HD32.1 *Thermal Microclimate*

Strumento per lo studio, la misura e la verifica del Microclima
Instrument for studying, measuring and controlling the Microclimate

UNI EN ISO 7726

UNI EN ISO 7730

UNI EN ISO 27243

UNI EN ISO 7933

UNI ENV ISO 11079

UNI EN ISO 8996

t_r	PPD	t_o	WBGT$_{Indoor}$	SW$_p$	PHS	DLE	WCI	PD$_f$
PMV	DR	t_{eq}	WBGT$_{Outdoor}$	E$_p$	IREQ	RT	PD$_v$	PD$_\Delta$

HD32.1

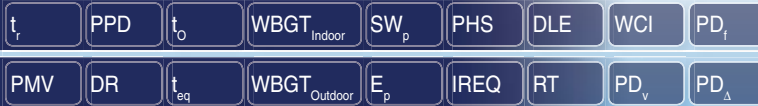| t_r	PPD	t_O	WBGT$_{Indoor}$	SW$_p$	PHS	DLE	WCI	PD$_f$
PMV	DR	t_{eq}	WBGT$_{Outdoor}$	E$_p$	IREQ	RT	PD$_v$	PD$_\Delta$

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 :** 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$_\Delta$:** Percentage Dissatisfied due to radiant asymmetry

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

The following table indicates the instrument memory capacity:

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

▶ *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 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.

▶ **EXPLANATORY TABLES - HOW TO USE PROBES FOR MICROCLIMATIC MEASUREMENTS**

DeltaLog10 Software	Operating program	Main calculated indices		Environments	Standard
DeltaLog10 BASIC	**A Prog.**	t_a : t_r : **PMV** : **PPD** : **DR** : t_o : t_{eq} :	Air temperature Mean radiant temperature Predicted mean vote Predicted Percentage Dissatisfied Draught rating Operative temperature Equivalent temperature	Moderate	UNI EN ISO 7730
DeltaLog10 Hot environments	**A Prog.**	**WBGT** : 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_f : 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/m²** : **µW/m²** : **W/m²** : **µmol/m²s** :	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	HP3217	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**)	•					•	
						•	
						•	•

▶ 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	HP3217	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	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

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
PD$_v$:	Percentage Dissatisfied with vertical temperature difference (head-ankles).	•		•	
PD$_f$:	Percentage Dissatisfied with floor temperature.		•		
				•	
PD$_\Delta$:	Percentage Dissatisfied with radiant asymmetry.				•

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 26x130 mm, probe Ø 14x210 mm. Connection cable 2 metres.

HP475AC: Combined %RH and Temperature probe. Connection cable 2 metres. Handle Ø 26x110 mm. Stainless steel stem Ø 12x560 mm. Point Ø 13.5x75 mm.

HP475AC.1: Combined %RH and Temperature probe. Stainless steel stem Ø14x500 mm 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 **ILLUMINAMNCE** equipped with SICRAM module, spectral response in agreement with standard photopic vision, diffuser for cosine correction. Measuring range: 0.01 lux…200·10^3 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/m^2…2000·10^3 cd/m^2.

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/m^2s, diffuser for cosine correction. Measuring range 0.01μmol/m^2s…10·10^3μmol/m^2s

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: 0.1·10^{-3}W/m^2…2000 W/m^2.

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: 0.1·10^{-3}W/m^2…2000 W/m^2.

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: 0.1·10^{-3}W/m^2…2000 W/m^2.

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: 0.1·10^{-3}W/m^2…2000 W/m^2.

LP 471 ERY: Radiometric probe for measuring **TOTAL EFFECTIVE IRRADIANCE** (W_{eff}/m^2) 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: 0.1·$10^{-3}W_{eff}$/m^2…2000 W_{eff}/m^2.

Costruzione strumenti di misura portatili e da tavolo
Trasmettitori a loop di corrente o tensione
Temperatura - Umidità - Pressione
Velocità dell'aria - Luce - Acustica
pH - Conducibilità - Ossigeno disciolto - Torbidità
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Temperatura - Umidità - Pressione - Acustica - Fotometria/Radiometria

SIT CENTRE N°124
Temperature - Humidity - Pressure - Photometry/Radiometry - Acoustics

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