility IEC1000-4-3
Electromagnetic interference emission EN55020 class B

The following table indicates the instrument memory capacity

Memory interval	Memory capacity	Memory interval	Memory capacity
15 seconds	22 hours	10 minutes	875 hours (about 36 days)
30 seconds	43 hours	15 minutes	1312 hours (about 54 days)
1 minute	87 hours (about 3 days and a half)	20 minutes	1750 hours (about 72 days)
2 minutes	175 hours (about 7 days)	30 minutes	2625 hours (about 109 days)
5 minutes	437 hours (about 18 days)	1 hour	5250 hours (about 218 days)

The following table explains how to use the operating programs and the different software applications available. A series of probes specially designed for different applications completes the instrument.

Delta Ohm is SIT Centre no. 124. Therefore, it can calibrate the probes employed and issue their SIT certificates..

DeltaLog10 Software	Operating program	Main calculated indices		Environments	Standard
DeltaLog10 BASIC	A Prog.	t_a t_r PMV PPD DR t_0 IS DI THI RSI SSI HI H T_{eq}	Air temperature Mean radiant temperature Predicted mean vote Predicted Percentage Dissatisfied Draught rating Operative temperature Scharlau index Tom index Thermohygrometric Index Relative Strain Index New Summer Simmer Index Hot index Humidex index Teq : Equivalent Temperature index	Moderate	UNI EN ISO 7730
DeltaLog10 Hot environments	A Prog	WGBT SW_p E_p PHS	Wet bulb globe temperature Sweat rate Predicted evaporative heat flow Predicted Heat Strain Model	Severe hot	UNI EN ISO 27243 UNI EN ISO 7933
DeltaLog10 Cold Environments	A Prog	IREQ DLE RT WCI	Required clothing insulation Duration limit exposure Recovery time Wind chill index	Severe cold	UNI EN ISO 11079
DeltaLog10 Analysis of Discomfort	B Prog	PD_v PD_t PD_Δ	Percentage Dissatisfied due to vertical temperature difference (head-ankles). Percentage Dissatisfied due to floor temperature Percentage Dissatisfied due to radiant asymmetry	Moderate	UNI EN ISO 7730
DeltaLog10 BASIC	C Prog.	t_a RH-t V_{a-t} Lux cd/m^2 $\mu\text{W/m}^2$ W/m^2 $\mu\text{mol/m}^2\text{s}$	Air temperature Humidity-temperature Air velocity, temperature and flow Illuminance Luminance Irradiance Irradiance PAR	General purpose	

Table of probes for HD32.1 A operating program: Microclimatic Analysis

TP3207	Dry bulb temperature probe.
TP3275	Globe temperature probe Ø 150mm (alternatively TP3276).
TP3276	Globe temperature probe Ø 50mm (alternatively TP3275).
AP3203	Omnidirectional hotwire probe.
HP3201	Natural wet bulb temperature probe.
HP3217	Combined temperature and relative humidity probe.
HP3217DM	Two-sensor probe for measuring natural wet bulb temperature and dry bulb temperature (alternatively: HP3201 and TP3207).



The following table lists all the necessary probes for determining the microclimatic indices.
The following indices are obtained by using the **DeltaLog10 BASIC** software:
Each line shows the combination of probes to use for calculating the indices

	TP3207	TP3275	TP3276	AP3203	HP3201	HH3217	HP3217DM
t_a : Air temperature..	x						
							x
						x	
t_r : Mean radiant temperature	x	x		x			
	x		x	x			
		x		x			x
			x	x			x
		x		x		x	
PMV : Predicted mean vote. PPD : Predicted Percentage Dissatisfied			x	x		x	
	x	x		x		x	
	x		x	x		x	
		x		x		x	x
		x		x		x	
DR : Draught rating.	x			x			
				x			x
				x		x	
T_o : Operative temperature..	x	x		x			
	x		x	x			
		x		x			x
			x	x			x
		x		x		x	
T_{eq} : Equivalent temperature. (necessary for measuring: atmospheric pressure)			x	x		x	
	x					x	
						x	x
IS : Scharlau index DI : Tom index THI : Thermohygrometric Index RSI : Relative Strain Index SSI : New Summer Simmer Index HI : Hot index H : Humidex index Teq : Equivalent Temperature index						x	
						x	
						x	
						x	
						x	
						x	
						x	
						x	



The following indices are obtained by using the **DeltaLog10 Cold Environments** software:
Each line shows the combination of probes to use for calculating the indices

	TP3207	TP3275	TP3276	AP3203	HP3201	HH3217	HP3217DM
(1)	x	x		x		x	
	x		x	x		x	
		x		x		x	x
			x	x		x	x
		x		x		x	
				x		x	
	x			x			
				x			x

(1) Using IREQ, DLE, RT, WCI it is possible to calculate:

- Ratio of surface area of the clothed body to the surface area of the nude body
- Mean skin temperature
- Fraction of wet skin
- Total convective heat conduction
- Total radiative heat conduction
- Partial water pressure at ambient temperature
- Surface temperature of clothing
- Evaporative resistance of limiting layer and clothing
- Heat exchange by evaporation
- Respiratory heat exchange by convection and evaporation
- Heat exchange by radiation
- Heat exchange by convection
- Duration limit exposure
- Required clothing insulation
- Intrinsic clothing insulation



The following indices are obtained by using the **DeltaLog10 Hot Environments software**:
Each line shows the combination of probes to use for calculating the indices

