Microclimate - WBGT

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HD 32.1
INSTRUMENT FOR STUDYING, MEASURING AND CONTROL-LING 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:

EN ISO 7726: Ergonomics of the thermal environment - Instruments for measuring physical quantities.
EN ISO 7730: Moderate Thermal Environments - Determination of the PMV and PPD indices and specification of the condition for thermal comfort.
EN ISO 27243: Hot environments. Estimation of the heat stress on working man, based on the WBGT Index (Wet bulb Globe temperature).
EN ISO 7933: Ergonomics of the thermal environment - Analytical determination and interpretation of heat stress using calculation of the predicted heat strain.
ENV ISO 11079: Evaluation of cold environments - Determination of required clothing insulation (IREQ).
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, CO and CO_2.

According to measurements performed, HD32.1, together with its specific software, calculates the following parameters:
- t_r : Mean radiant temperature
- **PMV :** Predicted Mean Vote
- **PPD :** Predicted Percentage Dissatisfied
- **DR :** Draught Rating
- t_0 : Operative temperature

- **IS :** Scharlau Index
- **DI :** Thom Index
- **THI :** Thermohygrometric Index
- **RSI :** Relative Strain Index
- **SSI :** New Summer Simmer Index
- **HI :** Heat Index
- **H :** Humidex Index
- T_{eq} : Equivalent Temperature Index

To compute the calculation of these indexes, temperature and relative humidity of the air have to be detected and the measured values to be inserted in the table "Discomfort indexes".
- $WBGT_{Indoor}$: 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 :** T_{re} - Water loss - $D_{lim\,tre}$ - $D_{limloss50}$ - $D_{limloss95}$
- **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
- **FLD :** Average Day Light Factor

The calculation of the FLD index requires light measurement (photometric probe LP-471PHOT). Requires program "**HD32.1 prog. C**"

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, CO and CO_2 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)	< 45µA

Security of stored data
Unlimited

Atmospheric pressure measurement with inbuilt sensor
Accuracy	±0.5hPa
Response time	1Hz

Temperature measurement with instrument
Pt100 measuring range	-200…+650°C
Resolution	0.01°C in the range ±199.99°C, 0.1°C outside this range
Accuracy	±0.01°C in the range ±199.99°C, ± 0.1°C outside this range
Temperature drift @20°C	0.003%/°C
Drift after 1 year	0.1°C/year

Instrument relative humidity measurement (capacitive sensor)
Measuring range	0…100%RH
Resolution	0.1%RH
Accuracy	±0.1%RH
Temperature drift @20°C	0.02%RH/°C
Drift after 1 year	0.1%RH/year

EXPLANATORY TABLES - HOW TO USE PROBES FOR MICROCLIMATIC MEASUREMENTS

DeltaLog10 Software	Operating program	Main calculated indices		Environments	Standard
DeltaLog10 BASIC	A Prog.	t_a: Air temperature t_r: Mean radiant temperature PMV: Predicted mean vote PPD: Predicted Percentage Dissatisfied DR: Draught rating t_o: Operative temperature	IS: Scharlau Index DI: Thom Index THI: Thermohygrometric Index RSI: Relative Strain Index SSI: New Summer Simmer Index HI: Heat Index H: Humidex Index T_{eq}: Equivalent Temperature Index To compute the calculation of these indexes, temperature and relative humidity of the air have to be detected and the measured values to be inserted in the table "Discomfort indexes".	Moderate	EN ISO 7730
DeltaLog10 Hot environments	A Prog.	WBGT: Wet bulb globe temperature SW_p: Sweat rate E_p: Predicted evaporative heat flow PHS: Predicted Heat Strain Model		Severe hot	EN ISO 27243 EN ISO 7933
DeltaLog10 Cold Environments	A Prog.	IREQ: Required clothing insulation DLE: Duration limit exposure RT: Recovery time WCI: Wind chill index		Severe cold	EN ISO 11079
DeltaLog10 Analysis of Discomfort	B Prog.	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		Moderate	EN ISO 7730
DeltaLog10 BASIC	C Prog.	t_a: Air temperature RH-t: Humidity-temperature V_a-t: Air velocity, temperature and flow Lux: Illuminance cd/m^2: Luminance $µW/m^2$: Irradiance W/m^2: Irradiance $µmol/m^2s$: PAR ppm: CO and CO_2	FLD: Average Day Light Factor The calculation of the FLD index requires light measurement (photometric probe LP471PHOT). Requires program "HD32.1 prog. C"	General purposes	

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
Memory	divided in 64 blocks
Storage capacity	*67600 storages of 8 inputs each*

Storage internal

to select between: 15, 30 seconds,
1, 2, 5, 10, 15, 20, 30 minutes and 1 hour

Printing internal

to select between: 15, 30 seconds,
1, 2, 5, 10, 15, 20, 30 minutes and 1 hour

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 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.

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).
HP3217DM	Two-sensor probe for measuring natural wet bulb temperature and dry bulb temperature (alternatively: HP3201 and TP3207).
AP3203	Omnidirectional hotwire probe (0°C…80°C)
AP3203-F	Omnidirectional hotwire probe (-30°C…+30°C)
HP3201	Natural wet bulb temperature probe.
HP3217R	Combined temperature and relative humidity probe.

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	AP3203-F	HP3201	HP3217R	HP3217DM
t_a: Air temperature.	•							
								•
							•	
t_r: Mean radiant temperature.	•	•		•	•			
	•		•	•	•			
		•		•	•			•
			•	•	•			•
		•		•	•		•	
			•	•	•		•	
PMV: Predicted mean vote.	•	•		•	•			
PPD: Predicted Percentage Dissatisfied	•		•	•	•			
		•		•	•		•	•
			•	•	•		•	•
		•		•	•		•	
			•	•	•		•	
DR: Draught rating.	•			•	•			
				•	•			•
				•	•	•		
t_o: Operative temperature.	•	•		•	•			
	•		•	•	•			
		•		•	•			•
			•	•	•			•
		•		•	•		•	
			•	•	•		•	
T_{eq}: Equivalent temperature. (necessary for measuring: **atmospheric pressure**)	•						•	
							•	
							•	•
IS : Scharlau Index							•	
DI : Thom Index							•	
THI : Thermohygrometric Index							•	
RSI : Relative Strain Index							•	
SSI : New Summer Simmer Index							•	
HI : Heat Index							•	
H : Humidex Index							•	
T_{eq} : Equivalent Temperature Index							•	
To compute the calculation of these indexes, temperature and relative humidity of the air have to be detected and the measured values to be inserted in the table "Discomfort indexes"								

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	HP3217R	HP3217DM
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	(1) T_{re}	•	•			•		
	Water loss	•		•		•		
	$D_{lim\ tre}$		•		•	•	•	•
	$D_{limloss50}$			•	•		•	•
	$D_{limloss95}$		•		•	•	•	
				•	•	•		

(1) 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

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-F [3]	HP3201	HP3217	HP3217DM
[2]	IREQ:	Required clothing insulation	•	•		•		•	
	DLE:	Duration limit exposure	•		•	•		•	
	RT:	Recovery time			•	•		•	•
	WCI:	Wind chill index			•	•		•	•
					•	•		•	
						•		•	
			•			•			
						•			•

[2] **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

[3] **AP3203: 0°C…+80°C**
AP3203-F: -30°C…+30°C

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	TP3207TR	LP 471 Phot
PD$_v$:	Percentage Dissatisfied with vertical temperature difference (head-ankles).	•	•			
			•			
PD$_f$:	Percentage Dissatisfied with floor temperature.			•		
PD$_r$:	Percentage Dissatisfied with radiant asymmetry.				•	
FLD:	Average Day Light Factor Requires HD32.1 program C					•

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. The instrument includes atmospheric pressure sensor.
DeltaLog10 Basic moderate environments Software (for operating systems from Windows 98 to Windows Vista).

