REV. 1.0
10 jan. 2007

LP PYRA 03

GB

Our instruments' quality level is the results of the product continuous development. This can bring about differences between the information written in this manual and the instrument that you have purchased. We cannot entirely exclude errors in the manual, for which we apologize.
The data, figures and descriptions contained in this manual cannot be legally asserted. We reserve the right to make changes and corrections without prior notice.

LP PYRA 03

1 Introduction

LP PYRA 03 pyranometer measures the irradiance on a plane surface (Watt/ m^2). Measured irradiance (Global Irradiance) is the result of the sum of direct solar irradiance and of diffuse irradiance.
LP PYRA 03 is a Second Class pyranometer in accordance with ISO 9060 and with the criteria of the WMO "Guide to Meteorological Instruments and Methods of Observation'", fifth edition (1983).
The pyranometer is produced in three versions:

LP PYRA 03	PASSIVE *
LP PYRA 03 AC	ACTIVE ,4..20 mA CURRENT output
LP PYRA 03 AV	ACTIVE , 0..1** or 0..5 or 0..10 V VOLTAGE output, to be defined at the order.

* Using SICRAM Module VP 472 it is possible to connect passive pyranometer to Indicator D09847.
** 0..1 output version can be connected to indicator HD2302.0 using SICRAM Module VP 474. The indicator reads directly in W/m^2.

2 Working Principle

LP PYRA 03 pyranometer is based on a thermopile sensor. The thermopile sensitive surface is coated with a black matt paint, which allows the pyranometer not to be selective at different wave lengths. The pyranometer spectral range is determined by the transmission of the glass dome type K5.
Radiant energy is absorbed by the thermopile black surface, thus creating a difference of temperature between the center of the thermopile (hot junction) and the pyranometer body (cold junction). Thanks to the Seebeck effect, the difference of temperature between hot and cold junction is converted into a Difference of Potential.
In order to grant the thermopile a proper thermal insulation from the wind and reduce the sensitivity to thermal irradiance, LP PYRA 03 is equipped with a 4mm thick dome which is 32mm in outer diameter. The dome protects the thermopile from the dust, which might change spectral sensitivity if ,it lies on the black surface,
To prevent internal condensation forming on the internal side of the dome under certain climatic conditions, three silica gel tablets are inserted inside the pyranometer to absorb humidity.

3 Installation and Mounting of the Pyranometer for the Measurement of Global Radiation:

- PYRA 03 pyranometer is to be mounted in an easy-to-reach location in order to clean the dome regularly and carry out maintenance. At the same time, make sure that no buildings, constructions, trees or obstructions exceed the horizontal plane where the pyranometer lies. If this is not possible, select a site where obstructions in the path of the sun from sunrise to sunset do not exceed 5 degrees of elevation. **N.B The presence of obstructions on the horizon line affects significantly the measurement of direct irradiance.**
- Pyranometer is to be located far from any kind of obstruction, which might reflect sunlight (or sun shadow) onto the pyranometer itself.
- In compliance with ISO TR9901 standard and WMO recommendations, when the pyranometer is used without the white shade disk, it is to be positioned so that its connector is pointed to the North Pole, if the instrument is used in the Northern Hemisphere, and to the South Pole, if used in the Southern Hemisphere. In any case, it is better to follow this suggestion even when the shade disk is applied.
- In order to allow an accurate horizontal positioning of the instrument, use the holes on the pyranometer body or suitable accessories (figure 1,2).

