

LPPIRG01 - LPPIRG01S



LPPIRG01 - LPPIRG01S PYRGEOMETER

The pyrheliometer **LPPIRG01** is used to measure the far infrared radiation (**FIR**). The measures are referred to radiations with wavelength greater than $4.5 \mu\text{m}$.

The far infrared radiation derives from the measure of the thermopile output signal and from the knowledge of the instrument temperature. The temperature measure is performed by a $10\text{k}\Omega$ NTC inserted in the body of the pyrheliometer.

The pyrheliometer can be used also for the study of energy balance. In this case, besides another pyrheliometer which measures infrared radiation upwards, it is necessary an albedometer (LPPYRA05, LPPYRA06 or LPPYRA11) to measure short wavelengths radiation ($<3 \mu\text{m}$).

The pyrheliometer is available in the following versions:

- **LPPIRG01**: Passive
- **LPPIRG01S**: With RS485 Modbus-RTU output.

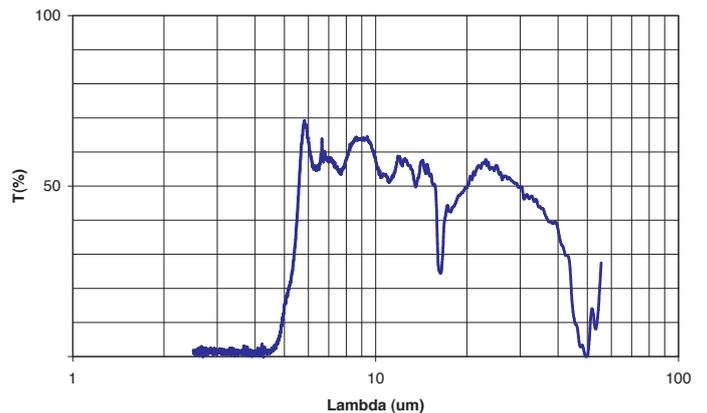
The pyrheliometer is supplied factory calibrated and with a calibration report. The calibration is carried out outdoors, for comparison with a reference standard pyrheliometer calibrated at WRC (World Radiation Center). The two instruments are kept outdoors for at least one night in the presence of clear sky. The data acquired by a data logger are then processed to obtain the calibration factor.

Technical specifications	
Sensor	Thermopile
Typical sensitivity	$5\text{-}10 \mu\text{V}/(\text{W}/\text{m}^2)$
Impedance	$33 \Omega \div 45 \Omega$
Measuring range	$-300 \div +300 \text{ W}/\text{m}^2$
Viewing angle	160°
Spectral range (50%) (transmission of the silicon window)	$5.5 \div 45 \mu\text{m}$
Operating temperature	$-40^\circ\text{C} \div 80^\circ\text{C}$
Output	Analog in $\mu\text{V}/\text{Wm}^2$ (LPPIRG01) Digital RS485 Modbus-RTU (LPPIRG01S)
Power supply	$5 \div 30 \text{ Vdc}$ (LPPIRG01S)
Connection	8-pole M12 connector
Weight	0.9 kg
Accuracy of levelling device	$< 0.1^\circ$
Protection degree	IP 67
MTBF	> 10 years
Technical specifications according to ISO 9060:2018	
Response Time	$< 28 \text{ s}$
Zero offset (type B) a) response to a $5 \text{ K}/\text{h}$ change in ambiente temperature	$< \pm 4 \text{ W}/\text{m}^2$
Long-term instability (1 year)	$< \pm 1.5 \%$
Non-linearity	$< \pm 1 \%$
Spectral selectivity	$< \pm 5 \%$
Temperature response	$< 3 \%$
Tilt response	$< \pm 2 \%$

Working Principle

The pyrheliometer LPPIRG01 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 sensor is covered by silicon window that has two basic purposes:

- protect the thermopile from the weather;
- determine the instrument spectral range: silicon is transparent to wavelengths longer than $1.1 \mu\text{m}$, therefore on the inside of the window there is a filter to block radiation up to $4.5\text{-}5 \mu\text{m}$. The silicon external surface, which is exposed to weather agents, has a scratch-resistant coating (DLC) to ensure strength and durability in all weather conditions. The scratch-resistant coating offers the advantage of cleaning the surface without risk of scratching the window. The transmission of the silicon window according to the wavelength variation is shown in the graphic below.



Radiant energy is absorbed/radiated by the thermopile black surface, thus creating a difference of temperature between the center of the thermopile (hot junction) and the pyrgeometer body (cold junction).

Thanks to the Seebeck effect, the difference of temperature between hot and cold junction is converted into a Difference of Potential.

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 infrared radiation at ground level (E_{FIR} ↓), besides the thermopile output signal, it is necessary to know the temperature of the pyrgeometer, as shown in formula 1:

$$E_{FIR} \downarrow = E_{term.} + \sigma \cdot T_B^4 \quad 1$$

Where:

$E_{term.}$ = net radiation (positive or negative) measured by the thermopile ($W m^{-2}$);

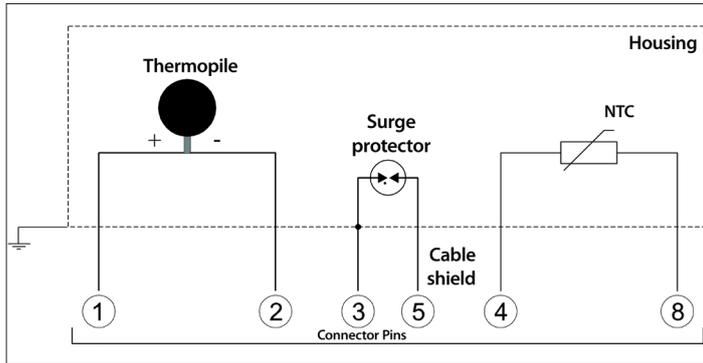
σ = Stefan-Boltzmann constant ($5.6704 \times 10^{-8} W m^{-2} K^{-4}$);

T_B = pyrgeometer temperature (K), obtained by the reading of the NTC resistance.