DeltaLog10 Hot environments Software: The use of this software requires the **complete HD32.1 basic Kit.**

DeltaLog10 Cold environments Software: The use of this software requires the **complete HD32.1 basic Kit.**

DeltaLog10 Analysis of discomfort Software: The use of this software requires the **B operating program: Analysis of discomfort** and the **complete HD32.1 basic Kit.**

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

HD32.1 Program B - Discomfort Analysis: HD32.1 program for discomfort measurements in moderate environments. Requires the software DeltaLog10 Discomfort Analysis.

HD32.1 Program C - Physical Quantities: HD32.1 program for the measurements of temperature, relative humidity, light, air speed, concentration of CO and CO_2. Requires the software DeltaLog10 Discomfort Analysis.

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.
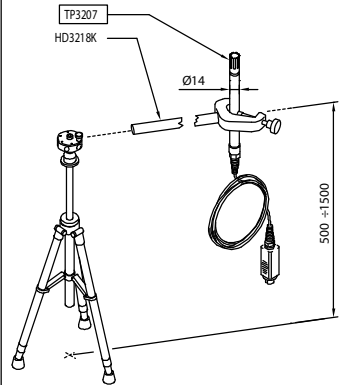
**PROBES FOR OPERATING PROGRAMS:**
A: Microclimatic Analysis
B: Analysis of Discomfort

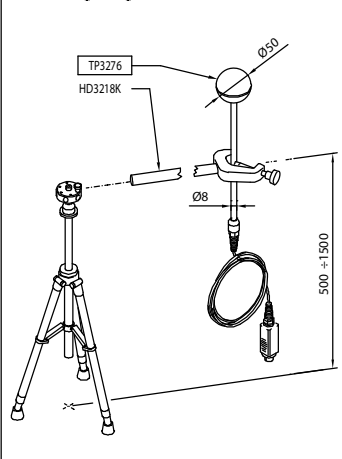**TP3207:** Temperature probe, Pt100 sensor. Probe stem Ø 14mm, length 140 mm. Cable length 2 metres. Equipped with SICRAM module.
Used for calculating the following indices: **IREQ, WCI, DLE, RT, PMV, PPD, WBGT, SR**. Used for calculating Mean radiant temperature.
Measuring range: -40°C…+100°C

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**.
Measuring range: -10°C…+100°C
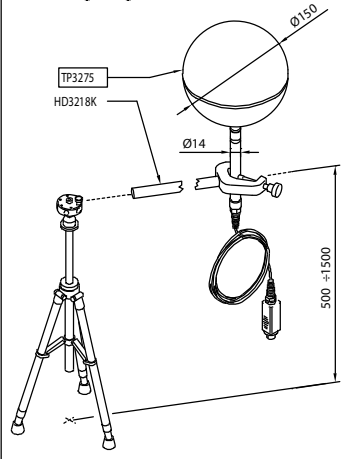
TP3276: Globe temperature probe, Pt100 sensor, globe Ø 50 mm.
Stem Ø 8 mm, length 110 mm. Cable length 2 metres. Equipped with SICRAM module. Used for measuring: **Mean radiant temperature, WBGT**.
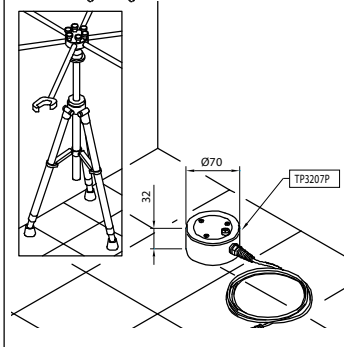Measuring range: -10°C…+100°C

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.
Measuring range: -10°C…+100°C
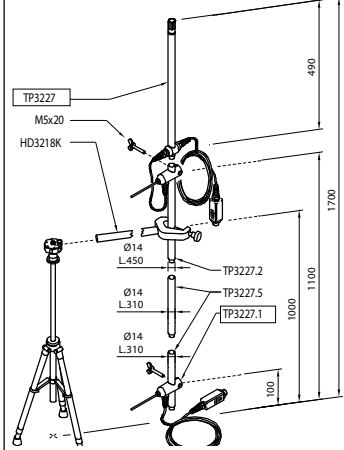
**TP3227PC:** Temperature probe composed of 2 independent probes, Pt100 sensor, one for measuring floor temperature (diameter Ø 70 mm, height 30 mm), the other for measuring temperature at the height of the ankles (diameter Ø 3 mm, height 100 mm). Cable length 2 metres. Equipped with double SICRAM module. Used for measuring **local discomfort due to vertical thermal gradient**. Measuring range: -10°C…+100°C
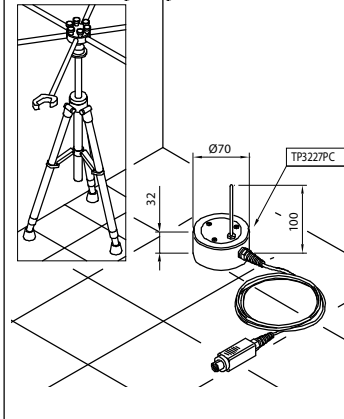

TP3207P: Pt100 sensor temperature probe, for measuring floor temperature (diameter Ø 70 mm, height 30 mm). Cable 2 meters long. Equipped with SICRAM module. Used for the assessment of dissatisfied people to floor temperature due to radiant asymmetry.
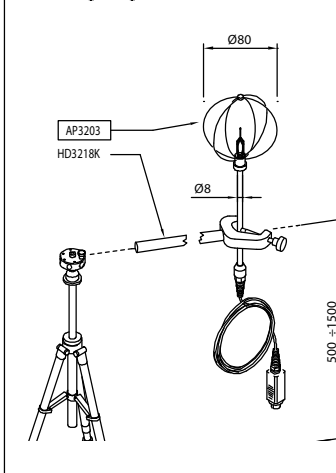Measuring range -10°C…+100°C

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**.
Measuring range: 0°C…+60°C
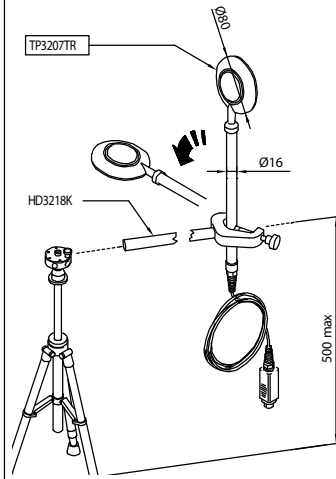
AP3203: Omnidirectional hotwire probe. Measuring range: air velocity 0÷5 m/s. Probe stem Ø 14 mm, length 110 mm. Cable length 2 metres. Equipped with SICRAM module.
Used for calculating the following indices: **IREQ, WCI, DLE, RT, PMV, PPD, SR**. Used for calculating Mean radiant temperature.
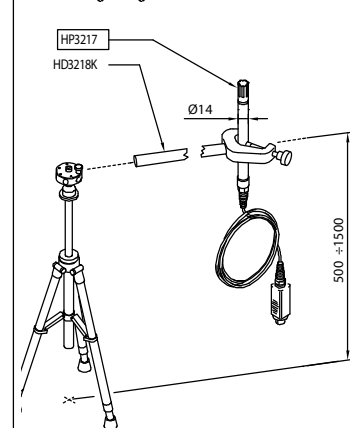Measuring range: 0°C…+80°C
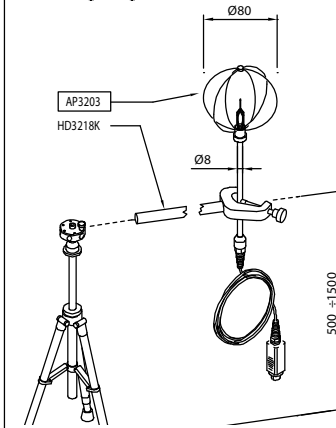
AP3203-F: Omnidirectional hotwire probe. Measuring range: air velocity 0÷5 m/s. Probe stem Ø 14 mm, length 110 mm. Cable length 2 metres. Equipped with SICRAM module.
Used for calculating the following indices: **IREQ, WCI, DLE, RT, PMV, PPD, SR**. Used for calculating Mean radiant temperature.
Measuring range: -30°C…+30°C

