

## Operating manual

Albedometer

**LPPYRA06**



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**Keep for future reference.**

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# 1 INTRODUCTION

The LPPYRA06 albedometer measures the net global radiation, as well as the albedo of grounds (albedo is the ratio between diffuse radiation from a determined surface and the quantity of radiation that arrives on the surface).

The LPPYRA06 is manufactured mounting two LPPYRA03 pyranometers in one housing only: one for measuring the incident radiation striking the ground [ ↓ ] and the other one measuring the reflected radiation [ ↑ ].

The output signals of the two pyranometers can be processed to get the desired physical quantity.

The LPPYRA06 can be used as a pyranometer for measuring global radiation. As a pyranometer, the LPPYRA06 is a Spectrally Flat Class C (Second Class) pyranometer in accordance with ISO 9060:2018 and with the criteria of the WMO "Guide to Meteorological Instruments and Methods of Observation".

The albedometer is supplied factory calibrated and with a calibration report. The calibration is carried out in accordance with the ISO 9847:1992 (type IIc) standard: "Calibration of field pyranometers by comparison to a reference pyranometer". The pyranometer is calibrated by comparison with the reference sample calibrated annually at WRC (World Radiation Center).

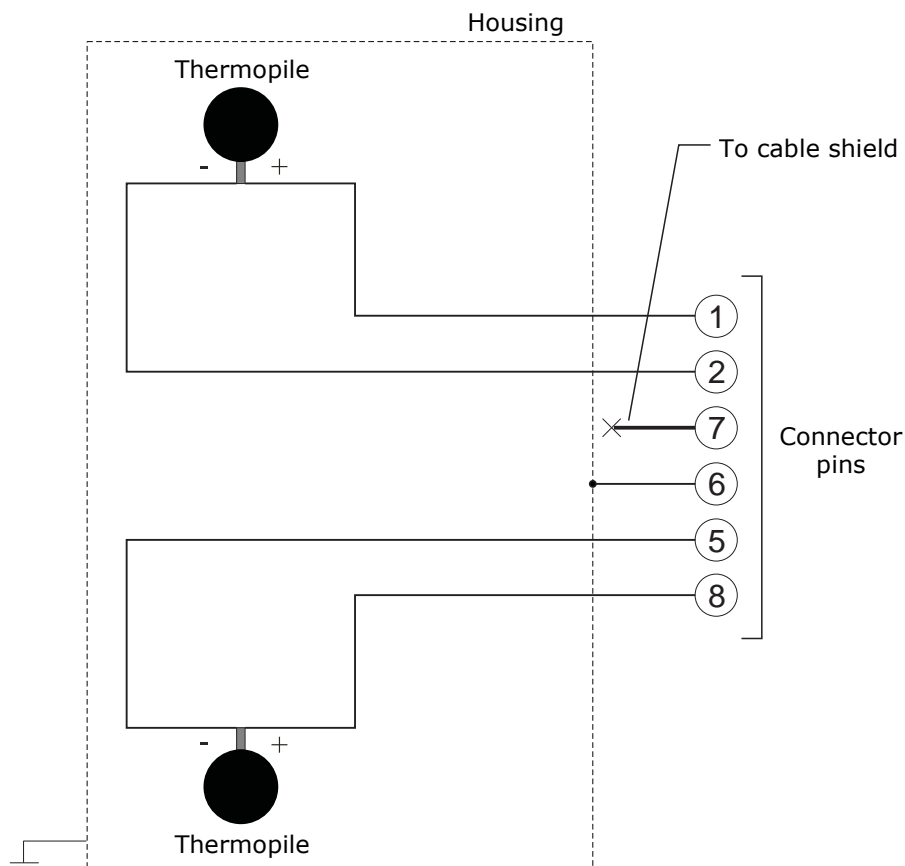
## 2 WORKING PRINCIPLE

The LPPYRA06 albedometer is based on a pair of thermopile sensors, one of them measuring the incident radiation on the ground [ ↓ ] and the other one the reflected radiation [ ↑ ]. Each thermopile works as an independent pyranometer. 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 two glass domes 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, LPPYRA06 is equipped with a 4 mm thick dome which is 32 mm in outer diameter on each side. The domes protect the thermopile from the dust, which might change spectral sensitivity if it lies on the black surface.

