OPERATING MANUAL

LPPYRA-Lite series

Pyranometers

EN

V2.0

senseca

Contents

1 Introduction

LPPYRA-Lite series pyranometers measure the **global irradiance** on a flat surface (W/m^2), sum of direct solar irradiance and diffuse irradiance.

The LPPYRA-Lite series falls within the **Spectrally Flat Class C** pyranometers according to the ISO 9060:2018 standard and meets the requirements of the WMO "Guide to Instruments and Methods of Observation".

The various models are distinguished by the type of output available:

	Output		
Model	**Digital RS485 Modbus-RTU**	**Digital SDI-12**	**Analog**
LPPYRA-Lite	--	--	mV
LPPYRA-LiteAC	--	--	2-wire (current loop) 4…20 mA
LPPYRA-LiteS	√	--	--
LPPYRA-LiteS12	--	√	--

The pyranometers are factory calibrated in accordance with the ISO 9847:2023 (Type A1) standard: "Calibration of pyranometers by comparison to a reference pyranometer". The calibration is performed by comparison with the reference sample calibrated annually at WRC (World Radiation Center).

An optional fixing base integrating a levelling device is available as an accessory, for installations where horizontal positioning is required.

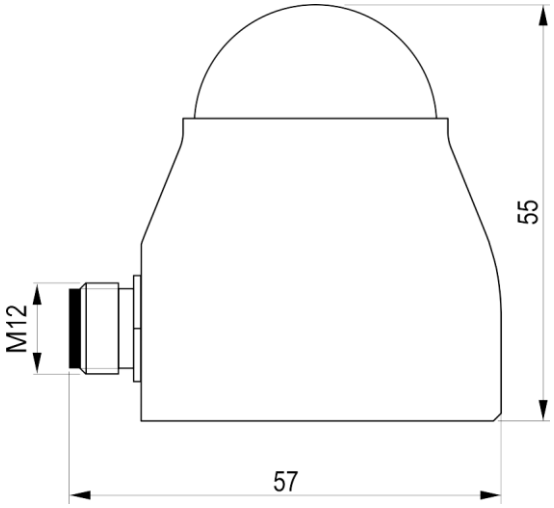
2 Technical specifications

Sensor		Thermopile
Typical sensitivity		5…15 µV/Wm^{-2}
Measuring range		0…2000 W/m^2
Viewing angle		2π sr
Spectral range (50%)		300…2800 nm
Output	LPPYRA-Lite LPPYRA-LiteAC LPPYRA-LiteS LPPYRA-LiteS12	passive in mV 2-wire (current loop) 4…20 mA RS485 Modbus-RTU SDI-12
Power supply	LPPYRA-Lite LPPYRA-LiteAC LPPYRA-LiteS LPPYRA-LiteS12	No power required 10…28 Vdc 5…30 Vdc 7…30 Vdc
Consumption	LPPYRA-LiteAC LPPYRA-LiteS LPPYRA-LiteS12	Equal to output signal (4…20 mA) 8 mA < 200 µA normal operation / < 5 mA during measurement
Connection		4-pole M12 (LPPYRA-Lite and LPPYRA-LiteAC) 8-pole M12 (LPPYRA-LiteS and LPPYRA-LiteS12)
Weight		150 g approx.
Operating conditions		-40…+80 °C / 0…100 %RH / Max. altitude 6000 m
Protection degree		IP 67
Materials		Housing: anodized aluminium Dome: optical glass
MTBF		> 10 years

Technical Specifications According to ISO 9060:2018

Classification	Spectrally Flat Class C
Response time (95%)	< 25 s
Zero offset	
a) response to a 200 W/m^2 thermal radiation	< |±20| W/m^2
b) response to a 5 K/h change in ambient temperature	< |±6| W/m^2
c) total zero offset including the effects a), b) and other sources	< |±30| W/m^2
Long-term instability (1 year)	< |±2| %
Non-linearity	< |±2| %
Directional response	< |±25| W/m^2
Spectral error	< |±2| %
Temperature response (-10…+40°C)	< |±3| %
Tilt response	< |±3| %

Dimensions (mm)



3 Measuring principle

LPPYRA-Lite series pyranometers are 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 wavelengths.

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.