		TP3207	TP3275	TP3276	AP3203	HP3201	HH3217	HP3217DM
WBGT Indoor: Wet bulb globe temperature			x			x		
SWp: Ep:	Sweat rate Predicted evaporative heat flow	x	x			x		
		x		x		x		
			x			x		x
				x		x		x
			x			x	x	
PHS	(2)	x	x		x		x	
	T _{re}	x		x	x		x	
	Water loss		x		x		x	x
	D _{lim tre}			x	x		x	x
	D _{limloss50}		x		x		x	
	D _{limloss95}			x	x		x	

(2)

T_{re} : Predicted rectal Temperature

D_{lim tre} : Maximum allowable exposure duration for heat storage

D_{limloss50} : Maximum allowable exposure duration for water loss, standard subject

D_{limloss95} : Maximum allowable exposure duration for water loss, 95% of the working population

Table of probes for HD32.1 B operating program: Analysis of Discomfort

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

The following table lists all the necessary probe for determining the microclimatic indices.
The following indices are obtained by using the **DeltaLog10 Analysis of Discomfort software**

Each line shows the combination of probes to use for calculating the indices

		TP3227K	TP3227PC	TP3207P	AP3207TR	LP471Phot
PD_v:	Percentage Dissatisfied with vertical temperature difference (head-ankles).	x		x		
PD_f:	Percentage Dissatisfied with floor temperature.		x			
				x		
PD_Δ:	Percentage Dissatisfied with radiant asymmetry.				x	
FLD:	Average daylight factor For the calculation of the FLD is necessary to measure light (luxmeter Sonda LP PHOT 471).					x

ORDERING CODES

HD32.1 Kit basic: It is composed of HD32.1 instrument, A operating program: Analysis of the Microclimate, four 1.5V alkaline batteries size C-BABY, instruction manual.
DeltaLog10 Basic Moderate Environments Software (for operating systems from Windows 98 to Windows XP).

DeltaLog10 Hot Environments Software:

The use of this software requires the complete HD32.1 Kit basic.

DeltaLog10 Cold Environments Software:

The use of this software requires the complete HD32.1 Kit basic.

DeltaLog10 Analysis of Discomfort Software:

The use of this software requires the B operating program: Analysis of discomfort and the complete HD32.1 Kit basic.

DeltaLog10 Physical Quantities Software: The use of this software requires the C operating program: Physical quantities and the complete HD32.1 Kit basic.

Probes, holder, case and cables must be ordered separately.

Accessories:

VTRAP32: Tripod equipped with 6-input head and 4 probe holders code HD3218K

9CPRS232: Connection cable 9 - pole Sub-D female connector for RS232C.

CP22: USB 2.0 connection cable connector type A - connector type B.

BAG32: Carrying case for the HD32 and its accessories.

SWD10: 100-240Vac/12Vdc-1A Stabilized mains power supply.

HD3218K: Probe shaft

AM32: Two-clamp shaft for two probes

AQC: 200cc. distilled water and 3 braids for HP3201 or HP3217DM probes.

Delta Ohm metrological laboratories are accredited by SIT in Temperature, Humidity, Pressure, Photometry/Radiometry, Acoustics and Air velocity. Probes can be supplied with SIT calibration certificate on request.

Probes for operating programs:

A: Microclimatic Analysis

B: Analysis of Discomfort

TP3207: Temperature probe, Pt100 sensor. Probe stem Ø 14mm, length 140 mm. Cable length 2 metres. Equipped with SICRAM module.

Used for calculating the following indices: IREQ,WCI, DLE, RT, PMV, PPD, WBGT, SR. Used for calculating Mean radiant temperature.

TP3275: Globe temperature probe, Pt100 sensor, globe Ø 150 mm. Stem Ø 14 mm, length 110 mm. Cable length 2 metres. Equipped with SICRAM module.

Used for measuring: Mean radiant temperature, WBGT.

TP3276: Globe temperature probe, Pt100 sensor, globe Ø 50 mm. Stem Ø 8 mm, length 110 mm. Cable length 2 metres. Equipped with SICRAM module.

Used for measuring: Mean radiant temperature, WBGT..

TP3227K: Temperature probe composed of 2 independent probes, Pt100 sensor. Stem diameter Ø 14 mm, length 500 mm. Cable length 2 metres. Equipped with double SICRAM module and TP3227.2 extension shaft Ø 14 mm, length 450 mm.

Used for measuring local discomfort due to vertical thermal gradient. It can be used for studying subjects sitting or standing. The height of one probe can be regulated.

TP3227PC: Temperature probe composed of 2 independent probes, Pt100 sensor, one for measuring floor temperature (diameter Ø 70 mm, height 30 mm), the other for measuring temperature at the height of the ankles (diameter Ø 3 mm, height 100 mm). Cable length 2 metres. Equipped with double SICRAM module.

Used for measuring local discomfort due to vertical thermal gradient.

TP3207P: Temperature probe, Pt100 sensor, for measuring floor temperature (diameter Ø 70 mm, height 30 mm). Cable length 2 metres. Equipped with SICRAM module.

Used for measuring local discomfort due to vertical thermal gradient.

TP3207TR: Probe for measuring radiant temperature. Probe stem Ø 16 mm, length 250 mm. Cable length 2 metres. Equipped with SICRAM module.

Used for the evaluation of dissatisfied people due to radiant asymmetry.

