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English

# Operating manual

PM / $CO_2$ Transmitter

# PMsense


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# 1 INTRODUCTION

**PMsense** is a **PM1.0**, **PM2.5** and **PM10** Particulate Matter transmitter suitable for outdoor air quality monitoring.

The dust particles concentration is measured using the laser scattering principle.

An optional $CO_2$ sensor can be integrated in the transmitter.

The transmitter has a digital RS485 output with MODBUS-RTU or ASCII proprietary protocol. A version with two additional 4…20 mA (0…10 V **on request when ordering**) analog outputs is available. The two analog outputs can be independently associated with any of the measured parameters.

The measuring circuit of the transmitter can be operated in continuous mode or, in order to extend the PM sensor lifetime, at cyclic intervals (default operating mode). The measuring cycle interval is user configurable.

The transmitter is maintenance-free and has fast response, high sensitivity, excellent stability and long operating life.

# 2 TECHNICAL SPECIFICATIONS

| | |
|---|---|
| **Particulate Matter** | |
| Measuring principle | Laser scattering |
| Measured pollutants | PM1.0, PM2.5 and PM10 |
| Measuring range | 0…1000 µg/m$^3$ (for each pollutant) |
| Particle size detection range | ∅ 0.3…10 µm |
| Linearity error | < 5% |
| Repeatability | < 3% |
| Sensor warm up time | 15 s |
| Sensor lifetime | 5 years approx. in 5 minutes cyclic operating mode (default)<br>> 10,000 hours in continuous operating mode (1 meas./s) |
| Temperature drift | < 0.01 µg/m$^3$/°C |
| **$CO_2$** (**only PMBsense…**) | |
| Measuring principle | Double wavelength NDIR |
| Measuring range | 0…5000 ppm |
| Accuracy | ±(50 ppm+3% of measurement) @ 25 °C and 1013 hPa |
| Response time | < 120 s (air speed= 2 m/s) |
| Long-term stability | 5% of measurement / 5 years |
| Temperature drift | 1 ppm/°C |
| **General specifications** | |
| Output | RS485 with Modbus-RTU or ASCII proprietary protocol<br>Only **PMsense-A**: 2 x analog 4…20 mA ($R_{Lmax}$ = 500 Ω); on request 2 x 0…10 V ($R_{Lmin}$ = 10 kΩ) |
| Power supply | 7…30 Vdc<br>(15…30 Vdc for 0…10 V analog outputs) |
| Power consumption | 25 mA @ 24 Vdc during measurement<br>4 mA in stand-by (only for cyclic operating mode)<br>The indicated consumption does not include the consumption due to the analog outputs |
| Connection | M12 8-pole circular connector |
| Operating conditions | -20…+70 °C / 0…95 %RH / 500…1500 hPa |
| Housing material | Polycarbonate |
| Protection degree | Housing equipped with a rain-proof and UV resistant inlet air filter – IP 53 |
| Dimensions | 120 x 94 x 71 (excluding M12 connector) |
| Weight | 330 g |

# 3 INSTALLATION

The transmitter is equipped with a bracket with U-bolt for the fixing to a Ø40…50 mm mast. It can be fixed to a wall using the bracket only, by removing the U-bolt.

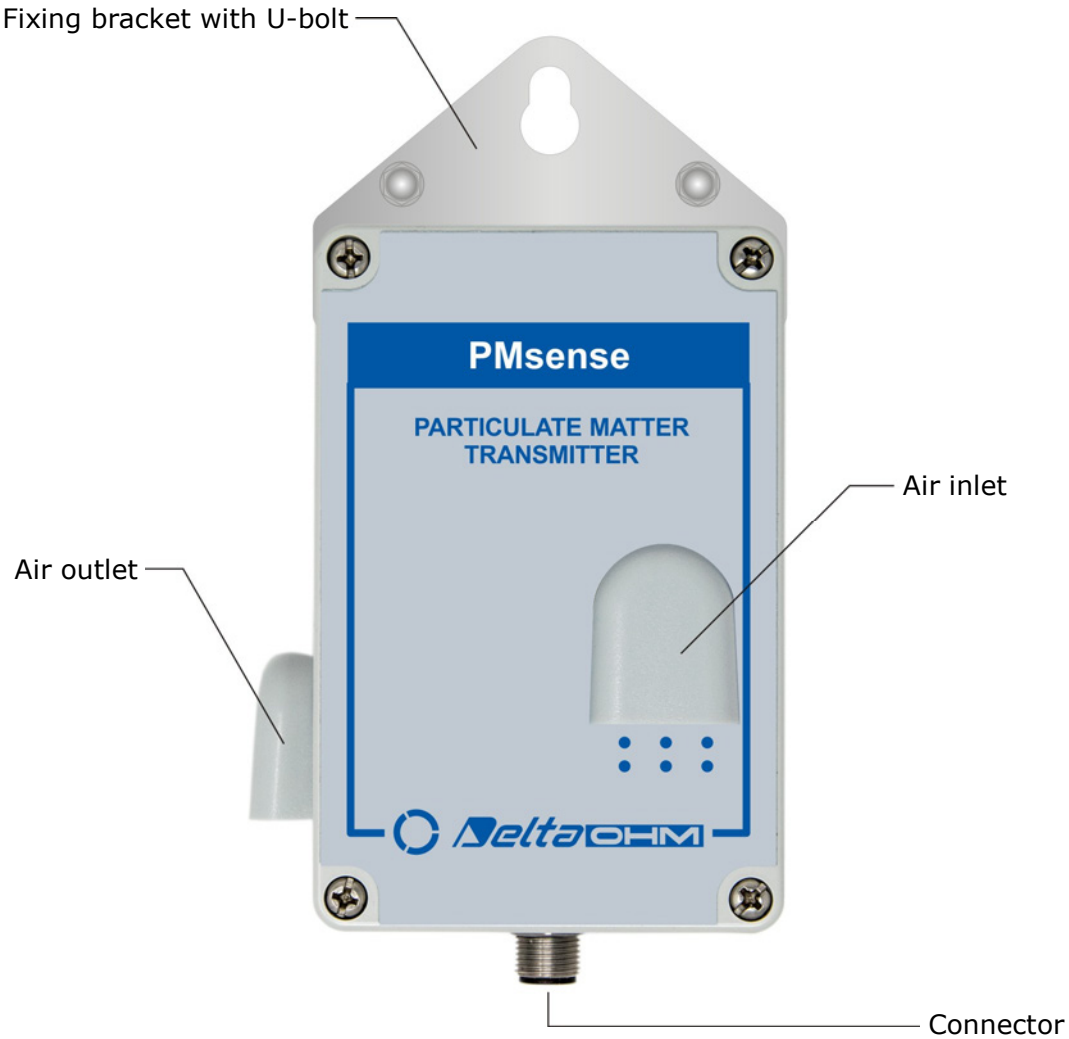



**Fig. 3.1: transmitter description**

## 3.1 ELECTRICAL CONNECTIONS

The transmitter has a M12 8-pole circular connector and uses the **CPM12-8DA... optional** cables, with M12 8-pole connector on one side and open wires on the other side.