LPPYRA-Lite is equipped with a glass dome, which grants the thermopile a proper thermal insulation from the wind and reduce the sensitivity to thermal irradiance. Furthermore, the dome protects the thermopile from the dust which, depositing on the blackened part, could change its spectral sensitivity.

To prevent condensation from forming on the internal side of the dome under certain climatic conditions, silica-gel is inserted inside the pyranometer to absorb moisture.

4 Installation

- The pyranometer must 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.**
- The pyranometer must be located far from any kind of obstruction, which might reflect sunlight (or sun shadow) onto the pyranometer itself.
- The mast height does not exceed the pyranometer plane to avoid measurement errors caused by any reflection or shadow of the mast itself.
- In compliance with ISO TR9901 standard and WMO recommendations, the pyranometer must 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.
- For fixing, use the M5 holes in the lower part of the pyranometer. For an accurate horizontal positioning, the optional **LPS40/32BL** fixing base integrating a bubble level can be used.

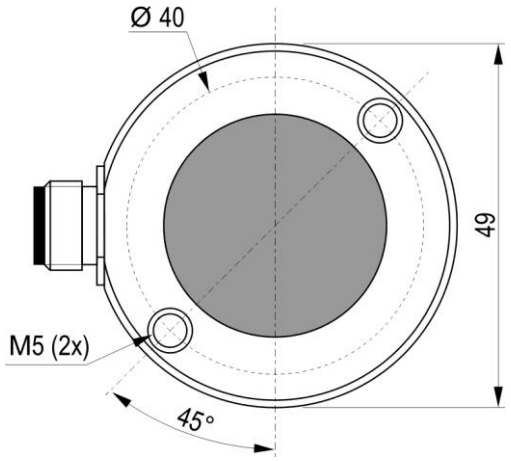
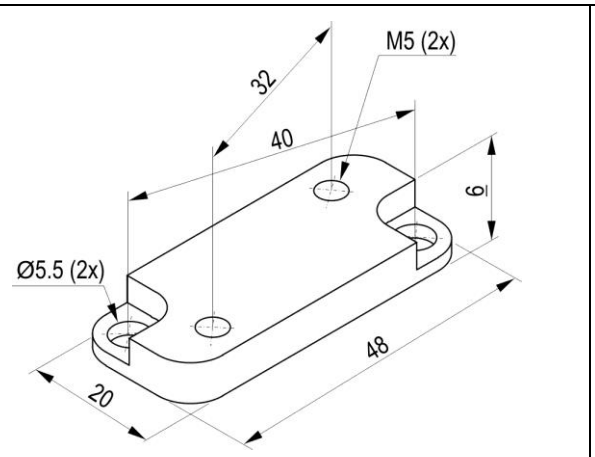
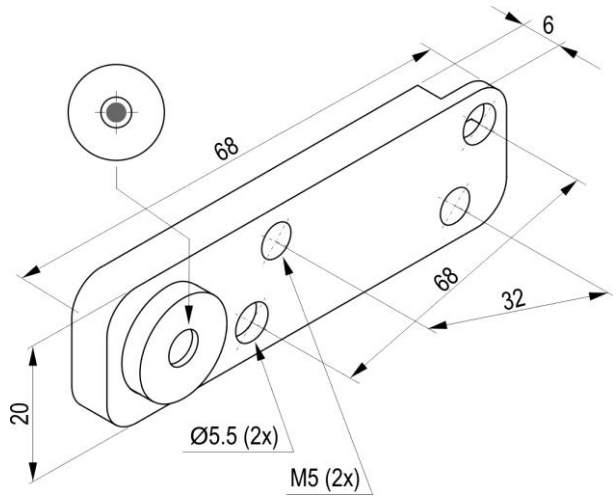