AP3203: Omnidirectional hotwire probe. Measuring range: air velocity 0÷5 m/s, temperature 0÷100 °C. Probe stem Ø 14 mm, length 110 mm. Cable length 2 metres. Equipped with SICRAM module.

Used for calculating the following indices: IREQ,WCI, DLE, RT, PMV, PPD, SR. Used for calculating Mean radiant temperature.

HP3201: Natural wet bulb probe. Pt100 sensor. Probe stem Ø 14 mm, length 110 mm. Cable length 2 metres. Equipped with SICRAM module, spare braid and 50cc. distilled water.

Used for measuring: WBGT.

HP3217: Combined temperature and relative humidity probe. Capacitive RH sensor, Pt100 temperature sensor. Probe stem Ø 14 mm, length 110 mm. Cable length 2 metres. Equipped with SICRAM module.

Used for calculating the following indices: IREQ,WCI, DLE, RT, PMV, PPD, SR.

HP3217DM: Double natural wet bulb probe and temperature probe (dry bulb). Probe stem Ø 14 mm, length 110 mm. Cable length 2 metres. Equipped with double SICRAM module, spare braid and 50cc. distilled water.

Probes for C operating program: physical quantities

Temperature probes equipped with SICRAM module

TP472I: Immersion probe, Pt100 sensor. Stem Ø 3 mm, length 300 mm. Cable length 2 metres.

TP472I.0: Immersion probe, Pt100 sensor. Stem Ø 3 mm, length 230 mm. Cable length 2 metres.

TP473P.0: Pointed probe, Pt100 sensor. Stem Ø4 mm, length 150 mm. Cable length 2 metres.

TP474C.0: Contact probe, Pt100 sensor. Stem Ø4 mm, length 230 mm, contact surface Ø 5 mm. Cable length 2 metres.

TP475A.0: Air probe, Pt100 sensor. Stem Ø4 mm, length 230 mm. Cable length 2 metres.

TP472I.5: Immersion probe, Pt100 sensor. Stem Ø 6 mm, length 500 mm. Cable length 2 metres.

TP472I.10: Immersion probe, Pt100 sensor. Stem Ø 6 mm, length 1000 mm. Cable length 2 metres..

Combined Relative Humidity and Temperature probes equipped with SICRAM module

HP472AC: Combined %RH and Temperature probe, dimensions Ø 26x170 mm. Connection cable 2 metres.

HP473AC: Combined %RH and Temperature probe. Handle dimensions Ø 26x130 mm, probe Ø 14x110 mm. Connection cable 2 metres.

HP474AC: Combined %RH and Temperature probe. Handle dimensions Ø 26x130mm, probe Ø 14x210 mm. Connection cable 2 metres.

HP475AC: Combined %RH and Temperature probe. Connection cable 2 metres. Handle Ø 26x110 mm.

HP475AC.1: Combined %RH and Temperature probe. Stainless steel stem Ø14x500mm with 20µm sintered stainless steel filter. Handle 80 mm. Connection cable 2 metres.

HP477DC: Combined sword %RH and Temperature probe. Connection cable 2 metres. Handle Ø 26x110 mm. Probe stem 18x4 mm, length 520 mm.

Combined Air velocity and Temperature probes equipped with SICRAM module

Hotwire

AP471 S1: Hotwire telescopic probe, measuring range: 0...40m/s. Cable length 2 metres.

AP471 S2: Omnidirectional hotwire telescopic probe, measuring range: 0...5m/s. Cable length 2 metres.

AP471 S3: Hotwire telescopic probe with tip easy to shape, measuring range: 0...40m/s. Cable length 2 metres

AP471 S4: Omnidirectional hotwire telescopic probe with base, measuring range: 0...5m/s. Cable length 2 metres.

AP471 S5: Omnidirectional hotwire telescopic probe, measuring range: 0...5m/s. Cable length 2 metres.

Vane

AP472 S1L Vane probe with thermocouple K, Ø 100mm. Speed 0.6 to 20m/s; temperature -25 to 80°C. Cable length 2 metres.

AP472 S1H Vane probe with thermocouple K, Ø 100mm. Speed 10 to 30m/s; temperature -25 to 80°C. Cable length 2 metres.

AP472 S2: Vane probe, Ø60mm. Measuring range: 0.25...20m/s. Cable length 2 metres.

AP472 S4L: Vane probe, Ø 16mm. Speed 0.6 to 20m/s. Cable length 2 metres.

AP472 S4LT: Vane probe, Ø 16mm. Speed 0.6 to 20m/s. Temperature -30 to 120°C with thermocouple K sensor (*). Cable length 2 metres.

AP472 S4H: Vane probe, Ø 16mm. Speed 10 to 50m/s. Cable length 2 metres.

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

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

Photometric/radiometric probes for measuring Light equipped with SICRAM module

LP 471 PHOT: Photometric probe for measuring ILLUMINANCE equipped with SICRAM module, spectral response in agreement with standard photopic vision, diffuser for cosine correction. Measuring range: 0.01 lux...200x10³ lux.

LP 471 LUM 2: Photometric probe for measuring LUMINANCE equipped with SICRAM module, spectral response in agreement with standard photopic vision, vision angle 2°. Measuring range: 0.1 cd/m²...2000x10³ cd/m².

