

Operating manual

Pyrheliometer

LPPYRHE16



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1 INTRODUCTION

The pyrhelimeter LPPYRHE16 measure the direct solar irradiance (W/m^2).

The receiving surface must be positioned perpendicularly to sun's rays, via a solar tracker or else. The use of apposite diaphragms allows only direct light to hit the surface of the sensor.

LPPYRHE16 is a B class pyrhelimeter in accordance with ISO 9060:2018 standard and with the criteria of the WMO "Guide to Meteorological Instruments and Methods of Observation", seventh edition (2008).

The pyrhelimeter has a field of view of 5° , in accordance with ISO 9060:2018 standard and WMO guide.

The pyrhelimeter is available in the following versions:

- **LPPYRHE16:** PASSIVE
- **LPPYRHE16AC:** ACTIVE with 4..20 mA CURRENT output
- **LPPYRHE16AV:** ACTIVE with 0..1 or 0..5 or 0..10 V VOLTAGE output to be defined when ordering.
- **LPPYRHE16S:** With RS485 Modbus-RTU output.

The pyrhelimeter is supplied factory calibrated and with a calibration report.

2 WORKING PRINCIPLE

The pyrliometer LPPYRHE16 is based on a passive thermopile sensor. The sensitive surface of the thermopile is coated with a matt black paint, which makes the pyrliometer not selective to the different wave lengths. The spectral range of the pyrliometer is determined by the transmission of the quartz window, whose function is to protect the sensor from dust and water. A special quartz allows to perform a non-selective measurement from 250 nm to 4000 nm.

The adopted sensor allows the response time to be lower than ISO 9060:2018 requirements for the classification of class B pyrliometers (the response time is under 9 seconds while the standard requires a response time lower than 15 seconds).

Radiant energy is absorbed by the blackened surface of the thermopile, thus creating a difference in temperature between the hot junction and the body of the pyrliometer, which acts in this case as a cold junction. Thanks to the Seebeck effect, the difference in temperature between hot and cold junction is converted into a Difference of Potential.

In order to reduce the variations of sensitivity depending on temperature and to fall within the specifications requested to a class B pyrliometer, LPPYRHE16 is provided with a passive compensation circuit. Figure 2.1 shows the typical variation of sensitivity at different temperatures. Deviations are calculated starting from sensitivity measured at 20 °C.

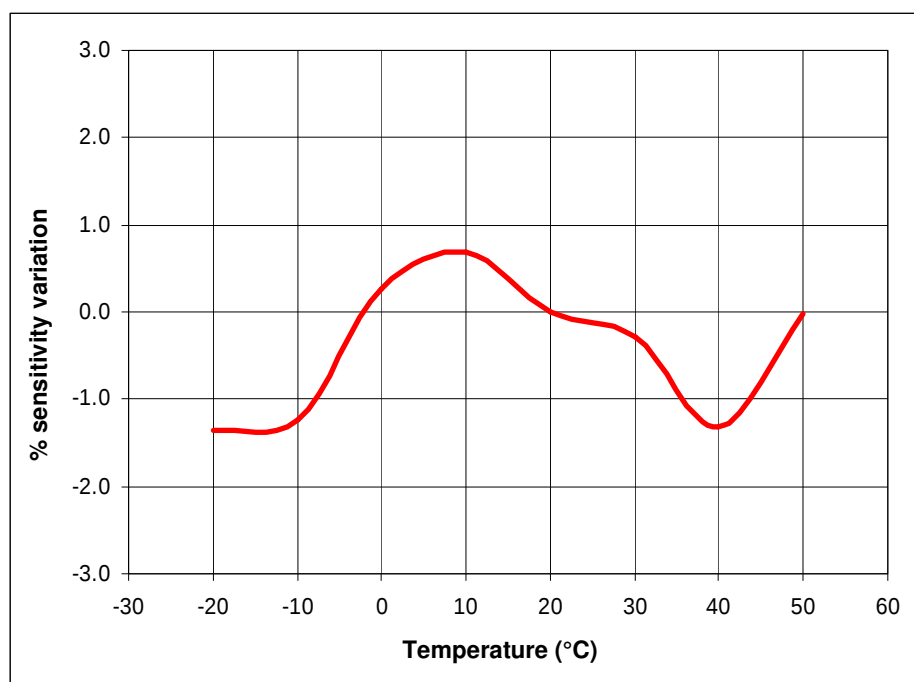


Fig. 2.1: % variation of sensitivity of the LPPYRHE16 pyrliometer with regard to sensitivity at 20 °C in the temperature range from -20 to 50 °C

LPPYRHE16 is a sealed instrument, for that reason a cartridge of silica-gel crystals is provided to absorb humidity inside the instrument, in order to prevent condensation from forming on the quartz window of the instrument, invalidating the performed measurements.

In accordance with WMO regulations, the angular field of view is 5° and the slope angle is 1° (figure 1).