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**.
Measuring range: 4°C…+80°C
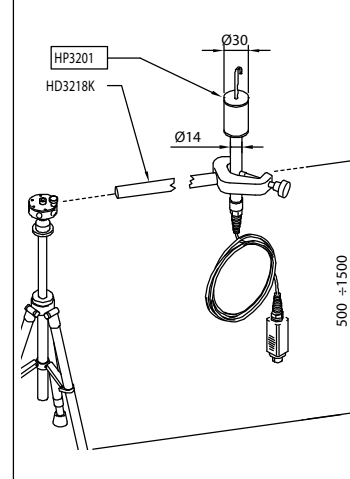
HHP3217R: Combined temperature and relative humidity probe. Capacitive RH sensor, Pt100 temperature sensor. Probe stem Ø 14 mm, length 110 mm. Cable length 2 metres. Equipped with SICRAM module.
Used for calculating the following indices: **IREQ, WCI, DLE, RT, PMV, PPD, SR**.
Measuring range: 40°C…+100°C

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.
Measuring range: 4°C…+80°C
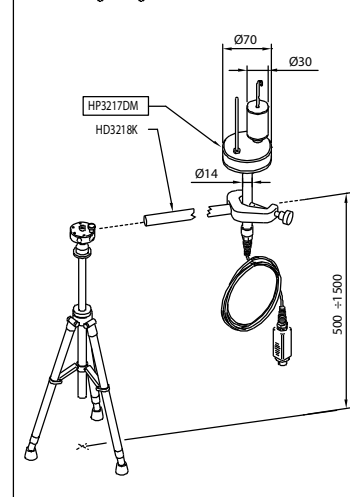
TECHNICAL DATA OF PROBES AND MODULES EQUIPPED WITH INSTRUMENT
Temperature probes Pt100 sensor with SICRAM module

Model	Type	App. range	Accuracy
TP472I	Immersion	-196°C…+500°C	±0.25°C (-196°C…+350°C) ±0.4°C (+350°C…+500°C)
TP472I.0	Immersion	-50°C…+400°C	±0.25°C (-50°C…+350°C) ±0.4°C (+350°C…+400°C)
TP473P	Penetration	-50°C…+400°C	±0.25°C (-50°C…+350°C) ±0.4°C (+350°C…+400°C)
TP473P.0	Penetration	-50°C…+400°C	±0.25°C (-50°C…+350°C) ±0.4°C (+350°C…+400°C)
TP474C	Contact	-50°C…+400°C	±0.3°C (-50°C…+350°C) ±0.4°C (+350°C…+400°C)
TP474C.0	Contact	-50°C…+400°C	±0.3°C (-50°C…+350°C) ±0.4°C (+350°C…+400°C)
TP475A.0	Air	-50°C…+250°C	±0.3°C (-50°C…+250°C)
TP472I.5	Immersion	-50°C…+400°C	±0.3°C (-50°C…+350°C) ±0.4°C (+350°C…+400°C)
TP472I.10	Immersion	-50°C…+400°C	±0.30°C (-50°C…+350°C) ±0.4°C (+350°C…+400°C)
TP49A	Immersion	-70°C…+400°C	±0.25°C (-50°C…+350°C) ±0.4°C (+350°C…+400°C)
TP49AC	Contact	-70°C…+400°C	±0.25°C (-50°C…+350°C) ±0.4°C (+350°C…+400°C)
TP49AP	Penetration	-70°C…+400°C	±0.25°C (-50°C…+350°C) ±0.4°C (+350°C…+400°C)
TP875	Globethermometer Ø 150mm	-30°C…+120°C	±0.25°C
TP876	Globethermometer Ø 50mm	-30°C…+120°C	±0.25°C
TP87	Immersion	-50°C…+200°C	±0.25°C
TP878 TP878.1	For solar panels	+5°C…+80°C	±0.25°C
TP879	For compost	-20°C…+120°C	±0.25°C

Common characteristics
Temperature drift @ 20°C   0.003%/°C

4 wire Pt100 and 2 wire Pt1000 Probes

Model	Type	Application range	Accuracy
TP47.100	Pt100 4 wires	-50…+400°C	Class A
TP47.1000	Pt1000 2 wires	-50…+400°C	Class A

Common characteristics
Temperature drift @ 20°C
Pt100   0.003%/°C
Pt1000   0.005%/°C

Probes equipped with SICRAM module
TP472I: Immersion probe, Pt100sensor. Stem Ø 3 mm, length 300 mm. Cable 2 meters long.

TP472I.0: Immersion probe, Pt100sensor. Stem Ø 3 mm, length 230 mm. Cable 2 meters long.

TP473P: Penetration probe, Pt100sensor. Stem Ø 4mm, length 150 mm. Cable 2 meters long.

TP473P.0: Penetration probe, Pt100sensor. Stem Ø 4mm, length 150 mm. Cable 2 meters long.

TP474C: Contact probe, Pt100sensor. Stem Ø 4mm, length 230mm, contact surface Ø 5mm. Cable 2 meters long.

TP474C.0: Contact probe, Pt100sensor. Stem Ø 4mm, length 230mm, contact surface Ø 5mm. Cable 2 meters long.

TP475A.0: Air probe, Pt100sensor. Stem Ø 4mm, length 230mm. Cable 2 meters long.

TP472I.5: Immersion probe, Pt100sensor. Stem Ø 6mm, length 500 mm. Cable 2 meters long.

TP472I.10: Immersion probe, Pt100sensor. Stem Ø 6mm, length 1,000mm. Cable 2 meters long.

TP49A: Immersion probe, Pt100sensor. Stem Ø 2.7mm, length 150mm. Cable 2 meters long. Aluminium handle.

TP49AC: Contact probe, Pt100sensor. Stem Ø 4 mm, length 150mm. Cable 2 meters long. Aluminium handle.

TP49AP: Penetration probe, Pt100sensor. Stem Ø 2.7mm, length 150mm. Cable 2 meters long. Aluminium handle.

TP875: Globe thermometer Ø 150 mm with handle. Cable 2 meters long.

TP876: Globe thermometer Ø 50 mm with handle. Cable 2 meters long.

TP87: Immersion probe, Pt100sensor. Stem Ø 3 mm, length 70 mm. Cable 2 meters long.

TP878: Contact probe for solar panels. Cable 2 meters long.

TP878.1: Contact probe for solar panels. Cable 5 meters long

TP879: Penetration probe for compost. Stem Ø 8 mm, length 1 meter. Cable 2 meters long.

Temperature probes without SICRAM module
TP47.100: Direct 4 wires Pt100 sensor immersion probe. Stem Ø 3 mm, length 230mm. 4 wires connection cable with connector, 2 meters long.

TP47.1000: Pt1000 sensor immersion probe. Stem Ø 3 mm, length 230mm. 2 wires connection cable with connector, 2 meters long.