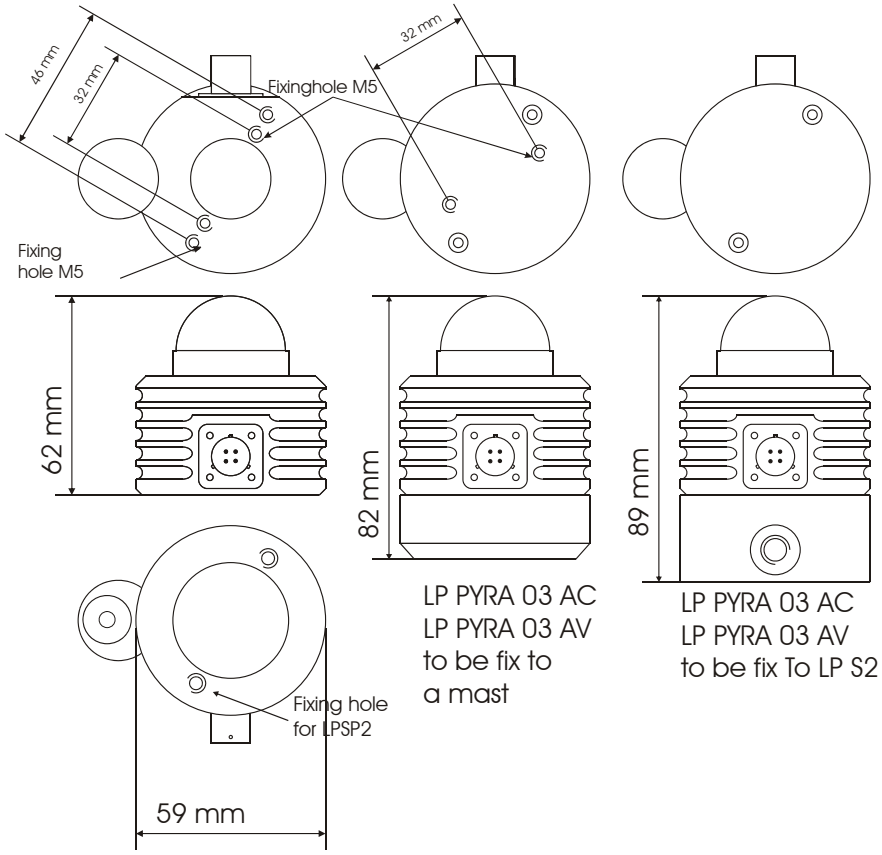

Fig 1

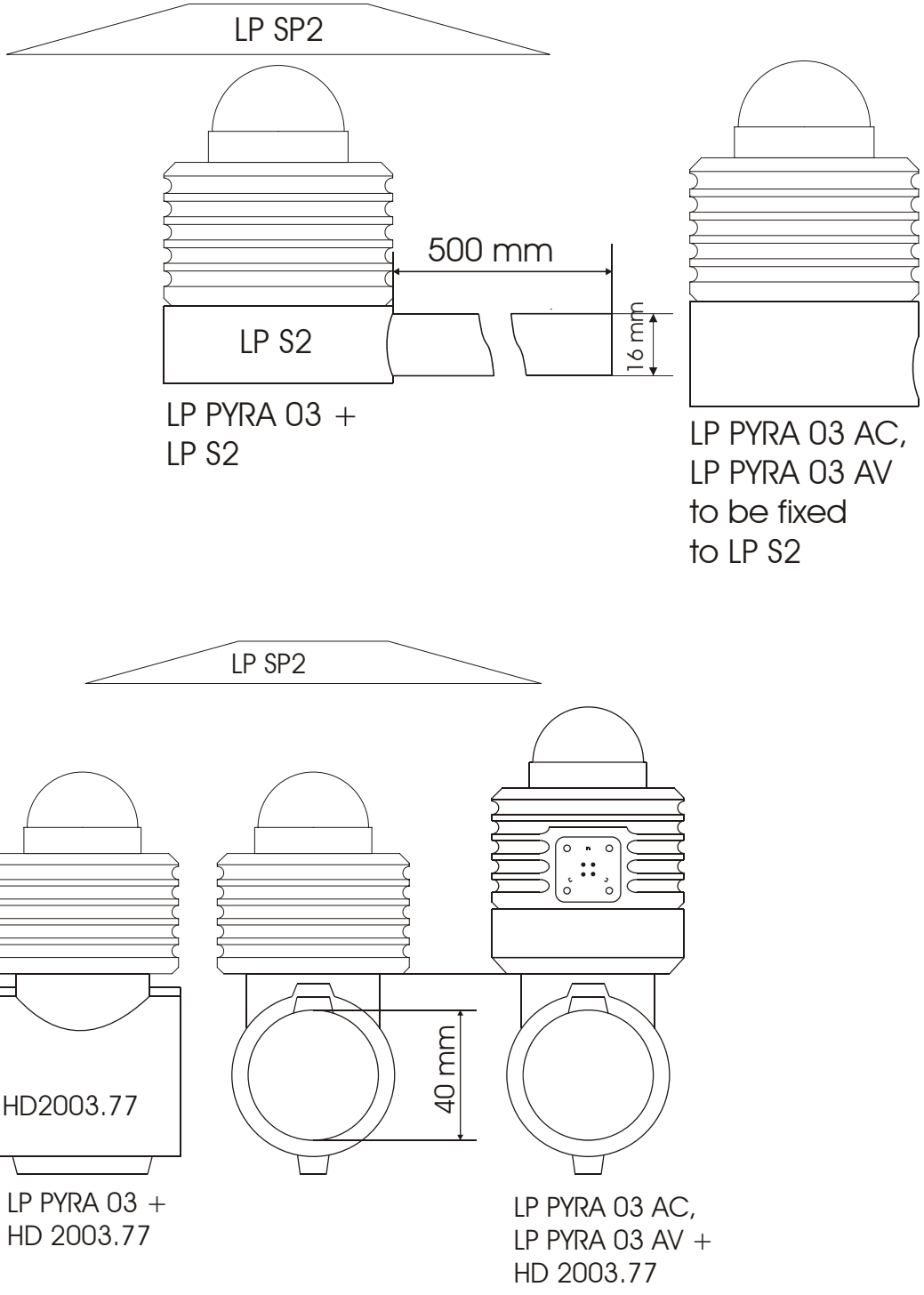
LP SP2
500 mm
LP S2
16 mm
LP PYRA 03 +
LP S2
LP PYRA 03 AC,
LP PYRA 03 AV
to be fixed
to LP S2
LP SP2
HD2003.77
40 mm
LP PYRA 03 +
HD 2003.77
LP PYRA 03 AC,
LP PYRA 03 AV +
HD 2003.77

Fig. 2

4 Electrical Connection and Requirements for Electronic Readout Devices:

LP PYRA 03 is produced in 3 versions, LP PYRA 03, LP PYRA 03 AC and LP PYRA 03 AV.