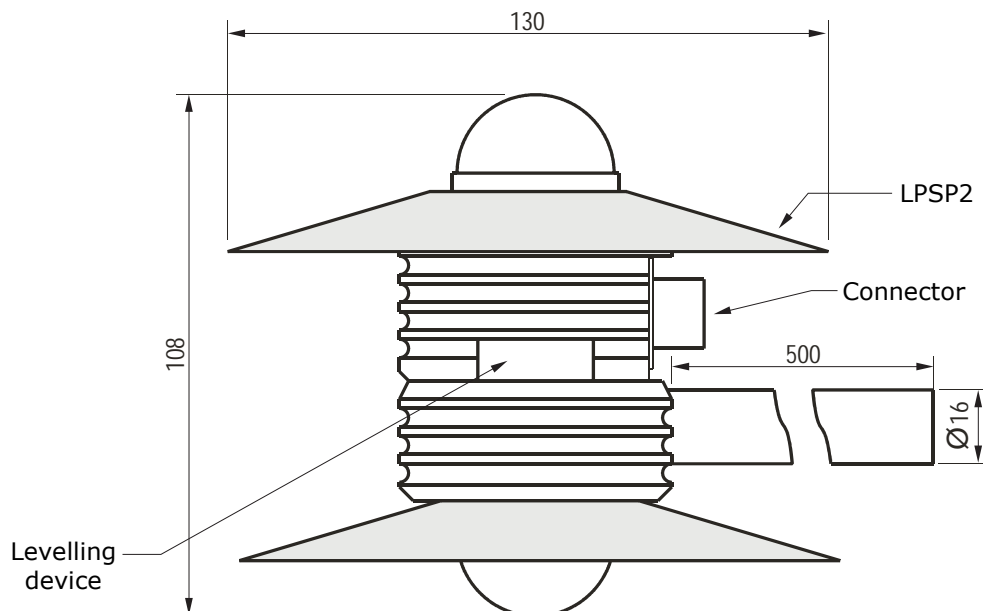
To prevent internal condensation forming on the internal side of the dome under certain climatic conditions, silica gel tablets are inserted inside the pyranometer to absorb humidity.



**Fig. 2.1: scheme of principle LPPYRA06**

### 3 INSTALLATION

- Mount the albedometer 1 – 2 m above the ground. Grass should be kept at the same height all the year long. In snowy regions, keep the instrument above the blanket of snow so that the distance from the albedometer to the snow be constant.
- The albedometer 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 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 pyranometer must 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 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. In any case, it is better to follow this suggestion even when the shade disk is applied.
- The mounting can be made using the rod provided with the instrument. In order to allow an accurate horizontal positioning, the pyranometer is equipped with a levelling device. The mast height does not exceed the pyranometer plane to avoid measurement errors caused by any reflection or shadow of the mast itself.
- It is preferably to thermally insulate the pyranometer from its mounting bracket ensuring, at the same time, a good electrical contact to ground.



**Fig. 3.1: fixing and dimensions**

## 4 ELECTRICAL CONNECTIONS

**LPPYRA06** has a 8-pole connector and uses the **CPM12AA8... optional** cables, with 8-pole connector on one side and open wires on the other side.

