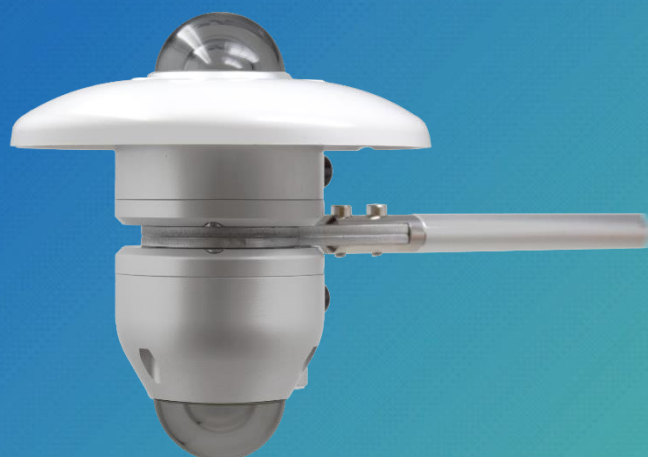


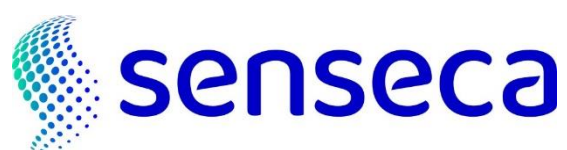
OPERATING MANUAL

LPS05 / LPS11

Albedometers



EN
V1.0



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1 Introduction

The albedometer consists of two pyranometers, one facing upward for measuring the global solar radiation and one facing downward for measuring the solar radiation reflected from a surface.

The albedometer allows the determination of **net solar radiation** (difference between global solar radiation and reflected solar radiation) and **albedo** (ratio of reflected solar radiation to global solar radiation).

The **LPS05** albedometer consists of two LPS02 **Spectrally Flat Class B** pyranometers, while the **LPS11** albedometer consists of two LPS10 **Spectrally Flat Class A** pyranometers according to ISO 9060:2018 standard.

The LPS02 and LPS10 pyranometers meet the requirements of the WMO "Guide to Instruments and Methods of Observation".

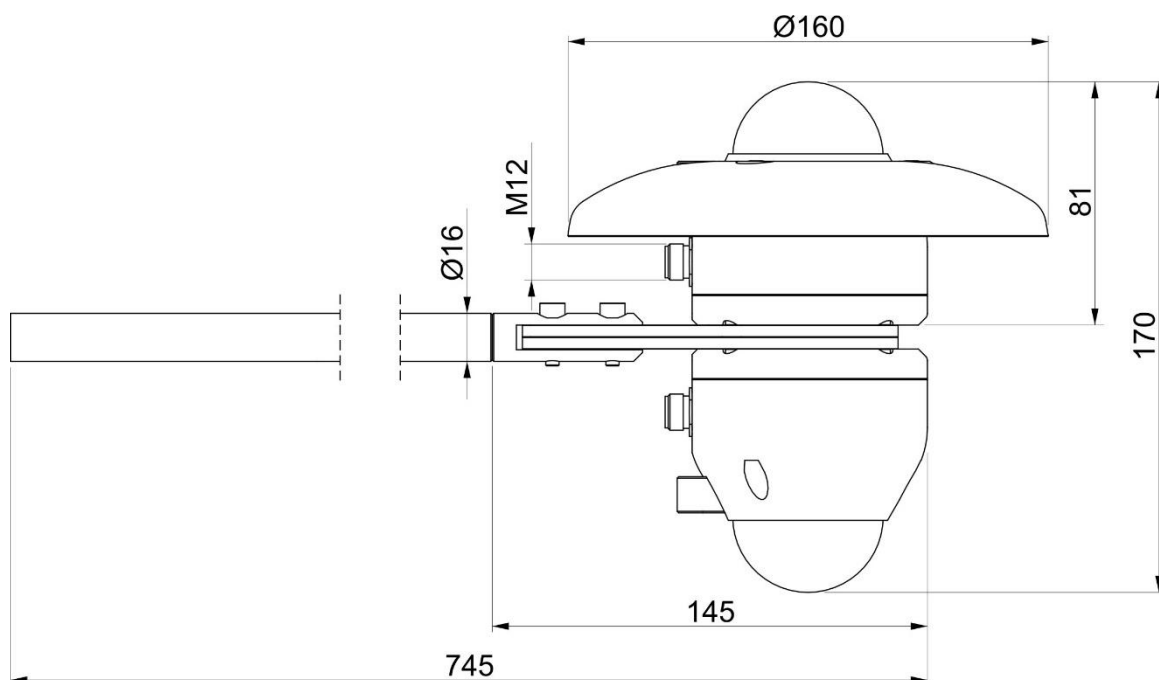
The integrated bubble level facilitates horizontal positioning during installation.