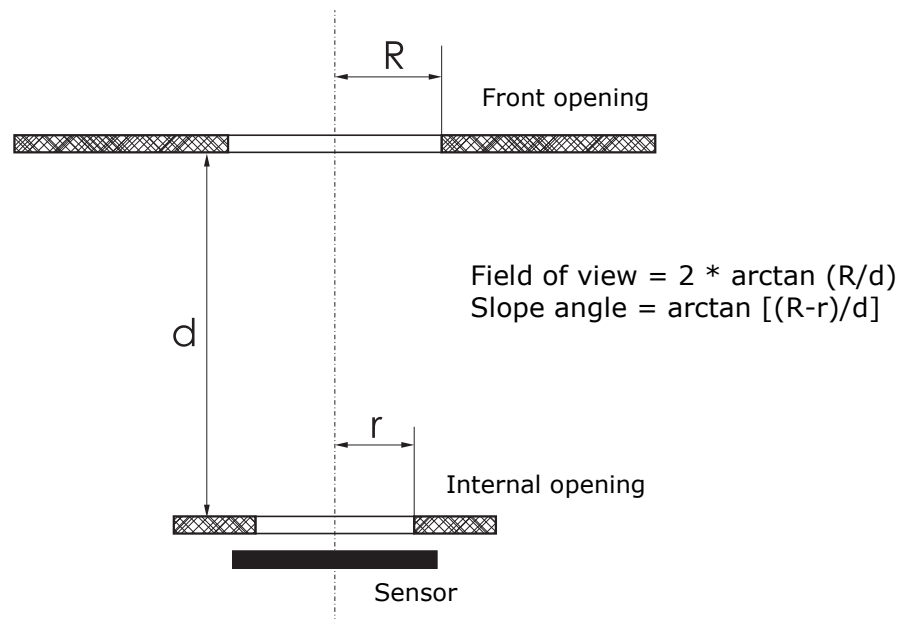


Fig. 2.2: field of view and slope angle

A light shield can be insert, in order to reduce light scattering contribution.

For spectral measurements of direct solar irradiance, which are useful for the determination of the spectral thickness in the atmosphere, the pyrheliometer LPPYRHE16 can be provided with an **optional** kit consisting of an appropriate light shield (which allows assemblage of the filter wheel) plus a revolving filters wheel. The filters wheel is equipped with the filters below:

Filter Type	Cutoff wave length [nm]		Average transmission coefficient
	Lambda short waves	Lambda long waves	
OG 530	526	2900	0.92
RG 630	630	2900	0.92
RG 695	695	2900	0.92

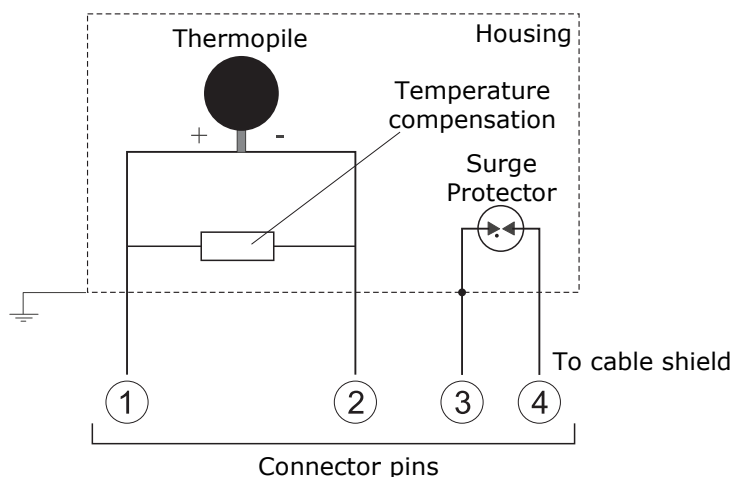


Fig. 2.3: scheme of principle LPPYRHE16 (version with mV output)

3 INSTALLATION

Before installing the pyr heliometer, refill the cartridge containing silica-gel crystals. Silica gel absorbs humidity inside the instrument and prevents, in particular climatic conditions, condensation on the internal wall of the quartz window and measurement alteration.

Do not touch the silica gel crystals with your hands while refilling the cartridge. Carry out the following instructions in an environment as drier as possible:

1. Unscrew the silica gel cartridge using a coin.
2. Remove the cartridge perforated cap.
3. Open the sachet containing silica gel (supplied with the pyr heliometer).
4. Fill the cartridge with the silica gel crystals.
5. Close the cartridge with its own cap, paying attention that the sealing O-ring be properly positioned.
6. Screw the cartridge to the pyr heliometer body using a coin.
7. Check that the cartridge is screwed tightly (if not, silica gel life will be reduced).
8. The pyr heliometer is ready for use.

The figure below shows the operations necessary to fill the cartridge with the silica gel crystals.