- LP PYRA 03 pyranometer is passive and it does not require any power supply.
- LP PYRA 03 AC, AV are active and need power supply.
  Required voltage is as follows:
  8-30 Vcc for LP PYRA 03 AC and LP PYRA 03 AV with 0..1V and 0..5V autput supply.
  14-30 Vcc for LP PYRA 03 AV with 0..10 V output.
- All version are supplied with a 4 pole connector.
- The optional cable is terminated with a connector at one end and it is made of PTFE UV-proof. It is provided with 3 wires and a braided wire (shield). Cable colors and connector poles are matched as follow (figure 3):

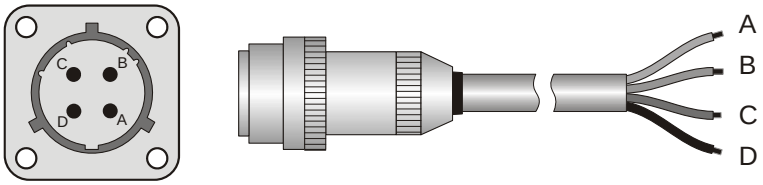

Fig.3

LP PYRA 03

Connector	Function	Color
A	Shield (⏚)	Black
B	Vout(+)	Red
C	Vout (-)	Blue
D	No connection	White

LP PYRA 03 AC

Connector	Function	Color
A	Shield (⏚)	Black
B	Positive (+)	Red
C	Negative (-)	Blue
D	No connection	White

LP PYRA 03 AV

Connector	Function	Color
A	Shield (⏚)	Black
B	(+) Vout	Red
C	(-) Vout e (-)Vcc	Blue
D	(+) Vcc	White

- LP PYRA 03 pyranometer is to be connected either to a millivoltmeter or to a data acquisition system. Typically, the pyranometer output signal does not exceed 20 mV. In order to better exploit the pyranometer features, the readout instrument should have a 1μV resolution.

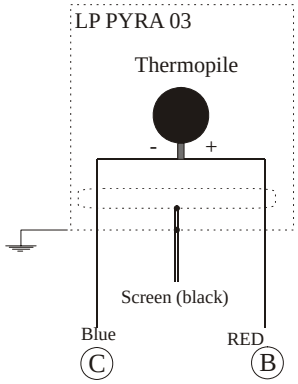

Fig. 4

- LP PYRA 03 AC is to be connected to a DMM and a power supply as show below (Figure 5).To read the signal, the load resistance must be ≤500Ω

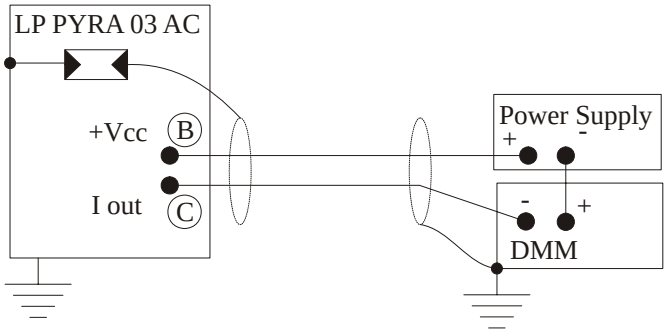

Fig. 5

- LP PYRA 03 AV is to be connected to a DMM and a power supply as show below (Figure 6). To read the signal, the load resistance must be ≥ 100kΩ

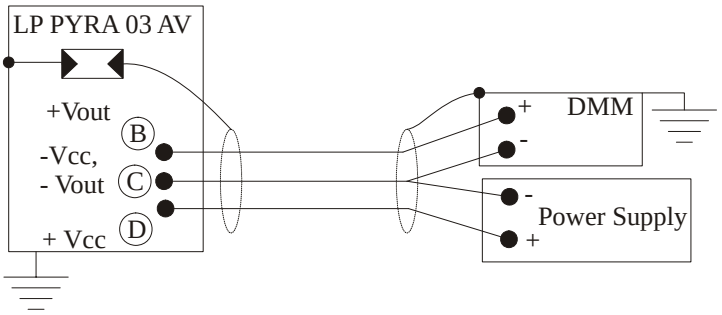

Fig. 6

5 Maintenance:

In order to grant measurement high accuracy. It is important to keep the outer glass dome clean. Consequently, the more the dome will be kept clean, the more measurements will be accurate. You can wash it using water and standard papers for lens, and if necessary using pure ETHYL alcohol. After using alcohol, clean again the dome with water only.

6 Calibration and Measurements:

LP PYRA 03

The pyranometer **S** sensitivity (or calibration factor) allows to determine global irradiance by measuring a signal in Volts at the thermopile ends. The **S** factor is measured in $\mu V/(Wm^{-2})$.

- Once the difference of potential (DDP) has been measured at the ends of the sensor, the E_e irradiance is obtained applying the following formula:

$$E_e = DDP/S$$

where;

E_e: is irradiance expressed in W/m^2,

DDP: is the difference of potential expressed in μV measured by the multimeter,

S: is the calibration factor in $\mu V/(W/m^{2)}$ shown on the pyranometer label (and mentioned in the calibration report).

LP PYRA 03 AC

The pyranometer sensitivity is set so that:

4..20 mA = 0..2000 W/m^2

To obtain irradiance the following procedure is to be applied:

-once you know the current (I_{out}) absorbed by the instrument and measured with the DMM, following formula must be applied:

$$Ee = 125 \cdot (I_{out} - 4mA)$$

where;

E_e: Irradiance in W/m^2,

I_{out}: current in mA absorbed by the pyranometer

LP PYRA 03 AV

The pyranometer sensitivity is set so that according to the version:

0..1 V = 0..2000 W/m^2

0..5 V = 0..2000 W/m^2

0..10 V = 0..2000 W/m^2

To obtain irradiance the following procedure is to be applied:

-once you know the instrument output voltage (V_{out}) measured with the DMM, following formula must be applied:

$$E_e = 2000 \cdot V_{out}$$ for the version 0…1 V

$$E_e = 400 \cdot V_{out}$$ for the version 0…5 V

$$E_e = 200 \cdot V_{out}$$ for the version 0…10 V

where;
E_e: Irradiance in W/m^2,
V_{out}: Output voltage (in Volt) measured by the voltmeter

Each Pyranometer is factory calibrated it is marked by its own calibration factor. To exploit all LP PYRA 03 Features it is highly recommended that the calibration be checked annually.
The instruments and the equipment of Delta Ohm Photometry-Radiometry meteorological laboratory grant the calibration of pyranometers according to the WMO specifications and ensure that measurements are traceable to the international standards.