TP47: Only connector for probe connection without SICRAM module: direct 3 and 4 wires Pt100, 2 wires Pt1000.
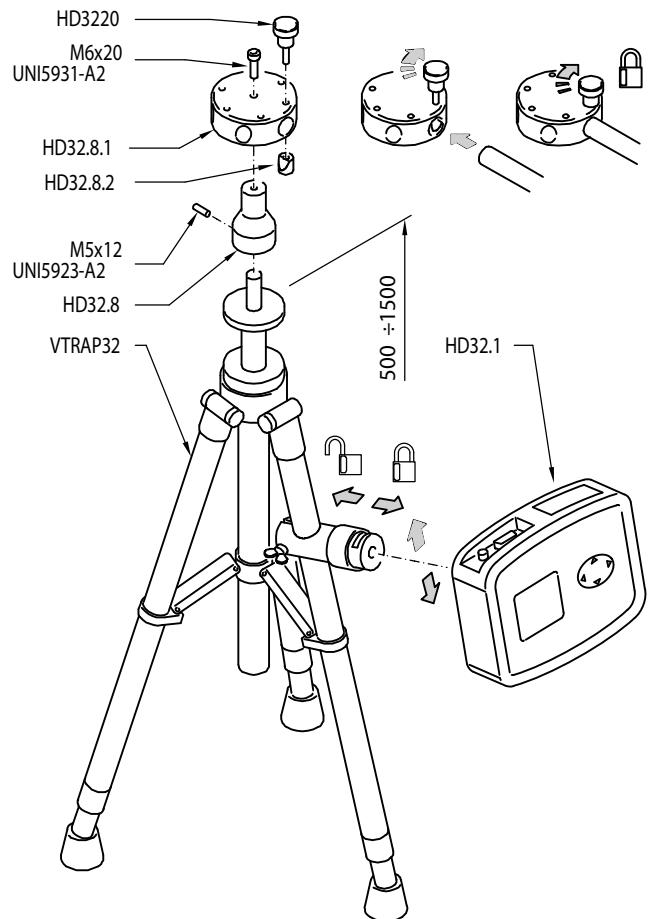
Relative humidity and temperature probes using SICRAM module

Model	Temperature sensor	Working range %RH	Working range Temperature	Accuracy %RH	Accuracy Temp
HP472ACR	Pt100	0…100%RH	-20°C…+80°C	0°C…40°C ±1,5%RH (5…90%RH) ±2,5%RH (90…100%RH)	±0.3°C
HP572ACR	Thermocouple K	0…100%RH	-20°C…+80°C		±0.5°C
HP473ACR	Pt100	0…100%RH	-20°C…+80°C		±0.3°C
HP474ACR	Pt100	0…100%RH	-40°C…+150°C	-40°C…150°C (180°C) ±(1,5+0,02 times the displayed value)	±0.3°C
HP475ACR	Pt100	0…100%RH	-40°C…+150°C		±0.3°C
HP475AC1R	Pt100	0…100%RH	-40°C…+150°C		±0.3°C
HP477DCR	Pt100	0…100%RH	-40°C…+150°C		±0.3°C
HP478ACR	Pt100	0…100%RH	-40°C…+150°C		±0.3°C

Common characteristics
Relative humidity

Sensor	Capacitive
Typical capacity @30%RH	300pF
Temperature drift @ 20°C	0.02%RH/°C
Response time %RH at constant temperature	10sec (10÷80%RH; air speed=2m/s, at constant temperature)

Temperature with Pt100 sensor

Temperature drift @ 20°C   0.003%/°C

Temperature with thermocouple K - HP572AC

Resolution	0.1°C
Temperature drift @ 20°C	0.02%/°C

Relative humidity and temperature probes complete with SICRAM module

HP472ACR: %RH and temperature combined probe, dimensions Ø 26x170 mm. 2 m connecting cable.

HP572ACR: %RH and temperature combined probe, **K thermocouple sensor**. Dimensions Ø 26x170 mm. 2 m connecting cable.

HP473ACR: %RH and temperature combined probe. Dimensions: handle Ø 26x130 mm, probe Ø 14x110 mm. 2m connecting cable.

HP474ACR: %RH and temperature combined probe. Dimensions: handle Ø 26x130 mm, probe Ø 14x210 mm. 2m connecting cable.

HP475ACR: %RH and temperature combined probe. 2 m connecting cable. Handle Ø 26x110 mm. Stainless-steel tube Ø 12x560 mm. Terminal tip Ø 13.5x75 mm.

HP475AC1R: %RH and temperature combined probe. 2 m connection cable. Handle Ø 26x110 mm. Stainless steel stem Ø 14x480 mm.

HP477DCR: %RH and temperature combined sword probe. 2 m connecting cable. Handle Ø 26x110 mm. Probe tube 18x4 mm, length 520 mm.

HP478ACR: %RH and temperature combined probe. Dimensions Ø 14x130 mm. 5m connection cable.

PROBES AND MODULES TECHNICAL DATA EQUIPPED WITH INSTRUMENT
Wind speed measurement probes
Hot-wire probes: AP471 S1 - AP471 S2 - AP471 S3 - AP471 S4 - AP471 S5

	AP471 S1 - AP471 S3	AP471 S2	AP471 S4 AP471 S5
Type of measure	Air speed, calculated flow rate, air temperature		
Type of sensor			
Speed	NTC thermistor	Omnidirectional NTC thermistor	
Temperature	NTC thermistor	NTC thermistor	
Measurement range			
Speed	0,1…40m/s	0,1…5m/s	
Temperature	-25…+80°C	-25…+80°C	0…80°C
Measurement resolution:			
Speed	0.01 m/s 0.1 km/h 1 ft/min 0.1 mph 0.1 knot		
Temperature	0.1°C		
Measurement accuracy:			
Speed	±0.1 m/s (0…0.99 m/s)	±0.05m/s (0…0.99 m/s)	
	±0.3 m/s (1.00…9.99 m/s)	±0.15m/s (1.00…5.00 m/s)	
	±0.8 m/s (10.00…40.0 m/s)		
Temperature	±0.8°C (-10…+80°C)	±0.8°C (-10…+80°C)	
Minimum speed	0.1 m/s		
Air temperature compensation	0…80°C		
Sensor working conditions	Clean air, RH<80%		
Battery life	Approx. 20 hours @ 20 m/s with alkaline batteries	Approx. 30 hours @ 5 m/s with alkaline batteries	
Unit of Measurement			
Speed	m/s – km/h – ft/min – mph – knot		
Flow rate	l/s - m³/s - m³/min - m³/h - ft³/s - ft³/min		
Pipeline section for flow rate calculation	0.0001…1.9999 m²		
Cable length	~2m		

Vane probes: AP472 S1… - AP472 S2 - AP472 S4…

	AP472 S1…	AP472 S2	AP472 S4… L	AP472 S4… LT	AP472 S4… H	AP472 S4… HT
Type of measure	Air speed, calculated flow rate, air temperature	Air speed, calculated flow rate	Air speed, calculated flow rate.	Air speed, calculated flow rate, air temperature.	Air speed, calculated flow rate.	Air speed, calculated flow rate, air temperature.
Diameter	100mm	60mm	16mm			
Type of measurement						
Speed	Vane	Vane	Vane			
Temperature	K thermocouple	----	----	K thermocouple	----	K thermocouple
Measurement range						
Speed (m/s)	0.6…25	0.5…20	0.8…20		10…40	
Temperature (°C)	-25…+80 (*)		-25…+80 (*)			
Resolution						
Speed	0.01 m/s 0.1 km/h 1 ft/min 0.1 mph 0.1 knot					
Temperature	0.1°C	----	----	0.1°C	----	0.1°C
Accuracy						
Speed	±(0.3 m/s +1.5%f.s.)	±(0.3m/s +1.5%f.s.)	±(0.4 m/s +1.5%f.s.)			
Temperature	±0.8°C	----	----	±0.8°C	----	±0.8°C
Minimum speed	0.6m/s	0.5m/s	0.8m/s		10m/s	
Unit of Measurement						
Speed	m/s – km/h – ft/min – mph – knot					
Flow rate	l/s - m³/s - m³/min - m³/h - ft³/s - ft³/min					
Pipeline section for flow rate calculation	0.0001…1.9999 m²					
Cable length	~2m					

(*) The indicated value refers to the vane's working range.

