LP PYRA 10
PYRANOMETER

The pyranometer LP PYRA 10 measures the irradiance on a flat surface (Watt/m^2). The radiation measured is the sum of direct solar irradiance and diffuse irradiance (global radiation).
The LP PYRA 10 is a pyranometer classified as Secondary in accordance with ISO 9060 and according to the publication "Guide to Meteorological Instruments and Methods of Observation", fifth edition (1983) of WMO
The pyranometer is available in three versions:

LP PYRA 10	PASSIVE *
LP PYRA 10 AC	ACTIVE with CURRENT 4..20 mA output
LP PYRA 10 AV	ACTIVE with VOLTAGE 0..1 V, 0..5 V, 0..10 V output, to specify at the time of ordering **.

* The passive version can be connected to the instrument through the indicator DO9847 by SICRAM module VP 472
** Version with 0...1 Volt output can be connected by SICRAM VP474 to the instrument HD2302.0 which provides direct reading in W/m^2.

2 Working principle
The pyranometer LP PYRA 10 is based on a thermopile sensor which surface is covered by a matt black paint so to allow the instrument not to be selective at various wavelengths. The spectral range of the pyranometer is determined by the transmission of the two glass domes type K5. The new sensor allows a response time less than the requirements of the ISO9060 standard for classifying Secondary pyranometers (response time is generally less than 9 seconds, where ISO9060 standard requires a response time less than 15 seconds).
Radiant energy is absorbed/radiated from the surface of the blackened thermopile, creating a temperature difference between the centre of the thermopile (hot junction) and the body of pyranometer (cold junction). The temperature difference between hot and cold junction is converted into Potential Difference thanks to the Seebeck effect.
A second thermopile is mounted inside the instrument and not accessible by light. This second thermopile, connected anti-series with respect to the sensor exposed to light, reduces the signals of pyranometer in sudden temperature changes (thermal shock).

In order to minimize variations of sensitivity according to the temperature, the LP PYRA 10 is equipped with passive compensation circuit. The graph 1 shows the typical variation of sensitivity at different temperatures.

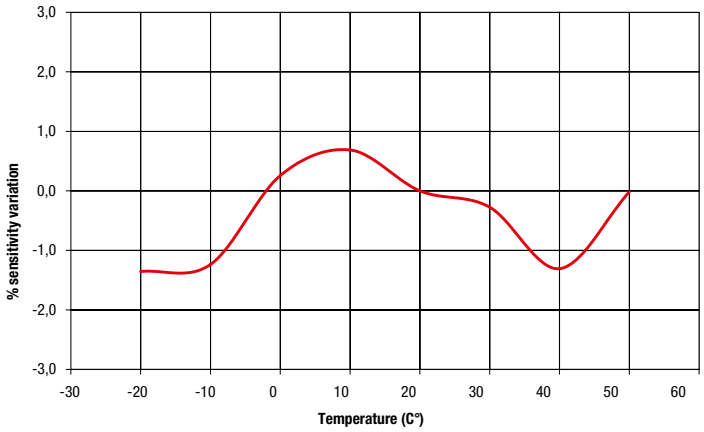


Grafico1:% change of the sensitivity of the pyranometer LP PYRA 10 compared to the sensitivity at 20 ° C in the temperature range between -20 and 50 ° C.

The deviations are calculated from the measured sensitivity at 20 ° C.

LP PYRA 10 has two concentric domes with external diameter of 50 mm and 30mm respectively, this to ensure a thermal insulation of the thermopile by the wind and reduce the sensitivity to radiation heat. The domes protect the thermopile from dust settling on the blackened it could change the spectral sensitivity.