LP 471 PAR: Quantum radiometric probe for measuring the photon flow in the chlorophyll range PAR (photosynthetically Active Radiation 400 nm...700 nm) equipped with SICRAM module, measurement in µmol/m²s, diffuser for cosine correction. Measuring range 0.01µmol/m²s...10x10³µmol/m²s

LP 471 RAD: Radiometric probe for measuring IRRADIANCE equipped with SICRAM module in the 400 nm...1050 nm spectral range, diffuser for cosine correction. Measuring range: 0.1x10⁻³W/m²...2000 W/m².

LP 471 UVA: Radiometric probe for measuring IRRADIANCE equipped with SICRAM module in the 315 nm...400 nm UVA spectral range, peak 360 nm, quartz diffuser for cosine correction.

Measuring range: 0.1x10⁻³W/m²...2000 W/m².

LP 471 UVB: Radiometric probe for measuring IRRADIANCE equipped with SICRAM module in the 280 nm...315 nm UVB spectral range, peak 305 nm, quartz diffuser for cosine correction.

Measuring range: 0.1x10⁻³W/m²...2000 W/m².

LP 471 UVC: Radiometric probe for measuring IRRADIANCE equipped with SICRAM module in the 220 nm...280 nm UVC spectral range, peak 260 nm, quartz diffuser for cosine correction.

Measuring range: 0.1x10⁻³W/m²...2000 W/m².

LP 471 ERY: Radiometric probe for measuring TOTAL EFFECTIVE IRRADIANCE (Weff/m²) according to the UV action curve (CEI EN 60335-2-27) equipped with SICRAM module. Spectral range: 250 nm...400 nm, quartz diffuser for cosine correction.

Measuring range: 0.1x10⁻³Weff/m²...2000 Weff/m².





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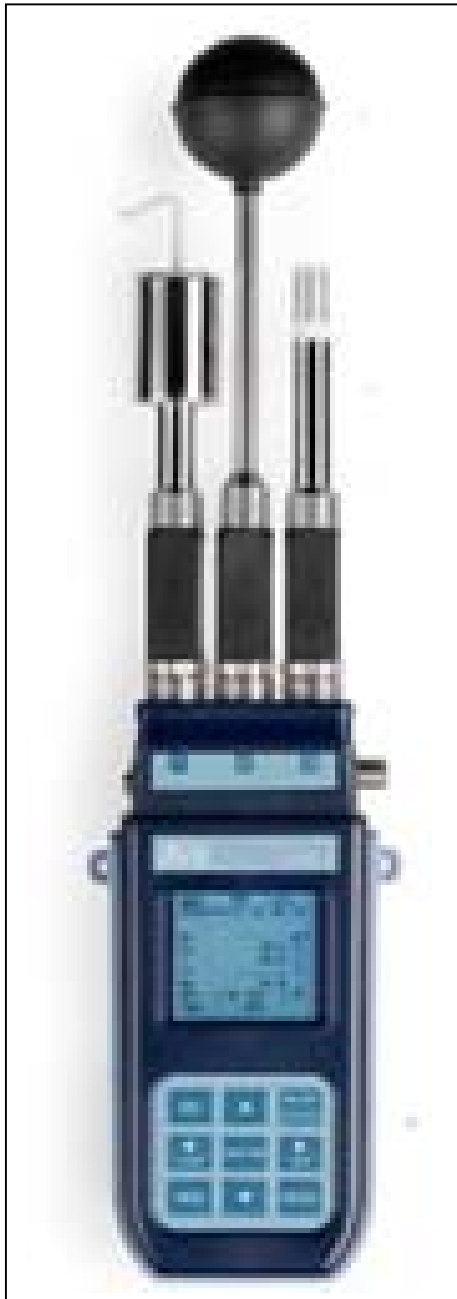
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HD 32.2 INSTRUMENT FOR THE ANALYSIS OF THE WBGT INDEX

HD 32.3 INSTRUMENT FOR THE ANALYSIS OF THE PMV AND WBGT INDEX



HD32.2 – WBGT Index is an instrument made by Delta Ohm srl for the analysis of WBGT index (Wet Bulb Glob Temperature: wet bulb temperature and globe thermometer temperature) in presence or in absence of solar radiation.

Reference Regulations:

ISO 7243: Hot environments. Estimation of the heat stress on working man, based on WBGT index (wet bulb temperature and Globe thermometer).

ISO 8996: Ergonomics of the thermal environment – Determination of the energy metabolism.

ISO 7726: Ergonomics of the thermal environment – Instruments for measuring physical quantities.

The instrument is provided with three inputs for probes with SICRAM module: the SICRAM module interface between the instrument and sensor connected and communicate the sensor parameters and calibration data to the instrument.

All SICRAM probes can be plugged into any of the inputs: they are automatically recognized upon turning the Instrument on.

The main features of the instrument are:

- Logging: data acquisition and logging to the integral instrument memory. Storage capacity: 64 different logging sections, sample interval, user selectable.
- You can set the automatic logging start with auto-start function(Start/Stop time).
- The measurement unit of the temperature: °C, °F, °K.
- Date and time of the instrument.
- The display of maximum, minimum, medium statistic parameters and their deletion.
- The data transfer speed via the RS232 serial port.

HD32.2 instrument can detect simultaneously the following quantities:

- Globe thermometer temperature **T_g**.
- Wet bulb temperature with natural ventilation **T_n**.
- Environment temperature **T**.

Starting from the detected values, HD32.2 can calculate:

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

WBGT (Wet Bulb Globe Temperature – Wet bulb temperature and globe thermometer) is one of the indexes used to determinate the occupational heat exposure.