Probes complete with SICRAM module
AIR speed measurement probes

Hot-wire PROBES:

AP471 S1: Hot-wire telescopic probe, measuring range: 0.1…40m/s. Cable length 2 metres.

AP471 S2: Omnidirectional hot-wire probe, measuring range: 0.1…5m/s. Cable length 2 metres.

AP471 S3: Hot-wire telescopic probe with terminal tip for easy position, measuring range: 0.1…40m/s. Cable length 2 metres.

AP471 S4: Omnidirectional hot-wire telescopic probe with base, measuring range: 0.1…5m/s. Cable length 2 metres.

AP471 S5: Omnidirectional hot-wire telescopic probe, measuring range: 0.1…5m/s. Cable length 2 metres.

Vane probes:

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

AP472 S2: Vane probe, Ø 60mm. Speed from 0.5 to 20m/s. Cable length 2 metres.

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

AP472 S4LT: Vane probe with thermocouple, Ø 16mm, speed from 0.8 to 20m/s. Temperature from -25 to 80°C with thermocouple K sensor. Cable length 2 metres.

AP472 S4H: Vane probe, Ø 16mm speed from 10 to 40m/s. Cable length 2 metres.

AP472 S4HT: Vane probe with thermocouple, Ø 16mm speed from 10 to 50m/s. Temperature from -25 to 80°C with thermocouple K sensor[*]. Cable length 2 metres.

Technical characteristics of photometric and radiometric probes complete with SICRAM module equipped with the instruments

ILLUMINANCE measurement probe LP 471 PHOT				
Measurement range (lux):	0.01…199.99	…1999.9	…19999	…199.99·10³
Resolution (lux):	0.01	0.1	1	0.01·10³
Spectral range:	in agreement with standard photopic curve V(λ)			
Class	C (B on request)			
Calibration uncertainty:	<4%			
f'1 (in agreement with photopic response V(λ)):	<8%			
f_2 (response according to the cosine law):	<3%			
f_3 (linearity):	<1%			
f_4 (instrument reading error):	<0.5%			
f_5 (fatigue):	<0.5%			
α (temp. coefficient) f_6 (T)	<0.05%K			
Drift after 1 year:	<1%			
Functioning temperature:	0…50°C			
Reference Standards	CIE n.69 - UNI 11142			

Photometric probe for **ILLUMINANCE** measurement, spectral response in agreement with standard photopic vision, diffuser for cosine correction.
Measurement range: 0.01 lux…200·10³ lux.
CIE69, UNI11142

Typical response curve: LP 471 PHOT
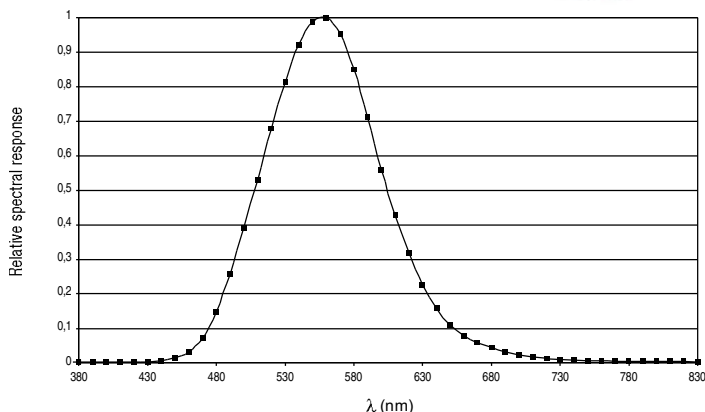
LUMINANCE measurement probe LP 471 LUM 2				
Measurement range (cd/m²):	0.1…1999.9	…19999	…199.99·10³	…1999.9·10³
Resolution (cd/m²):	0.1	1	0.01·10³	0.1·10³
Optical angle:	2°			
Spectral range:	in agreement with standard photopic curve V(λ)			
Class	C			
Calibration uncertainty:	<5%			
f'1 (in agreement with photopic response V(λ)):	<8%			
f_3 (linearity):	<1%			
f_4 (instrument reading error):	<0.5%			
f_5 (fatigue):	<0.5%			
α (temp. coefficient) f_6 (T)	<0.05%K			
Drift after 1 year:	<1%			
Functioning temperature:	0…50°C			
Reference Standards	CIE n.69 - UNI 11142			

Photometric probe for **LUMINANCE** measurement, spectral response in agreement with standard photopic vision, vision angle 2°.
Measurement range: 0.1 cd/m²…2000·10³ cd/m².

Typical response curve: LP 471 LUM2
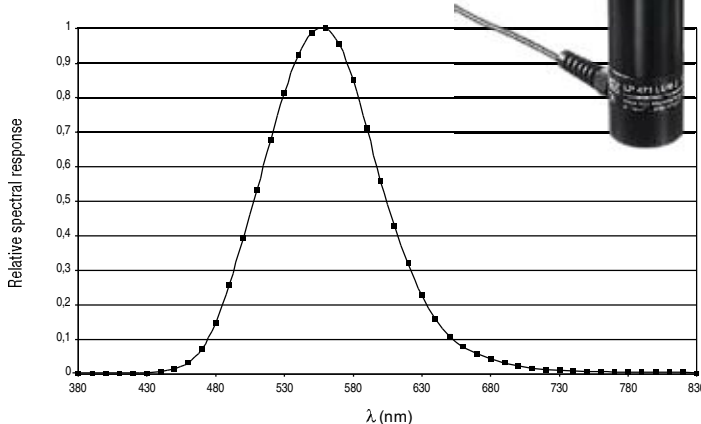
Quantum radiometric probe for the measurement of the photon flow across the chlorophyll range PAR LP 471 PAR			
Measurement range (μmol/m⁻²s⁻¹):	0.01…199.99	200.0…1999.9	2000…10000
Resolution (μmol/m⁻²s⁻¹):	0.01	0.1	1
Spectral range:	400nm…700nm		
Calibration uncertainty:	<5%		
f_3 (linearity):	<1%		
f_4 (instrument reading error):	±1digit		
f_5 (fatigue):	<0.5%		
Drift after 1 year:	<1%		
Working temperature:	0…50°C		

Quantum radiometric probe for the measurement of the photon flow across the chlorophyll range **PAR** (Photosynthetically Active Radiation 400nm…700nm), measurement in μmol/m²s. Measurement range: 0.01μmol/m⁻²s⁻¹…10·10³μmol/m⁻²s⁻¹.
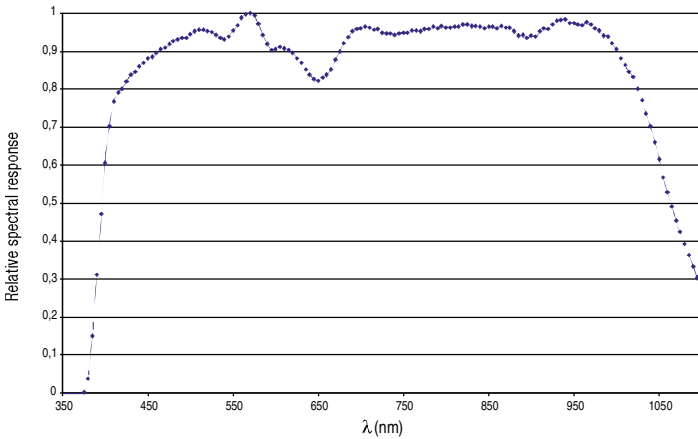
Typical response curve: LP 471 PAR
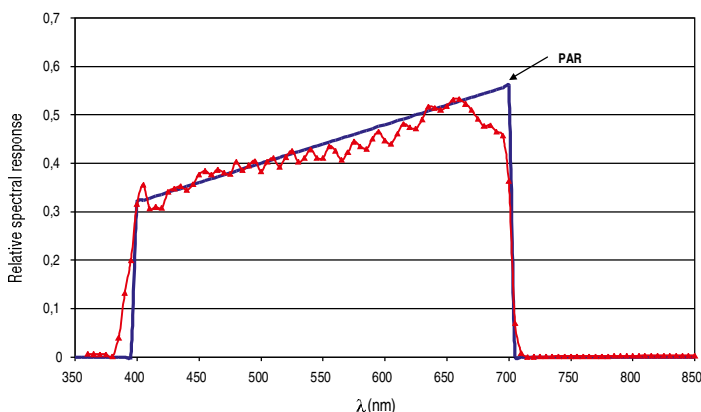
IRRADIANCE measurement probe LP 471 RAD			
Measurement range (W/m^2):	$0.1 \cdot 10^{-3}$ … $999.9 \cdot 10^{-3}$	1.000 …19.999	20.00 …199.99	200.0 …1999.9
Resolution (W/m^2):	$0.1 \cdot 10^{-3}$	0.001	0.01	0.1
Spectral range:	400nm…1050nm			
Calibration uncertainty:	<5%			
f_3 (linearity):	<1%			
f_4 (instrument reading error):	±1digit			
f_5 (fatigue):	<0.5%			
Drift after 1 year:	<1%			
Working temperature:	0…50°C			