7 Technical Specifications:

Typical sensitivity:	10 μV/(W/m^2)	LP PYRA 03
	4..20 mA (0-2000 W/m^2)	LP PYRA 03 AC
	0..1,5,10V(0-2000 W/m^2)	LP PYRA 03 AV
Impedance:	33 Ω ÷ 45 Ω	
Measuring Range:	0-2000 W/m^2	
Viewing angle:	2π sr	
Spectral range:	305 nm ÷ 2800 nm (50%)	
(Dome transmission)	335 nm ÷ 2200 nm (95%)	
Operating Temperature:	-40 °C ÷ 80 °C	
Dimensions:	figure 1	
Weight:	0.45 Kg	

Technical Specifications According to ISO 9060

1- Response Time: (95%)	<30 sec
2- Zero off-set:	
a) response to a 200W/m^2 thermal radiation:	< 25 W/m^2
b) response to a 5K/h change in ambient temperature:	< | 6 | W/m^2
3a- Long-term instability: (1 year)	< | ±2.5 | %
3b- Non-linearity:	< | ±2 | %
3c- Response according to the cosine law: Cosine Response	< | ±22 | W/m^2
3d- Spectral selectivity:	< | ±7 | %
3e- Response depending on temperature: Temperature response	<8 %
3f- Tilt response:	< | ±4 | %

8 Ordering Codes

ORDERING CODE	ARTICLE
LP PYRA 03	Second Class Pyranometer according to ISO 9060. It is Provided with spirit level, 4 pole plug and Calibration Report.
LP PYRA 03 AC	Second Class Pyranometer according to ISO 9060. It is Provided with spirit level, 4 pole plug and Calibration Report. 4..20 mA signal Output
LP PYRA 03 AV	Second Class Pyranometer according to ISO 9060. It is Provided with spirit level, 4 pole plug and Calibration Report. 0..1V, 0..5V, 0..10V signal output (to be defined when order)
CP AA 1.5	4 pole plug with UV proof cable, L=5m.
CP AA 1.10	4 pole plug with UV proof cable, L=10m.
LP SP2	Shade disk for pyranometer LP PYRA 03.
LP S2	Mounting kit including a support for LP PYRA 03 pyranometers, fastener screws of the pyranometer to the support and a support mast.
LP SP2+ LP S2	Mounting kit LP SP2 and LP S2
HD2003.77	Mounting kit to fix LP PYRA 03 to a ϕ 40mm mast. Fastener screws of the pyranometer to the support and LP SP2 shade disk also included in the mounting kit.
VP 472	SICRAM module for DO9847K for Pyranometers and Albedometers. The signal produced by the thermopile of pyranometer can be read in mV or W/m^2. The thermopile sensitivity can be set from 5 to 30 mV(kWm^{-2}).
VP 474	SICRAM module to connect the pyranometer to HD2302.0 indicator. The instrument read directly in W/m^2.

GARANZIA

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GUARANTEE

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GUARANTEE CONDITIONS

All DELTA OHM instruments have been subjected to strict tests and are guaranteed for 24 months from date of purchase. DELTA OHM will repair or replace free of charge any parts which it considers to be inefficient within the guarantee period. Complete replacement is excluded and no request of damages are recognized. The guarantee does not include accidental breakages due to transport, neglect, incorrect use, incorrect connection to voltage different from the contemplated for the instrument. Furthermore the guarantee is not valid if the instrument has been repaired or tampered by unauthorized third parties. The instrument has to be sent to the retailer without transport charge. For all disputes the competent court is the Court of Padua.

This guarantee must be sent together with the instrument to our service centre.
N.B.: Guarantee is valid only if coupon has been correctly filled in all details.

Instrument type ❑ **LP PYRA 03**

Serial number _____

RENEWALS

Date	Date
Inspector	Inspector
Date	Date
Inspector	Inspector
Date	Date
Inspector	Inspector

RoHS 2002/95/EC

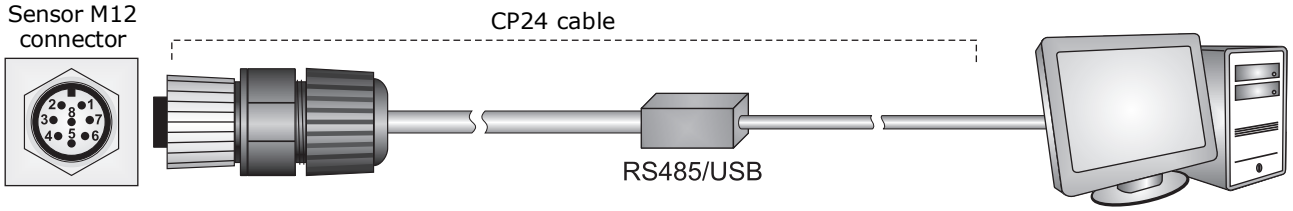
CE CONFORMITY	
Safety	EN61000-4-2, EN61010-1 LEVEL 3
Electrostatic discharge	EN61000-4-2 LEVEL 3
Electric fast transients	EN61000-4-4 LEVEL 3
Voltage variations	EN61000-4-11
Electromagnetic interference susceptibility	IEC1000-4-3
Electromagnetic interference emission	EN55020 class B