$E_{term.}$ is calculated from the sensitivity of the instrument C [$mV/(W m^{-2})$] and from the output signal U_{emf} according to formula 2:

$$E_{term.} = \frac{U_{emf}}{C} \quad 2$$

The first term of formula 1 represents 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 (assuming emissivity $\epsilon = 1$) at temperature T_B .



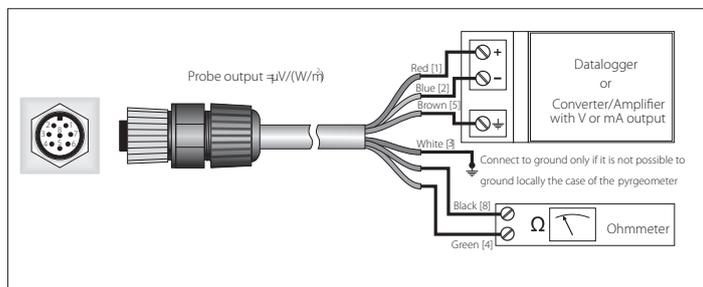
Scheme of principle LPPIRG01 (version with mV output)

Electrical Connections

The pyrgeometer has a 8-pole connector and uses the CPM12AA8PG... (LPPIRG01) or CPM12-8D... (LPPIRG01S) optional cables in UV resistant PTFE, with 8-pole connector on one side and open wires on the other side

LPPIRG01 CONNECTIONS

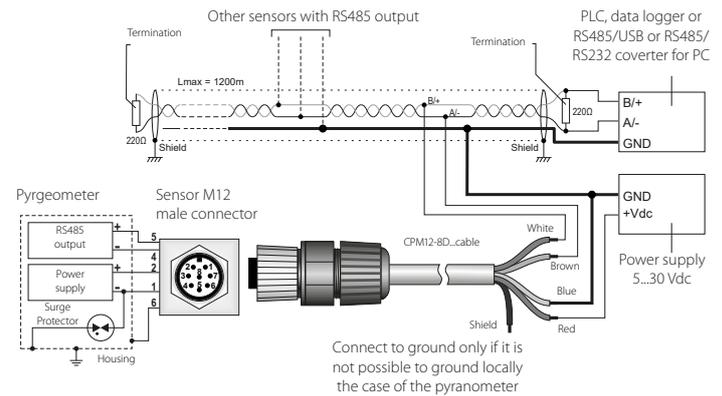
The pyrgeometer LPPIRG01 is passive and does not require power supply. It is to be connected either to a millivoltmeter or to a data acquisition system. Typically, the pyrgeometer output signal absolute value does not exceed 4 mV. In order to better exploit the pyrgeometer features, the readout instrument should have 1 mV resolution. To determine the pyrgeometer temperature, the NTC resistance must be read.



Connector	Function	Colour
1	$V_{out}(+)$	Red
2	$V_{out}(-)$	Blue
3	Housing	White
4	NTC	Green
5	Cable shield	Brown
6	Not connected	
7	Not connected	
8	NTC	Black

LPPIRG01S CONNECTIONS

The pyrgeometer LPPIRG01S has RS485 Modbus-RTU output and requires 5...30 Vdc external power supply. It is to be connected to a power supply and to a PLC, a data logger or a RS485/USB or RS485/RS232 converter for PC. The RS485 output is not isolated.



Connector	Function	Colour
1	Power supply negative (GND)	Blue
2	Power supply positive (+Vdc)	Red
3	Not connected	
4	RS485 A/-	Brown
5	RS485 B/+	White
6	Housing	Shield (Black)
7	Not connected	
8	Not connected	

ORDERING CODES

LPPIRG01: Pyrgeometer. Complete with shade disk, cartridge for silica-gel crystals, 2 spare sachets, levelling device, M12 8-pole connector and Calibration Report. CPM12AA8PG... cable has to be ordered separately.

LPPIRG01S: Pyrgeometer. Complete with shade disk, cartridge for silica-gel crystals, 2 spare sachets, levelling device, M12 8-pole connector and Calibration Report. RS485 Modbus-RTU output. Power supply 5...30 Vdc. CPM12-8D... cable has to be ordered separately.

LPSP1: UV-resistant shade disk.

LPS1: Fixing bracket for the pyrgeometer, suitable for $\varnothing 40 \div 50$ mm mast. Installation on horizontal or vertical mast.

HD2003.79K: Kit to mount the pyrgeometer on $\varnothing 40$ mm clamping. To install the pyranometer on a transverse mast.

HD2003.85K: Kit with adjustable height to mount the pyrgeometer on a $\varnothing 40$ mm mast.

CPM12AA8PG.x: Cable with 8-pole M12 connector on one end, open wires on the other end. Available lengths: 2, 5, 10 m.

CPM12-8D.x: Cable with 8-pole M12 connector on one end, open wires on the other end. Available lengths: 2, 5, 10 m.

CP24: PC connecting cable for the RS485 MODBUS parameters configuration of the LPPIRG01S pyrgeometer. With built-in RS485/USB converter. 8-pole M12 connector on instrument side and A-type USB connector on PC side.

LPSPG: Cartridge with desiccant silica-gel crystals, complete with O-ring and cap.

LPG: Pack of 5 sachets of silica-gel crystals.