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

Typical response curve: LP 471 RAD

IRRADIANCE measurement probe LP 471 UVB			
Measurement range (W/m^2):	$0.1 \cdot 10^{-3}$ … $999.9 \cdot 10^{-3}$	1.000 …19.999	20.00 …199.99	200.0 …1999.9
Resolution (W/m^2):	$0.1 \cdot 10^{-3}$	0.001	0.01	0.1
Spectral range:	280nm…315nm (Peak 305nm)			
Calibration uncertainty:	<5%			
f_3 (linearity):	<2%			
f_4 (instrument reading error):	±1digit			
f_5 (fatigue):	<0.5%			
Drift after 1 year:	<2%			
Working temperature:	0…50°C			

Radiometric probe for **IRRADIANCE** measurement, in the spectral range 280nm…315nm, peak 305nm, **UVB.** Measurement range: $0.1 \cdot 10^{-3}$W/m^2…2000 W/m^2.

Typical response curve: LP 471 UVB
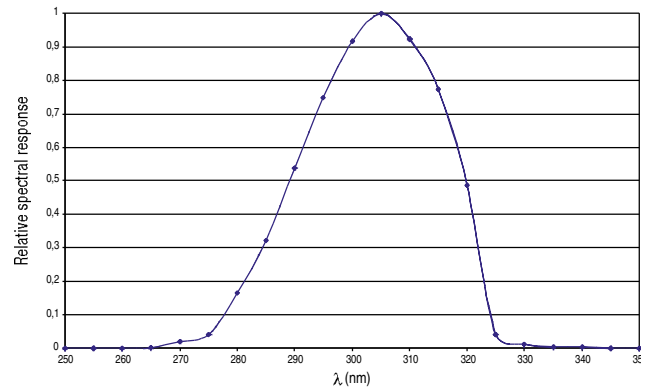
IRRADIANCE measurement probe LP 471 UVA			
Measurement range (W/m^2):	$0.1 \cdot 10^{-3}$ … $999.9 \cdot 10^{-3}$	1.000 …19.999	20.00 …199.99	200.0 …1999.9
Resolution (W/m^2):	$0.1 \cdot 10^{-3}$	0.001	0.01	0.1
Spectral range:	315nm…400nm (Peak 360nm)			
Calibration uncertainty:	<5%			
f_3 (linearity):	<1%			
f_4 (instrument reading error):	±1digit			
f_5 (fatigue):	<0.5%			
Drift after 1 year:	<2%			
Working temperature:	0…50°C			

Radiometric probe for **IRRADIANCE** measurement, in the 315nm…400nm, peak 360nm, **UVA** spectral range. Measurement range: $0.1 \cdot 10^{-3}$W/m^2…2000 W/m^2.

Typical response curve: LP 471 UVA
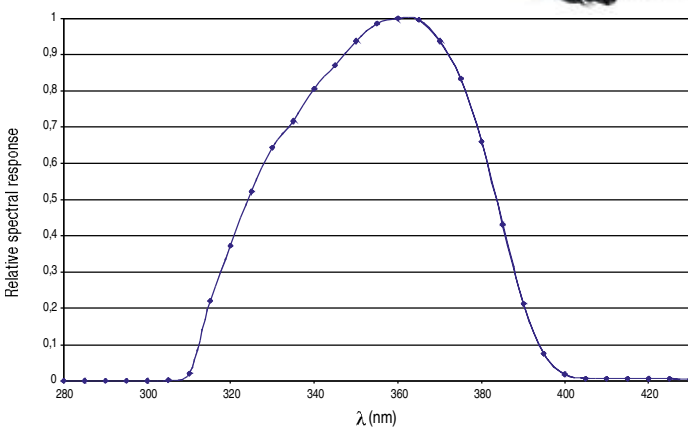
IRRADIANCE measurement probe LP 471 UVC			
Measurement range (W/m^2):	$0.1 \cdot 10^{-3}$ … $999.9 \cdot 10^{-3}$	1.000 …19.999	20.00 …199.99	200.0 …1999.9
Resolution (W/m^2):	$0.1 \cdot 10^{-3}$	0.001	0.01	0.1
Spectral range:	220nm…280nm (Peak 260nm)			
Calibration uncertainty:	<5%			
f_3 (linearity):	<1%			
f_4 (instrument reading error):	±1digit			
f_5 (fatigue):	<0.5%			
Drift after 1 year:	<2%			
Working temperature:	0…50°C			

Radiometric probe for **IRRADIANCE** measurement, in the spectral range 220nm…280nm, peak 260nm, **UVC**. Measurement range: $0.1 \cdot 10^{-3}$W/m^2…2000 W/m^2.

Typical response curve: LP 471 UVC
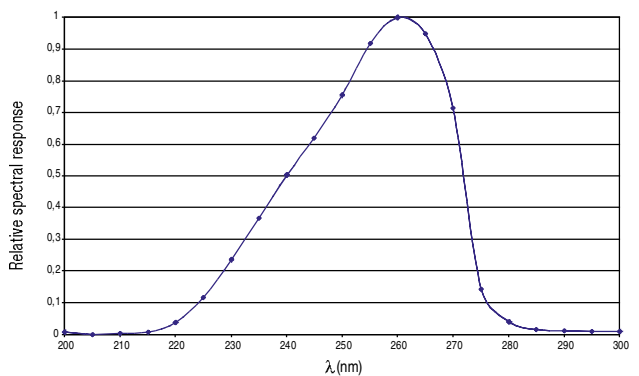
Measurement probe LP 471ERY of TOTAL EFFECTIVE IRRADIANCE (W/m²) according to the UV action curve UV (CEI EN 60335-2-27)				
Measurement range (W_{eff}/m²):	$0.1 \cdot 10^{-3}$ … $999.9 \cdot 10^{-3}$	1.000 …19.999	20.00 …199.99	200.0 …1999.9
Resolution (W_{eff}/m²):	$0.1 \cdot 10^{-3}$	0.001	0.01	0.1
Spectral range:	UV action curve for erythema measurement (250nm…400nm)			
Calibration uncertainty:	<15%			
f_3 (linearity):	<3%			
f_4 (instrument reading error	±1digit			
f_5 (fatigue):	<0.5%			
Drift after 1 year	<2%			
Working temperature:	0…50°C			
Reference standard	CEI EN 60335-2-27			

Radiometric probe for **EFFECTIVE TOTAL IRRADIANCE**
(W_{eff}/m²) according to the UV action curve
(CIE EN 60335-2-27). Spectral range: 250 nm…400 nm,
Measurement range: $0.1 \cdot 10^{-3} W_{eff}$ /m² … 2000 W_{eff} /m²