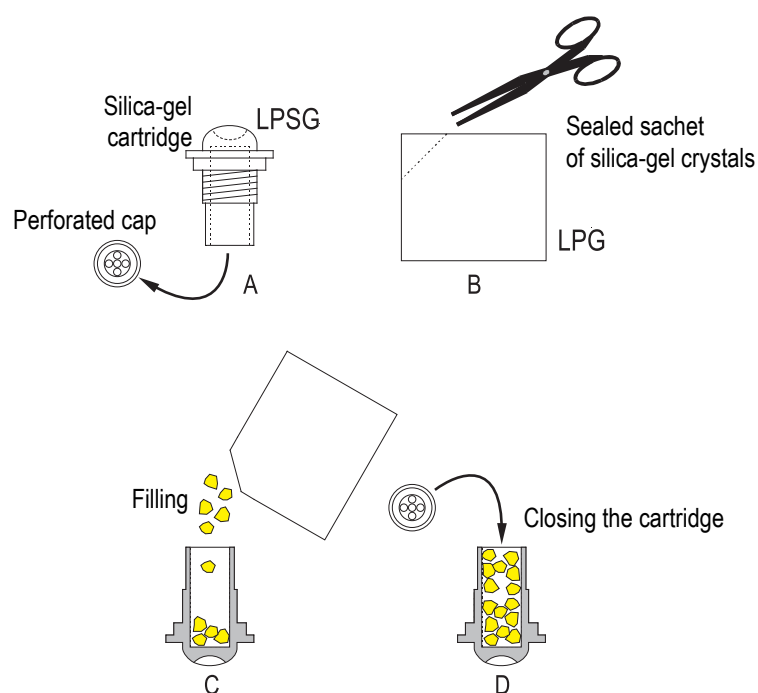


Fig. 3.1: filling the silica-gel cartridge

- The pyrheliometer must be mounted in an easy-to-reach location in order to clean the quartz window regularly and carry out maintenance. At the same time, make sure that no buildings, constructions, trees or obstructions intercept the sun's path during the day all year long.
- To point the pyrheliometer, the two holes in the front and back flange are used. To properly align the instrument, just make sure that the sun's beams that pass through the first hole (on the front flange of the pyrheliometer) reach the second hole (on the back flange).