3 Installation and mounting of the pyranometer to measure global radiation:
Before installing the pyranometer you need to load the cartridge containing silica gel crystals. The silica gel has the function of absorbing the moisture in the chamber domes and humidity in climatic conditions can lead to condensation on the inside of the domes by altering the extent. During the loading of silica gel crystals you should avoid wetting it or touching it with hands. The steps in a dry place (where possible) are:
1 unscrew the three screws that fix the white screen
2 remove the cartridge port silica gel with a coin

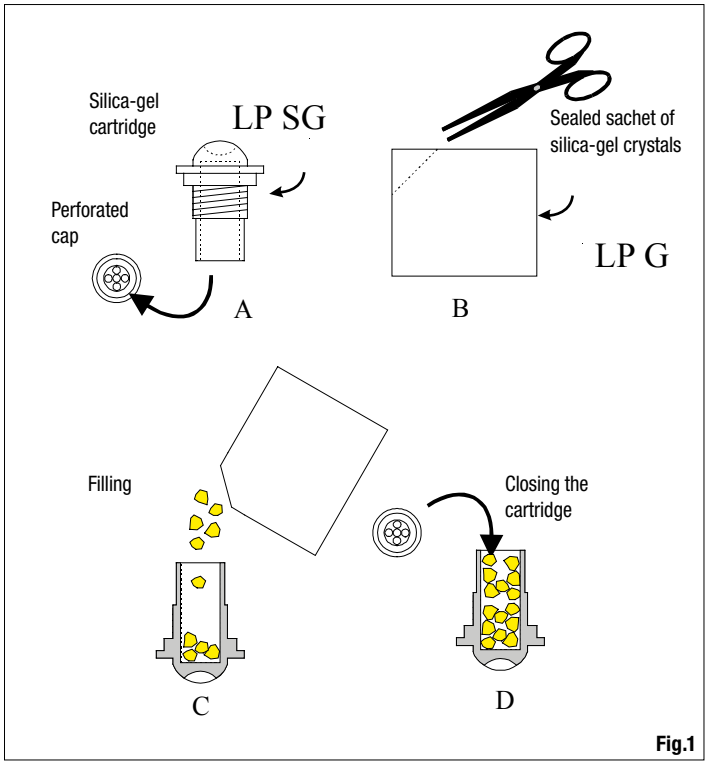


Fig.1

3 remove the stopper of the cartridge
4 open the envelope (supplied with ill pyranometer) containing silica gel
5 fill the cartridge with silica-gel crystals
6 close the cartridge with his cap, making sure that the O-ring seal is positioned correctly
7 screw the cartridge into the body of the pyranometer with a coin
8 make sure that the cartridge is firmly screwed (if not, the duration of the crystals of silica gel is reduced)
9 position the screen with screws and screw
10 the pyranometer is ready for use

Figure 1 briefly describes the operations necessary for loading the cartridge with silica-gel crystals.

- The LP PYRA 10 has to be installed in a location easily accessible for periodic cleaning of the silicon window. At the same time you should avoid buildings, trees or obstacles of any kind exceed the horizontal plane on which the pyrgeometer lies. In case this is not possible it is advisable to choose a location where the obstacles are lower than 5°.
- The pyranometer should be located far from any kind of obstacle that can project the reflection of the sun (or shadow) on the same pyranometer.
- When the pyranometer is used without the white screen should be positioned so that the cable comes out from the North pole if you use it in the NORTH hemisphere, and from the SOUTHERN pole if you use it in the SOUTH hemisphere, according to the ISO TR9901 standard and other WMO recommendations. In any case, it is preferable to comply with WMO/ISO recommendations also when the screen is used.
- For an accurate horizontal positioning, the pyranometer LP PYRA 10 is equipped with a spirit level, which adjustment is by two screws with lock nut that allows changing the pyranometer inclination. The fixing on a flat base can be performed by using two 6mm diam. holes and 65 mm wheelbase. In order to access the holes, remove the screen and re-place it back after mounting, see figure 2.
- In order to facilitate the installation of the pyranometer, Delta Ohm provides on request a range of accessories illustrated in Figure 3. The installer must take care that the height of the mast does not exceed the floor of the pyranometer, not to introduce errors extent caused by reflections and shadows caused by the pole.
- It is better to insulate the pyranometer from its support, while ensuring that there is a good electrical contact to earth.

