

HD48... SERIES, HD 49... SERIES



HD48...SERIES, HD49...SERIES PASSIVE OR ACTIVE TRANSMITTERS - TEMPERATURE, RELATIVE HUMIDITY AND TEMPERATURE, DEW POINT AND TEMPERATURE

HD48... and HD49... series of transmitters measure temperature, relative humidity and the dew point temperature.

Versions with only standard analog output or with only RS485 output with MODBUS- RTU protocol are available. The models with analog output provide a signal suitable for transmission to a remote display, recorder or PLC. The models with RS485 output are suitable for connection to a PC or PLC.

The models of the **HD48... series are active transmitters** and accept both direct and 24Vac alternating power supply; they have standard current (4...20 mA) or voltage (0...10V) outputs, or a serial RS485 output, depending on the model. The models of the **HD49... series are passive transmitters** and thus suitable to be inserted in a 4...20 mA current loop.

Both series of transmitters are designed for temperature and humidity control in conditioning and ventilation applications (HVAC/BEMS) in the following sectors: pharmacy, museums, clean rooms, ventilation ducts, industrial and civil sectors, crowded places, canteens, auditoria, gyms, high-density farms, greenhouses, etc.

The transmitters measure relative humidity with a well proven temperature compensated capacitive sensor that assures precise and reliable measurements in the course of time. Both HD48... and HD49... series are available in two probe temperature ranges: standard -20...+80 °C and extended -40...+150 °C for the most critical applications.

A stainless steel 10 µm filter protects the sensors against dust and particles (other filters are available for different applications).

The transmitters are factory calibrated and no further adjustments are required.

Each series is available in different versions:

- with horizontal probe for duct mounting (HD48...TO..., HD49...TO...),
- with vertical probe for wall mounting (HD48...TV..., HD49...TV...);
- with remote probe connected to the transmitter by means of a cable (HD48...TC..., HD49...TC...). Cable lengths available are 2, 5 and 10 m.

The probes can be supplied in two different lengths: 135 mm or 335 mm.

Various accessories are available for the installation: for example to fix the probe to the duct, it can be used the HD9008.31 flange, a 3/8" universal biconical connection or a PG16 metal cable gland (Ø 10...14 mm). A 4-digit optional display ("L" model) allows to display the measured parameters in a continuous or sequential mode.

Technical specifications		
	STANDARD RANGE	EXTENDED RANGE
Relative Humidity		
Sensor	Capacitive	
Measuring range	0...100 %RH	
Accuracy @T=15...35°C	±1.5 %RH (0...90 %RH), ±2.0 %RH (90...100 %RH)	
Accuracy @ rest of T range	±(1.5+1.5% of the measure) %RH	
Repeatability	0.4 %RH	
Sensor working temperature	-20...+80 °C	-40...+150 °C
Temperature		
Measuring range	-20...+80 °C	-40...+150 °C
Sensor	NTC 10kΩ	Pt100 class A
Accuracy	±0.3 °C (0...+70 °C) ±0.4 °C (-20...0 °C, +70...+80 °C)	±0.3 °C
Repeatability	0.05 °C	0.05 °C
Dew Point		
Sensor	Parameter calculated from relative humidity and temperature	
Measuring range	-20...+80 °C DP	
Accuracy	See table 1	
Repeatability	0.5 °C DP	
Type of output (according to the model)		
HD4807T...	Temperature	4...20 mA (-20...+80 °C), $R_L < 500\Omega$ 22 mA outside the measuring range
HD4807ET...	Temperature	4...20 mA (-40...+150 °C), $R_L < 500\Omega$ 22 mA outside the measuring range
HD48V07T...	Temperature	0...10 Vdc (-20...+80 °C), $R_L > 10k\Omega$ 11 Vdc outside the measuring range
HD48V07ET...	Temperature	0...10 Vdc (-40...+150 °C), $R_L > 10k\Omega$ 11 Vdc outside the measuring range
HD48S07T... HD48S07ET...	Temperature	Only RS485 with MODBUS-RTU protocol
HD4907T...	Temperature	4...20 mA (-20...+80 °C), $R_{Lmax} = (Vdc-12)/0.022$ 22 mA outside the measuring range
HD4907ET...	Temperature	4...20 mA (-40...+150 °C), $R_{Lmax} = (Vdc-12)/0.022$ 22 mA outside the measuring range
HD4801T... HD4801ET...	Relative Humidity	4...20 mA (0...100 %RH), $R_L < 500\Omega$ 22 mA outside the measuring range
HD48V01T... HD48V01ET...	Relative Humidity	0...10 Vdc (0...100% %RH), $R_L > 10k\Omega$ 11 Vdc outside the measuring range
HD48S01T... HD48S01ET...	Relative Humidity	Only RS485 with MODBUS-RTU protocol
HD4901T... HD4901ET...	Relative Humidity	4...20 mA (0...100 %RH), $R_{Lmax} = (Vdc-12)/0.022$ 22 mA outside the measuring range
HD4817T...	Relative Humidity	4...20 mA (0...100 %RH), $R_L < 500\Omega$ 22 mA outside the measuring range
	Temperature	4...20 mA (-20...+80 °C), $R_L < 500\Omega$ 22 mA outside the measuring range