The sensors 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).

2 Technical specifications

Sensor	Thermopile
Typical sensitivity	6...12 $\mu\text{V}/\text{Wm}^{-2}$
Measuring range	-200...4000 W/m^2
Viewing angle	2π sr
Spectral range (50%)	283...2800 nm
Output	Passive in mV
Connection	2 x 5-pole M12
Weight	1.4 kg approx.
Operating conditions	-40...+80 °C / 0...100 %RH / Max. altitude 6000 m
Bubble level accuracy	< 0.2°
Protection degree	IP 67
Materials	Housing: anodized aluminium Screen: ASA Dome: optical glass
MTBF	> 10 years

Dimensions (mm)



Technical Specifications According to ISO 9060:2018

	LPS05	LPS11
Classification	Spectrally Flat Class B	Spectrally Flat Class A
Response time (95%)	< 10 s	< 2 s
Zero offset		
a) response to a 200 W/m ² thermal radiation	< ±10 W/m ²	< ±7 W/m ²
b) response to a 5 K/h change in ambient temperature	< ±4 W/m ²	< ±2 W/m ²
c) total zero offset including the effects a), b) and other sources	< ±15 W/m ²	< ±10 W/m ²
Long-term instability (1 year)	< ±1 %	< ±0.5 %
Non-linearity	< ±1 %	< ±0.2 %
Directional response (up to 80° with 1000 W/m ² beam)	< ±18 W/m ²	< ±10 W/m ²
Spectral error	< ±0.5 %	< ±0.2 %
Temperature response (-10...+40°C)	< ±1.5 %	< ±0.5 %
Tilt response	< ±1 %	< ±0.2 %

3 Measuring principle

The two pyranometers composing the albedometer are independent and 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.

The pyranometer spectral range is determined by the transmission of the two concentric glass domes, with 50 and 30 mm outer diameters, which also grant the thermopile a proper thermal insulation from the wind and reduce the sensitivity to thermal irradiance. Furthermore, the domes protect the thermopile from the dust which, depositing on the blackened part, could change its spectral sensitivity.

The special material used to manufacture the domes allows the spectral range to be extended to short wavelengths starting from 283 nm.

Considering a standard solar spectrum, the portion of solar irradiation detected by the pyranometer is greater than 99.8%. Figure 3.1 shows the relative spectral sensitivity of the LPS02.../LPS10... pyranometers (**blue line**) and the standard solar spectrum (**red line**).

