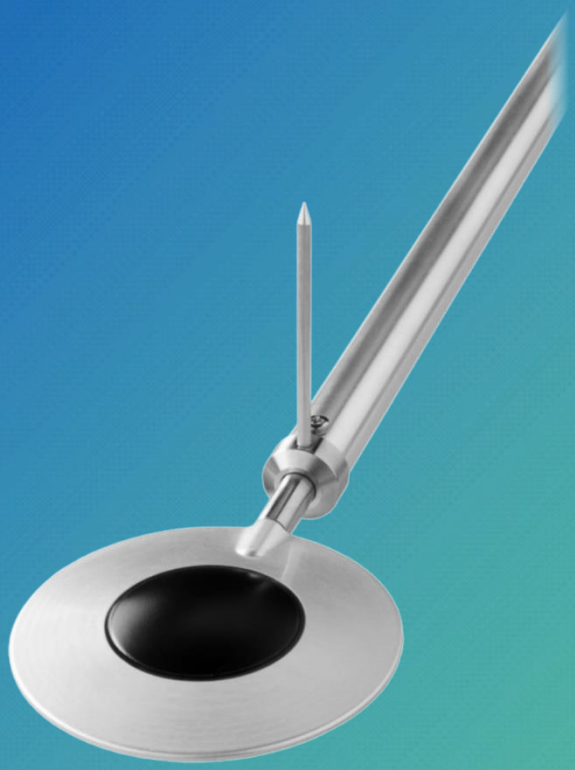
OPERATING MANUAL

LPNET07

Net irradiance meter



EN

V1.0

senseca

Contents

1 Introduction

LPNET07 measures the net irradiance across a surface from near ultraviolet to far infrared.

The net irradiance is the difference between the irradiance that reaches the upper surface and that on the lower surface of the radiometer.

The upper receiving surface measures direct plus diffuse solar irradiance and the long wavelength radiation emitted from the sky (clouds), while the lower receiving surface measures the solar irradiance reflected from the ground and the long wavelength radiation emitted from the earth.

The net irradiance is measured in the spectral range from 0.2 to 10 µm.

The radiometer is suitable for outdoor use in all weather conditions and requires little maintenance.

Supplied with bird spike and fixing shaft ∅16 mm, L=500 mm.

UV resistant fixed 5 m (standard) connection cable.

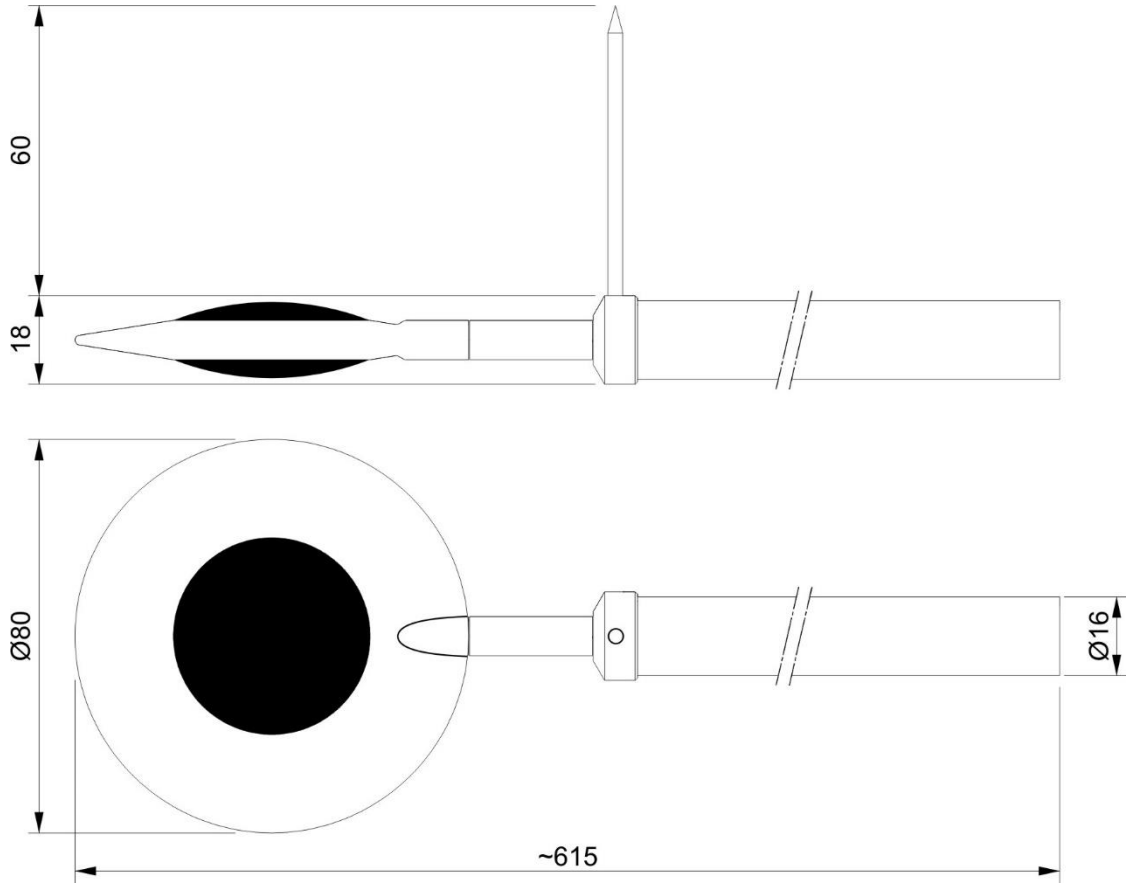
The radiometer is already factory calibrated and comes complete with calibration report. Calibration is performed by comparison with a reference net radiometer, using a solar simulator with parallel light beam as light source.