Fig. 4.1: position of fixing holes



LPS40/32



LPS40/32BL - Integrated levelling device

Fig. 4.2: optional fixing adapters from 40 to 32 mm holes centre distance

4.1 Optional mounting supports

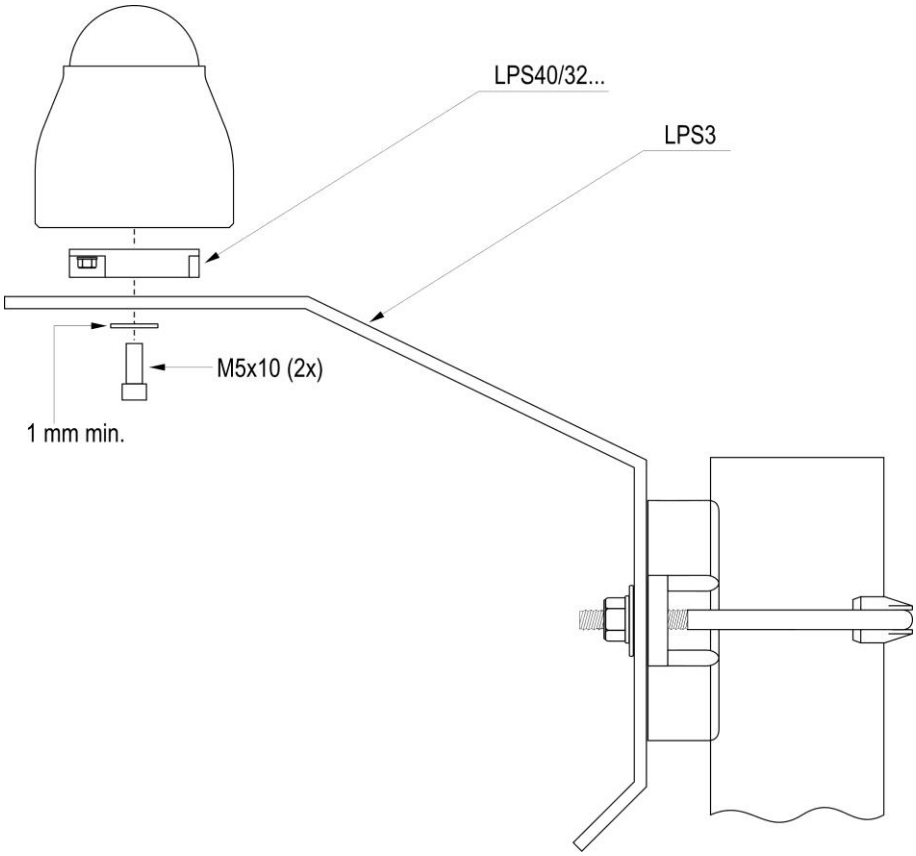


Fig. 4.3: LPS3 bracket for mast

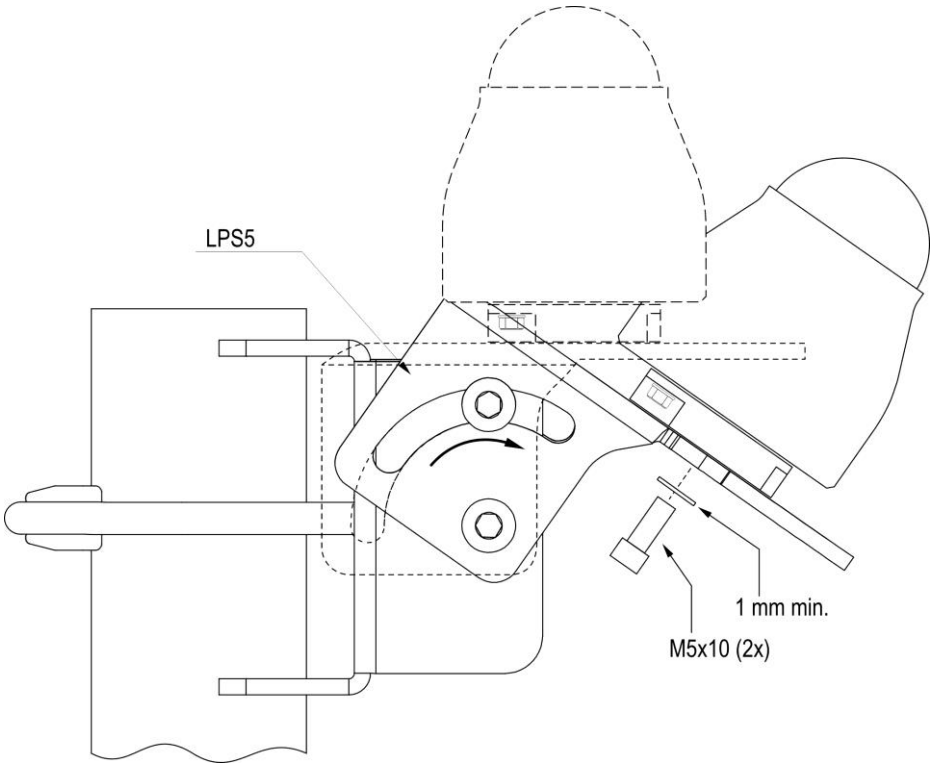


Fig. 4.4: LPS5 adjustable bracket for mast

4.2 Electrical connections

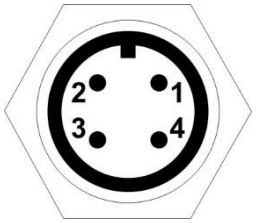
Warning!