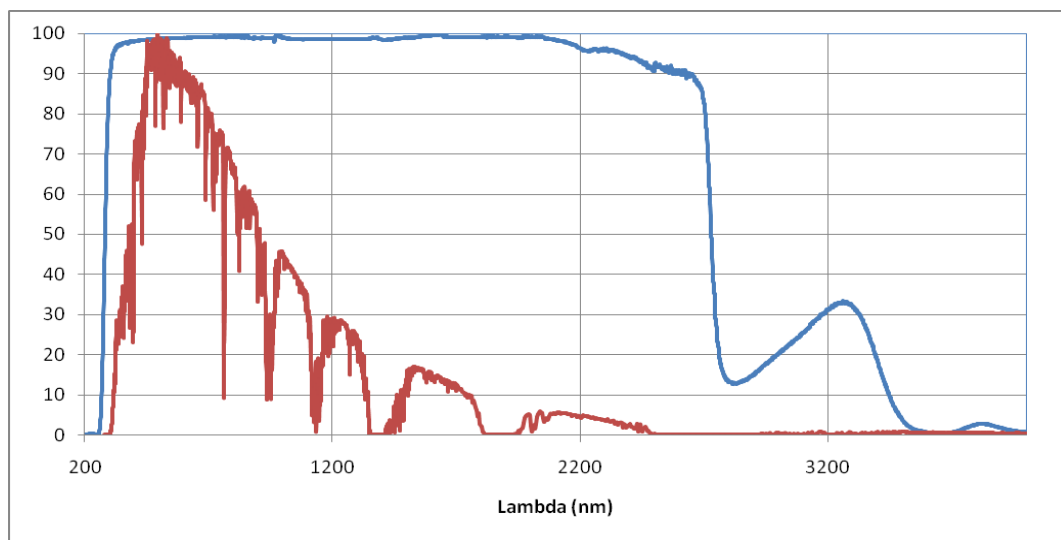


Fig. 3.1: LPS02.../LPS11... relative spectral sensitivity and standard solar spectrum

An internal compensation circuit minimizes the change of sensitivity with temperature. 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 albedometer should be placed at a height of 1-2 m above the ground. In the case of grassland, the height of the grass should be kept constant throughout the year. In snowy regions, care should be taken to adjust the height of the instrument so as to keep the distance from the blanket of snow constant.
- The albedometer must be mounted in an easy-to-reach location in order to clean the domes regularly and carry out maintenance. At the same time, make sure that no buildings, constructions, trees or obstructions exceed the horizontal plane where the upper 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 albedometer must be located far from any kind of obstruction, which might reflect sunlight (or sun shadow) onto the albedometer itself.
- The mast height does not exceed the upper 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, if the albedometer is used without the solar radiation protection screen, it must be positioned so that the connector points 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 recommendation even when the screen is used.
- Fix the albedometer support rod to a vertical mast using a cross clamp. For an accurate horizontal positioning, use the bubble level integrated in the albedometer.