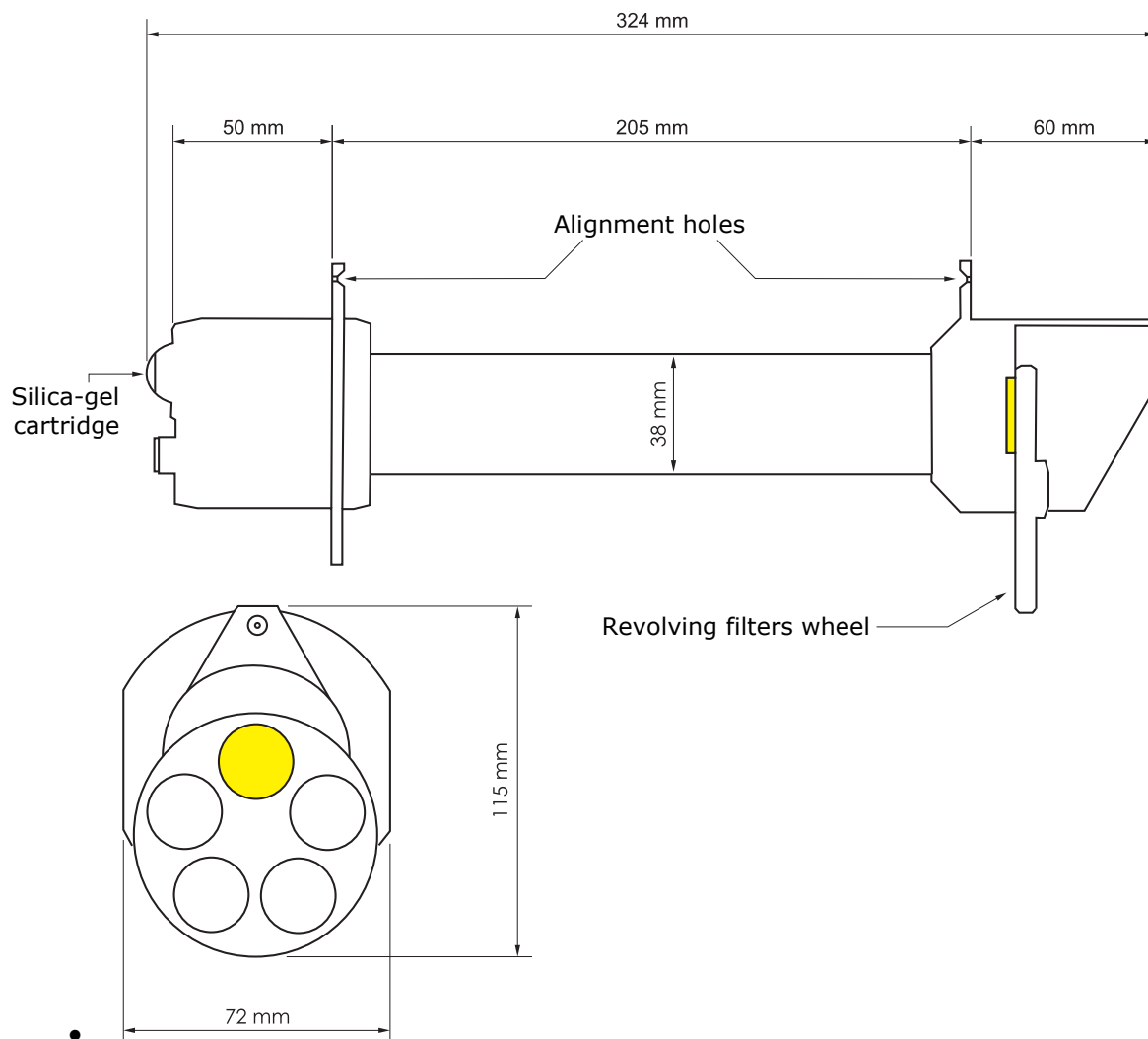


Fig. 3.2: description and dimensions

4 ELECTRICAL CONNECTIONS

LPPYRHE16, **LPPYRHE16AC** and **LPPYRHE16AV** have a 4-pole connector and use the **CPM12AA4... optional** cables in UV resistant PTFE, with 4-pole connector on one side and open wires on the other side.

LPPYRHE16S has a 8-pole connector and uses the **CPM12-8D... optional** cables in UV resistant PTFE, with 8-pole connector on one side and open wires on the other side.



The metallic housing of the pyrhelimeter should preferably be grounded ($\perp$) locally. In this case, do not connect the wire of the cable corresponding to the housing to prevent ground loops.

Only if it is not possible to ground locally the metallic case of the pyrhelimeter, connect the wire of the cable corresponding to the housing to ground ($\perp$).

The wire of the cable corresponding to the housing depends on the model: white wire in LPPYRHE16 and LPPYRHE16AC, black wire (cable shield) in LPPYRHE16S. In LPPYRHE16AV the housing is not connected directly to the connector.

4.1 LPPYRHE16 CONNECTIONS

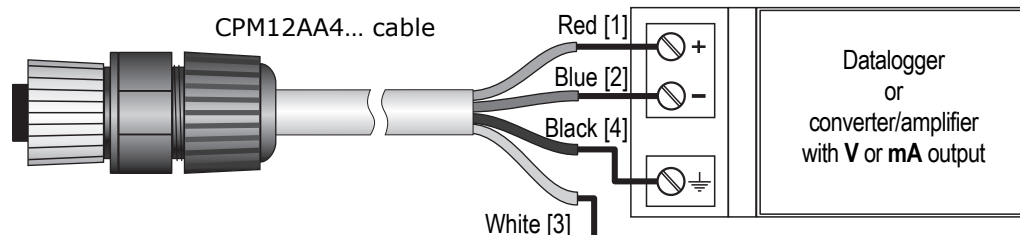
The pyrhelimeter LPPYRHE16 is passive and does not require power supply. It is to be connected either to a millivoltmeter or to a data acquisition system. Typically, the pyranometer output signal does not exceed 20 mV. In order to better exploit the pyrhelimeter features, the readout instrument should have 1 μ V resolution.

Connector	Function	Color
1	Vout (+)	Red
2	Vout (-)	Blue
3	Housing	White
4	Cable shield	Black

Sensor M12 male connector



CPM12AA4... cable



Connect to ground only if it is not possible to ground locally the case of the pyrhelimeter

Fig. 4.1: LPPYRHE16 connections

4.2 LPPYRHE16AC CONNECTIONS

The pyrhelimeter LPPYRHE16AC has **4...20 mA** output and requires **10...30 Vdc** external power supply. It is to be connected to a power supply and an instrument with 4...20 mA input as shown in fig. 4.2. The load resistance of the instrument reading the signal must be $\leq 500 \Omega$.