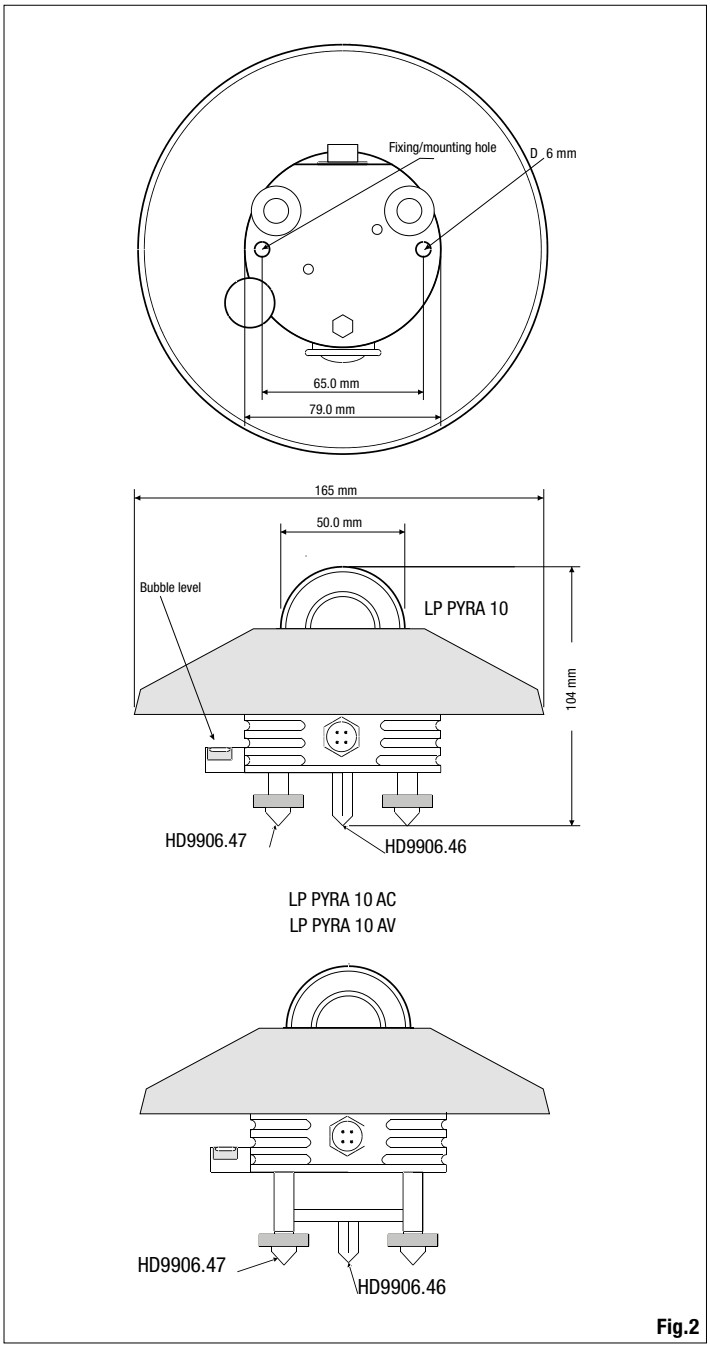


Fig.2

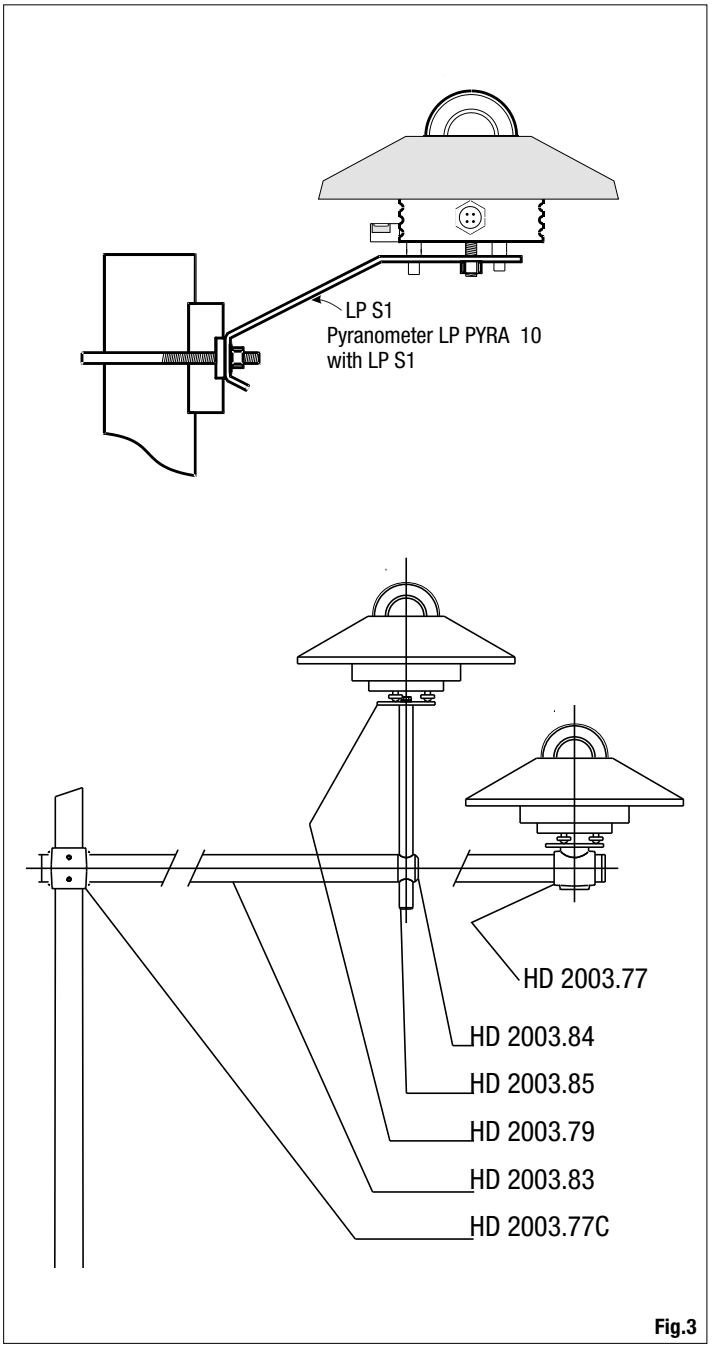


Fig.3

4 Electrical Connections and Requirements for Electronic reading:

The LP PYRA 10 is produced in three versions, LP PYRA 10, 10 AC and LP LP PYRA PYRA 10 AV.

- The LP PYRA 10 is passive and does not need power.
- Versions LP PYRA 10 AC, AV are active and need power. The voltage required is:

8-30 VDC for the versions LP PYRA 10 AC and LP PYRA 10 AV with 0..1V and 0..5 V output.

14-30 VDC for the version LP PYRA 10 AV with 0..10V output.

- All versions are equipped with 4-pin output connector.
- The optional cable, ending with a connector by one side, is made in PTFE resistant to UV and is provided with 7 wires plus braid (screen), the diagram with the correspondence between cable colours and connector poles is the following (figure 4):