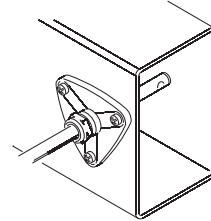
HD4817ET...	Relative Humidity	4...20 mA (0...100 %RH), $R_L < 500\Omega$ 22 mA outside the measuring range
	Temperature	4...20 mA (-40...+150 °C), $R_L < 500\Omega$ 22 mA outside the measuring range
HD48V17T...	Relative Humidity	11 Vdc outside the measuring range
	Temperature	0...10 Vdc (-20...+80 °C), $R_L > 10k\Omega$ 11 Vdc outside the measuring range
HD48V17ET...	Relative Humidity	0...10 Vdc (0...100 %RH), $R_L > 10k\Omega$ 11 Vdc outside the measuring range
	Temperature	0...10 Vdc (-40...+150 °C), $R_L > 10k\Omega$ 11 Vdc outside the measuring range
HD48S17T... HD48S17ET...	Relative Humidity	Only RS485 with MODBUS-RTU protocol
	Temperature	
HD4917T...	Relative Humidity	4...20 mA (0...100 %RH), $R_{Lmax} = (Vdc-12)/0.022$ 22 mA outside the measuring range
	Temperature	4...20 mA (-20...+80 °C), $R_{Lmax} = (Vdc-12)/0.022$ 22 mA outside the measuring range
HD4917ET...	Relative Humidity	4...20 mA (0...100 %RH), $R_{Lmax} = (Vdc-12)/0.022$ 22 mA outside the measuring range
	Temperature	4...20 mA (-40...+150 °C), $R_{Lmax} = (Vdc-12)/0.022$ 22 mA outside the measuring range
HD4877T...	Dew Point	4...20 mA (-20...+80 °C DP), $R_L < 500\Omega$ 22 mA outside the measuring range
	Temperature	4...20 mA (-20...+80 °C), $R_L < 500\Omega$ 22 mA outside the measuring range
HD48V77T...	Dew Point	0...10 Vdc (-20...+80 °C DP), $R_L > 10k\Omega$ 11 Vdc outside the measuring range
	Temperature	0...10 Vdc (-20...+80 °C), $R_L > 10k\Omega$ 11 Vdc outside the measuring range
HD48S77T...	Dew Point	Only RS485 with MODBUS-RTU protocol
	Temperature	
HD4977T...	Dew Point	4...20 mA (-20...+80 °C DP), $R_{Lmax} = (Vdc-12)/0.022$ 22 mA outside the measuring range
	Temperature	4...20 mA (-20...+80 °C), $R_{Lmax} = (Vdc-12)/0.022$ 22 mA outside the measuring range

Table 1 - Accuracy of dew point measurement:

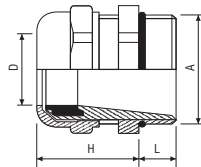
		°C DP										
		-20	-10	0	10	20	30	40	60	80		
Temperature °C	-20	≤±1										
	-10	≤±1	≤±1									
	0	≤±1	≤±1	≤±1								
	10	≤±3	≤±1	≤±1	≤±1							
	20	≤±4	≤±2	≤±1	≤±1	≤±1						
	30		≤±3	≤±1.5	≤±1	≤±1	≤±1					
	40				≤±2	≤±1	≤±1	≤±1				
	60				≤±5	≤±2.5	≤±2	≤±1	≤±1			
80						≤±4	≤±2	≤±1	≤±1			

Installation notes

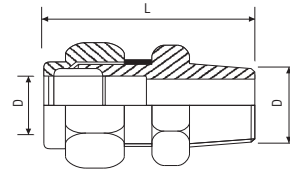
To fix the probe inside a ventilation duct, a pipe, etc., use for example the HD9008.31 flange, a PG16 metal cable gland (Ø10...14mm) or a 3/8" universal biconical connection.



HD9008.31 Flange



PG16 metal cable gland
D = 10...14 mm
L = 6.5 mm
H = 23 mm
A = PG16



Universal biconical connector
L = 35 mm
D = 14 mm
A = 3/8"

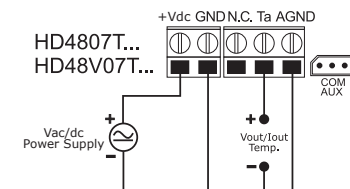
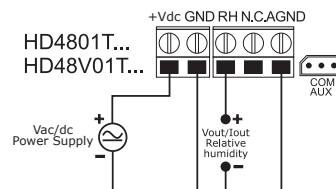
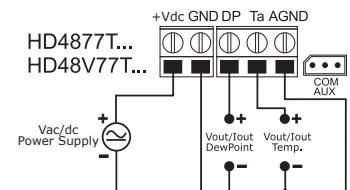
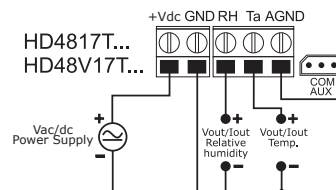
Power supply and electrical connections		
	HD48...	HD49...
Power supply	18...40 Vdc or 24 Vac ±10% 12...30 Vdc for MODBUS output	12...40 Vdc
Consumption	- 4 mA@24V(models with voltage output) - 4 mA@24V with open output, 20 mA@24V with 12 mA output (models with current output) - 2 mA@24V models with serial RS485 output	
Electrical connections	Screw type terminal block, max 1,5mm ² , M16 cable gland for input cable	
General characteristics		
Standard filter	PBT and 10 µm stainless steel grid protection (P8), 20 µm PTFE (P7) only for extended range	
TV probe working temperature	-20...+80 °C	
...TO...TC Probes working temperature	STANDARD RANGE	EXTENDED RANGE
	-20...+80 °C	-40...+150 °C
Electronics working temperature	-20...+60 °C	
Storage temperature	-20...+80 °C	
Electronics protection class	IP66	
Materials	ABS, polycarbonate	
Weight	from approx. 120 gr. (TV) to approx. 900 gr. (TC2.10)	
Case dimensions	80 x 84 x 44 (length x width x height)	

Electrical connections

HD48... series with analog output

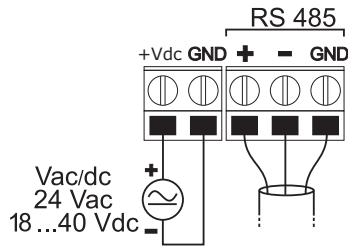
Power the instrument as shown in the below connection schemes, the power supply terminals are marked as +Vcc and GND. Depending on the model, the output signal is available between:

- Ta and AGND terminals for the transmitters of the HD4807T...and HD48V07T... series.
- RH% and AGND terminals for the transmitters of the HD4801T.. and HD48V01T.. series.
- RH% and AGND, Ta and AGND terminals for the transmitters of the HD4817T... and HD48V17T... series.
- DP and AGND, Ta and AGND terminals for the transmitters of the HD4877T... and HD48V77T... series.