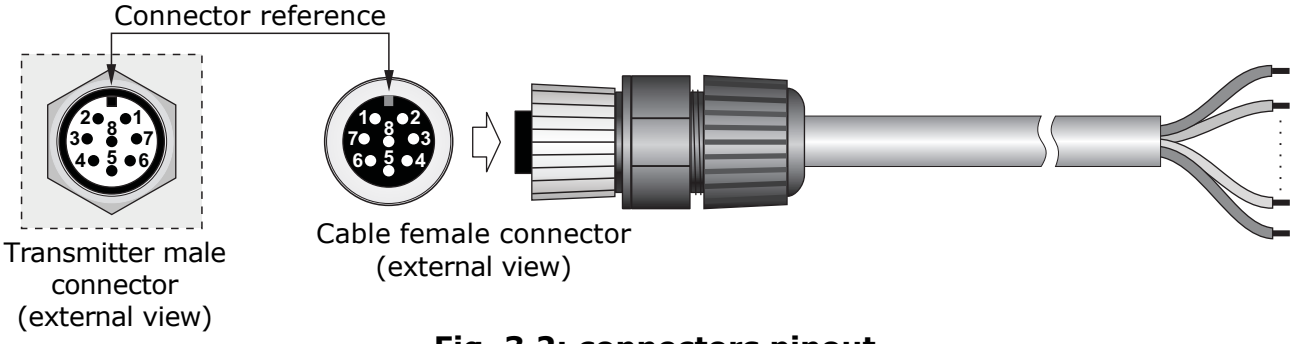



**Fig. 3.2: connectors pinout**

| Connector pin N° | Function | CPM12-8DA… wire color |
|---|---|---|
| 1 | Power supply negative (GND) | Blue |
| 2 | Power supply positive (+Vdc) | Red |
| 3 | Not used | --- |
| 4 | RS485 A/- | Brown |
| 5 | RS485 B/+ | White |
| 6 | Digital and analog outputs ground (SGND)* | Grey |
| 7 | Analog output 1 positve (AOUT1, **only PM[B]sense-A**) | Yellow |
| 8 | Analog output 2 positve (AOUT2, **only PM[B]sense-A**) | Green |
| | Cable shield ** | Black (thick wire) |

* The output ground (SGND) and the negative of the power supply (GND) are short-circuited inside the transmitter.

* The cable shield is not connected to the M12 connector.

To ensure a good noise immunity, it is recommended to connect the cable shield to ground (GND).

**RS485 connection:**

By default, the instrument has MODBUS address **1** and communication parameters 19200, 8E1. Different parameters can be set using the proprietary protocol or the MODBUS-RTU protocol.

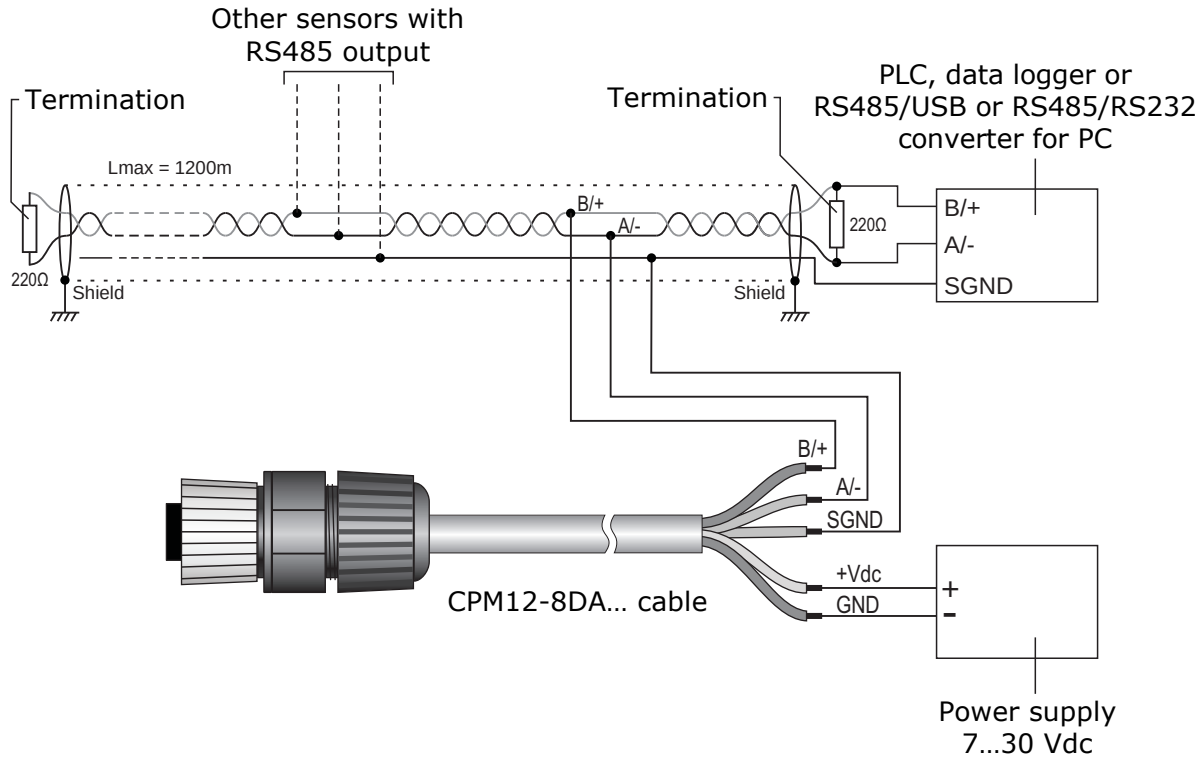



**Fig. 3.3: RS485 connection**

**Current analog output (only PM[B]sense-A):**

By default, the current analog outputs are 4…20 mA, with:

4 mA = 0 ppm

20 mA = 1000 µg/m$^3$

The analog output 1 is associated by default to PM2.5. The analog output 2 is associated by default to PM10.

