

WORKING PRINCIPLE

The LP UVB 02 radiometer is based on an innovative solid state photodiode, the spectral response of which was adapted to that desired by using special interferential filters. In particular, the used photodiode and filters have exceptional stability characteristics, both for temperature and through time. This allowed manufacturing of an instrument that does not need heating, thus reducing energy consumption.

Particular attention has been given to filter design so as to make the instrument completely blind to wavelengths outside the concerned pass-band. The solar energy within the 302nm–308nm spectral band is only 0.01% of the total energy from the sun reaching Earth's surface. The relevant spectral response curve is shown in Fig. 1A (in linear scale) and Fig. 1B (in logarithmic scale).

The LP UVB 02 is provided with a 50mm-external-diameter dome in order to supply a suitable protection of the sensor to the atmospheric agents. Quartz was chosen due to its optimum

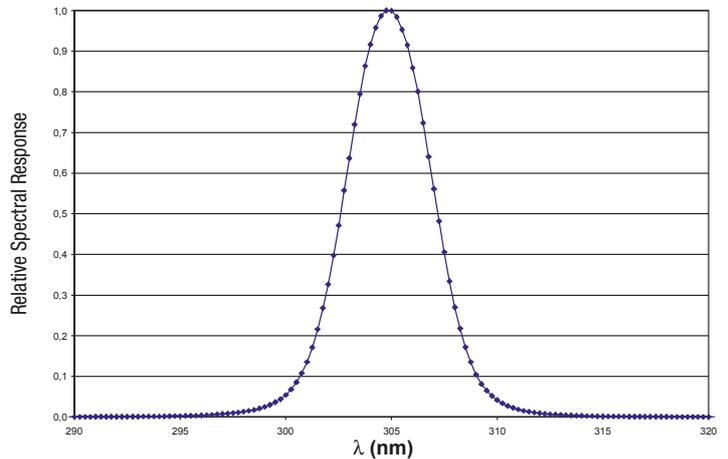


Fig. 1A

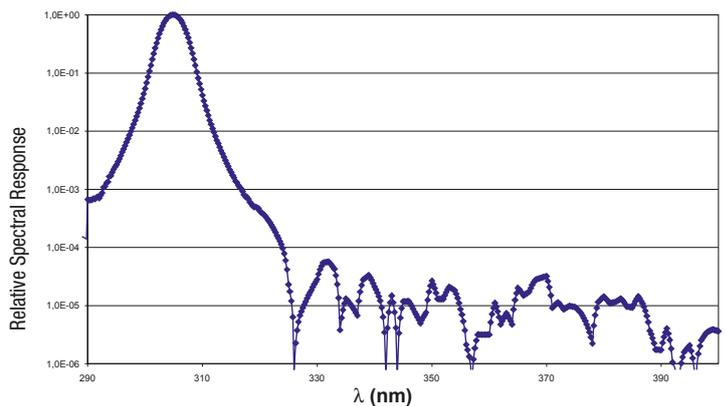


Fig. 1B

LP UVB 02 RADIOMETRIC PROBE FOR ENVIRONMENTAL USE

The LP UVB 02 radiometer measures the global irradiance in the UVB spectral region on a flat surface (Watt/m²). In particular, the instrument's spectral sensitivity is centered at 305nm with a 5nm band width (FWHM). The global irradiance is the sum of the direct solar irradiance and the sky diffuse irradiance on a surface parallel to the ground. In contrast to the visible spectrum where the direct component prevails over the diffuse component, in the UVB spectral region light is strongly diffused by atmosphere and thus the two components are equivalent. Therefore it is of primary importance for the instrument to be capable of measure both components accurately.

The LP UVB 02 probe is typically used in the following sectors:

- Monitoring the ozone layer. Indeed, the radiation around 295nm–315nm is strongly absorbed by ozone located in the stratosphere, therefore each small variation of the ozone layer corresponds to an increase or decrease of the radiation reaching the ground.
- Effects of UVB radiation (the most harmful to human health) on living beings.
- UVB radiation measurement in work spaces.