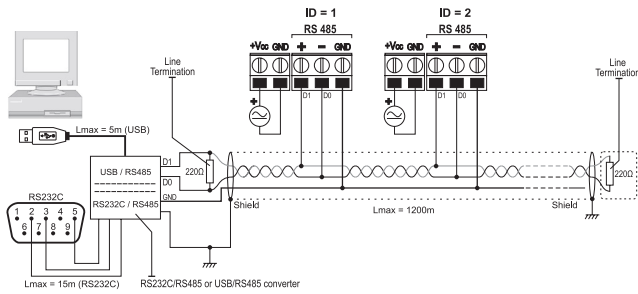


HD48...series with RS485 output

Connect the instrument as shown in the below connection schemes, the power supply terminals are marked as +Vcc and GND.



Thanks to RS485 output, several instruments can be connected to form a network. The instruments are connected in a sequence through a shielded cable with twisted pair for signals and a third wire for the ground.

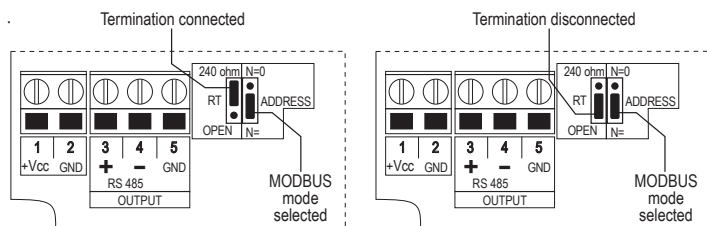


Line termination must be set at the two network ends. To polarize the line during nontransmission periods, resistor are connected between signal and power supply lines. The maximum number of devices that can be connected to the (Bus) line RS485 depends on the load characteristics of the devices to be connected.

The standard RS485 requires that the total load does not exceed 32 Unit Loads. The load of a HD48S... transmitter is equal to 1/4 of the unit load.

If the total load is more than 32 unit loads, divide the net in segments and insert a signal repeater between one segment and the next one. At the beginning and at the end of each segment a line termination must be connected.

The instrument has a built in line termination that can be connected or removed through a short jumper placed next to the terminal block. If the instrument is the last or the first device of a network group, connect the termination placing the short jumper between the "RT" and "240 ohm" indications. If the instrument is not at the end of a network group, remove the termination placing the short jumper between the "RT" and "OPEN" indications.



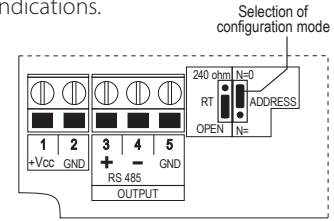
The cable shield must be connected to both line ends. The cable should have the following features:

- Characteristic impedance: 120 ohm
- Capacity: less than 50pF/m
- Resistance: less than 100 ohm/km
- gauge: 0,22 mm² (AWG24) at least.

The cable maximum length depends on baud rate and cable characteristics. Typically, the maximum length is 1200m. The data line must be kept separated from any power lines in order to prevent interferences on the transmitted signal. For connection to a PC, a RS232/RS485 or a USB/RS485 converter must be used. To operate with the MODBUS-RTU protocol be sure that the ADDRESS short jumper is between "ADDRESS" and "N=" indications.

Each transmitter of the network is univocally identified by an address. The address must be between 1 and 247. There must not be any other

transmitters connected with the same address. The address must be configured before connecting the instrument to the network. To set the instrument address use the software HD48STCAL downloadable from Delta OHM website and the RS48 cable with built in USB/RS485 adapter. To configure the instrument it is necessary to move the ADDRESS short jumper between the "ADDRESS" and "N=0" indications to select the setup mode. After the configuration, move the short jumper back between the "ADDRESS" and "N=" indications.



HD48S... - Setting the RS485 communication parameters of the transmitter with a standard communication program

Before connecting the transmitter to the RS485 network, an address must be assigned and the communication parameters be set, if different from the factory preset.