With the commands of the proprietary protocol it is possible to associate the analog outputs to different parameters, set the range 0…20 mA for the output and reverse the direction of the output, so that the output decreases as the measurement increases.

In case of measurement error, the output goes to 22 mA.

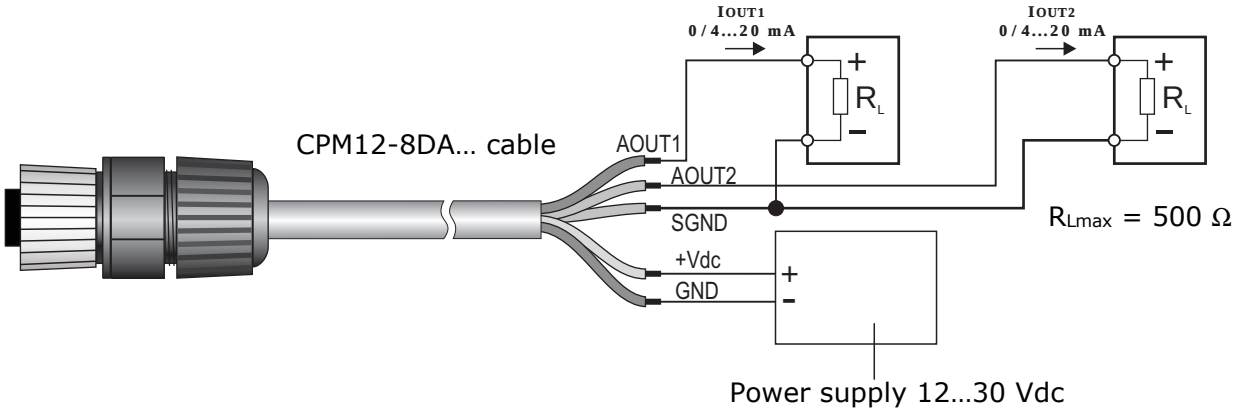



**Fig. 3.4: current analog outputs connection**

**Voltage analog output (optional, only PM[B]sense-A):**

By default, the voltage analog outputs are 0…10 V, with:

0 V = 0 ppm

10 V = 1000 µg/m$^3$

The analog output 1 is associated by default to PM2.5. The analog output 2 is associated by default to PM10.

With the commands of the proprietary protocol it is possible to associate the analog outputs to different parameters, set the range 2…10 V for the output and reverse the direction of the output, so that the output decreases as the measurement increases.

In case of measurement error, the output goes to 11 V.

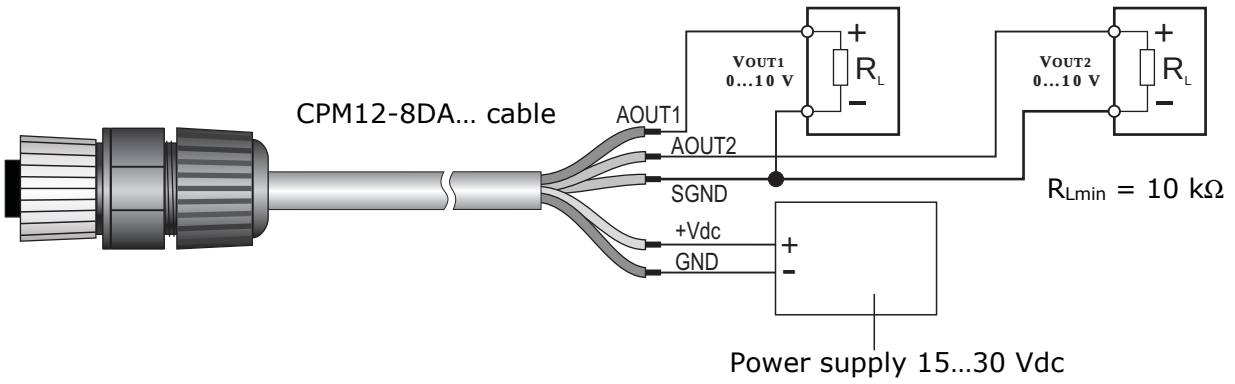



**Fig. 3.5: voltage analog outputs connection**

# 4 CONFIGURATION AND MEASUREMENT

The configuration of the instrument and the reading of the measurements can be done via the RS485 serial output, both with the proprietary protocol and with the MODBUS-RTU protocol.

In the first 10 seconds after the instrument power on, it is always active the proprietary protocol. After 10 seconds from power on, the operating protocol is activated, which by default is the MODBUS-RTU protocol.

It is possible to keep the proprietary protocol active even after 10 seconds from power on by sending, before the 10 seconds expire, the command **@** of the proprietary protocol. The proprietary protocol can be set as operating protocol by means of the DP0 command.

The commands of the proprietary protocol and the registers of the MODBUS-RTU protocol are described in detail in the following chapters.

**Particulate Matter measurement modes:**

The transmitter can perform the PM measurement in continuous mode, or, in order to extend the sensor lifetime, at cyclic intervals.

By default, the transmitter is configured to measure at cyclic intervals with an interval of 5 minutes. The measurement mode and the interval can be configured respectively by using the CPLS and CPLP commands of the proprietary protocol or the holding registers with address 15 and 16 of the MODBUS-RTU protocol.

In the measurement mode at cyclic intervals, the PM sensor is activated periodically for about a minute, at the end of which the measurement is made available and "frozen" (the sensor is deactivated) until the set cyclic measurement interval expires. The measurement provided is a value averaged during the minute of sensor activation.

In continuous measurement mode the sensor is always active, and the measurement provided is an averaged value chosen from the following possibilities:

- average over a 10 seconds interval, updated every second;
- average over a 60 seconds interval, updated every 10 seconds (default);
- average over a 15 min interval, updated every minute.

The type of average can be configured by using the CPS command of the proprietary protocol or the holding registers with address 19 of the MODBUS-RTU protocol.

**Status of the transmitter:**

There are two LEDs on the internal electronic board of the transmitter: the **green** LED indicates the presence of the external power supply (blinks once per second), the **red** LED indicates the presence of any measurement errors (normally off, it blinks twice per second if at least one of the measured parameters is in error).