The LP UVB 02 radiometer needs power to function. Power is required to amplify the weak signal generated by the photodiode. Indeed, the radiometer is a current/voltage amplifier (transimpedance amplifier). This choice measures sun-produced UVB irradiance. Indeed, the need to use sophisticated filters (partially attenuating the signal concerned) and the relatively weak sun-produced irradiation in this spectral area, in the best case, make the photodiode-generated current in the order of hundreds of pAmpere. So it is not possible to use cable meters or tens of meters long as the noise might be greater than the signal itself. Therefore the signal must be amplified.

LP UVB 02 is robust and was manufactured to operate for long periods without maintenance (if powered correctly). This characteristic makes it suitable for location in meteorological stations.

A platinum-resistance thermometer (Pt100) is inserted inside the LP UVB 02 in order to control its temperature. Internal temperature must remain within its functioning range, otherwise measurements could be affected by higher systematic errors than those asserted in the manual. Exposure to temperature higher than +60°C can alter the interferential-filters spectral characteristics.

transmission in the UV range.

The response in accordance with the cosine law has been obtained thanks to the particular shape of the diffuser and of the housing. The departure between a theoretical response and the measured one is shown in the Fig. 2.

The excellent relation between the response of the LP-UVB-02 and the cosine law allows to use the instrument also when the sun has a very low raising (the UVB diffuse radiation increases as the sun is leaving the zenith, therefore the error on the direct radiation, owing to the imperfect response according to the cosine law, becomes negligible referred to the measurement of the global radiation).

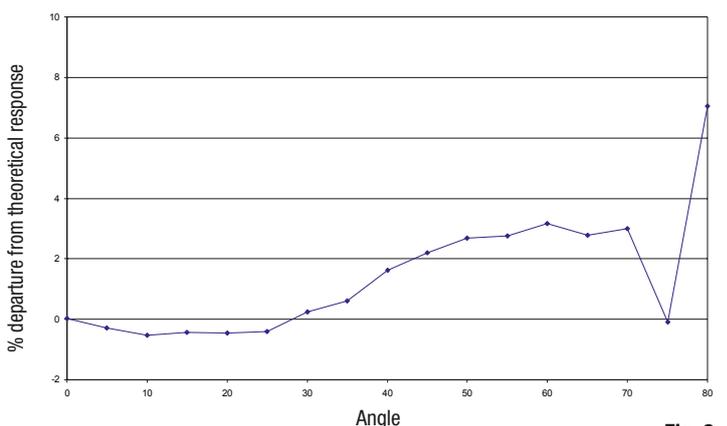


Fig. 2

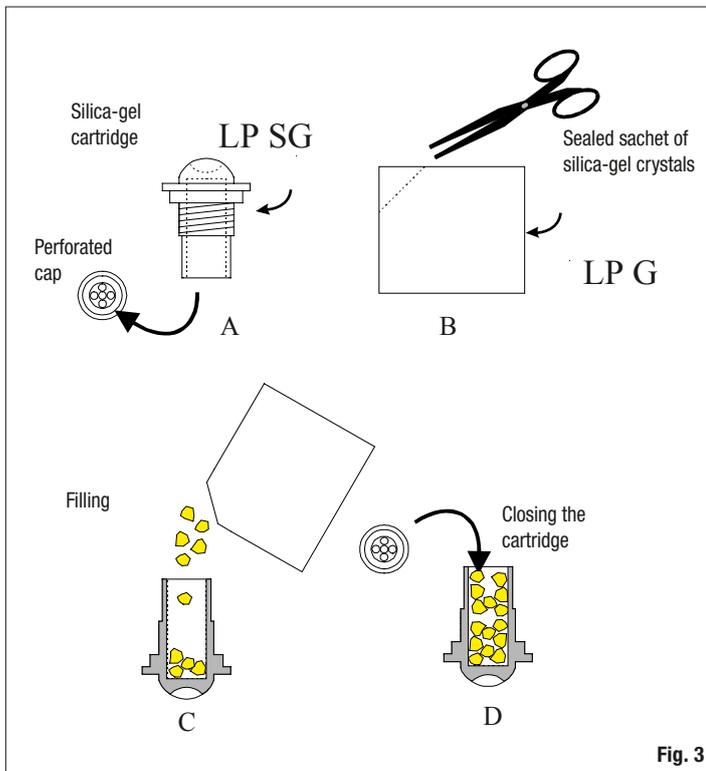


Fig. 3

- 8- check that the cartridge is screwed tightly (if not, the silica-gel life will be reduced)
- 9- position the shade disk and tighten it with the screws
- 10- the radiometer is ready for use

Fig. 3 shows the operations necessary to fill the cartridge with the silica-gel crystals.