In addition to meteorology for energy balance measurements, the radiometer can be used indoors for the measurement of radiant temperature (ISO 7726).

2 Technical specifications

Typical sensitivity	10 μV/(Wm^{-2})
Impedance	2…4 Ω
Measuring range	±2000 W/m^2
Viewing angle	180° upper sensor 180° lower sensor
Spectral range	0.2…100 μm
Response time (95%)	< 60 s
Operating temperature	-40…+80 °C
Materials	Housing and fixing shaft: anodized aluminium alloy Sensitive area: aluminium alloy with PTFE coating Bird spike: stainless steel
Weight	0.35 kg approx.

Dimensions (mm)



3 Measuring principle

The radiometer is based on a thermopile sensor, whose hot junction is in thermal contact with the upper receiver, while the cold junction is in thermal contact with the lower receiver. The temperature difference between the two receivers is proportional to the net irradiance, and is converted into a difference of potential by the Seebeck effect.

The two receivers consist of a PTFE-coated spherical dome portion, which allows outdoor installation for long periods without danger of damage and enables a constant spectral response from ultraviolet (200 nm) to far-infrared (100 µm).

The special shape of the two receivers guarantees an optimal response according to cosine law.

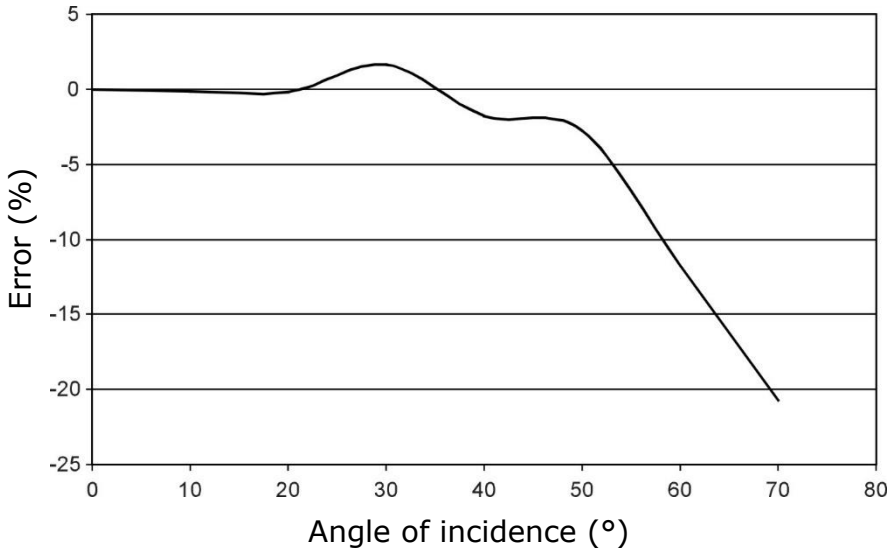
Response according to cosine law (directional error):

The irradiance on a surface should be measured with a sensor whose response, as a function of the light incidence angle, is Lambertian. A receiver is said to be Lambertian if its sensibility (S_ϑ) as a function of the incidence angle between the light and the receiver surface has a trend of the type:

$$S_\vartheta = S_0 \cos(\vartheta)$$

Where S_0 is the sensitivity when light strikes perpendicular to the surface, and ϑ is the angle between the normal to the surface and the incident light beam.

The following graph shows the trend of the typical error as a function of angle of incidence:



4 Installation

The radiometer must be mounted in an easy-to-reach location in order to clean the two sensitive surfaces regularly. At the same time, make sure that no buildings, constructions, trees or obstructions cast their shadow on the radiometer at any time during the day.

In the northern hemisphere, the radiometer should be oriented toward the south, while in the southern hemisphere, the radiometer should be oriented toward the north.