SETTING THE RS485 COMMUNICATION PARAMETERS OF LP PYRA...S PYRANOMETERS AND LP PYRHE 16 S PYRHELIOMETER WITH A STANDARD COMMUNICATION PROGRAM

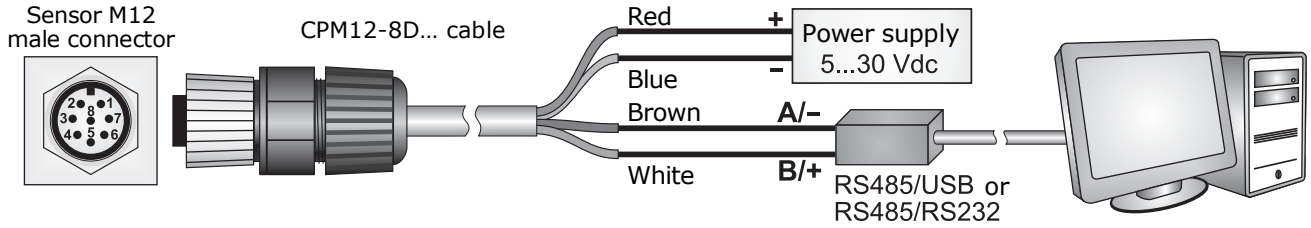
Before connecting the sensor to the RS485 network, an address must be assigned and the communication parameters must be set, if different from the factory preset.

The setting of the parameters is performed by connecting the sensor to the PC in one of the following two ways:

A. By using the optional **CP24** cable, with built-in RS485/USB converter. In this connection mode, the sensor is powered by the PC USB port. To use the cable, it is necessary to install the related USB drivers in the PC.



B. By using the supplied 8-pole M12 female connector or the optional **CPM12-8D...** cable and a generic RS485/USB or RS485/RS232 converter. In this connection mode, it is necessary to power the sensor separately. If a RS485/USB converter is used, it is necessary to install the related USB drivers in the PC.



NOTES ON THE INSTALLATION OF UNSIGNED USB DRIVER: before installing unsigned USB driver into operating systems starting from Windows 7, it is necessary to restart the PC by disabling the driver signing request. If the operating system is 64-bit, even after installation the request of driver signing have to be disabled each time the PC is restarted.

PROCEDURE FOR SETTING THE PARAMETERS:

1. Start with the sensor not powered (if the CP24 cable is used, disconnect one end of the cable).

2. Start a communication program, such as Hyperterminal. Set the Baud Rate to 57600 and set the communication parameters as follows (the sensor is connected to a COM type port):

Data Bits: 8
Parity: None
Stop Bits: 2

In the program, set the COM port number to which the sensor will be connected.

3. Switch the sensor on (if the CP24 cable is used, connect both ends of the cable).

4. Wait until the sensor transmits the **&** character, then send (within 10 seconds from the sensor power on) the **@** command and press **Enter**.

Note: if the sensor does not receive the **@** command within 10 seconds from power on, the RS485 MODBUS mode is automatically activated. In such a case, it is necessary to switch off and on again the sensor.

5. Send the command **CAL USER ON**.

Note: the command CAL USER ON is disabled after 5 minutes of inactivity.

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

Command	Response	Description
CMAnnn	&|	Set RS485 address to nnn Ranging from 1 to 247 Preset on 1
CMBn	&|	Set RS485 Baud Rate n=0 ⇒ 9600 n=1 ⇒ 19200 Preset on 1 ⇒ 19200
CMPn	&|	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
CMWn	&|	Set receiving mode after RS485 transmission n=0 ⇒ Violate protocol and go in Rx mode right after Tx n=1 ⇒ Respect protocol and wait 3.5 characters after Tx Preset on 1 ⇒ Respect the protocol

7. You can check the parameters setting by sending the following serial commands:

Command	Response	Description
RMA	*Address*	Read RS485 address
RMB	*Baud Rate* (0,1)	Read RS485 Baud Rate 0 ⇒ 9600 1 ⇒ 19200
RMP	*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
RMW	*Rx Mode* (0,1)	Read receiving mode after RS485 transmission 0 ⇒ Violate protocol and go in Rx mode right after Tx 1 ⇒ Respect protocol and wait 3.5 characters after Tx

Note: it is not required to send the CAL USER ON command to read the settings.

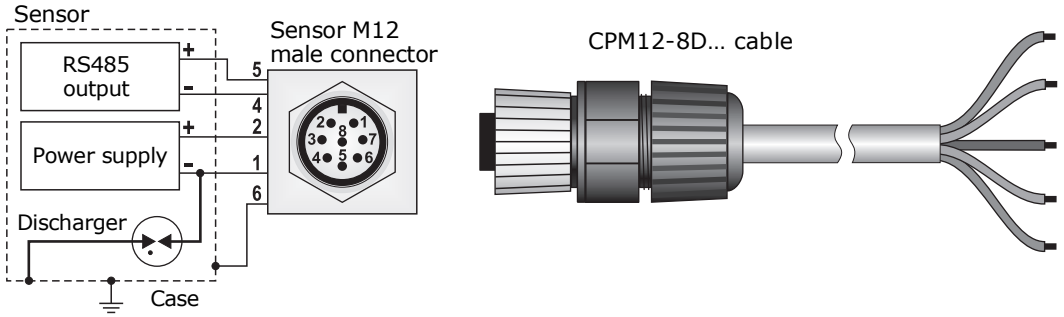
READING OF THE MEASURES WITH THE MODBUS-RTU PROTOCOL WHEN THE SENSOR IS IN OPERATING CONDITIONS (INSTALLED IN A NETWORK)

