Member of GHM GROUP

LPNET14

LPNET14
NET IRRADIANCE METER

LPNET14 is a 4-component net-radiometer for the measurement of the net radiation between 0.3 μm and 45 μm.
The net-radiometer consists of two pyranometers (one for the measurement of the global radiation $E_{sw}\downarrow$ and the other one for the measurement of the reflected solar radiation $E_{sw}\uparrow$) and a pair of pyrgeometers (one for the measurement of the infrared radiation emitted by the sky $E_{FIR}\downarrow$ and the other one for the infrared emitted by the ground surface $E_{FIR}\uparrow$).
The LPNET14 is equipped with a temperature sensor (NTC). The measurement of the temperature is needed for the measurement with the two pyrgeometers, in fact, the far infrared is derived by measuring the thermopile output and by the knowledge of the instrument's temperature.
The net radiometer is suitable for outdoor use in all weather conditions and requires little maintenance.

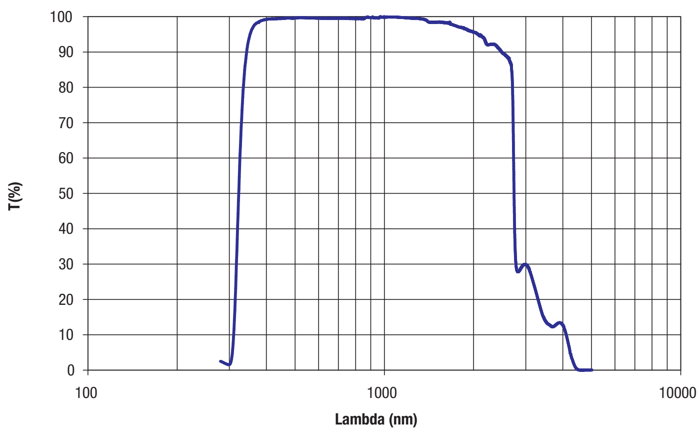


Fig. 1: Relative spectral response of the Delta OHM pyranometers.

Technical specifications	
Pyranometer - Second Class Pyranometer according to ISO 9060	
Typical Sensitivity	5 to 15 μV/(W/m²)
Impedance	33 Ω ÷ 45 Ω
Measuring range	0-2000 W/m²
Field of view	2π sr
Spectral range: (dome transmission)	300 nm ÷ 2800 nm (50%)
	335 nm ÷ 2200 nm (95%)
Working temperature	-40 °C ÷ 80 °C
Pyrgeometer	
Typical sensitivity	5-10 μV/(W/m²)
Impedance	33 Ω ÷ 45 Ω
Measuring range	-300 ÷ +300 W/m²
Viewing field	160°
Spectral range: (silicon window transmission)	4.5 μm ÷ 45 μm (50%)
Working temperature	-40 °C ÷ 80 °C

Working principle

The pyranometers that make up the LPNET14 measure the radiation for wave lengths between 0.3 μm e 3.0 μm, while the pyrgeometers measure the irradiance in the spectral range between 4.5 μm and 45 μm.

The pyranometers are based on a thermopile sensor which sensitive surface is covered by a matt black paint so to allow the instrument not to be selective at various wavelengths. The pyranometer spectral range is determined by the transmittance of the two glass domes type K5
Radiant energy is absorbed by the thermopile black surface, creating a difference of temperature between the centre 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.

Also the pyrgeometers are based on a thermopile. In this case, to protect the thermopile, silicon discs are used. Silicon is transparent to wavelengths longer than 1.1 μm therefore on the inside of the window there is a filter to block radiation up to 4.5- 5 μm. The silicon external surface, which is exposed to weathering, is coated with a scratch-resistant coating (DLC) to ensure strength and durability in all weather conditions. The anti-scratch coating offers the advantage of cleaning the surface without risk of scratching the window. Fig. 2 reports the transmission of the silicon window according to the wavelength variation:

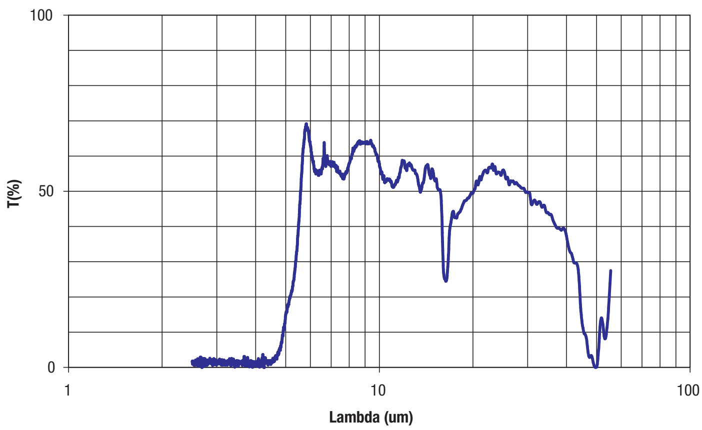


Fig. 2: Transmission of the silicon window.

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 pyrgeometer (cold junction). The temperature difference between hot and cold junction is converted into Potential Difference thanks to the Seebeck effect.
If the pyrgeometer temperature is higher than the radiant temperature of the portion of sky framed by the pyrgeometer, the thermopile will irradiate energy and the output signal will be negative (typical situation of clear sky) vice versa if the pyrgeometer temperature is lower than that portion of sky framed, the signal will be positive (typical situation of cloudy sky).

Therefore, for the calculation of the ground infrared ($E_{FIR}\downarrow$), besides the thermopile output signal, is necessary to know the T temperature of the pyrgeometer, as reported under the formula 1:

$$E_{FIR}\downarrow = E_{term.} + \sigma T_B^4$$

Where:

E_{term} = net radiation (positive or negative), measured by the thermopile [W m^{-2})], the value is calculated by the sensitivity of the instrument (C) [μV/(W m^{-2})] and by the output signal (U_{emf}) from formula 2;

$$E_{term.} = \frac{U_{emf}}{C}$$

σ = Stefan-Bolzmann constant (5.6704x10^{-8} W m^{-2} K^{-4});

T_B = pyrgeometer temperature (K), obtained by the reading of the NTC (10kΩ) resistance. In the manual (Table 1) is reported the resistance value according to the temperature for values included between -25°C and +55°C.

The first term of the formula 1 represent the net radiation, that is to say the difference between ground infrared radiation and the pyrgeometer emission, while the second term is the radiation emitted by an object (taken with submissiveness ε=1) at T_B temperature.

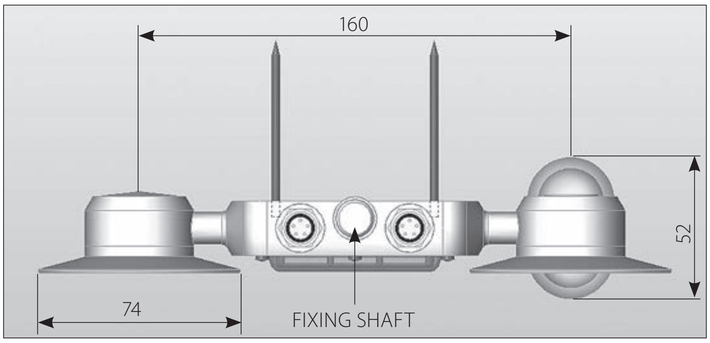


Fig. 4 - For an accurate horizontal positioning, the LPNET14 has to be fixed on a support pole by using the fixing bracket

Calibration

Each pyranometer and pyrgeometer that composes the instrument is calibrated individually. Therefore, each LPNET14 comes factory calibrated and has its own calibration factor.

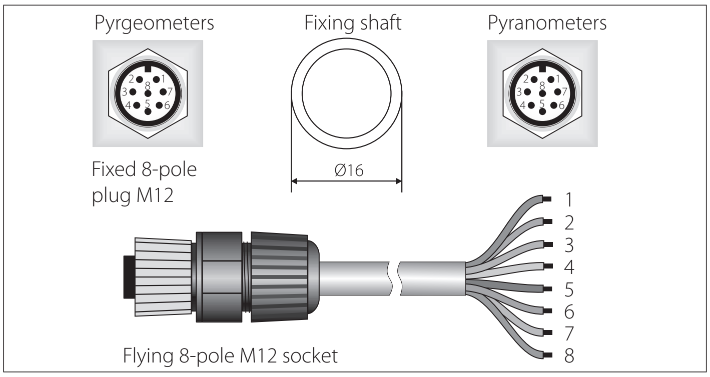
Pyrgeometer calibration is performed outdoors, by comparison with a sample pyrgeometer calibrated by the World Radiation Centre (WRC).