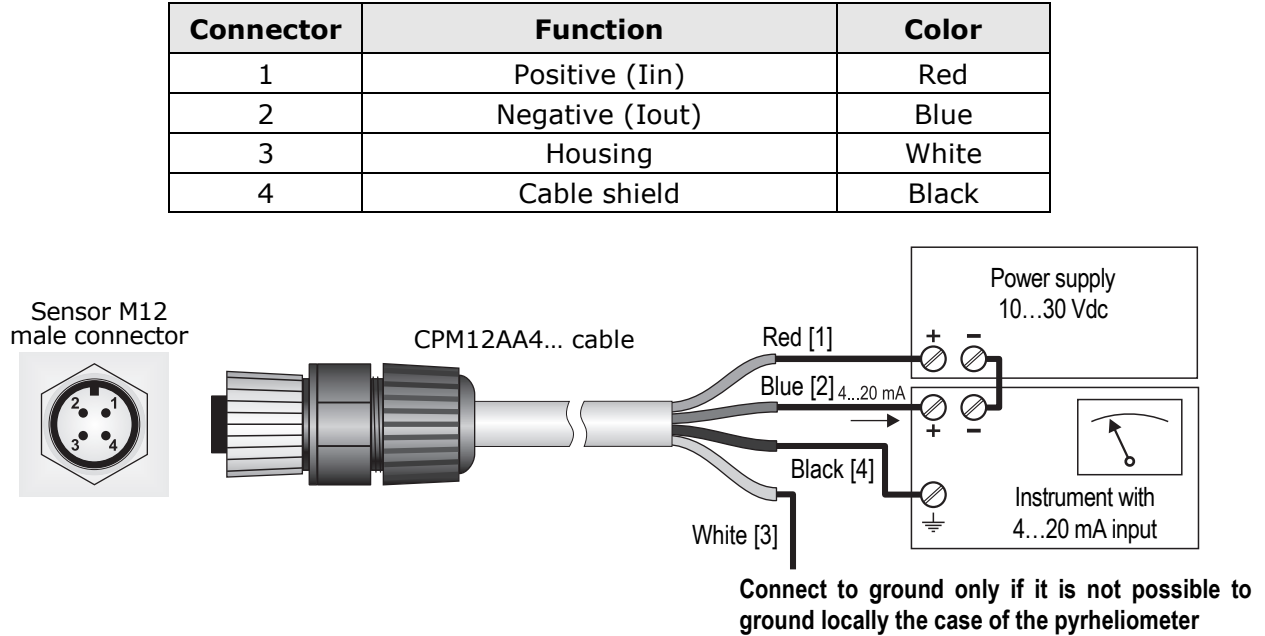


Fig. 4.2: LPPYRHE16AC connections

4.3 LPPYRHE16AV CONNECTIONS

The pyrhelimeter LPPYRHE16AV has **0...1 V**, **0...5 V** or **0...10 V** output (depending on the ordered output) and requires external power supply: **10...30 Vdc** for 0...1 V and 0...5 V outputs, **15...30 Vdc** for 0...10 V output. It is to be connected to a power supply and an instrument with voltage input as shown in fig. 4.3. The load resistance of the instrument reading the signal must be $\geq 100 \text{ k}\Omega$.

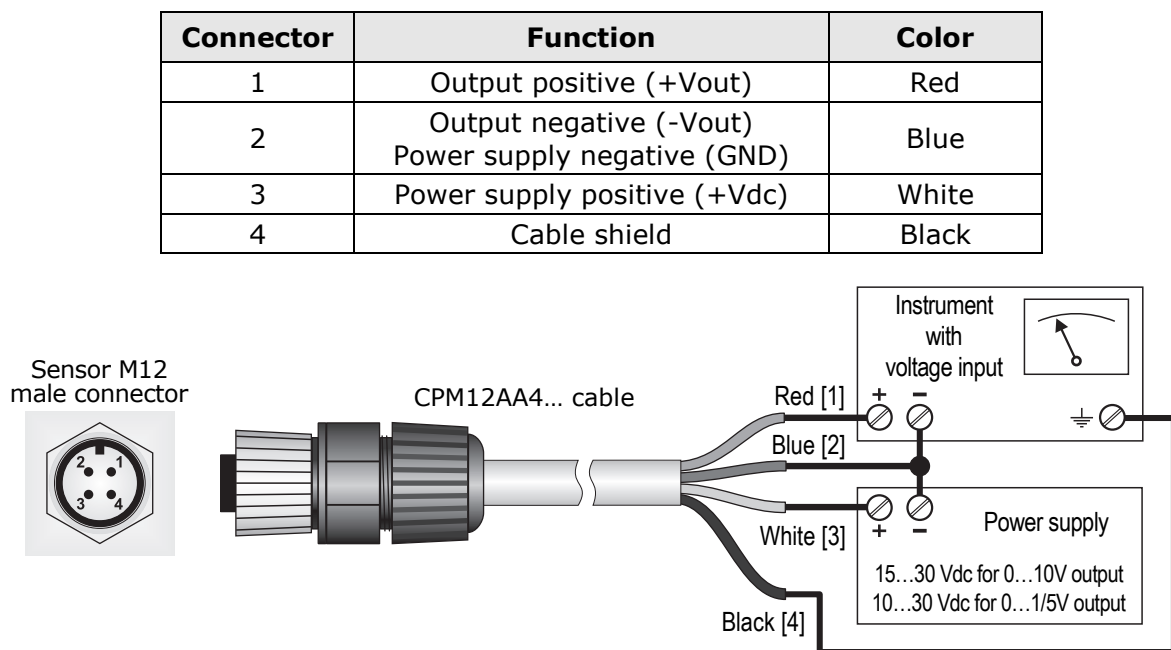


Fig. 4.3: LPPYRHE16AV connections

4.4 LPPYRHE16S CONNECTIONS

The pyrliometer LPPYRHE16S has **RS485 Modbus-RTU** output and requires **5...30 Vdc** external power supply. It is to be connected to a power supply and to a PLC, a data logger or a RS485/USB or RS485/RS232 converter for PC as shown in fig. 4.4. The RS485 output is not isolated.