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

Address	Quantity	Format
0	Temperature in °C (x10) [if available in the model]	16-bit Integer
1	Temperature in °F (x10) [if available in the model]	16-bit Integer
2	Solar radiation in W/m^2	16-bit Integer
3	Status register bit0=1 ⇒ solar radiation measurement error bit1=1 ⇒ temperature measurement error bit2=1 ⇒ configuration data error bit3=1 ⇒ program memory error	16-bit Integer
4	Average solar radiation in W/m^2 The average refers to the last 4 measures	16-bit Integer
5	Signal (in mV x 100) generated by the sensor	16-bit Integer

OPERATING MODE: the sensor enters RS485 MODBUS-RTU mode after 10 seconds from power on. In the first 10 seconds from power on the sensor does not reply to requests from the MODBUS master unit. After 10 seconds, it is possible to send MODBUS requests to the sensor.

CONNECTION:

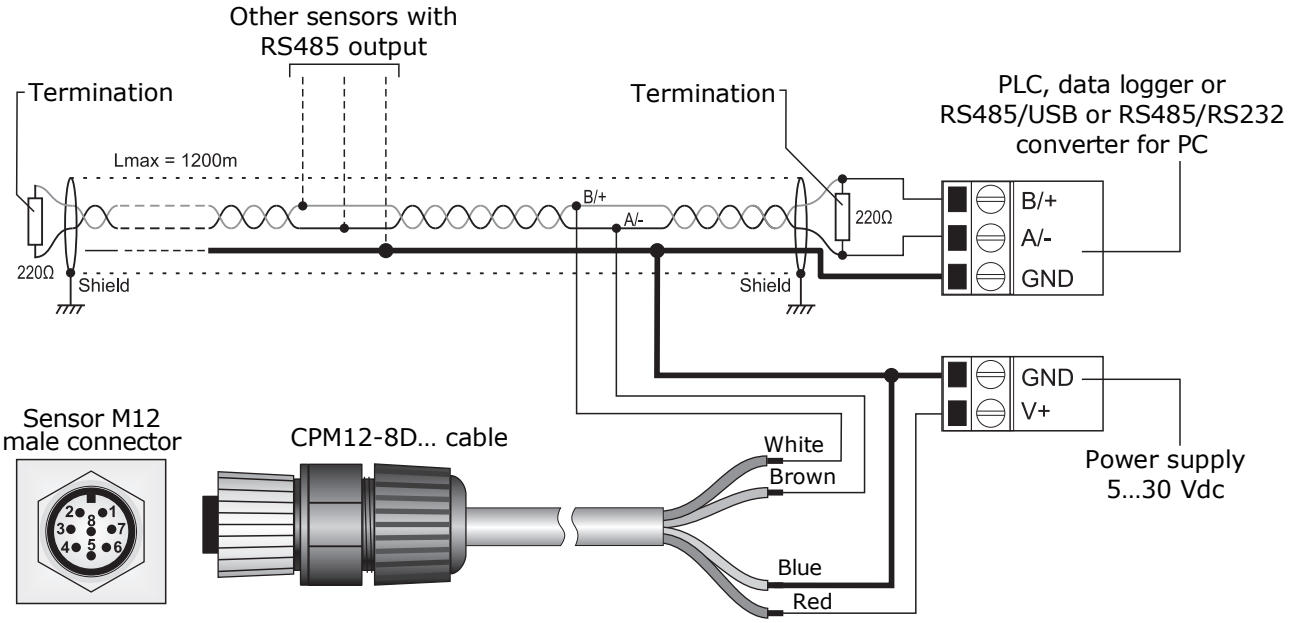


Connector	Function	Color
1	Power supply negative	Blue
2	Power supply positive	Red
3	Not connected	
4	RS485 A/-	Brown
5	RS485 B/+	White
6	Case	Shield (Black)
7	Not connected	
8	Not connected	

The RS485 output is not isolated.

⚠ **The metallic case of the sensor should preferably be grounded (⏚) locally. In this case, do not connect the shield of the CPM12-8D… cable to prevent ground loops.**

⚠ **Only if it is not possible to ground locally the metallic case of the sensor, connect the the shield of the CPM12-8D… cable to ground (⏚).**



Connection of RS485 output

CABLES:

CP24 PC connecting cable for the MODBUS parameters configuration. With built-in RS485/USB converter. 8-pole M12 connector on sensor side and A-type USB connector on PC side.

CPM12-8D.2 Cable with 8-pole M12 connector on one end, open wires on the other side. Length 2 m.

CPM12-8D.5 Cable with 8-pole M12 connector on one end, open wires on the other side. Length 5 m.

CPM12-8D.10 Cable with 8-pole M12 connector on one end, open wires on the other side. Length 10 m.

LP PYRA … S12 series

ENGLISH

Pyranometers with SDI-12 output

Rev. 1.1 – 05/10/2016

The pyranometers of the **LP PYRA…S12** series are solar radiation sensors with digital SDI-12 output.

Due to its low power consumption, SDI-12 standard is becoming very popular for environmental monitoring, expecially in battery/solar panel-powered data acquisition systems.

The sensors are compatible with version 1.3 of SDI-12 protocol and can be connected to the data logger HD32MT.3 or to any other data logger with SDI-12 input.

Electrical connections are made through an M12 connector.

The sensors are factory calibrated.