The parameters setting is performed as follows:

- If you have the RS48 cable, install the drivers in the PC.
- Connect the transmitter to a PC USB port using the cable RS48 (or alternatively through another USB/RS485 converter available, ensuring that their drivers are installed in the PC).
- Move the ADDRESS jumper between the sign "ADDRESS" and "N = 0" to select the configuration mode.
- Start a communication program such as Hyperterminal, and set the serial communication parameters as follows (the instrument is connected to a COM port type):

Baud rate: 115200
Parity: None
Data Bits: 8
Stop Bits: 2

- Send the serial commands given in the following table to set the RS485 MODBUS parameters:

Command	Response	Description
MA nnn	&	Set RS485 address Ranging from 1 to 247 Preset on 1
MB n	&	Set RS485 Baud Rate n=0 ⇒ 9600 n=1 ⇒ 19200 Preset on 1 ⇒ 19200
MP n	&	Set RS485 transmission mode n=0 ⇒ 8-N-1 (8 data bits, no parity, 1 stop bit) n=1 ⇒ 8-N-2 (8 data bits, no parity, 2 stop bits) n=2 ⇒ 8-E-1 (8 data bits, even parity, 1 stop bit) n=3 ⇒ 8-E-2 (8 data bits, even parity, 2 stop bits) n=4 ⇒ 8-O-1 (8 data bits, odd parity, 1 stop bit) n=5 ⇒ 8-O-2 (8 data bits, odd parity, 2 stop bits) Preset on 2 ⇒ 8-E-1
MW n	&	Set receiving mode after RS485 transmission n=0 ⇒ Violates the protocol and gets in listen mode immediately after the transmission n=1 ⇒ Respects the protocol and waits 3.5 characters after the transmission Preset on 1 ⇒ Respects the protocol

- You can check the parameter setting and read the information of the instrument by sending the following serial commands:

Command	Response	Description
G0		Transmitter Model
G2		Serial number of the transmitter
G3		Firmware Version
G4		Firmware Date

Command	Response	Description
L1	Address	Read RS485 address
L2	Baud Rate (0,1)	Read RS485 Baud Rate 0 ⇒ 9600 1 ⇒ 19200
L3	Tx Mode (0,1,2,3,4,5)	Read RS485 transmission mode 0 ⇒ 8-N-1 1 ⇒ 8-N-2 2 ⇒ 8-E-1 3 ⇒ 8-E-2 4 ⇒ 8-O-1 5 ⇒ 8-O-2
L4	Rx Mode (0,1)	Read receiving mode after RS485 transmission 0 ⇒ Violates the protocol and gets in listen mode immediately after Tx 1 ⇒ Respects the protocol and waits 3.5 characters after Tx
P0	&	Ping

- When finished, reposition the ADDRESS jumper between the indications "ADDRESS" and "N" to restore the MODBUS mode.

Reading of the measures with the MODBUS-RTU protocol when the instrument is in operating conditions (installed in a network)

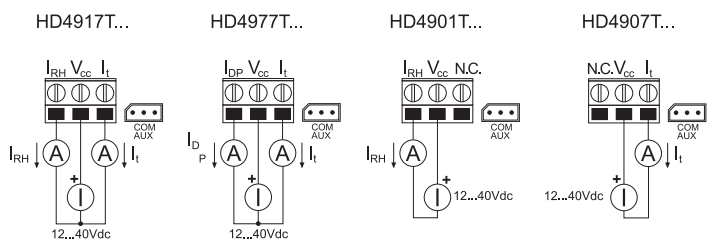
In MODBUS mode, you can read the values measured by the instrument through the function code 04h (Read Input Registers). The following table lists the quantities available with the appropriate register address:

Address	Quantities	Format
0	Temperature in °C (x10)	16-bit integer
1	Temperature in °F (x10)	16-bit integer
2	Relative Humidity in % (x10)	16-bit integer
3	Dew Point in °C (x10)	16-bit integer
4	Dew Point in °F (x10)	16-bit integer
5	State register Bit 0 = 1 ⇒ temperature measurement error Bit 1 = 1 ⇒ humidity measurement error Bit 2 = 1 ⇒ dew point calculation error Bit 3 = 1 ⇒ configuration data error	16-bit integer

HD49... series

Follow the connection schemes shown below, the maximum load resistance that can be connected to each 4...20 mA output depends on the power supply V_{cc} applied, according to the relation:

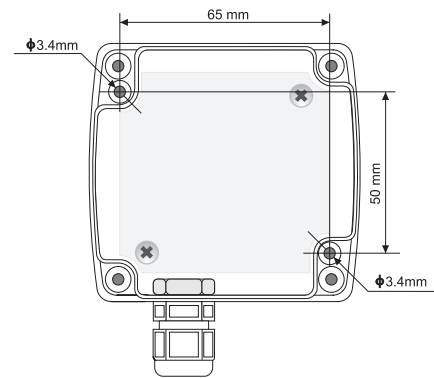
$$R_{L_{max}} = (V_{dc} - 12) / 0.022, \text{ e.g. if } V_{dc} = 24 \text{ Vdc the max load is } R_{L_{max}} = 545 \text{ ohm.}$$



Relative humidity probe calibration

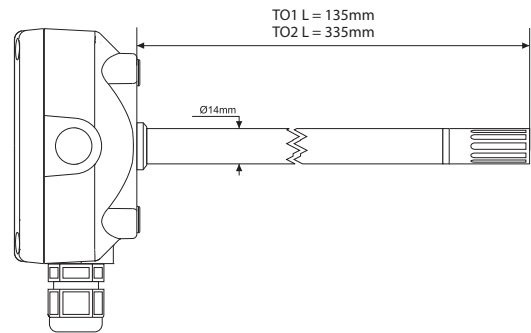
The HD48... and HD49... transmitters are supplied factory calibrated and ready to use. If necessary, it is possible to calibrate the relative humidity sensor using the saturated salt solutions HD75 (75 %RH saturated salt solution) and HD33 (33 %RH saturated salt solution) by connecting the instrument to the PC and using the HD48TCAL software.

Fixing holes

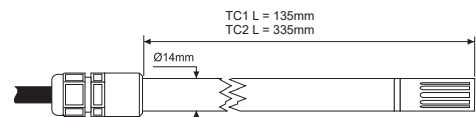
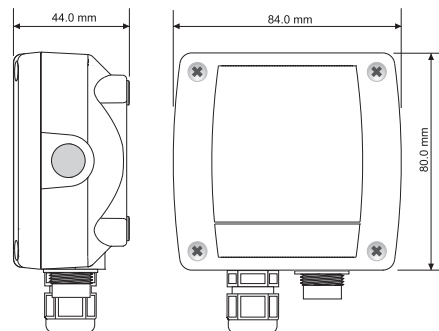


Dimensions

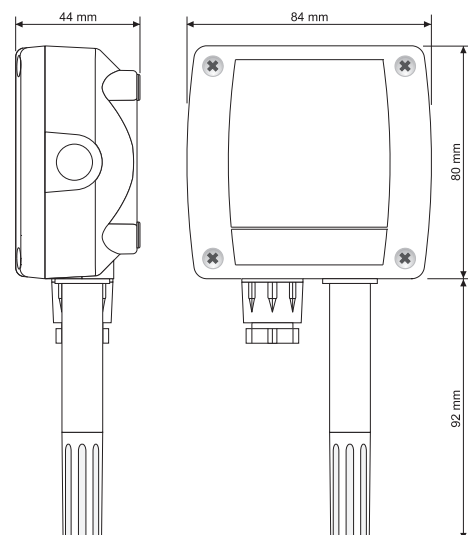
TO series



TC series



TV series



ORDERING CODES:

HD48

•	Display Blank = without display L = with LCD display
	Cable length (only for TC models) 2 = 2 m 5 = 5 m 10 = 10 m
	Probe length TO1 = 135 mm TO2 = 335 mm TC1 = 135 mm TC2 = 335 mm TV = vertical wall mounting
	Measuring range Blank = standard range -20...+80 °C E = extended range -40...+150 °C (except TV models)
Measured quantities 07 = Temperature 01 = Relative Humidity 17 = Temperature and Relative Humidity 77 = Temperature and Dew Point	
Output Blank = analog output 4...20 mA V = analog output 0...10 Vdc S = RS485 MODBUS-RTU output only Note: the models with analog output have an output for each measured quantity.	