It represents the value, related to the metabolic expenditure linked to a specific work activity, that causes a thermal stress when exceeded.

WBGT index combines the temperature measurement of wet bulb with natural ventilation t_{nw} with the globe thermometer t_g and, in some situations, with the air temperature t_a .

The calculation formula is the following:

- inside and outside a buildings in absence of solar radiation: $WBGT_{close\ environments} = 0,7\ t_{nw} + 0,3\ t_g$
- outside a building in presence of solar radiation: $WBGT_{outside\ environments} = 0,7\ t_{nw} + 0,2\ t_g + 0,1\ t_a$

where:

t_{nw} = natural wet bulb;

t_g = globe thermometer temperature;

t_a = air temperature.

The measured data should be compared with the limit values prescribed by the regulations; when exceeded you have to

- reduce directly the thermal stress on the examined work place;
- proceed to a detailed analysis of the thermal stress.

In order to measure the WBGT index, the following probes should be connected:

- **Natural wet bulb HP3201.2.**
- **TP3276.2 Globe thermometer probe.**
- **TP3207.2 Dry bulb temperature, of the measurement is performed in presence of solar radiation.**

In order to measure the WBGT index, you should refer to the following regulations:

- **ISO 7726**
- **ISO 7243**
- **ISO 8996**

Technical features

Instrument

Dimensions 185x90x40 mm
(Length x Width x Height)
Weight 470 g (batteries included)
Materials ABS, rubber
Display back light, with dot-matrix
160x160 points, visible area 52x42mm

Working conditions

Working temperature -5 ... 50°C
Storage temperature -25 ... 65°C
Working relative humidity 0 .. 90% RH no condensation

Protection Degree IP67

Instrument uncertainty ± 1 digit @ 20°C

Power supply

Mains power supply (code SWD10) 12Vdc/1A
Batteries 4 batteries 1.5V type AA
Autonomy 200 hours with 1800mAh alkaline batteries
Power absorbed with < 45Ma instrument off

Safety of the stored data unlimited

Connections

Input for probes with SICRAM module
3 Connectors 8 male poles DIN 45326

Serial Interface:

Pin: M12-8 poles.
Type: RS232C (EIA/TIA574) or USB 1.1 o 2.0
not insulated
Baud rate: from 1200 to 38400 baud.
with USB baud=460800
Data bit: 8
Parity: None
Flow control: Xon-Xoff
Cable length: max 15m

Memory

divided in 64 blocks.

Storage capacity**

67600 memorizations for each of the 3 inputs

Logging interval

selectable among: 15, 30 seconds, 1, 2, 5,10, 15, 20, 30 minutes and 1 hour.

TP3207.2 Temperature probe

Sensor type: Pt100 with thin-film
Accuracy: Class 1/3 DIN
Measurement range: -40 ÷ 100 °C
Resolution: 0.1°C
Temperature drift @20°C: 0.003%/°C
Drift after 1 year: 0.1°C/year
Connection: 4 wires plus SICRAM module
Connector: 8 female poles DIN45326
Dimensions: Ø=14 mm L= 150 mm
Response time T95: 15 minutes

TP3207.2 Temperature probe

Sensor type: Pt100 with thin-film
Accuracy: Class 1/3 DIN
Measurement range: -40 ÷ 100 °C
Resolution: 0.1°C
Temperature drift @20°C: 0.003%/°C
Drift after 1 year: 0.1°C/year
Connection: 4 wires plus SICRAM module
Connector: 8 female poles DIN45326
Dimensions: Ø=14 mm L= 150 mm
Response time T95: 15 minutes

HP3201.2 Natural ventilation wet bulb

Sensor type: Pt100
Accuracy: Class A
Measurement range: 4 °C ÷ 80 °C
Resolution: 0.1°C
Temperature drift @20°C: 0.003%/°C
Drift after 1 year: 0.1°C/year
Connection: 4 wires plus SICRAM module
Connector: 8 female poles DIN45326
Stem dimensions: Ø=14 mm L= 170 mm
Braid length: 10 cm. at least
Tank capacity: 15 cc.
Tank autonomy: 96 hours with RH=50%, t = 23°C
Response time T95: 15 minutes

** Storage capacity

Logging interval	Storage capacity
15 seconds	Approx. 11 days and 17 hours
30 seconds	Approx. 23 days and 11 hours
1 minute	Approx. 46 days and 22 hours
2 minutes	Approx. 93 days and 21 hours
5 minutes	Approx. 234 days and 17 hours

Logging interval	Storage capacity
10 minutes	Approx. 1 year and 104 days
15 minutes	Approx. 1 year and 339 days
20 minutes	Approx. 2 years and 208 days
30 minutes	Approx. 3 years and 313 days
1 hour	Approx. 7 years and 261 days

Ordering codes

HD32.2 Kit consisting of:

- HD32.2 WBGT Index instrument, 4 alkaline batteries from 1.5V type AA instruction manual, case.
- DeltaLog10 Software Warm environments: WBGT analysis.

Probes and cables have to be ordered separately.

Required probes for the measurement of WBGT:

- TP3207.2 Probe of dry bulb temperature.
- TP3276.2 Globe thermometer probe.
- TP3201.2 Natural ventilation wet bulb

Probes for HD32.2 WBGT Index

TP3207.2: Temperature probe for Pt100 sensor. Probe stem Ø 14mm, length 150 mm. Equipped with SICRAM module.