- The LP UVB 02 has to be mounted in a readily accessible location to be able to provide for a periodic cleaning of the external dome and for the maintenance. Check also that no building, construction, tree or obstruction exceeds horizontal plane where the radiometer lays. If this is not possible, select a site where obstructions do not exceed 5 degrees of elevation, in the path followed by the sun, between earliest sunrise and latest sunset.
- The radiometer has to be located far from any kind of obstruction, which might throw the solar radiation (or its shade) on the radiometer.
- The LP UVB 02 radiometer is provided with a spirit level for carrying an accurate horizontal leveling. The adjustment is made by means of two leveling screws that allow to adjust the radiometer inclination. Use the two 6mm-diameter and 65mm-interaxial-distance holes to mount the instrument on a plane. Remove the shade disk to access the holes and reposition it after mounting (see Fig. 4).
- The LP S1 mounting kit (Fig. 5), supplied on demand as an accessory, allows an easy mounting of the radiometer on a mast. The mast maximum diameter shall not exceed 50 mm. The operator shall take care that the mast height does not exceed the radiometer plane to avoid measurement errors caused by any reflection or shadow of the mast itself. To fix the radiometer to the mounting bracket, remove the shade disk loosening the three screws, fix the radiometer and mount the white shade disk again.
- It's suggested to thermally isolate the radiometer from its mounting brackets and to check that the electrical contact with the ground be done properly.

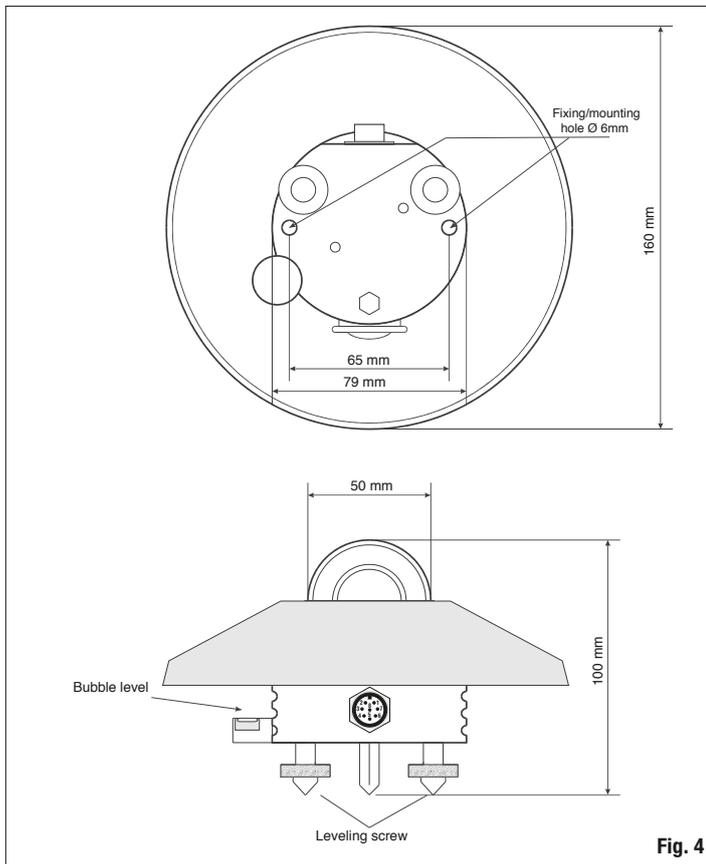


Fig. 4

Installation and Mounting of the Radiometer for the Measurement of the Global Radiation

Before installing the radiometer refill the cartridge containing the silica-gel crystals. Silica gel absorbs humidity in the dome chamber; in case of particular climatic conditions this humidity can cause condensation on the internal side of the dome and then modify the measurement. Do not touch the silica gel crystals with your hands and do not wet them while refilling the cartridge. Carry out the following instructions in an environment as dry as possible:

- 1- loosen the three screws that fix the white shade disk
- 2- unscrew the silica gel cartridge using a coin
- 3- remove the cartridge perforated cap
- 4- open the sachet containing the silica gel (supplied with the radiometer)
- 5- fill the cartridge with the silica-gel crystals
- 6- close the cartridge with its own cap, paying attention that the sealing O-ring be properly positioned and undamaged
- 7- screw the cartridge to the radiometer body using a coin