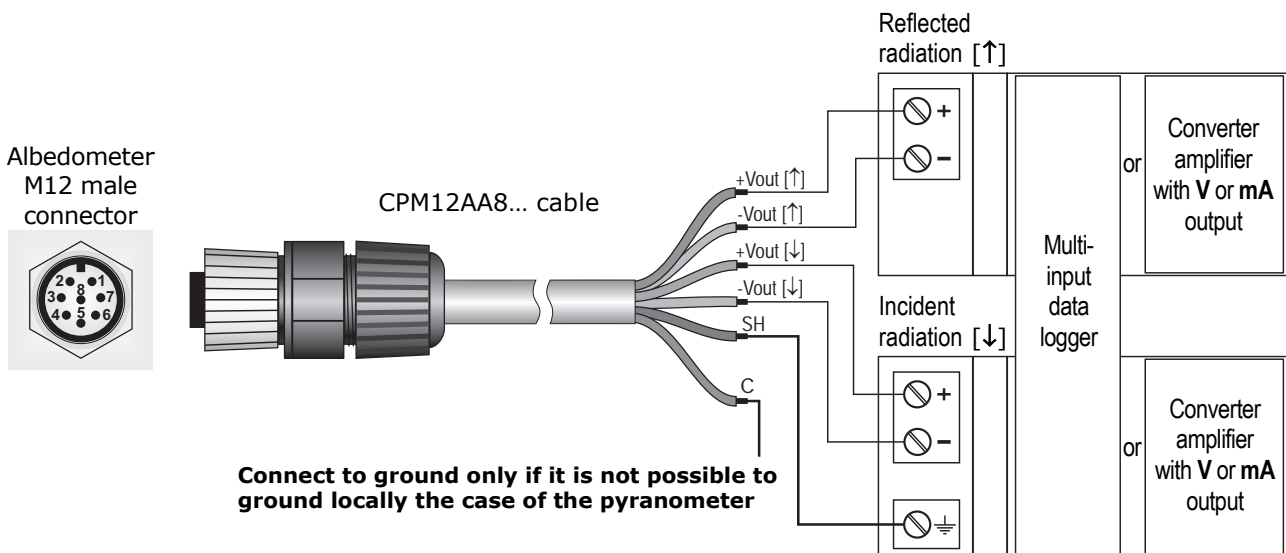


**The metallic housing of the albedometer should preferably be grounded ( $\perp$ ) locally. In this case, do not connect the wire of the cable corresponding to the housing to prevent ground loops.**

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

The albedometer LPPYRA06 is passive and does not require power supply. It is to be connected either to a millivoltmeter or to a data acquisition system (with at least two inputs). Typically, the albedometer output signal does not exceed 20 mV. In order to better exploit the albedometer features, the readout instrument should have 1  $\mu$ V resolution.

Connector	Function	Color
1	Output positive (+Vout) upper pyranometer [ $\downarrow$ ]	Red
2	Output negative (-Vout) upper pyranometer [ $\downarrow$ ]	Blue
3	Not connected	
4	Not connected	
5	Output negative (-Vout) lower pyranometer [ $\uparrow$ ]	Brown
6	Housing (C)	White
7	Cable shield (SH)	Black
8	Output positive (+Vout) lower pyranometer [ $\uparrow$ ]	Green



**Fig. 4.1: LPPYRA06 connections**

The shield has to be connected to the same ground as the readout instrument. Best safety is achieved through a perfect connection between housing and earth.

## 5 MEASUREMENT

Each of the two pyranometers forming the albedometer 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 pyranometer (and in the calibration report).

The sensitivity **S** is different for the two pyranometers.

The irradiance **E<sub>e</sub>** 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<sub>e</sub>** is the irradiance expressed in  $\text{W}/\text{m}^2$ ;

**DDP** is the difference of potential expressed in  $\mu\text{V}$  measured by the multimeter;

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

Albedo is the fraction of solar radiation that is reflected from the ground, with respect to incident radiation:

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

With the albedometer it is possible to calculate the net radiation making the difference between the incident global radiation and the reflected global radiation.