# 5 PROPRIETARY PROTOCOL

To use the proprietary protocol, it is necessary to connect the instrument to the PC via a RS485/USB (e.g. RS51K) or RS485/RS232 converter and use a standard serial communication program. In the serial communication program, set the COM port number to which the instrument is connected and the communication parameters as follows:

- If the MODBUS-RTU protocol is set as the operating protocol in the instrument (default), set the Baud Rate 57600 and the parameters 8N2 in the serial communication program, then power cycle the instrument and send the command **@** within 10 seconds from the instrument power on.
- If the proprietary protocol is already set as the operating protocol in the instrument, it is possible to operate with Baud Rate 57600 and parameters 8N2 by sending the command **@** within 10 seconds from the instrument power on, or you can let the 10 seconds pass without sending the command **@** and operate with the communication parameters set in the instrument (default 19200, 8E1).

To change the instrument configuration, the serial command **CAL USER ON** must be sent first (the instrument replies with USER CAL MODE ON). The command CAL USER ON is automatically disabled after a few minutes of inactivity. If the settings should be only read, the command CAL USER ON is not required.

Below is the list of the serial commands.

**Instrument information:**

| Command | Reply | Description |
|---|---|---|
| G0 | *Model* | Instrument model |
| G1 | &*Revision*\| | Instrument hardware revision |
| G2 | SN=nnnnnnnn | Instrument serial number |
| G3 | Firm.Ver.=x.y | Instrument firmware revision |
| G4 | Firm.Date=yyyy/mm/dd | Date of firmware revision |
| GC | Fact.Calib.Date= yyyy/mm/dd<br>User.Calib.Date= yyyy/mm/dd<br>Cal.Mode=*Factory* or *User* | Date of factory calibration<br>Date of user calibration ($CO_2$ only)<br>Type of calibration active ($CO_2$ only) |

**Protocol:**

| Command | Reply | Description |
|---|---|---|
| @ | &\| | Keeps the proprietary protocol operational even after 10 seconds from instrument power on. It must be sent within 10 seconds from instrument power on. |
| DPn | &\| | Sets the operating protocol:<br>▪ Proprietary if n=0<br>▪ MODBUS-RTU if n=1<br>*Default* : MODBUS-RTU (n=1) |
| GP | & n\| | Reads the operating protocol set in the instrument. |
| SM | &\| | Activates the MODBUS-RTU protocol immediately. |
| CMAn | &\| | Sets the instrument address for the MODBUS-RTU protocol to n.<br>The address should range within 1 and 247.<br>*Default* : 1 |
| RMA | & n\| | Reads the instrument address for the MODBUS-RTU protocol. |

*Note*: after sending the DP1 command, the instrument remains with the proprietary protocol. Send the command SM to activate the MODBUS-RTU protocol immediately, or power cycle the instrument.

### RS485 communication parameters:

| Command | Reply | Description |
|---|---|---|
| CMBn | &\| | Sets the Baud Rate:<br>▪ 1200 if n=0<br>▪ 2400 if n=1<br>▪ 4800 if n=2<br>▪ 9600 if n=3<br>▪ 19200 if n=4<br>▪ 38400 if n=5<br>▪ 57600 if n=6<br>▪ 115200 if n=7<br>*Default* : 19200 (n=4) |
| RMB | & n\| | Reads Baud Rate setting |
| CMPn | &\| | Sets parity and stop bits:<br>▪ 8N1 if n=0 [No parity, 1 stop bit]<br>▪ 8N2 if n=1 [No parity, 2 stop bits]<br>▪ 8E1 if n=2 [Even parity, 1 stop bit]<br>▪ 8E2 if n=3 [Even parity, 2 stop bits]<br>▪ 8O1 if n=4 [Odd parity, 1 stop bit]<br>▪ 8O2 if n=5 [Odd parity, 2 stop bits]<br>The number of data bits is fixed to 8.<br>*Default* : 8E1 (n=2) |
| RMP | & n\| | Reads the setting of parity and stop bits. |
| CMWn | &\| | Sets waiting time after transmission with MODBUS-RTU protocol:<br>▪ Immediate reception if n=0 (violates protocol)<br>▪ Waiting 3.5 characters if n=1 (respects protocol)<br>*Default* : Immediate reception (n=0) |
| RMW | & n\| | Reads the setting of waiting time after transmission with MODBUS-RTU protocol. |

### PM measurement settings:

| Command | Reply | Description |
|---|---|---|
| CPLSn | &\| | Sets the PM measurement mode:<br>▪ Continuous if n=0<br>▪ At cyclic intervals if n=1<br>*Default* : At cyclic intervals (n=1) |
| RPLS | & n\| | Reads the setting of the PM measurement mode. |
| CPLPn | &\| | Sets the cycle interval for the measurement mode at cyclic intervals.<br>The number of seconds must be greater than 70, in order to allow the sensor to take the measurement.<br>*Default* : 300 (=5 min) |
| RPLP | & n\| | Reads the setting of the cycle interval for the measurement mode at cyclic intervals. |

| Command | Reply | Description |
|---|---|---|
| CPSn | &\| | Sets the type of measurement averaging for the continuous measurement mode:<br>▪ Average over a 10 seconds interval, updated every second if n=0<br>▪ Average over a 60 seconds interval, updated every 10 seconds if n=1<br>▪ Average over a 15 minutes interval, updated every minute if n=2<br>*Default* : Average over a 60 seconds interval, updated every 10 seconds (n=1) |
| RPS | & n\| | Reads the type of measurement averaging for the continuous measurement mode. |

## Analog outputs (only PM[B]sense-A):

| Command | Reply | Description |
|---|---|---|
| CA1On | &\| | Enable/disable the offset of the analog output 1:<br>▪ Offset disabled if n=0 (0…20 mA or 0…10 V)<br>▪ Offset enabled if n=1 (4…20 mA or 2…10 V)<br>*Default* : Offset enabled (n=1) if the output is current, offset disabled (n=0) if the output is voltage (optional) |
| RA1O | & n\| | Reads the setting of the offset for the analog output 1. |
| CA1SOn | &\| | Sets the direct or inverse correspondence between analog output 1 and associated physical quantity:<br>▪ 4 mA/0 V ⇒ Min. quantity, 20 mA/10 V ⇒ Max. quantity if n=0<br>▪ 20 mA/10 V ⇒ Min. quantity, 4 mA/0 V ⇒ Max. quantity if n=1<br>*Default* : Direct correspondence (n=0) |
| RA1SO | & n\| | Reads the type of correspondace (direct or inverse) between analog output 1 and associated physical quantity. |
| CA1Tn | &\| | Associates the analog output 1 to:<br>▪ PM1.0 if n=0<br>▪ PM2.5 if n=1<br>▪ PM10 if n=2<br>▪ $CO_2$ if n=12 (only PMBsense-A)<br>*Default* : PM2.5 (n=1)<br>*Note: the PM measurement is updated according to the operating mode set with the CPLS, CPLP and CPS commands.* |
| RA1T | & n\| | Reads the physical quantity associated to analog output 1. |
| CA1Ln | &\| | Sets n as the minimum value of the measuring range of the physical quantity associated to the analog output 1.<br>If the output is associated to PM, the value must be expressed as a number of tenths (e.g. n=5 to indicate 0.5 µg/m$^3$). If the output is associated to $CO_2$, the value must be expressed as a number of units (e.g. n=200 to indicate 200 ppm).<br>*Default* : 0 |
| RA1L | & n\| | Reads the minimum value of the measuring range of the physical quantity associated to the analog output 1. |