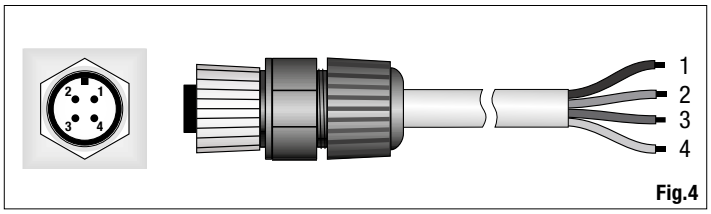


Fig.4

LP PYRA 10

Connector	Function	Color
4	Screen (⏚)	Black
1	Positive (+)	Red
2	Negative (-)	Blue
3	Case (⏦)	White

LP PYRA 10 AC

Connector	Function	Color
4	Screen (⏚)	Black
1	Positive (+)	Red
2	Negative (-)	Blue
3	Case (⏦)	White

LP PYRA 10 AV

Connector	Function	Color
4	Screen (⏚)	Black
1	(+) Vout	Red
2	(-) Vout and (-)Vcc	Blue
3	(+) Vcc	White

- LP PYRA 10 is connected to a millivoltmeter or to a data acquisition system. Typically, the signal from pyranometer not exceed 20 mV. The recommended resolution of the instrument reading in order to take full advantage of the pyranometer, is 1μV.