> The metallic housing of the pyranometer should preferably be grounded (earthed) locally. Do not connect the wire of the cable corresponding to the housing to ground, unless it is not possible to ground the pyranometer metallic housing locally via the support mast.

Internally there are surge protection devices connected to the housing. Grounding the housing allows the correct protection functionality of the devices.

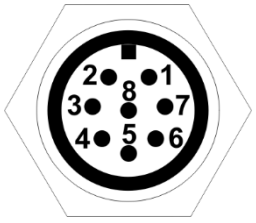
Connector pinout:

LPPYRA-Lite / LPPYRA-LiteAC:

Pyranometer male connector (external view)		Function		CPM12AA4… wire color
		LPPYRA-Lite	LPPYRA-LiteAC	
	1	+Vout	Iin (+)	Red
	2	-Vout	Iout (-)	Blue
	3	NC	NC	White
	4	Housing / Cable shield	Cable shield	Black

Note: in LPPYRA-LiteAC the housing is not connected to the connector.

LPPYRA-LiteS / LPPYRA-LiteS12:

Pyranometer male connector (external view)		Function		CPM12-8D… wire color
		LPPYRA-LiteS	LPPYRA-LiteS12	
	1	GND	GND	Blue
	2	+Vdc	+Vdc	Red
	3	NC	NC	--
	4	DATA – (RS485)	NC	Brown
	5	DATA + (RS485)	SDI-12	White
	6	Contenitore / Calza del cavo	Contenitore / Calza del cavo	Black
	7	NC	NC	--
	8	NC	NC	--

LPPYRA-Lite connections:

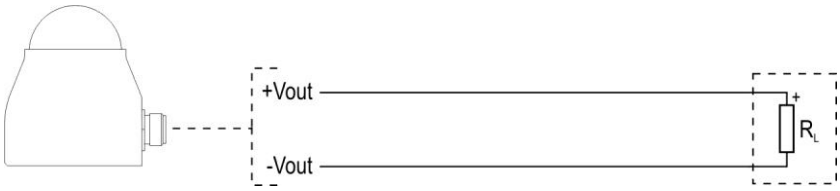


Fig. 4.5: LPPYRA-Lite connection diagram

The pyranometer does not require power supply. The typical output impedance of the sensor is <50 Ω.

The output signal typically does not exceed a few tens of mV. The recommended resolution of the reading instrument is 1 μV.

LPPYRA-LiteAC connections:

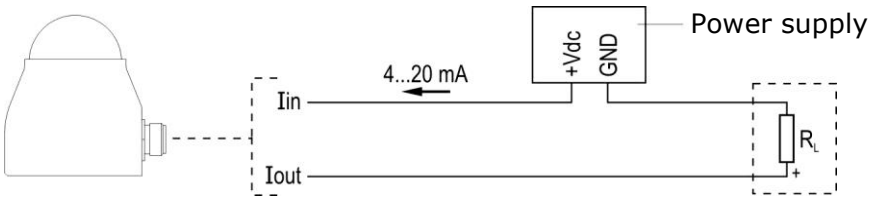


Fig. 4.5: LPPYRA-LiteAC connection diagram

Pyranometer power supply: 10…28 Vdc. Load resistance $R_L \leq 500$ Ω.

Connect the cable shield to the ground of the reading instrument.

In the event of an anomaly in the measurement (detected measurement outside the measuring range), the output goes to 22 mA.