HD49

•	Display Blank = without display L = with LCD display
	Cable length (only for TC models) 2 = 2 m 5 = 5 m 10 = 10 m
	Probe length TO1 = 135 mm TO2 = 335 mm TC1 = 135 mm TC2 = 335 mm TV = vertical wall mounting
	Measuring range Blank = standard range -20...+80 °C E = extended range -40...+150 °C (except TV models)
Measured quantities 07 = Temperature 01 = Relative Humidity 17 = Temperature and Relative Humidity 77 = Temperature and Dew Point	

Example

HD4807TV: Wall mounting digital active temperature transmitter. Temperature range: -20...+80 °C. Analog output: 4...20 mA (-20...+80 °C). Probe working range -20...+80 °C. Power supply 18...40 Vdc or 24 Vac.

HD48V17ETC25: Digital active temperature and relative humidity transmitter, extended range. AISI304 steel probe, diameter 14 mm and stem length 335mm, with 5m cable. Relative humidity range 0...100% RH, temperature range -40...+150 °C. Analog outputs: 0...10V (0...100 %RH) for RH and 0...10V (-40...+150 °C) for temperature. Probe working range -40...+150 °C. Power supply 18...40 Vdc or 24Vac.

Accessories

- RS48:** Cable for RS485 serial connection with built-in USB/RS485 converter.
- CP27:** Connection/converter cable from COM AUX serial port to USB.
- HD75:** 75 %RH saturated solution for the verification of the relative humidity sensor.
- HD33:** 33 %RH saturated solution for the verification of the relative humidity sensor.
- HD9008.31:** Wall flange with cable gland to fix Ø14 mm probes.

Protection for humidity probes Ø 14, thread M12x1

- P7:** 20 µm PTFE protection. Operating temperature: -40...150 °C.
- P8:** PBT and 10 µm stainless steel grid protection. Operating temperature: -40...120 °C.





DICHIARAZIONE DI CONFORMITÀ UE
EU DECLARATION OF CONFORMITY

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

Documento Nr. / Mese.Anno: **5033 / 11.2019**
Document-No. / Month.Year :

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

Codice prodotto: **HD48x01T... / HD48x07T... / HD48x17T... / HD48x77T...**
Product identifier :

Descrizione prodotto: **Trasmettitori attivi di temperatura e umidità**
Product description : **Temperature and humidity active transmitters**

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

Direttive / Directives	
2014/30/EU	Direttiva EMC / EMC Directive
2014/35/EU	Direttiva bassa tensione / Low Voltage Directive
2011/65/EU - 2015/863/EU	RoHS / RoHS

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

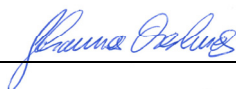
Norme armonizzate / Harmonized standards	
EN 61010-1:2010	Requisiti di sicurezza elettrica / Electrical safety requirements
EN 61326-1:2013	Requisiti EMC / EMC requirements
EN 50581:2012	RoHS / RoHS

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

Johannes Overhues

Amministratore delegato
Chief Executive Officer

Caselle di Selvazzano, 19/11/2019



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



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Product identifier :

Descrizione prodotto: **Trasmettitori passivi di temperatura e umidità**
Product description : **Temperature and humidity passive transmitters**

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

Direttive / Directives	
2014/30/EU	Direttiva EMC / EMC Directive
2014/35/EU	Direttiva bassa tensione / Low Voltage Directive
2011/65/EU - 2015/863/EU	RoHS / RoHS

Norme armonizzate applicate o riferimento a specifiche tecniche:
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Norme armonizzate / Harmonized standards	
EN 61010-1:2010	Requisiti di sicurezza elettrica / Electrical safety requirements
EN 61326-1:2013	Requisiti EMC / EMC requirements
EN 50581:2012	RoHS / RoHS

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

Johannes Overhues

Amministratore delegato
Chief Executive Officer

Caselle di Selvazzano, 19/11/2019



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

WARRANTY


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

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

TECHNICAL INFORMATION

The quality level of our instruments is the result of the continuous product development. This may lead to differences between the information reported in the manual and the instrument you have purchased. In case of discrepancies and/or inconsistencies, please write to sales@deltaohm.com. Delta OHM reserves the right to change technical specifications and dimensions to fit the product requirements without prior notice.

DISPOSAL INFORMATION

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

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