| Command | Reply | Description |
|---|---|---|
| CA1Hn | &\| | Sets n as the maximum value of the measuring range of the physical quantity associated to the analog output 1.<br>If the output is associated to PM, the value must be expressed as a number of tenths (e.g. n=50 to indicate 5.0 µg/m$^3$). If the output is associated to $CO_2$, the value must be expressed as a number of units (e.g. n=800 to indicate 800 ppm).<br>*Default* : 10000 (=1000.0 µg/m$^3$ of PM) |
| RA1H | & n\| | Reads the maximum value of the measuring range of the physical quantity associated to the analog output 1. |
| RA1F | & *Quantity*<br>*Minimum value*<br>*Maximum value* | Simultaneously provides the information obtainable with the RA1T, RA1L e RA1H commands. |
| CA2On | &\| | Enable/disable the offset of the analog output 2:<br>▪ Offset disabled if n=0 (0…20 mA or 0…10 V)<br>▪ Offset enabled if n=1 (4…20 mA or 2…10 V)<br>*Default* : Offset enabled (n=1) if the output is current, offset disabled (n=0) if the output is voltage (optional) |
| RA2O | & n\| | Reads the setting of the offset for the analog output 2. |
| CA2SOn | &\| | Sets the direct or inverse correspondence between analog output 2 and associated physical quantity:<br>▪ 4 mA/0 V ⇒ Min. quantity, 20 mA/10 V ⇒ Max. quantity if n=0<br>▪ 20 mA/10 V ⇒ Min. quantity, 4 mA/0 V ⇒ Max. quantity if n=1<br>*Default* : Direct correspondence (n=0) |
| RA2SO | & n\| | Reads the type of correspondace (direct or inverse) between analog output 2 and associated physical quantity. |
| CA2Tn | &\| | Associates the analog output 2 to:<br>▪ PM1.0 if n=0<br>▪ PM2.5 if n=1<br>▪ PM10 if n=2<br>▪ $CO_2$ if n=12 (only PMBsense-A)<br>*Default* : PM10 (n=2)<br>*Note: the PM measurement is updated according to the operating mode set with the CPLS, CPLP and CPS commands.* |
| RA2T | & n\| | Reads the physical quantity associated to analog output 2. |
| CA2Ln | &\| | Sets n as the minimum value of the measuring range of the physical quantity associated to the analog output 2.<br>If the output is associated to PM, the value must be expressed as a number of tenths (e.g. n=5 to indicate 0.5 µg/m$^3$). If the output is associated to $CO_2$, the value must be expressed as a number of units (e.g. n=200 to indicate 200 ppm).<br>*Default* : 0 |
| RA2L | & n\| | Reads the minimum value of the measuring range of the physical quantity associated to the analog output 2. |

| Command | Reply | Description |
|---|---|---|
| CA2Hn | &\| | Sets n as the maximum value of the measuring range of the physical quantity associated to the analog output 2.<br>If the output is associated to PM, the value must be expressed as a number of tenths (e.g. n=50 to indicate 5.0 µg/m$^3$). If the output is associated to $CO_2$, the value must be expressed as a number of units (e.g. n=800 to indicate 800 ppm).<br>*Default* : 10000 (=1000 µg/m$^3$ of PM) |
| RA2H | & n\| | Reads the maximum value of the measuring range of the physical quantity associated to the analog output 2. |
| RA2F | & *Quantity*<br>*Minimum value*<br>*Maximum value* | Simultaneously provides the information obtainable with the RA2T, RA2L e RA2H commands. |

**Reading of the measurement information:**

| Command | Reply | Description |
|---|---|---|
| P0 | &\| | Disable the sending of the measurement enabled with P1. |
| P1 | &\| | Enable the sending of the PM measurement every second, in the sequence described in command P5. |
| P5 | & *Measurements* | Prints the PM measurements in the following sequence:<br>▪ PM measurement error (0=no, 1=yes)<br>▪ PM1.0 in N° of particles/ml<br>▪ PM2.5 in N° of particles/ml<br>▪ PM10 in N° of particles/ml<br>▪ PM1.0 in µg/m$^3$<br>▪ PM2.5 in µg/m$^3$<br>▪ PM10 in µg/m$^3$<br>*Note: the PM measurement is updated according the operating mode set with the CPLS, CPLP and CPS commands.* |
| S0 | &\| | Disable the sending of the measurement enabled with S1. |
| S1 | &\| | Enable the sending of the measurement every second, in the sequence described in command S5. |
| S5 | & *Measurements* | Prints the measurements in the following sequence:<br>▪ PM measurement error (0=no, 1=yes)<br>▪ PM1.0 in µg/m$^3$<br>▪ PM2.5 in µg/m$^3$<br>▪ PM10 in µg/m$^3$<br>▪ $CO_2$ in ppm<br>▪ Atmospheric pressure in hPa (internal sensor for $CO_2$ measurement compensation)<br>▪ *Field not used*<br>▪ *Field not used*<br>▪ *Field not used*<br>▪ Power supply voltage<br>▪ Internal board temperature<br>*Note: the PM measurement is updated according the operating mode set with the CPLS, CPLP and CPS commands.* |

### $CO_2$ calibration (only PMBsense...):

A 2-point (CO21 and CO22 commands) or 1-point calibration (CO2O command) can be performed. The points are chosen by the user. To perform the calibration, the transmitter must be placed in an environment with a known $CO_2$ concentration.

While the 2-point calibration allows moving the two calibration points independently, and therefore also to adjust the slope of the sensor response curve, the 1-point calibration simply adds an offset to the measurement (the two calibration points are shifted of the same amount) and is typically accomplished by placing the transmitter in clean air.

Before performing the calibration, the type of calibration to be used must be set to "user" with the CC command.