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

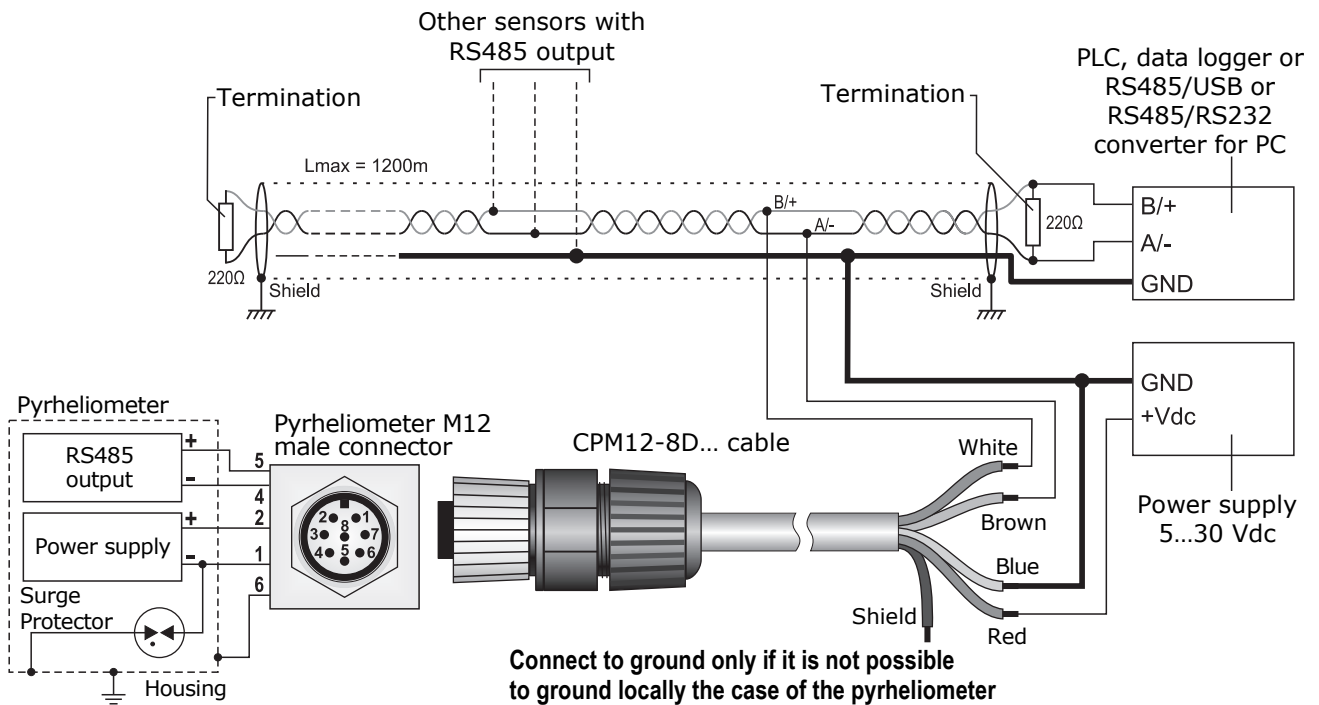


Fig. 4.4: LPPYRHE16S connections

Before connecting the pyrliometer to the RS485 network, set the address and the communication parameters, if different from the factory preset (see chapter 6).

5 MEASUREMENT IN THE MODELS WITH ANALOG OUTPUT

Below are the ways to calculate the direct irradiance in the models with analog output LPPYRHE16, LPPYRHE16AC and LPPYRHE16AV.

5.1 LPPYRHE16

Each pyrheliometer is distinguished by its own sensitivity (or calibration factor) **S** expressed in $\mu\text{V}/(\text{Wm}^{-2})$ and shown in the label on the pyrheliometer (and in the calibration report).

The irradiance **E_e** is obtained by measuring with a multimeter the difference of potential **DDP** at the ends of the sensor and applying the following formula:

$$E_e = DDP / S$$

where:

E_e is the irradiance expressed in W/m^2 ;

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

S is the sensitivity of the pyrheliometer expressed in $\mu\text{V}/(\text{Wm}^{-2})$.

5.2 LPPYRHE16AC

The 4...20 mA output signal corresponds to the 0...2000 W/m^2 irradiance range.

The irradiance **E_e** is obtained by measuring with a multimeter the current **I_{out}** absorbed by the sensor and applying the following formula:

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

where:

E_e is the irradiance expressed in W/m^2 ;

I_{out} is the current expressed in mA absorbed by the pyrheliometer.

5.3 LPPYRHE16AV

The output signal (0...1 V, 0...5 V or 0...10 V depending on the version) corresponds to the 0...2000 W/m^2 irradiance range.

The irradiance **E_e** is obtained by measuring with a multimeter the output voltage **V_{out}** of the sensor and applying the following formula:

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

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

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

where:

E_e is the irradiance expressed in W/m^2 ;

V_{out} is the output voltage expressed in V measured by the multimeter.