LPPYRA-LiteS connections:

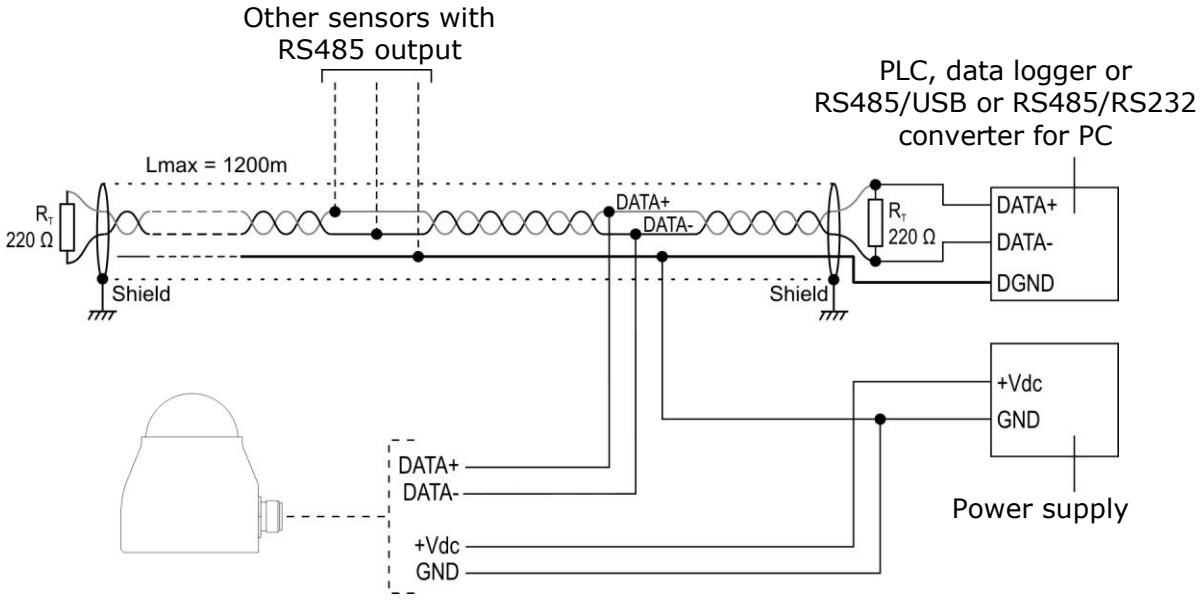


Fig. 4.7: LPPYRA-LiteS connection diagram

RS485 output:
The RS485 output is not isolated. Before connecting the pyranometer to the RS485 network, set the address and the communication parameters, if different from the factory preset (see "LPPYRA-LiteS configuration" chapter).

LPPYRA-LiteS12 connections:

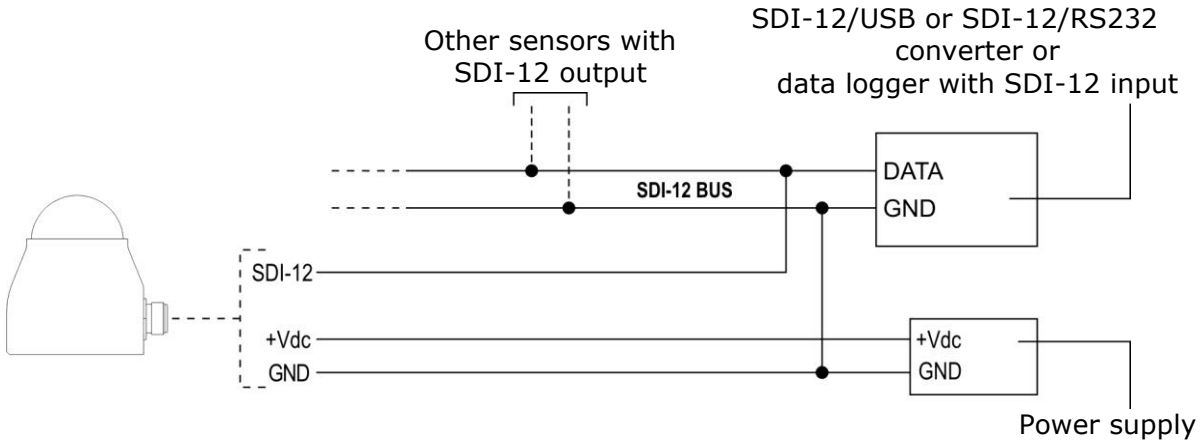


Fig. 4.8: LPPYRA-LiteS12 connection diagram

More sensors can be connected in parallel. The SDI-12 bus maximum length is 60 m.

The instrument should be configured to operate in SDI-12 mode. Set the address (see chapter "SDI-12 protocol") before connecting the instrument to the network.