Typical response curve: LP 471 ERY
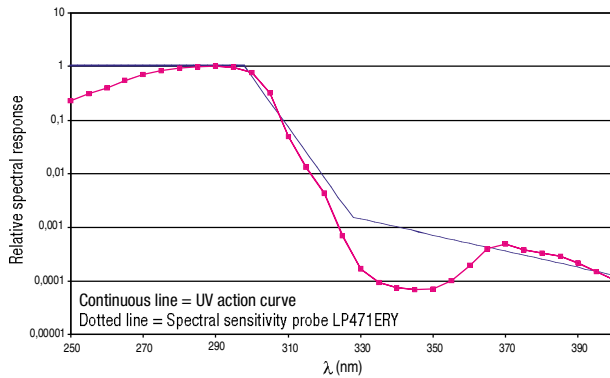
The probe LP 471 ERY measures the effective total irradiance (W_{eff}/m²) according to the UV action curve (CEI EN 60335-2-27). A particular type of photodiode and a combination of special filters bring the spectral response closer to the UV action curve. CEI EN 60335-2-27 standards establish a maximum allowable dose of 100J/m² for first-time exposure and an annual dose of 15000J/m². The typical spectral response curve of LP 471 ERY is shown in the Figure together with the UV action curve. The good accordance between the two curves enables the instrument to take reliable measurements of different types of lamps (and filters) used at present for tonning machines.

Probes complete with SICRAM module

LP 471 PHOT: Photometric probe for **ILLUMINANCE** measurement complete with SICRAM module, spectral response in agreement with standard photopic vision, diffuser for cosine correction. Measurement range: 0.01 lux…200·10³ lux.

LP 471 LUM 2: Photometric probe for **LUMINANCE** measurement complete with SICRAM module, spectral response in agreement with standard photopic vision, vision angle 2°. Measurement range: 0.1 cd/m²…2000·10³ cd/m².

LP 471 PAR: Quantum radiometric probe for the measurement of the photon flow across the chlorophyll range **PAR** (Photosynthetically Active Radiation 400nm…700nm) complete with SICRAM, measurement in µmol/m⁻²s⁻¹, diffuser for cosine correction. Measurement range: 0.01µmol/m⁻²s⁻¹…10·10³µmol/m⁻²s⁻¹.

LP 471 RAD: Radiometric probe for **IRRADIANCE** measurement complete with SICRAM module; in the 400nm…1050nm spectral range, diffuser for cosine correction. Measurement range: $0.1 \cdot 10^{-3}$W/m² …2000 W/m².

LP 471 UVA: Radiometric probe for **IRRADIANCE** measurement complete with SICRAM module; in the 315nm…400nm, peak 360nm, **UVA** spectral range, quartz diffuser for cosine correction. Measurement range: $0.1 \cdot 10^{-3}$W/m²…2000 W/m².

LP 471 UVB: Radiometric probe for **IRRADIANCE** measurement complete with SICRAM module, in the 280nm…315nm, peak 305nm, **UVB** spectral range, quartz diffuser for cosine correction. Measurement range: $0.1 \cdot 10^{-3}$W/m²…2000 W/m².

LP 471 UVC: Radiometric probe for **IRRADIANCE** measurement complete with SICRAM module, in the 220nm…280nm, peak 260nm, **UVC** spectral range, quartz diffuser for cosine correction. Measurement range: $0.1 \cdot 10^{-3}$W/m²…2000 W/m².

LP 471 ERY: Radiometric probe for **EFFECTIVE TOTAL IRRADIANCE** (W_{eff}/m²) according to the UV action curve (CEI EN 60335-2-27) complete with SICRAM module. Spectral range: 250 nm…400 nm, quartz diffuser for cosine correction. Measurement range: $0.1 \cdot 10^{-3} W_{eff}$ /m² … 2000 W_{eff} /m²

LP BL: Base with levelling device (except LP 471 LUM 2).

CO and CO₂ probes equipped with SICRAM module

HD320A2: Carbon monoxide (CO) probe, fullscale 500ppm. 2m cable. Complete with SICRAM module.

HD320B2: CO_2 probe, fullscale 500 ppm. Ø 14 mm, total length 200 mm. 2 m cable. Complete with SICRAM module.

HD320AS2

HD320A2

HD320B2

HD320A

HD320B

HD 32.2
INSTRUMENT FOR THE ANALYSIS OF THE 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 **Tg**.
- Wet bulb temperature with natural ventilation Tn.
- 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
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 (HP3201).**
- **TP3276.2 Globe thermometer probe (TP3276 or TP3275).**
- **TP3207.2 (TP3207) Dry bulb temperature, if 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**

HD2110/USB

HD2110/RS

SWD10

VTRAP30

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	< 45µA
instrument off	
Safety of the stored data	unlimited

TP3276.2

HP3201.2

TP3207.2

RS232
USB

External power supply

HD32.2

Example of immediate data print, obtained with HD40.1 printer.

```
=========================
   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
=========================
Notes:
=========================
```

NOTES

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 buld
Globe thermometer ventilation
Dry bulb temperature
WBGT in absence of direct solar radiation
WBGT in presence of direct solar radiation

HD40.1

TP3207.2 (TP3207) 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 T_{95}:	15 minutes

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

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 dimensions:	Ø=8 mm L= 170 mm
Response time T_{95}:	15 minutes

HP3201.2 (HP3201) 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 T_{95}:	15 minutes

Connections

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

AP3203.2
HP3217.2   TP3276.2

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
Stop bit:	1
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.

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
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 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

HD32.2A 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 version A**:
 • **TP3207** Dry bulb temperature.
 • **TP3275** Globe thermometer probe.
 • **TP3201** Natural ventilation wet bulb.

HP3201.2   TP3276.2   TP3207.2

Probes for HD32.2 WBGT Index:

TP3207.2: Temperature probe with 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 170 mm. Equipped with SICRAM module, spare parts of the braid and case of 50cc. distilled water.

Probes for HD32.2 version A:

TP3207: Temperature probe with Pt100 sensor. Probe stem Ø 14mm, length 140 mm. Cable length 2m. Equipped with SICRAM module. Used for the calculation of the indicies: **IREQ,WCI, DLE, RT, PMV, PPD, WBGT, SR**. Used for calculating Mean radiant temperature.

TP3275: Globe thermometer probe with Pt100 sensor, globe Ø 150 mm. Stem Ø 14 mm, length 110 mm. Cable length 2m. Equipped with SICRAM module. Used for calculating Mean radiant temperature and WBGT.

HP3201.2: Natural ventilation wet bulb. Pt100 sensor. Probe stem Ø 14 mm, length 110 mm. Cable length 2m. Equipped with SICRAM module, spare braids and 50cc of distilled water. Used for the measurement for WBGT calculation.

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

BAT.40: Spare battery pack for HD40.1 and HD40.2 printer with built-in temperature sensor.

RCT: The kit includes 4 thermal paper rolls, wide 57mm, diameter 32mm.