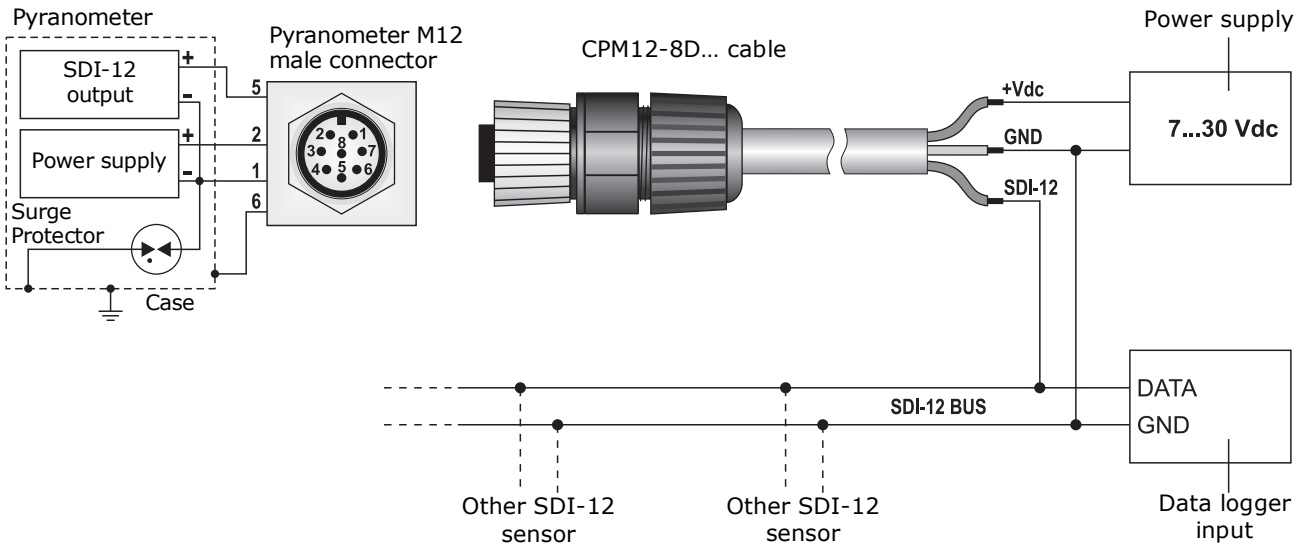
An NTC 10KΩ temperature sensor allows detecting the pyranometer internal temperature.

TECHNICAL CHARACTERISTICS

Solar radiation sensor	Thermopile
Temperature sensor	NTC 10KΩ (it detects the pyranometer internal temperature)
Power supply	7…30 Vdc
Power consumption	< 200 µA
Output	digital SDI-12
Connection	8-pole M12 connector
Measuring range and optical characterists	Same as LP PYRA … series

CONNECTION:

More SDI-12 sensors can be connected in parallel. The distance between a sensor and the acquisition system should not exceed 60 m. Before connecting the instrument to an SDI-12 network containing other sensors, set the address by using the proper SDI-12 command reported in the commands table.



M12 Connector	Function	Cable color
1	Power supply negative (GND) SDI-12 output negative	Blue
2	Power supply positive (+Vdc)	Red
3	Not connected	
4	Not connected	
5	SDI-12 output positive	White
6	Case	Shield (Black)
7	Not connected	
8	Not connected	

⚠ **The metallic case of the pyranometer should preferably be grounded (⏚) locally. In this case, do not connect the shield of the CPM12-8D... cable to prevent ground loops.**

⚠ **Only if it is not possible to ground locally the metallic case of the pyranometer, connect the the shield of the CPM12-8D... cable to ground (⏚).**

SDI-12 PROTOCOL

The protocol communication parameters are:

- baud rate: 1200
- data bits: 7
- parity: Even
- stop bits: 1

The communication with the instrument is performed by sending a command in the following form:

<Address><Command>!

with <Address> = address of the instrument the command is sent to
<Command> = type of operation requested to the instrument

The instrument reply is as follows:

<Address><Data><CR><LF>

with <Address> = address of the instrument which replies
<Data> = information sent by the instrument
<CR> = ASCII character *Carriage Return*
<LF> = ASCII character *Line Feed*

The sensors come with a factory address preset to 0. The address can be modified by using the proper SDI-12 command reported in the following table.

The following table reports the SDI-12 commands available. To comply with the SDI-12 standard, the instrument address is indicated in the table with the letter **a**.

SDI-12 Commands

Command	Instrument reply	Description
a!	a<CR><LF>	Verifies the presence of the instrument.
aI!	allccccccccmmmmmmvvvssssssss<CR><LF> with: a = address of the instrument (1 character) ll = SDI-12 compliant version (2 characters) cccccccc = manufacturer (8 characters) mmmmmm = instrument model (6 characters) vvv = firmware version (3 characters) ssssssss = serial number (8 characters) ⇒ Example of response: 013DeltaOhmLP-PYRA0016051518 with: 0 = instrument address 13 = SDI-12 version 1.3 compliant DeltaOhm = manufacturer's name LP-PYR = instrument model A00 = firmware version A.0.0 16051518 = serial number	Requests for information from the instrument.
aAb! Where: b = new address	b<CR><LF> Note: if the b character is not an acceptable address, the instrument responds with a instead of b.	Modification of the instrument address.
?!	a<CR><LF>	Request of the address of the instrument. If more than one sensor is connected to the bus, a conflict occurs.
TYPE M (START MEASUREMENT) AND TYPE C (START CONCURRENT MEASUREMENT) COMMANDS		
Irradiance, signal internal level and internal temperature		
aM! **aC!**	atttn<CR><LF> with: ttt = number of seconds necessary for the instrument to make the measure available (3 characters) n = number of detected variables (1 character for aM!, 2 characters for aC!) Note: ttt = 000 means that datum is immediately available.	Request to execute the measurement.
aD0!	a+n+w…w+v…v+t…t<CR><LF> with: n = content of the status register w…w = irradiance in W/m^2 v…v = signal internal level in mV t…t = internal temperature in the set unit of measurement (default °C) ⇒ Example of response: 0+0+228.7+3.294+25.1 probe address = 0 content of the status register = 0 irradiance = 228.7 W/m^2 signal internal level = 3.294 mV internal temperature = 25.1 °C *Note*: the status register normally contains zero; a value different from zero indicates an error condition.	Reads the measurement.