The two instruments are kept outdoors for a few days and nights in the presence of clear sky. The data acquired by a data logger is then processed to obtain the calibration factor.

To fully exploit the features of the probe LPNET14, it is recommended to perform the calibration verification every one or two years (the choice of calibration interval depends both on the accuracy to be achieved and on the installation location).

Electrical connections and requirements for electronic reading:

- The net-radiometer LPNET14 does not need any power supply.
- The instrument is equipped with two M12 8 pole connectors.
- The optional cables end with an 8 pole connector on one side and open wires at the other side. The cable is made in UV-resistant PTFE and is provided with 7 wires plus braid (screen), the diagram with the correspondence between wire colours and connector poles is the following.



Connector	Function		Colour
	Pyrgeometers	Pyranometers	
1	V_{out} (+) $E_{FIR}\downarrow$	V_{out} (+) $E_{SW}\downarrow$	Red
2	V_{in} (-) $E_{FIR}\downarrow$	V_{in} (-) $E_{SW}\downarrow$	Blue
3	screen (⏚)	screen (⏚)	Screen
4	NOT CONNECTED		
5	V_{out} (-) $E_{FIR}\uparrow$	V_{out} (-) $E_{SW}\uparrow$	Brown
8	V_{in} (+) $E_{FIR}\uparrow$	V_{in} (+) $E_{SW}\uparrow$	Green
6	NTC	NOT CONNECTED	White
7	NTC	screen (⏚)	Black

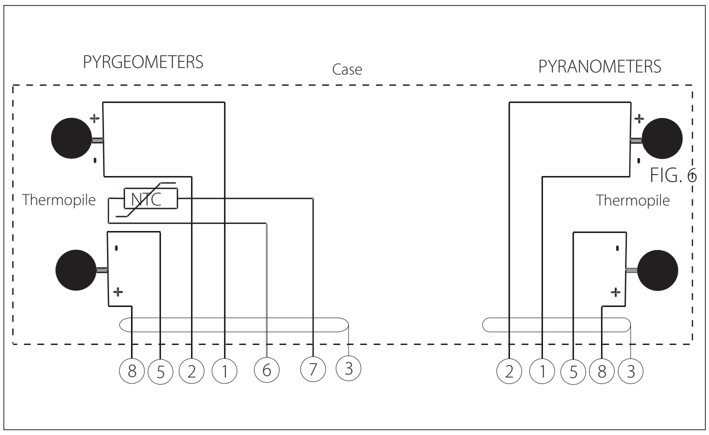
Table 1: correspondence pin-function

In order to obtain a measure, it is necessary to acquire simultaneously the signal of the four thermopiles and the NTC.

To measure the output signals of the four thermopiles, the four channels have to be connected to a millivoltmeter or a data logger. In order to fully exploit the features of the net-radiometer, the recommended resolution of the reading instrument is 1μV.

Moreover, it is necessary to read the NTC resistance so to determine temperature of the two pyrgeometers.

In the figure below, the electrical connections necessary to read the signal of the four thermopiles and the NTC are reported.



ORDERING CODES

LPNET14: Net-radiometer equipped with:

bracket Ø=16 mm length 400 mm, 2 bird spikes, 5 recharges of desiccant (composed of 2 silica-gel cartridges and one marker), level, 2 8-pole M12 connectors and Calibration Report.

ACCESSORIES

LPG2: 5 Recharges composed of 2 silica gel cartridges.

CPM12AA8.5: Cable with 8-pole M12 connector, 5 meters long.

CPM12AA8.10: Cable with 8-pole M12 connector, 10 meters long.