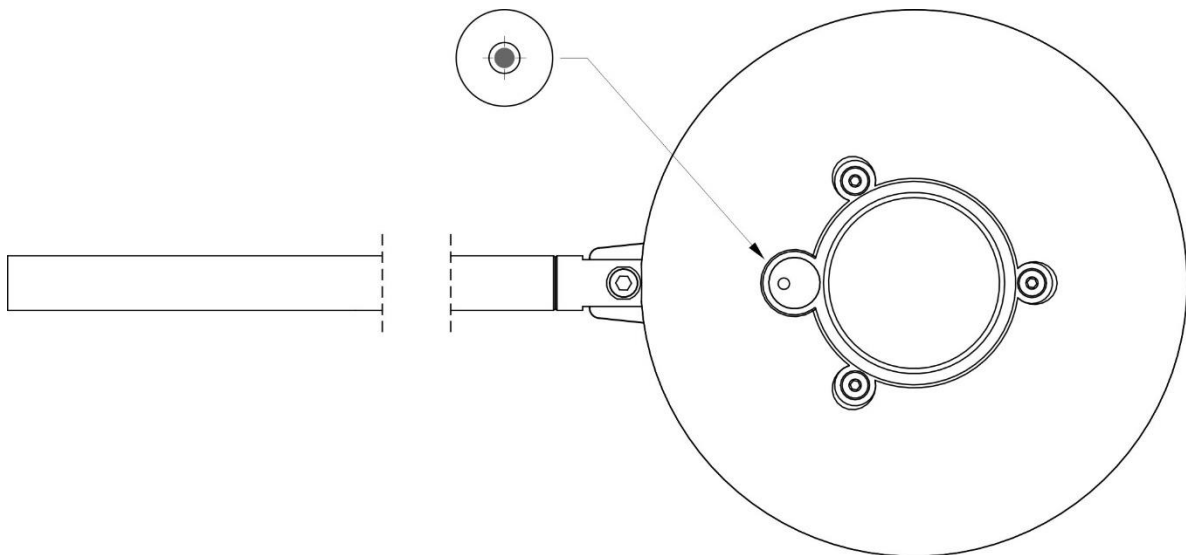


Fig. 4.1: position of bubble level

4.1 Electrical connections

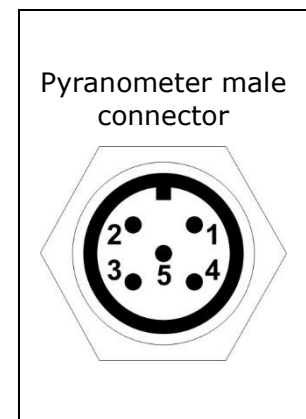
Warning!

The metallic housing of the two pyranometers should preferably be grounded locally. The CPM12... cable shield is connected to the connector shell and then to the metallic housing of the pyranometer. Do not connect the yellow/green wire (cable shield) 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.

Connectors pinout:

Pin	Function	CPM12-5... wire color
1	+Vout	Brown
2	-Vout	White
3	NC	Blue
4	NC	Black
5	NC	Grey
	Connector shell / Cable shield Pyranometer housing	Yellow/Green



Connections:

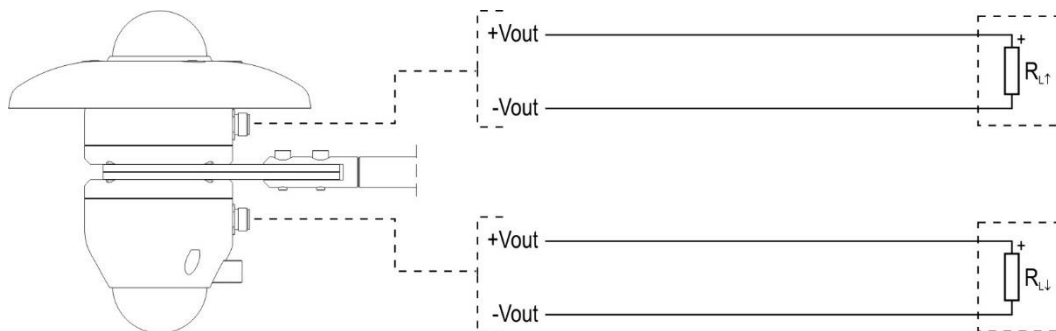


Fig. 4.2: connection diagram

The albedometer does not require power supply. The typical output impedance of the sensor is $<50 \Omega$.

The output signal typically does not exceed a few tens of mV. The recommended resolution of the reading instrument is $1 \mu\text{V}$.

5 Measurement

The pyranometers are distinguished by the sensitivity (or calibration factor) **S** expressed in $\mu\text{V}/(\text{Wm}^{-2})$, shown in the label on the sensor 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 sensor expressed in $\mu\text{V}/(\text{Wm}^{-2})$.

The albedo is calculated by making the ratio of the irradiance measured by the lower pyranometer (solar radiation reflected from the surface) to the irradiance measured by the upper pyranometer (global solar radiation):

$$ALBEDO = E_e [\uparrow] / E_e [\downarrow]$$

The net solar radiation is the difference **$E_e [\downarrow] - E_e [\uparrow]$** .

6 Maintenance

In order to grant measurements high accuracy, it is important to keep the outer glass domes clean. Consequently, the more the domes 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 domes with water only.

To minimize condensation and keep measurements accurate, desiccant silica-gel is provided inside the pyranometers base to absorb moisture. The silica-gel life is at least 10 years and can be replaced by the user.

To replace the silica-gel, disassemble the pyranometers from the holder as shown in the next figure and unscrew the 4 screws that fix the base to the main body of the pyranometer; remove the silica-gel sachet and insert a new sachet, then screw the pyranometer base back on and reassemble the holder.