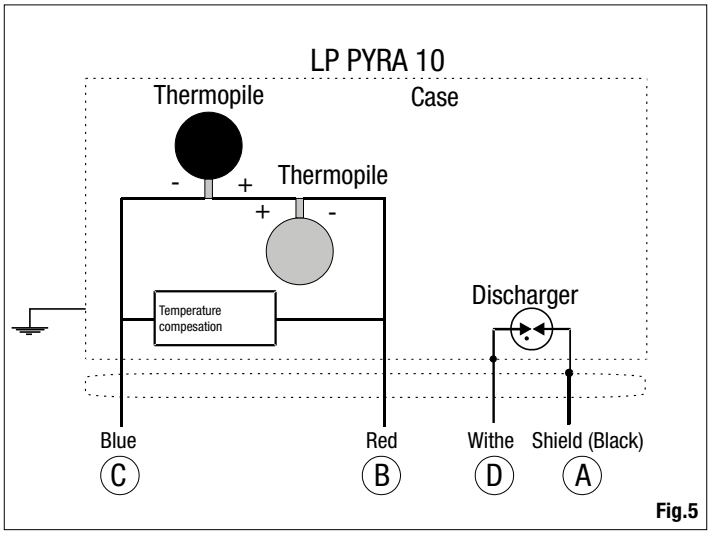


Fig.5

An example of connection reading system is shown in Figure 6.

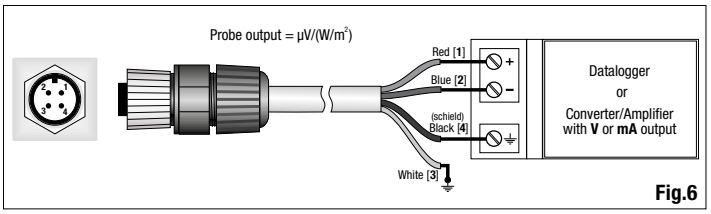


Fig.6

- LP PYRA 10 to be connected to an AC power supply and a multimeter as shown below (Figure 7), resistance load for reading the signal must be≤ 500 Ω:

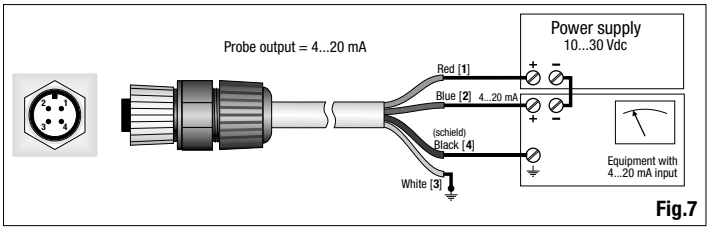


Fig.7

- LP PYRA 10 AV to be connected to a power supply and a multimeter, as shown below (Figure 8), the load resistance for reading the signal must be ≥ 100 KΩ:

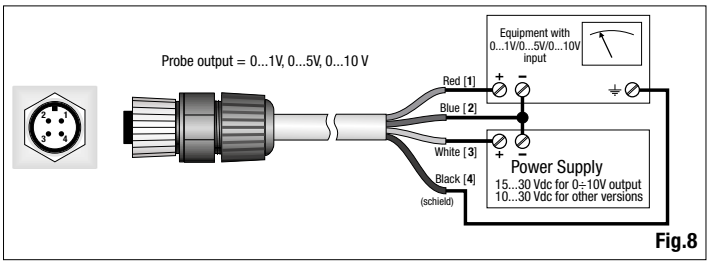


Fig.8

5 Maintenance:

In order to ensure a high measurement accuracy, it is necessary to keep clean the silicon window, so the higher the frequency of cleaning, the best measurement accuracy will be. Cleaning can be done with normal maps for cleaning photographic objectives and water, if not possible, simply use pure ethyl alcohol. After cleaning with alcohol, it is necessary also to clean the window again in silicon with water only.