TP3276.2: Globe thermometer probe with Pt100 sensor, globe Ø 50 mm. Stem Ø 8 mm, length 170 mm. Equipped with SICRAM module.

HP3201.2: Natural wet bulb. Pt100 sensor. Probe stem Ø 14 mm, length 170mm. Equipped with SICRAM module, spare parts of the braid and case of 50cc. distilled water.

Example of immediate data print, obtained with HD40.1

```
=====
ISO 7243 WBGT Index
=====
Model HD32.2 WBGT Index
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
=====
Date=2008/11/21 15:00:00
Tnw          21.2 °C
Tg           24.9 °C
Ta           31.3 °C
WBGT {i}     22.3 °C
WBGT {o}     23.0 °C
=====
```

Reference regulation

Instrument Model
Instrument firmware version
Instrument firmware date
Instrument Serial Number
Identification Code

Description of the probe connected
to input 1

Description of the probe connected
to input 2

Description of the probe connected
to input 3

Date and time
Natural wet bulb
Globe thermometer ventilation
Dry bulb temperature
WBGT in absence of direct solar radiation
WBGT in presence of direct solar radiation

Accessories:

VTRAP30: Tripod to suit HD32.2 instrument with a maximum height of 280 mm

HD2110/RS: Connection cable with M12 connector from the instrument side and with SubD female connector 9 poles for RS232C from PC side.

HD2110/USB: Connection cable with M12 connector from the instrument, USB 2.0 connector from PC side.

SWD10: 100-240Vac/12Vdc-1A mains voltage stabilized power supply.

AQC: 200cc. of distilled water and n° 3 braids for HP3201 or HP3217DM probes

HD40.1: printer (uses HD2110/RS cable)





HD32.3

WBGT: Wet Bulb Globe Temperature Meter

PMV: Predicted Mean Vote

HD32.3 – WBGT - PMV Index is an instrument made by Delta Ohm Srl for:

- Analysis of hot environments using WBGT index (Wet Bulb Globe Temperature: wet bulb temperature and Globe thermometer) in presence or absence of solar radiation.
- Analysis of the moderate warm environments using PMV index (Predicted Mean Vote) and PPD index (Predicted Percentage of Dissatisfied).

Reference Rules:

ISO 7243: Hot environments. Estimation of the heat stress on working man, based on WBGT index (wet bulb globe Thermometer).

ISO 8996: Ergonomics of the thermal environment. Determination of metabolic rate.

ISO 7726: Ergonomics of the thermal environment – Instruments for measuring physical quantities.

ISO 7730: Moderate thermal environments. Determination of PMV and PPD index and specification of the condition for thermal comfort.

The instrument is provided with three inputs for probes with SICRAM module: the SICRAM module interface between the instrument and sensor connected and communicate the sensor parameters and calibration data to the instrument.

All SICRAM probes can be plugged into any of the inputs: they are automatically recognized upon turning on the instrument.

The main features of the instrument are:

- Logging: data acquisition and logging in the integral instrument memory. Storage capacity: 64 different logging sections, sample interval, user selectable.
- Start and stop can be set automatically with the auto-start function.
- Selectable measurement unit of the temperature: °C, °F, °K.
- Date and time of the instrument.
- The display of maximum, minimum, medium statistic parameters and their deletion.
- The transfer speed of data via RS232 serial port.

HD32.3 instrument can detect simultaneously the following quantities:

- Globe thermometer temperature T_g with TP3276.2 probe.
- Natural wet bulb temperature T_{nw} with HP3201.2 probe.
- Environment temperature T with TP3207.2 probe.
- Relative humidity RH and environment temperature T with HP3217.2 probe.
- Air speed V_a with AP3203.2 probe.

Starting from the measured values, HD32.3 can calculate and display, with TP3207.2, HP3276.2, and HP3201.2 probes, the following indexes:

- WBGT (in) Index (Wet Bulb Globe Temperature: wet bulb temperature and globe thermometer) in absence of solar radiation.
- WBGT (out) Index (Wet Bulb Globe Temperature: wet bulb temperature and globe thermometer) in presence of solar radiation.

WBGT (Wet Bulb Globe Temperature – wet bulb and globe temperature) is one of the indexes used to determinate the occupational heat exposure. It represents the value, related to the metabolic expenditure linked to a specific work activity, that causes a thermal stress when exceeded.

WBGT index combines the measurement of wet bulb temperature t_{nw} with natural ventilation with the globe thermometer temperature t_g and, in some situations, with the air temperature t_a .

The calculation formula is the following:

- inside and outside the buildings in absence of solar radiation: $WBGT_{close\ environments} = 0,7\ t_{nw} + 0,3\ t_g$
- outside the buildings in presence of solar radiation: $WBGT_{outside\ environments} = 0,7\ t_{nw} + 0,2\ t_g + 0,1\ t_a$

where:

t_{nw} = wet bulb temperature with natural ventilation;

t_g = globe thermometer temperature;

t_a = air temperature.

The measured data should be compared with the limit values prescribed by the regulations; when exceeded you have to

- reduce directly the thermal stress on the examined work place;
- proceed to a detailed analysis of the thermal stress.

In order to measure the WBGT index, the following probes should be connected:

- **Natural wet bulb HP3201.2.**
- **TP3276.2 Globe thermometer probe.**
- **TP3207.2 Dry bulb temperature, of the measurement is performed in presence of solar radiation.**

In order to measure the WBGT index, you should refer to the following regulations:

- **ISO 7726**
- **ISO 7243**
- **ISO 8996**

PMV - PPD

Human thermal comfort is defined by ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers INC) as the state of mind that expresses satisfaction with the surrounding living or working environment.