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



## 7 TECHNICAL SPECIFICATIONS

<b>Sensor</b>	Thermopile
<b>Typical sensitivity</b>	5 ÷ 15 $\mu\text{V}/\text{Wm}^{-2}$
<b>Impedance</b>	33 ÷ 45 $\Omega$
<b>Measuring range</b>	0 ÷ 2000 $\text{W}/\text{m}^2$
<b>Viewing angle</b>	$2\pi$ sr
<b>Spectral range (50%)</b>	300 ÷ 2800 nm
<b>Operating temperature/humidity</b>	-40 ÷ 80 °C / 0 ÷ 100%
<b>Output</b>	Analog in $\mu\text{V}/\text{Wm}^{-2}$
<b>Connection</b>	8-pole M12 connector
<b>Dimensions</b>	Fig. 3.1
<b>Weight</b>	1.1 kg approx. (complete albedometer)
<b>Accuracy of levelling device</b>	< 0.2°
<b>Protection degree</b>	IP 67
<b>MTBF</b>	> 10 years

### Technical Specifications According to ISO 9060

<b>Classification</b>	Spectrally Flat Class C
<b>Response time (95%)</b>	< 20 s
<b>Zero offset</b>	
a) response to a 200 $\text{W}/\text{m}^2$ thermal radiation	< $ \pm 15  \text{ W}/\text{m}^2$
b) response to a 5 K/h change in ambiente temperature	< $ \pm 4  \text{ W}/\text{m}^2$
c) total zero offset including the effects a), b) and other sources	< $ \pm 20  \text{ W}/\text{m}^2$
<b>Long-term instability (1 year)</b>	< $ \pm 1  \%$
<b>Non-linearity</b>	< $ \pm 1.5  \%$
<b>Response according to the cosine law</b>	< $ \pm 20  \text{ W}/\text{m}^2$
<b>Spectral error</b>	< $ \pm 2  \%$
<b>Temperature response (-10...+40°C)</b>	< 3 %
<b>Tilt response</b>	< $ \pm 2  \%$

## 8 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.

## 9 ACCESSORIES ORDERING CODES

**LPSP2**

UV-resistant shade disk (spare part).

**CPM12AA8...**

Cable with 8-pole M12 connector on one end, open wires on the other end. Length 2 m (CPM12AA8.2), 5 m (CPM12AA8.5) or 10 m (CPM12AA8.10).

**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.**

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**DICHIARAZIONE DI CONFORMITÀ UE**  
**EU DECLARATION OF CONFORMITY**

**Delta Ohm S.r.L. a socio unico – Via Marconi 5 – 35030 Caselle di Selvazzano – Padova – ITALY**

Documento Nr. / Mese.Anno: **5126 / 07.2019**  
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: **LPPYRA06**  
Product identifier :

Descrizione prodotto: **Albedometro**  
Product description : **Albedometer**

I prodotti sono conformi alle seguenti Direttive Europee:  
*The products conform to following European Directives:*

Direttive / Directives	
2014/30/EU	Direttiva EMC / EMC Directive
2014/35/EU	Direttiva bassa tensione / Low Voltage Directive
2011/65/EU - 2015/863/EU	RoHS / RoHS

Norme armonizzate applicate o riferimento a specifiche tecniche:  
*Applied harmonized standards or mentioned technical specifications:*

Norme armonizzate / Harmonized standards	
EN 61010-1:2010	Requisiti di sicurezza elettrica / Electrical safety requirements
EN 61326-1:2013	Requisiti EMC / EMC requirements
EN 50581:2012	RoHS / RoHS

Il produttore è responsabile per la dichiarazione rilasciata da:  
*The manufacturer is responsible for the declaration released by:*

Johannes Overhues

Amministratore delegato  
Chief Executive Officer

Caselle di Selvazzano, 19/07/2019

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.*

## WARRANTY

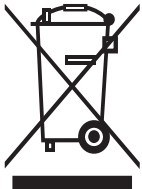
Delta OHM is required to respond to the "factory warranty" only in those cases provided by Legislative Decree 6 September 2005 - n. 206. Each instrument is sold after rigorous inspections; if any manufacturing defect is found, it is necessary to contact the distributor where the instrument was purchased 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.

Delta OHM 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. In case of discrepancies and/or inconsistencies, please write to sales@deltaohm.com. Delta OHM reserves 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.



**V2.2**  
**21/04/2021**