Command	Instrument reply	Description
Irradiance and internal temperature		
aM1! **aC1!**	atttn<CR><LF> with: ttt = number of seconds necessary for the instrument to make the measure available (3 characters) n = number of detected variables (1 character for aM1!, 2 characters for aC1!) Note: ttt = 000 means that datum is immediately available.	Request to execute the measurement.
aD0!	a+w…w+t…t<CR><LF> with: w…w = irradiance in W/m^2 t…t = internal temperature in the set unit of measurement (default °C) ⇒ Example of response: 0+228.7+25.1 probe address = 0 irradiance = 228.7 W/m^2 internal temperature = 25.1 °C	Reads the measurement.
Internal temperature		
aM2! **aC2!**	atttn<CR><LF> with: ttt = number of seconds necessary for the instrument to make the measure available (3 characters) n = number of detected variables (1 character for aM2!, 2 characters for aC2!) Note: ttt = 000 means that datum is immediately available.	Request to execute the measurement.
aD0!	a+t…t<CR><LF> with t…t = internal temperature in the set unit of measurement (default °C) ⇒ Example of response: 0+25.1 probe address = 0 internal temperature = 25.1 °C	Reads the measurement.
Signal internal level		
aM3! **aC3!**	atttn<CR><LF> with: ttt = number of seconds necessary for the instrument to make the measure available (3 characters) n = number of detected variables (1 character for aM3!, 2 characters for aC3!) Note: ttt = 000 means that datum is immediately available.	Request to execute the measurement.
aD0!	a+v…v<CR><LF> with v…v = signal internal level in mV ⇒ Example of response: 0+3.294 probe address = 0 signal internal level = 3.294 mV	Reads the measurement.

In addition to the above-mentioned commands, the sensor also implements the corresponding commands with CRC, that require to add a 3-character CRC code at the end of the reply before <CR><LF>. The format of these commands is obtained from the previous by adding the letter C: aMC!, aMC1!, aMC2!, aMC3!, aCC!, aCC1!, aCC2!, aCC3!. The sensor **does not** implement the type R (Continuous Measurements) commands.

Extended SDI-12 Commands

Command	Instrument reply	Description
aXSCAL USER ON!	a> USER ENABLED!<CR><LF>	Enables the configuration mode.
aXSCFD!	a> &<CR><LF>	Sets °C as temperature unit of measurement.
aXSCFE!	a> &<CR><LF>	Sets °F as temperature unit of measurement.
aXSCAL END!	a> LOCKED!<CR><LF>	Disables the configuration mode.

The extended commands allow setting the temperature unit of measurement. To change the unit of measurement:

1) Send the command **aXSCAL USER ON!** (note: **a**=instrument address).
2) Send the command **aXSCFD!** (to set °C) or **aXSCFE!** (to set °F).
3) Send the command **aXSCAL END!**

For more information about the SDI-12 protocol, visit the website "www.sdi-12.org".

ORDERING CODES:

LP PYRA 10S12 Pyranometer "**secondary standard**" according to ISO 9060. Supplied with shade disk, cartridge with silica-gel crystals, 2 spare sachets, levelling device and **Calibration Report**. **SDI-12 output**. Power supply 7…30 Vdc. **The cable CPM12-8D... has to be ordered separately**.

LP PYRA 13S12 Pyranometer "**secondary standard**" according to ISO 9060, with shadow ring for measuring the diffuse radiation only. Supplied with shade disk, cartridge with silica-gel crystals, 2 spare sachets, levelling device and **Calibration Report**. **SDI-12 output**. Power supply 7…30 Vdc. **The cable CPM12-8D... has to be ordered separately**.

LP PYRA 02S12 **First Class** pyranometer according to ISO 9060. Supplied with shade disk, cartridge with silica-gel crystals, 2 spare sachets, levelling device, connector and **Calibration Report**. **SDI-12 output**. Power supply 7…30 Vdc. **The cable CPM12-8D... has to be ordered separately**.

LP PYRA 12S12 **First Class** pyranometer according to ISO 9060, with shadow ring for measuring the diffuse radiation only. Supplied with shade disk, cartridge with silica-gel crystals, 2 spare sachets, levelling device and **Calibration Report**. **SDI-12 output**. Power supply 7…30 Vdc. **The cable CPM12-8D... has to be ordered separately**.

LP PYRA 03S12 **Second Class** pyranometer according to ISO 9060. Supplied with levelling device and **Calibration Report**. **SDI-12 output**. Power supply 7…30 Vdc. **The cable CPM12-8D... and the shade disk have to be ordered separately**.

CPM12-8D.2 Cable with 8-pole M12 connector on one end, open wires on the other side. Length 2 m.

CPM12-8D.5 Cable with 8-pole M12 connector on one end, open wires on the other side. Length 5 m.

CPM12-8D.10 Cable with 8-pole M12 connector on one end, open wires on the other side. Length 10 m.