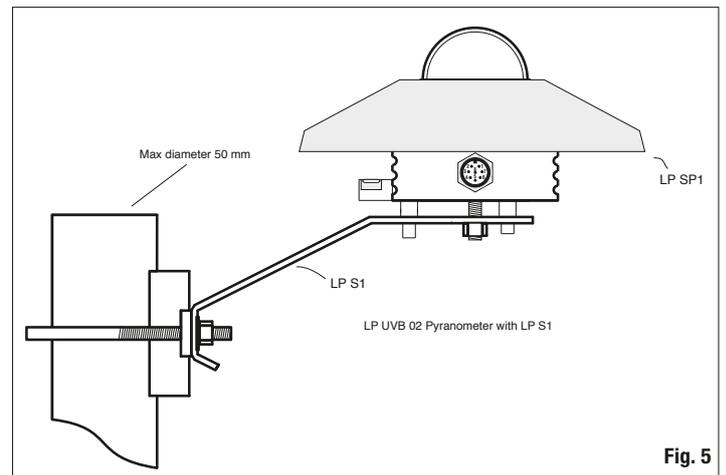


Fig. 5

Electrical Connections and Requirements for Electronic Readout Devices

The connections on the output connector are indicated below:

- Pin8: $V+$, positive supply voltage for LP UVB 02 internal electronics. $7Vdc < V+ < 30Vdc$
- Pin6: $VoutTemp+$, output signal for temperature measurement. $0V (-40^{\circ}C) < VoutTemp+ < 1V (+60^{\circ}C)$
- Pin2: $Vout+$, output signal for irradiance measurement in the UVB band. $0V < VoutUV+ < 4V$.
- Pin1: Ground of the two output signals, $VoutTemp+$, $VoutUV+$
- Pin7: Housing.
- Pin5: Power supply grounding.

- The LP UVB 02 has to be connected either to a voltmeter or to a data acquisition system with input impedance greater than $10K\Omega$. Typically, the radiometer output signal, when exposed to the sun, does not exceed 1 volt. In order to better exploit the radiometer features, the readout instrument should have 0.1mV resolution.

N.B. The input load resistance of the data acquisition system must be greater than $10K\Omega$. The connection scheme is shown in figure 6.

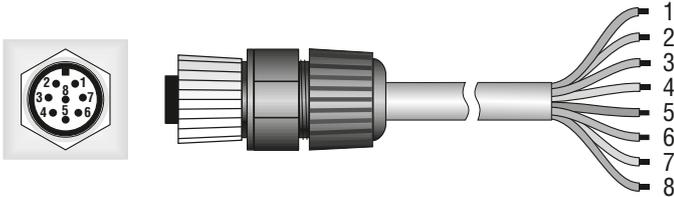
The cable supplied with the UV-resistant output connector has 5 wires plus the braid (screen); the colour code is shown in fig. 6.

Maintenance

It is important to keep the outer domes clean to grant the best measurement accuracy. Consequently, cleaning the dome more often will give more accurate measurements. Cleaning can be carried out using water and standard papers for lens, or, if not sufficient, using pure ETHYL alcohol. After using alcohol, clean again the dome with water only. Because of the high rise/fall in temperature between day and night, some condensation might appear on the radiometer dome.



WIRING DIAGRAM LP UVB 02



Fixed 8-pole plug M12

Flying 8-pole M12 socket

LP UVB 02

Connector	Function	Color
1	Signal GND	Red
2	V out UV (+)	Blue
3	Not connected	
4	Shield	Braid
5	Power GND	Brown
6	Vout Temp. (+)	White
7	Housing	Black
8	Power 7-30Vdc	Green

In this case the performed reading is highly overestimated. To minimize the condensation growth, the radiometer is provided with a cartridge containing desiccant material: Silica gel. The efficiency of the Silica gel crystals decreases in time with humidity absorption. Silica-gel crystals are active when their colour is **yellow**, and they turn **white** when they loose their power. Read the instructions of paragraph 3 on how to replace them. Silica gel typical duration goes from 2 to 6 months depending on the environment where the radiometer works. We recommend to calibrate the instrument annually. Calibration can be performed by DeltaOhm Metrological Laboratories, or by connecting it to an identical instrument calibrated with reference to a Primary Metrological Institute having a known calibration factor.