The transmitter allows manually setting, with the DA command, a string that is saved as the date and time of the calibration. The string must be set before performing the calibration.

| Command | Reply | Description |
|---|---|---|
| CO21n | & t\| | $CO_2$ calibration in the first point at n ppm.<br>The transmitter must first be placed in an environment with a known $CO_2$ concentration (the value n entered in the command).<br>The value t in the reply to the command indicates the number of seconds required for the transmitter to complete the calibration operation. During this time, the transmitter sends strings notifying the progress of the operation; for example:<br>"CO2 calib. Status:IN PROGRESS 8% Avg:1096ppm Dev:0ppm"<br>At the end, the OK 100% notification indicates that the operation was successful; for example:<br>"CO2 calib. Status:OK 100% Avg:1100ppm Dev:7ppm" |
| CO22n | & t\| | $CO_2$ calibration in the second point at n ppm.<br>Operation similar to the CO21command. |
| CO2On | & t\| | $CO_2$ calibration at n ppm (1-point calibration – offset adjustment).<br>Operation similar to the CO21command. |
| DAyyyy/mm/dd hh:mm:ss | &\| | Saves the string "aaaa/mm/gg hh:mm:ss" as the date and time when calibration is performed.<br>The command must be sent before performing the calibration. |
| GA | & yyyy/mm/dd hh:mm:ss | Reads the date and time saved with the DA command. |
| CCn | &\| | Sets the type of calibration to be used:<br>▪ User if n=0<br>▪ Factory if n=1<br>*Default* : Factory (n=1) |
| CO2D | &\| | Reset of user calibration. |

### Restoring the factory configuration:

| Command | Reply | Description |
|---|---|---|
| DFLT | &\| | Restores the factory configuration. |

# 6 MODBUS-RTU PROTOCOL

By default, the instrument has MODBUS address **1** and communication parameters 19200, 8E1. The address and the communication parameters can be changed by using the appropriate serial commands of the proprietary protocol or, alternatively, directly with MODBUS commands by changing the value of the Coils and Holding Registers described later.

The MODBUS-RTU protocol, if set as the operating protocol (default), is active after 10 seconds from the instrument power on.

In order to change the instrument configuration using the MODBUS-RTU protocol, the value 1 must be written first in the *Coil* number 2 (address 1).

Below is the list of registers (the tables show both the number and the address of the registers, with the address of the register equal to the number of the register decreased by 1, as defined in the MODBUS standard).

**Input Registers:**

| Number | Address | Description | Format |
|---|---|---|---|
| 1 | 0 | PM1.0 in N° of particles/ml.<br>*Measurement updated according the operating mode set with the CPLS, CPLP and CPS commands.* | 16-bit Integer |
| 2 | 1 | PM2.5 in N° of particles/ml.<br>*Measurement updated according the operating mode set with the CPLS, CPLP and CPS commands.* | 16-bit Integer |
| 3 | 2 | PM10 in N° of particles/ml.<br>*Measurement updated according the operating mode set with the CPLS, CPLP and CPS commands.* | 16-bit Integer |
| 4 | 3 | PM1.0 in µg/m$^3$ (x10).<br>*Measurement updated according the operating mode set with the CPLS, CPLP and CPS commands.* | 16-bit Integer |
| 5 | 4 | PM2.5 in µg/m$^3$ (x10).<br>*Measurement updated according the operating mode set with the CPLS, CPLP and CPS commands.* | 16-bit Integer |
| 6 | 5 | PM10 in µg/m$^3$ (x10).<br>*Measurement updated according the operating mode set with the CPLS, CPLP and CPS commands.* | 16-bit Integer |
| 7 | 6 | PM1.0 in N° of particles/ml.<br>*Measurement averaged over 10 s and updated every second. Available in continuous measurement mode.* | 16-bit Integer |
| 8 | 7 | PM2.5 in N° of particles/ml.<br>*Measurement averaged over 10 s and updated every second. Available in continuous measurement mode.* | 16-bit Integer |
| 9 | 8 | PM10 in N° of particles/ml.<br>*Measurement averaged over 10 s and updated every second. Available in continuous measurement mode.* | 16-bit Integer |
| 10 | 9 | PM1.0 in µg/m$^3$ (x10).<br>*Measurement averaged over 10 s and updated every second. Available in continuous measurement mode.* | 16-bit Integer |

| | | | |
|---|---|---|---|
| 11 | 10 | PM2.5 in µg/m$^3$ (x10).<br>*Measurement averaged over 10 s and updated every second. Available in continuous measurement mode.* | 16-bit Integer |
| 12 | 11 | PM10 in µg/m$^3$ (x10).<br>*Measurement averaged over 10 s and updated every second. Available in continuous measurement mode.* | 16-bit Integer |
| 13 | 12 | PM1.0 in N° of particles/ml.<br>*Measurement averaged over 60 s and updated every 10 s. Available in continuous measurement mode.* | 16-bit Integer |
| 14 | 13 | PM2.5 in N° of particles/ml.<br>*Measurement averaged over 60 s and updated every 10 s. Available in continuous measurement mode.* | 16-bit Integer |
| 15 | 14 | PM10 in N° of particles/ml.<br>*Measurement averaged over 60 s and updated every 10 s. Available in continuous measurement mode.* | 16-bit Integer |
| 16 | 15 | PM1.0 in µg/m$^3$ (x10).<br>*Measurement averaged over 60 s and updated every 10 s. Available in continuous measurement mode.* | 16-bit Integer |
| 17 | 16 | PM2.5 in µg/m$^3$ (x10).<br>*Measurement averaged over 60 s and updated every 10 s. Available in continuous measurement mode.* | 16-bit Integer |
| 18 | 17 | PM10 in µg/m$^3$ (x10).<br>*Measurement averaged over 60 s and updated every 10 s. Available in continuous measurement mode.* | 16-bit Integer |
| 19 | 18 | PM1.0 in N° of particles/ml.<br>*Measurement averaged over 15 min and updated every minute. Available in continuous measurement mode.* | 16-bit Integer |
| 20 | 19 | PM2.5 in N° of particles/ml.<br>*Measurement averaged over 15 min and updated every minute. Available in continuous measurement mode.* | 16-bit Integer |
| 21 | 20 | PM10 in N° of particles/ml.<br>*Measurement averaged over 15 min and updated every minute. Available in continuous measurement mode.* | 16-bit Integer |
| 22 | 21 | PM1.0 in µg/m$^3$ (x10).<br>*Measurement averaged over 15 min and updated every minute. Available in continuous measurement mode.* | 16-bit Integer |
| 23 | 22 | PM2.5 in µg/m$^3$ (x10).<br>*Measurement averaged over 15 min and updated every minute. Available in continuous measurement mode.* | 16-bit Integer |
| 24 | 23 | PM10 in µg/m$^3$ (x10).<br>*Measurement averaged over 15 min and updated every minute. Available in continuous measurement mode.* | 16-bit Integer |
| 27 | 26 | PM measurement error: 0=no, 1=yes. | Intero 16 bit |
| 29 | 28 | $CO_2$ in ppm. | Intero 16 bit |
| 34,35 | 33,34 | Atmospheric pressure in Pa (*)<br>*Internal sensor for $CO_2$ measurement compensation* | Intero 16 bit |
| 36 | 35 | Atmospheric pressure in hPa (x10)<br>*Internal sensor for $CO_2$ measurement compensation* | Intero 16 bit |
| 38 | 37 | Power supply voltage in Volt (x10). | 16-bit Integer |