The evaluation of this subjective condition can be objectified and quantified using integrated index that consider the micro climatic environment parameters (T_a , T_r , V_a , rh), and the work-related energy metabolic expenditure MET, and the typology of clothing (thermal insulation CLO) commonly used.

Among these indexes, the most precise one reflecting the influence of the above mentioned physical and physiological variables on thermal comfort is PMV (Predicted Mean Vote).

Synthetically, it comes from the equation of the thermal balance whose result is compared to a scale of psycho - physical health and expresses the average opinion (average foreseen vote) about the thermal sensations of a group of subjects.

From PMV is derived a second index called PPD (Predicted Percentage of Dissatisfied) that quantifies the percentage of subjects who will be dissatisfied with some micro climatic conditions.

ISO 7730 regulations suggests PMV use in presence of following variables that influence the thermal balance:

- Metabolic expenditure = $1 \div 4 \text{ met}$
- Thermal resistance of clothing = $0 \div 2 \text{ clo}$
- Dry bulb temperature = $10 \div 30^\circ\text{C}$
- Medium radiant temperature = $10 \div 40^\circ\text{C}$
- Air speed = $0 \div 1 \text{ m/sec}$
- Water vapour pressure = $0 \div 2,7 \text{ kpa}$

PMV is a particularly suitable index for the evaluation of work places with moderate microclimate such as houses, schools, offices, research laboratories, hospitals, and is useful to predict the number of people likely to feel uncomfortably warm or cool.

According to ISO 7730 PMV values range between $+0,5$ and $-0,5$, provides comfort conditions corresponding to a percentage of dissatisfied (PPD) lower than 10%.

(see table below)..

PMV	PPD %	EVALUATION THERMAL ENVIRONMENT
+3	100	Hot
+2	75,7	Warm
+1	26,4	Slightly warm
+0,85	20	Acceptable thermal condition
-0,5 < PMV < +0,5	<10	Comfortable
-0,85	20	Acceptable thermal condition
-1	26,8	Cool
-2	76,4	Cold
-3	100	Extremely cold

To calculate PMV and PPD indices, it's necessary to know:

- the working load (energy expenditure);
- the clothing thermal insulation.

Average radiant temperature T_r

The average radiant temperature is defined as the temperature of thermally uniform simulated environment that would exchange with a man the same thermal radiation power exchanged in the real environment.

In order to evaluate the average radiant temperature, it is necessary to measure:

the globe thermometer temperature, the air temperature, and the air speed measured close to the globe thermometer.



Technical features

Instrument

Dimensions 185x90x40 mm
(Length x Width x Height)
Weight 470 g (batteries included)
Materials ABS, rubber
Display back light, with dot-matrix
160x160 points, visible area 52x42mm

Working conditions

Working temperature -5 ... 50°C
Storage temperature -25 ... 65°C
Working relative humidity 0 .. 90% RH no condensation

Protection Degree IP67

Instrument uncertainty ± 1 digit @ 20°C

Power supply

Mains power supply (code SWD10) 12Vdc/1A
Batteries 4 batteries 1.5V type AA
Autonomy 200 hours with 1800mAh alkaline batteries
Power absorbed with < 45Ma instrument off

Safety of the stored data unlimited

Connections

Input for probes with SICRAM module
3 Connectors 8 male poles DIN 45326

Serial Interface:

Pin: M12-8 poles.
Type: RS232C (EIA/TIA574) or USB 1.1 o 2.0
not insulated
Baud rate: from 1200 to 38400 baud.
with USB baud=460800
Data bit: 8
Parity: None
Flow control: Xon-Xoff
Cable length: max 15m

Memory

divided in 64 blocks.

Storage capacity**

67600 memorizations for each of the 3 inputs.

Logging interval

selectable among: 15, 30 seconds, 1, 2, 5, 10, 15, 20, 30 minutes and 1 hour.

TP3276.2 globe thermometer probe Ø=50 mm

Sensor type: Pt100
Accuracy: Class 1/3 DIN
Measurement range: -10 ÷ 100 °C
Resolution: 0.1°C
Temperature drift @20°C: 0.003%/°C
Drift after 1 year: 0.1°C/year
Connection: 4 wires plus SICRAM module
Connector: 8 female poles DIN45326
Stem dimension: Ø=8 mm L= 170 mm
Response time T95: 15 minutes
Sonda de bulbo húmedo de ventilación natural
HP3201.2 Natural wet bulb
Sensor type: Pt100
Accuracy: Class A with platinum wire
Measurement range: 4 °C ÷ 80 °C
Resolution: 0.1°C
Temperature drift @20°C: 0.003%/°C
Drift after 1 year: 0.1°C/year
Connection: 4 wires plus SICRAM Module
Connector: 8 female poles DIN45326
Stem dimension: Ø=14 mm L= 170 mm
Braid length: 10 cm. at least
Tank capacity: 15 cc.
Tank autonomy: 96 hours with RH=50%, t = 23°C
Response time T95: 15 minutes