Calibration and Measurements

The radiometer **S** sensitivity (or calibration factor) allows to determine the irradiance by measuring a signal in Volts generated by the internal amplification circuit. It is possible that an offset be present on the output signal of some fractions of millivolts (0.3-0.4mV), in which case it is also recommended that the data be acquired at night and subtract the night-measurement offset from the performed measurements. Once the difference of potential (VoutUV+) has been measured at the ends of the resistance, the E_e irradiance is obtained applying the following formula:

$$E_e = [VoutUV+] / S$$

where:

- E_e : is the irradiance expressed in W/m^2 ,
- VoutUV+: is the difference of potential measured by the multimeter and expressed in V,
- S: is the calibration factor in $V/(W/m^2)$, shown on the radiometer label (and mentioned on the calibration report).

In the presence of a possible offset of OF Volts, the previous calculations must be modified as follows:

$$E_e = ([VoutUV+] - OF)/S$$

Similarly, to know the instrument internal temperature once the "VoutTemp+" voltage in volts is known, we get:

$$T = 100 \cdot [VoutTemp+] - 40 \text{ } ^\circ\text{C}$$

Supposing a voltage VoutTemp+=0.532V is read, the previous formula gives the radiometer internal temperature:

$$T = (100 \cdot 0.532) - 40 \text{ } ^\circ\text{C} = 13.2 \text{ } ^\circ\text{C}$$

Radiometers are individually calibrated at factory. Calibration is carried out by measuring the radiometer-produced output signal when hit by a parallel and homogeneous light-beam of 304nm monochromatic light.

Note: currently no international calibration standards for this type of radiometer exist; therefore, the calibration coefficient only makes sense if the procedure followed to obtain it has been specified. Therefore the user has to consider that the same radiometer calibrated with different procedures can have different sensitivity factors, as explained in the article "Source of Error in UV Radiation Measurements", T. C. Larason, C. L. Cromer issued in the "Journal of Research of the National Institute of Standards and Technology" Vol. 106, Num. 4, 2001. (The article is available free of charge on the NIST web site at the following address: <http://www.nist.gov/jers>)

Technical characteristics

UV MEASUREMENT

- Typical sensitivity: $\approx 5V/(W/m^2)$
- Response time: <0.5 sec (95%)
- Min. load impedance: 10 K Ω
- Measurement range: 0-8 W/m^2
- Viewing range: 2π sr
- Spectral range: 305nm Peak
302.5nm \div 307.5 nm (1/2)
304nm \div 309 nm (1/10)
297.5nm \div 311.75nm (1/100)
292.5nm \div 316.255nm (1/1000)
- Working temperature: -40 $^\circ\text{C}$ \div +60 $^\circ\text{C}$
- Response according to the cosine law: < 8 % (between 0 $^\circ$ and 80 $^\circ$)
- Long-term instability(1 year): < $|\pm 3|$ %
- Non linearity: <1 %
- Response according to temperature: < 0.01%/ $^\circ\text{C}$

TEMPERATURE MEASUREMENT

- Measurement range -40 $^\circ\text{C}$ +60 $^\circ\text{C}$
- Accuracy $\pm 0.2^\circ\text{C}$
- Min. load impedance: 10 K Ω

POWER SUPPLY

- Vdc+ 7-30 V DC
- Typical consumption: 3 mA
- Dimensions: Fig. 4
- Weight: 0.90 Kg.

ORDERING CODES:

LP UVB 02: Radiometer for outdoor measurements, complete with LP SP1 protection, 2 spare sachets with silica gel crystals, bubble level, flying M12 8-pole connector and Calibration Report. **Cable has to be ordered separately.**

LP S1: Mounting kit for LP UVB 02: bracket for attachment to a mast, including fasteners and leveling screws

LP SP1: UV resistant plastic shade disk (BASF LURAN S777K).

LP SG: Desiccant sachet with silica gel crystals, complete with inner O-ring and cap.

LP G: Packet with 5 silica gel spare cartridge.

CPM12 AA2.5: 8-pole UV resistant cable L=5 m.

CPM12 AA2.10: 8-pole UV resistant cable L=10 m.