The instrument should be mounted at a height of at least 1.5 m above the ground. Keep in mind that the flux on the lower receiver is representative of a circular surface with radius equal to ten times the height.

Avoid touching the receiving surfaces of the radiometer during installation.

4.1 Electrical connections

Warning!

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

The radiometer is passive and does not need any power supply.

The fixed cable has 2 wires plus shield:

Function	Wire color
+Vout (output signal positive)	Red
-Vout (output signal negative)	Blue
Cable shield / radiometer housing	Black

The typical output impedance of the sensor is 2…4 Ω.

The output signal is typically a few mV. The recommended resolution of the reading instrument (voltmeter or data logger) is 1 µV.

5 Measurement

The radiometer is distinguished by the sensitivity (or calibration factor) ***S*** expressed in μV/(Wm^{-2}), shown in the label on the sensor and in the calibration report.

The net irradiance $\boldsymbol{E_e}$ in W/m^2 is obtained by measuring with a multimeter the difference of potential ***DDP*** at the ends of the sensor and applying the following formula:

$$\mathbf{E_e = DDP / S}$$

where:

DDP is the difference of potential expressed in μV measured by the multimeter.

S is the sensitivity of the sensor expressed in μV/(Wm^{-2}).

If the difference of potential (DDP) is positive, the irradiance on the upper surface is higher than the irradiance on the lower surface (typically during daylight hours); if the difference of potential is negative, the irradiance on the lower surface is higher than the irradiance on the upper surface (typically at night).

5.1 Sensitivity as a function of wind speed

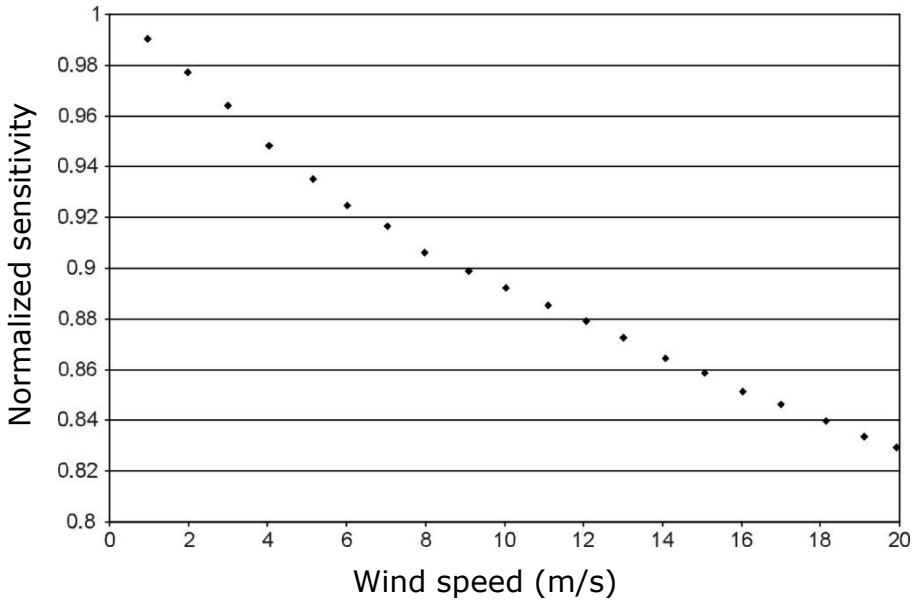
For the same radiant flux, the sensitivity, and consequently the output signal, of the radiometer decreases as wind speed increases. Measurements conducted in the wind tunnel have shown that $\mathbf{S_v}$ sensitivity as a function of wind speed **V** in m/s can be approximated by the following two functions:

$$\mathbf{S_v = S_0 (1 - 0.001 \times V)} \quad \text{For } V \leq 10 \text{ m/s}$$

$$\mathbf{S_v = S_0 (0.95 - 0.006 \times V)} \quad \text{For } 10 \text{ m/s} < V < 20 \text{ m/s}$$

Where $\mathbf{S_0}$ is the sensitivity with zero wind speed, which is the sensitivity supplied with the radiometer.

The following graph shows the trend of the normalized sensitivity as a function of wind speed:



If the wind speed is known, use the formula $\mathbf{E_e = DDP / S_v}$ to calculate the irradiance.

6 Maintenance

In order to grant measurements high accuracy, it is important to keep the two receiving surfaces clean. The higher the frequency of cleaning, the better the accuracy of measurements.

You can wash it using water and standard papers for lens. If necessary, use pure ETHYL alcohol. After using alcohol, clean again the receiving surfaces with water only.

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

7 Safety instructions

The radiometer 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.

NOTES

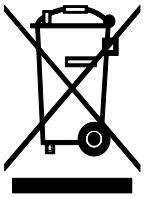
WARRANTY

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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