| | | | |
|---|---|---|---|
| 39 | 38 | Internal board temperature (x10). | 16-bit Integer |
| 41 | 40 | Instrument firmware revision. The most significant byte indicates the major revision; the less significant byte indicates the minor revision. | 16-bit Integer |
| 42 | 41 | Number of MODBUS communication error. | 16-bit Integer |

(*) The measure is a 32-bit integer value. Two consecutive registers must be accessed to read the value. The register with lower address contains the most significant bits.

**Coils:**

| Number | Address | Description | Format |
|---|---|---|---|
| 1 | 0 | Set 1 to restore the factory configuration. Bit zeroing is automatic. | Bit |
| 2 | 1 | Enable configuration change:<br>0=no (default), 1=yes.<br>The changes to *Coils* and *Holding Registers* will be accepted only if this register is set to 1. | Bit |
| 3 | 2 | Sets waiting time after transmission with MODBUS-RTU protocol:<br>0=immediate reception (default);<br>1=waiting 3.5 characters. | Bit |
| 4 | 3 | Enable/disable the offset of the analog output 1:<br>0=offset disabled (0…20 mA or 0…10 V, default if the output is voltage);<br>1=offset enabled (4…20 mA or 2…10 V, default if the output is current). | Bit |
| 5 | 4 | Sets the direct or inverse correspondence between analog output 1 and associated physical quantity:<br>0=4 mA/0 V ⇒ Min. quantity, 20 mA/10 V ⇒ Max. quantity (default);<br>1=20 mA/10 V ⇒ Min. quantity, 4 mA/0 V ⇒ Max. quantity. | Bit |
| 6 | 5 | Enable/disable the offset of the analog output 2:<br>0=offset disabled (0…20 mA or 0…10 V, default if the output is voltage);<br>1=offset enabled (4…20 mA or 2…10 V, default if the output is current). | Bit |
| 7 | 6 | Sets the direct or inverse correspondence between analog output 2 and associated physical quantity:<br>0=4 mA/0 V ⇒ Min. quantity, 20 mA/10 V ⇒ Max. quantity (default);<br>1=20 mA/10 V ⇒ Min. quantity, 4 mA/0 V ⇒ Max. quantity. | Bit |

**Holding Registers:**

| Number | Address | Description | Format |
|---|---|---|---|
| 1 | 0 | RS485 Baud Rate:<br>0=1200;<br>1=2400;<br>2=4800;<br>3=9600;<br>4=19200 (default);<br>5=38400;<br>6=57600;<br>7=115200. | 16-bit Integer |
| 2 | 1 | RS485 parity and stop bits:<br>0=8N1;<br>1=8N2;<br>2=8E1 (default);<br>3=8E2;<br>4=8O1;<br>5=8O2.<br>[N=no parity, E=even parity, O=odd parity] | 16-bit Integer |
| 3 | 2 | Instrument address for the MODBUS-RTU protocol (1…247, default=1). | 16-bit Integer |
| 4 | 3 | Association of a physical quantity to the analog output 1:<br>0=PM1.0;<br>1=PM2.5 (default);<br>2=PM10;<br>12=$CO_2$ (only PMBsense-A).<br>*Note: the PM measurement is updated according to the set operating mode.* | 16-bit Integer |
| 7,8 | 6,7 | Setting of the minimum value of the measuring range of the physical quantity associated to the analog output 1. (*)<br>If the output is associated to PM, the value is expressed as a number of tenths (e.g. 5 = 0.5 µg/m$^3$). If the output is associated to $CO_2$, the value is expressed as a number of units (e.g. 200 = 200 ppm). The default value is 0. | 16-bit Integer |
| 9,10 | 8,9 | Setting of the maximum value of the measuring range of the physical quantity associated to the analog output 1. (*)<br>If the output is associated to PM, the value is expressed as a number of tenths (e.g. 50 = 5.0 µg/m$^3$). If the output is associated to $CO_2$, the value is expressed as a number of units (e.g. 800 = 800 ppm). The default value is 10000 (=1000.0 µg/m$^3$ of PM). | 16-bit Integer |
| 11 | 10 | Association of a physical quantity to the analog output 2:<br>0=PM1.0;<br>1=PM2.5;<br>2=PM10 (default);<br>12=$CO_2$ (only PMBsense-A).<br>*Note: the PM measurement is updated according to the set operating mode.* | 16-bit Integer |

| Number | Address | Description | Format |
|---|---|---|---|
| 12,13 | 11,12 | Setting of the minimum value of the measuring range of the physical quantity associated to the analog output 2. (*)<br>If the output is associated to PM, the value is expressed as a number of tenths (e.g. 5 = 0.5 µg/$m^3$). If the output is associated to $CO_2$, the value is expressed as a number of units (e.g. 200 = 200 ppm). The default value is 0. | 16-bit Integer |
| 14,15 | 13,14 | Setting of the maximum value of the measuring range of the physical quantity associated to the analog output 2. (*)<br>If the output is associated to PM, the value is expressed as a number of tenths (e.g. 50 = 5.0 µg/$m^3$). If the output is associated to $CO_2$, the value is expressed as a number of units (e.g. 800 = 800 ppm). The default value is 10000 (=1000.0 µg/$m^3$ of PM). | 16-bit Integer |
| 16 | 15 | Setting of the PM measurement mode:<br>0=continuous;<br>1=at cyclic intervals (default). | 16-bit Integer |
| 17 | 16 | Setting of the cycle interval, in seconds, for the PM measurement mode at cyclic intervals.<br>The number of seconds must be greater than 70, in order to allow the sensor to take the measurement. The default value is 300 (=5 min). | 16-bit Integer Unsigned |
| 20 | 19 | Setting of the type of measurement averaging for the continuous PM measurement mode:<br>0=average over a 10 seconds interval, updated every second;<br>1=average over a 60 seconds interval, updated every 10 seconds (default);<br>2=average over a 15 minutes interval, updated every minute. | 16-bit Integer |
| 21 | 20 | Setting of the type of $CO_2$ calibration to be used:<br>0=user;<br>1=factory (default). | 16-bit Integer |

(*) The datum is a 32-bit integer value. Two consecutive registers must be accessed to read/write the value. The register with lower address contains the most significant bits.