Due to the high temperature fluctuations between day and night, it is possible that you get some condensation inside the pyranometer dome; reading done in this case is strongly overestimated. To minimize condensation inside the pyrgeometer, a proper cartridge Silica gel is supplied with the instrument. The efficiency of silica-gel crystals decreases over time with the absorption of moisture. When crystals of silica gel are efficient their colour is **yellow**, while when they gradually lose efficiency, their colour becomes **white/transparent**; to replace them, please refer to the instructions under paragraph 3. Silica gel typically lifetime goes from 4 to 12 months according to the environmental conditions where the pyranometer is working.

6 Calibration and measures:

LP PYRA 10

The sensitivity of the pyranometer S (or calibration factor) allows to determine the irradiance measured signal in volts across the thermopile. The **S** factor is in μV/(Wm^{-2}).

- Once measured the potential difference (DDP) at the ends of the probe, the radiation E_e is obtained by the following formula:

$$E_e = DDP/S$$

where;

E_e: is the Radiation expressed in W/m^2,

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

S: is the calibration factor reported on the pyranometer label (and on the calibration report) in μV/(W/m^2).

LP PYRA 10 AC

The sensitivity of the pyranometer is factory adjusted so that
4..20 mA = 0.. 2000 W/m^2
To get the value of radiation once you know the current (I_{out}) drawn by the instrument, you should apply the following formula:

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

where;
E_e: is the Radiation expressed in W/m^2,
I_{out}: is the current in mA absorbed by the instrument

LP PYRA 10 AV

The sensitivity of the pyranometer is factory adjusted so that, depending on the version you have chosen, you get:
0..1 V = 0.. 2000 W/m^2
0..5 V = 0.. 2000 W/m^2
0..10 V = 0.. 2000 W/m^2
Once you know the output voltage (Vout) of the instrument, to obtain the value of irradiation should apply the following formula:

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

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

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

where;
E_e: is the Radiation expressed in W/m^2,
V_{out}: is the output voltage (in Volts) measured with the voltmeter

Each pyranometer is individually factory calibrated and is distinguished by its calibration factor. To take full advantage of the LP PYRA 10 features, we recommend performing the calibration annually.
The instruments present in the metrology laboratory of Photo-Radiometry at Delta Ohm srl allows the calibration of the pyranometer according to the requirements of WMO, and ensures the traceability of measurements to international standards.

Specifications:

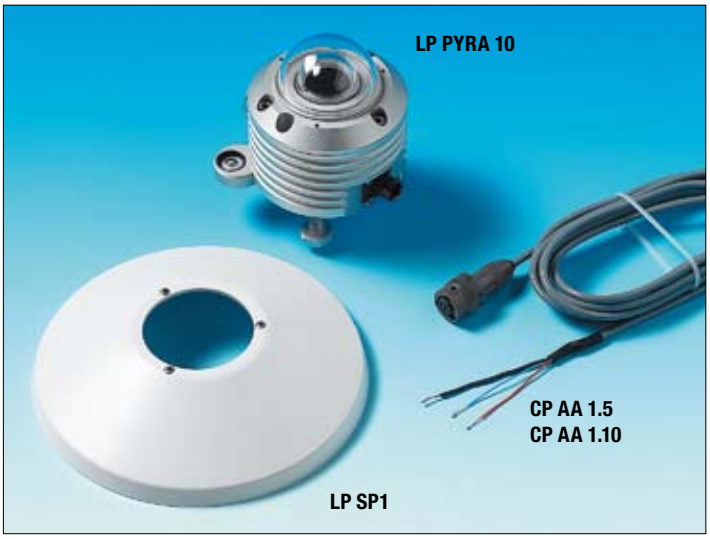
Typical sensitivity:	10 μV/(W/m2) LP PYRA 10
	4..20 mA (0-2000 W/m2) LP PYRA 10AC
	0..1,5,10V (0-2000 W/m2) LP PYRA 10AV
Impedance:	500 Ω ÷ 1000 Ω
Campo di misura:	0-2000 W/m2
Field of view:	2π sr
Spectral range:	305 nm ÷ 2800 nm (50%)
(trasmission of domes)	335 nm ÷ 2200 nm (95%)
Working temperature:	-40 °C ÷ 80 °C
Dimensions:	figure 1
Weight:	0.90 Kg