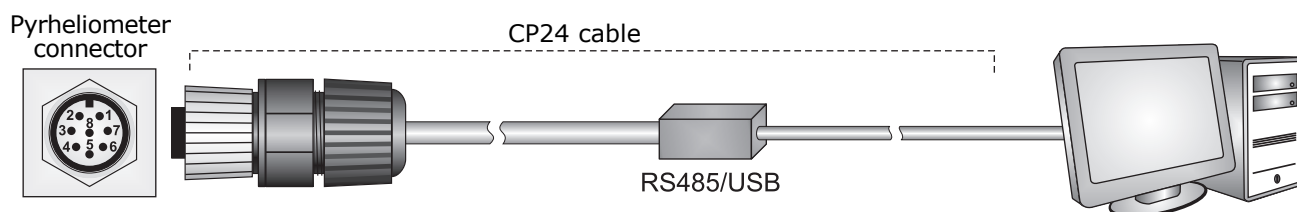
6 RS485 MODBUS-RTU OUTPUT

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

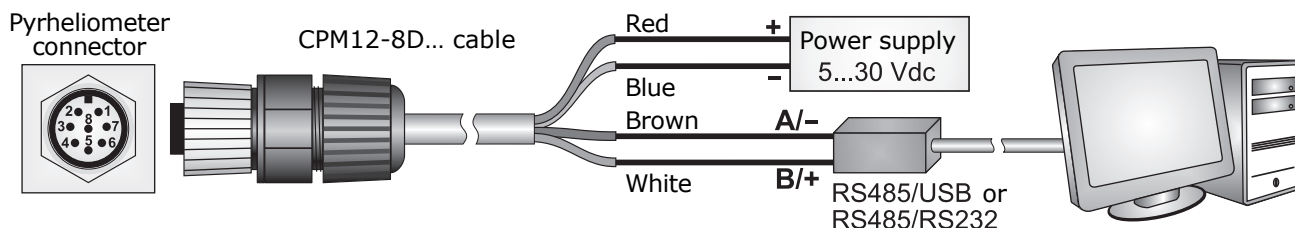
6.1 SETTING THE COMMUNICATION PARAMETERS

Connect the pyrhelimeter 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 pyrhelimeter 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:

1. Start with the pyrhelimeter not powered (if the CP24 cable is used, disconnect one end of the cable).
2. In the PC, start a serial communication program. Set the Baud Rate to 57600 and set the communication parameters as follows (the pyrhelimeter 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 pyrhelimeter will be connected.

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

4. Within 10 seconds from the pyrliometer power on, send the @ command and press **Enter**.

Note: if the pyrliometer 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 pyrliometer.

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
CMA _{nnn}	&	Set RS485 address to nnn Ranging from 1 to 247 Preset on 1
CMB _n	&	Set RS485 Baud Rate n=0 ⇒ 9600 n=1 ⇒ 19200 n=2 ⇒ 38400 n=3 ⇒ 57600 n=4 ⇒ 115200 Preset on 1 ⇒ 19200
CM _{Pn}	&	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
CM _{Wn}	&	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	<i>Address</i>	Read RS485 address
RMB	<i>Baud Rate</i> (0,1)	Read RS485 Baud Rate 0 ⇒ 9600 1 ⇒ 19200 2 ⇒ 38400 3 ⇒ 57600 4 ⇒ 115200
RMP	<i>Tx Mode</i> (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	<i>Rx Mode</i> (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.

6.2 READING THE MEASURES WITH THE MODBUS-RTU PROTOCOL

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

Number	Address	Quantity	Format
3	2	Solar radiation in W/m ²	16-bit Integer
4	3	Status register: bit0=1 ⇒ solar radiation measurement error bit2=1 ⇒ configuration data error bit3=1 ⇒ program memory error	16-bit Integer
5	4	Average values of the last 4 measurements	16-bit Integer
6	5	Signal generated by the sensor in $\mu\text{V}/10$ [e.g.: 816 means 8160 μV , the resolution is 10 μV]	16-bit Integer

Note: Register address = Register number - 1, as defined in the Modbus standard.

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

7 MAINTENANCE

In order to grant measurements high accuracy, it is important to keep the quartz window clean. Consequently, the more the window will be kept clean, the more measurements will be accurate.

You can wash it using water and standard papers for lens. If necessary, use pure ETHYL alcohol. After using alcohol, clean again the window with water only.

Because of the high temperature changes between day and night, some condensation might appear on the pyrliometer window. In this case the performed reading is highly over-estimated. To minimize the condensation, the pyrliometer is provided with a cartridge containing dessicant material (silica-gel). The efficiency of the silica-gel crystals decreases over time while absorbing humidity. Silica-gel crystals are efficient when their color is **yellow**, while they turn **white/translucent** as soon as they loose their efficiency. Read instructions at chapter 3 about how to replace the silica-gel crystals. Silica-gel typical lifetime goes from 2 to 6 months depending on the environment where the pyrliometer works.

To exploit all the pyrliometer features, it is highly recommended that the calibration be checked annually.