# 7 SAFETY INSTRUCTIONS

**General safety instructions**

The instrument has been manufactured and tested in accordance with the safety standard EN61010-1:2010 "Safety requirements for electrical equipment for measurement, control and laboratory use" and has left the factory in perfect safety technical conditions.

The instrument proper operation and operating safety can be ensured only if all standard safety measures as well as the specific measures described in this manual are followed.

The instrument proper operation and operating safety can be ensured only in the climatic conditions specified in this manual.

Do not use the instruments in places where there are:

- Corrosive or flammable gases.
- Direct vibrations or shocks to the instrument.
- High-intensity electromagnetic fields, static electricity.

**User obligations**

The instrument operator shall follow the directives and regulations below that refer to the treatment of dangerous materials:

- EEC directives on workplace safety.
- National law regulations on workplace safety.
- Accident prevention regulations.

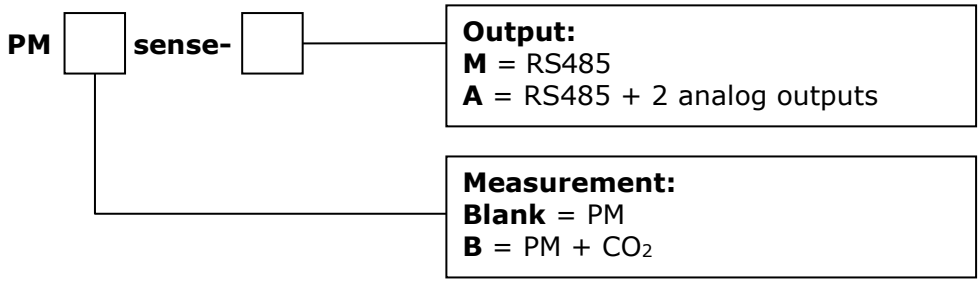
# 8 ORDERING CODES

**PMsense-M** PM1.0, PM2.5 and PM10 transmitter. RS485 output with MODBUS-RTU or proprietary protocol. Supplied with mounting bracket and 8-pole female free connector. **CPM12-8DA.x cable has to be ordered separately.**

**PMBsense-M** PM1.0, PM2.5, PM10 and $CO_2$ transmitter. RS485 output with MODBUS-RTU or proprietary protocol. Supplied with mounting bracket and 8-pole female free connector. **CPM12-8DA.x cable has to be ordered separately.**

**PMsense-A** PM1.0, PM2.5 and PM10 transmitter. RS485 output with MODBUS-RTU or proprietary protocol, two 0/4…20 mA (0…10 V **on request when ordering**) analog outputs. Supplied with mounting bracket and 8-pole female free connector. **CPM12-8DA.x cable has to be ordered separately.**

**PMBsense-A** PM1.0, PM2.5, PM10 and $CO_2$ transmitter. RS485 output with MODBUS-RTU or proprietary protocol, two 0/4…20 mA (0…10 V **on request when ordering**) analog outputs. Supplied with mounting bracket and 8-pole female free connector. **CPM12-8DA.x cable has to be ordered separately.**




**ACCESSORI**

**CPM12-8DA.x** Cable with 8-pole M12 connector on one end, open wires on the other end. Length 2 m (CPM12-8DA.2), 5 m (CPM12-8DA.5) or 10 m (CPM12-8DA.10) standard, other lengths on request.

**RS51K** Kit for connecting the transmitter RS485 output to a PC. It includes the SWD10 power supply and the RS485/USB adapter with:

- screw terminals for the connection to the CPM12-8DA.x cable (not included);
- USB connector for the connection to the PC;
- jack connector for connecting the SWD10 power supply.

## NOTES

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# 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:
*Document-No. / Month.Year* : **5161 / 10.2020**

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:
*Product identifier* : **PMsense-M / PMBsense-M**
**PMsense-A / PMBsense-A**

Descrizione prodotto:
*Product description* : **Trasmettitori di Particolato (PM) e $CO_2$**
***Particulate Matter (PM) and $CO_2$ 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:*

Alessandro Perego

Amministratore delegato
*Chief Executive Officer*

Caselle di Selvazzano, 30/10/2020

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.*

# GUARANTEE

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**TERMS OF GUARANTEE**

All DELTA OHM instruments are subject to accurate testing, and are guaranteed for 24 months from the date of purchase. DELTA OHM will repair or replace free of charge the parts that, within the warranty period, shall be deemed non efficient according to its own judgement. Complete replacement is excluded and no damage claims are accepted. The DELTA OHM guarantee only covers instrument repair. The guarantee is void in case of incidental breakage during transport, negligence, misuse, connection to a different voltage than that required for the appliance by the operator. Finally, a product repaired or tampered by unauthorized third parties is excluded from the guarantee. The instrument shall be returned FREE OF SHIPMENT CHARGES to your dealer. The jurisdiction of Padua applies in any dispute.

The electrical and electronic equipment marked with this symbol cannot be disposed of in public landfills. According to the Directive 2011/65/EU, the european users of electrical and electronic equipment can return it to the dealer or manufacturer upon purchase of a new one. The illegal disposal of electrical and electronic equipment is punished with an administrative fine.

This guarantee must be sent together with the instrument to our service centre.

IMPORTANT: Guarantee is valid only if coupon has been correctly filled in all details.

**Instrument Code:** ❑ **PM[B]sense-M** ❑ **PM[B]sense-A**

Serial Number _____

## RENEWALS

| | |
|---|---|
| Date _____ | Date _____ |
| Inspector _____ | Inspector _____ |
| Date _____ | Date _____ |
| Inspector _____ | Inspector _____ |
| Date _____ | Date _____ |
| Inspector _____ | Inspector _____ |

CE

RoHS 2011/65/EU

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The quality level of our instruments is the result of the constant development of the product. This may produce some differences between the information written in this manual and the instrument you have purchased. We cannot completely exclude the possibility of errors in the manual, for which we apologize.

The data, images and descriptions included in this manual cannot be legally asserted. We reserve the right to make changes and corrections with no prior notice.

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