5 LPPYRA-LiteS configuration

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

By default, the instrument has Modbus address **1** and communication parameters 19200, 8E1.

Connection to PC:

To connect the pyranometer to a PC USB port, to check or change the configuration, the **CP24** optional cable can be used, which also allows the pyrgeometer to be powered via the USB port.

To use the CP24 cable, the related USB drivers must be installed in the PC.

Alternatively, it is possible to use a standard RS485/USB or RS485/RS232 converter, powering the pyranometer separately.

Procedure:

1. Connect the pyranometer to the PC and start a standard serial communication program.
2. In the serial communication program, set the Baud Rate 57600, the parameters 8N2 and the COM port number to which the pyranometer is connected.
3. Power the pyranometer (or power cycle if already powered) and send the command **@** within 10 seconds from the instrument power on (the pyranometer replies **&|** if the command @ is recognized).

   Note: if the CP24 cable is used, to power cycle the pyranometer, disconnect the cable for a few seconds from the PC USB port, then reconnect it.
4. Send the command **CAL USER ON** to enable the configuration change. The command CAL USER ON is not required only for reading the settings.
5. Send the commands described in the table below.

The command CAL USER ON is automatically disabled after a few minutes of inactivity. The command CAL USER ON can be disabled immediately by sending the command CAL EXIT.

Command	Reply	Description
CMAn	&|	Sets the Modbus-RTU address (1…247) to n. Default=1
RMA	*Address*	Reads the Modbus-RTU address.
CMBn	&|	Sets the Baud Rate: ▪ 9600 if n=0 ▪ 19200 if n=1 (*default*) ▪ 38400 if n=2 ▪ 57600 if n=3 ▪ 115200 if n=4
RMB	*Baud Rate index*	Reads Baud Rate setting.
CMPn	&|	Sets parity and stop bits (data bits = 8 fixed): ▪ 8N1 if n=0 ▪ 8N2 se n=1 ▪ 8E1 if n=2 (*default*) ▪ 8E2 se n=3 ▪ 8O1 if n=4 ▪ 8O2 se n=5

Command	Reply	Description
RMP	*Parity and stop bits index*	Reads the setting of parity and stop bits.
CMWn	&|	Sets waiting time after transmission with Modbus-RTU protocol: ▪ Immediate reception if n=0 (violates protocol) ▪ Waiting 3.5 characters if n=1 (respects protocol) *Default* : Waiting 3.5 characters (n=1)
RMW	*Waiting time index*	Reads the setting of waiting time after transmission with Modbus-RTU protocol.

6 Modbus-RTU protocol (LPPYRA-LiteS)

The Modbus-RTU protocol is active after a few seconds from the sensor power on.

Below is the list of registers.

Input Registers:

Address	Description	Format
0	Temperature in °C (x10)	16-bit Integer
1	Temperature in °F (x10)	16-bit Integer
2	Irradiance in W/m^2	16-bit Integer
3	Status register: bit0=1 ⇒ irradiance measurement error bit2=1 ⇒ configuration data error bit3=1 ⇒ program memory error	16-bit Integer
4	Average values of the last 4 irradiance measurements	16-bit Integer
5	Signal generated by the sensor in µV/10 (e.g., 816 means 8160 µV, the resolution is 10 µV)	16-bit Integer

7 SDI-12 protocol (LPPYRA-LiteS12)

LPPYRA-LiteS12 is compatible with version 1.3 of SDI-12 protocol.

The communication parameters are "1200, 7E1".

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 following table reports the SDI-12 commands available. For consistency with SDI-12 standard documentation, the instrument address is indicated in the table with the letter **a**. The instrument leaves the factory with address preset to 0. The address can be changed by using the proper SDI-12 command reported in the table.

SDI-12 Commands

Command	Reply	Description
a!	a<CR><LF>	Checks for 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)	Request for instrument information.
aAb! Where: b =new address	b<CR><LF> Note: if the b character is not an acceptable address, the instrument replies with a instead of b.	Change of instrument address.
?!	a<CR><LF>	Request for instrument address. If more than a sensor is connected to the bus, a conflict will occur.