8 TECHNICAL SPECIFICATIONS

Sensor	Thermopile
Typical sensitivity	5 $\mu\text{V}/\text{Wm}^{-2}$
Impedance	5÷50 Ω
Measuring range	0÷2000 W/m^2
Viewing angle	5° (slope 1°)
Spectral range (50%)	200÷4000 nm
Operating temperature/humidity	-40÷80 °C / 0÷100%
Output	Analog in $\mu\text{V}/\text{Wm}^{-2}$ (LP PYRHE16) Analog 4÷20 mA (LPPYRHE16AC) Analog 0÷1 V, 0÷5 V or 0÷10 V (LPPYRHE16AV) Digital RS485 Modbus-RTU (LPPYRHE16S)
Power supply	10÷30 Vdc (LPPYRHE16AC and LPPYRHE16AV with 0÷1 V and 0÷5 V output) 15÷30 Vdc (LPPYRHE16AV with 0÷10 V output) 5÷30 Vdc (LPPYRHE16S)
Connection	4-pole M12 connector (LPPYRHE16, LPPYRHE16AC and LPPYRHE16AV) 8-pole M12 connector (LPPYRHE16S)
Dimensions	Fig. 3.2
Weight	1.5 kg

Technical Specifications According to ISO 9060:2018

Response time (95%)	< 9 s
Zero offset in response to a 5 K/h change in ambiente temperature	< $ \pm 3 \text{ W}/\text{m}^2$
Long-term instability (1 year)	< $ \pm 1 \%$
Non-linearity	< $ \pm 0.5 \%$
Spectral selectivity	< $ \pm 1 \%$
Temperature response	< $ \pm 2 \%$
Tilt response	< $ \pm 0.5 \%$

9 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.

10 ORDERING CODES

LPPYRHE16	B class pyrheliometer according to ISO 9060:2018. Complete with light shield, cartridge for silica-gel crystals, 3 spare sachets, M12 4-pole connector and Calibration Report. CPM12AA4... cable has to be ordered separately.
LPPYRHE16AC	B class pyrheliometer according to ISO 9060:2018. Complete with light shield, cartridge for silica-gel crystals, 3 spare sachets, M12 4-pole connector and Calibration Report. Output 4...20 mA. Power supply 10...30 Vdc. CPM12AA4... cable has to be ordered separately.
LPPYRHE16AV	B class pyrheliometer according to ISO 9060:2018. Complete with light shield, cartridge for silica-gel crystals, 3 spare sachets, M12 4-pole connector and Calibration Report. Output 0...1 Vdc, 0...5 Vdc or 0...10 Vdc (to be defined when ordering). Power supply 10...30 Vdc for the versions with output 0...1 Vdc and 0...5 Vdc, 15...30 Vdc for the version with output 0...10 Vdc. CPM12AA4... cable has to be ordered separately.
LPPYRHE16S	B class pyrheliometer according to ISO 9060:2018. Complete with light shield, cartridge for silica-gel crystals, 3 spare sachets, M12 8-pole connector and Calibration Report. RS485 Modbus-RTU output. Power supply 5...30 Vdc. CPM12-8D... cable has to be ordered separately.
CPM12AA4.2	Cable with 4-pole M12 connector on one end, open wires on the other end. Length 2 m.
CPM12AA4.5	Cable with 4-pole M12 connector on one end, open wires on the other end. Length 5 m.
CPM12AA4.10	Cable with 4-pole M12 connector on one end, open wires on the other end. Length 10 m.
CPM12-8D.2	Cable with 8-pole M12 connector on one end, open wires on the other end. Length 2 m.
CPM12-8D.5	Cable with 8-pole M12 connector on one end, open wires on the other end. Length 5 m.
CPM12-8D.10	Cable with 8-pole M12 connector on one end, open wires on the other end. Length 10 m.
CP24	PC connecting cable for the RS485 MODBUS parameters configuration of the LPPYRHE16S pyrheliometers. With built-in RS485/USB converter. 8-pole M12 connector on instrument side and A-type USB connector on PC side.
KIT16.16	Kit consisting of revolving filter wheel (5 positions) with 3 Shott filters (OG530, RG630, RG695), light shield and accessories to fix the wheel to the pyrheliometer.
LPSG	Cartridge to contain desiccant silica-gel crystals, complete with O-ring and cap. Spare part.

DELTA OHM metrology laboratories LAT N° 124 are ISO/IEC 17025 accredited by ACCREDIA for Temperature, Humidity, Pressure, Photometry / Radiometry, Acoustics and Air Velocity. They can supply calibration certificates for the accredited quantities.

**DICHIARAZIONE DI CONFORMITÀ UE**
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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: **LPPYRHE16 – LPPYRHE16AC – LPPYRHE16AV**
Product identifier : **LPPYRHE16S**Descrizione prodotto: **Pireliometro**
Product description : **Pyrheliometer**

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	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

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Amministratore delegato
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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



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: **LPPYRHE16...**

Serial Number _____

RENEWALS

Date _____

Inspector _____

Date _____

Inspector _____

Date _____

Inspector _____

Date _____

Inspector _____

Date _____

Inspector _____

Date _____

Inspector _____



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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