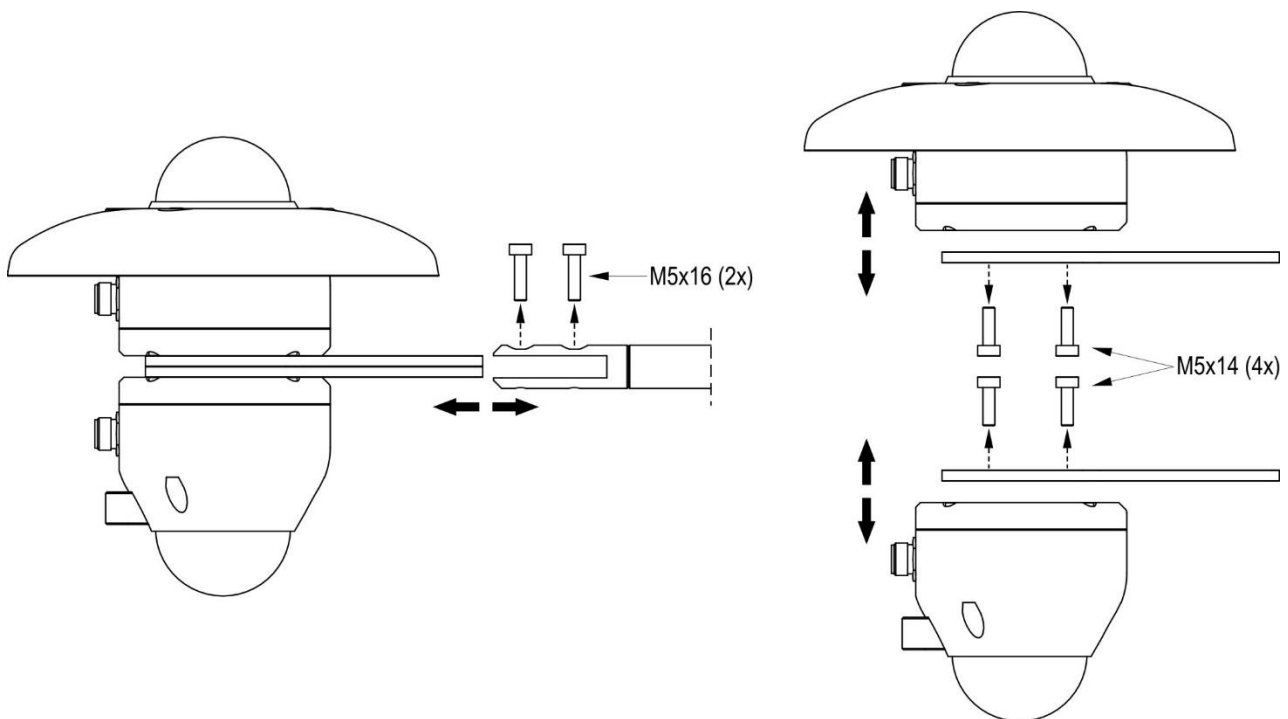


Fig. 6.1: disassembly of the pyranometers holder

Warning!

The silica-gel replacement must be done in an ESD-safe environment.

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

7 Safety instructions

The albedometer 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 sensor 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 sensor 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.

8 Accessories ordering codes

The albedometer is supplied with solar radiation protection screen, 2 M12 female free connectors (only if the optional cables are not ordered), support rod and calibration report.

Cables must be ordered separately.

Installation cables

CPM12-5... Cable with 5-pole M12 connector on one end, open wires on the other end. Length 5 m (CPM12-5.5) or 10 m (CPM12-5.10).

Spare parts

LPSP1A UV-resistant solar radiation protection screen.

LPG Silica-gel (5 sachets).

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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.

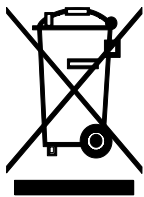
The manufacturer repairs the products that show defects of construction in accordance with the terms and conditions of warranty included in the manual of the product. For any dispute, the competent court is the Court of Padua. The Italian law and the "Convention on Contracts for the International Sales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



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