TP3275

HP3201   TP3207

HD32.2A

HD32.2.7

Microclimate - WBGT
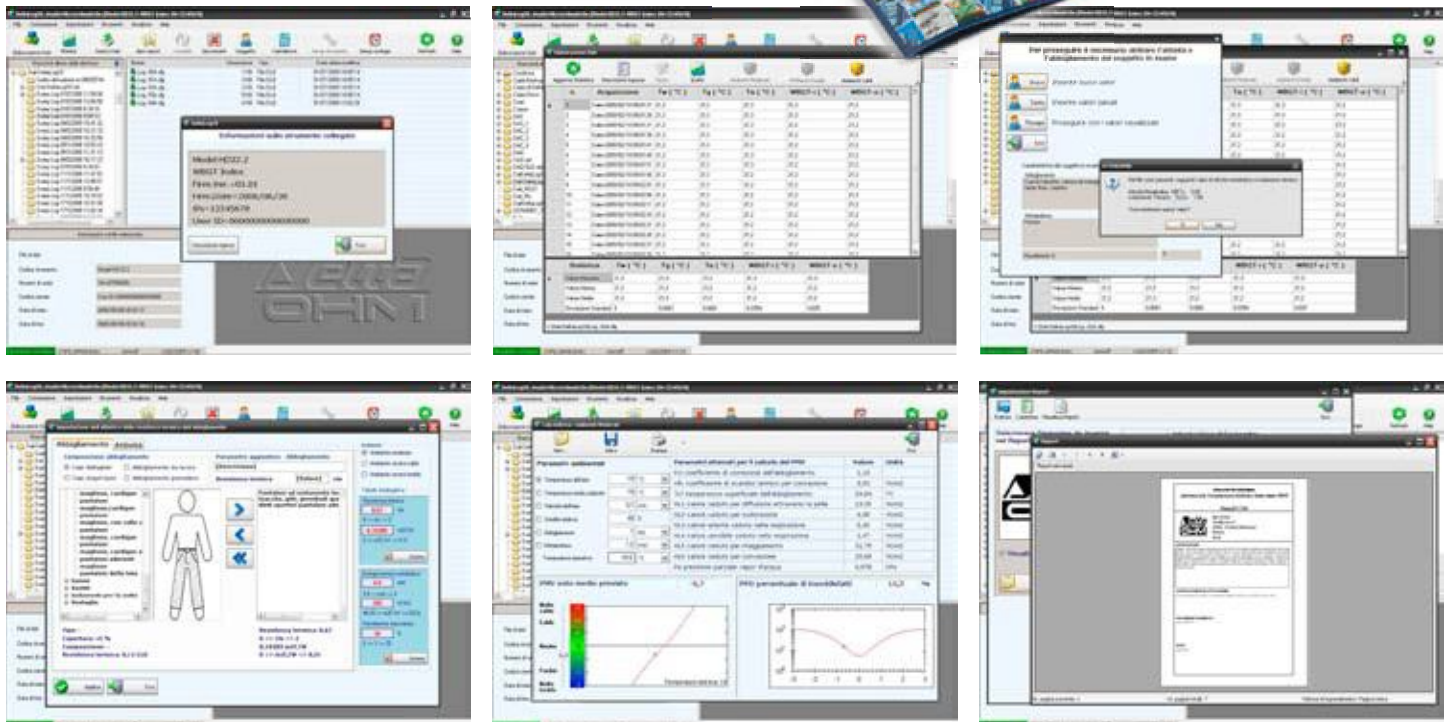
HD 32.3
INSTRUMENT FOR THE ANALYSIS OF THE INDICES:
WBGT - PMV - PPD

HD32.3 – WBGT - PMV Index is an instrument made by **Delta Ohm Srl** for:
- Analysis of hot environments using **WBGT** index (Wet Bulb Glob 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 **Tg** with **TP3276.2 (or TP3775)** probe.
- Natural wet bulb temperature **Tn** with **HP3201.2 (or HP3201)** probe.
- Environment temperature **T** with **TP3207.2** probe.
- Relative humidity **RH** and environment temperature **T** with **HP3217.2 (or TP3217)** probe.
- Air speed **Va** with **AP3203.2** probe.

Starting from the measured values, HD32.3 can **calculate** and **display,** with **TP3207.2R (or TP3207), HP3276.2 (or TP3775),** and **HP3201.2 (or HP3201)** probes, the following indexes:
- **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.

Starting from the measured values, the HD32.3 instrument can **calculate** and **display,** with **TP3217.2 (or TP3217), HP3276.2 (or HP3275),** and **AP3203.2 (or AP3203)** probes, the following indexes:
- Medium radiant temperature **Tr**.
- **PMV** Index (Predicted Mean Vote).
- **PPD** Index (Predicted Percentage of Dissatisfied).

WBGT

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 (or HP3201).**
- **TP3276.2 (or TP3275) Globe thermometer probe.**
- **TP3207.2 (or TP3207) 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 (Ta, Tr, Va, 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 ÷ 4 met
• Thermal resistance of clothing = 0 ÷ 2 clo
• Dry bulb temperature = 10 ÷ 30°C
• Medium radiant temperature = 10 ÷ 40°C
• Air speed = 0 ÷ 1 m/sec
• Water vapour pressure = 0 ÷ 2,7 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).

AP3203.2

TP3276.2

HP3217.2

HD40.1

RS232 USB

HP32.3

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  %
==========================
```

NOTES

Reference regulation

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

Table 1: valuation scale of the thermal environment

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, 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 (cod. SWD10)	12Vdc/1A
Batteries	4 batteries 1.5V type AA
Autonomy	200 hours with 1800mAh alkaline batteries
Power absorbed with	< 45μA
instrument off	
Safety of the stored data	Unlimited

TP3207.2 (TP3207) 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 T_{95}:	15 minutes

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

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 T_{95}:	15 minutes

HP3201.2 (HD3201) 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 T_{95}:	15 minutes

HP3217.2 (HP3217R) 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:	± 2%RH (15 ÷ 90 %RH) @ 20°C
	± 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 T_{95}:	15 minutes
Resolution:	0.1%RH, 0.1% °C

AP3203.2 (AP3203) 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

Connections

Input for SICRAM module probes	3 Connectors 8 male poles DIN 45326
Serial interface:	
Pin:	M12-8 poles.
Type:	RS232C (EIA/TIA574) or USB 1.1 o 2.0 no isolated

HD2110/USB

HD2110/RS

SWD10

VTRAP30

Baud rate:	from 1200 to 38400 baud.
	with USB baud=460800
Data bit:	8
Parity:	None
Stop Bit:	1
Flow Control:	Xon-Xoff
Cable length:	max 15m
Memory	divided in 64 blocks.
Storage capacity	67600 memorizations for each of 3 inputs.
Logging interval	selectable among: 15, 30 seconds, 1, 2, 5,
	10, 15, 20, 30 minutes and 1 hour.

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
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

HD32.3 is composed of:
• Instrument HD32.3, 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.

HD32.3A is composed of:
• Instrument HD32.3, 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 (TP3207)** Dry bulb temperature probe.
• **TP3276.2 (TP3275)** Globe thermometer probe.
• **HP3201.2 (HP3201) Natural w**et bulb temperature probe with natural ventilation.
The **probes** required for **PMV** measurement are:
• **HP3217.2 (HP3217R)** Combined e temperature and relative humidity probe
• **AP3203.2 (AP3203)** Omni-directional hot wire probe.
• **TP3276.2 (TP3275)** 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: Omni-directional 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 and PPD measurement.**

Probes for HD32.3 version A:
TP3207: Temperature probe with Pt100 sensor. Probe stem Ø 14mm, length 150mm. Cable 2m long. Equipped with SICRAM module. **Used for the calculation of the following indices:**
IREQ, WCI, DLE, RT, PMV, PPD, WBGT, SR.
TP3275: Globe thermometer sensor Pt100, globe Ø 150 mm. Stem Ø 14 mm, length 110 mm. Cable 2m long. Equipped with SICRAM module. **Used for Mean radiant temperature, WBGT.**
HP3201: Natural wet bulb. Pt100 sensor. Probe stem Ø 14 mm, length 110 mm. Equipped with SICRAM module, spare braid and 50 cc of distilled water. **Used for WBGT measurement.**
HP3217R: 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 and PPD measurement.**

AP3203: Omni-directional 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 and PPD 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)
BAT.40: Spare battery pack for HD40.1 and HD40.2 printer with built-in temperature sensor.
RCT: The kit includes 4 thermal paper rolls, wide 57mm, diameter 32mm.

HD32.2.7

TP3275

AP3203

HP3217R

HP32.2.7

HD32.3A