Type M (start measurement) and C (start concurrent measurement) commands

Command	Reply	Description
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 datum 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+25.0 probe address = 0 content of the status register = 0 irradiance = 228.7 W/m^2 signal internal level = 3.294 mV internal temperature = 25.0 °C *Note*: the status register normally contains zero; a value different from zero indicates an error condition.	Reads the measurement.
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 datum 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+25.0 probe address = 0 irradiance = 228.7 W/m^2 internal temperature = 25.0 °C	Reads the measurement.

Command	Reply	Description
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 datum 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+25.0 probe address = 0 internal temperature = 25.0 °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 datum 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 commands, the pyranometer also implements the corresponding commands with CRC, that require to add a 3-character CRC code at the end of the reply. The sensor **does not** implement the type R (Continuous Measurements) commands.

Type X (extended commands) commands

Command	Reply	Description
aXSCAL USER ON!	a> USER ENABLED!<CR><LF>	Enables configuration
aXSCFD!	a> &<CR><LF>	Sets °C
aXSCFE!	a> &<CR><LF>	Sets °F
aXSCAL END!	a> LOCKED!<CR><LF>	Disables configuration

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 protocol, visit the website "www.sdi-12.org".

8 Measurement with analog output

LPPYRA-Lite:

Each pyranometer is distinguished by its own sensitivity (or calibration factor) ***S*** expressed in μV/(Wm^{-2}), shown in the label on the pyranometer (and in the optional 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 pyranometer expressed in μV/(Wm^{-2}).

LPPYRA-LiteAC:

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 pyranometer.

9 Maintenance

In order to grant measurements high accuracy, it is important to keep the outer glass dome clean. 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. If necessary, use pure ETHYL alcohol. After using alcohol, clean again the dome with water only.

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

10 Safety instructions

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

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:

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

11 Accessories ordering codes

The pyranometer is supplied with M12 female free connector (only if the optional cable is not ordered).

Cables, fixing accessories and calibration report must be ordered separately.

Fixing accessories

LPS3	Fixing bracket for Ø 30…50 mm mast. Installation on horizontal or vertical mast. **LPS40/32... adapter is required**.
LPS5	Adjustable holder for mounting the pyranometer in an inclined position on Ø 30…50 mm mast. **LPS40/32... adapter is required**.
LPS40/32	Fixing adapter from 40 to 32 mm holes centre distance.
LPS40/32BL	Fixing adapter from 40 to 32 mm holes centre distance. With integrated levelling device. Accuracy of levelling device < 0.2°.

Installation cables

CPM12AA4...	Cable with 4-pole M12 connector on one end, open wires on the other end. Length 5 m (CPM12AA4.5) or 10 m (CPM12AA4.10). **For LPPYRA-Lite and LPPYRA-LiteAC**.
CPM12-8D...	Cable with 8-pole M12 connector on one end, open wires on the other end. Length 5 m (CPM12-8D.5) or 10 m (CPM12-8D.10). **For LPPYRA-LiteS and LPPYRA-LiteS12**.

PC connecting cables

CP24	PC connecting cable for the configuration of the pyranometer. With built-in RS485/USB converter. 8-pole M12 connector on sensor side and A-type USB connector on PC side. **For LPPYRA-LiteS**.

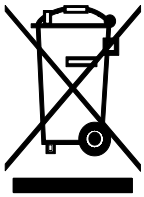
WARRANTY

The manufacturer is required to respond to the "factory warranty" only in those cases provided by Legislative Decree 6 September 2005 - n. 206. Each instrument is sold after rigorous inspections; if any manufacturing defect is found, it is necessary to contact the distributor where the instrument was purchased from. During the warranty period (24 months from the date of invoice) any manufacturing defects found will be repaired free of charge. Misuse, wear, neglect, lack or inefficient maintenance as well as theft and damage during transport are excluded. Warranty does not apply if changes, tampering or unauthorized repairs are made on the product. Solutions, probes, electrodes and microphones are not guaranteed as the improper use, even for a few minutes, may cause irreparable damages.
The manufacturer repairs the products that show defects of construction in accordance with the terms and conditions of warranty included in the manual of the product. For any dispute, the competent court is the Court of Padua. The Italian law and the "Convention on Contracts for the International Sales of Goods" apply.

TECHNICAL INFORMATION

The quality level of our instruments is the result of the continuous product development. This may lead to differences between the information reported in the manual and the instrument you have purchased.
We reserve the right to change technical specifications and dimensions to fit the product requirements without prior notice.

DISPOSAL INFORMATION



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

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

CE RoHS

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