Specifications according to ISO 9060

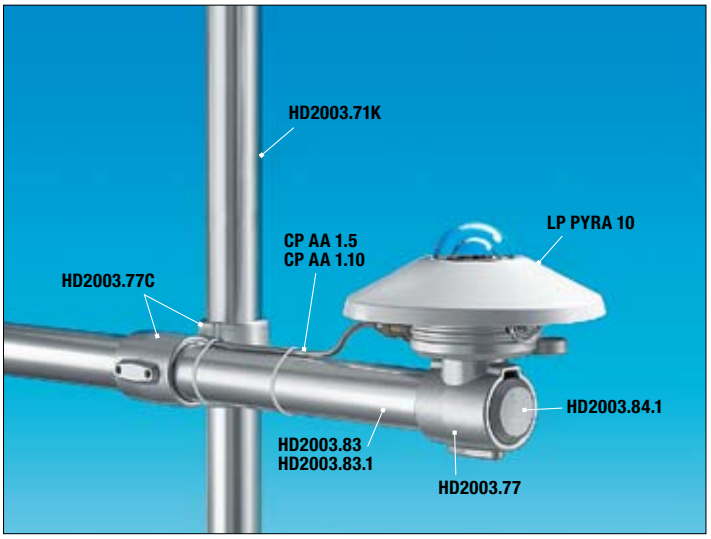
1-	Response time: (95%)	<9 sec
2-	Off-set Zero:	
	a) response to a thermal radiation of 200W/m2:	<7 W/m2
	b) response to a change of 5K/h in the room temperature:	< | ±2 | W/m2
3a-	Long-term instability: (1 year)	< | ±0.8 | %
3b-	Nonlinearity:	< | ±0.5 | %
3c-	Response according to Cosine law:	< | ±10 | W/m2
3d-	Spectral selectivity:	< | ±3 | %
3e-	Temperature response:	<2 %
3f-	Tilt response:	< | ±0.5 | %

PURCHASING CODE

LP PYRA 10: Secondary Pyranometer according to ISO 9060. Equipped with protection, silica-gel crystals cartridge, 3 recharges, level, 4-poles M12 connector and Report of Calibration ISO9001.
LP PYRA 10 AC: Secondary Pyranometer according to ISO 9060. Equipped with protection, silica-gel crystals cartridge, 3 recharges, level, 4-poles M12 connector and Report of Calibration ISO9001. 4...20mA current output signal.
LP PYRA 10 AV: Secondary Pyranometer according to ISO 9060. Equipped with protection, silica-gel crystals cartridge, 3 recharges, level, 4-poles M12 connector and Report of Calibration ISO9001. Voltage 0..1Vdc, 0..5Vdc, 0..10Vdc output signal, to define when ordering.
CPM AA 4.5: 4-poles M12 connector equipped with UV resistant cable, L=5 meters.
CPM AA 4.10: 4-poles M12 connector equipped with UV resistant cable, L=10 meters.
HD 2003.85: Mounting ki, with adjustable height, pyranometer palo with diameter ϕ 40 mm (HD2003.84 + HD2003.85 + HD2003.79)
HD 2003.79: Mounting kit pyranometer on clamping ϕ 40mm (HD2003.77 + HD2003.79)
HD 2003.77: Clamping for mast ϕ 40mm
LP SP1: Protective screen plastic UV resistant. LURAN S777K by BASF®
LP S1: Bracket positioning pyranometer LP PYRA 10, suitable for pole with a maximum diameter of 50mm.
LP SG: Cartridge containing silica gel crystals, complete with O-ring and cap.
LP G: Pack of 5 cartridges of silica gel crystals.



LP PYRA 10



LP PYRA 10 + HD2003.77C + HD2003.77