HP3217.2 Combined temperature and relative humidity probe

Sensor type: Pt100 with thin film for temperature
Capacitive sensor for relative humidity
Temperature accuracy: 1/3 DIN
Relative humidity accuracy: $\pm 2\%$ RH (15 ÷ 90 %RH) @ 20°C
 $\pm 2.5\%$ RH remaining range
Measuring range: temperature: -10 °C ÷ 80 °C
relative humidity: 5% ÷ 98% RH
Connection: 4 wires plus SICRAM Module
Connector: 8 female poles DIN45326
Dimensions: Ø=14 mm L= 150 mm
Response time T95: 15 minutes
Resolution: 0.1% RH, 0.1% °C

AP3203.2 Omnidirectional hot wire probe

Sensor type: NTC 10kohm
Accuracy: ± 0.05 m/s (0÷1 m/s)
 ± 0.15 m/s (1÷5 m/s)
Measuring range: 0÷5 m/s
0 °C ÷ 80 °C
Connection: 7 wires plus SICRAM Module
Connector: 8 female poles DIN45326
Stem dimension: Ø=8 mm L= 230 mm
Protection dimension: Ø=80 mm
Resolution: 0.01 m/s
Temperature drift @20°C: 0.06% /°C
Drift after 1 year: 0.12 °C/years

** Storage capacity

Logging interval

15 seconds	Approx. 11 days and 17 hours
30 seconds	Approx. 23 days and 11 hours
1 minute	Approx. 46 days and 22 hours
2 minutes	Approx. 93 days and 21 hours
5 minutes	Approx. 234 days and 17 hours

Storage capacity

Logging interval

10 minutes	Approx. 1 year and 104 days
15 minutes	Approx. 1 year and 339 days
20 minutes	Approx. 2 years and 208 days
30 minutes	Approx. 3 years and 313 days
1 hour	Approx. 7 years and 261 days

Storage capacity

ORDERING CODES

The kit for the analysis of WBGT and PMV consisting of:

- HD32.3 instrument, 4 alkaline batteries 1.5V type AA, instruction manual, case. DeltaLog10 Software for the analysis of WBGT and PMV indexes.

Probes and cables have to be ordered separately.

The probes required for WBGT measurement are:

- TP3207.2 Dry bulb temperature probe.
- TP3276.2 Globe thermometer probe.
- HP3201.2 Natural wet bulb temperature probe with natural ventilation.

The probes required for PMV measurement are:

- HP3217.2 Combined e temperature and relative humidity probe
- AP3203.2 Omnidirectional hot wire probe.
- TP3276.2 Globe thermometer probe.

Probes for HD32.3

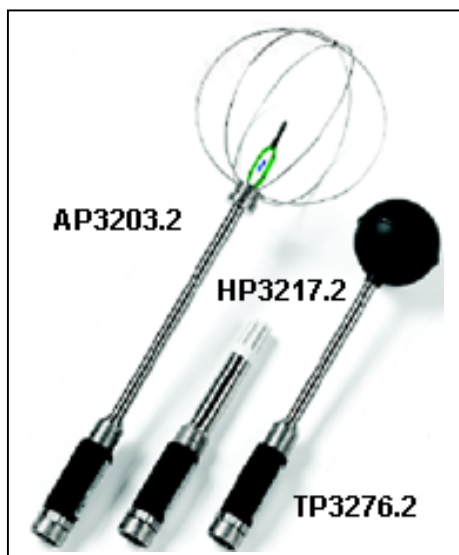
TP3207.2: Temperature probe with Pt100 sensor. Probe stem Ø 14mm, length 150mm. Equipped with SICRAM module. **Used for WBGT measurement.**

TP3276.2: Globe thermometer sensor Pt100, globe Ø 50 mm. Stem Ø 8 mm, length 170 mm. Equipped with SICRAM module. **Used for WBGT and PMV measurements.**

HP3201.2: Natural wet bulb. Pt100 sensor. Probe stem Ø 14 mm, length 170 mm. Equipped with SICRAM module, spares of braid and 50 cc of distilled water. **Used for WBGT measurement.**

HP3217.2: Combined temperature and relative humidity probe. Capacitive RH sensor, Pt100 temperature sensor. Probe stem Ø 14 mm, length 150 mm. Equipped with SICRAM module. **Used for PMW measurement.**

AP3203.2: Omnidirectional hot wire probe. Measuring range: air speed 0÷5 m/s, temperature 0÷100 °C. Probe stem Ø 8 mm, length 230 mm. Equipped with SICRAM module. **Used for PMW measurement.**



Accessories:

VTRAP30: Tripod to suit HD32.3 instrument with a maximum height of 280 mm

HD2110/RS: Connection cable with M12 connector from the instrument side and with SubD female connector 9 poles for RS232C from PC side.

HD2110/USB: Connection cable with M12 connector from the instrument, USB 2.0 connector from PC side.

SWD10: 100-240Vac/12Vdc-1A mains voltage stabilized power supply.

AQC: 200cc. of distilled water and n° 3 braids for HP3201 or HP3217DM probes

HD40.1: printer (uses HD2110/RS cable)

Example of immediate data printing of PMV, obtained with 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 %
=====
```

Reference rule

Instrument model
Version of the instrument
firmware
Date of the instrument
firmware
Serial number of the
instrument
Identification Code

Description of the probe
connected to input 1

Description of the probe
connected to input 2

Description of the probe
connected to input 3

Date and time

Air speed
Globe thermometer
temperature
Dry bulb temperature
Relative humidity
Metabolic expenditure
Resistance of clothing
PMV – Predicted Mean Vote
PPD – Predicted Percentage
of Dissatisfied

